Appendices

VOL 12



Santa Clara Valley Nonpoint Source Study

Volume I: Loads Assessment Report

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Submitted by

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in associated with

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APPENDIX A

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APPENDIX A
FIELD MONITORING PROGRAM

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APPENDIX A
FIELD MONITORING PROGRAM

A.1 INTRODUCTION

The field monitoring program was designed to provide data to characterize runoff concentrations and to estimate nonpoint source pollutant loads entering the Lower South Bay from Santa Clara County. Monitoring during storm events was conducted to provide data to calibrate and verify the hydrologic and pollutant simulation model. Hydrological and water quality data associated with base dry-weather streamflows were also collected to estimate dry-weather annual pollutant loads. A secondary objective was to obtain initial information on the toxicity of both storm-related and dry-weather flows in streams entering the Bay.

The field monitoring program utilized three types of stations, as follows:

- Land use stations - Small, relatively homogenous land use catchments were selected to represent major land use categories. Data from these catchments were used as input to the loading model.

- Stream stations - Stations that were located in the lower portions of watersheds and which received a composite of storm runoff waters from multiple land use categories. Stream stations were monitored to provide data to verify the loading model.

- Reservoir stations - Stations located immediately below the water supply reservoirs. These were utilized to provide data to establish upstream background water quality conditions and to estimate loads associated with reservoir releases.

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The field program can be conveniently described in terms of the following elements:

- The hydrology monitoring element consisted of continuously monitoring flows at stream and land use stations at hourly intervals throughout the duration of the monitoring program in order to estimate the hydrological component of the load.

- Water quality monitoring was conducted in three program elements: wet weather, dry weather, and reservoir release. Wet-weather water quality monitoring consisted of monitoring water quality at land use and stream stations for seven storm events. Storm composite samples were collected. The purpose of this sampling was to provide a basis for estimating pollutant loads during winter storm events. In order to estimate loads during winter base flow periods and summer dry-weather periods, dry-weather water quality monitoring was conducted by obtaining grab samples at the stream stations eight times through the program. To provide information on the water quality of water released from reservoirs, one round of reservoir release water quality monitoring was conducted at six stations immediately downstream of reservoirs.

- Bottom sediment sampling was conducted at the four stream stations. This sampling was conducted quarterly throughout the first year of the study. The purpose of this monitoring was to evaluate the role of bottom sediments as both a source and sink of pollutants associated with nonpoint source runoff.

- The bioassay testing program was designed as an initial screening of toxicity exerted by wet-weather samples obtained from land use and stream stations and dry-weather samples from stream stations.

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In addition to the above, a number of special studies were conducted to address specific concerns. These studies examined: (1) dissolved oxygen concentrations during storm events at selected stream stations, (2) dissolved metal concentrations in runoff, (3) settling rates of suspended particulates in stormwater collected from stream stations, and (4) concentrations of fecal streptococci bacteria in stormwaters.

A.2 SAMPLING STATIONS

The selection of appropriate sites for the field monitoring program was critical to characterize stormwater runoff pollutants. The following sections discuss the selection criteria and the characteristics of the selected catchments and stations.

A.2.1 Selection Criteria

Specific site selection criteria followed the general guidelines provided by Shelley (1979). Criteria used to select specific monitoring sites were (1) catchment characteristics, (2) hydraulic factors, and (3) accessibility and safety.

Catchment characteristics of primary concern in selection of land use stations were representativeness of land use, overall size of the catchment, and uniformity of land use. In practice, the latter two concerns tend to operate in an opposite fashion, thus constraining the suitability of many catchments for siting of monitoring stations. With increasing size of the catchment, it becomes more unlikely that the requirement for uniformity of land use can be met. In the case of stream stations, it was desirable that the stations be located as far downstream in the watershed as possible, yet upstream of any tidal influences that would adversely affect the rating curve.

Hydraulic factors were important considerations in selection of both land use and stream stations. In the case of open-channel stations, it was

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necessary that each be located at a site with an existing stage-discharge rating or at a site where adequate stage-discharge ratings could be established. Similarly, it was essential that manhole stations have suitable hydraulic characteristics for installation (and calibration) of the weirs. Thus, the following hydraulic factors were important considerations in the site selection process:

- Location at a site with an existing stage-discharge rating or at a site having a suitable control where a reliable rating curve could be developed
- Uniform and stable channel conditions for a distance equal to at least six channel widths upstream of the station
- Lack of tidal influence or backwater effects caused by downstream obstructions
- No evidence of surcharging or submergence over the normal range of precipitation (manhole installations)
- Adequate distance from major tributaries in order to allow for complete mixing

Safety and accessibility were important considerations, primarily to avoid accidents and injury, but also to ensure that field crews felt sufficiently safe so they exercised due care in conducting the field effort. Considerations included avoiding heavily trafficked areas or areas where light and/or visibility created conditions conducive to an accident with passing cars or trucks. Choice of station locations was also influenced by accessibility and security, and wherever possible, stations were located on SCVWD right-of-way which was secured.

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A.2.2 Catchment and Station Characteristics

The following describes the catchment and station characteristics for land use and stream stations. For reference, Table A-1 summarizes general information and Table A-2 gives estimates of the land use mix of each catchment.

A.2.2.1 Land Use Catchments. The land use catchments were selected to represent the following major land use categories: light and heavy industry, commercial, single- and multi-family residential, and open.

Station L1 was a light industrial site located on Junction Avenue. The catchment drains a 22-acre industrial park bordered by Charcot Avenue, Dado Avenue, and Coyote Creek (in San Jose). The station was located in a manhole on Junction Avenue near the Southern Pacific Railroad (SPRR) lines. The storm drain diameter was 30 inches, and a sharp-crested weir was placed in the manhole to facilitate flow measurements. Truck traffic on Junction Avenue was often heavy and on one occasion was sufficient to create vibrations that broke the 10-liter glass bottle in the automatic sampler suspended below the manhole.

Station L2 was a heavy-industrial site on a catchment that drains Walsh Avenue between the SPRR lines and Lafayette Street (in Santa Clara). This 28-acre catchment included warehouse distribution centers involving heavy truck traffic, a used-car parts distributor, a commercial carpet cleaning service, a printing shop, and small miscellaneous manufacturing and office facilities. Initially there was an open drum storage area that was associated with a carpet cleaning facility; however, the drums were found to have been removed on a field reconnaissance conducted on December 5, 1988. The station was located in the right-of-way east of the SPRR lines in a manhole with a 20-inch-diameter storm drain. A weir was installed in the manhole for flow measurements. There was evidence of an illicit discharge at this station in August 1988 that was analyzed and shown to be strongly caustic.

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Table A-1. STATION DESCRIPTION

Designation	Type of Station	Location	Location	Jurisdiction	Principal Land Use	Drainage Area (acres)	Conveyance	Remarks
L1	Land Use	Junction Avenue, between Charcot and Dado Streets	San Jose	San Jose	industrial park	22	30" R.C.P.	Manhole station, with weir installed
L2	Land Use	Walsh Avenue, near SPRR	Santa Clara	Santa Clara	heavy industry	28	27" R.C.P.	Manhole station, with weir installed
L3	Land Use	Frances and Beamer streets, north of Sunnyvale Caltrans RR Station	Sunnyvale	Sunnyvale	commercial	265	42" R.C.P.	Manhole station, with weir installed
L4	Land Use	Hale Creek, near Magdalena Rd.	Santa Clara County	SCVWD	low-density single-family residential (hillside)	1,633	open channel	SCVWD gaging station No. 33
L5	Land Use	Sunnyvale East Channel, near Fremont Avenue	Sunnyvale	SCVWD	single-family residential (valley)	2,080	channelized	Highly-erodable channel, rating developed
L6	Land Use	Pasetta and Williams, near San Tomas Expressway and SPRR	Santa Clara	Santa Clara	multi-family residential	85	33" R.C.P.	Manhole station, with weir installed

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Table A-1. STATION DESCRIPTION (continued)

Designation	Type of Station	Location	Location	Jurisdiction	Principal Land Use	Drainage Area (acres)	Conveyance	Remarks
L7	Land Use	Stevens Creek, above Stevens Creek Reservoir	Santa Clara County	SCVWD	open (forest)	8,410	natural	Rating developed but not considered reliable because of backwater effects
L8	Land Use	Packwood Creek, at Jackson Ranch (east of Anderson Reservoir)	Santa Clara County	SCVWD	open (ranchland)	6,464	natural	SCVWD gaging station No. 57
S1	Stream	Calabazas Creek, at Wilcox School	Santa Clara	SCVWD	mixed	9,216	natural	SCVWD gaging station No. 26A
S2	Stream	Sunnyvale East Channel, at Bayshore Frontage Road (A.P. Sta 2)	Sunnyvale	SCVWD	mixed	3,437	channelized	SCVWD gaging station No. 74
S3	Stream	Guadalupe River, at San Jose	San Jose	SCVWD	mixed	15,904	natural	USGS gaging station No. 169000
S4	Stream	Coyote Creek, at Montague	San Jose	SCVWD	mixed	79,552	natural	SCVWD high-flow gaging station No. 2060
R1	Reservoir Release	Below Stevens Creek Reservoir (A.P. Sta 14)	Santa Clara County	SCVWD	open	10,924	natural	SCVWD gaging station No. 44

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Table A-1. STATION DESCRIPTION (concluded)

Designation	Type of Station	Location	Location	Jurisdiction	Principal Land Use	Drainage Area (acres)	Conveyance	Remarks
R2	Reservoir Release	Below Lexington Reservoir	Santa Clara County	SCVWD	open	23,859	natural	SCVWD gaging station No. 67
R3	Reservoir Release	Below Guadalupe Reservoir	Santa Clara County	SCVWD	open	3,808	natural	SCVWD gaging station No. 17
R4	Reservoir Release	Below Almaden Reservoir	Santa Clara County	SCVWD	open	7,667	natural	SCVWD gaging station No. 16
R5	Reservoir Release	Below Calero Reservoir	Santa Clara County	SCVWD	open	4,621	natural	SCVWD gaging station No. 13
R6	Reservoir Release	Below Anderson Reservoir	Santa Clara County	SCVWD	open	124,787	natural	SCVWD gaging station No. 9

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Station		Area (Acres)	Open (%)	Residential[c]			Commercial (%)	Industrial[d]		Other (%)	Remarks
				Low Density (%)	Medium Density (%)	High Density (%)		Light (%)	Heavy (%)		
L1	Junction Ave.	2						100			
L2	Walsh Ave.	28							100		
L3	Frances and Beamer	265			58		42				resid. density ~ 6-7 d.u./acre
L4	Hale Creek	1633	20	80							resid. density ~ 1-2 d.u./acre
L5	Sunnyvale East, at Fremont Ave.	2,080	6	49	30		21				
L6	Passetta and Williams	85			30	53				17	medium density resid. ~ 6-7 d.u./acre, other land use includes church (5 acres) and school (9 acres)
L7	Stevens Creek, at Camp Castanoan	8,410	100								
L8	Packwood Creek	6,464	100								
S1	Calabazas Creek	9,216[b]	21	35	36		7				
S2	Sunnyvale East at Bayshore	3,437[b]		47	18	3	32				
S3	Guadalupe River	55,904[b]	30	23	34	4	5	3	1		
S4	Coyote Creek	79,552[b]	64	4	24	2	1	4	1		

[a] Based on county and city general land use plans as compiled by SCVWD (projections generally ranged between 1989 and 2000), field reconnaissances, and aerial photos.

[b] Does not include areas above upland reservoirs.

[c] Definition of low-, medium-, and high-density residential differed amongst municipalities, but generally was as follows: Low--1 to 5 dwelling units/acre; Medium--6 to 12 dwelling units per acre; High--greater than 12 dwelling units per acre.

[d] Light-industrial land use refers to industrial parks and high technology manufacturing. Heavy industry refers to more traditional manufacturing and distribution centers.

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Station L3 was a manhole station located at the intersection of Frances and Beamer Streets, north of the Sunnyvale Caltrans Station. The 300-acre catchment represented commercial and single-family residential land use and included the Sunnyvale Town Center and the Caltrans station. The drainage area was approximately bounded by the SPRR lines (north), Mathilde Avenue (west), Bayview Avenue (east), and Olive Avenue (south). A weir was also installed at this station.

Station L4 was located on Hale Creek near Magdalena Road. It drains a 1633-acre, low-density (1-2 dwelling units/acre), single-family residential area in Los Altos Hills. The station corresponded to SCVWD gaging station No. 33, which employs a sloping concrete weir as a hydraulic control for flow measurement.

Land use Station L5 was located on Sunnyvale East Channel at Fremont Avenue. It drains a 2080-acre predominantly single-family residential area. The monitoring station, located in a short earthen reach between Fremont Avenue and Ashbourne Drive, was just upstream of a concrete apron and box culvert which pass under Fremont Avenue. The channel was subject to extensive bank and bottom erosion, especially in the area downstream of the box culvert below Ashbourne Drive.

Station L6 was a 85-acre catchment consisting of a multi-family residential area bounded by Passetta, Williams, and Monroe streets, and Deborah Drive, and a single-family residential area located along Sheraton Drive and El Capitan Avenue. This catchment also included a church and school. The station was located in a manhole near the San Tomas Expressway and the SPRR. The second manhole upstream of the station was located at the junction of Passetta and Williams streets. The storm drain in the manhole was 33 inches in diameter. A weir was installed at this station to better estimate flows.

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Station L7 was on Stevens Creek, just upstream of Camp Castanoan Bridge, above Stevens Creek Reservoir. The 8410-acre drainage area consisted primarily of steep, heavily forested land in the Santa Cruz Mountains.

Station L8 was a second open land use catchment (6464 acres in area) located in the Diablo Range and draining primarily open ranchland. The station corresponded to the SCVWD gaging station No. 57 on Packwood Creek, upstream of Anderson Reservoir.

A.2.2.2 Stream Stations. Four stream stations were selected at locations near the Bay, but above the zone of tidal influence. The purpose of the stream stations was to provide a means of making loading estimates from large catchments solely with measured flow and water quality data. Such estimates could then be used as a check by comparing findings with the model predictions (based on the upstream land use characteristics). The following is a description of the stream stations.

Station S1 was located at the SCVWD gaging station No. 26A, located on Calabazas Creek near Wilcox school. The drainage area is 14 square miles and consists of approximately 80 percent residential/commercial and 20 percent open (Table A-2), the latter of which is located mostly in the upland portions of the catchment in the foothills of the Santa Cruz Mountains. The control is a sloping concrete weir.

Station S2 was located on Sunnyvale East Channel, just upstream of Awhanee Avenue (a frontage road along Bayshore Freeway). This catchment has an area of 5.2 square miles and is wholly urbanized, consisting of residential (68 percent) and commercial (32 percent) land use on the valley floor. The station corresponds to the SCVWD gaging station No. 74. The control is a sloping concrete weir.

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These two stations were selected to be representative of the smaller more urbanized watersheds on the west side of the Study Area.

Station S3 was the USGS station No. 1119000 on the Guadalupe River, located downstream of the confluence with Los Gatos Creek. This station has a total drainage area of 146 square miles and includes Los Gatos Creek and Lexington Reservoir, Guadalupe Creek and Guadalupe Reservoir, Ross Creek, Alamitos Creek and Almaden Reservoir, and Calero Creek and Calero Reservoir. This station was selected because it drains a large urbanized area that is accurately gaged. The area of the catchment below the reservoirs is approximately 85 square miles. The land use in this area is 30 percent open, 61 percent residential, 5 percent commercial, and 4 percent industrial (Table A-2).

Station S4 was located on Coyote Creek at Montague Expressway at the SCVWD high-flow gaging station No. 2060. This catchment includes Upper Penitencia and Silver and Thompson creeks, and Anderson and Coyote reservoirs. The catchment area below Anderson Reservoir is approximately 120 square miles, 64 percent of which is open ranch land located in the foothills of the Diablo Range. The remaining land use consists of 30 percent residential, 1 percent commercial, and 5 percent industrial (Table A-2). The SCVWD gaging station at this location was designed to record only flood stages, so this station had to be rated for more typical lower storm-event flows.

A.2.2.3 Reservoir Stations. The reservoir stations were located at SCVWD gaging stations below Stevens Creek, Lexington, Guadalupe, Almaden, Calero, and Anderson Reservoirs (Table A-1).

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A.3 SAMPLING AND ANALYSIS PROGRAM

A.3.1 Hydrology

The field study was designed to collect accurate hydrological information at each station to quantify discharges throughout the year and to collect flow-weighted composite samples. Thus, monitoring of stage (water depth) was performed continuously throughout the year, at all stations that had year-round flow.

The majority of open-channel stations were located at sites which had previously-established stage-discharge curves. Two of the open-channel stations (L5 and L7) required establishment of new stage-discharge curves. A third station (S4) required establishment of the low-flow portion of the rating curve.

Flow ratings at all four manhole installations were initially calculated using a standard weir-rating formula. These ratings were later calibrated at manhole installations L2, L3, and L6 using dye-dilution methods.

A.3.2 Water Quality

Water quality constituents included in the field monitoring program were selected based on the following factors:

- Constituents previously identified to be a major concern in Lower South Bay and its tributaries
- Constituents previously identified as prevalent in urban runoff studies conducted as part of EPA's National Urban Runoff Program
- Pollutants expected to be present in surface runoff waters from the Study Area, based upon industrial sources, or other specific local knowledge

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- Pollutants identified historically in nonpoint source runoff samples collected within the Study Area

The overall approach of the water quality studies was to examine a wide range (or "full suite") of potential pollutants in the early phases of the study and then develop a more refined list (or "reduced suite") of pollutants based upon results of the initial surveys (Table A-3). One analysis, organophosphate pesticides, was added to the reduced suite but was later eliminated, because none were detected.

A.3.3 Sediment Quality

The overall approach and list of sediment quality constituents (Table A-4) were similar to those described for the water quality testing program. The primary difference in the sediment quality program was that the reduced suite of constituents was originally expected to retain the broader scan of organic contaminants provided by the semi-volatile (EPA 625) GC/MS analysis. It was originally expected that a number of priority pollutant compounds would be detected in sediments, due to their low solubilities and their tendency to associate with fine particles. Due to low levels of these compounds detected, the final suite of constituents focused more directly on polynuclear aromatic hydrocarbons (PNA) that are produced as by-products of internal combustion engines.

Organophosphate pesticides were analyzed in the sediments on only one occasion. Since none were detected in the samples, this group of compounds was not included in later analyses.

A.4 SCHEDULE

The field monitoring program was initiated in February 1988 and completed in April 1989. Figure A-1 shows the schedule and Table A-5 gives specific sampling dates. A single survey was conducted to assess the quality of water discharged from six major reservoirs in the Santa Clara

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able A-3. SUITES FOR CHEMICAL ANALYSIS OF WATER QUALITY SAMPLES

lass	Complete Suite	Reduced Suite
rganics	Total Organic Halogens	Total Organic Halogens
	TOC	TOC
	Volatiles (624-GC/MS)	
	Semi-volatiles (625-GC/MS)	PNA (610)
608)	Organochlorine pesticides (608)	Organochlorine pesticides (608)
	Chlorinated herbicides (8150)	
letals, Total	Arsenic	Arsenic
	Cadmium	Cadmium
	Chromium (total)	Chromium (total)
		Chromium (hexavalent)
	Copper	Copper
	Lead	Lead
	Mercury	Mercury
	Nickel	Nickel
	Selenium	Selenium
	Silver	Silver
	Zinc	Zinc
lutrients	TKN	TKN
	NH_3-N	
	NO_2 and NO_3	
	Total Phosphate	
Bacteria	Total and fecal coliform	Total and fecal coliform
Other	BOD_5	BOD_5
	Temperature	Temperature
	pH	pH
	TSS	TSS
		Total hardness
		Turbidity

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Table A-4. SUITES FOR CHEMICAL ANALYSIS OF SEDIMENT QUALITY SAMPLES

Class	Complete Suite	Reduced Suite
Organics	TOC	
	Volatiles (8240-GC/MS)	
	Semi-volatiles	PNA (831)
		(8270-GC/MS)
	Organochlorine pesticides (8080)	Organochlorine pesticides (8080)
	Chlorinated herbicides (8150)	
Metals, Total	Arsenic	Arsenic
	Cadmium	Cadmium
	Chromium (total)	Chromium (total)
		Chromium (hexavalent)
	Copper	Copper
	Lead	Lead
	Mercury	Mercury
	Nickel	Nickel
	Selenium	Selenium
	Silver	Silver
	Zinc	Zinc
Nutrients	TKN	
	NH_3-N	
Other		Sediment particle size

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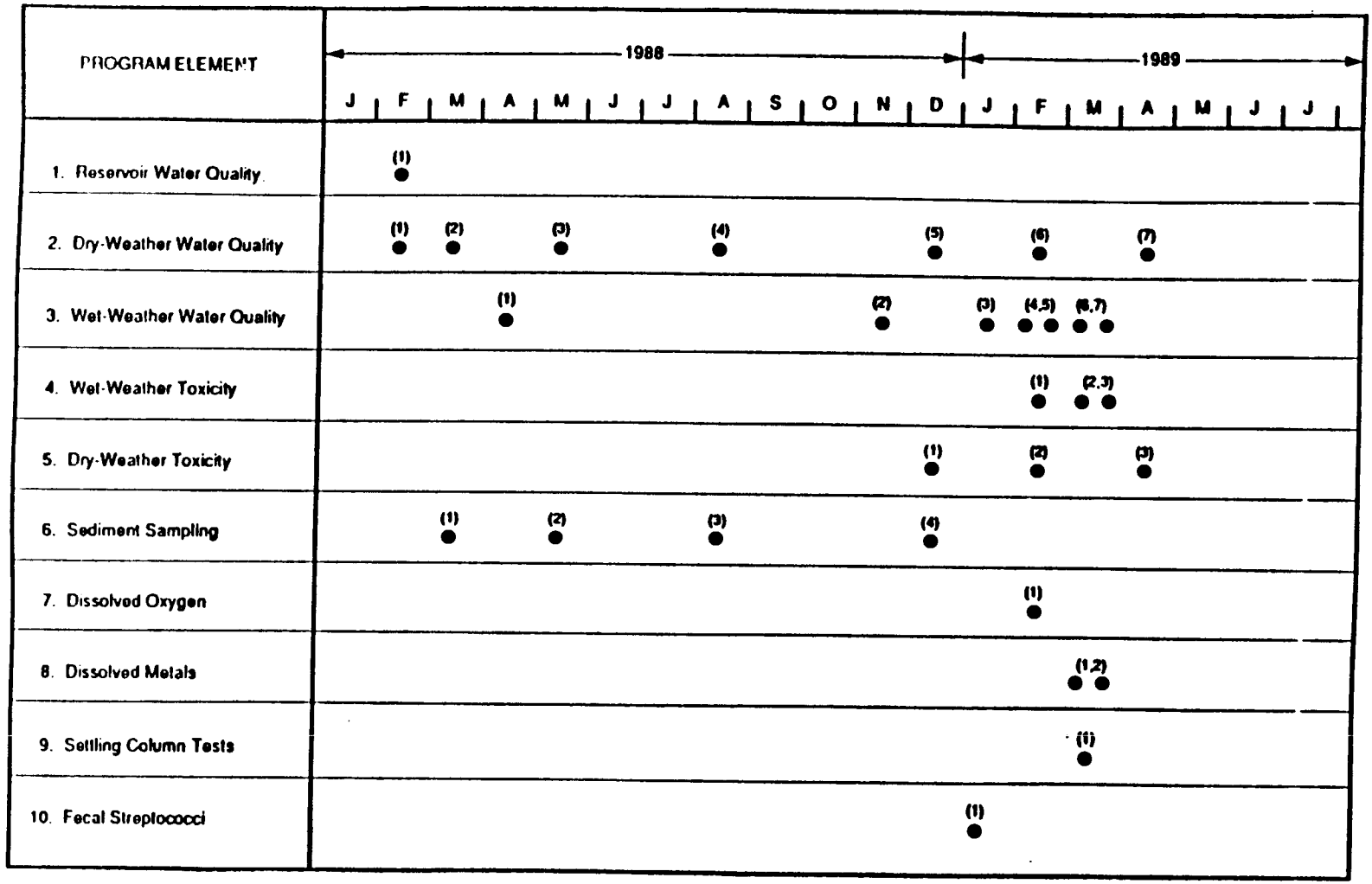

Figure A-1. SAMPLING SCHEDULE

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Table A-5. SAMPLING DATES

Program Element	Round	Sampling Date[a] Month	Day	Year
(1) Reservoir Water Quality	1	February	26	1988
(2) Dry-Weather Water Quality	1	February	26	1988
	2	March	30	1988
	3	May	11	1988
	4	August	22	1988
	5	December	12	1988
	6	February	1	1989
	7	April	6	1989
(3) Wet-Weather Water Quality	1	April	20	1988
	2	November	23	1988
	3	January	23	1989
	4	February	4	1989
	5	February	9	1989
	6	March	2	1989
	7	March	25	1989
(4) Wet-Weather Toxicity	1	February	9	1989
	2	March	2	1989
	3	March	25	1989
(5) Dry-Weather Toxicity	1	December	12	1988
	2	February	1	1989
	3	April	6	1989
(6) Sediment Sampling	1	March	30	1988
	2	May	11	1988
	3	August	22	1988
	4	December	12	1988
(7) Dissolved Oxygen	1	February	9	1989
(8) Dissolved Metals	1	March	25	1989
	2	April	6	1989
(9) Settling Column Tests	1	March	25	1989
(10) Fecal Streptococci Bacteria	1	January	23	1989

[a] Initial date only; sampling often continued for one or two additional days.

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Valley. The reservoir water quality survey was conducted on February 26, 1988, concurrently with the first dry-weather water quality survey.

A total of seven dry-weather water quality surveys were conducted during the 15-month field program. Four of these studies were conducted during winter months, two during the spring, and one in the autumn following a lengthy dry period.

Seven wet-weather (i.e., storm) events were sampled to obtain water quality data. The first and only storm event sampled in the 1987-88 wet-weather season occurred on April 20, 1988. The six remaining storm events that were sampled occurred in the 1988-89 wet-weather season. The first significant rainfall of the 1988-89 wet-weather season was sampled on November 23, 1988. The remaining five storm events monitored were in January, February, and March 1989.

Three wet-weather toxicity tests were conducted in February and March 1989. Dry-weather toxicity testing was coordinated with the December 12, 1988, and the February 1 and April 6, 1989, dry-weather water quality surveys.

The sediment sampling was fully completed during the first year of the study. The final quarterly sediment survey was completed on December 12, 1988.

A number of other program elements classified as "special studies" were completed in association with storm events sampled in early 1989. Detailed monitoring of dissolved-oxygen levels was performed at the four stream stations on February 9. Concentrations of dissolved metals were added to the suite of constituents measured in storm runoff during the March 25 and April 6 storm events. Experiments on settling rates of suspended particulates were conducted on samples collected on May 25. A special survey of concentrations of fecal streptococci bacteria was conducted in association with the January 23 storm event.

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A.5 EQUIPMENT

A.5.1 Station Design

Two generalized station designs were employed in the field study. The most common design was for monitoring flow and water quality in open channels. This configuration varied slightly among the several stations, depending upon specific site characteristics. The second type of station was designed for monitoring flow and water quality within storm sewers.

The following design considerations were common to both station configurations:

- Intakes must be protected from large objects transported by the stormwater runoff.
- Intakes must be located in a well mixed area not subject to burial or emergence.
- Water velocity in the intake hose during sampling must be maximized to maintain particulate material in suspension.
- Intake hose material must be appropriate to avoid metals and organic contamination of samples.
- Sample container material must be compatible with holding samples to be analyzed for both trace metals and organic compounds.
- The peristaltic pumps must be capable of delivering consistent sample volumes, regardless of intake hose length and changes in head associated with the rise and fall of stage in the water body being sampled.

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- Automatic samplers should not exceed a head difference of 20 feet above the water in order to prevent deterioration in water velocities within the intake and decreasing precision in sample volume.

All intakes were placed in cages constructed of quarter-inch stainless rod. These cages were designed to deflect moderate-sized objects around the intakes and the pressure sensors. Coarse stainless steel intake screens were used to reduce the likelihood of blockage within the sample tubing.

In most installations, intakes were positioned between 2 and 4 inches above the bottom, as recommended by Shelley (1979). This range was believed to be a reasonable compromise between avoidance of bedload transport and keeping the intake submerged. When base flow conditions allowed, the intake was positioned higher in the water column. For example, the base stage in Coyote Creek was typically around 3 feet, so the intake at this station was positioned 1.5 feet off the bottom.

The 3/8-inch (i.d.) intake hose was constructed of polyethylene on the outside and Teflon on the inside. The polyethylene provided the required physical strength while the Teflon provided a suitable material for handling samples which would be analyzed for either metals or organic compounds. The bore diameter of the intake hose was selected to maximize the velocity of flow within the hose (in order to prevent settling of suspended solids). An internal diameter of 3/8 inch was calculated to maintain the minimum velocities of 1 to 2 fps at head differences of up to 20 feet.

Consistent sample volumes were obtained over a wide range of head differences by development and use of an algorithm which could compensate for changes in head pressures. This algorithm was part of the specialized software developed to control the automatic samplers. The number of pump

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rotations necessary to obtain a sample volume of 500 ml was calculated as a function of intake hose length and an instantaneous measure of head pressure between the pump and surface of the water. This value could be calibrated in the field to compensate for specific station configurations.

The composite sample containers provided commercially by ISCO were inappropriate for collection of water for analysis of both trace metals and organic compounds. Borosilicate glass provided the best alternative for collection of water to be submitted for metals and organics. Thus 10-liter, borosilicate media bottles were used to replace the standard containers.

Although the open-channel and manhole installations shared common design criteria, the manhole installations were unique in that they required installation of a primary control device to increase accuracy of flow measurements, particularly at lower flows. Rectangular sharp-crested weirs were used, because they were found to be the most cost-effective primary control device to fabricate and install in this application.

A.5.2 Weirs

All weirs utilized in the manhole installations were rectangular weirs made from quarter-inch steel plate. The heights of the weirs were generally about one-half the diameter of each pipe. A rectangular cutout with a width equal to one-quarter of the pipe diameter and a depth equal to one-sixth of the diameter was placed in the center top portion of the weir to facilitate accurate measurement of lower flows (see Figure A-2).

Each weir was secured by stainless steel cable to eyebolts set in the wall of the manhole. This both prevented the weirs from becoming lodged in the pipe if they were to break loose during a storm event, and it allowed for quick removal of the weirs, if upstream flooding were to occur. Hoses were attached to the back of the weirs to aerate the nappe.

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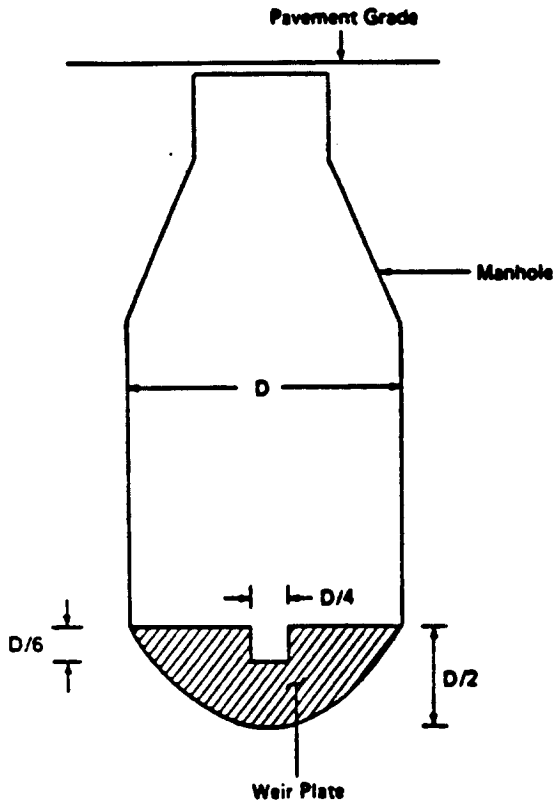

Figure A-2. WEIR SCHEMATIC

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A.5.3 Automatic Samplers and Stage Recorders

Automatic samplers and stage recorders were deployed in all of the open-channel and manhole installations. Each system consisted of an ISCO Model 2700 composite sampler, a Campbell Scientific Model CR-10 Data Logger and Control Module, and a pressure sensor. GeoKon Model AVW-1 Vibrating Wire pressure/temperature sensors were initially installed at all stations. These sensors were selected for the study on the basis of their extreme durability and accuracy. Nevertheless, a number of these sensors were observed to drift out of specifications in the early stages of the study. These sensors were then replaced with the newly available Druck Model PDCR-830 titanium pressure sensors. These Druck sensors proved to have both excellent accuracy and stability characteristics under a variety of field conditions.

The ISCO composite samplers were used to pump, cool, and store water samples during storm events. The standard programmable read-only memory (PROM) units which contain the instruction set for the samplers were specially modified to allow full external control via the sampler's flowmeter input data port. All pumping functions could then be controlled externally by the Campbell Scientific CR-10.

A.5.4 Data Logger

Campbell Scientific CR-10s were used at each station to provide overall system control functions and to serve as a central data processor and data storage module. Two types of data, high-resolution storm data and continuous (dry- and wet-weather) hydrology data, were recorded by the data logger. Data were nondestructively retrieved by use of a standard, portable tape deck. The tapes were then read by an IBM-compatible microcomputer with a Campbell Scientific PC-201 card. If the data dump was defective, the station could be revisited and the data retrieved again.

The storm data memory register stored detailed information on the storm events, including the time the storm mode was initiated, the time each

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sample was taken, and the storm runoff volume represented by each sample. After completely filling a 10-liter sample container, 15-minute-averaged values for temperature, stage, and flow were stored in the storm memory register until the station was visited by the field crews to change sample containers.

The continuous hydrology memory register maintained hourly-averaged temperature and stage data. These data were continuously recorded during storm events and base flow conditions.

A.5.5 Software to Initiate and Terminate Flow Composite Sampling

Software installed in each CR-10 was designed to continuously monitor stage at each monitoring station and then automatically initiate flow-weighted composite sampling. Pressure sensors were interrogated every 15 seconds to determine stage. Fifteen-minute averages of the stage data were then stored and later used to evaluate whether storm sampling should be initiated.

The software enabled storm sampling to be initiated, based upon both relative and absolute criteria. At the end of every 15-minute interval, stage or flow data (using stage-discharge equations) were compared to those obtained during the prior 15-minute interval. Storm sampling was initiated, if percentage increases in one of these parameters exceeded a given criterion, typically 20 percent. This criterion could be modified to adjust sensitivity of the "trigger," based upon the specific hydrological characteristics of each station.

In addition to comparing relative increases in either stage or flow, storm sampling could be automatically initiated if the 15-minute average stage measurement exceeded a set value. This trigger was particularly useful for stations that, under certain conditions, did not increase rapidly enough in stage to exceed the relative criteria or where no base flows were present.

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Flow-weighted composite sampling could also be terminated by software control of the system. The data loggers were programmed to terminate the storm sampling mode once the stage dropped below a level 20 percent greater than the storm initiation or trigger stage. Sampling would not terminate automatically without first filling a sample container.

A.5.6 Equipment and Installation

Instrumentation for all open channel installations was contained in custom-built 2-ft x 4-ft x 30-inch steel enclosures mounted on concrete pads. In natural channels, conduits for containment of pressure sensor leads and water intake tubing were installed through the concrete pad and led underground to the channel. In some cases, a short conduit (approximately 0.5 to 1.0 feet) was installed between the instrument enclosure and adjacent stilling wells. The pressure sensor could then be installed in the stilling well where it was well protected from potential vandalism. For installations where both stilling wells and concrete channels existed, both the pressure transducer and intake hose were run into the stilling well. The intake tubing was then fished through the lower communication port and mounted at the bottom of the channel.

Each storm sewer installation was completely contained within the existing manhole chambers. All equipment was suspended by metal cable slings from eyebolts installed in the concrete wall just under the manhole cover. A two-person field crew was required to conduct routine monitoring involving removal of the sampling equipment from the manhole. Data dumps and routine monitoring of station operation could be performed by one person, since the systems communication port was located immediately below the manhole cover.

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A.6 SAMPLING METHODS

A.6.1 Field Procedures and Training

A detailed set of Standard Operating Procedures (SOP) were developed for all phases of the field monitoring program. The SOP contained the following procedural instructions:

- Standard Observations
- Initial setup of the composite samplers
- Storm monitoring station software initiation
- Battery replacement
- Data retrieval
- Sample removal and handling
- Grab sampling
- Sample transfer and tracking

Field training sessions were held prior to each storm season for personnel expected to participate in storm monitoring. The training sessions involved review of the SOP and hands-on experience in interrogating a model storm monitoring station.

Additional training was provided in the field during station maintenance visits. Less experienced field personnel were routinely deployed with key project personnel. This enabled greater dissemination of important station-specific knowledge (e.g., location and special handling needs) and provided an opportunity to practice station interrogation skills that would be needed during the intensive storm monitoring events.

A.6.2 Grab Samples

Grab samples were taken for all water samples that were not appropriate for analysis from the pumped composite sample. Grab samples were necessary for bacteria, volatile organics, pH, and dissolved oxygen.

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Two methods were used to obtain grab samples of water. The primary method involved direct collection of the water sample in the sample container. The open container was attached to a stainless steel rod. This enabled the open container to be fully immersed as near as possible to the centroid of flow and eliminated potential contamination of the sample. This method was applied to samples collected for bacteria, volatile organics, and pH. Van Dorn (1.5-liter) bottle samplers were used for collection of samples for measurement of dissolved oxygen.

The guidelines followed by Kinnetic Laboratories field personnel for grab sampling during storm events calls for collection of samples in the early phase of the storm, certainly during the rising limb of the hydrograph. Most of the grab samples collected in this program were performed in the early phase of the storm.

Sediment grab samples were collected either by use of clean stainless steel scoops or by scraping the sediments directly into the sample containers. Four to five different scrapes were taken to comprise a single sample. A conscious effort was made to sample finer-grained sediments in depositional areas of the stream bed. In several cases, appropriate sediments were difficult to locate. In such cases, professional judgement was used to locate the most appropriate sediments along a given reach.

A.6.3 Automatic Samplers

Sampling of stormwater runoff was accomplished primarily by use of modified ISCO composite samplers. The automatic samplers were designed to take 500-ml aliquots of runoff water at time intervals corresponding to a given volume of water flowing by the monitoring station. The volume of runoff represented by each 500-ml sample was a user-specified value. The default setting for each site was 1/20 of the expected runoff volume for a 0.25-inch storm. The sampling rate at a given station could be altered in the field by increasing or decreasing this value. It was necessary to adjust this variable based upon both sample volume requirements (e.g.,

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additional analytical and bioassay water requirements) and anticipated rainfall in excess of 0.25 inches.

The percentage of the total storm represented by each composite sample varied widely among storm events and stations (Table A-6). The precipitation, runoff, and required sample volumes were important factors in determining the percentage of the storm from which flow-weighted composites were attained. After depositing 19 samples (9.5 liters) into the composite sample container, the monitoring system would go into standby mode until visited by the field crew. High sampling rates or brief, intense periods of rainfall occasionally caused the composite samplers to fill too rapidly and enter the standby mode. This would cause loss of storm coverage until the station was revisited by the field crew. Low sampling rates or lower than anticipated rainfall would result in good storm coverage but inadequate sample volumes.

A.6.4 Effects of Partial Storm Capture on Load Estimates

In the field monitoring efforts, it was not always possible to secure samples over the entire runoff period, for use in the flow-weighted composites that were analyzed. In some cases, this was due to the inability of field crews to reach all stations before runoff began. In most cases, it resulted from the sample collection container filling before runoff from the event had terminated. A record was maintained of the fraction of the total runoff volume that was sampled and incorporated in the samples for water quality analysis. This information is summarized in Table A-6 which lists, for each event at each station, the ratio of the sampled volume to the total volume of runoff.

As the listing indicates, the storm fraction sampled varied from event to event at any site, and the pattern was not consistent from site to site for a specific storm event. Fifty-seven (57) of a possible 70 station-events produced composite samples that were analyzed for water quality. Four station-events were missed due to equipment malfunction (SM). The

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Table A-6. PERCENT OF STORM EVENT RUNOFF SAMPLED[a]

Event No.	Date of Storm Event	Stations[b] L1	L2	L3	L4	L5	L6	S1	S2	S3	S4
1	4-20-88	21	95	98	NS	SM	33	SM	40	57	100
2	11-23-88	100	90	97	NS	75	95	17	33	61	50
3	1-23-89	NS	NS	NS	NS	73	NS	3[c]	50	57	NS
4	2-1-89	35	3[c]	85	70	73	SM	40*	29*	66	40
5	2-8-89	33	56	100	100	58	36	40	53	46*	63
6	3-2-89	32	79	100	50	100	100	51	99	65	74
7	3-23-89	NS	NS	78	60	100	95	36	50	SM	67

a The ratio of the volume sampled to the total volume of runoff is the percentage of the runoff sampled.

b Samples were not obtained at Station L8 because of lack of runoff; samples were obtained at Station L7, but the rating curve was affected by downstream activities.

c The percent sampled was considered too small for the data to be considered representative.

NS Not sampled (often because of lack of runoff).

SM Sampling equipment malfunctioned.

* Volume sampled did not include the storm peak.

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remaining nine (NS) produced no water quality samples, often due to lack of runoff.

An evaluation of the potential effect of the percentage of an event sampled on the estimate of the site median concentration (SMC) which was used in developing pollutant load estimates was structured on the basis of the following considerations.

- The data set as a whole covers a wide range of sampled fractions, and a significant spread in percent sampled also applies generally to individual stations.
- The quality data exhibit significant variability, with each station having a different mean or median.
- Concentrations of different pollutants have different orders of magnitude.
- Working separately with individual pollutants at individual sites provides too small a sample for reliable analysis.

To evaluate the effect of the fraction of the storm sampled, each EMC (event mean concentration for the site-event for each pollutant) was first normalized by computing the ratio of the individual concentration value to the SMC for the corresponding pollutant and site. Individual EMCs are tabulated in the Volume I Appendix document. The SMC values used are those presented in report Tables 6-2 and 6-3. Pollutants used in this analysis were those for which nearly all measurements were above detection limits. This set included six metals (Cd, Cr, Cu, Pb, Ni and Zn), plus TSS, BOD and Total Hardness (TH), to have several different basic pollutant types represented. The normalization procedure reduced all the data to a common basis, and provides a sample size of about 500 values for analysis.

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A comparison of the normalized pollutant concentrations in relation to the percentage of the storm event that was sampled is displayed by Figure A-3 for the Land Use Sites, and by Figure A-4 for the Stream Stations.

Pollutant concentrations for the Land Use Sites provided the primary basis for the load estimates. A good basis for comparison exists here, because 42 percent of the site-events captured 90 to 100 percent of the runoff (65 percent captured more than 70 percent). The display indicates that the variability in measured concentrations of the nine different pollutants is unrelated to the fraction of total runoff volume captured. There are a small number of individual values that deviate substantially from the median, but the bulk of the results (all pollutants, all sites, all percent captures) fall into a relatively narrow band either side of the site median (Ratio = 1). Note that each SMC reflects a series of events with an appreciable range of percent captures.

On this basis, we conclude that the pollutant site median concentrations, which provided the principal basis for load estimates, are not distorted by the lower percentages of total runoff that were sampled for some events. This situation, therefore, has not influenced the load estimates that were developed.

Results for the Stream Stations are generally similar, but with the difference that less than 10 percent of the values apply to events where more than 90 percent of the runoff was captured. For these stations, 85 percent of the values apply to events which captured between 30 and 70 percent of the storm flow. There is no trend indicated either within this range, or compared with the limited data at 100 percent runoff capture. The single set at 3 percent capture (event 3 at station S-1) would be appropriate to exclude, although this single set of values will not have a significant effect on the overall study results.

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Fig. A-3. Effect of Percentage of Total Storm Sampled on Event Mean Concentration Land Use Sites

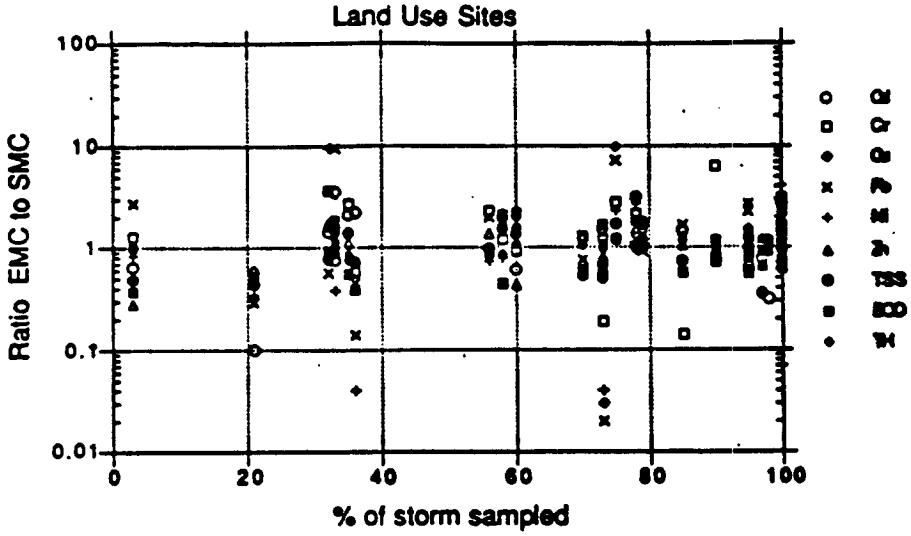
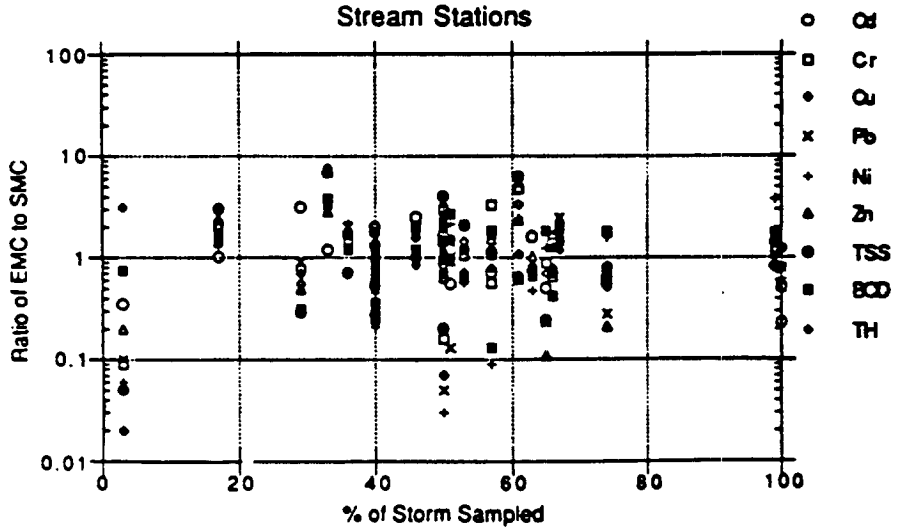


Fig. A-4. Effect of Percentage of Storm Sampled on Event Mean Concentration Stream Stations



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The stream concentrations were utilized in the study for comparison with projected in-stream concentrations computed from the land use runoff. The differences (measured concentrations were consistently greater than projections based on land runoff) provided the basis for a correction factor. The variation in percent capture of event runoff is not indicated to influence estimates of stream concentrations. However, because the bulk of this data is based on 30 to 70 percent capture of the total event values, there is a somewhat greater uncertainty in the concentration estimates for the Stream Stations, than is the case for the Land Use Sites.

A.6.5 Flow-Rating

Development of new stage-discharge relationships was required at three open channel stations and three manhole stations. In manhole stations, rectangular notched weirs were installed. Flow was then estimated based on the theoretical sharp-crested contracted weir equation (ISCO 1979):

$$Q = 3.33\ (L - 0.2H)H^{1.5}$$

where

Q = flow (cfs)
L = width of the weir crest (ft)
H = stage (feet)

This equation was verified by performing low-flow dye dilution measurements at the manhole stations. These tests indicated that some calibration of the weir equation was required for flow within the weir notch at stations L2 and L3. As a result, the following rating curves were used for low flows in these weirs:

$$Q = 1.73H^{.85} \text{ (Station L2)}$$
$$Q = 1.83H^{1.79} \text{ (Station L3)}$$

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Rating curves for stations L5, L7, and S4 were developed from discharge measurements. Rating curves were developed only for low flows at station S4, since a high flow rating curve had previously been developed by the SCVWD. Figures A-5, A-6, and A-7 show the rating curves for these three stations. Discharge measurements for these stations were generally good. For station S4, the rating curve was developed from 10 flow measurements, and a good fit was obtained to these data. However, the rating curves for stations L5 and L7 are at best of fair quality, given the low number (three) of discharge measurements used at each station.

Current-meter surveys were conducted to develop stage-discharge data at the three open-channel stations. Discharge methods were made using standard USGS methods (USGS 1970). It was desired that at least six discharge measurements be taken over a full range of stages in order to obtain reliable rating information at each site.

Dye-dilution methods were used to verify weir equations at three of the four manhole stations. (At these stations, provisions for a water supply could be arranged with the local water supplier.) Intra-acid Rhodamine WT was used as the tracer. Rhodamine WT is a nontoxic, fluorescent tracer dye that is commonly used in applications such as this. This dye is stable and is not easily adsorbed to particulates.

Flow was established at each station by use of upstream fire hydrants. Dye of a known concentration was injected into the turbulent flow at an upstream manhole by use of FMI constant displacement piston pumps. Stage, temperature, and dye concentration were then measured just upstream of the weir at the subject station. Periodic water samples were obtained for later laboratory verification of dye concentrations in order to provide backup to the field fluorometer and to make certain that concentrations were in the linear response range of the fluorometer. Due to the limited flow capacity of fire hydrants, verification of the theoretical weir equations was only possible for low-flow conditions.

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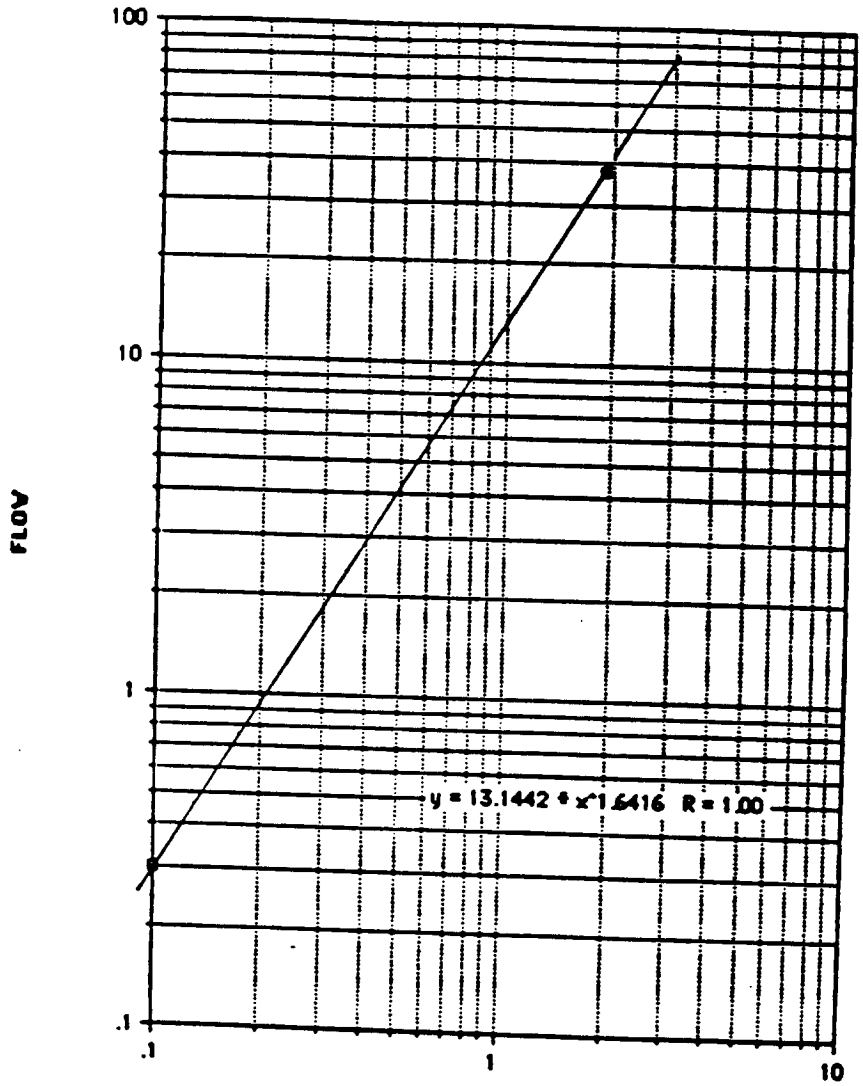

Figure A-5. Rating Curve for Station L5

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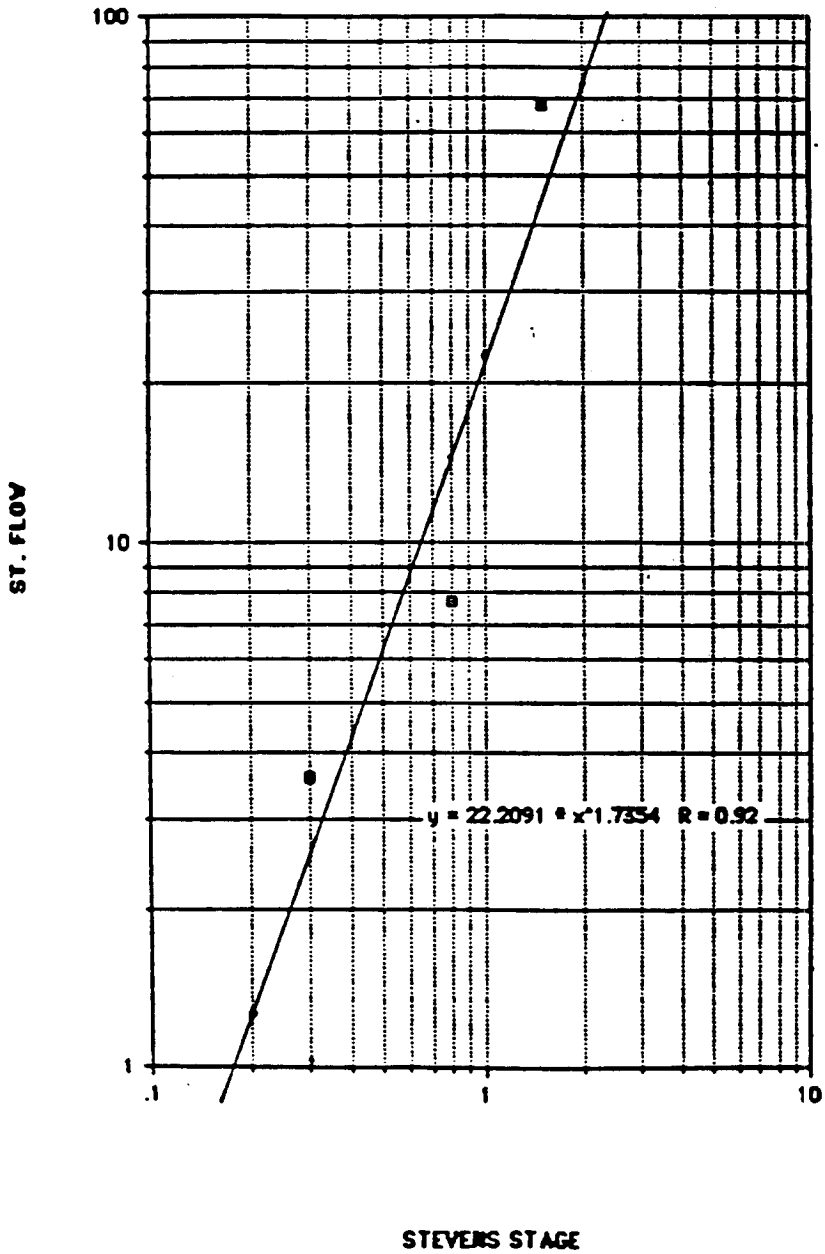

Figure A-6. Rating Curve for Station L7

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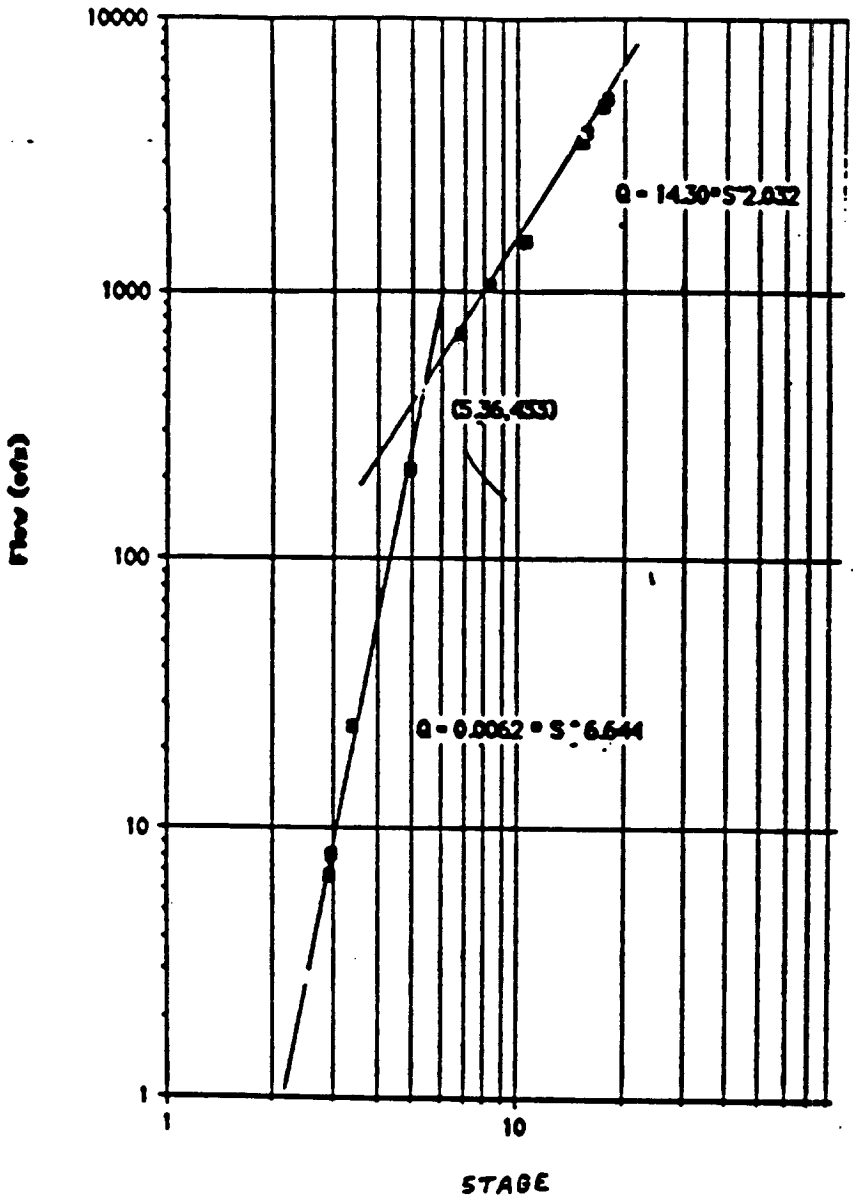

Figure A-7. Rating Curve for Station S4

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A modification of the channel occurred at one station, L7 (Stevens Creek at Camp Castanoan Bridge), midway through the study. That alteration required establishment of a second rating curve. A small rock dam was constructed just below the station in order to enhance the water supply system for Camp Castanoan. This dam was breached during a storm in early March, at which time the initial flow rating was reinstated.

A.6.6 Special Studies - Dissolved Oxygen

Many of the previous studies involving nonpoint source water quality have been concerned about depression of dissolved oxygen levels in the receiving waters. A single intensive study was conducted at each of the four stream stations to measure dissolved oxygen concentrations during and after stormwater discharges.

Dissolved oxygen was measured for a period of approximately 35 hours using duplicate Winkler titrations in lieu of polarographic membrane probe techniques. The titrations provide a much more accurate estimate of dissolved oxygen, particularly in the presence of oil and grease. Polarographic oxygen probes can become rapidly desensitized if contaminated with oil and grease.

Dissolved oxygen results did not show any signs of depression for all four stations studied. The DO results are summarized here and shown in Appendix D.8. For station S-1, DO ranged from 8.9 to 11.8 mg/L, and DO levels ranged from 8.6 to 12.2 for station S-2. The DO concentrations were similar for stations S-3 (9.7 to 10.4 mg/L) and S-4 (8.5 to 9.6 mg/L).

A.6.7 Special Studies - Dissolved Metals

Two sampling rounds were conducted to evaluate the relative contributions of dissolved metals and particulate-associated metals in stormwater runoff. Both dissolved and total metal concentrations were measured in all stormwater samples obtained during each storm event.

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Dissolved metal samples were subsampled from the composite storm samples in the same manner as the total metal samples. Prior to fixation, the dissolved metal samples were filtered through 0.45-micron polycarbonate filters. The filtrate was subsequently acidified with HNO_3 to a pH of less than 2.

A.6.8 Special Studies - Settling Column Tests

A preliminary screening of the settling characteristics of particulates present in the NPS discharges from the study area was made by conducting settling tests on samples taken from each of the stream stations (S-1, S-2, S-3, and S-4) during the storm runoff event in March 1989.

This effort was designed to provide information on settleability, for reference and potential use in the consideration of issues such as detention basin controls, sediment accumulation and scour in stream beds, and pollutant accumulations in bay sediments.

Because of the nature of the test procedure and the variability expected of particle size distributions in stormwater runoff, the results obtained should only be considered to provide a general approximation of the settling characteristics of particulates that are introduced to the South San Francisco Bay by nonpoint sources in the study area.

The tests were performed using a settling column constructed from an 8-inch in diameter by 5-foot, 1-inch-long lucite tube. Four sample ports are located at 1-foot intervals.

The column is filled to the top with a sample of the water to be tested, and then stirred to distribute the settleable solids uniformly throughout the column.

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A sample at time zero is analyzed to establish initial conditions. Total suspended solids (TSS) was selected as the pollutant analyzed for these tests.

Samples are then withdrawn from each port at selected time intervals after the start of the test. They are analyzed to determine the concentration of TSS that remains at the sample location after the elapsed time interval.

The difference between each such concentration and the amount present initially is used to compute a percent removal.

Since each combination of depth to a sample port and elapsed time to the sample reflects a specific distance settled in a specific interval of time, each sample corresponds to a settling velocity (feet per hour). Each such value corresponds to a percent removed value computed from the measured concentration.

The results can be interpreted as the percentage of the TSS in the sample that have settling velocities equal to or greater than the value represented by the port depth and sample time. The results are then plotted to provide an indication of the frequency distribution of pollutant settling velocities in the sample.

Test results are summarized in Table A-7. This table lists both the measured concentration and also the percentage of the initial concentration that each value represents. It also lists the set of settling velocities (in feet per hour) that are computed from the various combinations of depth and sample time. Note that the combinations employed result in multiple measurements for some settling velocities. In the table, the settling velocities are listed in increasing rank order, and for each of these the corresponding removal percentage is tabulated for each of the four samples.

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Table A-7. Settling Column Test Results

STA		MEASURED TSS CONCENTRATIONS						PERCENT TSS REMOVED					
		sample port	2	6	12	24	48	settling time <--hours--> settling distance feet	2	6	12	24	48
S-1	85	mg/l = initial TSS											
		1	53	34	25	8	14	1	38	60	71	91	84
		2	59	40	30	13	9	2	31	53	65	85	89
		3	63	39	23	13	10	3	26	54	73	85	88
		4	76	43	26	25	23	4	11	49	69	71	73
S-2	28	mg/l = initial TSS						sett dist FT					
		1	12	9	14	9	10	1	57	68	50	68	64
		2	15	16	19	9	8	2	46	43	32	68	71
		3	30	24	14	5	13	3	-7	14	50	82	54
		4	31	22	17	12	3	4	-11	21	39	57	89
S-3	22	mg/l = initial TSS											
		1	19	5	8	12	12	1	14	77	64	45	45
		2	24	9	9	5	4	2	-9	59	59	77	82
		3	17	15	18	9	5	3	23	32	18	59	77
		4	19	17	9	7	3	4	14	23	59	68	86
S-4	69	mg/l = initial TSS											
		1	58	43	32	28	10	1	16	38	54	59	86
		2	60	37	32	23	16	2	13	46	54	67	77
		3	73	53	31	25	22	3	-6	23	55	64	68
		4	69	55	31	22	17	4	0	20	55	68	75

Vs	% Greater than			
ft/hr	S-1	S-2	S-3	S-4
0.021	84	64	45	86
0.042	91	68	45	59
0.042	89	71	82	77
0.063	88	54	77	68
0.083	71	50	64	54
0.083	85	68	77	67
0.083	73	89	86	75
0.125	85	82	59	64
0.167	60	68	77	38
0.167	65	32	59	54
0.167	71	57	68	68
0.250	73	50	18	55
0.333	53	43	59	46
0.333	69	39	59	55
0.500	38	57	14	16
0.500	54	14	32	23
0.667	49	21	23	20
1.000	31	46	-9	13
1.500	26	-7	23	-6
2.000	11	-11	14	0

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Table A-8. Distribution of Settling Velocities - Pooled Test Results

SETT VELOC Vs ft/hr	% Greater Than S-1	S-2	S-3	S-4	Average % Removal 4 sites	Average % Removal for Vs	SETT VELOC Vs ft/hr
0.021	84	64	45	86	70	70	0.021
0.042	91	68	45	59	66		0.042
0.042	89	71	82	77	80	73	0.042
0.063	88	54	77	68	72	72	0.063
0.083	71	50	64	54	59		0.083
0.083	85	68	77	67	74		0.083
0.083	73	89	86	75	81	72	0.083
0.125	85	82	59	64	72	72	0.125
0.167	60	68	77	38	61		0.167
0.167	65	32	59	54	52		0.167
0.167	71	57	68	68	66	60	0.167
0.250	73	50	18	55	49	49	0.250
0.333	53	43	59	46	50		0.333
0.333	69	39	59	55	56	53	0.333
0.500	38	57	14	16	31		0.500
0.500	54	14	32	23	31	31	0.500
0.667	49	21	23	20	28	28	0.667
1.000	31	46	-9	13	20	20	1.000
1.500	26	-7	23	-6	9	9	1.500
2.000	11	-11	14	0	3	3	2.000

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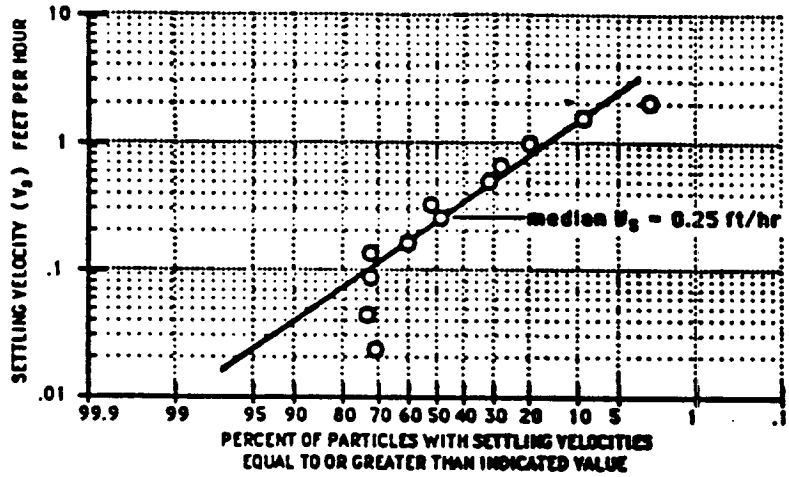

Figure A-9. Distribution of Settling Velocities of Pooled Data for Stream Stations

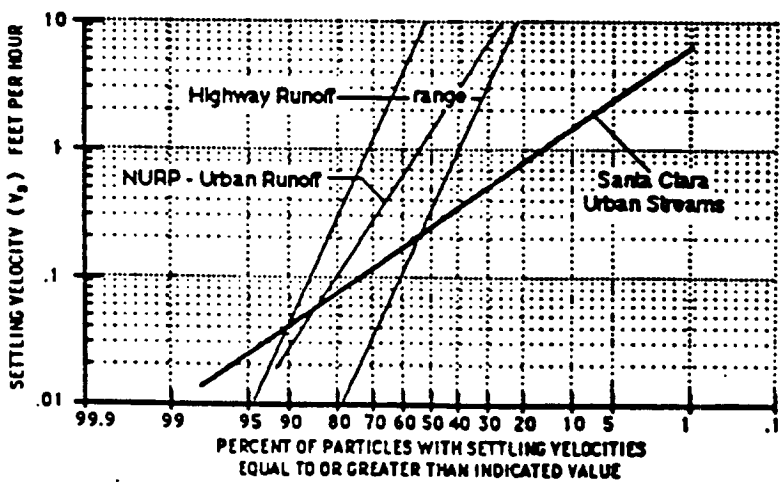

Figure A-10. Comparison of Settling Velocity Distribution from Different Sources

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Each of the samples shows a difference in particle sizes, reflected by the median settling velocities for the test, which range between 0.15 and 0.45 ft/hr. Because of the variability and the nature of the test, it would be inappropriate at this point to simply observe that the stream samples tested indicate a median settling velocity on the order of approximately 0.25 ft/hr, and having a distribution approximately as shown by Figure A-9.

These results are compared with the results of similar tests reported in other studies in Figure A-10. The principal indication is that the particulates in the Santa Clara wet weather stream samples are appreciably smaller in size (lower settling velocities) than those measured in direct runoff from urban or highway sites. This type of relationship can be expected if one considers that most of the bigger particles will have settled out rapidly in the stream, and as a result do not show up in these samples.

A.6.9 Special Studies - Fecal Streptococci

Analysis of fecal streptococci, together with fecal coliform, provide insight on possible sources of fecal contamination. Ratios of fecal coliform to fecal streptococci provide some indication as to whether the contamination was of human or nonhuman origin. Ratios in excess of 4.1 are sometimes considered to be primarily of human origin, whereas ratios less than 0.7 are considered to be of nonhuman origin. Ratios between 0.7 and 4.1 may be indicative of mixed human and nonhuman fecal contamination (Standard Methods 1980).

A survey of fecal streptococci and coliform bacteria was conducted at the four stream sites in order to assess possible sources of fecal contamination in nonpoint source runoff during storm events. Grab samples were taken at stream sites S1 through S4 during the third Wet-Weather Water Quality event in January 23, 1989. The analyses for both types of bacteria were conducted in accordance with Standard Methods for the Examination of Water and Wastewater (1980).

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Results of the fecal streptococci are presented in Appendix D.2-1. Ratios of fecal coliform to fecal streptococci show values ranging from about 1 (S3 and S4) to 10 (S1 and S2).

A.6.10 Subsampling Procedures, Sample Containers, and Preservatives

The 10-liter composite samples collected from the autosamplers during storm events were sealed with Teflon-lined polyethylene caps, packed in ice, and transported to Kinnetic Laboratories, Inc., in Santa Cruz for further processing. When multiple 10-liter bottles were collected for a single station, it was first necessary to thoroughly blend the samples. Blending of the composite samples was accomplished by use of a peristaltic pump and Teflon hose.

The peristaltic pump was also used to draw samples for each set of analyses. Samples for each analyses were placed in prelabeled containers with appropriate preservatives (see Table A-9). Whenever possible, analyses requiring common containers and preservation were placed in the same container in order to minimize sample handling.

Grab samples for analysis of sediment were placed directly into appropriate sample containers (see Table A-10). In most situations, common containers were used for collection and holding of sediments to be analyzed for (1) trace metals and inorganics and (2) volatile and semi-volatile organics. Single containers were utilized for organochlorine pesticides, chlorinated herbicides, and polynuclear aromatic hydrocarbons.

A.6.11 Field QA/QC

Several external or field quality control procedures were used to evaluate potential errors which could have been introduced during sample collection and subsequent analytical procedures. These external quality control checks were performed by blind submission of blanks and duplicates.

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ble A-9. CONTAINERS, PRESERVATIVES, AND HOLDING TIMES FOR AQUEOUS SAMPLES

ass	Min. Volume Utilized (ml)	Container	Preservation	Holding Time
<u>ganics</u>				
otal Organic Halogen (TOX)	250	G (amber) Teflon cap	Cool, 4°C H_2SO_4 to pH<2	7 days
otal Organic Carbon (TOC)	125	G (amber) Teflon cap	Cool, 4°C H_2SO_4 to pH<2	28 days
olatiles, GC/MS	125	G (amber) Teflon cap	Cool, 4°C	14 days
emi-volatiles, GC/MS	1000	G (amber) CH_3Cl rinse	Cool, 4°C 40 d(anal.)	7 d(extract)
rganochlorine pesticides	1000	G (amber) CH_3Cl rinse	Cool, 4°C 40 d(anal.)	7 d(extract)
hlorinated herbicides	1000	G (amber) CH_3Cl rinse	Cool, 4°C 40 d(anal.)	7 d(extract)
AA	1000	G (amber) CH_3Cl rinse	Cool, 4°C 40 d(anal.)	7 d(extract)
rganophosphate pesticides	1000	G (amber) CH_3Cl rinse	Cool, 4°C 40 d(anal.)	7 d(extract)
<u>tals</u>				
otal	500	P	Cool, 4°C HNO_3 to pH<2	6 months
• Chromium, hexavalent	200	P	Cool, 4°C	24 hours
• Mercury	100	P	Cool, 4°C HNO_3 to pH<2	28 days

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Table A-9. CONTAINERS, PRESERVATIVES, AND HOLDING TIMES FOR AQUEOUS SAMPLES (concluded)

Class	Min. Volume Utilized (ml)	Container	Preservation	Holding Time
Metals (continued)				
Dissolved	500	P	Cool, 4°C Filter, HNO_3 to pH<2	6 months
• Chromium, Hexavalent	200	P	Cool, 4°C	24 hours
• Mercury	100	P	Cool, 4°C HNO_3 to pH<2	28 days
Nutrients				
Total Kjeldahl Nitrogen (TKN)	200	P	Cool, 4°C H_2SO_4 to pH<2	28 days
Ammonia (NH_3-N)	200	P		
Nitrite (NO_2^--N)	15	P		
Nitrate (NO_3^--N)	15	P		
Total Phosphate	50	P		
Bacteria				
Total and fecal coliform	100	P	Cool, 4°C	6 hours
Fecal streptococcus	100	P	Cool, 4°C	6 hours
Others				
BOD_5	300	G	Cool, 4°C	6 hours
COD	100	P	H_2SO_4 to pH<2	7 days
Total Suspended Solids (TSS)	100	P	Cool, 4°C	7 days
Total hardness	100	P	HNO_3 to pH<2	6 months

P = Plastic laboratory container
G = Glass laboratory container

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ble A-10. CONTAINERS, PRESERVATIVES, AND HOLDING TIMES FOR SEDIMENT SAMPLES

ass	Min. Volume Utilized (ml)	Container	Preservation	Holding Time
ganics				
Total Organic Carbon (TOC)	125	G (amber) Teflon septum	Cool, 4°C H_2SO_4 to pH<2	28 days
Volatiles, GC/MS	500	G (amber) wide-mouth Teflon lid	Cool, 4°C	14 d(extract) 40 d(anal.)
Semi-volatiles, GC/MS	500	G (amber) wide-mouth Teflon lid	Cool, 4°C	14 d(extract 40 d(anal.)
Organochlorine pesticides	125	G (amber) Teflon septum	Cool, 4°C	14 d(extract) 40 d(anal.)
Chlorinated herbicides	370	G (amber) wide-mouth Teflon lid	Cool, 4°C	14 d(extract) 40 d(anal.)
PNA	250	G (amber) wide-mouth Teflon lid	Cool, 4°C	7 d(extract) 40 d(anal.)
Organophosphate pesticides	250	G (amber) wide-mouth Teflon lid	Cool, 4°C	7 d(extract) 40 d(anal.)
letals				
Total	250	P HNO_3 to pH<2	Cool, 4°C	6 months
lutrients				
Total Kjeldahl Nitrogen (TKN)	200	P	Cool, 4°C	28 days
Ammonia (NH_3-N)	200	P	Cool, 4°C	28 days

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Table A-10. CONTAINERS, PRESERVATIVES, AND HOLDING TIMES FOR SEDIMENT SAMPLES (concluded)

Class	Min. Volume Utilized (ml)	Container	Preservation	Holding Time
Others				
BOD_5	300	G	Cool, 4°C	
COD	100	P	H_2SO_4 to pH<2	7 days
Grain size distribution	50	P	Cool, 4°C	

P = Plastic laboratory container
G = Glass laboratory container

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Blanks used in the field QA/QC procedures consisted of both field blanks and trip blanks. Field blanks were used to assess errors due to bottle contamination and field sampling procedures. Field blanks were obtained by sampling contaminant-free waters (furnished by the laboratory) using procedures identical to those used for collection of field samples. The field blanks for samples taken from the composite samplers were obtained by pumping contaminant-free waters into sample containers. This same procedure was used to extract field samples from the composite sample. Field blanks for grab samples were obtained by pouring blank water into a sample container. Trip blanks were utilized to assess potential contamination from both sample containers and coolers used for sample transportation. These blanks consisted of contaminant-free water provided in a standard sample container by the laboratory. These blanks remained unopened in the coolers and were returned to the laboratory for analysis.

Field duplicates were utilized to evaluate data precision. Analysis of these types of control samples provide a measure of the variability due to natural factors in the water body, sampling procedures and analytical procedures. Field duplicates were collected in the same manner as the primary samples and submitted blind to the laboratory.

A third quality control check conducted as part of the field program was quarterly analysis of external spike samples. Samples containing certified levels of contaminants were purchased from ERA laboratories in Colorado and the National Bureau of Standards (PNAs only). These samples were received by the project QA/QC officer. The QA/QC officer then removed certification information and submitted the samples to each laboratory under chain-of-custody.

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A.7 LABORATORY ANALYSIS

A.7.1 Constituents and Methods

All analytical methods were either EPA or Standard Methods approved. All constituents and analytical methodologies used in this study are listed in Tables A-11 (water) and A-12 (sediments). All analytical method numbers cited in these tables refer to the following standard laboratory references:

- "SM":

  APHA-AWWA-WPCF. 1985. Standard Methods for the Examination of Water and Wastewater - 16th Edition.

- "Plumb":

  Plumb, Jr., R.H. 1981. Procedures for Handling and Chemical Analysis of Sediment and Water Samples. Prepared by Environmental Protection Agency/Corps of Engineers Technical Committee on Criteria for Dredged and Fill Material 81-4. Environmental Laboratory U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

- "EPA":

  U.S. Environmental Protection Agency. 1979 (Revised 1983). Methods for the Chemical Analysis of Water and Wastes. (EPA 600/4-79-020).

  U.S. Environmental Protection Agency. 1986. Test Methods for Evaluating Solid Waste, U.S. EPA SW-846, September 1986.

  U.S. Environmental Protection Agency. 1982. Methods for Organic Chemical Analysis for Municipal and Industrial Wastewater, (EPA 600/4-82-057).

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Table A-11. WATER QUALITY CONSTITUENTS AND TEST METHODS

Class	Constituent	Test Method
Organics	Total Organic Halogen (TOX)	EPA 9020
	Total Organic Carbon (TOC)	EPA 9060
	Volatiles (Purgeables), GC/MS	EPA 624
	Semi-volatiles (Base/Neutrals), GC/MS	EPA 625
	Organochlorine pesticides	EPA 608
	Chlorinated herbicides	EPA 8150
	Polynuclear Aromatic Hydrocarbons (PNA)	EPA 8100/610
	Organophosphate pesticides	EPA 614
Metals	Arsenic	EPA 206.2
	Cadmium	EPA 213.2
	Chromium, total	EPA 218.2
	Chromium, hexavalent	EPA 218.5
	Copper	EPA 220.2
	Lead	EPA 239.2
	Mercury	EPA 245.1
	Nickel	EPA 249.2
	Selenium	EPA 270.3
	Silver	EPA 272.2
	Zinc	EPA 289.2
Nutrients	Total Kjeldahl Nitrogen (TKN)	SM 420A
	Ammonia (NH_3-N)	SM 417D
	Nitrite (NO_2^--N)	SM 419
	Nitrate (NO_3^--N)	SM 418C
	Total Phosphate	SM 424F
Bacteria	Total coliform	SM 908A
	Fecal coliform	SM 908C
	Fecal streptococcus	SM 910A
Others	Five-day Biochemical Oxygen Demand (BOD_5)	SM 507
	Chemical Oxygen Demand	SM 508A
	Total Suspended Solids (TSS)	SM 209C
	Total hardness	EPA 130.2

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Table A-12. SEDIMENT QUALITY CONSTITUENTS AND TEST METHODS

Class	Constituent	Test Method
Organics	Total Organic Carbon (TOC)	EPA 9060
	Volatiles (Purgeables), GC/MS	EPA 8240
	Semi-volatiles (Base/Neutrals), GC/MS	EPA 8270
	Organochlorine pesticides	EPA 8080
	Chlorinated herbicides	EPA 8150
	Polynuclear Aromatic Hydrocarbons (PNA)	EPA 8100/610
	Organophosphate pesticides	EPA 8140
Metals	Arsenic	EPA 206.2
	Cadmium	EPA 213.2
	Chromium, total	EPA 218.2
	Chromium, hexavalent	EPA 218.5
	Copper	EPA 220.2
	Lead	EPA 239.2
	Mercury	EPA 245.1
	Nickel	EPA 245.1
	Selenium	EPA 270.3
	Silver	EPA 272.2
	Zinc	EPA 289.2
Nutrients	Total Kjeldahl Nitrogen (TKN)	SM 417D
	Ammonia (NH_3-N)	SM 417D
Others	Five-day Biochemical Oxygen Demand (BOD_5)	SM 507
	Chemical Oxygen Demand	SM 508A
	Sediment grain size distribution	Plumb

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A.7.2 Laboratory QA/QC

Laboratory procedures used to monitor bias and precision in analytical measurements included the following:

- Use of full-range internal calibration standards
- Analysis of laboratory blank water for every 10 samples analyzed by each methodology
- Analysis of a laboratory spike for every 10 samples
- Laboratory splits on 10 percent of the field samples submitted to the laboratory

Spikes were intended to evaluate the overall accuracy of the data set. Although spiking of either field samples or contaminant-free blank water was permitted by the project QA/QC plan, all spikes were performed using field samples in order to account for possible matrix interferences.

The laboratory blanks were conducted as part of each participating laboratories quality assurance plans. These blanks provided a measure of potential sources of contamination to the samples.

Laboratory splits were utilized to evaluate the precision of the analytical measurements. The duplicate data were used to calculate relative percent difference (RPD) values for each constituent. Upper and lower control limits based upon 95 percent confidence limits of historical laboratory splits were used to evaluate analytical precision and acceptability of the data.

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A.8 DATA MANAGEMENT

Hardcopies of analytical chemistry results received from each contract laboratory were entered into a spreadsheet database using Lotus 1-2-3. Separate spreadsheets were maintained for each major chemical analysis (e.g., PNAs, organochlorine pesticides) or class of analyses (e.g., physical data-TSS, pH).

Each spreadsheet contained information on the type of sample (e.g., dry-weather, wet-weather), station identification, a sequential event number, date of sampling, analytical laboratory sample identifier, and target detection limits for each analyte. Reported values and actual detection limit on the laboratory report were recorded for each analyte.

Copies of the individual laboratory reports (hardcopy), chain-of-custody documents, and the complete Lotus 1-2-3 database were provided to Woodward-Clyde Consultants by Kinnetic Laboratories, Inc.

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APPENDIX B

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APPENDIX B
HYDROLOGIC MODEL CALIBRATION AND VERIFICATION

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APPENDIX B
HYDROLOGIC MODEL CALIBRATION AND VERIFICATION

Stormwater quality loads for 11 watersheds were estimated by first determining the loads from each land use in each watershed, and then summing loads from all land uses to produce loads to the bay. Because land use loads were calculated as the product of flow volume and concentration, this methodology required estimates of 1) the volume of runoff from each land use category, and 2) the average concentration of pollutants from each land use category.

This Appendix describes the procedures used to estimate flow volumes. Section B.1 provides an overview of the Stormwater Management Model (SWMM), the rainfall-runoff model used to estimate flow volumes. Section B.2 describes the model setup for the Santa Clara Valley, Section B.3 discusses model calibration and verification, and Section B.4 presents estimates of stormwater runoff volumes for the Santa Clara Valley.

B.1 OVERVIEW OF SWMM

The review of hydrologic data presented in Section 5.0 provides insight into the historical magnitude and variability of rainfall and runoff in the Santa Clara Valley. However, to estimate nonpoint source loads, knowledge of the sources of storm runoff is required. Runoff from undeveloped areas will differ in terms of water quality from runoff in urban areas on the valley floor, and little can be learned about the apportionment of runoff between developed and undeveloped areas through analysis of existing streamflow records alone. Unless one is willing to install and operate many more stream gages for several years, the preferred way to estimate

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runoff from individual land uses and from ungaged areas is by using a rainfall-runoff model.

Rainfall-runoff models use physical and land use information about a catchment to calculate storm runoff from a given rainfall record. Rainfall-runoff models vary in complexity from relatively simple models such as the Rational Method (Linsley et al. 1982), to models which attempt to represent in detail the physical mechanisms through which rainfall is converted to runoff.

In this study, the U.S. EPA Stormwater Management Model Version IV (Huber et al. 1988) was used to estimate runoff volumes from land use areas for loads calculations. This model, referred to as SWMM, contains a detailed mathematical description of the hydrologic cycle, including runoff from impervious and pervious areas, infiltration, percolation to the water table, groundwater flow into channels, losses due to evapotranspiration, interception, and depression storage, and routing of runoff down stream channels. The model also has water quality and treatment components which are useful in evaluating the effects of control measures. Thus, SWMM is sufficiently detailed and general in scope to model the processes which are relevant to the estimation of nonpoint source loads.

SWMM represents a watershed as a set of hydrologic units referred to as subcatchments. Each subcatchment is assumed to have a unique set of runoff properties, including rainfall, area, width, slope, infiltration characteristics, and percent of impervious areas. The model simulates runoff over time using time steps determined by the interval at which rainfall data are available. For accurate simulation of storm hydrographs, this time step is typically on the order of 15 to 60 minutes. At each time step, the model performs a water balance on all subcatchments, as illustrated in Figure B-1. The volume of water available for surface runoff is determined by first subtracting losses for depression storage, infiltration, and evaporation from rainfall. The remaining water is routed

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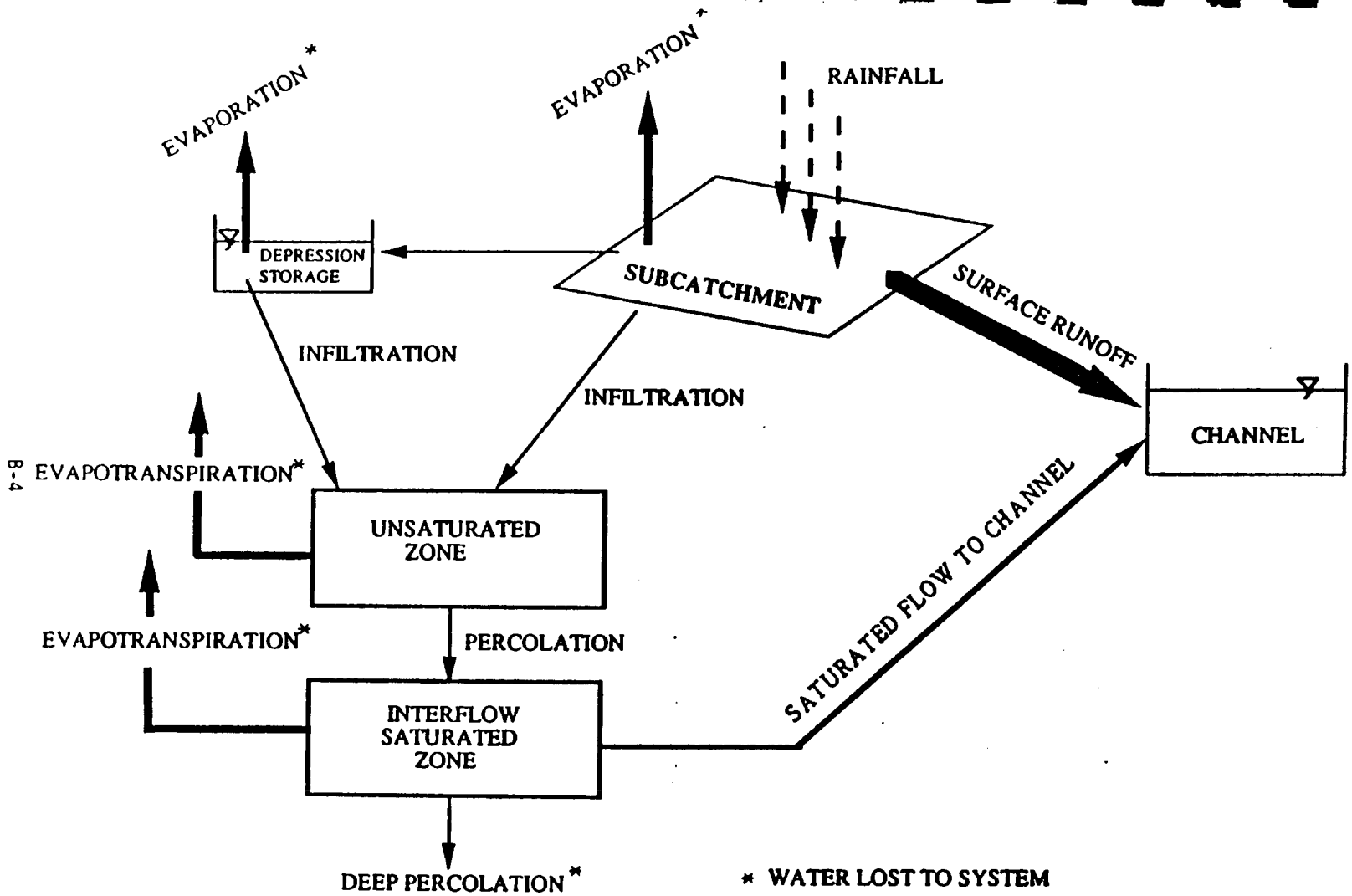

FIGURE B-1. SWMM Water Balance For a Subcatchment

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as runoff from the subcatchments into channels using a non-linear reservoir routing scheme, with the outflow rate determined by Manning's equation. Each subcatchment contains both pervious and impervious areas; runoff is more rapid from impervious areas because rainfall on these areas is not subject to infiltration losses. Water in depression storage, used to simulate storage in depressions on the ground surface, may either infiltrate or evaporate.

The subsurface component of the hydrologic cycle is represented in SWMM by two storage reservoirs, one for the unsaturated zone and one for the saturated zone. The volume of infiltration is determined using either a Horton or a Green-Ampt infiltration model. Infiltrated water then moves into the unsaturated zone, where it may either remain in storage, evapotranspirate, or percolate into the saturated zone. Water in the saturated zone may either remain in storage, flow into channels, or percolate out of the system. Flow from the saturated zone to channels is determined based on the difference in elevation between the water table and the channel water surface; the water table elevation is recalculated each time step based on the current volume of water in the saturated zone and the porosity of the saturated zone.

B.2 MODEL SETUP FOR THE SANTA CLARA VALLEY

The goal of this study was to estimate total nonpoint source loads from the Santa Clara Valley. Thus, SWMM was used to model runoff from the entire valley. For data management and calibration purposes, the valley was subdivided into the 11 major watersheds shown in Figure B-2. Streamflow data for calibration were available at the downstream ends of six of these watersheds; runoff from the remaining watersheds was estimated using SWMM without calibration.

Prior to using SWMM, a conceptual model of the important runoff processes occurring in the valley was developed. Based on the analysis of

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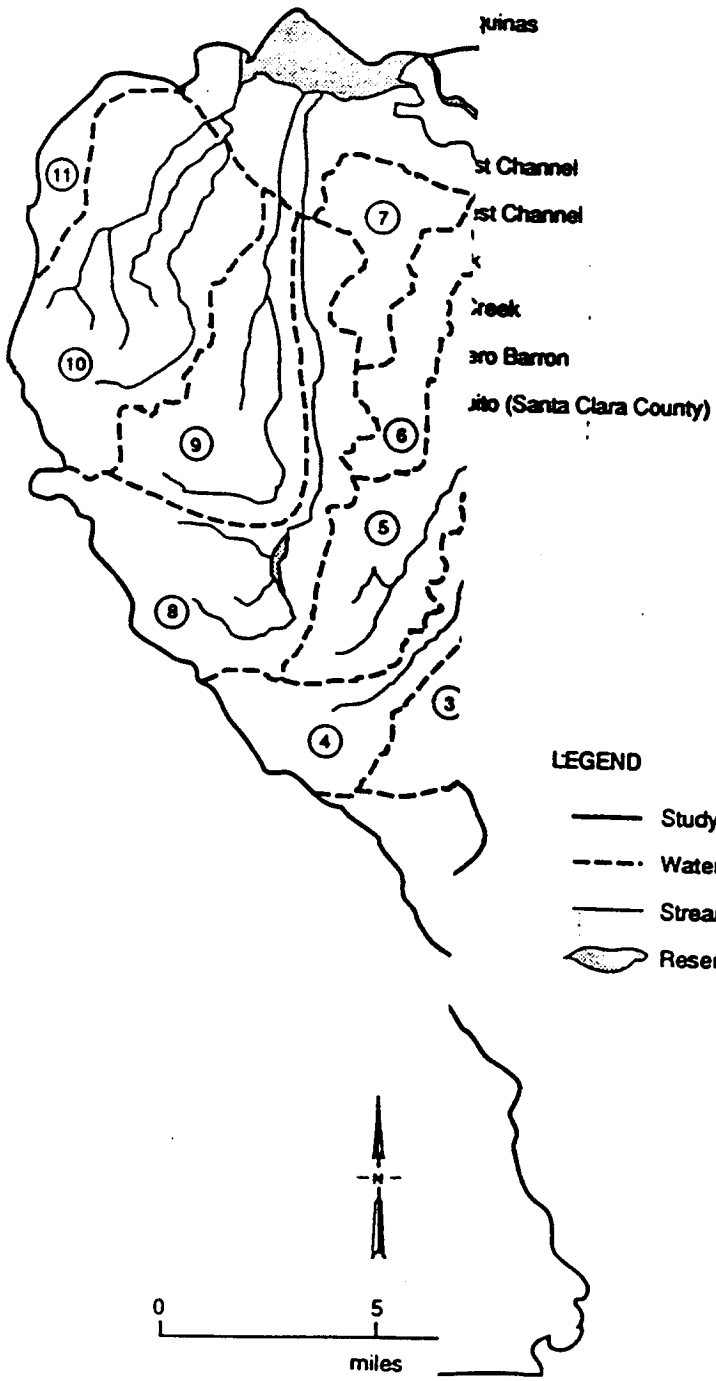

	AREA* (sq miles)	% of TOTAL
	124	33
	106	28
	28	7
	17	4
	21	6
	7	2
	5	2
	12	3
	17	4
	34	9
	7	2
	380	100

* Does not include areas above reservoirs

Figure B-2. WATERSHEDS IN STUDY AREA

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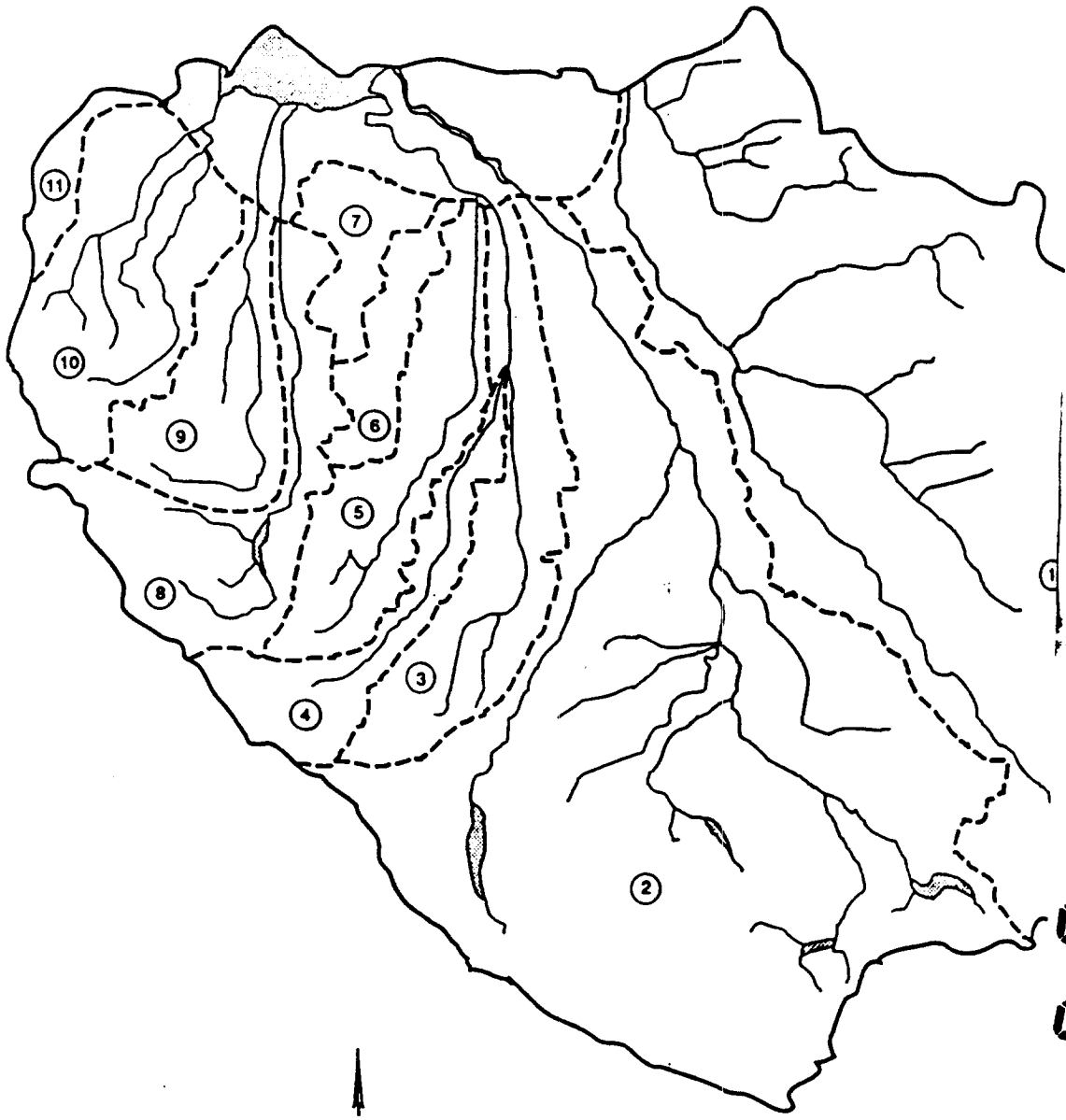

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WATERSHED	AREA* (sq miles)	% of TOTAL
(1) Coyote	124	33
(2) Guadalupe	108	28
(3) San Tomas Aquinas	28	7
(4) Saratoga	17	4
(5) Calabazas	21	6
(6) Sunnyvale East Channel	7	2
(7) Sunnyvale West Channel	5	2
(8) Stevens Creek	12	3
(9) Permanente Creek	17	4
(10) Adobe Matadero Barron	34	9
(11) San Francisquito (Santa Clara County)	7	2
	380	100

* Does not include areas above reservoirs

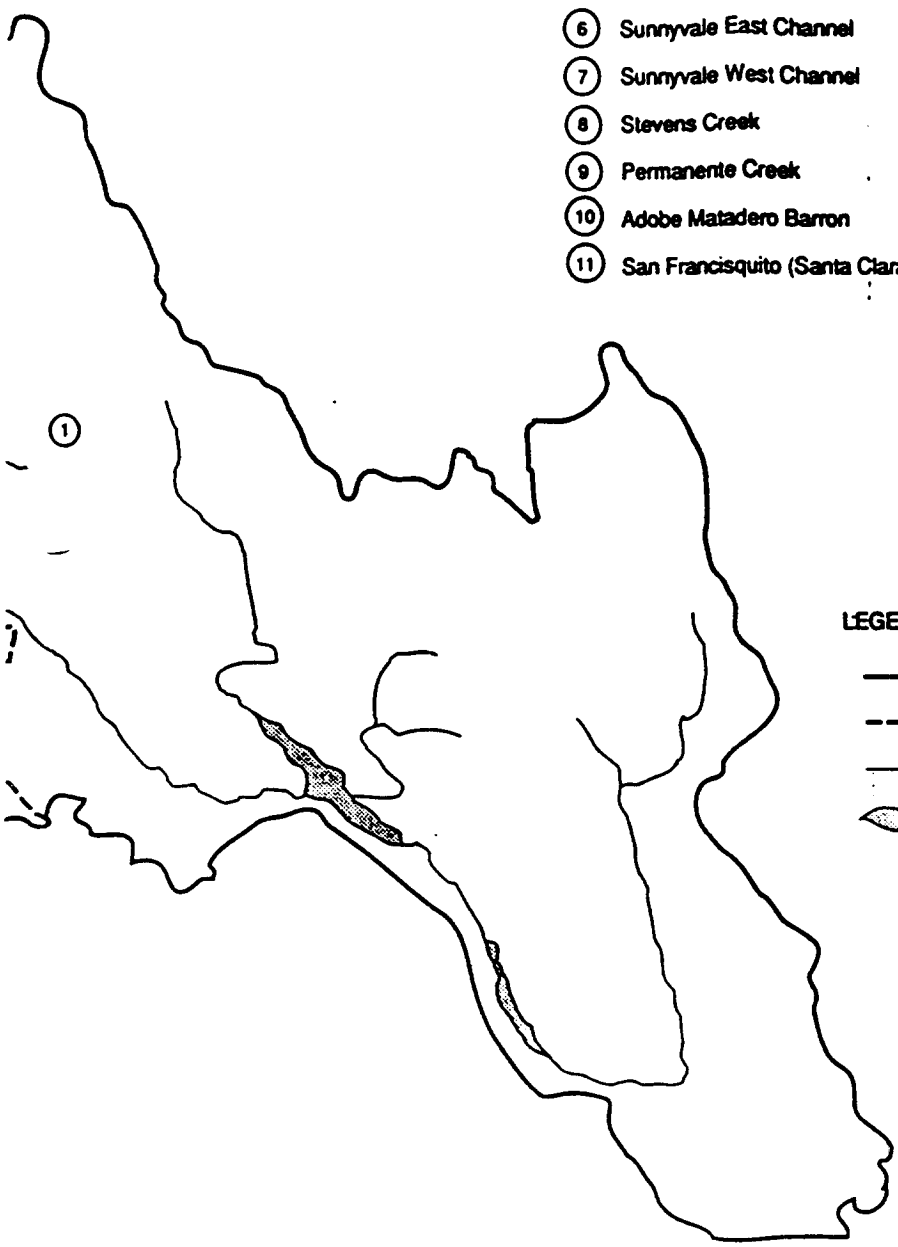

Figure B-2. WATERSHEDS IN STUDY AREA

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measured flow and precipitation data presented in Section 5.0, the following concepts were used to guide the application of SWMM to the study area:

1) Orographic effects on rainfall are strong, especially in the Santa Cruz Mountains.

2) Runoff on the valley floor occurs primarily from impervious areas associated with urban development.

3) Runoff from pervious areas occurs primarily in the Santa Cruz Mountains where rainfall intensities are sufficient to exceed soil infiltration capacities.

4) Runoff from pervious areas has a seasonal component, with the strongest runoff response occurring in the late wet season when antecedent soil moisture levels are highest.

5) Storm hydrographs typically have a 2- to 3-day recession component derived from subsurface flow rather than from surface runoff. This subsurface flow is probably interflow through temporarily saturated areas and perched groundwater in the unsaturated zone.

These concepts were used in determining how the SWMM runoff, infiltration, and groundwater algorithms were configured for this study, and will be referred to in terms of specific model parameters in the following sections. Section B.2.1 discusses how watersheds were subdivided into SWMM subcatchments, and Section B.2.2 describes procedures used to estimate model input parameters.

B.2.1 Watershed Discretization

The number and size of subcatchments used by SWMM should be determined by (1) the level of detail required in the model results, and (2) the level

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of detail at which data are available. For this study, complete data were available for relatively small subcatchments used by the Santa Clara Valley Water District (SCVWD) for their flood hydrograph modeling. However, this level of detail, while important for flood modeling, is not necessary for estimating annual-scale runoff and water quality loads. Huber and Dickenson (1988) present data and examples showing that small subcatchments can be lumped into larger SWMM subcatchments with little loss of information, as long as input parameters are scaled appropriately.

Because orographic effects on rainfall are so important in the Study Area, the first step in setting up subcatchments for this study was to divide each watershed into subareas over which rainfall was assumed to be uniformly distributed. The number of subareas were selected such that the variability of rainfall within watersheds was adequately represented. Figure B-3 illustrates the subarea breakdown for the Calabazas Creek watershed. The subareas shown are typical of those used in the smaller watersheds in the western part of the valley, with three subareas representing rainfall on 1) the lower valley floor, 2) the upper valley floor, and 3) the Santa Cruz Mountain foothills. Table B-1 summarizes the rain gages used to model runoff for all of the watersheds in the Study Area.

SWMM performs water balance calculations and estimates flows for areas represented by subcatchments. Thus, to estimate flows from individual land uses each rain gage subarea was divided into subcatchments for up to six land use categories (open, low density residential, medium density residential, high density residential, commercial, and industrial). These land use subcatchments represented "lumped areas" in that all of the areas of a given land use were modeled as a single contiguous subcatchment. In the example shown in Figure B-3, rain gage subarea 100 was subdivided into an open subcatchment, a low residential subcatchment, and a medium residential subcatchment. Because the land use breakdown for the area was 43 percent open, the open subcatchment had an area equal to 43 percent of

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Table B-1. RAIN GAGES USED TO MODEL RUNOFF IN EACH WATERSHED

Watershed	Rain Gages[a]	Calibrated?
Coyote Creek	NWS, 37, 123, 23, 99	yes
Guadalupe River	NWS, 1, 36, 123, 128	yes
San Tomas Aquinas Creek	NWS, 79, 108	yes
Saratoga Creek	77, 108	yes
Calabazos Creek	100, 108, 121	yes
Sunnyvale East	48	yes
Sunnyvale West	121	no
Stevens Creek	48, 100, 121	yes
Permanente Creek	48, 53, 100, 121	no
Adobe - Matadero - Barron	24, 48, 53	no
San Francisquito Creek	24, 53	no

[a] Rain gage numbers are based on the SCVWD numbering system. NWS refers to the San Jose National Weather Service gage.

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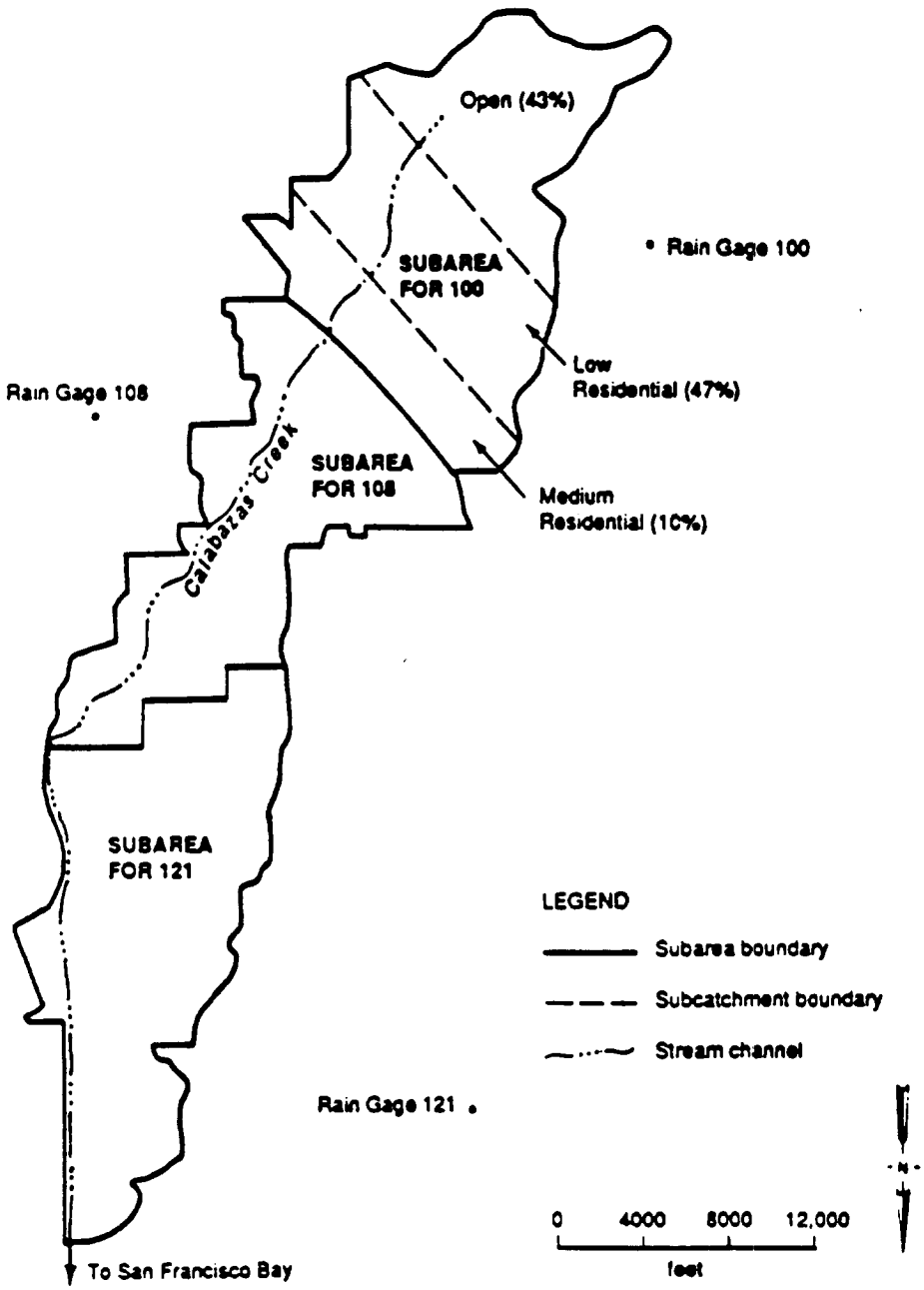

Figure B-3. SUBCATCHMENT BREAKDOWN FOR CALABAZAS CREEK

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the total area represented by rain gage 100. In general, physical properties such as rainfall, subcatchment width, and soil infiltration parameters were identical for all land use subcatchments in a given rain gage subarea. Land use properties such as impervious area were allowed to vary between land use subcatchments to reflect different levels of development.

B.2.2 Model Parameter Estimation

SWMM requires a number of parameters describing meteorology, catchment geometry, and runoff characteristics. The accuracy at which parameters can be estimated without model calibration varies. Thus, parameters can be grouped as follows:

1) Parameters which can be accurately estimated with no calibration (i.e., catchment area)

2) Parameters which can be estimated with reasonable accuracy, but must be refined through calibration (i.e., infiltration parameters)

3) Parameters which can be estimated only through model calibration (i.e., interflow outflow coefficients)

Table B-2 summarizes the important model input parameters and the corresponding estimation procedures; these are discussed in detail in the following paragraphs.

B.2.2.1 Rainfall. Rainfall is the driving force in the model, and is by far the most important input parameter. SWMM in this case was run continuously for multiple-year simulations, and required continuous records of 15-minute or hourly rainfall. Therefore, the continuous rainfall records available for SCVWD and NWS gages in the valley were used as inputs to the model. The SCVWD gages are weighing gages which record at 15-minute intervals with a precision of 0.1 inch. The one NWS gage, located in San

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Table B-2. SUMMARY OF SWMM RUNOFF INPUT PARAMETERS

Parameters	Estimation Procedure	Varies by Land Use?	Calibration Parameter?
Rainfall (in.)	NWS hourly and SCVWD 15-minute recording weighing gages (1974-1989). To correct for orographic effects, rainfall records were multiplied by isohyetal correction factors based on the ratio of average annual rainfall for subareas to the average at the gage.		
Potential Evapotranspiration Rate (in./day)	Average monthly pan evaporation data at the Almaden Recharge facilities, multiplied by monthly pan coefficients provided by the SCVWD.		
Area (acres)	Drainage areas were measured from drainage maps provided by the SCVWD.		
Slope (fraction)	Slop s were determined by area-weighting slopes for those SCVWD catchments contained in model subcatchment.	•	
Land Use (%)	Land use percentages were determined by area-weighting values for SCVWD catchments contained within each SWMM subcatchment.	•	
Catchment Width (feet)	Drainage area divided by the maximum length of overland flow.		•
Impervious Area (%)	Derived from calibration of SWMM for monitored land use catchments (Station L1-L7) for the 1988-89 season.	•	•
Surface Roughness	Values for each land use were derived from tables for grassy, paved, and forested surfaces in the SWMM User's Manual.	•	
Depression Storage (in.)	Values for each land use were derived from tables for grassy and paved surfaces in the SWMM User's Manual.	•	•
Infiltration Parameters	Hydrologic soil groups were mapped from Soil Conservation Service (SCS).	•	•
Interflow Parameters	Soil surveys (1941). Typical values for each soil group were then selected from tables in the SWMM User's Manual. The average for a SWMM subarea was determined by area-weighted averaging.		
Unsaturated zone	From typical values tabulated in SWMM user's manual for soil types surveyed by the SCS (1941).		•
Saturated zone	From typical values tabulated in SWMM user's manual for soil types surveyed by the SCS (1941).		•
Outflow coefficients	By calibration to match measured hydrographic recessions.	•	•

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Jose, is an hourly gage with a precision of 0.01 inch. A detailed description of these data is provided in Section 5.1.

The rainfall record for each subcatchment was selected by first identifying the rain gage located nearest to the centroid of the subcatchment area. The record for this rain gage then became the base rainfall record for the subcatchment. In selecting a base rainfall record, we also compared the elevation of the rain gage to that of the subcatchment (i.e., if the nearest gage were on a high ridge above the subcatchment, another gage at an elevation closer to that of the subcatchment was sometimes selected as a more representative record).

Once a base record was established for the subcatchment, the rainfall record was adjusted for the average difference between rainfall volumes in the subcatchment and at the rain gage. To accomplish this, rainfall records were multiplied by correction factors based on the ratio of average annual precipitation in the subcatchment to average annual precipitation in the rain gage:

$$R_{sc} = R_g * (P_{sc}/P_g) \qquad (B\text{-}1)$$

where

R_{sc} = 15-minute rainfall values used in modeling the sub catchment (in)
R_g = the corresponding 15-minute rainfall in the rain gage (in)
P_{sc} = the mean annual rainfall in the subcatchment (in)
P_g = the mean annual rainfall in the rain gage (in)

The mean annual rainfall for the catchment was estimated from annual average rainfall isohyets. Rainfall isohyets were derived from isohyetal maps provided by the SCVWD.

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Storm patterns within a year can be highly variable, and this correction of rainfall records based on long-term annual average rainfall totals will certainly not capture all of the spatial variability within an individual storm. However, the method does ensure that, on average, the rainfall record used in modeling runoff will have the correct cumulative volume. This method should therefore be sufficiently accurate for estimating annual flow volumes and loads.

B.2.2.2 Potential Evapotranspiration Rate. The potential evapotranspiration rate determines how much water could be lost to evaporation and transpiration. SWMM uses an average rate for each month of the year; for this study, these rates were estimated using the average monthly pan evaporation rates measured by the SCVWD at the Alamitos Recharge Facility. These pan evaporation rates were corrected by pan coefficients provided by the SCVWD.

B.2.2.3 Catchment Area, Slope, and Land Use. These data were available for catchments used by the SCVWD in their flood modeling. These catchments were smaller than the SWMM subcatchments used in this study. Consequently, model subcatchment areas were determined from the SCVWD catchment maps by summing the areas for the appropriate SCVWD catchments. Similarly, slopes and land use breakdown were determined by area-weighting the values for the SCVWD catchments comprising a SWMM subcatchment.

B.2.2.4 Catchment Width. SWMM represents each subcatchment as a rectangle defined by an area and width; the length of overland flow is then the area divided by the width. Catchment width is therefore an important parameter in determining the timing of runoff. This width is difficult to measure, since the actual shapes of subcatchments are rarely rectangular. As recommended in the SWMM Users Manual (Huber and Dickensen 1988), a first estimate of this parameter was obtained by dividing the subcatchment area by the maximum distance from catchment boundary to the main channel.

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B.2.2.5 Impervious Area. This parameter is defined as the percentage of an area that has no infiltration, i.e., paved areas, rooftops, etc. Impervious areas must also be connected, and paved areas that drain onto pervious areas should not be considered impervious. This parameter could conceivably be measured directly from aerial photos, but this would be extremely costly and of questionable accuracy for an area as large as the Santa Clara Valley.

The approach used here was to determine representative impervious areas for each land use by calibrating SWMM on storm data at the single land use catchments sampled in this study. These values were then adjusted during calibration of the larger watersheds to match observed runoff volumes.

B.2.2.6 Surface Roughness Coefficients and Depression Storages. These were estimated for pervious and impervious areas using values tabulated in the SWMM user's manual for various types of surfaces. Values tabulated for either paved, grassy, or forested surfaces were selected based on land use. Depression storages were also calibrated in forested areas to represent interception on vegetation.

B.2.2.7 Infiltration Parameters. For this study, the Green-Ampt option in SWMM was selected for modeling infiltration during storm events. The Green-Ampt infiltration model, while certainly idealized, is mechanistically rather than empirically based and has input parameters that can easily be related to known soil properties. For infiltration during storms, the model uses three parameters: 1) the saturated hydraulic conductivity, 2) a suction parameter, and 3) the maximum soil moisture deficit. The saturated hydraulic conductivity represents the infiltration rate at saturation. The suction parameter is used to model the effects of capillary suction in the soil. The maximum moisture deficit is analogous to porosity and determines the storage capacity of the soil layer that controls infiltration. Values of these parameters are tabulated for each of the four Soil Conservation Service (SCS) hydrologic soil groups in the SWMM User's Manual. Therefore,

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values for this study were determined by overlaying SCS soil survey maps (SCS 1941) onto maps of the SWMM subcatchments. The area of soils in each SCS hydrologic group were measured, and the average parameters for the watershed were determined by area weighting. The following calculation illustrates the method for the saturated hydraulic conductivity:

$$K = (\%A)(KA) + (\%B)(KB) + (\%C)(KC) + (\%D)(KD) \qquad (B\text{-}2)$$

where:

K = the average saturated hydraulic conductivity for a subcatchment
A, B, C, D = the four SCS hydrologic soil groups
%A = the percentage of the total area that are A soils
KA = the value of saturated hydraulic conductivity for A soils

In general, soils in the area ranged from B to D, where D soils have the lowest infiltration rates.

Between storms, SWMM uses a simple empirical algorithm to determine how dry soils are at the start of the next storm. As previously discussed, the antecedent soil moisture level is an important factor in determining runoff response in the Study Area, especially in the later months of the rainy season. Initial calibration of SWMM indicated that the empirical SWMM soil moisture depletion algorithm was not adequately reproducing the seasonality of soil moisture levels; soils were generally saturating during every storm and then drying out to the maximum moisture deficit within a few days. Thus, the model predicted that storms in February responded the same to rainfall as storms in November. The SWMM soil moisture depletion algorithm was therefore modified so that the depletion rate and storage capacity of the soil layer controlling infiltration could be adjusted during calibration. The depletion rate was defined as a fraction of the potential evapotranspiration rate:

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$$R_i = (F_d)(PET_i) \qquad (B\text{-}3)$$

where:

R_i = the soil moisture depletion rate for month i
PET_i = the potential evapotranspiration rate for month i
F_d = the soil moisture depletion factor

This modification allowed depletion rates to vary seasonally, and F_d was added as a calibration parameter for the model. To control the storage capacity of the soil, the thickness of the soil layer controlling infiltration was also added as a calibration parameter. This storage parameter could then be adjusted along with the depletion factor to match the observed seasonality in runoff.

B.2.2.8 Interflow Parameters. To model the interflow recession observed in many storm hydrographs in the Study Area, the SWMM groundwater model was configured as shown in Figure B-4. The bottom of the saturated zone was set at a relatively shallow depth (10 to 15 feet) so that the saturated zone rose rapidly during storm events and released stored water into channels within 1 to 7 days. This interflow system was modeled only in steep areas with high rainfall volumes; interflow was generally not observed in valley floor catchments.

Model input parameters in the unsaturated zone include storage parameters such as field capacity and wilting point, and parameters describing hydraulic conductivity as a function of soil moisture. These were generally estimated from tables of typical values for the appropriate SCS soil types. Similarly, the saturated zone is defined by storage parameters such as porosity and rate parameters such the saturated zone outflow coefficients. Flow from the saturated zone into the channel was calculated using the following model based on head differences between the channel and the saturated zone:

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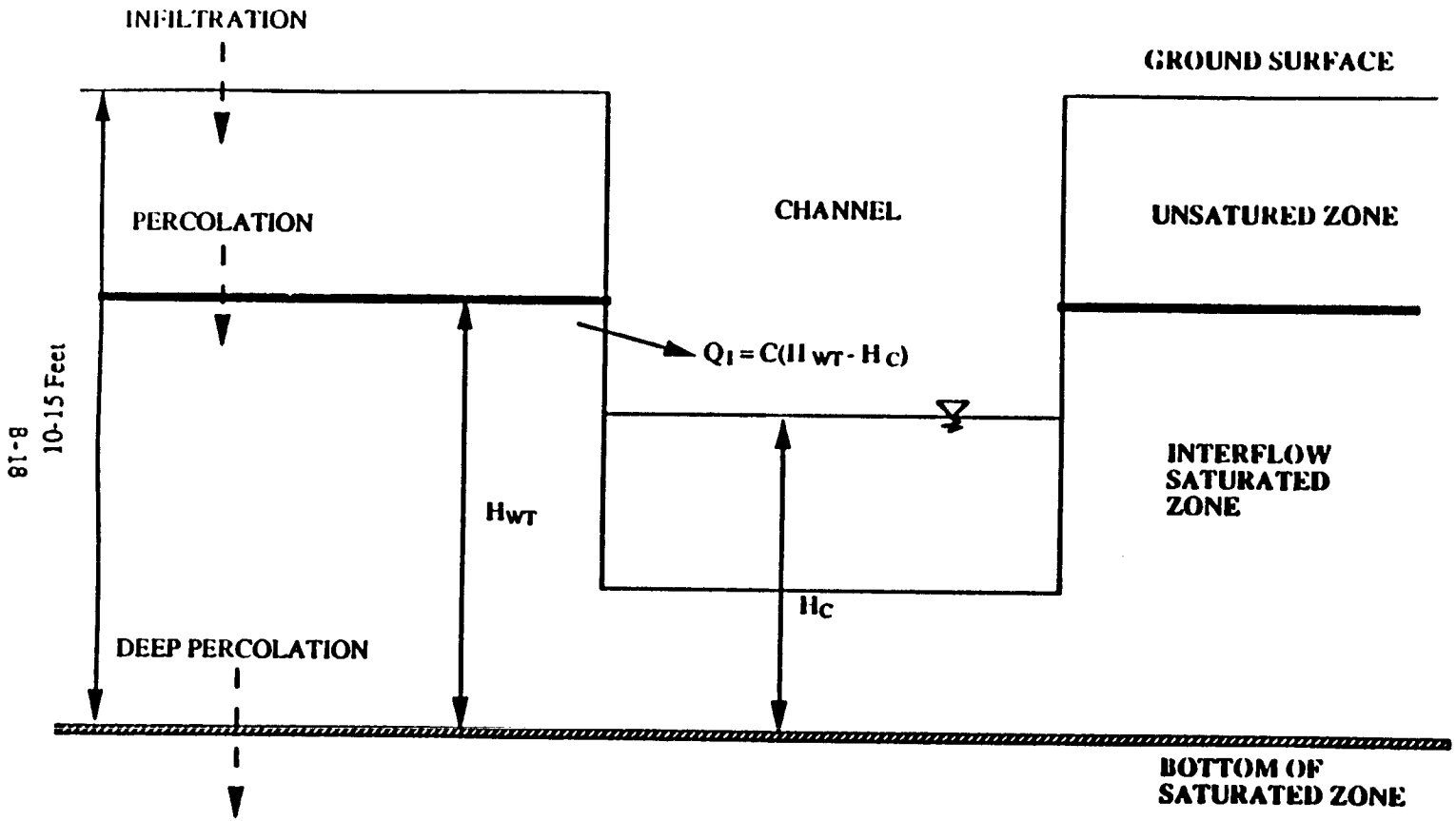

FIGURE B-4. SWMM Interflow Model

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$$Q_I = C(H_{wt} - H_c) \qquad (B\text{-}4)$$

where:

Q_I = interflow rate into the channel (cfs)
H_{wt} = elevation of the water table (ft)
H_c = elevation of water in the channel (ft)
C = interflow coefficient (ft^2/sec)

The interflow coefficient C is a calibration parameter which was primarily used to determine the magnitude of interflow into the channel. An additional calibration parameter, representing deep percolation out of the saturated zone, was used to steepen predicted hydrograph recessions to match observed recession curves.

B.2.2.9 Channel Data. Runoff and interflow from SWMM subcatchments were routed down channels using the SWMM non-linear routing algorithm. For this study, one channel was defined for each rain gage subarea, and input data were required specifying the slope, Manning's roughness coefficient, and cross section of each channel reach. Cross-sectional data for all streams were provided by the SCVWD in the form of HEC-2 input files used in flood modeling. From these, representative cross sections were selected and approximated as trapezoids for SWMM (defined by a bottom width and two side slopes). Manning's roughness coefficients and slopes were averaged for each channel reach modeled.

B.3 SWMM CALIBRATION AND VERIFICATION

Although SWMM is a state of the art model of rainfall-runoff processes, it, like all runoff models, represents an idealization of the actual processes occurring in a catchment. In addition, the spatial variability of model input parameters is difficult to account for in large catchments with many types of geology and land uses. Therefore, the model must be

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calibrated against measured streamflow data to produce reliable results. The calibration consists of running the model, comparing model prediction to measured streamflows, and adjusting the model calibration parameters to better match the observed flows. The process is repeated until the comparison between measured and predicted flows is deemed adequate. Calibration is then followed by verification, in which the calibrated model is run and compared to streamflow records for a period not included in the calibration period.

The following sections describe 1) calibration criteria, 2) selection of calibration periods, 3) calibration parameters, and 4) results for individual watersheds.

8.3.1 Calibration Goals and Criteria

To capture the year to year variability of runoff, SWMM was run continuously over several years during calibration and verification. Since the emphasis of this study was on annual loads from storm runoff, the primary goal of calibration was to match measured wet-season total runoff volumes. The runoff volume for a season consists primarily of runoff from relatively few storm events (typically less than 15), and matching wet-season runoff volumes required accurate simulation of individual storm events.

For calibration purposes, predicted flows were compared to measured flows at SCVWD and USGS stream gages. See Section 5.2 for a discussion of stream gages in the Study Area. A number of parameters were calculated to measure the quality of calibration. For comparing predicted versus measured wet-season totals, the following statistics were calculated:

$$RMSE = \frac{100\left(\sum_{i=1}^{n}(P_i - M_i)^2/n\right)^{1/2}}{M} \qquad (B\text{-}5)$$

$$BIAS = 100(P - M)/M \qquad (B\text{-}6)$$

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where:

P_1 = predicted wet-season runoff volume for year 1 (in.)
M_1 = measured wet-season runoff volume for year 1 (in.)
n = the number of years in the calibration period.
M = the mean measured wet-season runoff volume (in.)
P = the mean predicted wet-season runoff volume (in.)

The RMSE, or root mean square error, is a measure of the absolute magnitude of calibration errors expressed as a percentage of mean runoff. The BIAS indicates whether the model is on average over- or under-predicting runoff volumes, and is also expressed as a percentage of the mean wet-season runoff volume. The goal of calibration was to minimize both the RMSE and the BIAS.

Results of calibrations performed for comparable studies were consulted to derive specific calibration acceptance criteria. Alley (1986) summarizes calibration results from the USGS rainfall-runoff model DR3M for 37 catchments nationwide. In this study, calibration errors were measured by the mean absolute deviation (MAD) between predicted and observed flow volumes. On average, the MAD was on the order of 20 percent for the 37 simulated catchments. In a modeling study of three small urban catchments, Guay and Smith (1988) calibrated the USGS model DR3M to runoff data for 10 to 13 storms in one season. Prediction errors in total annual runoff volume for these three single land use catchments ranged from 10 to 25 percent. In a study performed on Permanente Creek in Santa Clara County, Nolan and Hill (1989) obtained calibration errors in total annual flow volume of 3 to 33 percent.

These studies indicate that calibration errors are generally on the order of 20 percent, but may range as high as 30 or 40 percent. The studies cited above generally focused on small (less than 100 acre) urban catchments with a single well-defined land use. None of these studies

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calibrated using more than 3 years of flow data. Thus, one would expect that the calibration errors obtained in modeling the large watersheds in the Santa Clara Valley for up to 10 years of flow data would be somewhat higher. Nonetheless, for this study a relatively ambitious calibration goal of 15 percent RMSE was used for annual flow predictions. Given the difficulties inherent in simulating large open areas, this goal was often not achieved. However, the RMSEs summarized in Table B-3 range from 1 to 40 percent, and are consistent with calibration errors obtained in other studies. More importantly, the biases in the model predictions are small, and range from 1 to 16 percent.

Daily predicted flows were compared to measured flows in two ways. First, daily predicted flows and measured flows were plotted together over time and visually compared. These plots were used for detailed analyses of the sources of calibration errors, particularly in terms of matching seasonal runoff patterns and hydrograph recessions. Finally, a Kolmogorov-Smirnov hypothesis test was used to compare the frequency distributions of measured and predicted daily flows. This test first calculates the maximum difference between measured and predicted cumulative probabilities. This difference is then compared to a test statistic based on the number of daily flows and the confidence level. If the maximum difference is less than the test statistic, the hypothesis that the predicted and measured flows are from the same population is accepted. This test, while it does not check that the flow on a given day is accurately predicted, does measure how well the model is reproducing the day to day variability of flows.

B.3.2 Selection of Calibration and Verification Periods

Runoff in the Study Area varies greatly from year to year, and the annual runoff volume for a wet year can be ten times greater than in a dry year. A calibration based on only one dry year would therefore not accurately represent runoff in wet years. Therefore, SWMM was calibrated and verified against as many years of streamflow data as were available,

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Table B-3. SUMMARY OF STREAM CALIBRATION/VERIFICATION

Watershed	Calibration Period	Verification Period	Calibration			Verification			Combined Calibration and Verification Period		
			Mean Wet-Season Runoff (in.)	RMSE (%)	Bias (%)	Mean Wet-Season Runoff (in.)	RMSE (%)	Bias (%)	Mean Wet-Season Runoff (in.)	RMSE[a] (%)	Bias[b] (%)
Calaveras Creek	1976-80, 86-88	1980-83, 1984-85, 1988-1989	4.00	8	-5	5.51	13	6	4.73	11	1
Stevens Creek	1977-1981	1975-77, 1981-83	1.96	15	1	2.15	45	1	2.06	34	-1
Sunnyvale East	1974-1982	1984-1989	5.66	6	3	3.31	3	-9	4.59	9	-1
Saratoga Creek	1974-1982	1982-1986	6.57	30	-8	11.98	13	10	8.19	22	0.1
San Tomas Aquinas Creek	1975-1981	1983-1987	6.58	17	-7	6.93	25	5	6.75	21	-2
Coyote Creek	1988-1 89	None	0.73	1	-1	None	None	None	0.73	1	-1
Berryessa Creek	1974-1979	1980-1982	1.39	19	-12	4.69	25	16	2.99	29	6
Guadalupe River	1977-1981	1981-82, 1987-89	2.92	30	-2	1.73	40	-3	2.4	40	-2
STUDY AREA			2.80	25	-4	2.98	22	5	2.8	25	-1

[a] RMSE measures the average error in predicted wet-season runoff, as a percentage of the mean wet-season runoff volume.

[b] BIAS measures the average bias (tendency to under- or over-predict) in predicted wet-season runoff, as a percentage of the mean wet-season runoff volume.

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with approximately two thirds of the record used for calibration and one third for verification. As discussed in Section 5.0, concurrent streamflow and rainfall data are generally available for the period 1974 through 1989, with occasional gaps due to gaging errors, data storage problems, and damage to stream gages. Table B-3 summarizes the calibration and verification periods for the various watersheds; calibration periods were typically 4 to 9 years in length, while verification periods were 3 to 5 years long. Both calibration and verification periods were selected to contain a mix of wet, dry, and average years. Note that there was only one year of data available for calibration of the Coyote Creek watershed.

B.3.3 Calibration Parameters

Table B-4 summarizes the values of parameters derived from calibration of SWMM for each watershed. For adjustment of runoff volumes in urban areas, the most important parameters were the percent of impervious area and depression storages. These parameters were especially important in dry years when almost all runoff was from impervious areas; the percent impervious area for each of the various land uses was therefore determined primarily through calibration on dry years. In open and low-residential areas, the most important parameters were the Green-Ampt infiltration and soil depletion parameters. The saturated hydraulic conductivity was used to determine the overall rate of infiltration (and therefore reduction in runoff). The soil moisture depletion parameters L and F_d were used to model the seasonality of infiltration (and runoff) by adjusting the rate at which soils dried out between storms. The interflow coefficient A1 and deep percolation factor DF were used to match hydrograph recessions, while CET, POR, and GRELEV defined the storage characteristics of the saturated zone.

B.3.3.1 Calibration of the Percent Imperviousness. One of the most sensitive model parameters in urban areas is the percent imperviousness. Runoff volumes are often directly proportional to the value of the percent imperviousness, meaning that if this parameter is doubled, runoff volumes

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Table B-4. PARAMETER VALUES USED IN THE CALIBRATION OF SWMM FOR EACH WATERSHED

Watershed	Sub Catchment	Rain Gage	Land Use Type	Area (acre)	% Imp.	Manning's n		Depression Storage		Infiltration Parameters		Initial Moist. Deficit	Soil Moist. Depletion Factor	Infil. Layer Thickness (in.)
						Imp.	Perv.	Imp. (in.)	Perv. (in.)	Suction Pres. (in.)	Hyd. Con. (in./hr)			
Coyote	Upper Pontiantia	99	Open	142.4	0	0.013	0.4	0.03	0.1	10	0.05	0.26	0.8	20
			Med. Res.	849.3	25	0.013	0.4	0.03	0.1	10	0.1	0.26	0.8	20
			High Res.	173.8	35	0.013	0.2	0.03	0.1	10	0.1	0.26	0.8	20
			Comm.	31.4	45	0.013	0.2	0.03	0.1	10	0.1	0.26	0.8	20
	Silver Thompson	90	Open	10519	0	0.013	0.4	0.03	0.1	10	0.05	0.26	0.8	20
			Low Res.	4432	15	0.013	0.2	0.03	0.1	10	0.1	0.26	0.8	20
			Med. Res.	4709	25	0.013	0.2	0.03	0.1	10	0.1	0.26	0.8	20
		86	Open	5201	0	0.013	0.4	0.03	0.1	10	0.1	0.26	0.8	20
			Med. Res.	4186	25	0.013	0.2	0.03	0.1	10	0.1	0.26	0.8	20
			High Res.	256	35	0.013	0.2	0.03	0.1	10	0.1	0.26	0.8	20
			Comm.	1903	60	0.013	0.2	0.03	0.1	10	0.1	0.26	0.8	20
			Industrial	1142	70	0.013	0.2	0.03	0.1	10	0.1	0.26	0.8	20
	Barrysse	323	Open	17860	0	0.013	0.2	0.03	0.1	10	0.18	0.26	0.2	7
			Low Res.	952	10	0.013	0.2	0.03	0.1	10	0.18	0.26	0.2	7
			Med. Res.	1452	20	0.013	0.2	0.03	0.1	10	0.18	0.26	0.2	7
			Comm.	541	40	0.013	0.2	0.03	0.1	10	0.18	0.26	0.2	7
			Industrial	465	50	0.013	0.2	0.03	0.1	10	0.18	0.26	0.2	7
		123	Low Res.	203.2	5	0.013	0.2	0.03	0.1	10	0.18	0.26	0.2	7
			Med. Res.	1579.3	13	0.013	0.2	0.03	0.1	10	0.18	0.26	0.2	7
		223	Open	2163.5	0	0.013	0.24	0.03	0.1	10	0.08	0.26	0.2	7
			Low Res.	961.5	5	0.013	0.2	0.03	0.1	10	0.18	0.26	0.2	7
			Med. Res.	80.1	20	0.013	0.2	0.03	0.1	10	0.18	0.26	0.2	7
			High Res.	40.1	30	0.013	0.2	0.03	0.1	10	0.18	0.26	0.2	7
San Ignac	79	79	Open	1479	6	0.03	0.4	0.03	0.1	10	0.1	0.26	0.4	10
			Low Res.	5108	10	0.03	0.2	0.03	0.1	10	0.1	0.26	0.4	10
			Med. Res.	739	20	0.03	0.2	0.03	0.1	10	0.1	0.26	0.4	10
			Comm.	74	50	0.03	0.2	0.03	0.1	10	0.1	0.26	0.4	10
	108	108	Open	331	0	0.03	0.2	0.05	0.15	10	0.2	0.26	0.4	10
			Low Res.	3526	10	0.03	0.2	0.05	0.15	10	0.2	0.26	0.4	10
			Med. Res.	667	20	0.03	0.2	0.05	0.15	10	0.2	0.26	0.4	10
			High Res.	551	30	0.03	0.2	0.05	0.15	10	0.2	0.26	0.4	10
			Comm.	441	40	0.03	0.2	0.05	0.15	10	0.2	0.26	0.4	10
	86	86	Low Res.	1870	10	0.03	0.2	0.05	0.15	10	0.2	0.26	0.4	10
			Med. Res.	375	20	0.03	0.2	0.05	0.15	10	0.2	0.26	0.4	10
			Industrial	2473	60	0.03	0.2	0.05	0.15	10	0.2	0.26	0.4	10

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Table B-6. PARAMETER VALUES USED IN THE CALIBRATION OF SWMM FOR EACH WATERSHED (continued)

Watershed	Sub Catchment	Rain Gage	Land Use Type	Area (acres)	% Imp.	Manning's n		Depression Storage		Infiltration Parameters		Initial Moist. Deficit	Soil Moist. Depletion Factor	Initl. Layer Thickness (in.)
						Imp.	Perv.	Imp. (in.)	Perv. (in.)	Suction Pres. (in.)	Hyd. Con. (in./hr)			
Saratoga	77	77	Open	5535	0	0.013	0.4	0.1	0.3	10	0.1	0.26	0.2	7
			Low Res.	554	5	0.013	0.2	0.1	0.3	10	0.1	0.26	0.2	7
	100	100	Open	199	0	0.013	0.2	0.1	0.3	10	0.3	0.26	0.2	7
			Low Res.	1755	5	0.013	0.2	0.1	0.3	10	0.3	0.26	0.2	7
			Med. Res.	2443	8	0.013	0.2	0.1	0.3	10	0.3	0.26	0.2	7
			High Res.	69	30	0.013	0.2	0.1	0.3	10	0.3	0.26	0.2	7
			Comm.	482	20	0.013	0.2	0.1	0.3	10	0.3	0.26	0.2	7
Sunnyvale East Channel	48	48	Low Res.	2048	10	0.013	0.2	0.03	0.1	9	0.12	0.26	0.7	7
			Med. Res.	637	20	0.013	0.2	0.03	0.1	9	0.12	0.26	0.7	7
			High Res.	106	30	0.013	0.2	0.03	0.1	9	0.12	0.26	0.7	7
			Comm.	1632	60	0.013	0.2	0.03	0.1	9	0.12	0.26	0.7	7
Guadalupe	Calero	220	Open	2057	0	0.013	0.4	0.2	0.3	0	0.05	0.25	0.8	10
			Low Res.	1316	5	0.013	0.2	0.2	0.3	0	0.05	0.25	0.8	10
	Almaden	120	Open	1689	0	0.013	0.4	0.2	0.3	0.0	0.05	0.20	0.8	10
			Low Res.	909	5	0.013	0.2	0.06	0.2	0.0	0.05	0.20	0.8	10
		123	Open	4313	0	0.013	0.4	0.2	0.3	9	0.05	0.20	0.8	10
		401	Open	2259	0	0.013	0.4	0.1	0.3	0	0.05	0.25	0.8	15
			Low Res.	3175	5	0.013	0.2	0.03	0.2	0	0.05	0.25	0.8	15
			Med. Res.	672	15	0.013	0.2	0.03	0.2	0	0.05	0.25	0.8	15
		301	Open	566	0	0.013	0.4	0.1	0.3	7.4	0.12	0.25	0.8	15
			Low Res.	840	5	0.013	0.2	0.03	0.2	7.4	0.12	0.25	0.8	15
		201	Low Res.	347	5	0.013	0.2	0.03	0.2	0	0.12	0.3	0.8	14
			Med. Res.	3124	15	0.013	0.2	0.03	0.2	0	0.12	0.3	0.8	14
			High Res.	347	30	0.013	0.2	0.03	0.2	0	0.12	0.3	0.8	14
			Comm.	521	50	0.013	0.1	0.03	0.2	0	0.12	0.3	0.8	14
		86	Open	1530	0	0.013	0.2	0.03	0.2	0.3	0.12	0.20	0.8	14
			Low Res.	1878	5	0.013	0.2	0.03	0.2	0.3	0.12	0.20	0.8	14
			Med. Res.	4951	15	0.013	0.2	0.03	0.2	0.3	0.12	0.20	0.8	14
			High Res.	1194	30	0.013	0.2	0.03	0.2	0.3	0.12	0.20	0.8	14
			Comm.	4448	50	0.013	0.1	0.03	0.2	0.3	0.12	0.20	0.8	14
			Industrial	3072	60	0.013	0.1	0.03	0.2	0.3	0.12	0.20	0.8	14
	Canoas	401	Open	2504	0	0.013	0.2	0.03	0.2	7.6	0.12	0.26	0.8	14
			Low Res.	477	5	0.013	0.2	0.03	0.2	7.6	0.12	0.26	0.8	14
			Med. Res.	6200	15	0.013	0.2	0.03	0.2	7.6	0.12	0.26	0.8	14
			High Res.	715	30	0.013	0.2	0.03	0.2	7.6	0.12	0.26	0.8	14
			Comm.	596	50	0.013	0.1	0.03	0.2	7.6	0.12	0.26	0.8	14
			Industrial	1431	60	0.013	0.1	0.03	0.2	7.6	0.12	0.26	0.8	14

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Table B-4. PARAMETER VALUES USED IN THE CALIBRATION OF SWMM FOR EACH WATERSHED (continued)

Watershed	Sub Catchment	Rain Gage	Land Use Type	Area (acres)	% Imp.	Manning's n		Depression Storage		Infiltration Parameters		Initial Moist. Deficit	Soil Moist. Depletion Factor	Infil. Layer Thickness (in.)
						Imp.	Perv.	Imp. (in.)	Perv. (in.)	Suction Pres. (in.)	Hyd. Con. (in./hr)			
Guadalupe	Ross	136	Open	1575	0	0.013	0.4	0.1	0.3	8.1	0.12	0.26	0.8	14
			Low Res.	1462	5	0.013	0.2	0.05	0.2	8.1	0.12	0.26	0.8	14
			Med. Res.	2923	15	0.013	0.2	0.05	0.2	8.1	0.12	0.26	0.8	14
			High Res.	256	30	0.013	0.2	0.05	0.2	8.1	0.12	0.26	0.8	14
			Comm.	191	50	0.013	0.1	0.05	0.2	8.1	0.12	0.26	0.8	14
	Los Gatos	125	Low Res.	2625	5	0.013	0.2	0.05	0.2	10	0.12	0.26	0.8	14
			Med. Res.	3000	15	0.013	0.2	0.05	0.2	10	0.12	0.26	0.8	14
			High Res.	600	30	0.013	0.2	0.05	0.2	10	0.12	0.26	0.8	14
			Comm.	1275	50	0.013	0.1	0.05	0.2	10	0.12	0.26	0.8	14
		36	Open	1935	0	0.013	0.4	0.1	0.3	10	0.12	0.26	0.8	10
			Low Res.	1290	5	0.013	0.2	0.06	0.2	10	0.12	0.26	0.8	10
			Med. Res.	645	15	0.013	0.2	0.05	0.2	10	0.12	0.26	0.8	10
			Comm.	161	50	0.013	0.1	0.05	0.2	10	0.12	0.26	0.8	10
Calaboras	100	100	Open	1965	0	0.013	0.4	0.1	0.3	9.1	0.03	0.24	0.8	10
			Low Res.	2158	6	0.013	0.2	0.1	0.3	9.1	0.025	0.24	0.8	10
			Med. Res.	457	15	0.013	0.2	0.1	0.3	9.1	0.025	0.24	0.8	10
	108	108	Low Res.	1133	10	0.013	0.2	0.06	0.1	7.9	0.025	0.3	0.6	7
			Med. Res.	2578	20	0.013	0.2	0.06	0.1	7.9	0.025	0.3	0.6	7
			Comm.	697	70	0.013	0.1	0.06	0.1	7.9	0.025	0.3	0.6	7
	121	121	Open	236	0	0.013	0.15	0.06	0.1	9.4	0.025	0.28	0.6	6
			Low Res.	1650	10	0.013	0.2	0.06	0.1	9.4	0.025	0.28	0.6	6
			Med. Res.	1083	20	0.013	0.2	0.06	0.1	9.4	0.025	0.28	0.6	6
			High Res.	330	30	0.013	0.2	0.06	0.1	9.4	0.025	0.28	0.6	6
			Comm.	1413	80	0.013	0.1	0.06	0.1	9.4	0.025	0.28	0.6	6
Stevens	100	100	Open	1022	0	0.013	0.4	0.1	0.3	10	0.07	0.20	0.8	10
			Low Res.	1250	6	0.013	0.2	0.1	0.3	10	0.07	0.20	0.8	10
	48	48	Low Res.	3068	0	0.013	0.2	0.06	0.1	10	0.1	0.20	0.7	8
			Med. Res.	98	20	0.013	0.2	0.06	0.1	10	0.1	0.20	0.7	8
			Comm.	98	50	0.013	0.1	0.06	0.1	10	0.1	0.20	0.7	8
	121	121	Open	44	0	0.013	0.16	0.06	0.1	10	0.1	0.20	0.7	8
			Low Res.	256	0	0.013	0.2	0.06	0.1	10	0.1	0.20	0.7	8
			Med. Res.	222	20	0.013	0.2	0.06	0.1	10	0.1	0.20	0.7	8
			High Res.	200	30	0.013	0.2	0.06	0.1	10	0.1	0.20	0.7	8
			Comm.	300	80	0.013	0.1	0.06	0.1	10	0.1	0.20	0.7	8

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Table B-6. PARAMETER VALUES USED IN THE CALIBRATION OF SWMM FOR EACH WATERSHED (continued)

Watershed	Sub Catchment	Rain Gage	Land Use Type	Area (acre)	% Imp.	Manning's n		Depression Storage		Infiltration Parameters		Initial Moist. Deficit	Soil Moist. Depletion Factor	Infil. Layer Thickness (in.)
						Imp.	Perv.	Imp. (in.)	Perv. (in.)	Suction Pres. (in.)	Hyd. Con. (in./hr)			
Sunnyvale West	48	48	Open	100	0	0.015	0.2	0.05	0.1	9	0.1	0.26	0.7	7
			Low Res.	651	10	0.015	0.2	0.05	0.1	9	0.1	0.26	0.7	7
			Med. Res.	511	20	0.015	0.2	0.05	0.1	9	0.1	0.26	0.7	7
			High Res.	169	30	0.015	0.1	0.05	0.1	9	0.1	0.26	0.7	7
			Comm.	33	60	0.015	0.1	0.05	0.1	9	0.1	0.26	0.7	7
San Francisquito	24	24	Open	2339	0	0.015	0.2	0.1	0.3	9	0.07	0.26	0.8	10
			Low Res.	340	6	0.015	0.2	0.1	0.3	9	0.07	0.26	0.8	10
	53	53	Open	1425	0	0.015	0.2	0.1	0.3	9	0.07	0.26	0.8	10
			Low Res.	483	0	0.015	0.2	0.1	0.3	9	0.07	0.26	0.8	10
			Med. Res.	45	20	0.015	0.2	0.08	0.2	9	0.07	0.26	0.8	10
			Comm.	345	50	0.015	0.1	0.08	0.1	9	0.07	0.26	0.8	10
Adobe	24	24	Open	2546	0	0.015	0.2	0.1	0.3	9	0.07	0.26	0.8	10
			Low Res.	315	6	0.015	0.2	0.1	0.3	9	0.07	0.26	0.8	10
	53	53	Open	557	0	0.015	0.2	0.08	0.1	9	0.05	0.26	0.6	7
			Low Res.	6192	0	0.015	0.2	0.08	0.1	9	0.05	0.26	0.6	7
			Comm.	209	50	0.015	0.1	0.08	0.1	9	0.05	0.26	0.6	7
	48	48	Low Res.	755	0	0.015	0.2	0.08	0.1	9	0.05	0.26	0.6	7
			Comm.	502	50	0.015	0.1	0.08	0.1	8	0.05	0.26	0.6	7
Barron	53	53	Open	48	0	0.015	0.2	0.08	0.1	9	0.05	0.26	0.6	7
			Low Res.	1458	6	0.015	0.2	0.1	0.3	9	0.07	0.26	0.8	10
			Med. Res.	48	20	0.015	0.2	0.08	0.1	9	0.05	0.26	0.6	7
			Comm.	48	50	0.015	0.1	0.08	0.1	9	0.05	0.26	0.6	7
	48	48	Low Res.	266	0	0.015	0.2	0.08	0.1	9	0.05	0.26	0.6	7
			Med. Res.	17	20	0.015	0.2	0.08	0.1	9	0.05	0.26	0.6	7
			Comm.	30	50	0.015	0.1	0.08	0.1	9	0.05	0.26	0.6	7
Matadero	53	53	Open	1933	0	0.015	0.2	0.1	0.3	9	0.07	0.26	0.8	10
			Low Res.	1933	6	0.015	0.2	0.1	0.3	8	0.07	0.26	0.8	10
			Med. Res.	145	15	0.015	0.2	0.08	0.2	9	0.07	0.26	0.8	10
			Comm.	821	50	0.015	0.1	0.08	0.1	9	0.07	0.26	0.8	10
	48	48	Open	505	0	0.015	0.2	0.08	0.1	8	0.05	0.26	0.6	7
			Low Res.	2173	0	0.015	0.2	0.08	0.1	9	0.05	0.26	0.6	7
			Med. Res.	410	20	0.015	0.2	0.08	0.1	9	0.05	0.26	0.6	7
			Comm.	1003	50	0.015	0.1	0.08	0.1	8	0.05	0.26	0.6	7

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Table H 4. PARAMETER VALUES USED IN THE CALIBRATION OF SWMM FOR EACH WATERSHED (concluded)

Watershed	Sub Catchment	Rain Gage	Land Use Type	Area (acres)	% Imp.	Manning's n		Depression Storage		Infiltration Parameters		Initial Moist. Deficit	Soil Moist. Depletion Factor	Infil. Layer Thickness (in.)
						Imp.	Perv.	Imp. (in.)	Perv. (in.)	Suction Pres. (in.)	Hyd. Cond. (in./hr)			
Portsmouth	Main	53	Open	323	0	0.013	0.4	0.1	0.3	9	0.07	0.26	0.8	10
			Low Res.	2704	6	0.013	0.2	0.1	0.3	9	0.07	0.26	0.8	10
			High Res.	108	30	0.013	0.2	0.00	0.1	9	0.07	0.26	0.8	10
			Comm.	54	50	0.013	0.1	0.00	0.1	9	0.07	0.26	0.8	10
	40	40	Open	290	0	0.013	0.4	0.1	0.3	9	0.05	0.26	0.6	7
			Low Res.	1101	8	0.013	0.2	0.00	0.1	9	0.05	0.26	0.6	7
			Comm.	58	50	0.013	0.1	0.00	0.1	9	0.05	0.26	0.6	7
	121	121	Open	150	0	0.013	0.2	0.00	0.1	9	0.05	0.26	0.6	7
			Low Res.	702	8	0.013	0.2	0.00	0.1	9	0.05	0.26	0.6	7
			Med. Res.	266	20	0.013	0.2	0.00	0.1	9	0.05	0.26	0.6	7
			High Res.	309	30	0.013	0.2	0.00	0.1	9	0.05	0.26	0.6	7
			Comm.	67	80	0.013	0.1	0.00	0.1	9	0.05	0.26	0.6	7

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will nearly double. This is especially true in urban areas with low rainfall intensities.

Estimation of the percent imperviousness can conceivably be performed by direct measurement from areal photographs. However, this is usually impractical for large areas such as the Santa Clara Valley. The usual practice is therefore to derive general values of this parameter for each land use category. However, even values tabulated in the literature for individual land uses may vary by as much as 100 percent. For instance, Table B-5 compares values tabulated for Santa Clara County by (1) the SCVWD, and (2) the U.S. Geological Survey (1977). In general, the USGS values are considerably lower than the SCVWD values. The USGS data also indicate considerable variability within land use categories, with values ranging from 6 percent in hillside residential areas to 10 percent in valley floor low-density residential areas. An important conclusion that can be drawn from this is that no one value can be realistically used to represent all low-density residential areas, since not all areas within the low-density category are paved or developed to the same extent.

For our calibration of SWMM, we initially used the percent imperviousness values developed by the SCVWD (shown in Table B-5). However, use of these values resulted in consistent overestimation of runoff. That this overestimation was derived from the imperviousness estimate became apparent when examining predicted runoff from small early season storms. Runoff from these storms comes primarily from paved areas, and the model consistently overpredicted runoff from these storms even when infiltration parameters were adjusted to prevent any pervious area runoff from occurring. We therefore adjusted the percent impervious values downward to match storm volumes for these types of events.

Clearly, percent imperviousness is a very sensitive calibration parameter, and should not be adjusted to account for processes that may be better represented by the pervious area infiltration parameters. To ensure

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Table B-5. COMPARISON OF CALIBRATED PERCENT IMPERVIOUSNESS VALUES TO VALUES SUPPLIED BY SCVWD

Land Use	SCVWD Percent Imperviousness	USGS (1977) Percent Imperviousness*	Calibrated Percent Imperviousness
Open	0	2	0
Low Residential	35	6, Hillsides 10, Valley Floor	3-10, Hillsides 8-10, Valley Floor 10-15, Eastern Valley Floor
Medium Residential	65	20	15-25
High Residential	75	32	30-35
Commercial	90	50	50-80
Industrial	90	40-50	50-70

* Values tabluated for Santa Clara County.

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that we were not adjusting percent imperviousness when calibration of infiltration parameters would have been more appropriate, calibration of this parameter was performed only to match runoff volumes from small storms where little runoff was occurring from pervious areas. The resulting calibrated percent imperviousness values are shown in Table B-4 for each watershed, and are summarized in Table B-5. As shown in Table B-5, the calibrated values are much lower than the original SCVWD values, but are consistent with percent imperviousness values tabulated by the USGS for Santa Clara County.

8.3.3.2 Sensitivity of the Model to Green-Ampt Infiltration Parameters. An important component of the SWMM rainfall-runoff calibration was the calibration of the Green-Ampt infiltration parameters. These parameters control infiltration of water on pervious surfaces, and thus play a critical role in predicting runoff from open areas. The Green-Ampt infiltration algorithm has three parameters: the saturated hydraulic conductivity, a capillary suction parameter, and the maximum soil moisture deficit. Sensitivity analyses of the model indicated that the controlling infiltration parameter was the saturated hydraulic conductivity, defined as the infiltration rate at saturation. Our calibration efforts therefore focused on this parameter, while leaving the values of the suction parameter and soil moisture deficit constant. As a result, occasionally the final calibrated value of the hydraulic conductivity was not consistent with the values of the suction parameter and maximum soil moisture deficit.

To test whether this inconsistency had a significant effect on the model results, a model run for Calabazas Creek was performed to demonstrate SWMM's insensitivity to the suction parameter and maximum soil moisture deficit. In this run, the values of these two parameters (which formerly corresponded to a moderately permeable "C" soil) were forced to be consistent with the calibrated hydraulic conductivity value (which corresponded to a low permeability "D" soil). Table B-6 summarizes the results of this analysis. In general, annual flow volumes were insensitive

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Table B-6. SENSITIVITY OF ANNUAL LOADINGS TO THE SUCTION AND INITIAL MOISTURE DEFICIT PARAMETERS

	Percent Difference from Original Model Results		
Year	Mixed	Open	Total
77-78	-3.29	-0.87	-3.00
78-79	-4.55	-2.21	-4.24
79-80	-4.14	-2.61	-3.93
80-81	-1.00	-0.65	-0.95
81-82	-2.17	-0.81	-1.99
82-83	-3.70	-1.40	-3.39
83-84	-3.70	-2.91	-3.61
84-85	-1.54	-4.33	-1.67
85-86	-2.09	-1.78	-2.06
86-87	-1.10	-2.80	-1.15
87-88	-0.98	-0.65	-0.96
88-89	0.00	-8.39	-0.02
Total	-2.93	-1.60	-2.78

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to these parameters. Annual loading results between the new run and the original run differed by as little as .02 percent in 1988-89, and by as much as 4 percent in 1978-79. Total loadings for the 1977-1989 period change by about 3 percent.

B.3.3.3 Sensitivity of the Model to Time Series Potential Evapotranspiration Data. Potential evapotranspiration (PE) was represented in the model by average pan evaporation rates for each month of the year. Evaporation data are used in the model to simulate (1) changes in depression storage between storms and (2) seasonal changes in soil moisture storages. These processes primarily affect the antecedent soil moisture levels before storms, and therefore are most important in nonurban areas. Soil moisture levels change on a monthly or seasonal time scale, indicating that predicted annual runoff volumes are not sensitive to day to day changes in evaporation rates.

Table B-7 summarizes the mean monthly evaporation rates used in the model, and also shows the standard deviation and range of observed monthly values for the period 1976 to 1988. Note that the standard deviation of monthly values is on the order of 20 percent or less of the mean, indicating that monthly evaporation shows little year to year variation. To test the sensitivity of the annual loading predictions to the use of monthly average PE data, a model simulation was performed for Calabazas Creek using time series PE data. Table B-8 compares the resulting flow predictions to those obtained using monthly average evaporation data. Annual loads predicted from the two data sets differed by 1 to 6 percent, while the mean annual load differed by only 1.6 percent. Thus, it is reasonable to conclude that monthly average PE data are adequate for annual loads prediction.

B.3.4 Calibration and Verification Results

Table B-3 summarizes the calibration and verification statistics for all of the watersheds for which flow data were available. Figures B-5

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Table B-7. MONTHLY AVERAGE POTENTIAL EVAPOTRANSPIRATION VALUES USED IN FLOW CALIBRATION

Month	Mean Evaporation (in.)	Standard Deviation (in.)	Range (in.)
October	2.93	.30	2.4 - 3.4
November	1.36	.26	0.8 - 1.8
December	0.79	.17	0.6 - 1.1
January	0.79	.13	0.6 - 1.0
February	1.45	.27	1.0 - 1.8
March	2.35	.53	1.9 - 3.3
April	3.95	.51	3.2 - 4.3
May	5.25	.73	4.3 - 6.7
June	6.69	.65	5.8 - 8.0
July	7.02	.88	6.0 - 9.0
August	5.96	.53	4.8 - 6.8
September	4.48	.83	3.0 - 6.1

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Table 8-8. SENSITIVITY OF ANNUAL FLOW PREDICTIONS TO THE USE OF AVERAGE VS TIME SERIES POTENTIAL EVAPOTRANSPIRATION DATA

Year	% Difference In Annual Flow Volume		
	Mixed Land Use	Open Land Use	Total
77-78	1.5	0.9	1.4
78-79	3.9	7.0	4.3
79-80	0.6	2.6	0.9
80-81	0.5	0.7	0.5
81-82	1.6	1.6	1.6
82-83	0.7	-0.5	0.6
83-84	2.6	4.8	2.9
84-85	4.6	23.7	5.5
85-86	2.1	3.1	2.2
86-87	1.1	2.8	1.1
TOTAL	1.6	2.0	1.6

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through B-11 plot predicted wet-season volumes against measured volumes. These statistics and plots measure how well the model was able to predict total wet-season runoff volumes. During calibration, RMSEs ranged from 1 to 38 percent, and the BIAS ranged from ±1 to ±12 percent. During verification, RMSEs ranged from 3 to 45 percent, and the BIAS ranged from ±1 to ±16 percent. For the combined period, RMSEs ranged from 1 to 40 percent of mean wet-season runoff, while the BIAS ranged from ±0.1 to ±6 percent. The flow-weighted average RMSEs for the Study Area were 25, 22, and 25 percent for the calibration, verification, and combined periods, respectively. Average BIASes were -4, 5, and -1 percent for these three periods. Details on the calibration and verification process for individual watersheds are presented below.

B.3.4.1 Calabazas Creek. Calabazas Creek originates in the foothills of the Santa Cruz Mountains and drains into Guadalupe Slough. Mean annual rainfall ranges from 12 inches near the Bay to 32 inches in the foothills. For SWMM, the catchment was divided into three rain gage subareas corresponding to SCVWD rain gages 100, 108, and 121. Model calibration was performed primarily against streamflow data for SCVWD streamgage 26a, located on the valley floor and representing about three-fourths of the total watershed area. In addition, streamflow data at SCVWD streamgage 31 were used to refine estimates of pervious runoff parameters in the upper portion of the watershed.

Calibration and verification results for Calabazas Creek, in terms of wet-season runoff, are illustrated in Figure B-5. The calibration for Calabazas Creek was generally accurate and unbiased, with a RMSE for the combined calibration/verification period of 11 percent of the mean volume and a BIAS of 1 percent. The predicted daily flow distribution passed the Kolmogorov-Smirnov distribution test at the 95 percent confidence level. The most important calibration parameters were the Green-Ampt infiltration parameters, used to model seasonal runoff. Matching the seasonal patterns of runoff required an infiltration layer with a thickness of 8 to 10

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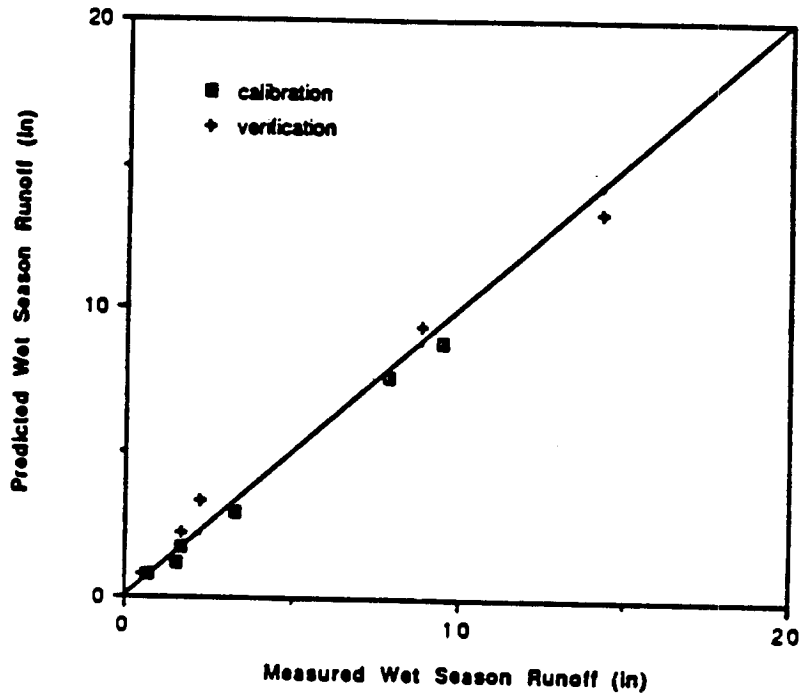

Figure B-5. Predicted versus Measured Wet Season Runoff for Calabazas Creek

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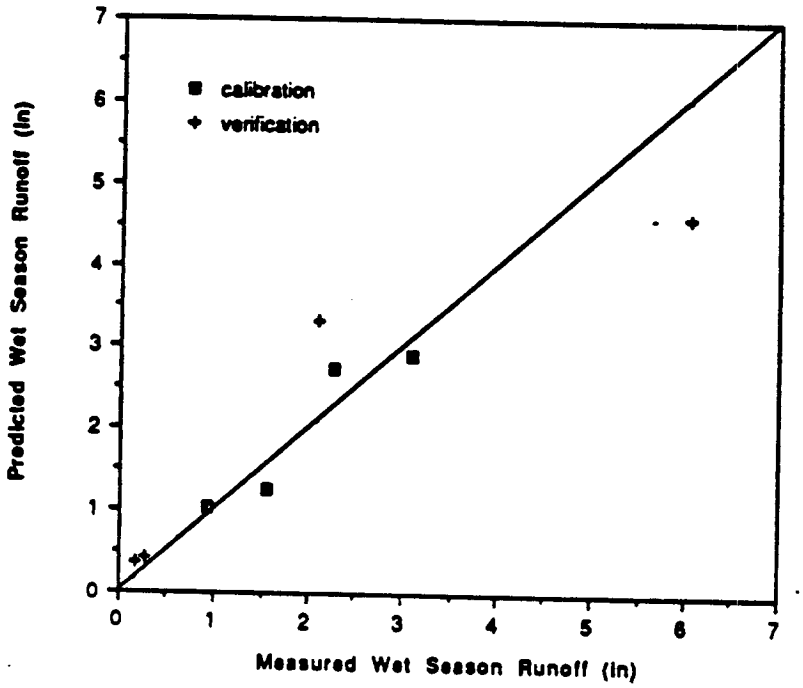

Figure B-6. Predicted versus Measured Wet Season Runoff for Stevens Creek

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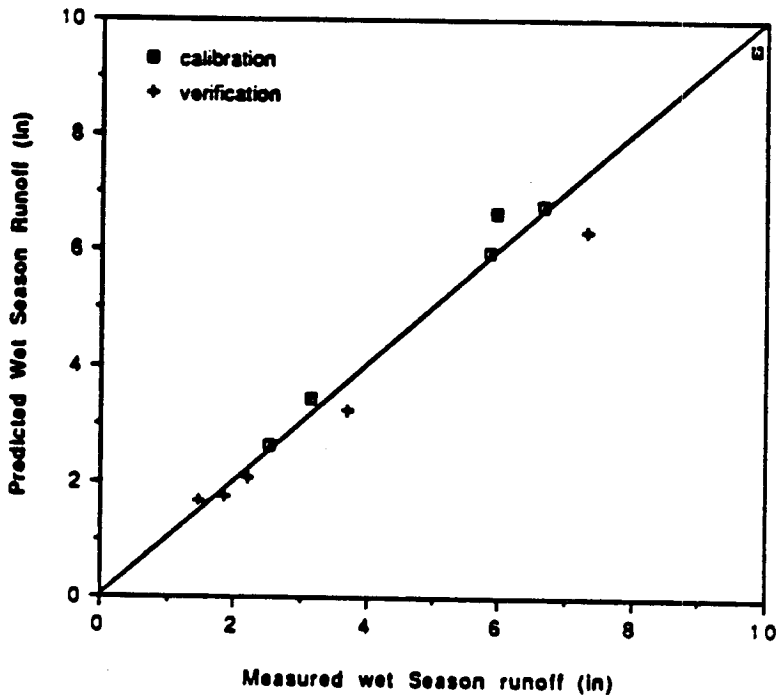

Figure B-7. Predicted versus Measured Wet Season Runoff for Sunnyvale East Channel

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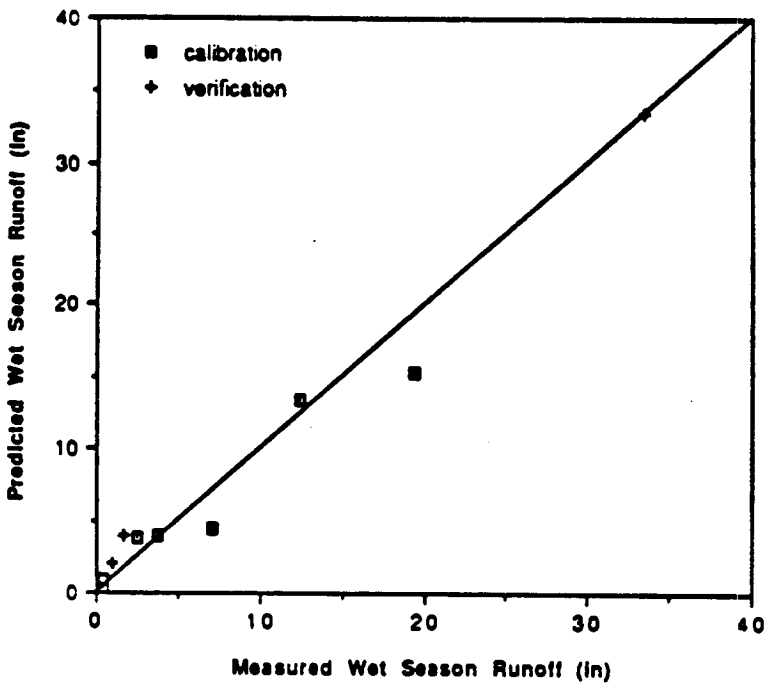

Figure B-8. Predicted versus Measured Wet Season Runoff for Saratoga Creek

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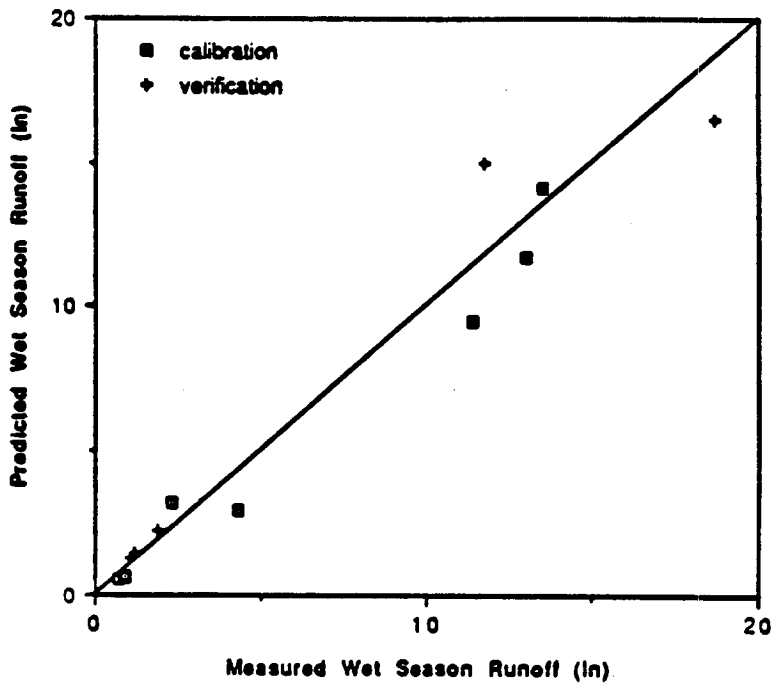

Figure B-9. Predicted versus Measured Wet Season Runoff for San Tomas Aquinas Creek

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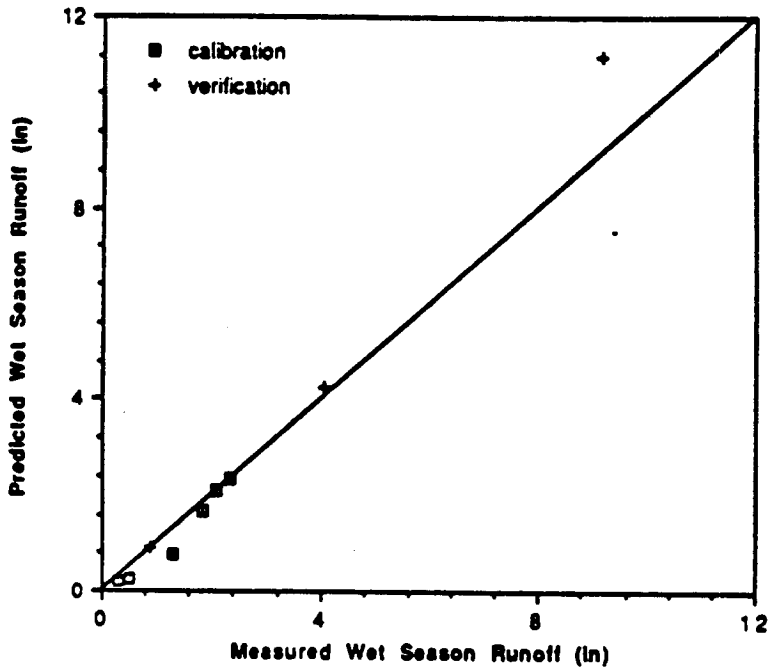

Figure B-10. Predicted versus Measured Wet Season Runoff for Berryessa Creek

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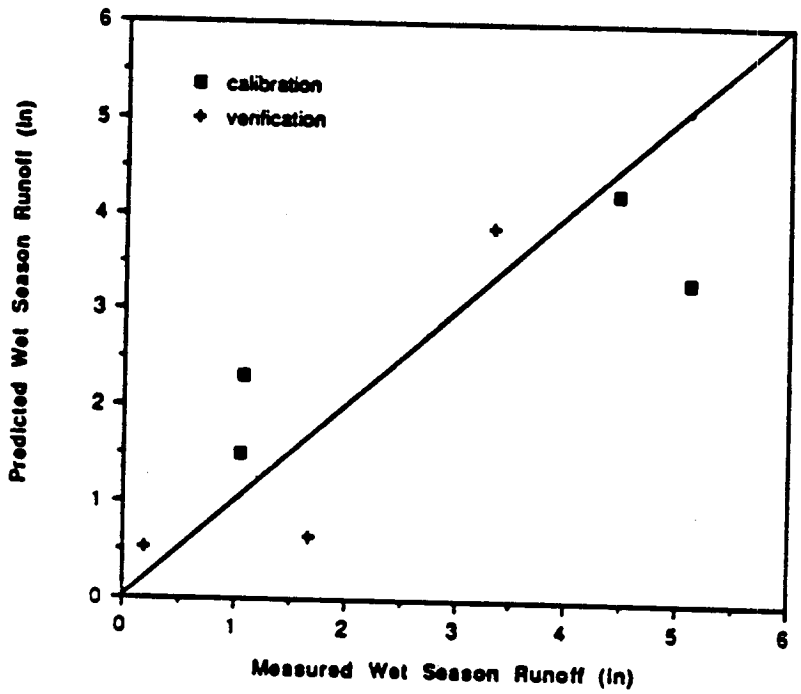

Figure B-11. Predicted versus Measured Wet Season Runoff for the Guadalupe River

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inches, so that the soil did not saturate until after the first or second major storm of the season.

B.3.4.2 Stevens Creek. Stevens Creek is in the western part of the valley, and extends from the county boundary in the Santa Cruz Mountains down to the Bay. Most of the undeveloped portion of the watershed flows into Stevens Creek Reservoir. This reservoir, while designed to store flows in the winter for release in the summer, does commonly release stormwater during wet years. Mean annual rainfall ranges from 12 inches near the Bay to 24 inches just below the reservoir, and is as high as 60 inches above Stevens Creek Reservoir.

Calibration of SWMM was performed only for the portion of the watershed below Stevens Creek Reservoir; flows out of the reservoir were represented by the record for SCVWD gage 44. Rain gage subareas were designated for SCVWD rain gages 100,48, and 121. The model was calibrated against measured flows at SCVWD gage 35, just north of the Central Expressway. To determine the amount of runoff occurring below the reservoir, flows from gage 44 (immediately below the reservoir) were subtracted from flows at gage 35. Also subtracted from the gage 35 record were diversion flows from Permanente Creek into Stevens Creek (measured by the difference between SCVWD gages 32a and 37). Calibration was limited to the period 1975 to 1983, when the diversion gage 37 was discontinued.

Figure B-6 shows the calibration results for Stevens Creek (areas downstream of Stevens Creek Reservoir). The RMSE for the combined calibration/verification period was 34 percent of the mean annual flow, and the BIAS was 1 percent. The model generally performed well, except in the 1981-82 season, when the model overpredicted runoff by about 60 percent. The predicted daily flow distribution passed the Kolmogorov-Smirnov distribution test at the 95 percent confidence level. Because the area downstream of the reservoir is mostly urbanized, the percent impervious area was the most important calibration parameter, although the Green-Ampt

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infiltration parameters were also important in modeling seasonal effects on runoff.

8.3.4.3 Sunnyvale East Channel. This watershed is a small urban area extending from the City of Cupertino down to the Bay. Mean annual rainfall in the basin ranges from 12 to 16 inches. The entire area was modeled using SCVWD rain gage 48. Calibration and verification were performed for the 1977 to 1989 record at SCVWD streamgage 74.

Calibration results are shown in Figure B-7. The RMSE in this case was 9 percent of the mean wet-season volume, while the BIAS was -1 percent. The predicted daily flow distribution passed the Kolmogorov distribution test at the 95 percent confidence level. The most important calibration parameters in this mostly urban, low rainfall catchment was the percent of impervious area; little or no seasonality was observed in runoff response to rainfall.

8.3.4.4 Saratoga Creek. Saratoga Creek extends from the county boundary in the Santa Cruz Mountains to its confluence with San Tomas Aquinas Creek. Mean annual rainfall ranges from 50 inches in the uplands to 12 inches near the Bay. For SWMM modeling, SCVWD rain gage 77 was used to represent the undeveloped upland areas, while rain gage 108 was used in the urban valley floor areas. Calibration and verification were performed on the record for SCVWD gage 25. The 1984-85 season was not included in the calibration or verification periods because the measured flow data for this year indicated an annual runoff coefficient of 0.95, which is unreasonable for a watershed which includes significant open and low-density residential areas.

Calibration and verification results for Saratoga Creek are shown in Figure B-8. The RMSE for the combined calibration/verification period was 22 percent of the mean wet-season volume, while the BIAS was .1 percent. The calibration of this watershed was complicated due to 1) the strong

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infiltration parameters were also important in modeling seasonal effects on runoff.

B.3.4.3 Sunnyvale East Channel. This watershed is a small urban area extending from the City of Cupertino down to the Bay. Mean annual rainfall in the basin ranges from 12 to 16 inches. The entire area was modeled using SCVWD rain gage 48. Calibration and verification were performed for the 1977 to 1989 record at SCVWD streamgage 74.

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Calibration and verification results for Saratoga Creek are shown in Figure B-8. The RMSE for the combined calibration/verification period was 22 percent of the mean wet-season volume, while the BIAS was .1 percent. The calibration of this watershed was complicated due to 1) the strong

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interflow recession component observed in many storms, and 2) the extremely strong response to runoff in wet years. To match observed storm response, it was necessary at times to force the model to shut off infiltration through saturation of the soil profile from below. Thus, the important model parameters were 1) the interflow recession constants, and 2) the soil and groundwater storage parameters.

B.3.4.5 San Tomas Aquinas Creek. This watershed is adjacent to Saratoga Creek and extends from the Santa Cruz Mountain foothills to its discharge point into Guadalupe Slough. Rainfall ranges from 12 to 40 inches per year on average. SCVWD rain gage 79 was used to represent the foothills and upper valley, gage 108 was used on the central valley floor, and the San Jose National Weather Service gage was used in the lower valley floor. Calibration was performed primarily at SCVWD streamgage 24, although data at SCVWD streamgage 29 were used to refine estimates of parameters in the upper portion of the catchment.

Calibration and verification results are shown in Figure B-9. The RMSE for wet-season volumes was 21 percent, while the BIAS was -2 percent. San Tomas Aquinas Creek was very similar to Saratoga Creek in terms of runoff, with storm hydrographs exhibiting a very strong interflow recession component and unusually strong response to rainfall. Again, the most important parameters were (1) interflow recession constants, and (2) soil and groundwater storage coefficients. An additional problem encountered here was the very different behavior of runoff between post-1983 and pre-1983 data. Measured flow data at gage 24 generally indicated less response to rainfall (i.e., lower runoff coefficients) after 1983, and we were unable to arrive at a calibration which could match both periods. One possible explanation for this is a change in the rating curve at gage 24 after the floods of the 1982-83 season.

B 3.4.6 Coyote Creek. This is the largest watershed in the valley, and drains the entire eastern side of the valley. Included are large

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undeveloped areas above Anderson Reservoir, Silver-Thompson Creek, Upper Penitencia Creek, and Berryessa Creek. For SWMM, Coyote Creek was modeled only between SCVWD streamgage 58 (below Anderson Reservoir) and the Bay; most of the area upstream of gage 58 either drain into reservoirs or are undeveloped areas. Storm runoff from these areas was therefore represented by the actual record for streamgage 58. The drainage area below this point is mixed urban and non-urban, with most of the non-urban areas located in the upper portions of Silver-Thompson and Upper Penitencia Creek.

The only streamgage on Coyote Creek below gage 58 is a high-flow gage which records only when stage is above 8.5 feet; the record here is consequently of limited usefulness. However, a continuous stage recorder was installed at this location for the 1988-89 sampling period as part of this study. Thus, Coyote Creek was calibrated for one year only (1988-89). This period was relatively dry, and use of the model for wetter years should be less reliable than if it had been calibrated over a variety of hydrologic conditions. The predicted wet-season volume for this period was 1 percent lower than measured. Because of the dryness of the calibration period, the most important calibration parameter was the percent of impervious area.

B.3.4.7 Berryessa Creek. The Berryessa Creek watershed is located on the eastern side of the valley on the slopes of the Diablo Range, and flows into Coyote Creek near the Bay. Rainfall in this area is much lower than in the Santa Cruz Mountains, and ranges from 14 to 20 inches on average per year. SCVWD rain gage 23 was used to model the upper parts of the catchment, and the San Jose National Weather Service gage was used to model the lower portions of the catchment. Calibration and verification were performed at SCVWD streamgage 64.

Figure B-10 show the calibration and verification results for this watershed. The overall RMSE was 29 percent of the mean annual flow, and the BIAS was 6 percent. The calibration was adequate in most years, with

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most of the RMSE resulting from the 2-inch overprediction of runoff in 1982-83.

B.3.4.8 Guadalupe River. The Guadalupe River is the second largest watershed in the valley, and extends from the Santa Cruz Mountains to the Bay. Major tributaries include Los Gatos Creek, Ross Creek, Calero Creek, Alamitos Creek, and Canoas Creek. Mean annual rainfall in the basin ranges from 12 inches near the Bay to about 50 inches on the Santa Cruz Mountain ridgeline. Rain gages used to model the watershed are shown in Table B-1.

The SCVWD operates an extensive reservoir and recharge system on the Guadalupe River. Most of the areas in the Santa Cruz Mountains drain into Lexington, Guadalupe, Almaden, and Calero reservoirs. Water released from Lexington Reservoir is also stored in Vasona Reservoir. For the most part, these reservoirs are designed to store runoff in the winter and release in the summer for groundwater recharge. However, during wet years the reservoirs do release significant volumes of winter storm runoff. Outflows from each reservoir are measured by stream gages located immediately below the reservoir spillways. Much of the water released by reservoirs during dry weather is diverted downstream into groundwater recharge ponds. Water can also be diverted into the watershed from Coyote Creek through the Coyote-Alamitos Canal.

Calibration and verification of SWMM on the Guadalupe River was performed using the flow record for the U.S. Geological Survey (USGS) gage immediately below the confluence with Los Gatos Creek. This gage is downstream of the recharge ponds, and represents all of the major Guadalupe tributaries. It does not measure runoff from much of the urban San Jose portion of the watershed. Calibration was performed for runoff from areas downstream of reservoirs; runoff above the reservoirs was represented in loads calculations by the actual reservoir release records. To determine the volume of runoff occurring downstream of reservoirs, reservoir releases were subtracted from the USGS gage record using the following rules:

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1) During storms, all of the water released from reservoirs reaches the USGS gage.

2) Between storms, all of the flow recorded by the USGS gage consists of reservoir releases minus diversions to recharge ponds.

These rules basically assume that released water is not diverted during storms, and that dry-weather reservoir releases are much larger than natural baseflow.

Calibration efforts on the Guadalupe River were less successful than at other watersheds, primarily because the Guadalupe River watershed is a highly managed system with numerous storage reservoirs and diversions. Because there were insufficient data to account for all of the stored and diverted water in the watershed, it was difficult to differentiate between storm runoff and water released from other sources. In several years, these data indicated storm runoff coefficients (runoff/rainfall) greater than 1.0 in February and March. As a results, SWMM was calibrated only during periods in which the measured flow data appeared to be reasonable (i.e., had reasonable runoff coefficients). Even focusing on these periods, the calibration/verification resulted in a wet-season RMSE of 40 percent and a BIAS of -2 percent. Calibration and verification results are plotted on Figure B-11. The predicted daily flow distribution passed the Kolmogorov-Smirnov test at the 95 percent confidence level. This calibration could have been improved by using parameter values which were completely inconsistent with those used in other basins. For instance, to match observed dry year totals (when all runoff is from impervious areas), the model would require percent impervious areas ranging from 1 to 20 percent in urban areas. In other similar basins, this parameter generally ranged from 10 to 80 percent. Given the mass balance problems observed in the measured flow data, the final calibration was determined using the best combination of parameters that was consistent with values used on Calabazas, Saratoga, San Tomas Aquinas, and Stevens Creek.

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B.3.4.9 Comparisons of Predictions with Observed Flows for Selected Storms. An important component of any calibration is visual comparison of predicted hydrographs with measured hydrographs. Analysis of calibration statistics alone is not sufficient; visual comparison must also be made to ensure that the model predictions are consistent with our understanding of the relevant physical processes. In this section, selected predicted and measured hydrographs are presented to give the reader some idea of how well we were able to simulate storm hydrographs.

Figures B-12, B-13, and B-14 are examples of the range of hydrograph comparisons we were able to obtain. Figure B-12 shows the measured and predicted daily average flows for February 1980 storms in Calabazas Creek, and is an example of an excellent match between the model and the observed flows. Both the peak and storm recession are accurately predicted by the model. Figure B-13 illustrates a poor match between predicted and observed flows for a December 1977 storm on San Tomas Aquinas Creek. In this case, the model significantly overpredicted the peak flow rate and total storm volume. Figure B-14 shows a perhaps more typical hydrograph comparison for a March 1979 storm on San Tomas Aquinas Creek. Here, the model overpredicts the peak flow rate by about 20 percent, but is able to accurately simulate the total storm volume.

B.4 WATERSHED RUNOFF PREDICTIONS

The goal of the SWMM calibration discussed in the previous section was to produce a model which could 1) estimate runoff in ungaged areas, and 2) estimate the contributions of various land uses to runoff. This section summarizes storm runoff predictions for the Santa Clara Valley. These predictions were made for all watersheds for water years 1977-78 through 1988-89, the period for which rainfall data are available for all catchments.

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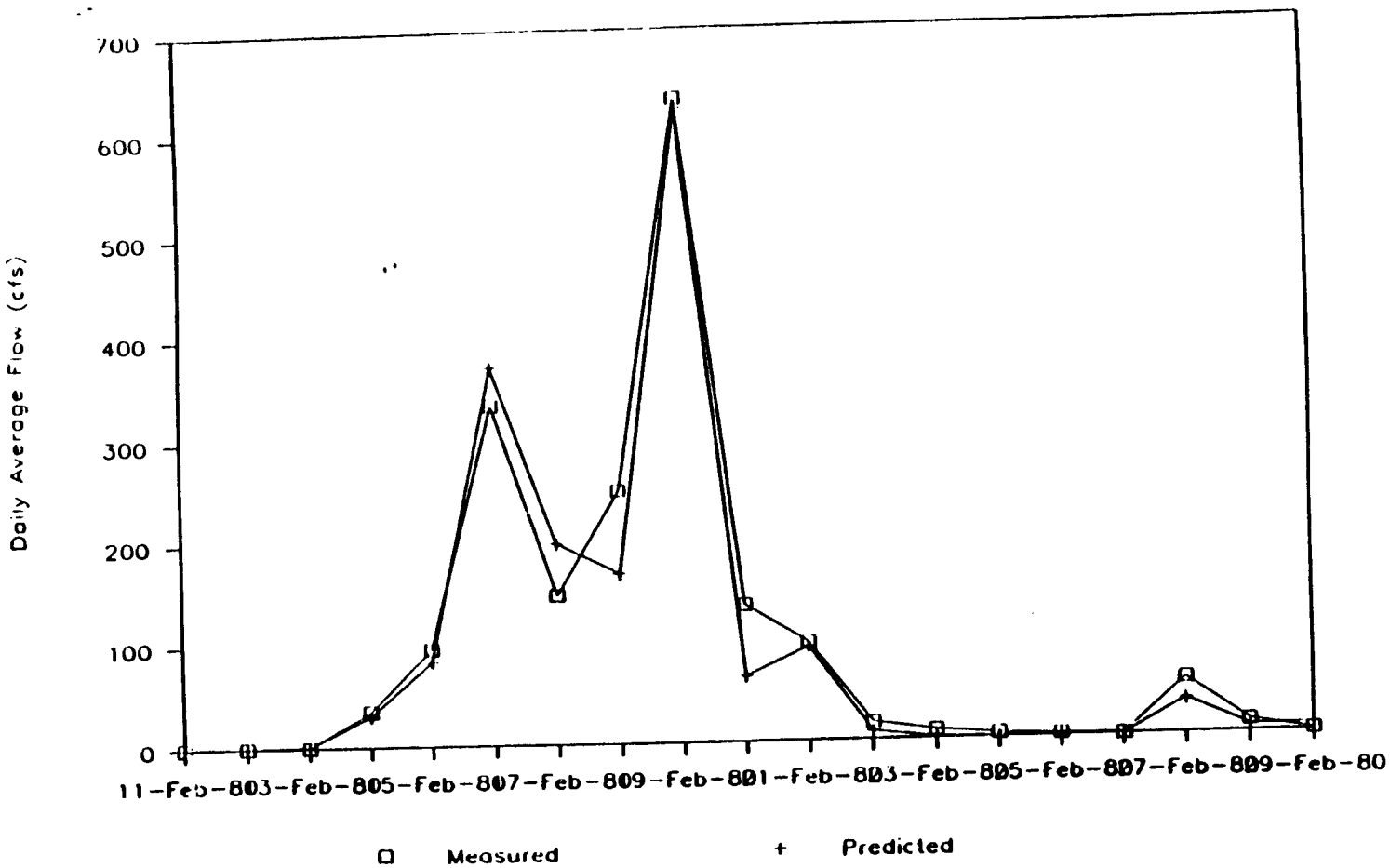

Figure B-12. Comparison of Predicted and Measured Hydrographs for Calabazas Creek, February 1980

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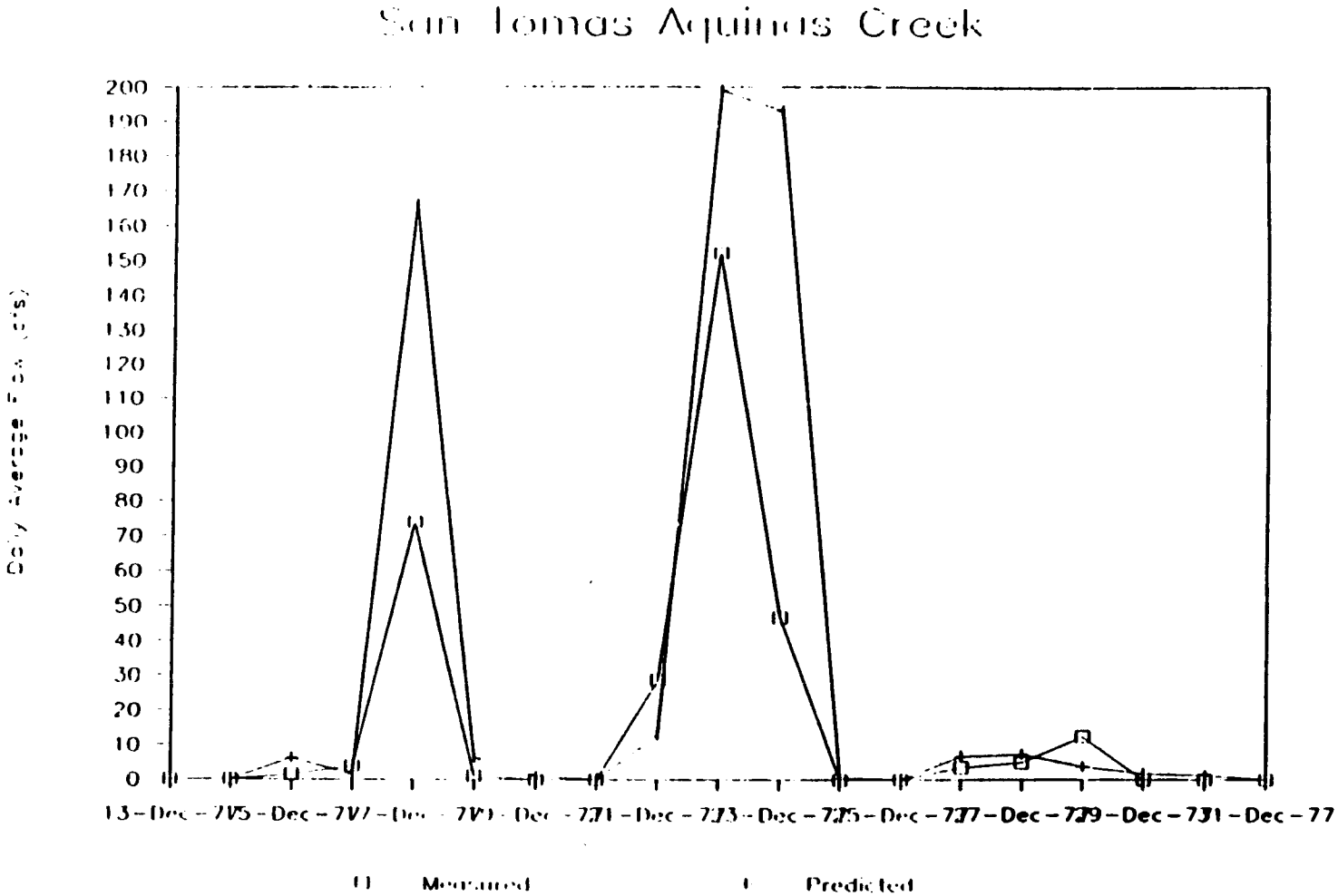

Figure B-13. Comparison of Predicted and Measured Hydrographs for San Tomas Aquinas Creek, December 1977

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Figure B-14. Comparison of Predicted and Measured Hydrographs for San Tomas Aquinas Creek, March 1979

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SWMM was used to predict runoff in three types of areas:

1) Areas for which the model was calibrated against measured streamflow data

2) Areas in calibrated watersheds that are downstream of the calibration gage

3) Watersheds for which no flow data are available for calibration

For areas in which the model was calibrated, flow predictions were made by simply running the calibrated version of the model for the projection period. To account for model errors in calibration/verification years, the predicted flows for each land use were then multiplied by the ratio of wet-season measured runoff to predicted runoff for that year. This correction scaled the predicted flows to match measured totals exactly, and assumed that the correction factor was the same for all land uses.

For watersheds with streamflow data for calibration, there were usually uncalibrated urban areas in the lower portions of the watersheds. This applies to the following watersheds: Coyote Creek, Guadalupe River, Calabazas Creek, Saratoga Creek, San Tomas Aquinas Creek, Sunnyvale East Channel, and Stevens Creek. Because Sunnyvale East Channel best represents typical northern valley urban areas, parameters calibrated for this watershed were used in other uncalibrated urban areas. Soils parameters were estimated based on soil type and calibration in areas with similar soils.

Most of the western portion of the valley has little or no flow data for calibration. This includes Permanente Creek, Adobe, Matadero, and Barron creeks, and Sunnyvale West Channel. In addition, as only the portion of the San Francisquito Creek watershed in Santa Clara County was modeled, flow data could not be used for calibration. In these areas, parameters were estimated from similar calibrated watersheds. In urban

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areas on the lower valley floor, parameters were estimated based on the calibration for Sunnyvale East Channel. In areas on the upper valley floor, parameters were estimated from the calibrations for Stevens Creek and Calabazas Creek. Finally, in upland areas calibration results for Stevens, Calabazas, and San Tomas Aquinas creeks were used to estimate parameters.

Table 8-9 summarizes the predicted annual storm runoff volumes for each watershed in the valley. As would be expected based on the relative drainage areas, 50 percent of storm runoff on average comes from Coyote Creek and the Guadalupe River. The highest runoff volume occurred during the 1982-83 season, while the lowest occurred in the 1988-89 season.

8.5 DETERMINISTIC WATER QUALITY MODELING OF CALABAZAS CREEK

As described in Section 8, loads in this study were derived as the product of annual runoff volume (from SWMM modeling) and annual mean concentration for each constituent and land use. These mean concentrations were obtained from statistical analysis of the water quality data collected at the land use and stream sampling stations. An alternative approach to estimate loads is to use the semi-empirical buildup-washoff models included in SWMM to predict runoff water quality. While these models are highly empirical and largely unverified, they do attempt to represent a number of the physical processes that are thought to determine runoff water quality. To compare this approach to the statistical mean concentration approach used in this study, the SWMM buildup washoff model was applied to estimate annual load from the Calabazas Creek watershed. A description of the model, calibration results, and predicted loads are provided in this section, as well as a comparison of the buildup-washoff load predictions to those derived from the statistical mean concentration model.

8.5.1 Model Description

The SWMM runoff water quality model is based on the concept of pollutant buildup and washoff. The concept behind this model is that a

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Table B-9. Storm Runoff Predictions for the Study Area

TOTAL WET WEATHER FLOWS (ac-ft)

Year	Coyote	Guadalupe	San Tomas	Saratoga	Calabazas	Sunnyvale East	Sunnyvale West	Stevens	Permanante	ABM	San Franciscquito	Total
77-78	15255	47158	14145	5110	9652	2192	1746	1632	5986	9357	1834	114066
78-79	11374	7491	5058	1630	3800	1160	1011	1204	1443	4082	755	39008
79-80	22384	26979	12414	6922	8136	2191	1510	1979	6685	9352	1973	100523
80-81	6089	6946	3646	1408	2297	925	694	676	982	2967	330	26960
81-82	16827	46421	14022	10786	9539	2526	2038	1645	9066	11845	2634	127348
82-83	42636	97976	20866	21380	15557	3698	2874	4787	17934	17617	3801	249125
83-84	8054	6372	4893	3483	4282	1190	1003	896	832	4441	992	36439
84-85	6609	8927	2539	814	2044	1383	1011	845	1176	3407	655	29411
85-86	18857	78009	12902	13197	8308	2792	1980	2167	8972	11678	1599	160462
86-87	5400	5709	1584	704	1856	689	577	445	452	3303	1521	22238
87-88	6799	8625	2141	977	2138	828	783	652	722	2317	366	26348
88-89	3507	1287	1877	506	1154	553	613	456	347	1293	200	11792
Average	13649	28492	8007	5577	5730	1677	1320	1449	4550	6805	1388	78643

TOTAL WET WEATHER FLOWS (%)

Year	Coyote	Guadalupe	San Tomas	Saratoga	Calabazas	Sunnyvale East	Sunnyvale West	Stevens	Permanante	ABM	San Franciscquito	Total
77-78	13.4	41.3	12.4	4.5	8.5	1.9	1.5	1.4	5.2	8.2	1.6	100
78-79	29.2	19.2	13.0	4.2	9.7	3.0	2.6	3.1	3.7	10.5	1.9	100
79-80	22.3	26.8	12.3	6.9	8.1	2.2	1.5	2.0	6.6	9.3	2.0	100
80-81	22.6	25.8	13.5	5.2	8.5	3.4	2.6	2.5	3.6	11.0	1.2	100
81-82	13.2	36.5	11.0	8.5	7.5	2.0	1.6	1.3	7.1	9.3	2.1	100
82-83	17.1	39.3	8.4	8.6	6.2	1.5	1.2	1.9	7.2	7.1	1.5	100
83-84	22.1	17.5	13.4	9.6	11.8	3.3	2.8	2.5	2.3	12.2	2.7	100
84-85	22.5	30.4	8.6	2.8	6.9	4.7	3.4	2.9	4.0	11.6	2.2	100
85-86	11.8	48.6	8.0	8.2	5.2	1.7	1.2	1.4	5.6	7.3	1.0	100
86-87	24.3	25.7	7.1	3.2	8.3	3.1	2.6	2.0	2.0	14.9	6.8	100
87-88	25.8	32.7	8.1	3.7	8.1	3.1	3.0	2.5	2.7	8.8	1.4	100
88-89	29.7	10.9	15.9	4.3	9.8	4.7	5.2	3.9	2.9	11.0	1.7	100
Average (%)	21.2	29.6	11.0	5.8	8.2	2.9	2.4	2.3	4.4	10.1	2.2	100

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supply of constituents builds up on the land surface during dry periods and is subsequently washed off during a storm. Pollutant buildup is assumed to occur as a function of time between storms. During a storm, washoff is assumed to occur as a function of the available mass of pollutants on the land surface and the rate of runoff. While the buildup-washoff concept does explain some of the mechanisms thought to produce runoff water quality, the model itself is highly empirical and requires substantial calibration to produce reasonable results.

Many studies have been conducted to determine rates of buildup on city streets. Sartor and Boyd (1972), among others, found that buildup appears to be non-linear, deveioping rapidly at first and then leveling off to a limit. This form of buildup is implemented in SWMM using an exponential buildup function:

$$P_{Shed} = P_{lim}*(1-\exp(-K_b*t)) \qquad (8-7)$$

where

P_{Shed} = mass of constituent in watershed at time t (lbs/acre)
P_{lim} = upper limit on constituent mass that can accumulate (lbs/acre)
K_b = buildup rate constant ($days^{-1}$)
t = time between storms (days)

Washoff is the process that mobilizes the accumulated constituents into runoff and streamflow. In stream channels and other areas of significant flow, this process is described by sediment transport theory, where flow rate and bottom shear stress are important factors. For thin overland flows (sheet flows) common during storms in urban environments, rainfall energy can also mobilize particles. Therefore, more intense storms are able to washoff more of a constituent than a less intense storm. Whatever mechanisms are involved, it is obvious that as rainfall and washoff continue the amount of constituen. remaining in the watershed diminishes.

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This observation, combined with the results of several empirical studies leads to the washoff formula used in SWMM:

$$Poff(t) = K_w * r^c * P_{shed} \qquad (B\text{-}8)$$

where

Poff = amount washed off at time t (lbs/acre)
K_w = washoff coefficient
r = runoff rate (in/hr)
c = empirical washoff exponent

Thus, the model has four input parameters: the limiting buildup rate (P_{lim}), the buildup rate constant (K_b), the washoff coefficient (K_w), and the washoff exponent (c). The buildup limit sets an upper limit on the availability of the constituents, and has a linear effect on the total mass load. The buildup rate constant sets the time scale of buildup between storms and thus attempts to capture the effects of "antecedent conditions." It can therefore be used to match observed water quality variations between sequential storm events. The washoff coefficient has a linear effect on the total mass that washes off during a storm. The washoff exponent primarily controls how load varies with time during a storm.

B.5.2 Model Calibration

None of the buildup-washoff model parameters can be measured directly, and all must be estimated by calibrating the model against measured water quality data. Few data on initial estimates of the buildup parameters are available in the literature for the types of constituents of concern in this study, although there are data on buildup rates of "dust and dirt" on parking lots and streets. The SWMM manual suggests an initial estimate of the washoff coefficient K_w of 4.6 in_{-1}, although other studies have used values ranging from .052 to 6.6 in_{-1}. The washoff exponent is suggested to range from 1.0 to 2.0, with a median value of 1.5.

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8.5.2.1 Data Used for Calibration. The buildup washoff model was calibrated against water quality data collected at the Calabazas Creek monitoring station (S1) for five storms in the 1988-89 season. The available water quality data consisted of Event Mean Concentrations (EMCs) derived from composite samples; no data on the time-dependence of concentrations within a storm were available. Three constituents, Total Suspended Solids (TSS), copper and lead, were chosen for this test of the water quality model portion of SWMM. Measured EMCs used in calibration are listed in Table B-10.

8.5.2.2 Calibration Methods. The goal of calibration was to match to the extent possible the observed EMCs for the five storms for each constituent. Calibration was performed by systematically changing the values of the four buildup washoff parameters to minimize the difference between the simulated and observed EMCs. A number of parameters were used to measure the accuracy of the calibration. The root mean square error (RMSE) of predicted vs. observed EMCs was used to quantify the magnitude of model calibration errors. This was reported as a percentage of the mean measured concentration. The BIAS, or sum of errors, was used to indicate if the model was systematically under or overpredicting EMCs. To verify that the model was reproducing the statistics of the measured data, the predicted mean and coefficient of variation of the EMCs for the five storms were compared to the mean and coefficient of variation of the observed data. Finally, the data for each storm were tabulated and plotted as a function of time to verify whether or not the model was reproducing the observed trends in the data.

8.5.2.3 Calibration Results. Table B-10 compares the calibrated model to the measured data, and lists the calibration statistics for each constituent. Final calibrated values of the model input parameters are shown in Table B-11. RMSEs for the calibrations ranged from 19 percent for copper to 25 percent for TSS, and were relatively unbiased. The model was able to accurately reproduce the means of the observed data, but consistently underestimated the coefficient of variation of the data.

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Table B-10. MEASURED AND CALIBRATED EMCs

STORM	TSS mg/l		Copper ug/l		Lead ug/l	
	Measured	Calib.	Measured	Calib.	Measured	Calib.
11/23/89	360	230	95	67	99	92
2/3/90	34	170	30	50	60	68
2/8/90	63	186	31	55	36	74
3/2/90	180	192	44	56	5	77
3/23/90	205	116	58	34	80	47
Mean	195	180	53	53	80	72
CV	1.22	0.26	0.51	0.26	1.80	0.26
% RMSE		25		19		22
% BIAS		18		9		28

CV = Coefficient of Variation

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Table B-11. CALIBRATED VALUES OF WATER QUALITY MODEL INPUT PARAMETERS

Constituent	Plim	Kb	Kw	a
TSS	82000	0.04	2.3	1.3
Copper	24	0.04	2.3	1.3
Lead	33	0.04	2.3	1.3

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Figure B-15 compares the predicted and observed EMCs as a function of time for Copper. The model was able to reproduce the relatively high concentrations observed in the first November storm, but was unable to simulate the low concentrations found in the January and February storms. Much of the rainfall in 1988-89 occurred in the last week of December 1988, and the low concentrations observed in January may be a result of heavy washoff of constituents from street surfaces in December. However, the model did not reproduce this effect. The model also could not reproduce the rapid drop in concentration that was measured in the second of the two March storms. Overall, although the model was on average able to match observed concentrations with an RMSE of about 20 percent, it was not particularly successful at matching the observed sequence and timing of storm concentrations.

B.5.3 Comparison of Annual Load Estimates for Deterministic and Constant Concentration Water Quality Models

The calibrated water quality model was used to estimate annual loads for the 12 year simulation period (water years 1977-78 to 1988-89). Table B-12 compares these results to the annual load predictions obtained from the statistical mean concentration model. In dry years such as the 1988-89 calibration period the two models give comparable estimates of annual load. However, the deterministic water quality model predicts loads that are 2-3 times lower in wet years such as 1982-83. Overall, the deterministic water quality model predicts significantly lower concentrations than does the mean concentration model.

The reasons behind this difference between the two methods lie primarily in the assumptions behind the buildup-washoff model. During wet years, the buildup-washoff model assumes that the increased number of storms will reduce the mass of pollutant available on the street surfaces for washoff. Thus, although flow volumes may be an order of magnitude higher in wet years than in dry years, predicted concentrations in runoff are lower due to this source limitation effect. On the other hand, the

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Figure B-15. Observed vs. Predicted Concentrations for Copper

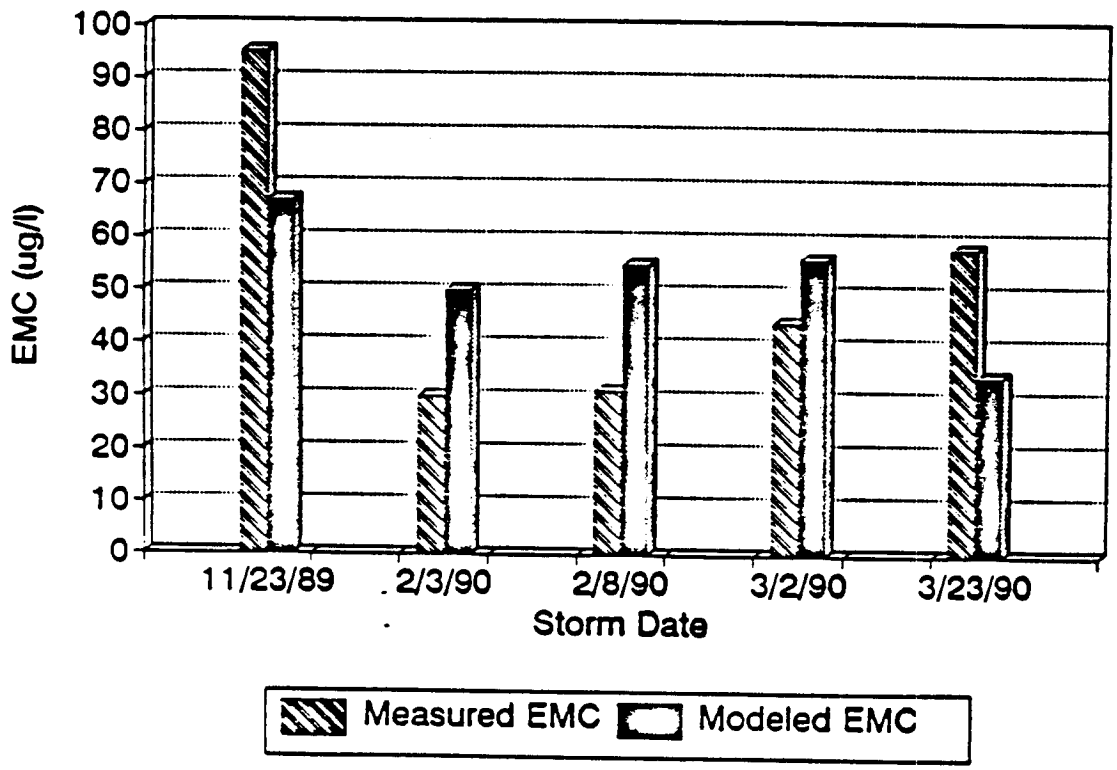

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Table B-12. COMPARISON OF ESTIMATED LOADS FOR CALABAZAS CREEK

LOAD IN POUNDS

WATER YEAR	TSS Buildup-Washoff	TSS Mean Conc.	COPPER Buildup-Washoff	COPPER Mean Conc.	LEAD Buildup-Washoff	LEAD Mean Conc.
1978	2,000,000	7,400,000	559	1,798	798	1,791
1979	1,210,000	2,900,000	338	700	483	696
1980	1,980,000	6,200,000	555	1,485	793	1,475
1981	1,180,000	1,800,000	330	422	472	420
1982	2,860,000	7,300,000	800	1,760	1,140	1,751
1983	2,980,000	11,900,000	834	2,850	1,190	2,831
1984	1,460,000	3,300,000	407	797	582	794
1985	1,260,000	1,600,000	352	405	503	407
1986	1,980,000	6,300,000	554	1,601	791	1,604
1987	724,000	1,400,000	203	375	289	378
1988	1,060,000	1,600,000	296	426	423	428
1989	580,000	870,000	162	238	232	240
Mean	1,630,000	4,380,833	457	1,071	652	1,068
Mean w/o 1982-83	1,481,273	3,697,273	414	910	591	908

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mean concentration method assumes no difference in average water quality between wet and dry years. There is of course no direct evidence that the "dilution" effect predicted by the buildup-washoff model actually occurs. In this study, little or no correlation was found between the time between storms and runoff concentration, implying that the number of storms in a year should have little effect on water quality concentrations.

In summary, the deterministic water quality model predicts significantly lower loads and concentrations in wet years. The model does account for a number of mechanisms that one would intuitively believe to occur during and between storms. However, the model requires substantial calibration, and was not able to accurately simulate observed patterns in water quality during the 1988-89 monitoring period. The mean concentration model used in loads estimation in the remainder of this study makes direct use of the observed water quality data, and requires little calibration. The mean concentration model, however, is unable to account for possible differences in water quality during wet and dry years. Currently, there are no data available to determine which (if either) of these models is best able to simulate water quality in wet years.

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APPENDIX C

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APPENDIX C
SUMMARY OF LABORATORY QA/QC

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APPENDIX C
SUMMARY OF LABORATORY QA/QC

Evaluation of the quality of the analytical data included:

1) Precision of laboratory duplicates (Table C.1)
2) Precision of field duplicates (Table C.2)
3) Precision of matrix spike and matrix spike duplicate recoveries (Table C.3)
4) Potential contamination of field and laboratory (method or reagent) blanks (Table C.4)
5) Laboratories performance on Environmental Resources Associates (ERA) quality control samples (Table C.5)

C.1 WATER SAMPLES

C.1.1 Laboratory Duplicates

Laboratory duplicates were routinely performed by the laboratory for a reduced suite of parameters. The only exception was for dry-weather 3 (May 12, 1989) and wet-weather 1 sampling events (May 5, 1989), where laboratory duplicate analyses were not generated. Results of laboratory duplicate analyses are presented in Tables C.1-1 to C.1-12. The precision of the laboratory duplicates is an indication of the variability in the extraction and analytical procedures in the laboratory. This precision is commonly expressed as a relative percent difference (RPD). The RPD was calculated by the following equation:

$$|\text{Conc (A)} - \text{Conc (B)}|/[[\text{Conc (A)} + \text{Conc (B)}]/2]$$

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where

Conc (A) = Concentration of primary duplicate sample
Conc (B) = Concentration of secondary duplicate sample
|Conc (A) - Conc (B)| = Difference between concentrations of primary and secondary duplicates expressed as absolute values

For the dry-weather sampling events 1, 2, 4, 5, 6, and 7, the RPD ranged from 0 to 29%, with a mean value of 6%. The RPDs for all wet-weather sampling events (2 to 7) were between 0 to 40% (mean of 16%), with the exception of two elevated RPDs for lead (55%) and mercury (100%) analyses for wet-weather 2 duplicate samples. Thus the reported RPDs for both dry and wet-weather samples are considered to be within laboratory acceptable limits.

C.1.2 Field Duplicates

Results of field duplicate samples are an indication of overall field variability, precision of field sampling and laboratory analyses. As such, the results of field duplicates have more variability than laboratory duplicates, which measure only laboratory performance. Field duplicate samples were collected and analyzed for a reduced parameter suite for all dry and wet-weather sampling events, with the exception of wet-weather 1 (May 5, 1989). The results of field duplicate analyses are presented in Tables C.2-1 to C.2-13. For all dry-weather field duplicate samples, the RPD ranged from 0 to 100%, with a mean of 23%. The RPD ranged from 0 to 94% for all wet-weather field duplicate samples; the mean value was 31%. These mean field duplicate RPDs are higher than the laboratory duplicate RPDs by about a factor of two to three, and likely represent the additional variability from field sampling.

C.1.3 Matrix Spike and Matrix Spike Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) recovery data are performed to evaluate accuracy and precision of each individual analytical

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method. The results of MS and MSD recoveries and also the RPD of these matrix spikes are summarized in Tables C.3-1 to C.3-10. Matrix spike recoveries for specific compounds analyzed under each method evaluated in this program were within acceptable limits according to the current EPA guidance for laboratory analyses (EPA, Test Methods for Evaluating Solid Waste, SW846, Third Edition). The RPD between MS and MSD recoveries were generally less than 30%, and therefore considered to be within EPA acceptable limits.

C.1.4 Laboratory (Method or Reagent) and Field Blanks

The purpose of laboratory and field blank analysis is to detect potential contamination from the laboratory and/or field sampling. All laboratory method blanks and field blanks were generally free of contaminants, with the exception of the detections of some organic compounds and metals.

C.1.4.1 Metals. It is important to note that the collection of field blanks in this sampling program was different for the dry- and wet-weather sampling events. Field blanks were obtained using procedures identical to those for collection of field samples. Dry-weather samples were collected by dipping sample containers in the sampling stream. Correspondingly, field blanks were collected by pouring laboratory reagent water (Milli-Q purified) into sample containers at each sampling station. Wet-weather composite samples were collected in the ISCO samplers in 10-liter borosilicate bottles, which were then taken to the laboratory. In the laboratory, a peristaltic pump with Teflon hose was used to fill individual sample bottles required for the various analyses (e.g., metals, pesticides, etc.). The Teflon hose was flushed with laboratory reagent water every time a new 10-liter sample bottle from each of the sampling stations was to be drained. At the end of this process, the Teflon hose was flushed and then laboratory reagent water was used to fill sample bottles for the blank analysis. This method of blank collection is commonly known as an

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equipment blank. Hereinafter, all "field blanks" collected in the wet-weather period will be referred to as equipment blanks.

For the dry-weather samples, field blanks showed low levels of zinc contamination in dry-weather 4 (0.011 mg/L), dry-weather 5 (0.014 mg/L), dry-weather 6 (0.010 mg/L), and dry-weather 7 (0.006 mg/L). These levels of zinc were generally equal to or lower than the actual zinc levels found in the stream samples (Stations S1 to S4). No zinc contamination was found in the method blank analyses for the above-listed dry-weather sampling rounds. Because the method blanks were free of contamination, the source of the zinc contamination in the field blank is not the laboratory reagent water or the acid-preservative.

In addition, mercury and lead were detected at 0.0003 mg/L and 0.003 mg/L in dry-weather 4 and 6, respectively. The impact of mercury and lead contamination on the actual concentrations found in water samples is minimal because of the following reasons:

1) Mercury and lead were not detected in method blanks.

2) Mercury and lead concentrations in the field blank are close to the detection limit of 0.0001 mg/L and 0.001 mg/L, respectively.

3) Mercury levels detected in actual water samples are about 10 times higher than those found in the field blank.

4) Lead was not detected in actual water samples except for a lead concentration of 0.004 mg/L detected in one stream sample.

For the wet-weather samples, low levels of some metals were detected in the equipment blanks from wet-weather 2 (Table C.4-8), wet-weather 3 (Table C.4-10), wet-weather 5 (Table C.4-12), and wet-weather 7 (Table C.4-14). The source of contamination is potentially from carryover

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of residual metals found in the hose used with the peristaltic pump. The concentrations found in the actual water samples were not corrected for these metal contaminants because all method blanks were generally free of metal contamination for the above-listed wet-weather sampling events with the exception of wet-weather 2, in which cadmium was detected in the method blank at the detection limit of 0.0002 mg/L.

For wet-weather 6, five metals--chromium (0.052 mg/L), copper (0.011 mg/L), lead (0.001 mg/L), nickel (0.06 mg/L), and zinc (0.018 mg/L)--were detected in the equipment blank. The source of these elevated metals is probably from the laboratory water. Because the Milli-Q purification system was broken during this sampling event, laboratory water was obtained from the solar still, which probably contained the elevated metals. Although the equipment blank was contaminated, the metals results for the actual water samples should not be affected because the samples did not come in contact with the solar still water except perhaps for a very small volume that may have adhered to the tubing from the flushing operation. The method blank analysis generally did not detect any metals concentrations that were comparable to those found in the equipment blank. For wet-weather 6, the only metal detected above the detection limit in the method blank was chromium. Chromium was detected at 0.002 mg/L in the first method blank and at a lower level of 0.001 mg/L in the second method blank.

C.1.4.2 Organics. Two volatile organics, methylene chloride and acetone, were detected in method blanks. Methylene chloride was detected at 6, 11, and 7 µg/L in method blanks for dry-weather 1 and 2, and wet-weather 1, respectively. Acetone was detected twice at 27 and 20 µg/L for dry-weather 2 and wet-weather 1, respectively. These volatile organics are commonly used solvents in the laboratory for sample extractions. Therefore, the detections of methylene chloride and acetone in storm runoff samples during dry-weather 1 and 2, and wet-weather 2, are suspect and most probably due to laboratory contamination.

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A semi-volatile organic, bis(2-ethylhexyl)phthalate (BEHP), was detected in method blanks from dry-weather 1 and 2, and wet-weather 1 and 2. The concentrations of BEHP ranged from 11 to 800 µg/L. The presence of BEHP is common in plastic material such as gloves and tubing. According to the current guidance from EPA on evaluation of phthalate data (EPA 1988), phthalates are common laboratory contaminants at levels of less than 100 µg/L. Based on evidence of BEHP contamination in the laboratory and EPA's current position on phthalate compounds, the detections of BEHP in storm runoff samples from L1, L2, and L6 are therefore suspect and most probably due to laboratory contamination.

A detection of 4,4'-DDE at 0.077 µg/L was found in a field blank from wet-weather 3. Since this organochlorine compound, 4,4'-DDE, was not detected in any of the storm runoff samples for wet-weather 3, this one-time detection of 4,4'-DDE in a field blank is likely due to field or laboratory contamination, and does not impact the results of organochlorine analyses of water samples collected from wet-weather 3.

C.2 SEDIMENT SAMPLES

Results of QC analyses for sediment samples are presented in Tables C.1-13, C.2-14 to C.2-16, and C.3-11 to C.3-14. Generally, the RPDs for laboratory and field duplicates were similar to those reported for the water samples. Matrix spike recoveries and RPDs of these matrix spike recoveries were also within acceptable limits.

As with the water samples, BEHP was detected in method blanks in the second and third sampling rounds. BEHP concentrations ranged from 940 to 2400 µg/kg The ubiquitous presence of BEHP in both laboratory and field environments is discussed earlier in Section C.1.4. Detections of BEHP in actual sediment samples from sampling events 2 and 3 are therefore suspect and likely due to laboratory artifacts.

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C.3 EXTERNAL REFERENCE SAMPLES

External reference samples were submitted to the laboratories by the Project Quality Control Officer. These samples were supplied by Environmental Resource Associates (ERA), Arvada, Colorado, with certified analyses of target parameters. External reference samples were selected by the project quality control officer to match specific method analyses, expected concentration ranges, and sample matrices as closely as possible. The analytical results supplied with the reference samples were not disclosed to the individual laboratories. Samples were submitted a total of five times on a quarterly basis throughout the study. A summary of the results of comparisons between laboratory performance and ERA results for selected constituents is presented in Table C.5.1. Results of each quarter are presented in Tables C.5.2 through C.5.6.

C.3.1 First Quarter ERA Quality Control Samples, 1988

All laboratory reported concentrations were within the advisory ranges of the external reference samples except for arsenic, semi-volatiles (1,2,3-trichlorobenzene), and pesticides (gamma-BHC and PCBs, Aroclor 1242). The advisory range is the range of values that an experienced laboratory can expect to attain using the most precise methods and equipment. In determining advisory ranges, ERA considers both the parameter and the most commonly used method of analysis for the parameter. The arsenic value was outside the advisory range, but was determined to be an acceptable level of performance by the individual laboratory. True and advisory values for ERA organic quality control samples (volatiles, semi-volatiles, pesticides and PCBs, and herbicides) are based on analytical results from applicable EPA reference methods. True values represent 100% recoveries for the analyses. Since many organic analytical methods do not yield 100% recoveries, ERA advisory ranges reflect typical recoveries from water samples for the applicable EPA methodologies. The semi-volatile and pesticides and PCBs values were within an acceptable level of performance by the laboratory.

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C.3.2 Second Quarter ERA Quality Control Samples

Laboratory reported values were within the advisory ranges except for the conventional constituents (BOD and TKN), and organic quality control samples such as volatiles (chloroform) and semi-volatiles (acenaphthene, benzo(a)pyrene, 2-chloronaphthalene, 1,3-dichlorobenzene and hexachlorobutadiene). The conventional constituent values were within acceptable levels of performance. The organic sample values were low due to laboratory contamination problems experienced during sample preparation.

C.3.3 Third Quarter ERA Quality Control Samples

Laboratory reported values outside the advisory ranges were for conventional constituents (TKN, ammonia, and phosphate) and organic quality control samples including:

1) Semi-volatiles (hexachloroethane, 1,2,4-trichlorobenzene, 2-chloronaphthalene, acenaphthylene)
2) Pesticides (aldrin and heptachlor epoxide)
3) PCBs (Aroclor 1242)

The pesticides and PCBs true values were near or below the detection limits for the laboratory, which caused recovery values to be unattainable by the laboratory.

C.3.4 Fourth Quarter ERA Quality Control Samples

Laboratory reported values were within the advisory ranges except for trace metals (arsenic, mercury, selenium, and silver), conventional constituents (ammonia, nitrate, phosphate), and organic quality control samples including semi-volatiles (1,4-dichlorobenzene and bis(2-chloroisopropyl)ether), PCBs (Aroclor 1221), and herbicides (2,4-D and 2,4,5-TP). The true values for PCBs and herbicides were below the detection limits for the laboratory and recovery values were unattainable. The herbicides ERA sample was no longer analyzed because the

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concentration levels of the analyte were always below laboratory detection limits. Due to complications during sample preparation for the metals analysis, low recoveries were reported by the laboratory. The conventional constituent values were acceptable levels of performance.

C.3.5 First Quarter ERA Quality Control Samples, 1989

Laboratory reported values were within the advisory ranges except for trace metals (lead and cadmium), and the organic quality control samples: pesticides (endrin aldehyde) and PCBs (Aroclor 1221). The concentration of endrin aldehyde and Aroclor 1221 were below the laboratory detection limits. The conventional constituent values and the trace metal values were acceptable levels of performance.

C.4 CONCLUSIONS

In summary, the QA/QC data are of acceptable quality according to the current EPA guidelines for laboratory analyses. Based on this QA/QC evaluation, the chemical data (water and sediment) collected in this program are therefore considered of good and reliable quality.

The precision of the data, represented by the relative percent difference (RPD), was evaluated for both field and laboratory duplicates. For field duplicates collected during wet and dry weather periods, the RPD ranged from 0 to 100 percent with an associated mean of 27 percent. For laboratory duplicates, the RPD ranged from 0 to 29 percent (mean of 6 percent) for dry weather samples, and 0 to 40 percent (mean of 16 percent) for wet weather samples. Results of field duplicate samples are an indication of overall field variability, and precision of field sampling techniques and laboratory analyses. As such, the results of field duplicates show more variability than laboratory duplicates, which measure only the precision of laboratory methods.

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The accuracy of the data is represented by the results of (1) matrix spike recoveries, and (2) external reference standards. Matrix spike recoveries for all constituents were within acceptable limits. Based on the results of five rounds of external reference standards, most of the metals concentrations (arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc) and other conventional pollutants (TKN, nitrate, phosphate, BOD, and total suspended solids) were within the "true" concentrations, therefore indicating that they are reliable values. It is important to note that cadmium, chromium, copper, lead, nickel, and zinc are the five metals used for estimates of metals loads to the Bay. For selenium and silver, however, the actual measured concentrations appear to underestimate the "true" concentrations by about 10 to 30 percent. These two metals were not used in the loading estimates, and were consistently found at low levels with a few values above the detection limit.

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APPENDIX C.1
PRECISION OF LABORATORY DUPLICATES

Table C 1.1 Dry Weather 1

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID. PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	RPD (%)	DATE SAMPLED
Chlorinated Herbicides	SW8150	03-137-1	03-137-11	S1	DW#1	2,4-D Dinamba	WATER	ug/L	13 5.1	13 4.9	0 4	27-Aug 88
TOX	SW9020	03-137-1	03-137-12	S1	DW#1	TOX	WATER	mg/L	0.00	0.00	0	27-Aug 88

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Table C 1 2 Dry Weather 2

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	RPD (%)	DATE SAMPLED
METALS	SW6010	2274-5	2274-5	S1	DW#2	Copper	WATER	mg/L	0.051	0.052	2	31-Mar-88
						Lead		mg/L	0.0006	0.0008	29	
						Mercury		mg/L	0.0003	ND	-	
						Silver		mg/L	0.0013	0.0012	8	
						Zinc		mg/L	0.003	0.003	0	
Organophos Pesticides	SW8140	S8-04-002-04	S8-04-002-04	S1	DW#2	Organophos. Pesticides	WATER	mg/L	ND	ND	-	31-Mar-88
NH3N	350.1	2274-4	2274-5	S4	DW#2	NH3N	WATER	ug/L	110	115	4	31-Mar-88
TKN	351.2	2274-4	2274-5	S4	DW#2	TKN	WATER	ug/L	690	720	4	31-Mar-88
TOC	415.1	2274-4	2274-5	S4	DW#2	TOC	WATER	ug/L	11400	11100	3	31-Mar-88
TKN	351.2	2274-5	2274-5	S4	DW#2	TKN	WATER	mg/L	2.2	2.2	0	31-Mar-88
BOD	405.1	2274-5	2274-5	S4	DW#2	BOD	WATER	mg/L	>15	>15	-	31-Mar-88
TSS	160.2	2274-5	2274-5	S4	DW#2	TSS	WATER	mg/L	20	22	10	31-Mar-88
pH	E150.1	2274-5	2274-5	S4	DW#2	pH	WATER	-	0.1	0.1	0	31-Mar-88
Pesticides & PCBs	E608	2274-5	2274-5	S4	DW#2	Pesticides/PCBs	WATER	ug/L	ND	ND	-	31-Mar-88
Chlorinated Herbicides	SW8150	84-020-0	84-020-0	S1	DW#2	Chlorinated Herbicides	WATER	ug/L	ND	ND	-	31-Mar-88

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Table C 1 3 Dry Weather 4

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	RPD (%)	DATE SAMPLED
Chlorinated Herbicides	SW8150	08 610 08	08 610 11	S1	DW#4	Chlorinated Herbicides	WATER	ug/L	ND	ND	-	23-Aug-88
Chlorinated Herbicides	SW8150	08 610 06	08 610 13	S1	DW#4	Chlorinated Herbicides	WATER	ug/L	ND	ND	-	23-Aug-88
Polynuclear Aromatic Hydrocarbons (PAH)	8310	S0 08 261 03A	S0 08 261 03AD	S5	DW#4	PAH Compounds	WATER	ug/L	ND	ND	-	23-Aug-88

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Table C 1 4 Dry Weather 5

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	RPD (%)	DATE SAMPLED
TOX	9020	12-322-4	12-322-14	S3	DW#5	TOX	WATER	mg/L	ND	ND	-	24-Dec-88
Chlorinated Herbicides	SW8150	12-322-4	12-322-14	S3	DW#5	Chlorinated Herbicides	WATER	ug/L	ND	ND	-	24-Dec-88

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Table C 1 5 Dry Weather 6

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	RPD (%)	DATE SAMPLED
TOC	E415 2	02 059 3	02 059 6	S3	DW#6	TOC	WATER	mg/L	1 7	1 8	6	2 Feb 89
TOX	9020	02 059 3	02 059 6	S3	DW#6	TOX	WATER	mg/L	<0 025	<0 025	-	2 Feb 89
METALS	SW6010	T 3531	T 3531	S3	DW#6	Arsenic	WATER	mg/L	ND	ND	-	2 Feb 89
						Cadmium		mg/L	ND	0 0006	-	
						Chromium, Total		mg/L	0 003	0 003	0	
						Chromium, Hex		mg/L	ND	ND	-	
						Copper		mg/L	ND	ND	-	
						Lead		mg/L	ND	ND	-	
						Mercury		mg/L	ND	ND	-	
						Nickel		mg/L	ND	0 002	-	
						Selenium		mg/L	0 0008	0 0009	12	
						Silver		mg/L	ND	ND	-	
						Zinc		mg/L	0 008	0 006	29	
BOD	405 1	T 3531	T 3531	S3	DW#6	BOD	WATER	mg/L	2 8	2 4	0	2 Feb 89
Turbidity	180 1	T 3531	T 3531	S3	DW#6	Turbidity	WATER	mg/L	4 6	4 8	4	2 Feb 89
Hardness	200 7	T 3531	T 3531	S3	DW#6	Hardness	WATER	mg/L	369	378	3	2 Feb 89
TKN	351 2	T 3531	T 3531	S3	DW#6	TKN	WATER	mg/L	ND	ND	-	2 Feb 89
TSS	160 2	T 3531	T 3531	S3	DW#6	TSS	WATER	mg/L	ND	ND	-	2 Feb 89

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Table C-18 Dry Weather 7

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	RPD (%)	DATE SAMPLED
TOC	415.2	04-195-3	04-195-8	S3	DW#7	TOC	WATER	mg/L	2.3	2.3	0	7-Apr-99
TOX	9020	04-195-3	04-195-8	S3	DW#7	TOX	WATER	mg/L	<0.025	<0.025	-	

R0054504

Table C 1 7 Wet Weather 2

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	RPD (%)	DATE SAMPLED
METALS	SW6010	T88-3264	T88-3264	S3	WW#2	Arsenic	WATER	mg/L	ND	ND	-	24-Nov-88
						Cadmium		mg/L	0.001	0.0007	35	
						Chromium, Total		mg/L	0.12	0.11	9	
						Chromium, Hex		mg/L	IS	IS	-	
						Copper		mg/L	0.17	0.15	13	
						Lead		mg/L	0.35	0.2	55	
						Mercury		mg/L	0.006	0.002	100	
						Nickel		mg/L	0.22	0.1	75	
						Selenium		mg/L	ND	ND	-	
						Silver		mg/L	0.0002	0.0002	0	
						Zinc		mg/L	0.45	0.4	12	
TKN	351.2	T88-3264	T88-3264	S3	WW#2	TKN	WATER	mg/L	5	5.3	0	24-Nov-88
Ammonia (as N)	350.1	T88-3264	T88-3264	S3	WW#2	Ammonia (as N)	WATER	mg/L	ND	ND	-	24-Nov-88
Nitrate (as N)	353.2	T88-3264	T88-3264	S3	WW#2	Nitrate (as N)	WATER	mg/L	0.82	0.65	5	24-Nov-88
Nitrite (as N)	354.1	T88-3264	T88-3264	S3	WW#2	Nitrite (as N)	WATER	mg/L	0.025	0.024	4	24-Nov-88
Hardness	200.7	T88-3264	T88-3264	S3	WW#2	Hardness	WATER	mg/L	180	180	0	24-Nov-88
Turbidity	180.1	T88-3264	T88-3264	S3	WW#2	Turbidity	WATER	mg/L	810	890	2	24-Nov-88
BOD	405.1	T88-3264	T88-3264	S3	WW#2	BOD	WATER	mg/L	4	IS	-	24-Nov-88
TSS	180.2	T88-3264	T88-3264	S3	WW#2	TSS	WATER	mg/L	1700	1700	0	24-Nov-88
Phosphorus	365.3	T88-3264	T88-3264	S3	WW#2	Phosphorus	WATER	mg/L	1.15	1.04	10	24-Nov-88
Pesticides & PCBs	E608	T88-3264	T88-3264	S3	WW#2	Pesticides & PCBs	WATER	ug/L	ND	ND	-	24-Nov-88

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Table C-1.8 Wet Weather 3

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	RPD (%)	DATE SAMPLED
TOC	415.2	01-530-S	01-530-S	S3	WW#3	TOC	WATER	mg/L	20	15	29	23-Jan-98
TOX	9020	01-530-S	01-530-S	S3	WW#3	TOX	WATER	mg/L	<0.02	<0.02	-	23-Jan-98

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Table C 1 9 Wet Weather 4

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	RPD (%)	DATE SAMPLED
Polynuclear Aromatic Hydrocarbons (PAH)	E610	045596 0005	045596 0005DU	LS	WW#4	Benzo(b)fluoranthene	WATER	ug/L	0 26	0 26	7	5-Feb-89
TKN	E415 2	02 154-5	02-154 13	LS	WW#4	TKN	WATER	mg/L	1 1	1 1	0	5-Feb-89
TOX	9020	02 154-5	02-154 13	LS	WW#4	TOX	WATER	mg/L	ND	ND	-	5-Feb-89

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Table C 1-10 Wet Weather 5

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	RPD (%)	DATE SAMPLED
Polynuclear Aromatic Hydrocarbons (PAH)	E610	045688-0001	045688 0001DU	L1	WW#5	Fluoranthene	WATER	ug/L	2.4	2.6	8	10-Feb-89
						Pyrene		ug/L	2	2.2	10	
						Benzo(a)anthracene		ug/L	0.58	0.6	7	
						Benzo(b)fluoranthene		ug/L	0.78	0.86	10	
						Benzo(k)fluoranthene		ug/L	0.34	0.37	8	
						Benzo(a)pyrene		ug/L	0.91	1	9	
						Benzo(ghi)perylene		ug/L	1.3	1.5	14	
						Indeno(1,2,3-c,d)pyrene		ug/L	1.4	1.2	15	
TOC	E415.2	02-388-1	02-388-14	L1	WW#5	TOC	WATER	mg/L	44	44	0	10-Feb-89
TOX	9020	02-388-1	02-388-14	L1	WW#5	TOX	WATER	mg/L	0.06	0.04	40	10-Feb-89

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Table C 1 11 Wet Weather 6

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	RPD (%)	DATE SAMPLED
Polynuclear Aromatic Hydrocarbons (PAH)	E610	46005 0006 SA	46005 0006 DU	S1	WW#6	PNA	WATER	ug/L	0.36	0.31	15	2-Mar-89
EC	415.2	03 115 1	03 115 12	L1	WW#6	TOC	WATER	mg/L	200	200	0	2-Mar-89

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Table C 1 12 Wet Weather 7

CHEMICAL (GROUP)	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	RPD (%)	DATE SAMPLED
TOC	415.2	93-665-7	93-665-11	S1	WW#7	TOC	WATER	mg/L	6.3	6.4	1	25-Mar-93

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Table C 1 13 Sediment 1

CHEMICAL (GRID)	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	RPD (%)	DATE SAMPLED
TOC	415 2	2274 5	2274 5	S4	Sed#1	TOC	SOIL	ug/g	11400	11100	3	31-Mar 89
Ammonia	351 2	2274 5	2274 5	S4	Sed#1	Ammonia	SOIL	ug/g	110	115	4	31-Mar-89
TKN	350 1	2274 5	2274 5	S4	Sed#1	TKN	SOIL	ug/g	690	720	4	31-Mar-89
Metals	SW8010	2274 5	2274 5	S4	Sed#1	Arsenic	SOIL	ug/g	7.9	8 8	11	31-Mar-89
						Cadmium		ug/g	0 37	0 32	14	
						Chromium, Total		ug/g	86	83	4	
						Copper		ug/g	35	33	6	
						Lead		ug/g	28	28	0	
						Mercury		ug/g	0 14	0 16	13	
						Nickel		ug/g	85	82	4	
						Selenium		ug/g	0 59	0.49	19	
						Silver		ug/g	1.2	1.1	9	
						Zinc		ug/g	100	110	10	
Pesticides & PCBs	SW8080	2274 5	2274 5	S4	Sed#1	gamma Chlordane	SOIL	ug/g	13	ND	NA	31-Mar-89
						alpha Chlordane			8 4	3 5	82	
						4,4' DDD			24	7	110	
						4,4' DDE			14	8 5	49	
						4,4' DDT			8 9	11	21	
						PCBs			80	44	58	

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APPENDIX C.2
PRECISION OF FIELD DUPLICATES

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Table C 2 1 Dry Weather 1

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	(%)	DATE SAMPLED
TOX	9020	03-137-1	03-137-11	S1	DW#1	TOX	WATER	mg/L	0.08	0.08	0	27-Feb-88
Chlorinated Herbicides	SW8150	03-137-1	03-137-11	S1	DW#1	2,4-D	WATER	ug/L	13	13	0	
						DICAMBA		ug/L	5.1	4.9	4	
TOX	9020	03-137-2	03-137-12	S2	DW#1	TOX	WATER	mg/L	<0.025	0.08	NA	27-Feb-88
Chlorinated Herbicides	SW8150	03-137-2	03-137-12	S2	DW#1	2,4-D	WATER	ug/L	ND	11	NA	
						DICAMBA		ug/L	ND	4.2	NA	
Chlorinated Herbicides	SW8150	E88-04-029	E88-04-029	S1	DW#1	Chlor. Herbicides	WATER	ug/L	ND	ND	NA	27-Feb-88

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Table C 2 2 Dry Weather 2

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	(%)	DATE SAMPLED
Metals	SW6010	2274-5	2274-5	S1	DW#2	Copper	WATER	mg/L	0.051	0.052	2	31-Mar-88
						Lead			0.0006	0.0008	29	
						Mercury			0.0003	ND	NA	
						Selenium			ND	ND	NA	
						Silver			0.0013	0.0012	8	
						Zinc			0.003	0.003	0	
Polynuclear Aromatic Hydrocarbons (PAH)	SW8100	S8-04-002-04	S8-04-002-04	S1	DW#2	PAH Compounds	WATER	ug/L	ND	ND	NA	31-Mar-88
Organo Pesticides	SW8140	S8-04-002-02	S8-04-002-02	S1	DW#2	Organo Pesticides	WATER	ug/L	ND	ND	NA	31-Mar-88
Chlorinated Herbicides	SW8150	04-020-8	04-020-89	S1	DW#2	Chlorinated Herbicides	WATER	ug/L	ND	ND	NA	31-Mar-88

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Table C 2 3 Dry Weather 3

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	(%)	DATE SAMPLED
Chlorinated Herbicides	SW8150	05 399 04	05 399 05	S4	DW#3	2,4 D	WATER	ug/L	61	56	9	12-May-88
						Dicamba			47	46	2	
Metals	SW6010	2378	2378	S4	DW#3	Copper	WATER	mg/L	0 008	0.01	22	12-May 88
						Lead			0 0076	0.0078	7	
						Mercury			ND	ND	NA	
						Selenium			ND	ND	NA	
						Silver			0 0034	0.0033	3	
						Zinc			0.023	0.026	12	
RCD	05.1	2378	2378	S4	DW#3	RCD	WATER	mg/L	0	0	0	12-May-88
TKN	351 2	2378	2378	S4	DW#3	TKN	WATER	mg/L	1.7	1.7	0	12-May 88
TSS	160 2	2378	2378	S4	DW#3	TSS	WATER	mg/L	30	30	28	12-May-88
pH	E150 1	2378	2378	S4	DW#3	pH	WATER	mg/L	7.5	7.7	3	12-May-88
Total Coliform	909C	2378	2378	S4	DW#3	Total Coliform	WATER	mg/L	000000	>1000000	NA	12-May-88
Fecal Coliform	909A	2378	2378	S4	DW#3	Fecal Coliform	WATER	mg/L	4000	7000	55	12-May-88
TOC	415 1	2378	2378	S4	DW#3	TOC	WATER	mg/L	33	22	40	12-May-88
Polynuclear Aromatic	E610	S8 88-165-04	S8-88-165-04D	S4	DW#3	Polynuclear Aromatic	WATER	ug/L	ND	ND	NA	12-May-88

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Table C 2 4 Dry Weather 4

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID. PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	(%)	DATE SAMPLED
TOX	9020	88-610-1	88-610-3	S3	DW#4	TOX	WATER	mg/L	ND	ND	NA	23-Aug-88
Chlorinated Herbicides	SW8150	88-610-1	88-610-3	S3	DW#4	Chlorinated Herbicides	WATER	ug/L	ND	ND	NA	23-Aug-88
Total Coliform	909C	S3	S5	S3	DW#4	Total Coliform	WATER	MPN/100	>2400	>2400	NA	23-Aug-88
Fecal Coliform	909A	S3	S5	S3	DW#4	Fecal Coliform	WATER	MPN/100	70	70	0	23-Aug-88
Pesticides & PCBs	E608	S3	S5	S3	DW#4	Pesticides & PCBs	WATER	ug/L	ND	ND	NA	23-Aug-88
Metals	SW6010	S3	S5	S3	DW#4	Copper	WATER	mg/L	0.011	0.007	44	23-Aug-88
						Lead			ND	0.014	NA	
						Mercury			0.0027	0.0025	8	
						Selenium			0.0023	0.0018	24	
						Silver			0.0024	0.003	22	
						Zinc			0.080	0.014	43	
Nitrite	354.1	S3	S5	S3	DW#4	Nitrite	WATER	mg/L	2	1.0	11	23-Aug-88
Nitrate	353.2	S3	S5	S3	DW#4	Nitrate	WATER	mg/L	ND	ND	NA	23-Aug-88
TKN	351.2	S3	S5	S3	DW#4	TKN	WATER	mg/L	1	3	100	23-Aug-88
TSS	160.2	S3	S5	S3	DW#4	TSS	WATER	mg/L	8.5	5.5	43	23-Aug-88
BOD	405.1	S3	S5	S3	DW#4	BOD	WATER	mg/L	7	5	33	23-Aug-88
Polynuclear Aromatic Hydrocarbons (PAH)	E61	S3	S5	S3	DW#4	PAH Compounds	WATER	ug/L	ND	ND	NA	23-Aug-88

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Table C 2 5 Dry Weather 5

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	(%)	DATE SAMPLED
Polynuclear Aromatic Hydrocarbons (PAH)	E610	44880 0003	44880 0003DU	S3	DW#5	PAH Compounds	WATER	ug/L	ND	ND	NA	13 Dec 88
RDX	8020	12 322 3	12 322 4	S3	DW#5	RDX	WATER	mg/L	ND	ND	NA	13 Dec 88
Chlorinated Herbicides	SW8150	12 322 3	12 322 4	S3	DW#5	Chlorinated Herbicides	WATER	mg/L	ND	ND	NA	13-Dec-88
Total Coliform	909C	S3	S5	S3	DW#5	Total Coliform	WATER	MPN/100	>2400	>2400	NA	13-Dec 88
Fecal Coliform	909A	S3	S5	S3	DW#5	Fecal Coliform	WATER	MPN/100	1100	400	82	13-Dec-88
Pesticides & PCBs	E608	T88 3340	T88 3340	S3	DW#5	Pesticides & PCBs	WATER	ug/L	ND	ND	NA	13-Dec-88
Metals	SW6010	T88 3340	T88 3340	S3	DW#5	Chromium, Hex Copper Lead Mercury Selenium Silver Zinc	WATER	mg/L	ND 0 003 ND ND 0 0003 ND 0 020	ND ND ND ND ND ND 0 014	NA NA NA NA NA NA 60	13-Dec-88
TKN	351 2	T88 3340	T88 3340	S3	DW#5	TKN	WATER	mg/L	ND	ND	NA	13 Dec 88
COD	405 1	T88 3340	T88 3340	S3	DW#5	COD	WATER	mg/L	ND	2	NA	13 Dec 88
TSS	160 2	T88 3340	T88 3340	S3	DW#5	TSS	WATER	mg/L	ND	ND	NA	13-Dec-88
Hardness	200 7	T88 3340	T88 3340	S3	DW#5	Hardness	WATER	mg/L	340	320	6	13-Dec 88
Turbidity	180 1	T88 3340	T88 3340	S3	DW#5	Turbidity	WATER	mg/L	8	5	10	13-Dec-88

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Table C 2 6 Dry Weather 6

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	(%)	DATE SAMPLED
Polynuclear Aromatic Hydrocarbons (PAH)	E610	045559 0003	045559 0005	S3	DW#6	PAH Compounds	WATER	ug/L	ND	ND	NA	2-Feb-89
Total Coliform	909C	S3	S5	S3	DW#6	Total Coliform	WATER	MPN/100	24000	11000	74	2-Feb-89
Fecal Coliform	909A	S3	S5	S3	DW#6	Fecal Coliform	WATER	MPN/100	43	23	61	2-Feb-89
TOC	415.1	02-059-3	02-059-5	S3	DW#6	TOC	WATER	mg/L	1.7	1.7	0	2-Feb-89
TOX	9020	02-059-3	02-059-5	S3	DW#6	TOX	WATER	mg/L	<0.025	<0.025	NA	2-Feb-89
Pesticides & PCBs	E608	T-3531	T-3531	S3	DW#6	Pesticides & PCBs	WATER	mg/L	ND	ND	NA	2-Feb-89
Metals	SW6010	T-3531	T-3531	S3	DW#6	Arsenic	WATER	mg/L	ND	ND	NA	2-Feb-89
						Cadmium			ND	0.0002	NA	
						Chromium,Total			0.003	0.003	0	
						Chromium, Hex			ND	ND	NA	
						Copper			ND	0.004	NA	
						Lead			ND	0.004	NA	
						Mercury			ND	ND	NA	
						Nickel			ND	ND	NA	
						Selenium			0.0008	0.0005	46	
						Silver			ND	ND	NA	
						Zinc			0.008	0.01	22	
BOD	405.1	T-3531	T-3531	S3	DW#6	BOD	WATER	mg/L	2.6	1.8	31	2-Feb-89
Turbidity	180.1	T-3531	T-3531	S3	DW#6	Turbidity	WATER	mg/L	4.6	3	42	2-Feb-89
Hardness	200.7	T-3531	T-3531	S3	DW#6	Hardness	WATER	mg/L	380	380	0	2-Feb-89
TKN	351.2	T-3531	T-3531	S3	DW#6	TKN	WATER	mg/L	ND	ND	NA	2-Feb-89
TSS	160.2	T-3531	T-3531	S3	DW#6	TSS	WATER	mg/L	ND	ND	NA	2-Feb-89

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Table C 2 7 Dry Weather 7

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	(%)	DATE SAMPLED
Total Coliform	909C	S3	S5	S3	DW#7	Total Coliform	WATER	MPN/100	4600	2400	63	7-Apr-99
Fecal Coliform	909A	S3	S5	S3	DW#7	Fecal Coliform	WATER	MPN/100	460	460	14	7-Apr-99
Pesticides & PCBs	E608	T-3839	T-3839	S3	DW#7	Pesticides & PCBs	WATER	mg/L	ND	ND	NA	7-Apr-99
Metals	SW6010	T-3839	T-3839	S3	DW#7	Arsenic	WATER	mg/L	0.001	0.001	0	7-Apr-99
						Cadmium			ND	0.0031	NA	
						Chromium,Total			0.003	ND	NA	
						Chromium, Hex			ND	ND	NA	
						Copper			0.004	0.003	29	
						Lead			ND	ND	NA	
						Mercury			ND	ND	NA	
						Nickel			0.002	ND	NA	
						Selenium			ND	ND	NA	
						Silver			0.002	ND	NA	
						Zinc			0.01	0.015	40	
TKN	351.2	T-3839	T-3839	S3	DW#7	TKN	WATER	mg/L	ND	ND	NA	7-Apr-99
TSS	160.2	T-3839	T-3839	S3	DW#7	TSS	WATER	mg/L	2.4	2.8	15	7-Apr-99
BOD	405.1	T-3839	T-3839	S3	DW#7	BOD	WATER	mg/L	1.8	1.8	0	7-Apr-99
Hardness	200.7	T-3839	T-3839	S3	DW#7	Hardness	WATER	mg/L	280	300	6	7-Apr-99
Turbidity	180.1	T-3839	T-3839	S3	DW#7	Turbidity	WATER	mg/L	4.8	3.8	23	7-Apr-99
TOC	415.1	04-195-3	04-195-5	S3	DW#7	TOC	WATER	mg/L	2.3	2.4	4	7-Apr-99
TOX	9020	04-195-3	04-195-5	S3	DW#7	TOX	WATER	mg/L	ND	ND	NA	7-Apr-99
Polynuclear Aromatic Hydrocarbons (PAH)	E610	040598-0003	040598-0005	S3	DW#7	PAH Compounds	WATER	ug/L	ND	ND	NA	7-Apr-99

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Table C 2 8 Wet Weather 2

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	Units	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	(%)	DATE SAMPLED
Volatile Organics	E624	8811103-09	8811103-11	S3	WW#2	Volatile Organics	WATER	ug/L	ND	ND	NA	24-Nov-88
Semivolatile Organics	E 625	8811103-09	8811103-11	S3	WW#2	Semivolatile Organics	WATER	ug/L	ND	ND	NA	24-Nov-88
METALS	SW6010			S3	WW#2	Arsenic	WATER	mg/L	ND	ND	NA	24-Nov-88
						Cadmium		mg/L	0.004	0.002	67	
						Chromium, Total		mg/L	0.14	0.065	73	
						Chromium, Hex		mg/L	IS	IS	NA	
						Copper		mg/L	0.18	0.072	86	
						Lead		mg/L	0.25	0.13	63	
						Mercury		mg/L	0.004	0.003	28	
						Nickel		mg/L	0.24	0.1	82	
						Selenium		mg/L	ND	ND	NA	
						Silver		mg/L	0.0004	ND	NA	
						Zinc		mg/L	0.81	0.28	84	
TOC	415.1	11-035-8	11-035-11	S3	WW#2	TOC	WATER	mg/L	23	9	88	24-Nov-88
TOX	9020	11-035-8	11-035-11	S3	WW#2	TOX	WATER	mg/L	0.028	0.056	82	24-Nov-88
Chlorinated Herbicides	SW8150	11-035-8	11-035-11	S3	WW#2	Chlorinated Herbicides	WATER	ug/L	ND	ND	NA	24-Nov-88
Pesticides & PCB's	E 608	S4	S5	S4	WW#2	4,4' DDE	WATER	ug/L	0.07	0.08	33	24-Nov-88
						4,4' DDT		ug/L	0.10	0.15	24	
						gamma chlordane		ug/L	0.1	ND	NA	
						Endosulfan I		ug/L	0.13	ND	NA	
						Endosulfan II		ug/L	0.08	ND	NA	
						Aroclor 1254		ug/L	ND	1.4	NA	
TKN	351.2	T88-3284	T88-3284	S4	WW#2	TKN	WATER	mg/L	1.0	1.0	12	24-Nov-88
Ammonia	350.1	T88-3284	T88-3284	S4	WW#2	Ammonia	WATER	mg/L	ND	ND	NA	24-Nov-88
Nitrite	354.1	T88-3284	T88-3284	S4	WW#2	Nitrite	WATER	mg/L	0.57	0.62	8	24-Nov-88
Nitrate	353.2	T88-3284	T88-3284	S4	WW#2	Nitrate	WATER	mg/L	0.045	0.032	34	24-Nov-88
Hardness	200.7	T88-3284	T88-3284	S4	WW#2	Hardness	WATER	mg/L	236	156	42	24-Nov-88
Turbidity	180.1	T88-3284	T88-3284	S4	WW#2	Turbidity	WATER	mg/L	380	650	52	24-Nov-88
BOD	405.1	T88-3284	T88-3284	S4	WW#2	BOD	WATER	mg/L	12	28	58	24-Nov-88
TSS	160.2	T88-3284	T88-3284	S4	WW#2	TSS	WATER	mg/L	430	1200	94	24-Nov-88
Phosphorus		T88-3284	T88-3284	S4	WW#2	Phosphorus	WATER	mg/L	0.55	0.68	44	24-Nov-88

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Table C 2 9 Wet Weather 3

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	(%)	DATE SAMPLED
Polynuclear Aromatic Hydrocarbons (PAH)	E 610	045459-0004	045459 0005	S3	WW#3	Fluoranthene	WATER	ug/L	0 29	0.28	11	24-Jan-89
						Pyrene		ug/L	0 33	0 32	3	
TOC	415 1	01-539-3	01-539-4	S2	WW#3	TOC	WATER	mg/L	19	19	0	24-Jan-89
TOX	9020	01-539-3	01-539-4	S2	WW#3	TOX	WATER	mg/L	0.04	0.04	0	24-Jan-89
Metals	SW6010	T-3497	T-3497	S2	WW#3	Arsenic	WATER	mg/L	ND	ND	NA	24-Jan-89
						Cadmium		mg/L	0.0006	0.0004	40	
						Chromium,Total		mg/L	0.004	0.003	29	
						Chromium, Hex		mg/L	ND	ND	NA	
						Copper		mg/L	0.003	0.002	40	
						Lead		mg/L	0.001	0.002	67	
						Mercury		mg/L	ND	ND	NA	
						Nickel		mg/L	ND	ND	NA	
						Selenium		mg/L	ND	ND	NA	
						Silver		mg/L	ND	ND	NA	
						Zinc		mg/L	0.14	0.22	44	
TKN	351.2	T-3497	T-3497	S2	WW#3	TKN	WATER	mg/L	1.7	1.5	13	24-Jan-89
BOD	405.1	T-3497	T-3497	S2	WW#3	BOD	WATER	mg/L	13	12	8	24-Jan-89
Pesticides & PCBs	E608	T-3497	T-3497	S2	WW#3	gamma-BHC (Lindane)	WATER	ug/L	0.032	ND	NA	24-Jan-89

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Table C 2 10 Wet Weather 4

CHEMICAL (CLASS)	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	RPD (%)	DATE SAMPLED
Polynuclear Aromatic Hydrocarbons (PAH)	E 610	045596-0005	045596-0011	L5	WW#4	Benzo(b)fluoranthene	WATER	ug/L	0.28	0.33	16	5-Feb-89
TOC	E 415.2	02-154-5	02-154-11	L5	WW#4	TOC	WATER	mg/L	11	11	0	5-Feb-89
TOX	E 415.2	02-154-5	02-154-11	L5	WW#4	TOX	WATER	mg/L	ND	ND	NA	5-Feb-89
Metals	SW6010	T-3553	T-3553	L5	WW#4	Arsenic	WATER	mg/L	ND	ND	NA	5-Feb-89
						Cadmium		mg/L	0.0028	0.0028	7	
						Chromium, Total		mg/L	0.028	0.011	87	
						Chromium, Hex		mg/L	ND	ND	NA	
						Copper		mg/L	0.032	0.019	51	
						Lead		mg/L	0.05	0.042	17	
						Mercury		mg/L	0.004	0.006	40	
						Nickel		mg/L	0.025	0.021	17	
						Selenium		mg/L	ND	ND	NA	
						Silver		mg/L	ND	ND	NA	
						Zinc		mg/L	0.2	0.18	11	
TKN	351.2	T-3553	T-3553	L5	WW#4	TKN	WATER	mg/L	1.2	1.7	34	5 Feb 89
BOD	405.1	T-3553	T-3553	L5	WW#4	BOD	WATER	mg/L	4.4	4.1	7	5-Feb-89
TSS	160.1	T-3553	T-3553	L5	WW#4	TSS	WATER	mg/L	52	46	12	5-Feb-89
Hardness	200.7	T-3553	T-3553	L5	WW#4	Hardness	WATER	mg/L	45	47	4	5-Feb-89
Turbidity	160.1	T-3553	T-3553	L5	WW#4	Turbidity	WATER	mg/L	73	87	18	5-Feb-89
Pesticides & PCBs	8080	T-3553	T-3553	L5	WW#4	Pesticides & PCBs	WATER	ug/L	0.05	0.05	0	5-Feb-89

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Table C 2 11 Wet Weather 5

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	(%)	DATE SAMPLED
Pesticides & PCBs	E608	T-3573	T 3573	S1	WW#5	Pesticides & PCBs	WATER	ug/L	ND	ND	NA	10-Feb-89
Total Coliform	909C	S1	S5	S1	WW#5	Total Coliform	WATER	MPN/100	>240000	>240000	NA	10-Feb-89
Fecal Coliform	909A	S1	S5	S1	WW#5	Fecal Coliform	WATER	MPN/100	>240000	11000	NA	10-Feb-89
Metals	SW6010	T-3573	T-3573	S1	WW#5	Arsenic	WATER	mg/L	ND	ND	NA	10-Feb-89
						Cadmium		mg/L	0.0035	0.0035	0	
						Chromium,Total		mg/L	0.019	0.019	0	
						Chromium, Hex		mg/L	ND	ND	NA	
						Copper		mg/L	0.032	0.03	6	
						Lead		mg/L	0.032	0.039	20	
						Mercury		mg/L	ND	ND	NA	
						Nickel		mg/L	ND	0.018	NA	
						Selenium		mg/L	ND	ND	NA	
						Silver		mg/L	ND	ND	NA	
						Zinc		mg/L	0.12	0.18	40	
TKN	51.2	T-3573	T-3573	S1	WW#5	TKN	WATER	mg/L	ND	1.8	NA	10-Feb-89
BOD	15.1	T-3573	T-3573	S1	WW#5	BOD	WATER	mg/L	6.7	4	50	10-Feb-89
TSS	180.2	T-3573	T-3573	S1	WW#5	TSS	WATER	mg/L	78	50	41	10-Feb-89
Hardness	200.7	T-3573	T-3573	S1	WW#5	Hardness	WATER	mg/L	60	50	18	10-Feb-89
Turbidity	180.1	T-3573	T-3573	S1	WW#5	Turbidity	WATER	mg/L	69	95	32	10-Feb-89
TOC	415.1	02-388-8	02-388-12	S1	WW#5	TOC	WATER	MPN/100	12	9.8	20	10-Feb-89
TOX	9020	02-388-8	02-388-12	S1	WW#5	TOX	WATER	MPN/100	ND	0.03	NA	10-Feb-89
Polynuclear Aromatic Hydrocarbons (PAH)	E610	45888-0008	45888-0012	S1	WW#5	Benzo(b) fluoranthene	WATER	ug/L	0.10	ND	NA	10-Feb-89

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Table C 2 12 Wet Weather 6

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID. PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	(%)	DATE SAMPLED
Pesticides & PCBs	E608	T-3659	T-3659	LS	WW#6	Pesticides & PCBs	WATER	ug/L	ND	ND	NA	3-Mar-89
Metals	SW6010	T-3659	T-3659	LS	WW#6	Arsenic	WATER	mg/L	ND	ND	NA	3-Mar-89
						Cadmium		mg/L	0.0013	0.0012	8	
						Chromium,Total		mg/L	0.017	0.017	0	
						Chromium, Hex		mg/L	ND	ND	NA	
						Copper		mg/L	0.05	0.05	0	
						Lead		mg/L	0.045	0.05	11	
						Mercury		mg/L	ND	0.0002	NA	
						Nickel		mg/L	0.06	0.05	18	
						Selenium		mg/L	ND	ND	NA	
						Silver		mg/L	ND	ND	NA	
						Zinc		mg/L	0.31	0.32	3	
TKN	351.2	T-3659	T-3659	LS	WW#6	TKN	WATER	mg/L	1.6	2.8	87	3-Mar-89
BOD	405.1	T-3659	T-3659	LS	WW#6	BOD	WATER	mg/L	13	15	14	3-Mar-89
TSS	160.2	T-3659	T-3659	LS	WW#6	TSS	WATER	mg/L	88	84	4	3-Mar-89
Hardness	200.7	T-3659	T-3659	LS	WW#6	Hardness	WATER	mg/L	35	56	51	3-Mar-89
Turbidity	180.1	T-3659	T-3659	LS	WW#6	Turbidity	WATER	mg/L	83	88	18	3-Mar-89
Total Coliform	909C	03-116-1	03-116-0	LS	WW#6	Total Coliform	WATER	MPN/100	48000	110000	82	3-Mar-89
Fecal Coliform	909A	03-116-1	03-116-0	LS	WW#6	Fecal Coliform	WATER	MPN/100	2400	4300	57	3-Mar-89

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Table C 2 13 Wet Weather 7

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	(%)	DATE SAMPLED
Metals	SW6010	T-3769	T-3769	S1	WW#7	Arsenic	WATER	mg/L	0.004	0.002	67	26-Mar-09
						Cadmium		mg/L	0.0013	0.0015	14	
						Chromium, Total		mg/L	0.027	0.030	29	
						Chromium, Hex		mg/L	ND	ND	NA	
						Copper		mg/L	0.055	0.061	10	
						Lead		mg/L	0.08	0.1	50	
						Mercury		mg/L	0.0002	ND	NA	
						Nickel		mg/L	0.09	0.11	20	
						Selenium		mg/L	ND	ND	NA	
						Silver		mg/L	0.0002	0.0003	40	
						Zinc		mg/L	0.24	0.37	43	
TSS	160.2	T-3769	T-3769	S1	WW#7	TSS	WATER	mg/L	190	220	15	26-Mar-09
BOD	405.1	T-3769	T-3769	S1	WW#7	BOD	WATER	mg/L	10	9.2	8	26-Mar-09
Hardness	200.7	T-3769	T-3769	S1	WW#7	Hardness	WATER	mg/L	48	64	29	26-Mar-09
Turbidity	180.1	T-3769	T-3769	S1	WW#7	Turbidity	WATER	mg/L	97	120	21	26-Mar-09
TOC	415.2	03-665-7	03-665-10	S1	WW#7	TOC	WATER	mg/L	0.3	0.1	2	26-Mar-09

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Table C 2 14 Sediment 1

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	RPD (%)	DATE SAMPLED
Chlorinated Herbicides	SW8150	88-388-9	88-388-10	84	Sed01	Chlorinated Herbicides	SOIL	mg/kg	ND	ND	NA	31-Mar-88

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Table C 2.15 Sediment 3

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	(%)	DATE SAMPLED
Chlorinated Herbicides	SW8150	08-610-8	08-610-10	S4	Sed#3	Chlorinated Herbicides	SOIL	mg/kg	ND	ND	NA	23-Aug-88
Pesticides & PCBs	E608	T88-2797	T88-2797	S4	Sed#3	gamma BHC (lindane)	SOIL	ug/kg	ND	7.8	NA	23-Aug-88
						alpha Chlordane			10	10	0	
						gamma chlordane			13	13	0	
						4,4' DDD			27	55	68	
						4,4' DDE			8.1	8.6	6	
						4,4' DDT			37	27	31	
Semivolatile Organics	E625	8808209-03	8808209-05	F1	Sed#3	Semivolatile Organics	SOIL	ug/kg	ND	ND	NA	23-Aug-88
Organophosphorus Pesticides	SW8140	S8-08-281-01	S8-08-281-03	S4	Sed#3	Organophosphorus Pesticides	SOIL	mg/kg	ND	ND	NA	23-Aug-88

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Table C 2 16 Sediment 4

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLE ID PRIMARY	SAMPLE ID DUPLICATE	STATION No	SAMPLING EVENT	ANALYTES	MATRIX	UNITS	CONCENTRATION PRIMARY	CONCENTRATION DUPLICATE	(%)
Polynuclear Aromatic Hydcarbons (PAH)	E610	44880-0009	44880-0011	S3	Sed#4	Phenanthrene	SOIL	ug/kg	ND	380	NA
						Fluoranthene			460	780	52
						Pyrene			420	460	9
						Benzo(a)anthracene			130	ND	NA
						Benzo(b)fluoranthene			250	410	48
						Benzo(k)fluoranthene			1:0	190	53
						Benzo(a)pyrene			230	360	44
Chlorinated Herbicides	SW8150	12-322-9	12-322-11	S3	Sed#4	Chlorinated Herbicides	SOIL	mg/kg	ND	ND	NA
Pesticides & PCBs	E608	T88-3339	T88-3339	S3	Sed#4	alpha-Chlordane	SOIL	ug/kg	13	9.8	28
						gamma chlordane			20	16	22
						4,4' DDD			24	17	34
						4,4' DDE			13	11	17
						4,4' DDT			25	ND	NA
						PCBs			240	125	63
Metals	SW6010	T88-3339	T88-3339	S3	Sed#4	Copper	SOIL	ug/kg	45	45	0
						Lead			64	86	29
						Mercury			3.0	2.6	32
						Selenium			1	1	0
						Silver			ND	ND	NA
						Zinc			160	150	6

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APPENDIX C.3
PRECISION OF MATRIX SPIKE
AND MATRIX SPIKE DUPLICATES

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Table C 3 1 Dry Weather 1

CHEMICAL GROUP	SAMPLE MATRIX	SAMPLING EVENT	SAMPLE ID No	ANALYTES	UNITS	MATRIX SPIKE MS CONC	MATRIX SPIKE MS REC CONC	MATRIX SPIKE MS REC (%)	MATRIX SPIKE DUPLICATE MSD CONC	MATRIX SPIKE DUPLICATE MSD REC CONC	MATRIX SPIKE DUPLICATE MSD REC (%)	LAB REC LIMITS (%)	RPD* (%)	LAB/ ANALYSIS DATE
Volatile Organics	WATER	DW#1	S1-2192	Phenol	ug/L	100	34	34	100	38	38	10--43	-14	Anametrix 8-Mar-89
				2 Chlorophenol	ug/L	100	83	83	100	75	75	13-84	-17	
				1,4 Dichlorobenzene	ug/L	50	23	48	50	31	62	12--88	-30	
				Nitrosodipropiamine	ug/L	50	32	64	50	36	72	25--88	-12	
				1,2,4 Trichlorobenzene	ug/L	50	26	52	50	32	64	17--78	-21	
				4 Chloro 3 methylphenol	ug/L	100	87	87	100	85	85	10--127	2	
				Acenaphene	ug/L	50	38	78	50	38	78	27--123	0	
				4 Nitrophenol	ug/L	100	21	21	100	17	17	10--88	21	
				2,4 Dinitrotoluene	ug/L	50	43	88	50	39	78	43--117	10	
				Pentachlorophenol	ug/L	100	67	67	100	51	51	10--151	27	
				Pyrene	ug/L	50	45	90	50	38	78	47-140	14	
METALS	WATER	DW#1	2274-5	Arsenic		-	-	NA	-	-	82	-	10	TexScan 25-May-88
				Cadmium		-	-	112	-	-	81	-	14	
				Chromium		-	-	113	-	-	75	-	4	
				Copper		-	-	112	-	-	89	-	0	
				Lead		-	-	107	-	-	88	-	0	
				Mercury		-	-	92	-	-	125	-	13	
				Nickel		-	-	73	-	-	87	-	4	
				Selenium		-	-	82	-	-	78	-	10	
				Silver		-	-	114	-	-	NA	-	2	
				Zinc		-	-	85	-	-	83	-	4	

* RPD values were calculated by the laboratory.

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Table C 3 2 Dry Weather 2

CHEMICAL GROUP	SAMPLE MATRIX	SAMPLING EVENT	SAMPLE ID No	ANALYTES	UNITS	MATRIX SPIKE MS CONC	MATRIX SPIKE MS REC CONC	MATRIX SPIKE MS REC (%)	MATRIX SPIKE DUPLICATE MSD CONC	MATRIX SPIKE DUPLICATE MSD REC CONC	MATRIX SPIKE DUPLICATE MSD REC (%)	LAB REC LIMITS (%)	RPD* (%)	LAB/ ANALYSIS DATE
METALS	WATER	DW#2	2274-5	Copper		-	-	100	-	-	104	-	2	TexScan
				Lead		-	-	99	-	-	89	-	20	25-May-88
				Mercury		-	-	111	-	-	104	-	NA	
				Selenium		-	-	110	-	-	92	-	NA	
				Silver		-	-	85	-	-	NA	-	8	
				Zinc		-	-	96	-	-	96	-	8	
Pesticides & PCB's	WATER	DW#2	2274-5	Aldrin		-	-	48	-	-	NA	-	NA	
				Gamma BHC		-	-	67	-	-	NA	-	NA	TexScan
				4,4' DDT		-	-	78	-	-	NA	-	NA	25-May-88
				Dieldrin		-	-	64	-	-	NA	-	NA	
				Endrin		-	-	61	-	-	NA	-	NA	
				Heptachlor		-	-	65	-	-	NA	-	NA	
Pesticides & PCB's	WATER	DW#2	2274-5	Aldrin		-	-	89	-	-	NA	-	NA	TexScan
				Gamma BHC		-	-	88	-	-	NA	-	NA	25-May-88
				4,4' DDT		-	-	112	-	-	NA	-	NA	
				Dieldrin		-	-	98	-	-	NA	-	NA	
				Endrin		-	-	121	-	-	NA	-	NA	
				Heptachlor		-	-	101	-	-	NA	-	NA	

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Table C 3 3 Dry Weather 4

CHEMICAL GROUP	SAMPLE MATRIX	SAMPLING EVENT	SAMPLE ID No	ANALYTE(S)	UNITS	MATRIX SPIKE MS CONC	MS REC CONC	MS REC (%)	MATRIX SPIKE DUPLICATE MSD CONC	MSD REC CONC	MSD REC (%)	LAB REC LIMITS (%)	RPD* (%)	LAB/ ANALYSIS DATE
Chlorinated Herbicides	WATER	DW#4	98-010 12	2,4,5-T		-	-	-	-	-	127	-	-	B&C
				2,4,5-TP		-	-	-	-	-	127	-	-	23-Aug-98
				2,4-D		-	-	-	-	-	-	-	-	
Polynuclear Aromatic Hydrocarbons (PAH)	WATER	DW#4	98-08 261 01A	Dibenz(a,h)anthracene	ug/L	50	16	32	-	-	-	-	-	IT
				Anthracene	ug/L	50	38	76	-	-	-	-	-	
				Benzo(a)pyrene	ug/L	50	31	63	-	-	-	-	-	
				Acenaphthene	ug/L	50	30	61	-	-	-	-	-	
Metals	WATER	DW#4	2797	Copper		-	-	101	-	-	-	-	-	TerrScan
				Lead		-	-	135	-	-	-	-	-	20-Oct-98
				Mercury		-	-	82	-	-	-	-	-	
				Selenium		-	-	102	-	-	-	-	-	
				Silver		-	-	108	-	-	-	-	-	
				Zinc		-	-	117	-	-	-	-	-	

* RPD values were calculated by the laboratory.

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Table C 3 4 Dry Weather S

CHEMICAL GROUP	SAMPLE MATRIX	SAMPLING EVENT	SAMPLE ID No	ANALYTES	UNITS	MATRIX SPIKE MS CONC	MATRIX SPIKE MS REC CONC	MATRIX SPIKE MS REC (%)	MATRIX SPIKE DUPLICATE MSD CONC	MATRIX SPIKE DUPLICATE MSD REC CONC	MATRIX SPIKE DUPLICATE MSD REC (%)	LAB REC LIMITS (%)	RPD* (%)	LAB/ ANALYSIS DATE
Polynuclear Aromatic Hydrocarbons (PAH)	WATER	DW#5	44888 0003 MS	Naphthalene	ug/L	5	2 7	54	5	2 94	59	-	-	CAL 21-Dec-88
				Fluorene	ug/L	1	0 649	65	1	0 682	68	-	-	
				Pyrene	ug/L	1	0 819	82	1	0 804	80	-	-	
				Benzo(a)pyrene	ug/L	0 5	0 402	80	0 5	0 398	80	-	-	
				Indeno(1,2,3 c,d)pyrene	ug/L	0 5	0 381	76	0 5	0 369	74	-	-	
Polynuclear Aromatic Hydrocarbons (PAH)	WATER	DW#5	44888-0009-MS	Naphthalene	ug/L	1000	ND	- -	-	-	-	-	-	CAL 21-Dec-88
				Fluorene	ug/L	200	ND	- -	-	-	-	-	-	
				Pyrene	ug/L	200	252	- -	-	-	-	-	-	
				Benzo(a)pyrene	ug/L	100	149	- -	-	-	-	-	-	
				Indeno(1,2,3 c,d)pyrene	ug/L	100	ND	- -	-	-	-	-	-	
TOC Chlorinated Herbicides	WATER	DW#5	12-322-15	TOC		-	-	114	-	-	-	-	-	B&C 5-Jan-89
				2,4,5 T		-	-	120	-	-	-	-	-	
				2,4,5 TP		-	-	94	-	-	-	-	-	
				2,4 D		-	-	110	-	-	-	-	-	
				2,4 DB		-	-	110	-	-	-	-	-	
				Dicamba		-	-	90	-	-	-	-	-	
				Dinoseb		-	-	100	-	-	-	-	-	
Volatile Organics	WATER	DW#5	88111183-09	1,1 dichloroethene	ug/L	50	60	120	50	64	108	61--157	11	Anametrix 5-Dec-88
				Freon 113	ug/L	50	44	88	50	41	82	81--150	7	
				Methylene chloride	ug/L	50	57	114	50	55	110	81--141	4	
				Chloroform	ug/L	50	55	110	50	52	104	78--127	6	
				1,1,1 trichloroethane	ug/L	50	60	120	50	56	112	80--147	7	
				Benzene	ug/L	50	63	126	50	60	120	66--137	5	
				1,2 dichloroethane	ug/L	50	61	122	50	59	118	82--121	3	
				Trichloroethene	ug/L	50	46	92	50	43	86	64--131	7	
				4 methyl 2 pentanone	ug/L	50	57	114	50	65	130	58--132	-13	
				Toluene	ug/L	50	58	116	50	56	112	88--125	4	
				Tetrachloroethene	ug/L	50	55	110	50	52	104	85--125	6	
				Chlorobenzene	ug/L	50	55	110	50	53	106	87--124	4	
				1,2 dichlorobenzene	ug/L	50	56	112	50	54	108	93--132	4	
Semivolatile Organics	WATER	DW#5	88111183-10	Phenol	ug/L	100	19	19	-	-	-	10--43		Anametrix 7-Dec-88
				2 chlorophenol	ug/L	100	32	32	-	-	-	13--64		
				1,4 dichlorobenzene	ug/L	50	10	20	-	-	-	12--68		
				Nitrosodipropylamine	ug/L	50	19	38	-	-	-	25--86		
				1,2,4 trichlorobenzene	ug/L	50	12	24	-	-	-	17--70		
				4 chloro 3 methylphenol	ug/L	100	74	74	-	-	-	10--127		
				Acenaphthene	ug/L	50	29	58	-	-	-	27--123		
				4 nitrophenol	ug/L	100	34	34	-	-	-	10--80		
				2,4 dinaretoluene	ug/L	50	35	70	-	-	-	43--117		
				Pentachlorophenol	ug/L	100	83	83	-	-	-	10--151		
				Pyrene	ug/L	50	39	78	-	-	- -	47--148		

R0054533

Table C-15 Dry Weather 8

CHEMICAL GROUP	SAMPLE MATRIX	SAMPLING EVENT	SAMPLE ID No	ANALYTES	UNITS	MATRIX SPIKE MS CONC	MS REC. CONC	MS REC. (%)	MATRIX SPIKE DUPLICATE MSD CONC	MSD REC. CONC	MSD REC. (%)	LAB REC. LIMITS (%)	RPD* (%)	LAB/ ANALYSIS DATE
Polynuclear Aromatic Hydrocarbons (PAH)	WATER	DW#8	845559 0003MS	Naphthalene	ug/L	5	3.1	62	5	2.1	42	-	38	CAL 14-Feb-89
				Fluorene	ug/L	1	0.86	86	1	0.87	87	-	25	
				Pyrene	ug/L	1	1.1	110	1	0.91	91	-	10	
				Benzo(a)pyrene	ug/L	0.5	0.56	112	0.5	0.47	94	-	17	
				Indeno(1,2,3-c,d)pyrene	ug/L	0.5	0.56	112	0.5	0.48	96	-	15	
Polynuclear Aromatic Hydrocarbons (PAH)	WATER	DW#8	845558 0003MS	Naphthalene	ug/L	5	3.08	62	5	2.14	43	-	38	CAL 15-Feb-89
				Acenaphthalene	ug/L	5	3.46	69	5	2.88	53	-	28	
				Acenaphthene	ug/L	10	7.81	78	10	6.49	65	-	18	
				Fluorene	ug/L	1	0.863	86	1	0.673	67	-	25	
				Phenanthrene	ug/L	0.4	0.393	98	0.4	0.323	81	-	20	
				Anthracene	ug/L	0.2	0.198	99	0.2	0.171	86	-	14	
				Fluoranthene	ug/L	0.5	0.539	108	0.5	0.483	93	-	15	
				Pyrene	ug/L	1	1.08	108	1	0.913	91	-	19	
				Benzo(a)anthracene	ug/L	0.5	0.520	105	0.5	0.440	88	-	15	
				Chrysene	ug/L	0.5	0.54	108	0.5	0.488	83	-	10	
				Benzo(b)fluoranthene	ug/L	0.25	0.213	85	0.25	0.185	74	-	14	
				Benzo(k)fluoranthene	ug/L	0.25	0.214	86	0.25	0.183	73	-	10	
				Benzo(a)pyrene	ug/L	0.5	0.56	112	0.5	0.47	94	-	17	
				Dibenzo(a,h)anthracene	ug/L	2	2.12	106	2	1.8	90	-	10	
				Benzo(g,h,i)perylene	ug/L	1	0.937	94	1	0.704	70	-	10	
				Indeno(1,2,3-cd)pyrene	ug/L	0.5	0.565	113	0.5	0.477	95	-	17	

* RPD values were calculated by the laboratory.

R0054534

Table C 3 6 Wet Weather 1

CHEMICAL GROUP	SAMPLE MATRIX	SAMPLING EVENT	SAMPLE ID No	ANALYTES	UNITS	MATRIX SPIKE MS CONC	MS REC CONC	MS REC (%)	MATRIX SPIKE DUPLICATE MSD CONC	MSD REC CONC	MSD REC (%)	LAB REC LIMITS (%)	RPD* (%)	LAB/ ANALYSIS DATE
Volatile Organics	WATER	WW#1	55300 L3	Phenol	ug/L	100	25	25	-	-	-	10--43	-	Anametrix 5-May-00
				2 Chlorophenol	ug/L	100	60	60	-	-	-	13--84	-	
				1,4 Dichlorobenzene	ug/L	50	28	56	-	-	-	12--68	-	
				Nitrosodipropylamine	ug/L	50	35	70	-	-	-	25--86	-	
				1,2,4 Trichlorobenzene	ug/L	50	30	60	-	-	-	17--70	-	
				4 Chloro-3-methylphenol	ug/L	100	85	85	-	-	-	10--127	-	
				Acenaphtene	ug/L	50	38	76	-	-	-	27--123	-	
				4 Nitrophenol	ug/L	100	32	32	-	-	-	10--66	-	
				2,4 Dinitrotoluene	ug/L	50	41	82	-	-	-	43--117	-	
				Pentachlorophenol	ug/L	100	100	100	-	-	-	10--151	-	
				Pyrene	ug/L	50	43	86	-	-	-	47--148	-	
METALS	WATER	WW#1	2330	Arsenic		-	-	120	-	-	120	-	0	Teclicon 27-May-00
				Cadmium		-	-	117	-	-	70	-	0	
				Chromium		-	-	66	-	-	102	-	25	
				Copper		-	-	114	-	-	66	-	3.2	
				Lead		-	-	134	-	-	100	-	0	
				Mercury		-	-	104	-	-	100	-	0	
				Nickel		-	-	103	-	-	106	-	4.3	
				Selenium		-	-	118	-	-	97	-		
				Silver		-	-	60	-	-	NA	-	10.2	
				Zinc		-	-	85	-	-	100	-	0	

R0054535

Table C 3 7 Wet Weather 2

CHEMICAL GROUP	SAMPLE MATRIX	SAMPLING EVENT	SAMPLE ID No	ANALYTES	UNITS	MATRIX SPIKE MS CONC	MATRIX SPIKE MS REC. CONC	MATRIX SPIKE MS REC. (%)	MATRIX SPIKE DUPLICATE MSD CONC	MATRIX SPIKE DUPLICATE MSD REC. CONC	MATRIX SPIKE DUPLICATE MSD REC. (%)	LAB REC. LIMITS (%)	RPD* (%)	LAB/ ANALYSIS DATE
METALS	WATER	WW#2	3264	Arsenic		-	-	72	-	-	78	-	NA	TesScan
				Cadmium		-	-	102	-	-	92	-	9	29-Nov-88
				Chromium		-	-	127	-	-	121	-	2	
				Copper		-	-	126	-	-	130	-	3	
				Lead		-	-	250	-	-	125	-	13	
				Mercury		-	-	98	-	-	80	-	25	
				Selenium		-	-	149	-	-	131	-	18	
				Silver		-	-	87	-	-	72	-	NA	
				Zinc		-	-	78	-	-	NA	-	8	
TIC	WATER	WW#2	11-635-13	TIC		-	-	80	-	-	-	-	-	B&C 24-Nov-88
Chlorinated Herbicides	WATER	WW#2	11-635-15	2,4,5-T		-	-	140	-	-	28	-	-	B&C 24-Nov-88
				2,4,5-TP Silvex		-	-	118	-	-	18	-	-	
				2,4-D		-	-	138	-	-	22	-	-	
				2,4-DB		-	-	198	-	-	68	-	-	
				Dicamba		-	-	108	-	-	32	-	-	
				Dinoseb		-	-	71	-	-	12	-	-	

* RPD values were calculated by the laboratory

R0054536

NOV 21 2 --- 0 3 5 2

Table C 3 8 Wet Weather 3

CHEMICAL (SEMIVOLATILES)	SAMPLE MATRIX	SAMPLING EVENT	SAMPLE ID No	ANALYTES	UNITS							QC LIMITS (%)	RPD* (%)	LAB/ ANALYSIS DATE
Polynuclear Aromatic Hydrocarbons (PAH)	WATER	WW#3	45459-0004	Naphthalene	ug/L	5	1 4	.	5	1 5	30	-	7	CAL 4-Feb-89
				Fluorene	ug/L	1	0 75	75	1	0.78	78	-	4	
				Pyrene	ug/L	1	1 3	97	1	1 4	107	-	10	
				Benzo(a)pyrene	ug/L	0 5	0 65	130	0 5	0 65	130	-	0	
				Indeno(1,2,3 c,d)pyrene	ug/L	0.5	0 65	130	0 5	0 64	128	-	2	
Polynuclear Aromatic Hydrocarbons (PAH)	WA ER	WW#3	045459-4MS/MSD	Naphthalene	ug/L	5	1 37	27	5	1 53	31	-	14	CAL 4-Feb-89
				Acenaphthylene	ug/L	5	3 5	70	5	3 46	69	-	1	
				Acenaphthene	ug/L	10	7 64	76	10	6 78	68	-	1	
				Fluorene	ug/L	1	0 752	75	1	0 778	78	-	4	
				Phenanthrene	ug/L	0.4	0 582	146	0.4	0 572	143	-	2	
				Anthracene	ug/L	0 2	0 158	79	0 2	0 173	87	-	10	
				Fluoranthene	ug/L	0.5	0 631	129	0.5	0 885	118	-	8	
				Pyrene	ug/L	1	1 34	101	1	1 38	105	-	4	
				Benzo(a)anthracene	ug/L	0 5	0 493	99	0 5	0 513	103	-	4	
				Chrysene	ug/L	0 5	0 588	118	0 5	0 608	122	-	3	
				Benzo(b)fluoranthene	ug/L	0 25	0 395	158	0 25	0 398	159	-	0 8	
				Benzo(k)fluoranthene	ug/L	0 25	0 258	102	0 25	0 26	104	-	2	
				Benzo(a)pyrene	ug/L	0 5	0 65	130	0 5	0 648	130	-	0	
				Dibenzo(a,h)anthracene	ug/L	2	1 62	81	2	1 58	79	-	3	
				Benzo(g,h,i)perylene	ug/L	1	0 761	76	1	0 823	82	-	7	
				Indeno(1,2,3 cd)pyrene	ug/L	0 5	0 648	130	0 5	0 644	128	-	1	

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Table C 3 9 Wet Weather 4

CHEMICAL GROUP*	SAMPLE MATRIX	SAMPLING EVENT	SAMPLE ID No	ANALYTES	UNITS	MATRIX SPIKE MS CONC	MS REC. CONC	MS REC. (%)	MATRIX SPIKE DUPLICATE MSD CONC	MSD REC. CONC	MSD REC. (%)	LAB REC. LIMITS (%)	RPD* (%)	LAB/ ANALYSIS DATE
Polynuclear Aromatic Hydrocarbons (PAH)	WATER	WW#4	045598 0005MS	Naphthalene	ug/L	5	ND	NC	-	-	-	-	-	CAL 17-Feb-89
				Fluorene	ug/L	1	0.58	58	-	-	-	-	-	
				Pyrene	ug/L	1	1.2	120	-	-	-	-	-	
				Benzo(A)pyrene	ug/L	0.5	0.5	100	-	-	-	-	-	
				Indeno(1,2,3 c,d)pyrene	ug/L	0.5	0.66	132	-	-	-	-	-	
TCC	WATER	WW#4	02 154-14	TCC		-	-	118	-	-	-	-	-	BBC
RX				RX		-	-	107	-	-	-	-	-	

* RPD values were calculated by the laboratory

R0054538

Table C 3 10 Wet Weather 5

CHEMICAL GROUP	SAMPLE MATRIX	SAMPLING EVENT	SAMPLE ID No	ANALYTES	UNITS	MATRIX SPIKE MS CONC	MATRIX SPIKE MS REC CONC	MATRIX SPIKE MS REC (%)	MATRIX SPIKE DUPLICATE MSD CONC	MATRIX SPIKE DUPLICATE MSD REC CONC	MATRIX SPIKE DUPLICATE MSD REC (%)	LAB REC LIMITS (%)	RPD* (%)	LAB/ ANALYSIS DATE
TOC	WATER	WW#5	02-388-015	TOC		-	-	120	-	-	-	-	-	B&C
TOX				TOX		-	-	105	-	-	-	-	-	
Polynuclear Aromatic Hydrocarbons (PAH)	WATER	WW#5	045559-0003MS	Naphthalene	ug/L	5	ND	NC	-	-	-	-	-	CAL 22-Feb-89
				Fluorene	ug/L	1	0.53	53	-	-	-	-	-	
				Pyrene	ug/L	1	2.9	90	-	-	-	-	-	
				Benzo(a)pyrene	ug/L	0.5	1.2	58	-	-	-	-	-	
				Indeno(1,2,3 c,d)pyrene	ug/L	0.5	1.6	NC	-	-	-	-	-	
									SAMPLE					
Polynuclear Aromatic Hydrocarbons (PAH)	WATER	WW#5	045888-0001	Naphthalene	ug/L	-	-	-	ND	ND	-	-	NC	CAL 15-Feb-89
				Acenaphthalene	ug/L	-	-	-	ND	ND	-	-	NC	
				Acenaphthene	ug/L	-	-	-	ND	ND	-	-	NC	
				Fluorene	ug/L	-	-	-	ND	ND	-	-	NC	
				Phenanthrene	ug/L	-	-	-	ND	ND	-	-	NC	
				Anthracene	ug/L	-	-	-	ND	ND	-	-	NC	
				Fluoranthene	ug/L	-	-	-	2.4	2.6	-	-	8	
				Pyrene	ug/L	-	-	-	2	2.2	-	-	9.5	
				Benzo(a)anthracene	ug/L	-	-	-	0.56	0.6	-	-	6.9	
				Chrysene	ug/L	-	-	-	ND	ND	-	-	NC	
				Benzo(b)fluoranthene	ug/L	-	-	-	0.70	0.86	-	-	9.8	
				Benzo(k)fluoranthene	ug/l	-	-	-	0.34	0.37	-	-	8.5	
				Benzo(a)pyrene	ug/L	-	-	-	0.91	1	-	-	9.4	
				Dibenzo(a,h)anthracene	ug/L	-	-	-	ND	ND	-	-	NC	
				Benzo(g,h,i)perylene	ug/L	-	-	-	1.3	1.6	-	-	14	
				Indeno(1,2,3 cd)pyrene	ug/L	-	-	-	1.4	1.2	-	-	15	

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Table C 3 11 Sediment 1

CHEMICAL CLASS	SAMPLE MATRIX	SAMPLING EVENT	SAMPLE ID No	ANALYTES	UNITS	MATRIX SPIKE MS CONC	MS REC CONC	MS REC (%)	MATRIX SPIKE DUPLICATE MSD CONC	MSD REC CONC	MSD REC (%)	LAB REC LIMITS (%)	RPD* (%)	LAB/ ANALYSIS DATE
Volatile Organics	SOIL	Sed01	553 04 R 3	Phenol	mg/kg	3300	2300	70	3300	2500	76	10--65	8	Anamatrix 13-Apr-88
				2 Chlorophenol	mg/kg	3300	2200	67	3300	2300	68	15--70	4	
				1,4 Dichlorobenzene	mg/kg	1700	1000	59	1700	1100	65	10--70	10	
				Nitrosodipropylamine	mg/kg	1700	1200	71	1700	1200	70	10--83	0	
				1,2,4 Trichlorobenzene	mg/kg	1700	1100	65	1700	1200	71	13--70	9	
				4 Chloro 3 methylphenol	mg/kg	3300	2800	86	3300	3100	94	30--90	7	
				Acenaphene	mg/kg	1700	1400	82	1700	1500	88	10--110	7	
				4 Nitrophenol	mg/kg	3300	2800	91	3300	2900	91	20--110	0	
				2,4 Dinitrotoluene	mg/kg	1700	1400	82	1700	1500	88	27--104	7	
				Pentachlorophenol	mg/kg	3300	2300	70	3300	2400	73	10--125	4	
				Pyrene	mg/kg	1700	1500	88	1700	1700	100	33--120	13	

* RPD values were calculated by the laboratory.

R005540

C-C72-- 2 VOA 12

Table C 3 12 Sediment 2

CHEMICAL GROUP	SAMPLE MATRIX	SAMPLING EVENT	SAMPLE ID No	ANALYTES	UNITS	MATRIX SPIKE MS CONC	MATRIX SPIKE MS REC CONC	MATRIX SPIKE MS REC (%)	MATRIX SPIKE DUPLICATE MSD CONC	MATRIX SPIKE DUPLICATE MSD REC CONC	MATRIX SPIKE DUPLICATE MSD REC (%)	LAB REC LIMITS (%)	RPD* (%)	LAB/ ANALYSIS DATE
Pesticides & PCBs	SOIL	Sed#2	2376	Lindane		-	-	82	-	-	88	-	4.6	TexScan
				Heptachlor		-	-	104	-	-	110	-	2.8	8-Jun-88
				Aldrin		-	-	60	-	-	60	-	0	
				Dieldrin		-	-	86	-	-	96	-	4.1	
				Endrin		-	-	108	-	-	112	-	1.8	
				4,4'-DDT		-	-	150	-	-	138	-	14	

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Table C 3 13 Sediment 3

CHEMICAL GROUP	SAMPLE MATRIX	SAMPLING EVENT	SAMPLE ID No	ANALYTES	UNITS	MATRIX SPIKE MS CONC	MATRIX SPIKE MS REC CONC	MATRIX SPIKE MS REC (%)	MATRIX SPIKE DUPLICATE MSD CONC	MATRIX SPIKE DUPLICATE MSD REC CONC	MATRIX SPIKE DUPLICATE MSD REC (%)	LAB REC LIMITS (%)	RPD* (%)	LAB/ ANALYSIS DATE
Organophosphorus Pesticides	SOIL	Sed#3	98-08-261-028	Ethoprop Ethion	mg/kg mg/kg	.	.	0.99 0.99	.	0.8 0.87	81 88	.	.	TenSon 6 Oct-98
Chlorinated Herbicides	SOIL	Sed#3	98-810-14	2,4,5 T 2,4,5 TP 2,4 D		.	.	.	.	.	86 75 56	.	.	BSC 23-Aug-98

* RPD values were calculated by the laboratory.

R0054542

Table C 3-14 Sediment 4

CHEMICAL GROUP	SAMPLE MATRIX	SAMPLING EVENT	SAMPLE ID No	ANALYTES	UNITS	MATRIX SPIKE MS CONC	MATRIX SPIKE MS REC CONC	MATRIX SPIKE MS REC (%)	MATRIX SPIKE DUPLICATE MSD CONC	MATRIX SPIKE DUPLICATE MSD REC CONC	MATRIX SPIKE DUPLICATE MSD REC (%)	LAB REC LIMITS (%)	RPD* (%)	LAB/ ANALYSIS DATE
Chlorinated Herbicides	SOIL	Sed#4	12-322-17	2,4,5-T		-	-	120	-	-	92	-	-	B&C 24-Dec-88
				2,4,5-TP		-	-	93	-	-	65	-	-	
				2,4-D		-	-	100	-	-	76	-	-	
				2,4-DB		-	-	120	-	-	88	-	-	
				Dicamba		-	-	98	-	-	54	-	-	

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APPENDIX C.4
RESULTS OF METHOD, FIELD, AND TRIP BLANKS

MB	Method Blank
TB	Trip Blank
FB	Field Blank
EB	Equipment Blank - collected only during the wet weather sampling rounds; see QA/QC discussion on blank contamination for details

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Table C 4-1 Dry Weather 1

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLING EVENT	SAMPLE/ ID No	ANALYTES	CONC.	UNITS	SAMPLING DATE	REMARKS
Volatile Organics	EPA 624	DW#1	MB	Methylene Chloride	6	ug/L	8-Mar-88	
Semivolatile Organics	EPA 625	DW#1	MB	BEHP*	18	ug/L	8-Mar-88	

* bis(2-ethylhexyl)phthalate

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Table C 4-2 Dry Weather 2

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLING EVENT	SAMPLE/ ID No	ANALYTES	CONC	UNITS	SAMPLING DATE	REMARKS
Volatile Organics	EPA 624	DW#2	MB	Acetone	27	ug/L	8-Apr-88	
				Methylene Chloride	11	ug/L		
Semivolatile Organics	EPA 625	DW#2	MB	BEHP*	800	ug/L	9-Apr-88	
Semivolatile Organics	EPA 625	DW#2	MB	BEHP*	410	ug/L	10-Apr-88	

* bis(2-ethylhexyl)phthalate

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Table C.4-3. Dry Weather 4

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLING EVENT	SAMPLE/ ID No.	ANALYTES	CONC.	UNITS	SAMPLING DATE
Chlor. Herbicides	SW8150	DW#4	FB	Chlor. Herbicides	ND	ug/l	23-Aug-88
TOX	9020	DW#4	FB	TOX	ND	mg/L	23-Aug-88
Chlor. Herbicides	SW8150	DW#4	TB	Chlor. Herbicides	ND	ug/L	23-Aug-88
TOX	9020	DW#4	TB	TOX	ND	mg/L	23-Aug-88
Total Coliform	909C	DW#4	FB	Total Coliform	ND	MPN/100 ml	1-Sep-88
Fecal Coliform	909A	DW#4	FB	Fecal Coliform	ND	MPN/100 ml	1-Sep-88
Metals	SW6010	DW#4	FB/ T88-2797	Mercury Zinc	0.0003 0.011	mg/L mg/L	26-Aug-88
Metals	SW6010	DW#4	MB	Metals	ND		26-Aug-88
Nitrite	354.1	DW#4	FB/ T88-2797	Nitrite	ND	mg/L	26-Aug-88
Nitrate	353.2	DW#4	FB/ T88-2797	Nitrate	ND	mg/L	26-Aug-88
TKN	351.2	DW#4	FB/ T88-2797	TKN	ND	mg/L	26-Aug-88
TSS	160.3	DW#4	FB/ T88-2797	TSS	2.5	mg/L	26-Aug-88
BOD	405.1	DW#4	FB/ T88-2797	BOD	8	mg/L	26-Aug-88
Polynuclear Aromati Hydrocarbons (PAH)	EPA 610	DW#4	FB/ S8-08-281 -04A	PAH Compounds	ND	ug/L	26-Aug-88

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Table C.4-4. Dry Weather 5

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLING EVENT	SAMPLE/ ID No.	ANALYTES	CONC.	UNITS	SAMPLING DATE
Polynuclear Aromatic Hydrocarbons (PAH)	EPA 610	DW#5	MB	PAH	ND	ug/L	
Polynuclear Aromatic Hydrocarbons (PAH)	EPA 610	DW#5	FB	PAH	ND	ug/L	13-Dec-88
TOX	9020	DW#5	FB/ 12-322-5	TOX	0.03	mg/L	13-Dec-88
TOX	9020	DW#5	MB/ 12-322-12	TOX	ND	mg/L	13-Dec-88
Chlor. Herbicides	SW8150	DW#5	FB/ 12-322-5	Chlor. Herbicides	ND	ug/L	13-Dec-88
Chlor. Herbicides	SW8150	DW#5	MB/ 12-322-19	Chlor. Herbicides	ND	ug/L	13-Dec-88
Total Coliform	909C	DW#5	FB	Total Coliform	ND	MPN/100 ml	24-Dec-88
Fecal Coliform	909A	DW#5	FB	Fecal Coliform	ND	MPN/100 ml	24-Dec-88
Pesticides & PCBs	E608	DW#5	FB/ T88-3340	Pest. & PCBs	ND	ug/L	24-Dec-88
Metals	SW6010	DW#5	FB/ T88-3340	Zinc	0.014	mg/L	24-Dec-88
Metals	SW6010	DW#5	MB	Metals	ND	mg/L	24-Dec-88
TKN	351.2	DW#5	FB/ T88-3340	TKN	ND	mg/L	24-Dec-88
TSS	160.3	DW#5	FB/ T88-3340	TSS	ND	mg/L	24-Dec-88
BOD	405.1	DW#5	FB/ T88-3340	BOD	ND	mg/L	24-Dec-88
Hardness	200.7	DW#5	FB/ T88-3340	Hardness	ND	mg/L	24-Dec-88
Turbidity	180.1	DW#5	FB/ T88-3340	Turbidity	ND	NTU	24-Dec-88
Polynuclear Aromatic Hydrocarbons (PAH)	EPA 610	DW#5	MB/ 44880-MB	PAH Compounds	ND	ug/L	24-Dec-88

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Table C.4-5. Dry Weather 6

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLING EVENT	SAMPLE/ ID No.	ANALYTES	CONC.	UNITS	SAMPLING DATE
Total Coliform	909C	DW#6	FB	Total Coliform	ND	MPN/100 ml	14-Feb-89
Fecal Coliform	909A	DW#6	FB	Fecal Coliform	ND	MPN/100 ml	14-Feb-89
Pesticides & PCBs	E608	DW#6	FB/ T-3531	Pesticides & PCBs	ND	ug/L	14-Feb-89
Metals	SW6010	DW#6	FB/ T-3531	Lead Zinc	0.003 0.010	mg/L	14-Feb-89
Metals	SW6010	DW#6	MB	Metals	ND	mg/L	14-Feb-89
TKN	351.2	DW#6	FB/ T-3531	TKN	ND	mg/L	14-Feb-89
TSS	160.3	DW#6	FB/ T-3531	TSS	ND	mg/L	14-Feb-89
BOD	405.1	DW#6	FB/ T-3531	BOD	ND	mg/L	14-Feb-89
Hardness	200.7	DW#6	FB/ T-3531	Hardness	ND	mg/L	14-Feb-89
Turbidity	180.1	DW#6	FB/ T-3531	Turbidity	ND	NTU	14-Feb-89
Polynuclear Aromatic Hydrocarbons (PAH)	EPA 610	DW#6	MB/ 45559-0006SA	PAH Compounds	ND	ug/L	14-Feb-89
Polynuclear Aromatic Hydrocarbons (PAH)	EPA 610	DW#6	MB/ 45559-0006SA	PAH Compounds	ND	ug/L	14-Feb-89

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Table C.4-6. Dry Weather 7

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLING EVENT	SAMPLE/ ID No.	ANALYTES	CONC.	UNITS	SAMPLING DATE
Total Coliform	909C	DW#7	FB	Total Coliform	ND	MPN/100 ml	19-Apr-89
Fecal Coliform	909A	DW#7	FB	Fecal Coliform	ND	MPN/100 ml	19-Apr-89
TOC	415.1	DW#7	FB/ 04-195-8	TOC	ND	mg/L	19-Apr-89
Pesticides & PCBs	E608	DW#7	FB/ T-3839	Pest. & PCBs	ND	ug/L	19-Apr-89
Metals	SW6010	DW#7	FB/ T-3839	Zinc	0.006	mg/L mg/L	19-Apr-89
Metals	SW6010	DW#7	MB	Metals	ND	mg/L	19-Apr-89
TKN	351.2	DW#7	FB/ T-3839	TKN	ND	mg/L	19-Apr-89
TSS	160.3	DW#7	FB/ T-3839	TSS	ND	mg/L	19-Apr-89
BOD	405.1	DW#7	FB/ T-3839	BOD	ND	mg/L	19-Apr-89
Hardness	200.7	DW#7	FB/ T-3839	Hardness	ND	mg/L	19-Apr-89
Turbidity	180.1	DW#7	FB/ T-3839	Turbidity	ND	NTU	19-Apr-89
Polynuclear Aromatic Hydrocarbons (PAH)	EPA 610	DW#7	FB 45559-0006SA	PAH Compounds	ND	ug/L	19-Apr-89
Polynuclear Aromatic Hydrocarbons (PAH)	EPA 610	DW#7	MB	PAH Compounds	ND	ug/L	19-Apr-89
Polynuclear Aromatic Hydrocarbons (PAH)	EPA 610	DW#7	FB 45559-0006SA	PAH Compounds	ND	ug/L	19-Apr-89

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Table C 4-7 Wet Weather 1

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLING EVENT	SAMPLE/ ID No.	ANALYTES	CONC.	UNITS	SAMPLING DATE	REMARKS
Volatile Organics	EPA 624	WWrl	MB	Acetone	20	ug/L	23-Apr-89	
				Methylene Chloride	7	ug/L		
Volatile Organics	EPA 624	WWrl	MB	Methylene Chloride	9	ug/L	26-Apr-89	
				1,1,1-trichloroethane	9	ug/L		
Semivolatile Organics	EPA 625	WWrl	MB	BEHP*	11	ug/L	4-May-89	

* bis(2-ethylhexyl)phthalate

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Table C 4-8 Wet Weather 2

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLING EVENT	SAMPLE/ ID No	ANALYTES	CONC	UNITS	SAMPLING DATE
TOC	415.1	WW#2	MB 11-635-17	TOC	0.7	mg/L	24-Nov-88
TOX	9020	WW#2	MB 11-635-17	TOX	ND	mg/L	24-Nov-88
Chlorinated Herbicides	SW8150	WW#2	MB 11-635-17	Chlorinated Herb	ND	ug/L	24-Nov-88
Volatile Organics	EPA 624	WW#2	MB	Volatile Organics	ND	ug/L	2-Dec-88
Volatile Organics	EPA 624	WW#2	MB	Volatile Organics	ND	ug/L	3-Dec-88
Volatile Organics	EPA 624	WW#2	MB	Volatile Organics	ND	ug/L	5-Dec-88
Semivolatile Organics	EPA 625	WW#2	MB	BEHP	120	ug/L	6-Dec-88
Semivolatile Organics	EPA 625	WW#2	MB	BEHP	50	ug/L	7-Dec-88
Metals	SW6010	WW#2	EB/ T88-3264	Cadmium Chromium,Total Mercury Silver	0.0002 0.002 0.0004 0.0002	mg/L mg/L mg/L mg/L	29-Nov-88
Metals	SW6010	WW#2	MB	Cadmium Chromium,Total Mercury Silver	0.0002 ND ND ND	mg/L mg/L mg/L mg/L	29-Nov-88
TKN	351.2	WW#2	EB T88-3264	TKN	ND	mg/L	29-Nov-88
Ammonia (as N)	350.1	WW#2	EB T88-3264	Ammonia (as N)	ND	mg/L	
Nitrate (as N)	353.2	WW#2	EB T88-3264	Nitrate (as N)	ND	mg/L	
Nitrite (as N)	354.1	WW#2	EB T88-3264	Nitrite (as N)	ND	mg/L	
Hardness	200.7	WW#2	EB T88-3264	Hardness	ND	mg/L	

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Table C 4-9 Wet Weather 2 (Continued)

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLING EVENT	SAMPLE/ ID No.	ANALYTES	CONC.	UNITS	SAMPLING DATE
TOX	9020	WW#2	EB/ 11-635-12	TOX	ND	mg/L	24-Nov-88
TOX	9020	WW#2	MB/ 11-635-17	TOX	ND	mg/L	24-Nov-88
TOC	415.1	WW#2	MB/ 11-635-17	TOC	0.7	mg/L	24-Nov-88
Chlor. Herbicides	SW8150	WW#2	EB/ 11-635-12	Chlor. Herbicides	ND	ug/L	24-Nov-88
Chlor Herbicides	SW8150	WW#2	MB/ 11-635-12	Chlor. Herbicides	ND	ug/L	24-Nov-88
Volatile Organics	EPA 624	WW#2	EB 8811183-12	Volatile Organics	ND	ug/L	3-Dec-88
Semivolatile Organics	EPA 625	WW#2	EB 8811183-12	Semivolatile Organics	ND	ug/L	8-Dec-88
Pesticides & PCB's	EPA 608	WW#2	EB	Pesticides & PCB	ND	ug/L	24-Nov-88
Total Coliform	909C	WW#2	EB	Total Coliform	ND	MPN/100 ml	24-Nov-88
Fecal Coliform	909A	WW#2	EB	Fecal Coliform	ND	MPN/100 ml	24-Nov-88

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Table C.4-10 Wet Weather 3

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLING EVENT	SAMPLE/ ID No	ANALYTES	CONC.	UNITS	SAMPLING DATE
Polynuclear Aromatic Hydrocarbons (PAH)	EPA 610	WW#3	MB	PAH Compounds	ND		2-Feb-89
Polynuclear Aromatic Hydrocarbons (PAH)	EPA 610	WW#3	EB	PAH Compounds	ND		4-Feb-89
TOX	9020	WW#3	EB 01-539-8	TOX	ND	mg/L	24-Jan-88
Metals	SW6010	WW#3	EB T-3497	Cadmium Zinc	0.0019 0.01	mg/L	14-Apr-88
Metals	SW6010	WW#3	MB	Metals	ND	mg/L	14-Apr-88
TKN	351.2	WW#3	EB T-3497	TKN	ND	mg/L	14-Apr-88
TSS	160.3	WW#3	EB T-3497	TSS	ND	mg/L	14-Apr-88
BOD	405.1	WW#3	EB T-3497	BOD	ND	mg/L	14-Apr-88
Hardness	200.7	WW#3	EB T-3497	Hardness	ND	mg/L	14-Apr-88
Turbidity	180.1	WW#3	EB T-3497	Turbidity	ND	NTU	14-Apr-88
Polynuclear Aromatic Hydrocarbons (PAH)	EPA 610	WW#3	EB 45559-0006SA	PAH Compounds	ND	ug/L	2-Feb-88
Polynuclear Aromatic Hydrocarbons (PAH)	EPA 610	WW#3	MB 45559-MB	PAH Compounds	ND	ug/L	2-Feb-88
Total Coliform	909C	WW#3	EB	Total Coliform	ND	MPN/100 ml	2-Feb-88
Fecal Coliform	909A	WW#3	EB	Fecal Coliform	ND	MPN/100 ml	2-Feb-88
Fecal Strep		WW#3	EB	Fecal Strep	ND	MPN/100 ml	2-Feb-88
Pesticides & PCB s	EPA 608	WW#3	EB T-3497	4,4'-DDE	0.077	ug/L	14-Apr-88

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Table C.4-11 Wet Weather 4

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLING EVENT	SAMPLE/ ID No.	ANALYTES	CONC.	UNITS	SAMPLING DATE
TOX	9020	WW#4	EB 02-154-12	TOX	ND	mg/L	5-Feb-89
Metals	SW6010	WW#4	EB T-3553	Metals	ND	mg/L	18-Apr-89
Metals	SW6010	WW#4	MB	Metals	ND	mg/L	18-Apr-89
TKN	351.2	WW#4	EB T-3553	TKN	ND	mg/L	18-Apr-89
TSS	160.3	WW#4	EB T-3553	TSS	ND	mg/L	18-Apr-89
BOD	405.1	WW#4	EB T-3553	BOD	ND	mg/L	18-Apr-89
Hardness	200.7	WW#4	EB T-3553	Hardness	ND	mg/L	18-Apr-89
Turbidity	180.1	WW#4	EB T-3553	Turbidity	ND	NTU	18-Apr-89
Polynuclear Aromatic Hydrocarbons (PAH)	EPA 610	WW#4	EB 45556-0012	PAH Compounds	ND	ug/L	17-Feb-89
Polynuclear Aromatic Hydrocarbons (PAH)	EPA 610	WW#4	MB 45556-MB	PAH Compounds	ND	ug/L	17-Feb-89
Pesticides & PCB's	EPA 608	WW#4	EB T-3553	Pesticides & PCB	ND	ug/L	18-Apr-89

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Table C.4-12 Wet Weather 5

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLING EVENT	SAMPLE/ ID No.	ANALYTES	CONC.	UNITS	SAMPLING DATE
TOX	9020	WW#5	EB 02-358-13	TOX	ND	mg/L	10-Feb-89
Metals	SW6010	WW#5	EB T-3572	Copper	0.004	mg/L	10-Feb-89
Metals	SW6010	WW#5	MB	Metals	ND	mg/L	10-Feb-89
TKN	351.2	WW#5	EB T-3572	TKN	ND	mg/L	10-Feb-89
TSS	160.3	WW#5	EB T-3572	TSS	ND	mg/L	10-Feb-89
BOD	405.1	WW#5	EB T-3572	BOD	ND	mg/L	10-Feb-89
Hardness	200.7	WW#5	EB T-3572	Hardness	ND	mg/L	10-Feb-89
Turbidity	180.1	WW#5	EB T-3572	Turbidity	ND	NTU	10-Feb-89
Polynuclear Aromatic Hydrocarbons (PAH)	EPA 610	WW#5	EB 45688-0013	PAH Compounds	ND	ug/L	22-Feb-89
Polynuclear Aromatic Hydrocarbons (PAH)	EPA 610	WW#5	MB 45688-MB	PAH Compounds	ND	ug/L	22-Feb-89
Pesticides & PCB's	EPA 608	WW#5	EB T-3572	Pesticides & PCB	ND	ug/L	10-Feb-89
Total Coliform	909C	WW#5	EB	Total Coliform	ND	MPN/100 ml	10-Feb-89
Fecal Coliform	909A	WW#5	EB	Fecal Coliform	ND	MPN/100 ml	10-Feb-89

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Table C.4-13 Wet Weather 6

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLING EVENT	SAMPLE/ ID No.	ANALYTES	CONC.	UNITS	SAMPLING DATE
Pesticides & PCB's	EPA 608	WW#6	EB T-3659	Pesticides & PCB	ND	ug/L	3-Mar-89
Total Coliform	909C	WW#6	EB	Total Coliform	ND	MPN/100 ml	3-Mar-89
Fecal Coliform	909A	WW#6	EB	Fecal Coliform	ND	MPN/100 ml	3-Mar-89
Metals* (Total)	SW6010	WW#6	EB T-3659	Chromium Copper Lead Nickel Zinc	0.052 0.011 0.001 0.06 0.018	mg/L	3-Mar-89
Metals* (Dissolved)	SW6010	WW#6	EB T-3659	Chromium Copper Nickel Zinc	0.001 0.006 0.004 0.015	mg/L	3-Mar-89
Metals (Total)	SW6010	WW#6	MB	Chromium Chromium	0.002 0.001	mg/L	3-Mar-89
TKN	351.2	WW#6	EB T-3659	TKN	ND	mg/L	3-Mar-89
Polynuclear Aromatic Hydrocarbons (PAH)	EPA 610	WW#6	EB 46005-0009	PAH Compounds	ND	ug/L	10-Mar-89
Polynuclear Aromatic Hydrocarbons (PAH)	EPA 610	WW#6	MB 46005-MB	PAH Compounds	ND	ug/L	10-Mar-89
TOX	9020	WW#6	EB 03-115-11	TOX	ND	mg/L	3-Mar-89

* Blank water was taken directly from the solar still; see QA/QC discussion on blank contamination

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Table C.4-14 Wet Weather 7

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLING EVENT	SAMPLE/ ID No.	ANALYTES	CONC.	UNITS	SAMPLING DATE
Metals	SW6010	WW#7	EB T-3769	Arsenic	0.001	mg/L	29-Mar-89
				Chromium	0.001		
				Zinc	0.003		
Metals	SW6010	WW#7	MB	Metals	ND	mg/L	29-Mar-89

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Table C.4-15 Sediment 2

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLING EVENT	SAMPLE/ ID No.	ANALYTES	CONC.	UNITS	SAMPLING DATE
Volatile Organics	EPA 624	Sed#2	MB	Volatile Organics	ND	ug/kg	3-Jun-88
Semivolatile Organics	EPA 625	Sed#2	MB	BEHP*	940	ug/kg	3-Jun-88

* bis(2-ethylhexyl)phthalate

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Table C.4-16 Sediment 3

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLING EVENT	SAMPLE/ ID No.	ANALYTES	CONC.	UNITS	SAMPLING DATE
Semivolatile Organics	EPA 625	Sed#3	MB	BEHP*	2400	ug/kg	13-Sep-88
Semivolatile Organics	EPA 625	Sed#3	MB	BEHP*	1400	ug/kg	13-Sep-88

* bis(2-ethylhexyl)phthalate

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Table C.4-17 Sediment 4

CHEMICAL GROUP	ANALYSIS METHOD	SAMPLING EVENT	SAMPLE/ ID No.	ANALYTES	CONC.	UNITS	SAMPLING DATE
Polynuclear Aromatic Hydrocarbons (PAH)	EPA 610	Sed#4	MB1	PAH Compounds	ND	ug/kg	-
Polynuclear Aromatic Hydrocarbons (PAH)	EPA 610	Sed#4	MB2	PAH Compounds	ND	ug/kg	-
Chlorinated Herbicides	SW8150	Sed#4	MB 12-322-12	Chlorinated Herb	ND	mg/kg	13-Dec-88

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APPENDIX C.5
RESULTS OF ERA QUALITY CONTROL SAMPLES

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Table C.5.1. SUMMARY OF RELATIVE PERCENT DIFFERENCES (RPD) BETWEEN ACTUAL AND ERA CERTIFIED CONCENTRATIONS

CONSTITUENT	1st Quarter '88			2nd Quarter '88			3rd Quarter '88			4th Quarter '88			1st Quarter '89			AVG.†
	ACTUAL CONC. (µg/L)	ERA * CERT. VALUE (µg/L)	RPD (%)	ACTUAL CONC. (µg/L)	ERA CERT. VALUE (µg/L)	RPD (%)	ACTUAL CONC. (µg/L)	ERA CERT. VALUE (µg/L)	RPD (%)	ACTUAL CONC. (µg/L)	ERA CERT. VALUE (µg/L)	RPD (%)	ACTUAL CONC. (µg/L)	ERA CERT. VALUE (µg/L)	RPD (%)	(%)
ARSENIC	165	133	11	130	152	-8	55	75.8	-16	70	43.6	23	124	131	-3	2
CADMIUM	78	78	0	105	102	1	96	97.9	-1	280	230	10	80	54.1	19	6
CHROMIUM	87	91	-2	175	181	4	100	99	1	200	172	8	300	257	8	4
COPPER	70	66	3	99	91	4	135	110	10	230	200	7	90	99.5	-5	4
LEAD	95	89	3	115	141	-10	175	169	2	200	160	11	140	154	-5	0
MERCURY	10	11	-5	11.2	9.8	8	4.6	3.8	10	4.5	3.4	14	4.4	3.4	13	8
NICKEL	74	77	-2	87	83	2	140	141	0	80	74.1	-11	80	131	-24	-7
SELENIUM	72	79	-5	134	137	-1	60	68	-8	28	49.1	-31	70	81.8	-8	-10
SILVER	75	79	-3	-	80	NC	-	-	NC	80	170	-55	20	40	-33	-30
ZINC	160	134	8	192	183	8	185	183	1	300	260	7	220	188	8	7
TKN	5	5.0	0	4.8	3	21	2.8	4	-18	3.7	4.8	-11	3.7	4.8	-11	-4
NITRATE as N	6.4	6.7	-2	4.4	4.5	-1	7	6.5	4	3.72	5.8	-20	-	-	NC	-5
PHOSPHATE as P	7.4	7.4	0	4.1	3.8	2	4.8	4.4	4	6.14	7.1	-7	-	-	NC	0
TSS	-	-	NC	85	71	-4	36.8	35	3	-	-	NC	78	85	-4	-2
BOD	-	-	NC	58	41	17	50	53	-3	80.2	82	13	32	43	-15	3

ERA = External Reference Standards provided by Environmental Resource Associates, Arvada, Colorado
- = Analysis Not Performed
NC = Not Calculated
AVG.† = Average of RPDs for All Available Quarterly Results

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Table C.5.2 First Quarter ERA Quality Control Samples for 1988

Analyte	Reported Concentration	ERA Certified Value	ERA Target Range	Comments
Oil and Grease	30 mg/bottle	35 mg/bottle	28-42 mg/bottle	
TRACE METALS	(ug/L)	(ug/L)	(ug/L)	
Arsenic	165	133	133-160	Conc. out of target range.
Cadium	78	78	62-94	
Chromium	87	91	73-109	
Copper	70	66	53-79	
Lead	95	89	71-107	
Mercury	10	11.0	8.8-13.0	
Nickel	74	77	62-92	
Selenium	72	79	63-95	
Silver	75	79	63-95	
Zinc	160	134	107-161	
Conventional Constituents				
pH	Value not reported.	9.1	8.9-9.3	
	(mg/L)	(mg/L)	(mg/L)	
BOD(5 day)	Value not reported.	65	49-81	
TOC	Value not reported.	43	34-52	
Kjeldahl nitrogen as N	5	5.0	3.9-6.1	
	(mg/L)	(mg/	(mg/L)	
Ammonia as N	6.6	6..	5.7-7.3	
Nitrate as N	6.4	6.7	5.9-7.5	
Phosphate as P	7.4	7.4	6.6-8.2	

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Table C.5.2 First Quarter ERA Quality Control Samples for 1988

Analyte	Reported Concentration	ERA Certified Value	ERA Target Range	Comments
VOLATILES (GC/MS)	(ug/L)	(ug/L)	(ug/L)	
chlorobenzene	74	73.1	27-100	
chloroform	15	13.9	10-17	
1,2-dichloroethane	46	46.3	31-66	
ethylbenzene	30	32.1	12-43	
methylene chloride	110	112	39-230	
1,1,1-trichloroethane	140	143	74-220	
trichloroethene	56	54.3	39-75	
SEMIVOLATILE (GC/MS)	(ug/L)	(ug/L)	(ug/L)	
acenaphthene	50	65.1	21-94	
bis(2-chloroethyl)ether	86	136	16-212	
4-chlorophenyl phenyl ether	55	64.8	28-102	
di-n-butyl phthalate	87	97.5	15-115	
diethyl phthalate	70	70.5	17-80	
naphthalene	100	173	66-230	
n-nitroso-di-n-propylamine	14	22.8	9-52	
1,2,4-trichlorobenzene	24	62.9	28-89	Conc. out of target range.
PESTICIDES (GC)	(ug/L)	(ug/L)	(ug/L)	
beta-BHC	0.76	0.88	0.31-1.3	
gamma-BHC (Lindane)	0.58	0.39	0.21-0.56	Conc. out of target range.
heptchlor	2.7	2.85	1.9-3.8	
endrin	1.0	1.44	0.6-2.2	
PCB'S (GC)				
Aroclor 1242	0.35	0.219	0.085-0.33	Conc. out of target range.
Toxaphene	0.47	0.263	0.11-0.33	Conc. out of target range.

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Table C.5.2 First Quarter ERA Quality Control Samples for 1988

Analyte	Reported Concentration	ERA Certified Value	ERA Target Range	Comments
HERBICIDES (GC)	(mg/L)	(mg/L)	(mg/L)	
2,4-D	0.31	0.540	0.14-0.66	
2,4,5-TP	0.35	0.320	0.11-0.45	

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Table C.5.3 Second Quarter ERA Quality Control Samples for 1988

Analyte	Reported Concentration	ERA Certified Value	ERA Target Range	Comments
Oil and Grease	35 mg/bottle	45 mg/bottle	35-55 mg/bottle	
TRACE METALS	(ug/L)	(ug/L)	(ug/L)	
Arsenic	130	152	122-182	
Cadium	105	102	82-122	
Chromium	175	161	129-193	
Copper	99	91	73-109	
Lead	115	141	113-169	
Mercury	11.2	9.6	7.7-12.0	
Nickel	87	83	66-100	
Selenium	134	137	110-164	
Silver	Conc. not reported	80	64-96	
Zinc	132	163	134-202	
Conventional Constituents				
pH	8.9	9.1	8.9-9.3	
	(mg/L)	(mg/L)	(mg/L)	
BOD(5 day)	58	41	31-51	Conc. out of target range.
TOC	Conc. not reported	27	21-33	
Kjeldahl nitrogen as N	4.6	3	2.4-3.6	Conc. out of target range.
	(mg/L)	(mg/L)		
Total Suspended Soilds	65	71	[illegible]	
	(mg/L)	(mg/L)	(mg/L)	
Ammonia as N	5.7	5.7	5.0-6.4	
Nitrate as N	4.4	4.5	4.0-5.0	
Phosphate as P	4.1	3.9	3.5-4.3	

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Table C.5.3 Second Quarter ERA Quality Control Samples for 1988

Analyte	Reported Concentration	ERA Certified Value	ERA Target Range	Comments
VOLATILES (GC/MS)	(ug/L)	(ug/L)	(ug/L)	
chloroform	35	23.7	16-29	Conc. out of target range.
1,2-dichloroethane	92	78.8	39-108	
bromodichloromethane	11	8.9	4-12	
trans-1,3-dichloropropene	42	26.3	10-43	
toluene	180	160	75-214	
ethylbenzene	101	96.5	36-129	
SEMIVOLATILE (GC/MS)	(ug/L)	(ug/L)	(ug/L)	
acenaphthene	31	75.1	35-109	Conc. out of target range.
benzo(b)fluoranthene	23	45.5	11-72	
benzo(a)pyrene	Not detected	15.9	3-26	Conc. out of target range.
bis(2-ethylhexyl)phthalate	43	102	29-161	
2-chloronapthalene	Not detected	21.1	13-25	Conc. out of target range.
1,3-dichlorobenzene	24	98	25-169	Conc. out of target range.
2,4-dinitrotoluene	54	130	51-181	
hexachlorobutadiene	12	62.9	15-73	Conc. out of target range.
nitrobenzene	49	88	31-158	
HERBICIDES (GC)	(mg/L)	(mg/L)	(mg/L)	
2,4-D	0.11	0.111	0.030-0.135	
2,4,5-TP		0.185	0.065-0.259	

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Table C.5.4 Third Quarter ERA Quality Control Samples for 1988

Analyte	Reported Concentration	EPA Certified Value	ERA Target Range	Comments
Oil and Grease	15 mg/bottle	20 mg/bottle	16-24 mg/bottle	Conc. out of target range.
TRACE METALS	(ug/L)	(ug/L)	(ug/L)	
Arsenic	55	75.8	55-95	
Cadium	96	97.9	73-122	
Chromium	100	99	74-124	
Copper	135	110	83-138	
Lead	175	169	127-211	
Mercury	4.6	3.8	2.8-4.8	
Nickel	140	141	106-176	
Selenium	60	68	57-85	
Zinc	185	183	137-229	
Conventional Constituents				
pH	9.2	8.8	8.6-9.0	
	(mg/L)	(mg/L)	(mg/L)	
BOD(5 day)	50	53	40-66	
TOC	30	35	27-43	
Kjeldahl nitrogen as N	2.8	4	3.2-4.8	Conc. out of target range.
Total Suspended Solids	36.8	35	29-41	
	(mg/L)	(mg/L)	(mg/L)	
Ammonia as N	4.6	3.8	3.3-4.3	Conc. out of target range.
Nitrate as N	7	6.5	5.8-7.2	
Phosphate as P	4.8	4.4	3.6-5.2	

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Table C.5.4 Third Quarter ERA Quality Control Samples for 1988

Analyte	Reported Concentration	EPA Certified Value	ERA Target Range	Comments
VOLATILES (GC/MS)	(ug/L)	(ug/L)	(ug/L)	
Methylene Chloride	85	77	27-160	
1,1-Dichloroethane	25	23.3	11-33	
Carbon Tetrachloride	15	12.3	8.8-76	
Benzene	70	58.3	22-76	
Chlorobenzene	19	15.5	5.7-21	
1,1,2,2-Tetrachloroethane	140	132	60-179	
SEMI-VOLATILE (GC/MS)	(ug/L)	(ug/L)	(ug/L)	
1,4-Dichlorobenzene	Not detected	9.65	4.1-12	
Hexachloroethane	Not detected	24.2	9.7-27	Conc. out of target range.
1,2,4-Trichlorobenzene	14	62.6	27-89	Conc. out of target range.
2-Chloronaphthalene	Not detected	13	7.8-15	Conc. out of target range.
Acenaphthylene	Not detected	44.8	15-65	Conc. out of target range.
Acenphthene	20	Not reported		Not in ERA sample.
2,4-dinitrotoluene	91	143	56-199	
Butylbenzylphthalate	63	93.7	14-142	
Bis(2-ethylhexyl)phthalate	33	79.3	22-125	
PESTICIDES (GC)	(ug/L)	(ug/L)	(ug/L)	
Aldrin	0.11	1.42	0.62--1.7	Conc. out of target range.
Heptachlor epoxide	ND	0.385	0.17--0.55	Conc. below laboratory
4,4'-DDD	0.095	0.135	0.06--0.16	detection limit.
4,4'-DDE	0.08	0.26	0.08--0.37	
4,4'-DDT	0.23	Not reported		Not in ERA sample.
Dieldrin	0.083	Not reported		Not in ERA sample.
Endrin	0.06	Not reported		Not in ERA sample.
PCB'S (GC)	(ug/L)	(ug/L)	(ug/L)	
Aroclor 1242	ND	0.219	0.085-0.33	Conc. below laboratory detection limit.

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Table C.5.4 Third Quarter ERA Quality Control Samples for 1988

Analyte	Reported Concentration	EPA Certified Value	ERA Target Range	Comments
Toxaphene	ND	0.263	0.11-0.33	Conc. below laboratory detection limit.
HERBICIDES (GC)	(mg/L)	(mg/L)	(mg/L)	
2,4-D	0.3	0.540	0.14-0.66	
2,4,5-TP	0.33	0.320	0.11-0.45	

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Table C.5.5 Fourth Quarter ERA Quality Control Samples for 1988

Analyte	Reported Concentration	ERA Certified Value	ERA Target Range	COMMENTS
Oil and Grease	38 mg/bottle	37 mg/bottle	29-45 mg/bottle	
TRACE METALS	(mg/L)	(mg/L)	(mg/L)	
Arsenic	70	43.6	33-54	Conc. out of target range.
Cadium	280	230	172-288	
Chromium	200	172	129-215	
Copper	230	200	150-250	
Lead	200	160	121-200	
Mercury	4.5	3.4	2.6-4.2	Conc. out of target range.
Nickel	60	74.1	56-93	
Selenium	26	49.1	37-61	Conc. out of target range.
Silver	50	170	110-210	Conc. out of target range.
Zinc	300	260	195-325	
Conventional Constituents				
pH	9.17	9	8.8-9.2	
	(mg/L)	(mg/L)	(mg/L)	
BOD(5 day)	80.2	62	46-78	Conc. out of target range.
TOC				
Kjeldahl nitrogen as N	3.7	4.6	3.7-5.5	
	(mg/L)		(mg/L)	
Ammonia as N	3.65	5.3	4.6-6.0	Conc. out of target range.
Nitrate as N	3.72	5.6	5.0-6.2	Conc. out of target range.
Phosphate as P	6.14	7.1	5.8-8.4	

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Table C.5.5 Fourth Quarter ERA Quality Control Samples for 1988

Analyte	Reported Concentration	ERA Certified Value	ERA Target Range	COMMENTS
VOLATILES (GC/MS)	(ug/L)	(ug/L)	(ug/L)	
1,1-dichloroethene	130	112	21-230	
Methylene chloride	87	85.5	30-170	
Trans-1,2-dichloroethene	16	15.3	10-20	
Toluene	19	13.5	7-22	
1,1,2-trichloroethane	98	100	52-140	
Tetrachloroethene	25	22.1	14-29	
SEMI-VOLATILE (GC/MS)	(ug/L)	(ug/L)	(ug/L)	
1,4-dichlorobenzene	31	237	60-390	Conc. out of target range.
bis(2-chloroisopropyl)Ether	14	68.7	25-110	Conc. out of target range.
Diethylphthalate	21	59.4	14-68	
Phenanthrene	12	23.6	12-28	
Fluoranthene	28	43.7	26-60	
Butylbenzyphthalate	41	139	21-210	
PESTICIDES (GC)	(ug/L)	(ug/L)	(ug/L)	
Aldrin	0.12	0.143	0.063-0.17	
Dieldrin	0.52	0.574	0.23-0.81	
Endrin	0.26	0.357	0.11-0.53	
PCB'S (GC)	(ug/L)	(ug/L)	(ug/L)	
Aroclor 1221	Not Detected	0.148	0.035-0.26	Conc. below laboratory detection limit.
HERBICIDES (GC)	(mg/L)	(mg/L)	(mg/L)	
2,4-D	Not Detected	0.625	0.17-0.79	Conc. below laboratory detection limit.
2,4,5-TP	Not Detected	0.173	0.061-0.24	Conc. below laboratory detection limit.

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Table C.5.6 First Quarter ERA Quality Control Samples for 1989

Analyte	Reported Concentration	ERA Certified Value	ERA Target Range	Comments
Oil and Grease	64 mg/bottle	55 mg/bottle	46-66 mg/bottle	
TRACE METALS	(ug/L)	(ug/L)	(ug/L)	
Arsenic	124	131	98-164	
Cadium	80	54.1	40-68	Conc. out of target range.
Chromium	300	257	192-321	
Copper	90	98.5	74-123	
Lead	140	154	115-192	
Mercury	4.4	3.4	2.6-4.2	Conc. out of target range.
Nickel	80	131	98-164	
Selenium	70	81.6	61-102	
Silver	20	40	21-65	
Zinc	220	188	141-235	
Conventional Constituents				
pH	9.1	8.9	8.7-9.1	
	(mg/L)	(mg/L)	(mg/L)	
BOD(5 day)	32	43	30-66	
TOC	23	28	22-34	
Kjeldahl nitrogen as N	3.7	4.6	3.7-5.5	
Total Suspended Solids	78	85	71-99	
PESTICIDES (GC)	(ug/L)	(ug/L)	(ug/L)	
gamma-BHC (lindane)	0.1	0.098	0.028-0.14	
Dieldrin	0.064	0.073	0.029-0.1	
Endrin	0.1	0.12	0.037-0.18	
Endrin aldehyde	ND	0.064	0.022-0.094	Conc. below laboratory detection limit.
PCB'S (GC)	(ug/L)	(ug/L)	(ug/L)	
Aroclor 1221	ND	0.967	0.14-1.3	Conc. below laboratory detection limit.

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APPENDIX D

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APPENDIX D
SANTA CLARA NONPOINT SOURCE WATER AND SEDIMENT QUALITY DATA

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APPENDIX D
SANTA CLARA NONPOINT SOURCE WATER AND SEDIMENT QUALITY DATA

The following section presents the water and sediment quality data collected for the Santa Clara Valley Nonpoint Source study. The data are organized by parameter type (e.g., metals, conventional, etc.) and are titled D.1 through D.7. Under each parameter type the data are further subdivided into water samples and sediment samples. In addition, the metals include subgroups for total and dissolved concentrations in the water column. Following is a list of the parameter types and the corresponding appendix section:

D.1 Metals
- D.1-1 Total metals in water column
- D.1-2 Dissolved metals in water column
- D.1-3 Total metals in sediment

D.2 Conventional parameters
- D.2-1 Conventional parameters in water column
- D.2-2 Conventional parameters in sediment

D.3 Organochlorine pesticides
- D.3-1 Organochlorine pesticides in water column
- D.3-2 Organochlorine pesticides in sediment

D.4 Chlorinated herbicides
- D.4-1 Chlorinated herbicides and TOX in water column
- D.4-2 Chlorinated herbicides in sediment

D.5 Organophosphate pesticides
- D.5-1 Organophosphate pesticides in water column
- D.5-2 Organophosphate pesticides in sediment

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D.6 Polynuclear aromatic hydrocarbons
- D.6-1 Polynuclear aromatic hydrocarbons in water column
- D.6-2 Polynuclear aromatic hydrocarbons in sediment

D.7 Volatiles and semi-volatiles
- D.7-1 Volatiles and semi-volatiles in water column
- D.7-2 Volatiles and semi-volatiles in sediment

D.8 Dissolved oxygen data from stream stations and settling data

Within each parameter subgroup, the data are further organized by sample I.D. along rows and with the parameters sampled along columns. The sample I.D. corresponds to the sampling station identification number (e.g., L1 through L7 for land use stations, S1 through S4 for stream stations, and R1 through R6 for reservoir release stations). Under each sample I.D. the data are again subdivided into samples collected during dry (DRY) and wet (WET) weather, when appropriate. Also shown under sample I.D. are field duplicate (FD), lab replicates (LR), and field blanks (FB).

Under each parameter type are the measured concentrations (or ND if non-detected) and the value of the detection limit for the sample collected. Blanks in the data set mean that an analysis was not performed for certain parameters (such as hexavalent chromium) during a particular sampling event.

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D.1 Metals

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D.1-1 Total metals in water column

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	Arsenic actual mg/l	DL mg/l	Cadmium actual mg/l	DL mg/l	Chromium actual mg/l	DL mg/l	Heavy Cr actual mg/l	DL mg/l	Copper actual mg/l	DL mg/l	Lead actual mg/l	DL mg/l
STANDARD REPORTING OBJECTIVES							0.001		0.0001		0.001				0.001		0.001
L1	4	20	1988	WET	1	0.001	0.001	ND	0.0002	0.006	0.001			0.021	0.001	0.010	0.001
L1	11	23	1988	WET	2	ND	0.001	0.001	0.0002	0.009	0.001			0.028	0.001	0.045	0.001
L1	2	4	1988	WET	4	ND	0.001	0.0021	0.0002	0.035	0.001	ND	0.01	0.026	0.001	0.050	0.001
L1	2	8	1988	WET	5	ND	0.001	0.0035	0.0002	0.018	0.001	ND	0.01	0.065	0.001	0.505	0.001
L1	3	2	1988	WET	6	ND	0.001	0.0014	0.0002	0.012	0.001	ND	0.01	0.055	0.001	0.035	0.001
L2	4	20	1988	WET	1	0.002	0.001	0.0052	0.0002	0.018	0.001			0.051	0.001	0.085	0.001
L2	11	23	1988	WET	2	ND	0.001	0.004	0.0002	0.21	0.001			0.051	0.001	0.14	0.001
L2	2	4	1988	WET	4	ND	0.001	0.0035	0.0002	0.042	0.001	ND	0.01	0.046	0.001	0.33	0.001
L2	2	8	1988	WET	5	ND	0.001	0.0052	0.0002	0.075	0.001	ND	0.01	0.047	0.001	0.230	0.001
L2	3	2	1988	WET	6	ND	0.001	0.0085	0.0002	0.038	0.001	ND	0.01	0.060	0.001	0.11	0.001
L2	3	25	1988	WET	7	0.001	0.001	0.0047	0.0002	0.038	0.001	NR	0.01	0.038	0.001	0.075	0.001
L3	4	20	1988	WET	1	0.001	0.001	0.0004	0.0002	0.007	0.001			0.026	0.001	0.053	0.001
L3	11	23	1988	WET	2	ND	0.001	0.001	0.0002	0.007	0.001			0.014	0.001	0.03	0.001
L3	2	4	1988	WET	4	ND	0.001	0.0018	0.0002	0.001	0.001	ND	0.01	0.016	0.001	0.077	0.001
L3	2	8	1988	WET	5	ND	0.001	0.0035	0.0002	0.016	0.001	ND	0.01	0.025	0.001	0.045	0.001
L3	3	2	1988	WET	6	ND	0.001	0.0012	0.0002	0.008	0.001	ND	0.01	0.033	0.001	0.035	0.001
L3	3	25	1988	WET	7	ND	0.001	0.0013	0.0002	0.015	0.001	ND	0.01	0.022	0.001	0.055	0.001
L4	2	4	1988	WET	4	ND	0.001	0.0012	0.0002	0.032	0.001	ND	0.01	0.012	0.001	0.003	0.001
L4	2	8	1988	WET	5	ND	0.001	0.0017	0.0002	0.021	0.001	ND	0.01	0.020	0.001	0.004	0.001
L4	3	25	1988	WET	7	ND	0.001	0.0006	0.0002	0.023	0.001	ND	0.01	0.033	0.001	0.007	0.001
L5	11	23	1988	WET	2	ND	0.001	0.003	0.0002	0.044	0.001			0.32	0.001	0.315	0.001
L5	1	23	1988	WET	3	ND	0.001	0.0008	0.0002	0.003	0.001	ND	0.01	ND	0.001	ND	0.001
L5	2	4	1988	WET	4	ND	0.001	0.0028	0.0002	0.028	0.001	ND	0.01	0.032	0.001	0.05	0.001
L5FD	2	4	1988	WET	4	ND	0.001	0.0026	0.0002	0.011	0.001	ND	0.01	0.018	0.001	0.042	0.001
L5	2	8	1988	WET	5	ND	0.001	0.0035	0.0002	0.018	0.001	ND	0.01	0.070	0.001	0.081	0.001
L5	3	2	1988	WET	6	ND	0.001	0.0013	0.0002	0.017	0.001	ND	0.01	0.050	0.001	0.045	0.001
L5FD	3	2	1988	WET	6	ND	0.001	0.0012	0.0002	0.017	0.001	ND	0.01	0.050	0.001	0.050	0.001
L5	3	25	1988	WET	7	ND	0.001	0.0011	0.0002	0.010	0.001	ND	0.01	0.044	0.001	0.11	0.001
L6	4	20	1988	WET	1	0.003	0.001	0.0012	0.0002	0.021	0.001			0.080	0.001	0.09	0.001
L6	11	23	1988	WET	2	ND	0.001	0.001	0.0002	0.016	0.001			0.054	0.001	0.11	0.001
L6	2	8	1988	WET	5	ND	0.001	0.0035	0.0002	0.014	0.001	ND	0.01	0.023	0.001	0.007	0.001
L6	3	2	1988	WET	6	0.002	0.001	0.0015	0.0002	0.074	0.001	ND	0.01	0.038	0.001	0.030	0.001
L6	3	25	1988	WET	7	0.002	0.001	0.0014	0.0002	0.023	0.001	ND	0.01	0.055	0.001	0.13	0.001
L7	11	23	1988	WET	2	ND	0.001	0.0004	0.0002	0.008	0.001			0.011	0.001	0.016	0.001
L7	2	4	1988	WET	4	ND	0.001	0.0007	0.0002	0.002	0.001	ND	0.01	ND	0.001	ND	0.001
L7	2	8	1988	WET	5	ND	0.001	0.0017	0.0002	0.012	0.001	ND	0.01	0.018	0.001	ND	0.001
L7	3	2	1988	WET	6	0.004	0.001	ND	0.0002	0.005	0.001	ND	0.01	0.004	0.001	0.001	0.001
L7	3	25	1988	WET	7	ND	0.001	0.0002	0.0002	0.022	0.001	NR	0.01	0.011	0.001	0.003	0.001
R1	2	27	1988	RES	1	0.003	0.001	ND	0.0002	0.006	0.001			0.006	0.001	0.002	0.001
R2	2	28	1988	RES	1	0.002	0.001	ND	0.0002	0.003	0.001			0.007	0.001	0.002	0.001
R3	2	27	1988	RES	1	0.002	0.001	ND	0.0002	0.003	0.001			0.005	0.001	0.002	0.001
R4	2	27	1988	RES	1	0.007	0.001	ND	0.0002	0.18	0.001			0.007	0.001	0.002	0.001
R5	2	27	1988	RES	1	0.004	0.001	ND	0.0002	0.0044	0.001			0.004	0.001	ND	0.001
R6	2	27	1988	RES	1	0.001	0.001	0.0007	0.0002	0.005	0.001			0.007	0.001	0.002	0.001

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	Arsenic actual mg/l	DL mg/l	Cadmium actual mg/l	DL mg/l	Chromium actual mg/l	DL mg/l	Heavy Cr actual mg/l	DL mg/l	Copper actual mg/l	DL mg/l	Lead actual mg/l	DL mg/l
							0.001		0.0001		0.001				0.001		0.001
STANDARD REPORTING OBJECTIVES																	
S1	2	26	1988	DRY	1	0.001	0.001	ND	0.0002	0.005	0.001			0.011	0.001	ND	0.001
S1	3	30	1988	DRY	2									0.051	0.001	0.0006	0.0005
S1LR	5	11	1988	DRY	3									0.052	0.001	0.0008	0.0005
S1	6	11	1988	DRY	5							ND		0.007	0.001	0.0018	0.0002
S1	12	12	1988	DRY	6	ND	0.001	0.0003	0.0002	0.001	0.001	ND	0.01	0.007	0.001	ND	0.001
S1	2	1	1989	DRY	7	ND	0.001	ND	0.0002	0.001	0.001	ND	0.01	ND	0.001	ND	0.001
S1	4	6	1988	DRY									0.01	0.006	0.001	ND	0.001
S1	11	23	1988	WET	2	ND	0.001	0.002	0.0002	0.046	0.001			0.005	0.001	0.008	0.001
S1	1	23	1989	WET	3	ND	0.001	0.0007	0.0002	0.002	0.001	ND	0.01	ND	0.001	0.004	0.001
S1	2	4	1989	WET	4	ND	0.001	0.0026	0.0002	0.007	0.001	ND	0.01	0.03	0.001	0.08	0.001
S1	2	6	1989	WET	5	ND	0.001	0.0035	0.0002	0.010	0.001	ND	0.01	0.032	0.001	0.032	0.001
S1FD	2	6	1989	WET	5	ND	0.001	0.0035	0.0002	0.010	0.001	ND	0.01	0.030	0.001	0.030	0.001
S1	3	2	1989	WET	6	0.003	0.001	0.0011	0.0002	0.028	0.001	ND	0.01	0.044	0.001	0.005	0.001
S1	3	26	1989	WET	7	0.004	0.001	0.0013	0.0002	0.027	0.001	ND	0.01	0.055	0.001	0.060	0.001
S1FD	3	26	1989	WET	7	0.002	0.001	0.0015	0.0002	0.030	0.001	ND	0.01	0.061	0.001	0.10	0.001
S2	2	26	1988	DRY	1	0.002	0.001	ND	0.0002	0.008	0.001			0.008	0.001	0.002	0.001
S2	3	30	1988	DRY	2									0.01	0.001	0.0018	0.0005
S2	5	11	1988	DRY	3							ND	0.01	0.008	0.001	0.0012	0.0002
S2	6	11	1988	DRY	5							ND	0.01	ND	0.001	ND	0.001
S2	12	12	1988	DRY	6	ND	0.001	0.0004	0.0002	0.002	0.001	ND	0.01	ND	0.001	ND	0.001
S2	2	1	1989	DRY	7	ND	0.001	0.0008	0.0002	0.003	0.001	ND	0.01	0.003	0.001	ND	0.001
S2	4	6	1988	DRY										0.072	0.001	0.072	0.001
S2	4	20	1988	WET	1	0.003	0.001	0.0008	0.0002	0.03	0.001			0.32	0.001	0.27	0.001
S2	11	23	1988	WET	2	ND	0.001	0.002	0.0002	0.003	0.001			0.003	0.001	0.001	0.001
S2	1	23	1989	WET	3	ND	0.001	0.006	0.0002	0.004	0.001	ND	0.01	0.002	0.001	0.002	0.001
S2FD	1	23	1989	WET	3	ND	0.001	0.0004	0.0002	0.003	0.001	ND	0.01	0.023	0.001	0.035	0.001
S2	2	4	1989	WET	4	ND	0.001	0.0053	0.0002	0.010	0.001	ND	0.01	0.060	0.001	0.081	0.001
S2	2	6	1989	WET	5	ND	0.001	0.0035	0.0002	0.028	0.001	ND	0.01	0.050	0.001	0.035	0.001
S2	3	2	1989	WET	6	0.003	0.001	0.0014	0.0002	0.029	0.001	ND	0.01	0.060	0.001	0.050	0.001
S2	3	26	1989	WET	7	ND	0.001	0.0016	0.0002	0.050	0.001	ND	0.01	0.060	0.001	0.060	0.001
S3	2	26	1988	DRY	1	0.001	0.001	ND	0.0002	0.006	0.001			0.003	0.001	0.002	0.001
S3	3	30	1988	DRY	2									0.004	0.001	0.0023	0.0005
S3	5	11	1988	DRY	3									0.005	0.001	0.0028	0.0002
S3	6	26	1988	DRY	4									0.011	0.001	ND	0.001
S3FD	6	26	1988	DRY	4							ND	0.01	0.007	0.001	0.014	0.001
S3	12	12	1988	DRY	5							ND	0.01	0.003	0.001	ND	0.001
S3FD	12	12	1988	DRY	6							ND	0.01	ND	0.001	ND	0.001
S3	2	1	1989	DRY	6	ND	0.001	ND	0.0002	0.003	0.001	ND	0.01	ND	0.001	ND	0.001
S3LR	2	1	1989	DRY	6	ND	0.001	0.0006	0.0002	0.003	0.001	ND	0.01	ND	0.001	ND	0.001
S3FD	2	1	1989	DRY	5	ND	0.001	0.0002	0.0002	0.003	0.001	ND	0.01	0.004	0.001	0.004	0.001
S3	4	6	1989	DRY	7	0.001	0.001	ND	0.0002	0.002	0.001	ND	0.01	0.004	0.001	ND	0.001
S3FD	4	6	1989	DRY	7	0.001	0.001	0.0031	0.0002	ND	0.001	ND	0.01	0.003	0.001	ND	0.001
S3	4	20	1988	WET	1	0.005	0.001	0.0016	0.0002	0.062	0.001			0.008	0.001	0.008	0.001
S3	11	23	1988	WET	2	ND	0.001	0.001	0.0002	0.12	0.001			0.17	0.001	0.35	0.001
S3LR	11	23	1988	WET	2	ND	0.001	0.0007	0.0002	0.11	0.001			0.15	0.001	0.2	0.001
S3	1	23	1989	WET	3	ND	0.001	0.0010	0.0002	0.014	0.001	ND	0.01	0.008	0.001	0.007	0.001
S3	2	4	1989	WET	4	ND	0.001	0.0010	0.0002	0.016	0.001	ND	0.01	0.06	0.001	0.001	0.001
S3	2	6	1989	WET	5	ND	0.001	0.0035	0.0002	0.051	0.001	ND	0.01	0.075	0.001	0.11	0.001
					6	ND	0.001	0.0007	0.0002	0.022	0.001	ND	0.01	0.033	0.001	0.012	0.001

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	Mercury actual mg/l	DL mg/l	Nickel actual mg/l	DL mg/l	Selenium actual mg/l	DL mg/l	Silver actual mg/l	DL mg/l	Zinc actual mg/l	DL mg/l
STANDARD REPORTING OBJECTIVES							0.0002		0.001		0.0002		0.0001		0.001
L1	4	20	1988	WET	1	ND	0.0002	0.016	0.001	ND	0.002	0.0003	0.0001	0.12	0.0(
L1	11	23	1988	WET	2	0.0012	0.0002	0.047	0.001	ND	0.0003	0.0002	0.0002	0.15	0.001
L1	2	4	1988	WET	4	ND	0.0002	0.038	0.002	ND	0.0002	0.0002	0.0002	0.26	0.001
L1	2	8	1988	WET	5	ND	0.0002	0.018	0.002	ND	0.0002	0.002	0.0002	0.25	0.001
L1	3	2	1988	WET	8	0.0002	0.0002	0.45	0.002	ND	0.0002	0.0013	0.0002	0.48	0.001
L2	4	20	1988	WET	1	0.0002	0.0002	0.020	0.001	ND	0.002	0.0003	0.0001	1.7	0.01
L2	11	23	1988	WET	2	0.0044	0.0002	0.04	0.001	ND	0.0003	0.0004	0.0002	0.85	0.001
L2	2	4	1988	WET	4	0.0007	0.0002	0.04	0.002	ND	0.0002	0.0005	0.0002	0.37	0.001
L2	2	8	1988	WET	5	ND	0.0002	0.035	0.002	ND	0.0002	0.007	0.0002	1.8	0.001
L2	3	2	1988	WET	8	ND	0.0002	0.08	0.002	ND	0.0002	0.0010	0.0002	2.8	0.001
L2	3	25	1988	WET	7	ND	0.0002	0.09	0.002	ND	0.0002	0.0020	0.0002	0.70	0.001
L3	4	20	1988	WET	1	ND	0.0002	0.015	0.001	ND	0.002	0.0004	0.0001	0.2	0.01
L3	11	23	1988	WET	2	ND	0.0002	0.010	0.001	ND	0.0003	ND	0.0002	0.14	0.001
L3	2	4	1988	WET	4	0.0005	0.0002	0.010	0.002	ND	0.0002	ND	0.0002	0.22	0.001
L3	2	8	1988	WET	5	ND	0.0002	ND	0.002	ND	0.0002	ND	0.0002	0.10	0.001
L3	3	2	1988	WET	8	0.0002	0.0002	0.03	0.002	ND	0.0002	ND	0.0002	0.20	0.001
L3	3	25	1988	WET	7	0.0002	0.0002	0.04	0.002	ND	0.0002	0.0001	0.0002	0.32	0.001
L4	2	4	1988	WET	4	0.0005	0.0002	0.014	0.002	0.0004	0.0002	0.0005	0.0002	0.08	0.001
L4	2	8	1988	WET	5	ND	0.0002	0.010	0.002	0.0005	0.0002	0.0005	0.0002	0.060	0.001
L4	3	25	1988	WET	7	ND	0.0002	0.06	0.002	0.001	0.0002	0.0030	0.0002	0.020	0.001
L5	11	23	1988	WET	2	0.003	0.0002	0.053	0.001	ND	0.0003	ND	0.0002	0.30	0.001
L5	1	23	1988	WET	3	ND	0.0002	ND	0.002	ND	0.0002	ND	0.0002	0.24	0.001
L5	2	4	1988	WET	4	0.0004	0.0002	0.025	0.002	ND	0.0002	ND	0.0002	0.2	0.001
LSFD	2	4	1988	WET	4	0.0008	0.0002	0.021	0.002	ND	0.0002	ND	0.0002	0.18	0.001
L5	2	8	1988	WET	5	ND	0.0002	0.018	0.002	ND	0.0002	ND	0.0002	0.53	0.001
L5	3	2	1988	WET	8	ND	0.0002	0.08	0.002	ND	0.0002	ND	0.0002	0.31	0.001
LSFD	3	2	1988	WET	8	0.0002	0.0002	0.05	0.002	ND	0.0002	ND	0.0002	0.32	0.001
L5	3	25	1988	WET	7	ND	0.0002	0.06	0.002	ND	0.0002	0.0002	0.0002	0.24	0.001
L6	4	20	1988	WET	1	0.0008	0.0002	0.031	0.001	ND	0.002	0.0003	0.0001	0.3	0.01
L6	11	23	1988	WET	2	0.002	0.0002	0.028	0.001	ND	0.0003	ND	0.0002	0.24	0.001
L6	2	8	1988	WET	5	ND	0.0002	ND	0.002	ND	0.0002	ND	0.0002	0.10	0.001
L6	3	2	1988	WET	8	ND	0.0002	0.11	0.002	ND	0.0002	ND	0.0002	0.20	0.001
L6	3	25	1988	WET	7	ND	0.0002	0.07	0.002	ND	0.0002	0.0002	0.0002	0.30	0.001
L7	11	23	1988	WET	2	0.002	0.0002	0.004	0.001	ND	0.0003	ND	0.0002	0.011	0.001
L7	2	4	1988	WET	4	0.0011	0.0002	0.009	0.002	ND	0.0002	ND	0.0002	0.021	0.001
L7	2	8	1988	WET	5	ND	0.0002	ND	0.002	ND	0.0002	ND	0.0002	ND	0.001
L7	3	2	1988	WET	8	0.0002	0.0002	0.008	0.002	0.001	0.0002	0.0002	0.0002	0.005	0.001
L7	3	25	1988	WET	7	ND	0.0002	0.08	0.002	ND	0.0002	0.0003	0.0002	0.012	0.001
R1	2	27	1988	RES	1	ND	0.0002	0.005	0.001	ND	0.0005	0.0004	0.0002	0.008	0.001
R2	2	28	1988	RES	1	ND	0.0002	0.003	0.001	ND	0.0005	0.0012	0.0002	0.005	0.001
R3	2	27	1988	RES	1	ND	0.0002	0.008	0.001	ND	0.0005	0.0002	0.0002	0.007	0.001
R4	2	27	1988	RES	1	ND	0.0002	0.027	0.001	ND	0.0005	ND	0.0002	0.01	0.001
R5	2	27	1988	RES	1	ND	0.0002	0.004	0.001	ND	0.0005	0.0003	0.0002	0.001	0.001
R8	2	27	1988	RES	1	ND	0.0002	0.003	0.001	ND	0.0005	0.0008	0.0002	0.010	0.001

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	Mercury actual mg/l	DL mg/l	Nickel actual mg/l	DL mg/l	Selenium actual mg/l	DL mg/l	Silver actual mg/l	DL mg/l	Zinc actual mg/l	DL mg/l
							0.0002		0.001		0.0002		0.0001		0.001
STANDARD REPORTING OBJECTIVES															
S1	2	28	1988	DRY	1	ND	0.0002	ND	0.002	ND	0.0002	0.0007	0.0002	0.076	0.001
S1	3	30	1988	DRY	2	0.0003	0.0002			ND	0.01	0.0013	0.0005	0.003	0.001
S1LR	3	30	1988	DRY	2	ND	0.0002			ND	0.01	0.0012	0.0005	0.003	0.001
S1	5	11	1988	DRY	3	ND	0.0002			ND	0.002	0.0024	0.0002	0.012	0.002
S1	12	12	1988	DRY	5	ND	0.0002			ND	0.0002	ND	0.0002	0.012	0.001
S1	2	1	1989	DRY	6	ND	0.0002	ND	0.002	ND	0.0002	ND	0.0002	0.014	0.001
S1	4	6	1989	DRY	7	ND	0.0002	0.002	0.002	ND	0.0002	ND	0.0002	0.006	0.001
S1	11	23	1988	WET	2	0.002	0.0002	0.08	0.001	ND	0.0003	0.0002	0.0002	0.35	0.001
S1	1	23	1989	WET	3	ND	0.0002	0.003	0.002	ND	0.0002	ND	0.0002	0.05	0.001
S1	2	4	1989	WET	4	0.0008	0.0002	0.021	0.002	ND	0.0002	ND	0.0002	0.20	0.001
S1	2	8	1989	WET	5	ND	0.0002	ND	0.002	ND	0.0002	ND	0.0002	0.12	0.001
S1FD	2	8	1989	WET	5	ND	0.0002	0.010	0.002	ND	0.0002	ND	0.0002	0.10	0.001
S1	3	2	1989	WET	6	0.0002	0.0002	0.10	0.002	0.001	0.0002	0.0002	0.0002	0.23	0.001
S1	3	28	1989	WET	7	0.0002	0.0002	0.08	0.002	ND	0.0002	0.0002	0.0002	0.24	0.001
S1FD	3	28	1989	WET	7	ND	0.0002	0.11	0.002	ND	0.0002	0.0003	0.0002	0.37	0.001
S2	2	28	1988	DRY	1	ND	0.0002	ND	0.002	ND	0.0002	0.0024	0.0002	0.008	0.001
S2	3	30	1988	DRY	2	ND	0.0002			0.01	0.01	0.0078	0.0005	0.007	0.001
S2	5	11	1988	DRY	3	ND	0.0002			0.005	0.002	0.0047	0.0002	0.0075	0.002
S2	12	12	1988	DRY	5	ND	0.0002			ND	0.0002	ND	0.0002	0.006	0.001
S2	2	1	1989	DRY	6	ND	0.0002	ND	0.002	ND	0.0002	ND	0.0002	0.020	
S2	4	6	1989	DRY	7	ND	0.0002	0.003	0.002	0.004	0.0002	0.0007	0.0002	0.010	0.001
S2	4	28	1988	WET	1	0.0003	0.0002	0.020	0.001	ND	0.002	0.0007	0.0001	0.33	0.01
S2	11	23	1988	WET	2	0.003	0.0002	0.12	0.001	ND	0.0003	0.0004	0.0002	0.02	0.001
S2	1	23	1989	WET	3	ND	0.0002	ND	0.002	ND	0.0002	ND	0.0002	0.14	0.001
S2FD	1	23	1989	WET	3	ND	0.0002	ND	0.002	ND	0.0002	ND	0.0002	0.22	0.001
S2	2	4	1989	WET	4	0.0005	0.0002	0.023	0.002	ND	0.0002	ND	0.0002	0.14	0.001
S2	2	8	1989	WET	5	ND	0.0002	0.010	0.002	ND	0.0002	ND	0.0002	0.35	0.001
S2	3	2	1989	WET	6	ND	0.0002	0.12	0.002	ND	0.0002	0.0003	0.0002	0.25	0.001
S2	3	28	1989	WET	7	ND	0.0002	0.08	0.002	ND	0.0002	0.0004	0.0002	0.27	0.001
S3	2	28	1988	DRY	1	ND	0.0002	ND	0.002	ND	0.0002	0.0009	0.0002	0.008	0.001
S3	3	30	1988	DRY	2	ND	0.0002			ND	0.01	0.0015	0.0005	0.002	0.001
S3	5	11	1988	DRY	3	ND	0.0002			ND	0.002	0.003	0.0002	0.0075	0.002
S3	8	25	1988	DRY	4	0.0027	0.0002			0.0023	0.0002	0.0023	0.0005	0.008	0.001
S3FD	8	25	1988	DRY	4	0.0023	0.0002			0.0018	0.0002	0.0018	0.0005	0.014	0.001
S3	12	12	1988	DRY	5	ND	0.0002			0.0003	0.0002	ND	0.0002	0.020	0.001
S3FD	12	12	1988	DRY	5	ND	0.0002			ND	0.0002	ND	0.0002	0.014	0.001
S3	2	1	1989	DRY	6	ND	0.0002	ND	0.002	0.0008	0.0002	ND	0.0002	0.008	0.001
S3LR	2	1	1989	DRY	6	ND	0.0002	0.002	0.002	0.0008	0.0002	ND	0.0002	0.008	0.001
S3FD	2	1	1989	DRY	6	ND	0.0002	ND	0.002	0.0005	0.0002	ND	0.0002	0.010	0.001
S3	4	6	1989	DRY	7	ND	0.0002	0.002	0.002	ND	0.0002	0.0002	0.0002	0.010	0.001
S3FD	4	6	1989	DRY	7	ND	0.0002	ND	0.002	ND	0.0002	ND	0.0002	0.015	0.001
S3	4	28	1988	WET	1	0.0010	0.0002	0.11	0.001	ND	0.002	0.0006	0.0001	0.27	0.01
S3	11	23	1988	WET	2	0.008	0.0002	0.22	0.001	ND	0.0003	0.0002	0.0002	0.45	0.001
S3LR	11	23	1988	WET	2	0.002	0.0002	0.1	0.001	ND	0.0003	0.0002	0.0002	0.4	0.001
S3	1	23	1989	WET	3	ND	0.0002	0.006	0.002	ND	0.0002	ND	0.0002	0.10	0.001
S3	2	4	1989	WET	4	0.0004	0.0002	0.004	0.002	ND	0.0002	ND	0.0002	0.23	0.001
S3	2	8	1989	WET	5	ND	0.0002	0.11	0.002	ND	0.0002	ND	0.0002	0.35	0.001
S3	3	2	1989	WET	6	ND	0.0002	0.08	0.002	0.001	0.0002	0.0004	0.0002	0.010	0.001

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	Mercury actual mg/l	DL mg/l	Nickel actual mg/l	DL mg/l	Selenium actual mg/l	DL mg/l	Silver actual mg/l	DL mg/l	Zinc actual mg/l	DL mg/l
STANDARD REPORTING OBJECTIVES							0.0002		0.001		0.0002		0.0001		0.001
B4	2	28	1988	DRY	1	ND	0.0002	ND	0.002	0.005	0.0002	0.0022	0.0002	0.018	0.001
S4	3	30	1988	DRY	2	ND	0.0002			ND	0.01	0.0033	0.0005	0.009	0.001
S4	5	11	1988	DRY	3	ND	0.0002			ND	0.002	0.0034	0.0002	0.023	0.002
S4	5	11	1988	DRY	3	ND	0.0002			ND	0.002	0.0033	0.0002	0.020	0.002
S4LR	5	11	1988	DRY	3	ND	0.0002			0.0018	0.0002	0.0018	0.0005	0.011	0.001
S4	8	25	1988	DRY	4	0.0023	0.0002			ND	0.0002	ND	0.0002	0.010	0.001
S4	12	12	1988	DRY	5	ND	0.0002			0.0004	0.0002	ND	0.0002	0.012	0.001
S4	2	1	1989	DRY	6	ND	0.0002	ND	0.002	0.001	0.0002	0.0002	0.0002	0.020	0.001
S4	4	8	1989	DRY	7	ND	0.0002	0.005	0.002						
S4	4	28	1988	WET	1	0.0003	0.0002	0.040	0.001	ND	0.002	0.001	0.0001	0.14	0.01
S4	11	23	1988	WET	2	0.004	0.0002	0.24	0.001	ND	0.0003	0.0004	0.0002	0.01	0.001
S4FD	11	23	1988	WET	2	0.003	0.0002	0.1	0.001	ND	0.0003	ND	0.0002	0.25	0.001
S4	2	4	1989	WET	4	0.0005	0.0002	0.037	0.002	ND	0.0002	ND	0.0002	0.17	0.001
S4	2	8	1989	WET	5	ND	0.0002	0.035	0.002	ND	0.0002	ND	0.0002	0.10	0.001
S4	3	2	1989	WET	6	ND	0.0002	0.12	0.002	0.001	0.0002	0.0003	0.0002	0.030	0.001
S4	3	25	1989	WET	7	ND	0.0002	0.15	0.002	ND	0.0002	0.0020	0.0002	0.42	0.001
FB	8	25	1988	DRY	4	0.0003	0.0002			ND	0.0002	ND	0.0005	0.011	0.001
FB	12	12	1988	DRY	5	ND	0.0002			ND	0.0002	ND	0.0002	0.014	0.001
FB	2	1	1989	DRY	6	ND	0.0002	ND	0.002	ND	0.0002	ND	0.0002	0.010	0.001
FB	4	8	1989	DRY	7	ND	0.0002	ND	0.002	ND	0.0002	ND	0.0002	0.006	0.001
FB	11	23	1988	WET	2	0.0004	0.0002	ND	0.001	ND	0.0003	0.0002	0.0002	ND	0.001
FB	1	23	1988	WET	3	ND	0.0002	ND	0.002	ND	0.0002	ND	0.0002	0.01	0.001
FB	2	8	1989	WET	5	ND	0.0002	ND	0.002	ND	0.0002	ND	0.0002	ND	0.001
FB	3	2	1989	WET	6	ND	0.0002	0.00	0.002	ND	0.0002	ND	0.0002	0.010	0.001
FB	3	25	1989	WET	7	ND	0.0002	ND	0.002	ND	0.0002	ND	0.0002	0.003	0.001

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	Arsenic actual mg/l	D.L. mg/l	Cadmium actual mg/l	D.L. mg/l	Chromium actual mg/l	D.L. mg/l	Hexav Cr actual mg/l	D.L. mg/l	Copper actual mg/l	D.L. mg/l	Lead actual mg/l	D.L. mg/l
STANDARD REPORTING OBJECTIVES							0.001		0.0001		0.001				0.001		0.001
S4	2	26	1988	DRY	1	0.002	0.001	ND	0.0002	0.005	0.001			0.01	0.001	0.001	0.001
S4	3	30	1988	DRY	2									0.008	0.001	0.0026	0.0005
S4	5	11	1988	DRY	3									0.008	0.001	0.0026	0.0002
S4LR	5	11	1988	DRY	3									0.01	0.001	0.0028	0.0002
S4	8	25	1988	DRY	4									0.012	0.001	ND	0.001
S4	12	12	1988	DRY	5							ND	0.01	0.003	0.001	ND	0.001
S4	2	1	1988	DRY	6	ND	0.001	0.0006	0.0002	0.004	0.001	ND	0.01	0.001	0.001	ND	0.001
S4	4	6	1988	DRY	7	0.002	0.001	ND	0.0002	0.003	0.001	ND	0.01	0.006	0.001	ND	0.001
S4	4	20	1988	WET	1	0.003	0.001	0.0005	0.0002	0.018	0.001			0.042	0.001	0.042	0.001
S4	11	23	1988	WET	2	ND	0.001	0.004	0.0002	0.14	0.001			0.18	0.001	0.25	0.001
S4FD	11	23	1988	WET	2	ND	0.001	0.002	0.0002	0.065	0.001			0.072	0.001	0.13	0.001
S4	2	4	1988	WET	4	ND	0.001	0.0044	0.0002	0.021	0.001	ND	0.01	0.038	0.001	0.042	0.001
S4	2	8	1988	WET	5	ND	0.001	0.0035	0.0002	0.023	0.001	ND	0.01	0.035	0.001	0.035	0.001
S4	3	2	1988	WET	6	ND	0.001	0.0012	0.0002	0.027	0.001	ND	0.01	0.027	0.001	0.015	0.001
S4	3	25	1988	WET	7	0.008	0.001	0.0048	0.0002	0.073	0.001	ND	0.01	0.11	0.001	0.13	0.001
FB	8	25	1988	DRY	4									ND	0.001	ND	0.001
FB	12	12	1988	DRY	5							ND	0.01	ND	0.001	ND	0.001
FB	2	1	1988	DRY	6	ND	0.001	ND	0.0002	ND	0.001	ND	0.01	ND	0.001	0.003	0.001
FB	4	8	1988	DRY	7	ND	0.001	ND	0.0002	ND	0.001	ND	0.01	ND	0.001	ND	0.001
FB	11	23	1988	WET	2	ND	0.001	0.0002	0.0002	0.002	0.001			ND	0.001	ND	0.001
FB	1	23	1988	WET	3	ND	0.001	0.0018	0.0002	ND	0.001	ND	0.01	ND	0.001	ND	0.001
FB	2	8	1988	WET	5	ND	0.001	ND	0.0002	ND	0.001	ND	0.01	0.004	0.001	ND	0.001
FB	3	2	1988	WET	6	ND	0.001	ND	0.0002	0.052	0.001	ND	0.01	0.011	0.001	0.001	0.001
FB	3	25	1988	WET	7	0.001	0.001	ND	0.0002	0.001	0.001	ND	0.01	ND	0.001	ND	0.001

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	Arsenic actual mg/l	Arsenic DL mg/l	Cadmium actual mg/l	Cadmium DL mg/l	Chromium actual mg/l	Chromium DL mg/l	Hexav Cr actual mg/l	Hexav Cr DL mg/l	Copper actual mg/l	Copper DL mg/l
STANDARD REPORTING OBJECTIVES															
L1	3	2	1989	WET	6	ND	0 001	0 005	0 0002	0 008	0 001	ND	0 01	0 010	0 001
L2	3	2	1989	WET	6	ND	0 001	0 001	0 0002	0 006	0 001	ND	0 01	0 013	0 001
L2	3	25	1989	WET	7	ND	0 001	ND	0 0002	0 006	0 001	ND	0 01	0 010	0 001
L3	3	2	1989	WET	6	ND	0 001	0 0003	0 0002	0 001	0 001	ND	0 01	0 009	0 001
L3	3	25	1989	WET	7	ND	0 001	ND	0 0002	0 001	0 001	ND	0 01	0 006	0 001
L4	3	25	1989	WET	7	ND	0 001	ND	0 0002	0 004	0 001	ND	0 01	0 002	0 001
L5	3	2	1989	WET	6	ND	0 001	0 0003	0 0002	0 001	0 001	ND	0 01	0 012	0 001
L5 FIELD DUP	3	2	1989	WET	6	ND	0 001	ND	0 0002	0 001	0 001	ND	0 01	0 010	0 001
L5	3	25	1989	WET	7	ND	0 001	ND	0 0002	0 002	0 001	ND	0 01	0 007	0 001
L6	3	2	1989	WET	6	ND	0 001	ND	0 0002	0 001	0 001	ND	0 01	0 009	0 001
L6	3	25	1989	WET	7	ND	0 001	0 0003	0 0002	0 002	0 001	ND	0 01	0 009	0 001
L7	3	2	1989	WET	6	ND	0 001	ND	0 0002	0 001	0 001	ND	0 01	0 004	0 001
L7	3	25	1989	WET	7	ND	0 001	ND	0 0002	0 001	0 001	ND	0 01	0 009	0 001
S1	3	2	1989	WET	6	ND	0 001	0 0002	0 0002	0 001	0 001	ND	0 01	0 010	0 001
S1	3	25	1989	WET	7	ND	0 001	ND	0 0002	0 001	0 001	ND	0 01	0 007	0 001
S5	3	25	1989	WET	7	ND	0 001	ND	0 0002	0 001	0 001	ND	0 01	0 008	0 001
S2	3	2	1989	WET	6	ND	0 001	0 0003	0 0002	0 001	0 001	ND	0 01	0 011	0 001
S2	3	25	1989	WET	7	ND	0 001	ND	0 0002	0 001	0 001	ND	0 01	0 008	0 001
S3	3	2	1989	WET	6	ND	0 001	0 0002	0 0002	0 003	0 001	ND	0 01	0 006	0 001
S4	3	2	1989	WET	6	ND	0 001	0 0002	0 0002	0 001	0 001	ND	0 01	0 007	0 001
S4	3	25	1989	WET	7	ND	0 001	ND	0 0002	0 001	0 001	ND	0 01	0 006	0 001
FB	3	2	1989	WET	6	ND	0 001	ND	0 0002	0 001	0 001	ND	0 01	0 006	0 001
FB	3	25	1989	WET	7	ND	0 001	ND	0 0002	ND	0 001	ND	0 01	0 001	0 001

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	Lead actual mg/l	Lead DL mg/l	Mercury actual mg/l	Mercury DL mg/l	Nickel actual mg/l	Nickel DL mg/l	Selenium actual mg/l	Selenium DL mg/l	Silver actual mg/l	Silver DL mg/l
STANDARD REPORTING OBJECTIVES															
L1	3	2	1989	WET	6	0.005	0.001	ND	0.0002	0.017	0.002	ND	0.0002	0.006	0.0002
L2	3	2	1989	WET	6	0.002	0.001	ND	0.0002	0.006	0.002	ND	0.0002	ND	0.0002
L2	3	25	1989	WET	7	0.003	0.001	ND	0.0002	0.008	0.002	ND	0.0002	0.0005	0.0002
L3	3	2	1989	WET	6	ND	0.001	ND	0.0002	ND	0.002	ND	0.0002	ND	0.0002
L3	3	25	1989	WET	7	ND	0.001	ND	0.0002	0.004	0.002	ND	0.0002	ND	0.0002
L4	3	25	1989	WET	7	ND	0.001	ND	0.0002	0.008	0.002	0.001	0.0002	0.002	0.0002
L5	3	2	1989	WET	6	ND	0.001	ND	0.0002	ND	0.002	ND	0.0002	ND	0.0002
L5 FIELD DUP	3	2	1989	WET	6	ND	0.001	ND	0.0002	0.005	0.002	ND	0.0002	ND	0.0002
L5	3	25	1989	WET	7	0.002	0.001	ND	0.0002	0.005	0.002	ND	0.0002	ND	0.0002
L6	3	2	1989	WET	6	ND	0.001	ND	0.0002	0.004	0.002	ND	0.0002	ND	0.0002
L6	3	25	1989	WET	7	0.003	0.001	ND	0.0002	0.008	0.002	ND	0.0002	ND	0.0002
L7	3	2	1989	WET	6	ND	0.001	ND	0.0002	ND	0.002	ND	0.0002	ND	0.0002
L7	3	25	1989	WET	7	ND	0.001	ND	0.0002	0.006	0.002	ND	0.0002	0.0002	0.0002
S1	3	2	1989	WET	6	ND	0.001	ND	0.0002	ND	0.002	0.001	0.0002	ND	0.0002
S1	3	25	1989	WET	7	ND	0.001	ND	0.0002	0.005	0.002	ND	0.0002	ND	0.0002
S5	3	25	1989	WET	7	ND	0.001	ND	0.0002	0.005	0.002	ND	0.0002	ND	0.0002
S2	3	2	1989	WET	6	ND	0.001	ND	0.0002	ND	0.002	ND	0.0002	ND	0.0002
S2	3	25	1989	WET	7	ND	0.001	ND	0.0002	0.005	0.002	ND	0.0002	ND	0.0002
S3	3	2	1989	WET	6	ND	0.001	ND	0.0002	0.006	0.002	0.001	0.0002	0.0002	0.0002
S4	3	2	1989	WET	6	ND	0.001	ND	0.0002	0.008	0.002	0.001	0.0002	0.0002	0.0002
S4	3	25	1989	WET	7	ND	0.001	ND	0.0002	0.006	0.002	ND	0.0002	0.0004	0.0002
FB	3	2	1989	WET	6	ND	0.001	ND	0.0002	0.004	0.002	ND	0.0002	ND	0.0002
FB	3	25	1989	WET	7	ND	0.001	ND	0.0002	ND	0.002	ND	0.0002	ND	0.0002

R0054589

D.1-2 Dissolved metals in water column

VOL 12 2 12900

D.1-3 Total metals in sediment

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R0054591

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	Zinc actual mg/l	DL mg/l
STANDARD REPORTING OBJECTIVES							
L1	3	2	1989	WET	6	0 3	0 001
L2	3	2	1989	WET	6	0 8	0 001
L2	3	25	1989	WET	7	0 20	0 001
L3	3	2	1989	WET	6	0 1	0 001
L3	3	25	1989	WET	7	0 10	0 001
L4	3	25	1989	WET	7	0 005	0 001
L5	3	2	1989	WET	6	0 1	0 001
L5 FIELD DUP	3	2	1989	WET	6	0 09	0 001
L5	3	25	1989	WET	7	0 10	0 001
L6	3	2	1989	WET	6	0 1	0 001
L6	3	25	1989	WET	7	0 10	0 001
L7	3	2	1989	WET	6	0 003	0 001
L7	3	25	1989	WET	7	0 007	0 001
S1	3	2	1989	WET	6	0 1	0 001
S1	3	25	1989	WET	7	0 040	0 001
S5	3	25	1989	WET	7	0 040	0 001
S2	3	2	1989	WET	6	0 1	0 001
S2	3	25	1989	WET	7	0 040	0 001
S3	3	2	1989	WET	6	0 017	0 001
S4	3	2	1989	WET	6	ND	0 001
S4	3	25	1989	WET	7	0 016	0 001
FB	3	2	1989	WET	6	0 015	0 001
FB	3	25	1989	WET	7	0 015	0 001

R0054592

D.2 Conventional parameters

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R0054593

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	Arsenic actual mg/kg	Arsenic D.L. mg/kg	Cadmium actual mg/kg	Cadmium D.L. mg/kg	Chromium actual mg/kg	Chromium D.L. mg/kg	Copper actual mg/kg	Copper D.L. mg/kg	Lead actual mg/kg	Lead D.L. mg/kg
STANDARD REPORTING OBJECTIVES							0.1		0.1		1		1		1
S1	3	30	1988	DRY	1	3.7	0.1	0.1	0.1	77	1	23	1	9	1
S1	5	11	1988	DRY	2	4.5	0.1	0.1	0.1	78	0.1	25	0.1	44	0.1
S1	8	22	1988	DRY	3		0.1		0.1		0.1	27	0.1	16	0.1
S1	12	12	1988	DRY	4							83	1	45	1
S2	3	30	1988	DRY	1	2.9	0.1	0.5	0.1	78	1	78	1	93	1
S2	5	11	1988	DRY	2	4.3	0.1	2	0.1	84	0.1	46	0.1	98	0.1
S2	8	22	1988	DRY	3		0.1		0.1		0.1	40	0.1	40	0.1
S2	12	12	1988	DRY	4							32	1	32	1
S3	3	30	1988	DRY	1	6.7	0.1	1.4	0.1	170	1	100	1	150	1
S3	5	11	1988	DRY	2	4.1	0.1	0.1	0.1	80	0.1	37	0.1	25	0.1
S3	8	22	1988	DRY	3		0.1		0.1		0.1	97	0.1	160	0.1
S3FD	8	22	1988	DRY	3		0.1		0.1		0.1	95	0.1	150	0.1
S3	12	12	1988	DRY	4							45	1	64	1
S3FD	12	12	1988	DRY	4							45	1	68	1
S3LR	12	12	1988	DRY	4							43	1	55	1
S4	3	30	1988	DRY	1	7.8	0.1	0.4	0.1	80	1	35	1	20	1
S4LR	3	30	1988	DRY	1	6.8	0.1	0.3	0.1	83	1	33	1	20	1
S4	5	11	1988	DRY	2	6.6	0.1	1.3	0.1	110	0.1	87	0.1	120	0.1
S4FD	5	11	1988	DRY	2	5.6	0.1	0.7	0.1	87	0.1	53	0.1	87	0.1
S4	8	22	1988	DRY	3		0.1		0.1		0.1	65	0.1	77	0.1
S4	12	12	1988	DRY	4							28	1	33	1

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	Mercury actual mg/kg	Mercury D.L. mg/kg	Nickel actual mg/kg	Nickel D.L. mg/kg	Selenium actual mg/kg	Selenium D.L. mg/kg	Silver actual mg/kg	Silver D.L. mg/kg	Zinc actual mg/kg	Zinc D.L. mg/kg	
							0.1		1		0.1		0.1			1
STANDARD REPORTING OBJECTIVES																
S1	3	30	1988	DRY	1	0.1	0.1	49	1	ND	0.1	1	0.1	70		1
S1	5	11	1988	DRY	2	0.05	0.02	68	0.1	ND	0.2	0.7	0.1	84		1
S1	8	22	1988	DRY	3	ND	0.02	68	0.1	0.3	0.1	0.6	0.1	68		1
S1	12	12	1988	DRY	4	0.38	0.1			0.27	0.1	ND	0.1	160		1
S2	3	30	1988	DRY	1	0.2	0.1	41	1	3.3	0.1	1.3	0.1	150		1
S2	5	11	1988	DRY	2	0.14	0.02	76	0.1	0.2	0.2	0.8	0.1	100		1
S2	8	22	1988	DRY	3	ND	0.02	76	0.1	1	0.1	1.5	0.1	88		1
S2	12	12	1988	DRY	4	0.15	0.1			1.2	0.1	ND	0.1	110		1
S3	3	30	1988	DRY	1	4.1	0.1	160	1	1.4	0.1	2	0.1	280		1
S3	5	11	1988	DRY	2	0.74	0.02	87	0.1	ND	0.2	0.7	0.1	88		1
S3	8	22	1988	DRY	3	4.7	0.02	97	0.1	0.8	0.1	2	0.1	340		1
S3FD	8	22	1988	DRY	3	4.4	0.02	110	0.1	1	0.1	1.8	0.1	330		1
S3	12	12	1988	DRY	4	3.6	0.1			1	0.1	ND	0.1	160		1
S3FD	12	12	1988	DRY	4	2.6	0.1			1	0.1	ND	0.1	150		1
S3LR	12	12	1988	DRY	4	2.7	0.1			0.85	0.1	ND	0.1	140		1
S4	3	30	1988	DRY	1	0.1	0.1	85	1	0.59	0.1	1.2	0.1	100		1
S4LR	3	30	1988	DRY	1	0.2	0.1	82	1	0.49	0.1	1.1	0.1	110		1
S4	5	11	1988	DRY	2	0.49	0.02	140	0.1	0.5	0.2	1.9	0.1	360		1
S4FD	5	11	1988	DRY	2	0.23	0.02	110	0.1	0.3	0.2	1	0.1	210		1
S4	8	22	1988	DRY	3	0.17	0.02	140	0.1	0.4	0.1	1.3	0.1	190		1
S4	12	12	1988	DRY	4	0.45	0.1			0.58	0.1	ND	0.1	89		1

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	TSS actual mg/L	TSS D.L. mg/L	NO3-N actual mg/L	NO3-N D.L. mg/L	NO2-N actual mg/L	NO2-N D.L. mg/L	NH3-N actual mg/L	NH3-N D.L. mg/L	TKN actual mg/L	TKN D.L. mg/L	PO4-P actual mg/L	PO4-P D.L. mg/L	pH
S2	2	26	1988	DRY	1	ND	10	2.5	0.1	0.012	0.005	ND	1	1	1	ND	0.1	8.6
S2	3	30	1988	DRY	2	5	1							0.6	0.1			8.7
S2	5	11	1988	DRY	3	0.5	0.1							4.8	0.1			8.4
S2	12	12	1988	DRY	5	ND	10							ND	1.0			
S2	2	1	1989	DRY	6	ND	10							ND	1			
S2	4	6	1989	DRY	7	ND	1.0							ND	1.0			
S2	4	20	1988	WET	1													
S2	11	23	1988	WET	2	990	10	0.51	0.1	0.051	0.01	ND	1	2.5	1	0.8	0.1	
S2	1	23	1989	WET	3	40	1.0							1.7	1.0			
S2FD	1	23	1989	WET	3	16	1.0							1.5	1.0			
S2	2	4	1989	WET	4	36	1							1.8	1			
S2FD	2	4	1989	WET	4	46	1							1.7	1			
S2	2	9	1989	WET	5	170	1							1.8	1			
S2	3	2	1989	WET	6	200	1.0							1.7	1.0			
S2	3	25	1989	WET	7	210	1.0											
S3	2	26	1988	DRY	1	ND	10	2.4	0.1	0.006	0.005	ND	1	ND	1	0.1	0.1	8.4
S3	3	30	1988	DRY	2	11	1							1.4	0.1			8.5
S3	5	11	1988	DRY	3	7	0.1							1.4	0.1			8.4
S3	8	22	1988	DRY	4	8.5	1	2	0.1	ND	0.1			1	0.5			
S3FD	8	22	1988	DRY	4	5.5	1	1.8	0.1	ND	0.1			3	0.5			
S3FD	8	22	1988	DRY	4													
S3	12	12	1988	DRY	5	ND	10							ND	1.0			
S3FD	12	12	1988	DRY	5	ND	10							ND	1.0			
S3	2	1	1989	DRY	6	ND	10							ND	1			
S3LR	2	1	1989	DRY	6	ND	10							ND	1			
S3FD	2	1	1989	DRY	6	ND	10							ND	1			
S3	4	6	1989	DRY	7	2.4	1.0							ND	1.0			
S3LR	4	6	1989	DRY	7													
S3FD	4	6	1989	DRY	7	2.8	1.0							ND	1.0			
S3	4	20	1988	WET	1													
S3	11	23	1988	WET	2	1700	10	0.62	0.1	0.025	0.01	ND	1	5	1	1.15	0.1	
S3FD	11	23	1988	WET	2													
S3LR	11	23	1988	WET	2	1700	10	0.65	0.1	0.024	0.01	ND	1	5.3	1	1.04	0.1	
S3	1	23	1989	WET	3	290	1.0							1.9	1.0			
S3FD	1	23	1989	WET	3													
S3LR	1	23	1989	WET	3													
S3	2	4	1989	WET	4	190	1							1.9	1			
S3	2	9	1989	WET	5	270	1							1.4	1			
S3	3	2	1989	WET	6	84	1.0							1.5	1.0			

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Sample I.D.	Date Sampled Month	Day	Year	Sample Type	Sample Event	TSS actual mg/L	TSS D.L. mg/L	NO3-N actual mg/L	NO3-N D.L. mg/L	NO2-N actual mg/L	NO2-N D.L. mg/L	NH3-N actual mg/L	NH3-N D.L. mg/L	TKN actual mg/L	TKN D.L. mg/L	PO4-P actual mg/L	PO4-P D.L. mg/L	pH
S4	2	26	1988	DRY	1	25	10	3.5	0.1	0.018	0.005	ND	1	2	1	0.1	0.1	8.4
S4	3	30	1988	DRY	2	20	1							2.2	0.1			8.1
S4	5	11	1988	DRY	3	30	0.1							1.7	0.1			7.5
S4FD	5	11	1988	DRY	3	39	0.1							1.7	0.1			7.7
S4	8	22	1988	DRY	4	18	1	2	0.1	ND	0.1			5	0.5			
S4	12	12	1988	DRY	5	13	10							ND	1.0			
S4	2	1	1988	DRY	6													
S4	2	1	1988	DRY	6	52	10							1.2	1			
S4	4	6	1988	DRY	7	5.2	1.0							ND	1.0			
S4D	3	30	1988	DRY	2	22	1							2.2	0.1			0.1
S4	4	20	1988	WET	1	250	1	1.2	0.1	0.03	0.01	0.2	0.1	2.5	0.1	0.9	0.1	7.6
S4	11	23	1988	WET	2	430	10	0.57	0.1	0.045	0.01	ND	1	1.9	1	0.55	0.1	
S4FD	11	23	1988	WET	2	1200	10	0.62	0.1	0.032	0.01	ND	1	1.6	1	0.06	0.1	
S4	1	23	1989	WET	3													
S4	2	4	1989	WET	4	120	1							1.2	1			
S4	2	8	1989	WET	5	150	1							1.1	1			
S4	3	2	1989	WET	6	130	1.0							ND	1.0			
S4	3	25	1989	WET	7	370	1.0											
FB	8	22	1988	DRY	4	2.5	1	ND	0.1	ND	0.1			ND	0.5			
FB	8	22	1988	DRY	4													
FB	12	12	1988	DRY	5													
FB	12	12	1988	DRY	5	ND	10							ND	1.0			
FB	2	1	1989	DRY	6													
FB	2	1	1989	DRY	6	ND	10							ND	1			
FB	4	8	1989	DRY	7													
FB	4	6	1989	DRY	7	ND	1.0							ND	1.0			
FB	11	23	1988	WET	2													
FB	11	23	1988	WET	2													
FB	11	23	1988	WET	2	IS	10	ND	0.1	ND	0.01	ND	1	ND	1	IS	0.1	
FB	1	23	1989	WET	3													
FB	1	23	1989	WET	3	ND	1.0							ND	1.0			
FB	2	8	1989	WET	5													
FB	2	8	1989	WET	5	NA	1							ND	1			
FB	3	2	1989	WET	6													
FB	3	2	1989	WET	6		1.0							ND	1.0			
FB	3	25	1989	WET	7		1.0											

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	TSS actual mg/L	TSS DL. mg/L	NO3-N actual mg/L	NO3-N DL. mg/L	NO2-N actual mg/L	NO2-N DL. mg/L	NH3-N actual mg/L	NH3-N DL. mg/L	TKN actual mg/L	TKN DL. mg/L	PO4-P actual mg/L	PO4-P DL. mg/L	pH
L1	4	20	1988	WET	1	23	1	1	0.1	0.02	0.01	0.2	0.1	2.8	0.1	0.3	0.1	7.5
L1	11	23	1988	WET	2	69	10	0.31	0.1	0.016	0.01	ND	1	1.1	1	0.23	0.1	
L1	2	4	1989	WET	4	72	1							4.3	1			
L1	2	9	1989	WET	5	82	1							2.7	1			
L1LR	2	9	1989	WET	5													
L1	3	2	1989	WET	6	40	1.0							3.0	1.0			
L1LR	3	2	1989	WET	6													
L2	4	20	1988	WET	1	76	1	0.7	0.1	0.05	0.01	0.6	0.1	2.2	0.1	0.8	0.1	7.5
L2	11	23	1988	WET	2	110	10	0.4	0.1	0.095	0.01	ND	1	1.7	1	0.56	0.1	
L2	2	4	1989	WET	4	64	1							2.8	1			
L2	2	9	1989	WET	5	130	1							1.9	1			
L2	3	2	1989	WET	6													
L2	3	2	1989	WET	6	130	1.0							ND	1.0			
L2	3	25	1989	WET	7	300	1.0											
L3	4	20	1988	WET	1	82	1	0.6	0.1	0.04	0.01	0.2	0.1	1.7	0.1	0.4	0.1	7.2
L3	11	23	1988	WET	2	19	10	0.65	0.1	0.049	0.01	ND	1	ND	1	0.15	0.1	
L3	2	4	1989	WET	4	40	1							5.5	1			
L3	2	9	1989	WET	5	62	1							2.4	1			
L3	3	2	1989	WET	6	58	1.0							ND	1.0			
L3	3	25	1989	WET	7	170	1.0											
L4	4	20	1988	WET	1													
L4	11	23	1988	WET	2													
L4	2	4	1989	WET	4	32	1							ND	1			
L4	2	9	1989	WET	5	94	1							1.1	1			
L4	3	2	1989	WET	6													
L4	3	25	1989	WET	7	80	1.0											
L5	4	20	1988	WET	1													
L5	11	23	1988	WET	2	110	10	0.7	0.1	0.028	0.01	ND	1	1.6	1	0.34	0.1	
L5	1	23	1989	WET	3	62	1.0							2.0	1.0			
L5	2	4	1989	WET	4	52	1							1.2	1			
L5LR	2	4	1989	WET	4													
L5	2	9	1989	WET	5	140	1							4.5	1			
L5	3	2	1989	WET	6	90	1.0							1.4	1.0			
L5FD	3	2	1989	WET	6	94	1.0							2.6	1.0			
L5	3	25	1989	WET	7	130	1.0											
L6	4	20	1988	WET	1													
L6	11	23	1988	WET	2	80	10	0.69	0.1	0.066	0.01	ND	1	1.8	1	0.24	0.1	
L6	2	9	1989	WET	5	54	1							ND	1			
L6	3	2	1989	WET	6	110	1.0							ND	1.0			
L6	3	25	1989	WET	7	92	1.0											

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	TSS actual mg/L	TSS D.L. mg/L	NO3-N actual mg/L	NO3-N D.L. mg/L	NO2-N actual mg/L	NO2-N D.L. mg/L	NH3-N actual mg/L	NH3-N D.L. mg/L	TKN actual mg/L	TKN D.L. mg/L	PO4-P actual mg/L	PO4-P D.L. mg/L	pH
L7	4	20	1988	WET	1													
L7	11	23	1988	WET	2	38	10	0.18	0.1	ND	0.01	ND	1	ND	1	0.10	0.1	
L7	2	4	1989	WET	4	26	1							1.5	1			
L7	2	9	1989	WET	5	12	1							ND	1			
L7	3	2	1989	WET	6	22	1.0							ND	1.0			
L7	3	25	1989	WET	7	420	1.0											
R1	2	27	1988	RES	1	24	10	0.1	0.1	0.006	0.005	ND	1	ND	1	ND	0.1	8
R2	2	26	1988	RES	1	11	10	0.8	0.1	0.009	0.005	ND	1	1	1	ND	0.1	8
R3	2	27	1988	RES	1	ND	10	0.2	0.1	0.005	0.005	ND	1	ND	1	ND	0.1	8.2
R4	2	27	1988	RES	1	84	10	0.1	0.1	0.006	0.005	ND	1	ND	1	0.2	0.1	8
R5	2	27	1988	RES	1	ND	10	ND	0.1	0.007	0.005	ND	1	1	1	0.1	0.1	8.5
R8	2	27	1988	RES	1	ND	10	0.2	0.1	0.006	0.005	ND	1	1	1	ND	0.1	8.8
S1	2	26	1988	DRY	1	ND	10	ND	0.1	ND	0.005	ND	1	2	1	0.1	0.1	8.2
S1	3	30	1989	DRY	2	3	1							1.1	0.1			8
S1	5	11	1988	DRY	3	1	0.1							1.4	0.1			8.7
S1	12	12	1988	DRY	5	ND	10							ND	1.0			
S1	2	1	1988	DRY	6	ND	10							ND	1			
S1	4	6	1988	DRY	7	1.6	1.0							ND	1.0			
S1	4	20	1988	WET	1													
S1	11	23	1988	WET	2	360	10	0.5	0.1	0.032	0.01	ND	1	2	1	0.56	0.1	
S1	1	23	1988	WET	3	5.5	1.0							ND	1.0			
S1	2	4	1989	WET	4	34	1							2	1			
S1	2	9	1989	WET	5	76	1							ND	1			
S1FD	2	9	1988	WET	5	50	1							1.8	1			
S1	3	2	1988	WET	6	180	1.0							1.4	1.0			
S1	3	25	1988	WET	7	190	1.0											
S1LR	3	25	1989	WET	7													
S1FD	3	25	1989	WET	7	220	1.0											

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D.2-1 Conventional parameters in water column

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Sample ID.	Date Sampled Month	Day	Year	Sample Type	Sample Event	TOC actual mg/L	TOC DL mg/L	BOD actual mg/L	BOD DL mg/L	COD actual mg/L	COD DL mg/L	Total Coliform MPN per 100ml of sample	Total Coliform DL MPN/100	Fecal Coliform MPN per 100ml of sample	Fecal Coliform DL MPN/100
S2	2	26	1988	DRY	1	5	1			31	5	35000	2	4600	2
S2	3	30	1988	DRY	2			4	1			1300	2	1300	2
S2	5	11	1988	DRY	3	5.3	1	ND	1			30000	2	2000	2
S2	12	12	1988	DRY	5			3	1			>2400	3	>2400	3
S2	2	1	1989	DRY	6	2.1	1	2.7	1			11000	3	93	3
S2	4	6	1989	DRY	7	1.9	1	2.5	1.0			2400	3	460	3
S2	4	20	1988	WET	1	13	1					54000	2	7000	2
S2	11	23	1988	WET	2	14	0.1	45	1			>240000	3	<240000	3
S2	1	23	1989	WET	3	19	1	13	1			24000	3	11000	3
S2FD	1	23	1989	WET	3	19	1	12	1						
S2	2	4	1989	WET	4	14	1	3.3	1						
S2FD	2	4	1989	WET	4	11	1	4.1	1						
S2	2	9	1989	WET	5	10	1	7.3	1			>240000	3	11000	3
S2	3	2	1989	WET	6	14	1	21	1.0			15000	3	4600	3
S2	3	25	1989	WET	7	7.3	1	8.4	1.0						
S3	2	26	1988	DRY	1	2	1			47	5	5400	2	2400	2
S3	3	30	1988	DRY	2			6	1			7900	2	4900	2
S3	5	11	1988	DRY	3	6.4	1	2	1			110000	2	2000	2
S3	8	22	1988	DRY	4			7	1			>2400	2	70	2
S3FD	8	22	1988	DRY	4			5	1						
S3FD	8	22	1988	DRY	4							>2400	2	70	2
S3	12	12	1988	DRY	5			ND	1			>2400	3	1100	3
S3FD	12	12	1988	DRY	5			2	1			>2400	3	460	3
S3	2	1	1989	DRY	6	1.7	1	2.6	1			24000	3	43	3
S3LR	2	1	1989	DRY	6	1.6	1	2.4	1						
S3FD	2	1	1989	DRY	6	1.7	1	1.9	1			11000	3	23	3
S3	4	6	1989	DRY	7	2.3	1	1.9	1.0			4600	3	1100	3
S3LR	4	6	1989	DRY	7	2.3	1								
S3FD	4	6	1989	DRY	7	2.4	1	1.6	1.0			2400	3	460	3
S3	4	20	1988	WET	1	13	1					240000	2	17000	2
S3	11	23	1988	WET	2	23	0.1	4	1			>240000	3	<240000	3
S3FD	11	23	1988	WET	2	9	0.1					>240000	3	46000	3
S3LR	11	23	1988	WET	2	8.4	0.1	IS	1						
S3	1	23	1989	WET	3	20	1	12	1			24000	3	4600	3
S3FD	1	23	1989	WET	3							110000	3	24000	3
S3LR	1	23	1989	WET	3	15	1								
S3	2	4	1989	WET	4	8.9	1	2.8	1						
S3	2	9	1989	WET	5	8.6	1	7.9	1			24000	3	4600	3
S3	3	2	1989	WET	6			12	1.0			46000	3	46000	3

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	TOC actual mg/L	TOC D.L. mg/L	BOD actual mg/L	BOD D.L. mg/L	COD actual mg/L	COD D.L. mg/L	Total Coliform MPN per 100ml of sample	Total Coliform D.L. MPN/100	Fecal Coliform MPN per 100ml of sample	Fecal Coliform D.L. MPN/100
L1	4	20	1988	WET	1	13	1	5				2300	2	2300	2
L1	11	23	1988	WET	2	6.8	0.1	9	1			110000	3	24000	3
L1	2	4	1989	WET	4	18	1	5.3	1						
L1	2	9	1989	WET	5	44	1	10	1			110000	3	15000	3
L1LR	2	9	1989	WET	5	44	1								
L1	3	2	1989	WET	6	260	1	35	1.0			9300	3	150	3
L1LR	3	2	1989	WET	6	260	1								
L2	4	20	1988	WET	1	23	1	13				7900	2	2300	2
L2	11	23	1988	WET	2	9.9	0.1	10	1			4600	3	2400	3
L2	2	4	1989	WET	4	11	1	3.6	1						
L2	2	9	1989	WET	5	13	1	8.4	1			4600	3	2400	3
L2	3	2	1989	WET	6							7500	3	93	3
L2	3	2	1989	WET	6			16	1.0						
L2	3	25	1989	WET	7	8.3	1	13	1.0						
L3	4	20	1988	WET	1	16	1	7				350000	2	7900	2
L3	11	23	1988	WET	2	9.2	0.1	7	1			46000	3	11000	3
L3	2	4	1989	WET	4	9.5	1	4.3	1						
L3	2	9	1989	WET	5	8.2	1	5.9	1			11000	3	4600	3
L3	3	2	1989	WET	6	12	1	12	1.0			24000	3	930	3
L3	3	25	1989	WET	7	8.9	1	14	1.0						
L4	4	20	1988	WET	1			7				24000	2	4900	2
L4	11	23	1988	WET	2							>240000	3	110000	3
L4	2	4	1989	WET	4	9.7	1	3.1	1						
L4	2	9	1989	WET	5	8.7	1	4.2	1			24000	3	2400	3
L4	3	2	1989	WET	6							15000	3	2400	3
L4	3	25	1989	WET	7	9.4	1	11	1.0						
L5	4	20	1988	WET	1							170000	2	4900	2
L5	11	23	1988	WET	2	12	0.1	10	1			4600	3	400	3
L5	1	23	1989	WET	3	21	1	14	1			24000	3	2400	3
L5	2	4	1989	WET	4	11	1	4.4	1						
L5LR	2	4	1989	WET	4	11	1								
L5	2	9	1989	WET	5	7.7	1	3.7	1			46000	3	2400	3
L5	3	2	1989	WET	6	12	1	13	1.0			46000	3	2400	3
L5FD	3	2	1989	WET	6	12	1	15	1.0			110000	3	4300	3
L5	3	25	1989	WET	7	6.7	1	12	1.0						
L6	4	20	1988	WET	1	17	1					70000	2	500	2
L6	11	23	1988	WET	2	14	0.1	13	1			46000	3	1500	3
L6	2	9	1989	WET	5	6.5	1	4.2	1			46000	3	15000	3
L6	3	2	1989	WET	6	18	1	25	1.0			2100	3	240	3
L6	3	25	1989	WET	7	8.3	1	10	1.0						

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	TOC actual mg/L	TOC D.L. mg/L	BOD actual mg/L	BOD D.L. mg/L	COD actual mg/L	COD D.L. mg/L	Total Coliform MPN per 100ml of sample	Total Coliform D.L. MPN/100	Fecal Coliform MPN per 100ml of sample	Fecal Coliform D.L. MPN/100
L7	4	20	1988	WET	1							17000	2	800	2
L7	11	23	1988	WET	2	7.1	0.1	5	1			110000	3	11000	3
L7	2	4	1989	WET	4	4.6	1	2.1	1						
L7	2	8	1988	WET	5	3.1	1	3.1	1			750	3	76	3
L7	3	2	1989	WET	6	3.7	1	7.2	1.0			93	3	93	3
L7	3	25	1988	WET	7	6.1	1	7.3	1.0						
R1	2	27	1988	RES	1	5	1			31	5	7.8	2	<2	2
R2	2	28	1988	RES	1	4	1			31	5	49	2	33	2
R3	2	27	1988	RES	1	4	1			16	5	2	2	<2	2
R4	2	27	1988	RES	1	4	1			16	5	7.8	2	4.5	2
R5	2	27	1988	RES	1	7	1			16	5	540	2	13	2
R8	2	27	1988	RES	1	6	1			ND	5	2	2	<2	2
S1	2	28	1988	DRY	1	9	1			63	5	2400	2	2400	2
S1	3	30	1988	DRY	2			8	1			4800	2	2300	2
S1	5	11	1988	DRY	3	0.4	1	1	1			130000	2	8000	2
S1	12	12	1988	DRY	5			3	1			>2400	3	>2400	3
S1	2	1	1989	DRY	6	3.0	1	3.6	1			4600	3	43	3
S1	4	6	1988	DRY	7	3.0	1	1.5	1.0			11000	3	1500	3
S1	4	20	1988	WET	1							350000	2	3300	2
S1	11	23	1988	WET	2	10	0.1	13	1			>240000	3	110000	3
S1	1	23	1989	WET	3	9.0	1	5.8	1			110000	3	46000	3
S1	2	4	1989	WET	4	14	1	2.8	1						
S1	2	8	1989	WET	5	12	1	6.7	1			>240000	3	>240000	3
S1FD	2	8	1989	WET	5	12	1	4.9	1			>240000	3	11000	3
S1	3	2	1989	WET	6	14	1	21	1.0			46000	3	24000	3
S1	3	25	1989	WET	7	8.3	1	10	1.0						
S1LR	3	25	1989	WET	7	8.4	1								
S1FD	3	25	1989	WET	7	8.1	1	9.2	1.0						

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	Fecal Strep MPN per 100ml of sample	Hardness DL. MPN/100	Hardness actual mg/L	Turbidity DL. mg/L	Turbidity actual NTU	Turbidity DL. NTU
L1	4	20	1988	WET	1			31	1	39	
L1	11	23	1988	WET	2			32	1	170	1
L1	2	4	1989	WET	4						
L1	2	9	1989	WET	5			36	1	82	1
L1LR	2	9	1989	WET	5			88	1.0	60	1.0
L1	3	2	1989	WET	6						
L1LR	3	2	1989	WET	6						
L2	4	20	1988	WET	1			47	1	77	
L2	11	23	1988	WET	2			42	1	170	1
L2	2	4	1989	WET	4			33	1	120	1
L2	2	9	1989	WET	5						
L2	3	2	1989	WET	6			47	1.0	140	1.0
L2	3	2	1989	WET	6			35	1.0	140	1.0
L2	3	25	1989	WET	7						
L3	4	20	1988	WET	1			33	1	21	
L3	11	23	1988	WET	2			32	1	66	1
L3	2	4	1989	WET	4			26	1	30	1
L3	2	9	1989	WET	5			25	1.0	51	1.0
L3	3	2	1989	WET	6			26	1.0	50	1.0
L3	3	25	1989	WET	7						
L4	4	20	1988	WET	1						
L4	11	23	1988	WET	2			530	1	37	1
L4	2	4	1989	WET	4			470	1	66	1
L4	2	9	1989	WET	5						
L4	3	2	1989	WET	6			550	1.0	64	1.0
L4	3	25	1989	WET	7						
L5	4	20	1988	WET	1			79	1	69	
L5	11	23	1988	WET	2			51	1.0	59	1.0
L5	1	23	1989	WET	3	2400	3	45	1	73	1
L5	2	4	1989	WET	4						
L5LR	2	4	1989	WET	4			41	1	110	1
L5	2	9	1989	WET	5			35	1.0	83	1.0
L5	3	2	1989	WET	6			59	1.0	69	1.0
L5FD	3	2	1989	WET	6			36	1.0	79	1.0
L5	3	25	1989	WET	7						
L6	4	20	1988	WET	1			56	1	36	
L6	11	23	1988	WET	2			25	1	30	1
L6	2	9	1989	WET	5			35	1.0	66	1.0
L6	3	2	1989	WET	6			37	1.0	100	1.0
L6	3	25	1989	WET	7						

R0054604

Sample I.D.	Date Sampled Month	Day	Year	Sample Type	Sample Event	Fecal Strep MPN per 100ml of sample	D.L. MPN/100	Hardness actual mg/L	D.L. mg/L	Turbidity actual NTU	D.L. NTU
L7	4	20	1988	WET	1						
L7	11	23	1988	WET	2			260	1	25	
L7	2	4	1989	WET	4			250	1	30	1
L7	2	9	1989	WET	5			250	1	11	1
L7	3	2	1989	WET	6			250	1.0	19	1.0
L7	3	25	1989	WET	7			170	1.0	360	1.0
R1	2	27	1988	RES	1						
R2	2	26	1989	RES	1						
R3	2	27	1989	RES	1						
R4	2	27	1989	RES	1						
R5	2	27	1989	RES	1						
R6	2	27	1989	RES	1						
S1	2	26	1989	DRY	1						
S1	3	30	1989	DRY	2						
S1	5	11	1989	DRY	3						
S1	12	12	1988	DRY	5			230	1.0	4	1.0
S1	2	1	1989	DRY	6			190	1	5.2	1
S1	4	6	1989	DRY	7			220	1.0	1.6	1.0
S1	4	20	1989	WET	1						
S1	11	23	1989	WET	2			110	1	240	
S1	1	23	1989	WET	3	4660	3	240	1.0	51	1.0
S1	2	4	1989	WET	4			110	1	69	1
S1	2	9	1989	WET	5			60	1	69	1
S1FD	2	9	1989	WET	5			50	1	95	1
S1	3	2	1989	WET	6			76	1.0	120	1.0
S1	3	25	1989	WET	7			48	1.0	97	1.0
S1LR	3	25	1989	WET	7						
S1FD	3	25	1989	WET	7			64	1.0	120	1.0

R0054605

VOL 12

2 -3C5

D.2-2 Conventional parameters in sediment

VOL 12

2

1306

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	Fecal Strep MPN per 100ml of sample	DL. MPN/100	Hardness actual mg/L	DL. mg/L	Turbidity actual NTU	DL. NTU
S2	2	26	1988	DRY	1						
S2	3	30	1988	DRY	2						
S2	5	11	1988	DRY	3						
S2	12	12	1988	DRY	5			500	1.0	3	1.0
S2	2	1	1989	DRY	6			530	1	2.5	1
S2	4	6	1989	DRY	7			500	1.0	3.2	1.0
S2	4	20	1988	WET	1						
S2	11	23	1988	WET	2						
S2	1	23	1989	WET	3	1100	3	330	1	480	
S2FD	1	23	1989	WET	3			120	1.0	39	1.0
S2	2	4	1989	WET	4			86	1.0	27	1.0
S2FD	2	4	1989	WET	4			100	1	83	1
S2	2	9	1989	WET	5			47	1	87	1
S2	3	2	1989	WET	6			76	1	79	1
S2	3	25	1989	WET	7			88	1.0	110	1.0
								77	1.0	120	1.0
S3	2	26	1988	DRY	1						
S3	3	30	1988	DRY	2						
S3	5	11	1988	DRY	3						
S3	8	22	1988	DRY	4						
S3FD	8	22	1988	DRY	4						
S3FD	8	22	1988	DRY	4						
S3	12	12	1988	DRY	5						
S3FD	12	12	1988	DRY	5			340	1.0	6	1.0
S3	2	1	1989	DRY	6			320	1.0	5	1.0
S3LR	2	1	1989	DRY	6			360	1	4.6	1
S3FD	2	1	1989	DRY	6			370	1	4.8	1
S3	4	6	1989	DRY	7			360	1	3.0	1
S3LR	4	6	1989	DRY	7			290	1.0	4.9	1.0
S3FD	4	6	1989	DRY	7			300	1.0	3.5	1.0
S3	4	20	1988	WET	1						
S3	11	23	1988	WET	2						
S3FD	11	23	1988	WET	2			180	1	910	
S3LR	11	23	1988	WET	2						
S3	1	23	1989	WET	3			180	1	890	
S3FD	1	23	1989	WET	3	4600	3	130	1.0	200	1.0
S3LR	1	23	1989	WET	3						
S3	2	4	1989	WET	4						
S3	2	9	1989	WET	5			130	1	180	1
S3	3	2	1989	WET	6			140	1	150	1
								300	1.0	34	1.0

R0054607

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	Fecal Strep MPN per 100ml of sample	Hardness D.L. MPN/100	Hardness actual mg/L	Hardness D.L. mg/L	Turbidity actual NTU	Turbidity D.L. NTU
S4	2	26	1988	DRY	1						
S4	3	30	1988	DRY	2						
S4	5	11	1988	DRY	3						
S4FD	5	11	1988	DRY	3						
S4	8	22	1988	DRY	4						
S4	12	12	1988	DRY	5			460	1.0	15	1.0
S4	2	1	1989	DRY	6						
S4	2	1	1989	DRY	6			420	1	36	1
S4	4	8	1989	DRY	7			420	1.0	7.9	1.0
S4D	3	30	1988	DRY	2						
S4	4	20	1988	WET	1						
S4	11	23	1988	WET	2			230	1	360	
S4FD	11	23	1988	WET	2			150	1	650	
S4	1	23	1989	WET	3	>240000	3				
S4	2	4	1989	WET	4			160	1	120	1
S4	2	8	1989	WET	5			140	1	100	1
S4	3	2	1989	WET	6			140	1.0	86	1.0
S4	3	25	1989	WET	7			200	1.0	220	1.0
FB	8	22	1988	DRY	4						
FB	8	22	1988	DRY	4						
FB	12	12	1988	DRY	5						
FB	12	12	1988	DRY	5			ND	1.0	ND	1.0
FB	2	1	1989	DRY	6						
FB	2	1	1989	DRY	6			ND	1	ND	1
FB	4	6	1989	DRY	7						
FB	4	6	1989	DRY	7			ND	1.0	ND	1.0
FB	11	23	1988	WET	2						
FB	11	23	1988	WET	2						
FB	11	23	1988	WET	2			ND	1	15	
FB	1	23	1989	WET	3	<3	3				
FB	1	23	1989	WET	3			ND	1.0	ND	1.0
FB	2	8	1989	WET	5						
FB	2	8	1989	WET	5			ND	1	ND	1
FB	3	2	1989	WET	6						
FB	3	2	1989	WET	6				1.0		1.0
FB	3	25	1989	WET	7				1.0		1.0

R0054608

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	PARTICLE SIZE % SAND 0 4 PHI %	% SILT 5 0 PHI %	% CLAY >=9 PHI %	NH3 N actual mg/kg	NH3 N DL mg/kg	TKN actual mg/kg	TKN DL mg/kg	TOC actual mg/kg	TOC DL mg/kg	BOD actual mg/kg	BOD DL mg/kg
STANDARD LIMITS										1		1		100		25
S1	3	30	1988	DRY	1				82	1	210	1	ND	100		
S1	8	22	1988	DRY	3	76 9	9 3	0								
S1	12	12	1988	DRY	4	94 1	5 1	0 8								
S2	3	30	1988	DRY	1				130	1	830	1	16500	100		
S2	8	22	1988	DRY	3	83 3	11 4	1 1								
S2	12	12	1988	DRY	4	81 7	16	2 3								
S3	3	30	1988	DRY	1				150	1	920	1	33700	100		
S3	8	22	1988	DRY	3	26 4	64 3	9 3								
S3	12	12	1988	DRY	4	90 1	8 4	1 3								
S3LR	12	12	1988	DRY	4	94	4 4	1 7								
S4	3	30	1988	DRY	1				110	1	690	1	11400	100		
S4LR	3	30	1988	DRY	1				115	1	720	1	11100	100		
S4	8	22	1988	DRY	3	67 1	26	6 9								
S4FD	8	22	1988	DRY	3	22 3	68 1	9 7								
S4	12	12	1988	DRY	4	84 5	14	1 4								
S4FD	12	12	1988	DRY	4	89 5	8 9	1 5								

R0054609

D.3 Organochlorine pesticides

VOL 12 2 1310

R0054610

D.3-1 Organochlorine pesticides in water column

VOL 12

2

R0054611

ORGANOCHLORINE PESTICIDES

Abbreviated Name	Actual Name
6CL-CHX-A	Alpha-BHC (hexachlorocyclohexane
6CL-CHX-B	Beta-BHC (hexachlorocyclohexane)
6CL-CHX-D	Delta-BHC (hexachlorocyclohexane)
6CL-CHX-G	Gamma-BHC (hexachlorocyclohexane)
G-CHLORDANE	Gamma-chlordane
ENDOSULFAN-A	Endosulfan I
ENDOSULFAN-B	Endosulfan II
ENDOSULFAN-S	Endosulfan sulfate
ENDRIN-ALD	Endrin aldehyde
HEPCL EPOX	Heptachlor epoxide
METHOXYCL	Methoxychlor
tPCB	Total polychlorinated biphenyls
DDD	4,4'-DDD
DDE	4,4'-DDE
DDT	4,4'-DDT

VOL 12

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1312

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	ALDRIN actual ug/l	ALDRIN DL ug/l	6CL CHX-A actual ug/l	6CL CHX-A DL ug/l	6CL-CHX-B actual ug/l	6CL-CHX-B DL ug/l	6CL-CHX-D actual ug/l	6CL-CHX-D DL ug/l	6CL-CHX-G actual ug/l	6CL-CHX-G DL ug/l	G-CHLORDANE actual ug/l	G-CHLORDANE DL ug/l
STANDARD REPORTING OBJECTIVES							0 05		0 05		0 05		0.05		0 05		0.1
S4	2	26	1988	DRY	1	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0.1
S4	3	30	1988	DRY	2	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0.1
S4	5	11	1988	DRY	3	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
S4	8	25	1988	DRY	4	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
S4	12	12	1988	DRY	5	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
S4	2	1	1989	DRY	6	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
S4	4	6	1989	DRY	7	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
S4	4	20	1988	WET	1	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0.1
S4	11	23	1988	WET	2	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
S4FD	11	23	1988	WET	2	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	0.1	0 1
S4	2	4	1989	WET	4	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
S4	2	8	1989	WET	5	ND	0 05	ND	0 05	ND	0.05	ND	0 05	ND	0 05	ND	0 1
SB	8	25	1988	DRY	4	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0.1
FB	8	25	1988	DRY	4	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0.1
FB	12	12	1988	DRY	5	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
FB	2	1	1989	DRY	6	ND	0 05	ND	0 05	ND	0.05	ND	0.05	ND	0 05	ND	0 1
FB	4	6	1989	DRY	7	ND	0.05	ND	0 05	ND	0.05	ND	0 05	ND	0.05	ND	0.1
FB	11	23	1988	WET	2	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0.1
FB	1	23	1988	WET	3	ND	0 05	ND	0 05	ND	0 05	ND	0.05	ND	0 05	ND	0 1
FB	2	9	1988	WET	5	ND	0 05	ND	0.05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
FB	3	2	1988	WET	6	ND	0 05	ND	0 05	ND	0.05	ND	0 05	ND	0 05	ND	0.1

R0054613

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	A-CHLORDANE actual ug/l	A-CHLORDANE DL ug/l	DDD actual ug/l	DDD DL ug/l	DDE actual ug/l	DDE DL ug/l	DDT actual ug/l	DDT DL ug/l	DIELDRIN actual ug/l	DIELDRIN DL ug/l	ENDOSULFAN A actual ug/l	ENDOSULFAN A DL ug/l
STANDARD REPORTING OBJECTIVES							0.1		0.1		0.05		0.1		0.05		0.05
L1	4	20	1988	WET	1	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
L1	11	23	1988	WET	2	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.1	ND	0.05
L1	2	4	1989	WET	4	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
L1	2	8	1989	WET	5	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
L1	3	2	1989	WET	6	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
L2	4	20	1988	WET	1	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
L2	11	23	1988	WET	2	ND	0.1	ND	0.1	ND	0.05	0.16	0.1	ND	0.1	ND	0.05
L2	2	4	1989	WET	4	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
L2	2	8	1989	WET	5	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
L3	4	20	1988	WET	1	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
L3	11	23	1988	WET	2	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.1	ND	0.05
L3	2	4	1989	WET	4	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
L3	2	8	1989	WET	5	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
L3	3	2	1989	WET	6	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
L4	2	4	1989	WET	4	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
L4	2	8	1989	WET	5	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
L5	11	23	1988	WET	2	ND	0.1	ND	0.1	0.05	0.05	0.13	0.1	ND	0.1	ND	0.05
L5	1	23	1989	WET	3	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
L5	2	4	1989	WET	4	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
L5	2	8	1989	WET	5	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
L5	3	2	1989	WET	6	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
L5FD	3	2	1989	WET	6	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
L6	4	20	1988	WET	1	0.3	0.1	ND	0.1	0.1	0.05	ND	0.1	ND	0.05	ND	0.05
L6	11	23	1988	WET	2	ND	0.1	ND	0.1	0.074	0.05	ND	0.1	ND	0.1	ND	0.05
L6	2	4	1989	WET	4	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
L6	2	8	1989	WET	5	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
L7	11	23	1988	WET	2	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.1	ND	0.05
L7	2	4	1989	WET	4	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
L7	2	8	1989	WET	5	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
L7	3	2	1989	WET	6	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
R1	2	27	1988	RES	1	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
R2	2	26	1988	RES	1	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
R3	2	27	1988	RES	1	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
R4	2	27	1988	RES	1	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
R5	2	27	1988	RES	1	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
R6	2	27	1988	RES	1	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05

R0054614

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	ALDRIN actual ug/l	ALDRIN DL ug/l	6CL CHX A actual ug/l	6CL CHX A DL ug/l	6CL-CHX B actual ug/l	6CL-CHX B DL ug/l	6CL-CHX D actual ug/l	6CL-CHX D DL ug/l	6CL-CHX G actual ug/l	6CL-CHX G DL ug/l	G-CHLORDANE actual ug/l	G-CHLORDANE DL ug/l
STANDARD REPORTING OBJECTIVES							0 05		0 05		0 05		0 05		0 05		0.1
L1	4	20	1988	WET	1	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
L1	11	23	1988	WET	2	ND	0 05	0 077	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
L1	2	4	1989	WET	4	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
L1	2	9	1989	WET	5	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
L1	3	2	1989	WET	6	ND	0 05	ND	0 05	ND	0.05	ND	0.05	ND	0 05	ND	0.1
L2	4	20	1988	WET	1	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0.1
L2	11	23	1988	WET	2	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
L2	2	4	1989	WET	4	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
L2	2	9	1989	WET	5	ND	0 05	ND	0 05	ND	0 05	ND	0.05	ND	0.05	ND	0.1
L3	4	20	1988	WET	1	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0.1
L3	11	23	1988	WET	2	ND	0 05	0 053	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
L3	2	4	1989	WET	4	ND	0 05	ND	0 05	ND	0 05	ND	0 05	0.18	0 05	ND	0 1
L3	2	9	1989	WET	5	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
L3	3	2	1989	WET	6	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0.05	ND	0.1
L4	2	4	1989	WET	4	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
L4	2	9	1989	WET	5	ND	0 05	ND	0 05	ND	0 05	ND	0.05	ND	0 05	ND	0 1
L5	11	23	1988	WET	2	ND	0 05	0 07	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
L5	1	23	1989	WET	3	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
L5	2	4	1989	WET	4	ND	0 05	ND	0 05	ND	0 05	ND	0 05	0 05	0 05	ND	0 1
L5	2	9	1989	WET	5	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
L5	3	2	1989	WET	6	ND	0 05	ND	0 05	ND	0.05	ND	0 05	ND	0 05	ND	0 1
L5FD	3	2	1989	WET	6	ND	0 05	ND	0 05	ND	0.05	ND	0 05	ND	0.05	ND	0.1
L6	4	20	1988	WET	1	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	0 2	0 1
L6	11	23	1988	WET	2	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0.1
L6	2	4	1989	WET	4	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0.1
L6	2	9	1989	WET	5	ND	0 05	ND	0 05	ND	0.05	ND	0.05	ND	0.05	ND	0.1
L7	11	23	1988	WET	2	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
L7	2	4	1989	WET	4	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
L7	2	9	1989	WET	5	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
L7	3	2	1989	WET	6	ND	0.05	ND	0 05	ND	0 05	ND	0.05	ND	0 05	ND	0.1
R1	2	27	1988	RES	1	ND	0 05	ND	0 05	ND	0.05	ND	0 05	ND	0 05	ND	0 1
R2	2	26	1988	RES	1	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
R3	2	27	1988	RES	1	ND	0 05	ND	0 05	ND	0.05	ND	0 05	ND	0 05	ND	0 1
R4	2	27	1988	RES	1	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
R5	2	27	1988	RES	1	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 05	ND	0 1
R6	2	27	1988	RES	1	ND	0 05	ND	0 05	ND	0 05	ND	0.05	ND	0 05	ND	0 1

R0054615

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	ALDRIN actual ug/l	DL ug/l	6CL CHX A actual ug/l	DL ug/l	6Cl actu ug							DL ug/l
STANDARD REPORTING OBJECTIVES							0 05		0 05								0 1
																	0 1
S1	2	26	1988	DRY	1	ND	0 05	ND	0 05	ND							0 1
S1	3	30	1988	DRY	2	ND	0 05	ND	0 05	ND							0 1
S1	5	11	1988	DRY	3	ND	0 05	ND	0 05	ND							0 1
S1	12	12	1988	DRY	5	ND	0 05	ND	0 05	ND							0 1
S1	2	1	1989	DRY	6	ND	0 05	ND	0 05	ND							0 1
S1	4	6	1989	DRY	7	ND	0.05	ND	0 05	ND							0.1
S1	11	23	1988	WET	2	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S1	1	23	1989	WET	3	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S1	2	4	1989	WET	4	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S1	2	8	1989	WET	5	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S1FD	2	8	1989	WET	5	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S1	3	2	1989	WET	6	ND	0.05	ND	0 05	ND	0.05	ND					0 1
S2	2	26	1988	DRY	1	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S2	3	30	1988	DRY	2	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S2	5	11	1988	DRY	3	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S2	12	12	1988	DRY	5	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S2	2	1	1989	DRY	6	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S2	4	6	1989	DRY	7	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S2	11	23	1988	WET	2	ND	0 05	0 05	0 05	ND	0 05	ND					0 1
S2	1	23	1989	WET	3	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S5	1	23	1989	WET	3	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S2	2	4	1989	WET	4	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S2	2	8	1989	WET	5	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S2	3	2	1989	WET	6	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S3	2	26	1988	DRY	1	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S3	3	30	1988	DRY	2	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S3	5	11	1988	DRY	3	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S3	8	25	1988	DRY	4	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S3FD	8	25	1988	DRY	4	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S3	12	12	1988	DRY	5	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S5	12	12	1988	DRY	5	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S3	2	1	1989	DRY	6	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S5	2	1	1989	DRY	6	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S3	4	6	1989	DRY	7	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S5	4	6	1989	DRY	7	ND	0.05	ND	0 05	ND	0 05	ND					0 1
S3	11	23	1988	WET	2	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S3LR	11	23	1988	WET	2	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S3	1	23	1989	WET	3	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S3	2	4	1989	WET	4	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S3	2	4	1989	WET	4	ND	0 05	ND	0 05	ND	0 05	ND					0 1
S3	2	8	1989	WET	5	ND	0.05	ND	0 05	ND	0 05	ND					0 1

R0054616

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	ENDOSULFN B actual ug/l	ENDOSULFN B DL ug/l	ENDOSULFN S actual ug/l	ENDOSULFN S DL ug/l	ENDRIN actual ug/l	ENDRIN DL ug/l	ENDRIN-ALD actual ug/l	ENDRIN-ALD DL ug/l	HEPTACHLOR actual ug/l	HEPTACHLOR DL ug/l
STANDARD REPORTING OBJECTIVES							0 05		0 1		0 1		0.1		0 05
L1	4	20	1988	WET	1	ND	0 05	0 12	0 1	ND	0 1	ND	0 1	ND	0 05
L1	11	23	1988	WET	2	ND	0 1	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L1	2	4	1989	WET	4	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L1	2	9	1989	WET	5	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L1	3	2	1989	WET	6	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L2	4	20	1988	WET	1	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L2	11	23	1988	WET	2	ND	0 1	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L2	2	4	1989	WET	4	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L2	2	9	1989	WET	5	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L3	4	20	1988	WET	1	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L3	11	23	1988	WET	2	ND	0 1	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L3	2	4	1989	WET	4	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L3	2	9	1989	WET	5	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L3	3	2	1989	WET	6	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L4	2	4	1989	WET	4	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L4	2	9	1989	WET	5	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L5	11	23	1988	WET	2	ND	0 1	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L5	1	23	1989	WET	3	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L5	2	4	1989	WET	4	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L5	2	9	1989	WET	5	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L5	3	2	1989	WET	6	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L5FD	3	2	1989	WET	6	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L6	4	20	1988	WET	1	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L6	11	23	1988	WET	2	ND	0 1	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L6	2	4	1989	WET	4	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L6	2	9	1989	WET	5	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L7	11	23	1988	WET	2	ND	0 1	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L7	2	4	1989	WET	4	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L7	2	9	1989	WET	5	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
L7	3	2	1989	WET	6	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
R1	2	27	1988	RES	1	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
R2	2	26	1988	RES	1	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
R3	2	27	1988	RES	1	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
R4	2	27	1988	RES	1	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
R5	2	27	1988	RES	1	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
R6	2	27	1988	RES	1	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05

R0054617

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	ENDOSLFN-B actual ug/l	ENDOSLFN-B DL ug/l	ENDOSLFN-S actual ug/l	ENDOSLFN-S DL ug/l	ENDRIN actual ug/l	ENDRIN DL ug/l	ENDRIN ALD actual ug/l	ENDRIN ALD DL ug/l	HEPTACHLOR actual ug/l	HEPTACHLOR DL ug/l
STANDARD REPORTING OBJECTIVES							0.05		0.1		0.1		0.1		0.05
S1	2	26	1988	DRY	1	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S1	3	30	1988	DRY	2	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S1	5	11	1988	DRY	3	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S1	12	12	1988	DRY	5	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S1	2	1	1989	DRY	6	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S1	4	6	1989	DRY	7	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S1	11	23	1988	WET	2	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S1	1	23	1989	WET	3	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S1	2	4	1989	WET	4	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S1	2	8	1989	WET	5	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S1FD	2	8	1989	WET	5	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S1	3	2	1989	WET	6	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S2	2	26	1988	DRY	1	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S2	3	30	1988	DRY	2	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S2	5	11	1988	DRY	3	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S2	12	12	1988	DRY	5	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S2	2	1	1989	DRY	6	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S2	4	6	1989	DRY	7	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S2	11	23	1988	WET	2	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S2	1	23	1989	WET	3	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S5	1	23	1989	WET	3	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S2	2	4	1989	WET	4	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S2	2	8	1989	WET	5	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S2	3	2	1989	WET	6	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S3	2	26	1988	DRY	1	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S3	3	30	1988	DRY	2	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S3	5	11	1988	DRY	3	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S3	8	25	1988	DRY	4	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S3FD	8	25	1988	DRY	4	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S3	12	12	1988	DRY	5	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S5	12	12	1988	DRY	5	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S3	2	1	1989	DRY	6	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S5	2	1	1989	DRY	6	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S3	4	6	1989	DRY	7	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S5	4	6	1989	DRY	7	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S3	11	23	1988	WET	2	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S3LR	11	23	1988	WET	2	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S3	1	23	1989	WET	3	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S3	2	4	1989	WET	4	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S3	2	4	1989	WET	4	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
S3	2	8	1989	WET	5	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	A-CHLORDANE actual ug/l	A-CHLORDANE DL ug/l	DDD actual ug/l	DDD DL ug/l	DDE actual ug/l	DDE DL ug/l	DDT actual ug/l	DDT DL ug/l	DIELDRIN actual ug/l	DIELDRIN DL ug/l	ENDOSLFN A actual ug/l	ENDOSLFN A DL ug/l
STANDARD REPORTING OBJECTIVES							0.1		0.1		0.05		0.1		0.05		0.05
S1	2	26	1988	DRY	1	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S1	3	30	1988	DRY	2	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S1	5	11	1988	DRY	3	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S1	12	12	1988	DRY	5	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S1	2	1	1989	DRY	6	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S1	4	6	1989	DRY	7	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.1	ND	0.05
S1	11	23	1988	WET	2	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.1	ND	0.05
S1	1	23	1989	WET	3	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S1	2	4	1989	WET	4	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S1	2	9	1989	WET	5	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S1FD	2	9	1989	WET	5	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S1	3	2	1989	WET	6	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S2	2	26	1988	DRY	1	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S2	3	30	1988	DRY	2	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S2	5	11	1988	DRY	3	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S2	12	12	1988	DRY	5	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S2	2	1	1989	DRY	6	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S2	4	6	1989	DRY	7	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.1	ND	0.05
S2	11	23	1988	WET	2	ND	0.1	0.13	0.1	0.08	0.05	0.25	0.1	ND	0.1	ND	0.05
S2	1	23	1989	WET	3	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S5	1	23	1989	WET	3	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S2	2	4	1989	WET	4	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S2	2	9	1989	WET	5	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S2	3	2	1989	WET	6	0.1	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S3	2	26	1988	DRY	1	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S3	3	30	1988	DRY	2	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S3	5	11	1988	DRY	3	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S3	8	25	1988	DRY	4	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.1	ND	0.05
S3FD	8	25	1988	DRY	4	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.1	ND	0.05
S3	12	12	1988	DRY	5	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S5	12	12	1988	DRY	5	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S3	2	1	1989	DRY	6	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S5	2	1	1989	DRY	6	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S3	4	6	1989	DRY	7	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.1	ND	0.05
S5	4	6	1989	DRY	7	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.1	ND	0.05
S3	11	23	1988	WET	2	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.1	ND	0.05
S3LR	11	23	1988	WET	2	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.1	ND	0.05
S3	1	23	1989	WET	3	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S3	2	4	1989	WET	4	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S3	2	4	1989	WET	4	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05
S3	2	9	1989	WET	5	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0.05

R0054619

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	A-CHLORDANE actual ug/l	A-CHLORDANE DL ug/l	DDD actual ug/l	DDD DL ug/l	DDE actual ug/l	DDE DL ug/l	DDT actual ug/l	DDT DL ug/l	DIELDRIN actual ug/l	DIELDRIN DL ug/l	ENDOSULFN A actual ug/l	ENDOSULFN A DL ug/l
STANDARD REPORTING OBJECTIVES							0 1		0.1		0.05		0.1		0.05		0 05
S4	2	26	1988	DRY	1	ND	0 1	ND	0 1	ND	0 05	ND	0.1	ND	0.05	ND	0 05
S4	3	30	1988	DRY	2	ND	0 1	ND	0 1	ND	0 05	ND	0.1	ND	0 05	ND	0 05
S4	5	11	1988	DRY	3	ND	0 1	ND	0.1	ND	0 05	ND	0.1	ND	0.05	ND	0 05
S4	8	25	1988	DRY	4	ND	0 1	ND	0 1	ND	0 05	ND	0.1	ND	0.1	ND	0 05
S4	12	12	1988	DRY	5	ND	0 1	ND	0 1	ND	0 05	ND	0.1	ND	0.05	ND	0 05
S4	2	1	1988	DRY	6	ND	0 1	ND	0 1	ND	0 05	ND	0.1	ND	0.05	ND	0 05
S4	4	6	1988	DRY	7	ND	0 1	ND	0.1	ND	0.05	ND	0.1	ND	0.1	ND	0 05
S4	4	20	1988	WET	1	ND	0 1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0 05
S4	11	23	1988	WET	2	ND	0 1	ND	0 1	0 07	0 05	0.19	0.1	ND	0.1	0.13	0 05
S4FD	11	23	1988	WET	2	ND	0 1	ND	0 1	0 05	0 05	0 15	0.1	ND	0.1	ND	0 05
S4	2	4	1988	WET	4	ND	0.1	ND	0.1	0 05	0 05	0 05	0.1	ND	0.05	ND	0 05
S4	2	8	1988	WET	5	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.05	ND	0 05
SB	8	25	1988	DRY	4	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.1	ND	0.05
FB	8	25	1988	DRY	4	ND	0.1	ND	0 1	ND	0 05	ND	0.1	ND	0 1	ND	0 05
FB	12	12	1988	DRY	5	ND	0 1	ND	0 1	ND	0.05	ND	0.1	ND	0 05	ND	0 05
FB	2	1	1988	DRY	6	ND	0 1	ND	0 1	ND	0 05	ND	0.1	ND	0 05	ND	0 05
FB	4	6	1988	DRY	7	ND	0.1	ND	0.1	ND	0.05	ND	0.1	ND	0.1	ND	0.05
FB	11	23	1988	WET	2	ND	0 1	ND	0 1	ND	0.05	ND	0.1	ND	0.1	ND	0.05
FB	1	23	1989	WET	3	ND	0 1	ND	0.1	0 077	0.05	ND	0.1	ND	0.05	ND	0 05
FB	2	9	1989	WET	5	ND	0 1	ND	0 1	ND	0 05	ND	0.1	ND	0.05	ND	0.05
FB	3	2	1989	WET	6	ND	0 1	ND	0 1	ND	0.05	ND	0.1	ND	0.05	ND	0.05

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	HEPCL EPOX actual ug/l	DL ug/l	METHOXYCL actual ug/l	DL ug/l	TOXAPHENE actual ug/l	DL ug/l	PCB actual ug/l	DL ug/l
STANDARD REPORTING OBJECTIVES							0 05		0 05		1		1
S1	2	26	1988	DRY	1	ND	0 05	ND	0 05	ND	1	ND	1
S1	3	30	1988	DRY	2	ND	0 05	ND	0 05	ND	1	ND	1
S1	5	11	1988	DRY	3	ND	0 05	ND	0 05	ND	1	ND	1
S1	12	12	1988	DRY	5	ND	0 05	ND	0 5	ND	1	ND	1
S1	2	1	1989	DRY	6	ND	0 05	ND	0 5	ND	1	ND	1
S1	4	6	1989	DRY	7	ND	0 05	ND	0 5	ND	1.0	ND	1.0
S1	11	23	1988	WET	2	ND	0 05	ND	0 5	ND	1	ND	1
S1	1	23	1989	WET	3	ND	0 05	ND	0 5	ND	1	ND	1
S1	2	4	1989	WET	4	ND	0 05	ND	0 5	ND	1.0	ND	1.0
S1	2	9	1989	WET	5	ND	0 05	ND	0 5	ND	1.0	ND	1.0
S1FD	2	9	1989	WET	5	ND	0 05	ND	0.5	ND	1.0	ND	1.0
S1	3	2	1989	WET	6	ND	0 05	ND	0.5	ND	1.0	ND	1.0
S2	2	26	1988	DRY	1	ND	0 05	ND	0 05	ND	1	ND	1
S2	3	30	1988	DRY	2	ND	0 05	ND	0 05	ND	1	ND	1
S2	5	11	1988	DRY	3	ND	0 05	ND	0 05	ND	1	ND	1
S2	12	12	1988	DRY	5	ND	0 05	ND	0 5	ND	1	ND	1
S2	2	1	1989	DRY	6	ND	0 05	ND	0 5	ND	1	ND	1
S2	4	6	1989	DRY	7	ND	0 05	ND	0 5	ND	1.0	ND	1.0
S2	11	23	1988	WET	2	ND	0 05	ND	0 5	ND	1	ND	1
S2	1	23	1989	WET	3	ND	0 05	ND	0 5	ND	1	ND	1
S5	1	23	1989	WET	3	ND	0 05	ND	0 5	ND	1	ND	1
S2	2	4	1989	WET	4	ND	0 05	ND	0 5	ND	1.0	ND	1.0
S2	2	9	1989	WET	5	ND	0 05	ND	0 5	ND	1.0	ND	1.0
S2	3	2	1989	WET	6	ND	0 05	ND	0.5	ND	1.0	ND	1.0
S3	2	26	1988	DRY	1	ND	0 05	ND	0 05	ND	1	ND	1
S3	3	30	1988	DRY	2	ND	0 05	ND	0 05	ND	1	ND	1
S3	5	11	1988	DRY	3	ND	0 05	ND	0 05	ND	1	ND	1
S3	8	25	1988	DRY	4	ND	0 05	ND	0 5	ND	1	ND	1
S3FD	8	25	1988	DRY	4	ND	0 05	ND	0 5	ND	1	ND	1
S3	12	12	1988	DRY	5	ND	0 05	ND	0 5	ND	1	ND	1
S5	12	12	1988	DRY	5	ND	0 05	ND	0 5	ND	1	ND	1
S3	2	1	1989	DRY	6	ND	0 05	ND	0 5	ND	1	ND	1
S5	2	1	1989	DRY	6	ND	0 05	ND	0 5	ND	1	ND	1
S3	4	6	1989	DRY	7	ND	0 05	ND	0 5	ND	1.0	ND	1.0
S5	4	6	1989	DRY	7	ND	0 05	ND	0 5	ND	1.0	ND	1.0
S3	11	23	1988	WET	2	ND	0 05	ND	0 5	ND	1	ND	1
S3FR	11	23	1988	WET	2	ND	0 05	ND	0 5	ND	1	ND	1
S3	1	23	1989	WET	3	ND	0 05	ND	0 5	ND	1	ND	1
S3	2	4	1989	WET	4	ND	0 05	ND	0 5	ND	1.0	ND	1.0
S3	2	4	1989	WET	4	ND	0 05	ND	0 5	ND	1.0	ND	1.0
S3	2	9	1989	WET	5	ND	0 05	ND	0.5	ND	1.0	ND	1.0

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	HEPCL EPOX actual ug/l	HEPCL EPOX DL ug/l	METHOXYCL actual ug/l	METHOXYCL DL ug/l	TOXAPHENE actual ug/l	TOXAPHENE DL ug/l	tPCB actual ug/l	tPCB DL ug/l
STANDARD REPORTING OBJECTIVES							0 05		0 05		1		1
S4	2	26	1988	DRY	1	ND	0.05	ND	0 05	ND	1	ND	1
S4	3	30	1988	DRY	2	ND	0 05	ND	0 05	ND	1	ND	1
S4	5	11	1988	DRY	3	ND	0 05	ND	0 05	ND	1	1.3	1
S4	8	25	1988	DRY	4	ND	0 05	ND	0 5	ND	1	ND	1
S4	12	12	1988	DRY	5	ND	0 05	ND	0 5	ND	1	ND	1
S4	2	1	1988	DRY	6	ND	0 05	ND	0 5	ND	1	ND	1
S4	4	6	1988	DRY	7	ND	0.05	ND	0 5	ND	1.0	ND	1.0
S4	4	20	1988	WET	1	ND	0 05	ND	0 05	ND	1	ND	1
S4	11	23	1988	WET	2	ND	0 05	ND	0 5	ND	1	ND	1
S4FD	11	23	1988	WET	2	ND	0 05	ND	0 5	ND	1	1.4	1
S4	2	4	1988	WET	4	ND	0 05	ND	0 5	ND	1.0	ND	1.0
S4	2	8	1988	WET	5	ND	0.05	ND	0 5	ND	1.0	ND	1.0
SB	8	25	1988	DRY	4	ND	0.05	ND	0 5	ND	1	1.3	1
FB	8	25	1988	DRY	4	ND	0 05	ND	0 5	ND	1	1 3	1
FB	12	12	1988	DRY	5	ND	0 05	ND	0 5	ND	1	ND	1
FB	2	1	1989	DRY	6	ND	0 05	ND	0 5	ND	1	ND	1
FB	4	6	1988	DRY	7	ND	0.05	ND	0 5	ND	1.0	ND	1.0
FB	11	23	1988	WET	2	ND	0 05	ND	0 5	ND	1	ND	1
FB	1	23	1988	WET	3	ND	0 05	ND	0 5	ND	1	ND	1
FB	2	8	1988	WET	5	ND	0 05	ND	0 5	ND	1.0	ND	1.0
FB	3	2	1988	WET	6	ND	0 05	ND	0.5	ND	1.0	ND	1.0

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	ENDOSLFN B actual ug/l	ENDOSLFN B DL ug/l	ENDOSLFN S actual ug/l	ENDOSLFN S DL ug/l	ENORIN actual ug/l	ENORIN DL ug/l	ENDRIN ALD actual ug/l	ENDRIN ALD DL ug/l	HEPTACHLOR actual ug/l	HEPTACHLOR DL ug/l
							0 05		0.1		0.1		0.1		0 05
STANDARD REPORTING OBJEC TIVES															
S4	2	26	1988	DRY	1	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
S4	3	30	1988	DRY	2	ND	0 05	ND	0 1	ND	0.1	ND	0 1	ND	0 05
S4	5	11	1988	DRY	3	ND	0 05	ND	0 1	ND	0.1	ND	0.1	ND	0 05
S4	8	25	1988	DRY	4	ND	0 1	ND	0 1	ND	0 1	ND	0 1	ND	0 05
S4	12	12	1988	DRY	5	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
S4	2	1	1989	DRY	6	ND	0 05	ND	0 1	ND	0 1	ND	0 1	ND	0 05
S4	4	6	1989	DRY	7	ND	0 05	ND	0.1	ND	0 1	ND	0.1	ND	0 05
S4	4	20	1988	WET	1	ND	0 05	ND	0 1	ND	0.1	ND	0.1	ND	0 05
S4	11	23	1988	WET	2	0 06	0 1	ND	0 1	ND	0 1	ND	0.1	ND	0 05
S4FD	11	23	1988	WET	2	ND	0 1	ND	0 1	ND	0.1	ND	0 1	ND	0 05
S4	2	4	1989	WET	4	ND	0 05	ND	0.1	ND	0.1	ND	0 1	ND	0 05
S4	2	9	1989	WET	5	ND	0 05	ND	0.1	ND	0.1	ND	0.1	ND	0.05
SB	8	25	1988	DRY	4	ND	0 1	ND	0 1	ND	0.1	ND	0.1	ND	0 05
FB	8	25	1988	DRY	4	ND	0 1	ND	0 1	ND	0.1	ND	0.1	ND	0 05
FB	12	12	1988	DRY	5	ND	0 05	ND	0 1	ND	0 1	ND	0.1	ND	0.05
FB	2	1	1989	DRY	6	ND	0 05	ND	0 1	ND	0.1	ND	0.1	ND	0 05
FB	4	6	1989	DRY	7	ND	0 05	ND	0.1	ND	0.1	ND	0.1	ND	0 05
FB	11	23	1988	WET	2	ND	0 1	ND	0 1	ND	0 1	ND	0.1	ND	0.05
FB	1	23	1989	WET	3	ND	0 05	ND	0 1	ND	0.1	ND	0.1	ND	0 05
FB	2	9	1989	WET	5	ND	0.05	ND	0 1	ND	0 1	ND	0.1	ND	0 05
FB	3	2	1989	WET	6	ND	0.05	ND	0.1	ND	0.1	ND	0.1	ND	0.05

R0054623

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	HEPCL EPOX actual ug/l	HEPCL EPOX DL ug/l	METHOXYCL actual ug/l	METHOXYCL DL ug/l	TOXAPHENE actual ug/l	TOXAPHENE DL ug/l	PCB actual ug/l	PCB DL ug/l
STANDARD REPORTING OBJECTIVES							0 05		0 05		1		1
L1	4	20	1988	WET	1	ND	0 05	ND	0 05	ND	1	ND	1
L1	11	23	1988	WET	2	ND	0 05	ND	0 5	ND	1	ND	1
L1	2	4	1989	WET	4	ND	0 05	ND	0 5	ND	1 0	ND	1 0
L1	2	9	1989	WET	5	ND	0 05	ND	0 5	ND	1.0	ND	1 0
L1	3	2	1989	WET	6	ND	0 05	ND	0 5	ND	1 0	ND	1.0
L2	4	20	1988	WET	1	ND	0 05	ND	0 05	ND	1	ND	1
L2	11	23	1988	WET	2	ND	0 05	ND	0 5	ND	1	ND	1
L2	2	4	1989	WET	4	ND	0 05	ND	0 5	ND	1.0	ND	1.0
L2	2	9	989	WET	5	ND	0 05	ND	0.5	ND	1.0	ND	1.0
L3	4	20	1988	WET	1	ND	0 05	ND	0 05	ND	1	ND	1
L3	11	23	1988	WET	2	ND	0 05	ND	0 5	ND	1	ND	1
L3	2	4	1989	WET	4	ND	0 05	ND	0 5	ND	1 0	ND	1.0
L3	2	9	1989	WET	5	ND	0 05	ND	0 5	ND	1 0	ND	1 0
L3	3	2	1989	WET	6	ND	0 05	ND	0 5	ND	1.0	ND	1.0
L4	2	4	1989	WET	4	ND	0 05	ND	0 5	ND	1 0	ND	1.0
L4	2	9	1989	WET	5	ND	0 05	ND	0 5	ND	1.0	ND	1.0
L5	11	23	1988	WET	2	ND	0 05	ND	0 5	ND	1	ND	1
L5	1	23	1989	WET	3	ND	0 05	ND	0 5	ND	1	ND	1
L5	2	4	1989	WET	4	ND	0 05	ND	0 5	ND	1.0	ND	1.0
L5	2	9	1989	WET	5	ND	0 05	ND	0 5	ND	1 0	ND	1 0
L5	3	2	1989	WET	6	ND	0 05	ND	0 5	ND	1.0	ND	1 0
L5FD	3	2	1989	WET	6	ND	0 05	ND	0 5	ND	1.0	ND	1.0
L6	4	20	1988	WET	1	ND	0 05	ND	0 05	ND	1	1.4	1
L6	11	23	1988	WET	2	ND	0 05	ND	0.5	ND	1	ND	1
L6	2	4	1989	WET	4	ND	0 05	ND	0 5	ND	1.0	ND	1.0
L6	2	9	1989	WET	5	ND	0 05	ND	0.5	ND	1.0	ND	1.0
L7	11	23	1988	WET	2	ND	0 05	ND	0 5	ND	1	ND	1
L7	2	4	1989	WET	4	ND	0 05	ND	0.5	ND	1.0	ND	1.0
L7	2	9	1989	WET	5	ND	0 05	ND	0.5	ND	1 0	ND	1.0
L7	3	2	1989	WET	6	ND	0 05	ND	0.5	ND	1.0	ND	1.0
R1	2	27	1988	RES	1	ND	0 05	ND	0 05	ND	1	ND	1
R2	2	26	1988	RES	1	ND	0 05	ND	0 05	ND	1	ND	1
R3	2	27	1988	RES	1	ND	0 05	ND	0 05	ND	1	ND	1
R4	2	27	1988	RES	1	ND	0 05	ND	0 05	ND	1	ND	1
R5	2	27	1988	RES	1	ND	0 05	ND	0 05	ND	1	ND	1
R6	2	27	1988	RES	1	ND	0.05	ND	0.05	ND	1	ND	1

R0054624

D.3-2 Organochlorine pesticides in sediment

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R0054625

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	ALDRIN actual µg/kg	ALDRIN D.L. µg/kg	6CL-CHX-A actual µg/kg	6CL-CHX-A D.L. µg/kg	6CL-CHX-B actual µg/kg	6CL-CHX-B D.L. µg/kg	6CL-CHX-D actual µg/kg	6CL-CHX-D D.L. µg/kg	6CL-CHX-G actual µg/kg	6CL-CHX-G D.L. µg/kg
STANDARD REPORTING OBJECTIVES							2		2		2		2		2
S1	3	30	1988	DRY	1	ND	2	ND	2	ND	2	ND	2	ND	2
S1	5	11	1988	DRY	2	ND	5	ND	5	ND	5	ND	5	ND	5
S1	8	22	1988	DRY	3	ND	5	ND	5	ND	5	ND	5	5	5
S1	12	12	1988	DRY	4	ND	4	ND	4	ND	4	ND	4	ND	4
S2	3	30	1988	DRY	1	ND	2	ND	2	ND	2	ND	2	ND	2
S2	5	11	1988	DRY	2	ND	5	ND	5	ND	5	ND	5	ND	5
S2	8	22	1988	DRY	3	ND	5	ND	5	ND	5	ND	5	ND	5
S2	12	12	1988	DRY	4	ND	4	ND	4	ND	4	ND	4	ND	4
S3	3	30	1988	DRY	1	ND	2	ND	2	ND	2	ND	2	ND	2
S3	5	11	1988	DRY	2	ND	5	ND	5	ND	5	ND	5	ND	5
S3	8	22	1988	DRY	3	ND	5	ND	5	ND	5	ND	5	ND	5
S3	12	12	1988	DRY	4	ND	4	ND	4	ND	4	ND	4	ND	4
S3FD	8	22	1988	DRY	3	ND	5	ND	5	ND	5	ND	5	7.8	5
S3FD	12	12	1988	DRY	4	ND	4	ND	4	ND	4	ND	4	ND	4
S4	3	30	1988	DRY	1	ND	2	ND	2	ND	2	ND	2	ND	2
S4	5	11	1988	DRY	2	ND	5	ND	5	ND	5	ND	5	ND	5
S4	8	22	1988	DRY	3	ND	5	ND	5	ND	5	ND	5	ND	5
S4	12	12	1988	DRY	4	ND	4	ND	4	ND	4	ND	4	ND	4
S4LR	3	30	1988	DRY	1	ND	2	ND	2	ND	2	ND	2	ND	2

R0054626

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	G-CHLORDANE actual µg/kg	G-CHLORDANE D.L. µg/kg	A-CHLORDANE actual µg/kg	A-CHLORDANE D.L. µg/kg	DDD actual µg/kg	DDD D.L. µg/kg	DDE actual µg/kg	DDE D.L. µg/kg	DDT actual µg/kg	DDT D.L. µg/kg	DIELDRIN actual µg/kg	DIELDRIN D.L. µg/kg
STANDARD REPORTING OBJECTIVES							4		3		2		2		4		2
S1	3	30	1988	DRY	1	ND	4	ND	3	2	2	2.4	2	ND	4	ND	2
S1	5	11	1988	DRY	2	6	5	8	6	ND	10	ND	5	ND	10	ND	5
S1	8	22	1988	DRY	3	ND	10	ND	10	ND	10	7	5	ND	10	ND	10
S1	12	12	1988	DRY	4	11	8	8.3	8	13	8	14	4	13	8	ND	4
S2	3	30	1988	DRY	1	7.4	4	6.4	3	12	2	7.8	2	6.4	4	ND	2
S2	5	11	1988	DRY	2	ND	6	ND	6	ND	10	ND	5	13	10	ND	5
S2	8	22	1988	DRY	3	ND	10	ND	10	ND	10	ND	5	ND	10	ND	10
S2	12	12	1988	DRY	4	ND	8	ND	8	ND	8	8.4	4	ND	8	ND	4
S3	3	30	1988	DRY	1	ND	4	28	3	22	2	26	2	26	4	ND	2
S3	5	11	1988	DRY	2	ND	6	ND	6	ND	10	ND	5	11	10	ND	5
S3	8	22	1988	DRY	3	13	10	10	10	27	10	8.1	5	37	10	ND	10
S3	12	12	1988	DRY	4	20	8	13	8	24	8	13	4	25	8	ND	4
S3FD	8	22	1988	DRY	3	13	10	10	10	22	10	8.6	5	27	10	ND	10
S3FD	12	12	1988	DRY	4	16	8	9.8	8	17	8	11	4	ND	8	ND	4
S4	3	30	1988	DRY	1	13	4	8.4	3	24	2	14	2	8.8	4	ND	2
S4	5	11	1988	DRY	2	ND	6	ND	6	ND	10	ND	5	ND	10	ND	5
S4	8	22	1988	DRY	3	13	10	10	10	31	10	12	5	28	10	ND	10
S4	12	12	1988	DRY	4	28	8	14	8	34	8	26	4	ND	8	ND	4
S4LR	3	30	1988	DRY	1	ND	4	3.5	3	7	2	8.5	2	11	4	ND	2

R0054627

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	ENDOSLFN-A actual µg/kg	ENDOSLFN-A D.L. µg/kg	ENDOSLFN B actual µg/kg	ENDOSLFN B D.L. µg/kg	ENDOSLFN-S actual µg/kg	ENDOSLFN-S D.L. µg/kg	ENDRIN actual µg/kg	ENDRIN D.L. µg/kg	ENDRIN-ALD actual µg/kg	ENDRIN-ALD D.L. µg/kg
STANDARD REPORTING OBJECTIVES							2		2		4		4		4
S1	3	30	1988	DRY	1	ND	2	ND	2	ND	4	ND	4	ND	4
S1	5	11	1988	DRY	2	ND	5	ND	5	ND	10	ND	10	ND	10
S1	8	22	1988	DRY	3	ND	5	ND	10	ND	10	ND	10	ND	10
S1	12	12	1988	DRY	4	ND	4	ND	4	ND	8	ND	8	ND	8
S2	3	30	1988	DRY	1	ND	2	3.4	2	ND	4	ND	4	ND	4
S2	5	11	1988	DRY	2	ND	5	ND	5	ND	10	ND	10	ND	10
S2	8	22	1988	DRY	3	ND	5	ND	10	ND	10	ND	10	ND	10
S2	12	12	1988	DRY	4	ND	4	ND	4	ND	8	ND	8	ND	8
S3	3	30	1988	DRY	1	ND	2	9	2	ND	4	ND	4	ND	4
S3	5	11	1988	DRY	2	ND	5	ND	5	ND	10	ND	10	ND	10
S3	8	22	1988	DRY	3	ND	5	ND	10	ND	10	ND	10	ND	10
S3	12	12	1988	DRY	4	ND	4	ND	4	ND	8	ND	8	ND	8
S3FD	8	22	1988	DRY	3	ND	5	ND	10	ND	10	ND	10	ND	10
S3FD	12	12	1988	DRY	4	ND	4	ND	4	ND	8	ND	8	ND	8
S4	3	30	1988	DRY	1	ND	2	ND	2	ND	4	ND	4	ND	4
S4	5	11	1988	DRY	2	ND	5	ND	5	ND	10	ND	10	ND	10
S4	8	22	1988	DRY	3	ND	5	ND	10	ND	10	ND	10	ND	10
S4	12	12	1988	DRY	4	ND	4	ND	4	ND	8	ND	8	ND	8
S4LR	3	30	1988	DRY	1	ND	2	ND	2	ND	4	ND	4	ND	4

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Sample ID	Date Sampled			Sample Type	Sample Event	HEPTACHLOR		HEPOX EPOX		METHOXYCL		TOXAPHENE		PCB	
	Month	Day	Year			actual µg/kg	D.L. µg/kg	actual µg/kg	D.L. µg/kg	actual µg/kg	D.L. µg/kg	actual µg/kg	D.L. µg/kg	actual µg/kg	D.L. µg/kg
STANDARD REPORTING OBJECTIVES							2		22		2		20		20
S1	3	30	1988	DRY	1	ND	2	ND	22	ND	2	ND	20	ND	20
S1	5	11	1988	DRY	2	ND	5	ND	5	ND	5	ND	100	ND	100
S1	8	22	1988	DRY	3	ND	5	ND	5	ND	50	ND	100	ND	100
S1	12	12	1988	DRY	4	ND	4	ND	4	ND	40	ND	80	140	80
S2	3	30	1988	DRY	1	ND	2	ND	22	ND	2	ND	20	ND	20
S2	5	11	1988	DRY	2	ND	5	ND	5	ND	5	ND	100	ND	100
S2	8	22	1988	DRY	3	ND	5	ND	5	ND	50	ND	100	ND	100
S2	12	12	1988	DRY	4	ND	4	ND	4	ND	40	ND	80	ND	80
S3	3	30	1988	DRY	1	ND	2	ND	22	ND	2	ND	20	390	20
S3	5	11	1988	DRY	2	ND	5	ND	5	ND	5	ND	100	ND	100
S3	8	22	1988	DRY	3	ND	5	ND	5	ND	50	ND	100	ND	100
S3	12	12	1988	DRY	4	ND	4	ND	4	ND	40	ND	80	240	80
S3FD	8	22	1988	DRY	3	ND	5	ND	5	ND	50	ND	100	ND	100
S3FD	12	12	1988	DRY	4	ND	4	ND	4	ND	40	ND	80	125	80
S4	3	30	1988	DRY	1	ND	2	ND	22	ND	2	ND	20	80	20
S4	5	11	1988	DRY	2	ND	5	ND	5	ND	5	ND	100	ND	100
S4	8	22	1988	DRY	3	ND	5	ND	5	ND	50	ND	100	ND	100
S4	12	12	1988	DRY	4	ND	4	ND	4	ND	40	ND	80	ND	80
S4LR	3	30	1988	DRY	1	ND	2	ND	22	ND	2	ND	20	44	20

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VOL 12 2 --3259

D.4 Chlorinated herbicides

VOL 12 2 1330

R0054630

D.4-1 Chlorinated herbicides and TOX in water column

VOL 12

2 1331

R0054631

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	TOX actual mg/l	TOX DL mg/l	2,4,5 T actual ug/l	2,4,5 T DL ug/l	SILVEX actual ug/l	SILVEX DL ug/l	2,4,D actual ug/l	2,4,D DL ug/l	2,4,DB actual ug/l	2,4,DB DL ug/l	DALAPON actual ug/l	DALAPON DL ug/l
STANDARD REPORTING LIMITS							0 025		1		1		5		10		500
L1	4	20	1988	WET	1	0 058	0 025	ND	1	ND	1	ND	5	ND	10	ND	500
L1	11	23	1988	WET	2	0 065	0 025	ND	1	ND	1	ND	5	ND	10	ND	500
L1	2	4	1989	WET	4	0 08	0 025										
L1	2	9	1989	WET	5	0 08	0 025										
L1ER	2	9	1989	WET	5	0 04	0 025										
L1	3	2	1989	WET	8		0 025										
L1ER	3	2	1989	WET	8	ND	0 025										
L2	4	20	1988	WET	1	0 048	0 025	ND	1	ND	1	ND	5	ND	10	ND	500
L2	11	23	1988	WET	2	0 033	0 025	ND	1	ND	1	ND	5	ND	10	ND	500
L2	2	4	1989	WET	4	ND	0 025										
L2	2	9	1989	WET	5	ND	0 025										
L3	4	20	1988	WET	1	0 042	0 025	ND	1	ND	1	ND	5	ND	10	ND	500
L3	11	23	1988	WET	2	0 036	0 025	ND	1	ND	1	ND	5	ND	10	ND	500
L3	2	4	1989	WET	4	ND	0 025										
L3	2	9	1989	WET	5	ND	0 025										
L3	3	2	1989	WET	8	ND	0 025										
L4	2	4	1989	WET	4	0 04	0 025										
L4	2	9	1989	WET	5	0 04	0 025										
L5	11	23	1988	WET	2	0 045	0 025	ND	1	ND	1	ND	5	ND	10	ND	500
L5	1	23	1989	WET	3	0 03	0 025										
L5	2	4	1989	WET	4	ND	0 025										
L5ER	2	4	1989	WET	4	ND	0 025										
L5FD	2	4	1989	WET	4	ND	0 025										
L5	2	9	1989	WET	5	0 03	0 025										
L5	3	2	1989	WET	8	ND	0 025										
L5FD	3	2	1989	WET	8	ND	0 025										
L6	4	20	1988	WET	1	0 051	0 025	ND	1	ND	1	ND	5	ND	10	ND	500
L6	11	23	1988	WET	2	0 028	0 025	ND	1	ND	1	ND	5	ND	10	ND	500
L6	2	9	1989	WET	5	ND	0 025										
L7	11	23	1988	WET	2	ND	0 025	ND	1	ND	1	ND	5	ND	10	ND	500
L7	2	4	1989	WET	4	ND	0 025										
L7	2	9	1989	WET	5	ND	0 025										
L7	3	2	1989	WET	8	ND	0 025										
R1	2	27	1988	RES	1	ND	0 025	ND	0 5	ND	0 5	ND	5	ND	5	ND	250
R2	2	28	1988	RES	1	ND	0 025	ND	0 5	ND	0 5	ND	5	ND	5	ND	250
R3	2	27	1988	RES	1	ND	0 025	ND	0 5	ND	0 5	ND	5	ND	5	ND	250
R4	2	27	1988	RES	1	ND	0 025	ND	0 5	ND	0 5	ND	5	ND	5	ND	250
R5	2	27	1988	RES	1	ND	0 025	ND	0 5	ND	0 5	ND	5	ND	5	ND	250
R6	2	27	1988	RES	1	ND	0 025	ND	0 5	ND	0 5	ND	5	ND	5	ND	250

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	TOX actual mg/l	TOX DL mg/l	2,4,5-T actual ug/l	2,4,5-T DL ug/l	SILVEX actual ug/l	SILVEX DL ug/l	2,4-D actual ug/l	2,4-D DL ug/l	2,4-DB actual ug/l	2,4-DB DL ug/l	DALAPON actual ug/l	DALAPON DL ug/l
S1	2	26	1988	DRY	1	0.08	0.025	ND	0.5	ND	0.5	13	3	ND	5	ND	250
S1FD1	2	26	1988	DRY	1	0.08	0.025	ND	0.5	ND	0.5	13	3	ND	5	ND	250
S1FD2	2	26	1988	DRY	1	0.08	0.025	ND	0.5	ND	0.5	11	3	ND	5	ND	250
S1	3	30	1988	DRY	2			ND	0.1	ND	0.1	ND	0.5	ND	1	ND	50
S1FD	3	30	1988	DRY	2			ND	0.1	ND	0.1	ND	0.5	ND	1	ND	50
S1	5	11	1988	DRY	3			ND	2	ND	2	ND	10	ND	20	ND	1000
S1	12	12	1988	DRY	5	0.12	0.025	ND	1	ND	1	ND	5	ND	10	ND	500
S1	2	1	1989	DRY	6	0.11	0.025										
S1	4	6	1989	DRY	7	0.09	0.025										
S1	11	23	1989	WET	2	0.042	0.025	ND	1	ND	1	ND	5	ND	10	ND	500
S1	1	23	1989	WET	3	0.10	0.025										
S1	2	4	1989	WET	4	0.03	0.025										
S1	2	9	1989	WET	5	ND	0.025										
S1FD	2	9	1989	WET	5	ND	0.025										
S1	3	2	1989	WET	6	ND	0.025										
S2	2	26	1988	DRY	1	ND	0.025	ND	0.5	ND	0.5	ND	3	ND	5	ND	250
S2	3	30	1988	DRY	2			ND	0.1	ND	0.1	ND	0.5	ND	1	ND	50
S2	5	11	1988	DRY	3			ND	1	ND	1	ND	5	ND	10	ND	500
S2	12	12	1988	DRY	5	ND	0.025	ND	1	ND	1	ND	5	ND	10	ND	500
S2	2	1	1989	DRY	6	ND	0.025										
S2	4	6	1989	DRY	7	ND	0.025										
S2	11	23	1988	WET	2	0.053	0.025	ND	1	ND	1	ND	5	ND	10	ND	500
S2	1	23	1989	WET	3	0.04	0.025										
S2FD	1	23	1989	WET	3	0.04	0.025										
S2	2	4	1989	WET	4	0.03	0.025										
S2	2	9	1989	WET	5	ND	0.025										
S2	3	2	1989	WET	6	ND	0.025										
S3	2	26	1988	DRY	1	ND	0.025	ND	0.5	ND	0.5	ND	3	ND	5	ND	250
S3	3	30	1988	DRY	2			ND	0.1	ND	0.1	ND	0.5	ND	1	ND	50
S3	5	11	1988	DRY	3			ND	1	ND	1	ND	5	ND	10	ND	500
S3	8	22	1988	DRY	4	ND	0.025	ND	1	ND	1	ND	5	ND	10	ND	500
S3FD	8	22	1988	DRY	4	ND	0.025	ND	1	ND	1	ND	5	ND	10	ND	500
S3	12	12	1988	DRY	5	ND	0.025	ND	1	ND	1	ND	5	ND	10	ND	500
S3	2	1	1989	DRY	6	ND	0.025										
S3LR	2	1	1989	DRY	6	ND	0.025										
S3FD	2	1	1989	DRY	6	ND	0.025										
S3	4	6	1989	DRY	7	ND	0.025										
S3LR	4	6	1989	DRY	7	ND	0.025										
S3FD	4	6	1989	DRY	7	ND	0.025										
S3	4	20	1988	WET	1			ND	1	ND	1	ND	5	ND	10	ND	500
S3	11	23	1988	WET	2	0.029	0.025	ND	1	ND	1	ND	5	ND	10	ND	500
S3FD	11	23	1988	WET	2	0.055	0.025	ND	1	ND	1	ND	5	ND	10	ND	500
S3LR	11	23	1988	WET	2	0.036	0.025	ND	1	ND	1	ND	5	ND	10	ND	500
S3	1	23	1989	WET	3	ND	0.025										

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S1R	1	23	1989	WET	3	ND	0.025
S3	2	4	1989	WET	4	ND	0.025
S3	2	9	1989	WET	5	ND	0.025
S3	3	2	1989	WET	6	ND	0.025

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	TOX actual mg/l	TOX DL mg/l	2,4,5-T actual ug/l	2,4,5-T DL ug/l	SILVEX actual ug/l	SILVEX DL ug/l	2,4-D actual ug/l	2,4-D DL ug/l	2,4-DB actual ug/l	2,4-DB DL ug/l	DALAPON actual ug/l	DALAPON DL ug/l
STANDARD REPORTING LIMITS							0.025		1		1		5		10		500
S4	2	28	1988	DRY	1	0.03	0.025	ND	0.5	ND	0.5	0.5	3	ND	5	ND	250
S4	3	30	1988	DRY	2			ND	0.1	ND	0.1	ND	0.5	ND	1	ND	50
S4	5	11	1988	DRY	3			ND	1	ND	1	61	5	ND	10	ND	500
S4	8	22	1988	DRY	4	ND	0.025	ND	1	ND	1	ND	5	ND	10	ND	500
S4	12	12	1988	DRY	5	ND	0.025	ND	1	ND	1	ND	5	ND	10	ND	500
S4FD	12	12	1988	DRY	5	ND	0.025	ND	1	ND	1	ND	5	ND	10	ND	500
S4FDUP	12	12	1988	DRY	5	ND	0.025	ND	1	ND	1	ND	5	ND	10	ND	500
S4	2	1	1989	DRY	6	0.03	0.025										
S4	4	6	1989	DRY	7	0.05	0.025										
S4D	5	11	1988	DRY	3			ND	1	ND	1	56	5	ND	10	ND	500
S4	4	20	1988	WET	1	0.029	0.025	ND	1	ND	1	ND	5	ND	10	ND	500
S4	11	23	1988	WET	2	0.028	0.025	ND	1	ND	1	ND	5	ND	10	ND	500
S4	2	4	1989	WET	4	ND	0.025										
S4	2	9	1989	WET	5	0.03	0.025										
5B	2	1	1989	DRY	6	ND	0.025										
5B	1	23	1989	WET	3	0.04	0.025										
5B	2	4	1989	WET	4	ND	0.025										
5B	2	9	1989	WET	5	0.05	0.025										
FB	8	22	1988	DRY	4	ND	0.025	ND	1	ND	1	ND	5	ND	10	ND	500
FB	12	12	1988	DRY	5	ND	0.025	ND	1	ND	1	ND	5	ND	10	ND	500
FB	4	6	1989	DRY	7	ND	0.025										
FB	11	23	1988	WET	2	ND	0.025	ND	1	ND	1	ND	5	ND	10	ND	500
FB	3	2	1989	WET	6	ND	0.025										

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	DICAMBA actual ug/l	DICAMBA DL ug/l	DICHLORPROP actual ug/l	DICHLORPROP DL ug/l	DINOSEB actual ug/l	DINOSEB DL ug/l	MCPA actual ug/l	MCPA DL ug/l	MCPP actual ug/l	MCPP DL ug/l
STANDARD REPORTING LIMITS							5		5		5		2000		2000
L1	4	20	1988	WET	1	ND	5	ND	5	ND	5	ND	2000	ND	2000
L1	11	23	1988	WET	2	ND	5	ND	5	ND	5	ND	2000	ND	2000
L1	2	4	1989	WET	4										
L1	2	9	1989	WET	5										
L1LR	2	9	1989	WET	5										
L1	3	2	1989	WET	6										
L1LR	3	2	1989	WET	6										
L2	4	20	1988	WET	1	ND	5	ND	5	ND	5	ND	2000	ND	2000
L2	11	23	1988	WET	2	ND	5	ND	5	ND	5	ND	2000	ND	2000
L2	2	4	1989	WET	4										
L2	2	9	1989	WET	5										
L3	4	20	1988	WET	1	ND	5	ND	5	ND	5	ND	2000	ND	2000
L3	11	23	1988	WET	2	ND	5	ND	5	ND	5	ND	2000	ND	2000
L3	2	4	1989	WET	4										
L3	2	9	1989	WET	5										
L3	3	2	1989	WET	6										
L4	2	4	1989	WET	4										
L4	2	9	1989	WET	5										
L5	11	23	1988	WET	2	ND	5	ND	5	ND	5	ND	2000	ND	2000
L5	1	23	1989	WET	3										
L5	2	4	1989	WET	4										
L5LR	2	4	1989	WET	4										
L5FD	2	4	1989	WET	4										
L5	2	9	1989	WET	5										
L5	3	2	1989	WET	6										
L5FD	3	2	1989	WET	6										
L6	4	20	1988	WET	1	ND	5	ND	5	ND	5	ND	2000	ND	2000
L6	11	23	1988	WET	2	ND	5	ND	5	ND	5	ND	2000	ND	2000
L6	2	9	1989	WET	5										
L7	11	23	1988	WET	2	ND	5	ND	5	ND	5	ND	2000	ND	2000
L7	2	4	1989	WET	4										
L7	2	9	1989	WET	5										
L7	3	2	1989	WET	6										
R1	2	27	1988	RES	1	ND	3	ND	3	ND	3	ND	1000	ND	1000
R2	2	28	1988	RES	1	ND	3	ND	3	ND	3	ND	1000	ND	1000
R3	2	27	1988	RES	1	ND	3	ND	3	ND	3	ND	1000	ND	1000
R4	2	27	1988	RES	1	ND	3	ND	3	ND	3	ND	1000	ND	1000
R5	2	27	1988	RES	1	ND	3	ND	3	ND	3	ND	1000	ND	1000
R6	2	27	1988	RES	1	ND	3	ND	3	ND	3	ND	1000	ND	1000

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	DICAMBA actual ug/l	DICAMBA DL ug/l	DICHLORPROP actual ug/l	DICHLORPROP DL ug/l	DINOSEB actual ug/l	DINOSEB DL ug/l	MCPA actual ug/l	MCPA DL ug/l	MCPP actual ug/l	MCPP DL ug/l
S1	2	26	1988	DRY	1	5.1	3	ND	3	ND	3	ND	1000	ND	1000
S1FD1	2	26	1988	DRY	1	4.9	3	ND	3	ND	3	ND	1000	ND	1000
S1FD2	2	26	1988	DRY	1	4.2	3	ND	3	ND	3	ND	1000	ND	1000
S1	3	30	1988	DRY	2	ND	0.5	ND	0.5	ND	0.5	ND	200	ND	200
S1FD	3	30	1988	DRY	2	ND	0.5	ND	0.5	ND	0.5	ND	200	ND	200
S1	5	11	1988	DRY	3	ND	10	ND	10	ND	10	ND	4000	ND	4000
S1	12	12	1988	DRY	5	ND	5	ND	5	ND	5	ND	2000	ND	2000
S1	2	1	1989	DRY	6										
S1	4	6	1989	DRY	7										
S1	11	23	1988	WET	2	ND	5	ND	5	ND	5	ND	2000	ND	2000
S1	1	23	1989	WET	3										
S1	2	4	1989	WET	4										
S1	2	9	1989	WET	5										
S1FD	2	9	1989	WET	5										
S1	3	2	1989	WET	6										
S2	2	26	1988	DRY	1	ND	3	ND	3	ND	3	ND	1000	ND	1000
S2	3	30	1988	DRY	2	ND	0.5	ND	0.5	ND	0.5	ND	200	ND	200
S2	5	11	1988	DRY	3	ND	5	ND	5	ND	5	ND	2000	ND	2000
S2	12	12	1988	DRY	5	ND	5	ND	5	ND	5	ND	2000	ND	2000
S2	2	1	1989	DRY	6										
S2	4	6	1989	DRY	7										
S2	11	23	1988	WET	2	ND	5	ND	5	ND	5	ND	2000	ND	2000
S2	1	23	1989	WET	3										
S2FD	1	23	1989	WET	3										
S2	2	4	1989	WET	4										
S2	2	9	1989	WET	5										
S2	3	2	1989	WET	6										
S3	2	26	1988	DRY	1	ND	3	ND	3	ND	3	ND	1000	ND	1000
S3	3	30	1988	DRY	2	ND	0.5	ND	0.5	ND	0.5	ND	200	ND	200
S3	5	11	1988	DRY	3	ND	5	ND	5	ND	5	ND	2000	ND	2000
S3	8	22	1988	DRY	4	ND	5	ND	5	ND	5	ND	2000	ND	2000
S3FD	8	22	1988	DRY	4	ND	5	ND	5	ND	5	ND	2000	ND	2000
S3	12	12	1988	DRY	5	ND	5	ND	5	ND	5	ND	2000	ND	2000
S3	2	1	1989	DRY	6										
S3FB	2	1	1989	DRY	6										
S3FD	2	1	1989	DRY	6										
S3	4	6	1989	DRY	7										
S3FB	4	6	1989	DRY	7										
S3FD	4	6	1989	DRY	7										
S3	4	26	1988	WET	1	ND	5	ND	5	ND	5	ND	2000	ND	2000
S3	11	23	1988	WET	2	ND	5	ND	5	ND	5	ND	2000	ND	2000
S3FD	11	23	1988	WET	2	ND	5	ND	5	ND	5	ND	2000	ND	2000
S3FB	11	23	1988	WET	2	ND	5	ND	5	ND	5	ND	2000	ND	2000
S3	1	23	1989	WET	3										

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S3LR	1	23	1989	WET	3
S3	2	4	1989	WET	4
S3	2	9	1989	WET	5
S3	3	2	1989	WET	6

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	DICAMBA actual ug/l	DICAMBA DL ug/l	DICHLOROPROP actual ug/l	DICHLOROPROP DL ug/l	DINOSEB actual ug/l	DINOSEB DL ug/l	MCPA actual ug/l	MCPA DL ug/l	MCPP actual ug/l	MCPP DL ug/l
STANDARD REPORTING LIMITS							5		5		5		2000		2000
S4	2	26	1988	DRY	1	ND	3	ND	3	ND	3	ND	1000	ND	1000
S4	3	30	1988	DRY	2	ND	0.5	ND	0.5	ND	0.5	ND	200	ND	200
S4	5	11	1988	DRY	3	47	5	ND	5	ND	5	ND	2000	ND	2000
S4	8	22	1988	DRY	4	ND	5	ND	5	ND	5	ND	2000	ND	2000
S4	12	12	1988	DRY	5	ND	5	ND	5	ND	5	ND	2000	ND	2000
S4FD	12	12	1988	DRY	5	ND	5	ND	5	ND	5	ND	2000	ND	2000
S4FDLR	12	12	1988	DRY	5	ND	5	ND	5	ND	5	ND	2000	ND	2000
S4	2	1	1989	DRY	6										
S4	4	6	1989	DRY	7										
S4D	5	11	1988	DRY	3	48	5	ND	5	ND	5	ND	2000	ND	2000
S4	4	20	1988	WET	1	ND	5	ND	5	ND	5	ND	2000	ND	2000
S4	11	23	1988	WET	2	ND	5	ND	5	ND	5	ND	2000	ND	2000
S4	2	4	1989	WET	4										
S4	2	9	1989	WET	5										
SB	2	1	1989	DRY	6										
SB	1	23	1989	WET	3										
SB	2	4	1989	WET	4										
SB	2	9	1989	WET	5										
FB	8	22	1988	DRY	4	ND	5	ND	5	ND	5	ND	2000	ND	2000
FB	12	12	1988	DRY	5	ND	5	ND	5	ND	5	ND	2000	ND	2000
FB	4	6	1989	DRY	7										
FB	11	23	1988	WET	2	ND	5	ND	5	ND	5	ND	2000	ND	2000
FB	3	2	1989	WET	6										

VOL 12

R0054637

D.4-2 Chlorinated herbicides in sediment

VOL 12 2 1338

R0054638

Sample I.D.	Date Sampled Month	Day	Year	Sample Type	Sample Event	2,4,5-T actual mg/kg	2,4,5-T D.L. mg/kg	SILVEX actual mg/kg	SILVEX D.L. mg/kg	2,4-D actual mg/kg	2,4-D D.L. mg/kg	2,4-DB actual mg/kg	2,4-DB D.L. mg/kg	DALAPON actual mg/kg	DALAPON D.L. mg/kg
STANDARD REPORTING OBJECTIVES							0.1		0.1		0.6		1		1
S1	3	30	1988	DRY	1	ND	0.05	ND	0.05	ND	0.3	ND	0.5		
S1	5	11	1988	DRY	2	ND	0.1	ND	0.1	ND	0.6	ND	1		
S1	8	22	1988	DRY	3	ND	0.1	ND	0.1	ND	0.6	ND	1	ND	1
S1LR	8	22	1988	DRY	3	ND	0.1	ND	0.1	ND	0.6	ND	1	ND	1
S1	12	12	1988	DRY	4	ND	0.1	ND	0.1	ND	0.6	ND	1	ND	50
S2	3	30	1988	DRY	1	ND	0.05	ND	0.05	ND	0.3	ND	0.5		
S2	5	11	1988	DRY	2	ND	0.1	ND	0.1	ND	0.6	ND	1		
S2	8	22	1988	DRY	3	ND	0.1	ND	0.1	ND	0.6	ND	1	ND	1
S2	12	12	1988	DRY	4	ND	0.1	ND	0.1	ND	0.6	ND	1	ND	50
S3	3	30	1988	DRY	1	ND	0.05	ND	0.05	ND	0.3	ND	0.5		
S3	5	11	1988	DRY	2	ND	0.1	ND	0.1	ND	0.6	ND	1		
S3	8	22	1988	DRY	3	ND	0.1	ND	0.1	ND	0.6	ND	1		
S3FD	8	22	1988	DRY	3	ND	0.1	ND	0.1	ND	0.6	ND	1	ND	1
S3	12	12	1988	DRY	4	ND	0.1	ND	0.1	ND	0.6	ND	1	ND	1
S3FD	12	12	1988	DRY	4	ND	0.1	ND	0.1	ND	0.6	ND	1	ND	50
														ND	50
S4	3	30	1988	DRY	1	ND	0.05	ND	0.05	ND	0.3	ND	0.5		
S4	5	11	1988	DRY	2	ND	0.1	ND	0.1	ND	0.6	ND	1		
S4FD	5	11	1988	DRY	2	ND	0.1	ND	0.1	ND	0.6	ND	1		
S4	8	22	1988	DRY	3	ND	0.1	ND	0.1	ND	0.6	ND	1		
S4	12	12	1988	DRY	4	ND	0.1	ND	0.1	ND	0.6	ND	1	ND	1
														ND	50

R0054639

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	2,4,5-T actual mg/kg	2,4,5-T D.L. mg/kg	SILVEX actual mg/kg	SILVEX D.L. mg/kg	2,4-D actual mg/kg	2,4-D D.L. mg/kg	2,4-DB actual mg/kg	2,4-DB D.L. mg/kg	DALAPON actual mg/kg	DALAPON D.L. mg/kg
STANDARD REPORTING OBJECTIVES							0.1		0.1		0.6		1		1
S1	3	30	1988	DRY	1	ND	0.05	ND	0.05	ND	0.3	ND	0.5		
S1	5	11	1988	DRY	2	ND	0.1	ND	0.1	ND	0.6	ND	1		
S1	8	22	1988	DRY	3	ND	0.1	ND	0.1	ND	0.6	ND	1	ND	1
S1LB	8	22	1988	DRY	3	ND	0.1	ND	0.1	ND	0.6	ND	1	ND	1
S1	12	12	1988	DRY	4	ND	0.1	ND	0.1	ND	0.6	ND	1	ND	50
S2	3	30	1988	DRY	1	ND	0.05	ND	0.05	ND	0.3	ND	0.5		
S2	5	11	1988	DRY	2	ND	0.1	ND	0.1	ND	0.6	ND	1		
S2	8	22	1988	DRY	3	ND	0.1	ND	0.1	ND	0.6	ND	1	ND	1
S2	12	12	1988	DRY	4	ND	0.1	ND	0.1	ND	0.6	ND	1	ND	50
S3	3	30	1988	DRY	1	ND	0.05	ND	0.05	ND	0.3	ND	0.5		
S3	5	11	1988	DRY	2	ND	0.1	ND	0.1	ND	0.6	ND	1		
S3	8	22	1988	DRY	3	ND	0.1	ND	0.1	ND	0.6	ND	1	ND	1
S3FD	8	22	1988	DRY	3	ND	0.1	ND	0.1	ND	0.6	ND	1	ND	1
S3	12	12	1988	DRY	4	ND	0.1	ND	0.1	ND	0.6	ND	1	ND	50
S3FD	12	12	1988	DRY	4	ND	0.1	ND	0.1	ND	0.6	ND	1	ND	50
S4	3	30	1988	DRY	1	ND	0.05	ND	0.05	ND	0.3	ND	0.5		
S4	5	11	1988	DRY	2	ND	0.1	ND	0.1	ND	0.6	ND	1		
S4FD	5	11	1988	DRY	2	ND	0.1	ND	0.1	ND	0.6	ND	1		
S4	8	22	1988	DRY	3	ND	0.1	ND	0.1	ND	0.6	ND	1	ND	1
S4	12	12	1988	DRY	4	ND	0.1	ND	0.1	ND	0.6	ND	1	ND	50

R0054640

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	DICHLOROPROP actual mg/kg	DICHLOROPROP D.L. mg/kg	DINOSEB actual mg/kg	DINOSEB D.L. mg/kg	MCPA actual mg/kg	MCPA D.L. mg/kg	MCPP actual mg/kg	MCPP D.L. mg/kg
STANDARD REPORTING OBJECTIVES							0.6		0.6		200		200
S1	3	30	1988	DRY	1	ND	0.3	ND	0.3	ND	100	ND	100
S1	5	11	1988	DRY	2	ND	0.6	ND	0.6	ND	200	ND	200
S1	8	22	1988	DRY	3	ND	0.6	ND	0.6	ND	200	ND	200
S1LR	8	22	1988	DRY	3	ND	0.6	ND	0.6	ND	200	ND	200
S1	12	12	1988	DRY	4	ND	0.6	ND	0.6	ND	200	ND	200
S2	3	30	1988	DRY	1	ND	0.3	ND	0.3	ND	100	ND	100
S2	5	11	1988	DRY	2	ND	0.6	ND	0.6	ND	200	ND	200
S2	8	22	1988	DRY	3	ND	0.6	ND	0.6	ND	200	ND	200
S2	12	12	1988	DRY	4	ND	0.6	ND	0.6	ND	200	ND	200
S3	3	30	1988	DRY	1	ND	0.3	ND	0.3	ND	100	ND	100
S3	5	11	1988	DRY	2	ND	0.6	ND	0.6	ND	200	ND	200
S3	8	22	1988	DRY	3	ND	0.6	ND	0.6	ND	200	ND	200
S3FD	8	22	1988	DRY	3	ND	0.6	ND	0.6	ND	200	ND	200
S3	12	12	1988	DRY	4	ND	0.6	ND	0.6	ND	200	ND	200
S3FD	12	12	1988	DRY	4	ND	0.6	ND	0.6	ND	200	ND	200
S4	3	30	1988	DRY	1	ND	0.3	ND	0.3	ND	100	ND	100
S4	5	11	1988	DRY	2	ND	0.6	ND	0.6	ND	200	ND	200
S4FD	5	11	1988	DRY	2	ND	0.6	ND	0.6	ND	200	ND	200
S4	8	22	1988	DRY	3	ND	0.6	ND	0.6	ND	200	ND	200
S4	12	12	1988	DRY	4	ND	0.6	ND	0.6	ND	200	ND	200

VOL 12

R0054641

D.5 Organophosphate pesticides

VOL 12 2 1342

R0054642

D.5-1 Organophosphate pesticides in water column

VOL 12 2 1343

R0054643

Sample I.D.	Date Sampled Month	Day	Year	Sample Type	Sample Event	AZINPHOS-METHYL actual ug/l	AZINPHOS-METHYL D.L. ug/l	CHLORPYRIFOS actual ug/l	CHLORPYRIFOS D.L. ug/l	COUMAPHOS actual ug/l	COUMAPHOS D.L. ug/l	DDVP actual ug/l	DEMETON D.L. ug/l	DEMETON actual ug/l	DEMETON D.L. ug/l
STANDARD REPORTING LIMITS							0.5		0.05		0.5		0.05		0.05
S1	3	30	1988	DRY	2	ND	2	ND	0.5	ND	2	ND	1	ND	1
S1LR	3	30	1988	DRY	2	ND	2	ND	0.5	ND	2	ND	1	ND	1
S2	3	30	1988	DRY	2	ND	2	ND	0.5	ND	2	ND	1	ND	1
S3	3	30	1988	DRY	2	ND	2	ND	0.5	ND	2	ND	1	ND	1
S4	3	30	1988	DRY	2	ND	2	ND	0.5	ND	2	ND	1	ND	1

R0054644

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	DIAZINON actual ug/l	DIAZINON D.L. ug/l	DIMETHOATE actual ug/l	DIMETHOATE D.L. ug/l	DISULFOTON actual ug/l	DISULFOTON D.L. ug/l	EPN actual ug/l	EPN D.L. ug/l	ETHOPROP actual ug/l	ETHOPROP D.L. ug/l	FENSULFOTHION actual ug/l	FENSULFOTHION D.L. ug/l
STANDARD REPORTING LIMITS							0.05		0.05		0.05		0.05		0.05		0.05
S1	3	30	1988	DRY	2	ND	0.5	ND	0.5	ND	0.5	ND	0.5	ND	0.5	ND	1
S1LR	3	30	1988	DRY	2	ND	0.5	ND	0.5	ND	0.5	ND	0.5	ND	0.5	ND	1
S2	3	30	1988	DRY	2	ND	0.5	ND	0.5	ND	0.5	ND	0.5	ND	0.5	ND	1
S3	3	30	1988	DRY	2	ND	0.5	ND	0.5	ND	0.5	ND	0.5	ND	0.5	ND	1
S4	3	30	1988	DRY	2	ND	0.5	ND	0.5	ND	0.5	ND	0.5	ND	0.5	ND	1

R0054645

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	FENTHION actual ug/l	FENTHION D.L. ug/l	MALATHION actual ug/l	MALATHION D.L. ug/l	MERPHOS actual ug/l	MERPHOS D.L. ug/l	MEVINPHOS actual ug/l	MEVINPHOS D.L. ug/l	MONOCROTOPHOS actual ug/l	MONOCROTOPHOS D.L. ug/l
STANDARD REPORTING LIMITS							0.1		0.05		0.05		0.05		0.05
S1	3	30	1988	DRY	2	ND	0.5	ND	1	NA	0.05	ND	1	ND	1
S1LR	3	30	1988	DRY	2	ND	0.5	ND	1	NA	0.05	ND	1	ND	1
S2	3	30	1988	DRY	2	ND	0.5	ND	1	NA	0.05	ND	1	ND	1
S3	3	30	1988	DRY	2	ND	0.5	ND	1	NA	0.05	ND	1	ND	1
S4	3	30	1988	DRY	2	ND	0.5	ND	1	NA	0.05	ND	1	ND	1

R0054646

Sample I D	Date Sampled Month	Day	Year	Sample Type	Sample Event	NALED actual ug/l	NALED D.L. ug/l	PARATHION, ETH actual ug/l	PARATHION, ETH D.L. ug/l	PARATHION, METH actual ug/l	PARATHION, METH D.L. ug/l	PHORATE actual ug/l	PHORATE D.L. ug/l	RONNEL actual ug/l	RONNEL D.L. ug/l
STANDARD REPORTING LIMITS							0.05		0.2		0.1		0.05		0.05
S1	3	30	1988	DRY	2	ND	5	ND	0.5	ND	0.5	ND	0.5	NA	1
S1LR	3	30	1988	DRY	2	ND	5	ND	0.5	ND	0.5	ND	0.5	NA	1
S2	3	30	1988	DRY	2	ND	5	ND	0.5	ND	0.5	ND	0.5	NA	1
S3	3	30	1988	DRY	2	ND	5	ND	0.5	ND	0.5	ND	0.5	NA	1
S4	3	30	1988	DRY	2	ND	5	ND	0.5	ND	0.5	ND	0.5	NA	1

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R0054647

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	SULFOTEPP actual ug/l	SULFOTEPP D.L. ug/l	SULPROFOS actual ug/l	SULPROFOS D.L. ug/l	TEPP actual ug/l	TEPP D.L. ug/l	TETRACHLORVINPHOS actual ug/l	TETRACHLORVINPHOS D.L. ug/l
STANDARD REPORTING LIMITS							0.05		0.05		0.1		0.02
S1	3	30	1988	DRY	2	ND	0.5	ND	0.5	ND	10	ND	2
S1LR	3	30	1988	DRY	2	ND	0.5	ND	0.5	ND	10	ND	2
S2	3	30	1988	DRY	2	ND	0.5	ND	0.5	ND	10	ND	2
S3	3	30	1988	DRY	2	ND	0.5	ND	0.5	ND	10	ND	2
S4	3	30	1988	DRY	2	ND	0.5	ND	0.5	ND	10	ND	2

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R0054648

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	TRICHLORONATE actual ug/l	D.L. ug/l
STANDARD REPORTING LIMITS							0.05
S1	3	30	1988	DRY	2	NA	0.5
S1LR	3	30	1988	DRY	2	NA	0.5
S2	3	30	1988	DRY	2	NA	0.5
S3	3	30	1988	DRY	2	NA	0.5
S4	3	30	1988	DRY	2	NA	0.5

R0054649

D.5-2 Organophosphate pesticides in sediment

VOL 12 2 13500

R0054650

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	AZINPHOS-METHYL actual mg/kg	AZINPHOS-METHYL D.L. mg/kg	CHLORPYRIFOS actual mg/kg	CHLORPYRIFOS D.L. mg/kg	COLMAPHOS actual mg/kg	COLMAPHOS D.L. mg/kg	DDVP actual mg/kg	DDVP D.L. mg/kg	DEMETON actual mg/kg	DEMETON D.L. mg/kg	DIAZINON actual mg/kg	DIAZINON D.L. mg/kg
							0.1		0.01		0.1		0.01		0.01		0.01
STANDARD REPORTING OBJECTIVES																	
S1	8	22	1988	DRY	3												
S2	8	22	1988	DRY	3	ND	2.5	ND	0.25	ND	1.25	ND	0.25	ND	0.25	ND	0.25
S3	8	22	1988	DRY	3	ND	1	ND	0.1	ND	0.5	ND	0.1	ND	0.1	ND	0.1
S3LR	8	22	1988	DRY	3	ND	1	ND	0.1	ND	0.5	ND	0.1	ND	0.1	ND	0.1
S4	8	22	1988	DRY	3	ND	1	ND	0.1	ND	0.5	ND	0.1	ND	0.1	ND	0.1
S3FD	8	22	1988	DRY	3	ND	1	ND	0.1	ND	0.5	ND	0.1	ND	0.1	ND	0.1

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R0054651

Sample I.D.	Date Sampled Month	Day	Year	Sample Type	Sample Event	DIMETHOATE actual mg/kg	DIMETHOATE D.L. mg/kg	DISULFOTON actual mg/kg	DISULFOTON D.L. mg/kg	EPN actual mg/kg	EPN D.L. mg/kg	ETHOPROP actual mg/kg	ETHOPROP D.L. mg/kg	FENSUL-FOTHION actual mg/kg	FENSUL-FOTHION D.L. mg/kg	FENTHION actual mg/kg	FENTHION D.L. mg/kg
							0.01		0.01		0.01		0.01		0.01		0
STANDARD REPORTING OBJECTIVES																	
S1	8	22	1988	DRY	3												
S2	8	22	1988	DRY	3	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.5	ND	0
S3	8	22	1988	DRY	3	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.2	ND	0
S3LR	8	22	1988	DRY	3	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.2	ND	0
S4	8	22	1988	DRY	3	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.2	ND	0
S3FD	8	22	1988	DRY	3	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.2	ND	0

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R0054652

Sample ID	Date Sampled: Month	Day	Year	Sample Type	Sample Event	MALATHION: actual mg/kg	MALATHION: DL mg/kg	MERPHOS: actual mg/kg	MERPHOS: DL mg/kg	MEVINPHOS: actual mg/kg	MEVINPHOS: DL mg/kg	MONOCROTOPHOS: actual mg/kg	MONOCROTOPHOS: DL mg/kg	NALED: actual mg/kg	NALED: DL mg/kg
							0.01		0.01		0.01		0.01		0.01
STANDARD REPORTING OBJECTIVES					3					ND	0.25	ND	1	ND	1.25
S1	8	22	1988	DRY	3	ND	0.25			ND	0.1	ND	0.4	ND	0.5
S2	8	22	1988	DRY	3	ND	0.1			ND	0.1	ND	0.4	ND	0.5
S3	8	22	1988	DRY	3	ND	0.1			ND	0.1	ND	0.4	ND	0.5
S3LR	8	22	1988	DRY	3	ND	0.1			ND	0.1	ND	0.4	ND	0.5
S4	8	22	1988	DRY	3	ND	0.1								
S3FD	8	22	1988	DRY											

R0054653

Sample I.D.	Date Sampled Month	Day	Year	Sample Type	Sample Event	PARATHION, ETH actual mg/kg	PARATHION, ETH D.L. mg/kg	PARATHION, METH actual mg/kg	PARATHION, METH D.L. mg/kg	PHORATE actual mg/kg	PHORATE D.L. mg/kg	RONNEL actual mg/kg	RONNEL D.L. mg/kg	SULFOTEPP actual mg/kg	SULFOTEPP D.L. mg/kg
							0.01		0.01		0.01		0.01		0.01
STANDARD REPORTING OBJECTIVES															
S1	8	22	1988	DRY	3										
S2	8	22	1988	DRY	3	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25
S3	8	22	1988	DRY	3	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1
S3LR	8	22	1988	DRY	3	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1
S4	8	22	1988	DRY	3	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1
S3FD	8	22	1988	DRY	3	ND	0.1	ND	0.1	ND	0.1	ND	0.1	ND	0.1

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R0054654

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	SULPROFOS actual mg/kg	SULPROFOS D.L. mg/kg	TEPP actual mg/kg	TEPP D.L. mg/kg	TETRACHLORVINPHOS actual mg/kg	TETRACHLORVINPHOS D.L. mg/kg	TRICHLORONATE actual mg/kg	TRICHLORONATE D.L. mg/kg
							0.01		0.1		0.01		0.01
STANDARD REPORTING OBJECTIVES													
S1	8	22	1988	DRY	3								
S2	8	22	1988	DRY	3	ND	0.25	ND	2	ND	0.5	ND	ND
S3	8	22	1988	DRY	3	ND	0.1	ND	0.8	ND	0.2	ND	0.1
S3LR	8	22	1988	DRY	3	ND	0.1	ND	0.8	ND	0.2	ND	0.1
S4	8	22	1988	DRY	3	ND	0.1	ND	0.8	ND	0.2	ND	0.1
S3FD	8	22	1988	DRY	3	ND	0.1	ND	0.8	ND	0.2	ND	0.1

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R0054655

D.6 Polynuclear Aromatic Hydrocarbons

VOL 12 2 1356

R0054656

POLYNUCLEAR AROMATIC HYDROCARBONS

Abbreviated Name	Actual Name
ACENAPE	Acenaphthene
ACENAPTYLE	Acenapthylene
BAA	Benzo(a)anthracene
BAP	Benzo(a)pyrene
BBF	Benzo(b)fluoranthene
BGHIP	Benzo(ghi)perylene
BKF	Benzo(k)fluoranthene
DBAHA	Dibenzo(a,h)anthracene
FLUORANTHN	Fluoranthene
ICDP	Indeno(1,2,3-cd)pyrene
PHENANTHRN	Phenanthrene

VOL 12 2 1357

D.6-1 Polynuclear Aromatic Hydrocarbons in water column

VOL 12 2 1358

R0054658

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	ACENAPE actual ug/l	ACENAPE DL ug/l	ACENAPTYLE actual ug/l	ACENAPTYLE DL ug/l	ANTHRACENE actual ug/l	ANTHRACENE DL ug/l	BAA actual ug/l	BAA DL ug/l	BAP actual ug/l	BAP DL ug/l	BBF actual ug/l	BBF DL ug/l
STANDARD REPORTING OBJECTIVES							2		2		2		2		2		2
L1	2	4	1989	WET	4	ND	200	ND	200	ND	7 0	ND	8 0	ND	5.0	ND	2 0
L1	2	9	1989	WET	5	ND	10	ND	10	ND	3 5	0 56	0 40	0.91	0 25	0 78	0 10
L1LR	2	9	1989	WET	5	ND	10	ND	10	ND	3 5	0 60	0 40	1.0	0 25	0 86	0 10
L1	3	2	1989	WET	6	ND	20	ND	200	ND	7.0	ND	0.80	ND	0.50	0.49	0.20
L2	2	4	1989	WET	4	ND	20	ND	200	ND	7.0	ND	0.80	ND	0 50	ND	0 20
L2	2	9	1989	WET	5	ND	10	ND	10	ND	0.70	ND	0.40	ND	0.25	0.10	0.10
L3	2	4	1989	WET	4	ND	20	ND	200	ND	7.0	ND	0.80	ND	0 50	ND	0 20
L3	2	9	1989	WET	5	ND	10	ND	20	ND	3.5	ND	0.40	ND	0.25	ND	0.10
L3	3	2	1989	WET	6	ND	20	ND	20	ND	7.0	ND	0.80	ND	0.50	ND	0.20
L4	2	4	1989	WET	4	ND	20	ND	20	ND	0.70	ND	0.080	ND	0 50	ND	0 20
L4	2	9	1989	WET	5	ND	10	ND	10	ND	3.5	ND	0.40	ND	0 25	ND	0.10
L5	1	23	1989	WET	3	ND	20	ND	20	ND	0.70	ND	0.080	ND	0.50	ND	0 20
L5	2	4	1989	WET	4	ND	20	ND	20	ND	7 0	ND	0 80	ND	0 50	0 28	0 20
L5	2	9	1989	WET	5	ND	10	ND	20	ND	3 5	ND	0 40	ND	0 50	0 32	0 10
L5	3	2	1989	WET	6	ND	20	ND	20	ND	7 0	ND	0 80	ND	0 50	0.27	0 20
L5LR	2	4	1989	WET	4	ND	20	ND	20	ND	7 0	ND	0 80	ND	0 50	0.26	0 20
L5FD	2	4	1989	WET	4	ND	20	ND	20	ND	7 0	ND	0 80	ND	0 50	0 33	0 20
L6	2	9	1989	WET	5	ND	10	ND	20	ND	3 5	ND	0.40	ND	0.50	ND	0.20
L7	2	4	1989	WET	4	ND	2 0	ND	2 0	ND	0 70	ND	0 080	ND	0.050	ND	0.020
L7	2	9	1989	WET	5	ND	2 0	ND	2 0	ND	0 70	ND	0 080	ND	0 050	ND	0 020
L7	3	2	1989	WET	6	ND	2 0	ND	2 0	ND	0.70	ND	0 080	ND	0.050	ND	0.020
S1	3	30	1988	DRY	2	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5
S1LR	3	30	1988	DRY	2	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5
S1	5	11	1988	DRY	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2
S1	12	12	1988	DRY	5	ND	2 0	ND	2 0	ND	0 70	ND	0 080	ND	0 050	ND	0 020
S1	2	1	1989	DRY	6	ND	2 0	ND	2 0	ND	0.70	ND	0 080	ND	0 050	ND	0 020
S1	4	6	1989	DRY	7	ND	2 0	ND	2 0	ND	0.70	ND	0 080	ND	0.050	ND	0.020
S1	1	23	1989	WET	3	ND	2 0	ND	2 0	ND	0.70	ND	0 080	ND	0.050	0.037	0.020
S1	2	4	1989	WET	4	ND	20	ND	20	ND	7 0	ND	0.80	0.52	0 50	0.46	0 20
S1	2	9	1989	WET	5	ND	10	ND	10	ND	3.5	ND	0 40	ND	0 25	0.15	0 10
S1FD	2	9	1989	WET	5	ND	10	ND	20	ND	3 5	ND	0.40	ND	0 25	ND	0 10
S1	3	2	1989	WET	6	ND	20	ND	20	ND	7 0	ND	0 80	ND	0 50	0 36	0 20
S1LR	3	2	1989	WET	6	ND	20	ND	20	ND	7.0	ND	0.80	ND	0.50	0.31	0 20

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	ACENAPE actual ug/l	ACENAPE DL ug/l	ACENAPTYLE actual ug/l	ACENAPTYLE DL ug/l	ANTHRACENE actual ug/l	ANTHRACENE DL ug/l	BAA actual ug/l	BAA DL ug/l	BAP actual ug/l	BAP DL ug/l	BBF actual ug/l	BBF DL ug/l
STANDARD REPORTING OBJECTIVES							2		2		2		2		2		2
S2	3	30	1988	DRY	2	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5
S2	5	11	1988	DRY	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2
S2	12	12	1988	DRY	5	ND	2.0	ND	2.0	ND	0.70	ND	0.080	ND	0.050	ND	0.020
S2	2	1	1989	DRY	6	ND	2.0	ND	2.0	ND	0.70	ND	0.080	ND	0.050	ND	0.020
S2	4	6	1989	DRY	7	ND	2.0	ND	2.0	ND	0.70	ND	0.080	ND	0.050	ND	0.020
S2	1	23	1989	WET	3	ND	20	ND	20	ND	0.70	ND	0.080	0.081	0.050	0.089	0.020
S2	2	4	1988	WET	4	ND	20	ND	20	ND	7.0	ND	0.80	ND	0.50	ND	0.20
S2	2	8	1989	WET	5	ND	20	ND	200	ND	3.5	ND	0.80	ND	0.50	0.67	0.20
S2	3	2	1989	WET	6	ND	20	ND	20	ND	7.0	ND	0.80	ND	0.50	ND	0.20
S3	3	30	1988	DRY	2	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5
S3	5	11	1988	DRY	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2
S3	8	22	1988	DRY	4	ND	1	ND	1	ND	1	ND	1	ND	1	ND	10
S3FD	8	22	1988	DRY	4	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1
S3FDLR	8	22	1988	DRY	4	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1
S3	12	12	1988	DRY	5	ND	2.0	ND	2.0	ND	0.70	ND	0.080	ND	0.050	ND	0.020
S3FD	12	12	1988	DRY	5	ND	2.0	ND	2.0	ND	0.70	ND	0.080	ND	0.050	ND	0.020
S3LR	12	12	1988	DRY	5	ND	2.0	ND	2.0	ND	0.70	ND	0.080	ND	0.050	ND	0.020
S3	2	1	1989	DRY	6	ND	2.0	ND	2.0	ND	0.70	ND	0.080	ND	0.050	ND	0.020
S3FD	2	1	1988	DRY	6	ND	2.0	ND	2.0	ND	0.70	ND	0.080	ND	0.050	ND	0.020
S3LR	2	1	1989	DRY	6	ND	2.0	ND	2.0	ND	0.70	ND	0.080	ND	0.050	ND	0.020
S3	4	6	1989	DRY	7	ND	2.0	ND	2.0	ND	0.70	ND	0.080	ND	0.050	ND	0.020
S3FD	4	6	1989	DRY	7	ND	2.0	ND	2.0	ND	0.70	ND	0.080	ND	0.050	ND	0.020
S3	1	23	1989	WET	3	ND	20	ND	20	ND	0.70	ND	0.080	ND	0.50	ND	0.20
S3FD	1	23	1989	WET	3	ND	20	ND	20	ND	0.70	ND	0.080	ND	0.50	ND	0.20
S3	2	4	1989	WET	4	ND	20	ND	20	ND	7.0	ND	0.80	ND	0.50	ND	0.20
S3	2	8	1988	WET	5	ND	10	ND	20	ND	3.5	ND	0.40	ND	0.25	ND	0.10
S4	3	30	1988	DRY	2	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5
S4	5	11	1988	DRY	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2
S4LR	5	11	1988	DRY	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2
S4	8	22	1988	DRY	4	ND	1	ND	1	ND	1	ND	1	ND	50	ND	1
S4	12	12	1988	DRY	5	ND	2.0	ND	2.0	ND	0.70	ND	0.080	0.11	0.050	0.083	0.020
S4	2	1	1988	DRY	6	ND	2.0	ND	2.0	ND	0.70	ND	0.080	ND	0.050	ND	0.020
S4	4	6	1988	DRY	7	ND	2.0	ND	20	ND	0.70	ND	0.080	ND	0.050	ND	0.020
S4	2	4	1989	WET	4	ND	20	ND	20	ND	7.0	ND	0.80	ND	0.50	ND	0.20
S4	2	8	1989	WET	5	ND	10	ND	20	ND	3.5	ND	0.40	ND	0.25	ND	0.10
S4	3	2	1989	WET	6	ND	20	ND	20	ND	7.0	ND	0.80	ND	0.50	ND	0.20

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	ACENAPE actual ug/l	ACENAPE DL ug/l	ACENAPTYLE actual ug/l	ACENAPTYLE DL ug/l	ANTHRACENE actual ug/l	ANTHRACENE DL ug/l	BAA actual ug/l	BAA DL ug/l	BAP actual ug/l	BAP DL ug/l	BBF actual ug/l	BBF DL ug/l
STANDARD REPORTING OBJECTIVES							2		2		2		2		2		2
5B	1	23	1988	WET	3	ND	2.0	ND	2.0	ND	0.70	ND	0.080	ND	0.050	ND	0.020
5B	2	4	1989	WET	4	ND	2.0	ND	2.0	ND	0.70	ND	0.080	ND	0.050	ND	0.020
5B	2	9	1989	WET	5	ND	2.0	ND	2.0	ND	0.70	ND	0.080	ND	0.050	ND	0.020
5B	3	2	1989	WET	6	ND	2.0	ND	2.0	ND	0.70	ND	0.080	ND	0.050	ND	0.020
FB	8	22	1988	DRY	4	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1
FB	12	12	1988	DRY	5	ND	2.0	ND	2.0	ND	0.70	ND	0.080	ND	0.050	ND	0.020
FB	2	1	1989	DRY	6	ND	2.0	ND	2.0	ND	0.70	ND	0.080	ND	0.050	ND	0.020
FB	4	6	1989	DRY	7	ND	2.0	ND	2.0	ND	0.70	ND	0.080	ND	0.050	ND	0.020

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	BGHIP actual ug/l	BGHIP DL ug/l	BKF actual ug/l	BKF DL ug/l	CHRYSENE actual ug/l	CHRYSENE DL ug/l	DBAHA actual ug/l	DBAHA DL ug/l	FLUORANTHN actual ug/l	FLUORANTHN DL ug/l	FLUORENE actual ug/l	FLUORENE DL ug/l
STANDARD REPORTING OBJECTIVES							2		2		2		2		2		2
L1	2	4	19 9	WET	4	ND	8 0	ND	2 0	ND	20	ND	20	3 3	2 0	ND	2 0
L1	2	9	19d9	WET	5	1.3	0 40	0 34	0 10	ND	1 0	ND	1.0	2 4	1 0	ND	1 0
L1LR	2	9	1989	WET	5	1 5	0 40	0 37	0 10	ND	1 0	ND	1.0	2.6	1 0	ND	1 0
L1	3	2	1989	WET	6	ND	0.80	0.22	0 20	ND	20	ND	2 0	ND	2.0	ND	2 0
L2	2	4	1989	WET	4	ND	0 80	ND	0 20	ND	20	ND	2 0	ND	2 0	ND	2 0
L2	2	9	1989	WET	5	ND	0.40	ND	0.10	ND	1.0	ND	1 0	ND	0.20	ND	1.0
L3	2	4	1989	WET	4	ND	0 80	ND	0 20	ND	20	ND	2 0	ND	2.0	ND	2 0
L3	2	9	1989	WET	5	ND	0 40	ND	0 10	ND	2 0	ND	1 0	ND	1 0	ND	1 0
L3	3	2	1989	WET	6	ND	0.80	ND	0 20	ND	2 0	ND	2.0	ND	2.0	ND	2 0
L4	2	4	1989	WET	4	ND	0 080	ND	0 20	ND	2 0	ND	2 0	ND	0 20	ND	2 0
L4	2	9	1989	WET	5	ND	0.40	ND	0 10	ND	1.0	ND	1.0	ND	1.0	ND	1 0
L5	1	23	1989	WET	3	ND	0 80	ND	0 20	ND	2 0	ND	2 0	0 26	0 20	ND	2 0
L5	2	4	1989	WET	4	ND	0 80	ND	0 20	ND	20	ND	2 0	ND	2 0	ND	2 0
L5	2	9	1989	WET	5	ND	0 40	0 14	0 10	ND	2 0	ND	1 0	ND	1 0	ND	1 0
L5	3	2	1989	WET	6	ND	0 80	ND	0 20	ND	2 0	ND	2 0	ND	2 0	ND	2.0
L5LR	2	4	1989	WET	4	ND	0 80	ND	0 20	ND	2 0	ND	2 0	ND	2.0	ND	2 0
L5FD	2	4	1989	WET	4	ND	0 80	ND	0 20	ND	2.0	ND	2.0	ND	2.0	ND	2.0
L6	2	9	1989	WET	5	ND	0 40	ND	0 20	ND	2 0	ND	2.0	ND	1.0	ND	1 0
L7	2	4	1989	WET	4	ND	0 080	ND	0 020	ND	0 20	ND	0 20	ND	0 20	ND	0.20
L7	2	9	1989	WET	5	ND	0 080	ND	0 020	ND	0 20	ND	0 20	ND	0 20	ND	0 20
L7	3	2	1989	WET	6	ND	0 080	ND	0.020	ND	0 20	ND	0 20	ND	0.20	ND	0 20
S1	3	30	1989	DRY	2	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5
S1LR	3	30	1989	DRY	2	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5
S1	5	11	1989	DRY	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2
S1	12	12	1988	DRY	5	ND	0 080	ND	0 020	ND	0 20	ND	0 20	ND	0 20	ND	0 20
S1	2	1	1989	DRY	6	ND	0 080	ND	0 020	ND	0 20	ND	0 20	ND	0 20	ND	0 20
S1	4	6	1989	DRY	7	ND	0 080	ND	0 020	ND	0 20	ND	0.20	ND	0.20	ND	0 50
S1	1	23	1989	WET	3	ND	0 080	ND	0 020	ND	0.20	ND	0 20	ND	0.20	ND	0 20
S1	2	4	1989	WET	4	ND	0 80	ND	0 20	ND	2 0	ND	2 0	ND	2 0	ND	2 0
S1	2	9	1989	WET	5	ND	0 40	ND	0 10	ND	1 0	ND	1 0	ND	1.0	ND	1 0
S1FD	2	9	1989	WET	5	ND	0 40	ND	0 10	ND	1.0	ND	1 0	ND	1 0	ND	1 0
S1	3	2	1989	WET	6	ND	0 80	ND	0.20	ND	2.0	ND	2.0	ND	2.0	ND	2 0
S1LR	3	2	1989	WET	6	ND	0 80	ND	0.20	ND	2.0	ND	2.0	ND	2.0	ND	2.0

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	BGHIP actual ug/l	BGHIP DL ug/l	BKF actual ug/l	BKF DL ug/l	CHRYSENE actual ug/l	CHRYSENE DL ug/l	DBAHA actual ug/l	DBAHA DL ug/l	FLUORANTHN actual ug/l	FLUORANTHN DL ug/l	FLUORENE actual ug/l	FLUORENE DL ug/l
STANDARD REPORTING OBJECTIVES							2		2		2		2		2		2
S2	3	30	1988	DRY	2	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5
S2	5	11	1988	DRY	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2
S2	12	12	1988	DRY	5	ND	0.080	ND	0.020	ND	0.20	ND	0.20	ND	0.20	ND	0.20
S2	2	1	1989	DRY	6	ND	0.080	ND	0.020	ND	0.20	ND	0.20	ND	0.20	ND	0.20
S2	4	6	1989	DRY	7	ND	0.080	ND	0.020	ND	0.20	ND	0.20	ND	0.20	ND	0.50
S2	1	23	1989	WET	3	ND	0.080	0.041	0.020	ND	2.0	ND	0.20	0.21	0.20	ND	2.0
S2	2	4	1989	WET	4	ND	0.80	ND	0.20	ND	2.0	ND	2.0	ND	2.0	ND	2.0
S2	2	9	1989	WET	5	ND	0.80	0.29	0.20	ND	20	ND	2.0	1.1	1.0	ND	2.0
S2	3	2	1989	WET	6	ND	0.80	ND	0.20	ND	2.0	ND	2.0	ND	2.0	ND	2.0
S3	3	30	1988	DRY	2	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5
S3	5	11	1988	DRY	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2
S3	8	22	1988	DRY	4	ND	2	ND	1	ND	1	ND	2	ND	1	ND	1
S3FD	8	22	1988	DRY	4	ND	2	ND	1	ND	1	ND	2	ND	1	ND	1
S3FDLR	8	22	1988	DRY	4	ND	2	ND	1	ND	1	ND	2	ND	1	ND	1
S3	12	12	1988	DRY	5	ND	0.080	ND	0.020	ND	0.20	ND	0.20	ND	0.20	ND	0.20
S3FD	12	12	1988	DRY	5	ND	0.080	ND	0.020	ND	0.20	ND	0.20	ND	0.20	ND	0.20
S3LR	12	12	1988	DRY	5	ND	0.080	ND	0.020	ND	0.20	ND	0.20	ND	0.20	ND	0.20
S3	2	1	1989	DRY	6	ND	0.080	ND	0.020	ND	0.20	ND	0.20	ND	0.20	ND	0.20
S3FD	2	1	1989	DRY	6	ND	0.080	ND	0.020	ND	0.20	ND	0.20	ND	0.20	ND	0.20
S3LR	2	1	1989	DRY	6	ND	0.080	ND	0.020	ND	0.20	ND	0.20	ND	0.20	ND	0.20
S3	4	6	1989	DRY	7	ND	0.080	ND	0.020	ND	0.20	ND	0.20	ND	0.20	ND	0.50
S3FD	4	6	1989	DRY	7	ND	0.080	ND	0.020	ND	0.20	ND	0.20	ND	0.20	ND	0.50
S3	1	23	1989	WET	3	ND	0.80	ND	0.20	ND	2.0	ND	2.0	0.29	0.20	ND	2.0
S3FD	1	23	1989	WET	3	ND	0.80	ND	0.20	ND	2.0	ND	2.0	0.26	0.20	ND	2.0
S3	2	4	1989	WET	4	ND	0.80	ND	0.20	ND	2.0	ND	2.0	ND	2.0	ND	2.0
S3	2	9	1989	WET	5	ND	0.40	ND	0.10	ND	1.0	ND	1.0	ND	1.0	ND	1.0
S4	3	30	1988	DRY	2	ND	5	ND	5	ND	5	ND	5	ND	5	ND	5
S4	5	11	1988	DRY	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2
S4LR	5	11	1988	DRY	3	ND	2	ND	2	ND	2	ND	2	ND	2	ND	2
S4	8	22	1988	DRY	4	ND	50	ND	1	ND	1	ND	50	ND	1	ND	1
S4	12	12	1988	DRY	5	ND	0.080	0.04	0.020	ND	0.20	ND	0.20	ND	0.20	ND	0.20
S4	2	1	1989	DRY	6	ND	0.080	ND	0.020	ND	0.20	ND	0.20	ND	0.20	ND	0.20
S4	4	6	1989	DRY	7	ND	0.080	ND	0.020	ND	0.20	ND	0.20	ND	0.20	ND	0.50
S4	2	4	1989	WET	4	ND	0.80	ND	0.20	ND	2.0	ND	2.0	ND	2.0	ND	2.0
S4	2	9	1989	WET	5	ND	0.40	ND	0.10	ND	1.0	ND	1.0	ND	1.0	ND	1.0
S4	3	2	1989	WET	6	ND	0.80	ND	0.20	ND	2.0	ND	2.0	ND	2.0	ND	2.0

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	BGHIP actual ug/l	BGHIP DL ug/l	BKF actual ug/l	BKF DL ug/l	CHRYSENE actual ug/l	CHRYSENE DL ug/l	DBAHA actual ug/l	DBAHA DL ug/l	FLUORANTHN actual ug/l	FLUORANTHN DL ug/l	FLUORENE actual ug/l	FLUORENE DL ug/l
STANDARD REPORTING OBJECTIVES							2		2		2		2		2		2
SB	1	23	1989	WET	3	ND	0.080	ND	0.020	ND	0.20	ND	0.20	ND	0.20	ND	0.20
SB	2	4	1989	WET	4	ND	0.080	ND	0.020	ND	0.20	ND	0.20	ND	0.20	ND	0.20
SB	2	9	1989	WET	5	ND	0.080	ND	0.020	ND	0.20	ND	0.20	ND	0.20	ND	0.20
SB	3	2	1989	WET	6	ND	0.080	ND	0.020	ND	0.20	ND	0.20	ND	0.20	ND	0.20
FB	8	22	1988	DRY	4	ND	2	ND	1	ND	1	ND	2	ND	1	ND	1
FB	12	12	1988	DRY	5	ND	0.080	ND	0.020	ND	0.20	ND	0.20	ND	0.20	ND	0.20
FB	2	1	1989	DRY	6	ND	0.080	ND	0.020	ND	0.20	ND	0.20	ND	0.20	ND	0.20
FB	4	6	1989	DRY	7	ND	0.080	ND	0.020	ND	0.20	ND	0.20	ND	0.20	ND	0.50

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Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	ICDP actual ug/l	ICDP DL ug/l	NAPTHALENE actual ug/l	NAPTHALENE DL ug/l	PHENANTHRIN actual ug/l	PHENANTHRIN DL ug/l	PYRENE actual ug/l	PYRENE DL ug/l
STANDARD REPORTING OBJECTIVES							2		2		2		2
L1	2	4	1989	WET	4	ND	20	ND	200	ND	60	ND	30
L1	2	9	1989	WET	5	14	10	ND	10	ND	30	20	1.5
L1LR	2	9	1989	WET	5	12	10	ND	10	ND	30	22	1.5
L1	3	2	1989	WET	6	ND	20	ND	200	ND	60	ND	30
L2	2	4	1989	WET	4	ND	20	ND	200	ND	60	ND	3.0
L2	2	9	1989	WET	5	ND	10	ND	10	ND	30	ND	0.30
L3	2	4	1989	WET	4	ND	20	ND	200	ND	60	ND	3.0
L3	2	9	1989	WET	5	ND	10	ND	20	ND	30	ND	1.5
L3	3	2	1989	WET	6	ND	20	ND	200	ND	60	ND	3.0
L4	2	4	1989	WET	4	ND	0.20	ND	20	ND	60	ND	0.30
L4	2	9	1989	WET	5	ND	1.0	ND	10	ND	30	ND	1.5
L5	1	23	1989	WET	3	ND	20	ND	20	ND	60	ND	0.30
L5	2	4	1989	WET	4	ND	20	ND	200	ND	60	ND	30
L5	2	9	1989	WET	5	ND	10	ND	20	ND	30	ND	1.5
L5	3	2	1989	WET	6	ND	20	ND	200	ND	60	ND	30
L5LR	2	4	1989	WET	4	ND	20	ND	200	ND	60	ND	30
L5FD	2	4	1989	WET	4	ND	20	ND	20	ND	60	ND	3.0
L6	2	9	1989	WET	5	ND	10	ND	20	ND	30	ND	1.5
L7	2	4	1989	WET	4	ND	0.20	ND	20	ND	0.60	ND	0.30
L7	2	9	1989	WET	5	ND	0.20	ND	20	ND	0.60	ND	0.30
L7	3	2	1989	WET	6	ND	0.20	ND	20	ND	0.60	ND	0.30
S1	3	30	1988	DRY	2	ND	5	ND	5	ND	5	ND	5
S1LR	3	30	1988	DRY	2	ND	5	ND	5	ND	5	ND	5
S1	5	11	1988	DRY	3	ND	2	ND	2	ND	2	ND	2
S1	12	12	1988	DRY	5	ND	0.20	ND	20	ND	0.60	ND	0.30
S1	2	1	1989	DRY	6	ND	0.20	ND	20	ND	0.60	ND	0.30
S1	4	6	1989	DRY	7	ND	0.20	ND	20	ND	0.60	ND	0.30
S1	1	23	1989	WET	3	ND	0.20	ND	20	ND	0.60	ND	0.30
S1	2	4	1989	WET	4	ND	20	ND	20	ND	60	ND	30
S1	2	9	1989	WET	5	ND	10	ND	20	ND	30	ND	1.5
S1FD	2	9	1989	WET	5	ND	10	ND	20	ND	30	ND	1.5
S1	3	2	1989	WET	6	ND	20	ND	200	ND	60	ND	3.0
S1LR	3	2	1989	WET	6	ND	2.0	ND	200	ND	60	ND	3.0

R0054665

Sample ID	Date Sampled Month	Day	Year	Sample Type	ICDP Sample Event	ICDP actual ug/l	ICDP DL ug/l	NAPTHALENE actual ug/l	NAPTHALENE DL ug/l	PHENANTHRN actual ug/l	PHENANTHRN DL ug/l	PYRENE actual ug/l	PYRENE DL ug/l
STANDARD REPORTING OBJECTIVES							2		2		2		2
S2	3	30	1988	DRY	2	ND	5	ND	5	ND	5	ND	5
S2	5	11	1988	DRY	3	ND	2	ND	2	ND	2	ND	2
S2	12	12	1988	DRY	5	ND	0.20	ND	2.0	ND	0.60	ND	0.30
S2	2	1	1989	DRY	6	ND	0.20	ND	2.0	ND	0.60	ND	0.30
S2	4	6	1989	DRY	7	ND	0.20	ND	2.0	ND	0.60	ND	0.30
S2	1	23	1989	WET	3	ND	0.20	ND	20	ND	6.0	ND	0.30
S2	2	4	1989	WET	4	ND	2.0	ND	20	ND	6.0	ND	3.0
S2	2	8	1989	WET	5	ND	2.0	ND	200	ND	6.0	ND	1.5
S2	3	2	1989	WET	6	ND	2.0	ND	200	ND	6.0	ND	3.0
S3	3	30	1988	DRY	2	ND	5	ND	5	ND	5	ND	5
S3	5	11	1988	DRY	3	ND	2	ND	2	ND	2	ND	2
S3	8	22	1988	DRY	4	ND	1	ND	1	ND	1	ND	1
S3FD	8	22	1988	DRY	4	ND	1	ND	1	ND	1	ND	1
S3FDLR	8	22	1988	DRY	4	ND	1	ND	1	ND	1	ND	1
S3	12	12	1988	DRY	5	ND	0.20	ND	20	ND	0.60	ND	0.30
S3FD	12	12	1988	DRY	5	ND	0.20	ND	2.0	ND	0.60	ND	0.30
S3LR	12	12	1988	DRY	5	ND	0.20	ND	2.0	ND	0.60	ND	0.30
S3	2	1	1989	DRY	6	ND	0.20	ND	2.0	ND	0.60	ND	0.30
S3FD	2	1	1989	DRY	6	ND	0.20	ND	2.0	ND	0.60	ND	0.30
S3LR	2	1	1989	DRY	6	ND	0.20	ND	2.0	ND	0.60	ND	0.30
S3	4	6	1989	DRY	7	ND	0.20	ND	20	ND	0.60	ND	0.30
S3FD	4	6	1989	DRY	7	ND	0.20	ND	20	ND	0.60	ND	0.30
S3	1	23	1989	WET	3	ND	2.0	ND	20	ND	6.0	0.33	0.30
S3FD	1	23	1989	WET	3	ND	2.0	ND	20	ND	6.0	0.32	0.30
S3	2	4	1989	WET	4	ND	2.0	ND	20	ND	6.0	ND	3.0
S3	2	8	1989	WET	5	ND	1.0	ND	20	ND	3.0	ND	1.5
S4	3	30	1988	DRY	2	ND	5	ND	5	ND	5	ND	5
S4	5	11	1988	DRY	3	ND	2	ND	2	ND	2	ND	2
S4LR	5	11	1988	DRY	3	ND	2	ND	2	ND	2	ND	2
S4	8	22	1988	DRY	4	ND	50	ND	1	ND	1	ND	1
S4	12	12	1988	DRY	5	ND	0.20	ND	2.0	ND	0.60	ND	0.30
S4	2	1	1989	DRY	6	ND	0.20	ND	2.0	ND	0.60	ND	0.30
S4	4	6	1989	DRY	7	ND	0.20	ND	20	ND	0.60	ND	0.30
S4	2	4	1989	WET	4	ND	2.0	ND	20	ND	6.0	ND	3.0
S4	2	8	1989	WET	5	ND	1.0	ND	20	ND	3.0	ND	1.5
S4	3	2	1989	WET	6	ND	2.0	ND	200	ND	6.0	ND	3.0

R0054666

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	ICDP actual ug/l	ICDP DL. ug/l	NAPTHALENE actual ug/l	NAPTHALENE DL ug/l	PHENANTHRN actual ug/l	PHENANTHRN DL. ug/l	PYRENE actual ug/l	PYRENE DL. ug/l
STANDARD REPORTING OBJECTIVES							2		2		2		2
5B	1	23	1989	WET	3	ND	0.20	ND	2.0	ND	0.60	ND	0.30
5B	2	4	1989	WET	4	ND	0.20	ND	2.0	ND	0.60	ND	0.30
5B	2	9	1989	WET	5	ND	0.20	ND	2.0	ND	0.60	ND	0.30
5B	3	2	1989	WET	6	ND	0.20	ND	2.0	ND	0.60	ND	0.30
FB	8	22	1998	DRY	4	ND	1	ND	1	ND	1	ND	1
FB	12	12	1988	DRY	5	ND	0.20	ND	2.0	ND	0.60	ND	0.30
FB	2	1	1989	DRY	6	ND	0.20	ND	2.0	ND	0.60	ND	0.30
FB	4	6	1989	DRY	7	ND	0.20	ND	2.0	ND	0.60	ND	0.30

VOL 12

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R0054667

D.6-2 Polynuclear Aromatic Hydrocarbons in sediment

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R0054668

Sample I.D.	Date Sampled Month	Day	Year	Sample Type	Sample Event	ACENAPE actual mg/kg	ACENAPE D.L. mg/kg	ACENAPTYLE actual mg/kg	ACENAPTYLE D.L. mg/kg	ANTHRACENE actual mg/kg	ANTHRACENE D.L. mg/kg	BAA actual mg/kg	BAA D.L. mg/kg	BAP actual mg/kg	BAP D.L. mg/kg	BBF actual mg/kg	BBF D.L. mg/kg
STANDARD REPORTING LIMITS							0.2		0.2		0.2		0.2		0.2		0.2
S1	12	12	1988	DRY	5	ND	1.100	ND	1.100	ND	0.400	0.230	0.045	0.490	0.280	0.540	0.110
S2	12	12	1988	DRY	5	ND	0.660	ND	0.660	ND	0.230	0.100	0.026	0.200	0.160	0.190	0.066
S3	8	22	1988	DRY	4	ND	1	ND	1	ND	1	ND	1	ND	1	ND	10
S3	12	12	1988	DRY	5	ND	0.650	ND	0.650	ND	0.230	0.130	0.026	0.230	0.160	0.250	0.065
S3FD	8	22	1988	DRY	4	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1
S3FD	12	12	1989	DRY	5	ND	0.910	ND	0.910	ND	0.320	ND	0.360	0.360	0.230	0.410	0.091
S4	8	22	1989	DRY	4	ND	1	ND	1	ND	1	ND	1	ND	50	ND	1
S4	12	12	1988	DRY	5	ND	0.710	ND	0.710	ND	0.250	0.270	0.180	0.270	0.180	0.360	0.071

VOL 12

2

R0054669

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	BGHIP actual mg/kg	BGHIP D.L. mg/kg	BKF actual mg/kg	BKF D.L. mg/kg	CHRYSENE actual mg/kg	CHRYSENE D.L. mg/kg	DBAHA actual mg/kg	DBAHA D.L. mg/kg	FLUORANTHN actual mg/kg	FLUORANTHN D.L. mg/kg
STANDARD REPORTING LIMITS							0.2		0.2		0.2		0.2		0.2
S1	12	12	1988	DRY	5	ND	0.450	0.270	0.110	ND	1.100	ND	0.110	0.910	0.110
S2	12	12	1988	DRY	5	ND	0.260	0.100	0.066	ND	0.660	ND	0.660	0.400	0.066
S3	8	22	1988	DRY	4	ND	2	ND	1	ND	1	ND	2	ND	1
S3	12	12	1988	DRY	5	ND	0.260	0.110	0.065	ND	0.650	ND	0.650	0.460	0.065
S3FD	8	22	1988	DRY	4	ND	2	ND	1	ND	1	ND	2	ND	1
S3FD	12	12	1988	DRY	5	ND	0.360	0.190	0.091	ND	0.910	ND	0.910	0.760	0.091
S4	8	22	1988	DRY	4	ND	50	ND	1	ND	1	ND	50	ND	1
S4	12	12	1988	DRY	5	ND	0.280	0.160	0.071	ND	0.710	ND	0.710	0.650	0.071

R0054670

Sample ID.	Date Sampled Month	Day	Year	Sample Type	Sample Event	FLUORENE actual mg/kg	FLUORENE D.L. mg/kg	ICDP actual mg/kg	ICDP D.L. mg/kg	NAPTHALENE actual mg/kg	NAPTHALENE D.L. mg/kg	PHENANTHRN actual mg/kg	PHENANTHRN D.L. mg/kg	PYRENE actual mg/kg	PYRENE D.L. mg/kg
STANDARD REPORTING LIMITS							0.2		0.2		0.2		0.2		0.2
S1	12	12	1988	DRY	5	ND	0.110	ND	1.100	ND	1.100	0.350	0.340	0.650	0.170
S2	12	12	1988	DRY	5	ND	0.066	ND	0.660	ND	0.660	ND	0.200	0.350	0.098
S3	8	22	1988	DRY	4	ND	1	ND	1	ND	1	ND	1	ND	1
S3	12	12	1988	DRY	5	ND	0.065	ND	0.650	ND	0.650	ND	0.190	0.420	0.097
S3FD	8	22	1988	DRY	4	ND	1	ND	1	ND	1	ND	1	ND	1
S3FD	12	12	1988	DRY	5	ND	0.091	ND	0.910	ND	0.910	0.380	0.270	0.460	0.140
S4	8	22	1988	DRY	4	ND	1	ND	50	ND	1	ND	1	ND	1
S4	12	12	1988	DRY	5	ND	0.071	ND	0.710	ND	0.710	0.260	0.210	0.570	0.110

R0054671

D.7 Volatiles and semi-volatiles

VOL 12 2 1372

R0054672

VOLATILES AND SEMI-VOLATILES

Abbreviated Name	Actual Name
3CLETHENE	Trichlorethene
METHYLECL	Methylene Chloride
B2ETHXPHTH	Bis(2-ethylhexyl) phthalate
2NOCTP	Di-n-octylphthalate

VOL 12 2

13773

D.7-1 Volatiles and semi-volatiles in water column

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R0054674

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	EPA 624 3CLETHE actual ug/l	3CLETHE D.L. ug/l	ACETONE actual ug/l	ACETONE D.L. ug/l	2 BUTANONE actual ug/l	2 BUTANONE D.L. ug/l	METHYLE CL actual ug/l	METHYLE CL D.L. ug/l	EPA 624 XYLENE-T actual ug/l	XYLENE-T D.L. ug/l	TOLUENE actual ug/l	TOLUENE D.L. ug/l
STANDARD REPORTING OBJECTIVES																13	5
W AVE	2	17	1988					80	20								
L1	4	20	1988	WWWO	1									9	5		
L1	11	23	1988	WWWO	2							54	5				
L2	4	20	1988	WWWO	1			45	20								
L2	11	23	1988	WWWO	2			30	20	130	20			55	5		
L3	4	20	1988	WWWO	1												
L3	11	23	1988	WWWO	2												
L5	11	23	1988	WWWO	2												
L6	4	20	1988	WWWO	1												
L6	11	23	1988	WWWO	2												
L7	11	23	1988	WWWO	2												
R1	2	26	1988	RFWO	1												
R2	2	26	1988	RFWO	1												
R3	2	26	1988	RFWO	1												
R4	2	26	1988	RFWO	1												
R5	2	26	1988	RFWO	1												
R6	2	26	1988	RFWO	1												
S1	2	26	1988	DWWO	1												
S1	11	23	1988	WWWO	2												
S2	2	26	1988	DWWO	1	6	5										
S2	4	20	1988	WWWO	1												
S2	11	23	1988	WWWO	2												
S3	2	26	1988	DWWO	1												
S3	4	20	1988	WWWO	1												
S3	11	23	1988	WWWO	2												
S3LR	11	23	1988	WWWO	2												
S4	2	26	1988	DWWO	1												
S4	4	20	1988	WWWO	1												
S4	11	23	1988	WWWO	2												
S4LR	11	23	1988	WWWO	2												

R0054675

Sample ID	Date Sampled Month	Day	Year	Sample Type	Sample Event	EPA 625 B2ETHXPHTH actual ug/l	B2ETHXPHTH D.L. ug/l	2NOCTP actual ug/l	2NOCTP D.L. ug/l	BENZOIC AC actual ug/l	BENZOIC AC D.L. ug/l	4-METHPHN actual ug/l	4-METHPHN D.L. ug/l
STANDARD REPORTING OBJECTIVES													
W AVE	2	17	1988			320	10			430	50	20	10
L1	4	20	1988	WWWQ	1	41	10						
L1	11	23	1988	WWWQ	2								
L2	4	20	1988	WWWQ	1	49	10						
L2	11	23	1988	WWWQ	2								
L3	4	20	1988	WWWQ	1								
L3	11	23	1988	WWWQ	2								
L5	11	23	1988	WWWQ	2								
L6	4	20	1988	WWWQ	1	43	10						
L6	11	23	1988	WWWQ	2								
L7	11	23	1988	WWWQ	2								
R1	2	26	1988	RFWQ	1								
R2	2	26	1988	RFWQ	1								
R3	2	26	1988	RFWQ	1								
R4	2	26	1988	RFWQ	1								
R5	2	26	1988	RFWQ	1								
R6	2	26	1988	RFWQ	1								
S1	2	26	1988	DWWQ	1								
S1	11	23	1988	WWWQ	2								
S2	2	26	1988	DWWQ	1								
S2	4	20	1988	WWWQ	1								
S2	11	23	1988	WWWQ	2								
S3	2	26	1988	DWWQ	1								
S3	4	20	1988	WWWQ	1								
S3	11	23	1988	WWWQ	2								
S3LR	11	23	1988	WWWQ	2								
S4	2	26	1988	DWWQ	1	82	10	38	10				
S4	4	20	1988	WWWQ	1								
S4	11	23	1988	WWWQ	2								
S4LR	11	23	1988	WWWQ	2								

R0054676

D.7-2 Volatiles and semi-volatiles in sediment

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CHEMICAL	GROUP	STATION	SAMPLING DATE	CONCENTRATION (ug/kg)
Toluene	Volatile	S3	3/30/88	5
Acetone	Volatile	S3	3/30/88	63
BEHP	Semi-Volatile	S3	3/30/88	2700
		S3	5/11/88	970
		S4	5/11/88	4400
		S4.duplicate	5/11/88	1400
Butylbenzyl-phthalate	Semi-Volatile	S3	3/30/88	490
Fluoranthene	Semi-Volatile	S3	3/30/88	330
		S4	5/11/88	400
Pyrene	Semi-Volatile	S3	3/30/88	330

VOL 12 2 1378

D.8 Dissolved Oxygen Data from Stream Stations and Settling Data

VOL 12 2 1379

R0054679

KINNETIC
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(408) 426-3900

VOL 12 2 1380

SANTA CLARA URBAN RUNOFF STUDY
10-11 February 89
Assessment of Discrete and Persistent Dissolved Oxygen

The following data are from samples collected at four stations in the Santa Clara Urban Runoff study area, at five-to-seven hour intervals.

STATION	LOCATION	DATE	TIME COLLECTED	x (mg/L) CONCENTRATION	STANDARD DEVIATION
S-1	Wilcox	10FEB89	04:40	11.83	0.042
S-1	Wilcox	10FEB89	10:30	11.66	0.071
S-1	Wilcox	10FEB89	17:30	10.81	0.127
S-1	Wilcox	10FEB89	23:00	10.03	0.028
S-1	Wilcox	11FEB89	04:00	8.94	0.106
S-1	Wilcox	11FEB89	09:00	10.31	0.014
S-1	Wilcox	11FEB89	15:00	10.01	0.071

Dane D. Hardin
Regional Manager

R0054680

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VOL 12 2 1381

SANTA CLARA URBAN RUNOFF STUDY
10-11 February 89
Assessment of Discrete and Persistent Dissolved Oxygen

The following data are from samples collected at four stations in the Santa Clara Urban Runoff study area at five-to-seven hour intervals.

STATION	LOCATION	DATE	TIME COLLECTED	x (mg/L) CONCENTRATION	STANDARD DEVIATION
S-2	Bayshore	10FEB89	04:13	11.33	0.106
S-2	Bayshore	10FEB89	09:50	10.81	0.170
S-2	Bayshore	10FEB89	16:50	10.59	0.078
S-2	Bayshore	10FEB89	22:05	9.27	0.028
S-2	Bayshore	11FEB89	03:30	8 51	0.035
S-2	Bayshore	11FEB89	08:30	9.19	0.049
S-2	Bayshore	11FEB89	14:30	12.18	0.042

Dane D. Hardin
Regional Manager

R0054681

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SANTA CLARA URBAN RUNOFF STUDY
0-11 February 89
Assessment of Discrete and Persistent Dissolved Oxygen

The following data are from samples collected at four stations in the Santa Clara Urban Runoff study area, at five-to-seven hour intervals.

STATION	LOCATION	DATE	TIME COLLECTED	x (mg/L) CONCENTRATION	STANDARD DEVIATION
S-3	Guadalupe	10FEB89	05:40	10.26	0.028
S-3	Guadalupe	10FEB89	12:10	10.04	0.028
S-3	Guadalupe	10FEB89	15:17	9.81	0.064
S-3	Guadalupe	10FEB89	20:25	9.85	0.0
S-3	Guadalupe	11FEB89	01:30	9.83	0.049
S-3	Guadalupe	11FEB89	06:30	9.65	0.014
S-3	Guadalupe	11FEB89	12:45	10.42	0.735

Dane D. Hardin
Regional Manager

VOL 12 2 1382

R0054682

KINNETIC LABORATORIES INCORPORATED

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VOL 12 2 1383

SANTA CLARA URBAN RUNOFF STUDY
10-11 February 89
Assessment of Discrete and Persistent Dissolved Oxygen

The following data are from samples collected at four stations in the Santa Clara Urban Runoff study area at two-to-seven hour intervals.

STATION	LOCATION	DATE	TIME COLLECTED	x (mg/L) CONCENTRATION	STANDARD DEVIATION
S-4	Coyote	10FEB89	01:15	9.44	N/A*
S-4	Coyote	10FEB89	03:10	8.70	0.042
S-4	Coyote	10FEB89	08:57	9.03	0.049
S-4	Coyote	10FEB89	16:05	8.47	0.021
S-4	Coyote	10FEB89	21:30	8.89	0.071
S-4	Coyote	11FEB89	03:00	8.84	0.057
S-4	Coyote	11FEB89	08:00	8.83	0.049
S-4	Coyote	11FEB89	14:05	9.57	0.134

*Only one sample was collected at this site.

Dane D. Hardin
Regional Manager

R0054683

TABLE 2 CERIODAPHNIA REPRODUCTION AND SURVIVAL

Santa Clara Valley NPS Sample #3334

Sample	Day #	Replicate a	b	c	d	e	f	g	h	i	j	Total Young	# Live Adults
Control	4	5	4	0	4	5	4	4	2	6	2	36	10
	5	5	0	4	3	0	0	0	8	0	8	28	10
	6	0	8	5	8	10	8	6	0	8	0	53	10
	7	12	10	11	12	12	12	10	10	12	12	113	10
S-1	4	X	X	X	X	X	X	X	X	X	X	X	0
	5	-	-	-	-	-	-	-	-	-	-	-	0
	6	-	-	-	-	-	-	-	-	-	-	-	0
	7	-	-	-	-	-	-	-	-	-	-	-	0
S-2	4	4	4	4	5	0	0	3	3	2	4	29	40
	5	0	0	0	0	5	0	4	5	7	10	31	10
	6	8	10	8	12	10	10	0	1	0	0	59	10
	7	5	0	0	0	0	0	12	12	10	2	41	10
S-3	4	4	3	4	5	5	4	6	4	4	4	43	10
	5	0	0	0	10	8	12	9	10	10	10	69	10
	6	12	10	12	1	0	0	0	0	0	8	43	10
	7	16	2	8	2	16	16	18	16	18	X	112	9
L-1	4	0	0	0	0	0	0	0	0	0	0	0	10
	5	0	0	0	0	X	0	0	0	0	X	0	8
	6	0	0	0	0	-	0	0	0	0	-	0	8
	7	0	0	0	0	-	0	0	0	0	-	0	8
L-2	4	4	5	4	5	5	4	5	6	5	6	49	10
	5	10	8	10	10	0	0	0	0	0	0	38	10
	6	14	0	0	0	12	10	12	8	10	13	79	10
	7	0	10	10	12	6	14	17	18	18	18	123	10

X = Adult Died

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TABLE 2 -cont. CERIODAPHNIA REPRODUCTION AND SURVIVAL

Santa Clara Valley NPS Sample #3334

Sample	Day #	Replicate a	b	c	d	e	f	g	h	i	j	Total Young	# Live Adults
Control	4	5	4	0	4	5	4	4	2	6	2	36	10
	5	5	0	4	3	0	0	0	8	0	8	28	10
	6	0	8	5	8	10	8	6	0	8	0	53	10
	7	12	10	11	12	12	12	10	10	12	12	113	10
L-3	4	5	4	4	X	5	5	4	5	4	4	40	9
	5	0	0	0	-	0	0	0	0	0	0	0	9
	6	0	12	0	-	0	0	0	0	4	0	16	9
	7	X	X	X	-	X	X	X	X	X	X	0	0
L-4	4	0	0	6	5	6	5	4	2	0	X	28	9
	5	5	8	0	0	0	0	0	8	8	-	29	9
	6	0	10	10	11	10	12	8	0	8	-	69	9
	7	0	2	12	0	12	8	8	3	0	-	45	9
L-5	4	2	X	4	5	5	3	5	4	6	7	41	9
	5	2	-	6	6	8	0	0	0	0	9	29	9
	6	5	-	0	3	0	5	8	9	6	0	36	9
	7	10	-	12	10	12	11	1	16	6	4	82	9
L-6	4	4	4	5	5	6	2	5	6	6	6	49	10
	5	0	0	0	0	0	0	0	0	0	0	0	10
	6	7	11	9	10	8	10	12	8	10	13	98	10
	7	18	18	18	20	20	18	16	18	14	20	180	10
L-7	4	6	4	6	5	4	5	3	6	5	6	50	10
	5	9	6	0	0	0	8	0	0	9	12	44	10
	6	0	0	8	8	10	3	10	11	0	0	50	10
	7	15	14	16	12	16	17	16	15	16	14	151	10

X = Male Died

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TABLE 3

CERIODAPHNIA - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3334

Dissolved Oxygen (mg/l)

Sample	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
	i*	f*	i	f	i	f	i	f	i	f	i	f	i	f
Control	8.2	6.6	8.2	7.2	8.2	7.4	8.2	7.9	8.1	7.8	8.2	7.8	8.1	7.8
S-1	9.4	6.4	8.7	7.3	9.0	7.1	8.5	7.6	8.8	7.7	8.4	7.8	8.4	7.7
S-2	9.0	6.4	8.9	7.7	9.0	7.0	8.1	8.0	9.0	7.9	8.8	7.8	8.7	7.8
S-3	8.3	6.5	8.0	7.3	8.5	7.4	8.5	8.0	8.2	7.8	8.2	7.8	8.0	7.8
L-1	9.4	6.4	9.6	7.0	10.0	6.7	10.2	7.8	9.8	7.8	9.2	7.8	10.0	7.8
L-2	9.0	6.5	8.8	7.7	9.0	7.2	9.2	7.9	8.6	7.9	8.6	7.8	8.5	7.8
L-3	9.0	6.3	9.2	7.3	9.0	7.3	10.0	7.9	9.4	7.8	9.2	7.7	8.0	7.8
L-4	9.4	6.8	9.2	7.4	9.4	7.5	9.4	8.0	9.4	7.9	9.8	7.7	9.4	7.8
L-5	9.0	6.6	9.0	7.4	9.0	7.7	7.9	7.9	8.6	7.8	8.2	7.9	8.0	7.8
L-6	9.1	6.7	8.6	7.4	9.1	7.5	9.2	7.9	8.5	7.8	8.0	7.8	8.0	7.9
L-7	9.2	6.7	9.0	7.3	9.2	7.4	10.3	8.0	9.0	7.8	9.8	7.8	9.4	7.6

*i = initial
f = final (just before renewal)

pH Value (units)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	8.0	8.1	7.9	7.7	8.0	7.9	7.9
S-1	6.6	7.1	6.7	7.0	6.9	6.6	6.5
S-2	7.5	7.4	7.1	7.2	7.2	7.0	7.0
S-3	7.9	7.7	7.4	7.5	7.4	7.3	7.3
L-1	10.5	10.4	10.4	10.4	10.2	10.1	10.4
L-2	7.3	7.1	6.8	6.5	6.7	6.7	6.7
L-3	7.3	7.4	7.0	6.6	6.8	6.7	6.7
L-4	8.0	8.0	7.6	7.8	7.6	7.6	7.6
L-5	7.4	7.4	6.9	7.1	7.0	6.9	6.9
L-6	7.4	7.5	7.3	7.1	7.1	7.1	7.0
L-7	8.2	8.3	8.0	8.1	8.0	7.8	7.9

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TABLE 3 - continued CERIODAPHNIA - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3334

Conductivity (umhos/cm)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	270	270	270	270	270	270	270
S-1	115	120	120	120	120	120	120
S-2	168	165	165	165	165	165	165
S-3	290	290	290	290	290	290	290
L-1	750	775	775	775	775	775	775
L-2	78	80	80	80	80	80	80
L-3	58	70	70	70	70	70	70
L-4	1100	1100	1100	1100	1100	1100	1100
L-5	175	180	180	180	180	180	180
L-6	60	75	75	75	75	75	75
L-7	600	600	600	600	600	600	600

Temperature (°C)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	25.0	25.5	25.5	24.0	25.0	25.0	25.0
S-1	25.0	25.5	25.5	23.9	25.5	25.0	25.0
S-2	25.0	25.5	25.5	25.0	25.5	25.0	25.0
S-3	25.0	25.5	25.5	25.0	25.5	25.0	25.0
L-1	25.0	25.5	25.5	23.9	25.5	25.0	25.0
L-2	25.0	25.5	25.5	25.0	25.5	25.0	25.0
L-3	25.0	25.5	25.5	25.0	25.5	25.0	25.0
L-4	25.0	25.5	25.5	24.0	25.5	25.0	25.0
L-5	25.0	25.5	25.5	24.1	25.5	25.0	25.0
L-6	25.0	25.5	25.5	25.3	25.5	25.0	25.0
L-7	25.0	25.5	25.5	24.4	25.5	25.0	25.0

Alkalinity/Hardness (as mg/l CaCO3)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	68/104	68/104	68/104	68/104	68/104	68/104	68/104
S-1	44/36	44/36	44/36	44/36	44/36	44/36	44/36
S-2	62/68	62/68	62/68	62/68	62/68	62/68	62/68
S-3	129/136	129/136	129/136	129/136	129/136	129/136	129/136
L-1	258/32	258/32	258/32	258/32	258/32	258/32	258/32
L-2	34/28	34/28	34/28	34/28	34/28	34/28	34/28
L-3	26/26	26/26	26/26	26/26	26/26	26/26	26/26
L-4	210/440	210/440	210/440	210/440	210/440	210/440	210/440
L-5	45/56	45/56	45/56	45/56	45/56	45/56	45/56
L-6	38/32	38/32	38/32	38/32	38/32	38/32	38/32
L-7	212/230	212/230	212/230	212/230	212/230	212/230	212/230

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TABLE 4

FATHEAD MINNOW LARVAE
MEAN PERCENT SURVIVAL (n=30) AND MEAN LARVAL DRY WEIGHT

Santa Clara Valley NPS Sample #3334

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	(mg) Mean Larval Dry Weight
Control	100	100	100	97	97	93	93	0.5407
S-1	100	100	100	100	100	97	97	0.3570
S-2	100	100	100	100	100	100	100	0.4200
L-1	37	33	29	0	0	0	0	------
L-2	0	0	0	0	0	0	0	------
L-4	100	100	97	97	97	97	97	0.5411
L-5	100	100	100	100	100	100	100	0.4100
L-7	100	100	100	100	97	97	97	0.4700

For Larval Weight Data (excludes L1 and L2)

Bartlett's B (calculated) = 22.42
Tabled X^2 value (p=0.01, 5 df) = 15.09
Bartlett's B (square root transformed data) = 17.64

ANOVA F (calculated) = 6.13
ANOVA F (tabled) = 3.11

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TABLE 5

FATHEAD MINNOW LARVAE
SURVIVAL AND LARVAL DRY WEIGHT DATA

Santa Clara Valley NPS Sample #3334

Sample	Replicate	Number of Survivors Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Mean Larval Dry Weight (mg)
Control	1	10	10	10	10	9	9	9	9	0.5222
	2	10	10	10	10	10	10	9	9	0.5000
	3	10	10	10	10	10	10	10	10	0.6000
S-1	1	10	10	10	10	10	10	9	9	0.4111
	2	10	10	10	10	10	10	10	10	0.4200
	3	10	10	10	10	10	10	10	10	0.3300
S-2	1	10	10	10	10	10	10	10	10	0.4400
	2	10	10	10	10	10	10	10	10	0.3800
	3	10	10	10	10	10	10	10	10	0.4400
L-1	1	10	1	1	1	1	0	0	0	------
	2	10	4	2	2		0	0	0	------
	3	10	6	6	5		0	0	0	------
L-2	1	10	0	0	0	0	0	0	0	------
	2	10	0	0	0	0	0	0	0	------
	3	10	0	0	0	0	0	0	0	------
L-4	1	10	10	10	10	10	10	10	10	0.4700
	2	10	10	10	9	9	9	9	9	0.6333
	3	10	10	10	10	10	10	10	10	0.5200
L-5	1	10	10	10	10	10	10	10	10	0.4300
	2	10	10	10	10	10	10	10	10	0.4100
	3	10	10	10	10	10	10	10	10	0.3900
L-7	1	10	10	10	10	10	10	10	10	0.4700
	2	10	10	10	10	10	10	10	10	0.4700
	3	10	10	10	10	10	9	9	9	0.4700

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TABLE 6

FATHEAD MINNOW LARVAE - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3334

Dissolved Oxygen (mg/l)

Sample	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
	i*	f*	i	f	i	f	i	f	i	f	i	f	i	f
Control	8.2	6.3	8.2	6.8	8.2	6.9	8.2	7.1	8.1	7.0	8.2	7.0	8.1	6.6
S-1	9.4	5.5	8.7	6.0	9.0	5.5	8.5	6.4	8.8	6.1	8.4	6.2	8.4	6.0
S-2	9.0	5.6	8.9	5.7	9.0	5.4	8.1	6.2	9.0	5.4	8.8	5.1	8.7	5.9
L-1	9.4	5.6	9.6	5.2	10.0	5.0	10.2	4.2	9.8	4.5	9.2	---	10.0	---
L-2	9.0	5.4	8.8	---	9.0	---	9.2	---	8.6	---	8.6	---	8.5	---
L-4	9.4	6.0	9.2	6.6	9.4	6.4	9.6	6.7	9.4	6.3	9.8	6.0	9.4	6.2
L-5	9.0	5.6	9.0	6.2	9.0	6.1	7.9	6.7	8.6	6.5	8.2	6.3	8.0	6.3
L-7	9.2	6.3	9.0	6.9	9.2	6.5	10.3	6.8	9.0	6.7	9.8	6.5	9.4	6.5

*i = initial
f = final (just before renewal)

pH Value (units)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	8.0	8.1	7.9	7.7	8.0	7.9	7.9
S-1	6.6	7.1	6.7	7.0	6.9	6.6	6.5
S-2	7.5	7.4	7.1	7.2	7.2	7.0	7.0
L-1	10.5	10.4	10.4	10.4	10.2	10.1	10.4
L-2	7.3	7.1	6.8	6.5	6.7	6.7	6.7
L-4	8.0	8.0	7.6	7.8	7.6	7.6	7.6
L-5	7.4	7.4	6.9	7.1	7.0	6.9	6.9
L-7	8.2	8.3	8.0	8.1	8.0	7.8	7.9

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TABLE 6 - continued

FATHEAD MINNOW LARVAE - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3334

Conductivity (umhos/cm)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	270	270	270	270	270	270	270
S-1	115	120	120	120	120	120	120
S-2	168	165	165	165	165	165	165
L-1	750	775	775	775	775	775	775
L-2	78	80	80	80	80	80	80
L-4	1100	1100	1100	1100	1100	1100	1100
L-5	175	180	180	180	180	180	180
L-7	600	600	600	600	600	600	600

Temperature (°C)

Sample	Day 1	Day 2	Day 3	Lay 4	Day 5	Day 6	Day 7
Control	25.0	25.5	25.5	24.0	25.0	25.0	25.0
S-1	25.0	25.5	25.5	23.9	25.5	25.0	25.0
S-2	25.0	25.5	25.5	25.0	25.5	25.0	25.0
L-1	25.0	25.5	25.5	23.9	25.5	25.0	25.0
L-2	25.0	25.5	25.5	25.0	25.5	25.0	25.0
L-4	25.0	25.5	25.5	24.0	25.5	25.0	25.0
L-5	25.0	25.5	25.5	24.1	25.5	25.0	25.0
L-7	25.0	25.5	25.5	24.4	25.5	25.0	25.0

Alkalinity/Hardness (as mg/l CaCO3)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	68/104	68/104	68/104	68/104	68/104	68/104	68/104
S-1	44/36	44/36	44/36	44/36	44/36	44/36	44/36
S-2	62/68	62/68	62/68	62/68	62/68	62/68	62/68
L-1	258/32	258/32	258/32	258/32	258/32	258/32	258/32
L-2	34/28	34/28	34/28	34/28	34/28	34/28	34/28
L-4	210/440	210/440	210/440	210/440	210/440	210/440	210/440
L-5	45/56	45/56	45/56	45/56	45/56	45/56	45/56
L-7	212/230	212/230	212/230	212/230	212/230	212/230	212/230

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TABLE 7

SELENASTRUM CAPRICORNUTUM
GROWTH AND ENVIRONMENTAL MONITORING DATA
Santa Clara Valley NPS Sample #3334 - Run #1

Sample	Cells/ml X 10^6 after 96 hours Replicate 1	Replicate 2	Replicate 3	Mean
Control	3.17	3.17	3.37	3.24
L-3	3.39	3.22	3.43	3.35
L-4	3.13	3.20	3.43	3.25
L-5	1.22	1.28	1.15	1.22
L-6	2.73	2.21	2.39	2.44
L-7	1.92	2.30	2.23	2.15

Bartlett's B (calculated) = 3.653
Tabled X^2 value (p=0.01, df=5) = 15.01
ANOVA F (calculated) = 76.98
ANOVA F (tabled) = 3.11

Temperature (°C)

Sample	Day 1	Day 2	Day 3	Day 4
Control	23.8	24.2	24.0	24.7
L-3	23.8	24.2	24.0	24.7
L-4	23.8	24.2	24.0	24.7
L-5	23.8	24.2	24.0	24.7
L-6	23.8	24.2	24.0	24.7
L-7	23.8	24.2	24.0	24.7

Initial pH Value and Conductivity

Sample	pH value	Conductivity (umhos/cm)
Control	8.0	270
L-3	7.3	58
L-4	8.0	1100
L-5	7.4	175
L-6	7.4	60
L-7	8.2	600

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TABLE 8

SELENASTRUM CAPRICORNUTUM
GROWTH AND ENVIRONMENTAL MONITORING DATA
Santa Clara Valley NPS Sample #3334 - Run #2

Sample	Cells/ml X 10^6 after 96 hours Replicate 1	Replicate 2	Replicate 3	Mean
Control	3.66	3.76	3.63	3.68
S-1	2.09	2.94	3.37	3.80
S-2	2.38	3.02	3.10	2.83
S-3	4.03	3.60	3.79	3.81
L-1	0.033	0.043	0.038	0.038
L-2	0.0022	0	0.010	0.0061

Bartlett's B (calculated) = 31.22 ANOVA F (calculated) = 121.4
Tabled X^2 value (p=0.01, df=5) = 15.01 ANOVA F (tabled) = 3.11
Bartlett's B (square root transformed data) = 14.88

Temperature (°C)

Sample	Day 1	Day 2	Day 3	Day 4
Control	24.3	24.4	24.8	24.5
S-1	24.3	24.4	24.8	24.5
S-2	24.3	24.4	24.8	24.5
S-3	24.3	24.4	24.8	24.5
L-1	24.3	24.4	24.8	24.5
L-2	24.3	24.4	24.8	24.5

Initial pH Value and Conductivity

Sample	pH value	Conductivity (umhos/cm)
Control	8.0	270
S-1	7.1	120
S-2	7.4	165
S-3	7.7	290
L-1	10.4	775
L-2	7.1	80

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APPENDIX A

Summary of Test Conditions

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square root transformed weight data. There was no significant decrease in mean larval weight in samples L-4 and L-7 when compared with the weight of laboratory water controls. There was significantly decreased larval weight in samples S1, S2 and L5.

Environmental monitoring data for fathead minnow larvae are summarized in Table 6.

Selenastrum

Growth and environmental monitoring data are summarized in Table 7.

Because of the large number of samples, the test was run in two batches. Run #1 included samples L3, L4, L5, L6 and L7. Run #2 included samples S1, S2, S3, L1 and L2. Each sample set had its own control.

For Run #1, cell number data were normally distributed (Shapiro-Wilkes) and homogeneous (Bartletts B = 3.653 vs tabled X^2 value at p=0.01 and 5 d.f. = 15.09). ANOVA and Dunnetts analyses were done on the untransformed data. There was no significant decrease in mean cell numbers in samples L3 and L4 when compared with growth in lab water controls. There were significantly decreased cell numbers in sample L5, L6 and L7.

For Run #2, cell number data were normally distributed (Shapiro-Wilkes), but were not homogeneous. Square root transformation corrected the homogeneity (Bartlett's B = 14.88 vs tabled critical value for p=0.01 and df=5 of 15.09). ANOVA and Dunnett's tests were done on the square root-transformed data. There was no significant decrease in mean cell numbers in samples S1, S2 and S3 when compared with growth in lab water controls. There were significantly decreased cell numbers in samples L1 and L2.

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TABLE 1

SUMMARY OF REPRODUCTION AND SURVIVAL FOR CERIODAPHNIA
Santa Clara Valley NPS Sample #3334

Sample	Total Young Produced/Replicate a	b	c	d	e	f	g	h	i	j	% Survival (n = 10)
Control	22	22	20	27	27	24	20	20	26	22	100
**S-1	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0
**S-2	17	14	12	17	15	10	19	21	19	16	100
**S-3	32	15	24	18	29	32	33	30	32	22	100
L-1	0	0	0	0	0*	0	0	0	0	0*	80
**L-2	18	23	33	24	23	28	34	32	33	37	100
**L-3	5*	16*	4*	0*	5*	5*	4*	5*	8*	4*	0
**L-4	5	24	28	16	28	25	20	13	22	0*	90
**L-5	15	0*	22	24	25	19	14	29	18	20	90
**L-6	29	33	32	35	34	30	33	32	30	39	100
L-7	30	24	30	25	30	33	29	32	30	32	100

* Adult died
** Sample was tested at 10% dilution

For Reproductive Data (excludes S1, L1 and L3)

Bartlett's B (calculated) = 19.86***
Tabled X^2 value (p=0.05, dF=7) = 18.48

Steel's Rank Sum, Sample S2 = 55
Steel's Rank Sum, Sample L3 = 55
Steel's Rank Sum, All others = >73

*** Data were not homogeneous and could not be corrected by transformation. Data were analyzed by Steel's Many-One Rank Test.

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R0054696

All algal counts were made manually with a hemacytometer and microscope. Treatment groups and controls were set up with a minimum of three replicates. Testing was conducted in an environmental chamber with continuous illumination of 400 ft/candles at 24 ± 2°C for 96 hours. All test flasks were innoculated with approximately 1×10^4 cells/ml from a 4 day old stock culture. Cultures were shaken twice daily by hand. Upon conclusion of testing, statistical analyses were made of final cell densities to determine EC50 concentrations using the Probit Method. Bartlett's test was used to confirm homogeneity of variance after which Dunnett's test was used.

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R0054697

Results and Conclusions

Ceriodaphnia

On 14 February, testing was initiated on all samples. Within 8 hours, all daphnids in samples S1, S2, S3, L2, L3, L4, L5 and L6 had died. Ten percent dilutions of those samples were prepared using laboratory water, and the entire test was re-started on 15 February. The reproduction and survival data summarized in Tables 1 and 2 are the results of testing 100% concentrations of samples L1 and L7, and 10% concentrations of the samples listed above. Data were statistically analyzed using the laboratory water controls as the comparative data.

Analysis of survival data by Fisher's Exact Test showed that samples S1, L1 and L3 produced statisticelly significant mortality when compared with laboratory water controls. Following protocol guidelines, reproduction data for those samples was excluded from subsequent statistical analysis.

Reproduction data were found to be non-homogeneous, with a Bartlett's B value of 19.86 (tabled Bartletts value at P = 0.01 for 7 df = 18.48). This non-homogeneity could not be corrected by data transformation (square root, log, arcsin), and subsequent analysis was done by Steel's Many-One Rank Test. The tabulated critical rank sum value for n= 10 and K=8 at P=0.05 is 73. Rank sums for samples S-2 (55) and L3 (55) were less than 73, indicating that reproduction in these samples was significantly lower than in the laboratory control water.

Environmental monitoring data are tabulated and presented in Table 3.

Fathead Minnow Larvae

Survival and growth (dry weight) data are summarized in Table 4, and data for individual replicate test containers are presented in Table 5.

Mortality in samples L1 and L2 was significantly higher than in control water, and these data were excluded from further statistical analysis.

Larval weight data were normally distributed (Shapiro-Wilkes) but were not homogeneous (Bartletts B = 22.42). Data transformation (square root, log, arcsin) did not correct the non-homogeneity. Protocol guidance suggests that Steel's Many-One Rank Test be used to analyze growth data, but Steel's cannot be used when there are less than 4 replicates. Telephone guidance from EPA Cincinnati directed us to transform the data to produce the Bartletts B value closest to the critical number, and use that transformed data set to perform Dunnett's test. Square root transformation produced a Bartlett's B value of 17.64, compared with a critical B at 0.05 with 5 df of 15.09. Dunnett's analysis was done on the

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Introduction

As part of the Santa Clara Valley Non-Point Source Program, toxicity testing must be carried out on water samples collected during both dry weather (four times) and wet weather (three times). Dry weather tests require daily collection of water samples at the four stream stations (S1-S4). Wet weather tests are conducted using a single composite sample of runoff water for the daily renewals. This test is the first of three wet weather tests. Three toxicity tests are conducted, utilizing Ceriodaphnia dubia (invertebrate), Pimephales promelas (fish) and Selenastrum capricornutum (plant).

The Ceriodaphnia and Pimephales tests are seven days in duration, and are static-renewal protocols, requiring daily replacement of test solutions. Collections of runoff water are made by MBL personnel and stored at 4°C. Aliquots of this stored water are used for daily renewals.

The three bioassays were performed concurrently. Daphnids and fish were run on 15-21 February, 1989. Algae were tested in two batches, 14-18 February and 15-19 February, 1989. Methods, results and data are presented in the following pages.

The samples were collected and delivered to MBL by Kinnetic Laboratories Inc. personnel. The experimental design called testing only undiluted (100%) stream water. A lab water control (EPA moderately-hard) was run to provide quality assurance data. The lab water results were also used as the comparative data for statistical comparisons.

Most of the runoff samples proved to be acutely toxic to Ceriodaphnia, producing 100% mortality within 8 hours of test initiation. Those acutely toxic samples were S1, S2, S3, L2, L3, L4, L5 AND L6. After consultation with our client, we prepared 1:10 dilutions of each of those samples and started the Ceriodaphnia test again using 10% concentrations.

Fathead minnow and Selenastrum bioassays were done with undiluted runoff samples.

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Methods

Ceriodaphnia

Test organisms were neonates derived from in-house cultures. Original broodstock was from EPA Duluth, received 11 May, 1988 and cultured in EPA moderately hard water prepared with Milli-Q water. Samples of stream test water were collected daily during the test, and lab control water was EPA moderately hard (Milli-Q).

The test was initiated with 4-8 hour old neonates derived from third broods of individually maintained broodstock. Testing was conducted with 10 individuals per treatment, each in individual plastic cups containing 15 ml of test solution. Test temperature was 25 ± 1°C and photoperiod was 16 hour light:8 hour dark. Test solutions were renewed daily, concurrent with transfers, water quality measurements and assessment of survival and reproduction. At each daily transfer, new media were inoculated with food (2 drops of Ceriodaphnia chow and 1 drop of Selenastrum culture, density approximately 2.5 X 10^6 cells/ml). Following the 7-day test period, survival data was statistically evaluated using the probit method to calculate the 96-hour LC50. Reproductive data was evaluated using ANOVA and Dunnett's Test after confirming data homogeneity by Bartlett's Test. Test conditions and organism data are summarized in Appendix Table A-1.

Fathead Minnow Larvae

Test organisms were larvae, less than 24 hours old, obtained from in-house culture. All larvae were from the same spawning substrate, but probably from multiple spawns. Original broodstock was purchased from Thomas Fish Farms, San Rafael, California, approximately March of 1988. Stream test water samples were collected fresh each day. Control water was EPA moderately hard (Milli-Q). Ten larvae were used in each test container and there were three replicate containers per concentration. Each larval container was fed three times daily with 750-1000 newly-hatched Artemia nauplii. Test temperature was 25 ± 1°C, and photoperiod was 16:8. Daily renewal of 80% of the test volume coincided with daily environmental monitoring and assessment of survival. After seven days of exposure, the test was terminated by addition of formalin to each container. Surviving larvae were dried and weighed, and weight data were statistically evaluated using Bartlett's Test followed by ANOVA and Dunnett's Test. Probit analysis of survival data was used to calculate the 96-hour LC_1. Test conditions and organism data are summarized in appendix Table A-2.

Selenastrum

Algal assays were conducted in sterile 250 ml Erlenmeyer flasks. Preparation of the nutrient medium followed guidelines set forth in EPA-600/9-78-018.

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R0054700

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VOL 12 2 1401

3 SPECIES BIOASSAY RESULTS:

SANTA CLARA VALLEY NON-POINT SOURCE PROGRAM

WET WEATHER TEST #1

SAMPLES RECEIVED 13 FEBRUARY, 1989 AND THEREAFTER

DRAFT

Prepared for

KINNETIC LABORATORIES, INC.
Santa Cruz, California

Prepared by

MARINE BIOASSAY LABORATORIES DIVISION
TOXSCAN, INC.
Watsonville, California

APRIL, 1989

MBL

A DIVISION OF TOXSCAN, INC.

R0054701

APPENDIX E

R0054702

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APPENDIX E
SANTA CLARA TOXICITY DATA

R0054703

8720115APE CON-2

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E.1
WET-WEATHER TOXICITY DATA

R0054704

Santa Clara Settling Column Test Results

STA	SAMP PORT	MEASURED TSS CONCENTRATIONS 2 hr	6 hr	12 hr	24 hr	48 hr	sett time <-hours-> sett dist (feet)	PERCENT TSS REMOVED 2	6	12	24	48
S-1		85 mg/l - Initial TSS										
	1	53	34	25	8	14	1	38	60	71	91	84
	2	59	40	30	13	9	2	31	53	65	85	89
	3	63	39	23	13	10	3	26	54	73	85	88
	4	76	43	26	25	23	4	11	49	69	71	73
S-2		28 mg/l - Initial TSS										
	1	12	9	14	9	10	1	86	89	84	89	88
	2	15	16	19	9	8	2	82	81	78	89	91
	3	30	24	14	5	13	3	65	72	84	94	85
	4	31	22	17	12	3	4	64	74	80	86	96
S-3		22 mg/l - Initial T:										
	1	19	5	8	12	12	1	78	94	91	86	86
	2	24	9	9	5	4	2	72	89	89	94	95
	3	17	15	1[illegible]	9	5	3	80	82	79	89	94
	4	19	17	-	-	3	4	78	80	89	92	96
S-4		69 mg/l - Initial TSS										
	1	58	43	32	28	10	1	32	49	62	67	88
	2	60	37	32	23	16	2	29	56	62	73	81
	3	73	53	31	25	22	3	14	38	64	71	74
	4	69	55	31	22	17	4	19	35	64	74	80

Distribution of Settling velocities

Vs ft/hr	% Greater Than S-1	S-2	S-3	S-4
0.021	84	64	45	86
0.042	91	68	45	59
0.042	89	71	82	77
0.063	88	54	77	68
0.083	71	50	64	54
0.083	85	68	77	67
0.083	73	89	86	75
0.125	85	82	59	64
0.167	60	68	77	38
0.167	65	32	59	54
0.167	71	57	68	68
0.250	73	50	18	55
0.333	53	43	59	46
0.333	69	39	59	55
0.500	38	57	14	16
0.500	54	14	32	23
0.667	49	21	23	20
1.000	31	46	-9	13
1.500	26	-7	23	-6
2.000	11	-11	14	0

R0054705

Distribution of Settling Velocities - Pooled Test Results

Vs ft/hr	% Greater Than S-1	S-2	S-3	S-4	Avg % Remov 4 tests	Avg % Remov for Vs	Vs ft/hr
0.021	84	64	45	86	70	70	0.021
0.042	91	68	45	59	66		
0.042	89	71	82	77	80	73	0.042
0.063	88	54	77	68	72	72	0.063
0.083	71	50	64	54	59		
0.083	85	68	77	67	74		
0.083	73	89	86	75	81	72	0.083
0.125	85	82	59	64	72	72	0.125
0.167	60	68	77	38	61		
0.167	65	32	59	54	52		
0.167	71	57	68	68	66	60	0.167
0.250	73	50	18	55	49	49	0.250
0.333	53	43	59	46	50		
0.333	69	39	59	55	56	53	0.333
0.500	38	57	14	16	31		
0.500	54	14	32	23	31	31	0.500
0.667	49	21	23	20	28	28	0.667
1.000	31	46	-9	13	20	20	1.000
1.500	26	-7	23	-6	9	9	1.500
2.000	11	-11	14	0	3	3	2.000

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TABLE A-1

Ceriodaphnia Bioassay

Test Type:	Static Daily Renewal
Test Endpoints:	Survival, Reproduction
Test Duration:	7 days - 168 hours
Temperature:	25 ± 1°C
Photoperiod:	16 L: 8 D
Start:	14 February, 1989, 11:00 hours
Finish:	21 February, 1989, 11:00 hours
Test Containers:	1 oz plastic cups
Test Volume:	15 ml
Dilution Water:	Not Appliceble
Test Material:	Santa Clara Valley NPS - Wet Weather #1
Test Concentrations:	100%, controls
# Replicates:	10
Organisms per replicate:	1
Test Species:	Ceriodaphnia dubia
Source:	in-house culture
Age:	4-8 hours
Acclimation/Culture Water:	EPA Moderately Hard (Milli-Q)
Diet:	Selenastrum, Ceriodaphnia chow

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TABLE A-2

Fathead Minnow Bioassay

Test Type:	Static Daily Renewal
Test Endpoints:	Survival, Growth
Test Duration:	7 days - 168 hours
Temperature:	25 ± 1°C
Photoperiod:	16 L: 8 D
Start:	14 February, 1989, 12:30 hours
Finish:	21 February, 1989, 12:30 hours
Test Containers:	1 liter glass jars
Test Volume:	500 ml
Dilution Water:	Not Applicable
Test Material:	Santa Clara Valley NPS - Wet Weather #1
Test Concentrations:	100%, control
# Replicates:	3
Organisms per replicate:	10
Test Species:	*Pimephales promelas* (Fathead minnow)
Source:	in-house culture
Age:	<24 hours
Culture Water:	Dechlorinated Tap
Diet:	*Artemia* nauplii

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TABLE A-3

Selenastrum Bioassay

Test Type:	Static
Test Endpoints:	Growth, (cell number)
Test Duration:	4 days, 96 hours
Temperature:	24 ± 2°C
Photoperiod:	Continuous light
Light Intensity:	400 ± 40 FC
Start:	14 & 15 February, 1989, 14:00 hours
Finish:	18 & 19 February, 1989, 14:00 hours
Test Containers:	250 ml Erlenmeyer flasks
Test Volume:	100 ml
Dilution Water:	Not Applicable
Test Material:	Santa Clara Valley NPS - Wet Weather #1
Test Concentrations:	100%, Control
# Replicates:	3
Organisms per replicate:	10,000/ml innoculated
Test Species:	*Selenastrum capricornutum*
Source:	In-house culture
Age:	4 days
Culture Water:	EPA Moderately Hard

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R0054709

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1410

3 SPECIES BIOASSAY RESULTS:

SANTA CLARA VALLEY NON-POINT SOURCE PROGRAM

WET WEATHER TEST #2

SAMPLES RECEIVED 11 MARCH, 1989 AND THEREAFTER

Prepared for

KINNETIC LABORATORIES, INC.
Santa Cruz, California

Prepared by

MARINE BIOASSAY LABORATORIES DIVISION
TOXSCAN, INC.
Watsonville, California

MAY, 1989

MBL

A DIVISION OF TOXSCAN, INC.

R0054710

Introduction

As part of the Santa Clara Valley Non-Point Source Program, toxicity testing must be carried out on water samples collected during both dry weather (four times) and wet weather (three times). Dry weather tests require daily collection of water samples at the four stream stations (S1-S4). Wet weather tests are conducted using a single composite sample of runoff water for the daily renewals. This test is the second of three wet weather tests. Three toxicity tests are conducted, utilizing Ceriodaphnia dubia (invertebrate), Pimephales promelas (fish) and Selenastrum capricornutum (plant).

The Ceriodaphnia and Pimephales tests are seven days in duration, and are static-renewal protocols, requiring daily replacement of test solutions. Collections of runoff water are made by MBL personnel and stored at 4°C. Aliquots of this stored water are used for daily renewals.

The three bioassays were performed concurrently. Daphnids and fish were run on 14-21 March, 1989. Algae were tested in two batches, 11-15 March and 12-16 March, 1989. Methods, results and data are presented in the following pages.

The samples were collected and delivered to MBL by Kinnetic Laboratories Inc. personnel. The experimental design called for testing only undiluted (100%) stream water. A lab water control (EPA moderately-hard) was run to provide quality assurance data. The lab water results were also used as the comparative data for statistical comparisons.

Some of the runoff samples proved to be acutely toxic to Ceriodaphnia, producing 100% mortality within 8 hours of test initiation. Those acutely toxic samples were S1, S2, L5 and L6. We prepared dilutions of each of those samples and started the Ceriodaphnia test again using 25% or 50% concentrations.

Fathead minnow and Selenastrum bioassays were done with undiluted runoff samples.

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Methods

Ceriodaphnia

Test organisms were neonates derived from in-house cultures. Original broodstock was from EPA Duluth, received 11 May, 1988 and cultured in EPA moderately hard water prepared with Milli-Q water. Samples of stream test water were collected daily during the test, and lab control water was EPA moderately hard (Milli-Q).

The test was initiated with 4-8 hour old neonates derived from third broods of individually maintained broodstock. Testing was conducted with 10 individuals per treatment, each in individual plastic cups containing 15 ml of test solution. Test temperature was 25 ± 1°C and photoperiod was 16 hour light:8 hour dark. Test solutions were renewed daily, concurrent with transfers, water quality measurements and assessment of survival and reproduction. At each daily transfer, new media were inoculated with food (2 drops of Ceriodaphnia chow and 1 drop of Selenastrum culture, density approximately 2.5 X 10^6 cells/ml). Following the 7-day test period, survival data was statistically evaluated using the probit method to calculate the 96-hour LC50. Reproductive data was evaluated using ANOVA and Dunnett's Test after confirming data homogeneity by Bartlett's Test. Test conditions and organism data are summarized in Appendix Table A-1.

Fathead Minnow Larvae

Test organisms were larvae, less than 24 hours old, obtained from in-house culture. All larvae were from the same spawning substrate, but probably from multiple spawns. Original broodstock was purchased from Thomas Fish Farms, San Rafael, California, approximately March of 1988. Stream test water samples were collected fresh each day. Control water was EPA moderately hard (Milli-Q). Ten larvae were used in each test container and there were three replicate containers per concentration. Each larval container was fed three times daily with 750-1000 newly-hatched Artemia nauplii. Test temperature was 25 ± 1°C, and photoperiod was 16:8. Daily renewal of 80% of the test volume coincided with daily environmental monitoring and assessment of survival. After seven days of exposure, the test was terminated by addition of formalin to each container. Surviving larvae were dried and weighed, and weight data were statistically evaluated using Bartlett's Test followed by ANOVA and Dunnett's Test. Probit analysis of survival data was used to calculate the 96-hour LC_1. Test conditions and organism data are summarized in appendix Table A-2.

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Selenastrum

Algal assays were conducted in sterile 250 ml Erlenmeyer flasks. Preparation of the nutrient medium followed guidelines set forth in EPA-600/9-78-018.

All algal counts were made manually with a hemacytometer and microscope. Treatment groups and controls were set up with a minimum of three replicates. Testing was conducted in an environmental chamber with continuous illumination of 400 ft/candles at 24 ± 2°C for 96 hours. All test flasks were innoculated with approximately $\bar{1} \times 10^4$ cells/ml from a 4 day old stock culture. Cultures were shaken twice daily by hand. Upon conclusion of testing, statistical analyses were made of final cell densities to determine EC50 concentrations using the Probit Method. Bartlett's test was used to confirm homogeneity of variance after which Dunnett's test was used.

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Results and Conclusions

Ceriodaphnia

On 13 March, rangefinder acute testing was initiated on all samples. Within 8 hours, all daphnids in samples S1, S2, L5 and L6 had died. Dilutions of those samples were prepared using laboratory water, and the entire test was re-started on 14 February. The reproduction and survival data summarized in Tables 1 and 2 are the results of testing 100% concentrations of samples L1, L3, L4 and L7, 50% concentrations of samples S1 and L5 and 25% concentrations of samples S2 and L6. Data were statistically analyzed using the laboratory water controls as the comparative data.

Analysis of survival data by Fisher's Exact Test showed that all samples except L7 produced statistically significant mortality when compared with laboratory water controls. Following protocol guidelines, reproduction data for those samples was excluded from subsequent statistical analysis.

Mean young production for Sample L7 was higher (25.8 per adult) than laboratory water controls (17.3 per adult). No statistical analysis was necessary to determine that Sample L7 did not inhibit reproduction when compared with controls.

Environmental monitoring data are tabulated and presented in Table 3.

Fathead Minnow Larvae

Survival and growth (dry weight) data are summarized in Table 4, and data for individual replicate test containers are presented in Table 5.

Mortality in sample L1 was significantly higher than in control water, and these data were excluded from further statistical analysis.

Larval weight data were normally distributed (Shapiro-Wilkes) and homogeneous (Bartletts B = 7.324). Dunnett's analysis was done on the untransformed weight data. There was no significant decrease in mean larval weight in samples S1, S2, L5, and L7 when compared with the weight of laboratory water controls.

Environmental monitoring data for fathead minnow larvae are summarized in Table 6.

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Selenastrum

Growth and environmental monitoring data are summarized in Table 7.

Because of the large number of samples, the test was run in two batches. Run #1 included samples S1, S2, S3, S4 and L1. Run #2 included samples L3, L4, L5, L6 and L7. Each sample set had its own control.

For Run #1, cell number data were normally distributed (Shapiro-Wilkes) and homogeneous (Bartletts B = 8.606 vs tabled X^2 value at p=0.01 and 4 d.f. = 13.28). There were no visible cells in sample L1 after four days of incubation, so these data were excluded from further statistical analysis. There were significantly decreased cell numbers in sample S1, S2, S3 and S4 when compared with growth in lab water controls.

For Run #2, cell number data were normally distributed (Shapiro-Wilkes) and homogeneous. (Bartlett's B = 9.736 vs tabled critical value for p=0.01 and df=5 of 15.09). ANOVA and Dunnett's tests were done on the untransformed data. There was no significant decrease in mean cell numbers in samples L3, L6 and L7 when compared with growth in lab water controls. There were significantly decreased cell numbers in samples L4 and L5.

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R0054715

TABLE 1

SUMMARY OF REPRODUCTION AND SURVIVAL FOR CERIODAPHNIA
Santa Clara Valley NPS Sample #3658

Sample	Total Young Produced/Replicate										% Survival (n = 10)
	a	b	c	d	e	f	g	h	i	j	
Control	21	17	6	19	17	18	17	20	18	20	100
S-1(50%)	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0
S-2(25%)	0*	0*	3*	0*	4*	5*	0*	3*	0*	0*	0
L-1	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0
L-3	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0
L-4	22*	6*	3*	10*	9*	10*	14*	23	8*	11*	10
L-5(50%)	0*	4*	0*	4*	0*	2*	4*	1*	3*	4*	0
L-6(25%)	4*	2*	2*	0*	0*	4*	5*	0*	2*	4*	0
L-7	25	26	21	18	31	27	25	27	29	29	100

* Organism died prior to test completion.

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TABLE 2 — CERIODAPHNIA REPRODUCTION AND SURVIVAL

Santa Clara Valley NPS Sample #3658

Sample	Day #	Replicate a	b	c	d	e	f	g	h	i	j	Total Young	# Live Adults
Control	4	5	3	2	4	1	4	3	3	4	4	33	10
	5	0	0	1	0	0	0	0	0	0	0	1	10
	6	6	6	3	7	8	6	6	8	6	8	64	10
	7	10	8	0	8	8	8	8	9	8	8	75	10
S-1 (50%)	4	X	X	X	X	X	X	X	X	X	X	0	0
	5	-	-	-	-	-	-	-	-	-	-	0	0
	6	-	-	-	-	-	-	-	-	-	-	0	0
	7	-	-	-	-	-	-	-	-	-	-	0	0
S-2 (25%)	4	X	X	3	X	4	5	X	3	X	X	15	4
	5	-	-	-	-	-	-	-	-	-	-	0	0
	6	-	-	-	-	-	-	-	-	-	-	0	0
	7	-	-	-	-	-	-	-	-	-	-	0	0
L-1 (100%)	4	X	X	X	X	X	X	X	X	X	X	0	0
	5	-	-	-	-	-	-	-	-	-	-	0	0
	6	-	-	-	-	-	-	-	-	-	-	0	0
	7	-	-	-	-	-	-	-	-	-	-	0	0
L-3 (100%)	4	X	X	X	X	X	X	X	X	X	X	0	0
	5	-	-	-	-	-	-	-	-	-	-	0	0
	6	-	-	-	-	-	-	-	-	-	-	0	0
	7	-	-	-	-	-	-	-	-	-	-	0	0
L-4 (100%)	4	4	0	3	4	3	4	5	4	5	4	36	10
	5	0	2	0	0	0	0	2	7	0	2	13	10
	6	9	4	X	6X	6X	6X	7	X	3X	5X	46	3
	7	9X	0X	-	-	-	-	-	12	-	-	21	1

X= Organism died prior to test completion

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TABLE 2 (cont.) CERIODAPHNIA REPRODUCTION AND SURVIVAL

Santa Clara Valley NPS Sample #3658

Sample	Day #	Replicate a	b	c	d	e	f	g	h	i	j	Total Young	# Live Adults
Control	4	5	3	2	4	1	4	3	3	4	4	33	10
	5	0	0	1	0	0	0	0	0	0	0	1	10
	6	6	6	3	7	8	6	6	8	6	8	64	10
	7	10	8	0	8	8	8	8	9	8	8	75	10
L-5 (50%)	4	X	4X	X	4X	X	2X	4X	1X	3X	4X	22	0
	5	-	-	-	-	-	-	-	-	-	-	0	0
	6	-	-	-	-	-	-	-	-	-	-	0	0
	7	-	-	-	-	-	-	-	-	-	-	0	0
L-6 (50%)	4	4X	2	2X	X	X	4X	5X	X	2X	4X	23	1
	5	-	X	-	-	-	-	-	-	-	-	0	0
	6	-	-	-	-	-	-	-	-	-	-	0	0
	7	-	-	-	-	-	-	-	-	-	-	0	0
L-7 (100%)	4	4	4	4	4	6	5	4	5	6	4	46	10
	5	0	0	0	0	0	0	7	0	0	9	16	10
	6	8	10	7	7	8	9	0	10	9	0	68	10
	7	13	12	10	7	17	13	14	12	14	16	128	10

X= Organism died prior to test completion.

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TABLE 3

CERIODAPHNIA - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3658

Dissolved Oxygen (mg/l)

Sample	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
	i*	f*	i	f	i	f	i	f	i	f	i	f	i	f
Control	7.8	7.7	7.8	7.6	7.6	7.5	7.7	7.7	7.7	7.7	8.1	7.6	8.1	7.2
S-1(50%)	7.7	7.5	8.5	7.5	8.3	7.5	-	-	-	-	-	-	-	-
S-2(25%)	8.7	7.5	10.0	7.5	9.1	7.5	9.8	7.5	9.4	-	-	-	-	-
L-1	6.5	502	707	706	707	705	-	-	-	-	-	-	-	-
L-3	9.6	7.2	9.4	7.6	-	-	-	-	-	-	-	-	-	-
L-4	9.5	7.6	9.2	7.6	8.9	7.5	9.2	7.7	9.2	7.7	9.4	7.6	9.3	5.6
L-5(50%)	9.2	7.4	9.2	7.6	9.6	7.5	10.1	7.6	10.3	-	-	-	-	-
L-6(50%)	8.6	7.2	10.0	7.5	8.6	7.5	8.4	7.1	-	-	-	-	-	-
L-7	9.6	7.6	10.2	7.6	9.8	7.6	10.0	7.7	10.4	7.5	10.2	7.6	10.1	6.4

*i = initial
f = final (just before renewal)

pH Value (units)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	7.8	8.0	7.9	7.9	7.8	7.8	7.9
S-1(50%)	6.5	6.5	6.6	-	-	-	-
S-2(25%)	6.7	6.8	6.9	6.8	6.9	-	-
L-1	5.6	5.7	5.9	-	-	-	-
L-3	6.4	6.6	-	-	-	-	-
L-4	7.7	7.9	8.0	7.9	7.9	7.9	7.9
L-5(50%)	6.4	6.5	6.7	6.7	6.4	-	-
L-6(50%)	6.7	6.8	7.2	7.2	-	-	-
L-7	7.8	7.9	7.9	7.8	7.8	7.9	7.8

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TABLE 3 - continued

CERIODAPHNIA - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3658

Conductivity (umhos/cm)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	275	275	275	275	275	275	275
S-1	140	140	140	140	140	140	140
S-2	140	140	140	140	140	140	140
L-1	2700	2700	2700	2700	2700	2700	2700
L-3	110	110	110	110	110	110	110
L-4	1100	1100	1100	1100	1100	1100	1100
L-5	90	90	90	90	90	90	90
L-6	100	100	100	100	100	100	100
L-7	600	600	600	600	600	600	600

Temperature (°C)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	25.0	25.0	25.5	25.5	25.2	23.2	25.0
S-1	25.0	25.0	25.5	-	-	-	-
S-2	25.0	25.0	25.5	25.0	-	-	-
L-1	25.0	25.0	25.5	-	-	-	-
L-3	25.0	25.0	-	-	-	-	-
L-4	25.0	25.0	25.5	25.0	25.5	25.2	25.0
L-5	25.0	25.0	25.5	25.0	26.0	-	-
L-6	25.0	25.0	25.5	25.0	25.5	-	-
L-7	25.0	25.0	25.5	25.0	25.5	25.2	25.0

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TABLE 3 - continued

CERIODAPHNIA - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3658

Alkalinity/Hardness (as mg/l CaCO3)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	78/102	78/102	78/102	78/102	78/102	78/102	78/102
S-1	57/56	57/56	57/56	57/56	57/56	57/56	57/56
S-2	58/66	58/66	58/66	58/66	58/66	58/66	58/66
L-1	274/88	274/88	274/88	274/88	274/88	274/88	274/88
L-3	28/32	28/32	28/32	28/32	28/32	28/32	28/32
L-4	214/508	214/508	214/508	214/508	214/508	214/508	214/508
L-5	32/44	32/44	32/44	32/44	32/44	32/44	32/44
L-6	32/44	32/44	32/44	32/44	32/44	32/44	32/44
L-7	222/272	222/272	222/272	222/272	222/272	222/272	222/272

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TABLE 4

FATHEAD MINNOW LARVAE
MEAN PERCENT SURVIVAL (n=30) AND MEAN LARVAL DRY WEIGHT

Santa Clara Valley NPS Sample #3658

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	(mg) Mean Larval Dry Weight
Control	100	100	100	100	100	100	100	0.2566
S-1	100	100	100	100	100	100	100	0.3666
S-2	100	100	100	100	100	100	97	0.2907
L-1	0	0	0	0	0	0	0	___
L-5	100	100	100	100	100	100	100	0.3533
L-7	100	100	100	93	90	90	90	0.4214

For Larval Weight Data

Bartlett's B = 7.324
Tabled X^2 value (p=0.05, 4 df) = 13.28

ANOVA F (calculated) = 8.648
ANOVA F (tabled) = 3.48

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TABLE 5

FATHEAD MINNOW LARVAE
SURVIVAL AND LARVAL DRY WEIGHT DATA

Santa Clara Valley NPS Sample #3658

Sample	Replicate	Number of Survivors Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Mean Larval Dry Weight (mg)
Control	1	10	10	10	10	10	10	10	10	0.210
	2	10	10	10	10	10	10	10	10	0.300
	3	10	10	10	10	10	10	10	10	0.260
S-1	1	10	10	10	10	10	10	10	10	0.370
	2	10	10	10	10	10	10	10	10	0.400
	3	10	10	10	10	10	10	10	9	0.330
S-2	1	10	10	10	10	9	9	9	9	0.310
	2	10	10	10	10	10	9	8	8	0.340
	3	10	10	10	10	8	8	8	8	0.222
L-1	1	10	0	0	0	0	0	0	0	---
	2	10	0	0	0	0	0	0	0	---
	3	10	0	0	0	0	0	0	0	---
L-5	1	10	10	10	10	10	10	10	10	0.350
	2	10	10	10	10	10	10	10	10	0.360
	3	10	10	10	10	10	10	10	10	0.350
L-7	1	10	10	10	10	10	10	10	10	0.440
	2	10	10	10	10	10	10	10	10	0.410
	3	10	10	10	10	8	7	7	7	0.4142

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TABLE 6

FATHEAD MINNOW LARVAE - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3658

Dissolved Oxygen (mg/l)

Sample	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
	i*	f*	i	f	i	f	i	f	i	f	i	f	i	f
Control	7.8	7.1	7.8	6.9	7.6	6.5	7.7	6.7	7.7	7.0	8.1	6.8	8.1	6.6
S-1	7.7	6.1	8.5	5.5	8.3	5.8	-	6.1	-	6.5	-	6.0	-	5.6
S-2	8.7	6.4	10.0	5.9	9.1	5.9	9.8	6.4	9.4	6.5	-	6.1	-	5.5
L-1	6.5	7.0	7.7	-	7.7	-	-	-	-	-	-	-	-	-
L-5	9.2	6.4	9.2	5.6	9.6	5.7	10.1	6.3	10.3	7.0	-	6.5	-	6.1
L-7	9.6	6.4	10.2	6.1	9.8	6.1	10.0	6.6	10.4	7.0	10.2	6.5	10.1	6.1

*i = initial
f = final (just before renewal)

pH Value (units)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	7.8	8.0	7.9	7.9	7.8	7.8	7.9
S-1	6.5	6.5	6.6	-	-	-	-
S-2	6.7	6.8	6.9	6.8	6.9	-	-
L-1	5.6	5.7	5.9	-	-	-	-
L-5	6.4	6.5	6.7	6.7	6.4	-	-
L-7	7.8	7.9	7.9	7.8	7.8	7.9	7.8

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TABLE 6 - continued

FATHEAD MINNOW LARVAE - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3658

Conductivity (umhos/cm)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	275	275	275	275	275	275	275
S-1	140	140	140	140	140	140	140
S-2	140	140	140	140	140	140	140
L-1	2700	2700	2700	2700	2700	2700	2700
L-5	90	90	90	90	90	90	90
L-7	600	600	600	600	600	600	600

Temperature (°C)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	25.0	25.0	25.5	25.5	25.2	23.2	25.0
S-1	25.0	25.0	25.5	-	-	-	-
S-2	25.0	25.0	25.5	25.0	-	-	-
L-1	25.0	25.0	25.5	-	-	-	-
L-5	25.0	25.0	25.5	25.0	26.0	-	-
L-7	25.0	25.0	25.5	25.0	25.5	25.2	25.0

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TABLE 6 - continued

CERIODAPHNIA - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3658

Alkalinity/Hardness (as mg/l CaCO3)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	78/102	78/102	78/102	78/102	78/102	78/102	78/102
S-1	57/56	57/56	57/56	57/56	57/56	57/56	57/56
S-2	58/66	58/66	58/66	58/66	58/66	58/66	58/66
L-1	274/88	274/88	274/88	274/88	274/88	274/88	274/88
L-5	32/44	32/44	32/44	32/44	32/44	32/44	32/44
L-7	222/272	222/272	222/272	222/272	222/272	222/272	222/272

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TABLE 7

SELENASTRUM CAPRICORNUTUM
GROWTH AND ENVIRONMENTAL MONITORING DATA
Santa Clara Valley NPS Sample #3658

Sample	Cells/ml X 10^6 after 96 hours Replicate 1	Replicate 2	Replicate 3	Mean
Control	2.54	2.56	2.49	2.53
S-1	2.03	1.91	1.99	1.98
S-2	1.86	1.69	1.78	1.78
S-3	1.71	1.93	2.29	1.98
S-4	1.79	1.82	1.96	1.86
L-1	0	0	0	0

Bartlett's B (calculated) = 8.606
Tabled X^2 value (p=0.05, df=4) = 13.28

ANOVA F (calculated) = 12.34
ANOVA F (tabled) = 3.48

Temperature (°C)

Sample	Day 1	Day 2	Day 3	Day 4
Control	25.0	26.5	25.9	25.3
S-1	25.0	26.5	25.9	25.3
S-2	25.0	26.5	25.9	25.3
S-3	25.0	26.5	25.9	25.3
S-4	25.0	26.5	25.9	25.3
L-1	25.0	26.5	25.9	25.3

Initial pH Value and Conductivity

Sample	pH value	Conductivity (umhos/cm)
Control	7.6	275
S-1	7.2	140
S-2	7.4	140
S-3	7.9	-
S-4	8.0	-
L-1	6.1	2700

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TABLE 8

SELENASTRUM CAPRICORNUTUM
GROWTH AND ENVIRONMENTAL MONITORING DATA
Santa Clara Valley NPS Sample #3658

Sample	Cells/ml X 10^6 after 96 hours Replicate 1	Replicate 2	Replicate 3	Mean
Control	1.51	2.10	2.13	1.91
L-3	2.06	2.28	2.09	2.14
L-4	0.44	0.48	0.53	0.48
L-5	1.12	1.02	0.98	1.04
L-6	2.72	2.82	2.92	2.82
L-7	2.04	2.19	2.13	2.12

Bartlett's B (calculated) = 9.736
Tabled X^2 value (p=0.05, df=4) = 15.09
ANOVA F (calculated) = 80.66
ANOVA F (tabled) = 3.11

Temperature (°C)

Sample	Day 1	Day 2	Day 3	Day 4
Control	24.2	24.0	23.8	24.4
L-3	24.2	24.0	23.8	24.4
L-4	24.2	24.0	23.8	24.4
L-5	24.2	24.0	23.8	24.4
L-6	24.2	24.0	23.8	24.4
L-7	24.2	24.0	23.8	24.4

Initial pH Value and Conductivity

Sample	pH value	Conductivity (umhos/cm)
Control	7.5	275
L-3	6.9	110
L-4	8.0	1100
L-5	6.9	90
L-6	7.0	100
L-7	8.2	600

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APPENDIX A

Summary of Test Conditions

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TABLE A-1

Ceriodaphnia Bioassay

Test Type:	Static Daily Renewal
Test Endpoints:	Survival, Reproduction
Test Duration:	7 days - 168 hours
Temperature:	25 ± 1°C
Photoperiod:	16 L: 8 D
Start:	14 March, 1989, 13:00 hours
Finish:	21 March, 1989, 13:00 hours
Test Containers:	1 oz plastic cups
Test Volume:	15 ml
Dilution Water:	Not Applicable
Test Material:	Santa Clara Valley NPS - Wet Weather #2
Test Concentrations:	100%, 50%, 25%, controls
# Replicates:	10
Organisms per replicate:	1
Test Species:	Ceriodaphnia dubia
Source:	in-house culture
Age:	4-8 hours
Acclimation/Culture Water:	EPA Moderately Hard (Milli-Q)
Diet:	Selenastrum, Ceriodaphnia chow

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TABLE A-2

Fathead Minnow Bioassay

Test Type:	Static Daily Renewal
Test Endpoints:	Survival, Growth
Test Duration:	7 days - 168 hours
Temperature:	25 ± 1°C
Photoperiod:	16 L: 8 D
Start:	14 March, 1989, 10:00 hours
Finish:	21 March, 1989, 10:00 hours
Test Conteiners:	1 liter glass jars
Test Volume:	500 ml
Dilution Water:	Not Applicable
Test Material:	Santa Clara Valley NPS - Wet Weather #2
Test Concentrations:	100%, control
# Replicates:	3
Organisms per replicate:	10
Test Species:	Pimephales promelas (Fathead minnow)
Source:	in-house culture
Age:	<24 hours
Culture Water:	Dechlorinated Tap
Diet:	Artemia nauplii

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TABLE A-3

Selenastrum Bioassay

Test Type:	Static
Test Endpoints:	Growth, (cell number)
Test Duration:	4 days, 96 hours
Temperature:	24 ± 2°C
Photoperiod:	Continuous light
Light Intensity:	400 ± 40 FC
Start:	11 & 12 March, 1989, 14:00 hours
Finish:	15 & 16 March, 1989, 14:00 hours
Test Containers:	250 ml Erlenmeyer flasks
Test Volume:	100 ml
Dilution Water:	Not Applicable
Test Material:	Santa Clara Valley NPS - Wet Weather #2
Test Concentrations:	100%, Control
# Replicates:	3
Organisms per replicate:	10,000/ml innoculated
Test Species:	*Selenastrum capricornutum*
Source:	In-house culture
Age:	4 days
Culture Water:	EPA Moderately Hard

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3 SPECIES BIOASSAY RESULTS:

SANTA CLARA VALLEY NON-POINT SOURCE PROGRAM

WET WEATHER TEST #3

SAMPLES RECEIVED 28 MARCH, 1989 AND THEREAFTER

Prepared for

KINNETIC LABORATORIES, INC.
Santa Cruz, California

Prepared by

MARINE BIOASSAY LABORATORIES DIVISION
TOXSCAN, INC.
Watsonville, California

MAY, 1989

MBL

A DIVISION OF TOXSCAN, INC.

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R0054733

Introduction

As part of the Santa Clara Valley Non-Point Source Program, toxicity testing must be carried out on water samples collected during both dry weather (four times) and wet weather (three times). Dry weather tests require daily collection of water samples at the four stream stations (S1-S4). Wet weather tests are conducted using a single composite sample of runoff water for the daily renewals. This test is the third of three wet weather tests. Three toxicity tests are conducted, utilizing Ceriodaphnia dubia (invertebrate), Pimephales promelas (fish) and Selenastrum capricornutum (plant).

The Ceriodaphnia and Pimephales tests are seven days in duration, and are static-renewal protocols, requiring daily replacement of test solutions. Collections of runoff water are made by MBL personnel and stored at 4°C. Aliquots of this stored water are used for daily renewals.

The three bioassays were performed concurrently. Daphnids and fish were run on 28 March - 4 April, 1989. Algae were tested in two batches, both run on 30 March - 4 April, 1989. Methods, results and data are presented in the following pages.

The samples were collected and delivered to MBL by Kinnetic Laboratories Inc. personnel. The experimental design called for testing only undiluted (100%) stream water. A lab water control (EPA moderately-hard) was run to provide quality assurance data. The lab water results were also used as the comparative data for statistical comparisons.

Based upon previous wet weather test results, we expected many of the runoff samples to produce rapid and complete mortality in Ceriodaphnia tests. After one day of exposure in this test, however, most Ceriodaphnia were still alive, so we did not prepare dilutions of any of the test samples. All species were tested with undiluted runoff samples.

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Methods

Ceriodaphnia

Test organisms were neonates derived from in-house cultures. Original broodstock was from EPA Duluth, received 11 May, 1988 and cultured in EPA moderately hard water prepared with Milli-Q water. Samples of stream test water were collected daily during the test, and lab control water was EPA moderately hard (Milli-Q).

The test was initiated with 4-8 hour old neonates derived from third broods of individually maintained broodstock. Testing was conducted with 10 individuals per treatment, each in individual plastic cups containing 15 ml of test solution. Test temperature was 25 ± 1°C and photoperiod was 16 hour light:8 hour dark. Test solutions were renewed daily, concurrent with transfers, water quality measurements and assessment of survival and reproduction. At each daily transfer, new media were inoculated with food (2 drops of *Ceriodaphnia* chov and 1 drop of *Selenastrum* culture, density approximately 2.5 X 10^6 cells/ml). Following the 7-day test period, survival data was statistically evaluated using the probit method to calculate the 96-hour LC50. Reproductive data was evaluated using ANOVA and Dunnett's Test after confirming data homogeneity by Bartlett's Test. Test conditions and organism data are summarized in Appendix Table A-1.

Fathead Minnow Larvae

Test organisms were larvae, less than 24 hours old, obtained from in-house culture. All larvae were from the same spawning substrate, but probably from multiple spawns. Original broodstock was purchased from Thomas Fish Farms, San Rafael, California, approximately March of 1988. Stream test water samples were collected fresh each day. Control water was EPA moderately hard (Milli-Q). Ten larvae were used in each test container and there were three replicate containers per concentration. Each larval container was fed three times daily with 750-1000 newly-hatched *Artemia* nauplii. Test temperature was 25 ± 1°C, and photoperiod was 16:8. Daily renewal of 80% of the test volume coincided with daily environmental monitoring and assessment of survival. After seven days of exposure, the test was terminated by addition of formalin to each container. Surviving larvae were dried and weighed, and weight data were statistically evaluated using Bartlett's Test followed by ANOVA and Dunnett's Test. Probit analysis of survival data was used to calculate the 96-hour LC_1. Test conditions and organism data are summarized in appendix Table A-2.

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Selenastrum

Algal assays were conducted in sterile 250 ml Erlenmeyer flasks. Preparation of the nutrient medium followed guidelines set forth in EPA-600/9-78-018.

All algal counts were made manually with a hemacytometer and microscope. Treatment groups and controls were set up with a minimum of three replicates. Testing was conducted in an environmental chamber with continuous illumination of 400 ft/candles at 24 ± 2°C for 96 hours. All test flasks were innoculated with approximately 1×10^4 cells/ml from a 4 day old stock culture. Cultures were shaken twice daily by hand. Upon conclusion of testing, statistical analyses were made of final cell densities to determine EC50 concentrations using the Probit method. Bartlett's test was used to confirm homogeneity of variance after which Dunnett's test was used.

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Results and Conclusions

Ceriodaphnia

Testing was initiated on 28 March, 1989. Reproduction and survival data are summarized in Table 1 and are presented in full in Table 2. Data was statistically analysed using the laboratory water as the comparitive dictum ("control").

Analysis of survival data by Fisher's Exact Test showed that all samples except L-2 and L-7 produced statistically significant mortality when compared with laboratory water controls. Following protocol guidelines, reproduction data for those samples was excluded from subsequent statistical analysis.

Reproduction data for control, L-2 and L-7 samples were found to be normally distributed (Shapiro-Wilkes test) and homogeneous (Bartlett's B = 2.760). Subsequent ANOVA and Dunnett's tests showed that there was significantly decreased young production in sample L-2 when compared with lab water controls. Sample L-7 was not significantly diferent from controls.

Environmental monitoring data are tabulated and presented in Table 3.

Fathead Minnow Larvae

Survival and growth (dry weight) data are summarized in Table 4, and data for individual replicate test containers are presented in Table 5.

Larval weight data were normally distributed (Shapiro-Wilkes) and homogeneous (Bartletts B = 11.89). Dunnett's analysis was done on the untransformed weight data. Mean larval weight in all samples tested was significantly decreased in comparison with larval weight of laboratory controls. For this data set, the minimum significant difference was 0.145 grams, representing a 17.9% reduction in larval weight from the control.

Environmental monitoring data for fathead minnow larvae are summarized in Table 6.

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Selenastrum

Growth and environmental monitoring data are summarized in Table 7.

Because of the large number of samples, the test was run in two batches. Run #1 included samples L4, L5, L6 and L7. Run #2 included samples S1,S2,S4,L2,and L3. Each sample set had its own control.

For Run #1, cell number data were normally distributed (Shapiro-Wilkes) and homogeneous (Bartletts B = 8.941 vs tabled X^2 value at p=0.01 and 4 d.f. = 13.28). There were significantly decreased cell numbers in samples L4, L5, L6 and L7 when compared with growth in lab water controls.

For Run #2, cell number data were normally distributed (Shapiro-Wilkes) but were not homogeneous (Bartletts B = 16.84). Data transformation (square root, log, arcsin) did not correct the non-homogenity. Protocol guidance suggests that Steel's Many-One Rank Test be used to analyze growth data, but Steel's cannot be used when there are less than 4 replicates. Telephone guidance from EPA Cincinnati directed us to transform the data to produce the Bartletts B value closest to the critical number, and use that transformed data set to perform Dunnett's test. Square root transformation produced a Bartlett's B value of 15.58, compared with a critical B at 0.05 with a 5df of 15.09. Dunnett's analysis was done on the square root trasformed data. There was no significant decrease in cell number in samples S1, S2, and L3 when compared with laboratory water controls. There were significantly decreased cell numbers in samples S4 and L2.

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TABLE 1

SUMMARY OF REPRODUCTION AND SURVIVAL FOR CERIODAPHNIA
Santa Clara Valley NPS Sample #3774

	Total Young Produced/Replicate (n = 10)										% Survival
a b	c	d	e	f	g	h	i	j			
Control	16	14	16	18	19	0*	19	20	18	16	90
S-1	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0
S-2	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0
S-4	2*	0*	0*	0*	4*	0*	0*	0*	1*	0*	0
L-2	17	2	0*	5	14	6	6	11	9	10	90
L-3	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0
L-4	0*	0*	0*	0*	0*	0*	2*	2*	0*	0*	0
L-5	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0
L-6	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0
L-7	20	10	17	21	18	20	19	19	20	15	100

* Organism died prior to test completion.

For Reproductive Data

Bartlett's B = 2.760
Tabled X^2 value (p=0.01, 2 df) = 9.210

ANOVA F (calculated) = 11.23
ANOVA F (tabled) = 3.35

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TABLE 2 CERIODAPHNIA REPRODUCTION AND SURVIVAL

Santa Clara Valley NPS Sample #3774

Sample	Day #	Replicate a	b	c	d	e	f	g	h	i	j	Total Young	# Live Adults
Control	4	4	0	0	0	0	0	0	4	2	2	12	10
	5	0	3	0	2	7	X	6	0	0	0	18	9
	6	5	4	7	6	5	-	6	6	6	6	51	9
	7	7	7	9	10	7	-	7	10	10	8	75	9
L-2	4	1	0	X	0	0	2	2	3	0	1	9	9
	5	0	2	-	0	2	0	0	0	2	0	6	9
	6	10	0	-	1	4	0	0	5	1	4	26	9
	7	6	0	-	4	8	4	4	3	5	5	39	9
L-7	4	3	2	3	2	3	2	2	1	2	2	22	10
	5	0	0	0	0	0	0	2	0	8	6	16	10
	6	8	5	5	9	7	9	5	8	0	5	61	10
	7	9	3	9	10	8	9	10	10	10	2	80	10

X= Organism died prior to test completion

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TABLE 3

CERIODAPHNIA - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3774

Dissolved Oxygen (mg/l)

Sample	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
	i*	f*	i	f	i	f	i	f	i	f	i	f	i	f
Control	7.6	7.6	7.4	7.7	7.5	7.9	7.5	7.6	7.6	7.5	7.7	7.6	7.6	7.1
S-1	9.1	7.5	8.6	7.6	-	-	-	-	-	-	-	-	-	-
S-2	8.9	7.4	8.2	7.6	7.9	7.6	-	-	-	-	-	-	-	-
S-4	8.6	7.5	7.5	7.6	8.0	7.7	9.1	7.6	-	-	-	-	-	-
L-2	8.7	7.4	8.0	7.4	7.9	7.7	8.7	7.6	8.1	7.5	7.4	7.7	8.0	7.0
L-3	8.4	7.4	8.0	7.4	8.3	7.6	9.0	7.6	-	-	-	-	-	-
L-4	8.7	7.5	8.6	7.5	8.7	7.8	9.7	7.5	-	-	-	-	-	-
L-5	9.7	7.4	18.8	7.5	8.9	7.7	9.5	7.6	-	-	-	-	-	-
L-6	7.4	7.4	-	-	-	-	-	-	-	-	-	-	-	-
L-7	9.8	7.4	9.3	7.4	9.6	7.9	9.4	7.6	9.4	7.5	9.8	7.7	9.8	6.7

*i= initial
f= final (just before renewal)

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TABLE 3 - continued

CERIODAPHNIA - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3774

pH Value (units)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	7.9	8.0	8.2	8.0	7.9	8.0	8.0
S-1	7.1	7.0	-	-	-	-	-
S-2	7.3	7.3	7.3	-	-	-	-
S-4	5.6	7.9	7.9	7.7	-	-	-
L-2	7.0	6.9	6.8	6.8	6.6	6.7	6.6
L-3	6.7	6.8	6.5	6.4	-	-	-
L-4	8.0	8.0	8.1	8.0	-	-	-
L-5	6.8	6.7	6.8	6.7	-	-	-
L-6	6.7	-	-	-	-	-	-
L-7	7.8	7.8	8.0	7.8	7.8	7.6	7.6

Conductivity (umhos/cm)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	330	-	-	-	-	-	-
S-1	145	-	-	-	-	-	-
S-2	140	140	145	-	-	-	-
S-4	825	-	-	-	-	-	-
L-2	80	80	80	82	80	80	80
L-3	55	55	58	58	-	-	-
L-4	1500	1500	1400	1400	-	-	-
L-5	90	90	80	80	-	-	-
L-6	70	-	-	-	-	-	-
L-7	360	360	350	360	340	360	360

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TABLE 3 - continued

CERIODAPHNIA - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3774

Temperature (°C)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	25.5	26	26	26	26	26	26
S-1	26	26	-	-	-	-	-
S-2	26	26	26	-	-	-	-
S-4	26	26	26.5	25.5	-	-	-
L-2	26	26	26	24.8	25.5	25	25.5
L-3	26	26	26.5	25	-	-	-
L-4	26	26	26	25	-	-	-
L-5	26	26	26.5	25	-	-	-
L-6	26	-	-	-	-	-	-
L-7	26	26	26.5	24	25.5	25	25.5

Alkalinity/Hardness (as mg/l CaCO3)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	87/120	87/120	87/120	87/120	87/120	87/120	87/120
S-1	48/46	48/46	48/46	48/46	48/46	48/46	48/46
S-2	52/60	52/60	52/60	50/60	52/60	52/60	52/60
S-4	200/165	200/165	200/165	200/165	200/165	200/165	200/165
L-2	35/40	35/40	35/40	35/40	35/40	35/40	35/40
L-3	35/24	35/24	35/24	35/24	35/24	35/24	35/24
L-4	295/583	295/583	295/583	295/583	295/583	295/583	295/583
L-5	42/32	42/32	42/32	42/32	42/32	42/32	42/32
L-6	47/28	47/28	47/28	47/28	47/28	47/28	47/28
L-7	155/176	155/176	155/176	155/176	155/176	155/176	155/176

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APPENDIX A

Summary of Test Conditions

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TABLE A-1

Ceriodaphnia Bioassay

Test Type:	Static Daily Renewal
Test Endpoints:	Survival, Reproduction
Test Duration:	7 days - 168 hours
Temperature:	25 ± 1°C
Photoperiod:	16 L: 8 D
Start:	12 December, 1988, 14:30 hours
Finish:	19 December, 1988, 14:30 hours
Test Containers:	1 oz plastic cups
Test Volume:	15 ml
Dilution Water:	Not Applicable
Test Material:	Santa Clara Valley NPS - Dry Weather #1
Test Concentrations:	100%, controls
# Replicates:	10
Organisms per replicate:	1
Test Species:	Ceriodaphnia dubia
Source:	in-house culture
Age:	4-8 hours
Acclimation/Culture Water:	EPA Moderately Hard (Milli-Q)
Diet:	Selenastrum, Ceriodaphnia chov

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TABLE A-2

Fathead Minnow Bioassay

Test Type:	Static Daily Renewal
Test Endpoints:	Survival, Growth
Test Duration:	7 days - 168 hours
Temperature:	25 ± 1°C
Photoperiod:	16 L: 8 D
Start:	12 December, 1988, 11:00 hours
Finish:	19 December, 1988, 11:00 hours
Test Containers:	1 liter glass jars
Test Volume:	500 ml
Dilution Water:	Not Applicable
Test Material:	Santa Clara Valley NPS - Dry Weather #1
Test Concentrations:	100%, control
# Replicates:	3
Organisms per replicate:	10
Test Species:	Pimephales promelas (Fathead minnow)
Source:	in-house culture
Age:	<24 hours
Culture Water:	Dechlorinated Tap
Diet:	Artemia nauplii

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TABLE A-3

Selenastrum Bioassay

Test Type:	Static
Test Endpoints:	Growth, (cell number)
Test Duration:	4 days, 96 hours
Temperature:	24 ± 2°C
Photoperiod:	Continuous light
Light Intensity:	400 ± 40 FC
Start:	13 December, 1988, 16:00 hours
Finish:	17 December, 1988, 16:00 hours
Test Containers:	250 ml Erlenmeyer flasks
Test Volume:	100 ml
Dilution Water:	Not Applicable
Test Material:	Santa Clara Valley NPS - Dry Weather #1
Test Concentrations:	100%, Control
# Replicates:	3
Organisms per replicate:	10,000/ml innoculated
Test Species:	*Selenastrum capricornutum*
Source:	In-house culture
Age:	4 days
Culture Water:	EPA Moderately Hard

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TABLE 4

FATHEAD MINNOW LARVAE
MEAN PERCENT SURVIVAL (n=30) AND MEAN LARVAL DRY WEIGHT
Santa Clara Valley NPS Sample #3774

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	(mg) Mean Larval Dry Weight
Control	100	100	100	100	100	100	100	0.4065
S-1	100	100	100	100	100	97	97	0.2630
S-2	100	100	100	100	100	100	97	0.2730
L-2	100	100	93	93	90	90	90	0.1750
L-3	100	97	97	97	97	97	97	0.2550
L-5	100	100	100	100	97	97	97	0.2650
L-6	100	100	97	97	93	93	93	0.2580
L-7	100	100	100	100	100	100	100	0.3317

For Larval Weight Data

Bartlett's B = 11.89
Tabled X^2 value (p=0.05, 7 df) = 18.48

ANOVA F (calculated) = 11.05
ANOVA F (tabled) = 2.66

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TABLE 5

FATHEAD MINNOW LARVAE
SURVIVAL AND LARVAL DRY WEIGHT DATA
Santa Clara Valley NPS Sample #3774

Sample	Replicate	Number of Survivors								Mean Larval
		Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Weight (mg
Control	1	10	10	10	10	10	10	10	10	0.400
	2	10	10	10	10	10	10	10	10	0.465
	3	10	10	10	10	10	10	10	10	0.355
S-1	1	10	10	10	10	10	10	10	10	0.235
	2	10	10	10	10	10	10	9	9	0.265
	3	10	10	10	10	10	10	10	10	0.290
S-2	1	10	10	10	10	10	10	10	10	0.275
	2	10	10	10	10	10	10	10	10	0.235
	3	10	10	10	10	10	10	10	10	0.310
L-2	1	10	10	10	10	10	10	10	10	0.175
	2	10	10	10	10	10	10	10	10	0.165
	3	10	10	10	8	8	7	7	7	0.185
L-3	1	10	10	9	9	9	9	9	9	0.270
	2	10	10	10	10	10	10	10	10	0.275
	3	10	10	10	10	10	10	10	10	0.230
L-5	1	10	10	10	10	10	10	10	10	0.245
	2	10	10	10	10	10	10	10	10	0.330
	3	10	10	10	10	10	9	9	9	0.230
L-6		10	10	10	9	9	8	8	8	0.255
	2	10	10	10	10	10	10	10	10	0.260
	3	10	10	10	10	10	10	10	10	0.260
L-7	1	10	10	10	10	10	10	10	10	0.340
	2	10	10	10	10	10	10	10	10	0.355
	3	10	10	10	10	10	10	10	10	0.300

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TABLE 6

FATHEAD MINNOW LARVAE - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3774

Dissolved Oxygen (mg/l)

Sample	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
	i*	f*	i	f	i	f	i	f	i	f	i	f	i	f
Control	7.6	6.7	7.4	5.9	7.5	6.3	7.5	6.7	7.6	6.4	7.7	5.2	7.6	5.1
S-1	9.1	6.6	8.6	5.5	8.6	5.8	9.0	6.5	9.0	6.0	8.5	4.9	9.4	5.0
S-2	8.9	6.4	18.2	4.5	7.9	5.6	8.4	6.5	8.3	5.9	7.5	4.5	8.2	5.1
L-2	8.7	6.7	8.0	5.5	7.9	5.3	8.7	6.3	8.1	6.2	7.4	5.4	8.0	5.0
L-3	8.4	6.6	8.0	5.4	8.3	5.6	9.0	6.5	8.8	5.8	8.1	4.6	9.3	4.8
L-5	9.7	6.5	8.8	5.2	8.9	5.3	9.5	6.4	9.4	5.9	8.7	4.9	9.3	4.9
L-6	7.4	6.4	7.4	4.9	7.1	5.4	7.5	6.3	7.3	5.7	7.2	4.5	7.8	5.0
L-7	9.8	6.7	8.3	5.5	9.6	6.1	9.4	6.8	9.4	6.2	9.8	5.1	9.8	5.7

*i = initial f= final (just before renewal)

pH Value (units)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	7.9	8.0	8.2	8.0	7.9	8.0	8.0
S-1	7.1	7.0	7.1	6.8	6.9	6.9	6.7
S-2	7.3	7.3	7.3	7.1	7.0	7.2	7.1
L-2	7.0	6.9	6.8	6.8	6.6	6.7	6.6
L-3	6.7	6.8	6.5	6.4	6.4	6.3	6.3
L-5	6.8	6.7	6.8	6.7	6.8	6.5	6.4
L-6	6.7	6.7	6.7	6.6	6.7	6.6	6.5
L-7	7.8	7.8	8.0	7.8	7.8	7.6	7.6

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TABLE 6 - continued

FATHEAD MINNOW LARVAE - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3774

Conductivity (umhos/cm)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	330	300	300	305	300	310	305
S-1	145	145	147	145	146	148	146
S-2	140	140	145	140	142	140	145
L-2	80	80	80	82	80	80	80
L-3	55	55	58	58	57	55	58
L-5	90	90	80	80	85	80	85
L-6	70	70	72	73	70	72	70
L-7	360	360	350	360	340	360	360

Temperature (°C)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	25.5	26	26	26	26	25	25.5
S-1	26	26	26	25	25.5	25	25.5
S-2	26	26	26	24.8	25.5	25	25.5
L-2	26	26	26	24.8	25.5	25	25.5
L-3	26	26	26.5	25	25.5	25	25.5
L-5	26	26	26.5	25	25.5	25	25.5
L-6	26	26	26.5	24.5	25.5	25	25.5
L-7	26	26	26.5	24	25.5	25	25.5

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TABLE 6 - continued

FATHEAD MINNOW LARVAL ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3774

Alkalinity/Hardness (as mg/l CaCO3)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	87/120	87/120	87/120	87/120	87/120	87/120	87/120
S-1	48/46	48/46	48/46	48/46	48/46	48/46	48/46
S-2	52/60	52/60	52/60	52/60	52/60	52/60	52/60
L-2	35/40	35/40	35/40	35/40	35/40	35/40	35/40
L-3	35/24	35/24	35/24	35/24	35/24	35/24	35/24
L-5	42/32	42/32	42/32	42/32	42/32	42/32	42/32
L-6	47/28	47/28	47/28	47/28	47/28	47/28	47/28
L-7	155/176	155/176	155/176	155/176	155/176	155/176	155/176

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TABLE 7

SELENASTRUM CAPRICORNUTUM
GROWTH AND ENVIRONMENTAL MONITORING DATA
Santa Clara Valley NPS sample # 774- Run #1

Sample	Cells/ml X 10^6 after 6 hours Replicate 1	Replicate 2	Replicate 3	Mean
Control	2.46	2.59	2.34	2.46
L-4	1.43	1.59	1.67	1.56
L-5	1.17	1.07	0.95	1.06
L-6	0.0066	0.0178	0.0089	0.0111
L-7	2.12	2.23	2.17	2.17

Bartlett's B (calculated) = 8.941
Tabled X^2 value (p=0.01, df=4) = 13.28

ANOVA F (calculated) = 3.0
ANOVA F (tabled) = 3.48

Temperature (°C)

Sample	Day 1	Day 2	Day 3	Day 4
Control	24.4	24.8	24.6	23.9
L-4	24.4	24.8	24.6	23.9
L-5	24.4	24.8	24.6	23.9
L-6	24.4	24.8	24.6	23.9

Initial pH Value and Conductivity

Sample	pH value	Conductivity (umhos/cm)
Control	7.5	300
L-4	8.0	1500
L-5	7.0	90
L-6	6.9	70
L-7	8.0	360

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TABLE 8

SELENASTRUM CAPRICORNUTUM
GROWTH AND ENVIRONMENTAL MONITORING DATA
Santa Clara Valley NPS Sample #3774

Sample	Cells/ml X 10^6 after 96 hours Replicate 1	Replicate 2	Replicate 3	Mean
Control	2.93	2.93	2.89	2.92
S-1	2.56	2.57	2.53	2.55
S-2	2.28	2.12	2.85	2.42
S-4	1.47	0.99	1.23	1.23
L-2	1.06	1.21	1.19	1.15
L-3	3.83	4.47	3.80	4.03

Bartlett's B (calculated) = 15.58 ANOVA F (calculated) = 65.5
Tabled X^2 value (p=0.01, df=5) = 15.01 ANOVA F (tabled) = 3.11

Temperature (°C)

Sample	Day 1	Day 2	Day 3	Day 4
Control	25.1	24.1	25.5	25.4
S-1	25.1	24.1	25.5	25.4
S-2	25.1	24.1	25.5	25.4
S-4	25.1	24.1	25.5	25.4
L-2	25.1	24.1	25.5	25.4
L-3	25.1	24.1	25.5	25.4

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TABLE 8 - continued

SELENASTRUM CAPRICORNUTUM
GROWTH AND ENVIRONMENTAL MONITORING DATA
Santa Clara Valley NPS Sample #3774 Run #2

Initial pH Value and Conductivity

Sample	pH value	Conductivity (umhos/cm)
Control	7.5	300
S-1	7.1	145
S-2	7.4	140
S-4	7.7	650
L-2	7.1	80
L-3	6.8	55

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APPENDIX A

Summary of Test Conditions

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TABLE A-1

Ceriodaphnia Bioassay

Test Type:	Static Daily Renewal
Test Endpoints:	Survival, Reproduction
Test Duration:	7 days - 168 hours
Temperature:	25 ± 1°C
Photoperiod:	16 L: 8 D
Start:	28 March, 1989, 10:00 hours
Finish:	4 April, 1989, 10:00 hours
Test Containers:	1 oz plastic cups
Test Volume:	15 ml
Dilution Water:	Not Applicable
Test Material:	Santa Clara Valley NPS - Wet Weather #3
Test Concentrations:	100%, 50%, 25%, controls
# Replicates:	10
Organisms per replicate:	1
Test Species:	Ceriodaphnia dubia
Source:	in-house culture
Age:	4-8 hours
Acclimation/Culture Water:	EPA Moderately Hard (Milli-Q)
Diet:	Selenastrum, Ceriodaphnia chow

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TABLE A-2

Fathead Minnow Bioassay

Test Type:	Static Daily Renewal
Test Endpoints:	Survival, Growth
Test Duration:	7 days - 168 hours
Temperature:	25 ± 1°C
Photoperiod:	16 L: 8 D
Start:	28 March, 1989, 11:00 hours
Finish:	4 April, 1989, 11:00 hours
Test Containers:	1 liter glass jars
Test Volume:	500 ml
Dilution Water:	Not Applicable
Test Material:	Santa Clara Valley NPS - Wet Weather #3
Test Concentrations:	100%, control
# Replicates:	3
Organisms per replicate:	10
Test Species:	Pimephales promelas (Fathead minnow)
Source:	in-house culture
Age:	<24 hours
Culture Water:	Dechlorinated Tap
Diet:	Artemia nauplii

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TABLE A-3

Selenastrum Bioassay

Test Type:	Static
Test Endpoints:	Growth, (cell number)
Test Duration:	4 days, 96 hours
Temperature:	24 ± 2°C
Photoperiod:	Continuous light
Light Intensity:	400 ± 40 FC
Start:	30 March, 1989, 10:00 and 14:00 hours
Finish:	3 April, 1989, 10:00 and 14:00 hours
Test Containers:	250 ml Erlenmeyer flasks
Test Volume:	100 ml
Dilution Water:	Not Applicable
Test Material:	Santa Clara Valley NPS - Wet Weather #3
Test Concentrations:	100%, Control
# Replicates:	3
Organisms per replicate:	10,000/ml innoculated
Test Species:	*Selenastrum capricornutum*
Source:	In-house culture
Age:	4 days
Culture Water:	EPA Moderately Hard

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DRY-WEATHER TOXICITY DATA

R0054760

MARINE BIOASSAY LABORATORIES
1234 HIGHWAY ONE
WATSONVILLE, CA 95076
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3 SPECIES BIOASSAY RESULTS:

SANTA CLARA VALLEY NON-POINT SOURCE PROGRAM

DRY WEATHER TEST #1

SAMPLES RECEIVED 12 DECEMBER, 1988 AND THEREAFTER

Prepared for

KINNETIC LABORATORIES, INC.
Santa Cruz, California

Prepared by

MARINE BIOASSAY LABORATORIES DIVISION
TOXSCAN, INC.
Watsonville, California

JANUARY 9, 1989

MBL

A DIVISION OF TOXSCAN, INC.

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R0054761

Introduction

As part of the Santa Clara Valley Non-Point Source Program, toxicity testing must be carried out on water samples collected during both dry weather (four times) and wet weather (twice). Dry weather tests require daily collection of water samples at the four stream stations (S1-S4). Wet weather tests will be conducted using a single composite sample of runoff water for the daily renewals. This test is the first of four dry weather tests. Three toxicity tests are conducted, utilizing Ceriodaphnia dubia (invertebrate), Pimephales promelas (fish) and Selenastrum capricornutum (plant).

The Ceriodaphnia and Pimephales tests are seven days in duration, and are static-renewal protocols, requiring daily replacement of test solutions with newly-collected test water samples. Daily collections of stream water are made by MBL personnel.

The three bioassays were performed concurrently. Daphnids and fish were run on 13-20 December,1988 while algae were tested on 13-17 December, 1988. Methods, results and data are presented in the following pages.

The samples were collected and delivered to MBL by MBL personnel. The experimental design called testing only undiluted (100%) stream water. A lab water control (EPA moderately-hard) was run to provide quality assurance data. The lab water results were also used as the comparative data for statistical comparisons.

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R0054762

Methods

Ceriodaphnia

Test organisms were neonates derived from in-house cultures. Original broodstock was from EPA Duluth, received 11 May, 1988 and cultured in EPA moderately hard water prepared with Milli-Q water. Samples of stream test water were collected daily during the test, and lab control water was EPA moderately hard (Milli-Q).

The test was initiated with 4-8 hour old neonates derived from third broods of individually maintained broodstock. Testing was conducted with 10 individuals per treatment, each in individual plastic cups containing 15 ml of test solution. Test temperature was 25 ± 1°C and photoperiod was 16 hour light:8 hour dark. Test solutions were renewed daily, concurrent with transfers, water quality measurements and assessment of survival and reproduction. At each daily transfer, new media were inoculated with food (2 drops of Ceriodaphnia chow and 1 drop of Selenastrum culture, density approximately 2.5 X 10^6 cells/ml). Following the 7-day test period, survival data was statistically evaluated using the probit method to calculate the 96-hour LC50. Reproductive data was evaluated using ANOVA and Dunnett's Test after confirming data homogeneity by Bartlett's Test. Test conditions and organism data are summarized in Appendix Table A-1.

Fathead Minnow Larvae

Test organisms were larvae, less than 24 hours old, obtained from in-house culture. All larvae were from the same spawning substrate, but probably from multiple spawns. Original broodstock was purchased from Thomas Fish Farms, San Rafael, California, approximately March of 1988. Stream test water samples were collected fresh each day. Control water was EPA moderately hard (Milli-Q). Ten larvae were used in each test container and there were three replicate containers per concentration. Each larval container was fed three times daily with 750-1000 newly-hatched Artemia nauplii. Test temperature was 25 ± 1°C, and photoperiod was 16:8. Daily renewal of 80% of the test volume coincided with daily environmental monitoring and assessment of survival. After seven days of exposure, the test was terminated by addition of formalin to each container. Surviving larvae were dried and weighed, and weight data were statistically evaluated using Bartlett's Test followed by ANOVA and Dunnett's Test. Probit analysis of survival data was used to calculate the 96-hour LC_1. Test conditions and organism data are summarized in appendix Table A-2.

Selenastrum

Algal assays were conducted in sterile 250 ml Erlenmeyer flasks. Preparation of the nutrient medium followed guidelines set forth in EPA-600/9-78-018.

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All algal counts were made manually with a hemacytometer and microscope. Treatment groups and controls were set up with a minimum of three replicates. Testing was conducted in an environmental chamber with continuous illumination of 400 ft/candles at 24 ± 2°C for 96 hours. All test flasks were innoculated with approximately $\bar{1}$ X 10^4 cells/ml from a 4 day old stock culture. Cultures were shaken twice daily by hand. Upon conclusion of testing, statistical analyses were made of final cell densities to determine EC50 concentrations using the Probit Method. Bartlett's test was used to confirm homogeneity of variance after which Dunnett's test was used.

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Results and Conclusions

Ceriodaphnia

Reproduction and survival data for Ceriodaphnia are summarized in Table 1, and are presented in full in Table 2. Data were statistically analyzed using the laboratory water as the comparative datum ("control").

No stream sample produced ≥ 50% mortality of Ceriodaphnia after 96 hours exposure. The 96-hour LC_{50} for Ceriodaphnia is >100% for all samples.

Reproduction data were determined to be homogeneous by Bartlett's test, with a B value of 0.5476. Tabled X^2 value for 4 d.f. at $p=0.05$ was 9.488. ANOVA and Dunnett's test were performed on the untransformed reproduction data. For these data, the minimum significant difference is 8.15 young per adult, representing a 45.3% reduction of mean young production from control levels. There was no significant reduction in young produced between any stream water and the lab water controls.

Environmental monitoring data are tabulated and presented in Table 3.

Fathead Minnow Larvae

Survival and growth (dry weight) data are summarized in Table 4, and data for individual replicate test containers are presented in Table 5.

There was no effluent concentration tested in which survival was less than 83%. The 96-hour LC_{50} values, therefore, are >100% for all samples.

Larval weight data were determined to be homogeneous, with a Bartlett's B value of 4.674. The tabled X^2 value for 4 d.f. at $p=0.05$ is 9.488. Subsequent ANOVA and Dunnetts analyses were done on the untransformed weight data. There was no significant decrease in mean larval weight in samples S-1, S-2 and S-3 when compared with the weight of dilution water controls. There was significantly decreased larval weight in the S-4 sample.

Environmental monitoring data for fathead minnow larvae are summarized in Table 6.

Selenastrum

Growth and environmental monitoring data are summarized in Table 7.

The lab water growth (cell number) data were set equal to 100% growth, and cell numbers in each stream sample were transformed to

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percentage of the lab water values. The 96-hour EC_{50} was calculated to be >100% of all stream samples.

Cell number data were homogeneous (Bartletts B = 0.9274 vs tabled X^2 value at p=0.05 and 4 d.f. = 9.488). ANOVA and Dunnetts analyses were done on the untransformed data. There was no signficant decrease in mean cell numbers in any of the stream samples when compared with growth in lab water controls.

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TABLE 1

SUMMARY OF REPRODUCTION AND SURVIVAL FOR CERIODAPHNIA
Santa Clara Valley NPS Sample #3334

Sample	Total Young Produced/Replicate										% Survival (n = 10)
	a	b	c	d	e	f	g	h	i	j	
Control	M	14	25	11	13	M	27	M	16	20	100
S-1	M	14	11	30	16	14	M	25	24	15	100
S-2	14	30	14	15	13	28	20	M	26	21	100
S-3	26	14	31	31	M	M	24	13	12	18	100
S-4	14	25	M	11	M	13	27	16	20	M	100

M = Male

For Reproductive Data

Bartlett's B (calculated) = 0.5476
Tabled X^2 value (p=0.05, df=4) = 9.488

ANOVA F (calculated) = 0.326
ANOVA F (table) = 2.65

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TABLE 2 CERIODAPHNIA REPRODUCTION AND SURVIVAL

Santa Clara Valley NPS Sample #3334

Sample	Day #	Replicate a	b	c	d	e	f	g	h	i	j	Total Young	# Live Adults
Control	4	M	0	4	0	3	M	4	M	0	2	13	10
	5	-	4	10	2	0	-	0	-	6	8	30	10
	6	-	0	0	0	4	-	9	-	4	0	17	10
	7	-	10	11	9	6	-	14	-	6	10	66	10
S-1	4	M	0	0	4	0	0	M	4	6	0	14	10
	5	-	4	3	0	4	4	-	0	2	5	22	10
	6	-	10	8	10	12	1	-	10	10	10	71	10
	7	-	0	0	16	0	9	-	11	6	0	42	10
S-2	4	0	4	0	0	0	0	4	M	4	0	12	10
	5	4	0	4	4	4	4	0	-	6	4	30	10
	6	10	12	10	11	9	10	6	-	6	7	83	10
	7	0	14	0	0	0	14	10	-	10	10	58	10
S-3	4	4	0	4	4	M	M	4	0	0	0	16	10
	5	0	6	0	0	-	-	0	4	4	6	20	10
	6	8	8	10	12	-	-	7	0	8	8	61	10
	7	14	0	17	15	-	-	13	9	0	4	72	10
S-4	4	0	4	M	0	M	0	0	0	0	M	4	10
	5	4	0	-	4	-	4	4	4	4	-	24	10
	6	10	10	-	0	-	9	10	9	9	-	56	10
	7	0	11	-	7	-	0	13	3	7	-	41	10

M = Male

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TABLE 3

CERIODAPHNIA - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3334

Dissolved Oxygen (mg/l)

Sample	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
	i*	f*	i	f	i	f	i	f	i	f	i	f	i	f
Control	8.1	7.9	8.2	8.2	8.0	8.0	8.3	8.0	8.4	8.3	8.2	8.0	8.6	7.1
S-1	9.4	7.9	9.3	8.2	8.6	8.1	9.4	8.0	9.5	8.4	9.0	7.9	9.8	6.9
S-2	9.4	7.9	9.7	8.0	8.8	8.0	9.4	8.0	9.4	8.4	9.5	7.9	9.4	7.2
S-3	8.6	7.9	9.0	8.0	8.6	8.0	9.2	8.0	9.3	8.4	9.5	7.9	9.3	7.1
S-4	8.5	7.9	9.1	8.2	8.6	8.1	9.0	8.1	9.3	8.4	8.5	8.0	8.6	7.1

*i = initial
f = final (just before renewal)

pH Value (units)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	8.1	7.9	8.0	7.9	8.0	7.8	8.1
S-1	8.6	7.9	8.1	8.2	8.2	8.2	8.2
S-2	8.6	8.0	8.2	8.4	8.5	8.1	8.2
S-3	8.4	8.1	8.2	8.2	8.2	8.1	8.2
S-4	8.3	7.9	8.2	8.1	8.0	8.1	8.1

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TABLE 3 - continued

CERIODAPHNIA - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3334

Conductivity (umhos/cm)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	340	335	320	350	345	340	330
S-1	750	775	800	800	790	790	790
S-2	1100	1150	1100	1100	1100	1250	1250
S-3	800	800	700	800	800	900	900
S-3	1425	1400	1500	1450	1450	1425	1425

Temperature (°C)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	25.0	25.5	24.5	24.5	24.0	25.0	24.0
S-1	25.0	25.5	24.5	24.5	24.0	25.0	24.0
S-2	25.0	25.5	24.5	24.5	24.0	25.0	24.0
S-3	25.0	25.5	24.5	24.5	24.0	25.0	24.0
S-4	25.0	25.5	24.5	24.5	24.0	25.0	24.0

Alkalinity/Hardness (as mg/l CaCO3)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	82/114	80/110	75/110	68/105	70/108	70/110	72/110
S-1	192/238	200/210	165/215	220/255	210/245	210/245	210/245
S-2	392/572	390/525	350/518	360/520	350/520	355/525	360/518
S-3	308/390	300/350	210/305	275/328	290/335	300/320	300/338
S-4	532/495	520/440	505/445	450/460	465/455	455/450	470/465

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TABLE 4

FATHEAD MINNOW LARVAE
MEAN PERCENT SURVIVAL (n=30) AND MEAN LARVAL DRY WEIGHT

Santa Clara Valley NPS Sample #3334

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	(mg) Mean Larval Dry Weight
Control	100	100	100	100	100	100	100	0.4067
S-1	100	100	100	100	100	100	97	0.4037
S-2	100	100	100	90	87	83	83	0.3606
S-3	100	100	100	100	100	100	97	0.4022
S-4	100	100	100	97	93	93	90	0.3428

For Larval Weight Data

Bartlett's B = 4.674
Tabled X^2 value (p=0.05, 4 df) = 9.488

ANOVA F (calculated) = 4.955
ANOVA F (tabled) = 3.48

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TABLE 5

FATHEAD MINNOW LARVAE
SURVIVAL AND LARVAL DRY WEIGHT DATA

Santa Clara Valley NPS Sample #3334

Sample	Replicate	Number of Survivors Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Mean Larval Dry Weight (mg)
Control	1	10	10	10	10	10	10	10	10	0.4100
	2	10	10	10	10	10	10	10	10	0.4100
	3	10	10	10	10	10	10	10	10	0.4000
S-1	1	10	10	10	10	10	10	10	10	0.3800
	2	10	10	10	10	10	10	10	10	0.4200
	3	10	10	10	10	10	10	10	9	0.4111
S-2	1	10	10	10	10	9	9	9	9	0.3444
	2	10	10	10	10	10	9	8	8	0.3750
	3	10	10	10	10	8	8	8	8	0.3625
S-3	1	10	10	10	10	10	10	10	9	0.3667
	2	10	10	10	10	10	10	10	10	0.4000
	3	10	10	10	10	10	10	10	10	0.4400
S-4	1	10	10	10	10	9	8	8	8	0.3250
	2	10	10	10	10	10	10	10	10	0.3700
	3	10	10	10	10	10	10	10	10	0.3333

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TABLE 6

FATHEAD MINNOW LARVAE - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3334

Dissolved Oxygen (mg/l)

Sample	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
	i*	f*	i	f	i	f	i	f	i	f	i	f	i	f
Control	8.1	6.8	8.2	7.2	8.0	6.5	8.3	6.7	8.4	6.8	8.2	6.2	8.6	6.8
S-1	9.4	7.1	9.3	7.1	8.6	6.6	9.4	6.5	9.5	7.0	9.0	5.8	9.8	6.5
S-2	9.4	7.3	9.7	7.2	8.8	6.6	9.4	7.1	9.4	7.3	9.5	6.9	9.4	7.1
S-3	8.6	7.2	9.0	7.0	8.6	6.7	9.2	6.9	9.3	7.0	9.5	6.3	9.3	7.1
S-4	8.5	7.0	9.1	7.1	8.6	6.6	9.0	6.9	9.3	7.1	8.5	6.0	8.6	6.6

*i = initial
f = final (just before renewal)

pH Value (units)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	8.1	7.9	8.0	7.9	8.0	7.8	8.1
S-1	8.6	7.9	8.1	8.2	8.2	8.2	8.2
S-2	8.6	8.0	8.2	8.4	8.5	8.1	8.2
S-3	8.4	8.1	8.2	8.2	8.2	8.1	8.2
S-4	8.3	7.9	8.2	8.1	8.0	8.1	8.1

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TABLE 6

FATHEAD MINNOW LARVAE - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3334

Dissolved Oxygen (mg/l)

Sample	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
	i*	f*	i	f	i	f	i	f	i	f	i	f	i	f
Control	8.1	6.8	8.2	7.2	8.0	6.5	8.3	6.7	8.4	6.8	8.2	6.2	8.6	6.8
S-1	9.4	7.1	9.3	7.1	8.6	6.6	9.4	6.5	9.5	7.0	9.0	5.8	9.8	6.5
S-2	9.4	7.3	9.7	7.2	8.8	6.6	9.4	7.1	9.4	7.3	9.5	6.9	9.4	7.1
S-3	8.6	7.2	9.0	7.0	8.6	6.7	9.2	6.9	9.3	7.0	9.5	6.3	9.3	7.1
S-4	8.5	7.0	9.1	7.1	8.6	6.6	9.0	6.9	9.3	7.1	8.5	6.0	8.6	6.6

*i = initial
f = final (just before renewal)

pH Value (units)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	8.1	7.9	8.0	7.9	8.0	7.8	8.1
S-1	8.6	7.9	8.1	8.2	8.2	8.2	8.2
S-2	8.6	8.0	8.2	8.4	8.5	8.1	8.2
S-3	8.4	8.1	8.2	8.2	8.2	8.1	8.2
S-4	8.3	7.9	8.2	8.1	8.0	8.1	8.1

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TABLE 6 - continued

FATHEAD MINNOW LARVAE - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3334

Conductivity (umhos/cm)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	340	335	320	350	345	340	330
S-1	750	775	800	800	790	790	790
S-2	1100	1150	1100	1100	1100	1250	1250
S-3	800	800	700	800	800	900	900
S-3	1425	1400	1500	1450	1450	1425	1425

Temperature (°C)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	25.0	25.5	24.5	24.5	24.0	25.0	24.0
S-1	25.0	25.5	24.5	24.5	24.0	25.0	24.0
S-2	25.0	25.5	24.5	24.5	24.0	25.0	24.0
S-3	25.0	25.5	24.5	24.5	24.0	25.0	24.0
S-4	25.0	25.5	24.5	24.5	24.0	25.0	24.0

Alkalinity/Hardness (as mg/l CaCO3)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	82/114	80/110	75/110	68/105	70/108	70/110	72/110
S-1	192/238	200/210	165/215	220/255	210/245	210/245	210/245
S-2	392/572	390/525	350/518	360/520	350/520	355/525	360/518
S-3	308/290	300/350	210/305	275/328	290/335	300/320	300/338
S-4	532/495	520/440	505/445	450/460	465/455	455/450	470/465

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TABLE 7

SELENASTRUM CAPRICORNUTUM
GROWTH AND ENVIRONMENTAL MONITORING DATA
Santa Clara Valley NPS Sample #3334

Sample	Cells/ml X 10^6 after 96 hours Replicate 1	Replicate 2	Replicate 3	Mean
Control	1.703	2.013	2.277	1.998
S-1	3.530	3.645	3.275	3.483
S-2	4.260	4.180	3.935	4.125
S-3	2.510	2.950	2.880	2.780
S-4	2.195	1.970	1.910	2.025

Bartlett's B (calculated) = 0.9274
Tabled X^2 value (p=0.05, df=4) = 9.488

ANOVA F (calculated) = 57.08
ANOVA F (tabled) = 3.48

Temperature (°C)

Sample	Day 1	Day 2	Day 3	Day 4
Control	25.0	25.5	24.3	24.5
S-1	25.0	25.5	24.3	24.5
S-2	25.0	25.5	24.3	24.5
S-3	25.0	25.5	24.3	24.5
S-4	25.0	25.5	24.3	24.5

Initial pH Value and Conductivity

Sample	pH value	Conductivity (umhos/cm)
Control	8.1	340
S-1	8.6	750
S-2	8.6	1100
S-3	8.4	800
S-4	8.3	1425

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R0054776

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3 SPECIES BIOASSAY RESULTS:

SANTA CLARA VALLEY NON-POINT SOURCE PROGRAM

DRY WEATHER TEST #2

SAMPLES RECEIVED 1 FEBRUARY, 1989 AND THEREAFTER

DRAFT

Prepared for

KINNETIC LABORATORIES, INC.
Santa Cruz, California

Prepared by

MARINE BIOASSAY LABORATORIES DIVISION
TOXSCAN, INC.
Watsonville, California

APRIL, 1989

MBL

A DIVISION OF TOXSCAN, INC

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All algal counts were made manually with a hemacytometer and microscope. Treatment groups and controls were set up with a minimum of three replicates. Testing was conducted in an environmental chamber with continuous illumination of 400 ft/candles at 24 ± 2°C for 96 hours. All test flasks were innoculated with approximately 1×10^4 cells/ml from a 4 day old stock culture. Cultures were shaken twice daily by hand. Upon conclusion of testing, statistical analyses were made of final cell densities to determine EC50 concentrations using the Probit Method. Bartlett's test was used to confirm homogeneity of variance after which Dunnett's test was used.

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Results and Conclusions

Ceriodaphnia

Reproduction and survival data for Ceriodaphnia are summarized in Table 1, and are presented in full in Table 2. Data were statistically analyzed using the laboratory water as the comparative datum ("control").

Analysis of mortality data by Fisher's Exact Test showed that sample S-2 produced statistically significant mortality when compared with laboratory water controls (Fishers b value = 3). Following protocol guidance, reproduction data from S-2 were not included in subsequent statistical analyses.

Reproduction data were found to be not normally distributed (D'Agostino's D value = 0.2397). Critical D values are 0.2655 to 0.2874. Data could not be normalized by any transformation (Square root, log, or arcsin $\sqrt{x}$), and subsequent analysis was done by the non-parametric Steel's Many-One Rank Test. The tabulated critical rank sum value for n=10 and k=4 is 76. Rank sums for S-1, S-3, S-4 and S-5 all exceeded 76, indicating that reproduction in these samples was not significantly lower than in the laboratory control water.

Environmental monitoring data are tabulated and presented in Table 3.

Fathead Minnow Larvae

Survival and growth (dry weight) data are summarized in Table 4, and data for individual replicate test containers are presented in Table 5. There was not enough sample from S-5 to do the fathead minnow bioassay, and only S-1 through S-4 were included.

Larval weight data were determined to be normally distributed (Shpiro-Wilkes test), and homogeneous, with a Bartlett's B value of 0.979. The tabled X^2 value for 4 d.f. at p=0.01 is 13.28. Subsequent ANOVA and Dunnetts analyses were done on the untransformed weight data. There was no significant decrease in mean larval weight in samples S-1, S-2, S-3 and S-4 when compared with the weight of dilution water controls.

Environmental monitoring data for fathead minnow larvae are summarized in Table 6.

Selenastrum

Growth and environmental monitoring data are summarized in Table 7.

Cell number data were normally distributed (Shapiro-Wilkes) and homogeneous (Bartletts B = 0.9274 vs tabled X^2 value at p=0.01 and 5 d.f.

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Introduction

As part of the Santa Clara Valley Non-Point Source Program, toxicity testing must be carried out on water samples collected during both dry weather (four times) and wet weather (twice). Dry weather tests require daily collection of water samples at stream stations. Wet weather tests will be conducted using a single composite sample of runoff water for the daily renewals. This test is the second of four dry weather tests. Three toxicity tests are conducted, utilizing Ceriodaphnia dubia (invertebrate), Pimephales promelas (fish) and Selenastrum capricornutum (plant).

The Ceriodaphnia and Pimephales tests are seven days in duration, and are static-renewal protocols, requiring daily replacement of test solutions with newly-collected test water samples. Daily collections of stream water were made only during the first two days of the test period. On the second day it became clear that an unexpected rainstorm was imminent, and the inclusion of storm runoff in our "dry weather" samples was not appropriate in terms of the study objectives. The decision was made, therefore, to collect enough sample on Day 2 (our last dry day) to perform daily renewals for the remainder of the 7-day test period. In summary, water collections were made only on Days 1 and 2 of the test period. Water collected on Day 2 was stored at 4°C for the remainder of the 7-day test period, and daily renewals on days 2-7 were done using this stored water.

The three bioassays were performed concurrently. Daphnids and fish were run on 3-10 February, 1989 while algae were tested on 3-7 February, 1989. Methods, results and data are presented in the following pages.

The samples were collected and delivered to MBL by MBL personnel. The experimental design called testing only undiluted (100%) stream water. A lab water control (EPA moderately-hard) was run to provide quality assurance data. The lab water results were also used as the comparative data for statistical comparisons.

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Methods

Ceriodaphnia

Test organisms were neonates derived from in-house cultures. Original broodstock was from EPA Duluth, received 11 May, 1988 and cultured in EPA moderately hard water prepared with Milli-Q water. Samples of stream test water were collected daily during the test, and lab control water was EPA moderately hard (Milli-Q).

The test was initiated with 4-8 hour old neonates derived from third broods of individually maintained broodstock. Testing was conducted with 10 individuals per treatment, each in individual plastic cups containing 15 ml of test solution. Test temperature was 25 ± 1°C and photoperiod was 16 hour light:8 hour dark. Test solutions were renewed daily, concurrent with transfers, water quality measurements and assessment of survival and reproduction. At each daily transfer, new media were inoculated with food (2 drops of Ceriodaphnia chow and 1 drop of Selenastrum culture, density approximately 2.5 X 10^6 cells/ml). Following the 7-day test period, survival data was statistically evaluated using the probit method to calculate the 96-hour LC50. Reproductive data was evaluated using ANOVA and Dunnett's Test after confirming data homogeneity by Bartlett's Test. Test conditions and organism data are summarized in Appendix Table A-1.

Fathead Minnow Larvae

Test organisms were larvae, less than 24 hours old, obtained from in-house culture. All larvae were from the same spawning substrate, but probably from multiple spawns. Original broodstock was purchased from Thomas Fish Farms, San Rafael, California, approximately March of 1988. Stream test water samples were collected fresh each day. Control water was EPA moderately hard (Milli-Q). Ten larvae were used in each test container and there were three replicate containers per concentration. Each larval container was fed three times daily with 750-1000 newly-hatched Artemia nauplii. Test temperature was 25 ± 1°C, and photoperiod was 16:8. Daily renewal of 80% of the test volume coincided with daily environmental monitoring and assessment of survival. After seven days of exposure, the test was terminated by addition of formalin to each container. Surviving larvae were dried and weighed, and weight data were statistically evaluated using Bartlett's Test followed by ANOVA and Dunnett's Test. Probit analysis of survival data was used to calculate the 96-hour LC_1. Test conditions and organism data are summarized in appendix Table A-2.

Selenastrum

Algal assays were conducted in sterile 250 ml Erlenmeyer flasks. Preparation of the nutrient medium followed guidelines set forth in EPA-600/9-78-018.

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TABLE 2 CERIODAPHNIA REPRODUCTION AND SURVIVAL

Santa Clara Valley NPS Sample #3533

Sample	Day #	Replicate a	b	c	d	e	f	g	h	i	j	Total Young	# Live Adults
Control	4	0	0	0	3	3	0	2	4	0	0	12	10
	5	6	5	5	0	3	6	0	7	4	3	39	10
	6	0	5	8	7	6	6	6	0	0	2	40	10
	7	12	7	10	9	6	7	10	9	8	9	87	10
S-1	4	6	7	7	7	7	6	6	5	2	5	58	10
	5	0	0	0	0	0	0	0	0	0	0	0	10
	6	13	10	12	10	11	15	13	11	11	11	117	10
	7	16	17	20	17	16	20	20	18	15	17	176	10
S-2	4	6	X	0	X	0	0	4	X	3	2	15	7
	5	0	-	0	-	4	X	0	-	0	0	4	6
	6	0	-	0	-	4	-	2	-	0	2	8	6
	7	X	-	0	-	X	-	0	-	0	X	0	3
S-3	4	5	6	6	6	1	6	4	5	4	1	44	10
	5	0	0	0	0	3	0	0	0	0	3	6	10
	6	10	8	10	10	8	11	10	11	9	9	96	10
	7	14	15	14	16	0	15	15	16	15	12	132	10
S-4	4	6	5	0	6	0	5	5	6	5	6	44	10
	5	0	0	0	0	0	0	0	0	0	0	0	10
	6	12	15	11	11	3	9	10	11	9	11	102	10
	7	19	21	17	18	0	15	17	15	13	16	151	10
S-5	4	6	4	6	0	6	4	5	4	5	0	40	10
	5	0	0	0	6	0	0	0	0	0	4	10	10
	6	9	12	9	10	11	8	10	9	8	8	94	10
	7	14	0	13	0	9	7	10	15	13	15	96	10

X = Adult Died

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TABLE 3

CERIODAPHNIA - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3533

Dissolved Oxygen (mg/l)

Sample	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
	i*	f*	i	f	i	f	i	f	i	f	i	f	i	f
Control	7.7	7.5	8.5	7.9	8.3	8.0	8.0	7.8	8.8	8.2	8.0	8.1	8.8	7.2
S-1	9.3	7.4	9.4	7.8	7.2	7.9	9.4	7.8	9.1	.8	9.9	7.1	9.9	6.7
S-2	10.0	7.4	10.4	7.9	9.8	7.9	10.1	7.8	10.2	8.0	10.6	7.4	10.8	6.4
S-3	8.2	7.4	10.4	7.8	10.0	7.9	9.6	7.7	9.6	7.9	10.6	7.5	10.6	6.8
S-4	7.8	7.4	8.9	7.8	8.8	7.9	8.9	7.6	9.4	7.9	10.2	7.4	10.2	7.2
S-5	8.5	7.4	10.4	7.8	10.0	7.9	9.6	7.7	9.6	7.9	10.6	7.5	10.6	6.8

*i = initial
f = final (just before renewal)

pH Value (units)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	7.8	7.4	7.9	.99	8.0	7.9	8.0
S-1	9.0	8.6	8.8	8.8	8.8	8.6	8.4
S-2	8.3	8.3	8.5	8.5	8.5	8.4	8.2
S-3	8.2	8.3	8.4	8.4	8.4	8.4	8.1
S-4	8.0	8.0	8.0	8.0	8.1	8.0	7.7
S-5	8.2	8.3	8.4	8.4	8.4	8.4	8.1

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= 15.09). ANOVA and Dunnetts analyses were done on the untransformed data. There was no signficant decrease in mean cell numbers in any of the stream samples when compared with growth in lab water controls. There were significantly increased cell numbers in samples S-2, S-3 and S-5.

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TABLE 1

SUMMARY OF REPRODUCTION AND SURVIVAL FOR CERIODAPHNIA
Santa Clara Valley NPS Sample #3533

Sample	Total Young Produced/Replicate										% Survival (n = 10)
	a	b	c	d	e	f	g	h	i	j	
Control	18	17	23	19	18	19	18	20	12	14	100
S-1	35	34	39	34	34	41	39	34	28	33	100
S-2	6*	0*	0	0*	8*	0*	6	0*	3	4*	30
S-3	29	29	30	32	12	32	29	32	28	25	100
S-4	37	41	28	35	3	29	32	32	27	33	100
S-5	29	16	28	16	26	19	25	28	26	27	100

* = Adult died prior to test completion

For Survival Data

Fisher's Exact Test - Critical b value = 6
- b value for sample S-2 = 3

For Reproductive Data

D'Agostino's D (calculated) = 0.2397*
Critical D interval (tabled) = 0.2655-0.2874
Steel's Critical Rank Sum = 76
Steel's Rank Sum for all samples =

* Data were not normally distributed and could not be normalized by transformation. Data were analyzed by Steel's Many-One Rank Test.

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TABLE 5

FATHEAD MINNOW LARVAE
SURVIVAL AND LARVAL DRY WEIGHT DATA

Santa Clara Valley NPS Sample #3533

Sample	Replicate	Number of Survivors								Mean Larval Dry Weight (mg)
		Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	
Control	1	10	10	10	10	10	10	10	9	0.4000
	2	10	10	10	10	10	10	9	9	0.4440
	3	10	10	10	10	10	10	10	10	0.4000
S-1	1	10	10	10	10	10	10	10	9	0.3770
	2	10	10	10	10	10	10	10	10	0.3540
	3	10	10	10	10	10	10	10	10	0.3300
S-2	1	10	10	10	10	10	10	10	10	0.3900
	2	10	10	10	10	9	9	8	8	0.4370
	3	10	10	10	10	8	8	8	8	0.3500
S-3	1	10	10	10	10	10	10	10	9	0.4110
	2	10	10	10	10	10	10	9	9	0.4550
	3	10	10	10	10	10	10	7	7	0.4000
S-4	1	10	10	10	10	10	10	10	9	0.4770
	2	10	10	10	10	10	10	9	9	0.4330
	3	10	10	10	10	10	10	10	9	0.4330

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TABLE 6

FATHEAD MINNOW LARVAE - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3533

Dissolved Oxygen (mg/l)

Sample	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
	i*	f*	i	f	i	f	i	f	i	f	i	f	i	f
Control	7.7	7.4	8.5	7.5	8.3	7.6	8.0	7.0	8.8	7.0	8.0	6.7	8.8	6.6
S-1	9.3	7.3	9.4	7.3	7.2	7.2	9.4	6.7	9.1	7.1	9.9	7.3	9.9	6.8
S-2	10.0	7.6	10.4	7.5	9.8	7.4	10.1	7.1	10.2	7.5	10.6	7.0	10.8	7.1
S-3	8.2	7.5	10.4	7.3	10.0	7.2	9.6	6.4	9.6	7.1	10.6	6.9	10.6	7.0
S-4	7.8	7.2	8.9	7.2	8.8	7.0	8.9	6.4	9.4	7.0	10.2	6.6	10.2	6.5

*i = initial
f = final (just before renewal)

pH Value (units)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	7.8	7.4	7.9	.99	8.0	7.9	8.0
S-1	9.0	8.6	8.8	8.8	8.8	8.6	8.4
S-2	8.3	8.3	8.5	8.5	8.5	8.4	8.2
S-3	8.2	8.3	8.4	8.4	8.4	8.4	8.1
S-4	8.0	8.0	8.0	8.0	8.1	8.0	7.7
S-5	8.2	8.3	8.4	8.4	8.4	8.4	8.1

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TABLE 3 - continued

CERIODAPHNIA - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3533

Conductivity (umhos/cm)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	280	280	---	---	---	---	---
S-1	530	1180	---	---	---	---	---
S-2	1090	1060	---	---	---	---	---
S-3	775	795	---	---	---	---	---
S-4	1320	1100	---	---	---	---	---
S-5	750	795	---	---	---	---	---

Temperature (°C)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	25.0	24.0	24.0	24.0	24.0	24.0	24.0
S-1	24.0	24.5	24.5	24.5	25.0	25.0	25.0
S-2	24.0	24.5	24.5	24.5	25.0	25.0	25.0
S-3	24.0	24.5	24.5	24.5	25.0	25.0	25.0
S-4	24.0	24.5	24.5	24.5	25.0	25.0	25.0
S-5	24.0	24.5	24.5	24.5	25.0	25.0	25.0

Alkalinity/Hardness (as mg/l CaCO3)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	76/102	76/102	---	---	---	---	---
S-1	180/224	---	---	---	---	---	---
S-2	368/530	---	---	---	---	---	---
S-3	280/370	---	---	---	---	---	---
S-4	472/454	---	---	---	---	---	---
S-5	280/370	---	---	---	---	---	---

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TABLE 4

FATHEAD MINNOW LARVAE
MEAN PERCENT SURVIVAL (n=30) AND MEAN LARVAL DRY WEIGHT

Santa Clara Valley NPS Sample #3533

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	(mg) Mean Larval Dry Weight
Control	100	100	100	100	100	97	93	0.4147
S-1	100	100	100	100	100	100	97	0.3537
S-2	100	100	100	97	97	87	87	0.3923
S-3	100	100	100	100	100	87	83	0.4220
S-4	100	100	100	100	100	97	90	0.4477

For Larval Weight Data

Bartlett's B = 0.979
Tabled X^2 value (p=0.01, 4 df) = 13.28

ANOVA F (calculated) = 4.08
ANOVA F (tabled) = 3.48

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APPENDIX A

Summary of Test Conditions

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TABLE 6 - continued

FATHEAD MINNOW LARVAE - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3533

Conductivity (umhos/cm)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	280	280	---	---	---	---	---
S-1	530	1180	---	---	---	---	---
S-2	1090	1060	---	---	---	---	---
S-3	775	795	---	---	---	---	---
S-4	1320	1100	---	---	---	---	---
S-5	750	795	---	---	---	---	---

Temperature (°C)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	25.0	24.0	24.0	24.0	24.0	24.0	24.0
S-1	24.0	24.5	24.5	24.5	25.0	25.0	25.0
S-2	24.0	24.5	24.5	24.5	25.0	25.0	25.0
S-3	24.0	24.5	24.5	24.5	25.0	25.0	25.0
S-4	24.0	24.5	24.5	24.5	25.0	25.0	25.0
S-5	24.0	24.5	24.5	24.5	25.0	25.0	25.0

Alkalinity/Hardness (as mg/l CaCO3)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	76/102	76/102	---	---	---	---	---
S-1	180/224	---	---	---	---	---	---
S-2	368/530	---	---	---	---	---	---
S-3	280/370	---	---	---	---	---	---
S-4	472/454	---	---	---	---	---	---
S-5	280/370	---	---	---	---	---	---

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TABLE 7

SELENASTRUM CAPRICORNUTUM
GROWTH AND ENVIRONMENTAL MONITORING DATA
Santa Clara Valley NPS Sample #3533

Sample	Cells/ml X 10^6 after 96 hours Replicate 1	Replicate 2	Replicate 3	Mean
Control	2.59	2.66	2.61	2.62
S-1	2.41	2.67	2.66	2.58
S-2	5.06	5.04	5.40	5.17
S-3	2.90	3.33	3.68	3.30
S-4	2.13	2.17	2.08	2.13
S-5	3.20	3.58	4.40	3.73

Bartlett's B (calculated) = 14.83
Tabled X^2 value (p=0.01, df=5) = 15.09
ANOVA F (calculated) = 36.39
ANOVA F (tabled) = 3.11

Temperature (°C)

Sample	Day 1	Day 2	Day 3	Day 4
Control	25.6	25.1	25.0	25.8
S-1	25.6	25.1	25.0	25.8
S-2	25.6	25.1	25.0	25.8
S-3	25.6	25.1	25.0	25.8
S-4	25.6	25.1	25.0	25.8
S-5	25.6	25.1	25.0	25.8

Initial pH Value and Conductivity

Sample	pH value	Conductivity (umhos/cm)
Control	7.9	280
S-1	8.8	480
S-2	8.5	1060
S-3	8.4	795
S-4	8.0	1100
S-5	8.5	795

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TABLE A-3

Selenastrum Bioassay

Test Type:	Static
Test Endpoints:	Growth, (cell number)
Test Duration:	4 days, 96 hours
Temperature:	24 ± 2°C
Photoperiod:	Continuous light
Light Intensity:	400 ± 40 FC
Start:	3 February, 1989, 13:00 hours
Finish:	7 February, 1989, 13:00 hours
Test Containers:	250 ml Erlenmeyer flasks
Test Volume:	100 ml
Dilution Water:	Not Applicable
Test Material:	Santa Clara Valley NPS - Dry Weather #2
Test Concentrations:	100%, Control
# Replicates:	3
Organisms per replicate:	10,000/ml innoculated
Test Species:	Selenastrum capricornutum
Source:	In-house culture
Age:	4 days
Culture Water:	EPA Moderately Hard

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TABLE A-1

Ceriodaphnia Bioassay

Test Type:	Static Daily Renewal
Test Endpoints:	Survival, Reproduction
Test Duration:	7 days - 168 hours
Temperature:	25 ± 1°C
Photoperiod:	16 L: 8 D
Start:	3 February, 1989, 10:00 hours
Finish:	10 February, 1989, 10:00 hours
Test Containers:	1 oz plastic cups
Test Volume:	15 ml
Dilution Water:	Not Applicable
Test Material:	Santa Clara Valley NPS - Dry Weather #2
Test Concentrations:	100%, controls
# Replicates:	10
Organisms per replicate:	1
Test Species:	*Ceriodaphnia dubia*
Source:	in-house culture
Age:	4-8 hours
Acclimation/Culture Water:	EPA Moderately Hard (Milli-Q)
Diet:	Selenastrum, *Ceriodaphnia* chow

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TABLE A-2

Fathead Minnow Bioassay

Test Type:	Static Daily Renewal
Test Endpoints:	Survival, Growth
Test Duration:	7 days - 168 hours
Temperature:	25 ± 1°C
Photoperiod:	16 L: 8 D
Start:	3 February, 1989, 12:00 hours
Finish:	10 February, 1989, 12:00 hours
Test Containers:	1 liter glass jars
Test Volume:	500 ml
Dilution Water:	Not Applicable
Test Material:	Santa Clara Valley NPS - Dry Weather #2
Test Concentrations:	100%, control
# Replicates:	3
Organisms per replicate:	10
Test Species:	Pimephales promelas (Fathead minnow)
Source:	in-house culture
Age:	<24 hours
Culture Water:	Dechlorinated Tap
Diet:	Artemia nauplii

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Introduction

As part of the Santa Clara Valley Non-Point Source Program, toxicity testing must be carried out on water samples collected during both dry weather (four times) and wet weather (twice). Dry weather tests require daily collection of water samples at stream stations. Wet weather tests will be conducted using a single composite sample of runoff water for the daily renewals. This test is the third of four dry weather tests. Three toxicity tests are conducted, utilizing Ceriodaphnia dubia (invertebrate), Pimephales promelas (fish) and Selenastrum capricornutum (plant).

The Ceriodaphnia and Pimephales tests are seven days in duration, and are static-renewal protocols, requiring daily replacement of test solutions with newly-collected test water samples. Daily collections of stream water were made by Kinnetic Laboratories (KLI) personnel.

The three bioassays were performed concurrently. Daphnids and fish were run on 9-16 April, 1989 while algae were tested on 8-12 April, 1989. Methods, results and data are presented in the following pages.

The experimental design called for testing only undiluted (100%) stream water. A lab water control (EPA moderately-hard) was run to provide quality assurance data. The lab water results were also used as the comparative data for statistical comparisons.

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Methods

Ceriodaphnia

Test organisms were neonates derived from in-house cultures. Original broodstock was from EPA Duluth, received 11 May, 1988 and cultured in EPA moderately hard water prepared with Milli-Q water. Samples of stream test water were collected daily during the test, and lab control water was EPA moderately hard (Milli-Q).

The test was initiated with 4-8 hour old neonates derived from third broods of individually maintained broodstock. Testing was conducted with 10 individuals per treatment, each in individual plastic cups containing 15 ml of test solution. Test temperature was 25 ± 1°C and photoperiod was 16 hour light:8 hour dark. Test solutions were renewed daily, concurrent with transfers, water quality measurements and assessment of survival and reproduction. At each daily transfer, new media were inoculated with food (2 drops of Ceriodaphnia chow and 1 drop of Selenastrum culture, density approximately 2.5×10^6 cells/ml). Following the 7-day test period, survival data was statistically evaluated using the probit method to calculate the 96-hour LC50. Reproductive data was evaluated using ANOVA and Dunnett's Test after confirming data homogeneity by Bartlett's Test. Test conditions and organism data are summarized in Appendix Table A-1.

Fathead Minnow Larvae

Test organisms were larvae, less than 24 hours old, obtained from in-house culture. All larvae were from the same spawning substrate, but probably from multiple spawns. Original broodstock was purchased from Thomas Fish Farms, San Rafael, California, approximately March of 1988. Stream test water samples were collected fresh each day. Control water was EPA moderately hard (Milli-Q). Ten larvae were used in each test container and there were three replicate containers per concentration. Each larval container was fed three times daily with 750-1000 newly-hatched Artemia nauplii. Test temperature was 25 ± 1°C, and photoperiod was 16:8. Daily renewal of 80% of the test volume coincided with daily environmental monitoring and assessment of survival. After seven days of exposure, the test was terminated by addition of formalin to each container. Surviving larvae were dried and weighed, and weight data were statistically evaluated using Bartlett's Test followed by ANOVA and Dunnett's Test. Probit analysis of survival data was used to calculate the 96-hour LC_1. Test conditions and organism data are summarized in appendix Table A-2.

Selenastrum

Algal assays were conducted in sterile 250 ml Erlenmeyer flasks. Preparation of the nutrient medium followed guidelines set forth in EPA-600/9-78-018.

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3 SPECIES BIOASSAY RESULTS:

SANTA CLARA VALLEY NON-POINT SOURCE PROGRAM

DRY WEATHER TEST #3

SAMPLES RECEIVED 7 APRIL, 1989 AND THEREAFTER

DRAFT

Prepared for

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R0054798

All algal counts were made manually with a hemacytometer and microscope. Treatment groups and controls were set up with a minimum of three replicates. Testing was conducted in an environmental chamber with continuous illumination of 400 ft/candles at 24 $\pm$ 2°C for 96 hours. All test flasks were innoculated with approximately 1×10^4 cells/ml from a 4 day old stock culture. Cultures were shaken twice daily by hand. Upon conclusion of testing, statistical analyses were made of final cell densities to determine EC50 concentrations using the Probit Method. Bartlett's test was used to confirm homogeneity of variance after which Dunnett's test was used.

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14999

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All algal counts were made manually with a hemacytometer and microscope. Treatment groups and controls were set up with a minimum of three replicates. Testing was conducted in an environmental chamber with continuous illumination of 400 ft/candles at 24 ± 2°C for 96 hours. All test flasks were innoculated with approximately $\bar{1}$ X 10^4 cells/ml from a 4 day old stock culture. Cultures were shaken twice daily by hand. Upon conclusion of testing, statistical analyses were made of final cell densities to determine EC50 concentrations using the Probit Method. Bartlett's test was used to confirm homogeneity of variance after which Dunnett's test was used.

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Results and Conclusions

Ceriodaphnia

Reproduction and survival data for Ceriodaphnia are summarized in Table 1, and are presented in full in Table 2. Data were statistically analyzed using the laboratory water as the comparative datum ("control").

Analysis of mortality data by Fisher's Exact Test showed that sample S-4 produced statistically significant mortality when compared with laboratory water controls (Fishers b value = 3). Following protocol guidance, reproduction data from S-4 were not included in subsequent statistical analyses.

Reproduction data were found to be normally distributed (D'Agostino's D test) and homogeneous (Bartlett's B = 9.81).

None of the samples produced significantly decreased young production when compared with laboratory water controls.

Environmental monitoring data are tabulated and presented in Table 3.

Fathead Minnow Larvae

Survival and growth (dry weight) data are summarized in Table 4, and data for individual replicate test containers are presented in Table 5. There was not enough sample from S-5 to do the fathead minnow bioassay, and only S-1 through S-4 were included.

Larval weight data were determined to be normally distributed (Shapiro-Wilkes test), and homogeneous, with a Bartlett's B value of 3.85. The tabled X^2 value for 4 d.f. at p=0.01 is 13.28. Subsequent ANOVA and Dunnetts analyses were done on the untransformed weight data. There was no significant decrease in mean larval weight in samples S-1, S-2, and S-4 when compared with the weight of dilution water controls. There was significantly decreased larval weight in sample S-3.

Environmental monitoring data for fathead minnow larvae are summarized in Table 6.

Selenastrum

Growth and environmental monitoring data are summarized in Table 7.

Cell number data were normally distributed (Shapiro-Wilkes) and homogeneous (Bartletts B = 5.86 vs tabled X^2 value at p=0.01 and 4 d.f. = 13.28). ANOVA and Dunnetts analyses were done on the untransformed data. There was no signficant decrease in mean cell numbers in samples S1, S2 and S3 when compared with growth in lab water controls. There were significantly decreased cell numbers in sample S-4.

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TABLE 3

CERIODAPHNIA - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3838

Dissolved Oxygen (mg/l)

Sample	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
	i*	f*	i	f	i	f	i	f	i	f	i	f	i	f
Control	7.6	7.7	7.9	7.8	8.0	7.5	8.1	7.8	8.0	7.9	8.2	7.8	8.0	7.1
S-1	9.2	7.7	9.2	7.5	10.0	7.4	9.5	7.6	9.4	8.0	9.7	7.5	7.8	7.0
S-2	10.0	7.7	10.5	7.2	9.8	7.5	10.4	7.8	10.4	7.8	10.0	7.7	8.7	7.0
S-3	9.1	7.8	9.4	7.4	9.7	7.4	8.9	7.7	9.4	7.9	8.8	7.7	7.7	7.1
S-4	8.2	7.8	9.5	7.5	8.8	7.4	8.7	7.8	8.4	7.8	7.2	7.6	7.2	7.3

*i = initial
f = final (just before renewal)

pH Value (units)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	8.0	7.9	7.9	8.0	7.9	7.7	7.9
S-1	8.2	7.9	8.0	8.7	8.1	8.1	7.9
S-2	8.2	8.2	8.0	8.4	8.2	8.2	8.1
S-3	8.1	8.1	7.8	8.1	8.0	7.8	7.9
S-4	8.0	7.9	7.8	8.1	7.8	7.7	7.9

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TABLE 3 - continued

CERIODAPHNIA - ENVIRONMENTAL MONITORING
Santa Clara Valley WPS Sample #3838

Conductivity (umhos/cm)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	275	250	285	310	300	270	285
S-1	700	7000	700	600	600	700	700
S-2	1100	1075	1110	1100	1100	1100	1150
S-3	780	780	790	810	740	800	840
S-4	1500	1580	1500	1550	1460	1560	1580

Temperature (°C)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	25.0	25.5	25.0	26.0	23.0	25.5	26.0
S-1	25.0	25.5	25.0	26.0	24.0	25.0	26.0
S-2	25.0	25.5	25.0	26.0	24.0	25.5	26.0
S-3	25.0	25 5	25.0	26.0	23.5	24.5	26.0
S-4	25.0	25.5	24.0	26.0	25.0	25.0	24.0

Alkalinity/Hardness (as mg/l CaCO3)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	60/100	65/100	67/100	67/100	65/100	67/102	65/102
S-1	125/215	115/218	204/218	142/184	190/190	195/210	212/208
S-2	275/475	300/485	359/550	366/590	352/625	352/584	420/580
S-3	200/320	210/320	275/330	252/344	350/304	275/336	330/294
S-4	390/425	390/435	505/450	512/432	482/440	525/460	550/440

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TABLE 1

SUMMARY OF REPRODUCTION AND SURVIVAL FOR CERIODAPHNIA
Santa Clara Valley NPS Sample #3838

Sample	Total Young Produced/Replicate										% Survival (n = 10)
	a	b	c	d	e	f	g	h	i	j	
Control	16	19	20	19	22	15	14	17	18	17	100
S-1	28	28	9	11*	29	34	34	24	28	30	90
S-2	13	0*	18	12	15	25	23	18	11	15	80
S-3	29	31	25	28	26	31	40	14	29	19	100
S-4	28*	18	15*	15*	15*	16*	19*	15*	17*	27*	10

* = Adult died prior to test completion

For Reproductive Data

Bartlett's B (calculated) = 9.81
Tabled x^2 value (p=0.01, dF=3) = 11.35

ANOVA F (calculated) = 9.95
ANOVA F (Tabled) = 2.86

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TABLE 2 CERIODAPHNIA REPRODUCTION AND SURVIVAL

Santa Clara Valley NPS Sample #3838

Sample	Day #	Replicate a	b	c	d	e	f	g	h	i	j	Total Young	# Live Adults
Control	4	3	4	3	0	3	4	4	0	4	2	27	10
	5	0	0	2	5	4	0	1	4	0	4	20	10
	6	4	6	6	4	7	3	4	2	5	3	44	10
	7	9	9	9	10	8	8	5	11	9	8	86	10
S-1	4	3	3	4	4	5	5	4	4	3	4	39	10
	5	1	10	0	7	8	11	13	5	11	0	66	10
	6	9	0	10	X	0	0	0	0	0	13	32	9
	7	15	15	15	-	16	18	17	15	14	13	138	9
S-2	4	3	X	4	5	5	4	4	3	5	5	38	9
	5	0	-	8	5	0	11	10	7	6	0	47	9
	6	7	-	0	0	4	0	0	0	X	6	17	8
	7	3	-	6	2	6	10	9	8	-	4	48	8
S-3	4	4	4	4	4	4	4	5	3	3	4	39	10
	5	0	11	0	12	10	12	10	0	0	0	55	10
	6	10	0	10	0	0	0	10	11	12	10	63	10
	7	15	16	11	12	12	15	15	0	14	15	120	10
S-4	4	2	5	3	5	5	3	4	4	4	4	39	10
	5	11	10	12	10	10	0	0	11	13	8	85	10
	6	15	0	X	0	0	13	0	X	X	15	43	7
	7	X	3	-	X	X	X	X	-	-	X	3	1

X = Adult Died

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TABLE 4

FATHEAD MINNOW LARVAE
MEAN PERCENT SURVIVAL (n=30) AND MEAN LARVAL DRY WEIGHT

Santa Clara Valley NPS Sample #3838

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	(mg) Mean Larval Dry Weight
Control	100	100	100	97	97	97	97	0.5200
S-1	100	97	97	97	97	97	97	0.4833
S-2	100	97	97	97	97	97	97	0.5100
S-3	100	100	97	97	97	97	97	0.4400
S-4	100	100	100	100	100	100	100	0.4500

For Larval Weight Data

Bartlett's B = 3.85
Tabled X^2 value (p=0.01, 4 df) = 13.28

ANOVA F (calculated) = 2.56
ANOVA F (tabled) = 3.48

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TABLE 5

FATHEAD MINNOW LARVAE
SURVIVAL AND LARVAL DRY WEIGHT DATA

Santa Clara Valley NPS Sample #3838

Sample	Replicate	Number of Survivors								Mean Larval Dr
		Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Weight (mg)
Control	1	10	10	10	10	10	10	10	10	0 00
	2	10	10	10	10	10	10	10	10	C. 00
	3	10	10	10	10	9	9	9	9	0..00
S-1	1	10	10	10	10	10	10	10	10	0.4600
	2	10	10	9	9	9	9	9	9	0.4500
	3	10	10	10	10	10	10	10	10	0.5400
S-2	1	10	10	9	9	9	9	9	9	0.5:00
	2	10	10	10	10	10	10	10	10	0.4800
	3	10	10	10	10	10	10	10	10	0.5300
S-3	1	10	10	10	9	9	9	9	9	0.4400
	2	10	10	10	10	10	10	10	10	0.4900
	3	10	10	10	10	10	10	10	10	0.3900
S-4	1	10	10	10	10	10	10	10	10	0.4900
	2	10	10	10	10	10	10	10	10	0.4500
	3	10	10	10	10	10	10	10	10	0.4100

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TABLE 7

SELENASTRUM CAPRICORNUTUM
GROWTH AND ENVIRONMENTAL MONITORING DATA
Santa Clara Valley NPS Sample #3838

Sample	Cells/ml X 10^6 after 96 hours Replicate 1	Replicate 2	Replicate 3	Mean
Control	3.10	3.02	3.11	3.08
S-1	3.13	3.47	3.10	3.23
S-2	3.82	3.62	3.76	3.73
S-3	3.03	2.96	3.97	2.99
S-4	1.49	1.34	1.44	1.42

Bartlett's B (calculated) = 5.86
Tabled X^2 value (p=0.01, df=4) = 13.28
ANOVA F (calculated) = 181.6
ANOVA F (tabled) = 3.48

Temperature (°C)

Sample	Day 1	Day 2	Day 3	Day 4
Control	26.2	25.3	24.8	25.4
S-1	26.2	25.3	24.8	25.4
S-2	26.2	25.3	24.8	25.4
S-3	26.2	25.3	24.8	25.4
S-4	26.2	25.3	24.8	25.4

Initial pH Value and Conductivity

Sample	pH value	Conductivity (umhos/cm)
Control	8.0	275
S-1	8.2	700
S-2	8.2	1100
S-3	8.1	780
S-4	8.0	1500

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TABLE 6

FATHEAD MINNOW LARVAE - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3838

Dissolved Oxygen (mg/l)

Sample	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
	i*	f*	i	f	i	f	i	f	i	f	i	f	i	f
Control	7.6	6.5	7.9	5.5	8.0	6.2	8.1	6.5	8.0	6.3	8.2	5.3	8.0	4.8
S-1	9.2	6.3	9.2	5.3	10.0	5.8	9.5	5.8	9.4	5.9	9.7	5.2	7.8	5.0
S-2	10.0	6.1	10.5	5.0	9.8	5.7	10.4	6.5	10.4	6.3	10.0	5.0	8.7	5.6
S-3	9.1	6.2	9.4	5.2	9.7	4.9	8.9	5.7	9.4	6.0	8.8	4.9	7.7	5.9
S-4	8.2	6.3	9.5	5.2	8.8	5.6	8.7	5.9	8.4	5.6	7.2	4.7	7.2	5.1

*i = initial
f = final (just before renewal)

pH Value (units)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	8.0	7.9	7.9	8.0	7.9	7.7	7.9
S-1	8.2	7.9	8.0	8.7	8.1	8.1	7.9
S-2	8.2	8.2	8.0	8.4	8.2	8.2	8.1
S-3	8.1	8.1	7.8	8.1	8.0	7.8	7.9
S-4	8.0	7.9	7.8	8.1	7.8	7.7	7.9

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TABLE 6 - continued

FATHEAD MINNOW LARVAE - ENVIRONMENTAL MONITORING
Santa Clara Valley NPS Sample #3838

Conductivity (umhos/cm)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	275	250	285	310	300	270	285
S-1	700	7000	700	600	600	700	700
S-2	1100	1075	1110	1100	1100	1100	1150
S-3	780	780	790	810	740	800	840
S-4	1500	1580	1500	1550	1460	1560	1580

Temperature (°C)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	25.0	25.5	25.0	26.0	23.0	25.5	26.0
S-1	25.0	25.5	25.0	26.0	24.0	25.0	26.0
S-2	25.0	25.5	25.0	26.0	24.0	25.5	26.0
S-3	25.0	25.5	25.0	26.0	23.5	24.5	26.0
S-4	25.0	25.5	24.0	26.0	25.0	25.0	24.0

Alkalinity/Hardness (as mg/l CaCO3)

Sample	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	60/100	65/100	67/100	67/10C	65/100	67/102	65/102
S-1	125/215	115/218	204/218	142/184	190/190	195/210	212/208
S-2	275/475	300/485	359/550	366/590	352/625	352/584	420/580
S-3	200/320	210/320	275/330	252/344	350/304	275/336	330/294
S-4	390/425	390/435	505/450	512/432	482/440	525/460	550/440

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APPENDIX A

Summary of Test Conditions

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TABLE A-1

Ceriodaphnia Bioassay

Test Type:	Static Daily Renewal
Test Endpoints:	Survival, Reproduction
Test Duration:	7 days - 168 hours
Temperature:	25 ± 1°C
Photoperiod:	16 L: 8 D
Start:	9 April, 1989, 11:00 hours
Finish:	16 April, 1989, 11:00 hours
Test Containers:	1 oz plastic cups
Test Volume:	15 ml
Dilution Water:	Not Applicable
Test Material:	Santa Clara Valley NPS - Dry Weather #3
Test Concentrations:	100%, controls
# Replicates:	10
Organisms per replicate:	1
Test Species:	Ceriodaphnia dubia
Source:	in-house culture
Age:	4-8 hours
Acclimation/Culture Water:	EPA Moderately Hard (Milli-Q)
Diet:	Selenastrum, Ceriodaphnia chow

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TABLE A-2

Fathead Minnow Bioassay

Test Type:	Static Daily Renewal
Test Endpoints:	Survival, Growth
Test Duration:	7 days - 168 hours
Temperature:	25 ± 1°C
Photoperiod:	16 L: 8 D
Start:	9 April, 1989, 12:00 hours
Finish:	16 April, 1989, 12:00 hours
Test Containers:	1 liter glass jars
Test Volume:	500 ml
Dilution Water:	Not Applicable
Test Material:	Santa Clara Valley NPS - Dry Weather #3
Test Concentrations:	100%, control
# Replicates:	3
Organisms per replicate:	10
Test Species:	Pimephales promelas (Fathead minnow)
Source:	in-house culture
Age:	<24 hours
Culture Water:	Dechlorinated Tap
Diet:	Artemia nauplii

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TABLE A-3

Selenastrum Bioassay

Test Type:	Static
Test Endpoints:	Growth, (cell number)
Test Duration:	4 days, 96 hours
Temperature:	24 ± 2°C
Photoperiod:	Continuous light
Light Intensity:	400 ± 40 FC
Start:	8 April, 1989, 13:00 hours
Finish:	12 April, 1989, 13:00 hours
Test Containers:	250 ml Erlenmeyer flasks
Test Volume:	100 ml
Dilution Water:	Not Applicable
Test Material:	Santa Clara Valley NPS - Dry Weather #3
Test Concentrations:	100%, Control
# Replicates:	3
Organisms per replicate:	10,000/ml innoculated
Test Species:	Selenastrum capricornutum
Source:	In-house culture
Age:	4 days
Culture Water:	EPA Moderately Hard

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APPENDIX F

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APPENDIX F
USGS/SCVWD WATER AND SEDIMENT QUALITY DATA

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8720115A-F CON-2

USGS STATION NO. 11168800
LOS GATOS CREEK AT
LINCOLN AVENUE AT SAN JOSE, CA

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R0054818

11168800 - LOS GATOS C AT LINCOLN AVE AT SAN JOSE CALIF

DATE	Flow (cfs)	Cond (µmohs)	pH	Temp (deg C)	TDS (mg/l)	Turbidity (NTU)	DO (mg/l)	DO (% sat)	Organic C (mg/l as C)	TH (mg/l as CaCO3)	Alkalinity (mg/l as CaCO3)
01/12/1980	110.0	315.0	7.1	14.0	190.0	34.0	9.8		6.7	130.0	94.0
01/29/1981	39.0	256.0	7.5	11.5	150.0	44.0	10.4	96	6.9	99.0	78.0
01/05/1982	41.0	204.0	7.8	11.0	120.0	180.0	10.5	95	6.2	87.0	74.0
01/21/1982	1.7	225.0	7.9	7.5	120.0	8.8	11.3	95	4.3	81.0	72.0
01/19/1893	9.7	245.0	8.2	9.5	140.0	5.7	11.3	99	4.0	100.0	84.0
01/27/1983	400.0	188.0	7.8	11.5	120.0	440.0	10.6	99	5.6	80.0	72.0
02/20/1980	202.0	192.0	7.0	12.0	120.0	580.0	10.4		6.2	79.0	67.0
02/17/1982	9.4	321.0	8.6	14.0	190.0	9.2	10.7	103	5.5	140.0	110.0
02/08/1983	561.0	236.0	8.0	11.0	140.0	130.0	11.2	102	4.2	100.0	90.0
02/28/1984	5.0	359.0	9.1	14.0	200.0	1.9	12.6	123	2.5	150.0	124.0
02/13/1986	45.0	420.0	8.2	12.0	260.0	19.0	10.5	97		190.0	137.0
02/24/1986	59.0	160.0	8.1	13.0	120.0	500.0	10.7	101		85.0	69.0
03/06/1980	32.0	272.0	7.8	12.5	160.0	99.0	10.3		6.9	110.0	89.0
03/30/1982	251.0	296.0	8.2	11.0	180.0	32.0	11.2	102	3.4	130.0	108.0
03/01/1983	2600.0	217.0	8.0	12.0	140.0	460.0	11.0		4.5	96.0	84.0
03/17/1984	3.4	307.0	8.6	14.0	180.0	3.0	12.1	116	4.1	140.0	113.0
03/10/1985	128.0	86.0	8.2	14.0	49.0	55.0	10.0	97		31.0	25.0
03/11/1986	551.0	228.0	8.2	14.0	140.0	130.0	10.7	104		97.0	83.0
04/12/1983	18.0	317.0	9.6	14.5	180.0	2.2	16.6	163	2.3	130.0	110.0
05/06/1980	1.0	323.0	8.2	15.0	190.0	1.3	10.1	100	4.2	110.0	73.0
05/17/1983	52.0	275.0	8.8	16.5	170.0	8.7	12.5	128	1.8	130.0	110.0
08/30/1983	1.6	286.0	8.5	23.0	180.0	0.8	11.4	133	2.0	130.0	110.0
09/08/1982	1.0	295.0	7.6	23.5	180.0	1.5	8.3	98	3.0	130.0	104.0
11/20/1979	0.7	407.0	8.2	11.5	240.0	6.6	11.1		6.5	150.0	110.0
11/17/1981	2.2	259.0	7.8	15.5	150.0	2.2	9.0	89	14.0	73.0	58.0
12/30/1981	3.9	408.0	8.4	14.5	240.0	1.0	11.2	110	3.5	120.0	86.0

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11168800 - LOS GATOS C AT LINCOLN AVE AT SAN JOSE CALIF

Period	Flow (cfs)	Cond (µmohs)	pH	Temp (deg C)	TDS (mg/l)	Turbidity (NTU)	DO (mg/l)	DO (% sat)	Organic C (mg/l as C)	TH (mg/l as CaCO3)	Alkalinity (mg/l as CaCO3)
All											
Mean	197.3	273.0	8.1	13.6	163.4	106.0	11.0	107	4.9	111.5	89.8
CV	2.62	0.29	0.07	0.26	0.28	1.67	0.13	0.16	0.53	0.29	0.26
n	26	26	26	26	26	26	26	21	22	26	26
Month											
Nov	1.5	333.0	8.0	13.5	195.0	4.4	10.1	89	10.3	111.5	84.0
Jan	86.5	263.0	7.8	11.4	154.?	101.9	10.7	99	5.3	99.6	80.0
Feb	146.9	281.3	8.2	12.7	171.7	206.7	11.0	105	4.6	124.0	99.5
March	511.9	246.1	8.4	13.1	147.0	111.6	11.7	116	4.2	104.9	87.4
May	26.5	299.0	8.5	15.8	180.0	5.0	11.3	114	3.0	120.0	91.5
Sept	1.3	290.5	8.1	23.3	180.0	1.2	9.9	116	2.5	130.0	107.0
Winter											
Nov-April	230.6	269.0	8.1	12.5	160.4	124.7	11.1	105.4	5.4	109.0	88.0
n	22	22	22	22	22	22	22	17	18	22	22
Summer											
May-Sept	13.9	294.8	8.3	19.5	180.0	3.1	10.6	114.8	2.8	125.0	99.3
n	4	4	4	4	4	4	4	4	4	4	4

C V = Coefficent of Variation
n = Sample number

R0054820

11168800 - LOS GATOS C AT LINCOLN AVE AT SAN JOSE CALIF

DATE	Flow (cfs)	Total Phosphorous (mg/l as P)	Dis Ortho P (mg/l as P)	Boron (mg/l as B)	Iron (mg/l as Fe)	Nitrogen NO2+NO3 (mg/l as N)	Dis. Ammonia (mg/l as N)	Total Organic N (mg/l as N)	Total ORG+NH3 (mg/l as N)	Total Nitrogen (mg/l as N)
01/12/1980	110.0	0.14	0.08	70.0	40.00	0.85	0.07	1.20	1.30	2.20
01/29/1981	39.0	0.12	0.06	40.0	40.00	0.81	0.10			
01/05/1982	41.0	0.16	0.09	40.0	59.00	1.20	0.11	0.65	0.78	2.00
01/21/1982	1.7	0.08	0.06	60.0	52.00	0.60	0.13	0.55	0.73	1.30
01/19/1893	9.7	0.05	0.01	50.0	30.00	0.33	0.06		1.10	1.40
01/27/1983	400.0	0.75	0.08	40.0	150.00	0.67	0.06	1.10	1.30	2.00
02/20/1980	202.0	0.50	0.06	50.0	160.00	1.10	0.04	1.50	1.70	2.80
02/17/1982	9.4	0.04	0.02	60.0	75.00	0.65	0.09	0.58	0.67	1.30
02/08/1983	561.0	0.16	0.07	40.0	19.00	0.32	0.10	0.92	1.00	1.30
02/28/1984	5.0	0.01	0.01	70.0	33.00	0.10	0.04	0.35	0.40	
02/13/1986	45.0	0.12	0.07	80.0	49.00		0.12	0.59	0.70	1.60
02/24/1986	59.0	0.24	0.02	30.0	84.00		0.05	1.10	1.20	2.00
03/06/1980	32.0	0.12	0.04	60.0	20.00	0.51	0.01	0.70	0.77	1.30
03/30/1982	251.0	0.02	0.03	60.0	10.00	0.40	0.12	0.42	0.52	0.92
03/01/1983	2600.0	0.66	0.03	40.0	130.00	0.30	0.12	1.70	1.80	2.10
03/17/1984	3.4	0.04	0.04	50.0	14.00	0.14	0.02	0.26	0.30	0.50
03/10/1985	128.0	0.38	0.18	20.0	44.00	0.34	0.15	1.40	1.60	1.90
03/11/1986	551.0	0.23	0.02	50.0	96.00		0.02	0.43	0.50	1.20
04/12/1985	18.0	0.03	0.02	70.0	17.00	0.10	0.06	0.61	0.70	
05/06/1980	1.0	0.01	0.00	160.0	10.00	0.02	0.03	0.83	0.93	0.97
05/17/1983	52.0	0.04	0.01	50.0	16.00	0.10	0.07	0.19	0.30	
08/30/1983	1.6	0.01	0.01	50.0	7.00	0.10	0.03		0.20	
09/08/1982	1.0	0.03	0.01	70.0	10.00	0.13	0.14	0.78	1.00	1.10
11/20/1979	0.7	0.02	0.02	110.0	10.00	0.33	0.07	0.34	0.43	0.76
11/17/1981	2.2	0.08	0.08	60.0	49.00	0.46	0.15	0.46	0.57	1.00
12/30/1981	3.9	0.07	0.05	130.0	10.00	0.98	0.07	0.54	0.66	1.70

R0054821

11168800 - LOS GATOS C AT LINCOLN AVE AT SAN JOSE CALIF

Period	Flow (cfs)	Total Phosphorous (mg/l as P)	Dis. Ortho P (mg/l as P)	Boron (mg/l as B)	Iron (mg/l as Fe)	Nitrogen NO2+NO3 (mg/l as N)	Dis. Ammonia (mg/l as N)	Total Organic N (mg/l as N)	Total ORG+NH3 (mg/l as N)	Total Nitrogen (mg/l as N)
All										
Mean	197.3	0.16	0.05	61.9	47.46	0.46	0.08	0.75	0.85	1.49
CV	2.62	1.26	0.86	0.49	0.93	0.75	0.54	0.55	0.52	0.38
n	26	26	26	26	26	23	26	23	25	21
Month										
Nov	1.5	0.05	0.05	85.0	29.50	0.40	0.11	0.40	0.50	0.88
Jan	86.5	0.20	0.06	61.4	54.43	0.78	0.09	0.81	0.98	1.77
Feb	146.9	0.18	0.04	55.0	70.00	0.54	0.07	0.84	0.95	1.80
March	511.9	0.21	0.05	50.0	47.29	0.30	0.07	0.79	0.88	1.32
May	26.5	0.03	0.01	105.0	13.00	0.06	0.05	0.51	0.62	0.97
Sept	1.3	0.02	0.01	60.0	8.50	0.12	0.09	0.78	0.60	1.10
Winter										
Nov-April	230.6	0.18	0.05	58.2	54.1	0.54	0.08	0.77	0.89	1.54
n	22	22	22	22	22	19	22	20	21	19
Summer										
May-Sept	13.9	0.02	0.01	82.5	10.8	0.09	0.07	0.80	0.61	1.04
n	4	4	4	4	4	4	4	3	4	2

C V = Coefficent of Variation
n = Sample number

R0054822

Station # 11168800 - LOS GATOS CREEK AT LINCOLN AVE. AT SAN JOSE CALIF

DATE	Flow (cfs)	Zn Dissolved (µg/l)	Zn Sediment (µg/gm)	Pb Dissolved (µg/l)	Pb Sediment (µg/gm)	Cu Dissolved (µg/l)	Cu Sediment (µg/gm)	As Dissolved (µg/l)	As Sediment (µg/gm)
01/05/1982	41	10	80	6	60	2	20	1	5
01/27/1983	400	4	60	1	50	3	10	1	4
02/20/1980	202	20	100	6	150	2	30	1	5
02/13/1986	45	18		2		2		1	
02/24/1986	59	10		1		1		1	
08/30/1983	1.6	6	30	1	20	2	10	1	3
09/08/1982	1	10	30	1	20	2	9	1	15
All									
Mean	107.1	11.1	60.0	2.6	60.0	2.0	15.8	1.0	6.4
CV	1.36	0.53	0.51	0.92	0.89	0.29	0.58	0.00	0.76
n	7	7	5	7	5	7	5	7	5
Winter									
Mean	149.4	12.4	80.0	3.2	86.7	2.0	20.0	1.0	4.7
n	5	5	3	5	3	5	3	5	3
Summer									
Mean	1.3	8.0	30.0	1.0	20.0	2.0	9.5	1.0	9.0
n	2	2	2	2	2	2	2	2	2

R0054823

Station # 11 68800 - LOS GATOS CREEK AT LINCOLN AVE. AT SAN JOSE CALIF

DATE	Flow (cfs)	Fe Sediment (µg/l)	Mn Dissolved (µg/l)	Mn Sediment (µg/gm)	Al Dissolved (µg/l)	Al Sediment (µg/gm)	Cb Sediment (µg/gm)
01/05/1982	41	13000	10	270	30	6500	10
01/27/1983	400	8500	11	200	130	5000	10
02/20/1980	202	6200	0	240	170	60	20
02/13/1986	45		6		20		
02/24/1986	59		10		30		
08/30/1983	1.6	5500	1	170	10	3200	10
09/08/1982	1	3200	10	110	10	1900	10
All							
Mean	107.1	7280.0	6.9	198.0	57.1	3332.0	12.0
CV	1.36	0.51	0.68	0.31	1.14	0.76	0.37
n	7	5	7	5	7	5	5
Winter							
Mean	149.4	9233.3	7.4	236.7	76.0	3853.3	13.3
n	5	3	5	3	5	3	3
Summer							
Mean	1.3	4350.0	5.5	140.0	10.0	2550.0	10.0
n	2	2	2	2	2	2	2

R0054824

Station # 11168800 - LOS GATOS CREEK AT LINCOLN AVE. AT SAN JOSE CALIF

DATE	Flow (cfs)	Cd Dissolved (µg/l)	Cd Sediment (µg/gm)	Cr Dissolved (µg/l)	Cr Sediment (µg/gm)	Hg Dissolved (µg/l)	Hg Sediment (µg/gm)	Ni AS NI) (01065)	Se Sediment (µg/gm)
01/05/1982	41	1	1	<10	30	<0.1	0.07	<100	<1
01/27/1983	400	<1	<1	<10	20	<0.1	0.06	<100	<1
02/20/1980	202	0	1	0	20	0.1	0.03	0	0
02/13/1986	45	<1		<10		<0.1		<100	
02/24/1986	59	<1		<10		<0.1		<100	
08/30/1983	1.6	<1	<1	<10	10	<0.1	0.04	<100	<1
09/08/1982	1	<1	<1	<10	6	<0.1	0.03	<100	<1

R0054825

11168800 - LOS GATOS C AT LINCOLN AVE AT SAN JOSE CALIF

DATE	Total Diazinon (µg/l)	Total 2,4-D, (µg/l)	Total Lindane (µg/l)	Total Malathion (µg/l)	Total Chlordane (µg/l)	Total DDD (µg/l)	Total DDE (µg/l)	Total DDT (µg/l)	Total Dieldrin (µg/l)	Total Heptachlor (µg/l)
02/20/1980	0.02		0.01	0	0	0	0	0.01	0	0
01/05/1982	0.03	0.02	0.01	0.13	0	0	0	0	0	0
09/08/1982	<0.01	0.02	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
01/27/1983	0.03	0.01	0.02	0.01	0.1	<0.010	0.01	<0.010	<0.010	<0.010
04/12/1983	0.01	0.03	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
08/30/1983	0.01	0.02	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
02/13/1986	0.1	0.03	<0.010	0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010

R0054826

11168800 · LOS GATOS C AT LINCOLN AVE AT SAN JOSE CALIF

DATE	Naphthalenes Polychlor (µg/l)	Total PCB (µg/l)	Total Aldrin (µg/l)	Total Endosulfan (µg/l)	Total Endrin (µg/l)	Total Ethion (µg/l)	Total Chlor Epoxide (µg/l)	Total Oxychlor (µg/l)	Total Methyl Parathion (µg/l)
02/20/1980	0	0	0	0	0	0	0	0	0
01/05/1982	0	0	0	0	0	0	0	0	0
09/08/1982	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
01/27/1983	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
04/12/1983	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
08/30/1983	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
02/13/1986	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01

R0054827

11160800 - LOS GATOS C AT LINCOLN AVE AT SAN JOSE CALIF

DATE	Total Methyl Trithion (µg/l)	Total Mirex (µg/l)	Total Perthane (µg/l)	Total Toxaphene (µg/l)	Total Trithion (µg/l)	Total 2,4,5-T (µg/l)	Total Silvex (µg/l)
02/20/1980	0	0	0	0	0		
01/05/1982	0	0	0	0	0	0	0
09/08/1982	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
01/27/1983	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
04/12/1983	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
08/30/1983	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
02/13/1986	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01

R0054828

8720115A-F CON-3

USGS STATION NO. 11168660
LOS GATOS CREEK AT
LARK AVENUE AT LOS GATOS, CA

VOL 12 2 1529

R0054829

11168660 · LOS GATOS C AT LARK A AT LOS GATOS CALIF

DATE	Flow (cfs)	Cond (µmohs)	pH	Temp (deg C)	TDS (mg/l)	Turbidity (NTU)	DO (mg/l)	DO (% sat)	Organic C (mg/l as C)	TH (mg/l as CaCO3)	Alkalinity (mg/l as CaCO3)
01/17/1979	34.0	339.0	7.5	10.0	200.0		8.9			150.0	110.0
01/12/1980	211.0	347.0	7.2	12.5	230.0	37.0	10.2		5.9	170.0	130.0
01/29/1981	68.0	343.0	7.2	11.0	190.0	46.0	10.5	96.0	8.2	140.0	110.0
01/05/1982	192.0	182.0	7.8	10.0	110.0	240.0	10.8	97.0	6.3	84.0	74.0
01/21/1982	16.0	366.0	7.8	8.5	210.0	24.0	10.8	93.0	4.2	170.0	143.0
01/19/1983	33.0	308.0	7.7	8.5	180.0	22.0	10.9	94.0	3.8	140.0	110.0
01/27/1983	108.0	177.0	7.7	10.5	130.0	340.0	10.4	95.0	5.6	81.0	74.0
01/15/1985	2.2	608.0	8.0	8.5	370.0	25.0	9.2	79.0	2.1	290.0	246.0
01/29/1985	2.7	588.0	7.9	9.0	350.0	20.0	9.2	80.0	3.6	270.0	236.0
01/29/1986	2.7	556.0	8.0	11.5	340.0	1.5	8.0	74.0		270.0	185.0
02/14/1979	24.0	388.0	8.4	12.5	240.0		7.6			180.0	120.0
02/19/1980	294.0	170.0	7.6	12.5	100.0	730.0	10.2		7.1	73.0	63.0
02/17/1982	43.0	303.0	8.0	13.0	170.0	56.0	10.2	96.0	5.2	140.0	112.0
02/08/1983	656.0	232.0	7.9	11.0	140.0	140.0	10.9	100.0	4.6	100.0	88.0
02/28/1984	24.0	355.0	8.5	12.0	210.0	3.2	10.6	99.0	2.9	160.0	133.0
02/08/1985	159.0	178.0	7.7	11.0	110.0	43.0	9.7	89.0		77.0	60.0
02/13/1986	47.0	443.0	8.2	11.5	270.0	20.0	9.8	90.0		210.0	153.0
02/24/1986	485.0	156.0	8.0	13.0	120.0	400.0	10.2	98.0		86.0	67.0
03/16/1979	17.0	410.0	8.3	13.5	250.0		11.5			190.0	140.0
03/27/1979	68.0	372.0	8.0	14.5	230.0		9.8			170.0	130.0
03/06/1980	369.0	271.0	7.3	12.0	160.0	110.0	10.6		11.0	120.0	89.0
03/05/1981	17.0	394.0	7.3	11.0	240.0	7.4	9.9	91.0	6.2	180.0	140.0
03/27/1981	18.0	396.0	8.1	13.0	240.0	12.0	9.6	91.0	6.5	180.0	140.0
03/30/1982	388.0	297.0	8.0	10.5	180.0	33.0	11.0	99.0	3.6	130.0	107.0
03/01/1983	1240.0	204.0	7.9	12.0	130.0	380.0	10.6	99.0	4.1	90.0	82.0
03/17/1984	29.0	346.0	8.3	13.5	210.0	8.0	9.0	86.0	5.6	160.0	129.0
03/10/1985	10.0	436.0	8.4	13.0	260.0	7.8	11.4	109.0		200.0	145.0
03/11/1986	649.0	228.0	8.2	14.0	130.0	120.0	10.1	99.0		97.0	74.0
04/12/1983	66.0	288.0	8.4	12.5	180.0	17.0	10.6	100.0	1.8	130.0	120.0
04/26/1979	21.0	387.0	8.1	15.5	230.0		9.8			170.0	120.0
05/23/1979	1.3	397.0	8.4	25.5	250.0		12.1			200.0	130.0
05/06/1980	23.0	316.0	8.2	16.5	200.0	9.0	9.9	102.0	7.2	150.0	120.0
05/19/1981	2.1	413.0	7.7	16.0	270.0	0.8	6.0	61.0	7.3	190.0	150.0
05/18/1982	31.0	293.0	8.2	15.0	190.0	8.6	9.7	97.0	2.2	140.0	118.0
05/17/1983	96.0	273.0	8.3	14.5	170.0	15.0	9.9	97.0	1.7	130.0	110.0

R0054830

05/13/1986	29.0	279.0	8.3	16.0	180.0	20.0	8.9	91.0		130.0	108.0
06/12/1984	21.0	353.0	8.3	19.0	210.0	1.5	8.2	89.0	2.8	160.0	133.0
06/13/1985	43.0	506.0	8.3	21.5	310.0	6.1	8.0	92.0		240.0	169.0
07/31/1979	13.0	387.0	7.7	21.0	240.0		8.9			160.0	130.0
07/16/1980	30.0	298.0	7.4	16.5	190.0	13.0	9.2	95.0	2.7	140.0	120.0
07/14/1981	12.0	437.0	8.0	22.5	280.0	1.5	6.9	81.0	5.0	200.0	150.0
07/20/1982	32.0	289.0	8.1	20.0	180.0	4.1	8.5	94.0	2.8	140.0	116.0
07/12/1983	60.0	301.0	8.2	17.5	170.0	5.0	8.9	94.0	1.9	130.0	110.0
07/10/1984	23.0	366.0	8.3	21.5	210.0	3.9	7.7	88.0	2.8	160.0	131.0
07/24/1985	13.0	563.0	8.1	24.0	340.0	1.6	6.7	81.0		260.0	198.0
07/22/1986	27.0	299.0	8.4	20.5	180.0	2.9	8.5	95.0		130.0	117.0
08/30/1983	46.0	292.0	8.1	19.0	180.0	3.3	8.4	91.0	2.0	140.0	110.0
08/27/1984	43.0	363.0	7.7	19.5	210.0	5.0	8.3	91.0	3.3	170.0	130.0
09/04/1979	28.0	399.0	8.2	21.0	240.0		8.4			180.0	120.0
09/10/1980	74.0	318.0	7.8	19.0	200.0	4.4	8.8		4.1	150.0	120.0
09/01/1981	11.0	488.0	7.6	22.0	300.0	1.5	6.8	79.0	3.4	220.0	160.0
09/08/1982	63.0	279.0	7.8	17.5	170.0	3.0	9.2	97.0	2.5	130.0	106.0
09/11/1985	2.2	554.0	8.0	17.0	330.0	3.5	6.4	67.0		250.0	194.0
09/23/1986	5.5	365.0	8.1	18.0	210.0	1.3	7.1	76.0		160.0	144.0
11/20/1979	10.0	446.0	7.5	13.5	300.0	1.8	9.5		11.0	230.0	160.0
11/18/1980	16.0	392.0	8.3	13.0	220.0	2.5	11.0	104.0	6.2	170.0	150.0
11/17/1981	31.0	377.0	7.9	15.5	240.0	15.0	9.0	91.0	15.0	170.0	130.0
11/16/1982	53.0	341.0	8.3	13.0	210.0	3.3	9.5	91.0	2.9	150.0	130.0
12/30/1981	0.6	459.0	7.7	12.0	270.0	3.0	7.0	66.0	5.9	210.0	180.0

R0054831

NOV 12

11160660 - LOS GATOS C AT LARK A AT LOS GATOS CALIF

Period	Flow (cfs)	Cond (µmohs)	pH	Temp (deg C)	TDS (mg/l)	Turbidity (NTU)	DO (mg/l)	DO (% sat)	Dis Organic C (mg/l as C)	TH (mg/l as CaCO3)	Alkalinity (mg/l as CaCO3)
All											
Mean	104.0	354.4	8.0	14.9	216.3	58.5	9.3	90.5	4.9	162.7	128.4
CV	2.01	0.29	0.04	0.28	0.29	2.29	0.15	0.11	0.58	0.31	0.29
n	59	59	59	59	59	51	59	46	39	59	59
Month											
Nov	27.5	389.0	8.0	13.8	242.5	5.7	9.8	95.3	8.8	180.0	142.5
Jan	60.9	388.5	7.7	10.2	234.5	75.9	9.6	86.0	5.1	179.5	145.3
Feb	216.5	278.1	8.0	12.1	170.0	198.9	9.9	95.3	5.0	128.3	99.5
March	261.0	331.1	8.0	12.7	200.9	77.2	10.4	96.8	5.5	149.7	117.8
May	29.7	357.4	8.2	17.7	223.3	8.7	9.2	89.9	4.2	167.8	128.7
July	26.3	367.5	8.0	20.4	223.8	4.6	8.2	89.7	3.0	165.0	134.0
Sept	34.1	382.3	7.9	19.1	230.0	3.1	7.9	83.5	3.1	175.0	135.5
Winter											
Nov - April	154.4	346.7	7.9	12.2	212.0	89.4	9.9	93.4	6.1	159.4	126.3
n	35	35	35	35	35	30	35	26	24	35	35
Summer											
May - Sept	30.4	369.1	8.0	19.1	225.7	5.5	8.4	87.7	3.4	169.3	132.7
n	24	24	24	24	24	21	24	20	15	24	24

C V = Coefficent of Variation
n = Sample number

R0054832

NOV 21

flow	tds	turb	th	tp	no2+no3	tn
27.50	242.50	5.65	180.00	0.03	0.31	1.20
60.93	234.55	75.85	179.55	0.17	0.79	1.64
216.50	170.00	198.89	128.25	0.26	0.54	2.33
261.00	200.91	77.24	149.73	0.10	0.39	1.13
29.71	223.33	8.71	167.78	0.04	0.20	0.96
26.25	223.75	4.57	165.00	0.03	0.09	0.81
34.09	230.00	3.14	175.00	0.04	0.10	0.89

R0054833

flow	tds	turb	th	tp	no2+no3	tn
27.50	242.50	5.65	180.00	0.03	0.31	1.20
60.93	234.55	75.85	179.55	0.17	0.79	1.64
216.50	170.00	198.89	128.25	0.26	0.54	2.33
261.00	200.91	77.24	149.73	0.10	0.39	1.13
29.71	223.33	8.71	167.78	0.04	0.20	0.96
26.25	223.75	4.57	165.00	0.03	0.09	0.81
34.09	230.00	3.14	175.00	0.04	0.10	0.89

R0054834

11168660 - LOS GATOS C AT LARK A AT LOS GATOS CALIF

DATE	Flow (cfs)	Total Phosphorous (mg/l as P)	Dis. Ortho P (mg/l as P)	Boron (mg/l as B)	Iron (mg/l as Fe)	Nitrogen NO2+NO3 (mg/l as N)	Dis. Ammonia (mg/l as N)	Total Organic N (mg/l as N)	Total ORG+NH3 (mg/l as N)	Total Nitrogen (mg/l as N)
01/17/1979	34.0	0.12	0.01	60.0	30.00	0.83	0.06	0.58	0.66	1.50
01/12/1980	211.0	0.12	0.04	60.0	50.00	0.77	0.14	1.20	1.30	2.10
01/29/1981	68.0	0.11	0.04	40.0	60.00	0.84	0.10	1.20	1.30	2.20
01/05/1982	192.0	0.18	0.10	40.0	85.00	1.10	0.10	0.84	0.96	2.10
01/21/1982	16.0	0.07	0.06	50.0	52.00	1.30	0.15	0.62	0.76	2.10
01/19/1983	33.0	0.08	0.01	50.0	15.00	0.29	0.06		0.40	0.70
01/27/1983	108.0	0.75	0.07	30.0	170.00	0.67	0.13	1.00	1.20	1.80
01/15/1985	2.2	0.13	0.04	80.0	6.00	0.72	0.44	0.47	0.90	1.60
01/29/1985	2.7	0.09	0.02	80.0	5.00	0.41	0.21	0.48	0.70	1.10
01/29/1986	2.7	0.05	0.02	80.0	5.00		0.12	0.57	0.70	1.20
02/14/1979	24.0	0.06	0.01	90.0	20.00	0.45	0.02	0.42	0.50	0.92
02/19/1980	294.0	0.63	0.08	50.0	160.00	1.00	0.06	2.70	3.00	4.10
02/17/1982	43.0	0.07	0.04	50.0	74.00	0.72	0.09	0.64	0.74	1.50
02/08/1983	656.0	0.15	0.07	40.0	16.00	0.32	0.12	1.10	1.20	1.50
02/28/1984	24.0	0.04	0.01	50.0	33.00	0.10	0.03	0.25	0.30	
02/08/1985	159.0	0.80	0.02	30.0	500.00	0.63	0.33	4.10	4.50	5.10
02/13/1986	47.0	0.07	0.06	90.0	32.00		0.15	0.56	0.70	1.40
02/24/1986	485.0	0.23	0.02	30.0	16.00		0.05	1.00	1.10	1.80
03/16/1979	17.0	0.03	0.01	80.0	30.00	0.54	0.04	0.39	0.46	1.00
03/27/1979	68.0	0.04	0.01	80.0	20.00	0.51	0.12	0.48	0.57	1.10
03/06/1980	369.0	0.11	0.03	50.0	70.00	0.44	0.01	1.20	1.20	1.70
03/05/1981	17.0	0.07	0.00	50.0	20.00	0.54	0.05	0.81	0.86	1.40
03/27/1981	18.0	0.05	0.00	40.0	10.00	0.32	0.04	0.64	0.67	0.99
03/30/1982	388.0	0.07	0.04	50.0	14.00	0.40	0.11	0.33	0.48	0.88
03/01/1983	1240.0	0.44	0.03	40.0	86.00	0.31	0.08	1.30	1.40	1.70
03/17/1984	29.0	0.05	0.02	50.0	9.00	0.18	0.05	0.67	0.70	0.90
03/10/1985	10.0	0.05	0.01	70.0	18.00	0.33	0.01	0.45	0.50	0.80
03/11/1986	649.0	0.12	0.02	40.0	110.00		0.04	0.33	0.40	1.00
04/12/1983	66.0	0.05	0.03	40.0	13.00	0.30	0.06	0.58	0.70	1.00
04/26/1979	21.0	0.03	0.02	90.0	20.00	0.38	0.01	0.35	0.43	0.83
05/23/1979	1.3	0.03	0.01	80.0	10.00	0.27	0.01	0.36	0.41	0.83
05/06/1980	23.0	0.03	0.00	50.0	10.00	0.20	0.06	1.40	1.50	1.70
05/19/1981	2.1	0.05	0.03	40.0	10.00	0.26	0.16	0.49	0.66	0.93
05/18/1982	31.0	0.07	0.01	40.0	9.00	0.16	0.11	0.47	0.57	0.73
05/17/1983	96.0	0.04	0.01	40.0	15.00	0.14	0.07	0.80	0.90	1.00

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05/13/1986	29.0	0.06	0.01	40.0	4.00		0.05	0.45	0.50	0.70
06/12/1984	21.0	0.01	0.01	50.0	9.00	0.10	0.03	0.36	0.40	
06/13/1985	43.0	0.05	0.01	70.0	3.00	0.10	0.05	0.32	0.40	
07/31/1979	13.0	0.01	0.01	90.0	10.00	0.03	0.04	0.34	0.36	0.41
07/16/1980	30.0	0.06	0.00	70.0	10.00	0.25	0.04	0.75	0.83	1.10
07/14/1981	12.0	0.05	0.02	60.0	10.00	0.04	0.11	0.48	0.73	0.82
07/20/1982	32.0	0.01	0.01	50.0	8.00	0.10	0.11	0.98	1.10	1.20
07/12/1983	60.0	0.04	0.01	40.0	11.00	0.10	0.06	0.46	0.50	
07/10/1984	23.0	0.01	0.01	50.0	3.00	0.10	0.01	0.26	0.30	
07/24/1985	13.0	0.04	0.04	70.0	10.00	0.01	0.06	0.35	0.40	
07/22/1986	27.0	0.01	0.01	50.0	11.00		0.04	0.26	0.30	0.50
08/30/1983	46.0	0.01	0.01	40.0	10.00	0.10	0.03	0.20	0.30	
08/27/1984	43.0	0.02	0.01	50.0	4.00	0.10	0.03	0.27	0.30	
09/04/1979	28.0	0.04		70.0	10.00		0.11	0.61	0.70	0.79
09/10/1980	74.0	0 04	0.04	70.0	10.00	0.08	0.04	0.54	0.56	0.66
09/01/1981	11.0	0.07	0.02	80.0	10.00	0.08	0.15	0.79	0.98	1.00
09/08/1982	63.0	0.04	0.01	50.0	3.00	0.15	0.10	0.68	0.90	1.10
09/11/1985	2.2	0.08	0.03	90.0	8.00	0.11	0.08	0.71	0.80	0.90
09/23/1986	5.5	0.05	0.01	60.0	5.00		0.05	0.32	0.40	
11/20/1979	10.0	0.02	0.02	80.0	10.00	0.18	0.12	0.45	0.61	0.79
11/18/1980	16.0	0.02	0.01	80.0	10.00	0.07	0.05			
11/17/1981	31.0	0.06	0.06	50.0	40.00	0.88	0.26	0.52	0.75	1.60
11/16/1982	53.0	0.01	0.01	50.0	5.00	0.10	0.08		1.20	
12/30/1981	0.6	0.12	0.09	60.0	26.00	0.99	0.11	0.52	0.66	1.60

R0054836

0E55-- 2 27 VOL

11168660 - LOS GATOS C AT LARK A AT LOS GATOS CALIF

Period	Flow (cfs)	Total Phosphorous (mg/l as P)	Dis Ortho P (mg/l as P)	Boron (mg/l as B)	Iron (mg/l as Fe)	Nitrogen NO2+NO3 (mg/l as N)	Dis. Ammonia (mg/l as N)	Total Organic N (mg/l as N)	Total ORG+NH3 (mg/l as N)	Total Nitrogen (mg/l as N)
All										
Mean	104.0	0.10	0.03	57.6	34.63	0.37	0.09	0.70	0.82	1.34
CV	2.01	1.58	0.92	0.31	2.05	0.86	0.86	0.87	0.80	0.62
	59	59	58	59	59	51	59	56	58	48
Month										
Nov	27.5	0.03	0.03	65.0	16.25	0.31	0.13	0.49	0.85	1.20
Jan	60.9	0.17	0.05	57.3	45.82	0.79	0.15	0.75	0.87	1.64
Feb	216.5	0.26	0.04	53.8	106.38	0.54	0.11	1.35	1.51	2.33
March	261.0	0.10	0.02	53.6	36.36	0.39	0.06	0.65	0.72	1.13
May	29.7	0.04	0.01	55.6	10.00	0.20	0.06	0.56	0.64	0.96
July	26.3	0.03	0.01	60.0	9.13	0.09	0.06	0.49	0.57	0.61
Sept	34.1	0.04	0.02	63.8	7.50	0.10	0.07	0.52	0.62	0.89
Winter										
Nov - April	141.5	0.14	0.03	57.4	51.20	0.51	0.11	0.81	0.99	1.57
n	35	35	35	35	35	31	35	32	34	32
Summer										
May - Sept	30.0	0.04	0.01	59.8	8.88	0.13	0.06	0.52	0.61	0.89
n	24	24	23	24	24	20	24	24	24	16

C V = Coefficent of Variation
n = Sample number

R0054837

VOL 12

2

Station # 11168660 - LOS GATOS CREEK AT LARK AVE. AT LOS GATOS CALIF

DATE	Flow (cfs)	Zn Dissolved (µg/l)	Zn Sediment (µg/gm)	Pb Dissolved (µg/l)	Pb Sediment (µg/gm)	Cu Dissolved (µg/l)	Cu Sediment (µg/gm)	As Dissolved (µg/l)	As Sediment (µg/gm)
01/17/1979	34	3		7		3		1	
01/05/1982	192	10	60	6	30	2	20	1	7
01/27/1983	108	7	60	1	20	2	20	1	4
02/19/1980	294	10	60	ND	90	1	20	1	5
02/08/1985	159	16	70	2	40	2	30	1	7
02/13/1986	47	51		3		1		1	
02/24/1986	185	10		1		2		1	
03/27/1981	18	10	40	ND	40	4	8	2	9
07/31/1979	13	3		ND		ND		1	
08/30/1983	46	6	30	1	10	1	20	1	3
08/27/1984	43	17	80	1	20	1	30	1	1
09/10/1980	74	10	50	4	40		20	2	4
09/01/1981	11	10	60	2	10	9	20	2	4
09/08/1982	63	10	50	1	20	1	20	1	4
09/11/1985	2.2	10	120	1	60	4	50	2	6
All									
Mean	105.9	12.2	61.8	2.5	34.5	2.5	23.5	1.3	4.9
CV	1.25	0.93	0.38	0.84	0.69	0.88	0.45	0.36	0.45
n	15	15	11	12	11	13	11	15	11
Winter									
Mean	167.1	14.6	58.0	3.3	44.0	2.1	19.6	1.1	6.4
CV	0.95	1.04	0.19	0.77	0.61	0.47	0.40	0.31	0.30
n	8	8	5	6	5	8	5	8	5
Summer									
Mean	36.0	9.4	65.0	1.7	26.7	3.2	26.7	1.4	3.7
CV	0.77	0.46	0.48	0.73	0.74	1.09	0.45	0.37	0.45
n	7	7	6	6	6	5	6	7	6

R0054838

VOL 12

2 -538

Station # 11168660 - LOS GATOS CREEK AT LARK AVE. AT LOS GATOS CALIF

DATE	Flow (cfs)	Fe Sediment (µg/l)	Mn Dissolved (µg/l)	Mn Sediment (µg/gm)	Al Dissolved (µg/l)	Al Sediment (µg/gm)	Co Sediment (µg/gm)
01/17/1979	34		10		10		
01/05/1982	192	14000	10	460	40	7500	10
01/27/1983	108	10000	30	410	150	6000	10
02/19/1980	294	7300	ND	190	50	640	10
02/08/1985	159	36000	400	780	50	16000	30
02/13/1986	47		41		10		
02/24/1986	485		10		40		
03/27/1981	18	7000	50	480	10	4200	10
07/31/1979	13		100		100		
08/30/1983	46	4800	24	300	10	2300	10
08/27/1984	43	18000	75	860	10	9300	10
09/10/1980	74	10000	130	350	ND	3400	20
09/01/1981	11	16000	10	600	ND	4000	10
09/08/1982	63	8000	20	310	10	3300	10
09/11/1985	2.2	22000	130	2100	10	13000	20
All							
Mean	105.9	13918.2	74.3	621.8	38.5	6330.9	13.6
CV	1.25	0.65	1.39	0.85	1.12	0.75	0.49
n	15	11	14	11	13	11	11
Winter							
Mean	167.1	14860.0	78.7	464.0	45.0	6868.0	14.0
CV	0.95	0.82	1.81	0.45	1.02	0.83	0.64
n	8	5	7	5	8	5	5
Summer							
Mean	36.0	13133.3	69.9	753.3	28.0	5883.3	13.3
CV	0.77	0.50	0.75	0.92	1.44	0.73	0.39
n	7	6	7	6	5	6	6

R0054839

3355-2

NOV 12

Station # 11168660 - LOS GATOS CREEK AT LARK AVE. AT LOS GATOS CALIF

DATE	Flow (cfs)	Cd Dissolved (µg/l)	Cd Sediment (µg/gm)	Cr Dissolved (µg/l)	Cr Sediment (µg/gm)	Hg Dissolved (µg/l)	Hg Sediment (µg/gm)	Ni Dissolved (µg/l)	Se Dissolved (µg/l)	Se Sediment (µg/gm)
01/17/1979	34	<2		<20		<0.1		ND		
01/05/1982	192	1	1	<10	30	<0.1	0.08	<100		<1
01/27/1983	108	<1	<1	<10	20	<0.1	0.05	<100		<1
02/19/1980	294	0	0	0	20	0	0.03	0		0
02/08/1985	159	<1	<1	<10	160	<0.1	1.5	<100	<1	<1
02/13/1986	47	<1		<10		<0.1		<100		
02/24/1986	485	<1		<10		<0.1		<100		
03/27/1981	18	0	0	10	14	0	0.9	0		0
07/31/1979	13	2		<20		<0.1		ND		
08/30/1983	46	<1	<1	<10	9	<0.1	0.06	<100		<1
08/27/1984	43	<1	<1	<10	40	<0.1	1.1	<100		<1
09/10/1980	74	0	2	0	21	0	0.04	0		0
09/01/1981	1	1	<1	0	30	0	0.06	0		0
09/08/1982	63	<1	<1	<10	20	<0.1	0.05	<100		<1
09/11/1985	2.2	1	0		680	<0.1	0.2	<100		<1

VOL 12

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R0054840

Station #11168660 - LOS GATOS CREEK AT LARK AVE. AT LOS GATOS CALIF

DATE	Total Diazinon (µg/l)	Total 2,4-D, (µg/l)	Total Lindane (µg/l)	Total Malathion (µg/l)	Total Chlordane (µg/l)	Total DDD (µg/l)	Total DDE (µg/l)	Total DDT (µg/l)	Total Dieldrin (µg/l)	Total Heptachlor (µg/l)
02/19/1980	0.01	0.02	0.01	0	0	0	0.01	0.02	0	0
09/10/1980	0	0	0	0	0	0	0	0	0	0
03/27/1981	0.01	0	0	0	0	0	0	0	0	0
09/01/1981	0	0.01	0	0.61	0	0	0	0	0	0
01/05/1982	0.01	0.02	0	0.1	0	0	0	0	0	0
09/08/1982	<0.01	<0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
01/27/1983	0.02		0.01	0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
04/12/1983	<0.01	<0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
08/30/1983	<0.01	<0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
08/27/1984	<0.01	0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
02/08/1985	0.16	0.04	0.01	0.01	0.1	0.01	0.01	0.01	<0.010	<0.010
09/11/1985	<0.01	<0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
01/29/1986	0.06	0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
02/13/1986	0.1	0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
02/24/1986	<0.01		<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
07/22/1986	<0.01	<0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
07/23/1986	<0.01	0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010

R0054841

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Station #11168660 - LOS GATOS CREEK AT LARK AVE. AT LOS GATOS CALIF

DATE	Naphthalenes Polychlor (µg/l)	Total PCB (µg/l)	Total Aldrin (µg/l)	Total Endosulfan (µg/l)	Total Endrin (µg/l)	Total Ethion (µg/l)	Total Chlor Epoxide (µg/l)	Total Oxychlor (µg/l)	Total Methyl Parathion (µg/l)
02/19/1980	0	0	0	0	0	0	0	0	0
09/10/1980	0	0	0	0	0	0	0	0	0
03/27/1981	0	0	0	0	0	0	0	0	0
09/01/1981	0	0	0	0	0	0	0	0	0
01/05/1982	0	0	0	0	0	0	0	0	0
09/08/1982	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
01/27/1983	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
04/12/1983	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
08/30/1983	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
08/27/1984	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
02/08/1985	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
09/11/1985	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
01/29/1986	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
02/13/1986	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
02/24/1986	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
07/22/1986	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
07/23/1986	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01

R0054842

Station #11168660 - LOS GATOS CREEK AT LARK AVE. AT LOS GATOS CALIF

DATE	Total Methyl Trithion (µg/l)	Total Mirex (µg/l)	Total Perthane (µg/l)	Total Toxaphene (µg/l)	Total Trithion (µg/l)	Total 2,4,5-T (µg/l)	Total Silvex (µg/l)
02/19/1980	0	0	0	0	0	0	0.01
09/10/1980	0	0	0	0	0	0	0
03/27/1981	0	0	0	0	0	0	0
09/01/1981	0	0	0	0	0	0	0
01/05/1982	0	0	0	0	0	0	0.01
09/08/1982	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
01/27/1983	<0.01	<0.01	<0.1	<1	<0.01		
04/12/1983	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
08/30/1983	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
08/27/1984	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
02/08/1985	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
09/11/1985	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
01/29/1986	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
02/13/1986	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
02/24/1986	<0.01	<0.01	<0.1	<1	<0.01		
07/22/1986	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
07/23/1986	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01

R0054843

USGS STATION NO. 11168000
LOS GATOS CREEK AT
LOS GATOS, CA

VOL 12

2

1544

R0054844

Station #11168000 -LOS GATOS CREEK AT LOS GATOS, CALIF.

DATE	Flow (cfs)	Cond (µmohs)	TDS (mg/l)	pH	Temp (deg C)	Turbidity (NTU)	DO (mg/l)	DO (% sat)	Organic C (mg/l as C)	TH (mg/l as CaCO3)	Alkalinity (mg/l as CaCO3)
1/12/80	62.0	217.0	125.0		13.0	100.0	10.1		7.6	94.0	79.0
1/29/81		340.0	191.2			160.0				140.0	
1/4/82		156.0	102.9			570.0				76.0	
1/20/82		341.0	191.2			22.0				160.0	
1/19/83	28.0	321.0	198.5	7.9	8.0	29.0	11.2	96	3.5	150.0	120.0
1/26/83		180.0	110.3			370.0				80.0	
1/15/85	0.4	530.0	323.5	8.1	7.5	0.5	13.4	112	1.6	270.0	222.0
1/29/85	0.3	539.0	323.5	7.8	7.5	0.3	12.4	104	2.5	260.0	222.0
1/26/86	4.1	488.0	294.1	8.0	11.0	24.0	10.8	99		230.0	148.0
2/19/80	99.0	186.0	117.6	7.4	12.0	550.0	10.1		5.0	81.0	75.0
2/16/82		286.0	169.1			120.0				130.0	
2/7/83		241.0	154.4			150.0				110.0	
2/27/84		343.0	205.9			16.0				150.0	
2/8/85	34.0	231.0	125.0	8.0	9.5	64.0	11.0	97		110.0	72.0
2/13/86	2.0	327.0	191.2	8.2	12.0	130.0	9.2	86		150.0	131.0
2/24/86	181.0	146.0	117.6	7.9		350.0	10.4			80.0	66.0
3/5/80		262.0	161.8			110.0				110.0	87.0
3/4/81		413.0	235.3			54.0				180.0	
3/25/81		414.0	235.3			70.0				180.0	
3/30/82	259.0	301.0	183.8	8.0	10.5	21.0	11.0	100	3.0	130.0	106.0
3/1/83			132.3			220.0				98.0	
3/17/84	22.0	340.0	198.5	8.1	11.0	7.6	10.9	99	2.9	150.0	126.0
3/10/85	16.0	400.0	235.3	8.2	11.0	28.0	11.4	104		170.0	
3/4/86	113.0	208.0	117.6	8.0	13.0	170.0	10.2	98		87.0	70.0
3/11/86	324.0	220.0	125.0	8.2	14.0	88.0	9.6	94		95.0	79.0
4/11/83			169.1			1.4				120.0	
4/15/86	47.0	244.0	139.7	8.1	13.0	53.0	10.2	98		100.0	89.0
5/6/80	19.0	281.0	176.5	8.0	13.0	36.0	10.9	104	6.1	130.0	98.0
5/18/81		421.0	250.0			19.0				180.0	
5/17/82		266.0	161.8			17.0				120.0	
5/16/83		271.0	169.1			19.0				120.0	
5/13/86	30.0	246.0	154.4	8.1	13.0	2.0	10.2	98		110.0	92.0
6/11/84			205.9			5.1				160.0	
6/11/85	46.0	515.0	330.9	8.3	19.0	6.5	9.0	99	3.7	250.0	176.0
6/10/86	52.0	252.0	154.4	8.3	15.0	1.5	10.8	108		110.0	98.0
7/16/80		292.0	176.5			12.0				130.0	100.0
7/13/81		455.0	279.4			6.1				210.0	
7/19/82		274.0	169.1			15.0				120.0	

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7/12/83	60.0	281.0	169.1	8.0	13.5	8.4	10.3	101	1.9	120.0	110.0
7/10/84	23.0	355.0	205.9	8.3	14.0	2.2	10.7	106		160.0	125.0
7/24/85	5.3	711.0	441.1	8.3	22.5	7.0	8.5	100		360.0	285.0
7/22/86	37.0	283.0	176.5	8.2	15.0	2.0	11.0	110		110.0	110.0
8/1/81		532.0	323.5			11.0				250.0	
8/29/83		285.0	176.5			4.0				140.0	
8/27/84	46.0	365.0	220.6	8.1	20.0	2.1	9.3	103	3.0	170.0	137.0
8/20/86	58.0	291.0	169.1	8.0	17.0	4.4	10.6	111		120.0	107.0
9/10/80		331.0	191.2			11.0				150.0	110.0
9/8/82	67.0	270.0	169.1	7.5	13.5	2.7	10.3	100	2.2	120.0	102.0
9/11/85	4.8	550.0	352.9	8.0	12.0	43.0	10.0	94		280.0	236.0
9/23/86	0.2	380.0	242.6	8.1	15.0	0.7	10.0	100		180.0	167.0
11/20/79	9.2	445.0	308.8	8.2	13.0	12.0	10.3		7.2	220.0	160.0
11/18/80		385.0	213.2			16.0				160.0	
11/16/81		347.0	205.9			15.0				160.0	
11/16/82	59.0	337.0	205.9	8.2	14.0	3.5	10.0	99	3.4	150.0	130.0
12/30/81	5.9	380.0	213.2	8.1	11.5	4.2	10.7	99	5.2	180.0	166.0
12/18/85	2.9	664.0	441.1	8.3	8.0	3.5	11.6	98		320.0	199.0

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R0054846

Station #11168000 -LOS GATOS CREEK AT LOS GATOS, CALIF.

Period	Flow (cfs)	Cond (µmohs)	TDS (mg/l)	pH	Temp (deg C)	Turbidity (NTU)	DO (mg/l)	DO (% sat)	Organic C (mg/l as C)	TH (mg/l as CaCO3)	Alkalinity (mg/l as CaCO3)
All											
Mean	53.7	342.2	205.9	8.1	13.0	67.3	10.5	101	3.9	155.0	129.4
CV	1.38	0.35	0.37	0.03	0.26	1.84	0.09	0.05	0.48	0.40	0.41
n	32	53	56	31	31	56	32	28	15	56	34
Month											
Nov	34.1	378.5	233.4	8.2	13.5	11.6	10.2	99	5.3	172.5	145.0
Jan	14.8	377.8	228.6	8.0	9.5	116.7	11.5	101	4.1	178.2	165.1
Feb	79.0	251.4	154.4	7.9	11.2	197.1	10.2	92	5.0	115.9	86.0
Mar	130.2	311.3	175.8	8.1	12.1	74.8	10.6	99	3.0	129.1	92.8
May	24.5	297.0	182.3	8.1	13.0	18.6	10.6	101	6.1	132.0	95.0
Jun	49.0	383.5	230.4	8.3	17.0	4.4	9.9	104	3.7	173.3	137.0
July	31.3	378.7	231.1	8.2	16.3	7.5	10.1	104	1.9	172.9	146.0
August	52.0	368.3	222.4	8.1	18.5	5.4	10.0	107	3.0	170.0	122.0
Sept	24.0	382.8	239.0	7.9	13.5	14.4	10.1	98	2.2	182.5	153.8
Winter											
Nov-Apr	66.8	330.1	195.8	8.0	11.1	107.1	10.8	98.9	4.2	147.9	123.5
n	19	31	33	18	18	33	19	15	10	33	19
Summer											
May-Oct	34.5	359.4	220.3	8.1	15.6	10.3	10.1	102.6	3.4	165.2	136.9
n	13	22	23	13	13	23	13	13	5	23	15

C V = Coefficent of Variation
n = Sample number

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Station #11168000 -LOS GATOS CREEK AT LOS GATOS, CALIF.

DATE	Flow (cfs)	Total Phosphorous (mg/l as P)	Dis. Ortho P (mg/l as P)	Boron (mg/l as B)	Iron (mg/l as Fe)	Nitrogen NO2+NO3 (mg/l as N)	Dis. Ammonia (mg/l as N)	Total Organic N (mg/l as N)	Total ORG+NH3 (mg/l as N)	Total Nitrogen (mg/l as N)
1/12/80	62.0	0.19	0.03	60.0	40.00	0.66	0.04	1.70	1.80	2.50
1/29/81		0.12	0.01	50.0	60.00	0.89	0.07			
1/4/82		0.16	0.05	30.0	970.00	0.83	0.08	0.70	0.81	1.70
1/20/82		0.06	0.03	50.0	110.00	0.48	0.17	0.45	0.65	1.10
1/19/83	28.0	0.05	0.02	50.0	17.00	0.26	0.06		0.70	1.00
1/26/83		0.38	0.03	30.0	110.00	0.31	0.06	1.20	1.50	1.80
1/15/85	0.4	0.01	0.01	100.0	17.00	0.10	0.01		0.20	
1/29/85	0.3	0.01	0.01	100.0	11.00	0.10	0.02		0.30	
1/26/86	4.1	0.12	0.03	80.0	22.00		0.10	0.68	0.80	1.80
2/19/80	99.0	0.72	0.02	40.0	50.00	0.78	0.04	2.20	2.40	3.20
2/16/82		0.06	0.02	50.0	22.00	0.38	0.08	0.37	0.47	0.88
2/7/83		0.12	0.06	40.0	9.00	0.23	0.12	0.84	0.90	1.10
2/27/84		0.06	0.02	50.0	14.00	0.10	0.03	0.78	0.80	0.90
2/8/85	34.0	0.14	0.03	40.0	170.00	1.10	0.01	1.30	1.30	2.40
2/13/86	2.0	0.08	0.04	70.0			0.05	0.82	0.90	1.70
2/24/86	181.0	0.20	0.02	40.0	130.00		0.07	0.74	0.90	1.60
3/5/80		0.14	0.03	60.0	110.00	0.41	0.03	0.84	0.90	1.30
3/4/81		0.11	0.01	50.0	20.00	0.69	0.03	0.71	0.77	1.50
3/26/81		0.12	0.00	40.0	20.00	0.48	0.00	1.50	1.50	2.00
3/30/82	259.0	0.03	0.03	50.0	15.00	0.33	0.12	0.26	0.41	0.74
3/1/83		0.18	0.01	30.0	40.00	0.22	0.14	0.66	0.80	1.00
3/17/84	22.0	0.03	0.03	50.0	12.00	0.18	0.02	0.27	0.30	0.50
3/10/85	16.0	0.04	0.01	60.0	30.00	0.35	0.01	0.57	0.60	1.00
3/4/86	113.0	0.17	0.02	40.0	47.00		0.03	0.44	0.50	1.20
3/11/86	324.0	0.13	0.02	40.0	110.00		0.02	0.32	0.40	1.00
4/11/83		0.06	0.03	40.0	19.00	0.21	0.08	0.28	0.40	0.60
4/15/86	47.0	0.06	0.03	40.0	15.00		0.02	0.26	0.30	0.90
5/6/80	19.0	0.05	0.01	50.0	30.00	0.32	0.01	0.53	0.63	0.91
5/18/81		0.08	0.03	30.0	20.00	0.51	0.08	1.00	1.20	1.70
5/17/82		0.07	0.03	40.0	13.00	0.19	0.12	0.52	0.64	0.84
5/16/83		0.04	0.01	40.0	20.00	0.15	0.08	0.08	0.20	0.40
5/13/86	30.0	0.05	0.02	50.0	9.00		0.02	0.28	0.30	0.80
6/11/84		0.04	0.02	50.0	10.00	0.20	0.01	0.28	0.30	0.50
6/11/85	46.0	0.03	0.01	80.0	3.00	0.10	0.03	0.46	0.50	
6/10/86	52.0	0.05	0.03	50.0	37.00		0.01	0.26	0.30	0.80
7/16/80		0.06	0.01	70.0	10.00	0.46	0.01	0.49	0.50	0.96
7/13/81		0.10	0.02	60.0	10.00	0.25	0.10	0.81	1.00	1.30
7/19/82		0.04	0.02	50.0	7.00	0.29	0.08			

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7/12/83	60.0	0.05	0.02	40.0	17.00	0.13	0.04	0.36	0.40	0.50
7/10/84	23.0	0.01	0.02	50.0	5.00	0.13	0.01	0.27	0.30	0.40
7/24/85	5.3			70.0	9.00					
7/22/86	37.0	0.04	0.01	50.0	5.00		0.02	0.39	0.40	0.80
8/1/81		0.07	0.00	70.0	10.00	0.16	0.06	0.85	0.71	0.84
8/29/83		0.03	0.02	40.0	5.00	0.16	0.08	0.61	0.70	0.90
8/27/84	46.0	0.04	0.03	50.0	31.00	0.10	0.01	0.24	0.30	
8/20/86	58.0	0.02	0.01	40.0	7.00		0.04		0.20	
9/10/80		0.07	0.03	70.0	10.00	0.11	0.04	0.46	0.49	0.62
9/8/82	67.0	0.04	0.01	50.0	4.00	0.27	0.08	0.34	0.60	0.90
9/11/85	4.8	0.35	0.02	110.0	36.00	0.16	0.51	2.00	2.50	2.70
9/23/86	0.2	0.02	0.01	70.0	16.00		0.03		0.20	
11/20/79	9.2	0.01	0.01	80.0	10.00	0.12	0.04	0.41	0.48	0.57
11/18/80		0.03	0.01	60.0	10.00	0.12	0.02			
11/16/81		0.05	0.05	60.0	97.00	0.85	0.14	0.44	0.59	1.50
11/16/82	59.0	0.01	0.01	50.0	5.00	0.10	0.10	0.99	1.10	
12/30/81	5.9	0.04	0.03	70.0	68.00	0.49	0.08	0.45	0.57	1.10
12/18/85	2.9	0.02	0.01	90.0	8.00		0.05	0.45	0.50	1.60

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Station #11168000 -LOS GATOS CREEK AT LOS GATOS, CALIF.

Period	Flow (cfs)	Total Phosphorous (mg/l as P)	Dis. Ortho P (mg/l as P)	Boron (mg/l as B)	Iron (mg/l as Fe)	Nitrogen NO2+NO3 (mg/l as N)	Dis. Ammonia (mg/l as N)	Total Organic N (mg/l as N)	Total ORG+NH3 (mg/l as N)	Total Nitrogen (mg/l as N)
All										
Mean	53.7	0.09	0.02	54.8	49.31	0.34	0.06	0.66	0.71	1.20
CV	1.38	1.24	0.57	0.33	2.67	0.76	1.19	0.70	0.70	0.53
n	32	55	55	56	55	43	55	47	52	45
Month										
Nov	34.1	0.03	0.02	62.5	30.50	0.30	0.08	0.61	0.72	1.04
Jan	14.8	0.11	0.02	64.5	130.27	0.46	0.07	0.80	0.78	1.58
Feb	79.0	0.20	0.03	47.1	65.83	0.52	0.06	1.01	1.10	1.68
Mar	130.2	0.10	0.02	45.5	39.82	0.36	0.05	0.56	0.63	1.07
May	24.5	0.06	0.02	42.0	18.40	0.29	0.06	0.48	0.59	0.93
Jun	49.0	0.04	0.02	60.0	16.67	0.15	0.02	0.33	0.37	0.65
July	31.3	0.05	0.02	55.7	9.00	0.25	0.04	0.46	0.52	0.79
August	52.0	0.04	0.02	50.0	13.25	0.14	0.05	0.57	0.48	0.87
Sept	24.0	0.12	0.02	75.0	16.50	0.18	0.17	0.93	0.95	1.41
Winter										
Nov-Apr	66.8	0.11	0.02	54.2	74.6	0.41	0.06	0.74	0.79	1.36
n	19	33	33	33	32	26	33	28	31	28
Summer										
May-Oct	34.5	0.06	0.02	55.7	14.1	0.22	0.07	0.54	0.59	0.93
n	13	22	22	23	23	17	22	19	21	17

C V = Coefficent of Variation
n = Sample number

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VOL 12

Station #11168000 - LOS GATOS CREEK AT LOS GATOS, CALIF.

DATE	Flow (cfs)	Zn Dissolved (µg/l)	Zn Sediment (µg/gm)	Pb Dissolved (µg/l)	Pb Sediment (µg/gm)	Cu Dissolved (µg/l)	Cu Sediment (µg/gm)	As Dissolved (µg/l)	As Sediment (µg/gm)
1/4/82		10	--	6	--	4	--	1	--
1/26/83		28	20	1	30	3	10	1	2
2/19/80	99	10	--	5	--	1	--	1	--
2/8/85	34	3	50	1	50	2	30	1	2
2/24/86	181	20	--	1	--	1	--	1	--
3/26/81		50	--	3	--	2	--	2	--
6/11/85	46	10	--	4	--	1	--	1	--
8/1/81		20	--	2	--	4	--	2	--
8/29/83		9	--	1	--	2	--	1	--
8/27/84	46	9	40	1	50	1	30	1	1
9/10/80		60	--	3	--	1	--	2	--
9/8/82	67	3	--	1	--	1	--	1	--
9/11/85	5	10	120	1	30	1	70	3	7
All									
Mean	68	19	58	2	40	2	35	1	3
CV	0.8	0.9	0.7	0.7	0.3	0.6	0.6	0.5	0.8
n	7	13	4	13	4	13	4	13	4
Winter									
Mean	105	20	35	3	40	2	20	1	2
CV	0.6	0.8	0.4	0.7	0.3	0.5	0.5	0.3	0.0
n	3	6	2	6	2	6	2	6	2
Summer									
Mean	41	17	80	2	40	2	50	2	4
CV	0.5	1.0	0.5	0.6	0.3	0.7	0.4	0.5	0.8
n	4	7	2	7	2	7	2	7	2

C V = Coefficent of Variation
n = Sample number

R0054851

Station #11168000 - LOS GATOS CREEK AT LOS GATOS, CALIF.

DATE	Flow (cfs)	Fe Sediment (µg/l)	Mn Dissolved (µg/l)	Mn Sediment (µg/gm)	Al Dissolved (µg/l)	Al Sediment (µg/gm)	Cb Sediment (µg/gm)
1/4/82		--	50	--	90	--	--
1/26/82		4500	3	240	20	3300	10
2/19/80	99	--	0	--	80	--	--
2/8/85	34	23000	22	660	120	15000	20
2/24/86	181	--	10	--	70	--	--
3/26/81		--	20	--	10	--	--
6/11/85	46	--	30	--	10	--	--
8/1/81		--	40	--	10	--	--
8/29/83		--	1	--	10	--	--
8/27/84	46	13000	280	640	10	9300	10
9/10/80		--	230	--	10	--	--
9/8/82	67	--	2	--	10	--	--
9/11/85	5	22000	420	270	150	11000	20
All							
Mean	68	15625	85	453	46	9650	15
CV	0.8	0.5	1.5	0.4	1.0	0.4	0.3
n	7	4	13	4	13	4	4
Winter							
Mean	105	13750	18	450	65	9150	15
CV	0.6	0.7	0.9	0.5	0.6	0.6	0.3
n	3	2	6	2	6	2	2
Summer							
Mean	41	17500	143	455	30	10150	15
CV	0.5	0.3	1.1	0.4	1.6	0.1	0.3
n	4	2	7	2	7	2	2

C V = Coefficent of Variation
n = Sample number

R0054852

Station #11168000 - LOS GATOS CREEK AT LOS GATOS, CALIF.

DATE	Flow (cfs)	Cd Dissolved (µg/l)	Cd Sediment (µg/gm)	Cr Dissolved (µg/l)	Cr Sediment (µg/gm)	Hg Dissolved (µg/l)	Hg Sediment (µg/gm)	Ni AS NI) (01065)	Sn Dissolved (µg/l)	Sn Sediment (µg/gm)
1/4/82		1	--	<10	--	<0.1	--	<100	--	--
1/26/83		<1	<1	<10	20	<0.1	0.05	<100	--	<1
2/19/80	99	0	--	0	--	0.00	--	0	--	--
2/8/85	34	<1	<1	<10	70	<0.1	0.05	<100	<1	<1
2/24/86	181	<1	--	<10	--	<0.1	--	<100	--	--
3/26/81		2	--	10	--	0.00	--	100	--	--
6/11/85	46	1	--	<10	--	<0.1	--	<100	--	--
8/1/81		0	--	10	--	0.00	--	0	--	--
8/29/83		<1	--	<10	--	<0.1	--	<100	--	--
8/27/84	46	<1	<1	10	50	<0.1	0.69	<100	--	<1
9/10/80		0	--	0	--	0.00	--	0	--	--
9/8/82	67	<1	--	<10	--	<0.1	--	<100	--	--
9/11/85	5	1	1	<10	380	<0.1	0.20	<100	--	1

R0054853

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Station #11168000 - LOS GATOS CREEK AT LOS GATOS, CALIF.

DATE	Total Diazinon (µg/l)	Total 2,4-D, (µg/l)	Total Lindane (µg/l)	Total Malathion (µg/l)	Total Chlordane (µg/l)	Total DDD (µg/l)	Total DDE (µg/l)	Total DDT (µg/l)	Total Dieldrin (µg/l)	Total Heptachlor (µg/l)
2/19/80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9/10/80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3/27/81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9/1/81	0.00	0.01	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00
1/5/82	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9/8/82	<0.01	<0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
4/12/83	<0.01	<0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
8/30/83	<0.01	<0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
8/27/84	<0.01	--	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
2/8/85	<0.01	<0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
9/11/85	<0.01	<0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
1/29/86	0.03	0.02	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010

R0054854

Station #11168000 - LOS GATOS CREEK AT LOS GATOS, CALIF.

DATE	Total Naphthalenes Polychlor (µg/l)	Total PCB (µg/l)	Total Aldrin (µg/l)	Total Endosulfan (µg/l)	Total Endrin (µg/l)	Total Ethion (µg/l)	Total Chlor Epoxide (µg/l)	Total Oxychlor (µg/l)	Total Methyl Parathion (µg/l)
2/19/80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9/10/80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3/27/81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9/1/81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1/5/82	0.00	0.00	0.00	0.00	0.00	0.00	--	0.00	0.00
9/8/82	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
4/12/83	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
8/30/83	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
8/27/84	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
2/8/85	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
9/11/85	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
1/29/86	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01

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Station #11168000 - LOS GATOS CREEK AT LOS GATOS, CALIF.

DATE	Total Methyl Trithion (µg/l)	Total Mirex (µg/l)	Total Perthane (µg/l)	Total Toxaphene (µg/l)	Total Trithion (µg/l)	Total 2,4,5-T (µg/l)	Total Silvex (µg/l)
2/19/80	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9/10/80	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3/27/81	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9/1/81	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1/5/82	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9/8/82	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
4/12/83	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
8/30/83	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
8/27/84	<0.01	<0.01	<0.1	<1	<0.01	--	--
2/8/85	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
9/11/85	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
1/29/86	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01

R0054856

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USGS STATION NO. 11171500
COYOTE CREEK NEAR
EDENVALE, CA

VOL 12

2

1557

R0054857

Station #11171500 - COYOTE C NR EDENVALE CALIF

Date	Flow (cfs)	Cond (µmohs)	TDS (mg/l)	pH	Temp (deg C)	Turbidity (NTU)	DO (mg/l)	DO (% sat)	Dis. Organic C (mg/l as C)	TH (mg/l as CaCO3)	Alkalinity (mg/l as CaCO3)
1/17/79	5.1	560.0	316.2	7.4	9.5		8.9			240.0	170.0
1/11/80		146 0	95.6			620.0				69.0	70.0
1/29/81		525.0	279.4			110.0				220.0	
1/5/82		195.0	102 9			270.0				83.0	
1/21/82		363.0	205 9			130.0				160.0	
1/19/83		526 0	301.4			44.0				230.0	
1/28/83	841.0	294.0	176.5	7.8	10 5	320.0	10.0	91	5.6	130.0	118.0
1/30/86	1.8	79.0	44.1	7.7	11.5	65.0	8.0	74		28.0	31.0
2/14/79	0.0	73.0	36.8	7.0	15.5		9.7			26.0	21.0
2/20/80	331.0	270.0	169.1	7.2	13.5	210.0	9.0		12.0	120.0	100.0
2/18/82	22.0	570.0	308.8	8.0	13.5	8.8	8.4	80	6.6	250.0	204.0
2/9/83	3300.0	311.0	183.8	8.0	10.5	210.0	10.6	95	5.3	140.0	124.0
2/28/84			382.3							300.0	
2/9/85	16.0	621.0	360.3	8.0	10.0	24.0	10.2	90		290.0	216.0
2/14/86	32.0	344.0	191.2	8.3	13.5	42.0	8.9	86		150.0	125.0
2/25/86	42.0	515.0	308.8	8.1	15.0	25.0	10.1	101		230.0	198.0
3/16/79	0.4	391.0	213.2	7.8	16.5		8.2			170.0	110.0
3/27/79	1.4	66.0	36.8	7.5	14.5		9.0			23.0	16.0
3/7/80	41.0	513.0	301.4	7.4	12.0	28.0	8.8		12.0	230.0	200.0
3/5/81		541.0	316.2			81.0				240.0	
3/28/81	3.8	605.0	345.6	8.2	13.5	3.5	7.8	75	7.8	270.0	210.0
3/31/82	486.0	239.0	125.0	7.9	10.5	48.0	10.0	90	4.9	100.0	92.0
3/2/83	5900.0	273.0	176.5	8.1	11.5	370.0	10.0	95	5.0	130.0	114.0
3/12/86	89.0	475.0	272.0	8.2	13.5	25.0	9.4	91		210.0	185.0
4/13/83	502.0	381.0	198.5	8.1	11.0	35.0	10.6	96	3.4	150.0	130.0
4/26/79	0.4	213.0	110.3	7.1	19.0		3.9			88.0	80.0
5/23/79	0.4	435.0	279.4	7.6	20.5		7.4			210.0	180.0
5/18/82	3.0	618.0	360.3	8.2	20.5	0.5	9.3	104	2.1	280.0	228.0
5/17/83		366.0	213.2			45.0				150.0	
5/14/86	5.2	463.0	272.0	8.2	17.5	2.1	7.2	76		200.0	176.0
7/31/79	0.3	431.0	250.0	7.6	28.0		5.5			170.0	170.0
7/17/80		406.0	227.9			4.4				170.0	150.0
7/15/81	1.9	383.0	242.6	8.0	20.5	0.8	5.8	65	6.1	170.0	150.0
7/20/82		457.0	264.7			76.0				200.0	
7/12/83		426.0	257.3			180.0				190.0	
7/11/84	4.6	488.0	286.7	8.2	22.0	1.6	6.0	69		230.0	179.0
8/30/83		556.0	294.1			150.0				220.0	
9/10/80	0.5	403.0	242.6	7.4	19.0	0.5	6.0		4.5	180.0	160.0

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9/2/81	0.9	380.0	220.6	7.8	18.0	0.7	5.6	60	3.3	160.0	150.0
9/7/82	5.5	442.0	250.0	7.7	20.5	0.8	6.8	76	3.3	190.0	158.0
9/24/86	2.1	357.0	220.6	7.9	16.5	0.5	6.8	71		160.0	141.0
11/17/81		527.0	294.1			30.0				230.0	
11/16/82		512.0	286.7			30.0				220.0	
12/31/81	0.6	489.0	279.4	7.4	11.0	5.6	5.5	50	3.7	210.0	164.0

R0054859

5555-2 VOL 12

Station #11171500 - COYOTE C NR EDENVALE CALIF

Period	Flow (cfs)	Cond (umohs)	TDS (mg/l)	pH	Temp (deg C)	Turbidity (NTU)	DO (mg/l)	DO (% sat)	Dis. Organic C (mg/l as C)	TH (mg/l as CaCO3)	Alkalinity (mg/l as CaCO3)
All											
Mean	388.0	400.7	234.1	7.8	15.3	88.8	8.1	82	5.7	177.7	141.3
CV	3.12	0.37	0.37	0.05	0.29	1.49	0.23	0.18	0.52	0.38	0.39
n	30	43	44	30	30	36	30	20	15	44	32
Month											
Nov		519.5	290.4			30.0				225.0	
Jan	212.1	353.0	200.1	7.6	10.6	195.6	8.1	72	4.7	152.2	110.6
Feb	534.7	386.3	242.6	7.8	13.1	86.0	9.6	90	8.0	188.3	141.1
Mar	878.0	387.1	220.6	7.9	12.9	84.4	9.2	89	6.6	169.2	132.1
May	2.3	419.0	247.0	7.8	19.4	15.9	7.0	90	2.1	185.6	166.0
July	2.3	431.8	254.9	7.9	23.5	52.6	5.8	67	6.1	188.3	162.3
Sept	2.3	395.5	233.4	7.7	18.5	0.6	6.3	69	3.7	172.5	152.3
Winter											
Nov-Apr	611.3	385	225	7.8	12.5	118.9	9.1	85.7	6.6	173.2	129.9
CV	2.44	0.45	0.45	0.05	0.16	1.28	0.13	0.16	0.47	0.46	0.49
n	19	27	28	19	19	23	19	13	10	28	20
Summer											
May-Oct	2.3	427	250	7.8	20.2	35.6	6.4	74.4	3.9	185.5	160.2
CV	0.90	0.21	0.21	0.05	0.15	1.74	0.21	0.19	0.39	0.22	0.21
n	11	16	16	11	11	13	11	7	5	16	12

R0054860

Station #11171500 - COYOTE C NR EDENVALE CALIF

Date	Flow (cfs)	Total Phosphorous (mg/l as P)	Dis Ortho P (mg/l as P)	Boron (mg/l as B)	Iron (mg/l as Fe)	Nitrogen NO3+NO2 (mg/l as N)	Dis. Ammonia (mg/l as N)	Total Organic (mg/l as N)	Total ORG+NH3 (mg/l as N)	Total Nitrogen (mg/l as N)
1/17/79	5.1	0.19	0.07	130.0	60.0	4.90	0.04	1.10	1.20	5.90
1/11/80		0.65	0.13	50.0	70.0	0.95	0.03	2.40	2.50	3.50
1/29/81		0.25	0.04	100.0	20.0	4.00	0.04			
1/5/82		0.41	0.24	50.0	230.0	1.20	0.09	1.30	1.50	2.70
1/21/82		0.23	0.16	70.0	350.0	2.00	0.22	1.10	1.30	3.30
1/19/83		0.19	0.08	100.0	19.0	4.00	0.06	1.20	1.30	5.30
1/28/83	841.0	0.34	0.10	70.0	75.0	0.93	0.06	1.50	1.70	2.60
1/30/86	1.8	0.22	0.14	40.0	120.0	0.40	0.18	0.15	1.40	1.80
2/14/79	0.0	0.22	0.09	20.0	40.0	0.31	0.08	0.46	0.54	0.82
2/20/80	331.0	0.59	0.23	90.0	130.0	1.70	0.09	1.70	1.90	3.60
2/18/82	22.0	0.08	0.05	130.0	53.0	3.50	0.07	1.20	1.30	4.80
2/9/83	3300.0	0.31	0.06	70.0	28.0	0.34	0.12		1.60	1.90
2/28/84		0.26	0.01	130.0	37.0	5.90	0.03	2.20	2.30	8.10
2/9/85	16.0	0.02	0.02	130.0	3.0	5.60	0.01	0.01	1.80	7.40
2/14/86	32.0	0.08	0.03	100.0	21.0	1.80	0.05	0.06	0.60	2.40
2/25/86	42.0	0.15	0.11	110.0	36.0	2.70	0.08	0.07	0.80	3.50
3/16/79	0.4	0.19	0.09	110.0	20.0	2.80	0.01	0.92	0.94	3.50
3/27/79	1.4	0.12	0.08	50.0	40.0	0.19	0.06	0.37	0.43	0.62
3/7/80	41.0	0.15	0.12	120.0	20.0	3.10	0.04	1.20	1.20	4.30
3/5/81		0.28	0.01	120.0	10.0	1.80	0.03	1.80	1.90	5.70
3/28/81	3.8	0.04	0.00	100.0	20.0	4.20	0.04	1.20	1.30	5.40
3/31/82	486.0	0.18	0.08	60.0	66.0	0.51	0.11	0.66	0.82	1.30
3/2/83	5900.0	0.45	0.02	70.0	100.0	0.34	0.14	2.30	2.40	2.80
3/12/86	89.0	0.14	0.08	100.0	65.0	2.00	0.14	0.10	0.80	2.80
4/13/83	502.0	0.05	0.02	70.0	18.0	0.88	0.08	0.60	0.70	1.60
4/26/79	0.4	0.37	0.13	100.0	600.0	0.06	0.03	1.20	1.40	1.50
5/23/79	0.4	0.05	0.05	210.0	10.0	0.12	0.01	0.42	0.49	0.59
5/18/82	3.0	0.03	0.02	120.0	9.0	4.40	0.10	0.65	0.78	5.30
5/17/83		0.11	0.02	80.0	11.0	0.93	0.06	1.00	1.10	2.00
5/14/86	5.2	0.01	0.01	100.0	7.0	2.00	0.03	0.03	0.50	2.50
7/31/79	0.3	0.02	0.03	130.0	20.0	0.02	0.03	0.24	0.24	0.29
7/17/80		0.08	0.01	120.0	10.0	1.00	0.01	2.20	2.20	3.20
7/15/81	1.9	0.05	0.02	90.0	30.0	0.20	0.12	0.63	0.85	1.10
7/20/82		0.08	0.03	100.0	3.0	1.70	0.09	1.80	1.90	3.50
7/12/83		0.35	0.03	90.0	5.0	1.90	0.07	1.80	1.90	3.80
7/11/84	4.6	0.01	0.02	110.0	3.0	1.00	0.05	0.01	0.50	1.50
8/30/83		0.28	0.01	100.0	9.0	2.50	0.05	2.20	2.30	4.80
9/10/80	0.5	0.03	0.00	110.0	30.0	0.95	0.05	0.45	0.48	1.40

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-- 015 -- 2 NOV 21

9/2/81	0.9	0.04	0.00	90.0	31.0	0.04	0.12	0.57	0.68	0.70
9/7/82	5.5	0.03	0.01	110.0	3.0	2.00	0.13	0.77	1.00	3.00
9/24/86	2.1	0.03	0.02	100.0	23.0	1.20	0.03	0.04	0.50	1.70
11/17/81		0.11	0.09	100.0	23.0	3.70	0.08	0.82	1.00	4.80
11/16/82		0.11	0.01	100.0	3.0	3.40	0.06	1.90	2.00	5.40
12/31/81	0.6	0.09	0.06	90.0	36.0	4.30	0.09	0.99	1.10	5.40

R0054862

Station #11171500 - COYOTE C NR EDENVALE CALIF

Period	Flow (cfs)	Total Phosphorous (mg/l as P)	Dis Ortho P (mg/l as P)	Boron (mg/l as B)	Iron (mg/l as Fe)	Nitrogen NO3+NO2 (mg/l as N)	Dis. Ammonia (mg/l as N)	Total Organic (mg/l as N)	Total ORG+NH3 (mg/l as N)	Total Nitrogen (mg/l as N)
All										
Mean	388.0	0.17	0.06	96.4	57.2	1.99	0.07	0.98	1.24	3.21
CV	3.12	0.88	0.97	0.33	1.84	0.82	0.65	0.74	0.50	0.59
n	30	44	44	44	44	44	44	42	43	43
Month										
Nov	0.0	0.11	0.05	100.0	13.0	3.55	0.07	1.36	1.50	5.10
Jan	212.1	0.29	0.11	77.8	108.9	2.52	0.09	1.22	1.50	3.81
Feb	534.7	0.21	0.08	97.5	43.5	2.73	0.07	0.81	1.36	4.07
Mar	878.0	0.18	0.06	88.9	39.9	1.76	0.07	1.02	1.17	3.11
May	2.3	0.11	0.05	122.0	127.4	1.50	0.05	0.66	0.85	2.38
July	2.3	0.10	0.02	106.7	11.8	0.97	0.06	1.11	1.27	2.23
Sept	2.3	0.03	0.01	102.5	21.8	1.05	0.08	0.46	0.67	1.70
Winter										
Nov-Apr	611.3	0.22	0.08	88.6	61.2	2.41	0.08	1.05	1.35	3.75
CV	2.44	0.71	0.77	0.34	1.21	0.72	0.65	0.68	0.43	0.51
n	19	28	28	28	28	28	28	26	27	27
Summer										
May-Oct	2.3	0.10	0.03	110.0	50.3	1.25	0.06	0.88	1.05	2.31
CV	0.90	1.23	1.19	0.27	2.92	0.93	0.65	0.86	0.65	0.65
n	11	16	16	16	16	16	16	16	16	16

R0054863

Station # 11171500 - COYOTE CREEK NEAR EDENVALE CALIF.

DATE	Flow (cfs)	Zn dissolved (µg/l)	Zn sediment (µg/l)	PB dissolved (µg/l)	PB sediment (µg/l)	Cu dissolved (µg/l)	Cu sediment (µg/l)	As dissolved (µg/l)	As sediment (µg/l)
1/17/79	5	3	--	3	--	4	--	2	--
1/5/82		10	--	6	--	4	--	3	--
1/28/83	841	3	60	--	50	2	10	1	6
2/20/80	331	10	8	ND	5	3	4	3	8
2/9/85	16	3	60	1	210	1	20	1	3
2/14/86	32	20	--	3	--	1	--	1	--
2/25/86	42	10	--	4	--	1	--	3	--
3/28/81	4	10	110	6	80	2	8	1	7
7/31/79	89	3	--	ND	--	ND	--	1	--
8/30/83		100	--	1	--	2	--	1	--
9/10/80	1	50	100	2	150	1	20	1	6
9/2/81	1	10	90	3	50	1	10	1	10
9/7/82	6	30	30	1	20	9	7	1	7
All									
Mean	124	20	65	3	81	3	11	2	7
CV	2.0	1.3	0.5	0.6	0.8	0.9	0.5	0.5	0.3
n	11	13	7	10	7	12	7	13	7
Winter									
Mean	182	9	60	4	86	2	11	2	6
CV	1.6	0.6	0.6	0.5	0.9	0.5	0.6	0.5	0.3
n	7	8	4	6	4	8	4	8	4
Summer									
Mean	24	39	73	2	73	3	12	1	8
CV	1.5	0.9	0.4	0.5	0.8	1.0	0.5	0.0	0.2
n	4	5	3	4	3	4	3	5	3

R0054864

Station # 11171500 - COYOTE CREEK NEAR EDENVALE CALIF.

DATE	Flow (cfs)	Fe sediment (µg/l)	Mn dissolved (µg/l)	Mn sediment (µg/l)	Al dissolved (µg/l)	Al sediment (µg/l)	Cb sediment (µg/l)
1/17/79	5	--	6	--	10	--	--
1/5/82		--	10	--	40	--	--
1/28/83	841	9500	3	280	60	3900	20
2/20/80	331	150	10	190	60	ND	5
2/9/85	16	26000	--	580	10	9400	30
2/14/86	32	--	10	--	30	--	--
2/25/86	42	--	10	--	20	--	--
3/28/81	4	6000	10	190	10	1800	30
7/31/79	89	--	10	--	100	--	--
8/30/83		--	91	--	10	--	--
9/10/80	1	6100	10	290	10	1600	40
9/2/81	1	14000	ND	230	10	1000	20
9/7/82	6	4300	10	290	10	1500	10
All							
Mean	124	9436	16	293	29	3200	22
CV	2.0	0.8	1.4	0.4	0.9	0.9	0.5
n	11	7	11	7	13	6	7
Winter							
Mean	182	10413	8	310	30	5033	21
CV	1.8	0.9	0.3	0.5	0.7	0.6	0.5
n	7	4	7	4	8	3	4
Summer							
Mean	24	8133	30	270	28	1367	23
CV	1.5	0.5	1.2	0.1	1.3	0.2	0.5
n	4	3	4	3	5	3	3

R0054865

Station # 11171500 - COYOTE CREEK NEAR EDENVALE CALIF.

DATE	Flow (cfs)	Cd dissolved (µg/l)	Cd sediment (µg/l)	Cr dissolved (µg/l)	Cr sediment (µg/l)	Hg dissolved (µg/l)	Hg sediment (µg/l)	Ni sediment (µg/l)	Se dissolved (µg/l)	Se sediment (µg/l)
1/17/79	5	5	--	ND	--	<0.1	--	ND	--	--
1/5/82		1	--	<10	--	<0.1	--	<100	--	--
1/28/83	841	<1	1	<10	50	<0.1	0.10	<100	--	<1
2/20/80	331	0	0	0	10	0.10	0.08	0	--	0
2/9/85	16	<1	<1	<10	160	<0.1	0.06	<100	<1	<1
2/14/86	32	1	--	<10	--	<0.1	--	<100	--	--
2/25/86	42	<1	--	<10	--	<0.1	--	<100	--	--
3/28/81	4	0	0	10	58	0.00	1.00	0	--	0
7/31/79	89	<2	--	ND	--	<0.1	--	ND	--	--
8/30/83		<1	--	10	--	<0.1	--	<100	--	--
9/10/80	1	1	1	0	58	0.00	0.14	0	--	--
9/2/81	1	0	<1	0	100	1.70	0.05	0	--	0
9/7/82	6	<1	<1	<10	20	<0.1	0.05	<100	--	<1

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Station #11171500 - COYOTE C NR EDENVALE CALIF

DATE	Total Diazinon (µg/l)	Total 2,4-D, (µg/l)	Total Lindane (µg/l)	Total Malathion (µg/l)	Total Chlordane (µg/l)	Total DDD (µg/l)	Total DDE (µg/l)	Total DDT (µg/l)	Total Dieldrin (µg/l)	Total Heptachlor (µg/l)
2/20/80	0.05	0.98	0	0	0	0.01	0.04	0.04	0	0
9/10/80	0	0	0	0	0	0	0	0	0	0
3/28/81	0.07	0.08	0	0	0	0	0	0	0	0
9/2/81	<0.01	0.01	0	0.24	0	0	0	0	0	0
1/6/82	0.06	0.02	0	0.03	0	0.02	0.03	0	0.01	0
9/7/82	0.01	<0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
1/28/83	0.03	<0.01	<0.020	<0.01	<0.2	<0.020	0.01	0.01	0.01	<0.020
4/13/83	0.02	0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
8/31/83	<0.01	<0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
2/9/85	0.04	<0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
1/30/86	0.41	0.08	0.01	1.3	0.2	<0.010	0.01	<0.010	<0.010	<0.010
2/14/86	0.1	0.03	<0.010	0.03	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
2/25/86	0.02	0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
9/24/86	0.02	0.02	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010

R0054867

Station #11171500 - COYOTE C NR EDENVALE CALIF

DATE	Total Naphthalenes Polychlor (µg/l)	Total PCB (µg/l)	Total Aldrin (µg/l)	Total Endosulfan (µg/l)	Total Endrin (µg/l)	Total Ethion (µg/l)	Total Chlor Epoxide (µg/l)	Total Oxychlor (µg/l)	Total Methyl Parathion (µg/l)
2/20/80	0	0	0	0	0.02	0	0	0	0
9/10/80	0	0	0	0	0	0	0	0	0
3/28/81	0	0	0	0	0	0	0	0	0
9/2/81	0	0	0	0	0	0	0	0	0
1/6/82	0	0	0	0	0.01	0	0	0	0
9/7/82	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
1/28/83	<0.20	<0.2	<0.020	<0.020	<0.020	0.01	<0.020	<0.02	<0.01
4/13/83	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
8/31/83	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
2/9/85	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
1/30/86	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
2/14/86	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
2/25/86	<0.10	<0.1	<0.010	<0.010	<0.010	0.01	<0.010	<0.01	<0.01
9/24/86	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01

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R0054868

Station #11171500 - COYOTE C NR EDENVALE CALIF

DATE	Total Methyl Trithion (µg/l)	Total Mirex (µg/l)	Total Perthane (µg/l)	Total Toxaphene (µg/l)	Total Trithion (µg/l)	Total 2,4,5-T (µg/l)	Total Silvex (µg/l)
2/20/80	0	0	0	0	0	0	0
9/10/80	0	0	0	0	0	0	0
3/28/81	0	0	0	0	0	0	0
9/2/81	0	0	0	0	0	0	0
1/6/82	0	0	0	0	0	0	0
9/7/82	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
1/28/83	<0.01	<0.02	<0.2	<2	<0.01	<0.01	<0.01
4/13/83	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
8/31/83	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
2/9/85	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
1/30/86	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
2/14/86	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
2/25/86	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
9/24/86	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01

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R0054869

8720115A-F CON-6

USGS STATION NO. 11169970
COYOTE CREEK BELOW
LEROY ANDERSON DAM NEAR MADRONE, CA

VOL 12

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1570

R0054870

STA 11 169 970 Coyote Creek - below Leroy Anderson dam - near Madrone CA

DATE	FLOW (inst) (CFS)	COND (US/CM)	TDS (mg/l)	pH	TEMP DEGC	TURBIDITY (NTU)	DO (mg/l)	DO (% sat)	DIS. ORGC (mg/l C)	TH mg/l CaCO3	ALK mg/l CaCO3
11/21/79	12	382	240	8.4	15.0	6	10.0	--	6.3	170	150
11/19/80	17	296	170	7.6	13.0	34	10.4	99	5.5	120	120
11/18/81	7.2	349	220	8.0	13.5	3	10.1	97	9.8	150	146
11/17/82	58	313	190	7.9	12.0	15	10.4	98	4.1	140	120
1/11/80	159	419	260	7.8	11.5	17	10.8	--	7.3	190	180
1/30/81	29	301	180	7.7	11.0	290	10.7	97	9.4	120	110
12/31/81	8.4	358	220	8.2	13.0	25	10.4	100	4.5	160	148
1/6/82	8.8	308	180	8.1	11.0	160	10.7	97	5.6	140	122
1/22/82	8	343	210	8.1	10.0	44	11.2	99	4.9	160	136
1/20/83	27	336	200	8.1	9.0	51	11.1	98	4.0	150	130
1/28/83	570	276	170	8.0	10.5	260	10.9	100	5.2	120	110
1/16/85	35	454	280	8.4	10.0	5	10.8	96	--	200	172
1/16/85	35	454	280	8.4	10.0	5	10.8	96	2.5	200	172
1/30/85	29	448	280	8.4	10.0	7	11.2	100	4.0	210	178
1/30/86	6.7	554	340	8.2	11.0	20	9.9	91	--	250	221
2/21/80	3.3	342	220	7.0	11.5	410	10.0	--	8.6	150	98
2/18/82	5.5	297	170	8.2	10.0	120	11.0	98	5.7	130	112
2/9/83	413	277	170	8.0	10.5	160	11.1	100	5.5	120	110
2/29/84	14	422	260	8.4	11.5	23	11.0	102	2.8	190	162
2/9/85	9.4	461	290	8.2	10.0	6	12.0	107	--	210	181
2/14/86	6.7	562	340	8.2	11.0	21	10.1	93	--	250	221
3/7/80	4.3	296	180	7.5	11.5	120	10.5	--	14.0	120	94
3/6/81	29	313	200	7.9	11.0	100	10.6	98	6.2	140	130
3/28/81	19	316	200	8.2	11.0	42	10.6	97	4.8	140	130
3/31/82	350	327	190	8.1	10.5	16	11.0	100	4.8	140	130
3/2/83	1000	250	160	8.2	11.0	310	10.4	98	5.4	110	100
3/16/84	24	428	250	8.2	11.5	12	11.2	103	2.7	180	164
3/11/85	9	463	280	8.3	10.5	4	13.5	122	--	210	170
3/12/86	20	291	160	8.2	13.5	78	10.1	98	--	120	102
4/13/83	432	324	170	8.1	11.5	43	10.9	101	3.9	120	110
5/7/80	40	271	170	7.6	12.0	20	10.7	100	9.8	120	98
5/20/81	52	325	200	8.0	12.0	26	10.6	99	7.8	140	130
5/18/82	21	314	170	8.1	11.0	14	11.0	101	4.1	130	122
5/18/83	371	305	190	8.1	12.0	20	10.8	101	3.2	130	120
5/14/86	48	264	150	8.1	13.0	28	10.0	96	--	99	98

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6/13/84	64	--	250	8.3	13.5	3	10.2	--	--	190	--
6/14/85	77	472	280	8.3	12.5	6	10.8	103	--	210	172
7/17/80	59	281	170	7.4	12.0	18	10.4	97	5.2	120	100
7/15/81	65	337	210	8.1	13.0	14	10.2	98	7.8	140	130
7/21/82	63	312	190	8.0	12.0	20	10.7	100	4.6	130	122
7/13/83	62	321	200	8.1	13.5	18	10.5	102	3.1	140	120
7/11/84	70	423	260	8.2	15.0	7	10.5	106	--	190	162
7/25/85	59	472	280	8.2	14.5	14	10.0	100	--	210	179
7/24/86	64	253	170	8.1	13.5	20	10.9	105	--	120	104
8/31/83	62	396	210	8.1	14.0	20	9.9	98	2.8	150	130
8/28/84	71	435	260	8.0	15.0	8	9.8	98	3.8	190	166
9/9/80	60	289	170	7.5	13.0	24	10.2	97	6.8	120	110
9/2/81	73	334	200	8.0	13.0	8	10.2	98	3.4	140	130
9/7/82	68	314	180	7.7	12.0	11	10.6	100	4.4	130	114
9/12/85	70	498	300	8.2	18.5	7	9.4	101	--	230	189
9/24/86	60	272	170	7.7	14.5	27	9.8	98	--	120	105

R0054872

STA 11 169 970 Coyote Creek - below Leroy Anderson dam - near Madrone CA

MONTHLY AND SEASONAL AVERAGES

PERIOD	FLOW (inst) (CFS)	COND (US/CM)	TDS (mg/l)	pH	TEMP DEGC	TURBIDITY (NTU)	DO (mg/l)	DO (% sat)	DIS. ORGC (mg/l C)	TH mg/l CaCO3	ALK mg/l CaCO3
ALL											
average	97	357	216	8.0	12.1	54	10.6	100	5.5	156	137
cov	1.84	0.22	0.23	0.04	0.15	1.63	0.06	0.04	0.44	0.25	0.24
MONTH											
NOV	24	335	205	8.0	13.4	14	10.2	98	6.4	145	134
JAN	83	386	236	8.1	10.6	80	10.8	97	5.3	173	153
FEB	75	394	242	8.0	10.8	123	10.9	100	5.7	175	147
MAR	182	336	203	8.1	11.3	85	11.0	102	6.3	145	128
APR	432	324	170	8.1	11.5	43	10.9	101	3.9	120	110
MAY	106	296	176	8.0	12.0	22	10.6	99	6.2	124	114
JUN	71	472	265	8.3	13.0	4	10.5	103	-	200	172
JULY	63	343	211	8.0	13.4	16	10.5	101	5.2	150	131
SEPT	67	357	213	7.9	14.3	14	10.0	99	4.6	155	136
NOV - APR	112	365	222	8.1	11.2	80	10.8	99	5.7	160	141
MAY - OCT	75	344	209	8.0	13.3	16	10.3	100	5.1	150	130

R0054873

STA 11 169 970 Coyote Creek - below Leroy Anderson dam - near Madrone CA

DATE	FLOW (inst) (CFS)	DIS. BORON (ug/l B)	DIS. IRON (ug/l Fe)	TOTAL P (mg/l P)	DIS. ORTHO P (mg/l P)	NO2+NO3 (mg/l N)	DIS. AMMONIA (mg/l N)	TOTAL ORGANIC (mg/l N)	TOTAL ORG+NH3 (mg/l N)	TOTAL N (mg/l N)
11/21/79	12	120	70	0.01	0.01	0.11	0.04	0.99	1.10	1.20
11/19/80	17	80	20	0.05	0.02	0.52	0.04	0.65	0.69	1.20
11/18/81	7.2	80	10	0.03		0.24	0.29	0.35	0.65	0.89
11/17/82	58	80	16	0.02	0.01	0.30	0.13	1.30	1.40	1.70
1/11/80	159	100	10	0.04	0.01	0.16	0.01	0.91	0.91	1.10
1/30/81	29	70	40	0.13	0.02	0.54	0.05			
12/31/81	8.4	100	10	0.05	0.02	0.13	0.09	0.54	0.67	0.80
1/6/82	8.8	80	24	0.10	0.04	0.42	0.08	0.69	0.80	1.20
1/22/82	8	90	28	0.05	0.03	0.23	0.11	0.50	0.64	0.87
1/20/83	27	80	8	0.05	0.01	0.20	0.06		0.30	0.50
1/28/83	570	80	69	0.18	0.03	0.20	0.06	0.98	1.10	1.30
1/16/85	35	120	12							
1/16/85	35	100	8	0.01	0.01	0.10	0.01		0.30	
1/30/85	29	100	7	0.01	0.01	0.10	0.01	0.38	0.40	
1/30/86	6.7	130	13	0.03	0.01	0.10	0.07	0.35	0.40	
2/21/80	3.3	90	170	0.64	0.04	0.67	0.07	2.70	2.90	3.60
2/18/82	5.5	90	30	0.05	0.02	0.26	0.10	0.56	0.68	0.94
2/9/83	413	70	33	0.12	0.06	0.20	0.09	0.74	0.80	1.00
2/29/84	14	90	11	0.02	0.01	0.20	0.02	0.29	0.30	0.50
2/9/85	9.4	100	3	0.01	0.01	0.10	0.01		0.70	
2/14/86	6.7	130	4	0.02	0.01	0.10	0.14	0.55	0.70	0.80
3/7/80	4.3	90	20	0.09	0.04	0.46	0.01	0.65	0.72	1.20
3/6/81	29	80	390	0.09	0.02	0.26	0.04	0.75	0.82	1.10
3/28/81	19	70	10	0.06	0.01	0.27	0.02	0.46	0.49	0.76
3/31/82	350	100	30	0.03	0.02	0.25	0.08	0.45	0.54	0.79
3/2/83	1000	70	120	0.26	0.02	0.20	0.09	0.95	1.10	1.30
3/16/84	24	80	5	0.02	0.02	0.30	0.05	0.38	0.40	0.70
3/11/85	9	100	6	0.01	0.01	0.10	0.01	0.25	0.30	
3/12/86	20	90	110	0.09	0.02	0.50	0.02	0.26	0.30	0.80
4/13/83	432	60	9	0.07	0.04	0.30	0.12	0.61	0.70	1.00
5/7/80	40	110	50	0.04	0.03	0.36	0.03	0.82	0.90	1.30
5/20/81	52	70	10	0.06	0.02	0.29	0.12	0.49	0.66	0.95
5/18/82	21	70	23	0.04	0.03	0.22	0.09	0.57	0.70	0.92
5/18/83	371	70	23	0.06	0.02	0.20	0.06	0.70	0.80	1.00

R0054874

6/13/84	64	80	7	0.01	0.01	0.20	0.01	0.50	1.00	
6/14/85	77	100	17	0.01	0.01	0.10	0.05	0.25	0.30	
7/17/80	59	110	50	0.08	0.02	0.56	0.01	0.93	0.96	1.50
7/15/81	65	80	20	0.06	0.01	0.34	0.10	0.50	0.70	1.00
7/21/82	63	80	15	0.03	0.02	0.31	0.08	1.30	1.40	1.70
7/13/83	62	70	15	0.05	0.02	0.30	0.05	0.43	0.50	0.80
7/11/84	70	80	3	0.01	0.02	0.20	0.01	0.17	0.20	0.40
7/25/85	59	60	12	0.01	0.01	0.10	0.03	0.28	0.30	
7/24/86	64	80	11	0.05	0.04	0.50	0.05	0.47	0.50	1.00
8/31/83	62	60	18	0.02	0.02	0.30	0.01	0.60	0.70	1.00
8/28/84	71	80	3	0.05	0.01	0.20	0.01	0.59	0.60	0.80
9/9/80	60	140	40	0.07	0.05	0.51	0.02	0.50	0.50	1.00
9/2/81	73	80	10	0.04	0.01	0.27	0.06	0.94	1.00	1.30
9/7/82	68	80	3	0.11	0.01	0.30	0.10	0.35	0.60	0.90
9/12/85	70	120	3	0.02	0.01	0.10	0.09	0.31	0.40	
9/24/86	60	80	15	0.04	0.01	0.50	0.03	0.58	0.60	1.10

R0054875

STA 11 169 970 Coyote Creek - below Leroy Anderson dam - near Madrone CA

MONTHLY AND SEASONAL AVERAGES

PERIOD	FLOW (inst) (CFS)	DIS. BORON (ug/l B)	DIS. IRON (ug/l Fe)	TOTAL P (mg/l P)	DIS. ORTHO P (mg/l P)	NO2+NO3 (mg/l N)	DIS. AMMONIA (mg/l N)	TOTAL ORGANIC (mg/l N)	TOTAL ORG+NH3 (mg/l N)	TOTAL N (mg/l N)
ALL				0.06	0.02	0.28	0.06	0.64	0.70	1.07
average	97	88	33	1.47	0.60	0.53	0.85	0.64	0.60	0.46
cov	1.84	0.21	1.83							
NOV	24	90	29	0.03	0.01	0.29	0.13	0.82	0.96	1.25
JAN	83	95	21	0.07	0.02	0.22	0.06	0.62	0.61	0.96
FEB	75	95	42	0.14	0.03	0.26	0.07	0.97	1.01	1.37
MAR	182	85	86	0.08	0.02	0.29	0.04	0.52	0.58	0.95
APR	432	60	9	0.07	0.04	0.30	0.12	0.61	0.70	1.00
MAY	106	80	28	0.05	0.02	0.29	0.06	0.59	0.69	0.99
JUN	71	90	12	0.01	0.01	0.15	0.03	0.62	0.65	1.20
JULY	63	80	18	0.04	0.02	0.33	0.05	0.58	0.65	1.07
SEPT	67	97	12	0.06	0.02	0.31	0.05	0.55	0.62	1.02
NOV - APR	112	91	43	0.08	0.02	0.26	0.07	0.69	0.74	1.10
MAY - OCT	75	85	18	0.04	0.02	0.30	0.05	0.58	0.65	1.04

MONTHLY AND SEASONAL AVERAGES

R0054876

Station #11169970 - COYOTE CREEK BELOW LEROY ANDERSON DAM NEAR MADRONE CALIF.

DATE	Flow (cfs)	Zn Dissolved (µg/l)	Zn Sediment (µg/gm)	Pb Dissolved (µg/l)	Pb Sediment (µg/gm)	Cu Dissolved (µg/l)	Cu Sediment (µg/gm)	As Dissolved (µg/l)	As Sediment (µg/gm)
1/6/82	9	10	20	1	10	2	20	2	8
1/28/83	570	3	50	1	20	2	260	1	3
2/21/80	3	10	40	ND	40	2	20	1	10
2/9/85	9	9	80	1	70	1	50	1	9
2/14/86	7	20		1		3		1	
2/25/86		10		2		1		2	
3/28/81	19	20	30	4	10	3	20	1	12
8/31/83	62	41	40	1	20	2	20	1	8
8/28/84	71	6	60	1	10	1	30	1	
9/9/80	60	10	20	2	10	2	20	2	6
9/2/81	73	10	40	2	10	1	20	1	14
9/7/82	68	10	20	1	10	3	10	1	4
9/12/85	70	10	70	1	10	1	70	2	12
All									
Mean	85	13	43	2	20	2	49	1	9
CV	1.7	0.7	0.5	0.6	0.9	0.4	1.4	0.4	0.4
n	12	13	11	12	11	13	11	13	10
Winter									
Mean	103	12	44	2	30	2	74	1	8
CV	2.0	0.5	0.5	0.7	0.8	0.4	1.3	0.4	0.4
n	6	7	5	6	5	7	5	7	5
Summer									
Mean	67	15	42	1	12	2	28	1	9
CV	0.1	0.8	0.4	0.4	0.3	0.4	0.7	0.4	0.4
n	6	6	6	6	6	6	6	6	5

R0054877

Station #11169970 - COYOTE CREEK BELOW LEROY ANDERSON DAM NEAR MADRONE CALIF.

DATE	Flow (cfs)	Fe Sediment (µg/gm)	Mn Dissolved (µg/l)	Mn Sediment (µg/gm)	Al Dissolved (µg/l)	Al Sediment (µg/gm)	Co Sediment (µg/gm)
1/6/82	9	8500	10	850	10	5000	20
1/28/83	570	9500	3	310	80	3900	10
2/21/80	3	9500	10	610	170	90	30
2/9/85	9	53000	6	1700	10	23000	40
2/14/86	7		100		10		
2/25/86			790		10		
3/28/81	19	10000	20	1700	10	4200	30
8/31/83	62	6000	11	240	10	2100	20
8/28/84	71	23000	9	1100	10	9800	30
9/9/80	60	8000	30	700	20	3000	20
9/2/81	73	19000	ND	1800	ND	4000	20
9/7/82	68	6500	10	1200	10	2600	20
9/12/85	70	28000	350	1900	10	14000	30
All							
Mean	85	16455	112	1101	30	6517	25
CV	1.7	0.8	2.0	0.5	1.5	1.0	0.3
n	12	11	12	11	12	11	11
Winter							
Mean	103	18100	134	1034	43	7238	26
CV	2.0	1.0	2.0	0.6	1.3	1.1	0.4
n	6	5	7	5	7	5	5
Summer							
Mean	67	15083	82	1157	12	5917	23
CV	0.1	0.6	1.6	0.5	0.3	0.8	0.2
n	6	6	5	6	5	6	6

R0054878

Station #11169970 - COYOTE CREEK BELOW LEROY ANDERSON DAM NEAR MADRONE CALIF.

DATE	Flow (cfs)	CD Dissolved (µg/l)	Cd Sediment (µg/gm)	Cr Dissolved (µg/l)	Cr Sediment (µg/gm)	Hg Dissolved (µg/l)	Hg Sediment (µg/gm)	Ni Sediment (µg/gm)	Se Dissolved (µg/l)	Se Sediment (µg/gm)
1/6/82	9	<1	<1	<10	20	<0.1	0.07	<100	--	<1
1/28/83	570	<1	1	<10	30	<0.1	0.11	<100	--	<1
2/21/80	3	0	0	0	30	0.00	0.13	0	--	0
2/9/85	9	<1	<1	<10	130	<0.1	0.07	<100	<1	<1
2/14/86	7	1	--	<10	--	<0.1	--	<100	--	--
2/25/86	--	<1	--	<10	--	--	--	<100	--	--
3/28/81	19	0	0	10	34	0.00	0.60	0	--	0
8/31/83	62	<1	<1	<10	20	<0.1	0.06	<100	--	<1
8/28/84	71	<1	<1	<10	70	<0.1	0.65	<100	--	<1
9/9/80	60	0	2	0	13	0.00	0.04	0	--	0
9/2/81	73	0	<1	0	60	1.90	0.04	0	--	0
9/7/82	68	<1	<1	<10	20	<0.1	0.06	<100	--	<1
9/12/85	70	2	<1	<10	950	<0.1	0.08	<100	--	<1

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R0054879

Station #11169970 - COYOTE C BL LEROY ANDERSON DM NR MADRONE CALIF

DATE	Total Diazinon (µg/l)	Total 2,4-D. (µg/l)	Total Lindane (µg/l)	Total Malathion (µg/l)	Total Chlordane (µg/l)	Total DDD (µg/l)	Total DDE (µg/l)	Total DDT (µg/l)	Total Dieldrin (µg/l)	Total Heptachlor (µg/l)
2/21/80	0	0	0	0	0	0	0	0	0	0
9/9/80	0	0	0	0	0	0	0	0	0	0
3/28/81	0	0	0	0	0	0	0	0	0	0
9/2/81	0	..	0	0.01	0	0	0	0	0	0
1/6/82	<0.01	0.02	0	<0.01	0	0	0	0	0	0
9/7/82	<0.01	<0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
1/28/83	<0.01	0.01	<0.020	<0.01	<0.2	<0.020	<0.020	<0.020	<0.020	<0.020
4/13/83	<0.01	0.02	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
8/31/83	<0.01	0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
8/28/84	<0.01	<0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
2/9/85	<0.01	0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
9/12/85	<0.01	<0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
1/30/86	<0.01	<0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010

R0054880

Station #11169970 - COYOTE C BL LEROY ANDERSON DM NR MADRONE CALIF

DATE	Total Naphthalenes Polychlor (µg/l)	Total PCB (µg/l)	Total Aldrin (µg/l)	Total Endosulfan (µg/l)	Total Endrin (µg/l)	Total Ethion (µg/l)	Total Chlor Epoxide (µg/l)	Total Oxychlor (µg/l)	Total ethyl Parathi (µg/l)	Total ethyl Trithion (µg/l)
2/21/80	0	0	0	0	0	0	0	0	0	0
9/9/80	0	0	0	0	0	0	0	0	0	0
3/28/81	0	0	0	0	0	0	0	0	0	0
9/2/81	0	0	0	0	0	0	0	0	0	0
1/6/82	0	0	0	0	0	0	0	0	0	0
9/7/82	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0 01	<0.01
1/28/83	<0.20	<0.2	<0.020	<0.020	<0.020	<0.01	<0.020	<0.02	<0.01	<0.01
4/13/83	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01
8/31/83	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01
8/28/84	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01
2/9/85	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01
9/12/85	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01
1/30/86	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01

R005488

Station #11169970 - COYOTE C BL LEROY ANDERSON DM NR MADRONE CALIF

DATE	Total Naphthalenes Polychlor (µg/l)	Total PCB (µg/l)	Total Aldrin (µg/l)	Total Endosulfan (µg/l)	Total Endrin (µg/l)	Total Ethion (µg/l)	Total Chlor Epoxide (µg/l)	Total Oxychlor (µg/l)	Total ethyl Parathi	Total Methyl Trithion (µg/l)
2/21/80	0	0	0	0	0	0	0	0	0	0
9/9/80	0	0	0	0	0	0	0	0	0	0
3/28/81	0	0	0	0	0	0	0	0	0	0
9/2/81	0	0	0	0	0	0	0	0	0	0
1/6/82	0	0	0	0	0	0	0	0	0	0
9/7/82	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01
1/28/83	<0.20	<0.2	<0.020	<0.020	<0.020	<0.01	<0.020	<0.02	<0.01	<0.01
4/13/83	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01
8/31/83	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01
8/28/84	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01
2/9/85	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01
9/12/85	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01
1/30/86	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01

R0054882

Station #11169970 - COYOTE C BL LEROY ANDERSON DM NR MADRONE CALIF

DATE	Total Mirex (µg/l)	Total Perthane (µg/l)	Total Toxaphene (µg/l)	Total Trithion (µg/l)	Total 2,4,5-T (µg/l)	Total Silvex (µg/l)
2/21/80	0	0	0	0	0	0
9/9/80	0	0	0	0	0	0
3/28/81	0	0	0	0	0	0
9/2/81	0	0	0	0	--	--
1/6/82	0	0	0	0	0	0
9/7/82	<0.01	<0.1	<1	<0.01	<0.01	<0.01
1/28/83	<0.02	<0.2	<2	<0.01	<0.01	<0.01
4/13/83	<0.01	<0.1	<1	<0.01	<0.01	<0.01
8/31/83	<0.01	<0.1	<1	<0.01	<0.01	<0.01
8/28/84	<0.01	<0.1	<1	<0.01	<0.01	<0.01
2/9/85	<0.01	<0.1	<1	<0.01	<0.01	<0.01
9/12/85	<0.01	<0.1	<1	<0.01	<0.01	<0.01
1/30/86	<0.01	<0.1	<1	<0.01	<0.01	<0.01

R0054883

8720115A-F CON-7

USGS STATION NO. 11167572
GUADALUPE RIVER AT
ALAMITOS RECHARGE FACILITY AT SAN JOSE, CA

VOL 12 2 1584

R0054884

Station #11167572 GUADALUPE RIVER AT ALAMITOS RECHARGE FACILITY AT SAN JOSE CALIF.

Period	Flow (cfs)	Cond (µmohs)	TDS (mg/l)	pH	Temp (deg C)	Turbidity (NTU)	DO (mg/l)	DO (% sat)	Dis. Organic C (mg/l as C)	TH (mg/l as CaCO3)	Alkalinity (mg/l as CaCO3)
01/18/1979	18.0	439	250	8.2	10.5	-	9.2			200	160
01/11/1980	-	477	270			30.0				220	170
01/29/1981	-	326	180			200.0				140	
01/04/1982	-	215	130			190.0				100	
01/20/1982	-	481	270			3.5				230	
01/18/1983	-	485	270			44.0				220	
01/26/1983	-	196	120			480.0				93	
01/15/1985	14.0	462	260	7.9	10.0	3.0	11.7	104	3.3	180	141
01/29/1985	7.2	466	270	8.3	11.0	2.3	13.0	118	3.0	180	137
01/29/1986	3.6	630	370	8.5	12.0	1.7	11.6	109		300	239
02/14/1979	68.0	415	240	7.8	13.5	-	10.7			170	130
02/18/1980	-	266	160			220.0				120	99
02/16/1982	-	391	210			46.0				190	
02/07/1983	-		180			100.0				140	
02/28/1983	-		130			190.0				98	
02/27/1984	-		320			-				260	
02/09/1985	40.0	428	240	7.9	10.0	39.0	9.4	83		180	134
02/13/1986	74.0	450		8.1	13.0	39.0	10.0	95		210	169
02/25/1986	247.0		200	8.0		40.0	10.2			170	133
03/16/1979	12 J	504	300	8.4	14.5	-	12.2			230	190
03/27/1979	86.0	372	220	7.9	14.5	-	9.3			180	140
03/05/1980	-	363	210			39.0				170	150
03/04/1981	-	512	290			16.0				220	
03/26/1981	-	498	280			54.0				200	
03/29/1982	-	355	210			32.0				180	
03/17/1984	13.0	530	300	8.4	16.0	2.0	9.4	94	3.0	250	
03/11/1985	14.0	477	270	8.0	13.0	12.0	9.6	91		210	160
03/11/1986	512.0	278	170	8.2	14.0	61.0	10.3	100		130	121
04/11/1983	-		300			20.0				250	
04/26/1979	15.0	557	330	8.2	18.0	-	9.7			280	220
05/23/1979	18.0	463	290	8.3	23.0	-	11.1			250	210
05/06/1980	-	451	280			18.0				240	200
05/18/1981	-	494	280			10.0				230	
05/17/1982	-	564	310			5.0				260	
05/16/1983	-	467	270			78.0				220	
05/13/1986	15.0	514	300	8.4	21.5	5.5	10.8	121		240	208
06/11/1984	-		300			7.3				250	218

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06/13/1985	11.0	583	340	8.4	25.0	1.5	9.8	120		290	240
07/31/1979	13.0	475	280	8.4	25.5	-	12.2			230	210
07/16/1980	-	493	280			1.3				220	200
07/13/1981	-	638	310			11.0				260	
07/19/1982	-	518	300			13.0				260	
07/12/1983	11.0	502	280	8.6	23.5	2.0	9.9	118	1.9	230	200
07/10/1984	17.0	495	290	8.6	26.0	4.4	10.1	126		250	215
07/22/1986	7.9	517	300	8.6	25.5	1.0	8.3	102		230	215
08/31/1981	-	439	240			-				210	
08/29/1983	-	527	300			15.0				260	
08/27/1984	1.8	550	310	8.0	23.0	1.1	6.9	81	3.9	260	234
09/04/1979	13.0	433	250	8.6	24.5	-	12.1			220	190
09/10/1980	-		330			12.0				270	220
09/07/1982	-	480	270			7.4				220	
09/11/1985	5.8	612	360	8.4	21.5	1.3	10.7	122		290	244
09/23/1986	13.0	456	270	8.2	20.0	1.5	9.3	103		220	190
11/20/1979	10.0	470	290	8.4	16.5	2.2	11.6		3.9	210	180
11/18/1980	-	448	250			18.0				210	
11/16/1981	-	429	240			42.0				190	
11/15/1982	-	509	290			15.0				240	
12/30/1981	25.0	551	320	7.8	13.5	7.8	8.6	83	3.8	250	204

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Station #11167572 GUADALUPE RIVER AT ALAMITOS RECHARGE FACILITY AT SAN JOSE CALIF.

Period	Flow (cfs)	Cond (µmohs)	TDS (mg/l)	pH	Temp (deg C)	Turbidity (NTU)	DO (mg/l)	DO (% sat)	Dis. Organic C (mg/l as C)	TH (mg/l as CaCO3)	Alkalinity (mg/l as CaCO3)
All											
Mean	47.6	464	265	8.2	17.7	44.7	10.3	104	3.3	214	184
CV	2.20	0.20	0.21	0.03	0.32	1.89	0.13	0.14	0.22	0.22	0.21
n	27	51	57	27	26	48	27	17	7	58	33
Month											
Nov	10.0	464	268	8.4	16.5	19.3	11.6		3.9	213	180
Jan	13.6	430	246	8.1	11.4	96.2	10.8	104	3.4	192	175
Feb	107.3	390	210	8.0	12.2	96.3	10.1	89		171	133
Mar	127.4	432	255	8.2	14.4	29.5	10.2	95	3.0	202	152
May	14.8	512	300	8.3	21.9	17.9	10.3	121		251	216
July	12.2	520	291	8.6	25.1	5.5	10.1	115	1.9	240	208
Sept	8.4	500	291	8.3	22.3	6.4	9.8	102	3.9	244	216
Winter											
Nov-Apr	76.3	428	243	8.1	13.0	67.2	10.5	97	3.4	192	156
n	15	29	33	15	14	29	15	9	5	34	17
Summer											
May-Sept	11.8	510	295	8.4	23.1	10.3	10.1	112	2.9	245	213
n	12	22	24	12	12	19	12	8	2	24	16

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Station #11167572 GUADALUPE RIVER AT ALAMITOS RECHARGE FACILITY AT SAN JOSE CALIF.

Period	Flow (cfs)	Total Phosphorous (mg/l as P)	Ortho P (mg/l as P)	Total Boron (mg/l as B)	Dis Iron (mg/l as Fe)	Nitrogen NO3+NO2 (mg/l as N)	Dis. Ammonia (mg/l as N)	Total Organic (mg/l as N)	Total ORG+NH3 (mg/l as N)	Total Nitrogen (mg/l as N)
01/18/1979	18	0.18	0.08	110	10	1.90	0.06	0.74	0.84	2.70
01/11/1980		0.15	0.11	120	60	1.60	0.04	1.10	1.10	2.70
01/29/1981		0.27	0.16	80	80	1.80	0.15			
01/04/1982		0.28	0.20	60	240	1.60	0.11	1.10	1.20	2.80
01/20/1982		0.10	0.09	100	46	2.60	0.21	0.53	0.76	3.40
01/18/1983		0.16	0.08	100	16	2.20	0.12	1.00	1.10	3.30
01/26/1983		0.33	0.10	50	150	0.63	0.08	1.30	1.60	2.20
01/15/1985	14	0.05	0.04	130	16	1.60	0.06	0.64	0.70	2.40
01/29/1985	7.2	0.04	0.02	130	12	1.50	0.04	0.48	0.50	2.10
01/29/1986	3.6	0.03	0.01	140	8		0.05	0.63	0.70	2.30
02/14/1979	68	0.11	0.04	160	60	1.40	0.02	0.63	0.72	2.10
02/18/1980		0.57	0.16	110	30	1.30	0.10	1.50	1.70	3.00
02/16/1982		0.07	0.04	80	13	1.20	0.11	0.59	0.71	1.70
02/07/1983		0.20	0.09	70	92	0.74	0.13	0.80	0.90	1.70
02/28/1983		0.25	0.09	50	160	0.45	0.14	1.30	1.50	2.00
02/27/1984		0.15	0.01	130	3	1.80	0.04	1.40	1.40	3.10
02/09/1985	40	0.13	0.04	110	37	0.87	0.04	1.20	1.30	3.00
02/13/1986	74	0.14	0.06	100	63		0.11	0.71	0.80	2.20
02/25/1986	247	0.06	0.03	80	43		0.04	0.36	0.40	2.00
03/16/1979	12	0.04	0.01	150	10	1.70	0.01	0.46	0.51	2.10
03/27/1979	86	0.11	0.03	130	30	1.10	0.06	0.45	0.51	1.50
03/05/1980		0.09	0.08	90	30	1.10	0.07	0.75	0.82	1.90
03/04/1981		0.13	0.02	130	20	2.30	0.04	1.20	1.30	3.40
03/26/1981		0.18	0.00	130	20	1.30	0.05	1.70	1.80	3.10
03/29/1982		0.05	0.05	100	10	1.10	0.10	0.54	0.68	1.80
03/17/1984	13	0.02	0.05	110	3	1.70	0.08	0.36	0.40	2.10
03/11/1985	14	0.07	0.05	120	34	1.60	0.06	0.41	0.50	2.10
03/11/1986	512	0.11	0.04	70	96		0.03	0.43	0.50	1.10
04/11/1983		0.06	0.03	110	3	1.80	0.10	1.50	1.60	3.40
04/26/1979	15	0.04	0.02	160	10	1.90	0.01	0.47	0.53	2.40
05/23/1979	18	0.03	0.01	130	10	0.83	0.01	0.32	0.40	1.30
05/06/1980		0.05	0.00	110	10	1.40	0.04	0.98	1.10	
05/18/1981		0.08	0.01	100	10	1.00	0.11	1.50	1.70	2.70
05/17/1982		0.05	0.02	110	9	2.10	0.10	0.85	0.98	3.00
05/16/1983		0.05	0.01	110	6	1.10	0.07	0.39	0.50	1.60
05/13/1986	15	0.03	0.01	130	3		0.02	0.39	0.40	1.70
06/11/1984		0.04	0.01	180	13	0.60	0.04	0.77	0.80	1.40

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06/13/1985	11	0.01	0.01	150	8	0.66	0.04	0.43	0.50	1.10
07/31/1979	13	0.01	0.01	130	10	0.64	0.04	0.37	0.38	1.00
07/16/1980		0.03	0.00	140	10	1.30	0.04	0.60	0.64	1.90
07/13/1981		0.08	0.02	120	10	0.78	0.12	1.00	1.20	2.00
07/19/1982		0.02	0.01	130	3	1.30	0.07	3.00	3.10	4.40
07/12/1983	11	0.02	0.01	140	6	0.90	0.04	0.76	0.80	1.70
07/10/1984	17	0.01	0.02	160	4	0.51	0.01	0.45	0.50	1.00
07/22/1986	7.9	0.02	0.01	130	7		0.02	0.37	0.40	1.10
08/31/1981		0.04	0.00	120	10	0.35		0.90	1.00	1.30
08/29/1983		0.05	0.01	130	3	0.92	0.03	1.00	1.10	2.00
08/27/1984	1.8	0.01	0.01	130	7	0.25	0.01	0.38	0.40	0.70
09/04/1979	13	0.02	0.01	140	10	0.29	0.03	0.55	0.58	0.87
09/10/1980		0.07	0.01	150	20	1.50	0.01	0.68	0.71	2.30
09/07/1982		0.04	0.01	120	6	0.82	0.14	0.69	0.90	1.70
09/11/1985	5.8	0.02	0.01	140	9	0.47	0.06	0.44	0.50	1.00
09/23/1986	13	0.02	0.01	130	5		0.05	0.34	0.40	1.00
11/20/1979	10	0.00	0.01	150	10	0.69	0.05	0.34	0.43	1.10
11/18/1980		0.03	0.01	130	10	0.84	0.05	0.49	0.54	1.40
11/16/1981		0.15	0.12	100	56	1.50	0.21	0.64	0.82	2.30
11/15/1982		0.05	0.01	140	4	0.97	0.15	1.50	1.60	2.60
12/30/1981	25	0.08	0.04	130	12	1.90	0.07	1.20	1.30	3.10

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Station #11167572 GUADALUPE RIVER AT ALAMITOS RECHARGE FACILITY AT SAN JOSE CALIF.

Period	Flow (cfs)	Phosphorous (mg/l as P)	Ortho P (mg/l as P)	Total Boron (mg/l as B)	Dis Iron (mg/l as Fe)	Nitrogen NO3+NO2 (mg/l as N)	Dis. Ammonia (mg/l as N)	Total Organic (mg/l as N)	Total ORG+NH3 (mg/l as N)	Total Nitrogen (mg/l as N)
All										
Mean	47.6	0.09	0.04	119	29	1.22	0.07	0.80	0.89	2.09
CV	2.20	1.08	1.14	0.23	1.50	0.46	0.70	0.60	0.57	0.39
n	27	58	58	58	58	51	57	57	57	56
Month										
Nov	10.0	0.06	0.04	130	20	1.00	0.12	0.74	0.85	1.85
Jan	13.6	0.15	0.08	105	59	1.73	0.09	0.87	0.98	2.70
Feb	107.3	0.19	0.06	99	56	1.11	0.08	0.94	1.05	2.31
Mar	127.4	0.09	0.04	114	26	1.52	0.06	0.78	0.86	2.25
May	14.8	0.04	0.01	131	9	1.20	0.05	0.68	0.77	1.90
July	12.2	0.03	0.01	136	7	0.91	0.05	0.94	1.00	1.87
Sept	8.4	0.03	0.01	133	9	0.66	0.05	0.62	0.70	1.36
Winter										
Nov-Apr	76.3	0.13	0.06	109	44	1.43	0.08	0.85	0.95	2.35
n	15	34	34	34	34	30	34	33	33	33
Summer										
May-Sept	11.8	0.04	0.01	133	8	0.93	0.05	0.73	0.81	1.70
n	12	24	24	24	24	21	23	24	24	23

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Station #11167572 GUADALUPE RIVER AT ALAMITOS RECHARGE FACILITY AT SAN JOSE CALIF.

DATE	Flow (cfs)	Zn dissolved (µg/l)	Zn sediment (µg/l)	PB dissolved (µg/l)	PB sediment (µg/l)	Cu dissolved (µg/l)	Cu sediment (µg/l)	As dissolved (µg/l)	As sediment (µg/l)
01/04/1982		20		4		6		2	
01/18/1979		3		4		3		2	
01/26/1983		3	30	1	10	4	20	1	9
02/09/1985	40	3	140	1	110	4	60	1	6
02/13/1986	74	14		2		1		1	
02/18/1980		50		3		3		1	
02/25/1986	247	10		3		1		1	
02/27/1984				1		2		1	
03/26/1981		80		3		4		2	
07/31/1979	13	3		ND		ND		1	
08/27/1984	1.8	30	50	1	10	1	30	1	1
08/29/1983		43		1		3		1	
08/31/1981		80		5		3		1	
09/07/1982		76		1		6		2	
09/10/1980		50		4		ND		2	
09/11/1985	6	10	90	1	10	1	70	1	9
All Data									
Mean	64	32	78	2	35	3	45	1	6
CV	1.48	0.93	0.63	0.62	1.43	0.57	0.53	0.36	0.60
n	6	15	4	15	4	14	4	16	4
Winter									
Mean	120	23	85	2	60	3	40	1	8
CV	0.92	1.22	0.92	0.51	1.18	0.52	0.71	0.36	0.28
n	3	8	2	9	2	9	2	9	2
Summer									
Mean	7	42	70	2	10	3	50	1	5
CV	0.83	0.72	0.40	0.85	0.00	0.73	0.57	0.38	1.13
n	3	7	2	6	2	5	2	7	2

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Station #11167572 GUADALUPE RIVER AT ALAMITOS RECHARGE FACILITY AT SAN JOSE CALIF.

DATE	Flow (cfs)	Fe sediment (µg/l)	Mn dissolved (µg/l)	Mn sediment (µg/l)	Al dissolved (µg/l)	Al sediment (µg/l)	Cb sediment (µg/l)
01/04/1982			20		20		
01/18/1979			8		10		
01/26/1983		11000	4	330	120	6400	20
02/09/1985	40	36000	15	2100	40	20000	30
02/13/1986	74		17		30		
02/18/1980			20		50		
02/25/1986	247		10		20		
02/27/1984							
03/26/1981			5		20		
07/31/1979	13		3		100		
08/27/1984	1.8	19000	8	360	10	9000	20
08/29/1983			2		10		
08/31/1981			ND		10		
09/07/1982			2		10		
09/10/1980			10		0		
09/11/1985	6	21000	10	630	10	12000	30
All Data							
Mean	64	21750	10	855	31	11850	25
CV	1.48	0.48	0.66	0.98	1.14	0.50	0.23
n	6	4	14	4	15	4	4
Winter							
Mean	120	23500	12	1215	39	13200	25
CV	0.92	0.75	0.52	1.03	0.91	0.73	0.28
n	3	2	8	2	8	2	2
Summer							
Mean	7	20000	6	495	21	10500	25
CV	0.83	0.07	0.67	0.39	1.63	0.20	0.28
n	3	2	6	2	7	2	2

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Station #11167572 GUADALUPE RIVER AT ALAMITOS RECHARGE FACILITY AT SAN JOSE CALIF.

DATE	Flow (cfs)	Cd dissolved (µg/l)	Cd sediment (µg/l)	Cr dissolved (µg/l)	Cr sediment (µg/l)	Hg dissolved (µg/l)	Hg sediment (µg/l)	Ni sediment (µg/l)	Se dissolved (µg/l)	Se sediment (µg/l)
01/04/1982		<1		<10		<0.1				
01/18/1979		<2		<20		<0.1		<200		
01/26/1983		<1	<1	<10	40	<0.1	4	<100		<1
02/09/1985	40	<1	<1	<10	100	<0.1	0	<100	<1	<1
02/13/1986	74	<1		<10		<0.1		<100		
02/18/1980		0		0		0		0		
02/25/1986	247	<1		<10		<0.1		<100		
02/27/1984		<1		<10		<0.1				
03/26/1981		2		10		0		100		
07/31/1979	13	<2		ND		<0.1		ND		
08/27/1984	1.8	<1	<1	10	80	<0.1	2	<100		<1
08/29/1983		<1		10		<0.1		<100		
08/31/1981		1		0		0		0		
09/07/1982		<1		10		<0.1		<100		
09/10/1980		1		0		0		0		
09/11/1985	6	<1	<1		1100	<0.1	4	<100		<1

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STATION #11167572 GUADALUPE RIVER AT ALAMITOS RECHARGE FACILITY AT SAN JOSE CALIF.

DATE	Total Diazinon (µg/l)	Total 2,4-D, (µg/l)	Total Lindane (µg/l)	Total Malathion (µg/l)	Total Chlordane (µg/l)	Total DDD (µg/l)	Total DDE (µg/l)	Total DDT (µg/l)	Total Dieldrin (µg/l)	Total Heptachlor (µg/l)
01/05/1982	0.05	0.03	0.01	0.09	0	0.01	0.01	0	0	0
01/26/1983	0.01	0.01	<0.010	<0.01	<0.1	<0.010	0.01	<0.010	0.01	<0.010
01/29/1986	0.11	0.04	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
02/09/1985	0.12	0.03	0.03	0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
02/13/1986	0.1	0.17	<0.010	0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
02/19/1980	0.03	0	0	0	0.1	0	0	0	0	0
02/25/1986	<0.01	<0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
03/27/1981	0.03	0.06	0.01	0	0	0	0	0	0	0
04/12/1983	0.01	0.02	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
07/22/1986	0.02	0.02	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
08/27/1984	0.01	0.03	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
08/30/1983	0.01	0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
09/01/1981	0.01	0.02	0	0.16	0	0	0	0	0	0
09/08/1982	0.01	<0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
09/10/1980	0	0	0	0	0	0	0	0	0	0
09/11/1985	0.01	0.03	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
09/23/1986	0.01	0.01	<0.010	<0.01	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010

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STATION #11167572 GUADALUPE RIVER AT ALAMITOS RECHARGE FACILITY AT SAN JOSE CALIF.

DATE	Naphthalenes Polychlor (µg/l)	Total PCB (µg/l)	Total Aldrin (µg/l)	Total Endosulfan (µg/l)	Total Endrin (µg/l)	Total Ethion (µg/l)	Total Chlor Epoxide (µg/l)	Total Oxychlor (µg/l)	Total Methyl Parathion (µg/l)
01/05/1982	0	0	0	0	0	0	0	0	0
01/26/1983	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
01/29/1986	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
02/09/1985	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
02/13/1986	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
02/19/1980	0	0	0	0	0	0	0	0	0
02/25/1986	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
03/27/1981	0	0	0	0	0	0	0	0	0
04/12/1983	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
07/22/1986	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
08/27/1984	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
08/30/1983	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
09/01/1981	0	0	0	0	0	0	0	0	0
09/08/1982	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
09/10/1980	0	0	0	0	0	0	0	0	0
09/11/1985	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01
09/23/1986	<0.10	<0.1	<0.010	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01

R0054895

STATION #11167572 GUADALUPE RIVER AT ALAMITOS RECHARGE FACILITY AT SAN JOSE CALIF.

DATE	Total Methyl Trithion (µg/l)	Total Mirex (µg/l)	Total Perthane (µg/l)	Total Toxaphene (µg/l)	Total Trithion (µg/l)	Total 2,4,5-T (µg/l)	Total Silvex (µg/l)
01/05/1982	0	0	0	0	0	0	0
01/26/1983	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
01/29/1986	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
02/09/1985	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
02/13/1986	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
02/19/1980	0	0	0	0	0	0	0
02/25/1986	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
03/27/1981	0	0	0	0	0	0	0
04/12/1983	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
07/22/1986	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
08/27/1984	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
08/30/1983	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
09/01/1981	0	0	0	0	0	0	0
09/08/1982	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
09/10/1980	0	0	0	0	0	0	0
09/11/1985	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01
09/23/1986	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01

R0054896

8720115A-F CON-8

VOL 12

USGS STATION NO. 11169000
GUADALUPE RIVER AT
SAN JOSE, CA

2

1597

R0054897

STATION #11169000 GAUDALUPE RIVER AT SAN JOSE, CALIF.

Period	Flow (cfs)	Cond (µmohs)	TDS (mg/l)	pH	Temp (deg C)	Turbidity (NTU)	DO (mg/l)	DO (% sat)	Dis. Organic C (mg/l as C)	TH (mg/l as CaCO3)	Alkalinity (mg/l as CaCO3)
1/17/79	52.0	405	230	7.6	9.0	--	11.0	--	5.1	180	140
1/12/80	221.0	300	180	7.4	15.0	28	9.1	--	--	130	97
1/29/81	293.0	282	150	7.4	11.0	130	10.2	93	--	110	90
1/5/82	943.0	242	140	7.9	11.0	270	10.5	95	--	110	100
1/21/82	137.0	369	210	8.0	9.0	6	11.0	95	--	170	144
1/19/83	68.0	454	260	8.1	10.0	27	10.7	95	--	200	170
1/27/83	1540.0	235	150	7.9	12.0	350	10.6	99	--	99	104
1/29/85	22.0	681	410	8.3	13.5	6.5	10.8	103	42.0	320	269
1/29/86	25.0	652	400	8.3	15.0	28	8.8	88	10.0	310	266
1/28/87	24.0	393	246	8.1	13.0	17	9.7	92	5.1	180	147
1/15/85	23.0	715	440	8.5	13.0	1.4	11.6	110	5.0	350	302
2/14/79	135.0	177	140	7.2	12.5	--	10.0	--	--	95	67
2/19/80	7900.0	172	100	6.8	12.5	800	9.7	--	--	68	62
2/17/82	348.0	362	200	8.6	12.0	50	10.0	92	--	170	160
2/8/83	934.0	270	150	8.0	12.0	150	10.7	100	--	120	84
2/28/84	28.0	695	200	8.6	15.0	5.7	12.0	120	18.0	310	128
2/9/85	116.0	496	290	8.2	10.0	30	10.8	95	30.0	220	178
2/13/86	124.0	466	280	8.3	14.0	81	10.0	97	42.0	220	171
2/24/86	925.0	202	150	8.2	11.0	330	11.1	100	98.0	110	94
2/11/87	31.0	605	362	8.4	16.0	6.8	11.4	116	3.3	270	230
3/16/79	27.0	288	160	7.7	13.5	--	8.5	--	--	100	71
3/27/79	453.0	176	100	7.5	13.5	--	9.5	--	--	73	52
3/6/80	302.0	336	190	7.8	13.0	57	10.0	--	--	150	130
3/5/81	21.0	394	230	7.7	12.0	19	10.0	94	--	160	120
3/27/81	3.7	332	190	8.0	15.5	16	8.4	84	--	130	120
3/30/82	480.0	323	190	8.1	11.0	48	10.4	94	--	150	122
3/1/83	4240.0	200	130	8.0	13.0	330	10.0	--	--	93	88
3/17/84	29.0	350	440	7.9	15.0	54	8.8	86	3.0	140	289
3/11/85	69.0	252	150	8.0	14.5	23	8.8	86	40.0	110	92
3/11/86	1480.0	258	150	8.2	13.5	110	10.2	98	39.0	110	100
3/5/87	200.0	342	198	7.9	14.0	24	9.3	91	12.0	140	117
4/12/83	61.0	554	250	9.0	14.0	15	13.1	128	16.0	250	170
4/26/79	31.0	259	150	7.2	18.5	--	6.8	--	19.0	88	62
5/23/79	0.7	895	520	8.1	18.5	--	7.8	--	--	360	290
5/6/80	0.7	826	490	8.2	16.5	5.2	7.4	76	--	370	310
5/19/81	0.5	866	510	8.1	16.0	2.1	6.3	64	--	370	340
5/18/82	3.7	918	570	8.3	17.5	0.5	12.1	127	--	430	384
5/17/83	103.0	411	420	8.5	18.0	6.5	10.0	105	6.0	190	270

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5/13/86	25.0	690	430	8.4	20.0	4	10.5	116	<3	320	272
6/12/84	24.0	817	420	8.5	20.0	1.1	11.8	131	5.0	340	283
6/13/85	20.0	736	450	8.4	22.0	4	8.9	102	4.0	350	295
6/2/87	20.0	712	461	8.4	22.0	4.5	10.4	119	- -	340	294
7/16/80	0.2	750	440	8.3	21.5	6.9	15.6	176	--	320	280
7/14/81	0.3	702	440	8.5	23.0	5.2	13.2	155	--	290	250
7/20/82	3.2	864	540	8.4	21.5	4.2	12.7	144	--	360	300
7/12/83	18.0	743	440	8.6	23.0	1	9.6	113	4.0	330	290
7/10/84	25.0	614	430	8.5	21.5	6.4	12.0	137	<3	320	283
7/24/85	22.0	748	430	8.0	22.0	23	10.9	127	6.0	340	288
7/22/86	22.0	765	460	8.4	21.5	8.6	11.5	131	4.0	340	310
7/7/87	17.0	722	450	8.4	23.0	32	8.7	102	2.8	340	305
8/1/79	0.3	735	460	8.2	26.0	--	10.9	--	15.0	310	270
8/30/83	20.0	713	400	8.3	23.0	4.5	10.6	124	11.0	350	277
8/27/84	22.0	721		8.3	21.0	16	9.7	109		330	
8/11/87	15.0	724	434	8.4	22.0	8	10.4	120	2.5	340	292
9/4/79	0.0	859	520	8.0	21.0	--	7.0	--	19.0	350	290
9/10/80	0.5	869	500	7.8	18.0	4	6.2	--	--	350	310
9/1/81	0.3	728	440	8.0	19.5	2.6	9.8	107	--	300	250
9/8/82	2.8	498	280	7.5	23.0	1.5	9.9	118	--	200	138
9/11/85	20.0	712	430	8.4	17.5	24	9.4	98	3.0	340	289
9/23/86	23.0	701	450	8.3	18.0	100	7.6	81	3.0	350	295
11/18/80	0.2	724	400	7.2	10.5	4.9	1.0	9	--	260	240
11/17/81	128.0	289	150	7.8	15.5	70	8.6	85	--	120	102
11/16/82	14.0	606	360	8.4	12.5	20	10.0	94	--	260	230
12/6/86	27.0	496	291	8.1	14.0	13	8.8	85	8.9	230	187
12/30/81	27.0	375	210	8.0	13.0	52	9.5	90	--	160	130

R0054899

STATION #11169000 GAUDALUPE RIVER AT SAN JOSE, CALIF.

Period	Flow (cf)	Cond (µmohs)	TDS (mg/l)	pH	Temp (deg C)	Turbidity (NTU)	DO (mg/l)	DO (% sat)	Dis. Organic C (mg/l as C)	TH (mg/l as CaCO3)	Alkalinity (mg/l as CaCO3)
All											
Mean	341.6	537	321	8.1	16.2	60.7	9.9	104	16.1	238	202
CV	3.32	0.42	0.44	0.05	0.27	2.16	0.20	0.24	1.25	0.43	0.45
n	64	64	63	64	64	56	64	51	30	64	63
Month											
Nov	42.3	529	300	7.9	13.1	27.0	7.1	68	8.9	218	190
Jan	281.3	425	252	8.0	12.0	83.3	10.3	96	13.4	193	163
Feb	1171.2	383	208	8.0	12.8	181.7	10.6	103	38.3	176	130
Mar	613.8	317	198	8.0	13.5	69.6	9.8	95	22.0	134	123
May	22.9	713	442	8.2	18.9	3.5	9.2	105	8.5	316	280
July	12.0	738	454	8.4	22.6	10.9	11.7	136	6.4	328	286
August	14.3	723	431	8.3	23.0	9.5	10.4	118	9.5	333	280
Sept	7.8	728	437	8.0	19.5	26.4	8.3	101	8.3	315	262
Winter											
Nov-Apr	579.8	391	229	8.0	12.8	96.2	9.9	94	23.8	172	145
n	37	37	37	37	37	33	37	29	16	37	37
Summer											
May-Sept	15.7	725	443	8.2	20.5	11.5	9.9	117	7.5	322	278
n	28	28	27	28	28	24	28	23	14	28	27

R0054900

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STATION #11169000 GAUDALUPE RIVER AT SAN JOSE, CALIF.

Period	Flow (cfs)	Total Phosphorous (mg/l as P)	Dis Ortho P (mg/l as P)	Boron (mg/l as B)	Iron (mg/l as Fe)	Nitrogen NO3+NO2 (mg/l as N)	Dis. Ammonia (mg/l as N)	Total Organic (mg/l as N)	Total Nitrogen (mg/l as N)
1/17/79	52.0	0.16	0.04	110	20	1.50	0.06	0.58	2.20
1/12/80	221.0	0.23	0.09	100	80	0.99	0.06	1.20	2.30
1/29/81	293.0	0.26	0.15	60	30	1.50	0.10	--	--
1/5/82	943.0	0.25	0.16	60	150	1.80	0.13	1.20	3.20
1/21/82	137.0	0.15	0.12	80	22	1.70	0.15	0.61	2.60
1/19/83	68.0	0.47	0.31	100	17	1.90	0.07	0.93	2.90
1/27/83	1540.0	0.60	0.08	50	150	0.80	0.09	1.10	2.10
1/29/85	22.0	0.07	--	0.04	150	3.50	0.60	0.55	4.20
1/29/86	25.0	0.17	0.07	0.06	150	--	1.10	0.98	4.30
1/28/87	24.0	0.10	0.05	90	19	1.70	0.05	1.20	2.90
1/15/85	23.0	0.02	--	0.02	160	3.60	0.30	- -	4.10
2/14/79	135.0	0.17	0.07	80	80	0.76	0.13	0.81	1.60
2/19/80	7900.0	2.80	0.20	70	190	0.93	0.09	4.50	5.60
2/17/82	348.0	0.06	0.04	80	38	0.80	0.08	0.57	1.50
2/8/83	934.0	0.21	0.09	50	40	0.60	0.09	1.00	1.70
2/28/84	28.0	0.14	--	0.05	80	1.40	0.60	0.47	2.00
2/9/85	116.0	0.10	--	0.03	130	1.20	1.00	0.97	3.10
2/13/86	124.0	0.09	0.06	0.02	90	--	1.10	1.00	2.60
2/24/86	925.0	0.21	0.04	0.02	70	--	1.10	1.00	2.10
2/11/87	31.0	0.04	0.02	160	5	- -	0.01	0.70	2.70
3/16/79	27.0	0.27	0.13	130	30	1.30	0.06	1.40	2.60
3/27/79	453.0	0.67	0.13	70	100	0.63	--	1.50	2.20
3/6/80	302.0	0.10	0.05	80	30	0.56	0.04	0.83	1.70
3/5/81	21.0	0.15	0.06	120	50	1.40	0.06	1.00	2.50
3/27/81	3.7	0.21	0.05	80	20	0.81	0.08	1.20	2.00
3/30/82	480.0	0.08	0.05	80	34	0.56	0.12	0.42	1.10
3/1/83	4240.0	0.79	0.07	50	240	0.43	0.12	1.90	2.50
3/17/84	29.0	0.02	--	0.01	160	3.30	1.00	0.55	4.20
3/11/85	69.0	0.18	--	0.1	60	0.88	0.70	0.61	1.60
3/11/86	1480.0	0.17	0.05	0.04	50	--	0.60	0.52	1.30
3/5/87	200.0	0.20	0.09	100	41	- -	0.03	1.80	3.10
4/12/83	61.0	0.04	--	0.01	80	1.10	0.60	1.00	1.70
4/26/79	31.0	0.21	0.07	160	70	0.82	0.06	1.00	1.90
5/23/79	0.7	0.13	0.09	450	10	0.79	0.01	0.82	1.70
5/6/80	0.7	0.13	0.04	220	20	1.40	0.03	1.40	3.00
5/19/81	0.5	0.24	0.14	190	10	1.70	0.21	0.86	2.80
5/18/82	3.7	0.15	0.09	210	9	2.60	0.12	0.95	3.50
5/17/83	103.0	0.05	--	0.04	160	3.20	1.00	0.47	4.20

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5/13/86	25 0	0 11	0.01	0 01	160	--	0 40	0.38	2.90
6/12/84	24.0	0 04	--	0 02	150	3.20	0 80	0 98	4.00
6/13/85	20 0	0 04	--	0 01	170	3.00	0.50	0 43	3.50
6/2/87	20.0	0 02	0.01	160	3	- -	0 04	1 00	3.60
7/16/80	0.2	0.22	0.05	220	30	0.31	0.01	1.30	1.70
7/14/81	0.3	0.24	0.15	150	10	1.00	0.17	0.86	2.10
7/20/82	3.2	0 20	0.19	180	3	1.20	0.06	1 80	3.10
7/12/83	18.0	0 05	--	0.03	150	2.70	0.90	0.96	3.80
7/10/84	25.0	0 04	--	0.01	150	3.30	0.60	0.74	3.90
7/24/85	22 0	0.05	--	0.02	100	3.20	0.90	0.84	4.10
7/22/86	22.0	0.03	0.02	0.01	160	- -	0 40	0.37	3.30
7/7/87	17.0	0.58	0.02	150	3	- -	0.04	0.80	3.30
8/1/79	0.3	0.07	0.10	210	20	1.40	0.07	0.72	2.10
8/30/83	20.0	0.03	--	0.02	160	3.20	0.50	0.78	3.60
8/27/84	22.0							0.58	
8/11/87	15.0	0.09	0.01	160	3	2.20	0.02	0.40	2.70
9/4/79	0.0	0 14	0.10	270	10	0.54	0.10	0.68	1.30
9/10/80	0.5	0.22	0.16	240	10	1.20	0.03	0.90	2.10
9/1/81	0.3	0.24	0.09	180	10	1.40	0.09	0.93	2.40
9/8/82	2.8	0.09	0.08	100	40	0.35	0.13	0.77	1.40
9/11/85	20.0	0.05	--	0.02	150	3.20	0.70	0.65	3.90
9/23/86	23.0	0.08	0.05	0.02	170	- -	0.40	- -	3.50
11/18/80	0.2	0.30	0.20	150	90	1.20	0.02	0.95	2.20
11/17/81	128.0	0.20	0.14	60	34	0.98	0.16	0.53	1.70
11/16/82	14.0	0.28	0.17	110	7	1.60	0.06	1.30	3.10
12/6/86	27.0	0.15	- -	120	51	- -	0.03	1.00	3.20
12/30/81	27.0	0.21	0.11	90	20	1.20	0.10	0.69	2.00

R0054902

STATION #11169000 GAUDALUPE RIVER AT SAN JOSE, CALIF.

Period	Flow (cfs)	Total Phosphorous (mg/l as P)	Dis Ortho P (mg/l as P)	Boron (mg/l as B)	Iron (mg/l as Fe)	Nitrogen NO3+NO2 (mg/l as N)	Dis. Ammonia (mg/l as N)	Total Organic (mg/l as N)	Total Nitrogen (mg/l as N)
All									
Mean	341.6	0.22	0.09	87.2	74	1.59	0.30	0.95	2.74
CV	3.32	1.69	0.68	1.03	0.86	0.61	1.14	0.60	0.35
n	64	63	47	63	63	51	62	61	62
Month									
Nov	42.3	0.23	0.17	110.0	46	1.26	0.07	0.95	2.55
Jan	281.3	0.22	0.12	61.7	81	1.84	0.23	0.90	2.98
Feb	1171.2	0.42	0.07	48.9	80	0.95	0.47	1.22	2.54
Mar	613.8	0.24	0.08	59.2	75	1.10	0.31	1.08	2.21
May	22.9	0.11	0.06	139.0	76	2.09	0.32	0.83	3.11
July	12.0	0.16	0.09	101.1	70	1.87	0.35	0.93	3.04
August	14.3	0.06	0.06	123.3	61	2.27	0.20	0.62	2.80
Sept	7.8	0.14	0.10	131.7	65	1.34	0.24	0.79	2.43
Winter									
Nov-Apr	579.8	0.28	0.10	63.0	75	1.35	0.30	1.04	2.57
n	37	37	29	37	37	30	36	35	36
Summer									
May-Sept	15.7	0.13	0.08	120.4	72	1.91	0.31	0.83	2.94
n	28	27	19	27	27	22	27	27	27

R0054903

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STATION 11 169000 - GUADALUPE RIVER AT SAN JOSE, CALIF.

GROUP A - PRESENT IN STREAM

DATE	FLOW	DIAZINON TOTAL (UG/L)	2,4-D TOTAL (UG/L)	LINDANE TOTAL (UG/L)	MALATHION TOTAL (UG/L)
1/17/79	52.00	0.07	0.07	0.02	0.00
8/1/79	0.33	0.20	0.11	0.01	0.00
2/19/80	7900.00	0.07	0.07	0.02	0.01
9/10/80	0.53	0.03	0.00	0.01	0.00
3/27/81	3.70	0.34	0.17	0.02	0.22
9/1/81	0.33	0.02	0.02	0.00	0.96
1/5/82	943.00	0.07	0.02	0.01	0.09
9/8/82	2.80	0.16	0.02	<0.010	<0.01
1/27/83	1540.00	< 0.01	< 0.01	<0.010	<0.01
4/12/83	61.00	0.01	0.03	<0.010	<0.01
8/30/83	20.00	0.02	0.05	<0.010	<0.01
8/27/84	22.00	0.01	0.04	<0.010	<0.01
2/9/85	116.00	0.09	0.07	0.04	0.01
9/11/85	20.00	0.04	< 0.01	<0.010	<0.01
1/29/86	25.00	0.18	0.01	<0.010	0.03
2/13/86	124.00	0.10	0.10	<0.010	0.01
2/24/86	925.00	< 0.01	< 0.01	<0.010	<0.01
7/22/86	22.00	0.01	0.11	<0.010	<0.01
9/23/86	23.00	0.02	0.03	<0.010	<0.01
ALL - AVG		0.08	0.05		
COV		1.14	0.92		
mid 82 - 86					
winter		0.08	0.04	see data	see data
summer		0.04	0.04	all < 0.010	all < 0.01
79 - mid 82					
winter		0.14	0.08	0.02	0.08
summer		0.08	0.04	0.01	0.32

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STATION 11 169000 - GUADALUPE RIVER AT SAN JOSE, CALIF.

GROUP B - SOME POSITIVE BEFORE MID 1982 - NONE > D.L. AFTER

DATE	FLOW	CHLORODANE TOTAL (UG/L)	DDD TOTAL (UG/L)	DDE TOTAL (UG/L)	DDT TOTAL (UG/L)	DIELDRIN TOTAL (UG/L)	HEPTACHLOR TOTAL (UG/L)
1/17/79	52.00	0.00	0.00	0.00	0.00	0.00	0.00
8/1/79	0.33	0.00	0.00	0.00	0.00	0.00	0.00
2/19/80	7900.00	0.60	0.04	0.04	0.11	0.02	0.02
9/10/80	0.53	0.10	0.01	0.00	0.00	0.00	0.00
3/27/81	3.70	0.10	0.00	0.00	0.00	0.00	0.00
9/1/81	0.33	0.00	0.00	0.00	0.00	0.00	0.00
1/5/82	943.00	0.00	0.01	0.01	0.00	0.00	0.00
9/8/82	2.80	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
1/27/83	1540.00	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
4/12/83	61.00	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
8/30/83	20.00	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
8/27/84	22.00	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
2/9/85	116.00	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
9/11/85	20.00	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
1/29/86	25.00	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
2/13/86	124.00	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
2/24/86	925.00	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
7/22/86	22.00	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010
9/23/86	23.00	<0.1	<0.010	<0.010	<0.010	<0.010	<0.010

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STATION 11 169000 - GUADALUPE RIVER AT SAN JOSE, CALIF.

GROUP C - NEVER DETECTED

DATE	ENDO-SULFAN TOTAL (UG/L)	ENDRIN TOTAL (UG/L)	ETHION TOTAL (UG/L)	CHLOR EPOXIDE TOTAL (UG/L)	OXY-CHLOR TOTAL (UG/L)	METHYL PARA-THION TOTAL (UG/L)	METHYL TRI-THION TOTAL (UG/L)	MIREX TOTAL (UG/L)	PER-THANE TOTAL (UG/L)	TOXA-PHENE TOTAL (UG/L)	TOTAL TRI-THION (UG/L)	245-T TOTAL (UG/L)	SILVEX TOTAL (UG/L)	NAPHTH-ALENES POLYCHL TOTAL (UG/L)	PCB TOTAL (UG/L)
Jan-79	0.00	0.00	0.00	0.00	--	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	--	0.00
Aug-79	0.00	0.00	0.00	0.00	--	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.05	--	0.00
Feb-80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
Sep-80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Mar-81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sep-81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jan-82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sep-82	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01	<0.10	<0.1
Jan-83	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01	<0.10	<0.1
Apr-83	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01	<0.10	<0.1
Aug-83	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01	<0.10	<0.1
Aug-84	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01	<0.10	<0.1
Feb-85	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01	<0.10	<0.1
Sep-85	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01	<0.10	<0.1
Jan-86	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01	<0.10	<0.1
Feb-86	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01	<0.10	<0.1
Feb-86	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01	<0.10	<0.1
Jul-86	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01	<0.10	<0.1
Sep-86	<0.010	<0.010	<0.01	<0.010	<0.01	<0.01	<0.01	<0.01	<0.1	<1	<0.01	<0.01	<0.01	<0.10	<0.1

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STATION 11 169000 GUADALUPE RIVER

GROUP #1

DATE	FLOW CFS	Zn dissolved ug/l	Zn sediment ug/gm	PB dissolved ug/l	PB sediment ug/gm	Cu dissolved ug/l	Cu sediment ug/gm	As dissolved ug/l	As sediment ug/gm
1/17/79	52.0	20	--	26	--	3	--	1	--
1/5/82	943.0	10	100	6	60	2	30	2	8
1/27/83	1540.0	6	70	1	80	2	20	1	4
1/28/88	24.0	8	- -	5	- -	2	- -	2	- -
2/19/80	7900.0	190	810	0	1000	2	40	2	8
2/9/85	116.0	3	110	2	80	3	180	1	4
2/13/86	124.0	28	--	1	--	3	--	1	--
2/24/86	925.0	20	--	1	--	1	--	1	--
3/27/81	3.7	20	70	3	20	6	20	3	10
8/1/79	0.3	6	--	ND	--	2	--	2	--
8/30/83	20.0	9	50	1	40	1	10	1	2
8/27/84	22.0	6	120	1	50	1	60	1	1
8/11/88	15.0	3	100	5	40	1	30	1	5
9/10/80	0.5	10	40	2	40	2	20	4	16
9/1/81	0.3	40	120	5	110	2	100	2	7
9/8/82	2.8	30	70	1	60	5	10	2	3
9/11/85	20.0	10	190	1	300	1	100	1	7
ALL DATA									
AVG	688.7	25	154	3.8	157	2.3	52	1.6	6.3
COV	2.78	1.78	1.36	1.63	1.76	0.61	0.99	0.52	0.65
WINTER									
AVG	1292.0	34	232	5.0	248	2.7	58	1.6	6.8
COV	1.96	1.74	1.39	1.62	1.70	0.53	1.18	0.47	0.39
SUMMER									
AVG	10.1	14	99	2.3	91	1.9	47	1.8	5.9
COV	0.99	0.93	0.52	0.83	1.04	0.72	0.85	0.59	0.86

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STATION 11 169000 GUADALUPE RIVER

GROUP #2 - NOT ENVIRONMENTALLY SIGNIFICANT

DATE	FLOW CFS	FE sediment ug/gm	Mn dissolved ug/l	Mn sediment ug/gm	Al dissolved ug/l	Al sediment ug/gm	Cb sediment ug/gm
1/17/79	52.0	--	4	--	10	--	--
1/5/82	943.0	16000	20	330	40	9500	20
1/27/83	1540.0	7000	10	350	120	3900	20
1/28/88	24.0	- -	10	- -	10		- -
2/19/80	7900.0	13000	10	400	60	700	30
2/9/85	116.0	30000	8	500	20	12000	20
2/13/86	124.0	--	5	--	10	--	--
2/24/86	925.0	--	10	--	40	--	--
3/27/81	3.7	7500	20	190	20	4200	20
8/1/79	0.3	--	30	--	50	--	--
8/30/83	20.0	6500	12	200	10	3500	10
8/27/84	22.0	22000	10	390	10	9300	20
8/11/88	15.0	13000	9	370	10		<50
9/10/80	0.5	10000	0	540	10	3100	30
9/1/81	0.3	16000	0	310	10	5000	20
9/8/82	2.8	4500	20	150	10	49000	<10
9/11/85	20.0	21000	20	660	10	12000	20
ALL DATA							
AVG	688.7	13,875	12	366	26	10,200	21
COV	2.78	0.55	0.69	0.41	1.10	1.32	0.27
WINTER							
AVG	1292.0	14,700	11	354	37	6,060	22
COV	1.96	0.64	0.53	0.32	0.97	0.76	0.20
SUMMER							
AVG	10.1	13,286	13	374	15	13,650	20
COV	0.99	0.51	0.82	0.48	0.94	1.29	0.35

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STATION 11 169000 GUADALUPE RIVER

GROUP #3 - BELOW DETECTION LIMIT

DATE	FLOW CFS	Ni dissolved ug/l	Cr dissolved ug/l	Cr sediment ug/gm	Cd dissolved ug/l	Cd sediment ug/gm	Hg dissolved ug/l	Hg sediment ug/gm	Se dissolved ug/l	Se sediment ug/gm
1/17/79	52.0	ND	ND	--	2	--	<0.1	--	--	--
1/5/82	943.0	<100	<10	60	1	1	<0.1	1.7	--	<1
1/27/83	1540.0	<100	<10	30	<1	1	<0.1	3.5	--	<1
1/28/88	24.0	<1	<1	- -	<1	- -	<.1	- -	1	- -
2/19/80	7900.0	0	0	50	0	2	0	1.7	--	0
2/9/85	116.0	<100	<10	90	<1	<1	<0.1	0.3	<1	<1
2/13/86	124.0	<100	<10	--	<1	--	<0.1	--	--	--
2/24/86	925.0	<100	<10	--	<1	--	<0.1	--	--	--
3/27/81	3.7	0	10	21	1	0	0	0.4	--	0
8/1/79	0.3	ND	ND	--	<2	--	<0.1	--	--	--
8/30/83	20.0	<100	<10	20	<1	<1	<0.1	0.03	--	<1
8/27/84	22.0	<100	<10	80	<1	<1	<0.1	0.9	--	<1
8/11/88	15.0	<1	2	50	<1	1	<.1	1.7	3	<1
9/10/80	0.5	0	0	43	0	2	0	10	--	0
9/1/81	0.3	0	0	50	0	<1	0	0.36	--	0
9/8/82	2.8	<100	<10	10	<1	<1	<0.1	0.08	--	<1
9/11/85	20.0	<100	--	740	1	0	<0.1	1.7	--	1

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APPENDIX G

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APPENDIX G
POINT SOURCE LOADS

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APPENDIX G
POINT SOURCE LOADS

G.1 WASTEWATER TREATMENT PLANT LOADS

Annual loads were estimated for the three Lower South Bay wastewater treatment plants (San Jose/Santa Clara, Sunnyvale, Palo Alto) based on self-monitoring data provided by the Regional Board for 1987 and 1988. The data, shown in Table G-1, give for each year the number of samples, the number of samples below the detection limit, the average concentration, and the load for each plant. The total annual load is then computed in the right-hand column. Loads were estimated using synoptic rather than average flow measurements. The mean annual flows for each treatment plant are also provided at the top of each table.

When the majority of samples are below detection, the estimated load is uncertain and conservative because the concentration was assumed to equal the detection limit, whereas the actual concentration is between zero and the detection limit. Comparisons with nonpoint source loads were made only for those constituents which were consistently measured at levels well above detection limits.

G.2 OTHER POINT SOURCES

There are a number of point source discharges to the area streams, operating under NPDES Permits. These are facilities which pump contaminated groundwater from the aquifer, subject it to treatment to remove contaminants, and then discharge to a stream, often via a storm drain. All of the identified discharges are upstream of the stream

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Table G-1. ESTIMATED ANNUAL LOADS FOR WASTEWATER TREATMENT PLANTS FOR 1987 AND 1988

	1987												
	PALO ALTO WWTP Qave=75.7 MGD				SAN JOSE SANTA CLARA WWTP Qave=121MGD				SUNNYVALE WWTP Qave=17.8MGD				
CONTAMINAN	NO. OF DATA POINTS	NO. OF BDL VALUES	AVE. CONC. (ug/l)	TOTAL ANNUAL LOAD (LB)	NO. OF DATA POINTS	NO. OF BDL VALUES	AVE. CONC. (ug/l)	TOTAL ANNUAL LOAD (LB)	NO. OF DATA POINTS	NO. OF BDL VALUES	AVE. CONC. (ug/l)	TOTAL ANNUAL LOAD (LB)	TOTAL LOAD (all plants LB)
ARSENIC	12	11	5	378	4	0	3	995	1	0	4	214	1,585*
CADMIUM	12	11	6	454	4	0	3	921	3	2	0	21	1,397*
CHROMIUM	12	4	7	532	4	0	4	1,401	48	2	8	252	2,185
COPPER	12	1	38	2,990	4	0	13	4,718	58	0	21	1,110	8,818
LEAD	10	2	12	918**	4	0	16	5,897	47	5	3	177	6,990**
MERCURY	12	8	1	39	4	4	0	111	-	-	-	0	++
NICKEL	12	1	20	1,589	4	0	25	8,906	48	0	25	1,335	11,810
SELENIUM	2	1	3	235	2	2	1	359	-	-	-	0	++
SILVER	11	1	11	830	4	0	2	553	48	5	1	70	1,452
ZINC	12	0	65	5,104	4	0	51	18,813	58	0	48	2,139	26,056
AMMONIA	12	0	1,800	140,911	12	0	1,800	509,720	12	0	3,300	176,916	807,547
CYANIDE	7	5	23	1,801	8	6	100	+	3	2	10	536	+
OIL & GREASE	12	0	800	62,627	12	0	700	258,002	12	0	1,700	91,130	411,758
PHENOLS	4	4	17	1,315	4	0	2	811	-	-	-	0	++

Note: For the estimation of the total annual loads, if the concentration was BDL (Below Detection limit), the value used to estimate the load was the detection limit, therefore the load estimate is a maximum.

* Load estimates subject to much uncertainty because most concentrations were BDL

** Total annual load for Palo Alto WWTP based on conc. from Jan-Oct (Nov and Dec were 100 ug/l, which appear to be unusually high

+ Load estimate not made because of unusually high detection limit (100 ug/l), at San Jose Santa Clara WWTP, and most concentrations were BDL

++ Total load for all plants not calculated because no data was reported from Sunnyvale WWTP

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Table G-1(continued). ESTIMATED ANNUAL LOADS FOR WASTEWATER TREATMENT PLANTS FOR 1987 AND 1988

	PALO ALTO WWTP Ave=7.5 MGD				SAN JOSE SANTA CLARA WWTP* Ave=110MGD				SUNNYVALE WWTP Ave=16 8MGD				
CONTAMINANT	NO OF DATA POINTS	NO OF BDL VALUES	AVE CONC (µg/l)	TOTAL ANNUAL LOAD (LB)	NO OF DATA POINTS	NO OF BDL VALUES	AVE CONC (µg/l)	TOTAL ANNUAL LOAD (LB)	NO OF DATA POINTS	NO OF BDL VALUES	AVE CONC (µg/l)	TOTAL ANNUAL LOAD (LB)	TOTAL LOAD (all plants LB)
ARSENIC	12	3	3	222	12	0	2	719	52	52	1	51	992*
CADMIUM	12	12	5	358	12	0	3	899	52	52	1	51	1,308*
CHROMIUM	12	2	7	501	12	0	4	1,330	52	52	3	138	1,969*
COPPER	12	1	31	2,219	12	0	13	4,601	52	0	17	870	7,690
LEAD	12	4	17	1,217	12	0	19	6,829	52	0	7	358	8,408
MERCURY	12	10	1	36	12	12	0	72	52	52	1	51	159*
NICKEL	12	6	15	1,074	12	0	29	10,424	52	0	24	1,228	12,726
SILVER	12	6	5	379	12	0	2	719	52	52	2	102	1,201*
ZINC	12	0	71	5,082	12	0	62	22,249	52	52	36	1,842	29,174*
NITRATE	12	0	15,000	1,073,741	12	0	19,700	7,090,900	49	0	9,900	501,505	8,656,146
TKN	12	0	2,200	157,482	12	0	2,700	970,479	25	0	7,600	388,923	1,516,883
PHOSPHATE	12	0	18,300	1,309,964	12	0	17,400	6,254,196	25	0	21,500	1,100,241	8,664,401
TSS	12	0	4,700	336,439	12	0	1,200	431,324	164	0	11,000	562,914	1,330,677
BOD	12	0	3,100	221,906	12	0	4,000	1,437,746	164	0	5,780	295,788	1,955,438
AMMONIA	12	0	1,400	100,216	12	0	1,500	539,155	54	0	3,500	179,109	818,480
CYANIDE	4	0	20	1,432	12	12	100	+	52	52	10	512	+
OIL & GREASE	11	0	700	50,108	12	0	700	251,606	50	9	3,000	150,120	459,841
PHENOLS	4	0	46	3,314	4	0	1	467	52	0	40	2,047	5,829

Note: For the estimation of the total annual loads, if the concentration was BDL (Below Detection limit), the value used to estimate the load was the detection limit, therefore the load estimate is a maximum.

* Load estimates subject to much uncertainty because most concentrations were BDL.

+ Load estimate not made because of unusually high detection limit (100 ug/l), at San Jose Santa Clara WWTP, and most concentrations were BDL.

++ Total load for all plants not calculated because no data was reported from Sunnyvale WWTP.

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monitoring stations used in the study, and would therefore influence the conditions at the station, primarily during dry weather periods.

As part of their permit requirements, these plants submit regular reports providing information on discharge quantity and quality. For this study, WCC obtained and reviewed these reports for each of the facilities which discharge, covering a substantial portion of 1987. This source was useful in establishing the approximate rate and total volume of discharge by these point sources. There are usually a large number of flow observations reported, and the degree of fluctuation between observations is nominal, so that the average that was computed for use in the load estimates is considered to provide a suitable indicator of the quantity of treated groundwater discharged to the streams.

Characterization of the quality of these discharges is a different matter. The principal constraint imposed by the data in the Permit reports is that the laboratory analyses performed examined only organic compounds (the pollutants of concern at these sites), and, following treatment, all concentrations reported (with isolated occasional exceptions) were below detection levels.

To address this limitation, the RWQCB requested the facilities involved to conduct a special supplementary survey to provide information on heavy metal levels in the discharge. Heavy metals are a normal component of urban runoff and this information would provide a common element to use for comparisons of sources. Results from the single sample analyzed by these special studies were reviewed, and the concentrations observed were combined with the discharge flows from the more comprehensive flow records, to compute estimates of the pollutant loads from the point sources.

These results are summarized by Table G-2. Facilities are organized by stream, and the discharge rate and concentrations of observed pollutants are listed. Copper and zinc are selected for load computations because

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TABLE G-2 SUMMARY OF POINT SOURCE POLLUTANT DISCHARGES

Wet Seas - days= 212 Oct - Apr
Dry Seas - days= 153 May-Sept

CALABAZAS STA S-1

PS Facility	Disch Q (gpm)	Disch Q (cfs)	Pollutant Conc µg/l Cu	Zn	other rep'td	Season Pollutant Load (lbs) WET (212 da) Cu	Zn	dry (153 da) Cu	Zn
1 Unocal	4	0.009		170	As 6 ; Se 9	0	1.7	0	1.2
2 Hewlett Packard	1.5	0.003			Se 5	0	0	0	0
3 Nat'l Semicond	75	0.167			org - approx 10	0	0	0	0
4 Intersil	0.64	0.001		134	-	0	0.2	0	0.2
5 Siemens	18.8	0.042	152	331	-	7.2	15.8	5.2	11.4
6 Signetics	201	0.448		60	-	0	30.5	0	22.0
PS Total	301	0.670	9.5	63		7.2	48.2	5.2	34.8

SUNNYVALE EAST STA S-2

PS Facility	Disch Q (gpm)	Disch Q (cfs)	Pollutant Conc µg/l Cu	Zn	other rep'td	Season Pollutant Load (lbs) WET (212 da) Cu	Zn	dry (153 da) Cu	Zn
1 Signetics	75	0.167		30		0	5.7	0	4.1
2 Signetics	85	0.189		60		0	12.9	0	9.3
3 Adv Micro	98	0.218			Pb 55; Ag 19; 245	0	0	0	0
4 TRW	26	0.058	5.5	35	-	0.4	2.3	0.3	1.7
PS Total	284	0.633	0.5	29		0.4	20.9	0.3	15.1

GUADALUPE STA S-3

PS Facility	Disch Q (gpm)	Disch Q (cfs)	Pollutant Conc µg/l Cu	Zn	other rep'td	Season Pollutant Load (lbs) WET (212 da) Cu	Zn	dry (153 da) Cu	Zn
1 IBM	1406	3.133		33	Se 6; org 1 to 30	0	117.5	0	84.8
2 Fairchild	1054	2.348			TCE 1.2	0	0	0	0
3 Lincoln Prop	250	0.557	21	39	Se 4 ; As 1	13.3	24.7	9.6	17.8
PS Total	2710	6.038	2	21		13.3	142.2	9.6	102.6

COYOTE STA S-4

PS Facility	Disch Q (gpm)	Disch Q (cfs)	Pollutant Conc µg/l Ni	Zn	other rep'td	Season Pollutant Load (lbs) WET (212 da) Ni	Zn	dry (153 da) Ni	Zn
1 So Pacific Pipe	2400	5.347	130		Cd 13	790	0	570	0
2 SC Co Transit	0.1	0.000		90		0	0.023	0	0.016
PS Total	2400	5.347	130	0.004		790	0.023	570	0.016

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they are the only metals that appear to be present often enough to include in a watershed summary. Coyote Creek is a partial exception, in that nickel, rather than copper is present. Zinc appears to be the only heavy metal that is observed in most of the discharges.

The flows are assumed to be uniform throughout the year, and the mass loads computed from the listed flows and concentrations are shown for the wet and dry seasons. These results are presented for each discharge, as is the total for all the discharges upstream of each stream monitoring station. The concentrations shown for the PS total for the watershed are the flow weighted concentrations for the composite point source discharges above each station, which could be compared with the measured concentrations at the station. Chapter 8 of the report discusses the influence of the presence of pollutants from upstream point sources on the projections of loads from watersheds that do not contain such facilities.

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APPENDIX H

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APPENDIX H
ANALYSIS OF UNCERTAINTY IN LOAD ESTIMATES

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APPENDIX H
ANALYSIS OF UNCERTAINTY IN LOAD ESTIMATES

The annual nonpoint source load estimates presented in Section 8 were derived from simulated flows and measured concentration data. Because the exact values of flows and concentrations are not known, annual load estimates have some degree of uncertainty associated with them. In this appendix we describe and quantify this uncertainty, so that future decisions and analyses can be based on both the loads estimates and their associated confidence levels.

The sources of uncertainty in loads estimates are summarized and discussed in Section H.1. Section H.2 then presents the procedures used to quantify uncertainty. Section H.3 discusses the results of the quantitative uncertainty analysis in terms of confidence bounds on annual load estimates for the entire valley.

H.1 SOURCES OF UNCERTAINTY

For the purposes of this study, annual loads are estimated as the product of annual flow volume and mean concentrations for each land use. Thus, uncertainty in the load arises from (1) uncertainty in the estimate of flow from each watershed and land use, and (2) uncertainty in the estimate of mean concentrations for each land use.

H.1.1 Uncertainty in Flow Estimates

Storm runoff flow volumes were estimated in this study using the rainfall-runoff model SWMM, as described in Appendix B. In watersheds where flow data were available, the model was calibrated to match observed

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flow volumes. In watersheds where no flow data were available, the model was applied using input data from similar calibrated watersheds. The following factors contribute to uncertainty in flow estimates:

1. Model input parameters are not known exactly,

2. The model itself is an inexact representation of the actual hydrologic processes,

3. The measured flows used in calibration of the model are not exact.

Calibration of the model against observed flows attempts to minimize the first two components of flow uncertainty. However, as described in Appendix B it is not possible to arrive at a perfect calibration for any one watershed. Root Mean Square Errors (RMSEs) in annual load estimates generally ranged from 15 to 25 percent, but were as high as 40 percent in some watersheds. Errors in uncalibrated watersheds would be expected to be higher.

Even if the calibration resulted in a perfect match with observed flows, there would be some uncertainty associated with errors in flow measurements. The magnitude of these errors is currently unknown, but is assumed to be small relative to calibration errors in most watersheds. A possible exception to this is the Guadalupe River, where flow measurements were found to be inconsistent with reservoir release data (see Section 5.3.2 for a detailed discussion).

H.1.2 Uncertainty in the Mean Concentration

The annual mean concentrations for each land use and constituent were estimated from the sampling data collected during the 1987-88 and 1988-89 monitoring periods. The following factors contribute to the uncertainty in the estimated mean concentrations:

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1. Mean concentrations for each land use were estimated from a finite number of water quality samples (generally less than 25). Statistically, the degree of uncertainty in the mean decreases with large samples sizes, and increases as the sample variance increases. For industrial and open land uses, mean concentrations were estimated based on 5 or fewer samples.

2. Measured concentrations are subject to laboratory and field sampling errors. As discussed in Section C.4, laboratory QA/QC data indicated the data collected in this study are of good and reliable quality. Relative percent differences (RPDs) between field duplicates were on average 29 percent, and ranged from 0 to 100 percent. For laboratory duplicates, relative percent differences were on average 16 percent, and ranged from 0 to 40 percent.

3. Data collected during the 1987-88 and 1988-89 monitoring periods may not be representative of other years with higher rainfall. The monitoring period for this study unfortunately coincided with several years of drought in California. Thus, there is the concern that water quality in wet and normal years might differ significantly from data collected during dry years. As discussed in Section 8.6.4, dry years differ from wet years primarily in terms of the number of storms, not the volume of storms. Data collected during the monitoring period suggest little relationship between runoff volume, storm frequency, and concentration. However, buildup-washoff, water quality modeling results for Calabazas Creek (Appendix B) suggest that water quality is significantly different in wet years such as 1982-83 than in dry years such as the monitoring period. This component of uncertainty cannot be quantified until monitoring data are collected in wet years.

4. Land use concentrations were corrected by loads correction factors to compensate for differences between land use and stream station concentrations. As discussed in Section 8.6.2, the processes that might be explained by these loads correction factors are currently unknown. We

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believe that these factors probably account for processes occurring within the stream bed. This component of uncertainty cannot be quantified until more data are collected on stream processes and stream bed water quality.

H.2 PROCEDURES USED TO QUANTIFY UNCERTAINTY

For this analysis, uncertainty is quantified by deriving confidence bounds on annual loads estimates, given the uncertainty in flow and concentration. A first-order, second moment approach is used, assuming that the distribution of load estimates for a given year can be described completely by the mean and variance of the estimates. Alternative methods for uncertainty analysis (e.g., Monte Carlo simulation) can give a more precise evaluation of uncertainty, but generally require more data and computational time than is practical for a modeling study of this scale.

The following sections describe the procedures and equations used in the analysis. Key assumptions include:

- Flow and concentration are assumed to be independent of each other.
- Uncertainty due to differences between water quality during the dry monitoring period and wetter years is not quantified, due to the lack of data. This component of uncertainty should be evaluated when wet-year water quality data are collected.
- Uncertainty due to stream bed processes is not evaluated, again due to lack of quantitative data on the effects of these processes.
- The mean and variance in flow estimates can be quantified using the model calibration errors, expressed as the ratio of observed to predicted annual flow volumes.

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- The distribution of load estimates can be described completely by the mean estimate and the variance in estimates.

- In deriving confidence bounds, the distribution of errors in loads estimates is assumed to be Log Normal.

H.2.1 Uncertainty in Loads from a Single Land Use in a Watershed

The estimate of annual load from a single land use within a watershed is computed from the following model:

$$L_{ij} = Q_{ij} \bar{C}_j \qquad \text{(H-1)}$$

where

L_{ij} = the estimated load for a given year from watershed i, land use j

Q_{ij} = the estimated flow volume from watershed i, land use j

$\bar{C}_j$ = the estimated mean concentration for land use j

Because Q_{ij} and Cm_j are not precisely known, the expected value (or mean estimate) of L_{ij} is estimated by correcting the estimated flow by the mean calibration error:

$$E[L_{ij}] = E[Q_{ij}]\, E[C_j] = (Q_{ij}\bar{e}_i)\bar{C}_j \qquad \text{(H-2)}$$

where

$E[\,]$ = expected value (or mean) of $[\,]$

$\bar{e}_i$ = the mean flow model calibration error for watershed i, expressed as the mean ratio of observed to predicted flows

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The variance of load estimates about this mean has two components. The first component, referred to as the intrinsic variance, accounts for the variability of flow and concentration estimates, assuming that the mean estimates of flow and concentration are known exactly:

$$\mathrm{Var}[L_{ij}]_{int} = (Q_{ij}\bar{e}_i)^2\mathrm{Var}[C_j] + \bar{C}_j^2\mathrm{Var}[Q_{ij}] + \mathrm{Var}[Q_{ij}]\mathrm{Var}[C_j] \quad \text{(H-3)}$$

where

$$\mathrm{Var}[\,] = \text{variance of } [\,] \quad \text{(H-4)}$$

The variance in C_j is simply the variance in the measured water quality samples for land use j, and accounts for both natural storm to storm variability and variability due to measurement (QA/QC) errors. The variance in Q_{ij} can be derived from the model calibration errors as follows:

$$\mathrm{Var}[Q_{ij}] = Q_{ij}^2\,\mathrm{Var}[e_i] \quad \text{(H-5)}$$

where e_i is the ratio of observed to predicted flows for watershed i.

The second component of the uncertainty in load estimates is the parametric variance. The parametric variance accounts for the fact that the mean estimates of flow and concentration are derived from limited data sets, and are therefore uncertain:

$$\mathrm{Var}[L_{ij}]_{par} = \mathrm{Var}[\,E[Q_{ij}]\,E[C_j]\,] \quad \text{(H-6)}$$

$$= (Q_{ij}\bar{e}_i)^2\mathrm{Var}[C_j]/n_c + \bar{C}m_j^2Q_{ij}^2\mathrm{Var}[e_i]/n_e + Q_{ij}^2\mathrm{Var}[e_i]\,\mathrm{Var}[C_j]/(n_e n_c)$$

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where

n_c = number of concentration data
n_e = number of years of data used to estimate the mean model error

The total variance in load estimates for a given year is then given by the sum of the intrinsic and parametric variances:

$$Var[L_{ij}] = Var[L_{ij}]_{int} + Var[L_{ij}]_{par} \quad \text{(H-7)}$$

H.2.2 Uncertainty in Annual Loads Estimates for the Entire Study Area

The expected value of annual load estimates for the study area in year t is the sum of the mean load estimates for each watershed and land use in year t:

$$E[L_t] = \Sigma_i \Sigma_j E[L_{ij}] \quad \text{(H-8)}$$

where

$E[L_t]$ = the expected value of the load estimate for the study area in year t

Similarly, the variance in the estimate of the total annual load is the sum of the variances of load from each watershed and land use:

$$Var[L_t] = \Sigma_i \Sigma_j Var[L_{ij}] \quad \text{(H-9)}$$

H.2.3 Uncertainty in the Mean Annual Load Estimate

The mean annual load is the mean of the annual loads for the 12 year simulation period, and is estimated as follows:

$$E[L] = \Sigma_t E[L_t] / n_t \quad \text{(H-10)}$$

where

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n_t = the number of years in the simulation period

The estimated mean is uncertain due to (1) the limited number of years of data used to estimate E[L], and (2) the parametric uncertainty in the mean estimates of flow and concentration. As a result, the variance in the mean annual load estimate is the sum of the sample variance of annual loads and the parametric variance:

$$Var[\ E[L]\ ] = \Sigma_t[(L_t - E[L])^2/(n_t-1) + Var[L_t]_{par}]/n_t \qquad (H\text{-}11)$$

H.2.4 Estimation of Confidence Bounds

The equations given above allow for the estimation of the mean estimate and the variance in estimates for (1) study area loads for any year t, and (2) the mean annual study area load. The next step in the analysis is to derive confidence bounds by assuming a distribution of estimates about the mean estimate. For this study, a log normal distribution of loads estimates was assumed. While there is no direct evidence that load estimates should be log normally distributed, this distribution is commonly observed in environmental data, and has the advantage of being bound by zero. Log normal distributions are described completely by the mean and variance.

H.2.5 Data Used in the Uncertainty Analysis

The uncertainty analysis described above requires (1) estimates of the flow model calibration errors, and (2) estimates of the mean and variance of concentrations for each land use and constituent.

Table H-1 summarizes the mean and variance of the model calibration error ratios (e_i) for each calibrated watershed. These were derived directly as the ratio of observed to predicted annual flow volumes for each calibration period. To quantify error ratios for uncalibrated watersheds, simulation experiments were conducted in which data from one calibrated

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Table H-1. SUMMARY OF FLOW CALIBRATION ERROR RATIOS FOR EACH WATERSHED

Watershed	Mean Error (em_1)	Variance of Errors	Number of Values
Coyote Creek	1.01	0.20*	6*
Guadalupe River	1.22	1.11	9
San Tomas Aq. Cr.	1.20	0.09	12
Saratoga Creek	1.02	0.20	10
Calabazas Creek	1.02	0.04	11
Sunnyvale East Ch.	1.10	0.03	11
Stevens Creek**	1.28	0.27	8
Ungaged Areas**	1.19	0.28	22

*Since only 1 year of calibration was available for Coyote Creek, the variance in error was estimated as the mean of the variances from the 6 other calibrated watersheds.

**Derived from simulation experiments on Sunnyvale East and San Tomas Aquinas Creek.

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watershed were used to simulate runoff from a second calibrated watershed. Thus, the second watershed was treated as if it were uncalibrated. For these experiments, Sunnyvale East Channel was simulated using Calabazas Creek model data, and San Tomas Aquinas Creek was simulated using Saratoga Creek data. The resulting error ratios are summarized in Table H-1.

The means and variances of concentrations for each land use were obtained from statistical analysis of the sampling data, as described in Section 6. Table H-2 summarizes these for each land use and constituent.

H.3 RESULTS OF THE UNCERTAINTY ANALYSIS

Results of the uncertainty analysis for total loads from the study area are presented here as confidence bounds about the estimated load. Confidence bounds define the region in which one believes the true estimate of load lies, at a given level of confidence. Thus, 90 percent confidence bounds define the bounds between which one is 90 percent certain that the true value lies. Narrow confidence bounds imply a low level of uncertainty in an estimate, while wide confidence bounds imply high uncertainty.

Table H-3 summarizes the 90 percent confidence bounds for the mean annual total load estimate for each chemical parameter. In general, the 90 percent bounds are about plus or minus 50 to 60 percent away from the mean estimate. The relative widths of the bounds vary little among the different chemical parameters.

Note that these confidence bounds account only for uncertainty in flow estimates and in mean concentration estimates for land uses. They do not account for possible differences in water quality between wet and dry years, nor do they account for possible stream bed processes.

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Table H-2 SUMMARY OF CONCENTRATION STATISTICS

LANDUSE TYPE	STATIONS	SEASON	Cadmium MEAN µg/l	median	CV	N	Chromium MEAN µg/l	median	CV	N	Copper MEAN µg/l	median	CV	N	Lead MEAN µg/l	median	CV	N	Nickel MEAN µg/l	median	CV	N	ZINC MEAN µg/l	median	CV	N
INDUSTRIAL	L2	WET	5.9	5.45	0.4	5	39.1	33.73	0.62	5	52.8	49.11	0.4	5	133.5	121.76	0.48	5	54.8	48.10	0.51	5	1471.3	1326	0.48	5
RESIDENTIAL/ COMMERCIAL	L1,L3,L4, L5,L8	WET	1.7	1.32	0.84	25	21.1	14.30	1.08	25	58.5	30.93	1.29	25	88.8	37.08	1.3	25	48.9	24.88	1.3	25	251.3	200	0.76	25
OPEN	L7	WET	0.6	0.43	0.98	5	10.8	7.92	0.77	5	8.8	7.37	0.7	5	4.8	2.45	1.3	5	10.4	11.21	1.3	5	10.8	7.98	0.76	5
RESERVOIRS	R1,8	DRY	0.3	0.24	0.72	6	8.7	4.90	0.91	6	6.3	5.87	0.4	6	1.8	1.76	0.4	6	6.3	5.53	1.12	6	8.8	6.77	0.63	6
STREAM	S1	WET	2.2	1.85	0.49	5	28.3	21.91	0.82	5	32.5	46.80	0.51	5	63.4	38.87	1.3	5	98.2	47.50	0.97	5	268.5	249	0.4	5
	S2	WET	2.3	1.98	0.84	7	41.7	25.44	1.3	7	68.1	42.15	1.3	7	84.5	38.33	1.3	7	81.8	31.57	1.3	7	336.9	268	0.81	7
	S3	WET	1.8	1.38	0.98	6	40.8	24.98	1.3	6	70.1	48.22	1.3	6	85.6	52.18	1.3	6	107.4	65.48	1.3	6	283.7	179	1.3	6
	S4	WET	3.2	2.18	1.05	6	45.2	34.81	0.83	6	65.6	53.01	0.73	6	82.6	53.26	1.17	6	88.5	75.45	0.84	6	263.8	174	1.13	6
STREAM	S1,S2, S3,S4	DRY	0.3	0.26	0.46	17	3.5	2.66	0.72	17	7.4	4.60	1.25	26	1.4	1.24	0.47	26	2.8	2.00	-	12	13.4	10	0.81	26

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Table H-2. SUMMARY OF CONCENTRATION STATISTICS (Concluded)

LANDUSE TYPE	STATIONS	SEASON	BOD MEAN mg/L	median	CV	N	NO3-N MEAN mg/L	median	CV	N	PO4-P MEAN mg/L	median	CV	N	TKN MEAN mg/L	median	CV	N	TSS MEAN mg/L	median	CV	N
INDUSTRIAL	L2	WET	12.7	11.8	0.4	5	0.8	0.5	0.41	2	1.0	0.7	0.4	2	1.0	1.8	0.4	4	151.7	134.1	0.53	5
RESIDENTIAL/ COMMERCIAL	L1,L3,L4, L5,L6	WET	10.0	8.3	0.67	25	0.7	0.6	0.4	6	0.7	0.3	0.4	6	2.1	1.8	0.61	20	76.1	65.8	0.58	24
OPEN	L7	WET	5.1	4.4	0.60	5	0.18			1	0.10			1	1.1	1.0	0.4	4	84.0	51.8	1.3	5
RESERVOIRS	R-1,6	DRY	5.1	4.4	0.50	5	0.3	0.2	1.03	5	0.3	0.1	0.4	6	1.0		-	1	48.7	20.5	1.3	3
STREAM	S1	WET	11.3	8.3	0.92	5	0.50		-	1	0.50		-	1	1.8	1.0	0.4	4	100.1	121.7	1.2	5
	S2	WET	17.3	11.8	1.07	6	0.51		-	1	0.00		-	1	2.1	1.8	0.4	3	234.2	142.8	1.3	6
	S3	WET	9.2	6.6	0.74	5	0.63		-	1	1.10		-	1	2.4	2.1	0.56	6	454.2	277.0	1.3	6
	S4	WET	10.8	7.0	0.95	5	0.50		-	2	0.73		-	2	1.5	1.4	0.4	5	240.3	208.3	0.67	5
STREAM	S1,S2, S3,S4	DRY	3.0	2.0	0.80	22	2.3	1.4	1.3	6	0.10		-	4	1.4	1.3	0.51	28	12.0	7.0	1.3	20

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Table H-3. SUMMARY OF 90 PERCENT CONFIDENCE BOUNDS FOR MEAN ANNUAL LOAD ESTIMATES

CHEMICAL PARAMETER	MEAN ANNUAL LOAD (1000 lbs)	90 PERCENT BOUNDS LOWER (1000 lbs)	90 PERCENT BOUNDS UPPER (1000 lbs)
Cadmium	0.51	0.3	0.77
Chromium	9.7	5.3	17.7
Copper	14.6	8.4	24
Lead	14.6	8.6	23.7
Nickel	20.6	11.5	35.6
Zinc	50	31.2	77
BOD	2,110	1,500	3,840
NO3-N	206	102	360
PO4-P	161	147	216
TKN	378	294	744
TSS	68,600	43,400	133,000

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As an example of how this information can be interpreted, the estimated mean annual copper loading is 14,600 lbs. Uncertainty results indicate that we can be 50 percent certain the actual mean annual load is between 11,500 and 17,600 lbs. We can be 90 percent certain the actual mean annual load is between 8400 and 24,000 lbs.

As an indication of how uncertainty varies year to year, Figure H-1 presents the confidence bounds about the estimated annual copper load for each of the twelve simulated years. As would be expected, confidence bounds tend to be wider for individual years than they are for the mean (i.e., we are more certain about the mean of the 12 annual load estimates than we are of any one year's load). 90 percent bounds are about plus or minus 95 percent away from the estimated value.

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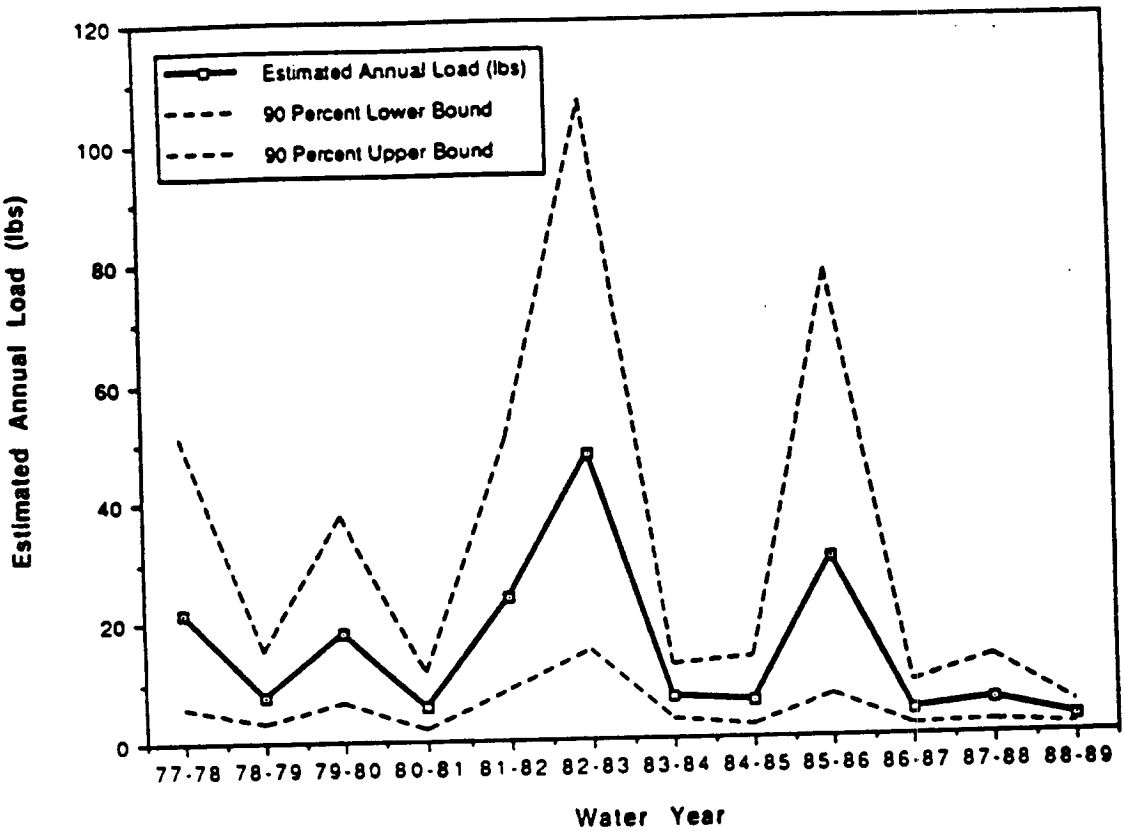

Figure H-1. 90 Percent Confidence Bounds on Annual Copper Loads

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ORANGE COUNTY
NPDES STORMWATER PERMIT PROGRAM

PROPOSED WATER QUALITY MONITORING PROGRAMS FOR THE ORANGE COUNTY STORMWATER SYSTEM AND RECEIVING WATERS

FEBRUARY 20, 1991

Submitted to the San Diego and Santa Ana
Regional Water Quality Control Boards
in Compliance with NPDES
Stormwater and Urban Runoff Permits
CA 0108740 and CA 8000180

A COOPERATIVE PROJECT OF THE ORANGE COUNTY FLOOD CONTROL DISTRICT, THE COUNTY OF ORANGE, AND ITS TWENTY-NINE INCORPORATED CITIES

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Executive Summary

The following report was prepared in response to the requirements contained in Stormwater and Urban Runoff Permits issued to the County of Orange and its incorporated cities. These permits, prepared by the Santa Ana and San Diego Regional Water Quality Control Boards, require that proposals for water quality monitoring programs be submitted to the Boards by November 30, 1990.

The proposed monitoring program for storm channels and receiving waters consists of field screening (channels only); dry-weather, flow-composite, sampling; and storm sampling.

Field screening will be used to detect gross contamination which may be indicative of illegal disposal of pollutants. Monitoring locations were sited on channels which have drainage areas greater then one square mile or which have industrial (manufacturing) land uses in the drainage areas. Reports exhibiting elevated concentrations of field-screened constituents will be referred to the EMA Water Pollution Section for further investigation.

Data from dry-weather and storm sampling will be used to estimate the total annual volume of contaminants discharged by each monitored channel. These monitoring locations will be in channels which are identified in the permits as "Waters of the State", or will be in major tributaries to "Waters of the State".

Storm monitoring of channels will also be used to evaluate the level of contamination during and after storm events. Samples will be analyzed from the first 3 hours of the storm (first flush), the next 21 hours, and from two consecutive 36 hour periods (after the first day). These data will be used to compute four-day average, contaminent concentrations.

The receiving water monitoring program includes stations in the Huntington Harbour; Sunset, Anaheim, and Bolsa Bays; Upper and Lower Newport Bays; and Dana Point Harbor. These stations will also be monitored during and subsequent to storms for the same contaminents as in the channel monitoring program.

In the channel and receiving water monitoring programs semiannual sampling of bed sediment will also be conducted to determine the chronic effects of stormwater runoff.

The permits are renewable and have a term of five years. They were issued in July of 1990. The water quality monitoring programs will be initiated in January of 1991. The FY 1990/91 labor requirement will be 3432 hours ($88,200). Equipment expenditures will be $33,000 and analytical costs will be $100,300. Total first year costs are estimated at $221,500. Annual costs in the four subsequent years (adjusted for cost of living) will include 5424 labor hours ($146,900 - $170,000), averages of $65,100 for equipment and $255,900 for analytical services. Annual totals are projected to be between $436,800 and $516,100.

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3.0 Introduction

To comply with Order Nos. 90-71 (NPDES No. CA 8000180) and 90-38 (NPDES No. CA 0108740), Stormwater and Urban Runoff Management Permits issued by the Santa Ana and San Diego California Regional Water Quality Control Boards (RWQCB), the following water quality monitoring program is proposed.

The water quality monitoring will be conducted by the County of Orange Environmental Management Agency (EMA) by the authority granted by California Assembly Bill No. 3664 which amended the Orange County Flood Control Act. The ammended Act gives EMA (formerly the Orange County Flood Control District) the legal authority to "carry on technical and other investigations, examinations, or tests of all kinds, making measurements, collecting data, and making analyses, studies, and inspections pertaining to water supply, control of floods, use of water, water quality, nuisance, pollution, waste, and contamination of water both within and without the District."

The monitoring program will be funded through a cooperative agreement (Stormwater Permit Implementation Agreement) between the County and its incorporated cities.

This program was prepared with the following considerations:

1. Program objectives established in the permit;
2. Funding available for personnel, equipment and analytical services;
3. Present and proposed equipment and staffing;
4. Safety during storm monitoring;
5. Existing data;
6. Historical annual frequency of representative storms; and
7. Tidal influences on the collection of representative samples.

The proposals for Receiving Water and Stormwater System Monitoring Programs have been combined in this document.

A description of the present, channel and receiving water monitoring programs maintained by EMA is included in Appendix 1.

4.0 Objectives

The objectives of the monitoring program as stated in the Santa Ana RWQCB Permit are:

a. To define the type, magnitude (concentration and mass load*) and sources of pollutants in the stormwater system discharges within each permittees respective jurisdiction so that appropriate pollution prevention and correction measures can be identified;

b. To evaluate the effectiveness of pollution prevention and correction measures; and

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c. To evaluate the compliance with water quality objectives established for the stormwater system or its components.

In addition, it is proposed that the program assess the impacts of selected, permitted, NPDES discharges on the discharges of the Municipal Separate Storm Sewer System. These NPDES discharges include the runoff from nurseries in the San Diego Creek watershed. Information gathered during the life of the permit (FYs 90-95) will be used in developing future monitoring programs.

4.1 Discussion

Objective a.

To define the mass load of pollutants from the stormwater system will be a substantial undertaking. The degree of accuracy in determining this quantity will be a function of the available equipment, manpower and funds (for analytical services). The program will concentrate on the major regional* facilities which discharge directly to large receiving water bodies (Pacific Ocean; Huntington Harbour/Sunset, Anaheim and Bolsa Bays; Upper Newport Bay; Dana Point Harbor; Santa Ana and San Gabriel Rivers; and San Juan Creek).

To calculate the mass load from major regional facilities will require a representative sampling of these outfalls throughout the year. This representative sampling entails flow-weighted* automatic sample collection during storms and the dry season. Equipment required includes automatic wastewater samplers with toxics (synthetic organic compounds) sampling capabilities and continuous water discharge recorders. The proposed monitoring program reflects the current and proposed availability of this required equipment.

To assist in the development of the appropriate pollution prevention and correction measures (generally water pollution enforcement activities) a field screening program is proposed. This program will detect gross contamination by illegal/illicit* connections.

Objective b.

To assume that the water quality benefit from each Best Management Practice (BMP) could be measured by water quality monitoring is very presumptuous. The only BMPs which may result in any statistically significant change in water quality would be water quality structures (eg. basins; water quality benefit would be determined by monitoring the quality of inflow and outflow) or the elimination (through enforcement activities) of a significant (high mass load relative to ambient) illegal/illicit connection. The San Diego Creek Sediment Monitoring Program, a cooperative project of the County of Orange, the Irvine Company and the cities of Irvine, Tustin and Newport Beach, assesses the sediment trapping efficiency of in-channel basins in San Diego Creek. Much of the contaminants found in stormwater discharge are adsorbed onto the finer sediments.

Assessing the effectiveness of some BMP programs can be conducted by monitoring the volume of collected material (recycled oil, street sweepings etc.) which may have otherwise entered the storm sewer system. This

* terms marked with an asterisk are defined in Section 13.0

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assessment approach will be developed in subsequent compliance program documents.

The proposed water quality monitoring program is designed to identify trends in the receiving water quality which result from the entire BMP program.

Objective c.

Both Regional Boards have adopted as a general objective, the State Water Resources Control Board Resolution No. 68-16, the policy of nondegradation of the waters of the state of California. In this resolution it is stated, "WHEREAS the California Legislature has declared that it is the policy of the State that the granting of permits and licenses for unappropriated water and the disposal of wastes into the waters of the state shall be so regulated as to achieve highest water quality consistent with maximum benefit to the people of the State and shall be controlled so as to promote the peace, health, safety and welfare of the people of the State; and ..."

Water quality objectives (limiting concentrations) have been adopted by each RWQCB, in their respective Basin Plans, to protect the waters with specific beneficial uses. Most of these objectives are applicable only to waters designated as Municipal Water Supply (MUN) and would not be appropriate for channels which are primarily stormwater conveyances. Other objectives were developed to protect freshwater and marine habitats.

The monitoring program for the Stormwater Permit should only evaluate the types of contamination which significantly effect the existing or intended beneficial uses of the receiving waters*. The following is a list of chemical characteristics which were considered in developing the monitoring programs.

1. Biostimulatory substances (compounds of nitrogen and phosphorus) can lead to nuisance growths of plants and algae.

2. The illegal introduction of acidic or alkaline substances to the stormdrain system can alter the pH and create chronic or acute toxicity problems for the indigenous biota.

3. Discharges of waters with high temperature can be harmful or lethal to aquatic life in the receiving water.

4. Unionized ammonia* can be toxic to aquatic life. The concentration of this contaminent is a function of the pH and the temperature.

5. Depressed dissolved oxygen levels can result from inputs of substances which impart a high biochemical (BOD) or chemical (COD) oxygen demand on the receiving waters. Stormwaters typically have elevated BODs and CODs.

6. Trace elements* at high concentrations can be toxic to aquatic life. These can be introduced into the system by illegal discharges from plating or integrated circuit board companies.

7. The toxicity of trace elements is inversely proportional to the hardness*.

8. PCBs, organochlorine pesticides and herbicides (PHP)* are toxic to aquatic life and have been detected in several channels and receiving

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waters in the the Toxic Substance Monitoring Program (TSMP) and the State Mussel Watch Program (SMW).

9. Many organic and inorganic contaminants are adsorbed onto settleable and suspended solids. Settleable solids can deposit in the receiving waters reducing circulation and impacting navigation. Contaminated settleable solids introduce toxics at the bottom of the food chain. These toxic compounds can be concentrated at higher levels of the food chain.

5.0 Equipment Inventory

The County's Environmental Resources Division currently maintains a large inventory of water quality and hydrographic monitoring equipment. These include automatic wastewater samplers, portable and laboratory diagnostic equipment, fluvial* and bed sediment samplers, streamgages, a fleet of vehicles, and a boat. Table 1a is a list of the laboratory and transportable field equipment. Table 1b is a list of the equipment currently in the field at streamgaging stations near the proposed sampling locations. This hydrographic monitoring equipment includes water level sensors (mechanical floats or manometers), graphic analog recorders, and transmitting dataloggers. The information is transmitted (by radio frequency) to the County's ALERT Flood Warning System. The system is capable of converting the water level information into discharge rates so that flow compositing of discrete samples can be conducted in the laboratory.

Flow-weighting* of composite samples will be dependent on the availability of necessary equipment and the desired analyses. To collect samples for full-spectrum analyses (organic and inorganic), the wetted components of the automatic sampler must be composed of inert materials. Presently EMA has two such samplers (ISCO 2700) and will order three more (ISCO 3700) in FY 1990/91. These new samplers will be used to replace the oldest samplers in the current inventory. The Model 3700 allows a more accurate flow compositing (when integrated with a flowmeter) because it is capable of mainteining a uniform sample volume whereas the model 2700 (operates on a timed collection cycle; sample volume is influenced by the level of water in the channel) does not.

The current sampler inventory also includes seven older model ISCO samplers (1680) which have only inorganic sampling capabilities (nutrients and trace elements). These also can be integrated with a flowmeter to obtain a reasonable, flow-weighted sample. A Manning Model 4500T automatic sampler is also available. This unit can collect representative samples which are high in suspended or settleable solids. Its vacuum collection system (versus ISCO's peristaltic* pump) provides a higher sample transport velocity with less settling of solids in the collection line. The model 4500T also can ensure uniform sample volumes but does not have toxics (organic) monitoring capability. In order to collect flow-weighted composites, it will require a compatible flowmeter or it will be utilized in channels with continuous water level recorders.

Future equipment purchases will include automatic samplers (with full spectrum sampling capability) and compatible flowmeters. Ten samplers with flowmeters will be ordered during FY 91/92. Five additional samplers with compatible flowmeters will be ordered in FY 92/93 to replace the remaining ISCO model 1680s.

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Table 1a Equipment Inventory

Item No.	Quant.	Equipment	Function	Notes
1	1	ISCO Model 1392 Wastewater Sampler	Automatic sampling of nutrients and trace elements	To be retired when 1990 equipment is received
2	7	ISCO Model 1680 Wastewater Sampler	Same as above	No toxics monitoring capability
3	2	ISCO Model 2700 Wastewater Sampler	Automatic sampling of complete range of substances	Non-uniform sample volumes
4	3	ISCO Model 3700 Wastewater Sampler	Same as above with uniform volume collection	Will be ordered before 1/91
5	5	ISCO 3200 Series Portable Flowmeters	Continuous water level monitoring and flow-comp.	Will be ordered before 1/91
6	1	Manning Model 4500T Wastewater Sampler	Automatic sampling of water with high suspended solids	No toxics capability; req. compatible flowmeter
7	2	Hydrolab Surveyor II with datalogger	Multiparameter oceanographic probe	Dissolved oxygen, pH, temperature, conductivity
8	1	ISCO Model 1392 Pump Head	Depth sampling	
9	3	YSI Model 518 Dissolved Oxygen Meter	Field monitoring	Analog readout, temperature compensating
10	1	YSI Model 53 Dissolved Oxygen Meter	Same as above	Digital readout, temperature compensating
11	3	YSI Model 33 S-C-T Conductivity Meter	Same as above	Non temperature compensating; Will be replaced in FY 91/92
12	1	Amber Science Conductivity Meter	Same as above	Temperature compensating to 25C
13	2	Beckman Model 21 pH Meter	Same as above	
14	1	Ekman Petite Ponar Sediment Sampler	Sampling of bottom material	
15	1	8" LaMotte Limnological Secchi Disk	Field turbidity measurement	Will order oceanographic model in FY 90/91
16	1	Kemmerer 2L Depth Sampler	Subsurface sampling	

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Table 1a Equipment Inventory

Item No.	Quant.	Equipment	Function	Notes
17	1	Sierra Misco Remote Dissolved Oxygen Sensor	Continuous dissolved oxygen monitoring	
18	1	Dodge Ram Van	Sampling vehicle, boat towing	Will be replaced in FY 92/93
19	1	GMC Jimmy 4X4	Same as above	
20	1	Chevrolet K-5 Blazer	Sampling vehicle	Will be replaced in FY 92/93
21	1	GMC Utility Body Pickup	Hydrographic monitoring	
22	1	15' Boston Whaler with 35HP Outboard Engine	Herbor, bay and reservoir monitoring	
23	1	Perkin Elmer Model 30308 AA Spectrophotometer	Trace element analyses	For samples req. immediate analysis for enforcement
24	1	Orion Model 900 Ionanalyzer	pH and specific ion analyses	
25	1	Micromeritics Sedigraph Model 5200	Particle size distribution of fluvial sediment samples	For silt clay fractions
26	1	Visual Accumulation Tube	Same as above	For sand less than 1 mm
27	3	Montedoro Whitney PVH-2A Velocity Flow Meter	Field discharge measurements	
28	2	Rickly Hydrological 4-wheel base cranes	Hydrographic monitoring and fluvial sediment collection	with Scientific Instruments 8-56 sounding reels
29	4	Depth Integrating Sediment Samplers	Fluvial sediment sample collection	

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Table 1b Continuous Water Level Recording Stations

Channel Name	Streamgage Location	Present Equipment Status	Notes
1 Bolsa Chica Channel	at Westminster Avenue	FS / A-71 / ATB / ATDL	
2 Anaheim Barber City Channel	at Rancho Road	HgM / A-71 / ATB / ATDL	
3 Westminster Channel	d/s Beach Boulevard	FS / A-71 / ATB / ATDL	Sampled at McFadden Ave.
4 East Garden Grove-Wintersburg Channel	at Gothard Street	FS / A-35 / ATB / ATDL	Sampled at Goldenwest St.
5 Santa Ana River	at Imperial Highway	HgM / A-35 / ATB / AT	
6 Santa Ana River	at Fifth Street	HgM / A-71	operated by USGS
7 Santiago Creek	at Bristol Street	HgM / A-71 / ATB / ATDL	operated by USGS
8 Santa Ana-Delhi Channel	at Irvine Avenue	FDWG / A-71 / ATB / ATDL	
9 San Diego Creek	at Culver Drive	FDWG / A-71 / ATB / ATDL	
10 San Diego Creek	at Campus Drive	FDWG / A-71 / ATB / ATDL	
11 Peters Canyon Wash	at Barranca Parkway	FS / A-71 / ATB / ATDL	
12 Laguna Canyon Channel	at Woodland Avenue	FS / A-71 / ATB / ATDL	Infrared transmitter/repeater
13 Aliso Creek	u/s PCH	HgM / A-71	Impacted by shifting sand
14 San Juan Creek	at La Novia	HgM / A-71 / ATB / AT	
15 Trabuco Creek	at Camino Capistrano	FS / 2A-35 / AT	
16 Oso Creek	at Crown Valley Parkway	FS / A-71 / ATB / ATDL	will be impacted by const.

FS - Float level sensor
HgM - Leopold Stevens or Scientific Instruments Mercury manometer
FDWG - Fluid Data Watergage
A-35 - Leopold Stevens A-35 continuous water level stripchart recorder
A-71 - Leopold Stevens A-71 continuous water level stripchart recorder
2A-35 - Leopold Stevens dual pen, continuous water level stripchart recorder
ATB - ALERT tipping bucket raingage
AT - ALERT transmitter
ATDL - ALERT transmitter with datalogger

6.0 Field Screening Program

This program is designed to detect gross contamination of regional flood control facilities by illegal/illicit discharges. It will consist of 1 dry season (2 samplings at least 4 hours apart) and one storm sampling of the facilities listed in Table 2. A map with these locations can be found in the Appendices. The criteria for channel selection were drainage area size and/or presence of industrial land uses in the corresponding watershed. Those channels with drainage areas greater than one square mile, and smaller conduits with industrialized watersheds are included. Also included are retention/detention basins with detention times greater than 24 hours.

The monitoring parameters will be those listed on the attached Field Screening Information sheet (Figure 1). This information includes channel configuration, discharge rate (measured if pollution observed; otherwise estimated), instrumental determinations of physical conditions, visual and olafectory observations, and field chemical analyses. This list of information was developed from the draft federal regulations. The chemical analyses will be used as indicators of swimming pool (chlorine residual), illegal construction dewatering (total suspended and settleable solids), printed circuit board (copper), plating (chromium, cyanides), plastics manufacturing and sewer line (phenols) discharges.

A sample for Chemical Oxygen Demand (COD) will be collected and analyzed at the Environmental Resources Laboratory. Samples will also be collected for "laboratory" analyses if high silt-clay turbidity or foam is observed.

The in-situ chemical analyses will be performed with a field uv-visible spectrophotometer* and pre-packaged, single analysis reagents. Samples will be vacuum filtered through a 0.45 micron glass fiber filter before analyses.

Information which indicates pollution will be referred to the Water Pollution Section of the Environmental Resources Division. If the source is determined to be continuous and non-point, followup sampling will be performed to assess the mass loading. Identified point sources will be issued a discharge permit by the Regional Board or be eliminated through enforcement.

The stations in the field screening program will be monitored each year according to the procedure outlined above. Additional channels will be added to the list if the land uses in the watersheds become industrial.

7.0 Channel Monitoring Program

The proposed channel monitoring program includes the streamcourses also identified in the permits as receiving waters. In addition to these receiving water channels, five stations in the Huntington Harbour watershed, five stations in the Upper Newport Bay watershed and two quality control stations are included in the program. Table 3 is a list of the proposed locations. The sites can also be found on the map in the Appendices.

7.1 Monitoring Locations

The rationale for selection of these monitoring locations included the existence of prior monitoring data; the proximity of existing, continuous discharge monitoring locations; and general compliance to the lists of "Waters of the State" in the permits. The additional stations were chosen because they

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Table 2 Field Screening Locations

No.	Channel Name	EMA Fac. Number	Sampling Site Location	Cities in Drainage Area	Thom. Bros. Map Page
1	Coyote Creek	A01	at Euclid Ave.	Br,LH	2-A5
2	Coyote Creek	A01	u/s A03 confluence	BP,Br,LH	4-E6
3	Brea Creek	A02	at Western Ave.	Br,Ful,LH	5-B5
4	Fullerton Creek	A03	at Valley View St.	BP,Ful	9-E1
5	Brea Canyon Channel	A04	at Puente	Br	6-C1
6	Loftus Diversion Channel	A06	at Imperial Hwy.	Br,Ful	7-A1
7	Imperial Channel	A07	at Imperial Hwy.	Br,Ful,LH	1-F6
8	La Mirada Creek	A08	at La Habra Blvd.	LH	1-D4
9	Tonner Canyon Channel	A09	u/s A04 confluence	Co	3-A3
10	Carbon Creek Channel	B01	at Bloomfield St.	Ana,BP,Cyp	9-C6
11	Carbon Creek Channel	B01	at Placentia Ave.	Ana,Pla,YL	12-A1
12	Carbon Creek Channel	B01	at East St.	Ana,Ful,Pla,YL	11-E1
13	Carbon Creek Channel	B01	at Brookhurst St.	Ana,Ful,Pla,YL	10-F3
14	Placentia Storm Channel	B01S03	at Orangethorpe Ave.	Ful,Pla	12-A1
15	Moody Creek Channel	B02	u/s A01 confluence	BP,Cyp,LP	9-C4
16	Los Alamitos Channel	C01	at Westminster Ave.	LA,SS	19-C6
17	Los Alamitos Basin	C01B02	at Westminster Ave.	LA Co,SS	19-E1
18	Bolsa Chica Channel	C02	at Westminster Blvd.	LA,SS,Wes	14-D6
19	Stanton Storm Channel	C02S01	at Valley View St.	Cyp,Stn	14-F2
20	Jonathan Storm Channel	C02S03	at Valley View St.	Cyp	14-F1
21	Anaheim-Barber City Channel	C03	at Rancho Rd.	Ana,GG,HB,Wes	20-E1
22	Humbolt Storm Channel	C03S02	at Springdale St.	Wes	14-F6
23	Westminster Channel	C04	at McFadden Ave.	GG,HB,Wes	20-F3
24	E. Garden Grove Wintersburg	C05	at Goldenwest Ave.	Ana,GG,HB,Wes	21-B5
25	West Street Basin	C05B01	at West & Chapman	GG	16-C3
26	Hester Basin	C05B02	at Hester & Lampson	Ana,GG,Or	16-D4
27	Ocean View Channel	C06	at Beach Blvd.	FV	21-C5
28	Greenville Banning Channel	D03	at Sunflower	SA	28-A2
29	Greenville Banning Channel	D03	at Hamilton Ave.	SA,CH	27-A6
30	Fairview Channel	D04	u/s D03 Confluence	CH	27-A5
31	Fountain Valley Channel	D05	at Bushard Ave.	FV,HB	26-E3
32	Carbon Canyon Diversion Ch.	E02	at SA River	Ana	12-C3
33	Miller Basin	E02B01	at Miller & Orangethorpe	Ana,YL	7-C6
34	Carbon Creek Channel	E03	at Chapman Ave.	Pla	7-C5
35	Richfield Channel	E05	u/s E04 confluence	Pla,YL	7-D6
36	Esperanza Channel	E06	at Esperanza Rd.	YL	8-E5
37	Collins Channel	E07	at SA River	Or	17-B1
38	Santiago Creek Channel	E08	at Bristol St.	Or,SA,VP	16-F5
39	Villa Park Dam	E08D01	at Lolita St.	Co	13-E6
40	Gypsum Creek Channel	E09	u/s Owl Rock Concrete	Co	43-C2
41	Bitterbush Channel	E11	at SA River	Or	17-A3
42	Southeast Anaheim Channel	E12	at SA River	Ana,Or	16-F3
43	Santa Ana-Delhi Channel	F01	at Sunflower	SA	22-D2
44	Santa Ana-Delhi Channel	F01	u/s F03 confluence	CH,SA	27-F4
45	Santa Ana-Delhi Channel	F01	at Mesa Dr.	CH,HB,SA	28-A6
46	Santa Ana Gardens Channel	F02	at Sunflower Ave.	SA	28-A2
47	Paularino Channel	F03	at Bristol St.	CH	27-F4

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Table 2 Field Screening Locations

No.	Channel Name	EMA Fac. Number	Sampling Site Location	Cities in Drainage Area	Thom. Bros. Map Page
48	Bonita Canyon Channel	F04	u/s F05 confluence	Irv	32-C1
49	San Diego Creek	F05	at Campus Dr.	Irv	28-D6
50	Peters Canyon Channel	F06	at Barranca Pkwy.	Irv,Tus	28-F2
51	El Modena-Irvine Channel	F07	at Michelle Dr.	Tus	24-B5
52	Lane Channel	F08	at Jamboree Rd.	Irv,SA	28-E4
53	Armstrong Storm Channel	F08S01	at Lane Channel	Irv	28-D3
54	Barranca Channel	F09	at Jamboree Rd.	Irv,Tus	28-E3
55	Santa Ana-Santa Fe Channel	F10	u/s F06 confluence	SA,Tus	29-B1
56	South West Tustin Channel	F11	at McFadden Ave.	SA	23-B4
57	North Tustin Channel	F12	at Holt Ave.	Co,Tus	24-A1
58	Rechill Channel	F13	at Irvine Blvd.	Co	24-B2
59	San Joaquin Channel	F14	u/s F05 confluence	Irv	28-E5
60	Sand Canyon Channel	F15	u/s F05 confluence	Irv	28-E6
61	Bee Canyon Channel	F17	at Irvine Center Dr.	Co,Irv	29-F6
62	Agua Chinon Channel	F18	at Irvine Center Dr.	Irv	51-A6
63	Serrano Creek Channel	F19	at Alton Pkwy.	Irv	29A-C1
64	Borrego Canyon Channel	F20	at Alton Pkwy.	Co,Fed,	51-B6
65	Canada Channel	F23	at Lake Forrest Rd.	Irv	29A-B3
66	Central Irvine Channel	F25	u/s F06 confluence	Co,Irv	24-C5
67	Rattlesnake Canyon Wash	F26	at Bryan Ave.	Co	24-C4
68	Hicks Canyon Wash	F27	at Culver Dr.	Co,Irv	24-E4
69	E. Costa Mesa Channel	G02	at Highland Ave.	CM,NB	31-E5
70	Santa Isabella Channel	G03	at Irvine Ave.	CM	31-F2
71	Big Canyon Wash	G04	at Jamboree Blvd.	NB	31-F4
72	Laguna Canyon Channel	I02	at Woodland Ave.	Co,LB	34-E1
73	Aliso Creek Channel	J01	at Aliso Creek Rd.	Co	29C-E6
74	Aliso Creek Channel	J01	at PCH	Co	35-A5
75	Sulphur Creek Channel	J03	at Laguna Niguel Park	Co	35-E2
76	Narco Channel	J04	at Aliso Creek Rd.	Co	29C-E6
77	English Canyon Channel	J07	at Los Alisos Blvd.	Co	29B-A4
78	Salt Creek Channel	K01	at PCH	DP	37-C3
79	San Juan Creek Channel	L01	at PCH	SJC	38-F4
80	San Juan Creek Channel	L01	at Hot Springs Canyon Rd.	Co	63-B1
81	Trabuco Creek Channel	L02	at Camino Capistrano	Co,SJC	36-B3
82	Trabuco Creek Channel	L02	at Trabuco Creek Rd.	Co	56-58-E5
83	Oso Creek Channel	L03	at Crown Valley Pkwy.	MV	29D-B5
84	Oso Creek Channel	L03	at Alicia Pkwy.	MV	29B-D4
85	La Paz Channel	L04	u/s L03 confluence	MV	29D-B3
86	Estrella Storm Drain	M00S01	at PCH	SC	38-C6
87	Marquita Storm Channel	M00S07	at Pacific Ocean	SC	39-C3
88	Prima Descheche Channel	M01	at El Camino Real	SC	39-A1
89	Segunda Descheche Channel	M02	at El Camino Real	SC	39-C2

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Figure 1

Field Screening Information

DATE:____/____/_____

CHANNEL NAME:_____ **EMA FACILITY NO.:**_____

SAMPLING LOCATION: u/s d/s _____

THOM BROS MAP PAGE:_____

DRAINAGE AREA: industrial/commercial/agricultural/other_____

CHANNEL CONFIGURATION: concrete, earthen, pipe, culvert, trapezoidal, vertical walled, rectangular box, gabion, grass lined, rip-rap, other_____

DIMENSIONS: CH WIDTH/PIPE DIAM_____ ft/in **AVE DEPTH:**_____ft/in

WEATHER: sunny, cloudy, windy, hot, cold, rain, fog, other_____

TIME:_____ **AIR TEMP:**_____C

FLOWRATE:_____cfs est/meas
pH:_____ **EC:**_____umhos/cm
DO:_____ppm **TEMP:**_____C
FLOATABLES: yes/no
DESCRIBE:_____
OIL SHEEN: yes/no
ODOR: yes/no
DESCRIBE:_____
TURBIDITY: yes/no/organic/ silt-clay **Sample #** _____
FOAM: yes/no **Sample #** _____
ALGAE: yes/no
AQUATIC LIFE: yes/no/stressed

TOTAL CHLORINE:_____mg/L
DISSOLVED Cu:_____mg/L
PHENOL:_____mg/L
Sample #:_____
DISSOLVED Cr^{6+}:_____mg/L
FREE CYANIDE:_____mg/L
COD SAMPLE #:_____
COD:_____mg/L

COMMENTS:_____

TIME:_____ **AIR TEMP:**_____C

FLOWRATE:_____cfs est/meas
pH:_____ **EC:**_____umhos/cm
DO:_____ppm **TEMP:**_____C
FLOATABLES: yes/no
DESCRIBE:_____
OIL SHEEN: yes/no
ODOR: yes/no
DESCRIBE:_____
TURBIDITY: yes/no/organic/ silt-clay **Sample #** _____
FOAM: yes/no **Sample #** _____
ALGAE: yes/no
AQUATIC LIFE: yes/no/stressed

TOTAL CHLORINE:_____mg/L
DISSOLVED Cu:_____mg/L
PHENOL:_____mg/L
Sample #:_____
DISSOLVED Cr^{6+}:_____mg/L
FREE CYANIDE:_____mg/L
COD SAMPLE #:_____
COD:_____mg/L

COMMENTS:_____

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Table 3 Channel Monitoring Locations

Huntington Harbour/Anaheim, Sunset, Bolsa Bay Watershed

##	Station	STORET Code	Location
18	Bolsa Chica Channel *	BCC02	at Westminster Avenue
21	Anaheim Barber City Channel *	ABCC03	at Rancho Road
23	Westminster Channel *	WMCC04	at McFadden Avenue
24	E. Garden Grove-Wintersburg Channel *	EGWC05	at Goldenwest Street
A	Sunset Channel	SUNC07	at Seybrook Drive

Upper Newport Bay Watershed

##	Station	STORET Code	Location
45	Santa Ana-Delhi Channel *	SADF01	at Irvine Avenue
48	Bonita Canyon Channel B	BCF04	at San Diego Creek Conf.
B	San Diego Creek B*	WYLSED	at Culver Drive
49	San Diego Creek B*	SDHF05	at Campus Drive
50	Peters Canyon Wash B*	BARSED	at Barranca Parkway
52	Lane Channel	LANF08	at Jamboree Road
54	Barranca Channel	BRCF09	at Jamboree Road
60	Sand Canyon Channel B	SCCF15	at Culver Drive
61	Bee Canyon Channel B	BEEF17	at Irvine Center Drive
62	Aqua Chinon Wash B	ACWF18	at Irvine Center Drive
63	Serrano Creek B	SERF19	at Alton Parkway
67	Rattlesnake Canyon Wash B	RCWF26	at Alton Parkway
68	Hicks Canyon Wash B	HCWF27	at Bryan Avenue
69	Costa Mesa Channel	CMCG02	at Highland Avenue
70	Santa Isabella Channel	SICG03	at Irvine Avenue
71	Big Canyon Wash	BCWG04	at Back Bay Drive

South County Watershed

Station	STORET Code	Location
72 Laguna Canyon Channel B*	LCWI02	at Woodland Avenue
74 Aliso Creek Channel B*	ACJ01	u/s PCH
75 Sulphur Creek Channel B*	SCBJ03	d/s Sulphur Creek Dam
C San Juan Creek B*	SJCL01	at La Novia Avenue
80 San Juan Creek B	ONBL01	at Hot Springs Canyon Rd.
81 Trabuco Creek B*	TCOL02	at Camino Capistrano
83 Oso Creek B*	OSOL03	at Crown Valley Parkway
88 Prima Deschecha Channel B	PDCH01	at El Camino Real
89 Segunda Deschecha Channel B	SDCH02	at El Camino Real

Santa Ana River Watershed

Station	STORET Code	Location
D Santa Ana River B*	SARIMP	at Imperial Highway
E Santa Ana River B*	SARE01	at Fifth Street
38 Santiago Creek B*	SANE08	at Bristol Street
F Silverado Creek B	SILE17	at Silverado Canyon Road

B Identified as a water of the State in the Stormwater Permits
* Continously recording streamgage located nearby
Table 2 designation (See Location Map)
A-F Stations are not identified in Table 2 (See Location Map)

are tributary to "Waters of the State" and, in some instances (Lane and Serrance Channels), have exhibited (in the current monitoring program) higher than system average concentrations of heavy metals.

Two quality control stations (upper San Juan Creek and Silverado Creek) will also be monitored to establish "no or limited urban impact" conditions to which the urban channels can be compared. These channels have also been designated as "Waters of the State" in the Stormwater Permits.

7.2 Monitoring Parameters

The selection of monitoring parameters was based on the analyses of past data from EMA, the RWQCB-SAR Toxic Substance Monitoring Program (TSMP) for Huntington Beach Channels and the State Mussel Watch Program (SMW).

A voluminous amount of data has been collected during dry weather conditions. Both the TSMP and EMA data show that aqueous concentrations of organochlorine pesticides and trace metals (except for rare instances) have been low or below the detection limits of the laboratory. Sediment samples collected from the channel bottoms have exhibited higher relative concentrations of these contaminants. This is a logical observation since these contaminants tend to be adsorbed onto silt and clay particles which deposit onto the channel bottom when water velocities decrease after storms. Shellfish collected in the SMW have also shown bioaccumulation of these substances.

7.2.1 Dry-weather

The constituents monitored during dry weather conditions will include biostimulatory substances (nutrients*) which tend to be found in the dissolved form. This nutrient sampling will be conducted in channels which have historically produced high (>20 ppm as NO3) mean nitrate concentrations or are directly tributary to major waters of the state (Pacific Ocean, Sunset/Bolsa Bay, and Upper Newport Bay). These stations include those in the upper San Diego Creek watershed, San Juan Creek, Aliso Creek, Prima Deschecha, Segunda Deschecha, Bolsa Chica and East Garden Grove-Wintersburg Channels.

Stations which have exhibited high (relative to system average) dry-weather trace element concentrations, such as Lane and Serrance Channels in the San Diego Creek watershed, will be sampled for these contaminants.

Bed sediment sampling of channels, designated as waters of the state, will be used to assess the magnitude of pollutent (trace elements, PHP, Polynuclear Aromatic Hydrocarbons* [PAH]) deposition. PAHs include the byproducts of combustion (automotive emissions) and are washed into the system during storms. This sampling will also be conducted in Lane and Serrance Channels to evaluate the potential for pollutant discharges to San Diego Creek during high water velocities (scouring). Samples will be collected in specially prepared glass containers with teflon caps. The bed material will be sampled as close to midchannel as possible. This type of sampling however, will not be conducted in channels which are concrete-lined.

7.2.2 Storms

Storm monitoring will include collection of samples for nutrients and trace metals. The mean values of the storm data will be assumed representative of all storms for that channel. These mean values will be used in computing the

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annual mass pollutant load from those channels. During the first 24 hours of each monitored storm samples will be collected for both nutrients and trace metals.

Two additional samples from the subsequent 72 hour period will also be analyzed. The additional samples will be collected at channels (except upper San Juan Creek and Silverado Creek) which are designated as "Waters of the State".

Some storm samples will also be analyzed for particle size distribution to correlate the level of contamination to the concentrations of transported silts and clays. If a significant correlation can be developed between silt/clay and pollutant concentrations, the former analyses can be used to supplement the chemical concentration data used in mass load calculations.

These particle size distribution analyses are much less expensive than chemical analyses. They can be performed in the Environmental Resources Laboratory. Grab samples of fluvial (transported) sediment can be collected during storm sampling with equipment currently available.

Initially this correlation analysis will be attempted for stations which are presently monitored in the San Diego Creek sediment transport study. If a significant correlation is identified, the sampling will be expanded to other stations.

7.3 Monitoring Frequency

The frequency must be developed so that the program is cost effective and produces data which can be used to address the program objectives. An initial frequency will be proposed and modified according to analysis of the collected data.

For example, if after 2 years of representative storm sampling (5-10 storms) no (below detection limit) trace element contamination is detected, the monitoring frequency for those parameters will be reduced. If the standard deviation of the mean concentration is low the same reduction will be implemented. If however, a mean concentration of a contaminant exceeds a water quality standard but the standard deviation of that mean is high, the sampling frequency for that contaminant will be increased to more accurately assess the mass loading.

Before implementation, modifications (changes in sampling location, parameters monitored, sampling and analytical procedures, or monitoring frequency) must first be approved by the Executive Officers of the Regional Boards.

The proposed initial frequency is outlined in Table 3a.

7.3.1 Dry-weather

The proposed initial frequency for dry weather monitoring for nutrients and trace elements (at locations identified in 7.2.1) is monthly. This is based on the present equipment, staffing, the analytical services budget, and the past observed seasonal variations in concentrations and water discharges. Nutrient monitoring will be conducted using the entire inventory of automatic samplers. Sites without continuous water level recorders will be sampled with automatic samplers and compatible flowmeters. Field determinations of

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Table 3a - Channel Monitoring Frequencies

Huntington Harbour Watershed

STORET Code	Nutrients	Trace(aq)	Trace(s)	PHP(s)	PAH(s)
BCC02	m/st	st			
ABCC03	st	st			
UHCC04	st	st			
EGUC05	m/st	st			
SUHC07	st	st			

Newport Bay Watershed

STORET Code	Nutrients	Trace(aq)	Trace(s)	PHP(s)	PAH(s)
SADF01	st	st			
BCF04	st	st/f	semi	semi	semi
SDHF05	m/st/f	st/f	semi	semi	semi
UYLSED	m/st/f	st/f	semi	semi	semi
BARSED	m/st/f	st/f	semi	semi	semi
LANF08	st	m/st	semi	semi	semi
BRCF09	st	m/st	semi	semi	semi
SCCF15	m/st	st/f	semi	semi	semi
BEEF17	m/st/f	st/f	semi	semi	semi
AGUF18	m/st/f	st/f	semi	semi	semi
SERF19	m/st/f	st/f	semi	semi	semi
RCUF26	m/st/f	st/f	semi	semi	semi
HCUF27	m/st/f	st/f	semi	semi	semi
CNCG02	st	st			
SICG03	st	st			
BCUG04	st	st			

South County Watershed

STORET Code	Nutrients	Trace(aq)	Trace(s)	PHP(s)	PAH(s)
LCUI02	st	st/f			
ACJ01	m/st/f	st/f	semi	semi	semi
SCBJ03	st	st/f	semi	semi	semi
SJCL01	m/st	st/f	semi	semi	semi
TCOL02	st	st/f	semi	semi	semi
OSOL03	st	st/f	semi	semi	semi
PDCH01	m/st	st/f	semi	semi	semi
SDCH02	m/st	st/f			
ONBL01	m/st	st	semi	semi	semi

Santa Ana River Watershed

STORET Code	Nutrients	Trace(aq)	Trace(s)	PHP(s)	PAH(s)
SARIMP	st	st/f	semi	semi	semi
SARE01	st	st/f	semi	semi	semi
SAME08	st	st/f	semi	semi	semi
SILE17	m/st	st	semi	semi	semi

m - monthly; semi - semiannual; st - storm; f - 72 hr followup

dissolved oxygen, electrical conductance*, pH and temperature will be made at the time of sampler collection.

Semiannual sediment sampling will be conducted before the storm season to assess the magnitude of dry season, pollutant deposition and after the storm season to assess the deposition and/or removal (due to channel scouring) as a result of storms.

7.3.2 Storms

The period designated as the official storm season by EMA is October 15 to April 15 of each year. This period was established from storm frequency analysis.

The automatic sampling equipment will be left in the field (on storm activation mode) during this period and will be serviced weekly (battery changes, sample line/strainer inspection and operation checks). Since the number of storm samplings is a function of the number of representative storms*, the available staff and equipment, an annual frequency can only be estimated. Two storm samplings per station will be attempted during the 1990-91 season. During subsequent seasons 3-5 samplings will be attempted.

The data from storm sampling will be used to characterize the distribution of pollutants during and after storm events. An automatic sampler will be programmed to activate when the water level in the channel is indicative of a storm. The level of activation will be above the maximum, observed (from discharge hydrograph analysis) diurnal water surface elevation. Once activated, 24 discrete, hourly samples will be collected. The time of activation can be determined from the the memory on the sampler or remotely from the ALERT system computer (from the water level at activation).

Samples collected in the first three hours (first flush) will be flow-composited in the laboratory (using hydrographic information from the ALERT system or from flowmeter records) and sent out for analysis. The remaining 21 samples will also be flow-composited and analyzed. Field measurements will also be made at the time of sampler collection.

A 72-hour sampling (24 discrete samples: one collected every three hours) will be initiated within 12 hours of cessation of the first 24-hour sampling. The first 12 samples will be flow-composited and sent to the laboratory for analyses; the remaining 12 samples will be processed similarly. In addition to determining the degree of contamination during and after the storm, the data will be used to determine 4-day average concentrations of the monitored substances.

In the first year of the program, the five, newer model (ISCO 2700 and 3700), automatic samplers will be used for storm sampling. The remaining sampler inventory will be used to conduct the monthly sampling. The samplers used for storm monitoring will be dedicated to one watershed per month. If at least two representative storms are sampled during the month in that watershed, the samplers will be moved to another watershed.

The Upper Newport Bay watershed is comprised of more tributaries than available samplers. The most important monitoring sites are those which are located on direct tributaries to the Upper Newport Bay. Bonita Canyon Channel, although not a direct tributary, is listed as a "Water of the State",

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has exhibited high trace element concentrations in storm effluent, and is downstream of the San Diego Creek monitoring station. The following monitoring priority has been established.

1. San Diego Creek at Campus Drive
2. Santa Ana Delhi-Channel at Irvine Avenue
3. Big Canyon Wash at Back Bay Drive
4. Costa Mesa Channel at Highland Avenue
5. Bonita Canyon Channel at San Diego Creek confluence
6. Santa Isebella Channel at Irvine Avenue
7. Lane Channel at Jamboree Road
8. Peters Canyon Wash at Barranca Parkway
9. Barranca Channel at Jamboree Road
10. San Diego Creek at Culver Drive
11. All other channels

8.0 Receiving Water Program

8.1 Monitoring Locations

The waterbodies that will be monitored in the Receiving Water Program include the Huntington Harbour/Anaheim, Sunset, Bolsa Bay complex; the Upper and Lower Newport Bay; Dana Point Harbor; the Santa Ana River; San Diego and San Juan Creeks. The last three waterbodies are included in the Channel Monitoring Program as are many of the other channels designated as "Waters of the State" (See Section 8).

The monitoring locations were chosen on the basis of the existence of past data and the proximity of tributary inputs. The locations are listed in Table 4 and maps are in the appendices. As in the Channel Monitoring Program, quality control (assumed to be limitedly affected) stations at the Harbor entrances will also be monitored.

8.2 Monitoring Parameters

8.2.1 Dry-weather

Dry season sampling will include semiannual sediment analyses for organic and trace element concentrations as well as nutrient evaluations of the water.

8.2.2 Storms

These locations will be sampled during storms, for the same contaminants monitored in the channel program (storms). Samples representative of the entire water column will be collected with a USGS depth integrating sampler which has been coated with trace metal (epoxy) paint. The depth of the fresh water lens" will also be noted. Field readings of dissolved oxygen, electrical conductivity, pH and temperature will be made throughout the water column at the time of sampling. The Hydrolab with datalogger enables the operator to make these measurements quickly.

8.3 Monitoring Frequency

The proposed frequencies for Harbor/Bay monitoring are outlined in Table 4b.

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Table 4 Harbor/Bay Monitoring Locations

Huntington Harbour/Anaheim, Sunset, Bolsa Bay

Station	STORET Code	Location
Sunset Aquatic Park	HUNSUN	near U.S. Navy bouys
Huntington Harbour	HUNBCC	near Bolsa Chica Channel mouth
Huntington Harbour	HUNWAR	at Warner Avenue
Christiana Bay	HUNCRB	near Sunset Channel outlet
Anaheim Bay @	HUNHAR	between ends of jetties
Bolsa Bay	BBOLR	at old launch ramp

Newport Bay

Station	STORET Code	Location
Upper Newport Bay *	UNBSDC	in the ski zone d/s San Diego Creek
Upper Newport Bay *	UNBSCW	SE/North Island, d/s Big Canyon Wash
Upper Newport Bay *	UNBNSB	W/Shellmaker Island, E/North Star Beach
Upper Newport Bay *	UNBNDB	near entrance to Newport Dunes
Upper Newport Bay @	UNBCNB	at PCH
Lower Newport Bay @	LNBHIR	in Harbor Island Reach near Collins Isle
Lower Newport Bay @	LNBTUB	in the Turning Basin
Lower Newport Bay	LNBRIN	in the Rhine Channel
Lower Newport Bay @	LNBHAR	at the Harbor entrance

Dana Point Harbor

Station	STORET Code	Location
East Basin	DAPTEB	near stormdrain outlet
West Basin	DAPTWB	near stormdrain outlet
Launch ramp	DAPTLB	near stormdrain in launch ramp bulkhead
Boatyard	DAPTLR	near boatyard dock
Harbor Entrance @	DAPTHE	between ends of jetties

@ monitored only during storms
* monthly nutrient monitoring

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Table 4a - Harbor/Bay Monitoring Frequencies

Huntington Harbour/Sunset, Anaheim, Bolsa Bays

STORET Code	Nutrients	Trace(aq)	Trace(s)	PHP(s)	PAH(s)
HUNSUN	semi/st/f	st/f			
HUNBCC	semi/st/f	st/f	semi	semi	semi
HUNWAR	semi/st/f	st/f	semi	semi	semi
HUNCRB	semi/st/f	st/f	semi	semi	semi
HUNHAR	st	st			
BBOLR	semi/st/f	st/f	semi	semi	semi

Newport Bay

UNBSDC	m/st/f	st/f	semi	semi	semi
UNBBCW	m/st/f	st/f	semi	semi	semi
UNBNSB	m/st/f	st/f			
UNBNDB	m/st/f	st	semi	semi	semi
UNBCHB	st	st			
LNBHIR	semi/st/f	st/f	semi	semi	semi
LNBTUB	st	st			
LNBRIN	st	st	semi	semi	semi
LNBHAR	st	st			

Dana Point Harbor

DAPTEB	semi/st/f	st/f	semi	semi	semi
DAPTUB	semi/st/f	st/f	semi	semi	semi
DAPTLB	semi/st/f	st/f	semi	semi	semi
DAPTLR	st/f	st/f	semi	semi	semi
DAPTHE	st	st			

m - monthly; semi - semiannual; st - storm; f - 96 hr followup

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8.3.1 Dry-weather

Dry weather monitoring will be conducted monthly (to monitor the influences of tributary inflows and tidal flushing) in the Upper Newport Bay and semiannually (pre and post storm season) at other locations (unless designated storm only in Table 4). Monthly nutrient sampling will be conducted in the Upper Newport Bay on the days during which the automatic samplers are collected in the watershed. The nutrient content of the tributary discharges are assumed to be seasonally influenced; monthly sampling will allow three determinations per season. This should be adequate to develop a cause and effect relationship between the tributary inputs and the quality of the water in the Upper Bay.

Control stations at the Harbor entrances will only be sampled during storms (if safe to do so); problems with rapid currents, depth to bottom, and boat traffic make semiannual benthic sediment sampling impractical at these sites.

8.3.2 Storms

The storm monitoring frequency will be dependent on the weather and will be limited by the amount of equipment (one boat) and available manpower. Monitoring of storms greater than 0.5 inches in magnitude will be attempted. This volume of rainfall should be great enough for these receiving waters to exhibit a fresh water influence. Two followup samplings, 48 and 96 hours from the initial storm sampling, will also be conducted to assess the chronic and acute influences of the runoff on the receiving waters.

As in the channel monitoring program, the frequency will be modified according to the analyses of the data.

9.0 Database Management

The water quality monitoring data will be entered into the USEPA's national water quality database, located in Triangle Park, North Caroline. This database management system is known as STORET, an acronym meaning storage/retrieval. The data storage and retrieval process is performed by PC communication, via modem, with the system mainframe.

Chemical data from the contractor laboratory and field data collected by Enviromental Resources staff are tranformed into the proper computer format and are transmitted to the National Computer Center. After the transmitted data is integrated into the STORET database, the information is rechecked and edited, if necessary.

Retrievals of information can be in various forms including raw data, statistics, graphical displays and maps. These retrievals are also performed with the PC/modem link.

10.0 Quality Assurance

All methods of analyses employed by the contractor laboratory shall be from 40 CFR Part 136, "Guidelines for Establishing Test Procedures for the Analyses of Pollutants Under the Clean Water Act". Included are the APHA-AWWA-WPCF Standard Methods for the Examination of Water and Wastewater, 18th Edition. Field, chemical test methods shall be EPA approved (if available).

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Quality assurance of chemical analyses performed by the contractor laboratory will be conducted by the contractor laboratory through its internal quality control program and by a blind, check-sample submittal program conducted by the County.

With every batch of samples submitted to the contractor laboratory, at least one synthetically prepared, spiked or replicate sample for each ten samples will be included. The synthetic or spiked samples containing trace elements or organic compounds will be prepared using aliquots of commercially or EPA prepared stock solutions. Quality assurance samples containing nutrients will be prepared from aliquots of stock solutions prepared in the Environmental Resources laboratory. Replicate samples will be splits of well-mixed samples. Both fractions will be sent to the laboratory to evaluate the precision of analyses.

The accuracy of analyses will be evaluated from the results of the synthetic and spiked sample submittals. A deviation from the contract (Attachment 3) limits of error will result in a request to reanalyze the batch of samples containing the QC sample. Only that constituent which exhibits the discrepancy will be reanalyzed in each sample.

The quality of the field screening analyses will be maintained by performing analyses on chemical standards from the spectrophotometer vendor. These analyses will be conducted at the beginning of each week in which field screening is scheduled.

11.0 Program Costs

The costs for the sampling programs will include manpower, equipment and contracted analytical services. Manpower includes sample collection / preparation, hydrographic monitoring and calculations, equipment maintenance, employee training, laboratory contract administration including quality control, database management and report preparation.

11.1 Labor

11.1.1 Sampling/Water Quality Monitoring

A team of two persons is required to conduct the water quality field sampling. This sampling includes field screening and channel/receiving water monitoring (storm and dry-weather). The time required includes transportation, sample collection, automatic sampler deployment, sample preparation (labeling, preservation, logging, laboratory submittal) and equipment maintenance. The required manpower is summarized in Table 5.

11.1.2 Hydrographic Monitoring

EMA conducts hydrographic monitoring to support its Public Works/Flood Control Design and Field Operations Divisions. Hydrographic monitoring for the Stormwater Program which exceeds these requirements will be charged to the Program. This monitoring will include maintenance, stage-discharge calibration and preparation of annual discharge summaries for stations on receiving water channels which presently do not have (or were not previously scheduled to have) continuous water level recorders. Each new gaging station will require 120 manhours annually. Calculations of precipitation intensities for stations in excess of the number in the present program will also be

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Table 5 - Analytical Cost and Labor Estimates (1990 dollars)

Activity	Type of Analyses	Annual Freq.	No. of Stations	Samples per/Stn	Cost per Analysis	Total Cost	Labor (hrs)
Field Screening	Varied	2	90		EMA		1080
Channel Monitoring (monthly)	Nutrients	12	17	1	$110	$22,440	480
	Trace(aq)	12	2	1	$123	$2,952	
Channel Monitoring (semiannual)	Trace(sed)	2	23	1	$138	$6,348	160
	PHP(sed)	2	23	1	$315	$14,490	
	PAH(sed)	2	23	1	$404	$18,584	
Channel Monitoring (3-5 storms)	Nutrients	4	34	2	$110	$29,920	544
	Trace(aq)	4	34	2	$123	$33,456	
Channel Monitoring (72 hr storm followup)	Nutrients	4	8	2	$110	$7,040	336
	Trace(aq)	4	21	2	$123	$20,664	
Upper Newport Bay Monitoring (monthly)	Nutrients	12	4	1	$110	$5,280	144
Harbor/Bay Monitoring (semiannual)	Nutrients	2	9	1	$110	$1,980	120
	Trace(sed)	2	13	1	$138	$3,588	
	PHP(sed)	2	13	1	$315	$8,190	
	PAH(sed)	2	13	1	$404	$10,504	
Harbor/Bay Monitoring (storm)	Nutrients	2	20	1	$110	$4,400	120
	Trace(aq)	2	20	1	$123	$4,920	
Harbor/Bay Monitoring (48/96 hr storm followup)	Nutrients	2	13	2	$110	$5,720	240
	Trace(aq)	2	13	2	$123	$6,396	
QA/QC Samples	Nutrients	50	1	1	$110	$5,500	
	Trace(aq)	30	1	1	$123	$3,690	
	Trace(sed)	10	1	1	$138	$1,380	
	PHP(sed)	10	1	1	$315	$3,150	
	PAH(sed)	10	1	1	$404	$4,040	
Hydrographic Monitoring							1000
In-house Analyses							80
Contract Administration							240
Database Management							240
Report Writing							400
Training							240
Totals						$224,632	5424

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charged to the program. These calculations will require 40 hours annually to complete.

11.1.3 Analytical Services Contract Administration

Contract administration includes quality control sample preperation, analytical report evaluation, and invoice processing. This will require approximately 20 hours per month or 240 hours annually.

11.1.4 Database Management

Database management as described in Section 10.0 will require approximately 20 hours monthly or 240 hours annually.

11.1.5 Report Writing

Compilation of data and report writing will require approximately 400 hours annually. The reports will include rainfall intensities at 23 existing EMA precipitation gages, discharge summaries for streamgeges near water quality stations, calculations of the annual pollutent load from each monitored channel and a summary of the impacts of those discharged pollutants on the the water and bed sediment quality of each receiving water. The results of the monitoring will also be used in the modification of existing BMPs or the implementation of new BMPs.

The report will be reviewed by the Orange County City Engineers Stormwater Committee before submittal to the Regional Water Quality Control Boards.

11.1.6 Compilation of Existing Data

This activity will be conducted only in the first year. It entails compiling all water quality and hydrographic information gathered since 1980. This information will include (as outlined in the permit) the following:

a. Analytical and flow data for stormwater samples collected from the stormwater conveyance system outfalls, and within any waters of the United States;

b. Precipitation data from the precipitation stations and the duration of storm events (if available);

c. Discharge data from the stormwater conveyance systems as determined from gaging stations;

d. Analysis of the data and the major pollutants identified in the stormwater discharges from each drainage area to each receiving water and a determination whether the identified pollutants came from non-point or point-source discharges.

Approximately 320 hours will be required to complete this process.

11.1.7 Training

Training must be completed by all staff throughout the life of the permit. This training will include OSHA-required hazardous material handling;

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equipment operation; new employee orientation; and computer software usage (STORET). Approximately 240 hours annually will be devoted to training.

11.1.8 Labor Summary

The total annual manpower requirement will be approximately 5424 hours. Most of the work will be performed by Environmental Resources Specialist IIs who are presently compensated at an hourly rate (including overhead) of $23.79. The 5424 hours will compute to approximately $129,000. Approximately half of the storm sampling however, will be conducted during non-working (overtime) hours. The total number of overtime hours required annually is 910. This computes to an additional $10,800 or a total of $139,900. With an annual cost of living adjustment of 5% the labor costs will be $146,900 in FY 91/92.

Since the program will be initiated after the midpoint of the first budget year, the corresponding first year costs will be lower. Of the costs outlined in Section 12, only those for equipment and field screening will be uneffected by the starting date for the program. The esteblishment of additional gaging stations in FY 91/92 will result in an additional manpower requirement (960 hrs) in that and subsequent years. The number of storms which will be sampled after the first year will also increase as additional sampling equipment will be available. Table 6 reflects the differences in the first yeer and annual totals for analytical services and labor. The value for labor includes 550 hours of overtime. Table 6a outlines the annual labor requirements (regular and overtime hours) for the the program.

11.2 Analytical Services

The costs for analytical services were derived from the 1989-90 fee schedule from the current analytical services vendor, Brown and Caldwell Analytical Laboratories. The costs per analysis and the total annual costs are also outlined in Table 5. Prices for analyses can be expected to increase 10% per year to compensate for the increases in the cost of living and disposal costs for completed samples.

11.3 Equipment Costs

Equipment which will be required to supplement the existing inventory of EMA includes automatic samplers; flowmeters; field, diagnostic equipment and analytical reagents; and continuous, water level, recording gages.

Three automatic samplers (@ $3500), five compatible flowmeters (@ $3000), and a field, uv-visible spectrophotometer (@ $1600) w/reagents ($800) will be ordered during the 1990-91 Budget Year. This will cost approximately $28,000.

Ten additional samplers with compatible flowmeters, another spectrophotometer with reagents, and two temperature compensating conductivity meters (@$1300) will be ordered during FY 91/92.

Continuous water level recording gages will be installed at the urban channels which are identified as "Waters of the State" and currently lack this equipment. Eight stations currently fit this criteria. They are Serrano Creek; Segunda Deschecha, Prima Deschecha, Sand Canyon, and Bee Canyon Channels; and Rattlesnake Canyon, Hicks Canyon and Agua Chinon Washes. The cost of the equipment per station is approximately $7500. This equipment will also be purchased in FY 91/92.

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Table 6 - FY 90/91 Analytical Cost and Labor Estimates

Activity	Type of Analyses	Annual Freq.	No. of Stations	Samples per/Stn	Cost per Analysis	Total Cost	Labor (hrs)
Field Screening	Varied	2	90		EMA		1080
Channel Monitoring (monthly)	Nutrients	6	17	1	$110	$11,220	240
	Trace(aq)	6	2	1	$123	$1,476	
Channel Monitoring (semiannual)	Trace(sed)	1	23	1	$138	$3,174	80
	PNP(sed)	1	23	1	$315	$7,245	
	PAH(sed)	1	23	1	$404	$9,292	
Channel Monitoring (storm)	Nutrients	2	34	2	$110	$14,960	272
	Trace(aq)	2	34	2	$123	$16,728	
Channel Monitoring (72 hr storm followup)	Nutrients	2	8	2	$110	$3,520	168
	Trace(aq)	2	21	2	$123	$10,332	
Upper Newport Bay Monitoring (monthly)	Nutrients	6	4	1	$110	$2,640	72
Harbor/Bay Monitoring (semiannual)	Nutrients	1	9	1	$110	9990	60
	Trace(sed)	1	13	1	$138	$1,794	
	PNP(sed)	1	13	1	$315	$4,095	
	PAH(sed)	1	13	1	$404	$5,252	
Harbor/Bay Monitoring (storm)	Nutrients	1	20	1	$110	$2,200	60
	Trace(aq)	1	20	1	$123	$2,460	
Harbor/Bay Monitoring (48/96 hr storm followup)	Nutrients	1	13	2	$110	$2,860	120
	Trace(aq)	1	13	2	$123	$3,198	
QA/QC Samples	Nutrients	25	1	1	$110	$2,750	
	Trace(aq)	15	1	1	$123	$1,845	
	Trace(sed)	5	1	1	$138	$690	
	PNP(sed)	5	1	1	$315	$1,575	
	PAH(sed)	5	1	1	$404	$2,020	
Hydrographic Monitoring							40
In-house Analyses							40
Compilation of Existing Data							320
Contract Administration							120
Database Management							120
Report Writing							400
Training							240
Totals						$112,316	3432

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Table 6a - Annual Labor Summary

Activity	FY 90/91		FY 91/92		FY 92/93		FY 93/94		FY 94/95	
	RH	OT	RH	OT	RH	OT	RH	OT	RH	OT
Field Screening	810	270	810	270	810	270	810	270	810	270
Channel Monitoring (monthly)	240		480		480		480		480	
Channel Monitoring (semiannual)	80		160		160		160		160	
Channel Monitoring (storm)	136	136	272	272	272	272	272	272	272	272
Channel Monitoring (storm followup)	84	84	168	168	168	168	168	168	168	168
Upper Newport Bay Moni. (monthly)	72		144		144		144		144	
Harbor/Bay Monitoring (semiannual)	60		120		120		120		120	
Harbor/Bay Monitoring (storm)	60		120		120		120		120	
Harbor/Bay Monitoring (storm followup)	60	60	120	120	120	120	120	120	120	120
Comp. of Existing Data	320									
Hydrographic Monitoring	40		920	80	920	80	920	80	920	80
In-House Analyses	40		80		80		80		80	
Lab Contract Admin.	120		240		240		240		240	
Database Management	120		240		240		240		240	
Report Writing	400		400		400		400		400	
Training	240		240		240		240		240	
Totals	2882	550	4514	910	4514	910	4514	910	4514	910

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Four vehicles will be used in the sampling program. Two of these will be replaced FY 92/93 at a cost of $20,000 each.

Miscellaneous equipment expenditures (analytical reagents; automatic sampler, repair parts; field sampling equipment; etc) will be approximately $5000 annually. Table 7 presents the proposed annual equipment expenditures by fiscal year.

11.4 Cost Summary

The first year costs will be approximately $221,500, which includes 3432 hours (550 overtime hours), $32,800 in equipment, and $100,300 in analytical services. Starting in FY 91/92, total costs will increase because the monitoring period will be an entire year, additional equipment purchases will allow more sampling and analytical costs will consequentially rise. Table 8 summarizes the total costs (manpower, equipment, and analytical services) of the water quality monitoring programs for channels and receiving waters. Cost of living adjustments are also included. An annual increase of 10% is projected for equipment and analytical services; salaries for staff can be expected to increase by 5% annually.

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Table 7 - Annual Equipment Costs

Equipment	cost/item *	FY 90/91	FY 91/92	FY 92/93	FY 93/94	FY 94/95
Automatic Sampler	$3,500	3	10	5		
Flowmeter	$3,000	5	10	5		
Spectrophotometer	$1,500	1	1			
Field Screening Reagents	$1,000	1	1	1	1	1
Streamgages	$7,500		8			
Vehicles	$20,000			2		
Conductivity Meters	$1,300		2			
Miscellaneous Supplies	$5,000	1	1	1	1	1
TOTAL *		$33,000	$135,100	$78,500	$6,000	$6,000
TOTAL (adj. for cost of living)			$148,600	$95,000	$8,000	$8,800

* 1990 dollars

Table 8 - Total Annual Costs

Item	FY 90/91	FY 91/92	FY 92/93	FY 93/94	FY 94/95
Labor @ #	$88,200	$146,900	$154,200	$161,900	$170,000
Equipment *	$33,000	$148,600	$95,000	$8,000	$8,800
Analytical Services *	$112,300	$247,100	$271,800	$299,000	$328,900
TOTALS	$233,500	$542,600	$521,000	$468,900	$507,700

@ Environmental Resources Specialist II hourly rate of $23.79 (w/benefits)
# with 5% annual cost of living adjustments
* with 10% annual cost of living adjustments

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12.0 Definition of Terms

Beneficial Uses - Categories into which specific Waters of the State have been assigned by the Regional Water Quality Control Board. A listing of the present and intended beneficial uses of each Water of the State can be found in the respective Regional Water Quality Control Board Basin Plans.

Best Management Practices (BMPs) - Programs, procedures, or structural devices intended to reduce the impact of non-point source urban runoff on the receiving waters.

electrical conductance - also known as specific conductance or electrical conductivity. It is the numerical expression of ability of a solution to carry an electric current. It is proportional to the concentration of dissolved ionic solids.

flow-weighted sampling - Samples are collected in proportion to the volume of water passing the sampling point. The composite of all samples collected is representative of the entire period of collection.

fluvial - That sediment which is transported when water velocity increases as during storms.

freshwater lens - The layer of freshwater will flows over the more dense salt water layer. This situation occurs when the magnitude of the tributary discharge into the saline receiving water is great, as in a storm.

hardness - The amount of calcium carbonate dissolved in water.

illegal/illicit - When referring to discharges an illicit connection is an undocumented or unpermitted conduit. An illegal discharge is one which is in direct violation of an ordinance.

mass load - The annual total mass (pounds or tons) discharged from a tributary stream into a receiving water.

nutrients - The physical or chemical characteristics from the following list.

- nitrate + nitrite
- ammonia
- Total Kjeldahl Nitrogen (TKN)
- total phosphate
- total suspended solids (TSS)
- volatile suspended solids (VSS)
- pH
- dissolved oxygen
- specific conductance
- turbidity

Polynuclear Aromatic Hydrocarbons (PAHs) - Those organic compounds from the following list.

- Acenaphthene
- Acenaphthylene
- Anthracene
- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(ghi)perylene
- Benzo(k)flouranthene
- Chrysene
- Dibenzo(a,h)anthracene
- Fluoranthene
- Fluorene
- Indeno(1,2,3-cd)pyrene
- Naphthalene
- Phenanthrene
- Pyrene

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PCB - Polychlorinated biphenyls. Those analyzed by EMA include:

Aroclor 1016	Aroclor 1221	Aroclor 1232
Aroclor 1242	Aroclor 1248	Aroclor 1254
Aroclor 1260	Aroclor 1262	

peristaltic - When describing a pump, it is fluid transport in a tubing when a rotating pinch roller assembly compresses the tubing in the pump housing. The fluid moves in the direction of rotation.

PHP - Pesticides, herbicides and PCBs.

Aldrin	2,4-D
Chlordane	2,4,5-TP Silvex
Dieldrin	Malethion
Endosulfan I	Methoxychlor
Endosulfan II	Ethyl Parathion
Endosulfan sulfate	Perthane
Endrin	Simazine
Heptachlor epoxide	p,p' DDD
Heptachlor	p,p' DDE
alphe BHC	p,p' DDT
beta BHC	Toxephene
delte BHC	PCBs from above
gamma BHC (lindane)	

regional facilities - Flood control channels with drainage areas greater than one square mile. Designated by a letter followed by two numeric characters (e.g. C02 - Boise Chice Channel).

representative storms - Those storm events during which at least 0.1 inch of rain falls and which were preceded by at least 96 hours of dryness.

spectrophotometer - An instrument used in colorometric analysis. A solution containing an unknown concentration of a substance is treated with reagents to form a colorometric complex. The intensity of the color of this complex is measured against that of a complexed solution of known concentration.

stormwater - as defined by the EPA means storm water runoff, snow melt runoff, surface runoff, street cleaning or maintenance, runoff from fire fighting, infiltration (other than infiltration contaminated by seepage from sanitary sewers or by other discharges) and drainage. Included is runoff from residential car washing and irrigation.

trace elements - Those elements from the following list:

copper	lead	zinc	nickel
chromium	cadmium	silver	

unionized ammonia - Dissolved gaseous ammonia.

13.0 Appendices

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Figure 1

Field Screening Information

DATE:____/____/_____

CHANNEL NAME:_____ EMA FACILITY NO.:_____

SAMPLING LOCATION: u/s d/s _____

THOM BROS MAP PAGE:_____

DRAINAGE AREA:industrial/commercial/agricultural/other_____

CHANNEL CONFIGURATION:concrete, earthen, pipe, culvert, trapezoidal, vertical walled, rectangular box, gabion, grass lined, rip-rap, other_____

DIMENSIONS: CH WIDTH/PIPE DIAM_____ ft/in AVE DEPTH:_____ft/in

WEATHER: sunny, cloudy, windy, hot, cold, rain, fog, other_____

TIME:_____ AIR TEMP:_____C

FLOWRATE:_____cfs est/meas
pH:_____ EC:_____umhos/cm
DO:_____ppm TEMP:_____C
FLOATABLES: yes/no
DESCRIBE:_____
OIL SHEEN: yes/no
ODOR: yes/no
DESCRIBE:_____
TURBIDITY: yes/no/organic/
silt-clay Sample # _____
FOAM: yes/no Sample # _____
ALGAE: yes/no
AQUATIC LIFE: yes/no/stressed

TOTAL CHLORINE:_____mg/L
DISSOLVED Cu:_____mg/L
PHENOL:_____mg/L
Sample #:_____
DISSOLVED Cr^{6+}:_____mg/L
FREE CYANIDE:_____mg/L
COD SAMPLE #:_____
COD:_____mg/L

COMMENTS:_____

_____

_____

TIME:_____ AIR TEMP:_____C

FLOWRATE:_____cfs est/meas
pH:_____ EC:_____umhos/cm
DO:_____ppm TEMP:_____C
FLOATABLES: yes/no
DESCRIBE:_____
OIL SHEEN: yes/no
ODOR: yes/no
DESCRIBE:_____
TURBIDITY: yes/no/organic/
silt-clay Sample # _____
FOAM: yes/no Sample # _____
ALGAE: yes/no
AQUATIC LIFE: yes/no/stressed

TOTAL CHLORINE:_____mg/L
DISSOLVED Cu:_____mg/L
PHENOL:_____mg/L
Sample #:_____
DISSOLVED Cr^{6+}:_____mg/L
FREE CYANIDE:_____mg/L
COD SAMPLE #:_____
COD:_____mg/L

COMMENTS:_____

_____

_____

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APPENDIX 1

PRESENT WATER QUALITY MONITORING PROGRAM FOR THE ORANGE COUNTY ENVIRONMENTAL MANAGEMENT AGENCY'S FLOOD CONTROL DRAINAGE FACILITIES AND THEIR RESPECTIVE RECEIVING WATERS

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Overview

From 1973 to 1990, the Environmental Resources Division of the County of Orange Environmental Management Agency conducted routine water quality monitoring on drainage facilities which are tributary to water bodies identified as waters of the state by the San Diego and Santa Ana Regional Water Quality Control Boards. The receiving waters were also monitored routinely to assess the chronic effects on established (by the Regional Boards) beneficial uses.

The data collected from in-situ monitoring and laboratory analyses of the samples were compiled in the EPA's STORET, national water quality database. An alpha-numeric designation was assigned to each station in the monitoring network. The first two or three letters usually are an abbreviation of the channel name (e.g. EGUC05-East Garden Grove-Wintersburg Channel) and the last three alphanumeric characters represent the drainage basin and facility number (e.g. EGUC05-channel 05 in drainage basin C). The receiving waters are identified by a three or four alphabetic designation for the harbor or bay complex followed by two or three characters which represent the location (e.g. LNBRIN-Lower Newport Bay in the Rhine Channel).

The storm channel sampling stations were grouped into three separate watershed or drainage area monitoring programs. These drainage areas impact (1) Huntington Harbour / Anaheim, Sunset, Bolsa Bays; (2) Upper and Lower Newport Bays; and (3) South County, Dana Point Harbor. The sites were selected to assess the contributions from the upstream drainage areas associated with each facility. A specific land use or combination of land uses has been identified for each drainage area. Table 1 is a list of the storm channel monitoring stations. Table 2 is a list of the locations monitored in the receiving water program.

Monitoring Parameters/Frequencies

When the storm channel monitoring program was initiated in 1973, monthly nutrient and trace element sampling was performed at several locations. Additional constituents were evaluated semiannually to address impacts on the sediment (contaminant deposition, adsorption) and public concerns on controversial issues (Mercury, Selenium, DDT,PCBs, radioactivity). The monitored constituents are listed in Table 3. Some of these stations were deleted (lack of relevent data) and others have been added (to better identify sources of pollution) during the term of the program.

The receiving water program was initiated in 1976. The monitoring frequency was established as monthly with each Harbor or Bay complex sampled on the day subsequent to the sampling of the corresponding watershed. The monitoring parameters are similar to those of the storm channels. However, storm sampling was performed only in the Newport Bay (twice). Depth monitoring at 1 meter intervals (pH, conductivity, dissolved oxygen, and temperature) was also conducted to assess gross differences in chemical character from surface to bottom. These differences are typically found near the mouths of tributary channels with high flowrates (during storms). When field monitoring identifies this stratification, samples from the surface and bottom layers were collected.

Storm sampling of channels consisted of collecting grab samples and conducting

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in-situ measurements . selected stations in each . ershed. The chemical analyses included, in addition to nutrients and trace elements, total coliforms, oil and grease and Methylene Blue Active Substances (MBAS). As the program expanded, automatic samplers were used to collect 24-hr composite samples during dry weather and storm conditions. Stations for which storm run-off sampling data are available are included in Table 4.

For routine (dry-weather) channel monitoring samples were generally collected using an automatic sampler which collects one sample per hour for a 24-hour period. The composite sample was then used as a representative mean for the entire period. This composite sampling technique was employed at the following sites.

Huntington	Newport	South County
BCC02	SABF01	ACJ01
ABCC03	SDHF05	SJCL01
WMCC04	LANF08	TCOL02
EGWC05	SRCF09	OSOL03

The channel monitoring program was modified in the mid 1980's so that the normal, dry-weather, frequency of sampling for each watershed was bimonthly. Storm sampling was limited to the Newport Bay Watershed and some of these stations were only sampled during periods of significant storm run-off (>0.5 inches of rainfall in the watershed). Other locations in the Newport Bay Watershed were modified for only nitrate assessment. Excessive levels of this constituent have been identified as having an adverse impact on the beneficial uses of the Upper Newport Bay. Stations with sampling requirements different from the standard program are included in Table 5.

The Receiving Water Program was modified to a similar bimonthly sampling frequency.

Supplemental Information

Some of the monitoring stations are located near continuous water level recording gages from which discharge rates can be obtained. This information can be used to compute loading values for each constituent. The County also maintains a system of recording/non-recording raingages some of which have data transmitting capabilities.

Chemical Analysis Program

All analyses were performed using procedures outlined in 40 CFR Part 136, "Guidelines for Establishing Test Procedures of Pollutants Under the Clean Water Act". These analytical methods include those outlined in "Standard Methods for the Examination of Water and Wastewater", a joint publication of the American Water Works Association, the American Public Health Association and the Water Pollution Control Federation. From 1983 to 1990 analyses for trace elements in fresh water samples were conducted at the Environmental Resources Division Laboratory; all others were performed by a contracted laboratory certified by the Calif. Dept. of Health Services.

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Table 1

Storm Channel Monitoring Stations

Huntington Watershed

STORET Code	Facility Name/Location	Drainage Area Characterization
BCC02	Bolsa Chica Ch. at Westminster Ave.	AGR,RES,REC,MIL,CON
ABCC03	Anaheim-Barber City Ch. at Naval RR	RES,REC,CON
WMCC04	Westminster Ch. at McFadden Ave.	RES,CON,CEM,CON
EGWC05	E. Garden Grove-Wintersburg Ch. at Gothard Ave.	RES,REC,CON
CCBA01	Coyote Cr. at Knott Ave.	IND,CON,RES

South County Watershed

ACJ01	Aliso Cr. at Pacific Coast Hwy.	RES,REC,POTW,CON
SCBJ03	Sulphur Cr. u/s Laguna Niguel Lake	RES,CON
SCK01	Salt Cr. at Pacific Coast Hwy.	RES,REC
SJCL01	San Juan Cr. at Pacific Coast Hwy.	RES,AGR,CON,POTW
TCOL02	Trabuco Cr. at Del Obispo	RES,AGR,CON
OSOL03	Oso Cr. at Crown Valley Pkwy.	RES,CON
SDCH02	Segunda Deschaca Ch. at El Camino Real	RES,CON

Newport Bay Watershed

SADF01	Santa Ana-Delhi Ch. at Irvine Ave.	RES,CON,AIR
SCF04	Bonita Canyon Ch. at San Diego Cr.	DUMP
SDNF05	San Diego Cr. at Campus Dr.	AGR,RES,IND,CON,SED
LANF08	Lane Ch. at Jamboree Rd.	IND,CON
BRCF09	Barranca Ch. at Jamboree Rd.	IND,CON
SJCF14	San Joaquin Ch. at Harvard Ave.	RES,REC
SCCF15	Sand Canyon Ch. at Culver Dr.	REC,RES
CICF25	Central Irvine Ch. at Yale Ave.	AGR,RES,CON
RCWF26	Rattlesnake Canyon Wash at Bryan Ave.	AGR
NCWF27	Hicks Canyon Wash at Culver Dr.	AGR
MINF28	Mines Ch. at Mines Nursery	AGR
CNCG02	E. Costa Mesa Ch. at Highland Ave.	RES,CON
SICG03	Santa Isabella Ch. at Irvine Ave.	RES
BCWG04	Big Canyon Wash at Back Bay Drive	RES,REC,CON
BARSED	Peters Canyon Wash at Barranca Pkwy.	AGR,CON,SED
WYLSED	San Diego Cr. at Culver Dr.	AGR,RES,CON,SED

AIR- Airport
AGR- Agricultural (nurseries, row crops)
CEM- Cemetery (greenbelt runoff)
CON- Commercial (shopping centers, small bus. incl. auto repair shops)
DUMP- Landfill
IND- Light industry (manufacturing plants, medical research)
MIL- Military base
POTW- Publically owned treatment works
REC- Recreational Areas w/green belts (golf courses, public parks)
SED- Fluvial sediment sampling location

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Table 2

Receiving Water Monitoring Stations

Huntington Harbour, Anaheim, Sunset and Seise Bays

STORET Code	Station Description/ Location	Selection Rationale
HUNSUN	Sunset Aquatic Park near naval bouys	To monitor C02/C03/C04 effects
HUNBCC	Near mouth of Seise Chica Channel	Same as above
HUNNAR	Entrance to Anaheim Bay	Control station
HUNWAR	Near Warner Ave. Bridge	To monitor C05 effects
HUNCRB	In Christiana Bay	To monitor C07 effects
SBOLR	Seise Bay at old launch ramp	To monitor C08 effects

Upper Newport Bay

UNBSDC	Near F05 mouth	To monitor F05 and trib effects
UNBBCU	Near 604 mouth	To monitor 604 effects
UNBNSB	North Star Beach	To monitor tidal effects on F05 inputs
UNBNDB	Entrance to Newport Dunes	To monitor stormdrain inputs
UNBCNB	At PCH bridge	To monitor effects of constriction/increased velocity

Lower Newport Bay

LNBTUB	Turning Basin	To monitor effects of heavy boat traffic
LNBRIN	Rhine Channel	To monitor boatyard operations
LNBHIR	Harbor Island Reach	To monitor effects of F05 on the Lower Bay
LNBNAR	Harbor Entrance	Control station

Dana Point Harbor

DAPTWB	West Basin	To monitor stormdrain effects
DAPTEB	East Basin	Same as above
DAPTOP	Turning Basin	To monitor area of limited circulation
DAPTLR	Near launch ramp	To monitor stormdrain and boatyard effects
DAPTHE	Harbor Entrance	Control station

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Table 3

Water Quality Monitoring Parameters

Constituents Monitored (Aqueous)

Nutrients	Trace Elements	In-situ Parameters
Turbidity	Chromium	Conductivity
Nitrate as NO3	Copper	Dissolved Oxygen
Ammonia as N	Lead	Temperature
Total Kjeldahl Nitrogen	Zinc	pH
Total Phosphate		
Total Susp. Solids		
Volatile Susp. Solids		

Semiannual Parameters[a]

Trace Elements	Sediment Analyses
Cadmium	Cadmium, Chromium, Copper, Lead,
Selenium	Mercury, Selenium, Zinc, Pesticides,
Mercury	Herbicides and PCBs

[a] only at stations that have exhibited higher than watershed average mean values for these constituents or have been identified in Regional Water Quality Control Board studies as having significant levels of these constituents.

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Table 4

Past and Present Storm Monitoring Locations

Station	Period
Huntington/No. County	
BCC02	73-83
UNCC04	76-84
EGUC05	73-84
CCBA01	74-84
SARE01-Santa Ana River @ Fifth St.	73-84
SARFEA-Santa Ana River @ Featherly Park	77-83
Newport	
SADF01	73-Present
BCF04	80-Present
SDNF05	73-Present
LANF08	79-Present
BRCF09	80-Present
SJCF14	80-Present
SCCF15	80-Present
CICF25	80-Present
RCWF27	80-Present
NINF28	80-Present
CNCG02	74-Present
SICG03	76-Present
BCWG04	74-Present
South County	
SCK01	74-84
ACJ01	74-84
SCBJ03	74-84
SJCL01	74-84
TCOL02	74-84
OSOL03	76-84

Table 5

Stations with Special Monitoring Requirements

Stations	Frequency
CNCG02,SICG03	Storm runoff only
RCWF26,NINF28,WYLSED,BARSED,SDNF05*	monthly nitrate
LANF08*,SRCF09*	storm runoff

* water level activated automatic storm discharge sampling in addition to normal bimonthly sampling.

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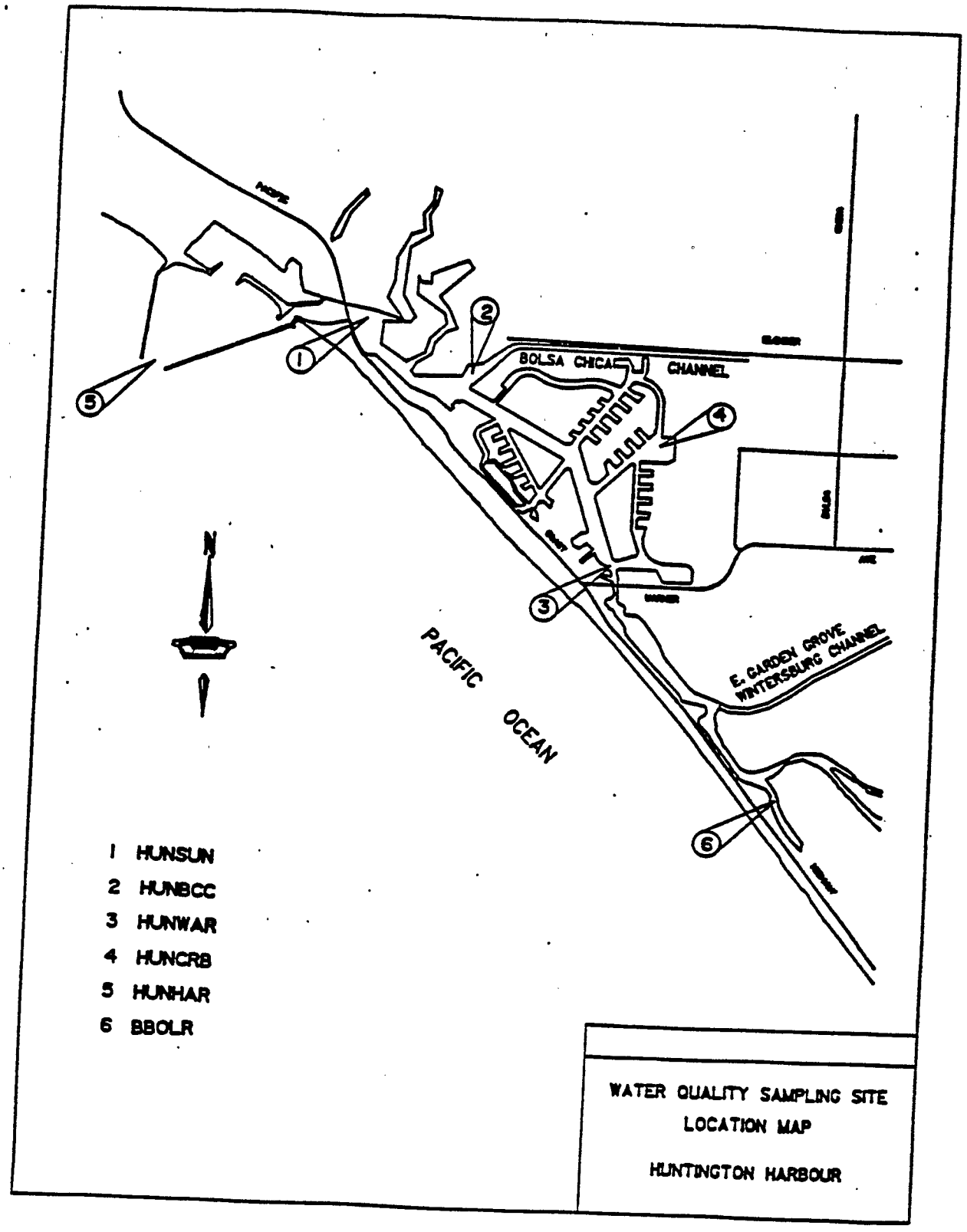
APPENDIX 2

LOCATION MAPS OF SAMPLING SITES IN THE HARBORS AND BAYS OF ORANGE COUNTY


BOLSA CHICA CHANNEL
PACIFIC OCEAN
E. GARDEN GROVE WINTERSBURG CHANNEL
N
1 HUNSUN
2 HUNBCC
3 HUNWAR
4 HUNCRB
5 HUNHAR
6 BBOLR
WATER QUALITY SAMPLING SITE
LOCATION MAP
HUNTINGTON HARBOUR

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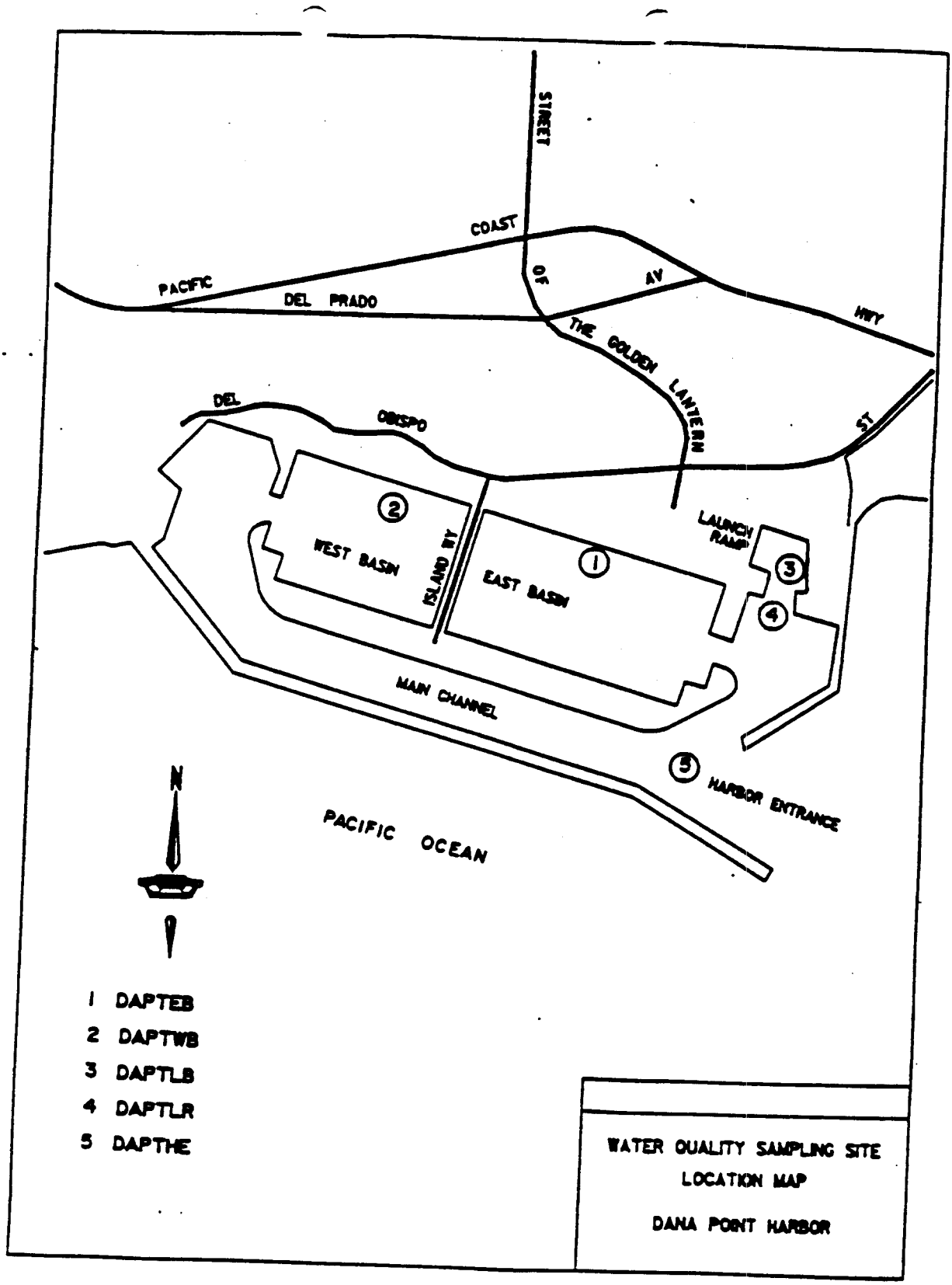

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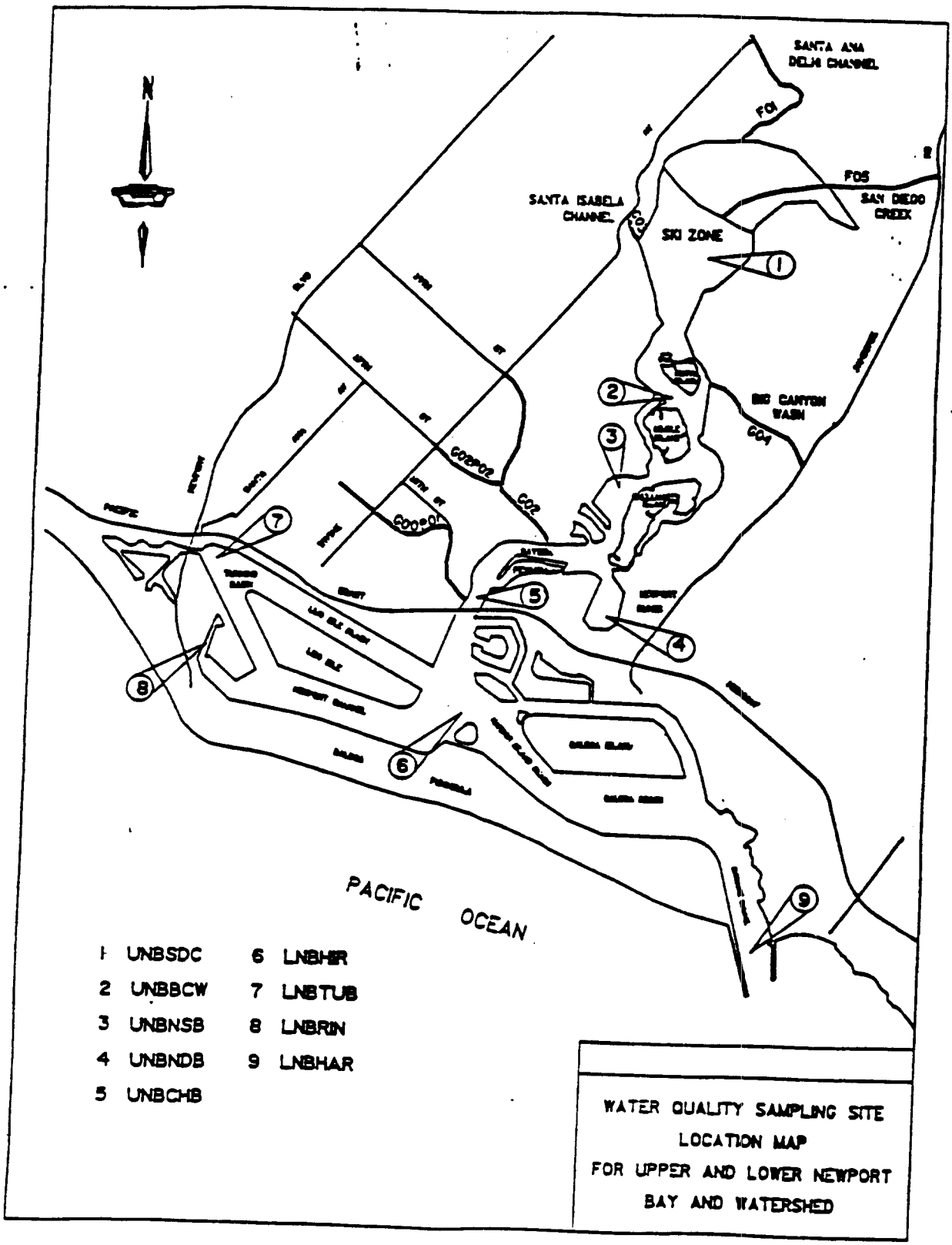

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APPENDIX 3

LOCATION MAP OF SAMPLING SITES IN FLOOD CONTROL CHANNELS OF ORANGE COUNTY

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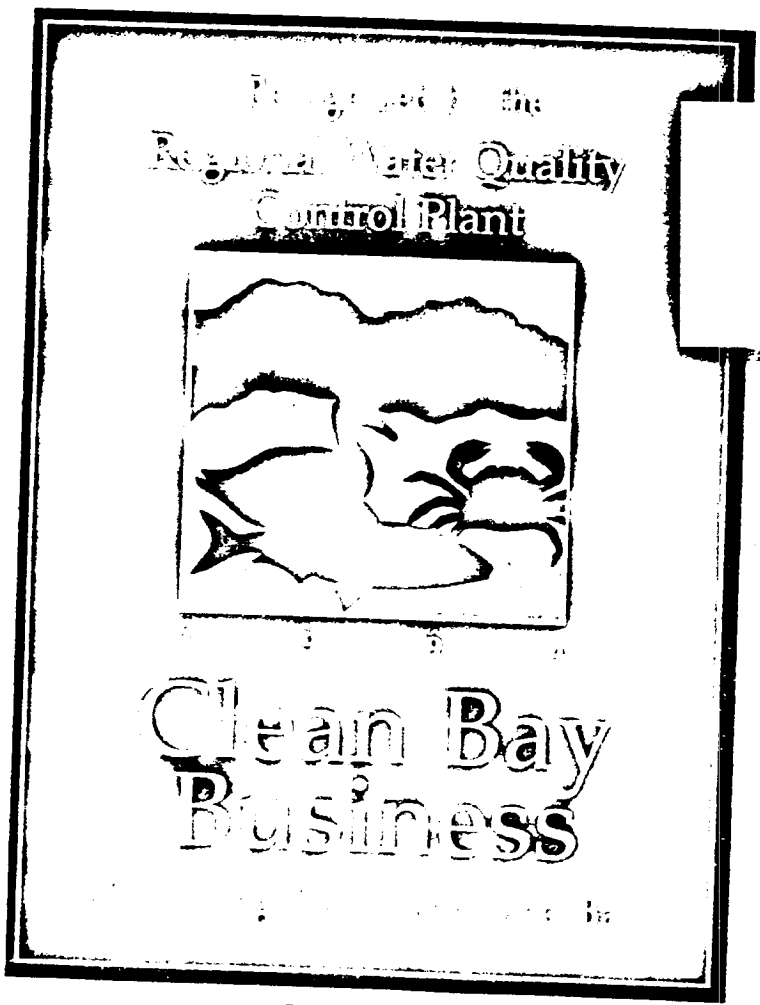
1993 SUMMARY REPORT

VEHICLE SERVICE FACILITY WASTE MINIMIZATION PROGRAM



February 1994

Prepared for
Palo Alto Regional Water Quality Control Plant
Palo Alto California

Prepared by
Uribe & Associates
Palo Alto California

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Carlos Miguel Urrunaga

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1993 SUMMARY REPORT

VEHICLE SERVICE FACILITY WASTE MINIMIZATION PROGRAM



February 1994

Prepared for
Palo Alto Regional Water Quality Control Plant
Palo Alto California

Prepared by
Uribe & Associates
Palo Alto California

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Executive Summary

The Palo Alto Regional Water Quality Control Plant (RWQCP) treats wastewater generated in East Palo Alto, Los Altos, Los Altos Hills, Mountain View, Palo Alto, and Stanford. In order to meet stricter effluent limits for discharge to San Francisco Bay, the RWQCP is targeting specific business types to reduce their metals loading to the RWQCP. One of the targeted business types is vehicle service facilities.

As part of the effort to reduce pollution from vehicle service facilities, the RWQCP and Uribe & Associates (U&A) developed the Vehicle Service Facility Waste Minimization Program. Implementation of this program began in 1992. This report summarizes the results of the second year of the Vehicle Service Facility Waste Minimization Program.

The program scope is multi-media, pollutants entering both the storm and sanitary sewer systems are targeted for reduction. The program approach combines increased regulation, education, and positive incentives to encourage waste minimization. The two major elements of this approach are **on-site visits**, and a **positive incentive program**.

On-site visits provided technical assistance to 375 vehicle service facilities in 1993. Besides providing information and assistance, shop visits were used to determine compliance with vehicle-related ordinance requirements. The number of shops in compliance with the sewer use ordinance is steadily increasing. At the beginning of the program in 1992, only 12 shops (4%) were in full compliance with the 15 requirements after their initial visit. By the end of the first year, 48% of the shops (156) were in compliance. After the visits in 1993, 179 (54%) shops were in compliance with these requirements.

Some of the most significant results of the 1993 visits include:

- From 1992 to 1993, the number of retail vehicle service shops with direct discharges to storm drains decreased from 56 to 2 (96% reduction). Elimination of these last two discharges is pending.
- From 1992 to 1993, the number of violations of the sewer use ordinance was reduced by 66%. The violations of some of the requirements were reduced by as much as 100%.

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- There was little reduction in violations caused primarily by poor employee training. This result indicates that shops may need more help with training and that more rigorous enforcement of the training requirement may be needed.

As a positive incentive, "Clean Bay Business" recognition was given to shops that met established criteria. The criteria included complying with all of the requirements of the revised sewer use ordinance. In the fall of 1992, the first group of 131 shops was recognized as Clean Bay Businesses. In the spring of 1993, an additional 25 shops were recognized for having met the criteria. In the fall of 1993, the total number of Clean Bay Businesses recognized reached 179.

In addition to on-site visits and the positive incentive program, there were three additional components to the program in 1993, permitting and monitoring, a fleet outreach program, and a car wash coupon program.

The first of these components was permitting and monitoring of shops with sanitary sewer discharges. The revised sewer use ordinance requires that any discharges of parts wash water or vehicle wash water to the sanitary sewer be permitted by an industrial waste discharge permit. The first visits to the shops in 1992 identified 125 discharges that required a permit. The outreach efforts that year resulted in about one-half of these shops eliminating their discharges (i.e., zero discharge). In 1993, almost all of the rest of the shops with sanitary sewer discharges were issued industrial waste discharge permits. At the end of 1993, permits for the last two shops were pending.

A fleet outreach program was implemented to further reduce pollutants generated from vehicle servicing. A survey was conducted to identify businesses maintaining fleets of vehicles in the service area. Those companies maintaining greater than five vehicles on-site were visited to provide information on water quality protection and to determine the status of the facility's compliance with the sewer use ordinance. The results of this program include:

- Of the 328 companies contacted, 128 (39%) had fleets of more than five vehicles.
- Seventy-five companies (23%) were found maintaining more than five vehicles on-site and in the service area, and were therefore included in the program.

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- Vehicle washing is the primary activity conducted by fleets with the potential to damage surface water quality.
- Over one-half of the fleets visited this year were washing their vehicles in areas draining to storm drains. Half of these fleets were using mobile washing companies.
- Seven (17%) of the fleets visited had wash racks connected to the sanitary sewer.
- Leaking vehicles parked on the company property also created storm water quality problems.

A car wash coupon program was also initiated to encourage the public to use commercial car washes in order to reduce pollutant discharges to the storm drain system from residential car washing. Coupons were distributed giving the public a financial incentive for using commercial car washes.

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1993 Summary Report

Vehicle Service Facility Waste Minimization Program

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1.0 Introduction

The Palo Alto Regional Water Quality Control Plant (RWQCP) treats wastewater generated in East Palo Alto, Los Altos, Los Altos Hills, Mountain View, Palo Alto, and Stanford. In order to meet stricter effluent limits for discharge to San Francisco Bay, the RWQCP is targeting specific business types to reduce their metals loading to the RWQCP. One of the targeted business types is vehicle service facilities.

As part of the effort to reduce pollution from vehicle service facilities, the RWQCP and Uribe & Associates (U&A) developed the Vehicle Service Facility Waste Minimization Program. Implementation of this program began in 1992. In the first year, 318 facilities were visited and provided with information about revisions to the sewer use ordinance and about best management practices (BMPs), which are shop practices designed to reduce pollutant discharges. In 1993, after the addition of fleet operations to the program, 375 shops were visited. For information on the first year of the program see the *1992 Summary Report for the Vehicle Service Facility Waste Minimization Program* (Uribe & Associates, 1993a). This report summarizes the results of the second year of the Vehicle Service Facility Waste Minimization Program.

2.0 Program Scope and Approach

The program scope is multi-media, pollutants entering both the storm and sanitary sewer systems are targeted for reduction. The program approach combines increased regulation, education, and positive incentives to encourage waste minimization. The two major elements of the positive approach are:

- **On-site visits** of vehicle service facilities to help them reduce the pollutants they generate. In the first year of the program, shop "visits" and shop information packages were used to help the shops learn how to meet the new requirements. These information packages included best management practices and lists of product/service vendors. In 1993, shops were revisited to provide further outreach and to assess their compliance status.

- **A positive incentive program** encourages pollutant reduction by extending incentives and recognition to facilities that make efforts to prevent pollution. In both years of the program, shops that met the criteria were recognized as "Clean Bay Businesses." The shops received free publicity in

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local newspapers via full page ads, and recognition items such as decals and patches to publicize their status.

Three additional components of the program in 1993 were:

- **Permitting and monitoring** was completed for shops with sanitary sewer discharges. Of the 375 open shops in the service area, only 61 still have discharges or open floor drains. In 1993, 59 of these shops were permitted and samples collected of their discharges. Permits for the other two shops are pending.

- **A fleet outreach** program was implemented to identify businesses maintaining fleets of vehicles in the service area and to help them prevent pollution and comply with the ordinance requirements for vehicle service facilities.

- **A car wash coupon program** was initiated to encourage the public to use commercial car washes in order to reduce pollutant discharges to the storm drain system from residential car washing. The commercial car washes that participated in this program all discharge through a pretreatment system to the RWQCP. This program combined pubic education with a financial incentive to wash cars at a participating commercial car wash in the service area.

3.0 Shop Visits - Methods

This year, as last year, inspectors visited each of the 334 retail automotive shops in the service area. Also, visits were conducted at the 41 new fleet operations identified this year (see Section 7.0). The method of conducting visits in 1993 was similar to the method used in 1992, except for the following differences:

- In the first year, the initial visits to all shops in the service area were made by Uribe and Associates. This year, the City of Mountain View Environmental Safety Division conducted all the visits within Mountain View.

- At the outset of the program, appointments were made with the shops for visits. Later, it became clear that making shop visits unannounced saves considerable telephone and travel time. In 1993, all visits were made unannounced except to the new fleets in the program (see Section 7.0).

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- In 1992, all shops were given a period of time to correct problems and then notify the RWQCP. If a shop notified the RWQCP that problems were corrected, they were revisited to confirm that they met Clean Bay Business criteria. In 1993, all shops were notified of any problems but only the Clean Bay Businesses from 1992 that had minor problems were given the opportunity for a revisit.

- In 1993, the *Shop Information Package* (Uribe & Associates, 1993b) was only given to new shops or shops that had changed management. A *Fleet Operations Information Package* (Uribe & Associates, 1993c) was developed and given to all new fleets (see Section 7.0).

- One fact sheet was revised prior to the 1993 visits and was distributed during the visits of all the shops. This fact sheet covers requirement 11 of the ordinance which regulates the discharge of materials to the storm and sanitary sewer from shop cleaning activities. The fact sheet was modified to ensure that shops understood that this requirement covers not only the cleaning of indoor surfaces but also of outside paved areas.

- Inspection checklists were simplified this year. A copy of the inspection checklist used is attached as Appendix A. The second page is a form used to notify the facilities of the requirements they did not meet.

- In the first year, samples were collected from a few shops for background information. This year, samples were taken from all shops with permitted waste discharges to ascertain their compliance with the discharge limits.

4.0 Shop Visits - Results

4.1 Introduction

There are currently 375 open and regulated vehicle service facilities in the RWQCP's Source Control Management (SCM) database. The vast majority of these facilities are retail shops (334) and the rest are fleets (41). In the first year of the program, 1992, there were 326 facilities in the SCM database.

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4.2 Database - 1993 Numbers

Changes to the RWQCP's SCM database include:

- 22 facilities have closed or moved from the service area,
- 24 new retail facilities have opened, and
- 41 businesses maintaining fleets were added (see Section 7.0).

4.3 Compliance with Vehicle Service Facility Requirements

The number of shops in compliance with the sewer use ordinance is steadily increasing. At the beginning of the program in 1992, only 12 shops (4%) were in full compliance with the 15 requirements after their initial visit. By the end of the first year, 48% of the shops (156) were in compliance. After the visits in 1993, 179 (54%) shops were in compliance with the requirements. For a detailed discussion of the specific requirements, see the 1992 Summary Report (Uribe & Assoc., 1993a). The ordinance requirements are provided in Appendix B.

From 1992 to 1993, there was a significant decrease in the rate of noncompliance for each requirement (see Figures 4-1 and 4-2, data is for all cities except Mountain View). Overall, there was a 66% decrease in the number of violations.

Figure 4-1 shows the decrease in noncompliance rates for each ordinance requirement. There was a significant reduction in the number of violations of most requirements. For example, violations of the two vehicle washing requirements were reduced by 96% (#9, wash water to sanitary sewer) and 80% (#10, wash water to storm drain). The smallest reduction in violations included a 12% reduction in violations of the spill cleanup requirement (#2), and a 35% reduction in leak containment (requirement #7) violations. Both these types of violations could be reduced further if employee training were improved. An effort should be made in the next year of the program to provide more assistance in training and to enforce the training requirement more rigorously.

Figure 4-2 shows the number of violations in each year, grouped by type of requirement. This figure shows that there was a 87% reduction in violations specific to sanitary sewer protection and a 55% reduction in violations specific to storm drain protection. There was also a 65% reduction in violations of requirements that protect both the sanitary sewer and the storm drain. These requirements include employee training, spill prevention, and cleanup.

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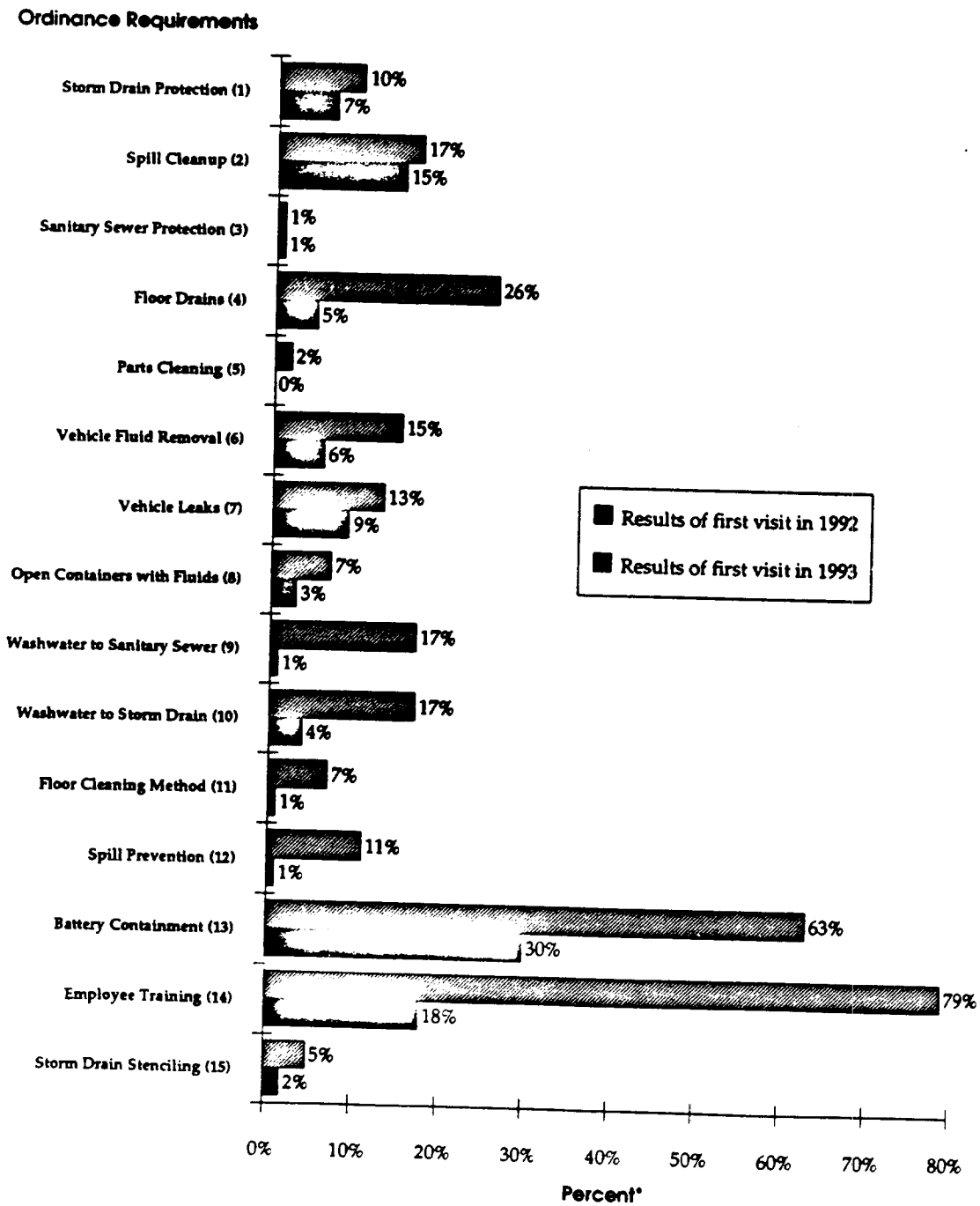
Figure 4-1 Reduction in Noncompliance Rates



*Data for all cities except Mountain View

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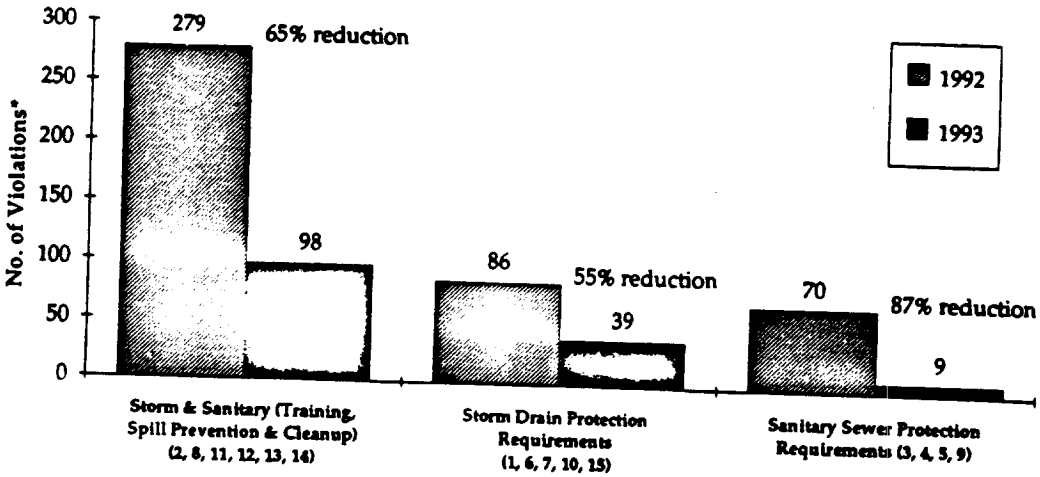

Figure 4-2 Reduction in Sanitary and Storm Sewer Violations
*Note: Data for all cities except Mountain View

Sanitary sewer-related violations were reduced most significantly because these discharges are distinct and therefore relatively easy to identify and address. All of these violations were resolved by plugging floor drains or obtaining permits for sanitary discharges. While the number of direct discharges to the storm drain was reduced drastically (see below), other storm water-related violations are more difficult to resolve. These include providing secondary containment for vehicle fluid removal, vehicle washing, and containing vehicle leaks.

Some of the most significant improvements made from 1992 to 1993 include (data for all cities):

- A reduction in the number of direct discharges from retail facilities to storm drains from 56 to only 2 (96% reduction). Elimination of these last two discharges is pending. The corrected discharges were mostly from vehicle washing but also included parking lot cleaning, wet sanding of vehicles, and in one case, the use of an outdoor sink.

- At the end of 1992, 68 shops in the service area had unpermitted open sumps and floor drains, down from 125 at the beginning of the year. By the time of the 1993 visits, only two unpermitted sumps or floor drains were found, a 97% reduction. Permits for these remaining discharges are pending. The rest of these discharges had either been discontinued by plugging the drain or permitted by the RWQCP.

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- Six automotive machine shops were found discharging parts cleaning wastewater into the sanitary sewer in 1992 without an industrial waste discharge permit. This year they are all in compliance. Two shops have industrial waste discharge permits and four shops became zero dischargers.

5.0 Permitting and Monitoring

5.1 Introduction

The 1992 amendments to the sewer use ordinance require that any discharge of parts wash water or vehicle wash water to the sanitary sewer be permitted by an industrial waste discharge permit. Shops with open sumps or floor drains are also required to obtain permits or permanently plug these drains.

The first visits to the shops in 1992 identified 125 discharges that required a permit. The outreach efforts that year resulted in about one-half of these shops eliminating their discharges. In 1993, almost all of the rest of the shops with sanitary sewer discharges were issued industrial waste discharge permits. At the end of 1993, permits for the last two shops were pending. About 84% of the facilities are "zero dischargers" to the sanitary sewer.

5.2 Permitting

Fifty-seven permits were issued to vehicle service facilities this year. The RWQCP issued permits to 23 shops in Palo Alto, two in East Palo Alto, and one each in Los Altos and Los Altos Hills. The City of Mountain View Environmental Safety Division issued 30 permits to shops located in Mountain View. There are a total of 59 permitted vehicle service facilities in the service area (16% of all vehicle service facilities), including two permits issued prior to the implementation of this program. These 59 permitted facilities include:

- 14 fleets (e.g., garbage cos., transportation cos., school district)
- 12 general repair shops,
- 11 car washes,
- 9 gas stations,
- 6 rental car agencies,
- 4 body shops,
- 2 automotive machine shops, and
- 1 radiator repair shop.

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Vehicle wash water is the primary discharge from these facilities. The sources of the wash water include:

- cleaning both vehicle exteriors and engines (28 of the permitted shops (47%)),
- cleaning vehicle exteriors only (19 shops (32%)),
- cleaning engines only (2 shops),
- sumps for general use (e.g., floor cleaning wastes) (5 shops),
- parts cleaning (3 shops), and
- radiator cleaning (1 shop).

A RWQCP permit includes the following conditions:

- Self-monitoring on a monthly or quarterly basis depending on discharge flow rate. The shops are required to analyze each sample for two metals (copper and lead), or more depending on the type of activity generating the waste.
- Conducting weekly visual inspections of any treatment systems (generally oil/water separators).
- Cleaning the treatment system at least quarterly.
- Logging inspection results and cleaning events.
- Submitting an annual report, reporting violations within 24 hours, and reporting spills immediately. Beginning in 1994, permitted shops will be required to submit sampling results quarterly.

A sample permit for a Palo Alto facility is included in Appendix C.

5.3 Sampling of Permitted Facilities

U&A collected samples of each permitted facility. For most facilities, this was the first sample taken of their wastewater. Most samples were collected from the last chamber of a two or three chambered sump. An Isco sampler was used to pump wastewater from the exit point of the sump into a sample container. Figure 5-1 is a photograph of this sampling activity. In some cases, samples were collected from a sewer clean-out downstream of the permitted discharge prior to dilution with other discharges.

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U&A measured the samples for pH in the field. The samples were put into containers with nitric acid as a preservative. U&A then labeled and logged the samples on a Chain of Custody form and delivered them to the RWQCP, who later delivered them to the lab for metals analyses.

5.4 Sampling Results

The quality of water in these initial samples varied significantly. It was apparent from the color of some samples that they contained large quantities of oil and grease. Figure 5-2 is a photograph showing six of the most interesting sample colors.

The analytical results of the samples collected are summarized in Table 5-1 and Table 5-2 below. It should be noted that the results are based on the collection of only one sample at each permitted shop.

Tables 5-1 and 5-2 summarize the data for all but one of the samples, wash water from a paving company. This fleet operation's sample had metal concentrations one order of magnitude higher than the next highest results. These extremely high levels in one sample increased the mean and standard deviation of the pooled data inordinately and therefore the results of this one sample were treated as an outlier and were not used in calculations.

Table 5-1 lists the range and mean for each metal by primary business activity. The results in this table show:

- Eighteen shops (32%) exceeded their discharge limits for one or more metals.
- By city, the number and percent of sampled shops with a discharge limit violation was one (50%) in East Palo Alto, one (100%) in Los Altos Hills, nine (30%) in Mountain View, and seven (30%) in Palo Alto.
- General repair shops, gas stations, and the one radiator repair shop exceeded the metals limits most severely and frequently.
- The highest lead concentration (aside from the one paving company) was from a gas station with 32 mg/L.
- A gas station also had the lowest lead level reported -- 0.008 mg/L, well below the local limit of 0.5 mg/L.

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Figure 5.1 Sump Sampling by U&A

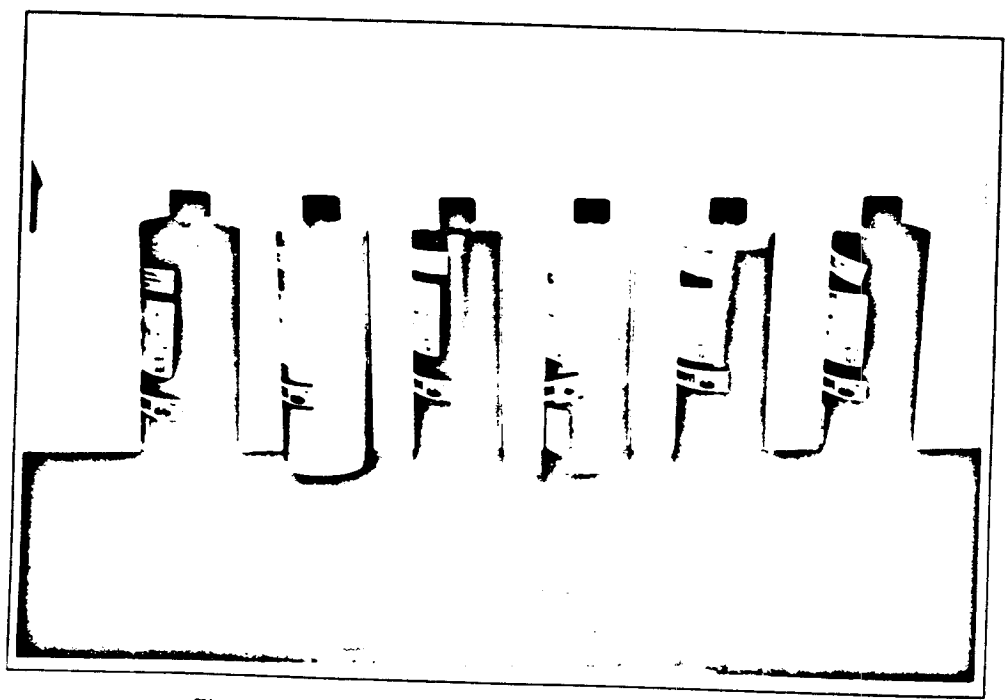

Figure 5.2 Sample Bottles Showing Variation in Color

(As a comparison, the wastewater in the third sample bottle from the right appeared to be relatively clear water)

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- The limits most often exceeded were copper (14% of sampled shops), lead (18%), and zinc (29%), with 8, 10 and 16 exceedances respectively. Almost all of the shops with exceedances (16 of the 18 shops or 89%) violated the zinc limit (2.0 mg/L).

- The cadmium limit was exceeded twice, and chromium and nickel limits were each exceeded once.

- There are only two radiator repair shops in the service area. One is closed-loop and has no discharge. The other shop exceeded the limits for copper (3 times the limit), lead (36 times the limit), and zinc (5 times the limit).

- Although a number of the vehicle washing discharges violated metals limits, none of these violations were at commercial car washes.

Table 5-2 lists the same figures calculated for waste generating activity, rather than business type, since there is not a direct correlation between type of business and waste generating activities. For instance, a general repair shop may discharge wastewater from parts cleaning, floor cleaning, or vehicle exterior cleaning. Some car washes clean only vehicle exteriors and others clean engines as well. The data in Table 5-2 show:

- Wastewater from sumps used for general cleaning (e.g., floor cleaning) most consistently exceeded metals limits. Five shops with this type of discharge were sampled. Three (60%) of these shops violated one or more of the permit limits.

- Twenty-eight shops were sampled that clean both engines and vehicle exteriors. Surprisingly, only three of these shops exceeded the lead limit and five exceeded the zinc limit.

- Of the nineteen shops washing only vehicle exteriors, two exceeded the lead limits, one by 60 times the limit. The zinc limit was exceeded by six shops (32%).

- One of the two shops conducting parts cleaning exceeded the lead limit, the other was in compliance.

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Table 5-1 Initial Sampling Results - Primary Business Activity

Constituent (Limit)	Primary Business Activity								
	General Repair	Machining	Radiator Repair	Body Repair	Car Rental	Car Washing	Fleet Operation	Gas Station	Weighted* Totals
Cadmium (0.1 mg/L)									
Number of samples	13	1	1	4	5	10	12	7	53
Range (mg/L)	0.005-0.23	NA	NA	0.02-0.03	0.0011-0.006	0.006-0.02	0.01-0.061	0.005-0.03	0.0011-0.23
Mean (mg/L)	0.03	0.0006	0.01	0.03	0.01	0.02	0.03	0.01	0.02
Std. Dev. (mg/L)	0.06	0	0	0.01	0.004	0.01	0.02	0.01	0.02
Mean % Local Limit	33%	1%	10%	28%	5%	16%	28%	13%	22%
# Violations (%)	1 (8%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (2%)
Chromium (2.0 mg/L)									
Number of samples	13	1	1	4	5	10	12	8	54
Range (mg/L)	0.006-0.78	NA	NA	0.009-0.2	0.0027-0.05	0.011-0.043	0.005-0.381	0.005-.8	0.0027-0.8
Mean (mg/L)	0.14	0.12	0.04	0.08	0.02	0.021	0.08	0.11	0.08
Std. Dev. (mg/L)	0.24	0	0	0.09	0.02	0.01	0.11	0.28	0.13
Mean % Local Limit	7%	6%	2%	4%	1%	1%	4%	6%	4%
# Violations (%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Copper (2.0 mg/L)									
Number of samples	13	1	1	4	5	10	12	9	55
Range (mg/L)	0.044-20.1	NA	NA	0.24-0.52	0.0410-0.4400	0.17-0.81	0.012-1.43	0.1-16.0	0.012-20.1
Mean (mg/L)	2.32	0.012	6	0.44	0.15	0.39	0.33	3.26	1.38
Std. Dev. (mg/L)	5.41	0	0	0.13	0.17	0.2	0.4	6.17	2.44
Mean % Local Limit	116%	1%	300%	22%	8%	20%	17%	163%	69%
# Violations (%)	4 (31%)	0 (0%)	1 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (22%)	7 (13%)
Lead (0.5 mg/L)									
Number of samples	13	1	1	4	5	10	12	9	55
Range (mg/L)	0.038-12.34	NA	NA	0.07-0.81	0.008-0.2500	0.031-0.150	0.021-0.580	0.008-32.0	0.008-32.0
Mean (mg/L)	1.54	0.01	18.06	0.34	0.08	0.1	0.27	5.55	1.71
Std. Dev. (mg/L)	3.55	0	0	0.33	0.1	0.04	0.19	11.38	2.78
Mean % Local Limit	308%	2%	3,602%	68%	16%	19%	55%	1,110%	342%
# Violations (%)	3 (23 %)	0 (0%)	1 (100%)	1 (25%)	0 (0%)	0 (0%)	1 (8 %)	3 (33%)	9 (16%)
Nickel (1.0 mg/L)									
Number of samples	13	0	1	4	5	10	12	8	53
Range (mg/L)	0.01-0.5		NA	0.10-0.18	0.0080-0.0410	0.042-0.230	0.0032-0.3910	0.022-2.5	0.0032-2.5
Mean (mg/L)	0.1		0.037	0.13	0.02	0.14	0.13	0.42	0.16
Std. Dev. (mg/L)	0.13		0	0.04	0.02	0.06	0.13	0.85	0.21
Mean % Local Limit	10%		4%	13%	2%	14%	13%	42%	16%
# Violations (%)	0 (0%)		0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (13 %)	1 (2%)
Zinc (2.0 mg/L)									
Number of samples	13	1	1	4	5	10	12	9	55
Range (mg/L)	0.18-40.01	NA	NA	1.24-4.26	0.23-7.26	0.43-1.93	0.08-2.22	0.08-47.0	0.08-47.0
Mean (mg/L)	5.93	0.05	10.5	2.85	1.75	1.04	0.94	9.96	3.98
Std. Dev. (mg/L)	10.88	0	0	1.57	3.09	0.48	0.7	18.36	6.21
Mean % Local Limit	296%	3%	525%	142%	87%	52%	47%	4,979%	932%
# Violations (%)	6 (46%)	0 (0%)	1 (100%)	2 (50%)	1 (20%)	0 (0%)	2 (17 %)	3 (33 %)	15 (27%)

NA = Not applicable

*Totals for Mean, Std. Dev. & Mean % Local Limit are weighted by the # of samples in each activity

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Table 5-2 Initial Sampling Results - Waste Generating Activity

Constituent (Limit)	Waste Generating Activity					Weighted* Totals
	Exterior Vehicle Washing Only	Engine Cleaning or Exterior Vehicle & Engine Cleaning	Parts Cleaning	Radiator Cleaning	General / Floor Cleaning	
Cadmium (0.1 mg/L)						
Number of samples	18	28	2	1	4	53
Range (mg/L)	0.0011 - 0.03	0.002 - 0.23	0.0006 - 0.0406	NA	0.005 - 0.03	0.0011-0.23
Mean (mg/L)	0.01	0.1	0.0206	0.01	0.01	0.06
Std. Dev. (mg/L)	0.01	0.37	0.0283	0	0.01	0.20
Mean % Local Limit	14%	99%	21%	10%	13%	59%
# Violations (%)	0 (0%)	1 (4%)	0 (0%)	0 (0%)	0 (0%)	1 (2%)
Chromium (2.0 mg/L)						
Number of samples	18	28	2	1	5	54
Range (mg/L)	0.0027-0.20	0.005-0.49	0.12-0.78	NA	0.008-0.8	0.0027-0.8
Mean (mg/L)	0.03	0.08	0.45	0.04	0.17	0.08
Std. Dev. (mg/L)	0.04	0.12	0.47	0	0.35	0.13
Mean % Local Limit	2%	4%	23%	2%	9%	4%
# Violations (%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Copper (2.0 mg/L)						
Number of samples	19	28	2	1	5	55
Range (mg/L)	0.0410-16.0	0.012-20.1	0.012-0.111	NA	0.13-12.0	0.012-20.1
Mean (mg/L)	1.35	1.12	0.06	6	2.58	1.38
Std. Dev. (mg/L)	3.6	3.75	0.07	0	5.27	3.63
Mean % Local Limit	68%	56%	3%	300%	129%	69%
# Violations (%)	3 (16%)	2 (7%)	0 (0%)	1 (100%)	1 (20%)	7 (13%)
Lead (0.5 mg/L)						
Number of samples	19	28	2	1	5	55
Range (mg/L)	0.008-32.0	0.030-12.34	0.010-0.81	NA	0.008-17.0	0.008-32.0
Mean (mg/L)	1.83	0.81	0.41	18.06	3.57	1.71
Std. Dev. (mg/L)	7.31	2.47	0.57	0	7.51	4.49
Mean % Local Limit	3,650%	161%	82%	3,602%	7,148%	2061%
# Violations (%)	2 (11%)	3 (11%)	1 (50%)	1 (100%)	2 (40%)	9 (16%)
Nickel (1.0 mg/L)						
Number of samples	19	28	1	1	4	53
Range (mg/L)	0.008-2.5	0.0032-0.5	NA	NA	0.010-0.310	0.0032-2.5
Mean (mg/L)	0.21	0.14	0.016	0.037	0.09	0.16
Std. Dev. (mg/L)	0.56	0.012	0	0	0.15	0.22
Mean % Local Limit	21%	14%	2%	4%	9%	16%
# Violations (%)	1 (5%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (2%)
Zinc (2.0 mg/L)						
Number of samples	19	28	2	1	5	55
Range (mg/L)	0.23-47.0	0.08-40.01	0.05-0.18	NA	0.360-37.0	0.08-47.0
Mean (mg/L)	4.17	3.08	0.12	10.5	8.57	3.98
Std. Dev. (mg/L)	10.54	7.72	0.09	0	15.93	9.02
Mean % Local Limit	2,085%	154%	6%	525%	4,286%	1198%
# Violations (%)	6 (32%)	5 (18%)	0 (0%)	1 (100%)	3 (60%)	15 (27%)

NA = Not applicable

*Totals for Mean, Std. Dev. & Mean % Local Limit are weighted by # of samples in each activity.

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The range of results for each metal and waste generating activity was very large (often three orders of magnitude). This large range in data shows that other factors, besides the activity performed, play a big role in determining metals concentration. These factors include implementation of best management practices, regularity of sump cleaning, and the time interval between sump cleaning and sampling.

6.0 Positive Incentive Program

6.1 Introduction

The second major element to the program's approach is a positive incentive program. Shops meeting the criteria described below are formally recognized by the RWQCP as "Clean Bay Businesses." Positive incentives are in the form of publicity in the local media, and decals and customer brochures at the shop to advertise its Clean Bay Business status.

6.2 Criteria

The program has three criteria for recognition:

- **Shop visit completed** - The shop must be visited by RWQCP staff or its representatives.

- **Compliance with ordinance requirements** - Based on the inspection checklist results, the shop must be in compliance with the fifteen ordinance requirements. Shops that were Clean Bay Businesses last year were given the opportunity to correct minor violations within a limited period of time in order to maintain their Clean Bay Business standing. Shops with permitted discharges must meet local limits.

- **No significant violations related to surface water** - The names of those shops meeting the first two criteria are circulated to other environmental regulatory agencies (e.g., County Health Department, City Fire Department) to receive their concurrence that the shop has no significant violations pending of which the RWQCP may not be aware. The violations must be related to surface water. Groundwater, air quality, noise, aesthetics, and other potential issues were not considered.

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6.3 Clean Bay Businesses

At the beginning of the program in 1992, only 12 shops (4%) were in full compliance with the 15 requirements after their initial visit. In the fall of 1992, the first group of 131 shops were recognized as Clean Bay Businesses. In the spring of 1993, an additional 25 shops were recognized for having met the criteria. In the fall of 1993, at the end of the second year of the program, the total number of Clean Bay Businesses recognized reached 179. Figure 6-1 shows the increase in Clean Bay Businesses for the first two years of the program.

In addition to the 179 Clean Bay Businesses recognized this year, eleven shops that were in compliance with all 15 vehicle service facility requirements were not recognized as Clean Bay Businesses. This was because ten of these shops had sample results exceeding one or more permit limits. One shop was kept off the list due to violations of hazardous materials requirements that threatened surface water quality.

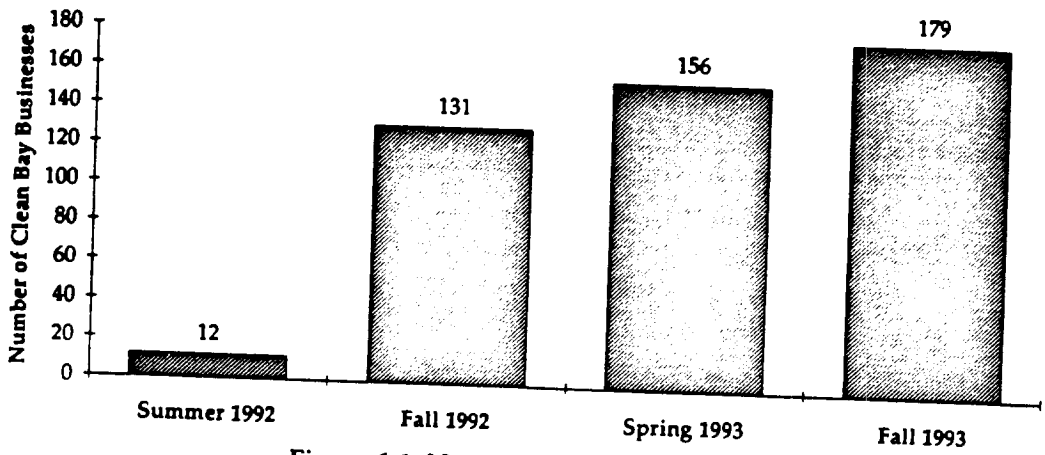

Figure 6-1 Number of Clean Bay Businesses

Twenty-nine shops (19%) that were Clean Bay Businesses in 1992 were not recognized in 1993. Of these twenty-nine shops, fourteen (9% of the 1992 list) were not recognized because of ordinance violations. Five of these shops were in violation of one or more of the 15 requirements and nine shops were not recognized due to discharge limit violations. The other sixteen shops were not recognized for a variety of reasons including: six closed their business, two were fleets and no longer eligible to be Clean Bay Businesses, four were no longer subject to the ordinance because they did not conduct regulated activities, and

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three shops were removed from the list for violations of their Conditional Use Permit issued by the Mountain View Planning and Community Development Department.

6.4 Recognition Items

Each of the Clean Bay Businesses received a recognition packet (Appendix D) containing the following items:

- Decals - for display in shop windows, walls, or display counters;
- Brochures - for distribution to customers; and
- Camera-ready "tear strips" - for use in display ads (e.g., newspaper, phone book), business cards, stationery, etc.

The Clean Bay Business decal was changed slightly this year to distinguish the 1994 recognition items from the 1992-93 items. The year on the decal was changed and the background color on the decals was changed from blue to green. In addition to the recognition items provided directly to the shops, the RWQCP purchased full page ads (also included in Appendix D) in three local newspapers (San Jose Mercury News, Palo Alto Weekly, and The View) announcing the Clean Bay Business recognition and listing all 179 shops by name and location.

7.0 Fleet Outreach Program

7.1 Introduction

In 1992, during the first year of the program, only city maintenance yards or those fleet operations whose main business activity involved vehicle use were visited. These categories of fleets included schools, transportation (bus) companies, moving services, trucking companies, garbage collection companies, and rental car companies.

In 1993, additional fleet maintenance operations were targeted in an effort to further reduce pollutants generated from vehicle servicing. Examples of the other types of businesses with fleets include large corporations, golf courses, and service companies (e.g., landscaping/gardening, painting, carpet cleaning). The identified fleets were visited to provide information on water quality protection and to determine the status of the fleet's compliance with the sewer

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use ordinance. Information from the visits was added to the RWQCP's Source Control Management database and follow-up visits were made.

7.2 Regulation of Fleet Maintenance Facilities

The sewer use ordinance developed for vehicle service facilities applies to all facilities that conduct at least one vehicle maintenance activity. Maintenance activities include: repair, fueling, fluid replacement, parts cleaning, salvaging, and washing. For the purposes of the ordinance, a fleet was defined as follows:

- Consists of more than five vehicles in one location,
- Located within the RWQCP service area, and
- Conducts at least one vehicle maintenance activity on-site.

Some companies with large fleets conduct many vehicle maintenance activities, however the primary maintenance activity conducted on-site at fleet yards is vehicle washing. The vehicle washing requirements in the sewer use ordinance include requirement 9, which states that vehicle wash water may not enter the sanitary sewer unless it is discharged in accordance with an industrial wastewater discharge permit. Requirement 10 prohibits the discharge of wash water to a storm drain if it contains soap, or if it results from routine washing of dirty vehicles in a fleet washing operation. These ordinance requirements apply to vehicle washing whether it is done at a wash rack or by a mobile cleaner.

7.3 Survey of Fleet Maintenance Facilities

In 1993, an extensive telephone survey was conducted of businesses in the service area to search for and identify fleets not visited in 1992. A list of approximately 300 businesses in 55 different categories was generated from phone book listings. The survey was designed to determine how many of the potential fleets were "fleets" as defined by the ordinance. A copy of the survey worksheet is attached in Appendix E. Questions included:

- Does your company own more than 5 vehicles?
- Are they kept in one location?
- Is that location in the RWQCP service area?
- Are the vehicles serviced on-site?
- If so, which activities are performed?

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Information was gathered about off-site maintenance practices and about mobile vehicle maintenance businesses that provided services to the fleet owner. During the phone calls, visits were scheduled with the companies that maintain more than five vehicles on-site and in the service area.

7.4 Findings of Fleet Survey

Of the total 328 companies contacted, 128 (39%) had fleets of greater than five vehicles, 178 (54%) had a fleet of five or fewer vehicles, and 22 companies were no longer in business. Of the 128 companies with fleets of greater than five vehicles, 32 (25%) housed their fleet outside the service area, and 21 (16%) had all of the maintenance done at retail service facilities, many of which were already visited as part of this program. The remaining 75 companies (23%) were conducting maintenance on more than five vehicles on-site and in the service area, and were therefore included in the program. These 75 companies were visited, 34 in 1992, and 41 after the survey in 1993.

Table 7-1 summarizes the status of the 328 companies contacted in the first two years of the program. The distribution of visited fleets in the various business categories is shown in Figure 7-1. These figures are given as an indication of the number of fleets other cities might find amongst businesses in their service area.

Table 7-1 lists 33 of the 55 categories of businesses contacted. The first column lists the total number of businesses contacted in each category. The second column lists the number of businesses that have more than five vehicles that are serviced on-site and in the service area. These are the businesses that were visited. Also listed in this column, is the percentage of the total number of fleets visited in each category of business. For example, 16% (or 12 of the 75 fleets visited) are car or truck rental companies.

The third column of Table 7-1 gives the number of businesses that have more than five vehicles (regardless of whether they are serviced on-site or in the service area) and the percent of the total number contacted in the category. For example, 10 pest control companies were contacted. Forty percent of these had fleets of greater than five vehicles. However, none of these four businesses kept the vehicles in the service area or serviced them on-site, so none were visited.

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As can be seen from Table 7-1, 100% of the businesses in certain categories were maintaining five vehicles on-site and were therefore visited as fleets. These categories included car rental agencies, bus companies, and post offices.

Table 7-1 Summary of Fleet Survey Results

Type of Business	# Visited fleets with >5 vehicles, serviced on-site (% of fleets visited)	Total # of fleets with >5 vehicles (% of # contacted)	Total number of businesses contacted
Car/Truck Rental	12 (16%)	12 (100%)	12
Postal Services	8 (11%)	8 (100%)	8
Landscaping/Gardening	5 (7%)	6 (35%)	17
Research & Development	4 (5%)	5 (30%)	15
Schools	4 (5%)	4 (100%)	4
Garbage Cos.	4 (5%)	4 (100%)	4
Golf Courses	4 (5%)	4 (100%)	4
City Maintenance Yards	4 (5%)	4 (100%)	4
Electronics Manufacturers	3 (4%)	12 (36%)	33
Transportation Cos.	3 (4%)	7 70%)	10
Moving Services	2 (3%)	4 (57%)	7
Trucking Services	2 (3%)	2 (100%)	2
Electrical Services	2 (3%)	6 (40%)	15
Towing Services	2 (3%)	2 (14%)	14
Flying Clubs	2 (3%)	2 (100%)	2
Hospitals, Labs, Medical	1 (2%)	5 (16%)	32
Carpet Cleaning	1 (2%)	4 (25%)	16
Painting Services	1 (2%)	1 (11%)	9
Telephone Services	1 (2%)	2 (100%)	2
Courier Services	1 (2%)	1 (14%)	7
Security Services	1 (2%)	3 (50%)	6
Dairy Products	1 (2%)	1 (50%)	2
Vending Machines	1 (2%)	3 (50%)	6
Military Installations	1 (2%)	1 (100%)	1
Cable Services	0 (0%)	4 (80%)	5
Nonprofit Resales	0 (0%)	3 (100%)	3
Pest Control	0 (0%)	4 (40%)	10
Mailing Services	0 (0%)	2 (100%)	2
Newspapers	0 (0%)	1 (20%)	5
Food Delivery	0 (0%)	0 (0%)	8
Laundries	0 (0%)	0 (0%)	7
Janitorial Services	0 (0%)	0 (0%)	13
Funeral Services	0 (0%)	0 (0%)	5
Other	5 (7%)	9 (28%)	38
Total	75	126 (38%)	328

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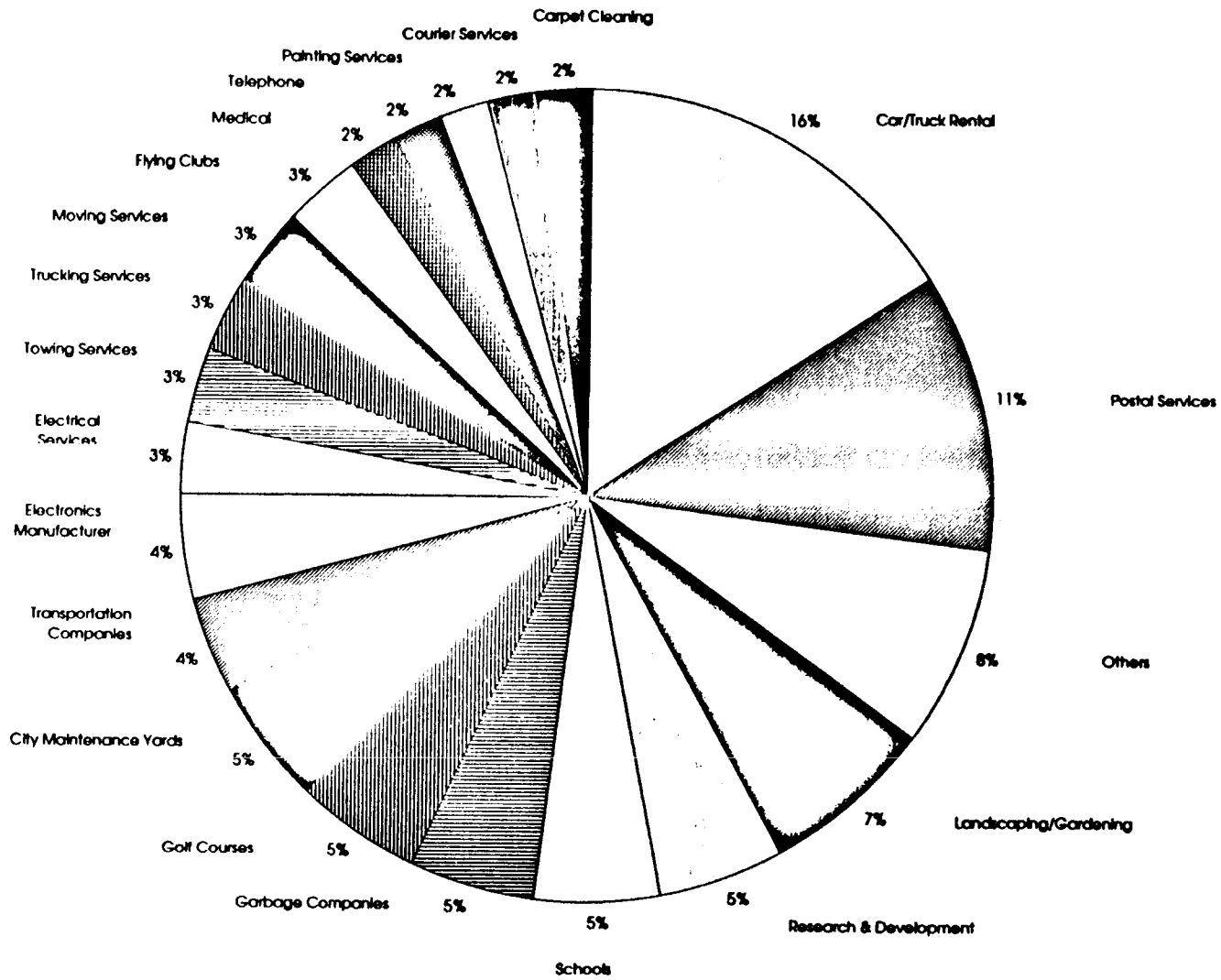
Figure 7-1 Distribution of Businesses Regulated as Fleets



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However, in other categories our survey showed little correlation between type of business and size of fleet. For example, seemingly similar large corporations have fleets ranging in size from zero to over fifty vehicles. Most service industries (electrical, painting, cleaning, gardening, etc.) were found to have zero to eight vehicles, but one electrical servicing company we visited had close to 100 vehicles.

Appendix F presents the complete results of the fleet survey.

7.5 Fleet Visits

Visits were conducted between June and August 1993. The visits were similar to those conducted at retail facilities. A *Fleet Operations Information Package* (Uribe & Associates, 1993c) was given to each fleet manager. This package contained the same information as the *Shop Information Package* (Uribe & Associates, 1992) supplied to retail facilities, except that it did not contain information on the Clean Bay Business program. Clean Bay Business recognition was not offered to fleets whose primary business activity was not related to vehicle service (e.g., U.S. Postal Service).

7.6 Findings of Fleet Visits

Vehicle Washing Activities

The primary activity conducted by fleets with the potential to damage surface water quality is washing vehicles in areas draining to storm drains. Twenty-two of the 41 fleets (54%) visited this year were washing their vehicles in areas draining to storm drains. Of the remaining fleets, seven (17%) had wash racks connected to the sanitary sewer, five (12%) washed vehicles in areas that allowed the wastewater to soak into the ground, six (15%) had the vehicles washed off-site, and one cleaned vehicles with rags only. Eleven of the twenty-two fleets (50%) washed in areas that drain to storm drains were washed by mobile cleaning services. None of these discharges was routed to the sanitary sewer. The RWQCP is working on guidelines for mobile cleaning to eliminate these non-storm water discharges.

The volume of contaminated wastewater entering storm drains from fleet washing can be significant. For example, two fleets were washing over 100

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vehicles in parking lots draining to storm drains. One of these is a U.S. Postal Office and the other is a large electrical servicing company.

There are a variety of methods to comply with the requirement prohibiting wash water discharge to storm drains. Companies can construct a wash rack with an oil/water separator and discharge to the sanitary sewer. They can also take their vehicles to commercial car washes with permitted discharges to the sanitary sewer. A few companies with small fleets have unpaved areas that can be used to wash vehicles allowing all of the wastewater to percolate or evaporate, rather than running off into storm drains. One car rental agency is complying by cleaning vehicles with wet rags only.

Most of the companies with a small number of vehicles plan to comply by taking their vehicles to a commercial washing facility. Many fleet managers felt they could not afford the expense of the commercial car wash nor the time to deliver the cars to the car wash. However, we found that even some companies with large fleets are using commercial car washes. Most commercial car washes offer corporate rates for fleets and the companies reduce the time commitment by having the driver of the vehicle stop at the car wash during their business travel. Another concern expressed by a tree service company is the difficulty in finding a commercial facility equipped to handle large vehicles.

One potential socioeconomic impact of moving fleet washing operations to commercial car washes is the closing of mobile cleaning companies. In order for these companies to stay in business and to operate in a way that protects surface water quality, methods and products are needed to contain the wastewater and redirect it or transport it to a sanitary sewer. Methods and products that are currently used by mobile cleaners in other parts of the state and country include:

- Plugging the storm drain and pumping out the wash water, and
- Employing a temporary boom to collect and vacuum up the wash water before it reaches a storm drain.

The RWQCP has met with some of the mobile cleaners to agree to acceptable methods of protecting storm drains. For example at the Palo Alto Airport, mobile cleaners are using rags to clean the dirtiest portions of the airplanes. Then, a fine mist of water is applied to rinse off dust from the upper surfaces of

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the plane. This reduces the quantity and improves the quality of the water discharged.

A regional effort to control discharges from mobile cleaners is currently being planned. Efforts will include investigating alternative methods and products to reduce and control pollutants generated by mobile cleaning.

Other Fleet Findings

Other findings of the fleet visits include:

- Leaking vehicles parked on company property created storm water quality problems. This is particularly true for large transportation and garbage companies. Diesel engines in trucks and buses tend to leak more than gasoline engines. Garbage trucks use hydraulic fluid in several places in order to operate the various lifts, making it difficult to contain a leak and identify its source. Most fleet managers are hesitant, if not completely resistant, to placing drip pans under every vehicle with a tendency to drip oil, for fear of the pans being driven over and the contents, if any, spilled.
- Some fleets operations clean their parking lots and flush not only leaked fluids but also soaps into the storm drains.
- Some fleet operations dispense fuel. Often the fuel pumps are located close to and upgradient of storm drains, increasing the potential for spills to contaminate storm water.

8.0 Car Wash Coupon Program

This year, a pilot car wash coupon program was developed and implemented. The purpose of this program was to educate the public about the pollution of storm water resulting from cleaning cars at home and the benefits of using commercial car washes that treat the wastewater and send it to the RWQCP for further treatment before discharge to the bay. The program also provided a $2 off coupon as a positive incentive for using commercial car washes.

Commercial car washes were contacted for input on the program. All of the car washes in the service area were enthusiastic about participating. The RWQCP reimbursed them $2 for each coupon they received. The coupon was printed on a flier featuring Flo, the Storm Drain Program's mascot raccoon, and the name

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and address of each commercial car wash in the area. A copy of the coupon is included in Appendix G.

A total of 3,000 coupons were distributed. The number of coupons distributed was limited by the budget set aside for reimbursing the car washes and by the uncertainty of the return rate. An adult-sized Flo the raccoon handed out coupons at local schools. Some coupons were distributed at the Stanford University Earth Day fair. However, the number distributed was fewer than expected because of rainy weather that held down attendance. Other coupons were available at distribution points around town, including libraries, the recycling center, and City Hall.

The number of coupons actually used was disappointingly few. The total number of coupons used was only 40, all from one car wash facility. One reason for the poor rate of return may have been that the largest car washes in the area have very aggressive coupon programs already. One of these car washes regularly offers $5 off their standard price. Although it was stated on the coupon that the $2 off applied to the "regular or discounted price" of the car wash, it may not have been understood that the coupon could be used together with other coupons. Another reason for the poor usage rate may have been that the coupon did not look like a coupon. It looked more like an educational piece and as a result probably did not catch people's attention.

The RWQCP is considering revising the coupon and redistributing them this year. Last year the coupons were distributed in the spring when it was still raining regularly. This year the program may be more successful if coupons are distributed in the middle of summer when the rains have stopped.

9.0 Program Effectiveness

This section summarizes program effectiveness information presented elsewhere in this report.

9.1 Retail Facilities

- The number of shops in compliance with the sewer use ordinance is steadily increasing. At the beginning of the program in 1992, only 12 shops (4%) were in full compliance with the 15 requirements after their initial visit. By the end of the first year, 48% of the shops (156) were in compliance. After

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the visits in 1993, 179 (54%) shops were in compliance with these requirements.

- From 1992 to 1993, the number of violations of the sewer use ordinance was reduced by 66%. The violations of some of the requirements were reduced by as much as 100%.

- There was little reduction in violations caused primarily by poor employee training. This result indicates that shops may need more help with training and that more rigorous enforcement of the training requirement may be needed.

- There was a significant reduction in the number of direct discharges from retail facilities to storm drains from 56 to only 2 (96% reduction). Elimination of these last two discharges is pending. The corrected discharges were mostly from vehicle washing but also included parking lot cleaning, wet sanding of vehicles, and in one case, the use of an outdoor sink.

- About 84% of the vehicle service facilities in the service area are "zero dischargers" to the sanitary sewer.

- At the end of 1992, 68 shops in the service area had unpermitted open sumps and floor drains, down from 125 at the beginning of the year. By the time of the 1993 visits, only two unpermitted sumps or floor drains were found, a 97% reduction. Permits for these remaining discharges are pending. The rest of these discharges had either been discontinued by plugging the drain or permitted by the RWQCP.

- Six automotive machine shops were found discharging parts cleaning wastewater into the sanitary sewer in 1992 without an industrial waste discharge permit. This year they are all in compliance. Two have industrial waste discharge permits and four became zero dischargers.

- In the fall of 1992, the first group of 131 shops was recognized as Clean Bay Businesses. In the spring of 1993, an additional 25 shops were recognized for having met the criteria. In the fall of 1993, the total number of Clean Bay Businesses recognized reached 179.

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9.2 Fleet Operations

- Forty-one fleet operations, not previously identified because their primary business activity is not vehicle service or transportation, were found by the fleet survey and are now part of the vehicle service facility waste minimization program. Their addition represents a 12% increase in the number of facilities in the program.

9.3 Car Wash Coupon Program

- Approximately 3,000 fliers with coupons were distributed to the public this year. These fliers educated the public about storm water impacts from car washing at home and gave an incentive to use commercial car washes. Although only 40 coupons were actually used, future public education effort should reduce the amount of vehicle wash water entering storm drains.

10.0 Recommendations

The following are recommendations for continued improvement in the program:

In terms of the decrease in noncompliance rates for each ordinance requirement, the smallest reduction in violations included a 12% reduction in violations of the spill cleanup requirement (#2), and a 35% reduction in leak containment (requirement #7) violations. Both these types of violations could be reduced further if employee training were improved. An effort should be made in the next year of the program to provide more assistance in training and to enforce the training requirement more rigorously.

The sampling results this year indicate that factors, other than the type of activity performed, play a big role in determining metals concentration. These factors include implementation of best management practices, regularity of sump cleaning, and the time interval between sump cleaning and sampling. As more data is collected on these maintenance activities and on wastewater quality, more conclusions can be drawn. These conclusions should be used to help noncomplying shops to achieve compliance.

Over one-half of the fleets visited this year were washing vehicles in areas draining to storm drains. Half of these are using mobile washing companies. Efforts should be continued to address these mobile businesses on a regional basis.

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The RWQCP is considering revising the car wash coupon and redistributing them this year. Last year the coupons were distributed in the spring when it was still raining regularly. This year the program may be more successful if coupons are distributed in the middle of summer after the rains have stopped.

11.0 References

Uribe & Associates, 1992. Shop Information Package - Vehicle Service Facility Waste Minimization Program, April 1992.

Uribe & Associates, 1993a. 1992 Summary Report - Vehicle Service Facility Waste Minimization Program, prepared for Palo Alto Regional Water Quality Control Plant, February 1993.

Uribe & Associates, 1993b. Shop Information Package - Vehicle Service Facility Waste Minimization Program, August 1993.

Uribe & Associates, 1993c. Fleet Operations Information Package - Vehicle Service Facility Waste Minimization Program, May 1993

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APPENDIX A

INSPECTION CHECKLIST

INSPECTION REPORT

VEHICLE SERVICE FACILITIES

A. GENERAL INFORMATION

1. DATE:_____
2. PURPOSE FOR VISIT:_____

3. FACILITY NAME:_____
4. FACILITY ADDRESS:_____
5. MAILING ADDRESS (IF DIFFERENT):_____
6. CONTACT PERSON:_____
7. TITLE:_____
8. PHONE NUMBER:_____

9. PRIMARY BUSINESS ACTIVITY:_____
_____

INSPECTOR NAMES:_____

SUBCATEGORIES:

general repair _____	fuel dispensing _____
radiator repair _____	exterior vehicle washing _____
dip washing _____	machining _____
engine cleaning _____	salvage/wrecking _____
body repair _____	painting _____
fleet operations_____	

B. FACILITY SCHEMATIC:

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C. COMPLIANCE WITH ORDINANCE ITEMS:
(please circle numbers of ordinance violated and explain if necessary)

1. no discharge to storm drains:_____
2. clean up spills immediately:_____
3. process discharge w/permit:_____
4. floor drains w/permit:_____
5. parts cleaning rinsewater discharged w/permit:_____
6. vehicle fluid removal inside building or over secondary containment:_____
7. leaks contained immediately:_____
8. unattended drip pans or open containers w/in secondary containment:_____
9. vehicle washing w/permit:_____
10. vehicle washing w/out soap to storm:_____
(excepting commercial or fleet washing facilities)
11. three step floor cleaning procedures:_____
(rags or absorbents, dry sweep, & then mop)
12. spill clean-up materials kept in stock:_____
13. batteries w/secondary containment & earthquake protection:_____
14. annual employee training:_____
15. stencilled storm drains:_____

RATING:____ 3 = no changes needed 1 = major changes needed
2 = minor change (vio. 13,14,15) 0 = serious violations

D. ESTIMATED FLOW:_____

E. INSPECTION REMARKS:_____

INSPECTED BY:_____

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F. Cleaning Activities					
Activity	Number	Type of cleaning material used (e.g. water, steam, solvent, heat, dry abrasives, alkali cleaner, detergent, cosmolene remover, etc.)	Waste handling (e.g. sanitary sewer, storm sewer; shipped for hazardous waste disposal, solid waste disposal, treatment or recycling; onsite reuse, recycle or treatment, etc.)	Sewer use permit? (yes/no / NA)	Comments
I. Parts cleaning	Units				
a. Sink(s)(e.g.solvent)					
b. Spray cans					
c. Hot tank(s)					
d. Steam cleaners					
e. Jet Sprays					
f. Mechanical cleaning					
g. other*					
h. other*					
i. other*					
II. Engine/Undercarriage	#/day				
a. Engines					
b. Undercarriages					
III. Vehicle washing	Veh./day				

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G. Other Activities

Note: Complete columns in bold first. Complete remaining columns if time allows and information is available.

Activity	Activity present	Waste handling (e.g. sanitary sewer, storm sewer, shipped for hazardous waste disposal, solid waste disposal, treatment or recycling; (onsite reuse, recycle or treatment, etc.)	Sewer use permit? (yes/no/ NA)	Comments
I. Fluid removal/Replacement				
a. Radiator fluid				
b. Motor oil				
c. Transmission fluid				
d. Hydraulic fluid				
e. Differential lubricant				
f. Refrigerant				
II. Radiator Repair				
a. Boil out tank				
b. Flush booth waste				
c. Test tank waste				
d. Other				
III. Battery replacement				
IV. Body shop wastes				
a.				
b.				
c.				
V. Machining				
VI. Wrecking/Salvaging				
VII. Other				
VIII. Other				

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APPENDIX B

TEXT OF ORDINANCE REQUIREMENTS

Excerpt from the Revised
REGIONAL WATER QUALITY CONTROL PLANT
1992 SEWER USE ORDINANCE
affecting
VEHICLE SERVICE FACILITIES

16.09.010 Definitions.

(19) "Pretreatment system" means a treatment system at an industrial or commercial facility that is designed to treat water prior to entering the city's sewer system.

(21) "Secondary containment" means and shall have the meaning specified by Title 17 of this code.

16.09.110 Standards. (Partial list)

Instantaneous Concentration Allowable

Parameter	*Maximum*	*Minimum*
Oil grease **	20 mg/liter	–
Oil grease (total)	200 mg/liter	–
Cadmium	0.1 mg/liter	–
Chromium, Hexavalent	1.0 mg/liter	–
Chromium (total)	2.0 mg/liter	–
Copper	2.0 mg/liter	–
Lead	0.5 mg/liter	–
Nickel	1.0 mg/liter	–
Zinc	2.0 mg/liter	–
pH	11.0 units	5.5 units
Total Toxic Organics (TTO)	1.0 mg/liter	–
Any Single Toxic Organic	.75 mg/liter	–

** Gravity separation at a temperature of 20° C and a pH of 4.5

16.09.113 Requirements for vehicle service facilities.

(a) Definitions. For the purposes of this section the following words and phrases shall be as defined herein.

(1) "Commercial vehicle washing facility" means a commercial facility where vehicle washing is a primary business activity. Commercial vehicle washing facilities include, but are not limited to, mobile washing rigs.

(2) "Fleet washing facility" means a facility for washing vehicles, at a location where a business maintains six or more vehicles.

(3) "Ground surfaces" means and includes dirt, gravel, or other unpaved surfaces.

(4) "Vehicle" means a mode of transporting people or things. Vehicles include, but are not limited to, automobiles, trucks, recreational vehicles, tractors, airplanes and boats.

(5) "Vehicle fluid" means a liquid used in or drained from a motor vehicle. Vehicle fluids include, but are not limited to, gasoline, diesel fuel, motor oil, brake fluid, radiator fluid, hydraulic fluid, transmission fluid, and coolant.

(continued on back)

NOTE: Paragraph numbering corresponds to the Palo Alto Municipal Code. Numbering systems used for the other cities in the service area (East Palo Alto, Los Altos, Los Altos Hills, and Mountain View) will vary.

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(continued from inside back cover)

(6) "Vehicle service facility" means a commercial or industrial facility that conducts one or more of the following operations with respect to vehicles or components of vehicles: vehicle repair, fuel dispensing, vehicle fluid replacement, engine and parts cleaning, body repair, vehicle salvage and wrecking, or vehicle washing.

(b) All vehicle service facilities shall be operated, on and after October 1, 1992, in accordance with the following standards:

(1) No person shall dispose of, nor permit the disposal, directly or indirectly, of vehicle fluids, hazardous materials, or rinsewater from parts cleaning operations into storm drains.

(2) All owners and operators of vehicle service facilities shall ensure that any vehicle fluid, hazardous material, or rinsewater from parts cleaning operations that comes into contact with any floor, pavement or ground surface is cleaned up immediately from such surface.

(3) No person shall dispose of vehicle fluids or rinsewater from parts cleaning operations into the sanitary sewer system except pursuant to an industrial waste discharge permit obtained in accordance with this chapter.

(4) No vehicle service facilities shall contain floor drains, excepting only such floor drains as are connected to wastewater pretreatment systems for which an industrial waste discharge permit has been obtained in accordance with this chapter.

(5) No tanks, containers or sinks used for parts cleaning or rinsing shall be connected to the storm drain system, or to the sanitary sewer system except pursuant to an industrial waste discharge permit obtained in accordance with this chapter.

(6) No person shall perform vehicle fluid removal outside a building, nor on asphalt or ground surfaces, whether inside or outside a building, except in such a manner as to ensure that any spilled fluid will be in an area of secondary containment.

(7) Leaking vehicle fluids shall be contained or drained immediately.

(8) No person shall leave unattended drip pans or other open containers containing vehicle fluid, unless such containers are in use or in an area of secondary containment.

(9) No person shall discharge wastewater from vehicle washing operations or wash racks to the sanitary sewer system except pursuant to an industrial waste discharge permit obtained in accordance with this chapter. Nothing in this subsection shall be construed to prohibit the proper reuse of wastewater.

(10) No person shall discharge into the storm drain water from vehicle washing operations, except from rinsing of vehicle exterior surfaces, with water only, for appearance purposes. This exception does not apply to commercial vehicle washing facilities or fleet washing facilities.

(11) Vehicle service facilities shall be cleaned using only those methods of cleaning that ensure that no materials are discharged to the storm drain or to the sanitary sewer system, except for wastewater which is discharged to the sanitary sewer system pursuant to an industrial waste discharge permit obtained in accordance with this chapter; provided, however, that a permit shall not be required for facilities that use the following three-step sequence for cleaning floors:

(i) Clean up spills with rags or other absorbent materials.

(ii) Sweep floor using dry absorbent material.

(iii) Mop floor. Mop water must be discharged to the sanitary sewer via a toilet or sink.

(12) All owners and operators of vehicle service facilities shall ensure that spill prevention and clean-up equipment and absorbent materials are kept in stock at all times and are readily available for use.

(13) No acid-containing batteries shall be stored except within secondary containment.

(14) All owners and operators of vehicle service facilities shall ensure that all employees of such facilities are trained, upon hiring and annually thereafter, regarding best management practices in accordance with guidelines issued and published by the superintendent.

(15) All owners and operators of vehicle service facilities shall post or cause to be posted signs on all storm drains located on the property of the facility notifying persons that the discharge of wastes into the storm drain is illegal.

In the case of any conflict between the provisions of this section and other provisions of this chapter, this section will apply.

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APPENDIX C

SAMPLE PERMIT

R0055029

VEHICLE SERVICE FACILITY DISCHARGE PERMIT

Discharger:
Facility Address:

Permit Number:

This Vehicle Service Discharge Permit is granted to the above facility to discharge treated vehicle service wastewater and domestic waste to the City of Palo Alto sewer collection system in compliance with the City of Palo Alto Sewer Use Ordinance Chapter 16.09, any applicable provisions of Federal or State law and regulations, and in accordance with all provisions set forth herein. In addition to the Specific Permit Conditions (Attachment 1), the discharger's attention is specifically directed to Attachment 2 (Standard Permit Conditions) of this permit, which refers to certain provisions of City of Palo Alto Municipal Code, Chapter 16.09. Violation of the conditions set forth herein may result in civil and criminal penalties as described in Chapter 16.09.140, but not limited to civil liability of $6,000 per day.

This permit is issued to in accordance with the application filed on February 4, 1993 with the Palo Alto Regional Water Quality Control Plant (RWQCP) and in conformity with plans, specifications, and other data submitted in support of the above application. This permit is not transferrable without submission of a new discharge permit application and written consent of the superintendent.

Effective Date: May 27, 1993
Expiration Date: May 27, 1996

Phil Bobel, Manager
Environmental Compliance Division

Bill Miks, Manager
Palo Alto Regional Water Quality Control Plant

Attachments:
1. Specific Permit Conditions
2. Standard Conditions
3. Sampling Instructions
4. Sampling Location Diagram
5. Inspection/Maintenance Log Form

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Attachment 1

SPECIFIC PERMIT CONDITIONS

Part A. Discharge Conditions

1. Discharge Rate

The discharge rate from this facility shall not exceed a maximum process flow rate of 22,000 gallons per month and a total flow rate of 22,000 gallons per month. Any increase in either discharge rate from this facility requires the prior approval of the Palo Alto Regional Water Quality Control Plant (RWQCP).

Part B. Sampling Location

The designated sampling point is after the treatment system and prior to discharge to the sanitary sewer. The designated sampling point is labelled Sampling Point "1" on the attached sampling point diagram (Attachment 4).

Part C. Effluent Limitations

During the term of this permit, the discharge from this facility shall not exceed the following effluent limitations at sampling point "1":

Applicable Effluent Limits*

PARAMETER	INSTANTANEOUS MAXIMUM	PARAMETER	INSTANTANEOUS MAXIMUM
Arsenic	0.01	Silver	0.25
Beryllium	1.00	Zinc	2.00
Cadmium	0.10	Fluoride	65.0
Chromium (total)	2.00	Formaldehyde	5.00
Copper	2.00	Oil & Grease	200.0
Cyanide	1.00	Phenols	1.00
Lead	0.50	TTO**	1.00
Mercury	0.05	pH	5.5-11.0
Nickel	1.00	Susp. Solids	6,000
Selenium	2.00		

*All limits are given in mg/L except for pH.
**TTO=Total Toxic Organics

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Part D. **Monitoring and Maintenance**

1. Sampling Frequency

The facility operator shall conduct sampling according to the schedule provided in the following table:

PARAMETER	SAMPLING FREQUENCY
Copper	quarterly
Lead	quarterly

Revisions to the sampling frequency may be considered based on performance.

Part E. **Treatment System**

1. Treatment System

The facility operator shall operate and maintain the two-stage oil/water separator specified in the permit application.

2. Visual Inspection

The facility operator shall conduct a visual inspection of the oil/water separator a minimum of once per week to ensure that the system is operating properly and to determine if cleaning is necessary. A written log/record of the inspections shall be kept on the attached Inspection/Maintenance Log Form, Attachment #5. Inspection dates, observations, and any actions or cleaning required shall be logged.

3. Cleaning/Maintenance

The facility operator shall clean and maintain the oil/water separator a minimum of once per month, or more frequently if suggested by a visual inspection. A written log/record of the cleaning/maintenance events shall be kept on the attached Inspection/Maintenance Log Form, Attachment #5. Cleaning/maintenance dates, observations, and any further actions required shall be logged.

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R0055032

Part F. **Reporting**

1. Annual Report of Continued Compliance

The facility operator shall submit an Annual Report of Continued Compliance (ARCC) to the RWQCP by January 15th of each calendar year. The report shall contain all the changes that may have affected the quantity and the quality of the effluent during the past twelve month reporting period. The report shall also contain the analytical results from all sampling events required by Part D of this permit. In addition, a copy of the log (Attachment #5) of treatment system visual inspections and cleaning/maintenance events, as specified in Part E, shall also be submitted. The ARCC shall be completed according to the guidelines provided by the RWQCP.

2. Noncompliance Reporting

If the results of any sampling analysis indicates that the discharge has exceeded the allowable limits, the facility operator must:

i. Verbally inform the RWQCP of the violation within 24 hours of the dischargers knowledge of the violation.

ii. Submit a written report to the RWQCP, within fifteen working days of the discharger's knowledge of the noncompliance, explaining the following: the nature, volume, and duration of the violation; and mitigation measures taken to correct the noncompliance and prevent reoccurrence.

3. Spill Reporting

The facility operator shall immediately notify the RWQCP by phone, at 415-329-2598 (24 hour number), in the event of a spill and discharge to either the storm or sanitary sewer system. In addition, the facility operator shall submit a written report to the RWQCP, within fifteen days of the discharger's knowledge of the noncompliance, explaining the following: the nature, volume, and duration of the violation; and mitigation measures to correct the noncompliance and prevent reoccurrence.

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Attachment 2

STANDARD CONDITIONS

The following list of sections from Chapter 16.09 of the Palo Alto Sewer Use Ordinance have particular application to the Permit and are incorporated therein by reference:

Section	TITLE
16.09.010	Definitions
16.09.020	Industrial Wastes Discharge Permit
16.09.030	Industrial Wastes Discharge Permit Procedure
16.09.031	Compliance Schedule
16.09.032	New Sources
16.09.033	Reporting Requirements for all Permitted Dischargers
16.09.035	Personnel Orientation
16.09.040	Modification, Suspension or Revocation of Industrial Waste Discharge Permit
16.09.050	Permit Issuance, Denial, Modification, Revocation, or Suspension
16.09.060	Waste Sampling Locations
16.09.061	Discharger Monitoring
16.09.075	Limitations on Point of Discharge
16.09.080	Confidentiality
16.09.090	Accidental Discharge Prevention
16.09.095	Discharger Self-Monitoring
16.09.100	Prohibitions
16.09.110	Standards
16.09.115	Prohibition Against Dilution
16.09.130	Damage to Facilities
16.09.150	Compliance with the Pretreatment Regulations
16.09.152	District's Right to Terminate Discharge
16.09.155	Noncompliance and Increased Loading Reporting

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Attachment #5

VEHICLE SERVICE FACILITY-TREATMENT SYSTEM

INSPECTION/MAINTENANCE LOG

DATE	VISUAL INSPECTION	CLEANING/ MAINTENANCE	OBSERVATIONS/ COMMENTS
eg. 6/17/92	eg. yes		eg. sump clogged, needs cleaning
eg. 6/18/92		eg. yes	eg. sump cleaned, sludge removed and disposed of as a hazardous waste

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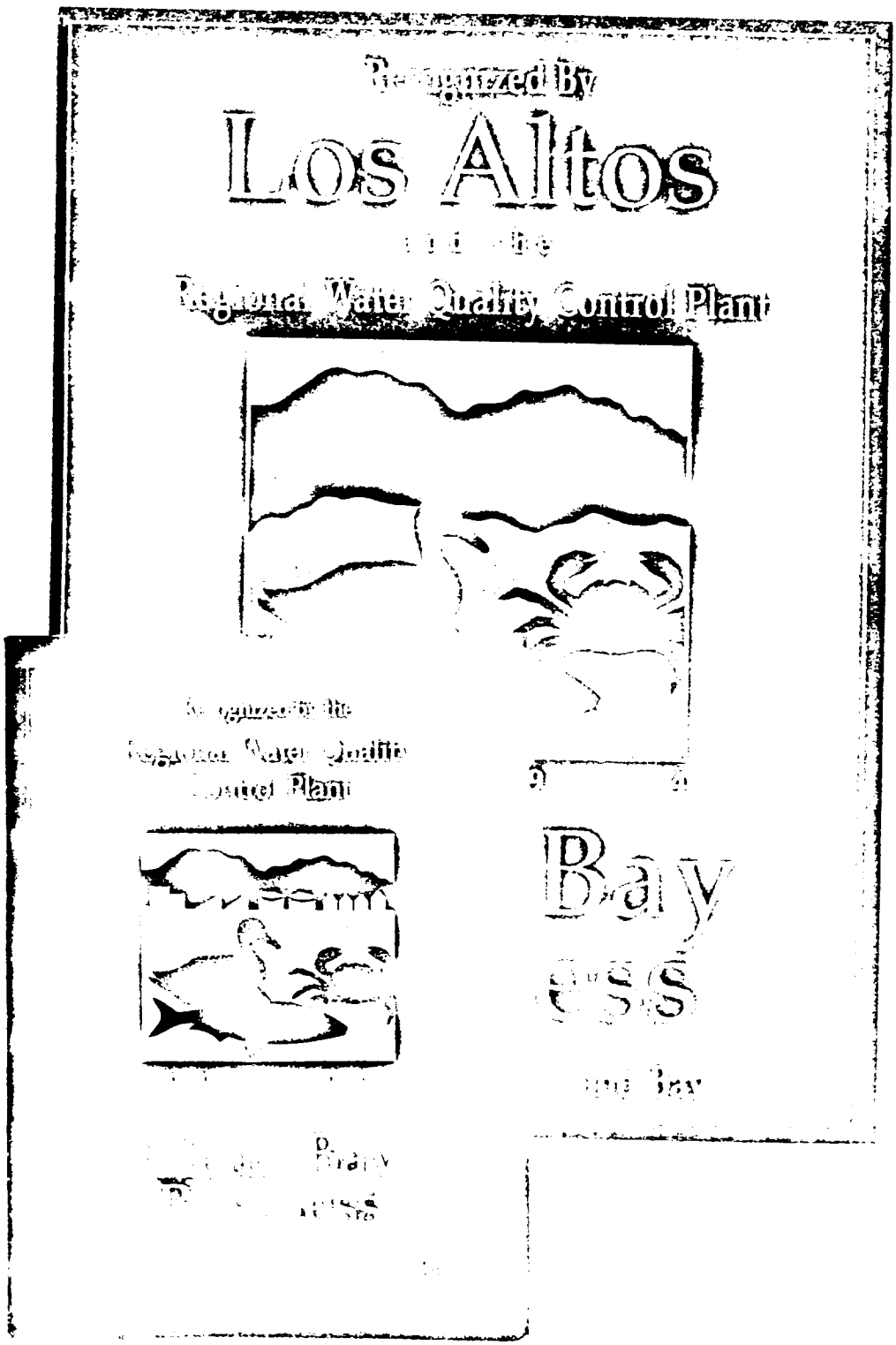
APPENDIX D

RECOGNITION PACKET AND NEWSPAPER ADVERTISEMENT



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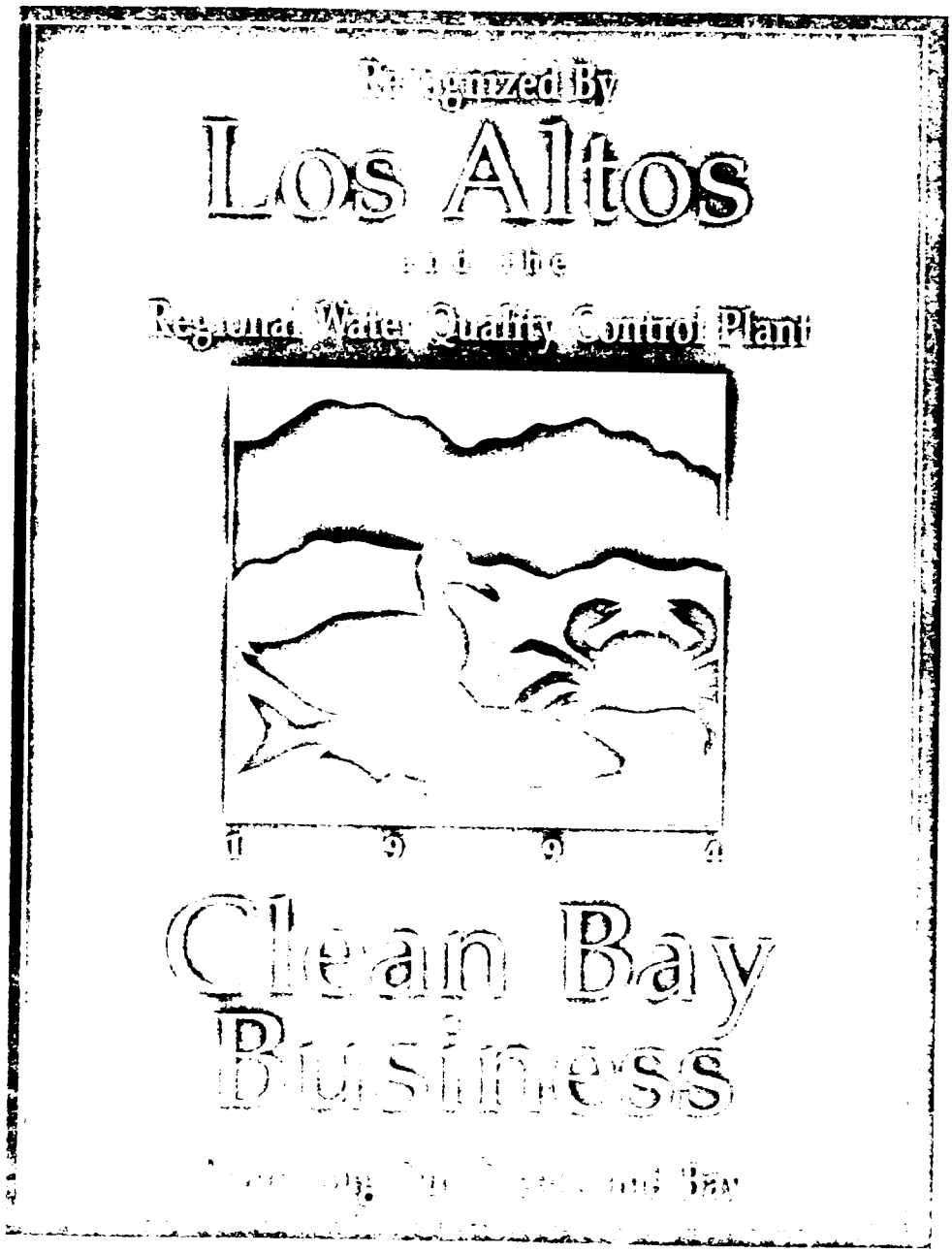
Torrance, CA 90503 #PV119E

R0055037



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R0055038

It's important for residents to know that washing or working on cars at home can pose severe hazards for the environment.

- ❑ If you wash your car with soap, do it on a grassy area where soapy water will not run into the street, and dispose of the bucket of suds into a sink or toilet.
- ❑ Take care to catch drips when you change vehicle fluids.
- ❑ Recycle used motor oil and antifreeze.
- ❑ If you cannot take these precautions, consider having a ***Clean Bay Business*** take care of your car.



Regional Water Quality Control Plant

Operated by the City of Palo Alto for the communities of East Palo Alto, Los Altos, Los Altos Hills, Mountain View, Palo Alto, and Stanford

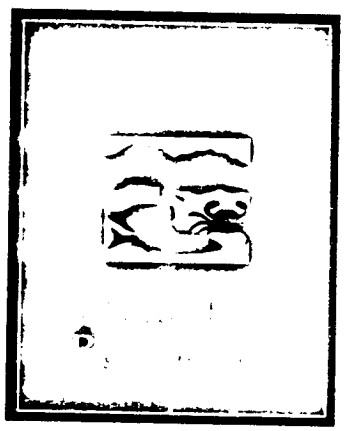
VOL 12 2 1139

R0055039

See if your favorite auto shop is a 1994

CLEAN BAY BUSINESS

These vehicle service facilities have made special efforts to protect local creeks and San Francisco Bay, by adopting shop practices that keep pollutants away from both storm drains and the sewer system.



Look for the green 1994 emblem in East Palo Alto, Los Altos, Mountain View, Palo Alto, and Stanford.

East Palo Alto
Accinelli's Cycle Goodies
Cavallino Collision Repair
Moonlite Car Wash
Tedlock's Auto Supply
University Chevron

Los Altos
Allied Auto Work
Altos Oaks Union Service
Arco AM/PM Mini Market
Beacon Oil Company
California Automotive Service
Chevron Automotive Center
Foothill Auto Service
Foothill Chevron Service
Los Altos City Yard
Los Altos Tire Service
Rancho Auto Service/Union 76
Village Chevron
Village Motors

Mountain View
A-1 Auto Tech
A-1 Foreign Auto Repair & Parts
Accutune and Brake
Americana Shell
America's Tire Company
Arco-Automotive Service Center
Auto Care Center
Bay Muffler
Beautiful Cars
Beautiful Sportscars
Bela's Autosports Service
BTN Automotive
C&C Body Shop
California BMW
Camino Car Wash
Car Clinic
Chevron USA
Clarke's Machine
Cole Garage
Corporate Auto Works
Corvette Repair
Cupertino-Mt.View Mercedes Service
Custom Muffler
D&D Tire & Auto
Dave's Body Shop
Dean's Foreign Car Service
Depot Garage
Diablo Auto Polishing & Detailing
Dinan Engineering
Don's Automotive
El Monte Unocal Service
Ellsworth Brothers Machine Shop
Euro Quattro
Eurocar Engineering
European Auto Detail
European Auto Works
Evelyn Auto Body
Express Lube
FCC Auto Body
Family Car Wash
Far Performance Service Center
Felix Auto Repair
Firestone Mastercare Service
Fortes Auto Body & Frame
Grant Road Shell
Grey's Thunderbird Nest
Griffin's Carburetor
Hall's Auto Cleaners/Family Car Wash
Harold's Auto Detailing
Heyer Performance
Howard Tire
Independence Acura Service
Independence Auto Body
Jaguar Performance Center
Jiffy Lube
Joe's Foreign Car
Larry's AutoWorks
Leslo's Auto Repair
Lee's Auto Center
Lou's Automotive
Lozano Brushless Car Wash
Midas Muffler
Middlefield Auto Service
Midway Automotive Machine Shop
Modderman Porsche Service
Moffett Blvd. Exxon
Moonlite Coin Car Wash (3 locations)
Mtn. View Auto Body & Paint
Mtn. View Automotive Service
Mtn. View Exxon (2 locations)
Mtn. View Foreign Car Service
Mtn. View Shell
Paragon Automotive Service Center
Performance Technology
Pedro's Auto Clinic
Precise Mobile Auto Repair
Quality Auto Repair
Quality Tune-Up
Rich's Truck Tire Service
Rodriguez Auto Service
Ron's Safety Service
Peter Schmid Transmissions
Steve Weiss Enterprises
Transmission Techniques
Tuban Industrial Products
Victor Tire
Yarnell's Service Center

Palo Alto
AA Radiator
Accutune
Akins Body Shop
Art's Body Shop
Auto Motor & Sport
Avis Rent-A-Car/Peninsula Lease
BP Oil Corp
Barron Park Automotive
Baumann Automotive
Bill Benson Auto
Bill's Unocal
Bill Young's Body Shop
Bill Young's Goodyear
British Auto Service
Budget/Sears Rent-A-Car
Carlson Porsche
Cho's Arco Garage
Cycle City
D & M Motors
Dollar Rent-A-Car
Dorn's Safety Service
Ellison's Automotive
Embarcadero Shell
Executive Helicopter Service
Exxon (San Antonio Rd.)
Hans Imported Car Service
Heiming's Auto Repair
Hongehold Truck Rentals & Sales
Hertz Rent-A-Car
Hileman Automotive Service
Honda Small Car Shop
Jiffy Lube (2 locations)
Jim Davis Automotive
Jim's Mobile Toyota Repair
Kurt's Auto Service
LP Automotive
Lawrence Tire Service
Lutz Ford
Maaco Auto Painting & Body Works
McCord Motorsports
Nine Minute Oil & Lube
Ole's Car Shop
Palo Alto Aero Service
Palo Alto Airport
Palo Alto Auto Clinic
Palo Alto BP
Palo Alto Deluxe Carwash
Palo Alto Fuel Services
Palo Alto German Car Corp.
Palo Alto Radiator Shop
Palo Alto Transmission Service
Park Automotive Service
Park Avenue Motors
Precision Auto Service
Rosenthal Service
Ross's Aircraft
Say Ray Foreign Auto Service
Service Auto Supply
Sherman's Auto Service
Speedometer Service Palo Alto
Stanford BMW
Stanford Honda
Stanford Nissan
Sundance Flying Club
Toyota of Palo Alto
Viking Motor Body Co.
West Valley Flying Club
Western Avionics

Stanford
Campus Service

The Regional Water Quality Control Plant is operated by the City of Palo Alto for the communities of East Palo Alto, Los Altos, Los Altos Hills, Mountain View, Palo Alto, and Stanford.

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R0055040

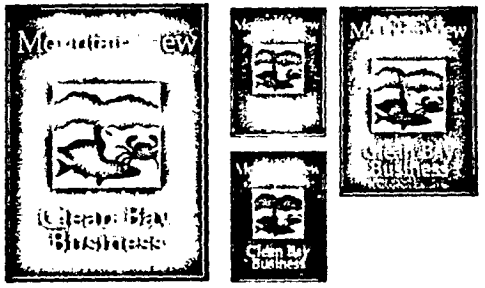
Congratulations on being recognized as a Clean Bay Business!

What works best for you? Below is a list of items that we sent to all Clean Bay Businesses last year. Please circle the items you would like to receive next year, and write in the amount you think you could use. Feel free to list ideas for new items. Thank you for responding!

____ *Decal(s) (6 inch by 8 inch)*
____ *Bumper sticker(s)*
____ *Brochure(s)*
____ *Sheet(s) of camera ready emblems for advertising*
____ *Patch(es) for hats or uniforms*
____ *Other ideas (please list):*_____
_____
_____

*We'd appreciate any other feedback on the Clean Bay Business program:*_____
_____
_____

Suzanne Healy
RWQCP
2501 Embarcadero Way
Palo Alto, CA 94303



Tear-sheet
(Above, sheet of camera ready emblems)

Clean Bay Business Response Postcard
(Left, showing both sides)

R0055041

Regional Water Quality Control Plant

Operated by the City of Palo Alto
for the communities of East Palo Alto,
Los Altos, Los Altos Hills, Mountain View,
Palo Alto, and Stanford University

January 19, 1994

Jim Kuhl
Paragon Automotive Service Center
249 Evelyn Avenue, West
Mountain View, CA 94041

Dear Jim Kuhl:

CONGRATULATIONS! You have met the Regional Water Quality Control Plant's (RWQCP) criteria for recognition as a Clean Bay Business for 1994. We commend you for your efforts to keep pollutants out of local creeks and San Francisco Bay (via the storm drain and sanitary sewer systems). We greatly appreciate the time, energy, and expense that you have invested in becoming an environmentally proactive business.

We are enclosing a variety of materials for your use including: decals, camera-ready tear strips, and brochures. The decals are for your shop windows, walls, or display counters. Please note that they may not be used for vehicle windows because of CHP size restrictions. The tear strips are provided so that you may use the Clean Bay Business logo in your advertising or on business cards or stationery. The brochures are for you to hand out to your customers at the counter. Please let us know if you need additional brochures through out the year.

We'd also like to let you know that we will be running ads in the local newspapers during the week of January 17 announcing the Clean Bay Business program. All businesses receiving the 1994 recognition will be listed. The advertisement will be placed in the San Jose Mercury News, the Palo Alto Weekly, and The View.

Lastly, we will be placing in ad in the automotive repair section of the yellow pages in the telephone book. The ad will feature the Clean Bay Business logo and a brief message. The message suggests that people ask their favorite auto repair shop if it is a Clean Bay Business. It also explains that Clean Bay Businesses have made extra efforts to reduce pollution and protect our creeks and Bay.

Thank you again for your pollution prevention efforts! Please fill out the enclosed "response card" and include any program suggestions or comments that you may have. Please call Suzanne Healy, at 415-329-2117, if you have any questions.

Sincerely,

Margaret Bitle

Phil Bobel, Manager
Environmental Compliance Division

2501 Embarcadero Way, Palo Alto CA 94303 Tel (415) 329-2598 Fax (415) 494-3537

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R0055042

SPECIAL SUMMER OFFER:
(with this coupon)

Kurt's

Kurt's Auto Service
780 High Street
Downtown Palo Alto
☎ 321-0461

SMOG INSPECTION

$29.95

Plus $7.00 for certificate. Please present coupon when you bring your car in. Not valid with other offers.
(Regular price: $40 plus certificate.)

INTRODUCTORY OFFER FOR NEW CUSTOMERS

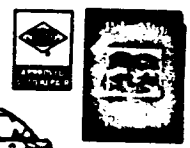
10% OFF
ANY SERVICE OR REPAIR

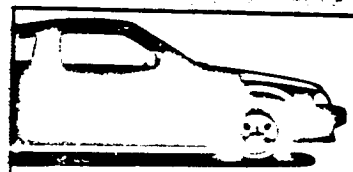
(Offer applies to in-house labor only. May not be used with other discounts. Not applicable for smog certification. Please present coupon when you bring your car in.)



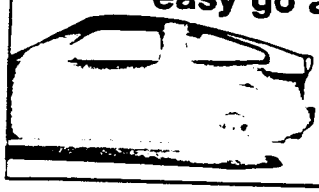
Kurt's

Kurt's Auto Service
780 High Street
Downtown Palo Alto
☎ 321-0461

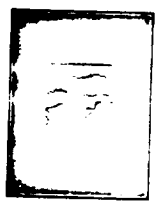




It's easy come, easy go at



Honda small car SHOP



- Servicing Honda and Acura Exclusively
- Complete Factory scheduled services
- ASE Certified; AAA authorized

$10 OFF
Labor on all intermediate services

$15 OFF
Labor on all major services

111 Homer at High Street
In downtown Palo Alto
329-0666
Expires 11/30/93
Mon.-Fri. 7:30-5:00

Please present coupon before final payment

Examples of Advertisements Using Camera Ready
Clean Bay Business Logos

VOL 12 2 1743

FUEL INJECTION SPECIALISTS

PALO ALTO
4200 EL Camino Real at Arastradero
856-3003



While You Wait! No Appointment Necessary

SMOG CHECK $17.95
Reg. $22.50
PLUS CERTIFICATE
With coupon only • Expires 5-20-94

EXPERT TUNE-UP $44.95
- 6 Month/ 6,000 Mile Guarantee
- Electronic Ignition Cars
- Fuel-Injected Cars
6 & 8 Cyl. extra

MOST CARS (Reg. $49.95)
With coupon only • Expires 5-20-94

OIL CHANGE $20.95
- Install New Oil Filter
- Add Up to 5 Quarts Premium Multi-Grade Motor Oil
- While You Wait- No Appointment Necessary

MOST CARS (Reg. $24.95)
$2.00 For Hazardous Waste Recycling
With coupon only • Expires 5-20-94

ALL YOU NEED!
- ALTERNATORS & GENERATORS
- SCOPE & ADJUST
- COOLING SERVICE
- CV BOOTS

We offer complete **ONE-STOP SERVICE. Save 10% OFF** any of the services listed below with this coupon.
- BELTS & HOSES
- ENGINE DIAGNOSTICS
- VALVE ADJUSTMENT
- TRANSMISSION SERVICE
- SCHEDULED MAINTENANCE - 15K & 30K
- TIMING BELTS

SAVE 10%
With coupon only • Expires 5-20-94

MONEY MAILER OF PALO ALTO (415)494-1515 • 313-05-006-ABC

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Example of Advertisement Using Camera Ready
Clean Bay Business Logo

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APPENDIX E

FLEET SURVEY WORKSHEET

R0055045

WORKSHEET FOR _____

Primary Business Activity _____

Interviewer Name _____

Intervlewee Name _____

Call Date/Time _____

Visit Date/Time _____

1. One or more company vehicles kept in a single location? Yes No

2. Location of Fleet: PA ST EPA LA LAH MV Other _____

3. Size of Fleet: _____. If less than or equal to 5, any plans for future expansion?

4. Type of Service

	Exterior Vehicle Washing		Vehicle Fueling		General Repair/Maintenance	
a) Is service performed on-site?	Yes	No	Yes	No	Yes	No
If not on-site, then where?	_____		_____		_____	
	_____		_____		_____	
b) By company or off-site contractor?	Company	Contractor	Company	Contractor	Company	Contractor
c) Contractor Info: Name	_____		_____		_____	
Location	_____		_____		_____	
Phone number	_____		_____		_____	

5. Contact Name/Title _____

Direct Phone _____ Company Name _____

Headquarters or Branch If Branch, where are Headquarters? _____

Fleet Address _____

Same as Mailing Address? Yes No If not, mailing address is _____

_____

R0055046

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APPENDIX F

FLEET SURVEY RESULTS

TABLE F-1 Results of Fleet Survey							
Type of Business	Number visited (>5 vehicles maintained on-site & in service area) (% of total visited)	Total number of businesses contacted	Number of fleets with >5 vehicles (% of # contacted)	Number of businesses with >5 vehicles but maintained by commercial shops	Number of businesses with >5 vehicles, but not in service area	Number of businesses with less than 5 vehicles	Number of companies out of business
Car/Truck Rental	12 (16%)	12	12(100%)	0	0	0	0
Postal Services	8 (11%)	8	8 (100%)	0	0	0	0
Landscaping/Gardening	5 (7%)	17	6 (35%)	1	0	9	2
Research & Development	4 (5%)	15	5 (30%)	1	0	10	0
Schools	4 (5%)	4	4 (100%)	0	0	0	0
Garbage Cos.	4 (5%)	4	4 (100%)	0	0	0	0
Golf Courses	4 (5%)	4	4 (100%)	0	0	0	0
City Maintenance Yards	4(5%)	4	4(100%)	0	0	0	0
Electronics Manufacaturer	3 (4%)	32	12 (38%)	7	2	19	1
Transportation Cos.	3 (4%)	10	7 (70%)	0	4	1	2
Moving Services	2 (3%)	7	4 (57%)	0	2	3	0
Trucking Services	2 (3%)	2	2 (100%)	0	0	0	0
Electrical Services	2 (3%)	15	6 (40%)	2	2	8	1
Towing Services	2 (3%)	14	2 (14%)	0	0	8	3
Flying Clubs	2 (3%)	2	2 (100%)	0	0	0	0
Hospitals, Labs, Medical	1 (2%)	32	5 (16%)	2	2	25	2
Carpet Cleaning	1 (2%)	16	4 (25%)	1	2	10	2
Painting Services	1 (2%)	9	1 (11%)	0	0	7	1
Telephone Services	1 (2%)	2	2 (100%)	0	1	0	0
Chemical Industry	1 (2%)	2	1 (50%)	0	0	0	1
Courier Services	1 (2%)	7	1 (14%)	0	0	5	1
Airports	1 (2%)	1	1 (100%)	0	0	0	0
Equipment Sales	1 (2%)	1	1 (100%)	0	0	0	0

R0055048

TABLE F-1 Results of Fleet Survey

Type of Business	Number visited (>5 vehicles maintained on-site & in service area) (% of total visited)	Total number of businesses contacted	Number of fleets with >5 vehicles (% of # contacted)	Number of businesses with >5 vehicles but maintained by commercial shops	Number of businesses with >5 vehicles, but not in service area	Number of businesses with less than 5 vehicles	Number of companies out of business
Military Installations	1 (2%)	1	1 (100%)	0	0	0	0
Security Services	1 (2%)	6	3 (50%)	1	1	3	0
Reprographics	1 (2%)	1	1 (100%)	0	0	0	0
Dairy Products	1 (2%)	2	1 (50%)	0	0	1	0
Wholesale Distributor	1 (2%)	3	2 (67%)	1	0	1	0
Vending Machines	1 (2%)	6	3 (50%)	2	0	3	0
Cable Services	0	5	4 (80%)	2	2	1	0
Landfill	0	1	1 (100%)	1	0	0	0
Nonprofit Resales	0	3	3 (100%)	0	3	0	0
Pest Control	0	10	4 (40%)	0	4	5	1
Mailing Services	0	2	2 (100%)	0	2	0	0
Newspapers	0	5	1 (20%)	0	1	3	1
Bottling Company	0	1	1 (100%)	0	1	0	0
Driving Instruction	0	4	1 (25%)	0	1	2	1
Food Delivery	0	8	0 (0%)	0	0	8	0
Laundries	0	7	0 (0%)	0	0	7	0
Janitorial Services	0	14	1 (7%)	0	1	11	2
Funeral Services	0	5	0 (0%)	0	0	5	0
Software	0	5	1 (20%)	0	1	4	0
Detective Services	0	1	0 (0%)	0	0	1	0
Financial Services	0	2	0 (0%)	0	0	2	0
Helicopter Services	0	1	0 (0%)	0	0	1	0
Plating Shops	0	3	0 (0%)	0	0	3	0

R0055049

TABLE F-1 Results of Fleet Survey							
Type of Business	Number visited (>5 vehicles maintained on-site & in service area) (% of total visited)	Total number of businesses contacted	Number of fleets with >5 vehicles (% of # contacted)	Number of businesses with >5 vehicles but maintained by commercial shops	Number of businesses with >5 vehicles, but not in service area	Number of businesses with less than 5 vehicles	Number of companies out of business
Data Retrieval Services	0	1	0 (0%)	0	0	1	0
Garden Supply	0	1	0 (0%)	0	0	1	0
Storage	0	1	0 (0%)	0	0	1	0
Office Design	0	1	0 (0%)	0	0	1	0
Residences	0	1	0 (0%)	0	0	1	0
Scientific Instruments	0	1	0 (0%)	0	0	1	0
Equipment Rentals	0	3	0 (0%)	0	0	3	0
Metal Shop	0	2	0 (0%)	0	0	2	0
Ampitheater	0	1	0 (0%)	0	0	1	0
TOTAL	75	328	126 (38%)	21	32	177	22

R0055050

APPENDIX G

CAR WASH COUPON

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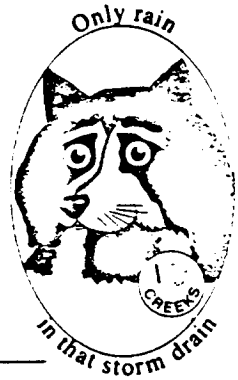
This coupon entitles the bearer to $2 off the regular or discounted price of a carwash at the facilities listed.

Coupon B: Coin-op Car Washes

Absolutely no cash value

May 19
11 a.m. to 8 p.m.
Family Car Wash
2080 El Camino, MV

May 12
11 a.m. to 8 p.m.
Family Car Wash
975 Bay St., MV



N°

May 22 and 23
June 5 and 6
9 a.m. to 6 p.m.

Moonlite Car Washes
East Palo Alto and
Mountain View

VOID

Customer's signature _____

The Regional Water Quality Control Plant and partner cities assume no responsibility for any damage to persons or property associated with use of this coupon.

If you really must wash your car at home, Flo hopes you ll

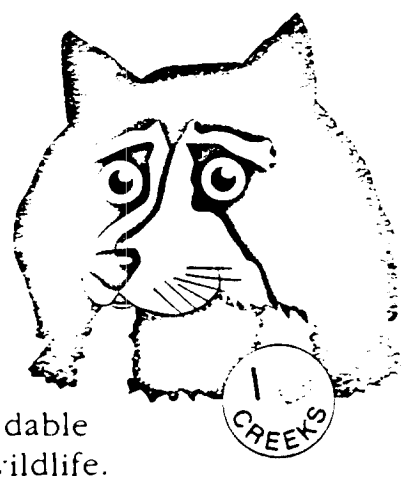
- ✓ *Always use a bucket for soapy water, and pour it down the sink or toilet when you re done.*
- ✓ *Wash the car on a lawn or grassy area where soap and water will not run off into the street.*
- ✓ *Use only water if you can.*
- ✓ *Conserve water by using a hose with an automatic shutoff attachment.*

Flo s friends at the Regional Water Quality Control Plant and the storm drain programs of East Palo Alto, Los Altos, Los Altos Hills, Mountain View, and Palo Alto are sponsoring this car wash discount program to help you protect wildlife and the Bay.

Keep pollution away from storm drains!

The Regional Water Quality Control Plant is operated by the City of Palo Alto for the communities of East Palo Alto, Los Altos, Los Altos Hills, Mountain View, Palo Alto, and Stanford.

Flo says, "Protect the Bay! Take that car to a car wash!"



Commercial car washes are good because they send soap and greasy water to the sewer, NOT to storm drains, creeks, and Bay. Even biodegradable soaps contain ingredients that are harmful to wildlife.

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Use Coupon A below for a $2 discount at a full service or automated car wash until June 30, 1993:

Bill Bailey's Chevron
808 N. Shoreline Blvd., MV

Camino Car Wash
1101 W. El Camino Real, MV

Diablo Auto Polishing
230 Villa, MV

Jackson's Auto Laundry
610 High St., PA

Lozano Brushless Car Wash
2690 W. El Camino, MV

Palo Alto Deluxe Car Wash
841 El Camino Real, PA

Rengstorff Shell
110 N. Rengstorff Ave., MV

Shoreline Shell & Car Wash
807 N. Shoreline Blvd., MV

For your convenience, these coin-operated washes will have someone present to redeem Coupon B (on reverse) on special days:

Family Car Washes:
2080 El Camino, MV
11 a.m. to 8 p.m. on **May 1**

975 Bay St., MV
11 a.m. to 8 p.m. on **May 12**

Moonlite Car Washes will redeem coupons for tokens on **May 22 and 23** and **June 5 and 6**, 9 a.m. to 6 p.m. Tokens may be used any time.

Moonlite Car Washes:
2024 Manhattan Ave., EPA
2380 Old Middlefield Way, MV

951 Dale Avenue, MV
466 N. Shoreline Blvd, MV

This coupon entitles the bearer to $2 off the regular or discounted price of a carwash at the facilities listed.

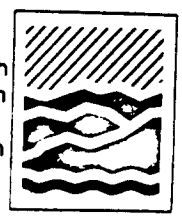
Coupon A: Service/Automated Wash

Absolutely no cash value

Bill Bailey's Chevron
Camino Car Wash
Diablo Auto Polishing
Jackson's Auto Laundry



Lozano Brushless Car Wash
Palo Alto Deluxe Car Wash
Rengstorff Shell
Shoreline Shell & Car Wash



Expiration Date: June 30, 1993

Customer's signature _____

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Analysis of BMP Performance and Longevity

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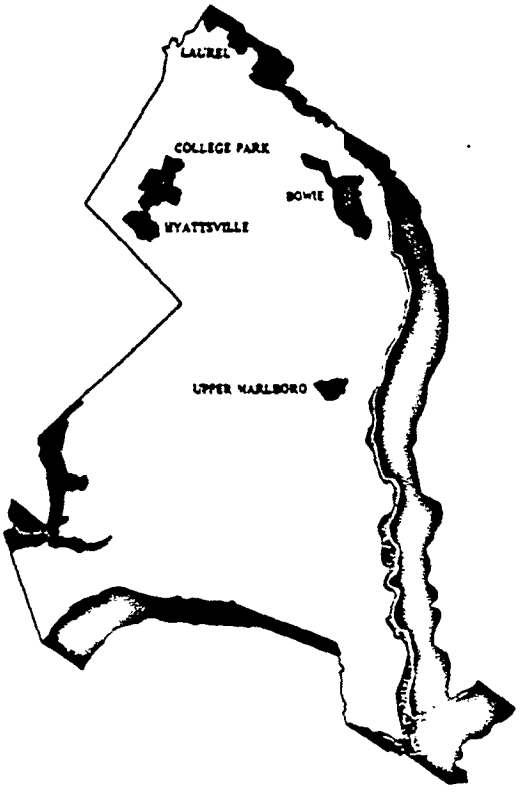
Watershed Protection Branch



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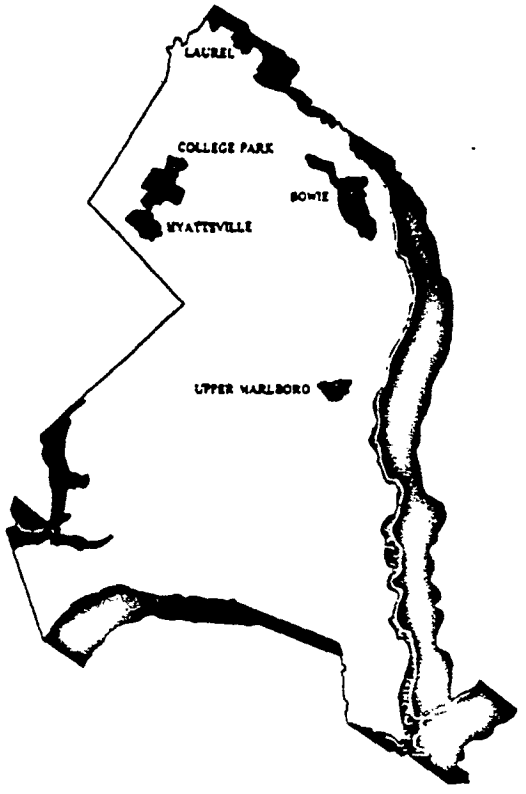

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Natural Solutions To Urban Runoff Problems

VOL 12 2 1757

R0055057

Analysis of Urban BMP Performance and Longevity in Prince George's County, Maryland

-Final Report-

Prepared For:

Prince George's County Department of Environmental Resources Watershed Protection Branch

Prepared by:

John Galli

Department of Environmental Programs
Metropolitan Washington Council of Governments
777 North Capitol Street, N.E.
Washington, D.C. 20002

August, 1992

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ABSTRACT

Title:	Analysis of Urban BMP Performance and Longevity In Prince George's County, Maryland
Date:	August, 1992
Author:	John Galli, Anacostia Restoration Team Department of Environmental Programs Metropolitan Washington Council of Governments
Agency:	The Metropolitan Washington Council of Governments is the regional organization of the Washington, D.C. area's major local governments and their governing officials. COG works towards solutions to such regional problems as energy shortages, traffic congestion, inadequate housing, air and water pollution. COG is also the areawide wastewater management agency for the Washington area and is involved with regional policy issues related to provision of adequate wastewater treatment, sludge disposal, nonpoint source pollution control, and municipal water supplies.
Report Abstract:	Study examined the performance and longevity of 11 types of water quality and quantity BMP's in use in Prince George's County, Maryland since 1984. BMP types which were field surveyed included infiltration trenches and basins, dry wells, porous pavement, grassed swales, ED dry ponds, wet ponds artificial marshes, pocket wetlands, oil/grit separators and dry ponds. Background literature survey information on the fundamental design, performance capability and limitations of currently employed or proposed BMP systems was integrated with findings from the field survey portion of the study. Design strengths and weaknesses, maintenance aspects, structural-related problems and environmental attributes for 156 BMP sites inspected during the study are critically assessed. Study recommendations include both generic and specific criteria and techniques for improving BMP water quality and quantity performance, system longevity, maintenance, public safety, and environmental and aesthetic quality.
Report Price:	$20.00
Publication Number:	92711
Order Copies From:	Metropolitan Washington Council of Governments 777 North Capitol Street, N.E., Suite 300 Washington, DC 20002-4201
Copyright	August 1992

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Executive Summary

The purpose of this study was three-fold: 1.) evaluate the overall effectiveness of stormwater management BMP's presently in use in Prince George's County, MD, 2.) provide, via an independent urban SWM task force, a forum for review and comment on both study findings and existing SWM design criteria, and 3.) where appropriate (or warranted) make recommendations to improve performance, maintenance and/or the environmental value of these BMP systems. In order to accomplish the preceding objectives, COG staff reviewed over 200 as-built stormwater management plans, conducted a field evaluation survey of 156 different BMP sites in the County, performed a comprehensive literature review of recent BMP monitoring studies and associated environmental findings, and both presented findings and solicited input from Prince George's County SWM task force members.

A general summary assessment of the 11 BMP types field surveyed in the study is graphically presented in Figure 1. As seen in Figure 1, considerable variation exists in both the relative ability and long-term reliability of BMP's to meet various performance and environmental objectives. Based on the results from this study, several important conclusions and recommendations regarding present generation BMP design and use can be made:

General BMP Performance Capability and Reliability

It is important to recognize that no single BMP type is ideally suited for every situation and that each brings with it various performance, maintenance and environmental advantages and disadvantages.

1. BMP's which can consistently achieve moderate to high levels of removal for both particulate and soluble pollutants include: wet ponds, artificial marshes, sand filters (not field surveyed in this study) and infiltration trenches. Of the preceding BMP types, only wet ponds and artificial marshes have demonstrated a general ability to continue to function as designed for relatively long periods of time without routine maintenance.

2. BMP's which are generally incapable of providing reliable pollution reduction until their fundamental design is improved or modified include: infiltration basins, porous pavement, grass filters and swales, smaller so-called 'pocket' wetlands, extended detention (ED) dry ponds, and oil/grit separators. The redesign of porous pavement systems does not, at this time, appear feasible. Furthermore, because of the inability to provide pre-treatment control for porous pavement and the system's high maintenance requirement and failure rate, the future use of this BMP in the WMA is not

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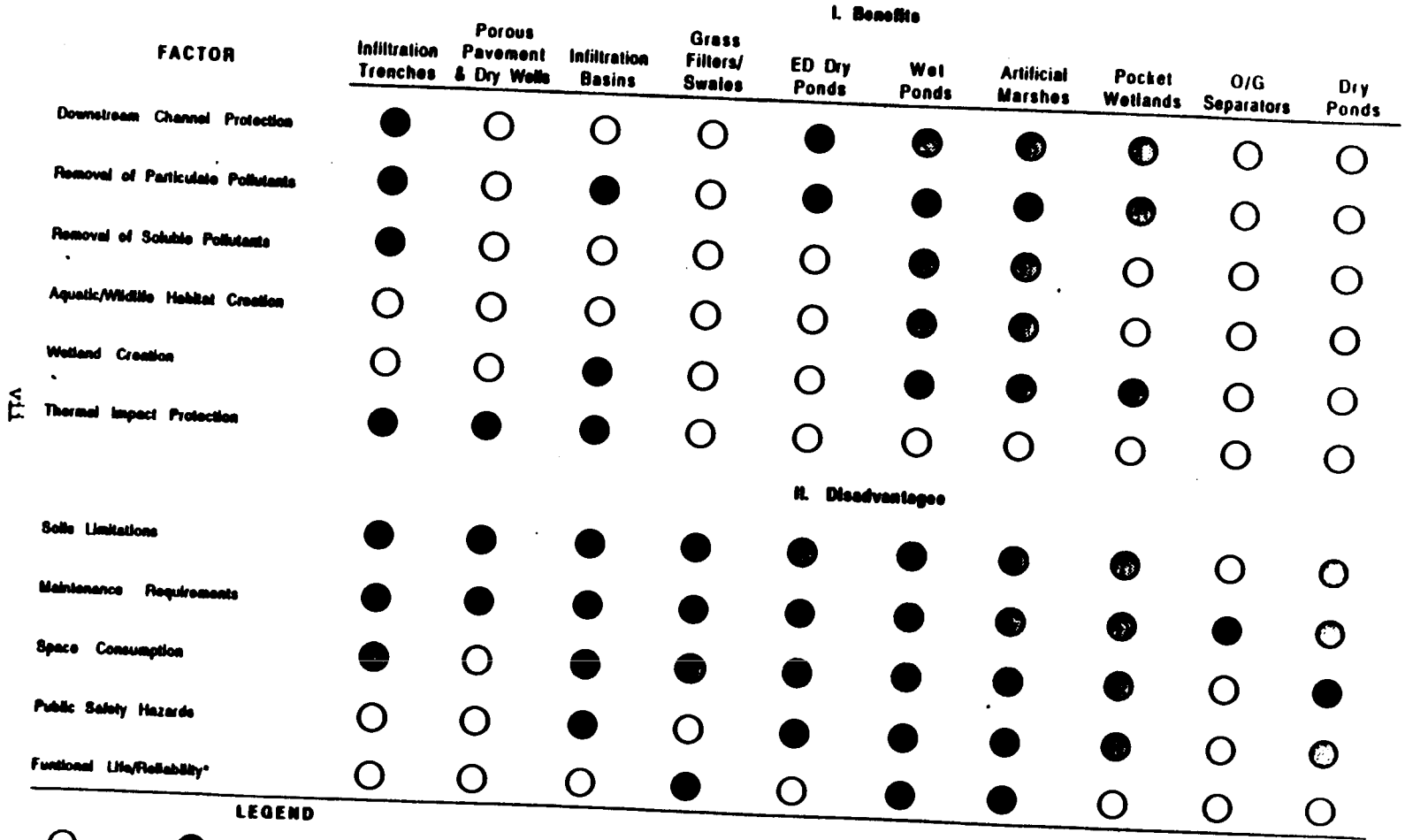
FIGURE 1

SUMMARY: GENERAL ATTRIBUTES OF BMP SYSTEMS FIELD SURVEYED



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recommended. It should be noted that the PGDER Watershed Protection Branch has recently disallowed the use of porous pavement.

3. As a group, infiltration BMP's are extremely fragile systems with characteristically high failure rates. Results from this study revealed that many existing infiltration facilities failed or were not working as designed due to poor initial site selection, lack of proper maintenance, or both.

4. Given both the susceptibility of infiltration basins to clogging problems and their extremely high failure rate, water quality and quantity control can generally be achieved more reliably with other BMP's. The employment of present generation infiltration basin systems is no longer permitted by PGDER. Future design modifications which could significantly enhance both basin reliability and system longevity include:

   a.) the incorporation of adequate pre-treatment control,

   b.) limiting the maximum ponding depth to approximately two feet so as to reduce the risk of post-construction soil compaction problems, and

   c). intentionally oversizing water quality storage volumes to account for eventual loss of infiltration capacity.

5. The PGDER Watershed Protection Branch has recently required that all future oil/grit separators be constructed as off-line facilities. While this step should help to improve overall performance, considerable uncertainty still remains about the pollutant removal capability and maintenance requirements of present generation oil/grit separators. Pending monitoring results from both off-line and prototype second generation oil/grit separators, the continued employment of oil/grit separators is strongly discouraged. As an alternative, the Watershed Protection Branch should seriously entertain the use of off-line sand filters. It is further recommended that the employment of sand filters be considered for all development sites having an associated catchment area of 10 acres or less.

6. Results from this study confirm that dry ponds are unable to provide water quality control benefits, offer little in the way of either stream channel erosion protection or environmental amenities, and require a high level of maintenance. For all of these reasons, the future employment of dry ponds is not recommended. Alternative BMP's include artificial marshes, wet ponds and ED dry ponds. It is further recommended that the majority of the existing dry ponds in the County be gradually converted over into one of the three preceding BMP types.

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Pond Location

7. With regard to on-stream versus off-stream pond siting, off-stream wet ponds, marshes and ED dry ponds appear to perform their water quantity and quality control duties as well as those located on-stream. Each choice of location has both environmental and water quality trade-offs. Where the treatment of both baseflow and stormflow is desired and where wetlands/receiving stream-related issues (such as thermal regime alteration) are not critical, the preferred approach is generally an on-stream system.

Wet Pond/Artificial Marsh Design

8. Both wet ponds and artificial marshes should withdraw water from at or near their surface. Mid-level or bottom release locations are generally discouraged because of the strong possibility of discharging water with low dissolved oxygen concentrations/poor water quality characteristics downstream.

9. The current minimum permanent pool storage volume requirement for wet ponds should be increased so as to provide higher levels of water quality control. It is recommended that: 1.) the minimum permanent pool volume for wet ponds be increased from 0.5 to 1.0 inches per impervious acre and 2.) a multiplier, land use intensity/watershed imperviousness level coefficient be employed to account for anticipated increases in pollutant loadings. A similar multiplier approach is further recommended for artificial marsh systems.

10. Results from this study indicated that a large percentage of both wet ponds and artificial marshes were designed as marsh/pond 'hybrids'. In other words, they were both too shallow to generally support adult gamefish populations year-round, and too deep to permit the establishment of emergent vegetation. It is strongly recommended that all future wet ponds and artificial marshes feature variable microtopography, so as to provide a proper balance between shallow water, mid-depth and deep water areas.

11. Field survey results revealed that short internal flow length was partially responsible for suboptimal water quality performance at several wet pond, artificial marsh and ED dry pond sites. It is strongly recommended that a minimum 1:1 internal flow path length be required.

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Extended Detention Control

12. Stream channel erosion protection is generally best achieved through the employment of ED-type controls. Because of practical ED orifice sizing constraints, the employment of ED dry ponds, marshes and/or wet ponds is generally not feasible for catchment areas of 10 acres or less.

13. Results form this study revealed that only about 50 percent of the ED stormwater management facilities surveyed were capable of generally meeting their target ED times. In fact, survey results indicated that the runoff produced from smaller, less intense rainfall events often flowed through the majority of these facilities with little or no detention. What appears to be needed, is an improved ED approach which can more reliably provide a minimum of 6-12 hours of detention over a broader range of both storm size and rainfall intensity conditions. Possible design improvements include a greater use of gate valves or the employment of a proportioning weir outlet system.

Inspection and Maintenance

14. Without routine inspection and proper maintenance, BMP performance and functional life will ultimately be greatly reduced. The PGDER Watershed Protection Branch is to be strongly commended for its recent implementation of a comprehensive stormwater management inspection program. In order to provide maximum long-term protection of County water resources, this critical program element will require both adequate funding and staffing for the foreseeable future.

Landscaping and Mowing

15. The majority of the pond BMP systems surveyed would have benefitted, from both an aesthetic and wildlife habitat perspective, from greater pond landscaping treatment. Greater adherence to existing PGDER stormwater management aquatic and terrestrial landscaping criteria is strongly recommended. Where wildlife habitat creation is an objective, both grass mowing height and frequency should be adjusted to better meet target species requirements. Consultation with local wildlife biology experts and SWM maintenance personnel is strongly recommended.

Signage and Safety Features

16. It is strongly recommended that future wet ponds and artificial marshes be posted with appropriate information/warning and environmental

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education signage. In addition, the incorporation of pond safety features such as safety benches and aquatic shelves should largely eliminate the need for pond fencing.

Future Research Needs

17. During the course of the study, it became evident that additional BMP research is needed in at least two major areas: a.) comprehensive performance monitoring of oil/grit separators (to provide information necessary for the formulation of second generation design improvements, possible retrofit modification of existing structures, and enhanced maintenance and residual material disposal practices) and b.) development of improved ED calculation/methodology and control systems (which can provide greater ED control over a broader spectrum of storm scenarios)

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For organizational purposes this report has been divided into five chapters. Chapter one briefly describes study design and methodology. The second chapter provides the reader with background information on the fundamental design, performance capability and limitations of currently employed or proposed BMP systems. In the third chapter, a brief overview of the major physical and hydraulic factors which affect the performance of wet ponds and artificial marshes is presented. Chapter four provides detailed information on the results from the field survey portion of the study. Included in this chapter are: background findings from as-built file review, observations on general BMP performance and system longevity, description of BMP type-specific performance, maintenance and/or structural problems, and the identification of environmental attributes. In the fifth and final chapter, both generic and specific criteria and techniques were identified to improve the following: 1.) BMP water quality and quantity control performance, 2.) system longevity, 3.) maintenance, 4.) public safety and 5.) environmental and aesthetic features. In addition, both alternative BMP practices and future research needs are discussed. Last, a list of possible BMP retrofit candidate sites identified through the field survey was developed and included in the final section.

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Introduction

Since the inception of its 1984 stormwater management (SWM) ordinance, the Prince George's County SWM program has become a model throughout the State of Maryland. In the ensuing years, both the number and type of SWM facilities have proliferated throughout the County. As expected, this has raised a number of concerns from the engineering, development and environmental communities regarding the long-term performance, pollutant removal capability, longevity, maintenance burden, hydrologic performance and environmental attributes of these urban Best Management Practices (BMP's).

In response, the Prince George's County Department of Environmental Resources (PGDER) Watershed Protection Branch concurred that an independent and in-depth assessment of the general performance and reliability of urban SWM practices within the County was needed. Subsequently, the Watershed Protection Branch contracted the Metropolitan Washington Council of Governments (COG) to perform a comprehensive evaluation. As a result, a study was undertaken in 1991 to accomplish the following objectives:

1. Evaluate a representative sub-population of urban BMP's installed since 1984 with respect to performance, longevity and maintenance. This would entail a comprehensive field review under both wet and dry weather conditions, and would focus on isolating both critical design factors and procedures.

2. Provide, with respect to current SWM design specifications for urban BMP's, a forum for independent review and input. This objective was to be met through the creation of an urban SWM task force, composed of prominent individuals selected by the Manager of the Watershed Protection Branch.

3. Prepare a comprehensive report on specific design recommendations which would serve to improve water quality/quantity performance, reduce maintenance burdens and increase the overall environmental value of urban SWM practices.

In order to accomplish the preceding objectives a three-part study was required. Part one of the study consisted of the review of SWM as built-engineering drawings and computations for the complete range of BMP types presently in operation. BMP types included: infiltration trenches, infiltration basins, dry wells, porous pavement, grass filters/swale systems, extended detention dry ponds, wet ponds, artificial marshes, oil/grit separators and dry ponds. In the second part of the study, actual BMP field performance was evaluated by COG staff. Part three of the study featured a comprehensive literature review to identify expected BMP pollutant removal efficiency and potential environmental amenities/impacts.

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Chapter 1. Prince George's County BMP Field Evaluation Study Design and Methodology

As previously stated, the purpose of this study was three-fold: 1.) comprehensively assess current Prince George's County stormwater management (SWM) water quality and quantity control design criteria; 2.) perform both a thorough field evaluation of a representative sub-population of BMP's presently in operation in the County, as well as, conduct a literature survey on the present status of BMP monitoring studies and technologies; and 3.) develop a series of both generic and BMP specific recommendations to further improve BMP performance, facilitate SWM maintenance operations, and enhance the aesthetic value and environmental opportunities associated with BMP's.

In order to meet the preceding objectives, a study design featuring three major tasks, or elements was formulated. Under the first task, COG Staff screened over 250 as-built files both to identify potential BMP design strengths and weaknesses and to check for general compliance with existing County SWM design criteria. Next, approximately 200 as-built plans representing the full array of BMP types in use were comprehensively reviewed. Pertinent information obtained from these plans, such as age, drainage area, land uses controlled, etc., was combined with field survey findings to form the data base backbone of the study. In addition, COG staff performed a literature survey of over 60 recent SWM monitoring studies from across the country. Last, as-built file review data, field survey results and literature review findings were synthesized to formulate specific study recommendations.

The following sections briefly describe the site selection process, field survey methodologies and calculations employed in the study.

A. Site Selection

With the assistance of PGDER staff, as-built files were obtained for each BMP type. Subsequently, an inventory of candidate BMP inspection sites was conducted. General background information, such as site name, P.G. County file number, street map book location, watershed area, catchment size, land use and age, was complied for nearly 200 existing BMP sites (Appendix A). On the basis of general BMP type representativeness and site accessibility, 156 sites were selected and subsequently field surveyed by COG staff. As seen by the BMP site distribution in Figure 1, a concerted effort was made to survey BMP sites representative of soil, watershed location, and land use conditions prevalent throughout the County.

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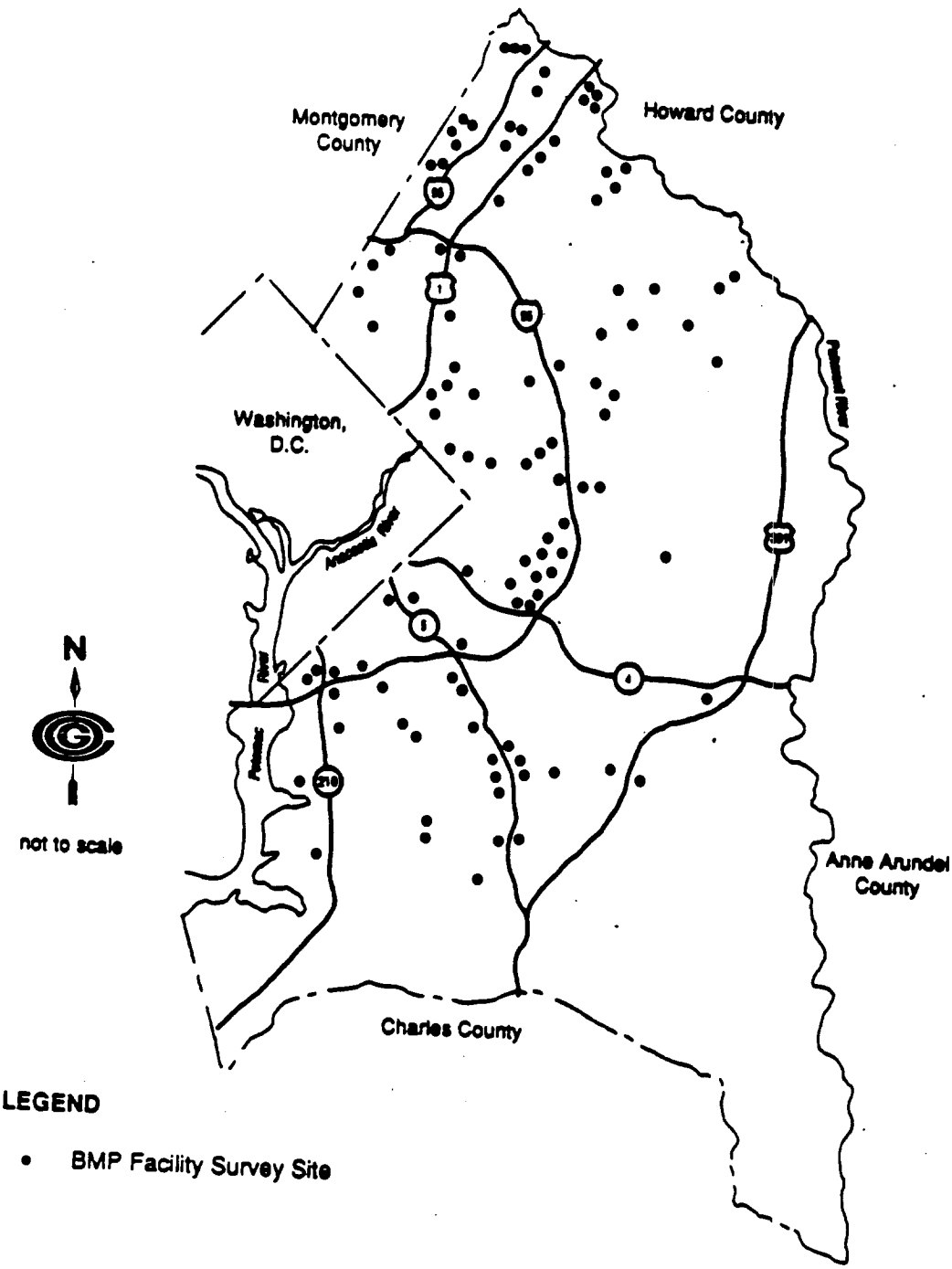
Figure 2. General Location of Prince George's County BMP Field Survey Sites



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B. General Field Survey Protocols

Survey Forms

In order to properly integrate both pertinent as-built file information and field survey data, COG staff developed a series of BMP evaluation forms (Appendix B). Background information such as BMP design features, ownership, maintenance responsibilities, associated site imperviousness, etc., was recorded, along with both BMP site inspection performance findings and receiving stream survey results. In addition, two to four representative black and white photographs were taken per survey site, so as to: a.) document existing conditions and b.) provide a reference base for future site inspections by local government personnel. All of the preceding information was incorporated in logbook form. It should be noted that the evaluation survey forms used in this study were partially based on forms currently in use by the Maryland Department of the Environment (MDE).

Development of a Relative Index System

In an effort to further standardize field investigation reporting, a qualitative index measuring system was developed for each of the following physical/biological parameters: A. floatable materials and visible, oily residual material (present in oil/grit separators and infiltration sump pits); B. degree of substrate fouling (fouling defined as the presence or absence of patinas of silt/fine organic material and/or algal growth on the surface of stones, as well as, the presence or absence of slime coatings on the underside of stones); and C. general aquatic/wildlife habitat value. Both of the first two indices (A. and B.) employed the same, 1 - 5 descriptive scale system. Under this system, a value of one indicated either no visible oil, floatable material or substrate fouling; whereas, a value of five signified a heavy presence. Similarly, the aquatic-wildlife habitat index was based on a descriptive scale of 1 - 3; with a value of one representing a low habitat value condition and a value of three signifying excellent site conditions. For a more detailed description of the preceding indices the reader is referred to Appendix B.

Physical Measurements

Field measurements of channel width, bank height, water depth, etc., were made with either a 100 foot fiberglass tape measure or collapsible 12 foot long wooden rod. Stream channel measurements were taken at approximately 100 foot intervals. The wooden rod was used extensively for measuring both permanent pool and sediment depth. It should be noted that 1/8 inch diameter holes were drilled at one inch intervals over the first foot to better determine sediment depths in both oil/grit separators and infiltration sump pits.

Residual material present in both oil/grit separators and infiltration sump pits was sampled with a custom-made scoop. The 'scooper' featured a nine foot long PVC

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handle attached at a 90-degree angle to a 50 cubic inch capacity sediment bucket. Five sediment samples per water-holding chamber were taken. The five samples were composited in the field to create one composite sediment sample per chamber. The residual material was then qualitatively categorized as to the general percent coarse-grained, fine-grained and coarse organic material present. This was achieved by both feel (rubbing the material between the fingers) and visual comparison against known reference particle size material. The color, odor, and amount of oil present were also qualitatively described.

Stream discharge was calculated via the Embody Float Method (Embody, 1927). Substrate composition was visually determined.

C. Water Quality Grab Sampling

The following water quality parameters were measured, under both dry and wet weather conditions, during the study:

- Secchi depth,
- temperature,
- dissolved oxygen (DO)
- pH,
- alkalinity,
- carbon dioxide (CO_2), and
- total dissolved solids (TDS)

Secchi depth, which is an indication of water transparency or clarity, was measured with a standard 20 centimeter diameter secchi disk. From these secchi depth measurements the general trophic status (a measure of the relative productiveness of a body of water) was determined using the Carlson (1977) secchi disk trophic state index system.

Temperature was measured via a Hach model No. 4450 temperature meter. DO, pH, alkalinity and carbon dioxide levels were measured with a Hach kit (model No. FF-2). This kit employs the Winkler-titration method for measuring DO concentrations. TDS levels were determined with a Hach TDS meter (model No. 44400). It should be noted that water samples from observation wells, oil/grit separators and infiltration sump pits were obtained with a hand-operated pump (Black and Decker - 'jackrabbit' pump).

D. Sediment Trapping Rate Calculations

The sediment trapping rate for oil/grit separators and infiltration sump pits was estimated via the following approach: 1.) the average depth of sediment was first converted both to total volume and weight (using an assumed average weight of 60 lbs/cubic foot), and 2.) sediment weights were divided by the catchment area and age

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of the structure (or age class) to obtain an average estimated sediment trapping rate expressed in lbs/ac/year.

E. Data Manipulation - SAS Architecture

The Statistical Analysis System (SAS), which is a mainframe computer system for data analysis, was employed to statistically analyze field survey data. A series of SAS programs were specifically written to meet the three following objectives:

1. Convert and reformat Lotus 1-2-3 field survey data into a series of data fields for each BMP type;

2. Statistically analyze, via the PROC UNIVARIATE (procedure analysis package), field survey data sets; and

3. Test for the general strength of association between various BMP design elements and field survey results, through a series of Pearson's rank correlation analyses.

F. Literature Review

COG staff conducted a comprehensive literature review of over 80 recent BMP performance and environmentally-related studies. One of the major accomplishments of this subtask was the compilation of study findings into a comprehensive tabular format. This information is included as Tables 1 and 2 of the report.

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Chapter 2. Background BMP Capsule Summaries

This chapter provides general background information on the fundamental designs, performance capabilities and limitations of 11 currently employed or proposed urban BMP systems in the Washington Metropolitan Area (WMA). Major findings for each BMP type appear in a capsule summary format and are presented in the following order:

- infiltration trenches;
- dry wells;
- infiltration basins;
- grass/filters/grass swale systems;
- porous pavement;
- extended detention dry ponds;
- artificial marshes;
- wet ponds;
- sand filters;
- peat-sand filters; and
- oil/grit separators;

It should be noted that each capsule summary represents a synthesis of findings from both available published data and the Prince George's County BMP field evaluation portion of the study. As previously stated, a summary assessment of the general overall effectiveness of current BMP's is included as Table 1. Actual reported pollutant removal efficiency data for nearly 60 wet pond and wetland systems is summarized in Table 2. Reference sketches for each of the preceding BMP types are provided in Appendix D.

* - prototype system slated for construction in the District of Columbia

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TABLE I

A COMPARATIVE ASSESSMENT OF THE EFFECTIVENESS OF CURRENT URBAN BEST MANAGEMENT PRACTICES (MWCOG, 1992)

URBAN BMP OPTIONS*	RELIABILITY FOR POLLUTANT REMOVAL	LONGEVITY*	APPLICABLE TO MOST DEVELOPMENTS	WILDLIFE HABITAT POTENTIAL	ENVIRONMENTAL CONCERNS	COMPARATIVE COST	SPECIAL CONSIDERATIONS
STORMWATER WETLANDS	Moderate to High depending on design	20+ years expected	Applicable to most sites if land is available.	High.	Stream warming; natural wetland alteration.	Marginally higher than wet ponds.	Recommended with design improvements and with the use of macropools and wetlands
EXTENDED DETENTION PONDS	Moderate, but not always reliable	20+ years, but frequent clogging and short detention common.	Widely applicable, but requires at least 10 acres of drainage area.	Moderate.	Possible stream warming and habitat destruction.	Lowest cost alternative in size range	Recommended with design improvements and with the use of macropools and wetlands
WET PONDS	Moderate to high	20+ years	Widely applicable, but requires drainage area of greater than 2 acres.	Moderate to high.	Possible stream warming, trophic shifts, habitat	Moderate to high compared to conventional	Recommended, with careful site evaluation
MULTIPLE POND SYSTEMS	Moderate to high; redundancy increases reliability.	20+ years	Widely applicable.	Moderate to high.	Selection of appropriate pond option minimizes overall environmental impact.	Most expensive pond option	Recommended
INFILTRATION TRENCHES	Presumed moderate	50 % failure rate within five years.	Highly restricted (soils, ground water, slope, area, sediment input).	Low.	Slight risk of ground water contamination.	Cost-effective on smaller Rehab costs can be considerable.	Recommended with pretreatment and geotechnical evaluation.
INFILTRATION BASINS	Presumed moderate, if working	40 - 100 % failure within five years.	Highly restricted (see infiltration trench).	Low to moderate.	Slight risk of ground water contamination.	Construction cost moderate, but rehab cost high.	Not widely recommended until longevity is improved
POROUS PAVEMENT	High (if working)	75 % failure within five years.	Extremely restricted (karstic, soils, ground water, slope, area, sediment input).	Low.	Possible ground water impacts; uncontrolled runoff.	Cost-effective compared to conventional asphalt when working properly.	Recommended in highly restricted applications with careful construction and effective maintenance.
SAND FILTERS	Moderate to high	20+ years	Applicable (for smaller developments).	Low.	Minor.	Comparatively high construction costs and frequent maintenance.	Recommended, with local demonstration
GRASSED SWALES	Low to moderate, but unreliable.	20+ years	Low density development and roads.	Low.	Minor.	Low compared to curb and gutter.	Recommended, with checkdams, as one element of a BMP system
FILTER STRIPS	Unreliable in urban settings.	Unknown, but may be limited.	Restricted to low density areas.	Moderate if forested.	Minor.	Low.	Recommended as one element of a BMP system
WATER QUALITY INLETS	Presumed low	20+ years	Small, highly impervious catchments (< 2 acres).	Low.	Decomposition of hydrocarbon loadings. Disposal of hydrocarbon and toxic residuals.	High, compared to trenches and sand filters.	Not currently recommended as a primary BMP option

*based on current designs and prevailing maintenance practices

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TABLE 2

THE POLLUTANT REMOVAL CAPABILITY OF POND AND WETLAND SYSTEMS: A REVIEW (MWCOG, 1992)

NOTE: The table below provides summary data on the pollutant removal capability of nearly sixty stormwater pond and wetland systems. Each study differs with respect to pond design, number of storms monitored, pollutant removal calculation technique, and monitoring technique, so exact comparisons between studies are not appropriate.

TYPE	NO.	NAME	STATE	NO. OF STORMS	WATER-SHED AREA (Acres)	TREAT-MENT VOL. (In./Acre)	REMOVAL EFFICIENCY (%)								
							TSS	TP	SP	TN	NO3	COD	Pb	Zn	OTHER
DRY ED	1	Lakeridge	VA	28	88.0	0.00	14.0	20.0	(-6.0)	10.0	9.0	(-1.0)		(-10.0)	
	2	London Commons	VA	27	11.4	0.22	A: 29.0 B: 74.0	40.0 56.0		25.0 60.0		17.0 41.0	39.0 25.0	24.0 40.0	
	3	Stedwick	MD	25	34.0	0.30	70.0	13.0		24.0		27.0	62.0	57.0	TKN: 30.0
	4	Maple Run III	TX	17	28.0	0.50	30.0	18.0		35.0	52.0	22.0	29.0	(-38.0)	TOC: 30.0 Cu: 31.0 BOD: 35.0 NH3: 55.0 FColi: 78.0
	5	Oakhampton	MD		16.8	0.50*	87.0	26.0	(-12.0)		(-10.0)				NH4: 53.5
	6	None given	KS	19	12.3	3.42	3.0	19.0	0.0		20.0	16.0	66.0	65.0	

Note: An asterisk (*) denotes an inferred value.

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THE POLLUTANT REMOVAL CAPABILITY OF POND AND WETLAND SYSTEMS...(CONT'D)

TYPE	NO.	NAME	STATE	NO. OF STORMS	WATER-SHED AREA (Acres)	TREAT-MENT VOL. (In./Acre)	REMOVAL EFFICIENCY (%)								
							TSS	TP	SP	TN	NO3	COD	Pb	Zn	OTHER
WET PONDS	7	Seattle	WA	5	0.75		86.7	78.4				64.4	65.1	65.2	Cu: 66.5
	8	Boynton Beach	FL	8			91.0		76.0		87.0				TKN: 58.0
	9	Grace Street	MI	18		VB/VR=.52	32.0	12.0		6.0	(-1.0)		26.0		TKN: 7.0 BOD: 3.0
	10	Pitt-AA	MI	6	4872.0	VB/VR=0.52	32.0	18.0			7.0	23.0	62.0	13.0	TKN: 14.0 BOD: 21.0
	11	Unqua	NY	8		VB/VR=3.07	60.0	45.0					80.0		TOC: 7.0
	12	Waverly Hills	MI	29		VB/VR=7.57	91.0	79.0		62.0	66.0	69.0	95.0	91.0	Cu: 57.0 TKN: 60.0 BOD: 69.0
	13	Lake Ellyn	IL	23		VB/VR=10.70	84.0	34.0					78.0	71.0	Cu: 71.0
	14	Lake Ridge	MN	20	315.0	0.08	A: 90.0 B: 85.0	61.0 37.0	11.0 8.0	41.0 24.0	10.0 17.0		73.0 52.0		TKN: 50.0 TKN: 28.0
	15	West Pond	MN	8	76.0	0.15	65.0	25.0			61.0		8.0-79.0	66.0	TOC: 19.0 TKN: 23.0 Cr: 48.0-76.0 Cd: 12.0-91.0
	16	McCarrons	MN	21	608.0	0.19	91.0	78.0		85.0		90.0	90.0		
	17	McKnight Basin	MN	20	725.0	0.22	A: 85.0 B: 85.0	48.0 34.0	13.0 12.0	30.0 14.0	24.0 11.0		67.0 63.0		TKN: 31.0 TKN: 15.0
	18	Monroe Street	WI		238.0	0.26	90.0	65.0	70.0			70.0	70.0	65.0	Cu: 75.0 FColi: 70.0 Pest: 25-50.0 Hydro: 75-90
	19	Runaway Bay	NC	5	437.0	0.33	54.0	24.0						42.0	TKN: 20.0

Note: An asterisk (*) denotes an inferred value.

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THE POLLUTANT REMOVAL CAPABILITY OF POND AND WETLAND SYSTEMS...(CONT'D)

TYPE	NO.	NAME	STATE	NO. OF STORMS	WATER-SHED AREA (Acres)	TREAT-MENT VOL. (In./Acre)	REMOVAL EFFICIENCY (%)								
							TSS	TP	SP	TN	NO3	COD	Pb	Zn	OTHER
WET PONDS (Cont'd)	20	Buckland	CT	7	20.0	0.40	61.0	45.0			22.0		18.0-59.0	51.0	Cd: < 0 TKN: 24.0 TOC: 33.0 Cu: 38.0
	21	Highway Site	FL	13	41.6	0.55	65.0	17.0		21.0		7.0	41.0	37.0	
	22	Woodhollow	TX	14	381.0	0.55	54.0	46.0		39.0	45.0	41.0	76.0	69.0	TKN: 26.0 NH3: 28.0 BOD: 39.0 FColi: 46.0
	23	SR 204	WA	5	1.8	0.60	99.0	91.0				69.1	88.2	87.0	Cu: 90.0
	24	Farm Pond	VA		51.4	1.13	85.0	86.0	73.0	34.0					NH3: (-107.0)
	25	Burke	VA	29	27.1	1.22	(-33.3)	39.0	77.0	32.0		21.0	84.0	38.0	
	26	Westleigh	MD	32	48.0	1.27	81.0	54.0	71.0	37.0		35.0	82.0	26.0	TKN: 27.0
	27	Mercer	WA	5	7.6	1.72	75.0	67.0				76.9	23.0	38.0	Cu: 51.0
	28	I-4	FL	6	26.3	2.35	54.0	69.0			97.0		41.0-94.0	69.0	TOC: 45.0 TKN: 68.0 Cd: 43.0-51.0 Cu: 66.0-81.0
	29	Timber Creek	FL	9	122.0	3.11*	64.0	60.0	80.0	15.0	80.0				
	30	Maitland	FL	30-40	49.0	3.65			90.0		87.0		95.0	96.0	PP: 11.0 Cu: 77.0 NH3: 82.0
	31	Lakeside	NC	5	65.0	7.16	91.0	23.0						82.0	TKN: 6.0

Note: An asterisk (*) denotes an inferred value.

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THE POLLUTANT REMOVAL CAPABILITY OF POND AND WETLAND SYSTEMS...(CONT'D)

TYPE	NO.	NAME	STATE	NO. OF STORMS	WATER-SHED AREA (Acres)	TREAT-MENT VOL. (In./Acre)	REMOVAL EFFICIENCY (%)								
							TSS	TP	SP	TN	NO3	COD	Pb	Zn	OTHER
WET ED	32	Uplands	ONT	5	860.0		82.0	69.0							FColi: 97.0
	33	East Barrhaven	ONT		2139.0	0.12	52.0	47.0							FColi: 56.0
	34	Kennedy-Burnett	ONT	6	395.0	0.62	98.0	79.0		54.0			39.0	21.0	BOD: 36.0 FColi: 99.0
STORMWATER WETLANDS	35	EWA3	IL				72.0	59.0			70.0				Fe: 48.0
	36	EWA4	IL				76.0	55.0			42.0				Fe: 43.0
	37	EWA5	IL				89.0	69.0			70.0				Fe: 50.0
	38	EWA6	IL				98.0	97.0			95.0				Fe: 92.0
	39	B31	WA	13	461.7	0.01	14.0	(-2.0)			4.0				
	40	PC12	WA	13	214.8	0.03	56.0	(-2.0)			20.0				
	41	McCarrons	MN	21	608.0	0.31	87.0	36.0		24.0		79.0	68.0		
	42	Queen Anne's	MD			0.50*	65.0	39.0	44.0	23.0	55.0				NH4: 55.0 ON: (-5.0) PP: 7.2
	43	Swift Run	MI	5	1207.0	0.60	85.0	3.0	29.0		80.0	2.0	82.0		BOD: 4.0
	44	Tampa Office Pond	FL	3 - 8	6.3	0.61	64.0	55.0	65.0					34.0	ON: (-3.7)
	45	Highway Site	FL	13	41.6	0.81	66.0	19.0		30.0		18.0	75.0	50.0	
	46	Palm Beach PGA	FL		2340.0	2.00*	50.0	62.0			33.0				NH3: 17.0 BOD: 35.0 TOC: 10.0 TKN: 16.0
ED WETLANDS	47	Benjamin Franklin	VA		40.0	0.08	62.0	14.9	23.6		60.0			(-73.5)	Cd: (-79.8) NH3: 0.0 TKN: 4.4

Note: An asterisk (*) denotes an inferred value.

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THE POLLUTANT REMOVAL CAPABILITY OF POND AND WETLAND SYSTEMS...(CONT'D)

TYPE	NO	NAME	STATE	NO. OF STORMS	WATER-SHED AREA (Acres)	TREAT-MENT VOL. (In./Acre)	REMOVAL EFFICIENCY (%)								
							TSS	TP	SP	TN	NO3	COD	Pb	Zn	OTHER
ED WETLANDS (Cont'd)	48	Tanner's Lake	MN	10	413.0	0.10	A: 62.0 B: 63.0	24.0 7.0	10.0 (-14.0)	36.0 5.0	23.0 1.0		63.0 59.0		TKN: 40 0 TKN: 7 0
	49	Mayo Chapel	MD		97.0	0.10*	24.0	16.0	24.0		35.0				NH3: 43 0
	50	Clear Lake	MN		1070.0	0.15*	76.0	54.0	40.0						TKN: 25 0 NH3: 55 0
NATURAL WETLANDS	51	Hidden Lake	FL		55.4	1.08*	83.0	7.0	(-109.0)	(-1.6)	80.2		54.0	40.0	ON: (-24 0) Cu: 40 0 NH3: 62 0 Cd: 70 0 BOD: 81 0
	52	Wayzata	MN		73.0	1.25*	94.0	78.0					94.0	82.0	NH3: (-44 0) Cd: 67 0 Cu: 80 0
POND/WETLAND SYSTEMS	53	Lake Manasco	FL	3	23393.0		92.0	64.0		11.0	15.0	28.0	55.0	59.0	NH4: (-39.0) TKN: 11.0 NO3: 15.0 BOD: 42 0
	54	Carver Ravine	MN	15	170.0	.30*	A: 46.0 B: 20.0	24.0 1.0	21.0 1.0	15.0 (-6.0)	18.0 9.0		42.0 6.0		TKN: 14 0 TKN: (-10 0)
	55	McCarrons	MN	21	608.0	>0.50	94.0	78.0		83.0		93.0	90.0		
	56	Lake Jackson	FL		2230.0	.88*	96.0	90.0		75.0	70.0				NH4: 37.0
	57	Highway Site	FL	13	41.6	>1.35	89.0	36.0		43.0			84.0	67.0	
	58	Long Lake	ME	11	18.0	2.0*	95.0	92.0							

Note: An asterisk (*) denotes an inferred value.

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I. Infiltration Trenches

Infiltration trenches are shallow, excavated trenches which are backfilled with clean, 1.0-3.0 inch diameter stone to provide temporary underground storage of stormwater. In general, the first 0.5 inches of runoff from the impervious portion of the catchment is directed into the trench, whereupon it gradually percolates into the underlying soil. All infiltration trench systems include either a pre-treatment grass filter strip or wet sump pit/water quality inlet for reducing incoming loads of suspended solids, oils and grease. Newer infiltration trenches also feature a six inch thick sand layer underneath the stone reservoir to both enhance drainage and reduce the risk of soil compaction during trench construction.

Infiltration trenches are commonly used to provide first flush water quality control for drainage areas less than 10 acres in size. Because of their relatively high pollutant removal efficiency, low number of associated secondary environmental impacts, and ability to closely replicate pre-development hydrology they along with infiltration basins and other infiltration-type practices have received preferred BMP status by MDE. As with all infiltration BMP systems, pollutant removal is accomplished by physical filtration, adsorption, and microbial decomposition in the underlying subsoil, as well as via the trapping of particulate matter within the pre-treatment portion of the system.

Capsule Summary

Pollutant Removal Capability: Although performance data on conventional infiltration trenches is rare, trenches are believed to have high capability to remove particulate pollutants and a moderate capability to remove most soluble pollutants. It should be noted that certain soluble pollutants such as nitrates, chlorides and various hydrocarbon-based products can effectively migrate through the underlying soil.

Longevity: Theoretically, the life expectancy of infiltration trenches should be approximately equal to that of septic fields (i.e., - 15-30 years). However, conventional infiltration trenches have thus far generally proven to have much shorter life spans. Slightly over half partially or totally fail within the first five years of construction. Longevity could be improved through more rigorous site-specific geotechnical evaluation, regular inspection and maintenance, and enhanced pre-treatment control.

Feasibility: The application of trenches, like other infiltration practices, is severely restricted by soils, water table, slope and contributing drainage area conditions. These conditions must be carefully investigated in the field before proceeding with design.

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Environmental Concerns: Concerns persist about the possibility of groundwater contamination by trenches. Studies to date do not indicate a major risk, but have noted migration of nitrate and chlorides.

Environmental Benefits: The widespread use of infiltration trenches in a watershed could help to replicate pre-development hydrology, increase dry-weather baseflow, and reduce bankfull flooding frequency. Unfortunately, this benefit is often not realized in practice given the short lifetimes of conventional trenches. In addition, because infiltration trenches can be located under parking lots (not recommended) or in lawn areas, they can help preserve more on-site natural area.

Costs: While infiltration trenches are more costly than pond systems in terms of cost per unit of runoff treated, they are a cost-effective option for smaller sites where ponds cannot be applied.

Adaptability: Because of practical volume of storage limitations, infiltration trenches typically cannot treat large amounts of stormwater runoff. As such, they are generally restricted to smaller development sites where water quality control is the primary management objective.

Maintenance Burden: To enhance longevity and maintain performance, trenches and associated pre-treatment systems do require significant maintenance. Most conventional trenches do not appear to be regularly maintained in the field and thus many will require costly rehabilitation or replacement to maintain their function.

II. Dry Wells

Dry wells are small infiltration trench systems generally employed to capture and treat the first 0.5 inches of roof runoff from either small, individual commercial buildings or single family residences. From a design standpoint, they differ from infiltration trench systems in that they rarely, if ever, include any pre-treatment feature. In general, roof runoff is delivered via a roof leader/perforated dry well inlet pipe into the upper portion of the stone reservoir. The stone reservoir, which is typically buried one foot below ground level, includes an observation well for routine inspection. Runoff which exceeds the infiltration capacity of the system is discharged to the surface, via an overflow pipe located within the roof leader.

The pollutant removal efficiency, longevity, feasibility, maintenance burdens and environmental benefits and concerns associated with dry wells are comparable to those previously described for conventional infiltration trench systems. However, it should be noted that dry wells are generally longer-lived. In a recent MDE study (Lindsey et al., 1991) reported that 72 percent of the dry well systems surveyed were still working

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after five years. This represents the highest working rate for any infiltration BMP system presently in use in the WMA. More than likely, reduced sediment and particulate organic material loads are responsible for the higher dry well working rate.

III. Infiltration Basins

Infiltration basins are typically sump-like, grass-lined dry ponds where incoming stormwater runoff is temporarily stored until it gradually percolates through the soil of the basin floor. In general, infiltration basins are designed to capture and treat the first 0.5 inches of runoff from the impervious portion of drainage areas less than 50 acres in size. Unlike infiltration trench systems, conventional infiltration basins do not include stone reservoir storage areas, observation wells, or any dedicated pre-treatment system. The vast majority of the basins inspected in the field survey portion of this study featured both a concrete barrel and riser control structure, and had associated catchment areas of less than 10 acres.

Capsule Summary

Pollutant Removal Capability: Performance data unavailable. However, like infiltration trenches they are presumed to have high pollutant removal efficiency rates for particulate pollutants ($\geq$ 75 percent removal) and moderate removal for most soluble pollutants ($\geq$ 45 percent removal).

Longevity: Infiltration basins are relatively short-lived. Lindsey (et al., 1991) reported that only 38 percent of the basins surveyed were still capable of infiltrating runoff after five years . Major design refinement, better construction practices and additional site investigation work will be required to improve longevity.

Feasibility: The application of basins is restricted by numerous site factors (soils, slope, water table and contributing watershed area).

Environmental Concerns: The greatest environmental concern relative to infiltration basins is the fact that their water quality benefits may not be realized due to widespread failure. Groundwater contamination is frequently cited as a risk, yet studies to date indicate that pollutant migration is very localized in scope.

Environmental Benefits: When infiltration basins work, they can replicate pre-development hydrology more closely than other BMP options. Basins also provide more habitat value than other infiltration systems. Not surprisingly, the vast majority of basins which do fail become defacto artificial marsh systems. Although significant storage volume is typically lost, many basins are still capable of providing partial water

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quality control, as well as, environmental benefits generally associated with small artificial marsh systems.

Costs: An attractive feature of infiltration basins is their cost-effectiveness. They are projected to cost only ten to twenty percent more than dry detention ponds; however, the cost of an improved infiltration basin may be much higher.

Adaptability: Infiltration basins consume a considerable amount of space, often making them poorly suited for smaller development sites. In addition, because of their high susceptibility to clogging they are not recommended for sites which generate high amounts of suspended solids.

Maintenance Burden: Regular maintenance activities apparently cannot prevent rapid clogging and compaction of infiltration basins. Once clogged and/or compacted it has been very difficult to restore their original function; thus, many have been converted to wet ponds or artificial marshes.

IV. Grass Filter Strips/Grass Swales

Conventional grass filter strips and swales are long, relatively flat sloping earthen conveyance systems in which pollutants are removed from urban runoff principally through physical filtration through the grass cover crop, and secondarily via infiltration through the underlying soil. Enhanced grassed swale systems feature a series of low height check dams which provide temporary detention storage; thereby, improving the gravitational settling and infiltration characteristics of the system.

Both grass filter strips and grassed swales are commonly designed to safely convey large infrequent storm flows, such as the 10-year frequency storm, from the contributory drainage area. Unfortunately, comprehensive water quality design criteria for grass filters and other vegetative filtration systems are presently unavailable.

Capsule Summary

Pollutant Removal Capability: Conventional grass filter and swale designs have achieved mixed performance in removing particulate pollutants such as suspended solids and soluble nutrients. Vegetative filters that increase detention, infiltration and physical filtration have the potential to substantially improve removal rates.

Longevity: Conventional filters and swales can last an indefinite period of time if properly designed, periodically mowed, and if sediment deposits are removed as necessary.

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Feasibility: Grass filter strips and swale systems are typically restricted to: 1) small, flat development sites less than 2-3 acres in size where runoff velocities, soils and/or high water table problems are not limiting, and 2) within road right-of-way (ROW) areas where similar slope, soils, and runoff volume/velocity conditions are not restrictive.

Environmental Concerns: Direct over-fertilization and herbicide use together with leaching from culverts and wash-off from lawn areas may, under certain conditions, increase the presence of trace metals, nutrients and toxics.

Environmental Benefits: Grass swales eliminate curbs and gutters along roads and parking lots, thereby slightly decreasing overall site imperviousness levels. Because grass filter systems are typically maintained as lawn area and are often directly adjacent to areas with high automobile traffic, their wildlife habitat value is relatively low.

Costs: Swales are usually less expensive to construct than curb and gutter but may require more land.

Adaptability: Swale performance diminishes sharply in larger highly urbanized settings. Also, swales should generally not receive construction stage runoff.

Maintenance Burden: Mowing, periodic rill and gully repair, and reseeding of bare spots are the primary maintenance activities.

V. Porous Pavement

Porous pavement systems consist of an underground, filter cloth-lined stone reservoir area overlain by a two to four inch thick layer of specially mixed asphalt, in which much of the fine aggregate material has been intentionally left out. The asphalt layer, which has both a high void ratio and rough surface texture, is often referred to as "popcorn" asphalt. Like most infiltration BMP systems, porous pavement can effectively remove both fine particulate and soluble pollutants present in urban runoff. In addition, it can provide partial water quantity control, as well as, groundwater recharge benefits. Its use is generally restricted to flat, small to medium size parking lot areas where only light to moderate automobile parking and traffic occurs.

Because of its high failure rate, porous pavement is rarely used any more in the WMA. Additional background information is presented in the following capsule summary.

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Capsule Summary

Pollutant Removal Capability: Porous pavement systems have been shown to have high removal rates for both particulate ($\geq$ 80 percent removal) and soluble pollutants ($\geq$ 65 percent removal). The majority of the removal is a function of the exfiltration of runoff into the subsoil, and subsequent physical filtration, adsorption and microbial decomposition/transformation of pollutants.

Longevity: Porous pavement sites generally have one of the highest BMP failure rates (75% have reportedly failed within the first five years). Failure is due to partial or total clogging of the facility that occurs:

- Immediately after construction;
- Over time, when porous asphalt is clogged by sediment and oil; and
- When pavement is resurfaced with non-porous asphalt.

Feasibility: The use of porous pavement is highly constrained, requiring deep and permeable soils, restricted traffic (automobile traffic only), and suitable adjacent land uses.

Environmental Concerns: Concerns range from possible groundwater contamination (exacerbated by leaching of asphalt materials and hydro-carbons) to the loss of benefits due to premature failure.

Environmental Benefits: When operating properly, porous pavement can replicate pre-development hydrology, increase groundwater recharge, and provide excellent pollutant removal. Because the treatment area is physically located beneath the parking lot, the employment of porous pavement can help preserve more natural on-site area.

Costs: Porous pavement can be a very cost-effective BMP in the commercial areas where it can be applied. While the asphalt is more expensive than conventional pavement, porous pavement may (in some cases) eliminate the need for conventional on-site storm drainage systems.

Adaptability: Use of porous pavement may be restricted in regions with harsh winters, arid regions or regions with high atmospheric deposition rates, and in areas of sole-source aquifers.

Maintenance Burden: Quarterly vacuum sweeping and/or jet hosing is needed to maintain porosity. Field data, however, indicate that this routine maintenance practice is generally not followed.

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VI. Extended Detention Dry Ponds

Extended detention dry ponds (ED dry ponds), differ from conventional dry ponds in that they are intentionally designed to capture and slowly release stormwater runoff from smaller, more frequent storms. Review of local ED dry pond design criteria revealed high variability both in ED design storm size and ED period. In the WMA, ED dry ponds have been designed to provide 6 to 40 hours of ED control for 0.25 inches of runoff per impervious acre all the way upto the full two-year frequency storm.

ED dry ponds rely almost exclusively on gravitational settling to remove pollutants. Depending upon the volume and length of time runoff is detained, ED dry ponds can achieve moderate to high removal efficiencies for particulate pollutants. They are also one of the more effective BMP's in reducing downstream channel erosion problems. Because of practical orifice sizing constraints, ED dry ponds are generally employed to control runoff from contributory drainage areas of 10 acres or greater.

Capsule Summary

Pollutant Removal Capability: Conventional ED dry ponds provide moderate yet highly variable removal of particulate pollutants, such as sediment, phosphorus and organic carbon, but provide negligible removal of soluble pollutants. They are also highly susceptible to resuspension problems, particularly if routine maintenance is neglected.

Longevity: While few conventional ED dry ponds built to date have totally failed, many do not operate as designed, some are clogged and have become defacto wet ponds, and a majority are not achieving target detention times.

Feasibility: The enhanced ED dry pond can be utilized in most low visibility development situations, as a retrofit practice, or in combination with wetlands or permanent pools. ED dry ponds can be located either on or off-stream and can be designed to treat runoff over a broad drainage area size range.

Environmental Concerns: Poorly-maintained ED dry ponds may create nuisances and are not popular with nearby residents. If improperly designed and located, ED dry ponds can degrade forests, wetlands and other natural habitat areas, and can contribute to downstream thermal loading problems.

Environmental Benefits: Enhanced ED dry ponds can provide both excellent downstream channel erosion protection and valuable wetland and wet meadow habitat.

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Costs: ED dry ponds are generally the least costly stormwater quality ponds to construct, but also have the greatest regular maintenance burden of any stormwater pond system.

Adaptability: ED dry ponds are an adaptable BMP that can be applied to most, if not all, parts of the WMA.

Maintenance Burden: Conventional ED dry pond designs exhibit chronic clogging and are often difficult to mow. Debris and sand deposits quickly accumulate. This is particularly the case for ED dry ponds which are located directly on streams.

VII. Artificial Marshes

Artificial marshes are retention ponds predominantly comprised of large, shallow-depth water areas ideally suited for the establishment and growth of wetland plant species. These stormwater wetlands are designed to maximize pollutant removal through gravitational settling, dilution, filtration, and biological uptake and retention mechanisms. Artificial marshes may be located either on or off-stream and generally provide both water quality and quantity control for a wide array of drainage area and land use conditions.

Enhanced artificial marshes are designed for more effective pollutant removal and greater wetland plant species diversity and aquatic/wildlife habitat. They generally feature design elements such as extended detention control, a sediment forebay, complex microtopography, and extensive pond and terrestrial landscaping with native aquatic plants, shrubs and trees. Few stormwater wetlands are capable of replicating all of the varied ecological functions and attributes of natural wetland systems.

Capsule Summary

Pollutant Removal Capability: In general, conventional artificial marshes have a high pollutant removal capability that is roughly comparable to that of conventional wet ponds. Sediment removal can be greater in well-designed stormwater wetlands, but phosphorus removal is variable.

Longevity: Larger well-designed conventional artificial marshes should generally function for approximately 10 years before requiring major sediment removal or other rehabilitation work.

Feasibility: Enhanced artificial marshes can be applied to most development situations where sufficient baseflow, groundwater and/or contributory drainage area is available to maintain normal pool elevations.

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Environmental Concerns: If located improperly, the construction of artificial marshes may impact existing forests and natural wetlands, and can also contribute to downstream thermal loading problems.

Environmental Benefits: With careful design and siting, enhanced artificial marshes can create unique and valuable habitat for waterfowl and wildlife.

Costs: Construction costs for artificial marshes have not been systematically analyzed, but are expected to be similar to those for wet ponds. Maintenance costs may average three to five percent of construction costs annually.

Adaptability: Enhanced artificial marshes can be adapted for most parts of the WMA. Their use in coldwater stream areas, however, may often be inappropriate due to temperature-related concerns.

Maintenance Burden: Artificial marshes require greater maintenance in the first one to three years to properly establish wetland vegetation. Thereafter, the maintenance burden is similar to other pond systems.

VIII. Wet Ponds

Wet ponds differ from artificial marshes in that they feature a large, deep permanent pool area which is generally over four feet deep. Most conventional wet ponds have traditionally been graded with 3:1 underwater slopes, so as to intentionally discourage the establishment of cattails and other emergent plants. More recently, however, an increasing number of wet ponds are being designed with shallow underwater benches or shelves around their perimeter. These aquatic benches are typically less than one foot deep and provide both an added safety feature, as well as, a suitable area for the creation of fringe marsh habitat. Wet pond permanent pools are generally sized on a volumetric basis; with the permanent pool volume corresponding to all (or some major portion) of the design water quality storm runoff volume.

Wet ponds, along with artificial marshes, are among the top BMP's in terms of providing water quality and quantity control benefits over a broad range of storm frequency/size, drainage area and land use scenarios. They may be constructed either on or off-stream. Typically, wet ponds are restricted to catchment areas of 10 acres or greater.

Enhanced wet ponds are designed to provide higher levels of water quality control, downstream channel erosion protection, and wildlife and aquatic habitat amentities. They typically feature design elements such as extended detention control, a sediment forebay area, aquatic benches to support emergent wetland plants, multiple-

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cells, and extensive pond and terrestrial landscaping with a variety of native aquatic plants, shrubs and trees.

Capsule Summary

Pollutant Removal Capability: Conventional wet ponds provide moderate to high removal of both particulate and soluble urban stormwater pollutants. Reliable removal rates can be achieved with permanent pool volumes ranging from 0-.5 to 1.0 inches of runoff per impervious acre.

Longevity: Well-designed wet ponds can function for twenty years or more and very few conventional ponds have ever failed to provide some water quality benefit. Performance will decline over time, however, unless regular sediment cleanout is undertaken.

Feasibility: Wet ponds can be utilized in both low and high visibility development situations if the contributing watershed area is greater than ten acres and/or a reliable source of baseflow exists.

Environmental Concerns: If located improperly, wet ponds can have several adverse environmental impacts, including downstream warming, trophic shifts, and a slight risk of poor quality pond effluent during dry weather. Local impacts include possible wetland and forest destruction, and slight risks of sediment and/or groundwater contamination. For larger wet ponds, sacrifice of upstream channels together with the possible creation of fish barriers are concerns.

Environmental Benefits: An enhanced wet pond can be an attractive landscape and community feature, and can create a warm-water fishery, waterfowl habitat and wetlands in urbanized areas.

Costs: Wet pond costs are twenty-five to forty percent greater than those reported for conventional stormwater detention. Maintenance costs range from three to five percent of construction costs annually.

Adaptability: Enjoys wide spread use. Permanent pool size needs to reflect contributory drainage area acreage, type and source of water supply and local runoff frequency. Pond performance may decline slightly during ice and snowmelt runoff conditions.

Maintenance Burden: Wet ponds have a modest maintenance burden, consisting primarily of inspections, mowing of the embankment and buffers, and removal of sediment, trash and debris from the permanent pool.

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IX. Sand Filters

Sand has been employed successfully in sewage trickling filter installations in the United States since around the turn of the century. Its ability to remove effectively suspended solids and other pollutants, as well as, its general low cost and availability makes sand an ideal filtering medium for the treatment of urban stormwater runoff.

Nationally, sand filters have been used as an urban stormwater management BMP for about 10-years. While numerous variations exist, the most wide-spread stormwater sand filter systems feature the following basic design elements:

- off-line locations;
- sized to capture and treat first flush runoff volume;
- pre-treatment sediment basin or sump pit;
- sand filter basin with 18 inch layer of fine to medium grain sand;
- perforated PVC underdrain system; and
- emergency, over-spill system.

Other noteworthy sand filter BMP systems include the parking lot sand-trench system and the underground sand filter (which is presently in use in the District of Columbia).

Capsule Summary

Pollutant Removal Capability: Sand filter removal rates are high for sediment and trace metals, and moderate for nutrients, BOD and fecal coliform.

Longevity: Sand filters appear to have excellent longevity due to their off-line design and the high porosity of sand as a filtering media; however, relatively simple but frequent maintenance is generally required to maintain long-term performance.

Feasibility: Because sand filters are a man-made soil system, they can be applied to most development sites and have few constraining factors. Most sand filters have been used to treat small drainage areas of less than 50 acres. Their flexible design allows them to be used in both surface and underground applications.

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Environmental Concerns: Sand filters have very few environmental-related problems. Surface sand filters can be an eyesore; hence, they may enjoy limited community acceptance in some regions.

Environmental Benefits: Particularly useful for groundwater protection. Little or no wildlife habitat value is provided.

Costs: For small sites, sand filters are generally more costly than infiltration trenches (by a factor of two or three), but have lower regular maintenance/rehab costs.

Adaptability: To date, sand filters have only been widely applied in one region of the country, and some localities may experience some initial problems in importing the technology. This BMP appears to be well-suited for most parts of the WMA.

Maintenance Burden: Sand filters generally require annual maintenance. This usually involves surface sediment removal, removal of trash, debris and leaf litter, and filter cloth replacement.

X. Peat-Sand Filters

Peat-sand filters (PSF) are made-soil, filtration systems which were first developed as alternative wastewater treatment systems. Their high phosphorus (P), biochemical oxygen demand (BOD), and pathogen removal capabilities, coupled with their simple design, low-maintenance and affordability make them an attractive alternative to many conventional treatment systems. PSF systems combine the many attributes of peat with a nutrient removing grass cover crop and a subsurface sand layer to achieve high overall pollutant removal efficiency within a single, relatively compact unit. These attributes make them very attractive as potential urban stormwater BMP's.

Prototype stormwater management peat sand filters generally feature three basic components: a small pre-treatment wet pool, a flow splitting weir/diversion box, and an off-line peat-sand filter bed basin area. Runoff is generally applied to the peat basin surface via gravitational flow/surface flooding. The system is designed to reduce nonpoint source pollutant loadings by capturing and treating first flush runoff from the impervious portion of the contributory watershed. Surface and subsurface storage and detention within the PSF system also provides partial flow attenuation for smaller, high frequency storms; thereby, reducing the frequency of stream channel scouring events.

Capsule Summary

Pollutant Removal Capability: Removal rates for the untested peat-sand filter system are projected to be very high for particulate pollutants and moderate to high for most soluble pollutants.

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Longevity: The general life expectancy of the peat layer is 10-25 years. The remainder of the system should have longevity comparable to that of pond systems.

Feasibility: Peat-sand filters are man-made soil systems which may be applied to most development sites. While they may be used to treat first flush runoff from both small to large-sized catchments, they are essentially restricted to watershed areas which are fully developed. In addition, the ability of peat-sand filter systems to operate fully during colder, winter months is unknown.

Environmental Concerns: Peat-sand filters have very few associated environmental problems.

Environmental Benefits: Well-suited for urban stormwater retrofit application. Grassed peat basin and pre-treatment wet pool provide some wildlife habitat value.

Costs: Peat-sand filters are projected to cost significantly more than conventional pond systems. Their regular maintenance and rehabilitation costs, however, are approximately the same.

Adaptability: Year-round use in colder climates unknown. Selection of proper peat material is critical to system success. Limited by cost and availability of fibric/hemic peat. Construction of system requires expertise unfamiliar to many localities.

Maintenance Burden: Requires mowing one to three times per year and collection and disposal of grass clippings. Also, sediment and trash removal from the pre-treatment wet pool.

XI. Oil/Grit Separators

Oil/grit separators, also known as water quality inlets, are modified versions of rectangular gravitational settling tanks long used by the petroleum refining industry for the separation of oily wastes from water. The primary objective behind the employment of oil/grit separators is to reduce the quantity of nonpoint source pollutants associated with the settleable solids portion of the first flush of urban runoff; particularly, automotive-derived petroleum products. Most oil/grit separators feature two underground water-holding chambers plus a third, dry outlet chamber. In general, oil/grit separator permanent pools are sized so as to provide a minimum 200-400 cubic feet of dead storage volume per impervious acre of drainage.

Capsule Summary

Pollutant Removal Capability: Current designs of oil/grit separators generally have limited pollutant removal capability and appear to mostly trap coarse-grained sediments

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and some hydrocarbons. Removal of silt, clay, soluble nutrients, trace metals, oily emulsions and organic matter is generally expected to be slight. Re-suspension also appears to limit long-term removal. Actual removal only occurs when oil/grit separators are cleaned out. Currently, a lack of effective disposal methods hampers the recommended quarterly clean-out of trapped residuals.

Longevity: Longevity of oil/grit separators is high. Over ninety-five percent of all separators are operating as designed in their first five years of operation.

Feasibility: Oil/grit separators are most commonly employed to treat runoff from small developments of two acres or less (such as gas stations, parking lots, fast food outlets, and convenience stores).

Environmental Concerns: The greatest concern is the pollutant toxicity of trapped residuals and oily waters, and how the toxicity influences the ultimate disposal of the residuals. A secondary concern is the possibility of pulse loadings of the trapped residuals during larger storm events (due to re-suspension). This is particularly the case for oil/grit separators which are located on-line.

Environmental Benefits: Oil/grit separators show some capacity to trap trash, debris, and other floatables, thereby preventing their discharge to receiving waters.

Costs: The cost of pre-cast oil/grit separators averages about $8,000 per structure. The separators are costly on a runoff volume treated basis, averaging three to four times the unit cost of trenches or sand filters.

Adaptability: Oil/grit separators can be adapted to all regions of the country.

Maintenance Burden: Oil/grit separators require quarterly clean-outs. However, few acceptable clean-out and disposal techniques currently exist, often making maintenance difficult.

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Chapter 3. Retention Pond Performance - An Overview of Physical and Hydraulic Factors

Background

In general, artificial lakes, ponds and marshes located on-stream produce (in varying degree) the following physical, chemical and biological changes in the natural downstream condition: 1.) dampening and moderation of peak flow discharges, 2.) temperature regime alteration, 3.) reduction in downstream sediment transport, 4.) modification in the type and supply of organic material and food available to the biological community and, 5) shifts in both species composition and trophic structure in the aquatic community 6.) water chemistry changes related to concentrations of dissolved oxygen (DO), nutrients and reduced compounds. The extent of these modifications is dependent on conditions both upstream, and within the retention facility (e.g., - inflow pollutant loads, age, trophic state, presence of density currents, degree of thermal stratification, hydraulic residence time, and withdrawal depth and volume of discharge (Wright, 1967; Petts, 1984; Galli, 1990; Walburg, et al., 1981).

Among the more important interrelated physical and hydraulic design factors influencing the water quality performance of SWM wet ponds and artificial marshes are release depth (e.g., - surface, mid-level, bottom, etc.), hydraulic residence time, permanent pool volume and depth, and surface area. While it is beyond the scope of this study to examine each of these factors in detail, the following sections provide a brief summary of major literature survey findings.

Release Depth

It is generally understood that both the chemical properties and temperature of water downstream of retention facilities are heavily dependent upon the water quality and temperature within the facility at the release depth. Typically, water quality in these facilities is best at or very near the surface (Galli, 1988; Redfield, 1983)[1/]. Under normal dry weather conditions, total dissolved solids, phosphorous and nitrogen concentrations generally decrease in the upper portions of the water column through physical settling and algal and bacterial assimilation. Adsorption to clay and organic particles and subsequent flocculation/gravitational settling may further reduce surface concentrations of these and other pollutants. Functionally, surface release facilities closely resemble

1/ Downstream water quality can also be modified by groundwater inflow, stormwater inputs, riparian vegetation and climatological conditions.

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natural water bodies in that they continuously discharge warmer surface waters; thereby dissipating heat brought in by both the inflow and that which accumulates at or near the surface from solar heating (Wright, 1967).

In contrast, subsurface release facilities can (depending on permanent pool volume size, stratification patterns and withdrawal depth conditions) produce several unnatural modifications in both the diurnal and seasonal temperature regime (Walburg, et al., 1981). These changes to the receiving streams thermal regime generally fall into one or more of the following five categories: increased diurnal constancy, increased seasonal constancy, spring/summer temperature depression, fall/winter temperature elevation and thermal pattern changes. In addition, subsurface withdrawal facilities (particularly bottom and/or deep release) generally release water with higher nutrient and suspended solids levels and lower dissolved oxygen concentrations than do surface release facilities (Galli, 1988; Petts, 1984; Walburg et al., 1981). It is also important to note that release depth changes relative to the retention facility's water surface elevation.

Hydraulic Residence Time

Numerous studies have shown that, typically, the longer the hydraulic residence time the better the overall pollutant removal performance (Kulzer, 1989; Driscoll, 1983). Hydraulic residence time, which is generally calculated by dividing the permanent pool volume by the average outflow discharge rate, is normally greater in SWM ponds and marshes having large associated permanent pool volumes. In general, a mean annual hydraulic residence time of 14-30 days has been recommended for achieving high total phosphorous removal rates (Driscoll, 1988; Kulzer, 1989; Schueler, 1987). Longer hydraulic residence times usually improve the biological treatment, chemical transformation and gravitational/physical settling of pollutants present in stormwater runoff.

With regard to gravitational settling, laboratory settling column studies (Whipple and Hunter, 1981; Randal et al., 1982, OWML, 1983) have shown that approximately 30 to 70 percent of the particulate pollutant load present in urban runoff settles out in the first six to twelve hours. Thereafter, removal of smaller diameter particles, such as fine silt and clay-sized material, occurs incrementally over a much longer time frame (usually days or weeks). Because of the slow settling velocity of smaller-sized particles (Table 3), the selection of the pond release depth(s) greatly influences its overall pollutant removal efficiency. It is further noted that: 1.) silt and clay-sized particles comprise the greater portion of the suspended solids fraction, 2) totally quiescent conditions are rarely encountered in most wet pond and artificial marsh systems, and 3.) ED control can increase both stormflow residence time and overall sediment trapping performance.

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Table 3. Typical Settling Velocities Under Quiescent Conditions (modified from MDE, 1987a)

	Particle Size	Diameter (microns)	Average Settling Velocity (ft/hr)
Sand	V. Coarse	1000-2000	1170-2370
	Coarse	500-1000	630-1170
	Medium	125-250	300-630
	Fine	62-125	30-120
Silt	Coarse	31-62	9-30
	Medium	16-31	2-9
	Fine	8-16	0.5-2.0
	V. Fine	4-8	0.1-0.5
Clay		<4	0.1

Permanent Pool Volume and Depth

The pollutant removal efficiency of wet ponds and artificial marshes often increases with increasing permanent pool volume/treatment volume. Although this relationship is hardly linear, a larger permanent pool volume generally serves to improve both hydraulic residence times and pollutant dilution capabilities. While permanent pool sizing rules are imprecise, a minimum permanent pool volume equal to the mean annual runoff volume is often cited (Kulzer, 1989).

Permanent pool depth is also an important factor in that it: 1.) largely determines where both emergent and submerged aquatic plants may grow, 2.) influences both particle settling dynamics and sediment trapping efficiency, 3.) affects internal nutrient cycling and retention dynamics, as well as, dissolved oxygen distributions, and 4.) greatly influences thermodynamic conditions. In general, shallow water bodies less than three feet deep which are not well protected from the mixing effect of either wind or turbulent flow, are often prone to sediment resuspension problems.

Surface Area

Typically, wet ponds and marshes with large surface areas have correspondingly greater permanent pool volumes, as well as, more area for the support of both higher and lower forms of aquatic plant life (e.g., - emergent and submerged aquatic plants, phytoplankton, and periphyton). These, as well as other factors, tend to enhance both their overall pollutant removal performance and aquatic/wildlife habitat value. Once

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again, no hard and fast surface area sizing rule exists. However, both computer modelling and field studies suggest that a minimum surface area to catchment ratio of between one and three percent should result in improved pollutant removal performance (Kulzer, 1989; Driscoll, 1988).

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Chapter 4. Prince George's County BMP Field Survey Results

From May through December, 1991 COG staff field surveyed over 150 stormwater management BMP sites located throughout Prince George's County, Md.. BMP sites, which were carefully pre-screened on the basis of the availability of as-built engineering plans and overall BMP type representativeness, were inspected under wet and dry weather conditions. At all sites, an effort was made to : 1.) determine whether or not the BMP was providing water quality and/or quantity benefits as designed, 2.) isolate design elements and procedures which work (or do not work) in the field, 4.) quantify physical, chemical and/or biological differences in the upstream versus downstream condition, 5.) assess existing and/or potential aquatic/wildlife habitat value, and 6.) where warranted, identify possible BMP retrofit opportunities. A breakdown of the number of facilities surveyed, by both BMP type and area of maintenance responsibility, is included as Table 4). As seen in Table 4, maintenance responsibility for approximately 27 percent of the BMP sites surveyed resided within the public domain.

The following six sections summarize the major field survey study findings for each BMP system type. Additional information is provided in Appendix D.

I. Infiltration Systems

A. Infiltration Trenches

Background

Representing almost 42 percent of the 500- plus water quality control facilities constructed between 1985-91, infiltration trenches are currently the most widely used BMP in Prince George's County (Figure 3). Under the field survey portion of the study, COG staff inspected a total of 38 infiltration trench facilities. Classification of surveyed infiltration trench systems by pre-treatment type revealed that 31 (82 percent) employed sump-pits; whereas, seven (18 percent) featured grass filter strips. As-built plan review also identified 18 trenches (47.4 percent) which specified a six inch thick bottom layer of sand. With regard to aggregate material used for the stone reservoir portion of the system, washed bankrun gravel was specified 42.1 percent of the time. All 38 infiltration trenches employed the MDE recommended filter cloth lining approach of lining the top and sides, only.

A review of Prince George's County stormwater management files revealed that infiltration trenches are being employed to treat runoff from the full spectrum of land uses. Results from the field survey show that they are most often associated with small commercial developments of less than 2.0 acres. The vast majority of the infiltration

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Table 4. Summary: 1991 Prince George's County BMP Field Survey

	BMP Type	No. of Facilities Surveyed	No. of Publicity Maintained Facilities/Structures
I.	Infiltration Systems (55 total)		
	• Infiltration Trenches w/sump pits	31	9
	• Infiltration Trenches w/grass filter strips	7	2
	• Infiltration Basins	12	2
	• Dry Wells	2	0
	• Porous Pavement	3	3
II.	Grass Filters/Grass Swales Systems	6	3
III.	Extended Detention Dry Ponds	12	9
IV.	Artificial Marshes (9 total)		
	• Conventional Artificial Marsh	7	1
	• ED Artificial Marsh	2	1
V.	Wet Ponds (12 total)		
	• Conventional Wet Ponds	12	10
	• ED Wet Ponds (none in as-built files)	0	0
VI.	Oil/Grit Separators (53 total)		
	• Type I - One-Wet Chamber	5	0
	• Type II - Two-Wet Chamber	48	0
VII.	Dry Ponds	9	5
	Total	156	42(26.9%)

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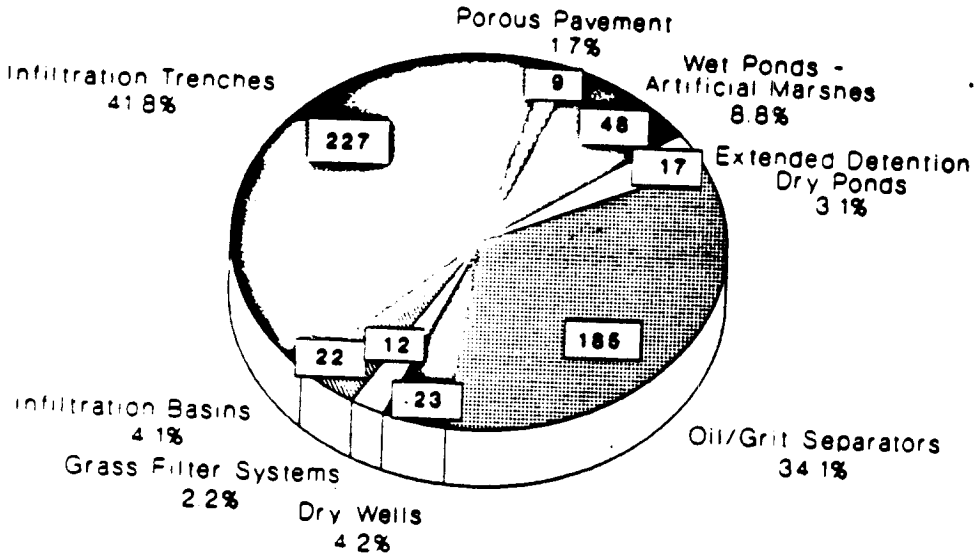
Figure 3. Summary: Number and Type of Prince George's County Water Quality BMP Systems In Operation, 1985-1991



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trench systems surveyed were sized to treat the first 0.5 inches of runoff from the impervious portion of the site. Infiltration trench systems had an average age of 2.5 years. Trenches with sump pits were generally older than their vegetative filter counterparts.

Additional background survey highlights are listed below and graphically summarized in Figures 4 and 5.

- Age Range (yrs): 0.5 - 5.1 (avg.-2.4)
- D.A. to Structure Range (ac): 0.2-5.0 (avg.-1.3)
- Range of Water Quality Runoff Volumes Controlled: 0.5 in/imp. ac - 0.5 in/ac
- Sump Pit Permanent Pool Depth Range (ft): 0.0-7.4 (avg.-3.2)
- No. of Sump Pits with Feeder Pipe Elbow: 22 out of 31 (71.0%)
- Grass Filter Strip Length Range (ft): 3.0-50.0 (avg.-23.9)
- Average Height of Grass (in): 2.0-12.0 (avg.-4.1)
- Trench Soil Textural Class Range: Urban Land Use Complex, Silt Loam, Sandy Loam, Gravel Loam, Gravel-Sandy Loam, Sandy Loam, Loam, Silty Clay Sand, Loam Sand, and Mixed Alluvial
- General Availability of Soil Boring Information: 32 out of 38 sites
- Land Uses Controlled: Single Family Residential, Townhouses, Garden Apartments and Commercial

General Performance and System Longevity

Results (Table 5) show that slightly less than half of all the inspected infiltration trenches were working as designed (i.e., - either not infiltrating water, exhibiting signs of slow infiltration, short-circuiting of runoff, etc.).

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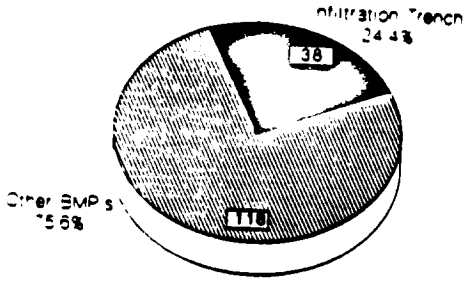
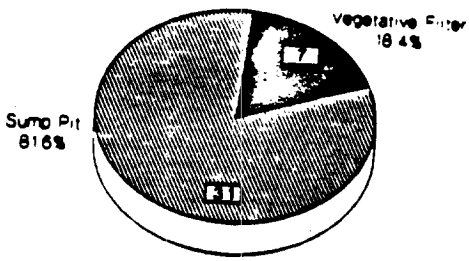
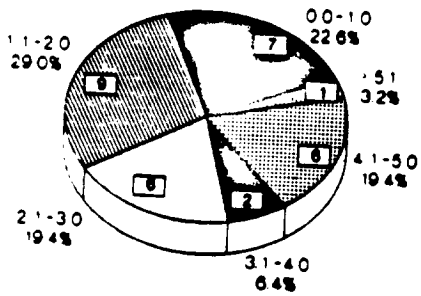
Figure 4. Infiltration Trench Systems: Background Summary



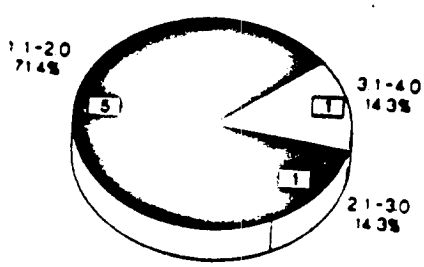
BMP Systems Surveyed (N=156)



Pre-Treatment Type (N=38)

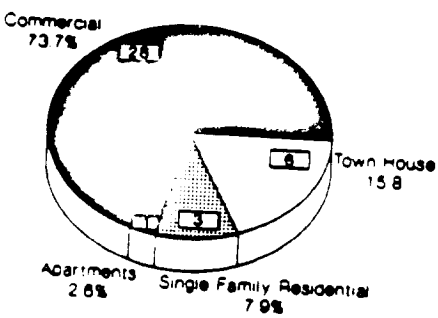


Sump Pit (N=31)

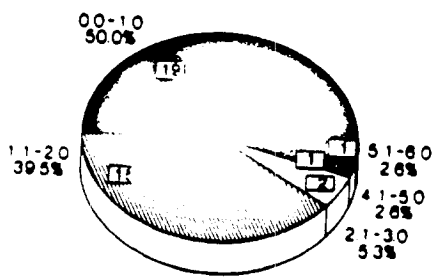


Vegetative Filter (N=7)

Age of System (yrs)



Land Uses Controlled (N=38)



Drainage Area to Trench (ac) (N=38)

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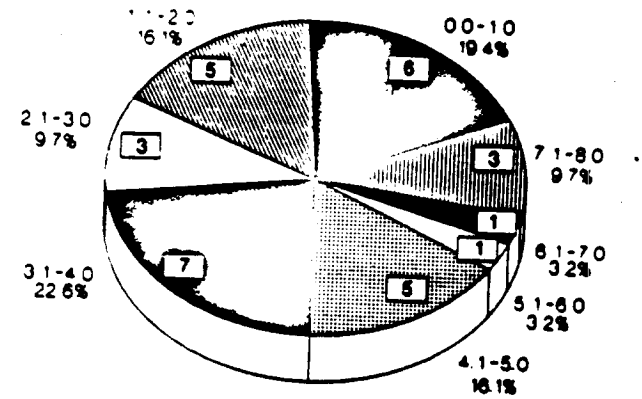
Figure 5. Infiltration Sump Pit: Permanent Pool Depth and Volume (N=31)



R0055112

Table 5. General Infiltration Trench Performance (N=38)

No. and Percent Working As Designed

Pre-Treatment Type	Yes	No	Unknown
Sump Pit	15 (48.4%)	13 (42.0%)	3 (9.6%)
Grass Filter	3 (42.9%)	4 (57.1%)	- - -
Total	18 (47.4%)	17 (44.7%)	3 (7.9%)

Not surprisingly, the general performance of both infiltration trench types declined over time (Figure 6). System failure was more pronounced for the grass pre-treatment type, in which no trench over two years old was working as designed. Sump pit systems were markedly less fragile. In fact, several trenches were still functioning after almost five years of service. Results further showed that the percentages of infiltration trenches either with or without a bottom sand layer, which were working as designed, were nearly identical (55.6% versus 55.0%).

Performance, Maintenance and/or Structural Problems

The major performance, site selection, maintenance and/or structural problems identified by the field survey are graphically shown in Figure 7. As seen in Figure 7, slow infiltration was the leading problem in approximately 40 percent of the systems surveyed. Almost one-third of the infiltration trenches had standing water present in their observation well(s) more than 48 hours after a storm event.

Partial and/or total loss of infiltration capacity was often abetted by either questionable site selection, design shortcomings, inadequate construction practices, lack of routine maintenance; or combinations thereof. For example, survey results revealed that seven infiltration trenches were located in areas having a relatively high water table (water encountered 5-7 feet below the ground surface). Nearly one-fifth of the trenches were constructed in questionable soils. In addition, three out of the seven pre-treatment grass filter strips (42.9 percent) were shorter than the required 20 foot length.

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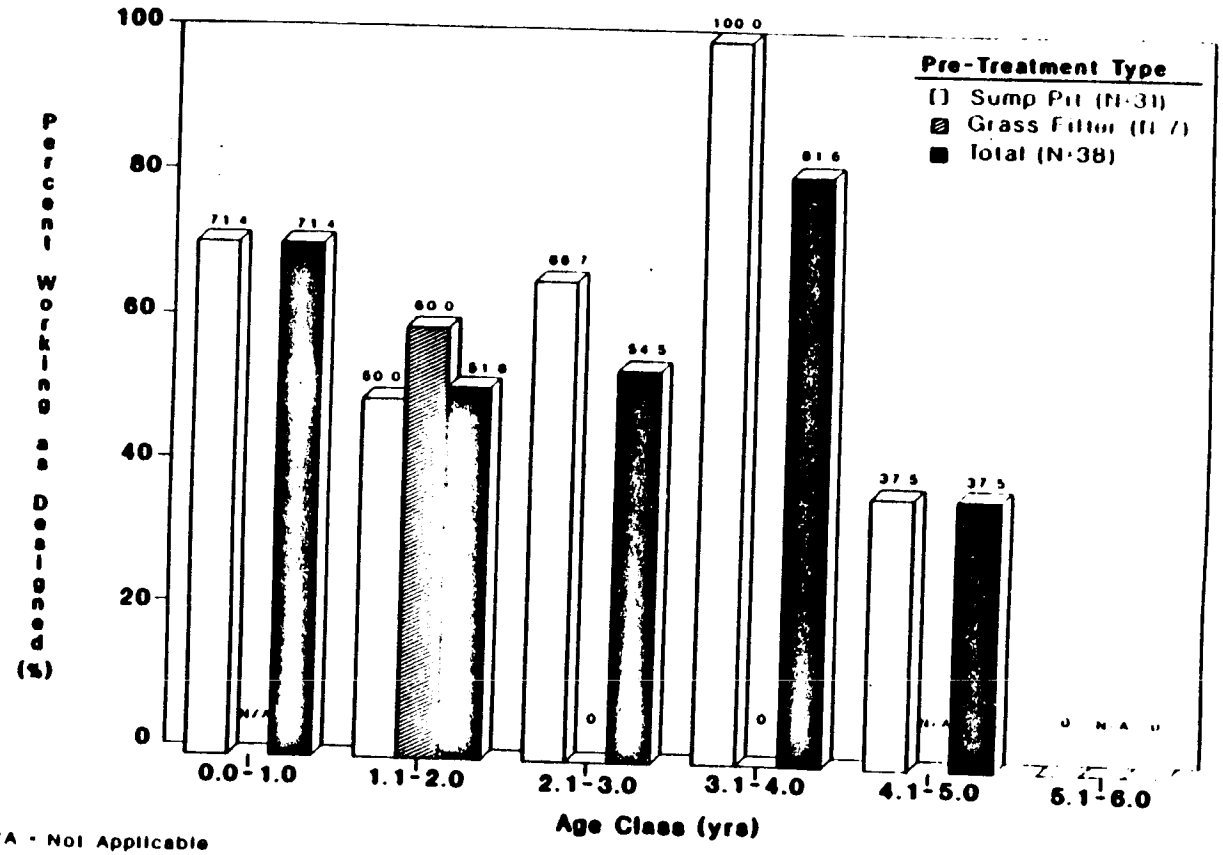
Figure 6. Infiltration Trenches: Performance Over Time[1/]



1/ N/A - Not Applicable

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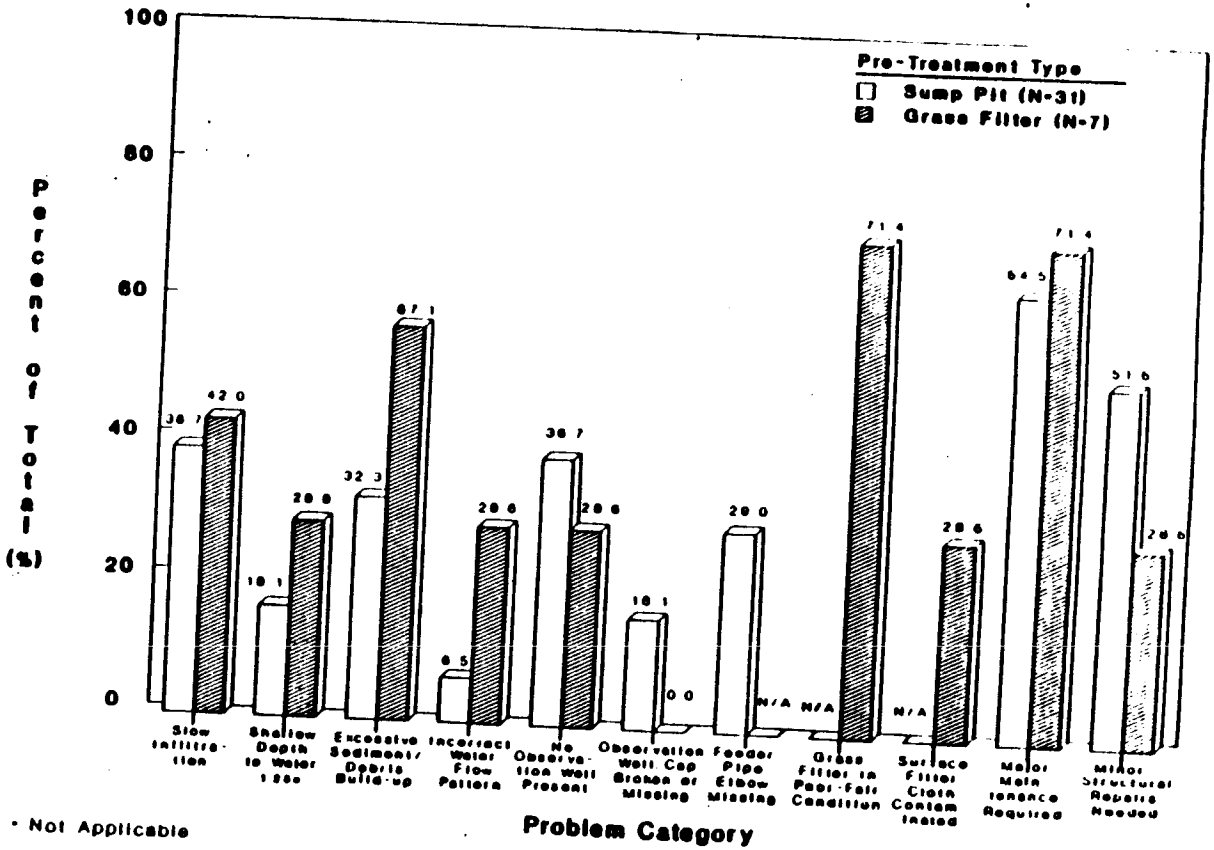
Figure 7. Infiltration Trenches: Typical Performance, Maintenance and/or Structural-Related Problems 1/



1/ N/A - Not Applicable

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With the exception of routine mowing of the grass filter strips, none of the infiltration trenches surveyed appeared to have ever had regular maintenance performed. Overall maintenance condition was rated as follows (no. out of 38 facilities indicated):

Poor	-	11 (29.0%)
Fair	-	13 (34.2%)
Good	-	10 (26.3%)
Very Good	-	4 (10.5%)

It should also be noted that routine observation well inspection was made more difficult by the high diversity of observation well caps encountered.

Structurally, 18 out of the 38 infiltration facilities (47.4 percent) required some minor amount of repair work. The number and type of observed structural problems were as follows (no. out of 38 facilities indicated):

- 2 - brick sump pits not holding any water
- 2 - no observation wells present
- 5 - observation well caps broken or missing
- 9 - elbow on feeder pipe missing

Environmental Attributes

Unlike most BMP systems, infiltration trenches can be located under either parking lot or lawn area; thereby, increasing the possibility of preserving a larger amount of natural on-site area. As expected, no meaningful wildlife habitat value was directly associated with either infiltration trench system types. It should be noted that infiltration sump pits do not appear to support any life.

Infiltration Sump Pits

Because of the heavy reliance on sump pits for pre-treatment control and their functional similarity to oil/grit separators, COG staff felt that a more comprehensive evaluation of the sediment trapping performance of these systems was warranted. Major findings on the general nature of the residual material present, volume of sediment trapped, and average sediment trapping rate are graphically summarized in Figures 8-10.

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As seen in Figure 8, coarse-grained inorganic sediment (fine sand grain size or larger) constituted the major portion of the residual material present in the sump pits. Fine inorganic material (smaller than fine sand) typically accounted for 25 percent of the residual material. The remaining portion was generally comprised of larger organic material such as leaves, twigs, etc.

Further examination of sump pit sediment deposits (Figure 8) revealed that over half of the sump pits contained little or no visible oily materials. However, approximately 30 percent had moderate to high amounts of oil present.

Based on sediment depth readings, COG staff was able to estimate the volume of sediment present in each sump pit. Results show that a rather broad range exists in the quantity of residual material present (Figure 9). From both a performance and maintenance standpoint, nearly 22 percent of the sump pits had managed to trap a rather considerable volume of sediment (i.e., - one cubic yard / 27 cubic feet or greater). Taking this information one step further, the sediment trapping rate (on a lbs/ac/year basis) was calculated for each sump pit age class. As seen in Figure 10, the mean sump pit sediment trapping rate for the entire population was 280.6 lbs/ac/year. More importantly, however, is the finding that sump pit sediment retentiveness generally decreased over time. This was most likely caused by stormflow scouring and resuspension problems within the structure. Additional infiltration sump pit findings are included in Appendix D.

B. Dry Wells and Porous Pavement

A total of two dry well facilities and two porous pavement sites were comprehensively inspected by COG staff (a third dry well facility was also casually surveyed). Field survey results for both BMP types are summarized in Table 6.

As seen in Table 6, all three dry wells had considerable amounts of standing water present in their observation wells, indicating loss of all or most of their infiltration capacity. Results also revealed that none of the dry well systems surveyed had gutter guards or any other type of pre-treatment control.

With regard to porous pavement, repeated water pour tests at four separate locations within the J. and L. Valve Corp. porous pavement parking lot area revealed that the major portion of the system was still functioning as designed. However, pavement areas with higher vehicular traffic, such as driveway areas, had lost virtually all infiltration capacity. It should be noted that the parking lot was not posted to alert one of the presence of porous pavement. Also, it did not appear that the porous pavement lot had ever been maintained.

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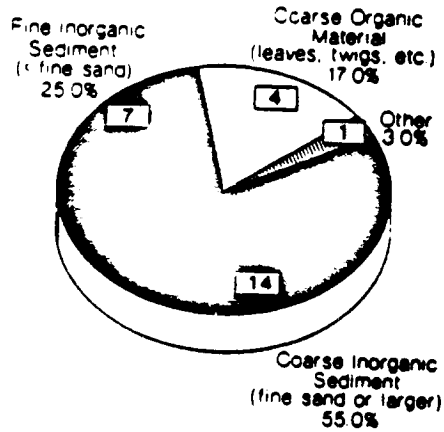
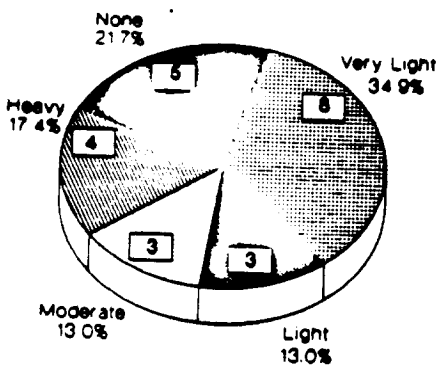
Figure 8. Infiltration Sump Pits: Residual Particle Size Distribution and Relative Quantity of Oil in Sediment



Average Composition of Total Material Present (%)
(N=28)



Relative Quantity of Oil in Sediment (% of Sump Pits)
(N=28)

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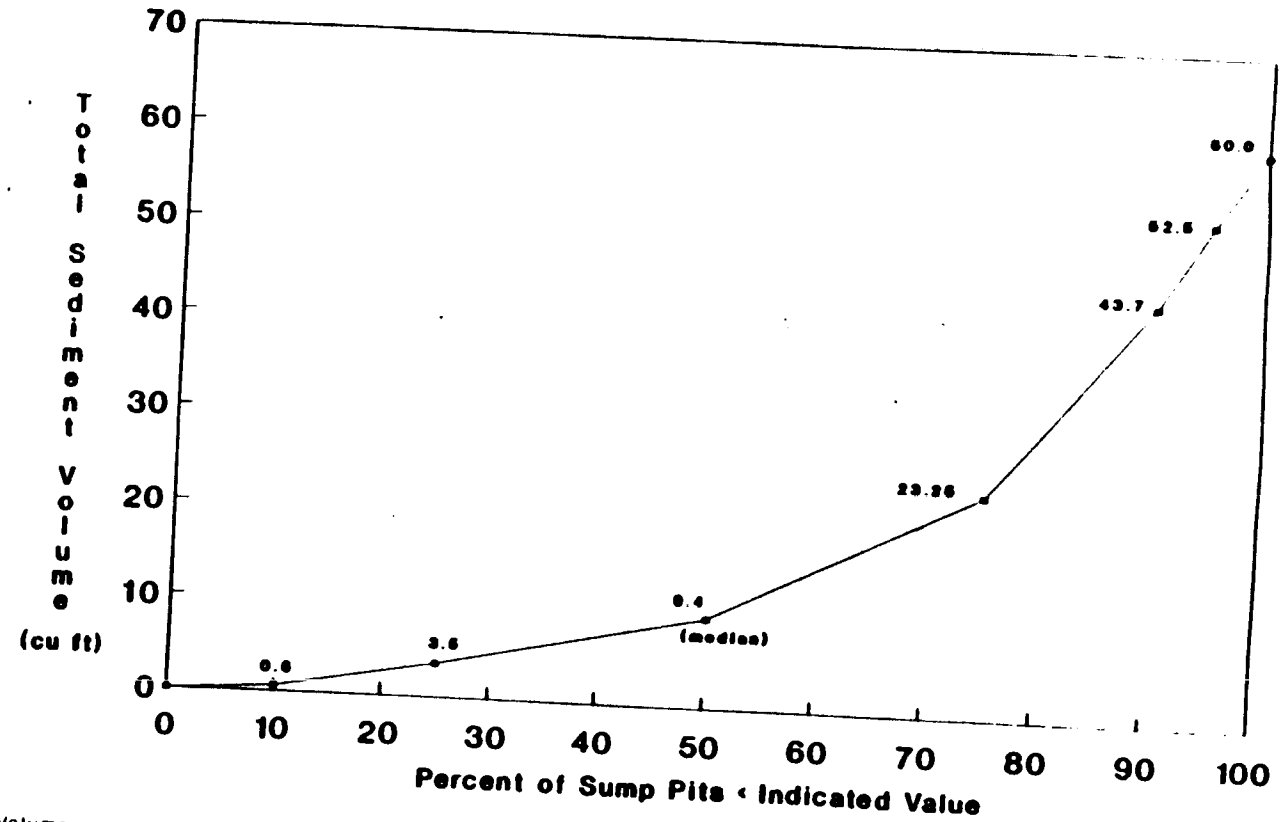
Figure 9. Infiltration Sump Pits: Total Volume of Sediment Present 1/ (N-29)



1/ Volume estimated from average of four depth measurements.

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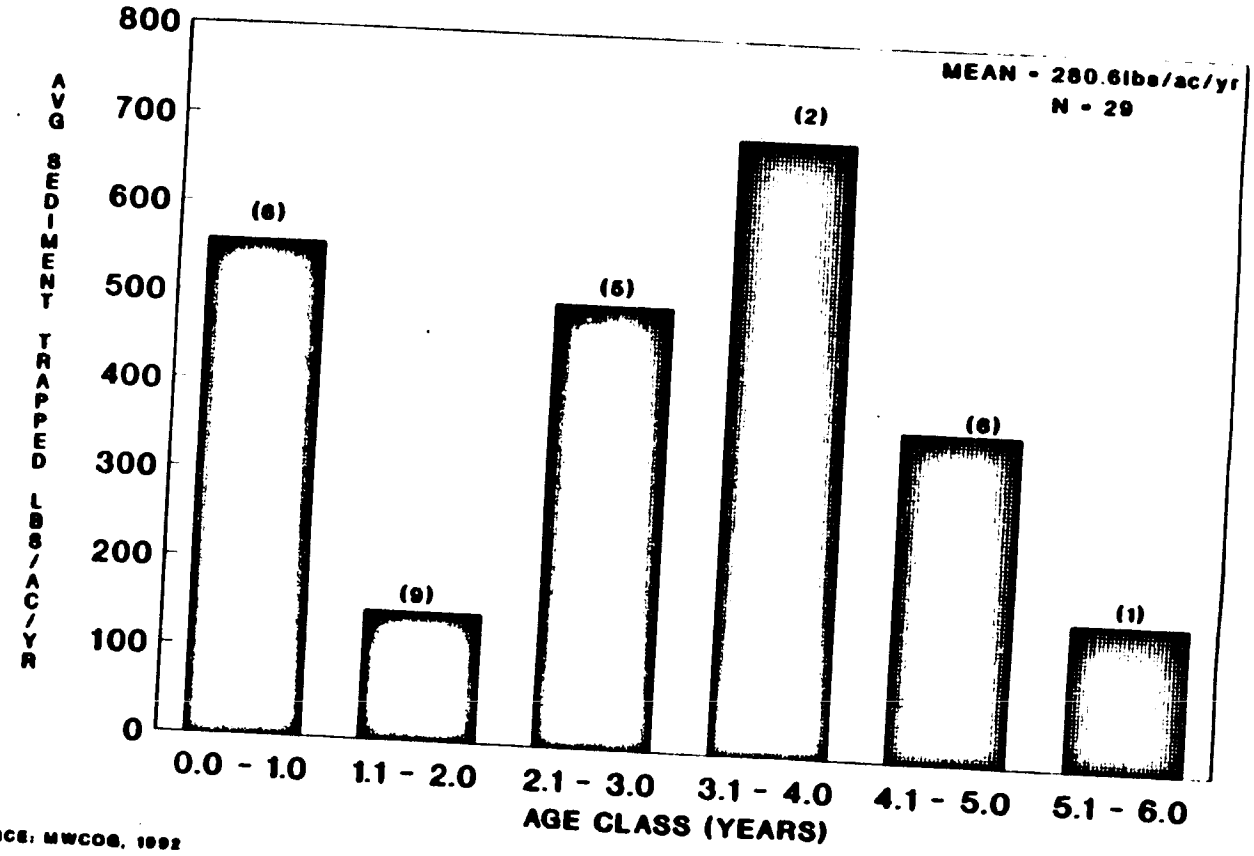
FIGURE 10

INFILTRATION TRENCH SUMP PITS: SEDIMENT TRAPPING PERFORMANCE



SOURCE: MWCOG, 1992

(No.) = Indicates number of structures per age class

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Table 6. Summary: Dry Well and Porous Pavement Field Survey Results

Site Name	BMP Type	Land Use	Age of Structure (yrs)	D.A. to Structure (ac)	Pre-treatment System	Soil Type	Depth of H_2O in Obs. Well (in)	Working as Designed
1.) Highbridge #2	Dry Well	SF	5.6	0.03	None	Sandy Loam	5.0	No
2.) Highbridge #5	Dry Well	SF	4.9	0.03	None	Sandy Loam	7.0	No
3.) Ritchie Ind. Park*	Dry Well	Ind.	approx. 5.0	0.11	None	Sandy Loam	approx. 12.0	No
4.) River Towne Commons	Porous Pavement	Com.	1.9	2.0 1.6	None	Silt Loam	—	No (for both)
5.) J & L Valve Fit Corp.	Porous Pavement	Ind.	4.1	0.11	None	Sandy Loam	—	Yes

* – Casually Surveyed

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C. Infiltration Basins

Background

A total of 12 infiltration basins, representing slightly over half of the total constructed in the County since 1985, were inspected by COG staff. As seen in Figure 11, the majority of the infiltration basins were between two and three years old. Two-thirds of the surveyed sites were associated with small commercial developments having catchment areas of between one and four acres. The majority of the basins surveyed were relatively small; averaging just under one-tenth of an acre in size. Seventy five percent of the facilities had concrete riser-barrel outlet structures. None of the basins surveyed had any formal type of pre-treatment system. Additional background findings are listed below.

- Age Range (yrs): 0.5-5.1 (avg.-2.8)
- D.A. to Structure Range (ac): 0.8-9.3 (med.-1.8)
- Range of Water Quality Runoff Volumes Controlled: 0.5 in/imp. ac to runoff volume generated from a one-inch rainfall event
- Basin Surface Area Range (ac): 0.01-0.18 (med.-0.10)
- Percent Excavated Basin - 100%
- Basin Soil Textural Class Range: Urban Land Use Complex, Silt Loam, Sandy Loam, and Gravel-Sandy Loam
- General Availability of Soil Boring Information: 7 out of 12 sites
- Land Uses Controlled: Single Family Residential, Institutional Commercial and Industrial

General Performance and System Longevity

Unfortunately, not one of the 12 infiltration basins surveyed was working as designed. In fact, all 12 facilities exhibited either surface ponding or saturated soil conditions. Although none of the basins were capable of infiltrating any runoff, seven facilities (58.3 percent) had enough available storage to provide at least some partial water quality control.

Over the years, infiltration basins have earned the reputation of being extremely fragile BMP's with characteristically high failure rates. Although this reputation is

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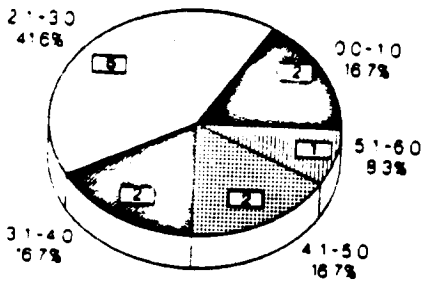
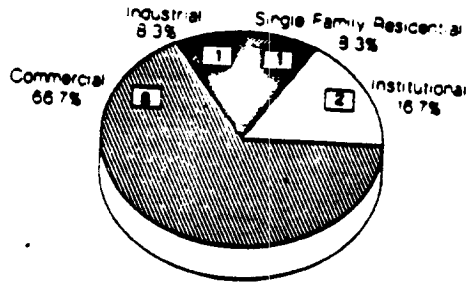
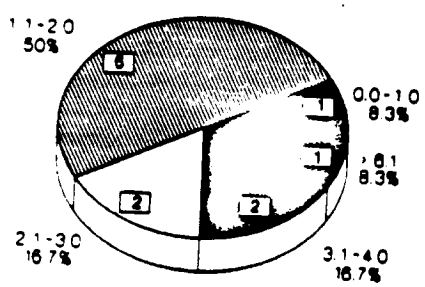
Figure 11. Infiltration Basins: Background Summary (N=12)



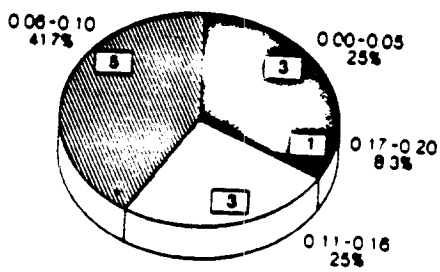
Age (yrs)



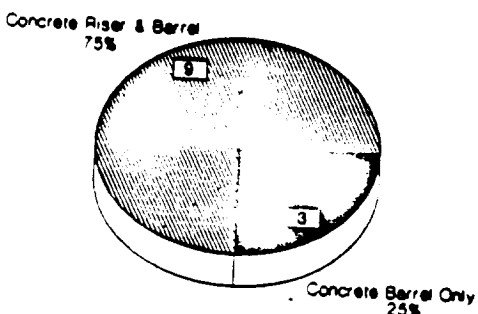
Land Uses Controlled



Drainage Area to Basin (ac)



Bottom Surface Area (ac)



Outlet Structure Type

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generally well-deserved, examination of as-built file information revealed that poor initial site selection may have contributed to several system failures. For example, one of the surveyed basins was constructed in an area where the depth to the seasonally high water table was less than four feet. Two others were built on sites in which the depth to the water table was questionable. In addition, seven of the 12 basins appear to have been constructed on soils with generally less than ideal soil textural classifications (i.e., - Beltsville silt loam and urban land complex designations).

Importantly, results strongly suggest that the majority of infiltration basins are likely to fail within their first year due to either clogging and/or compaction of the soil surface, unsuitable site conditions or combinations thereof. It should be noted that gradual sealing of the soil surface may occur, after construction, through the lawnroller-like effect of repeatedly flooding a basin with several feet of standing, silt-ladened water.

Performance, Maintenance and/or Structural Problems

As seen in Figure 12, the principal basin performance problem was total loss of infiltration capacity. Both internal and external sediment loadings contributed to this problem. Three of the 12 basins (25.0 percent) had excessive sediment/debris build-up. Other maintenance-related problems included erosion at both inflow and outflow locations, poorly stabilized side slopes, and partial clogging of the outlet structure. None of the basins required any structural type repairs. This was largely due to both the employment of concrete risers and barrels and extremely simple design of the basins. It should be noted that the only apparent regular maintenance performed at any of the 12 sites was grass mowing of non-flooded areas. Overall maintenance ratings for the infiltration basins were as follows (no. out of 12 facilities indicated).

Poor	-	3 (25%)
Fair	-	6 (50%)
Good	-	3 (25%)
Very Good	-	0 (0%)

Environmental Attributes

With only one exception, all of the infiltration basins surveyed had permanent pools with well-developed stands of emergent wetland vegetation. Both the permanent pool characteristics and environmental attributes of these defacto artificial marsh systems are graphically summarized in Figure 13. As seen in Figure 13, the average maximum depth of standing water was one foot. The maximum July - August, 1991 basin surface water temperature was a warm, 86.0 °F. Typically, the areal extent of floating algal mats was inversely proportional to the amount of emergent aquatic vegetation present.

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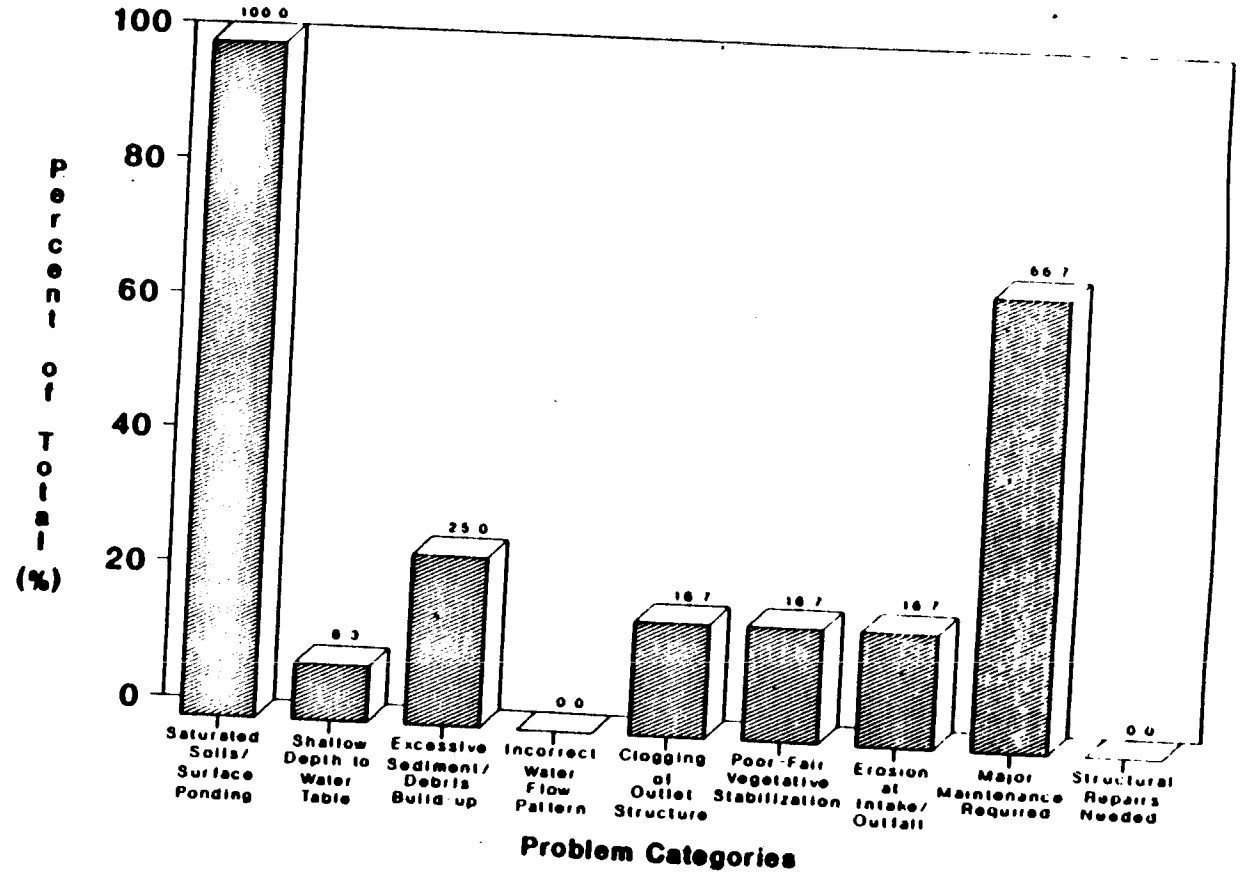
Figure 12. Infiltration Basins: Typical Performance, Maintenance and/or Structural Problems (N-12)



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Based on the COG aquatic/wildlife habitat value index system, the average infiltration basin score was 1.3 (low value rating). In general, the highest habitat scores were associated with larger facilities that had a good mix between stands of emergent vegetation and open water, and were relatively isolated from automobile and pedestrian traffic areas. Submerged aquatic vegetation, including wild celery (Valisneria americana) was observed growing at three sites. Both frogs and toads were abundant at 50 percent of the basins inspected. Mosquito larvae were observed at only one relatively young site. It appears that the abundant supply of natural predators such as dragon fly and damselfly larvae help to generally keep the mosquito problem in check.

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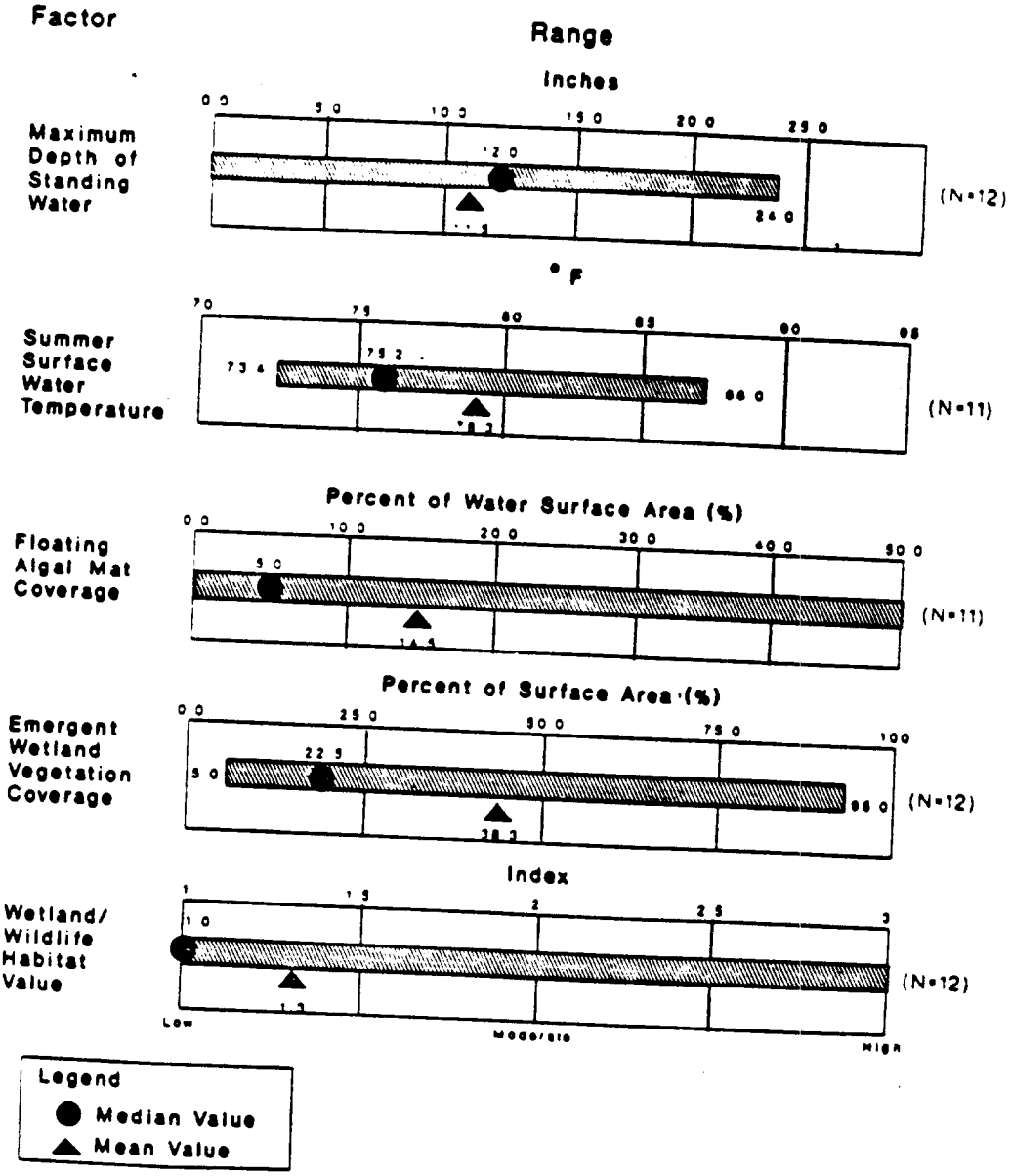
Figure 13. Infiltration Basins: Ponding Characteristics and Environmental Attributes



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II. Grass Filter Strip/Grass Swale Systems

All of the grass filter systems surveyed were, at a minimum, designed to safely convey runoff (at non-erosive velocities) from the 10-year frequency storm. While these systems were constructed in the absence of specific water quality design criteria, it was assumed that first flush water quality benefits would occur via filtration through the grass cover crop. With this as background, COG staff set out to comprehensively examine both the filtering capability of the grass cover crop, as well as, the system's apparent ability to safely convey larger stormflows.

Background

Six grass filter systems, three conventional grass swales without checkdams and three enhanced swales with checkdams, were field inspected by COG staff. As seen in Figure 14, all of the systems surveyed were between two and four years old. Associated land uses were equally split between institutional uses, such as recreational centers, and small commercial developments. Two-thirds of the catchment areas were between one and two acres; with the remainder, less than one acre in size. All of the surveyed sites were extremely flat. Additional background survey highlights are summarized as follows.

- Age Range (yrs): 1.3-2.6 (avg.-2.2)
- Checkdam Material Type: No.2 bluestone, surge stone (WSSC Class I rip-rap), and earth berm
- Checkdam Height Range (in): 4-12 (avg. 9.0)
- Grass Filter System Length Range (ft): 230-500.0 (avg.-417.0)
- Grass Filter Bottom Width Range (ft): 3.0-20.0 (avg.-11.3)
- Grass Filter Slope Range (%): 1.0-3.0 (avg.-1.7)
- Range in Height of Grass (in): 1.0-5.0(avg.-3.0)
- Relative Density of Grass Range (Index: 1-3): 1-3 (low-to high), avg.-2.3 (moderate)
- No. with Partial Shade: 2 (33.3%)
- System Soil Textural Class Range: Silt Loam, Loamy Sand, Gravelly Loamy Sand

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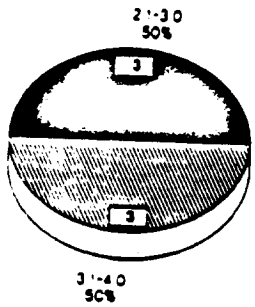
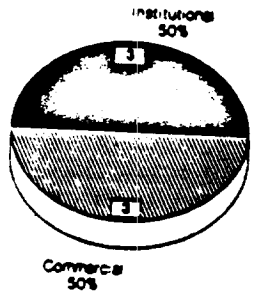
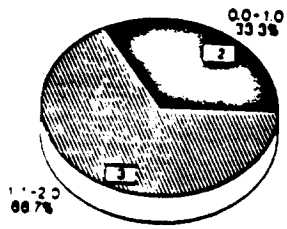
Figure 14. Grass Filter Strip / Grass Swale Systems: Background Summary (N=6)



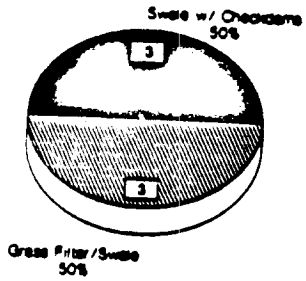
Age (yrs)



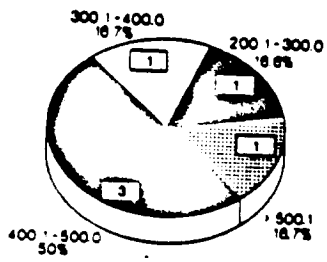
Land Uses Controlled



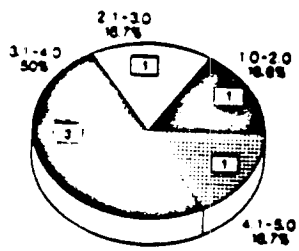
Drainage Area (ac)



System Type



Length of Filter (ft)



Average Grass Height (in)

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- Land Uses Controlled: Institutional, Commercial (Fast Food) and Commercial (Office Bldg.)

General Performance and System Longevity

Because of severe runoff filtering limitations associated with both short grass height and low to moderate grass densities, only one out of the three conventional grass swales was judged capable of providing any first flush water quality control benefits. Conversely, two out of the three grass swales with checkdams appeared to be capable of both physically filtering and partially infiltrating runoff from small, low intensity storm events. Results confirmed the value of using enhanced grassed swales with checkdams. As stated earlier, checkdams provide temporary detention storage and lengthened contact time, thereby, improving the gravitational settling and infiltration characteristics of the system.

With regard to large stormflow conveyance, all six grass filter sites appeared to still be working as designed. However, all six sites were showing some evidence of gradual system deterioration, partially related to high runoff velocities. Without some additional corrective and/or preventative maintenance work, it is extremely doubtful that any of these systems will continue to be working as designed in another two or three years.

Performance, Maintenance and/or Structural Problems

Without question, the leading cause of poor performance was low grass height. As seen in Figure 15, over 80 percent of the grass filters surveyed were identified as being mowed too close to the ground (i.e., - grass height of $\leq$ 3 inches). Bare spots, poor drainage (localized sump areas with saturated soil conditions), and internal short-circuiting problems (around checkdams) were additionally noted at one-third of the sites. None of the grass filter systems exhibited any sign of either excessive sediment build-up or oil contamination. Sand deposition was observed in only the first five to ten feet of the grass filter; with the majority of this material being retained at the pavement - grass interface.

Tall fescue, Kentucky bluegrass, and crabgrass were the dominant grasses present in these systems. Invasive annual grasses and weeds, such as crabgrass, can reduce overall system filtering ability (particularly during the colder months of the year) when they experience seasonal die-back. As seen in Figure 15, 50 percent of the sites required major maintenance such as reseeding of bare spots, stabilization of rill erosion areas and regrading of low spots. In addition, structural repair work on one-half of the checkdams was warranted (i.e., - repair eroding areas and replace dislodged stone).

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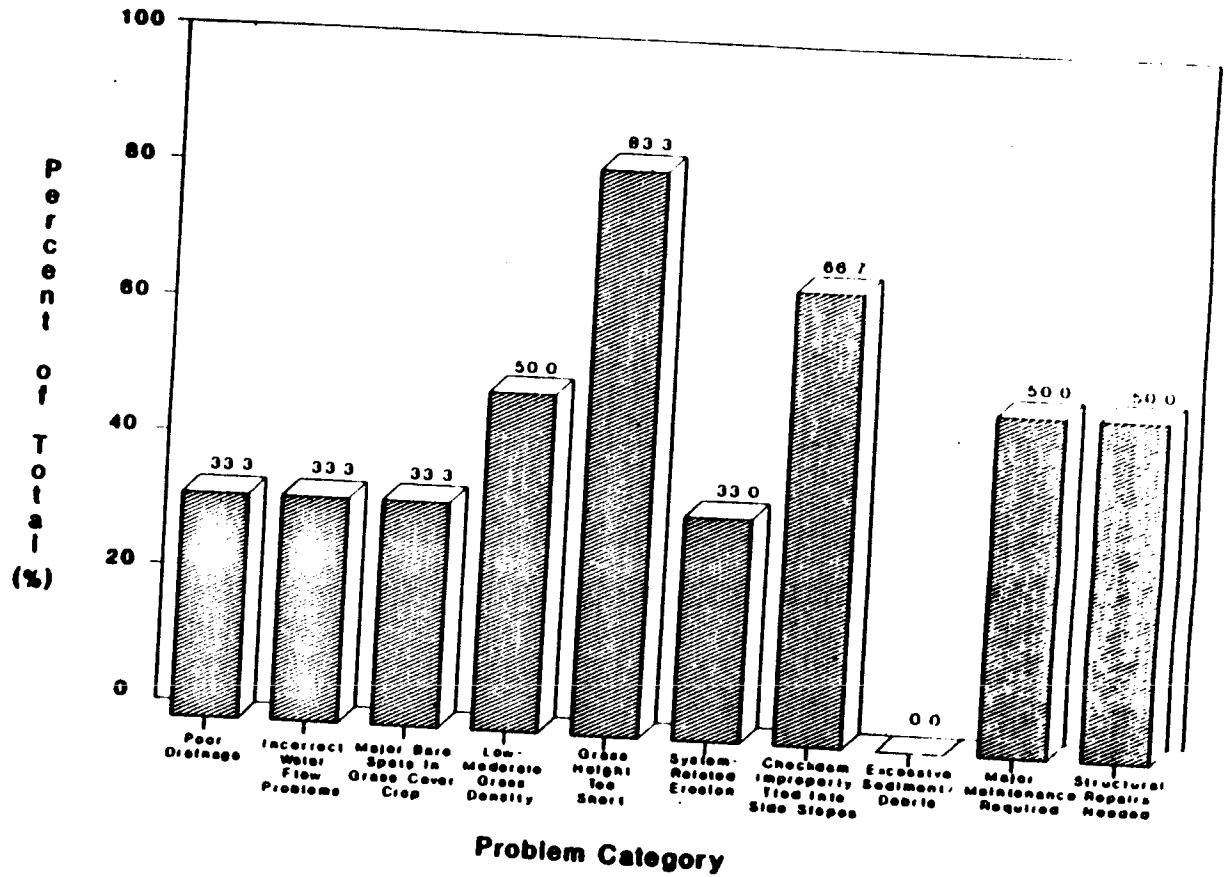
Figure 15. Grass Filter Strip / Grass Swale Systems:
Typical Performance, Maintenance and/or Structural Problems (N=6)



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Environmental Attributes

Given that all of the grass filter systems inspected were maintained as lawn area, their wildlife habitat value was extremely limited. However, allowing the grass cover crop to grow one foot tall or higher between mowings would provide greater habitat opportunities for both small mammals, as well as, for many song birds. Alternatively, wildlife habitat could be improved by incorporating a minimum 10-12 foot wide, no-mow buffer strip into the design.

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III. Extended Detention Dry Ponds

Background

Twelve ED dry ponds, representing almost 71 percent of the total number in operation in the County since 1985, were field surveyed by COG staff. As seen in Figure 16, all of the inspected ED facilities were less than four years old; with the majority being under one year in age. ED dry ponds were associated with both the entire spectrum of land uses and catchment area size range. Review of as-built file information revealed that the drainage areas controlled by these facilities ranged from as small as 0.8 acres all the way up to 1164.8 acres. In addition, a rather broad range in both ED period and range in the runoff volume controlled was further noted. The average ED period and design ED runoff volume were 15.8 hours and 0.5 inches of runoff/impervious acre, respectively. Not surprisingly, ED dry ponds were constructed in both on and off-stream locations. Additional background highlights are listed below and graphically summarized in Figure 17.

- Age Range (yrs): 0.1-3.6 (avg.-1.9)
- D.A. to Structure Range (ac): 0.8-1164.8 (med.-21.1)
- Design ED Period Range (hrs): 6-40 (med.-10.0)
- Range of Runoff Volumes Controlled by ED: 0.25-1.0 in./imp. ac; 0.5 in/ac., runoff from full 2-yr storm
- No. with Micropools: 3 (25%)
- No. with Gate Valve ED Control: 1 (8.3%)
- No. with Pond Drain: 1 (8.3%)
- Range in Minimum Flowpath Length (ft): 18-approx. 1200 (med.-140)

General Performance and System Longevity

Performance

In abstract terms, the concept of gradually releasing stormwater runoff over a pre-determined period of time (i.e., -ED control) appears quite simple. However, in practice, the goal of consistently achieving design ED times and release rates over

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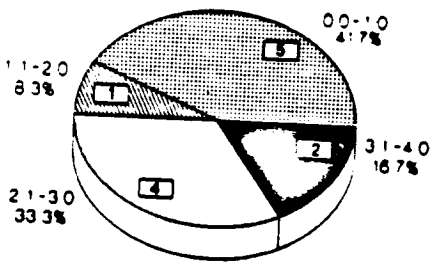
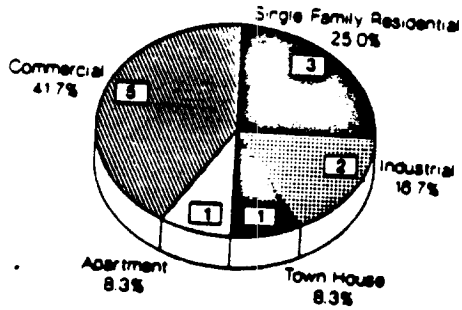
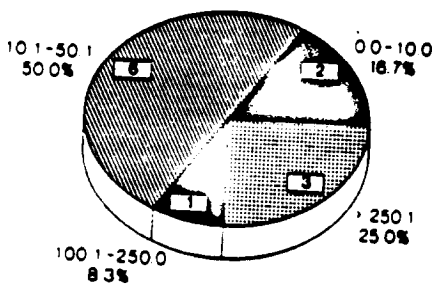
Figure 16. ED Dry Ponds: Background Summary (N=12)



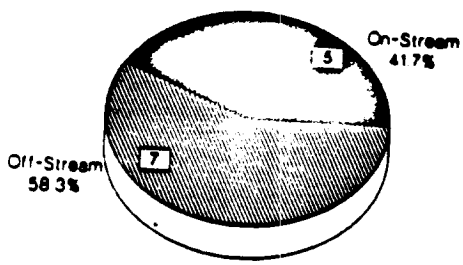
Age (yrs)



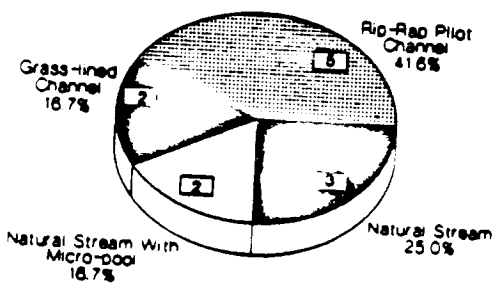
Land Uses Controlled



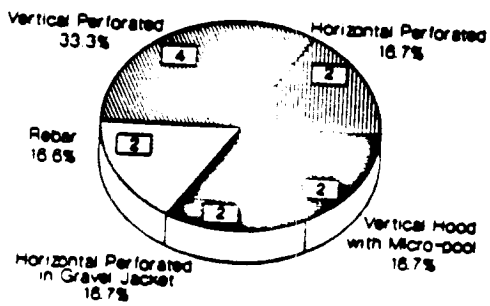
Drainage Area (ac)



Pond Location



Internal Conveyance System



Trash Rack Type

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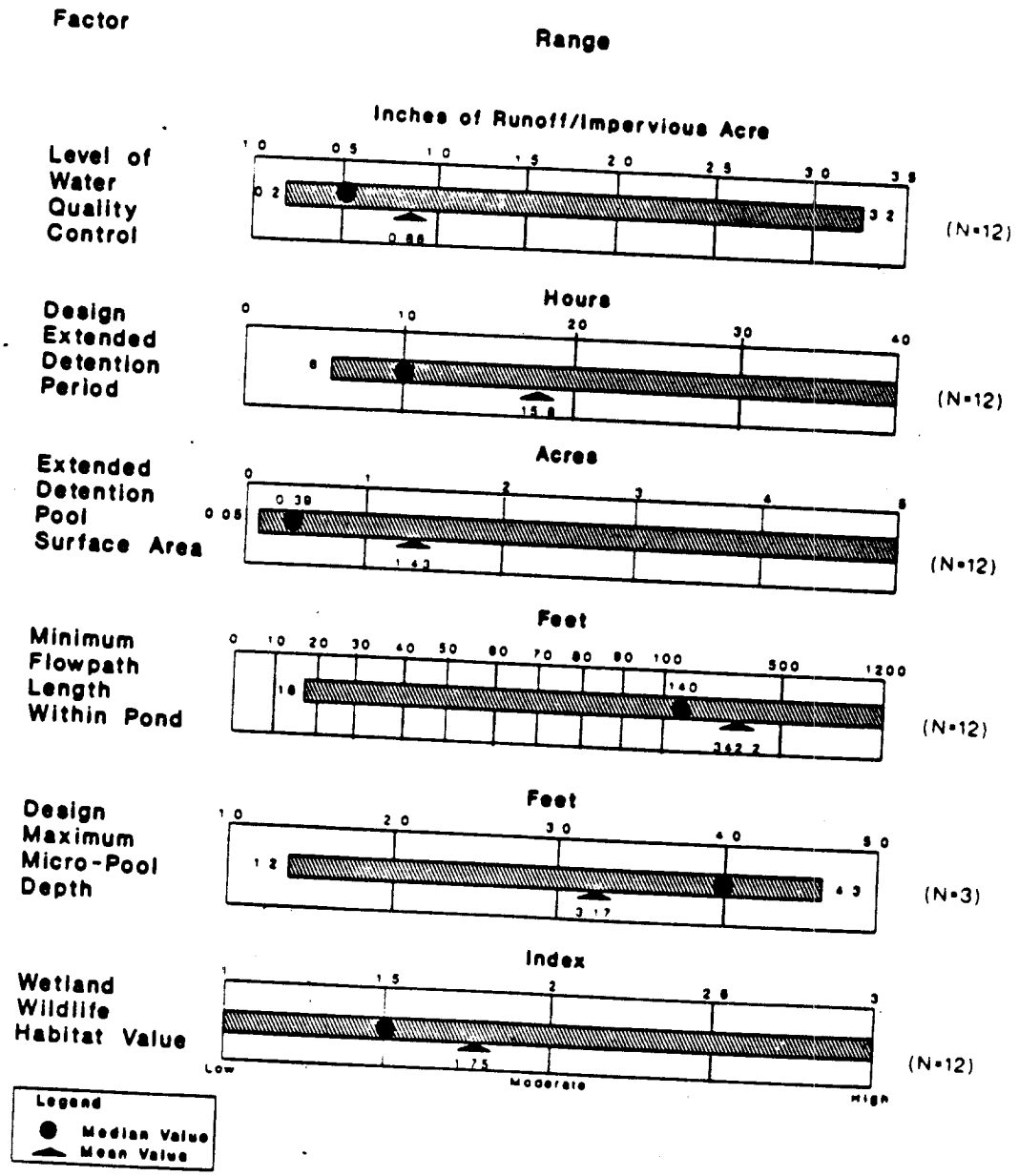
Figure 17. ED Dry Ponds: Design Features and Environmental Attributes



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anything other than a narrow range of stormflow conditions is very difficult to achieve. Results from this study show that only about 50 percent of the ED dry ponds were able to generally meet their target ED times. A second major finding was that the runoff produced by smaller, less intense rainfall events generally flowed through these facilities subject to little or no ED control. This was particularly the case for older ED dry ponds which were intentionally designed to provide water quality control for larger, less frequent storm events. In addition, a review of the as-built files showed that the majority of the ED release rates were calculated using the rather crude 'Kerplunk' method (i.e., - dividing the design storm runoff volume by the target ED period). This approach may also have been a factor in the generally poor control of smaller storms.

Because most of the off-stream located ED dry ponds had no upstream/ downstream channel network, a full assessment of their effect on downstream areas was generally not possible. Consequently, only on-stream facilities were comprehensively evaluated. Major findings from the stream survey portion of the study are summarized in Figure 18.

Although no major difference in upstream versus downstream channel stability was noted, all of the ED dry ponds surveyed (including off-stream ponds) appeared to have generally had a positive, downstream stabilizing influence. Among the more positive effects observed, was the significant reduction in the amount of sand and silt-sized inorganic sediment present in downstream reaches. As expected, these facilities are trapping and retaining large volumes of this material within the upstream channel network. In two cases, heavy in-channel sediment deposition was still evident nearly 300 feet upstream of the control structure. Little if any overbank deposition was observed at any of the five in-stream facilities inspected.

Limited wet weather monitoring confirmed the general inability of ED dry ponds to remove either clay-sized particles or dissolved pollutants commonly present in urban stormwater runoff. Additional secondary evidence of this shortcoming was provided via the examination of the degree of substrate fouling present (i.e., - presence or absence of surface patinas of silt/fine organic material and/or algal growth, and slime coatings on the underside of stones. As seen in Figure 18, the relative level of downstream substrate fouling was generally slightly higher than that observed upstream of the major stormwater inflow point(s).

System Longevity

By the nature of their design, ED dry ponds are particularly susceptible to clogging problems. Field survey results revealed that, because of clogging, two of the twelve pond sites were functioning as defacto retention ponds. Present design criteria stipulate that the minimum acceptable ED size opening shall be two inches in diameter. Field inspection results confirmed that a two inch opening is capable of working for

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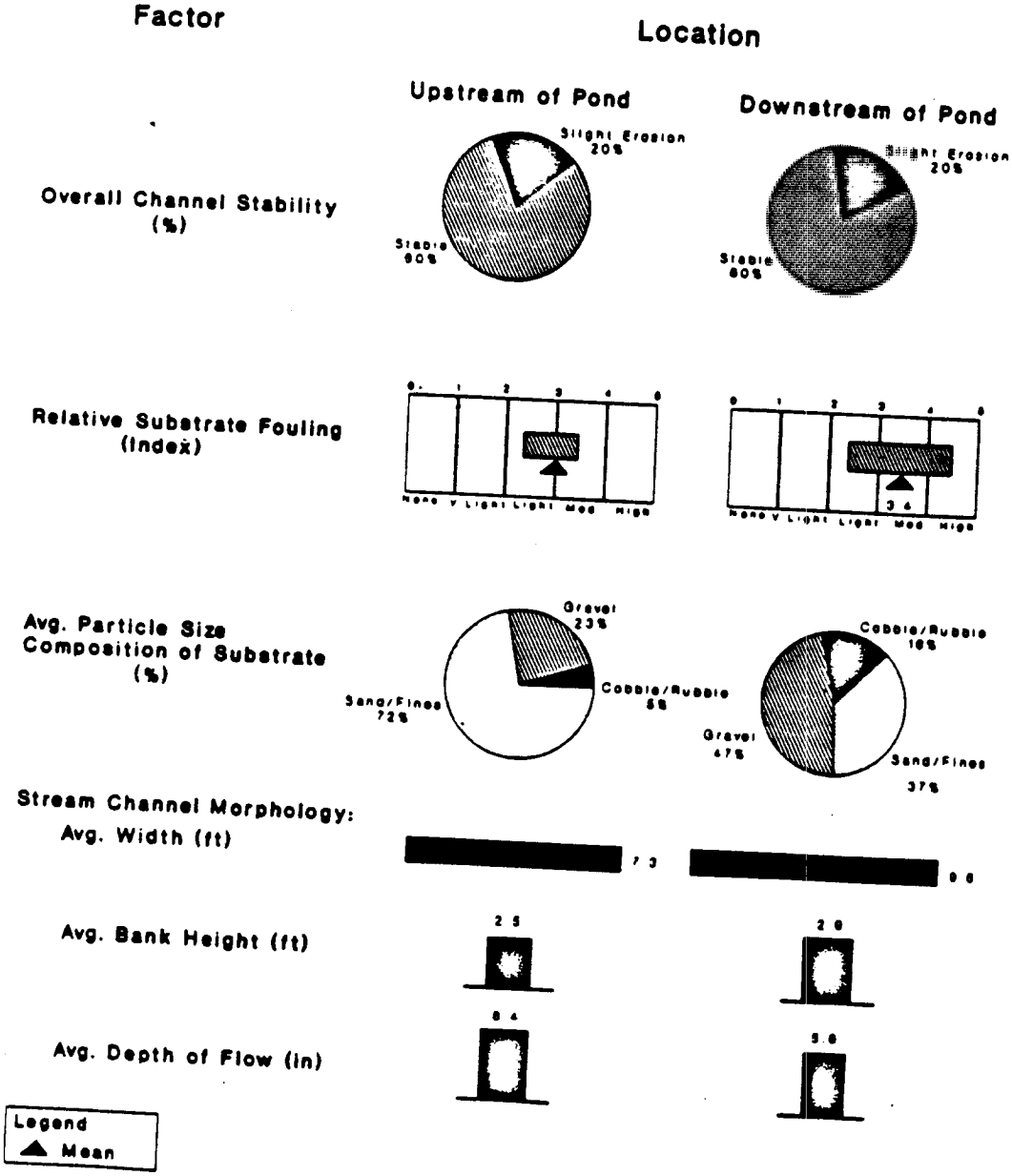
Figure 18. ED Dry Ponds: Receiving Stream Survey Results (N=5)



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relatively long periods of time with out clogging, provided that a very effective trash rack/anti-clogging system is employed.

Based on field observations, the horizontal perforated PVC pipe with gravel jacket proved to be the least effective anti-clogging system. Far more effective were the vertical stand pipe and trash rack systems, and the use of a micropool with a vertical hood extending well into the permanent pool. In addition, the minimum acceptable perforation size opening appeared to be 0.75-1.0 inches diameter. In COG staff's opinion, without the regular removal of accumulated sediment and debris it is highly unlikely that most ED dry ponds would remain 'dry' for more than two or three years.

Performance Maintenance and/or Structural Problems

Many of the above-referenced problems have already been discussed. As seen in Figure 19, clogging problems were endemic to 25 percent of the ED dry ponds surveyed. Other maintenance-related problems included poor vegetative stabilization of side slopes and embankment areas, excessive sediment/debris build-up, and displacement of rip-rap at both inflow and outflow locations. The overall maintenance condition for the twelve ED dry ponds surveyed are summarized below (no. out of 12 facilities indicated).

Poor	-	3 (25%)
Fair	-	4 (33.3%)
Good	-	4 (33.3%)
Very Good	-	1 (8.3%)

From a structural standpoint, all of the facilities surveyed appeared to be well-constructed. Seventy-five percent were problem-free. Structural problems, which warranted repair work were identified as follows:

No. of Facilities	Problem
1	seepage/leak in brick riser
1	leak in gabion weir wall
1	poor grout work around concrete barrel

Environmental Attributes

Several of the on-stream ED dry ponds provided some secondary wetland/wildlife habitat benefit. In general, the highest habitat scores (Figure 17) were associated with the larger facilities which featured a good supply of food, cover and water; capable of supporting a diverse faunal community. As for aquatic habitat benefits, four out of the five downstream reaches surveyed showed some slight improvement over upstream conditions (one showed no change). These improvements

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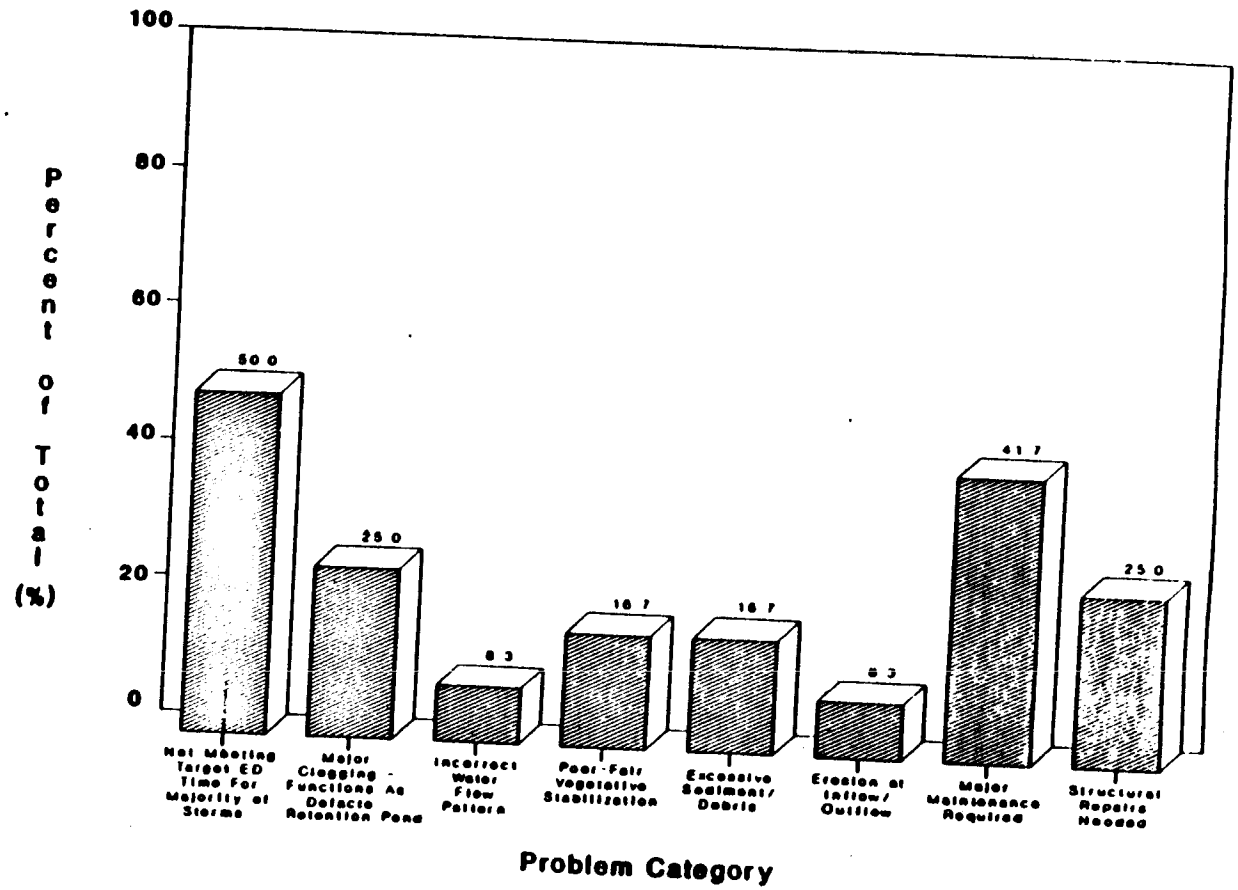
Figure 19. ED Dry Ponds: Typical Performance, Maintenance and/or Structural Problems (N-12)



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were primarily associated with both the greater stability of the flow regime and a reduction in the percentage of sand/fines present in the substrate.

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IV. Wet Ponds

Background

A total of 12 wet ponds were field surveyed in the study. As seen in Figure 20, 75 percent of the ponds were between one and three years old. Slightly more than one-half of the ponds were located on flowing streams. Associated catchment area size ranged from 4.0 to 338.2 acres with a median drainage area of 54.6 acres. The majority of the surveyed ponds had permanent pool surface areas of 0.5 acres, or less. Permanent pool storage volumes also varied considerably between pond sites; ranging from between 0.25 to 5.0 inches per impervious acre (Table 7). All 12 wet ponds featured a surface release design without ED control.

Only three ponds incorporated sediment forebays into their design. The majority of the ponds surveyed had a maintenance bench along at least one side of the pond. Fewer than one-half of the wet ponds employed either an aquatic bench or a pond drain. The large percentage of ponds without a drain feature was largely a function of excavation depth. Maximum and mean pond depths ranged from 3-5 - 7.0 feet and 2.5 - 4.5 feet, respectively (Figure 21).

Additional background information is both listed below and included in Appendix D.

- Age Range (yrs.) 1.5 - 1.4 (avg. - 99.3)
- D.A. to Structure Range (ac): 4.0 - 332.2 (avg. - 99.3)
- Range of Permanent Pool Storage Provided (in./impervious ac.): 0.25 - 5.0 (med. - 1.08)
- No. with Multiple Cells - 0
- Range in Pond Length/Width Ratio: 0.9 - 11.5 (med. - 2.3)
- Range in Minimum Internal Flow Path Length (ft): 20 - 535 (med. - 82.5)
- Range in Associated Watershed Imperviousness (%): 15-85 (med. - 50)
- Pond Surface Area Range (ac): 0.15 - 4.9 (med. - 0.48)
- Pond Surface Area to Catchment Area Ratio (%): 0.5 - 3.8 (med. - 1.0)

Water Quality Grab Sampling Results

Major pond water quality grab sampling results are graphically depicted in Figures 22 and 23. Additional information is found in Appendix D. From an overall water quality standpoint, three out of the top four rated ponds were located off-stream.

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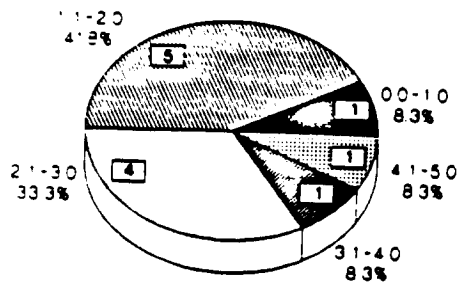
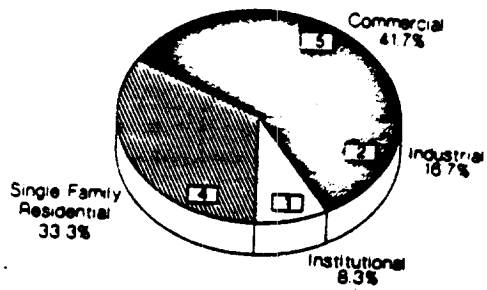
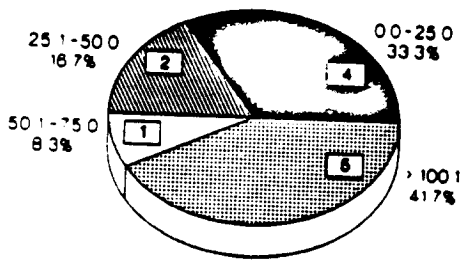
Figure 20. Wet Ponds: Background Summary (N=12)



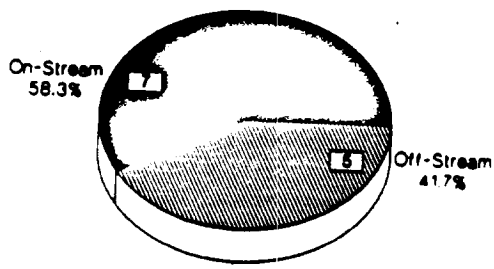
Age (yrs)



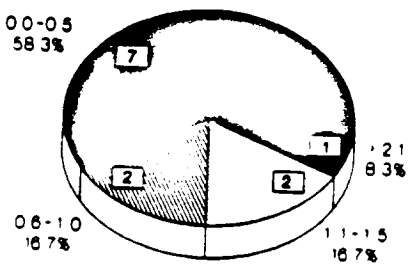
Land Uses Controlled



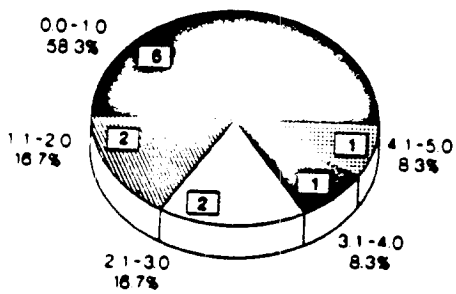
Drainage Area (ac)



Pond Location



Surface Area (ac)



Permanent Pool Storage Volume (in/imp/ac)

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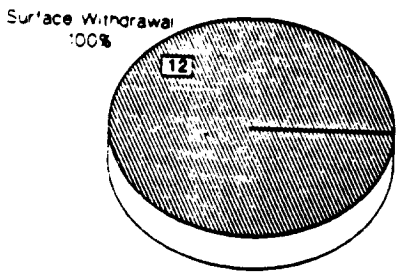
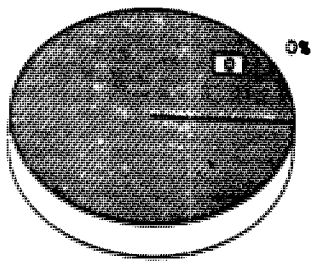
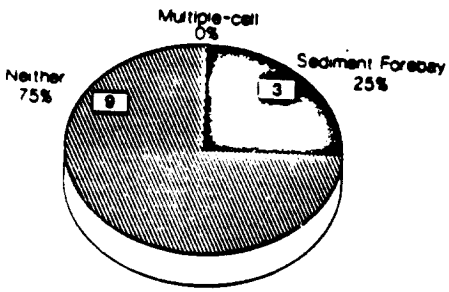
Figure 20 (continued). Wet Ponds: Background Summary



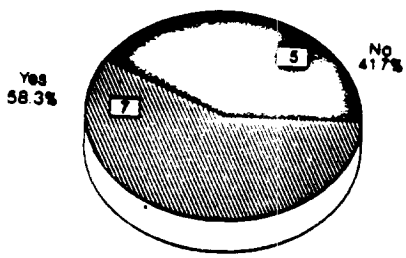
Release Depth



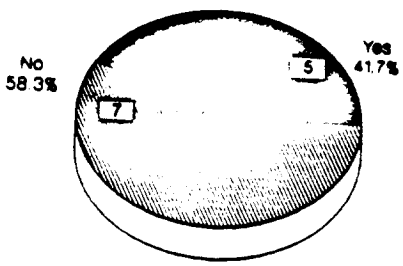
Extended Detention Control



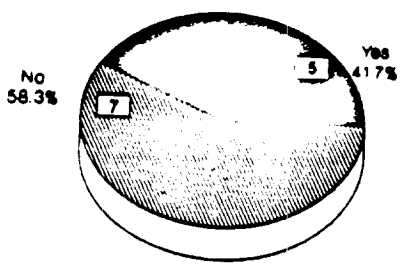
Sediment Forebays / Multiple Cells



Maintenance Bench Present



Aquatic Bench Present



Pond Drain Feature

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Figure 21. Wet Ponds: Maximum and Mean Permanent Pool Depth (N=12)

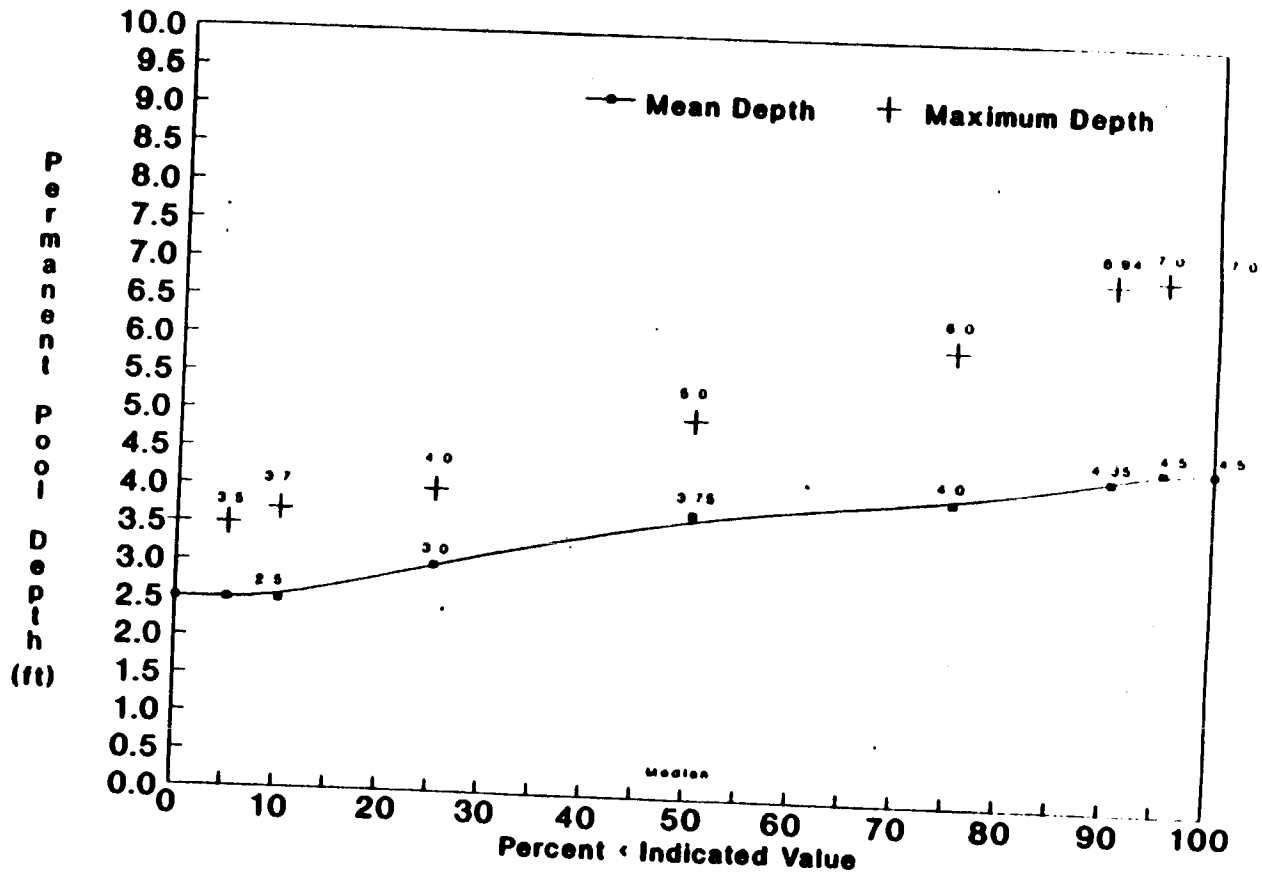

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Table 7. Summary: Prince George's County Retention Pond Background Survey Results

Site No.	Name	Land Use	Pond Type	Pond Location	Age (yrs.)	D.A. to Structure (ac.)	Pond Surface Area (ac.)	Level of Control: Water Quantity	Level of Control: Water Quality (lb./day/ac.)	Watershed Imperviousness: %	Watershed Imperviousness: Ac.	Permanent Pool Depth (ft.): Max.	Permanent Pool Depth (ft.): Mean	Perm. Pool Vol. (ac.-ft.)	Perm. Pool/ Surface Area Ratio	D.A./ Surface Area Ratio	D.A./ Perm. Pool Vol. Ratio	Imp. Area/ Surface Area Ratio	Imp. Area/ Perm. Pool Vol. Ratio
P-1	Capitol College Student	Inst.	WP	Off	2.1	11.7	0.76	2,10,100	3.40	10.0	2.0	3.0	3.0	0.00	2.9	14.1	19.6	10.0	1.1
P-2	Clinton View	SF	AM	Off	3.0	12.1	0.10	2	0.17	30.0	3.4	3.0	0.3	0.01	0.3	121.0	403.3	34.0	80.0
P-3	Alfred W. Cooksey Prop.	Comm.	EDAM	Off	1.5	1.1	0.01	2,10	0.30	01.0	0.9	1.5	1.0	0.00	1.0	36.7	36.7	30.0	30.0
P-4	Agnes Subdivision	Ind.	WP	Off	2.9	9.1	0.31	2,10,100	1.75	01.0	7.7	4.0	3.5	1.40	3.5	29.4	0.3	24.0	7.0
P-5	Center Park	Comm.	WP	Off	2.5	24.5	0.44	2,10,100	0.30	01.0	11.0	4.0	2.5	0.00	0.6	11.7	27.2	21.0	17.6
P-6	Hampton Park Lot #9	Ind.	AM	Off	1.0	0.6	0.02	2	0.30	70.0	0.4	2.3	1.3	0.00	1.5	30.0	30.0	20.0	15.1
P-7	Landover Manor Mini Storage	Comm.	AM	Off	1.4	2.0	0.30	2,10	0.30	90.0	2.5	2.5	1.0	0.20	1.0	14.0	14.0	11.5	12.5
P-11	Madame Woods	SF	WP	On	4.1	172.1	0.00	2,10	0.05	20.0	46.2	6.5	4.0	3.30	4.0	195.0	49.2	34.5	11.5
P-12	Penn Station	Comm.	WP	On	1.5	20.6	0.75	2,10,100	0.30	01.0	34.3	4.0	4.0	1.00	4.0	114.4	20.5	27.2	24.3
P-13	Premier Comm. Park	Comm.	WP	Off	1.5	122.0	1.07	2,10,100	1.30	30.0	44.4	5.0	4.0	2.00	4.7	114.0	34.4	43.4	9.3
P-14	Racquet Terrace	Apt.	AM	Off	1.5	2.5	0.04	2,10	0.00	70.0	1.9	2.5	2.0	0.10	2.3	70.0	20.0	47.5	19.0
P-15	Largo Park East Ch. #1	Comm.	WP	On	2.5	27.0	0.17	2	0.25	75.0	20.4	4.5	3.0	0.60	3.5	272.9	61.2	167.1	47.5
P-16	Hamilton Estates	Comm.	EDAM	Off	1.5	9.3	0.15	2	0.75	01.0	7.9	3.0	3.5	0.50	3.5	62.0	10.5	32.7	11.5
P-17	Stone Chalet	Comm.	AM	Off	2.4	2.0	0.04	2,10	0.25	01.0	1.7	1.5	1.5	0.04	1.3	30.0	30.0	42.5	47.5
P-18	Tantallon Square	SF	AM	Off	2.5	44.0	0.75	2,10,100	2.10	25.0	11.0	4.5	2.5	2.10	2.5	30.7	21.0	64.7	5.2
P-19	Salvation Army Adult Rehab.	Ind.	WP	Off	0.4	4.0	0.15	2,10	2.30	80.0	3.2	5.0	4.0	0.60	4.0	26.7	6.7	26.5	5.1
P-20	Md 95 Comp. Park #5 (Upper)	Comm.	AM	On	3.0	221.0	0.37	2,10,100	0.30	40.0	88.4	5.0	2.5	1.40	2.5	597.7	137.9	133.1	155.1
P-21	Md 95 Comp. Park #5 (Lower)	Comm.	WP	On	3.0	256.0	1.36	2,10,100	0.30	40.0	102.4	6.0	4.0	5.00	4.0	206.5	51.2	82.6	20.1
P-22	Brandon Pond #5	SF	WP	On	2.0	71.3	0.77	2,10,100	2.20	10.0	12.0	4.1	3.0	2.30	3.0	92.6	30.9	14.6	5.5
P-23	Wingate	SF	WP	On	1.5	234.2	4.00	2,10,100	3.00	11.0	20.7	7.0	4.3	20.20	4.3	60.0	15.9	20.4	2.4
P-24	Montpelier Hills	SF	WP	On	1.7	114.0	0.52	2,10,100	0.30	30.0	30.0	2.5	2.5	1.40	2.7	222.0	82.9	111.5	41.4
MAXIMUM VALUE					4.5	234.2	4.00		3.00	90.0	102.4	7.0	4.5	20.20	4.7	307.7	400.3	167.1	155.1
MINIMUM VALUE					0.4	0.6	0.00		0.17	01.0	0.4	1.5	0.3	0.00	0.3	14.0	6.7	20.0	2.4
MEAN					2.1	71.0	0.44		1.19	54.3	34.7	4.1	2.7	2.20	2.7	106.5	58.1	34.2	27.1
MEDIAN					1.5	12.1	0.20		0.30	40.0	7.7	4.0	2.5	0.60	2.7	80.2	34.4	24.0	11.5
VARIANCE					1.0	9190.2	1.04		1.40	762.2	850.0	2.5	1.0	20.20	1.6	8400.0	20201.6	3004.2	1111.5
COEFFICIENT OF VARIATION (%)					48.9	134.4	366.46		102.36	48.8	100.0	37.4	43.0	207.00	46.9	84.9	152.6	87.0	134.9
STANDARD DEVIATION					1.0	95.4	1.02		1.22	27.6	29.2	1.6	1.2	4.50	1.3	89.4	34.4	45.0	34.0
STANDARD ERROR																			
NO. OF OBSERVATIONS					20	20	20		20	20	20	20	20	20	20	20	20	20	20

KEY ABBREVIATIONS:

Comm. = Commercial — WP = Wet Pond — Off = Off-stream — M Calculated from field survey data

Ind. = Industrial — EDAM = Extended Detention Attributed Month — On = On-stream — SF Prince field survey

S.F. = Single Family Residential — (24 hrs. EDA)

Apt. = Apartment — AM = Attributed Month

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Figure 22. Wet Ponds: Carlson Secchi Disc Trophic State Category

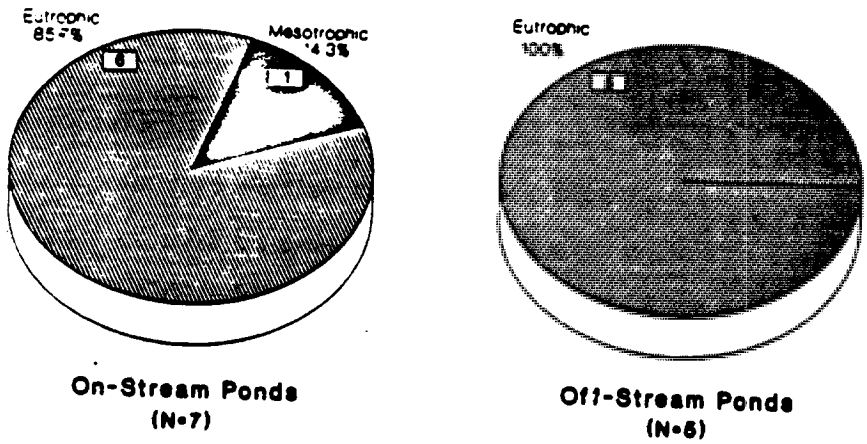

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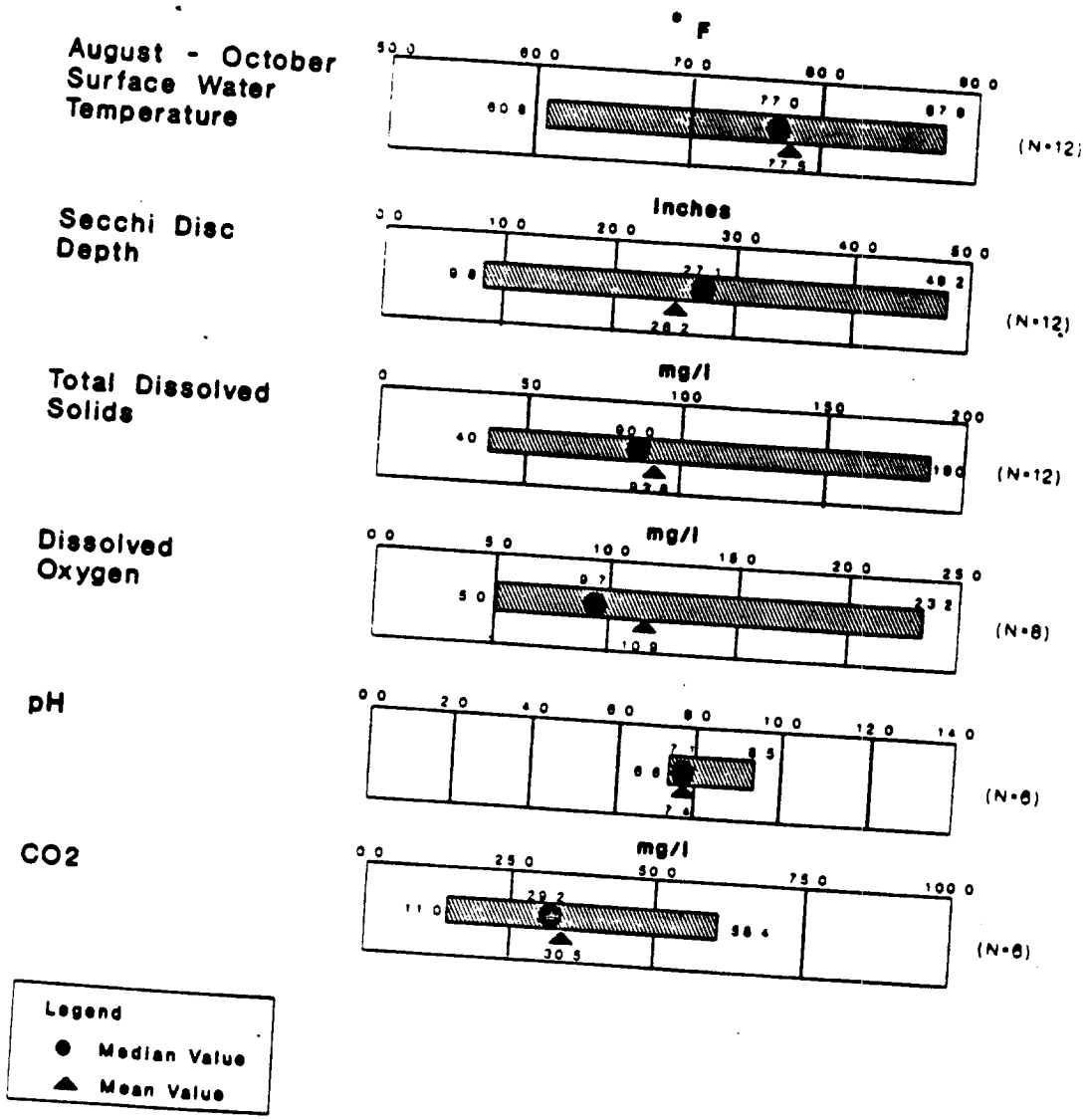
Figure 23. Wet Ponds: Water Quality Grab Sampling Results



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As seen in Figure 22, little difference in trophic category status was observed between on and off-stream pond systems. All of the wet ponds surveyed were either eutrophic or mesotrophic.

One-third of the pond sites had highly turbid, sediment-ladened water. High average depth of sediment was recorded at two sites. Both of these ponds were older, on-stream types with relatively large upstream drainage areas and active construction in the watershed.

No violation of the 5.0 mg/L MDE Class I DO standard was observed at any pond site. Total dissolved solids, carbon dioxide (CO_2), and pH levels were all within the range expected for eutrophic bodies of water. Not surprisingly, surface water temperatures during the late August to early October sampling period were generally warm (median - 77.0°F).

General Performance and System Longevity

Performance

Field survey results strongly suggested that all 12 wet ponds were generally providing both water quantity and quality control as designed. Partial supporting evidence of this is provided in Figure 24. As seen in Figure 24, varying levels of downstream improvement were recorded in several major categories. These included: 1.) a slight increase in overall channel stability, 2.) a slight decrease in the level of substrate fouling, 3.) improved morphological characteristics such as reduced channel width and bank height and increased depth of flow, and 4.) reduction in total dissolved solids. In addition, casual macroinvertebrate sampling results indicated a general improvement in downstream aquatic habitat/stream quality conditions. As expected, the only negative result was an average downstream water temperature increase of 7.7°F.

Based on field observations, wet ponds with permanent pool volumes over 1.0 inches/impervious acre appeared to outperform those having smaller volumes. No significant correlation was noted between the amount of rooted aquatic vegetation present and the areal extent of floating algal mats.

On the basis of sediment depth measurements, COG staff was able to estimate the average annual sediment deposition rate for both the wet ponds and artificial marsh systems surveyed. As seen in Figure 25, off-stream wet ponds and marshes had an average sediment deposition rate of approximately 0.8 yds^3 per acre of drainage area per year. This rate was almost 2.2 times higher than the rate for on-stream retention systems (which was 0.37 yds^3/ac/year). While these preliminary results should be viewed cautiously, they suggest that off-stream facilities may be more efficient sediment traps.

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Figure 24. On-Stream Ponds: Receiving Stream Survey Results

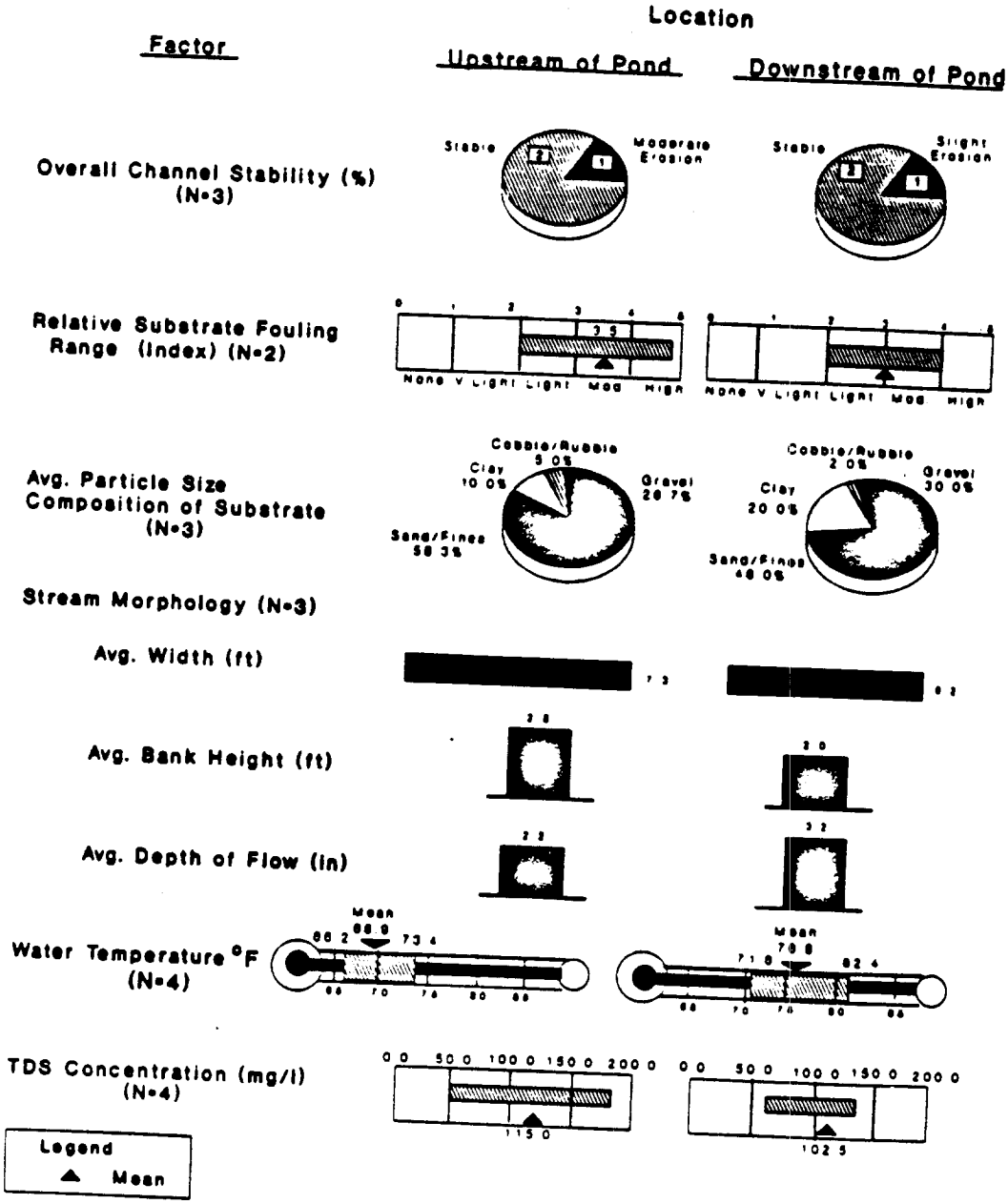

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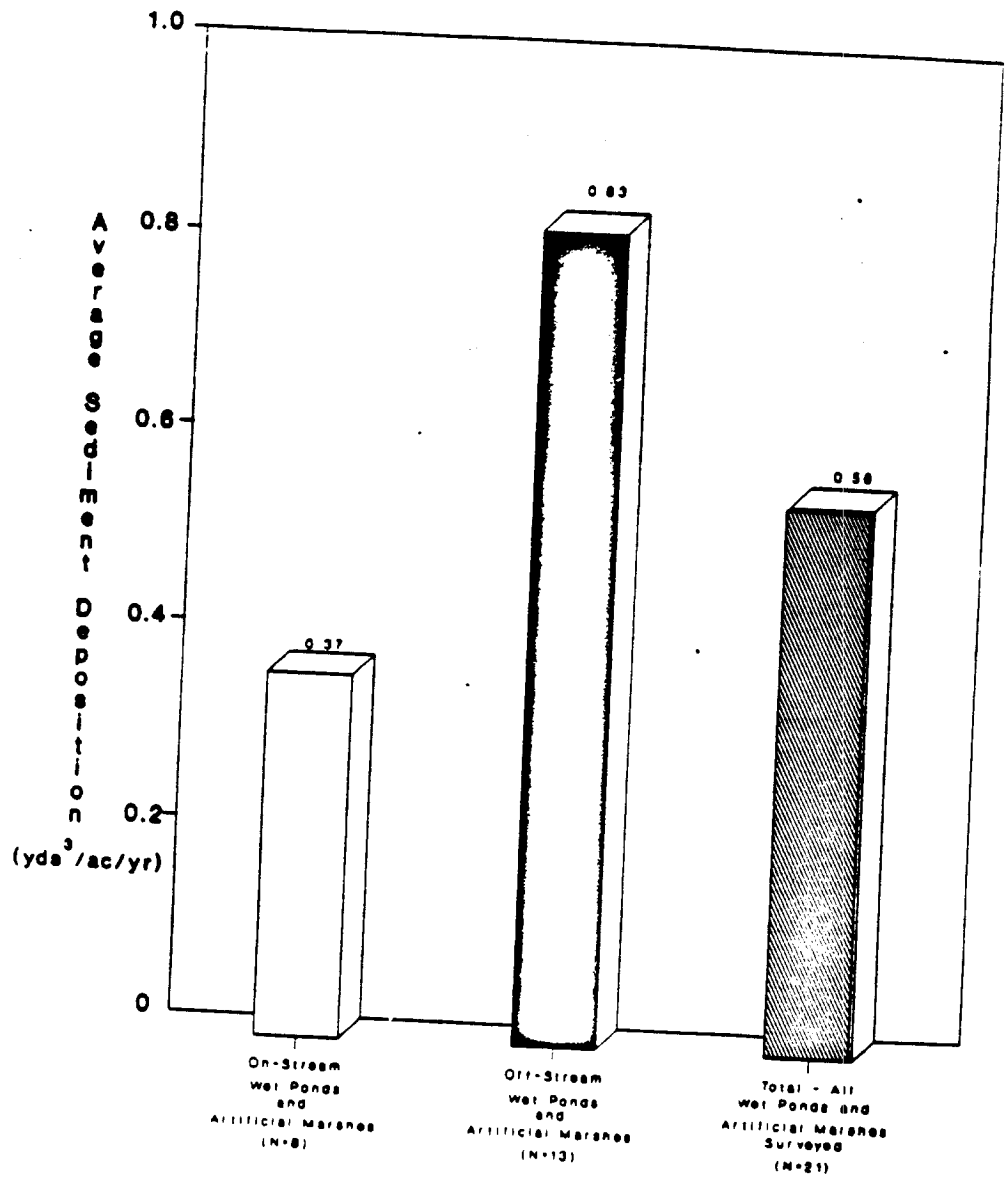
Figure 25. Retention Ponds: Estimated Sediment Deposition Rate



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System Longevity

All of the wet ponds surveyed employed both long-lived concrete risers and barrels. With the exception of the two on-stream ponds which had excessive amounts of sediment deposition, the majority of the ponds surveyed appeared to have lost very little, if any, permanent pool volume. Invariably, the greatest depth of sediment was associated with the pond inlet area. As previously indicated, only 33 percent of the ponds employed a sediment forebay in their design. While forebays generally do not extend the sediment removal interval, they would appear to greatly facilitate dredging operations by confining most of the larger grained sediment to one location within the pond. As such, forebays should help extend the life span of other potentially valuable deep water areas.

Performance, Maintenance and/or Structural Problems

As a group, overall pond water quality performance was rated as being good. However, both poor internal flowpath length and large sediment deposits are thought to have reduced the individual performance of several pond sites. With regard to the former, one-third of the ponds featured major storm drain outfalls located within 50 feet of the outlet structure. In most of these cases, little if any intervening emergent vegetation was present to slow down and filter runoff before it exited the pond. Thus, it would be expected that these ponds would experience short-circuiting problems during most storm events. It is further noted that 50 percent of the pond sites had relatively short internal flowpath lengths of less than 100 feet. Sediment deposits, which appeared highly susceptible to resuspension during large stormflow conditions, were observed at one-quarter of the ponds.

One of the more interesting study findings regarded the amount of trash present. In general, the quantity of floatable trash and debris was relatively light and well-defined trash lines were observed infrequently. Given both the high percentage (58%) of commercial and industrial land uses in the contributory watersheds and generally suspect pond maintenance, a higher amount of floatable material would have been expected. These findings strongly suggest that a substantial portion of the smaller-sized floatable material is washed out during successive storm events. Contributing to the overall problem was the exclusive reliance upon bar-type trash tracks with large on-center spacing. None of the ponds surveyed employed the more retentive hooded trash rack or reverse sloping pipe outlet design. As seen in Figure 26, few clogging problems were reported.

The majority of the ponds surveyed appeared to be regularly mowed. Relatively few maintenance problems, other than vegetative stabilization and sediment removal were observed. From an aesthetic standpoint, one-third of the pond sites would have benefitted from additional landscaping treatment. Also, three of the ponds were totally enclosed by a five foot high chain link fence; thereby, creating a very unnatural looking pondscape. Maintenance access to seven of the ponds was rated as excellent, courtesy

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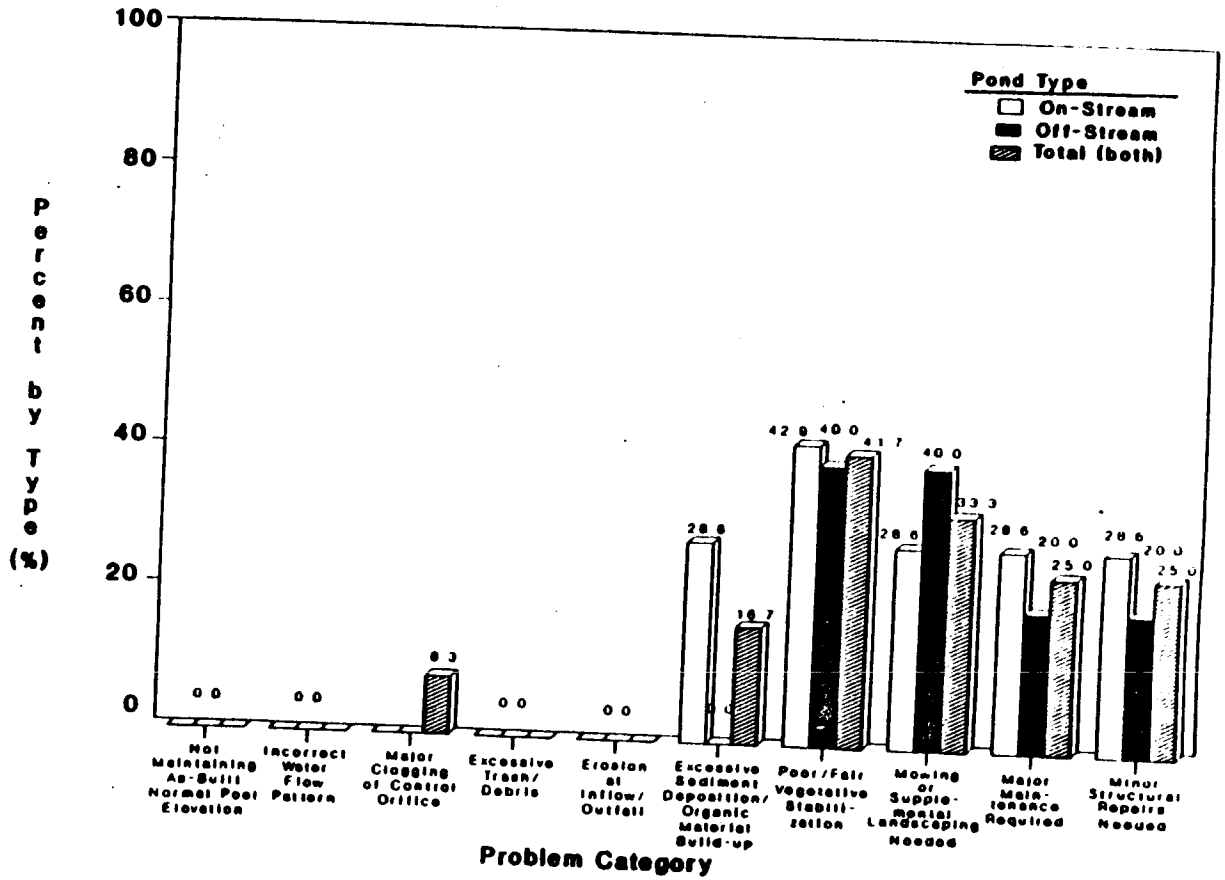
Figure 26. Wet Ponds: Typical Performance, Maintenance and/or Structural Problems (N=12)



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of their maintenance bench design features. Overall wet pond maintenance condition was rated as follows (No. of ponds indicated).

Poor	-	1	(8.3%)
Fair	-	3	(25.0%)
Good	-	6	(50.0%)
Very Good	-	2	(16.7%)

Eight of the pond sites (66.7%) were judged to have adequate space for future on-site sediment dewatering operations. However, only two out of 12 sites appeared to have enough flat area(s) for permanent on-site sediment disposal. Also, none of the as-built plans identified potential sediment disposal sites.

Structurally, all of the ponds appeared to be in generally good condition. The only problems observed were poor grout work around the barrel/riser joint of two ponds and one pond whose damaged trash rack was barely hanging on the face of the riser. It should be noted that this trash rack was made out of heavy concrete reinforcing wire instead of larger diameter, welded rebar or smooth bar.

Environmental Attributes

As expected, the highest aquatic/wildlife habitat index scores were recorded at the larger, older, on-stream ponds which featured: large stands of emergent aquatic vegetation, adjacent mature forest area, and a good mix between shallow and deeper open water (> 4 ft. deep). Overall, the average habitat index score, Figure 27, was 1.7 (low to moderate range).

With the exception of one relatively young pond, all of the sites supported emergent aquatic vegetation around their perimeter. Emergent wetland vegetation coverage ranged from 0 - 28.6 percent of the pond surface; with a mean coverage of 12.4 percent. Field survey results also indicted that cattails (Typha latifolia) were the dominant emergent wetland plant species at 9 out of the 12 pond sites. Other dominant and co-dominant species observed were American three-square (Scirpus americanus), spike rush (Eleocharis sp.), soft-stem bulrush (Scirpus validus) and arrowhead (Sagittaria latifolia). Review of the as-built files indicated that only one pond was the recipient of intentional emergent aquatic plantings. However, only one species, arrowhead, was introduced there.

Somewhat to COG staff's surprise, two-thirds of the pond sites supported varying amounts of submerged aquatic vegetation. As seen in Figure 27, as much as 50.5 percent of the pond bottom area was covered with this vegetation. Observed species included Hydrilla verticillata, coontail (Ceratophyllum demersum), and eurasian millfoil (Myriophyllum spicatum). From a warmwater fisheries standpoint, 10 - 50 percent bottom coverage is generally considered beneficial (Gougeon, 1992). The presence of this vegetation is also significant in that it provides additional filtration and removal of both suspended solids and nutrients present in the water column.

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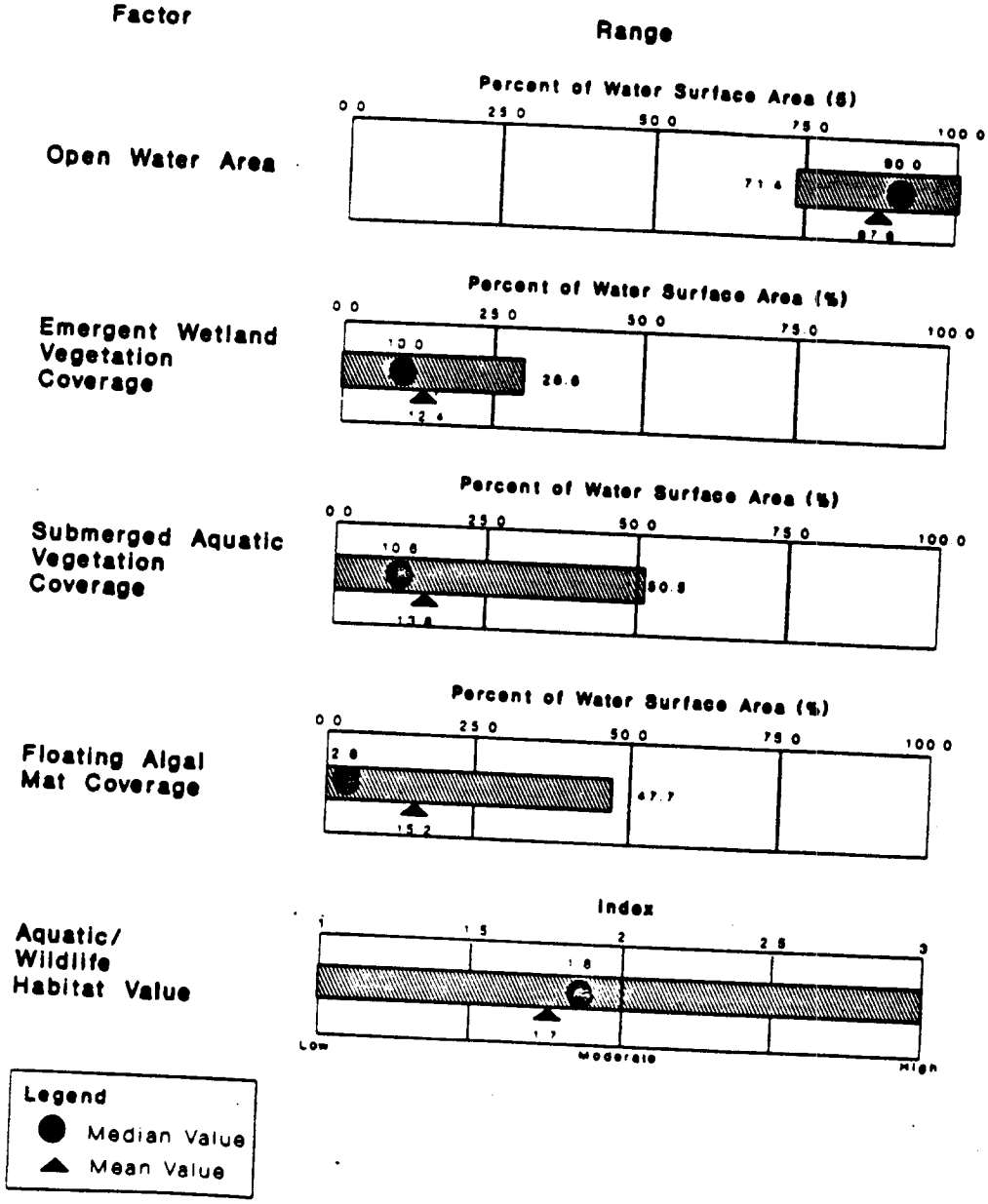
Figure 27. Wet Ponds: Environmental Attributes (N=12)



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With regard to wildlife, green (Rana clamitans) and/or pickeral frogs (Rana palustris) were observed at eight out of the 12 wet ponds inspected. Painted (Chysemys picta), spotted (Clemmys guttata) and/or snapping turtles (Chelydra serpentina) were also observed at two pond sites. Native minnow species were present at one site and sunfish and largemouth bass were seen at two others. Several of the ponds supported ducks and geese. No mosquito larvae were observed.

Depth-Area/Depth-Volume Distributions

In an effort to better assess each pond's potential ability to support rooted aquatic plants and gamefish, the approximate percentage of the permanent pool area and volume associated with each of the three following depth zones were calculated:

I.	Shallow Water Zone	-	Depth, 0.0 - 1.5 feet. Zone most commonly associated with emergent aquatic plant communities. Both plant diversity and densities are typically greatest in those areas which are less than one foot deep. Emergent vegetation in this zone generally provides food and cover for a variety of wildlife, including juvenile gamefish.
II.	Mid-depth Zone	-	Depth, 1.6 - 4.0 feet. Zone in which the majority of submerged aquatic plants are found in SWM ponds.
III.	Deep Water Zone	-	Depth, over 4.0 feet. Provides deeper water habitat required by adult gamefish populations on a year-round basis.

While the preceding depth zones are somewhat arbitrary, results (Figure 28) indicated that one-third of the pond sites were designed as marsh/pond 'hybrids.' In other words, they were both too shallow to generally support a healthy adult gamefish population year-round, and too deep to meet MDE (1987) recommended wetland design guidelines of approximately 75 percent emergent vegetation coverage.

As for submerged aquatic plants, the availability of light in the water column is generally considered to be the principal factor limiting their depth distribution. Generally, the maximum depth for growth is very closely associated with the maximum secchi depth (which in this study was approximately four feet).

In COG staff's opinion, site R-11 (which featured both a sediment forebay and an extensive aquatic shelf area around the entire pond perimeter) would serve as a relatively good model for general wet pond depth-area/depth-volume distribution design. It is further noted that this pond had a maximum depth of approximately 7.0 feet.

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Figure 28
WET PONDS: SURFACE AREA , PERMANENT POOL VOLUME AND DEPTH-AREA/VOLUME DISTRIBUTION

Surface Area (ac) and Site Number	Permanent Pool Volume (in/imp. ac)	Depth Range (ft)	Percent of Volume (%)	Percent of Surface Area (%)
0.28 (R-1)	3.40	<=1.5 1.6 - 4.0 >4.1	40.4% 49.0% 10.6%	35.7% 42.9% 21.4%
0.31 (R-4)	1.75	<=1.5 1.6 - 4.0 >4.1	46.0% 54.0% 0.0%	16.7% 83.3% 0.0%
0.44 (R-6)	0.50	<=1.5 1.6 - 4.0 >4.1	37.8% 62.2% 0.0%	27.2% 72.8% 0.0%
0.88 (R-11)	0.85	<=1.5 1.6 - 4.0 >4.1	34.3% 39.2% 26.5%	36.4% 27.2% 36.4%
0.25 (R-12)	0.50	<=1.5 1.6 - 4.0 >4.1	39.6% 45.1% 15.3%	20.0% 40.0% 40.0%
1.07 (R-13)	1.30	<=1.5 1.6 - 4.0 >4.1	37.1% 46.9% 16.0%	23.4% 15.8% 60.8%

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Figure 28 (Continued)
WET PONDS: SURFACE AREA , PERMANENT POOL VOLUME AND DEPTH-AREA/VOLUME DISTRIBUTION

Surface Area (ac) and Site Number	Permanent Pool Volume (in/imp. ac)	Depth Range (ft)	Percent of Volume (%)	Percent of Surface Area (%)
0.17 (R-15)	0.25	<=1.5 1.6 - 4.0 >4.1	40.0% 50.0% 10.0%	23.5% 64.7% 11.8%
0.15 (R-19)	2.30	<=1.5 1.6 - 4.0 >4.1	36.8% 47.4% 15.8%	13.3% 26.7% 60.0%
1.24 (R-21)	0.50	<=1.5 1.6 - 4.0 >4.1	29.7% 42.7% 27.6%	20.1% 47.6% 32.3%
0.77 (R-22)	2.30	<=1.5 1.6 - 4.0 >4.1	50.0% 50.0% 0.0%	25.0% 75.0% 0.0%
4.90 (R-23)	5.00	<=1.5 1.6 - 4.0 >4.1	32.2% 48.8% 19.0%	36.8% 34.2% 29.0%
0.55 (R-24)	.030	<=1.5 1.6 - 4.0 >4.1	39.6% 60.4% 0.0%	39.4% 60.6% 0.0%

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V. Artificial Marshes

Background

Nine artificial marsh systems, five conventional marshes and three enhanced marshes, were field surveyed in the study. All of the marsh facilities surveyed were less than four years old; with slightly more than half being under two years in age. As seen in Figure 29, artificial marshes were most frequently associated with small commercial development sites. Although the drainage area size range ran from 0.6 to 221.0 acres, two-thirds of the catchment were less than 20 acres in size. Given the relatively small drainage areas controlled, all of the marshes (except for one) were located off-stream. Marsh surface areas ranged from 0.03 to 0.75 acres. Roughly half of the marshes surveyed were the aptly named pocket wetland variety (i.e., - surface area $\leq$ 0.1 acres).

Permanent pool storage volumes ranged from 0.17 to 2.30 inches per impervious acre. All of the marshes surveyed were of the surface release type. Only two facilities provided ED control (both had a design 24-hr. ED period). The majority of the marshes were classified as being hypereutrophic (i.e., - indicative of undesirable, highly productive and nutrient-rich water). Maximum and mean marsh depth ranged from 1.3 - 5.0 feet and 0.3 - 3.5 feet, respectively (Figure 30). Other background highlights are both listed below and presented in Appendix D.

- Age Range (yrs.): 1.4 - 3.8 (avg. - 2.4)
- D.A. to Structure Range: 0.6 - 221.0 (med. - 2.8)
- Range of Permanent pool Storage Provided (in/imperviousness acre): 0.17-2.30 (med. - 0.50)
- No. with Multiple Cells - 1
- Range in Marsh Pond Length/Width Ratio: 1.4 - 5.4 (avg - 3.1)
- Range in Minimum Internal Flowpath Length (ft): 20 - 140 (med.-70)
- Marsh Surface Area Range (ac): 0.02 - 0.75 (avg. - 0.21)
- Marsh surface Area to Catchment Area Ratio (%): 0.3 - 7.1 (avg. - 2.3)
- No. of Marshes Fenced - 6 (66.7%)

Water Quality Grab Sampling

The major findings from both the artificial marsh and wet pond grab sampling portions of the study are presented in Table 8. As seen in Table 8, several obvious water

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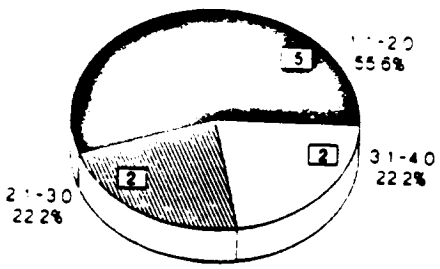
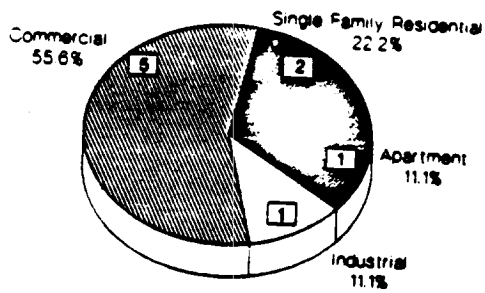
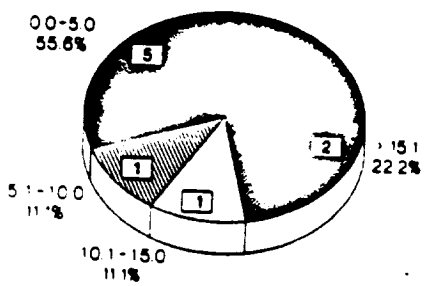
Figure 29. Artificial Marshes: Background Summary (N=9)



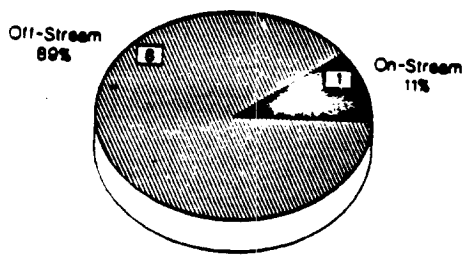
Age (yrs)



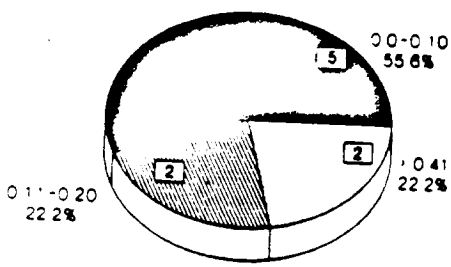
Land Uses Controlled



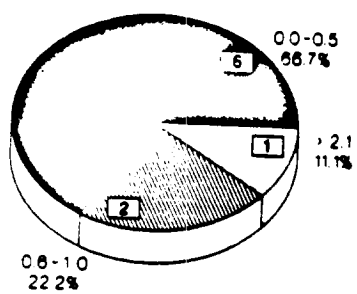
Drainage Area (ac)



Marsh Location



Surface Area



Permanent Pool Storage Volume (in/imp. ac)

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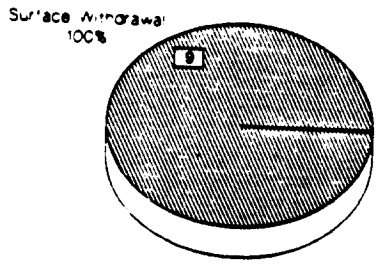
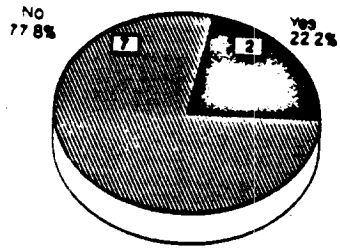
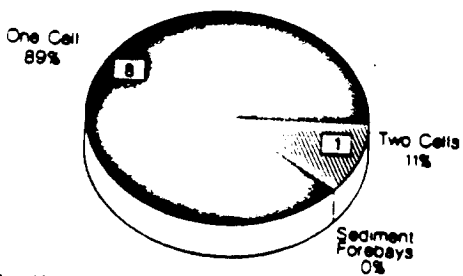
Figure 29 (continued). Artificial Marshes: Background Summary (N=9)



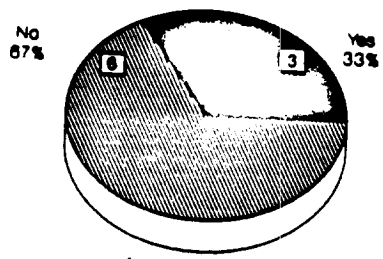
Release Depth



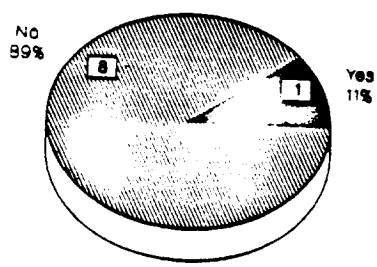
Extended Detention Control



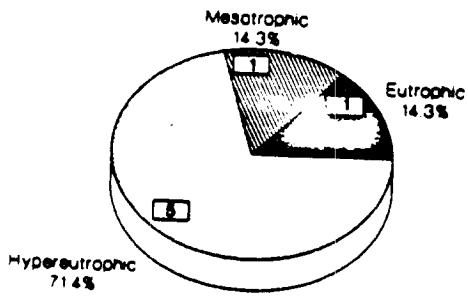
Sediment Forebays / Multiple Cells



Maintenance Bench Present



Aquatic Bench Present



Carlson Secchi Disc
Trophic State Category
Off-Stream Marshes
(N=7)

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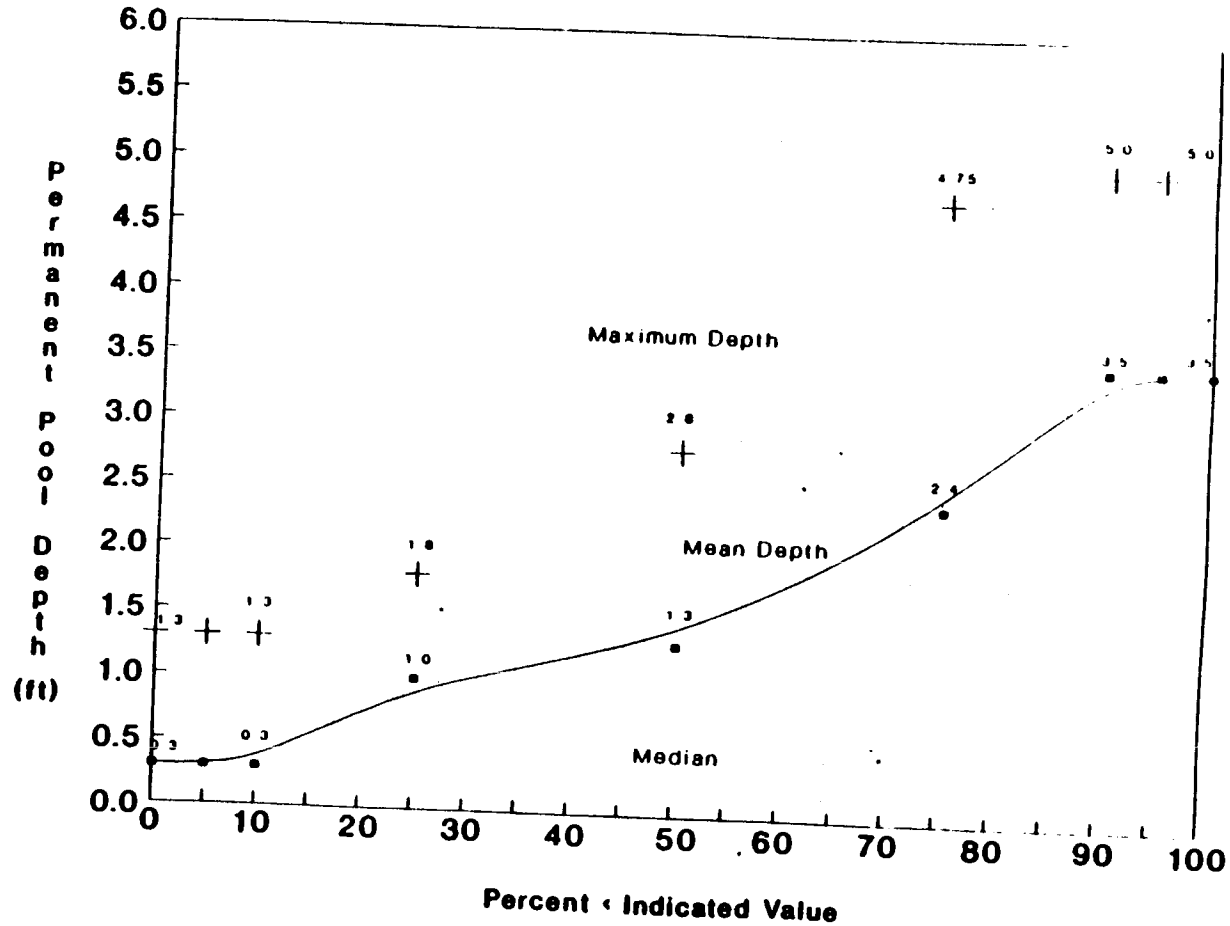
Figure 30. Artificial Marshes: Maximum and Mean Permanent Pool Depths (N-9)



R0055161

Table 8. Water Quality Grab Sampling Results: Artificial Marshes vs Wet Ponds

	Factor/Parameter	Artificial Marshes	Wet Pond
1.	Surface Area (ac)		
	Range:	0.02 - 0.75	0.15 - 4.9
	Mean:	0.21	0.92
2.	Permanent Pool Volume (in/imp. ac)		
	Range:	0.17 - 2.3	0.25 - 5.0
	Mean:	0.66	1.58
3.	Tropic State Category (%):		
	Mesotrophic	14.3	8.3
	Eutrophic	14.3	91.7
	Hypereutrophic	71.4	0.0
4.	Secchi Depth (in.)		
	Range:	5.9 - 55.1	9.8 - 49.2
	Mean	22.0	26.4
5.	Surface Water Temperature (°F) (Sept. - Oct., 1992)		
	Range:	59.0 - 82.4	64.4 - 93.2
	Mean:	74.3	84.2
6.	Total Dissolved Solids (mg/L)		
	Range:	40-170	40 - 220
	Mean:	84.5	102.5
7.	Dissolved Oxygen (mg/L)		
	Range:	1.5 - 10.6	5.0 - 23.2
	Mean:	4.6	10.9
8.	pH		
	Range:	6.5 - 9.1	6.6 - 8.5
	Mean:	7.4	7.5
9.	CO_2		
	Range:	11.6 - 81.6	11.0 - 58.4
	Mean:	38.9	30.5
10.	Percent Surface Algal Mat Coverage (%)		
	Range:	0 - 100	0-47.7
	Mean:	8.1	28.4

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quality differences were recorded between the two BMP systems. Among these were: 1.) the surveyed marshes were predominantly hypereutrophic; 2.) wet ponds tended to be both considerably warmer and better oxygenated . One-third of the artificial marshes failed to meet the 5.0 mg/L DO standard for Class I waters. No apparent correlation was noted between marsh DO concentration and the amount of emergent vegetation present, 3.) CO_2 levels were higher in the artificial marshes, suggesting higher respiration and decomposition rates in these systems, and 4.) the percentage of the permanent pool area covered by floating algal mats was much lower in the marsh systems. This may have been partially due to the proportionately higher amount of emergent aquatic vegetation generally present in the marshes.

While none of the artificial marshes surveyed appeared to be anoxic, the lowest DO readings were recorded at the pocket wetland sites. This finding suggests that some of these systems are being pushed to their limit to breakdown both external and internal organic loads. The high CO_2 readings also observed at the pocket wetland sites partially supports this line of reasoning.

General Performance and System Longevity

Performance

Field survey results revealed that three out of the nine artificial marsh systems were not working as designed. Two of the problem marshes were unable to maintain their design normal pool elevations because of pond drain leakage problems. Conversely, the third marsh experienced major clogging problems with its ED orifice, resulting in a four foot increase in the normal pool elevation. It should be noted that the rebar trash rack employed at this site provided little protection for the two-inch diameter ED orifice.

Another major leading performance-related problem associated with permanent pool depth was the highly variable amount of emergent aquatic vegetation present. As seen in Table 9, not one of the nine marshes surveyed met the MDE 75 percent emergent vegetation coverage guideline. Close examination of marsh depth/volume distributions (Figure 31) revealed that at least four of the marshes were far too deep to permit the establishment of even modest (40 - 50 percent) emergent vegetation coverage.

Based on MDE wetland design guidelines, approximately 25 percent of the marsh should have maximum depths ranging from two to three feet. However, as seen in both Figure 31 and Table 9, one-third of the marsh sites had maximum depths of 18 inches or less. This resulted in almost complete emergent vegetation coverage with little or no open water area provided. From both a biofiltration/water quality performance and wildlife habitat standpoint, a proper balance between open water and emergent vegetation area is critical.

As previously indicated, the majority of the artificial systems inspected were constructed off-stream. Even though much of the survey period was drier than normal,

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Figure 31
ARTIFICIAL MARSHES: SURFACE AREA , PERMANENT POOL VOLUME AND DEPTH-AREA/VOLUME DISTRIBUTION

Site Number and Surface Area (ac)	Permanent Pool Volume (in/imp. ac)	Depth Range (ft)	Percent of Volume (%)	Percent of Surface Area (%)
● 0.10 (R-2)	0.17	<=1.5 1.6 - 4.0 >4.1	100.0% 0.0% 0.0%	100.0% 0.0% 0.0%
● 0.03 (R-3)	0.50	<=1.5 1.6 - 4.0 >4.1	100.0% 0.0% 0.0%	100.0% 0.0% 0.0%
● 0.02 (R-8)	0.50	<=1.5 1.6 - 4.0 >4.1	74.3% 25.7% 0.0%	83.0% 17.0% 0.0%
● 0.20 (R-9)	0.50	<=1.5 1.6 - 4.0 >4.1	75.0% 25.0% 0.0%	86.3% 13.7% 0.0%
● 0.04 (R-14)	0.60	<=1.5 1.6 - 4.0 >4.1	36.0% 64.0% 0.0%	32.1% 67.9% 0.0%
● 0.15 (R-16)	0.75	<=1.5 1.6 - 4.0 >4.1	40.0% 57.8% 2.2%	31.0% 60.1% 8.9%
● 0.04 (R-17)	0.50	<=1.5 1.6 - 4.0 >4.1	100.0% 0.0% 0.0%	100.0% 0.0% 0.0%
○ 0.75 (R-18)	2.30	<=1.5 1.6 - 4.0 >4.1	45.7% 44.3% 10.0%	25.0% 63.7% 11.3%
○ 0.57 (R-20)	0.20	<=1.5 1.6 - 4.0 >4.1	40.7% 56.0% 3.3%	39.3% 46.5% 15.2%

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Table 9. Artificial Marshes: Percent Emergent Vegetation Coverage[1/]

Site No.	Age (yr)	D.A. (ac)	Marsh Surface Area (ac)	Max. Depth (ft)	Percent Emergent Vegetation Coverage (%)
R-2	3 0	12.1	0.10	1.0	90.0
R-3	1.5	1.1	0.03	1.3	100.0
R-8	1.8	0.6	0.02	2.3	100.0
R-9	1.4	2.8	0.20	2.1	25.0
R-14	1.8	2.8	0.04	2.8	25.0
R-16	1.8	9.3	0.15	5.0	6.7
R-17	3.4	2.0	0.04	1.5	100.0
R-18	3.8	44.0	0.75	4.5	0.0
R-20	3.0	221.0	0.57	5.0	0.0

[1/]Site No R-14 was the only marsh site where submerged aquatic vegetation was observed.

the off-stream locations did not appear to have any real effect on design normal pool elevations. It should be noted that at least three out of the eight off-stream marshes received some groundwater inflow. Also, the larger marsh sites seemed to generally provide both better water quality control and far greater environmental amenities.

With regard to ED control, only one of the two ED marshes appeared to be providing any real ED. However, because the marsh had its ED orifice partially plugged, it was providing far more than the 24 hours of ED control for which it was designed. In addition, most of the design storm storage in the marsh was lost due to a major increase in normal pool height.

The age of the marsh system also strongly influences performance. For example, it normally takes at least two or more growing seasons to naturally develop extensive, dense beds of emergent aquatic vegetation; hence, plant densities may not provide optimal stormflow velocity dissipation, biofiltration and pollutant uptake and wildlife habitat opportunities during this initial start-up period. Both the start-up period and the threat of creating undesirable plant monoculture systems can be reduced through the artificial introduction of a variety of native wetland plant species. Based on both field surveys and review of as-built file information, it appears that no wetland plantings were made at any of the nine marsh sites surveyed.

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Overall, emergent aquatic plant diversity at the marshes was relatively poor. Cattails were the dominant volunteer species present, typically comprising 70 - 90 percent of the emergent plant community. Phragmites was not observed at any site.

System Longevity

Results showed that four of the marshes had lost considerable permanent pool storage via sediment and/or organic detritus build-up. It should be noted that the two most severe cases were shallow pocket wetlands. Given their relatively small size, without regular sediment/debris removal and routine inspection and maintenance of the outlet control structure, few pocket wetlands would be expected to function as designed for more than four or five years. Not surprisingly, a strong positive correlation $r = 0.755$ ($p < 0.05$), was recorded between average sediment depth and the age of the marsh.

In general, the incorporation of both a two- to three-foot deep sediment forebay at the marsh inlet and a similarly deep area at the control structure would improve marsh longevity and reduce the need for frequent and highly disruptive sediment removal from the entire marsh bottom. Alternatively, the use of a two-cell wetland design (such as the R-18 marsh site) should accomplish the same objectives.

Performance, Maintenance and/or Structural Problems

As seen in Figure 32, over half of the marshes surveyed required some additional vegetative stabilization of side slope and/or embankment areas. Although current Prince George's County design criteria require that an additional one foot of depth be provided for sediment storage, the majority of the marshes did not meet this criterion. Other findings are listed below.

- On a volumetric basis, the amount of permanent pool storage provided was the same for all land use categories;
- While the average length/width ratio of the surveyed marshes was slightly over 3:1, minimum internal flowpath lengths were generally very short (median ~70 linear feet). This was particularly the case for the pocket wetland sites;
- Only three of the nine marshes inspected included a maintenance bench in their design;
- Three out of nine control orifices lacked a protective trash rack. Of the six control structures which had trash racks, five employed the rebar variety and one used a perforated, vertical pvc pipe; and
- Four out of the nine marsh sites lacked adequate areas for future sediment dewatering operations. None of the as-built plans identified potential on-site sediment disposal areas;

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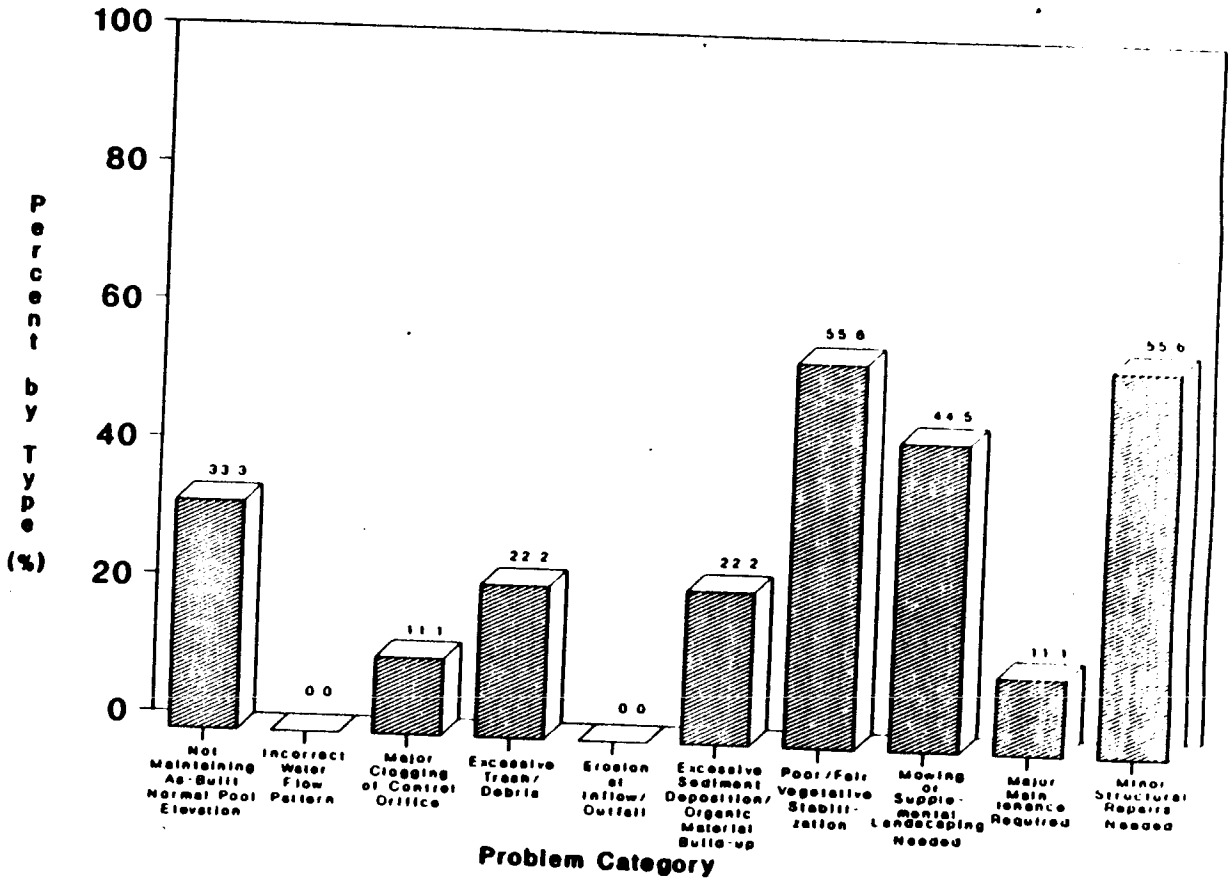
Figure 32. Artificial Marshes:Typical Performace, Maintenance and/or Structural Problems (N=9)



R0055167

Overall, artificial marsh maintenance condition was rated as follows (No. out of 9 sites indicated).

Poor	-	1	(11.1%)
Fair	-	4	(44.5%)
Good	-	3	(33.3%)
Very Good	-	1	(11.1%)

Environmental Attributes

As seen in Figure 33, the average aquatic/wildlife habitat index score was 1.4 (low overall habitat rating). The relatively poor habitat scores were attributed to four major limiting factors: 1.) small marsh size - the median surface area of the systems surveyed was 0.10 acres, 2.) poor environmental location - six out of nine marshes were located either directly adjacent to high traffic paved areas, or in mowed open space, 3.) high mean permanent pool depth - four out of nine sites had average depths $\geq$ 2 feet. These depths effectively restricted the pond bottom area available for the support of emergent aquatic vegetation, and 4.) off-stream location - eight out of nine marshes were hydraulically remote from open receiving streams.

With regard to wildlife, amphibians (frogs and toads) were observed at five out of nine marshes. Native minnow species were present at two sites. Goldfish and Koi were also observed at one marsh location. No mosquito larvae were observed at any of the marshes.

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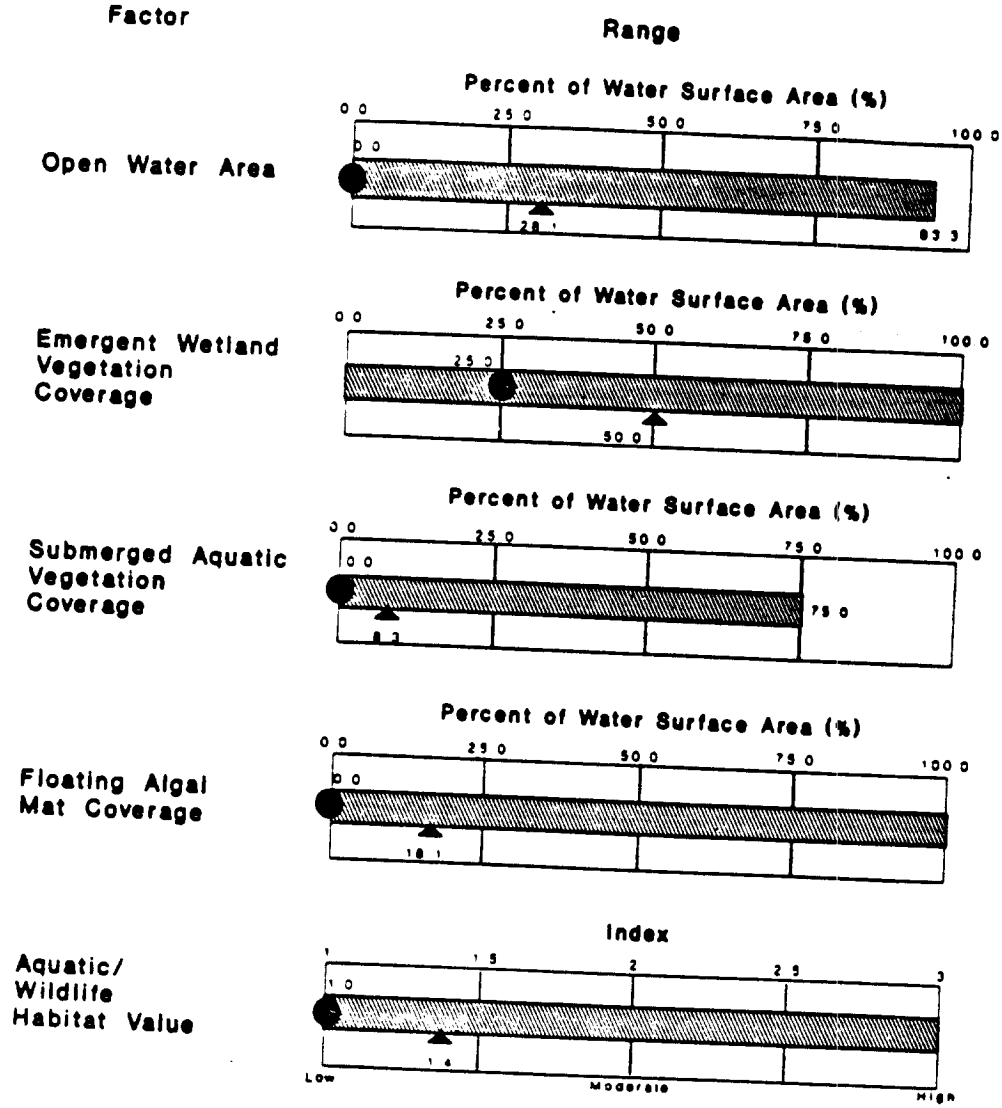
Figure 33. Artificial Marshes: Environmental Attributes (N=9)



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VI. Oil/Grit Separators

Background

Fifty-three oil/grit separators, representing approximately 29 percent of the total constructed in the County since 1985, were inspected by COG staff. As seen in Figure 34, nearly three-quarters of the structures surveyed were less than two years old. Oil/grit separators were most frequently employed to treat parking lot runoff from small commercial drainage areas of less than one acre. Based on the number of water holding chambers present, oil/grit separators were placed into one of the following categories: 1.) Type I - single wet chamber and 2.) Type II - two wet chambers. It should be noted that the Type I separator is the older design type and under current SWM design criteria is no longer allowed. Over 90 percent of the separators surveyed were Type II's.

All of the oil/grit separators were of the poured-in-place variety (i.e., no pre-cast structures used). Current sizing criteria requires that a minimum permanent pool volume of 200 ft.^{3}/impervious acre of drainage be provided. Review of as-built file information revealed that 33 of the 53 oil/grit separators provided more than the minimum amount of permanent pool storage (Table 10).

Additional background information is presented below and included in Appendix D.

- Age Range 0.7 - 4.9 (avg. - 1.7)
- D.A. to Structure Range (ac): 0.3 - 11.3 (avg. - 1.4)
- Water Quality Runoff Volume Controlled: 0.5 in/imp.ac (assuming clean-out of 4x - 5x/yr)
- Permanent Pool Depth Range: 2.0 - 6.8 (avg. - 4.7)
- Permanent Pool volume Range (cuft):

  Grit Chamber - 27.2 - 780.0 (avg. - 204.2)
  Oil Chamber - 31.5 - 393.3 (avg. - 110.5)

- Avg. Storage Volume above Permanent Pool (cuft): 218.7
- Total Length/Width Ratio Range: 1.9 - 5.6 (avg. - 2.9)
- No. of On-Line Structures: 53 (100%)

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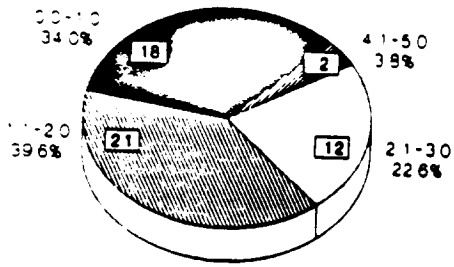
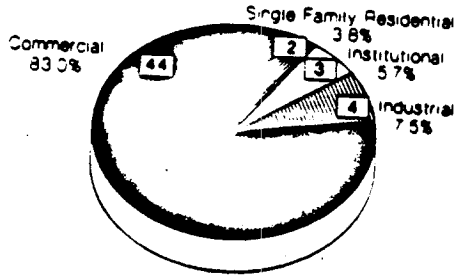
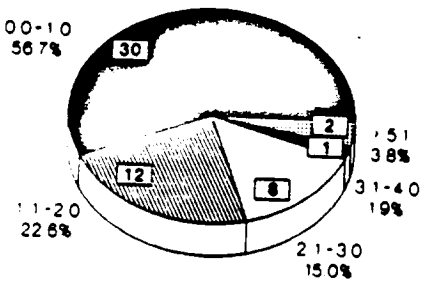
Figure 34. Oil/Grit Separators: Background Summary (N=53)



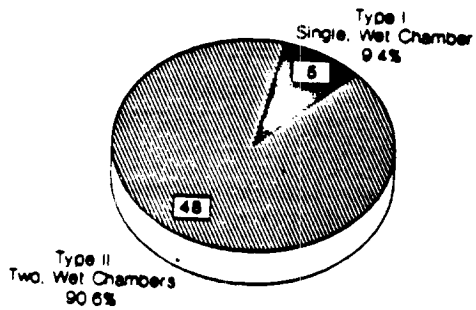
Age (yrs)



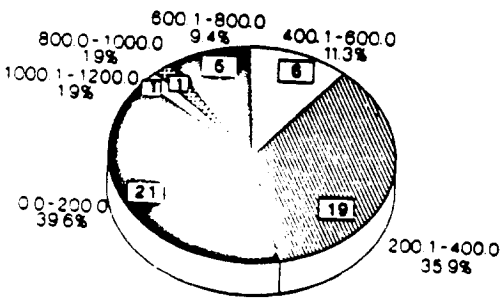
Land Uses Controlled



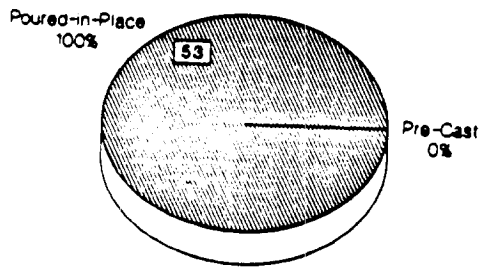
Drainage Area (ac)



Structure Type



Total Permanent Pool Volume (cu ft)



Construction Type

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Table 10. Summary: Prince George's County Oil/Grit Separator Field Survey Results

Site No.	Name	Land Use	Sz. No.	Age of Site (yrs.)	D.A. To Site (ac.)	Date Inspected	No. of Storm Channels	Permanent Pool Depth (ft.)	Perm. Pool Vol. (cu.ft.)	Perm. Pool Vol. (cu.ft./ac.)	Storage Vol. Above Perm. Pool (cu.ft.)	Total Length/Width Ratio (L/W)	Depth of Sed. (in.)	Depth of Sed. (in.)	Sediment Depth (in.)	Sediment Depth (in.)	Removed Volume (cu.yd.)
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAXIMUM VALUE				[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
MINIMUM VALUE				[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
MEAN				[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
MEDIAN				[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
VARIANCE				[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
COEFFICIENT OF VARIATION (%)				[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
STANDARD DEVIATION				[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
STANDARD ERROR				[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
NUMBER OF OBSERVATIONS = N				[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

KEY ABBREVIATIONS:
Comm. = Commercial
Ind. = Industrial
Inst. = Institutional
S.F. = Single Family
N/A. = Not Applicable

N = Permanent pool volume and storage volume above permanent pool from As-Built plans.

R0055172

General Performance and System Longevity

Performance

Fifty-one (96.2 percent) of the oil/grit separators surveyed were working as designed. When compared against all of the other BMP systems surveyed, only wet ponds proved to be less trouble-free than oil/grit separators. Much of this success is attributed to both the simple design and rugged construction of oil/grit separators.

Although oil/grit separators were essentially problem-free, their long-term ability to both trap and retain sediment, oils and grease and other pollutants was quite limited. As seen in Figure 35, neither the Type I or II oil/grit separator (nor the infiltration sump pit) were particularly retentive of sediment over time. The relatively poor long-term trapping efficiencies were greatly assisted by the practice of locating these structures on-line. In fact, all of the structures surveyed were located directly on-line, where they are subject up to full 10-year frequency storm flow-through. Under turbulent flow-through conditions, residual materials may be effectively resuspended and transported out of the facility. It is also important to note that none of the oil/grit separators have ever been maintained.

Results also showed that both the single wet chamber (Type I) oil/grit separator and infiltration sump pit (also one wet chamber) were more retentive of fine-grained residual material than the Type II separator (Figure 36). Conversely, the Type II separator was somewhat more efficient at both trapping and retaining oily sediments and floatable trash and debris.

Preliminary results suggest that sediment trapping performance may be more strongly influenced by internal design features such as port and elbow intake end locations than by permanent pool volume size or chamber geometry. For example, correlation analyses revealed that a significant negative relationship, $r = -0.609$ ($p < 0.05$), exists between the percentage of fine sediment found in grit chambers and weir wall port invert location (i.e., the higher off the bottom the less fine sediment). In addition it appears that extending the elbow intake end more than one to two feet below the permanent pool may actually promote the undesirable concentration and siphoning-off of smaller diameter sediment particles. As expected, oil chambers generally contained a higher percentage of fine sediment than did grit chambers.

All of the oil/grit separators had relatively high amounts of organic colloidal material present in suspension in each chamber. Stormflow monitoring results indicated that a large portion of this material is flushed out of the structure. In addition, relatively large quantities of emulsified oil were also observed in the discharge.

Limited stormflow monitoring of total dissolved solids (TDS) revealed no difference between inflow and outflow concentrations. These results confirm that oil/grit separators are generally ineffective at removing dissolved pollutants. In addi-

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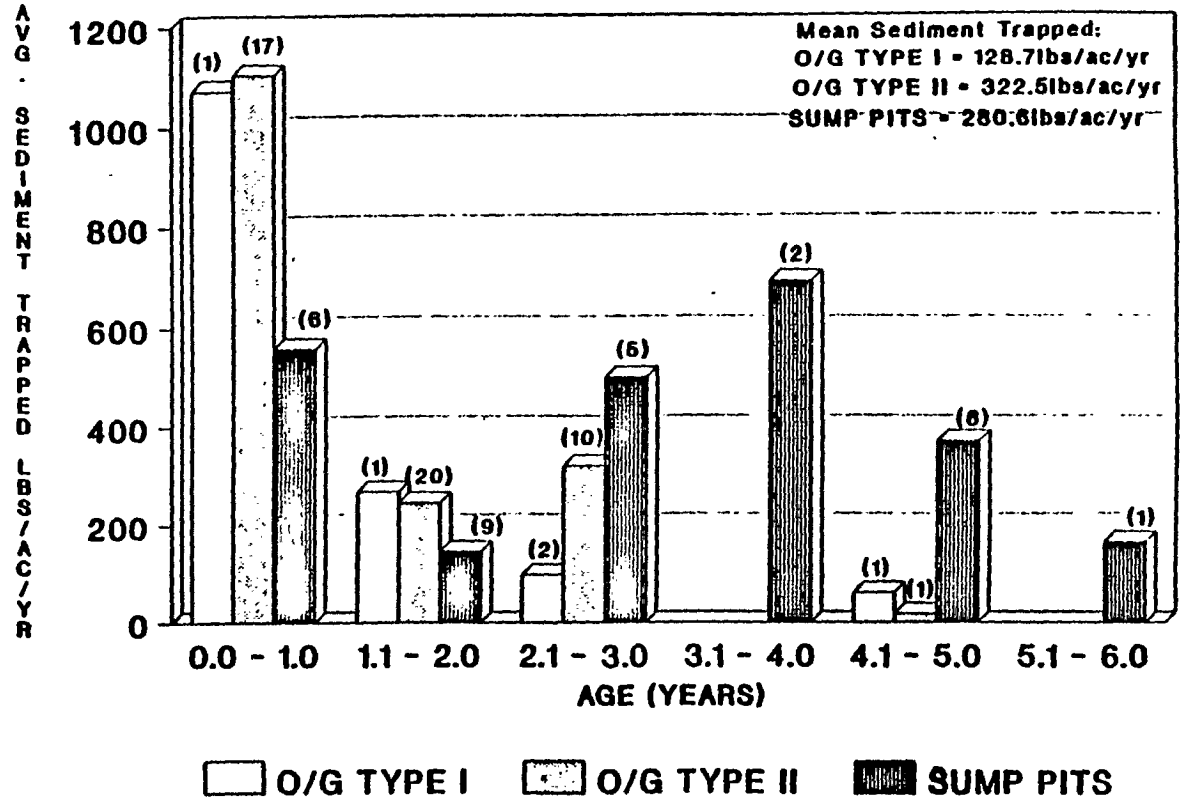
FIGURE 35

OIL/GRIT SEPARATORS AND SUMP PITS: SEDIMENT TRAPPING PERFORMANCE



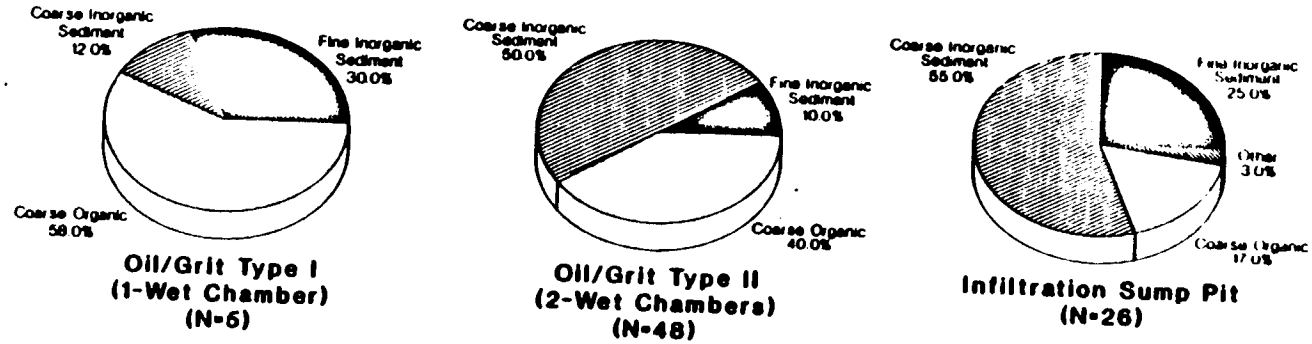
TYPE I = 1 Water Chamber; TYPE II = 2 Water Chambers

(No.) = Indicates number of structure types per age class

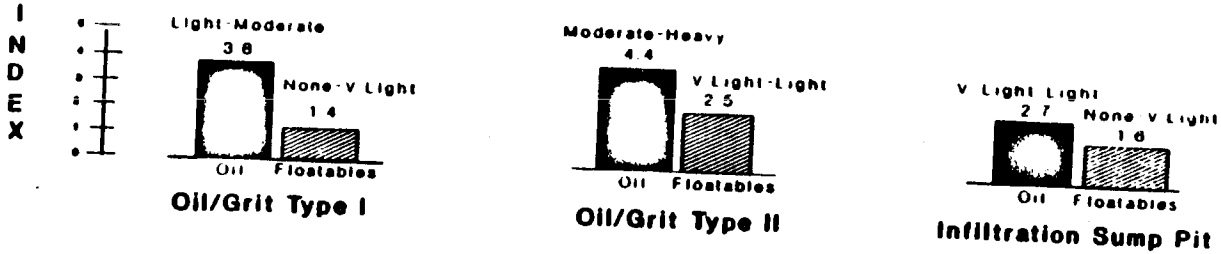
R0055174

Figure 36. Oil/Grit Separators vs. Sump Pits: General Sediment Composition and Relative Quantity of Oil and Floatable Materials Present

Average Composition of Total Material Present



Average Quantity of Oil in Sediment and Floatable Materials Present



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tion, dye test results revealed that, under light rainfall intensity conditions, the minimum pollutant residence time in oil/grit separators is generally less than 26 minutes. Higher intensity rainfall would be expected to significantly reduce this residence time.

Concurrent dye test and stormwater discharge rate monitoring results also indicated that oil/grit separators do contain quiescent areas where very slow, non-uniform water mixing and turnover occurs. In fact, under light to moderate intermittent rainfall conditions some 30 - 50 percent of the dye was still visible within the structure after 2.5 hours.

System Longevity

As previously indicated, because of their all-concrete construction and rugged design, oil/grit separators are structurally long-lived. However, data clearly shows that without routine sediment and trash removal, this BMP rapidly loses its effectiveness over time. In fact, results indicated that, without maintenance, performance drops precipitously after the first year. Again, the practice of locating these structures on-line is thought to contribute greatly to both the resuspension and scour of residual material.

Performance, Maintenance and/or Structural Problems

With the exception of some minor trash-rack related clogging problems, all of the maintenance-related problems centered around the removal of sediment and floatable items such as plastic cups and wrappers. In order to reduce the loss of residual material, a sediment clean-out frequency of at least four times per year is strongly recommended for all on-line oil/grit separators.

Environmental Attributes

None. As expected, results from the field investigation revealed that oil/grit separators do not support any aquatic life. No aquatic worms, mosquito, or midge fly larvae were observed in either the water column or in the sediment. It is thought that the presence of oil sheens, which cover the surface of the permanent pools, plus oil contamination of the sediment effectively preclude their presence.

If properly maintained, oil/grit separators do demonstrate some ability to trap oil adsorbed to particulate material, sediment, leaves and a variety of floatable objects; thereby preventing their discharge to local streams.

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Chapter 5. Study Recommendations

The recommendations which appear in this chapter represent a synthesis of findings derived from the three main study tasks, plus guidance obtained from consultation with both local and national SWM and natural resource experts. Both general and specific criteria and techniques were identified to improve the following: 1.) BMP water quality / quantity control performance, 2.) system longevity, 3.) maintenance, 4.) public safety, and 5.) environmental and aesthetic features. Second, both new possible BMP practices and future research needs are discussed. Last, a list of possible BMP retrofit candidate sites identified through the field survey has been included.

For organizational purposes, the chapter has been arranged as follows: I. Recommendations for Present BMP Systems, II. New BMP Practices and Future Research Needs, and III. BMP Retrofit Opportunities.

I. Recommendations for Present BMP Systems

A. General Infiltration System Recommendations

1.) **Site Analysis.** Per current PGDER criteria, a very rigorous site suitability study which, at a minimum, includes BMP site specific soil borings and laboratory testing of soil infiltration/permeability characteristics and depth to the seasonal high water table, is required. Results from this study revealed that many existing infiltration facilities either failed or were not working as designed due to poor initial site selection. In COG staff's opinion, any proposed infiltration site where groundwater is encountered within 15 feet of existing grade is highly suspect, and is therefore not recommended for such use. Also, where infiltration basins are proposed, the soils analysis should determine the maximum allowable surface ponding depth which will not contribute to premature soil surface compaction.

2.) **Soil Borings.** The practice of generally requiring only one soil boring per infiltration site needs to be re-examined. In COG staffs opinion, one boring should be required for every 50 feet of infiltration system length.

3.) **Pre-Treatment.**

- Because of their high susceptibility to clogging, greater pre-treatment controls are needed for all infiltration systems. It is therefore recommended that extraordinary and redundant pre-treatment

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control measures be required. The use of a small, sump pit-sand filter system for pre-treatment control should be seriously considered.

- Pre-treatment control(s) for dry wells, such as gutter guards and/or sump pits, should be mandatory.

- The premise that infiltration basins do not require pre-treatment measures, because of the suspended solids filtration provided by their grassed surface, is flawed. Without adequate pre-treatment control the bottom area of most basins will rapidly seal, resulting in loss of infiltration capacity. Therefore, the incorporation of pre-treatment control measures such as a large grass filter strip, gravel/sand filter, etc., is strongly recommended.

4.) **Construction Practices.** In order to reduce the likelihood of either internal or external sediment contamination problems, infiltration trench systems with grass filter strips and infiltration basins should not receive any stormwater runoff until a full, dense turf has been established. It is further recommended that the exposed stone reservoir portion of infiltration trenches be sealed with 4 mil plastic sheeting throughout the turf establishment period.

5.) **Inspection/Maintenance.** Given the highly fragile nature of infiltration systems, routine inspection and maintenance is extremely critical. It is recommended that these systems be inspected at least two to four times per year, and preferably after a significant rainfall event.

6.) **Observation Well Cap.** Observation well cap specifications should be standardized and the maximum number of types allowed should be restricted to no more than two or three. Whenever possible, observation wells should not be located in high traffic areas of parking lots, sidewalks, or private driveways.

B. Infiltration Trenches

1.) **Stone Reservoir Location.** The current practice of allowing infiltration trenches to be located beneath paved surfaces, such as parking lots, should be seriously re-examined. To reduce the potential for costly maintenance and/or system reconstruction, it is strongly recommended that the stone reservoir portion be located in

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a lawn-type area and as close to the ground surface as possible (i.e.,- bottom should be within 8 feet of the surface)

2.) **Stone Type.** To reduce the possibility of self-contamination from residual stone dust, it is recommended that only washed bank run gravel be permitted for the stone reservoir portion of these systems (i.e., - double-washed bluestone gravel is not recommended).

3.) **Construction Practices.** During construction, the bottom of the infiltration trench should generally be roto-tilled so as to reduce the probability of initial soil compaction (caused by excavation with large, heavy equipment).

4.) **Bottom Sand Layer Feature.** A six inch deep bottom sand layer is mandatory for all trenches so as to both promote better drainage and reduce the risk of soil compaction (when the trench is backfilled with stone) Strict compliance with this existing design criteria is recommended.

5.) **Off-Line Design.** In order to reduce both the frequency of turbulent flow-through and the associated scour/resuspension of residual material, all future infiltration trenches with sump pits should have the sump pit area located off-line.

6.) **Sump Pit Feeder Pipe Elbow.** The sump pit feeder pipe elbow intake end should extend down approximately one foot below the normal pool elevation. This withdrawal depth appears to represent the best compromise for reducing the amount of suspended solids, oil and floatable materials siphoned-off into the feeder pipe/stone reservoir.

7.) **Inspection/Maintenance.** Because of their functional similarity to oil/grit separators, all sump pits which are located on-line should be inspected and, if warranted, cleaned-out four times per year.

8.) **Permanent Pool Depth.** The recommend permanent pool depth for sump pits is four feet.

9.) **Grass Filter Design.** For infiltration trench systems with pre-treatment grass filter strips the following grass filter design and maintenance criteria are recommended:

a.) The slope of the filter strip should be approximately one percent along its entire length and zero percent across its width;

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b.) The presently required 20 foot minimum filter length needs to be increased, particularly, for those areas receiving high suspended solids loads. A minimum 50 foot filter length is recommended for all sites.

c.) Ideally, the mowed height of the grass should be 2-4 inches taller than the maximum flow depth of the design water quality storm; and

d.) The grass filter should be located in a sunny area.

10.) **Pre-treatment Control Selection.** Because of their lower overall maintenance requirements, sump pits are generally preferred over grass filter strips.

C. Infiltration Basins

1.) **Recommended Design Changes.** Because of the fragile nature of infiltration basins and their extremely high failure rate, water quality and quantity control can generally be achieved more reliably with other BMP's. Given the present infiltration basin performance shortcomings, the following design changes appear warranted:

a.) Future basins should include adequate pre-treatment control, a stone infiltration trench area for basin dewatering, and observation wells (See Figure 37);

b.) Ponding depth should not be so great as to contribute to the compaction of the soil surface. A maximum ponding depth of two feet is generally recommended; and

c.) Basin water quality storage volumes should be intentionally oversized to account for the eventual total loss of infiltration capability. In addition, both a riser/barrel control structure and pond drain feature are recommended.

D. Porous Pavement

1. Because of the inability to provide pre-treatment control for porous pavement, and the system's high maintenance requirement and failure rate, the future employment of this BMP is not recommended.

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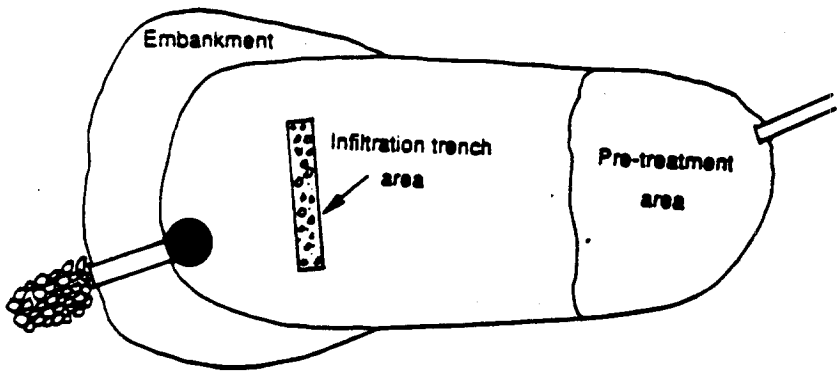
Figure 37. Infiltration Basins: Recommended Design Changes

PLAN VIEW



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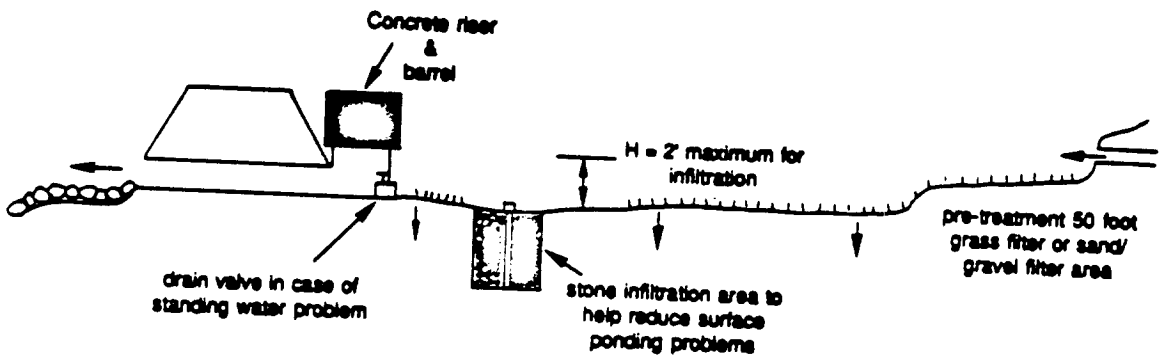
PROFILE



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E. Grass Filter Strip/Grass Swale Systems

1.) **Alternative BMP's.** Because of their limited ability to remove dissolved pollutants, conventional grass filter systems should be viewed as pre-treatment systems. In general, grass filter systems are most effective when: 1) they are used in combination with other BMP's and 2) their use is restricted to relatively small, flat sites where runoff volumes are not large.

2.) **Site Analysis.** A rigorous site suitability analysis, which includes laboratory testing of soil infiltration/permeability characteristics and suitability for the intended grass cover crop, is recommended.

3.) **Grass Selection.** Grasses used in water quality filter strips/swale systems should have the following characteristics:

- high stem density, well-branched top growth, and a root system which is very resistant to temporary inundation/flooding;
- grass stems should exhibit a high resistance to being 'flattened' by the design storm;
- should be an aggressive grower, tolerant of both periodic drought and runoff carrying varying concentrations of road salts; and
- should form dense sod. Avoid bunch-type grasses.

Recommended grasses include, but are not limited to, the following:

Ky-31 tall fescue, reed canary grass, redtop, and roughstalked blue grass. Note, the preceding grasses can be mixed.

4.) **General Design Criteria.** In order to maximize the removal of nonpoint source pollutants the following design criteria are recommended:

- underlying soils should have a high infiltration rate. An fc of $\geq$ 1.0 inches/ hour is recommended. It is further recommended that the soils be tilled before the

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grass cover crop is established to restore infiltration capacity lost during previous grading operations;

- grass filter systems should be constructed in sunny locations;
- the filter strip should, at a minimum, be as long as the contributing impervious area;
- the slope of grass filter/swale systems should be nearly flat (i.e., - one percent bottom slope along its entire length and zero percent slope across its width). Note, an underdrain system may, in some cases, be desirable;
- for swale systems, relatively broad, minimum bottom channel width to channel depth ratio of 3:1 is recommended;
- maximum water quality design storm flow velocities through the filter must be kept well below 1 fps. It is further recommended that the maximum allowable Q10 velocity be less than 3 fps.
- the mowed height of the grass should be 2-4 inches taller than the maximum flow depth of the design water quality storm. For Ky-31 tall fescue, reed canary grass, redtop, and/or roughstalked bluegrass a minimum mow height of 6 inches is generally recommended. Note, this would most likely require the use of a sickle bar-type mower.

5.) **Swale Systems.**

- In order to improve the performance of swale systems, a series of notched or ported low head checkdams (≤ 12 inches high) should be incorporated into their design. Note, the maximum recommended ponding time of runoff backed up behind the checkdams is 12 hours. Also, the area around each checkdam needs to be properly armored with stone.
- For both maintenance and long-term system design performance reasons, earth and/or stone checkdams should generally be avoided.

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- Designers should seriously consider integrating redundant pollutant removal enhancement features, such as stilling basins, stone infiltration trenches, and/or checkdams, into their swale systems.

6.) **Inspection/Maintenance.** It is recommended that grass filter strips/swale systems be carefully inspected seasonally and preferably after a significant rainfall event.

- Routine maintenance should include: the immediate repair of newly formed channels or gullies, reseeding/sodding of bare spots, removal of trash, leaves and/or accumulated sediment, and the control of woody or other undesirable vegetation. In addition, the filter strip may require periodic mechanical aeration to restore infiltration capacity. Routine fertilization and/or use of pesticides is strongly discouraged.

7.) **Signage.** The grass filter/swale system should have proper signage so that it can be readily distinguished from other lawn-type areas.

8.) **Wildlife Habitat.** In order to increase the wildlife habitat potential of these systems it is recommended that an additional, minimum 10-12 foot wide buffer strip be incorporated into their design. This buffer strip could be planted with a variety of food producing grasses/small shrubs and/or native wildflowers.

9.) **Miscellaneous.** As-built plans should include certification of the type of grass cover crop used.

F. Extended Detention Dry Ponds

1.) **Basic ED Design.** Results from this study revealed that a large percentage of ED dry ponds failed to meet their design ED period. What is badly needed is a new ED control system which is truly capable of providing a minimum of 6 - 12 hours detention over a broad range of storm-size and rainfall intensity conditions. One possible design improvement is the employment of a proportioning weir-type system (Figure 38). A second alternative is the greater use of gate valves, which

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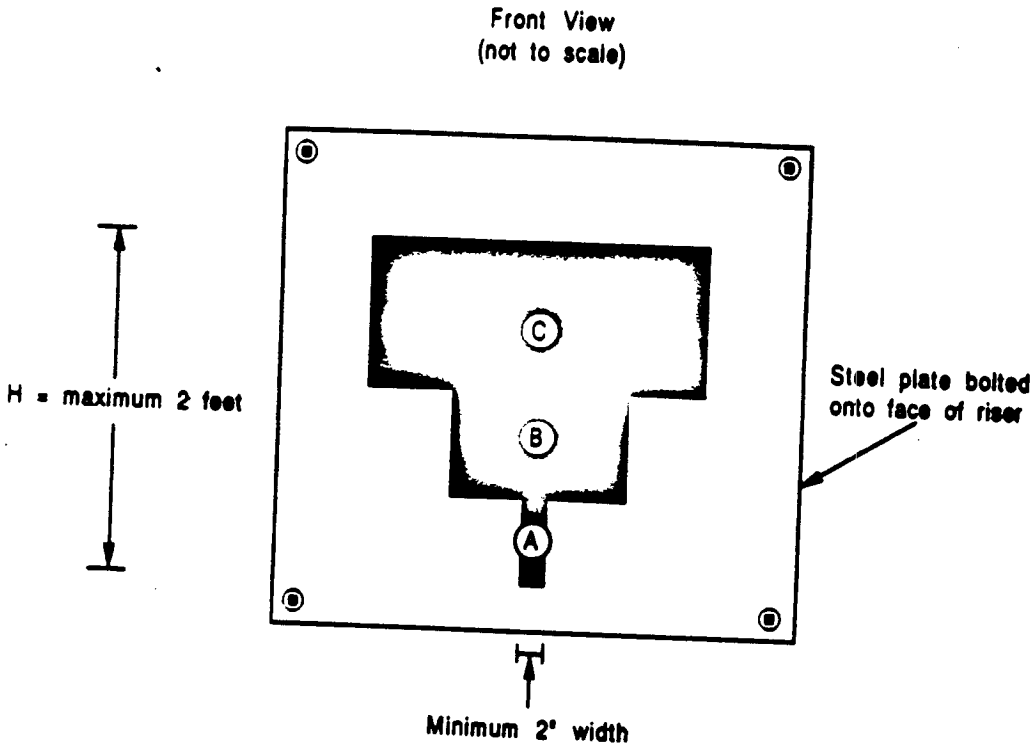
Figure 38. ED Control Orifice: Conceptual Proportioning Weir Outlet System



A - Bottom slot control - small-sized, low intensity rainfall/storms

B - Middle and bottom slots - for medium-sized, moderate intensity rainfall/storms

C - Full slot control - for larger, less frequent storm events or high intensity rainfall storms

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provide greater operational flexibility in adjusting ED times. However, even these control improvement features cannot completely compensate for a release rate based on a single size storm event.

2.) **ED Calculations.** Although the present one-year 24-hour frequency storm inflow/outflow centroid method for calculating ED time is an improvement over the old 'Kerplunk' method, it too is deficient in that it is unable to accurately estimate the volume of runoff produced by storms of smaller size or different intensity levels. Further research in this area is needed.

3.) **On-Stream Locations.** For on-stream ED dry ponds which serve large drainage areas, design consideration needs to be given to the removal of sediment deposited within the upstream channel network. Without proper design and maintenance, there exists a strong probability that an eroding, braided channel network could develop. Good vehicular access to these areas is essential.

4.) **Micropools.** Micropools should be sized on the basis of both expected annual sediment deposition rates and design sediment-removal frequency.

5.) **Pond Drain.** Because of the high probability of clogging and hence ponding, ED dry pond design should include a pond drain feature.

6.) **Trash Racks.** The horizontal perforated PVC pipe and gravel jacket system should be dropped in favor of a vertical slotted/perforated standpipe or vertical perforated half-round CMP-type trash rack. However, whenever possible, a micropool/mini-wetland system with either a partially submerged hood or reverse slope pipe is the preferred approach.

7.) **Maintenance Access.** Good vehicular access to key ED dry pond component areas, such as the trash rack/micropool and pilot channel(s), is absolutely essential.

8.) **Inspection.** ED dry ponds which control high trash/debris and/or sediment-producing land uses should be inspected on a monthly basis (or after each major storm event).

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9.) **Perforation Size.** The minimum acceptable perforation size opening for trash rack/anti-clogging systems should be 0.75 - 1.0 inches diameter.

10.) **Minimum Orifice Size.** The existing PGDER minimum two-inch diameter ED orifice sizing criterion works in the field and should therefore not be changed.

11.) **Internal Flowpath Length.** ED dry pond systems should feature a design which maximizes the flowpath length between the stormwater inflow point(s) and the outlet/control structure. A minimum 3:1 pond length/width ratio is further recommended.

12.) **Minimum D.A. Requirements.** Because of the generally small orifice diameter/cross-sectional area required to achieve ED control, conventional ED dry ponds are not recommended for sites having drainage areas of less than 10 acres.

13.) **Shading.** To reduce potential downstream thermal problems, both pilot and outfall channels should be shaded to the greatest extent possible.

14.) **Forested Locations.** When an ED pond is proposed to be located in a forested area, the existing forest must be evaluated for flood tolerance. In general, priority forest retention areas should be avoided.

15.) **Landscaping.** To improve both wildlife habitat value and aesthetics, ED dry ponds should generally be landscaped with native tree and shrub species.

16.) **Ergonomics** - Place valves, manhole covers, steps, platforms, etc., within safe and easy reach. Reduce vandalism potential by properly limiting access to the control structure and its appurtenances (i.e., lock up).

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G. Wet Ponds and Artificial Marshes

Wet Ponds

1.) **Permanent Pool Volume.** The present 0.5 inches of permanent pool storage per impervious acre sizing requirement should be increased and modified to include a multiplier, land use intensity/imperviousness level coefficient to account for anticipated increases in pollutant loadings. It is recommended that the minimum permanent pool storage requirement for all wet ponds be set at 1.0 inch/impervious acre.

2.) **Permanent Pool Depth.** Approximately 10-20 percent of the permanent pool area should be less than 18 inches deep, and should include a minimum 10 foot wide by zero to 12 inch deep aquatic bench system. All wet ponds should generally have a maximum depth of between 4-8 feet. However, where game fish are planned to be introduced, the maximum pond depth should be at least six feet.

3.) **Surface Area.** The minimum wet pond surface area to catchment area ratio should be one percent (50.0 percent of the ponds surveyed had a surface area ratio of $\leq$1.0%).

4.) **Extended Detention Control.** It is strongly recommended that wet ponds serving larger sites, approximately 50 acres or greater, include a minimum of 6-12 hours of ED storage volume (for 0.25-0.50 inches of runoff/impervious acre) above the permanent pool. A maximum ED ponding depth of two feet is generally recommended.

5.) **Pond Configuration.** A minimum 3:1 pond length/width ratio is recommended. In order to reduce potential short-circuiting problems, storm drain outfalls should be strategically located so as to maximize flowpath length within the pond. Internal flowpath length can often be maximized through the employment of earthen berms or baffles located within the permanent pool. In addition, the use of a multiple-celled pond configuration should be considered as an option for reducing both potential short-circuiting and turbulent flow problems.

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6.) **Release Depth.** As a rule, wet ponds should withdraw water at or within 18 inches of the surface. Mid-level and bottom release locations are generally discouraged because of the strong possibility of discharging water with poor DO/water quality characteristics downstream.

7.) **Sediment Storage and Removal.** Sediment storage volume sizing should be based on both expected annual sediment deposition rates and design sediment-removal frequency. The employment of a sediment forebay area or alternatively, a multiple-cell configuration is recommended. In addition, whenever possible, future wet ponds should include adequate on-site sediment dewatering and disposal areas.

8.) **Maintenance Access.** A 10-12 foot wide maintenance bench should be provided so as to allow full vehicular access to both the outlet/control structure area and to at least one other side of the pond. Maintenance access road(s) should have a grade of less than 12 percent.

9.) **Trash Rack/Clogging Reduction Systems.** Field survey results indicated that both the partially submerged vertical hood and the submerged, reverse sloping ED pipe-type systems were far superior to the rebar design trash rack and should be the required approach.

10.) **Aquatic and Terrestrial Plantings.** Both aquatic and wildlife habitat and pond aesthetics could be significantly enhanced through the systematic introduction of native plant materials. Pond plantings are strongly encouraged so as to reduce the potential for the creation of monotypic cattail stands.

11.) **Longevity of Control Structures.** The use of concrete risers and barrels is the correct approach and should be a requirement for all future wet pond and artificial marsh systems.

12.) **Pond Location.** Off-stream ponds and marshes appear to perform their water quantity and quality control duties as well as those located on-stream. Each choice of location has both environmental and water quality trade-offs. Where the treatment of both baseflow and stormflow is desired and where wetlands/receiving stream-related issues (such as thermal regime alteration) are not critical, the preferred approach is an on-stream system.

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13.) **Signage.** Both wet ponds and artificial marshes should be posted with an information/warning sign prohibiting swimming, ice skating, diving and/or other activities considered inappropriate or dangerous. It is further recommended that the posting of a small, companion environmental education sign also be considered.

14.) **Fencing.** The use of fences around wet ponds and marshes is generally not recommended. However, where deemed necessary, a wooden split-rail fence with a dark colored chain link backing is preferred over the traditional five foot high, galvanized chain link fence.

15.) **Safety Features.** To lessen the risk of accidentally falling into deep water areas, all retention pond systems should be designed with both wide aquatic shelves and safety/maintenance bench features.

16.) **Forested Locations.** When a wet pond or artificial marsh is proposed to be located in a forested area, the existing forest must be evaluated for flood tolerance. In general, priority forest retention areas should be avoided.

17.) **Shading.** To reduce potential downstream thermal problems, both inflow and outflow channels should be shaded to the greatest extent possible.

18.) **Ergonomics.** Place valves, manhole covers, steps, platforms, etc., within safe and easy reach. Reduce vandalism potential by properly limiting access to the control structure and its appurtenances (i.e., lock up).

Artificial Marshes

1.) **Surface Area.** The minimum marsh surface area to catchment area ratio should be two percent (Note, 55.6% of the marshes surveyed had a surface area ratio of (≤2%). A larger marsh surface area ratio is recommended for high nonpoint source pollution generating land use areas (e.g., - large commercial and/or industrial sites).

2.) **Permanent Pool Volume.** The present 0.5 inches of permanent pool storage per impervious acre sizing

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requirement should be modified to include a multiplier, land use intensity/imperviousness level coefficient. As currently envisioned, the proposed minimum permanent pool storage volume would increase incrementally with increasing levels of site imperviousness/pollutant loads.

3.) **Permanent Pool Depth.** Approximately 50-70 percent of the permanent pool area should be less than 12 inches deep, and should include a minimum 12 foot wide by zero to six inch deep aquatic bench system. Shallow, variable depths are required for the establishment of a well-balanced emergent plant community. The remainder of the permanent pool area should be less than 5 feet deep. A large pocket of deeper water (between 2-5 feet deep) is recommended for both marsh inlet and outlet areas.

4.) **Extended Detention Control.** It is strongly recommended that artificial marshes serving larger sites, approximately 10 acres or greater, include a minimum of 6-12 hours of ED storage volume (for 0.25-0.5 inches of runoff/impervious acre) above the permanent pool. A maximum ED ponding depth of two feet is generally recommended. In addition, either a gate valve or proportioning-type weir should be employed.

5.) **Marsh Configuration.** A minimum 3:1 pond length/width ratio is recommended. In order to reduce potential short-circuiting problems, storm drain outfalls should be strategically located so as to maximize flow path length within the marsh. As previously indicated, internal flowpath length can often be maximized through the employment of earthen berms or baffles located within the permanent pool. In addition, the use of a two-celled marsh configuration should be considered as an option for reducing both potential short-circuiting and turbulent flow problems.

6.) **Release Depth.** A surface release design is generally recommended for all artificial marsh systems.

7.) **Sediment Storage and Removal.** Sediment storage volume sizing should be based on both expected annual sediment deposition rates and design sediment-removal frequency. Field survey results suggest that for most marsh systems, the presently required one foot sediment storage volume may be filled within the space of 5-7 years. Where possible, a 10-year sediment removal schedule is encouraged. For all marsh systems, a sediment forebay or a two-wet celled configuration

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is strongly recommended. In addition, whenever possible, all future marsh systems should include adequate on-site sediment dewatering and disposal areas.

8.) **Maintenance Access.** A 10-12 foot wide maintenance bench should be provided so as to allow full vehicular access to both the outlet/control structure area and to at least one other side of the marsh.

9.) **Trash Rack/Clogging Reduction System.** Field survey results indicated that both the partially submerged vertical hood and the submerged, reverse sloping ED pipe-type systems were far superior to the rebar design trash rack and should be the required approach.

10.) **Aquatic and Terrestrial Plantings.** Both aquatic and wildlife habitat could be significantly enhanced through the systematic introduction of native plant materials. Marsh plantings with 7-10 native emergent species is strongly recommended.

H. Oil/Grit Separators

1.) **Alternative BMP's.** Given their limited pollutant removal capability and need for frequent costly maintenance, the employment of oil/grit separators is generally not recommended. As an alternative, the PGDER Watershed Protection Branch should seriously entertain the use of sand filters.

2.) **Off-Line Location.** All of the structures surveyed were located directly on-line, where they are subject up to full 10-year frequency storm flow-through. Under turbulent flow conditions, residual material may be effectively resuspended and transported out of the facility. Per recent PGDER criteria, all future oil/grit separators must be located off-line.

3.) **Inspection/Maintenance.** None of the oil/grit separators inspected in the study have ever been maintained. In order to reduce the loss of residual material, a sediment clean-out frequency of at least four times per year is strongly recommended for all on-line oil/grit separators.

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4.) **Reduction of High Flow - Through Rate.** The relatively short pollutant residence times in these passive gravitational settling systems is generally insufficient for the removal of most silt-sized particles. In order to settle the major portion of this material, a minimum 45-60 minute residence time (under quiescent conditions) would be required. Unfortunately, this would be difficult to achieve without both significantly increasing storage capacity and reducing discharge rate/outlet orifice size.

5.) **Internal Location of Ports and Elbow Intake End.** Results indicate that the invert locations of both weir wall ports and the elbow intake end strongly influence sediment settling/retention dynamics. It appears that extending the elbow intake end more than 1-2 feet below the permanent pool may actually promote the undesirable concentration and siphoning-off of smaller diameter sediment particles. Therefore, a one foot withdrawal depth is recommended.

6.) **Suspended Solids Particle Size, Colloidal Material and Emulsified Oil.** The present oil/grit separator design operates under the assumption that oil floats at or near the water surface and that an inverted elbow extending three feet below the normal pool will trap and retain most of this material. Both field and literature survey results indicate that a large portion of the oil in urban runoff is quickly adsorbed onto fine sediment. Furthermore, oil which is in an emulsified state tends to remain in suspension and is not effectively trapped by an inverted elbow. Importantly, overall oil/grit separator performance is additionally hampered by the fact that much of the suspended solids are comprised of silt and clay-sized inorganic particles, as well as, colloidal organic material. Removal of the preceding materials through conventional gravitational settling is difficult, if not impossible to achieve. Thus, the next improved generation of oil/grit separators will need to include some type of additional filtering component, such as a sand filter element, in its design.

7.) **Coalescing Plates.** Given their high cost and high associated maintenance, the use of internal coalescing plates for improving oil/grit separator performance is not recommended.

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8.) **Monitoring Needs.** Additional performance monitoring of oil/grit separators is needed to better quantify pollutant removal efficiencies and to provide information necessary for the formulation of possible design improvements and retrofit changes.

I. Dry Ponds

1.) **Alternative BMP's.** Because of their inability to provide water quality benefits, limited stream channel protection capability, and high maintenance requirements, the future employment of dry ponds is not recommended. Alternative replacement BMP's include: artificial marshes, wet ponds and ED dry ponds. It is further recommended that the majority of the existing dry ponds in the County be gradually converted over into one of the three preceding BMP types.

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II. Alternative BMP's and Future Research Needs

Alternative BMP's - Sand Filters

Given both performance and reliability shortcomings of current oil/grit separators and infiltration BMP's, the employment of alternative SWM practices merits serious consideration. This is particularly the case for small catchment areas of less than 10 acres in size; where the employment of more traditional BMP's, such as wet ponds, artificial marshes, and/or ED dry ponds, is often neither feasible nor desirable.

Having carefully evaluated several possible alternative BMP systems, it is COG staff's opinion that sand filters represent the most flexible, reliable and affordable alternative. This conclusion is based on the following facts: 1.) sand filters have been successfully employed for several years in both surface and underground SWM applications, 2.) they have a proven ability to provide water quality control for small to medium size drainage areas, 3.) the pollutant removal efficiency of these systems is generally moderate to high for most stormwater constituents, 4.) vis-a-vis infiltration trenches or basins, sand filters are generally both far more resistant to clogging, and in the event of system failure, easier and cheaper to rehabilitate, 5.) sand filters can be coupled with either dry surface detention or underground pipe storage to provide full stormwater management control, 6.) on a volume-of-runoff treated basis, sand filters can be more economical to construct than either infiltration trenches or oil/grit separators, 7.) the removal and disposal of accumulated surface scum and contaminated sand does not require elaborate and/or costly procedures or disposal sites and 8.) sand filters pose no groundwater contamination threat. For all of the above reasons, it is strongly recommended that sand filters, along with infiltration trenches, be considered as the preferred BMP for small development sites with catchment areas of 10 acres or less.

Future Research Needs

During the course of the study, it became evident that additional BMP research is needed in at least two major areas: a.) comprehensive performance monitoring of oil/grit separators (to provide information necessary for the formulation of second generation design improvements, possible retrofit modifications of existing structures, and enhanced maintenance and residual material disposal practices) and b.) development of improved ED calculation/methodology and control systems (which can provide greater ED control over a broader spectrum of storm scenarios).

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III. BMP Retrofit Opportunities

Based on field survey findings, COG staff has identified several existing BMP sites which appear to be likely candidates for future retrofit work. Presented below, in tabular format, are preliminary retrofit recommendations for 15 sites.

Table 11. Candidate BMP Retrofit Sites

Site No.	Name	BMP Type	Preliminary Recommendations
I-43	Tick Tock Plaza	Infiltration Basin	• Excavate to convert to artificial marsh. • Stabilize side slopes with combination of grass and shrub vegetation.
I-44	Park Virginia Manor	Infiltration Basin	• Excavate to convert to artificial marsh. • Add concrete riser to ex. barrel.
G-10	Decatur Heights	Oil/Grit Separator	• On an experimental basis, add a small sand filter component to the third chamber (outfall chamber).
R-16	Stanallen Estates	ED Artificial Marsh	• Replace ex. rebar trash rack with either a vertical hood or reverse sloping pipe system.

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Table 11. Cont'd

Site No.	Name	BMP Type	Preliminary Recommendations
R-18	Tantallon Square	Artificial Marsh	• Regrade shoreline areas so as to create aquatic benches. • Perform aquatic and terrestrial pond-scaping.
R-22	Dontrine Pond #2	Wet Pond	• Add ED control feature. • Replace ex. wire mesh trash rack.
R-24	Montpelier Hills	Wet Pond	• Remove sediment deposit/excavate to maximum 6 ft. depth. • Add ED control feature. • Landscape Pond.
E-3	Den Lee Park	ED Dry Pond	• Convert to ED artificial marsh via excavation.
E-6	Lowes of Bowie	ED Dry Pond	• ditto
E-12	Inglewood Business	ED dry Pond	• Add gate valve to provide greater ED control. • Add micropool feature. • Replace ex. bar-type trash rack with a vertical hood.

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Table 11. Cont'd

Site No.	Name	BMP Type	Preliminary Recommendations
E-14	Montpelier Hills #3	ED Dry Pond	• Add micropool feature. • Replace ex. perforated standpipe system with either a vertical hood or reverse sloping pipe.
D-1	Branch Ave. Plaza	Dry Pond	• Convert to ED artificial marsh. • Perform pondscaping.
D-9	Md. Corporate Center	Dry Pond	• ditto
D-10	Newport Towne	Dry pond	• ditto
D-11	Parcel 'D' Addition to Pleasant	Dry Pond	• ditto

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Glossary of Terms

Aquatic Bench - A ten to fifteen foot bench around the inside perimeter of a permanent pool that is approximately one foot deep. Normally vegetated with emergent plants, the bench augments pollutant removal, provides habitat, conceals trash and water level drops, and enhances safety.

Biochemical Oxygen Demand - the quantity of oxygen utilized in the breakdown of pollutants via bacterial, fungal, algal, and/or other biologically driven processes, as well as, through chemical oxidation.

Eutrophication - the process through which bodies of water generally become more nutrient-rich and biologically productive.

Exfiltration - The downward movement of runoff through the bottom of an infiltration BMP into the subsoil.

Extended Detention - A stormwater design feature that generally provides for the gradual release of a volume of water (0.25 - 1.0 inches per impervious acre) over a 6 - 40 hour period to increase settling of urban pollutants, and protect channels from scouring flows.

Macroinvertebrates - animals without backbones that are large enough to be retained on a U.S. Standard No. 30 sieve, 0.595 mm openings.

Secchi Disk - a 20 cm diameter disk with four equal-sized, alternating white and black colored areas used for the approximate evaluation of the transparency or clarity of water.

Sump Pit - A single-chamber oil/grit separator used to pretreat runoff before it enters an infiltration trench.

Trophic State - refers to the productivity/nutrient status of a water body. In general, marshes, ponds and lakes are placed into one of four categories based on the following characteristics:

- oligotrophic (low nutrient loads and/or biological productivity)
- mesotroplic (moderate nutrient loads and/or biological productivity)
- eutrophic (high nutrient loads and/or biological productivity; generally viewed as being an undesirable condition)
- hypereutrophic (excessively high and undesirable nutrient loads and/or biological productivity.

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Appendix A:

Prince George's County BMP Study
As-Built Plan File Listing

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Table 1. Prince George's County BMP Evaluation Site List

BMP SITE NO.	NAME	P.G. CO. CSD/SD NO.	LOCATION (P.G. Co. Grid No.)	WATERSHED	BMP TYPE	D.A. TO BMP (AC.)	LAND USE	MO./YEAR CONSTRUCTED
I-1	Southwell General Part.	SD86065	20-F2	Potomac	Infilt.-Tr. (2)	1.29	Comm.	1/90
						0.63		
					Oil/Grit (2)	1.29		
						0.63		
I-2	Autoville Block F	SD87234	04-B11	Anacostia	Infilt.-Tr. (2)	0.24	Comm.	6/88
						0.46		
I-3	Belton Parcels A & B	SD86014	04-E5	Anacostia	Infilt.-Tr. (2)	1.40	Comm.	5/86
						1.35		
I-4	Beltsville Comm. Center	SD88737	04-F6	Anacostia	Infilt.-Tr.	1.40	Comm.	10/88
I-5	Bradco Corporation	CSD85135	09-B11	Anacostia	Infilt.-Ba.	1.75	Ind.	4/86
I-6	Branch Ave. Commerce	CSD88034	20-G13	Potomac	Infilt.-Tr.	0.48	Comm.	12/88
I-7	Branch Plaza	CSD87341	20-E8	Anacostia	Infilt.-Tr.	3.72	Comm.	12/88
I-8	Brinkley Prof. Center	SD86074	19-J8	Potomac	Infilt.-Tr.	1.30	Comm.	2/90
					Infilt.-Ba.	1.30		
I-9	Brinkley Station Turhouse	SD85142	19-H8	Potomac	Infilt.-Tr.	2.64	TH	11/89
I-10	Calverton Building	SD87449	04-A2	Anacostia	Infilt.-Tr. (2)	0.97	Comm.	5/90
						1.37		
					Oil/Grit	4.17		
I-11	Calverton Building 7	CSD89141	04-A3	Anacostia	Infilt.-Tr. (2)	0.57	Comm.	12/89
						0.78		
					Oil/Grit	0.85		
I-12	Camp Springs Square	SD86092	20-F9	Potomac	Infilt.-Tr. (2)	3.20	Comm.	5/90
						1.78		
					Oil/Grit	-		
I-13	Cherry Lane Center Par #5	SD86023	02-B9	Patuxent	Infilt.-Tr. (3)	0.24	Comm.	8/86
						0.53		
						1.19		
I-14	Chester Grove Tourhouses	SD85096	21-B1	Patuxent	Infilt.-Tr.	0.17	TH	3/87
I-15	Chestnut Heights	SD87213	11-E2	Patuxent	Infilt.-Tr. (2)	3.40	SF	11/88

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Table 1. Prince George's County BMP Evaluation Site List

BMP SITE NO.	NAME	P.G. CO. CSD/SD NO.	LOCATION (P.G. Co. Grid No.)	WATERSHED	BMP TYPE	D.A. TO BMP (AC.)	LAND USE	NO./YEAR CONSTRUCTED
I-16	Clinton Service Park	SD85122	20-H13	Patuxent	Infilt.-Tr. (4)	1.34 0.91 0.09	Comm.	9/85
I-17	College Park	SD87034	09-A3	Anacostia	Infilt.-Tr.	0.82 0.25		
I-18	Huron Center	SD87147	20-G12	Potomac	Infilt.-Tr.	2.46 0.29	Comm. Comm.	8/88 12/87
I-19	East Lake	SD87187	16-A4	Patuxent	Infilt.-Tr. (4)	0.37 1.08 0.61	Apt.	9/89
I-20	Econolodge	SD87356	20-H13	Potomac	Oil/Grit Infilt.-Tr. (2)	1.30 0.66 2.03	Comm.	8/89
I-21	Largo/Oxford Parcel L	SD86148	15-F6	Patuxent	Infilt.-Tr. (8)	0.89 0.62 0.83 0.85 1.32 0.54 1.15 1.29 1.75	Apt.	6/89
I-22	Franklin Terrace	SD85148	04-E1	Anacostia	Infilt.-Tr.	0.22	SF	3/90
I-23	Hollywood On the Hill	CSD89014	04-C10	Anacostia	Infilt.-Tr.	0.30	Comm.	11/89
I-24	Indian Creek Village	SD86039	04-G6	Anacostia	Infilt.-Tr. (4)	1.60 1.60 1.60	TH	7/90
I-25	Indian Queen South	SD86089	24-K4	Potomac	Infilt.-Tr. (2)	1.53 0.58	SF	10/88

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Table I. Prince George's County BMP Evaluation Site List

BMP SITE NO.	NAME	P.G. CO. CSD/SD NO.	LOCATION (P.G. Co. Grid No.)	WATERSHED	BMP TYPE	D.A. TO BMP (AC.)	LAND USE	MO./YEAR CONSTRUCTED
I-26	Jiffy Lube	SD87419	04-D7	Anacostia	Infilt.-Tr.	0.41		
I-27	Kettering	SD86041	15-H5	Patuxent	Infilt.-Tr.	0.60	Comm.	6/88
I-28	Lands of Joseph Nazario	SD87082	09-B12	Anacostia	Infilt.-Tr.	5.00	TH	5/88
I-29	Marinucci Tract	SD87326	04-G3	Anacostia	Infilt.-Ba. (3)	1.48	Comm.	6/88
						2.07	Comm.	12/88
						1.38		
I-30	Marlboro Pike Shop. Ctr.	SD87259	14-B9	Anacostia	Infilt.-Tr. (3)	1.66		
						0.75	Comm.	6/89
						0.25		
						1.27		
I-31	Marlborough Towne Comm.	SD87020	22-J6	Patuxent	Oil/Grit (2)	-		
					Infilt.-Tr. (3)	1.00	Comm.	10/88
						1.70		
						0.60		
					Oil/Grit (3)	1.00		
						1.70		
						0.60		
I-32	Mayfair	SD86068	01-K9	Patuxent	Infilt.-Tr.	5.10	Comm.	5/89
I-33	Oakcrest Plaza	SD87063	02-C9	Patuxent	Infilt.-Ba.	1.82	Comm.	12/87
I-34	Oaklawn Shopping Center	SD88179	25-J1	Potomac	Infilt.-Tr.	1.00	Comm.	6/89
I-35	Oxon Hill Retail Center	CSD88016	25-A1	Potomac	Infilt.-Tr.	0.02	Comm.	10/89
I-36	Pascal Center	SD88151	15-B6	Patuxent	Infilt.-Tr.	1.12	Comm.	9/89
I-37	Pep Boys	CSD88400	14-G12	Potomac	Infilt.-Tr. (2)	0.93	Comm.	1/90
						0.96		
					DP	-		
I-38	Ritchie Station	SD86124	15-C9	Patuxent	Infilt.-Tr.	0.70	Comm.	12/87
I-39	Rivertowne Commons	SD86013	19-D8	Anacostia	Infilt.-Tr.	5.34	Comm.	6/89
					Infilt.-PP (6)	27.5		
*I-40	Riverview Office Building	SD87054	19-D8	Anacostia	Infilt.-Tr. (2)	1.07	Comm.	7/87

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Table 1. Prince George's County BMP Evaluation Site List

BMP SITE NO.	NAME	P.G. CO. CSD/SD NO.	LOCATION (P.G. Co. Grid No.)	WATERSHED	BMP TYPE	D.A. TO BMP (AC.)	LAND USE	NO./YEAR CONSTRUCTED
I-41	Silver Hill Park	SD88276	19-E2	Potomac	Infilt.-Tr.	1.85		
I-42	Sunrise Townhouses	SD88757	19-F9	Potomac	Infilt.-Tr.	0.35	Comm.	5/90
I-43	Tick Tock Plaza	SD87125	08-E2	Anacostia	Infilt.-Ba.	0.32	TH	4/90
					Oil/Grit (2)	3.18	Comm.	9/88
						0.32		
I-44	Virginia Manor Park	CSD85353	01-J10	Anacostia	Infilt.-Tr.	1.10		
I-45	Andrews Auto Village	SD88320	20-H12	Potomac	Infilt.-Tr.	2.44	Ind.	10/88
					Oil/Grit	0.30	Comm.	3/90
I-46	Al's Supermarket	SD86073	19-D8	Potomac	Infilt.-BW.	-		
I-47	Arora Office Building	SD87085	26-G3	Potomac	Infilt.-Tr.	0.41	Comm.	3/86
I-48	Ashwood Center	CSD87586	15-C7	Patuxent	Infilt.-Tr.	0.56	Comm.	8/89
I-49	Beaver Heights Lots 9&10	CSD87242	14-B2	Anacostia	Infilt.-Tr. (3)	1.17	Comm.	3/90
						0.22	Inst.	6/89
						0.02		
I-50	Burgess Comm. District	CSD86515	08-B6	Anacostia	Infilt.-Tr.	0.03		
I-51	Buck Lodge Park	CSD86336	03-H9	Anacostia	Infilt.-Ba.	0.60	Comm.	4/89
I-52	Corridor Office Park	CSD85033	15-G5	Patuxent	Infilt.-Ba.	0.84	Inst.	3/88
I-53	Don Lee Acres	SD85123	26-G6	Potomac	Infilt.-Ba. (2)	4.62	Comm.	11/86
						3.60	SF	11/87
I-54	Cherry Lane Parcel #2	SD85166	02-C9	Patuxent	Infilt.-Ba. (2)	1.00		
						1.73	Comm.	4/87
I-55	Cherry Lane Parcel #6	CSD85109	02-C9	Patuxent	Infilt.-Tr. (2)	3.26		
						1.20	Comm.	9/86
I-56	Cherry Hill Condos	CSD87385	03-E4	Anacostia	Infilt.-Tr.	1.13		
I-57	Greenbelt Lot #6	CSD85110	01-C11	Anacostia	Infilt.-BW.	1.25	Apt.	11/88
I-58	Green Meadows	CSD89527	08-E4	Anacostia	Infilt.-Tr.	0.86	SF	4/87
I-59	Hampton Park Lot #12	SD86158	15-C7	Patuxent	Infilt.-Tr.	0.51	Comm.	8/90
I-60	Highbridge Lot #2	CSD85253	11-E1	Patuxent	Infilt.-BW.	0.93	Comm.	5/87
						0.20	SF	11/85

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Table 1. Prince George's County BMP Evaluation Site List

BMP SITE NO.	NAME	P.G. CO. CSD/SD NO.	LOCATION (P.G. Co. Grid No.)	WATERSHED	BMP TYPE	D.A. TO BMP (AC.)	LAND USE	NO./YEAR CONSTRUCTED
I-61	Highbridge Lot #4	CSD85189	11-E1	Patuxent	Infilt.-DW.	0.22	SF	9/85
I-62	Highbridge Lot #5	CSD85407	11-E1	Patuxent	Infilt.-DW	0.28	SF	6/86
I-63	Melwood Junction Lots 182	CSD85321	21-F11	Potomac	Infilt.-DW. (2)	0.06	SF	6/86
						0.05		
I-64	Panorama Court Lot #7	CSD85184	18-K11	Potomac	Infilt.-DW. (2)	0.03	SF	12/86
						0.03		
I-65	Rollingcrest Comm. Center	CSD85544	08-B5	Anacostia	Infilt.-Be.	2.14	Inst.	10/86
I-66	Woodberry Sq. Lot #1	CSD87322	20-C10	Potomac	Infilt.-Tr.	2.45	Comm.	5/89
I-67	Dontrine Sub. 182	SD85143	06-F12	Patuxent	Infilt.-Be.	9.32	SF	12/90
					WP	17.3		6/89
I-68	Home Acres	CSD89225	04-C4	Anacostia	Infilt.-DW. (4)	0.02	Inst.	1/90
						0.03		
						0.05		
I-69	Marlton Sec. 4	SD87357	28-E2	Patuxent	Infilt.-Tr. (2)	0.05		
						0.40	TH	5/90
I-70	Price Club	SD89720	04-E6	Anacostia	Infilt.-Tr. (4)	0.52		
						4.37	Comm.	9/90
						5.70		
						3.21		
I-71	Beltsville Terrace	SD87149	04-B6	Anacostia	Infilt.-Tr.	0.02		
I-72	Fellowship Church	CSD86787	27-A4	Potomac	Infilt.-Tr. (2)	0.43	Comm.	8/90
						0.38	Inst.	9/88
						0.33		
I-73	Largo Centre	CSD85033	15-E5	Patuxent	BP Infilt.-Be.	3.55		
I-74	Public Storage	CSD86052	15-A6	Patuxent	Infilt.-Be.	1.40	Comm.	11/86
I-75	Ridgley Church of God	CSD86423	15-E13	Patuxent	Infilt.-Tr.	2.88	Comm.	7/88
					ED-Dry	1.38	Inst.	10/90
I-76	J & L Valve Fitting Co.	CSD85112	15-B8	Patuxent	Infilt.-PP.	1.38		
						1.81	Comm.	4/87

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Table 1. Prince George's County BMP Evaluation Site List

BMP SITE NO.	NAME	P.G. CO. CSD/SD NO.	LOCATION (P.G. Co. Grid No.)	WATERSHED	BMP TYPE	D.A. TO BMP (AC.)	LAND USE	NO./YEAR CONSTRUCTED
I-77	Surratt House	CSD86619	26-G2	Potomac	Infilt.-Ba.	1.20	Inst.	10/90
I-78	Laurel Technology Center	CSD84380	01-G7	Patuxent	Infilt.-VF.	2.80	Comm.	8/86
I-79	McDonald's Allentown Road	CSD87228	20-B10	Potomac	Infilt.-VF.	1.25	Comm.	11/88
I-80	Ramblewood Parcel 4	CSD86723	16-B9	Patuxent	Infilt.-VF. (3)	1.37	Inst.	1/90
I-81	Carlson Springs	SD86142	14-K3	Patuxent	Infilt.-Ba.	1.00	Comm.	1/90
I-82	St. Barnabas Comm. Center	SD87039	20-A2	Potomac	Infilt.-Ba.	3.59	Comm.	3/90
G-1	Acme Iron Works Warehouse	SD89568	09-C13	Anacostia	Oil/Grit	0.38	Comm.	2/90
G-2	Auth Road Parcel H-1	SD87333	20-C6	Potomac	Oil/Grit	1.08	Comm.	11/88
G-3	Beltsville Supply	SD87181	04-G4	Anacostia	Oil/Grit	1.00	Comm.	6/90
G-4	Bronco Building	SD87186	04-G4	Anacostia	Oil/Grit	0.62	Comm.	3/90
G-5	Bryan Property	SD87241	04-J1	Anacostia	Oil/Grit	1.32	Comm.	2/89
G-6	Capital Plaza Safeway	SD88032	09-F9	Anacostia	Oil/Grit	2.90	Comm.	12/89
G-7	Clinton Station	SD87202	20-G13	Potomac	Oil/Grit	0.85	Comm.	6/88
G-8	Collington Center	SD87237	17-B7	Patuxent	Oil/Grit (2)	2.30	Comm.	8/88
G-9	Colonial Village Shops	SD87283	11-F4	Patuxent	Oil/Grit	2.10		
G-10	Decatur Heights	SD87491	09-B9	Anacostia	Oil/Grit	1.22	Comm.	6/88
G-11	Ricker Family Partnership	SD88040	05-H13	Patuxent	Oil/Grit	0.80	Comm.	6/90
G-12	Clinton View Section 2	SD87076	26-B3	Potomac	Oil/Grit	0.30	Ind.	11/88
G-13	Collington Center	SD88307	17-B7	Patuxent	Oil/Grit	11.3	SF	11/89
G-14	Dewes Property	SD87523	01-E8	Anacostia	Oil/Grit	3.72	Comm.	1/90
G-15	Exxon-Powder Mill Rd.	SD87474	04-F5	Anacostia	Oil/Grit	0.42	Comm.	6/90
G-16	Glen Dale Plaza	CSD88014	10-H1	Patuxent	Oil/Grit	0.48	Comm.	3/90
G-17	Hollo Track	SD88003	10-E5	Patuxent	Oil/Grit	0.52	Comm.	5/89
G-18	Inglewood Business Center	CSD88054	15-D1	Patuxent	Oil/Grit (4)	-	Ind.	-
						0.81	Comm.	10/90
						0.77		
						0.31		
						0.51		

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Table 1. Prince George's County BMP Evaluation Site List

BMP SITE NO.	NAME	P.G. CO. CSD/SD NO.	LOCATION (P.G. Co. Grid No.)	WATERSHED	BMP TYPE	D.A. TO BMP (AC.)	LAND USE	NO./YEAR CONSTRUCTED
G-19	Kentucky Fried Chicken	SD89026	09-K7	Anacostia	Oil/Grit	0.46	Comm.	7/90
G-20	Lanham Mini Storage	SD89006	10-C10	Anacostia	Oil/Grit	0.55	Comm.	8/90
G-21	McDonald's-Clinton Square	SD88069	20-G12	Potomac	Oil/Grit	-	Comm.	5/90
G-22	McDonald's-St. Barnabas	SD87424	19-G7	Anacostia	Oil/Grit	1.10	Comm.	4/90
G-23	McDonald's-Hillcrest Hts.	SD87325	19-J1	Anacostia	Oil/Grit	0.70	Comm.	-
G-24	MD 50 Ind. Park Lot 84	SD86196	14-F1	Anacostia	Oil/Grit (2)	1.80	Ind.	2/90
G-25	MD 95 Corp. Ctr. Lots 487	SD88263	05-H13	Patuxent	Oil/Grit (2)	1.40 1.47	Comm.	2/90
G-26	Metro Business Center .	SD87199	10-G7	Patuxent	Oil/Grit (2)	2.09 0.42	Comm.	6/88
G-27	Northampton Bus. Park	CSD88078	15-F5	Patuxent	Oil/Grit (3)	2.21 0.74 0.55	Comm.	9/89
G-28	Oxon Hill Subdivision	SD88158	19-C8	Potomac	Oil/Grit	-		
G-29	Patuxent Place	SD87098	02-B5	Patuxent	Oil/Grit (2)	0.60 0.78	SF Comm.	6/90 1/90
G-30	Washington Bus. Park	SD87114	10-G7	Patuxent	Oil/Grit	2.50 5.24	Comm.	7/88
G-31	Burgess Add. to Marlboro	CSD88777	22-J9	Patuxent	Oil/Grit	1.82	Comm.	5/89
G-32	Cabin Branch Ind. Center	CSD89012	09-F13	Anacostia	Oil/Grit	-	Ind.	3/89
G-33	Exxon-Riggs Road	SD86119	08-E4	Anacostia	Oil/Grit	0.59	Comm.	1/90
G-34	Hardees-Capital Heights	CSD89027	15-C6	Patuxent	Oil/Grit	0.79	Comm.	7/89
G-35	P.G. Int'l Comm. Center	CSD88249	17-B6	Patuxent	Oil/Grit (2)	0.38 0.50	Comm.	6/89
G-36	Precision Tune	CSD88020	04-E6	Anacostia	Oil/Grit	0.41	Comm.	6/89
G-37	Police Services Complex	CSD88750	14-K1	Anacostia	Oil/Grit (2)	0.70 1.10	Inst.	4/90
G-38	Three Brothers Center	CSD88230	09-B9	Anacostia	Oil/Grit	1.92	Ind.	5/90
G-39	TSA Property	CSD88226	10-A13	Anacostia	Oil/Grit	0.64	Comm.	3/90

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Table 1. Prince George's County BMP Evaluation Site List

BMP SITE NO.	NAME	P.G. CO. CSD/SD NO.	LOCATION (P.G. Co. Grid No.)	WATERSHED	BMP TYPE	D.A. TO BMP (AC.)	LAND USE	MO./YEAR CONSTRUCTED
G-40	Kenilworth Park Med. Ctr.	SD89056	09-D5	Anacostia	Oil/Grit	0.25	Comm.	12/90
G-41	Addison Heights	CSD87368	14-G6	Anacostia	Oil/Grit	0.75	Comm.	5/90
G-42	Ardwick Ind. District	CSD85162	10-A9	Anacostia	Oil/Grit (2)	2.50 2.70	Comm.	5/87
G-43	Autoville Block E	CSD85403	04-B9	Anacostia	Oil/Grit	1.40	Comm.	7/86
G-44	Children's Palace	CSD89212	14-J13	Anacostia	Oil/Grit (2)	0.85 0.57	Comm.	11/89
G-45	Church of N. Brentwood	CSD86618	08-J9	Anacostia	Oil/Grit	2.60	Inst.	9/87
G-46	Collington Center	CSD86412	17-B7	Patuxent	Oil/Grit (2)	-	Comm.	1/89
G-47	Duley Property	CSD89377	22-B12	Patuxent	Oil/Grit	1.20	Comm.	8/90
G-48	Duvall Amoco	CSD89201	22-C12	Patuxent	Oil/Grit	1.27	Comm.	4/89
G-49	Exxon-Central Ave.	CSD89094	15-D6	Patuxent	Oil/Grit	0.34	Comm.	9/90
G-50	Forrestville Comm. Center	CSD89504	21-A1	Patuxent	Oil/Grit	0.33	Comm.	6/90
G-51	Kent Village Shopping Ctr	CSD86824	09-J12	Anacostia	Oil/Grit	2.42	Comm.	2/89
G-52	Landover Baptist Church	CSD87269	10-A12	Anacostia	Oil/Grit	2.61	Inst.	7/89
G-53	McDonald's-Central Ave.	CSD87336	15-C6	Patuxent	Oil/Grit	1.22	Comm.	4/89
G-54	MD 50 Industrial Park	CSD86323	14-G1	Anacostia	Oil/Grit	32.2	Ind.	9/88
G-55	Open Material Storage	CSD88246	09-K10	Anacostia	Oil/Grit	0.32	Ind.	10/90
G-56	Silver Hill Mixed Use	SD89156	20-A1	-	Oil/Grit (2)	1.21 2.22	Comm.	8/90
G-57	Southern MD Med. Center	SD87014	26-K5	Potomac	Oil/Grit (2)	-	Comm.	1/87
G-58	TNW Joint Venture	SD87320	20-A5	Potomac	Oil/Grit	-	Comm.	9/90
G-59	Tuxedo Ind. Park	CSD85172	14-C1	Anacostia	Oil/Grit (3)	-	Comm.	8/88
*R-1	Capitol College Student	CSD88318	05-D3	Anacostia	WP	15.7	Inst.	4/89
R-2	Clinton View	SD86043	26-C2	Potomac	WP	12.1	SF	6/88
R-3	Albert W. Courtney Prop.	CSD87382	19-C11	Potomac	ED - AM	1.13	Comm.	11/89
R-4	Apter Subdivision	SD85065	15-D9	Patuxent	WP	9.10	Ind.	6/88
R-5	Cabin Branch Ind. Center	CSD85190	09-F13	Anacostia	WP	0.92	Ind.	4/88

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Table 1. Prince George's County BMP Evaluation Site List

BMP SITE NO.	NAME	P.G. CO. CSD/SD NO.	LOCATION (P.G. Co. Grid No.)	WATERSHED	BMP TYPE	D.A. TO BMP (AC.)	LAND USE	NO./YEAR CONSTRUCTED
R-6	Center Park	SD87300	04-A6	Anacostia	WP	24.5	Comm.	11/88
R-7	Collington Life Care Comm	SD86002	10-H13	Patuxent	WP	236	TH	8/90
					Infilt.-Ba.	?		
R-8	Hampton Park Lot #9	CSD85503	15-B7	Patuxent	AM	0.57	Comm.	6/89
R-9	Landover Metro Mini Ster.	CSD88057	09-H11	Anacostia	AM	2.80	Comm.	1/90
R-10	Manor Farm Lot #3	CSD86035	15-B5	Patuxent	AM	4.50	Comm.	11/88
					Oil/Grit	0.48		
*R-11	Marietta Woods	SD79082	10-G2	Patuxent	WP	-	SF	11/86
R-12	Penn Station Shopping Ctr	SD88092	14-E12	Anacostia	WP	28.6	Comm.	11/89
*R-13	Procter Commercial Par 1	SD87144	20-K12	Potomac	WP	7.50	Comm.	8/89
R-14	Racquet Towers	SD87134	03-F10	Anacostia	AM	2.82	Apt.	8/89
R-15	Largo Park Ex. Office	SD87053	15-F2	Patuxent	AM- WP	22.3	Comm.	6/89
R-16	Stanallen Estates Par. J	SD86087	02-F13	Patuxent	ED - AM	9.30	Comm.	7/89
*R-17	Susse Chalet	SD86009	19-B8	Anacostia	AM	1.70	Comm.	12/87
*R-18	Tantallon Square	SD84068	25-B10	Potomac	AM	12.7	SF	7/87
*R-19	Salvation Army	CSD89320	09-B11	Anacostia	WP	3.97	Inst.	1/91
E-1	Ballows Property	SD86165	20-B5	Potomac	ED - Dry	21.6	Comm.	10/87
E-2	Cherry Hill	SD87248	03-J5	Anacostia	ED - Dry	19.7	SF	4/90
E-3	Dan Lee by the Park	SD87203	26-F7	Potomac	ED - Dry	32.2	SF	7/90
E-4	Doctor's Hospital	CSD87358	10-B2	Anacostia	ED - Dry	1.62	Inst.	3/89
E-5	London Woods	SD87214	14-F9	Anacostia	ED - Dry	7.30	SF	4/89
E-6	Lowe's of Boule	CSD87441	17-D3	Patuxent	ED - Dry	11.0	Comm.	12/88
E-7	Mt. Calvary Church	CSD84132	10-C8	Anacostia	ED - Dry	12.0	Inst.	5/88
E-8	North Hampton Parcel J	SD87103	15-F6	Patuxent	ED - Dry	24.6	Comm.	2/89
*E-9	Oaklyn Parcel A Blk F	SD85131	09-E10	Anacostia	ED - Dry	8.00	Comm.	10/88
E-10	Seabrook	CSD84296	10-F3	Patuxent	ED - Dry	8.40	Comm.	11/89
E-11	Washington Bus. Park	SD86088	10-G6	Patuxent	ED - Dry (2)	8.80	Comm.	5/88
						3.30		

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Table 1. Prince George's County BMP Evaluation Site List

BMP SITE NO.	NAME	P.G. CO. CSD/SD NO.	LOCATION (P.G. Co. Grid No.)	WATERSHED	BMP TYPE	D.A. TO BMP (AC.)	LAND USE	NO./YEAR CONSTRUCTED
E-12	Inglewood Business Center	SD86040	15-E2	Patuxent	ED - Dry	329	Comm.	1/88
E-13	Largo Park	SD86046	15-F3	Patuxent	ED - Dry	37.9	Comm.	9/87
E-14	Indian Creek SWMF 283		04-G1	Anacostia	ED - Dry (2)	1164		
						1011	?	?
*D-1	Branch Ave. Plaza	CSD84350	20-E7	Potomac	DP	19.1	Inst.	12/88
D-2	Brandywine Country	SD83022	28-C4	Patuxent	DP	FC	SF	11/89
D-3								
*D-4	Cherryvale	SD87128	03-K5	Anacostia	DP	109	SF	9/89
D-5	Deerpond	SD85015	20-E7	Potomac	DP	3.34	Comm.	8/87
D-6	Hardees-Beltsville	CSD84362	04-E6	Anacostia	DP	0.96	Comm.	10/85
D-7	KFC	CSD86114	19-E8	Potomac	AN	0.88	Comm.	4/88
D-8	Marlow Heights Ind. Park	SD87250	20-A5	Potomac	AN	4.19	Ind.	2/89
D-9	MD Corporate Center	SD86191	05-H13	Patuxent	DP	69.3	Ind.	8/88
D-10	Newport Towne	SD86012	03-J4	Anacostia	DP	22.1	TH	9/87
D-11	Parcel D Add. to Pleasant	CSD84346	14-G6	Anacostia &	DP	12.5	Comm.	7/87
D-12	Princess Garden Center	CSD86092	10-B5	Anacostia	DP	4.97	Inst.	11/88
D-13	Public Storage	SD88368	21-A2	Potomac	DP	3.78	Comm.	6/90
D-14	Sebert H. Keiffer	CSD85086	20-B10	Potomac	DP	2.88	Comm.	6/89
D-15	Solid Rock Church	CSD87343	09-B4	Anacostia	DP	2.96	Inst.	10/89
*D-16	Fort Washington Pro. Park	SD86169	25-C8	Potomac	DP	0.58	Comm.	2/87
D-17	UPS Dist. Facility	SD80082	01-G7	Patuxent	DP (3)	20.8	Comm.	?
						34.4		
						26.6		

Key Abbreviations:

Infilt.-Tr.: Infiltration trench
Infilt.-Ba.: Infiltration basin

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Table 1. Prince George's County BMP Evaluation Site List

BMP SITE NO.	NAME	P.G. CO. CSD/SD NO.	LOCATION (P.G. Co. Grid No.)	WATERSHED	BMP TYPE	D.A. TO BMP (AC.)	LAND USE	NO./YEAR CONSTRUCTED

Infilt.-PP.: porous pavement
Infilt.-DW.: dry well
Infilt.-VF.: vegetative filter
Oil/Grit: oil/grit separator
ED-Dry: extended detention dry pond
ED-Wet: extended detention wet pond
ED-AM: extended detention artificial wetland
WP: wet pond
AM: artificial marsh
DP: dry pond

SF: single family residential
TH: townhouse
Comm.: commercial
Ind.: industrial
Inst.: institutional

*: file on hold; lacks information on storage volumes and design release
FC: field check

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Appendix B:

I. Relative Index System

   A. Floatables and Oily Residual Material

   B. Substrate Fouling

   C. Aquatic/Wildlife Habitat

II. BMP Field Survey Forms - Example Copies

III. Field Protocol for Oil/Grit Separators and Infiltration Trench Sump Pits

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A. Floatables and Oily Residual Material Indices

A qualitative index measuring system, based on visual estimates of both the amount of floatable materials (plastic cups, wrappers, etc) and oil-in-sediment present in both oil/grit separators and infiltration sump pits, was used to standardize field observations. The indices featured a 1-5 descriptive scale system. General observed field conditions and corresponding index values are described below.

I. Floatables

Percent of Permanent Pool Area Covered	Verbal Description	Point Value
0-5	None	1.0
6-20	Very Light	2.0
21-35	Light	3.0
36-50	Moderate	4.0
≥51	Heavy	5.0

II. Oil-in-Sediment

Residual Material Characteristics	Verbal Description	Point Value
• No oily discharge, no oily smell, does not leave oil stain on hands	None	1.0
• Very light oily discharge, little odor, generally does not stain	Very Light	2.0
• Light oily discharge when disturbed, faint oily odor, generally stains	Light	3.0
• Moderate oily discharge (oozes out freely), distinct odor, stains	Moderate	4.0
• Heavy oily discharge (free-flowing), very strong odor, stains	Heavy	5.0

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B. **Substrate Fouling**

In order to qualitatively assess organic carbon, nutrient and sediment loadings, COG staff visually examined the stream substrate for evidence of the following: a.) patinas of silt/fine organic material and/or algal growth on the surface of stones and b.) slime coatings on the underside of stones. The stream assessment protocol employed in the study involved the inspection of 10 rocks (large gravel or larger sized material) per riffle. In general, three or more riffles were examined per BMP/receiving stream site.

A relative substrate fouling index based on a 1-5 descriptive scale was employed. Under this system, the 10 stones were composited into one sample so that a single riffle score could be assigned. Scoring was determined as follows:

Approximate % of Underside Surface Area 'Fouled'	Verbal Description	Point Value
0-5	None	1.0
6-15	Very Light	2.0
16-25	Light	3.0
26-50	Moderate	4.0
≥ 51	Heavy	5.0

Individual riffle scores were later averaged to produce one receiving stream substrate fouling score per BMP site.

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C. Aquatic/Wildlife Habitat

A relative aquatic/wildlife habitat index system, which was based on a descriptive scale of 1-3, was employed in the study. As previously stated, under this system a value of one represented a low habitat value condition and a value of three indicated excellent site conditions. Factors used in assessing existing habitat conditions included, but were not limited to, the following:

- size of BMP site/pond area;
- extent of human presence and traffic (e.g., - proximity to roads; mowed areas, houses, etc.);
- size of water body/water source and amount of open water;
- type, size and age of surrounding forested area;
- water depth distribution;
- percent of pond bottom area supporting submerged aquatic vegetation (SAV) and emergent aquatic plants;
- observed vegetational community diversity, quality and quantity;
- presence or absence of downed trees, snags or other habitat features;
- water quality conditions; and
- observed faunal diversity

In general, the highest habitat scores were associated with older, large BMP pond sites which featured: surrounding mature deciduous forest; a large permanent pool size; near equal distribution between shallow water, mid-depth and deep water areas; 10-50% SAV coverage; large no-mow zones around the pond perimeter; and were physically connected to a larger, natural riparian corridor area.

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Appendix B

Example of
BMP Evaluation Forms

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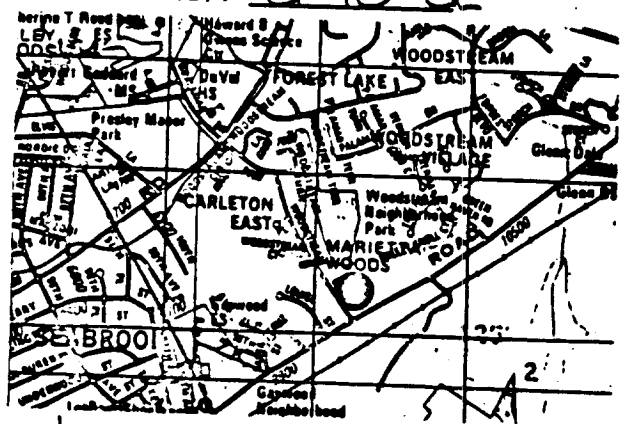
Prince George's County
Stormwater Management BMP Evaluation Survey

1. BMP Site Name: Marietta Woods
   ~~C&D~~/SD#: 79082
2. Watershed: Patuxent River
   Subwatershed: Folly Branch
3. MDE Water Use Class: Class I
4. Location (PG Grid Coordinates): G:10-G2
   Vicinity Map:



5. BMP Type: Retention Pond (Wet Pond) water quality & quantity control
6. Design Features: (A) Sediment Forebay (B. Approx. dim. 480' x 80'
   (C. Design storm: 2 10 yr (D. 42" RCP control struct.)
   (E. Aquatic Bench, 5' wide)
7. Year Constructed: 11/20/86 ABL
8. Ownership: Northridge Limited Partnership
9. Maintenance Responsibility: Public
10. Date Inspected: 9/11/91 AMC
11. Are "As Built" Plans Available: Yes X No ___
12. Site Area: 48 acres D.A. to BMP: 172.1 acres
13. Land Use(s): Residential
14. Imperviousness: 28.0 % _____ RCN _____ 'C'

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Sheet B

15. On-Site Soil Type(s): CfC : Christiana Urban Land Complex
Depth to water table: N.A.

16. Rain Conditions During The Preceding 72 Hours: None

17. Type of Pre-Treatment Provided: None.

18. Is An Observation Well Present?: Yes ___ No ✓
Observation Well Examination Performed?: Yes ___ No ___

Evaluation Criteria

Is There Evidence of:

19. Inapproriate Ponding of Water? Yes ___ No ✓

20. Slow Infiltration? Yes ___ No ✓

21. Incorrect Water Flow Patterns? Yes ___ No ✓

22. Clogging? Yes ___ No ✓

23. Excessive Sediment/Debris? Yes ___ No ✓

24. Water Bypassing Facility? Yes ___ No ✓

25. Erosion at Intake/Outfall? Yes ___ No ✓

26. Type of Conveyance System? 1.) Two 15" RCP's
Condition: 2.) 24" RCP, 3.) 42" RCP with good backup
All in V. good condition.

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27. Structural Failures/Repairs Needed? Yes ___ No ✓

28. Design Shortcomings? 1) No trash rack on control structure, 2) No pond drain; 3.) No. ED control

29. Maintenance Needed? None

BMP Performance Summary

Is The BMP Working as Designed? Yes ✓ No ___

Is The BMP Providing Water Quality/Quantity Benefits? Yes ✓ No ___

30. Comments: 1) Trash line extends approx. 1 ft above the normal pool elev.. Amount of trash/debris present - light

Sketch:

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Receiving Stream Condition

31. Drainage Area 172.1 acres Stream Gradient N1.0 %

32. Estimated Stream Flow 1) upstream - approx. 0.25 cfs 2) downstream - 0.4 cfs

33. Average Stream Channel Width/Depth:
Upstream 6'-0" / 2'-0" ft Downstream 8'-6" / 1'-0" ft

Wetted Perimeter:
Upstream 5'0" / 4" ft Downstream 8'-6" / 7" ft

34. General Channel Stability: 1) Upstream - stable. Vegetation growing down to water line. 2) Downstream - stable.

35. General Substrate Composition (%)
Upstream: Boulder ____ Rubble 5'0 Cobble 5% Clay ~~Gravel~~ 10%
Gravel 20% Sand 60% Silt ____ Other ____
Downstream: Gravel - 7.5%, Cobble - 17%, Sand - 12%, Silt - 5%

36. Degree of Embeddedness/Sediment Load: 1) Upstream: High amount of embedding and transport of sand. Approx. 0.5" of sand deposits along ~~toes~~ banks.
2) Downstream - low embedding, low sediment transport

37. Degree of Substrate "Fouling": 1) Upstream - high. Rocks & wood coated w/brown, floc-type material; 2) Downstream - mod.-low fouling.

38. General Aquatic/Riparian Habitat Condition(s):
1) Upstream - fair. Stream has few riffles, mostly series of pools & runs. Several pools over 2' deep. Stream has high sand load
2) Downstream - good. Stable banks w/veg. growing down to water. Good balance ~~between~~ pools and riffles. One pool approx. 2' deep.

39. Miscellaneous: 1) Observed no fish or crayfish upstream (only frogs).
2) Observed fish immediately downstream of 12" barrels.

40. Preliminary Stream Quality Rating: 1) Upstream - Fair. Macroinvert. diversity is relatively depauperate, water quality appears to be in fair range.
2) Downstream - good. Macroinvert. diversity is fairly good, water quality better than upstream.

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K-11 Marietta Woods

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Prince George's County
Pond Data Addendum Sheet

41. Pond Surface Area: 0.88 ~~approx.~~ acres

Vol. of Storage ac-ft	Vol. of Storage d.a.-in	Water Surface Elev. ft.	Design Release cfs	
		128.75		nor. pool
		132.17		2-yr
		134.95		10-yr
		136.75		100-yr
—		—	—	ext. det.

No comps

Normal Pool Depth (ft): 6.75' maximum ✓ field 4' approx. mean Pond bottom 122.00

Principal Spillway: Twin 42" RCP's (one @ 2.86%, one @ 0.92%)

Emergency Spillway: None.

Pond Side Slopes: 3:1 above aquatic Bench, 2:1 below bench

Type of Trash Rack Present: None. Twin 42" RCP's are clean (somewhat protected by emergent vegetation growing in front of structure

Maintenance/Safety Bench Present?: Yes X No
Defacto bench present along north side of pond. Access to pond is very good

Number, Type and Size of Control Openings: 1.) 42" RCP's (2x)

Type of Pond Drain Present: None

Aquatic Bench Present?: X Yes ___ No
5' wide bench w/ 4:1 slope @ elev. 127.50

Is Pond Fenced?: ___ Yes ✓ No

Type, Location and Amount of Aquatic/Wetland Vegetation Present:
1.) Emergent vegetation — Common three square (70%), Cattails (10%), Spatterdock (20%)

R0055228

Algal mat – cover: approx. 5% of water surface

Soft stem bulrush (1 < %), spike rush (< 1%). Approx. 90% of pond is open water.
2) Woody veg. – black willows, alders, river birch, red maple
3.) Submerged – milfoil (light amount) approx 15%
4.) Misc. – light amount of duckweed, extensive amount of grasses growing along pond margin.

Type of Landscaping Present: None.

Wetland/Wildlife Habitat Value: High. 1) Pond supports extensive fringe marsh; area adjacent to pond is mix of wild meadow and hardwood forest (approx. 30 yrs old). Extensive mature forest/stream valley present upstream and downstream of pond. 2) Observed spotted turtles, painted turtles, numerous frogs, sunfish, Little green herons, 3) Pond used for recreational fishing

Photographic Description:

Photograph #	35	: long view of pond from sed. forebay area
Photograph #	36, 37	: control structure (2x)
Photograph #	1	: Pond from Rte 564
Photograph #	2	: pond outfall – Twin 42" RCP's

1040 hrs
1450 hrs

Miscellaneous: 1) Pond: TDS = 100 mg/L, Air = 31 °C, H_2O = 24 °C, Secchi = 71 cm (28"), pond is slightly turbid, DO = 8.0 mg/L, pH = 7.0, Alkalinity = 55 mg/L ($CaCO_3$), CO_2 = 58 mg/L
2) Upstream: TDS = 140 mg/L, Air = 29 °C, H_2O = 19 °C
3.) Downstream: TDS = 110 mg/L, Air = 27 °C, H_2O = 24 °C

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R-11 Marietta Woods (Wet Pond)



Pond View From Lanham-Severn Rd. (Md. 564). Looking Upstream.



Twin 42" RCP Barrels (Downstream View).

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R0055230

VOL 12 2 1991

Oil/Grit Separator Survey Sheet

Date: 05/13/91 County PRINCE GEORGE'S

Site/Location: DECATUR HEIGHTS (SEVEN-ELEVEN) / Page 9-B9

Structure No.: 2 System No.: SD #87491 Site No. G10

General type: Pre-cast _____ Poured-In place X Other _____

Type of System: Off-Line: _____ Terminal: _____ On-Line: X

Number of Chambers Present: 3

Freeboard Clearance and Volume:
Freeboard Clearance (in) N/A INTERIOR WALLS TO TOP SLAB.

Freeboard Volume:
N/A 1st Chamber N/A 2nd Chamber

Total Freeboard Volume N/A.

Number Size and Type of Weir Wall Ports shown on As-Builts:
2 TOTAL 8" ϕ PVC (AREA = 0.70 ft²) 1st-2nd Chamber Weir Wall

N/A 2nd-3rd Chamber Weir Wall

Type of Trash Rack Present: PERFORATED TRASH RACK (ACCMP) ½ PIPE.

Inverted Elbow Used in "Oil" Chamber: Yes X No _____

Size and Type of Elbow: 15" ϕ CMP. (AREA = 1.23 ft²)

Quantity and Type of Floatables Present:
(none, very light, light, moderate, or heavy).

1st Chamber Moderate, Soda Cups & Cans, paper, bottles
6" Oil Stain all round sides walls.

2nd Chamber None. 12" Stain all round walls

3rd Chamber None.

Presence of Undisturbed Oil Sheen: (yes or no).
YES 1st Ch. YES 2nd Ch. YES 3rd Ch.

Secchi Depth (in): 10 cm 1st Ch. 45 cm 2nd Ch. N/A 3rd Ch.

R0055231

Chamber Characteristics:

Length ft	Width ft	Depth (ft) Plan	Depth (ft) Field	Volume (DEAD STORAGE) ft3	
10	3	4.53	4'-7"	135.9	1st Chamber
6	3	4.53	4'-7"	81.54	2nd Chamber
4	3	0'-0"	0'-0"		3rd Chamber

1ST CH. = 105.60ft³ 2ND CH. = 63.36ft³ ⇒ 168.96ft³ Total Design Volume ft3 (ACTIVE STORAGE)

Evidence of Leaking Joints or other Water Holding Problem(s):

Yes_____ No X

Avg. Depth (in), Approx. % of Sediments, (fine/coarse) and Organics (plant material, oil, associated odor):

1st Chamber 2", 3", 6", 2" Avg = 3.25"; 80% coarse, 20% organic and some oil (heavy) strong odor.

2nd Chamber ¼", ½", ¼", ¼ Avg = ½"; 75% fine sandy material. 25% organic, strong odor. Moderate oil presence.

3rd Chamber N/A

Photographic Description:

Photo# 8 — Overall view from across street with John standing up

Photo# 9 — 1st Chamber

Photo# 10 — 2nd Chamber

Photo# 11 — 3rd Chamber.

R0055232

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Field Protocol For Oil/Grit Separators

1. Remove manhole covers and visually inspect for: a.)presence of oil sheen, b.)type and quantity of floatable materials present, and c.)height(in.) and quantity of oil coatings on side walls.

2. Verify: a.) type of trash rack and b.)diameter (in.) and type of elbow(s) present.

3. Measure Secchi Depth(in.) in both grit and oil chambers.

4. Measure depth(ft.) of permanent pool in both grit and oil chambers.

5. Determine average depth(in.) of sediment in both grit and oil chambers (avg. of 4 measurements per chamber).

6. Take 5 sediment "scoop" samples per chamber to form two composite samples (one composite sample per water holding chamber). Categorize residual material present in samples as to percent coarse grain, fine grain, and organic material. Qualitatively describe color, odor and amount of oil present.

7. Visually inspect condition of storm drain structure(s) draining to the oil/grit separator. Record presence or absence of blockages, flow by-pass/short-circuiting, andoverall operating condition of the system.

8. Take 2-4 photos per oil/grit separator and record photo no. and description on data sheet.

9. Replace manhole covers.

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R0055233

FIELD PROTOCOL FOR INFILTRATION TRENCH SYSTEMS WITH PRE-TREATMENT SUMP PITS/O-G SEPARATORS

1.) Remove manhole covers and observation well cap(s).

2.) Measure depth of standing water (in.) present in bottom of observation well(s). Calculate average depth (in.). If water is present, take sample from both well(s) and sump pit and qualitatively determine water clarity.

3.) Inspect sump pit for: a.) presence of oil sheen, b.) type and quantity of floatable materials present, and c.) height (in.) and quantity of oil coatings on side walls.

4.) Measure secchi depth (in.) in sump pit.

5.) Measure depth (ft.) of permanent pool in sump pit.

6.) Determine average depth (in.) of sediment in sump pit (avg. of 4 measurements per chamber).

7.) Take 5 sediment "scoop" samples from sump pit to form one composite sample. Categorize residual material present in sample as to percent fine grain, coarse grain and organic material.

8.) Replace manhole covers and observation well cap(s).

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R0055234

Appendix C:

Synopsis of Current Prince George's County SWM Design Criteria

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R0055235

I. Priority of Water Quality Measures to be Utilized

Where water quality measures are to be implemented onsite, the order of preference shall be as follows:

a) Infiltration practices
b) Retention facilities
c) Extended detention facilities
d) Oil/grit separators (commercial/industrial sites only) 200 cf/acre of impervious area.
e) A combination of other measures (i.e. tree preservation, grass swales, level spreaders, vegetated filter strips, check dams, etc...)

The concept approval letter requires the utilization of one of the measures listed above unless site constraints prove the measure infeasible, then generally the next measure down on the list must be selected and a revised concept approval must be obtained. If the quality measures required by the Concept letter cannot be implemented a revised concept approval must be obtained.

Infiltration Planning Considerations

Infiltration practices shall be designed for the 1/2" of runnoff from impervious surfaces, including rooftops. Infiltration practices may be waived if the conditions exist:

a) Soils are determined to have infiltration rates less than 0.5 inches per hour based on actual soils data boring. (Refer to Appendix 3-3 for Suitable Soils Listing and Appendix 3-4 for Unsuitable Soils Listing as a general guide.)

b) The area is determined to have a high water table (including seasonally high water tables). The minimum depth to the water table is 2 feet from the infiltration bed.

c) The site is located upgrade of and in close proximity to an unstable soils stratum, such as Marlboro Clay. (Refer to the Prince George's County map book delineation for Marlboro Clay outcrops and refer to Appendix 4-4).

d) The site is on existing slopes of 20% or greater.

Soil borings may be required in cases where a determination of infiltration feasibility is critical, e.g. where the development as proposed offers little opportunity for alternative water quality practices. Otherwise, available soils/water table data may be used at the concept approval stage.

In those cases where infiltration is determined to be infeasible, retention of the first 1/2 inch of runoff from the impervious area shall be considered.

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II. General Guidelines for Water Quality Control

a) For Public facility measures:

- Retention (wet basins) - The perranent pool storage will be sized to hold 1/2 inch of runoff for all impervious areas within the area of development. For regional facilities, ultimate development of the total drainage area according to zoning maps shall be used. For all basins an additional 1-foot depth shall be provided for sedimentation.

- Extended Detention - The one-year 24-hour frequency storm will be detained temporarily for an additional 12 hours. This interval shall be measured by determining the time interval between the time of mass inflow centroid and the time of the mass outflow centroid. The extended detention volume may not be incorporated within the 2-year pool volume requirement.

- The most preferred extended detention design includes a shallow permanent pool. By designing a facility with a permanent pool, the pollutant removal is enhanced by allowing greater settling time. Settling column experiments have shown that suspended sediments will settle 70% within 6 hours under testing conditions (based on data presented in the "Controlling Urban Runoff" by C.O.G., 1986). Twelve (12) hours was selected to allow for less than ideal conditions as well as for capturing additional settling quantities.

- In order to ensure the expected settling, the design of the facility should be such that the flow length from the inflow point to the discharge point is maximized.

The release opening shall be no smaller than a 2-inch diameter orifice. The orifice must be protected by a trash rack or hood which is capable of preventing the orifice from blocking. Generally, a low flow-pipe discharging to the riser structure protected by a gravel blanket and slotted standpipe is sufficient. The preferred designs acceptable in Prince George's County are shown in detail in C.O.G.'s "Controlling Urban Runoff Manual, July, 1987.

b) Private On-Site and Off-Site Facility Measures:

- Retention Systems (Wet Basins) - These facilities will store the first 1/2 inch of runoff for the impervious area of the site. Underground storage retention is not permitted.

- Extended Detention - These facilities will store 1/2 inch of runoff for the impervious area of the site and release this volume over a period of 24-hours. The detention time may be reduced to 10 hours for a drainage area less than the following:

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Type	Approximate % of Imperviousness	Acreage
Low Density Residential (RE, RR, R80, R55)	20	50
Med Density Residential (R35, RT, R20, R30, R18)	50	20
High Density Residential (R-H, R10, R-10A), and Industrial (I1, I2, I3, I4)	80	10
Commercial (C1, CO, CA, CC, CG, etc.)	90	10

Other developments not listed may reduce the detention time to 10 hours when the total volume of 1/2 inch of runoff for the impervious area is less than 18,000 cubic feet.

III. General Design Considerations

a) Riser structures must be reinforced concrete (Appendix 4-24 E). Outfall pipes must be round, reinforced concrete pipe with rubber gasket joints and anti-seep collars as per ASTM C-361 and SCS MD378 (Appendix 4-27). Outflow pipes require a low concrete cradle within the embankment area. Provide a concrete cradle detail (Appendix4-24 D).

b) Sodded embankment and side slopes are to be 3 feet horizontal to 1 foot vertical maximum (3:1).

c) All dams require a minimum of a 5' deep core trench below the existing ground. Note: Where necessary or as determined by the soils engineer, the core trench may need to be extended to reach suitable material as determined in the MD378.

d) For dry basins passing a continuous stream flow, the vegetated floor is to have a 2 percent minimum slope to direct the flow toward the riser area. A rip-rap pilot channel is to be provided to prevent erosion of the facility. Appropriate vegetation is to be provided along the pilot channel to allow for temperature reduction.

e) Soil boring locations are to be shown on the plan view, profile and cross-section of the center line of dam.

f) If the design includes a permanent pool, a pond drain capable of draining the pond within a 24 hour time period shall be provided.

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g) For all basins, the assumed phreatic line shall be drawn at a four horizontal to one vertical slope from the intersection of the 10 year W.S.E.L. and the embankment to the invert of the outflow pipe, unless specified (100 year W.S.E.L.) by WPB.

h) Stormwater management riser structure openings shall be protected from clogging by trash racks:

- The dimensions of the trash rack openings shall be no larger than three-quarters the dimension of the opening to be protected. The minimum dimension will be not less than 6 inches unless otherwise directed by WPB.

- The trash rack on the primary outflow shall have 6 times the cross-sectional area of the outflow protected opening. Computations must indicate that the criteria is met.

- Vertical bars shall be located outside of horizontal bars and spaced 9 inches maximum on center.

- The trash rack shall project out a minimum of 6" from the riser wall.

- The reinforcing bars used in the fabrication of a trash rack shall be sized according to the design. However, in no case bars less than 1/2" (#4) shall be utilized. All trash racks shall be painted with battleship gray paint to prevent corrosion.

i) For basins with permanent pools, provide a hood or inverted elbow over the orifice opening to prevent oils and other floatable objects from leaving the pond. The hood should extend at least 12 inches below the surface of the permanent pool. Be sure that adequate clearance is provided below the inverted elbow to avoid blockage (minimum 1').

j) If it can be incorporated into the design, the elbow or hood should draw from the bottom 1/3 of the permanent pool to provide a cooler discharge and to minimize the effects of thermal pollution.

k) Show all physical improvements and existing conditions. Provide 1' or 2' contour intervals to define surface features.

l) Show all storm drainage inflow and outflow improvements and provide adequate rip-rap protection extending into wet pool areas or into pilot channels in dry pool areas.

m) Provide sections, details and profiles of the SWM embankment, with pertinent supporting information.

n) Risers designs will require structural review if nonstandard design.

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o) Outfall protection shall be based on the 10-year discharge from the facility. The outfall should be protected as per SCS outfall protection charts and rip-rap shall be sized accordingly. (Appendix 4-10)

p) For basins with maintenance benches, all storm drain outfalls must be located beyond the bench and next to the permanent pool W.S.E.L. The bench may be slightly elevated to allow for the pipe crossing with a 1-foot minimum cover for the pipe crossing.

q) The riser/barrel connection shall be water-tight and sealed by using proper water stops.

r) Construction specifications notes should be provided on the stormwater management plan as per Appendix 4-12.

Infiltration Devices

General

Infiltration systems shall be designed in accordance with the current WRA "Standards and Specifications for Infiltration Practices." The manual is available through the State of Maryland, MDE. Infiltration facilities shall also meet the following guidelines and criteria:

1) Field Investigation

a) To be done by boring or open excavation.

b) Soil description to include all soil horizons.

c) Soil texture to be identified according to USDA soil classification.

d) Soil boring depth shall extend a sufficient distance below the bottom of the proposed trench to determine groundwater conditions. The required water table buffer (seasonally variable; see appendix 4-24A) or at least 2' below the bottom of the trench, whichever is greater.

e) Ground water elevation to be recorded at time of boring and after 24 hours. Based on this information, the seasonal high ground water table shall be determined.

2) Detailed Laboratory and Field Tests

a) Grain-size sieve analysis and hydrometer tests where appropriate are required to determine USDA classification.

b) Insitu infiltration tests may be used to determine infiltration rate by one of the following methods if desired:

- Health Department Constant Test (perc. test)

- Flooding basin

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- Cylinder Infiltrometer

- Air entry permeator

c) Soil boring locations to correspond to location of proposed infiltration trenches.

d) A minimum of one boring for every 50' length of infiltration trench.

e) Soil boring location stakes to be left in the field for inspection purposes.

f) Soils investigation to be performed by licensed soils or geotechnical engineer.

3) Infiltration trench not permitted in Marlboro Clays. Check geological information for presence of Marlboro Clays.

Trench Design Criteria

1) Infiltration systems shall be located at least 25 feet, horizontal distance, from basement walls.

2) Special consideration should be made for excessive depth of infiltration trenches.

3) Infiltration systems designed to handle runoff from commercial or industrial impervious parking areas shall be a minimum of 100 feet from any water supply well.

4) An observation well is required for each trench.

5) Infiltration systems shall not receive runoff until the entire contributory drainage area to the infiltration system is permanently stabilized.

6) Soil borings must indicate depth to seasonal high water table and bedrock, if any. Minimum distance acceptable from bottom of trench and water table is 2.0'.

7) Generally, soil borings shall be located within the infiltration facility boundary and shown on the SWM plan view sheet. In addition, soil suitability shall be field-verified at the time of installation.

8) Notes shall be provided indicating infiltration construction specifications. See Appendix 4-9 for notes.

9) Appropriate ROWs are to be provided in accordance with the easement and rights-of-way chapter for public systems.

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10) Provide a 6" layer of clean, washed sand in place of filter fabric on the bottom of the trench; (Note: This area is not to be included in the trench volume computations.)

11) All dimensions of the trench shall be shown on the detail sheet. Provide adequate information, inverts, elevations and dimensions as necessary for all pipes and trenches.

12) Provide approved filter cloth on top and sides of trench.

13) A minimum of 5' horizontal distance shall be maintained between a utility line and infiltration trench. No utility line should be placed over, under or within infiltration trench.

14) The infiltration trench shall not be placed in fill area.

15) The infiltration trench shall not be placed on slopes greater then 20%. When the trench is placed on a slope, the trench should be a minimum of 25' away from the proposed grade.

16) No more then 1/2 acre of impervious area for residential development and 1 acre impervious area for commercial should drain to an infiltration trench for each inlet. Also Tc for impervious area should not be more than 5 minutes.

17) The infiltration trench should not be provided at a location which could cause water problems in down grade properties.

18) Trenches shall be filled with 1 1/2" to 3" washed bank-run gravel or Md. #2 or #3 washed crushed bluestone. Bluestone must be obtained from an approved supplier.

19) Minimum allowable void ratio is .35.

20) Infiltration structures shall not be placed upstream of Marlboro Clay outcrops.

21) Locations of trenches shall be shown on plan view and profile of the storm drain plans.

22) Maximum trench depth should be such that it will drain within 72 hours.

23) The surface drainage systems require a minimum of a 20-foot grass buffer filter prior to runoff entering the trench.

24) Infiltration trenches shall not be utilized as an integral part of the main conveyance system. If the trench runoff is received via a storm drainage system, the trench must be located "off-line". An off-line trench shall be connected to an inlet structure that has a sump chamber with minimum depth of 3' below the trench inlet pipe. (Appendix 4-9 for sample detail)

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25) The invert of the outfall discharge pipe shall be higher than the invert of the infiltration feeder pipe by the head plus 1/2 pipe diameter of feeder pipe required for the peak inflow into the infiltration trench.

26) Plans should specify the perforation spacing and sizing with the minimum total area > 5x the cross-sectional area of the feeder pipe in the trench.

27) The minimum allowable infiltration rate 0.50 inches/hour.

Oil and Grit Separators

General

Oil-grit separators may be used if approved by the Stormwater Concept Section to enhance water quality from small commercial areas when the preferred water quality measures have been proven infeasible. Oil-grit separators are applicable in areas where heavy automobile traffic and/or parking lots contribute large loads of oil, grit and trash to runoff water. (Appendix 4-11 for sample detail)

Design Procedures

1) Size the structure horizontally by computing the volume of storage needed for the oil. Provide 200 cubic-feet of storage per acre of impervious parking area directed to the structure. The depth of the oil storage shall be a minimum of 3 feet measured from the normal pool surface down to the intake end of the 90-degree elbow pipe. The depth of grit storage shall be 1.5 feet minimum under the oil storage.

   a) The first two chambers are for storage and the third chamber is for controlling the discharge and does not contribute to the storage volume.

   b) The minimum acceptable width of the chambers is 3 feet.

   c) Oil storage volume should be calculated as the total length of the 1st and 2nd chambers x width x length of drawdown pipe.

   d) The minimum depth from the normal pool surface to bottom of the structure shall be 4.5'.

   e) Size the structure vertically by first establishing the inverts of the inflow and outflow pipes. The invert of the inflow pipe shall not be lower than the normal pool elevation. The invert of the outflow pipe should allow enough head to pass the 10-year storm discharge.

   f) The trash rack protecting the orifices shall have an area 3 x the combined area of the orifices.

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g) Determine the size of 90-degree elbow pipe that could pass the 10-year storm discharge through the structure allowing for 1-foot of freeboard.

2. Show the hydraulic gradient through each chamber of the structure based on the 10-year storm. Assume that the velocity head is zero and the gradient will be at the water surface. The hydraulic gradient shall not be higher than the proposed grade. Provide one foot of freeboard from the HGL to the top slab.

IV. Stormwater Management Quantity Requirements

Generally all developments will be required to attenuate the 2-year and 10-year storms using the following control structures (listed in preferred order):

a) Regional Stormwater Management Facility
b) Onsite facility
c) Infiltration combined with "b" above when no other quantity management option is available.

Required water quality measures may be incorporated with the stormwater attenuation facilities or installed separately. 100 year storm attenuation will generally be required only in cases where potential for flooding of downgrade developed properties exist.

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Appendix D:

Additional BMP Background Information

I. Infiltration Trenches

II. Infiltration Basins

III. Grass Filter/Grass Swale Systems

IV. ED Dry Ponds

V. Wet Ponds

VI. Artificial Marshes

VII. Oil/Grit Separators

VIII. Dry Ponds

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I.

TABLE 1 : SUMMARY

DRAFT

BMP Site No.	Name & Location	Land Use	No. Type & Age of Structure	Infiltration BMP Design Features					
				Pre-Treatment System Type	Filter Cloth Lining	Bottom Sand Layer	Aggregate Size & Type	On-Site Soil Type	Soil Boring Depth To Water Table
I-1	Southwood General Part 20-F2	Comm.	(2) Infilt. Tr. 1.4 yrs	6' Deep O/G Separator	Top & Sides	No	Pea Gravel	BlbB: Beltsville silt loam	Dry @ 13'
I-2	Autoville Block F 04-B11	Comm.	(2) Infilt. Tr. 4.4 yrs.	Sump Pit #2 - 3.5' (D) #4 - 4.5' (D)	Top, Sides & Bottom	No	1"-3" Gravel	ShB2: Sassafras sandy loam	Dry @ 20'
I-3	Belton Parcels A&B 01-E5	Comm.	(2) Infilt. Tr. 6.0 yrs.	Vegetative Filter	Top, Sides & Bottom	No	#2 Stone	GeB2: Christiana silt loam	Dry @ 15'
I-4	Beltsville Commercial Center 04-F6	Comm.	(1) Infilt. Tr. 2.6 yrs.	Sump Pit 4' Deep	Top & Sides	Yes	#2 Washed Gravel	OcE: Ochlockonee Sandy loam	Dry @ 10'
I-5	BRADCO Corporation 01-B11	IND.	(1) Infilt. Ba. 5.1 yrs	NONE	None	No	N/A	SwB: Sunnyside Urban land Complex	Water @ 13.5'
I-6	Branch Ave. Commerce 20-G13	Comm.	(1) Infilt. Tr. 2.5 yrs	Sump Pit 3.8' deep	Top, Sides & Bottom	Yes	#2 or #3 Stone	BmB: Beltsville Urban land Complex	Water @ 6'

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TABLE 1 : SUMMARY: T

INFILTRATION BMP DESIGN FEATURES ②

BMP SITE NO.	NAME & LOCATION	LAND USE	NO., TYPE & AGE OF STRUCTURE	PRE-TREATMENT SYSTEM TYPE	FILTER CLOTH LINING	BOTTOM SAND LAYER	AGGREGATE SIZE & TYPE	ON-SITE SOIL TYPE	SOIL BORING DEPTH TO WATER TABLE
I-7	BRANCH PLAZA 20-E8	Comm	(1) Infilt.-Tr. 2.5 YRS	Sump Pit 4' Deep	Top, Sides & Bottom	No	2" to 3" Washed Gravel	CaB2: CHILLUM SILT LOAM	Dry @ 26.5'
I-8	BRINKLEY PROF CENTER (Retrofit) 19-J8	Comm.	(1) Infilt.-Tr. (1) Infilt.-Ba. 1.3 YRS.	NONE FOR BOTH	N/A None for I.B.	No for Both	N/A	CmC3: Collington Fine Sandy Loam	Water @ 8.5': IT 8.' : IB
I-9	BRINKLEY STATION TOWNHOUSE 19-H8	T.H.	(1) Infilt.-Tr. 1.6 YRS.	Vegetative Filter	Top & SIDES	No	#2 STONE	SgE: Sassafras Gravelly Sandy Loam	Dry @ 11'
I-10	CALVERTON BUILDING 04-A2	Comm.	(2) Infilt.-Tr. STR #4 & #5 1.0 YRS.	Sump Pit 4' Deep	Top, Sides & Bottom	No	2"-3" Washed Gravel	SfC2: Sassafras Gravelly Loam	Water @ 13.5'
I-11	CALVERTON BUILDING 7 04-A3	Comm.	(2) Infilt.-Tr. STR #3 & #5 1.5 YRS.	Sump Pit 4' Deep	Top & SIDES	YES	2"-3" Washed Gravel	F1: 30% SgD2: 15% SfD2: 15% MuB2: 40%	N/A → Fullerton Loam; Sassafras gravelly Sandy Loam; Sassafras gravelly Loam; Mattapex silt Loam

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TABLE I. : SUMMARY

INFILTRATION BMP DESIGN FEATURES

BMP SITE NO.	NAME & LOCATION	LAND USE	No., TYPE & AGE OF STRUCTURE	PRE-TREATMENT SYSTEM TYPE	FILTER CLOTH LINING	BOTTOM SAND LAYER	AGGREGATE SIZE & TYPE	ON-SITE SOIL TYPE	SOIL BORING DEPTH TO WATER TABLE
I-12	CAMP SPRINGS SQUARE 20-F9	Comm.	(2) Infilt. Tr. STR. 1 & 8 10 YR	Sump Pits 4.5' DEEP	SIDES ONLY	No	1½" to 3" Washed Gravel	ShA: Sassafras Sandy Loam	Dry @ 8'
I-13	CHERRY LANE CENTER PARTS 02-D9		(3) Infilt. Tr. STR. #3,4,5 48 YRS	None	Top, Sides & Bottom	No	N/A	BlB2: Bellsville Silt Loam	Dry @ 21'
I-14	CHESTER GROVE TOWN HOUSES 21-D1	I.H.	(1) Infilt. Tr 4.2 YRS.	Vegetative Filter	Top, Sides & Bottom	No	2" Washed Gravel	BmB: Bellsville Urban Land Complex	N/A
I-15	CHESTNUT HEIGHTS 11-E2	S.F.	(2) Infilt. Tr STR #2 & #3 26 YRS	Sump Pit 5' Deep	Top & Sides	Yes	2" Washed Gravel	MyA: Matawan Fine Sandy Loam	Dry @ 14'
I-16	CLINTON SERVICE PARK 20-H3	Comm.	(4) Infilt. Tr. STR. #3,5,8,12 5.0 Yrs	None (Filter cloth inside of perf. pipe)	Top, Sides & Bottom	No	N/A	BlA: Bellsville Silt Loam	N/A

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TABLE 1 : SUMMARY:

BMP Site No.	Name & Location	Land Use	No., Type & Age of Structure	Infiltration BMP Design Features					
				Pre-Treatment System Type	Filter Cloth Lining	Bottom Sand Layer	Aggregate Size & Type	On-Site Soil Type	Soil Boring Depth To Water Table
I-17	College Park 09-A3	Comm.	(1) Infilt. Tr. 28 Yrs	Sump Pit 4' Deep	Sides Only	Yes	#2 Washed Gravel	MnC2: Mattapeake Silt loam	Water @ 9.2'
I-18	Duron Center 20-G12	Comm	(1) Infilt. Tr. 35 Yrs	Sump Pit 6' Deep	Top & Sides	Yes	1½"-3" Washed Gravel	SnB2: Sassafras Gravelly Sandy Loam	Dry @ 15'
I-19	East Lake 16-A4	Apt.	(4) Infilt. Tr. SIR #2, 4, 5 & 1 1.7 Yrs	Sump Pit 4' Deep	Top & Sides	Yes	#2 washed Stone	CmC2: Collington fine sandy loam	SIR #7: Water @ 5.2' SIR #2, 4, 15 Dry @ 20'
I-20	Econo Lodge 20-H13	Comm.	(2) Infilt. Tr. SIR #1 & #2 18 Yrs	Sump Pit 4' DEEP	Top & Sides	No	2" washed Gravel	GmB: Galestown Urban Land Complex	Water @ 6'

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R0055249

TABLE 1.2: SUMMARY

INFILTRATION BMP DESIGN FEATURES

(5)

BMP SITE NO.	NAME & LOCATION	LAND USE	NO., TYPE & AGE OF STRUCTURE	PRE-TREATMENT SYSTEM TYPE	FILTER CLOTH LINING	BOTTOM SAND LAYER	AGGREGATE SIZE & TYPE	ON-SITE SOIL TYPE	SOIL BORING DEPTH TO WATER TABLE
I-21	Largo/Oxford Parcel L * some profiles crossed out 15-F6	Apt.	(8) Infilt. Tr. STR D1- 1.9 YRS.	Sump Pit 2' DEEP	Top & Sides	No	#1 Stone	BHB2: Beltsville Silt loam	Water @: D1: =11' D12: =17' D2: =9.5' D15: 9' D3: =10' D16: 7' D6: =9' D9: 10.5'
I-22	FRANKLIN TERRACE 04-E1	S.F.	(1) Infilt. Tr. 1.2 YRS.	Sump Pit 3.5' deep	Top & Sides	No	1½" - 3" Washed Stone	BlB2: Beltsville Silt Loam	Not Avail.
I-23	HOLLYWOOD ON THE HILL 04-C10	Comm.	(1) Infilt.-Tr. 1.6 YRS.	Sump Pit 4' DEEP	Top & Sides	Yes	1½" - 3" washed gravel or Stone	SpC: Silty Clayey Sand	Dry to 10'
I-24	INDIAN CREEK VILLAGE * some details crossed out. 04-G6	T.H.	(4) Infilt. Tr. STR #4, 14, 15, 17 0.8 YRS	Sump Pit 4' DEEP	Top & Sides	No	AASHTO #3, #4 or #5 Distribution	KpB2: Keyport Silt loam	Water @ 9' to 10' for all trenches
I-25	INDIAN QUEEN SOUTH 24-K4	S.F.	(2) Infilt. Tr. 2.6 YRS.	Sump Pit 4' DEEP	Top & Sides	Yes	#2 washed Gravel	BlA: Beltsville Silt Loam	ALL DRY @ 15'

R0055250

TABLE 1 : SUMMARY

INFILTRATION BMP DESIGN FEATURES

BMP Site No.	Name & Location	Land Use	No. Type & Age of Structure	Pre-Treatment System Type	Filter Cloth Lining	Bottom Sand Layer	Aggregate Size & Type	On-Site Soil Type	Soil Boring Depth To Water Table
I-26	Jiffy Lube 04-D7	Comm.	(1) Infil.-Tr. 29 yrs	Vegetative Swale for partial inflow	Sides only	Yes	2"-3" Washed Gravel	RdC3: Rd B2: Rumford Loamy Sand	Dry @ 16.5'
I-27	Kettering 15-H5	T.H.	(1) Infil.-Tr. Str #40 30 yrs	Sump At 5' deep	Top & Sides	No	AASHTO Specs	CmA: Collington fine sandy loam	Dry @ 6'
I-28	Lands of Joseph Nazaro 09-B12	Comm	(1) Infil.-Tr Str # 3 29 yrs	Sump pit 3' Deep	Top, Sides & Bottom	No	#2 stone	SaD: Sandy & Clayey	Dry @ 15'
I-29	Marinucci Tract 04-G3	Comm.	(3) Infil.-Ba Str #1,2,13 25 yrs.	Vegetative Swale for Str #11-3	N.A.	No	N.A.	SuC2: Sunnyside Loam	Dry @ #1 : 12.6' #2 : 17.7' #3 : 15.2
I-30	Marlboro Pike Shopping Center 14-B9	Comm	(5) Infil. Tr. Str #10,13 16 1.9 yrs.	Sump Pit 3' Deep w/ Baffle	Top, Sides, & Bottom	No	3" clean Gravel	Paved Area	Dry @ #10 : 26' #16 : 15' #13 : 15'

R0055251

TABLE 1 : SUMMARY

INFILTRATION BMP DESIGN FEATURES

(7)

BMP SITE NO.	NAME & LOCATION	LAND USE	NO., TYPE & AGE OF STRUCTURE	PRE-TREATMENT SYSTEM TYPE	FILTER CLOTH LINING	BOTTOM SAND LAYER	AGGREGATE SIZE & TYPE	ON-SITE SOIL TYPE	SOIL BORING DEPTH TO WATER TABLE
I-31	MARLBOROUGH TOWNE COMM 22-J6	Comm.	(3) Infilt. Tr. STR #111, 113, 115 26 YRS	Oil / Grit Separator For all 3	Top & Sides	Yes	N/A	GmB: Galestown Urban Land Complex	Water @ #111 : 7' #113 : 8'3" 115 : 9'4"
I-32	MAYFAIR 01-K9	Comm. III	(1) Infilt. Tr. 20 YRS	Sump Pit 3' DEEP (No elbow)	Top & Sides	Yes	N/A	B1B2: Beltsville Silt Loam	Dry @ 14'
I-33	OAKCREST PLAZA 02-C9	Comm.	(1) Infilt. Ba. 3.5 YRS.	None	N/A.	No	N/A.	B1A: Beltsville Silt loam	Water @ 5' B.S.
I-34	OAKLAWN SHOPPING CENTER 25-J1	Comm	(1) Infilt. Tr. 1.9 YRS.	Sump Pit 4' DEEP	Top & Sides	Yes	3/4" Washed Gravel	B1A: Beltsville Silt loam	Water @ 18'
I-35	OXON HILL RETAIL CENTER C5-A1	Comm.	(1) Infilt. Tr. 1.6 YRS	Sump Pit 4' DEEP	Top & Sides	Yes	2"-3" Washed Gravel	EK: ELKTON Silt Loam ShB2: Sassafras Sandy loam	N/A

R0055252

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TABLE 1 : SUMMARY

INFILTRATION BMP DESIGN FEATURES (8)

BMP SITE NO.	NAME & LOCATION	LAND USE	NO., TYPE & AGE OF STRUCTURE	PRE-TREATMENT SYSTEM TYPE	FILTER CLOTH LINING	BOTTOM SAND LAYER	AGGREGATE SIZE & TYPE	ON-SITE SOIL TYPE	SOIL BORING DEPTH TO WATER TABLE
I-36	PASCAL CENTER 15-B6	Comm.	(1) Infilt.-TR. STR #8 1.7 YRS	Sump Pit 4' DEEP	Top & Sides	Yes	1½"-3" clean stone	SmA: Shrewsbury fine sandy loam	Water @ 18'
I-37	PEP-BOYS 14-G12	Comm.	(1) Infilt.-TR. STR #1 & #2 1.3 YRS.	Sump Pit 4' DEEP	Top & Sides	Yes	2" washed Bankrun Gravel	BlA: Beltsville Silt Loam	Water @ 13' for #1 Dry @ 16.5' for #2
I-38	RITCHIE STATION 15-C9	Comm.	(1) Infilt.-TR STR #2 3.5 YRS.	Vegetative Filter	Top & Sides	No	2" washed Gravel	SO: Shrewsbury, Urban land Complex	Water @ 5'
I-39	RIVERTOWNE COMMONS 19-D8	Comm.	(1) Infilt.-TR. STR #41 (6) Infilt.-PP 1.9 YRS.	Sump Pit 4' DEEP None	Top & Sides Sides & bottom	No	1"-3" crushed stone & Varies	BlC2: Beltsville Silt Loam	Water @ 6'-12' for all infilt. areas

R0055253

VOL 12 2 1953

TABLE 1 : SUMMARY: INFILTRATION BMP DESIGN FEATURES (9)

BMP SITE NO.	NAME & LOCATION	LAND USE	NO., TYPE & AGE OF STRUCTURE	PRE-TREATMENT SYSTEM TYPE	FILTER CLOTH LINING	BOTTOM SAND LAYER	AGGREGATE SIZE & TYPE	ON-SITE SOIL TYPE	SOIL BORING DEPTH TO WATER TABLE
I-40	RIVERVIEW OFFICE BUILDING 19-D8	Comm.	(2) Infilt.-Tr. STR #4 & #5 3.8 YRS	NO DETAILS	N/A	N/A	N/A	BlB2: Beltsville Silt Loam	N/A
I-41	SILVER HILL PARK 19-K2	Comm.	(1) Infilt.-Tr. STR #3 1.0 YR.	SUMP PIT 4' DEEP	Top & Sides	Yes	1½"-3" Clean, washed Aggregate	BmB: Beltsville Urban Land Complex MnB2 Matapeake	Dry @ 10' Silt Loam
I-42	SUNRISE TOWNHOUSES 19-F9	T.H.	(1) Infilt.-Tr. 1.1 YRS	Vegetative Filter (for partial D.A.)	Top & Sides	Yes	1½-3" washed Gravel	Mw: Mixed Alluvial Land	N/A
I-43	TICK TOCK PLAZA 08-E2	Comm.	(1) Infilt.-Ba STR. #6 2.7 YRS	None	None	No	N/A	CbB: Chillum Urban Land Complex	Dry @ 16.5'

R0055254

VOL 12 2 1954

TABLE 1 : SUMMARY: INFILTRATION BMP DESIGN FEATURES (10)

BMP SITE NO.	NAME & LOCATION	LAND USE	NO., TYPE & AGE OF STRUCTURE	PRE-TREATMENT SYSTEM TYPE	FILTER CLOTH LINING	BOTTOM SAND LAYER	AGGREGATE SIZE & TYPE	ON-SITE SOIL TYPE	SOIL BORING DEPTH TO WATER TABLE
I-44	VIRGINIA MANOR PARK 01-J10	IND.	(1) Infilt. Bm 2.6 YRS.	Vegetative Filter	Top & Sides	No	1½"-3" STONE	BlB2: Beltsville Silt Loam	N/A
I-45	ANDREW'S AUTO VILLAGE 20-H12	Comm.	(1) Infilt.-Tr. STR. HIC 1.2 YRS.	Sump Pit 4' DEEP	Top & Sides	Yes	#2 washed Stone	GeB: Galestown Sandy Loam	Water @ 5' [illegible]
I-46	AL'S SUPERMARKET 19-D8	Comm.	(1) Infilt. Bw STR. C Tr. 5.2 YRS	Sump Pit 2'6" DEEP	Top & Sides	No	1"-2" Washed Stone	BmB: Beltsville Silt Loam	Water @ 5'
I-47	ARORA OFFICE BUILDING 26-G3	Comm.	(1) Infilt.-Tr. 1.8 YRS.	Vegetative Filter: (3' wide) Timber wall "Grit Pit"	Top & Sides	Yes	No. 2 Stone	*ShB2: (75%) Sassafras Sandy Loam MuA: (25%) Mattapex Silt Loam	Water @ 6'

R0055255

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TABLE I : SUMMARY: INFILTRATION BMP DESIGN FEATURES (11)

BMP SITE NO.	NAME & LOCATION	LAND USE	NO., TYPE & AGE OF STRUCTURE	PRE-TREATMENT SYSTEM TYPE	FILTER CLOTH LINING	BOTTOM SAND LAYER	AGGREGATE SIZE & TYPE	ON-SITE SOIL TYPE	SOIL BORING DEPTH TO WATER TABLE
I-48	ASHWOOD CENTER 15-C7	Comm.	(1) Infilt.-Tr. STR #15 1.2 YRS	Sump Pit 4' DEEP	Top & Sides	Yes	#2 Gravel	CmD3, CmC3: Collington Fine Sandy Loam	Water @ 27'4"
I-49	BEAVER HTS. LOTS 9 & 10 14-B2	INST.	(3) Infilt.-Tr. STR #9, 10, 11A 1.9 YRS.	Sump Pit 4' DEEP	Top & Sides	Yes	2"-3" Stone	ScC: Sandy & Clayey	Dry @ 12'
I-50	BURGESS COMM. DISTRICT 08-D6	Comm.	(1) Infilt.-Tr. 2.1 YRS	Sump Pit 3'8" Deep (Vegetative Swale)	Top & Sides	Yes	1½"-3" Stone	KeC2: Keyport Fine Sandy Loam	Dry @ 15'
I-51	BUCK LODGE PARK 03-H9	INST.	(1) Infilt.-Ba. 3.2 YRS	None	N/A	No	N/A	B1B2 * Beltsville Silt Loam	N/A

R0055256

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TABLE I : SUMMARY: INFILTRATION BMP DESIGN FEATURES (12)

BMP SITE NO.	NAME & LOCATION	LAND USE	NO., TYPE & AGE OF STRUCTURE	PRE-TREATMENT SYSTEM TYPE	FILTER CLOTH LINING	BOTTOM SAND LAYER	AGGREGATE SIZE & TYPE	ON-SITE SOIL TYPE	SOIL BORING DEPTH TO WATER TABL
I-52	CORRIDOR OFFICE PARK 15 G5	Comm.	(1) Infilt.-Ba STR #5 4.6 YRS.	None	N/A	No	N/A	CmA Collington Fine Sandy Loam	N/A
I-53	DEN LEE ACRES 26-G6	SF.	(2) Infilt.-Ba. 3.6 YRS.	None	N/A	Yes	N/A	* RdC2 RdB2 RUMFORD LOAMY SAND	N/A
I-54	CHERRY LANE PARCEL #2 02-C9	Comm.	(2) Infilt.-Ba. #1 & #2 4.1 YRS	None	N/A	No	N/A	BlB2: Beltsville Silt Loam	N/A
I-55	CHERRY LANE PARCEL #6 02-C9	Comm.	(2) Infilt.-Tr. STR #S1 & #S2 4.7 YRS	N/A	Top, Sides & Bottom	No	AASHTO STD-M6	BlB2: Beltsville Silt Loam	N/A
I-56	CHERRY HILL CONDOS 03-K4	Apt.	(1) Infilt.-Tr. 2.6 YRS	Vegetative Filter strip (Sodded channel)	Top & Sides	Yes	N/A	SgC2, SgD2: Sassafras Gravelly Loam	Dry @ 13'

R0055257

VOL 12 2 1957

TABLE 1 : SUMMARY: INFILTRATION BMP DESIGN FEATURES (13)

BMP SITE NO.	NAME & LOCATION	LAND USE	NO., TYPE & AGE OF STRUCTURE	PRE-TREATMENT SYSTEM TYPE	FILTER CLOTH LINING	BOTTOM SAND LAYER	AGGREGATE SIZE & TYPE	ON-SITE SOIL TYPE	SOIL BORING DEPTH WATER TA
I-57	GREENCASTLE LOT #6 01-C11	S.F.	(1) Infilt.-DW 4.1 YRS	N/A	N/A	N/A	N/A	CtB2: Croom Gravelly Sandy Loam	N/A
I-58	GREEN MEADOWS 08-E4	Comm.	(1) Infilt.-TR STR #1 0.8 YRS	Sump Pit 4' DEEP	Top & Sides	Yes	1½"-3" Washed Gravel	SkB or SkC Sassafras Urban Land Complex	Dry @ 15'
I-59	HAMPTON PARK LOT #12 15-C7	Comm.	(1) Infilt.-TR 4.0 YRS.	Sump Pit 3'7" DEEP	Sides only	No	2" stone	CmB2: Collington Fine Sandy Loam	N/A
I-60	HIGHBRIDGE LOT #2 11-E1	S.F.	(1) Infilt.-DW 5.6 YRS	Vegetative Swale	Top, Sides & Bottom	No	1½"-3" Stone	ShA: (?) Sassafras Sandy Loam	N/A
I-61	HIGHBRIDGE LOT #4 11-E1	S.F.	(1) Infilt.-DW 5.7 YRS	Vegetative Swale	Top, Sides & Bottom	No	1½"-3" Stone	ShA: Sassafras Sandy Loam	N/A

R0055258

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TABLE 1.2: SUMMARY: INFILTRATION BMP DESIGN FEATURES (14)

BMP SITE NO.	NAME & LOCATION	LAND USE	NO., TYPE & AGE OF STRUCTURE	PRE-TREATMENT SYSTEM TYPE	FILTER CLOTH LINING	BOTTOM SAND LAYER	AGGREGATE SIZE & TYPE	ON-SITE SOIL TYPE	SOIL BORING DEPTH TO WATER TABLE
I-62	HIGHBRIDGE LOT #5 11-E1	S.F.	(1) Infilt. - DW 4.9 YRS	Vegetative Swales	Top, Sides & Bottom	No	1½" - 3" STONE	ShA: Sassafras Sandy Loam	N/A
I-63	MELWOOD JUNCTION LOTS 1 & 2 21-F11	S.F.	(2) Infilt. - DW STR #1 & #2 4.9 YRS	Vegetative Filter Strip	Top, Sides & Bottom	No	1½" - 3" Stone	AdA: * Adelphia Fine Sandy loam WaA: Westphalia Fine Sandy Loam	N/A
I-64	PANORAMA COURT LOT #7 18-K11	S.F.	(2) Infilt. - DW 4.5 YRS	None	Top, Sides & Bottom	No	1½" - 3" Stone	GdB: * Galestown Loamy Sand	N/A
I-65	ROLLINGCREST COMM. CENTER 08-D5	Inst.	(1) Infilt. - Ba. C3 4.6 YRS	Grass Swale	N/A	N/A	N/A	SgC2: Sassafras Gravelly Sandy Loam	N/A

R0055259

VOL 12 2 1959

TABLE 1 : SUMMARY: INFILTRATION BMP DESIGN FEATURES (15)

BMP SITE NO.	NAME & LOCATION	LAND USE	NO., TYPE & AGE OF STRUCTURE	PRE-TREATMENT SYSTEM TYPE	FILTER CLOTH LINING	BOTTOM SAND LAYER	AGGREGATE SIZE & TYPE	ON-SITE SOIL TYPE	SOIL BORING DEPTH TO WATER TABLE
I-66	WOODBERRY SQUARE Lot #1 20-C10	Comm.	(1) Infilt. Tr. STR #3 2.0 YRS.	Sump Pit 4' DEEP	Top & Sides	Yes	1½"-3" Gravel	BlB2: Beltsville Silt Loam	Dry @ 19.5'
I-67	DONTRINE SUB 1&2 06-F12	S.F.	(1) Infilt. Ba. STR #1 0.5 YR.	None	N/A.	N/A.	N/A.	SgD3: Sassafras Gravelly Sandy Loam	Dry @ 15.3'
I-68	Home Acres 04-C4	Inst.	(4) Infilt. DW STR #1,2,3,4 1.3 YRS.	None	Top & Sides	No	#2 washed stone	SgB2: Sassafras Gravelly Sandy Loam	Dry @ 20'
I-69	MARLTON SEC 4 28-E2	T.H.	(2) Infilt. Tr. STR #1&2 1.0 YR.	Sump Pit 4' DEEP (Baffle)	Top, Sides & Bottom	Yes	#2 washed Gravel	WaD3: Westphalia fine Sandy Loam	Water @ 18'
I-70	PRICE CLUB 04-E6	Comm.	(4) Infilt. Tr. STR #29,31,34,35 0.7 YRS.	Sump Pit 4' Deep	Top & Sides	Yes	2" washed Gravel	SkB: Sassafras Urban Land Complex	Water @ #29: 17.5' #31: NA #34: 18' #35: NA

R0055260

TABLE 1[illegible]: SUMMARY: INFILTRATION BMP DESIGN FEATURES (16)

BMP SITE NO.	NAME & LOCATION	LAND USE	NO., TYPE & AGE OF STRUCTURE	PRE-TREATMENT SYSTEM TYPE	FILTER CLOTH LINING	BOTTOM SAND LAYER	AGGREGATE SIZE & TYPE	ON-SITE SOIL TYPE	SOIL BORING DEPTH TO WATER TABLE
I-71	BELTSVILLE TERRACE 04-D6	Comm.	(1) Infilt. TR STR #4 0.8 YRS	Sump Pit 4' DEEP	Top, Sides & Bottom	No	#2 washed Rock	RdC3: Rumford Loamy Sand	Water @ 10'9"
I-72	FELLOWSHIP CHURCH 27-A4	Inst.	(2) Infilt.-TR. STR #1 & 2 2.7 YRS	None	Top & Sides	Yes	No. 2 Washed Gravel	SgB2: Sassafras Gravelly Sandy Loam	N/A
I-73	LARGO CENTRE 15-G5	Comm.	(1) Infilt.-Ba. STR #5 4.9 YRS.	None	N/A	N/A	N/A	CmA: Collington Fine Sandy Loam	N/A
I-74	PUBLIC STORAGE 15-A6	Comm.	(1) Infilt.-Ba. 2.8 YRS	None	N/A	N/A	N/A	CmD3: Collington Fine Sandy Loam	Water @ 12'
I-75	RIDGLEY CHURCH OF GOD 15-E13	Inst.	(1) Infilt.-TR 0.6 YRS	Ext. Det.: Dry	Top & Sides	Yes	2"-2½" Stone	BmB: Beltsville Urban Land Complex	Water @ 10'4"

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TABLE 1 : SUMMARY: INFILTRATION BMP DESIGN FEATURES (17)

BMP SITE NO.	NAME & LOCATION	LAND USE	NO., TYPE & AGE OF STRUCTURE	PRE-TREATMENT SYSTEM TYPE	FILTER CLOTH LINING	BOTTOM SAND LAYER	AGGREGATE SIZE & TYPE	ON-SITE SOIL TYPE	SOIL BORING DEPTH TO WATER TABLE
I-76	J&L VALVE FITTING CO. 15-B8	Comm.	(1) Infilt.-PP 4.1 YRS	None	Bottom	NA.	Varies ½"-2" Aggregate	CmB2: Collington fine sandy Loam	N/A.
I-77	SURRATT HOUSE 26-G2	Inst.	(1) Infilt.-Ba 0.6 YRS	None	N/A	Yes	N/A	ShB2: Sassafras Sandy Loam	Water @ 11.5'
I-78	LAUREL TECHNOLOGY CENTER	Comm.	(1) Infilt.-VF 2.6 YRS	None	N/A	N/A	N/A	GaB: Galestown Gravelly Loamy Sand	N/A
I-79	McDONALD'S ALLENTOWN ROAD 20-B10	Comm.	(1) Infilt. VF 2.6 YRS	None	N/A	N/A	N/A	BlB2: Beltsville Silt Loam	N/A
I-80	RAMBLEWOOD PARCEL 4 16-D9	Inst.	(3) Infilt.-VF 1.3 YRS	None	N/A	N/A	N/A	CmC3 Collington fine sandy Loam	N/A

R0055262

VOL 12 2 -- 0502

Table 2. Summary: Prince George's County Infiltration BMP Field Survey Results

SITE NO.	NAME	LAND USE	BMP TYPE	STR. NO.	AGE OF STR.1/ (YRS.)	D.A. To STRUCTURE (AC)	DATE INSPECTED	PRE-TREATMENT SYSTEM	SOIL TYPE	MIN. HEAD (Ft.)	AVG. DEPTH OF SEDIMENT (in.)	RECENT DEPTH (in.)	TDS SWMP (mg/l)	TDS WELL (mg/l)	DEPTH OF WATER IN OBS. WELL (in.)	WORKING AS DESIGNED
I-3	Bolton Parcels A & B	Comm.	Infilt.-Tr.	10A	5.0	1.4	7/1	3'-1" sump pit	CoA2	3.5	3.9	30.4	50	--	--	Yes
								1'-6" sump pit	Silt loam	3.5	11.3	11.8	50	--	--	Yes
I-4	Beltsville Comm. Center	Comm.	Infilt.-Tr.	2	2.4	1.4	6/30	3'-6" sump pit	BcB Sandy loam	3.5	2.5	11.8	60	360	24.0	No
I-5	Bradco Corporation	Ind.	Infilt.-Ba.		5.1	1.8	6/30	None	UuB Urban	N/A	N/A	--	--	--	--	No
I-6	Branch Ave. Commerce	Comm.	Infilt.-Tr.	4	2.5	0.5	7/10***	4'-0" sump pit	UuB Urban	0.0	N/A	N/A	30	160	3.0	Yes
I-9	Brinkley Station Townhouse	MU	Infilt.-Tr.		1.6	2.6	7/11**	15'Veg.filt.	SgB Sandy loam	10.0	N/A	N/A	--	--	--	No
I-10	Calverton Building	Comm.	Infilt.-Tr.	4	1.0	1.0	7/2	2'-2" sump pit	SfC2	3.0	2.0	31.5	200	120	23.0	No
				5		0.4		2'-2" sump pit	Gravel loam	3.0	3.3	80.0	200	190	64.0	No
I-11	Calverton Building 7	Comm.	Infilt.-Tr.	3	1.9	0.8	7/6**	4'-1" sump pit	MuB2 Silt loam	3.0	-0.3	20.5	230	N/A	Dry	Yes
I-12	Camp Springs Square	Comm.	Infilt.-Tr.	8	1.0	1.7	7/19*	4'-4" sump pit	SmA Sandy loam	1.5	2.0	13.0	60	N/A	Dry	Yes
I-13	Cherry Lane Center Par 88	Comm.	Infilt.-Tr.	3	4.0	1.0	7/3**	10" sump pit	BI B2	1.0	6.3	12.6	70	--	--	No
				5		0.5		2'-0" sump pit	Silt loam	1.0	6.5	11.8	70	--	--	No
I-17	College Park	Comm.	Infilt.-Tr.		2.0	2.5	7/2	6'-0" sump pit	MuC2 Silt loam	1.0	16.0	15.8	320	--	--	No
I-18	Duron Center	Comm.	Infilt.-Tr.		5.5	0.7	7/10***	2'-0"- sump pit	MuB2 Gr.-sand.loam	7.0	11.0	13.8	60	--	Dry	?

R0055263

NOV 21 2003

Table 2. Summary: Prince George's County Infiltration BMP Field Survey Results

SITE NO.	NAME	LAND USE	BMP TYPE	STR. NO.	AGE OF STR.1/ (YRS.)	D.A. To STRUCTURE (AC)	DATE INSPECTED	PRE-TREATMENT SYSTEM	SOIL TYPE	INIT. HEAD (ft.)	AVG. DEPTH OF SEDIMENT (in.)	SECCHI DEPTH (in.)	TDS SUMP (mg/l)	TDS WELL (mg/l)	DEPTH OF WATER IN OBS. WELL (in.)	WORKING AS DESIGNED
I-20	Stonelodge	Comm.	Infilt.-Tr.	1	1.0	2.0	7/10**	4'-0" sump pit	SB1 Sandy loam	5.0	9.50	24.0	30	60	6.0	Yes
I-21	Largo/Watford Parcel L	Apt.	Infilt.-Tr.	2	1.9	0.8	6/22*	4'-0" sump pit	BlB2 Silt loam	4.0	2.50	22.0	--	--	12.0	No
I-22	Franklin Terrace	SF	Infilt.-Tr.		1.2	0.2	6/3*	Dry sump pit	BlB2 Silt loam	6.0	15.0	N/A	N/A	N/A	N/A	No
I-23	Hollywood On the Hill	Comm.	Infilt.-Tr.		1.6	0.3	6/3*	4'1" sump pit	Spc Silty clay sand	1.0	0.50	17.7	60	190	13.0	No
I-24	Indian Creek Village	TH	Infilt.-Tr.	14	0.8	1.6	6/3*	15" sump pit	EpB2	1.0	1.00	12.2	--	N/A	Dry	Yes
				17		1.6		19" sump pit	Silt loam	1.0	1.50	15.7	--	N/A	Dry	Yes
				14		1.6	7/3*	ditto	ditto	ditto	--	--	--	N/A	Dry	Yes
				17		1.6		ditto	ditto	ditto	--	--	--	N/A	Dry	Yes
I-25	Indian Queen South	SF	Infilt.-Tr.	5	2.6	0.4	7/11*	6'-0" sump pit	BlA Silt loam	2.0	6.50	18.1	50	210	6.0	Yes
				4			7/11*	2'-2" sump pit	ditto	2.0	3.50	17.7	90	240	3.5	Yes
I-26	Jiffy Lube	Comm.	Infilt.-Tr.		2.9	0.6	7/1*	32" Veg.Filt.	BaC3 Loamy sand	12.0	--	--	--	--	Dry	No
I-27	Kettering	TH	Infilt.-Tr.	35	3.0	5.0	6/6	5' sump pit	CaA Sandy loam	1.0	45.0	--	220	--	--	Yes
I-29	Normandi Trace	Comm.	Infilt.-Ba.	1	2.5	2.1	7/3*	None	BaC2	0.0	--	12.0	50	--	--	No
				2		1.4		None	Loam	0.0	--	12.0	50	--	--	No
				3		1.7		None		0.0	--	18.0	100	--	--	No
I-32	Mayfair	TH	Infilt.-Tr.	1	2.0	5.1	6/10	2'-1" sump pit	BlB2	3.0	3.00	13.0	130	N/A	Dry	Yes

R0055264

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Table 2. Summary: Prince George's County Infiltration BMP Field Survey Results

SITE NO.	NAME	LAND USE	BMP TYPE	STR. NO.	AGE OF STR.1/ (YRS.)	D.A. To STRUCTURE (AC)	DATE INSPECTED	PRE-TREATMENT SYSTEM	SOIL TYPE	MIN. HEAD (ft.)	AVG. DEPTH OF SEDIMENT (in.)	SECCHI DEPTH (in.)	TDS SUMP (mg/l)	TDS WELL (mg/l)	DEPTH OF WATER IN OBS. WELL (in.)	WORKING AS DESIGNED
I-20	Econoledge	Comm.	Infilt.-Tr.	1	1.8	2.0	7/10***	4'-10 sump pit	SB1 Sandy loam	5.0	9.50	24.8	30	60	6.0	Yes
I-21	Large/Oxford Parcel L	Apt.	Infilt.-Tr.	2	1.9	0.0	4/22*	4'-8" sump pit	BIB2 Silt loam	4.0	2.50	22.0	--	--	12.0	No
I-22	Franklin Terrace	SF	Infilt.-Tr.		1.2	0.2	6/3*	Dry sump pit	BIB2 Silt loam	6.0	15.0	N/A	N/A	N/A	N/A	No
I-23	Hollywood On the Hill	Comm.	Infilt.-Tr.		1.6	0.3	6/3*	4'1" sump pit	Spc Silty clay sand	1.0	0.50	17.7	60	110	13.0	No
I-24	Indian Creek Village	TH	Infilt.-Tr.	14	0.0	1.6	6/3*	15" sump pit	KpB2	1.0	1.00	12.2	--	N/A	Dry	Yes
				17		1.6		19" sump pit	Silt loam	1.0	1.50	15.7	--	N/A	Dry	Yes
				14		1.6	7/3*	ditto	ditto	ditto	--	--	--	N/A	Dry	Yes
				17		1.6		ditto	ditto	ditto	--	--	--	N/A	Dry	Yes
I-25	Indian Queen South	SF	Infilt.-Tr.	5	2.6	0.4	7/11*	6'-9" sump pit	BIA Silt loam	2.0	6.50	10.1	50	210	6.0	Yes
				4												
							7/11*	2'-2" sump pit	ditto	2.0	3.50	17.7	90	740	3.5	Yes
I-26	Jiffy Lube	Comm.	Infilt.-Tr.		2.9	0.6	7/1*	32' Veg.Filt.	RdC3 Loamy sand	12.0	--	--	--	--	Dry	No
I-27	Kettering	TH	Infilt.-Tr.	35	3.0	5.0	8/8	5'sump pit	CaA Sandy loam	1.0	45.0	--	220	--	--	Yes
I-29	Mariwuaci Tract	Comm.	Infilt.-Ge.	1	2.5	2.1	7/3*	None	BuC2	0.0	--	12.0	50	--	--	No
				2		1.4		None	Loam	0.0	--	12.0	50	--	--	No
				3		1.7		None		0.0	--	18.0	100	--	--	No
I-32	Mayfair	TH	Infilt.-Tr.	1	2.0	5.1	6/10	2'-1" sump pit	BIB2	3.0	3.00	13.0	130	N/A	Dry	Yes

2

R0055265

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Table 2. Summary: Prince George's County Infiltration BMP Field Survey Results

SITE NO.	NAME	LAND USE	BMP TYPE	STR. NO.	AGE OF STR.1/ (YRS.)	D.A. To STRUCTURE (AC)	DATE INSPECTED	PRE-TREATMENT SYSTEM	SOIL TYPE	MIN. HEAD (Ft.)	AVG. DEPTH OF SEDIMENT (in.)	SECCHI DEPTH (in.)	TDS SUMP (mg/l)	TDS WELL (mg/l)	DEPTH OF WATER IN OBS. WELL (in.)	WORKING AS DESIGNED
I-32	Mayfair Cont'd.						7/3*	ditto	Silt loam ditto	ditto	4.00	--	--	--	Dry	Yes
I-33	Oakcrest Plaza	Comm.	Infilt.-Bo.		3.5	1.8	7/4**	None	BiA Silt loam	0.0	N/A	24.0	60	--	--	No
I-36	Pascal Center	Comm.	Infilt.-Tr.		1.7	1.1	4/23**	7'-5" sump pit	SmA Sandy loam	5.5	1.50	--	--	--	--	?
I-38	Ritchie Station	Comm.	Infilt.-Tr.		3.5	0.7	4/22*	57' Veg. Filt.	SD Urban	0.0	--	N/A	--	--	42.0	No
I-39	Riverteams Commons	Comm.	Infilt.-PP	1 2	1.9	2.0 1.6	8/23***	None None	BiC2 Silt loam	0.0 0.0	-- --	-- --	-- --	-- --	-- --	No No
I-42	Sunrise Townhouses	TH	Infilt.-Tr.		1.1	0.3	7/11*	None Fut.	MuE2 Mixed alluvial	0.0	--	--	--	--	--	Yes
I-43	Tick Tock Plaza	Comm.	Infilt.-Bo.		2.7	3.2	8/30	None	ChB Urban	0.0	--	6.0	40	--	--	No
I-44	Virginia Manor Park	Ind.	Infilt.-Bo		2.6	2.4	7/1	90' Veg.Filt.	BiB2 Silt loam	0.0	--	--	--	--	--	No
I-45	Andrews Auto Village	Comm.	Infilt.-Tr.		1.2	1.5	7/10***	25'Veg.Filt.	GaB Sandy loam	0.5	--	--	70	--	--	Yes
I-46	Al's Supermarket	Comm.	Infilt.-Tr.		5.2	0.4	8/23***	2'-6" sump pit	Bmp Silt loam	2.5	24.0	--	110	--	Dry	No
I-47	Arora Office Building	Comm.	Infilt.-Tr.		1.8	0.6	7/10***	mini-sump	ShA2 Sandy loam	4.0	--	--	--	--	Dry	Yes

R0055266

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Table 2. Summary: Prince George's County Infiltration BMP Field Survey Results

SITE NO.	NAME	LAND USE	BMP TYPE	STR. NO.	AGE OF STR.1/ (YRS.)	D.A. To STRUCTURE (AC)	DATE INSPECTED	PRE-TREATMENT SYSTEM	SOIL TYPE	MIN. HEAD (Ft.)	AVG. DEPTH OF SEDIMENT (in.)	SECCHI DEPTH (in.)	TDS DROP (mg/l)	TDS WELL (mg/l)	DEPTH OF WATER IN OBS. WELL (in.)	WORKING AS DESIGNED
I-48	Ashwood Center	Comm.	Infilt.-Tr.	5	1.2	0.2	4/23**	sand-sump	Ca Cl Sandy loam	3.5	0.00	--	--	Dry	Yes	Yes
I-51	Duck Lodge Park	Inst.	Infilt.-Ba.		3.2	0.8	7/2	None	B1B2 Silt loam	0.0	N/A	10.0	90	--	--	No
I-54	Cherry Lane Parcel 02	Comm.	Infilt.-Ba.	1	4.1	3.3 1.7	7/6**	None	B1B2 Silt loam	0.0	N/A	20.0	190 60	--	--	No
I-55	Cherry Lane Parcel 06	Comm.	Infilt.-Tr		4.7	1.2 1.1	7/6**	15" sump pit	B1B2 Silt loam	1.0	2.0 3.0	12.0 11.0	N/A 80	--	--	Yes No
I-56	Cherry Hill Condos	Apt.	Infilt.-Tr.		2.6	1.3	7/6**	36" Veg.Filt.	SgB2 Gravel loam	4.0	0.0	N/A	80	90	55.0	No
I-59	Hampton Park Lot B12	Comm.	Infilt.-Tr.		4.0	0.9	4/22*	4'-0" sump pit	ChB2 Sandy loam	3.0	1.5	--	--	--	--	No
I-60	Highbridge Lot 02	SF	Infilt.-Ba.		5.6	0.2	8/23***	None	BkA Sandy loam	3.0	--	--	--	30	5.0	No
I-62	Highbridge Lot 05	SF	Infilt.-Ba		4.9	0.3	8/23***	None	BkA Sandy loam	3.0	--	--	--	110	7.0	No
I-67	Somerton Sub. 102	SF	Infilt.-Ba.	1	0.5	0.3	8/23***	None	SgB3 Gr.-sand.loam	0.0	--	15.0	60	--	--	No
I-70	Price Club	Comm.	Infilt.-Tr.	35	0.7	0.8	4/10	4'-0" sump pit	UkA Urban	1.0	1.00	35.4	90	N/A	Dry	Yes
I-71	Bottsville Terrace	Comm.	Infilt.-Tr.		0.8	0.4	4/3*	4'-0" sump pit	AdC3 Loamy sand	1.5	N/A	11.0	N/A	N/A	N/A	?

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R0055268

Table 2. Summary: Prince George's County Soil Inventory and Field Survey Results

SITE NO.	NAME	LAND USE	SOIL TYPE	SLOPE (%)	AGE OF SITE (YRS.)	A.A. TO DISTURBANCE (AC)	DATE INSPECTED	PRE-TREATMENT SYSTEM	SOIL TYPE	MEAN DEPTH (ft.)	AVG. DEPTH OF SATURATION (in.)	RESTRICTIVE DEPTH (in.)	SOIL (mg/l)	PHOS (mg/l)	NOX (mg/l)	DEPTH OF WATER IN WELL (in.)	SOURCE OF DESIGNED AS
I-76	J & L Valve Fitting Co.	Comm.	Ind/Ltt.-Op.	4.1	1.8	0/OP	None		Cn&Z Sandy loam	0.7	--	--	--	--	--	--	Yes
I-77	Barrett Manor	Mult.	Ind/Ltt.-Ga.	0.6	1.2	7/OP+	None		BhA2 Sandy loam	0.9	--	6.0	60	--	--	--	No
I-78	Laurel Technology Center	Comm.	Ind/Ltt.-Wr.	2.6	2.0	7/2P+	None		&&B Loamy sand	0.9	--	--	--	--	--	--	Yes
I-79	Robinwild's Allentown Road	Comm.	Ind/Ltt.-Wr.	2.6	1.3	0/2P+	None		9/5+ dltlsh 81U2 81lt loam	--	--	--	--	--	--	--	No
I-80	Bamblewood Parcel 4	Mixed.	Ind/Ltt.-Wr.	1 2 4	1.3	1.4 0.5 1.5	0/S	None	CnC3 Sandy loam	0.9	--	--	--	--	--	--	No
I-83	Manor Farm Sub. Parts	Comm.	Ind/Ltt.-Tr.		1.6	1.0	0/S	4'-0" comp plt	CnC2 Sandy loam	5.0	0.75	32.3	30	27	--	--	No
										0.0	--	--	--	--	--	--	Yes

INFILTRATION TRENCH WITH SUMP PIT PRE-TREATMENT CONTROL

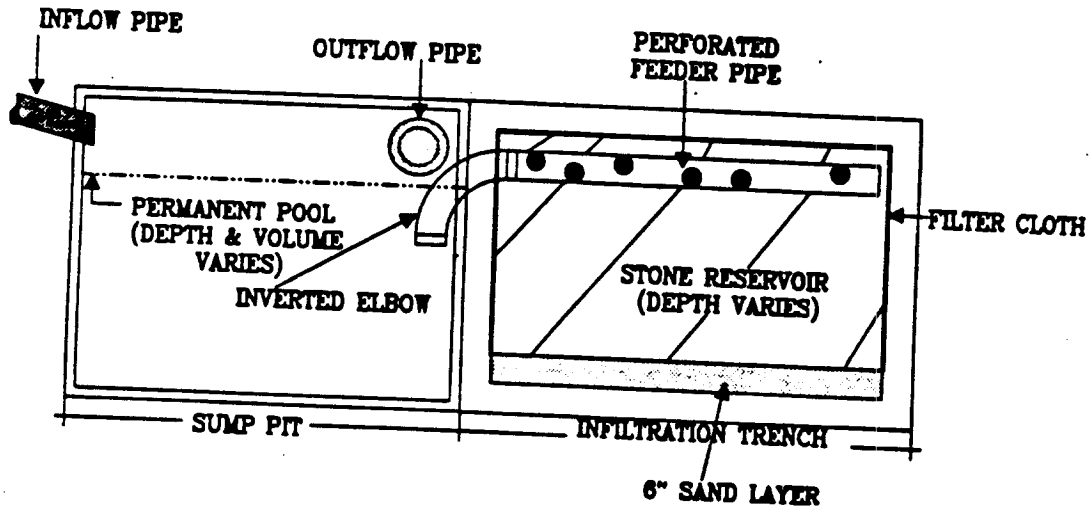

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TABLE 3 INFILTRATION TRENCHES WITH SUMP PITS: RESIDUAL SEDIMENT VOLUME, PARTICLE SIZE, AND QUANTITY OF OIL PRESENT

Site No.	Name	Sump Pit Str. No.	Age of Str. (yrs)	D.A. To Str. (ac)	Sump Pond Depth (ft)	Sump Pond Vol. (cuft)	Avg. Depth of Sediment (in)	Volume of Sediment(cuft)	Residual Particle Size Distribution: Clay	Silt	Coarse Deposits	Relative Quantity of Oil in Sediment (Index)	Avg. Oil Layer Thickness (in)	Total Depth (in)	Percent Porosity (Average Values)	Oil - To - Water Ratio in Sediment
1-1	Balboa Parcels A & B		3.0	1.4	3.0	110.0	3.0	22.4	0.00	0.30	0.70	1	0.0	30.0		
1-2	- - -		3.0	1.4	1.5	30.0	1.5	22.4	0.70	0.30	0.00	1	0.0	11.0		
1-4	Balboa Cmns. Or.		3.0	1.4	3.1	111.1	3.0	0.4	0.70	0.30	0.00	1	0.0	11.0		
1-5	Beach Ave. Comm.		3.1	0.1	4.0	44.0	-	-	-	-	-	1	0.0	11.0		
1-10	Columbia Bldg.		1.0	1.0	7.1	200.0	3.0	0.0	-	-	-	1	0.0	30.0		
1-11	Columbia 01		1.0	1.0	7.1	200.0	3.0	0.0	-	-	-	1	0.0	30.0		
1-12	Coral Springs Sq.		0.6	0.1	4.1	80.0	2.1	0.0	0.30	0.60	0.10	1	0.0	30.0		
1-13	Cherry Lane Cir. Park		1.0	1.7	4.1	80.1	2.0	2.4	0.00	0.30	0.70	1	0.0	30.0		
1-15	- - -		1.0	1.0	0.0	70.0	2.0	0.0	0.00	0.30	0.70	1	0.0	30.0		
1-17	College Park		0.6	0.1	7.0	110.1	2.0	0.0	-	-	-	1	0.0	30.0		
1-18	Elaine Center		1.0	0.1	5.0	170.0	2.0	0.0	0.00	0.11	0.00	1	0.0	30.0		
1-19	Estero Lodge		1.0	0.1	3.1	30.0	1.0	0.0	0.30	0.30	0.00	1	0.0	30.0		
1-21	Largo/Oxford Parcel L		1.0	0.0	4.0	140.1	2.1	0.0	0.30	0.30	0.00	1	0.0	30.0		
1-22	Franklin Terr.		0.0	0.0	0.0	130.0	2.1	0.0	0.30	0.30	0.00	1	0.0	30.0		
1-23	Hollywood on the Hill		0.0	0.0	0.0	-	0.0	0.0	0.30	0.30	0.00	1	0.0	30.0		
1-24	Indian Creek Village		1.0	0.1	4.1	30.0	0.1	0.0	0.30	0.30	0.00	1	-	0.0		
1-34	- - -		0.0	1.0	1.0	30.1	1.0	0.7	0.30	0.30	0.00	1	0.0	11.0		
1-35	Indian Queen Estate		0.0	1.0	1.0	30.1	1.0	1.4	0.30	0.30	0.00	1	0.0	11.0		
1-37	- - -		0.0	1.0	1.0	30.1	1.0	1.4	0.30	0.30	0.00	1	0.0	11.0		
1-31	Kenning		2.0	0.0	3.0	200.0	2.1	0.0	0.30	0.30	0.00	1	0.0	30.0		
1-32	Kipton		2.0	0.0	3.0	77.1	2.1	0.0	0.30	0.30	0.00	1	0.0	30.0		
1-33	Point Comm		2.0	0.0	3.0	30.0	0.0	0.0	0.30	0.30	0.00	1	0.0	30.0		
1-45	Al's Supermarket		2.0	0.0	2.1	30.6	2.1	0.0	0.30	0.30	0.00	1	0.0	11.0		
1-46	Ashwood Center		2.0	0.0	2.1	30.6	2.1	0.0	0.30	0.30	0.00	1	0.0	11.0		
1-47	Cherry Lane Par.26		2.1	0.0	0.0	0.0	0.0	0.0	0.30	0.30	0.00	1	0.0	11.0		
1-48	- - -		0.1	0.0	0.0	0.0	0.0	0.0	0.30	0.30	0.00	1	0.0	11.0		
1-49	Hampton Park Lot 13		0.1	0.0	0.0	30.1	2.1	0.0	0.30	0.30	0.00	1	0.0	11.0		
1-50	Palm Club		0.1	0.0	0.0	0.0	0.0	0.0	0.30	0.30	0.00	1	0.0	11.0		
1-51	Belleville Terr.		0.0	0.0	0.0	30.0	1.0	0.0	0.30	0.30	0.00	1	0.0	11.0		
1-53	Manor Point Ben. Park		1.0	1.0	2.0	130.0	0.0	2.4	0.00	0.00	0.11	1	0.0	30.0		
MAXIMUM VALUE																
MINIMUM VALUE																
MEAN																
MEDIAN																
VARIANCE																
COEFFICIENT OF VARIATION (CV)																
STANDARD DEVIATION																
STANDARD ERROR																
NUMBER OF OBSERVATIONS = N																

KEY ABBREVIATIONS:
Comm. = Commercial
SF = Single Family Residential
TH = Townhouse
Apt. = Apartments

* - Sediment Depth Approximated

OIL IN SEDIMENT INDEX:
1 - None
2 - Very Light
3 - Light
4 - Moderate
5 - Heavy

R0055270

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II. TABLE 4. INFILTRATION BASINS: FIELD SURVEY RESULTS

Site No.	Name	Land Use	Str. No.	Age of Str. (yrs)	D.A. To Str. (ac)	Basin Surface Area (ac)	Soil Textural Class	Avg. Depth of Standing H2O (in)	Secchi Depth 1/ (in)	TDS (mg/l)	Air Temp. (°c)	H2O Temp. (°c)	Emergent Wetland Vegetation Coverage 2/ (%)	Aquatic/Wildlife Habitat Value (index)	Working As Designed
I-5	Bradco Corp.	Ind.	1	5.1	1.8	0.04	Urban Land	12.0	-	-	-	-	5	1	No
I-29	Mastermel Trust	Comm.	1	2.5	2.1	0.12	Loam	24.0	12.0	50	31	28	5	1	No
I-29	" "	Comm.	2	2.5	1.4	0.08	Loam	12.0	12.0	50	31	23	80	2	No
I-29	" "	Comm.	3	2.5	1.7	0.10	Loam	10.0	18.0	100	31	27	30	1	No
I-33	Oakcrest Plaza	Comm.	1	3.5	1.8	0.10	Silt Loam	10.0	24.0	60	24	24	10	2	No
I-43	Tick Tock Plaza	Comm.	1	2.7	3.2	0.10	Urban Land	6.0	6.0	40	33	30	70	1	No
I-44	Virginia Manor Park 3/	Comm.	1	2.6	2.4	0.08	Silt Loam	0.0	-	-	-	-	10	1	No
I-51	Buckledge Park	Inst.	1	3.2	0.8	0.04	Silt Loam	6.0	10.0	90	29	23	40	1	No
I-54	Cherry Lane Par. #2	Comm.	1	4.1	3.3	0.12	Silt Loam	20.0	20.0	190	23	24	15	1	No
I-54	" " "	Comm.	2	4.1	1.7	0.12	Silt Loam	12.0	12.0	60	23	24	10	1	No
I-67	Dentrine	SF	1	0.5	9.3	0.18	Gravel-Sandy Loam	12.0	15.0	60	35	28	90	3	No
I-77	Sarratt House	Inst.	1	0.6	1.2	0.03	Sandy Loam	6.0	6.0	60	26	24	95	1	No
MAXIMUM VALUE				5.1	9.3	0.18		24.0	24.0	190.0	35.0	30.0	95	3	
MINIMUM VALUE				0.5	0.8	0.04		0	6.0	40.0	23.0	23.0	5	1	
MEAN				2.8	2.6	0.1		11.5	13.5	76.0	28.6	25.7	38.3	1.3	
MEDIAN				2.65	1.8	0.10		12.0	12.0	60	30	24	23.5	1	
VARIANCE				1.6	4.6	0.0		41.4	30.7	1744.0	16.0	7.0	1155.6	0.4	
COEFFICIENT OF VARIATION (%)				45.4	84.1	54.2		36.0	41.0	54.9	14.3	10.3	88.7	46.8	
STANDARD DEVIATION				1.3	2.2	0.0		6.4	5.5	41.8	4.1	2.6	34.0	0.6	
STANDARD ERROR															
NUMBER OF OBSERVATIONS				12	12	12		12	10	10	10	10	12	12	

KEY ABBREVIATIONS:
Ind. = Industrial
Comm. = Commercial
Inst. = Institutional
SF = Single Family

AQUATIC/WILDLIFE HABITAT VALUE INDEX:
1 = Low (basin size, size of perm pool, vegetation and/or BMP location severely limiting to fauna)
2 = Moderate (basin size, size of perm pool, vegetation and/or BMP location mod. limiting to fauna)
3 = High (basin size, size of perm pool, vegetation and/or BMP location capable of supporting diverse faunal community)

1/ = Except for I-29 str. 11, Secchi Depth = Max. water depth.

2/ = Percent of basin surface area covered with emergent plants (e.g. - cattails).

3/ = Basin has 90ft. long veg. filt. for pretreatment.

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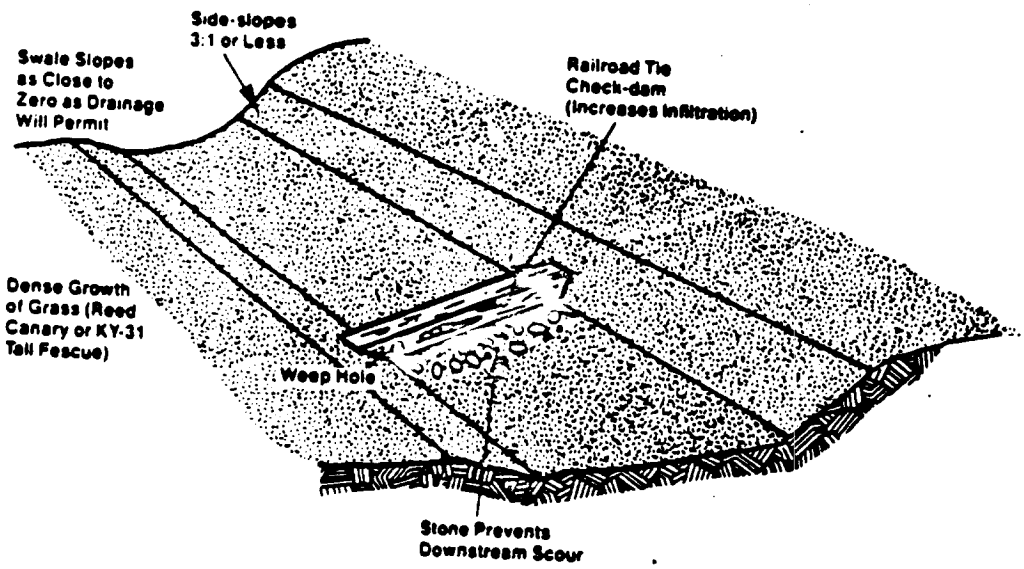
III.

Schematic Design of an Enhanced Grassed Swale



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N.

Table3. Summary: Prince George's County Extended Detention Dry Pond Field Survey Results

Site No.	Name	Land Use	Pond Location	Age of System (yrs.)	D.A. to Str. (Ac.)	Date Inspected	Watershed Imperviousness S	Watershed Imperviousness Area	ED Pond Surface Area (ac.)	Level of Control Water Quality	Level of Control Water Quality (Surface ac)	Design ED Pond (Elev.)	ED Control Opening (in.)	Approx. Trashline Elev. (ft.)	Min. Flow Path Length (ft.)	Design Micro-Pool Depth (ft.)	Max. Depth of Standing Water (ft.)	Trash Rack/ED Anti-Clogging System
S-1	Bellevue Property	Comm.	On	2.0	31.0	10/7*	65	16.4	0.60	2.10	0.70	49.0	3.0 dia.	1.0	350.0	N/A	2.1	12" pref. PVC manhole w/ 3/16" holes
S-2	Cherry Hill	S.F.	Off	1.1	14.0	10/6*	30	4.4	0.12	2.10	0.35	50.0	3.0 dia.	3.0	75.0	1.3	3.3	6" bank. pref. pipe to gravel jacket
S-3	Bus Lot by the Park	S.F.	Off	0.5	32.2	10/7*	35	12.2	0.30	2.10, 3.00	0.30	54.0	3.0 dia.	1.0	45.0	N/A	0.0	3/2 round mop w/ 1" holes
S-4	Lower of Bonds	Comm.	Off	2.0	14.0	10/6**	65	9.2	0.34	2.10	0.50	52.0	3.0 dia.	1.0	350.0	N/A	0.0	3/2 round mop w/ 1" holes
S-5	North Hampton Pond 'F'	Apt.	Off	3.3	33.6	10/6	34	7.0	0.30	2.10	0.50	54.0	3.0 dia.	1.3	170.0	N/A	0.0	6" pref. PVC manhole w/ 3/8" holes
S-11	Washington Business Park																	
A.	Pond #1	Comm.	Off	3.0	0.3	10/7	65	0.5	0.02	2.10	0.30	4.0	2.25x2.25	0.3	10.0	N/A	0.0	6" bank. pref. PVC pipe w/ 1" holes
B.	Pond #2	Comm.	Off	3.0	3.3	10/7	65	3.3	0.20	2.10	0.30	4.0	2.75x2.75	2.3	40.0	N/A	2.6	6" bank. pref. PVC pipe w/ 1" holes
S-12	Inglewood Business Ctr.	Comm.	On	3.4	200.0	10/7	40	30.7	4.34	2.10, 3.00	3.30	30.0	30.0 dia.	0.0	600.0	N/A	0.0	Staged, orifice 3'-0" x 3'-11", 12" ctr.
S-14	Montpelier Hills #2	TH	Off	1.0	10.3	10/7*	35	6.0	0.44	2.10	1.40	30.0	12.0 dia.	1.0	40.0	N/A	0.3	12" pref. PVC mdpipe w/1" holes, grav. jack.
S-15	Indian Creek #3	Comm.-Ind.	On	0.5	101.3	9/30*	35	35.4	4.00	2.10, 3.00	1.30	30.0	6.0x24.0	4.0	1000.0	4.3	3.3	3/3 round mop w/ 1.5" holes
S-16	Indian Creek #2	S.F.-Ind.	On	0.5	1164.0	9/30*	35	443.3	3.00	2.10, 3.00	1.30	7.3	6.0x24.0	4.3	1000.0	4.0	3.0	3/3 round mop w/ 1.5" holes
S-17	Longfellow Street	S.F.-Comm.	On	0.1	120.0	10/17*	40	48.0	0.00	-	0.35	50.0	4.0 dia.	0.0	650.0	N/A	1.0	orifice, 4" ctr
Maximum Value				3.0	1164.0		65	443.3	3.00		3.30	49.0		4.3	1000.0		3.3	
Minimum Value				0.1	0.3		30	0.5	0.02		0.30	4.0		0.0	10.0		0.0	
Mean				1.9	234.6		34	56.9	1.40		0.90	33.0		1.7	342.3		1.3	
Median				1.7	31.1		30	10.1	0.30			30.0		1.0	340.0		0.5	
Variance				1.0	155764.1		479	23360.9	3.64		0.07	111.4		2.1	340340.0		1.7	
Coefficient of Variation (%)				52.7	170.4		40	157.9	233.00		32.73	46.9		60.0	300.3		98.9	
Standard Deviation				1.3	304.7		22	152.9	1.91		0.60	15.6		1.4	378.3		1.3	
Standard Error																		
Number of Observations = N				12	12		12	12						12	12		12	

Key Abbreviations

Apt. = Apartment
Comm. = Commercial
S.F. = Single Family Residential
TH = Townhouse
Ind. = Industrial

* = Date visible previous 24 hrs.
** = Date visible previous 48 hrs.
*** = Date visible previous 72 hrs.
N/A = Not applicable

Pond Location
On = On-stream
Off = Off-stream

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Table 6. Summary: Prince George's County Retention Pond General Performance

Pond No.	Name	Land Use	Pond Type	Pond Location	Age (yrs.)	D.A. in Hectares (ac.)	Pond Surface Area (ac.)	Surface Area % of D.A.	Beneficial Pondtop Present	Average Depth of Sediment (ft.)	Pond Side Present	Pond Present	Relative Quantity of Trash & Debris (Qual.)	Type of Maintenance Needed	Aquatic/Wildlife Habitat Value (Qual.)	Working As Designed
P-1	Capitol College Retest	Inst.	WP	Off	3.1	13.7	0.30	2.2	Yes	No	No	No	No	No	1.0	11	2.0	Yes
P-2	Citizens View	S.F.	AM	Off	2.0	15.1	0.50	3.3	No	No	No	No	Yes	No	2.0	10	3.0	No
P-3	Alfred W. Greenway Prop.	Comm.	BB/AM	Off	1.3	1.1	0.05	2.3	No	No	No	No	Yes	No	1.0	6.10	1.0	Yes
P-4	Agnes Subdivision	Ind.	WP	Off	2.0	2.1	0.24	2.4	No	No	No	No	Yes	No	4.0	6,8,9	1.0	Yes
P-5	Clarion Park	Comm.	WP	Off	2.0	24.3	0.40	1.6	No	No	No	No	Yes	No	3.0	6,7,8,9,10	1.0	Yes
P-6	Hampton Park Lot 29	Ind.	AM	Off	1.0	4.6	0.05	2.3	No	No	No	No	No	No	4.0	6	1.0	Yes
P-7	Landover Metro Mall Storage	Comm.	AM	Off	2.0	3.0	0.20	3.1	No	No	No	No	Yes	No	1.0	8	1.0	Yes
P-11	Modular Woods	S.F.	WP	On	4.5	170.1	0.50	0.3	Yes	Yes	Yes	No	No	No	2.0	11	2.0	Yes
P-12	Pine Hollow	Comm.	WP	On	1.5	30.6	0.30	0.9	No	Yes	No	No	No	No	4.0	6,8	1.1	Yes
P-13	Premier Center, Pnd.	Comm.	WP	Off	1.0	122.0	1.00	0.8	No	Yes	No	No	No	No	2.0	9	1.0	Yes
P-14	Rangoni Terrace	Apt.	AM	Off	2.0	2.0	0.05	2.4	No	No	No	No	Yes	No	1.0	6,9	1.0	Yes
P-15	Largo Pnd. Bus. Ctr. III	Comm.	WP	On	2.0	30.0	0.70	2.4	No	Yes	No	No	No	No	3.0	6,9,10	1.1	Yes
P-16	Shoulton Estates	Comm.	Multi	Off	1.5	9.3	0.10	1.5	No	No	No	No	Yes	No	3.0	6,9,10	1.0	No
P-17	Swan Chase	Comm.	AM	Off	2.4	3.0	0.05	1.9	No	No	No	No	Yes	No	2.0	7	1.0	Yes
P-18	Tremblay Square	S.F.	AM	Off	2.0	46.0	0.70	1.7	Yes	Yes	No	No	0.5,0.1	No	1.0	7,8,9,10	1.0	Yes
P-19	Salvation Army Addn Retnt.	Inst.	WP	Off	2.0	4.0	0.10	2.5	No	No	No	No	Yes	No	4.0	6,9	1.0	Yes
P-20	MA 95 Corp. Park #1 (Right)	Comm.	AM	On	3.0	226.0	0.50	0.2	No	Yes	No	No	Yes	No	3.0	6,9,10	2.0	No
P-21	MA 95 Corp. Park #1 (Center)	Comm.	WP	On	3.0	226.0	1.30	0.6	No	Yes	No	No	Yes	No	2.0	9	2.0	Yes
P-22	Shoulton Pond #2	S.F.	WP	On	3.0	71.2	0.70	1.1	No	Yes	No	No	Yes	No	3.0	6,9,10	2.0	Yes
P-23	Wagons	S.F.	WP	On	1.5	226.2	4.00	1.8	No	Yes	No	No	Yes	No	1.0	9	1.1	Yes
P-24	Mosquito Hills	S.F.	WP	On	2.7	116.0	0.20	0.2	Yes	Yes	No	No	0.7	No	4.0	6,7,8	2.0	Yes
MAXIMUM VALUE																		
MINIMUM VALUE																		
MEAN																		
MEDIAN																		
VARIANCE																		
COEFFICIENT OF VARIATION (%)																		
STANDARD DEVIATION																		
STANDARD ERROR																		
NO. OF OBSERVATIONS																		

KEY ABBREVIATIONS

Comm. = Commercial
Ind. = Industrial
S.F. = Single Family Residential
Apt. = Apartments
WP = Wet Pond
Multi = Extended Detention Multiple Chamber Wet Pond
AM = Artificial Marsh

OS = Off-Stream
On = On-Stream
BB = Bio-Basin
T = Tree Vista
Pen. = Partially Penned

Beneficial Pondtop Present Index
0 = None
1 = Very Slight
2 = Slight
3 = Moderate
4 = Heavy

Maintenance Needs Index
0 = Overall Pond Removal
1 = Sediment Removal
2 = Shoreline/Inflow Control
3 = Aerating/Landscape Planting
4 = Overall Structure Repair
5 = Other

Aquatic/Wildlife Habitat Value Index
1 = Low (good mix, few of grass, pond, vegetation within limit)
Needs considerable Building or Repair
2 = Moderate (good mix, few of grass, pond, vegetation within limit)
Needs considerable Building or Repair
3 = High (good mix, few of grass, pond, vegetation within limit)
Needs repair of vegetative Shore Control Planting(s)

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Table 3. [illegible]

Site No.	Name	Loc.	Loc. Type	Date Sampled	D.A. = E.P. (mi.²)	Total Sodium Adsorption Ratio	Total Magnesium Hardness (mg/L)	Total Hardness (mg/L)	Inorganic Nitrogen (mg/L)	Inorganic Phosphorus (mg/L)	Sodium Adsorption Ratio	Temperature (deg. C) Air	Temperature (deg. C) Water	Secchi Depth (ft.)	TDS (mg/l)	DO (mg/l)	PH	COD (mg/l)	Alkalinity (mg/l)
R-1	Capitol College Station	Comm.	WP	09/10	12.7	0.38	3.0	0.39	0.00	0.00	0.07	30	24	30.1	73				
R-2	Ottawa View	S.P.	AM	09/16	13.1	0.70	1.0	0.86	0.00	0.00	0.00	34	30	13.0	70				
R-3	Athens W. Community Prop.	Comm.	EBAM	09/10**	1.1	0.00	1.3	0.00	0.00	0.00	0.00	34	30	3.0	30	2.3	7.0	31.0	30.0
R-4	Apex Subdivision	Comm.	WP	09/11	9.1	0.24	4.0	0.33	0.00	0.00	0.00	37	34	5.0	30	9.3	7.0	33.0	34.0
R-5	Center Park	Comm.	WP	09/04	34.3	0.04	4.0	0.00	0.00	0.00	0.00	30	22	27.5	30				
R-6	Shoppers Park Lot #9	Comm.	WP	09/07					0.04	0.00	0.11	33	24	30.4	220	23.3			
R-7	Lindenow Manor Mini Storage	Comm.	AM	09/16	0.4	0.00	2.0	0.00			0.31	30	22	10.7	160	11.0			
R-11	Modern Woods	S.P.	AM	09/08**	2.0	0.20	2.1	0.11	0.00	0.00	0.02	33	27	12.3	80				
R-12	Penn Station Shopping Ctr.	Comm.	WP	09/11	173.1	0.00	0.0	0.00	0.00	0.00	0.00	35	32	33.0	40	10.4	9.1	31.0	30.0
R-13	Pioneer Corners, Park	Comm.	WP	09/10**	30.0	0.23	0.0	0.33	0.00	0.00	0.04	34	24	30.0	160	8.0	7.0	30.4	31.0
R-14	Sampson Terrace	Comm.	WP	09/14	122.0	1.07	2.0	0.32	0.11	0.24	0.00	30	22	30.5	110	3.0	7.0	30.2	30.0
R-16	" "	Apt.	AM	09/08	2.0	0.04	2.0	0.00	0.00	0.00	0.00	37	30	31.5	40	8.2	8.3	31.0	31.0
R-17	Loops Park Estes. Co. #1	Comm.	AM	09/08*					0.00	0.00	0.00	34	22	33.0	60				
R-18	Brandon Estates	Comm.	WP	09/07	27.0	0.17	4.0	0.14	0.00	0.00	0.00	30	24	33.0	30				
R-19	" "	Comm.	EBAM	09/08*	9.3	0.15	2.0	0.14	0.00	0.00	0.00	37	30	40.2	80	11.4	6.0	30.4	40.0
R-20	Penn Choke	Comm.	EBAM	10/08***					0.00	0.00	0.00	34	27	41.3	80				
R-21	Transition System	Comm.	AM	09/10**	2.0	0.04	2.1	0.00	0.00	0.00	0.00	30	17	33.1	70	4.0	7.1	31.0	40.0
R-22	Johnston Army Addit Subdiv.	S.P.	AM	09/16	44.0	0.33	0.0	0.73	0.00	0.00	0.00	33	22	3.0	170	1.3	6.3	41.4	40.0
R-23	Mil 95 Corp. Park #1 (Signal)	Comm.	WP	09/08	4.0	0.13	2.0	0.13	0.00	0.00	0.00	30	27	13.0	80				
R-24	" " " (Signal)	Comm.	AM	09/08	231.0	0.17	2.0	0.17	0.00	0.00	0.00	30	24	33.0	30	9.4	8.3	34.0	30.0
R-25	Mil 95 Corp. Park #1 (Lowes)	Comm.	WP	09/08					0.00	0.00	0.00	30	22	33.4	130				
R-26	" " " (Lowes)	Comm.	WP	09/08	286.0	1.34	6.0	1.10	0.00	0.13	0.00	37	33	11.3	80				
R-32	Brandon Pond #9	Comm.	WP	09/08					0.00	0.00	0.00	34	30	27.4	130				
R-33	Wingate	S.P.	WP	09/10***	71.3	0.77	4.1	0.75	0.11	0.00	0.00	33	30	33.4	130				
R-34	Mosquito Hills	S.P.	WP	09/11	230.3	4.00	7.0	4.00	0.10	0.00	0.00	34	34	17.7	30				
		S.P.	WP	09/10	114.0	0.21	2.3	0.43	0.00	0.00	0.00	30	27	9.0	130				
MAXIMUM VALUE					286.3	4.00	7.0	4.00	0.11	0.24	0.31	37	34	33.4	220	23.3	9.1	34.4	34.0
MINIMUM VALUE					0.4	0.00	1.0	0.00	0.00	0.00	0.00	30	17	3.0	30	1.3	6.3	31.0	23.0
MEAN					71.0	0.41	4.1	0.77	0.02	0.00	0.00	33.7	26.3	24.0	94.0	8.0	7.3	33.3	33.3
MEDIAN					34.3	0.20	4.0	0.33	0.00	0.00	0.00	30	30	33.4	80	9.4	7.1	33.4	34.0
VARIANCE					9110.2	1.04	3.0	1.00	0.00	0.00	0.00	33.7	13.3	144.3	1771.0	30.3	0.7	434.7	31.0
COEFFICIENT OF VARIATION (%)					134.6	144.46	44.4	177.37	34.73	334.55	176.36	60	51	30.0	44.0	30.3	11.0	61.3	11.1
STANDARD DEVIATION					95.4	1.00	1.7	1.00	0.00	0.13	0.00	3.1	3.7	12.0	42.3	5.5	0.8	20.8	3.3
STANDARD ERROR					20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
NUMBER OF OBSERVATIONS																			

KEY ABBREVIATIONS:

Comm. = Commercial
Ind. = Industrial
S.P. = Single Family
Apt. = Apartment

WP = Wet Pond
EBAM = Extended Duration Acidified Month
AM = Acidified Month

* = Rain within previous 24 hrs.
** = Rain within previous 48 hrs.
*** = Rain within previous 72 hrs.

M Penn Field Survey

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Wet Pond

Table 8 : Correlation Matrix

Category	Factor / Parameter	① Avg. Depth of Pond Sediment (Ft)	② Carlson SD Trophic Category Score	③ Aquatic/Wildlife Habitat Value (Index)	④ Pond TDS Conc. (mg/L)	⑤ Secch. Depth (m)	⑥ Percent Surface Algal Mat(s)
External	1.) Age of Pond	-0.035	0.005	0.474	0.142	0.518	0.515
	2.) D.A. (ac)	-0.011	0.521	0.407	0.302	0.435	-0.391
	3.) Watershed Imperviousness (%)	-0.209	-0.686	-0.700	0.080	0.550	0.554
	4.) Watershed Construction Activity Level (Index)	-0.100	0.120	0.180	0.080	-0.296	-0.435
	5.) Pond Environmental Setting (Index)	0.462	0.553	0.730	0.032	-0.221	-0.214
	6.) Stream Location	0.350	0.209	0.467	0.266	-0.054	-0.444
Volume Size	7.) Pond Surface Area (ac)	-0.133	0.566	0.062	0.275	-0.567	-0.295
	8.) Surface % of Catchment (%)	-0.321	0.014	-0.685	-0.342	-0.264	0.162
	9.) Max. Perm. Pool Depth (Ft)	-0.492	0.497	0.382	0.145	-0.206	-0.287
	10.) Mean Perm. Pool Depth (Ft)	-0.602	0.309	0.115	-0.231	-0.281	-0.524
	11.) Total Perm. Pool Vol. (in./imp. ac)	-0.257	0.616	-0.111	-0.139	-0.583	-0.209
	12.) Percent of Perm. Pool Vol. ≤ 2.5 Ft deep (%)	0.373	-0.166	-0.197	-0.398	0.038	0.062
	13.) Percent of Perm. Pool Vol. 2.6-4.0 Ft deep (%)	0.474	-0.249	-0.531	0.351	-0.064	0.441
	14.) Percent of Perm Pool vol. ≥ 4.1 Ft deep (%)	-0.515	0.254	0.457	-0.092	0.021	-0.336
Pond Morphometry	15.) Shoreline Length (Ft)	-0.096	0.589	0.119	0.393	-0.585	-0.172
	16.) Pond L/W Ratio	0.199	0.203	0.066	0.699	-0.155	0.474
	17.) Surface Area / Max. Depth Ratio	-0.027	0.551	0.075	0.272	-0.601	-0.310
	18.) Surface Area / Mean Depth Ratio	-0.044	0.557	0.073	0.311	-0.591	-0.273
	19.) Avg Sediment Deposition Depth (Ft)		0.223	0.310	0.183	-0.316	-0.151
Internal Design	20.) Min. Flow Path Length (Ft)	-0.263	0.557	0.013	0.341	-0.552	-0.197
	21.) x-sect Area of low flow opening	-0.224	-0.078	0.339	0.038	0.199	-0.393
	22.) Sediment Forebay / Multiple Cell	0.256	0.343	0.647	0.041	-0.133	-0.178
Biological	23.) Percent Emergent Vegetation Area (%)	0.151	-0.100	0.066	-0.288	0.195	0.359
	24.) Percent Open Water (%)	-0.151	0.100	-0.066	0.288	-0.195	-0.359
	25.) Percent Submerged Vegetation (%)	-0.294	-0.214	0.232	-0.538	0.338	-0.089

Legend

☒ - Significant Correlation ($P < .05$)

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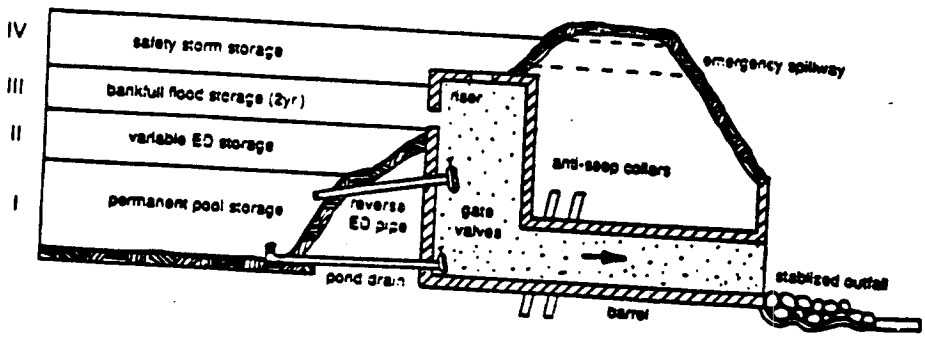
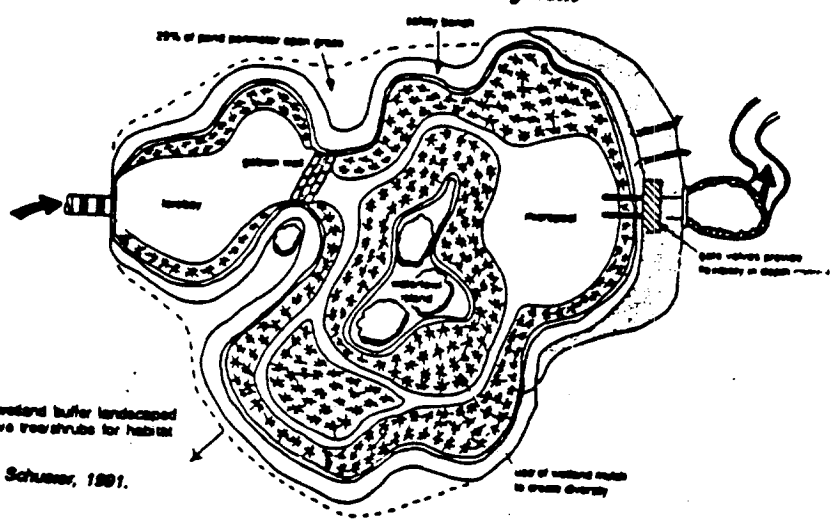
VI.

Cross-section View of a Standard ED Pond System Design



Schematic Design of an Enhanced Shallow Marsh System



Source: Schueler, 1991.

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Table 9 : Artificial Marsh Correlation Matrix

Category	Factor / Parameter	① Avg. Depth of Sediment (Ft)	② Carlson SD Trophic Category Score	③ Aquatic/Wildlife Habitat Value (Index)	④ Pond TDS Conc. (mg/L)	⑤ Secch. Depth (ft)	⑥ Percent Surface Algal Mat(s)
External	1.) Age of Pond	0.755	0.228	0.179	0.553	-0.445	0.064
	2.) D.A. (ac)	0.288	-0.132	0.775	0.177	-0.118	-0.178
	3.) Watershed Imperviousness (%)	-0.271	0.112	-0.425	0.077	0.244	-0.226
	4.) Watershed Construction Activity Level (Index)	0.053	0.146	0.892	0.159	-0.276	-0.353
	5.) Pond Environmental Setting (Index)	-0.097	0.003	0.802	-0.137	-0.271	-0.100
	6) Stream Location	0.206	-0.105	0.802	0.197	-0.186	-0.250
Volume Size	7.) Pond Surface Area (ac)	0.446	-0.168	0.275	-0.032	-0.023	0.166
	8.) Surface % of Catchment (%)	-0.200	0.386	-0.465	-0.379	0.455	-0.054
	9.) Max. Perm. Pool Depth (ft)	0.117	-0.770	0.247	-0.126	0.336	0.074
	10) Mean Perm. Pool Depth (ft)	0.191	-0.847	-0.252	0.008	0.279	0.260
	11) Total Perm. Pool Vol. (in./imp. ac)	0.475	-0.087	-0.483	-0.080	-0.094	0.546
	12) Percent of Perm. Pool Vol. ≤ 1.5 ft deep (%)	-0.028	0.873	0.058	0.299	-0.358	-0.429
	13.) Percent of Perm. Pool Vol. 1.6-4.0 ft deep (%)	-0.039	-0.895	-0.060	-0.316	0.391	0.402
	14.) Percent of Perm Pool Vol. ≥ 4.1 ft deep (%)	0.545	-0.137	-0.014	-0.083	-0.100	0.362
Pond Morphometry	15) Shoreline Length (ft)	0.494	-0.146	0.205	-0.046	-0.006	0.180
	16) Pond L/W Ratio	0.262	0.178	-0.507	0.399	0.128	-0.078
	17) Surface Area / Max. Depth Ratio	0.307	-0.061	0.289	-0.184	0.097	-0.044
	18) Surface Area / Mean Depth Ratio	0.091	-0.097	0.502	-0.218	0.137	-0.197
	19) Avg Sediment Deposition Depth (ft)		0.430	-0.035	0.710	-0.578	0.299
Internal Design	20.) Min. Flow Path Length (ft)	0.319	-0.072	0.789	0.489	-0.211	-0.332
	21.) x-sect. Area of low flow opening	0.410	-0.032	0.757	0.275	-0.220	-0.152
	22.) Extended Detention Vol. (in./imp. ac)	-0.442	-0.346	-0.033	-0.083	0.298	-0.368
	23) Extended Detention Period (hrs)	-0.453	-0.164	0.043	-0.085	0.161	-0.377
	24) Sediment Forebay / Multiple Cell	0.543	0.010	-0.229	-0.056	-0.194	0.500
Biological	25) Percent Emergent Vegetation Area (%)	0.007	0.757	-0.031	0.364	-0.533	-0.128
	26.) Percent Open Water (%)	-0.629	-0.828	-0.439	-0.533	0.865	-0.058
	27.) Percent Submerged Vegetation (%)	-0.299	-0.309	-0.229	-0.310	0.023	0.500

Legend

(T)... - Transition Criterion (... < ...)

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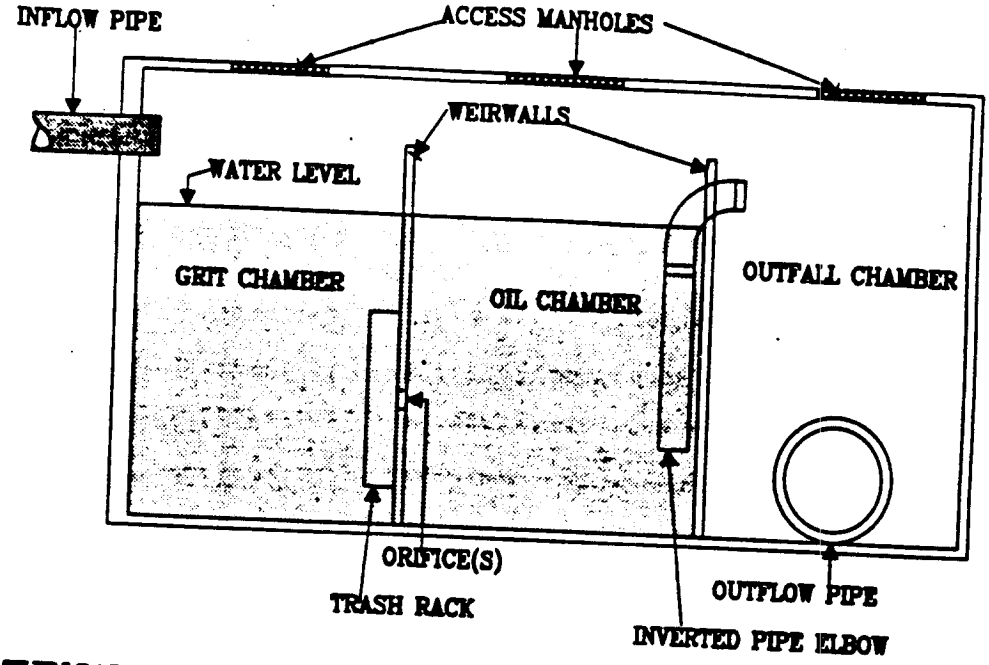
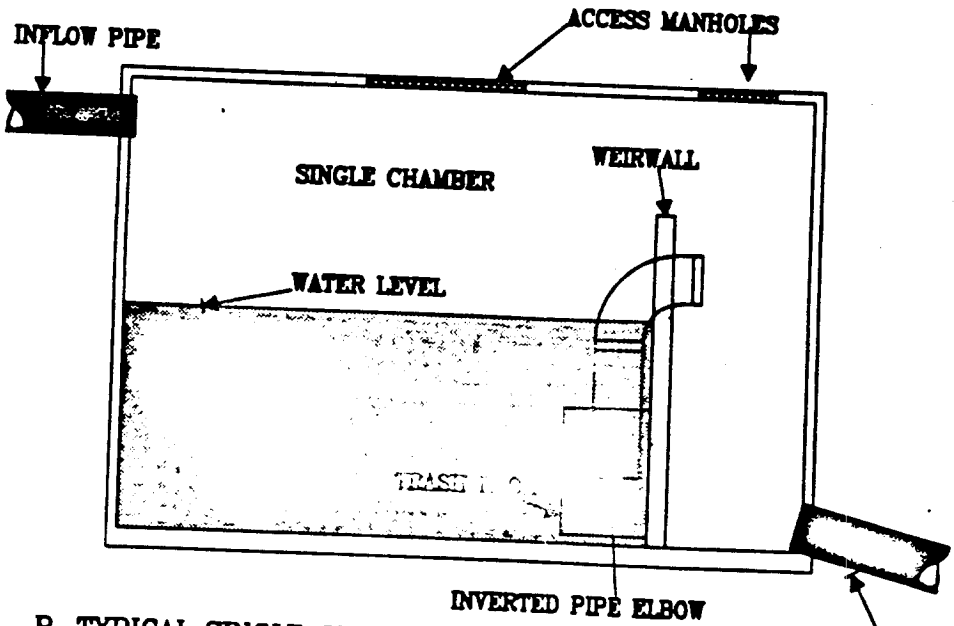
VII. FIGURE 1. SCHEMATIC OF OIL/GRIT SEPARATOR



A. TYPICAL THREE CHAMBER STRUCTURE (TYPE-II)



B. TYPICAL SINGLE CHAMBER STRUCTURE (TYPE-I)

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TABLE B8-OIL/GRIT SEPARATOR: RESIDUAL SEDIMENT VOLUME AND PARTICLE SIZE DISTRIBUTION

Site No.	Name	Land Use	Str. No.	Age of Str. (yrs.)	No. of Weir Chambers	Average Permanent Pool Depth (ft.)	Perm. Pool Vol. (cub.) Gals wh.	Perm. Pool Vol. (cub.) Oil wh.	Volume of Sediment Gals wh. (cub.)	Volume of Sediment Oil wh. (cub.)	Total Volume of Sediment (cub.)	Total Residual Particle Size Distribution b/ Coarse	Fine	Coarse Organic
G-1	Acme Iron Works Warehouse	Comm.	2	2.3	2	4.5	66.5	43.2	0.6	0.4	1.0	0.5	0.5	0.5
G-2	Belleville Supply	Comm.	3	1.0	2	3.0	133.0	90.0	0.5	10.0	11.5	0.0	0.5	0.5
G-3	Bryce Property	Comm.	4	2.3	2	4.5	203.1	265.1	2.0	2.5	3.3	0.3	0.0	0.5
G-4	Capital Plaza Subway	Comm.	1	1.5	2	3.0	200.4	196.0	2.5	1.7	4.2	0.0	0.4	0.4
G-5	Clinton Bureau	Comm.	1	3.0	1	6.0	254.0	N/A	2.0	N/A	2.5	0.0	0.0	1.0
G-6	Collington Center	Comm.	6	2.0	2	4.5	700.0	130.0	10.0	1.7	10.7	0.9	0.0	0.1
G-7	" "		10	2.0	2	4.0	300.0	90.0	25.5	0.5	24.6	0.5	0.0	0.5
G-8	Colonial Village Shops	Comm.	4	3.0	2	4.3	410.7	190.3	10.6	0.1	10.3	0.3	0.0	0.7
G-10	Bremer Heights	Comm.	2	1.0	2	4.0	213.0	91.3	0.1	0.4	0.5	0.1	0.0	0.1
G-13	Clinton View Section 2	SF	11	1.0	2	4.5	634.5	305.3	14.3	2.0	19.1	0.9	0.1	0.0
G-15	Lenox-Powder Mill Rd.	Comm.	3	1.0	2	4.0	121.0	91.5	0.5	0.3	7.6	0.6	0.1	0.1
G-16	Glen Dale Plaza	Comm.	27	2.0	2	3.0	90.0	40.0	0.6	0.5	1.3	0.0	0.5	0.5
G-17	Hollo Tract	Ind.	5	1.0	2	4.5	214.0	132.3	4.0	0.0	3.6	0.0	0.1	0.0
G-18	Inglewood Business Cent.	Comm.	205	0.7	2	3.0	120.4	122.4	2.0	1.0	3.6	0.0	0.0	0.2
G-19	" " "		207	0.7	2	4.7	60.1	32.4	2.3	0.5	2.0	0.0	0.0	0.2
G-16	" " "		205	0.7	2	4.5	84.0	34.0	2.4	0.0	4.3	0.0	0.0	0.1
G-11	" " "		210	0.7	2	5.0	90.0	80.0	4.5	4.5	9.0	0.2	0.2	0.6
G-19	Kennedy Fried Chicken	Comm.	2-3	0.5	2	5.1	122.0	44.4	0.0	0.7	0.2	0.0	0.0	0.2
G-21	McDonald's-Clinton Square	Comm.	4	1.0	2	4.5	179.6	117.7	15.0	2.3	20.1	0.7	0.0	0.2
G-22	McDonald's-N. Dumbarton	Comm.	2	1.3	2	4.5	204.0	225.0	2.6	1.0	4.5	0.0	0.0	1.0
G-23	McDonald's-Millmont Blvd.	Comm.	10	2.0	2	4.5	121.0	75.3	0.1	0.0	1.3	0.1	0.0	0.2
G-24	MD 20 Ind. Park Lot 44	Ind.	3	1.3	2	4.0	217.5	94.0	0.0	1.0	1.0	0.4	0.2	0.2
G-24	" " "		4	1.3	2	5.0	112.5	50.0	2.3	0.0	2.4	0.0	0.0	0.2
G-27	Northampton Ind. Park	Comm.	1	1.0	2	4.5	133.0	90.0	2.6	0.0	0.0	0.1	0.0	0.0
G-28	" " "		2	1.0	2	4.3	100.0	72.0	4.0	1.3	2.3	0.0	0.0	1.0
G-27	" " "		7	1.0	2	4.5	67.5	45.0	2.2	0.6	2.5	0.2	0.0	0.2
G-26	Oxon Hill Subdivision	SF	5	1.0	2	4.7	100.2	70.4	0.0	0.0	0.0	0.0	0.0	0.0
G-29	Fremont Plaza	Comm.	5	1.4	2	5.5	200.4	80.2	4.4	1.2	7.0	0.9	0.0	0.1
G-29	" "		7	1.4	2	4.0	220.2	90.5	20.3	2.0	24.0	0.0	0.0	1.0
G-30	Washington Ind. Park	Comm.	5	2.0	2	4.5	130.5	140.0	25.0	2.7	27.0	0.9	0.0	0.1
G-31	Bequest Add. to Marlboro	Comm.	1	2.0	2	4.5	67.5	45.0	2.0	0.4	2.5	0.2	0.0	0.2
G-33	Elmer-Biggs Road	Comm.	11	1.4	1	2.0	27.2	N/A	4.0	N/A	4.0	0.0	0.0	1.0
G-34	Harbour-Capitol Heights	Comm.	21	1.0	2	3.0	90.1	70.1	2.7	1.0	3.7	0.7	0.0	0.3
G-33	F.B. Int'l Comm. Cntr.	Comm.	6	2.0	2	3.3	200.5	120.0	4.0	1.7	4.3	0.7	0.0	0.3
G-35	" " " "		10	2.0	2	4.5	66.0	66.0	2.0	0.5	2.7	0.0	0.0	0.3
G-37	Police Services Complex	Ind.	3	1.3	2	3.3	100.0	72.0	2.0	0.3	14.3	0.0	0.4	1.0
G-37	" " "		4	1.3	2	4.4	200.4	72.4	20.1	0.7	20.1	0.0	0.0	1.0
G-38	Three Brothers Center	Ind.	7	1.0	2	4.7	100.0	66.0	2.5	2.7	0.2	0.4	0.1	0.2
G-39	TIA Property	Comm.	1	1.0	2	4.5	90.0	102.0	4.7	2.2	6.9	0.2	0.1	0.2
G-43	Annville Block E	Comm.	C	4.0	1	2.0	74.7	N/A	4.2	N/A	4.2	0.2	0.2	0.0
G-47	Duley Property	Comm.	2	0.5	1	4.0	200.0	N/A	10.1	N/A	10.7	0.1	0.0	0.0
G-48	DeVall Annex	Comm.	-	2.2	1	4.2	133.3	N/A	2.0	N/A	2.0	0.0	1.0	0.0
G-49	Lenox-Central Avenue	Comm.	M2	0.5	1	4.7	70.0	46.7	1.0	0.4	2.5	0.2	0.0	0.7
G-28	Pennsville Comm. Cntr.	Comm.	2	1.0	2	4.2	31.3	44.4	2.1	0.9	4.0	0.5	0.0	0.5
G-34	Lots VII. Shopping Ctr.	Comm.	7	2.3	2	4.5	204.0	140.3	10.3	2.6	20.1	0.6	0.3	0.1
G-32	Landover Baptist Church	Inst.	1	1.0	2	3.0	111.0	111.0	4.1	0.5	5.0	0.5	0.0	0.5
G-33	McDonald's-Central Avenue	Comm.	33	2.0	2	4.4	127.5	127.2	2.0	1.3	4.4	0.7	0.2	0.0
G-36	Silver Hill Mixed Use	Comm.	6	0.7	2	4.5	210.0	140.0	2.0	1.3	4.3	0.0	0.1	0.0
G-36	" " " "		10	0.7	2	4.4	130.5	134.7	N/A	N/A	N/A	N/A	N/A	N/A
G-37	Southern MD Med. Cntr.	Comm.	14	4.4	2	4.4	442.2	142.0	0.0	0.0	0.0	0.1	0.0	0.0
G-39	Tenado Ind. Park	Comm.	3	3.3	2	3.1	31.3	40.3	4.7	1.4	6.1	0.0	0.1	0.2
G-39	" " "		3	0.4	2	3.0	71.9	40.3	10.0	1.9	11.9	0.9	0.0	0.1
G-39	" " "		4	0.4	2	3.1	44.3	30.3	2.1	0.3	0.4	0.7	0.0	0.1
							MAXIMUM VALUE		25.0	10.0	27.0	0.9	1.0	1.0
							MINIMUM VALUE		0.0	0.0	0.0	0.0	0.0	0.0
							MEAN		6.9	2.0	7.0	0.4	0.1	0.4
							MEDIAN		3.0	1.3	4.3	0.3	0.0	0.1
							VARIANCE		36.6	5.3	33.6	0.1	0.0	0.1
							COEFFICIENT OF VARIATION		96.7	128.3	65.0	70.3	193.5	66.0
							STANDARD DEVIATION		5.9	2.6	7.2	0.3	0.3	0.3
							STANDARD ERROR		1.3	0.7	1.6	0.1	0.1	0.1
							NUMBER OF OBSERVATIONS		22	17	20	20	22	22

KEY ABBREVIATIONS:
Comm. = Commercial
Ind. = Industrial
Inst. = Institutional
S.F. = Single Family
N/A. = Not Applicable

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TABLE [illegible] OIL/GRIT SEPARATOR: QUANTITY OF OIL AND FLOATABLE MATERIALS PRESENT

Site No.	Name	Land Use	Str. No.	Age of Str. (yrs.)	No. of Water Chambers	Surface Oil sheen/ Grease seen Presence (Yes ch.)	Surface Oil sheen/ Grease seen Presence (No ch.)	Avg. Oil stain Height (in.) (Yes ch.)	Avg. Oil stain Height (in.) (No ch.)	Relative Quantity of Oil in Sediment (Index.) (Yes ch.)	Relative Quantity of Oil in Sediment (Index.) (No ch.)	Percent Floatables coverage (Index) (Yes ch.)	Percent Floatables coverage (Index) (No ch.)	Working As Designed	Type of Maintenance Needed
G-1	Acme Iron Works Warehouse	Comm.	2	3.3	2	Yes	Yes	12.0	12.0	5	5	4	3	Yes	6
G-2	Bakerville Supply	Comm.	3	1.0	2	No	Yes	0.0	12.0	5	4	3	3	Yes	7
G-3	Bryan Property	Comm.	4	2.5	2	Yes	Yes	2.0	13.0	5	5	3	4	Yes	6
G-4	Capital Plaza Safeway	Comm.	1	1.5	2	Yes	Yes	10.0	0.0	5	4	4	2	Yes	6
G-5	Clinton Station	Comm.	1	3.0	1	Yes	-	7.0	0.0	5	N/A	3	N/A	Yes	7
G-6	Collington Center	Comm.	6	2.0	2	Yes	Yes	3.0	1.5	5	5	3	1	Yes	7
G-8	" "		10	2.0	2	Yes	Yes	10.0	0.5	5	4	3	1	Yes	7
G-9	Colonial Village Shops	Comm.	4	5.0	2	Yes	Yes	0.0	13.0	5	5	3	4	Yes	4,7
G-10	Dunster Heights	Comm.	2	1.0	2	Yes	Yes	0.0	12.0	5	4	4	1	Yes	4,7
G-12	Clinton View Section 2	SF	10	1.0	2	Yes	Yes	2.0	3.0	3	3	3	1	Yes	7
G-13	Eaton-Powder Mill Rd.	Comm.	3	3.0	2	Yes	Yes	0.0	10.0	5	5	3	1	Yes	7
G-14	Glen Dale Plaza	Comm.	27	2.0	2	Yes	Yes	0.0	7.0	5	5	4	1	Yes	6
G-17	Hollis Trash	Ind.	5	1.0	2	Yes	Yes	2.0	1.0	3	3	3	1	Yes	7
G-18	Inglewood Business Ctrs.	Comm.	300	0.7	2	Yes	Yes	2.0	2.0	4	4	3	1	Yes	7
G-19	" " "		300	0.7	2	Yes	Yes	1.5	4.0	3	3	3	1	Yes	7
G-20	" " "		300	0.7	2	Yes	Yes	4.0	4.0	3	4	3	1	Yes	7
G-21	" " "		300	0.7	2	Yes	Yes	10.5	17.0	5	5	3	1	Yes	7
G-22	Kentucky Fried Chicken	Comm.	1-3	0.5	2	Yes	Yes	9.0	9.0	5	4	3	3	Yes	4,7
G-23	McDonald's-Clinton Square	Comm.	4	1.0	2	Yes	Yes	7.0	12.5	5	5	4	3	Yes	4,7
G-24	McDonald's-St. Barnabas	Comm.	2	1.2	2	Yes	Yes	2.5	7.0	5	5	4	3	Yes	4
G-25	McDonald's-Hillcrest Hts.	Comm.	10	7.0	2	Yes	Yes	10.0	4.0	5	5	3	1	Yes	9
G-26	MD 30 Ind. Park Lot 24	Ind.	2	1.2	2	Yes	Yes	2.5	0.0	4	4	3	1	Yes	7
G-27	" " "		4	1.0	2	Yes	Yes	2.0	12.0	5	5	3	4	Yes	4,7
G-28	Northampton Bus. Park	Comm.	1	1.0	2	Yes	Yes	0.0	12.5	5	5	3	1	Yes	7
G-29	" " "		2	1.0	2	Yes	Yes	0.5	12.0	5	5	4	1	Yes	4,7
G-30	" " "		7	1.0	2	Yes	Yes	2.5	2.5	5	5	3	1	Yes	7
G-31	Green Hill Subdivision	SF	3	1.0	2	Yes	Yes	0.0	7.0	5	5	3	1	Yes	9
G-32	Potomac Plaza	Comm.	5	1.0	2	Yes	Yes	2.0	1.5	4	4	3	1	Yes	7
G-33	" "		7	1.0	2	Yes	Yes	2.0	2.0	4	5	4	3	Yes	4,7
G-34	Washington Bus. Park	Comm.	5	2.0	2	Yes	Yes	2.5	10.5	4	5	3	3	Yes	7
G-35	Burgess Add. to Medicine	Comm.	1	2.0	2	Yes	Yes	1.0	10.5	3	5	3	1	Yes	7
G-36	Eaton-Riggs Road	Comm.	8	1.0	1	Yes	-	2.0	0.0	5	N/A	3	N/A	Yes	7
G-37	Hardiner-Capital Heights	Comm.	31	1.0	2	Yes	Yes	20.5	24.0	5	5	3	3	Yes	4,7
G-38	P.G. Int'l Comm. Ctrs.	Comm.	4	1.0	2	Yes	Yes	0.0	7.0	5	5	3	3	Yes	7
G-39	" " " "		10	3.0	2	Yes	Yes	0.0	7.0	5	5	3	3	Yes	7
G-40	Pallas Services Complex	Ind.	3	1.2	2	Yes	Yes	0.0	2.5	5	5	3	3	Yes	4,7
G-41	" " "		4	1.2	2	Yes	Yes	2.0	2.5	5	5	3	3	Yes	7
G-42	Three Southern Center	Ind.	7	1.0	2	Yes	Yes	2.0	12.0	5	5	3	4	Yes	4,7
G-43	TSA Property	Comm.	1	1.0	2	Yes	Yes	2.0	2.0	5	4	3	1	No	7
G-44	Antonville Block E	Comm.	C	4.7	1	No	-	0.0	0.0	5	N/A	3	N/A	Yes	2,5
G-45	Dulay Property	Comm.	2	0.0	1	Yes	-	2.5	2.0	5	N/A	3	N/A	Yes	9
G-46	DuVall Annex	Comm.	4	2.5	1	Yes	-	24.0	0.0	5	N/A	3	N/A	Yes	7
G-47	Eaton-Central Avenue	Comm.	102	0.0	2	Yes	Yes	20.0	20.0	5	5	3	3	Yes	7
G-48	Forestville Comm. Ctrs.	Comm.	2	1.0	2	Yes	Yes	20.0	13.5	5	5	3	3	Yes	4,7
G-49	East Vil. Shopping Ctrs.	Comm.	7	2.5	2	Yes	Yes	12.0	12.0	5	5	4	3	Yes	4,7
G-50	Landover Baptist Church	Ind.	1	1.0	2	Yes	Yes	0.5	12.5	5	5	3	1	Yes	7
G-51	McDonald's-Central Avenue	Comm.	10	2.0	2	Yes	Yes	4.0	2.0	5	5	3	3	No	7
G-52	Silver Hill Mixed Use	Comm.	6	0.7	2	Yes	Yes	10.0	0.0	5	5	3	3	Yes	7
G-53	" " " "		10	0.7	2	Yes	Yes	20.0	24.0	4	5	3	3	Yes	7
G-54	Southern MD Med. Ctrs.	Comm.	14	4.4	2	Yes	Yes	2.0	2.0	5	5	3	4	Yes	4,7
G-55	Toledo Ind. Park	Comm.	2	1.3	2	Yes	Yes	2.0	10.0	5	5	3	3	Yes	4,7
G-56	" " "		3	0.4	2	Yes	Yes	7.0	2.0	5	5	3	4	Yes	4,7
G-57	" " "		4	0.4	2	Yes	Yes	0.0	2.5	5	5	3	3	Yes	7
MAXIMUM VALUE								24.0	20.0	5.2	5.0	5.0	5.0		
MINIMUM VALUE								0.0	0.0	1.0	1.0	1.0	1.0		
MEAN								4.0	6.5	4.3	4.3	2.5	2.3		
MEDIAN								2.0	7.0	5	5	3	3		
VARIANCE								44.5	44.0	1.5	1.3	1.7	2.1		
COEFFICIENT OF VARIATION (%)								112.5	70.4	30.5	30.1	34.5	42.7		
STANDARD DEVIATION								6.0	6.6	1.2	1.1	1.3	1.3		
STANDARD ERROR															
NUMBER OF OBSERVATIONS = 30								30	40	30	40	30	40		

KEY ABBREVIATIONS:
Comm. = Commercial
Ind. = Industrial
Inst. = Institutional
S.F. = Single Family

OIL IN SEDIMENT AND FLOATABLES INDEX:
1 - None
2 - Very Light
3 - Light
4 - Moderate

MAINTENANCE/REPAIR NEEDED:
6 - Floatables Removed (Recommended when below 20% of surface covered with floating debris)
7 - Sediment Removed (Recommended when 1" or more of sediment present)
8 - Structural Repair
9 - [illegible]

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Date: 10/17/91
Observer: John Galli (MWCOG)

Stormflow Monitoring Chronology for Decatur Heights Oil/Grit Separator (G-10)

Time	Observation/Measurement
1440 Hrs.	• Secchi Depth - 22cm grit chamber, 22 cm oil chamber TDS - 40 mg/L grit ch., 40 mg/L oil ch. Water depth - 4'-9" grit ch., 4'-9" oil ch.;
* 1453 Hrs.	• Released dye capsule #1 into stormwater runoff flowing along curb (approx. 8 ft. from throat inlet)
	• Dye immediately mixed with runoff and flowed into grit chamber;
1457 Hrs.	• Green dye observed covering surface of grit chamber (which contained moderate amount of floatables);
	• No dye observed in oil chamber;
	• Dye strength in girt chamber is generally weak;
1500 Hrs.	• Released 2nd dye capsule along curb;
* 1512 Hrs.	• Green dye observed in oil chamber - covers approx. 15% of surface area (concentrated in front, right hand corner near M.H. Steps).
1515 Hrs.	• Discharge from elbow into outfall chamber is 13.6 gal/min.. Rainfall intensity is light;
	• Photo ref. #12 = green dye in grit chamber;
* 1518 Hrs.	• Rainfall intensity increased to moderate level;
	• Water in grit chamber slightly more turbulent at point of inflow, oil chamber - quiescent;
** 1519 Hrs.	• Light trace of green dye observed flowing into outfall chamber (chamber # 3);
	• Photo ref. # 15 = white bucket with green dye water taken from outfall chamber;

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10/17 Field Monitoring of G10 Cont'd.

Time	Observation/Measurement
	• Photo ref. # 16 = green dye flowing out of elbow;
1524 Hrs.	• All three chambers bright green (ie - full strength), complete mixing/stasis appears to have been achieved;
	• Photo ref. # 17 = bright green dye in oil chamber;
1530 Hrs.	• Discharge from elbow into outfall chamber is now 60.0 gal./min (discharge rate basically unchanged from 1520 Hrs.);
1532 Hrs.	• Photo ref. # 19 = green dye in outfall chamber
1539 Hrs.	• Permanent Pool/Water depth: grit chamber - 4'-10", oil chamber 4'-9", outfall chamber - 12"; Note, 1 in. head difference between grit and oil chambers;
	• Avg. sediment depth: (based on 4 measurements) grit chamber - 3.0" oil chamber - 0.5"
1545 Hrs.	• Rainfall intensity has slacked-off to very light drizzle;
1550 Hrs.	• Discharge from elbow into outfall chamber is 15.0 gal/min.;
1600 Hrs.	• All chambers still bright green;
1600 - 1620 Hrs.	• Rain stopped. Little runoff entering O/G separator;
1620 - 1720 Hrs.	• Rainfall intensity moderate;
1720 Hrs.	• Green dye still visible in grit chamber, but strength greatly reduced (approx. 30% of maximum);
	• Oil chamber is still green. Dye strength is approx. 40-50% of maximum;
	• Light trace of dye still visible in discharge from elbow into outfall chamber.
	• Discharge from elbow approx. the same as that of 1530 hrs.
1730 Hrs.	• Closed all manhole covers.

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10/17 Field Monitoring of G10 Cont'd.

Miscellaneous:

- Dye used is marine distress type;
- Approx. 0.25 in of rain fell between 1440 and 1730 Hrs.;
- 1 Liter water sample collected from each chamber prior to release of dye;
- All three chambers contained significant oil sheens. Discharge from oil chamber to outfall chamber relatively clear, low to mod. amt. of suspended solids with oil globules noted;
- Normal permanent pool depth for G-10 is 4'-7";
- Sediment depths on 10/17 almost identical to those recorded on 5/13;
- 3 ft. deep sink hole has developed approx. 12' downslope of the outfall chamber. Green dye observed flowing through bottom of sink hole.
- Rescued small snapping turtle swimming in grit chamber.

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VIII. Table/Summary: Prince George's County Dry Pond Background Survey Results

Site No.	Name	Land Use	Pond Location	Age (Yrs)	D.A. Ac. (ac)	Pond Surface Area (ac)	Level of Quantity Control	Partial Water Quality Benefits	Watershed Impervious S	Watershed Impervious A.C	Maint. Bench Present	Pilot Channel Tip	Pond Fenced	Relative Quantity Trash & Debris (Index)	Type of Maintenance	Wildlife Habitat Value (Index)	Working As Designed
D-1	Branch Ave. Plaza	Inst.	Off	2.5	10.1	0.40	2,10,100	No	35.0	6.7	No	Grass/Riprap	No	2	6	1	Yes
D-4	Cherryvale	SF	Ga	1.7	100.3	0.50	2,10,100	No	20.0	27.3	No	None	No	1	11	3	No
D-5	Deer pond	Comm.	Off	2.8	4.8	0.20	2,10,100	No	75.0	3.6	No	Concrete	No	2	7	1	Yes
D-9	Md. Corporate Center	Ind.	Ga	2.8	60.3	1.20	10,100	Yes	50.0	34.7	No	Grass	No	2	8	3	Yes
D-10	Newport Towns	TH	Off	3.5	22.1	0.40	10,100	Yes	45.0	9.0	No	None	Yes	2	7,8,9	1	No
D-11	Parcel "B" Add. to Pleasant	Comm.	Ga	3.9	12.5	0.17	2,10,100	No	80.0	80.0	Yes	Concrete	No	4	6,7,8,9,10	1	No
D-12	Princess Garden Ctr.	Inst.	Off	2.8	5.0	0.60	2,10	No	35.0	1.8	No	Rip-rap	No	2	7,8, 9	1	Yes
D-13	Pebble Storage	Comm.	Off	1.3	3.7	0.60	2,10,100	No	90.0	3.30	No	None	Yes	2	8,9,10	1	No
D-14	Robert H. Keiffer	Comm.	Off	3.0	5.0	0.60	10,100	No	70.0	1.40	No	None	Yes	2	8,9	1	Yes
MAXIMUM VALUE				3.9	40.3	0.6			90.0	34.7				4.0		3.0	
MINIMUM VALUE				1.3	0.0	0.0			0.0	1.4				1.0		1.0	
MEAN				2.7	15.4	0.2			52.2	11.0				2.1		1.4	
VARIANCE				0.6	416.3	0.0			764.7	126.5				0.5		0.7	
COEFFICIENT OF VARIATION (%)				28.6	132.6	70.0			52.8	108.5				34.9		57.6	
STANDARD DEVIATION				0.6	20.4	0.2			27.6	14.2				0.7		0.8	
STANDARD ERROR																	
NO. OF OBSERVATIONS				9	9	9			9	9				9		9	

KEY ABBREVIATIONS:

Comm. - Commercial
Ind. - Industrial
S.F. - Single Family Residential
Apt. - Apartment

Off - Off-stream
Ga - Ga-stream
NS - Not Significant
* - Gate Valve
Post - Partially Fence of

Trash/Debris Quantity Index:

1 - None
2 - Very Light
3 - Light
4 - Moderate
5 - Heavy

Maintenance/Repair Needed:

6 - General Trash Removal
7 - Sediment Removal
8 - Erosion/Sediment Control
9 - Mowing Aesthetic Planting
10 - Control Resource Repair/Maintenance
11 - None

Aquatic/Wildlife Habitat Value Index:

1 - Low (pond size, size of perm. pool, vegetation and/or BMP location extremely limiting to forms)
2 - Moderate (pond size, size of perm. pool, vegetation and/or BMP location moderately limiting to forms)
3 - High (pond size, size of perm. pool, vegetation and/or BMP location capable of supporting diverse forms/ community)

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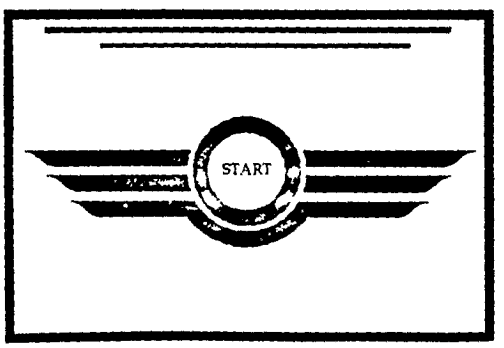

R0055287

KENNETH L. EDWARDS
GENERAL MANAGER-CHIEF ENGINEER

1995 MARKET STREET
RIVERSIDE, CA 92501-1719
(909) 275-1200
(909) 788-9965 FAX

RIVERSIDE COUNTY FLOOD CONTROL
AND WATER CONSERVATION DISTRICT
January 3, 1995

Mr. Gerard J. Thibeault
Santa Ana Regional Water
Quality Control Board
2010 Iowa Avenue, Suite 100
Riverside, CA 92507-2409

Dear Mr. Thibeault: Re: NPDES Permit Application

On behalf of the Riverside County Flood Control District and the Cities and Countyof Riverside County within the Santa Ana drainage area, we are submitting the enclosed application for the renewal of our NPDES municipal stormwater permit. Our existing NPDES permit (Order 90-104), which expires on July 1, 1995, requires us to submit for renewal 180 days before expiration.

This application addresses the requirements listed in the our existing NPDES permit and also addresses the October 11, 1994 "Municipal Stormwater Resources Management Plan Components" guidance prepared by the Regional and State Board staffs. A similar application for permit renewal for the Santa Margarita area of Riverside County will be submitted to the San Diego Regional Water Quality Control Board (RWQCB) by January 17, 1995.

There are three items presented in the application that I would like to note to you in this letter as follows:

1. The area currently covered by the existing permit includes all of Riverside County within the jurisdiction of the Santa Ana RQWCB. We have, of course, been concentrating our efforts in the cities and urbanized areas of the County. We wish to continue to focus our resources on these 'municipal areas of greatest concern'. To address this objective, a set of criteria was developed which denotes areas not within the jurisdiction of the permittees (Federal and State facilities), excluded from coverage under the stormwater program (agricultural operations), or not within the intent of the municipal program (open space and vacant undeveloped properties). Our application proposes that the new permit include a reference to these three criteria stating that our programs need not apply to them.

2. We have included in the application a proposed permit for your consideration. The proposed permit is written to reference the plans and documents that we have already developed during the current permit period. This proposed permit (modified for that area) will be presented to the San Diego RWQCB in order to promote consistency between the two permit areas.

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3. Opportunities for coordinating some municipal stormwater programs on a regional, State-wide and national level are currently under consideration and may become available during the next permit period. These opportunities currently include public education and stormwater sampling. The application and the proposed permit provide the flexibility for modifying compliance programs in order to join the coordinating efforts as they become available.

As noted in our discussions with Ms. Pavlova Vitale of your office, additional implementation assistance will be needed for the permittees. Following submittal of this application, we will begin preparation of individual implementation matrices for each of the permittees. Two types of matrices will be provided. The first matrix will identify all of the compliance best management practices (BMPs), department(s) responsible for implementation, references for program requirements, schedule and man-hour requirements. The second type of matrix will be similar to the first; however, it will identify for each department, all of the BMPs for which they have implementation responsibility and the other information provided in the first matrix. We believe that these matrices will facilitate understanding and implementation of the permit requirements and the municipal stormwater program.

Based on our conversations with Ms. Vitale, we understand that the specific provisions of the application will be open to discussion and comment through May of 1995. During that time we will provide any additional information requested.

I would like to thank you and your staff for your continued cooperation and support which you have provided to us and the other permittees in this program. We look forward to working with you in the development and implementation of the permit programs. If you have any questions, please call me at 909/275-1250 or Jason Christie at 909/275-1273.

Very truly yours,

Kenneth L. Edwards

KENNETH L. EDWARDS
General Manager-Chief Engineer

c: Co-permittees
Bob Collacott
Woodward-Clyde

JRC:slj
rcfc\407

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NPDES MUNICIPAL STORMWATER APPLICATION FOR PERMIT RENEWAL

TO

SANTA ANA REGIONAL WATER QUALITY CONTROL BOARD
STATE OF CALIFORNIA
JANUARY 3, 1995

BY

THE FLOOD CONTROL DISTRICT, COUNTY, AND CITIES OF RIVERSIDE COUNTY

SANTA ANA WATERSHED

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SECTION 1

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1.1 MUNICIPAL STORMWATER NPDES PERMIT PROGRAM

1.1.1 Federal NPDES Stormwater Regulations

In 1987 Congress enacted the Water Quality Act (WQA) which amended portions of the Clean Water Act (CWA) and set requirements for permitting stormwater runoff. Section 402(p) of the CWA required that the United States Environmental Protection Agency (USEPA) establish regulations setting forth a program for National Pollutant Discharge Elimination System (NPDES) applications and corresponding permits for discharges from municipal and industrial separate storm drain systems. USEPA published its draft regulations in December 1989 for review and comment.

The Final Rule for NPDES Permit Application Regulations for Storm Water Discharges was published on November 16, 1990. The Final Rule specifies who is covered by the regulations; prescribes a variety of required information-gathering, planning, and reporting activities; and sets forth a schedule for compliance with the two-part permit application requirements. The Final Rule also sets forth specific application requirements for identified industries.

1.1.2 Stormwater NPDES Permitting in California

In most states, including California, the NPDES permitting program is administered at the state level, rather than by USEPA. California's Porter-Cologne Water Quality Control Act established the State Water Resources Control Board (SWRCB) and the system of nine Regional Water Quality Control Boards (RWQCBs) (Section 13000, "Water Quality," et seq., of the California Water Code). The SWRCB sets statewide policy and, together with the RWQCBs, implements state and federal laws and regulations, including the NPDES program.

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1.1.2.1 Municipal Stormwater NPDES Permitting

Prior to publishing of the Final Rule, representatives from USEPA's Region IX office and the SWRCB worked with many local municipal agencies (especially in Southern California) and encouraged them to seek "early" NPDES stormwater permits before the final regulations were promulgated. The objective was to give the municipal agencies (as permittees) and the respective RWQCBs the flexibility to tailor the permit requirements to conditions in California while meeting the statutory requirements of the CWA. It was also viewed as a means of facilitating prompt implementation of municipal stormwater management programs, rather than waiting for two or more years for the two-step permitting process.

1.1.2.2 Industrial Stormwater NPDES Permitting

To implement the industry-related provisions of the federal stormwater regulations, the SWRCB adopted the General Industrial Activities Stormwater Permit (Industrial Permit). The Industrial Permit mandates that regulated industries must file for coverage, prepare and implement a stormwater pollution prevention plan (SWPPP) and a monitoring program, and report annually. The monitoring program requires dry-weather observations, wet-weather observations, and stormwater sampling. Industrial facilities that discharge stormwater to a municipal storm drain system must also comply with additional stormwater requirements established by the municipality where the facility is located.

1.1.2.3 Construction Stormwater NPDES Permitting

To implement the construction-related provisions of the federal stormwater regulations, the SWRCB adopted the General Construction Activities Stormwater Permit (Construction Stormwater Permit). The Construction Stormwater Permit currently applies to projects which disturb five or more acres of land area. In the future, in response to a lawsuit by the National Resources Defense Council and a decision by the Ninth Circuit Court of Appeals, the USEPA is expected to issue new regulations which may reduce the five-acre threshold.

The Construction Stormwater Permit mandates that regulated projects file for coverage and prepare a SWPPP and a monitoring program. Unlike the Industrial Permit, the Construction Stormwater Permit does not require stormwater sampling. However,

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dischargers are required to conduct regular visual inspections of the construction site to assess if the stormwater quality controls identified in the SWPPP are functioning properly and if additional controls are needed. As with the Industrial Permit, construction sites that discharge stormwater to a municipal storm drain system must also comply with additional stormwater requirements established by the municipality where the construction site is located. Since most construction is primarily regulated at the local level, the SWRCB strongly encourages management programs associated with municipal stormwater NPDES permits to require construction projects to comply with the provisions of the Construction Stormwater Permit and to develop and enforce local policies and ordinances that address stormwater quality from construction sites.

1.2 RIVERSIDE COUNTY MUNICIPAL STORMWATER NPDES PERMITS

Portions of Riverside County fall under the jurisdiction of three RWQCBs. Roughly, the northwest quarter of the county falls under the jurisdiction of the Santa Ana RWQCB; the southwest quarter falls under the San Diego RWQCB; and the eastern half falls under the Colorado River Basin RWQCB.

In May 1990, the Riverside County Flood Control and Water Conservation District (RCFC&WCD) and the County of Riverside (County) joined with the cities of Beaumont, Corona, Hemet, Lake Elsinore, Moreno Valley, Norco, Perris, Riverside, and San Jacinto to prepare and submit an application for an NPDES municipal stormwater discharge permit for the Santa Ana region of the county. An "early" permit was issued in July 1990 by the Santa Ana RWQCB (Board Order 90-104). That permit is referred to throughout this document as the Santa Ana Permit. On July 10, 1992, the newly incorporated cities of Calimesa and Canyon Lake were added to the Santa Ana Permit. The RCFC&WCD is the Principal Permittee, and the remaining 11 municipalities and the County are considered Co-Permittees. The Principal Permittee and the Co-Permittees are referred to collectively as the Permittees. A copy of the Santa Ana Permit is included as Appendix A.

In June 1990, the RCFC&WCD and the County joined with the City of Temecula to prepare and submit an NPDES permit application for an area-wide stormwater discharge permit for the Santa Margarita region of the county. An "early" permit for this area was issued in July 1990 by the San Diego RWQCB (Board Order 90-46). On May 18, 1992, the

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City of Murrieta was added to that permit. The RCFC&WCD is the Principal Permittee, and the two municipalities and the County are considered Co-Permittees.

On May 16, 1994, a Part II Municipal Permit Application for compliance with the federal NPDES municipal stormwater regulations was submitted to the Colorado River Basin RWQCB for the eastern areas of Riverside County. The co-applicants included the RCFC&WCD, the County, and the cities of Banning, Cathedral City, Coachella, Desert Hot Springs, Indian Wells, Indio, La Quinta, Palm Desert, Palm Springs, Rancho Mirage, and the Coachella Valley Water District. As of this writing, no response to this application has been received from the Colorado River Basin RWQCB.

1.3 MISSION STATEMENT

The Permittees of the Riverside County municipal stormwater NPDES permits are committed to a cooperative program of pollution control measure activities which reduce or eliminate pollutants in stormwater to the maximum extent practicable. This program minimizes the impact on public and private resources and maximizes the benefits to the community by improving the environment. The program emphasizes pollution prevention, control measure activities, utilization of existing resources and programs, and coordination with regional and state compliance activities.

1.4 ORGANIZATION OF PERMIT APPLICATION

This municipal stormwater NPDES application for permit renewal (Permit Application) addresses the Report of Waste Discharge requirements for permit renewal as described in Section 2.3 of this report. In addition, information described in the "Municipal Stormwater Management Plan Components" guidance document dated October 11, 1994, which was prepared by the SWRCB in consultation with the RWQCBs, is generally addressed. In discussions with Santa Ana RWQCB staff, this guidance document has been described as only advisory since it has not been officially adopted by either the SWRCB or the RWQCBs.

To effectively communicate the interests and concerns of the Permittees and to facilitate coordination with the information provided in this Permit Application, a draft permit has been prepared for consideration by the Santa Ana RWQCB and is presented in Section 11.0.

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SECTION 2

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2.1 SANTA ANA DRAINAGE AREA

Approximately one-quarter of Riverside County drains into water bodies within the Santa Ana RWQCB area. About 1,360 square miles of the Santa Ana RWQCB area is under the jurisdiction of the RCFC&WCD. This area has a population of approximately 930,000. Stormwater discharges from urbanized areas within the Santa Ana RWQCB area consist mainly of surface runoff from residential, commercial, and industrial development. The RCFC&WCD's storm drain system includes an estimated 200 miles of drainage facilities. The Co-Permittee's storm drain systems include an estimated 57 miles of drainage facilities. Maps of the existing storm drain facilities are included as Appendix B, which is bound as a separate volume of this Application.

The surface water bodies (or portions thereof) in Riverside County within the Santa Ana RWQCB area are:

Rivers and Streams

- Santa Ana River, Reaches 3 and 4
- Tributary to South Bank of Santa Ana River
  - Tequesquite Arroyo (Sycamore Creek)
  - Temescal Creek, Reaches 1, 2, 3, 4, 5, and 6
  - tributaries to Temescal Creek
    - Coldwater Canyon Creek
    - Bedford Canyon Creek
  - other tributaries to these creeks
- Tributary to North Bank of Santa Ana River
  - Day Creek
  - San Sevaine Creek

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- San Jacinto River Basin
  - San Jacinto River, Reaches 1, 2, 3, 4, 5, 6, and 7
  - Bautista Creek, headwaters to Debris Dam
  - Strawberry Creek
  - San Jacinto River, North Fork
  - Fuller Mill Creek
  - Stone Creek
  - Salt Creek
  - other tributaries: Indian, Hurkey, Poppet, and Potrero Creeks
- San Timoteo Creek Area Streams
  - San Timoteo Creek, Reaches 3 and 4
  - Little San Gorgonio Creek
  - other tributaries to these creeks, both mountain and valley reaches

Lakes and Reservoirs

- Lake Evans
- Lake Mathews
- Canyon Lake
- Lake Fulmor
- Lake Perris
- Lee Lake
- Mockingbird Reservoir
- Lake Elsinore
- Lake Hemet

The beneficial uses of these surface water bodies include: municipal and domestic supply, agricultural supply, industrial service supply, industrial process supply, groundwater recharge, water contact recreation, non-contact water recreation, warm freshwater habitat, cold freshwater habitat, wildlife habitat, and preservation of rare and endangered species.

The major topographic features in the area inciude the Santa Ana, San Jacinto, San Bernardino, and Little San Bernardino Mountains. The Santa Ana Mountain range trends southeasterly along the western border of Riverside County and forms a barrier between the Pacific Ocean and the inland valleys of Riverside County. However, the major orographic barrier in the region lies approximately 50 miles to the east. It is comprised of the San Bernardino and San Jacinto Mountain ranges, which also trend southeasterly across Riverside County. Between the Santa Ana and the San Bernardino-San Jacinto barriers lies an area of broken topography including valleys, plateaus, and minor mountain ranges. Most of the mountainous regions of Riverside County lie either in the Cleveland or San Bernardino National Forests.

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Historically, the inland valleys have been devoted primarily to agriculture. Land uses within the county currently range from residential and commercial to mining and agriculture. Agricultural land uses include citrus and fruit orchards; row crops, such as sugar beets and potatoes; and pasture land, both irrigated and dry; dairies; and stockyards. However, over the past 15 years, urbanization has steadily increased, and development has occurred at an unprecedented pace in many areas of Riverside County.

2.2 SANTA ANA REGIONAL DRAINAGE AREA MANAGEMENT PLAN

The Santa Ana Permit required the development of a drainage area management program. The Permittees submitted the Santa Ana Regional Drainage Area Management Plan (DAMP) to the Santa Ana RWQCB in February 1993. The DAMP was approved by the Santa Ana RWQCB on January 18, 1994. The DAMP is included in this Permit Application by reference.

The DAMP describes 34 best management practices (BMPs) to be developed and implemented: 13 regulatory BMPs, 3 solid waste BMPs, 6 operation and maintenance BMPs, and 12 educational BMPs. Specific actions necessary to implement the BMPs and a schedule for BMP implementation are also presented in the DAMP.

Progress reports on the implementation of the DAMP were submitted to the Santa Ana RWQCB in 1993 and 1994. The Permittees will revise the DAMP by July 31, 1997. An annual progress report on implementation of the DAMP will be submitted to the Santa Ana RWQCB by September 30 of each year during the permit period.

2.3 APPLICATION REQUIREMENTS OF SANTA ANA RWQCB ORDER 90-104

Santa Ana RWQCB Order 90-104 expires on July 1, 1995. In accordance with Title 23, Chapter 3, Subchapter 9 of the California Code of Regulations, a Report of Waste Discharge must be filed no later than 180 days before the expiration date as an application for a new waste discharge permit. The Santa Ana Permit requires that the Report of Waste

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Discharge "shall include, but is not limited to, the following:

a. Summary of the results of the monitoring program.

b. Summary of the BMPs implemented and evaluations of their effectiveness.

c. Summary of the procedures implemented to detect, identify, and eliminate illegal discharges and illicit disposal practices and an evaluation of their effectiveness.

d. Summary of enforcement procedures and actions taken to require stormwater dischargers to comply with the approved stormwater management programs.

e. Summary of measures implemented to control pollutants in surface runoff from construction sites and an evaluation of their effectiveness.

f. Evaluation of the need for additional BMPs, source control, and/or structural control measures.

g. Proposed plan of stormwater/urban runoff quality management activities that will be undertaken during the term of the next permit.

h. Any significant changes to the storm drain systems, outfall locations, detention/retention basins, and structural/nonstructural controls."

In addition to these requirements, the Santa Ana RWQCB staff has endorsed the "Municipal Stormwater Management Plan Components" guidance document dated October 11, 1994. Although it is not a regulatory requirement, this Permit Application generally follows this guidance document.

2.4 AREA COVERED UNDER THE PERMIT APPLICATION

Currently, all of that portion of Riverside County within the jurisdiction of the Santa Ana RWQCB is included under the Santa Ana Permit. However, that permitted area includes large areas to which the municipal stormwater NPDES regulations were not intended to apply and areas not under the jurisdiction of the Permittees. The municipal stormwater NPDES regulations are intended to address stormwater discharges from urbanized areas (i.e., areas with commercial, industrial, or residential land uses) which discharge to municipal separate storm sewers.

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To allow the Permittees to focus their resources on managing stormwater from municipal areas under their respective jurisdictions, this Permit Application proposes to exclude from coverage under the new permit the following areas, for the reasons described:

- national parks and monuments - these areas are not under the jurisdiction of the Permittees or within the intent of the stormwater provisions of the Clean Water Act;
- state and federal facilities - these facilities are not under the jurisdiction of the Permittees;
- Native American tribal lands - these areas are not under the jurisdiction of the state or the Permittees and are regulated directly by the USEPA (i.e., not through the California SWRCB or the RWQCBs);
- Caltrans facilities - Caltrans facilities and operations are not under the jurisdiction of the Permittees and are being permitted separately by the RWQCB;
- open space and rural (non-urbanized) areas - these areas are not within the intent of the stormwater provisions of the Clean Water Act. For the purposes of this application, these areas have been identified as those census tract areas: 1) with a population density of less than 200 per square mile; 2) with a density of 100 parcels per square mile; and 3) with a density of 50 parcels with structures per square mile;
- agricultural areas - these activities are specifically excluded under the provisions of the Clean Water Act; and
- utilities and special districts - these facilities and operations are not under the jurisdiction of the Permittees (e.g., Lake Mathews, University of California - Riverside, public schools, etc.).

As a partial illustration, Figure 2-1 generally depicts state and federal lands in Riverside County within the jurisdiction of the Santa Ana RWQCB for which coverage under a municipal stormwater NPDES permit is not requested. As presently non-urbanized areas become developed, they will be added to the permitted area. For example, as areas are proposed for development, standard conditions of approval will be applied and compliance with local stormwater and construction/grading ordinances will be required, as will compliance with the Construction Stormwater Permit. In addition, the Santa Ana RWQCB

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may add state agencies, special districts, federal agencies, or other entities to the new permit. The Permittees will rely on the Santa Ana RWQCB to regulate the compliance of state and federal agencies with the stormwater requirements as it has sole jurisdiction for their compliance with NPDES.

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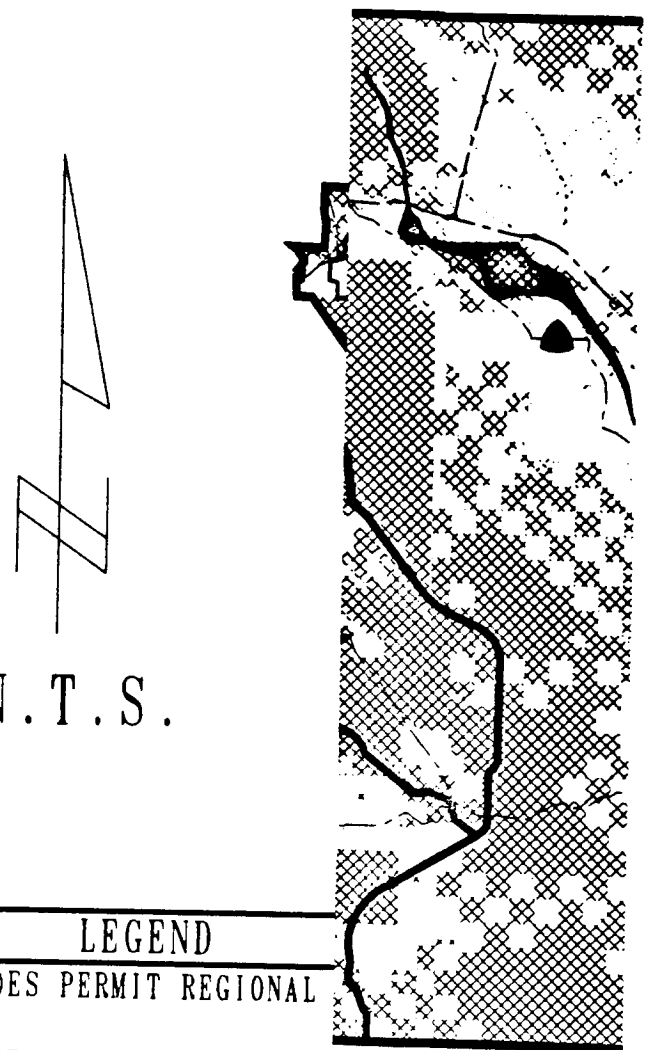
WESTERN R RMIT AREA



N.T.S.

LEGEND

- NPDES PERMIT REGIONAL
- SANTA ANA PERMIT
- SANTA MARGARITA PERMIT
- STATE & FEDERAL LANDS FROM NPDES PERMIT AREA

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COUNTY OF RIVERSIDE · TRANSPORTATION and LAND MANAGEMENT AGENCY

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FIGURE 2-1

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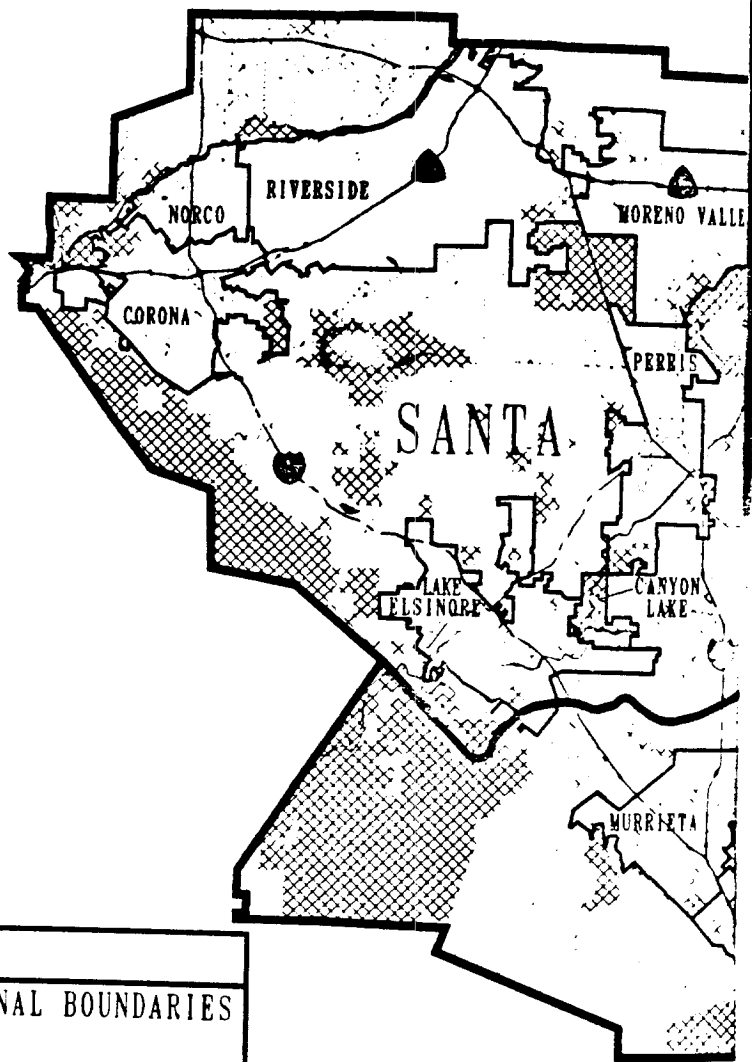

N.T.S.

LEGEND	
	NPDES PERMIT REGIONAL BOUNDARIES
	SANTA ANA PERMIT
	SANTA MARGARITA PERMIT
	STATE & FEDERAL LANDS EXEMPTED FROM NPDES PERMIT AREAS

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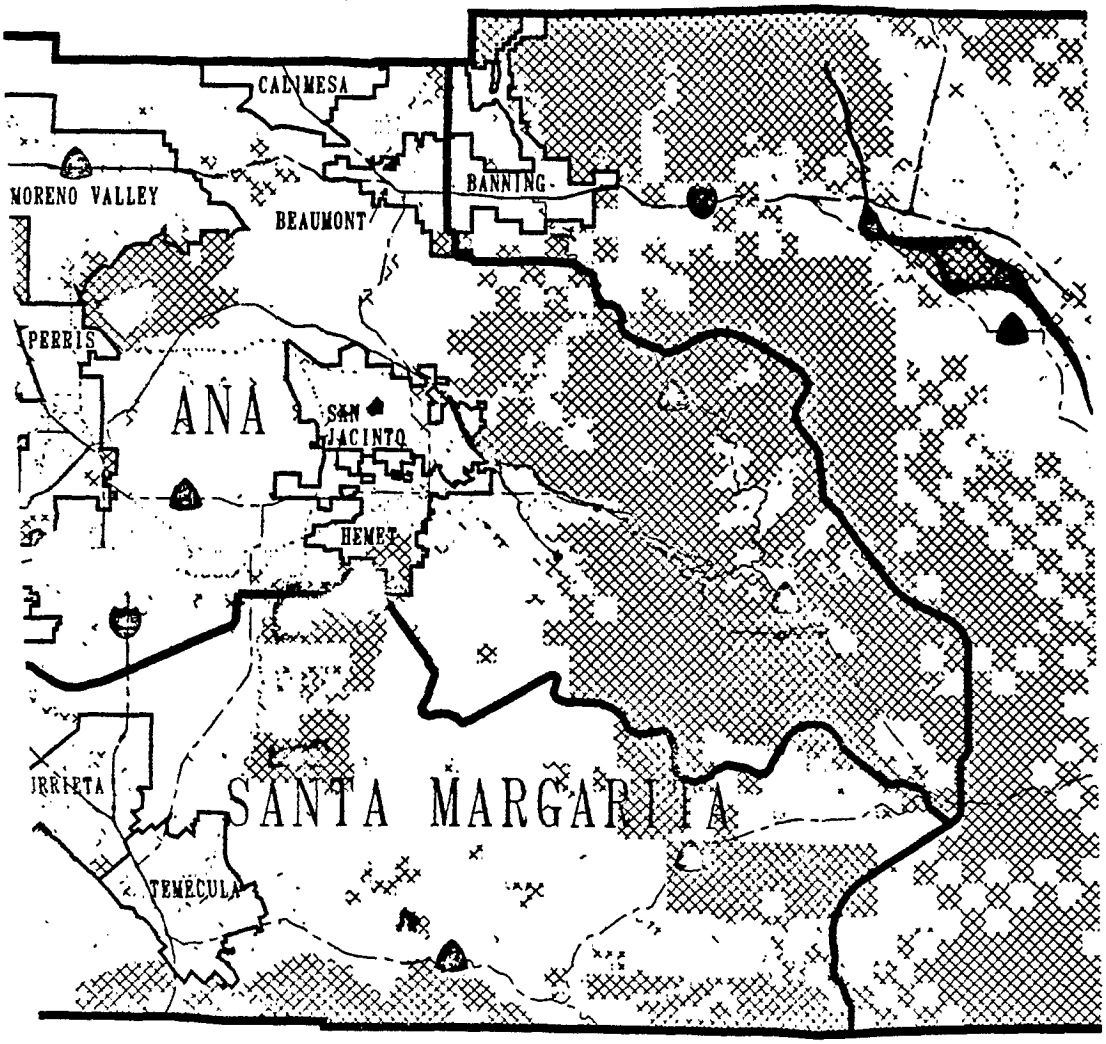
COUNTY NPDES PERMIT AREA



his map was made by the Riverside County Geographic Information System.
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e most current information.

COUNTY OF RIVERSIDE · TRANSPORTATION and LAND MANAGEMENT AGENCY

12/06/94

FIGURE 2-1

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SECTION 3

R0055316

3.1 PROGRAM STRUCTURE AND ORGANIZATION

3.1.1 Administrative Organization

The RCFC&WCD is designated as the Principal Permittee in the Santa Ana Permit. The County of Riverside and the following cities are Co-Permittees in the Santa Ana Permit:

- Beaumont
- Canyon Lake
- Hemet
- Morena Valley
- Perris
- San Jacinto
- Calimesa
- Corona
- Lake Elsinore
- Norco
- Riverside

A list of Permittee contacts for the municipal stormwater NPDES program is provided in Appendix C.

The RCFC&WCD and the Co-Permittees are co-applicants for this Permit Application. Copies of letters of intent to participate in the Riverside County municipal stormwater NPDES program are included in Appendix D.

The relationship between the Principal Permittee and the Co-Permittees and the committees is depicted in the organization chart, which is included as Figure 3-1. To facilitate coordination of the Riverside County stormwater compliance activities, the Santa Margarita Advisory Committee has been combined with the Santa Ana Advisory Committee and sub-committees.

The responsibilities of the Principal Permittee and the Co-Permittees are defined in the Santa Ana Permit and the Implementation Agreement. The responsibilities of the Principal

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Permittee are:

- coordinate compliance activities with the Co-Permittees;
- prepare operating budgets for the RCFC&WCD activities;
- prepare plans for and monitor the implementation programs;
- coordinate and submit reports to the Santa Ana RWQCB;
- conduct inspections of the RCFC&WCD's storm drain system;
- conduct the stormwater monitoring program; and
- conduct the public education program.

The responsibilities of the Co-Permittees are:

- develop site-specific compliance requirements;
- perform compliance monitoring and inspections;
- submit storm drain maps and compliance reports;
- exercise enforcement authority for achieving compliance;
- review and implement stormwater management programs;
- prepare individual budget or report on its stormwater program compliance activities; and
- prepare an internal implementation plan and schedule for site specific BMPs.

3.1.2 Committees

To assist in guiding the direction of the Riverside County Stormwater/Cleanwater Program, two committees were established, the Advisory Committee and the Construction and New Development Sub-Committee. A third committee, the Industrial and Commercial Stormwater Sub-Committee, will be formed in 1995 to assist the Advisory Committee.

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3.1.2.1 Advisory Committee

The purpose of the Advisory Committee is to assist the Principal Permittee in interpreting the requirements of the Santa Ana Permit and planning the implementation of the BMPs outlined in the Santa Ana Regional DAMP. This committee includes representatives of each of the Co-Permittees and meets several times annually on an ad-hoc basis. The decisions of this committee are based on a consensus of the participating representatives.

3.1.2.2 Construction and New Development Sub-Committee

The Construction and New Development Sub-Committee assisted the Advisory Committee in developing BMPs intended to reduce pollutants in stormwater discharge from new development. The sub-committee included representatives from the Co-Permittees, the RCFC&WCD, the RWQCBs, and the development community. In addition, the meetings were informally open to participation by various interest groups which may be affected by the construction and new development requirements. Several industry representatives were invited to make presentations on issues affecting their operations. It was determined that the recommended BMPs for new development should be incorporated into the Santa Ana Regional DAMP as a supplement. The Construction and New Development Sub-Committee has completed its task and was disbanded in December 1994.

3.1.2.3 Industrial and Commercial Stormwater Sub-Committee

An Industrial and Commercial Stormwater Sub-Committee will be formed in 1995. Members of this sub-committee will be representatives of the Permittees, local regulatory agencies or districts, and the industrial and commercial sector. The Industrial and Commercial Sub-Committee will assist the Advisory Committee in establishing priorities and providing guidance for the industrial and commercial facility inspection programs that will be developed and implemented by the Co-Permittees. This sub-committee and the Public Education Coordinator for the Stormwater/Cleanwater Protection Program will work together to develop the "clean business" incentive program.

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3.2 IMPLEMENTATION AGREEMENT

On November 19, 1991 the RCFC&WCD, the County, and the cities of Beaumont, Corona, Hemet, Lake Elsinore, Moreno Valley, Norco, Perris, Riverside, and San Jacinto entered into a NPDES Stormwater Discharge Permit Implementation Agreement (Implementation Agreement). In an amendment dated January 12, 1993, the cities of Calimesa and Canyon Lake also became parties to the Implementation Agreement. This Implementation Agreement resulted from a cooperative effort which began in 1990 between the RCFC&WCD, the County, and the cities to establish a coordinated and cost-effective means to comply with the municipal stormwater NPDES permit program.

The purposes of the Implementation Agreement are to:

- develop an integrated stormwater discharge management program designed to improve water quality in the County and in the region;
- establish a cooperative and coordinated municipal stormwater NPDES compliance program;
- identify the responsibilities of the Principal Permittee and the Co-Permittees; and
- establish funding responsibilities and a mechanism for the cost-sharing of county-wide compliance activities, including:
  - developing a stormwater management plan (DAMP);
  - implementing stormwater management programs;
  - stormwater monitoring;
  - administering the program; and
  - paying the annual municipal stormwater NPDES permit renewal fees.

The Implementation Agreement was developed with the full participation of the Permittees. The term of the Implementation Agreement is "indefinite or as long as required for compliance with the CWA." However, it will be necessary to revise the agreement following adoption of the new permit. A copy of the Implementation Agreement is included as Appendix E.

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3.3 INTERAGENCY AGREEMENTS

3.3.1 Hazardous Materials Emergency Response

The County's Fire Department staffs and maintains a Hazardous Materials Emergency Response Team. To help ensure the existence and level of activity of this team and to meet the requirements of the municipal stormwater NPDES permits, the RCFC&WCD has entered into an agreement with the County whereby the RCFC&WCD contributes to the funding of the County Fire Department's Hazardous Materials Emergency Response Team. The RCFC&WCD contributes $450,000 each year (subject to an escalation clause) toward salaries, equipment, and maintenance of the County's Hazardous Materials Emergency Response Team. In January of each year, the County submits a report to the RCFC&WCD on the activities, responses, and cases performed or conducted during the preceding year. The report contains a narrative description of the team, its operations, and any major spills. The report also includes categorical information regarding responses inside and outside the RCFC&WCD's jurisdiction, traffic-related responses, construction-related responses, drug enforcement responses, etc. A current budget and revenue sources for the Hazardous Materials Emergency Response Team is also provided in the report. A copy of this agreement is included as Appendix F.

3.3.2 Household Hazardous Waste Collection Program

To increase household hazardous waste collection program activities within the County and to meet the requirements of the municipal stormwater NPDES permits, the RCFC&WCD has entered into an agreement with the County's Department of Environmental Health, whereby the RCFC&WCD contributes to the funding of the County's household hazardous waste collection program. The RCFC&WCD contributes $450,000 each year (subject to an escalation clause) toward salaries, equipment, waste disposal, and maintenance of the County's household hazardous waste collection program. The remaining operating funds (approximately $900,000) are provided from tipping fees collected by the Waste Resources Management District. Under the agreement the County conducts up to 15 regularly scheduled household hazardous waste collection events during each year, and each collection event must include two Saturdays. Each month, the County must advertise the annual schedule for the household hazardous waste collection events in a local newspaper. In

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January of each year, the County submits a report to the RCFC&WCD on the prior year's program. The report contains a narrative summary of the household hazardous waste collection program and the collection events. The report also includes information regarding materials collected, waste disposal cost, labor cost, materials cost, and a current budget and revenue sources for the program. A copy of this agreement is included as Appendix F.

3.3.3 Interagency Inspection and Enforcement Options

The Hazardous Materials Management Division of the County's Department of Environmental Health conducts inspection and enforcement activities related to the management of hazardous materials at commercial and industrial facilities. The Hazardous Materials Management Division has indicated that they would be willing to expand their inspection and enforcement activities to include municipal stormwater NPDES permit requirements or stormwater ordinance compliance for the Co-Permittees on a reimbursable basis. Other options may also exist, such as using wastewater pre-treatment inspectors, fire department inspectors, or other existing commercial and industrial facility inspection programs. These options for interagency agreements to perform inspection and enforcement for municipal stormwater programs will continue to be investigated. As workable, cost-effective arrangements are identified, these options will be presented to the Co-Permittees as alternatives to developing their own inspection and enforcement programs.

3.3.4 Education

A position has been established to provide education and outreach in support of the Stormwater/Cleanwater Protection Program. The activities of this county-wide program are described in Section 8.0. The Public Education Coordinator is funded 85 percent by the RCFC&WCD and 15 percent by the County, based on the population within and outside of the jurisdiction of the RCFC&WCD. Day-to-day guidance and direction is provided by the RCFC&WCD with overall guidance provided by the Advisory Committee.

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3.4 FISCAL RESOURCES

3.4.1 Benefit Assessment

The RCFC&WCD's funding source for the municipal stormwater NPDES program is a benefit assessment that covers the entire Santa Ana regional drainage area, including county and city jurisdictions. Property owners are assessed for the benefit derived from the development and implementation of the municipal stormwater NPDES program by the RCFC&WCD. Predominantly remote mountainous areas have been exempted from the assessments, since little or no urban pollution of stormwater is generated in those areas. Undeveloped vacant parcels and agricultural parcels are also exempted from the benefit assessment. The assessment is calculated using the County Tax Assessor's data for each parcel. The amount of the assessment is based on proportionate stormwater runoff, which is related to the size and land use of the parcel.

Since the benefit assessment covers urban areas throughout the jurisdiction of the RCFC&WCD, activities that are considered common and of equal benefit to all are financed in whole or in part by the funds generated through this benefit assessment. These "umbrella" activities include the stormwater monitoring program, support of the County's Hazardous Materials Emergency Response Team, support of the County's household hazardous waste collection program, and support of the stormwater education program.

3.4.2 County Service Area 152

The County formed County Service Area (CSA) 152 in December 1991 to provide partial funding for compliance activities associated with the municipal stormwater NPDES permits. Originally, CSA 152 assessment was collected through property tax bills as an annual ten-dollar charge per parcel in the unincorporated portion of the county. For fiscal year 1993-94, the County adopted the same method for assessment calculation as the RCFC&WCD, and calculations for CSA 152 are now performed by the RCFC&WCD.

The County has refined their assessment method for fiscal year 1994-95. Two sub-zones of the unincorporated areas of the County were formed. The sub-zones represent areas of higher service and lower service (i.e., high or low relative stormwater quality impact). The

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rates for each zone are based on the level and type of services received by the property owners in these areas. The sub-zones were determined by a statistical assessment methodology for CSA 152 that is based upon three criteria: 1) population per square mile, 2) parcels per square mile, and 3) parcels with structures per square mile.

Local jurisdictions besides the County may belong to a CSA. Under the laws that govern CSA's, sub-areas may be established within one CSA with different assessment rates in each sub-area. The cities of Corona, Moreno Valley, Norco, and Riverside have joined CSA 152. These cities set their individual rates and decide how to allocate these funds.

3.4.3 Other Funding Sources

The City of Hemet funds their municipal stormwater NPDES program through an increased utility charge. The charge is added to monthly utility bills by the City of Hemet, the Lake Hemet Water District, or the Eastern Municipal Water District in their respective billing/service areas within the city. As with other programs, the level of funding for the NPDES stormwater compliance program indirectly reflects the level of public support. Increases in program activities may exceed funding currently available. As public understanding and support for stormwater quality control increases, support for increased funding levels for the compliance program may also be expected.

The cities of Calimesa, Canyon Lake, Lake Elsinore, Perris, and San Jacinto finance their municipal stormwater NPDES programs through their general funds. Due to the small size of these cities and the limited extent of their storm drain systems, these cities believe use of their general funds is an adequate funding mechanism at this time.

3.4.4 Budget for 5-Year Permit Period

Fiscal Analysis reports, which presented expenditure, budget, and funding information for the municipal stormwater NPDES program, were submitted to the Santa Ana RWQCB in 1991, 1992, 1993, and 1994. Table 3-1 presents expenditure data for fiscal year 1993-94 and budget data for fiscal year 1994-95 for each Permittee. Table 3-2 presents budget data for 1994-95 by category of expenditure.

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Detailed budget information for 1995-96 is not available at this time. Since some of the municipal stormwater NPDES programs are not developed completely or are yet to be developed, it is difficult to estimate the budget for those programs. Additionally, as more experience is gained in implementing the stormwater programs and as program coordination efforts improve, cost-savings should be achieved. An annual Fiscal Analysis report will be submitted to the Santa Ana RWQCB by September 30 of each year during the permit period.

3.5 LEGAL AUTHORITY

3.5.1 Porter-Cologne Act

The CWA allows the USEPA to delegate its NPDES permitting authority to states with approved environmental regulatory programs. The State of California has an approved environmental regulatory program and has been delegated authority to implement the NPDES program. California's Porter-Cologne Water Quality Control Act established the SWRCB and the system of nine RWQCBs (Section 13000, "Water Quality," et seq., of the California Water Code). The SWRCB and the RWQCBs are responsible for the protection and, where possible, the enhancement of the quality of California's waters. The SWRCB sets statewide policy, and together with the RWQCBs, implements state and federal laws and regulations, including the NPDES program.

Although local governments may have ordinances designed to protect or enhance water quality, these ordinances are only complementary to the NPDES program, and the SWRCB and the RWQCBs have primary and ultimate responsibility for enforcement of the NPDES program.

3.5.2 Local Government Authority

The federal stormwater regulations require permittees to demonstrate adequate legal authority to implement the stormwater NPDES program, including controls on industry and construction. The DAMP contains a detailed evaluation of the legal authority of the Permittees. Both the police power and the "home rule" power enunciated in the California constitution confer broad authority on local government to regulate public health, safety, and

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welfare. However, these ordinances were enacted to address concerns such as zoning, flood control, nuisance litter control, or blockage of storm drains, and were not enacted for the purposes of regulating stormwater quality. As a result, the Co-Permittees's various ordinances tend to differ in scope and focus from the municipal stormwater NPDES program. This is particularly true with respect to the inspection and monitoring requirements of the federal stormwater regulations. In order to close gaps in the local regulatory scheme and to create uniformity in ordinances, the Co-Permittees will adopt essentially the same model ordinances for stormwater/urban runoff management and discharge control and for grading and erosion control. It expected that the Co-Permittees will have these ordinances adopted by December 31, 1995.

Local government authority is limited by the state and federal constitutions and statutes. Therefore, the following facilities and activities are not within the jurisdiction of the Permittees:

- state and federal facilities and activities;
- agricultural operations;
- utilities and special districts; and
- Native American tribal lands.

In this Permit Application, the Permittees propose to exclude these areas from coverage under the new permit (see Section 2.4).

3.5.2.1 Stormwater/Urban Runoff Management and Discharge Ordinance

The County of Riverside has developed a proposed stormwater/urban runoff management and discharge controls ordinance. A copy of the proposed ordinance is included as Appendix G. The proposed ordinance has been submitted to the other Co-Permittees and the Santa Ana RWQCB for review. The proposed ordinance would provide the authority to:

- prohibit disposal of wastes (potential pollutants) to any street, alley, sidewalk, storm drain, inlet, catch basin, etc.;

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- prohibit the storage or use of equipment or hazardous materials in such as manner that hazardous substances may be discharged to the storm drain system;
- require BMPs for construction sites;
- require (with discretion) new development or redevelopment to take measures to control the volume and rate of stormwater runoff;
- prohibit illicit connections and discharges to the storm drain system;
- prohibit any discharge that would result in a violation of the municipal stormwater NPDES permit;
- require (with discretion) proof of compliance with the Industrial Permit, Construction Stormwater Permit, and/or the Dewatering General Permit for issuance of grading, building, or occupancy permits;
- require property owners to maintain good housekeeping practices; and
- inspect property for compliance with the ordinance and issue notices of violation for failure to comply.

Each Co-Permittee will pursue adoption of the proposed stormwater ordinance by their respective City Councils or Board of Supervisors. However, the County of Riverside will not proceed with adoption of the proposed stormwater ordinance until the Santa Ana Regional DAMP has completed the California Environmental Quality Act review process. It is unlikely that the other Co-Permittees will adopt the proposed stormwater ordinance prior to adoption by the County.

3.5.2.2 Grading and Erosion Control Ordinance

The Co-Permittees have existing ordinances for grading and erosion control at construction sites. The County is in the process of developing an improved ordinance and is consulting its own agencies and the Santa Ana RWQCB for review and comment. The other Co-Permittees are in the process of reviewing their ordinances, but will not pursue revision of their ordinances until the County has finalized its proposed ordinance, which will be used as a model.

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TABLE 3-1
MUNICIPAL STORMWATER NPDES
1993-94 EXPENDITURE DATA AND 1994-95 BUDGET DATA

Permittee	Population	1993-94 Expenditures	1994-95 Budget
Beaumont	10,700		
Calimesa	7,400	$10,400	$11,000
Canyon Lake	10,600	$4,400	$4,600
Corona	94,500	$132,823	$223,000
Hemet	52,800		
Lake Elsinore	24,150	$103,650	$114,000
Moreno Valley	134,700	$295,000	$376,459
Norco	24,700		
Perris	30,200	$92,000	$110,000
Riverside	244,200	$164,050	$270,450
San Jacinto	24,000	$85,000	$90,000
Riverside County	272,640	$611,256	$1,000,000
RCFC&WCD	-	$1,102,989	$1,971,600
Total	930,590	$2,601,568	$4,171,109

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TABLE 3-2
MUNICIPAL STORMWATER NPDES
1994-95 BUDGET DATA BY CATEGORY

Permittee	Reconnaissance Survey	Public Education	Other BMP Implementation	Monitoring	Miscellaneous	Total
Beaumont	-	-	-	-	-	-
Calimesa	-	-	$9,000	-	$2,000	$11,000
Canyon Lake	-	-	-	-	-	-
Corona	$10,000	$10,000	(a) $147,000	-	$56,000	$223,000
Hemet	-	-	-	-	-	-
Lake Elsinore	-	$2,500	(a) $109,000	-	$2,500	$114,000
Moreno Valley	$19,650	$8,600	$299,600	-	$48,609	$376,459
Norco	-	-	-	-	-	-
Perris	-	-	$110,000	-	-	$110,000
Riverside	$130,000	$15,000	$90,000	-	$35,450	$270,450
San Jacinto	$5,000	-	$85,000	-	-	$90,000
Riverside County	-	$47,500	$871,500	-	$81,000	$1,000,000
RCFC&WCD	-	$194,400	$1,139,400	$155,000	$482,800	$1,971,600
Total	$164,650	$278,000	$2,860,500	$155,000	$708,359	$4,166,509

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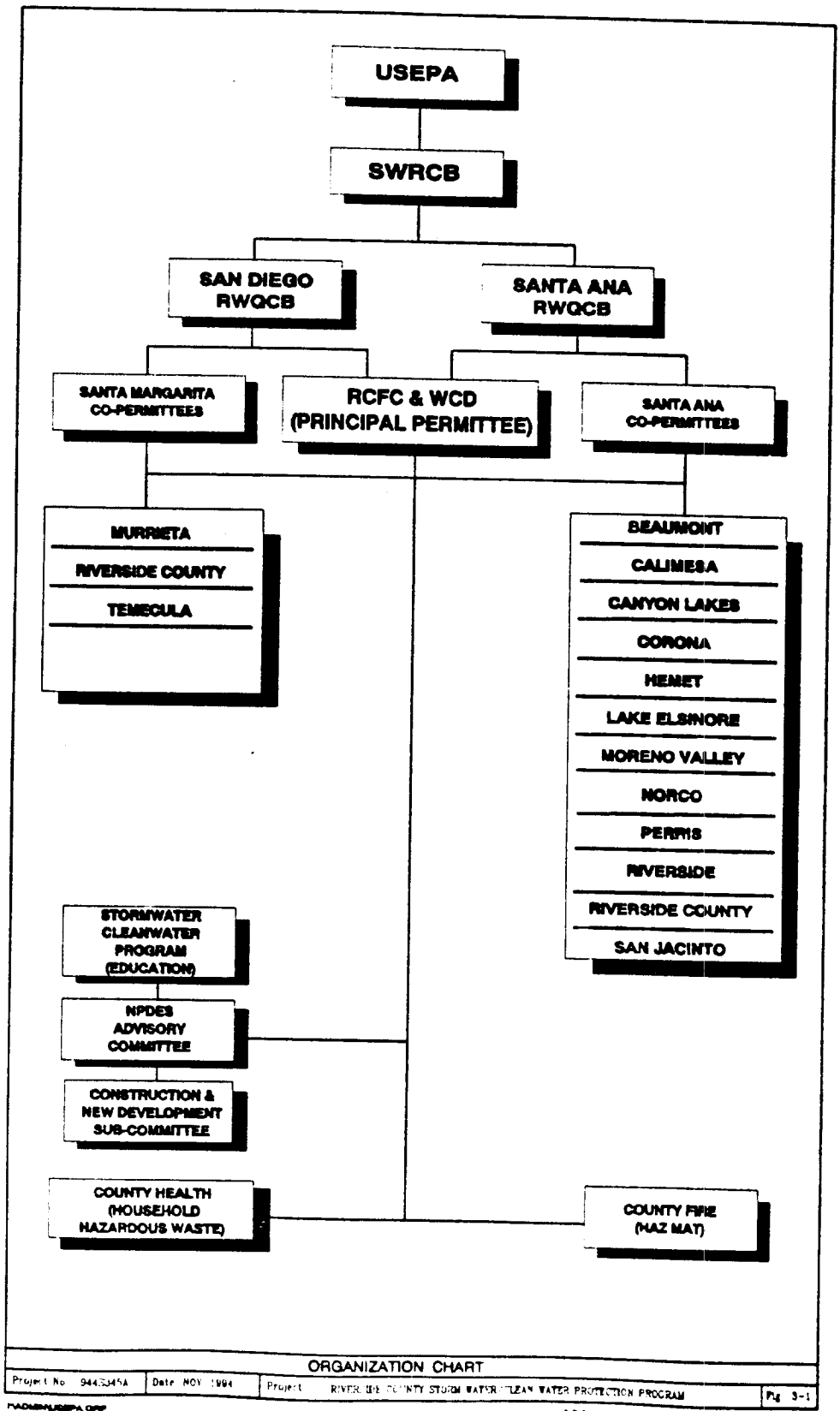

ORGANIZATION CHART

Project No 94453454	Date NOV 1994	Project RIVERSIDE COUNTY STORM WATER/CLEAN WATER PROTECTION PROGRAM	Fig 3-1

Woodward - Clyde Consultants

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SECTION 4

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4.0 ILLICIT CONNECTIONS AND ILLEGAL DISCHARGES

The elimination of illicit connections and illegal discharges to storm drain systems is a major component of this program, which is intended to improve or protect the quality of stormwater/urban runoff and the affected receiving waters.

4.1 RECONNAISSANCE SURVEY PROGRAM

In accordance with the Santa Ana Permit, reconnaissance surveys were conducted to identify illicit and undocumented connections and illegal discharges to the storm drain systems. It was assumed that undocumented connections resulted in illegal discharges until determined otherwise. Further, the Permittees are required to "effectively eliminate all identified illegal discharges/illicit connections in the shortest time practicable, and in no case later than July 1, 1995."

The reconnaissance surveys of the storm drain systems were limited to underground storm drains of 36-inch diameter or larger and open channels. The majority of the Permittees utilized television camera video taping of their storm drain systems. Some of the Permittees, including Moreno Valley, inspected their storm drain systems manually, since their systems were not very extensive. Each undocumented connection to a storm drain system was traced back to its origin. Almost 200 undocumented connections to the underground storm drain systems were found. *With the inspections and investigations almost complete, none of the connections have been determined to be illegal connections with regard to stormwater NPDES program.*

Numerous undocumented connections to the RCFC&WCD's open channels were also discovered. Most of these connections appear to be either landscape or pool drains originating from residences. Table 4-1 presents a summary of the reconnaissance surveys conducted by the Permittees. The most recent Annual Progress Report on the Reconnaissance Survey Program for Storm Drain Facilities was submitted to the Santa Ana RWQCB in September 1994. The Reconnaissance Survey Plan and subsequent progress reports to the Santa Ana RWQCB are incorporated in this Permit Application by reference.

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The Permittees are continuing to investigate the remaining undocumented connections to their storm drain systems. Once the origin of the connection has been determined, where appropriate, the connections will be permitted by the owner or operator of the discharging facility. If the connection is determined to be unacceptable under the municipal stormwater NPDES regulations, the Permittees will take action to have the illicit connection or illegal discharge eliminated or permitted by the RWQCB. The Permittees expect that illicit connections and illegal discharges to their storm drain systems will be eliminated by July 1, 1995, barring lengthy enforcement actions.

Training of field personnel to identify and report illegal discharges is described in Section 7.6.3. In addition, the following implementation protocols will be developed to facilitate these efforts:

- procedures for conducting the storm drain system inspection;
- guidance materials and standardized checklists and reporting forms for performing and documenting storm drain system inspections;
- identification of personnel responsible for reviewing field reports and coordinating enforcement;
- procedures to coordinate with agency(s) with authority to enforce local stormwater ordinances (i.e., code enforcement, County Environmental Health, etc.); and
- procedures to coordinate enforcement with the RWQCB and other agencies.

4.2 CONTROL MEASURES

The Santa Ana Regional DAMP describes the BMPs (control measures), implementation responsibilities, and time frame for BMP implementation. Some of those BMPs pertain to eliminating illicit connections and illegal discharges. The more important measures related to illicit connections and illegal discharges are discussed in Sections 4.2.1 and 4.2.2.

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4.2.1 Illicit Connections

The Permittees will implement an ongoing program for detecting illicit connections to storm drain systems. Investigations for potential illicit connections will be conducted when that possibility is indicated by the monitoring program, citizen complaints, or public employee reports. Storm drain channels will be inspected for illicit connections again during 1997-98. The underground storm drains will not be inspected during the next permit period (1995-2000) for the following reasons:

1) the current reconnaissance survey of underground storm drains has yet to identify any illicit connections;

2) the underground storm drain systems are predominantly inaccessible (under streets and roads); and

3) inspection of underground storm drains is a relatively expensive component of the municipal stormwater NPDES program. These resources will be more effectively applied to other NPDES program activities.

It is believed that an inspection of underground storm drain systems once every ten years would be appropriate. However, where monitoring or inspection activities identify evidence of an illegal discharge to an underground storm drain, efforts will be made to identify the source.

4.2.2 Illegal Discharges

The three primary types of pollutant discharges (or illegal dumping) that must be controlled or eliminated are caused by:

- individuals who do not know that their action is illegal (or harmful);
- individuals who know that their action is illegal; and
- accidental spills.

To address the problem of individuals who do not know their actions are illegal, two steps were taken. The first step was the implementation of an education and outreach program to inform the public of the impact of illegal discharges on surface water quality. The second step was the implementation of a program to inform the public of the household hazardous

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waste collection program operated by the County's Department of Environmental Health as an alternative to illegal dumping. The household hazardous waste collection program will reduce the amount of material illegally disposed to the municipal storm drain system. This program was expanded with an initial contribution of $300,000 (presently $450,000). By providing two weekend collection events instead of one, increasing the total number of annual events, and increasing the publicity of the events, the program was able to increase the awareness and convenience of proper disposal.

The education and outreach program and municipal employees will be used to prevent and/or identify individuals who know their actions are illegal. The Stormwater/Cleanwater Education and Outreach Program being developed and implemented will increase public awareness, promote proper disposal of household hazardous waste, and encourage reporting of suspected illegal discharges. An "800" telephone number for toll-free reporting of illegal or improper pollution activities and for requesting information was established in October 1994. By calling 800/506-2555, the caller is connected to an operator who will provide the name and telephone number of the appropriate municipal staff to help the caller. The municipal staff can assist callers with information regarding recycling, disposal of waste, reporting of dumping, street and catch basin maintenance, and other information or services. Reports of discharges are referred to the appropriate agencies for response. In addition, public employees will receive training to recognize and report suspected illegal discharges observed during the course of their work (see Section 7.6.3).

For several years the County's Fire Department has maintained a Hazardous Materials Emergency Response Team. This team responds to accidental spills and dumping of hazardous materials, and supports other agencies encountering hazardous materials (e.g., police during drug lab raids). This includes coordinating containment and cleanup of spills which may impact the storm drain system. Three years ago, with the County facing financial problems, the team was almost permanently disbanded. The RCFC&WCD, on behalf of the Permittees, contributed $300,000 to help ensure that the team remained intact. Since then, the team has responded to over 360 incidents annually. The continued support of the County's Hazardous Materials Emergency Response Team will help ensure that hazardous materials from spills or dumping have minimal impact on storm drain systems and receiving waters.

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4.3 ENFORCEMENT PROCEDURES

Presently, the Co-Permittees must utilize existing regulations to manage stormwater quality (e.g., nuisance laws, littering ordinances, public health regulations, etc.). The Co-Permittees plan to adopt a comprehensive stormwater ordinance during 1995. A copy of the Stormwater/Urban Runoff Management and Discharge Controls ordinance is provided in Appendix G. This ordinance will prohibit:

- disposal of wastes (potential pollutants) to any street, alley, sidewalk, storm drain, inlet, catch basin, etc.;
- illicit connections and discharges to the storm drain system; and
- any discharge that would result in a violation of the municipal stormwater NPDES permit.

Enforcement actions may include citations, notice of violation, cease and desist notices, and, in some cases, arrest depending on the nature and intent of the discharge and the number of previous violations.

4.4 COORDINATION WITH OTHER NPDES PERMITS

4.4.1 Non-Stormwater Permits

The Co-Permittees will notify the Santa Ana RWQCB of detected non-storm water discharges to their storm drain systems. In addition, the RCFC&WCD will request the opportunity to review and comment on proposed point source discharge permits for discharges to surface waters in Riverside County. The Permittees oppose permitting of point source discharges which may impair their ability to meet the requirements of the Riverside County municipal stormwater NPDES permits. Proposed point source discharge permits will be reviewed and comments may be provided by the RCFC&WCD to the RWQCB. If the RWQCB were to issue permits for discharges that are not acceptable to the Permittees, the Permittees may refuse to accept the discharge into their storm drain systems.

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4.4.2 Construction Stormwater Permit

The Permittees will continue to require private construction projects to demonstrate compliance with the Construction Stormwater Permit prior to the issuance of local construction and grading permits. In addition, building and grading inspectors will be provided training on construction BMPs using the California Stormwater Best Management Practice Handbook - Construction Activities. The Permittees will notify the RWQCB of construction activities not in compliance with the Construction Stormwater Permit when additional enforcement support is needed. Enforcement actions and investigations related to stormwater control from construction activities will be summarized in the annual report to the RWQCB.

4.4.3 Industrial Permit

When identified, the Permittees will notify the RWQCB of industrial facilities which are not in compliance with the requirements of the Industrial Permit. The Permittees will develop a commercial and industrial facilities inspection program as described in Section 6.3.

4.5 REPORTING TO THE SANTA ANA RWQCB

An annual report will be submitted by the Principal Permittee to the RWQCB summarizing the information related to the illicit connection and illegal discharge elimination program. The Reconnaissance Survey Implementation Plan will be replaced with an Illegal Discharge Control Plan which will be submitted to the Santa Ana RWQCB in mid-1996 for review and approval.

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TABLE 4-1
SUMMARY OF RECONNAISSANCE SURVEYS

Permittee	Underground Pipe (feet)	Inspected (feet)	Undocumented Connections Found	Connection Source Unknown	Open Channel (feet)	Inspected (feet)	Undocumented Connections Found	Connection Source Unknown	Comments
Beaumont	-	-	-	-	-	-	-	-	No response.
Calimesa	0	NA	NA	NA	0	NA	NA	NA	
Canyon Lake	3,940	3,940	0	0	0	NA	NA	NA	
Corona	146,866	143,666	88	-	10,560	0	-	-	Work ongoing.
Hemet	15,170	15,170	0	0	13,120	13,120	0	0	
Lake Elsinore	2,600	2,600	0	0	1,200	1,200	0	0	
Moreno Valley	40,203	40,203	0	0	0	NA	NA	NA	
Norco	10,234	10,234	0	0	0	NA	NA	NA	
Perris	10,181	10,181	0	0	0	NA	NA	NA	
Riverside	80,000	0	-	-	10,600	5,300	0	0	Work ongoing.
San Jacinto	0	NA	NA	NA	0	NA	NA	NA	
County of Riverside	9,654	8,554	1	0	52,026	52,026	2	3	Work ongoing.
RCFC&WCD	785,685	785,685	104	3	697,097	697,097	300	50	Work ongoing.

Notes: (1) NA = Not Applicable.
(2) Survey included underground pipes of 36-inch diameter or larger and channels constructed before July 1990.

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SECTION 5

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The Construction and New Development Sub-Committee prepared a supplement (Supplement A) to the Santa Ana Regional DAMP which requires implementation of site-specific BMPs intended to reduce pollutants in stormwater discharge from new development and redevelopment projects. Supplement A is included as Appendix H to this Permit Application. The Construction and New Development Sub-Committee has placed emphasis on building upon existing programs and achieving uniformity of implementation by the Permittees. Proposed measures will apply to both private- and public-sector development projects and both structural and non-structural control measures have been included.

5.1 PLANNING PROCESS FOR DEVELOPMENT AND REDEVELOPMENT

5.1.1 Watershed Protection Policies

The Permittees will monitor and coordinate with watershed protection programs which may be implemented by the RWQCB, the Santa Ana Watershed Planning Agency (SAWPA) and others during the next permit period. Applicable policies related to construction and new development developed in these efforts will be incorporated into the DAMP.

5.1.2 Coordination with CEQA

The Permittees will adopt policies (some already have) that will include evaluation of construction-period and post-construction stormwater impacts during staff review of California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) documents. Where appropriate, measures to mitigate anticipated stormwater quality impacts will be incorporated into environmental documents and incorporated into standard conditions of approval for proposed development and redevelopment projects.

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5.1.3 Site Planning Practices

The requirement for a post-construction stormwater quality BMPs will be specified in each Permittee's standard conditions of approval. The standard conditions of approval will require project proponents to include in their plans BMPs that will be incorporated into the project to control nonpoint source pollutants after construction. Supplement A will be adopted by the Permittees and uniformly implemented by to promote consistency.

5.1.4 General Plans and Master Plans

The California General Plan Law and the CEQA provide a basis for municipalities to review and comment on proposed projects within their jurisdiction. Under the General Plan Law, municipalities are required to develop policies and regulations that guide development within the municipality. Each development project is then reviewed for conformance with these policies. Under CEQA, projects are also subject to review and comment for adverse impacts the projects may have on the environment, including impacts from stormwater discharges. As the Permittees revise their General Plans or Master Plans, the management of stormwater quantity and quality will be addressed, and the measures identified in Supplement A will be incorporated into those plans.

5.1.5 Planning/Public Works Interface

Construction inspectors will monitor projects for implementation of stormwater quality control measures incorporated as conditions of approval by Planning. Where the conditions are not implemented, inspectors will take appropriate follow-up actions, including enforcement where appropriate, to ensure that the stormwater quality control measures are implemented.

5.1.6 Implementation Procedures

Each Permittee will take the following actions:

- Train personnel responsible for permitting or development plan review regarding the new development BMPs included in Supplement A. Personnel training is described in Section 7.6 of this Permit Application.

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- Make Supplement A available to development or permit applicants at the earliest possible time in the application/permit process.

- Notify applicants of known water quality problems which may affect the proposed development at the earliest possible opportunity.

- Modify procedures for approval of grading, building, and similar permits to include applicable BMPs from Supplement A. Permits will not be issued until conditions of approval related to stormwater quality management are satisfied.

5.2 CONTROL MEASURES FOR CONSTRUCTION SITES

Section IV.1.c of the Santa Ana Permit requires the DAMP to include "a full range of structural and non-structural BMPs" that shall be required at new construction sites. "All industrial or commercial construction operations that result in a disturbance of one acre or more of total land area (or smaller parcel of land which is a part of a larger common development) and residential construction sites that result in a disturbance of five acres or more of total land area (or a smaller parcel of land which is a part of a larger common development) shall be required to develop and implement BMPs, including a long-term funding mechanism and commitment to support required maintenance of the BMPs, to control erosion/siltation and contaminated runoff from the construction sites."

The Co-Permittees have existing ordinances for grading and erosion control at construction sites. The County is in the process of developing an improved ordinance and is consulting its own agencies and the Santa Ana RWQCB for review and comment. A copy of the County's proposed grading and erosion control ordinance is included as Appendix I. The other Co-Permittees are in the process of reviewing their ordinances, but will not pursue revision of their ordinances until the County has finalized its proposed ordinance, which will be used as a model. By December 1995, the Co-Permittees should have revised grading and erosion control ordinances in place.

5.2.1 Permits

The model grading and erosion control ordinance will include a requirement that an erosion control plan be submitted for review and approval by the appropriate municipal department prior to the issuance of a grading and/or building permits. Also, if the construction site is

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subject to the Construction Stormwater Permit, the applicant will have to show proof of compliance with the Construction Stormwater Permit prior to the issuance of the local grading and/or building permits.

5.2.2 Bonding

Bonding is a mechanism used by municipalities to ensure that various conditions of approval and items specified in plans, including stormwater quality control measures, are implemented in private-sector development projects. Bonding involves the deposit of cash or the purchase of a policy from a bonding firm by the developer for a specific development project. The amount of the bond is based on the anticipated cost of the required improvement. If the conditions of approval are not met, the municipality may use the deposited funds or may cash-in the bond policy to complete the work. As stormwater quality control measures are written into plans or included as conditions of approval, they are being covered by the bonding mechanism.

5.2.3 Inspections

The County has developed a one-day training program for construction inspectors. This training program has been made available to the other Permittees for a nominal charge. This training program will be conducted on an as-needed basis to train new inspectors and to provide refresher training. This training program addresses soil erosion, construction pollution control measures, and the requirements of the Construction Stormwater Permit. Reporting and follow-up procedures, including enforcement alternatives, will also be addressed at this training program.

Construction inspectors will specifically inspect the construction site for compliance with the erosion control plan or with the SWPPP prepared for the Construction Stormwater Permit. A summary of the activities of this program will be incorporated into the annual report submitted to the RWQCB (Section 10.3.4).

5.3 CONTROL MEASURES FOR NEW DEVELOPMENT AND REDEVELOPMENT

It is generally understood that, as development progresses, the percentage of paved surface

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increases, the discharge rate and volume of runoff increases, and the amount of pollutants in stormwater runoff also increases. Section IV.1.c of the Santa Ana Permit requires the DAMP to include provisions that "all new developments and existing facilities with significant redevelopment, irrespective of their size, must develop individual, comprehensive, long-term, post-construction stormwater management plans, incorporating structural and non-structural BMPs. These management plans shall include a long-term funding mechanism and commitment to support required maintenance of the BMPs."

Supplement A to the DAMP specifies structural and non-structural BMPs that will become "standard" practices for new development or redevelopment. Each new development will be required to implement appropriate non-structural BMPs in keeping with the size and type of development and the potential for stormwater pollution. Each new development will also be required to implement appropriate "routine" structural BMPs. "Routine" structural BMPs are economical, practicable, small-scale measures, which can be feasibly applied at the smallest unit of development.

5.4 ENFORCEMENT

Construction inspectors have received training in the available enforcement alternatives. Enforcement actions may include cease and desist orders, fines, and stop work orders.

5.5 COORDINATION WITH CONSTRUCTION STORMWATER PERMIT

As stated previously, where applicable, grading and/or building permits will not be issued without proof of compliance with the Construction Stormwater Permit. The Permittees will develop procedures such that the Santa Ana RWQCB will be notified when non-compliance with the Construction Stormwater Permit is suspected.

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SECTION 6

6.1 IDENTIFICATION OF SOURCES

In prior years, "specific industrial sources" (including name, location, and Standard Industrial Code) discharging stormwater to Permittee municipal storm drain systems were identified and reported to the Santa Ana RWQCB to satisfy requirement IV.2.d of the Santa Ana Permit. The identification of industrial and commercial facilities will help the Permittees in developing appropriate stormwater quality programs and will be useful in prioritizing the implementation of control measures pertaining to industrial and commercial facilities.

6.2 CONTROL MEASURES

The DAMP established a number of BMPs specifically applicable to industrial or commercial facilities. A few of the more significant BMPs that will be implemented by the Permittees are:

- evaluate the need to establish local regulations giving municipalities the authority to require oil and grease controls in areas which may be significant sources of oil and grease to stormwater (e.g., retail gasoline stations, automotive shops, parking areas, food service establishments)
- develop, implement, and enforce regulations requiring landowners and/or tenants to provide covers (roofs, tarps) to keep rain off of areas which contain potential pollutants (storage areas) and to keep stormwater runoff from draining through areas which contain potential pollutants
- educate/inform on impacts from gasoline, fuel oil, and oil and grease - effective use of good housekeeping practices, oil/grease traps, and the proper use of absorbents and cleaning compounds by industrial and commercial facilities

The proposed stormwater/urban runoff ordinance to be adopted by the Co-Permittees during 1995 contains provisions that prohibit the storage of "grease, oil, motor vehicles, machine parts, or other objects that may leak grease, oil, or other hazardous substances such

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that these substance are discharged into any street, alley, sidewalk, storm drain, inlet, catch basin, conduit, or other drainage structure." The proposed ordinance also requires that "where BMP guidelines or requirements have been identified by any federal, State of California, regional, and/or county agency, for any activity, operation, or facility which may cause or contribute to stormwater pollution or contamination, ... , every person undertaking such activity or operation, or owning or operating such facility shall comply with such guidelines or requirements." Compliance with additional BMPs identified by the municipality would also be required by the proposed ordinance.

The education and outreach program has components directed at industrial and commercial facilities. Research and evaluation of educational materials and outreach programs targeted for industries and commercial activities has begun and will continue during 1995. During 1996 a "clean business" incentive program will be initiated. The education and outreach program is discussed in more detail in Section 8.0.

6.3 INSPECTIONS

The purpose for inspecting industrial and commercial facilities is to identify compliance or non-compliance with local stormwater ordinances and regulations and to ensure that BMPs are being implemented to manage discharges to municipal storm drain systems. Inspections of commercial and industrial facilities will also be a component of the "clean business" incentive program.

A sub-committee (Industrial/Commercial Stormwater Sub-Committee) will be formed with representatives of the Permittees, local regulatory agencies or districts, and the industrial and commercial sector. This sub-committee will assist the Advisory Committee in establishing priorities and providing guidance for the industrial and commercial facility inspection programs that will be developed and implemented by the Co-Permittees. The Industrial/Commercial Stormwater Sub-Committee and the Public Education Coordinator for the Stormwater/Cleanwater Protection Program will work together to develop the "clean business" incentive program.

Local programs exist for inspection of industrial and commercial facilities on a regular basis. Such programs may address environmental or public health, fire prevention and safety,

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hazardous materials management, industrial and commercial waste management (solid), and wastewater pretreatment. By July 1, 1996, each Co-Permittee will elect to have inspections related to their stormwater ordinances and regulations and/or the "clean business" incentive program incorporated into existing inspection programs or will develop a separate inspection program depending upon the needs and resources of the Co-Permittee. The inspection programs developed will include:

- identification of the person responsible for overseeing the inspection programs;
- procedures for conducting the inspection, including reporting, follow-up, and enforcement;
- a standardized checklist and inspection report form for use during inspections;
- training of personnel to conduct inspections;
- frequency of inspection based upon the type of industrial or commercial facility; and
- coordination with the applicable Regional Water Quality Control Boards and other jurisdictional agencies.

6.4 COORDINATION WITH INDUSTRIAL PERMIT

The Permittees will develop procedures which will include notification to the Santa Ana RWQCB when non-compliance with the Industrial Permit is suspected. The Santa Ana RWQCB will also be notified regarding the identification of illegal discharges from commercial or industrial facilities to the municipal storm drain system. Other findings from the commercial or industrial facility inspections may also be communicated to the Santa Ana RWQCB. The Santa Ana RWQCB will implement investigations and enforcement actions, as appropriate, in response to these notifications.

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SECTION 7

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All of the Permittees perform functions that may have an impact of stormwater quality, including construction and maintenance of storm drain and flood control systems, construction and maintenance of streets and roads, maintenance of vehicles and/or heavy equipment, operation and maintenance of wastewater collection systems, collection and disposal of solid waste, landscape maintenance, and weed control.

7.1 STORM DRAIN SYSTEM AND FLOOD CONTROL

The Permittees will continue to evaluate existing programs for catch basin, inlet, and storm drain cleaning and maintenance of open channels. As additions to storm drain systems or as capital improvements of existing storm drain systems are planned, the Permittees will consider designs and retro-fit options that will enhance stormwater quality.

7.2 STREETS AND ROADS

The Co-Permittees have ongoing programs for street and road maintenance, including street sweeping and pavement management. The DAMP identified two BMPs specific to these activities.

Most of the Co-Permittees have regular schedules for street sweeping in areas where streets are constructed with curbs and gutters. A few of the Co-Permittees have modified their street sweeping schedules such that streets in commercial, business, and industrial areas are swept weekly. The Co-Permittees will continue to prioritize and evaluate problem areas which may benefit from a more frequent street sweeping schedule. As additional streets within the Co-Permittees jurisdictions have curb and gutter installed, those streets will be included in the street sweeping program.

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The County has initiated a street sweeping pilot study of one area, which was selected based upon :

- streets and roads passing through particular land use areas;
- streets and roads not within city limits; and
- road segments with curb and gutter.

The pilot study route (approximately 300 centerline miles) will be swept once per month for 12 months beginning in the spring of 1995. Records will be kept for number of miles swept, amount of debris removed, field inspection of the route after sweeping, and evaluation of the pilot study. The RCFC&WCD will collect samples of the runoff and material collected by the street sweepers for analysis. The information gained from this street sweeping pilot study will be used to:

- identify other areas within the County for sweeping;
- prepare County budget for street sweeping;
- evaluate and refine street sweeping programs of the other Co-Permittees; and
- determine the effectiveness of alternative methods.

By December 31, 1995, the Co-Permittees will evaluate their pavement management programs, and where appropriate, revise their program to protect stormwater quality. The Co-Permittees will consider measures such as:

- regular repair of potholes and worn pavement to reduce sediment load in stormwater runoff;
- avoiding paving work during wet weather;
- implementing BMPs for concrete (storage, mixing, pouring, and cleanup); and
- covering catch basins, inlets, and manholes during application of seal coat, tack coat, etc.

7.3 CORPORATION YARDS

Corporation yards include areas or facilities that are regularly used for vehicle maintenance or washing, other maintenance, chemical storage or use (such as a painting facility), waste management, or supportive activities for field crews. These are essentially industrial

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activities being performed at municipal corporation yards. To the extent that corporation yards do not perform vehicle maintenance activities, municipalities are generally not required to obtain an Industrial Permit for their corporation yards. The Permittees do not intend to prepare stormwater pollution prevention plans, per se, for their corporation yards unless (or until) they are required by regulation. However, the Permittees will assess their facilities and operations and implement BMPs needed to reduce exposure of stormwater to potential pollutants.

7.4 PUBLIC FACILITIES

Municipalities manage a variety of public facilities, including parks and recreation areas, swimming pools, golf courses, schools, civic or community centers, and parking lots. Managing such facilities often requires the storage and use of chemicals (e.g., fertilizers, herbicides, pesticides, chlorine), discharges of non-storm water, and management of waste.

The Permittees will evaluate their existing programs or procedures for managing public facilities. BMPs will be implemented, as appropriate, to minimize the exposure of stormwater to potential pollutants. The control measures may include:

- developing a list of approved herbicides and pesticides and the respective uses;
- periodic training in chemical storage and use;
- storage of equipment, materials, or chemicals indoors, under roofs, or covered by tarps;
- training in the proper disposal of wash waters, swimming pool water, or fountain water; and
- regular sweeping of parking lots and use of absorbents to cleanup automobile fluid leaks.

7.5 SEWAGE SYSTEMS

The Riverside County Department of Environmental Health, RWQCB, and sanitation agencies in Riverside County will be contacted to document existing procedures for

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responding to sewage spills. These procedures will be reviewed, and recommendations for containment and disposal to reduce the amount of sewage discharged to the storm drain system will be recommended.

7.6 EMPLOYEE TRAINING

7.6.1 Permitting and Plan Review

The Permittees will train personnel responsible for permitting or development plan review regarding the new development BMPs included in Supplement A. This will include a review of the California Stormwater Best Management Practice Handbook - Construction Activities.

7.6.2 Construction Inspection

Building and grading inspectors not previously trained will be provided training on construction BMPs using the California Stormwater Best Management Practice Handbook - Construction Activities. This program was initiated in 1993 for County employees and made available to city and other interested parties in December, 1994.

7.6.3 Storm Drain Inspection

City, County, and the RCFC&WCD maintenance, inspection and other field personnel will be trained to recognize evidence of illegal discharges and dumping (e.g., stains, materials in or discoloration of water, stressed vegetation, etc.). In addition, they will receive instructions on reporting and documentation procedures.

7.6.4 Operations

City, County, the RCFC&WCD and other public agency personnel will be provided training to increase awareness of procedures to reduce pollution related to their job activities.

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7.7 COMPLIANCE WITH INDUSTRIAL PERMIT AND CONSTRUCTION STORMWATER PERMIT

The Permittees operate facilities and conduct activities which are within the intent of the Industrial and Construction Stormwater Permits. Additional facilities and activities may be included in the USEPA Phase II regulations which may be promulgated during the next permit period. The Permittees will comply with the Industrial Permit and the Construction Stormwater Permit in operating municipal facilities and conducting operations. This may include submitting Notices of Intent (NOI) to comply with the general permits, preparing and implementing storm water pollution prevention plans, conducting monitoring and submitting annual reports to the RWQCB. To the extent of their legal authority, the Permittees will require and encourage other public agencies (e.g., Caltrans, special districts, public utilities) to comply with the Construction Stormwater Permit for construction projects within the Permittee's jurisdiction.

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SECTION 8

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8.0
EDUCATION AND OUTREACH

Education and outreach are seen by the Permittees as the keystone to municipal stormwater management. The primary focus of the education and outreach program is to keep pollutants out of the storm drain system rather than treating stormwater at the "end of the pipe." Because source reduction means controlling human activity and encouraging behavioral change, education about the effects of stormwater pollution and fostering broad participation in pollution prevention and control are critical to the success of the education and outreach program.

8.1 PROGRAM TO DATE

The RCFC&WCD and the County of Riverside established a full-time Public Education/Information Coordinator position to assist the Permittees in performing the education and outreach component of the municipal stormwater NPDES program. The Public Education/Information Coordinator develops and implements the stormwater education and outreach program for the Permittees. Materials and products produced for the education and outreach program are routinely submitted for comment and approval to the Permittees, Riverside County Waste Resources Management District, the County's Department of Environmental Health, and the County's Public Information Officer.

Coordination with other existing pollution prevention programs is ongoing. Staff from the County of Riverside Administrative Office, the County's Department of Environmental Health, and the Riverside County Waste Resources Management District meet regularly to coordinate similar pollution prevention program efforts. In addition there is coordination with programs such as the Riverside-Corona Resource Conservation District, the Coachella Valley Association of Governments' (CVAG) Illegal Dumping Task Force and the Western Riverside Council of Governments. Participation in a joint outreach program with the Southern California Coalition for Pollution Prevention (an industry-backed group) may also be pursued.

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8.1.1 General Outreach

General outreach provides information and materials to the general public about stormwater pollution prevention. The general outreach activities of the Stormwater/Cleanwater Protection Program which have been implemented to date include:

- The Riverside County education and outreach program commenced with the development of a program name/theme/message:

StormWater CleanWater PROTECTION PROGRAM

Stormwater should be
Cleanwater only . . .
Help keep our water clean!

- An information brochure was developed to introduce the assessment fee associated with the municipal stormwater NPDES program and mailed to over 150,000 property owners. The brochure informed residents of FACTS about the Stormwater/Cleanwater Protection Program and ACTIONS . . . what they can do to help protect their water. The brochure is also available in Spanish.

- Two half-page Sunday advertisements were printed to accompany the information brochure. Advertisements appeared county-wide through the Press Enterprise (all zones), the Desert Sun and the Californian daily newspapers.

- Public information presentations were conducted in eleven cities to introduce the Stormwater/Cleanwater Protection Program to city residents. The presentations included overhead transparencies, photos, and a question and answer forum.

- The Stormwater/Cleanwater Protection Program's toll-free number (800/506-2555) was established. It was determined that the establishment of one central number for all residents in Riverside County would make distribution of collateral material less complicated by alleviating the need to list 23 city phone numbers. The toll-free number is monitored by an answering service which refers calls to the appropriate agency based on the callers questions and their location. The toll-free number serves all cities within Riverside County, excluding Blythe (which is exempt from NPDES stormwater regulations).

- The brochure "Stormwater Pollution . . . What You Should Know" was developed. The toll-free number is listed in the brochure. The brochure introduces the problem of stormwater pollution, its effects on the environment

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and informs residents of primary things they can do to help prevent it. The brochure is also available in Spanish. Each city in Riverside County is supplied with brochures for distribution.

- The brochure "20 Ways to Protect Your Water" was developed. The toll-free number is referenced in the brochure. This brochures provides 20 specific examples of how residents can help protect their water by activities in their home, their yard, their auto, and their neighborhood. The brochure is also available in Spanish. Each city in Riverside County is supplied with brochures for distribution.

- The Stormwater/Cleanwater Protection Program display booth was constructed and made its debut at the 1994 Lake Perris Farmer's Fair. Over 800 packets of information were handed out at the fair via the display booth.

- A Stormwater/Cleanwater Protection Program magnet in the shape of a water drop was developed. The magnet relays the program message of "Help Keep Our Water Clean." It also references the toll-free number for information: on how to protect our water; for proper disposal of household hazardous waste; how to recycle motor oil; and how to report illegal dumping.

- Coordination with other agencies, such as Riverside-Corona Resource Conservation District and CVAG's Illegal Dumping Task Force, has created a cooperative arrangement to share resources and outreach opportunities. Riverside-Corona Resource Conservation District publishes stormwater pollution information and promotes the County's household hazardous waste collection events. CVAG has agreed to promote the Stormwater/Cleanwater Protection Program's toll-free telephone number.

8.1.2 Focused Outreach

Focused outreach provides information and materials pertinent to a specific aspect of stormwater pollution prevention or to a specific group of people, businesses, or industries. The focused outreach activities which have been implemented by the Stormwater/Cleanwater Protection Program to date include:

- Five utility inserts have been developed. Two specifically address stormwater pollution from motor oil. The Stormwater/Cleanwater Protection Program produced 105,000 utility inserts for the City of Riverside to be distributed in the their November 1994 utility bill. Coordination with various water districts and utility agencies is ongoing to schedule mailing of inserts.

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- Research and evaluation of existing educational materials for focus groups such as construction and industry are ongoing. A "clean business" incentive program will be modelled after the Bellevue, Washington program, "Business Partners for Clean Waters," which includes manuals on BMPs for construction, industry, and automotive businesses.

8.1.3 Education Programs

Stormwater education programs include components directed toward children in school systems or developed for municipal employee training. The stormwater education activities which have been implemented by the Stormwater/Cleanwater Protection Program to date include:

- Research and evaluation of existing educational materials for school grades K-12 are ongoing. A preliminary cartoon character has been selected: "Water Warrior" pollution prevention warriors who protect our water. Various reference materials will be developed such as: book covers and markers, pencils and coloring books.

- The HAZMAN coloring book from the Riverside County Environmental Health Department and the "Solution to Pollution Is You" pamphlet from the Riverside-Corona Resource Conservation District was provided to children as part of the information packet the Stormwater/Cleanwater display booth distributed at the Farmer's Fair. We will continue to distribute these items pending full development of the "Water Warriors" program for the Stormwater/Cleanwater Protection Program.

- Riverside County's Building and Safety Department staff has provided soil erosion and sediment control training to over 100 County employees including planners; engineers; road, grading, and building inspectors; equipment operators; and other field personnel.

- The Riverside County's employee newsletter, Network, published a special edition on various pollution prevention programs within the County. The six-page newsletter informed over 10,000 employees of the various programs and informed them about how to actively participate in pollution prevention.

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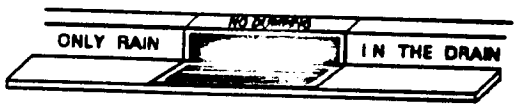
8.1.4 Citizen Participation

Components of the Stormwater/Cleanwater Protection Program have been developed to actively involve citizens in protecting stormwater quality. The citizen participation activities which have been implemented by the Stormwater/Cleanwater Protection Program to date include:

- The theme for the storm drain stencil campaign has been selected and will be:



- Each Permittee in Riverside County will be provided with a supply of stencils and a stencil program instructional kit. The Permittees, with assistance from the Public Education/Information Coordinator, will coordinate with local volunteer groups for stenciling days/activities.

- The toll-free phone number is designed to refer callers' questions to the appropriate agency. If a caller wants to report a full catch basin, or report illegal dumping, the answering service will refer the call to the appropriate agency. The operator will also advise the caller that if they were unable to reach the referenced agency/individual, or were dissatisfied with the help they received, they should call the toll-free number again and the operator will refer their call directly to the Stormwater/Cleanwater Public Education Coordinator. All cities within Riverside County have provided the Stormwater/Cleanwater referral service with a list of contact names for various agencies and programs.

8.2 FIVE-YEAR PLAN: 1995-2000

Education and outreach will be continued as a fundamental element of the Stormwater/Cleanwater Protection Program during the next permit period. This will include continuation and further development of the programs implemented during the current permit period as described in the following sections.

8.2.1 General Outreach

Written, audio, and video products for general outreach will be developed during the next

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permit period. A supply of the brochures and reference products developed will be provided to all cities within Riverside County for distribution at information counters, special meetings, etc. Some of the products contemplated are:

Written Materials

- periodic media kit – media kits will be distributed to local daily and weekly newspapers (Permit years 1-3);
- a brochure on the Stormwater/Cleanwater Protection Program with a theme "a partnership with your local government"; brochure will be distributed through a direct mailing campaign (Permit years 1-2);
- reference products, such as bags, pens, pencils, posters (Permit years 1-2);
- information packet to be distributed at the County's household hazardous waste collection events conducted throughout the County; packet will include stormwater pollution brochures, handouts, magnets, as well as, the County's Department of Environmental Health household hazardous waste recycling information (Permit years 1-2);
- bus stop shelter billboards – will require coordination with Riverside Transit Authority (RTA) for western Riverside County and the Sun Bus for the desert area (Permit years 2-4);
- tabletop and floor stand brochure display for distribution at public libraries and for city public information counters (Permit year 2);
- half-page and quarter-page newspaper advertisements to continue to increase public awareness (Permit years 1-5);

Audio Materials

- several public service announcements – coordinate production with the County of Riverside, Health Services Agency Media Production Center (Permit years 1-2);
- paid advertisement versus public service announcements – requires assessment of budget feasibility (Permit years 1-5);

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Video Materials

- an educational video and a 60-90 second public service announcement, film will show various locations throughout Riverside County (i.e. eastern desert area and western Riverside areas) - coordinate development and production with the County of Riverside, Health Services Agency Media Production Center (Permit years 1-2);
- air video on local cable station (Permit years 2-5); and
- copies of video to schools accompanying grades K-12 educational material (Permit years 2-5).

The Stormwater/Cleanwater display booth will be scheduled for various fairs throughout Riverside County including fairs for Earth Week and Pollution Prevention and Water Awareness Week. Brochures and reference products will also be distributed at these events.

8.2.2 Focused Outreach

The focused outreach information and materials to be developed during the next permit period are:

- a brochure on alternatives to toxic or hazardous household products (Permit years 1-2);
- a brochure on less toxic pest control methods (Permit years 1-2);
- additional utility inserts focusing on potential pollutants such as pesticides, fertilizers and illegal dumping; continuing coordination with water districts and utility agencies for scheduled mailing of inserts (Permit years 1-3);
- a series of BMP manuals for construction, industry, and automotive businesses for the "clean business" incentive program; contact businesses and seek partnership in the program; reference products to be developed will include: posters describing good housekeeping practices for various industries, "clean business" posters for displays, and "clean business" decals to affix to windows at participating businesses (Permit years 2-4);
- a series of workshops to introduce developers to the NPDES Guidelines for New Development (Permit years 2-4); and

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- a kick-off event coordinated with the County's Department of Environmental Health for the opening of two permanent battery, oil, and anti-freeze collection centers in Riverside County; kick-off activities, information packets and media opportunities will be coordinated (Permit year 2).

8.2.3 Education Programs

Stormwater education programs developed during the next permit period will expand upon topics and materials used in school curriculums. Development of training programs for municipal employees regarding stormwater pollution prevention and compliance and enforcement of stormwater regulations will also be emphasized. Education programs or activities contemplated are:

- A graphic artist will be retained to develop "Water Warriors" characters and drawings. (Permit year 1-2)
- The County will utilize the services of the Riverside-Corona Resource Conservation District for the development of:
  - stormwater protection curriculum and activity books with the "Water Warriors" theme for elementary schools;
  - teacher workshops to introduce school curriculum and activity books; and
  - school assembly presentations. (Permit years 1-2)
- Additional workshops for soil erosion and sediment control will be developed in coordination with the Riverside-Corona Resource Conservation District and the San Diego RWQCB. (Permit years 1-2)
- A workshop will be developed for the County's Automotive Fleet Services Division and various County road and maintenance facilities, to present BMPs for automotive servicing. (Permit years 2-3)
- A workshop will be developed for the County's Building Services Division on proper storage and disposal of hazardous materials and hazardous wastes. (Permit years 2-3)

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- A workshop will be developed to introduce the County's Stormwater/Urban Runoff Management and Discharge Controls Ordinance to County Planning and Development staff. (Permit year 2)

8.2.4 Citizen Participation

Components of the Stormwater/Cleanwater Protection Program will continue to promote the active involvement of citizens in protecting stormwater quality. These efforts may include the following:

- Although each city will be working with volunteer groups for storm drain stenciling, the County will conduct annual county-wide "Catch Basin Stenciling Days." Kick-off events will be coordinated with media opportunities. The events will coincide with Earth Week and/or Pollution Prevention Week activities. (Permit years 1-5)

- Community services groups such as the Kiwanis Club, Lions Club, and Rotary Club and environmental groups, will be contacted to coordinate stormwater education presentations. (Permit years 1-5)

- Organize "Clean-Up" day activities. Coordinate with volunteers to target specific areas in Riverside County for community clean-ups. Coordinate with the CVAG Illegal Dumping Task Force to participate in their "Clean-Sweep" program. Kick-off events and media opportunities will be coordinated. (Permit years 1-5)

- Coordinate and participate in special community activities associated with Earth Week, Pollution Prevention Week, and Water Awareness Week. (Permit years 1-5)

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9.0 CONSOLIDATED PROGRAM FOR WATER QUALITY MONITORING

A monitoring program plan was submitted to the Santa Ana RWQCB in 1991 for the portion of Riverside County under their jurisdiction. In March 1993, a second monitoring program plan was submitted to the San Diego RWQCB for the portion of Riverside County under their jurisdiction. In 1994, a third monitoring program was proposed in the permit application for the area of Riverside County under the jurisdiction of the Colorado River Basin RWQCB. To coordinate these three monitoring programs, the RCFC&WCD and the other Co-Permittees in Riverside County decided to pursue a county-wide monitoring program. A Consolidated Program for Water Quality Monitoring (Monitoring Program) was submitted to the three RWQCBs in October 1994 and is included as part of this Permit Application by reference. The Monitoring Program includes protocols for:

- "basic" sampling;
- bioassays;
- citizen complaints;
- sediment sampling;
- screening; and
- special tests (e.g., tap water).

"Basic" sampling includes dry weather observations and sampling, storm event sampling, and receiving water sampling.

Initiatives to coordinate stormwater quality monitoring are being discussed at the federal, state, and regional levels. These initiatives contemplate potential revisions in local stormwater monitoring programs including participation in special studies, increased data sharing, and modification of baseline data collection activities. It is anticipated that one or more of these initiatives may be implemented as early as fiscal year 1995/96. The Monitoring Program may be modified to reflect the participation of the Permittees in the coordinated monitoring programs or to reflect the findings of special studies.

This section summarizes the information provided in the Monitoring Program. It should be noted that the Monitoring Program may be modified throughout the next permit period to reflect findings, new information, and changing conditions in storm drain facilities and other environmental factors.

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9.1 OBJECTIVES OF THE MONITORING PROGRAM

The objectives of the monitoring program are to:

- assess mass loading rates from urban storm drain systems to the receiving waters;
- assess the influence of land uses on stormwater runoff quality;
- detect illegal discharges;
- conduct compliance monitoring of surface water quality;
- assess the effectiveness of various BMPs designed to control stormwater pollution;
- identify stormwater quality problem areas and/or trends;
- identify stormwater pollutants of concern;
- establish baseline conditions; and
- establish a database for future reference, research, and analysis.

9.2 MONITORING PROGRAM

The primary components of the Monitoring Program are:

- dry weather observations and sampling;
- storm event sampling;
- screening;
- sediment sampling; and
- receiving waters sampling.

Additionally, the monitoring program includes responding to citizen complaints and conducting special tests or studies.

9.2.1 Schedule for Implementation

During the 5-year permit period, the implementation schedule for various components of

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the Monitoring Program will be:

Component	Year 1	Year 2	Year 3	Year 4	Year 5
Dry Weather	X	X	X	X	X
Storm Event	X	X	X	X	X
Screening		X	X	X	
Sediment Sampling	X	X	X	X	X
Receiving Waters	X	X	X	X	X
Bioassay	X				X

9.2.2 Monitoring and Sampling Locations

The twenty dry weather monitoring stations are located at Arlington, Anza, Bly, Box Springs, Hemet, La Sierra, Mag Center, Sunnymead, Sunnyslope, Temescal Channel, University, Lower San Sevaine, North Norco, Corona, Fairmont, Four Corners, Canyon Springs, Hospital, Trailer Park, and Perris Line J.

The ten storm event sampling stations are located at Anza, Box Springs, Mag Center, San Sevaine, Corona, Fairmont, Four Corners, Canyon Springs, Hospital, and Trailer Park.

The screening stations are located at Mag Center and Arlington.

The fourteen sediment sampling stations are located at North Norco, Anza Basin, Monroe Basin, Jurupa Basin, Rubidoux Basin, Kansas Basin, Marlborough Basin, Columbia Basin, Canyon Springs Basin, Perris Valley Drain, Salt Creek Channel Outlet, Hemet Channel, San Jacinto Drain, and Buena Vista Basin.

The six receiving water sampling stations are located at Lake Elsinore, Temescal Gravel Pit, Lake Evans, Santa Ana River, San Jacinto River, and Lake Mathews.

Stations for bioassay testing have not been identified at this time.

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The locations of these various stations are depicted on maps included in the Consolidated Program for Water Quality Monitoring submitted to the three RWQCBs in October 1994.

9.2.3 Quality Assurance Program

The objective of the Quality Assurance Program is to ensure that the results of the Monitoring Program are based on reliable data. The Quality Assurance Program addresses the following elements of sample collection and analysis:

- development of standard sample collection and equipment maintenance procedures;
- education and training of sampling personnel;
- sample handling procedures;
- specification of standardized laboratory procedures;
- documentation including the development of standardized reporting forms; and
- development of standardized data management procedures.

9.2.4 Data Management

Field and laboratory data are maintained on a computer data base maintained by the RCFC&WCD which was based on a program entitled "Speedware." Critical limits for in-house evaluation of water quality data were developed by the RCFC&WCD based on a review of a combination of references. Water quality data generated by the Monitoring Program is evaluated based on comparison with these critical limits, which are viewed as typical of "raw surface water." The data and evaluation are provided in an annual report to the Santa Ana RWQCB.

9.2.5 Budget

The budget for the Monitoring Program in the Santa Ana Region for fiscal year 1994-95 is $194,100. The total budget for the Monitoring Program, including the Whitewater and

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Santa Margarita River watersheds, is $307,900. Assuming no modifications to the Monitoring Program, it may be anticipated that the annual monitoring costs would be fairly constant over the next permit period, if adjusted for inflation. However, the actual costs may fluctuate depending on the implementation of coordinated regional, state, and federal monitoring initiatives. In addition, as previously noted the Monitoring Program may be modified to reflect findings, new information, and changing conditions in the storm drain facilities and other environmental factors. These modifications may also result in changes in the cost of the monitoring activities.

9.3 EVALUATION OF MONITORING DATA

9.3.1 Pollutant Loading

Analytical data collected under the Monitoring Program include data for receiving waters and stormwater discharges. These data are maintained on a common computer data base. However, due to the inherent variability of stormwater quality and the inexact nature of discharge measurements, the data will only provide a general indication of pollutant loading. In addition, due to this variability, many years of data will be needed to identify trends in pollutant loading, particularly as they may be attributable to the implementation of source control programs.

9.3.2 Source Identification

The primary focus of dry weather water quality monitoring is to assess whether the ongoing program to identify and eliminate illicit connections and illegal discharges to the municipal storm drain system is succeeding. Dry weather monitoring and discharge measurements in the Santa Ana region are conducted at 20 fixed stations. Wet weather sampling and discharge measurements are also conducted at some of these stations. These monitoring activities may provide information for source identification. Where water quality criteria are chronically exceeded, or where visual observations or citizen complaints point to possible polluting activities, efforts will be made to identify the source of the water quality problem. Sources may include illicit connections, illegal discharges, poor housekeeping practices by commercial or industrial entities, or certain land uses. Where sources are identified, follow-up actions to address these sources will be implemented.

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9.3.3 Performance of Control Measures

As noted in Section 9.3.1, it will not be possible to evaluate the overall effectiveness of the municipal stormwater NPDES program through water quality monitoring due to the inherent variability and inexact nature of the data. The Permittees are participating in the development of coordinated stormwater monitoring programs on regional, state, and potentially, national, levels. During development of the coordinated monitoring programs, the Permittees will promote incorporation of special studies to evaluate specific stormwater quality control measures. These special studies may include evaluation of specific activities (e.g., street sweeping) and/or types of facilities (e.g., parking lot oil/water separators).

Section 10.0 describes the methods other than water quality monitoring which will be used to evaluate the effectiveness of the municipal stormwater NPDES program.

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SECTION 10

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10.0 PROGRAM EVALUATION

The effectiveness of the municipal stormwater NPDES program (Stormwater/Cleanwater Protection Program) will be assessed on a regular and consistent basis. The evaluation component of the Stormwater/Cleanwater Protection Program will include a schedule for evaluation, a clear definition of what will be evaluated, a methodology for the evaluation of BMP implementation and effectiveness, and designation of responsibility for carrying out the evaluation. In addition, there will be a process to follow up on the information generated by the evaluation. The Stormwater/Cleanwater Protection Program will be revised based on the program evaluation.

10.1 PERFORMANCE STANDARDS

The Advisory Committee will be responsible for developing and adopting evaluation criteria for implementation and performance of the various components criteria for evaluation of the Stormwater/Cleanwater Protection Program. The Advisory Committee may elect to establish subcommittees to develop these criteria for specific program components. The criteria developed will include the concept that the BMPs identified in the DAMP will be implemented to the maximum extent possible. Standard implementation schedules and reporting formats will be developed for each BMP by the Advisory Committee for use by the Permittees. The Permittees will be required to document BMP implementation using a standard format according to an established schedule. The utilization of quantitative approaches (direct and indirect) for measuring implementation and effectiveness of BMPs will be used whenever possible. The evaluation and reporting methods developed will facilitate year-to-year comparisons.

The evaluation component of the Stormwater/Cleanwater Protection Program will assess the effectiveness of the Stormwater/Cleanwater Protection Program on at least four levels:

- extent of implementation of BMPs;
- indirect quantitative measures;
- indicators of public awareness; and
- water quality monitoring.

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10.1.1 Extent of Implementation of BMPs

Criteria to judge the extent of implementation of each of the BMPs included in the DAMP will be developed in 1995. The criteria will include minimum implementation levels to be achieved by the Permittees. The criteria will also provide that over the next permit period each BMP is implemented to the maximum extent practicable by the Permittees. The targeted completion date for developing these evaluation criteria for implementation is September 1, 1995.

The purchase and installation of equipment to implement BMPs will be documented and reported. Examples may include purchase and use of street sweepers, flow control devices, recycling bins, etc. Reporting will be simple and consist of a brief written description of the equipment and a photograph if it is very unusual.

Revisions to written procedures needed to implement BMPs will be developed and reported. Examples may include changes to written procedures for handling and storage of hazardous waste, equipment operation, etc. Reporting will consist of updating the Stormwater/Cleanwater Protection Program and compiling a copy of revised standard operating procedures for review by personnel.

When changes to practices that do not have written procedures are needed to implement BMPs, these changes will be reported. Examples may include changes in handling and storage of waste, equipment operation, equipment maintenance, cleaning practices, etc. Reporting will be simple and consist of a brief memo to personnel describing the revised practices.

Training may be needed where changes in personnel, routine operations and maintenance, or implementation of new practices are proposed. The number of personnel trained, the type of training given, and how often the training occurs will be reported in a memo.

Incremental costs incurred for implementation of BMPs will be reported. Such costs may include one-time and continuing costs. Expenditures of money are an indicator of the extent and level of efforts undertaken to implement the BMPs.

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Under the Santa Ana Permit, Task XIII.f requires an evaluation of the need for additional BMPs, source controls, or structural control measures. However, the implementation of BMPs is relatively recent. Before recommending changes to BMPs or additional BMPs beyond those currently being implemented or proposed by the Permittees, a uniform data collection and reporting methodology will be established for each of the BMPs. This methodology will be used by the Permittees to allow for a uniform area-wide evaluation of BMP implementation. The uniform data collection methodology will be developed by June 1, 1996.

10.1.2 Indirect Quantitative Measures

Indirect quantitative measures will also be used for program evaluation. For some BMPs, it is possible to measure the volume or weight of material collected. As these materials are no longer available for contact with storm water, the total amount of storm water pollutants discharged is assumed to be reduced by this amount.

For other BMPs, reporting the frequency an amount of the action are reasonable measures for documenting effectiveness. For example, reporting the frequency of street sweeping and the number of curb miles swept per year are reasonable measures for documenting BMP effectiveness. Other examples include reporting the number of brochures distributed that identify alternative disposal methods, the number of inspections conducted, and the preventive maintenance tasks performed.

For structural controls, such as detention basins and drainage swales, visual inspections can provide useful information regarding performance. For example, patterns of sediment deposition can provide insight into the effectiveness of a structural control. Similarly, observations of floating or suspended material, oil and grease, discoloration, and odors in discharges are an indicator of performance. Such observations will be documented and used to modify maintenance practices or to recommend modifications to the control.

Some specific examples include the following:

- Street Sweeping – A method of evaluating the quantity and types of pollutants removed by street sweeping may be developed and implemented. This may include studying what kind of pollutants are removed by the sweeping,

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measuring the size of the pollutants, and the volume or weight of material removed. The frequency of street sweeping the number of curb miles swept per year may also be reported.

- Use of 800 Hotline Number - In mid-October 1994, Riverside County implemented an 800 hotline number for citizens to report suspected stormwater pollution incidents. The frequency of the calls to the hotline will be used as an indicator of the level of awareness of the program and the number of pollution incidents in each Co-Permittee area.

- Waste Oil Recycling - Riverside County has begun collection of statistics on the amount of waste oil recycled. The assumption is that an increase in the amount of waste oil recycled results in a decrease in the amount of waste oil illegally disposed to the storm drain system. The amount of waste oil recycled will be used as an indicator of the effectiveness of this program in reducing stormwater pollution.

- Household Hazardous Waste Collection - Riverside County has implemented a household hazardous waste collection program. It is assumed that a portion of this hazardous waste would result in stormwater pollution if not properly disposed. The amount of household hazardous waste collected under this program will be used as an indicator of the effectiveness of this program in reducing stormwater pollution.

10.1.3 Indicators of Public Awareness

The effectiveness of the Stormwater/Cleanwater Protection Program public awareness campaign will be measured by increases in community participation at the County's household hazardous waste collection events, the use of the Stormwater/Cleanwater Protection Program toll-free telephone number, and program recognition in the general community. Telephone surveys will be conducted to measure the public's awareness of stormwater pollution issues and to gauge the effectiveness of the Stormwater/Cleanwater Protection Program public information efforts during the last three years of the next permit period.

10.1.4 Monitoring

Since BMPs have only been implemented for a short period, there is little or no monitoring data available to adequately assess their effectiveness in improving stormwater quality.

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Methods to assess the effectiveness of the BMPs through stormwater monitoring will be evaluated and, where useful, implemented during the next permit period. However, stormwater quality monitoring is difficult to use in assessing BMP effectiveness for stormwater pollution prevention. The difficulty arises from storm event variability in frequency, duration, and magnitude. Further, monitoring data are being collected concurrent with implementation of many BMPs so that determining the true effectiveness of a specific BMP is unlikely and speculative, at best.

10.1.5 Level of Compliance with State Permit Programs

The Stormwater/Cleanwater Protection Program includes measures to promote compliance with the Industrial Permit and Construction Stormwater Permit. The number of notices of intent and permits issued to industries and construction projects in the Santa Ana River watershed will be obtained and evaluated as an indicator of the success of the Stormwater/Cleanwater Protection Program's activities. Enforcement actions and investigations related to State permit programs will be documented.

10.2 ANNUAL REPORTS

This section describes the annual reporting and Permittee performance evaluation processes which the municipal stormwater NPDES program has conducted during the first five-year permit period. The modifications to the processes planned for the next five-year permit period are described and the respective roles and responsibilities of the Principal Permittee, Co-Permittees, committees, and the Santa Ana RWQCB are presented. In general, the annual reports will discuss the program implemented during the previous year and present a plan that will be implemented during the current year. In addition, the findings of the evaluation of the previous year's program will be used to suggest changes that are appropriate for implementation during the next year, including revisions to the five-year plan.

10.2.1 Reporting Process

The process of annual reporting of the activities of the Permittees to comply with the Santa Ana Permit has evolved over the permit period. The first annual report (fiscal year 1990-

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91) was produced by the Principal Permittee using information supplied by the Co-Permittees. The second and third annual reports (fiscal years 1991-92 and 1992-93) were compiled by the Principal Permittee using slightly modified reporting forms from the previous year, and some sections (e.g., monitoring) were added as new compliance programs were initiated. The fourth annual report (fiscal year 1993-94) was produced by the Principal Permittee using reporting formats developed by a consultant. Blank copies of the standardized reporting forms used by the Co-Permittees are included in Appendix J. In the future, the Advisory Committee will be utilized to assist in developing more effective report formats for fiscal year 1994-95 and throughout the next five-year permit period.

10.2.2 Evaluation Process

Evaluation of Permittee performance was included as a provision of the Santa Ana Permit (Item I.7). Other provisions in the Santa Ana Permit required annual reporting of progress on implementation of illicit connection and illegal discharge elimination programs and an evaluation of the progress of implementation of community-specific activities to reduce the discharge of pollutants in stormwater. The evaluation process conducted during fiscal year 1992-93 included information obtained from questionnaires completed by the Co-Permittees regarding the activities implemented that fiscal year.

10.2.3 Purposes of Annual Reporting

The main purpose of annual reporting is to demonstrate compliance with the Santa Ana Permit. A secondary purpose is to provide a mechanism for improving the implementation of activities or to provide information improving the management of stormwater pollution control programs. These are described below, followed by a summary of the format and content of the annual report.

10.2.3.1 Demonstration of Compliance

This requires the Permittees to provide detailed descriptions of, and pertinent data related to, activities they have implemented to reduce the discharge of pollutants in stormwater. Other information required to be reported include the results of the municipal stormwater monitoring activities, evaluation/assessment of control measure activities in reducing

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pollutants in stormwater, and an evaluation/assessment of the performance of each Permittee in implementation of control measure activities.

10.2.3.2 Mechanism for Improvement

The annual report provides a mechanism for the Permittees to identify activities which are proven effective and to update the DAMP for their continued implementation, and to identify activities which are ineffective, or do not add significant benefit to reduction of pollutants in stormwater, and should no longer be included in the annual report, or implemented as activities of the stormwater pollution reduction effort. Activities which are proven effective include various education efforts (e.g., stenciling, pest brochure, tri-folds), illegal dumping response programs, illicit connection elimination programs, among others. Activities which are implemented for other purposes, and indirectly benefit stormwater pollution reduction efforts include litter control, recycling/collection of household hazardous wastes, stormwater facility maintenance, and street sweeping.

10.3 ANNUAL REPORTING FORMATS

Annual reports covering various elements of the compliance program will be submitted to the Santa Ana RWQCB by November 30 of each year during the next permit period. The annual reports include the items described below.

10.3.1 Water Quality Monitoring

The Water Quality Monitoring report will be submitted on August 31 of each year and will include a summary of the water quality and quantity data collected during the previous fiscal year. In addition, calculations of the pollutant loadings and an analysis of the data will be provided. Modifications to the water quality monitoring program based on the findings or resulting from coordination with regional, state, or federal initiatives will also be presented in conjunction with a budget for the monitoring program for the next fiscal year.

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10.3.2 Progress Report

A Progress Report on the overall permit compliance program will be provided by September 30 of each year. This report will consist of several elements. The fiscal analysis will include a summary of funding, the sources of funding, and how it will be distributed. In addition, an estimate of the cost of each of the compliance program elements and the personnel or contracts that will be required to implement the program will be presented. Estimates for each of the subsequent remaining years of the permit will also be presented.

A program analysis addressing the evaluation of the effectiveness of the program will be included in the Progress Report. This will include a summary of the extent of implementation of BMPs and indirect quantitative measures, indicators of public awareness, monitoring, and the level of compliance with other SWRCB or RWQCB permit programs. Finally, the Progress Report will include a description of modifications to management of the program.

10.3.3 Illicit Connections and Illegal Discharges

A report on the illicit connection and illegal discharges control programs summarizing the following information will be included in the Annual Illegal Discharge Control Report:

- storm drain system inspections conducted;
- illicit connections and illegal discharges identified and eliminated;
- illicit connections and illegal discharges which have not been eliminated;
- enforcement actions taken to eliminate illicit connections or illegal discharges;
- public education pertaining to illicit connections and illegal discharges; and
- public employee training relative to illicit connections and illegal discharges.

10.3.4 Construction

A report on the construction inspection program summarizing the following information will be included in the Annual Report:

- number of inspections;
- standard mitigation measures implemented;
- follow-up actions taken;

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- enforcement actions taken;
- planned modifications to the inspection program; and
- construction inspector training relative to stormwater pollution control.

10.4 SUB-ANNUAL MEETING

Annually, between April 15 and May 15, the Permittees will meet with the Santa Ana RWQCB to report on the implementation of that year's program, present a preliminary budget for the next fiscal year program addressing the funding issues for the upcoming budget process, and to discuss preliminary plans for the next year, including what revisions to the five year plan will be required. Feedback from these discussions will be used in preparation of the Annual Report.

10.5 INTERNAL REPORTING

A series of standardized reporting forms have been prepared for use in communicating compliance activities to the Santa Ana RWQCB. These forms are included in the DAMP.

10.6 STORMWATER MANAGEMENT PLAN REVISIONS

The DAMP will continue to evolve during the next permit period. However, to minimize confusion and promote compliance, the DAMP will only be formally updated once during the next permit period. An updated DAMP will be provided to each of the Permittees and the Santa Ana RWQCB.

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SECTION 11

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California Regional Water Quality Control Board
Santa Ana Region
2010 Iowa Avenue, Suite 100
Riverside, CA 92507-2409

FACT SHEET

PROJECT

The attached pages contain information concerning an application for waste discharge requirements and a National Pollutant Discharge Elimination System (NPDES) permit, Order 95-____, NPDES No. CA _____, which prescribes waste discharge requirements for urban stormwater runoff from the cities and the unincorporated areas in Riverside County within the jurisdiction of the Santa Ana Regional Board. On January 3, 1995 the Riverside County Flood Control and Water Conservation District (RCFC&WCD), the County of Riverside, the Cities of Beaumont, Calimesa, Canyon Lake, Corona, Hemet, Lake Elsinore, Moreno Valley, Norco, Perris, Riverside, and San Jacinto (hereinafter collectively referred to as the Permittees), submitted NPDES Application No. _____ for an area-wide stormwater discharge permit under NPDES. The permit application was submitted in accordance with the previous NPDES permit (Order No. 90-104, NPDES No. CA 8000192) which expires July 1, 1995. Additionally, the permit application follows guidance provided by the staffs of the State Water Resources Control Board (State Board) and Regional Water Quality Control Boards (Regional Boards).

PROJECT AREA

The permitted area is delineated by the San Bernardino-Riverside County boundary line on the north and northwest, the Orange-Riverside County boundary line on the west, the Santa Ana-San Diego Regional Board boundary line on the south, and the Santa Ana Colorado River Basin Regional Board boundary line on the east. Areas of the County not addressed or which are excluded by the stormwater regulations and areas not under the jurisdiction of the Permittees are excluded from the area requested for coverage under this permit application. This includes the following areas and activities:

- federal lands and state properties, including, but not limited to, military bases, national forests, hospitals, colleges and universities, and highways;
- Native American tribal lands;

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- open space and rural (non-urbanized) areas;
- agricultural lands; and
- utilities and special districts.

As a partial illustration, federal and state lands in Riverside County within the jurisdiction of the Santa Ana Regional Board, for which coverage under a municipal stormwater NPDES permit is excluded, are shown in Appendix A (Western Riverside County NPDES Permit Area).

CLEAN WATER ACT REQUIREMENTS

The Federal Clean Water Act (CWA) allows the United States Environmental Protection Agency (USEPA) to delegate its NPDES permitting authority to states with an approved environmental regulatory program. The State of California is one of the delegated states. The Porter-Cologne Act (California Water Code) authorizes the State Board, through its Regional Boards, to regulate and control the discharge of pollutants into waters of the State and tributaries thereto. Section 405 of the Water Quality Act (WQA) of 1987 added Section 402(p) to the CWA. Pursuant to Section 402(p)(4) of the CWA, the USEPA promulgated regulations for stormwater permit applications for stormwater discharges associated with industrial activities and municipal separate storm drain systems serving a population of 100,000 or more. This permit governing municipal stormwater discharges meets both the statutory requirements of Section 402(p)(3)(B) and all requirements applicable to an NPDES permit issued under the issuing authority's discretionary authority in accordance with Section 401(a)(1)(B) of the CWA.

AREA-WIDE STORMWATER PERMIT

To regulate and control stormwater discharges from the Riverside County area to the municipal storm drain systems, an area-wide approach is essential. The entire storm drain system is not controlled by a single entity; the RCFC&WCD, the County, several Cities and the State Department of Transportation (Caltrans), U.S. Army Corps of Engineers, in addition to other smaller entities, manage the systems. In addition to the Cities, the County and the RCFC&WCD, there are a number of other significant contributors of urban stormwater runoff to these storm drain systems. These include: large institutions such as the State university system, schools, hospitals, etc.; federal facilities such as military sites, etc.; State agencies such as Caltrans, water and wastewater management agencies such as Eastern and Western Municipal Water District; the National Forest Service and State parks. The Regional Board has issued a separate NPDES permit to Caltrans. In addition, Caltrans, and the other contributors identified, are not under the jurisdiction of the Permittees. The management and control of the entire flood control system cannot be effectively carried out without the cooperation and efforts of all these entities. Also, it would not be meaningful to issue a separate stormwater permit to each of the entities within

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the permitted area whose land/facilities drain into the storm drain systems operated by the Permittees. The Regional Board has concluded that the best management option for the Riverside County area is to issue an area-wide stormwater permit to the RCFC&WCD, Riverside County, and the cities in Riverside County. A separate stormwater NPDES permit has been issued to Caltrans. Stormwater discharges from other state, federal, utility, or special district facilities and state or federal lands will either be added to the Riverside County permit or permitted separately.

Some of the RCFC&WCD storm drain systems discharge into storm drain systems controlled by other entities, such as the Orange County Flood Control District, which is (or will be) regulated under the Regional Board's Order No. 95-_____, NPDES No. CA _____. Some areas within Riverside County are within the Colorado River Basin and San Diego Regional Boards' jurisdiction. Permit requirements for stormwater runoff from the drainage areas of Riverside County within the jurisdiction of the San Diego and Colorado River Basin Regional Boards are addressed by these Regional Boards.

COORDINATION WITH OTHER REGIONAL AGENCIES

In developing best management practices and monitoring programs, consultation/coordination with other drainage management entities and other Regional Boards is essential. Regional Board staff will coordinate the program with other Regional Boards and other flood control entities/cities on an "as needed" basis. The permit/program process is at the same stage of development in both the Santa Ana and San Diego Regional Board areas of Riverside County. Common programs, reports, implementation schedules and efforts are desirable and will be utilized to the maximum extent practicable.

EXISTING FACILITIES AND PROGRAMS

Within the Santa Ana Region, the RCFC&WCD serves a population of approximately 930,000, occupying an area of approximately 1,360 square miles. The RCFC&WCD's system includes an estimated 200 miles of open and closed storm drains. The storm drain systems operated by the remaining Permittees include an estimated 57 miles of open and closed storm drains. Approximately one-quarter (1/4) of Riverside County drains into water bodies within this Regional Board's jurisdiction. Stormwater discharges from urbanized areas consist mainly of surface runoff from residential, commercial, and industrial developments. In addition, there are stormwater discharges from agricultural land uses, including dairy operations. However, the WQA specifically excludes agricultural discharges from regulation under this program. The constituents of concern and significance in these discharges are: total suspended solids, biochemical oxygen demand (BOD), chemical oxygen demand (COD), oil and grease (O&G), heavy metals, nutrients and organic chemicals such as base/neutral and acid extractables, pesticides and herbicides, and petroleum hydrocarbon components.

To protect the beneficial uses of waters of the State, the pollutants from all sources need

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to be controlled. Recognizing this, and the fact that stormwater discharges contain pollutants, the Permittees and the Regional Board have all agreed that an area-wide stormwater permit is the most effective way to develop and implement a comprehensive stormwater management program in a timely manner. This area-wide stormwater permit contains requirements with time schedules that will allow the Permittees to continue to address water quality problems caused by urban stormwater runoff through their management programs to reduce pollutants in stormwater discharges to the maximum extent practicable.

PERMIT REQUIREMENTS

In accordance with Section 402(p)(3), as part of a program to reduce the pollutants in stormwater discharges to the maximum extent practicable, the Permittees have been required to submit existing management plans and programs being implemented or developed in the previous municipal stormwater NPDES permit to reduce pollutants in stormwater discharges. In addition, the Permittees will be required to report, review and/or revise the management programs and control measures in accordance with a time schedule approved by the Executive Officer of the Regional Board for this municipal permit.

If existing management programs are not effective in controlling pollutant loading and in achieving the water quality objectives of the receiving waters, additional programs shall be developed and implemented upon consultation and approval of the Executive Officer.

The permit also requires the development and implementation of management programs and/or best management practices (BMPs) during the life of the permit such that the quality of stormwater discharged can be improved and the water quality objectives of the receiving waters can be met ultimately. It is also expected that through implementation of these programs and/or BMPs the beneficial uses of the receiving waters will be protected.

BENEFICIAL USES

Stormwater flows which are discharged to municipal storm drain systems in Riverside County are tributary to various water bodies (inland surface streams and lake and reservoirs) of the state. The beneficial uses of these water bodies include municipal and domestic supply, agricultural supply, industrial service supply, industrial process supply, groundwater recharge, water contact recreation, non-contact water recreation, warm freshwater habitat, cold freshwater habitat, wildlife habitat, and preservation of rare and endangered species. The ultimate goal of this stormwater management program is to protect the beneficial uses of the receiving waters.

ANTIDEGRADATION ANALYSIS

The Regional Board has considered whether a complete antidegradation analysis, pursuant to 40 CFR 131.12 and State Board Resolution No. 68-16, is required for these stormwater

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discharges. The Regional Board finds that the pollutant loading rates to the receiving waters will be reduced with the implementation of the requirements in this order. As a result, the quality of stormwater discharges and receiving waters will be improved, thereby protecting the beneficial uses of waters of the United States. This is consistent with the federal and state antidegradation requirements and a complete antidegradation analysis is not necessary.

PUBLIC WORKSHOP

The Regional Board recognizes the significance of Riverside County's Stormwater/Cleanwater Protection Program and will conduct, participate, and/or assist with at least one workshop every year during the term of this permit to promote and discuss the progress of the stormwater management program. The details of the annual workshop will be published in local newspapers and mailed to interested parties. Persons wishing to be included in the mailing list for any of the items related to this permit may register their name, mailing address and phone number with the Regional Board office at the address given below.

PUBLIC HEARING

The Regional Board will hold a public hearing regarding the proposed waste discharge requirements. The public hearing is scheduled to be held on Friday, June __, 1995, at 9:00 a.m. at the _____. Further information regarding the conduct and nature of the public hearing concerning these waste discharge requirements may be obtained by writing or visiting the Santa Ana Regional Board office, 2010 Iowa Avenue, Suite 100, Riverside, CA 92507.

WRITTEN COMMENTS

Interested persons are invited to submit written comments on the proposed waste discharge requirements and the Executive Officer's proposed determinations. Comments should be submitted by _____ either in person or by mail to:

Pavlova Vitale
California Regional Water Quality Control Board
Santa Ana Region
2010 Iowa Avenue, Suite 100
Riverside, CA 92507

INFORMATION AND COPYING

Persons wishing further information may write to the above address or call Pavlova Vitale at 909/782-4290. Copies of the application, proposed waste discharge requirements, and other documents (other than those which the Executive Officer maintains as confidential)

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are available at the Regional Board office for inspection and copying by appointment scheduled between the hours of 10:00 a.m. and 4:00 p.m., Monday through Thursday (excluding holidays).

REGISTER OF INTERESTED PERSONS

Any person interested in a particular application or group for applications may leave his name, address and phone number as part of the file for an application. Copies of tentative waste discharge requirements will be mailed to all interested parties.

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California Regional Water Quality Control Board
Santa Ana Region

ORDER NO. 95-____

NPDES NO. CA95_____

Waste Discharge Requirements
for the Riverside County Flood Control
and Water Conservation District,
the County of Riverside
and the Incorporated Cities of Riverside County
For Area-Wide Urban Stormwater Runoff
Within the Santa Ana Region of Riverside County

The California Regional Water Quality Control Board, Santa Ana Region (hereinafter called Regional Board), finds that:

1. On January 3, 1995, the Riverside County Flood Control and Water Conservation District (RCFC&WCD) in cooperation with the County of Riverside and the Cities of Beaumont, Calimesa, Canyon Lake, Corona, Hemet, Lake Elsinore, Moreno Valley, Norco, Perris, Riverside and San Jacinto (hereinafter collectively referred to as the Permittees), submitted National Pollutant Discharge Elimination System (NPDES) Application No. CA 95____ for an area-wide stormwater discharge permit under the NPDES.

2. The 1972 Clean Water Act (CWA) recognized the need to prohibit the discharge of pollutants to surface water bodies from point sources such as industrial facilities and municipal sewage treatment plants. The discharge of pollutants from point sources is regulated by the NPDES permit system, which requires technology-based controls for treatment of wastewater. Stormwater point source discharges were exempt from the NPDES permitting requirements unless these discharges were contaminated by industrial/commercial activity. The Regional Board recognized the water quality problems associated with stormwater from industrial facilities and has issued a number of stormwater permits for such facilities in accordance with the United States Environmental Protection Agency (USEPA) regulations.

3. In 1976, the USEPA issued new regulations establishing a comprehensive permitting program for all stormwater discharges except for rural runoff uncontaminated by industrial/commercial activity. Channelized stormwater runoff continued to be defined as non-point source unless designated otherwise by the permitting authority.

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4. Since 1976, the USEPA has issued several revisions to the stormwater regulations. Section 405 of the Water Quality Act (WQA) of 1987 added Section 402(p) to the CWA. Pursuant to Section 402(p)(4) of the CWA, the USEPA was required to promulgate regulations for stormwater discharges associated with industrial activities and municipal separate storm drain systems serving a population of 100,000 or more, or area designated by the Director of the USEPA or permitting State agency.

5. On December 7, 1988, the USEPA published its proposed regulations for stormwater discharges in the Federal Register to solicit public comments. Final regulations were promulgated and published in the Federal Register on November 16, 1990.

6. The beneficial uses of a number of water bodies within Riverside County are threatened or impaired which may be in part due to urban stormwater runoff and non-stormwater flows from urbanized areas. These water bodies include the Santa Ana River, Reaches 3 and 4, Canyon Lake, Lake Elsinore, Lake Evans and Lake Mathews. A comprehensive stormwater and urban runoff management and regulatory program is essential for the protection of the water resources of the Region. The RCFC&WCD, the County of Riverside, the Cities in Riverside County, and the Regional Board have recognized this fact, and as a first step toward protecting water quality in the area, a comprehensive stormwater management program has been developed. This order outlines the existing programs and specifies additional requirements and/or modifications to achieve water quality objectives for the Riverside County drainage areas within the Santa Ana Region. The intent of this permit is to regulate pollutants associated with discharges of stormwater from municipal storm drain systems and improve water quality in the Region in a timely manner.

7. Within the Santa Ana Region, the RCFC&WCD serves a population of approximately 930,000, occupying an area of approximately 1,360 square miles. The RCFC&WCD's storm drain system includes an estimated 200 miles of opened and closed storm drains, and the systems operated by the remaining Permittees include an estimated 57 miles of opened and closed storm drains.

8. The discharges from the municipal storm drain system consists of surface runoff generated from various land uses in all the hydrologic drainage areas which discharge into water bodies in Riverside County. The quality of these discharges varies considerably and is affected by land use activities, basin hydrology and geology, season, the frequency and duration of storm events and point source discharges permitted by the Regional Board under NPDES. The constituents of concern and significance in these discharges are: total and fecal coliform, enterococcus, total suspended solids, biochemical oxygen

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demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC), oil and grease, heavy metals, nutrients, base/neutral and acid extractables, pesticides and herbicides, and petroleum hydrocarbon components.

9. There are several entities whose land/facilities drain into the Riverside County municipal storm drain systems operated by the Permittees. The RCFC&WCD operates approximately 85 percent of the storm drain systems within the Region, and has agreed to be the lead party in implementing the provisions of this order. The remaining storm drain systems are owned and operated by the County and Cities within the county and by the State Department of Transportation (Caltrans). The County of Riverside and the incorporated Cities within the county have agreed to cooperate with the RCFC&WCD in controlling and improving the quality of urban runoff from their respective areas. The RCFC&WCD has been named as the Principal Permittee and the County of Riverside and the incorporated Cities have been named as the Co-Permittees. Appendix B lists the incorporated Cities with their 1994 estimated populations. Of the eleven Cities, there are two Cities with an estimated 1994 population over 100,000. The Regional Board has issued a separate stormwater NPDES permit to Caltrans.

10. Due to the enormous variability in stormwater quality and the complexity of the urban runoff management program, this area-wide stormwater permit is categorized as a major NPDES permit. This area-wide stormwater permit requires all entities discharging stormwater/urban runoff into the storm drain systems or any surface water bodies to have appropriate controls for proper management of this runoff. The Regional Board has the discretion and authority to require non-cooperating entities to participate in this area-wide permit or obtain individual stormwater discharge permits, pursuant to 40 CFR 122.26(a). The entities listed in Appendix C are considered as potential permittees of stormwater to the Riverside County drainage areas. It is expected that these entities will also work cooperatively with the RCFC&WCD, the County of Riverside and Cities to manage urban runoff.

11. The RCFC&WCD, as the Principal Permittee, will obtain (within its powers) the cooperation of all entities in implementing the provisions of this order. The Permittees have agreed upon the responsibilities as described in the November 19, 1991 Implementation Agreement. This agreement will be revised to reflect this order. In general, the RCFC&WCD, as the Principal Permittee, is responsible for the monitoring program, general overall education program, the RCFC&WCD fiscal information, coordinating and submitting Permittee reports to the Regional Board and conducting inspections of the RCFC&WCD's storm drain systems. The County of Riverside and the incorporated cities, as the Co-Permittees, will develop and

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implement site-specific compliance requirements, perform compliance monitoring and inspections, submit storm drain maps, fiscal and other information and compliance reports to the RCFC&WCD, exercise enforcement authority for achieving compliance with programs or BMPs, and review and implement stormwater management programs. The Regional Board will regulate stormwater discharges from state and federal facilities and activities, public utilities, and special districts and other stormwater discharges not under the jurisdiction of the Permittees.

12. The RCFC&WCD obtains its authority to control stormwater discharges, to prohibit discharges or connections to their facilities and to require compliance and carry out inspections of the storm drain systems within the District's boundaries from the RCFC&WCD Act. Various County and city ordinances which address industrial wastes and waste discharges, and land use within the unincorporated areas of Riverside County and Cities can be used by the Permittees to implement compliance activities. The Permittees have various forms of legal authority in place, such as charters, State Code Provisions for General Law Cities, city ordinances, and applicable portions of municipal codes and the State Water Code, to regulate stormwater/urban runoff discharges.

13. The RCFC&WCD has an active surface water quality monitoring program as described in detail in Appendix D of this Order. Initiatives to coordinate stormwater quality monitoring are being discussed at the federal, state and regional levels. These initiatives contemplate potential revisions in local stormwater monitoring programs including participation in special studies, increased data sharing, and modification of baseline data collection activities. It is anticipated that one or more of these initiatives may be implemented as early as fiscal year 1995/96. The Monitoring Program may be modified to reflect the participation of the Permittees in the coordinated monitoring programs or to reflect the findings of special studies.

14. A Water Quality Control Plan was adopted by the Regional Board on Month Day, 1994. The Plan contains water quality objectives and beneficial uses of waters in the Santa Ana Region.

15. The requirements contained in this order are necessary to implement the Water Quality Control Plan.

16. An attempt has been made to incorporate all of the essential elements of the federal stormwater regulations in this permit.

17. Stormwater discharges to the storm drain systems in Riverside County within the Santa Ana Region are tributary to various water bodies of the State. The

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identified water bodies are as follows (only a portion of some of the water bodies listed below is within Riverside County):

A. Inland Surface Streams

a. Santa Ana River
Santa Ana River, Reaches 3 and 4

b. Tributary to South Bank Santa Ana River
Tequesquite Arroyo (Sycamore Creek)
Temescal Creek, Reaches 1, 2, 3, 4, 5 and 6
Temescal Tributaries
Coldwater Canyon Creek
Bedford Canyon Creek
Other tributaries to these creeks

c. Tributary to North Bank Santa Ana River
Day Creek
Sevaine Creek

d. San Jacinto River Basin
San Jacinto River, Reaches 1, 2, 3, 4, 5, 6 and 7
Bautista Creek - Headwaters to Debris Dam
Strawberry Creek
San Jacinto River, North Fork
Fuller Mill Creek
Stone Creek
Salt Creek
Other tributaries: Indian, Hurkey, Poppet and Potrero Creeks

e. San Timoteo Creek Area Streams
San Timoteo Creek, Reach 4
Little San Gorgonio Creek
Other Tributaries to these Creeks - Valley Reaches
Other Tributaries to these Creeks - Mountain Reaches

f. Reche Canyon
Reche Canyon

B. Lake and Reservoirs

a. Lake Evans
b. Lee Lake
c. Lake Mathews

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d. Mockingbird Reservoir
e. Canyon Lake
f. Lake Elsinore
g. Lake Fulmor
h. Lake Hemet
i. Lake Perris

The beneficial uses of these water bodies include municipal and domestic supply (MUN), agricultural supply (AGR), industrial service supply (IND), industrial process supply (PROC), groundwater recharge (GWR), water contact recreation (REC-1), non-contact water recreation (REC-2), warm freshwater habitat (WARM), cold freshwater habitat (COLD), wildlife habitat (WILD), and preservation of rare and endangered species (RARE). The beneficial uses of individual water bodies are shown on Appendix E.

18. Stormwater discharged from the storm drain systems operated by the County of San Bernardino drain into various water bodies in the project/permit area. These water bodies include the Santa Ana River and San Timoteo Creek and various mountain creeks. The County of San Bernardino has been issued an area-wide stormwater permit (Order No. 90-) for effective control of the pollutants in the stormwater runoff discharged from its storm drain systems.

19. Numeric and narrative water quality standards exist (as found in the Basin Plan's Water Quality objectives) for the water bodies listed in Item No. 17 above. Currently, this Permit does not contain numeric limitations for any constituents because the impact of stormwater discharges on the water quality of the above named receiving waters has not been fully determined. Extensive water quality monitoring and analysis of the data are essential to make that determination. This order requires the Permittees to continue to monitor the stormwater discharges or begin monitoring as necessary, and to analyze the data. Additionally, since this order also requires development and implementation of BMPs by the Permittees, the pollutants in the stormwater runoff will be improved. The ultimate goal of the urban stormwater runoff management program is to attain water quality consistent with the water quality objectives for the receiving waters to protect the beneficial uses.

20. With respect to industrial activities, the Regional Board currently regulates discharges of point source process wastewater and non-process wastewater and stormwater discharges to storm drain systems through NPDES permits. Point source discharges other than stormwater will continue to be regulated by the Regional Board. Industrial stormwater dischargers are required to cooperate with the Permittees to control the discharge of pollutants in the stormwater runoff from individual facilities or to obtain individual industrial stormwater discharge or NPDES General Industrial or NPDES General Construction

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Permits from the Regional Board.

21. Recognizing the need for public involvement and participation in the development and implementation of an effective stormwater/urban runoff management program, the Regional Board will conduct at least one workshop each year during the term of this permit. The purposes of the workshops will be to solicit comments and to inform the public of the progress of the program. Written comments submitted will be forwarded to the State Board, the USEPA, and the RCFC&WCD for their review and comments.

22. In accordance with California Water Code Section 13389, the issuance of waste discharge requirements for this discharge is exempt from those provisions of the California Environmental Quality Act (CEQA) contained in Chapter 3 (commencing with Section 21100), Division 13 of the Public Resources Code.

23. The Regional Board has considered an antidegradation analysis, pursuant to 40 CFR 131.12 and State Board Resolution No. 68-16, for this discharge. The Regional Board finds that the stormwater discharges are consistent with the Federal and State antidegradation requirements and a complete antidegradation analysis is not necessary.

24. The Regional Board has notified the Permittees and interested agencies and persons of its intent to issue waste discharge requirements for this discharge and has provided them with an opportunity to submit their written views and recommendations.

25. The Regional Board, in a public hearing, heard and considered all comments pertaining to the discharge and to the tentative requirements.

IT IS HEREBY ORDERED that the Permittees, in order to meet the provisions contained in Division 7 of the California Water Code and regulations adopted thereunder, and the provisions of the Clean Water Act, as amended, and regulations and guidelines adopted thereunder, shall comply with the following:

I. RESPONSIBILITIES OF PRINCIPAL PERMITTEE

The Principal Permittee shall be responsible to manage the program overall, including:

1. Conduct water quality and necessary hydrographic monitoring of the storm drain system as agreed to by the Executive Officer, as contained in the Consolidated Program for Water Quality Monitoring (Appendix D) and as noted in Section VI of this Order. Initiatives to coordinate stormwater quality

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monitoring are being discussed at the federal, state and regional levels. These initiatives contemplate potential revisions in local stormwater monitoring programs including participation in special studies, increased data sharing, and modification of baseline data collection activities. It is anticipated that one or more of these initiatives may be implemented as early as fiscal year 1995/96. The Monitoring Program may be modified to reflect the participation of the Permittees in the coordinated monitoring programs or to reflect the findings of special studies.

2. Implement uniform methods and criteria for storm drain system inspections by all Permittees as agreed to by the Executive Officer, as contained in the Reconnaissance Survey Implementation Plan (Appendix F) and as noted in Section IV of this Order.

3. Conduct inspections/surveillance for illegal discharges to the storm drain facilities within its jurisdiction (ownership) as noted in Section IV of this Order.

4. Implement management programs, and implementation plans within its jurisdiction and powers as required by this Order.

5. Prepare and submit to the Regional Board all the reports, plans and programs as required by this Order.

6. Monitor the implementation of the plans and programs to determine their effectiveness in attaining water quality objectives to the MEP (maximum extent practicable).

7. Coordinate all the activities with the Regional Board.

8. Enact legislation and ordinances as necessary to establish legal authority within the scope and powers of the RCFC & WCD Act.

9. Obtain public input for any proposed management and implementation plans.

10. Pursue enforcement actions as necessary to ensure compliance with stormwater management programs and implementation plans within the scope and powers of the RCFC & WCD Act.

11. Respond to or arrange for a response to emergency situations such as accidental spills, leaks, illegal discharges, illicit connections etc. to prevent or reduce the discharge of pollutants to storm drain systems and waters of the United States.

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II. RESPONSIBILITIES OF THE CO-PERMITTEES

The Co-Permittees shall be responsible to manage the program within their respective jurisdictions, including:

1. Conduct inspections/surveillance for illegal discharges to the storm drain facilities within their jurisdiction as noted in Section IV of this Order.

2. Conduct and coordinate with the Principal Permittee any surveys and characterizations needed to identify pollutant sources and drainage areas

3. Review, comment and approve management programs, monitoring programs (not stormwater sampling), implementation plans and other elements of the overall program.

4. Implement management programs, monitoring programs (not stormwater sampling) implementation plans and other elements of the overall program within each respective jurisdiction as required by this Order.

5. Submit storm drain facility system maps with periodic revisions as necessary to the Principal Permittee.

6. Prepare and submit all reports and other information to the Principal Permittee in a timely manner with sufficient time for the group report to be submitted, in accordance with Section IX, to the Executive Officer.

7. Adopt resolutions and ordinances as necessary to establish legal controls required for direction of staff or to enable enforcement action to prevent or prosecute stormwater pollution violations.

8. Pursue enforcement actions as necessary to ensure compliance with the stormwater management programs and the implementation plans.

9. Respond to or arrange for a response to emergency situation(s) such as accidental spills, illegal discharges, illicit connections, etc. to prevent or reduce the discharge of pollutants to the storm drain facilities and waters of the United States.

III. RESPONSIBILITIES OF THE RWQCB

1. The RWQCB shall review and provide written comments on reports, plans and other submittals within 60 days. Failure of the RWQCB to provide written comments within this time period will constitute approval.

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2. The RWQCB shall institute investigation and enforcement actions in response to reports of non-compliance with the Industrial and Construction Stormwater Permits and illegal discharges, as appropriate, including those reported by the Permittees.

3. The RWQCB shall coordinate review and approval of NPDES Permits for discharge to surface waters or storm drain facilities in Riverside County with the Permittees. NPDES permits shall not be issued where there will be a conflict with the requirements of the Permit or objectives of the municipal stormwater compliance program.

4. The RWQCB shall regulate and assist in coordinating pollution control programs for stormwater and other discharges from areas and activities in Riverside County excluded from this Permit (e.g., Caltrans, state and federal facilities, agricultural activities, etc.).

5. The RWQCB shall facilitate municipal stormwater permit compliance activities by participating in meetings and providing guidance.

6. The RWQCB shall provide current listings of Notices of Intent (NOI) filed for compliance with the Industrial and Construction Stormwater Permits, SWRCB De-minimus Permit (proposed), General Dewatering Permit and others to the Permittees on request.

7. The RWQCB shall support and facilitate development and implementation of area-wide and regional stormwater compliance programs.

IV. GENERAL REQUIREMENTS

1. The Permittees shall prohibit illegal discharges from entering into the municipal storm drain facilities. Discharges conditionally allowed to enter storm drain facilities are specified in Section IV.

2. The Permittees have developed and begun implementation of best management practices (BMPs) to control discharges of pollutants to the maximum extent practicable to the waters of the United States. The BMPs so developed, are found in the Santa Ana Drainage Area Management Plan (DAMP) (Appendix G). The DAMP shall be up-dated and revised, if necessary, in accordance with Section IX (REPORTING).

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V. ILLEGAL DISCHARGE CONTROL PROGRAM

1. The Permittees shall implement the Reconnaissance Survey Implementation Plan as developed by the Permittees, as the result of Order 90-104, and included in this Order as Appendix F. In addition or modification to said Plan the following shall apply:

   A. Storm drain systems not previously inspected must be inspected for illegal discharges and illicit connections during the first permit year. This applies to pipes 36 inches and larger built before June 1990 and channels with a bottom width larger than two feet or a depth greater than three feet.

   B. Underground storm drains previously inspected need not be inspected during this permit period.

   C. Channels will be inspected during the third year of the permit period for illegal discharges and illicit connections.

   D. All illicit connections identified shall be eliminated during this permit period.

   E. All illicit discharges identified shall be traced to their source and the source eliminated or permitted by the Regional Board.

   F. A yearly report shall be submitted to the Regional Board, by the month and day specified in Section IX (REPORTING), and shall include the following information:

      1. List of all drainage facilities inspected preformed during the year.

      2. List of all illegal and illicit connections and discharges found during the year and all previously found that have not been eliminated or permitted by the Regional Board.

      3. Information of all inspections, enforcement or other actions taken regarding illegal discharges, illicit connections, illegal disposal of wastes, etc. to public right of ways, public properties or receiving waters, that may or does cause water pollution.

      4. A description of how the Permittees preformed all the actions/duties listed above.

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5. A Reconnaissance Survey Implementation Plan updated from the previous permit period shall be submitted in the first permit year. The up-date shall be complete with reporting forms and how the forms are processed, public personnel/inspector training information or process, who the internal enforcement agency or personnel are and the legal authority used (i.e. laws, ordinance, etc.) for enforcement. If an outside agency preforms the enforcement (i.e. a city has the County Environmental Health Department for enforcement) the agreement needs to be cited and the enforcement process described.

6. The up-dated Reconnaissance Survey Implementation Plan shall be submitted in accordance with Section IX REPORTING. Previous reconnaissance plans and reports have been submitted and are accepted by the Board; no retroactive revisions will be made other than those noted herein.

VI. DRAINAGE AREA MANAGEMENT PLAN

Submittals made for the DAMP under order 90-104 have been accepted and no revisions are required unless stated in this Order.

1. The Permittees have developed and are implementing Santa Ana Regional DAMP which is included in this Order as Appendix G. This plan has been approved by the Executive Officer and will meet the requirements of this section if properly implemented. Appendixes H through L included with this Order and noted below are the result of development of different portions of the DAMP. These Appendixes H through L are hereby included in the DAMP as DAMP Supplements A through E ; as noted below.

Appendix H	New Development Conditions Supplement "A"
Appendix I	Education Program Outline Supplement "B"
Appendix J	Stormwater Ordinance Supplement "C"
Appendix K	Soil Erosion Control Ordinance Supplement "D"
Appendix L	NPDES Reporting Forms Supplement "E"

2. The DAMP shall be reviewed, evaluated and revised as needed by the Permittees and an updated DAMP shall be submitted in accordance with Section IX (REPORTING). The Permittees shall address all the best management practices (BMPs) in the DAMP and its Supplements as well as

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the following:

A. Enforcement procedures/programs established by the cities and County for the enforcement of the Stormwater and the Soil Erosion Control ordinances.

B. BMPs or stormwater pollution prevention plans (SWPPPs) used by the Co-Permittees at their facilities, buildings and yards.

C. Hazardous/toxic waste collection programs.

D. Hazardous/toxic spill response

E. Cooperative action taken with or for the state in conjunction with the state's NPDES Construction General Permit.

F. Cooperative actions taken with or for the state in conjunction with the state's NPDES Industrial General Permit.

G. A listing of all of the Permittees' facilities or projects that are permitted with the NPDES Industrial or Construction General Permits.

3. The Permittees shall submit a DAMP progress report, except during the second permit year, assessing the progress of implementation of the DAMP and evaluating the effectiveness of the BMPs developed for the stormwater discharges. The yearly progress report will also address all of the items A through G listed in Section V.2 DRAINAGE AREA MANAGEMENT PLAN. The DAMP progress report will be submitted in accordance with the schedule in Section IX (REPORTING).

VII. WATER QUALITY MONITORING

1. The Principal Permittee shall implement the Consolidated Program for Water Quality Monitoring (CPWQM) included in this Order as Appendix D. The CPWQM was developed by the RCFC&WCD to address water quality monitoring in Regions 8 and 9 as a program for stormwater system monitoring, receiving water monitoring and data analysis of the monitoring. The CPWQM was written to also include monitoring in Region 7 once a permit is issued.

   The Board supports the concept of a consolidated monitoring program as long as the particular issues of concern of this Regional Board are addressed. In general, a study or pilot program in one Region will be acceptable by this Board as it is deemed to apply and need not be repeated in the Santa Ana

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River watershed.

2. In addition to implementing the CPWQM the Permittees shall include in their monitoring program the following:

   A. The CPWQM shall have the following purposes:

      1. To assess the quality of stormwater entering receiving waters.

      2. To assess water quality status or changes in the receiving waters.

      3. To provide a basis for mass loading estimates.

      4. To provide support to the Illegal Discharge Control Program for the investigation and discovery of illegal discharges or sources of stormwater pollutants.

      5. To characterize pollutants 'produced' by different land uses.

      6. To support the selection, modification, or evaluation of BMPs implemented from the DAMP.

   B. In general the CPWQM shall be supportive of the other programs and activities of the overall NPDES Stormwater Program.

3. Data Analysis Report

   A. The results of the chemical analysis and quantitative data (such as flow, precipitation, and discharge data) shall be compiled according to the drainage area and storm events monitored. The mass loading rates for the pollutant of concern shall be calculated.

   B. An evaluation shall be performed for the calculated mass loading rates from the stormwater and receiving water monitoring. Any impact of the discharges from the storm drainage systems on the receiving waters shall be discussed, starting with the most significantly impacted receiving water bodies. The evaluation shall be concluded with recommendations and the corrective actions proposed for any resulting discrepancies.

4. The RCFC&WCD shall continue the implementation the CPWQM and shall submit a CPWQM progress report and Data Analysis report on the dates specified in Section IX (REPORTING).

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VIII. FISCAL ANALYSIS

1. A Fiscal Analysis report shall be submitted to the Regional Board on the dates specified in Section IX (REPORTING). The report shall include information on or an analysis of the following:

   A. Each Permittee's expenditures for the previous fiscal year.

   B. Each Permittee's budget for the current fiscal year.

   C. A description of the source of funds for items 1 and 2

   D. Contract services (relating to the NPDES Program) - describing the service provided and the amount charged for the service.

   E. A list of staff, type of work, estimated time dedicated to the stormwater program and estimated cost.

IX. PROGRAM ANALYSIS

1. Each year the Principal Permittee shall conduct an analysis of the effectiveness of the overall stormwater management program. If the water quality objectives of the receiving waters are violated as a result of urban stormwater runoff discharges, the Principal Permittee shall identify proposed action(s) which intend to result in the attainment of the water quality objectives. The Principal Permittee shall also propose a time schedule to implement the new action(s).

2. The Program Analysis Report shall provide information explaining or showing the institutional arrangements of the Permittees as a group and individually and the legal authority each has to implement or enforce the various programs of this Order as follows:

   A. a macro flow chart showing all the Permittees and their relationship with each other and other key agencies;

   B. a micro flow chart showing the internal relationships between each Permittee's departments and any external agencies;

   C. a chart of all the BMPs, programs, and actions and the responsible party; and

   D. a copy of all agreements for the implementation or performance of services related to the NPDES Stormwater

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Program. Once submitted, such agreements need not be submitted the following years.

3. An evaluation of each BMP from the DAMP and other program elements prescribed in this Order implemented by each individual Permittee shall be included with the Program Analysis Report. The Principal Permittee shall develop standard reporting forms and methods for the evaluation. The proposed evaluation forms shall be submitted to the Regional Board for review and approval six months prior to submittal of the Program Analysis Report.

4. Existing data and information pertinent to this program shall be updated annually and submitted as part of the Program Analysis Report; unless covered elsewhere in this Order. The existing information and data to be updated shall include but not be limited to:

   A. Any changes or additions in storm drainage facilities, new outfalls, or any new major structural controls.

   B. Identification of land uses in each drainage area that is sampled during the previous year. The map shall show the storm drain system, drainage boundaries, sampling location and the following groups of land uses: commercial; industrial (including hospitals); parks, schools, and churches; residential; undeveloped and rural (less than one house per two-acres); and agriculture.

   C. Any additional industries subject to the State's General Industrial Activities Stormwater Permit identified during the last year.

X. REPORTING

1. All reports shall be signed by the Principal Permittee or duly authorized representative of the Permittees and shall be submitted to the Regional Board under penalty of perjury.

2. The Permittees shall be responsible for the submittal of the needed information, forms, data, or other materials needed to meet the requirements of each and every submittal with or without request from the Principal Permittee or the Regional Board to the Principal Permittee. Said information, forms, data, or other material submitted for reporting to the Regional Board shall be signed by a duly authorized representative of that Permittee under penalty of perjury.

3. Reports or submittals required in the previous sections of this Order shall be

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submitted in accordance with the following schedule:

	Submittal/Report	Frequency	Date
A.	Water Quality Monitoring 1. Stormwater 2. Receiving Waters 3. Data Analysis	Yearly	August 31
B.	Progress Report 1. Fiscal Analysis 2. Program Analysis 3. Existing Data Update 4. DAMP Progress 5. Program Management	Yearly	September 30
C.	Illegal Discharge Control 1. Personnel Training/Reports 2. Facility/Channel Survey 3. Monitoring Investigations 4. Construction Controls 5. Illegal Reports & Actions 6. Enforcement Actions	Yearly	October 31
D.	DAMP Revision	Once	July 31, 1996
E.	Reconnaissance Survey Implementation Plan/ Illegal Discharge Control Plan Revision	Once	June 30, 1996

XI. EXPIRATION AND RENEWAL

1. This Order expires on July 1, 2000 and the Permittees must file a Permit Renewal Application in accordance with Title 23, Division 3, Chapter 9 of the California Code of Regulations as applicable not later than 180 days in advance of such expiration date as application for issuance of new waste discharge requirements. This Permit Renewal Application shall include, but not be limited to, the following:

   A. Summary of the results of the Monitoring Program.

   B. Summary of the DAMP BMPs implemented and evaluations of their effectiveness.

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C. Summary of the Illegal Discharge Control Program

D. Evaluation of the need for additional BMPs, source control,and other control measures.

E. Proposed plan of urban stormwater runoff quality management activities that will be undertaken during the term of the next Order.

F. Any significant changes to the storm drain systems, outfall, detention or retention basins or dams, and other controls.

XII. CERTIFICATION

This Order shall serve as a NPDES permit pursuant to Section 402(p) of the Clean Water Act, or amendments thereto, and shall become effective 10 days after date of its adoption, provided that the Regional Administrator of the Environmental Protection Agency has no objection. If the Regional Administrator objects to its issuance, the permit shall not become effective until such objection is withdrawn.

I, Gerard J. Thibeault, Executive Officer, do hereby certify that the foregoing is a full, true, and correct copy of an order adopted by the California Regional Water Control Board, Santa Ana Region, on June 29, 1995.

Gerard J. Thibeault
Executive Officer

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R0055407

Developing Successful Runoff Control Programs For Urbanized Areas



Prepared by:
Northern Virginia Soil and Water Conservation District
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Developing Successful Runoff Control Programs for Urbanized Areas

Prepared by:

Northern Virginia Soil and Water Conservation District
Fairfax, Virginia

in fulfillment of Grant # X-820828-01-0/1/2 from the Nonpoint Source Control Branch, Office of Water, U.S. Environmental Protection Agency

Final Report

July 1, 1994

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Executive Summary

This manual defines the institutional and programmatic issues which are crucial to the success of runoff control programs in already urbanized or urbanizing areas. These nontechnical factors are often decisive in determining the effectiveness and success of such programs.

The manual describes strategies which local communities can use to develop the institutional frameworks needed to implement runoff control programs. The strategies are described in the program development section of the manual and in the case studies presented.

Each community will have different urban runoff management needs, environmental concerns and available resources. Yet, building an effective program requires certain common key steps. This manual lays out the essential elements, which will also be useful in preparing the management plans required by various Federal regulations and programs. In addition, retrofitting for runoff control may be necessary in some urban areas to achieve the water quality improvements necessary under current Federal and state mandates.

The Coastal Zone Act Reauthorization Amendments of 1990 (CZARA), §6217, required the development of the Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters (USEPA, 1993). States with coastal zone management programs are required to develop coastal nonpoint pollution control programs consistent with these Management Measures. The "Existing Development Management Measure" of Chapter Four (Urban Areas) requires development and implementation of programs to reduce pollution from existing development.

The National Pollutant Discharge Elimination System (NPDES) Storm Water Permit Program, established by §402(p) of the Clean Water Act, requires permits for certain municipal and industrial storm water discharges. In addition, this program requires the development of storm water management plans for the areas covered by the permit, which usually includes urbanized areas.

Both of these programs could involve the use of retrofits to achieve water quality improvements. While program requirements may differ based on the specific regulatory authority, the goals of these programs are complementary and many of the same management practices are applicable and satisfy the requirements of both programs. The case studies presented in this manual provide examples of the innovative ways in which many local governments are meeting the requirements of multiple programs to improve water quality. However, communities need to refer to

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applicable state and Federal regulations to assure that they are in compliance with all regulatory requirements.

The manual describes ways that local governments can approach the issues surrounding the implementation of urban runoff retrofit technology even when the control options are limited. It reviews appropriate "ultra-urban" technologies for situations where more conventional, land-intensive control practices are not feasible. Specific recommendations are summarized to help program implementation personnel develop strong institutional frameworks and create effective urban runoff control programs. The recommendations presented are largely based on the program implementation experiences of the case study communities featured in the manual. They include:

Problem Identification

- Identify problems clearly at the outset
- Define runoff control program objectives, requirements, and penalties

Priority & Goal Setting

- Consider innovative and cost effective retrofit methods
- Prioritize retrofit alternatives and set realistic goals to implement

Adequate Funding

- Identify stable and/or dedicated funding sources for urban runoff management programs
- Utilize cost-share approaches among agencies
- Utilize economic incentives to reduce amounts of stormwater discharges, e.g., utility fee reductions for reduced amounts of impervious surface
- Identify opportunities for public/private partnerships to conduct nonpoint source pollution control activities
- Obtain participation and support from private interests who will benefit from urban runoff control programs

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Multilateral Approaches

- Use teams or multi-agency work groups wherever possible
- Create effective institutional structures
- Identify related Federal, state and local programs and assess their storm water control effectiveness and degree of interaction
- Designate a lead agency to coordinate program development and implementation
- Designate sufficient agency staff to support implementation projects

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DEFINING THE PROBLEM OF URBAN RUNOFF MANAGEMENT

Introduction

This manual recommends strategies for communities to use to develop the institutional frameworks necessary for the successful implementation of urban runoff control projects, including retrofit projects in developed areas. It provides practical information for local government personnel who wish to develop such programs. While each community will have different runoff management needs and available resources, building an effective program requires certain common steps. This manual describes the step-by-step procedures necessary to develop effective programs to reduce nonpoint source pollution from urban runoff in developed areas.

Institutional factors have a significant impact on the effectiveness of urban runoff control programs. Because the development of institutional frameworks is vital to effective program implementation, this manual emphasizes program development, rather than specifying technical requirements for programs. (Technical manuals for the implementation of urban runoff controls are listed in the Bibliography.) It recommends strategies and outlines the step-by-step procedures which are necessary to develop urban nonpoint source pollution control programs.

Finally, in the accompanying case studies, this manual describes some approaches which local governments have successfully used to implement urban runoff control programs.

Purpose and Intended Audience of this Manual

This manual provides specific guidance to help local governments implement urban runoff programs. It does not track all regulatory requirements; these will differ by state and locality. Rather, it addresses certain elements of urban runoff control programs that are often problematic for municipalities considering program implemention. It is designed to help them through the program development and implementation process.

A local government wishing to develop an urban runoff control program for developed areas needs to base its approach on local conditions. This manual describes the basic issues in sufficient depth, with the use of examples, to enable a local government to design an effective program based on its particular needs.

The audience for this manual includes public agencies such as local environmental regulatory agencies; regional and local planning agencies; councils of governments; planning commissions, departments of public works, soil and water conservation

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districts, and other agencies concerned with land use, development, and urban runoff management.

However, the general public also needs to be included along with interested environmental groups and elected officials as part of the process of managing urban runoff problems and issues; this manual seeks to impart a basic level of knowledge about these issues to the nonprofessional or nontechnical person.

The purpose of the case studies is to present alternatives for local governments to consider in formulating solutions to urban runoff problems. They have been chosen to provide examples of innovative and successful alternatives in the field.

Brief History of Runoff Control

Urban runoff has not always been recognized as a major contributor of pollutants. Historically, urban nonpoint source pollution has been overlooked by surface water regulation agencies at the local, state and federal levels. Efforts to control surface water quality degradation concentrated on point sources. Urban nonpoint source pollution control focused on street sweeping, used motor oil recycling, and public education.[1] In addition, local governments have historically been concerned mostly with urban runoff quantity control. Water quality concerns have now become equally important for municipalities because of federal and state mandates.

During the first fifteen years of the national program to abate and control water pollution, EPA and the states have focused most of their water pollution control activities on so-called "point sources," such as discharges through pipes from sewage treatment plants and industrial facilities. These point sources have been regulated by EPA and the states through the National Pollutant Discharge Elimination System (NPDES) permit program established by Section 402 of the Clean Water Act.

Congress also amended the Clean Water Act in 1987 to require EPA to establish phased NPDES requirements for storm water discharges. Storm water discharge permits will provide a mechanism for monitoring the discharge of pollutants to waters of the United States and for establishing appropriate controls.[2]

The attempts to control point source pollution have reduced pollutant loads and

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[1]Murray, James, "Nonpoint Pollution: First Step in Control," in Design of Urban Runoff Quality Controls, Roesner et al, eds. American Society of Civil Engineers (New York, 1989), p. 378.

[2]USEPA, "Overview of the Storm Water Program," Office of Wastewater Enforcement and Compliance, Permits Division. Washington, DC: March, 1993.

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considerable progress has been made in restoring and maintaining water quality. However, the abatement of point source pollution did not solve all water quality problems. Recent studies and surveys by EPA and by state water quality agencies indicate that the majority of the remaining water quality impairments in our nation's rivers, streams, lakes, estuaries, coastal waters, and wetlands result from nonpoint source pollution and other nontraditional sources, such as urban storm water discharges and combined sewer overflows.

Congress amended the Clean Water Act in 1987 to focus greater national efforts on controlling nonpoint sources. Section 319 of the Act was enacted to establish a national program to control nonpoint sources of water pollution. In addition, Congress enacted Section 6217 of the Coastal Zone Act Reauthorization Amendments (CZARA) in 1990 to address the impact of nonpoint source pollution on coastal waters.

In recent years EPA introduced the Watershed Protection Approach (WPA) as a flexible framework for focusing and integrating current efforts and exploring innovative methods for achieving environmental objectives. The WPA focuses on four major elements: 1) identifying specific geographic locations; 2) integrating available authorities to deal with all pollution sources; 3) involving all stakeholders in analyzing and creating solutions; and 4) measuring effectiveness against clearly established objectives. These key elements are derived from experience gained over the past few years in many states and other EPA efforts such as the Clean Lakes and National Estuaries Programs.

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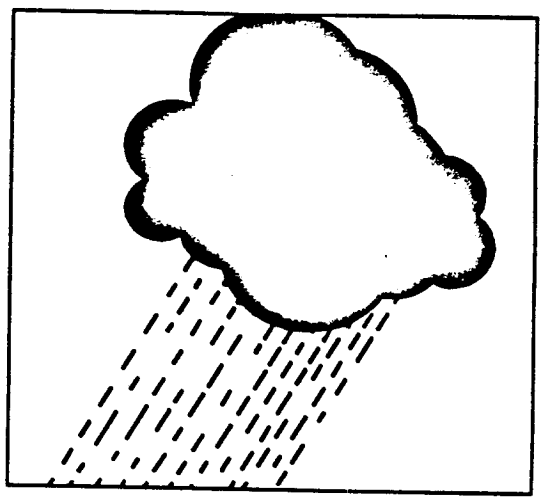
How Urban Runoff Adversely Affects Water Resources



Urbanized areas and areas in which development has altered the natural hydrology and infiltration characteristics of the land typically experience increased surface runoff. Land development alters the natural balance between runoff and natural absorption areas by replacing them with greater amounts of impervious surface. The result is increased rates and volumes of surface runoff.

The negative impacts of urbanization on water quality has been well-documented in a number of sources, including the Nationwide Urban Runoff Program (NURP) and the States' reports written in response to the requirements of §305(b) and §319 of the Clean Water Act. For example, the States report that urban runoff and storm sewers are the second leading source of water quality impairment of lakes and estuaries, and the third leading source of water quality impairment of rivers in the United States.[3]

As a consequence of the increased quantity and rate of runoff, greater amounts of pollutants are carried into receiving waters, and water quality degradation increases. Other negative impacts include the increased susceptibility of eroded land to flooding, other hydrologic changes, and wildlife and in-stream habitat degradation. [See Box 1]

The Need for Urban Runoff Management

Many American cities contain areas in which buildings, parking facilities and urban streets and walkways cover almost one hundred percent of the land surface. This creates runoff conditions but offers no room for structural urban runoff quality management facilities such as extended dry detention or wet ponds. Even when redevelopment occurs within these areas, high land values usually require replacement by similarly intense land uses in order to provide economic viability for the project. Conventional best management practices (BMPs) are difficult, if not

[3]USEPA, The Quality of Our Nation's Water: 1992, Office of Water, EPA Document 841-S-94-002, March 1994, p. 10.

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impossible, to implement in this context.

In such situations, innovative BMP applications requiring little or no above ground coverage are necessary in order to meet increasingly stringent Federal and state urban runoff pollution control requirements. In highly urbanized areas, the use of innovative urban quality control retrofitting is the primary option to improve the water quality of surface waters which receive runoff discharges from older urbanized areas.

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Why worry about urban runoff?

What is the problem with urban runoff anyway?

Storm water runoff picks up pollutants and debris as it traverses developed areas, particularly parking lots and streets. During storm events, pollutants are picked up and flushed directly into local lakes, creeks, and streams, without being filtered by the soil or natural vegetative cover. This endangers water quality. Better pollution control is needed to reduce the amount of contamination affecting these water bodies.

Isn't new development the cause of all these problems?

New development, in many localities, has to meet strict regulations on the quality and quantity of storm water runoff. However, many of our current water quality problems are caused by runoff from older, developed areas. We can't solve the problem without retrofitting older stormwater control devices or installing them where none currently exist.

How can we solve this problem?

As the public becomes aware that there are problems with urban runoff quality, and begins to take action, the water quality of area streams and rivers should improve. As people learn that the storm drain at the end of the street flows straight to a nearby stream, they will be more interested in what drains to, or is dumped in, the street catch basin. They will also press their elected officials to incorporate stronger stormwater treatment standards into both new development and redevelopment projects in their community.

How urban runoff affects water resources.

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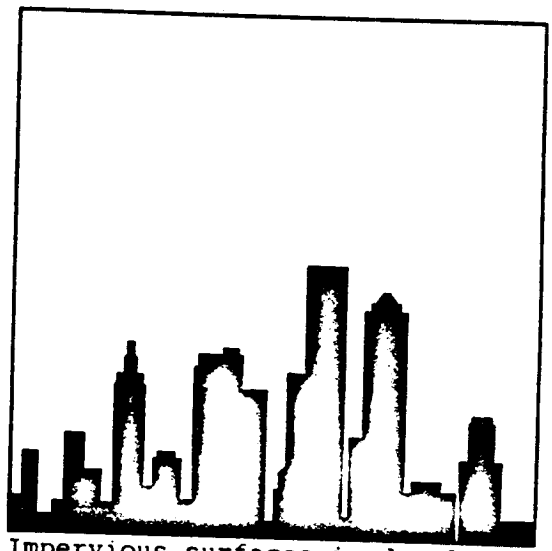
Retrofitting Developed Areas

As urbanization occurs, and areas of impervious surface increase, maintenance of water quality becomes increasingly difficult. Retrofit of structural controls is often the only feasible alternative for improving water quality in developed areas.

Ideally, as land is developed best management practices would be implemented to control present and future urban runoff problems. However, controlling pollutants in runoff from new development alone will not solve existing water quality problems. Therefore, retrofitting is necessary. It is also the primary option for developed areas to improve urban runoff water quality.



Impervious surfaces in developed areas may cover 100% of the land surface.

Retrofitting is a process that involves the modification of existing surface water runoff control structures or surface water runoff conveyance systems which were designed to control flooding, so they will also serve a water quality improvement function.

Retrofitting should also be considered as an opportunity to improve existing water quality best management practices. Existing practices may be inadequate or performing poorly, or they may simply lack the pollutant removal capability of newer BMP designs. The least expensive and most practicable retrofit opportunities often involve the improvement of existing urban BMPs. BMP retrofits are a widely used technique. The opportunity to improve existing urban BMPs at modest cost, or to convert older dry storm water detention ponds, for example, into more efficient wet extended detention ponds is afforded by a retrofit approach.

Factors such as the presence of existing development, or a community's financial constraints, may limit runoff management options; targeting may be necessary to identify priority pollutants and select the most appropriate retrofit methods. This is particularly true in highly urbanized areas where land is limited and the use of conventional pond systems is restricted.

In highly urbanized areas, sand filters or water quality inlets with oil grit separators

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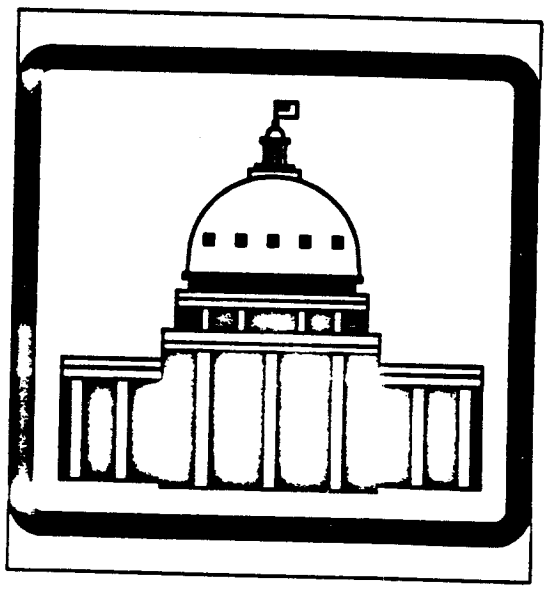
may be appropriate for retrofits because they do not limit land usage. Sand filters, however, may be a better alternative for treating hydrocarbon runoff from small sites than oil grit separators because sand is a superior filtering medium. Recent research questions the effectiveness of oil grit separators at removing hydrocarbon pollutants.[4]

Urban runoff retrofitting for nonpoint source pollution control includes a broad range of different techniques which attempt to reduce the adverse impacts of urban runoff on receiving waters. The types of retrofit techniques will differ depending upon where they are placed in the storm drainage network.

Local Governments' Compliance with Federal and State Regulations



The current storm water management requirements and drainage needs in major population centers are significant. EPA storm water permit regulations require large (>250,000) and medium (>100,000) size municipalities to have storm water discharge permits for discharges from their storm sewer systems under the National Pollutant Discharge Elimination System (NPDES) storm water permit program. Large- and medium-size municipalities nationwide are now applying for these permits which will require implementation of comprehensive storm water management programs to control storm water runoff.

In addition, Section 6217(g) of the Coastal Zone Act Reauthorization Amendments (CZARA) of 1990 requires States to develop coastal nonpoint source pollution control programs, including a management program to control runoff from existing development. The new coastal zone requirements are only applicable, however, in areas which are not subject to the NPDES storm water permitting regulations.

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[4] Schueler, Thomas R., "Hydrocarbon Hotspots in the Urban Landscape: Can They Be Controlled?" in Watershed Protection Techniques. Volume 1(1), February 1994, p. 3-5.

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The increasing stringency of federal, state and local regulations are all examples of the emphasis being placed on minimizing both point and nonpoint source pollution from urban runoff.

Summary of Selected Federal Water Quality Programs

Coastal Zone Management Act of 1972 (CZMA)

- established a program to encourage states to develop comprehensive programs to protect and manage coastal resources

Coastal Zone Act Reauthorization Amendments of 1990 (CZARA) §6217

- mandated state coastal programs to address nonpoint source pollution affecting coastal water quality and required the development of the Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters which states are to incorporate into their coastal nonpoint source programs

National Pollutant Discharge Elimination System (NPDES) Storm Water Permit Program

- established by §402(p) of the Clean Water Act; requires permits for certain municipal and industrial storm water discharges

Clean Water Act §319: Nonpoint Source Control Program

- initiated a national program which resulted in state nonpoint source management programs to control nonpoint sources of water pollution and protect groundwater

Clean Water Act §320: National Estuary Program

- focused point and nonpoint pollution control on geographically-targeted, high priority estuarine waters; controls are selected and implemented on a watershed basis

EPA's Watershed Protection Approach

- voluntary effort to align traditional regulatory and nonregulatory programs to support watershed protection in an integrated, holistic manner

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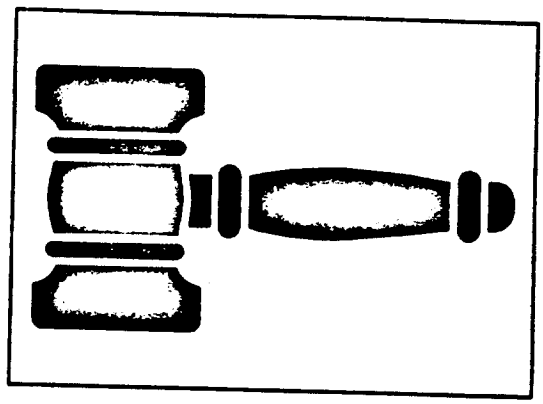
While program requirements may differ based on the specific regulatory authority, the goals of these programs are complementary and many of the same management practices are applicable and satisfy the requirements of multiple programs. The case studies presented in this manual provide examples of the innovative ways in which many local governments are meeting the requirements of multiple programs. This manual will help communities develop and implement programs to improve water quality. However, communities need to refer to applicable state and Federal regulations to assure that they are in compliance with all regulatory requirements.



For example, some communities are not subject to NPDES permit requirements but may be subject to requirements under the Coastal Zone Act Reauthorization Amendments of 1990 ("CZARA"), and vice versa. In addition, some states have additional regulatory programs that may govern the management of storm water or runoff in the absence of Federal requirements. Other communities may not be subject to any regulatory requirements at this time, but the public is increasingly aware of runoff problems and their causes and some control of runoff is becoming inevitable.

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BRIEF SURVEY OF CURRENT METHODS AND TECHNIQUES

Types of Urban Runoff Retrofit Techniques[5]

Retrofit techniques can be differentiated depending upon where they are placed in the storm drainage network. Some of these are described below:

- Source retrofit: Use of techniques that attenuate runoff and/or pollutant generation before it enters a storm drain system, e.g., reducing impervious areas, using pollution prevention practices
- Open channel retrofit: These are installed within an open channel below a storm drain outfall, e.g., an extended detention shallow marsh pond system.
- Natural channel retrofit: Depending on the size of the channel and the area of the floodplain, a natural channel may provide several retrofit options
- Off-line retrofit: Involves the use of a flow-splitter to divert the first flush of runoff to a lower open area for treatment; used where land is available for off-line treatment
- Existing BMP retrofit: The retrofit of an existing BMP to improve its pollutant removal efficiency or capacity (ability to detain flow) or both.
- In-line retrofit: Used where there are space constraints that prevent the use of diversions to treatment areas.

Urban runoff retrofits involve a broad range of different techniques intended to reduce the adverse impacts of urban runoff on receiving waters. [See Box 2] The overall goal should be to achieve some reasonable degree of hydrologic control and pollutant removal (in relation to cost-effectiveness) as a result of the retrofit. Otherwise, the retrofit is not worth doing.

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[5] as identified in MWCOG, Watershed Restoration Source Book, p. 59.

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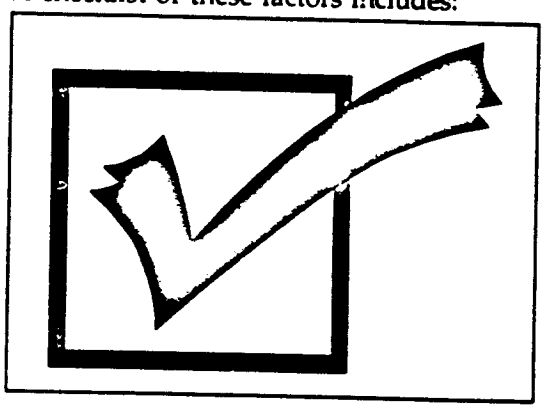
Technical factors affect the site-specific suitability of particular retrofit technologies. A checklist of these factors includes:



- land use
- climate
- size of drainage area
- soil permeability
- slopes
- depth to water table
- space requirements
- type and condition of the water resource to be protected
- depth to bedrock
- pollutants to be addressed
- maintenance access

Nonstructural Methods to Control Urban Runoff

Land use controls can be a cost effective means to control urban runoff. They have a maintenance cost/multiple use advantage over structural BMPs in many cases, and should be employed in redevelopment situations where appropriate. Furthermore, land use controls may be necessary along with structural measures in order for a jurisdiction to meet its water quality goals.

Strategies for implementing land use controls may include limits on impervious surfaces, encouragement for the preservation of open space, and promotion of cluster development. The use of nonstructural and structural best management practices for controlling urban nonpoint source pollution can also be required as a condition of development approval.

Zoning

Zoning is a powerful tool which communities can use to control the type of development or redevelopment allowed within their boundaries. Following are some examples of zoning controls that can be used to protect water resources:

- cluster development: constructing dwellings close together to preserve open space
- down-zoning: changing an established zone to require a lower density
- conditional zoning: allowing certain activities only under specified conditions that protect water resources

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- overlay zoning: placing additional zoning requirements on an area that is already zoned for a specific activity or use; through the use of resource overlay zoning, high pollution activities can be controlled in sensitive areas

- open space preservation: protecting open space and buffer zones near water bodies, e.g., greenways or riparian corridors

Structural Runoff Controls for Highly Urbanized Areas[6]

1. Innovative Practices

In areas where impervious materials cover almost one hundred percent of the surface, conventional BMPs requiring large amounts of land and good soil conditions are usually not feasible. These types of BMPs include dry ponds, wet ponds, constructed wetlands and various sorts of infiltration devices.

On sites where standard BMPs are not feasible, one should consider the use of unconventional or innovative BMPs sometimes known as "ultra-urban" BMPs. These systems are designed to function by gravity flow between the components. They include: 1) sand filtration systems; 2) underground sand filters consisting of multiple chambers; 3) surface sand filters such as double-trench systems; and 4) peat/sand filtration systems.

Each is briefly described below:

Sand filtration systems: The City of Austin, Texas has developed a BMP which consists of a sedimentation and filtration basin and is appropriate for use on redevelopment sites where topography, space limitations and high value land do not allow the use of traditional BMPs. These filtration systems are primary water quality control structures. In order to ensure the long-term effectiveness of these systems, it is necessary to protect the filter media from excessive sediment loading. A sediment trapping structure is required to be located prior to the filtration basin. Austin sand filter sytems are particularly well-suited to regional storm water control.

Underground sand filters with multiple chambers: This is a system consisting of a structure containing three chambers, one each for pre-treatment, filtration and discharge. The first chamber is a pre-treatment facility performing the same function as a water quality inlet, removing floating debris and material such as oil and grease.

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[6] A more detailed description of these controls and their effectiveness is provided in the Alexandria Supplement to the Northern Virginia BMP Handbook. [see Bibliography]

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The second chamber is a filtration device, while the third is a clear well discharging directly to the storm sewer system. The District of Columbia uses underground sand filters as in-line facilities for both storm water quality and peak flow attenuation. One of the major advantages of the D.C. sand filter is that it does not take up any space on the surface, allowing full use of high-value urban land. This aspect makes it particularly attractive to land developers.

Surface sand filter systems: This system is usually referred to as the Delaware sand filter because it was developed for use in Delaware. Unlike the other filters described in this section, the surface sand filter system is intended to be an on-line facility, processing all runoff leaving the site up to the point where the overflow limit is reached. It consists of two parallel concrete trenches, one for sedimentation, the other for filtration. A major advantage of this filter design is that it requires a depth of only 30 inches from the ground surface to the bottom of the paved trench, making it useful in areas with high water tables. The simplicity of the design also facilitates maintenance.

Peat/sand filtration systems: Peat/sand filters are filtration systems which were first developed as alternative wastewater systems. Peat is an excellent natural filter of many types of effluents and pollutants and is just beginning to be used for urban runoff quality management. A peat/sand filter system should be considered for use on developments of several acres where the pollutant removal requirement is higher than could be expected to be achieved through the use of other ultra-urban BMPs. In addition, peat/sand filters require less site area than most conventional BMPs. However, it should be noted that, under certain conditions, peat filters can become net exporters of nutrients.

Use of Public Rights-of-Way

A retrofit technique which has been identified for use in a land-limited context is the use of public rights-of-way as an opportunity for runoff controls such as wet ponds, vegetated swales or meandering vegetated channels. This would include the use of land under bridges and overpasses, the median strips of roads and highways, and the exit ramp rights-of-way off major highways.

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2. Retrofit Capability of Selected BMPs[7]

Extended Detention Ponds: Frequently used in retrofit applications, particularly within dry storm water management ponds.

Wet Ponds: Occasionally used in retrofit situations, particularly within dry storm water basins

Constructed Storm Water Wetlands: An effective retrofit technique. Can be achieved by adding wetland features to dry storm water basins.

Infiltration Trenches: Limited by soil conditions.

Infiltration Basins: Not recommended for retrofit settings, especially in the coastal zone.

Porous Pavement: Limited by soils which have been modified in most urbanized watersheds and are not capable of providing adequate infiltration.

Sand/Peat Sand Filters: Designed as end-of-pipe retrofits in several applications. A double-trench version has been designed for parking lot retrofits.

Grassed Swales: Although not suitable for ultra-urban areas because of the difficulty of preventing erosion in highly impervious areas, retrofit option may involve installing check dams to increase contact time in existing swales.

Filter Strips: Although the percentage of impervious surface in highly urbanized areas limits the usefulness of this practice as a water quality control device in ultra-urban settings, this type of retrofit is appropriate if enough land is available.

Water Quality Inlets: Although water-quality inlets are often used in ultra-urban areas, their low pollutant removal capability limits their usefulness as a retrofit technology.

[7] More detailed information on the retrofit capability of these practices can be found in A Current Assessment of Urban Best Management Practices. [see Bibliography]

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DEVELOPMENT & IMPLEMENTATION OF AN URBAN RUNOFF CONTROL PROGRAM

While the program elements discussed in this section are considered important to program development and success, they do not necessarily fulfill all regulatory requirements which may be applicable to a given municipality. Planners and program managers should check on all relevant program requirements when developing their programs.

Important Program Elements

An urban runoff control and retrofit implementation program involves both technical and programmatic components and should include the following elements:

- technical capability
- use of appropriate technology
- implementation authority/enabling legislation
- funding mechanism or resource commitment
- institutional support structures

The case studies which are part of this manual demonstrate that local motivation is critical to the successful implementation of urban runoff controls. Also, successful implementation will not occur without a strong local commitment of personnel and resources. Regulations, ordinances, enabling legislation, design criteria, construction specifications, inspections and enforcement, and operations and maintenance procedures should all be clear and explicit. Appropriate technology for implementing runoff control measures must exist and must be at an affordable cost to the agency. If the foregoing are not present, implementation or continued successful program performance may not occur.

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Important Elements for Program Success

- Technical Capability
- Design Criteria for Selection of Appropriate Technology
- Implementation Authority/Enabling Legislation
- Dedicated Funding Mechanism
- Staffing/Training/Institutional Support/Operations & Maintenance

The box above depicts some of the key elements for developing and conducting a successful urban runoff control program. All of them may significantly affect program outcome:

- technical capability and the choice of an appropriate technical solution
- implementation authority and a dedicated funding mechanism
- the often-neglected elements of program staffing, proper training, strong institutional support, and the proper operations and maintenance procedures

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Building a Strong Institutional Foundation

Urban runoff management program practitioners strongly support the view that the success or failure of urban runoff control programs depends upon effective institutional frameworks. The following elements are often cited as crucial to program success:

Programmatic:

- adequate problem assessment
- BMP targeting and selection methodology (e.g., on-site vs. regional facilities)
- appropriate design criteria
- adequate staffing and training
- responsibility for success of total program vested in a single agency at an appropriate level of authority

Funding/Implementation:

- dedicated program funding, such as a storm water utility fee
- ease of operation and maintenance procedures
- administrative mechanism to ensure O & M is performed

Each of these elements must receive adequate institutional support if a successful urban runoff control program is to be implemented. In order to develop the necessary institutional frameworks, the local government should focus sustained attention on the institutional aspects of program development. There should be a recognition that developing an institutional framework is essential to support a successful multi-agency, long-term urban nonpoint source runoff program.

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How can communities develop a successful program?

Each local government may have different tasks to complete to create a successful program. However, certain common threads run through all the case studies described in this manual and these can be instructive in helping local governments to put together effective urban runoff control programs.

A strong motivation to act is essential.

Frequently the strongest motivation to act is economic. In the Southeastern Massachusetts area case study, the closure of thousands of acres of shellfish beds due to contamination by storm water runoff resulted in millions of dollars of lost income to local residents and serious disruption to local economies.

For other communities, such as Austin, TX, protection of drinking water supplies is a high priority. Still others, such as Orlando, FL, are concerned about the water quality of the hundreds of lakes within its metropolitan region.

Teamwork is essential to accomplish your goals.

Pick the right people and the right organizations. The experience gained from the case studies proves that teamwork is necessary to achieve the desired results. The nature of the urban runoff problem means that any solution will cut across departmental, bureaucratic and organizational boundaries. The high cost of storm water control projects, especially retrofits, makes cost-sharing among organizations particularly advisable. So identify the key players early and make good working relationships a high priority. Don't neglect the important role of private organizations and interests.

The need for adequate staffing and training should be recognized.

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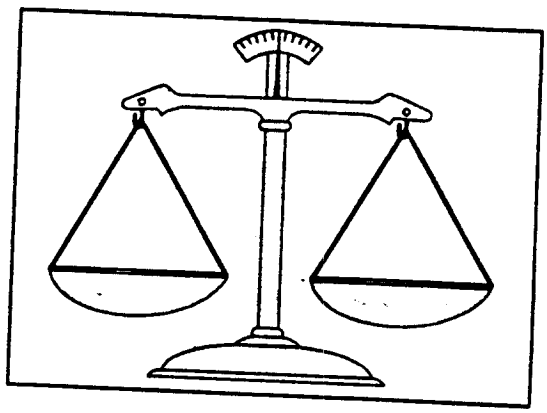
Assessing Institutional Resources



Two initial goals should be considered by a local government interested in developing an urban runoff control program:

1) developing or improving its institutional capacity to mitigate the urban runoff water quality problems which it faces

2) ensuring that its institutional capacity matches its technical ability to deal with the problem.

Implementation personnel should evaluate the following factors as part of an initial assessment of institutional structures:

- Identify the key agencies and personnel

Determine who the key players are in the relevant agencies. Typically, there are four major groups involved in the institutional water quality decision-making process:

1) legislative
2) regulatory
3) consulting professionals
4) "users" such as developers, clients, citizens (also includes environmental advocacy groups)

The program manager should be aware that the typical bureaucratic organization of institutions into branches, divisions, departments, etc., can hamper the ability of the organization to carry out its program goals and hinder program effectiveness. The most successful programs find ways to break the bureaucratic logjam.

- Identify all relevant existing programs and assess their effectiveness

This may involve looking at an array of water quality programs scattered across different agencies and departments. Look for opportunities to modify these programs to reach the desired goals. Make sure that existing governmental structures are capable of implementing proposed programs. Finally, identify what new programs are needed.

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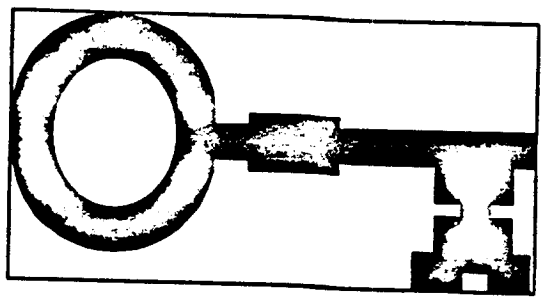
- Determine the motivations and goals of the key agencies

They may be acting in response to a perceived problem such as a health hazard or to a water use impairment. Remember that not all organizations are subject to the same level of political pressure.



- Determine whether political support exists

This includes both established and grassroots structures. Political support for environmental issues becomes especially significant in times of resource constraints and competing interests.

- Identify appropriate pollution control techniques

Consult a BMP manual, such as those listed in the Bibliography, for the types of control mechanisms appropriate to a particular site.

- Identify funding options

This might include study of the feasibility of a dedicated funding source such as a storm water utility and development of a fee structure.

- Consider the limitations of available technology

The potential for solving a problem may be limited by many factors over which the implementing authority has no control. This includes performance limitations of technology as well as any site-specific constraints.

Conclusion

The importance of developing institutional structures cannot be overstated. Effective urban runoff management is greatly helped by the presence of strong institutional mechanisms. Furthermore, the case studies support the conclusion that where urban runoff quality control is institutionalized through dedicated funding mechanisms such as storm water utilities, innovative and comprehensive programs (including retrofit activity) are the rule.

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Setting Priorities/Selecting Management Practices

Urban nonpoint source runoff problems may be numerous in a given area and the solutions are often complex. Funding to solve these problems is usually limited, so it is necessary to set priorities so that the worst problems can be targeted for attention.

A ranking methodology should be developed for a specific study area (e.g., a watershed) in order to encourage a phased approach and to allocate scarce resources optimally. Once particular waterbodies and sources have been targeted for action, the local government can then determine the most cost effective approach to solve the problem.

The following factors should be considered in the ranking process:

- waterbody importance
- type of use (recreation/aquatic life/drainage)
- status of use (impaired or denied uses)
- level of use
- pollutant loads

The key point to be made about the ranking process is that it should reflect local issues and concerns. The ranking factors can be assigned different degrees of weight based on the degree of local importance.

In evaluating and selecting appropriate control practices, local governments should consider:

- Does the practice selected meet any applicable regulatory requirements?
- Is the selected control buildable and effective?

Relying upon structural controls is different from the use of source controls and regulatory or non-structural controls. Complex structural controls pose both construction and future maintenance challenges that should not be overlooked.

Use the following as a checklist of the tests which the proposed BMP should pass to be considered for implementation:

- Does it meet regulatory requirements?
- Is it effective at pollutant removal?
- Can it gain public acceptance?
- Is it technically implementable/easily maintained?
- What are the associated costs?

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The process of setting priorities and targeting urban runoff problems is a complex process consisting of many factors and should be performed in a systematic manner.

How To Overcome Roadblocks to Implementation

Two of the biggest "roadblocks" to implementation of urban runoff control retrofit projects are high cost and shortage of funding and the lack of available land in urbanized areas. Many participants in the urban runoff management and planning process describe the extreme difficulty of implementing urban runoff retrofits because of the lack of available land at highly urbanized sites and the lack of funding for these typically expensive projects. The most difficult sites are those where land for siting control practices is severely constrained or non-existent. The high cost associated with retrofitting older urban storm drainage systems requires a careful evaluation of pollutant reduction goals and the targeting of control practices.

Land Availability

In the urban context, land may be strictly limited and/or its value may be prohibitive for some uses. Practices requiring large land areas are simply not feasible. The three most used control devices for storm water quality management, viz., dry ponds, wet ponds, and infiltration devices, are not always suitable for urban retrofit situations because of space constraints or underlying soil conditions.

On sites where these types of conventional practices are not feasible, innovative and experimental approaches should be tried. Newer ultra-urban technologies that take up little or no above-ground space should be used. Performance monitoring should be done to verify effectiveness.

Cost of Implementation

The extremely high cost of retrofit projects - engineering studies, land acquisition, and the actual construction costs - raises the question of how realistic these projects are for many local governments to achieve. In addition to initial project cost, there is also the continuing and long-term cost associated with operations and maintenance. Some ways to reduce the high cost of these projects include:

- utilizing state or federal cost-share programs where available (e.g. FEMA floodplain "buyout" or EPA nonpoint source grants)
- encouraging multi-jurisdictional efforts to spread the cost and benefits
- soliciting volunteers and in-kind contributions to reduce project cost

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- creation of special districts or dedicated funds such as storm water utilities

- low interest state revolving fund (SRF) loans for nonpoint source control projects

The use of high value urban land is the biggest obstacle to implementing retrofits for many municipalities. Land which would ordinarily be generating revenue for the municipality is removed from the tax rolls. This is a clear institutional disincentive to implement retrofits in highly urbanized areas. If a local government considers water quality improvement as a goal desired by the community, then the revenue loss might be viewed differently by the public, and would be easier to justify politically.

Localities are increasingly turning to methods of returning the costs of storm water discharges to individual property owners, through mechanisms such as storm water utility fees or storm drainage and flood control fees. The goal of these programs is to provide economic incentives to property owners to reduce the amount of storm water discharges from their land by offering credits for implementation of best management practices, as well as to reduce the burdensome cost to already fiscally-strained jurisdictions.

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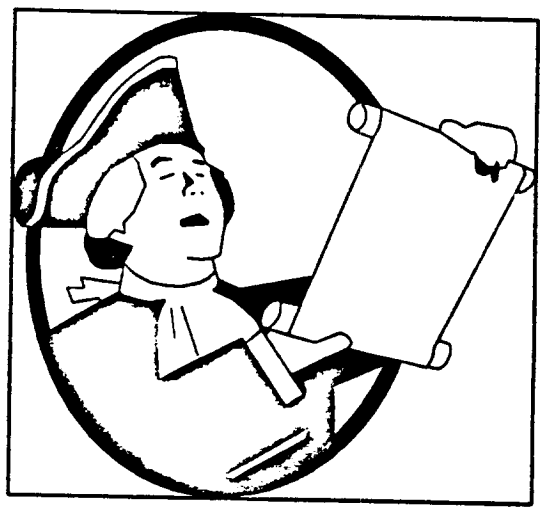
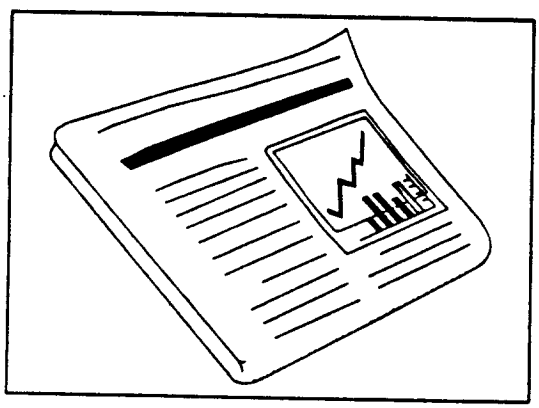
Increasing Public Awareness



To ensure adequate support for urban runoff control programs, the public needs to be educated about the nature of urban nonpoint source pollution and the benefits of controlling urban runoff. These issues are not readily understood by large segments of the public. The need to heighten public awareness cannot be overemphasized.

Urban runoff control programs must have public backing and involvement to succeed. There is broad general support for environmental concerns and this support can be translated into political support for urban runoff control programs. However, adequate funds must be devoted to public information and education programs about the nature, causes and solutions of urban runoff and urban nonpoint source pollution. The public must recognize the seriousness of urban runoff pollution, and understand the importance of local commitment for a successful urban runoff management or retrofit program.



Public education is an essential tool for increasing public awareness and generating political support. Educational efforts typically include:

- program meetings and presentations
- program materials such as newsletters, fact sheets, brochures, and posters
- homeowner education programs
- media campaigns
- coordination with activist groups for program support

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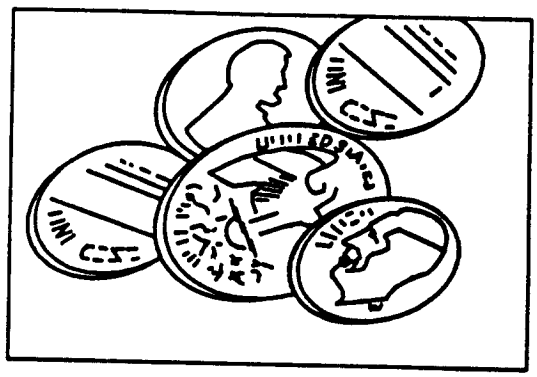
Creating a Stable Funding Mechanism



Runoff control programs are usually implemented at the local level. Local communities generally have limited budgets and limited staffing which impedes effective implementation. Sources of funding at the Federal and state levels are also limited and uncertain, and cannot be counted upon to provide total project funding.

One successful institutional response by many municipalities has been the establishment of storm water utilities. Some jurisdictions have used storm water utilities to fund the basic "hardware" of urban runoff management, while others have included funding for watershed planning and retrofitting programs.

Special taxing districts, such as a watershed improvement district, can levy taxes and borrow money to engage in a wide range of nonpoint source pollution control activities. A special taxing district is similar to a school district or a sanitary district and functions as a special governmental unit in a particular area. Real estate within its boundaries is appraised and taxed to fund program activities.

The purpose of a dedicated funding source such as a storm water utility or a special taxing district is to provide a stable and reliable method of financing storm water management programs. The development of comprehensive and effective programs requires a secure funding base.

[More information on funding options is provided below.]

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Policies and Procedures vs. Programs and Institutional Frameworks.

Effective prevention and control of urban runoff pollution requires both defined policies and procedures, and effective programs and institutional structures. Just having policies on paper is no guarantee of an effective program. Institutions must be organized in such a way as to implement the policies and carry out the procedures.

Indeed, the implementation phase is just the final step in an often long process of planning and preparation. It must be accompanied by a real institutional committment to change ineffective and outmoded structures, to break through political or bureaucratic impasse, and to see that programs function effectively.

The question for the local program manager is: Are the local government's agencies organized to efficiently and effectively carry out runoff control activities? Are the various agencies involved clear about their responsibilities? Responsibilities of each involved party can become a major issue when urban nonpoint source control projects involve multiple agencies, as they almost always do.

The responsibility of each agency involved in an urban runoff control project should be clearly spelled out.

The complexity of developing and implementing urban runoff control programs, including the special considerations relative to retrofit situations, means that the following distinct phases should be well-known to the program manager:[8]

- planning phase: analyze, evaluate, plan
- preparation phase: prepare budget, allocate resources, and obtain permits
- pilot project phase: test selected BMPs
- full-scale implementation: construct selected BMPs
- evaluation/documentation: evaluate program effectiveness

[8] U.S. Environmental Protection Agency, "Evaluating Nonpoint Source Control Projects in an Urban Watershed," in Nonpoint Source Watershed Workshop. Seminar Publication # EPA/625/4-91/027.

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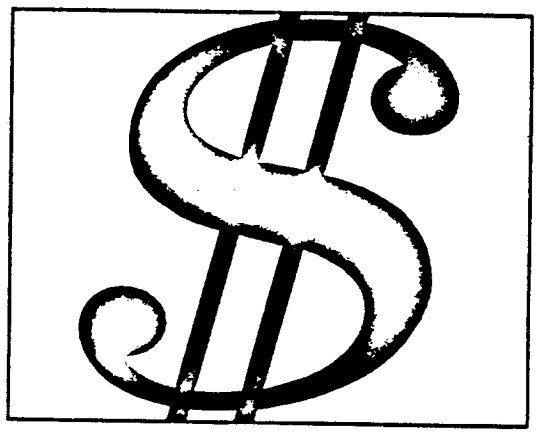
Funding Options/Alternative Funding Approaches

Implementation of urban runoff control programs at the local level often requires non-Federal funding. Now that governments at all levels are facing fiscal constraints, alternative funding sources are becoming increasingly important. Following is a discussion of some of these approaches:



Local governments with strong institutional frameworks have led the way in the development of utilities specifically designed to abate NPS pollution or targeted at a particular type of NPS pollution:

- Local governments are using the utility concept to develop institutional approaches incorporating homeowner responsibility for some runoff management practices (e.g., septic system maintenance, small construction grading and landscaping permits requiring best management practices to control runoff)

- Storm water utilities are spreading all over the country as a way of providing a dedicated funding source for urban runoff control projects; a storm water utility is to storm water what a sewage utility is to sewage and a water utility is to drinking water. It is a dedicated funding source or "stand alone" service unit within the city government which generates revenues through fees for service. It is responsible for the operation, construction and maintenance of storm water management devices and for storm water system planning.

State revolving loan funds were very successful in the early years of point source pollution control and are now being adapted to nonpoint sources:

- State revolving loan funds, originally established for states to upgrade sewage treatment facilities through construction grants, may also be used to fund a wide variety of nonpoint source control projects and best management practices (BMPs)

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Special fees and taxes are another source of dedicated project funds for nonpoint source pollution control:

- This approach involves the use of user fees/special taxes to fund nonpoint source pollution projects and programs, such as special taxes and fees on the sale of fertilizers and pesticides, waste disposal, and underground storage tanks

Some innovative approaches being used to fund urban nonpoint source pollution control programs include:

- Special tax districts, such as watershed improvement districts, which can be created to protect highly valued water bodies.
- Checkoff on tax forms to fund restoration and conservation programs.
- Revenue bonds, which are long-term municipal bonds guaranteed solely by the dedication of project funds.
- Public/private partnerships can be used to pay for capital and/or operating expenses for storm water facility projects when neither could fund them alone.
- An annual nonpoint source pollution control tax based on property size and land use (not on value) is being used in Puget Sound, Washington.
- The sale of special license plates in Maryland and Virginia has raised substantial amounts of money to restore the Chesapeake Bay.

Types of Funding Mechanisms Available to Local Governments

- General funds

  The use of general funds may require the re-allocation of existing revenues.

- Long-term borrowing

  Large structural BMPs may require funding through bond issues.

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- Pro-rata share fees

  These fees are typically based on an assessment of the development's potential to contribute to urban runoff problems.

- Storm water utilities

  Utilities typically assess a fee based on the percentage of a site's impervious area.

- Special assessment districts

  Funds for projects in a district can be raised by assessing fees to landowners in the district.

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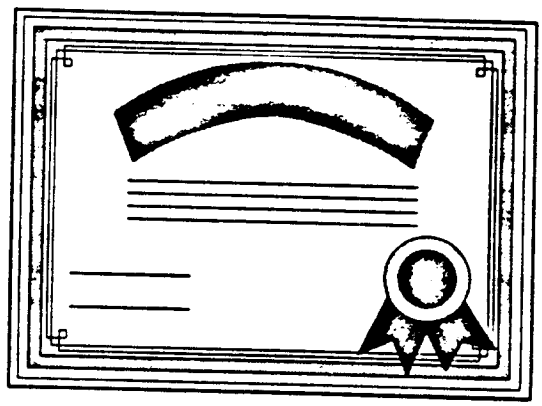
Elements of Successful Programs/Solutions



The case studies presented in this manual were selected as examples of exemplary local government initiatives in the area of urban runoff control and/or retrofit implementation. The case studies included are all "success stories," and they display certain common elements. Among these are the following:

- strong institutional motivation to act on problem
- political and/or grassroots support for action
- skilled personnel
- knowledge of available technologies
- dedicated funding source, such as a storm water utility fee
- an environment of institutional cooperation and a long-term commitment to work together
- targeting strategy/process to maximize use of limited resources

Many communities are recognizing the benefit of preventing ecological and habitat destruction to avoid the very high costs associated with the restoration of degraded resources. The most successful communities take a pro-active stance with regard to regulatory requirements, and use proper planning techniques to prevent degradation of water resources. They are realizing the economic, environmental and social benefits of protecting the existing ecosystem through land use controls, development restrictions and urban best management practices.

Conclusions and Recommendations

Effective urban runoff control programs are built upon numerous institutional, economic and technical factors. The most successful programs examined in this project displayed a strong institutional or programmatic focus, in additional to having a strong motivation (usually economic) to act on a problem. Furthermore, the case study communities displayed strong political and/or grassroots support for community action as well as skilled personnel.

Solutions must be tailored to each communities' particular circumstances, but the following recommendations may assist the interested community to more quickly develop an urban runoff control or retrofit program for developed areas.

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Recommendations

- Identify and obtain stable, if not dedicated, funding sources for urban runoff programs, including retrofit programs.
- Utilize cost-share approaches among agencies to maximize resource impact and obtain participation and support from private interests benefitting from urban runoff control projects.
- Use team or multilateral approaches wherever possible; given the nature of urban runoff problems, most solutions will need to cut across bureaucratic and organizational boundaries.
- Focus effort initially on building institutional structures to support comprehensive urban runoff control programs.
- Identify water quality problems and prioritize retrofit alternatives.
- Identify all existing related programs and assess their effectiveness and modify where needed.
- Consider innovative, cost effective, and environmentally responsible ways of retrofitting.
- Utilize economic incentives (such as tax or fee reductions) to motivate property owners to employ runoff control and/or retrofit strategies.
- Make retrofit projects a condition of approval for redevelopment projects.
- Create a single management agency charged with overall responsibility to plan and coordinate program implementation and conduct and/or monitor operations and maintenance activities.
- Designate agency staff to support implementation of projects.
- Do adequate retrofit planning and realistic goal setting.
- Select knowledgeable contractors or contractors with a good track record in water quality and urban runoff control projects.

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- Supervise, even direct if necessary, the construction phase of all projects.
- Educate developers, consultants, contractors, politicians and the general public about urban nonpoint source pollutions issues.
- Identify opportunities for public/private partnerships to conduct nonpoint source pollution control activities.

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Introduction to the Case Studies

The following case studies exemplify many of the institutional, regulatory, planning and implementation issues discussed throughout this manual. They describe the experiences of selected local governments in dealing with the problem of urban runoff management in developed areas. Many of the approaches described in the case studies are highly innovative and will be useful guides for other localities considering the implementation of urban runoff control and/or retrofit programs.

This manual utilizes the case studies to illustrate some approaches which localities are successfully using to manage urban runoff problems. It provides examples of jurisdictions where institutional frameworks have been successfully developed to support urban runoff management and retrofit programs. Institutional issues are given great emphasis in the case studies, as in the main narrative, because institutional issues, rather than purely technical ones, are believed to be a common obstacle to the successful implementation of urban runoff management projects.

The case studies demonstrate the many different ways communities have developed and implemented urban runoff management programs. Each program is unique, based on the magnitude and negative impact of that community's urban runoff problem, the available resources and existing pollution control programs, and the existing regulatory context in which the local government is operating.

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City of Alexandria, Virginia

Introduction

Municipalities are being confronted by increasingly stringent local, state, and Federal environmental regulations. Complying with these regulations is a challenge. The approach taken by the City of Alexandria, Virginia is a case study which illustrates this point.

Alexandria is situated on the tidal Potomac River, across and down river from Washington, DC. Because of its location, the City must comply with Virginia's "Chesapeake Bay Preservation Act." The Act's implementing regulations required the City to designate "Chesapeake Bay Preservation Areas" within its boundaries. The City as a whole was designated to be a preservation area. This designation means that development and redevelopment of land in the City must achieve specified storm water management criteria. For permitted development, nonpoint source pollution loads cannot exceed pre-development loads based on average land cover conditions. For redevelopment of land currently served by water quality best management practices (BMPs), nonpoint source pollution in post-development runoff cannot exceed the load existing prior to redevelopment. For redevelopment of land not currently served by water quality BMPs, a ten percent reduction in nonpoint source pollution in runoff must be achieved when compared to the load existing prior to redevelopment.

Meeting these storm water management criteria in Alexandria has indeed been a challenge. Implementing conventional water quality BMPs to control the quality of storm water discharges is often either economically impractical or physically impossible because of a number of factors such as a lack of physical space, extremely high land values, a high water table, or unsuitable soil conditions. The City has met the challenge by adopting and adapting for local use a class of BMPs dubbed "ultra-urban."

Ultra-urban BMPs are non-conventional BMPs that are particularly suited for use in highly urbanized areas. They are based on sand filter technology and are currently used in other parts of the United States. Alexandria has installed four of these ultra-urban BMPs in intensely developed areas. In order to facilitate the use of sand filter technology, the City has published design criteria for various ultra-urban BMPs in the Alexandria Supplement to the Northern Virginia BMP Handbook.

The Alexandria Supplement states that the standard types of BMP facilities such as dry ponds, wet ponds, and infiltration devices are not suitable for use in large areas of Alexandria because of space limitations or poor soil conditions. The planner, developer, or engineer is therefore urged to consider the use of unconventional or

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innovative BMPs. It should be noted that infiltration is not the preferred method in Alexandria and will only be approved where it can be clearly demonstrated that it will work. Most areas of Alexandria do not contain soils that are conducive to the use of infiltration devices. (Marine clay is the prevalent soil type in Alexandria and the region.)

To complicate the problem, Alexandria, in common with many older cities developed in previous centuries, has sections of combined sanitary and storm sewers. During heavy or prolonged storm events, combined sewer overflows (CSOs) may occur, discharging directly into streams. Alexandria has applied for an NPDES permit for the CSOs from the Virginia Department of Environmental Quality.

Strategy

The development of design criteria to guide local developers, culminating in the Alexandria Supplement to the Northern Virginia BMP Handbook, resulted from the City's engineering staff consulting with jurisdictions across the country where similar ultra-urban technology is being proposed or has been implemented.

It should be noted that the City's strategy of implementing ultra-urban BMPs was essentially driven by the lack of available land and alternatives. Most other BMPs were fairly easily screened out because of the severe space constraints. Available technology aside, the other principal strategy issue requires that opportunities be seized as they arise, usually from redevelopment.

The general strategy employed in the implementation of these retrofits was one of exploiting any available opportunities. Cooperation was solicited from developers. The double trench Delaware sand filters which were implemented did not take up any valuable land above-ground and this was a strong selling point for bottom-line conscious developers. This allowed them full economic use of the land. The focus has been on available sites. Parking lots have been the chief sites suitable for the Delaware sand filters, and implementation has been limited to them.

One advantage of the Delaware sand filter for Alexandria is that it requires a total depth of 30 inches from the ground surface to the bottom of the paved trench. This is critical in portions of the city where the depth to groundwater is minimal. In addition, the simplicity of the system and the ready accessibility of the chambers for regular maintenance makes the Delaware-type filter very suitable for site conditions which are typical in Alexandria. This type of system is appropriate for up to five acres of 100% impervious cover.

Two [District of Columbia] underground vault sand filter systems were installed on a 3-acre townhouse development in the Winter/Spring of 1994. The principal advantage of these systems is that they may be placed under streets, and in cells of

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parking garages, allowing full economic use of the surface areas.

Cost

The cost of implementing sand filter technology varies due to site-specific conditions. Most of the devices already implemented in Alexandria were prototypes, making accurate cost estimates difficult. However, a range based on the characteristic design of the Delaware, Austin, and District of Columbia designs can be estimated. The costs of Austin sand filters, typically suitable for large-scale sites, range from $13,000 to $19,000 per impervious acre. The D.C. sand filter, which is characterized by an underground vault with sediment and filtration chambers, originally cost around $35,000 per unit, but through economies such as pre-cast concrete and standardized design, costs have come down considerably to the $12,000 to $16,000 range. It should be borne in mind that the early models of these systems are essentially prototypes and that costs are highly variable. Economies of scale are likely to come about through routine implementation. The use of prefabrication and modular units may further reduce costs in the future.[9]

Effectiveness of Ultra-Urban BMPs compared with Conventional BMPs

Most of the (Delaware) double-trench sand filters implemented to date in Alexandria have not been subjected to long-term monitoring and Delaware does not rate these systems for nutrient removal efficiency. Based on long-term monitoring of sand filtration systems done by Austin, Texas, the Delaware system is rated at 80% suspended solids removal rate. Alexandria, however, recognizes a TP (total phosphorus) removal rate of 40%.[10]

The Virginia Chesapeake Bay Local Assistance Department has provided a grant to the City of Alexandria to monitor the performance of the first two Delaware sand filters constructed in the city.

Other Institutional Issues

This case study illustrates the benefit of having a committed public official dedicated to implementation of nonpoint source pollution control technology. The City Engineer has implemented retrofits mostly on his own initiative, having had relatively few bureaucratic obstacles to overcome.

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[9] Warren Bell, A Catalog of Stormwater Quality Best Management Practices for Ultra-Urban Watersheds. Presented at the National Conference on Urban Runoff Management in Chicago, IL on April 2, 1993.

[10] Ibid.

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There are other programs described in case studies in this manual where institutional support comes from the "grass roots." It is vital to have public support for pollution control programs, but building support for these programs may sometimes require that public officials take the lead and steer programs past the numerous bureaucratic obstacles.

For more information...

For more information on the City of Alexandria's program, call the Transportation and Environmental Services Department at (703) 838-4320.

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Southeastern Massachusetts

This case study looks at storm water retrofit projects in the following areas of Cape Cod:

- Buzzards Bay/Buttermilk Bay:
  1) Sprague's Cove Storm Water Remediation Project (Town of Marion)
  2) Broad Marsh River Storm Water Remediation Project (Town of Wareham)
  3) Electric Avenue Beach Storm Water Demonstration Project (Town of Bourne)
  4) Hen Cove NPS Pollution Mitigation Project (Town of Bourne)
- Town of Yarmouth
- Town of Orleans

Existing Nonpoint Pollution Problems on Cape Cod

A Cape Cod Section 208 planning study identified the following pollutants in storm water runoff from urban sources at various locations on the Cape:

Organics: Oil and grease (hydrocarbons), benzene, xylene, and toluene from auto emissions or atmospheric deposition. Runoff from roads into Buzzards Bay is estimated to contribute 33,000 lbs. of petroleum hydrocarbons a year to the Bay.

Inorganics: Nitrates, phosphates, ammonia, chloride, sodium, calcium, potassium, barium, iron, cadmium, chromium, copper, lead, and zinc have all been identified in runoff from a section of Route 28 near Falmouth.

Biological: Bacteriological contaminants (mostly fecal coliform) in storm water runoff were strongly implicated in the closure of shellfish beds in Buttermilk Bay (Bourne).

I. Case Studies

Buzzards Bay Area

In Buzzards Bay, over 8,000 acres of shellfish beds are believed to be closed as a

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direct result of storm water contamination. This represents an estimated economic loss of $24 million to communities in the Buzzards Bay area.[11] The Buzzards Bay Comprehensive Conservation Management Plan (CCMP) adopted in 1992 calls for the prevention of new storm water discharges to the Bay, as well as the remediation of existing discharges that pose a threat to water resources. The plan also calls for towns to inventory and prioritize storm water discharges for remediation. After towns have evaluated their storm water needs, they can proceed based on available resources. Funding, however, is one of the most significant factors affecting the ability of Southeastern Massachusetts area towns to deal with their urban runoff problems.

The development of the Buzzards Bay CCMP resulted in some significant accomplishments for the Buzzards Bay region:

- it established overlay district protection to limit nitrogen inputs to marine waters of Buttermilk Bay (a first in the nation)
- it resulted in the development of regional strategies, approaches and enforceable mechanisms as part of the Massachusetts Coastal Zone Management program

1. Electric Avenue Beach

Strategy and Rationale

An existing storm water system was retrofitted at Electric Avenue Beach in Bourne, Massachusetts as a demonstration project as part of the Buzzards Bay Project (a joint project of the Massachusetts Coastal Zone Management Program and the U.S. Environmental Protection Agency). The project was undertaken in response to high fecal coliform bacteria levels found in wet weather storm drain discharges to Buttermilk Bay, a tidal embayment in the towns of Bourne and Wareham at the northern end of Buzzards Bay. The Buzzards Bay Project funded the implementation of a storm water infiltration system in order to test the effectiveness of these systems in removing bacterial and nutrient contamination from the storm water runoff entering Buttermilk Bay.

The storm water infiltration system was designed to intercept a one-year design storm from the adjacent watershed and to avoid direct discharge of the first flush to the Bay. Instead, the flow enters a settling tank for removal of solids and floatable waste and is then discharged to infiltration galleys. The only flow which is

[11] Buzzards Bay Project, "Bay Watch," (Newsletter) Spring/Summer 1993 Vol. 7 (5), p. 1.

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discharged from the original outfall is from a one-year storm or better. Monitoring provided by the Barnstable County Health Department has confirmed a reduction in bacterial loading.

There are other points which make this project noteworthy:

- the infiltration galleys are preceded by oil/grit chambers designed to reduce clogging in the infiltration devices
- because the infiltration devices are very close to the beach area, the distance to groundwater is approximately two feet - groundwater sampling has not shown any contamination, however
- a substantial reduction in construction costs was achieved by utilizing personnel from the Town of Bourne's Department of Public Works

One of the unique aspects of this demonstration project was that the EPA Region I and Buzzards Bay Project oversight staff utilized the Department of Public Works personnel from the Town of Bourne for construction of the storm water infiltration system. The significant institutional consideration here is that the experience gained by Town staff in the design of the demonstration project could be used for the construction and maintenance of additional storm water infiltration systems. This enhances the storm water quality control expertise of Town personnel and further institutionalizes the process.

Effectiveness

At the Electric Avenue demonstration project site in Bourne, monitoring indicates that the retrofit structures are removing over 95% of the fecal coliform from storm water runoff.

2. Hen Cove Nonpoint Source Pollution Mitigation Project

Storm water runoff pollution was implicated in the closure of shellfish beds and a swimming beach in Hen Cove. The Buzzards Bay Project assisted the Town of Bourne in retrofitting the adjacent storm drain systems so that pollutants are not discharged directly to the Cove.

Strategy and Rationale

The Hen Cove project targeted specific storm drain systems which currently allow direct discharge of untreated storm water into the Cove. The mitigation project incorporated the use of leaching chambers and the surrounding soil to treat the "first flush." (During heavier or more severe storms, excessive runoff will overflow into the

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conventional storm drain system.) Several individual leaching chambers were placed under the road surface throughout the watershed (there are 13 so far). At each location, runoff from the road will be diverted into a storm drain with a settling basin to allow sediments and other solids to settle out. From the storm drain inlet, the storm water is then piped under the road surface into leaching chambers. The leaching chambers are pre-cast, perforated concrete structures which are surrounded by crushed stone. Storm water is temporarily stored in the chambers and in the voids between the crushed stone until it seeps into the surrounding soils. Groundwater monitoring will determine the success of this approach by determining the amount and type of pollution attenuation in the surrounding soils.

3. Sprague Cove Storm Water Remediation Project

The Buzzards Bay Project is working with the Town of Marion, Massachusetts, to reduce pollutants associated with storm water runoff entering Spragues Cove. Spragues Cove is a small, shallow embayment on the shore of Sippican Harbor. Currently its three-acre area of valuable shellfish beds is closed for shell-fishing because it exceeds both state and Federal bacteria standards for shellfishing.

The largest storm drain system drains approximately 64 acres of watershed directly in the Cove. The mitigation project will incorporate the use of a constructed wetland system to treat the "first flush."

Strategy and Rationale

Several treatment alternatives for the storm water draining into Spragues Cove were considered:

- No action. The drainage system continues to function and shellfishing areas remain closed because of high fecal coliform counts
- Mechanical treatment methods such as chlorination, ultraviolet light, ozone and reverse osmosis
- Physical methods of treatment such as infiltration, settling or constructed wetlands

The Town of Marion reviewed the alternatives and decided that a constructed wetland system met the objectives of the project. The system will include a settling basin, marshland vegetation, and an open, deep water pool. The settling basin allows for coarse sediments and particulates to settle out prior to entering the wetland treatment system. In the wetland itself, physical and biological processes will treat and remove pollutants from the water. The restored wetland system will have a hydraulic detention time of over 14 days.

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The wetland system will be constructed where a salt marsh previously existed. The site was filled decades earlier with dredge spoil from nearby Sippican Harbor. In addition to providing water quality improvements, the restored wetlands system will enhance the fish and wildlife habitat in the area. Currently the site has little habitat value.

Effectiveness

Existing research on using wetlands to treat wastewater for fecal coliform indicates that at least 95 percent or greater is typically removed. Fecal coliform counts associated with storm water from the Spragues Cove outfall are significantly lower than previously recorded levels. The water quality monitoring plan will be part of the quality assurance/quality control (QA/QC) plan required by the U.S. Environmental Protection Agency.

Costs and Funding

The Town of Marion and the Buzzards Bay Project obtained $25,000 through the Massachusetts Department of Environmental Protection's 319 grant program. The Town provided an in-kind match valued at $35,000 to cover the cost of construction, equipment and labor. The Town also donated the land on which the wetland system will be constructed (estimated value of $100,000 per acre). A total of two to three acres of land will be utilized for the project at a total cost of $200,000 to $300,000. Additionally, the U.S. Fish and Wildlife Service granted the Town $10,000 for the project under the Wetland Restoration Program. Planning and technical assistance will be provided by an interdisciplinary team from the Soil Conservation Service (SCS).

4. Broad Marsh River Storm Water Remediation Project

Broad Marsh River is a tributary to the Wareham River estuary. It is located in the Town of Wareham in the northern part of Buzzards Bay. The entire Broad Marsh River has been closed to shellfishing and some beaches closed to swimming due to high fecal coliform concentrations. The most significant source of pathogens and fecal coliform pollution in the river is associated with storm water runoff from discharges from adjacent storm drain systems. Other potential sources, such as migratory waterfowl and boats, have been deemed insignificant.

The primary objective of the storm water remediation project is to reduce the amount of pollution (mostly fecal coliform) from storm water runoff entering Broad Marsh River.

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Strategy and Rationale

Several alternatives were considered for the treatment of storm water runoff from storm drain systems adjacent to the Broad Marsh River:

- No action. Fecal coliform pollution would continue unabated and result in the continued closure of shellfishing beds and many beach closures for swimming.
- Extended detention basins, wet ponds or constructed wetlands would be used to detain the first flush of runoff for at least 24 hours.
- Infiltration structures such as infiltration basin at the end of each storm drain system, or a series of leaching chambers under the existing road surface

The selected alternative was the use of leaching chambers placed under the road surface. The rationale for selecting this alternative is typical in many retrofit situations; detention basins were rejected because, as an "end-of-pipe" practice, they require considerable commitment of land to function properly. Since there are 16 storm water outfalls to this section of the Broad Marsh River, there would have to be 16 detention basins and this would require the acquisition of a large amount of land, including some dwellings. This choice was not deemed feasible. Infiltration basins located at the end of a pipe have a similar need for large land commitment. The leaching chamber option was chosen because leaching chambers placed under the road surface would minimize the disruption to the present drainage system and would not require a large land commitment.

Effectiveness

This project is not yet fully established. However, to demonstrate the effectiveness of the leaching chambers, the project will monitor a minimum of three chambers.

Costs and Funding

The Buzzards Bay Project was initially unable to fund the Broad Marsh River project. However, the Buzzards Bay Project together with the Town of Wareham, requested funding under the Massachusetts Department of Environmental Protection's 319 (Nonpoint Source) Program and successfully secured funding in the amount of $88,450 to help reduce pollution loadings from storm water runoff.

5. Town of Yarmouth

In 1991, the Town of Yarmouth implemented the retrofit of a drainage system to

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eliminate the direct discharge of storm water runoff containing high fecal coliform counts to the Bass River. The drainage system was retrofitted to direct the flow into a retention basin to allow storm water to percolate through a gravel bed. This design also allowed for evaporation to remove pollutants. The retrofit substantially reduced fecal coliform counts from pre-retrofit levels and improved the water quality in several ways:

- it has reduced velocity, encouraging infiltration
- it further reduced the velocity through infiltration and evaporation
- fecal coliform counts are lower even after similar pre-retrofit rainfall events

Effectiveness

Water quality monitoring performed by the Barnstable County Department of Health Laboratory both before the retention basin retrofit and afterward revealed substantially reduced fecal coliform counts.[12]

6. Town of Orleans

The Town of Orleans, Massachusetts is a community on Cape Cod which has extensive coastal waters, including three estuaries. These waters contain important commercial shellfishing areas. In 1988, several areas within the Town's waters were closed to shellfishing due to bacterial contamination. Through sampling of storm drain outfalls and receiving waters, and from a review of existing water quality data, the Town identified storm water runoff as a significant source of contamination from bacteria and other pollutants to its coastal waters.

Strategy and Rationale

Three drainage areas were targeted as having significant adverse impacts on water quality in sensitive areas and in need of remediation. The Town's strategy was to: 1) identify the three high priority areas for development and implementation of pollution control measures; 2) establish a storm water management committee; 3) screen BMP alternatives to choose best available means to remove bacteria and solids; and 4) appropriate funds for study of conceptual approaches and engineering designs and for construction of the BMPs at the three high priority sites.

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[12] Town of Yarmouth, "Effects of Route 6 Storm Drainage Improvements on Water Quality in Bass River," November 11, 1992.

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Prior to undertaking the projects, which are scheduled for completion in May, 1993, the Town acted on the consultant's recommendations and took the following actions:

- scoped potential solutions
- focus on BMPs for control of bacteria and solids
- prior to choosing BMPs, Town conducted field investigations, which included the following steps:

    - mapping drainage systems
    - analyzing pollution treatment alternatives
    - sizing treatment facilities
    - designing O & M programs

The BMP selection process identified the most feasible and cost effective practices for use in the three drainage systems which were to be retrofitted. In addition, the Town of Orleans Storm Water Quality Task Force was set up to insure the project's technical quality and to address local concerns.

A range of BMPs were considered for control of bacteria and solids and their associated nutrients. The following BMPs were considered for this project, because they are targeted for the control of solids and bacteria:

- extended detention ponds
- retention basins
- infiltration trenches (subsurface leaching gallies)
- filtration beds

A system of sub-surface leaching gallies was used at three sites because of limited land but suitable soil conditions; one site consisted of a detention basin upstream of a filter bed structure because soil conditions were too poor to permit infiltration.

Institutional Issues

The Town's principal institutional motivation for implementing the retrofit projects was the adverse economic impact of closed shellfish beds. Abating and controlling the bacterial contamination from storm water runoff was directly tied to economic concerns and this was a very strong motivation for the Town to organize a task force and to act on the problem. The Town appropriated funds to develop conceptual approaches and engineering designs, as well as for the construction of the necessary BMPs.

II. Regional Cooperation: Role of the Cape Cod Commission

The Cape Cod Commission works with towns on Cape Cod on various matters

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including local transportation projects. In Barnstable County, shellfish bed closures were the principal motivation for the Commission to become involved with storm water issues. The Commission trys to de-politicize issues and use all "levers" available, including state environmental review processes, such as coastal zone management consistency review, to affect outcomes.

Strategy

The strategy employed by the Cape Cod Commission utilizes several different components to maximize the leverage which the Commission can employ to facilitate implementation of storm water retrofit projects on Cape Cod. They try to use all the "levers" available, such as coastal zone management consistency review and the implementation of the Buzzards Bay Management Plan as part of the National Estuary Program (EPA). The Cape Cod Commission works as a coordinator [much like MWCOG in Anacostia watershed restorations] with the Massachusetts Department of Public Works (Mass DPW) and local governments on storm water remediation and retrofitting as part of local transportation projects.

The Cape Cod Commission (through the Cape Cod Marine Water Quality Task Force) has developed a process for prioritizing storm water drainage mitigation projects. This process includes the development of a numerical index to rank proposed projects. The worksheet is keyed to the concerns of Barnstable County, viz., the safety and harvestability of shellfish beds, as well as the safety of areas used for swimming and recreation.

For more information...

For more information about the Buzzards Bay Project and other programs in Southeastern Massachusetts, call the Buzzards Bay program office at (503) 748-3600.

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City of Austin, Texas

Background

The City of Austin, Texas, stretches from the Texas hill country of the Edwards Plateau, eastward to the Blackland Prairie and the Gulf Coastal Plain. A unique environment results from this rapid geologic and ecologic transition.

The Colorado River flows directly through the City. Three riverine lakes - Lake Travis, Lake Austin and Town Lake - are the three most downstream reservoirs of a chain of reservoirs on the Colorado River known as the Highland Lakes. These reservoirs are the City's main water supply, as well as being tourism and recreational resources.

Another key water resource in the area is the Edwards Aquifer, a limestone aquifer on the western side of the City. The aquifer is the sole source of water supply to several communities south of Austin.

These water resources are potentially threatened by water pollution resulting from storm water runoff and other sources of nonpoint pollution. In response to this threat, the City has developed one of the best watershed protection programs in the country. The keystone of this program is the Comprehensive Watersheds Ordinance.

Development of the Comprehensive Watersheds Ordinance

In order to protect water resources from degradation due to urban nonpoint source pollution, the City enacted several watershed protection ordinances in 1988. These ordinances were combined into a single code which applies to the entire city and to its extraterritorial jurisdiction. The City of Austin Land Development Code and the Environmental Criteria Manual provide guidance for water quality management. The 1988 regulations became the basic building blocks of the Austin storm water management and BMP implementation and retrofit program.

The original catalyst for the consolidation of the existing watershed protection ordinances was the comprehensive planning effort known as "Austin Tomorrow." This plan identified nonpoint source pollution as a potential threat to Austin's environmental and economic well-being.

Monitoring of Austin's creeks and lakes followed this study and in 1978 the Lake Austin Watershed Ordinance became the first water quality related ordinance and nonpoint source pollution control ordinance to be adopted in the region.

In 1981, the City of Austin joined the EPA-sponsored Nationwide Urban Runoff

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Program (NURP) study and began monitoring its storm water structural controls in 1982. Subsequent watershed protection ordinances were passed from 1980-1984 to cover additional environmentally-sensitive areas.

By 1986, the City of Austin had had eight years of experience with watershed protection ordinances and appointed the Comprehensive Watersheds Ordinance Task Force to develop the consolidated ordinance and provide final review and recommendations for implementing the consolidation of the numerous existing ordinances.

Overview of the Comprehensive Watersheds Ordinance

The Comprehensive Watersheds Ordinance (CWO) was directed at preventing urban runoff pollution by placing requirements on proposed new development with Austin and its extraterritorial jurisdiction. Although the Comprehensive Watersheds Ordinance originally existed as a stand-alone document, it has since been incorporated into the City's Land Development Code. In addition, there have been several amendments to it since 1986 and more are anticipated in the future to better protect various sensitive areas. Nevertheless, knowledge of the evolution of the Ordinance is helpful to understanding Austin's strategy for urban nonpoint source pollution control.

Specific pollutants were not addressed in the Comprehensive Watersheds Ordinance. Control of specific pollutants was instituted only for the sensitive Barton Springs Zone, which recharges the Edwards Aquifer. Several ordinances for the protection of this sensitive area have been put in place over the last several years.

The Ordinance required a range of widely accepted and proven structural and nonstructural nonpoint source pollution controls to be included in new development projects. These controls included best management practices (BMPs) such as impervious cover limitations, water quality buffer zones, protection of critical environmental features, limitations on disturbance of the natural stream, erosion control practices, sedimentation and filtration basins, and wastewater disposal requirements. One significant aspect of the ordinance was the use of nonstructural controls to prevent and mitigate nonpoint pollution associated with development. The rationale behind this approach was that impervious cover limitations and buffer zone requirements have been proven to maintain the basic hydrologic balance.

Protection of non-drinking water supply watersheds in the eastern side of Austin were not given high priority. Downstream of Town Lake the Colorado River is not used for drinking water supply. Furthermore, clay soils dominate on the eastern side of the City; therefore, maintaining infiltration and recharge is not a critical goal in these watersheds.

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Effectiveness of the Ordinance

The City of Austin standard sand filter design requires the first half inch of runoff from a site to be diverted into a sedimentation basin and then filtered through sand. This design is based on eight years of monitoring filter ponds of different designs.[13] The demonstrated removal efficiency of the sedimentation/filtration ponds for total suspended solids is 75% to 97%.

An important consideration learned from the Austin experience regarding effectiveness is that maintenance is critical to ensure BMP effectiveness, yet timely maintenance is problematic at both a local and nationwide level. Another is that the best protection for water resources is believed to be afforded by a combination of structural and non-structural controls as provided for in the Comprehensive Watersheds Ordinance. Structural controls alone are not always effective, nor can they prevent an increase in pollutants from high intensity developments.

Austin's non-degradation strategy for contributing watersheds is to limit the percent of impervious cover in new developments and to reduce post-development pollutant loads through a menu of storm water control practices, and a program of retrofitting storm water treatment measures in developed areas. Austin has incorporated this strategy into the framework of the City of Austin Land Development Code through a mechanism known as an "impervious cover cap." The impervious cover cap is established by setting a Maximum Sustainable Removal Rate for storm water treatment measures at 90%; beyond this point, storm water control measures cannot be relied upon to reduce the pollutant loads associated with additional impervious cover down to the pre-development level.

This strategy aims to reduce excessive reliance on storm water treatment measures because of their inherent limitations and risk of failure due to lack of maintenance and their need for replacement. Impervious cover levels, on the other hand, do not change over time, do not require maintenance, and their life span is infinite provided their nature is unchanged.

However, the Austin program recognizes that modification of the City's development regulations would provide only a partial solution to the problem of water quality degradation. It sees retrofitting of structural storm water controls as the only way to reduce pollutant loads from existing development and development projected but not

[13] Parrish, John H. and Stephen Stecher, "Nonpoint Source Pollution Control in the City of Austin." City of Austin, Environmental and Conservation Services Department, March 1991, p. 5.

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yet built.[14]

The Austin program has recognized that, in light of the growing trend toward limiting building density and/or impervious cover as a means of nonpoint source control in residential areas, there is a need to establish a clear linkage between development density or impervious cover and pollutant loadings. In addition, the city recognized that more study is needed on the effects of types of land use on the quality of storm water runoff.

The City's Storm Water Monitoring Program has provided the city an opportunity to evaluate the effectiveness of its varied array of storm water quality controls, and also to assess whether they are over- or under-designed relative to site conditions.

First Flush of Runoff and its Effects on Storm Water Control Structure Design[15]

Austin's Environmental Resource Management Division published a report (1990) showing that the first 1/2 inch of runoff did not necessarily carry the bulk of the storm load. This was contrary to the prevailing assumption that the first 1/2 inch of runoff in a storm washes off 90% of pollutants from the impervious cover. The report suggested that for a development with 90% impervious cover, only 40% of the total storm load would be washed off in the first 1/2 inch of runoff.

The implication of the report for control structure design was that a control structure designed to capture and treat only the first 1/2 inch of runoff would only remove about 40% of the total annual load. The bypass or untreated annual load could be substantial. The report did not suggest an alternative structural control design; it merely raised the issue of a substantial amount of pollutant load in excess flow from a structure designed to capture and treat the first 1/2 inch. Changes to the City's Land Development Code in December 1993 resulted in the treatment volume increasing with the amount of impervious area on the site, starting at .50 inch plus .10 inch per 10% increase in impervious cover over 20% of the site.

However, urbanized watersheds should be targeted for priority control based on other findings. Another Austin study confirms that storm water runoff pollutant loads increase with watershed imperviousness, and that loading rates of urbanized

[14] Ibid., p. 15

[15] City of Austin, Environmental Resource Management Division, "The First Flush of Runoff and Its Effects on Control Structure Design." June, 1990.

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creek watersheds were significantly higher than those from small suburban sites.[16]

Sand Filter Program

The City of Austin has developed a sand filtration best management practice for use in storm water quality management. The sand filtration systems are the primary water quality control structures.

The City had previously implemented a storm water monitoring program in 1984. This study was conducted to determine annual removal efficiencies of six storm water quality control structures, including three filtration basins, one wet pond, one sedimentation (dry) pond, and one retention/filtration basin system. The structures were monitored between 1984 and 1989, and comparative measurements of inflows and outflows were taken to determine concentrations of pollutants.

Effectiveness of removal for the following parameters was measured:

- Fecal coliform
- Total suspended solids (TSS)
- BOD/COD
- Nitrogen
- Phosphorus
- Heavy metals

The study[17] concluded that the sand filtration basin is an effective structural control measure for most of the described pollutant parameters. Sand filtration is a demonstrated success in Austin, although officials concede that maintenance is sometimes inadequate and sporadic.[18] There have also been some isolated technical and/or design failures, such as slope erosion and construction failures which have resulted in inadequately performing BMPs.

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[16]City of Austin, Environmental Resource Management Division, "Stormwater Pollutant Loading Characteristics for Various Land Uses in the Austin Area." March, 1990.

[17]City of Austin, Environmental Resource Management Division, "Removal Efficiencies of Stormwater Control Structures." Final Report, May 1990, p. 16.

[18]Personal communication with Les Tull, Engineer, City of Austin, Texas, May 25, 1993.

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Strategy

The Austin sand filter program was implemented in response to regulatory requirements, viz., the consolidation and enactment of several watershed protection ordinances in 1988. In addition, political pressure to act came from citizens demanding action to protect water quality. The City of Austin's Land Development Code and Environmental Criteria Manual provide documentation and guidelines for the City's water quality management efforts.

Prior to enactment of the watershed protection ordinances, the City implemented a storm water monitoring program in 1984 to evaluate storm water control measures and to develop a database to quantify the effects of impervious cover and land use on water quality and also to evaluate the effectiveness of various structural storm water control measures already in use.

The basic strategy and philosophy guiding the Austin program has been to make new development and redevelopment pay the costs attributable to its impact and to mitigate all impacts of new development. While this has been the strategy, it has not been possible to accomplish this for all aspects of the development process, such as permits and review. In addition, the City assumes responsibility for maintaining water quality controls for single-family development. This approach includes a provision for payment of a fee in lieu of constructing BMPs so as not to restrict development. "Fee in lieu of" funds are used for retrofit projects for existing development, but only within the most highly urbanized and developed watersheds classified as "urban" in the Land Development Code.[19]

There are many components to the Austin storm water management amd urban nonpoint pollution control program. These include retrofit watershed master planning, source control of pollutants, and public education. A current emphasis is on the public education component, which includes videos and posters with the theme of abating urban nonpoint source pollution.

Austin's strategy sees the key to a successful nonpoint source control program as the targeting of critical areas to achieve high pay-off returns. The City's focus is on potential deterioration of local water supplies, viz., Lake Travis, Lake Austin, Town Lake and the Edwards Aquifer. The Comprehensive Watersheds Ordinance requires the strongest nonpoint source controls in those developments in watersheds which contribute to the drinking water supply.

Targeting new development is seen as a cost effective method of preventing future nonpoint source problems. Required controls which are prescribed in the Ordinance

[19] Ibid.

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can be included in the initial land planning. Since the primary controls set forth in the Ordinance are non-structural, raw land cost is the main cost for new development associated with nonpoint source controls. However, structural controls are also used and these have a cost to the developer. Since impervious cover limitations are the most important non-structural control specified in the Ordinance, retrofitting existing development has proven to be difficult. Retrofitting structural controls has also been difficult, due to limited location and high land costs.

The City's retrofit program uses public education as its main tool to build and keep the necessary public support for storm water management programs through the use of videos, posters, and other media. In addition, Austin has initiated a process of storm water retrofit master planning as a way of maximizing the scarce public resources available for this purpose.

Developing a strategy for controlling nonpoint source pollution from urbanized watersheds is particularly difficult, and much more complex than preventing nonpoint source pollution from developing watersheds. Retrofitting BMPs in urban areas is still a "pioneering" activity and involves considerable experimentation and cost. While there are an increasing number of localities pursuing retrofit strategies, there is no broad national experience with retrofit implementation.

BMP selection in retrofit situations is also problematic; for example, wet ponds are an excellent BMP for controlling nutrients, yet they are often very difficult to site under retrofit conditions.

Non-degradation Strategy[20]

Austin has developed a non-degradation strategy for a particularly sensitive and important area known as the Barton Springs Zone, which covers several watersheds. The strategy is "design-based" rather than being entirely a technology- or performance-based approach. The design-based approach requires that compliance be designed into a project before it is built based upon best available scientific and engineering principles. This strategy includes a City-funded program for retrofitting storm water controls.

Other elements of the non-degradation strategy include:

- strengthening existing regulations by limiting exemptions
- limiting impervious cover to levels at which generated pollutants can be

[20]Parrish/Stecher, "Nonpoint Source Pollution Control in the City of Austin," March 1991., p. 12

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reduced to background levels by an array of storm water control practices

Importance of Non-structural Controls in Austin's Program

One of the distinctive features of Austin's storm water management strategy is the emphasis given to the use of non-structural controls. The basic assumptions of this approach are the following:[21]

- structural controls alone cannot prevent an increase in pollutants from high intensity development
- maintenance requirements are high for structural controls compared to the maintenance needed for impervious cover limitations and buffer zones
- sole dependence on structural controls is not wise for protecting the City's water resources; a combination of structural and non-structural controls is the best strategy

Institutional Issues

Austin created a city department of environmental conservation, the Environmental and Conservation Services Department, in 1987. Its central focus is resource conservation and environmental protection, as distinct from public works. This department is co-equal with other City departments. It oversees the work of public and private agencies under its jurisdiction. This institutional arrangement is clearly intended to provide support for effective environmental and regulatory (enforcement) action.

The Environmental and Conservation Services Department and the Department of Public Works "share" a drainage utility (storm water utility). Drainage projects are funded with fees from the drainage utility. "Storm water" is not separately identified on the utility bill, nor described as such officially.

Costs and Financing

Most storm water programs are funded by the drainage utility. or drainage fee. Public works drainage projects in the Capital Improvements Program are paid for with bond sales which are repaid with tax (general fund) revenues at this time.

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[21]Parrish/Stecher, "Nonpoint Source Pollution Control in the City of Austin," p.6

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Development is expected to "pay for itself," that is, development must pay for the cost of controls associated with that development. However, in reality, development fees pay for approximately 30% of the land development review and permit programs. Nevertheless, the program's emphasis on non-structural controls means that the cost for the City is considerably lower (because of less monitoring and inspection) than if structural controls were the sole means of control.

The Austin program also takes the view that preventing adverse water quality impacts from nonpoint source pollution is much less expensive than trying to restore water quality after it has been degraded. One of the stated goals of the Comprehensive Watersheds Ordinance is to avoid the cost of retrofitting existing development.

There are significant costs throughout the institutional structure related to control of nonpoint source pollution. Preventing NPS pollution can avoid or reduce other costs such as wastewater treatment, the need for dredging lakes and waterways, and health risks associated with toxics pollution. The Austin view is that the cost of restoration, retrofitting, dredging, advanced types of water treatment, development of new water supplies, and lost recreational and economic values can easily dwarf the cost of prevention.[22]

Other NPS Control Programs

The City of Austin has also initiated non-structural and low-structural development controls to limit impervious surface areas for storm water management purposes. They have established a critical zone in which no construction is allowed, as well as a transition zone where development is limited or not allowed in order to preserve riparian areas.

Other programs which the City has instituted to control urban nonpoint source pollution include the following pollution prevention and source control programs:

- household hazardous waste collection: provides for safe disposal of hazardous materials
- street cleaning and litter collection program
- xeriscape and integrated pest management (IPM) programs: minimizes inputs to the environment from fertilizers and pesticides; both approaches stress the minimal use of the least harmful substances to control pests and weeds; IPM is encouraged in municipal operations

[22]Parrish/Stecher, "Nonpoint Source Pollution Control in the City of Austin," p.7

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BMP Siting Considerations

There is a diversity of opinion as to whether it is better to construct large regional BMPs or numerous smaller BMPs closer to pollutant sources. The preferred approach in Austin is to construct numerous smaller BMPs and capture water as close to the source as possible for the following reasons:

1) need to capture less water to achieve the pollutant removal desired

2) capital and maintenance costs are less if the BMPs are smaller

3) maintaining the natural hydrology is easier with smaller BMPs - in addition, the need for groundwater recharge is addressed, whereas if channeling water further down the watershed was done, groundwater recharge would not occur (or recharge of polluted water could occur before the runoff reached the treatment device)

4) protection of smaller waterways from pollution and channel erosion

Summary and Conclusion

Austin has attempted to come to terms with its nonpoint source pollution problems through implementation of the Comprehensive Watersheds Ordinance and other ordinances since 1986. The City recognizes the actual and potential costs of nonpoint source pollution as it relates to safeguarding of drinking and groundwater supplies, maintaining tourism and recreational opportunities, and protecting wildlife habitat, to name a few.

Austin is "ahead of the curve" in terms of meeting EPA and state water quality goals. These efforts will continue to pay benefits into the future. The development and implementation of the Comprehensive Watersheds Ordinance could be a model for other local governments in their efforts to control nonpoint source pollution.

Relevance of Austin's Watershed Approach for Other Jurisdictions

Austin's Comprehensive Watersheds Ordinance is easily transferable to other jurisdictions and to other hydrogeologic conditions. The Texas Water Commission cited Austin's Ordinance as an example of the kinds of controls which local governments in Texas could implement as part of the Nonpoint Source Management Plan which the state submitted to the U.S. Environmental Protection Agency.

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Because the Ordinance is based on BMPs instead of on design or performance standards, it is widely applicable to other situations and does not require specialized staffs for its implementation. The Ordinance is accompanied by a technical manual which specifies the technical aspects of the controls which it requires.

Numerous other jurisdictions in Texas have adopted watershed protection ordinances based on the same framework as Austin's. Governmental entities across the country have requested copies of the Comprehensive Watersheds Ordinance for guidance on how to protect their water resources and control nonpoint source pollution.

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Austin's Program at a Glance

Steps to Implementation

1) Comprehensive Planning Process: "Austin Tomorrow"

2) Appointed Watershed Ordinance Task Force

3) Consolidation of Watershed Protection Ordinances

4) Passed Comprehensive Watershed Ordinance

5) Targeting of Critical Areas: Austin's strategy uses targeting of critical areas to achieve cost effective control.

   - Controls for New Development
   - Identify Candidate Retrofit Sites

Retrofit Program

A strategy for controlling nonpoint source pollution from urbanized watersheds involves considerable coordination, experimentation and cost.

1) Use Public Education to Build Support

2) Use Retrofit Master Planning to Maximize Scarce Resources

For more information...

For more information about the City of Austin's program, call the Environmental and Conservation Services Department at (512) 499-2501.

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City of Orlando, Florida

Introduction

The City of Orlando, Florida has taken a pioneering role in trying to solve its water quality problems related to urban storm water runoff. Protection of its numerous lakes and wetlands has been a primary motivation for action. Within the corporate limits of Orlando there are some 83 named lakes, which lie within five major drainage basins. The City has the distinction of having been designated a "National Storm Water City of the Year" by the U.S. Environmental Protection Agency. It earned this distinction because of its aggressive storm water management and retrofit program.

Some of the innovative storm water treatment systems and retrofit methods used in Orlando include storm water wetlands, alum injection, exfiltration, lake aeration, sediment control devices, trash screens and shoreline and littoral zone vegetation.

Some of the other approaches being used in Orlando are:

- storm drain retrofits and water quality enhancements when performing corrective maintenance (e.g., vertical volume recovery unit for drainage to Lake Lawsona)
- exfiltration basin retrofits to existing city storm drains
- littoral zone enhancement and revegetation with native aquatic plants
- creation of storm water wetlands for pre-treatment of runoff entering lakes (e.g., Lake Lorna Doone)
- depressional landscaping to encourage runoff infiltration (e.g., Lake Ivanhoe)

One of the many major retrofit projects in the Orlando area is the Lake Greenwood urban wetland, which is a wetland and storm water management system in an urban environment close to downtown Orlando.

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Evolution of the Florida Storm Water Program/Major Regulatory Components

The major components of Florida's storm water program are three pieces of legislation: the 1982 storm water permit requirements for new development; the 1987 Surface Water Improvement and Management Act (SWIM), which provided a framework for watershed planning; and the 1989 storm water legislation, which established program goals and extended program coverage to existing agricultural and forestry sources.

The Surface Water Protection and Management section of the 1989 storm water legislation provides the regulatory framework for the Florida storm water management program, particularly the watershed approach. This program was enacted by the Florida legislature to restore the state's degraded water bodies and to protect those still in good condition.

The landmark 1989 storm water legislation was intended to integrate the various existing storm water laws and programs into a comprehensive watershed management program. Most importantly, the 1989 law emphasized the watershed approach to correcting existing storm water deficiencies and it gave a regulatory impetus to retrofitting. The 1989 law also established the State Storm Water Demonstration Grant Program which provides matching grants for storm water treatment projects undertaken by local governments which have implemented storm water utilities. The grant program is clearly an inducement to Florida municipalities to set up storm water utilities.

Lessons Learned in Florida's Storm Water Program

The Florida storm water program has been successful at minimizing storm water problems associated with new growth, but it has been much less successful in restoring water bodies degraded by storm water discharges. The piecemeal approach cannot address one of the state's largest problems, however, the problem of retrofitting drainage systems, which includes:

- retrofitting of existing storm water drainage systems to reduce pollutant discharges to state waters
- correcting storm water infrastructure deficiencies related to the state's rapid growth

Livingston stresses that the solution is comprehensive and coordinated work

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throughout the watershed.[23] He emphasizes the need to address land use, water resources, and infrastructure planning within a watershed context. He also states that a dedicated funding source, such as a storm water utility is also important for maintaining an effective program.

Lessons Learned in Orlando

The Orlando experience suggests that one of the requirements for successful urban runoff control and retrofit projects is the importance of control of the project and the need to write very good specifications so that water quality goals are met. Engineers and consultants may have an economic incentive to design BMPs which may not be commensurate with the implementing authority's water quality goals.

Experience reveals that engineers and consultants may sometimes have a mechanistic approach to problem solving and therefore advocate a hydraulic solution rather than water quality one in some instances. They know how to get the water off-site as quickly as possible, but this is not necessarily commensurate with a water quality solution.

The best way for the implementing authority to ensure success is to be in control of the project, to know the solution that is necessary, and then see that it is done correctly.

Greenwood Urban Wetland

The Greenwood Urban Wetland in Orlando is a constructed urban wetland located within a 522-acre drainage basin. Storm water runoff collected within the 522-acre sub-basin flows into Lake Greenwood, which lies at the lowest point in a 4.5 square mile urbanized area. The artificial wetland was built to alleviate flooding, to pre-treat storm water runoff prior to discharge into drainage wells (which discharge water to the upper Floridan acquifer), and to re-use the stored water to irrigate an adjacent cemetery and park. City-owned land which was previously vacant was excavated to form a series of ponds and a bypass stream leading to five drainage wells.

The storm water quality enhancement component of the wetland plan came about as a result of the City's concern for protecting its groundwater supply. Proximity to groundwater is a prime concern in most of Florida.

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[23]Livingston, Eric H., "Lessons Learned from a Decade of Stormwater Treatment in Florida." Bureau of Surface Water Management, Florida Department of Environmental Regulation, Undated.

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The storm water "treatment train" concept was incorporated into the Lake Greenwood urban wetland. The BMPs included in this treatment train are: a sediment and trash screening device; a littoral zone with vegetation; and aerators to increase microbiological activity.

Effectiveness of the Greenwood Urban Wetland

Water quality monitoring of Lake Greenwood was begun in 1987 - one year prior to the beginning of construction of the wetland. This was done to obtain a baseline profile and to ascertain the trophic state of the lake. Both before and immediately after construction, the lake exhibited eutrophic to hyper-eutrophic conditions. After completion of the project, the lake's trophic state indices were in the mesotrophic range.

Prior to construction, the water quality of Lake Greenwood was not in compliance with Florida Class III (recreation and wildlife propagation) water quality standards. Since construction, there have been no water quality standards violations of any parameters tested, including EPA-listed pesticides. Further monitoring of the storm water treatment system is being planned for wet weather pollutant removal efficiencies and further hydraulic analysis. An ongoing storm water monitoring program was begun in 1991.

Based on the preliminary sampling data, it is clear that the Lake Greenwood urban wetland storm water management system has enhanced water quality within the lake and also the quality of the water discharged to the drainage wells (which discharge to a major acquifer).

Development of Orlando's Storm Water Utility

Storm water projects in Orlando have traditionally been financed out of general fund revenues, as is common in most municipalities. In addition, Orlando has used revenue from a state gasoline tax for projects which also have a road/transportation component. Depending upon general fund revenues, however, often results in projects being deferred to pay for more critical governmental functions such as police and fire. The City has adopted an aggressive program of storm water system repair and replacement, pollution control, and lake enhancement. This problem has been funded in the past through the City's general property tax budget, but this source is no longer adequate for the scope of the problem today, particularly in view of increasingly stringent state and Federal water pollution control requirements.

To provide for the effective management and financing of a storm water system within the City of Orlando, the City established a storm water utility. The storm

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water utility generates its revenue through user fees. A storm water service charge is levied on every parcel of land in the City. The fee is based on the amount of storm water which a particular parcel passes on to the storm water drainage system.

The storm water utility is responsible for the operation, construction and maintenance of storm water management devices, for storm water system planning and lake management.

Packed Bed Storm Water Filter Artificial Wetland[24]

One innovative project which was proposed by the City and implemented through a consultant was the "packed bed filter." This experimental storm water BMP will be used (just coming on line in July 1993) to treat a small but highly urbanized portion of the drainage basin which flows into Clear Lake. The project was initially proposed in response to concerns about the lake's water quality.

The drainage basin for Clear Lake consists of over three square miles of highly developed urban area. This retrofit technique became necessary because best management practices (BMPs) for new development are not appropriate in the highly urbanized and completely built-out Clear Lake basin. This innovative method of storm water treatment was selected both for its presumed pollutant removal efficiency, as well as the necessity of using a BMP which could function within a limited area where land utilization constraints exist.

The packed bed filter is an example of technology transfer - a common wastewater treatment technique which has application to urban storm water pollution treatment. The filter utilizes a treatment train of two components, one of which is a packed bed filter system planted with wetland macrophytes for nutrient uptake. Put more simply, the system is a packed-bed filter (similar to a trickling filter) with hydroponically-growing aquatic plants. During dry weather or low flow conditions, the device will treat water from Clear Lake using the continuous flow to maintain the planted beds.

The device has a limited storage volume, so a decision was made that in order to maximize the removal of the most pollutants, the goal would be to capture less than the first one-half inch of runoff from a larger acreage than a greater amount from a smaller acreage. It is hoped that this will result in the treatment of a dirtier waste stream and reduce the amount of pollutants reaching the receiving waters of Clear Lake.

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[24]Dyer, Riddle, Mills & Precourt, Preliminary Engineering Report: Packed Bed Filter. Prepared for the City of Orlando, FL, April, 1991, p. 4-3.

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Pollutant Removal Efficiency Cosiderations for Packed Bed Filters

Although the packed bed filter implemented by the City of Orlando has only recently been brought on line [July 1993], there are certain operational considerations for packed bed filters as they relate to treating urban storm water runoff. Packed bed systems intended to treat storm water do not have to meet the strict effluent quality criteria that would be required for wastewater. Indeed, the concentration of pollutants in storm water most closely resembles tertiary treated wastewater with the exception of solids concentrations. This is one reason why the packed bed storm water treatment system was designed to treat a larger flow with lesser removal efficiency than a higher removal rate from a smaller flow.

The packed bed filter employs the concept of a "treatment train." The concept of a treatment train of BMPs involves a series of unit operations designed to remove the largest amount of contaminants from runoff, typically greater than the pollutant removal achievable through individual unit operations.

The packed bed filter system is a new technology and a transfer of technology from wastewater treatment systems to storm water management systems. As an experimental practice for storm water treatment, many elements need to be monitored for their relation to long-term effectiveness:

- hydraulic residence time
- bed media
- plant materials for the packed beds
- depth
- travel length
- velocity
- liners

Use of Alum for Treatment of Storm Water Runoff

One technology showing promise is the use of alum to treat storm water runoff. Two lakes in Orlando, Lakes Dot and Lucerne, and one in suburban Winter Park, Lake Osceola, are having their storm water inputs from large urbanized drainage basins pre-treated with alum. The alum treatment concept was initially tested on Lake Ella in Tallahassee.

Alum treatment of storm water runoff was selected after an analysis of the pollution abatement alternatives. Conventional storm water management techniques such as retention, detention, or exfiltration were deemed not feasible due to space limitations, or because of the poor infiltration capacities of watershed soils. The alum is injected and mixes with the storm water in the storm sewer lines. Floc accumulation begins

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immediately and the floc settles on the lake bottom.

Alum injection is wastewater treatment technology being adapted to storm water quality control. There is still some question whether it can be considered a retrofit technology, but its use as a pollution abatement alternative involves many of the hallmarks of a retrofit situation:

- infeasibility of conventional storm water management techniques such as retention/detention
- infeasibility of using exfiltration systems due to limitations of available space and poor infiltration capacities of watershed soils

Another Case Study in Florida

Lake Jackson Regional Storm Water Management System

Rapidly urbanizing areas in the Megginnis Arm watershed were causing water quality degradation in Lake Jackson in Leon County near Tallahassee. A regional storm water detention system was designed and constructed through a cooperative effort of the Florida Department of Environmental Regulation, the Northwest Florida Water Management District, and with funding from EPA's Clean Lakes Program and the State of Florida. The facility consists of a wet detention pond with a heavy sediment basin at the inflow, a sand filter system designed to filter particular pollutants from storm water, and a three-cell constructed wetland designed to remove dissolved pollutants such as nutrients.

Construction of the system was completed in 1983 at a cost $2,664,389. Maintenance operations, which consist of sediment and clay removal from the top of the filter fabric do not exceed $30,000 per year.

Effectiveness of the Lake Jackson facility

Florida State University researchers conducted a long-term storm water sampling program of the facility and its individual components. Overall, the facility has performed up to design specifications within the constraints of space and the technical level of the equipment used. However, the increasing urbanization of the watershed has resulted in larger volumes of storm water draining into the facility, well beyond its design capacity. To overcome these deficiencies, the facility was enlarged to provide longer detention of more storm water, allowing the facility to

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detain larger storms and limiting the discharge of untreated storm water into Lake Jackson.

Lessons learned from Lake Jackson experience

Some of the lessons learned in the construction of the Lake Jackson regional storm water management system include the following design considerations:

- storage volume and the amount of water bypassing the system are critical design elements; the system should be designed based on maximum anticipated buildout in the watershed
- adequate funding must be provided to operate and maintain the system
- wetlands systems require some maintenance such as dredging to remove accumulated sediments and organic matter; they will not work indefinitely without maintenance

For more information:

For more information about the City of Orlando's program, call the Storm Water Utility Bureau at (407) 246-2370.

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County of Fairfax, Virginia

Regulatory Context

Fairfax County, Virginia is subject to the following Federal and State legislation and programs:

- Amendments to the 1987 Clean Water Act requiring NPDES permits for storm water discharges
- Virginia storm water management regulations (at local option)
- Erosion and Sediment Control Law
- Chesapeake Bay Preservation Act
- Section 404 of the Clean Water Act (wetlands protection)
- Water quality requirements under the Reauthorization of the Clean Water Act pending Congressional consideration in 1994

The County may also be subject to some requirements related to recent coastal zone legislation to which Virginia as a coastal state would be subject. States must develop a coastal nonpoint source pollution control program as a requirement of the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA). The State programs must be approved by EPA and NOAA by 1995.

Background[25]

Fairfax County has been involved in storm water control for more than 30 years. During the 1950s and 1960s, the emphasis was on storm water conveyance and channelization, which included delineation of flood plains and implementation of flood control projects. Beginning in 1972, on-site storm water detention was required for all new development. In the 1980s, water quality BMPs were required for new development in the southern areas of the County draining to the Occoquan reservoir, the major source of drinking water for Fairfax County.

In addition to the Master Drainage Plans which were prepared for all watersheds in

[25]County of Fairfax, Virginia. Draft. National Pollutant Discharge Elimination System. Municipal Storm Water Discharge Permit Application, Part 2. November 1992.

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the County during the 1970s, a supplemental Regional Storm Water Management Plan was prepared in 1988. This plan provides for regional storm water control ponds to control both quantity and quality. Wherever opportunities exist, the County intends to expand the implementation of regional storm water management ponds from the current pilot project involving seven watersheds. Implementation of the planned storm water control facilities over the past 20 years has resulted in expenditures of approximately $60 million, financed primarily through storm bonds.

There are presently over 1,500 storm water management facilities located in the County. In addition, there are 30 major lakes and over 100 smaller lakes and ponds which function as BMPs and provide water quality benefits in Fairfax County.

In 1989, the Fairfax County Board of Supervisors adopted the "Regional Storm Water Management Plan." The adoption of this plan marked a shift in philosophy on implementing storm water management from reliance on on-site controls to what are viewed as more effective regional controls.

Current Activities

The Fairfax County Department of Public Works is currently in the process of obtaining various permits or implementing programs designed to provide water quality improvements. These activities include:

- obtaining an NPDES permit from the Virginia Department of Environmental Quality; part 2 of the application has been submitted and the County is awaiting approval from the State
- implementing on-site best management practice (BMP) requirements for new developments in Chesapeake Bay Preservation Areas to protect water quality
- implementing a regional storm water management program to provide water quality improvements for both existing and new development, and to protect downstream wetlands and habitat
- implementation of stream channel erosion protection projects
- adopted a Water Supply Protection Overlay District requiring BMPs in the watershed of the County's water supply reservoir
- re-zoned much of the Occoquan watershed [water supply reservoir] to Residential/Conservation District (R-C) with 5 acre minimum lots
- adoption of an Environmental Quality Corridor Policy to protect land

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and surface water resources

Ongoing Activities

As part of the County program to comply with NPDES requirements, there is a 5-year monitoring program of selected storm water outfalls. The outfalls were selected based on different land uses and, based on the final monitoring results, typical pollutant loadings for each land use will be extrapolated.

There are approximately 44 regional storm water management facilities in the Difficult Run watershed alone. The County currently spends approximately $1 to $2 million per year on capital construction for storm water control facilities. However, prior to the recent downturn in the economy, typical drainage facility expenditures totalled $2 million to $4 million per year. Due to current economic conditions, the Fiscal Year 1994 appropriation has been reduced to $341,000.

To pay for these costs out of declining general fund revenues is becoming difficult for the County and this has led to discussion about establishing a storm water utility as a dedicated source of funding for storm water management and control. A storm water utility feasibility study is currently in progress.

Role of the Chesapeake Bay Preservation Act

In Virginia, the Chesapeake Bay Preservation Act (CBPA) is a significant storm water management program through its BMP requirements and use of buffers such as the environmentally sensitive Resource Protection Areas (RPA). The regulatory requirements of this program need to be considered by developers and local governments such as Fairfax County, in addition to other storm water management regulations.

Proposed Management Program

The County's proposed management program consists of the following elements:

- continuation of ongoing requirements and programs such as implementation of the Chesapeake Bay ordinance which requires structural BMPs on all new development
- implementation of suitable water quality control facilities
- providing inspection and maintenance of storm water management facilities

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- increased public awareness of the importance of clean storm water

The County recognizes that the proposed management program will require additional County funds and is currently evaluating the feasibility of establishing a storm water utility to provide a dedicated funding source for storm water management.

The County will look for opportunities to retrofit storm water devices and to implement additional regional ponds in all the County's watersheds in existing developed areas that are now without water quality controls. The County's Comprehensive Land Use Plan also encourages the retrofitting of existing storm water management ponds to become more effective BMPs.

Regional Storm Water Management Plan

In 1989, the County Board of Supervisors adopted a "Regional Storm Water Management Plan" which proposed 134 regional ponds in the most rapidly developing watersheds in the County. The adoption of this plan marked a shift in Fairfax County's approach to implementing storm water management from onsite controls to regional controls. This shift was based on the belief that regional controls are more effective. Concerning the retrofit of existing facilities, proposed development plans are reviewed by the Department of Public Works for opportunities to implement regional storm water management to supplement the pilot Regional Storm Water Management Plan for developing watersheds. In addition, the feasibility of retrofitting existing or porposed flood management projects to include water quality is evaluated.

Non-structural BMPs: Environmental Quality Corridors

Environmental Quality Corridors (EQCs) are the primary non-structural best management practice used by the County to protect water resources. Although the core of the EQC system will be the County's stream valleys, lands may be included within the EQC system if they achieve any of the following:

- habitat quality
- corridor-like quality
- aesthetic quality
- pollution reduction capability

The stream valley component of the EQC system includes the following:

- 100-year flood plains and flood plain soils
- soils with development constraints adjacent to wetlands, streams, and steep slopes

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- additional areas where above-described buffers are insufficient to protect water resources

Current Funding/Future Funding of Water Quality Programs[26]

There are ongoing County water quality programs which are supported out of the General Fund. These programs are:

- monitoring programs
- emergency response
- public awareness
- public facilities maintenance

The County's NPDES permit application clearly states the necessity of developing new funding sources for implementation of capital improvement projects for water quality.

The following point illustrates the tenuousness of funding water quality improvement projects out of general or bond funds: The currently approved bond referendum funds have almost been expended, and the latest storm bond referendum was defeated by voters in 1990. Neither the general or storm bond funds can be relied upon to provide stable funding for future storm water quality capital improvement needs.

Yet the County estimates that $11.79 million per year will be required to implement regional storm water management over the next decade, and to provide for maintenance of these facilities. County staff are determining the feasibility of establishing a storm water utility to provide long term capital as well as maintenance funds for the County's storm water control facilities.

In the interim, two methods to fund capital construction of water quality control improvements are being pursued. These are: use of storm drainage pro rata share program funds; and proffer agreements with developers. Both of these sources are relatively insignificant at the present time, due to the downturn in economic activity.

For more information...

For more information about Fairfax County's program, call the Storm Water Management Branch at (703) 324-5800.

[26] Ibid.

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Cities of Eugene and Portland, Oregon

City of Eugene

Background

The City of Eugene developed its Comprehensive Storm Water Management Plan (CSWMP) in response to Clean Water Act regulations requiring medium-size cities and counties to improve and manage the quality of their storm water. The plan is a model of a rational and comprehensive approach to dealing with the problem of runoff from urbanized areas. From its beginning as a conventional program emphasizing flood control and rapid conveyance of storm water runoff off-site, the City has developed a plan which does not merely conform with, but exceeds, the evolving Federal mandates for water quality management.

The principal motivation for initiating development of the Comprehensive Storm Water Management Plan in 1991 was the imminent promulgation of a Federal mandate (NPDES) requiring jurisdictions of medium size (between 100,000 and 250,000 population), to reduce discharges of pollutants to receiving waters from storm water runoff.

The Comprehensive Storm Water Management Plan

The City's storm water management program goes further than meeting Federal and state water quality requirements. It has taken the problem of meeting its legal requirements and turned it into an opportunity to offer a broad-based solution through a **multiple objective approach** to protecting, enhancing and restoring the City's water quality.

The multiple objective approach of the Eugene plan includes storm water management. Wetlands adjacent to Amazon Creek and other drainage channels are considered to be hydrologically connected to the City's storm water conveyance system. The plan recognizes the central role that wetlands play in storm water management.

According to the plan, the five-year start-up phase of the storm water management program includes major program activities such as planning and administration, capital projects (including retrofitting), operations and maintenance, enforcement and inspections, and public communications and outreach. The City has already developed a storm water utility and user fee structure.

The City, however, did not have the necessary organizational structure and programmatic resources in place to address the many issues involved in managing

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storm water quality. It determined that the proper way to address the whole range of storm water issues was within a coordinated, comprehensive framework. Among the factors which influenced its decision to develop a comprehensive strategy were the following:

- commitments already made to implement the recently approved West Eugene Wetlands Plan (see below), as well as how the new mandates could be incorporated into this Plan
- a new proposed plan, the Natural Resources Functional Plan, aimed at protecting the city's riparian and waterways corridors; this plan calls for the City's urban runoff management plan to address the relationship between riparian habitat, water quality and flood conveyance
- implementation of other goals and policies contained in the city's general land use plan

The CSWMP encourages this multiple objectives approach to storm water management, including flood control, water quality treatment, and natural resources protection. In addition, it strengthens the existing ordinances and implementation activities already in place.

Relation of the Wetlands Plan to Storm Water Plan

Amazon Creek is the central drainage feature of Eugene. The channelization of Amazon Creek (completed in 1959) significantly altered the hydrologic and hydraulic conditions of the area. Although flood control benefitted the community and allowed agriculture, commercial, and residential development to spread westward in the city, it also had the unfortunate effect of hydrologically isolating surrounding wetlands. This isolation and the subsequent draining of wetlands resulted in environmental degradation.

Consequently, wetland restoration is a high priority for the City of Eugene. It proposes to begin this process through a demonstration project called the Lower Amazon Creek Restoration Project which aims to restore the hydrologic interchange with surrounding wetlands, and restore fish and wildlife habitat and other associated water resource values. This will be accomplished through the removal of levees, in whole or in part; through modifying culverts; and through breaching levees at selected locations.

In addition to restoration of historic wetlands, the city is developing a program to use constructed wetlands for storm water quality treatment. The City is interested in using these constructed wetlands to control (pre-treat) pollutants in urban runoff

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which enters a natural wetland system in West Eugene.

This idea grew out of the preparation and planning to develop the West Eugene Wetlands Plan (WEWP), with the goal being the preservation of the natural system through the pre-treatment of runoff from areas of the City. Without such treatment, the degradation of the remaining existing natural wetlands would be a virtual certainty. Storm water management is seen as critical to the success of the WEWP, and to the survival of the wetlands themselves.

The use of constructed wetlands as a treatment process for urban runoff is emerging as an alternative to conventional processes. Some of the advantages to using constructed wetlands to temporarily store or treat storm water include:

- water quality improvement
- flood, erosion and storm damage reduction
- replenishing surface and ground water supply
- provision of fish and wildlife habitat
- aesthetic or amenity benefit[27]

Regulatory Issues

There are numerous Federal laws and regulations, executive orders, as well as comparable state and local regulations and ordinances which regulate activity in wetlands or potential wetland areas. Current Federal policy forbids the use or modification of natural wetlands to treat storm water.

Nevertheless, the following points should be borne in mind:

- wetlands are functionally part of many municipal separate storm sewers
- wetlands in urban areas may be dependent on storm water for their very existence

Therefore, the strict application of regulations which forbid the degradation of wetlands can have unintended consequences in watershed and wetland planning. The City of Eugene experience suggests that flexibility should be allowed when determining the level of appropriate protection for wetlands and that this can be accomplished through a planning process which involves the local community as well as Federal and state agencies which regulate these resources.

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[27]City of Eugene, OR. Conceptual Engineering Design for Water Quality Workshop. Final Report. Department of Public Works, City of Eugene, OR, undated.

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Eugene's Existing Storm Water Program

The City's current storm water system has historically been focused on providing flood control services. With its emphasis on storm water conveyance and flood control, the existing program was in conflict with Federal mandates for water quality management. Since the natural water quality treatment systems, such as riparian areas, waterway corridors and wetlands have been extensively replaced with conventional, structural conveyance facilities, ways need to be found to not only stem the removal of natural systems, but seek opportunities to preserve them. The CSWMP recognizes this goal and integrates it into the plan.

The City is faced with significant and complex issues as it seeks to transform its existing storm water management program to meet the challenge of complying with Federal mandates and heightened citizens' expectations. The framework of the CSWMP will allow it to do this within a comprehensive planning context.

The City already has a dedicated revenue source to fund general and storm sewer capital projects, the storm water utility user fee. It is the major revenue source for the existing program, and is expected to be the principal revenue source for the new, expanded program. The City has reviewed and analyzed current policy in light of evolving Federal water quality mandates, and has refined its policy to include the following:

- that all users of the storm water system contribute to the financing of the program
- that property owners be encouraged to incorporate practices beyond the minimum required through the use of financial incentives such as fee reductions, etc.

Retrofitting and Eugene's Storm Water Management Plan

Eugene's CSWMP contains a specific capital facilities best management practice (BMP) for retrofitting existing facilities, where feasible and appropriate, to achieve water quality goals. These retrofits may include the installation of in-line sediment traps, detention/infiltration facilities, wetlands or riparian (re)vegetation, or simply the modification of flood control facilities (i.e., storm drain inlets, retention basins, or drainage channels) to function as water quality facilities.

Additionally, the capital facility BMP directly addresses the NPDES requirement that the City assess the existing drainage and flood control facilities in order to determine if retrofitting them would improve water quality.

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The capital facilities program includes retrofitting as one of the major activities scheduled during the five-year start-up phase of the City's comprehensive storm water management program, with retrofit implementation commencing around 1996.

The activities conducted as part of the retrofitting component of the Plan, include:

- preparing a master list of existing facilities with relevant retrofit considerations for each type
- conducting an inventory of existing flood control facilities that will provide information necessary to determine whether retrofits of these facilities are feasible or not
- reviewing inventory results to select sites and facilities where retrofits would be most appropriate
- developing a preliminary plan for retrofitting, with a schedule and estimated costs
- developing funding plans for retrofits

Eugene's Public Outreach Effort

An important feature in the evolution of the City's program are the numerous methods for disseminating information about the development of the storm water management program. These methods range from neighborhood newspapers such as the Eugene Storm Water Connections, with general information about the City's storm water management program, to more targeted information sheets, brochures, and stickers, to community workshops to introduce citizens to storm water pollution issues.

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Important Elements in Eugene's Program

The importance of the West Eugene wetlands to the overall stormwater management plan.

- the integration of natural resource elements into the overall stormwater management framework and looking at the watershed and how it functions as an integrated unit

The significance of the multiple objective planning approach and why it could be a model.

- opportunity to address urban runoff issues from a comprehensive perspective, including wildlife habitat, recreation, resource conservation education, etc.

The high level and quality of citizen involvement and how this reduces conflict.

- widespread citizen involvement with two-way communication and feedback mechanisms facilitates consensus decision-making

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For more Information...

For more information about the City of Eugene's storm water program, contact the Storm Water Program Coordinator at (503) 683-6839.

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City of Portland

Introduction

The City of Portland, Oregon, has developed innovative and comprehensive urban runoff control strategies to meet the water quality requirements of Federal and state legislation. Its program encompasses a wide range of activities for controlling both point and nonpoint source pollution. The range of activities alone - from transportation improvements to improved pesticides management - serves to illustrate the diffuse nature of nonpoint source pollution.

Portland's storm water management program has been designed to be a constantly evolving program which implements the management practices that succeed, modifies or eliminates those that do not, and seeks to develop the most efficient and productive practices throughout the program's life. Based on a balanced economic and environmental approach, its goal is to develop and implement the most successful municipal storm water permit program in the Pacific Northwest.

Storm Water Permit Program (NPDES) Activities

The City of Portland, whose total population is roughly 450,000, has been classified as a medium-size municipality for the purposes of the NPDES storm water permitting program because less than 250,000 people are served by its municipal separate storm sewer system. A significant portion of the city is served by combined storm and sanitary sewers, which are subject to other Clean Water Act regulations.

Under Oregon state-wide land use planning law, each city must define an urban growth boundary (UGB) within which urban development is confined. Once approved, they have the force of law. Within Portland's urban growth boundary, six other agencies operate "municipal-like" separate storm water conveyance systems. Together with the City, the six have become co-applicants for the Portland NPDES storm water permit application. The co-applicants include Multnomah County, Multnomah Drainage District #1, Peninsula Drainage Districts #1 and #2, the Port of Portland, and the Oregon Department of Transportation.

Although the permit has not yet been issued, the seven co-applicants are currently conducting a number of programs and practices that directly or indirectly improve the quality of storm water. While the NPDES permit application is a joint effort of all the co-applicants, each co-applicant has responsibility for implementation of their individual storm water management plan.

Significantly, from an institutional point of view, the City's NPDES program implementation schedule has been developed to coincide with the majority of the co-

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applicants' fiscal year budget schedules. The goal of this action is ease of implementation, but it also represents a concrete and very sensible method for facilitating institutional cooperation.

NPDES Program Implementation Strategy

Portland's NPDES program strategy is to build on a foundation of existing urban runoff control practices. The City developed existing management program (EMP) fact sheets corresponding to each regulatory requirement. Portland's proposed NPDES management program emphasizes and builds upon existing storm water controls and management practices. The program intends to limit the introduction of new practices as much as possible, but where appropriate it will phase in new practices during the life of the permit.

However, BMPs were developed to meet NPDES requirements not covered by existing programs. The co-applicants have grouped BMPs into implementation categories:

- public education and involvement
- operations and maintenance procedures
- industrial and commercial controls
- illicit discharge controls
- new development standards
- structural controls
- planning/system preservation and development

Nonpoint Source Program Activities - Some Examples

1. Used Oil Recycling Program

The City has a comprehensive solid waste and recycling program, which includes used oil curbside pickup that properly recycles used oil. Although many jurisdictions maintain used oil recycling programs, few offer pickup of used motor oil as in Portland. (The City also provides yard debris, cardboard, paper, newspaper, and metals residential curbside pickup.)

2. "Skinny Streets" Program

The City Office of Transportation has implemented new design standards for certain street categories in an attempt to reduce environmental impacts, such as minimizing the impervious area of new streets and preserving existing vegetation.

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3. Snow and Ice Control

Sand and gravel materials are used at varying levels and picked up as soon as possible after a storm has passed, which may take a few days or several weeks. By comparison, many jurisdictions remove these materials only after the winter has passed, if they collect them at all.

4. Pesticide/Herbicide Application

All applicators participate in an Integrated Pest Management (IPM) training program. In addition, the City Planning Bureau has landscape requirements which reduce the need for pesticides, herbicides, and fertilizer through the use of native plantings. They are also developing an environmental seed mix.

Approach to Institutional Issues

The process by which the Portland NPDES permit co-applicants put together their storm water permit application reveals some of the institutional issues which impact upon the ability of a jurisdiction to carry out effective storm water management. The seven jurisdictions have different institutional motivations and agendas and degrees of political accountability and these factors affect how they approach and deal with the problem of urban runoff management and control.

For example, the Oregon Department of Transportation (ODOT), one of the seven co-applicants in the permit process, has as its mission the building of roads, not managing storm water. Nevertheless, the ODOT maintains hundreds of miles of storm sewer pipes that collect and transport storm water surface runoff, in addition to open ditches and dry wells. It also has responsibility for 14 major storm sewer outfalls in Portland.

The ODOT, however, is not subject to the same direct political pressures to pursue its storm water management goals as, for instance, the City of Portland. The same holds for the special drainage districts, the Port of Portland and other co-applicants. This presents the potential for different outcomes. Such a divergence of institutional interests and objectives could potentially limit the effectiveness of the storm water management program.

However, the Portland experience illustrates how potentially problematic institutional issues can be dealt with early in the program planning process and the result is likely to be a more effective urban runoff control program. In the process of developing the storm water management plan, the City's consultants worked with all the co-applicants to define and clarify issues related to their proposed BMPs. As part of this process they considered:

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- the department or division within the agency which would be affected by or involved with the implementation of the BMP;
- the agency's existing conditions related to the BMP, and the tasks necessary to implement it;
- the degree to which the implementation of the BMP is likely to affect existing staff and/or resources

The fact that the process used in Portland considers these sometimes subtle but important institutional concerns increases the probability of a successful outcome. It also points up the importance of "issue scoping" and framework development to ensure program effectiveness.

Program Funding

The City finances its storm water management activities through the levy of a drainage fee which is based on the amount of runoff allowed to flow into the storm sewer system. In 1992, the City initiated a storm water drainage discount program. Discounts in the drainage fee are given to propoerty owners who limit the quantity of storm water discharged from their property. The discount may be as high as one hundred percent.

Discounts for water quality are not cuurently included in this program, but the City code permits the imposition of such a fee and discount program in the future. The existing discount program is directed at sites with on-site disposal systems.

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BMP Selection and Screening Factors used in Portland's Planning Process

- Life Cycle Costs - The approximate cost of initial implementation and future operation.

- Regulatory Requirements - Does it meet existing and anticipated Federal, state and local regulations?

- Pollutants - Does it offer reasonable control of the targeted pollutants?

- Implementability - Is it likely to be accepted and funded by the various public agencies, city departments, and the general public?

- Reliability - Does the BMP function predictably and is it effective over time?

- Environmental Impact - Consider the environmental impacts and benefits of the BMP.

- Equitability - How are the costs and benefits of the BMP distributed?

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Portland's proposed NPDES stormwater management plan is innovative and has the following components:

- It emphasizes non-structural source controls including education and maintenance programs.
- It builds upon existing programs such as curbside recycling, household hazardous waste collection, etc.
- It encourages regional efforts and programs.
- It emphasizes cooperation among its NPDES co-applicants to improve water quality.
- It phases in management plans to allow for budgetary and resource constraints.

Portland's NPDES program highlights

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Portland's Compliance Strategies

- Consider urban runoff issues as permanent issues which require a long-term planning approach.
- Share information and ideas and look for opportunities to cooperate on projects, or share costs with other jurisdictions, etc.
- Work closely with regulatory personnel throughout permit period to discern their objectives, priorities and intentions.
- Be creative and proactive in complying with permit and regulatory requirements.

For more information...

For more information about Portland's urban runoff management program, please call the Bureau of Environmental Services at (503) 823-7236.

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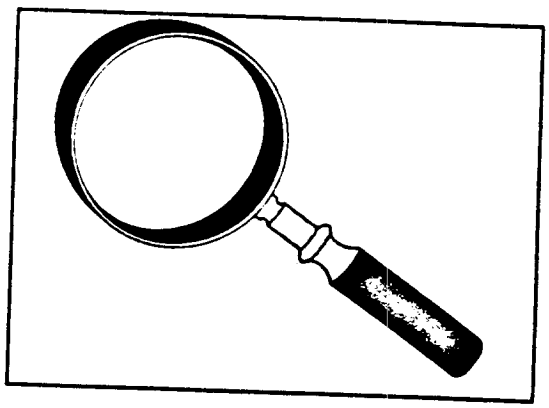
Glossary



Best Management Practice (BMP): A practice or combination of practices that are determined to be the most effective and practical (including technological, economic, and institutional considerations) means of controlling point and nonpoint pollutant levels compatible with environmental quality goals.

Constructed urban runoff wetlands: Those wetlands that are intentionally created on sites that are not wetlands for the primary purpose of wastewater or urban runoff treatment and are managed as such. Constructed wetlands are normally considered as part of the urban runoff collection and treatment system.

Drainage Basin: A geographic and hydrologic sub-unit of a watershed.

End of Pipe Control: Water quality control technologies suited for the control of existing urban storm water at the point of storm sewer discharge to a stream. Due to typical space constraints, these technologies are usually designed to provide water quality control rather than quantity control.

First Flush: The delivery of a disproportionately large load of pollutants during the early part of storms due to rapid runoff of accumulated pollutants. The first flush of runoff has been defined several ways (e.g., one-half inch per impervious acre).

Impervious cover cap: A mechanism which establishes a Maximum Sustainable Removal Rate for storm water control measures at 90%. The City of Austin, Texas has incorporated this concept into its Land Development Code. It is designed to avoid over-reliance on storm water control measures and recognizes their inherent limitations and risk of failure due to lack of maintenance.

Impervious surface: A hard surface area that either prevents or retards the entry of water into the soil mantle as under natural conditions prior to development and/or a hard surface area that causes water to run off the surface in greater quantities or at an increased rate of flow from the flow present under natural conditions prior to development. Common impervious surfaces include walkways, driveways, parking lots, concrete or asphalt paving, etc.

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Municipal separate storm sewer systems: Any conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains) that is owned or operated by the State or local government entity, is used for collecting or conveying storm water, and is not part of a publicly-owned treatment works (POTW).

NPDES: National Pollutant Discharge Elimination System, created by Section 402 of the Clean Water Act.

Post-development peak runoff: Maximum instantaneous rate of flow during a storm, after development is complete.

Retrofit: The creation or modification of an urban runoff management system in a previously developed area. This may include wet ponds, infiltration systems, wetland plantings and other BMP techniques for improving water quality. A retrofit can consist of the construction of a new BMP in a developed area, the enhancement of an older urban runoff management structure, or a combination of improvement and new construction.

Ultra-urban: Non-conventional BMPs that are particularly suited for use in highly urbanized areas; based on sand filter technology

Urban runoff: That portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation. The land area that drains into a receiving waterbody.

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Actions Speak LOUDER Than Legislation

Positive experiences provide direction for urban runoff management

Tom Mumley, Geoff Brosseau

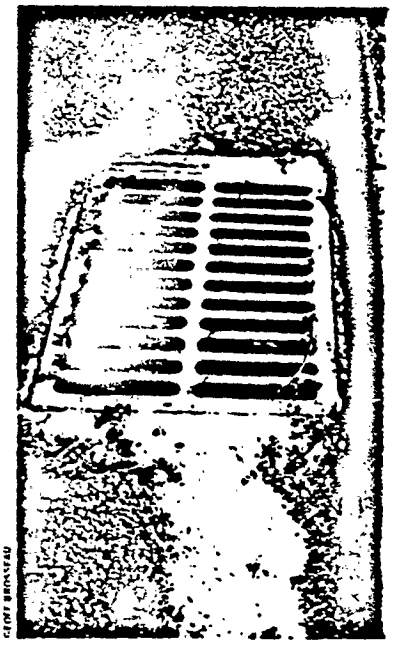
The current wrangling in the U.S. Congress over Clean Water Act (CWA) reauthorization and the potential for protracted debate over Coastal Zone Management Act (CZMA) reauthorization threaten to divert attention from pollution caused by urban runoff. The problem is too important to wait until legislators, lawyers, and technical experts find the perfect solution. While valuable research and discussion goes on, municipalities and states can establish successful programs to manage this complex process.

Three federal legislative initiatives exist to guide states in controlling urban runoff pollution: CWA Section 319, Coastal Zone Reauthorization Amendments of 1990 (CZARA) nonpoint program requirements, and CWA Section 402 stormwater permit requirements. All three initiatives rely on implementation of technically and economically effective best management practices or measures through a framework at the local level (see Table, *Legislation Covering Urban Runoff Pollution*).

CWA Section 319. States are required to prepare and implement nonpoint source management programs for their waters under CWA Section 319. These programs must identify best management practices (BMPs) and other measures to control individual nonpoint sources, such as urban runoff.

Most states have based their nonpoint source management programs on three general approaches: voluntary implementation of BMPs, regulatory-based encouragement, and direct regulation. Most programs rely primarily on voluntary mechanisms. Regulatory-based encouragement mechanisms, such as waiving the need for a permit if BMPs or management measures are implemented, are used sparingly, and direct regulation via permits are used even less frequently.

CZARA Section 6217. Section 6217 of CZARA requires states to restore and protect coastal waters by preparing a nonpoint source pollution control program. The act also required EPA to publish its guidance document, *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* ((g) Guidance). The (g) Guidance defines management measures as "economically achievable measures for the control of pollutants...[that] reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint pollution control practices," for each major source of pollution and identifies specific management practices for implementing them. The management measures are mandatory, the management practices are elective. One management measure mandates implementation of pollution prevention and education programs to reduce pollutants in urban runoff. Suggested management practices to achieve this measure include general public outreach, used oil and other material recycling programs, storm drain stenciling, and pollution prevention strategies for specific commercial businesses.



Eliminating illegal discharges is key to managing urban runoff pollution.

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Legislation Covering Urban Runoff Pollution

	CWA[a] Section 319	CZARA[b] Section 6217	CWA Section 402
Levels of government	State and municipal	State and municipal	Federal, state, and municipal
General mandate	Nonpoint source management program	Coastal nonpoint pollution control program	Stormwater quality management programs
Method	Best management practices (BMPs) and management measures	Management measures and management practices	Management practices, control techniques, and system, design, and engineering methods
Goal	Reduce the level of pollution resulting from urban runoff to the maximum extent practicable	Restore and protect coastal waters through economically achievable measures for the control of pollutants from urban runoff	Reduce the discharge of pollutants from municipal separate storm sewer systems to the maximum extent practicable
Regulatory approach	Voluntary implementation of BMPs, regulatory-based encouragement, direct regulation	Enforceable policies and mechanisms (regulatory-based encouragement and direct regulation)	NPDES[c] permits (regulatory-based encouragement and direct regulation)

[a] *Clean Water Act*
[b] *Coastal Zone Act Reauthorization Amendments of 1990*
[c] *National Pollutant Discharge Elimination System*

CZARA also requires implementation of management measures through enforceable policies and mechanisms at the state, regional, or local level similar to the regulatory-based encouragement and direct regulation approaches of CWA Section 319. States also may consider economic incentives and disincentives or other innovative approaches. For example, if a nonpoint source is controlled voluntarily, an enforceable mechanism need not be imposed. Although the guidance includes management measures to control urban runoff, all stormwater discharges covered by the National Pollutant Discharge Elimination System (NPDES) stormwater permit program are excluded from coverage under Section 6217.

CWA Section 402. CWA Section 402 requires NPDES permits to be issued for large stormwater dischargers—industry and municipal separate storm sewers serving more than 100,000 people. Permits also may be issued on a case-by-case basis if EPA or a state determines that a smaller stormwater discharge contributes to a violation of a water quality standard or pollutes U.S. waters.

Section 402 mandates that discharge permits for municipal separate storm sewers include requirements for pollutant controls—management practices, control techniques, and system, design, and engineering methods. Aware of the difficulties in regulating discharges from municipal storm systems through traditional end-of-pipe treatment, Congress intended for EPA and delegated states to develop much broader permit requirements than those in wastewater permits.

Legislation and Regulatory Approaches

The legislative initiatives allow various approaches—voluntary, regulatory-based encouragement, or direct regulation—for urban runoff management. But how well does each work?

Voluntary implementation. If voluntary implementation alone worked, the country would not be facing environmental problems. The prevailing attitude toward the environment is often reluctance, even unwillingness, to do more than is required. Certainly, any legislative initiative should provide for voluntary actions, but to depend on it as the primary approach for reaching a goal is to ignore human nature.

Direct regulation. The use of direct regulation
- promotes consistency and accountability across programs and across the country,
- indicates that the problem is severe enough to warrant more of a command-and-control approach than a purely voluntary one,
- makes it easier for cities, counties, and businesses to commit limited resources to a program, and
- helps establish a baseline or default for considering regulatory-based encouragement approaches.

The use of direct regulation has the potential to cause problems, especially in dealing with stormwater discharges, if the approach is not

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well implemented. Permitting of municipalities has a favorable track record in places like the San Francisco Bay area, where its implementation has included flexible requirements that are practical, constructive, and effective.

Regulatory incentives. Regulatory incentive uses the best of the voluntary and regulatory approaches to create a balanced, cooperative arrangement in which positive actions are encouraged and rewarded and negative actions are discouraged and punished. Although some might view it as forced volunteerism, this interpretation sells the approach far short of its potential.

Like direct regulation, regulatory incentive has been used by regulators and municipalities to create some of the most successful urban runoff management programs.

Beyond Legislative Initiatives

Which initiative—CWA, CZARA, or some hybrid—leads to the most effective and efficient urban runoff management programs possible?

Success has been determined more by the willingness of local individuals to work together than by the specific initiative. Where local individuals have taken charge of their programs, urban runoff management has been successful. Where local individuals have resisted, problems have occurred with all the initiatives.

Setting up a well-organized, flexible management program at the local level is essential to controlling urban runoff pollution. The key challenge is to focus appropriate management actions on the most important sources. Two factors make this difficult: lack of complete data on water quality problems and pollutant sources, and the competition for limited resources between problem identification and pollution control.

A good management program includes a decision-making process that enables appropriate early actions while new information is being gathered. The framework of the program must be flexible enough to allow managers to improve problem identification and phase in additional actions, as necessary.

The following program elements are integral to establishing the framework of an urban runoff management program.

Program management. Successful management programs require involvement and coordination of numerous local government entities. For this coordination to succeed, it must follow defined procedures for decision making. Making joint decisions also requires defining roles and responsibilities for a wide range of agencies, (such as city, county, and flood management), departments (such as, public works and planning), and individuals; coordinating procedures among participating agencies and departments; and demonstrating legal authority and adequate fiscal resources.

Public information and participation. Public education is essential for a successful and cost-effective management program. General nonpoint source education, specific education programs focused on individual pollution sources and activities, and opportunities for public involvement are important components.

Illicit discharge elimination and prevention. A focus on illicit connections and illegal dumping, the most obvious and crucial sources of pollutants in urban runoff, is a key component of a management program. The program must identify pollution sources, prevention or control measures, public education initiatives, system surveillance, and, if necessary, enforcement procedures. Program managers must decide whether discharges are insignificant discharges from fixed or mobile sources, discharges that might be acceptable if authorized and managed in accordance with a permit, or those that must be prohibited. Coordinating discharge control measures with municipal wastewater agencies may be necessary.



Flo the Racoon, the official mascot of the storm drain program in Palo Alto, Calif., helps build community involvement.

Industrial and commercial sources. A management program also must identify industrial and commercial categories of urban runoff pol-

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lution. The significance of industrial or commercial sources depends on the characteristics of a municipality and its oversight of such sources. After identifying local sources, municipalities should develop appropriate management strategies such as outreach and inspection programs. Coordination with other outreach, inspection, and regulatory programs also is essential to avoid redundant or conflicting actions and to avoid unnecessary focus on clean businesses.

New development and redevelopment. Cities in the process of development or redevelopment can use a full range of treatment and source control measures. The significance of this action area depends on its characteristics, development or redevelopment potential, and existing planning and permitting procedures. Control measures can be instituted at any stage—from site planning and design, through ground breaking and construction, to facility and property management.

Public agency activities. Many public agencies already have programs that benefit water quality. Among the activities that can benefit an urban runoff pollution program are improved storm drain system design, operation, and maintenance; flood management activities; operation and maintenance of streets and roads; and management of public facilities, such as maintenance yards, parks and recreational facilities, parking facilities, schools, hospitals, and other institutions.

Program evaluation. The effectiveness and efficiency of an urban runoff program must be documented. Specific activities include monitoring, such as identifying municipality and watershed characteristics or initiating pilot studies, documenting actions, and reporting activities to program decision makers, the public, and state and federal agencies.

Most successful urban runoff management programs have incorporated a sound decision-making and management framework that includes all these elements. Successful programs also have common attributes that go beyond this framework. Each of the following attributes, taken alone, may not ensure a program's success, but taken together, they make success much more likely.

Comprehensive scope. An effective program must weigh the significance of a wide range of real or potential problems, sources, activities, and actions. Cost-effective and efficient actions in one program area often depend on coordination with other activities. If the scope of a program is limited, actions taken within its framework may have a negative impact on another area.

Watershed approach. Urban runoff water quality problems are caused by the cumulative effects of many varied sources. Urban runoff management programs are essentially watershed management programs. Inherent to the concept of watershed management are stakeholder involvement, water quality assessment, problem identification, and a well-defined plan of action to correct problems. A watershed-based approach embraces communication, collaboration, and coordination among municipalities within the watershed. By using this approach, municipalities are able to focus resources when and where they will achieve the greatest benefit.

Consensus-based partnerships. Agreements and institutional arrangements within or between agencies are more easily established in a cooperative, consensus-based atmosphere. No entity is capable of assuming all responsibilities of a urban runoff management program. Program success also depends on the cooperation and support of affected sources—the public, businesses, and other agencies.

Phased approach and continuous improvement. Urban runoff management programs evolve and mature over time to reflect changing conditions. Successful programs are based on continuous evaluation and improvement. Actions that have certain and cost-effective benefits are implemented first; actions with less certain applicability and benefits are implemented on a reduced level or pilot scale to evaluate their effectiveness.

Local leadership. Local leadership is essential for a successful program. Key individuals at the local level either can make a program work or stand in its way.

Whatever direction or legislative initiative Congress and President Clinton finally select should promote these common attributes of successful programs and encourage the use of a consistent, comprehensive management framework. Specific initiatives should provide for a variety of approaches, because urban runoff is highly variable, as are watersheds. What may work in one situation or locale will not work everywhere. Legislation and regulations alone cannot ensure success. Success depends on the people and the approaches taken in translating legislation and regulations into programs and progress.

Tom Mumley is the urban runoff program manager at the San Francisco Bay Regional Water Quality Control Board, and ***Geoff Brosseau*** *is executive director of the Bay Area Stormwater Management Agencies Association in Oakland, Calif.*

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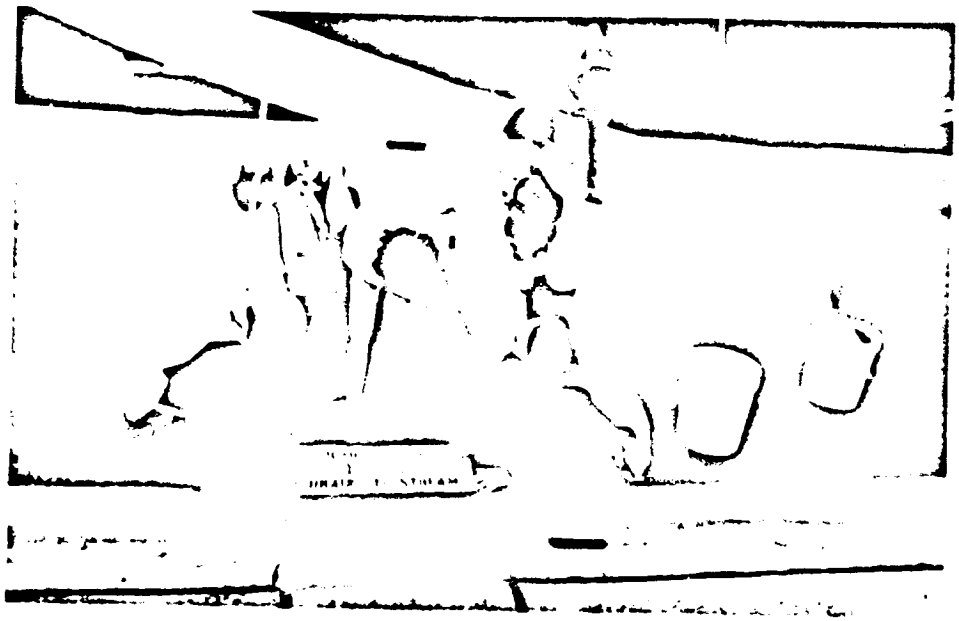

Stormwater Management Manual for the Puget Sound Basin

(The Technical Manual)

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Editor's Note

Many thanks to those of you who reviewed and commented on the previous drafts of the manual. Much of the continued improvement of the manual has been, and will continue to be, the result of reviewers' comments and constructive criticisms.

The final version of the manual has been prepared following review of the June, 1991 "Public Review Draft" that was distributed to some 900 reviewers last summer. Technical workshops were held in Everett, Bellevue, Tacoma, and Olympia during August and September, 1991. Written comments were received from 55 reviewers.

Changes in the Puget Sound Stormwater Management Program

The Puget Sound Stormwater Management Program mandated by the Puget Sound Water Quality Management Plan (PSWQMP) has changed substantially since the release of the 1991 draft manual. There are no longer two "companion" rules. The language requiring the adoption of local stormwater management programs has been placed in the PSWQMP instead of being contained in rule form.

The Puget Sound Water Quality Management Plan states that local stormwater management programs are to be consistent with the Plan, as well as Ecology's guidance, model ordinances and Stormwater Management Manual. Ecology is to monitor compliance with the Plan requirements, reviewing the status of each local program every two years. Information on implementation schedules and procedures for reviewing local programs are provided in the "Stormwater Program Guidance Manual for the Puget Sound Basin" (hereafter referred to as the Guidance Manual), a companion to this manual. Copies of either this manual or the Guidance Manual can be obtained by calling (206) 438-7116 or (206) 438-7059. The cost is not known for certain as we go to press, but should be approximately $40.00 (U.S.) for either manual. Do not send us funds, as a bill will be sent with the manual.

Changes Made to the Manual

Changes were made to the 1991 draft manual based both on new information available and comments received. Some things didn't change: for example, we are still emphasizing the use of infiltration where appropriate. A reduced release rate of 50% of the pre-developed discharge rate has been retained for streambank erosion control. The correction factors have been kept but they are only necessary for streambank erosion control BMPs. The 7-day design storm has not been incorporated at this time. Further hydrologic modelling and analysis is planned for this year with the goal of providing more accurate and easy-to-use methods (see "Unfinished Business", below).

Volume IV

- Information on golf courses has been included.
- Street sweeping has been added as a BMP.

Status Reports

Detailed information on NPDES, the Sediment Standards, the relationship of BMPs to the water quality standards, and information on program requirements can be found in the Guidance Manual. Included below are some other status reports.

Training and Technical Assistance

In July, 1992 we will be conducting our first workshops for local government staff. These day-long workshops will be sited throughout the basin and provide an overview of Ecology's stormwater management program. Based on input received at these workshops, we will develop other training sessions.

Eventually we will be providing a wide range of training and technical assistance to both local government staff and others. As a start, funds have been committed to the Center for Urban Water Resources Management at the University of Washington for three different tasks. The first is to continue their popular on-site visits to local jurisdictions. The second task will be to develop a half day (approximate) course on erosion and sediment control which would be appropriate for construction site personnel. The course would then be taped and distributed. The third task is to implement a "hotline" for local government personnel questions. This task would also include cataloging the information that the Center now has available, and includes funding for some applied research. We hope to continue some form of this funding from year to year.

We also anticipate developing a videotape of approved erosion and sediment control BMPs.

Vactor Waste Disposal Issues

We recognize that the lack of accepted procedures and locations for the disposal of waste from maintenance activities is one of the greatest problems confronting stormwater operation and maintenance programs. Disposal of the liquid and solid waste material from vactor trucks and other maintenance operations is a concern because of the potential to contaminate surface or ground water. Some existing disposal practices may violate dangerous waste regulations, or otherwise be harmful to the environment.

In order for Ecology to develop guidelines that address appropriate disposal practices, more information is needed on the nature of vactor wastes. In response to this data gap, two grants from EPA have been used to collect and analyze vactor waste samples. Final results of the sampling will be available in September, 1992.

We will be using the sampling results and other available data to develop disposal options. At this time it is not known if disposal procedures will be issued as guidelines or a rule (regulation).

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New Development/Redevelopment

- The threshold for land disturbing activities between small parcels and large parcels has been increased to 1 acre (page I-2-2).
- The size threshold of 11.5% for redevelopment sites greater than 1 acre in size was dropped. 5,000 square feet is used as the trigger, regardless of the size of the development (page I-2-4).
- A "documented water quality problem" is now defined (page I-2-4).

Minimum Requirements

- Many editorial changes were made to better clarify the content and rationale for the Minimum Requirements. The modifiers "General" and "Special" for Minimum Requirements were dropped, and the requirements arranged in a more logical order. Objectives were added for each Minimum Requirement.
- The Erosion and Sediment Control "General Criteria" were moved from Chapter II-4 to Chapter I-2, and consolidated as Minimum Requirement #1, Erosion and Sediment Control.
- The off-site analysis requirement (now Minimum Requirement #8, Off-site Analysis and Mitigation) was simplified.
- The ability to use an implemented and adopted basin plan to modify the Minimum Requirements was included (see Minimum Requirement #9, Basin Planning).

Remainder of Chapter I-2

- More specific information and two examples of experimental BMPs have been provided.

Chapter I-3

- A Small Parcel BMP checklist which can be used "as-is" or modified by the local government has been added. Completion of this checklist can be considered to have met the Small Parcel Erosion and Sediment Control Requirements.
- Large parcels require the development of a "Stormwater Site Plan" which is in turn made up of a Large Parcel Erosion Control Plan (LPESC) and a Permanent Stormwater Quality Control Plan (PSQC). The LPESC addresses erosion and sediment control during the construction phase, and the PSQC plan addresses permanent stormwater management facilities.

Chapter I-4

- The BMP selection process has been revised to more clearly define the type of pollution problem that a BMP is targeted to control. The problem may be water quality (WQ), which addresses either nutrients or conventional pollutants, streambank erosion control (SBEC), source control or, as is most likely, a combination of these types.

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Ecology's Solid and Hazardous Waste program is currently working on revisions to Ch. 173-304 WAC, the minimum functional standards for solid waste facilities. These revisions may be an appropriate mechanism for addressing vactor waste. Contaminated soils have been identified as one of five issues that are to be addressed in the proposed revisions, and vactor waste will be looked at as part of this issue. The proposed process for these revisions is to collect information this summer, publish a draft EIS with draft rule language in December of 1992, a final EIS in April of 1993, and adopt final rules in September of 1993.

We intend to prepare a supplemental guidance paper on disposal procedures when we have enough information to begin to answer key questions about the characteristics of these materials.

SEPA Checklist and DNS

A SEPA checklist was filled out for the Stormwater Management Manual as it was determined that the manual was subject to SEPA review as a non-project action. The DNS was published in the March 16-20, 1992 SEPA Register. There was no comment period required.

Status of the WSDOT Manual

WSDOT is required to develop their Highway Runoff Manual within 6 months after this manual is published. Roads and right-of-way issues will be addressed in this manual, and we anticipate that local governments will also be able to make use of this information.

Technical Advisory Committee

The technical advisory groups (TAGs) that were originally constituted by Ecology need to be reconstituted. We anticipate developing those TAGs into a standing advisory committee to review experimental BMPs in consultation with Ecology and provide review of the many technical questions still on our agenda. We expect to reformulate this committee later this year as part of the manual update process.

Unfinished Business

In a field as complex and rapidly changing as stormwater management, there will always be "unfinished business". The PSWQMP requires that the manual be updated yearly. Based on the progress of some ongoing research projects, we anticipate that the next version of the manual will include the results of the HSPF runoff files research done at the University of Washington.

Other additions we hope to make are the use of the 7-day storm for streambank erosion control, and the inclusion of more detailed isopluvial maps for the entire Puget Sound basin.

We still do not have a definitive answer as to the cost of implementing these new procedures. We have funds available for development of a document similar to a Small Business Economic Impact Statement (SBEIS), and hope to have this complete within the next year. Related to the economic question as a whole is whether or not the cost is relatively higher for small commercial sites than for larger sites. This is one of the major problems we hope to address with the SBEIS.

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Because of problems with the use of small (less than 1 inch) orifice sizes, runoff from small commercial developments cannot now be adequately controlled through the use of wet ponds. There is no easy solution to this problem, and we hope that local governments will work together with developers to develop and implement alternatives to site-specific wet ponds in the future.

Lastly, we hope to be able to desktop publish the manual in order to make it more user friendly than it currently is. In time, we may also have both a "pocket" version of the manual and a computerized version available.

Peter B. Birch, Ph.D., Helen E. Pressley and Patrick D. Hartigan
Editors and Compilers

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FOREWORD

For years stormwater management has meant controlling water quantity. Increased runoff is directly related to an increase in impervious surfaces (roads, parking lots and rooftops) which prevent runoff from soaking into the ground.

Today we recognize that stormwater runoff also contributes to water quality degradation. Stormwater carries excessive amounts of sediment from exposed construction sites, and other pollutants which wash off streets and parking lots, industrial sites and residential lawns and gardens. These pollutants include oil and grease, pesticides and fertilizers, harmful bacteria and metals such as lead, cadmium and copper.

What is the State Doing About Urban Stormwater?

In response to stormwater quality problems, the Puget Sound Water Quality Management Plan directed Ecology to:

- Develop guidance consisting of program implementation guidance for local governments including model ordinances;
- Develop a technical manual addressing erosion and sediment control, runoff control and control of pollution from urban land uses; and
- Work with the Washington State Department of Transportation (WSDOT) on a program to control runoff from state highways in the Puget Sound basin.

This manual, which is essentially a stormwater Best Management Practices (BMP) manual, has been developed in response to the above requirements. It is intended for use by local governments, tribes, and WSDOT in the Puget Sound basin (see Figure 1). A more complete description of Ecology's program is found in Chapter I-1.

Acknowledgements

This manual could never have been completed without the contributions of many local government public works and planning officials, representatives from other state agencies, and other affected and interested parties including industries and tribes. Their insights and practical knowledge gained from years of experience in the field have been particularly valuable. In addition, their useful comments and thorough review of earlier drafts improved the quality and utility of the manual.

We would also like to thank the Puget Sound Water Quality Authority for their successful endeavors to obtain support and funding for stormwater as an element of the Puget Sound Water Quality Management Plan. In particular, we would like to thank Vallana Piccolo who has diligently attended technical advisory group meetings and provided helpful review throughout the manual development process.

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Figure 1 Puget Sound Basin



PUGET SOUND BASIN

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Members of each of the three technical advisory groups are acknowledged in the appropriate volume of the manual. In addition, we would like to express our appreciation to the following persons, all of whom contributed extensively to the manual.

Randall Parsons (now in another position with King County), as Senior Engineer with the King County Storm and Surface Water Division, was responsible for developing the King County Surface Water Design Manual which formed the basis for much of the information contained in thie manual.

Dr. Gary Minton, of Resource Planning Associates, was the principal author of Volume IV - Urban Land Use BMPs, and thus made a substantial contribution to the development of this manual.

Dr. Richard Horner, director of the Center for Urban Water Resources Management at the University of Washington, provided the basis for the biofiltration chapter in Volume III. Together with the Puget Sound Wetlands and Stormwater Research Committee, he authored the guidance for the management of natural wetlands found in the same volume.

Thomas Schueler, author of the Urban Land Uses BMP Manual published by the Metropolitan Washington (D.C.) Council of Governments graciously consented to the use of some illustrations and text from that manual.

All other references are noted as they occur in the manual and are listed at the end of each chapter.

We are particularly grateful to the other members of Ecology's Urban Nonpoint Management Unit: Gerald Anderson (now with Ecology's Southwest Regional Office), Ann Wessel, Melany Lee, Gary Kruger, Gary Cooper, Kim Van Zwalenburg (now with Ecology's Shoreland Program), Heather Saunders (now with Thurston County) and many other Ecology staff members for their help and suggestions during the development of this manual.

We would like to apologize in advance for any errors of omission or commission; while all due diligence has been exercised, inevitably errors creep in to a work of this size and complexity. Any questions or further comments regarding the manual should be directed to either Helen Pressley (206) 438-7089 or Pat Hartigan (206) 493-9454.

Peter B. Birch, Ph.D, Helen E. Pressley and Patrick D. Hartigan
Compilers and Editors

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Stormwater Management Manual for the Puget Sound Basin

(The Technical Manual)

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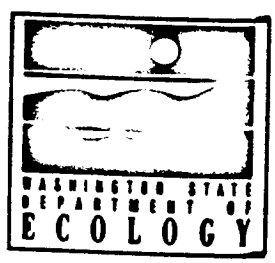

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CHAPTER I-1

INTRODUCTION

I-1.1 EFFECTS OF URBANIZATION

The pre-settlement Puget Sound basin was primarily forested in alder, maple, fir, hemlock and cedar. The area's bountiful rainfall supported the forest and the many creeks, springs, ponds, lakes and wetlands. The forest system provided protection by intercepting rainfall in the canopy, reducing the possibility of erosion and the deposition of sediment in waterways. The trees and the forest duff layer absorbed large amounts of runoff releasing it slowly to the streams through interflow in the soil.

As settlement occurred and the population grew, trees were logged and land was cleared for buildings, parking lots and pasture. Roads were cut through slopes, and low spots, often wetlands, were filled. Drainage patterns were irrevocably altered.

Once areas are cleared, the increase in compacted and impervious surfaces in turn increases both the volume of surface runoff, the peak rate of flow, and decreased ground water recharge. Runoff that was previously slowly released to streams through interflow now runs quickly off the surface directly into the streams. This increases both the velocity and total quantity of flow causing streambank erosion and general habitat destruction. Sediment from increasingly eroded and unstable streambanks and cleared areas is deposited downstream filling ponds, streambeds and stormwater facilities. An additional consequence is that summer base flows are greatly reduced because of a lack of interflow.

Runoff from urban areas has been shown to contain many different types of pollutants, depending on the nature of the activities in those areas. The runoff from roads and highways is contaminated with oil and grease, lead, cadmium and other pollutants. Uncontrolled runoff from industrial areas can contain PCBs, heavy metals, high pH concrete dust, and many other toxic chemicals. Residential areas contribute herbicides, pesticides, fertilizers and animal waste to runoff. All of these contaminants can seriously impair beneficial uses of receiving waters.

Aquatic life is greatly affected by urbanization within an ecosystem. Habitats are drastically altered when a stream changes its configuration and deposits its sediment load in response to urbanization. Natural riffles, pools, gravel bars and other areas are altered or destroyed. Spawning areas, particularly those of salmonids, are lost. Urbanization also tends to cause an increase in water temperature as vegetation which shades the water is removed. A rise in water temperature may cause algal blooms which reduces the amount of dissolved oxygen in the water. The lack of dissolved oxygen can cause fish and other aquatic organisms to die. When a species' habitat requirements are not met they either move elsewhere or die off, and other species, often exotic and undesirable, move in to take their place.

While the impacts of urbanization can be readily conceptualized, the magnitude of the problem may not be generally realized. This can be illustrated by looking at the hydrologic regime and the pollutant loads of different land use types. Figure I-1.1 illustrates the former by showing the increases in peak flow rates resulting from the conversion of forest land to residential and commercial development. The changes in flow rates and hydrologic regimes can cause severe erosion of streambanks and severely degrade aquatic habitat. Figure I-1.2 illustrates the change in the pollutant load (the product of runoff volume and pollutant concentration) of total phosphorus for different land uses as compared to pre-development conditions. It is not unusual for loads to increase by several hundred to several thousand percent

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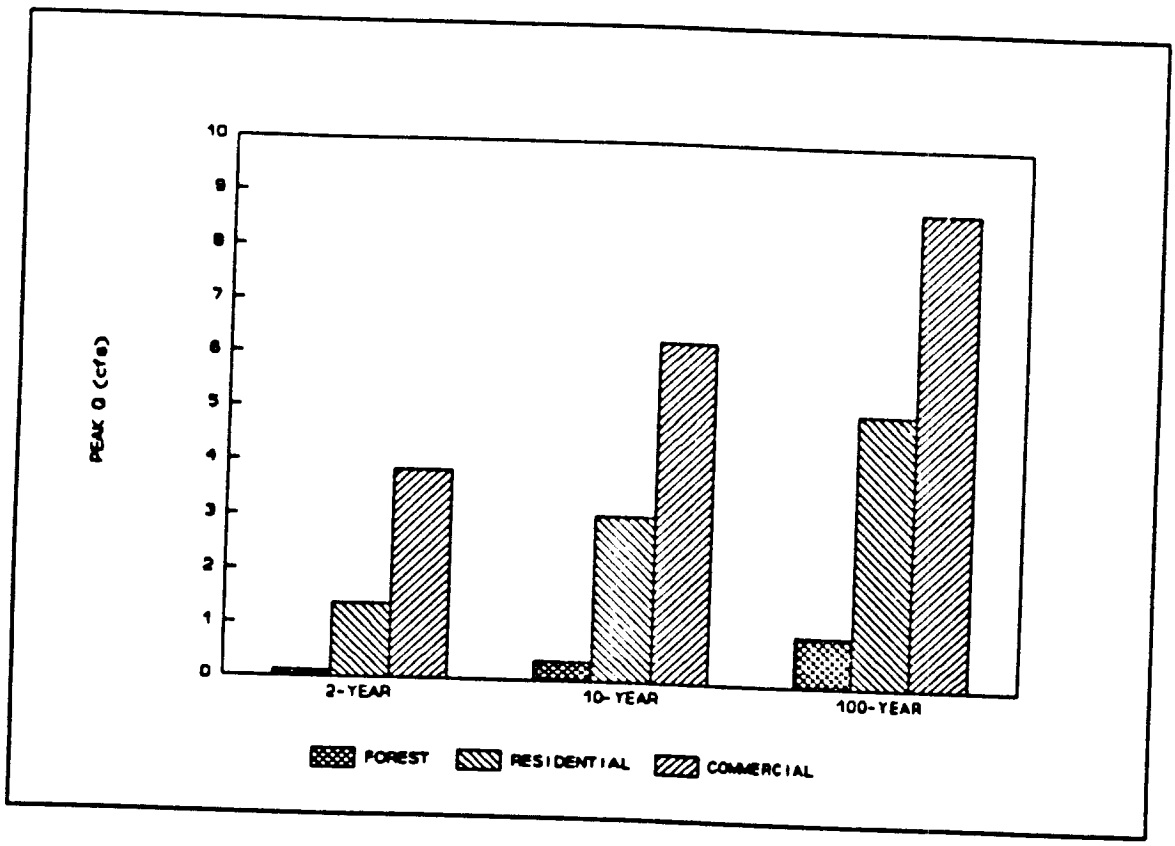
FIGURE I-1.1[1]
PEAK RUNOFF FLOW RATES FOR DIFFERENT LAND USES
FOR THE 2, 10, AND 100-YEAR, 24-HOUR DESIGN STORM EVENTS



over pre-development conditions. Thus, two primary objectives of stormwater management programs need to be the control of runoff flows and the reduction of pollutant loads.

It can be difficult to quantify cause-and-effect relationships when evaluating changes in hydrologic regimes and pollutant loads caused by urbanization. Experiences locally and elsewhere have shown, however, that urbanization can be a significant cause of pollution problems with both short-term and long-term impacts prevailing. Short term changes in water quality can restrict contact recreation, stress aquatic organisms, and damage shellfish beds. Long-term impacts on stream morphology often occur when urbanization changes natural hydrologic conditions. The long-term accumulation of pollutants into receiving waters can also create problems which can be particularly difficult to correct, such as eutrophication, polluted groundwater, and contaminated sediments.

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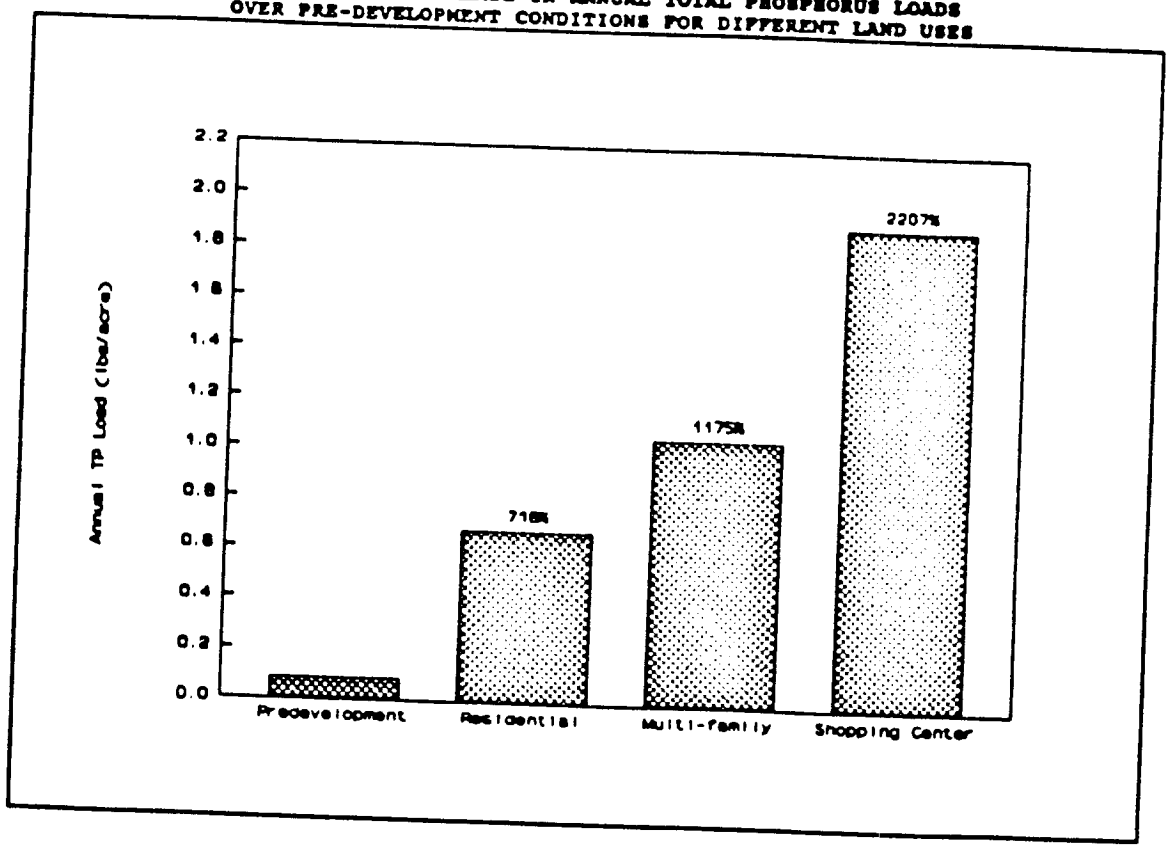
FIGURE I-1.2[2]
HYPOTHETICAL INCREASE IN ANNUAL TOTAL PHOSPHORUS LOADS
OVER PRE-DEVELOPMENT CONDITIONS FOR DIFFERENT LAND USES



While urbanization has already significantly impacted water resources in the Northwest, there are many opportunities to control future impacts as well as reduce existing ones. As better policies and improved control strategies are developed the effects of urbanization should be slowed and eventually controlled to the extent that beneficial uses that have been lost are restored. One potentially significant change on the horizon is an increased emphasis in managing stormwater as a resource. As human population growth continues stormwater may be used increasingly to augment water supplies, recharge aquifers, improve fisheries, and provide public recreation.

I-1.2 DEVELOPMENT OF BEST MANAGEMENT PRACTICES (BMPS) TO IMPROVE WATER QUALITY

Best Management Practices are defined as physical, structural, and/or managerial practices that, when used singly, or in combination, prevent or reduce pollution of water. The types of BMPs are source control, runoff treatment, and streambank erosion control. Source control BMPs, as the term implies, aim to prevent pollution, or other adverse effects of stormwater, from occurring. Examples of

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source control BMPs include methods as various as using mulches and covers on disturbed soil, putting roofs over outside storage areas, tracking down and eliminating illicit connections to storm drains. Runoff treatment BMPs include facilities that remove pollutants by simple gravity settling of particulate pollutants, filtration, biological uptake, and soil adsorption. Streambank erosion control BMPs typically control the rate, frequency, and flow duration of stormwater runoff releases. Examples of runoff treatment and streambank erosion control BMPs detention ponds, biofiltration swales, infiltration trenches, and dry vaults.

The primary purpose of using BMPs is to protect beneficial uses of water resources through the reduction of pollutant loads and concentrations, and by reducing streambank erosion and protecting stream habitat in general. If it is found that, after the implementation of BMPs, beneficial uses are still threatened or impaired, then additional controls may be required.

Stormwater management programs should keep in mind that it is generally more cost effective to prevent impacts using source control than using runoff treatment to remove pollutants. However, since source controls cannot prevent all impacts, some combination of measures will always be needed. The need to provide streambank erosion control BMPs depends on whether a development site discharges to a stream system, either directly or indirectly.

Runoff treatment BMPs can accomplish impressive levels of pollutant load reductions if properly designed and maintained. However, the increase in pollutant loads from urban areas is typically so large that, even with the use of BMPs, it is unlikely they will be reduced to levels approximating pre-development conditions. Figure I-1.3 illustrates this by presenting a typical pre-development pollutant load and comparing it with loads from a multi-family (MF) development. With no controls, the urban load increases nearly 1200 percent above the pre-development level. The figure illustrates the loads which theoretically would result if BMPs were applied with removal efficiencies of 50, 75, and 90 percent, respectively (the latter an extremely high level which may not be generally attainable, though infiltration can achieve this). As can be seen, even at high levels of treatment, substantial increases over pre-development levels occur, e.g., with a 75 percent removal efficiency the load is over 200 percent higher than the pre-development load. While using pre-development conditions as a basis of comparison may not be always justified, it does offer insight into the potential impacts of urbanization.

Streambank erosion control can be accomplished by BMPs which detain runoff flows and also by those which physically stabilize eroding streambanks. Both types of measures may be necessary in urban watersheds. BMPs which detain runoff can reduce peak flow rates to near pre-development conditions and are to be designed attempt to replicate the natural hydrologic regime. The need to control streambank erosion is gaining widespread attention as it is often the single largest source of sedimentation within a watershed and is a major factor contributing to the destruction of aquatic habitat.

Streambank erosion is largely due to increases in bankfull flow conditions which occur in urban watersheds. In undisturbed watersheds the bankfull condition generally occurs only about once in every two years on average. In urbanized watersheds both the frequency and duration of the bankfull condition can increase many fold, because of the effect of impervious surfaces on surface runoff. Bankfull conditions are a highly erosive state and, as the frequency and duration of their occurrence increases, the greater the amount of erosion results. While it may be impossible to totally recreate the frequency and duration of the pre-development bankfull condition, BMPs should be designed with that as an objective. Conventional detention practices which control peak flow rates from large, infrequent storms for flood control purposes are only partially effective at reducing the frequency and duration of bankfull flow conditions. One particularly effective practice which is

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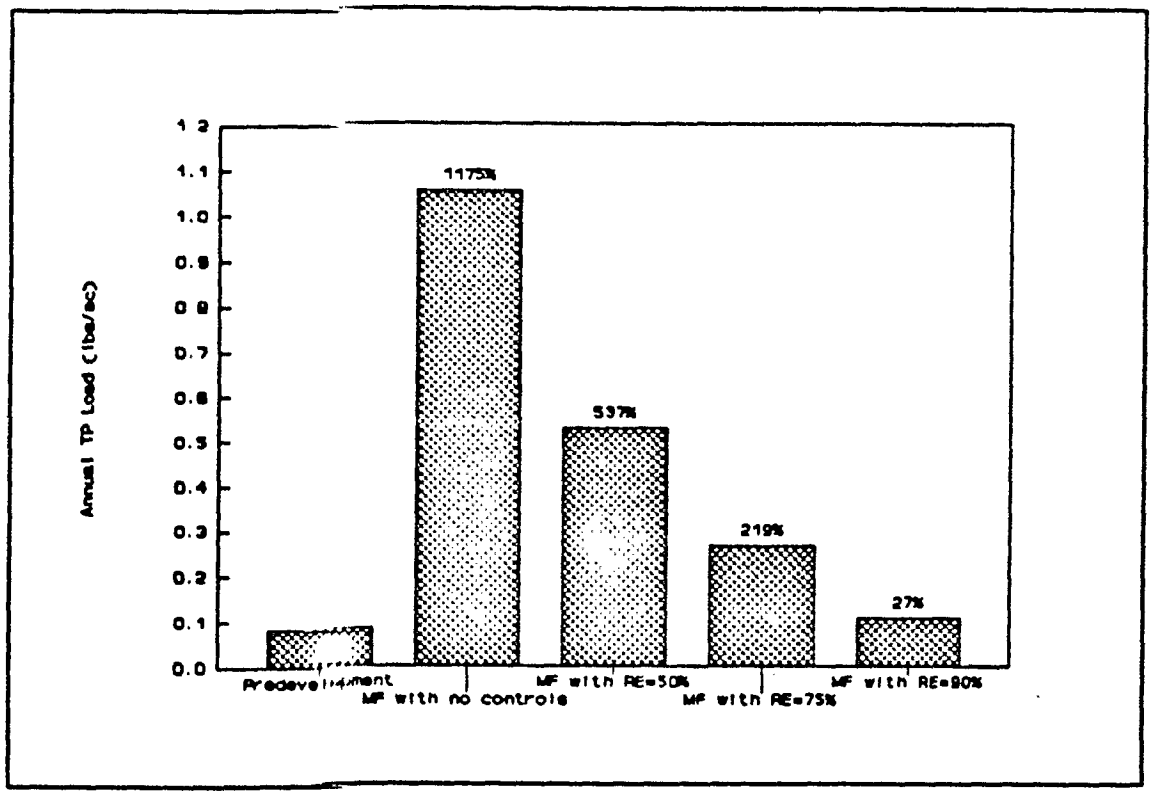
FIGURE I-1.3[1]
HYPOTHETICAL INCREASE IN ANNUAL POLLUTANT LOADS FOR A MULTI FAMILY DEVELOPMENT OVER PRE-DEVELOPMENT CONDITIONS UNDER VARIOUS CONTROL SCENARIOS



RE = Annual Removal Efficiency

gaining attention is infiltration, because of it's ability to decrease both peak rates and volumes, and increase summer stream baseflows. If infiltration is not feasible the alternative is large detention ponds that store runoff and release it at a very slow rate to minimize erosion and habitat destruction in general.

In summary, it is clear that treatment BMPs alone cannot normally be expected to solve all water quality problems caused by stormwater runoff. They must be complemented with source controls. The effectiveness of comprehensively implemented BMP programs have yet to be demonstrated. Many doubt their effectiveness. However, given the large number of measures now available (and new ideas that are being generated) future results may be surprising. The key will be the correct balance between education and enforcement for source control, and proper design and operation and maintenance for treatment.

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I-1.3 ECOLOGY'S STORMWATER PROGRAM

The 1991 Puget Sound Water Quality Management Plan requirements form the foundation of the stormwater program developed by the Department of Ecology. The Plan was first adopted in 1987, updated in 1989, and again in 1990, 1991 and 1992. The Plan and Ecology's stormwater programs apply to the cities and counties, and WSDOT, in the Puget Sound basin. What follows is a summary of the major elements of the Plan requirements.

I-1.3.1 Local Stormwater Program

Basic Stormwater Program for All Counties and Cities

The 1992 revisions to the PSWQMP changed the implementation of Ecology's program from a rules-based program to one implemented through language contained in the Plan. RCW 90.70.070(1) states "In conducting planning, regulatory, and appeals actions, the state agencies and local governments identified in the plan must evaluate, and incorporate as applicable, subject to the availability of appropriated funds or other funding sources, the provisions of the plan, including any guidelines, standards, and timetables contained in the plan."

The 1992 Plan language calls for all jurisdictions in Puget Sound to adopt a basic stormwater program (Plan element SW-1). Densely populated urbanized areas in the Sound are to implement additional requirements for comprehensive urban stormwater programs, and, in accordance with EPA regulations, meet the requirements of municipal stormwater NPDES permits (Plan element SW-2). Supplemental guidance, including model ordinances, and this technical manual are being prepared to describe how local governments can implement their stormwater programs and meet the requirements of the rules.

The Plan requires all 111 local jurisdictions to implement stormwater management programs which include:

- Ordinances for all new development and redevelopment which address control of off-site water quality, the use of source control BMPs, the effective treatment of the water quality design storm, the use of infiltration where appropriate, the protection of stream channels and wetlands, and erosion and sediment control.
- Operation and maintenance programs for new and existing public and private stormwater systems.
- Record keeping of new public and private drainage systems and facilities.
- Adoption of either Ecology's technical manual or a manual with substantially equivalent technical standards.
- Education programs to educate citizens about stormwater and its effects on water quality, flooding, and fish/wildlife habitat, and to discourage illicit dumping into storm drains.
- Coordination with provisions of the Growth Management Act, where appropriate.
- Basin planning.

Proposed schedule:

All cities and counties will be required to adopt ordinances and a technical manual that is "substantially equivalent" to this manual, and meet operation and maintenance requirements by July 1, 1994.

Comprehensive Stormwater Programs for Urban Areas

The Plan also sets standards and procedures for comprehensive stormwater programs

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that will be implemented by all urbanized areas. This program is in addition to the requirements of the basic stormwater programs described above.

Urbanized areas will be identified by the U.S. Bureau of Census definition.

These programs will address runoff from new and existing industrial, commercial, public facilities and residential areas, including streets and roads.

At minimum, each urban stormwater program shall include:

- Identification and ranking of potentially significant pollutant sources and their relationship to the drainage system and water bodies through an ongoing assessment program.
- Investigations and corrective actions of problem storm drains, including sampling.
- Programs for operation and maintenance of storm drains, detention systems, ditches, and culverts.
- A water quality response program, to investigate sources of pollutants, spills, fish kills, illegal hookups, dumping, and other water quality problems. These investigations should be used to support compliance/enforcement efforts.
- Assurance of adequate local funding for the stormwater program through surface water utilities, sewer charges, fees, or other revenue-generating sources.
- Local coordination arrangements such as interlocal agreements, joint programs, consistent standards, or regional boards or committees.
- Ordinances requiring implementation of stormwater controls for new development and redevelopment.
- A stormwater public education program aimed at residents, businesses, and industries in the urban area.
- Inspection, compliance, and enforcement measures.
- An implementation schedule.
- If, after implementation of the control measures listed above, there are still discharges that cause significant environmental problems, retrofitting of existing development and/or other water quality controls of discharges from new and existing development may be required.

Schedule:

Ecology shall review municipal NPDES Part 1 and 2 applications on the schedule established by EPA. Ecology shall write and issue individual NPDES permits on the following schedule: November 1993 for large municipalities; and May 1994 for medium municipalities. All urbanized areas shall implement programs by the year 2000.

I-1.3.2 Technical Manual and Guidance

This manual is part of the guidance package being developed by Ecology. Along with this manual, supplemental guidance will be provided to assist local governments in implementing their stormwater management programs. Examples include:

- Guidance on stormwater utility formation
- An example Erosion and Sediment Control Plan
- Model ordinances
- Guidance for an education program
- NPDES stormwater permit guidance
- Maintenance program guidance
- Guidance on developing a manual that is "substantially equivalent" to Ecology's manual

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This guidance is currently in draft form and will be released at approximately the same time that this version of the manual is released.

I-1.3.3 Puget Sound Highway Runoff Program

Ecology has worked with the Washington State Department of Transportation (WSDOT) to adopt a rule and develop a program to control the quality of runoff from state highways in the Puget Sound basin. WSDOT will:

- Adopt a Highway Runoff Manual equivalent to Ecology's technical manual to use as guidance for managing highway runoff
- Adopt a vegetation management program
- Include BMPs a part of new construction projects
- Inventory and retrofit existing state highways with water quality BMPs where practicable
- Monitor where applicable
- Submit biennial reports to Ecology

Public workshops were held on the draft rule in January 1990, at Port Townsend, Everett and Tacoma, and meetings were held with the tribes. Public hearings were held in Bremerton on March 13, in Everett on March 14, and in Tacoma on March 15, 1991.

Schedule:

The Highway program was signed May 21, 1991 and became effective on June 21,1991.

I-1.4 DEVELOPMENT OF THIS MANUAL

The Puget Sound Water Quality Authority (PSWQA) recognized the need for overall guidance for stormwater quality improvement, and incorporated requirements to implement a cohesive, integrated approach in the Puget Sound Water Quality Management Plan (PSWQMP or Plan). This technical manual, as mentioned above, has been developed in response to one of the plan's stormwater elements (SW-3.1). It emphasizes source control BMPs as the first and most cost effective method of eliminating or reducing pollution of stormwater. Source control BMPs are the more desirable method of controlling pollution and reducing erosion than are treatment BMPs because once sediment or pollutants enter runoff it is considerably more difficult and expensive to remove them. Treatment BMPs should only be used as a second line of defense to remove pollutants that could not be controlled by source control BMPs.

A primary purpose of this manual is to set out the Minimum Requirements and provide guidance on how to prepare and implement stormwater site plans. These plans are required for new development and redevelopment on both large subdivisions and small parcels, and must meet all of the applicable Minimum Requirements contained in Chapter I-2. These requirements are, in turn, satisfied by the application of BMPs. In doing so the plans will address the impacts of new development and redevelopment on stormwater runoff, and to the maximum extent practicable, mitigate deleterious effects.

The stormwater site plans developed by using this manual are not a substitute for an adopted and implemented comprehensive basin plan. Knowledge gained from a basin plan can be used to better select locations for on-site facilities, and plan regional facilities where needed. In addition, basin plans allow for the construction and siting of facilities so that environmentally sensitive areas are not affected by unwise development.

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A second important purpose of the manual is to provide information for users who are retrofitting BMPs to existing development. Retrofitting will primarily occur when a local government or Ecology has detected a stormwater drainage problem emanating from existing development and, as a result, has directed the implementation of BMPs to correct the problem.

A third purpose of the manual is to provide a reference source for users who wish to prepare technical bulletins, leaflets, etc. for purposes of education and/or specialized BMP implementation. Examples would include technical leaflets for individual homeowners, local governments, homeowners' associations, and business operators.

I-1.5 USERS OF THE MANUAL

The users of this manual will be engineers, planners and environmental scientists from local government and private industry. Local government officials will use the manual as a reference for reviewing stormwater site plans, for retrofitting of BMPs, and for providing technical advice in general. Private industry will primarily use the manual for information on how to develop and implement stormwater site plans, and as a reference for technical specifications of BMPS.

We anticipate that Ecology's NPDES stormwater permit writers will use this manual as a reference, and affected industries and municipalities will also use it to determine design criteria for the BMPs required as part of their permit.

I-1.6 ORGANIZATION OF THE MANUAL

The manual is organized into four volumes. Volume I provides an introduction and overview, a description of the Minimum Requirements, guidance on preparation of a stormwater site plan, and a method for selecting BMPs according to the requirements and the needs of the site. The glossary and notation information are found at the back of Volume I.

Volume II covers erosion and sediment control. BMPs for construction sites and other areas are covered, and BMPs for Small Parcels are also included. Information on NPDES construction permits, and the methodology for developing an Erosion and Sediment Control plan are also discussed.

The two topics covered in Volume III are runoff treatment and streambank erosion control. BMPs for infiltration, detention, conveyance systems, and other stormwater facilities are covered. Also included are hydrologic methods for calculating flow rates and volumes for sizing of drainage facilities.

Volume IV addresses control of runoff pollution produced by urban land uses. These include commercial, industrial, residential and public agency land uses.

I-1.7 HOW TO USE THIS MANUAL

The chapters in Volume I should be read first. Once a preliminary selection of BMPs has been made, those specific BMPs (found in Volumes II, III or IV) should be reviewed.

The Minimum Requirements contained in Chapter I-2 form the basis for all stormwater site plans. They are indicated in bold print. The standards set by this manual are the minimum requirements, and all other manuals will have to be substantially equivalent to that minimum standard. Local governments have the option of enacting stricter standards than those outlined in this manual, using parts of this manual

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and developing appropriate other sections for their local area, or developing an entirely new manual for use by their government.

An effort has been made to be as flexible as possible to enable local governments to tailor site plans to their specific requirements. As long as Minimum Requirements in Chapter I-2 are met, the exact methods used to meet them are up to the local government. If other technical manuals are developed and used, they must be reviewed by Ecology as part of the local government's basic stormwater program and determined to be "substantially equivalent ". Supplementary guidelines which will be issued at or around the time of this version of this manual will describe the process for determining whether or not a manual is of an equivalent technical standard.

Once the preliminary BMP selection is made a stormwater site plan including an ESC plan can be completed. Overall stormwater site plan requirements are found in Chapter I-3. A final BMP selection should be made taking into account the appropriateness to the site, the cost, and the relative advantages and disadvantages of each BMP. Much of the information needed to assist in this decision is found under each specific BMP entry.

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[1] Figure I-1.1 was developed from the SBUH model for a 10-acre site with the following conditions: Forest with CN = 64; Residential site with 25% impervious cover, CN = 75 and 98 for pervious and impervious areas, respectively; Commercial site with 75% impervious cover (same CN's as for residential site).

[2] Data for Figures I-1.2 and I-1.3 were derived from the EPA's National Urban Runoff Program and work by Thomas Schueler. The following assumptions were made:

Annual rainfall = 40 inches Annual runoff coefficient Rv = Pj*(.05+.009*IC)
Annual fraction of rainfall which generates runoff (Pj) = 0.9

Land Use Condition	Impervious Cover (%)	Annual Runoff Coefficient Rv	Concentration TP (mg/L)
Pre-development	2	0.07	0.15
Residential	30	0.32	0.26
Multi-family	50	0.50	0.26
Shopping Center	95	0.91	0.26

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CHAPTER I-2

MINIMUM REQUIREMENTS FOR ALL NEW DEVELOPMENT AND REDEVELOPMENT

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CHAPTER I-2

MINIMUM REQUIREMENTS FOR ALL NEW DEVELOPMENT AND REDEVELOPMENT

I-2.1 INTRODUCTION

The 1991 Puget Sound Water Quality Management Plan (as amended) requires all counties and cities within the Puget Sound drainage basin to adopt ordinances to control runoff from new development and redevelopment by July 1994. The Plan also directs local governments to adopt stormwater programs which include minimum requirements for new development and re-development set by the Plan and in guidance developed by Ecology. These ordinances are to address:

"... at a minimum: (1) the control of off-site water quality and quantity (as related to quality) impacts; (2) the use of source control best management practices and treatment best management practices; (3) the effective treatment, using best management practices of the storm size and frequency (design storm) as specified in the manual for proposed development; (4) the use of infiltration, with appropriate precautions, as the first consideration in stormwater management; (5) the protection of stream channels and wetlands; and (6) erosion and sedimentation control for new construction and re-development projects."

This chapter has been developed in response to the direction in the Plan. The reader is also referred to Volume II of the "Stormwater Program Guidance Manual for the Puget Sound Basin" (hereafter referred to as the Guidance Manual), a companion to this technical manual, which contains a model ordinance that incorporates these Minimum Requirements.

There are several sets of requirements for proposed new development and redevelopment that are applied depending on the type and size of the proposed development. In general, small sites are required to control erosion and sedimentation from construction activities while larger sites must also provide permanent control of stormwater runoff. Sites being redeveloped must generally meet the same minimum requirements as new development sites for the portion of the site being redeveloped. In addition, redevelopment sites must provide source control BMPs for the entire site. There may also be situations in which additional controls are required for sites, regardless of type or size, as a result of basin plans or special water quality concerns.

Development sites are to demonstrate compliance with the Minimum Requirements through the preparation of Stormwater Site Plans (SSP). The plans are described in detail in Chapter I-3 and in the Guidance Manual.

Two major components of these plans are an Erosion and Sediment Control (ESC) Plan and a Permanent Stormwater Quality Control (PSQC) Plan. The ESC plan is intended to be temporary in nature to control pollution generated during the construction phase only, primarily erosion and sediment. The PSQC is intended to provide permanent BMPs for the control of pollution from stormwater runoff after construction has been completed. For small sites, this requirement is met by implementing a Small Parcel Erosion and Sediment Control Plan.

A flow chart demonstrating these requirements is shown in Figure I-2.1.

Definitions:

> New development - means the following activities: land disturbing activities, structural development, including construction, installation or expansion of a building or other structure; creation of impervious surfaces; Class IV - general forest practices that are conversions from timber land to other uses;

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and subdivision, short subdivision and binding site plans, as defined in Ch.58.17.020 RCW. All other forest practices and commercial agriculture are not considered new development.

Redevelopment - means, on an already developed site, the creation or addition of impervious surfaces, structural development including construction, installation or expansion of a building or other structure, and/or replacement of impervious surface that is not part of a routine maintenance activity; and land disturbing activities associated with structural or impervious redevelopment.

Impervious surface - means a hard surface area which either prevents or retards the entry of water into the soil mantle as under natural conditions prior to development, and/or a hard surface area which causes water to run off the surface in greater quantities or at an increased rate of flow from the flow present under natural conditions prior to development. Common impervious surfaces include, but are not limited to, roof tops, walkways, patios, driveways, parking lots or storage areas, concrete or asphalt paving, gravel roads, packed earthen materials, and oiled, macadam or other surfaces which similarly impede the natural infiltration of stormwater. Open, uncovered retention/detention facilities shall not be considered as impervious surfaces.

Land disturbing activity - means any activity that results in a change in the existing soil cover (both vegetative and nonvegetative) and/or the existing soil topography. Land disturbing activities include, but are not limited to demolition, construction, clearing, grading, filling and excavation.

Source control BMP - A BMP that is intended to prevent pollutants from entering stormwater. A few examples of source control BMPs are erosion control practices, maintenance of stormwater facilities, constructing roofs over storage and working areas, and directing wash water and similar discharges to the sanitary sewer or a dead end sump.

Throughout this Chapter, guidance to meet the requirements of the 1991 Puget Sound Water Quality Management Plan (as amended) is written in bold and supplemental guidelines that serve as advice and other materials are not in bold.

I-2.2 EXEMPTIONS

- Commercial agriculture, and forest practices regulated under Title 222 WAC, except for Class IV General forest practices that are conversions from timber land to other uses, are exempt from the provisions of the minimum requirements. All other new development is subject to the minimum requirements.

I-2.3 SMALL PARCEL MINIMUM REQUIREMENTS

- The following new development shall be required to control erosion and sediment during construction, to permanently stabilize soil exposed during construction, to comply with Small Parcel Requirements 1 through 4, and to prepare a Small Parcel Erosion and Sediment Control Plan:

  (a) Individual, detached, single family residences and duplexes.
  (b) Creation or addition of less than 5,000 square feet of impervious surface area.
  (c) Land disturbing activities of less than one acre.

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Objective: The objective of this requirement is to address the cumulative effect of sediment coming from a large number of small sites.

Supplemental Guidelines: Small parcels under 5,000 sq.ft. in size and individual, detached, single family residences and duplexes, require the simplified erosion and sediment controls contained in a Small Parcel Erosion and Sediment Control Plan (SPESC). This plan is required to fulfil the Small Parcel Minimum Requirements outlined below in Section I-2.3. The Small Parcel BMPs found in Section II-5.10 in Volume II are used to develop the plan. A complete description of a Small Parcel ESC Plan can be found in Section I-3.3. The SPESC plan is meant to be temporary in nature to deal with erosion and sediment generated during the construction phase only. Local governments may choose to apply additional permanent, site-specific stormwater controls to small parcels.

One method of proof of compliance could be the use of a checklist similar to that found in Figure I-3.1. This list can be adapted as necessary to include individual requirements of a local government.

SMALL PARCEL REQUIREMENT #1 Construction Access Route

- Construction vehicle access shall be, whenever possible, limited to one route. Access points shall be stabilized with quarry spall or crushed rock to minimize the tracking of sediment onto public roads.

Supplemental Guidelines: If sediment is inadvertently transported onto public roads, roads shall be cleaned thoroughly at the end of the day by shoveling or sweeping. Street washing should only be done after the bulk of the sediment has been removed by sweeping.

SMALL PARCEL REQUIREMENT #2 Stabilization of Denuded Areas

- Soil stabilization. All exposed and unworked soils shall be stabilized by suitable application of BMPs, including but not limited to sod or other vegetation, plastic covering, mulching, or application of ground base on areas to be paved. All BMPs shall be selected, designed and maintained in accordance with an approved manual. From October 1 through April 30, no soils shall remain exposed for more than 2 days. From May 1 through September 30, no soils shall remain exposed for more than 7 days.

Supplemental Guidelines: BMPs should be selected which are appropriate for the time of the year and anticipated duration of use.

SMALL PARCEL REQUIREMENT #3 Protection of Adjacent Properties

- Adjacent properties shall be protected from sediment deposition by appropriate use of vegetative buffer strips, sediment barriers or filters, dikes or mulching, or by a combination of these measures and other appropriate BMPs.

SMALL PARCEL REQUIREMENT #4 Maintenance

- All erosion and sediment control BMPs shall be regularly inspected and maintained to ensure continued performance of their intended function.

SMALL PARCEL REQUIREMENT #5 Other BMPs

- As required by the local Plan Approval Authority, other appropriate BMPs to mitigate the effects of increased runoff shall be applied.

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I-2.4 NEW DEVELOPMENT AND REDEVELOPMENT - APPLICATION OF MINIMUM REQUIREMENTS

I-2.4.1 New Development

All new development that includes the creation or addition of 5,000 square feet, or greater, of new impervious surface area, and/or land disturbing activity of one acre or greater, shall comply with Minimum Requirements #1 through #11 in Sections I-2.5 through I-2.15 and prepare a Stormwater Site Plan.

All new development that includes the creation or addition of 5,000 square feet, or greater, of new impervious surface area, and land disturbing activity of less than one acre, shall comply with Minimum Requirements #2 through #11 in Sections I-2.6 through I-2.15 and the Small Parcel Minimum Requirements found in section I-2.2, above. This category of development shall also prepare a Stormwater Site Plan that includes a Small Parcel Erosion and Sediment Control Plan.

This section does not apply to the construction of individual, detached, single family residences and duplexes. Those types of new development are included in the Small Parcel Minimum Requirements.

Objective: The objective of this standard is to define the application of the Minimum Requirements. The objective of these requirements is to reduce pollution and minimize erosion and sedimentation from new development.

Supplemental Guidelines: Basin planning is encouraged and may be used to tailor certain of the Minimum Requirements to a specific basin (see Minimum Requirement #9). The Minimum Requirements for Small Parcels are found in Section I-2.2. See page I-2-1 for the definition of new development. See Chapter I-3 for a description of Stormwater Site Plans.

I-2.4.2 Redevelopment

A. Where redevelopment of ≥ 5,000 square feet occurs:

The new development Minimum Requirements #1 through #11, Sections I-2.5 through I-2.15, shall apply to that portion of the site that is being redeveloped, and source control BMPs shall be applied to the entire site, including adjoining parcels if they are part of the project. A Stormwater Site Plan shall be prepared.

B. In addition to the above requirements, where one or more of the following conditions apply, a Stormwater Site Plan shall also be prepared that includes a schedule for implementing the Minimum Requirements to the maximum extent practicable, for the entire site, including adjoining parcels if they are part of the project. An adopted and implemented basin plan (Minimum Requirement #9) may be used to develop redevelopment requirements that are tailored to a specific basin.

1. Existing sites greater than 1 acre in size with 50% or more impervious surface.

2. Sites that discharge to a receiving water that has a documented water quality problem. Subject to local priorities, a documented water quality problem includes, but is not limited to water bodies:

   (i) Listed in reports required under section 305(b) of the Clean Water Act, and designated as not supporting beneficial uses;

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(ii) Listed under section 304(l)(1)(A)(i),304(l)(1)(A)(ii), or 304(l)(1)(B) of the Clean Water Act as not expected to meet water quality standards or water quality goals;

(iii) Listed in Washington State's Nonpoint Source Assessment required under section 319(a) of the Clean Water Act that, without additional action to control nonpoint sources of pollution cannot reasonably be expected to attain or maintain water quality standards.

3. Sites where the need for additional stormwater control measures have been identified through a basin plan, the watershed ranking process under Ch. 400-12 WAC, or through Growth Management Act planning.

Objective: The objective of the redevelopment standard is to reduce pollution from existing sites. The long-term goal of this standard is to accomplish this reduction through development and implementation of basin plans.

Supplemental Guidelines: Minimum Requirements 1 through 11 always apply to the portion of the site that is being redeveloped, if the redevelopment is over 5,000 sq. ft. in size. In addition, source control BMPs are always required for the entire site. A basin plan could be used to vary the thresholds for application of the minimum requirements to the entire site, beyond the portion of the site that is being redeveloped. See Chapter I-3 for the description of a Stormwater Site Plan.

I-2.5 MINIMUM REQUIREMENT #1: EROSION AND SEDIMENT CONTROL

- All new development and redevelopment that includes land disturbing activities of ≥1 acre shall comply with Erosion and Sediment Control Requirements 1 through 14, below. Compliance with the Erosion and Sediment Control Requirements shall be demonstrated through implementation of a Large Parcel Erosion and Sediment Control Plan.

  All new development and redevelopment that includes land disturbing activities of <1 acre shall comply with the Small Parcel Minimum requirements found in section I-2.2, above. Compliance with the Small Parcel Requirements shall be demonstrated through implementation of a Small Parcel Erosion and Sediment Control Plan.

Objective: To control erosion and prevent sediment from leaving the site.

Supplemental Guidelines:

Large parcels are defined as those >1 acre in size. Parcels of this size are required to implement a Large Parcel ESC plan which meets the Erosion and Sediment Control Requirements found in Minimum Requirement #1. Additionally, a Permanent Stormwater Quality Control Plan (PSQC) must be developed which meets Minimum Requirements 2 through 11. An acceptable Stormwater Site Plan (SSP) for a large parcel contains both of these elements, the ESC plan, and the PSQC, and fulfills all the Minimum Requirements.

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If an ESC plan is found to be inadequate (with respect to the Erosion and Sediment Control Requirements), then the Plan Approval Authority[1] within the Local Government will require that other BMPs be implemented, as appropriate.

Erosion and Sediment Control Minimum Requirements

Guidance to meet the requirements of the 1991 Puget Sound Water Quality Management Plan (as amended) is written in bold, and supplemental guidelines that serve as advice and other materials are not in bold.

The following erosion and sediment control requirements shall be met:

EROSION AND SEDIMENT CONTROL REQUIREMENT #1: Stabilization and Sediment Trapping

- **All exposed and unworked soils shall be stabilized by suitable application of BMPs. From October 1 to April 30, no soils shall remain unstabilized for more than 2 days. From May 1 to September 30, no soils shall remain unstabilized for more than 7 days. Prior to leaving the site, stormwater runoff shall pass through a sediment pond or sediment trap, or other appropriate BMPs.**

Supplemental Guidelines: This criterion applies both to soils not yet at final grade and soils at final grade. The type of stabilization BMP used may be different depending on the length of time that the soil is to remain unworked.

Soil stabilization refers to BMPs which protect soil from the erosive forces of raindrop impact and flowing water. Applicable practices include vegetative establishment, mulching, plastic covering, and the early application of gravel base on areas to be paved. Soil stabilization measures should be selected to be appropriate for the time of year, site conditions, and estimated duration of use. Soil stockpiles must be stabilized or protected with sediment trapping measures to prevent soil loss.

These requirements are *especially* important in areas adjacent to streams, wetlands or other sensitive or critical areas.

EROSION AND SEDIMENT CONTROL REQUIREMENT #2: Delineate Clearing and Easement Limits

- **In the field, mark clearing limits and/or any easements, setbacks, sensitive/critical areas and their buffers, trees and drainage courses.**

EROSION AND SEDIMENT CONTROL REQUIREMENT #3: Protection of Adjacent Properties

- **Properties adjacent to the project site shall be protected from sediment deposition.**

Supplemental Guidelines: This may be accomplished by preserving a well-vegetated buffer strip around the lower perimeter of the land disturbance, by installing perimeter controls such as sediment barriers, filters or dikes, or sediment basins, or by a combination of such measures.

Vegetated buffer strips may be used alone only where runoff in sheet flow is expected. Buffer strips should be at least 25 feet in width. If at any time it is found that a vegetated buffer strip alone is ineffective in stopping sediment movement onto adjacent property, additional perimeter controls must be provided.

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[1] The Plan Approval Authority is defined as that department within a local government that has been delegated authority to approve erosion and sediment control plans.

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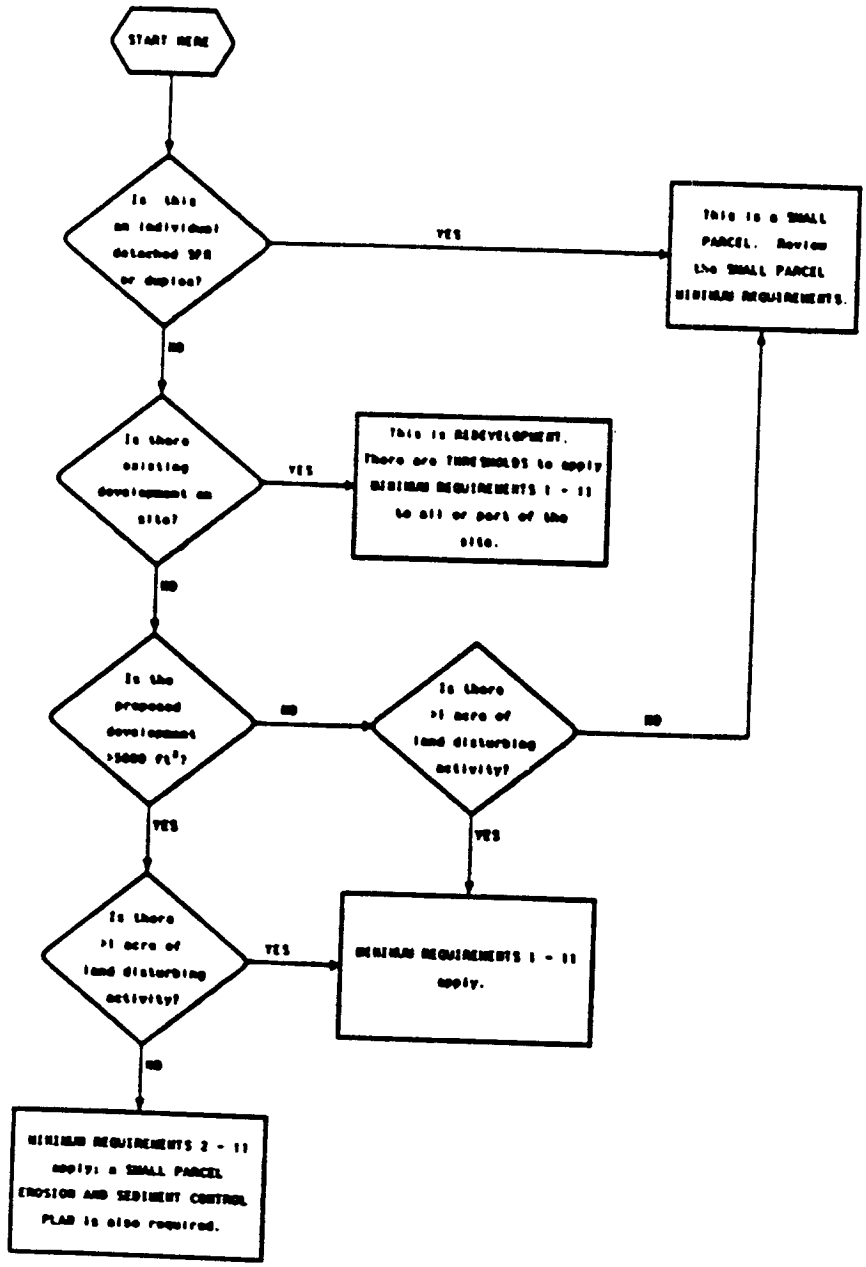
Figure I-2.1 Flowchart Demonstrating Minimum Requirements



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EROSION AND SEDIMENT CONTROL REQUIREMENT #4: Timing and Stabilization of Sediment Trapping Measures

- Sediment ponds and traps, perimeter dikes, sediment barriers, and other BMPs intended to trap sediment on-site shall be constructed as a first step in grading. These BMPs shall be functional before land disturbing activities take place. Earthen structures such as dams, dikes, and diversions shall be seeded and mulched according to the timing indicated in Erosion and Sediment Control Requirement #1.

EROSION AND SEDIMENT CONTROL REQUIREMENT #5: Cut and Fill Slopes

- Cut and fill slopes shall be designed and constructed in a manner that will minimize erosion. In addition, slopes shall be stabilized in accordance with Erosion and Sediment Control Requirement #1.

Supplemental Guidelines: Consideration should be given to the length and steepness of the slope, the soil type, upslope drainage area, ground water conditions, and other applicable factors. Slopes which are found to be eroding excessively within two years of construction must be provided with additional slope stabilizing measures until the problem is corrected.

1. Roughened soil surfaces are preferred to smooth surfaces on slopes (see BMP E2.35 in Chapter II-5).

2. Interceptors (see BMP E2.55 in Chapter II-5) should be constructed at the top of long steep slopes which have significant drainage areas above the slope. Diversions or terraces may also be used to reduce slope length.

3. Concentrated stormwater should not be allowed to flow down cut or fill slopes unless contained within an adequate temporary or permanent channel, or pipe slope drain (see BMP E2.25 in Chapter II-5).

4. Wherever a slope face crosses a water seepage plane which endangers the stability of the slope, adequate drainage or other protection should be provided (BMPs E2.30 and E2.75 in Chapter II-5).

EROSION AND SEDIMENT CONTROL REQUIREMENT #6: Controlling Off-site Erosion

- Properties and waterways downstream from development sites shall be protected from erosion due to increases in the volume, velocity, and peak flow rate of stormwater runoff from the project site.

EROSION AND SEDIMENT CONTROL REQUIREMENT #7: Stabilization of Temporary Conveyance Channels and Outlets

- All temporary on-site conveyance channels shall be designed, constructed and stabilized to prevent erosion from the expected velocity of flow from a 2-year, 24-hour frequency storm for the developed condition. Stabilization adequate to prevent erosion of outlets, adjacent streambanks, slopes and downstream reaches shall be provided at the outlets of all conveyance systems.

EROSION AND SEDIMENT CONTROL REQUIREMENT #8: Storm Drain Inlet Protection

- All storm drain inlets made operable during construction shall be protected so that stormwater runoff shall not enter the conveyance system without first being filtered or otherwise treated to remove sediment.

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EROSION AND SEDIMENT CONTROL REQUIREMENT #9: Underground Utility Construction

- The construction of underground utility lines shall be subject to the following criteria:

  (i) Where feasible, no more than 500 feet of trench shall be opened at one time.

  (ii) Where consistent with safety and space considerations, excavated material shall be placed on the uphill side of trenches.

  (iii) Trench dewatering devices shall discharge into a sediment trap or sediment pond.

EROSION AND SEDIMENT CONTROL REQUIREMENT #10: Construction Access Routes

- Wherever construction vehicle access routes intersect paved roads, provisions must be made to minimize the transport of sediment (mud) onto the paved road. If sediment is transported onto a road surface, the roads shall be cleaned thoroughly at the end of each day. Sediment shall be removed from roads by shoveling or sweeping and be transported to a controlled sediment disposal area. Street washing shall be allowed only after sediment is removed in this manner.

EROSION AND SEDIMENT CONTROL REQUIREMENT #11: Removal of Temporary BMPs

- All temporary erosion and sediment control BMPs shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

EROSION AND SEDIMENT CONTROL REQUIREMENT #12: Dewatering Construction Sites

- Dewatering devices shall discharge into a sediment trap or sediment pond.

EROSION AND SEDIMENT CONTROL REQUIREMENT #13: Control of Pollutants Other Than Sediment on Construction Sites

- All pollutants other than sediment that occur on-site during construction shall be handled and disposed of in a manner that does not cause contamination of stormwater.

EROSION AND SEDIMENT CONTROL REQUIREMENT #14: Maintenance

- All temporary and permanent erosion and sediment control BMPs shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with an approved manual.

EROSION AND SEDIMENT CONTROL REQUIREMENT #15: Financial Liability

- Performance bonding, or other appropriate financial instruments, shall be required for all projects to ensure compliance with the approved erosion and sediment control plan.

I-2.6 MINIMUM REQUIREMENT #2: PRESERVATION OF NATURAL DRAINAGE SYSTEMS

- Natural drainage patterns shall be maintained, and discharges from the site shall occur at the natural location, to the maximum extent practicable.

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Objective: To preserve and utilize natural drainage systems to the fullest extent because of the multiple stormwater benefits these systems provide.

Supplemental Guidelines: Natural drainage systems provide many water quality benefits and should be preserved to the fullest extent possible. In addition to conveying and attenuating stormwater runoff, these systems are less erosive, provide ground water recharge, and support important plant and wildlife resources. Effective utilization of the natural system can maintain environmental and aesthetic attributes of a site as well as be a cost-effective measure to convey stormwater runoff.

Creating new drainage patterns requires more site disturbance and can upset stream dynamics of the drainage system, thus tending to increase erosion and sedimentation. Creating new discharge points can create significant streambank erosion problems as the receiving water body typically must adjust to the new flows. Newly created drainage patterns can seldom, if ever, provide the multiple benefits of natural drainage systems. Where no conveyance system exists at the adjacent downstream property line and the discharge was previously unconcentrated flow or significantly lower concentrated flow, then measures must be taken to prevent downstream impacts. Necessary drainage easements may be obtained from downstream property owners.

I-2.7 MINIMUM REQUIREMENT #3: SOURCE CONTROL OF POLLUTION

- Source control BMPs shall be applied to all projects to the maximum extent practicable. Source control BMPs shall be selected, designed, and maintained according to an approved manual.

  An adopted and implemented basin plan (Minimum Requirement #9) may be used to develop source control requirements that are tailored to a specific basin, however, in all circumstances, source control BMPs shall be required for all sites.

Objective: The intention of source control BMPs is to prevent stormwater from coming in contact with pollutants. They are a cost effective means of reducing pollutants in stormwater, and, therefore, should be a first consideration in all projects.

Supplemental Guidelines: A list of many source control BMPs is provided in the BMP selection chapter, Chapter I-4. For construction sites see Chapter II-5; for post-construction development sites see Volume III; for specific urban land uses see Volume IV.

I-2.8 MINIMUM REQUIREMENT #4: RUNOFF TREATMENT BMPS

- All projects shall provide treatment of stormwater. Treatment BMPs shall be sized to capture and treat the water quality design storm, defined as the 6-month, 24-hour return period storm. The first priority for treatment shall be to infiltrate as much as possible of the water quality design storm, only if site conditions are appropriate and ground water quality will not be impaired. Direct discharge of untreated stormwater to ground water is prohibited. All treatment BMPs shall be selected, designed, and maintained according to an approved manual.

  Stormwater treatment BMPs shall not be built within a natural vegetated buffer, except for necessary conveyance systems as approved by the local government.

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An adopted and implemented basin plan (Minimum Requirement #9) may be used to develop runoff treatment requirements that are tailored to a specific basin.

Objective: The purpose of runoff treatment is to reduce pollutant loads and concentrations in stormwater runoff using physical, biological, and chemical removal mechanisms. When site conditions are appropriate infiltration can potentially be the most effective BMP for runoff treatment.

Supplemental Guidelines: See Volume III. The water quality design storm (see Appendix AI-2.1) is intended to capture more than 90 percent of the annual runoff.

Infiltration can provide both treatment of stormwater, through the ability of certain soils to remove pollutants, and volume control of stormwater, by decreasing the amount of water that runs off to surface water. Infiltration can be very effective at treating stormwater runoff but soil conditions must be appropriate to achieve effective treatment while not impacting ground water resources. Methods currently in use such as direct discharge into dry wells do not achieve adequate water quality treatment and are therefore not permitted.

If stormwater is being discharged to a stream, see I-2.9, Streambank Erosion Control for additional requirements.

If stormwater is being discharged to a wetland, see I-2.10, Wetlands for additional requirements.

I-2.9 MINIMUM REQUIREMENT #5: STREAMBANK EROSION CONTROL

- The requirement below applies only to situations where stormwater runoff is discharged directly or indirectly to a stream, and must be met in addition to meeting the requirements in Minimum Requirement #4, Runoff Treatment BMPs:

  Stormwater discharges to streams shall control streambank erosion by limiting the peak rate of runoff from individual development sites to 50 percent of the existing condition 2-year, 24-hour design storm while maintaining the existing condition peak runoff rate for the 10-year, 24-hour and 100-year, 24-hour design storms. As the first priority, streambank erosion control BMPs shall utilize infiltration to the fullest extent practicable, only if site conditions are appropriate and ground water quality is protected. Streambank erosion control BMPs shall be selected, designed, and maintained according to an approved manual.

  Stormwater treatment BMPs shall not be built within a natural vegetated buffer, except for necessary conveyance systems as approved by the local government.

  An adopted and implemented basin plan (Minimum Requirement #9) may be used to develop streambank erosion control requirements that are tailored to a specific basin.

Objective: To reduce streambank erosion which results from increased runoff due to development. The standard is intended to reduce the frequency and magnitude of bankfull flow conditions, which are highly erosive and increase dramatically as a result of development. Conventional flood detention practices do not adequately control streambank erosion because only the peak rate of flow is decreased, not the *frequency* and *duration* of bankfull conditions.

Supplemental Guidelines: See Chapter III-4. Reduction of flows through infiltration decreases streambank erosion and helps to maintain base flow throughout the summer months. However, infiltration should only be used where ground water

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quality is not threatened by such discharges. The use of an artificial treatment system, such as an aquatard (see Chapter III-3) shall be considered in areas with highly permeable soils. Treatment of the water quality design storm must be accomplished prior to discharge to these soils. If highly permeable soils are present they should be utilized for streambank erosion control by infiltrating flows greater than the water quality design storm.

I-2.10 MINIMUM REQUIREMENT #6: WETLANDS

- The requirements below apply only to situations where stormwater discharges directly or indirectly through a conveyance system into a wetland, and must be met in addition to meeting the requirements in Minimum Standard #4, Runoff Treatment BMPs.

  (a) Stormwater discharges to wetlands must be controlled and treated to the extent necessary to meet the State Water Quality Standards, Ch. 173-201 WAC, or Ground Water Quality Standards, Ch. 173-200 WAC, as appropriate.

  (b) Discharges to wetlands shall maintain the hydroperiod and flows of existing site conditions to the extent necessary to protect the characteristic uses of the wetland. Prior to discharging to a wetland, alternative discharge locations shall be evaluated, and natural water storage and infiltration opportunities outside the wetland shall be maximized.

  (c) Created wetlands that are intended to mitigate for loss of wetland acreage, function and value shall not be designed to also treat stormwater.

  (d) In order for constructed wetlands to be considered treatment systems, they must be constructed on sites that are not wetlands and they must be managed for stormwater treatment. If these systems are not managed and maintained in accordance with an approved manual for a period exceeding three years these systems may no longer be considered constructed wetlands. Discharges from constructed wetlands to waters of the state (including discharges to natural wetlands) are regulated under Ch. 90.48 RCW, Ch. 173-201 WAC, and Ch. 173-200 WAC.

  (e) Stormwater treatment BMPs shall not be built within a natural vegetated buffer, except for necessary conveyance systems as approved by the local government.

  An adopted and implemented basin plan (Minimum Requirement #9) may be used to develop requirements for wetlands that are tailored to a specific basin.

Objective: To ensure that wetlands receive the same level of protection as any other waters of the state. Wetlands are extremely important natural resources which provide multiple stormwater benefits, including ground water recharge, flood control, and streambank erosion protection. They are easily impacted by development unless careful planning and management are conducted. Wetlands can be severely degraded by stormwater discharges from urban development due to pollutants in the runoff and also due to disruption of natural hydrologic functioning of the wetland system. Changes in water levels and the duration of inundations are of particular concern.

Supplemental Guidelines: See Chapter III-5. These requirements are a management tool to assist in meeting the state water quality standards. While it is always necessary to pre-treat stormwater prior to discharge to a wetland, there are limited circumstances where wetlands may be used for detention of stormwater.

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Definitions: See glossary for definitions of wetlands, constructed wetland, created wetland, and abandonment.

I-2.11 MINIMUM REQUIREMENT #7: WATER QUALITY SENSITIVE AREAS

- Where local governments determine that the Minimum Requirements do not provide adequate protection of water quality sensitive areas, either on-site or within the basin, more stringent controls shall be required to protect water quality.

  Stormwater treatment BMPs shall not be built within a natural vegetated buffer, except for necessary conveyance systems as approved by the local government.

  An adopted and implemented basin plan (Minimum Requirement #9) may be used to develop requirements for water quality sensitive areas that are tailored to a specific basin.

Objective: To ensure protection of water quality in sensitive areas.

Supplemental Guidelines: Water quality sensitive areas are areas that are sensitive to a change in water quality, including but not limited to, lakes, ground water management areas, ground water special protection areas, sole source aquifers, critical aquifer recharge areas, well head protection areas, closed depressions, fish spawning and rearing habitat, wildlife habitat, and shellfish protection areas. Areas such as steep or unstable slopes or erosive stream banks which can cause water quality problems should also be included. Water quality sensitive areas may be identified through jurisdiction-wide inventories, the watershed planning process required under Ch. 400-12 WAC, critical area designation in accordance with Ch. 365-190 WAC, local drainage basin planning, and/or on a site-by-site basis (e.g. using a threshold determination under SEPA).

I-2.12 MINIMUM REQUIREMENT #8: OFF-SITE ANALYSIS AND MITIGATION

- All development projects shall conduct an analysis of off-site water quality impacts resulting from the project and shall mitigate these impacts. The analysis shall extend a minimum of one-fourth of a mile downstream from the project. The existing or potential impacts to be evaluated and mitigated shall include, at a minimum, but not be limited to:

  (i) excessive sedimentation
  (ii) streambank erosion
  (iii) discharges to ground water contributing or recharge zones
  (iv) violations of water quality standards
  (v) spills and discharges of priority pollutants

Objective: To ensure that future impacts from the project will be controlled and/or existing impacts will not be aggravated by the project.

Supplemental Guidelines: Further information on off-site analysis is being developed.

I-2.13 MINIMUM REQUIREMENT #9: BASIN PLANNING

- Adopted and implemented watershed-based basin plans may be used to modify any or all of the Minimum Requirements, provided that the level of protection for surface or ground water achieved by the basin plan will equal or exceed that which would be achieved by the Minimum Requirements in the absence of a basin

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plan. Basin plans shall evaluate and include, as necessary, retrofitting of BMPs for existing development and/or redevelopment in order to achieve watershed-wide pollutant reduction goals. Standards developed from basin plans shall not modify any of the above requirements until the basin plan is formally adopted and fully implemented by local government. Basin plans shall be developed according to an approved manual.

Objective: To promote watershed-based planning as a means to develop and implement comprehensive water quality protection measures. Primary objectives of basin planning are to reduce pollutant loads and hydrologic impacts to streams and wetlands.

Supplemental Guidelines: While Minimum Requirements #3 through #7 establish protection standards for individual sites, they do not evaluate the overall pollution impacts and protection opportunities which could exist at the watershed level. In order for a basin plan to serve as a means of modifying the minimum requirements it must be formally adopted by all jurisdictions that have responsibilities under the basin plan, and construction and regulations called for by the plan must be complete. This is what is meant by an adopted and implemented basin plan.

Basin planning provides a mechanism by which the on-site standards can be evaluated and refined based on an analysis of an entire watershed. Basin plans are especially well-suited to develop control strategies to address impacts from future development and to correct specific problems whose sources are known or suspected. Basin plans can be effective at addressing both long-term cumulative impacts of pollutant loads and short-term acute impacts of pollutant concentrations, as well as hydrologic impacts to streams and wetlands.

In general, the standards established by basin plans will be site-specific but may be augmented with regional solutions for Source Control (Minimum Requirement #2) and Streambank Erosion Control (Minimum Requirement #4).

I-2.14 MINIMUM REQUIREMENT #10: OPERATION AND MAINTENANCE

- An operation and maintenance schedule shall be provided for all proposed stormwater facilities and BMPs, and the party (or parties) responsible for maintenance and operation shall be identified.

Objective: To ensure that stormwater control facilities are adequately maintained and operated properly.

Supplemental Guidelines: Inadequate maintenance is likely the leading cause of failure for stormwater control facilities. The description of each BMP in Volume II and III includes a section on maintenance. The Guidance Manual also includes a section on developing an operation and maintenance program and a model operation and maintenance ordinance.

I-2.15 MINIMUM REQUIREMENT #11: FINANCIAL LIABILITY

- Performance bonding or other appropriate financial instruments shall be required for all projects to ensure compliance with these standards.

Objective: To ensure that development projects have adequate financial resources to fully implement stormwater management plan requirements and that liability is not unduly incurred upon local governments.

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Supplemental Guidelines: The type of financial instrument required is less important than ensuring that there are adequate funds available in the event that non-compliance occurs.

I-2.16 EXCEPTIONS

- Exceptions to Minimum Requirements #1 through #10 may be granted prior to permit approval and construction. An exception may be granted following a public hearing, provided that a written finding of fact is prepared, that addresses the following:

  (i) The exception provides equivalent environmental protection and is in the overriding public interest; and that the objectives of safety, function, environmental protection and facility maintenance, based upon sound engineering, are fully met;

  (ii) That there are special physical circumstances or conditions affecting the property such that the strict application of these provisions would deprive the applicant of all reasonable use of the parcel of land in question, and every effort to find creative ways to meet the intent of the Minimum Requirements has been made;

  (iii) That the granting of the exception will not be detrimental to the public health and welfare, nor injurious to other properties in the vicinity and/or downstream, and to the quality of waters of the state; and

  (iv) The exception is the least possible exception that could be granted to comply with the intent of the Minimum Requirements.

Supplemental Guidelines: Ecology encourages the Plan Approval Authority to impose additional or more stringent criteria as appropriate for their area. Additionally, criteria which may be inappropriate or too restrictive for an area may be modified through basin planning (Minimum Requirement #9). Modification of any of the minimum requirements which are deemed inappropriate for the site may be done by granting an exception.

The exception procedure is an important element of the plan review and enforcement programs. It is intended to maintain a necessary flexible working relationship between local officials and applicants. Plan Approval Authorities should consider these requests judiciously, keeping in mind both the need of the applicant to maximize cost-effectiveness and the need to protect off-site properties and resources from damage.

I-2.17 EXPERIMENTAL BMPs

Experimental best management practices are defined as BMPs which have not been tested and evaluated by the Department of Ecology in collaboration with local governments and technical experts. Some so-called Experimental BMPs will likely be minor variations on an existing theme. In that case, Ecology would review and approve or disapprove the BMP in as timely a manner as possible. Where new designs are developed (examples as below, in Section I-2.17.2), the review will be extended through the use of a standing committee of technical experts. These persons will review and comment on the practice, and Ecology will then determine whether or not these BMPs should be approved and/or added to this manual.

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I-2.17.1 Approval of Experimental BMPs

Approval to use an Experimental BMP may be granted subject to initial approval by the Department of Ecology and the local government. If such Experimental BMPs prove useful they may be incorporated into later editions of this manual following appraisal of the results and appropriate technical review conducted by Ecology in collaboration with local governments and other interested parties. Approval to use an Experimental BMP will only be granted when a suitable contingency plan using approved BMPs has been provided by the applicant to be used in the event that the Experimental BMP does not perform adequately.

In addition, several Experimental BMPs have been included in the manual. People may wish to use these BMPs on a trial basis, subject to approval by the local government and provision of a contingency plan. In any event, use of Experimental BMPs is encouraged whenever applied research is being undertaken so that more information is made available to facilitate judgement on their applicability and possible adoption as an approved.

I-2.17.2 Example Experimental BMPs

The two BMPs described below are examples of Experimental BMPs where a thorough design review and monitoring process is occurring. Both designs have undergone significant modification based on the monitoring data collected and both are still in the prototype stage. Please note that these examples are presented for informational purposes only. While these Experimental BMPs appear to be effective at controlling some types of pollutants, Ecology is not in a position to confirm or deny their efficacy at this time.

The two Experimental BMPs that are currently under development are a catchbasin filter system designed by Emcon Northwest, and a compost stormwater treatment system designed by W&H Pacific.

Catchbasin Filter System

EMCON Northwest, Inc. has recently developed a catchbasin filter (patent pending) that prevents sediments and other contaminants from entering storm drainage systems. The catchbasin filter is inserted in the catchbasin just below the grating. The catchbasin filter is equipped with a sediment trap and up to three layers of a fiberglass filter material (see Figure II-5.26). This type of system may not be applicable in all catchbasins but would work well at construction sites, industrial facilities, service stations, marinas/boatyards, etc.

During research and development of the catchbasin filter, EMCON Northwest, Inc. has found that particulates as small as 15 microns are retained by the filter. Additionally, high levels of particulate heavy metals, oil and grease and TSS have been removed at both industrial facilities and construction sites. This system would be useful in small drainage areas, and for treatment of highly turbid runoff prior to discharge.

For further information, contact John MacPherson at EMCON Northwest Inc., (206) 485-5000.

Compost Stormwater Treatment System

W&H Pacific worked with the Washington County Dept. of Land Use and Transportation (WCDLUT), Oregon, to develop this experimental BMP. The United Sewage Agency (USA) provided sampling and laboratory analysis for the project; the Portland Metropolitan Service District (Metro) provided additional funding; and the University of Washington College of Forest Resources was contracted to perform bench-scale

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leaching and adsorption capacity tests on selected composts. The compost chosen for the prototype facility was made from deciduous leaves collected in the fall; other types of compost evaluated were not satisfactory.

This project is a good example of intergovernmental cooperation and interaction between public and private sectors in developing new and potentially cost-effective technology for stormwater pollution control. The goal of the project was to effectively treat road runoff using a BMP which reduced the amount of land necessary.

The prototype test facility is located at S.W. 185th Avenue in Washington County, Oregon, and serves a total drainage area of 72 acres. The facility is designed for a peak hydraulic loading of 6.7 cfs (one-third the 2-year design storm). Higher flows are bypassed. Nine storms were monitored in 1991, and the system has been successful in removing, to low levels, many types of conventional pollutants .

The prototype facility utilized 3% of the land area required for a properly designed stormwater detention pond sized for the same site conditions.

The project recently won an Engineering Excellence Grand Award from the Consulting Engineers Council of Oregon, as well as a national Grand Award from the American Consulting Engineers Council.

For further information on this experimental BMP, contact Bill Stewart at W&H Pacific, (503) 626-0455.

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APPENDIX AI-2.1

DERIVATION OF THE WATER QUALITY DESIGN STORM

In instances where the stormwater management requirement is treatment to remove pollutants only without an additional requirement to control peak rate discharge there arises the need to establish an appropriate design storm for sizing of treatment BMPs. This design storm needs to be the minimum size to provide treatment of all the runoff volume from the site except that from relatively rare floods. Sizing a treatment facility for infrequent storms would result in a large facility that would be greatly under-utilized most of the time. The cost becomes prohibitive to treat a few extra percent of the total runoff volume.

TABLE AI-2.1 ANALYSIS OF SEA-TAC RAINFALL FROM 1950 - 1977 (Prepared by Resource Planning Associates (1))

Storm Event Size	Precip. Amount	# of Events	Rainfall Amount of Larger Events	Proportion of Total[2]
1-month, 24-hr.	0.65"	390	415"	62%
6-month, 24-hr.	1.35"	58	101"	91%
1-year, 24-hr.	1.60"	31	55"	95%
2-year, 24-hr.	2.00"	9	23"	98%

[2] The total rainfall from 1950 to 1977 was 1,100". The proportion of total represents the amount of rainfall accounted for by that storm size, and smaller sizes. For example the 1-month, 24-hour storm, and smaller storms, accounted for 1,100 - 415/1,100 = 62%.

Table AI-2.1 shows that relatively small storms account for a considerable proportion of the total rainfall; for example the 6-month, 24-hour, and smaller storms, accounted for over 90% of the total rainfall during the period 1950 through 1977; 98% of the rainfall was accounted for by storm sizes up to the 2-year, 24-hour storm. Of course the proportion of runoff produced by the rainfall for any particular surface type will increase with increasing storm size. On the other hand, smaller storms may tend to produce runoff with higher concentrations of some pollutants because of the "first flush" effect which may occur in highly impervious areas following a dry spell. Therefore, as a first approximation, it seems reasonable to simply assume that the proportion of rainfall is approximately equal to the proportion of runoff.

Having arrived at this point, the next step is to decide what is an appropriate runoff proportion to use in sizing the water quality storm. Ideally we would want to treat 100% of all runoff but the data in Table AI-2.1 show that the incremental proportion of rainfall (and hence runoff) accounted for rapidly diminishes for storm sizes larger than the 6-month, 24-hour storm. This means that the marginal costs for treating stormwater will rapidly increase when facilities are sized for storms larger than the 6-month, 24-hour storm. This point is demonstrated by considering a simple example using a one acre urban site with a curve number of 95 and time of concentration of 10 minutes. Using the SBUH method the following peak runoff rates and runoff volumes were obtained:

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Storm Event	Precip.	Peak Runoff	Volume
1-mo., 24-hr.	0.65"	0.061 cfs	1000 cu-ft
6-mo., 24-hr.	1.3"	0.21 cfs	3000 cu-ft
1-yr., 24-hr.	1.6"	0.28 cfs	4010 cu-ft
2-yr., 24-hr.	2.0"	0.38 cfs	5380 cu-ft

Since the treatment facility size will be in proportion to the peak runoff or runoff volume we can next compare the facility size required for each design storm with the proportion of total runoff generated by that and smaller storms (estimated from Table AI-2.1). (For this example we can use the total runoff volume as the indicator of required facility size.)

Storm Event	Facility Size	Proportion of Runoff
1-mo., 24-hr.	1000 cu-ft	62%
6-mo., 24-hr.	3000 cu-ft	91%
1-yr., 24-hr.	4010 cu-ft	95%
2-yr., 24-hr.	5380 cu-ft	98%

From this we can calculate that greatly diminishing returns are achieved by increasing the facility size beyond that needed for the 6-month, 24-hour storm. Sizing the facility for a 1-year, 24-hour storm instead of a 6-month storm requires an increase of about 33% for an increase of only 4% of volume treated from an already high value of approximately 90%. Further increasing the size to that required for the 2-year, 24-hour storm requires a further increment of about 36% for a further gain of only 3% in the long term runoff volume treated.

Therefore, as a first approximation, it seems reasonable to select the 6-month, 24-hour design storm as the Water Quality design storm.

(However, protection of beneficial uses in receiving waters will always be required. Therefore there may be instances, depending on the nature of the pollutants to be controlled and the receiving waters, that the 6-month storm will be deemed inadequate by the local government and/or Ecology or other State agencies. In these instances a larger design storm shall be chosen.)

Having selected the 6-month, 24-hour design storm as the first approximation, the next step is to determine a method for estimating the size of the storm, given that the isopluvial maps do not provide values for less than the 2-year storm. One method is to plot the logarithm of the return period against the precipitation value for the published storms - the 2, 5, 10, 25, 50 and 100-year frequencies. This was done for several locations around the Puget Sound basin - Bellingham, Everett, Seattle, Tacoma and Olympia. In each case a near perfect regression line was obtained, except that the slope and intercept varied in accordance with the differences in rainfall received at the various locations. Each regression line was then extrapolated to the 6-month frequency and rainfall value estimated. The ratio of the 6-month value to the 2-year value was then determined for each station. This ratio was found to average 0.64 with little variation between the stations. Therefore, for a rule of thumb method, the 6-month, 24-hour design storm can be estimated for any location within the Puget Sound basin as 0.64 times the 2-year, 24-hour storm value.

References:

(1) Resource Planning Associates, Water Quality Best Management Practices Manual for the City of Seattle, 1989.

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APPENDIX AI-2.2

ADDITIONAL BASIN PLANNING GUIDANCE AS APPLIED TO THE MINIMUM REQUIREMENTS

Basin Planning Applied to Source Control (Minimum Requirement #3)

Basin plans should identify potential sources of pollution and develop strategies to eliminate or control these sources to the fullest extent possible. At a minimum, a basin plan should include the following source control strategies:

(1) Detection and correction of illicit discharges to storm sewer systems, including the use of dry weather sampling and dye-tracing techniques;
(2) Identification of existing businesses, industries, utilities, and other activities which may store materials susceptible to spillage or leakage of pollutants into the storm sewer system;
(3) Elimination or control of pollutant sources identified in (2);
(4) Identification and control of future businesses, industries, utilities, and other activities which may store materials susceptible to spillage or leakage of pollutants into the storm sewer system;
(5) Training and Public education

Basin Planning Applied to Runoff Treatment (Minimum Requirement #4)

Basin plans should develop runoff treatment standards to reduce pollutant loads based on an evaluation of the water resources to be protected within or downstream of a watershed. The evaluation must include an analysis of existing and future conditions. Additional levels of control beyond Minimum Requirement #4 may be justified in order to control the impacts of future development. While direct cause-and-effect impacts will rarely be known for future development, standards should be developed based on an evaluation of pollutant loads and modeling of receiving water conditions.

Runoff treatment standards developed from a basin plan must apply to individual development sites. Regional treatment BMPs, in general, will not be considered an acceptable substitute for on-site treatment standards for two primary reasons. One is the stream systems upstream of regional facilities are defined as waters of the state and shall be protected (i.e., they are not to be considered as simply conveyance systems to the regional facility). Second, the pollutant removal effectiveness of regional treatment BMPs has not been demonstrated to be equivalent to on-site treatment BMPs. Regional BMPs may offer some advantages in construction and operation and maintenance costs and Ecology may approve such BMPs on a case-by-case basis.

On-site standards developed from basin planning can be flexible provided that the level of runoff treatment for all sites in a watershed is equivalent to that which would be achieved by Minimum Requirement #3. For example, site A may be able to achieve a higher pollutant load reduction goal than site B and this is acceptable provided that the two sites together achieve the equivalent level of treatment provided by the Minimum Requirement #3.

Basin plans shall evaluate retrofitting opportunities, such as installation of extended detention outlets for existing stormwater detention facilities.

Basin Planning Applied to Streambank Erosion Control (Minimum Requirement #5)

Basin planning is well-suited to control streambank erosion for both existing and future conditions. Streambank erosion control standards developed from a basin plan may include a combination of on-site, regional, and stream protection/rehabilitation

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measures. On-site standards shall be the primary mechanism to protect streambanks from the impacts of future conditions. Regional streambank erosion control BMPs are to used primarily to correct existing downstream streambank erosion problems. Stream protection/rehabilitation measures may be applied wherever streambank erosion problems currently exist which will not be corrected by on-site or regional BMPs.

Basin Planning Applied to Wetlands and Water Quality Sensitive Areas (Minimum - Requirements #6 and #7, respectively)

Basin planning should be used to develop additional protection standards for wetlands and water quality sensitive areas. These standards must include source control, runoff treatment, and streambank erosion control standards. Additional standards may also be developed which are specific to the needs of the wetland or sensitive area to be protected, such as management of a wetland's hydrology and hydroperiods, establishment of buffer zones for wellheads, and ground water contributing and recharge zones, and management of streamflows for the benefit of fish populations.

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CHAPTER I-3

PREPARATION OF STORMWATER SITE PLANS

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CHAPTER I-3

PREPARATION OF STORMWATER SITE PLANS

I-3.1 INTRODUCTION

The purpose of this chapter is to provide summarized guidelines on how Erosion and Sediment Control (ESC) Plan and Permanent Stormwater Quality Control (PSQC) Plans, the plans which make up a Stormwater Site Plan (SSP) can be prepared. The thresholds and Minimum Requirements for these plans are described in detail in Chapter I-2. More details on plan preparation with examples of forms and submittal requirements are provided in the "Stormwater Program Guidance Manual for the Puget Sound Basin", (known hereafter as the Guidance Manual), a companion manual to this technical manual available from the Urban Nonpoint Management Unit.

The goal of this chapter is to provide a framework for uniformity in plan preparation. Such uniformity will promote predictability throughout the region and help secure prompt governmental review and approval. Properly drafted engineering plans and supporting documents will also facilitate the operation and maintenance of the proposed system long after its review and approval.

Please note that this chapter describes <u>how</u> to prepare a Stormwater Site Plan - the specific BMPs and design methods and standards to be used are contained in Volumes II-IV. ESC plans are covered in detail in Chapter II-4, and an example ESC plan is shown (to be drafted) in the Guidance Manual. Guidelines for selecting BMPs are given in Chapter I-4. Note also that all plans, except small parcel plans, shall be stamped by a professional engineer licensed in the State of Washington. All land boundary surveys used, and any legal descriptions prepared, except those for small parcels, must be stamped by a professional land surveyor licensed in the State of Washington.

I-3.2 REQUIREMENTS AND CONTENTS OF STORMWATER SITE PLANS

Three types of stormwater site plans are covered here. The first is a Small Parcel Erosion and Sediment Control (SPESC) Plan. Small parcels, such as individual single family dwellings cause water quality problems during the construction period rather than after construction (except in aggregate, which is addressed elsewhere). As a result, the small parcel Minimum Requirements (Chapter I-2) and Small Parcel BMPs (Chapter II-4) intentionally address ESC-related concerns.

The second type of plan is a hybrid of the simpler Small Parcel ESC and the more elaborate Stormwater Site Plan (SSP). Proposed developments with >5,000 ft^2 of impervious surface and land disturbing activities of <1 acre planned shall implement the Small Parcel ESC Plan. The Minimum Requirements for these plans are found in section I-2.2. In addition to the Small Parcel ESC Plan, developments of this size are required to implement a full-scale Permanent Stormwater Quality Control Plan (PSQC) which satisfies the remaining Minimum Requirements found in Chapter I-2.

Lastly, new development or redevelopment which meets the criteria set forth in Section I-2.4 must develop and implement both a full-scale ESC and SSP.

I-3.3 SMALL PARCEL EROSION AND SEDIMENT CONTROL PLANS

The following new development shall be required to control erosion and sediment during construction, to permanently stabilize soil exposed during construction, to comply with the Small Parcel Requirements 1 through 4, and to prepare a SPESC:

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Figure I-3.1 Checklist for Small Parcel Minimum Requirements (adapted from the City of Redmond)

The applicant shall submit two copies of a site improvement and drainage plan on 8½ by 11" paper showing the following:

- ☐ Provide the name, address, and phone number of owner or contact person.
- ☐ Designate north arrow, lot number and plat, address, date and street name fronting structure.
- ☐ Show all proposed structures and any existing structures on the site.
- ☐ Locate and size all streams, swales or drainage channels on or within 25 feet of the site which may involve or affect the drainage of the site to be developed. Indicate all existing stormwater pipes.
- ☐ Indicate the direction and location of surface water runoff entering the site from all adjacent property.
- ☐ Indicate what type of system(s) will be used to convey runoff away from the proposed structures.
- ☐ Phase clearing so that only those areas that are actively being worked are uncovered. From October 1 through April 30, no soils shall remain exposed for more than 2 days. From May 1 through September 30, no soils shall remain exposed for more than 7 days.
- ☐ Indicate where excavated basement soil stockpiles (if applicable) will be located. The stockpile should be covered until the stockpile is either used or removed. Piles should be situated so that sediment does not run into the street or adjoining yards.
- ☐ Backfill basement walls, where applicable, as soon as possible and rough grade the lot.
- ☐ Remove excess soil from the site as soon as possible after backfilling.
- ☐ Stabilize denuded areas of the site by mulching, seeding, planting, or sodding.
- ☐ Adjacent properties shall be protected from sediment deposition by appropriate use of vegetative buffer strips, sediment barriers or filters, dikes or mulching, or by a combination of these measures and other appropriate BMPs.
- ☐ If a lot has a soil bank higher than the curb, a trench or berm should be installed moving the bank several feet behind the curb. This will reduce the occurrence of gully and rill erosion while providing a storage and settling area for stormwater.
- ☐ Construction vehicle access shall be, whenever possible, limited to one route. Indicate the location of the construction entrance. Apply gravel or crushed rock to the driveway area and restrict truck traffic to this one route. Driveway paving can be installed directly over the gravel. This measure requires periodic inspection and maintenance including washing, top-dressing with additional stone, reworking and compaction.

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- Provide for periodic street cleaning to remove any sediment that may have been tracked out. Sediment should be removed by shovelling or sweeping and carefully removed to a suitable disposal area where it will not be re-eroded.

- Inspect all erosion and sediment control BMPs installed regularly, especially after any large storm. Maintenance, including removal and proper disposal of sediment should be done as necessary (generally when one-half or more of the total capacity of the system is filled with sediment).

For further information on small parcel BMPs, please see Chapter II-5, Section II-5.10.

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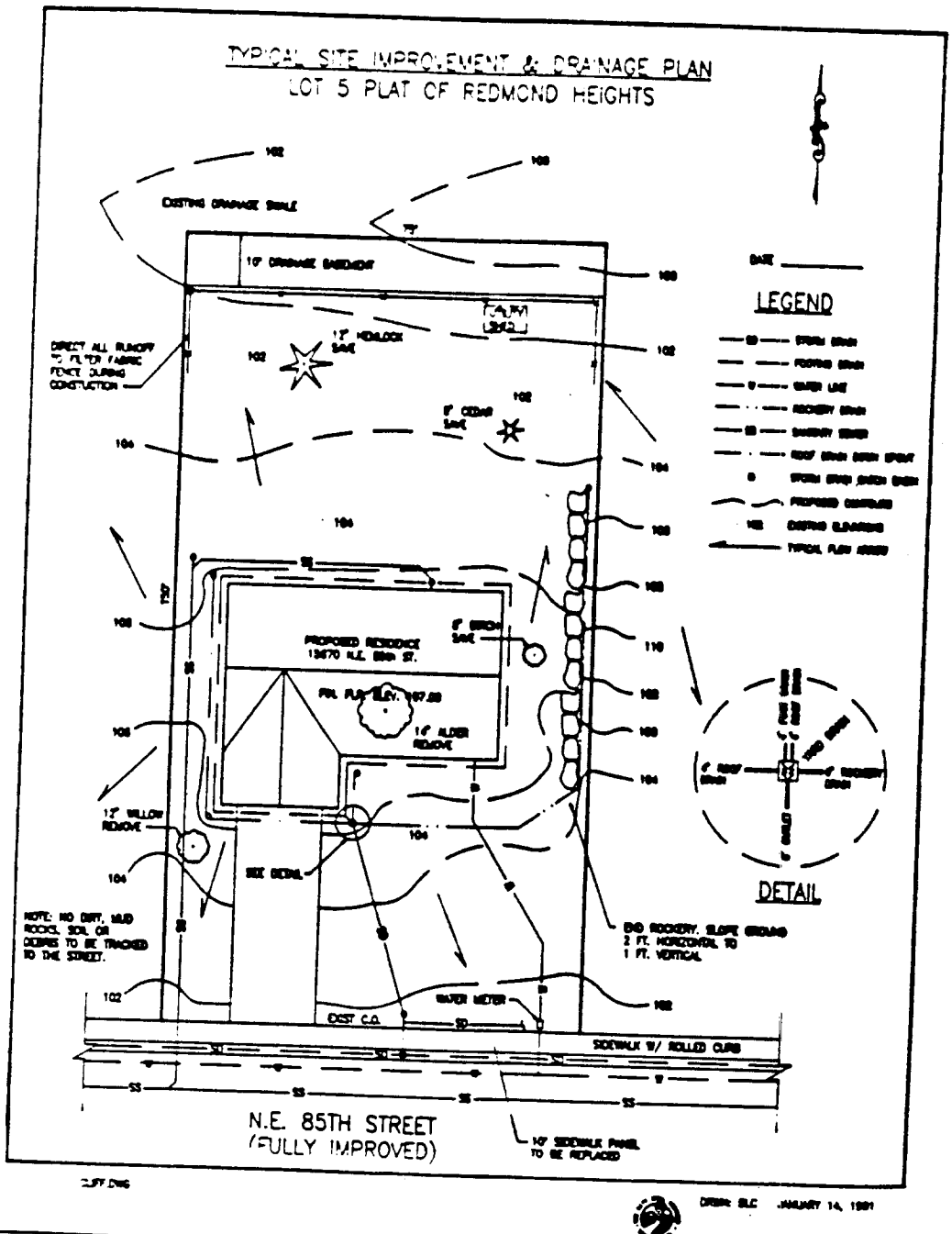
Figure I-3.2 Typical Site Improvement and Drainage Plan



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(a) Individual, detached, single family residences and duplexes.
(b) Creation or addition of less than 5,000 square feet of impervious surface area.
(c) Land disturbing activities of less than 1 acre.

The contents of a Small Parcel ESC Plan will depend upon the exact nature of the project. It will generally contain some elements of the full ESC as determined by the local government. The Small Parcel ESC must describe how the small parcel erosion control requirements will be met.

A Small Parcel ESC Plan should contain a plot plan which includes:

- A vicinity map to clearly locate property
- An accurate location of the structure and its access
- All applicable setback requirements
- Location of all applicable ESC BMPs
- Existing site features or water quality sensitive areas, if appropriate.

The checklist found in Figure I-3.1 can also be used.

All proposed developments where >5,000 ft^2 of impervious surface and land disturbing activities of <1 acre are planned, shall implement the Small Parcel Requirements found in section I-2.2. In addition to the Small Parcel ESC Plan, developments of this size are required to implement a full-scale Stormwater Site Plan which satisfies the remaining Minimum Requirements found in Chapter I-2.

I-3.4 LARGE PARCEL EROSION AND SEDIMENT CONTROL PLANS

As set forth in Chapter I-2, all new development and redevelopment that includes *land disturbing activities* over an area 1 acre and greater requires an ESC Plan as a subset of the Stormwater Site Plan (SSP). Land disturbing activities are defined as any activity that results in a change in the existing soil cover (both vegetative and nonvegetative) and/or the existing topography. Land disturbing activities include construction, clearing, grading, filling, and excavation.

A Large Parcel Erosion and Sediment Control Plan (ESC Plan) shall provide for the interception and treatment of all potential silt-laden runoff that could occur during clearing, grading, construction and site stabilization. The ESC Plan must provide measures to assure that no silt-laden runoff leaves the site during construction and stabilization. As mentioned earlier, if only land disturbing activities are proposed, only a LPESC Plan is required. Also, relevant parts of the SSP should be included when only a ESC Plan is required, these include a plot plan and preliminary conditions summary.

A Large Parcel Erosion and Sediment Control Plan should, at a minimum, include the following:

- Location of clearing limits and easements, setbacks, water quality sensitive areas and their buffers.
- Locations and descriptions of all erosion and sediment control measures for each phase of construction.
- Cross sections of fill or excavations.

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Figure I-3.3 Flowchart Showing Various Development Types

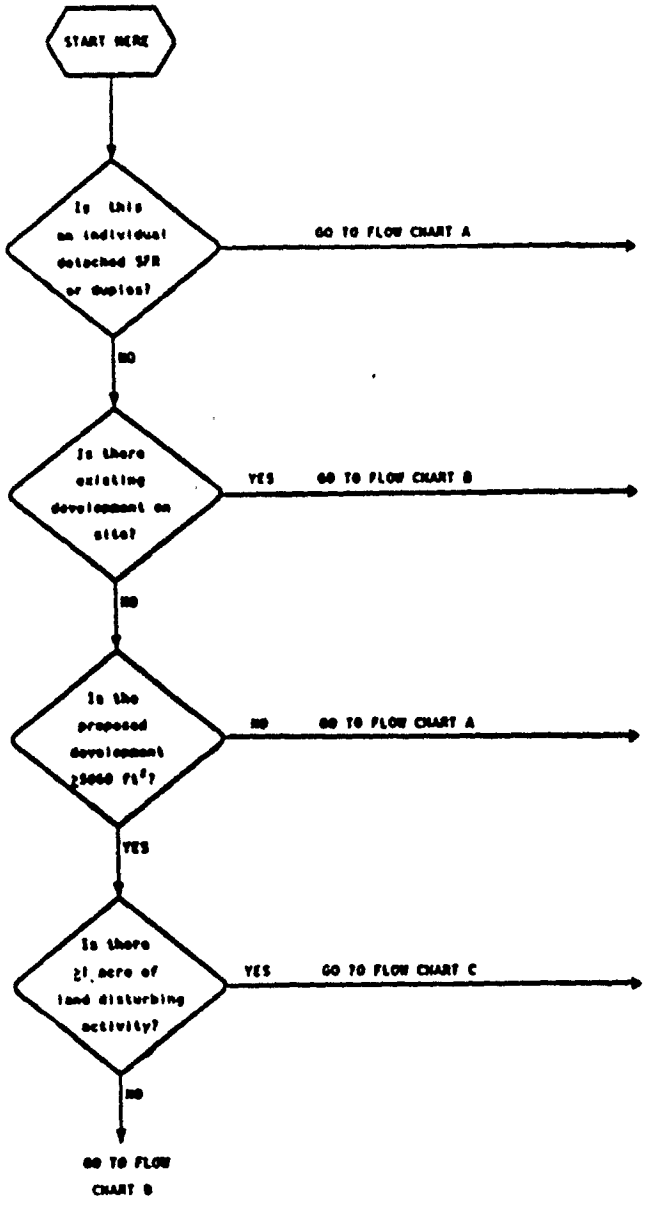

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Figure I-3.4 Flowchart Showing Steps for Small Parcels

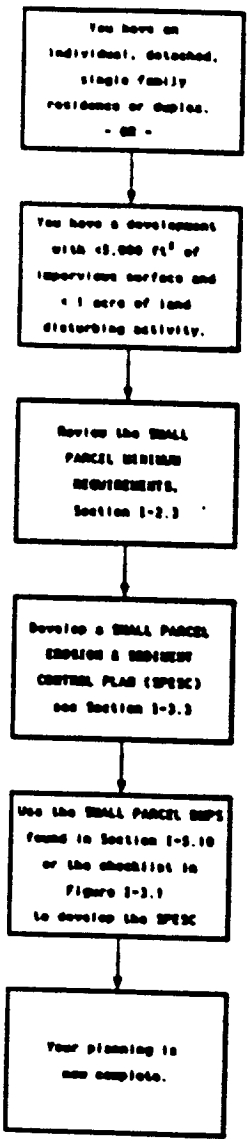

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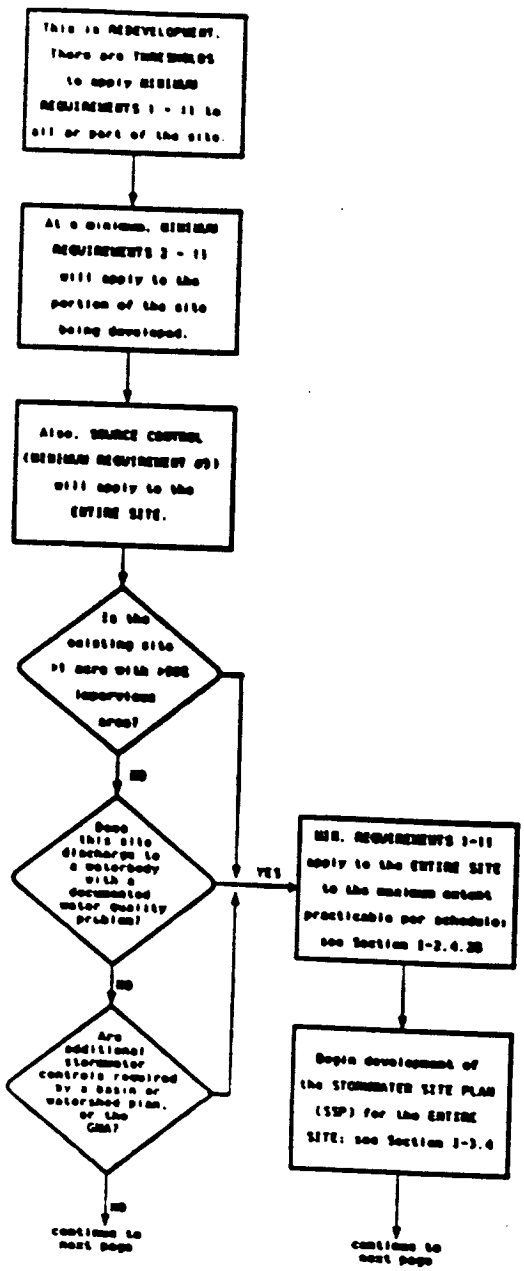
Figure I-3.5 Flowchart Showing Steps for Redevelopment



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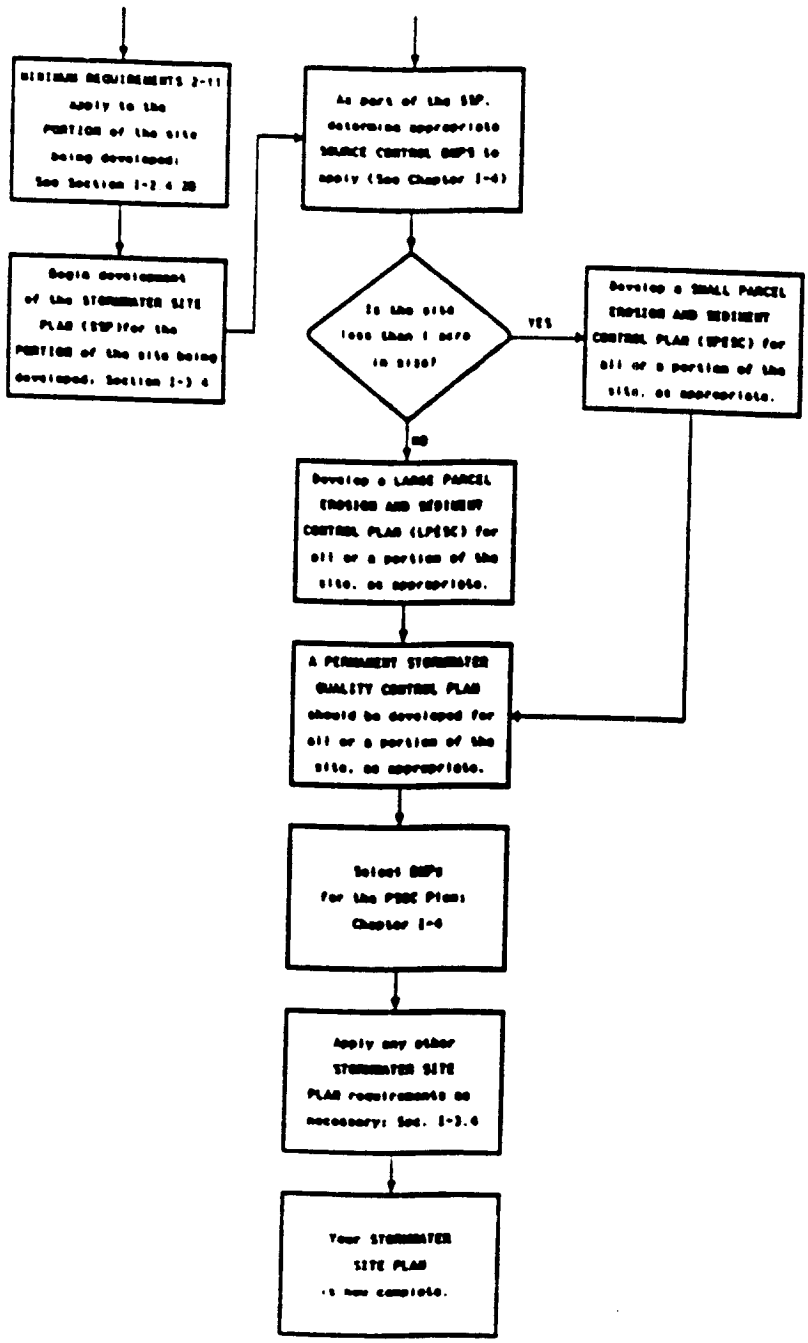

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Figure I-3.6 Flowchart Showing Steps for New Development

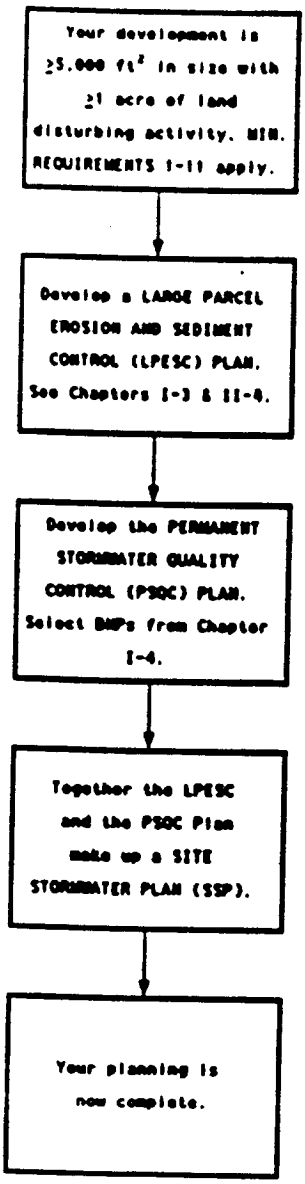

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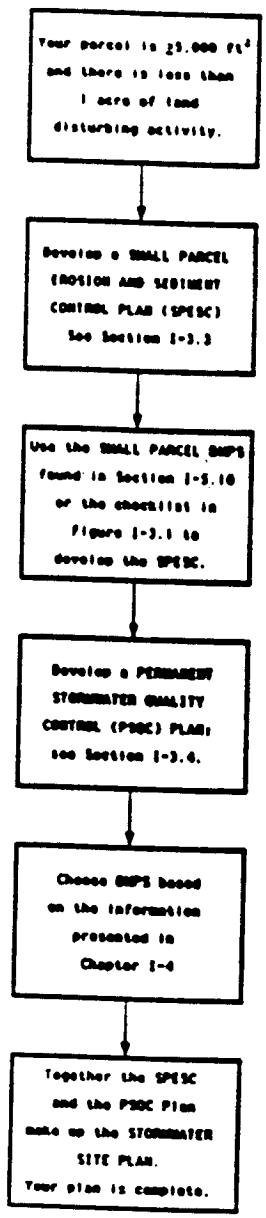
Figure I-3.7 Flowchart Showing Steps for "Hybrid" Projects



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ESC plans are explained in detail in Chapter II-4, and an example ESC Plan (to be drafted) is shown in the Guidance Manual.

I-3.5 STORMWATER SITE PLANS

The Puget Sound Water Quality Management Plan (PSWQMP) requires that all jurisdictions within the Puget Sound Basin adopt ordinances requiring stormwater controls (for example, site plans, including ESC plans) for all new development and redevelopment as defined below.

New Development Standard

New development - means the following activities: land disturbing activities, structural development, including construction, installation or expansion of a building or other structure; creation of impervious surfaces; Class IV - general forest practices that are conversions from timber land to other uses; and subdivision, short subdivision and binding site plans, as defined in Ch.58.17.020 RCW. All other forest practices and commercial agriculture are not considered new development.

All new development that includes the creation or addition of 5,000 square feet, or greater, of new impervious surface area, and/or land disturbing activity of one acre or greater, shall comply with Minimum Requirements #1 through #11 in Sections I-2.5 through I-2.15 and prepare a Stormwater Site Plan.

All new development that includes the creation or addition of 5,000 square feet, or greater, of new impervious surface area, and land disturbing activity of less than one acre, shall comply with Minimum Requirements #2 through #11 in Sections I-2.6 through I-2.15 and the Small Parcel Minimum Requirements found in section I-2.2, above. This category of development shall also prepare a Stormwater Site Plan that includes a Small Parcel Erosion and Sediment Control Plan.

This section does not apply to the construction of individual, detached, single family residences and duplexes. Those types of new development are included in the Small Parcel Minimum Requirements.

Redevelopment Standard

Redevelopment - means, on an already developed site, the creation or addition of impervious surfaces, structural development including construction, installation or expansion of a building or other structure, and/or replacement of impervious surface that is not part of a routine maintenance activity; and land disturbing activities associated with structural or impervious redevelopment.

A. Where redevelopment of ≥ 5,000 square feet occurs:

   The new development Minimum Requirements, Sections I-2.5 through I-2.15, shall apply to that portion of the site that is being redeveloped, and source control BMPs shall be applied to the entire site, including adjoining parcels if they are part of the project.

B. Where one or more of the following conditions apply, a Stormwater Site Plan shall be prepared that includes a schedule for implementing the Minimum Requirements to the maximum extent practicable, for the entire site, including adjoining parcels if they are part of the project. An adopted and implemented basin plan (Minimum Requirement #9) may be used to develop redevelopment requirements that are tailored to a specific basin.

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1. Existing sites greater than 1 acre in size with 50% or more impervious surface.

2. Sites that discharge to a receiving water that has a documented water quality problem.

A documented water quality problem includes, but is not limited to water bodies:

(i) Listed in reports required under section 305(b) of the Clean Water Act, and designated as not supporting beneficial uses;

(ii) Listed under section 304(l)(1)(A)(i), 304(l)(1)(A)(ii), or 304(l)(1)(B) of the Clean Water Act as not expected to meet water quality standards or water quality goals;

(iii) Listed in Washington State's Nonpoint Source Assessment required under section 319(a) of the Clean Water Act that, without additional action to control nonpoint sources of pollution cannot reasonably be expected to attain or maintain water quality standards.

3. Sites where the need for additional stormwater control measures has been identified through a basin plan.

The Stormwater Site Plan (SSP) should be a comprehensive report containing all technical information and analysis necessary to evaluate the proposed stormwater facilities. In addition, the SSP should provide the necessary information to prepare final construction plans, profiles, details, notes and specifications for all stormwater facilities.

The Stormwater Site Plan contains the following sections:

I. Project Overview
II. A plot plan, including:
- locations of structures, other impervious surfaces
- locations of stormwater runoff control facilities
- lot layout
- setback requirements
- existing site features
- water quality sensitive areas
- road rights-of-way and easements

III. Preliminary Conditions Summary
IV. Off-Site Analysis
V. Analysis and design of proposed stormwater runoff control facilities, including treatment and source control BMPs, and streambank erosion control requirements.
VI. Special Reports and Studies
VII. Basin and Community Planning Areas
VIII. Other Permits
IX. Erosion and Sediment Control Plan (see I-3.4)
X. Bond Quantities Worksheet, Retention/Detention Facility Summary Sheet and Sketch, and Declaration of Covenant
XI. Maintenance and Operations Manual

The SSP must be stamped and dated by a professional civil engineer licensed in the State of Washington. Every SSP should contain each of the sections listed above.

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If a section does not apply, the applicant may simply mark with "N/A." This standardized format will allow a quicker, and more efficient review of information. A consistent format will also provide accurate, time efficient researching of SSPs approved for other projects in the same basin.

Additional information may be required if the development impacts water quality sensitive areas. The extent of the additional information which will be required can be estimated at the initial application screening, but not determined definitively until as late as the SEPA Threshold Determination.

For further details on the SSP consult the local government, and the Guidance Manual.

I-3.6 OTHER PERMITS AND PLAN REQUIREMENTS

Other agencies, such as those listed below, may require a stormwater site plan to describe the proposed project's impact on surface, ground and stormwater. The applicant should take care to note that these other agency requirements are separate from, and in addition to, the local government's requirement for a stormwater site plan. The applicant is responsible to coordinate joint agency review. Some permits or applications can be reviewed simultaneously by more than one agency; others may require the applicant to obtain one type of permit or approval prior to another agency's review. Agency Permit/Approvals that may be necessary include but are not limited to:

AGENCY	REQUIREMENT
Washington State Department of Transportation	Developer/Local Agency Agreement
Washington State Department of Ecology	Short Term Water Quality Modification Approval and/or Dam Safety Permit
Washington State Department of Fisheries	Hydraulic Project Approval
Washington State Department of Wildlife	Hydraulic Project Approval
United States Army Corps of Engineers	Section 404 Permit & Section 10 Permit/letter of permission

The publication "Commonly Required Environmental Permits for Washington State" #90-29 is now available from the Department of Ecology. It covers these permit requirements (and many more) in a general fashion, and directs the reader to the proper agency for assistance.

I-3.7 PLAN REVIEW PROCEDURES: FORMS AND WORKSHEETS

The Guidance Manual provides examples of the following forms and worksheets:

A Predesign meeting form
B Stormwater site plan worksheet
C Summary of site drainage conditions
D Retention/detention summary sketch and sheet

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E Declaration of covenant
F Bond quantities worksheets
G Drainage release covenant
H Drainage easements

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CHAPTER I-4

BMP SELECTION PROCESS FOR

PERMANENT STORMWATER QUALITY CONTROL PLANS

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CHAPTER I-4

BMP SELECTION PROCESS FOR PERMANENT STORMWATER QUALITY CONTROL PLANS

I-4.1 INTRODUCTION

The purpose of this chapter is to provide guidance for selecting permanent BMPs for new development and redevelopment sites (including retrofitting of redevelopment sites). The task of selecting BMPs is necessary in order to complete the Permanent Stormwater Quality Control Plan, an important component of the Stormwater Site Plan (see Chapters I-2 and I-3 for guidance on these plans). Please note that guidelines for the Erosion and Sediment Control Plan and appropriate BMPs are not covered in this chapter; for guidance on these BMPs refer to Volume II of this manual.

Ecology's pollution control strategy is to first emphasize pollution *prevention* and, second, pollution *treatment*. By preventing pollution from occurring in the first place the need for treatment can be reduced or, in some cases, eliminated. The three stormwater control objectives that are intended to implement this strategy, and the classification of BMPs for each objective, are the following:

(i) Pollution prevention using *source control* BMPs
(ii) Pollution treatment using *runoff treatment* BMPs
(iii) Protection of stream ecosystems from erosion and sedimentation using *streambank erosion control* BMPs

The classification system for BMPs is presented in Section I-4.2. A step-by-step process for selecting BMPs is provided in Section I-4.3.

I-4.2 CLASSIFICATION OF BMPs

BMPs have been classified based on their ability to implement the pollution control strategy described above. Pollution prevention is accomplished through the use of source control BMPs. Treatment is provided by runoff treatment BMPs. A third classification that overlaps both prevention and treatment is that of streambank erosion control. Figure I-4.1 provides a schematic of the classification system and Table I-4.1 lists the BMPs according to this system.

Note: Table I-4.1 does not include natural and created wetlands as these are not considered to be BMPs. The primary stormwater management objective for natural wetlands will be to protect or enhance the beneficial uses of these systems. This means that stormwater must be treated prior to discharge to these wetlands. It does not mean that stormwater discharges to natural wetlands are prohibited; if this were to occur then these wetlands would be severely damaged or lost. See Minimum Requirement #6 and Chapter III-5 for stormwater management guidance for natural wetlands.

Table I-4.1 does include a Constructed Wetland (BMP RD.09); this is an artificial wetland located on a non-wetland site for the exclusive purpose of managing stormwater. Created wetlands designed for a mitigation project should not be used for stormwater treatment as stormwater may be detrimental to the beneficial uses being mitigated for (e.g. wildlife habitat or contact recreation).

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Table I-4.1
List of All Source Control, Runoff Treatment, and Streambank Erosion Control BMPs

BMP Category and Name		Source Control	Runoff Treatment	Streambank Erosion Control
(a) Infiltration and Filtration BMPs (Chapter III-3)				
BMP RI.05	WQ Infiltration Basin		X	0
BMP RI.06	SBEC Infiltration Basin			X
BMP RI.10	WQ Infiltration Trench		X	0
BMP RI.11	SBEC Infiltration Trench			X
BMP RI.15	Roof Downspout System		X	0
BMP RI.20	WQ Porous Pavement		X	0
BMP RI.21	SBEC Porous Pavement			X
BMP RI.30	WQ Concrete Grid/Modular Pavement		X	0
BMP RI.31	SBEC Concrete Grid/Modular Pavement			X
BMP RF.05	Sand Filtration Basin		X	
BMP RF.10	Sand Filtration Trench		X	
BMP RF.15E	Aquatard System (Experimental)		X	
(b) Detention BMPs (Chapter III-4)				
BMP RD.05	Wet Pond (Conventional Pollutants)		X	0
BMP RD.06	Wet Pond (Nutrient Control)		X	0
BMP RD.09	Constructed Wetland		X	0
BMP RD.10	Presettling Basin		X(p)	
BMP RD.11	Extended Detention Dry Pond		X(p)	X
BMP RD.15	Wet Vault/Tank		X	0
BMP RD.20	Extended Detention Dry Vault/Tank			X
(c) Biofiltration BMPs (Chapter III-6)				
BMP RB.05	Biofiltration Swale		X	
BMP RB.10	Vegetative Filter Strip		X	

WQ = "Water Quality" SBEC = "Streambank Erosion Control"
X - Provided by this BMP
X(p) - Provides pretreatment only
0 - Option; can be provided with proper planning and design

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Table I-4.1 (continued)
List of All Source Control, Runoff Treatment, and Streambank Erosion Control BMPs

BMP Category and Name		Source Control	Runoff Treatment	Streambank Erosion Control
(d) Oil/Water Separators (Chapter III-7)				
BMP RO 05	Spill Control (SC) Oil/Water Separator		X	
BMP RO 10	API Oil/Water Separator		X	
BMP RO 15	CPS Oil/Water Separator		X	
(e) Stream Stabilization BMPs (Chapter III 8)				
BMP RS 05	Vegetative Streambank Stabilization	X		X
BMP RS 10	Bioengineering Methods	X		X
BMP RS 15	Structural Streambank Stabilization	X		X
(f) Source Control for Urban Land Uses (Chapter IV-4)				
BMP S1.10	Fueling Stations	X		
BMP S1.20	Vehicle/Equipment Washing and Steam Cleaning	X		
BMP S1.30	Loading and Unloading Liquid Materials	X		
BMP S1.40	Above Ground Tanks for Liquid Storage	X		
BMP S1.50	Container Storage of Liquids, Food Wastes or Dangerous Wastes	X		
BMP S1.60	Outside Storage of Raw Materials, By products or Finished Products	X		
BMP S1.70	Outside Manufacturing Activities	X		
BMP S1.80	Emergency Spill Cleanup Plans	X		
BMP S1.90	Vegetation Management/Integrated Pest Management	X(n)		
BMP S2.00	Maintenance of Storm Drainage Facilities	X(n)		
BMP S2.10	Locating Illicit Connections to Storm Drains	X		
BMP S2.20	Street Sweeping	X(n)		

WQ = "Water Quality" SBEC = "Streambank Erosion Control"
X - Provided by this BMP
X(n) - These may also be used as source control BMPs when nutrient control is required by the Plan Approval Authority
0 - Option; can be provided with proper planning and design

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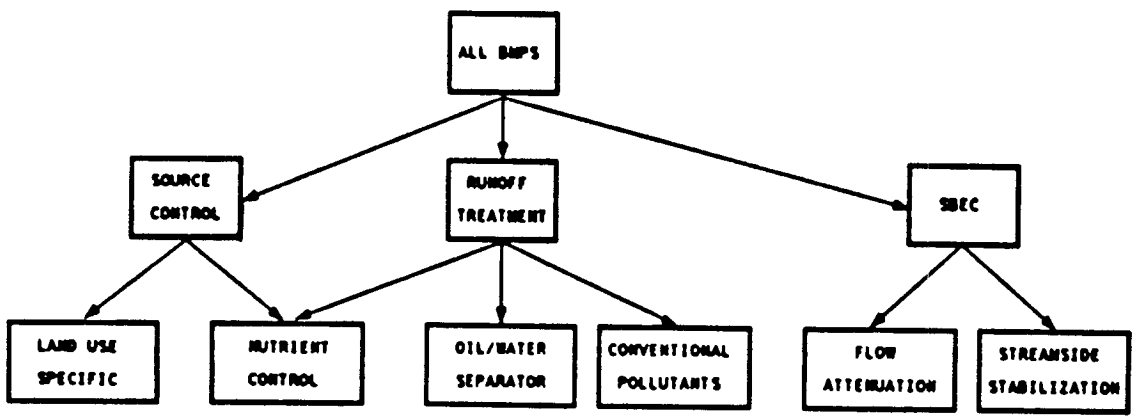
I-4.2.1 Source Control BMPs

Source control BMPs are designed to prevent pollutants from entering stormwater by eliminating the source of pollution or preventing contact of pollutants with rainfall and runoff. Source control BMPs are either specific to the type of land use being proposed for development or are intended to control a specific type of pollution problem existing within a watershed, such as nutrients that may contribute to eutrophication. Examples of source control BMPs include reducing or eliminating use of a pesticide, covering areas used to store chemicals, and street sweeping during dry weather conditions.

Figure I-4.1
Classification of Stormwater BMPs



I-4.2.2 Runoff Treatment BMPs

Runoff treatment BMPs are designed to remove pollutants that are contained in runoff. Treatment BMPs utilize a variety of mechanisms to remove pollutants from stormwater including sedimentation, filtration, plant uptake, ion exchange, adsorption, and bacterial decomposition. Examples of runoff treatment BMPs include infiltration trenches, wet ponds, biofiltration swales, and vegetative filter strips. The goal of runoff treatment BMPs is to provide effective treatment of at least 90 percent of the runoff generated by development. To achieve this goal, these BMPs are sized to treat the 6-month, 24-hour design storm (also referred to as the water quality design storm, or the runoff treatment design storm).

Ecology has identified two categories of pollutants that are targeted for runoff treatment; "conventional" pollutants and "nutrients." Conventional pollutants are those that are typically associated with particulates and that can be treated by a range of BMPs. Examples of conventional pollutants are total suspended solids, heavy metals, and fecal coliform. Nutrients, on the other hand, exist in both suspended and dissolved phases and can be more difficult to control. Examples of

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nutrients are phosphorus and nitrogen. Nutrients can be a concern for both surface water and ground water. Eutrophication of lakes is typically caused by nutrients and ground water contamination by nitrates is also a common problem.

A subcategory of runoff treatment BMPs is those that provide pretreatment in order to protect primary treatment BMPs from siltation. The selection of pretreatment BMPs is described further in the BMP selection process (Section I-4.3) and illustrated in Table I-4.6.

A special category of runoff treatment BMPs includes those designed to remove oil contained in runoff. Oil, being lighter than water, typically floats on top of the water column and different removal techniques may be needed for treatment. Oil will, however, often adhere to suspended solids. Oil concentrations in urban runoff are often too low to justify the use of oil/water separators, but some land uses may require these BMPs, especially when the possibility of spills is present. There are three basic types of oil/water separators. Spill control (SC-type) are designed only to capture spills, while API and CPS-type separators are specifically designed to remove free oil from the water column. Sand filtration BMPs are currently allowed as an interim alternative to API and CPS oil/water separators in this edition of the manual. The ability of sand filtration to remove free oil shows promise but is under further investigation.

I-4.2.3 Streambank Erosion Control BMPs

Streambank erosion control (SBEC) BMPs are designed to prevent or control the excessive erosion that typically occurs in streams located in urbanizing watersheds. This erosion results not only because of the dramatic increase in peak flow rates from runoff but also due to increases in the frequency and duration of high flow conditions. Conventional flood control ponds are only marginally effective at controlling streambank erosion because they control only peak flow rates. The goal of streambank erosion control BMPs is to replicate, to the extent possible, the pre-existing hydrologic regime in streams by attenuating runoff from development sites and slowly releasing it back to the natural system.

The two-year return period storm has been identified as a key event for controlling streambank erosion. The two-year storm is typically the event in which streams are flowing "bankfull," a highly erosive condition. Urbanization increases the frequency and duration of bankfull conditions, thus greatly accelerating the streambank erosion process. Larger storms, such as the 10-year and 100-year events, are also important for streambank erosion control. These storms may periodically alter the morphology of streams and are important for the transport and deposition of sediments necessary for the ecological health of stream systems.

Ecology's streambank erosion control standards attempt to replicate, to the extent practicable, the stream flow conditions that would occur under natural conditions for specified design storms. Accordingly BMPs are to be designed to meet the following on-site detention requirements:

- Limit the peak rate of runoff to 50 percent of the *existing site condition* 2-year, 24-hour design storm, with a correction factor applied;
- Maintain the peak flow rate of runoff for the *existing site condition* 10-year and 100-year, 24-hour storms, with a correction factor applied.

The correction factor is applied to the BMP volume and should range from 20 to 50 percent for sites with impervious cover ranging from 20 to 100 percent. A correction factor is necessary to account for the inadequacies of current hydrologic analysis methods. Improved methods are under development and should be available no later than 1993. See Chapter III-1 for more details.

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Definition: Existing site condition means - (a) For developed sites with stormwater facilities that have been constructed to meet the standards in the Minimum Requirements of this manual, existing site conditions shall mean the existing conditions on the site.

(b) For developed sites that do not have stormwater facilities that meet the Minimum Requirements, existing site conditions shall mean the conditions that existed prior to local government adoption of a stormwater management program. If in question, the existing site conditions shall be documented by aerial photograph records, or other appropriate means.

(c) For all sites in water quality sensitive areas as identified under Minimum Requirement #7, Water Quality Sensitive Areas, existing site conditions shall mean undisturbed forest, for the purpose of calculating runoff characteristics.

(d) For all undeveloped sites outside of water quality sensitive areas, existing site conditions shall mean the existing conditions on the site.

Ecology recognizes, however, that the flow attenuation criteria described above may not be adequate in itself to protect streams since, in many cases, damage may have already occurred. To partially address this, a group of *streamside stabilization* BMPs are provided that are designed to correct *existing* problems (see Table I-4.1).

An additional point to keep in mind is that site-specific BMPs designed to meet the above criteria may only be partially effective at controlling the cumulative effects of runoff from all sites in a watershed. For effective control of streambank erosion it may be necessary to develop and implement watershed-wide strategies that address impacts from both new and existing development on a regional level. Minimum Requirement #9, Basin Planning, is intended to facilitate such strategies.

I-4.2.4 Infiltration

Infiltration is Ecology's highest priority for both runoff treatment and streambank erosion control, provided proper conditions exist for its use. Infiltration can provide multiple benefits, including pollution removal, control of streambank erosion, ground water recharge, and flood control. One condition that can limit the use of infiltration is the need to protect ground water quality. No discharge of *untreated* stormwater to ground water will be allowed. To adequately address the protection of ground water when evaluating infiltration it is important to understand the difference between soils that are suitable for runoff treatment or streambank erosion control, or both. Sufficient organic content to remove pollutants must be present for soils to provide runoff treatment. Examples are silty and sandy loams. These soils may have fairly low percolation rates that could render them infeasible for infiltrating the large volumes of runoff required for streambank erosion control. Coarser soils, such as gravelly sands, can provide streambank erosion control but are wholly inadequate for providing treatment of runoff. The use of coarser soils for infiltrating runoff is allowable, but runoff treatment must *always* precede discharge to these soils. Thus, there will be instances when soils are suitable for treatment but not streambank erosion control, and vice versa.

I-4.2.5 On-line vs. Off-line Configuration

Some BMPs can combine runoff treatment and streambank erosion control into the same facility or can be located together in series; either of these configurations will be called "on-line" systems. In other cases runoff treatment must be provided separate from streambank erosion control; an "off-line" system. On-line systems are typically detention-type BMPs that maintain a "permanent pool" of water for runoff treatment purposes and also have a "live storage" volume above the permanent pool to temporarily detain runoff for streambank erosion control purposes (See Figure I-4.2

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for an illustration of "dead" and "live" storage concepts). Off-line systems are typically those that are not capable of providing streambank erosion control (e.g., water quality infiltration trench) or whose pollutant removal mechanisms are not compatible with providing streambank erosion control (e.g., oil/water separator). The decision as to which configuration to use is discussed in the description of each individual BMP provided in Chapters III-3 through III-7.

The ability of detention-type BMPs to provide both runoff treatment and streambank erosion control into the same facility can be an important one. This feature can be useful for controlling stormwater pollution from existing development sites by retrofitting existing flood control ponds to provide extended detention of the 6-month, 24-hour storm.

I-4.3 STEP-BY-STEP SELECTION PROCESS FOR BMPS

A five step BMP selection process is presented that uses the classification scheme presented in Figure I-4.1. A summary of the steps is depicted in Figure I-4.3; a detailed description follows.

I-4.3.1 STEP 1: DETERMINE STORMWATER CONTROL SCENARIO FROM TABLE I-4.2

The purpose of Step 1 of the BMP selection process is to determine if some or all of the three stormwater control objectives are to be achieved by an individual development, i.e., Source Control, Runoff Treatment, and Streambank Erosion Control.

Use Table I-4.2 to evaluate the eight possible stormwater control scenarios that could apply to a development site. The table presents the appropriate classification and sequence of runoff control BMPs required for each scenario. Upon completion, the user can then proceed to Step 2 to select individual BMPs.

STEP 1A: Determine if Oil/Water Separator BMPs are Required Based on Land Use Type

The requirement to use oil/water separators is dependent upon the specific land use proposed for development. Volume IV describes all of the major urban land use types (both public and private) that are likely to occur in either a proposed new development or in an existing development. While a number of activities may require the use of spill control (SC-type) separators, only a few will necessitate API or CPS-type separators. At a minimum, the following land use types have been identified as requiring API or CPS-type oil/water separators:

- Industrial Machinery and Equipment, Trucks and Trailer Aircraft, Parts and Aerospace, Railroad Equipment
- Log Storage and Sorting Yards
- Airfields and Aircraft Maintenance
- Fleet Vehicle Yards
- Railroads
- Gas Stations
- Retail/Wholesale Vehicle and Equipment Dealers
- Vehicle Maintenance and Repair
- Construction Businesses (paving, heavy equipment storage and maintenance, storage of petroleum products)

As an alternative to an API or CPS-type oil/water separator, a sand filtration BMP may be used to provide treatment of oil *(Note: This alternative is being recommended on an interim basis and further evaluation is necessary)*. See Chapter III-3 for more information on sand filters.

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Figure I-4.2
Conceptual Detention BMP Providing Both Runoff Treatment
and Streambank Erosion Control

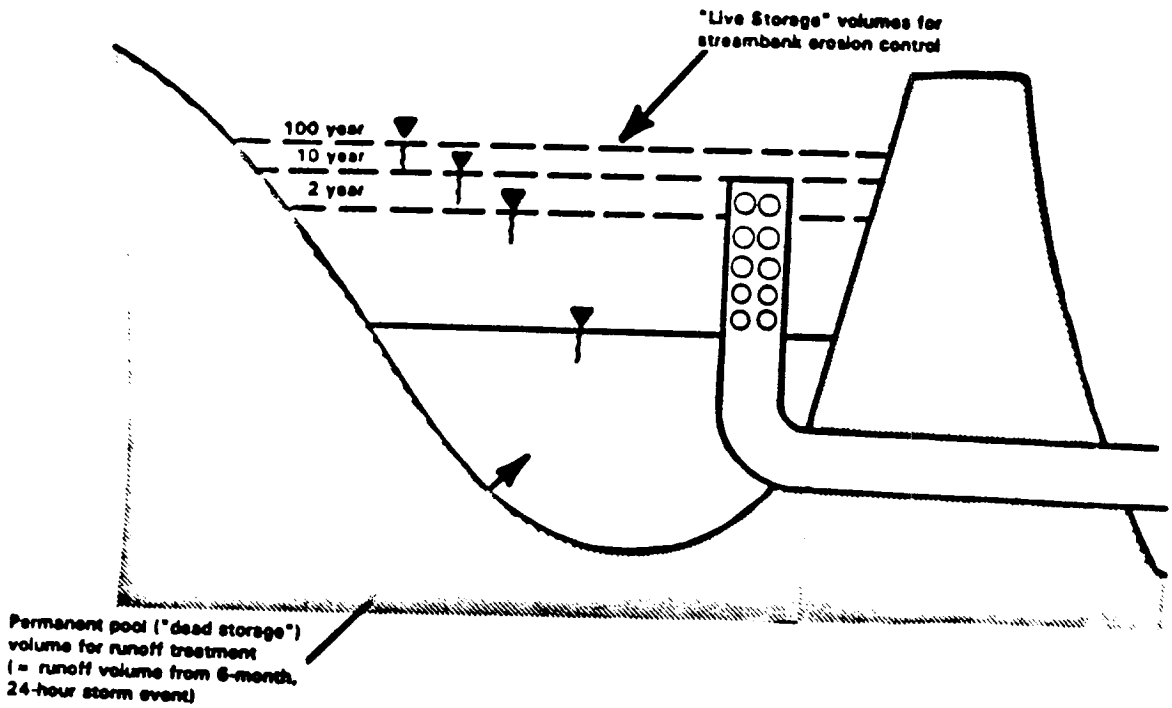

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Figure I-4.3 Summary of Steps for BMP Selection Process

PRELIMINARY STEP: Review Chapter I-2 prior to starting the BMP selection process.

STEP 1: Determine Stormwater Control Scenario from Table I-4.2

STEP 1A: Determine if Oil/Water Separator BMPs are Required based on Land Use Type

STEP 1B: Determine if Nutrient Control is Required *in addition* to Treatment of Conventional Pollutants

STEP 1C: Determine if Streambank Erosion Control is Required

STEP 1D: Determine Final Stormwater Control Scenario from Table I-4.2

STEP 2: Select Source Control BMPs

STEP 2A: Select Source Control BMPs based on Land Use Type

STEP 2B: Select Source Control BMPs for Nutrient Control, if required, as determined from Step 1B

STEP 2C: Prepare Final Source Control BMP List

STEP 3: Select Runoff Treatment and Streambank Erosion Control BMPs

STEP 3A: Select type of Oil/Water Separator, if required, as determined in Step 1A

STEP 3B: Determine initial order of preference of runoff treatment BMPs from Table I-4.4

STEP 3C: Determine initial order of preference of streambank erosion control BMPs from Table I-4.5

STEP 3D: Screen BMPs based on Comparative Stormwater Benefits and Restrictions using Table I-4.6

STEP 3E: Screen Runoff Treatment and Streambank Erosion Control BMPs based on Other Physical Factors

STEP 3F: Prepare Modified BMP List

STEP 3G: Prepare Final BMP List

STEP 4: Complete Stormwater Site Plan

STEP 4A: Complete Permanent Stormwater Quality Control Plan

STEP 4B: Review other Stormwater Site Plan requirements

STEP 4C: Complete Stormwater Site Plan

STEP 5: Submit Final Stormwater Site Plan to the Plan Approval Authority

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TABLE I-4.2
STORMWATER CONTROL SCENARIOS

Scenario		BMP Sequence and Selections
1. O/W Separator Required:	NO	
Nutrient Control Required:	NO	Source Control → Runoff Treatment (Conventional)
Streambank Erosion Control:	NO	
2. O/W Separator Required:	NO	
Nutrient Control Required:	NO	Source Control → Runoff Treatment → SBEC (Conventional)
Streambank Erosion Control:	YES	
3. O/W Separator Required:	NO	
Nutrient Control Required:	YES	Source Control → Runoff Treatment → SBEC
Streambank Erosion Control:	YES	(including nutrients) (Nutrients)
4. O/W Separator Required:	NO	
Nutrient Control Required:	YES	Source Control → Runoff Treatment
Streambank Erosion Control:	NO	(including nutrients) (Nutrients)
5. O/W Separator Required:	YES	
Nutrient Control Required:	NO	Source Control → O/W Separator → Runoff Treatment (Conventional)
Streambank Erosion Control:	NO	
6. O/W Separator Required:	YES	
Nutrient Control Required:	NO	Source Control → O/W Separator → Runoff Treatment → SBEC (Conventional)
Streambank Erosion Control:	YES	
7. O/W Separator Required:	YES	
Nutrient Control Required:	YES	Source Control → O/W Separator → Runoff Treatment → SBEC
Streambank Erosion Control:	YES	(including nutrients) (Nutrients)
8. O/W Separator Required:	YES	
Nutrient Control Required:	YES	Source Control → O/W Separator → Runoff Treatment
Streambank Erosion Control:	NO	(including nutrients) (Nutrients)

Explanation:

SBEC = "Streambank Erosion Control"

O/W separator requirement is based on specified land uses. See Step 1A.

Runoff treatment requirement is to provide treatment of the 6-month, 24-hour design storm. Requirement for nutrient control is determined by local government of Plan Approval Authority. See Step 1B.

Streambank erosion control requirement determined by local government of Plan Approval Authority. See Step 1C.

Nutrient treatment is *in addition* to treatment of conventional pollutants. See Step 1B.

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STEP 1B: Determine if Nutrient Control is Required in Addition to Treatment of Conventional Pollutants

The requirement to provide nutrient control is determined by the Plan Approval Authority. In general, nutrient control will be needed for surface waters if eutrophication is a concern, or for drinking water supplies (surface or ground) if the threat of nitrate contamination exist. The decision to require nutrient control should be based on an assessment of receiving water bodies within the local government's jurisdiction. Should nutrient control be mandated then both Source Control and Runoff Treatment BMPs shall be required. Sources of information used to make this determination should include, at a minimum, the following:

(i) Those waterbodies reported under section 305(b) of the Clean Water Act, and designated as not supporting beneficial uses;

(ii) Those listed under section 304(l)(l)(A)(i), 304(l)(l)(A)(ii), or 304(l)(l)(B) of the Clean Water Act;

(iii) Those listed in Washington State's Nonpoint Source Assessment required under section 319(a) of the Clean Water Act.

(iv) Sites where the need for additional stormwater control measures has been identified through a basin plan, the watershed ranking process under Ch. 400-12 WAC, or through Growth Management Act planning.

STEP 1C: Determine if Streambank Erosion Control is Required

There are two decisions that must be made in this step. First, is attenuation of peak flows required per Minimum Requirement #5? Second, is there an *existing* streambank erosion problem that requires corrective action?

For attenuating runoff flows, streambank erosion control will be required when stormwater discharges are made either directly or indirectly through a conveyance system into a stream. The streambank erosion control requirement is established by the Plan Approval Authority. Situations where streambank erosion control may not be required are when there is a direct discharge to a bay, lake, or Puget Sound. A discharge to a regional detention pond could also waive this requirement, but only if the pond is designed to provide a level of protection to downstream segments equivalent to Ecology's streambank erosion control requirement.

In cases where a streambank erosion problem already exists, streamside stabilization measures may be required. The selection and design of these BMPs will be made on a case-by-case basis. Where basin plans (see Minimum Requirement #9) have been implemented there may be different or additional streambank erosion control standards.

STEP 1D: Determine Stormwater Control Scenario from Table I-4.2

There are eight (8) possible outcomes, or stormwater control scenarios, from the determinations made in Steps 1A, 1B, and 1C. Table I-4.2 summarizes each scenario and defines the classification and sequence of BMPs that are to be used for each.

I-4.3.2 STEP 2: SELECT SOURCE CONTROL BMPs

Two different source control selections must be made in this step. First, select BMPs based on the type of land use proposed for development. Land use-specific source control BMPs are required for all developments. Second, select source control BMPs to provide control of nutrients, if necessary, as determined in Step 1B.

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STEP 2A: Select Source Control BMPs based on Land Use Type

The first task for the user is to fill out a checklist that identifies the key activities that may result in stormwater contamination (see Table I-4.3). If the user is a private business, then examine the table of contents of Chapter IV-2 to locate the particular grouping in which that business falls. If the user is a public entity, then examine Chapter IV-3. After locating the particular grouping in which that business or public entity falls, turn to the page indicated to identify the appropriate source control BMPs (Table I-4.1 lists source control BMPs).

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Table I-4.3 Activities Checklist

CHECK ACTIVITIES THAT ARE OCCURRING OR WILL BE OCCURRING
(see Chapter IV-2 for the appropriate land use, and Chapter IV-5 for relevant BMPs)

Uncovered vehicle parking ____

Indicate number of parking spaces ____

Washing of vehicles or equipment ____

Vehicle or equipment fueling ____

Loading or unloading of liquid materials ____

Storage of raw materials, byproducts or products of manufacturing processes ____

Above-ground bulk storage of fuel, petroleum or chemicals ____

Use of underground tanks ____

Use of pesticides or fertilizers ____

Livestock husbandry ____

Temporary storage of liquid or solid wastes ____

Indicate type of waste:

Dangerous/Extremely Hazardous waste ____

Food wastes ____

Used oil ____

Other (briefly describe)_____

_____

_____

Do you have or will you be obtaining a permit from the Department of Ecology to store Dangerous or Extremely Hazardous wastes? ____

Do you intend to connect inside drains to the public sanitary sewer? Will you be discharging process water directly to a surface water? ____

DESCRIBE ANY OTHER OUTSIDE ACTIVITIES NOT COVERED ABOVE _____

_____

_____

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Effective maintenance programs must be considered an integral part of a source control program. See, in particular, Chapters IV-3 and IV-4 for guidance on conducting maintenance.

STEP 2B: Select Source Control BMPs for Nutrient Control, if required, as determined from Step 1B

Sources of nutrients in urban runoff include fertilizers used for landscaping, grass clippings, leaf litter, car washing operations, and pet wastes. These sources should be managed to prevent contact with and transport by stormwater. Impervious areas adjacent to landscaped areas can be significant sources of nutrients when leaves and grass clippings are deposited on them. In addition, atmospheric deposition of nutrients onto impervious surfaces can generate significant amounts of pollution.

The following can be considered to be appropriate source control BMPs for nutrient control (see Chapter IV-4 for detailed guidance):

- BMP S1.90, Vegetation Management/Integrated Pest Management
- BMP S2.00, Maintenance of Storm Drainage Facilities
- BMP S2.20, Street Sweeping of impervious areas (e.g., curbs where accumulation of leaf litter occurs).

Additional maintenance guidance provided in Chapter IV-3 should also be considered and incorporated in this step.

STEP 2C: Prepare Final Source Control BMP List

Final selection of source control BMPs is made after consulting the detailed standards and specifications in relation to site specific conditions. For this the user is referred to Volume IV. A detailed description of each BMP will be found there that will enable final selections to be made.

I-4.3.3 STEP 3: SELECT RUNOFF TREATMENT AND STREAMBANK EROSION CONTROL BMPS

The goal of this step is to select BMPs that meet the runoff treatment and streambank erosion control requirements identified in Step 1D.

To avoid confusion, the selection of oil/water separators is made prior to selection of other BMPs. Note that a distinction is made between runoff treatment and streambank erosion control BMPs. It is important to understand the fundamental difference between these two functions when selecting BMPs. Some BMPs can combine both of these functions into the same facility. See the discussion in Section I-4.2.

STEP 3A: Select Type of Oil/Water Separator, if required, as determined from Step 1A.

Spill control (SC-type) separators will often be required in cases where storage of petroleum-based products occurs. API or CPS-type oil/water separators may be required where high traffic volumes or extensive use of petroleum-based products occur. A knowledge of the oil and grease characteristics (e.g., particle size, specific gravity) will be useful for selecting the correct type of separator. Consult Chapter III-7 for detailed design criteria. Sand filtration BMPs may also be used for treating oil in stormwater runoff on an interim basis (see Chapter III-3).

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STEP 3B: Determine Initial Order of Preference of Runoff Treatment BMPs from Table I-4.4

Use Table I-4.4 to determine the initial order of preference for runoff treatment BMPs. The rationale for the initial order of preference is based primarily on the relative effectiveness of the various BMPs at removing pollutants. Note that a wider range of options exist if nutrient control is not required. Infiltration is the preferred practice for treatment, provided that proper soil conditions exist and ground water is adequately protected.

Table I-4.4 Initial Order of Preference of Runoff Treatment BMPs*

Rank	Nutrient Control Required	Nutrient Control Not Required
1	Infiltration (BMP RI.05, 10, 20, 30)	Infiltration (BMP RI.05, 10, 20, 30)
2	Constructed Wetland (BMP RD.09) or Wet Pond with marsh (BMP RD.06)	Constructed Wetland (BMP RD.09) or Wet Pond - with marsh (BMP RD.06) or Wet Pond - without marsh (BMP RD.05) or Biofiltration Swale (BMP RB.05) or Vegetative Filter Strip (BMP RB.10) or Sand Filtration (BMP RF.05 or RF.10)
3	(No other BMPs recommended)	Wet Vault/Tank (BMP RD.15)

* Pretreatment BMPs are not included in this list.

Note: BMPs with the same rank number have an equal level of preference, e.g., if nutrient control is not required then any of the six types of BMPs listed are equally acceptable.

STEP 3C: Determine Initial Order of Preference of Streambank Erosion Control BMPs

Use Table I-4.5 to determine the initial order of preference for streambank erosion control BMPs. Two types of streambank erosion control BMPs are illustrated, i.e., those that detain and *attenuate flows* and those that are used to *stabilize* eroding streambanks. The rationale for the initial order of preference is, in both cases, to replicate the natural condition to the maximum extent practical. Recall the restrictions on the use of infiltration, i.e., proper soil conditions must exist and ground water quality must be protected.

Table I-4.5
Initial Order of Preference of Streambank Erosion Control BMPs

Rank	Flow Attenuation	Streamside Stabilization
1	Infiltration (see Table I-4.1)	Vegetative Streambank Stabilization (BMP RS.05) or Bioengineering Method (BMP RS.10)
2	Detention (see Table I-4.1)	Structural Stabilization (BMP RS.15)

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STEP 3D: Screen BMPs based on Comparative Stormwater Benefits and Restrictions

Use Table I-4.6 to evaluate the comparative benefits and restrictions that may apply to the types of BMPs selected in steps 3B and 3C (initial order of preference). This table provides important information such as whether a BMP can achieve control of nutrients as well as conventional pollutants, whether a BMP requires or provides pretreatment, and if streambank erosion control can be provided. Some BMPs can achieve multiple purposes while others cannot.

Note in Table I-4.6 that similarly named *infiltration* BMPs may serve different purposes. Ones that are labeled "WQ" (acronym for "Water Quality") are primarily intended to provide treatment of runoff and may not be appropriate for fully infiltrating the large volumes of runoff required for streambank erosion control. Water Quality (WQ) BMPs will typically have soils of relatively low permeability that contain organic matter; examples are silty and sandy loams. It is extremely important that they be protected from sedimentation that could clog the soil pore spaces; thus pretreatment is always required for Water Quality infiltration BMPs.

Infiltration BMPs that are labeled "SBEC" (an acronym for Streambank Erosion Control) are not suitable for runoff treatment and are to be used exclusively for providing streambank erosion control. These BMPs will typically utilize well drained soils that are low in organic material and are less prone to clog; examples are coarse sands and gravelly sands. Treatment of stormwater runoff must always precede discharge to SBEC infiltration BMPs.

A detailed description with design criteria for each runoff treatment and streambank erosion control BMP is provided in Volume III.

STEP 3E: Screen Runoff Treatment and Streambank Erosion Control BMPs based on Other Physical Factors

Two of the most important physical factors to consider are the total contributing catchment area and the types of soils on the site. Many BMPs can only be applied within relatively narrow ranges of catchment area and soil type, as shown in Tables I-4.7 and I-4.8. Note that in some situations a BMP may or may not be feasible and final selection should be based on a detailed examination of the site conditions and the standards and specifications.

Table I-4.9 presents a matrix that shows whether a BMP is also subject to other physical restrictions. Solid squares indicate that a factor is generally not a restriction while an unshaded square indicates that a restriction which may prohibit the use of a BMP. A partially shaded square indicates that a factor could restrict the use of a BMP, but careful site planning and BMP design may overcome the restriction.

As a general rule pond BMPs face fewer restrictions than do infiltration BMPs.

The nature of each of the physical factors outlined in the screens is described below.

BMP Drainage Area (Table I-4.7)

Pond BMPs generally require more drainage area than other BMPs. Infiltration trenches, vaults/tanks, and biofilters are more suitable for smaller areas. Wet pond-type BMPs located on small sites may lose their "permanent pool" during summer months but should retain the permanent pool during the winter months when the majority of rainfall occurs. Measures should be taken to ensure that the "shallow marsh" BMPs (BMP RD.06 and BMP RD.09) do not lose their vegetation during dry periods. See Chapter III-3 for further guidance.

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TABLE I-4.6
COMPARATIVE STORMWATER MANAGEMENT BENEFITS AND RESTRICTIONS
FOR RUNOFF TREATMENT AND STREAMBANK EROSION CONTROL BMPs

BMP ID	BMP Name	Treats Conventional Pollutants?	Provides Nutrient Control?	Pre-treatment Required?	Provides Pre-treatment?	Provides SBEC?	Notes
RI.05	WQ Infiltration Basin	Yes	Yes	Yes	No	Option	Proper soil conditions required
RI.06	SBEC Infiltration Basin	No	No	No	No	Yes	Use of excessively drained soils
RI.10	WQ Infiltration Trench	Yes	Yes	Yes	No	Option	Proper soil conditions required
RI.11	SBEC Infiltration Trench	No	No	No	No	Yes	Use of excessively drained soils
RI.15	Roof Downspout System	Yes	N/A	No	No	Option	For rooftop runoff only
RI.20	WQ Porous Pavement	Yes	Yes	Yes	No	Option	Proper soil conditions required
RI.21	SBEC Porous Pavement	No	No	No	No	Yes	Use of excessively drained soils
RI.30	WQ Concrete Grid/Modular Pavement	Yes	Yes	Yes	No	Option	Proper soil conditions required
RI.31	SBEC Concrete Grid/Modular Pavement	No	No	No	No	Yes	Use of excessively drained soils
RF.05	Sand Filtration Basin	Yes	No	Yes	Yes[1]	No	Can be used to treat oil
RF.10	Sand Filtration Trench	Yes	No	Yes	Yes[1]	No	Can be used to treat oil
RF.15E	Aquatard System	Yes	?	?	?	?	Experimental
RD.05	Wet Pond (Conventional Pollutants)	Yes	No	No[2]	No	Option	
RD.06	Wet Pond (Nutrient Control)	Yes	Yes	No	No	Option	
RD.09	Constructed Wetland	Yes	Yes	No[2]	No	Option	
RD.10	Presettling Basin	Limited[3]	No	No	Yes	No	
RD.11	Extended Detention Dry Pond	Limited[3]	No	No	Yes	Yes	
RD.15	Wet Vault/Tank	Yes	No	No	Limited[4]	Option	
RD.20	Extended Detention Dry Vault/Tank	No	No	No	No	Yes	
RB.05	Biofiltration Swale	Yes	No	No[2]	Yes	No	
RB.10	Vegetative Filter Strip	Yes	No	No[2]	Yes	No	
RO.05	Spill Control (SC) Oil/Water Separator	No[5]	No	No[6]	No	No	
RO.10	API Oil/Water Separator	No[5]	No	No[6]	No	No	
RO.15	Coalescing Plate Separator (CPS)	No[5]	No	No[6]	No	No	
RS.05	Vegetative Streambank Stabilization	No	No	No	No	Yes	
RS.10	Bioengineering Methods of Streambank Stabilization	No	No	No	No	Yes	
RS.15	Structural Streambank Stabilization	No	No	No	No	Yes	

WQ = "Water Quality" SBEC = "Streambank Erosion Control"

1 Can be used for pretreatment of oil to protect wet pond-type BMPs from siltation
2 Exception is when oil/water separators are required for specific land uses (see Volume IV)
3 Provides *pretreatment* only
4 Not an acceptable pretreatment BMP for water quality infiltration BMPs
5 Provides *oil treatment* only
6 Assumes low influent concentration of suspended solids.

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It should be noted that the drainage area served does not have to be fixed. By creatively using local topography and drainage the catchment area can be varied. For example the drainage of a site could be divided to facilitate use of infiltration trenches. However, this technique may not be used to justify use of a vault or tank.

Soil Type (Table I-4.8)

The permeability of the soil underlying a BMP has a profound influence on its effectiveness. This is particularly true for infiltration BMPs, that are best suited in silty to loamy soils for *runoff treatment* and coarser soils for *streambank erosion control*. They cannot be used on sites that have final infiltration rates (f) of less than 0.5 inches per hour. Wet pond-type BMPs will need to be lined when located over permeable soils in order to maintain a permanent pool. Likewise, biofiltration-type BMPs may need to be lined so that runoff is not lost to infiltration before adequate treatment has taken place.

Other Physical Factors (Table I-4.9)

Slope

Steep slopes restrict the use of several BMPs. For example, biofiltration swales must be situated on sites with slopes of less than 5%. Infiltration BMPs are not suitable when the slope exceeds 15%.

High Water Table

The water table acts as an effective barrier to exfiltration and can sharply reduce the efficiency of an infiltration system. If the high water table extends to within three (3) feet of the bottom of an infiltration BMP, the site is seldom suitable.

Depth to Bedrock/Hardpan/Till

The downward exfiltration of stormwater is also impeded if a bedrock or till layer lies too close to the surface. If the impervious layer lies within two (2) feet below the bottom of the infiltration BMP the site is not suitable. Similarly, pond BMPs are often not feasible if bedrock lies within the area that must be excavated.

Proximity to Foundations and Wells

Since infiltration BMPs divert runoff back into the soil, some sites may experience problems with local seepage. This can be a real problem if the BMP is located too close to a building foundation. Another risk is ground water pollution, hence the requirement to site infiltration systems more than 100 feet away from drinking water wells.

Maximum Depth

Wet ponds are also subject to a maximum depth limit for the "permanent pool" volume. Deep ponds (greater than 6 feet) may stratify during summer and create low oxygen conditions near the bottom resulting in re-release of phosphorus and other pollutants back into the water.

High Sediment Input

Many BMPs are unable to handle the large loads of sediment that may occur during construction. Infiltration BMPs are particularly susceptible to rapid clogging and subsequent failure if significant sediment loads are allowed to enter the structure. Therefore infiltration BMPs must not be installed until all the land in the contributing drainage area is properly stabilized. Although sediment loads drop

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sharply after construction is completed, gradual clogging of infiltration systems can still occur. Thus infiltration ponds and trenches require a pretreatment device to filter out sediment and other coarse material before they reach the facility (see Chapter III-3).

Pond BMPs can be can be used for sediment control during the construction phase with proper conversion, clean out and regrading. Even after construction sediment deposits will build up, and must be removed periodically. The cost and scope of sediment removal can be reduced by sediment forebays.

STEP 3F: Prepare Modified BMP List

The initial BMP selection may have to be modified after completing Steps 3A through 3E. Verify that the proposed BMPs will still meet the source control, runoff treatment, and streambank erosion control requirements established in Step 1. Modify the list as necessary.

STEP 3G: Prepare Final BMPs

Final selection of runoff control BMPs is made after consulting the detailed standards and specifications in relation to site specific conditions. For this the user is referred to Volume III. A detailed description of each BMP will be found here that will enable final selections to be made.

I-4.3.4 STEP 4: COMPLETE STORMWATER SITE PLAN

The purpose of this step is to complete development of the Stormwater Site Plan so that it can be submitted to the local government or Plan Approval Authority for approval. The user must first complete development of the Permanent Stormwater Quality Control Plan, including design and construction drawings.

STEP 4A: Complete development of the Permanent Stormwater Quality Control Plan

Compile the final list of source control, runoff treatment, and streambank erosion control BMPs and proceed to design them using the detailed guidance in Volumes III and IV.11 To complete the Permanent Stormwater Quality Plan both a report and a set of construction drawings must be completed. Refer to Chapter I-3 and the "Stormwater Program Guidance Manual for the Puget Sound Basin" for guidance on completing this plan *(Note: This guidance has not been completed at publication time. It is scheduled to be completed in 1992).*

STEP 4B: Review other Stormwater Site Plan requirements

The Permanent Stormwater Quality Control Plan is but one of several documents that are required for the Stormwater Site Plan. Review Chapter I-3 and the "Stormwater Program Guidance Manual for the Puget Sound Basin" for further details.

STEP 4C: Finalize Stormwater Site Plan

Incorporate all other documents and site plans required for the completion of the Stormwater Site Plan.

I-4.3.5 STEP 5: SUBMIT FINAL STORMWATER SITE PLAN TO PLAN APPROVAL AUTHORITY

The Plan Approval Authority may be the local government. Check with your local government to determine who within that government is the Plan Approval Authority.

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I-4.4 REFERENCES

1. Schueler, Thomas R., Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs, Metropolitan Washington Council of Governments, July, 1987.

2. Resource Planning Associates, Water Quality Best Management Manual for Commercial and Industrial Land Uses, Prepared for the City of Seattle, 1989.

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Table I-4.7
Screening BMPs Based on Drainage Area

BMP Type	Recommended Drainage Area (acres)
Infiltration Basin	0 - 50
Infiltration Trench	0 - 50
Roof Downspout System	0.11 (5000 sq.ft.)
Porous Pavement	0 - 15
Concrete Grid/Modular Pavement	0 - 15
Sand Filtration Basin	0 - 50
Sand Filtration Trench	0 - 50
Wet Pond (Conventional Pollutants)	0 - 100*
Constructed Wetland/Wet Pond (Nutrient Control)	5 - 100*
Presettling Basin	0 - 100
Extended Detention Dry Pond	0 - 100
Vault/Tank (Wet or Dry)	0 - 5
Biofiltration Swale	0 - 10
Vegetative Filter Strip	0 - 10
Oil/Water Separator	0 - 5

* These BMPs maintain a permanent pool that, ideally, should not go dry. To maintain a permanent pool will typically require a minimum drainage area. This is especially important for constructed wetlands and wet ponds that utilize a shallow marsh system (i.e., wet pond for nutrient control). Wet ponds that do not utilize a shallow marsh system may be allowed to periodically go dry but only during the summer dry season. In some cases a smaller drainage area than that shown above may be acceptable. See the criteria for individual BMPs in Chapter III-4.

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Table I-4.8 Screening BMPs Based on Soil Type

Soil Type	WQ Infiltration	SBEC Infiltration	Wet Pond*	Dry Pond*	Biofiltration* (Swale or Filter Strip)
Coarse Sands or Cobbles		■			
Sand		■			
Loamy Sand	■	■			■
Sandy Loam	■				■
Loam	■				■
Silt Loam					■
Sandy Clay Loam					■
Clay Loam			■	■	■
Silty Clay Loam			■	■	■
Sandy Clay			■	■	■
Silty Clay			■	■	
Clay			■	■	

■ Indicates that use of BMP is appropriate for this soil type

* Coarser soils may be used for these BMPs if a liner is installed to prevent infiltration.

WQ = "Water Quality" BMP (primarily designed for *runoff treatment*)

SBEC = "Streambank Erosion Control" (*runoff treatment* is not provided)

Note: Sand filtration BMPs are not listed in this table as their feasibility is not dependent on soil type.

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Table I-4.9
Screening BMPs Based on Other Physical Factors

BMP Type	Slope	High Water Table	Depth to Bedrock	Proximity to Foundations	Maximum Depth	High Sediment Input
Infiltration Basin	◘	□	□	□	■	□
Infiltration Trench	□	□	□	□	□	□
Roof Downspout System	□	□	□	□	□	□
Porous Pavement	□	□	□	□	■	□
Concrete Grid/Modular Pavement	□	□	□	□	■	□
Sand Filtration Basin	■	■	◘	■	■	□
Sand Filtration Trench	□	■	◘	■	□	□
Wet Pond/Constructed Wetland	■	■	◘	◘	□	◘
Presettling Basin	■	■	◘	■	■	■
Extended Detention Dry Pond	■	■	◘	■	■	■
Vault/Tank (Wet or Dry)	■	■	◘	■	■	■
Biofiltration Swale	◘	◘	◘	■	◘	◘
Vegetative Filter Strip	□	◘	◘	■	□	◘
Oil/Water Separator	■	■	◘	■	■	□

■ Generally not a restriction

◘ Can be overcome with careful site design

□ May preclude the use of a BMP

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GLOSSARY AND NOTATION

Note: The following terms are provided for reference and use with this manual. They shall be superseded by any other definitions for these terms adopted by ordinance unless they are defined in a Washington State WAC or RCW or are used and defined as part of the Minimum Requirements for all new development and redevelopment.

AASHTO classification - The official classification of soil materials and soil aggregate mixtures for highway construction, used by the American Association of State Highway and Transportation Officials.

Absorption - The penetration of a substance into or through another, such as the dissolving of a soluble gas in a liquid.

Adjacent steep slope - A slope with a gradient of 15 percent or steeper within five hundred feet of the site.

Adsorption - The adhesion of a substance to the surface of a solid or liquid; often used to extract pollutants by causing them to be attached to such adsorbents as activated carbon or silica gel. Hydrophobic, or water-repulsing adsorbents, are used to extract oil from waterways when oil spills occur. Heavy metals such as zinc and lead often adsorb onto sediment particles.

Aeration - The process of being supplied or impregnated with air. In waste treatment, the process used to foster biological and chemical purification. In soils, the process by which air in the soil is replenished by air from the atmosphere. In a well aerated soil, the soil air is similar in composition to the atmosphere above the soil. Poorly aerated soils usually contain a much higher percentage of carbon dioxide and a correspondingly lower percentage of oxygen.

Aerobic - Living or active only in the presence of free (dissolved or molecular) oxygen.

Aerobic bacteria - Bacteria that require the presence of free oxygen for their metabolic processes.

Aggressive plant species - Opportunistic species of inferior biological value that tend to out-compete more desirable forms and become dominant; applied to native species in this manual.

Algae - Primitive plants, many microscopic, containing chlorophyll and forming the base of the food chain in aquatic environments. Some species may create a nuisance when environmental conditions are suitable for prolific growth.

Algal bloom - Proliferation of living algae on the surface of lakes, streams or ponds; often stimulated by phosphate over-enrichment. Algal blooms reduce the oxygen available to other aquatic organisms.

American Public Works Association or APWA - the adopted edition of the Washington State Chapter of the American Public Works Association.

Anadromous - Fishes ascending rivers from the sea for breeding.

Anaerobic - Living or active in the absence of oxygen.

Anaerobic bacteria - Bacteria that do not require the presence of free or dissolved oxygen for metabolism.

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Annual flood - The highest peak discharge on average which can be expected in any given year.

Antecedent moisture conditions - The degree of wetness of a watershed or within the soil at the beginning of a storm.

Anti-seep collar - A device constructed around a pipe or other conduit and placed through a dam, levee, or dike for the purpose of reducing seepage losses and piping failures.

Anti-vortex device - A facility placed at the entrance to a pipe conduit structure such as a drop inlet spillway or hood inlet spillway to prevent air from entering the structure when the pipe is flowing full.

Applicant - The person who has applied for a development permit or approval.

Approved manual - means a stormwater management manual approved by Ecology.

Appurtenances - Machinery, appliances, or auxiliary structures attached to a main structure, but not considered an integral part thereof, for the purpose of enabling it to function.

Aquifer - A geologic stratum containing ground water that can be withdrawn and used for human purposes.

As-built drawings - Engineering plans which have been revised to reflect all changes to the plans which occurred during construction.

As-graded - the extent of surface conditions on completion of grading.

BSBL - See Building set back line.

Background - A description of pollutant levels arising from natural sources, and not because of man's immediate activities.

Backwater - Water upstream from an obstruction which is deeper than it would normally be without the obstruction.

Bankfull discharge - A flow condition where streamflow completely fills the stream channel up to the top of the bank. In undisturbed watersheds, the discharge conditions occurs on average every 1.5 to 2 years and controls the shape and form of natural channels.

Base flood - A flood having a one percent chance of being equaled or exceeded in any given year. This is also referred to as the 100-year flood.

Base flood elevation - The water surface elevation of the base flood. It shall be referenced to the National Geodetic Vertical Datum of 1929 (NGVD).

Baseline sample - A sample collected during dry-weather flow (i.e., it does not consist of runoff from a specific precipitation event).

Basin plan - A plan and all implementing regulations and procedures including but not limited to land use management adopted by ordinance for managing surface and storm water quality and quantity management facilities and features within individual subbasins.

Bearing capacity - The maximum load that a material can support before failing.

Bedrock - The more or less solid rock in place either on or beneath the surface of the earth. It may be soft, medium, or hard and have a smooth or irregular surface.

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Bench - a relatively level step excavated into earth material on which fill is to be placed.

Berm - A constructed barrier of compacted earth, rock or gravel.

Best management practice (BMP) - Physical, structural, and/or managerial practices that, when used singly or in combination, prevent or reduce pollution of water, and have been approved by Ecology.

Biochemical oxygen demand (BOC) - An indirect measure of the concentration of biologically degradable materials present in organic wastes. The amount of free oxygen utilized by aerobic organisms when allowed to attack the organic material in an aerobically maintained environment at a specified temperature (20°C) for a specific time period (5 days), and thus stated as BOD_5. It is expressed in milligrams of oxygen utilized per liter of liquid waste volume (mg/l) or in milligrams of oxygen per kilogram of waste solution (mg/kg = ppm = parts per million parts). Also called biological oxygen demand.

Biodegradable - Capable of being readily broken down by biological means, especially by bacterial action. Degradation can be rapid or may take many years depending upon such factors as available oxygen and moisture.

Bioengineering - Restoration or reinforcement of slopes and stream banks with living plant materials.

Biofilter - A designed, vegetated treatment facility where the more or less simultaneous processes of filtration, infiltration, adsorption and biological uptake of pollutants in stormwater takes place when runoff flows over and through . Vegetation growing in these facilities acts as both a physical filter which causes gravity settling of particulates by regulating velocity of flow, and also as a biological sink when direct uptake of dissolved pollutants occurs. The former mechanism is probably the most important in western Washington where the period of major runoff coincides with the period of lowest biological activity.

Biofiltration - The process of reducing pollutant concentrations in water by filtering the polluted water through biological materials.

Biological control - A method of controlling pest organisms by means of introduced or naturally occurring predatory organisms, sterilization, the use of inhibiting hormones, or other means, rather than by mechanical or chemical means.

Biological magnification - The increasing concentration of a substance along succeeding steps in a food chain. Also called biomagnification.

Bollard - A post (may or may not be removable) used to prevent vehicular access.

Bond - A surety bond, cash deposit or escrow account, assignment of savings, irrevocable letter of credit or other means acceptable to or required by the manager to guarantee that work is completed in compliance with the project's drainage plan and in compliance with all local government requirements.

Borrow area - A source of earth fill material used in the construction of embankments or other earth fill structures.

Buffer - The zone contiguous with a sensitive area that is required for the continued maintenance, function, and structural stability of the sensitive area. The critical functions of a riparian buffer (those associated with an aquatic system) include shading, input of organic debris and coarse sediments, uptake of nutrients, stabilization of banks, interception of fine sediments, overflow during high water events, protection from disturbance by humans and domestic animals, maintenance of wildlife habitat, and room for variation of aquatic system boundaries

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over time due to hydrologic or climatic effects. The critical functions of terrestrial buffers include protection of slope stability, attenuation of surface water flows from storm water runoff and precipitation, and erosion control.

Building setback line (BSBL) - A line measured parallel to a property, easement, drainage facility or buffer boundary, that delineates the area (defined by the distance of separation) where buildings, or other obstructions are prohibited (including decks, patios, outbuildings, or overhangs beyond 18 inches). Wooden or chain link fences and landscaping are allowable within a building setback line. In this manual the minimum building setback line shall be 5 feet.

CIP - See Capital Improvement Project.

Capital Improvement Project or Program (CIP) - A project prioritized and scheduled as a part of an overall construction program or, the actual construction program.

Catchbasin - A chamber or well, usually built at the curb line of a street, for the admission of surface water to a sewer or subdrain, having at its base a sediment sump designed to retain grit and detritus below the point of overflow.

Catchline - The point where a severe slope intercepts a different, more gentle slope.

Catchment - Surface drainage area.

Channel - A feature that conveys surface water and is open to the air.

Channel, constructed - Channels or ditches constructed (or reconstructed natural channels) to convey surface water.

Channel, natural - Streams, creeks, or swales that convey surface/ground water and have existed long enough to establish a stable route and/or biological community.

Channel stabilization - Erosion prevention and stabilization of velocity distribution in a channel using vegetation, jetties, drops, revetments, and/or other measures.

Channel storage - Water temporarily stored in channels while enroute to an outlet.

Channelization - Alteration of a stream channel by widening, deepening, straightening, cleaning, or paving certain areas to change flow characteristics.

Check dam - Small dam constructed in a gully or other small watercourse to decrease the streamflow velocity, minimize channel scour, and promote deposition of sediment.

Chemical oxygen demand (COD) - A measure of the amount of oxygen required to oxidize organic and oxidizable inorganic compounds in water. The COD test, like the BOD test, is used to determine the degree of pollution in water.

Civil engineer - a professional engineer licensed in the State of Washington in Civil Engineering who is experienced and knowledgeable in the practice of soils engineering.

Civil engineering - the application of the knowledge of the forces of nature, principles of mechanics and the properties of materials to the evaluation, design and construction of civil works for the beneficial uses of mankind.

Clay lens - A naturally occurring, localized area of clay which acts as an impermeable layer to runoff infiltration.

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Clearing - The destruction and removal of vegetation by manual, mechanical, or chemical methods.

Closed depression - An area which is lowlying and either has no, or such a limited, surface water outlet that during storm events the area acts as a retention basin.

Cohesion - The capacity of a soil to resist shearing stress, exclusive of functional resistance.

Coliform bacteria - Microorganisms common in the intestinal tracts of man and other warm-blooded animals; all the aerobic and facultative anaerobic, gram-negative, nonspore-forming, rod-shaped bacteria which ferment lactose with gas formation within 48 hours at 35°C. Used as an indicator of bacterial pollution.

Commercial agriculture - Those activities conducted on lands defined in RCW 84.34.020(2), and activities involved in the production of crops or livestock for wholesale trade. An activity ceases to be considered commercial agriculture when the area on which it is conducted is proposed for conversion to a nonagricultural use or has lain idle for more than five (5) years, unless the idle land is registered in a federal or state soils conservation program, or unless the activity is maintenance of irrigation ditches, laterals, canals, or drainage ditches related to an existing and ongoing agricultural activity.

Compaction - densification of a fill by mechanical means.

Compensatory storage - New excavated storage volume equivalent to the flood storage capacity eliminated by filling or grading within the flood fringe. Equivalent shall mean that the storage removed shall be replaced by equal volume between corresponding one foot contour intervals that are hydraulically connected to the floodway through their entire depth.

Compost - Organic residue or a mixture of organic residues and soil, that has undergone biological decomposition until it has become relatively stable humus.

Composting - A controlled process of degrading organic matter by microorganisms. Present day composting is the aerobic, thermophilic decomposing of organic waste to relatively stable humus. Humus with no more than 25 percent dead or living organisms is stable enough not to reheat or cause odor or fly problems. It can undergo further, slower decay.

Comprehensive planning - Planning that takes into account all aspects of water, air, and land resources and their uses and limits.

Conservation district - A public organization created under state enabling law as a special-purpose district to develop and carry out a program of soil, water, and related resource conservation, use, and development within its boundaries, usually a subdivision of state government with a local governing body and always with limited authority. Often called a soil conservation district or a soil and water conservation district.

Constructed wetland - those wetlands intentionally created on sites that are not wetlands for the primary purpose of wastewater or stormwater treatment and managed as such. Constructed wetlands are normally considered as part of the stormwater collection and treatment system.

Contour - An imaginary line on the surface of the earth connecting points of the same elevation.

Conveyance - A mechanism for transporting water from one point to another, including pipes, ditches, and channels.

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Conveyance system - The drainage facilities, both natural and man-made, which collect, contain, and provide for the flow of surface and stormwater from the highest points on the land down to a receiving water. The natural elements of the conveyance system include swales and small drainage courses, streams, rivers, lakes, and wetlands. The human-made elements of the conveyance system include gutters, ditches, pipes, channels, and most retention/detention facilities.

Cover crop - A close-growing crop grown primarily for the purpose of protecting and improving soil between periods of permanent vegetation.

Created wetland - means those wetlands intentionally created from nonwetland sites to produce or replace natural wetland habitat (e.g., compensatory mitigation projects).

Critical Areas - at a minimum, areas which include wetlands, areas with a critical recharging effect on aquifers used for potable water, fish and wildlife habitat conservation areas, frequently flooded areas, geologically hazardous areas, including unstable slopes, and associated areas and ecosystems.

Critical depth - The depth which minimizes the specific energy of flow (E).

Critical Drainage Area - An area with such severe flooding, drainage and/or erosion/sedimentation conditions that the area has been formally adopted as a Critical Drainage Area by rule under the procedures specified in an ordinance.

Critical flow - Flow at the critical depth and velocity.

Critical reach - The point in a receiving stream below a discharge point at which the lowest dissolved oxygen level is reached and stream recovery begins.

Culvert - Pipe or concrete box structure which drains open channels, swales or ditches under a roadway or embankment. Typically with no catchbasins or manholes along its length.

Cut - Portion of land surface or area from which earth has been removed or will be removed by excavating; the depth below original ground surface to excavated surface.
Cut-and-fill - Process of earth moving by excavating part of an area and using the excavated material for adjacent embankments or fill areas.

DNS - See Determination of nonsignificance.

Dead storage - The volume available in a depression in the ground below any conveyance system, or surface drainage pathway, or outlet invert elevation that could allow the discharge of surface and stormwater runoff.

Dedication of land - Refers to setting aside a portion of a property for a specific use or function.

Degradation - (Biological or chemical) The breakdown of complex organic or other chemical compounds into simpler substances, usually less harmful than the original compound, as with the degradation of a persistent pesticide. (Geological) Wearing down by erosion. (Water) The lowering of the water quality of a watercourse by an increase in the pollutant loading.

Degraded (disturbed) wetland (community) - A wetland (community) in which the vegetation, soils, and/or hydrology have been adversely altered, resulting in lost or reduced functions and values; generally, implies topographic isolation; hydrologic alterations such as hydroperiod alteration (increased or decreased quantity of water), diking, channelization, and/or outlet modification; soils alterations such as presence of fill, soil removal, and/or compaction; accumulation

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of toxicants in the biotic or abiotic components of the wetland; and/or low plant species richness with dominance by invasive weedy species.

Denitrification - The biochemical reduction of nitrates or nitrites in the soil or organic deposits to ammonia or free nitrogen.

Depression storage - The amount of precipitation that is trapped in depressions on the surface of the ground.

Design engineer - The professional civil engineer licensed in the State of Washington who prepares the analysis, design, and engineering plans for an applicant's permit or approval submittal.

Design storm - A prescribed hyetograph and total precipitation amount (for a specific duration recurrence frequency) used to estimate runoff for a hypothetical storm of interest or concern for the purposes of analyzing existing drainage, designing new drainage facilities or assessing other impacts of a proposed project on the flow of surface water. (A hyetograph is a graph of percentages of total precipitation for a series of time steps representing the total time during which the precipitation occurs.)

Detention - the release of stormwater runoff from the site at a slower rate than it is collected by the stormwater facility system, the difference being held in temporary storage.

Detention facility - an above or below ground facility, such as a pond or tank, that temporarily stores stormwater runoff and subsequently releases it at a slower rate than it is collected by the drainage facility system. There is little or no infiltration of stored stormwater.

Detention time - The theoretical time required to displace the contents of a stormwater treatment facility at a given rate of discharge (volume divided by rate of discharge).

Determination of Nonsignificance (DNS) - The written decision by the responsible official of the lead agency that a proposal is not likely to have a significant adverse environmental impact, and therefore an EIS is not required.

Development - For the purposes of this document any activity that requires a permit or approval, including but not limited to a building permit, grading permit, shoreline substantial development permit, conditional use permit, unclassified use permit, zoning variance or reclassification, planned unit development, subdivision, short subdivision, master plan development, building site plan, or right-of-way use permit. See also the definitions for new development, redevelopment and land disturbing activities.

Discharge - Outflow; the flow of a stream, canal, or aquifer. One may also speak of the discharge of a canal or stream into a lake, river, or ocean. (Hydraulics) Rate of flow, specifically fluid flow; a volume of fluid passing a point per unit of time, commonly expressed as cubic feet per second, cubic meters per second, gallons per minute, gallons per day, or millions of gallons per day.

Dispersed discharge - Release of surface and stormwater runoff from a drainage facility system such that the flow spreads over a wide area and is located so as not to allow flow to concentrate anywhere upstream of a drainage channel with erodible underlying granular soils.

Ditch - A long narrow excavation dug in the earth for drainage with its top width less than 10 feet at design flow.

Divide, Drainage - The boundary between one drainage basin and another.

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Drain - A buried pipe or other conduit (closed drain). A ditch (open drain) for carrying off surplus surface water or ground water.

(To) Drain - To provide channels, such as open ditches or closed drains, so that excess water can be removed by surface flow or by internal flow. To lose water (from the soil) by percolation.

Drainage - Refers to the collection, conveyance, containment, and/or discharge of surface and storm water runoff.

Drainage basin - A geographic and hydrologic subunit of a watershed.

Drainage channel - A drainage pathway with a well-defined bed and banks indicating frequent conveyance of surface and stormwater runoff.

Drainage course - A pathway for watershed drainage characterized by wet soil vegetation; often intermittent in flow.

Drainage easement - A legal encumbrance that is placed against a property's title to reserve specified privileges for the users and beneficiaries of the drainage facilities contained within the boundaries of the easement.

Drainage pathway - The route that surface and stormwater runoff, leaving any part of the site, follows downslope.

Drainage review - An evaluation by Plan Approving Authority staff of a proposed project's compliance with the drainage requirements in this manual or its technical equivalent.

Drainage, Soil - As a natural condition of the soil, soil drainage refers to the frequency and duration of periods when the soil is free of saturation; for example, in well-drained soils the water is removed readily but not rapidly; in poorly drained soils the root zone is waterlogged for long periods unless artificially drained, and the roots of ordinary crop plants cannot get enough oxygen; in excessively drained soils the water is removed so completely that most crop plants suffer from lack of water. Strictly speaking, excessively drained soils are a result of excessive runoff due to steep slopes or low available water-holding capacity due to small amounts of silt and clay in the soil material. The following classes are used to express soil drainage:

Well drained - Excess water drains away rapidly and no mottling occurs within 36 inches of the surface.

Moderately well drained - Water is removed from the soil somewhat slowly, resulting in small but significant periods of wetness. Mottling occurs between 18 and 36 inches.

Somewhat poorly drained - Water is removed from the soil slowly enough to keep it wet for significant periods but not all of the time. Mottling occurs between 8 and 18 inches.

Poorly drained - Water is removed so slowly that the soil is wet for a large part of the time. Mottling occurs between 0 and 8 inches.

Very poorly drained - Water is removed so slowly that the water table remains at or near the surface for the greater part of the time. There may also be periods of surface ponding. The soil has a black to gray surface layer with mottles up to the surface.

Drawdown - Lowering of the water surface (in open channel flow), water table or piezometric surface (in ground water flow) resulting from a withdrawal of water.

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Drop-inlet spillway - Overall structure in which the water drops through a vertical riser connected to a discharge conduit.

Drop spillway - Overall structure in which the water drops over a vertical wall onto an apron at a lower elevation.

Drop structure - A structure for dropping water to a lower level and dissipating its surplus energy; a fall. A drop may be vertical or inclined.

Dry weather flow - The combination of sanitary sewage, and industrial and commercial wastes normally found in sanitary or storm sewers during the dry weather season of the year. Also that flow in streams during the dry season.

EIS - See Environmental Impact Statement.

ESC - Erosion and Sediment Control (Plan).

Earth material - any rock, natural soil or fill and/or any combination thereof.

Easement - The legal right to use a parcel of land for a particular purpose. It does not include fee ownership, but may restrict the owners use of the land.

Embankment - A structure of earth, gravel, or similar material raised to form a pond bank or foundation for a road.

Emergent plants - Aquatic plants that are rooted in the sediment but whose leaves are at or above the water surface. These wetland plants often have high habitat value for wildlife and waterfowl, and can aid in pollutant uptake.

Emergency spillway - A vegetated earth channel used to safely convey flood discharges in excess of the capacity of the principal spillway.

Energy dissipator - Any means by which the total energy of flowing water is reduced. In stormwater design, they are usually mechanisms that reduce velocity prior to, or at, discharge from an outfall in order to prevent erosion. They include rock splash pads, drop manholes, concrete stilling basins or baffles, and check dams.

Energy gradient - The slope of the specific energy line (i.e., the sum of the potential and velocity heads.)

Engineering geologist - a geologist experienced and knowledgeable in engineering geology.

Engineering geology - the application of geologic knowledge and principles in the investigation and evaluation of naturally occurring rock and soil for use in the design of civil works.

Engineering plan - A plan prepared and stamped by a professional civil engineer. An engineering plan contains a Technical Information Report and Site Improvement Plans which are described in detail in Chapter I-3.

Enhancement - To raise value, desirability, or attractiveness of an environment associated with surface water.

Environmental Impact Statement (EIS) - A document that discusses the likely significant adverse impacts of a proposal, ways to lessen the impacts, and alternatives to the proposal. They are required by the national and state environmental policy acts when projects are determined to have significant environmental impact.

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Erodible granular soils - Soil materials that are easily eroded and transported by running water, typically fine or medium grained sand with minor gravel, silt, or clay content. Such soils are commonly described as Everett or Indianola series soil types in the SCS classification. Also included are any soils showing examples of existing severe stream channel incision as indicated by unvegetated streambanks standing over two feet high above the base of the channel.

Erosion - The wearing away of the land surface by running water, wind, ice, or other geological agents, including such processes as gravitational creep. Also, detachment and movement of soil or rock fragments by water, wind, ice, or gravity. The following terms are used to describe different types of water erosion:

Accelerated erosion - Erosion much more rapid than normal or geologic erosion, primarily as a result of the influence of the activities of man or, in some cases, of the animals or natural catastrophes that expose bare surfaces (e.g., fires).

Geological erosion - The normal or natural erosion caused by geological processes acting over long geologic periods and resulting in the wearing away of mountains, the building up of floodplains, coastal plains, etc. Synonymous with natural erosion.

Gully erosion - The erosion process whereby water accumulates in narrow channels and, over short periods, removes the soil from this narrow area to considerable depths, ranging from 1 to 2 feet to as much as 75 to 100 feet.

Natural erosion - Wearing away of the earth's surface by water, ice, or other natural agents under natural environmental conditions of climate, vegetation, etc., undisturbed by man. Synonymous with geological erosion.

Normal erosion - The gradual erosion of land used by man which does not greatly exceed natural erosion. See Natural erosion.

Rill erosion - An erosion process in which numerous small channels only several inches deep are formed; occurs mainly on recently disturbed and exposed soils. See Rill.

Sheet erosion - The removal of a fairly uniform layer of soil from the land surface by runoff.

Splash erosion - The spattering of small soil particles caused by the impact of raindrops on wet soils. The loosened and spattered particles may or may not be subsequently removed by surface runoff.

Erosion classes (soil survey) - A grouping of erosion conditions based on the degree of erosion or on characteristic patterns. Applied to accelerated erosion, not to normal, natural, or geological erosion. Four erosion classes are recognized for water erosion and three for wind erosion.

Erosion/sedimentation control - Any temporary or permanent measures taken to reduce erosion; control siltation and sedimentation; and ensure that sediment-laden water does not leave the site.

Erosion and sediment control facility - A type of drainage facility designed to hold water for a period of time to allow sediment contained in the surface and stormwater runoff directed to the facility to settle out so as to improve the quality of the runoff.

Escarpment - A steep face or a ridge of high land.

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Estuarine wetland - Generally, an eelgrass bed; salt marsh; or rocky, sandflat, or mudflat intertidal area where fresh and salt water mix. (Specifically, a tidal wetland with salinity greater than 0.5 parts per thousand, usually semi-enclosed by land but with partially obstructed or eporadic access to the open ocean).

Estuary - An area where fresh water meets salt water, or where the tide meets the river current (e.g., bays, mouths of rivers, salt marshes and lagoons). Estuaries serve as nurseries and spawning and feeding grounds for large groups of marine life and provide shelter and food for birds and wildlife.

Eutrophication - Refers to the process where nutrient over-enrichment of water leads to excessive growth of aquatic plants, especially algae.

Evapotranspiration - The collective term for the processes of evaporation and plant transpiration by which water is returned to the atmosphere.

Excavation - the mechanical removal of earth material.

Exfiltration - The downward movement of runoff through the bottom of an infiltration BMP into the soil layer or the downward movement of water through soil.

Existing site conditions means - (a) For developed sites with stormwater facilities that have been constructed to meet the standards in the Minimum Requirements of this manual, existing site conditions shall mean the existing conditions on the site.

(b) For developed sites that do not have stormwater facilities that meet the Minimum Requirements, existing site conditions shall mean the conditions that existed prior to local government adoption of a stormwater management program. If in question, the existing site conditions shall be documented by aerial photograph records, or other appropriate means.

(c) For all sites in water quality sensitive areas as identified under Minimum Requirement #7, Water Quality Sensitive Areas, existing site conditions shall mean undisturbed forest, for the purpose of calculating runoff characteristics.

(d) For all undeveloped sites outside of water quality sensitive areas, existing site conditions shall mean the existing conditions on the site.

Experimental best management practice (BMP) - A BMP that has not been tested and evaluated by the Department of Ecology in collaboration with local governments and technical experts.

FIRM - See Flood Insurance Rate Map.

Fertilizer - Any material or mixture used to supply one or more of the essential plant nutrient elements.

Fill - a deposit of earth material placed by artificial means.

Filter fabric - A woven or nonwoven, water-permeable material generally made of synthetic products such as polypropylene and used in stormwater management and erosion and sediment control applications to trap sediment or prevent the clogging of aggregates by fine soil particles.

Filter fabric fence - A temporary sediment barrier consisting of a filter fabric stretched across and attached to supporting posts and entrenched. The filter fence is constructed of stakes and synthetic filter fabric with a rigid wire fence backing where necessary for support.

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Filter strip - A strip of vegetation used to retard or collect sediment for the protection of diversions, drainage basins, or other structures. Often used in conjunction with a level spreader to keep flow from becoming channelized in the filter strip.

Flocculation - The process by which suspended colloidal or very fine particles are assembled into larger masses or floccules which eventually settle out of suspension. This process occurs naturally but can also be caused through the use of such chemicals as alum.

Flood - An overflow or inundation that comes from a river or any other source, including (but no limited to) streams, tides, wave action, storm drains or excess rainfall. Any relatively high stream flow overtopping the natural or artificial banks in any reach of a stream.

Flood control - Methods or facilities for reducing flood flows and the extent of flooding.

Flood control project - A structural system installed to protect land and improvements from floods by the construction of dikes, river embankments, channels, or dams.

Flood frequency - The frequency with which the flood of interest may be expected to occur at a site in any average interval of years. Frequency analysis defines the "n-year flood" as being the flood that will, over a long period of time, be equaled or exceeded on the average once every "n" years.

Flood fringe - That portion of the floodplain outside of the floodway which is covered by floodwaters during the base flood; it is generally associated with standing water rather than rapidly flowing water.

Flood Hazard Areas - Those areas subject to inundation by the base flood. Includes, but is not limited to streams, lakes, wetlands, and closed depressions.

Flood Insurance Rate Map (FIRM) - The official map on which the Federal Insurance Administration has delineated many areas of flood hazard, floodway, and the risk premium zones.

Flood Insurance Study - The official report provided by the Federal Insurance Administration that includes flood profiles and the FIRM.

Flood peak - The highest value of the stage or discharge attained by a flood; thus, peak stage or peak discharge.

Floodplain - The total area subject to inundation by the base flood including the flood fringe and floodway.

Flood-proofing - Adaptations that ensure a structure is substantially impermeable to the passage of water below the flood protection elevation that resists hydrostatic and hydrodynamic loads and effects of buoyancy.

Flood protection elevation - the base flood elevation or higher as defined by the local government.

Flood protection facility - Any levee, berm, wall, enclosure, raise bank, revetment, constructed bank stabilization or armoring, that is commonly recognized by the community as providing significant protection to a property from inundation by flood waters.

Flood routing - An analytical technique used to compute the effects of system storage dynamics on the shape and movement of flow represented by a hydrograph.

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Flood stage - The stage at which overflow of the natural banks of a stream begins.

Floodway - The channel of the river or stream and those portions of the adjoining floodplains which are reasonably required to carry and discharge the base flood flow. The portions of the adjoining floodplains which are considered to be "reasonably required" is defined by flood hazard regulations.

Forebay - An easily maintained, extra storage area provided near an inlet of a BMP to trap incoming sediments before they accumulate in a pond or wetland BMP.

Forest practice - Any activity conducted on or directly pertaining to forest land and relating to growing, harvesting, or processing timber, including but not limited to:

a. Road and trail construction.
b. Harvesting, final and intermediate.
c. Precommercial thinning.
d. Reforestation.
e. Fertilization.
f. Prevention and suppression of diseases and insects.
g. Salvage of trees.
h. Brush control.

Forested communities (wetlands) - In general terms, communities (wetlands) characterized by woody vegetation that is greater than or equal to 6 meters in height; in this manual the term applies to such communities (wetlands) that represent a significant amount of tree cover consisting of species that offer wildlife habitat and other values and advance the performance of wetland functions overall.

Freeboard - The vertical distance between the design water surface elevation and the elevation of the barrier which contains the water.

Frequently flooded areas - the 100-year floodplain designations of the Federal Emergency Management Agency and the National Flood Insurance Program or as defined by the local government.

Frost-heave - The upward movement of soil surface due to the expansion of water stored between particles in the first few feet of the soil profile as it freezes. May cause surface fracturing of asphalt or concrete.

Frequency of storm (design storm frequency) - The anticipated period in years that will elapse, based on average probability of storms in the design region, before a storm of a given intensity and/or total volume will recur; thus a 10-year storm can be expected to occur on the average once every 10 years. Sewers designed to handle flows which occur under such storm conditions would be expected to be surcharged by any storms of greater amount or intensity.

Functions - The ecological (physical, chemical, and biological) processes or attributes of a wetland without regard for their importance to society (see also values). Wetland functions include food chain support, provision of ecosystem diversity and fish and wildlife habitat, floodflow alteration, ground water recharge and discharge, water quality improvement, and soil stabilization.

Gabion - A rectangular or cylindrical wire mesh cage (a chicken wire basket) filled with rock and used as a protecting agent, revetment, etc., against erosion. Soft gabions, often used in streambank stabilization, are made of geotextiles filled with dirt, in between which cuttings are placed.

Gage or gauge - Device for registering precipitation, water level, discharge, velocity, pressure, temperature, etc. Also, a measure of the thickness of metal;

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e.g., diameter of wire, wall thickness of steel pipe.

Gaging station - A selected section of a stream channel equipped with a gage, recorder, or other facilities for determining stream discharge.

Geologist - A person who has earned a degree in geology from an accredited college or university or who has equivalent educational training and has at least five years of experience as a practicing geologist or four years of experience and at leaet two years post-graduate study, research or teaching. The practical experience shall include at least three years work in applied geology and landslide evaluation, in close association with qualified practicing geologists or geotechnical professional/civil engineers.

Geologically hazardous areas - areas that because of their susceptibility to erosion, sliding, earthquake or other geological events, are not suited to the siting of commercial, residential or industrial development consistent with public health or safety concerns.

Geometrics - The mathematical relationships between points, lines, angles and surfaces used to measure and identify areas of land.

Geotechnical professional civil engineer - A practicing, geotechnical/civil engineer licensed as a professional Civil Engineer with the State of Washington who has at least four years of professional employment as a geotechnical engineer in responsible charge, including experience with landslide evaluation.

Grade - The slope of a road, channel, or natural ground. The finished surface of a canal bed, roadbed, top of embankment, or bottom of excavation; any surface prepared for the support of construction such as paving or the laying of a conduit.

(To) Grade - To finish the surface of a canal bed, roadbed, top of embankment or bottom of excavation.

Gradient terrace - an earth embankment or a ridge-and-channel constructed with suitable spacing and an acceptable grade to reduce erosion damage by intercepting surface runoff and conducting it to a stable outlet at a stable nonerosive velocity.

Grassed waterway - A natural or constructed waterway, usually broad and shallow, covered with erosion-resistant grasses, used to conduct surface water from an area at a reduced flow rate. See also biofilter.

Ground water - Water in a saturated zone or stratum beneath the land surface or a surface water body.

Ground water recharge - Inflow to a ground water reservoir.

Ground water table - The free surface of the ground water, that surface subject to atmospheric pressure under the ground, generally rising and falling with the season, the rate of withdrawal, the rate of restoration, and other conditions. It is seldom static.

(the) Guidance Manual - "The Stormwater Program Guidance Manual for the Puget Sound Basin"; a companion manual to this technical manual which contains program implementation guidance for local governments. Examples of the guidance contained are model ordinances, public education information, and guidance on setting up a stormwater utility.

Gully - A channel caused by the concentrated flow of surface and stormwater runoff over unprotected erodible land.

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Habitat - The specific area or environment in which a particular type of plant or animal lives. An organism's habitat must provide all of the basic requirements for life and should be protected from harmful contaminants.

Hardpan - A cemented or compacted and often clay-like layer of soil that is impenetrable by roots.

Harmful pollutant - A substance that has adverse effects to an organism including immediate death, chronic poisoning, impaired reproduction, cancer or other effects.

Head (Hydraulics) - The height of water above any plain of reference. The energy, either kinetic or potential, possessed by each unit weight of a liquid, expressed as the vertical height through which a unit weight would have to fall to release the average energy possessed. Used in various compound terms such as pressure head, velocity head, and head loss.

Head loss - Energy loss due to friction, eddies, changes in velocity, or direction of flow.

Heavy metals - Metals of high specific gravity, present in municipal and industrial wastes, that pose long-term environmental hazards. Such metals include cadmium, chromium, cobalt, copper, lead, mercury, nickel, and zinc.

Humus - Organic matter in or on a soil, composed of partly or fully decomposed bits of plant tissue or from animal manure.

Hydraulic gradient - Slope of the potential head relative to a fixed datum.

Hydrodynamics - means the dynamic energy, force, or motion of fluids as affected by the physical forces acting upon those fluids.

Hydrograph - A graph of runoff rate, inflow rate or discharge rate, past a specific point over time.

Hydrologic cycle - The circuit of water movement from the atmosphere to the earth and return to the atmosphere through various stages or processes as precipitation, interception, runoff, infiltration, percolation, storage, evaporation, and transpiration.

Hydrologic Soil Groups - A soil characteristic classification system defined by the U.S. Soil Conservation Service in which a soil may be categorized into one of four soil groups (A, B, C, or D) based upon infiltration rate and other properties.

Hydrology - The science of the behavior of water in the atmosphere, on the surface of the earth, and underground.

Hydroperiod - a seasonal occurrence of flooding and/or soil saturation; it encompasses depth, frequency, duration, and seasonal pattern of inundation.

Hyetograph - A graph of percentages of total precipitation for a series of time steps representing the total time in which precipitation occurs.

Illicit discharge - All non-stormwater discharges to stormwater drainage systems that cause or contribute to a violation of state water quality, sediment quality or ground water quality standards, including but not limited to sanitary sewer connections, industrial process water, interior floor drains, car washing and greywater systems.

Impact basin - A device used to dissipate the energy of flowing water. Generally constructed of concrete in the form of a partially depressed or partially submerged vessel, it may utilize baffles to dissipate velocities.

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Impervious - A surface which cannot be easily penetrated. For instance, rain does not readily penetrate paved surfaces.

Impervious surface - means a hard surface area which either prevents or retards the entry of water into the soil mantle as under natural conditions prior to development, and/or a hard surface area which causes water to run off the surface in greater quantities or at an increased rate of flow from the flow present under natural conditions prior to development. Common impervious surfaces include, but are not limited to, roof tops, walkways, patios, driveways, parking lots or storage areas, concrete or asphalt paving, gravel roads, packed earthen materials, and oiled, macadam or other surfaces which similarly impede the natural infiltration of stormwater. Open, uncovered retention/detention facilities shall not be considered as impervious surfaces.

Impoundment - A natural or man-made containment for surface water.

Improvement - Streets (with or without curbs or gutters), sidewalks, crosswalks, parking lots, water mains, sanitary and storm sewers, drainage facilities, street trees and other appropriate items.

Infiltration - means the downward movement of water from the surface to the subsoil.

Infiltration facility (or system) - A drainage facility designed to use the hydrologic process of surface and stormwater runoff soaking into the ground, commonly referred to as a percolation, to dispose of surface and stormwater runoff.

Ingress/egress - The points of access to and from a property.

Inlet - A form of connection between surface of the ground and a drain or sewer for the admission of surface and stormwater runoff.

Insecticide - A substance, usually chemical, that is used to kill insects.

Interception (Hydraulics) - The process by which precipitation is caught and held by foliage, twigs, and branches of trees, shrubs, and other vegetation. Often used for "interception loss" or the amount of water evaporated from the precipitation intercepted.

Interflow - That portion of rainfall that infiltrates into the soil and moves laterally through the upper soil horizons until intercepted by a stream channel or until it returns to the surface for example, in a wetland, spring or seep.

Intermittent stream - A stream or portion of a stream that flows only in direct response to precipitation. It receives little or no water from springs and no long-continued supply from melting snow or other sources. It is dry for a large part of the year, ordinarily more than three months.

Invasive weedy plant species - Opportunistic species of inferior biological value that tend to out-compete more desirable forms and become dominant; applied to non-native species in this manual.

Invert - The lowest point on the inside of a sewer or other conduit.

Invert elevation - The vertical elevation of a pipe or orifice in a pond which defines the water level.

Isopluvial map - A map with lines representing constant depth of total precipitation for a given return frequency.

Lag time - The interval between the center of mass of the storm precipitation and the peak flow of the resultant runoff.

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Lake - An area permanently inundated by water in excess of two meters deep and greater than 20 acres in size as measured at the ordinary high water marks.

Land disturbing activity - means any activity that results in a change in the existing soil cover (both vegetative and nonvegetative) and/or the existing soil topography. Land disturbing activities include, but are not limited to demolition, construction, clearing, grading, filling and excavation.

Landslide - Episodic downslope movement of a mass of soil or rock that includes but is not limited to rockfalls, slumps, mudflows, and earthflows. For the purpose of these rules, snow avalanches are considered to be a special case of landsliding.

Landslide Hazard Areas - Those areas subject to a severe risk of landslide.

Large Parcel Erosion and Sediment Control Plan" or "LPESC Plan" - a plan to implement BMPs to control pollution generated during land disturbing activity. Guidance for preparing a Large Parcel ESC Plan is contained in Chapter II-4. *[Note: Ecology will be adding a sample Large Parcel ESC Plan to the Guidance Manual.]*

Leachate - Liquid that has percolated through soil and contains substances in solution or suspension.

Leaching - Removal of the more soluble materials from the soil by percolating waters.

Legume - A member of the legume or pulse family, Leguminosae, one of the most important and widely distributed plant families. The fruit is a "legume" or pod. Includes many valuable food and forage species, such as peas, beans, clovers, alfalfas, sweet clovers, and vetches. Practically all legumes are nitrogen-fixing plants.

Level spreader - A temporary ESC device used to spread out stormwater runoff uniformly over the ground surface as sheet flow (i.e., not through channels). The purpose of level spreaders are to prevent concentrated, erosive flows from occurring, and to enhance infiltration.

Local government - Any county, city, or town having its own incorporated government for local affairs.

Low flow channel - An incised or paved channel from inlet to outlet in a dry basin which is designed to carry low runoff flows and/or baseflow, directly to the outlet without detention.

Lowest floor - The lowest enclosed area (including basement) of a structure. An area used solely for parking of vehicles, building access, or storage, in an area other than a basement area, is not considered a building's lowest floor, provided that the enclosed area meets all of the structural requirements of the flood hazard standards.

MDNS - A Mitigated Determination of Nonsignificance (See DNS and Mitigation).

Manning's equation (Hydraulics) - An equation used to predict the velocity of water flow in an open channel or pipelines:

$$V = \frac{1.486 R^{2/3} s^{1/2}}{n}$$

where:

V is the mean velocity of flow in feet per second
R is the hydraulic radius in feet
S is the slope of the energy gradient or, for assumed uniform flow, the slope of the channel in feet per foot; and

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n is Manning's roughness coefficient or retardance factor of the channel lining.

Mass wasting - The movement of large volumes of earth material downslope.

Master Drainage Plan - A comprehensive drainage control plan intended to prevent significant adverse impacts to the natural and manmade drainage system, both on and off-site.

Mean annual water level fluctuation - Derived as follows--

(1) Measure the maximum water level (e.g., with a crest stage gage, Reinelt and Horner 1990) and the existing water level at the time of the site visit (e.g., with a staff gage) on at least eight occasions spread through a year.

(2) Take the difference of the maximum and existing water level on each occasion and divide by the number of occasions.

Mean depth (Hydraulics) - Average depth; cross-sectional area of a stream or channel divided by its surface or top width.

Mean velocity - The average velocity of a stream flowing in a channel or conduit at a given cross-section or in a given reach. It is equal to the discharge divided by the cross-sectional area of the reach.

Measuring weir - A shaped notch through which water flows are measured. Common shapes are rectangular, trapezoidal, and triangular.

Mechanical analysis - The analytical procedure by which soil particles are separated to determine the particle size distribution.

Mechanical practices - Soil and water conservation practices that primarily change the surface of the land or that store, convey, regulate, or dispose of runoff water without excessive erosion.

Metals - Elements, such as mercury, lead, nickel, zinc and cadmium, that are of environmental concern because they do not degrade over time. Although many are necessary nutrients, they are sometimes magnified in the food chain, and they can be toxic to life in high enough concentrations. They are also referred to as heavy metals.

Mitigation - means, in the following order of preference:

(a) Avoiding the impact altogether by not taking a certain action or part of an action;

(b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation, by using appropriate technology, or by taking affirmative steps to avoid or reduce impacts;

(c) Rectifying the impact by repairing, rehabilitating or restoring the affected environment;

(d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and

(e) Compensation for the impact by replacing, enhancing, or providing substitute resources or environments.

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Modification, Modified (wetland) - A wetland whose physical, hydrological, or water quality characteristics have been purposefully altered for a management purpose, such as by dredging, filling, forebay construction, and inlet or outlet control.

Monitor - To systematically and repeatedly measure something in order to track changes.

Monitoring - The collection of data by various methods for the purposes of understanding natural systems and features, evaluating the impacts of development proposals on such systems, and assessing the performance of mitigation measures imposed as conditions of development.

NGPE - See Native Growth Protection Easement.

NGVD - National Geodetic Vertical Datum (see Base flood elevation).

NPDES - The National Pollutant Discharge Elimination System as established by the Federal Clean Water Act.

National Pollutant Discharge Elimination System (NPDES) - The part of the federal Clean Water Act, which requires point source dischargers to obtain permits. These permits are referred to as NPDES permits and, in Washington State, are administered by the Washington State Department of Ecology.

Native Growth Protection Easement (NGPE) - An easement granted for the protection of native vegetation within a sensitive area or its associated buffer. The NGPE shall be recorded on the appropriate documents of title and filed with the County Records Division.

Natural location - means the location of those channels, swales, and other non-manmade conveyance systems as defined by the first documented topographic contours existing for the subject property, either from maps or photographs, or such other means as appropriate.

New development - means the following activities: land disturbing activities, structural development, including construction, installation or expansion of a building or other structure; creation of impervious surfaces; Class IV - general forest practices that are conversions from timber land to other uses; and subdivision and short subdivision of land as defined in RCW 58.17.020. All other forest practices and commercial agriculture are not considered new development.

Nitrate (NO_3) - A form of nitrogen which is an essential nutrient to plants. It can cause algal blooms in water if all other nutrients are present in sufficient quantities. It is a product of bacterial oxidation of other forms of nitrogen, from the atmosphere during electrical storms and from fertilizer manufacturing.

Nitrification - The biochemical oxidation process by which ammonia is changed first to nitrites and then to nitrates by bacterial action, consuming oxygen in the water.

Nitrogen, Available - Usually ammonium, nitrite, and nitrate ions, and certain simple amines available for plant growth. A small fraction of organic or total nitrogen in the soil is available at any time.

Nonpoint source pollution - Pollution that enters a water body from diffuse origins on the watershed and does not result from discernible, confined, or discrete conveyances.

Normal depth - The depth of uniform flow. This is a unique depth of flow for any combination of channel characteristics and flow conditions. Normal depth is calculated using Manning's Equation.

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Nutrients - Essential chemicals needed by plants or animals for growth. Excessive amounts of nutrients can lead to degradation of water quality and algal blooms. Some nutrients can be toxic at high concentrations.

Off-site - Any area lying upstream of the site that drains onto the site and any area lying downstream of the site to which the site drains.

Off-system storage - Facilities for holding or retaining excess flows over and above the carrying capacity of the stormwater conveyance system, in chambers, tanks, lagoons, ponds, or other basins that are not a part of the subsurface sewer system.

On-site - The entire property that includes the proposed development.

Ordinary High Water Mark - The term ordinary high water mark means the line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank; shelving; changes in the character of soil destruction on terrestrial vegetation, or the presence of litter and debris; or other appropriate means that consider the characteristics of the surrounding area.

The ordinary high water mark will be found by examining the bed and banks of a stream and ascertaining where the presence and action of waters are so common and usual, and so long maintained in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland, in respect to vegetation. In any area where the ordinary high water mark cannot be found, the line of mean high water shall substitute. In any area where neither can be found, the channel bank shall be substituted. In braided channels and alluvial fans, the ordinary high water mark or substitute shall be measured so as to include the entire stream feature.

Orifice - An opening with closed perimeter, usually sharp-edged, and of regular form in a plate, wall, or partition through which water may flow, generally used for the purpose of measurement or control of water.

Outlet - Point of water disposal from a stream, river, lake, tidewater, or artificial drain.

Outlet channel - A waterway constructed or altered primarily to carry water from man-made structures, such as terraces, tile lines, and diversions.

Overflow - A pipeline or conduit device, together with an outlet pipe, that provides for the discharge of portions of combined sewer flows into receiving waters or other points of disposal, after a regular device has allowed the portion of the flow which can be handled by interceptor sewer lines and pumping and treatment facilities to be carried by and to such water pollution control structures.

Overflow rate - Detention basin release rate divided by the surface area of the basin. It can be thought of as an average flow rate through the basin.

Overtopping - To flow over the limits of a containment or conveyance element.

Peak discharge - The maximum instantaneous rate of flow during a storm, usually in reference to a specific design storm event.

Peak-shaving - Controlling post-development peak discharge rates to pre-development levels by providing temporary detention in a BMP.

Percolation - The movement of water through soil.

Percolation rate - The rate, usually expressed as a velocity, at which water moves through saturated granular material.

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Permanent Stormwater Quality Control (PSQC) Plan - a plan which includes permanent BMPs for the control of pollution from stormwater runoff after construction and/or land disturbing activity has been completed. For small sites, this requirement is met by implementing a Small Parcel Erosion and Sediment Control Plan. Guidance on preparing a PSQC Plan is contained in Chapter I-3 and Chapter I-4. *[Note: Ecology will add a sample Large Parcel ESC Plan to the Guidance Manual.]*

Permeability rate - The rate at which water will move through a saturated soil. Permeability rates are classified as follows:

a. Very slow - Less than 0.06 inches per hour.
b. Slow - 0.06 to 0.20 inches per hour.
c. Moderately slow - 0.20 to 0.63 inches per hour.
d. Moderate - 0.63 to 2.0 inches per hour.
e. Moderately rapid - 2.0 to 6.3 inches per hour.
f. Rapid - 6.3 to 20.0 inches per hour.
g. Very rapid - More than 20.0 inches per hour.

Permeable soils - Soil materials with a sufficiently rapid infiltration rate so as to greatly reduce or eliminate surface and stormwater runoff. These soils are generally classified as SCS hydrologic soil types A and B.

Person - Any individual, partnership, corporation, association, organization, cooperative, public or municipal corporation, agency of the state, or local government unit, however designated.

Perviousness - Related to the size and continuity of void spaces in soils; related to a soil's infiltration rate.

Pesticide - A general term used to describe any substance - usually chemical - used to destroy or control organisms; includes herbicides, insecticides, algicides, fungicides, and others. Many of these substances are manufactured and are not naturally found in the environment. Others, such as pyrethrum, are natural toxins which are extracted from plants and animals.

pH - A measure of the alkalinity or acidity of a substance which is conducted by measuring the concentration of hydrogen ions in the substance. A pH of 7.0 indicates neutral water. A 6.5 reading is slightly acid.

Physiographic - Characteristics of the natural physical environment (including hills).

Planned unit development (PUD) - A special classification authorized in some zoning ordinances, where a unit of land under control of a single developer may be used for a variety of uses and densities, subject to review and approval by the local governing body. The locations of the zones are usually decided on a case-by-case basis.

Plat - A map or representation of a subdivision showing the division of a tract or parcel of land into lots, blocks, streets, or other divisions and dedications.

Plunge pool - A device used to dissipate the energy of flowing water that may be constructed or made by the action of flowing. These facilities may be protected by various lining materials.

Point discharge - The release of collected and/or concentrated surface and storm water runoff from a pipe, culvert, or channel.

Pollution - Contamination or other alteration of the physical, chemical, or biological properties, of waters of the state, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid,

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gaseous, solid, radioactive or other substance into any waters of the state as will or is likely to create a nuisance or render such waters harmful, detrimental or injurious to the public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or to livestock, wild animals, birds, fish or other aquatic life.

Prediction - For the purposes of this document an expected outcome based on the results of hydrologic modelling and/or the judgment of a trained professional civil engineer or geologist.

Pretreatment - The removal of material such as gross solids, grit, grease, and scum from flows prior to physical, biological, or physical treatment processes to improve treatability. Pretreatment may include screening, grit removal, stormwater, and oil separators.

Priority peat systems - Unique, irreplaceable fens that can exhibit water pH in a wide range from highly acidic to alkaline, including fens typified by Sphagnum species, Ledum groenlandicum (Labrador tea), Drosera rotundifolia (sundew), and Vaccinium oxycoccos (bog cranberry); marl fens; estuarine peat deposits; and other moss peat systems with relatively diverse, undisturbed flora and fauna. Bog is the common name for peat systems having the Sphagnum association described, but this term applies strictly only to systems that receive water income from precipitation exclusively.

Professional civil engineer - A person registered with the State of Washington as a professional engineer in civil engineering.

Project - The proposed action of a permit application or an approval which requires a drainage review.

Puget Sound basin - Puget Sound south of Admiralty Inlet (including Hood Canal and Saratoga Passage); the waters north to the Canadian border, including portions of the Strait of Georgia; the Strait of Juan de Fuca south of the Canadian border; and all the lands draining into these waters as mapped in Water Resources Inventory Areas numbers 1 through 19, set forth in WAC 173-500-040.

R/D - See Retention/detention facility.

Rare, threatened, or endangered species - Plant or animal species that are regional relatively uncommon, are nearing endangered status, or whose existence is in immediate jeopardy and is usually restricted to highly specific habitats. Threatened and endangered species are officially listed by federal and state authorities, whereas rare species are unofficial species of concern that fit the above definitions.

Rational method - A means of computing storm drainage flow rates (Q) by use of the formula Q = CIA, where C is a coefficient describing the physical drainage area, I is the rainfall intensity and A is the area. This method is no longer used in the technical manual.

Reach - A length of channel with uniform characteristics.

Receiving waters - Bodies of water or surface water systems receiving water from upstream manmade (or natural) streams.

Recharge - The flow to ground water from the infiltration of surface and stormwater runoff.

Redevelopment - On an already developed site, the creation or addition of impervious surfaces, structural development including construction, installation or expansion of a building or other structure, and/or replacement of impervious surface that is

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not part of a routine maintenance activity; and land disturbing activities associated with structural or impervious redevelopment.

Regional - An action (here, for stormwater management purposes) that involves more than one discrete property.

Regional detention facility - A stormwater quantity control structure designed to correct existing excess surface water runoff problems of a basin or subbasin. The area downstream has been previously identified as having existing or predicted significant and regional flooding and/or erosion problems.

This term is also used when a detention facility is used to detain stormwater runoff from a number of different businesses, developments or areas within a catchment. The use of regional detention facilities may be more efficient than on-site stormwater treatment although the preferred option is to include some on-site stormwater treatment through the use of grassy swales etc. even when regional detention facilities are used.

Release rate - The computed peak rate of surface and stormwater runoff for a particular design storm event and drainage area conditions.

Residential density - The number of persons per unit of residential land area. Net density includes only occupied land. Gross density includes unoccupied portions of residential areas, such as roads and open space.

Restoration - Actions performed to reestablish wetland functional characteristics and processes that have been lost by alterations, activities, or catastrophic events in an area that no longer meets the definition of a wetland.

Retention - The process of collecting and holding surface and stormwater runoff with no surface outflow.

Retention/detention facility (R/D) - A type of drainage facility designed either to hold water for a considerable length of time and then release it by evaporation, plant transpiration, and/or infiltration into the ground; or to hold surface and stormwater runoff for a short period of time and then release it to the surface and stormwater management system.

Retrofitting - The renovation of an existing structure or facility to meet changed conditions or to improve performance.

Return interval - A statistical term for the average time of expected interval that an event of some kind will equal or exceed given conditions (e.g., a stormwater flow that occurs every 2 years).

Rhizome - A modified plant stem that grows horizontally underground.

Riffles - Fast sections of a stream where shallow water races over stones and gravel. Riffles usually support a wider variety of bottom organisms than other stream sections.

Rill - A small intermittent watercourse with steep sides, usually only a few inches deep. Often rills are caused by an increase in surface water flow when soil is cleared of vegetation.

Riprap - A facing layer or protective mound of stones placed to prevent erosion or sloughing of a structure or embankment due to flow of surface and stormwater runoff.

Riparian - Pertaining to the banks of streams, wetlands, lakes or tidewater.

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Riser - A vertical pipe extending from the bottom of a pond BMP that is used to control the discharge rate from a BMP for a specified design storm.

Rodenticide - A substance used to destroy rodents.

Runoff - Water originating from rainfall and other precipitation that is found in drainage facilities, rivers, streams, springs, seeps, ponds, lakes and wetlands as well as shallow ground water.

SCS - Soil Conservation Service, U.S. Department of Agriculture.

SCS Method - A hydrologic analysis based on the Curve Number method (National Engineering Handbook - Section 4: Hydrology, August 2971).

SEPA - See State Environmental Policy Act.

Salmonid - A member of the fish family Salmonidae. Chinook, coho, chum, sockeye and pink salmon; cutthroat, brook, brown, rainbow and steelhead trout; Dolly Varden, kokanee and char are examples of salmonid species.

Saturation point - In soils, the point at which a soil or an aquifer will no longer absorb any amount of water without losing an equal amount.

Scour - Erosion of channel banks due to excessive velocity of the flow of surface and stormwater runoff.

Sediment - Fragmented material that originates from weathering and erosion of rocks or unconsolidated deposits, and is transported by, suspended in, or deposited by water.

Sedimentation - The depositing or formation of sediment.

Sensitive emergent vegetation communities - Assemblages of erect, rooted, herbaceous vegetation, excluding mosses and lichens, at least some of whose members have relatively narrow ranges of environmental requirements, such as hydroperiod, nutrition, temperature, and light. Examples include fen species such as sundew and, as well as a number of species of Carex (sedges).

Sensitive life stages - Stages during which organisms have limited mobility or alternatives in securing the necessities of life, especially including reproduction, rearing, and migration periods.

Sensitive scrub-shrub vegetation communities - Assemblages of woody vegetation less than 6 meters in height, at least some of whose members have relatively narrow ranges of environmental requirements, such as hydroperiod, nutrition, temperature, and light. Examples include fen species such as Labrador tea, bog laurel, and cranberry.

Settleable solids - Those suspended solids in stormwater that separate by settling when the stormwater is held in a quiescent condition for a specified time.

Sheet erosion - The relatively uniform removal of soil from an area without the development of conspicuous water channels.

Sheetflow - Runoff which flows over the ground surface as a thin, even layer, not concentrated in a channel.

Shoreline development - The proposed project as regulated by the Shoreline Management Act. Usually the construction over water or within a shoreline zone (generally 200 feet landward of the water) of structures such as buildings, piers, bulkheads, and breakwaters, including environmental alterations such as dredging and

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filling, or any project which interferes with public navigational rights on the surface waters.

Short circuiting - The passage of runoff through a BMP in less than the design treatment time.

Siltation - The process by which a river, lake, or other water body becomes clogged with sediment. Silt can clog gravel beds and prevent successful salmon spawning.

Site - The portion of a piece of property which is directly subject to development.

Slope - Degree of deviation of a surface from the horizontal; measured as a numerical ratio, percent, or in degrees. Expressed as a ratio, the first number is the horizontal distance (run) and the second is the vertical distance (rise), as 2:1. A 2:1 slope is a 50 percent slope. Expressed in degrees, the slope is the angle from the horizontal plane, with a 90° slope being vertical (maximum) and 45° being a 1:1 or 100 percent slope.

Sloughing - The sliding of overlying material. It is the same effect as caving, but it usually occurs when the bank or an underlying stratum is saturated or scoured.

Small Parcel Erosion and Sediment Control Plan or "SPESC Plan" - a plan for small sites to implement temporary BMPs to control pollution generated during the construction phase only, primarily erosion and sediment. Guidance for preparing a Small Parcel ESC Plan is contained in Chapter I-3.

Soil - The unconsolidated mineral and organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants.

Soil group, hydrologic - A classification of soils by the Soil Conservation Service into four runoff potential groups. The groups range from A soils, which are very permeable and produce little or no runoff, to D soils, which are not very permeable and produce much more runoff.

Soil horizon - A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming factors.

Soil profile - A vertical section of the soil from the surface through all horizons, including C horizons.

Soil structure - The relation of particles or groups of particles which impart to the whole soil a characteristic manner of breaking; some types are crumb structure, block structure, platy structure, and columnar structure.

Soil permeability - The ease with which gases, liquids, or plant roots penetrate or pass through a layer of soil.

Soil stabilization - The use of measures such as rock lining, vegetation or other engineering structures to prevent the movement of soil when loads are applied to the soil.

Sorption - The physical or chemical binding of pollutants to sediment or organic particles.

Source control BMP - A BMP that is intended to prevent pollutants from entering stormwater. A few examples of source control BMPs are erosion control practices, maintenance of stormwater facilities, constructing roofs over storage and working areas, and directing wash water and similar discharges to the sanitary sewer or a dead end sump.

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Specific energy - The total energy within any system with respect to the channel bottom, equal to the potential head plus velocity and pressure heads.

Spillway - A passage such as a paved apron or channel for surplus water over or around a dam or similar obstruction. An open or closed channel, or both, used to convey excess water from a reservoir. It may contain gates, either manually or automatically controlled, to regulate the discharge of excese water.

State Environmental Policy Act (SEPA) - The Washington State law intended to minimize environmental damage. SEPA requires that state agencies and local governments consider environmental factors when making decisions on activities, such as development proposals over a certain size and comprehensive plans. As part of this process, environmental documents are prepared and opportunities for public comment are provided.

Steep slope - Slopes of 40 percent gradient or steeper.

Storm drains - The encloseed conduits that transport surface and stormwater runoff toward points of discharge (sometimes called storm sewers).

Storm drain system - Refers to the system of gutters, pipes, streams, or ditches used to carry surface and stormwater from surrounding lands to streams, lakes, or Puget Sound.

Storm frequency - The time interval between major storms of predetermined intensity and volumes of runoff for which storm sewers and other structures are designed and constructed to handle hydraulically without surcharging and backflooding, e.g., a 2-year, 10-year or 100-year storm.

Storm sewer - A sewer that carries stormwater and surface water, street wash and other wash waters or drainage, but excludes sewage and industrial wastes. Also called a storm drain.

Stormwater - That portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, channels or pipes into a defined surface water channel, or a constructed infiltration facility.

Stormwater drainage system - constructed and natural features which function together as a system to collect, convey, channel, hold, inhibit, retain, detain, infiltrate, divert, treat or filter stormwater.

Stormwater facility - A constructed component of a stormwater drainage system, designed or constructed to perform a particular function, or multiple functions. Stormwater facilities include, but are not limited to, pipes, swales, ditches, culverts, street gutters, detention basins, retention basins, constructed wetlands, infiltration devices, catchbasins, oil/water separators, sediment basins and modular pavement.

Stormwater Management Manual for the Puget Sound Basin or "Manual" - this manual as prepared by Ecology that contains BMPs to prevent, control or treat pollution in stormwater [or a technically equivalent Manual approved by Ecology].

Stormwater Program - Either the Basic Stormwater Program or the Comprehensive Stormwater Program as appropriate to the context of the reference. See the "Stormwater Program Guidance Manual for the Puget Sound Basin" for a complete description of the requirements of each program.

Stormwater Site Plan - a plan which includes an Erosion and Sediment Control (ESC) Plan and/or a Permanent Stormwater Quality Control Plan (PSQC). For small sites, this plan is the equivalent of a Small Parcel Erosion and Sediment Control Plan. Guidance on preparing a Stormwater Site Plan is contained in Chapter I-3.

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Stream gaging - The quantitative determination of stream flow using gages, current meters, weirs, or other measuring instruments at selected locations. See Gaging station.

Streambanks - The usual boundaries, not the flood boundaries, of a stream channel. Right and left banks are named facing downstream.

Stream classification - The following stream classification which applies to all streams.

1. Type 1 streams are all streams inventoried as Shorelines of the State under Ch. 90.58 RCW.

2. Type 2 streams are all streams smaller than Type 1 streams that flow year around during years of normal rainfall, or are used by salmonids.

3. Type 3 streams are streams that are intermittent or ephemeral during years of normal rainfall and are not used by salmonids.

Streams - Those areas where surface waters flow sufficiently to produce a defined channel or bed. A defined channel or bed is indicated by hydraulically sorted sediments or the removal of vegetative litter or loosely rooted vegetation by the action of moving water. The channel or bed need not contain water year-round. This definition is not meant to include irrigation ditches, canals, storm water runoff devices or other entirely artificial watercourses unless they are used to convey Type 1 and 2 streams naturally occurring prior to construction. Those topographic features that resemble streams but have no defined channels (i.e. swales) shall be considered streams when hydrologic and hydraulic analyses done pursuant to a development proposal predict formation of a defined channel after development.

Structure - A catchbasin or manhole in reference to a storm drainage system.

Stub-out - A short length of pipe provided for future connection to a storm drainage system.

Subbasin - A drainage area which drains to a water course or waterbody named and noted on common maps and which is contained within a basin.

Subcatchment - A subdivision of a drainage basin (generally determined by topography and pipe network configuration).

Subcritical flow - Flow at depths greater than the critical depth.

Sub-division retention/detention facility - A retention/detention facility which is both (1) located within or associated with a short or formal plat sub-division containing only single family or duplex residential structures located on individual lots; and 2) which is required to handle excess runoff generated by development of an area of which two-thirds or more is designated for single family or duplex residential structures located on individual lots.

Subdrain - A pervious backfilled trench containing stone or a pipe for intercepting ground water or seepage.

Subgrade - A layer of stone or soil used as the underlying base for a BMP.

Subsoil - The B horizons of soils with distinct profiles. In soils with weak profile development, the subsoil can be defined as the soil below the plowed soil (or its equivalent of surface soil), in which roots normally grow. Although a common term, it cannot be defined accurately. It has been carried over from early days when "soil" was conceived only as the plowed soil and that under it as the "subsoil."

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Substrate - The natural soil base underlying a BMP.

Supercritical flow - Flow at depths less than the critical depth.

Surcharge - The flow condition occurring in closed conduits when the hydraulic grade line is above the crown of the sewer.

Surface and stormwater - Water originating from rainfall and other precipitation that is found in drainage facilities, rivers, streams, springs, seeps, ponds, lakes, and wetlands as well as shallow ground water.

Surface and stormwater management system - Drainage facilities and any other natural features which collect, store, control, treat and/or convey surface and stormwater.

Suspended solids - Organic or inorganic particles that are suspended in and carried by the water. The term includes sand, mud, and clay particles (and associated pollutants) as well as solids in stormwater.

Swale - A shallow drainage conveyance with relatively gentle side slopes, generally with flow depths less than one foot.

Terrace - An embankment or combination of an embankment and channel across a slope to control erosion by diverting or storing surface runoff instead of permitting it to flow uninterrupted down the slope.

Tile, Drain - Pipe made of burned clay, concrete, or similar material, in short lengths, usually laid with open joints to collect and carry excess water from the soil.

Tile drainage - Land drainage by means of a series of tile lines laid at a specified depth and grade.

Time of concentration - The time period necessary for surface runoff to reach the outlet of a subbasin from the hydraulically most remote point in the tributary drainage area.

Toe of slope - a point or line of slope in an excavation or cut where the lower surface changes to horizontal or meets the exiting ground slope.

Top of slope - a point or line on the upper surface of a slope where it changes to horizontal or meets the original surface.

Topography - General term to include characteristics of the ground surface such as plains, hills, mountains; degree of relief, steepness of slopes, and other physiographic features.

Total dissolved solids - The dissolved salt loading in surface and subsurface waters.

Total solids - The solids in water, sewage, or other liquids, including the dissolved, filterable, and nonfilterable solids. The residue left when the moisture is evaporated and the remainder is dried at a specified temperature, usually 130°C.

Toxic - Poisonous, carcinogenic, or otherwise directly harmful to life.

Tract - A legally created parcel of property designated for special nonresidential and noncommercial uses.

Trash rack - A structural device used to prevent debris from entering a spillway or other hydraulic structure.

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Travel time - The estimated time for surface water to flow between two points of interest.

Treatment BMP - A BMP that is intended to remove pollutants from stormwater. A few examples of treatment BMPs are detention ponds, oil/water separators, biofiltration swales and constructed wetlands.

Turbidity - Dispersion or scattering of light in a liquid, caused by suspended solids and other factors; commonly used as a measure of suspended solids in a liquid.

Underdrain - Plastic pipes with holes drilled through the top, installed on the bottom of an infiltration BMP which are used to collect and remove excess runoff.

Undisturbed buffer - A zone where development activity shall not occur, including logging, and/or the construction of utility trenches, roads, and/or surface and stormwater facilities.

Undisturbed low gradient uplands - Forested land, sufficiently large and flat to infiltrate surface and storm runoff without allowing the concentration of water on the surface of the ground.

Unstable slopes - those sloping areas of land which have in the past exhibited, are currently exhibiting, or will likely in the future exhibit, mass movement of earth.

Unusual biological community types - Assemblages of interacting organisms that are relatively uncommon regionally.

Urbanized area - Areas designated and identified by the U.S. Bureau of Census according to the following criteria: an incorporated place and densely settled surrounding area that together have a maximum population of 50,000.

USEPA - The United States Environmental Protection Agency.

Values - Wetland processes or attributes that are valuable or beneficial to society (also see Functions). Wetland values include support of commercial and sport fish and wildlife species, protection of life and property from flooding, recreation, education, and aesthetic enhancement of human communities.

Vegetation - all organic plant life growing on the surface of the earth.

Water body - Surface waters including rivers, streams, lakes, marine waters, estuaries, and wetlands.

Water quality - A term used to describe the chemical, physical, and biological characteristics off water, usually in respect to its suitability for a particular purpose.

Water quality BMP - A BMP specifically designed for pollutant removal.

Water quality design storm - The 6-month 24-hour design storm.

Water quality standards - Minimum requirements of purity of water for various uses; for example, water for agricultural use in irrigation systems should not exceed specific levels of sodium bicarbonate, pH, total dissolved salts, etc. In Washington, the Department of Ecology sets water quality standards.

Water quality swale - An open vegetated drainage channel intended to optimize water quality treatment of surface and stormwater runoff by following the specific design criteria described in the manual.

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Watershed - a geographic region within which water drains into a particular river, stream, or body of water as identified and numbered by the State of Washington Water Resource Inventory Areas (WRIAs) as defined in Chapter 173-500 WAC.

Water table - The upper surface or top of the saturated portion of the soil or bedrock layer, indicates the uppermost extent of ground water.

Weir - Device for measuring or regulating the flow of water.

Weir notch - The opening in a weir for the passage of water.

Wetlands - Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. This includes wetlands created, restored or enhanced as part of a mitigation procedure. This does not include constructed wetlands or the following surface waters of the state intentionally constructed from sites that are not wetlands: Irrigation and drainage ditches, grass-lined swales, canals, agricultural detention facilities, farm ponds, and landscape amenities.

Wetland edge - Delineation of the wetland edge shall be based on the U.S. Army Corps of Engineers Wetlands Delineation Manual, Technical Report Y-87-1, U.S. Army Engineers Waterways Experiment Station, Vicksburg, Miss. (1987)

Wetponds and wetvaults - Drainage facilities for water quality treatment that contain permanent pools of water that are filled during the initial runoff from a storm event. They are designed to optimize water quality by providing retention time in order to settle out particles of fine sediment to which pollutants such as heavy metals absorb, and to allow biologic activity to occur that metabolizes nutrients and organic pollutants.

Zoning ordinance - An ordinance based on the police power of government to protect the public health, safety, and general welfare. It may regulate the type of use and intensity of development of land and structures to the extent necessary for a public purpose. Requirements may vary among various geographically defined areas called zones. Regulations generally cover such items as height and bulk of buildings, density of dwelling units, off-street parking, control of signs, and use of land for residential, commercial, industrial, or agricultural purposes. A zoning ordinance is one of the major methods for implementation of a comprehensive plan.

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NOTATION

This list of notations is provided only as a guide to some of the notations used in this report. The exact definition and units are listed when the symbol is used. Since the same symbol can be used for different design methods, the exact definition should be obtained directly from the appropriate section of the report.

A	=	drainage area (mi^2), also full cross-sectional area of culvert barrel (ft^2)
A_b	=	top surface area of basin (ft^2), also area of pond bottom (ft^2)
A_d	=	drainage area
A_p	=	surface area of porous asphalt pavement (ft^2)
A_s	=	surface area of swale (ft^2), also average surface area for detention BMP
A_t	=	total area (acres)
C	=	estimated runoff coefficient
CN	=	SCS runoff curve number
ΔCN	=	change in curve number
D	=	interior height of culvert barrel (ft)
D_{50}	=	median stone diameter (riprap)
d	=	average permanent pool depth of a detention BMP
d_b	=	basin depth (ft)
d_c	=	critical depth (ft)
d_p	=	depth of porous asphalt paving stone subbase (ft)
d_s	=	depth of swale check dam (ft)
dt	=	time interval in minutes
d_x	=	a mixture of riprap sizes where the percent of stone by weight is <x (the specified diameter)
E	=	designated fraction of particulates to be removed by a BMP
f	=	final infiltration rate of soil (in/hr)
f_d	=	infiltration rate including a safety factor of two
g	=	acceleration due to gravity, 32.2 ft/sec^2
H	=	stage height (ft) or water depth above pond bottom, also $H = H_f + H_o + H_{ca}$; head on orifice
H_c	=	specific head at critical depth ($d_c + V_c^2/2g$) (ft)

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H_d	=	design depth of pond
H_e	=	entrance head loss (ft) = $K_e(V^2/2g)$
H_{ex}	=	exit head loss (ft) = $V^2/2g$
H_f	=	Friction loss (ft) = $V^2n^2L/2.22R^{1.33}$ Note: if $(H_f + TW - LS) < D$, adjust H_f such that $(H_f + TW - LS) = D$. This will keep the analysis simple and still yield reasonable results (erring on the conservative side)
HW	=	headwater depth above inlet invert (ft)
h_o	=	distance from the hydraulic grade line at the 2-year flow on the outflow pipe to the overflow elevation
I	=	inflow at time 1 and time 2
I(t)	=	instantaneous hydrograph, in cfs (SBUH hydrograph method)
i	=	hydraulic gradient (ft/ft)
K_e	=	entrance loss coefficient
k	=	time of concentration velocity factor (feet/second)
k_c	=	time of concentration velocity factor; channel flow
k_s	=	time of concentration velocity factor; shallow flow
L	=	distance of flow across a given segment, also length of culvert (ft), also width of emergency overflow weir
MB_d	=	mean tributary basin elevation above sea level (ft)
M_s	=	potential average snowmelt during storms (in)
m	=	number of flow segments
N_s	=	number of check dams along total length of swale
n	=	Manning's "n"
n_s	=	sheet flow; Manning's effective roughness coefficient
O	=	outflow at time 1 and time 2
P	=	rainfall depth (inches)
P_R	=	the total precipitation at a site for the 24-hour design storm event for the given return frequency (R)
Q	=	flow or discharge (cfs), also runoff depth from overlying area of dry well (ft), also orifice area
Q_a	=	after development depth of runoff (inches)
Q_b	=	before development depth of runoff (inches)
Q_c	=	depth of runoff from contributing area (ft)

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Q_d	=	runoff depth in inches over a given area
Q_o	=	average release rate from detention BMP
Q_s	=	depth of runoff controlled by vegetated swale (inches)
Q_t	=	release rate for orifice
Q_{total}	=	total flow at maximum head
Q(t)	=	the routed flow of the runoff hydrograph (SBUH method)
$Q_{10\%}$	=	the flow that is not exceeded more than 10% of the time during the months of adult (salmonid) migration
ΔQ	=	change in runoff depth (inches)
Δq	=	change in peak discharge (cfs)
R	=	hydraulic radius (ft) in Manning's equation
R(t)	=	the total runoff depth at time increment dt, in inches; also known as precipitation excess
S	=	storage at time 1 and time 2, also culvert barrel slope (ft/ft)
S(H)	=	storage (ft^3) at stage height (H)
S_d	=	the largest volume from an initial pond sizing
S_f	=	friction slope = $n^2V^2/2.21R^{4/3}$
S_o	=	slope of flow path (ft/ft), also bottom slope
T	=	width of swale or vegetated filter strip
T_c	=	time of concentration (hrs)
T_t	=	travel time of overland flow across separate flow path segments
$T_{1,2,n}$	=	the consecutive flow paths of different land cover categories having significant differences in flow path slope
TW	=	tailwater depth above invert of culvert outlet (ft) Note: if TW < (D + d_c)/2, set TW = (D + d_c)/2.
t_d	=	design detention time of a BMP
Δt	=	time interval; time 2 - time 1
V	=	average velocity across the land cover (ft/sec), also barrel velocity (fps), also mean velocity
V_c	=	flow velocity at critical depth (fps)
V_{max}	=	maximum allowed velocity of runoff in a biofilter
V_{pp}	=	permanent pool volume
V_r	=	void ratio

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V_{soil}	=	settling velocity of the deign soil particle
W_{50}	=	the median stone size (riprap)
w	=	settling velocity of target particle
y	=	depth of flow
y_n	=	normal flow depth
z	=	basin side slope ratio (h:v)
z^1, z^2	=	side slope ratio of swale cross section (h:v)
α	=	energy coefficient which corrects for the non-uniform distribution of velocity over the channel cross-section

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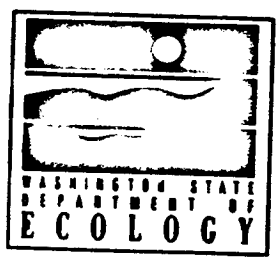
Stormwater Management Manual for the Puget Sound Basin

(The Technical Manual)

Volume II - Erosion and Sediment Control



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Purpose of this Volume

This volume of the manual provides technical information to help in controlling erosion and sedimentation from new construction activities in the Puget Sound basin. Detailed standards and specifications for BMPs as well as background information on the erosion process and how it may be controlled are included. These BMPs are to be used to develop a detailed Erosion and Sediment Control Plan, as set out in Minimum Requirement #1 (see Chapter I-2). For a general overview of the entire stormwater program, please refer to Chapter I-1 in Volume I.

The target audience includes both officials in local governments who are responsible for administering ordinances pertaining to construction activities, and the development community. In a broader sense, this volume is intended for both engineers and planners because minimization of erosion requires good planning as well as good engineering and, most importantly, close collaboration between the two disciplines.

Chapter Contents

Chapter II-1 provides a general overview of the erosion and sedimentation process and the basic principles by which it may be controlled.

Chapter II-2 explores the concept of BMPs. Seven major problem areas that are encountered during the construction process are discussed, and the various erosion and sedimentation control BMPs that can be applied to each of these areas are briefly described.

Chapter II-3 contains BMPs to deal with pollutants other than sediment. This chapter has been included because many pollutants are adsorbed by or otherwise associated with sediment. Many of these pollutants can be generated during the construction process as a result of the use of petroleum products, fertilizers, pesticides, and other construction chemicals. Some of these pollutants may be hazardous. This chapter outlines how the generation of these wastes can be minimized, and for those that are generated, how they should be handled and disposed of.

Information on NPDES stormwater construction permits and the preparation of an Erosion and Sediment Control (ESC) plan can be found in Chapter II-4.

Chapter II-5 presents the design standards for erosion and sediment control BMPs. BMPs are the means by which Minimum Requirement #1 can be satisfied. In some cases the standards and specifications of BMPs are more in the form of guidelines, such as seeding mixtures for cover practices. In most others the standards and specifications are the minimum technical requirements. Examples include the depth of sediment traps, length of construction entrances etc. Some of the BMPs are simple and easy to apply, such as mulching, but others such as sediment ponds require design by a professional engineer, using the standards set out in this manual. Best management practices for individual family lots and small sites may be found at the end of Chapter II-5.

Acknowledgements

This volume of the manual was compiled by adapting existing manuals with advice from a technical advisory group comprised of people representing local agencies and other interested parties within the Puget Sound basin. The major sources of material include:

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(i) King County Surface Water Management Manual, January 1990.
(ii) Michigan State Guidebook for Erosion and Sediment Control, 1975.
(iii) Stormwater Management Manual (SNOMET/King Co. 208 Plan), prepared by URS, 1977.
(iv) Construction and Erosion Control, King County Conservation District, December 1981.
(v) Virginia Erosion and Sediment Control Handbook, Second Edition 1980.
(vi) Erosion and Runoff Control, Clark County Conservation District, January, 1981.
(vii) Construction Site Erosion and Sediment Control Inspector Training Manual, Center for Urban Water Resources Management, University of Washington, prepared by Loren Reinelt, October, 1991.

Information was also drawn from the Maryland Erosion and Sedimentation Control Manual (1983) and the Water Quality Manual of the Association of General Contractors of Washington.

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CHAPTER II-1

THE EROSION AND SEDIMENTATION PROCESS

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CHAPTER II-1

THE EROSION AND SEDIMENTATION PROCESS

II-1.1 IMPACTS OF EROSION AND SEDIMENTATION

Erosion and sedimentation produced by land development damages the environment and is costly to society. Fisheries resources, recreational resources, and aesthetic qualities may be lost or severely degraded. Harbors, lakes, and rivers fill and must be dredged. Sediments become contaminated.

Contractors, consultants, regulators, and inspectors can significantly affect soil loss. When land is developed, erosion increases by 2-40,000 times (1,2). Such erosion is estimated to produce approximately 70 percent of all sediment produced in this country (7). However, using good erosion control practices can greatly reduce this. For example, a study in Lake Tahoe Basin compared practices at two similar construction sites (3). Without erosion control, estimated soil loss exceeded background levels by 100-1000 times. Using good erosion control practices, soil loss was only double background levels.

Everyone is affected by damages from increased erosion and sedimentation. There are a variety of ways.

- The soil loses nutrients as clays, silts, and fine organic matter wash away. Reestablishing vegetation is difficult. The contractor must either import costly topsoil or apply fertilizers.
- Sediment clogs culverts and storm sewers resulting in frequent and costly maintenance. Without maintenance culverts may wash out and storm sewers fail. Siltation also decreases flow capacities.
- Landslides cause damage on-site and off-site.
- Detention facilities fill rapidly with sediment increasing cleaning costs.
- Infiltration devices may become clogged. This has been cited as the major cause of their failure.
- As velocity decreases, streams deposit sediment requiring dredging of obstructed channels. Additionally, harbors must be dredged more often to keep them open for navigation.
- Lakes age more rapidly. As the sediment builds, shallow areas may become covered by waterlilies or weeds. Increased nutrients may cause algal blooms, which deplete oxygen and can lead to fish kills.
- We lose aesthetics. Many citizens value clean streams. An eroded, silt-clogged stream or lake is ugly.
- Turbidity (water cloudiness) and suspended sediment increases. This impairs the feeding ability of aquatic animals, clogs gill passages of fish, and reduces photosynthesis.
- Fish spawning is seriously impacted. Clean gravels provide a habitat for fish eggs and permit a free flow of well oxygenated water around the eggs and alevines (young with egg yolk still attached). Sediment-clogged gravel prevents successful spawning. Sedimentation following spawning can smother the eggs or alevines.

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The costs associated with these damages vary. Some are easy to quantify, others more difficult. The loss of aesthetic values or of recreational values is hard to quantify. People prefer to canoe in clear streams. Others, who would prefer to water-ski close to home, are confronted with a lake clogged with sediment and weeds. The costs for restoration and management of a single lake can easily run into the millions of dollars.

Reductions in spawning habitat, and thus reduction in salmon and trout production, cause economic losses to sports fisheries and traditional Native American fisheries. When lost, natural production is replaced by hatchery production. The public incurs expenses for construction, operation, and maintenance of hatcheries, and loses the natural production which many people consider superior.

Most quantifiable are the maintenance costs of man-made structures and harbors. Increased maintenance is necessary for culverts, storm sewers, retention/detention facilities, dams, rivers, and harbors. Harbor maintenance, for example, is expensive. The Seattle District of the U.S. Army Corps of Engineers, which does about one-third of the maintenance dredging in Puget Sound, currently budgets about $706,000 yearly for direct costs of dredging. This does not include administrative and other associated costs. Total yearly costs for dredging and administration for the Corps, the Ports and others runs into several million dollars. As city, county, state, and federal taxpayers, we all pay for these costs.

Impact Prevention

The problems listed above make it imperative to minimize erosion on construction sites. This is achieved through control of runoff. Knowledge of the erosion and sedimentation process is helpful in understanding the role of BMPs in runoff control.

II-1.2 THE EROSION AND SEDIMENTATION PROCESS

Soil erosion is defined as the removal and loss of soil by the action of water, ice, gravity, or wind. This section deals principally with soil erosion caused by the force of falling and flowing water.

The erosion process includes the detachment and transport of soil particles. The force of raindrops falling on bare or sparsely vegetated soil detaches soil particles. Water running along the ground surface picks up these particles and carries them along. As runoff increases in velocity and concentration, it detaches more soil particles, cuts rills and gullies into the soil surface, and adds to its sediment load.

II-1.2.1 Types of Water Erosion

Types of erosion caused by falling and flowing water are illustrated in Figure II-1.1; they include raindrop, sheet, rill and gully, and stream and channel erosion.

1. Raindrop Erosion: Erosion resulting from the direct impact of falling drops of rain on soil particles. This impact dislodges soil particles so that they can then be easily transported by runoff.

2. Sheet Erosion: The removal of a layer of exposed surface soil by the action of raindrop splash and runoff. The water moves in broad sheets over the land and is not confined in small depressions.

3. Rill and Gully Erosion: As runoff flows it concentrates in rivulets, cutting grooves called rills into the soil surface. If the flow of water is sufficient, rills may develop into gullies.

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4. Stream and Channel Erosion: Increased volume and velocity of runoff may cause erosion of the stream or channel banks and bottom.

II-1.2.2 Sedimentation

Sedimentation is defined as the settling out of soil particles transported by water (Figure II-1.2). Sedimentation occurs when the velocity of water in which soil particles are suspended is slowed for a sufficient time to allow particles to settle out. Heavier particles, such as sand and gravel, settle more rapidly than fine particles such as clay and silt.

II-1.3 FACTORS INFLUENCING EROSION

The inherent erosion potential of any area is determined by four interrelated, principal factors: soil characteristics, vegetative cover, topography, and climate (Figure II-1.3).

II-1.3.1 Soil Characteristics and the Geology of the Puget Sound Basin

Soil properties which influence erosion by rainfall and runoff are those factors which affect the infiltration capacity of a soil and those which affect the resistance of the soil to detachment and being carried away by falling or flowing water. The vulnerability of a soil to erosion is called erodibility. Some key factors which control erodibility are:

- particle size and gradation
- organic content
- soil structure
- soil permeability

Particle Size

Soils that contain high proportions of silt and very fine sand are generally the most erodible and are easily detached and carried away. The erodibility of these soils is decreased as the percentage of clay or organic matter increases. Clay acts as a binder and tends to limit erodibility. Most soils with a high clay content are relatively resistant to detachment by rainfall and runoff. Once eroded, however, clays are easily transported and settle out slowly.

Organic Content

Organic matter creates a favorable soil structure, improving its stability and permeability. This increases infiltration capacity, delays the start of erosion, and reduces the amount of runoff.

Soil Structure

Organic matter, particle size and gradation affect soil structure (the arrangement, orientation, and organization of particles). Well-drained and well-graded gravels and gravel mixtures with little or no silt are the least erodible soils. Their high permeability and infiltration capacity helps prevent or delay runoff.

Soil Permeability

Soil permeability refers to the ease by which water passes through a given soil. Clay soils have high water holding capacity relative to sands and gravels, but poor infiltration characteristics. Although clay particles are harder to detach, they are more vulnerable to erosion because they tend to increase runoff.

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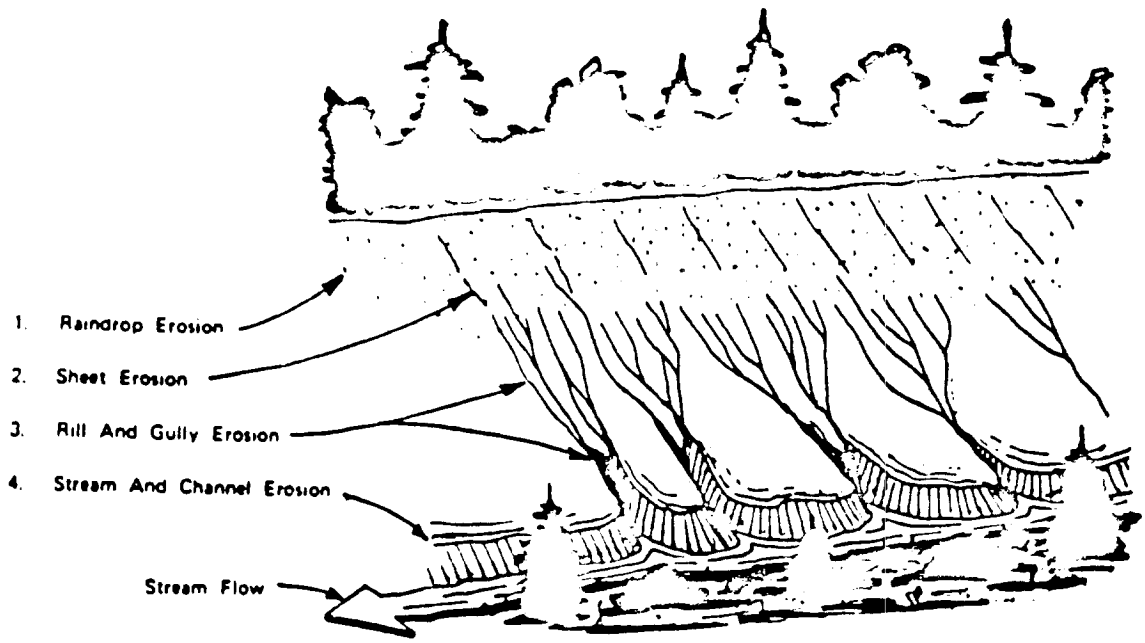
Figure II-1.1 Types of Erosion



The Puget Lowland and Associated Watersheds

The landscape of Puget Sound is the product of a long history of mountain-building and subsidence, glaciation and volcanism, erosion and deposition. In addition, the makeup of surface soils is affected to varying degrees by landslide and slopewash activities. The fundamental geologic division in the Puget Sound region is between the Puget Lowland and the Cascade and Olympic mountain ranges. The terrain of the Puget Lowland is made up of a series of rolling plateaus (drift plains) cut by steep-sided valleys. The drift plains are built of unconsolidated sediment deposited during glacial and non-glacial periods during the past two million years. These deposits range from a thin veneer over bedrock hills to a depth of 3,600 feet in the deepest basin.

Two kinds of large valleys cross the lowlands. The longest and deepest of these (Hood Canal, Central Puget Sound, Lake Washington-Duwamish-Puyallup, Sammamish and Snoqualmie troughs) trend roughly north-south and were carved in their present form during the most recent glaciation. Their shapes reflect the direction of flow in ice streams and/or subglacial rivers in the bottom of the continental glaciers that filled the lowland. On the other hand, the canyons of the Nooksack, Skagit, Stillaguamish, Green, Puyallup, Nisqually and Olympic drainages were excavated by streams flowing off the retreating ice sheet and down the Cascade and Olympic mountains.

Although bedrock is not exposed extensively in the Puget Sound region, its underlying structure controls runoff and erosion. The properties of rocks, glacial

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underlying structure controls runoff and erosion. The properties of rocks, glacial deposits and soils exposed at the ground surface determine their reactions to weathering and erosion, and their ability to absorb and transmit water.

Glacial Deposits

Glacial deposits can be divided into two broad categories: till and outwash. The till, and underlying sediments, have undergone one or more glaciations. The weight of up to 4,000 feet of ice has compacted these deposits and can greatly affect their mechanical and hydraulic properties, particularly if the deposit is fresh and undisturbed. Till deposits contain large amounts of silt or clay, often intermixed with large cobbles, and have low percolation rates. Only a small fraction of infiltrated precipitation reaches the regional ground water table through the till. The rest moves laterally through the thin surface soil above the till deposit (generally as shallow subsurface flow), often reemerging at the base of hillslopes. Soils may become saturated during large storms and produce significant amounts of surface runoff. The peak runoff rate from till areas is therefore generally quite high. The lateral flow of subsurface water may also make some types of soil more vulnerable to sloughing.

In most of the drift plains, the outwash sediment deposited by streams that flowed off the front of the ice sheet are common. For the most part these sediments are coarse-grained, well-bedded, porous and loose. Some of these deposits are now terraces along modern stream valleys. Most outwash soils have high percolation rates, and rainfall in these areas is quickly absorbed. Creeks draining outwash deposits often intersect the ground water table and receive most of their flow from ground water discharge. Even for the largest storms, stream flow response is slow, with peak flow often lagging several days behind the rainfall that produced it. Erosion associated with outwash soils is much less than that associated with till. In contrast, erosion of fine-grained sandy outwash can be particularly severe.(8)

II-1.3.2 Vegetative Cover

Vegetative cover (Figure II-1.4) plays an extremely important role in controlling erosion by:

- Shielding the soil surface from the impact of falling rain.
- Slowing the velocity of runoff, thereby permitting greater infiltration.
- Maintaining the soil's capacity to absorb water.
- Holding soil particles in place.

By limiting the removal of existing vegetation, and by decreasing duration of exposure, soil erosion can be significantly reduced. Special consideration should be given to the maintenance of existing vegetative cover on areas of high erosion potential such as erodible soils, steep slopes, drainageways, and the banks of streams.

II-1.3.3 Topography

The size and shape of a watershed influences the amount and rate of runoff. Several control measures, described in Chapters II-2 and II-5, deal with protecting vulnerable areas from high concentrations of runoff.

Slope length and steepness are key elements in determining the volume and velocity of runoff. As slope length and/or steepness increase, the rate of runoff increases and the potential for erosion is magnified.

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Slope orientation is also a factor in determining erosion potential (Figure II-1.5). For example, a slope that faces south and contains droughty soils may have such poor growing conditions that vegetative cover will be difficult to reestablish.

II-1.3.4 Climate

The frequency, intensity, and duration of rainfall and temperature are fundamental factors in determining the amounts of runoff produced. As the volume and/or the velocity of runoff increase, the capacity of runoff to detach and transport soil particles increases.

Where storms are frequent, intense, or of long duration, erosion risks are high (Figure II-1.6). Seasonal changes in temperature, as well as variations in rainfall, help to define the high erosion risk period of the year. If precipitation falls as snow, no erosion will take place. In the spring, however, melting snow adds to the runoff, and erosion potential will be high. Because the ground is still partially frozen, its infiltration capacity is reduced.

The Puget Sound basin and adjacent areas vary significantly in storm intensity and duration from most of the rest of the country. This area is characterized in fall, winter and spring by storms that are mild in intensity and long-lasting in duration. Rainfall in the summer is sporadic and mild. Statistical analysis of the rainfall patterns in this area indicate that storms occur, on the average, every two days in the fall, winter and early spring, and every 7 days in the late spring and summer. These climatic differences are significant because storms in this area require the use of different management tools than do storms in other parts of the country.

II-1.4 BASIC PRINCIPLES: A SUMMARY

From this brief discussion of the erosion process and the factors that influence erosion, seven major principles of erosion and sedimentation control can be summarized.

1. Plan the development to fit the site.
2. Minimize the extent of the disturbed area and duration of exposure.
3. Stabilize and protect disturbed areas as soon as possible.
4. Keep runoff velocities low.
5. Protect disturbed areas from runoff.
6. Retain sediment within the corridor or site area.
7. Implement a thorough maintenance and follow-up program.

Each of these principles is discussed below in more detail.

1. Plan the Development to Fit the Particular Topography, Soils, Drainage Patterns, and Natural Vegetation of the Site.

   Detailed designing should be employed to assure that roadways, buildings, and other permanent features of the development conform to the natural characteristics of the site. Large graded areas should be located on the most level portion of the site. Areas subject to flooding should be avoided and floodplains should be kept free from filling and other development. Areas with steep slopes, erodible soils and soils with severe limitations for the intended uses should not be utilized without overcoming the limitations

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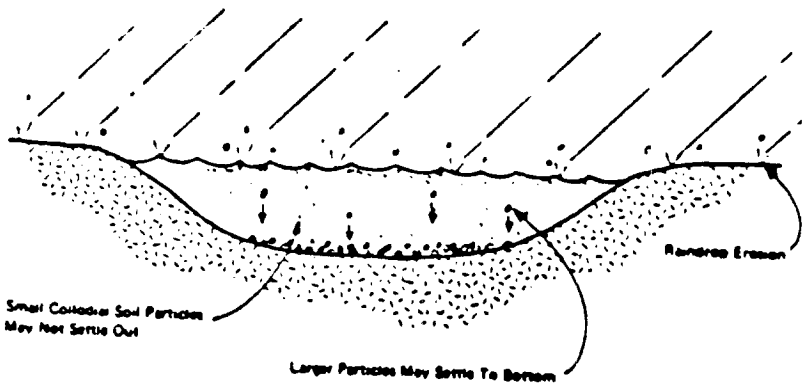
Figure II-1.2 Cross-Section of Flowing Waterway



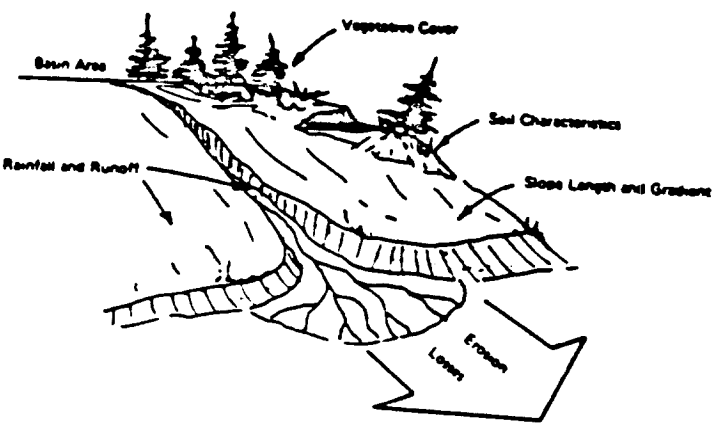


Figure II-1.3 Characteristics Which Affect Erosion Losses

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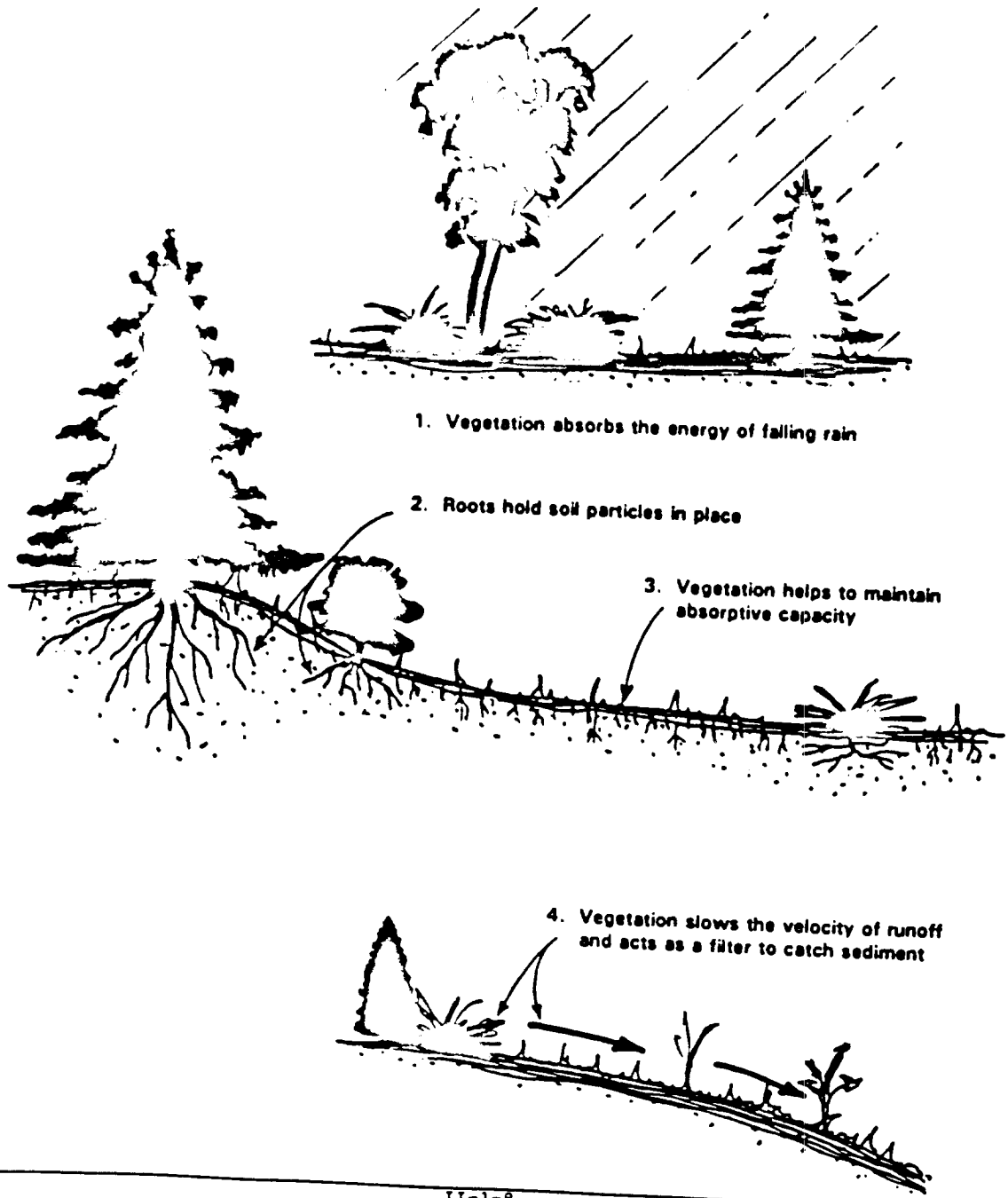
Figure II-1.4 Effect of Vegetation on Stormwater Runoff



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through sound engineering practices. For instance, long steep slopes can be broken by benching, terracing, or constructing diversion structures (see Chapter II-2.).

Erosion control, development, and maintenance costs can be minimized by selecting a site suitable by its nature for a specific proposed activity, rather than attempting to modify a site to conform to a proposed activity. This kind of planning can be more easily accomplished where there is a general land use plan based upon a comprehensive inventory of soils, water, and other related resources.

2. Minimize the Extent of the Area Exposed at One Time and the Duration of Exposure.

When earth changes are required and the natural vegetation is removed, keep the area and the duration of exposure to a minimum. Plan the phases or stages of development so that only the areas which are actively being developed are exposed. All other areas should have a good cover of temporary or permanent vegetation or mulch. Grading should be completed as soon as possible after it is begun. Then immediately after grading is complete, permanent vegetative cover should be established in the ar As cut slopes are made and as fill slopes are brought up to grade, these eas should be revegetated as the work progresses. This is known as staged seeding. Minimizing grading of large or critical areas during the period October-April reduces the risk of erosion.

3. Stabilize and Protect Disturbed Areas as Soon as Possible.

Two methods are available for stabilizing disturbed areas: mechanical (or structural) methods and vegetative methods. In some cases, these are combined in order to retard erosion. These control measures are discussed in Chapter II-2.

4. Keep Runoff Velocities Low.

The removal of existing vegetative cover and the resulting increase in impermeable surface area during development will increase both the volume and velocity of runoff. These increases must be taken into account when providing for erosion control. Slope changes should be designed to keep slope length and gradient to a minimum. Short slopes, low gradients, and the preservation of natural vegetative cover can keep runoff velocities low. This will limit erosion hazards.

5. Protect Disturbed Areas from Stormwater Runoff.

Measures can be utilized to prevent off-site water from entering and running over the disturbed area. These protective measures are described in Chapter II-2.

6. Retain Sediment Within the Corridor or Site Area.

Sediment can be retained by two methods: (1) by filtering runoff as it flows and (2) by detaining sediment-laden runoff for a period of time so that soil particles settle out. The best way to control sediment, however, is to prevent erosion in the first place.

7. Implement a Thorough Maintenance and Follow-Up Program.

This last principle is <u>vital</u> to the success of the six other principles. A

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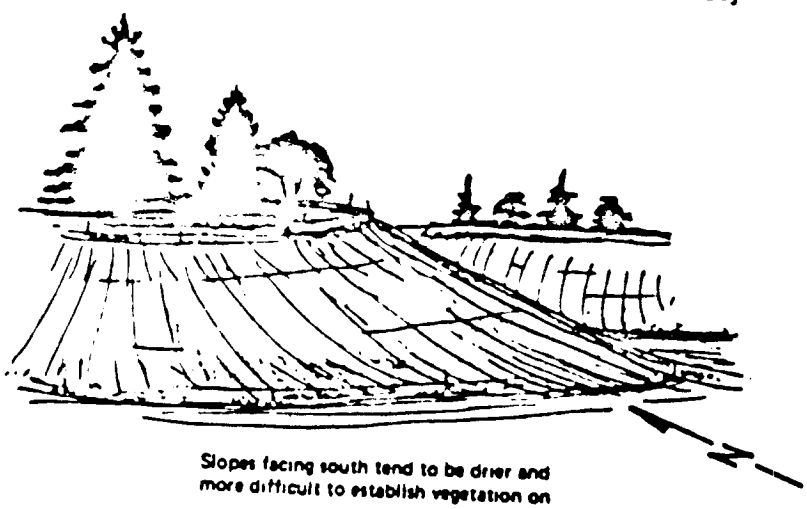
Figure II-1.5 Slope Orientation Affects Erodibility



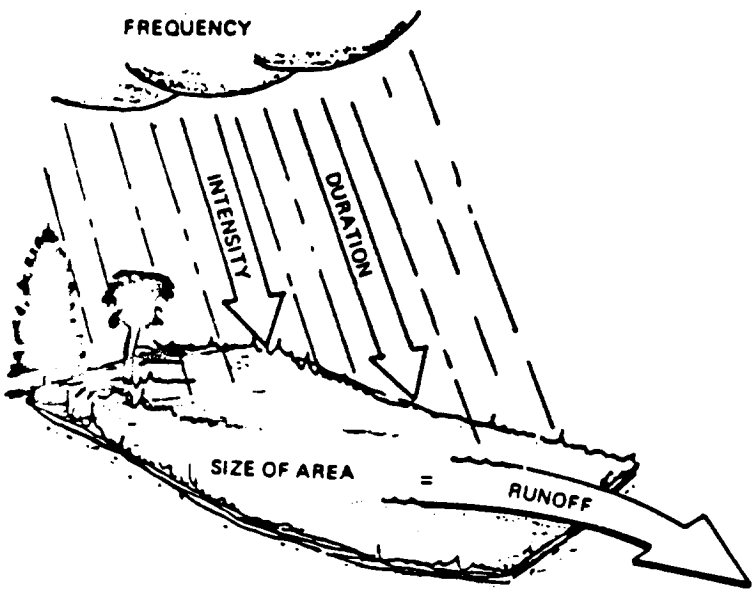


Figure II-1.6 Rainfall Characteristics Help to Determine Amounts of Runoff

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Figure II-1.6 Rainfall Characteristics Help to Determine Amounts of Runoff

the erosion and sediment control practices. These practices must be maintained just as construction equipment must be maintained and materials checked and inventoried. An example of applying this principle would be to start a routine "end of day check" to make sure that all control practices are working properly.

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CHAPTER II-2

BEST MANAGEMENT PRACTICES FOR PROBLEM AREAS ON CONSTRUCTION SITES

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CHAPTER II-2

BEST MANAGEMENT PRACTICES FOR PROBLEM AREAS ON CONSTRUCTION SITES

II-2.1 BEST MANAGEMENT PRACTICES

Understanding the basic processes of erosion and sedimentation and the basic principles of control provides the foundation for developing and implementing a successful erosion and sedimentation control plan. This chapter will outline the types of erosion and sediment control measures (Best Management Practices) that can be applied before, during and after the development process. Best Management Practices (BMPs) are defined as physical, structural, and/or managerial practices, that when used singly or in combination, prevent or reduce pollution of water and have been approved by Ecology.

The purpose of this chapter is to provide guidelines and background information that will assist in choosing the most suitable BMPs to control erosion and sediment from construction sites. This is done by describing the major problem areas and the appropriate BMPs that could be implemented to manage the problem. Complete standards and specifications for each BMP are provided in Chapter II-5.

Best Management Practices are those practices that are currently believed to provide the most effective, practicable means of preventing or reducing pollution generated by non-point sources. They are used to implement the general principles presented in the previous chapter. Most importantly, they change with time, as we discover or become aware of other practices that better accomplish their purposes.

Most of the BMPs presented in this manual either minimize erosion or control sedimentation. In any construction project, it is most important to do everything feasible to prevent erosion first. Stabilizing slopes, creating natural vegetation buffers, diverting runoff frc exposed areas, controlling the volume & velocity of runoff and conveying that runoff away from the development area all serve to decrease erosion. Silt fences, sediment traps and diversions all trap sediment before it leaves the site. Sedimentation control should only deal with the sediment produced from unavoidable erosion.

Best Management Practices fall into a number of categories. Frequently they are split into cover BMPs, including grasses, mulches or other materials used to stabilize soil surfaces, or structural BMPs including check dams, sediment ponds (basins)[1], diversions and other structural techniques. Most sites require the use of several types of BMPs to adequately control erosion and sedimentation, so vegetative BMPs and structural BMPs are often used together to address a single problem. BMPs may be temporary or permanent. Soil that is exposed for a lengthy time is a large contributor to erosion and it should be stabilized as soon as possible. Thus, a temporary control measure (vegetative or structural), may be used because more grading will be needed later in the project or because putting in a permanent control is not immediately feasible. Measures left in place for a year or less are generally considered temporary (Figure II-2.1). In some cases temporary BMPs can be planned into a development in such a way that they may become permanent as completion of various phases of the development occurs. For example, sediment ponds can, with modification, function as permanent detention ponds (Figure II-2.2).

Monitoring and Maintenance

No matter whether BMPs are temporary or permanent, structural or vegetative, monitoring and maintenance of BMPs is vital. The importance of maintenance has been supported by a survey of BMPs by the King County Conservation District (1).

[1] The terms sediment pond and sediment basin are used interchangeably.

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Table II-2.1 Categories, Examples and Effectiveness of BMPs
(adapted from Reinelt, 1991)

Site Design and Construction Management:

- Preserving Natural Vegetation*
- Buffer Zones*
- Gradient Terraces*
- Dust Control

Site and Drainage Way Stabilization

- Stabilized Construction Entrance*
- Riprap
- Construction Road Stabilization
- Vegetative Streambank Stabilization
- Bioengineering Protection of Very Steep Slopes
- Bioengineering Methods of Streambank Protection
- Structural Streambank Protection

Flow Diversion

- Interceptor Dike and Swale*
- Level Spreader
- Pipe Slope Drains
- Subsurface Drains

Overland Flow Management

- Biofilters (see Chapter III-6)
- Temporary Seeding of Stripped Areas**
- Permanent Seeding**
- Mulching and Matting**
- Plastic Covering
- Sodding**
- Topsoiling
- Inlet Protection
- Outlet Protection
- Check Dams**
- Surface Roughening

Sediment Trapping

- Filter Fence**
- Brush Barrier
- Straw Bale Barrier***
- Gravel Filter Berm
- Sediment Trap***
- Sediment Pond**

Effectiveness Ratings (from the King County Conservation District)

Most Effective *

Moderately Effective **

Least Effective ***

Note: Effectiveness ratings are not available for all BMPs listed.

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Preliminary results indicate that the major reason for BMP failure is poor maintenance. BMPs should be inspected regularly, particularly before, during, and after a major storm. Specific maintenance requirements of individual BMPs are dealt with in Chapter II-5.

II-2.1.1 Problem Areas

The remainder of this chapter will examine particular problem areas of the construction site (such as slopes or surface drainageways) and will describe which BMPs best alleviate problems associated with each area. The areas are:

1. Slopes
2. Streams and Waterways
3. Surface Drainageways
4. Enclosed Drainage Inlets and Outfalls
5. Large, Flat Surface Areas
6. Borrow Areas
7. Adjacent Properties

A listing of the BMPs and the problem area, or areas, they are appropriate for, is presented as a uniform coding system in Table II-2.2 at the end of this chapter. This has been introduced to promote uniformity in the specification and presentation of BMPs on Erosion and Sedimentation Control (ESC) plans. Each BMP has been assigned a specific number, code and symbol.

Assigned numbers should be used to identify BMPs in the narrative or other written portions of the plan, while the practice symbol should be used to identify practices on the map or site plan. The BMP can be further defined to indicate whether it is proposed as a temporary or permanent measure by using the notation "t" or "p". For example SOp = permanent sodding; STt = temporary sediment trap. The practice symbols are based upon similar systems used in other states such as Virginia and Maryland. We hope that the system will become widely used so that ESC plans will become more uniform and understandable throughout the Puget Sound basin.

Note: The American Society of Agricultural Engineers (ASAE) is proposing to standardize mapping symbols for erosion and sediment control structures and practices. These symbols differ somewhat from those now in this manual, as they are based on another resource. Since those symbols are still in the discussion stage, we have chosen to continue to use the practice symbols found in the Virginia manual.

II-2.2 SLOPES

Slopes greatly increase the potential for erosion. As slope length and steepness increase, runoff velocity increases. This increases the capacity of water to detach and transport soil particles. Steeper slopes usually have faster runoff velocities, less infiltration and more erosion than less steep slopes.

Modifying a slope by clearing existing vegetative cover also increases its vulnerability to erosion. Vegetation slows down runoff velocity and root systems hold soil particles in place. Vegetation maintains the soil's capacity to absorb precipitation. The following conditions indicate a need for special care when modifying or creating a slope:

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1. Extensive length.[2]

2. Moderate to extreme steepness. (greater than about 7%)

3. High soil erodibility.

4. Difficulty of reestablishing vegetative cover.

Vegetative stabilization, diversion measures, slope drains and slope stabilization measures may counteract problems created by modifying slopes.

II-2.2.1 Vegetative Stabilization Techniques (BMPs E1.10, E1.15, E1.30, E1.35, E1.40)

Vegetative Buffer Strips

Maintaining a natural vegetative buffer or filter strip at the base of a slope retains sediment on site and is the preferred method for control of erosion. If the natural vegetative cover is left, other cover techniques such as mulch or plastic covering will not have to be used. Undisturbed vegetation is by far the best method to maintain unstable slopes. If the natural vegetative covering must be disturbed, methods such as placing sod strips at intervals along the face of the slope also help (Figure II-2.8). These measures help slow runoff, trap sediment, and reduce the volume of runoff.

Grass or grass and legumes are the most commonly used plant material for stabilizing slopes. Plants are usually established in one of three ways (Figure II-2.9):

1. Hydro-seeding: A mixture of seeds, fertilizer, and water is sprayed on the slope. A mulch and a mulch tacking agent can also be applied. This method is effective on large areas.

2. Standard seeding: Seed is drilled or broadcast either mechanically or by hand. A cultipacker or similar tool is used after seeding to make the seedbed firm and to provide seed covering. The proper timing of seeding, mulching, and watering is important for areas seeded in this manner.

3. Sodding: Sod strips are laid across the slope and in this way instant cover is provided. Sod should be placed on a prepared bed and pegged on steep slopes. Watering is important. This method is effective and is often used on steep slopes.

II-2.2.2 Diversion Measures Used to Control Erosion (BMP E2.55)

A dike, ditch or a combination dike/ditch can divert runoff from the face of an exposed slope. For short slopes, placing these diversion measures at the top works well. For longer slopes, placing the dikes or ditches across the slope at intervals effectively reduces slope length. Temporary diversions must remain in place until slopes have been permanently restabilized.

Diversion ditches can be bare channels, vegetatively stabilized channels, or channels lined with a hard surface material (Figure II-2.3). To determine what size and design is appropriate for each situation consider the following:

1. The amount of runoff to be diverted.

2. The velocity of runoff in the diversion.

[2] As a general rule there will be a potential hazard if slope lengths exceed the following: 0-7% - 300 feet; 7-15% - 150 feet; >15% - 75 feet.

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3. The erodibility of the soils on the slope.

4. The erodibility of the soils within the channel.

When properly constructed, diversions minimize runoff over disturbed slopes. They may also collect runoff and divert it to a sediment trap or pond.

Since diversions concentrate the volume of surface runoff, they increase its erosive force. The contractor should release runoff onto a stabilized area to reduce erosion potential. Gradually reducing the slope of the diversion channel is sometimes adequate. The contractor may also use level spreaders, or stormwater conveyance channels such as grassed waterways (Figure II-2.4).

II-2.2.3 Slope Drains (BMPs E2.25, E2.70)

Where disposing of runoff laterally is unsatisfactory, the contractor may drain it over the slope face. Slope drains can run down the surface of the slope as sectional downdrains, paved chutes, or pipes placed beneath the ground surface (Figure II-2.5).

On-surface sectional downdrains are usually pipes made of corrugated metal, bituminous fiber, or other material; these slope drains are temporary. Paved chutes covered with a surface of concrete or bituminous material are usually permanent. Subsurface pipes are also permanent.

The contractor should protect against erosion at the inlet; otherwise undercutting at the lip of the drain and piping under the drain frequently occur. Compacting the soil carefully at the mouth of the slope drain and anchoring it adequately can prevent this undercutting. Also, any areas cleared to construct the drain should be revegetated and stabilized.

Figure II-2.1 Temporary Control Measures Used During Construction

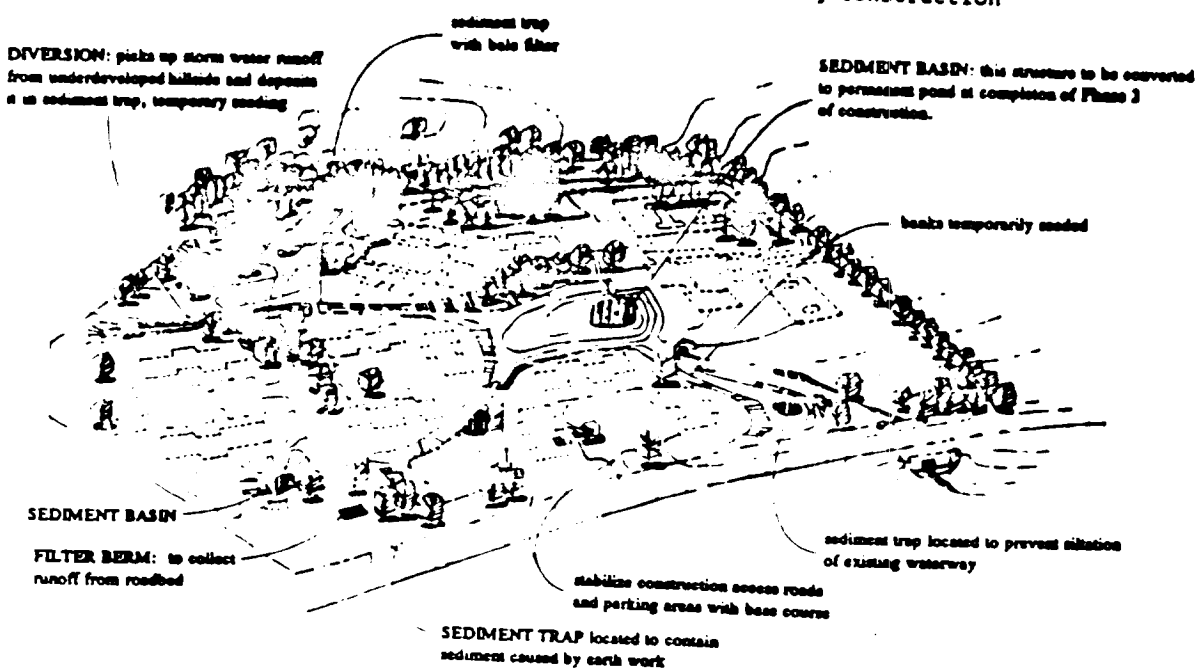

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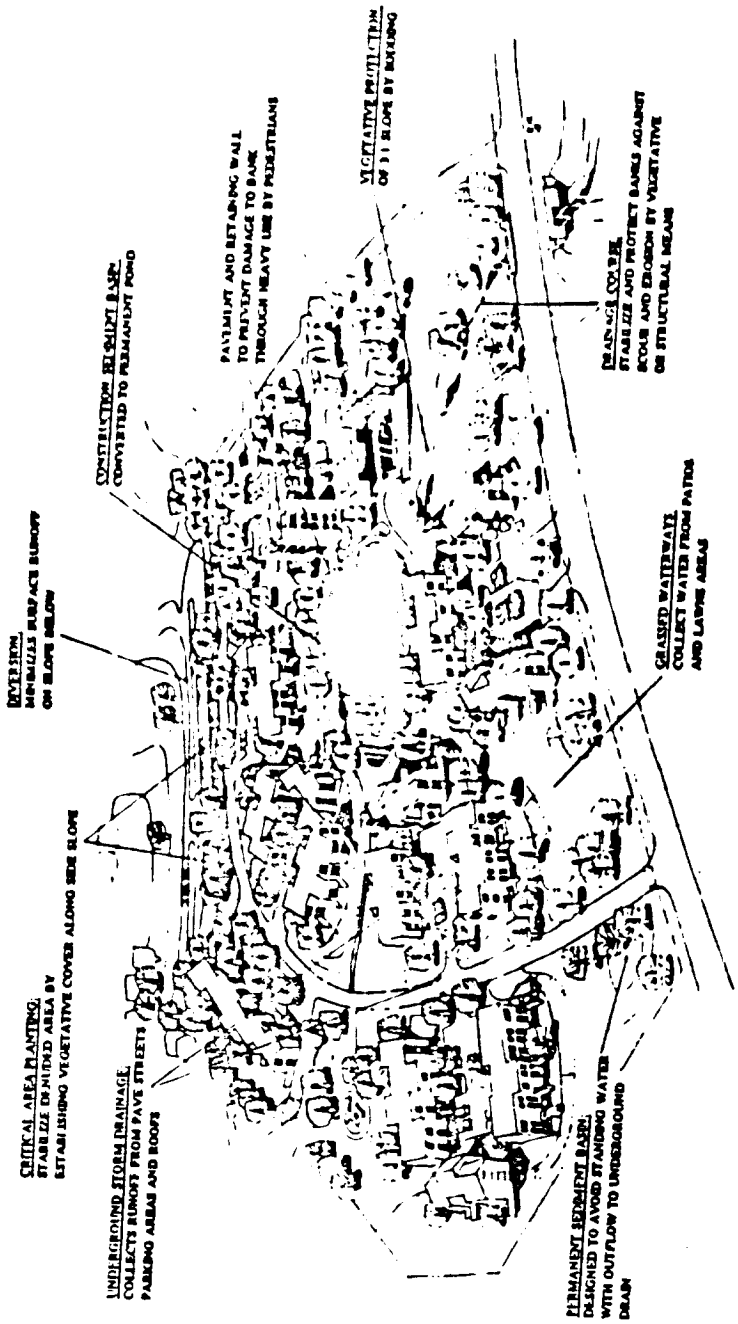
Figure II-2.2 Many Temporary Measures can be Made Permanent



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At the slope drain outlet, energy dissipators (such as riprap) are frequently necessary. Not using a dissipator can result in serious erosion problems at the outflow end of the drain. The dissipator slows the velocity of the runoff to a nonerosive level. Riprap is one effective energy dissipator.

II-2.2.4 Structural Slope Stabilization Measures (BMPs E2.35, E2.40, E2.45)

The most effective way to decrease erosion is to avoid modifying slopes. The angle of repose naturally achieved is the most stable for that soil type and situation. However, during construction it is often necessary to modify existing slopes or to create non-natural slopes. Cut and fill slopes are a good example.

One way to stabilize slopes is to reduce their steepness. To choose an appropriate slope ratio we consider the soil's stability, drainage characteristics, and erodibility. The type of vegetative cover and the type of maintenance are also important.

To reduce extreme slope a developer may use retaining walls (Figure II-2.6). Retaining walls are often used when a slope is too steep to establish and maintain vegetation. They obviate disturbance of the upper parts of natural slopes when lower parts are disturbed. Thus, trees or other naturally stable vegetation can be maintained. The cost of building retaining walls is significant but many areas are difficult or impossible to stabilize otherwise. Another way to protect slopes against erosion is to reduce length by using diversions or benches, as previously mentioned.

When slopes are disturbed, leaving them rough reduces velocity and increases infiltration rates. Rough slopes hold water, seed, and mulch better than smooth slopes.(2) Slope surfaces can be roughened by running wheeled construction equipment across the slope, or tracked equipment up and down the slope face. The grooves created by the construction equipment should run across the slope horizontally, and not up and down the slope. Slopes can also be scarified to produce the desired surface roughness (Figure II-2.7).

A suitable soil, good seedbed preparation, and adequate lime and fertilizer are required for all of these methods. However, special precautions need to be taken to avoid nutrients (especially phosphorus) from fertilizers being washed into waterways.

If final grading is delayed more than a few days, the contractor should stabilize exposed slopes immediately after completing rough grading. For short periods of protection either temporary mulching or temporary seeding and mulching together should be used.

When slopes are cut to final grade, permanent vegetative stabilization measures are implemented. Selecting appropriate plant materials depends on:

1. Soil and climate conditions.
2. Duration, quantity, and velocity of runoff.
3. Time required to establish cover.
4. Maintenance requirements.
5. Site use.

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Figure II-2.3 Diversion Control Measures

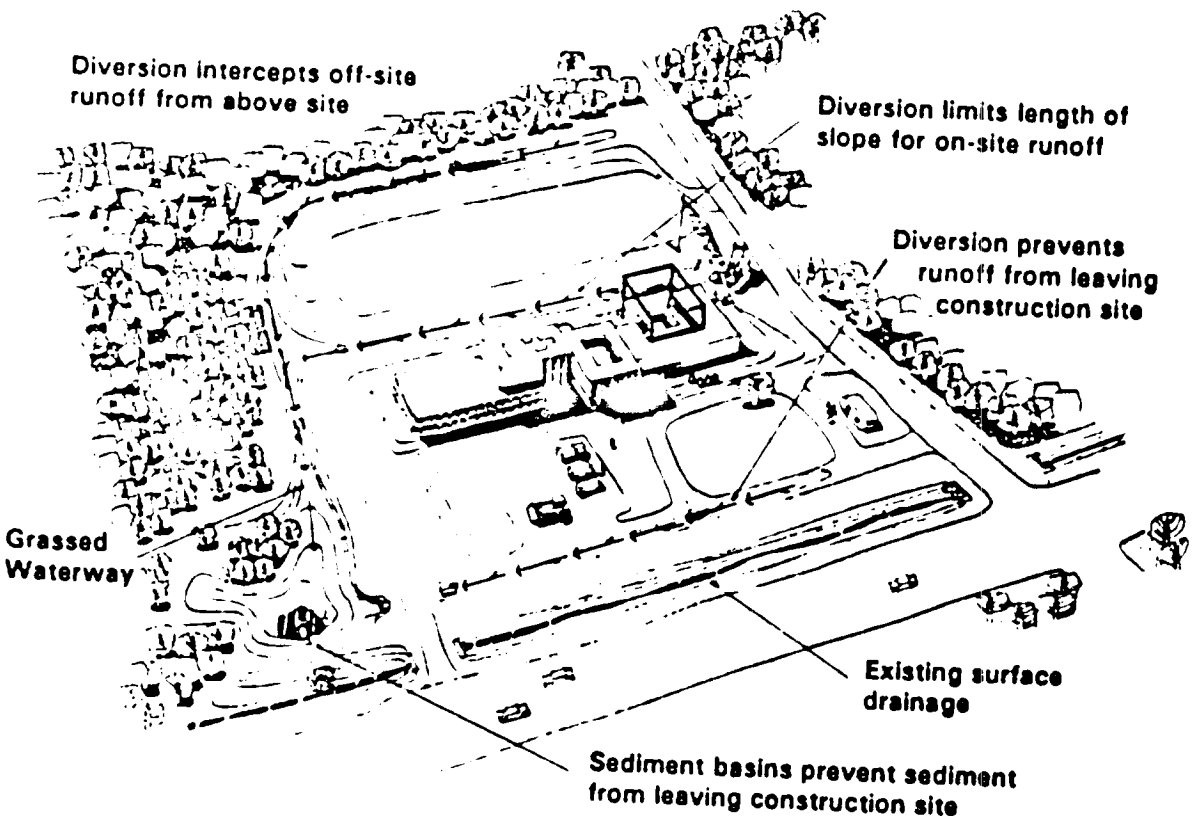

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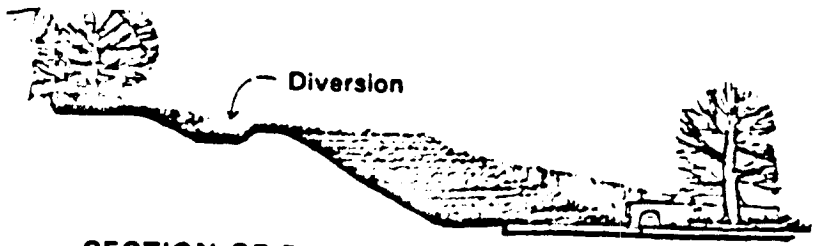
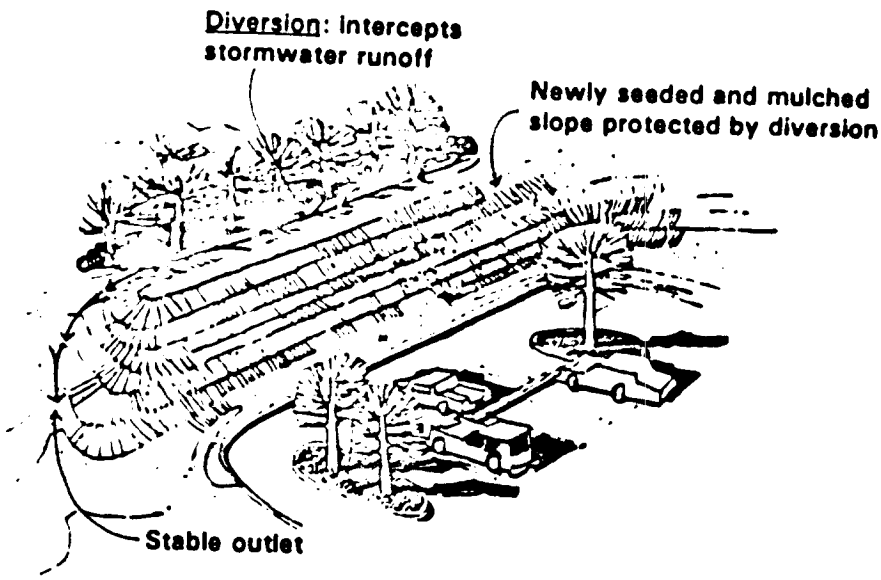
Figure II-2.4 Diversion Control Measures



SECTION OF DIVERSION AT TOP OF SLOPE



DIVERSION OF CONTROL MEASURES CAN INTERCEPT STORMWATER RUNOFF BEFORE IT REACHES SLOPES

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Figure II-2.5 Slope Drains

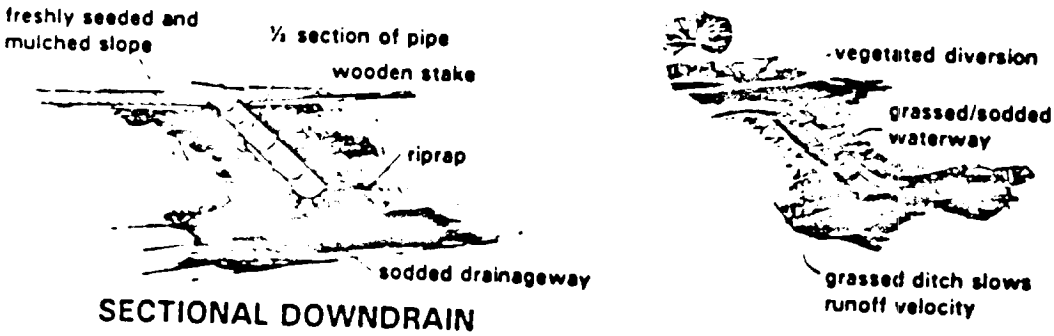

Figure II-2.6 Use of Retaining Walls

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Establishing grass successfully requires that contractors:

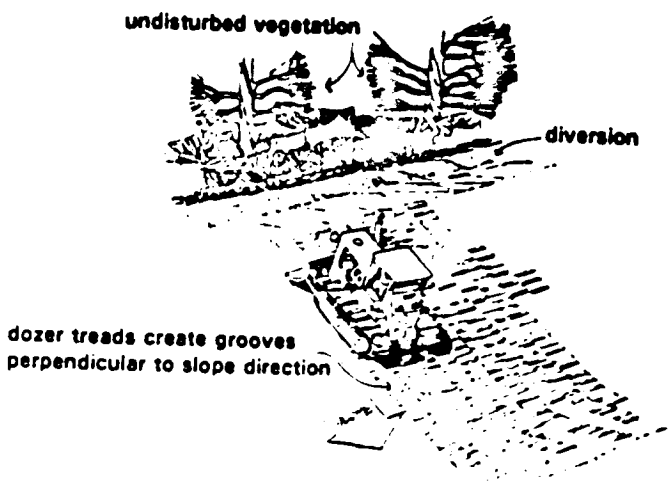
1. Select proper seeding mixture for the site.
2. Observe seeding dates.
3. Cover area to be seeded with topsoil.
4. Prepare seedbed and plant properly.
5. Apply the correct amount of fertilizer for the specific seed or plant type.
6. Protect slope from wind and water erosion during establishment.
7. Ensure that adequate water is available during establishment and in dry periods, if necessary (by natural or other means).

Clear plastic covering provides immediate protection to slopes that cannot be prepared and seeded during the seeding period and/or during initial establishment of seeded areas. However, plastic covering also increases the quantity and velocity of runoff, requiring safe disposal of it onto stabilized areas. Additionally, plastic becomes a disposal problem once it is removed from the slopes it is protecting. Generally, mulches are a better solution for covering exposed areas.

Mulches

Mulching after permanent seeding as well as before seeding protects exposed areas for short periods. Mulches decrease the impact of falling rain, slow runoff velocity and increase the capacity of the soil to absorb water. Mulches hold seeds in place, preserve soil moisture, and insulate germinating seeds from the extremes of heat and cold. Many mulches are available: these include straw and woodchips.

Figure II-2.7 Slope Roughening



Unvegetated Slopes Should Be Temporarily Scarified To Minimize Runoff Velocities

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Most mulches must be anchored. Another alternative is to disc the mulch just enough to anchor it. While tacking agents can be used, they are only effective under the right conditions and cannot be used to try and solve problems with unsuitable soils or excessively steep slopes.

Special Problems

On fill slopes, compaction can be a major factor in erosion control. In addition to other compaction controls required by the nature of the project, the minimum criterion recommended for successful erosion control on fill slopes is to meet or exceed the standards described in WSDOT Standard Specifications Section 2-03.3(14)C "Compacting Earth Embankments."(3) Running heavy equipment over the fill usually compacts it adequately. Formal testing may not be required. On cut slopes, ground water seepage can cause erosion problems. Seepage causes piping and soil slippage. (4)

Slope is an important factor in the success of vegetative restabilization measures. On steep slopes (2:1 or steeper; 2 feet horizontal distance to 1 foot vertical rise) normal tillage equipment cannot be used to prepare a seedbed. Stormwater runoff will result in the loss of seeds, fertilizer, and soil. Sod can be used to stabilize steep slopes instead of seeding where grades are more than 2:1. Sod on steeper slopes must be anchored with pegs.

Sandy soils present a special problem for establishing vegetation, especially in areas where the sand is deep and droughty. American beach grass is one solution to this problem. This plant is established by hand planting live plants.

Steeply sloped areas such as lake shores and road banks involve three special considerations:

1. To ensure probability of successful stabilization, banks should consist of slopes that are 2:1 or flatter.

2. The toe of the slope must be protected from undercutting or other erosive forces by mechanical means where necessary.

3. Water seepage coming out on the face of the slope should be intercepted by a properly designed drainage system (Figure II-2.10).

II-2.2.5 Summary

This section reviewed a range of choices available for erosion control on slopes. These measures may protect other areas exposed during development. A summary follows:

1. Diversion measures: Diversions can intercept stormwater runoff before it reaches disturbed slopes or other exposed areas. They can also collect runoff and convey it to a sediment basin or other suitable location.

2. Vegetative buffer strips: Natural vegetative filters retain sediment on-site. The contractor can significantly reduce erosion on slopes through proper application of these control measures.

3. Slope stabilization control measures: Slopes can be stabilized both mechanically and vegetatively. A slope exposed for longer than a few days should be stabilized by using temporary mulching and seeding. Retaining walls reduce slope and stabilization problems.

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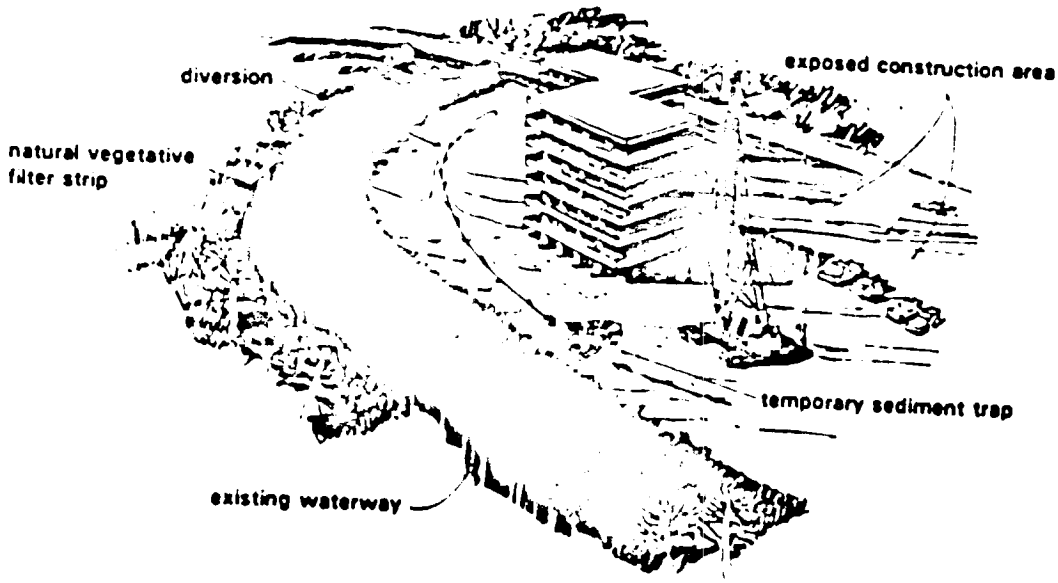
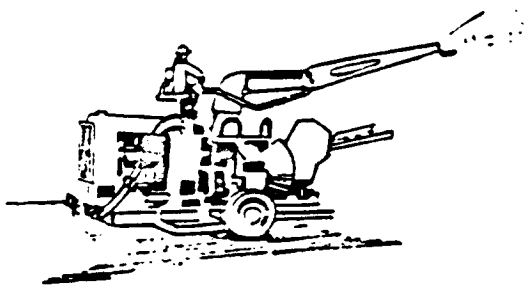
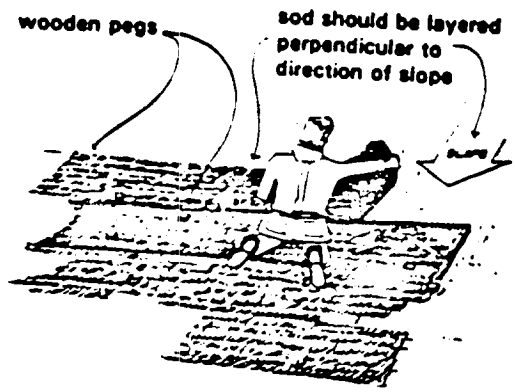
Figure II-2.8 Natural Vegetative Filter Strips



NATURAL VEGETATIVE FILTER STRIPS HELP TO MINIMIZE SEDIMENTATION



HYDRO-SEEDING



SODDING

Figure II-2.9 Seeding Methods

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II-2.3 STREAMS AND WATERWAYS

Protecting streams and waterways on and near sites undergoing development and protecting areas downstream from development involves three goals:

1. The increased sediment loads carried by surface runoff from areas under construction must not be allowed to enter streams.

2. Stream banks must be protected from erosion hazards caused by increases in runoff volume and velocity.

3. The rates of release of increased volumes of runoff into streams and waterways and the velocity of flow in stream channels must be controlled.

There are several characteristics that serve to identify streams that are particularly vulnerable to erosion. Streams which have a small channel capacity and steep banks are very susceptible to erosion. Streams which flow through areas of erodible soil and streams with sharp meanders or bends in the channel alignment are also prone to erosion (4). Before development begins, nearby streams should be analyzed to identify potential problem areas.

II-2.3.1 Streambank Stabilization Measures (BMPs E2.75-2.90)

The maintenance of existing vegetation on stream banks is a fundamental principle of erosion and sedimentation control. Streambank vegetation serves to stabilize the soil, slow runoff and dissipate its erosive energy, and to filter sediment from runoff. To prevent the destruction of streambank vegetation, stream crossing and construction traffic along the banks must be controlled. Culverts or temporary bridges for vehicle crossings should be constructed only where necessary (Figure II-2.11).

(Note: federal, state and local permits may all be required before streambank (or near streambank) work can commence - see Chapter I-3.

Vegetative Measures

Where stream banks must be disturbed or where existing cover is inadequate, grass or grass-legume mixtures may be established. Immediately after grading on stream banks has been completed, vegetative restabilization measures must be initiated. Willows and other natural vegetation, as well as grass and legumes, are recommended for the protection of stream banks. Woody vegetation is used where ice damage may occur.(6)

Structural Measures

Stream banks can be protected from erosion by structural as well as vegetative measures. Where vegetation will not provide sufficient protection, banks can be protected with revetments and deflectors, as well as other mechanical measures. However, willows and other vegetation can also be used in conjunction with structural measures. This is a biomechanical approach. Biomechanical and vegetative methods are always preferred over purely structural measures, which only should be used when absolutely necessary.

Revetments, which cover the banks, are commonly used where sharp bends or constrictions in the stream channel (such as culverts, bridges, or grade control structures) occur. Riprap, gabions, sacked concrete, and concrete or asphalt paving are commonly used as revetment materials. Deflectors consist of jetties or pilings that angle outward from the bank in a downstream direction and deflect currents away from vulnerable bank areas (Figure II-2.12).

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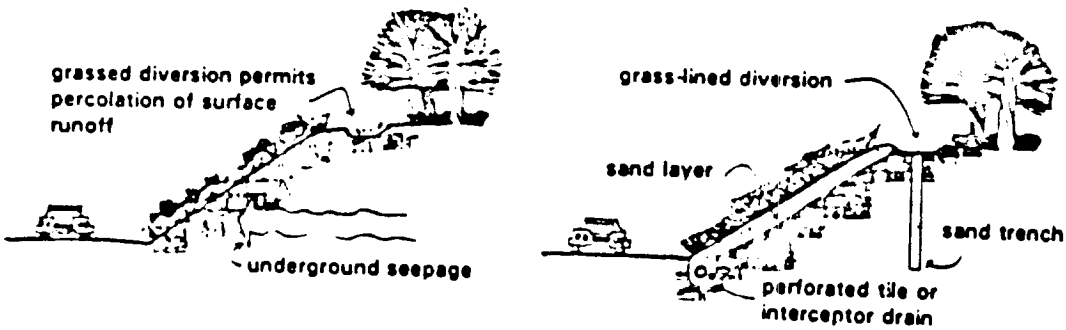
Figure II-2.10 Slope Drain



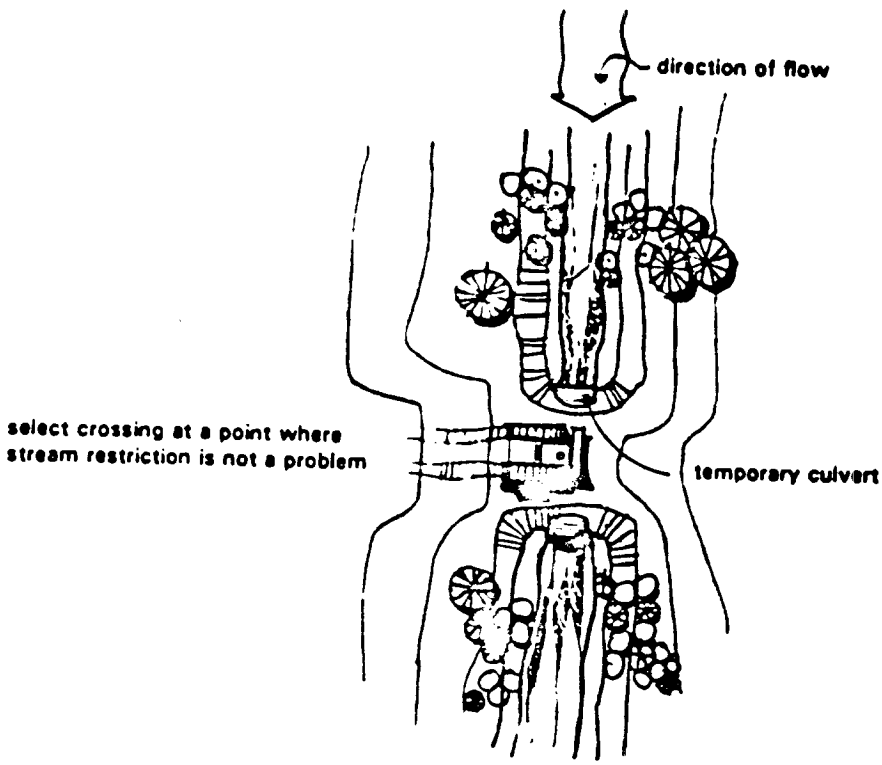


Figure II-2.11 Stream Crossing

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II-2.3.2 Sediment Control Measures (BMPs E2.60, E3.10 through 3.40)

The first essential step in preventing sediment from entering streams and waterways is to control erosion on construction sites. A second necessary step in sediment control is to trap sediment that is transported by runoff before it reaches streams and waterways or leaves the construction site.

To trap sediment, the runoff must be detained for a sufficient period of time (up to 40 hours or longer) to allow the suspended soil particles to settle out. The amount of sediment which is deposited will depend on the speed at which runoff flows through the sediment trap, the length of time that runoff is detained, and the size and weight of the soil particles which are in suspension (6).

Several techniques are available for controlling the amount of sediment which reaches streams and waterways. Vegetative filter strips (preferably strips left in their natural state) between streams and development areas serve to slow runoff and filter out sediment. Check dams can also be constructed in drainageways. Check dams placed at regular intervals within a drainage channel are a temporary sediment control measure that is easy and economical to construct (Figure II-2.13). Barriers are constructed of bags filled with peagravel or crushed rock and stacked in an interlocking manner which is designed to trap sediment and reduce the velocity of flow. Bags filled with peagravel tend to filter the water. They do not totally block the flow like sandfilled bags.

Piping, or undercutting, can be reduced by setting the bags at least 6 inches into the bottom of the drainageway and compacting excavated soil along the upstream side (Figure II-2.14).

Streams may also be protected from increased sediment loads by trapping runoff in sediment basins or ponds before it is released into stream channels. In addition to trapping sediment, these basins are designed to release runoff at nonerosive rates. Such sediment basins can be constructed by excavating a pit or by construction of an impoundment (Figure II-2.15).

Sediment basins often consist of an earthen dam, mechanical spillway (including a perforated riser pipe), and an emergency spillway. The construction of sediment basins should be completed before clearing and grading begin. They are generally located at or near the low point of the site. Points of discharge from sediment basins must be stabilized. In many developments these temporary sediment basins may be converted into permanent retention/detention basins (Figure II-2.16).

II-2.3.3 Summary

The two categories of BMPs used to protect streams and waterways from erosion and sedimentation are:

1. Streambank stabilization BMPs: Streambanks can be stabilized by using vegetative or mechanical control techniques. Deciding which method is appropriate includes factors such as the volume and velocity of water in the stream, the gradient and shape of the stream, and maintenance of control measures.

2. Sedimentation control BMPs: It is necessary to prevent sediment from entering streams and waterways and this can be done by using vegetative filters and sediment traps or basins and check dams. Sediment traps and basins can be either temporary or permanent. Sediment traps are usually temporary and are removed and filled in after construction. Permanent sediment ponds may become a part of the final development in the form of ponds or small lakes. These ponds can be attractive after development is completed.

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II-2.4 SURFACE DRAINAGEWAYS

Surface runoff, and runoff intercepted by erosion control measures such as diversions, must be collected by drainageways and let out in stabilized areas, storm sewers, or sediment basins. The design of these drainageways ensures that runoff is transported without risk of erosion or flooding. Unless surface drainageways are adequately designed, constructed, and maintained, they can become a major source of sediment pollution.

Development should be planned to maintain and utilize the naturally stabilized drainageways that exist on a site. Increases in runoff volume and velocity because of changes in soil and surface conditions during and after construction must be anticipated and controlled to the maximum extent possible. Where the capacity of the natural site drainage channels is exceeded, additional capacity, stabilizing vegetation, and/or structural measures may be needed.

Allowable design velocities vary with soil conditions, the character of the channel lining, and anticipated runoff volume. Formulas and techniques for determining runoff flows, channel cross sections, slopes, stabilizing covers, and design velocity are discussed in Volume III, Chapter III-2 instead of this volume to avoid duplication in BMPs.

II-2.4.1 Grade Control Structures

To reduce the velocity of runoff in drainageways, a variety of grade control structures can be used. These structures can be either temporary or permanent depending on the long-range requirements for the site. Pipe drops and drop spillways can be used.

II-2.4.2 Summary

Erosion and sedimentation from surface runoff can be minimized through the use of the following:

1. Grassed waterways: These channels may be stabilized through seeding and mulching or with sod, and are the preferred form of conveyance.

2. Lined channels: Lined channels should be used where water velocities are high, but are an undesirable alternative to grassed waterways.

3. Grade control structures: In some cases, grade control structures are necessary to reduce runoff velocity to non-erosive levels. Care should be taken to ensure the protection of channel sides and bottoms.

II-2.5 ENCLOSED DRAINAGE: INLET AND OUTFALL CONTROL

The capacity of vegetated drainage channels may be exceeded by the increases in runoff caused by construction activities. As a result, vegetatively-lined channels may scour and erode. Enclosed storm sewers can safely convey runoff of high concentrations and velocities; they can also serve to decrease the velocity of runoff and release it at preferred rates of flow. The following factors should be considered in determining when to use a storm sewer:

1. Whether or not existing enclosed storm sewers are available within reasonable proximity to the site or if there is a natural outlet available.

2. What the actual size of paved areas is and what the ratio of paved areas is to vegetated areas.

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The installation of storm sewers, grassy swales, and other runoff control systems before major building construction begins can aid in controlling site runoff and in avoiding erosion hazards. Volume III contains BMPs for runoff quality and quantity control.

Diversions and surface drainageways are needed to intercept runoff and to convey runoff to storm sewers.

II-2.5.1 Drain Inlet Sediment Filters (BMPs E3.30, E3.35)

The capacity of the storm sewer system itself can be severely impaired by sediment deposits within the system. Sediment should be prevented from entering the enclosed storm sewer by the use of small sediment traps or sumps and filters at system inlets. Filters made of crushed rock, gravel, or sod, can be placed at inlets where sediment traps cannot be constructed (Figures II-2.17 and II-2.18). It is essential to regularly check and clean out these sediment traps and filters to insure that they function properly.

II-2.5.2 Enclosed Drains and Sediment Basins (BMP E3.40)

Where enclosed drainage systems do not tie into existing storm drainage mains, consideration must be given to the location and design of the enclosed drainage system outlet. These outlets must be resistant to erosion. The rate of release must be controlled and the energy of flow must be dissipated. It is essential that sediment be removed from runoff before it is released from the site or corridor. Sediment basins are frequently used at storm sewer outlets during construction.

II-2.5.3 Summary

Enclosed storm sewer systems can safely convey high velocities and large volumes of runoff as well as aid in preventing erosion during and after construction. Sediment must be prevented from entering the storm sewer system and it must be removed from runoff. The following BMPs achieve these purposes:

1. Drain inlet sediment filters prevent sediment from entering the storm sewer system.

2. Enclosed drains and sediment basins mus be carefully located and designed to:

   a. Trap sediment that may be in storm water before it is released off the site or downstream.

   b. Control the volume and velocity of runoff.

The use of temporary control measures can reduce the accumulation of sediment in an enclosed drainage system.

II-2.6 LARGE, FLAT SURFACE AREAS

II-2.6.1 Exposed Surfaces (BMPs E1.10, E1.15, E2.10, E2.15, E3.10, E3.40)

Although erosion rates on steep exposed slopes are higher than on flat or gently sloping areas, all areas of exposed soil are vulnerable to erosion. If erosion control is ignored on large areas of nearly flat or gently sloping land, it will be possible for significant amounts of soil to be eroded. Clearing, grading, and vegetative restabilization in these areas can be timed so that the extent of exposed area and the duration of exposure is minimized. These areas require prompt

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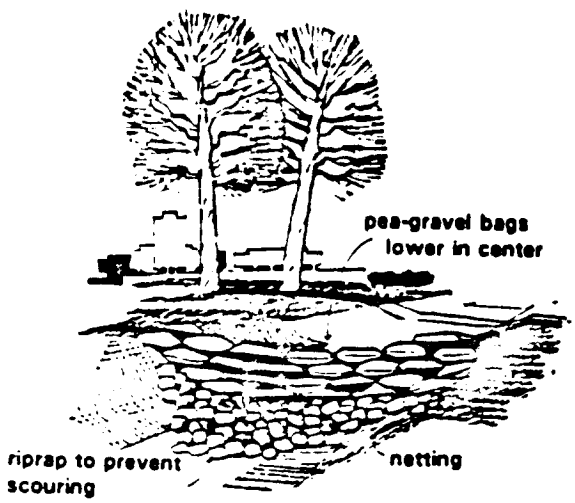
Figure II-2.12 Riprap Revetment Can Help to Minimize Erosion



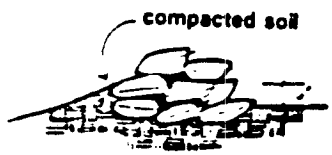


PEA-GRAVEL BAG CHECK DAM

Figure II-2.13 Check Dam



PROBLEM



PREVENT PIPING

Figure II-2.14 Proper Construction of Check Dam

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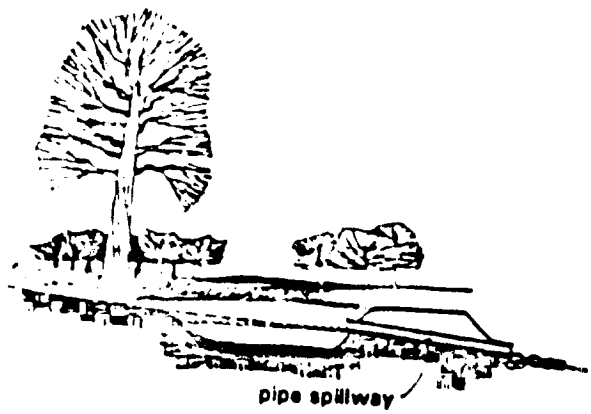
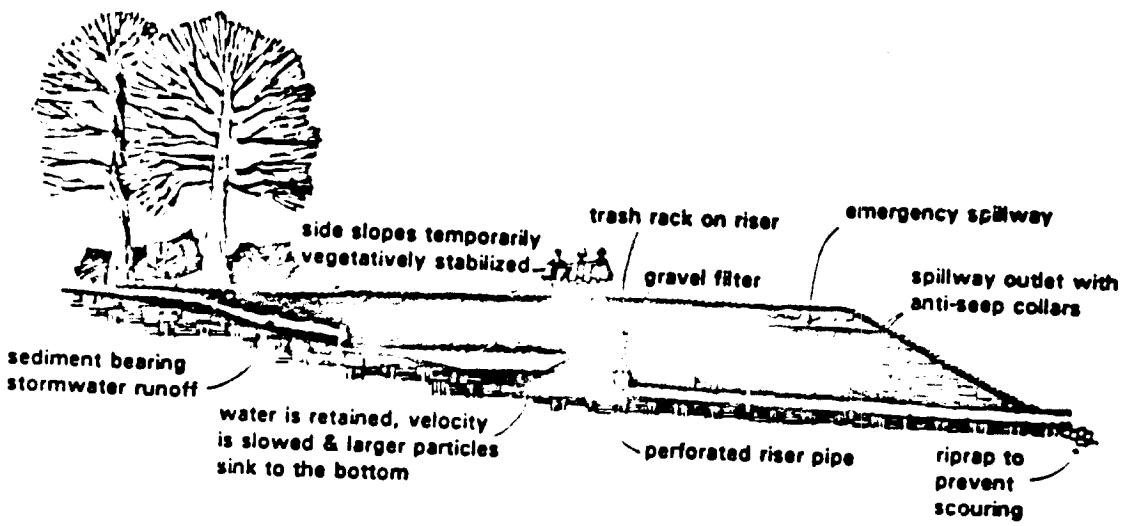
Figure II-2.15
Profile Through Typical Embankment Sediment Basin



PROFILE THROUGH AN EXCAVATED SEDIMENT BASIN



PROFILE THROUGH TYPICAL EMBANKMENT SEDIMENT BASIN

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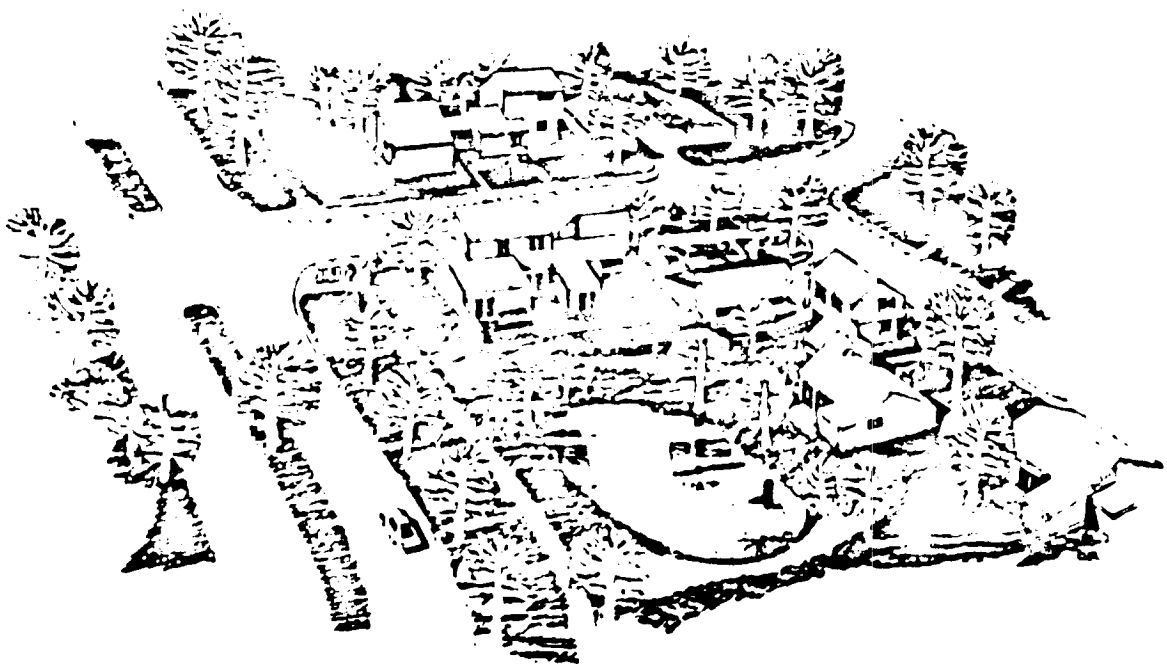
Figure II-2.16 Detention Basin



PERMANENT RETENTION BASINS CAN BE INTEGRATED INTO A DEVELOPMENT

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vegetative restabilization. Temporary seeding or mulching is required where large areas will not be permanently stabilized within recommended time limits. Diversions, sediment barriers, or traps constructed on the lower side of large disturbed areas should be used to intercept and collect sediment.

Rights-of-way and parking areas that are being prepared for paving must be protected from rainfall and runoff. Diversions should be constructed to protect these areas from runoff before clearing and grading begin.

Areas that are being prepared for paving should be properly compacted because compaction makes the exposed surface area less vulnerable to erosion. Cleared rights-of-way may be covered with crushed aggregate to reduce erosion. Where rights-of-way will not be used for construction traffic, they can be seeded with a temporary cover.

Gravel or stone filter berms should be used at intervals along the gradient right-of-way to intercept runoff and direct it to stabilized areas, drainageways, or enclosed drainage system inlets. Filter berms also serve to slow and filter runoff and collect sediment. These berms can be crossed by construction equipment.

II-2.6.2 Paved Surfaces (BMP E3.25)

An increase in paved or compacted surface area on a site greatly increases the rate of site runoff. For example, a 20 percent increase in paved area can cause runoff to more than double during a heavy rainfall (8). In addition, the velocity of runoff moving across a paved surface is higher than the velocity of runoff moving across an area of exposed earth or vegetation. Pavement provides very little resistance to flow and does not allow any infiltration. Runoff draining from a paved surface area is also often highly concentrated.

The concentration of runoff leaving paved areas is highly erosive. After construction is complete, the paved roadway itself can serve as a drainageway with curbs and gutters conducting runoff to enclosed drainage system inlets. Where it is not economically feasible to install curbs and gutters, paved surfaces should be designed so that runoff will travel the shortest possible distance across the paved areas. This will prevent large accumulations of runoff from leaving paved areas at high velocities in any one area.

Well-stabilized drainageways will be necessary to receive and convey the increased volumes and velocities of runoff from paved surfaces. Where concentrated flows of runoff leave paved surface areas, outlet points must be especially well stabilized.

II-2.6.3 Summary

The amount of erosion on flat and gently sloping surface areas can be significant. Erosion on these areas can be minimized by:

1. Scheduling development in phases: The extent of the exposed area and the duration of exposure should be kept to a minimum.
2. Vegetative restabilization: Prompt surface stabilization with either temporary or permanent vegetative cover minimizes erosion.
3. Sediment traps: These measures trap soil eroded from exposed surface areas before it is carried off the site or into waterways.

Areas being prepared for paving should be protected from erosion by the use of:

1. Gravel or stone filter berms: Filter berms slow and filter runoff and divert runoff from the exposed right-of-way.

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2. Compaction: Compaction reduces the vulnerability of the exposed right-of-way to erosion, but increases the velocity and amount of runoff.

3. Aggregate cover: Aggregate cover stabilizes the soil surface while allowing the movement of construction equipment on the right-of-way.

By implementing the control measures listed above, soil erosion on exposed surface areas and areas adjacent to paved surfaces can be minimized.

II-2.7 BORROW AND STOCKPILE AREAS (BMPs E1.10, E1.20, E1.35, E1.50, E2.35, E2.55)

Borrow areas, especially those that are located off the development site, cannot be ignored in erosion and sedimentation control planning. Borrow areas, as well as stockpile and spoil areas, must be stabilized.

Borrow and stockpile areas present the same set of problems for the control of erosion and sedimentation as exposed cut and fill slopes. All areas are erodible. Runoff should be diverted from the face of the slopes which are exposed in the excavation process. The runoff must then be conveyed in stabilized channels to stable disposal points.

The BMPs used to control erosion on slopes, such as the top of dikes, diversions, slope drains, etc., should also be used in borrow areas. Only those sections of the borrow area which are currently needed to supply fill should be stripped. Immediately after the required fill has been taken, the exposed area should be stabilized. If practical, each phase of the borrow operation should be:

1. graded
2. covered with topsoil
3. seeded with permanent vegetation and mulched

If final grading is delayed for more than a few days, temporary seeding should be used. By properly timing the disturbance of the natural cover in the borrow area in carefully planned phases, the area of exposed soil and the duration of exposure are reduced and, therefore, erosion losses are reduced.

The topsoil from borrow areas is stripped and stockpiled for later redistribution on the disturbed area. These stockpiles should be located on the uphill side of the excavated area wherever possible so that they can act as diversions. Stockpiles should be shaped and seeded with temporary cover. They can also be covered with plastic and circled at the bottom with a ditch to catch the runoff.

Where borrow areas are off the development site, a separate system for trapping sediment from the borrow area is needed. After the excavation is complete, borrow areas must be restored. Regrading to ensure proper drainage and to blend the borrow area with the surrounding topography is required. Stockpiled topsoil is then redistributed and permanent vegetative cover established.

II-2.8 ADJACENT PROPERTIES

The protection of adjacent properties and waterways from accelerated erosion and sedimentation is an important concern. Relevant BMPs for protecting adjacent properties have already been discussed under the previous problem areas. The following list illustrates some of the BMPs which can be used:

1. Sediment traps

2. Diversions

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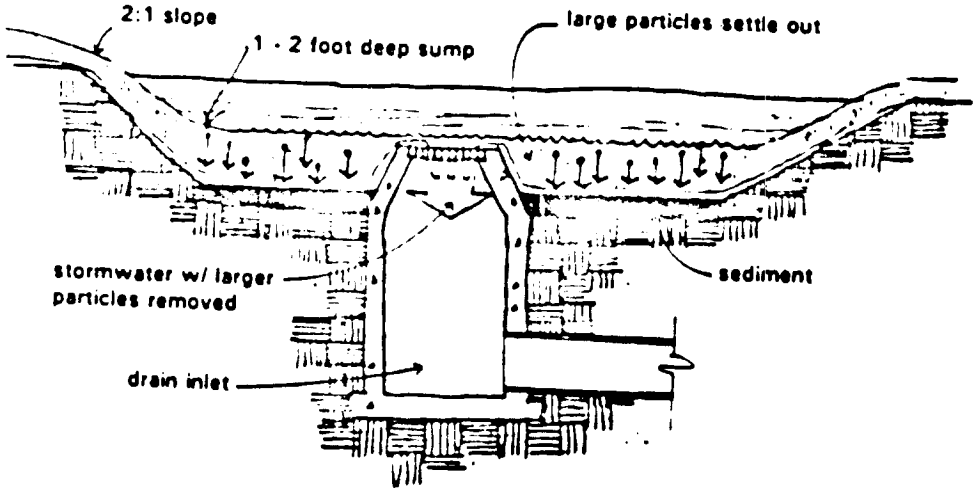
Figure II-2.17 Inlet Sediment Trap



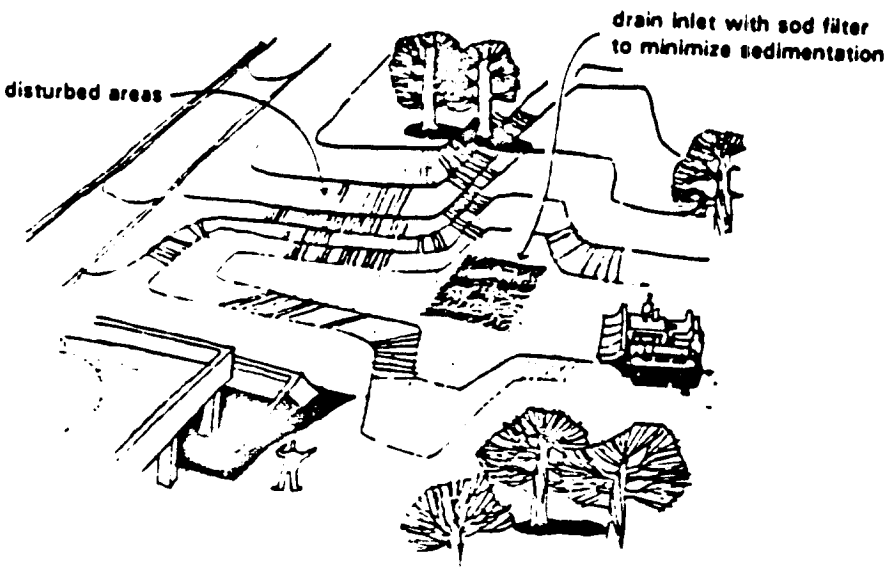


Figure II-2.18 Sod Filter for Drain Inlet

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3. Grass waterways
4. Rock and washed gravel check dams
5. Vegetative filter strips
6. Filter fences

A more complete list of applicable BMPs is shown in The Unified Coding System in Table II-2.2.

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Table II-2.1 Unified Coding System for Erosion and Sedimentation Control BMPs and Their Applicability to Control Various Problem Areas

BMPs	Code	Symbol	Problem Areas: Slope Protection	Waterway Protection	Surface Protection	Enclosed Drainage	Large Flat Areas	Borrow Areas	Adjacent Properties
I. Cover Practices									
E1.10 Temporary Seeding	TS		X		X		X	X	X
E1.15 Mulching & Matting	MU		X				X	X	
E1.20 Clear Plastic Covering	CPC		X					X	
E1.25 Preserving Natural Vegetation	VEG		X	X					
E1.30 Buffer Zones	BZ		X	X					X
E1.35 Permanent Seeding & Planting	PS		X				X		
E1.40 Sodding	SO		X		X		X	X	X
E1.45 Topsoiling	TO		X				X	X	

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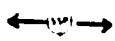
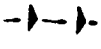
BMPs	Code	Symbol	Slope Protection	Waterway Protection	Surface Protection	Enclosed Drainage	Large Flat Areas	Borrow Areas	Adjacent Properties
II. Erosion Control									
E2.10 Stabilized Construction Entrance & Tire Wash	CE						X		
E2.15 Construction Road Stabilization	CRS		X						
E2.20 Dust Control	DC						X	X	X
E2.25 Pipe Slope Drains	PSD		X						
E2.30 Subsurface Drains	SD		X						
E2.35 Surface Roughening	SR		X				X		
E2.40 Gradient Terraces	GT		X					X	
E2.45 Bioengineered Protection of Very Steep Slopes	SSP		X					X	
E2.50 Level Spreader	LS			X					
E2.55 Interceptor Dike & Swale	IDS		X					X	X
E2.60 Check Dams	CD			X					X
E2.70 Outlet Protection	OP			X	X				

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BMPs	Code	Symbol	Slope Protection	Waterway Protection	Surface Protection	Enclosed Drainage	Large Flat Areas	Borrow Areas	Adjacent Properties
II. Erosion Control, con't.									
E2.75 Riprap	RR		X	X	X				
E2.80 Vegetative Streambank Stabilization	VSS			X					
E2.85 Bioengineering Methods of Streambank Stabilization	BSS			X					
E2.90 Structural Streambank Protection	SSB			X					
III. Sediment Retention									
E3.10 Filter Fence	FF			X		X			X
E3.15 Straw Bale Barrier	STB			X		X			X
E3.20 Brush Barrier	BB		X	X					X
E3.25 Gravel Filter Berm	GFB	GFB	X	X			X		X
E3.30 Storm Drain Inlet Protection	IP		X			X			X
E3.35 Sediment Trap (or Sump)	ST			X	X				X
E3.40 Sediment Pond (or Basin)	SB			X	X	X			X

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II-2.9 REFERENCES

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(3) Washington State Dept. of Transportation, Standard Specifications for Road, Bridge and Municipal Construction, 1988.

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CHAPTER II-3

GUIDELINES FOR CONTROLLING POLLUTANTS OTHER THAN SEDIMENT ON CONSTRUCTION SITES

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CHAPTER II-3

GUIDELINES FOR CONTROLLING POLLUTANTS OTHER THAN SEDIMENT ON CONSTRUCTION SITES

II-3.1 INTRODUCTION

Potential pollutants other than sediment associated with construction activity, include numerous hazardous wastes as well as other solid and liquid wastes. Hazardous wastes include pesticides (insecticides, fungicides, herbicides, rodenticides etc.), petrochemicals (oils, gasoline, asphalt degreaser etc.) and other construction chemicals such as concrete products, sealer, paints, and wash water associated with these products. Other wastes include paper, wood, garbage, sanitary wastes, and fertilizer.

Practices must be used that prevent these potential pollutants from leaving the construction site. Good erosion and sediment control, coupled with stormwater management, will deter the movement of large amounts of sediment off the site. [It must be recognized, however, that pollutants carried in solution in runoff water, or fixed with sediment crystalline structures (e.g., crystalline clays), will be carried through the erosion and sediment control defenses.] Pollutants such as oils, waxes, and water-insoluble pesticides, form surface films on water and on solid particles, and also, oil films serve as a medium for concentrating water-soluble insecticides. Other than by use of very costly water-treatment facilities, or long runoff water detention periods, these pollutants become nearly impossible to control once present in the runoff.

The most economical and effective controls for pollutants other than sediment generated on construction sites, are the exercise of good "housekeeping" practices, and an awareness by construction workers, planners, engineers, and developers of the need and purpose of compliance with federal, state, and local regulations. For example, most pesticides can kill forms of life other than their pest targets. Certain insecticides can persist for months or years in soil and water, and many toxic chemicals can be passed along plant and animal food chains. Similarly, high levels of nutrients (principally phosphorus and nitrogen) from fertilizers used to revegetate exposed subsoils in graded areas may enter waterways and ponds, and increase the growth of algae at the surface to such an extent that light penetration in the water column is decreased. The end result is over-enrichment (or eutrophication). In confined water bodies, over-enrichment can lead to complete deoxygenation of the water and consequent death of fish and other organisms.

Ways must be found to protect ponds, wetlands, lakes, streams, and coastal and estuarine water bodies from damage by sediment and other pollutants generated during construction activities.

The variety of pollutants and the severity of the damage they cause depend upon a number of factors. The most significant of these include:

1. The nature of the construction activity.
2. The physical characteristics of the construction site, including such factors as weather, time of year for construction, topography, soil condition, drainage systems, etc.
3. The proximity, quantity, and quality of the receiving waters (i.e., the amount and purity of the water receiving the contaminated runoff).

It is reasonable to expect, for example, that potential pollution resulting from fertilizers used during revegetation would be more severe on a highway or housing

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development than for a shopping center development. This is because highways and housing developments usually have far greater landscaping requirements than shopping centers which are composed mostly of rooftops and pavement.

The physical characteristics of the construction site have a major bearing on the potential severity of pollution from construction activities. As in the case of sediment, the vast majority of all pollutants are carried into the receiving waters via runoff. The amount of runoff coming from a construction site is dependent upon hydrologic factors. These include the amount, intensity, and frequency of rainfall; the infiltration rate of the soil; surface roughness; and the length and steepness of the ground slope. Large areas denuded or stripped of vegetation, long slopes, steep slopes, tight soils, and high intensity rainfall are all factors conducive to heavy runoff.

Another physical factor influencing the severity of pollution is the proximity of the pollutant, or potential pollutant, to the receiving water. For example, fertilizers applied to a streambank are more apt to cause water pollution than fertilizers applied to a slope well upland of the waterway.

The following information deals with the nature and control of various construction-related pollutants, other than sediment.

II-3.2 BMP C1.10 PESTICIDE CONTROL

Although the word "pesticide" has come to mean only those chemicals which attack insect populations, here the word is used to include herbicides and rodenticides as well as chemicals commonly known as pesticides. Insecticides, rodenticides, and herbicides have historically been used on construction sites to increase health and safety, maintain a pleasant environment, and reduce maintenance and fire hazards. Often, rodents are attracted to construction sites and rodenticides are used.

Pesticides shall only be used in conjunction with Integrated Pest Management (IPM). IPM utilizes a needs assessment which determines which method to use and the necessity of controlling a pest population. Pesticides should be the tool of last resort; methods which are the least disruptive to the environment and to human health should be used first (1). IPM as a BMP is further discussed in Volume IV, Chapter IV-4, BMP S1.90.

If pesticides must be used, clearance for use of any of these chemicals is often required by restrictive federal and state regulations. All pesticides should be stored and applied in accordance with regulations of the State Department of Agriculture, WAC 16-228-185. EPA has produced a pamphlet "Suspended, Canceled and Restricted Pesticides" (Jan. 1985), which includes information on many pesticides. As it is more than five years old, it is wise to check with EPA's Region 10 Pesticides Branch, Seattle, if any questions regarding the use of pesticides arise. An awareness of the need to adhere to recommended dosages, type of application equipment, time of application, cleaning of application equipment, and safe disposal of these chemicals, will go far in limiting the pollution of waterways. Application rates should conform to registered label direction. Many of these compounds are considered "Dangerous Wastes" and must be disposed of properly. Disposal of excess pesticides and pesticide-related wastes should conform to registered label directions for the disposal and storage of pesticides and pesticide containers set forth in applicable federal, state and local regulations. General disposal procedures are:

- Dispose of through a licensed waste management firm or treatment, storage and disposal company (TSD).
- Use up, or give away to garden center, landscape service, etc.

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- Triple rinse containers before disposal, reuse rinse waters as product.

"Hazardous Waste Pesticides - Determining if Your Pesticide is a Hazardous Waste," booklet #[illegible]-14 provides guidance and is available from Ecology's Publications Office. For more information call Hazards Line (587-3292) or Hazardous Substance Information Hotline (1-800-633-7585).

Pesticide storage areas on the construction site should be protected from the elements, from vandals, and from the curious. Warning signals should be placed in areas recently sprayed or treated with the most dangerous pesticides. Persons involved in the mixing and application of these chemicals, to be in compliance with the law, must wear suitable protective clothing.

Other practices include:

- Set aside a locked, weather-resistant storage area.
- Lids should be tightly closed.
- Keep in a cool, dry place. Many pesticides rapidly lose their effectiveness if stored in areas exposed to heat.
- In case of a leak, put original container into a larger container and label it properly.
- Check containers periodically for leaks or deterioration.
- Keep a list of products in storage.
- Use plastic sheeting to line the area.
- The applicator must follow the notification requirements of the WDSA. Neighbors on properties adjacent to the one being sprayed should also be notified prior to spraying.
- All storage sheds, dumpsters or other storage facilities should be regularly monitored for leaks and repaired as necessary. Remind workers during subcontractor or safety meetings about proper storage and handling of materials.

II-3.3 BMP C1.20 HANDLING OF PETROLEUM PRODUCTS

Petroleum products are widely used during construction activities. They are used as fuels and lubricants for vehicular operations, power tools, and general equipment maintenance. These pollutants include oils, fuels such as gasoline, diesel oil, kerosene, lubricating oils, and grease. Asphalt paving can be a pollutant source as it continues to release various oils for a considerable length of time. Most of these pollutants adhere to soil particles and other surfaces easily.

One of the best modes of control is to retain sediments containing oil on the construction site. Soil erosion and sediment control practices can effectively accomplish this. Improved maintenance and safe storage facilities will reduce their chances of contaminating construction sites. One of the greatest concerns confronting uses of these petroleum products is the method for waste disposal. Oil and oily wastes such as crankcase oil, cans, rags, and paper dropped in oils and lubricants, can be best disposed of in proper receptacles or recycled (call 1-800-RECYCLE). Waste oil for recycling should not be mixed with degreasers, solvents, antifreeze, or brake fluid. The dumping of these wastes in sewers and other drainage channels is illegal and could result in fines or job shutdown. A further

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source of these pollutants is leaky vehicles. Proper maintenance of equipment and installation of proper stream crossings will further reduce pollution of water by these sources. Stream crossings should be minimized through proper planning of access roads.

Guidelines for storing petroleum products are as follows:

- Store products in weather-resistant sheds where possible.
- Create shelter around area with cover and wind protection.
- Line the storage area with double layer of plastic sheeting or similar material.
- Create impervious berm around the perimeter.
- Capacity of bermed area should be 110 percent of largest container.
- All products should be clearly labeled.
- Keep tanks off the ground.
- Keep lids securely fastened.
- Contact local fire marshall for more information.
- Post information for procedures in case of spills. Persons trained in handling spills should be on-site or on call at all times.
- Materials for cleaning up spills should be kept on-site and easily available. Spills should be cleaned up immediately and the contaminated material properly disposed of.
- Specify a staging area for all vehicle maintenance activities. This area should be located away from all drainage courses.
- All storage sheds, dumpsters or other storage facilities should be regularly monitored for leaks and repaired as necessary. Remind workers during subcontractor or safety meetings about proper storage and handling of materials.

II-3.4 BMP C1.30 NUTRIENT APPLICATION AND CONTROL

Inorganic nutrient pollution is most often caused by fertilizers used in revegetating graded areas. The use of proper soil-stabilization measures, sediment control, and stormwater detention structures can be effective means of keeping these materials out of waterways. Only small amounts of inorganic nutrients are beneficial to the productivity of waterways, while excess amounts result in over-enrichment (eutrophication).

Nutrient pollution can be minimized by working fertilizers and liming materials into the soil to depths of 4 to 6 inches, and by proper timing of the application. Hydro-seeding operations, in which seed, fertilizers and lime are applied to the ground surface in a one-step operation, are more conducive to nutrient pollution than are conventional seedbed-preparation operations, where the fertilizers and lime are tilled into the soil. In the case of surface dressings, control can be achieved by applying the required quantity of fertilizer in more than one operation. For example, an area requiring an application of 500 lbs. per acre of fertilizer could be dressed with about 125 lbs. per acre at four separate times over the growing season.

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Use of fertilizers containing little or no phosphorus may be required by local authorities if the development is near sensitive water bodies. In any event great care should be taken to use only the minimum amount of phosphorus needed, as determined by soil tests, or advice from the local Conservation District or Soil Conservation Service.

Near sensitive surface waters, the addition of lime can affect the pH (or acidity) of runoff and receiving waters. Importation of topsoil is better than heavily liming and fertilizing exposed subsoil.

II-3.5 BMP C1.40 SOLID WASTE HANDLING AND DISPOSAL

Solid waste is one of the major pollutants caused by construction. Solid waste is generated from trees and shrubs removed during land clearing for construction of streets and parking facilities, and during the installation of structures. Other wastes include wood and paper from packaging and building materials, scrap metals, sanitary wastes, rubber, plastic and glass pieces, masonry products, and others. Food containers such as beverage cans, coffee cups, lunch-wrapping paper and plastic, cigarette packages, leftover food, and aluminum foil contribute a substantial amount of solid waste to the construction site.

The major control mechanism for these pollutants is to provide adequate disposal facilities. Collected solid waste should be removed and disposed of at authorized disposal areas. Frequent garbage removal helps maintain construction sites in a clean and attractive manner. Waste containers should be labelled and located in a covered area. Lids should be kept closed at all times. Any useful materials should be salvaged and recycled. For instance, masonry waste can be used for filling borrow pits; trees and brush from land-clearing operations can be converted into woodchips through mechanical chippers and then used as mulch in graded areas. Sanitary facilities must be convenient and well maintained to avoid indiscriminate soiling of adjacent areas. Selective (rather than wholesale) removal of trees is helpful in conservation of soil and reduction of wood wastes. Indiscriminate removal of trees and other beneficial vegetation should be avoided.

Soil erosion and sediment control structures capture much of the solid waste from construction sites. Constant removal of litter from these structures will reduce the amount of solid waste despoiling the landscape. The extension of local and state anti-litter ordinances to cover construction sites is also a viable control mechanism. Adherence to these regulations by construction personnel reduces unnecessary littering through carelessness and negligence.

II-3.6 BMP C1.50 USE OF CHEMICALS DURING CONSTRUCTION

Many types of chemicals may be used during construction activities. These chemical pollutants include paints, acids for cleaning masonry surfaces, cleaning solvents, asphalt products, soil additives used for stabilization and other purposes, concrete-curing compounds, and many others. These materials are carried by sediment and runoff from construction sites.

A large percentage of these pollutants can be effectively controlled through implementation of source control soil erosion and sedimentation control practices. By using only the recommended amounts of these materials and applying them in a proper manner, pollution can be further reduced. As in the case of other pollutants, good housekeeping is the most important means of controlling pollution.

The correct method of disposal of wastes varies with the material. Wash-up waters from water-based paints may go into a sanitary sewer, but wastes from oil-based paints, cleaning solvents, thinners, and mineral spirits must be disposed of through

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a licensed waste management firm or TSD. Disposal of concrete products, additives, and curing compounds depends on the product. Information is available from the local health department or the Hazardous Substance Information Hotline (1-800-633-7585).

II-3.7 OTHER POLLUTANTS

Other pollutants include concrete wash water from concrete mixers, acid and alkaline solutions from exposed soil or rock units high in acid, and alkaline-forming natural elements.

The control of these pollutants involves good site planning and pre-construction geological surveys. Neutralization of these pollutants often provides the best treatment. Sealing of fractures in the bedrock with grout and bentonite will reduce the amount of acid or alkaline seepage from excavations. Adequate treatment and disposal of concrete further reduces pollution.

II-3.8 GENERAL GUIDELINES

General guidelines for managing or minimizing any of the above hazardous wastes are as follows:

II-3.8.1 BMP C1.60 Managing Hazardous Products

- Buy and use only what is needed. Leftovers need to be stored, re-used, given away, recycled or disposed of safely.
- Read labels and follow directions on the label. Hazardous products may be labeled:

Danger	Poisonous	Volatile
Combustible	Caustic	Explosive
Warning	Corrosive	Flammable
Caution		

- Try to keep products in original containers and always keep them well-labeled. If the product must be transferred to smaller containers, use the proper size funnel and avoid spills. Label all containers.
- Labels can fall off with weathering. To prevent, cover with transparent tape. To relabel, use a metal tag attached to the container or use a stencil and spray paint.
- Do not mix chemical substances unless recommended by the manufacturer.
- Use in well-ventilated areas. Protect skin, eyes, nose, and mouth when necessary by wearing gloves, respirator, or other protective clothing.
- Keep corrosive liquids away from flammable liquids.
- Look for nontoxic or less toxic options (check with the State Department of Ecology Office of Waste Reduction at 1-800-822-9933).
- Use all of the product before disposing of the container.
- There are private firms that specialize in the cleanup of spills.

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II-3.8.2 BMP C1.70 Equipment Washing

Thinners or solvents should not be discharged into the sanitary or storm sewer systems when cleaning large machine parts where discharge of water is required. Use alternative methods for cleaning larger equipment parts such as high pressure, high temperature water washes, or steam cleaning.

Equipment washing detergents can be used and wash water discharged into the sanitary system if grit is removed from the solution first. The water discharged into the sewer must not exceed the discharge limits set by the Sewer Authority.

Small parts can be cleaned with degreasing solvents which are reused after filtering or recycled. These solvents should not be discharged into any sewer. Further information is available from the Department of Ecology.

II-3.8.3 BMP C1.80 Spill Control Planning and Cleanup

Construction site supervisors shall adopt a spill control plan and identify persons responsible for implementing the plan if a spill of a dangerous or hazardous waste should occur. Any spill that occure, regardless of the size and/or type of spill, should be reported to the following agencies:

- If the spill of a hazardous substance could reach surface waters, the following agencies must be notified (there are fines for failing to notify):

  National Response Center 1-800-424-8802 (24-hour)

- Locally, notify the regional Department of Ecology offices:

  Northwest Region - Redmond 649-7000 (24-hour)
  Southwest Region - Olympia 753-2353 (24-hour)

- Within the City of Bellevue

  Storm & Surface Water Utility 455-7846 (24-hour)

- For spills within salt water

  U.S. Coast Guard 286-5440

There are fines for failing to notify the appropriate authority when a spill occurs.

Some of the important components of a spill control plan are:

- Establish who to notify in the event of a spill, particularly if it is hazardous.
- Provide specific clean-up instructions for different products handled on site.
- Assign a person to be in charge of clean-up assistance.
- Prepare spill containment and clean-up lists that are easy to find and use.
- Post a summary of the clean-up plan at appropriate locations.
- If a spill occurs, demobilize it as quickly as possible.

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- If there is a change that the spill could enter a storm drain or sewer, plug the inlet and turn off or divert any incoming water.
- Cover the spill with absorbent material such as kitty litter or sawdust. Do not use straw. Dispose of the used absorbent per Ecology or manufacturer's instructions. If the spill is flammable, dispose of as directed by the local fire marshal.
- Keep the area well ventilated.

II-3.8.4 BMP C1.90 Treatment and Disposal of Contaminated Soils

Contaminated ground water or soil may be encountered during earthwork activities or by the spill or leak of a hazardous product. The contaminant may be known or unknown. Sampling and laboratory tests may be required to determine whether a landfill can accept the contaminated soil. In some cases it is possible to reduce the hazardous potential of the soil by aerating it, for example. Local health departments can supply the necessary procedures. Private firms can also be consulted for disposal.

The Model Toxics Control Act, Ch. 70.105 RCW, requires that Ecology's Toxic Cleanup Program be notified if contaminated soil or ground water is encountered during a project.

II-3.8.5 BMP C 2.00 Concrete Trucks/Spray Washing of Exposed Aggregate Driveways and Walkways

The washout from a concrete truck should be disposed of into:

- A designated area which will later be backfilled: a slurry pit.
- An area where the concrete wash can harden, be broken up, and then put in the dumpster.
- A location which is not subject to surface water runoff, and more than 50 feet away from a storm drain, open ditch, or receiving water.

Never Dump Into:

- Sanitary sewer
- Storm drain
- Soil or pavement which carries stormwater runoff.

When spray washing driveways or walkways to expose the aggregate, all wash water should be diverted or sprayed to the sides, not down the driveway. If water must run down the driveway towards the street or sidewalk, it should be diverted at the bottom to a sump or sediment trap.

II-3.8.6 BMP C2.10 Use of Sandblasting Grits

If used to clean old buildings where lead, cadmium, or chrome-based paints were applied, the sandblasting grits are a hazardous waste. They cannot be washed into any sewer system. Contact a licensed waste management firm or TSD facility.

II-3.8.7 BMP C2.20 Disposal of Asbestos and PCBs

Use and disposal of these potential pollutants are regulated by both state and federal agencies. For further information, contact:

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For Asbestos:

Puget Sound Air Pollution Control Agency: 296-7330
U.S. EPA: 442-7369

For Wastes Containing PCBs:

Washington Department of Ecology, Hazardous Waste Section: 449-6687
U.S. EPA: 442-7369

II-3.9 REFERENCES

(1) Washington Toxics Coalition, letter dated January 31, 1990.

(2) Reinelt, Loren, Construction Site Erosion and Sediment Control Inspector Training Manual, Center for Urban Water Resources Management, University of Washington, October, 1991.

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CHAPTER II-4

NPDES STORMWATER PERMIT REQUIREMENTS AND THE DEVELOPMENT OF LARGE PARCEL EROSION AND SEDIMENT CONTROL PLANS

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CHAPTER II-4

NPDES STORMWATER PERMIT REQUIREMENTS AND THE DEVELOPMENT OF LARGE PARCEL EROSION AND SEDIMENT CONTROL PLANS

INTRODUCTION

Two different types of requirements commonly must be satisfied for construction sites. Those sites larger than 5 acres must comply with the requirements that will be contained In the baseline General NPDES Stormwater Permit (now under development). All new development and redevelopment sites larger than 1 acre must comply with Erosion and Sediment Control Requirements 1 through 14 (see Chapter I-2). This compliance is demonstrated through the submittal of an Erosion and Sediment Control (ESC) Plan.

II-4.1 NPDES STORMWATER PERMITS

EPA's National Pollutant Discharge Elimination System Permit (NPDES) regulations for stormwater (40 CFR Parts 122, 123 and 124) became effective on November 16, 1990. Washington is a NPDES delegated state which requires Ecology to administer NPDES permits. Cities and counties with a population of 100,000 and greater that have separate storm sewer systems, most industries that discharge stormwater associated with industrial activities or storage of raw materials, and construction sites 5 acres in area and greater are required to apply for NPDES permits. Stormwater from industrial uses that does not come in contact with industrial activities or storage of raw materials or products, such as runoff from roofs and parking lots, generally does not require a NPDES permit.

The purpose of the new stormwater NPDES regulations is to:

- Prohibit non-stormwater discharges into storm sewers
- Reduce discharge of stormwater-borne pollutants to the maximum extent practicable
- Establish a permit system for stormwater discharges

The Stormwater Management Program that Ecology and the Puget Sound Water Quality Authority are preparing for the Puget Sound Basin will be as consistent as possible with NPDES requirements. The thrust of the Stormwater Program is to direct the 111 cities and counties in the Basin to adopt and implement programs to prevent water pollution and enhance water quality for themselves and privately owned facilities in their jurisdiction. NPDES is a statewide permit program that Ecology will administer directly to cities, counties and regulated industrial facilities including construction sites.

Construction activity including clearing, grading and excavation activities that result in the disturbance of five acres or more will require a permit. Parcels less than five acres in area that are part of a common plan of development or sale totaling five acres or more will also be required to obtain a permit. Ecology anticipates that at the point that a permit program is developed, that construction sites will be covered as part of the baseline general permit to be published in final form in August, 1992. Once the permit is finalized, the contractor will be required to send to Ecology a Notice of Intent to begin construction 30 days before construction is to begin. At this time, details are not finalized.

Applications for coverage under the baseline permit should be submitted after Ecology adopts the permit (targeted for August, 1992), but before the current federal deadline of October 1, 1992. Applications will consist of filing a NOTICE

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OF INTENT (NOI). Ecology has not yet decided on the information requirements for a NOTICE OF INTENT. Proposed requirements for a Notice of Intent will be discussed at public workshops and hearings.

At this time there will be no charges associated with the filing of the NOI. Ecology charges a fee for permits as allowed under State regulation, Chapter 173-224 WAC. That regulation does not identify a fee for facilities which will be covered under the baseline permit for storm water. Ecology plans to seek an increased legislative appropriation for the next biennium (July 1, 1993-June 30, 1995) to administer storm water permits. Fees would be set by amending the fee rule. There will be opportunities for public comment on the fee proposals. Subject to the appropriation and adoption of the amended fee regulation, fees for storm water permits would become effective after July 1, 1993.

PROPOSED ECOLOGY INDUSTRIAL/CONSTRUCTION PERMIT DEADLINES

May, 1992	Ecology holds public workshops, hearing on baseline permit.
August, 1992	Projected adoption of Ecology's baseline permit (including construction activities). The permit is effective 30 days later.
After 10/31/92	New industries must submit a NOTICE OF INTENT (to Ecology), and develop a pollution prevention plan (to be retained by the industry), before commencement of construction of a storm water discharge. EPA has proposed that these be completed at least 30 days prior to commencement.

ECOLOGY CONTACTS

Industrial permits		Municipal permits	
• Stan Ciuba	(206) 438-7042	• Gary Kruger	(206) 438-7529
• Ed O'Brien	(206) 438-7037		

II-4.2 INTRODUCTION TO LARGE PARCEL EROSION AND SEDIMENT CONTROL PLANS

This section is designed to provide an overview of the important components and process for developing, reviewing and implementing Large Parcel Erosion and Sediment Control (ESC) plans for construction sites. A separate example LPESC plan will be provided in the Stormwater Program Guidance Manual for the Puget Sound Basin currently being developed as a companion document to this manual. Small Parcel ESC requirements can be found in Chapters I-3 and II-5.

Section II-4.3 contains basic information which all site planners and plan reviewers should become familiar with. It describes criteria for plan format and content, ideas for improved planning effectiveness and sources of technical assistance.

Section II-4.4 outlines and describes a recommended step-by-step procedure for developing an erosion and sediment control plan from data collection to finished product. This procedure is written in general terms to be applicable to all types of projects.

Site planners, as well as local plan approving authorities, are urged to become familiar with the contents of this chapter so that plans will

eventually become more standardized and thus more meaningful throughout the Puget Sound basin.

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II-4.3 GENERAL GUIDELINES

II-4.3.1 What is a Large Parcel Erosion and Sediment Control Plan?

A Large Parcel ESC plan is a document which describes the potential for erosion and sedimentation problems on a construction project over 1 acre in size and explains and illustrates the measures which are to be taken to control those problems. The plan has a written portion known as a narrative and an illustrative portion known as a map or site plan.

The LPESC plan should be an independent entity. While it is a good idea to include erosion and sediment control standards and specifications in contract documents, the erosion and sediment control plan itself should be a separate document which can stand alone.

A LPESC plan is required for all new development and redevelopment where greater than 1 acre of land disturbing activities occur. See Chapter I-2 for more specific information on which type of planning is appropriate.

II-4.3.2 What is an "Adequate" Plan?

An erosion and sediment control plan must contain sufficient information to satisfy the Plan Approval Authority of the local government that the problems of erosion and sedimentation have been adequately addressed for a proposed project. The length and complexity of the plan should be commensurate with the size of the project, the severity of site conditions, and the potential for off-site damage.

In general, plans for constructing a few homes in a small subdivision do not need to be as complex as a plan for a large shopping center development or a large subdivision. Also, plans for projects undertaken on flat terrain will generally be less complicated than plans for projects constructed on steep slopes where the erosion potential is higher. The greatest level of planning and detail should be evident on plans for projects which are large in size, directly adjacent to flowing streams, other sensitive areas, or high value properties where damage may be particularly costly or detrimental to the environment.

The primary requirements that determine the adequacy of a plan are the Erosion and Sediment Control standards found in Minimum Requirement #1, described in Chapter I-2. Each of these Erosion and Sediment Control Requirements applicable to a project should be satisfied in the LPESC Plan unless a specific variance is granted by the Plan Approval Authority. The design and implementation of the LPESC plan should specifically fulfill all the Erosion and Sediment Control Requirements contained within Minimum Requirement #1 unless an exemption has been granted by the local government. As a guide to format, the site planners and plan reviewers should use the checklist contained in Section II-4.4.6. The step-by-step procedure outlined in this section is recommended for the development of all plans.

II-4.3.3 A Narrative is Important

The narrative is a written statement which explains and justifies the erosion and sediment control decisions made for a particular project. The narrative is especially important to the Plan Approval Authority because it contains concise information concerning existing site conditions, construction schedules, and other pertinent items which are not contained in a typical site plan.

The narrative is also important to the construction superintendent and inspector who are responsible to see that the plan is implemented properly. It provides them with a single report which describes where and when the various erosion and sediment control BMPs should be installed.

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II-4.3.4 BMP Standards and Specifications

Chapters II-3 and II-5 of this volume of the manual contain standards and specifications for BMPs. These standards apply within the Puget Sound drainage basin except where an adopted and implemented basin plan is in place (see Minimum Requirement #9 in Chapter I-2). Wherever any of these BMPs are to be employed on a site, the specific title and number of the BMP should be clearly referenced in the narrative and marked on the plan. By referencing this manual properly, (or, the locally adopted technical equivalent of this manual) the site planner can reduce the need for detailed drawings and lengthy descriptions of the practices in the plan.

Modifications to standard practices or new innovative conservation practices may also be employed, but such practices (Experimental BMPs) must be thoroughly described and detailed to the satisfaction of Ecology and the Plan Approval Authority of the local government before they may be used (see Section I-2.17).

II-4.3.5 General Principles in Selecting BMPs for a Large Parcel Erosion and Sediment Control Plan

- Prevention of pollutant release is superior to pollutant capture later. Select source control BMPs as a first step.
- Selection of BMPs must depend on site characteristics and the construction plan.
- The proper first step is a site drainage analysis. Determine where runoff will enter, cross and exit the site.
- Flowing water has a tendency to concentrate in channels instead of flowing as sheet flow.
- Determine whether subsurface water is a factor.
- Divert runoff from exposed areas wherever possible.
- Existing vegetation is the most effective erosion control.
- Limit and phase clearing.
- Use materials found on the site wherever possible.
- Incorporate natural drainage features whenever possible, using adequate buffers and protecting areas where flow enters the drainage system.
- Keep structures simple.
- Minimize slope length and steepness.
- Keep runoff velocities low.
- Reduce the tracking of sediment off-site.
- Select and install controls that can be maintained.
- Select appropriate BMPs from Chapter II-3 for the control of pollutants not associated with sediment.

II-4.3.6 Standard Practice Coding System

Site planners are urged to use the standard numbering and coding system for BMPs contained in this manual. Table II-2.2 in Chapter II-2 lists each practice with its

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designated number, symbol, and code. Use of this coding system will result in increased uniformity of plans and increase their readability to plan reviewers, job superintendents, and inspectors Puget Sound-wide. Since the BMPs in Chapter II-3 are not site-specific, they have not been given codes or symbols.

II-4.3.7 Comprehensive Site Planning

Erosion and sediment control planning should be an integral part of the site planning process, not just an afterthought. The potential for soil erosion should be a significant consideration when deciding upon the layout of buildings, parking lots, roads, and other facilities. Adverse environmental impacts and costly erosion and sediment control measures can be minimized if the site design can be adapted to existing site conditions and good conservation principles are used. Additionally, if thought is given to the design of temporary erosion control devices, they may be able to be converted into permanent facilities as well.

II-4.3.8 Who is Responsible for Preparing a Plan?

The owner or lessee of the land being developed has the responsibility for plan preparation and submission. The owner or lessee may designate someone (i.e., an engineer, architect, contractor, etc.) to prepare the plan, but he/she retains the ultimate responsibility. It is important for the developer to comply with the requirements of the local government and Minimum Requirement #1 contained in Chapter I-2 of this manual.

II-4.3.9 Technical Assistance

Possible sources of erosion and sediment control planning assistance within the state include:

1. Conservation Districts: These districts have elected representatives (directors) from each locality. One of the primary functions of these districts is to provide assistance to landowners for soil conservation planning and implementation. The USDA-Soil Conservation Service provides conservation districts with technical assistance. Requests for assistance in preparing erosion and sediment control plans for a construction site can be made through a district.

2. USDA-Soil Conservation Service: The Soil Conservation Service (SCS) provides technical assistance or conservation planning and implementation to landowners throughout the country through local conservation districts. In addition, the SCS is involved in soil surveys within the state. Requests can be made through a Soil Conservation Service field office for a soil survey on a specific site. These requests will be acted upon according to local priorities.

II-4.4 STEP-BY-STEP PROCEDURE

The five basic steps in producing a LPESC plan are summarized below:

Step 1 - Data Collection

A. Topography
B. Drainage
C. Soils
D. Ground Cover
E. Adjacent Areas
F. Existing Development
G. On and Off-Site Utilities

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Step 2 - Data Analysis

A. Topography - Slope gradients, lengths
B. Drainage - Outline existing natural and manmade drainage patterns
C. Soils - Erodibility (K) factors, permeability
D. Ground Cover - Trees, grassy areas, sensitive or endangered vegetation
E. Adjacent Areas - Streams, roads, buildings, etc.

Step 3 - Site Plan Development

A. Fit development to terrain
B. Locate construction in the least critical areas
C. Utilize cluster development whenever possible
D. Minimize paved areas
E. Utilize the natural drainage system and natural drainage locations whenever possible

Step 4 - Plan for Erosion and Sediment Control

A. Determine limits of clearing and grading
B. Divide the site into drainage areas
   - Consider each area separately
C. Select erosion and sediment control BMPs, emphasizing source control and vegetative BMPs.
   - Vegetative, especially buffers, preservation of natural vegetation and flagging
   - Structural
   - Management measures
D. Plan for stormwater management

Step 5 - Include BMPs for the Control of Pollutants Other Than Sediment

A. Review Chapter II-3 in this volume
B. Select appropriate BMPs based on the practices which will be used on-site.

Step 6 - Plan Preparation

A. Narrative
B. Site Plan

Note: The LPESC plan may be a subset of the Stormwater Site Plan. Full details on how to prepare the Stormwater Site Plan and how the LPESC plan is integrated into it are provided in Chapter I-3. In particular, most of the work for steps 1 and 2 will have been done when preparing the Site Improvement Plan Base Map. The actual LPESC plan is part of the Site Improvement Plan. All the hydrologic and hydraulic information used to analyze and size the ESC facilities must be included in Section IX of the Technical Information Report.

II-4.4.1 Step 1 - Data Collection

Inventory the existing site conditions to gather information which will help develop the most effective erosion and sediment control plan. The information obtained should be plotted on a map and explained in the narrative portion of the plan.

A. Topography - A small-scale topographic map of the site should be prepared to show the existing contour elevations at intervals of from 1 to 5 feet depending upon the slope of the terrain.

B. Drainage Patterns - All existing drainage swales and patterns on the site should be located and clearly marked on the topographic map including all

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existing underground storm drain pipe systems.

C. Soils - Major soil type(s) on the site should be determined and shown on the topographic map. Soils information can be obtained from a soil survey if one has been published for the county. If a soil survey is not available, a request can be made to a district Soil Conservation Service Office. Commercial soils evaluations are also available. Soils information should be plotted directly onto the map or an overlay of the same scale for ease of interpretation.

D. Ground Cover - The existing vegetation on the site should be shown. Such features as tree clusters, grassy areas, and unique or sensitive vegetation should be shown on the map. Unique vegetation may include existing trees above a given diameter. Local requirements regarding tree preservation should be investigated. In addition, existing denuded or exposed soil areas should be indicated.

E. Adjacent Areas - Areas adjacent to the site should be delineated on the topographic map. Such features as streams, roads, lakes, wetlands, and wooded areas, etc., should be shown. These features should receive special attention during the construction project because of the potential for off-site damage.

F. Existing Development - Existing buildings and facilities (if any) on-site or adjacent to the site should be shown on the topographic map.

G. On and Off-Site Utilities - Identify all utility corridor locations, roadways, associated clearing limits and BMPs for all on-site and off-site utility construction.

II-4.4.2 Step 2 - Data Analysis

When all of the data in Step 1 are considered together, a picture of the site potentials and limitations should begin to emerge. Determination should be made to determine those areas which have potential critical erosion hazards. The following are some important points to consider in site analysis:

A. Topography - The primary topographic considerations are slope steepness and slope length. Because of the effect of runoff, the longer and steeper the slope, the greater the erosion potential. When the percent of slope has been determined, areas of similar steepness should be outlined. Slope gradients can be grouped into three general ranges of soil erodibility:

0-7% - Low erosion hazard
7-15% - Moderate erosion hazard
>15% - High erosion hazard

Within these slope gradient ranges, the greater the slope length, the greater the erosion hazard. Therefore, in determining potential critical areas the planner should be aware of excessively long slopes. As a general rule, the erosion hazard will become critical if slope lengths exceed the following values:

0-7% - 300 feet
7-15% - 150 feet
>15% - 75 feet

These distances may be shorter in areas with highly erodible soils.

B. Natural Drainage - Natural drainage patterns which consist of overland flow, swales and depressions, and natural watercourses, should be identified in order to plan around critical areas where water will concentrate. Where it is

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possible, natural drainageways and discharge locations should be used to convey runoff over and off the site to avoid the expense and problems of constructing an artificial drainage system. Man-made ditches and waterways will become part of the erosion problem if they are not properly stabilized. Care should also be taken to be sure that increased runoff from the site will not erode or flood the existing natural drainage system. Possible sites for stormwater retention and detention should also be located at this point.

The site should also be checked for areas of saturated soil and/or areas where ground water may be encountered during construction. Construction in these areas should be avoided where possible.

C. Soils - Such soils properties as flood hazard, natural drainage, depth to bedrock, depth to seasonal water table, permeability, shrink-swell potential, texture, and erodibility should exert a strong influence on land development decisions.

D. Ground Cover - Ground cover is the most important factor in terms of preventing erosion. Any existing vegetation which can be saved will prevent erosion better than any constructed BMP. Trees and other vegetation protect the soil and beautify the site after construction. If the existing vegetation cannot be saved, consider such practices as staging construction, temporary seeding, or temporary mulching. Staging of construction involves stabilizing one part of the site before disturbing another. In this way, the entire site is not disturbed at once and the time without ground cover is minimized. Temporary seeding and mulching involve seeding or mulching areas which would otherwise lie open.

Buffers around water bodies or other sensitive areas should be delineated and the clearing limits flagged.

E. Adjacent Areas - An analysis of adjacent properties should focus on areas downslope from the construction project. Water bodies which will receive direct runoff from the site are a major concern. The potential for sediment pollution and/or downstream channel erosion and deposition should be considered and addressed. The potential for sediment deposition on adjacent properties due to sheet and rill erosion should also be analyzed so that appropriate sediment trapping measures can be planned.

II-4.4.3 Step 3 - Site Plan Development

After analyzing the data and determining the site limitations, the planner can then develop a site plan. Locate the buildings, roads, and parking lots and develop landscaping plans to exploit the strengths and overcome the limitations of the site. The following are some points to consider when making these decisions:

A. Fit the development to the terrain. The development of an area should be tailored to the existing site conditions to avoid unnecessary land disturbance and minimize erosion hazards and costs and other environmental impacts.

B. Confine construction activities to the least critical areas. Any land disturbance in highly erodible areas will necessitate the installation of more costly control measures.

C. Cluster buildings together. This minimizes the amount of disturbed area, concentrates utility lines and connections in one area, and provides more open natural space. The cluster concept not only lessens the erodible area and the amount of impervious surface, it reduces runoff, and generally reduces development costs.

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D. Minimize impervious areas. Keep paved areas such as parking lots and roads to a minimum. This goes hand in hand with cluster developments in eliminating the need for duplicating parking areas, access roads, etc.

E. Utilize the natural drainage system. The natural drainage system and natural drainage locations of a site should be preserved instead of replaced with storm drains or concrete channels. The potential for downstream damages due to increased runoff can thus be minimized.

II-4.4.4 Step 4 - Plan for Erosion and Sediment Control

When the layout of the site has been decided upon, a plan to control erosion and sedimentation from the disturbed areas must be formulated. The Erosion and Sediment Control Requirements listed in Minimum Requirement #1 in Chapter I-2 establish a minimum level of control required for all projects.

The following general procedure is recommended for ESC control planning:

A. Determine limits of clearing and grading. Decide exactly which areas must be disturbed in order to accommodate the proposed construction. Pay special attention to critical areas. Show all limits of clearing for flagging in the field.

B. Divide the site into drainage areas. Determine how runoff will travel over the site. Consider how erosion and sedimentation can be controlled in each small drainage area before looking at the entire site. Remember, it is easier to control erosion than to contend with sediment after it has been carried downstream.

C. Select erosion and sediment control BMPs. Erosion and sediment control BMPs can be divided into three broad categories: cover practices, structural practices, and management measures. Cover practices, such as leaving buffer strips, seeding and mulching are the preferred BMPs and should be used first. Structural practices, such as sediment ponds and inlet protection should be implemented only after cover practices are used as a first line of defense. Management measures are construction management techniques such as staging construction which, if properly utilized, can minimize the need for physical controls and possibly reduce costs.

1. Cover Practices - Keep in mind that the first line of defense is to prevent erosion. This is accomplished by protecting the soil surface from raindrop impact and overland flow of runoff using source control BMPs. The best way to protect the soil surface is to preserve the existing ground cover. Where land disturbance is necessary, temporary seeding or mulching can be used on areas which will be exposed.

   Erosion and sediment control plans must contain provisions for permanent stabilization of disturbed areas. Selection of permanent vegetation should include the following considerations:

   a. establishment requirements
   b. adaptability to site conditions
   c. aesthetics
   d. maintenance requirements

2. Structural Practices - Structural practices are generally more costly and less efficient than are source controls. However, they are usually necessary since not all disturbed areas can be protected with vegetation. They are often used as a second or third line of defense in series with other vegetative or structural practices to capture sediment before it leaves the site.

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It is very important that structural practices be selected, designed, and constructed according to the standards and specifications in Chapter II-5 of this volume. Improper use or inadequate installation can create problems which are greater than the structure was designed to solve.

3. Management Measures - Good construction management is as important as physical practices for erosion and sediment control, and there is generally little or no cost involved. Following are some management considerations which can be employed.

   a. Sequence construction so that no area remains exposed for an unnecessarily long period of time.

   b. Temporary seeding should be done immediately after grading.

   c. When possible, avoid grading activities during November through March since these months have the highest potential for erosive rainfall.

   d. On large projects, stage the construction so that one area can be stabilized before another is disturbed.

   e. Develop and carry out a regular maintenance schedule for erosion and sediment control practices.

   f. Physically mark off limits of land disturbance on the site with tape, signs or other methods, so the workers can see areas to be protected.

   g. Make sure that all workers understand the major provisions of the erosion and sediment control plan.

   h. Responsibility for implementing the erosion and sediment control plan should be designated to one individual (preferably the job superintendent or foreman).

D. Properties and waterways downstream from the development site shall be protected from erosion due to increases in volume, velocity and peak flow rate of stormwater runoff.

2 2 4 1 4

II-4.4.5 Step 5 -Include BMPs for the Control of Pollutants Other than Sediment

A. Review Chapter II-3 in this volume - This chapter provides information on common construction practices which cause pollution other than erosion and sedimentation. These range from nutrient and pesticide control to disposal of solid and/or dangerous wastes.

B. Select appropriate BMPs based on the practices which will be used on-site - Based on the type of work to be done on-site, select the appropriate BMPs and include their use in the narrative plan. Areas where equipment washing may occur or where contaminated soils may be located on the site also should be noted on the site plan.

II-4.4.6 Step 6 - Prepare the Plan

All of the necessary planning work has been done in steps 1 through 5. The final step consists of consolidating the collected information and developing it into a specific erosion and sediment control plan for the project.

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The plan consists of two parts: a narrative and a site plan. The narrative verbally explains the problems and their solutions with all necessary documentation. Justification should be provided for all solutions. The site plan is a series of maps or drawings pictorially explaining information contained in the narrative.

Following is a checklist of items which should be included in a narrative and on a site plan. This checklist can be used by a site planner as a quick reference to determine if all the major items are included in the erosion and sediment control plan.

II-4.4.7 Checklist for Erosion and Sediment Control Plans

Narrative

- ☐ Project description - Briefly describe the nature and purpose of the land disturbing activity, and the amount of grading involved.
- ☐ Existing site conditions - A description of the existing topography, vegetation, and drainage.
- ☐ Adjacent areas - A description of neighboring areas such as streams, lakes, residential areas, roads, etc., which might be affected by the land disturbance. Provide perimeter control of runoff on all necessary property boundaries.
- ☐ Soils - A brief description of the soils on the site giving such information as soil names, mapping unit, erodibility, permeability, depth, texture, and soil structure.
- ☐ Critical areas - A description of areas on the site which have potential serious erosion problems.
- ☐ Erosion and sediment control BMPs - A description of the BMPs which will be used to control erosion and sedimentation on the site. Specify the construction sequence.
- ☐ Permanent stabilization - A brief description, including specifications, of how the site will be stabilized after construction is completed.
- ☐ Stormwater management considerations - Will the development of the site result in increased peak rates of runoff? Will this potentially result in channel degradation downstream? If so, consideration must be given to stormwater control structures on the site (see Minimum Requirement #5 in Chapter I-2).
- ☐ Maintenance - A schedule of regular inspections and repair of erosion and sediment control structures should be set forth.
- ☐ Calculations - Any calculations made for the design of such items as sediment ponds, diversions, waterways, and calculations for runoff and stormwater detention basin design (if applicable). All calculations must bear the signature and stamp of an engineer licensed in the State of Washington.
- ☐ Non-ESC BMPs Required - Indicate which BMPs from Chapter II-3 will be used on-site.

Site Plan

- ☐ Vicinity map - A small map locating the site in relation to the surrounding area.
- ☐ Existing contours - Existing contours of the site should be shown on a map.

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- ☐ Existing vegetation - The existing tree lines, grassy areas, or unique vegetation should be shown on a map.
- ☐ Soils - The boundaries of the different soil types should be shown on a map.
- ☐ Indicate north - The direction of north in relation to the site should be shown.
- ☐ Critical erosion areas - Areas with potentially serious erosion problems should be shown on a map.
- ☐ Existing drainage patterns - The dividing lines and the direction of flow for the different drainage areas should be shown on a map.
- ☐ Final contours - Changes to the existing contours should be shown on a map. Use a bold dashed line showing developed condition drainage divides.
- ☐ Limits of clearing and grading - Areas which are to be cleared and graded should be outlined on a map.
- ☐ Cut and Fill Slopes - Show all cut and fill slopes, indicating top/bottom of slope catch lines.
- ☐ Conveyance -
  - (1) Designate locations for grass-lined swales, interceptor trenches, or ditches.
  - (2) Show all drainage pipes, ditches, or cut-off trenches associated with erosion/sediment control.
  - (3) Provide all temporary pipe inverts or minimum slopes and cover.
  - (4) Show grades, dimensions, location, and direction of flow in all ditches and swales.
  - (5) Provide details of bypassing off-site runoff around clearing limits/disturbed areas and sediment pond/trap.
  - (6) Indicate locations and outlets of any possible dewatering systems.
- ☐ Location of BMPs - The locations of the erosion and sediment control and stormwater management BMPs used on the site should be shown on a map. In particular, locate the construction entrance and detail. Specify length, width, thickness and rock size of the entrance.
- ☐ Sediment Control Facilities -
  - (1) Show all the locations of sediment trap(s)/pond(s) (if required) and all associated pipes and structures.
  - (2) Dimension pond berm widths and all inside and outside pond slopes.
  - (3) Indicate the trap/pond storage required and the depth, length, and width dimensions.
  - (4) Provide typical section views throughout pond and outlet structure.
  - (5) Provide typical details of gravel cone and standpipe, and/or other filtering devices.

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(6) Detail stabilization techniques for outlet/inlet.

(7) Detail control/restrictor device location and details.

(8) Specify mulch and/or recommended cover of berms and slopes.

(9) Provide rock specifications and detail for rock check dam, if used.

(10) Specify spacing for rock check dams as required for actual slopes on-site.

(11) Provide front and side sections of typical rock check dams.

(12) Indicate locations and provide details and specifications for silt fabric fence (include installation detail).

- ☐ Detailed drawings - Any structural practices used that are not referenced to this manual or other local manuals should be explained and illustrated with detailed drawings.

- ☐ Non-ESC BMPs - Indicate any equipment washdown areas, areas of contaminated soils or other BMPs used where there are site-specific requirements.

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CHAPTER II-5

STANDARDS AND SPECIFICATIONS FOR
BEST MANAGEMENT PRACTICES FOR EROSION AND SEDIMENT CONTROL

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CHAPTER II-5

STANDARDS AND SPECIFICATIONS FOR BEST MANAGEMENT PRACTICES FOR EROSION AND SEDIMENT CONTROL

II-5.1 INTRODUCTION

Best Management Practices (BMPs) are defined as physical, structural and/or managerial practices, that when used singly or in combination, prevent or reduce pollution of water and have been approved by Ecology. This chapter contains the standards and specifications for erosion and sediment control BMPs which form the backbone of any Erosion and Sediment Control Plan.

II-5.2 STANDARDS AND SPECIFICATIONS FOR COVER PRACTICES

Specifications and design criteria of BMPs for erosion and sedimentation control can be broadly divided into two categories: cover practices (such as seeding and mulching) and structural practices (such as sediment ponds, filter fences, etc.) which require engineering standards and specifications. Structural control BMPs are dealt with in the next section.

Vegetative cover is the most important form of erosion control possible because it prevents or reduces erosion rather than attempting to trap sediment after soil has already eroded. In addition, it adds to the aesthetic and functional value of a development.

Cover practices can be divided into temporary and permanent measures. Temporary measures are implemented to provide a quick cover to soils that are exposed for longer than 2-7 days, or if an erosion problem already exists on the site during the development phase. They include:

- seeding
- mulching and matting
- clear plastic covering

Permanent measures are implemented both during and on completion of construction activities. They include:

- preserving natural vegetation
- buffer zones
- permanent seeding and planting
- sodding

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II-9.3 TEMPORARY COVER PRACTICES

II-9.3.1 BMP E1.10: Temporary Seeding of Stripped Areas

Code: (TS) Symbol: —TS—

Definition The establishment of a temporary vegetative cover on disturbed areas by seeding with appropriate rapidly growing annual plants.

Purpose

To provide temporary soil stabilization by planting grasses and legumes to areas which would remain bare for more than 7 days where permanent cover is not necessary or appropriate.

Conditions Where Practice Applies

- Permanent structures are to be installed or extensive re-grading of the area will occur prior to the establishment of permanent vegetation.
- Areas which will not be subjected to heavy wear by construction traffic.
- Areas sloping up to 10% for 100 feet or less (where temporary seeding is the only BMP used.

Advantages

- This is a relatively inexpensive form of erosion control but should only be used on sites awaiting permanent planting or grading. Those sites should have permanent measures used (see BMP E1.35, Permanent Seeding and Planting).
- Vegetation will not only prevent erosion from occurring, but will also trap sediment in runoff from other parts of the site.
- Temporary seeding offers fairly rapid protection to exposed areas.

Disadvantages/Problems

- Temporary seeding is only viable when there is a sufficient window in time for plants to grow and establish cover. During the establishment period the bare soil should be protected with mulch (see BMP E1.15) and/or clear plastic covering (see BMP E1.20).
- If sown on subsoil, growth will be poor unless heavily fertilized and limed. Because over-fertilization can cause pollution of stormwater runoff, other practices such as mulching (BMP E1.15) alone may be more appropriate. The potential for over-fertilization is an even worse problem in or near aquatic systems.
- Once seeded, areas cannot be used for heavy traffic.
- May require regular irrigation to flourish. Regular irrigation is not encouraged because of the expense and the potential for erosion in areas that are not regularly inspected. The use of low maintenance native species should be encouraged, and planting should be timed to minimize the need for irrigation.

Planning Considerations

Sheet erosion, caused by the impact of rain on bare soil, is the source of most fine particles in sediment. To reduce this sediment load in runoff, the soil surface

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itself should be protected. The most efficient and economical means of controlling sheet and rill erosion is to establish vegetative cover. Annual plants which sprout rapidly and survive for only one growing season are suitable for establishing temporary vegetative cover. Temporary seeding is effective when combined with construction phasing so bare areas of the site are minimized at all times.

Temporary seeding may prevent costly maintenance operations on other erosion control systems. For example, sediment basin clean-outs will be reduced if the drainage area of the basin is seeded where grading and construction are not taking place. Perimeter dikes will be more effective if not choked with sediment.

Temporary seeding is essential to preserve the integrity of earthen structures used to control sediment, such as dikes, diversions, and the banks and dams of sediment basins.

Proper seedbed preparation and the use of quality seed are important in this practice just as in permanent seeding. Failure to carefully follow sound agronomic recommendations will often result in an inadequate stand of vegetation that provides little or no erosion control.

Design Criteria

- Time of Planting - Planting should preferably be done between April 1 and June 30, and September 1 through October 31. If planting is done in the months of July and August, irrigation may be required. If planting is done between November 1 and March 31, mulching shall be required immediately after planting. If seeding is done during the summer months, irrigation of some sort will probably be necessary.

- Site Preparation - Before seeding, install needed surface runoff control measures such as gradient terraces, interceptor dike/swales, level spreaders, and sediment basins.

- Seedbed Preparation - The seedbed should be firm with a fairly fine surface. Perform all cultural operations across or at right angles to the slope. See BMP E1.45, Topsoiling, and BMP E2.35, Surface Roughening for more information on seedbed preparation. A minimum of 2-4 inches of tilled topsoil is required.

- Fertilization - as per suppliers and/or Soil Conservation Service recommendations. Developments adjacent to water bodies must use non-phosphorus fertilizer.

- Seeding - seeding mixtures will vary depending on the exact location, soil type, slope, etc. Information on mixes may be obtained from local suppliers, the Washington State Department of Transportation, or the Soil Conservation Service. However, approval to use any particular mix must be obtained from the local government. The following seed mix is supplied as guidance.

Name	Proportions By Weight	Percent Purity	Percent Germination
Redtop (Agrostis alba)	10%	92	90
Annual Rye (Lolium multiflorum)	40%	98	90
Chewings Fescue (Festuca rubra commutata)	40%	97	80
White Dutch Clover (Trifolium repens)	10%	96	90

- "Hydro-seeding" applications with approved seed-mulch-fertilizer mixtures may also be used.

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Maintenance

- Seeding should be supplied with adequate moisture. Supply water as needed, especially in abnormally hot or dry weather or on adverse sites. Water application rates should be controlled to prevent runoff.
- Re-seeding - Areas which fail to establish vegetative cover adequate to prevent erosion shall be re-seeded as soon as such areas are identified.
- All temporary erosion and sediment control measures should be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment must be removed or stabilized on site. Disturbed soil areas resulting from removal should be permanently stabilized.

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II-5.3.2 BMP E1.15: Mulching and Matting

Code: (MU) Symbol: —MU—

Definition Application of plant residues or other suitable materials to the soil surface.

Purpose

To provide immediate protection to exposed soils during the period of short construction delays, or over winter months through the application of plant residues, or other suitable materials, to exposed soil areas.

Mulches also enhance plant establishment by conserving moisture and moderating soil temperatures. Mulch helps hold fertilizer, seed, and topsoil in place in the presence of wind, rain, and runoff and maintains moisture near the soil surface.

Conditions Where Practice Applies

- In areas which have been seeded either for temporary or permanent cover, mulching should immediately follow seeding.
- Areas which cannot be seeded because of the season, or are otherwise unfavorable for plant growth.
- Areas which have been seeded as specified in Temporary Seeding (BMP E1.10).
- In an area of greater than 2:1 slope, mulching should immediately follow seeding

Advantages

- Mulching offers instant protection to exposed areas.
- Mulches conserve moisture and reduce the need for irrigation.
- Neither mulching nor matting require removal; seeds can grow through them unlike plastic coverings.

Disadvantages/Problems

- Care must be taken to apply mulch at the specified thickness, and on steep slopes mulch must be supplemented with netting.
- Thick mulches can reduce the soil temperature, delaying seed germination.
- Mulches such as straw, which are often applied to areas after grading must then be removed and either composted or landfilled. Straw is hollow, so it can actually draw water into the ground below it if the straw is at an angle.

Planning Considerations

Mulches are applied to the soil surface to conserve a desirable soil property or to promote plant growth. A surface mulch is one of the most effective means of controlling runoff and erosion on disturbed land (see Figure II-5.1 for a comparison of pollutant loading reductions for various mulches).

Mulches can increase the infiltration rate of the soil, reduce soil moisture loss by evaporation, prevent crusting and sealing of the soil surface, modify soil temperatures, and provide a suitable microclimate for seed germination.

Organic mulch materials, such as straw, wood chips, bark, and wood fiber, have been

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found to be the most effective, although straw is preferred.

A variety of nets and mats have been developed for erosion control in recent years, and these are also used as mulches, particularly in critical areas such as waterways. They may be used to hold other mulches to the soil surface.

The choice of materials for mulching will be based on the type of soil to be protected, site conditions, season, and economics. It is especially important to mulch liberally in mid-summer and prior to winter, and on cut slopes and southern slope exposures. Table II-5.1 gives a comparison of costs based on 1988 figures.

Organic Mulches

Straw - Straw is the mulch most commonly used in conjunction with seeding. Its use is recommended where immediate protection is desired and preferably where the need for protection will be less than 3 months. The straw should come from wheat or oats, and may be spread by hand or machine. If the straw is not clean, weed growth can occur. Straw can be windblown and must be anchored down. Common anchoring methods are:

1. Crimping, disking, rolling or punching into the soil;

2. Covering with netting;

3. Spraying with a chemical or fiber binder (tackifier); and

4. Keeping moist. Natural precipitation can often provide sufficient moisture.(2)

Corn Stalks - These should be shredded into 4 to 6-inch lengths. Stalks decompose slowly and are resistant to windblow.

Wood Chips - Suitable for areas that will not be closely mowed, and around ornamental plantings. Chips decompose slowly and do not require tacking. They must be treated with 12 pounds nitrogen per ton to prevent nutrient deficiency in plants. Chips can be a very inexpensive mulch if they are obtained from trees cleared on the site. However, both wood and bark chips tend to wash down slopes of more than 6 percent and create problems by clogging inlet grates etc. and are therefore not preferred for use in those areas.

Bark Chips, Shredded Bark - By-products of timber processing. Used in landscaped plantings. Bark is also a suitable mulch for areas planted to grasses and not closely mowed; may be applied by hand or mechanically. Bark is not usually toxic to grasses or legumes, and additional nitrogen fertilizer is not required.

Wood Fiber - Used in hydro-seeding operations, applied as part of the slurry. These short cellulose fibers do not require tacking, although a tacking agent or soil binders are sometimes used with wood fiber. The longer the fiber length, the better the wood fiber will work in erosion control. This form of mulch does not provide sufficient protection to erodible soils to be used alone during the severe heat of summer or for late fall seedings. Wood fiber hydro-seed slurries may be used to tack straw mulch. This combination treatment is well suited for steep slopes and critical areas, and severe climate conditions.

There are other organic materials which make excellent mulches but are only available locally or seasonally. Creative use of these materials can reduce costs.

Manure Mulches - Manure mulches should be well-aged and are not recommended for use near waterbodies.

Chemical Mulches and Soil Binders

The use of synthetic, spray-on materials (except tacking agents used with hydro-seeding) is not recommended. A major problem with their use is the creation of impervious surfaces and, possibly, adverse effects on water quality. Research has

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shown that they can cause more erosion when used than does bare exposed soil.

Nets and Mats - Used alone, netting does not retain soil moisture or modify soil temperature. It stabilizes the soil surface while grasses are being established, and is useful in grassed waterways and on slopes. Light netting may also be used to hold other mulches in place. Its relatively high cost makes it most suitable for small sites.

The most critical aspect of installing nets and mats is obtaining firm, continuous contact between the material and the soil. Without such contact, the material is useless and erosion occurs. It is important to use an adequate number of staples and to roll the material after laying it to ensure that the soil is protected.

Table II-5.1 Summary of Estimated Service Lives and Costs
1988 Base - Horner, January, 1990

Technique[a]	Estimated Service Life (months)	Estimated Cost ($/(acre served) (6 months service)
Straw (4 T/ac)	3	3,200
Straw (1.25 T/ac)	3	2,500
Straw (4 T/ac) manure-mulched, fertilized, seeded	6	2,400
Jute mat	6	3,700
Fiberglass	6	3,600
Woven straw blanket	6	4,100
Synthetic fiber blanket	6	3,300
Wood fiber mulch (1.25 T/ac) fertilized, seeded	6	1,300
Wood fiber mulch (1.25 T/ac) with tackifier (50 gal/ac), fertilized, seeded	6	1,900
Wood fiber mulch (1.25 T/ac) with tackifier (90 gal/ac), fertilized, seeded	6	2,100
Wood fiber mulch (1.25 T/ac) with tackifier (120 gal/ac), fertilized, seeded	6	2,300
Chemical agent	6	2,100
Plastic sheeting	6	2,300
Designed sedimentation pond	> 6	< 4,200
Non-designed pond	> 6	< 7,500

[a] The estimated cost of seeding where it was used is based on hydro-seeding (approximately $500/acre).

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Figure II-5.1 Mean TSS and Overall Pollutant Loading Reductions of Slope Treatments Relative to Controls from Horner, January, 1990

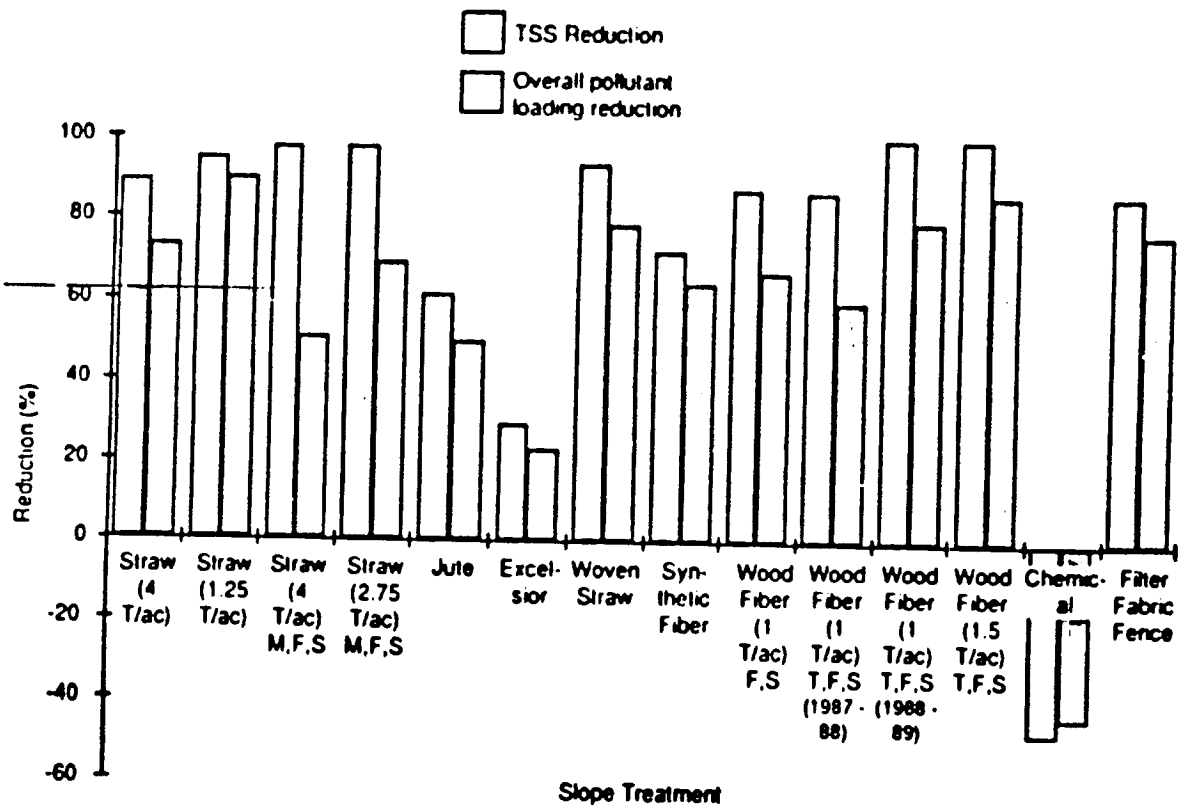

Figure 3. Mean TSS and Overall Pollutant Loading Reductions of Slope Treatments Relative to Controls

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Design Criteria

- Site Preparation - Same as Temporary Seeding.
- Mulch Materials, Application Rates, and Specifications - See Table II-5.2.
- Erosion blankets (nets and mats) may be used on level areas, on slopes up to 50 percent, and in waterways. Where soil is highly erodible, nets shall only be used in connection with an organic mulch such as straw and wood fiber. Jute nets shall be heavy, uniform cloth woven of single jute yarn, which if 36 to 48 inches wide shall weigh an average of 1.2 lbs./linear yard. It must be so applied that it is in complete contact with the soil. If it is not, erosion will occur beneath it. Netting shall be securely anchored to the soil with No. 11 gauge wire staples at least 6 inches long, with an overlap of three inches.
- Excelsior blankets are considered protective mulches and may be used alone on erodible soils and during all times of year.
- See Figure II-5.2 for orientation of netting and matting.

Maintenance

- Mulched areas should be checked periodically, especially following severe storms, when damaged areas of mulch or tie-down material should be repaired.
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

References

Horner, Richard R., Juno Guedry and Michael H. Kortenhof, Improving the Cost Effectiveness of Highway Construction Site Erosion and Pollution Control, Washington State Dept. of Transportation, WA-RD 200.1, January, 1990.

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Table II-5.2 Guide to Mulch Materials, Rates and Uses

Mulch Material	Quality Standards	Application Rates /1000 ft²	/acre	Depth of Application	Remarks[1]
Gravel, slag or crushed stone	Washed, ¼ - 1½" size	9 yds³		3 inches	Excellent mulch for short slopes and around woody plants & ornamentals. Use where subject to foot traffic. Approx. 2000 lbs/yd³
Hay or straw	Air dried, free from unwanted seeds & coarse material	75-100 lbs. or 2-3 bales	1½-2½ tons or 90-120 bales	Minimum of 2 inches	Use where the mulching effect is to be maintained for >3 months. Is subject to wind blowing unless kept moist or tacked down. Most common & widely used mulching material. Can be used in critical erosion areas.
Wood fiber cellulose (partially digested wood fibers)	Dyed green should not contain growth inhibiting factors.	25 - 30 lbs.	1000-1500 lbs.		If used on critical areas, double the normal application rate. Apply w/hydromulcher. No tie-down required. Packaged in 100 lb. bags.

[1]All mulches will provide some degree of (1) erosion control, (2) moisture conservation, (3) weed control, and (4) reduction of soil crusting.

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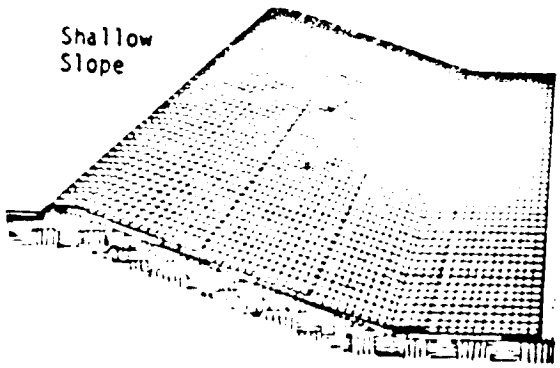
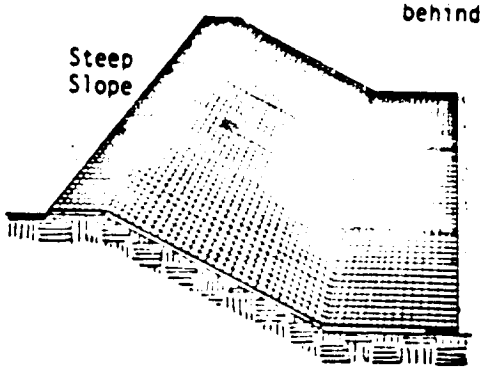
Figure II-5.2 Orientation of Netting and Matting



On shallow slopes, strips of netting may be applied across the slope.
(Slopes up to 1:1)

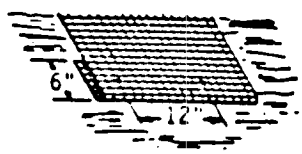
Where there is a berm at the top of the slope, bring the netting over the berm and anchor it behind the berm.

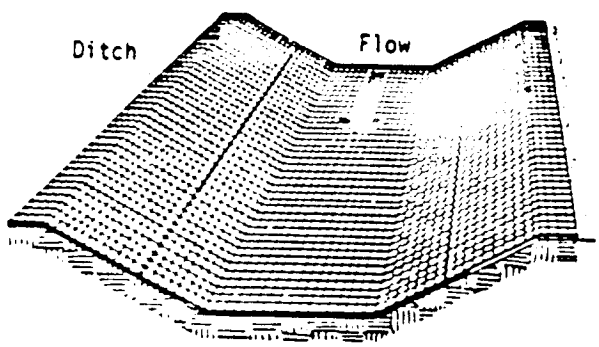




On steep slopes, apply strips of netting parallel to the direction of flow and anchor securely.
(Slopes greater than 1:1)

Bring netting down to a level area before terminating the installation. Turn the end under 6" and staple at 12" intervals.





In ditches, apply netting parallel to the direction of flow. Use check slots every 15 feet. Do not join strips in the center of the ditch.

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II-5.3.3 BMP E1.20: Clear Plastic Covering

Code: (PC) Symbol: —⊖—

Definition The covering with clear plastic sheeting of bare areas which need immediate protection from erosion.

Purpose

To provide immediate temporary erosion protection to slopes and disturbed areas that cannot be covered by mulching, in particular during the specified seeding periods or as otherwise required by the local government. Clear plastic is also used to protect disturbed areas which must be covered during short periods of inactivity to meet November 1-March 31 cover requirements. Because of many disadvantages clear plastic covering is the least preferred covering BMP.

Conditions Where Practice Applies

- Disturbed areas which require immediate erosion protection.
- Areas seeded during the time period from November 1 to March 1. (Note: Plantings at this time require clear plastic covering for germination and protection from heavy rains.

Advantages

- Clear plastic covering is a good method of protecting bare areas which need immediate cover and for winter plantings.
- May be quickly and easily placed.

Disadvantages/Problems

- There can be problems with vandals and maintenance.
- The sheeting will result in rapid, 100% runoff which may cause serious erosion problems and/or flooding at the base of slopes unless the runoff is properly intercepted and safely conveyed by a collecting drain. This is strictly a temporary measure, so permanent stabilization is still required.
- It is relatively expensive.
- The plastic may blow away if it is not adequately overlapped and anchored.
- Ultraviolet and possibly visible light can cause some types of plastic to become brittle and easily torn.
- Plastic must be disposed of at a landfill; it is not easily degradable in the environment.
- If plastic is left on too long during the spring it can severely burn any vegetation that has grown under it during cooler periods.

Design Criteria

- Clear plastic sheeting shall have a minimum thickness of 6 mil and meet the requirements of WSDOT/APWA Section 9-14.5.
- Covering shall be installed and maintained tightly in place by using sandbags or tires on ropes with a maximum 10 foot grid spacing in all directions. All seams shall be taped or weighted down full length and there shall be at least a 1 to 2 foot overlap of all seams. Seams should then be rolled and staked or

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tied.

- Covering shall be installed immediately on areas seeded between November 1 to March 1, and remain until vegetation is firmly established.
- When the covering is used on unseeded slopes, it shall be left in place until the next seeding period.
- Sheeting should be toed in at the top of the slope to prevent surface flow beneath the plastic.
- Sheeting should be removed as soon as is possible once vegetation is well grown to prevent burning the vegetation through the plastic sheeting, which acts as a greenhouse.

Maintenance

- Check regularly for rips and places where the plastic may be dislodged. Contact between the plastic and the ground should always be maintained. Any air bubbles found should be removed immediately or the plastic may rip during the next windy period. Re-anchor or replace the plastic as necessary.

All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

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II-5.4 PERMANENT COVER PRACTICES

II-5.4.1 BMP E1.25: Preserving Natural Vegetation

Code: (VEG) Symbol: —VEG—

Definition Minimizing exposed soils and consequent erosion by clearing only where construction will occur.

Purpose

To reduce erosion by preserving natural vegetation wherever practicable.

Condition Where Practice Applies

- Natural vegetation should be preserved on steep slopes, near perennial and intermittent watercourses or swales, and on building sites in wooded areas.
- As required by local governments.

Advantages

Preserving natural vegetation will:

- Help reduce soil erosion.
- Beautify an area.
- Save money on landscaping costs.
- Provide areas for wildlife.
- Possibly increase the value of the land.
- Provide buffers and screens against noise.
- Moderate temperature changes and provide shade and cover habitat for surface waters and land. This is especially important where detention ponds drain to salmonid-bearing streams. Increases in water temperature tend to lower the dissolved oxygen available for aquatic life.

Disadvantages/Problems

- Saving individual trees can be difficult, and older trees may become a safety hazard. Cottonwood and alder trees are especially prone to blowdown.

Planning Considerations

New development often takes place on tracts of forested land. In fact, building sites are often selected because of the presence of mature trees. However, unless sufficient care is taken and planning done, in the interval between buying the property and completing construction much of this resource is likely to be destroyed. The property owner is ultimately responsible for protecting as many trees as possible, with their understory and groundcover. This responsibility is usually exercised by agents--the planners, designers and contractors. It takes 20 to 30 years for newly planted trees to provide the benefits for which we value trees so highly.

Design Criteria

Natural vegetation can be preserved in natural clumps or as individual trees, shrubs and vines.

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The preservation of individual plants is more difficult because equipment is generally used to remove unwanted vegetation. The points to remember when attempting to save individual plants are:

- Is the plant worth saving? Consider the location, species, size, age, vigor, and the work involved. Local governments may also have ordinances to save natural vegetation and trees.

- Is the tree or shrub a desirable plant? Is it shallow-rooted, do the roots seek water, or are insects and disease a problem? Shallow-rooted plants can cause problems in the establishment of lawns or ornamental plants. Water-seeking roots can block sewer and tile lines. Insects and diseases can make the plant undesirable. This is especially true with aphid on alder and maple.

- Old and/or large plants do not generally adapt to changes in environment as readily as young plants of the same species. Usually, it is best to leave trees which are less than 40 years of age. Some of the hardwoods (Red alder, Cherry, etc.) mature at approximately 50 years of age. After maturity they rapidly decline in vigor. Conifers, after 40 years of age, may become a safety hazard due to the possibility of breakage or blowdown, especially where construction has left only a few scattered trees in an area that was formerly dense woods. While old large trees are sometimes desirable, the problem of later removal should be considered. Again, local governments may have requirements to preserve older, larger specimen trees. It is expensive to cut a large tree and to remove the tree and stump from a developed area. Thinning some branches from trees can provide avenues for wind and hence lessen the "sail" effect.

- Clearly flag or mark areas around trees that are to be saved. It is preferable to keep ground disturbance away from the trees at least as far out as the dripline.

Plants need protection from three kinds of injuries:

- Construction Equipment -- This injury can be above or below the ground level. Damage results from scarring, cutting of roots, and compaction of the soil. Such injuries can be prevented by roping or fencing a buffer zone around plants to be saved prior to construction (Figure II-5.3.).

- Grade Changes -- Changing the natural ground level will alter grades which affect the plant's ability to obtain the necessary air, water, and minerals. Minor fills usually do not cause problems although sensitivity between species does vary. Cedars are more sensitive. Trees can tolerate fill of 6 inches or less. For shrubs and other plants the fill should be less. When there are major changes in grade, it may become necessary to supply air to the roots of plants. This can be done by placing a layer of gravel and a tile system over the roots before the fill is made. A tile system protects a tree from a raised grade.

  The tile system should be laid out on the original grade leading from a dry well around the tree trunk. The system should then be covered with small stones to allow air to circulate over the root area (see Figure II-5.3).

  Lowering the natural ground level can seriously damage trees and shrubs. The highest percentage of the plant roots are in the upper 12 inches of the soil and cuts of only 2-3 inches can cause serious injury. To protect the roots it may be necessary to terrace the immediate area around the plants to be saved. If roots are exposed, construction of retaining walls may be needed to keep the soil in place. Plants can also be preserved by leaving them on an undisturbed, gently sloping mound. To increase the chances for survival, it is best to limit grade changes and other soil disturbances to areas outside the dripline of the plant (Figure II-5.3).

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- Excavations -- Protect trees and other plants when excavating for tile, water, and sewer lines. Where possible, the trenches should be routed around trees and large shrubs. When this is not possible, it is best to tunnel under them. This can be done with hand tools or with power augers.

  If it is not possible to route the trench around plants to be saved, then the following should be observed:

  Cut as few roots as possible. When you have to cut -- cut clean. Paint cut root ends with a wood dressing like asphalt base paint.

  Backfill the trench as soon as possible.

  Tunnel beneath root systems as close to the center of the main trunk to preserve most of the important feeder roots.

Some problems that can be encountered with a few specific trees are:

- Maple, Dogwood, Red alder, Western hemlock, Western red cedar and Douglas fir do not readily adjust to changes in environment and special care should be taken to protect these trees.

- The tipover hazard of Pacific silver fir is high while that of Western hemlock is moderate. The danger of tipover increases where dense stands have been thinned. Other species (unless they are on shallow, wet soils under 20 inches deep) have a low tipover hazard.

- Cottonwoods, maples, and willows have water-seeking roots. These can cause trouble in sewer lines and filter fields. On the other hand, they thrive in high moisture conditions that other trees would succumb to.

- Thinning operations in pure or mixed stands of Grand fir, Pacific silver fir, Noble fir, Sitka spruce, Western red cedar, Western hemlock, Pacific dogwood, and Red alder can cause serious disease problems. Disease can become established through damaged limbs, trunks, roots, and freshly cut stumps. Diseased and weakened trees are also susceptible to insect attack.

Maintenance

- Inspect flagged areas regularly to make sure flagging has not been removed. If tree roots have been exposed or injured, re-cover and/or seal them.

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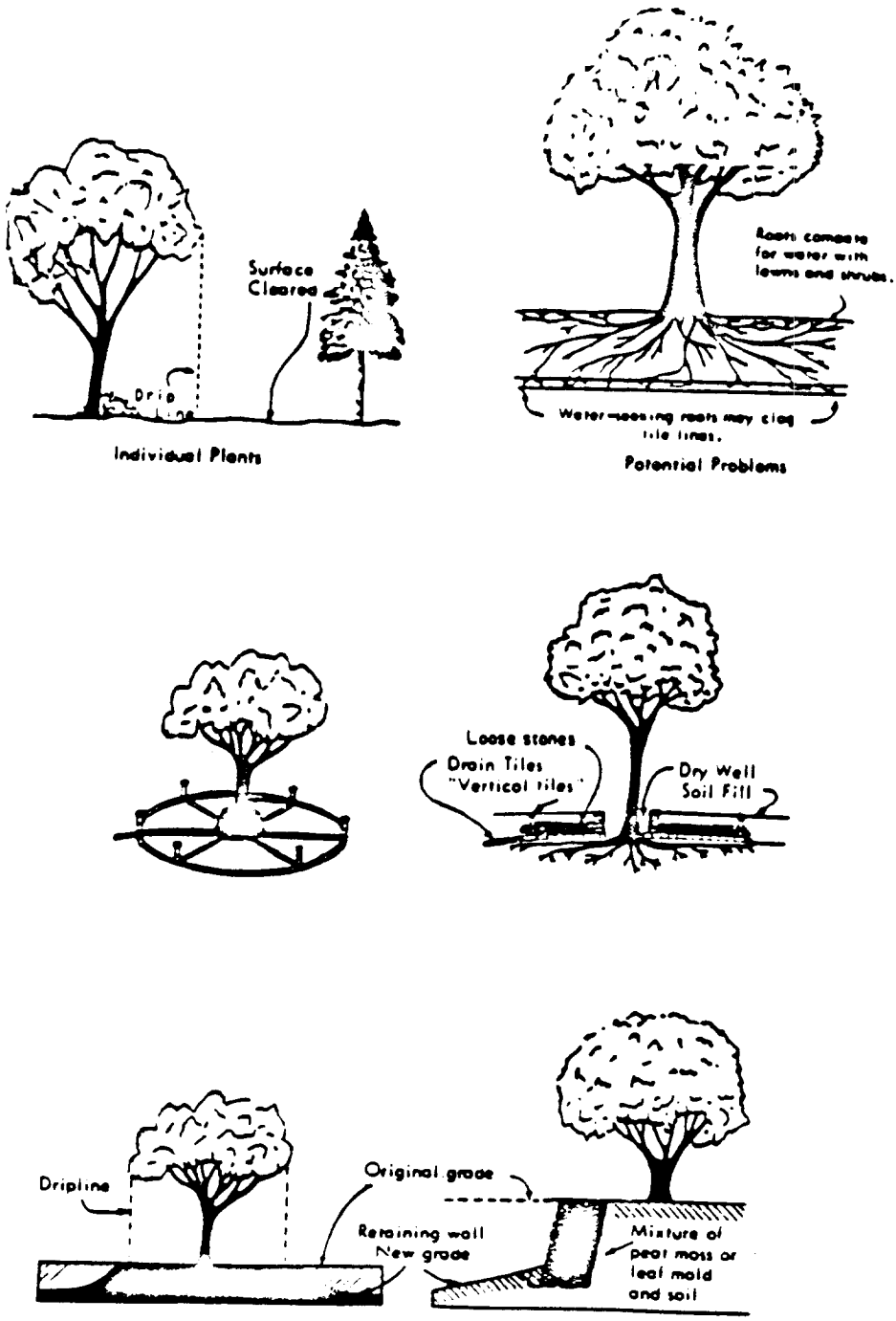
Figure II-5.3 Preserving Natural Vegetation



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II-5.4.2 BMP E1.30: Buffer Zones

Code: (BZ) Symbol:

Definition and Purpose An undisturbed area or strip of natural vegetation or an established suitable planting that will provide a living filter to reduce soil erosion and runoff velocities.

Conditions Where Practice Applies

- Natural buffer zones are used along streams and other bodies of water that need protection from erosion and sedimentation. Vegetative buffer zones can be used to protect natural swales and incorporated into natural landscaping of an area.

Advantages

- Buffer zones provide critical habitat adjacent to streams and wetlands, as well as assist in controlling erosion, especially on unstable steep slopes. Buffers along streams and other water bodies also provide wildlife corridors, a protected area where wildlife can move from one place to another.
- Act as a visibility and noise screen.

Disadvantages/Problems

- Extensive buffers will increase development costs.

Design Criteria

- Preserving natural vegetation or plantings in clumps, blocks, or stripe is generally the easiest and most successful method.
- Leave all unstable steep slopes in natural vegetation.
- Fence or flag clearing limits and keep all equipment and construction debris out of the natural areas.
- Keep all excavations outside the dripline of trees and shrubs.
- Do not push debris or extra soil into the buffer zone area because it will cause damage from burying and smothering.
- Vegetative buffer zones for streams, lakes or other waterways should be a minimum of 100 feet wide on each side with increases subject to other on-site sensitive conditions, existing vegetative conditions and erosion hazard potential (see Table II-5.3 for setback guidelines).

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Table II-5.3 Minimum Recommended Guidelines for Undisturbed Vegetative Setbacks From Wetlands, Streams, Lakes and Other Sensitive/Critical Areas: (Expressed in feet from "ordinary high water mark".) [1]

Wetlands[2]

Category I	High intensity	300 feet
	Low intensity	200 feet
Category II	High intensity	200 feet
	Low intensity	100 feet
Category III	High intensity	100 feet
	Low intensity	50 feet
Category IV	High intensity	50 feet
	Low intensity	25 feet

Streams: To be completed at a later date.

Lakes: To be completed at a later date.

[1] The term "ordinary high water mark" means the line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank; shelving; changes in the character of soil destruction on terrestrial vegetation, or the presence of litter and debris; or other appropriate means that consider the characteristics of the surrounding area.

[2] Source: Model Wetlands Protection Ordinance, Dept. of Ecology, September, 1990. Note: These buffer ranges have been established to reflect the impact of intense land uses on wetland functions and values. The ratings system (Categories I-IV) are based on the Puget Sound Wetlands Rating System as set out in the same document.

[3] Poor, fair, good and excellent conditions refers to percent coverage and growing condition of vegetation.

[4] Erosion hazard ratings are based on the percent slope and hydrologic soil group of bare ground, as defined by the SCS.

NOTE: If ground cover is improved through reseeding reduce recommendations to next level within the same category except for excellent rating which is minimum specification.

Maintenance

- Inspect the area frequently to make sure flagging remains in place and the area remains undisturbed.

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II-5.4.3 BMP E1.35: Permanent Seeding and Planting

Code: (PS) Symbol:

Definition The establishment of perennial vegetative cover on disturbed areas.

Purpose

To establish permanent vegetation (such as grasses, legumes and trees and shrubs) as rapidly as possible to prevent soil erosion by wind or water, and to improve wildlife habitat and site aesthetics.

To provide pollutant filtration (biofiltration) in vegetation-lined channels and to establish constructed wetlands as required (see BMP RW.10 in Chapter III-4 and RV.05 in Chapter III-6).

Conditions Where Practice Applies

- Graded, final graded or cleared areas where permanent vegetative cover is needed to stabilize the soil.
- Areas which will not be brought to final grade for a year or more.
- Vegetation-lined channels.
- Retention or detention ponds as required.

Advantages

- Well established grass and ground covers can give an aesthetically pleasing, finished look to a development.
- Once established, the vegetation will serve to prevent erosion and retard the velocity of runoff.

Disadvantages/Problems

- Vegetation and mulch cannot prevent soil slippage and erosion if soil is not inherently stable.
- Coarse, high grasses that are not mowed can create a fire hazard in some locales. Very short mowed grass, however, provides less stability and sediment filtering capacity.
- Grass planted to the edge of a watercourse may encourage fertilizing and mowing near the water's edge and increase nutrient and pesticide contamination.
- May require regular irrigation to establish and maintain.

Planning Considerations

Vegetation controls erosion by reducing the velocity and the volume of overland flow and protecting the bare soil surface from raindrop impact.

Areas which must be stabilized after the land has been disturbed require vegetative cover. The most common and economical means of establishing this cover is by seeding grasses and legumes.

Advantages of seeding over other means of establishing plants include the small initial establishment cost, the wide variety of grasses and legumes available, low labor requirement, and ease of establishment in difficult areas.

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Consider the microclimate(s) within the development area. Low areas may be frost pockets and require hardier vegetation since cold air tends to sink and flow towards low spots. South-facing slopes may be more difficult to re-vegetate because they tend to be sunnier and drier.

Disadvantages which must be dealt with are the potential for erosion during the establishment stage, a need to reseed areas that fail to establish, limited periods during the year suitable for seeding, and a need for water and appropriate climatic conditions during germination.

There are so many variables in plant growth that an end product cannot be guaranteed. Much can be done in the planning stages to increase the chances for successful seeding. Selection of the right plant materials for the site, good seedbed preparation, timing, and conscientious maintenance are important. Whenever possible, native species of plants should be used for landscaping. These plants are already adapted to the locale and survivability should be higher than with exotic species.

Native species are also less likely to require irrigation, which can be a large maintenance burden and is neither cost-effective nor ecologically sound.

If non-native plant species are used, they should be tolerant of a large range of growing conditions and as low-maintenance as possible.

Design Criteria

- Vegetation cannot be expected to supply an erosion control cover and prevent slippage on a soil that is not stable due to its texture, structure, water movement, or excessive slope.

- Seeding should be done immediately after final shaping, except during the period of November 1 through March 1, when the site should be protected by mulching or plastic covering until the next seeding period.

- Permanent vegetation may be in the form of grass-type growth by seeding or sodding, or it may be trees or shrubs, or a combination of these. Establishing this cover may require the use of supplemental materials, such as mulch or jute netting (see BMP E1.15).

- Site Preparation: Install needed surface runoff control measures such as gradient terraces, berms, dikes, level spreaders, waterways, and sediment basins prior to seeding or planting.

- Seeding Grasses and Legumes: Seedbed Preparation -- If infertile or coarse textured subsoil will be exposed during land shaping, it is best to stockpile topsoil and respread it over the finished slope at a minimum 2 to 6-inch depth and roll it to provide a firm seedbed. If construction fills have left soil exposed with a loose, rough, or irregular surface, smooth with blade and roll. If cuts or construction equipment have left a tightly compacted surface, break with chisel plow or other suitable implement. Perform all cultural operations across or at right angles to the slope (contoured), such as with cat tracks on the final pass. The seedbed should be firm with a fairly fine surface.

- Soil Amendments: Rates will depend on site characteristics and soil, but as a guide, apply lime at the rate of 100 pounds per 1,000 square feet. Apply actual nitrogen at the rate of 1-2 pounds per 1,000 sq. feet, phosphoric acid at the rate of 1.5 pounds per 1,000 sq. feet, and potassium at the rate of 1.5 pounds per 1,000 sq. feet. Work in lime and other nutrients to a depth of a minimum of 4 inches with suitable equipment. Scatter amendments uniformly and work into the soil during seedbed preparation.

- Seeding: Apply an appropriate mixture to the prepared seedbed at a rate of 120 lbs/acre. (Seed mixture may be varied by the local government to take account of local conditions).

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Urban Application:

Name	Portions by Weight	Percent Purity	Germination
Kentucky Bluegrass	30%	85	80
Creeping Red Fescue	40%	98	90
Perennial Rye	30%	95	90

Rural Application:

Kentucky Bluegrass (*Poa pratensis*)	15%	85	80
Tall Fescue (*Festuca arundincea*)	40%	95	90
Perennial Rye (*Lolium perenne*)	30%	95	90
Chewings Fescue	15%	95	90

Cover the seed with topsoil or mulch no deeper than ½ inch. It is better to work topsoil into the upper soil layer rather than spread a layer of it directly onto the top of the native soil.

"Hydro-seeding" applications with approved seed-mulch-fertilizer mixtures may also be used.

Wetlands Seed Mixtures: For newly created wetlands, a wetlands specialist should design plantings to provide the best chance of success. As a guide apply the following mixture at a rate of 60 lbs/acre, and/or additional tubers for cattail, bulrush, slough sedge, as required by the local government. See Chapter III-4, Volume III for more information on constructed wetlands.

Do not under any circumstances use introduced, invasive plants like reed canarygrass (*Phalaris arundinacea*) or purple loosestrife (*Lythrum salicaria*). Using plants such as these will cause many more problems than they will ever solve.

Name	Proportions by Weight	Percent Purity	Germination
Red Top (*Agrostis alba*)	30%	92	80
Birdsfoot Trefoil (*Lotus corniculatus*)	30%	90	80
Creeping Red Fescue	40%	98	90

Tree and Shrub Planting

Besides their erosion and sediment control values, trees and shrubs also provide natural beauty and wildlife benefits. When used for the latter, they are usually more effective when planted in clumps or blocks. These procedures should be followed:

1. Trees and shrubs will do best in topsoil. If no topsoil is available, they can be established in subsoil with proper amendment. If trees and shrubs are to be planted in subsoil, particular attention should be paid to amending the soil with generous amounts of organic matter. Mulches should also be used.

2. Good quality planting stock should be used. Normally one or two-year old deciduous seedlings, and three or four-year old coniferous transplants, when properly produced and handled are adequate. Stock should be kept cool and moist from time of receipt and planted as soon as possible.

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3. Competing vegetation, if significant, should be pulled out of the area where the plant or plants are to be placed.

Maintenance

Inspect seeded areas for failure and make necessary repairs and reseed immediately. Conduct or follow-up survey after one year and replace failed plants where necessary.

- If vegetative cover is inadequate to prevent rill erosion, overseed and fertilize in accordance with soil test results.
- If a stand has less than 40% cover, reevaluate choice of plant materials and quantities of lime and fertilizer. Re-establish the stand following seedbed preparation and seeding recommendations, omitting lime and fertilizer in the absence of soil test results. If the season prevents resowing, mulch or jute netting is an effective temporary cover.

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II-5.4.4 BMP E1.40: Sodding

Code: (SO) Symbol: —S—

Definition Stabilizing fine-graded disturbed areas by establishing permanent grass stands with sod.

Purpose

To establish permanent turf for immediate erosion protection or to stabilize drainageways where concentrated overland flow will occur.

Conditions Where Practice Applies

- Disturbed areas which require immediate vegetative cover.
- Waterways carrying intermittent flow, where immediate stabilization or aesthetics are factors and other locations which are particularly suited to stabilization with sod.

Advantages

- Sod will give immediate protection.
- Sod gives an immediate vegetative cover, which is both effective in checking erosion and is aesthetically pleasing.
- Good sod has a high density of growth which is superior in protection to a recently seeded area.
- Sod can be placed at any time of the year provided that soil moisture is adequate and the ground is not frozen.

Disadvantages/Problems

- Sod is expensive.
- Sod is heavy and handling costs are high.
- Good quality sod, free from weed species, may be difficult to obtain.
- If laid in an unfavorable season, midsummer irrigation may be required. This also applies to very droughty sandy soils.
- Grass species in the sod may not be suitable for site conditions.
- If mowing is required, do not use grass sod on slopes steeper than 3:1 (use minimum maintenance ground covers).
- If not anchored or drained properly, sod will "roll up" in grassed waterways.

Design Criteria

- Shape and smooth the surface to final grade in accordance with the approved grading plan.
- Use of topsoil shall be in accordance with the requirements of Topsoiling (BMP E1.50).
- Add lime to reach a soil pH value of 6.5 (based on soil tests).
- Fertilize according to a soil test or in the absence of a test use available

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nitrogen, phosphorus and potash as prescribed for permanent seeding. Use fertilizers that are not highly soluble.

- Work lime and fertilizer into the soil 1 to 2 inches deep and smooth the surface.
- Lay strips of sod beginning at the lowest area to be sodded and perpendicular to the direction of water flow. Wedge strips securely in place. Square the ends of each strip to provide for a close, tight fit. Stagger joints at least 12 inches. Staple if on steep slopes.
- Roll the sodded area and irrigate.
- When sodding is carried out in alternating strips, or other patterns, seed the areas between the sod immediately after sodding.
- Sod should be free of weeds and be of uniform thickness (Approx. 1 in.) and should have a dense root mat for mechanical strength.

Maintenance

- Inspect sodded areas regularly, especially after large storm events. Re-tack, re-sod, or re-seed as necessary.

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II-5.4.5 BMP E1.45: Topsoiling

Code: (TO) Symbol: —⏚—

While not a permanent cover practice in itself, topsoiling has been included in this section because it is an integral component of preparing permanent cover to those areas where there is an unsuitable soil surface for plant growth. Use of in-situ or imported topsoil is always preferable to planting in subsoil.

Definition Preserving and using topsoil to enhance final site stabilization with vegetation.

Purpose

To provide a suitable growth medium for final site stabilization with vegetation.

Conditions Where Practice Applies

- Preservation or importation of topsoil is determined to be the most effective method of providing a suitable growth medium, and the slopes are less than 2:1.
- Applicable to those areas with highly dense or impermeable soils or areas where planting is to be done in subsoil, where mulch and fertilizer alone would not provide a suitable growth medium.

Advantages

- Topsoil stockpiling ensures that a good growth medium will be available for establishing plant cover on graded areas. It has a high organic matter content and friable consistency, water holding capacity and nutrient content.
- The stockpiles can be used as noise and view baffles during construction.

Disadvantages/Problems

- Stripping, stockpiling, and reapplying topsoil, or importing topsoil may not always be cost-effective. It may also create an erosion problem if improperly secured.
- Unless carefully located, storage banks of topsoil may also obstruct site operations and therefore require double handling.
- Topsoiling can delay seeding or sodding operations, increasing exposure time of denuded areas.
- Most topsoil contains some weed seeds.

Planning Considerations

Topsoil is the surface layer of the soil profile, generally characterized as being darker than the subsoil due to the presence of organic matter. It is the major zone of root development, carrying much of the nutrients available to plants, and supplying a large share of the water used by plants.

Topsoiling is strongly recommended where ornamental plants or high-maintenance turf will be grown. Topsoiling is a required procedure when establishing vegetation on shallow soils, and soils of critically low pH (high acid) levels.

If topsoiling is to be done, the following items should be considered:

1. *Whether an adequate volume of topsoil exists on the site. Topsoil should be spread at a depth of 2-4 inches. More topsoil will be needed if the subsoil is*

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rocky.

2. *Location of the topsoil stockpile so that it meets specifications and does not interfere with work on the site.*

3. *Allow sufficient time in scheduling for topsoil to be spread and bonded prior to seeding, sodding, or planting.*

4. *Care must be taken not to apply to subsoil if the two soils have contrasting textures. Sandy topsoil over clayey subsoil is a particularly poor combination, as water creeps along the junction between the soil layers and causes the topsoil to slough.*

5. *If topsoil and subsoil are not properly bonded, water will not infiltrate the soil profile evenly and it will be difficult to establish vegetation. The best method to prevent a lack of bonding is to actually work the topsoil into the layer below for a depth of at least 6 inches.*

Design Criteria

- Field exploration of the site shall be made to determine if there is surface soil of sufficient quantity and quality to justify stripping. Topsoil shall be friable and loamy (loam, sandy loam, silt loam, sandy clay loam, clay loam). Areas of natural ground water recharge should be avoided.

- Stripping shall be confined to the immediate construction area. A 4 to 6 inch stripping depth is common, but depth may vary depending on the particular soil. All surface runoff control structures shall be in place prior to stripping.

- Stockpiling of topsoil shall occur in the following manner:

  a. Side slopes of the stockpile shall not exceed 2:1.

  b. An interceptor dike with gravel outlet and silt fence shall surround all topsoil stockpiles.

  c. Erosion control seeding or covering with clear plastic or other mulching materials (see BMPs E1.10, E1.20) of stockpiles shall be completed within 7 days of the formation of the stockpile.

- Topsoil shall not be placed while in a frozen or muddy condition, when the subgrade is excessively wet, or when conditions exist that may otherwise be detrimental to proper grading or proposed sodding or seeding.

- Previously established grades on the areas to be topsoiled shall be maintained according to the approved plan.

Maintenance

- Cover piles with clear plastic covering until needed.

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II-5.5 STANDARDS AND SPECIFICATIONS FOR STRUCTURAL AND BIOMECHANICAL PRACTICES

Structural and biomechanical control practices are used to either reduce erosion or retain sediment on the construction site. The BMPs in this section have been divided into two basic groups based on these characteristics. The standards and specifications of each BMP are presented in the same format used for nonstructural practices.

Structural erosion control BMPs include measures for site stabilization (such as stabilized construction entrances), slope protection (such as pipe slope drains) and drainageway protection (such as level spreaders). Sediment control BMPs include filter fences, berms, and sediment traps. Table II-2.2 in Chapter II-2 gives the coding for these and all other BMPs in the volume.

Structural control is more effective when combined with vegetative protection and appropriate grading practices as part of an Erosion and Sediment Control (ESC) Plan (see the supplemental guidelines on preparing an ESC plan). Control measures may be either permanent or temporary depending on whether they will remain in use after development is complete.

Although temporary structures are emphasized in this section, they may be combined with permanent control facilities to provide protection of downstream properties during construction. Temporary ESC facilities provide siltation control, but downstream erosion protection must also be provided. Accordingly, the allowable discharge from development sites shall not exceed 50% of the pre-development peak flow for the 2-year, 24-hour storm.

It is also important not to disturb areas of natural ground water discharge and/or retention. To accomplish this, a permanent detention pond may have to be constructed first with modifications allowing it to temporarily function as a sediment pond. Or, a control structure as specified in Chapter III-4 of the Runoff Control Volume may be required on the outlet of the sediment pond.

The design of structural measures for erosion and sedimentation control is accomplished by carefully predetermining appropriate factors. The design storm, maximum drainage area, slope and other restrictions are noted for each BMP. The design criteria and limitations are important; if they are not observed, the simplest measures will fail and erosion control will not be achieved.

In most ESC designs, especially for sites larger than 5 acres, several small structures will function more effectively than a single large structure. For example, a combination of BMPs, such as filter fences, temporary dikes/swales, and several small sediment traps/ponds (depending on subbasin configuration) may be used as opposed to a single large sediment pond.

Maintenance is also of critical importance for proper operation of structural BMPs and must be considered in their design. Maintenance requirements and frequency vary with each BMP and its performance criteria. At a minimum, the ESC plan shall require monthly maintenance, or following each runoff producing storm (whichever occurs more frequently), for silt removal and proper operation of all ESC facilities. ESC facilities may have to be replaced or relocated depending on their performance under field conditions.

The following factors should be considered when designing structural control measures:

- Use material available on-site whenever possible.
- Keep structures simple and take advantage of permanent facilities unless the permanent structures are for infiltration.
- Install the most important control structures first.

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- Install BMPs correctly; visit the site during and after storms to be sure that all structures are properly located, constructed, and functioning as designed.
- Install control measures in sequences which minimize land disturbance. For example, install interceptor dikes/swales and drainage trenches before seeding to avoid disturbing the seedbed. Avoid disturbing or removing existing vegetation whenever possible.
- Do not block a natural drainageway. Make certain that all necessary permits have been obtained before starting any work in a wetland, stream, or other sensitive area.
- Place control measures out of the way of construction operations.
- Make field modifications where necessary with the approval of the local jurisdiction.
- Provide access for maintenance.

Although design and construction standards and specifications are presented in some detail, this section is not a substitute for training in hydraulic and construction engineering. The materials presented are guidelines to assist in the design of erosion control measures. The standards and specifications provided should not be considered rigid requirements except where statutory requirements are indicated. Where local experience has shown that an alternate design will work better, it may be used as long as it meets the requirements contained found in Chapter I-2 and is approved by the local government. Designers are encouraged to continuously seek out new, more reliable solutions for controlling erosion and sediment.

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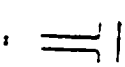
II-5.6 STRUCTURAL EROSION CONTROL BMPs.

II-5.6.1 BMP E2.10: Stabilized Construction Entrance and Tire Wash

Code: (CE) Symbol: 

Definition A temporary stone-stabilized pad located at points of vehicular ingress and egress on a construction site.

Purpose

To reduce the amount of mud, dirt, rocks, etc. transported onto public roads by motor vehicles or runoff by constructing a stabilized pad of rock spalls at entrances to construction sites and washing of tires during egress.

Conditions Where Practice Applies

- Whenever traffic will be leaving a construction site and moving directly onto a public road or other paved areas.

Advantages

- Mud on vehicle tires is significantly reduced which avoids hazards caused by depositing mud on the public roadway.
- Sediment, which is otherwise contained on the construction site, does not enter stormwater runoff elsewhere.

Planning Considerations

Construction entrances provide an area where mud can be removed from vehicle tires before they enter a public road. If the action of the vehicle traveling over the gravel pad is not sufficient to remove the majority of the mud, then the tires must be washed before the vehicle enters a public road. If washing is used, provisions must be made to intercept the wash water and trap the sediment before it is carried off-site. Construction entrances should be used in conjunction with the stabilization of construction roads to reduce the amount of mud picked up by vehicles.

It is important to note that this BMP will only be effective if sediment control is used throughout the rest of the construction site.

Design Criteria

- Material should be quarry spalls (where feasible), 4 inches to 8 inches size.
- The rock pad shall be at least 12 inches thick and 100 feet in length for sites more than 1 acre; and may be reduced to 50 feet in length for sites less than 1 acre.
- A filter fabric fence (see BMP E3.10) should be installed down-gradient from the construction entrance in order to contain any sediment-laden runoff from the entrance.
- Width shall be the full width of the vehicle ingress and egress area (minimum 20 feet).
- Additional rock should be added periodically to maintain proper function of the pad.
- See Figure II-5.4 for details.

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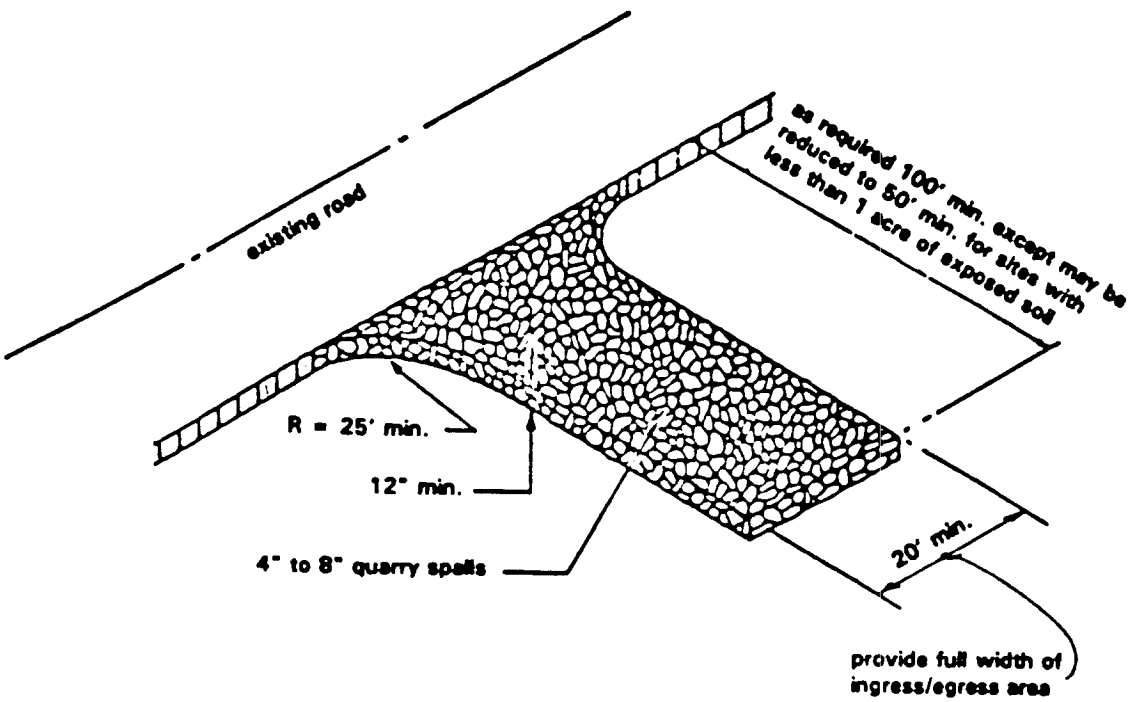
- Tire washing should be done before the vehicle enters a paved street. Washing should be done on an area covered with crushed rock and the wash water should be drained to a sediment retention facility such as a sediment trap or basin.
- The volume of wash water produced by tire washing should be included when calculating the sediment trap or basin size.

Maintenance

- The entrance shall be maintained in a condition which will prevent tracking or flow of mud onto public rights-of-way. This may require periodic top dressing with 2-inch stone, as conditions demand, and repair and/or cleanout of any structures used to trap sediment. All materials spilled, dropped, washed, or tracked from vehicles onto roadways or into storm drains must be removed immediately.
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

Figure II-5.4 Stabilized Construction Entrance



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II-5.6.2 BMP E2.15: Construction Road Stabilization

Code: (RS) Symbol: 

Definition The temporary stabilization with stone of access roads, subdivision roads, parking areas, and other on-site vehicle transportation routes immediately after grading.

Purpose

- To reduce erosion of temporary road beds by construction traffic during wet weather.
- To reduce the erosion and therefore regrading of permanent road beds between the time of initial grading and final stabilization.

Conditions Where Practice Applies

- Wherever rock-base roads or parking areas are constructed, whether permanent or temporary, for use by construction traffic.
- Note: Exceptions may be granted in areas with gravelly soils, such as the Everett series, as approved by the local government.

Advantages

- Efficiently constructed road stabilization not only reduces on-site erosion but can significantly speed on-site work, avoid instances of immobilized machinery and delivery vehicles, and generally improve site efficiency and working conditions during adverse weather.

Disadvantages/Problems

- Measures on temporary roads must be cheap not only to install but also to demolish if they interfere with the eventual surface treatment of the area.
- Application of aggregate to construction roads may need to be made more than once during a construction period.

Planning Considerations

Areas which are graded for construction vehicle transport and parking purposes are especially susceptible to erosion. The exposed soil surface is continually disturbed, leaving no opportunity for vegetative stabilization. Such areas also tend to collect and transport runoff waters along their surfaces. During wet weather, they often become muddy quagmires which generate significant quantities of sediment that may pollute nearby streams or be transported off-site on the wheels of construction vehicles. Dirt roads can become so unstable during wet weather that they are virtually unusable.

Immediate stabilization of such areas with stone may cost money at the outset, but it may actually save money in the long run by increasing the usefulness of the road during wet weather.

Permanent roads and parking areas should be paved as soon as possible after grading. As an alternative, the early application of stone may solve potential erosion and stability problems and eliminate later regrading costs. Some of the stone will also probably remain in place for use as part of the final base course of the road.

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Design Criteria

- A 6-inch course of 2 to 4-inch crushed rock, gravel base, or crushed surfacing base course shall be applied immediately after grading or the completion of utility installation within the right-of-way. A 4-inch course of asphalt treated base (ATB) may be used in lieu of the crushed rock, or as advised by the local government.
- Where feasible, alternative routes should be made for construction traffic; one for use in dry condition, the other for wet conditions which incorporate the measures listed below.
- Temporary roads should follow the contour of the natural terrain to the maximum extent possible. Slope should not exceed 15 percent. Roadways should be carefully graded to drain transversely. Provide drainage swales on each side of the roadway in the case of a crowned section, or one side in the case of a super-elevated section. Drainage swales shall be designed in accordance with the standards given in Chapter III-2.
- Installed inlets shall be protected to prevent sediment-laden water entering the drain sewer system (see Section II-5.8.5 on Storm Drain Inlet Protection BMP E3.30).
- Simple gravel berms without a trench can be used for less traveled roads.
- Undisturbed buffer areas should be maintained at all stream crossings.
- Areas adjacent to culvert crossings and steep slopes should be seeded and mulched and/or covered.
- Dust control should be used when necessary (see BMP E2.20).

Maintenance

- Inspect stabilized areas regularly, especially after large storm events. Add crushed rock if necessary and reestabilize any areas found to be eroding.
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

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II-5.6.3 BMP E2.20: Dust Control

Code: (DC) Symbol: —@—

Definition Reducing surface and air movement of dust during land disturbing, demolition, and construction activities.

Purpose

To prevent surface and air movement of dust from exposed soil surfaces.

Conditions Where Practice Applies

- In areas (including roadways) subject to surface and air movement of dust where on-site and off-site damage is likely to occur if preventive measures are not taken.

Advantages

- A decrease in the amount of dust in the air will decrease the potential for accidents and respiratory problems.

Disadvantages/Problems

- Use of water on-site to control dust emissions, particularly in areas where the soil is already compacted, can cause a runoff problem where there wasn't one.

Planning Considerations

Construction activities inevitably result in the exposure and disturbance of soil. Fugitive dust is emitted both during the activities (i.e., excavation, demolition, vehicle traffic, human activity) and as a result of wind erosion over the exposed earth surfaces. Large quantities of dust are typically generated in "heavy" construction activities, such as road and street construction and subdivision, commercial and industrial development, which involve disturbance of significant areas of soil surface. Research at construction sites has established an average dust emission rate of 1.2 tons/acre/month for active construction. Earthmoving activities comprise the major source of construction dust emissions, but traffic and general disturbance of the soil also generate significant dust emissions.

In planning for dust control, remember that the less soil is exposed at any one time, the less potential there will be for dust generation. Therefore, phasing a project and utilizing temporary stabilization practices upon the completion of grading can significantly reduce dust emissions.

Design Criteria

- Minimize the period of soil exposure through use of temporary ground cover and other temporary stabilization practices (see Seeding and Mulching, BMPs E1.10 and E1.15).
- Sprinkle the site with water until surface is wet. Repeat as needed. To prevent carryout of mud onto street, refer to Stabilized Construction Entrance (BMP E2.10).
- Spray exposed soil areas with approved dust palliative. Oil should not be used for dust suppression. Check with the local government to see which other dust palliatives may be used in the area.

Maintenance

- Respray area as necessary to keep dust to a minimum.

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II-5.7.4 BMP E2.25: Pipe Slope Drains

Code: (PSD) Symbol: 

Definition A pipe extending from the top to the bottom of a cut or fill slope and discharging into a stabilized water course or a sediment trapping device or onto a stabilization area.

Purpose

To carry concentrated runoff down steep slopes without causing gullies, channel erosion, or saturation of slide-prone soils.

Conditions Where Practice Applies

- Where a temporary (or permanent) measure is needed for conveying runoff down a slope without causing erosion.

Advantages

- Slope drains provide a potentially effective method of conveying water safely down steep slopes.

Disadvantages/Problems

- Care must be taken to correctly site drains and not underdesign them. Also, when clearing takes place prior to installing these drains, care must be taken to revegetate the entire easement area, otherwise erosion tends to occur beneath the pipelins, resulting in gully formation.

Planning Considerations

There is often a significant lag between the time a cut or fill slope is completed and the time a permanent drainage system can be installed. During this period, the slope is usually not stabilized and is particularly vulnerable to erosion. This situation also occurs on slope construction which is temporarily delayed before final grade is reached. Temporary slope drains can provide valuable protection of exposed slopes until permanent drainage structures can be installed. When used in conjunction with diversion dikes, temporary slope drains can be used to convey stormwater from the entire drainage area above a slope to the base of the slope without erosion. It is very important that these temporary structures be installed properly since their failure will often result in severe gully erosion. The entrance section must be securely entrenched, all connections must be watertight, and the conduit must be staked securely.

Design Criteria

- The capacity for temporary drains shall be sufficient to handle a 10-year, 24-hour peak flow. This may be computed using the conveyance design method in Chapter III-1 of the Runoff Control Volume. Permanent pipe slope drains shall be sized for the 25-year 24-hour peak flow.
- The maximum drainage area allowed per pipe is ten acres. For larger areas, a rock-lined channel or more than one pipe shall be installed (see Volume III Chapter III-2).
- The entrance shall consist of a standard flared end section for culverts 12 inches and larger with a minimum 6-inch metal toe plate to prevent runoff from undercutting the pipe inlet. The slope of the entrance shall be at least 3 percent (Figure II-5.5).

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- The soil around and under the pipe and entrance section shall be thoroughly compacted to prevent undercutting.
- The flared inlet section shall be securely connected to the slope drain and have watertight connecting bands.
- Slope drain sections shall be securely fastened together and have gasketed watertight fittings, and be securely anchored into the soil.
- Interceptor dikes shall be used to direct runoff into a slope drain. The height of the dike shall be at least 1 foot higher at all points than the top of the inlet pipe.
- The area below the outlet must be stabilized with a riprap apron (see BMP E2.70, Outlet Protection, for the appropriate outlet material).
- If the pipe slope drain is conveying sediment-laden water, direct all flows into the sediment trapping facility.
- Materials specifications for the type of pipe used shall be set by the local government.

Maintenance

- Check inlet and outlet points regularly, especially after heavy storms. The inlet should be free of undercutting, and no water should be going around the point of entry. If there are problems, the headwall should be reinforced with compacted earth or sand bags. The outlet point should be free of erosion and installed with appropriate outlet protection (see BMP E2.70).
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

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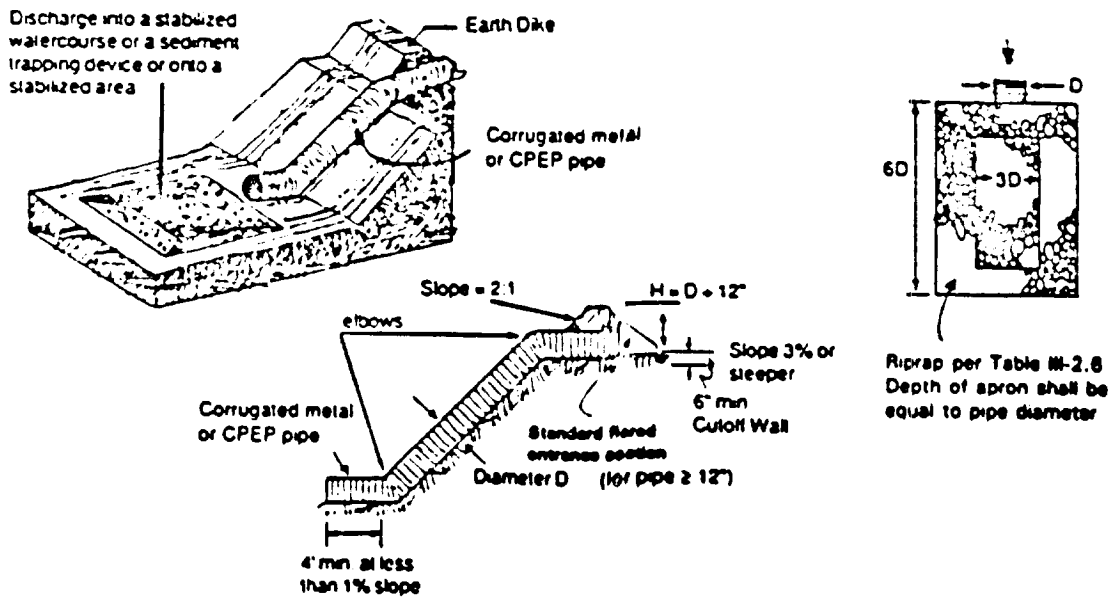
Figure II-5.5 Pipe slope Drains



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II-5.6.5 BMP E2.30: Subsurface Drains

Code: (SD) Symbol: ~ — ~

Definition A perforated conduit such as a pipe, tubing, or tile installed beneath the ground to intercept and convey ground water.

Purpose

To provide a dewatering mechanism for draining excessively wet, sloping soils--usually consisting of an underground perforated pipe that will intercept and convey ground water.

Conditions When Practice Applies

- Wherever excessive water must be removed from the soil. The soil must be deep and permeable enough to allow an effective system to be installed.

Advantages

- Subsurface drains often provide the only practical method of stabilizing excessively wet, sloping soils.

Disadvantages/Problems

- Problems may be encountered with tree roots (see Maintenance).
- Pipes cannot be located under heavy vehicle crossings.

Planning Considerations

Subsurface drainage systems are of two types; relief drains and interceptor drains. Relief drains are used either to lower the water table in order to improve the growth of vegetation, or to remove surface water. They are installed along a slope and drain in the direction of the slope. They can be installed in a gridiron pattern, a herringbone pattern, or a random pattern (Figure II-5.6).

Interceptor drains are used to remove water as it seeps down a slope to prevent the soil from becoming saturated and subject to slippage. They are installed across a slope and drain to the side of the slope. They usually consist of a single pipe or series of single pipes instead of a patterned layout (Figure II-5.7).

Design Criteria

- Subsurface drain shall be sized for the required capacity. The minimum diameter for a subsurface drain shall be four inches.
- The minimum velocity required to prevent silting is 1.4 ft./sec. The line shall be graded to achieve at least this velocity.
- Filter material and fabric shall be used around all drains for proper bedding and filtration of fine materials.
- The outlet of the subsurface drain shall empty into a sediment trap or pond. If free of sediment, it shall empty into a receiving channel, swale, or stable vegetated area adequately protected from erosion and undermining.
- The strength and durability of the pipe shall meet the requirements of the site in accordance with the manufacturer's specifications.

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Construction Specifications

- The trench shall be constructed on a continuous grade with no reverse grades or low spots.
- Soft or yielding soils under the drain shall be stabilized with gravel or other suitable material.
- Deformed, warped, or otherwise unsuitable pipe shall not be used.
- Filter material shall be placed as specified with at least 3 inches of material on all sides of the pipe.
- Backfilling shall be done immediately after placement of the pipe. No sections of pipe shall remain uncovered overnight or during a rainstorm. Backfill material shall be placed in the trench in such a manner that the drain pipe is not displaced or damaged.

Maintenance

- Subsurface drains shall be checked periodically to ensure that they are free-flowing and not clogged with sediment.
- The outlet shall be kept clean and free of debris.
- Surface inlets shall be kept open and free of sediment and other debris.
- Trees located too close to a subsurface drain often clog the system with their roots. If a drain becomes clogged, relocate the drain or remove the trees as a last resort. Drain placement should be planned to minimize this problem.
- Where drains are crossed by heavy vehicles, the line shall be checked to ensure that it is not crushed.
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

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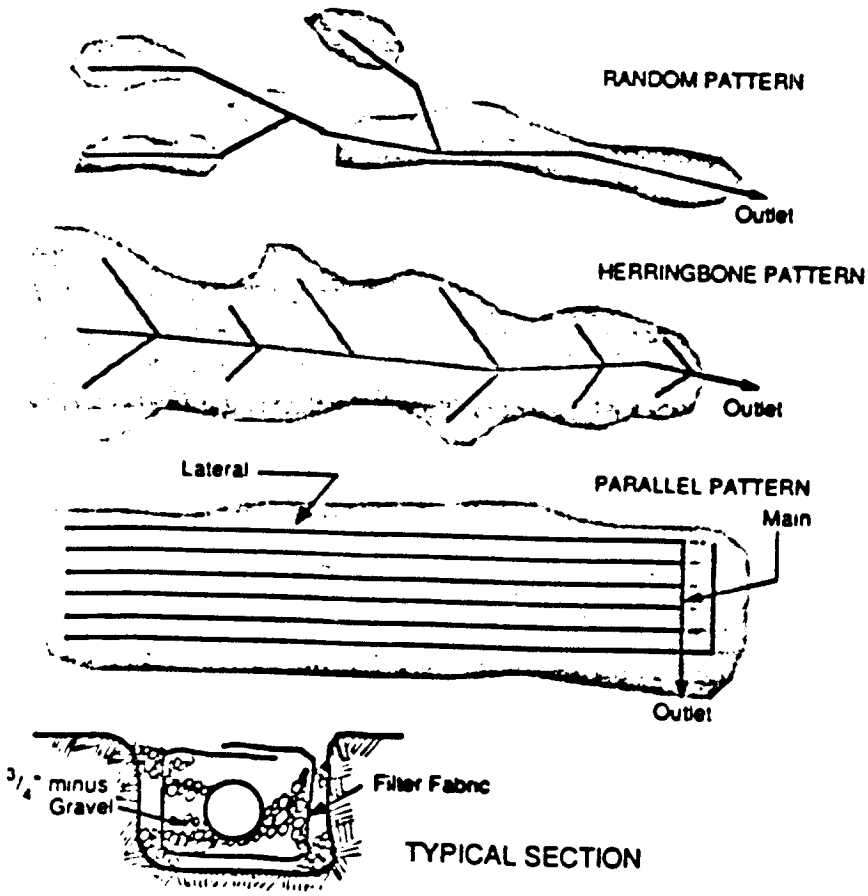
Figure II-5.6 Subsurface Drain Layout



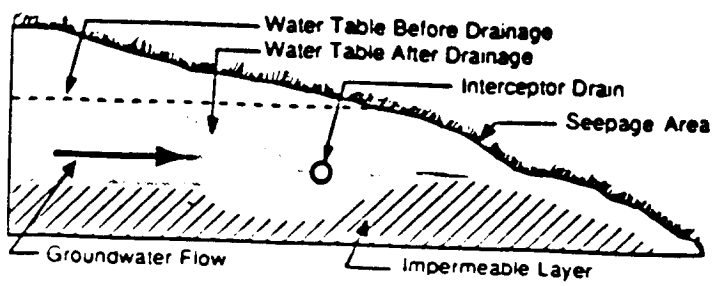


Figure II-5.7 Effect of Subsurface Drain on Water Table

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II-5.7.6 BMP E2.35: Surface Roughening

Code: (SR) Symbol: —≈—

Definition Provision of a rough soil surface with horizontal depressions created by operating a tiller or other suitable equipment on the contour or by leaving slopes in a roughened condition by not fine grading them.

Purpose

To aid in establishment of vegetative cover, reduce runoff velocity, increase infiltration, and provide for sediment trapping.

Conditions Where Practice Applies

- All slopes steeper than 3:1, and greater than 5 vertical feet, require surface roughening; either stair-step grading, grooving, furrowing, or tracking if they are to be stabilized with vegetation.

Advantages

- Surface roughening provides some instant erosion protection on bare soil while vegetative cover is being established.
- It is an inexpensive and simple erosion control measure.

Disadvantages/Problems

- While this is a cheap and simple method of erosion control, it is of limited effectiveness in anything more than a moderate storm.

Planning Considerations

Graded areas with smooth, hard surfaces give a false impression of "finished grading" and a job well done. It is difficult to establish vegetation on such surfaces due to reduced water infiltration and the potential for erosion. Rough slope surfaces with uneven soil and rocks left in place may appear unattractive or unfinished at first, but they encourage water infiltration, speed the establishment of vegetation, and decrease runoff velocity.

Rough, loose soil surfaces give lime, fertilizer, and seed some natural coverage. Niches in the surface provide microclimates which generally provide a cooler and more favorable moisture level than hard flat surfaces; this aids seed germination.

There are different methods for achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, grooving, and tracking. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

1. *Disturbed areas which will not require mowing may be stair-step graded, grooved, or left rough after filling.*
2. *Stair-step grading is particularly appropriate in soils containing large amounts of soft rock. Each "step" catches material which sloughs from above, and provides a level site where vegetation can become established. Stairs should be wide enough to work with standard earth moving equipment.*
3. *Areas which will be mowed (these areas should have slopes less steep than 3:1) may have small furrows left by disking, harrowing, raking, or seed-planting machinery operated on the contour.*

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4. *It is important to avoid excessive compacting of the soil surface when scarifying. Tracking with bulldozer treads is preferable to not roughening at all, but is not as effective as other forms of roughening, as the soil surface is severely compacted and runoff is increased.*

Design Criteria

Graded areas with slopes greater than 3:1 but less than 2:1 should be roughened before seeding (Figures II-5.8a,b). This can be accomplished in a variety of ways, including "track walking," or driving a crawler tractor up and down the slope, leaving a pattern of cleat imprints parallel to slope contours.

Graded areas steeper than 2:1 should be stair-stepped with benches as shown in Figure II-5.9. The stair-stepping will help vegetation become established and also trap soil eroded from the slopes above.

Maintenance

- Areas which are graded in this manner should be seeded as quickly as possible.
- Regular inspections should be made of the area. If rills appear, they should be re-graded and re-seeded immediately.

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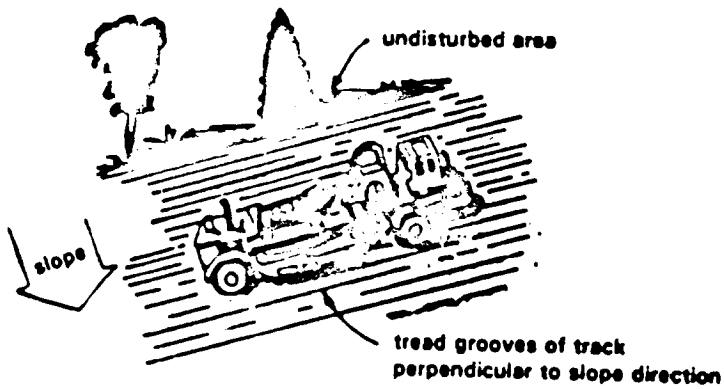
Figure II-5.8(a) Heavy Equipment Can Be Used To Mechanically Scarify Slopes



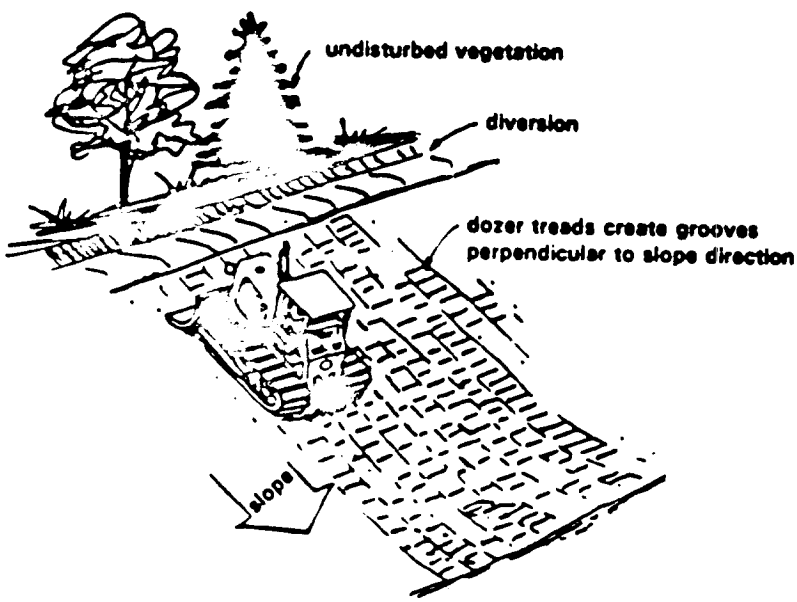


Figure II-5.8(b) Unvegetated Slopes Should be Temporarily Scarified to Minimize Runoff Velocities

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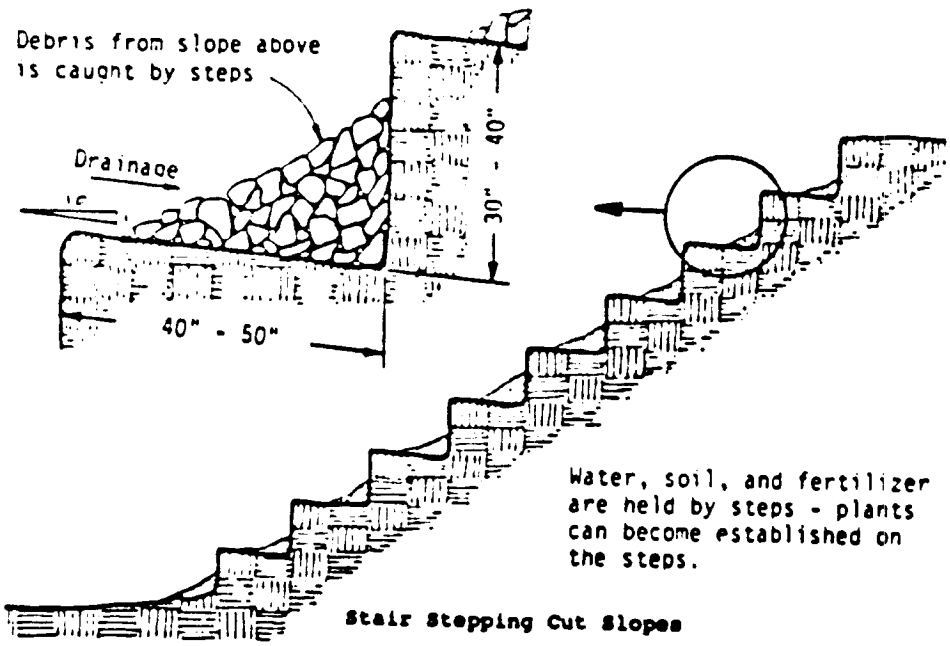
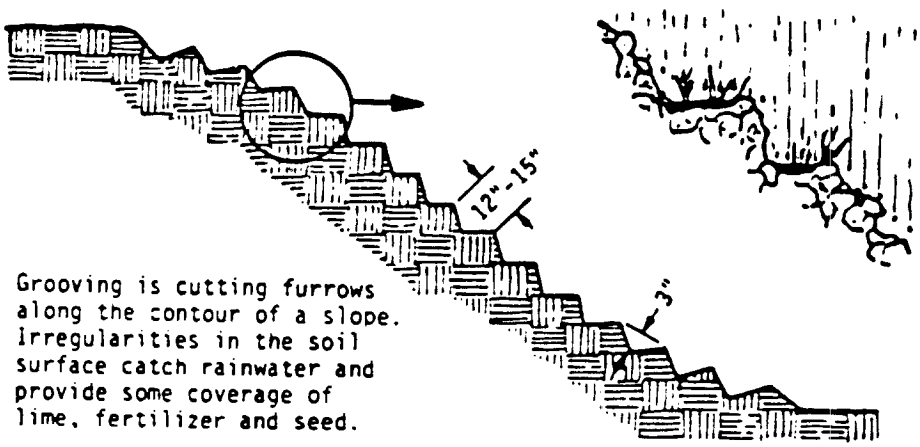
Figure II-5.9 Stair-Stepping Cut Slopes and Grooving Slopes



Stair Stepping Cut Slopes



Grooving Slopes

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II-5.7.7 BMP E2.40: Gradient Terraces

Code: (GT) Symbol: 

Definition An earth embankment or a ridge-and-channel constructed with suitable spacing and with an acceptable grade.

Purpose

To reduce erosion damage by intercepting surface runoff and conducting it to a stable outlet at a nonerosive velocity. (This standard covers the planning and design of gradient terraces and does not apply to diversions.)

Conditions Where Practice Applies

- Gradient terraces normally are limited to denuded land having a water erosion problem. They should not be constructed on deep sands or on soils that are too stony, steep, or shallow to permit practical and economical installation and maintenance. Gradient terraces may be used only where suitable outlets are or will be made available.

Advantages

- Gradient terraces lower the velocity of runoff, increase the distance of overland flow, and reduce effective hydraulic gradient. They also hold moisture and minimize sediment.

Disadvantages/Problems

- May significantly increase cut and fill costs and cause sloughing if excessive water infiltrates soils.

Design Criteria

- The maximum spacing of gradient terraces should be determined by the following method: $V.I. = xs + y$

  Where: V.I. = vertical interval in feet
  x = 0.8 for Washington[1]
  s = land slope in feet per 100 feet
  y = a soil and cover variable with values from 1.0 to 4.0[2]

- The minimum constructed cross-section should meet the design dimensions.
- The top of the constructed ridge should not be lower at any point than the design elevation plus the specified overfill for settlement. The opening at the outlet end of the terrace should have a cross section equal to that specified for the terrace channel.

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[1] U.S. Soil Conservation Service, National Engineering Handbook

[2] Values of "y" are influenced by soil erodibility and cover practices. The lower values are applicable to erosive soils where little to no residue is left on the surface. The higher value is applicable only to erosion-resistant soils where a large amount of residue (1½ tons of straw/acre equivalent) is on the surface.

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- Channel Grade - Channel grades may be either uniform or variable with a maximum grade of 0.6 feet per 100 feet length. For short distances, terrace grades may be increased to improve alignment. The channel velocity should not exceed that which is nonerosive for the soil type with the planned treatment.

- Outlet - All gradient terraces should have adequate outlets. Such an outlet may be a grassed waterway, vegetated area, or tile outlet. In all cases the outlet must convey runoff from the terrace or terrace system to a point where the outflow will not cause damage. Vegetative cover should be used in the outlet channel.

- The design elevation of the water surface of the terrace should not be lower than the design elevation of the water surface in the outlet at their junction, when both are operating at design flow.

Specifications

- Vertical spacing determined by the above methods may be increased as much as 0.5 feet or 10 percent, whichever is greater, to provide better alignment or location, to avoid obstacles, to adjust for equipment size, or to reach a satisfactory outlet (Figure II-5.10).

- The drainage area above the top should not exceed the area that would be drained by a terrace of equal length with normal spacing.

- Capacity - The terrace should have enough capacity to handle the peak runoff expected from a 2-year, 24-hour design storm without overtopping.

- Cross-Section - The terrace cross-section should be proportioned to fit the land slope. The ridge height should include a reasonable settlement factor. The ridge should have a minimum top width of 3 feet at the design height. The minimum cross-sectional area of the terrace channel should be 8 square feet for land slopes of 5 percent or less, 7 square feet for slopes from 5 to 8 percent, and 6 square feet for slopes steeper than 8 percent. The terrace can be constructed wide enough to be maintained using a small cat.

Maintenance

- Maintenance should be performed as needed. Terraces should be inspected regularly; at least once a year, and after large storm events.

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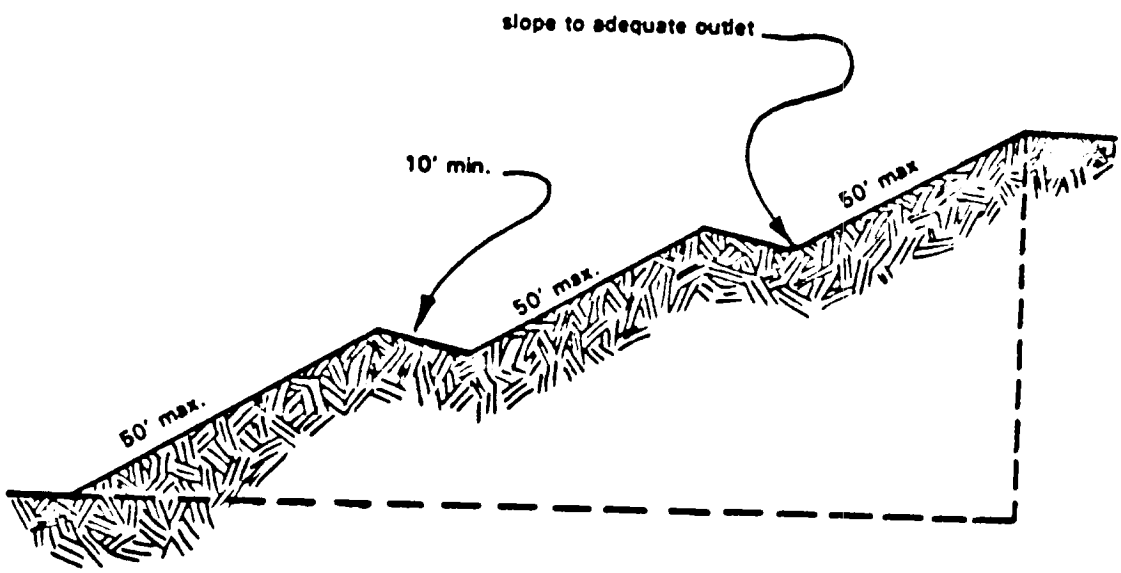
Figure II-5.10 Gradient Terraces



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II-5.7.8 BMP E2.45: Bioengineered Protection of Very Steep Slopes

Code: (SSP) Symbol: ←→

Definition Steep slope protection using a combination of vegetative and mechanical measures.

Purpose

To stabilize steep banks.

Conditions Where Practice Applies

- Slopes of steep grade, cut and fill banks, and unstable soil conditions that cannot be stabilized using ordinary vegetative techniques.

Advantages

- Vegetation reduces sheet erosion on slopes and impedes sediment at the toe of the slope.
- Where soils are unstable and liable to slip due to wet conditions, utilization of soil moisture by vegetation can reduce the problem.
- Shrubs and trees shelter slopes against the impact of rainstorms, and the humus formed by decaying leaves further helps to impede runoff.
- Mechanical measures help to stabilize soil long enough to allow vegetation to become established.

Disadvantages/Problems

- The planting of non-seeded material such as live willow brush is a specialized operation and cannot be highly mechanized or installed by unskilled labor.
- The methods described are effective but require a complete knowledge of soil, hydrology, and other physical data to design measures that will adequately solve the problem.

Design Criteria

The following bioengineering methods can be used after slopes have been protected by diversion of runoff (covered in BMP E2.55) or through the terracing of slopes (BMP E2.40).

- Sod walls or retaining banks are used to stabilize terraces. Sod is piled by tilting it slightly toward the slope and should be backfilled with soil and compacted as they are built up. Sod walls can be as steep as 1:8 but should not be higher than 5 feet (Figure II-5.11a).
- Timber frame stabilization is effective on gradients up to 1:1 and involves the following steps in construction: 1) Lay soil retarding frames of 2 x 4 in. vertical members and 1 x 4 in. horizontal members on slopes. Frames on slopes over 15 feet in length need to be anchored to slope to prevent buckling. 2) Attach 14 gauge galvanized tire wires for anchoring wire mesh. 3) Fill frames with moist topsoil and compact the soil. 4) Spread straw 6 inches deep over slope. 5) Cover straw with 14 gauge 4-inch mesh galvanized reinforced wire. 6) Secure wire mesh at least 6 feet back of top slope. 7) Plant ground cover plants through straw into topsoil (Figure II-5.11b).
- Woven willow whips (Figure II-5.11c) may be used to form live barriers for immediate erosion control. Construction: 1) 3 foot poles are spaced at 5 foot

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distances and driven into the slope to a depth of 2 feet. 2) 2 foot willow sticks are inserted between poles at one foot distances. 3) Live willow branches of 5 foot length are sunk to a depth of 1 inch and interwoven with poles and stocks. 4) Spaces between the woven 'fences' are filled with top-soil. Fences are generally arranged parallel to the slope or in a grid pattern diagonal to the direction of the slope.

- Berm Planting. 1) Excavate ditches from 3 to 5 feet apart along the slope and shape a berm on the downslope side. Construct ditches with 5 percent longitudinal slope. 2) Plant rooted cuttings on 3 foot centers and mulch. Suitable trees are willow, alder, birch, pine, and selected shrubs. In extremely dry situations, rooted cuttings can be planted in biodegradable plastic bags that are watered at the time of planting (Figure II-5.11d).

- Brush Layers. 1) Prepare 3 foot "niches" as shown. 2) Lay unrooted 5 foot live branches of willow or poplar at close spacing. 3) Starting at foot of slope, backfill lower ditch with excavated material from ditch above it. Operation should be carried out during dormant season (Figure II-5.11e).

Maintenance

- Regardless of the stabilization method used, inspections should be made on a regular basis to make sure the system is functioning correctly.

- Note: There are a number of manufacturers who provide prefabricated bioengineered devices for the protection of steep slopes.

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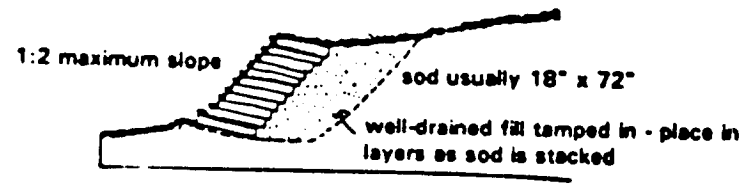

Figure II-5.11(a) Sod Retaining Bank

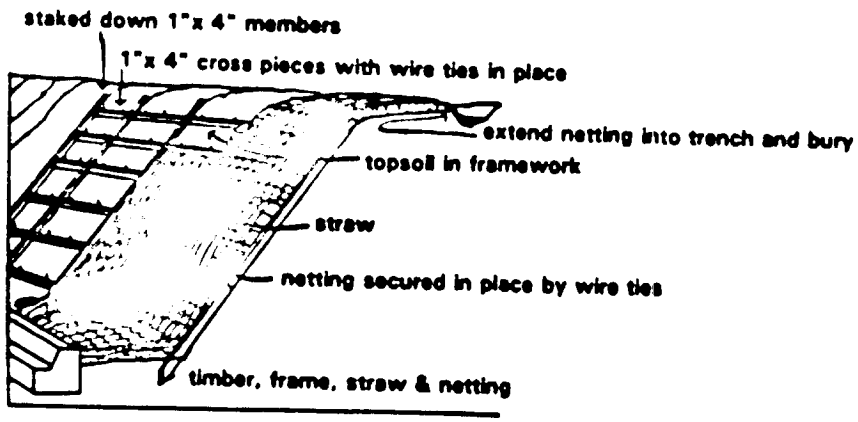

Figure II-5.11(b) Timber Frame Stabilization

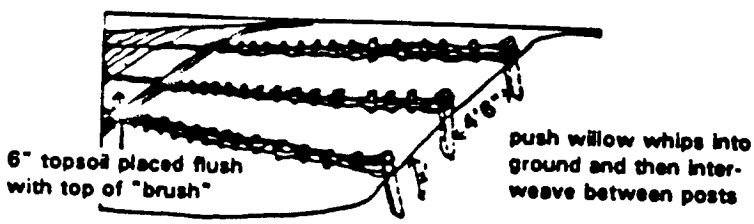

Figure II-5.11(c) Woven Willow Whips

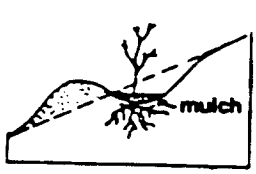

Figure II-5.11(d)
Berm Planting

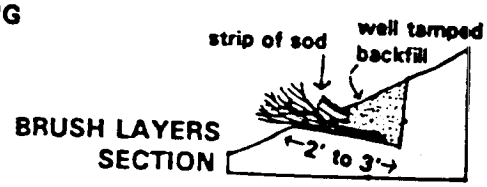

Figure II-5.11(e)
Brush Layers

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II-5.7.9 BMP E2.50: Level Spreader

Code: (LS) Symbol: [redacted]

Definition A temporary outlet for dikes and diversions consisting of an excavated depression constructed at zero grade across a slope.

Purpose

To convert concentrated runoff to sheet flow and release it onto areas stabilized by existing vegetation.

Condition Where Practice Applies

- To be constructed on undisturbed areas that are stabilized by existing vegetation and where concentrated flows are anticipated to occur at 0 percent grade.

Advantages

- Level spreaders disperse the energy of concentrated flows, reducing erosion potential and encouraging sedimentation.

Disadvantages/Problems

- If the level spreader has any low points, flow tends to concentrate there. This concentrated flow can create channels and cause erosion. If the spreader serves as an entrance to a water quality treatment system, short-circuiting of the forebay may happen and the system will be less effective in removing sediment and particulate pollutants.

Planning Considerations

Interceptor dikes and swales (BMP E2.55) call for a stable outlet for concentrated stormwater flows. The level spreader can be used for this purpose provided the runoff is relatively free of sediment. If properly constructed, the level spreader will significantly reduce the velocity of concentrated stormwater and spread it uniformly over a stable undisturbed area.

Particular care must be taken during construction to ensure that the lower lip of the structure is level. If there are any depressions in the lip, flow will tend to concentrate at these points and erosion will occur, resulting in failure of the outlet. This problem may be avoided by using a grade board or a gravel lip over which the runoff must flow when exiting the spreader. Regular maintenance is essential for this practice.

Design Criteria

- The grade of the channel for the last 20 feet of the dike or interceptor entering the level spreader shall be less than or equal to 1 percent. The grade of the level spreader shall be 0 percent to ensure uniform spreading of storm runoff (Figure II-5.12).
- A 6-inch high gravel berm placed across the level lip shall consist of washed crushed rock, 2 to 4 inch or 3/4 inch to 1½ inch size.
- The spreader length will be determined by estimating the flow expected from the 25-year, 24-hour design (Q_{25}), and selecting the appropriate length from the following table:

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Q, in CFS	Min. Length, in Feet
0 - 0.1	15
0.1 - 0.2	20
0.2 - 0.3	30
0.3 - 0.4	40

- The width of the spreader should be at least 6 feet.
- The depth of the spreader as measured from the lip should be at least 6 inches and it should be uniform across the entire length.
- The slope of the undisturbed outlet should not exceed 6½ percent.

Maintenance

- The spreader should be inspected after every runoff event to ensure that it is functioning correctly. The contractor should avoid the placement of any material on or prevent construction traffic across the structure. If the spreader is damaged by construction traffic, it shall be immediately repaired.

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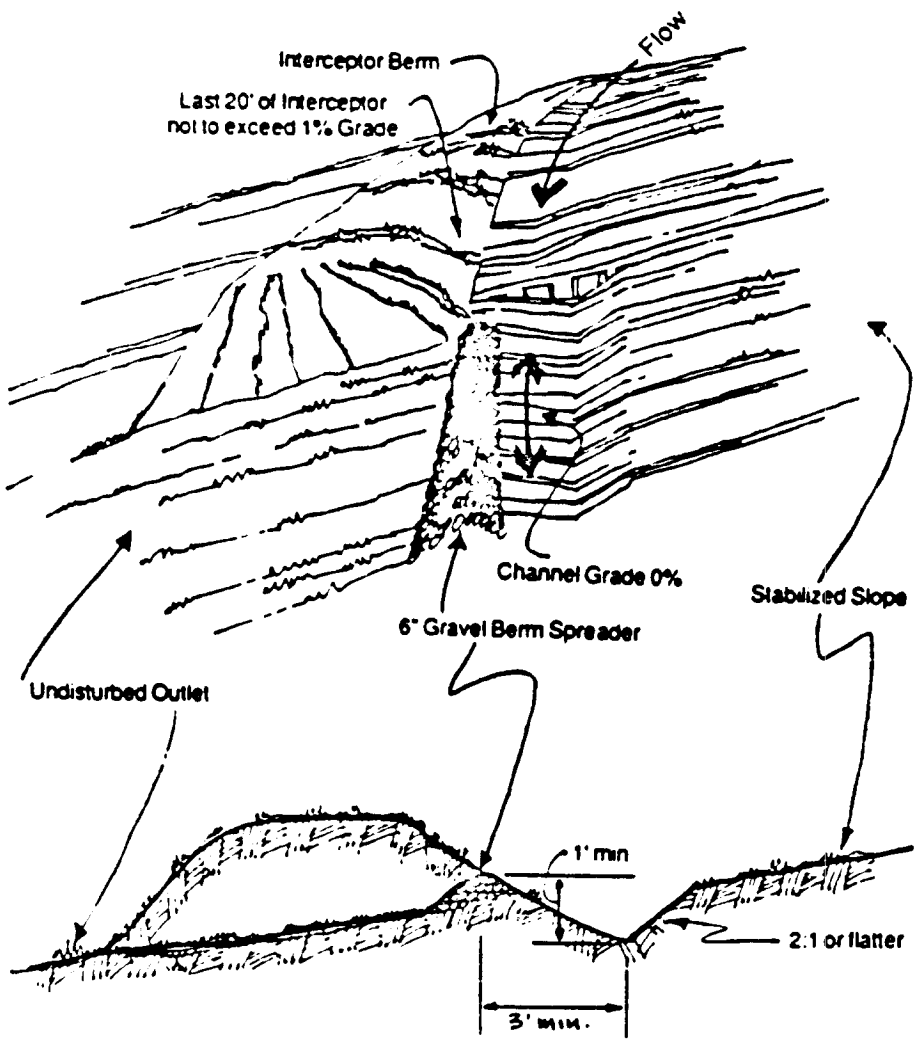
Figure II-5.12 Level Spreader



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II-5.7.10 BMP E2.55: Interceptor Dike and Swale

Code: (IDS) Symbol: 

Definition A ridge of compacted soil or a swale with vegetative lining located at the top or base of a sloping disturbed area.

Purpose

To intercept storm runoff from drainage areas above unprotected slopes and direct it to a stabilized outlet.

Conditions Where Practice Applies

- Where the volume and velocity of runoff from exposed or disturbed slopes must be reduced. When an interceptor dike/swale is placed above a disturbed slope, it reduces the volume of water reaching the disturbed area by intercepting runoff from above (Figures II-5.13a,b). When it is placed horizontally across a disturbed slope, it reduces the velocity of runoff flowing down the slope by reducing the distance that the runoff can flow directly downhill.

Advantages

- This BMP provides a practical, inexpensive method to divert runoff from erosive situations.

Disadvantages/Problems

- None

Planning Considerations

A temporary diversion dike or swale is intended to divert overland sheet flow to a stabilized outlet or a sediment trapping facility during establishment of permanent stabilization on a sloping disturbed area. When used at the top of a slope, the structure protects exposed slopes by keeping upland runoff away. When used at the base of a slope, the structure protects adjacent and downstream areas by diverting sediment-laden runoff to a sediment trapping facility.

If the dike or swale is going to remain in place for longer than 15 days, it shall be stabilized with temporary or permanent vegetation. The slope behind the dike or swale is also an important consideration. The dike or swale must have a positive grade to assure drainage, but if the slope is too great, precautions must be taken to prevent erosion due to high velocity of flow.

This practice is considered an economical one because it uses material available on the site and can usually be constructed with equipment needed for site grading. The useful life of the practice can be extended by stabilizing the dike or swale with vegetation.

Design Criteria

- Interceptor dikes shall meet the following criteria:

Top Width	2 feet minimum.
Height	18 inches minimum. Measured from upslope toe and at a compaction of 90 percent ASTM D698 standard proctor.
Side Slopes	2:1 or flatter.

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Grade	Topography dependent, except that dike shall be limited to grades between 0.5 and 1.0 percent.

Horizontal Spacing of Interceptor Dikes

Slopes	<5%	=	300 feet
Slopes	5-10%	=	200 feet
Slopes	10-40%	=	100 feet

Stabilization

Slopes	=	<5%	Seed and mulch applied within 5 days of dike construction (see BMP E1.10).
Slopes	=	5-40%	Dependent on runoff velocities and dike materials. Stabilization should be done immediately using either sod or riprap to avoid erosion.

Outlet

The upslope side of the dike shall provide positive drainage to the dike outlet. No erosion shall occur at the outlet. Provide energy dissipation measures as necessary. Sediment-laden runoff must be released through a sediment trapping facility.

Other

Minimize construction traffic over temporary dikes.

- Interceptor swales shall meet the following criteria:

Bottom Width	2 feet minimum; the bottom shall be level.
Depth	1 foot minimum.
Side Slope	2:1 or flatter.
Grade	Maximum 5 percent, with positive drainage to a suitable outlet (such as a sediment trap).
Stabilization	Seed as per BMP E1.10 Temporary Seeding, or E2.75 Riprap 12 inches thick pressed into the bank and extending at least 8 inches vertical from the bottom.

Swale Spacing

Slope of disturbed area:

<5%	=	300 feet
5-10%	=	200 feet
10-40%	=	100 feet

Outlet: Level Spreader or Riprap to stabilized outlet/sedimentation pond.

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Maintenance

- The measure should be inspected after every major storm and repairs made as necessary. Damage caused by construction traffic or other activity must be repaired before the end of each working day.
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

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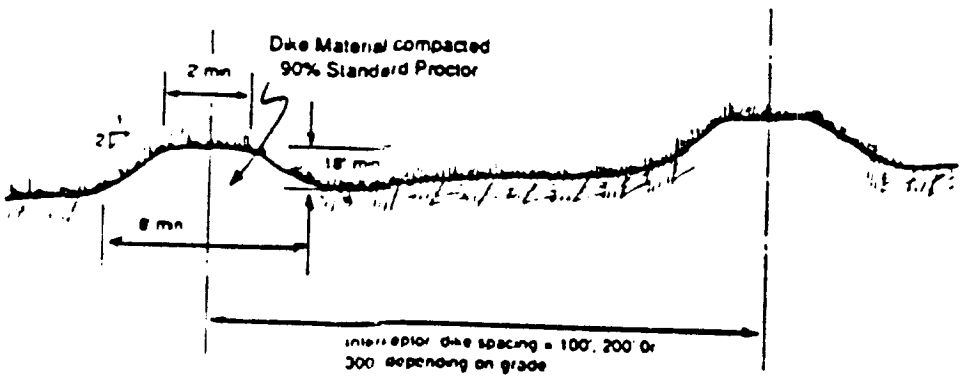
Figure II-5.13(a) Temporary Interceptor Dikes



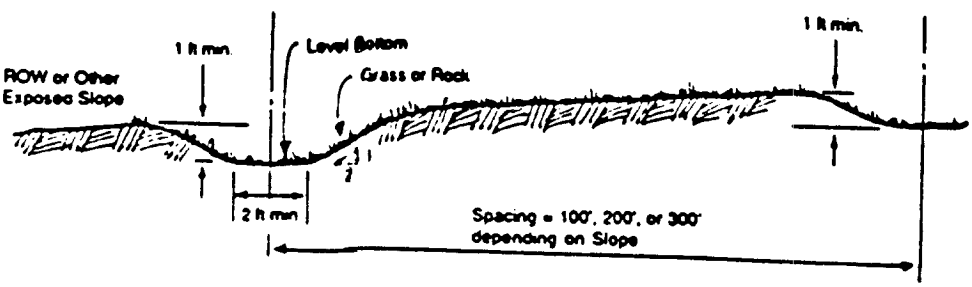


Figure II-5.13(b) Interceptor Swale

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II-5.7.11 BMP E2.60: Check Dams

Code: (CD) Symbol: -)—)-

Definition Small dams constructed across a swale or drainage ditch.

Purpose

To reduce the velocity of concentrated flows, reducing erosion of the swale or ditch, and to slow water velocity to allow retention of sediments.

Conditions Where Practice Applies

- Where temporary channels or permanent channels are not yet vegetated, channel lining is infeasible and, therefore, velocity checks are required.
- In small open channels which drain 10 acres or less. No check dams may be placed in streams (unless approved by the State Departments of Fisheries or Wildlife as appropriate). Other permits may also be necessary.
- Check dams in association with sumps work more effectively at slowing flow and retaining sediment.

Advantages

- Check dams not only prevent gully erosion from occurring before vegetation is established, but also cause a high proportion of the sediment load in runoff to settle out.
- In some cases, if carefully located and designed, these check dams can remain as permanent installations with very minor regrading, etc. They may be left as either spillways, in which case accumulated sediment would be graded and seeded, or as check dams to precipitate further sediment coming off that site.

Disadvantages/Problems

- Because of their temporary nature, many of these measures are unsightly, and they should be removed or converted to permanent check dams before dwelling units are rented or sold.
- Removal may be a significant cost depending on the type of check dam installed.
- Temporary check dams are only suitable for a limited drainage area.
- Clogging by leaves in the fall may be a problem.

Planning Considerations

Check dams can be constructed of either stone, logs, or pea gravel filled sandbags. Log check dams may be more economical from the standpoint of material costs, since logs can often be salvaged from clearing operations. However, log check dams require more time and hand labor to install. Stone for check dams, on the other hand, must generally be purchased. However, this cost is offset somewhat by the ease of installation.

If stone check dams are used in grass-lined channels which will be mowed, care should be taken to remove all the stone from the channel when the dam is removed. This should include any stone which has washed downstream.

Since log check dams are embedded in the soil, their removal will result in more disturbance of the soil than will removal of stone check dams. Consequently, extra care should be taken to stabilize the area when log dams are used in permanent

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ditches or swales.

Design Criteria

- Check dams can be constructed of either rock, pea-gravel filled bags or logs (Figures II-5.14a,b). Provide a deep sump immediately upstream (see Figure II-5.14c).
- The maximum spacing between the dams shall be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam (Figure II-5.14c).
- Rock check dams shall be constructed of appropriately sized rock. The rock must be placed by hand or mechanical placement (no dumping of rock to form dam) to achieve complete coverage of the ditch or swale and to ensure that the center of the dam is lower than the edges. The rock used must be large enough to stay in place given the expected design flow through the channel.
- Log check dams shall be constructed of 4 to 6-inch diameter logs. The logs shall be embedded into the soil at least 18 inches (Figure II-5.14a).
- In the case of grass-lined ditches and swales, check dams shall be removed when the grass has matured sufficiently to protect the ditch or swale unless the slope of the swale is greater than 4 percent. The area beneath the check dams shall be seeded and mulched immediately after dam removal.

Maintenance

- Check dams shall be monitored for performance and sediment accumulation during and after each runoff producing rainfall. Sediment shall be removed when it reaches one half the sump depth.
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

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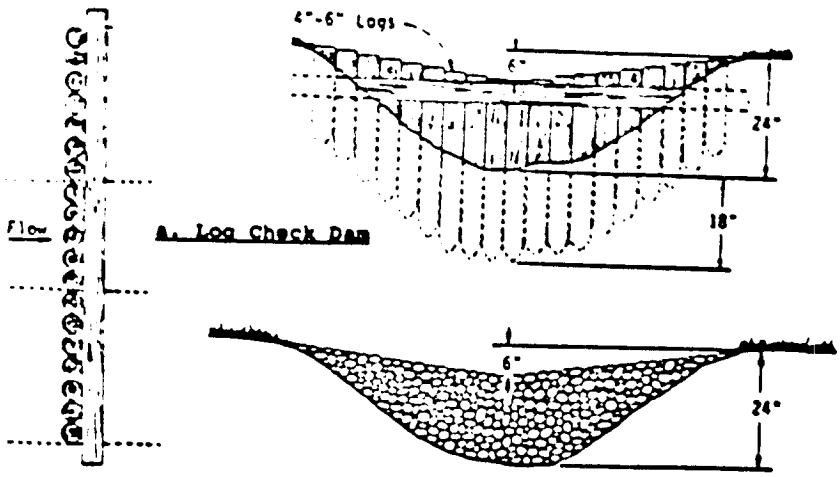
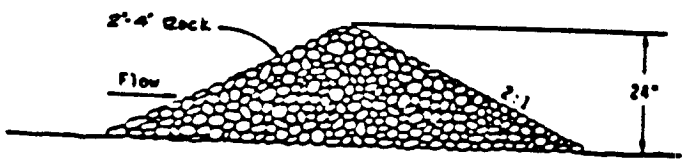
Figure II-5.14 Check Dams



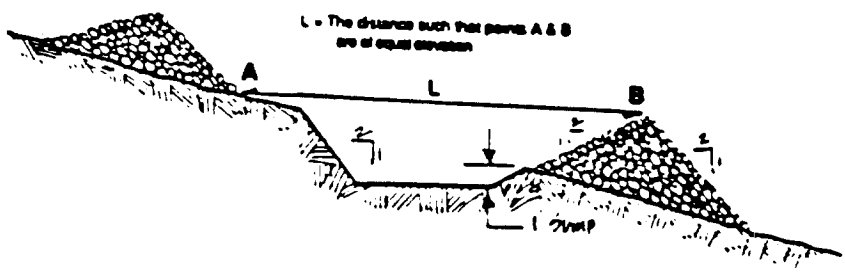
a. Log Check Dam

NO SCALE



b. Rock Check Dam

NO SCALE



c. Spacing Between Check Dams

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II-5.7.12 BMP E2.70: Outlet Protection

Code: (OP) Symbol: [redacted]

Definition Structurally lined aprons or other acceptable energy dissipating devices placed at the outlets or pipes or paved channel sections.

Purpose

To prevent scour at stormwater outlets, and to minimize the potential for downstream erosion by reducing the velocity of concentrated stormwater flows.

Condition Where Practice Applies

- Applicable to the outlets of all pipes, interceptor swale outlets, and channel sections where the velocity of flow at the design capacity of the outlet will exceed the permissible velocity of the receiving channel or area.

Advantages

- Plunge pools which can develop without outlet protection may severely weaken the embankment and thus threaten its stability.
- Protection can prevent scouring at a culvert mouth and thus prevent gully erosion which may gradually extend upstream.

Disadvantages/Problems

- Some types of structures may be unsightly.
- Sediment removal may be difficult.

Planning Considerations

An outfall is defined as a concentrated discharge point which directs collected surface water flows into an open drainage feature, natural or manmade. These drainage features include ditches, channels, swales, closed depressions, wetlands, streams, rivers, ponds, lakes, or other open bodies of water. In nearly every case, the outfall will consist of a pipe discharging flows from a storm pipe system, a culvert, or a detention facility.

Design Criteria

See Sections III-2.3.4 and 2.3.5 in the Runoff Control Volume.

Maintenance

All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with an approved manual. Rock may need to be added if sediment builds up in the pore spaces of the outlet pad.

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II-5.7.13 BMP E2.75: Riprap

Code: (RR) Symbol: 

Definition A permanent, erosion-resistant ground cover of large, loose, angular stone.

Purpose

To slow the velocity of concentrated runoff or to stabilize slopes with seepage problems and/or non-cohesive soils by placement of large, loose, angular stone.

Conditions Where Practice Applies

- Soil-water interfaces, where the soil conditions, water turbulence, water velocity, and expected vegetative cover, are such that the soil may erode under the design flow conditions.

Advantages

- Riprap offers an easy-to-use method for decreasing water velocity and protecting slopes from erosion. It is simple to install and maintain.
- Riprap provides some water quality benefits by increasing roughness and decreasing the velocity of the flow, inducing settling.

Disadvantages/Problems

- Riprap is more expensive than vegetated slopes.
- Riprap does not provide the habitat enhancement that other vegetative BMPs do.

Planning Considerations

Graded vs. Uniform Riprap

Riprap is classified as either graded or uniform. A sample of graded riprap would contain a mixture of stones which vary in size from small to large. A sample of uniform riprap would contain stones which are all fairly close in size.

For most applications, graded riprap is preferred to uniform riprap. Graded riprap forms a flexible self-healing cover, while uniform riprap is more rigid and cannot withstand movement of the stones. Graded riprap is cheaper to install, requiring only that the stones be dumped so that they remain in a well-graded mass. Hand or mechanical placement of individual stones is limited to that necessary to achieve the proper thickness and line. Uniform riprap requires placement in a more or less uniform pattern, requiring more hand or mechanical labor.

Riprap sizes can be designated by either the diameter or the weight of the stones. It is often misleading to think of riprap in terms of diameter, since the stones should be rectangular instead of spherical. However, it is simpler to specify the diameter of an equivalent size of spherical stone. Table II-5.4 below lists some typical stones by weight, spherical diameter and the corresponding rectangular dimensions. These stone sizes are based upon an assumed specific weight of 165 lbs./ft³

Design Criteria

Also see Table III-2.27, Rock Protection at Outfalls in the Runoff Control Volume.

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Table II-5.4 Size of Riprap Stones

Weight (lbs)	Mean Spherical Diameter (ft)	Rectangular Shape Length (ft)	Width, Height (ft)
50	0.8	1.4	0.5
100	1.1	1.75	0.6
150	1.3	2.0	0.67
300	1.6	2.6	0.9
500	1.9	3.0	1.0
1000	2.2	3.7	1.25
1500	2.6	4.7	1.5
2000	2.75	5.4	1.8
4000	3.6	6.0	2.0
6000	4.0	6.9	2.3
8000	4.5	7.6	2.5
20000	6.1	10.0	3.3

Since graded riprap consists of a variety of stone sizes, a method is needed to specify the size range of the mixture of stone. This is done by specifying a diameter of stone in mixture for which some percentage, by weight, will be smaller. For example, d_{85} refers to a mixture of stones in which 85 percent of the stone by weight would be smaller than the diameter specified. Most designs are based on d_{50}. In other words, the design is based on the median size of stone in the mixture.

Sequence of Construction

Since riprap is used where erosion potential is high, construction must be sequenced so that the riprap is put in place with the minimum possible delay. Disturbance of areas where riprap is to be placed should be undertaken only when final preparation and placement of the riprap can follow immediately behind the initial disturbance. Where riprap is used for outlet protection, the riprap should be placed before or in conjunction with the construction of the pipe or channel so that it is in place when the pipe or channel begins to operate.

Maintenance

- Riprap coverings should be inspected on a regular basis and after every large storm event.
- All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with an approved manual.

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II-5.7.14 BMP E2.80: Vegetative Streambank Stabilization

Code: VSS Symbol: 

Definition The use of vegetation to stabilize streambanks.

Purpose

To protect streambanks against erosion through vegetative means.

Condition Where Practice Applies

- Applicable to water areas and all land uses. To be used to stabilize banks in swales, creeks, streams, and rivers as well as man-made ditches, canals and impoundments, including ponds and storage basins.

Advantages

- Streambank vegetation can break wave action and the velocity of flood flows.
- Roots and rhizomes stabilize streambanks.
- The reduction of velocity can lead to the deposit of water-borne soil particles.
- Certain reeds and bulrushes have the capability of improving water quality by absorbing certain pollutants such as heavy metals, detergents, phenols, and indols (1).
- Plants regenerate themselves and adapt to changing natural situations, thus offering a distinct economic advantage over mechanical stabilization.
- Wildlife and fisheries habitat is improved.

Disadvantages/Problems

- Native plants may not be carried by regular nurseries and may need to be collected by hand, or obtained from specialty nurseries. Nurseries which carry these plants may require a long lead time for large orders.
- Flow retarding aspects of vegetated waterways need to be taken into account.

Planning Considerations

A primary cause of stream channel erosion is the increased frequency of bank-full flows which often results from upstream development. Most natural stream channels are formed with a bank-full capacity to pass the runoff from a storm with a 1.5 to 2-year recurrence interval. However, in a typical urbanizing watershed, stream channels may become subject to a 3 to 5-fold increase in the frequency of bank-full flows if stormwater runoff is not properly managed. As a result, stream channels that were once parabolic in shape and covered with vegetation may be transformed into wide rectangular channels with barren banks.

In recent years, a number of structural measures have evolved to strengthen and protect the banks of rivers and streams. These methods, when employed correctly, immediately ensure satisfactory protection of the banks. However, many such structures are expensive to build and to maintain. Without constant upkeep, they are exposed to progressive deterioration by natural agents. The materials used often prevent the reestablishment of native plants and animals, especially when the

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design is executed according to standard cross-sections which ignore natural variations of the stream system. Very often these structural measures destroy the appearance of the site. Additionally, structural stabilization and channelization can alter the hydrodynamics of a stream and only serve to transfer erosion potential and associated problems downstream.

In contrast, the utilization of living plants instead of or in conjunction with structures has many advantages. The degree of protection, which may be low to start with, increases as the plants grow and spread. The repair and maintenance of structures is unnecessary where self-maintaining streambank plants are established. The protection provided by natural vegetation is more reliable and effective when the cover consists of natural plant communities adapted to their site.

Design Criteria

- Design must be prepared based on criteria and input/review by a qualified fisheries biologist.
- Streambanks can be divided into: 1) aquatic plant zones at the mean low-water level (MWL); 2) reed bank zones covered at bankfull stage (BF); 3) lower riparian zones or open floodway zones naturally covered with willows and shrubbery plants (OF); 4) upper riparian areas or flood fringe areas that would naturally be covered with canopy-forming trees (FF) (see Figure II-5.15a).
- Aquatic plants are often considered weeds and a nuisance though they do slow down streamflow and protect the streambed. Primary emphasis of streambank stabilization lies in the bankfull zone.
- The reed bank zone forms a permeable obstacle, slowing down current waves by friction. Suitable plants can be found by consulting the guidelines found in Chapter III-5. Their shoots, with a root clump, can be planted in pits at 1/2 to 1 a foot depth below water, or in a reed roll as in Figure II-5.15b. A trench 1-1/2 feet wide and deep is dug behind a row of stakes; wire netting is then stretched from both sides between upright planks; coarse gravel is dumped on this and covered with reed clumps until the two edges of the netting can just be held together with wire. The upper edge of the roll should not be more than two inches above water level. Finally, the planks are taken out and gaps in the ditch are backfilled.
- The lower riparian zone in the Puget Sound region has a natural growth of willow, alder, cottonwood, small maples, and various berries. These vegetative types can be reintroduced on denuded floodplains to stabilize the soil with their roots. In periods of high water, their upper branches reduce the speed of the current and thereby the erosive force of water. The most commonly used vegetative stabilizer for this zone is willow because of its capability to develop secondary roots on cut trunks and to throw up suckers. Willows are planted either as individual cuttings bound together in various forms or wired together in "fascines."
- Fascines (Figure II-5.16a) have a diameter of 3 to 12 inches and contain brushwood and sticks and coarse gravel or rubble in the center tightly wound around. Packed fascine-work (Figure II-5.16b) can be employed on cut banks. It consists of 1 foot layers of branches covered with young, freshly cut shoots secured by stakes. The spaces between the shoots are filled with dirt and another layer is added on top. Another technique is the use of willow mattresses (Figure II-5.16c) made from 4 to 6 foot willow switches set into 6-inch trenches held down by stakes that are braided or wired together. The entire mattress is lightly covered with dirt. A variation of this method is the brush-mesh technique which is designed to stabilize breached cut banks and to encourage the deposition of sediment (Figure II-5.16d). It involves the following steps:

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1. Placement of poles at 10 foot distance.
2. Placement of large branches and brush facing the stream.
3. Setting cuttings of live willow branches between the brush vertically, and
4. Securing vertical willows with cuttings set diagonally facing the streamflow.

- Slip banks of the lower riparian zone and tidal banks can be stabilized with grass (3). First the bank needs to be graded to a maximum slope of 3:1. Topsoil should be conserved for reuse; lime (2 tons/acre) and fertilizer (1,000 lbs/acre of 10:10:10) should be applied. Coarse grass and beach grass should be planted at the water's edge to trap drift sand; and bermuda grass, suitable for periodic inundation, should occupy the face of the slope, followed by tall fescue on higher ground.

Maintenance

- Streambanks are always vulnerable to new damage. Repairs are needed periodically. Banks should be checked after every high-water event is over. Gaps in the vegetative cover should be fixed at once with new plants, and mulched if necessary. Fresh cuttings from other plants on the bank can be used, or they can be taken from mother-stock plantings if they are available.
- All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with an approved manual.

References

(1) Seibert, P., Importance of Natural Vegetation for the Protection of the Banks of Streams, Rivers and Canals: Freshwater. The Council of Europe. Manhattan Publishing Co., New York, 1968.

(2) U.S. Soil Conservation Service, Interim Standards and Specifications for Vegetative Tidal Bank Stabilization, College Park, Maryland, 1969.

(3) Schiechtl, Hugo, Bioengineering for Land Reclamation and Conservation, University of Alberta Press, 1980.

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Figure II-5.15a
Streambank Vegetative Zones



Figure II-5.15b
Reed Roll

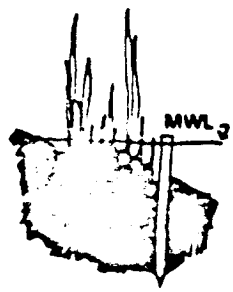

Figure II-5.16a
Fascines

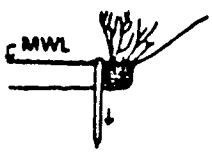

Figure II-5.16b
Packed Fascine-Work

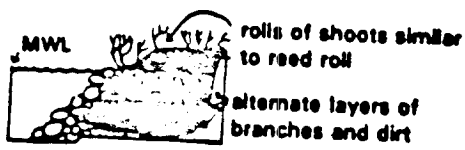

Figure II-5.16c
Willow Mattress

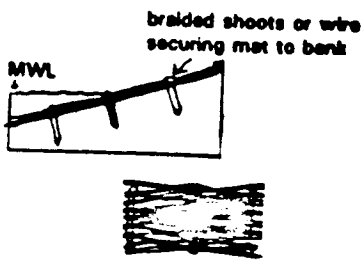

Figure II-5.16d
Brush-Mesh Protection



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II-5.7.15 BMP E2.85: Bioengineering Methods of Streambank Stabilization

Code: BSS Symbol: BSS

Definition Methods of stabilizing streambanks through a combination of vegetative and mechanical means.

Purpose

To provide protection of critical sections of streambank where ordinary vegetative means of protection are not feasible or offer insufficient protection.

Conditions Where Practice Applies

- To be used in streams with swift flow where the flow/soil conditions exceed the stabilizing effect of purely vegetative channel protection.

Advantages

- Mechanical materials provide for interim and immediate stabilization until vegetation takes over.
- Once established, vegetation can outlast mechanical structures and requires little maintenance while regenerating itself.
- Aesthetic benefits and wildlife habitat.

Disadvantages/Problems

- Slightly higher initial cost and need for professional advice. (It is recommended that the services of a qualified bioengineer be sought for this work).
- The methods described are effective but require a complete knowledge of soils, hydrology, and other physical data to design measures that will adequately solve the problem and stand up to the test of time.

Design Criteria

Streams in urban settings may carry an increase in runoff of such great magnitude that they cannot be maintained in a natural state. In these cases bioengineering methods can provide for stabilization without complete visual degradation and they can provide higher effectiveness than purely mechanical techniques. This applies primarily to: 1) the reed bank zone (BF) and 2) the lower riparian zone (OF) (Figure II-5.17a). The following techniques apply to the reed bank zone:

Reed berms (Figure II-5.17b), consisting of a combination of reeds and riprap, break wave action, and erosion of banks by currents. Banks should not exceed a 2:1 slope. Riprap is placed to form a berm that extends beyond the surface at mean low-water level, separating the reed bed from the body of water.

Willow jetties (Figure II-5.17c) can be constructed at the water level to stabilize a cutbank by deflecting the current and by encouraging deposition of sediment. Steps:

1. Dig ditches diagonally to direction of flow, and place fill to form berm downstream from ditch.

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2. Set 2-foot willow branches (4 feet may be needed) at 45° angle and 3-inch spacing facing downstream.

3. Weigh down branches with riprap extending beyond water level.

Willow gabions (Figure II-5.17d) can be used when a hard-edged effect is desired to deflect the eroding flow of water. Live willow branches, pointing downstream, are inserted through the wire mesh when the gabion is packed with stone and an addition of finer materials. Branches need to be long enough to extend through the gabion into the soil of the bank. They also should be placed at an angle back into the slope.

Piling revetment (Figure II-5.17e) with wire facings is especially suited for the stabilization of cutbanks with deep water. It involves the following steps:

1. Drive heavy timbers (8-12 inch diameter) on 6 to 8-foot centers along bank to be protected to point of refusal or one half length of pile below maximum scour.

2. Fasten heavy wire fencing to the post and if the streambed is subject to scour, extend it horizontally on the streambed for a distance equal to the anticipated depth of scour and weight with concrete blocks. As scour occurs, this section will drop into place.

3. Pile brush on the bank side of the fence, and plant willow saplings on bank to encourage sediment deposits.

In the lower riparian zone (Figure II-5.17f) (open floodway) bank stabilization efforts should be concentrated on critical areas only. The stabilizing effect of riprap can be supplemented with willows which will bind soil through their roots and screen the bank. Banks can be paved with stone (set in sand). Willow cuttings in joints need to be long enough to extend to natural soil and should have 2 to 4 buds above surface. Willow branches in riprap should be installed simultaneously. Branches should extend 1 foot into the soil below stone and 1½ feet above ground, pointing downstream.

Willow branch mat revetment (Figure II-5.17g) takes the following steps to install:

1. Grade slope to approximately 2:1 and excavate a 3 foot ditch at the toe of slope.

2. Lay live willow brush with butts upslope and anchor mat in the ditch below normal waterline by packing with large stones.

3. Drive 3-foot willow stakes 2½ feet on center to hold down brush; connect stakes with No. 9 galvanized wire and cover brush slightly with dirt to encourage sprouting.

Maintenance

- Costs vary according to local availability of labor. However, there are practically no maintenance costs for the vegetation once it is established, since it holds the banks 'naturally' as compared to concrete 'improvement' that constantly needs repairs.

- All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with an approved manual.

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References

(1) USDA, Soil Conservation Service, Engineering Field Manual for Conservation Practices, 1969.

(2) USDA, Soil Conservation Service, Farm Planners Engineering Handbook for the Upper Mississippi Region, Agricultural Handbook #57, 1953.

(3) Schiechtl, H. Bioengineering for Land Reclamation and Conservation, University of Alberta Press, 1980.

(4) Gray, Donald H. and Leiser, A.T, Biotechnical Slope Protection and Erosion Control, Leiser Van Reinhold Inc., 1982.

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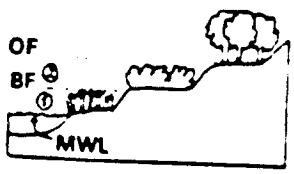

Figure II-5.17a
Reed Bank Zone (BF)
and Lower Riparian Zone (OF)

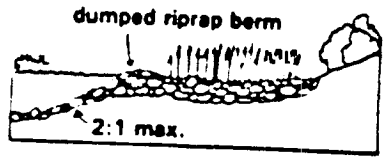

Figure II-5.17b
Reed Berm

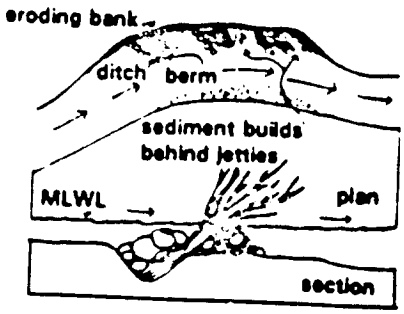

Figure II-5.17c
Willow Jetty

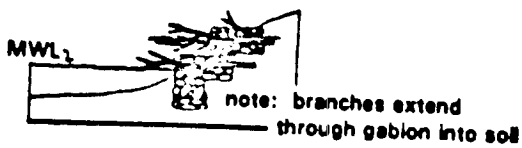

Figure II-5.17d
Willow Gabion

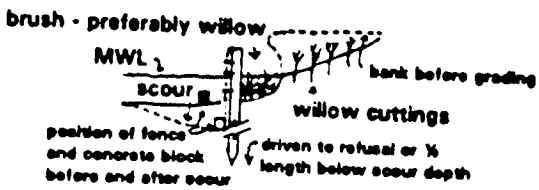

Figure II-5.17e
Piling Revetment

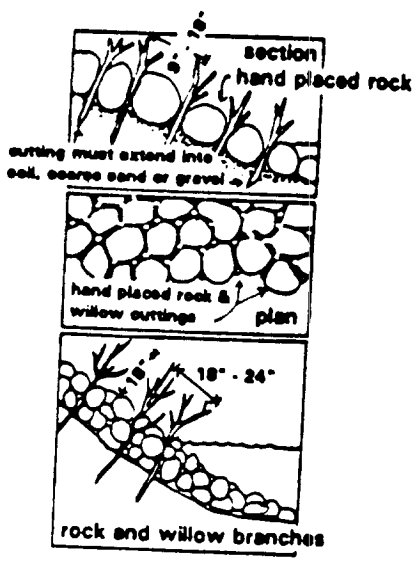

Figure II-5.17f
Willow Branches in Riprap

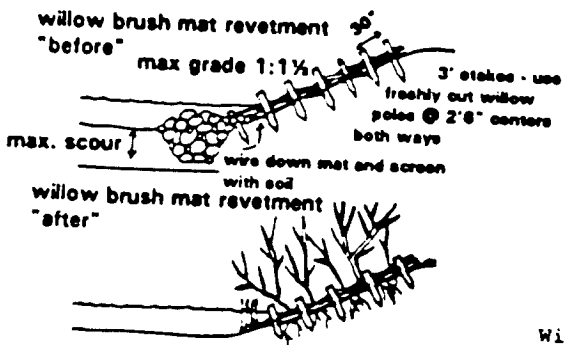

Figure II-5.17g
Willow Branch Mat Revetment

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II-5.7.16 BMP E2.90: Structural Streambank Stabilization

Code: SSB Symbol: 

Definition Methods of stabilizing the banks and streams with permanent structures.

Purpose

To protect streambanks from the erosive forces of moving water, where vegetative or bioengineered methods are insufficient or infeasible.

Conditions Where Practice Applies

- Streambank sections, where excessive erosion is anticipated because of highly erodible soils.

Advantages

- Permanent structural measures are an effective method of preventing severe streambank erosion.

Disadvantages/Problems

- Most types of structural stabilization do not offer any water quality benefits except for the potential for reduced erosion and downstream siltation.

Planning Considerations

Stream channel erosion problems vary widely in type and scale and there are many different structural stabilization techniques which have been employed with varying degrees of effectiveness. The purpose of this specification is merely to point out some of the practices which are available and to establish some broad guidelines for their selection and design. Such structures should be planned and designed in advance by a professional engineer licensed in the state of Washington. Many of the practices referenced here involve the use of manufactured products and should be designed and installed in accordance with manufacturer's specifications.

Before selecting a structural stabilization technique, the designer should carefully evaluate the possibility of using vegetative stabilization (BMP E2.80) or bioengineering measures (BMP E2.85) to achieve the desired protection. Vegetative techniques are generally less costly and more compatible with natural stream characteristics, and, in most instances, HPAs from the state Departments of Fisheries and Wildlife may require this method.

Design Criteria

- Design must be prepared based on criteria and input/review from a qualified fisheries biologist.
- Since each reach of channel requiring protection is unique, measures for streambank protection shall be installed according to a plan and adapted to the specific site. Design shall be developed according to the following principles:

  a. Bottom scour shall be controlled, by either natural or structural means, before any permanent type of bank protection can be considered feasible. See Chapter III-2, Volume III for channel design.

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b. Stream requirements must be met.

These include, but are not necessarily limited to, development limitations imposed by the local government's Sensitive Area Ordinance (if applicable), the requirements of the Shoreline Management Act and permit requirements from State and Federal agencies such as a Hydraulic Project Approval (HPA, Washington Depts. of Fish and Wildlife), Dam Safety (Washington Dept. of Ecology), and Navigation, Shoreline and Section 101 and 404 permits for the Corps of Engineers.

c. Special attention shall be given to maintaining and improving habitat for fish and wildlife.

d. Structural measures must be effective for the design flow and be capable of withstanding greater flows without serious damage.

- The following structural streambank stabilization measures may be considered:

a. Riprap - heavy angular stone placed on the streambank to provide armor protection against erosion.

b. Gabion - rectangular, pervious, semi-flexible rock-filled wire baskets which can be used to armor streambanks.

c. Reinforced Concrete - retaining walls or bulkheads used to armor eroding sections of streambank.

d. Log Cribbing - retaining structure built of logs to protect streambanks from erosion. (Log cribbing can have vegetation inserted between logs.)

e. Grid Pavers - modular concrete units with interspersed void areas which can be used to armor the streambank while maintaining porosity and allowing the establishment of vegetation.

Maintenance

- Inspections should be made regularly and after each large storm event. Repairs should be made as quickly as possible after the problem occurs.
- All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with an approved manual.

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II-5.8 SEDIMENT RETENTION

II-5.8.1 BMP E3.10: Filter Fence

Code: (FF) Symbol: -x-x-x-

Definition A temporary sediment barrier consisting of a filter fabric stretched across and attached to supporting posts and entrenched. The filter fence is constructed of stakes and synthetic filter fabric with a rigid wire fence backing where necessary for support.

Purpose

1. To intercept and detain small amounts of sediment under sheet flow conditions from disturbed areas during construction operations in order to prevent sediment from leaving the site.

2. To decrease the velocity of sheet flows.

Conditions Where Practice Applies

- Filter fences must be provided just upstream of the point(s) of discharge of runoff from a site, before the flow becomes concentrated. They may also be required:

  1. Below disturbed areas where runoff may occur in the form of sheet and rill erosion; wherever runoff has the potential to impact downstream resources.

  2. Perpendicular to minor swales or ditch lines for contributing drainage areas up to one acre in size.

Advantages

- Downstream riparian areas will not be damaged by sediment deposits originating from the development.

- Sediment will not cause damage to fish habitat.

Disadvantages/Problems

- Filter fences are not practical where large flows of water are involved, hence the need to restrict their use to drainage areas of one acre of less, and flow rates of lese than 0.5 cfs. This flow should not be concentrated; it should be spread out over many linear feet of filter fabric fence.

- Problems may arise from incorrect selection of pore size and/or improper installation.

- Filter fences should not be constructed in streams or used in V-shaped ditches. They are not an adequate method of runoff control for anything deeper than sheet or overland flow.

Planning Considerations

Laboratory work at the Virginia Highway and Transportation Research Council has shown that silt fences can trap a much higher percentage of suspended sediments than can straw bales. Silt fences are preferable to straw barriers in many cases. However, while the failure rate of silt fences is lower than that of straw barriers, there are many instances locally in which silt fences have been improperly

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installed. The installation methods outlined here can improve performance.

Fabric Types:

There are four types of material used for filter fabric fences; woven slit-film fabric, woven monofilament fabrics, woven composites (of differing materials) and non-woven heat-treated or needle punched fabrics. Slit-film fabrics are made from woven sheets of nonporous polymers. The sheets are very thin but are cut or slit in wider bands to form the threads which are then woven into the fabric. Since slit-film weaves use strands that are quite thin, the resulting woven fabric has little rigidity, and pore spaces are not uniform. Wire fencing must be used as a backing for this type of filter fabric fence. While this type of fabric is generally cheapest and the most widely used, the additional costs of the wire fence installation must be figured in.

Woven monofilament fabrics are made from uniform spun or extruded filaments which are then woven to form the fabric. They are usually thicker and thus more rigid than slit-film fabrics. The pores in monofilament fabrics are regularly spaced and the increased rigidity offers more resistance to pore distortion. The material has a very low flow-through rate. Woven composites are similar in structure but use more than one fiber type.

Non-woven fabrics are made by using either continuous filaments or short staple fibers. These fibers are then bonded together by various processes that can include a needling process that intertwines the fibers physically, or a thermal or chemical bonding operation that fuses adjacent fibers together. The resulting fabric has a random fiber orientation and may have a thickness that ranges from thick felt to a relatively thin fabric.

King County Conservation District recently completed tests on 18 different types of filter fabrics. Their results have been incorporated into the design criteria.

Design Criteria

- Drainage area of 1 acre or less or in combination with sediment basin in a larger site.
- Maximum slope steepness (normal (perpendicular) to fence line) 1:1.
- Maximum sheet or overland flow path length to the fence 100 feet.
- No concentrated flows greater than 0.5 cfs.
- Selection of a filter fabric is based on soil conditions at the construction site (which affect the apparent opening size (AOS) fabric specification) and characteristics of the support fence (which affect the choice of tensile strength). The designer shall specify a filter fabric that retains the soil found on the construction site yet will have openings large enough to permit drainage and prevent clogging. The larger the AOS number, the smaller the AOS size of the opening in the fabric.
- The material used in a filter fabric fence must have sufficient strength to withstand various stress conditions and it also must have the ability to allow passage of water while retaining soil particles. The ability to pass flow through must be balanced with the material's ability to trap sediments.

The following criteria are recommended for selection of the AOS:

1. Because of the properties of soils in the Puget Sound basin, field work must be done to determine the optimum AOS for filter fence installations. Because of glaciation, many soils in this area contain both cobbles and

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fines. If an SCS standard soil description is used, (e.g. Alderwood gravelly sandy loam) the AOS specified will not be sufficient to trap the finer particles of soil. Including gravels and larger sizes skews the results towards an AOS which is too small to capture suspended settleable solids and reduce TSS. Monofilament and non-woven geotextiles must have a minimum AOS of 70 when used in glacial soils. Composites and slit film fabrics must be extra-strength to perform similarly; in their case the AOS range may be from 40-60. In areas where Mazama ash is plentiful in the soil profile, a larger AOS will be necessary, or, fabric with an AOS of 70 should be used for outwash soils.

2. For all other soil types, the AOS should be determined by first passing soil through a #10 sieve (2.0 mm). Based on the amount of the remaining soil, by weight, which passes through a U.S. standard sieve No. 200, select the AOS to retain 85 percent of the soil. Where direct discharge to a stream, lake, or wetland will occur, then the AOS shall be no larger than Standard Sieve No. 100.

Non-woven and regular strength slit film fabrics shall be supported with wire mesh. Filter fabric material shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0°F. to 120°F.

Standard Notes

In addition to the Technical Information Report (see Chapter I-3) required by the local government when preparing an erosion and sediment control plan, add the following notes to the Filter Fabric Fence Detail (Figure II-5.18):

a. The filter fabric shall be purchased in a continuous roll cut to the length of the barrier to avoid use of joints. When joints are necessary, filter cloth shall be spliced together only at a support post, with a minimum 6 inch overlap, and both ends securely fastened to the post.

b. Posts shall be spaced a maximum of 6 feet apart and driven securely into the ground a minimum of 30 inches (where physically possible).

c. A trench shall be excavated approximately 8 inches wide and 12 inches deep along the line of posts and upslope from the barrier. The trench shall be constructed to follow the contour.

d. When slit film filter fabric is used, a wire mesh support fence shall be fastened securely to the upslope side of the posts using heavy-duty wire staples at least 1 inch long, tie wires or hog rings. The wire shall extend into the trench a minimum of 4 inches and shall not extend more than 36 inches above the original ground surface.

e. Slit film filter fabric shall be wired to the fence, and 20 inches of the fabric shall extend into the trench. The fabric shall not extend more than 36 inches above the original ground surface. Filter fabric shall not be stapled to existing trees. Other types of fabric may be stapled to the fence.

f. When extra-strength or monofilament fabric and closer post spacing are used, the wire mesh support fence may be eliminated. In such a case, the filter fabric is stapled or wired directly to the posts with all other provisions of Standard Note "e" applying. Extra care should be used when joining or overlapping these stiffer fabrics.

g. Local governments may specify the use of properly compacted native material. In many instances, this may be the preferred alternative because the soil forms a more continuous contact with the trench below, and use of native materials

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cuts down on the number of trips that must be made on and off-site. If gravel is used instead, the trench shall be backfilled with ¼-inch minimum diameter washed gravel. Care must be taken when using gravel to ensure good contact between the fabric and the trench bottom to prevent undercutting.

h. Filter fabric fences shall be removed when they have served their useful purpose, but not before the upslope area has been permanently stabilized. Retained sediment must be removed and properly disposed of, or mulched and seeded.

Maintenance

- Inspect immediately after each rainfall, and at least daily during prolonged rainfall. Repair as necessary.
- Sediment must be removed when it reaches approximately one third the height of the fence, especially if heavy rains are expected.
- Any sediment deposits remaining in place after the filter fence is no longer required shall be dressed to conform with the existing grade, prepared and seeded.
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

References:

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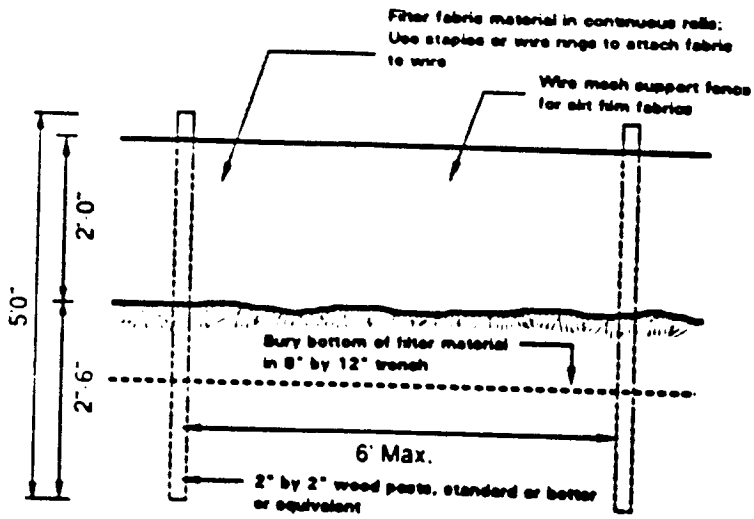
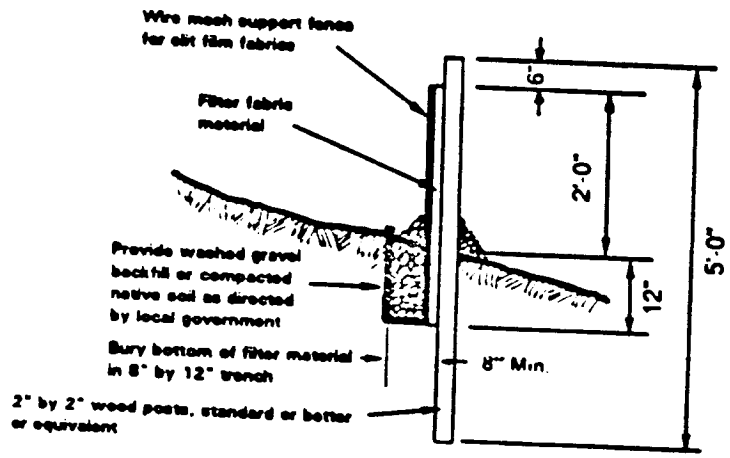
Figure II-5.18 Filter Fabric Fence Detail





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II-5.8.2 BMP RD.15 Straw Bale Barrier

Code: (STB) Symbol:

Definition A temporary sediment barrier consisting of a row of entrenched and anchored straw bales.

Purpose

1. To intercept and detain small amounts of sediment from disturbed areas of limited extent to prevent sediment from leaving the site.
2. To decrease the velocity of sheet flows and low-to-moderate level channel flows.

Conditions Where Practice Applies

- Below disturbed areas subject to sheet and rill erosion.
- Where the size of the drainage area is no greater than 1/4 acre per 100 feet of barrier length; the maximum slope length behind the barrier is 100 feet; and the maximum slope gradient behind the barrier is 50 percent (2:1).
- In minor swales or ditch lines where the maximum contributing drainage area is no greater than 2 acres.
- Where effectiveness is required for less than 3 months.
- Under no circumstances should straw bale barriers be constructed in live streams or in swales where there is the possibility of a washout.

Advantages

- When properly used, straw bale barriers are an inexpensive method of sediment control.

Disadvantages/Problems

- Straw bale barriers are easy to misuse and can become contributors to a sediment problem instead of a solution.
- It is difficult to tell if bales are securely seated and snug against each other.

Planning Considerations

Based on observations made locally and in Virginia, Pennsylvania, Maryland, and other parts of the nation, straw bale barriers have not been as effective as many users had hoped they would be. There are three major reasons for such ineffectiveness.

1. *Improper use of straw bale barriers has been a major problem. Straw bale barriers have been used in streams and drainageways where high water velocities and volumes have destroyed or impaired their effectiveness.*
2. *Improper placement and installation of the barriers, such as staking the bales directly to the ground with no soil seal or entrenchment, has allowed undercutting and end flow. This has resulted in additions to, rather than removal of, sediment from runoff waters.*

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3. *Inadequate maintenance lowers the effectiveness of these barriers. For example, trapping efficiencies of carefully installed straw bale barriers on one project in Virginia dropped from 57 percent to 16 percent in one month due to lack of maintenance.*

There are serious questions about the continued use of straw bale barriers as they are presently installed and maintained. Averaging approximately $4.00 per linear foot, the thousands of straw bale barriers used annually represent sufficient expense that optimum installation procedures should be emphasized. If such procedures are carefully followed, straw bale barriers can be quite effective. Therefore, continued designation of straw bale barriers as a BMP will be contingent upon significant improvement in the installation and maintenance procedures applied to their use.

Design Criteria

- A formal design is not required.
- Sheet Flow Applications

  1. Bales shall be placed in a single row, lengthwise on the contour, with ends of adjacent bales tightly abutting one another.

  2. All bales shall be either wire-bound or string-tied. Straw bales shall be installed so that bindings are oriented around the sides rather than along the tops and bottoms of the bales in order to prevent deterioration of the bindings (Figure II-5.19).

  3. The barrier shall be entrenched and backfilled. A trench shall be excavated the width of a bale and the length of the proposed barrier to a minimum depth of 4 inches. The trench must be deep enough to remove all grass and other material which might allow underflow. After the bales are staked and chinked (filled by wedging), the excavated soil shall be backfilled against the barrier. Backfill soil shall conform to the ground level on the downhill side and shall be built up to 4 inches against the uphill side of the barrier (Figure II-5.19).

  4. Each bale shall be securely anchored by at least 2 stakes or re-bars driven through the bale. The first stake in each bale shall be driven toward the previously laid bale to force the bales together. Stakes or re-bars shall be driven deep enough into the ground to securely anchor the bales. Stakes should not extend above the bales but instead should be driven in flush with the top of the bale for safety reasons.

  5. The gaps between the bales shall be chinked (filled by wedging) with straw to prevent water from escaping between the bales. Loose straw scattered over the area immediately uphill from a straw bale barrier tends to increase barrier efficiency. Wedging must be done carefully in order not to separate the bales.

  6. Inspection shall be frequent and repair or replacement shall be made promptly as needed.

  7. Straw bale barriers shall be removed when they have served their usefulness, but not before the upslope areas have been permanently stabilized.

- Channel Flow Applications

  1. Bales shall be placed in a single row, lengthwise, oriented perpendicular to the contour, with ends of adjacent bales tightly abutting one another.

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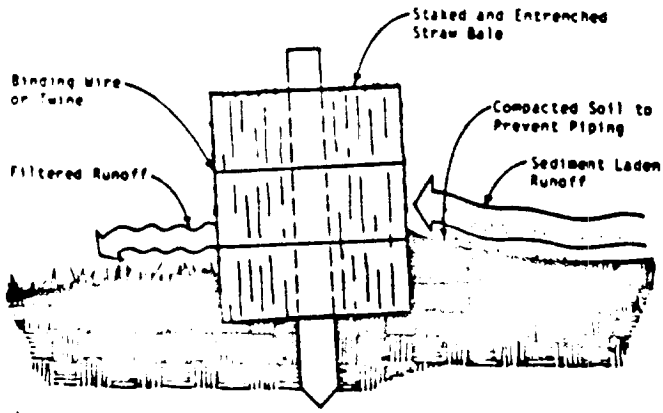
Figure II-5.19 Cross-Section of a Properly Installed Straw Bale Barrier



2. The remaining steps for installing a straw bale barrier for sheet flow applications apply here, with the following addition.

3. The barrier shall be extended to such a length that the bottoms of the end bales are higher in elevation than the top of the lowest middle bale (Figure II-5.20) to assure that sediment-laden runoff will flow either through or over the barrier but not around it.

Maintenance

- Straw bale barriers shall be inspected immediately after each runoff-producing rainfall and at least daily during prolonged rainfall.
- Close attention shall be paid to the repair of damaged bales, end runs, and undercutting beneath bales.
- Necessary repairs to barriers or replacement of bales shall be accomplished promptly.
- Sediment deposits should be removed after each runoff-producing rainfall. They must be removed when the level of deposition reaches approximately one-half the height of the barrier.
- Any sediment deposits remaining in place after the straw bale barrier is no longer required shall be dressed to conform to the existing grade, prepared and seeded.
- All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with an approved manual.
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

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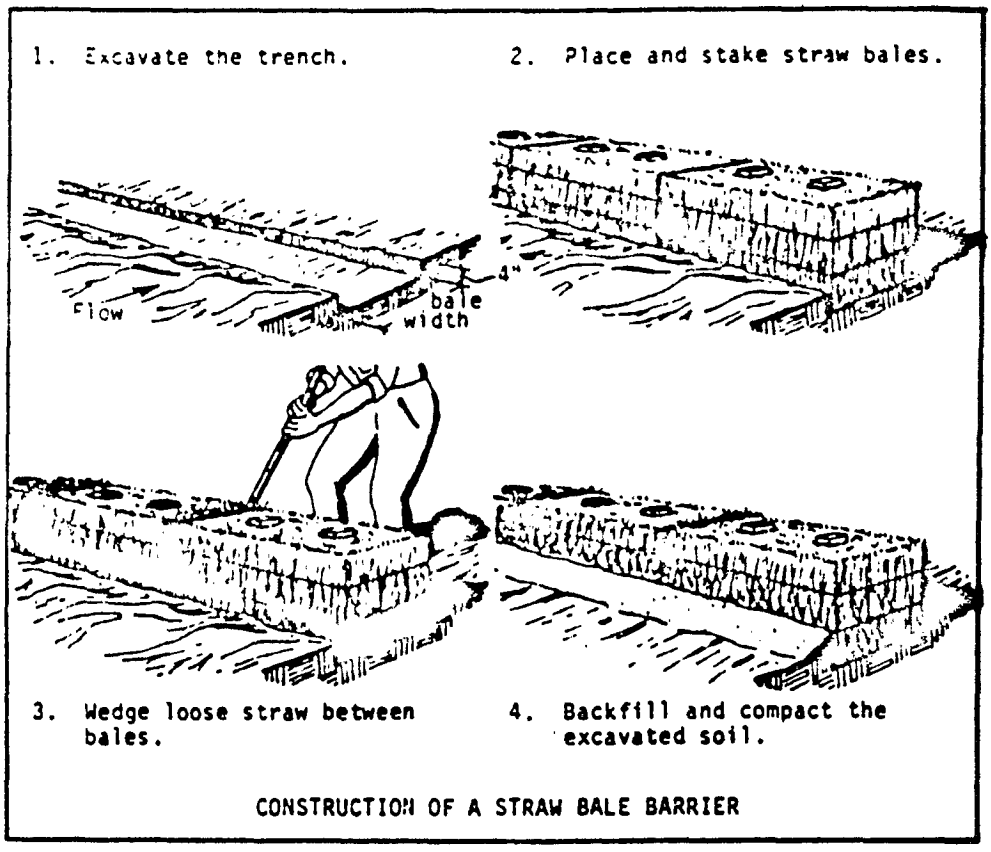
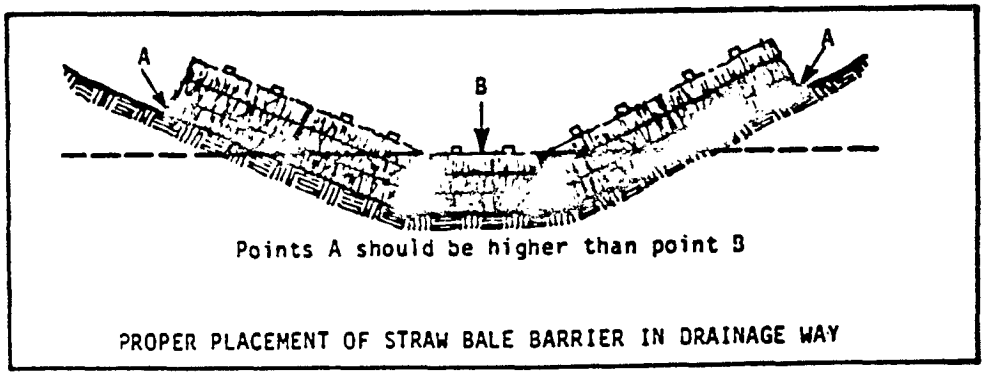
Figure II-5.20 Proper Installation of a Straw Bale Barrier





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II-5.8.3 BMP E3.20: Brush Barrier

Code: (BB) Symbol: [redacted]

Definition A temporary sediment barrier constructed at the perimeter of a disturbed area from residue materials available from cleaning and grubbing on-site.

Purpose

To intercept and retain sediment from limited disturbed areas.

Conditions Where Practice Applies

- Below disturbed areas of less than one quarter acre that are subject to sheet and rill erosion, where enough residue material is available for construction of such a barrier. Note: This does not replace a sediment trap or pond.

Advantages

- Brush barriers can often be constructed using materials found on-site.

Problems

- None

Planning Considerations

Organic litter and spoil material from site clearing operations is usually burned or hauled away to be dumped elsewhere. Much of this material can be used effectively on the construction site itself. During clearing and grubbing operations, equipment can push or dump the mixture of limbs, small vegetation, and root mat along with minor amounts of soil and rock into windrows along the toe of a slope where erosion and accelerated runoff are expected. Anchoring a filter fabric over the berm enhances the filtration ability of the barrier. Because brush barriers are fairly stable and composed of natural materials, maintenance requirements are small. Material containing large amounts of wood chips should not be used because of the potential for leaching from the chips.

Design Criteria

- Height 3 feet (minimum) to 5 feet (maximum).
- Width 5 feet at base (minimum) to 15 feet (maximum).
- Filter fence anchored over the berm will enhance its filtration capacity.
- Further design details are illustrated in Figure II-5.21.

Maintenance

- Brush barriers generally require little maintenance, unless there are very heavy deposits of sediment. Occasionally, tearing of the fabric may occur.
- When the barrier is no longer needed the fabric can be removed to allow natural establishment of vegetation within the barrier. Over time the barrier will rot. All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to assure continued performance. All maintenance and repair shall be conducted in accordance with an approved manual.

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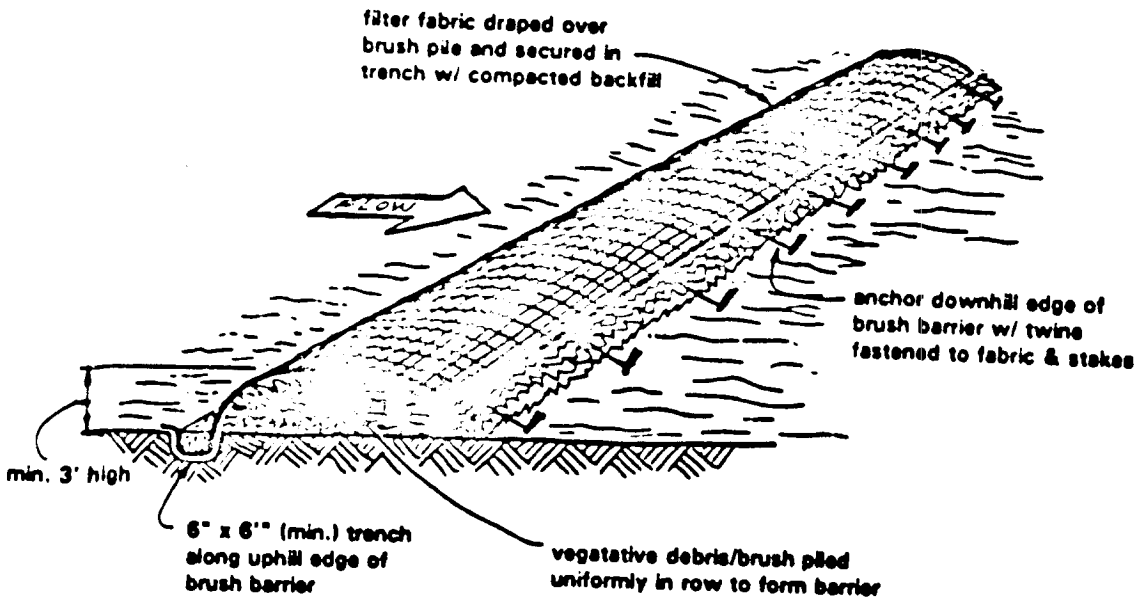
Figure II-5.21 Brush Barrier



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II-5.8.4 BMP E3.25: Gravel Filter Berm

Code: GFB Symbol: GFB

Definition A gravel berm constructed on rights-of-way or traffic areas within a construction site.

Purpose

To retain sediment from traffic areas by using a filter berm of gravel or crushed rock.

Conditions Where Practice Applies

- Where a temporary measure is needed to retain sediment from rights-of-way or in traffic areas on construction sites.

Advantages

- This is a very efficient method of sediment removal.

Disadvantages/Problems

- This BMP is more expensive to install than are other BMPs which use materials found on-site.

Design Criteria

- Berm material shall be ¼ to 3 inches in size, washed, well-graded gravel or crushed rock with less than 5 percent fines (Figure II-5.22).
- Spacing of berms:

  every 300 feet on slopes less than 5 percent
  every 200 feet on slopes between 5 and 10 percent
  every 100 feet on slopes greater than 10 percent

- Berm dimensions:

  1 foot high with 3:1 side slopes
  8 linear feet per 1 cfs runoff based on the 10-year, 24-hour design storm.

Maintenance

- Regular inspection is required; sediment shall be removed and filter material replaced as needed.
- All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with an approved manual.

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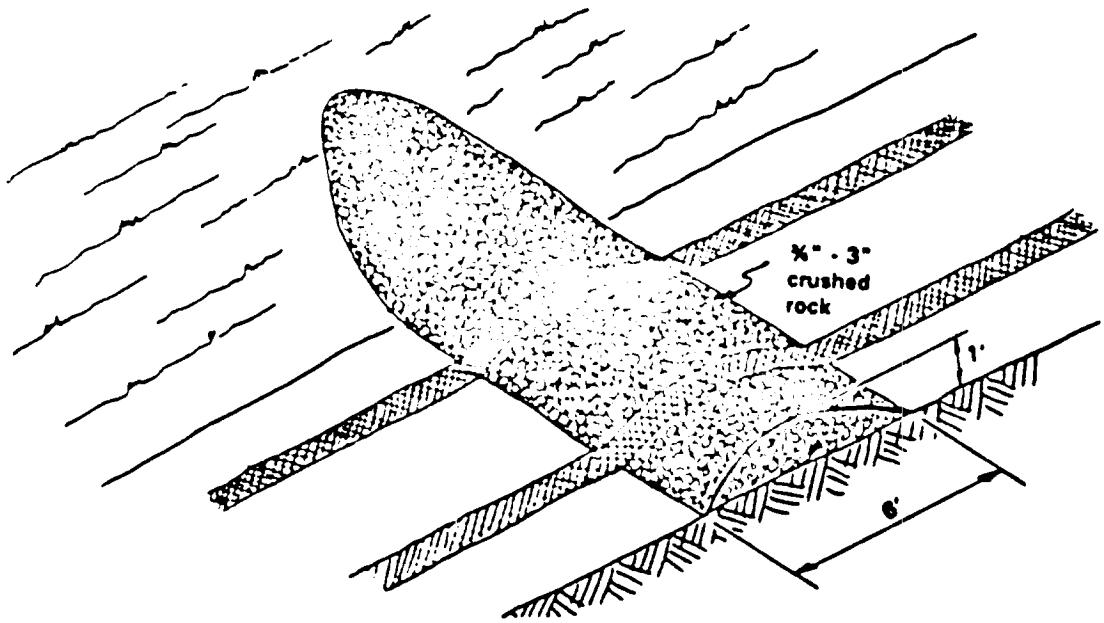
Figure II-5.22 Gravel Filter Berm



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II-5.8.5 BMP E3.30: Storm Drain Inlet Protection

Code: (IP) Symbol:

Definition A sediment filter or an excavated impounding area around a storm drain, drop inlet, or curb inlet.

Purpose

To prevent sediment from entering storm drainage systems prior to permanent stabilization of the disturbed area.

Conditions Where Practice Applies

- Where storm drain inlets are to be made operational before permanent stabilization of the disturbed drainage area. Different types of structures are applicable to different conditions:

  a. Filter Fabric Fence - applicable where the inlet drains a relatively small (less than 1 acre) flat area (less than 5 percent slope). (see Figure II-5.23). Do not place fabric under grate as the collected sediment may fall into the drain when the fabric is retrieved. This practice cannot easily be used where the area is paved because of the need for driving stakes to hold the material.

  b. Block and Gravel Filter - applicable where heavy flows (greater than 0.5 cfs) are expected (Figure II-5.24).

  c. Gravel and Wire Mesh Filter - applicable where flows greater than 0.5 cfs are expected and construction traffic may occur over the inlet (Figure II-5.25).

Advantages

- Inlet protection prevents sediment from entering the storm drain system and clogging it.

Disadvantages/Problems

- Sediment removal may be difficult, especially under high flow conditions.

Planning Considerations

Storm sewers which are made operational before their drainage area is stabilized can convey large amounts of sediment to natural drainageways. In cases of extreme sediment loading, the storm sewer itself may clog and lose a major portion of its capacity. To avoid these problems, it is necessary to prevent sediment from entering the system at the inlets.

There are several types of inlet filters and traps which have different applications dependent upon site conditions and type of inlet. Other innovative techniques for accomplishing the same purpose are encouraged, but only after specific plans and details are submitted to and approved by the Plan Approving Authority of the local government (see Design Criteria for the description of a new method currently under development by Emcon Northwest). Note that these various inlet protection devices are for drainage areas of less than one acre. Runoff from larger disturbed areas should be routed through a Temporary Sediment Trap or Pond (see BMPs E3.35, E3.40).

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The best way to prevent sediment from entering the storm sewer system is to stabilize the site as quickly as possible, preventing erosion and stopping sediment at its source.

Design Criteria

- Grates and spaces of all inlets should be secured to prevent seepage of sediment-laden water.
- All inlet protection measures should include sediment sumps of 1 to 2 feet in depth, with all side slopes (Figure II-5.23).
- Installation procedure for filter fabric fence:
  a. Place 2 inch by 2 inch wooden stakes around the perimeter of the inlet a maximum of 3 feet apart and drive them at least 8 inches into the ground. The stakes must be at least 3 feet long.
  b. Excavate a trench approximately 8 inches wide and 12 inches deep around the outside perimeter of the stakes.
  c. Staple the filter fabric (for materials and specifications, see BMP E3.10, Filter Fence) to wooden stakes so that 32 inches of the fabric extends out and can be formed into the trench. Use heavy-duty wire staples at least ½ inch in length.
  d. Backfill the trench with 3/4 inch or less washed gravel all the way around.
- Installation procedure for block and gravel filter:
  a. Place wire mesh over the drop inlet so that the wire extends a minimum of 1 foot beyond each side of the inlet structure. Use hardware cloth or comparable wire mesh with one-half inch openings. If more than one strip is necessary, overlap the strips. Place filter fabric over the wire mesh.
  b. Place concrete blocks lengthwise on their sides in a single row around the perimeter of the inlet, so that the open ends face outward, not upward. The ends of adjacent blocks should abut. The height of the barrier can be varied, depending on design needs, by stacking combinations of blocks that are 4 inches, 8 inches, and 12 inches wide. The row of blocks should be at least 12 inches but no greater than 24 inches high (Figure II-5.24).
  c. Place wire mesh over the outside vertical face (open end) of the concrete blocks to prevent stone from being washed through the blocks. Use hardware cloth or comparable wire mesh with one half inch openings.
  d. Pile washed stone against the wire mesh to the top of the blocks. Use 3/4 to 3 inch gravel.
- Installation procedure for gravel and wire mesh filter:
  a. Place wire mesh over the drop inlet so that the wire extends a minimum of 1 foot beyond each side of the inlet structure. Use hardware cloth or comparable wire mesh with 1/2 inch openings. If more than one strip of mesh is necessary, overlap the strips. Place filter fabric over wire mesh.
  b. Extend the filter fence/wire mesh beyond the inlet opening at least 18 inches on all sides. Place 3/4 to 3-inch gravel over the filter fabric/wire mesh. The depth of the gravel should be at least 12 inches

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over the entire inlet opening (see Figure II-5.25).

Experimental Inlet Protection BMP:

EMCON Northwest, Inc. has recently developed a catchbasin filter (patent pending) that prevents sediments and other contaminants from entering storm drainage systems. The catchbasin filter is inserted in the catchbasin just below the grating. The catchbasin filter is equipped with a sediment trap and up to three layers of a fiberglass filter material (see Figure II-5.26). This type of system may not be applicable in all catchbasins but would work well at construction sites, industrial facilities, service stations, marinas/boatyards, etc.

During research and development of the catchbasin filter, EMCON Northwest, Inc. has found that particulates as small as 15 microns are retained by the filter. Additionally, high levels of particulate heavy metals, oil and grease and TSS have been removed at both industrial facilities and construction sites. The catchbasin filter is equipped with an overflow mechanism which allows it to pass peak flows up to 240 gallons per minute. Effective filtration can be accomplished at flows as high as 40 gallons per minute.

For further information, contact John MacPherson at EMCON Northwest Inc., (206) 485-5000.

Please note that this information is presented for informational purposes only. While this technology appears to be an effective method of controlling some types of pollutants, Ecology is not in a position to confirm or deny its efficacy at this time.

Maintenance

- For systems using filter fabric: Inspections should be made on a regular basis, especially after large storm events. If the fabric becomes clogged, it should be replaced. Sediment should be removed when it reaches approximately one-half the height of the fence. If a sump is used, sediment should be removed when it fills approximately one half the depth of the hole.
- For systems using stone filters: If the stone filter becomes clogged with sediment, the stones must be pulled away from the inlet and cleaned or replaced. Since cleaning of gravel at a construction site may be difficult, an alternative approach would be to use the clogged stone as fill and put fresh stone around the inlet.
- All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with an approved manual.
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

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Figure II-5.23 Filter Fabric Fence Inlet Filter

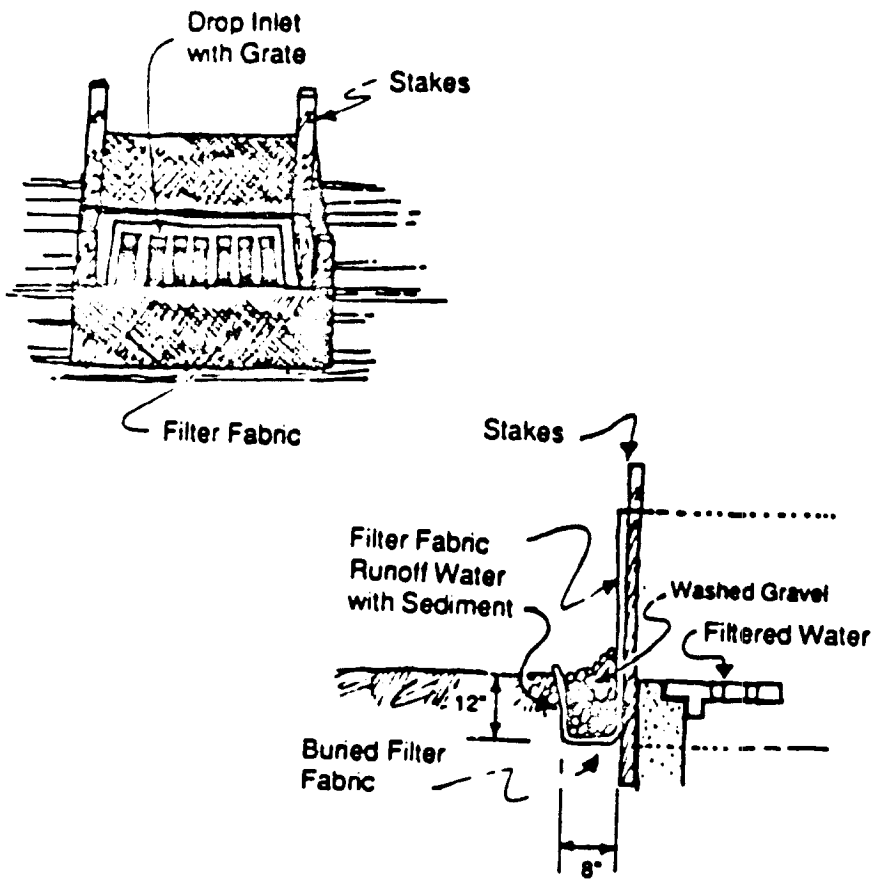

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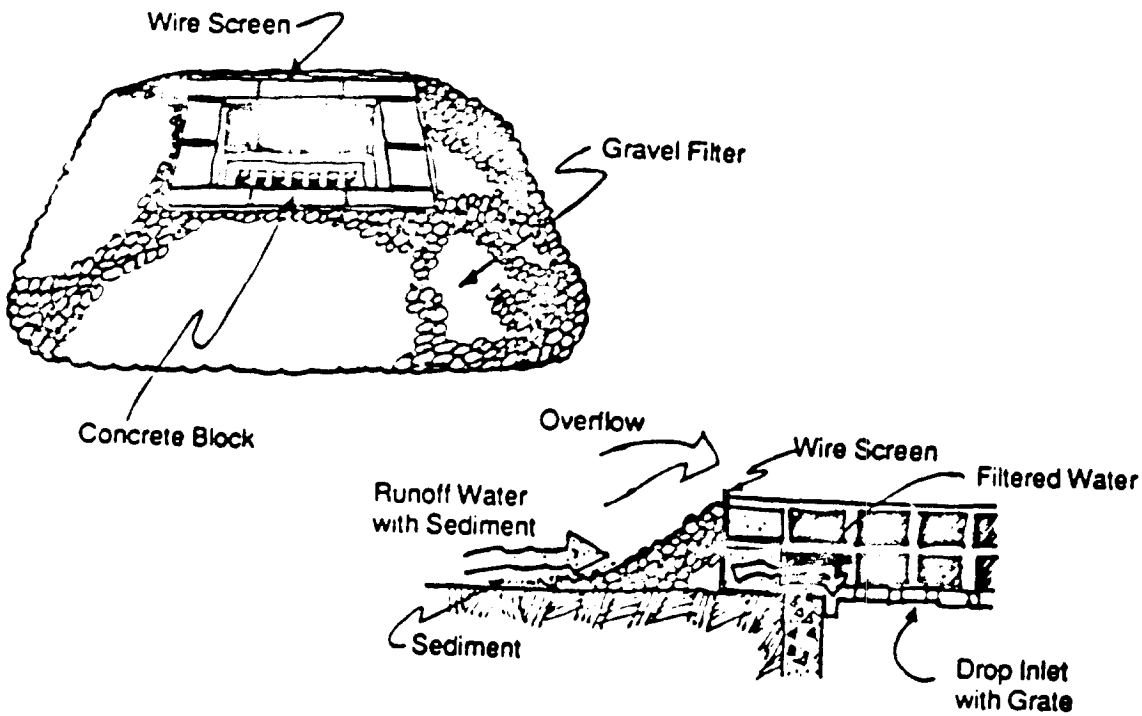
Figure II-5.24 Block and Gravel Filter



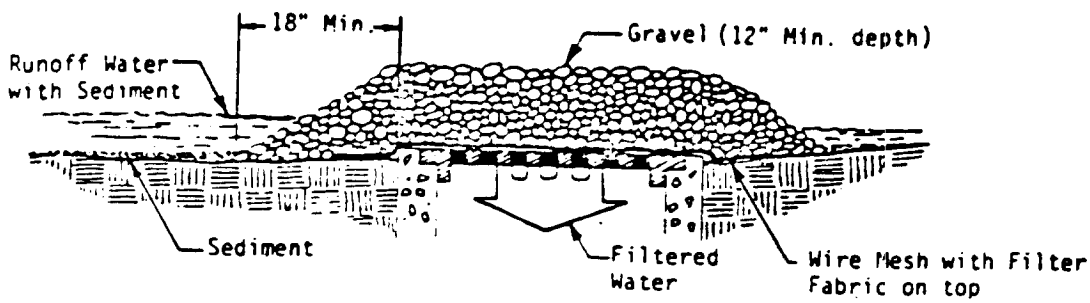


Figure II-5.25 Gravel and Wire Mesh Filter

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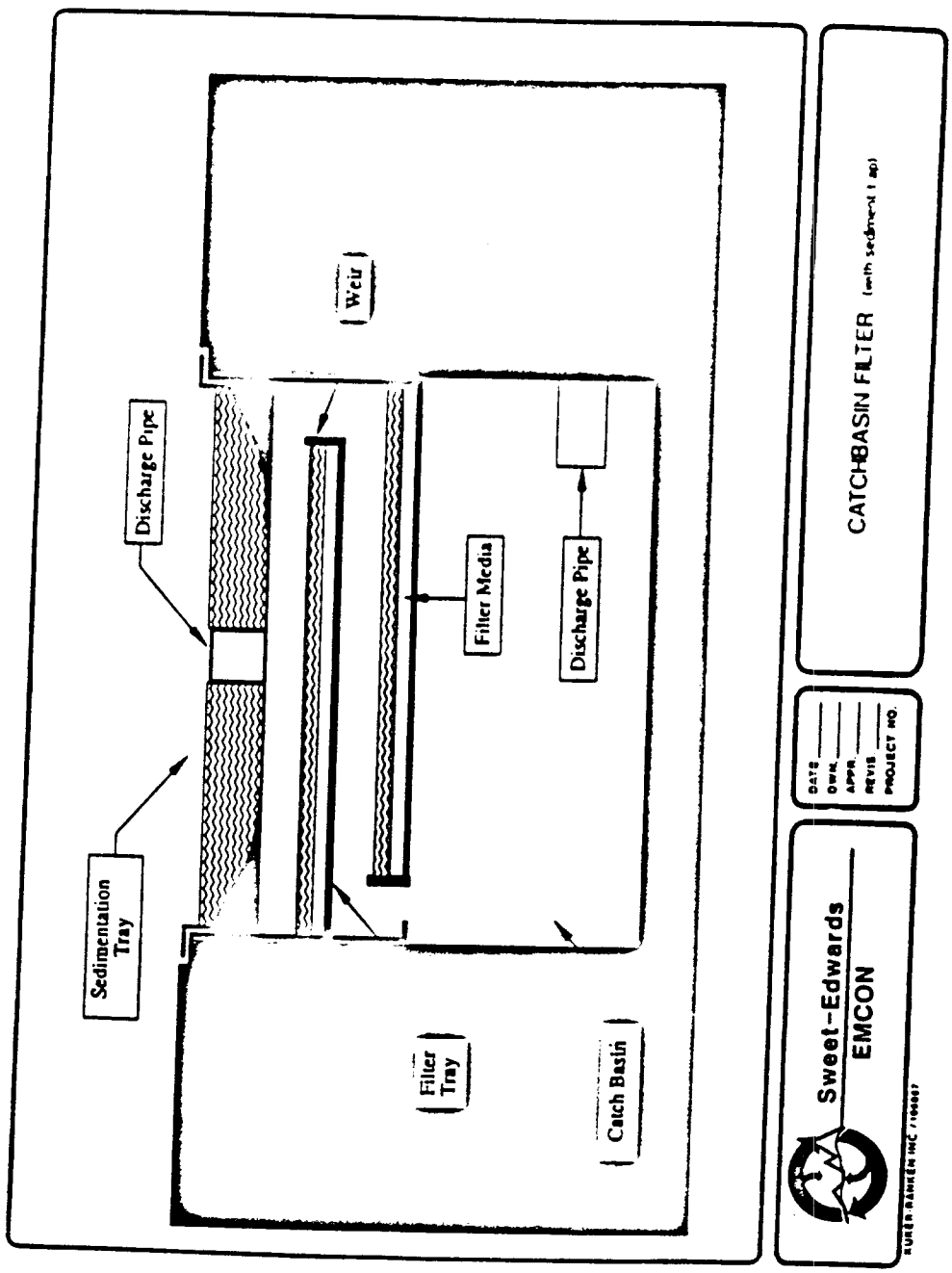
Figure II-5.26 Experimental Catchbasin Filter With Sediment Trap



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II-5.8.6 BMP E3.35: Sediment Trap

Code: (ST) Symbol: ▬▬

Editor's Note: Based on comments that were received during the technical review period of the manual, BMPs E3.35 (Sediment Trap) and E3.40 (Sediment Pond) were revised and the use of the Universal Soil Loss Equation to calculate the sediment storage volume was dropped. Instead, volume calculations are to be based on one of the methods found in Volume III, Runoff Control, and a constant depth for sediment storage.

It is important to understand that sizing is perhaps less important for these BMPs (because of their temporary nature) than is constant maintenance. Inspections must be made and sediment removed regularly for either of these BMPs to function well.

Definition A small temporary ponding area, with a gravel outlet, formed by excavation and/or by constructing an earthen embankment.

Purpose

To collect and store sediment from sites cleared and/or graded during construction. It is intended for use on relatively small building areas, with no unusual drainage features, and projected quick build-out time. It should help in reducing silt-laden runoff. This silt-laden runoff clogs off-site conveyance systems and destroys habitat, particularly in streams. The trap is a temporary measure (with a design life of approximately 6 months) and is to be maintained until the site area is permanently protected against erosion by vegetation and/or structures.

Conditions Where Practice Applies

- Proposed building sites where the tributary drainage area is less than 3 acres.

Advantages

- Downstream riparian properties will not be damaged by sediment deposits originating from that development.
- Sediment deposits downstream will not reduce the capacity of the stream channel.
- Sediment will not cause the clogging of downstream impoundments and other facilities.

Disadvantages/Problems

- Serves only limited areas.
- Sediment traps (and ponds, see BMP E3.40) are only practically effective in removing sediment down to about the medium silt size fraction. Runoff with sediment of finer grades (fine silt and clay) will pass through untreated, emphasizing the need to control erosion to the maximum extent first.

Planning Considerations

Sediment traps should be used only for small drainage areas. If the contributing drainage area is greater than 3 acres, refer to Sediment Ponds (see BMP E3.40), or subdivide the catchment area (see Figure II-5.27).

Sediment must be periodically removed from the trap. Plans shall detail how this

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sediment is to be disposed of, such as by use in fill areas on-site, or removal to an approved off-site dump. Sediment traps, along with other perimeter controls, shall be installed before any land disturbance takes place in the drainage area.

Safety

See Section II-5.8.7, Sediment Ponds (BMP E3.40).

Design Criteria

The sediment trap may be formed completely by excavation or by construction of a compacted embankment. It shall have a 1.5 foot deep sump for sediment storage. The outlet shall be a weir/spillway section, with the area below the weir acting as a filter for sediment and the upper area as the overflow spillway depth.

- See Figures II-5.27 and II-5.28 for details.
- The temporary sediment trap volume can be found by computing the detention volume required for the 2-year, 24-hour design storm using one of the approved methods found in Volume III, Chapter 1. Side slopes should not exceed 3:1. After determining the necessary volume, size the trap by adding an additional 1½ feet for sediment accumulation to the volume computed using the 2-year, 24-hour design storm.
- To complete the design of the temporary sediment trap:
  a. Figures II-5.28 and II-5.29 may be useful in designing the sediment trap.
  b. A 3:1 aspect ratio between the trap length and width of the trap is desirable. Length is defined as the average distance from the inlet to the outlet of the trap. This ratio is included in the computations for Figure II-5.28 for the surface area at the interface between the settling zone and sediment storage volume.
  c. Determine the bottom and top surface area of the sediment storage volume to be provided (see Figure II-5.29) using 1½ feet in depth for sediment storage and 3:1 side slope from the bottom of the trap. Note the trap bottom should be level.
  d. Determine the total trap dimensions by adding the depth required for the 2-year, 24-hour design storm above the surface of the sediment storage volume, while not exceeding 3:1 side slopes (see Figure II-5.29).

Maintenance

- The key to having a functional sediment trap is continual monitoring and regular maintenance. The size of the trap is less important to its effectiveness than is regular sediment removal. Sediment should be removed from the trap when it reaches approximately one foot in depth (assuming a 1½ sediment accumulation depth). Regular inspections should be done and additional inspections made after each large runoff-producing storm.
- All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with an approved manual.
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

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Figure II-5.27 ESC Structural Practices

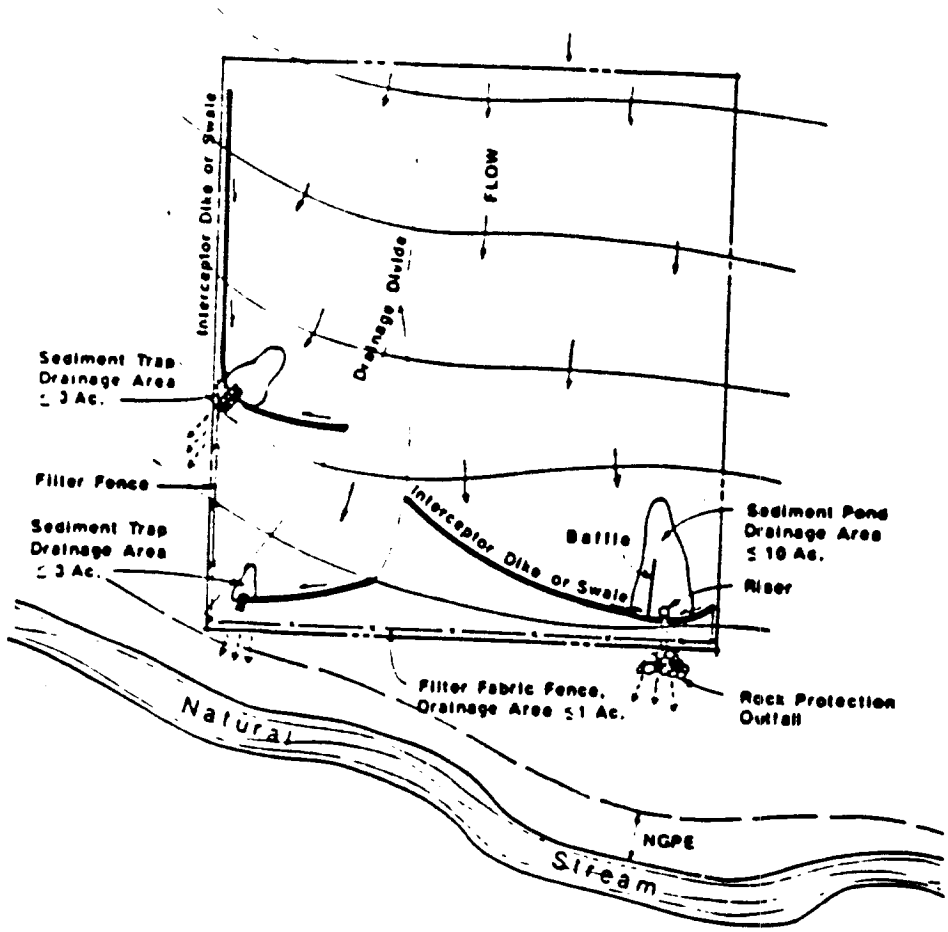

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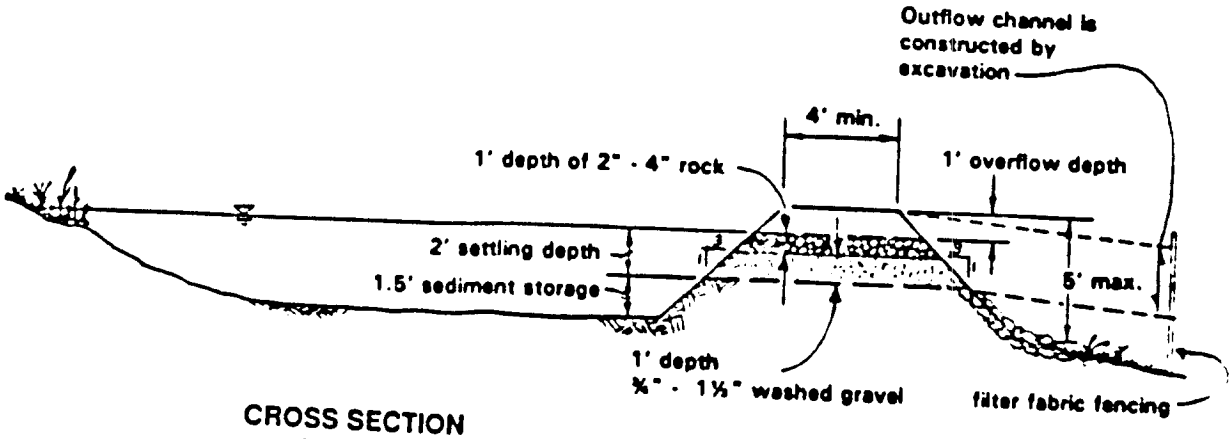
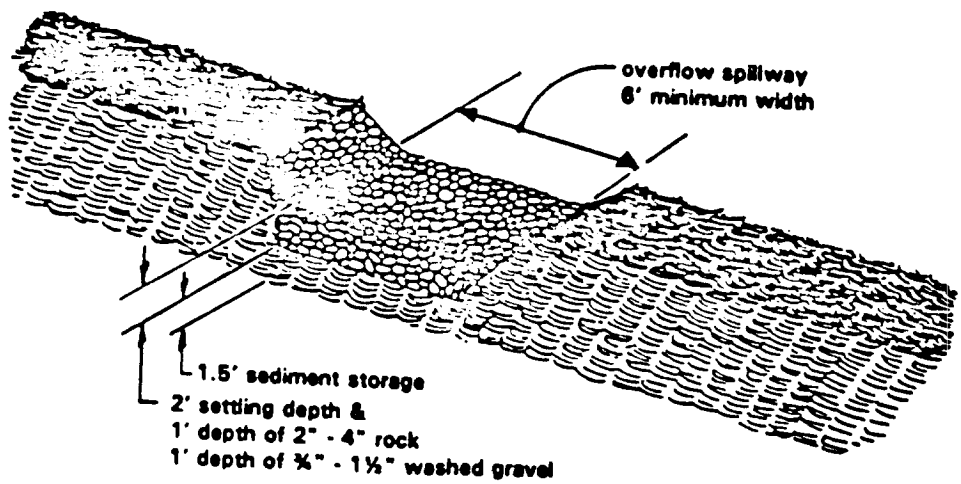
Figure II-5.28 Sediment Trap



CROSS SECTION
NO SCALE

note: may be constructed by excavation or by building a berm



SEDIMENT TRAP OUTLET
NO SCALE

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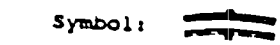
II-5.8.7 BMP E3.40: Temporary Sediment Pond (or Basin)

Code: S8 Symbol: 

Editor's Note: Based on comments that were received during the technical review period of the manual, BMPs E3.35 (Sediment Trap) and E3.40 (Sediment Pond) were revised and the use of the Universal Soil Loss Equation to calculate the sediment storage volume was omitted. Instead, volume calculations are to be based on one of the methods found in Volume III, Runoff Control, and a constant depth for sediment storage.

It is important to understand that sizing is perhaps less important for these BMPs (because of their temporary nature) than is constant maintenance. Inspections must be made and sediment removed regularly for either of these BMPs to function well.

Definition A temporary basin with a controlled stormwater release structure formed by constructing an embankment of compacted soil across a drainageway, or other suitable locations.

Purpose

To collect and store sediment from sites cleared and/or graded during construction or for extended periods of time before reestablishment of permanent vegetation and/or construction of structures. It is intended to help prevent erosion on the site which results in silt-laden runoff. The basin is a temporary measure (with a design life less than 1 year) and is to be maintained until the site area is permanently protected against erosion.

Conditions Where Practice Applies

- Proposed construction sites where the tributary drainage is less than 10 acres.

Safety

Sediment traps and ponds must be installed only on sites where failure of the structure would not result in loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities. Also, sediment traps and ponds are attractive to children and can be very dangerous. Local ordinances regarding health and safety must be adhered to. If fencing of the pond is required, the type of fence and its location shall be shown on the ESC plan.

Advantages

- Because of additional detention time, sediment ponds may be capable of trapping smaller sediment particles than traps. However, they are most effective when used in conjunction with other BMPs such as seeding or mulching.

Disadvantages/Problems

- Ponds may become an "attractive nuisance" and care must be taken to adhere to all safety practices.
- Sediment ponds are only practically effective in removing sediment down to about the medium silt size fraction. Sediment-laden runoff with smaller size fractions (fine silt and clay) will pass through untreated emphasizing the need to control erosion to the maximum extent first.

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Planning Considerations

Effectiveness

Sediment basins are at best only 70-80 percent effective in trapping sediment which flows into them. Therefore, they should be used in conjunction with erosion control practices such as temporary seeding, mulching, diversion dikes, etc. to reduce the amount of sediment flowing into the basin. Sediment basins are most effective when designed with a series of chambers.

Location

To improve the effectiveness of the basin, it should be located so as to intercept the largest possible amount of runoff from the disturbed area. The best locations are generally low areas below disturbed areas. Drainage into the basin can be improved by the use of diversion dikes and ditches. The basin must not be located in a stream but should be located to trap sediment-laden runoff before it enters the stream. The basin should not be located where its failure would result in the loss of life or interruption of the use or service of public utilities or roads.

Multiple Use

Sediment basins may be designed as permanent structures to remain in place after construction is completed for use as stormwater detention ponds. Wherever these structures are to become permanent, or if they exceed the size limitations of the design criteria, they must be designed as permanent ponds by a professional engineer licensed in the State of Washington. Permanent ponds are dealt with in Volume III, Runoff Control.

Design Criteria

The sediment pond may be formed by partial excavation and/or by construction of a compacted embankment. It may have one or more inflow points carrying polluted runoff. Baffles to spread the flow throughout the basin should be included (Figure II-5.30). A securely anchored riser pipe is the principal discharge mechanism along with an emergency overflow spillway. The riser pipe shall be solid with two 1-inch diameter dewatering holes located at the top of the sediment storage volume on opposite sides of the riser pipe as shown in Figure II-5.30. Outlet protection is provided to reduce erosion at the pipe outlet.

- The sediment pond volume is the sum of the sediment storage volume (3 feet in depth) plus a settling volume of not less than 2 feet in depth. The sediment depth is computed based on the basin surface area required to settle out the design particle at the design inflow rate.

  Computing the settling zone volume: The settling zone volume may be approximated by assuming a 2 foot depth above the sediment storage volume and extending the 3:1 side slopes as necessary, or by computing the precise volume as outlined below. The maximum settling zone depth shall be 4 feet.

  a. Pond surface area

     The settling zone volume is determined by the pond surface area which is computed using the following equation: $(SA) = 1.2Q_{in} / V_{in}$

     Where Q_{in} = design inflow based on the peak discharge from a 10-year, 24-hour duration design storm event from the tributary drainage area as computed using the methods described in Chapter III-1 of Volume III, Runoff Control.

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V_s = the settling velocity of the design soil particle. The design particle chosen is medium silt (0.02 mm) (1) This has a settling velocity (V_s) of 0.00096 ft/sec. Note that for the relatively common sandy loam soils found in the Puget Sound basin, approximately 80 percent of the soil particles are larger than 0.02 mm. Thus, choosing a design particle size of 0.02 mm gives a theoretical trapping efficiency of approximately 80 percent. In practice, and for more finely textured soils, the trapping efficiency would be less. However, as a general rule, it will not be necessary to design for a particle of size less than 0.02 mm, especially since the surface area requirement increases dramatically for smaller particle sizes. For example, a design particle of 0.01 mm requires about three times the surface area of 0.02 mm. However, for sites with very finely textured soils, the local government may require a smaller design particle size than 0.02 mm. Note also that choosing a V_s of 0.00096 ft/sec equates to a surface area (SA) of 1250 sq. ft. per cfs of inflow.

b. Settling depth (SD) should not be less than 2 feet and is also governed by the sediment storage volume surface area and relationship to the basin length (L). The basin length is defined as the average distance from the inlet to the outlet of the pond.

   The ratio of L/SD should be less than 200.

The settling volume is therefore the surface area (SA) times the required settling depth.

To complete the design of the sediment pond:

Total sediment pond volume and dimension are determined as outlined below:

a. Determine pond geometry for the sediment storage volume calculated above using 3 feet in depth and 3:1 side slopes from the bottom of the basin. Note, the basin bottom is level.

b. Extend the pond side slopes (at 3:1 max.) as necessary to obtain the settling zone volume at 2 foot depth minimum or as determined above, 4 foot maximum.

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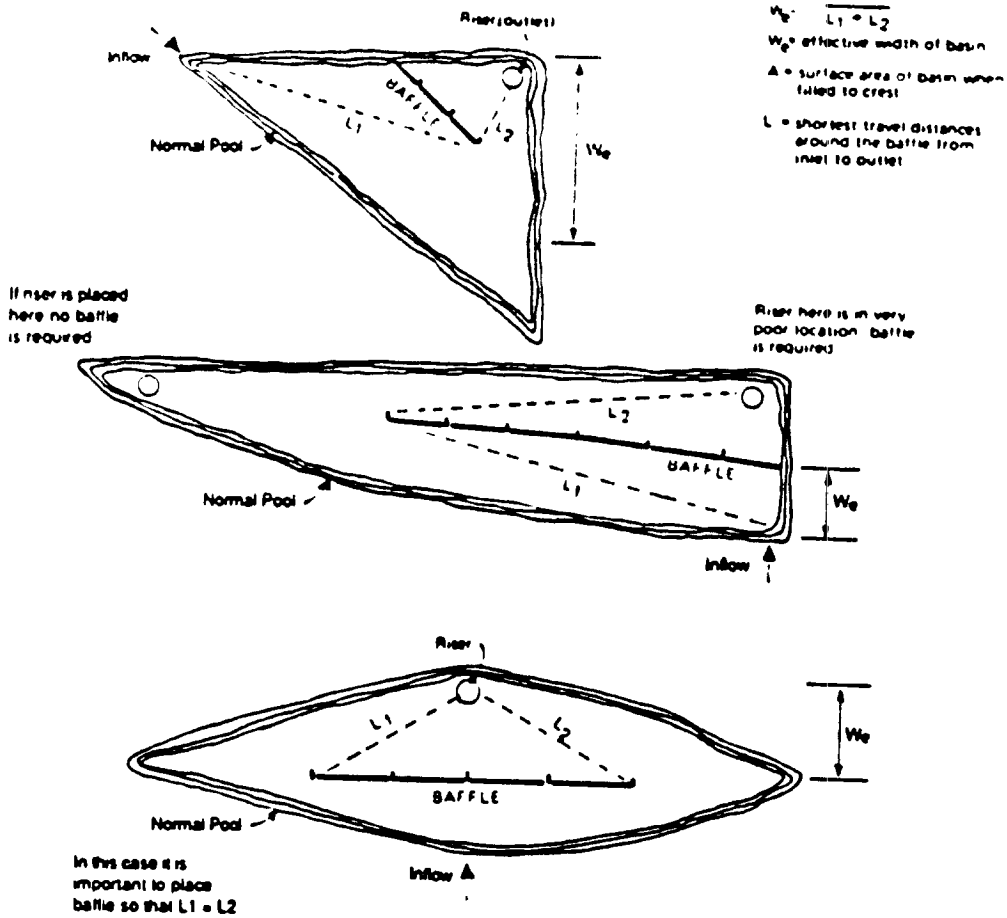
Figure II-5.29 Sedimentation Pond Baffles



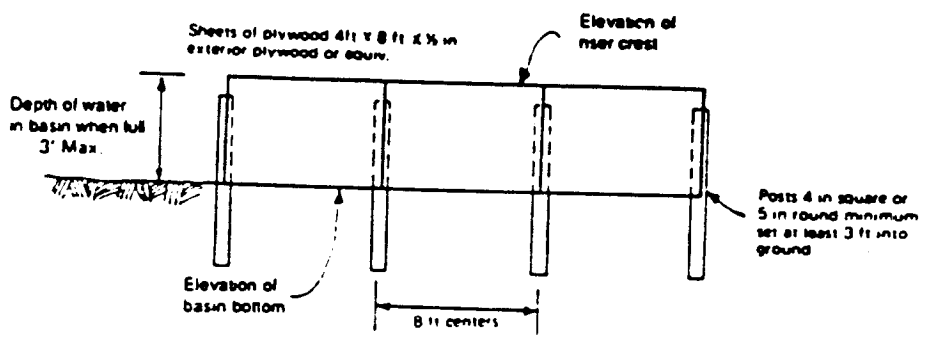


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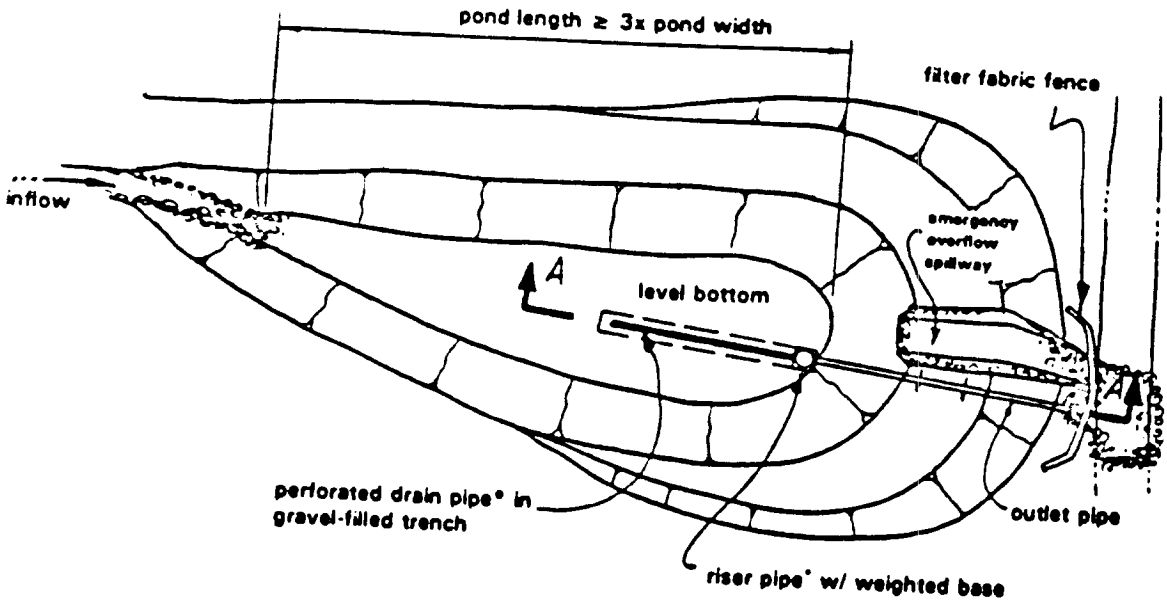
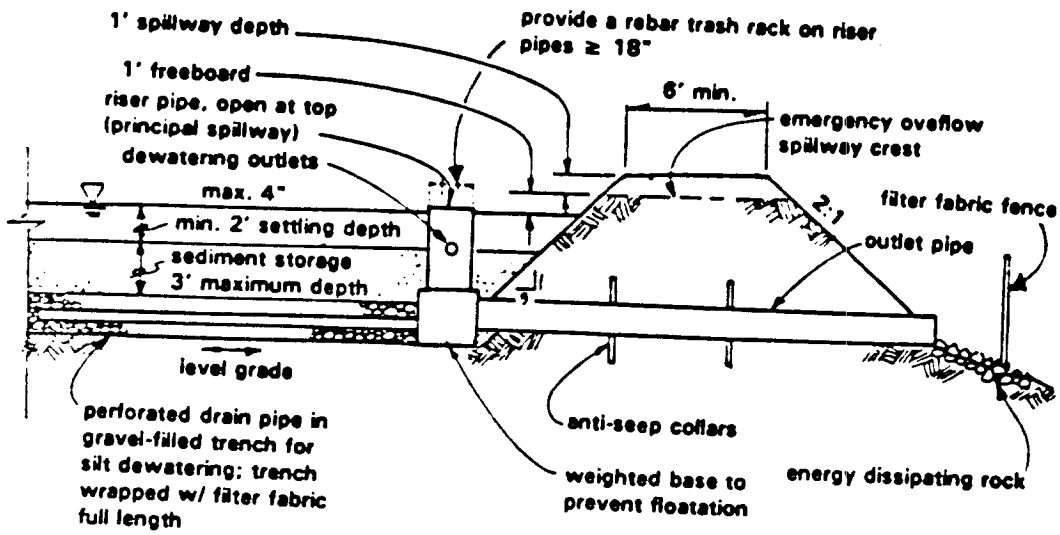
Figure II-5.30 Sediment Pond



* Note: Sediment dewatering may be accomplished with perforated pipe in trench as shown or with a perforated riser pipe covered with filter fabric and a gravel "cone". A control structure may also be required; see Conditions Where Practice Applies



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d. Adjust the geometry of the basin to effectively combine the settling zone volume and sediment storage volumes while preserving the depth and side slope criteria.

Provide baffles to prevent short-circuiting (see Figure II-5.30). A 6:1 aspect ratio between the basin length and width of the pond is desirable.

Maintenance

- Inspections should be made regularly, especially after large storm events. Sediment should be removed when it fills one half of the pond's total sediment storage area. The effectiveness of a sediment pond is based less on its size than on regular sediment removal.
- All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with an approved manual.
- All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal shall be permanently stabilized.

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II-5.9 EROSION AND SEDIMENT CONTROL ON INDIVIDUAL HOMESITES AND SMALL PARCELS

Background

Construction of many small developments can cause large amounts of sediment to be transported to receiving waters. Many stormwater management professionals in the Puget Sound basin believe that construction of individual family residences and businesses on small parcels causes more than three-quarters of all erosion problems in the area.

The conclusion drawn by a Metro study of single family residential construction sites was that a minority of sites cause a majority of the problems. Only 26 percent of the sites had any BMPs in place and 10 percent of the total surveyed had water quality problems (mainly sedimentation). Fifteen of the 52 sites that had water quality problems were located within 50 feet of a water body (3).

The erosion-sedimentation process on smaller areas is similar to that on larger areas and is primarily influenced by four factors:

1. Climate - The frequency, intensity, and duration of precipitation influences the amount of runoff from a given area particularly when the ground surface is exposed or unprotected.

2. Soils - The texture, structure, and organic matter content (and thus the permeability and infiltration rate) of a soil largely determines its tendency to erode.

3. Topography - The size, shape, and slope characteristics (steepness, length, and profile) of a watershed or a small lot within the watershed influences the amount, duration, and intensity of runoff.

4. Vegetative Cover - The type, amount, and consistency of vegetation and ground litter are important in keeping erosion processes to a minimum. There are a number of characteristics of an effective vegetative cover:

   a. Vegetative cover absorbs the energy of raindrops. Raindrops detach soil particles and destroy soil structure, and the splash of rain hitting the ground can transport soil particles. On an erodible soil, a very heavy rainfall may splash as much as 100 tons of soil per acre of exposed land and move each particle 4 to 5 feet (4).

   b. Vegetative cover will reduce the volume and velocity of storm runoff. Vegetation absorbs water, and a thick mass of vegetation on the soil surface will also serve as a barrier to prevent high velocity surface runoff.

   c. Roots aid in binding soil particles together giving the soil resistance to erosion.

   d. Roots break up a heavy soil structure and increase its porosity. This increases the soils ability to absorb water. Undisturbed forest soils in the Pacific Northwest have only small amounts of surface runoff even during the largest storms.

   e. Vegetation aids in removing surface and subsurface water through evapotranspiration. In a coniferous forest, evapotranspiration will release back to the air up to 40 percent of all precipitation over a years time.

The following are some of the damaging activities and conditions that may occur during development:

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- Often, exposed and unprotected soil is left throughout the development. When runoff occurs, sediment is transported into the nearest stormwater facility or stream, eventually clogging it.
- Vehicles and heavy equipment track soil from the development onto the street. Gullies formed by tire tracks become channels for runoff flow.
- Vegetation bordering streams or lakes is often removed during construction. This increases the water temperature by removing shade. An increase in water temperature can contribute to algae blooms and may change the species composition of the lake or stream. Because the vegetation has been removed, there is no barrier to prevent sediment from entering the stream. This can clog spawning grounds and fishes' gills.

These problems may occur during work performed by subcontractors who are on-site for a very short time. Cooperation and communication between buyers (or developers), builders, and subcontractors are essential to minimize erosion and damage to the environment.

Some important design principles for controlling erosion and sedimentation in developing areas are as follows:

1. Plan the development to fit the particular topography, soils, waterways, and natural vegetation of a site.
   a. Avoid wet areas. Wet areas can often be identified by the type of vegetation that grows there. Skunk cabbage, rushes, horsetail ferns, sedges, cattails, willows, and shrubby-looking stunted red alders may be found in moist or even saturated soil conditions. Check the area during the wet season, not in the middle of the summer.
   b. Consider the effect of changes in topography. Wet areas are often found at the base of hills. Other wet areas are found along streams, in depressions where water can collect, and in natural drainageways.
   c. Building on steep slopes without erosion BMPs can cause severe erosion problems because of uncontrolled, high velocity surface runoff.
2. Do not plan construction or other site disturbance activities during the rainy season.
3. Minimize the length and angles of graded slopes and fills.
4. Retain and/or properly manage runoff volume and velocity on areas subject to erosion. Divert runoff away from disturbed areas.
5. Save natural vegetation whenever possible to act as a buffer zone and help stabilize the soil.
6. Keep sediment on-site.
7. Stabilize disturbed areas immediately upon completion of earthmoving activities. Use temporary or permanent seeding, or mulches such as straw to provide immediate protection from erosion. The County Conservation District office or local Soil Conservation Service office can provide information on seeding mixtures and application rates.
8. Erosion and sediment control facilities must be maintained after they are installed. They must be inspected on a regular basis and repaired or replaced as necessary.

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II-5.10 BMPS FOR SMALL PARCELS

A Small Parcel Stormwater Management Plan must be developed which satisfies the Small Parcel Minimum Requirements found in Volume II, Chapter II-2. These in turn may be satisfied by employing a suitable selection from the following list of BMPs.

BMP ES.10 Planned Clearing and Grading.

Plan and implement proper clearing and grading of the site. It is most important only to clear the areas needed, thus keeping exposed areas to a minimum. Phase clearing so that only those areas that are actively being worked are uncovered.

Note: Clearing limits should be flagged in the lot or area prior to initiating clearing.

BMP ES.20 Excavated Basement Soil

Locate excavated basement soil a reasonable distance behind the curb, such as in the backyard or side yard area. This will increase the distance eroded soil must travel to reach the storm sewer system. Soil piles should be covered until the soil is either used or removed. Piles should be situated so that sediment does not run into the street or adjoining yards.

BMP ES.30 Backfilling

Backfill basement walls as soon as possible and rough grade the lot. This will eliminate large soil mounds which are highly erodible and prepares the lot for temporary cover which will further reduce erosion potential.

BMP ES.40 Removal of Excess Soil

Remove excess soil from the site as soon as possible after backfilling. This will eliminate any sediment loss from surplus fill.

BMP ES.50 Management of Soil Banks

If a lot has a soil bank higher than the curb, a trench or berm should be installed moving the bank several feet behind the curb. This will reduce the occurrence of gully and rill erosion while providing a storage and settling area for stormwater.

BMP ES.60 Construction Road Access

Apply gravel or crushed rock to the driveway area and restrict truck traffic to this one route. Driveway paving can be installed directly over the gravel. This measure will eliminate soil from adhering to tires and stops soil from washing into the street. This measure requires periodic inspection and maintenance including washing, top-dressing with additional stone, reworking and compaction. (For further details see BMP E?.10, Chapter II-5.7.1).

BMP ES.70 Soil Stabilization

Stabilize denuded areas of the site by mulching, seeding, planting, or sodding. For further details on standards and specifications, see BMPs No. E1.10, E1.15, E1.35, E1.40 in Chapter II-5.

BMP ES.80 Street Cleaning

Provide for periodic street cleaning to remove any sediment that may have been tracked out. Sediment should be removed by shovelling or sweeping and carefully removed to a suitable disposal area where it will not be re-eroded.

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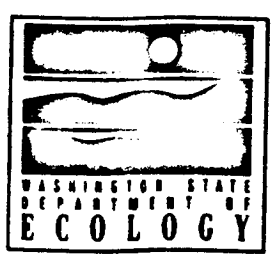
(The Technical Manual)

Volume III - Runoff Control



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Purpose of This Volume

The purpose of this volume of the stormwater manual is to provide technical assistance in the control of both stormwater runoff quality and quantity. Prior to the use of BMPs in this volume, Chapter I-2, "Minimum Requirements for All New Development and Redevelopment," Chapter I-3, "Preparation of Stormwater Site Plans," and Chapter I-4, "BMP Selection Process for Permanent Stormwater Quality Control Plans" should be read. These chapters provide an overview of the necessary requirements and the basis for the proper selection of BMPs to fit a particular site.

Chapter Contents

Chapter III-1 reviews methods of hydrologic analysis, covers the use hydrograph methods for sites and provides an overview of various computerized modeling methods and analysis of closed depressions. The appendix at the end of the chapter by Bruce Barker et al. provides information on the latest efforts to produce a revised hydrologic analysis methods that will provide more accurate estimation of runoff for sites in western Washington. The appendix also includes a paper by Pat Powers of the Washington State Dept. of Fisheries which provides the rationale for a discharge rate of 50 percent of the preexisting 2-year, 24-hour design storm peak rate.

Chapter III-2 covers the design of conveyance systems including pipe systems, culverts, outfalls, open channels and floodplain/floodway analysis.

Chapter III-3 covers infiltration and filtration facilities. General limitations are listed to ensure that infiltration facilities are installed properly and to minimize ground water contamination. Infiltration basins, infiltration trenches, roof downspout systems, modular pavement, porous pavement, sand filtration basins, sand filtration trenches, and aquatards are covered.

Chapter III-4 covers detention facilities. Although infiltration systems are the preferred method for treatment of stormwater, detention systems are necessary in areas where infiltration is not possible. BMPs presented in this chapter include wet ponds, constructed wetlands, pre-settling basins, extended detention dry ponds, vaults and tanks.

Chapter III-5 provides information on natural and created wetlands. These wetlands are not considered to be BMPs but are to be managed to maintain their beneficial uses. While they serve a function in stormwater management they are not to be considered the primary facilities for providing runoff treatment or streambank erosion control. The role of natural wetlands in stormwater management is still open to question in many minds, but preliminary guidelines developed by Richard R. Horner, Coordinator of the Puget Sound Wetlands Research Committee, are provided for discussion purposes.

Chapter III-6 covers the design of biofiltration swales and vegetative filter strips.

Chapter III-7 covers oil/water separators, which have limited applications in controlling stormwater runoff.

Chapter III-8 covers stream stabilization BMPs. These BMPs are designed to correct existing streambank erosion problems by stabilizing eroding streambanks, preferably using vegetative techniques. These can augment BMPs which are designed to provide streambank erosion control using detention techniques.

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Acknowledgments

This volume of the manual was compiled by adapting from existing material and with the advice of a technical advisory group comprised of people representing local agencies and other interested parties within the Puget Sound basin. The major sources of material include:

(i) King County Surface Water Management Manual, January, 1990

(ii) Standards and Specifications for Infiltration Practices, Maryland Department of Natural Resources, February, 1984.

(iii) Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs, Metropolitan Washington Council of Governments, prepared by Thomas R. Schueler, 1987.

(iv) Guidelines for Constructing Wetland Stormwater Basins, Maryland Dept. of Natural Resources, March, 1987.

In addition, Dr. Richard Horner provided original material on design of biofilters, and preliminary guidelines on natural wetlands and stormwater management.

Other sources that were used less extensively are referenced at the end of each section or chapter. Members of the technical advisory group include:

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Peter B. Birch, Ph.D., Helen E. Pressley and Patrick D. Hartigan
Compilers and Editors

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CHAPTER III-1

HYDROLOGIC ANALYSIS

III-1.1 INTRODUCTION

The broad definition of hydrology is "the science which studies the source, properties, distribution, and laws of water as it moves through its closed cycle on the earth (the hydrologic cycle)." As applied in this manual, however, the term "hydrologic analysis" addresses and quantifies only a small portion of this cycle. That portion is the relatively short-term movement of water over the land resulting directly from precipitation and called surface water or stormwater runoff. Localized and long-term ground water movement must also be of concern, but generally only as they affect or relate to the movement of water on or near the surface, such as stream base flow or infiltration systems.

The purpose of this chapter is to define the minimum computational standards required and also to outline how these may be applied, and to reference where more complete details may be found, should they be needed. The chapter also provides details on the hydrologic design process; that is what are the steps required in conducting a hydrologic analysis, including flow routing.

III-1.2 DISCUSSION OF HYDROLOGIC ANALYSIS METHODS USED FOR DESIGNING BMPs

The use of SCS-based hydrologic models has limitations when designing streambank erosion control BMPs and efforts are underway to develop improved hydrologic analysis methods for the Puget Sound basin. Particularly promising is the Hydrologic Simulation Program Fortran (hereafter "HSPF"), a continuous simulation model as opposed to the single event SCS-type models. It is anticipated that HSPF will be available for use within the next year. In the interim, the use of SCS-based methods is recommended so long as appropriate correction factors are incorporated and design concerns are taken into account. This discussion will focus on the use of the Santa Barbara Urban Hydrograph method (hereafter "SBUH"). Note that the use of SCS-type models may continue to be acceptable for designing runoff treatment BMPs. Please note that to meet Minimum Requirement #3 Runoff Treatment, the 6-month, 24-hour water quality design storm must be treated.

Before utilizing the SBUH method, it is important to understand the different concerns for the runoff treatment storm as opposed to the streambank erosion control storms. The runoff treatment storm is the 6-month, 24-hour event and the major concern with using SBUH is the need to accurately model inflow hydrographs for infiltration, filtration, and detention-type BMPs. Recall that the 6-month, 24-hour storm volume is equal to 64 percent of the volume of the 2-year, 24-hour storm event. No correction factor to the BMP volume is necessary for the runoff treatment storm. The situation with the streambank erosion control storms (i.e., the 2, 10, and 100-year events) is quite different. For these events, BMPs are sized based on a comparison of the *existing condition* hydrograph with the *developed condition* hydrograph (for runoff treatment only the *developed condition* is modeled). There are two primary concerns with the use of SBUH when designing streambank erosion control BMPs. The first is how it estimates peak flow rates for pervious areas. The second concern is the use of a 24-hour duration storm, which is too short a duration in the Puget Sound basin for larger storms.

A summary of the concerns with SBUH is in order. While SBUH gives acceptable estimates of total runoff volumes, it tends to overestimate peak flow rates from pervious areas because it cannot adequately model subsurface flow (which is a dominant flow regime for pre-development conditions in the Puget Sound basin). One

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reason SBUH overestimates the peak flow rate for pervious areas is because the actual time of concentration is typically greater than what is assumed. Better flow estimates could be made if a longer time of concentration was used. This would change both the peak flow rate (i.e., it would be lower) and the shape of the hydrograph (i.e., peak occurs somewhat later) such that the hydrograph would better reflect actual conditions. Note that it is *not* necessary to make corrections to the curve number ("CN") for modeling runoff from pervious areas when using SBUH.

The other major weakness of the current use of SBUH is that it is used to model a 24-hour storm event, which is too short to model larger storms in the Puget Sound basin. The use of a 7-day storm is a more correct choice for Puget Sound, in conjunction with the use of a continuous simulation model, such as HSPF. The SBUH model may not be adequate for modeling 7-day events and it is anticipated that it will be eventually replaced by the HSPF model. Note that the use of the 7-day duration storm will apply *only* to streambank erosion control BMPs and not to runoff treatment BMPs, as the 24-hour duration event is the correct one for runoff treatment purposes.

When designing a runoff treatment BMP, the primary concern with using SBUH is modeling of the inflow hydrograph to the BMP. SBUH tends to underestimate the time of concentration, thus the peak flow rate occurs too early. This can create problems for detention-type BMPs, such as pre-settling basins and dry vaults, because these BMPs are designed to achieve a 24-hour *residence time*. Calculation of the residence time is sensitive to the shape of the inflow hydrograph. The inflow hydrograph is also of fundamental importance when designing an infiltration or filtration BMP as these BMPs are sized based on a routing of the inflow hydrograph through the BMP. The best solution at this time is to try to account for subsurface flow when estimating the time of concentration. For sites with low impervious cover, this will increase the time of concentration, thus reducing the peak flow rate and shifting the peak rate to a somewhat later time. Note that for BMPs which maintain "permanent pools" (e.g., wet ponds) then none of the above concerns apply since the permanent pool volume is adequately predicted by SBUH.

When designing streambank erosion control BMPs, it will be necessary to apply a correction factor to the design volume of the BMP when using SBUH to model 24-hour storm events. Ecology currently recommends that correction factors of 20 percent and 50 percent apply to residential sites and commercial sites, respectively. Figure III-1.1 is provided which graphically illustrates the correction factor based on site impervious cover. This correction factor is to be applied to the volume of the BMP without changing its depth or the design of the outlet structure, thus an increase in surface area will result.

Appendix AIII-1.2 discusses this issue further. Also included in another appendix are the isopluvial maps for the 2, 10, and 100-year, 24-hour storm events.

III-1.3 MINIMUM COMPUTATIONAL STANDARDS

The minimum computational standards required depend on the type of information required and the size of the drainage area to be analyzed, as follows:

1. For all computations, except for basin plans or equivalent, the minimum standard shall be the Soil Conservation Service Unit Hydrograph (SCSUH) method (1) with the level pool routing method, or equivalent hydrograph techniques, subject to approval of the local government. The Santa Barbara Urban Hydrograph (SBUH) method is also an acceptable method.

2. If a basin plan is being prepared, then the hydrologic analysis shall be performed using a continuous simulation model such as EPA's Hydrological Simulation Program - Fortran (HSPF) model (2), or EPA's Stormwater Model (SWM) (3), or equivalent, as approved by the local government.

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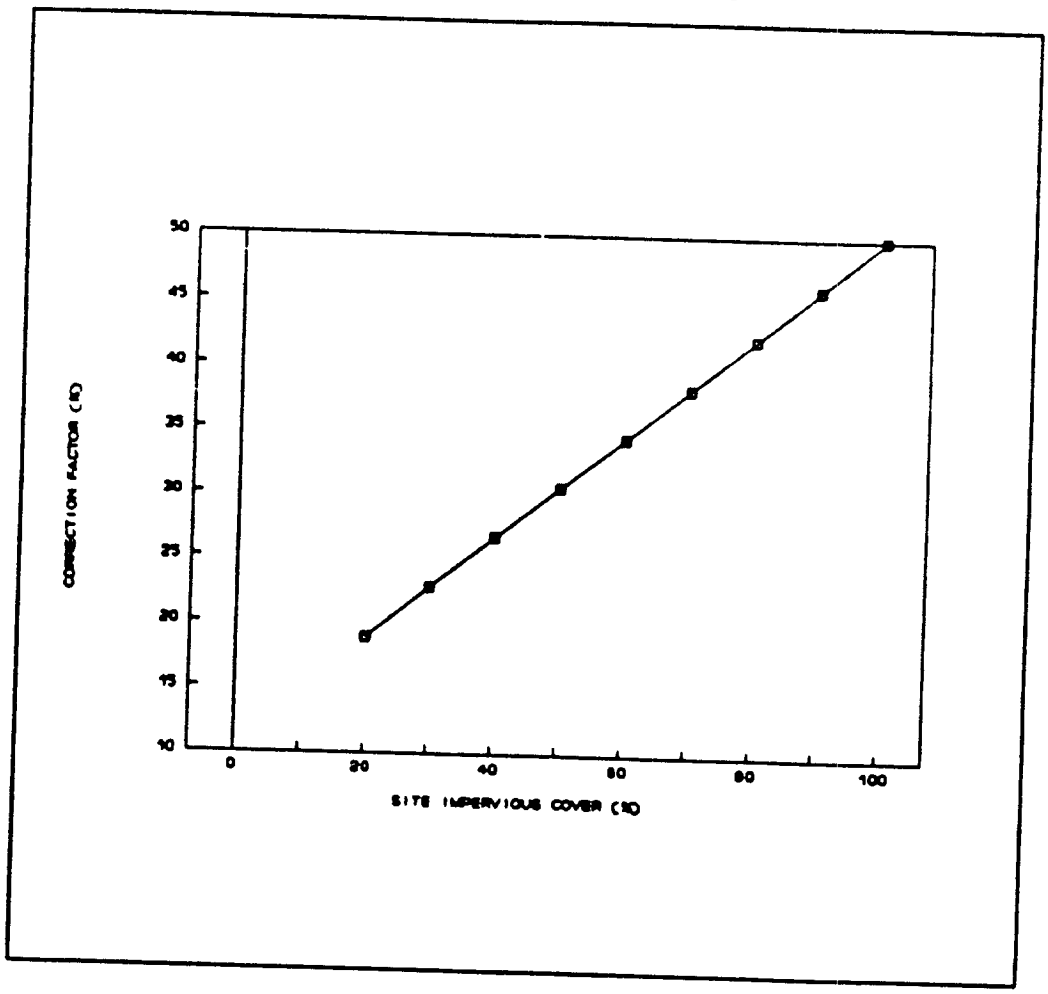
FIGURE III-1.1
Volume Correction Factor to be Applied to
Streambank Erosion Control BMPs
Based on Site Impervious Cover



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Significant progress has been made by the United States Geological Survey (in cooperation with the counties of King, Snohomish, Pierce, and Thurston, and METRO) with the development of a local version of the HSPF model. This work has involved development of "runoff files" for various land types defined by vegetation, slope, and soil type (3). These runoff files will describe runoff characteristics of simulated runoff from a watershed with measured runoff. As a result, one will be able to simulate runoff from any other ungauged basin where only the distribution of land types is known. The model will be able to be applied on individual development sites of less than about 200 acres. This work is expected to be completed within the next year through a grant with the Center for Urban Water Resources Management at the University of Washington.

A continuous simulation model has a considerable advantage over the SCS and Rational Methods (and similar methods) that are single event-based. The single event model cannot take into account storm events that may occur just before or just after the single event (the design storm) that is under consideration. In addition, the runoff files generated for the HSPF model are the result of a considerable effort to introduce local parameters into the model and are therefore believed to result in better estimation of runoff than the SCS or Rational methods.

On the other hand, the HSPF model is relatively complex to use and is best suited for large scale applications such as basin plans or master drainage plans (see below).

III-1.4 HYDROGRAPH METHOD

Hydrograph analysis utilizes the standard plot of runoff flow versus time for a given design storm, thereby allowing the key characteristics of runoff such as peak, volume, and phasing to be considered in the design of drainage facilities.

The physical characteristics of the site and the design storm determine the magnitude, volume, and duration of the runoff hydrograph. Other factors such as the conveyance characteristics of channel or pipe, merging tributary flows, branching of channels, and flooding of lowlands can alter the shape and magnitude of the hydrograph. In the following sections, the key elements of hydrograph analysis are presented, namely:

- Design storm hyetograph
- Runoff parameters
- Hydrograph synthesis
- Hydrograph routing
- Hydrograph summation and phasing
- Computer applications

III-1.4.1 Design Storm Hyetograph

All storm event hydrograph methods require the input of a rainfall distribution or design storm hyetograph. The design storm hyetograph is essentially a plot of rainfall depth vereus time for a given design storm frequency and duration. It is usually presented as a dimensionless plot of unit rainfall depth (increment rainfall depth for each time interval divided by the total rainfall depth) versus time.

The hyetograph provided in this section is to be used for all hydrograph analysis. See Figure III-1.2 and Table III-1.1. The hyetograph is the standard SCS Type 1A

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rainfall distribution resolved to 10-minute time intervals for greater sensitivity in computing peak rates of runoff in urbanizing basins. The hyetograph was interpolated by Surface Water Management Division staff from King County from the SCS mass distribution and may differ slightly from the distribution used in other SCS-based computer models, particularly those which are not resolved to 10-minute time intervals.

The design storm hyetograph is constructed by multiplying the dimensionless hyetograph times the rainfall depth (in inches) for the design storm.

The total depth of rainfall (in tenths of an inch) for storms of 24-hour duration and 2, 5, 10, 25, 50, and 100-year recurrence intervals are published by the National Oceanic and Atmospheric Administration (NOAA). The information is presented in the form of "isopluvial" maps for each state. Isopluvial maps are maps where the contours represent total inches of rainfall for a specific duration. Isopluvial maps for the Puget Sound basin for the 2, 5, 10, 25, 50, and 100-year recurrence interval and 24-hour duration storm events can be found in the NOAA Atlas 2, "Precipitation - Frequency Atlas of the Western United States, Volume IX-Washington. Appendix III-2-A provides the isopluvials for the 2, 10, and 100-year, 24-hour design storms for the Puget Sound basin.

For project sites with tributary drainage areas above elevation 1000 MSL, an additional total precipitation must be added to the total depth of rainfall, for the 25, 50, and 100-year design storm events, to account for the potential average snowmelt which occurs during major storm events.

This M_s factor is computed as follows:

$$M_s \text{ (in inches)} = 0.004 \, (MB_u - 1000);$$

where:

MB_u = the mean tributary basin elevation above sea level (in feet).

Example:

Given: Project location: East of North Bend near I-90. MB_u = 1837 feet.

Design Storm Event: 25-year (for culvert sizing); P_{25} = 7 inches

Compute: $M_s = 0.004 \, (MB_u - 1000) = (0.004) \, (1837 - 1000)$

$= \underline{3.35 \text{ inches}}$

Adjusted P_{25} = $P_{25} + M_s$
= (7 inches) + (3.35 inches)
= $\underline{10.35 \text{ inches}}$

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Table III-1.1 24-hour Design Storm Hyetograph Values

TIME FROM BEGINNING OF STORM	PERCENT RAINFALL	CUMUL PERCENT RAINFALL	TIME FROM BEGINNING OF STORM	PERCENT RAINFALL	CUMUL PERCENT RAINFALL	TIME FROM BEGINNING OF STORM	PERCENT RAINFALL	CUMUL PERCENT RAINFALL
0	0.00	0.00	480	1.80	46.34	960	0.50	81.40
10	0.40	0.40	490	1.34	47.68	970	0.50	81.90
20	0.40	0.80	500	1.34	49.02	980	0.50	82.40
30	0.40	1.20	510	1.34	50.36	990	0.40	82.80
40	0.40	1.60	520	0.88	51.24	1000	0.40	83.20
50	0.40	2.00	530	0.88	52.12	1010	0.40	83.60
60	0.40	2.40	540	0.88	53.00	1020	0.40	84.00
70	0.40	2.80	550	0.88	53.88	1030	0.40	84.40
80	0.40	3.20	560	0.88	54.76	1040	0.40	84.80
90	0.40	3.60	570	0.88	55.64	1050	0.40	85.20
100	0.40	4.00	580	0.88	56.52	1060	0.40	85.60
110	0.50	4.50	590	0.88	57.40	1070	0.40	86.00
120	0.50	5.00	600	0.88	58.28	1080	0.40	86.40
130	0.50	5.50	610	0.88	59.16	1090	0.40	86.80
140	0.50	6.00	620	0.88	60.04	1100	0.40	87.20
150	0.50	6.50	630	0.88	60.92	1110	0.40	87.60
160	0.50	7.00	640	0.72	61.64	1120	0.40	88.00
170	0.60	7.60	650	0.72	62.36	1130	0.40	88.40
180	0.60	8.20	660	0.72	63.08	1140	0.40	88.80
190	0.60	8.80	670	0.72	63.80	1150	0.40	89.20
200	0.60	9.40	680	0.72	64.52	1160	0.40	89.60
210	0.60	10.00	690	0.72	65.24	1170	0.40	90.00
220	0.60	10.60	700	0.72	65.96	1180	0.40	90.40
230	0.70	11.30	710	0.72	66.68	1190	0.40	90.80
240	0.70	12.00	720	0.72	67.40	1200	0.40	91.20
250	0.70	12.70	730	0.72	68.12	1210	0.40	91.60
260	0.70	13.40	740	0.72	68.84	1220	0.40	92.00
270	0.70	14.10	750	0.72	69.56	1230	0.40	92.40
280	0.70	14.80	760	0.57	70.13	1240	0.40	92.80
290	0.82	15.62	770	0.57	70.70	1250	0.40	93.20
300	0.82	16.44	780	0.57	71.27	1260	0.40	93.60
310	0.82	17.26	790	0.57	71.84	1270	0.40	94.00
320	0.82	18.08	800	0.57	72.41	1280	0.40	94.40
330	0.82	18.90	810	0.57	72.98	1290	0.40	94.80
340	0.82	19.72	820	0.57	73.55	1300	0.40	95.20
350	0.95	20.67	830	0.57	74.12	1310	0.40	95.60
360	0.95	21.62	840	0.57	74.69	1320	0.40	96.00
370	0.95	22.57	850	0.57	75.26	1330	0.40	96.40
380	0.95	23.52	860	0.57	75.83	1340	0.40	96.80
390	0.95	24.47	870	0.57	76.40	1350	0.40	97.20
400	0.95	25.42	880	0.57	76.90	1360	0.40	97.60
410	1.34	26.76	890	0.50	77.40	1370	0.40	98.00
420	1.34	28.10	900	0.50	77.90	1380	0.40	98.40
430	1.34	29.44	910	0.50	78.40	1390	0.40	98.80
440	1.80	31.24	920	0.50	78.90	1400	0.40	99.20
450	1.80	33.04	930	0.50	79.40	1410	0.40	99.60
460	3.40	36.44	940	0.50	79.90	1420	0.40	100.00
470	5.40	41.84	950	0.50	80.40	1430		
480	2.70	44.54	960	0.50	80.90	1440		

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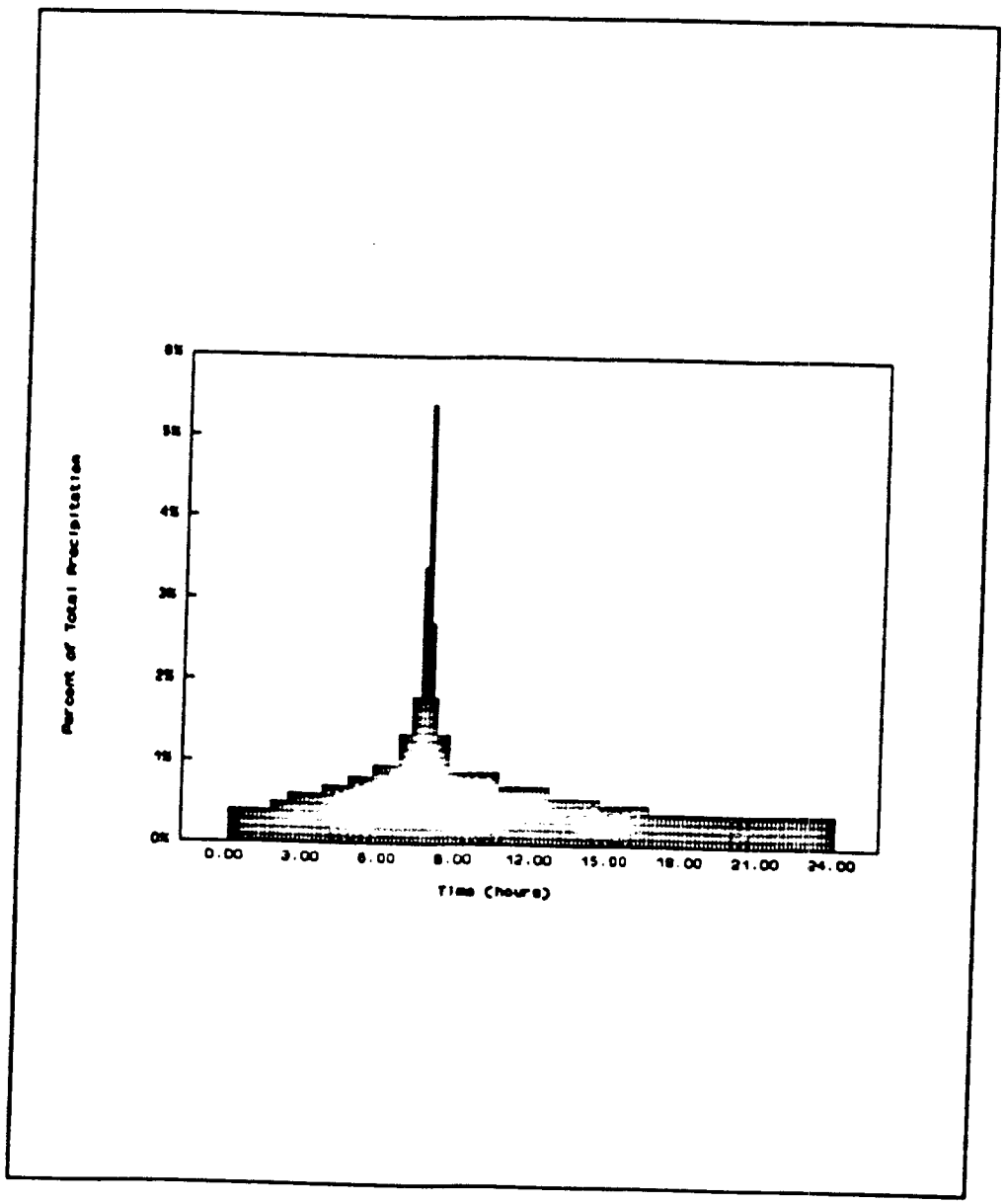
Figure III-1.2
24-hour Design Storm Hyetograph for
Type 1A Rainfall Distribution



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III-1.4.2 Runoff Parameters

All storm event hydrograph methods require input of parameters which describe physical drainage basin characteristics. These parameters provide the basis from which the runoff hydrograph is developed. This section describes the 3 key parameters (area, curve number, and time of concentration) used to develop the hydrograph using the method of hydrograph synthesis discussed in Sec. III-1.4.3.

Area

The proper selection of homogeneous basin areas is required to obtain the highest degree of accuracy in hydrograph analysis. Significant differences in land use within a given drainage basin must be addressed by dividing the basin area into subbasin areas of similar land use and/or runoff characteristics. For example, a drainage basin consisting of a concentrated residential area and a large forested area should be divided into two subbasin areas accordingly. Hydrographs should then be computed for each subbasin area and summed to form the total runoff hydrograph for the basin.
To further enhance the accuracy of hydrograph analysis, all pervious and impervious areas within a given basin or subbasin shall be analyzed separately. This may be done by either computing separate hydrographs for each area and combining them to form the total runoff hydrograph or by computing the precipitation excess for each area and combining the two to obtain the total precipitation excess, which is then used to develop the runoff hydrograph. This procedure is explained further in Section III-1.4.3 "Hydrograph Synthesis". By analyzing pervious and impervious areas separately the errors associated with averaging these areas are avoided and the true shape of the runoff hydrograph is better approximated.

Curve Number

The Soil Conservation Service (SCS), has for many years, conducted studies into the runoff characteristics of various land types. After gathering and analyzing extensive data, SCS has developed relationships between land use, soil type, vegetation cover, interception, infiltration, surface storage, and runoff. The relationships have been characterized by a single runoff coefficient called a "curve number." The National Engineering Handbook - Section 4: Hydrology (NEH-4, SCS, August 1972) contains a detailed description of the development and use of the curve number method.

SCS has developed "curve number" (CN) values based on soil type and land use. The combination of these two factors is called the "soil-cover complex." The soil-cover complexes have been assigned to one of four hydrologic soil groups, according to their runoff characteristics. SCS has classified over 4,000 soil types into these four soil groups. Table III-1.2 shows the hydrologic soil group of most soils in the Puget Sound basin and provides a brief description of the four groups.

Table III-1.3 shows the CNs, by land use description, for the four hydrologic soil groups. These numbers are for a 24-hour duration storm and typical antecedent soil moisture condition preceding 24-hour storms in Western Washington. Note these CNs are not, therefore, "average," but rather calibrated by the SCS for Western Washington and should not be used with "wet" or "dry" modifications. Modeling performed to calibrate to actual rainfall and/or runoff data should start with the original SCS CNs published in TR-55. (5)

The following are important criteria/considerations for selection of CN values:

1. Many factors may affect the CN value for a given land use. For example, the movement of heavy equipment over bare ground may compact the soil so that it has a lesser infiltration rate and greater runoff potential than would be indicated by strict application of the CN value based on pre-development conditions at the site.

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Table III-1.6 Hydrologic Soil Groups for Soils in the Puget Sound Basin

Soil Type	Hydrologic Soil Group	Soil Type	Hydrologic Soil Group
Agnew	C	Colter	C
Ahl	B	Custer	ND
Aits	C	Dabob	ND
Alderwood	C	Delphi	D
Arenta, Alderwood	B	Dick	ND
Arenta, Everett	B	Dimal	D
Ashoe	B	Dupont	D
Baldhill	B	Earlmont	C
Barneston	C	Edgewick	C
Beumgard	B	Eld	B
Beausite	B	Elwell	B
Belfast	C	Esquatzel	B
Bellingham	D	Everett	A
Bellingham variant	C	Everson	D
Boistfort	B	Galvin	D
Bow	D	Getchell	A
Briscot	D	Giles	B
Buckley	C	Godfrey	D
Bunker	B	Greenwater	A
Cagey	C	Grove	C
Carlsborg	ND	Harstine	C
Casey	ND	Hartnit	ND
Cassolary	C	Hoh	ND
Cathcart	B	Hoko	ND
Centralia	B	Hoodsport	ND
Chehalis	B	Hoogdal	C
Chesaw	A	Hoypus	ND
Cinebar	B	Huel	ND
Clallam	C	Indianola	ND
Clayton	B	Jenne	B
Coastal beaches	variable	Jumpe	ND
Kapowsin	C/D	Kalaloch	C
Katula	C	Renton	D
Kilchis	C	Republic	B
Kitsap	C	Riverwash	variable
Klaus	ND	Rober	C
Klone	ND	Salal	C
Latea	C	Salkum	B
Lebam	B	Sammamish	D
Lummi	ND	San Juan	ND
Lynnwood	ND	Scamman	D
Lystair	ND	Schneider	B
Mal	C	Seattle	D
Manley	B	Sekiu	ND
Mashel	B	Semiahmoo	D
Maytown	C	Shalcar	D
McKenna	D	Shano	B
McMurray	ND	Shelton	C
Melbourne	B	Si	C
Menzel	ND	Sinclair	C
Mixed Alluvial	variable	Skipopa	D
Molson	B	Skykomish	B
Mukilteo	C/D	Snahopish	ND
Naff	B	Snohomish	D
Narger	A	Solduc	B
National	ND	Solleks	ND
Neilton	A	Spana	D

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Soil Type	Hydrologic Soil Group	Soil Type	Hydrologic Soil Group
Newberg	B	Spanaway	A/B
Nisqually	B	Springdale	B
Nooksack	C	Sulsavar	B
Norma	C/D	Sultan	C
Ogarty	C	Sultan variant	B
Olete	ND	Sumas	C
Olomount	C	Swantown	ND
Olympic	B	Tacoma	D
Orcas	D	Tanwax	ND
Oridia	D	Tealwhit	ND
Orting	ND	Tenino	C
Oso	C	Tisch	D
Ovall	C	Tokul	ND
Pastik	C	Townsend	C
Pheeney	C	Triton	ND
Phelan	ND	Tukwila	D
Pilchuck	C	Tukey	ND
Potchub	C	Urban	variable
Poulsbo	C	Vailton	B
Prather	C	Verlot	C
Puget	D	Wapato	ND
Puyallup	B	Warden	B
Queets	ND	Whidbey	ND
Quilcene	ND	Wilkeson	B
Ragnar	B	Winston	A
Rainier	C	Woodinville	B
Raught	B	Yelm	C
Reed	ND	Zynbar	B

Hydrologic Soil Group Classifications

A. (Low runoff potential). Soils having high infiltration rates, even when thoroughly wetted, and consisting chiefly of deep, well-to-excessively drained sands or gravels. These soils have a high rate of water transmission.

B. (Moderately low runoff potential). Soils having moderate infiltration rates when thoroughly wetted, and consisting chiefly of moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

C. (Moderately high runoff potential). Soils having slow infiltration rates when thoroughly wetted, and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine textures. These soils have a slow rate of water transmission.

D. (High runoff potential). Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a hardpan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

ND Data not currently available for this soil type.

*From SCS, TR-55, Second Edition, June 1986, Exhibit A-1. Revisions made from SCS, Soil Interpretation Record, Form #5, September 1988 and various county soil surveys.

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2. CN values can be area weighted when they apply to pervious areas of similar CNs (within 20 CN points). However, high CN areas should not be combined with low CN areas. In this case, separate hydrographs should be generated and summed to form one hydrograph unless the low CN areas are less than 15 percent of the subbasin.

3. Separate CN values must be selected for the pervious and impervious areas of an urban basin or subbasin. For single family residential areas the percent impervious given in Table III-1.3 shall be used to compute the respective pervious and impervious areas. For proposed commercial areas, PUDs etc., the percent impervious must be computed from the site plan. For all other land uses the percent impervious must be estimated from best available aerial topography and/or field reconnaissance. The pervious area CN value shall be a weighted average of all the pervious area CNs within the subbasin. The impervious area CN value shall be 98.

4. For storm duration other than 24 hours, an adjustment must be made to the CN values given in Table III-1.3. Based on information obtained from SCS, the following equation shall be used for adjusting these CNs for the seven-day design storm:

$$CN\ (7\ day) = 0.1549\ CN + 0.8451\ ((CN^{2.345}/631.8) + 15)$$

Example: The following is an example of how CN values are selected for a sample project.

Select CNs for the following development:

Existing Land Use	-	forest (undisturbed)
Future Land Use	-	residential plat (3.6 DU/GA)
Basin Size	-	10 acres
Soil Type	-	80% Alderwood, 20% Ragnor

Table III-1.2 shows that Alderwood soil belongs to the "C" hydrologic soil group and Ragnor soil belongs to the "B" group. Therefore, for the existing condition, CNs of 76 and 64 are read from Table III-1.3 and areal weighted to obtain a CN value of 74. For the developed condition with 3.6 DU/GA the percent impervious of 39 percent is interpolated from Table III-1.3 and used to compute pervious and impervious areas of 6.1 acres and 3.9 acres, respectively. The 6.1 acres of pervious area consists of residential yards and lawns covering the same proportions of Alderwood and Everett soil (80 percent and 20 percent respectively). Therefore, CNs of 90 and 85 are read from Table III-1.3 and areal weighted to obtain a pervious area CN value of 89. The impervious area CN value is 98. The result of this example is summarized below:

On-Site Condition	Existing	Developed	
Land use	Forest	Residential	
Pervious area	10 ac.	6.1 ac.	
CN of pervious area	74	89	
Impervious area	0 ac.	3.9 ac.	
CN of impervious area	---	98	

SCS Curve Number Equations

The rainfall-runoff equations of the SCS curve number method relates a land area's runoff depth (precipitation excess) to the precipitation it receives and to its natural storage capacity, as follows:

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Table III-1.3 SCS Western Washington Runoff Curve Numbers
(Published by SCS in 1982) Runoff curve numbers for selected agricultural, suburban and urban land use for Type 1A rainfall distribution, 24-hour storm duration.

LAND USE DESCRIPTION		CURVE NUMBERS BY HYDROLOGIC SOIL GROUP A	B	C	D
Cultivated land(1):	winter condition	86	91	94	95
Mountain open areas:	low growing brush & grasslands	74	82	89	92
Meadow or pasture:		65	78	85	89
Wood or forest land:	undisturbed	42	64	76	81
Wood or forest land:	young second growth or brush	55	72	81	86
Orchard:	with cover crop	81	88	92	94
Open spaces, lawns, parks, golf courses, cemeteries, landscaping.					
Good condition:	grass cover on ≥75% of the area	68	80	86	90
Fair condition:	grass cover on 50-75% of the area	77	85	90	92
Gravel roads & parking lots:		76	85	89	91
Dirt roads & parking lots:		72	82	87	89
Impervious surfaces, pavement, roofs etc.		98	98	98	98
Open water bodies:	lakes, wetlands, ponds etc.	100	100	100	100
Single family residential(2):					
Dwelling Unit/Gross Acre	%Impervious(3)				
1.0 DU/GA	15				
1.5 DU/GA	20				
2.0 DU/GA	25				
2.5 DU/GA	30				
3.0 DU/GA	34				
3.5 DU/GA	38				
4.0 DU/GA	42				
4.5 DU/GA	46				
5.0 DU/GA	48				
5.5 DU/GA	50				
6.0 DU/GA	52				
6.5 DU/GA	54				
7.0 DU/GA	56				
PUD's, condos, apartments, commercial businesses & industrial areas	%impervious must be computed				

Separate curve number shall be selected for pervious & impervious portions of the site or basin

(1) For a more detailed description of agricultural land use curve numbers refer to National Engineering Handbook, Sec. 4, Hydrology, Chapter 9, August 1972.
(2) Assumes roof and driveway runoff is directed into street/storm system.
(3) The remaining pervious areas (lawn) are considered to be in good condition for these curve numbers.

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$$Q_d = (P_R - 0.2S)^2 / (P_R + 0.8S) \quad \text{for } P_R \geq 0.2S$$

and $$Q_d = 0 \quad \text{for } P_R < 0.2S$$

where:

Q_d = runoff depth in inches over the area,
P_R = precipitation depth in inches over the area, and
S = potential maximum natural detention, in inches over the area, due to infiltration, storage, etc.

The area's potential maximum detention, S, is related to its curve number, CN:

$$S = (1000 / CN) - 10$$

The combination of the above equations allows for estimation of the total runoff volume by computing total runoff depth, Q_d, given the total precipitation depth, P_R. For example, if the curve number of the area is 70, then the value of S is 4.29. With a total precipitation for the design event of 2.0 inches, the total runoff depth would be:

$$Q_d = [2.0 - 0.2\ (4.29)]^2 / [2.0 + 0.8\ (4.29)] = \underline{0.24 \text{ inches}}$$

This computed runoff represents inches over the tributary area. Therefore, the total volume of runoff is found by multiplying Q_d by the area (with necessary conversions):

$$\text{Total runoff Volume (cu. ft.)} = 3{,}630 \text{ (cu. ft./ac. in.)} \times Q_d \text{ (in)} \times A \text{ (ac)}$$

If the area is 10 acres, the total runoff volume is:

$$3{,}630 \text{ cu. ft./ac. in.} \times 0.24 \text{ in.} \times 10 \text{ ac.} = \underline{8{,}712 \text{ cu. ft.}}$$

When developing the runoff hydrograph, the above equation for Q_d is used to compute the incremental runoff depth for each time interval from the incremental precipitation depth given by the design storm hyetograph. This time distribution of runoff depth is often referred to as the precipitation excess and provides the basis for synthesizing the runoff hydrograph.

Travel Time and Time of Concentration for Use in Hydrograph Analysis (based on the methods described in Chapter 3, SCS TR-55(5))

Travel time (T_t) is the time it takes water to travel from one location to another in a watershed. T_t is a component of time of concentration (T_c), which is the time it takes for runoff to travel from the hydraulically most distant point of the watershed. T_c is computed by summing all the travel times for consecutive components of the drainage conveyance system. T_c influences the shape and peak of the runoff hydrograph. Urbanization usually decreases T_c, thereby increasing peak discharge. T_c can be increased as a result of either ponding behind small or inadequate drainage systems (including storm drain inlets and road culverts) or by reduction of land slope through grading.

Water moves through a watershed as sheet flow, shallow concentrated flow, open channel flow or some combination of these. The type of flow that occurs is best determined by field inspection.

Travel time (T_t) is the ratio of flow length to flow velocity:

$$T_t = \frac{L}{60V}$$

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where:

T_t = travel time (minutes)
L = flow length (feet)
V = average velocity (feet/sec) and
60 = conversion factor from seconds to minutes

Time of concentration (T_c) is the sum of T_t values for the various consecutive flow segments.

$$T_c = T_{t_1} + T_{t_2} + \ldots T_{t_m}$$

where:

T_c = time of concentration (minutes) and
m = number of flow segments

Sheet Flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (n_s) (a modified Manning's effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges and rocks; and erosion and transportation of sediment) is used. These n_s values are for very shallow flow depths of about 0.1 foot and are only used for travel lengths up to 300 feet. Table III-1.4 gives Manning's n_s values for sheet flow for various surface conditions.

For sheet flow of up to 300 feet, use Manning's kinematic solution to directly compute T_t.

$$T_t = \frac{0.42\ (n_s L)^{0.8}}{(P_2)^{0.527} (s_o)^{0.4}}$$

where:

T_t = travel time (min),
n_s = sheet flow Manning's effective roughness coefficient (from Table III-1.4).
L = flow length (ft),
P_2 = 2-year, 24-hour rainfall (in), and
s_o = slope of hydraulic grade line (land slope, ft/ft)

Velocity Equation

A commonly used method of computing average velocity of flow, once it has measurable depth, is the following equation:

$$V = k\sqrt{s_o}$$

where:

V = velocity (ft/s)
k = time of concentration velocity factor (ft/s)
s_o = slope of flow path (ft/ft)

"k" is computed for various land covers and channel characteristics with assumptions made for hydraulic radius using the following rearrangement of Manning's equation:

$$k = (1.49(R)^{0.667})/n$$

where:

R = an assumed hydraulic radius
n = Manning's roughness coefficient for open channel flow

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Shallow Concentrated Flow: After a maximum of 300 feet, sheet flow is assumed to become shallow concentrated flow. The average velocity for this flow can be calculated using the k_c values from Table III-1.4 in which average velocity is a function of watercourse slope and type of channel. After computing the average velocity using the Velocity Equation above, the travel time (T_t) for the shallow concentrated flow segment can be computed using the Travel Time Equation described above.

Open Channel Flow: Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where lines indicating streams appear (in blue) on United States Geological Survey (USGS) quadrangle sheets. The k_c values from Table III-1.4 used in the Velocity Equation above or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bankfull conditions. After average velocity is computed the travel time (T_t) for the channel segment can be computed using the Travel Time Equation above.

Lakes or Wetlands: Sometimes it is necessary to estimate the velocity of flow through a lake or wetland at the outlet of a watershed. This travel time is normally very small and can be assumed as zero. Where significant attenuation may occur due to storage effects, the flows should be routed using the "level pool routing" technique described in Section III-1.4.4.

Limitations: The following limitations apply in estimating travel time (T_t).

- Manning's kinematic solution should not be used for sheet flow longer than 300 feet.
- In watersheds with storm drains, carefully identify the appropriate hydraulic flow path to estimate T_c. Storm sewers generally handle only a small portion of a large event. The rest of the peak flow travels by streets, lawns, and so on, to the outlet. Consult a standard hydraulics textbook to determine average velocity in pipes for either pressure or nonpressure flow.
- A culvert or bridge can act as a reservoir outlet if there is significant storage behind it. A hydrograph should be developed to this point and the "level pool routing" technique described in Section III-1.4.4 should be used to determine the outflow rating curve through the culvert or bridge.

Example: The following is an example of travel time and time of concentration calculations.

Given: An existing drainage basin having a selected flow route composed of the following five segments. Note: Drainage basin is in Federal Way and has a P_2 = 2.1 inches.

Segment 1: L = 200 ft. Forest with dense brush (sheet flow)
s_o = 0.03 ft/ft, n_s = 0.80

Segment 2: L = 300 ft. Pasture (shallow concentrated flow)
s_o = 0.04 ft/ft, k_s = 11

Segment 3: L = 50 ft. Small pond (year around)
s_o = 0.00 ft/ft, k_c = 0

Segment 4: L = 300 ft. Grassed waterway (intermittent channel)
s_o = 0.05 ft/ft, k_c = 17

Segment 5: L = 500 ft. Grass-lined stream (continuous)
s_o = 0.02 ft/ft, k_c = 27

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Table III-1.4 "n" AND "k" Values Used in Time Calculations for Hydrographs

"n_s" Sheet Flow Equation Manning's Values (for the initial 300 ft. of travel)	n_s
Smooth surfaces (concrete, asphalt, gravel, or bare hand packed soil)	0.011
Fallow fields or loose soil surface (no residue)	0.05
Cultivated soil with residue cover (s≤ 0.20 ft/ft)	0.06
Cultivated soil with residue cover (s> 0.20 ft/ft)	0.17
Short prairie grass and lawns	0.15
Dense grasses	0.24
Bermuda grass	0.41
Range (natural)	0.13
Woods or forest with light underbrush	0.40
Woods or forest with dense underbrush	0.80

*Manning values for sheet flow only, from Overton and Meadows 1976 (See TR-55, 1986)

"k" Values Used in Travel Time/Time of Concentration Calculations

Shallow Concentrated Flow (After the initial 300 ft. of sheet flow, R = 0.1)	k_s
1. Forest with heavy ground litter and meadows (n = 0.10)	3
2. Brushy ground with some trees (n = 0.060)	5
3. Fallow or minimum tillage cultivation (n = 0.040)	8
4. High grass (n = 0.035)	9
5. Short grass, pasture and lawns (n = 0.030)	11
6. Nearly bare ground (n = 0.25)	13
7. Paved and gravel areas (n = 0.012)	27

Channel Flow (intermittent) (At the beginning of visible channels R = 0.2)	k_c
1. Forested swale with heavy ground litter (n = 0.10)	5
2. Forested drainage course/ravine with defined channel bed (n = 0.050)	10
3. Rock-lined waterway (n = 0.035)	15
4. Grassed waterway (n = 0.030)	17
5. Earth-lined waterway (n = 0.025)	20
6. CMP pipe (n = 0.024)	21
7. Concrete pipe (0.012)	42
8. Other waterways and pipe 0.508/n	

Channel Flow (Continuous stream, R = 0.4)	k_c
9. Meandering stream with some pools (n = 0.040)	20
10. Rock-lined stream (n = 0.035)	23
11. Grass-lined stream (n = 0.030)	27
12. Other streams, man-made channels and pipe 0.807/n**	

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Table III-1.5 Values of the Roughness Coefficient, "n"

Type of Channel and Description	Manning's "n" (Normal)
A. Constructed Channels	
a. Earth, straight and uniform	
1. Clean, recently completed	0.018
2. Gravel, uniform section, clean	0.025
3. With short grass, few weeds	0.027
b Earth, winding and sluggish	0.025
1. No vegetation	0.025
2. Grass, some weeds	0.030
3. Dense weeds or aquatic plants in deep channels	0.035
4. Earth bottom and rubble sides	0.030
5. Stony bottom and weedy banks	0.035
6. Cobble bottom and clean sides	0.040
c. Rock lined	
1. Smooth and uniform	0.035
2. Jagged and irregular	0.040
d. Channels not maintained, weeds and brush uncut	
1. Dense weeds, high as flow depth	0.080
2. Clean bottom, brush on sides	0.050
3. Same, highest stage of flow	0.070
4. Dense brush, high stage	0.100
B. Natural Streams	
B-1 Minor streams (top width at flood stage < 100 ft.)	
a. Streams on plain	
1. Clean, straight, full stage no riffs or deep pools	0.030
2. Same as above, but more stones and weeds	0.035
3. Clean, winding, some pools and shoals	0.040
4. Same as above, but some weeds	0.040
5. Same as 4, but more stones	0.050
6. Sluggish reaches, weedy deep pools	0.070
7. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.100
b. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages	
1. Bottom: gravel, cobbles, and few boulders	0.040
2. Bottom: cobbles with large boulders	0.050
B-2 Flood plains	
a. Pasture, no brush	
1. Short grass	0.030
2. High grass	0.035
b. Cultivated areas	
1. No crop	0.030
2. Mature row crops	0.035
3. Mature field crops	0.040
c. Brush	
1. Scattered brush, heavy weeds	0.050
2. Light brush and trees	0.060
3. Medium to dense brush	0.070
4. Heavy, dense brush	0.100
d. Trees	
1. Dense willows, straight	0.150
2. Cleared land with tree stumps, no sprouts	0.040
3. Same as above, but with heavy growth of sprouts	0.060
4. Heavy stand of timber, a few down trees, little undergrowth, flood stage below branches	0.100
5. Same as above, but with flood stage reaching branches	0.120

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Calculate travel times (T_t's) for each reach and then sum them to calculate the drainage basin time of concentration (T_c).

Segment 1: Sheet flow (L <300 feet), $T_t = \frac{0.42\,(nL)^{0.8}}{(P_2)^{0.5}\,(s_o)^{0.4}}$

$T_1 = \frac{(0.42)((0.80)(200))^{0.8}}{(2.1)^{0.5}\,(0.03)^{0.4}}$ = 68 minutes

Segment 2: Shallow concentrated flow $V = k_s\sqrt{s_o}$

$V_2 = (11)\sqrt{(0.04)} = 2.2$ ft/s

$T_2 = \frac{L}{60V} = \frac{(300)}{60(2.2)}$ = 2 minutes

Segment 3: Flat water surface

T_3 = 0 minutes

Segment 4: Intermittent channel flow

$V_4 = (17)\sqrt{(0.05)} = 3.8$ ft/s

$T_4 = \frac{(300)}{60(3.8)}$ = 1 minute

Segment 5: Continuous stream

$V_5 = (27)\sqrt{(0.02)} = 3.8$ ft/s

$T_5 = \frac{(500)}{60(3.8)}$ = 2 minutes

$T_c = T_1 + T_2 + T_3 + T_4 + T_5$

$T_c = 68 + 2 + 0 + 1 + 2$ = 73 minutes

It is important to note how the initial sheet flow segment's travel time dominates the time of concentration computation. This will nearly always be the case for relatively small drainage basins and in particular the existing site conditions. This also illustrates the significant impact urbanization has on the surface runoff portion of the hydrologic process.

III-1.4.3 Hydrograph Synthesis

This section presents a description of the Santa Barbara Urban Hydrograph (SBUH) method. It is given here as a guideline only, as it is only one of the many SCS-based hydrograph methods that are available for use. This particular method is favored by King County because staff there have found the SBUH method to be more consistent and better suited for analysis of small urban basins. Other local governments may favor other hydrograph-based methods such as the SCS TR-20 method (1), or, preferably, simplified versions of the HSPF model when they are developed.

The Santa Barbara Urban Hydrograph Method

The SBUH method, like the Soil Conservation Service Urban Hydrograph (SCSUH) method, is based on the curve number (CN) approach, and also uses SCS equations for

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computing soil absorption and precipitation excess. The SCSUH method works by converting the incremental runoff depths (precipitation excess) for a given basin and design storm hydrographs of equal time base according to basin time of concentration and adds them to form the runoff hydrograph. The SBUH method, on the other hand, converts the incremental runoff depths into instantaneous hydrographs which are then routed through an imaginary reservoir with a time delay equal to the basin time of concentration.

The SBUH method was developed by the Santa Barbara County Flood Control and Water Conservation District, California. The SBUH method directly computes a runoff hydrograph without going through an intermediate process (unit hydrograph) as the SCSUH method does. By comparison, the calculation steps of the SBUH method are much simpler and can be programmed on a calculator or a spreadsheet program.

The SBUH method uses two steps to synthesize the runoff hydrograph:

Step one - computing the instantaneous hydrograph, and Step two - computing the runoff hydrograph.

The instantaneous hydrograph, I(t), in cfs, at each time step, dt, is computed as follows:

$$I(t) = 60.5\ R(t)\ A/dt$$

where:

R(t) = total runoff depth (both impervious and pervious runoffs) at time increment dt, in inches (also known as precipitation excess)

A = area in acres
dt = time interval in minutes*

* NOTE: A maximum time interval of 10 minutes should be used for all design storms of 24-hour duration. A maximum time interval of 60 minutes should be used for the 100-year, 7-day design storm.

The runoff hydrograph, Q(t), is then obtained by routing the instantaneous hydrograph I(t), through an imaginary reservoir with a time delay equal to the time of concentration, T_c, of the drainage basin. The following equation estimates the routed flow, Q(t):

$$Q(t+1) = Q(t) + w[I(t) + I(t+1) - 2Q(t)]$$

where:

$w = dt/(2T_c + dt)$
dt = time interval in minutes

Example: To illustrate the SBUH method, Tables III-1.6 and III-1.7 show runoff hydrograph values computed by this method for both existing and developed conditions. Figure III-1.3 illustrates the hydrographs for existing and developed conditions. Note, this example was prepared using the LOTUS 123 spreadsheet program and illustrates how the method can be used with a personal computer. Copies of this program and a Fortran version are available (with minimal documentation) from King County Surface Water Management Division.

III-1.4.4 Hydrograph Routing

This section presents the methodology for routing a hydrograph through an existing retention/detention facility or closed depression, and for sizing a new retention/detention facility using hydrograph analysis.

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Storage Routing Technique

The "level pool routing" technique presented here is one of the simplest and most commonly used hydrograph routing methods. This method is described in "Handbook of Applied Hydrology," Chow, V. Te, 1964, (6) and elsewhere, and is based on the continuity equation:

Inflow - Outflow = Change in storage

$$\left[\frac{I_1 + I_2}{2} - \frac{O_1 + O_2}{2}\right] = \frac{\Delta S}{\Delta t} = S_2 - S_1$$

where:

I	=	Inflow at time 1 and time 2
O	=	Outflow at time 1 and time 2
S	=	Storage at time 1 and time 2
Δt	=	Time interval, 2-1

The time interval, Δt, must be consistent with the time interval used in developing the inflow hydrograph. The time interval used for a 24-hour storm is 10 minutes while the time interval used for a 7-day storm is 60 minutes. The Δt variable can be eliminated by dividing it into the storage variables to obtain the following rearranged equation:

$$I_1 + I_2 + 2S_1 - O_1 = O_2 + 2S_2$$

If the time interval, Δt, is in minutes, the units of storage (S) are now [cf/min] which can be converted to cfs by multiplying times 1 min/60 sec.

The terms on the left-hand side of the equation are known from the inflow hydrograph and from the storage and outflow values of the previous time step. The unknowns O and S can be solved interactively from the given stage-storage and stage-discharge curves.

The following section gives the specific hydrograph routing steps:

1. Develop stage-storage relationship

- For retention/detention facilities with vertical sides (vaults), the stored volume is simply the bottom area times the height.

- For ponds with 3:1 side slopes, the stored volume can be computed by averaging the pond surface area with the bottom area. The following equation was derived based on this assumption and for a square pond but provides a reasonable trial estimate for typical ponds of other shapes:

$$S(H) = 18H^3 + (6 * H^2 * (A_b)^{0.5}) + A_b H$$

where:

H	=	stage height (ft) or water depth above pond bottom
A_b	=	area of pond bottom (sq. ft.)
S(H)	=	storage (cu. ft.) at stage height, H.

- For irregularly shaped areas the stage-storage curve may be developed as follows:

a. Obtain topographic contours of an existing or proposed retention/detention facility site and planimeter (or otherwise compute) the area enclosed by each contour. For example, see Figure III-1.4 in which each contour represents a one-foot interval. Contour 71 is the lowest portion of the site and represents

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zero storage. Contour 76 represents a potential stage of 5 feet above the bottom of the facility.

b. Calculate the average area between each contour. For the example given above, the average area between contours 71 and 72 would be:

$$\frac{600 + 4400}{2} = 2500 \text{ sq. ft.}$$

c. Calculate the volume between contours by multiplying the average area between contours by the difference in elevation. To illustrate, the volume between contours 71 and 72 would be:

(2500)(1 foot) = 2500 cu. ft.

Similarly,

Area 72-73	-	6550 cu. ft.
Area 73-74	-	10050 cu. ft.
Area 74-75	-	12950 cu. ft.
Area 75-76	-	16750 cu. ft.

d. Define the total storage below each contour. This is just the sum of the volumes computed in the previous step for the contour in question. For example, there is no storage below contour 71, 2500 cu. ft. below Contour 72, and (6550 + 2500 = 9050 cu. ft. below Contour 73).

In summary,

Contours	Stage	Sum of Volumes		Total Volume
Contours 71-72	1	0 + 2500	=	2500 cu. ft.
Contours 72-73	2	2500 + 6500	=	9050 cu. ft.
Contours 73-74	3	9050 + 10050	=	19100 cu. ft.
Contours 74-75	4	19100 + 12950	=	32050 cu. ft.
Contours 75-76	5	32050 + 16750	=	48800 cu. ft.

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TABLE III-1.6
SBUH HYDROGRAPH VALUES FOR EXISTING SITE CONDITION

Given: Area = 10 acres; P = 2.9 inches (10-year, 24-hour event); dt = 10 minutes; Tc = 73 minutes
PERVIOUS AREA: Area = 10 acres; CN = 74; S = 3.51; 0.25 = 0.70
IMPERVIOUS AREA: Area = 0 acres; CN = 98; S = 0.20; 0.25 = 0.04

Column (3) = SCS Type 1A rainfall distribution
Column (4) = Column (3) * P
Column (5) = Accumulated sum of Column (4)
Column (6) = (If P ≤ 0.25) = 0, (If P > 0.25) = ((Column (5) - 0.25)^2)/(Column (5) + 0.85) where the PERVIOUS AREA S value is used
Column (7) = Column (6) of present time step - Column (6) of previous time step
Column (8) = Same as Column (6) except use IMPERVIOUS AREA S value
Column (9) = Column (8) of present time step - Column (8) of previous time step
Column (10) = ((PERVIOUS AREA/TOTAL AREA) * Column (7)) + ((IMPERVIOUS AREA/TOTAL AREA) * Column (9))
Column (11) = (60.5 * Column (10) * TOTAL AREA)/dt where dt = 10 minutes
Column (12) = Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt/(2Tc + dt) = 0.0641

(1) Time Increment	(2) Time (min)	(3) Rainfall Distrib (Fraction)	(4) Incre. Rainfall (inches)	(5) Accumul. Rainfall (inches)	(6) PERVIOUS AREA Accum. Runoff (inches)	(7) PERVIOUS AREA Incre. Runoff (inches)	(8) IMPERVIOUS AREA Accum. Runoff (inches)	(9) IMPERVIOUS AREA Incre. Runoff (inches)	(10) Total Runoff (inches)	(11) Instant Flowrate (cfs)	(12) Design Flowrate (cfs)
1	0	0	0	0	0	0	0	0	0	0.0	0.0
2	10	0.004	0.0116	0.012	0.000	0.000	0.000	0.000	0.000	0.0	0.0
3	20	0.004	0.0116	0.023	0.000	0.000	0.000	0.000	0.000	0.0	0.0
4	30	0.004	0.0116	0.035	0.000	0.000	0.000	0.000	0.000	0.0	0.0
5	40	0.004	0.0116	0.046	0.000	0.000	0.000	0.000	0.000	0.0	0.0
6	50	0.004	0.0116	0.058	0.000	0.000	0.001	0.001	0.000	0.0	0.0
7	60	0.004	0.0116	0.070	0.000	0.000	0.004	0.002	0.000	0.0	0.0
8	70	0.004	0.0116	0.081	0.000	0.000	0.007	0.003	0.000	0.0	0.0
9	80	0.004	0.0116	0.093	0.000	0.000	0.011	0.004	0.000	0.0	0.0
10	90	0.004	0.0116	0.104	0.000	0.000	0.015	0.005	0.000	0.0	0.0
11	100	0.004	0.0116	0.116	0.000	0.000	0.020	0.005	0.000	0.0	0.0
12	110	0.005	0.0145	0.131	0.000	0.000	0.027	0.007	0.000	0.0	0.0
13	120	0.005	0.0145	0.145	0.000	0.000	0.035	0.008	0.000	0.0	0.0
14	130	0.005	0.0145	0.160	0.000	0.000	0.044	0.008	0.000	0.0	0.0
15	140	0.005	0.0145	0.174	0.000	0.000	0.053	0.009	0.000	0.0	0.0
16	150	0.005	0.0145	0.189	0.000	0.000	0.062	0.009	0.000	0.0	0.0
17	160	0.005	0.0145	0.205	0.000	0.000	0.072	0.010	0.000	0.0	0.0
18	170	0.006	0.0174	0.220	0.000	0.000	0.084	0.012	0.000	0.0	0.0
19	180	0.006	0.0174	0.238	0.000	0.000	0.097	0.013	0.000	0.0	0.0
20	190	0.006	0.0174	0.255	0.000	0.000	0.110	0.013	0.000	0.0	0.0
21	200	0.006	0.0174	0.273	0.000	0.000	0.123	0.013	0.000	0.0	0.0
22	210	0.006	0.0174	0.290	0.000	0.000	0.137	0.014	0.000	0.0	0.0
23	220	0.006	0.0174	0.307	0.000	0.000	0.151	0.014	0.000	0.0	0.0
24	230	0.007	0.0203	0.328	0.000	0.000	0.168	0.017	0.000	0.0	0.0
25	240	0.007	0.0203	0.348	0.000	0.000	0.185	0.017	0.000	0.0	0.0
26	250	0.007	0.0203	0.368	0.000	0.000	0.202	0.017	0.000	0.0	0.0
27	260	0.007	0.0203	0.389	0.000	0.000	0.219	0.017	0.000	0.0	0.0
28	270	0.007	0.0203	0.409	0.000	0.000	0.237	0.018	0.000	0.0	0.0
29	280	0.007	0.0203	0.429	0.000	0.000	0.255	0.018	0.000	0.0	0.0
30	290	0.0082	0.0238	0.453	0.000	0.000	0.276	0.021	0.000	0.0	0.0
31	300	0.0082	0.0238	0.477	0.000	0.000	0.297	0.021	0.000	0.0	0.0
32	310	0.0082	0.0238	0.501	0.000	0.000	0.318	0.021	0.000	0.0	0.0
33	320	0.0082	0.0238	0.524	0.000	0.000	0.340	0.022	0.000	0.0	0.0
34	330	0.0082	0.0238	0.548	0.000	0.000	0.362	0.022	0.000	0.0	0.0
35	340	0.0082	0.0238	0.572	0.000	0.000	0.384	0.022	0.000	0.0	0.0
36	350	0.0095	0.0276	0.599	0.000	0.000	0.409	0.026	0.000	0.0	0.0
37	360	0.0095	0.0276	0.627	0.000	0.000	0.435	0.026	0.000	0.0	0.0
38	370	0.0095	0.0276	0.655	0.000	0.000	0.461	0.026	0.000	0.0	0.0
39	380	0.0095	0.0276	0.682	0.000	0.000	0.486	0.026	0.000	0.0	0.0
40	390	0.0095	0.0276	0.710	0.000	0.000	0.512	0.026	0.000	0.0	0.0
41	400	0.0095	0.0276	0.737	0.000	0.000	0.539	0.026	0.000	0.0	0.0
42	410	0.0134	0.0389	0.776	0.001	0.001	0.575	0.037	0.001	0.1	0.0
43	420	0.0134	0.0389	0.815	0.003	0.002	0.613	0.037	0.002	0.1	0.0
44	430	0.0134	0.0389	0.854	0.006	0.003	0.650	0.037	0.003	0.2	0.0
45	440	0.018	0.0522	0.906	0.011	0.005	0.700	0.050	0.005	0.3	0.1
46	450	0.018	0.0522	0.958	0.017	0.006	0.750	0.050	0.006	0.4	0.1
47	460	0.054	0.0986	1.057	0.032	0.015	0.846	0.096	0.015	0.9	0.2
48	470	0.054	0.1566	1.213	0.065	0.032	0.999	0.153	0.032	2.0	0.3
49	480	0.027	0.0783	1.292	0.085	0.020	1.075	0.077	0.020	1.2	0.5
50	490	0.018	0.0522	1.344	0.099	0.014	1.127	0.051	0.014	0.9	0.6
51	500	0.0134	0.0389	1.383	0.110	0.011	1.165	0.038	0.011	0.7	0.6

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TABLE III-1 6
SBUH HYDROGRAPH VALUES FOR EXISTING SITE CONDITION (continued)

(1) Time Increment	(2) Time (min)	(3) Rainfall Depth (fraction)	(4) Incre. Rainfall (inches)	(5) Accumul. Rainfall (inches)	(6) PERVIOUS AREA Accum. Runoff	(7) Incre. Runoff	(8) IMPERVIOUS AREA Accum. Runoff (inches)	(9) Incre. Runoff (inches)	(10) Total Runoff (inches) (inches)	(11) Instant. Flowrate (cfs) (inches)	(12) Design Flowrate (cfs)
52	510	0 0134	0 0389	1 422	0 122	0 012	1 205	0 038	0 012	0 7	0 6
53	520	0 0134	0 0389	1 460	0 134	0 012	1 241	0 038	0 012	0 7	0 6
54	530	0 0088	0 0255	1 486	0 143	0 008	1 266	0 025	0 008	0 5	0 6
55	540	0 0088	0 0255	1 511	0 151	0 009	1 291	0 025	0 009	0 5	0 6
56	550	0 0088	0 0255	1 537	0 160	0 009	1 317	0 025	0 009	0 5	0 6
57	560	0 0088	0 0255	1 563	0 169	0 009	1 342	0 025	0 009	0 5	0 6
58	570	0 0088	0 0255	1 588	0 178	0 009	1 367	0 025	0 009	0 6	0 6
59	580	0 0088	0 0255	1 614	0 188	0 009	1 392	0 025	0 009	0 6	0 6
60	590	0 0088	0 0255	1 639	0 197	0 010	1 417	0 025	0 010	0 6	0 6
61	600	0 0088	0 0255	1 665	0 207	0 010	1 442	0 025	0 010	0 6	0 6
62	610	0 0088	0 0255	1 690	0 217	0 010	1 468	0 025	0 010	0 6	0 6
63	620	0 0088	0 0255	1 716	0 227	0 010	1 493	0 025	0 010	0 6	0 6
64	630	0 0088	0 0255	1 741	0 237	0 010	1 518	0 025	0 010	0 6	0 6
65	640	0 0088	0 0255	1 767	0 247	0 010	1 543	0 025	0 010	0 6	0 6
66	650	0 0072	0 0209	1 788	0 256	0 009	1 564	0 021	0 009	0 5	0 6
67	660	0 0072	0 0209	1 808	0 265	0 009	1 585	0 021	0 009	0 5	0 6
68	670	0 0072	0 0209	1 829	0 274	0 009	1 605	0 021	0 009	0 5	0 6
69	680	0 0072	0 0209	1 850	0 283	0 009	1 626	0 021	0 009	0 5	0 6
70	690	0 0072	0 0209	1 871	0 292	0 009	1 647	0 021	0 009	0 5	0 6
71	700	0 0072	0 0209	1 892	0 301	0 009	1 667	0 021	0 009	0 5	0 6
72	710	0 0072	0 0209	1 913	0 310	0 009	1 688	0 021	0 009	0 6	0 6
73	720	0 0072	0 0209	1 934	0 319	0 009	1 709	0 021	0 009	0 6	0 6
74	730	0 0072	0 0209	1 955	0 329	0 009	1 729	0 021	0 009	0 6	0 6
75	740	0 0072	0 0209	1 975	0 338	0 010	1 750	0 021	0 010	0 6	0 6
76	750	0 0072	0 0209	1 996	0 348	0 010	1 771	0 021	0 010	0 6	0 6
77	760	0 0072	0 0209	2 017	0 358	0 010	1 791	0 021	0 010	0 6	0 6
78	770	0 0057	0 0165	2 034	0 366	0 008	1 808	0 016	0 008	0 5	0 6
79	780	0 0057	0 0165	2 050	0 374	0 008	1 824	0 016	0 008	0 5	0 6
80	790	0 0057	0 0165	2 067	0 382	0 008	1 841	0 016	0 008	0 5	0 6
81	800	0 0057	0 0165	2 083	0 389	0 008	1 857	0 016	0 008	0 5	0 5
82	810	0 0057	0 0165	2 100	0 398	0 008	1 873	0 016	0 008	0 5	0 5
83	820	0 0057	0 0165	2 116	0 406	0 008	1 890	0 016	0 008	0 5	0 5
84	830	0 0057	0 0165	2 133	0 414	0 008	1 906	0 016	0 008	0 5	0 5
85	840	0 0057	0 0165	2 149	0 422	0 008	1 923	0 016	0 008	0 5	0 5
86	850	0 0057	0 0165	2 166	0 430	0 008	1 939	0 016	0 008	0 5	0 5
87	860	0 0057	0 0165	2 183	0 439	0 008	1 955	0 016	0 008	0 5	0 5
88	870	0 0057	0 0165	2 199	0 447	0 008	1 972	0 016	0 008	0 5	0 5
89	880	0 0057	0 0165	2 216	0 455	0 008	1 988	0 016	0 008	0 5	0 5
90	890	0 005	0 0145	2 230	0 463	0 007	2 003	0 014	0 007	0 4	0 5
91	900	0 005	0 0145	2 245	0 470	0 007	2 017	0 014	0 007	0 5	0 5
92	910	0 005	0 0145	2 259	0 478	0 008	2 031	0 014	0 008	0 5	0 5
93	920	0 005	0 0145	2 274	0 485	0 008	2 046	0 014	0 008	0 5	0 5
94	930	0 005	0 0145	2 288	0 493	0 008	2 060	0 014	0 008	0 5	0 5
95	940	0 005	0 0145	2 303	0 501	0 008	2 075	0 014	0 008	0 5	0 5
96	950	0 005	0 0145	2 317	0 508	0 008	2 089	0 014	0 008	0 5	0 5
97	960	0 005	0 0145	2 332	0 516	0 008	2 103	0 014	0 008	0 5	0 5
98	970	0 005	0 0145	2 346	0 524	0 008	2 118	0 014	0 008	0 5	0 5
99	980	0 005	0 0145	2 361	0 532	0 008	2 132	0 014	0 008	0 5	0 5
100	990	0 005	0 0145	2 375	0 539	0 008	2 147	0 014	0 008	0 5	0 5
101	1000	0 005	0 0145	2 390	0 547	0 008	2 161	0 014	0 008	0 5	0 5
102	1010	0 004	0 0116	2 401	0 554	0 006	2 173	0 012	0 006	0 4	0 5
103	1020	0 004	0 0116	2 413	0 560	0 006	2 184	0 012	0 006	0 4	0 5
104	1030	0 004	0 0116	2 424	0 566	0 006	2 196	0 012	0 006	0 4	0 4
105	1040	0 004	0 0116	2 436	0 573	0 006	2 207	0 012	0 006	0 4	0 4
106	1050	0 004	0 0116	2 448	0 579	0 006	2 219	0 012	0 006	0 4	0 4
107	1060	0 004	0 0116	2 459	0 585	0 006	2 230	0 012	0 006	0 4	0 4
108	1070	0 004	0 0116	2 471	0 592	0 006	2 242	0 012	0 006	0 4	0 4
109	1080	0 004	0 0116	2 482	0 598	0 006	2 253	0 012	0 006	0 4	0 4
110	1090	0 004	0 0116	2 494	0 605	0 007	2 265	0 012	0 007	0 4	0 4
111	1100	0 004	0 0116	2 506	0 611	0 007	2 276	0 012	0 007	0 4	0 4
112	1110	0 004	0 0116	2 517	0 618	0 007	2 288	0 012	0 007	0 4	0 4
113	1120	0 004	0 0116	2 529	0 625	0 007	2 299	0 012	0 007	0 4	0 4
114	1130	0 004	0 0116	2 540	0 631	0 007	2 311	0 012	0 007	0 4	0 4
115	1140	0 004	0 0116	2 552	0 638	0 007	2 322	0 012	0 007	0 4	0 4
116	1150	0 004	0 0116	2 564	0 644	0 007	2 334	0 012	0 007	0 4	0 4
117	1160	0 004	0 0116	2 575	0 651	0 007	2 346	0 012	0 007	0 4	0 4
118	1170	0 004	0 0116	2 587	0 658	0 007	2 357	0 012	0 007	0 4	0 4

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TABLE III-1 6
SBUH HYDROGRAPH VALUES FOR EXISTING SITE CONDITION (continued)

(1) Time Increment	(2) Time (min)	(3) Rainfall Depth (fraction)	(4) Incre Rainfall (inches)	(5) Accumul Rainfall (inches)	(6) PERVIOUS AREA Accum Runoff	(7) Incre Runoff	(8) IMPERVIOUS AREA Accum Runoff (inches)	(9) Incre Runoff (inches)	(10) Total Runoff (inches)	(11) Instan Flowrate (cfs) (inches)	(12) Design Flowrate (cfs)
119	1180	0 004	0 0116	2 598	0 664	0 007	2 369	0 012	0 007	0 4	0 4
120	1190	0 004	0 0116	2 610	0 671	0 007	2 380	0 012	0 007	0 4	0 4
121	1200	0 004	0 0116	2 622	0 678	0 007	2 392	0 012	0 007	0 4	0 4
122	1210	0 004	0 0116	2 633	0 685	0 007	2 403	0 012	0 007	0 4	0 4
123	1220	0 004	0 0116	2 645	0 691	0 007	2 415	0 012	0 007	0 4	0 4
124	1230	0 004	0 0116	2 656	0 698	0 007	2 426	0 012	0 007	0 4	0 4
125	1240	0 004	0 0116	2 668	0 705	0 007	2 438	0 012	0 007	0 4	0 4
126	1250	0 004	0 0116	2 680	0 712	0 007	2 449	0 012	0 007	0 4	0 4
127	1260	0 004	0 0116	2 691	0 719	0 007	2 461	0 012	0 007	0 4	0 4
128	1270	0 004	0 0116	2 703	0 726	0 007	2 472	0 012	0 007	0 4	0 4
129	1280	0 004	0 0116	2 714	0 732	0 007	2 484	0 012	0 007	0 4	0 4
130	1290	0 004	0 0116	2 726	0 739	0 007	2 496	0 012	0 007	0 4	0 4
131	1300	0 004	0 0116	2 738	0 746	0 007	2 507	0 012	0 007	0 4	0 4
132	1310	0 004	0 0116	2 749	0 753	0 007	2 519	0 012	0 007	0 4	0 4
133	1320	0 004	0 0116	2 761	0 760	0 007	2 530	0 012	0 007	0 4	0 4
134	1330	0 004	0 0116	2 772	0 767	0 007	2 542	0 012	0 007	0 4	0 4
135	1340	0 004	0 0116	2 784	0 774	0 007	2 553	0 012	0 007	0 4	0 4
136	1350	0 004	0 0116	2 796	0 781	0 007	2 565	0 012	0 007	0 4	0 4
137	1360	0 004	0 0116	2 807	0 788	0 007	2 576	0 012	0 007	0 4	0 4
138	1370	0 004	0 0116	2 819	0 795	0 007	2 588	0 012	0 007	0 4	0 4
139	1380	0 004	0 0116	2 830	0 803	0 007	2 599	0 012	0 007	0 4	0 4
140	1390	0 004	0 0116	2 842	0 810	0 007	2 611	0 012	0 007	0 4	0 4
141	1400	0 004	0 0116	2 854	0 817	0 007	2 623	0 012	0 007	0 4	0 4
142	1410	0 004	0 0116	2 865	0 824	0 007	2 634	0 012	0 007	0 4	0 4
143	1420	0 004	0 0116	2 877	0 831	0 007	2 646	0 012	0 007	0 4	0 4
144	1430	0 004	0 0116	2 888	0 838	0 007	2 657	0 012	0 007	0 4	0 4
145	1440	0 004	0 0116	2 900	0 845	0 007	2 669	0 012	0 007	0 4	0 4

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TABLE III-1.7
SBUH HYDROGRAPH VALUES FOR DEVELOPED SITE CONDITION

Given: Area = 10 acres; Pt = 2.9 inches (10-year, 24-hour event); dt = 10 minutes; Tc = 75 minutes
PERVIOUS AREA: Area = 6.1 acres; CN = 89; S = 1.24; 0.75 = 0.25
IMPERVIOUS AREA: Area = 3.9 acres; CN = 98; S = 0.20; 0.25 = 0.04

Given: Area = 10 acres; Pt = 2.9 inches (10-year, 24-hour event); dt = 10 minutes; Tc = 20 minutes

Column (1) = SCS Type 1A rainfall distribution
Column (4) = Column (3) * Pt
Column (5) = Accumulated sum of Column (4)
Column (6) = (If P ≤ 0.25) = 0, (If P > 0.25) = ((Column (5) - 0.25)^2) (Column (5) + 0.85) where the PERVIOUS AREA S value is used
Column (7) = Column (6) of present time step - Column (6) of previous time step
Column (8) = Same as Column (6) except use IMPERVIOUS AREA S value
Column (9) = Column (8) of present time step - Column (8) of previous time step
Column (10) = ((PERVIOUS AREA/TOTAL AREA) * Column (7)) + ((IMPERVIOUS AREA/TOTAL AREA) * Column (9))
Column (11) = (60 / 5 * Column (10) * TOTAL AREA) where dt = 10 minutes
Column (12) = Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt/(2Tc + dt) = 0.1515

(1) Time Increment	(2) Time (min)	(3) Rainfall Depth (inches)	(4) Incre Rainfall (inches)	(5) Accumul Rainfall (inches)	(6) PERVIOUS AREA Accum Runoff (inches)	(7) Incre Runoff (inches)	(8) IMPERVIOUS AREA Accum Runoff (inches)	(9) Incre Runoff (inches)	(10) Total Runoff (inches)	(11) Instant Flow rate (cfs)	(12) Design Flow rate (cfs)
1	0	0	0	0	0	0	0	0	0	0.0	0.0
2	10	0.004	0.0116	0.012	0.000	0.000	0.000	0.000	0.000	0.0	0.0
3	20	0.004	0.0116	0.023	0.000	0.000	0.000	0.000	0.000	0.0	0.0
4	30	0.004	0.0116	0.035	0.000	0.000	0.000	0.000	0.000	0.0	0.0
5	40	0.004	0.0116	0.046	0.000	0.000	0.000	0.000	0.000	0.0	0.0
6	50	0.004	0.0116	0.058	0.000	0.000	0.000	0.000	0.000	0.0	0.0
7	60	0.004	0.0116	0.070	0.000	0.000	0.001	0.001	0.000	0.0	0.0
8	70	0.004	0.0116	0.081	0.000	0.000	0.004	0.002	0.001	0.1	0.0
9	80	0.004	0.0116	0.093	0.000	0.000	0.007	0.003	0.001	0.1	0.0
10	90	0.004	0.0116	0.104	0.000	0.000	0.011	0.004	0.002	0.1	0.0
11	100	0.004	0.0116	0.116	0.000	0.000	0.015	0.005	0.002	0.1	0.1
12	110	0.005	0.0145	0.131	0.000	0.000	0.020	0.005	0.002	0.1	0.1
13	120	0.005	0.0145	0.145	0.000	0.000	0.027	0.007	0.003	0.2	0.1
14	130	0.005	0.0145	0.160	0.000	0.000	0.035	0.008	0.003	0.2	0.1
15	140	0.005	0.0145	0.174	0.000	0.000	0.044	0.008	0.003	0.2	0.1
16	150	0.005	0.0145	0.189	0.000	0.000	0.053	0.009	0.005	0.2	0.2
17	160	0.005	0.0145	0.203	0.000	0.000	0.062	0.009	0.004	0.2	0.2
18	170	0.006	0.0174	0.220	0.000	0.000	0.072	0.010	0.004	0.2	0.2
19	180	0.006	0.0174	0.238	0.000	0.000	0.084	0.012	0.005	0.3	0.2
20	190	0.006	0.0174	0.255	0.000	0.000	0.097	0.013	0.005	0.3	0.2
21	200	0.006	0.0174	0.273	0.001	0.000	0.110	0.013	0.005	0.3	0.3
22	210	0.006	0.0174	0.290	0.001	0.000	0.123	0.013	0.006	0.3	0.3
23	220	0.006	0.0174	0.307	0.003	0.001	0.137	0.014	0.006	0.4	0.3
24	230	0.007	0.0203	0.328	0.005	0.002	0.151	0.014	0.006	0.4	0.3
25	240	0.007	0.0203	0.348	0.008	0.003	0.168	0.017	0.008	0.5	0.4
26	250	0.007	0.0203	0.368	0.011	0.003	0.185	0.017	0.008	0.5	0.4
27	260	0.007	0.0203	0.389	0.015	0.004	0.202	0.017	0.009	0.5	0.4
28	270	0.007	0.0203	0.409	0.019	0.004	0.219	0.017	0.009	0.5	0.5
29	280	0.007	0.0203	0.429	0.023	0.005	0.237	0.018	0.009	0.6	0.5
30	290	0.0082	0.0238	0.453	0.029	0.006	0.255	0.018	0.010	0.6	0.5
31	300	0.0082	0.0238	0.477	0.036	0.007	0.276	0.021	0.012	0.7	0.6
32	310	0.0082	0.0238	0.501	0.043	0.007	0.297	0.021	0.012	0.7	0.6
33	320	0.0082	0.0238	0.524	0.051	0.008	0.318	0.021	0.013	0.8	0.7
34	330	0.0082	0.0238	0.548	0.059	0.008	0.340	0.022	0.013	0.8	0.7
35	340	0.0082	0.0238	0.572	0.068	0.009	0.362	0.022	0.013	0.8	0.7
36	350	0.0095	0.0276	0.599	0.078	0.011	0.384	0.022	0.014	0.8	0.8
37	360	0.0095	0.0276	0.627	0.089	0.011	0.409	0.026	0.016	1.0	0.8
38	370	0.0095	0.0276	0.655	0.101	0.012	0.435	0.026	0.017	1.0	0.9
39	380	0.0095	0.0276	0.682	0.113	0.012	0.461	0.026	0.017	1.0	0.9
40	390	0.0095	0.0276	0.710	0.126	0.013	0.486	0.026	0.018	1.1	1.0
41	400	0.0095	0.0276	0.737	0.139	0.013	0.512	0.026	0.018	1.1	1.0
42	410	0.0134	0.0389	0.776	0.158	0.019	0.539	0.026	0.018	1.1	1.0
43	420	0.0134	0.0389	0.815	0.179	0.020	0.575	0.037	0.026	1.6	1.1
44	430	0.0134	0.0389	0.854	0.200	0.021	0.613	0.037	0.027	1.6	1.3
45	440	0.018	0.0522	0.906	0.229	0.029	0.650	0.037	0.027	1.7	1.4
46	450	0.018	0.0522	0.958	0.260	0.031	0.700	0.050	0.037	2.3	1.6
47	460	0.034	0.0986	1.057	0.320	0.061	0.750	0.050	0.038	2.3	1.8
48	470	0.054	0.1566	1.213	0.424	0.103	0.846	0.096	0.074	4.5	2.3
49	480	0.027	0.0783	1.292	0.478	0.054	0.999	0.153	0.123	7.4	3.4
50	490	0.018	0.0522	1.344	0.516	0.037	1.127	0.051	0.043	2.6	3.8

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TABLE III-1.7
SBUH HYDROGRAPH VALUES FOR DEVELOPED SITE CONDITION (continued)

(1) Time Increment	(2) Time (min)	(3) Rainfall Depth (inches)	(4) Incr Rainfall (inches)	(5) Accumul Rainfall (inches)	(6) PERVIOUS AREA Accum Runoff (inches)	(7) PERVIOUS AREA Incr Runoff (inches)	(8) IMPERVIOUS AREA Accum Runoff (inches)	(9) IMPERVIOUS AREA Incr Runoff (inches)	(10) Total Runoff (inches)	(11) Instant Flow rate (cfs)	(12) Design Flow rate (cfs)
51	500	0.0134	0.0389	1.381	0.564	0.028	1.165	0.038	0.032	1.9	3.3
52	510	0.0134	0.0389	1.422	0.572	0.028	1.203	0.038	0.032	2.0	2.9
53	520	0.0134	0.0389	1.460	0.601	0.029	1.241	0.038	0.032	2.0	2.6
54	530	0.0088	0.0255	1.486	0.620	0.019	1.266	0.025	0.021	1.3	2.3
55	540	0.0088	0.0255	1.511	0.639	0.019	1.291	0.025	0.022	1.3	2.0
57	560	0.0088	0.0255	1.563	0.678	0.019	1.342	0.025	0.022	1.3	1.7
58	570	0.0088	0.0255	1.588	0.698	0.020	1.367	0.025	0.022	1.3	1.5
59	580	0.0088	0.0255	1.614	0.717	0.020	1.392	0.025	0.022	1.3	1.5
60	590	0.0088	0.0255	1.639	0.737	0.020	1.417	0.025	0.022	1.3	1.4
61	600	0.0088	0.0255	1.665	0.757	0.020	1.442	0.025	0.022	1.3	1.4
62	610	0.0088	0.0255	1.690	0.777	0.020	1.468	0.025	0.022	1.3	1.4
63	620	0.0088	0.0255	1.716	0.797	0.020	1.493	0.025	0.022	1.3	1.4
64	630	0.0088	0.0255	1.741	0.818	0.020	1.518	0.025	0.022	1.3	1.4
65	640	0.0088	0.0255	1.767	0.838	0.020	1.543	0.025	0.022	1.3	1.4
66	650	0.0072	0.0209	1.788	0.855	0.017	1.566	0.021	0.018	1.1	1.3
67	660	0.0072	0.0209	1.808	0.871	0.017	1.585	0.021	0.018	1.1	1.3
68	670	0.0072	0.0209	1.829	0.888	0.017	1.605	0.021	0.018	1.1	1.2
69	680	0.0072	0.0209	1.850	0.905	0.017	1.626	0.021	0.018	1.1	1.2
70	690	0.0072	0.0209	1.871	0.922	0.017	1.647	0.021	0.018	1.1	1.2
71	700	0.0072	0.0209	1.892	0.939	0.017	1.667	0.021	0.018	1.1	1.1
72	710	0.0072	0.0209	1.913	0.956	0.017	1.688	0.021	0.018	1.1	1.1
73	720	0.0072	0.0209	1.934	0.973	0.017	1.709	0.021	0.019	1.1	1.1
74	730	0.0072	0.0209	1.955	0.990	0.017	1.729	0.021	0.019	1.1	1.1
75	740	0.0072	0.0209	1.975	1.008	0.017	1.750	0.021	0.019	1.1	1.1
76	750	0.0072	0.0209	1.996	1.025	0.017	1.771	0.021	0.019	1.1	1.1
77	760	0.0072	0.0209	2.017	1.042	0.017	1.791	0.021	0.019	1.1	1.1
78	770	0.0057	0.0165	2.034	1.056	0.014	1.808	0.016	0.015	0.9	1.1
79	780	0.0057	0.0165	2.050	1.070	0.014	1.824	0.016	0.015	0.9	1.0
80	790	0.0057	0.0165	2.067	1.084	0.014	1.841	0.016	0.015	0.9	1.0
81	800	0.0057	0.0165	2.083	1.097	0.014	1.857	0.016	0.015	0.9	1.0
82	810	0.0057	0.0165	2.100	1.111	0.014	1.873	0.016	0.015	0.9	0.9
83	820	0.0057	0.0165	2.116	1.125	0.014	1.890	0.016	0.015	0.9	0.9
84	830	0.0057	0.0165	2.133	1.139	0.014	1.906	0.016	0.015	0.9	0.9
85	840	0.0057	0.0165	2.149	1.153	0.014	1.923	0.016	0.015	0.9	0.9
86	850	0.0057	0.0165	2.166	1.167	0.014	1.939	0.016	0.015	0.9	0.9
87	860	0.0057	0.0165	2.183	1.181	0.014	1.955	0.016	0.015	0.9	0.9
88	870	0.0057	0.0165	2.199	1.195	0.014	1.972	0.016	0.015	0.9	0.9
89	880	0.0057	0.0165	2.216	1.209	0.014	1.988	0.016	0.015	0.9	0.9
90	890	0.005	0.0145	2.230	1.222	0.012	2.005	0.014	0.013	0.8	0.9
91	900	0.005	0.0145	2.245	1.234	0.012	2.017	0.014	0.013	0.8	0.9
92	910	0.005	0.0145	2.259	1.246	0.012	2.031	0.014	0.013	0.8	0.8
93	920	0.005	0.0145	2.274	1.259	0.012	2.046	0.014	0.013	0.8	0.8
94	930	0.005	0.0145	2.288	1.271	0.012	2.060	0.014	0.013	0.8	0.8
95	940	0.005	0.0145	2.303	1.284	0.012	2.075	0.014	0.013	0.8	0.8
96	950	0.005	0.0145	2.317	1.296	0.012	2.089	0.014	0.013	0.8	0.8
97	960	0.005	0.0145	2.332	1.309	0.012	2.105	0.014	0.013	0.8	0.8
98	970	0.005	0.0145	2.346	1.321	0.012	2.118	0.014	0.013	0.8	0.8
99	980	0.005	0.0145	2.361	1.334	0.013	2.132	0.014	0.013	0.8	0.8
100	990	0.005	0.0145	2.375	1.346	0.013	2.147	0.014	0.013	0.8	0.8
101	1000	0.005	0.0145	2.390	1.359	0.013	2.161	0.014	0.013	0.8	0.8
102	1010	0.004	0.0116	2.401	1.369	0.010	2.173	0.012	0.011	0.6	0.8
103	1020	0.004	0.0116	2.413	1.379	0.010	2.184	0.012	0.011	0.6	0.7
104	1030	0.004	0.0116	2.424	1.389	0.010	2.196	0.012	0.011	0.6	0.7
105	1040	0.004	0.0116	2.436	1.399	0.010	2.207	0.012	0.011	0.6	0.7
106	1050	0.004	0.0116	2.448	1.409	0.010	2.219	0.012	0.011	0.6	0.7
107	1060	0.004	0.0116	2.459	1.419	0.010	2.230	0.012	0.011	0.6	0.7
108	1070	0.004	0.0116	2.471	1.429	0.010	2.242	0.012	0.011	0.6	0.7
109	1080	0.004	0.0116	2.482	1.439	0.010	2.253	0.012	0.011	0.6	0.7
110	1090	0.004	0.0116	2.494	1.449	0.010	2.265	0.012	0.011	0.6	0.7
111	1100	0.004	0.0116	2.506	1.460	0.010	2.276	0.012	0.011	0.6	0.7
112	1110	0.004	0.0116	2.517	1.470	0.010	2.288	0.012	0.011	0.6	0.6
113	1120	0.004	0.0116	2.529	1.480	0.010	2.299	0.012	0.011	0.6	0.6
114	1130	0.004	0.0116	2.540	1.490	0.010	2.311	0.012	0.011	0.6	0.6
115	1140	0.004	0.0116	2.552	1.500	0.010	2.322	0.012	0.011	0.6	0.6
116	1150	0.004	0.0116	2.564	1.510	0.010	2.334	0.012	0.011	0.6	0.6

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TABLE III-1.7
SBUH HYDROGRAPH VALUES FOR DEVELOPED SITE CONDITION (continued)

(1) Time Increment	(2) Time (min)	(3) Rainfall Depth (inches)	(4) Incre. Rainfall (inches)	(5) Accumul. Rainfall (inches)	(6) PERVIOUS AREA Accum. Runoff (inches)	(7) PERVIOUS AREA Incre. Runoff (inches)	(8) IMPERVIOUS AREA Accum. Runoff (inches)	(9) IMPERVIOUS AREA Incre. Runoff (inches)	(10) Total Runoff (inches)	(11) Instant. Flowrate (cfs)	(12) Design Flowrate (cfs)
117	1160	0.004	0.0116	2.575	1.521	0.010	2.546	0.012	0.011	0.6	0.6
118	1170	0.004	0.0116	2.587	1.531	0.010	2.557	0.012	0.011	0.6	0.6
119	1180	0.004	0.0116	2.598	1.541	0.010	2.569	0.012	0.011	0.6	0.6
120	1190	0.004	0.0116	2.610	1.551	0.010	2.580	0.012	0.011	0.6	0.6
121	1200	0.004	0.0116	2.622	1.562	0.010	2.592	0.012	0.011	0.6	0.6
122	1210	0.004	0.0116	2.633	1.572	0.010	2.603	0.012	0.011	0.6	0.6
123	1220	0.004	0.0116	2.645	1.582	0.010	2.615	0.012	0.011	0.7	0.6
124	1230	0.004	0.0116	2.656	1.592	0.010	2.626	0.012	0.011	0.7	0.6
125	1240	0.004	0.0116	2.668	1.603	0.010	2.638	0.012	0.011	0.7	0.7
126	1250	0.004	0.0116	2.680	1.613	0.010	2.649	0.012	0.011	0.7	0.7
127	1260	0.004	0.0116	2.691	1.623	0.010	2.661	0.012	0.011	0.7	0.7
128	1270	0.004	0.0116	2.703	1.633	0.010	2.672	0.012	0.011	0.7	0.7
129	1280	0.004	0.0116	2.714	1.644	0.010	2.684	0.012	0.011	0.7	0.7
130	1290	0.004	0.0116	2.726	1.654	0.010	2.696	0.012	0.011	0.7	0.7
131	1300	0.004	0.0116	2.738	1.664	0.010	2.707	0.012	0.011	0.7	0.7
132	1310	0.004	0.0116	2.749	1.675	0.010	2.719	0.012	0.011	0.7	0.7
133	1320	0.004	0.0116	2.761	1.685	0.010	2.730	0.012	0.011	0.7	0.7
134	1330	0.004	0.0116	2.772	1.695	0.010	2.742	0.012	0.011	0.7	0.7
135	1340	0.004	0.0116	2.784	1.706	0.010	2.753	0.012	0.011	0.7	0.7
136	1350	0.004	0.0116	2.796	1.716	0.010	2.765	0.012	0.011	0.7	0.7
137	1360	0.004	0.0116	2.807	1.726	0.010	2.776	0.012	0.011	0.7	0.7
138	1370	0.004	0.0116	2.819	1.737	0.010	2.788	0.012	0.011	0.7	0.7
139	1380	0.004	0.0116	2.830	1.747	0.010	2.799	0.012	0.011	0.7	0.7
140	1390	0.004	0.0116	2.842	1.758	0.010	2.811	0.012	0.011	0.7	0.7
141	1400	0.004	0.0116	2.854	1.768	0.010	2.823	0.012	0.011	0.7	0.7
142	1410	0.004	0.0116	2.865	1.778	0.010	2.834	0.012	0.011	0.7	0.7
143	1420	0.004	0.0116	2.877	1.789	0.010	2.846	0.012	0.011	0.7	0.7
144	1430	0.004	0.0116	2.888	1.799	0.010	2.857	0.012	0.011	0.7	0.7
145	1440	0.004	0.0116	2.900	1.810	0.010	2.869	0.012	0.011	0.7	0.7

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FIGURE III-1.3
Example SBUH Hydrographs for Existing and Developed Site Conditions

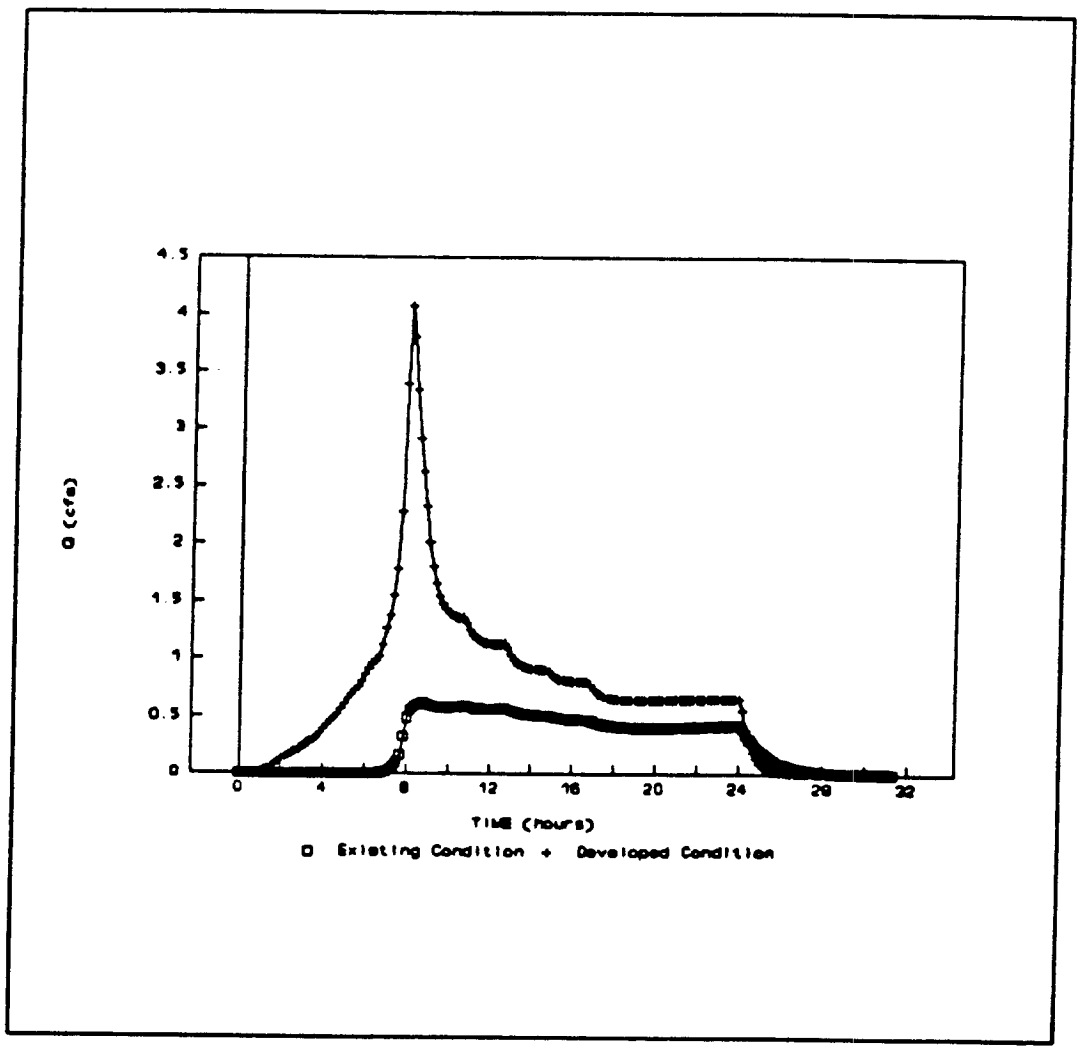

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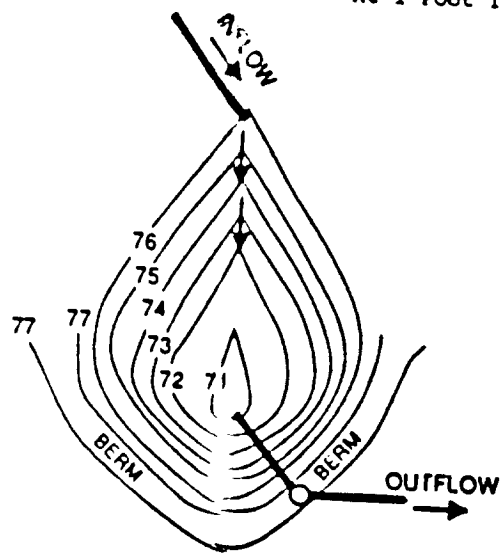
Figure III-1.4 Proposed Retention/Detention Facility Site Contours At 1 Foot Intervals



Area within each contour	
71	600 sq. ft.
72	4400 sq. ft.
73	8700 sq. ft.
74	11400 sq. ft.
75	14500 sq. ft.
76	19000 sq. ft.

Figure III-1.5 Stage-Storage Relationship

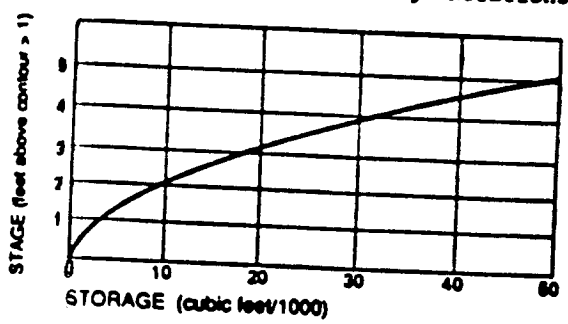


Figure III-1.6 Routing Curve for t = 60 minutes

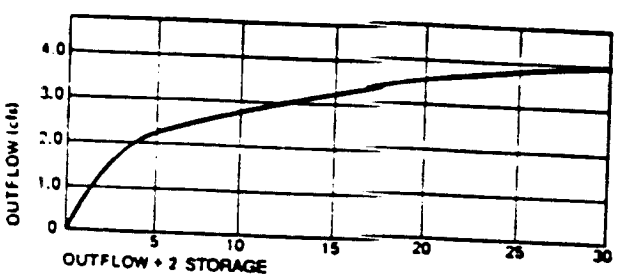
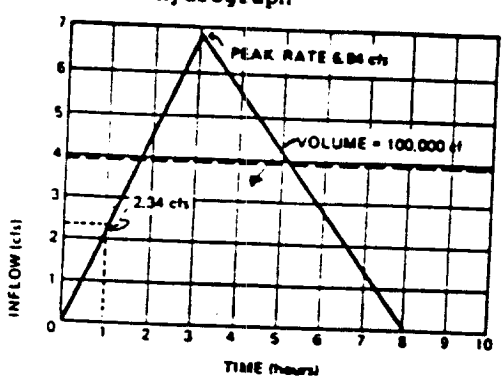


Figure III-1.7 Simplified Example of Inflow Hydrograph



$Q_{ALLOWABLE}$ = 4.0 cfs
(maximum outflow desired)

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2. Develop a curve called the "routing curve" which is simply a plot of outflow for a given stage versus a term, O + 2S, for the same stage. This curve may be easily plotted by setting up a table like Table III-1.8. The units for the expression of outflow, O, are cubic-feet per second for the time period of interest. For this example, the time period, Δt, of 60 minutes will be used for illustrative purposes. (Usually Δt will be 10 minutes to correspond to the time steps used in preparing the hydrographs.) Therefore, all variables in the rearranged continuity equation must have the units of cfs. This means that the storage which was plotted in cubic feet must be converted from ft^3 to cfs by dividing it by the time interval, Δt. For the storage below Contour 2 this would be:

$$\frac{S}{\Delta t} = \frac{2500\ ft^3}{(60\ min)} \quad \frac{1\ min}{60\ sec} = 0.694\ cfs$$

Table III-1.8 Tabulation of Data for Routing Curve

Elevation Feet	Stage Feet	Outflow* O cfs	Storage S cfs**	2S cfs	O + 2S cfs
72	1	1.76	0.694	1.388	3.15
73	2	2.49	2.514	5.028	7.52
74	3	3.05	5.306	10.612	13.66
75	4	3.52	8.903	17.806	21.33
76	5	3.94	13.556	27.112	31.05

* from 8" orifice, stage-discharge relationship [Q = (orifice area)(0.62) $\sqrt{2gh}$, where h = stage]

** from stage-storage curve, Figure III-1.5, volume converted to cfs for 60-minute time intervals.

For this example, the maximum allowable outflow was arbitrarily selected to be 4.0 cfs (this value is normally the pre-developed runoff rate from the site) and the maximum stage in the pond of 5 feet.

The "Outflow" column in Table III-1.8 is the stage-discharge relationship for an 8-inch orifice outlet pipe. The 8-inch pipe size was chosen because the maximum allowable outflow is approximately 4.0 cfs at the maximum desired storage depth of 5 feet. From Table III-1.8 the routing curve is plotted as shown in Figure III-1.6.

3. The final step is to route the inflow hydrograph through the proposed storage facility by completing successive columns of Table III-1.9 for each time period. For illustrative purposes a simple triangular shaped inflow hydrograph will be assumed as shown in Figure III-1.7.
The routing table is completed by the following steps. Keep in mind the equation used:

$$I_1 + I_2 + 2S_1 - O_1 = O_2 + 2S_2 \text{ (For each time period, } \Delta t)$$

Step

1. Initial inflow, I_1, is the inflow at the beginning of each time period and is read from the inflow hydrograph for each time period. For period 1, I_1 in this example is zero, and this is entered in Row (1) of the routing table.

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Table III-1.9 Tabular Calculation of Outflow Using Level Pool Routing

Row	Variables	Time Periods (Δt = 60 min/usually Δt = 10min.)) 1	2	3	4	5	6	7	8	9	10	11	12
(1)	I_1	0	2.34	4.64	6.94	5.55	4.18	2.79	1.39	0	0	0	0
(2)	I_2	2.34	4.64	6.94	5.55	4.18	2.79	1.39	0	0	0	0	0
(3)	$2S_1$	0	0.84	3.97	10.17	16.23	18.96	18.76	15.97	10.86	5.21	1.11	0
(4)	$I_1+I_2+2S_1$	2.34	7.82	15.55	22.66	25.96	25.93	22.94	17.36	10.86	5.21	1.11	0
(5)	O_1	0	1.50	2.35	3.03	3.40	3.60	3.57	3.40	3.10	2.55	1.55	0
(6)	O_2+2S_2	2.34	6.32	13.20	19.63	22.56	22.33	19.37	13.96	7.76	2.66	.	0
(7)	Stage$_1$ (ft)	0	0.7	2.31	2.90	3.77	4.12	4.10	3.75	3.05	2.65	0.80	0
(8)	Elevation (ft)	71.0	71.7	73.31	73.90	74.77	75.12*	75.10	74.75	74.05	73.65	71.80	71.0

* Maximum floodplain elevation

2. I_2, inflow at the end of the time period, is read from the inflow hydrograph, and entered in Row (2) for each time period. This same value is the initial inflow for the next time period. For our example, I_2, for time period 1 is 2.34 cfs; this is also entered in Row (1) of time period 2 as I_1.

3. Two times the initial storage, $2S_1$, is entered in Row (3). For the example, initial storage for time period 1 is zero. Subsequent values entered as $2S_1$ are calculated after the remaining values for the preceding time period are filled in. This is explained below.

4. Enter in Row (4) the sum of Rows (1), (2), and (3), for the appropriate time period. In this case, the sum for time period 1 is 2.34.

5. O_1, outflow initially for the time period, is entered in Row (5). For time period 1, O_1 is zero in this case. Subsequent values are read from the routing curve after Row (6) has been calculated. This is explained below.

6. From the routing equation, the entry in Row (6), $O_2 + 2S_2$, is the difference between Row (4), $I_1 + I_2 + 2S_1$, and Row (5), O_1. For time period 1, this value is 2.34. This is entered and the process repeated.

7. The value of O_1 for the next time period is read from the routing curve (Figure III-1.6) for the previous value of $O_2 + 2S_2$. In this case, a value of 1.50 is obtained for O_1 for time period 2, corresponding to ($O_2 + 2S_2 = 2.34$). Therefore, 1.50 is entered in Row (5) for time period 2.

8. The value of $2S_1$ for the next time period is the difference between the previous value of ($O_2 + 2S_2$) and the corresponding value of O_1 read from the routing curve as in Step 7, above. For this example,

$O_2 + 2S_2$ = 2.34 (for time period 1)

O_1 = 1.50 (for time period 2)

$2S_1$ = ($O_2 + 2S_2$) - O_1 = 0.84 (for time period 2)

Therefore, enter 0.84 in Row (3) for time period 2.

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9. Find the sum of Rows (1), (2), and (3) and enter value in Row (4).

10. Subtract value in Row (5) from Row (4) and enter result in Row (6).

11. Refer to routing curve for next value of O_1, corresponding to result of Step 10.

Continue this process until the outflow hydrograph, as represented by the tabulated values of O_1, returns to zero.

Row (7) of entries in the Table III-1.8 (stage at the beginning of each time period) is obtained by dividing each value of $2S_1$ by 2, and referring to the stage-storage curve, Figure III-1.8. For example, for time period 3, $2S_1$ equals 3.97 cfs-min, half of which is 1.98 cfs-min. Referring to stage-storage curve for storage 1.98 cfs-min. (or 1.98 x 3600 = 7,128 cu. ft.), a stage of 1.6 feet is obtained. Adding these stages to the elevation of the first contour (71) allows floodplain or maximum water surface (Row (8)) for each time period to be computed.

Finally, plot the values of O_1 for each time period to plot the complete outflow hydrograph, as shown in Figure III-1.8. The volume which must be stored is represented by the dark shaded area, and may be obtained through graphical techniques. The volume may also be closely estimated from the largest tabulated value of $2S_1$, divided by 2, and converted to cubic feet. This will exactly coincide with the true peak only if two hydrographs cross exactly at the end of a time interval. However, this inaccuracy in volume would be very small, and for practical purposes may be neglected.

In summary, the characteristics of the sample detention facility and the selected eight-inch orifice outlet are such that the peak runoff rate will be reduced below the required 4.0 cfs. Furthermore, the full five feet of available storage is not used and the maximum floodplain elevation generated in the pond is 75.12 feet. This indicates that additional trials or iterations could be performed to optimize the size and outlet control of this sample detention pond.

Sizing a Detention Facility for Multiple Design Storm Events

To design a storage facility to meet performance requirements of 2, 10, and 100-year storm control, it is usually necessary to perform many iterative routings to arrive at a minimum facility size with the proper outlet (orifice) control. Each iterative routing requires that the facility size (stage-storage curve) and/or outlet configuration (stage-discharge curve) be adjusted and tested for performance. Such iteration can be cumbersome, even with the use of a computer. To minimize the number of iterations, a graphical evaluation of the developed inflow hydrographs is useful in approximating the storage volume and outlet configuration of a hypothetical detention pond that meets the performance requirements, prior to beginning the iteration process to finalize the design of a detention facility.

The following simplified example presents a graphical approach to approximating storage volume and outlet configuration.

1. Assume the following performance requirements (allowable release rates) and developed peak inflow rates have been noted from hydrographs generated for the purposes of sizing a standard on-site detention pond:

Design Storm	Allowable Release	Developed Inflows
2-year, 24-hour	P_2Q_{rel} = 0.23 cfs	P_2Q_{dev} = 1.65 cfs
10-year, 24-hour	$P_{10}Q_{rel}$ = 1.40 cfs	$P_{10}Q_{dev}$ = 3.46 cfs
100-year, 24-hour	$P_{100}Q_{rel}$ = 3.47 cfs	$P_{100}Q_{dev}$ = 5.89 cfs

Note: This example illustrates detaining the peak flows for the 2, 10, and 100-year, 24-hour duration design storms. The required performance for the 100-year

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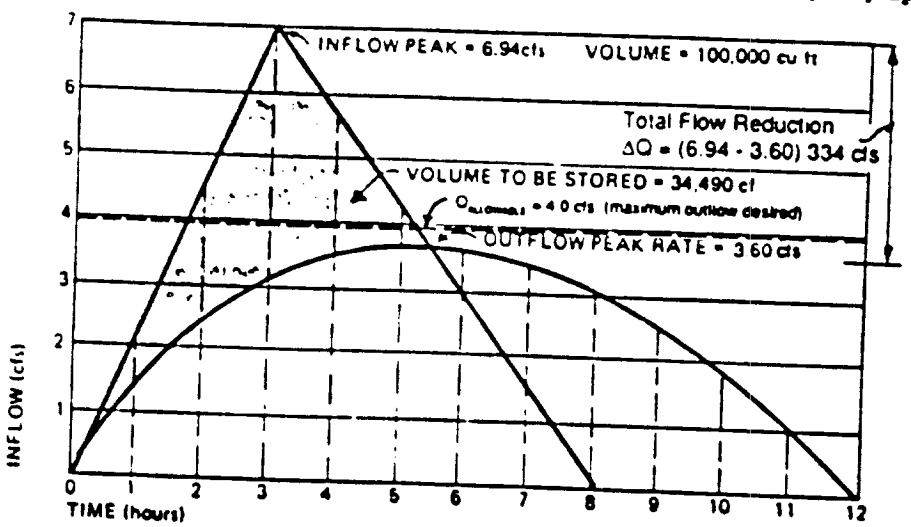
Figure III-1.8 Simplified Example of Inflow and Outflow Hydrograph



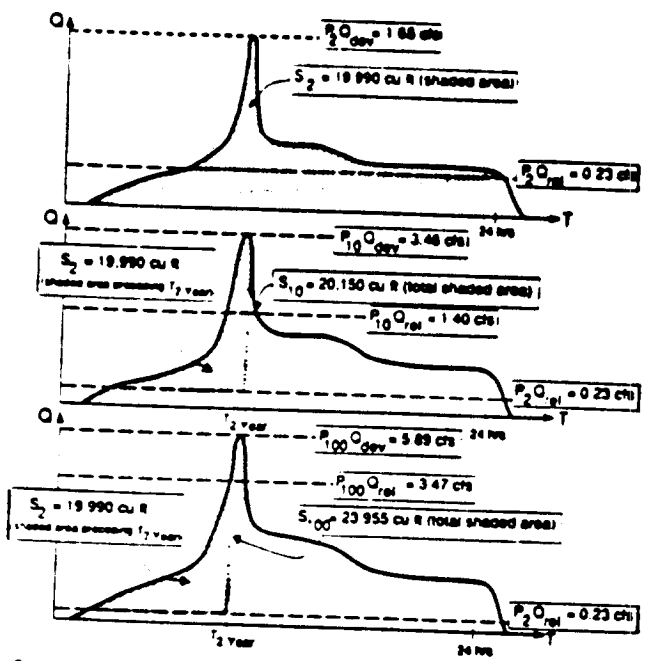


Figure III-1.9 Plots of the Developed Condition Inflow Hydrographs for the 2, 10, and 100-Year Design Storms

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design storm may in some cases be more than the pre-developed flow rate depending on downstream conditions.

2. Plots of the developed inflow hydrographs are used to graphically approximate the detention storage required to achieve the performance.

3. Starting with the 2-year hydrograph, the 2-year allowable release rate (P_2Q_{rel}) (which must not be exceeded) is plotted as a horizontal line extending from time zero to the point where it intercepts the falling limb of the hydrograph. A line is drawn from the beginning of the inflow hydrograph to this point. This line approximates the outflow rating curve of a control structure of a hypothetical detention facility which would restrict outflow to not exceed P_2Q_{rel} and thus approximates the rising limb of a hypothetical outflow hydrograph.

4. As in standard inflow-outflow hydrograph analysis, the area under the inflow hydrograph, less the area under the rising limb of the hypothetical outflow hydrograph, graphically approximates the amount of inflow which must be stored, detained and released once the inflow hydrograph falls below the allowable release rate. This volume of storage for the 2-year storm (as shaded) is termed S_2 and can thus be approximated by measuring the area with a planimeter. In this example, the vertical scale is 1 inch = 0.936 cfs and the horizontal scale is: 1 inch = 5.65 hours, then for a planimetered area measurement of 1.05 sq. in.: S_2 = (1.05 sq. in.)(0.936 cfs/in.) (5.65 hrs./in.) (3600 sec./hr.) 19,990 cu. ft.

5. The 10 and 100-year developed inflow hydrographs must now each be examined to determine which will require the most storage volume in addition to the 19,900 cu. ft. approximated for the 2-year storm. Note, the amount of storage volume needed to control the 10-year storm may exceed that of the 100-year when using this method. This occurs because the peak flows for the 10- and 100-year inflow hydrographs are similar in magnitude, and the difference between 10-year allowable release and developed peak rates can be substantially greater than for the 100-year. The interception point with the $P_{10}Q_{rel}$ thus occurs further down the falling limb than for the 100-year, resulting in a larger storage volume required.

   The 10 or 100-year allowable release rate ($P_{10}Q_{rel}$ or $P_{100}Q_{rel}$) (which must not be exceeded) is plotted as a horizontal line extending from time zero to the point where it intercepts the falling limb of the corresponding hydrograph.

   By trial and error, the time (T_2-year) at which the S_2 volume occurs, while maintaining P_2Q_{rel}, is determined by planimeter. From this point, a line is drawn to connect to the $P_{10}Q_{rel}$ or $P_{100}Q_{rel}$ point on the falling limb. The area from time T_2-year under the inflow hydrograph to this point, less the area under the rising limb of the hypothetical outflow hydrograph (shown as the slender shaded triangle(s)), represents the additional storage volume needed to meet the required performance. The total storage volume S_{10} or S_{100} can then be computed by adding the additional storage volume to S_2.

6. From the storage volumes computed above, choose the largest of the three volumes for the initial pond sizing. In this case the 100-year volume, S_{100}, is the largest. Therefore, call it S_d.

$$S_d = 23{,}955 \text{ cu. ft.}$$

7. Estimate the bottom area, A_b, of the pond assuming 3:1 side slopes and a design depth, H_d, of 4 feet. The following equation may be used:

$$A_b = \left| \frac{(4(S_d/H_d) - 36H_d^2)}{2} - 3H_d \right|^2$$

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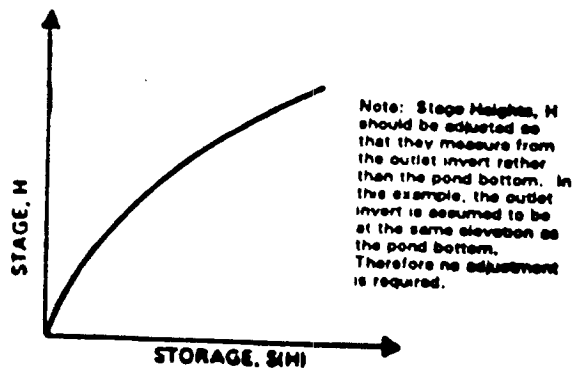
= 4154 sq. ft.

8. Compute the stage-storage curve using the following equation for ponds with 3:1 side slopes.

$$S(H) = 18H^3 + 6H^2\sqrt{A_b + A_b H}$$

Figure III-1.10
Stage - Storage Curve

Stage, H*	Storage, S(H)
0.0	0.0
0.5	2,176
1.0	4,559
1.5	7,162
2.0	9,999
2.5	13,083
3.0	16,428
3.5	20,048
4.0	23,955



*Note: Stage heights, H, should be adjusted so that they measure from the outlet invert rather than the pond bottom. In this example, the outlet invert is assumed to be at the same elevation as the pond bottom. Therefore, no adjustment is required.

9. From the stage-storage curve, determine the depth, H, required for the 2-year storage volume.
For S_2 = 19,990 cu. ft.; H_2 = 3.49 feet

Special Note: It has been found through experience that usually only two orifices are necessary to meet 2, 10 and 100-year performance requirements. The bottom orifice is therefore sized to meet the 2-year performance requirement, while the top orifice is located above the 2-year water surface and is sized and situated such that both the 10-year and 100-year performance requirements are met. This is further illustrated as the example continues.

10. Size the bottom orifice for the 2-year allowable release, P_2Q_{rel} = 0.23 cfs, using the following derivation of the orifice equation:

$Q = C\,a\sqrt{2g\,H}$ Standard orifice equation

where:

C = entrance loss coefficient = 0.62 (typ.)
a = area of orifice = $\pi d^2/4$, where d = diameter of orifice
g = acceleration of gravity = 32.2 ft/s²
H = head on orifice

For 2-year allowable release:

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P_2Q_{rel} = 0.23 cfs; H_2 = 3.49 feet

$P_2Q_{rel} = C\ a\ \sqrt{2g\ H_2}$

rearranging to solve for a:

$a = P_2Q_{rel}/C\ \sqrt{2g\ H_2}$

substituting for diameter:

$d_o^2/4 = P_2Q_{rel}/\ C\ \sqrt{2g\ H_2}$

$d_o^2 = 4P_2Q_{rel}/\ C\ \sqrt{2g\ H_2}$

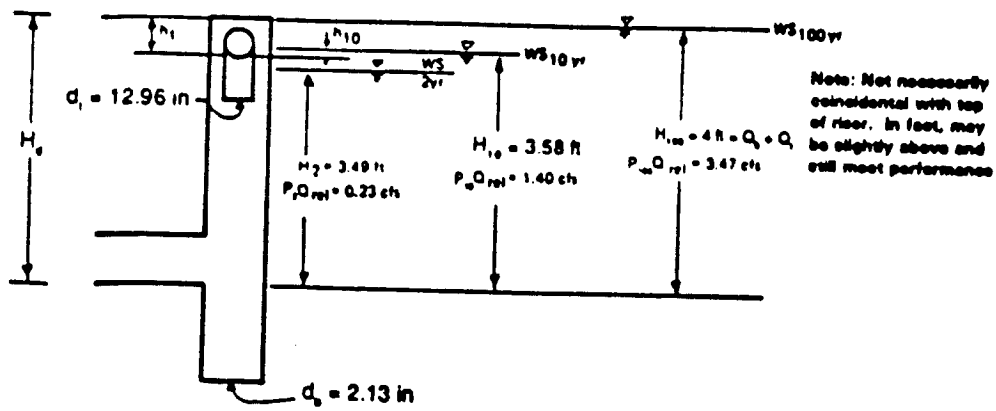
$d_o = \sqrt{4P_2Q_{rel}/\pi C\ \sqrt{2g\ H_2}}$

$d_o = \sqrt{4(0.23)/(\pi)(0.62)\ \sqrt{2(32.2)(3.49)}}$

d_o = 0.18 feet (= 2.13 inches)

11. Sketch and consider the following flow control restrictor schematic:

Figure III-1.11 Flow Control Restrictor Schematic



12. Size and situate the top orifice at or above the 2-year water surface (WS 2-year). This may require some trial and error. The release rate for this orifice is:

$Q_1 = Q_{total} - Q_o$, where Q_{total} = 3.47 cfs (total flow at maximum head)

$Q_o = CA_o\sqrt{2gh}$ where $A_o = \pi d^2/4$

d = 0.18 feet, thus $A_o = \pi(.18)^2/4 = 0.025$ ft.
h = 4 feet

$\therefore Q_o = 0.62(0.025)\sqrt{2(32.2)4} = 0.25$ cfs

Q_1 = 3.47 cfs - 0.25 cfs = 3.22 cfs

The size of this orifice will depend on its vertical location as specified by its head, h_1. h_1 in this example, must be less than 0.51 feet so that the top orifice is above the 2-year water surface. Therefore, try h_1 = 0.5 feet:

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Top Orifice Diameter, $d_t = \sqrt{\frac{4Q_t}{\pi C\sqrt{2gh_t}}}$

$$d_t = \sqrt{\frac{4(3.22)}{\pi(0.62)\sqrt{2(32.2)(0.5)}}}$$

$$= \underline{1.08 \text{ feet}} \ (= 12.96 \text{ inches})$$

13. Check for 10-year volume by:

a. Computing h_{10} (see Figure III-1.11)

$$h_{10} = \left| \frac{Q_{10} - Q_t}{CA_o} \right|^2 \cdot (2g)^{-1}$$

$A_o = \pi d^2/4$ where $d = 1.08$ ft.; $A_o = 0.92$ ft.^{2}

$$h_{10} = \left| \frac{1.40 - 0.21}{0.62(0.92)} \right|^2 \cdot [2(32.2)]^{-1} = 0.07 \text{ ft.}$$

b. Computing $H_{10} = 3.49$ feet + 0.07 feet = 3.56 feet

c. Check the stage-storage curve to see if there is sufficient volume at H_{10} = 3.56 feet:
For $H_{10} = 3.56$ feet: $S(H) = 20{,}501$ cu. ft.

Recalling $s_{10} = 20{,}150$ cu. ft.

20,501 cu. ft. > 20,150 cu. ft. okay

Note: Since the top-orifice size of 12.96 inches is too large to feasibly install in the upper 0.5 feet of the riser pipe, a notch weir must be substituted per details and equations given in Chapter III-2, Control Structures. Also, the 100-year water surface in this example is shown at the same elevation as the top of the riser. This will not necessarily be the case. In fact, it may be slightly above the riser and still meet performance.

The stage/storage/discharge information for a hypothetical detention facility developed above can then be used as a guide to design the actual detention facility. The design is checked using the "level pool routing" technique described at the beginning of this section. The stage/storage/discharge data from the actual facility design is used with each of the developed inflow hydrographs routed through the facility in order to demonstrate that the required performance is met.

The practical limits of orifice sizing may be between ¼ inch and 1 inch in diameter. This could restrict the ability of small sites to satisfy some detention requirements. Local governments should pursue alternative detention requirements, such as the use of regional facilities (for a group of small lots, for example), for small sites. This is the point in the process where a number of iterations may be required in order to calibrate and optimize the actual facility design to meet performance with the minimal amount of storage volume. With experience and over time, techniques and methods will be developed that may assist the design engineer in this process. Ecology and local governments will inform the engineering community of these techniques and methods as they become available.

III-1.4.5 Hydrograph Summation and Phasing

One of the key advantages of hydrograph analysis is the ability to accurately describe the cumulative effect of runoff from several basins and/or subbasins having different runoff characteristics and travel times. This cumulative effect is best characterized

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by a single hydrograph which is obtained by summing the individual hydrographs from tributary basins at a particular "discharge point of interest." The general procedure for performing a hydrograph summation is described below:

Hydrograph Summation

1. Select the "discharge point of interest" at which the hydrographs will be summed.

2. Estimate the time required for each hydrograph to travel from its point discharge to the "discharge point of interest." This travel time can be estimated using the methods presented in Section III-1.4.3 under "Travel Time and Time of Concentration."

3. Shift each hydrograph according to its travel time to the "discharge point of interest" as shown below in Figure III-1.12.

4. Sum the shifted hydrographs by adding the ordinate flow values at each time interval as shown below in Figure III-1.13.

Figure III-1.12 Shifting the Hydrographs Using Travel Time

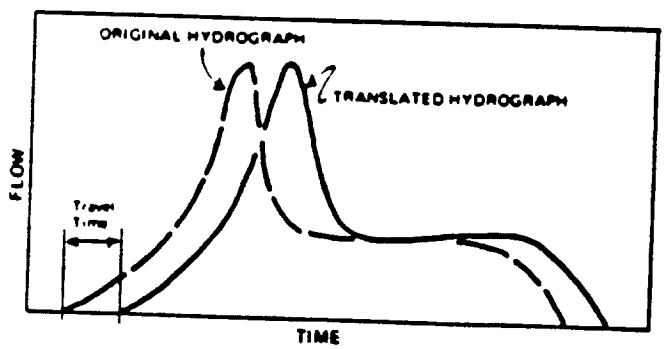
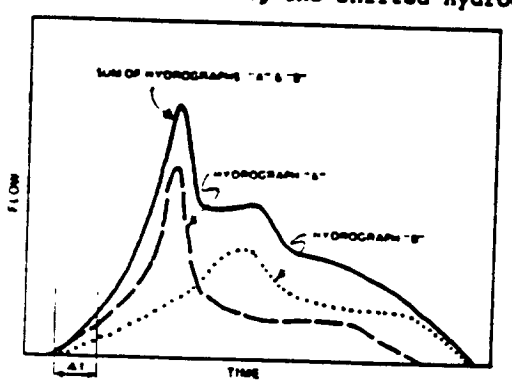


Figure III-1.13 Summing the Shifted Hydrographs



Note: Δt has been previously defined as 10 minutes or less for a 24-hour duration storm and 60 minutes for a 7-day duration storm.

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Hydrograph Phasing Analysis

The ability to characterize cumulative effects through the summation of hydrographs provides a valuable tool for analyzing the interaction of on-site and off-site hydrographs both before and after development. This interaction of hydrographs is generally referred to as "hydrograph phasing" due to the similarity with compound waveshapes. This hydrograph phasing analysis is required in order to determine the effect of the compound hydrograph shape on the downstream system.

The general procedure for performing a hydrograph phasing analysis is as follows:

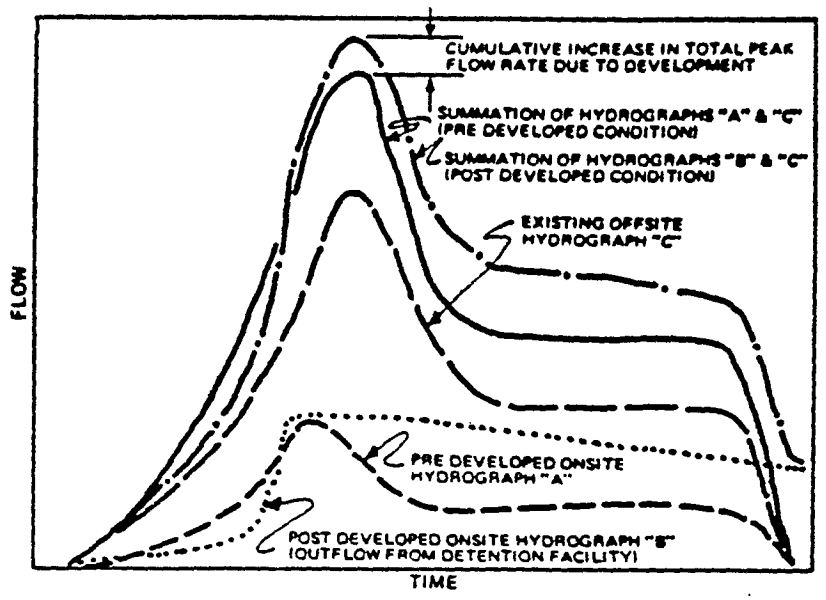
1. Select the "discharge point of interest" at which the on-site and off-site runoff hydrographs will be summed and compute travel times as explained under "Hydrograph Summation."

2. Compute the pre-developed on-site hydrograph and the existing off-site hydrograph for the design storm of interest. Shift and sum these hydrographs as explained under "Hydrograph Summation."

3. Compute the post-developed on-site hydrograph. If on-site detention is provided, this hydrograph will be the outflow hydrograph from the facility. Shift and sum this hydrograph with the existing off-site hydrograph.

4. Plot the above two summations as shown below to obtain a comparison of cumulative effects:

Figure III-1.14 Hydrograph Phasing Analysis



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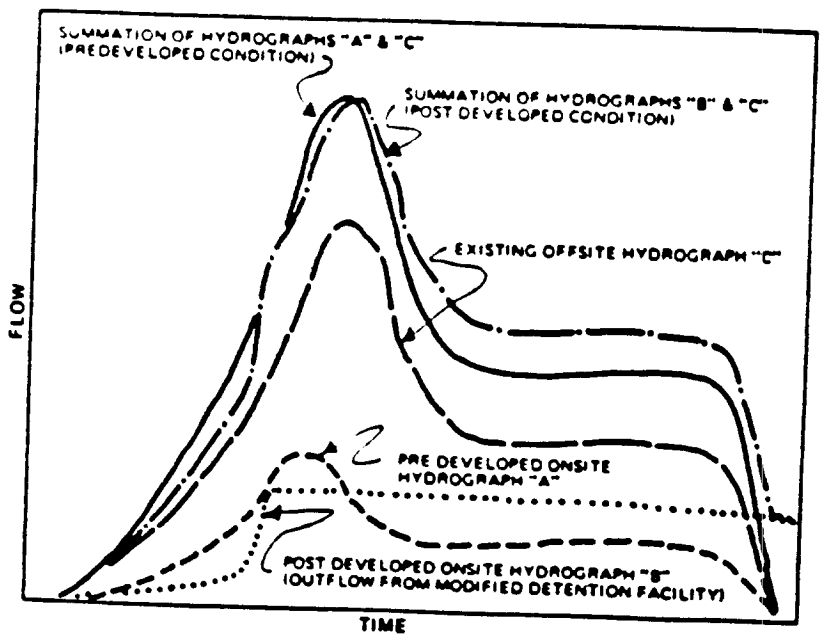
The above example plot illustrates how a development with standard on-site detention can cause an increase in peak flow at some point downstream. If this is the case, the local government shall require this condition be addressed by reducing the release rate from the detention facility such that the cumulative effect downstream is negligible as shown in the plot below:

Figure III-1.15 Reducing the Release Rate to Decrease Downstream Effects



III-1.4.6 Computer Applications

SBUH Method and Level Pool Routing

The computations required to generate the runoff hydrographs and perform the level pool routing techniques presented in this chapter can be performed manually. However, due to their volume and repetitive nature, a programmable calculator and/or a personal computer will perform these computations much quicker and with a likely higher degree of accuracy. Because of the familiarity that practicing engineers have with either a programmable calculator or a personal computer, they are encouraged to write their own routines to perform the hydrograph analysis.

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Computer Models

Local governments may make available programs and application templates developed in-house. These will likely be available on a "make-your-own-copy basis" and will be provided with minimal documentation and no formal support. Software developers are preparing programs that they plan to market and support. Local governments will maintain a list of these programs as they are approved by them for use.

III-1.5 CLOSED DEPRESSION ANALYSIS

The analysis of closed depressions requires careful assessment of the existing hydrologic performance in order to evaluate the impacts a proposed project will have. The applicable requirements, (see Minimum Requirement #7) and the local government's Sensitive Areas Ordinance and Rules (if applicable) should be thoroughly reviewed prior to proceeding with the analysis.

Analysis and Design Criteria

The infiltration rates used in the analysis of closed depressions shall be determined according to the procedures in Chapter III-3. A minimum of four surface tests shall be performed to prepare an average surface infiltration rate based on the following criteria:

1. For closed depressions containing standing water, soil texture tests shall be performed on dry land adjacent to, and on opposite sides of the standing water (as is feasible), such that the elevation of the testing surface at the bottom of the test pit is one foot above the standing water elevation.

2. For closed depressions without standing water, infiltration rate tests shall be performed in the bottom of the closed depression at locations of similar elevation, and on opposite sides of the bottom area (as is feasible), such that the elevation of the testing surface at the bottom of the test pits is at least one foot above any observed ground water table.

Projects proposing to modify or compensate for replacement storage in a closed depression shall meet the design criteria for detention ponds as described in Chapter III-4.

Method of Analysis

Closed depressions are analyzed using hydrographs routed as described in Section III-1.4.4 "Hydrograph Routing." Infiltration shall be addressed where appropriate. In assessing the impacts of a proposed project on the performance of a closed depression there are three cases that dictate different applications of the performance standard as follows:

1. **CASE 1:**

The 100-year, 7-day duration design storm flow from the drainage basin tributary to the closed depression is routed into the closed depression using only infiltration as outflow. If runoff does not overflow the closed depression, then no runoff may leave the closed depression for the 100-year, 7-day duration design storm following development of a proposed project. This may be accomplished by excavating additional storage volume in the closed depression (subject to all applicable requirements, for example providing a defined overflow system).

2. **CASE 2:**

The 100-year, 7-day duration design storm flow from the drainage basin tributary to the closed depression is routed into the closed depression using only infiltration as

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outflow. If runoff does overflow the closed depression, then the 100-year, 24-hour duration design storm flow from the drainage basin tributary to the closed depression is routed into the closed depression using only infiltration as outflow. If this does not cause outflow, then the allowable release rate is that which occurred for the 100-year, 7-day duration design storm. This performance can be met by excavating additional storage volume in the closed depression (subject to all applicable requirements, for example providing a defined overflow system).

3. **CASE 3:**

The 100-year, 7-day duration design storm flow and the 100-year, 24-hour duration design storm flow from the drainage basin tributary to the closed depression are routed into the closed depression using only infiltration as outflow, and both cause overflow to occur. Then the closed depression shall be analyzed as a detention/infiltration pond. The required performance, therefore, is to not exceed the existing runoff rates for the 2, 10, and 100-year, 24-hour duration and 100-year, 7-day duration design storms. This will require that a control structure, emergency overflow spillway, access road, and other design criteria described in Chapter III-4 be met and, if it is to be maintained by the local government, the closed depression placed in a tract dedicated to the local government. If it is to be privately maintained, it must be located in a drainage easement dedicated to the public.

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APPENDIX AIII-1.1

ISOPLUVIAL MAPS FOR DESIGN STORMS

Included in this appendix are the 2, 10 and 100-year, 24-hour design storm and mean annual precipitation isopluvial maps for the Puget Sound basin. These have been taken from NOAA Atlas 2 "Precipitation - Frequency Atlas of the Western United States, Volume IX, Washington.

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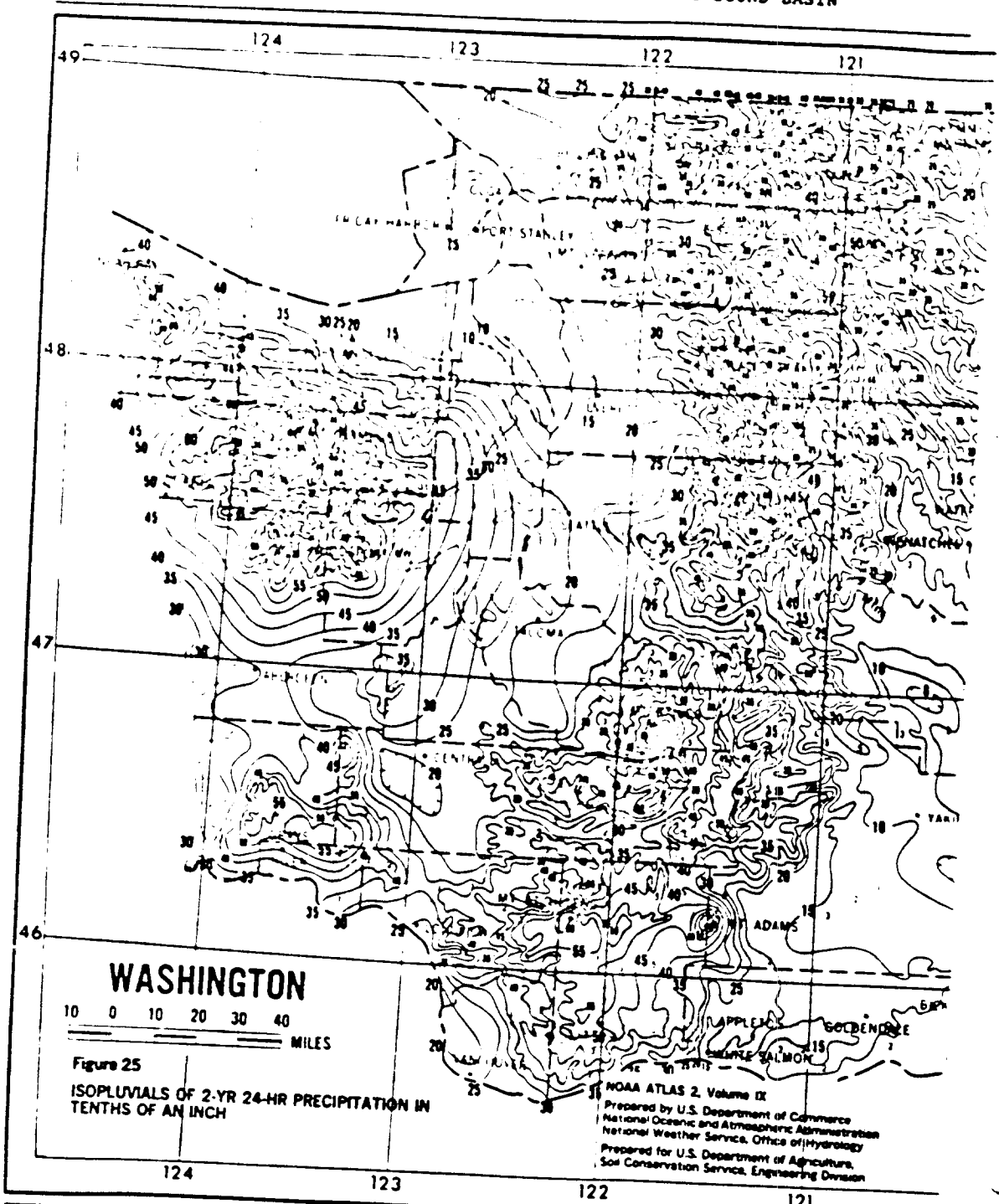

Figure 25

ISOPLUVIALS OF 2-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

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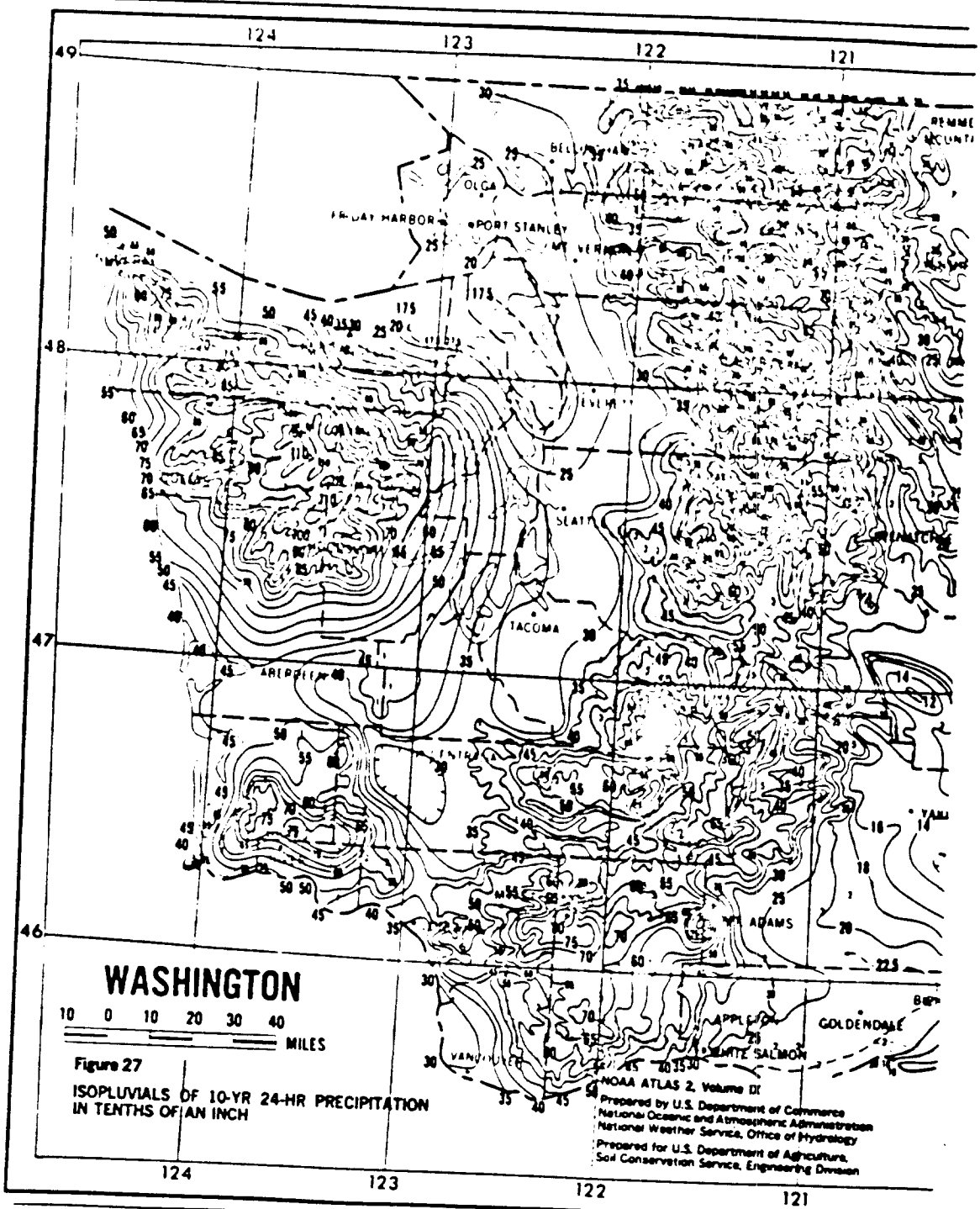

Figure 27

ISOPLUVIALS OF 10-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

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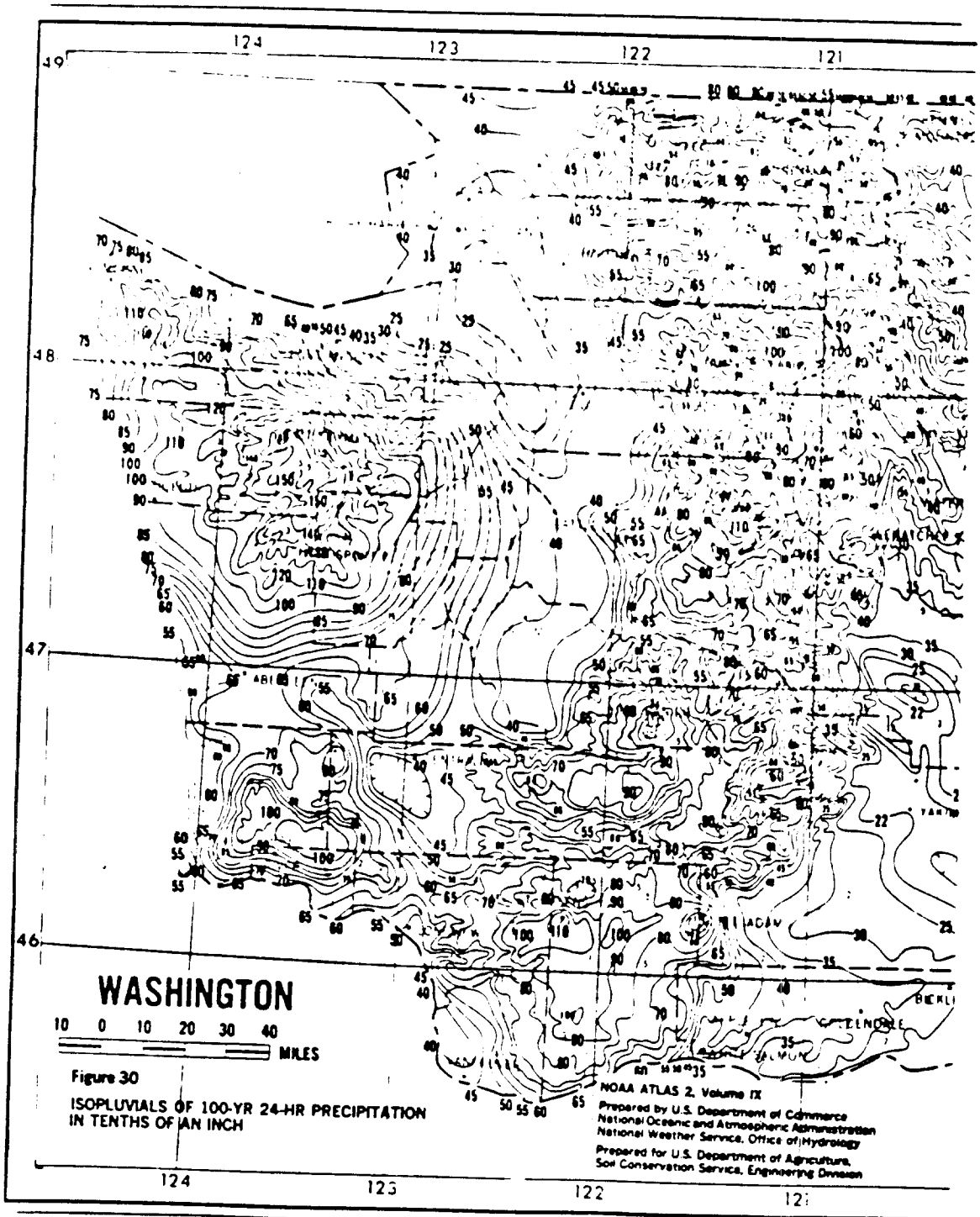

Figure 30

ISOPLUVIALS OF 100-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

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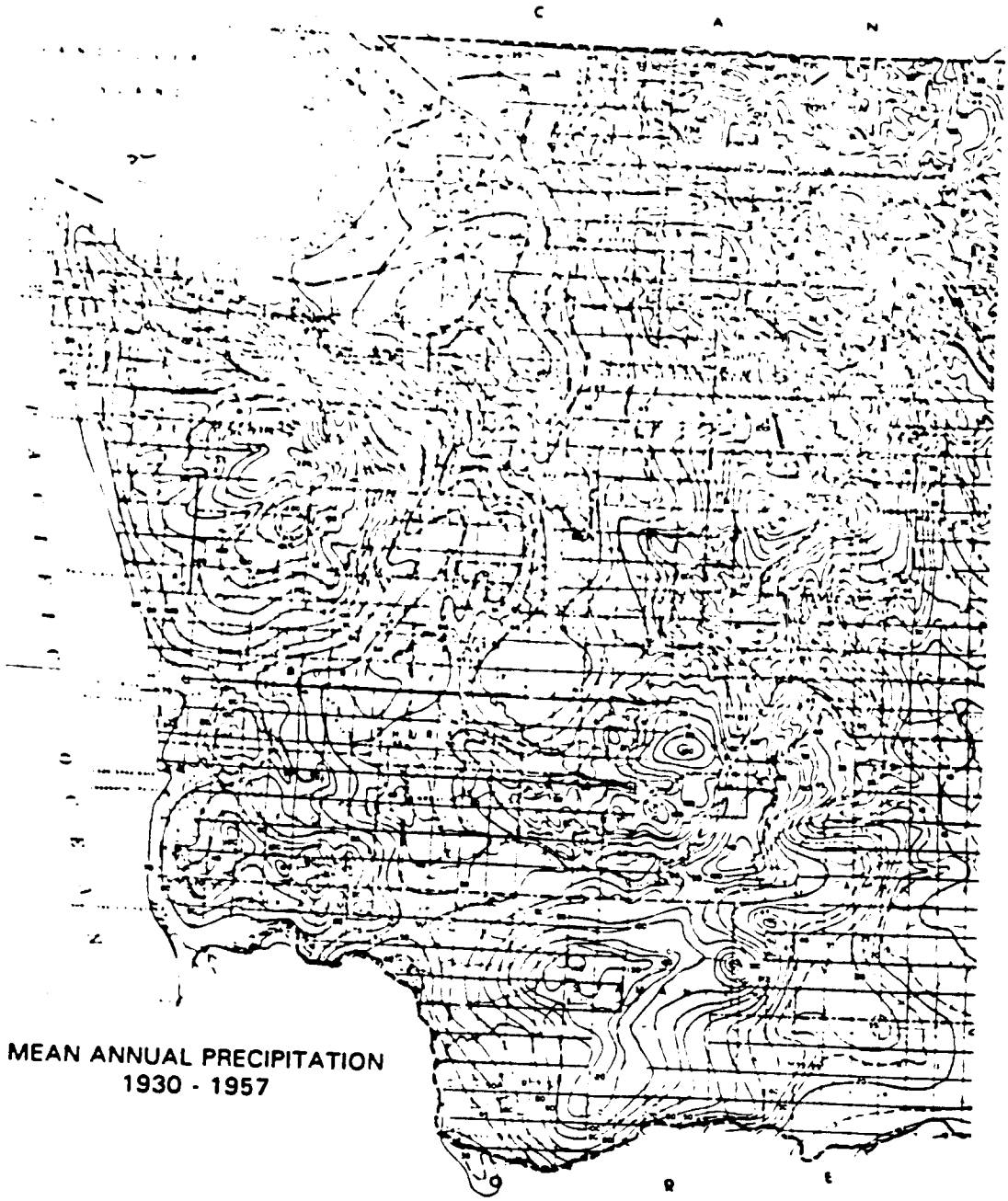

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APPENDIX AIII-1.2

PERFORMANCE OF DETENTION PONDS DESIGNED ACCORDING TO CURRENT STANDARDS

Bruce L. Barker, Ralph D. Nelson P.E., and Mark S. Wigmosta

Introduction

On-site detention has been widely adopted as a means to control the increased rate of runoff from urbanized areas. When an area is developed, a detention pond or vault is constructed to reduce the increased flows with urbanization. Past detention standards and design methods have not been adequate to mitigate these increased flows in King County. The sediment and pollutants associated with higher flows are ultimately deposited in Puget Sound. Thus, the proper functioning of detention ponds in urban areas is critical to the protection of stream systems and the water quality in Puget Sound.

Recent field data and new computer modeling suggest that the existing methods of detention pond design are not adequate for the hydrologic conditions found in the Puget Sound area. Peak flow releases from detention ponds designed under current standards were found to increase substantially over undeveloped conditions. This indicates that mitigation for development has not been adequate to date, and furthermore, the volume to fully mitigate peak flows with detention is actually much greater than the current methods estimate.

Detention Standards and Methods in King County

Rational Methods

In King County, the detention of stormwater runoff was first mandated by the Storm Drainage Control Manual (King County, 1979). The requirements in the manual focused on flood control. Ponds were typically designed such that post-developed 10-year flows were reduced to pre-developed 10-year flow levels (10-year standard). The method recommended for design was the Yrjanainen and Warren (Y&W) method with peak runoff rates based on the rational method. In 1985, an amendment was made requiring multiple orifices with the intent to control a greater range of flows.

In 1987, King County conducted a field survey (King County, 1987) of the streams in urbanizing areas and found substantial damage in urban areas with on-site detention ponds designed according to 1979 standards. The cause of damage was three-fold. First, drainage facilities were not being maintained properly; second, inspection during construction was inadequate; and third, the methods of design did not adequately protect the stream systems from erosion.

While many of these facilities were not functioning properly because of poor design and maintenance, the ponds having better design and maintenance failed to protect the stream system from flooding and most notably, erosion.

Single Event Methods

Recently, more stringent detention standards have been adopted in an attempt to prevent further degradation of streams. The King County Surface Water Design Manual (King County, 1989) requires that post-developed 2 and 10-year flows be reduced to pre-developed 2 and 10-year levels respectively with the resulting pond volume increased by a 30% safety factor (1.3(2-10 year)standard). The inclusion of more frequent events (2-year) in addition to the 10-year events was intended to reduce the amount of erosion by the more frequent storms. The approved design event methodology is the single event approach. The manual recommends the use of the Santa Barbara Urban Hydrograph (SBUH) method (Stubchaer, 1975), which incorporates much of the Soil Conservation Service (SCS, 1972) approach.

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Other standards required by King County have sought to address, for example, the increased flow volume in addition to the peak flow. A standards recommended by the Bear Creek Basin Plan (King County, 1990) recommends that the 2, 10 and 100-year flows be reduced to pre-developed ½ of the 2, 2 and 10-year flows respectively (the "stream protection standard").

Use of a Continuous Simulation Model to Quantify Pond Performance

The performance of detention ponds designed to existing standards was tested using the Hydrological Simulation Program - Fortran (HSPF) (U.S. EPA, 1984). This model uses mathematical relationships to describe the physical processes controlling the hydrology of the watershed. Using inputs of precipitation and evaporation, HSPF computes the amount of discharge to the creek continuously through time from surface, shallow sub-surface, and ground water flow.

The HSPF model was calibrated to stream systems in urbanizing King and Snohomish Counties by the USGS (USGS, 1990). Using the calibrated model, a 39-year continuous record of rainfall collected at the Seattle-Tacoma Airport station was used to create a 39-year series of flows from hypothetical but typical site developments. The flows computed by HSPF were then routed through the detention ponds designed according to current methods and the resulting performance assessed. Return periods for the discharge from each pond tested were computed using a Log-Pearson analysis (WRC, 1977).

A total of 12 different detention ponds representing six different methods and standards, and two different land uses were evaluated in the tests. The design methods included the Y&W and SBUH methods. Pond release standards and design methods are summarized in Table A1.

Table A1
Detention Pond Designs Tested

Detention Pond	Design Method	Release Standard
1979 Design Manual	Y&W	10-year single orifice
1979 Design Manual	Y&W	10-year multiple orifice
1989 Design Manual	SBUH 24-hour event	1.3 (2-10-year)
1990 Bear Creek Standard	SBUH 24-hour event	Stream protection

The ponds were sized for 25 and 50 acre site conversions of forest to commercial and residential land uses on till soils. The commercial site is assumed to be 100% impervious and the residential site is assumed to be 23% impervious with the remaining area covered by grass.

Simulated Pond Performance

Existing Methods and Standards

The different methods and standards evaluated for the tests produced a wide range of pond volumes (Table 2). It is clear that the 1989 Design Manual Standard provides substantially more detention volume than past standards. This increased volume is reflected in the performance of each detention pond.

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Figure AIII-2.1

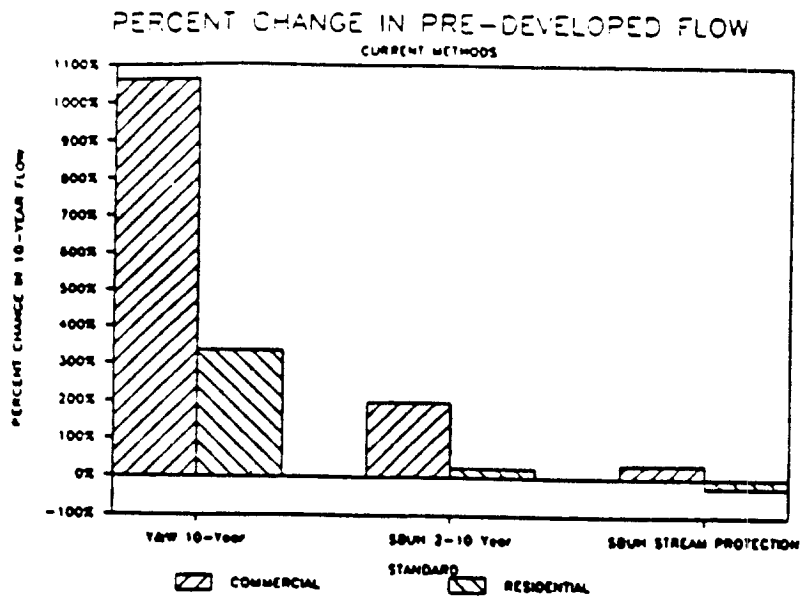

FIGURE 2

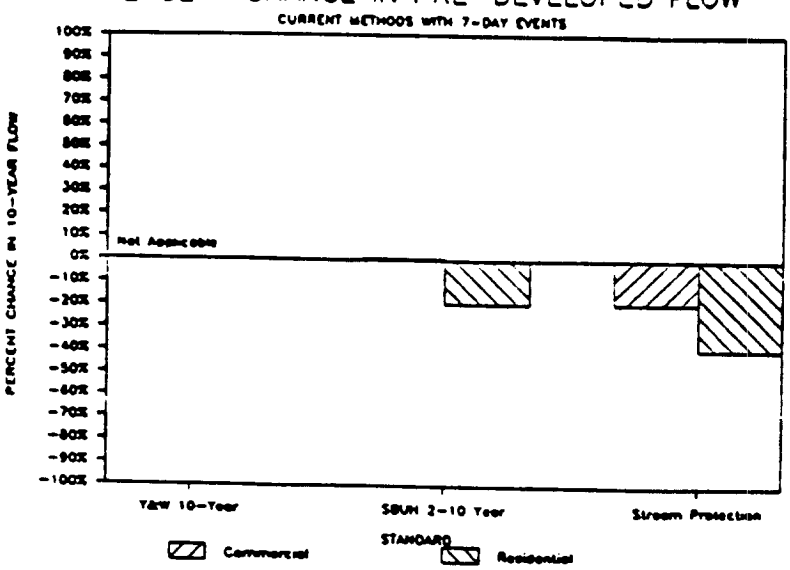

Figure AIII-2.2

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Table A2
Detention Volumes From Current Design Methods

Detention Pond	Volume (Inches)	
	Commercial	Residential
1979 Design Manual	0.51	0.19
1989 Design Manual	1.99	1.19
Bear Creek Standard	3.69	2.72

Figure 1 compares the performance of the detention ponds tested for a forested site converted to commercial and residential land uses. The ponds designed according to the 1979 manual performed the worst with 10-year flows from the commercial site pond increasing by a factor of 10 over pre-developed levels. Ponds designed according to the 1989 Design Manual performed substantially better with the 10-year flows from the commercial site increasing by a factor of 2 over pre-developed levels. Flows from the pond designed to the Bear Creek stream protection standard, which is intended to control 10-year flows to a 2-year pre-developed flow level, also increased by 30% over pre-developed 10-year levels. Overall, ponds designed for residential development densities performed better than the commercial sites. Flows from the 1979 manual, 1989 manual, and Stream Protection ponds changes by 350%, 20% and -10% respectively.

The generally poor performance is the result of the ponds filling and overtopping at a frequency greater than the design storm. The reason for this is the inherent assumption in any event-based design that the pond is empty when an event begins. Because pre-developed runoff rates in the Puget Sound area are low relative to post-developed rates, the ponds drain slowly and contain water for many consecutive days during the winter. Thus, when a large event occurs, the full pond volume is not available and the pond overtops. When a detention pond is full, pond inflows are not detained, and the pond outflow nearly equals the inflow, increasing the potential for downstream flooding and erosion.

The multiple orifice configuration tended to increase the time for the pond to drain, thus making it more susceptible to overtopping than the ponds designed with a single orifice.

Additional Volume Required to Control Peak Flows

Examination of discharge hydrographs from the ponds designed according to the SBUH method indicates that it takes from five to ten days to reach maximum discharge during a storm event. Therefore, the design storm event, or design series of events, should be of similar length.

The simulated ponds designed by the SBUH method were redesigned using a 7-day event in an effort to improve pond performance. A 7-day duration design storm based on a modified distribution developed by Schaefer (1990) was used. The performance of ponds designed with this 7-day storm are shown in Figure 2 for two design standards. The pond designed to the 2-10 standard matches the pre-developed peak flow, and the pond designed with the stream protection standard did not overtop during the simulation period. This indicates the ponds were performing as designed.

The ponds sized with the 7-day event produce detention ponds that are larger than the volumes determined by existing standards having obvious implications for development costs. For example, a commercial development pond requires 50% more detention with a 2-10 release standard, and 57% more storage with a stream protection release standard over existing design methodology. The increased detention storage is considerably less with residential developments. The increase

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is approximately 23% with a pond release rate of 2-10, and 14% with a stream protection standard.

Summary

Past on-site design methodology has not been effective at controlling increased flows associated with urbanization. Increased flows have caused flooding and erosion damage to stream systems. These increased flows transport sediment and pollutants to Puget Sound, which is the final receiving body for streams in King County.

The performance of detention ponds designed according to various standards indicates that none of the methods or standards that have been used in King County to date reduce flows to the design level. The underlying cause of this is the assumption that the ponds are empty when the storm event begins. The continuous model shows this not to be the case, with the ponds designed according to event methods operating partially full for periods of several consecutive days at a time throughout the winter.

The pond performance was improved by designing the ponds using a longer design storm. This storm was chosen to be 7 days to match the apparent length of time ponds drain in the winter. The ponds designed with the 7-day event matched the design goals. However, they were considerably larger than ponds designed by current standards, 50% for commercial ponds and 20% for residential ponds.

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CHAPTER III-2

CONVEYANCE SYSTEMS

III-2.1 PURPOSE AND SCOPE

This chapter presents acceptable methods for the analysis and design of conveyance systems. It also includes a section on control structures, or catchbasins, which link the conveyance system to the runoff treatment and streambank erosion control BMPs. The reader is referenced also to Chapter III-1, which provides details on hydrologic analysis methods, and to Chapters III-3 through III-8, which present acceptable methods for analysis and design of infiltration systems, detention facilities, and other water quality facilities. Before proceeding with analysis and design of these systems and facilities, and drainage plan and design, the design engineer should thoroughly review the site specific stormwater management plan requirements as set forth in Chapters I-2 and I-3.

Each of the sections in this chapter contain the methods of analysis, design criteria, and standard details for the various systems or facilities. They are organized with basically similar formats to provide consistency and quick reference to information. They may include:

- An Overview of topic and purpose.
- Design Guidelines and criteria for system design and alternative system applications.
- Site Constraints such as easement requirements, building setbacks, etc.
- Subsections with most containing the following information:
  - An introduction to the topic.
  - Specific Design Criteria such as acceptable materials, maximum slopes, geometrics, etc.
  - Methods of Analysis for hydraulic system design including standard charts, nomographs, tables, etc. and reference to applicable material.
  - Standard Details are provided or referenced in other publications.

III-2.2 GENERAL DESIGN CRITERIA

This manual and the local government's Road Standards provide established standards for engineering design, suitability of purpose, and method of analysis. The Washington State Department of Transportation/APWA (WSDOT/APWA) Standard Specifications for Road, Bridge, and Municipal Construction, most recent edition, also provides approved specifications and standards for design and construction.

III-2.3 CONVEYANCE SYSTEM DESIGN AND ANALYSIS

III-2.3.1 Overview

A conveyance system includes all portions of the surface water system, either natural or man-made, that transport storm and surface water runoff. The purpose of the conveyance system is to drain surface water from properties, up to a specific design flow, so as to provide protection to property and the environment.

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A properly designed pipe system will maximize hydraulic efficiency by utilizing proper material, slope, and pipe size. An ideal channel section will be sized to provide adequate capacity for design flows while minimizing erosion and allowing for aesthetics, habitat preservation, and enhancement of water quality.

A man-made conveyance system should emulate the natural conveyance system to the extent feasible. Inflow to the system and discharge from the system should occur at the natural drainage points as determined by topography and existing drainage patterns.

Conveyance systems can be separated into the following five categories:

- Pipe systems
- Culverts
- Outfalls
- Open channels
- Floodplains/floodways

Open, vegetated channels are the preferred method of conveyance. The vegetation will help keep the channel from eroding, and can provide some amount of water quality treatment. Open channels also simplify tracing illegal dumping when it occurs.

III-2.3.2 Analysis and Route Design Requirements

Analysis

- All existing and proposed conveyance systems shall be analyzed and designed using the peak flows from the hydrographs developed using the procedures described in Chapter III-1.

Route Design

- The most efficient route selected for new conveyance systems will result from careful consideration of the topography of the area to be traversed and the legal property boundaries.
- Unless topography prohibits, new conveyance system alignments on private property must be located in drainage easements that are adjacent and parallel to property lines and are not split between adjacent properties.

  Exception: Streams and natural drainage channels will not be relocated strictly to meet this requirement.

- Aesthetic considerations and traffic routes may dictate the placement and alignment of open channels. Appropriate vehicular and pedestrian traffic crossings must be provided in the design.

Easements and Building Setback Lines

- All public and privately maintained conveyance systems shall be located in drainage easements in accordance with requirements of the local government.

  Exception: Roof downspout, minor yard and footing drains unless they serve other adjacent properties.

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III-2.3.3 Pipe Systems

Pipe systems are networks of storm drain pipes, catchbasins, manholes, inlets, and outfalls designed and constructed to convey storm and surface water. The hydraulic analysis of flow in storm drain pipes typically is limited to "gravity flow"; however, in analyzing existing systems it may be necessary to address pressurized conditions. Pump systems shall be designed using the hydraulic methods which apply to sanitary sewer pump systems.

Design Criteria for Pipe Systems

(1) Pipe material, joints, and protective treatment shall be in accordance with WSDOT/APWA Standard Specifications Section 9.05 and AASHTO and ASTM treatment standards. Galvanized pipe is not recommended because of its tendency to leach zinc to the environment.

(2) Pipe Sizes, Slopes, and Velocities

- Pipe sizes and lengths, minimum slopes and velocities and design flow by structure shall be according to Washington Department of Ecology "Criteria for Sewage Works Design" or local government standards, whichever is the more stringent.

- Change of Pipe Size (does not apply to detention tanks):

  - Changes of pipe size (increase or decrease) are allowed only at junctions, and structures must be located at all junctions. (Exceptions may be allowed by the local government's Road Standards.)

  - Downsizing of pipes is not a recommended practice and should only be allowed under special conditions (i.e. no hydraulic jump can occur; downstream pipe slope is significantly greater than the upstream slope; significant cost savings can be realized; velocities remain in the 3 - 8 fps range, etc.)

(3) Structures

- Table III-2.1 presents the allowable structures and pipe sizes allowed by size of structure.

- The methods described in Chapter 5, Sections 4 and 5, of the Washington State Department of Transportation (WSDOT) Hydraulics Manual can be used in determining the capacity of inlet grates when capacity is of concern with the following exceptions:

  - Use design peak flows as required in Chapter III-1 of this manual.

  - Assume grate areas on slopes are 80 percent free of debris. "Vaned" grates, 95%.

  - Assume grate areas in sags or low spots are 50 percent free of debris. "Vaned" grates, 75%.

- Catchbasin (or manhole) diameter shall be determined by pipe orientation at the junction structure. A plan view of the junction structure, drawn to scale, will be required when more than four pipes enter the structure on the same plane, or if angles of approach and clearance between pipes is of concern. The plan view (and sections if necessary) must insure a minimum distance (of solid concrete wall) between pipe openings of 8 inches for

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48 inch and 54 inch catchbasins and 12 inches for 72 inch and 96 inch catchbasins.

Catchbasin evaluation of structural integrity for H-20 loading may be required for multiple junction catchbasins and other structures.

- Catchbasins shall be provided within 50 feet of the entrance to a pipe system to provide for silt and debris removal.
- HDPP pipe systems longer than 100 feet must be secured at the upstream end and the downstream end placed in a 4 foot section of the next larger pipe size. This sliding sleeve connection allows for the high thermal expansion/ contraction coefficient of this pipe material.
- The maximum slope of the ground surface for a radius of 5 feet around a catchbasin grate shall be 3:1.

Table III-2.1 Allowable Structures and Pipe Sizes

Catchbasin Type(1)	Maximum Pipe Diameter (2)CMP, Spiral Rib CPEP, HDPP, PVC (Inches)	Maximum Pipe Diameter Concrete and Ductile Iron (Inches)
Inlet(4)	12	12
Type 1(3)	18	12
Type 1L(3)	24	18
Type 2-48-inch dia.	30	24
Type 2-54-inch dia	36	30
Type 2-72-inch dia.	54	48
Type 2-96-inch dia.	72	72

(1) Catchbasins, including manhole steps, ladder, and handholds shall conform to the local government's Road Standards.
(2) Generally these pipe materials will be one size larger than concrete due to smaller wall thickness. However, for angled connections or those with several pipes on the same plane, this will not apply.
(3) Maximum 5 vertical feet allowed between grate and invert elevation.
(4) Normally allowed only for use in privately maintained drainage systems and must discharge to a C.B. immediately downstream.

(4) Pipe Alignment/Connections/Cover

- Pipes must be laid true to line and grade with no curves, bends, or deflections in any direction (except for HDPP and Ductile Iron with flanged restrained

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mechanical joint bends (not greater than 30°) on steep slopes].

- A break in grade or alignment or changes in pipe material shall occur only at catchbasins or manholes.
- Connections to a pipe system shall be made only at catchbasins or manholes. No wyes or tees are allowed except on roof/footing/yard drain systems on pipes 8 in. in diameter, or less, with clean-outs upstream of each wye or tee. Additional exceptions may be made by the local government.
- Provide 6 inches minimum vertical and 3 feet minimum horizontal clearance (outside surfaces) between storm drain pipes and other utility pipes and conduits. For crossings of sanitary sewer lines the Washington Department of Ecology criteria will apply. Note that for pipe diameters less than 12 inches in diameter (when not listed in these tables), use the cover specifications for the 12 inch diameter pipes.
- Pipe cover over storm pipes in local government road rights-of-way shall be per the Road Standards of the local government. Pipe cover is measured from the finished grade elevation down to the top of the outside surface of the pipe. Under collection roadways, driveways, parking stalls, or other areas subject to light vehicular loading, pipe cover may be reduced to a 1-foot minimum if recommended by pipe manufacturers.
- Pipe cover in areas not subject to vehicular loads, such as landscape planters and yards, may be reduced to a 1 foot minimum.

(5) Debris Barriers

Debris barriers (trash racks) are required on all pipes entering a closed pipe system. See Figure III-2.8 for required debris barrier on pipe ends outside of roadways. See Figure III-2.10 and Section III-2.3.4 for requirements on pipe ends (culverts) projecting from driveways or roadway sideslopes.

(6) Drainage Easements

Drainage easements are required for maintenance and access over pipes located outside of the road right-of-way (see local government requirements), except downspout roof drains, yard drains, and footing drains.

Methods of Analysis

Two methods of hydraulic analysis using Manning's equation are used for the analysis of pipe systems. The first method is the Uniform Flow Analysis Method and is used for the preliminary design of new pipe systems. The second method is the Backwater Analysis Method and is used to analyze the capacity of both proposed, and existing, pipe systems.

(1) Uniform Flow Analysis Method

Used for the preliminary sizing of new pipe systems to convey the peak rate of runoff for the 25-year design storm event.

Assumptions:

- Flow is uniform in each pipe (i.e., depth and velocity remain constant throughout the pipe for a given flow).
- Friction head loss in the pipe barrel alone controls capacity. Other head losses (i.e., entrance, exit, junction, etc.) and any backwater effects or

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inlet control conditions, which may be present or anticipated in the system, are not specifically addressed.

Each pipe within the system is sized and sloped such that its barrel capacity at normal full flow (computed by Manning's Equation) is equal to or greater than the 25-Year design flow. The nomograph in Figure III-2.1 can be used for an approximate solution of Manning's Equation. For more precise results, or for partial pipe full conditions, solve Manning's Equation directly:

$$V = \frac{1.49\ R^{2/3}\ s^{1/2}}{n}$$

or, using the continuity equation, $Q = AV$

$$Q = \frac{1.49\ AR^{2/3}s^{1/2}}{n}$$

where:

Q = Discharge in cfs
V = Velocity in fps
A = Area in ft^2
n = Manning's roughness coefficient in $s\text{-}ft^{1/6}$ (see Table III-2.2)
R = Hydraulic radius = area/wetted perimeter, in ft.
s = Slope of the energy grade line in ft/ft

For pipes flowing partially full, the actual velocity may be estimated from the hydraulic properties shown in Figure III-2.1 by calculating Q_{full} and V_{full} and using the ratio of Q_{design}/Q_{full} to find V and d (depth of flow).

Table III-2.2 provides the recommended Manning's "n" values for preliminary design using the Uniform Flow Analysis Method for pipe systems. (Note, the "n" valves for this method are 15% higher in order to account entrance, exit, junction, and bend head losses.)

Table III-2.2 Manning's "n" Values for Pipes

Type of Pipe Material	Analysis Method: Backwater Flow	Analysis Method: Uniform Flow
A. Concrete pipe and CPEP-smooth interior pipe	0.014	0.012
B. Annular Corrugated Metal Pipe or Pipe Arch:		
1.2-2/3" x 1/2" corrugation (riveted)		
a. plain or fully coated	0.028	0.024
b. paved invert (40% of circumference paved):		
(1) flow full depth	0.021	0.018
(2) flow 0.8 depth	0.018	0.016
(3) flow 0.6 depth	0.015	0.013
c. treatment 5	0.015	0.013
2.3" x 1" corrugation	0.031	0.027
3.6" x 2" corrugation (field bolted)	0.035	0.030
C. Helical 2-2/3" x 1/2" corrugation and CPEP-single wall	0.028	0.024
D. Spiral rib metal pipe and PVC pipe	0.013	0.011
E. Ductile iron pipe cement lined	0.014	0.012
F. High density polyethylene pipe (butt fused only)	0.009	0.009

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(2) Backwater Analysis Method

Used to analyze the capacity of both proposed and existing pipe systems to convey the peak rate of runoff for the 25, and 100-year design storm events (Note, structures for proposed pipe systems must be demonstrated to provide a minimum of 0.5 feet of freeboard between the headwater surface (hydraulic grade line) and the top of the structure for the 25-year peak rate of runoff. Structures may overtop for the 100-year peak rate of runoff. When overtopping occurs for the 100-year peak rate of runoff, the additional flow over the ground surface is analyzed using the methods described in Section III-2.3.6 and added to the flow capacity of the pipe system determined, as described below.)

This method is used to compute a simple backwater profile (hydraulic grade line) through a proposed, or existing, pipe system for the purposes of verifying adequate capacity. It incorporates a rearranged form of Manning's Equation expressed in terms of friction slope (i.e., slope of the energy grade line in ft/ft). The friction slope is used to determine the head losses to obtain water surface elevations at all structures along the pipe system.

The backwater analysis begins at the downstream end of the pipe system and is computed back through each pipe segment and structure upstream. The friction, entrance and exit head losses computed for each pipe segment are added to that segment's tailwater elevation (the water surface elevation at the pipe's outlet) to obtain its "outlet control" headwater elevation. This elevation is then compared with the "inlet control" headwater elevation, computed assuming the pipe's inlet alone is controlling capacity using the methods for inlet control presented in Section III-2.3.4. The condition that creates the highest headwater elevation then determines the pipe's capacity. The approach velocity head is then subtracted from the controlling headwater elevation and the junction and bend head losses are then added to compute the total headwater elevation which is then used as the tailwater elevation for the upstream pipe segment.

The Backwater Calculation Sheet in Figure III-2.3 can be used to compile the head losses and headwater elevations for each pipe segment. The numbered columns on this sheet are described in Figure III-2.4 simplify this analysis (as described in Figure III-2.4, therefore, this method should not be used to compute stage/discharge curves for level pool routing purposes. Instead, a more sophisticated backwater analysis, such as BWPIP, is recommended. The BWPIP computer program currently used by King County S.W.M. can be used to quickly compute a family of backwater profiles for a given range of flows through a proposed or existing pipe stream.

Details

In addition to the details shown as Figures III-2.5 through III-2.12, Standard Construction Details are available in the local government Road Standards.

III-2.3.4 Culverts

Culverts are relatively short segments of pipe of circular, elliptical, rectangular, or arch cross section. They are usually placed under road embankments to convey surface water flow safely under the embankment. They may be used to convey flow from constructed or natural channels including streams. In addition to the design criteria described below, other agencies such as the Washington State Departments of Fisheries or Wildlife may have requirements which will affect the design of proposed culverts.

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Figure III-2.1 - Nomograph for Sizing Circular Drains Flowing Full

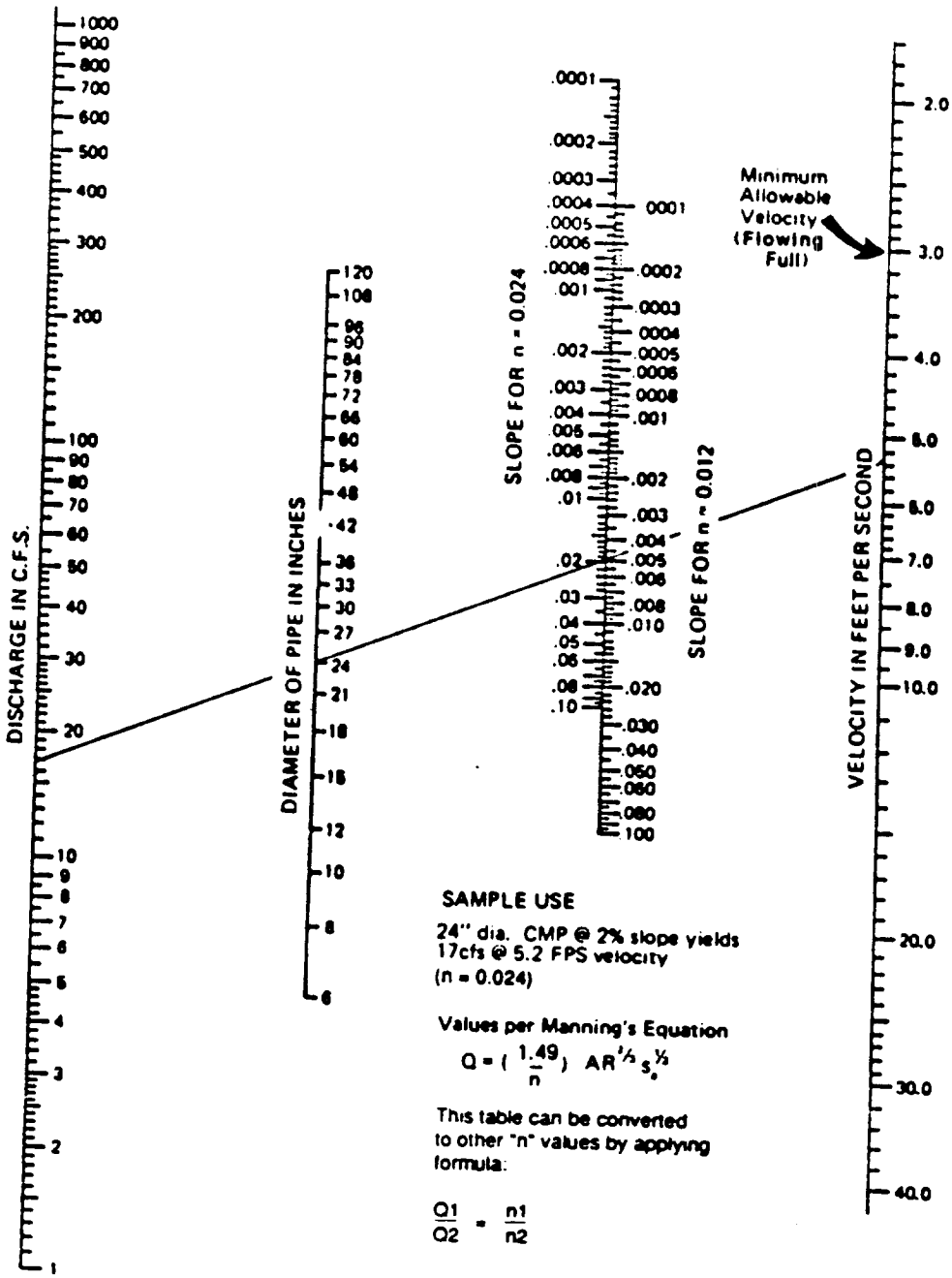

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Figure III-2.2 - Circular Channel Ratios

Experiments have shown that n varies slightly with depth. This figure gives velocity and flow rate ratios for varying n (solid line) and constant n (broken line) assumptions.

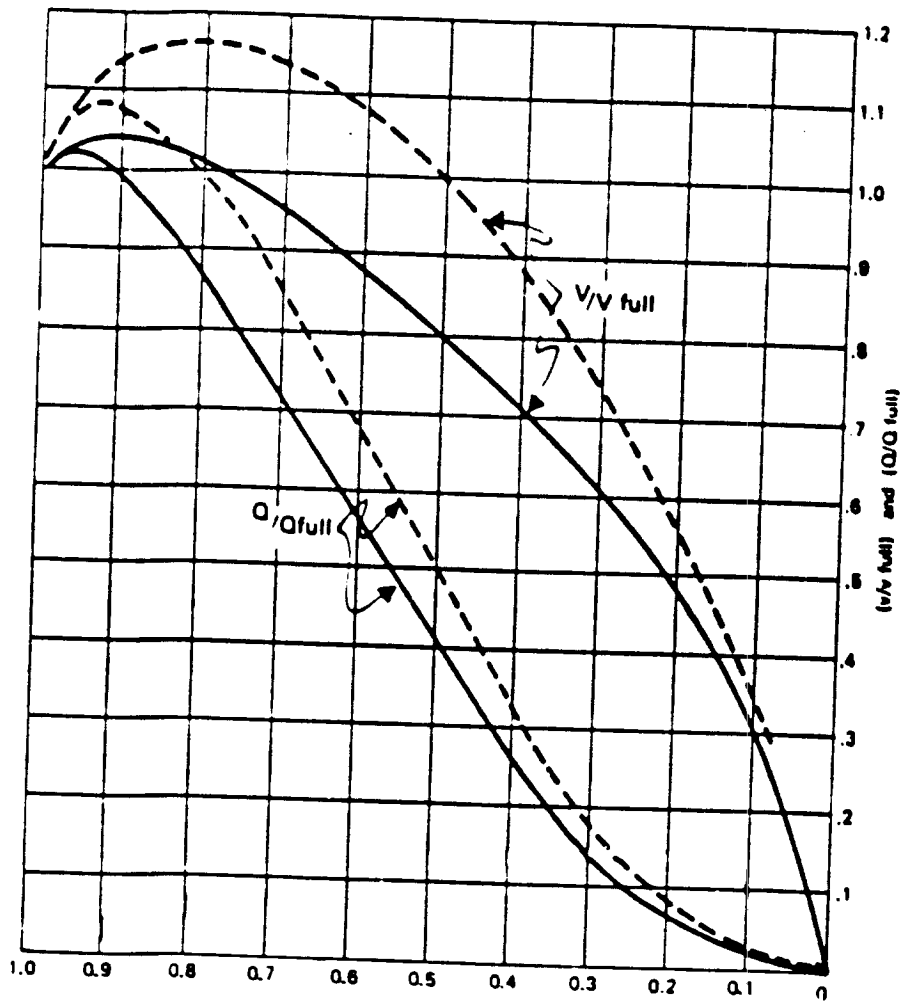

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Figure III-2.3 - Backwater Calculation Sheet

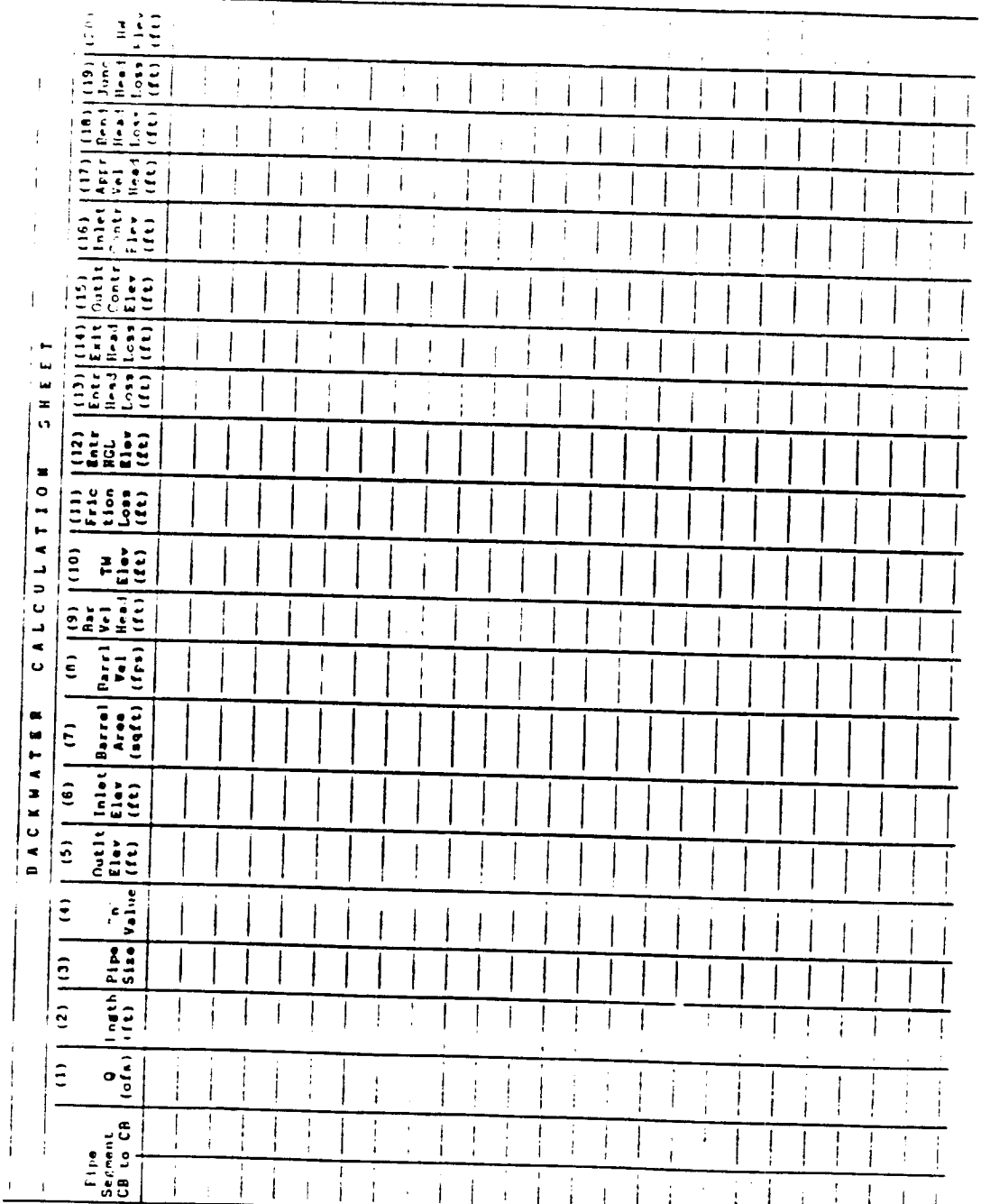

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Figure III-2.4 - Backwater Calculation Sheet Notes

Column (1) - Design flow to be conveyed by pipe segment
Column (2) - Length of pipe segment
Column (3) - Pipe Size: indicate pipe diameter or span x rise
Column (4) - Manning's "n" value
Column (5) - Outlet Elevation of pipe segment
Column (6) - Inlet Elevation of pipe segment
Column (7) - Barrel Area is the full cross sectional area of the pipe
Column (8) - Barrel Velocity is the full velocity in the pipe as determined by

$V = Q/A$ or Col (8) = Col (1) / Col (7)

Column (9) - Barrel Velocity Head = $V^2/2g$ or $(\text{Col (8)})^2/2g$
Where: $g = 32.2$ ft./sec^2 (acceleration due to gravity)

Column (10) - Tailwater (TW) Elevation: this is the water surface elevation at the outlet of the pipe segment. If the pipe's outlet is not submerged by the TW and the TW depth is less than $(D + d_c)/2$, set the TW elevation equal to $(D + d_c)/2$ to keep the analysis simple and still obtain reasonable results (D = pipe barrel height and d_c = critical depth, both in ft. See Figure 4.3.5H for determination of d_c).

Column (11) - Friction Loss = $S_f \times L$ or $S_f \times$ Col (2)
Where: S_f is the friction slope or head loss per lineal foot of pipe as determined by Manning's Equation expressed in the form

$S_f = (nV)^2/2.22\,R^{1.33}$

Column (12) - Hydraulic Grade Line (HGL) Elevation just inside the entrance of the pipe barrel: this is determined by adding the friction loss to the TW elevation

Col (12) = Col (11) + Col (10)

If this elevation falls below the pipe's inlet crown, it no longer represents the true HGL when computed in this manner. The true HGL will fall somewhere between the pipe's crown and either normal flow depth or critical flow depth, which ever is greater. To keep the analysis simple and still obtain reasonable results (i.e. erring on the conservative side), set the HGL elevation equal to the crown elevation.

Column (13) - Entrance Head Loss = $K_e \times V^2/2g$ or $K_e \times$ Col (9) Where: K_e = Entrance Loss Coefficient (from Table 4.3.5A). This is the head loss due to flow contractions at the pipe entrance.

Column (14) - Exit Head Loss = $1.0 \times V^2/2g$ or $1.0 \times$ Col (9)
This is the velocity head lost or transferred downstream.

Column (15) - Outlet Control Elevation = Col (12) + Col (13) + Col (14)
This is the maximum headwater elevation assuming the pipe's barrel and inlet/outlet characteristics are controlling capacity. It does not include structure losses or approach velocity considerations.

Column (16) - Inlet Control Elevation (See Section 4.3.5 for computation of inlet control on culverts): This is the maximum headwater elevation assuming the pipe's inlet is controlling capacity. It does not include structure losses or approach velocity considerations.

Column (17) - Approach Velocity Head: this is the amount of head/energy being supplied by the discharge from an upstream pipe or channel section, which serves to reduce the headwater elevation. If the discharge is from a pipe, the approach velocity head is equal to the barrel velocity head computed for the upstream pipe. If the upstream pipe outlet is significantly higher in elevation (as in a drop manhole) or lower in elevation such that its discharge energy would be dissipated, an approach velocity head of zero should be assumed.

Column (18) - Bend Head Loss = $K_b \times V^2/2g$ or $K_b \times$ Col (17)
Where: K_b = Bend Loss Coefficient (from Figure 4.3.4E). This is the loss of head/energy required to change direction of flow in an access structure.

Column (19) - Junction Head Loss: this is the loss in head/energy which results from the turbulence created when two or more streams are merged into one within the access structure. Figure 4.3.4F can be used to determine this loss or it can be computed using the following equations derived from Figure 4.3.4F.

Junction Head Loss = $K_j \times V^2/2g$ or $K_j \times$ Col (17)
Where: K_j is the Junction Loss Coefficient determined by

$K_j = (Q_s/Q_c)/(1.18 + 0.63(Q_s/Q_c))$

Column (20) - Headwater (HW) Elevation: this is determined by combining the energy heads in Columns 17, 18, and 19 with the highest control elevation in either Column 15 or 16, as follows:

Col (20) = Col (15 or 16) - Col (17) + Col (18) + Col (19)

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Figure III-2-5 - Bend Head Losses in Structures

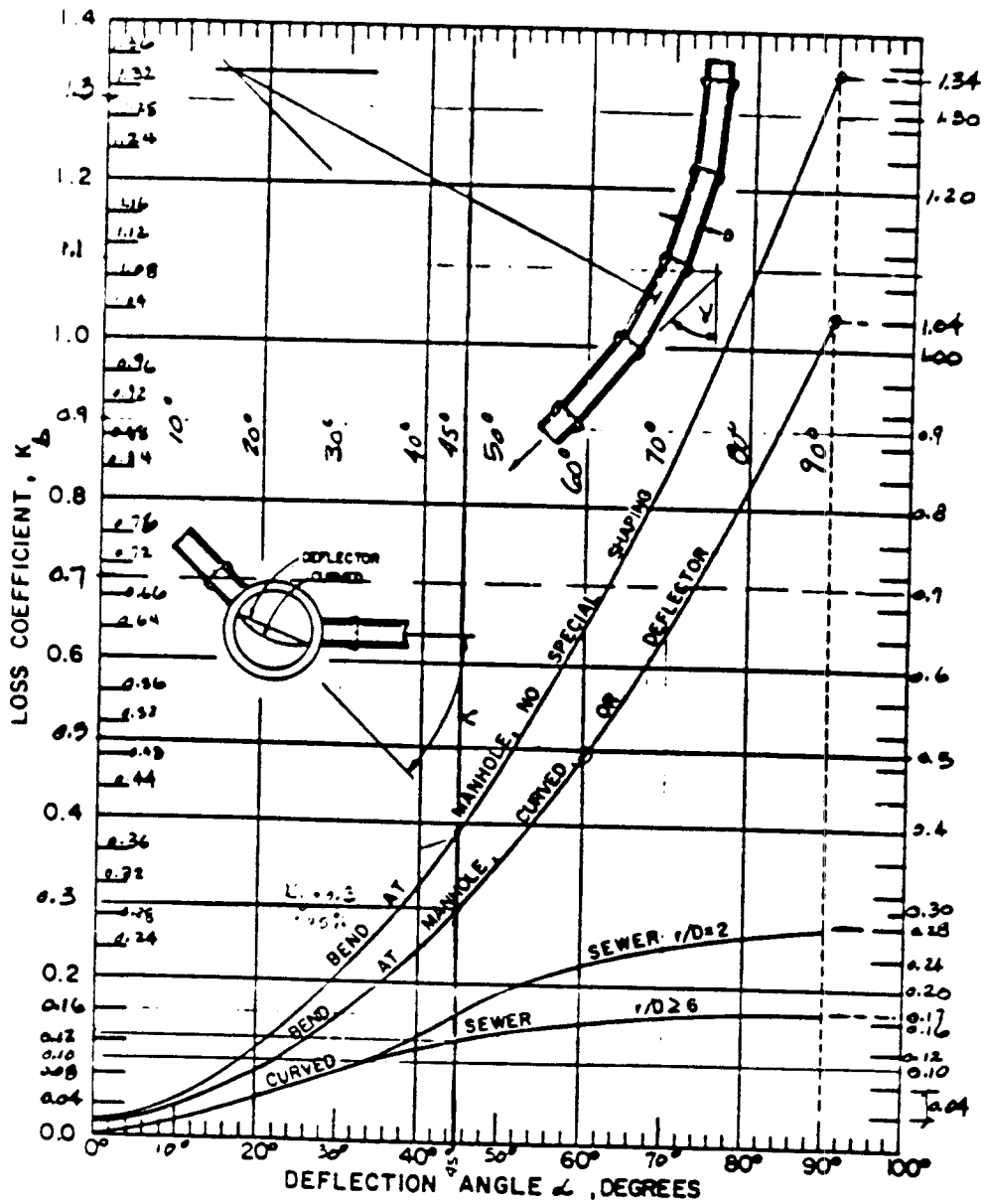

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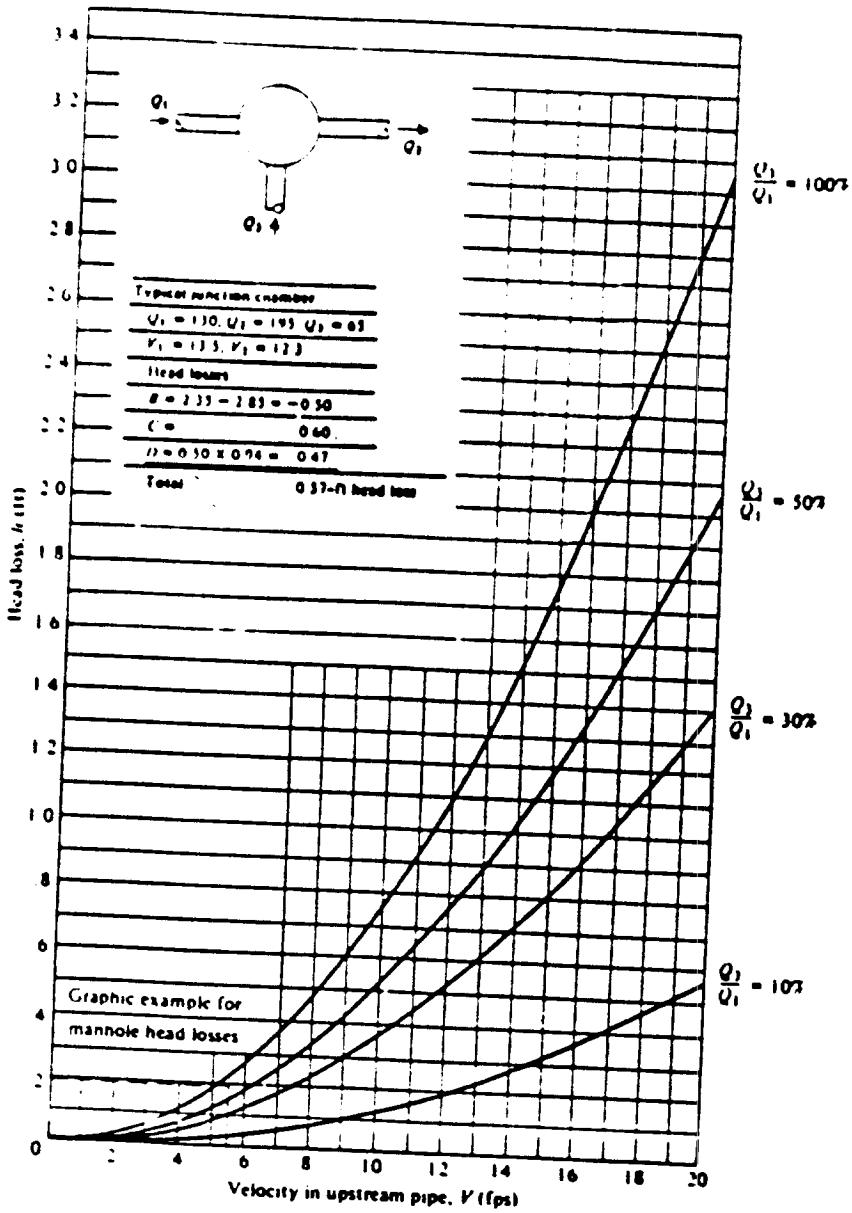
Figure III-2.6 - Junction Headloss in Structures



Source: Baltimore County Department of Public Works

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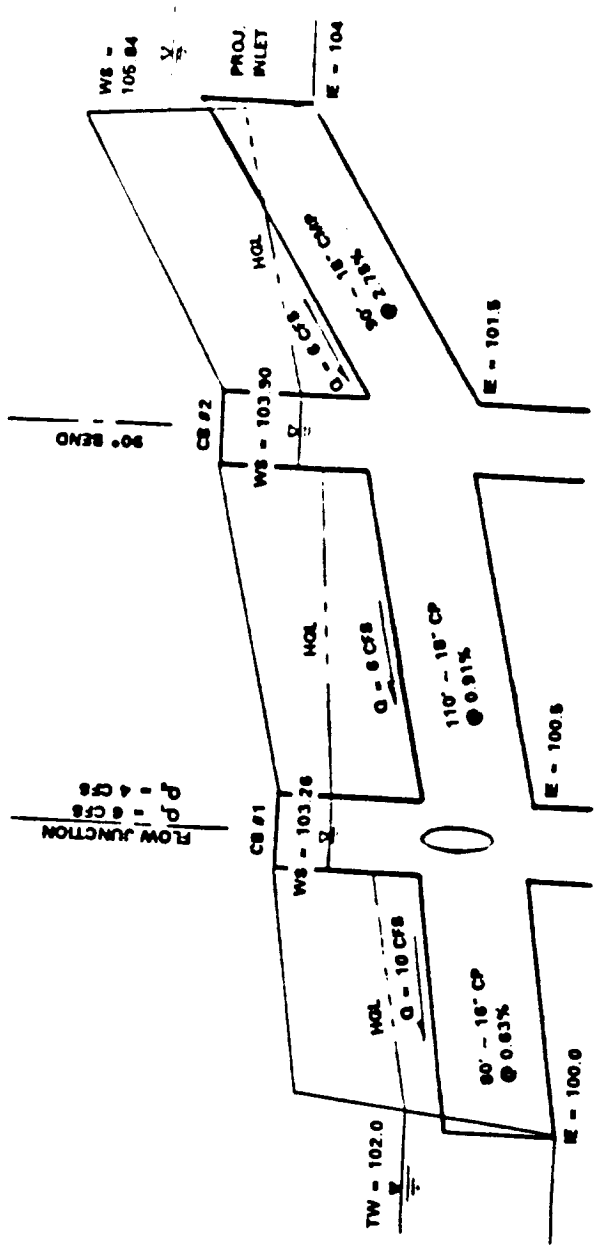
Figure III-2.7 - Backwater Pipe Calculation



BACKWATER CALCULATION SHEET

Pipe Segment CB to CB	(1) Q (cfs)	(2) Length (ft)	(3) Pipe Size	(4) Value	(5) Outlt Elev (ft)	(6) Inlet Elev (ft)	(7) Barrel Area (sqft)	(8) Barrl Vel (fps)	(9) Bar Vel Head (ft)	(10) TW Elev (ft)	(11) Friction Loss (ft)	(12) Entr HGL Elev (ft)	(13) Entr Head Loss (ft)	(14) Exit Head Loss (ft)	(15) Outlt Contr Elev (ft)	(16) Inlet Contr Elev (ft)	(17) Appr Vel Head (ft)	(18) Bend Head Loss (ft)	(19) Junct Head Loss (ft)	(20) HW Elev (ft)
1	10	80	18"	0.012	100.00	100.50	1.77	5.65	0.50	102.00	0.62	102.62	0.25	0.50	103.37	102.75	-0.18	0.00	0.00	103.24
2	6	110	18"	0.012	100.50	101.60	1.77	3.39	0.18	103.26	0.31	103.57	0.69	0.18	103.84	102.95	-0.18	0.24	0.0	103.[illegible]
3	6	90	18"	0.024	101.50	104.00	1.77	3.39	0.18	103.90	1.00	(104.9) 105.54	0.16	0.18	105.84	105.80	-0.0	0.0	0.0	105.84

SELECT THE GREATER ELEVATION

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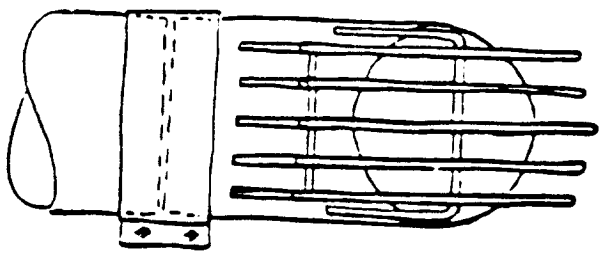
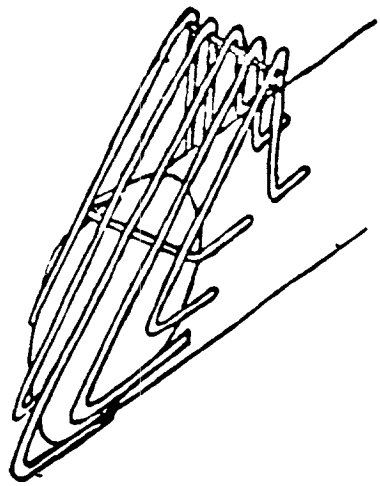
Figure III-2.8 - Debris Barrier

Notes:

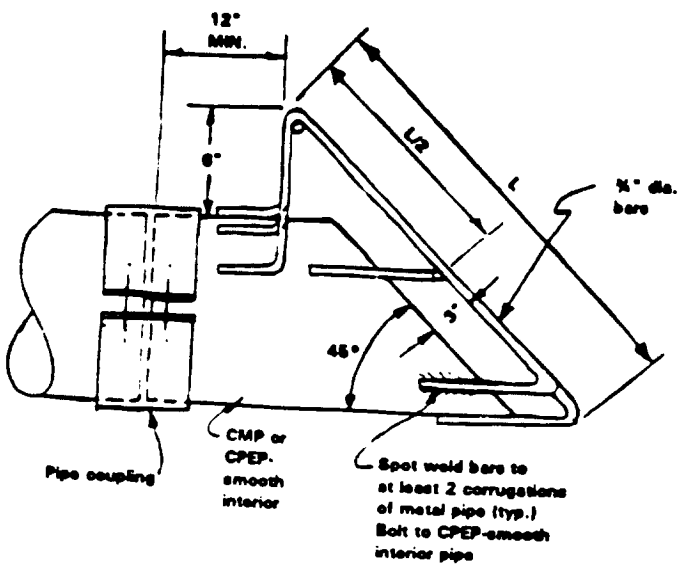
1. This debris barrier is for use outside roadways on pipes ≤ 36" dia. See Fig. III-2.9 for debris barriers on pipes projecting from driveway or roadway sideslopes.
2. CPEP-smooth interior pipe requires bolts to secure debris barrier to pipe.



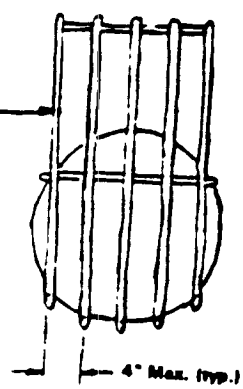
PLAN



ISOMETRIC



SIDE VIEW



END VIEW

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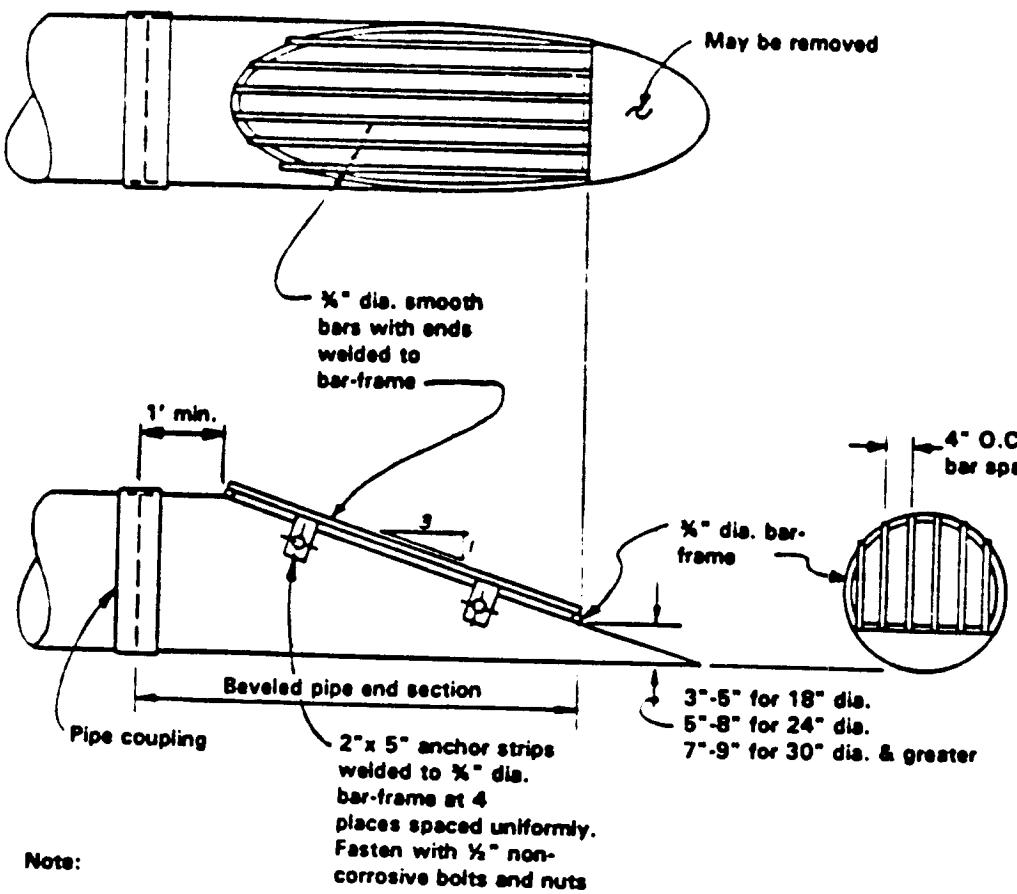
Figure III-2.9 - Debris Barrier



Note:

1. CMP end-section shown.

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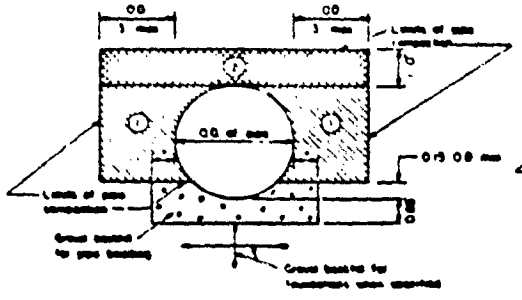
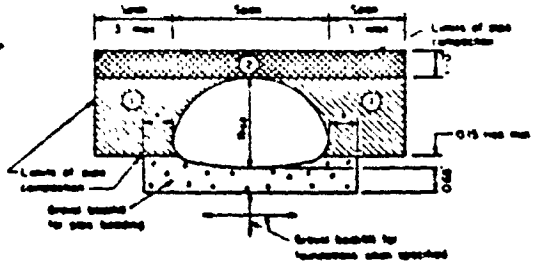
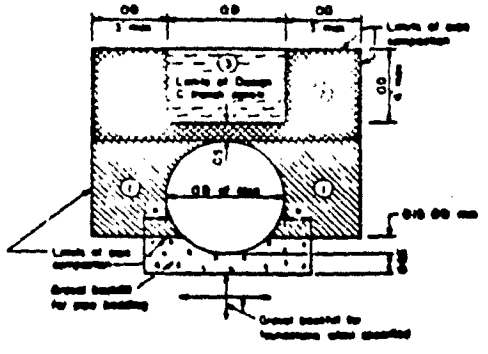
Figure III-2.10 - Pipe Comparison Designs (A and C) and Backfill



DESIGN A



TYPICAL PIPE-ARCH INSTALLATION



DESIGN C

CLEARANCE BETWEEN PIPES
MULTIPLE INSTALLATIONS

PIPE	SIZE	MIN DIST BETWEEN BARRELS
CIRCULAR PIPE CONCRETE & METAL DESIGN A (DIAMETER)	12" to 24"	12"
	30" to 96"	(Diam ÷ 2)
	102" to 180"	48"
CIRCULAR PIPE CONCRETE ONLY DESIGN C (DIAMETER)	12" to 36"	24"
	42" to 96"	72"
	102" to 180"	72"
PIPE-ARCH METAL ONLY (SPAN)	18" to 36"	12"
	43" to 140"	(Span ÷ 3)
	140" to 199"	48"

LEGEND
PIPE COMPACTION ZONE

1 Backfill material placed in 08" loose layers and compacted to 90% maximum density

2 Method B or C compaction

3 Bedding stone or hay with wires or straps not less compacted density)

NOTES

1 Pipe compaction lengths shown on this plan are for pipe construction in an embankment. For pipe construction in a trench, the horizontal limits of the pipe compaction zone shall be the walls of the trench.

2 All steel and aluminum pipe and pipe-arches shall be installed in accordance with Design A.

3 Concrete pipe with elliptical reinforcement shall be installed in accordance with Design A.

4 Concrete pipe, pipe or with circular reinforcement, shall be installed with Design A or a combination of Designs A and C, as determined by the Engineer.

5 For Design C, it is assumed that the soils for Zone 3 be constructed as near optimum as possible.

6 OD is equal to the outside diameter of a pipe or the outside span of pipe-arch. The dimensions shown as OD with 3 and 4 maximum shall be OD until OD equals 3 and 4 at which point 3 and 4 shall be used.

7 1'-0" for diameters 12" through 42" and for spans through 30". 2'-0" diameters greater than 42" and for spans greater than 30".

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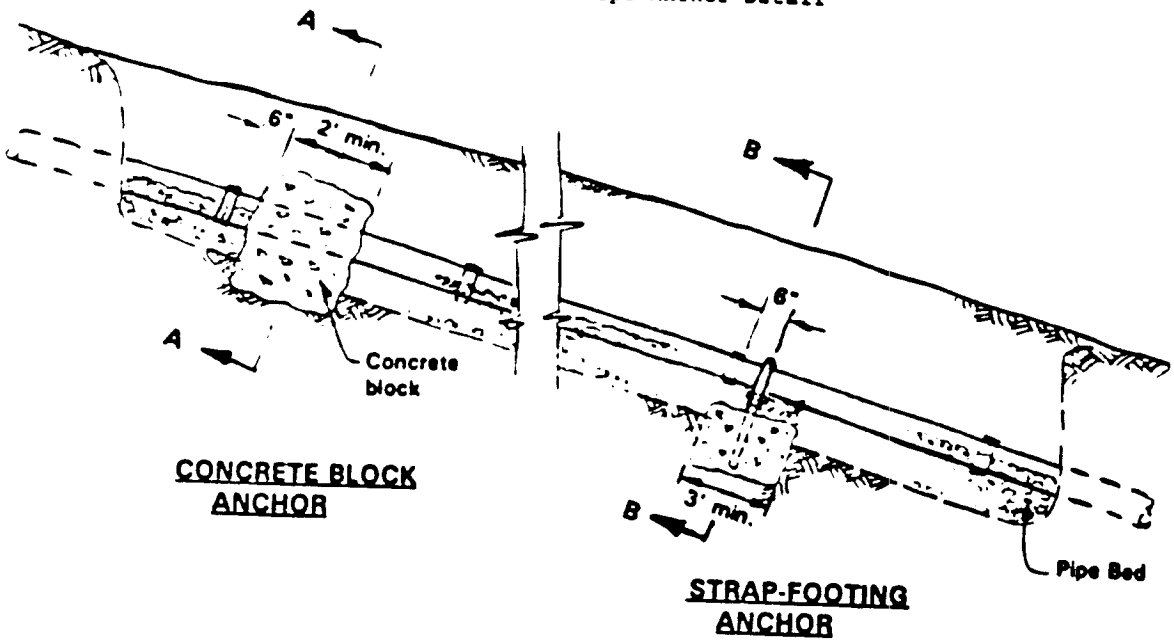
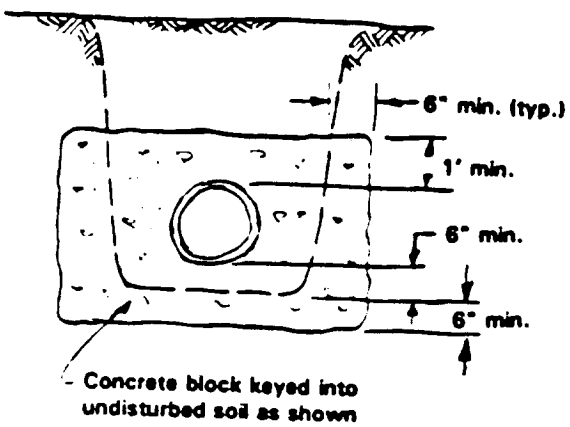
Figure III-2.11 - Pipe Anchor Detail



CONCRETE BLOCK ANCHOR

STRAP-FOOTING ANCHOR



SECTION A-A
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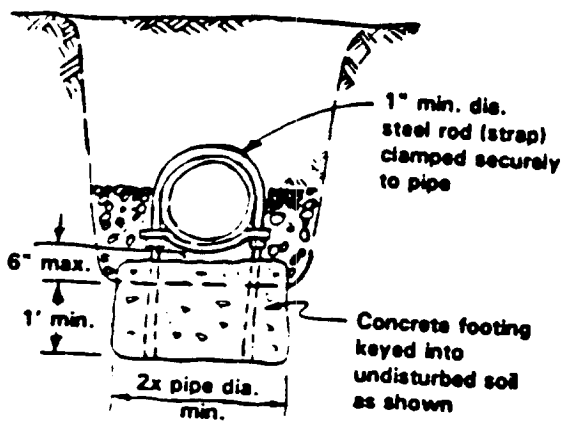
Note: For HDPP, pipe must be free to slide inside a 4' long section of pipe one size diameter larger.



SECTION B-B
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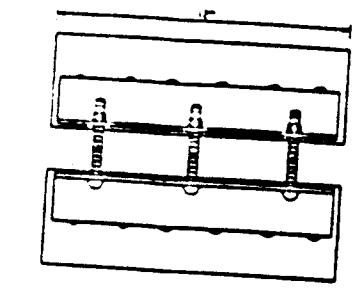
Figure III-2.12 - Corrugated Metal Pipe, Coupling and/or General Pipe Anchor Assembly



SMOOTH COUPLING BAND FOR CONCRETE PIPE

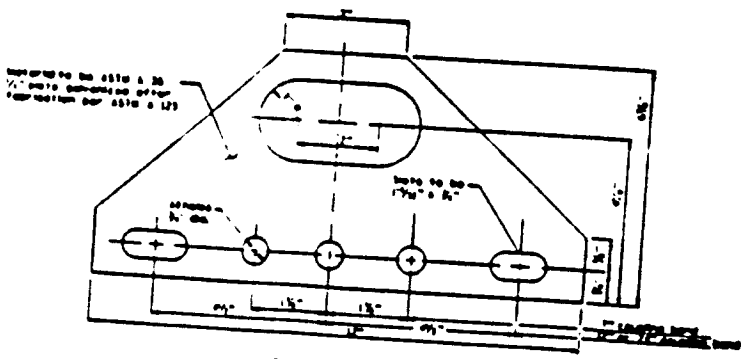
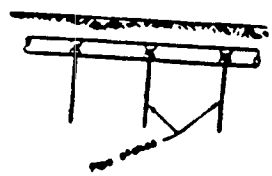
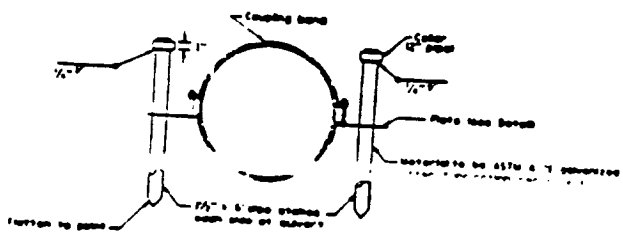


PLATE DETAIL





ANCHOR ASSEMBLY - CORRUGATED METAL PIPE

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Design Criteria for Culverts

Headwater

- For new culverts 18 inches in diameter or less, maximum allowable 25-year design storm event headwater elevation (measured from the inlet invert) shall not exceed 2 times the pipe diameter/arch culvert use.
- For new culverts larger than 18 inches in diameter, maximum 25-year design storm event headwater elevation for the new culvert shall not be less than 0.5 feet lower than the road or parking lot subgrade.
- Maximum design headwater elevation for new culverts shall be a minimum of 1 foot below road subgrade.

Inlet

- For culverts 18 inches in diameter and larger, the embankment around the culvert inlet shall be protected from erosion by rock lining or riprap as specified in Table III-2.4, except the length and height shall be as follows:
  - Length: extend upstream of culvert 5 feet minimum
  - Height: at design headwater elevation
- Trash racks/debris barriers are required on culverts that are over 60 feet in length or that are inlets to pipe systems, and that are 18 inches to 36 inches in diameter (see Figures III-2.8 and III-2.9). Exceptions are culverts on Class 1 or 2 streams.
- Inlet structures, such as concrete headwalls, may provide a more economical design by allowing the use of smaller entrance coefficients, and hence smaller diameter culverts. When properly designed they will also protect the embankment from erosion and eliminate the need for rock lining.
- In order to maintain the stability of roadway embankments, concrete headwalls, wingwalls, or tapered inlets and outlets may be required if right-of-way and/or easement constraints prohibit the culvert extending to the toe of the embankment slope. Normally concrete inlet structures/headwalls installed in or near roadway embankments must be flush with, and conforming to the slope of the embankment.

Outlets

- For culverts 18 inches in diameter and larger, the receiving channel of the outlet shall be protected from erosion by rock lining specified in Table III-2.4, except the height shall be 1 foot above maximum tailwater elevation or 1 foot above the crown - whichever is higher (see Figure III-2.21).
- Standard details for various culvert end designs such as wing walls and tapered inlets may be found in the Washington State Department of Transportation Highway Hydraulic Manual.

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Table III-2.3 Entrance Loss Coefficients

Type of Structure and Design of Entrance	Coefficient K_e
Pipe, Concrete and D.I.	
Projecting from fill, socket (bell) end	0.2
Projecting from fill, square cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
End-section conforming to fill slope*	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side- or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal and Other Non-Concrete or D.I.	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
End-section conforming to fill slope*	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side- or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side- or slope-tapered inlet	0.2

*Note: "End section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections incorporating a closed taper in their design have a superior hydraulic performance.

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Table III-2.4 Rock Protection at Outfalls

Discharge Velocity at Design Flow (fps)			REQUIRED PROTECTION Minimum Dimensions				
			Type	Thickness	Width	Length	Height
0	to	≤5	Riprap*	1 ft.	Diameter + 6 ft.	8 ft. or 4X Dia., whichever is greater	Crown + 1 ft.
6	to	≤10	Riprap**	1 ft.	Diameter +6 ft. or 3X Diameter, whichever is greater	12 ft. or 3X Dia., whichever is greater	Crown +1 ft.
11	to	≤20	Gabion	1 ft.	(As required)	(As required)	Crown +1 ft.
20		NA	Engineered Energy Dissipator Required				

* Riprap shall be in accordance with section 9-13.1 of the WSDOT/APWA Standard Specifications. Riprap to be reasonably well graded with rock gradation as follows:

Passing 8 inch square sieve 100% or Maximum stone size 8"
Passing 6 inch square sieve 40-60% or Medium stone size 6"
Passing 2 inch square sieve 0-10% or Minimum stone size 2"

** Riprap to be reasonably well graded with rock gradation as follows:

Maximum stone size 24" (nominal diameter)
Median stone size 16"
Minimum stone size 4"

Note: Riprap sizing governed by the side slopes on outlet channel, assumed to be 3:1.

Methods of Analysis for Culverts

The theoretical analysis of culvert flow can be extremely complex because of the wide range of possible flow conditions which can occur due to various combinations of inlet and outlet submergence and flow regime within the culvert barrel. An exact analysis usually involves detailed backwater calculations, energy and momentum balance, and application of the results of hydraulic model studies.

Simple procedures have been developed, however, wherein the various flow conditions are classified and analyzed on the basis of a control section. A control section is a location where there is a unique relationship between the flow rate and the upstream water surface elevation. Many different flow conditions exist over time, but at any given time the flow is either governed by the culvert's inlet geometry

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(inlet control); or by a combination of inlet geometry, barrel characteristics, and tailwater elevation (outlet control). Figure III-2.13 illustrates typical conditions of inlet and outlet control.

The procedures presented here provide for the analysis of both inlet and outlet control conditions to determine which is governing flow capacity and what that capacity is.

Inlet Control Analysis

Nomographs such as those provided in Figures III-2.14 and III-2.15 can be used to determine the inlet control headwater depth at design flow for various types of culverts and inlet configurations. These nomographs were originally developed by the Bureau of Public Roads - now the Federal Highway Administration (FHWA) - based on their studies of culvert hydraulics. These and other nomographs can be found in the FHWA publication, Hydraulic Design of Highway Culverts, HDS No. 5 (Report No. FHWA-IP-85-15), September 1985; or the WSDOT Hydraulic Manual.

Also available in the FHWA publication are the design equations used to develop the inlet control nomographs. These equations are presented below:

For unsubmerged inlet conditions defined by $Q/AD^{0.5} \leq 3.5$;

Form(1)* $HW/D = H_c/D + K(Q/AD^{0.5})^M - 0.5S$**

Form(2)* $HW/D = K(Q/AD^{0.5})^M$

For submerged inlet conditions defined by $Q/AD^{0.5} \leq 4.0$;

$HW/D = c(Q/AD^{0.5})^2 + Y - 0.5S$**

where:

HW	=	Headwater depth above inlet invert, ft.
D	=	Interior height of culvert barrel, ft.
H_c	=	Specific head at critical depth ($d_c + V_c^2/2g$), ft.
Q	=	Flow, cfs.
A	=	Full cross sectional area of culvert barrel, sq ft.
S	=	Culvert barrel slope, ft/ft
K,M,c,Y	=	Constants from Table III-2.6
d_c	=	Critical depth (see Figure III-2.18), ft.
V_c	=	Flow velocity at critical depth, fps.
g	=	Acceleration due to gravity, 32.2 ft/sec^2.

* The appropriate equation form for various inlet types is specified in Table III-2.7.

** For mitered inlets use +0.7S instead of -0.5S.

Note, between the unsubmerged and submerged conditions, there is a transition zone ($3.5 < Q/AD_{0.5} < 4.0$) for which there is only limited hydraulic study information. The transition zone is defined empirically by drawing a curve between and tangent to the curves defined by the unsubmerged and submerged equations. In most cases, the transition zone is short and the curve is easily constructed.

Outlet Control Analysis

Nomographs such as those provided in Figures III-2.16 and III-2.17 can be used to determine the outlet control headwater depth at design flow for various types of culverts and inlets. Outlet control nomographs other than those provided can be found in FHWA HDS No.5 or the WSDOT Hydraulic Manual.

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The outlet control headwater depth can also be determined using the simple backwater analysis procedure presented in Section III-2.3.3 for analyzing pipe system capacity. This procedure is summarized as follows for culverts:

$$HW = H + TW - LS$$

where:

H	=	$H_f + H_e + H_{ex}$
H_f	=	Friction Loss, ft. = $V^2n^2L/2.22R^{1.33}$ Note, if (H_f + TW-LS) <D, adjust H_f such that (H_f + TW-LS) = D. This will keep the analysis simple and still yield reasonable results (erring on the conservative side).
H_e	=	Entrance Head Loss, ft. = $K_e(V^2/2g)$
H_{ex}	=	Exit Head Loss, ft. = $V^2/2g$
TW	=	Tailwater depth above invert of culvert outlet, ft. Note, if TW < $(D+d_c)/2$, set TW = $(D+d_c)/2$. This will keep the analysis simple and still yield reasonable results.
L	=	Length of culvert, ft.
S	=	Slope of culvert barrel, ft/ft.
D	=	Interior height of culvert barrel, ft.
V	=	Barrel velocity, fps.
n	=	Manning's roughness coefficient (from Table III-2.2).
R	=	Hydraulic radius, ft.
K_e	=	Entrance loss coefficient (from Table III-2.3).
g	=	Acceleration due to gravity, 32.2 ft/sec^2.
d_c	=	Critical depth (see Figure III-2.19), ft.

Note, the above procedure should not be used to develop stage/discharge curves for level pool routing purposes because its results are not precise for flow conditions where the hydraulic grade line falls significantly below the culvert crown (i.e., less than full flow conditions).

Fish Passage Guidelines: Culvert Installations

This guidance, dated April 12, 1990, has been provided by the Washington State Department of Fisheries.

Introduction

This report presents guidelines for use by designers and resource managers to assure juvenile and adult salmonid (trout and salmon) fish passage, as required, at culvert installations. Guidelines for special structures such as fishways and streambed controls are not included. In general, these special structures are not considered satisfactory for fish passage at road crossings except in extraordinary circumstances.

Authority

The authority of the Washington Department of Fisheries (WDF) and Washington Department of Wildlife (WDW) in this regard is the Hydraulic Law, RCW 75.20.100 which requires that a Hydraulic Project Approval (HPA) be obtained from these agencies for work within the ordinary high water line of streams. In addition, if a culvert is a fish obstruction, RCW 75.20.060 requires that fish passage be provided with a fishway, or that the obstruction be removed.

Fish Migration Needs

Maintaining free upstream passage for migrating salmonids at culvert sites is essential. The success or failure of a fish migrating through a culvert depends on the swimming ability of the fish, the hydraulic conditions at the site, and proper

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maintenance of the culvert (e.g. debris removal). An interruption or delay by any obstruction in the upstream migration of adult salmonids can adversely affect the spawning success by depleting the fish's limited energy budget before the fish reaches an acceptable spawning area.

This can result in spawning in marginal spawning areas or loss of spawning ability and increasing the possibility of injury, disease, or predation. A complete obstruction will result in full loss of production from the habitat upstream of that point.

In many areas, necessary juvenile upstream migration occurs as a response to water conditions, predation, and population pressures. Juvenile migration and redistribution is a means for increased survival and full stream production. An obstruction to juvenile fish migration may result in a limit to production both upstream and downstream from the barrier. Design guidelines for areas requiring upstream juvenile migration are very restrictive due to the size and limited swimming ability of these fish.

Excessive water velocity, inadequate water depth, excessive vertical drop at the culvert outfall, and debris blockages are the most frequent causes of fish passage problems at culverts. Consideration of these factors for successful fish passage must include design provisions for the fish having the most restrictive swimming ability rather than just the strongest swimmer. Otherwise, undesirable genetic selection will occur in favor of the strongest fish.

Culvert Design Criteria

Table III-2.5 presents the hydraulic criteria for the design of culverts for the passage of salmon and steelhead. Satisfaction of these criteria is essential to approval of the culvert installation. These criteria are based on numerous literature references, of which the most significant are included in the attached bibliography. These criteria are the limits of athletic ability for the weakest fish of each species; there is no safety factor for fish passage built into a structure designed by these criteria. In a natural stream channel, the average flow characteristic may often exceed these criteria. The diversity of natural channel beds and formations, however, provides paths of access with suitable depths and velocities and only brief exposure to excessive conditions. Relatively smooth culverts, on the other hand, provide no such diversity and the average flow characteristics within the culvert approach the maximum.

Baffles within culverts are not recommended as a means of providing fish passage and are acceptable only if all other options are deemed unfeasible or less desirable by the fisheries agencies. Full bridging structures (bottomless structures with foundations and supports placed beyond the margin of the channel) are preferred to ensure against fish passage problems. In important spawning areas, culverts are not allowed unless assurance can be made, to the satisfaction of the fisheries agencies, for full replacement of habitat disrupted or lost.

It is recognized that fish passage through culverts as well as through many natural channels cannot be practically provided at all discharges. Acceptable hydraulic design of culverts includes selection of appropriate design flows from which the flow characteristics can be derived by hydraulic analysis. The low flow depth design should be the 2-year, 7-day low flow discharge for the subject basin or 95 percent exceedance flow for migration months of the fish species of concern. When sufficient data is available, the high flow design discharge, to determine velocity, should be the flow that is not exceeded more than 10 percent of the time during the months of adult migration ($Q_{10\%}$). That flow can be approximated by

$$Q_{10\%} = 0.18 \times (Q_2) + 36$$

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for cases where the 2-year flood event is greater than 44 cfs. Q_2 is the 2-year flood event in cubic feet per second. For cases where Q_2 is less than 44 cfs, the design flow can be approximated as equalling the 2-year flood event (Bates, 1988).

Appropriate statistical or hydrological methods must be applied for the determination of these flows. These methods, as well as the methods of calculating the resulting hydraulic characteristics, should be documented within the HPA application. An acceptable alternative to the hydrologic and hydraulic analysis is described in the following section.

These flow event criteria may be modified for specific proposals as necessary for unusual fish passage requirements, or where other mutually agreed upon methods of empirical or hydrologic analysis are used, or where special facilities are deemed adequate by the fisheries agencies.

Culvert Size and Slope

Culvert size (diameter or equivalent) and slope must consider and accommodate juvenile and/or adult fish passage. At any given flow, hydraulic characteristics within a culvert are most sensitive to the variables of size and slope. Acceptable hydraulic characteristics (depth, velocity) and the design flows from which they are derived are presented in Table III-2.5.

The velocity criteria for juvenile salmonids is based on the assumption that, for culverts up to 60 feet in length, roughness within the culvert will provide a passable migration path along flow boundaries, where the velocity will be less than the 4.0 fps average flow velocity required by Table III-2.5. By limiting the design flow velocity to 4.0 fps, bed material can be expected to deposit in the culvert to provide that roughness. Also, juvenile salmonid passage typically occure when flows are much less than the 2-year flood frequency flow design suggested by Table III-2.5.

A hydrologic analysis may not be warranted for very small streams. An acceptable alternative to the hydrologic and hydraulic analyses described above is to install a culvert on level grade (0% slope), with a diameter (or span) at leaet as large as the characteristic toe width of the stream channel. The toe width, the horizontal distance between the points where the banks and streambed join, includes the width of gravel bars, if present. Consideration must, of course, also be given to flood capacity and debris and bed load passage. No culvert should be designed to be structurally jeopardized at flows less than a 100-year flood.

Debris racks are not an acceptable alternative to paesage of debris through the culvert. Placement of multiple parallel culverts is not desirable due to increased potential of blockage by debris.

Elevation

Culverts must be placed below the natural channel grade (countersunk) by a minimum 20 percent of the culvert diameter or rise. The natural channel grade is defined as the profile connecting the low flow hydraulic controls in the natural channel. Culvert capacity for flood design flow must be determined by using the remaining capacity of the culvert.

The minimum depth criteria presented in Table III-2.5 can be applied to the culvert, assuming no bed material is retained within the structure.

In the case of culverts proposed for channels with gradients that, if applied to the culvert, would cause a water velocity greater than that acceptable for fish passage, the upstream end of the culvert may be further countersunk. Approval of either option must be on a site-specific basis. Generally, an additional countereink of

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1.0 foot at the upstream end is acceptable for culverts in channels with gradients up to 3.0 percent. A bridge may be required in more severe cases.

General Design Considerations

To design a culvert solely by the criteria presented here ignores the presence or potential of on-going or eventual changes in dimensions or characteristics of the stream channel. Natural changes related to the continual evolution of the basin and channel are always present. Such changes may be accelerated or reversed by basin land use changes or by influences of structural changes or development within a particular reach of channel. Such changes must be accounted for in the design of any effective hydraulic structure within a natural stream corridor. This is especially important in the case of culverts, since the athletic limitations of fish are more restrictive and often prevail as a limiting design factor over corresponding structural and hydraulic constraints.

Table III-2.5 Fish Passage Design Criteria for Culvert Installation

Criteria	Juvenile Salmonid[1] < 6 in. (150 mm)	Adult Trout < 6 in. (150 mm)	Adult Pink Chum	Adult Sockeye Coho, Chinook Steelhead
1. Velocity, maximum (fps)[2]				
Culvert length (ft.)				
a. 10 - 60	4.0	4.0	5.0	6.0
b. 60 - 100	(Not allowed)[3]	4.0	4.0	5.0
c. 100 - 200		3.0	3.0	4.0
d. > 200		2.0	2.0	3.0
2. Depth, minimum (ft.)[4]	0.3	0.8	0.8	1.0

1. Juvenile salmonid passage is required for reaches of streams where migration to seasonal rearing habitat occurs. This is a site-specific requirement to be determined by the resource agency's field representatives.

2. High design flow for velocity shall be 2-year frequency flood flow unless specifically stated otherwise.

3. For culverts longer than 60 feet, an excessive risk of passage failure exists for juvenile salmonids.

4. Low design flow depth shall be 2-year, 7-day low flow unless specifically stated otherwise. Depth considerations do not apply within structures with natural beds.

Fish passage improvements may be required as a result of channel evolution and changes. Any fish passage improvement should initially be located at the downstream end of the scour pool at the discharge of the culvert. For this reason, in new project planning, an area extending at least 30 feet downstream of the culvert should be included within the right-of-way or under the control of the owner of the road crossing.

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A scour pool may develop at the culvert outlet due to poor energy dissipation through the culvert. The scour pool is important to the protection of the downstream channel. In a bedrock or non-erodible channel, a scour pool may nor form by itself, in which case one should be constructed. A pool 3 feet deep by 20 feet long is recommended.

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Fish Culvert Installation Bibliography

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Table III-2.6 - Constants for Inlet Control Equations

Table III - 2.6

					UNSUBMERGED		SUBMERGED		
FHWA Chart No.*	Shape and Material	Nomographs Scale	Inlet Edge Description	Equation Form	K	M	C	Y	Reference
1	Circular Concrete	1	Square edge w headwall	1	0.0098	2.0	0.0398	0.67	(56)(57)
		2	Groove end w/headwall		0078	2.0	0292	.74	(56)(57)
		3	Groove end projecting		0045	2.0	0317	.69	(56)(57)
2	Circular CMP	1	Headwall	1	0078	2.0	0379	69	(56)(57)
		2	Mitered to slope		0210	1.33	0463	75	(57)
		3	Projecting		0340	1.50	0553	54	(57)
3	Circular	A	Beveled ring, 45° bevels	1	0018	2.50	0300	74	(57)
		B	Beveled ring, 33.7° bevels*		0018	2.50	0243	83	(57)
8	Rectangular Box	1	30° to 75° wingwall flares	1	026	1.0	0385	81	(56)
		2	90° and 15° wingwall flares		061	0.75	0400	80	(56)
		3	0° wingwall flares		061	0.75	0423	82	(8)
9	Rectangular Box	1	45° wingwall flare d = 0.43D	2	510	667	0309	80	(8)
		2	18° to 33.7° wingwall flare - d = 0.43D		486	667	0249	.83	(8)
10	Rectangular Box	1	90° headwall w: 3/4" chamfers	2	515	667	.0375	.79	(8)
		2	90° headwall w: 45° bevels		495	667	.0314	.82	(8)
		3	90° headwall w: 33.7° bevels		486	667	.0252	.865	(8)
11	Rectangular Box	1	3/4" chamfers, 45° skewed headwall	2	522	667	0402	.73	(8)
		2	3/4" chamfers, 30° skewed headwall		533	667	.0425	.705	(8)
		3	3/4" chamfers, 15° skewed headwall		545	667	04505	.68	(8)
		4	45° bevels, 10°-45° skewed headwall		498	667	0327	75	(8)
12	Rectangular Box 3/4" chamfers	1	45° wingwall flares - offset	2	497	667	.0339	.803	(8)
		2	33.7° wingwall flares - offset		493	667	0361	.806	(8)
		3	18.4° non-offset wingwall flares-30° skewed barrel		495	.667	.0386	.71	(8)
13	Rectangular Box Top Bevels	1	45° wingwall flares - offset	2	497	.667	0302	.835	(8)
		2	33.7° wingwall flares - offset		495	667	.0252	.881	(8)
		3	18.4° wingwall flares - offset		493	667	.0227	887	(8)
16-19	C.M. Boxes	1	90° headwall	1	0083	2.0	.0379	.69	(57)
		2	Thick wall projecting		0145	1.75	.0419	.64	(57)
		3	Thin wall projecting		0340	1.5	0496	57	(57)

*See FHWA HDS No. 5

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Table III-2.6 - Constants for Inlet Control Equations (Continued)

Table III - 2.6, continued

FHWA Chart No.	Shape and Material	Mano-graph Scale	Inlet Edge Description	Equation Form	UNSUBMERGED K	UNSUBMERGED M	SUBMERGED c	SUBMERGED Y	Reference
29	Horizontal Ellipse Concrete	1 2 3	Square edge with headwall Groove end with headwall Groove end projecting	1	0.0100 0.0018 0.0045	2.0 2.5 2.0	0.0398 0.0292 0.0317	0.67 0.74 0.69	(57) (57) (57)
30	Vertical Ellipse Concrete	1 2 3	Square edge with headwall Groove end with headwall Groove end projecting	1	0.0100 0.0018 0.0045	2.0 2.5 2.0	0.0398 0.0292 0.0317	0.67 0.74 0.69	(57) (57) (57)
34	Pipe arch 18" corner Radius CM	1 2 3	90° headwall Mitered to slope Projecting	1	0.0083 0.0300 0.0340	2.0 1.0 1.5	0.0398 0.0463 0.0398	0.57 0.75 0.53	(57) (57) (57)
35	Pipe arch 18" corner Radius CM	1 2 3	Projecting No bevels 33.7° bevels	1	0.0296 0.0087 0.0030	1.5 2.0 2.0	0.0487 0.0361 0.0264	0.55 0.68 0.75	(56) (56) (56)
36	Pipe arch 31" corner Radius CM	1	Projecting No bevels 33.7° bevels	1	0.0296 0.0087 0.0030	1.5 2.0 2.0	0.0487 0.0361 0.0264	0.55 0.68 0.75	(56) (56) (56)
40-42	Arch CM	1 2 3	90° headwall Mitered to slope Thin wall projecting	1	0.0083 0.0300 0.0340	2.0 2.0 1.5	0.0379 0.0463 0.0496	0.69 0.75 0.57	(57) (57) (57)
55	Circular	1 2	Smooth tapered inlet throat Rough tapered inlet throat	2	.534 .519	.555 .64	0.0196 0.0289	0.89 0.90	(3) (3)
56	Elliptical Inlet face	1 2 3	Tapered inlet - beveled edges Tapered inlet - square edges Tapered inlet - thin edge projecting	2	.536 .5035 .547	.622 .719 .80	0.0368 0.0478 0.0598	0.83 0.80 0.75	(3) (3) (3)
57	Rectangular	1	Tapered inlet throat	2	.475	.667	0.0179	0.97	(3)
58	Rectangular Concrete	1 2	Side tapered - less favorable edges Side tapered - more favorable edges	2	.56 .56	.667 .667	0.0466 0.0378	0.85 0.87	(3) (3)
59	Rectangular Concrete	1	Slope tapered - less favorable edges Slope tapered - more favorable edges	2	.50 .50	.667 .667	0.0466 0.0378	0.65 0.71	(3) (3)

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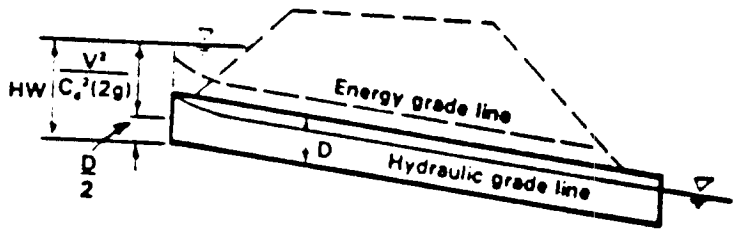
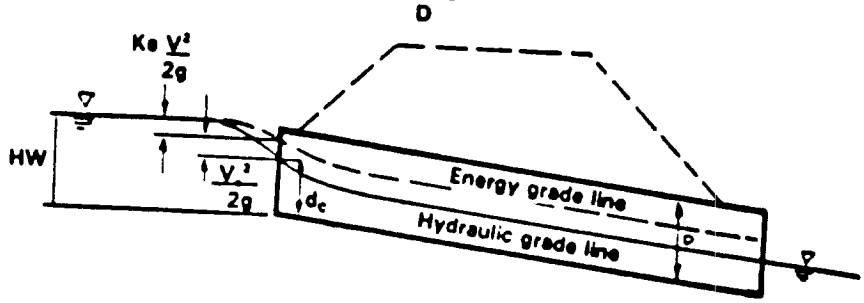
Figure III-2.13 - Inlet/Outlet Control Conditions



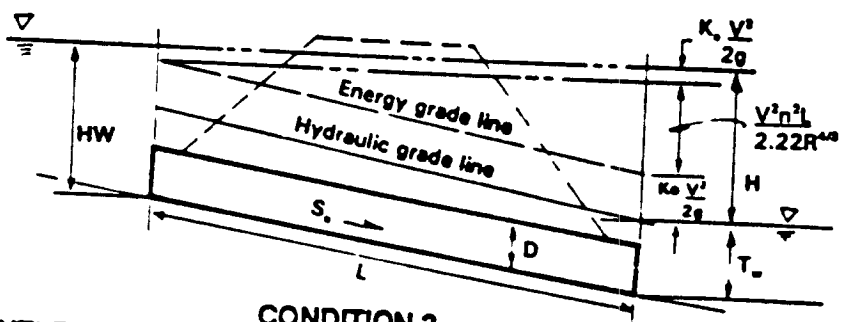
CONDITION 1a
INLET CONTROL - SUBMERGED INLET, FREE OUTFALL

$\frac{HW}{D} > 1.3$



CONDITION 1b
INLET CONTROL

$\frac{HW}{D} < 1.3$



CONDITION 2
OUTLET CONTROL - SUBMERGED INLET AND OUTLET

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Figure III-2.14 - Headwater Depth for Smooth Interior Pipe Culverts With Inlet Control

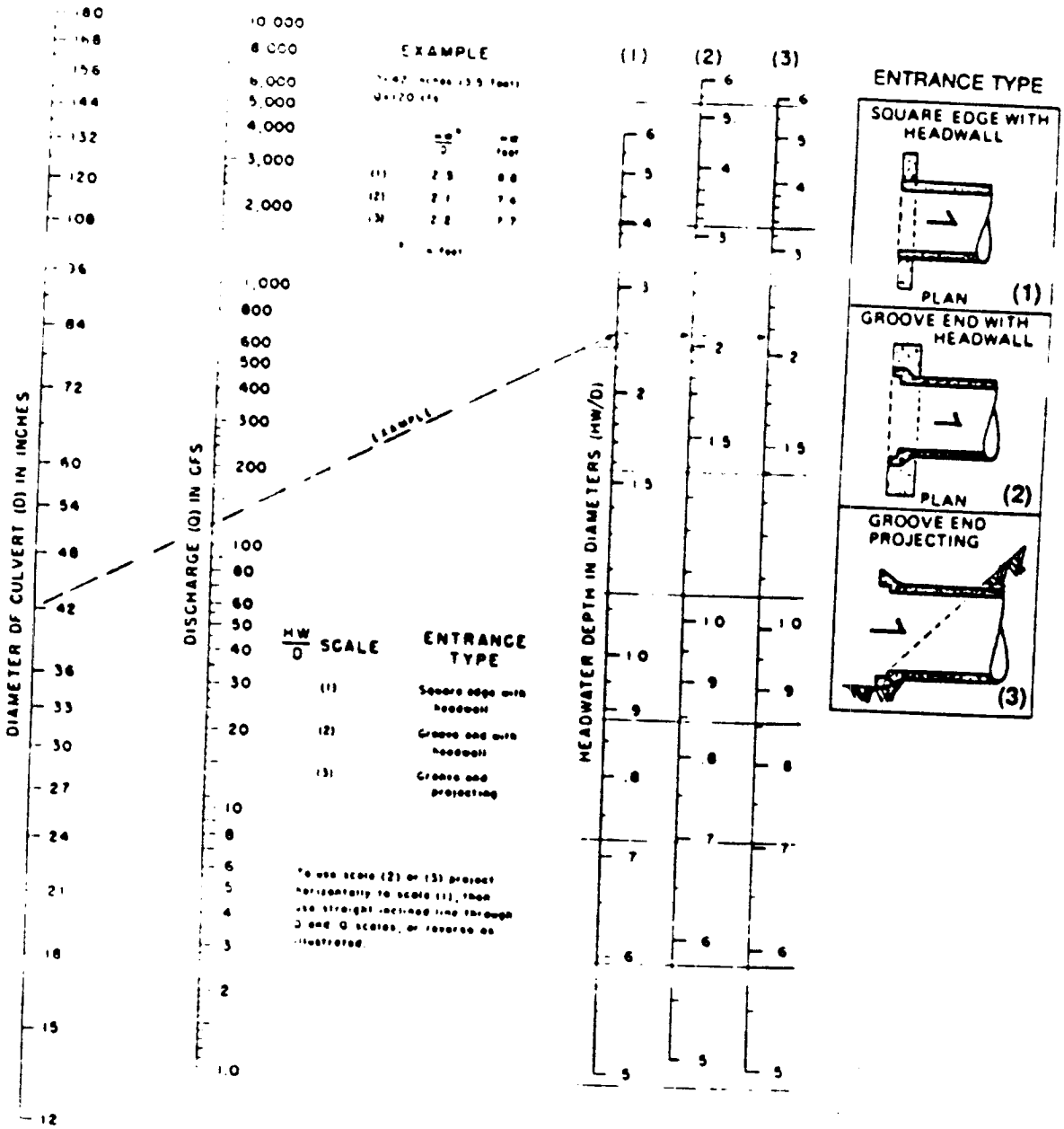

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Figure III-2.15 - Headwater Depth for Corrugated Pipe Culverts With Inlet Control

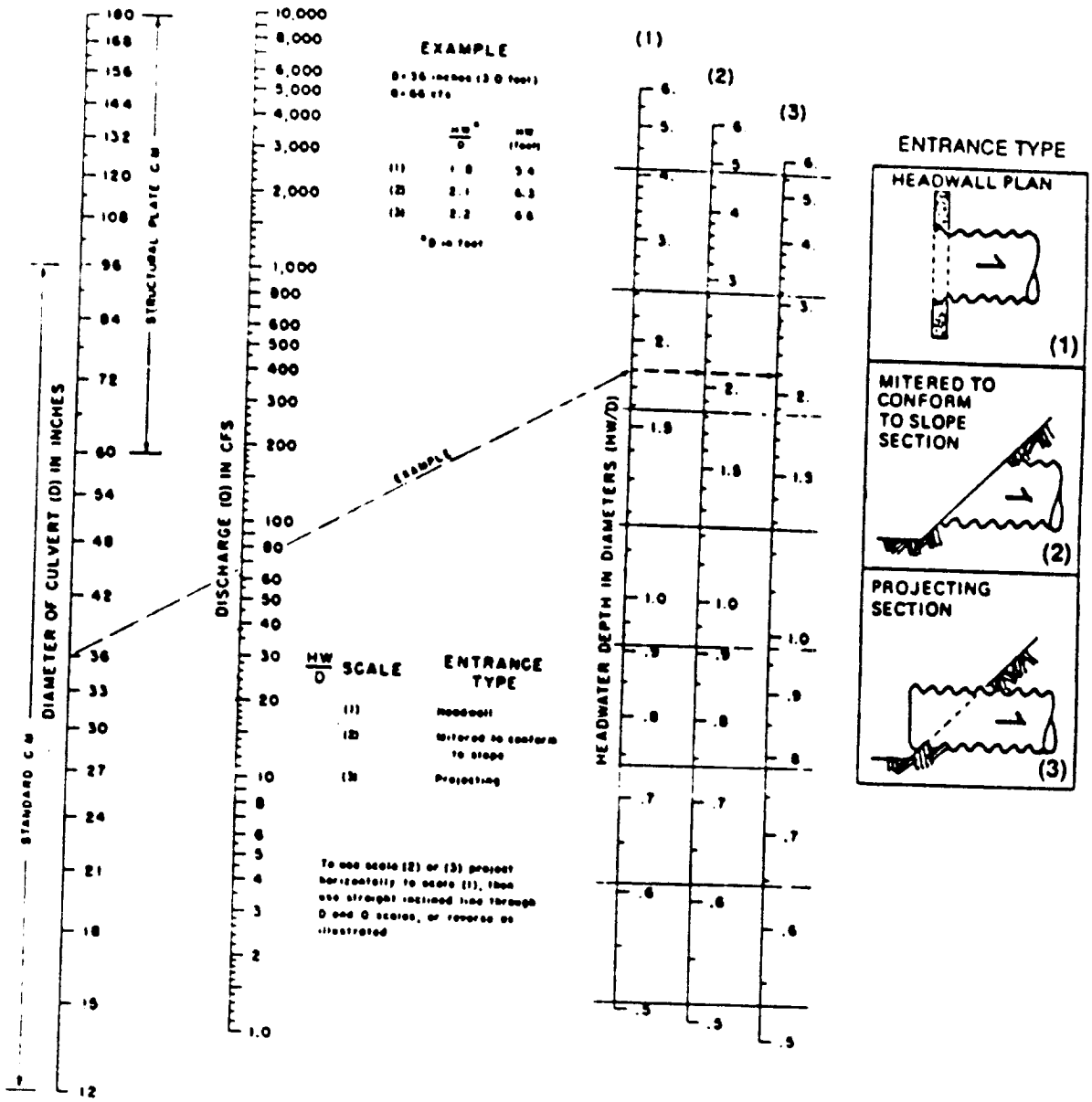

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Figure III-2.16 - Head for Culverts (Pipe W/"n" = 0.024), Flowing Full With Outlet Control

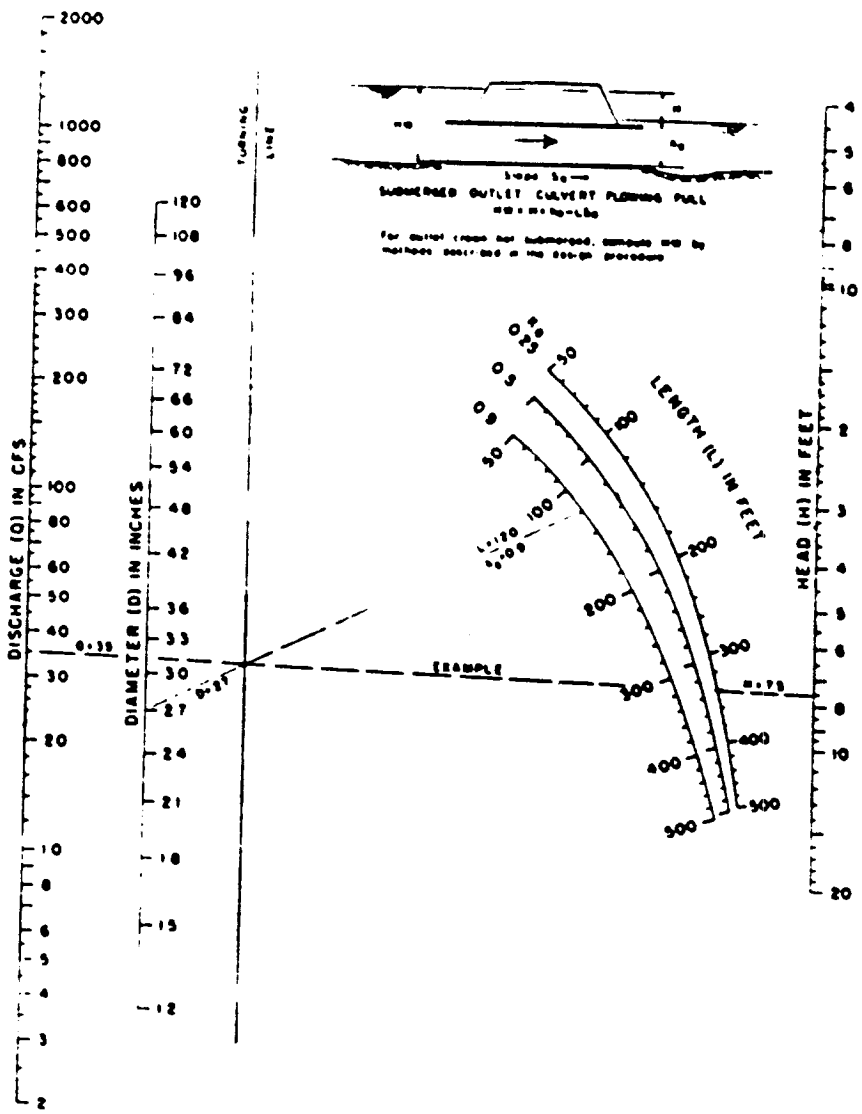

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Figure III-2.17 - Head for Culverts (Pipe W/"n" = 0.012), Flowing Full With Outlet Control

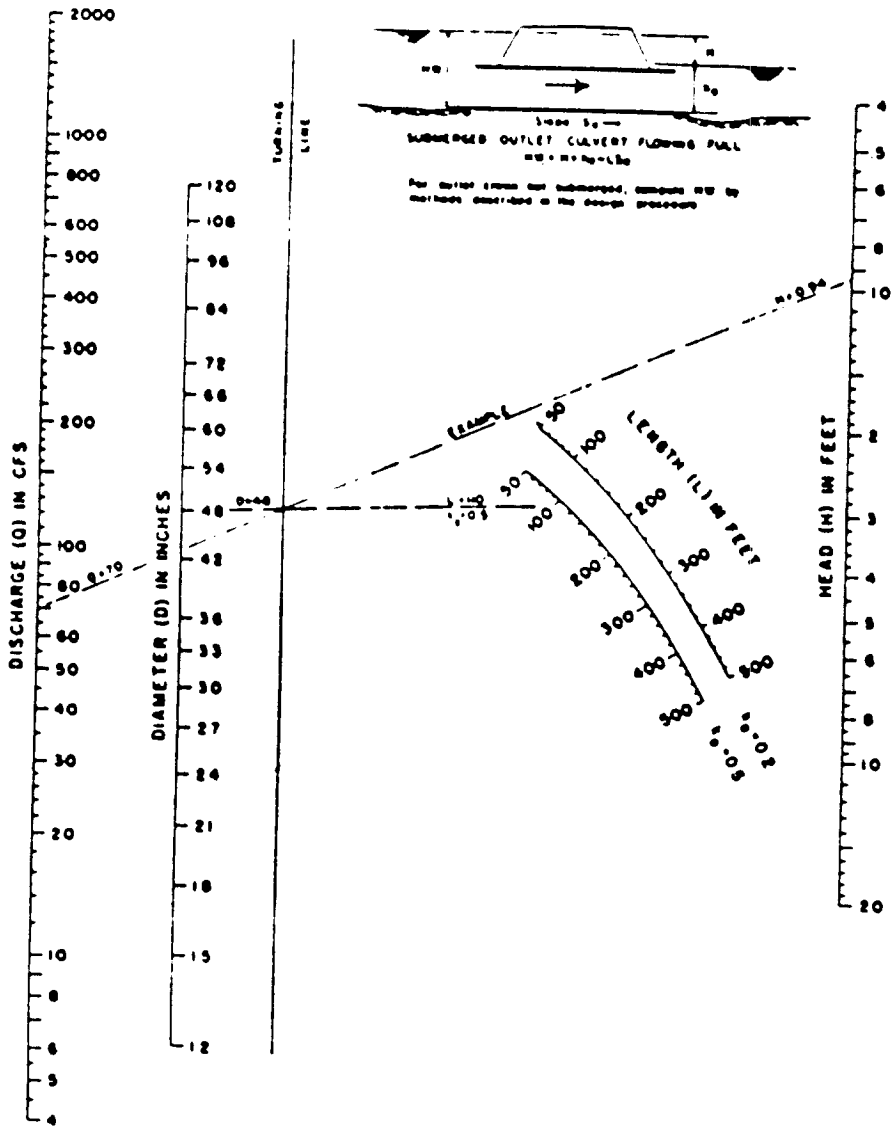

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Figure III-2.18 - Headwater Depth for Concrete Box Culverts Flowing Full With Outlet Control ("n" = 0.012)

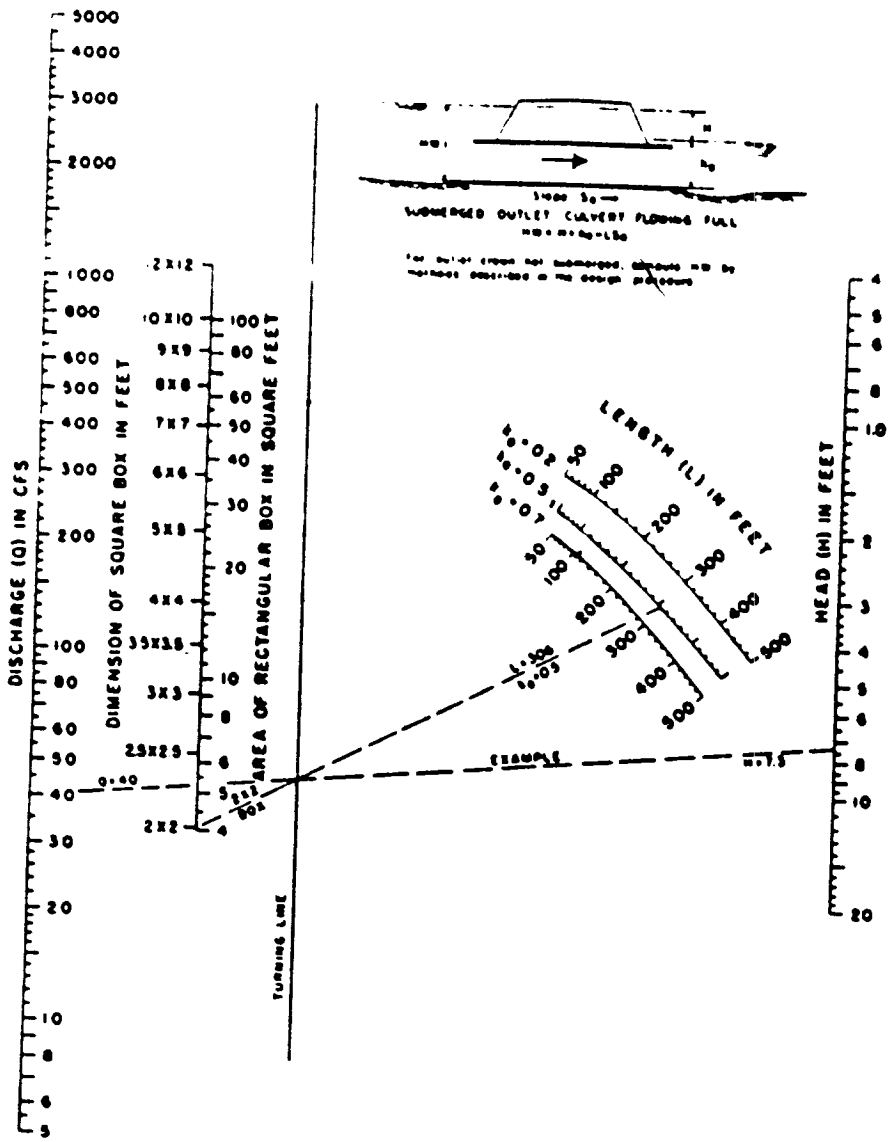

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Figure III-2.19 - Critical Depth of Flow for Circular Culverts

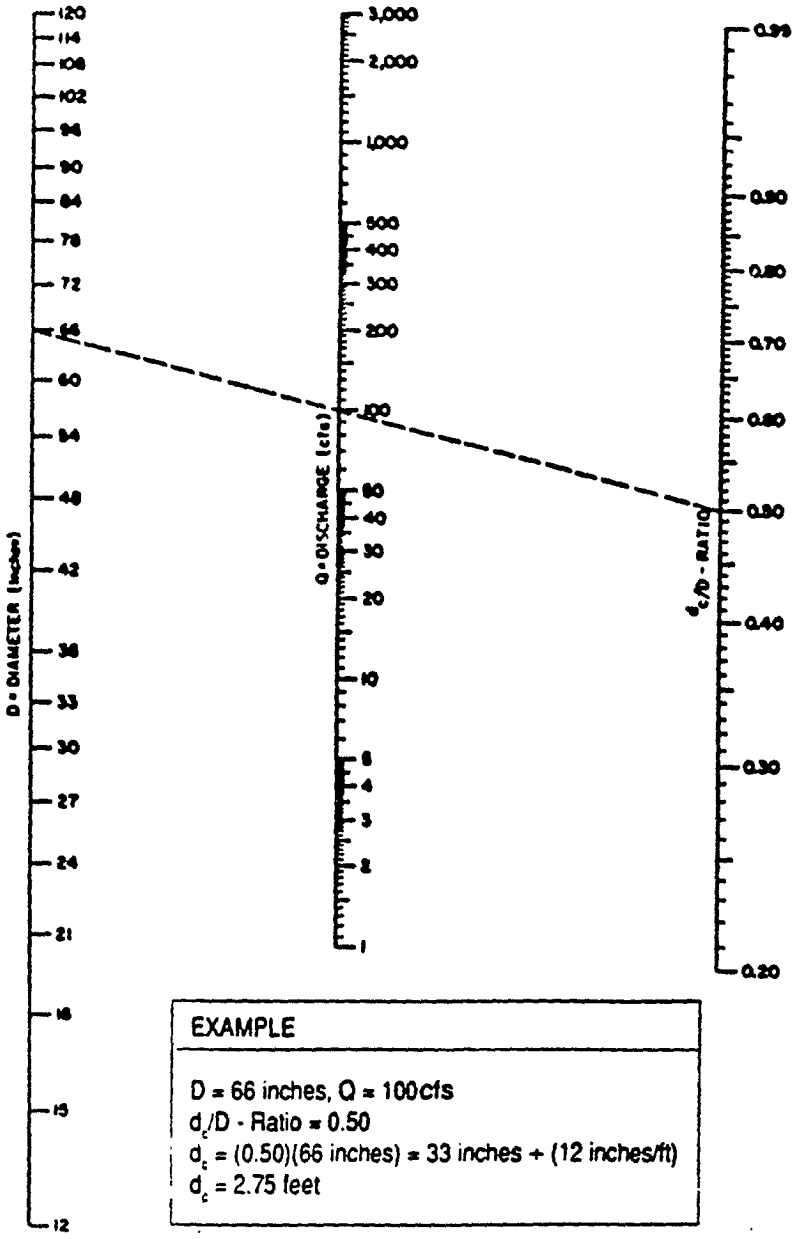

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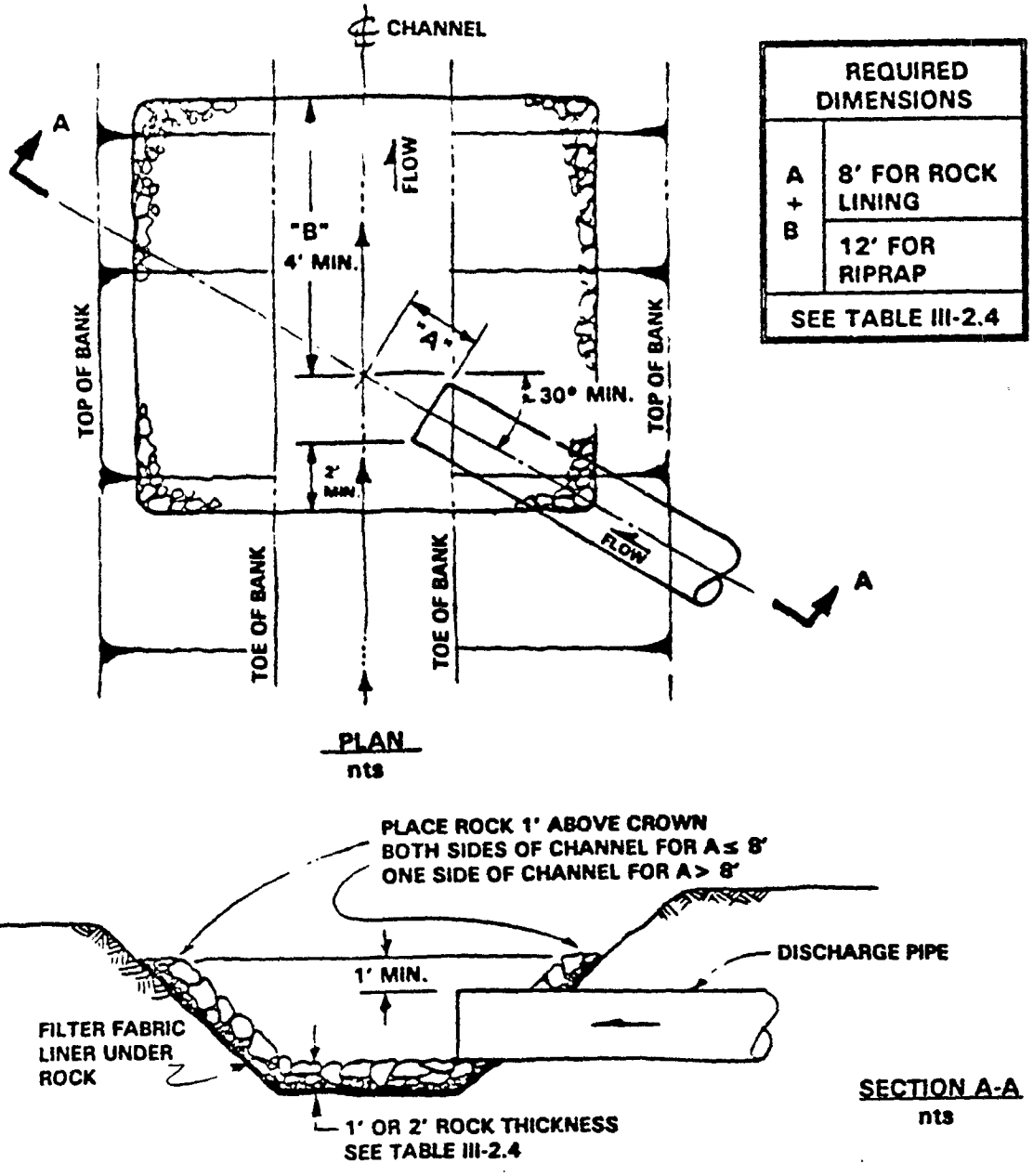
Figure III-2.20 - Culvert Discharge Protection



REQUIRED DIMENSIONS	
A + B	8' FOR ROCK LINING
	12' FOR RIPRAP
SEE TABLE III-2.4	

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III-2.3.5 Outfalls

Design Criteria and Methods of Analysis for Outfalls

- All outfalls (at a minimum) shall be provided with a rock splash pad (see Figure III-2.21). The flow dispersal trench shown in Figure III-2.22 shall only be used as an outfall as described. For outfalls with a velocity at design flow greater than 10 fps, a gabion dissipator or engineered energy dissipator shall be required (see Table III-2.7).

- Mechanisms which reduce velocity prior to discharge from an outfall are encouraged. Examples are drop manholes and rapid expansion into pipes of much larger size.

- Engineered energy dissipators, including stilling basins, drop pools, hydraulic jump basins, baffled aprons, and bucket aprons, are required for outfalls with velocity at design flow greater than 20 fps. These should be designed using published or commonly known techniques found in such references as Hydraulic Design of Energy Dissipators for Culverts and Channels published by the Federal Highway Administration of the United States Department of Transportation (1); Open Channel Hydraulics, by V.T. Chow (2), Hydraulic Design of Stilling Basins and Energy Dissipators, EM 25, Bureau of Reclamation 1978 (3), and others, such as those published by the Soil Conservation Service.

- Examples of alternate mechanisms include concepts such as a bubble-up structure (which will eventually drain) and a structure fitted with reinforced concrete posts. Alternate mechanisms such as these should be designed using sound hydraulic principles and consideration of ease of construction and maintenance.

- Inlet control will usually dictate outfall pipe system capacity. These conditions should be carefully examined, as well as the consequences, should the inlet to the pipe system become plugged or capacity exceeded.

Outfall Systems Traversing Steep Slopes

- Based on past experience in King County, and elsewhere, outfall systems constructed of pipe segments which are banded and/or gasketed have failed. This has resulted from leaks developing at the joints, accelerating erosion around the pipe, and inevitable failure of the system. These failures on steep or unstable slopes can result in incision of the adjacent slopes and downstream sedimentation which clogs conveyance systems and destroys wildlife habitat or worse, mudflows which can cause extensive damage and pose a serious risk of injury or death.

- These outfall failures have promoted the requirement for the use of continuously fused, welded or flange bolted mechanical joint pipe systems with proper anchoring for outfalls on steep slopes. For the past several years high density polyethylene pipe (HDPP) has been used very successfully in preventing these failures. While high in material costs, its relative ease of installation, high performance, and durability makes its life cycle cost comparable, if not much lower than traditional installations. Ductile iron pipe with flange-bolted mechanical joints also has proven reliable for steep slope applications.

Design Criteria for Outfall Systems Traversing Steep Slopes

- Outfall pipes systems shall be installed in trenches with standard bedding on slopes up to 20 percent. On slopes greater than 20 percent, outfall

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pipe systems shall be placed on the ground surface with proper pipe anchorage.

- HDPP outfall systems must be designed to address the material limitations as specified by the manufacturer, in particular thermal expansion/contraction, and pressure design. The coefficient of thermal expansion and contraction for HDPP is on the order of 0.001 inch per foot per Fahrenheit degree. Sliding sleeve connections to address this thermal expansion and contraction shall be used. These sleeve connections consist of a section of the appropriate length of the next larger size diameter of pipe into which the outfall pipe is fitted. These sleeve connections must be located as close to the discharge end of the outfall system as is practical.

- Due to HDPP's ability to transmit flows of very high energy, special consideration for energy dissipation must be made. A sample gabion mattress energy dissipator for this purpose has been provided in Figure III-2.21. Flows of very high energy will require a specifically engineered energy dissipator structure, as described above.

III-2.3.6 Open Channels

Open channels can be classified as either natural or constructed. Natural channels are generally referred to as streams, creeks, or swales, while constructed channels are most often called ditches or, simply, channels. The local government's Sensitive Areas Ordinance and Rules (if adopted) and the Minimum Requirements (Chapter I-2) should be reviewed for requirements related to streams.

Natural channels are defined as those which have occurred naturally due to the flow of surface waters or those that, although originally constructed by human activity, have taken on the appearance of a natural channel including a stable route and biological community. They may vary hydraulically along each channel reach and should be left in their natural condition wherever feasible or required, in order to maintain natural hydrologic functions and wildlife habitat benefits from established vegetation.

Constructed channels are those constructed or maintained by human activity and include bank stabilization of natural channels. Constructed channels shall be either rock-lined, vegetation-lined, or lined with appropriately "bio-engineered" vegetation.

Vegetation-lined channels are the preferred type of constructed channels when properly designed and constructed. The vegetation stabilizes the slopes of the channel, controls erosion of the channel surface, and removes pollutants. The channel storage, low velocities, water quality benefits, and greenbelt multiple-use benefits create significant advantages over other constructed channels. The presence of vegetation in channels creates turbulence which results in loss of energy and increased flow retardance; therefore, the design engineer must consider sediment deposition and scour, as well as flow capacity.

Rock-lined channels are necessary where a vegetative lining will not provide adequate protection from erosive velocities. They may be constructed with quarry spall riprap, gabions, or slope mattress linings. The rock lining increases the turbulence, resulting in a loss of energy and increased flow retardance. Rock lining also permits a higher design velocity and therefore a steeper design slope than in grass-lined channels. Rock linings are also used for erosion control at culvert/storm drain outlets, at sharp channel bends, channel confluences, and locally steepened channel sections. Rock-lined channels should only be used when careful consideration has shown that vegetated channels are not feasible.

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Figure III-2.21 - Gabion Outfall Detail

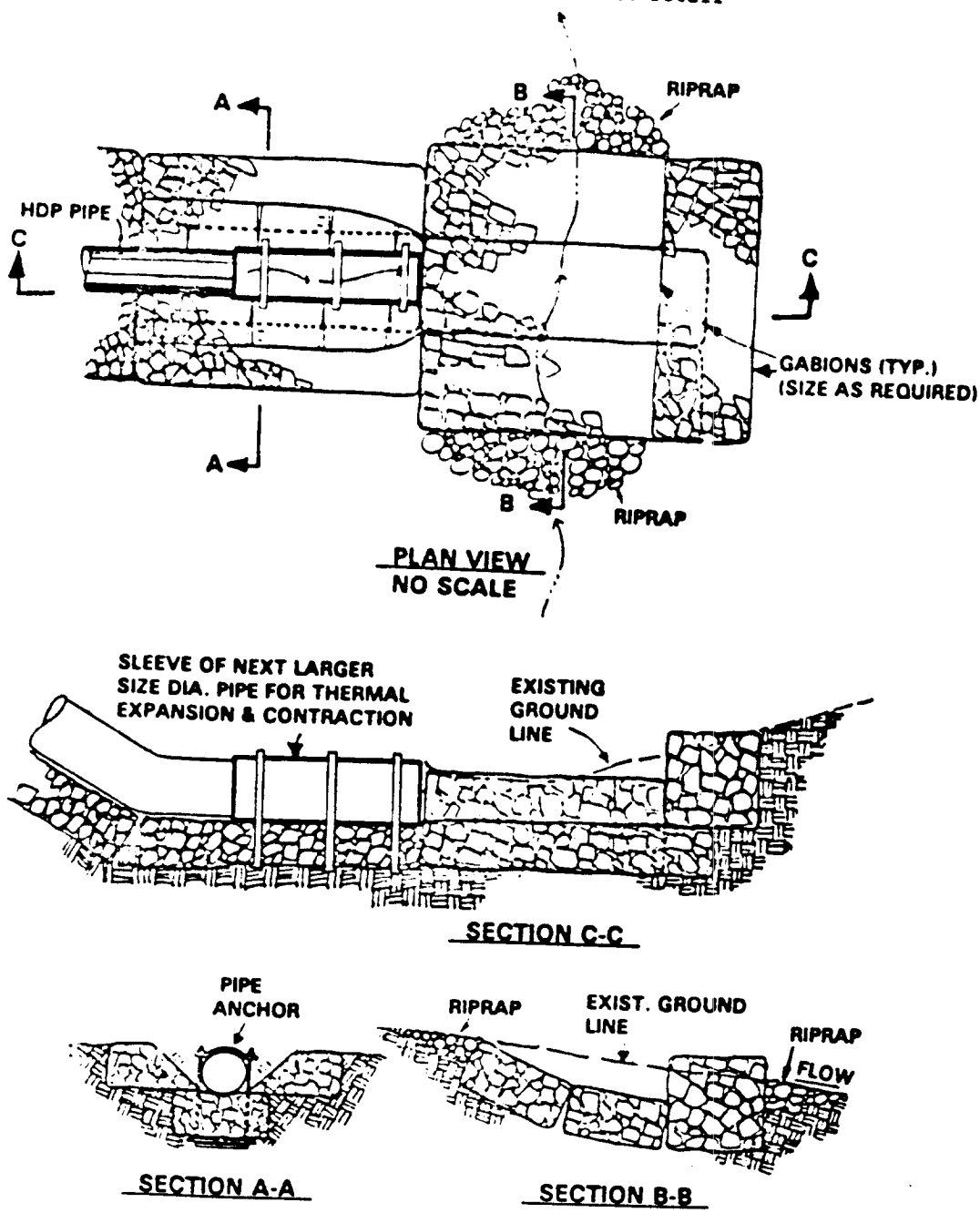

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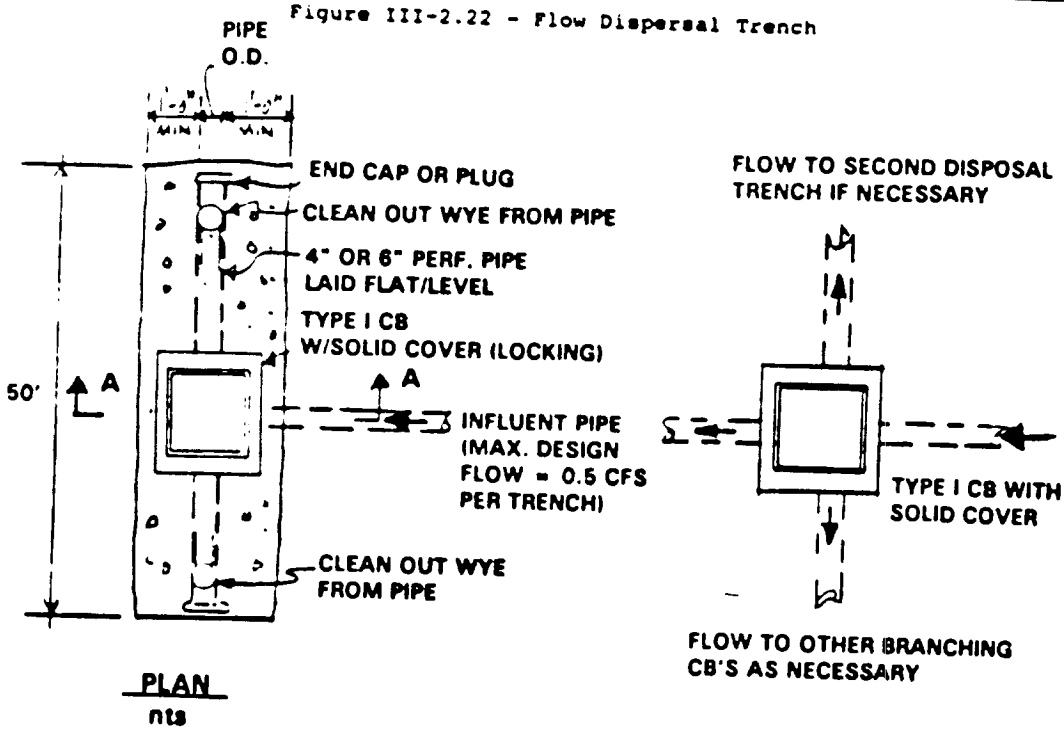
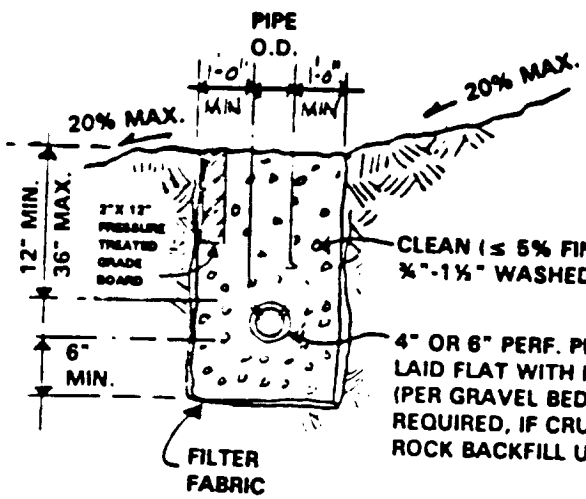
Figure III-2.22 - Flow Dispersal Trench



PLAN
nts



SECTION A-A
nts

NOTES:
1. THIS TRENCH SHALL BE CONSTRUCTED SO AS TO PREVENT POINT DISCHARGE AND/OR EROSION.
2. TRENCHES MAY BE PLACED NO CLOSER THAN 50 FEET TO ONE ANOTHER.
3. TRENCH AND GRADE BOARD MUST BE LEVEL; ALIGN TO FOLLOW CONTOURS OF SITE.
4. GRADE BOARD SUPPORT POST SPACING AS REQUIRED BY SOIL CONDITIONS.

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Design Criteria

Geometry: Channel section geometry shall be trapezoidal, V-shaped parabolic, or segmental as shown in Figures III-2.26 through III-2.28. Side slopes shall be not steeper than 3:1 for vegetation-lined channels and 2:1 for rock-lined channels unless engineered (roadside ditches shall be per local government Road Standards).

Minimum Velocity: In order to promote infiltration, biofiltration, and deposition of silt prior to entering closed pipe systems or natural channels, the minimum velocity is 0.5 fps.

Channel Freeboard: Provide minimum 0.5 ft. above design flows.

Maximum Slope/Velocity: Vegetation-lined channels shall have bottom slope gradients of 5 percent or less and a maximum average velocity at design flow of 5 fps.

Stabilization: Rock-lined channels or bank stabilization of natural channels shall be used when design flow velocities exceed 5 fps. Rock lining shall be in accordance with Table III-2.7 or stabilized with bioengineering methods as described below.

Easements: An access easement for maintenance is required along all constructed channels located on private property. Required easement widths and building setback lines vary with channel top width as required by the local government.

Bioengineered Channels and Bank Stabilization

Soil "Bioengineering" is a highly specialized science that uses living plants and plant parts to stabilize eroded or damaged land. Its application to eroded stream or river banks provides desirable alternatives to the conventional methods of rock armoring.

Properly bioengineered systems are capable of providing a measure of immediate soil protection and mechanical reinforcement. As the plants grow they produce a vegetative protective cover and a root reinforcing matrix in the soil mantle. This root reinforcement serves several purposes:

(1) The developed anchor roots provide both shear and tensile strength to the soil, thereby providing protection from the frictional shear and tensile velocity components to the soil mantle during the time when flows are receding and pore pressure is high in the saturated bank.

(2) The root mat provides a living filter in the soil mantle which allows for the natural release of water after the high flows have receded.

(3) The combined root system exhibits active friction transfer along the length of the living roots. This consolidates soil particles in the bank and serves to protect the soil structure from collapsing and the stabilization measures from failing.

The vegetative cover provides immediate protection during high flows by laying flat against the bank and covering the soil like a blanket. It also reduces pore pressure in saturated banks through transpiration by acting as a natural "pump" to "pull" the water out of the banks after flows have receded. For further details on bioengineering methods see BMPs E2.45, E2.80, E2.85 and E2.90 in Volume II, Erosion and Sediment Control.

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Riprap Design
(from a paper prepared by M. Schaefer, Ph.D., Dam Safety Section, Washington State Department of Ecology.)

In the placing of riprap, stones are placed on the channel sides and bottom to protect the underlying material from being eroded. Proper riprap design requires the determination of the median size of stone, the thickness of the riprap layer, the gradation of stone sizes and the selection of angular stones which will interlock when placed. Research by the U.S. Army Corps of Engineers has provided criteria for selecting the median stone size, W_{50} (Figure III-2.23). If the riprap is to be used in a highly turbulent zone, such as at a culvert outfall, downstream of a stilling basin, at sharp changes in channel geometry, etc., the median stone (W_{50}) should be increased from 200 percent to 600 percent depending on the severity of the locally high turbulence. The thickness of the riprap layer should generally be twice the median stone diameter (D_{50}) or at least that of the maximum stone. The riprap should have a reasonably well graded assortment of stone sizes within the following gradation:

$$1.25 \leq \frac{Dmax}{D_{50}} \leq 1.50, \quad \frac{D_{15}}{D_{50}} = 0.50, \quad \frac{Dmin}{D_{50}} = 0.25$$

For a more detailed analysis and design procedure for riprap requiring water surface profiles and estimates of tractive force, refer to the paper by Maynard et al., Journal of Hydraulic Engineering (A.S.C.E.), July, 1989.

Riprap Filter Design

The riprap should be underlain by a sand and gravel filter (or filter fabric) to keep the fine materials in the natural channel from being washed through the voids in the riprap. Likewise, the filter material must be selected so that it is not washed through the voids in the riprap. Adequate filters can usually be provided by a reasonably well graded sand and gravel material where:

$$D_{15} < 5d_{85}$$

Where d refers to the sieve opening through which 85 percent of the material being protected will pass and D_{15} has the same interpretation for the filter material. A filter with a D_{50} of 0.5 mm will protect any finer material including clay. Where very large riprap is used it is sometimes necessary to use two filter layers between the material being protected and the riprap.

Example:

What riprap design should be used for protection of a stream bank at a culvert outfall where the outfall velocities in the vicinity of the downstream toe are expected to be about 8 fps?

From Figure III-2.23, W_{50} = 6.5 lbs, since the downstream area below the outfall will be subjected to severe turbulence, increase W_{50} by 400%, use:

W_{50} = 26 lbs, D_{50} = 8.0 inches

The gradation of the riprap is shown in Figure III-2.24, and the minimum thickness would be 1 foot (from Table III-2.7); however, 16 inches to 24 inches of riprap thickness would provide some additional insurance that the riprap will function properly in this highly turbulent area.

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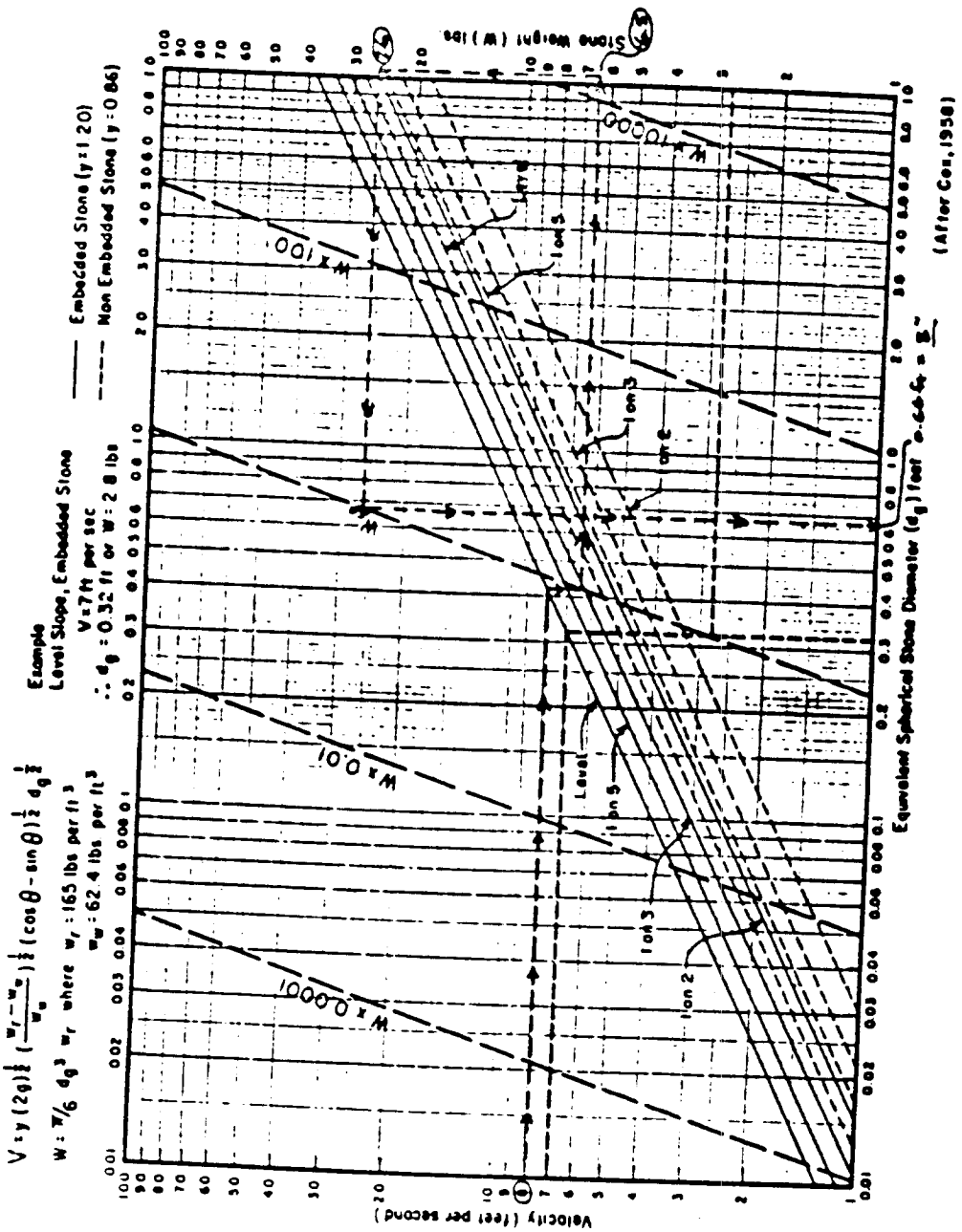
Figure III-2.23 - Mean Channel Velocity vs. Median Stone Weight (W_{50}) and Equivalent Stone Diameter



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Inspection of Figure III-2.24 shows that the gradation curve for ASTM C-33, size number 57 coarse aggregate (used in concrete mixes), would meet the filter criteria. Applying the filter criteria to the coarse aggregate would demonstrate that any underlying material whose gradation was coarser than that of a concrete sand would be protected.

For additional information and procedures for specifying filters for riprap and general guidance, refer to the Army Corps of Engineers Manual EM 1110-2-1601 (1970) "Hydraulic Design of Flood Control Channels," paragraph 14, Rip Rap Protection.

Table III-2.7 Channel Protection

Velocity at Design Flow (fps)				
Greater than	Less than or equal to	Required Protection	Thickness	Min. Height Above Design Water Surface
0	5	Grass Lining***	N/A	0.5 ft.
5	8	Riprap*, ***	1 ft.	1 ft.
8	12	Riprap**	2 ft.	2 ft.
12	20	Slope mattress Gabion, etc.	Varies	2 ft.

* Riprap shall be in accordance with section 9-13.1 of the WSDOT/APWA Standard Specifications.

* Riprap shall be reasonably well graded assortment of rock with the following gradation:

Maximum stone size 12"
Median stone size 8"
Minimum stone size 2"

** Riprap shall be reasonably well graded assortment of rock with the following gradation:

Maximum stone size 24"
Median stone size 16"
Minimum stone size 4"

Note: Riprap sizing governed by side slopes on channel, assumed ~3.1.

*** Bioengineered lining allowed for design flow up to 8 fps.

Methods of Analysis

Three methods of analysis are presented here for sizing and analyzing open channels.

(1) Manning's Equation for Preliminary Sizing of Open Channels

This method is used for preliminary sizing of open channel reaches of uniform cross-section and slope (i.e., prismatic channels), and uniform roughness. It assumes the

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flow depth (or normal depth), and flow velocity, remain constant throughout the channel reach for a given flow.

The charts in Figures III-2.26 and III-2.27 can be used to obtain graphic solutions of Manning's Equation for common ditch sections. For conditions outside the range of these charts, or for more precise results, Manning's Equation can be solved directly from its classic forms:

$$V = 1.49/n\ R^{2/3}\ S^{1/2} \quad \text{or} \quad Q = 1.49/n\ A\ R^{2/3}\ S^{1/2}$$

Table III-2.8 provides a reference for selecting the appropriate "n" values for open channels. A number of engineering reference books, such as "Open-Channel Hydraulics" by V.T. Chow (Table 5-6 and Figure 5-5), may also be used as a guide in the selection of "n" values. Figure III-2.28 contains the geometric elements of common channel sections useful in determining area (A), wetted perimeter (WP), and hydraulic radius (R = A/WP)

Note, if flow restrictions occur which raise the water level above normal depth within a channel reach, a backwater condition (or non-uniform flow) is said to exist. This condition can result from flow restrictions created by a downstream culvert, bridge, dam, pond, lake, etc., or a downstream channel reach having a higher than normal flow depth. If backwater conditions are found to exist, a backwater profile should be computed to verify that the channel's capacity is still adequate. The Direct Step or Standard Step backwater methods can be used for this purpose.

(2) Direct Step Backwater Method

This method may be used to calculate a water surface profile for a channel when the downstream receiving facility creates a restriction to normal flow (e.g. an open channel transition to a culvert). Application of this method to prismatic channels is characterized by dividing the channel into short reaches for analysis. A reach is any length of channel which exhibits common hydraulic characteristics such as cross-section, roughness, and slope.

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Table III-2.8 - Values of the Roughness Coefficient, "n"

Type of Channel and Description	Manning's "n" (Normal)
A Constructed Channels	
a. Earth, straight and uniform	
1. Clean, recently completed	0.018
2. Gravel, uniform section, clean	0.025
3. With short grass, few weeds	0.027
b. Earth, winding and sluggish	0.025
1. No vegetation	0.025
2. Grass, some weeds	0.030
3. Dense weeds or aquatic plants in deep channels	0.035
4. Earth bottom and rubble sides	0.030
5. Stony bottom and weedy banks	0.035
6. Cobble bottom and clean sides	0.040
c. Rock lined	
1. Smooth and uniform	0.035
2. Jagged and irregular	0.040
d. Channels not maintained, weeds and brush uncut	
1. Dense weeds, high as flow depth	0.080
2. Clean bottom, brush on sides	0.050
3. Same, highest stage of flow	0.070
4. Dense brush, high stage	0.100
B. Natural Streams	
B-1 Minor streams (top width at flood stage < 100 ft.)	
a. Streams on plain	
1. Clean, straight, full stage no rifts or deep pools	0.030
2. Same as above, but more stones and weeds	0.035
3. Clean, winding, some pools and shoals	0.040
4. Same as above, but some weeds	0.040
5. Same as 4, but more stones	0.050
6. Sluggish reaches, weedy deep pools	0.070
7. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.100
b. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages	
1. Bottom: gravel, cobbles, and few boulders	0.040
2. Bottom: cobbles with large boulders	0.050
B-2 Flood plains	
a. Pasture, no brush	
1. Short grass	0.030
2. High grass	0.035
b. Cultivated areas	
1. No crop	0.030
2. Mature row crops	0.035
3. Mature field crops	0.040
c. Brush	
1. Scattered brush, heavy weeds	0.050
2. Light brush and trees	0.060
3. Medium to dense brush	0.070
4. Heavy, dense brush	0.100
d. Trees	
1. Dense willows, straight	0.150
2. Cleared land with tree stumps, no sprouts	0.040
3. Same as above, but with heavy growth of sprouts	0.060
4. Heavy stand of timber, a few down trees, little undergrowth, flood stage below branches	0.100
5. Same as above, but with flood stage reaching branches	0.120

*Note, these "n" values are "normal" values for use in analysis of channels. For conservative design for channel capacity the "maximum" values listed in other references should be considered. For channel bank stability the minimum values should be considered

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Figure III-2.24 - Riprap Gradation Curve

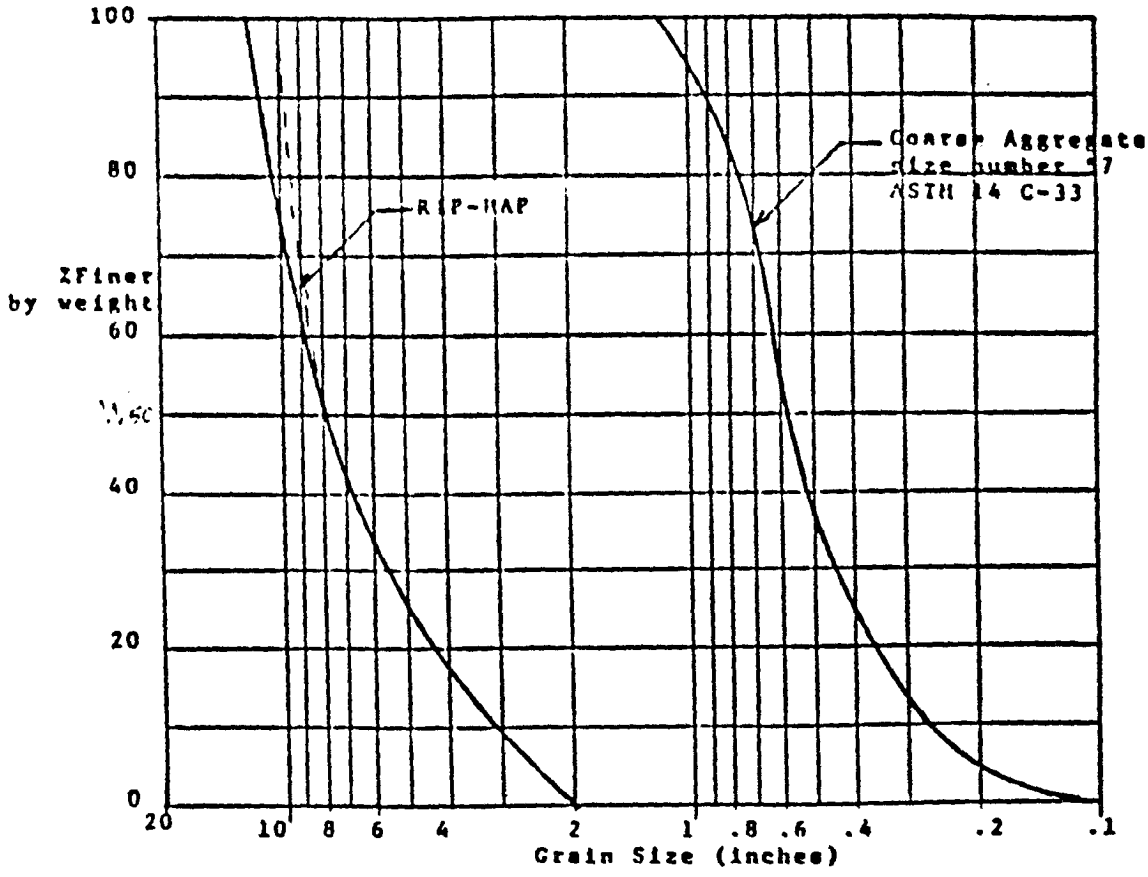

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Figure III-2.25 - Open Channel Flow Profile Computation

$Q =$ _____ $n =$ _____ $S_0 =$ _____ $\alpha =$ _____ $Y_n =$ _____

Y (1)	A (2)	R (3)	$R^{4/3}$ (4)	V (5)	$\alpha V^2/2g$ (6)	E (7)	ΔE (8)	S_f (9)	$\bar{S}_f$ (10)	$S_0 - \bar{S}_f$ (11)	Δx (12)	x (13)

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Figure III-2.26 - Ditches, Common Sections

PROPERTIES OF DITCHES

NO.	DIMENSIONS				HYDRAULICS			
	[illegible]	B	H	W	a	p	R	R^m
D-1	—	—	6%	5'-0"	1.84	5.16	0.356	0.502
D-1C	—	—	[illegible]	[illegible]	[illegible]	[illegible]	0.246	0.341
D-2A	[illegible]	2'-0"	1'-0"	5'-0"	3.50	5.61	0.624	0.730
B	2:1	2'-0"	1'-0"	6'-0"	4.00	6.47	0.618	0.726
C	3:1	2'-0"	1'-0"	8'-0"	5.00	8.32	0.601	0.717
D-3A	[illegible]	3'-0"	1'-6"	7'-6"	7.88	8.41	0.937	0.958
B	2:1	3'-0"	1'-6"	9'-0"	9.00	9.71	0.927	0.951
C	3:1	3'-0"	1'-6"	12'-0"	11.25	12.49	0.901	0.933
D-4A	[illegible]	3'-0"	2'-0"	9'-0"	12.00	10.21	1.175	1.114
B	2:1	3'-0"	2'-0"	11'-0"	14.00	11.94	1.173	1.112
C	3:1	3'-0"	2'-0"	15'-0"	18.00	15.65	1.150	1.097
D-5A	[illegible]	4'-0"	3'-0"	13'-0"	25.50	14.82	1.721	1.436
B	2:1	4'-0"	3'-0"	16'-0"	30.00	17.42	1.722	1.437
C	3:1	4'-0"	3'-0"	22'-0"	39.00	22.97	1.698	1.423
D-6A	2:1	—	1'-0"	4'-0"	2.00	4.47	0.447	0.584
B	3:1	—	1'-0"	6'-0"	3.00	6.32	0.475	0.609
D-7A	2:1	—	2'-0"	8'-0"	8.00	8.94	0.895	0.929
B	3:1	—	2'-0"	12'-0"	12.00	12.65	0.949	0.965
D-8A	2:1	—	3'-0"	12'-0"	18.00	13.42	1.341	1.216
B	3:1	—	3'-0"	18'-0"	27.00	18.97	1.423	1.265
D-9	2:1	—	1'-0"	14'-0"	7.00	14.14	0.495	0.626
D-10	2:1	—	2'-0"	28'-0"	28.00	28.28	0.990	0.993
D-11	2:1	—	3'-0"	42'-0"	63.00	42.43	1.485	1.302

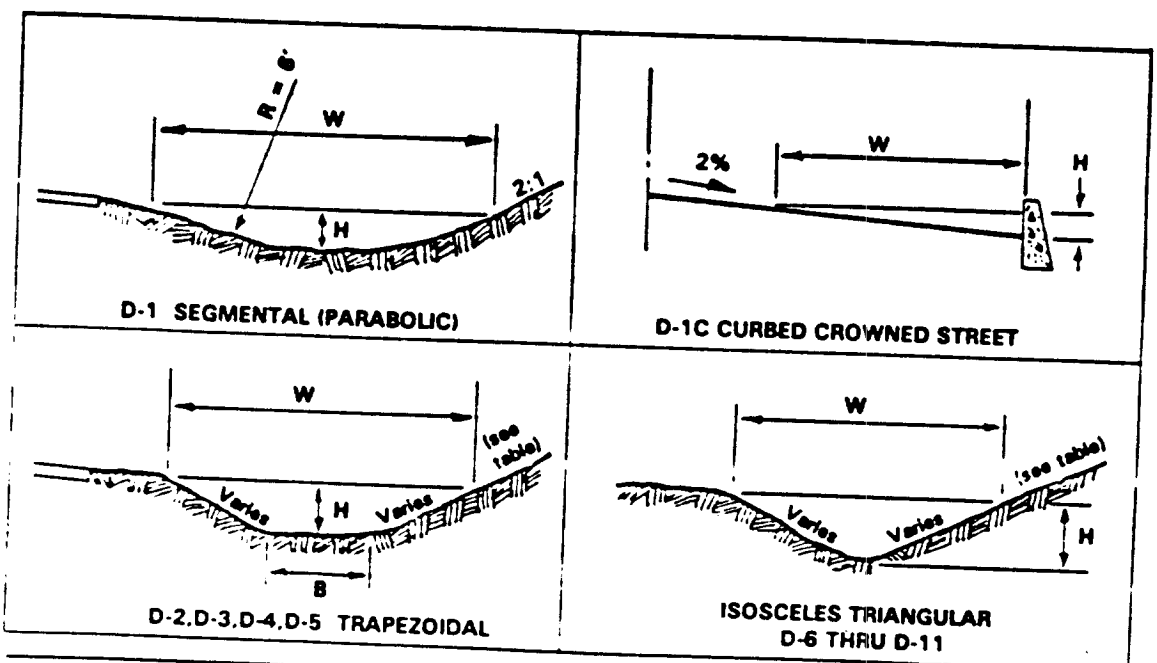

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Figure III-2.27 - Drainage Ditches, Common Sections

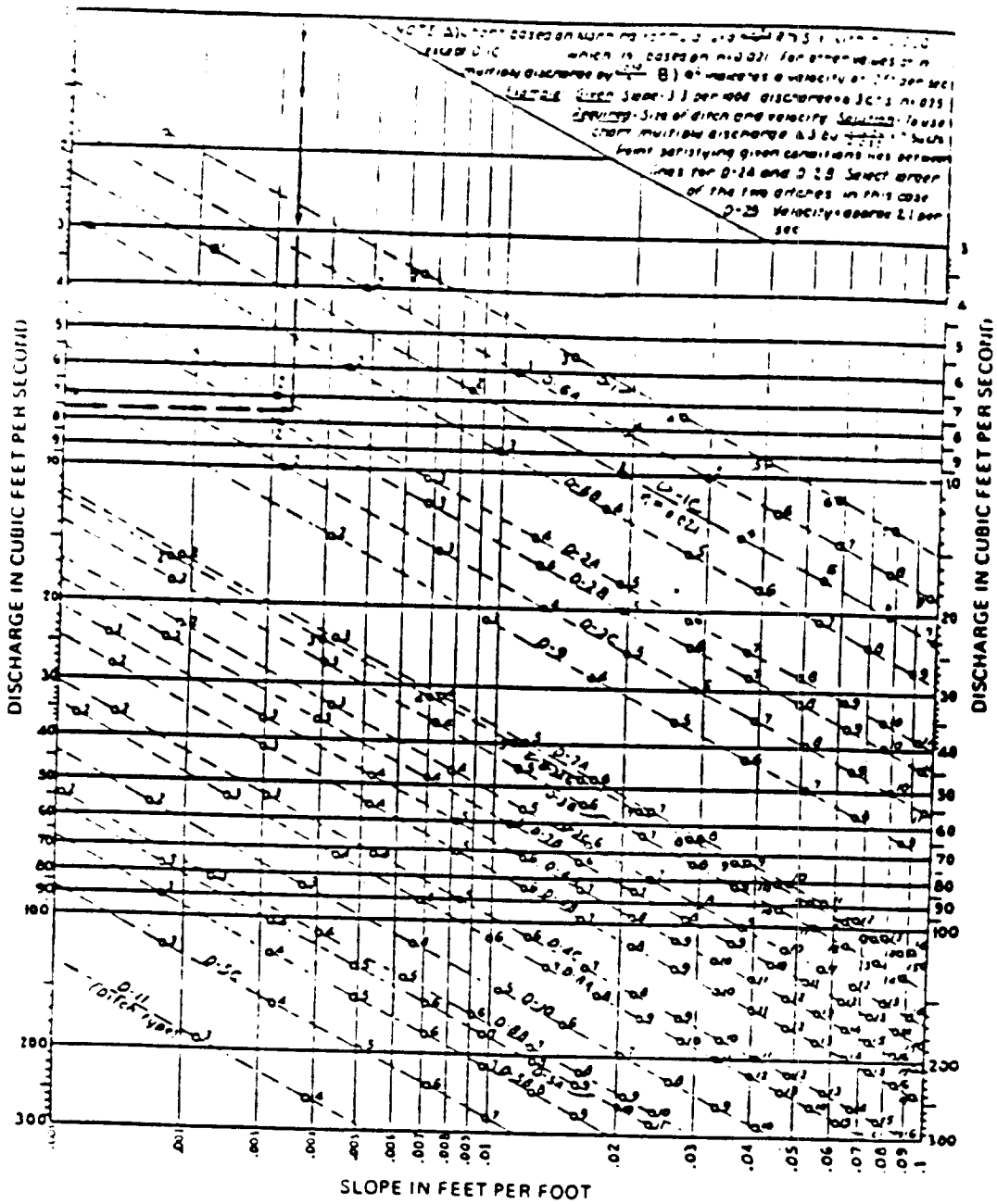

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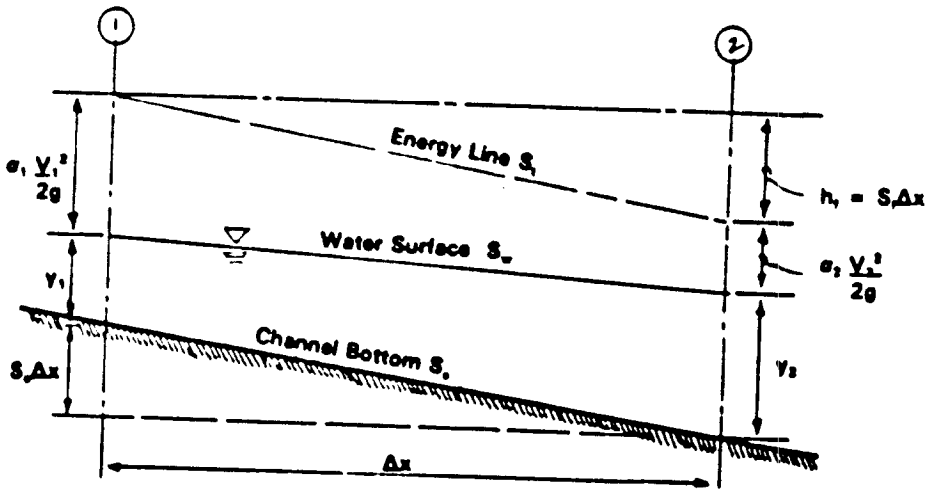
Figure III-2.28 - Geometric Elements of Common Sections

Section	Area A	Wetted perimeter P	Hydraulic radius R	Top width T	Hydraulic depth D	Section factor Z	$A\sqrt{R}$
Rectangle	by	$b+2y$	$\frac{by}{b+2y}$	b	y	$by^{1.5}$	$by^{1.5}$
Trapezoid	$(b+zy)y$	$b+2y\sqrt{1+z^2}$	$\frac{(b+zy)y}{b+2y\sqrt{1+z^2}}$	$b+2zy$	$\frac{(b+zy)y}{b+2zy}$	$\frac{(b+zy)^{2.5}}{\sqrt{b+2zy}}$	$\frac{(b+zy)^{2.5}}{\sqrt{b+2zy}}$
Triangle	zy^2	$2y\sqrt{1+z^2}$	$\frac{zy}{2\sqrt{1+z^2}}$	$2zy$	$\frac{y}{2}$	$\frac{zy^{2.5}}{\sqrt{2}}$	$\frac{zy^{2.5}}{\sqrt{2}}$
Circle	$\frac{1}{8}(\theta-\sin\theta)d^2$	$\frac{1}{2}\theta d$	$\frac{1}{4}\left(1-\frac{\sin\theta}{\theta}\right)d$	$2\sqrt{y(d-y)}$	$\frac{(\theta-\sin\theta)d}{8\sin\frac{\theta}{2}}$	$\frac{(\theta-\sin\theta)^{1.5}d^{2.5}}{2^{2.5}\sqrt{\sin\frac{\theta}{2}}}$	$\frac{(\theta-\sin\theta)^{1.5}d^{2.5}}{2^{2.5}\sqrt{\sin\frac{\theta}{2}}}$
Parabola	$\frac{2}{3}Ty$	$T+\frac{8y^2}{3T}$	$\frac{2T^2y}{3T^2+8y^2}$	$\frac{3A}{2y}$	$\frac{2}{3}y$	$\frac{\sqrt{6}}{9}Ty^{2.5}$	$\frac{\sqrt{6}}{9}Ty^{2.5}$
Semi-ellipse	$\frac{\pi}{2}ay$	$\pi\sqrt{\frac{a^2+y^2}{2}}$	$\frac{ay}{\pi\sqrt{2(a^2+y^2)}}$	$\frac{2ay}{a}$	$\frac{ay}{2a}$	$\frac{\sqrt{2}}{3\pi}ay^{2.5}\sqrt{3a^2+y^2}$	$\frac{\sqrt{2}}{3\pi}ay^{2.5}\sqrt{3a^2+y^2}$
Semi-ellipse (bottom segment)	$\frac{\pi}{2}ay-\frac{a}{b}(b-y)\sqrt{2by-y^2}$	$\pi\sqrt{\frac{a^2+y^2}{2}}-\frac{2}{b}\sqrt{2by-y^2}$	$\frac{\frac{\pi}{2}ay-\frac{a}{b}(b-y)\sqrt{2by-y^2}}{\pi\sqrt{\frac{a^2+y^2}{2}}-\frac{2}{b}\sqrt{2by-y^2}}$	$2a\sqrt{\frac{2y}{b}-\frac{y^2}{b^2}}$	$\frac{\frac{\pi}{2}ay-\frac{a}{b}(b-y)\sqrt{2by-y^2}}{2a\sqrt{\frac{2y}{b}-\frac{y^2}{b^2}}}$	$\frac{\left(\frac{\pi}{2}ay-\frac{a}{b}(b-y)\sqrt{2by-y^2}\right)^{1.5}}{\sqrt{2a\sqrt{\frac{2y}{b}-\frac{y^2}{b^2}}}}$	$\frac{\left(\frac{\pi}{2}ay-\frac{a}{b}(b-y)\sqrt{2by-y^2}\right)^{1.5}}{\sqrt{2a\sqrt{\frac{2y}{b}-\frac{y^2}{b^2}}}}$

* Satisfactory approximation for the interval $0 < s \leq 1$, where $s = y/d$. When $s > 1$, use the next expression. $P = (\pi/2)\sqrt{1+s^2}\,(1+\sqrt{1+s^2})d$

To illustrate analysis of a single reach, consider the following diagram, Figure III-2.29:

Figure III-2.29 - Cross-Sections for Use in the Direct Step Backwater Method



Equating the total head at cross-sections 1 and 2, the following equation may be written:

$$S_o \Delta x + y_1 + \frac{\alpha_1 V_1^2}{2g} = y_2 + \frac{\alpha_2 V_2^2}{2g} + S_f \Delta x$$

Solving for Δx,

$$\Delta x = \frac{E_2 - E_1}{S_o - S_f} = \frac{\Delta E}{S_o - S_f}$$

Where E is specific energy and assuming $\alpha_1 = \alpha_2$, = α, where α is the energy coefficient which corrects for the non-uniform distribution of velocity over the channel cross-section.

$$E = y + \frac{\alpha V^2}{2g}$$

and: y = depth of flow
V = mean velocity
α = energy coefficient
S_o = bottom slope
S_f = friction slope = $\frac{n^2 V^2}{2.21 R^{4/3}}$

g = acceleration due to gravity = 32.2 ft/s²

Typical values of the energy coefficient, α, are as follows:

Channels, regular section	1.15
Natural streams	1.3
Shallow vegetated flood fringes (includes channel)	1.75

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Figure III-2.30 - Open Channel Flow Profile Computation

Q = _____ n = _____ S_o = _____ α = _____ Y_n = _____

Y (1)	A (2)	R (3)	$R^{4/3}$ (4)	V (5)	$\alpha V^2/2g$ (6)	E (7)	ΔE (8)	S_f (9)	$\bar{S}_f$ (10)	$S_o - \bar{S}_f$ (11)	Δx (12)	x (13)

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For a given flow, channel slope, Manning's "n", and energy coefficient, α, together with a beginning water surface elevation, y_2, the values of Δx may be calculated for arbitrarily chosen values of y_1. The coordinates defining the water surface profile are obtained from the cumulative sum of Δx and corresponding values of y. Values of Manning's n may be found in Table III-1.8.

The normal flow depth, y_o, should first be calculated from Manning's Equation to establish the upper limit of the backwater effect.

Calculating the coordinates of the water surface profile using this method is an iterative process achieved by choosing a range of flow depths, beginning at the downstream end, and proceeding incrementally up to the point of interest or to the point of normal flow depth. This is best accomplished by the use of a table (see Figures III-2.30 and III-2.31) or a computer program (as discussed below).

To illustrate this method, consider the following example:

Given: Q = 30 cfs
n = 0.030
s_o = 0.007
α = 1.15

Assume a culvert is flowing full at 30 cfs with a headwater depth of 6 feet. The channel entering the culvert is a V-section with 2:1 side slopes.

Calculate the backwater profile upstream of the culvert to a point near the normal flow.

From Manning, $y_o = \dfrac{\left(\dfrac{Qn}{1.743\sqrt{s_o}}\right)^{3/8}}{} = 1.98$ ft.

The step computations are carried out as shown in Figure III-2.31 above. The values in each column of the table are explained as follows:

Col. 1. Depth of flow in ft. assigned from 6 to 2 ft.
Col. 2. Water area in ft.^{2} corresponding to depth y in Col. 1
Col. 3. Hydraulic radius in ft. corresponding to y in Col. 1
Col. 4. Four-thirds power of the hydraulic radius
Col. 5. Mean velocity in fps obtained by dividing Q(30 cfs) by the water area in Col. 2.
Col. 6. Velocity head in feet
Col. 7. Specific energy in ft. obtained by adding the velocity head in Col. 6 to depth of flow in Col. 1.
Col. 8. Change of specific energy in ft. equal to the difference between the E value in Col. 7 and that of the previous step.
Col. 9. Friction slope S_f, computed from V as given in Col. 5 and $R^{4/3}$ in Col. 4.
Col. 10. Average friction slope between the steps, equal to the arithmetic mean of the friction slope just computed in Col. 9 and that of the previous step.
Col. 11. Difference between the bottom slope S_o, and the average friction slope, S_f.
Col. 12. Length of the reach in ft. between the consecutive steps, computed by $\Delta X = \Delta E/(S_o - S_f)$ or by dividing the value in Col. 8 by the value in Col. 11.
Col. 13. Distance from the beginning point to the section under consideration. This is equal to the cumulative sum of the values in Col. 12 computed for previous steps.

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Figure III-2.31 Example Direct Step Backwater Method

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
6.0	72.0	2.28	3.78	0.42	0.0031	6.0031	—	0.00002	—	—	—	—
5.5	60.5	2.46	3.31	0.50	0.0040	5.5040	0.4990	0.00003	0.000025	0.00698	71.50	71.5
5.0	50.0	2.24	2.92	0.60	0.0064	5.0064	0.4976	0.00005	0.000040	0.00696	71.49	142.99
4.5	40.5	2.01	2.54	0.74	0.0098	4.5098	0.4966	0.00009	0.000070	0.00693	71.64	214.63
4.0	32.0	[illegible]	2.17	0.94	0.0157	4.0157	0.4941	0.00016	0.000127	0.00687	71.89	286.52
3.5	24.5	[illegible]	1.82	1.22	0.0268	3.5268	0.4889	0.00033	0.000246	0.00675	72.38	358.90
3.0	[illegible]	[illegible]	1.48	[illegible]	0.0476	3.0476	0.4772	0.00076	0.000547	0.00645	73.95	432.85
2.5	[illegible]	[illegible]	[illegible]	2.40	0.029	2.6029	0.4467	0.00201	0.001387	0.00561	79.58	512.43
2.0	[illegible]	[illegible]	0.86	3.75	0.2511	2.2511	0.3518	0.00663	0.004320	0.00268	131.27	643.70

The step computations are carried out as shown in Figure 4.3.7G, above. The values in each column of the table are explained as follows:

- Col. 1 — Depth of flow in ft, assigned from 6 to 2 ft.
- Col. 2 — Water area in ft^2 corresponding to depth y in Col. 1
- Col. 3 — Hydraulic radius in ft corresponding to y in Col. 1
- Col. 4 — Four-thirds power of the hydraulic radius
- Col. 5 — Mean velocity in fps obtained by dividing Q(30 cfs) by the water area in Col. 2.
- Col. 6 — Velocity head in feet
- Col. 7 — Specific energy in fps obtained by adding the velocity head in Col. 6 to depth of flow in Col. 1
- Col. 8 — Change of specific energy in ft, equal to the difference between the E value in Col. 7 and that of the previous step
- Col. 9 — Friction slope S_f, computed from V as given in Col. 5 and $R^{4/3}$ in Col. 4.
- Col. 10 — Average friction slope between the steps, equal to the arithmetic mean of the friction slope just computed in Col. 9 and that of the previous step
- Col. 11 — Difference between the bottom slope S_o, and the average friction slope, S_f.
- Col. 12 — Length of the reach in ft between the consecutive steps, computed by $X = E/(S_o - S_f)$ or by dividing the value in Col. 8 by the value in Col. 11
- Col. 13 — Distance from the beginning point to the section under consideration. This is equal to the cumulative sum of the values in Col. 12 computed for previous steps.

As with the hydrologic methods described in Chapter 1, there are a number of software programs available for use on personal computers that use variations of the standard direct step backwater method for determining water surface profiles. The most common and widely accepted program is published and is supported by the United States Army Corps of Engineers Hydraulic Engineering Center and is called HEC-2. It is the model required by the Federal Emergency Management Administration (FEMA) for use in performing flood hazard studies for preparing flood insurance maps. Other programs include WSP-2 published by the SCS, WSPRO or E-431 published by U.S.G.S., and the "BW" programs written by the Surface Water Management Division at King County.

(3) Standard Step Backwater Method for Analyzing Channel Capacity

This method is a variation of the Direct Step Backwater Method and can be used to compute backwater profiles on both prismatic and non-prismatic channels. In this method, stations are established along the channel where cross-section data is known or has been determined through field survey. The computation is carried out in steps from station to station rather than throughout a given channel reach as is done in the Direct Step method. As a result, the analysis involves significantly more trial and error calculation in order to determine the flow depth at each station.

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Because of the iterative calculations involved, use of a computer to perform the analysis, is recommended, such as the "BW" series of programs available from King County, SWM Division.

III-2.3.7 Floodplain/Floodway Analysis

Determination of a Minor Floodplain

In some situations, a minor floodplain must be determined in order to address the compatibility and impacts of a proposed project, such as in ditches behind roadway cross culverts. When evaluating the conveyance system capacity, the floodplain may be determined using the direct step backwater method, standard step backwater method, or software programs described in Section III-2.3.6.

Major Floodplain/Floodway Studies

When a floodplain/floodway study will be used under a Sensitive Areas Ordinance or to justify a Flood Insurance Rate Map revision to the Federal Emergency Management Administration (FEMA), the study must conform to FEMA regulations described in Part 65 of 44 CFR. Note that FEMA has a map correction process for individual properties based on demonstrating an error in the original mapping by submitting new technical information (see Part 70 of CFR Ch. 1). For additional requirements, consult the local government.

III-2.4 CONTROL STRUCTURES

A control structure is a catchbasin with a restrictor device designed to control the outflow from the catchbasin to meet a desired performance level. The restrictor device is usually a multiple orifice, consisting of two (or more) orifices and a weir section sized and located to meet performance.

Multiple Orifices A maximum of five orifices may be used to meet performance requirements.

In some cases, only two orifices are necessary to meet the 2, 10, and 100-year water quality/optional flood control requirement: one at the bottom and one near the top of the riser, although additional orifices may best utilize detention storage volume. Several orifices may be located at the same elevation if necessary to meet performance requirements.

The minimum orifice diameter is 0.5 inch, though diameters of 1 inch or more are preferred.

In some cases, performance requirements may require the top orifice/elbow to be located too high on the riser to physically construct (e.g., a 13-inch-diameter orifice positioned 0.5 feet from top of riser). In these cases, a notch weir in the riser pipe may be used to meet performance as described below.

Riser and Weir Restrictor Properly designed weirs may be used as flow restrictors, however, they must be sized to pass the developed peak flow for the 100-year, 24-hour design storm for developed site conditions.

Riser (or weir) overflow may be utilized for that portion of the release rates above the 6-month, 24-hour design storm flow, provided the combined orifice and overflow do not exceed performance requirements.

Figure III-2.38 can be used to calculate the head in feet above a riser of given diameter and for a given flow (usually the 100-year, 24-hour design storm flow for developed conditions).

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III-2.4.1 Methods of Analysis

The methods of analysis for detention storage volume and discharge rates shall be in accordance with the hydrologic methods described in Chapter III-1.

Flow analysis of orifices and weirs may be done using the following methods:

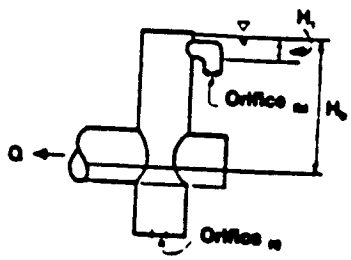
Orifices: Flow-through orifice plates in a standard "tee" section or turn-down elbow may be approximated by the general equation:

$$Q = CA\ (2gh)^{0.5} \text{ in cfs}$$

where: A = area of orifice, ft^2
C = 0.62, coefficient of discharge
h = hydraulic head in feet
g = acceleration of gravity = 32.2 ft/sec^2

Figure III-2.32 illustrates this simplified application of the orifice equation.

Figure III-2.32 Simple Orifice



$$Q = C\,A_0\,(2gh_0)^{1/2} + C\,A_1\,(2bh_1)^{1/2}$$

$$= C\,(2g)^{1/2}\,(A_0(h_0)^{1/2} + A_1\,(h_1)^{1/2}) \quad \text{cfs}$$

h_0 = distance from hydraulic grade line at the 2 year flow of the outflow pipe to the overflow elevation

Rectangular, Sharp Crested Weir: The notch weir design shown in Figure III-2.33 may be analyzed using standard weir equations for the fully contracted condition.

$$Q = C(L-0.2H)H^{3/2} \text{cfs}$$

where: C = 3.27 + 0.40 H/P (in feet).
L = Length of the portion of the riser circumference as necessary (in feet), not to exceed 50 percent of the circumference.
H and P as shown in the figure
D = Inside riser diameter

Note that to account for side contractions, subtract 0.1 H from L for each side of the notch weir.

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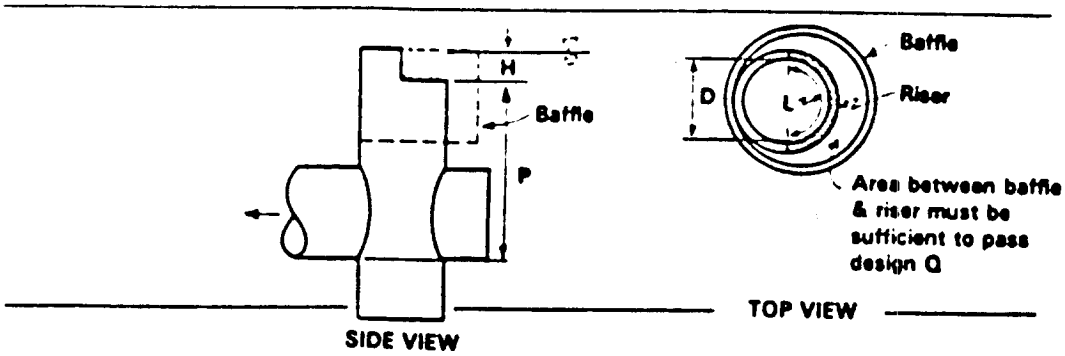
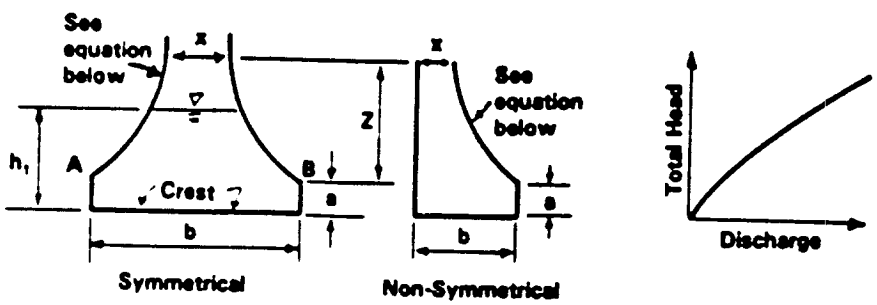
Figure III-2.33 Notch Weir



Proportional or Sutro Weir: This weir is designed so that the discharge is proportional to the total head. This design may be useful in some cases to meet required performance.

The Sutro Weir consists of a rectangular section joined to a curved portion which provides proportionality for all heads above a line connecting points A and B (see Figure III-2.34).

Figure III-2.34 Sutro Weir



The head-discharge relationship is:

$$Q = C_d\ b\ (2ga)^{0.5}\ (h_1 - a/3)$$

Values of C_d for both symmetrical and non-symmetrical Sutro Weirs are summarized below in Table III-2.9 (Note that when b > 1.50 or a > 0.30 use C_d = 0.6.):

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Table III-2.9 Values of C_d for Sutro Weirs

C_d Values, Symmetrical

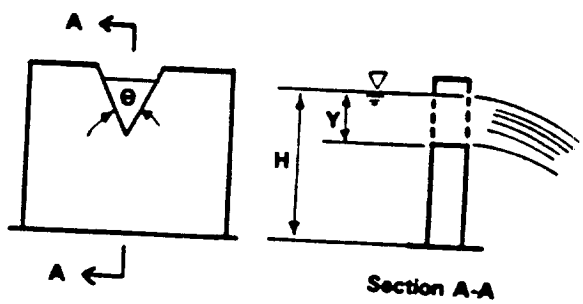
	b, ft.				
a (ft)	0.50	0.75	1.0	1.25	1.50
0.02	0.608	0.613	0.617	0.6185	0.619
0.05	0.606	0.611	0.615	0.617	0.6175
0.10	0.603	0.608	0.612	0.6135	0.614
0.15	0.601	0.6055	0.610	0.6115	0.612
0.20	0.599	0.604	0.608	0.6095	0.610
0.25	0.598	0.6025	0.6065	0.608	0.6085
0.30	0.597	0.602	0.606	0.6075	0.608

C_d Values, Non-Symmetrical

	b, ft.				
a (ft)	0.50	0.75	1.0	1.25	1.50
0.02	0.614	0.619	0.623	0.6245	0.625
0.05	0.612	0.617	0.621	0.623	0.6235
0.10	0.609	0.614	0.618	0.6195	0.620
0.15	0.607	0.6115	0.616	0.6175	0.618
0.20	0.605	0.610	0.614	0.6155	0.616
0.25	0.604	0.6085	0.6125	0.614	0.6145
0.30	0.603	0.608	0.612	0.6135	0.614

V-Notch, Sharp Crested Weir: V-Notch weirs, as shown in Figure III-2.35, may be analyzed using standard equations for the fully contracted condition.

Figure III-2.35 V-Notch, Sharp Crested Weir



Where values of C_d may be taken from the following chart:

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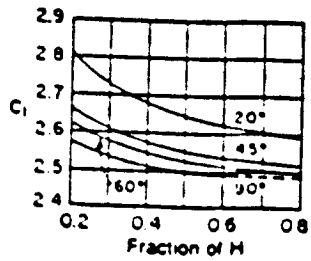

$Q = C_d(\text{Tan}(\theta/2))H^{5/2}$, in cfs

Details

Standard control structure details are shown in Figures III-2.36 and III-2.37.

III-2.4.3 Maintenance of Control Structures

Control structures and catch basins have a history of maintenance-related problems and it is imperative that a good maintenance program be established for their proper functioning. A typical problem is that sediment builds up inside the structure which blocks or restricts flow to the inlet. To prevent this problem these structures should be routinely cleaned out a least twice per year. Regular inspections of control structures should be conducted to detect the need for non-routine cleanout, especially if construction or land-disturbing activities are occurring in the contributing drainage area.

A 15-foot wide access road to the control structure should be installed for inspection and maintenance.

Table III-2.10 provides maintenance recommendations for control structures and catch basins.

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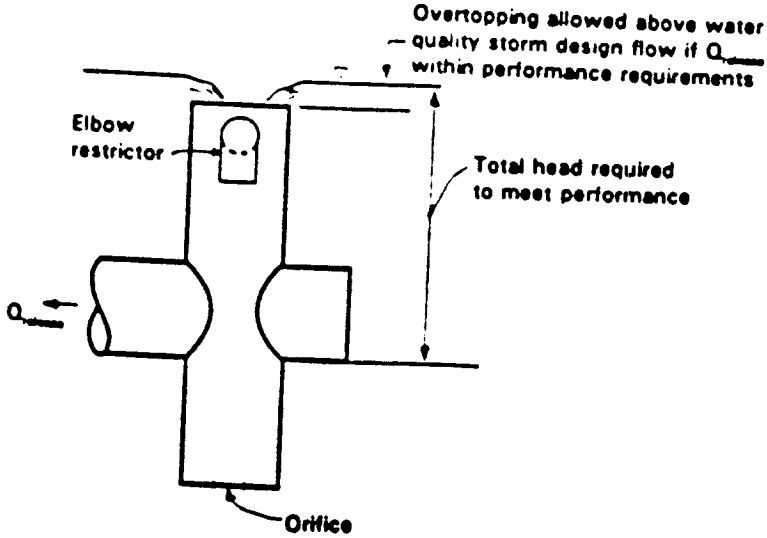
Figure III-2.36 Standard Control Structure Detail - Orifice Control



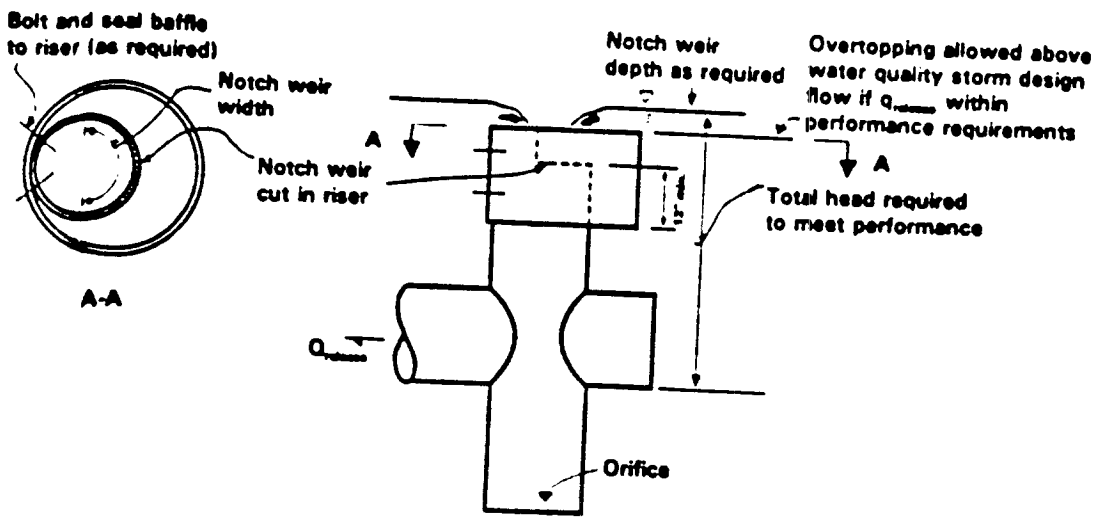


Figure III-2.37 Standard Control Structure Detail - Notch Control

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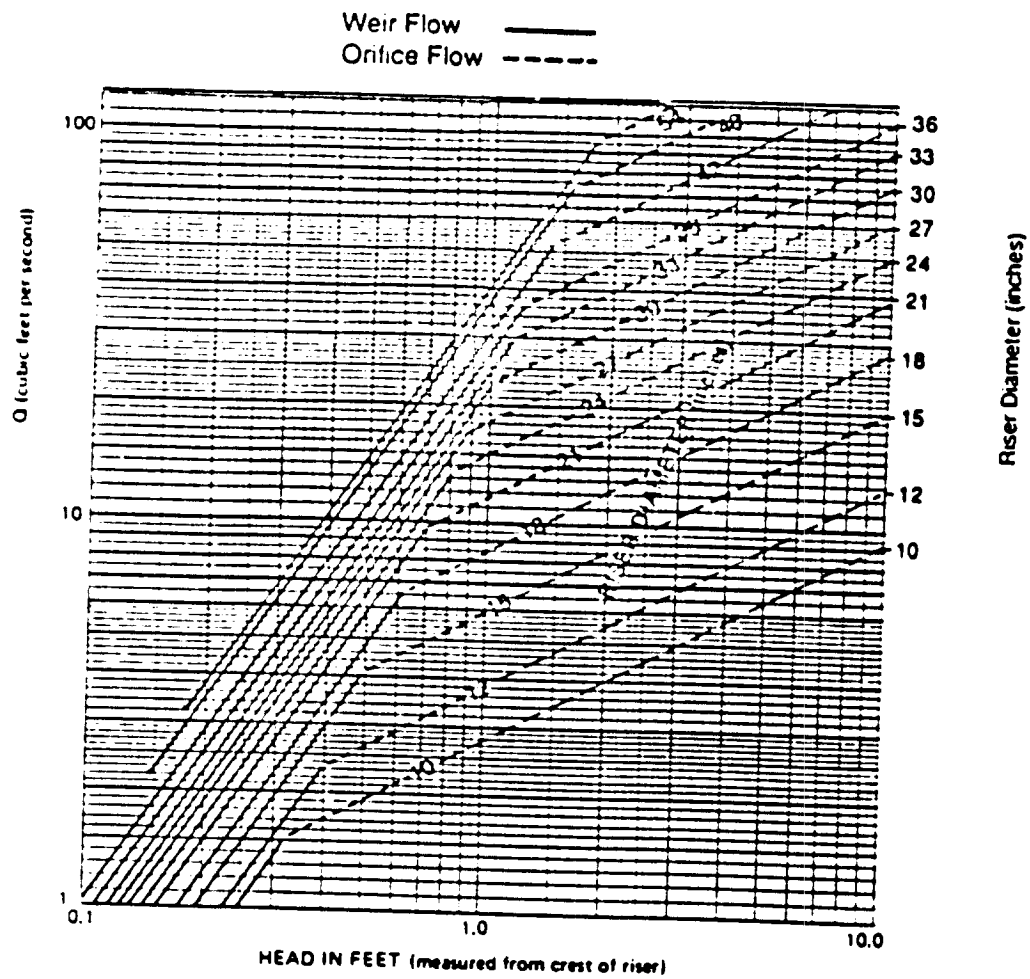
Figure III-2.38 Riser Inflow Curves



SOURCE: USDA-SCS

$Q_{WEIR} = 9.739\ DH^{3/2}$

$Q_{ORIFICE} = 3.782\ D^2H^{1/2}$

Q in cfs, D and H in feet

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Table III-2.10 Maintenance of Control Structures and Catchbasins

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
I. Control Structure/ Flow Restrictor - General	Trash & Debris (includes sediment)	Distance between debris buildup & bottom of orifice is < 1½ feet.	All trash & debris removed.
	Structural Damage	Structure is not securely attached to manhole wall & outlet pipe structure should support at least 1000# of up or down pressure.	Structure securely attached to wall & outlet pipe.
		Structure is not in upright position (up to 10° from plumb allowed)	Structure in correct position.
		Connections to outlet pipe are not watertight & show signs of rust.	Connections to outlet pipe are watertight, structure repaired or replaced and works as designed
		Any holes - other than designed holes - in structure	Structure has no holes other than designed holes.
Clean-out Gate	Damaged or missing	Clean-out gate is not watertight or is missing	Gate is watertight and works as designed.
		Gate cannot be moved up & down by one maintenance person.	Gate moves up and down easily and is watertight.
		Chain leading to gate is missing or damaged	Chain is in place & works as designed.
		Gate is rusted over 50% of its surface area	Gate is repaired or replaced to meet design standards.
	Obstructions	Trash, debris, sediment or vegetation blocking the plate.	Plate is free of all obstructions & works as designed
Overflow Pipe	Obstructions	Trash or debris is blocking or potentially blocking the overflow pipe.	Pipe is free of all obstructions & works as designed.
Manhole		See "Pipes/Tanks" standard, Section III-4.6.1	See "Pipes/Tanks" standard, Section III-4.6.1.
II. Catchbasins - General	Trash & Debris (includes sediment)	Trash & debris ≥ ½ ft.³ which is located immediately in front of the catchbasin opening or is blocking capacity by >10%.	No trash or debris immediately in front of the catchbasin opening.
		Trash or debris in the basin that exceeds ½ the depth from the bottom of basin to the invert of the lowest pipe.	No trash or debris in the catchbasin.
		Trash or debris in any inlet or pipe blocking more than ½ of its height.	Inlet & outlet pipes free of trash or debris.
		Dead animals or vegetation that could generate odors or dangerous gases (e.g. methane)	No dead animals or vegetation present within the catchbasin.

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Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Catchbasins - General, cont'd.		No conditions present which would attract or support the breeding of insects or rodents.	
	Structural Damage to Frame and/or Top Slab	Frame is even with curb.	
		Top slab is free of holes & cracks.	
		Frame is sitting flush on top slab.	
	Cracks in Basin Walls or Bottom	Basin repaired or replaced to design standards.	
		No cracks more than ¼ in. wide at the joint of inlet/outlet pipe.	
	Settlement/misalignment	Basin replaced or repaired to design standards.	
	Fire Hazard	No flammable chemicals present.	
	Vegetation	No vegetation blocking opening to basin.	
		No vegetation or root growth present.	
	Pollution	No pollution present other than surface film.	
	60°F Older than ¼ in. & longer than 1 ft. at the joint of any inlet or outlet pipe or any evidence of soil particles entering the catchbasin through cracks.		
	Basin has settled > 1 in. or has rotated > 2 in. out of alignment.		
	Presence of chemicals such as natural gas, oil and gasoline.		
	Vegetation growing across & blocking >10% of the basin opening.		

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CHAPTER III-3

INFILTRATION AND FILTRATION BEST MANAGEMENT PRACTICES

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CHAPTER III-3

INFILTRATION AND FILTRATION BEST MANAGEMENT PRACTICES

III-3.1 INTRODUCTION

III-3.1.1 Background

Infiltration and filtration are two stormwater management techniques which are becoming more widespread in use. *Infiltration* systems percolate runoff into the soil, where it can remove pollution and recharge ground water. *Filtration* systems use treatment media such as sand to treat pollutants. A filtration BMP will typically have an underdrain system that conveys treated runoff to a detention BMP or to the point of ultimate discharge.

Infiltration is the preferred stormwater management practice due to its ability to both effectively treat runoff and control streambank erosion. Benefits of infiltration include preservation of baseflow in streams, recharge of ground water, reduction of peak runoff flows which can cause flooding, and reduction/elimination of expensive stormwater conveyance systems.

Filtration BMPs typically provide runoff treatment but not streambank erosion control. In general, these BMPs are not as effective at removing pollutants as infiltration BMPs but this may change as research continues into the use of other filtration media, such as compost and peat.

Experience has shown that infiltration and filtration can be successfully utilized if adherence to proper design, construction, and maintenance standards is followed. Where operating problems with infiltration BMPs have occurred, the primary causes of failure have been:

- inadequate soil investigation, resulting in poorly designed systems (infiltration);
- improper construction practices, especially compaction of soil (both infiltration and filtration);
- siltation which clogs soils used for infiltration, especially due to construction-related erosion and sedimentation. All infiltration and filtration BMPs must be preceded by a pretreatment BMP to remove suspended solids (both infiltration and filtration).

The standards in this chapter are intended to prevent these problems from occurring. In addition to these standards, there may be local, state, and national regulatory requirements which must be met.

Infiltration BMPs are not practical in all cases. The feasibility of using infiltration depends not only on the nature of the soils but also on the need to protect ground water quality. The location and depth to bedrock, the water table, or impermeable layers (such as glacial till) can preclude the use of infiltration. In addition, the proximity of infiltration BMPs to wells, foundations, septic tank drainfields, unstable slopes, and other features can restrict its use. General limitations are described in Section III-3.3.

III-3.1.2 Purpose and Scope

The purpose of this chapter is to present general and specific criteria for the evaluation, design, construction, and maintenance of infiltration and filtration BMPs.

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Sections III-3.2 and III-3.3 should be read carefully before proceeding to other sections in this chapter. Section III-3.2 discusses the important differences between runoff treatment and streambank erosion control, as applied to infiltration and filtration BMPs. Section III-3.3 provides important planning information specifically for *infiltration* BMPs, including identifying conditions which may preclude the use of infiltration.

Criteria for the following BMPs is presented (note that infiltration BMPs are denoted as "RI" whereas filtration BMPs are denoted "RF"):

BMP RI.05	Water Quality Infiltration Basin
BMP RI.06	Streambank Erosion Control Infiltration Basin
BMP RI.10	Water Quality Infiltration Trench
BMP RI.11	Streambank Erosion Control Infiltration Trench
BMP RI.15	Roof Downspout System
BMP RI.20	Water Quality Porous Pavement
BMP RI.21	Streambank Erosion Control Porous Pavement
BMP RI.30	Water Quality Concrete Grid and Modular Pavement
BMP RI.31	Streambank Erosion Control Concrete Grid and Modular Pavement
BMP RF.05	Sand Filtration Basin
BMP RF.10	Sand Filtration Trench
BMP RF.15E	Aquatard System (Experimental)

Experimental BMPs, such as an aquatard system, are encouraged, subject to the conditions described in Chapter I-2.

III-3.2 RUNOFF TREATMENT AND STREAMBANK EROSION CONTROL

Minimum Requirements #4 and #5 require development sites to provide runoff treatment and control streambank erosion, respectively (see Chapter I-2). The runoff treatment (water quality) design storm is the 6-month, 24-hour event. The streambank erosion control standard is to limit peak flows discharged from the *developed* site to 50 percent of the *existing* condition 2-year, 24-hour event and maintain the *existing* condition peak flow rates for the 10-year and 100-year, 24-hour design storms, with appropriate correction factors (see Chapter III-1 for further details).

A clear distinction is made between infiltration BMPs used for runoff treatment in contrast to those used for streambank erosion control. For runoff treatment to be provided soils must contain sufficient organic matter to accomplish pollutant removal. Coarser soils cannot be used for runoff treatment as they lack clay minerals or an oxide coating and will be less efficient at adsorbing heavy metal and phosphate ions. Excessively drained soils should be used, however, for streambank erosion control, provided that stormwater is treated *prior* to discharge to these soils. There may be some instances when a soil can be used for both runoff treatment and streambank erosion control. A more likely scenario is that the infiltration BMP used for runoff treatment will be located "off-line" from the main conveyance system and that the infiltration BMP with coarser soils will be located "on-line" to provide streambank erosion control.

Filtration BMPs, unlike some infiltration BMPs, should not be used for streambank erosion control; their primary function will be to treat runoff. These BMPs should be placed "off-line" as experience has shown that when filtration BMPs are installed "on-line" they are more prone to failure due to siltation, resuspension of trapped particles, and displacement of treatment media by erosive flows.

Infiltration BMPs used for runoff treatment will be labeled as "Water Quality" BMPs while those used only for streambank erosion control (SBEC) will be so labeled.

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Runoff treatment is accomplished by infiltration BMPs by utilizing the ability of soils and vegetative root systems to bind, decompose, and/or trap pollutants contained in stormwater runoff. Soils must have an adequate infiltration rate, contain sufficient organic material, and maintain aerobic conditions in order to provide optimum treatment of runoff.

In filtration BMPs using sand media, pollutants are removed primarily by physical means. These BMPs have limited ability to provide biological treatment.

Streambank erosion can be controlled most effectively by infiltration, in some cases maintaining pre-development hydrologic conditions. The ability of soil to meet this requirement depends primarily on soil permeability (infiltration rate) and subsurface conditions.

In cases where infiltration is feasible but cannot *fully* meet the runoff treatment and streambank erosion control standards, it should still be utilized to the fullest extent possible, in conjunction with other BMPs. Note, however, that soils suitable for runoff treatment will likely drain too slowly to be used for controlling streambank erosion. Likewise, soils suitable for controlling streambank erosion will be too coarse to adequately treat runoff.

Filtration BMPs should not be used for streambank erosion control.

III-3.3 FEASIBILITY ANALYSIS AND GENERAL LIMITATIONS FOR INFILTRATION BMPs

III-3.3.1 Overview

This section provides the basis for an assessment of the maximum amount of on-site infiltration that is practically achievable for each hydrologic soil group. In addition, it provides guidance in determining important design variables.

The most desirable situation, of course, is to mimic the natural situation by infiltrating an amount of runoff in the developed state such that the amount of runoff occurring in the pre-developed state is maintained. In practice this becomes difficult to achieve when there are large increases in impervious surface.

For a site to be suitable it must meet or exceed all of the specific criteria listed under GL-1 through 6. Should a site investigation reveal that any one of the General Limitations cannot be met, the implementation of the infiltration practice should not be pursued.

III-3.3.2 General Limitations

The General Limitations (GL's) are governed by the physical suitability of the site and the need to prevent pollution of ground water. They include:

- GL-1 Soil Suitability
- GL-2 Depth to Bedrock, Water Table, or Impermeable Layer, or Dissimilar soil layer
- GL-3 Proximity to Drinking Water Wells, Septic Tanks, Drainfields, Building Foundations, Structures, Native Growth Protection Easements, and Property Lines
- GL-4 Land Slope
- GL-5 Drainage Area
- GL-6 Control of Siltation

GL-1 Soil Suitability

The suitability of soil for infiltration is to be based on evaluating the following:

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(a) For runoff treatment, the soil infiltration rate, (f), shall be between 0.5 and 2.4 inches per hour;

(b) For streambank erosion control there is no limitation on soil infiltration rate but a minimum rate of 0.5 inches per hour is recommended;

(c) Runoff must infiltrate through at least 18 inches of soil which has a minimum cation exchange capacity (CEC) of 5 milliequivalents per 100 grams of dry soil.

(d) Soils with 30 percent or greater clay content or 40 percent or greater silt/clay content shall not be used;

(e) Infiltration systems shall not utilize fill material nor be placed over fill soils;

(f) Any stone subgrade installed as part of an infiltration structure must extend below the frost line.

(g) Aerobic conditions are to be maintained to the fullest extent possible for runoff treatment BMPs by designing them to drain the water quality design storm in 24 hours or less. *(Note: If a Water Quality Infiltration Basin or Trench (BMP RI.05 or RI.06, respectively) is preceded by a Presettling Basin (BMP RD.10) then the combination of both BMPs (i.e., the Presettling Basin and the Infiltration BMP) must be designed to drain the 6-month, 24-hour design storm within 24 hours. This is necessary to ensure that aerobic conditions are maintained in the infiltration BMP.)*

In addition, it is recommended that a more detailed soils investigation be conducted if potential impacts to ground water are a concern, or if the applicant is proposing to infiltrate in areas underlain by till or other impermeable layers. No formal procedures have been adopted for use in this manual. For further investigations, consultation with soils and ground water specialists is recommended. One document which may be of use is the Soil Conservation Service's "Washington State Water Quality Guide," available (in limited supply) from the SCS office in Spokane, Washington (W. 316 Boone Avenue, Spokane, WA 99201-2348).

GL-2 Depth to Bedrock, Water Table, or Impermeable Layer

The base of all facilities shall be located at least three feet above the seasonal high water mark, bedrock (or hardpan), and/or impermeable layer. A high water table can indicate the potential for ground water contamination. Also, infiltration may be inhibited by the water table; this could result in the BMP not functioning as designed.

GL-3 Proximity to Drinking Water Wells, Septic Tanks, Drainfields, Building Foundations, Structures, Native Growth Protection Easements (NGPE), and Property Lines

The proximity of infiltration facilities to other structures and facilities must be taken into account. Otherwise the potential exists to contaminate ground water, disrupt the proper functioning of septic tank systems, damage foundations and other property. The site designer/engineer must conduct an investigation to determine the most appropriate locations of infiltration facilities; this is best done on a case-by-case basis but the following basic criteria is provided for information purposes:

- Infiltration facilities on commercial and industrial sites should be placed no closer than 100 feet from drinking water wells, septic tanks

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or drainfields, and springs used for public drinking water supplies.

- Infiltration facilities should be situated at least 20 feet downslope and 100 feet upslope from building foundations. Infiltration facilities should be situated at least 20 feet from a NGPE. An exception is roof downspout systems which should be located a minimum of 10 feet from any structure, property line or NGPE, and 30 feet from a water supply well, septic tank or drainfield.

GL-4 Land Slope

Slope restrictions depend on the BMP selected. Application of infiltration practices on a steep grade increases the chance of water seepage from the subgrade to the lower areas of the site and reduces the amount of water which actually infiltrates.

Infiltration facilities can be located on slopes up to 15 percent as long as the slope of the base of the facility is less than 3 percent. All basins should be a minimum of 50 feet from any slope greater than 15 percent.

GL-5 Drainage Area

Infiltration BMPs are limited in their ability to accept flows from larger drainage areas. The following drainage area limitations will be applied:

- Infiltration basins - maximum of 50 acres
- Infiltration trenches - maximum of 15 acres
- Porous pavement - maximum of 15 acres
- Concrete grid/modular pavement - maximum of 15 acres
- Roof downspout system - maximum of 5000 square feet

GL-6 Control of Siltation

Surveys show that siltation is one of the major reasons for failure of infiltration facilities. This often occurs during construction, thus it is most important not to excavate trenches or ponds to final grade during this phase. Even after construction it is vital to prevent as much sediment as possible from entering by first routing the water through a pretreatment BMP. Also there may be other construction activities upstream that take place and could result in surges of sediment entering the site.

The following conditions also apply:

(a) Final construction of infiltration facilities shall not be done until after other site construction has finished and the site has been properly stabilized with permanent erosion control practices as outlined in Volume II, Erosion and Sediment Control.

(b) Infiltration facilities are not recommended for use as temporary sediment traps during the construction phase. Infiltration facilities should be constructed only after upstream drainage areas have been stabilized. If an infiltration BMP is to be used as a sediment trap it must not be excavated to final grade until after the upstream drainage area has been stabilized. Any accumulation of silt in the basin must be removed before putting it in service.

(c) Inflow to infiltration BMPs used for runoff treatment, other than roof downspout systems, must first pass through a pretreatment BMP in order to minimize the suspended solid load and prevent siltation of the infiltration facility.

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III-3.3.3 Feasibility Analysis Discussion

Collection and analysis of soils, geologic, and hydrologic information are a critical component of the planning and design process for infiltration BMPs. A subsurface investigation must be conducted under the supervision of an engineer or scientist of appropriate qualifications. The investigation shall involve both a review of the available literature from the U.S. Soil Conservation Service and any other relevant sources and a field investigation as part of the overall geotechnical site investigation.

A soils report is required for each location. A soil log should be taken at a minimum 3 foot depth below the proposed base of the facility and an additional soil log shall be taken for every 5,000 square feet of infiltrating surface area.

To effectively design an infiltration structure, the following information is required:

(a) Textural character of the soil horizons and/or strata units within the subsoil profile. Based on this textural analysis the following variables are to be determined:

(i) soil infiltration rate, "f"
(ii) soil cation exchange capacity (or CEC),
(iii) percent clay content in soil

(b) Location of the seasonal high ground water table, depth to bedrock or impermeable layer, and/or depth to dissimilar soil layers (duplex soils).

The first step in determining the site capabilities should be to conduct an on-site investigation, in conjunction with consulting the available soil survey data. Soil Surveys are available for all counties in Washington and may be obtained from the Soil Conservation Service of the local Soil Conservation District. Due to glaciation, soil types may vary dramatically within a small area. An on-site investigation is always necessary because local conditions may be different than what published soil survey data indicates.

For larger land developments, soil information has traditionally been collected during the geotechnical site investigation in order to determine foundation conditions for structures and to design earth structures such as fills and cuts. The standard method of conducting subsurface investigations is to drill holes and collect a 1-⅜ inch diameter soil sample, 1.5 feet long at 3 to 5 foot intervals in the boring using a split-spoon sampler. Solid augers are also used to collect large samples for compaction testing but do not provide an accurate picture of the soil profile.

The soil final infiltration rate and cation exchange capacity are obtained by identifying the soil textures by a gradation test for each of the changes in soil profile. The soil textures presented in Table III-3.1 correspond to the soil textures of the U.S. Dept. of Agriculture (USDA) Textural Triangle presented in Figure III-3.1. (Note: much work remains in order to determine the cation exchange capacity of soils; the information provided in this manual is preliminary and will be revised as more information becomes available).

The data presented in Table III-3.1 are based on the analysis of over 5,000 soil samples under carefully controlled procedures by the USDA. The cation exchange capacity values are preliminary at this time. The use of the soil properties established in the table for design and review procedures will offer two advantages. First, it will provide for consistency of results in the design procedures, and

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second, it will eliminate the need for the laborious and costly process of conducting field and laboratory infiltration and permeability tests.

For runoff treatment, the most suitable soils will generally be in Hydrologic Group B (see Table III-3.2 for a list of Puget Sound soils by this grouping); Group A soils are excessively well-drained and create a potential ground water pollution problem. Some Group C soils may also be suitable for runoff treatment, such as the Alderwood series which have porous A & B horizons. However, Group C soils may not be suitable if they overlay a virtually impervious glacial till (hardpan) at 2-4 feet. The upper horizons may meet the criterion, but the till would not. The special case of till soils is discussed further under GL-2. If the soil borings reveal that the soil is layered, then this must be taken into account when sizing the BMP (sizing procedure is described in Section III-3.4).

For streambank erosion control the most suitable soils will generally be in Hydrologic Group A, though it is possible some Group B soils could also be used.

An example of a typical subsurface exploration program for basin design and for trench design is shown in Figures III-3.2 and III-3.3, respectively. The finished grade for the basin example in Figure III-3.2 and the trench example in Figure III-3.3 are less than four feet above the static water table in a sand and gravel unit.

The location of the seasonal high ground water table can be determined by field observation of static water elevation in borings, changes in soil moisture content, and changes in soil color (mottling, for example). It should be noted that the ground water table elevation fluctuates not only on a seasonal basis but also on an annual basis in response to prolonged periods of wet and dry precipitation cycles. Thus, the field work should be supplemented with consultation of the local government's health and public works departments to benefit from their long-term experience with local ground water conditions.

Ground water occurs under two types of conditions, water table and artesian. Water table conditions exist where the water-bearing materials that make up the ground water reservoir are not overlain by impervious strata and water from precipitation may directly enter the reservoir by downward percolation. The upper surface of the saturated zone, which is under atmospheric pressure is called the water table or ground water table. Its position is marked by the static water level in wells or borings. Figure III-3.4 presents a schematic cross-section showing the general pattern of flow under water table conditions. In nearly all cases, these conditions will prevail over artesian conditions in influencing the design of infiltration practices.

Artesian conditions are formed where the water that moves along the waterbearing bed passes beneath relatively impervious stratum and is confined under pressure other than atmospheric. If an artesian reservoir is penetrated by a well, the water level in the artesian well will rise above the elevation of the confining stratum. The water is artesian whether or not it rises to or above the land surface. The imaginary surface coinciding with the level to which the water rises in a well penetrating an artesian reservoir is called the piezometric surface. A typical artesian situation is depicted in Figure III-3.5.

The specific details of appropriate subsurface exploration techniques can be found in references number 1 through 12.

Developments which occur on sloping and rolling sites may use extensive cut and fill operations. The use of infiltration systems on fill material is not permitted because of the possibility of creating an unstable subgrade. Fill areas can be very susceptible to slope failure due to slippage along the interface of the in-situ and fill material. This condition could be aggravated if the fill material is allowed to become saturated by using infiltration practices.

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Table III-3.1 Soil Properties Classified by Soil Texture

Texture Class	Infiltration Rate Hydrologic (inches/hr.)	Cation Exchange Capacity (milliequivalents/ 100 grams)	Effective Water Capacity (inches per inch)	Hydrologic Soil Group
Coarse Sands or Cobbles	20.00	<5.0	---	A
Sand	8.27	<5.0	0.35	A
Loamy Sand	2.41	5.0	0.31	A
Sandy Loam	1.02	>5.0	0.25	B
Loam	0.52	>5.0	0.19	B
Silt Loam	0.27	>5.0	0.17	C
Sandy Clay Loam	0.17	>5.0	0.14	C
Clay Loam	0.09	>5.0	0.14	D
Silty Clay Loam	0.06	>5.0	0.11	D
Sandy Clay	0.05	>5.0	0.08	D
Silty Clay	0.04	>5.0	0.09	D
Clay	0.02	>5.0	0.08	D

Source (except for cation exchange capacity): Rawls, Brakensiek, and Saxton, 1982 (16)

Cation exchange capacity values are estimated from Buckman and Brady, 1969. (23)

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Figure III-3.1 U.S.D.A. Textural Triangle

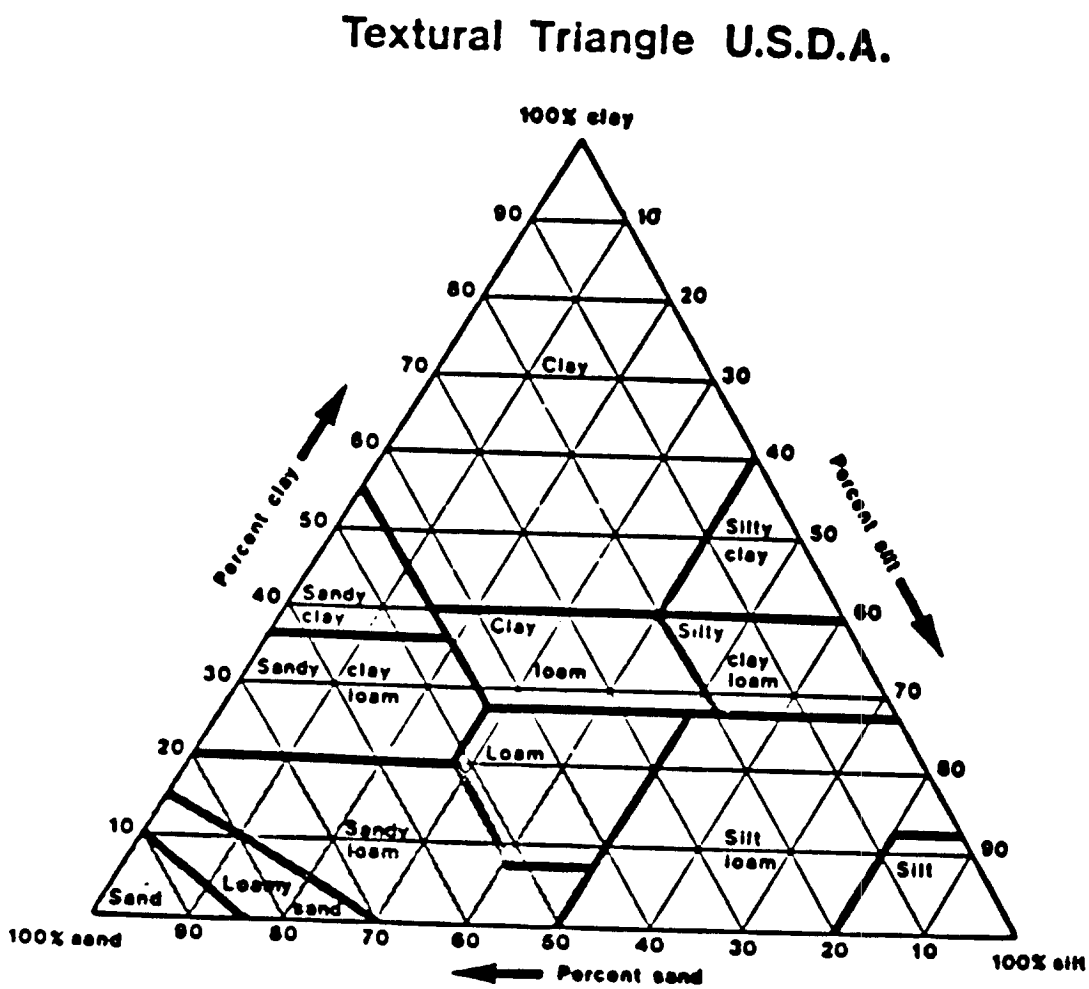

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Table III-3.2
Hydrologic Soil Groups for Soils in the Puget Sound Basin

Soil Type	Hydrologic Soil Group	Soil Type	Hydrologic Soil Group
Agnew	C	Colter	C
Ahl	B	Custer	ND
Aits	C	Dabob	ND
Alderwood	C	Delphi	D
Arents, Alderwood	B	Dick	ND
Arents, Everett	B	Dimal	D
Ashoe	B	Dupont	D
Baldhill	B	Earlmont	C
Barneston	C	Edgewick	C
Baumgard	B	Eld	B
Beausite	B	Elwell	B
Belfast	C	Esquatzel	B
Bellingham	D	Everett	A
Bellingham variant	C	Everson	D
Boistfort	B	Galvin	D
Bow	D	Getchell	A
Briscot	D	Giles	B
Buckley	C	Godfrey	D
Bunker	B	Greenwater	A
Cagey	C	Grove	C
Carlsborg	ND	Harstine	C
Casey	ND	Hartnit	ND
Cassolary	C	Hoh	ND
Cathcart	B	Hoko	ND
Centralia	B	Hoodsport	ND
Chehalis	B	Hoogdal	C
Chesaw	A	Hoypus	ND
Cinebar	B	Huel	ND
Clallam	C	Indianola	ND
Clayton	B	Jonas	B
Coastal beaches	variable	Jumps	ND
Kapowsin	C/D	Kalaloch	C
Katula	C	Renton	D
Kilchis	C	Republic	B
Kitsap	C	Riverwash	variable
Klaus	ND	Rober	C
Klone	ND	Salal	C
Lates	C	Salkum	B
Lebam	B	Sammamish	D
Lummi	ND	San Juan	ND
Lynnwood	ND	Scamman	D
Lystair	ND	Schneider	B
Mal	C	Seattle	D
Manley	B	Sekiu	ND
Mashel	B	Semiahmoo	D
Maytown	C	Shalcar	D
McKenna	D	Shano	B
McMurray	ND	Shelton	C
Melbourne	B	Si	C
Menzel	ND	Sinclair	C
Mixed Alluvial	variable	Skipope	D
Molson	[illegible]	Skykomish	B
Mukilteo	C/D	Snahopish	ND
Naff	B	Snohomish	D
Narger	[illegible]	Solduc	B
National	ND	[illegible]lleks	ND
Neilton	A	[illegible]ana	D

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Table III-3.2
Hydrologic Soil Groups for Soils in the Puget Sound Basin

Soil Type	Hydrologic Soil Group	Soil Type	Hydrologic Soil Group
Newberg	B	Spanaway	A/B
Nisqually	B	Springdale	B
Nooksack	C	Sulmar	B
Norma	C/D	Sultan	C
Ogarty	C	Sultan variant	B
Olete	ND	Sumas	C
Olomount	C	Swantown	ND
Olympic	B	Tacoma	D
Orcas	D	Tanwax	ND
Ordal	D	Tealwhit	ND
Orting	ND	Tenino	C
Oso	C	Tisch	D
Ovall	C	Tokul	ND
Pamik	C	Townsend	C
Phoenay	C	Triton	ND
Pilchuck	ND	Tukwila	D
Potchub	C	Tukey	ND
Poulsbo	C	Urban	variable
Prather	C	Vashon	B
Puget	D	Verlot	C
Puyallup	B	Wapato	ND
Queets	ND	Warden	B
Quilcene	ND	Whidbey	ND
Ragnar	B	Wilkeson	B
Rainier	C	Winston	A
Raught	B	Woodinville	B
Reed	ND	Yelm	C
		Zynbar	B

Hydrologic Soil Group Classifications

A. (Low runoff potential). Soils having high infiltration rates, even when thoroughly wetted, and consisting chiefly of deep, well-to-excessively drained sands or gravels. These soils have a high rate of water transmission.

B. (Moderately low runoff potential). Soils having moderate infiltration rates when thoroughly wetted, and consisting chiefly of moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

C. (Moderately high runoff potential). Soils having slow infiltration rates when thoroughly wetted, and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine textures. These soils have a slow rate of water transmission.

D. (High runoff potential). Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a hardpan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

ND Data not currently available for this soil type.

*From SCS, TR-55, Second Edition, June 1986, Exhibit A-1. Revisions made from SCS, Soil Interpretation Record, Form #5, September 1988 and various county soil surveys.

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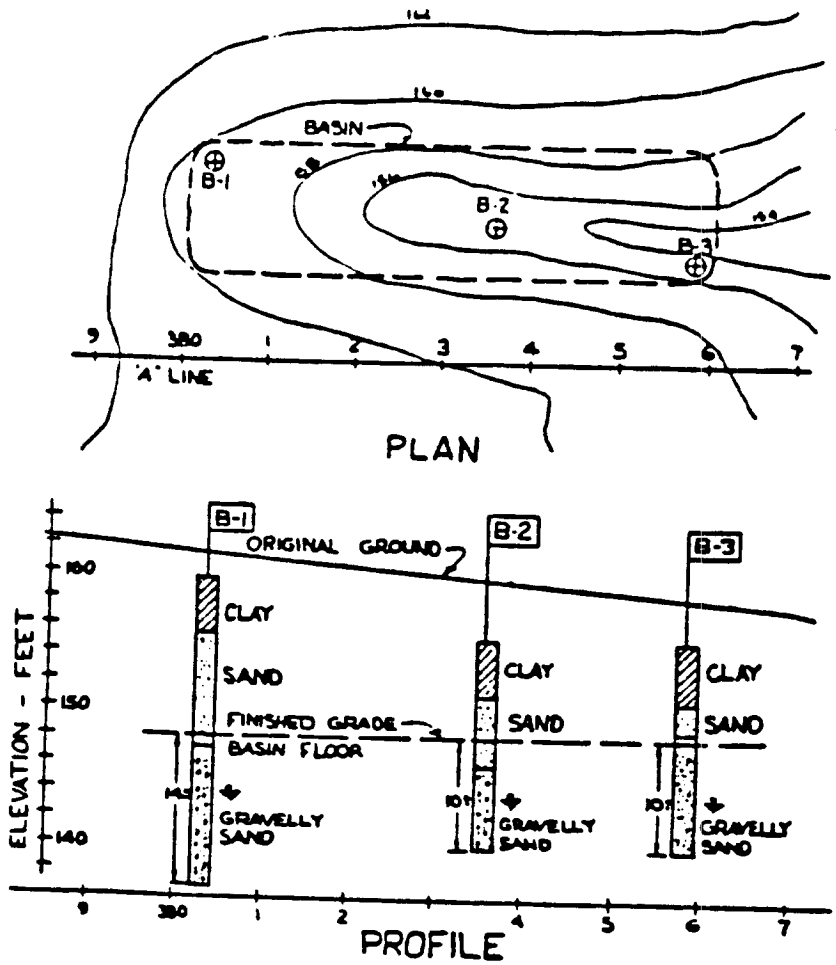
Figure III-3.2 Typical Exploration Program for Design of Infiltration Basins [1]



[1] Source: Hannon, 1980 (13)

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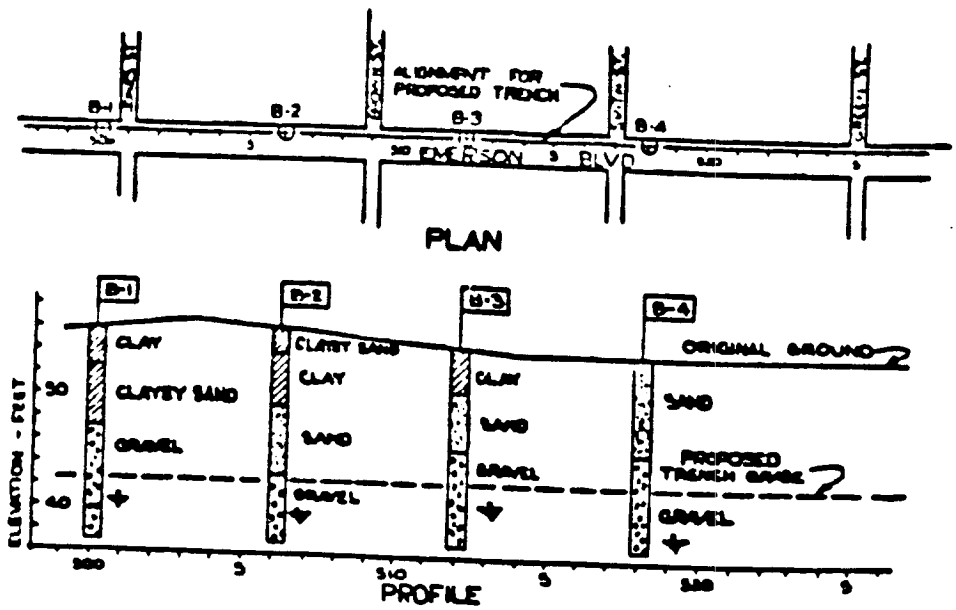
Figure III-3.3 Typical Exploration Program for Design of Infiltration Trenches [2]



[2] Source: Hannon, 1980 (13)

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Figure III-3.4 General Flow Pattern Under Water Table Conditions

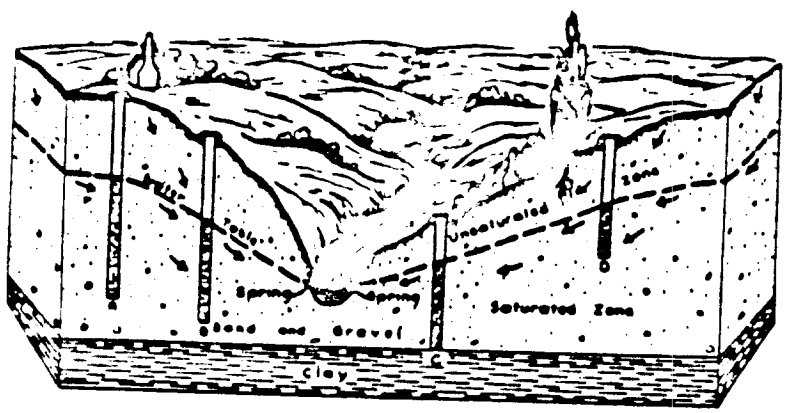

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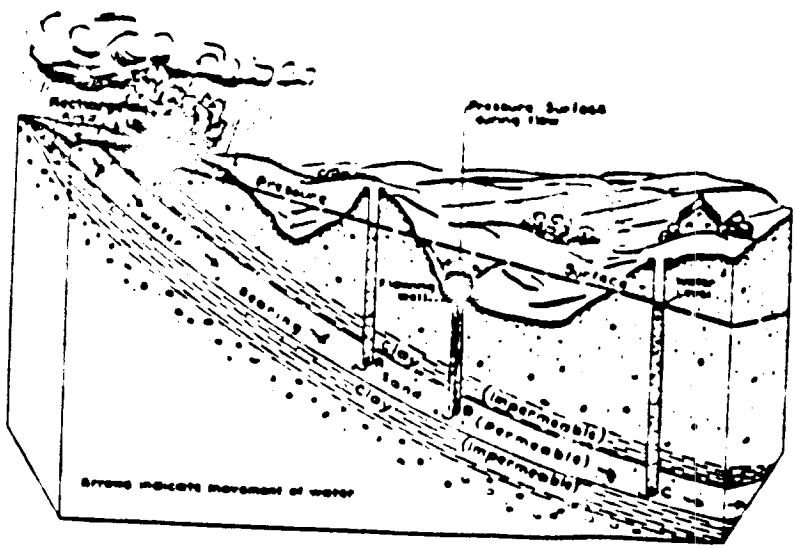
Figure III-3.5 Artesian System



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In summary, the following procedure may be used for investigating the feasibility of using infiltration BMPs:

Preliminary Screening - Investigate soil characteristics and General Limitations based on published soil surveys, local studies, and field investigations of site. If the soil infiltration rate is less than 0.5 inches per hour, the site is not feasible for infiltration. If the soil infiltration rate is greater than 2.4 inches per hour it may be acceptable for streambank erosion control purposes but not runoff treatment.

Soil Borings - Soil borings will be required for two purposes:

(1) Collect soil samples so that a textural analysis can be conducted. The textural analysis is to be used to determine the following variables:

- infiltration rate, f
- cation exchange capacity, CEC
- percent clay content

Soils identified by the textural analysis as Hydrologic Soil Group B are the most appropriate ones for providing *runoff treatment*; those which are Hydrologic Soil Group A are most appropriate for providing *streambank erosion control*.

If this analysis indicates that any of the conditions in General Limitation #1 are violated, then infiltration should not be pursued.

(2) Determine location and depth to the seasonal high water table, bedrock, impermeable layer, and/or dissimilar soil layers.

If this analysis indicates that any of the conditions in General Limitation #2 are violated, then infiltration should not be pursued.

At this point, the feasibility of infiltration should be clearly established. If feasible, the applicant may proceed to size and design the BMP as described in Sections III-3.4, III-3.6, and III-3.7 subject to meeting all other General Limitations.

III-3.4 GENERAL DESIGN CRITERIA FOR INFILTRATION AND FILTRATION BMPs

A Darcy's Law approach is recommended for sizing both infiltration and filtration BMPs. Stage-storage and stage-discharge relationships can be developed and, through an iterative process, the final BMP size and geometry can then be determined by routing the appropriate design storm(s) through the facility. See Section III-1.4.3 for guidance on developing storage-discharge relationships.

Darcy's Law of ground water movement can be used to develop the stage-discharge relationship (Figure III-3.6 illustrates Darcy's Law):

$$Q = f * i * A_s, \text{ where}$$

Q = flowrate at which runoff is infiltrated/filtrated by BMP
f = infiltration rate of soil or filtration media
i = hydraulic gradient
A_s = Surface area of the infiltration or filtration BMP

Conservative values of "f" should be used. For infiltration BMPs, a factor of safety of two should be applied to the infiltration rate determined from the textural analysis and, hereafter, the design infiltration rate will be labeled "f_d" where $f_d = 0.5 * f$. For sand filtration BMPs an "f" value of about 2 inches per

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hour is recommended for design purposes. This appears to be a low value but reflects actual rates achieved by operating sand filtration systems treating urban runoff.

NOTE: A_s is not the cross-sectional area of the BMP, e.g., for a trench with length L_t, width W, and depth D, the bottom area of the trench is $A_s = L_t * W$ while the cross-sectional area is W * D. The surface area A_s is determined from the basin geometry; it may be necessary to planimeter or otherwise compute the area (see Section III-1.4.4 for an example).

The hydraulic gradient is given by the equation:

$$i = \frac{h + L}{L}$$

where h is the height of the water column over the infiltration/filtration media and L is the distance from the top surface of the BMP to the water table, bedrock, impermeable layer, or soil layer of different infiltration rate (for latter applied to sand filtration BMPs it is the bottom of the filtration bed = 18").

If the approximate area available for the BMP is known then a preliminary stage-discharge relationship can be developed, i.e.,

$$Q = f_d * \frac{h + L}{L} * A_s$$

If the approximate depth available for the BMP is known then a stage-storage relationship can also be developed (see Section III-1.4). A minimum of one foot of freeboard is recommended when establishing the BMP depth.

The appropriate design storms can then be routed through the BMP using a level pool analysis (Section III-1.4.4) to finalize the BMP size and geometry. This will be an iterative process. The analysis must demonstrate that the BMP will completely percolate the design storm within 24 hours (or 48 hours for the 100-year event). If this is not the case the surface area and or depth of the BMP will have to be increased. If the analysis indicates that the design storms can only be partially infiltrated the BMP should still be utilized but the additional runoff must be conveyed to another BMP for runoff treatment and/or streambank erosion control. *(Note: If a Water Quality Infiltration Basin or Trench (BMP RI.05 or RI.06, respectively) is preceded by a Presettling Basin (BMP RD.10) then the <u>combination</u> of both BMPs (i.e., the Presettling Basin <u>and</u> the Infiltration BMP) must be designed to drain the 6-month, 24-hour design storm within 24 hours. This is necessary to ensure that aerobic conditions are maintained in the infiltration BMP.)*

<u>Preliminary Sizing Example</u>

An infiltration trench is proposed to treat the 6-month, 24-hour design storm for a development site. Soils investigations indicate that a sandy loam soil (f = 1.5 in/hr) extends for at least 5 feet below the land surface. A BMP depth of about 3 feet is proposed. The surface area available for the BMP is approximately 100 square feet. The depth to the water table is estimated to be 75 feet. No impermeable soil layers were detected within 10 feet of the surface and none expected within at least 50 feet. For preliminary design purposes the trench is planned to be 30 feet long, 3 feet wide, and 2 feet deep. It will be filled with rocks such that the void ratio is 0.4. The following preliminary design is developed:

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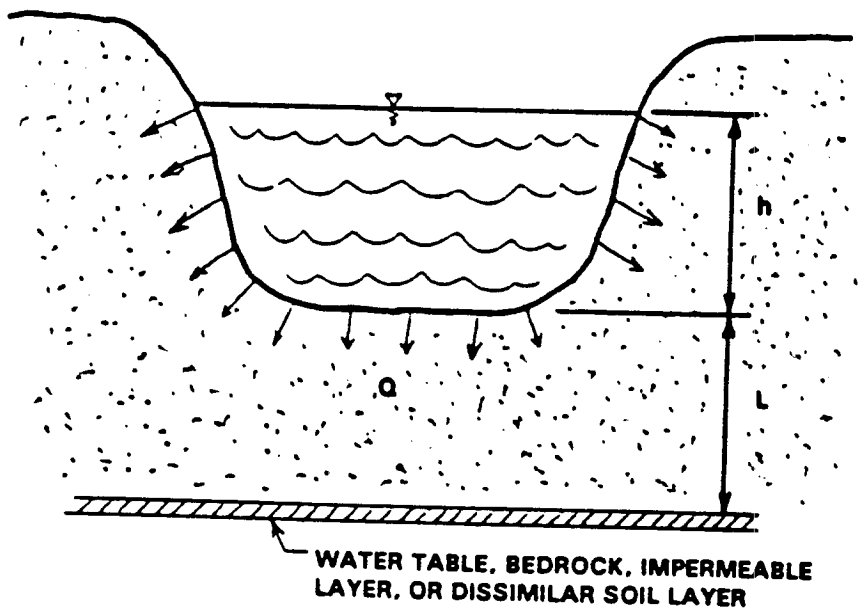
Figure III-3.6
Darcy's Law of Ground water Movement



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Stage-discharge Relationship

f = 1.5 inches/hour, thus f_d = 0.5 * 1.5 = 0.75 inches/hour
= 0.0625 ft/hr

h = variable - maximum of 2 feet

L = assume 10 feet

A_s = bottom surface area = 30 * 3 = 90 sq. ft.

Solving for Q in Darcy's equation gives:

$$Q = f_d * \frac{h + L}{L} * A_s = 0.0625 * \frac{h + 10}{10} * 90 \quad \text{or,}$$

$$Q = (1.25 * h) + 12.5$$

Stage-storage Relationship

The stage-storage relationship would be:

S = A_s * h * Void Ratio

= 90 * h * 0.4, or

S = 36 * h

Results of Preliminary Sizing

The tabular form of the stage-discharge and stage-discharge relationships would be:

h (ft)	i (ft/ft)	Q (cfs)	S (cu.ft.)
0.0	1.0	5.6	0
0.5	1.05	5.9	18
1.0	1.1	6.2	36
1.5	1.15	6.5	54
2.0	1.2	6.8	72

Note that for design purposes it may be simpler to set the hydraulic gradient, i, equal to 1 thus making the discharge independent of stage.

At this point a level pool routing should be conducted to develop the final design dimensions of the BMP, ensuring, however, that the BMP will completely infiltrate the design storm(s) within 24 hours.

III-3.5 CONSTRUCTION AND MAINTENANCE

III-3.5.1 Overview

The failure of infiltration and filtration BMPs to function properly can often be traced back to construction and maintenance issues. By utilizing appropriate construction practices and conducting systematic and rigorous maintenance, infiltration/filtration BMPs should function properly.

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III-3.5.2 Construction

Regardless of the type of infiltration/filtration practice to be constructed, careful consideration must be given in advance of construction to the effects of the work sequence, techniques, and the equipment employed during construction of the facility. Serious maintenance problems can be averted, or in large part mitigated, by the adoption of relatively simple measures during construction.

Previous experience with infiltration and filtration practices in the States of Maryland and Texas has shown that these BMPs must not be put into use, or preferably even constructed, until the drainage areas that contribute runoff to the structure have been adequately stabilized. When this precaution is not taken, infiltration/filtration structures often become clogged with sediment from upland construction and thus fail to operate properly from the outset. It cannot be emphasized enough how important it is to protect these facilities from sediment deposition at all times.

Care must also be taken to not compact soils during the construction phase as this can seriously affect infiltration and filtration rates. If vehicles must be driven over the infiltration/filtration BMP during construction only those with large tracks shall be used.

Specific construction methods and specifications are provided for each infiltration and filtration BMP in Sections III-3.6 and III-3.7

III-3.5.3 Maintenance

The maintenance requirements of infiltration and filtration BMPs are an important aspect which is often not addressed in the planning and design of these structures. Infiltration and filtration basins can be visually inspected and easily maintained. The surface of an infiltration/filtration trench or roof downspout system can also be visually inspected and maintained, but the subsurface storage area cannot. It is therefore a requirement to install an observation well in practices such as these in order to have an observation mechanism available.

Infiltration and filtration practices must be regularly inspected. Specific maintenance specifications and recommendations are provided for each infiltration and filtration BMP in Sections III-3.6 and III-3.7.

III-3.6 STANDARDS AND SPECIFICATIONS FOR INFILTRATION BMPs

III-3.6.1 Overview

This section presents detailed standards and specifications for the following infiltration best management practices:

BMP RI.05 Water Quality (WQ) Infiltration Basin
BMP RI.06 Streambank Erosion Control (SBEC) Infiltration Basin
BMP RI.10 Water Quality (WQ) Infiltration Trench
BMP RI.11 Streambank Erosion Control Infiltration Trench
BMP RI.15 Roof Downspout System
BMP RI.20 Water Quality (WQ) Porous Pavement
BMP RI.21 Streambank Erosion Control (SBEC) Porous Pavement
BMP RI.30 Water Quality (WQ) Concrete Grid and Modular Pavement
BMP RI.31 Streambank Erosion Control (SBEC) Concrete Grid and Modular Pavement

The standards and specifications for each of the above BMPs contains, where appropriate, information on the following topics:

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- Purpose and Definition
- Planning Considerations
- Design Criteria
- Construction and Maintenance Criteria

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III-3.6.2 BMP RI.05 Water Quality (WQ) Infiltration Basin

Purpose and Definition

This BMP is a vegetated open impoundment which is designed primarily for runoff treatment purposes and not streambank erosion control. Runoff conveyed to the basin is infiltrated into the underlying soil, where pollutant removal by the soil and vegetative root system takes place. The underlying soil will likely have insufficient permeability to be used for streambank erosion control. Infiltration basins are made by constructing a dam or an embankment, or by excavating a pit or a dugout.

Figure III-3.7 illustrates an infiltration basin.

Planning Considerations

Appropriate soil conditions and the protection of ground water are among the important considerations which may limit the use of the BMP. See Section III-3.3 for a description of General Limitations.

This BMP will typically be located off-line from the primary conveyance/detention system because streambank erosion control is generally not provided. Water Quality Infiltration BMPs must always be preceded by a pretreatment BMP to remove suspended solids that could clog the infiltration soils.

Drainage areas can be up to 50 acres for Water Quality Infiltration Basins. Basin depths are generally from 3 - 12 feet.

Design Criteria

The design procedure described in Section III-3.4 should be used to design an infiltration basin.

- General - The construction of structures, materials allowed, accessibility for maintenance, safety measures, easements, and hydraulic design methods shall be the same as those required for detention basins in Chapter III-4.
- Soils Investigation - A minimum of one soils log shall be required for each 5,000 square feet of infiltration basin area (plan view area) and in no case less than three soils logs per basin. Each soils log shall extend a minimum of 3 feet in depth below the bottom of the proposed basin, describe the SCS series of the soil, the textural class of the soil horizon(s) through the depth of the log, and note any evidence of high ground water level, such as mottling. In addition, the location of impermeable soil layers or dissimilar soil layers shall be determined.
- The design infiltration rate, f_d, will be equal to one-half the infiltration rate found from the soil textural analysis.
- Pretreatment - Water Quality Infiltration Basins must be preceded by a pretreatment BMP. See Chapter I-4 for selecting appropriate pretreatment BMPs.
- Slopes - Basins should be a minimum of 50 feet from any slope greater than 15 percent. A geotechnical report should address the potential impact of the basin infiltration upon the steep slope.

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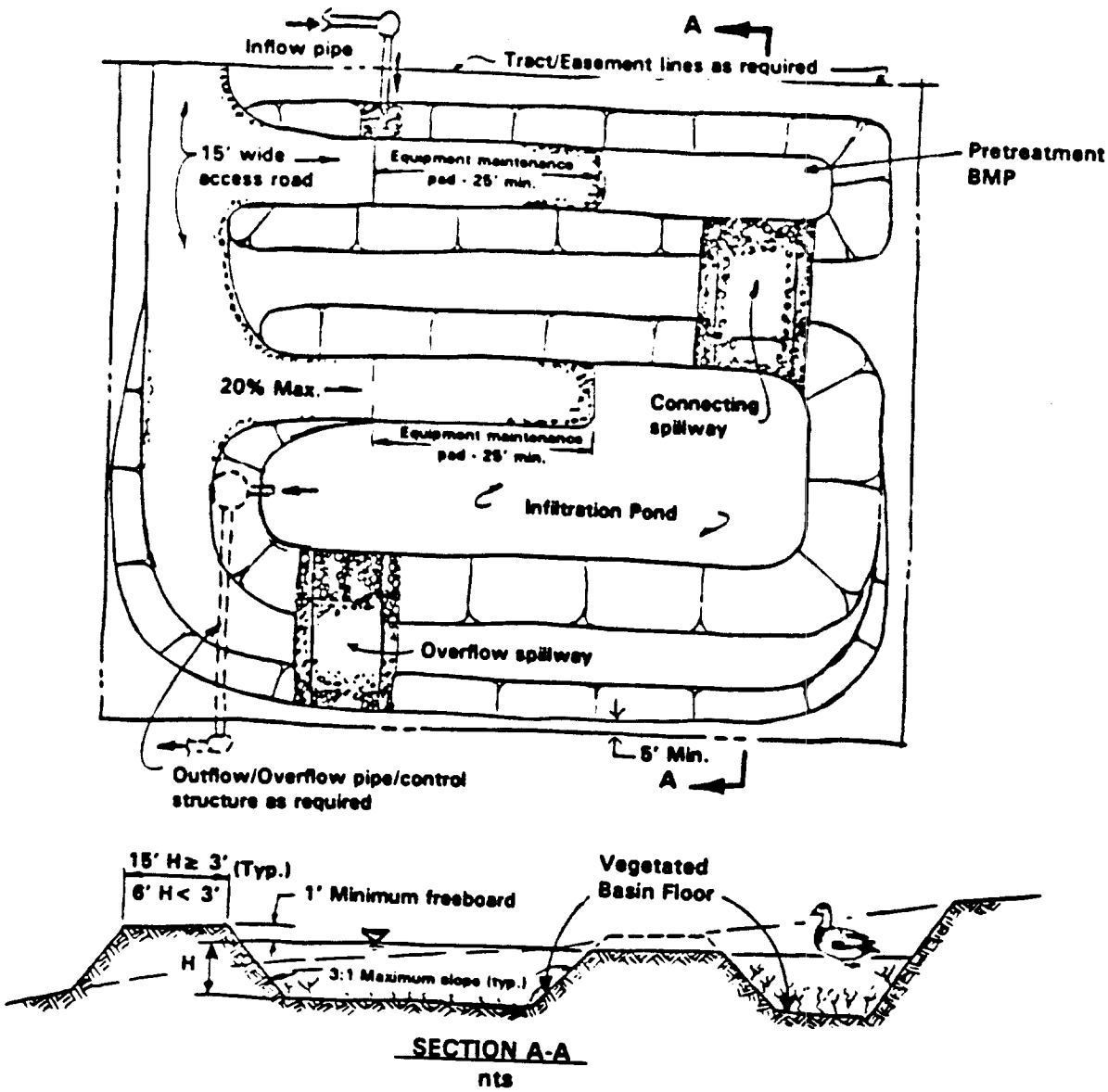
Figure III-3.7
Infiltration Basin



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Note: Detail is schematic representation only. Actual configuration will vary depending on specific site constraints and applicable design criteria.

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- Buildings - Basins should be a minimum of 100 feet upslope and 20 feet downslope from any building.

- Surface Area - The infiltration surface area (A_s) used for sizing the basin shall be computed by measuring the surface area (plan view area) below the maximum design water surface.

- Drawdown Time - Water Quality Infiltration basins shall be designed to completely drain stored runoff within one day following the occurrence of the 6-month, 24-hour design storm. Thus, a maximum allowable drawdown time of 24 hours shall be used. This will ensure that the necessary aerobic conditions exists in order to provide effective treatment of pollutants. If a Presettling Basin (BMP RD.10) precedes the infiltration basin, the *combined* drawdown time for both BMPs should be 24 hours.

- Vegetation - The basin floor and side banks are to be vegetated. See Volume II for criteria on establishing permanent vegetation.

Construction and Maintenance Criteria

Construction Schedule

The sequence of various phases of basin construction shall be coordinated with the overall project construction schedule. A program should schedule rough excavation of the basin with the rough grading phase of the project to permit use of the material as fill in earthwork areas. The partially excavated basin could serve as a temporary sediment trap or pond in order to assist in erosion and sediment control during construction. However, basins near the final stages of excavation should never be used prematurely for runoff disposal. Drainage from untreated, freshly constructed slopes within the watershed area would load the newly formed basin with a heavy concentration of fine sediment. This could seriously impair the natural infiltration characteristics of the basin floor. Final grade of an infiltration basin shall not be attained until after its use as a sediment control basin is completed.

Specifications for basin construction should state the earliest point in construction progress when storm drainage may be directed to the basins, and the means by which this delay in use should be accomplished. Due to the wide variety of conditions encountered among projects, each should be separately evaluated in order to postpone use as long as is reasonably possible.

Excavation

Initial basin excavation should be carried to within 1 foot of the final elevation of the basin floor. Final excavation to the finished grade should be deferred until all disturbed areas in the watershed have been stabilized or protected. The final phase of excavation should remove all accumulated sediment. Relatively light-tracked equipment is recommended for this operation to avoid compaction of the basin floor. After the final grading is completed, the basin floor should be deeply tilled by means of rotary tillers or disc harrows to provide a well-aerated, highly porous surface texture.

Lining Material

A healthy stand of vegetation is to be established on the basin floor and side slopes. This vegetation will not only prevent erosion and sloughing, but will also provide a natural means of maintaining infiltration rates and will provide additional pollution removal. Erosion protection of inflow points to the basin shall also be provided (e.g., riprap, flow spreaders, energy dissipators). Removal

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of accumulated sediment is a problem only at the basin floor. Little maintenance is normally required to maintain the infiltration capacity of side slope areas.

Selection of suitable vegetative materials for the basin floor and side slopes to be stabilized, and application of correct amounts of fertilizer and mulches shall be done in accordance with Volume II, Standards and Specifications for Soil Erosion and Sediment Control. Local extension agencies should also be consulted.

Maintenance

Inspection Schedule

- When infiltration basins are first placed into use they should be inspected on a monthly basis, and more frequently if a large storm occurs in between that schedule. During the period October 1 through March 31 inspections shall be conducted monthly. Thereafter, once it is determined that the basin is functioning in a satisfactory manner and that there are no potential sediment problems, inspection can be reduced to a semi-annual basis with additional inspections following the occurrence of a large storm. This inspection shall include investigation for potential sources of contamination.

Sediment Control

- The basin should be designed with maintenance in mind. Access should be provided for vehicles to easily maintain the forebay (presettling basin) area and not disturb vegetation, or resuspend sediment any more than is absolutely necessary.

- Grass bottom. n infiltration basins seldom need replacement since grass serves as a good filter material. If silty water is allowed to trickle through the turf, most of the suspended material is strained out within a few yards of surface travel. Well established turf on a basin floor will grow up through sediment deposits forming a porous turf and preventing the formation of an impenetrable layer. Grass planted on basin side slopes will also prevent erosion.

Vegetation Maintenance

- Maintenance of vegetation established on the basin floor and side slopes is necessary in order to promote dense turf with extensive root growth which enhances infiltration, prevents erosion and consequent sedimentation, and prevents invasive weed growth. Bare spots are to be immediately stabilized and revegetated.

- The use of low-growing, stoloniferous grasses will permit long intervals between mowings. Mowing twice a year is generally satisfactory. Fertilizers should be applied only as necessary and in limited amounts to avoid contributing to the pollution problems, including ground water pollution, that the infiltration basin is there to solve. Consult the local extension agency for appropriate fertilizer types and application rates.

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III-3.6.3 BMP RI.06 Streambank Erosion Control (SBEC) Infiltration Basin

Purpose and Definition

This BMP is similar in design to the Water Quality Infiltration Basin (BMP RI.05) except that it is designed to provide only streambank erosion control; the soils underlying this BMP will be too coarse for runoff treatment purposes. Stormwater must always be treated prior to discharge to this BMP.

Figure III-3.7 illustrates an infiltration basin.

Planning Considerations

Appropriate soil conditions and the protection of ground water are among the important considerations which may limit the use of the BMP. See Section III-3.3 for a description of General Limitations.

Unlike the Water Quality Infiltration Basin, this basin will typically be located "on-line" and be an integral component of the primary conveyance/detention system. The 6-month, 24-hour design storm must be completely treated prior to runoff being discharged to this BMP.

Drainage areas can be up to 50 acres for Water Quality Infiltration Basins. Basin depths are generally from 3 - 12 feet.

Design Criteria

The design procedure described in Section III-3.4 should be used to design an infiltration basin.

- General - The construction of structures, materials allowed, accessibility for maintenance, safety measures, easements, and hydraulic design methods shall be the same as those required for detention basins in Chapter III-4.
- Soils Investigation - A minimum of one soils log shall be required for each 5,000 square feet of infiltration basin area (plan view area) and in no case less than three soils logs per basin. Each soils log shall extend a minimum of 3 feet in depth below the bottom of the proposed basin, describe the SCS series of the soil, the textural class of the soil horizon(s) through the depth of the log, and note any evidence of high ground water level, such as mottling. In addition, the location of impermeable soil layers or dissimilar soil layers shall be determined.
- The design infiltration rate, f_d, will be equal to one-half the infiltration rate found from the soil textural analysis.
- Overflow route - An overflow route must be identified in the event that the basin capacity is exceeded. This overflow route should be designed to meet Minimum Requirement #2 (Preservation of Natural Drainage Systems).
- Runoff Treatment - Runoff from the 6-month, 24-hour design storm is to be completely treated prior to discharge to this BMP.
- Slopes - Basins should be a minimum of 50 feet from any slope greater than 15 percent. A geotechnical report should address the potential impact of the basin infiltration upon the steep slope.
- Buildings - Basins should be a minimum of 100 feet upslope and 20 feet downslope from any building.

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- The infiltration surface area (A_s) used for sizing the basin shall be computed by measuring the surface area (plan view area) below the maximum design water surface.

- Spillways - The bottom elevation of the low-stage orifice should be designed to coincide with the one-day infiltration capacity of the basin. All other aspects of the principal spillway design and the emergency spillway shall follow the details provided for detention basins in Chapter III-4.

- Drawdown Time - Streambank Erosion Control Infiltration Basins shall be designed to completely drain stored runoff within one day following the occurrence of the 10-year, 24-hour design storm and within two days of the 100-year, 24-hour design storm (with appropriate correction factors as discussed in Chapter III-1). Thus, a maximum allowable drawdown time of 48 hours is permissible.

- Vegetation - The embankment, emergency spillways, spoil and borrow areas, and other disturbed areas shall be stabilized and planted in accordance with Minimum Requirement #1 (Erosion and Sediment Control).

Construction and Maintenance Criteria

Construction Schedule

The sequence of various phases of basin construction shall be coordinated with the overall project construction schedule. A program should schedule rough excavation of the basin with the rough grading phase of the project to permit use of the material as fill in earthwork areas. The partially excavated basin could serve as a temporary sediment trap or pond in order to assist in erosion and sediment control during construction. However, basins near the final stages of excavation should never be used prematurely for runoff disposal. Drainage from untreated, freshly constructed slopes within the watershed area would load the newly formed basin with a heavy concentration of fine sediment. This could seriously impair the natural infiltration characteristics of the basin floor. Final grade of an infiltration basin shall not be attained until after its use as a sediment control basin is completed.

Specifications for basin construction should state the earliest point in construction progress when storm drainage may be directed to the basins, and the means by which this delay in use should be accomplished. Due to the wide variety of conditions encountered among projects, each should be separately evaluated in order to postpone use as long as is reasonably possible.

Excavation

Initial basin excavation should be carried to within 1 foot of the final elevation of the basin floor. Final excavation to the finished grade should be deferred until all disturbed areas in the watershed have been stabilized or protected. The final phase of excavation should remove all accumulated sediment. Relatively light-tracked equipment is recommended for this operation to avoid compaction of the basin floor. After the final grading is completed, the basin floor should be deeply tilled by means of rotary tillers or disc harrows to provide a well-aerated, highly porous surface texture.

Lining Material

Infiltration basins can be open or be lined with a 6 to 12-inch layer of filter material such as coarse sand or a suitable filter fabric to help prevent the buildup of impervious deposits on the soil surface. The filter layer can be replaced or cleaned when/if it becomes clogged. When a 6-inch layer of organic material is specified for disking or spading into the basin floor to increase the permeability

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of the soil, the basin floor should be soaked or inundated for a brief period and then allowed to dry subsequent to this operation. This induces rapid decay in the organic material and prevents the organic matter from becoming hydrophobic, loosening the upper soil layer.

Establishing a healthy stand of vegetation on the basin side slopes and floor is recommended. This vegetation will not only prevent erosion and sloughing, but will also provide a natural means of maintaining relatively high infiltration rates. Erosion protection of inflow points to the basin shall also be provided. Removal of accumulated sediment is a problem only at the basin floor. Little maintenance is normally required to maintain the infiltration capacity of side slope areas.

Selection of suitable vegetative materials for the side slopes and all other areas to be stabilized, and application of correct amounts of fertilizer and mulches shall be done in accordance with Volume II, Erosion and Sediment Control. Local extension agencies should also be consulted.

Maintenance

Inspection Schedule

- When infiltration basins are first placed into use they should be inspected on a monthly basis, and more frequently if a large storm occurs in between that schedule. During the period October 1 through March 31 inspections shall be conducted monthly. Thereafter, once it is determined that the basin is functioning in a satisfactory manner and that there are no potential sediment problems, inspection can be reduced to a semiannual basis with additional inspections following the occurrence of a large storm (e.g. approximately 1 inch in 24 hours). This inspection shall include investigation for potential sources of contamination.

Sediment Control Effect on Vegetated Basins

- The basin should be designed with maintenance in mind. Access should be provided for vehicles to easily maintain the forebay (presettling basin) area and not disturb vegetation, or resuspend sediment any more than is absolutely necessary.

- Cleanout frequency of infiltration basins will depend on whether they are vegetated or non-vegetated and will be a function of their storage capacity, recharge characteristics, volume of inflow, and sediment load.

- Grass bottoms in infiltration basins seldom need replacement since grass serves as a good filter material. If silty water is allowed to trickle through the turf, most of the suspended material is strained out within a few yards of surface travel. Well established turf on a basin floor will grow up through sediment deposits forming a porous turf and preventing the formation of an impenetrable layer. Grass filtration works well with long, narrow, shoulder-type depressions (swales, ditches etc.) where highway runoff flows down a grassy slope between the roadway and the basin. Grass planted on basin side slopes will also prevent erosion.

Sediment Removal From Non-Vegetated Basins

- Sediment is most easily removed when the basin floor (or presettling basin) is completely dry and after the silt layer has mud-cracked and separated from the basin floor. It is recommended that hand raking and removal be done if possible to avoid compaction of the infiltration media by equipment. Large-tracked vehicles should not be used in order to prevent compaction of the basin floor.

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Tilling of the Non-Vegetated Basin Floor

- All accumulated sediment must be removed prior to tilling operations. As tilling is required periodically, and at least once annually, the frequency of sediment removal will be reduced to small operations on a regular basis.

- Tilling may be necessary to restore the natural infiltration capacity by overcoming the effects of surface compaction, and to control weed growth on the basin floor.

- Rotary tillers or disc harrows will normally serve this purpose. Light tractors should be employed for these operations. In the event that heavy equipment has caused deeper than normal compaction of the surface, these operations should be preceded by deep plowing. In its final condition after tilling, the basin floor should be level, smooth, and free of ridges and furrows to ease future removal of sediment and minimize the material to be removed during future cleaning operations. A levelling drag, towed behind the equipment on the last pass will accomplish this.

- In the spring the basin surface may be quite porous due to the effects of frost and subsequent thawing. The infiltration capacity diminishes rapidly thereafter. To enhance infiltration capacity, tilling should be done once each season from late June through September. To control vegetative growth, an additional light tillage may be necessary during the growing season. Precautions must be observed to avoid working any of the sediment accumulation into the basin floor as a part of a light cultivation for weed control. ANY cultivation or tilling operation must be preceded in all cases by careful sediment removal.

Side Slope Maintenance

- Maintenance of side slopes is necessary to promote dense turf with extensive root growth which enhances infiltration through the slope surface, prevents erosion and consequent sedimentation of the basin floor, and prevents invasive weed growth.

- Seed mixtures should be the same as those recommended in the Erosion and Sediment Control Volume.

- The use of low-growing, stoloniferous grasses will permit long intervals between mowings. Mowing twice a year is generally satisfactory. Fertilizers should be applied only as necessary and in limited amounts to avoid contributing to the pollution problems, including ground water pollution, that the infiltration basin is there to solve. Consult the local extension agency for appropriate fertilizer types and application rates.

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III-3.6.4 BMP RI.10 Water Quality (WQ) Infiltration Trench

Purpose and Definition

This BMP is a shallow excavated trench designed primarily to provide runoff treatment but not streambank erosion control. The soils underlying this BMP must be capable of removing pollutants from runoff and will likely have insufficient permeability to be used for streambank erosion control. Trenches are generally 2 to 10 feet in depth backfilled with a coarse stone aggregate, allowing for temporary storage of storm runoff in the voids between the aggregate material. Stored runoff then gradually infiltrates into the surrounding soil. The surface of the trench can be covered over with grating and/or consist of stone, gabion, sand, or a grassed covered area with a surface inlet.

One alternative design is to install a pipe in the trench and surround it with coarse stone; this will increase the temporary storage capacity of the trench. A second alternative design is to build a vault or tank without a bottom (see BMP RD.15 for details). An infiltration vault/tank is equivalent to a detention vault with the bottom acting as the outlet, instead of having a control structure.

Figures III-3.8 illustrates a Water Quality Infiltration Trench, located off-line from the primary conveyance/detention system. Figure III-3.9 shows a schematic of a typical infiltration trench. Figures III-3.10 through III-3.15 illustrate other variations of trench designs.

Planning Considerations

Appropriate soil conditions and the protection of ground water are among the important considerations which may limit the use of this BMP. See Section III-3.3 for a description of General Limitations. One advantage of trenches is that they have less tendency to become clogged with sediment than do other infiltration BMPs.

This BMP will typically be located "off-line" from the primary conveyance/detention system in order to effectively treat pollutants and protect the infiltration soils from clogging. Water Quality Infiltration BMPs must always be preceded by a pretreatment BMP to remove sediments that could clog the infiltration soils.

An infiltration trench will generally be used in relatively small drainage areas (usually less than 15 acres). This practice can be used in residential lots, commercial areas, parking lots and open space areas. Trenches are one of the few BMPs that are relatively easy to fit into the margin, perimeter, and other less-utilized areas of developed sites, making them particularly suitable for retrofitting. A trench may also be installed under a swale to increase the storage of the infiltration system.

Design Criteria

The procedure described in Section III-3.4 should be used to design an infiltration trench. Trenches are assumed to have rectangular cross-sections, thus the infiltration surface area (sides and bottom) can be readily calculated from the trench geometry. The storage volume of the trench must take into account the volume of backfill material placed in the trench (i.e., void ratio).

The same general criteria that were presented for Water Quality Infiltration Basins (BMP RI.05) shall apply to trenches; the following information is also provided for guidance:

- Soils Investigation - A minimum of one soils log shall be required for every 50 feet of trench length, and in no case less than two soils logs for each proposed

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trench location. Each soils log should extend a minimum of 3 feet below the bottom of the trench, describe the SCS series of the soil, the textural class of the soil horizon(s) through the depth of the log, and note any evidence of high ground water level, such as mottling. In addition, the location of impermeable soil layers or dissimilar soil layers shall be determined.

- The design infiltration rate, f_d, will be equal to one-half the infiltration rate found from the soil textural analysis.

- Pretreatment - Water Quality Infiltration Trenches must be preceded by a pretreatment BMP. See Chapter I-4 for selecting appropriate pretreatment BMPs.

- Drawdown Time - Infiltration trenches shall be designed to empty the 6-month, 24-hour storm event within one day (24 hours). This will ensure that the necessary aerobic conditions exists in order to provide effective treatment of pollutants. If a Presettling Basin (BMP RD.10) precedes the infiltration trench, the *combined* drawdown time for both BMPs should be 24 hours.

- Backfill Material - The aggregate material for the infiltration trench shall consist of a clean aggregate with a maximum diameter of 3 inches and a minimum diameter of 1.5 inches. The aggregate should be graded such that there will be few aggregates smaller than the selected size. Void space for these aggregates is assumed to be in the range of 30 percent to 40 percent.

- Filter Fabric - The aggregate fill material shall be completely surrounded as shown in Figure III-3.9 with an engineering filter fabric. In the case of an aggregate surface, filter fabric should surround all of the aggregate fill material except for the top one foot.

- Overflow Channel - In general, because of the small drainage areas controlled by an infiltration trench, an emergency spillway is not necessary. In all cases, the overland flow path of surface runoff exceeding the capacity of the trench should be evaluated to preclude the development of uncontrolled, erosive, concentrated flow. A nonerosive overflow channel leading to a stabilized watercourse shall be provided.

- Seepage Analysis and Control - An analysis shall be made to determine any possible adverse effects of seepage zones when there are nearby building foundations, basements, roads, parking lots or sloping sites. Developments on sloping sites often require the use of extensive cut and fill operations. The use of infiltration trenches on fill sites is not permitted.

- Buildings - Infiltration trenches should be located 20 feet downslope and 100 feet upslope from building foundations.

- Observation Well - An observation well shall be installed for every 50 feet of infiltration trench length. The observation well will serve two primary functions: it will indicate how quickly the trench dewaters following a storm and it will provide a method of observing how quickly the trench fills up with sediments. Figure III-3.16 illustrates observation well details.

  The observation well should consist of perforated PVC pipe, 4 to 6 inches in diameter. It should be located in the center of the structure and be constructed flush with the ground elevation of the trench as shown in Figure III-3.9. The top of the well should be capped to discourage vandalism and tampering.

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Construction and Maintenance Criteria

Construction Timing

An infiltration trench shall not be constructed or placed into service until all of the contributing drainage area has been stabilized and approved by the responsible inspector.

Trench Preparation

Excavate the trench to the design dimensions. Excavated materials shall be placed away from the trench sides to enhance trench wall stability. Care should also be taken to keep this material away from slopes, neighboring property, sidewalks and streets. It is recommended that this material be covered with plastic if it is to be left in place for more than 30 days (see BMP E1.20 in Volume II).

Fabric Laydown

The filter fabric roll must be cut to the proper width prior to installation. The cut width must include sufficient material to conform to the trench perimeter irregularities and for a 12 inch minimum top overlap.

Place the fabric roll over the trench and unroll a sufficient length to allow placement of the fabric down into the trench. Stones or other anchoring objects should be placed on the fabric at the edge of the trench to keep the lined trench open during windy periods. When overlaps are required between rolls, the upstream roll should overlap a minimum of 2 feet over the downstream roll in order to provide a shingled effect. The overlap insures fabric continuity and allows the fabric to conform to the excavated surface during aggregate placement and compaction.

Stone Aggregate Placement and Compaction

The stone aggregate should be placed in lifts and compacted using plate compactors. As a rule of thumb, a maximum loose lift thickness of 12 inches is recommended. The compaction process ensures fabric conformity to the excavation sides, thereby reducing potential soil piping, fabric clogging, and settlement problems.

Overlapping and Covering

Following the stone aggregate placement, the filter fabric shall be folded over the stone aggregate to form a 12 inch minimum longitudinal overlap. The desired fill soil or stone aggregate shall be placed over the lap at sufficient intervals to maintain the lap during subsequent backfilling.

Potential Contamination

Care shall be exercised to prevent natural or fill soils from intermixing with the stone aggregate. All contaminated stone aggregate shall be removed and replaced with uncontaminated stone aggregate.

Voids Behind Fabric

Voids may be created between the fabric and excavation sides and shall be avoided. Removing boulders or other obstacles from the trench walls is one source of such voids. Natural soils should be placed in these voids at the most convenient time during construction to ensure fabric conformity to the excavation sides. Soil piping, fabric clogging, and possible surface subsidence will be avoided by this remedial process.

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Unstable Excavation Sites

Vertically excavated walls may be difficult to maintain in areas where the soil moisture is high or where soft or cohesionless soils predominate. These conditions require laying back of the side slopes to maintain stability; trapezoidal rather than rectangular cross-sections may result. This is acceptable, but any change in the shape of the stone reservoir needs to be taken into consideration in size calculations.

Traffic Control

Heavy equipment and traffic shall be restricted from travelling over the infiltration areas to minimize compaction of the soil. The trench should be flagged or marked to keep equipment away from the area.

Observation Well

An observation well, as described in the previous section on design criteria and shown in Figure III-3.16 shall be provided. The depth of the well at the time of installation will be clearly marked on the well cap.

Maintenance

Inspection Schedule

- The observation well should be monitored periodically. For the first year after completion of construction, the well should be monitored after every large storm (>1 inch in 24 hours), and, during the period October 1 through March 31 inspections shall be conducted monthly. From April 1 through September 30, the facility should be monitored on a quarterly basis. A log book shall be maintained by the responsible person designated by the local government indicating the rate at which the facility dewaters after large storms and the depth of the well for each observation. Once the performance characteristics of the structure have been verified, the monitoring schedule can be reduced to an annual basis unless the performance data indicate that a more frequent schedule is required.

Sediment Removal

- Sediment buildup in the top foot of stone aggregate or the surface inlet should be monitored on the same schedule as the observation well. A monitoring well in the top foot of stone aggregate shall be required when the trench has a stone surface. Sediment deposits shall not be allowed to build up to the point where it will reduce the rate of infiltration into the trench.

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Figure III-3.8
Water Quality Infiltration Trench System

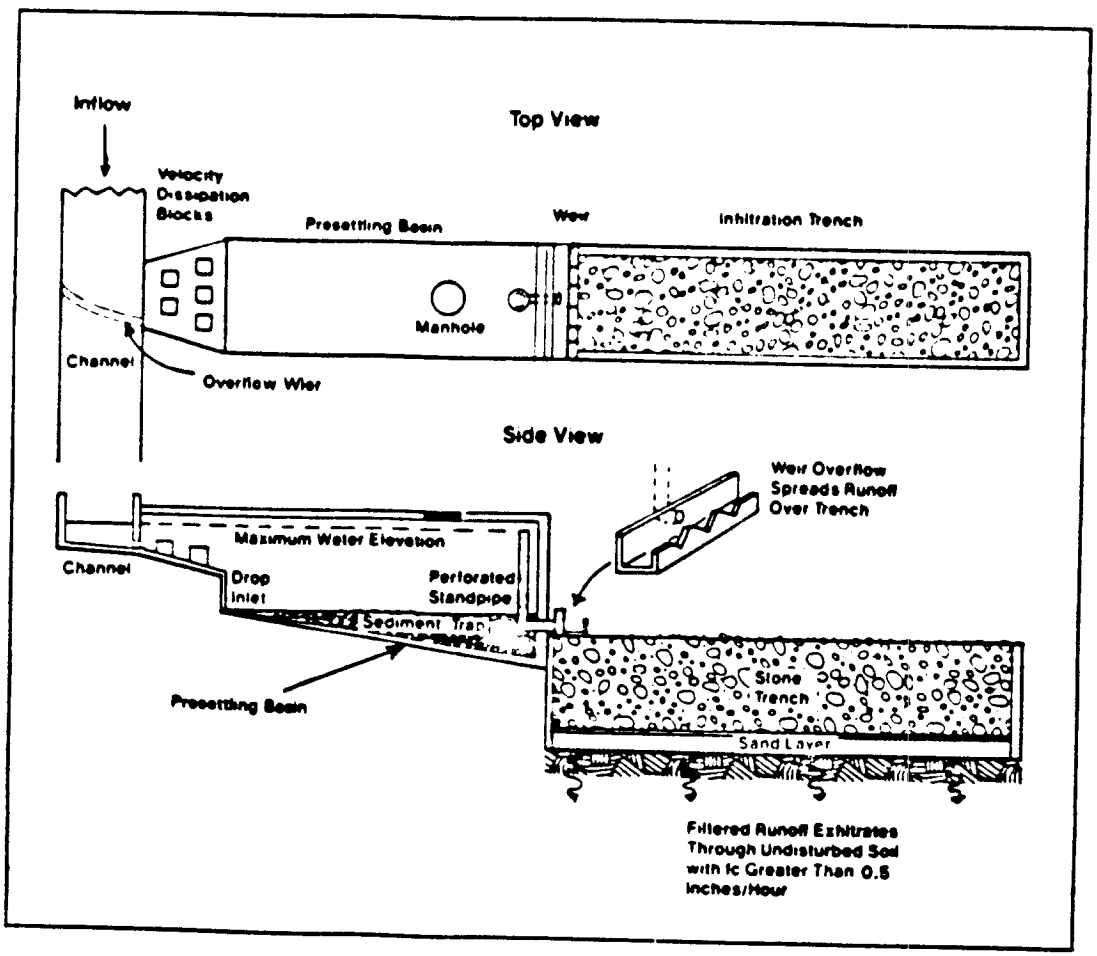

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Figure III-3.9 Schematic of an Infiltration Trench
(Reproduced with permission from Schueler (16))

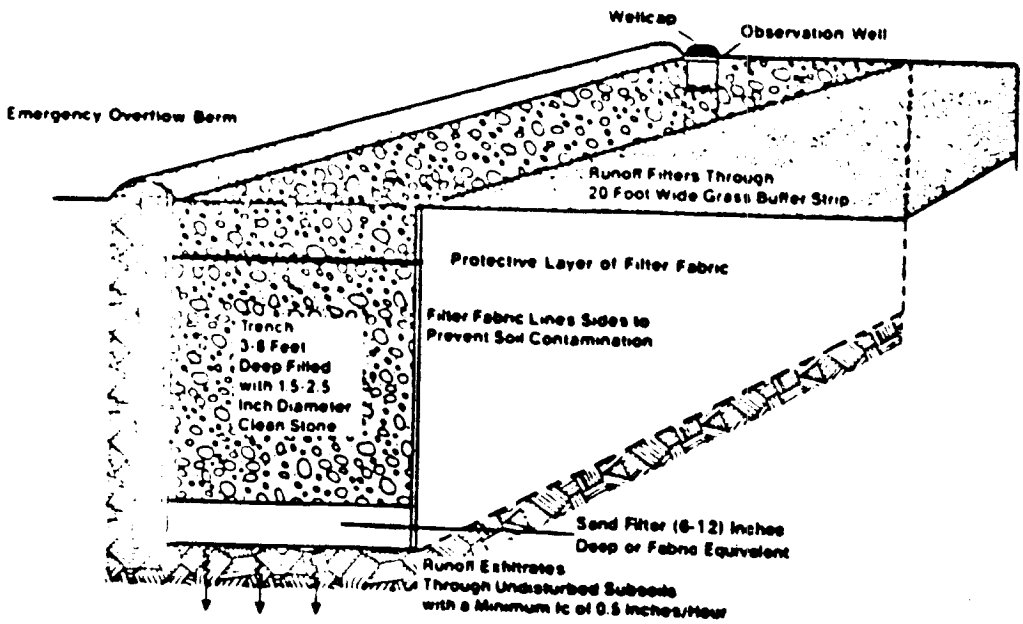

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Figure III-3.10 Median Strip Trench Design
(Reproduced with permission from Schueler (16))

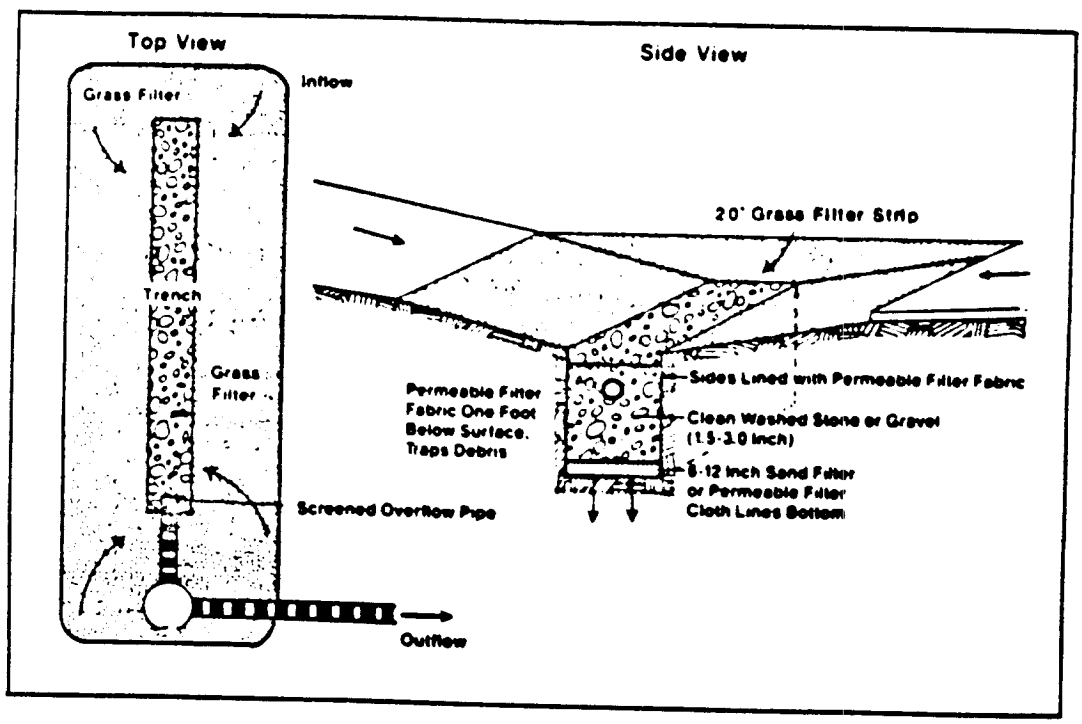

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Figure III-3.11 Parking Lot Perimeter Trench Design
(Reproduced with permission from Schueler (16))

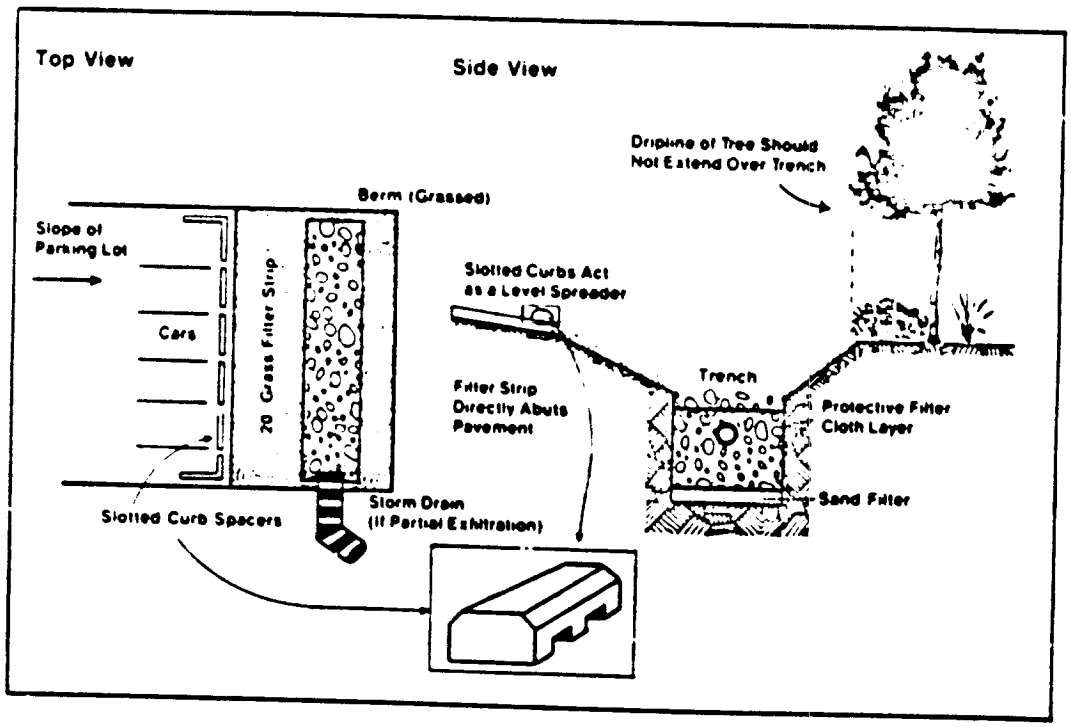

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Figure III-3.12 Oversized Pipe Trench Design
(Reproduced with permission from Schueler (16))

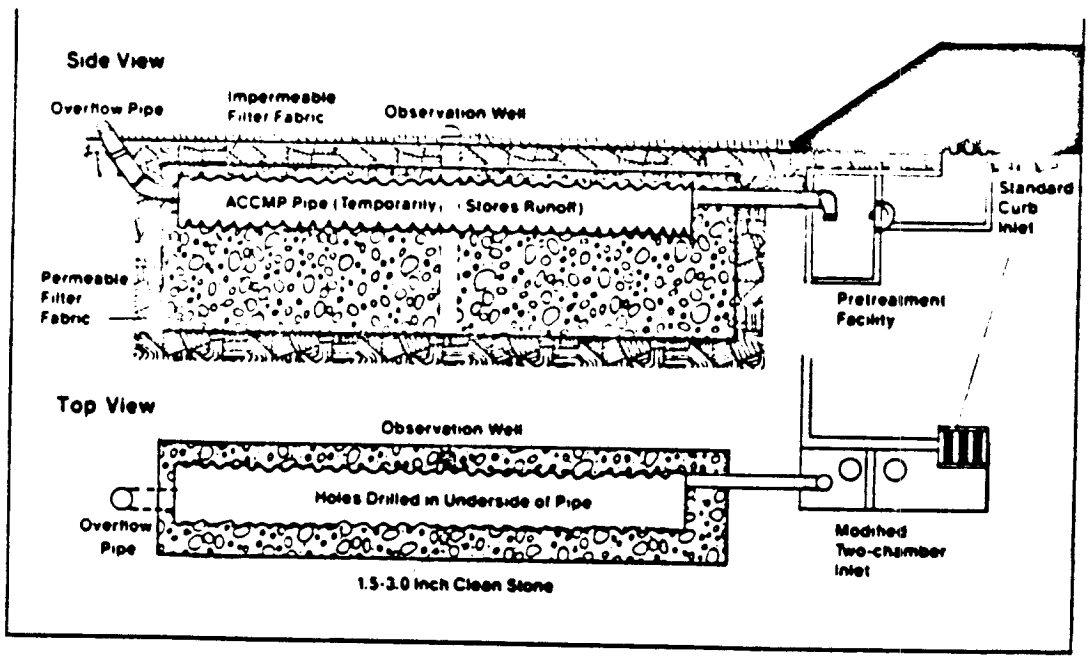

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Figure III-3.13 Swale/Trench Design
(Reproduced with permission from Schueler (16))

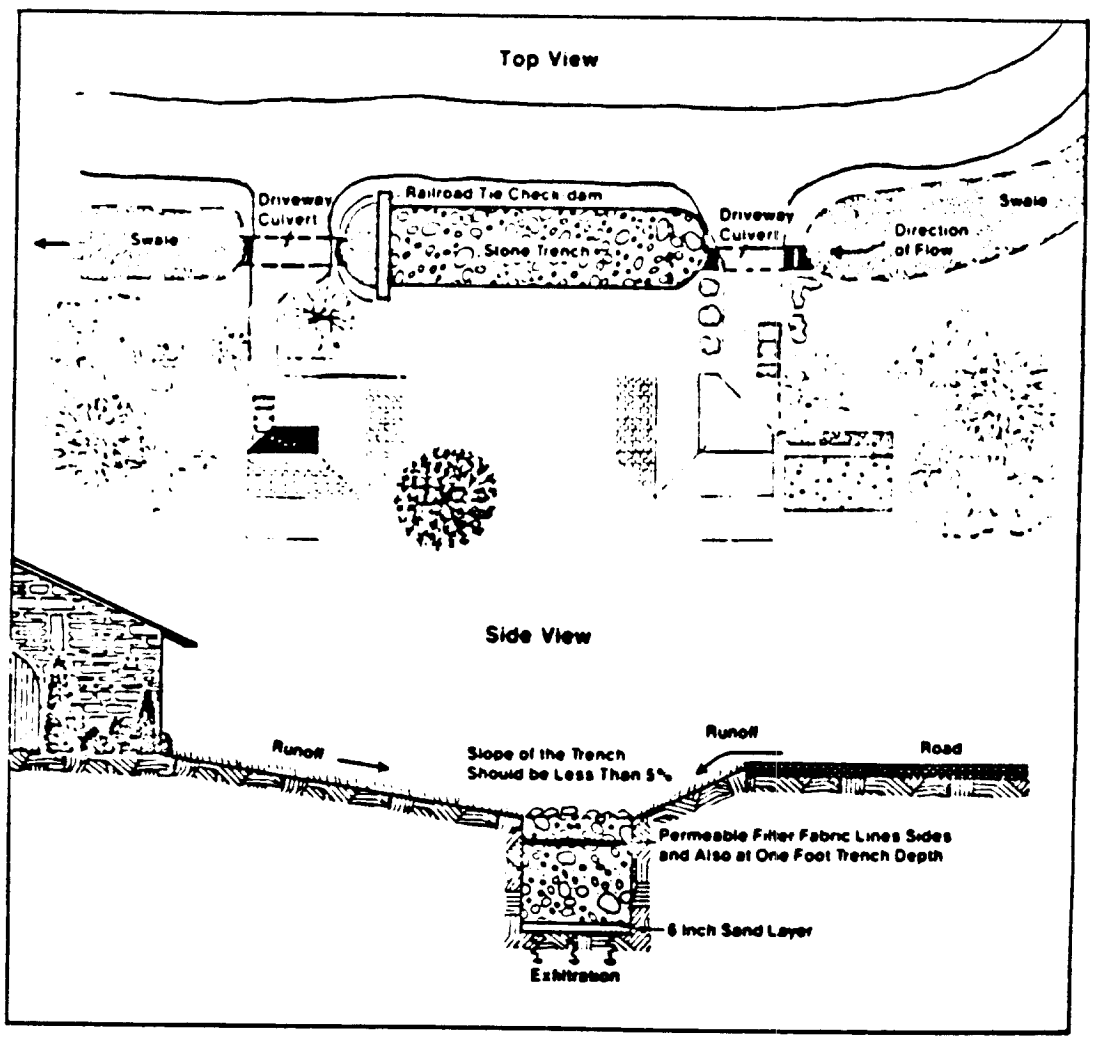

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Figure III-3.14 Under-the-Swale Trench Design
(Reproduced with permission from Schueler (16))

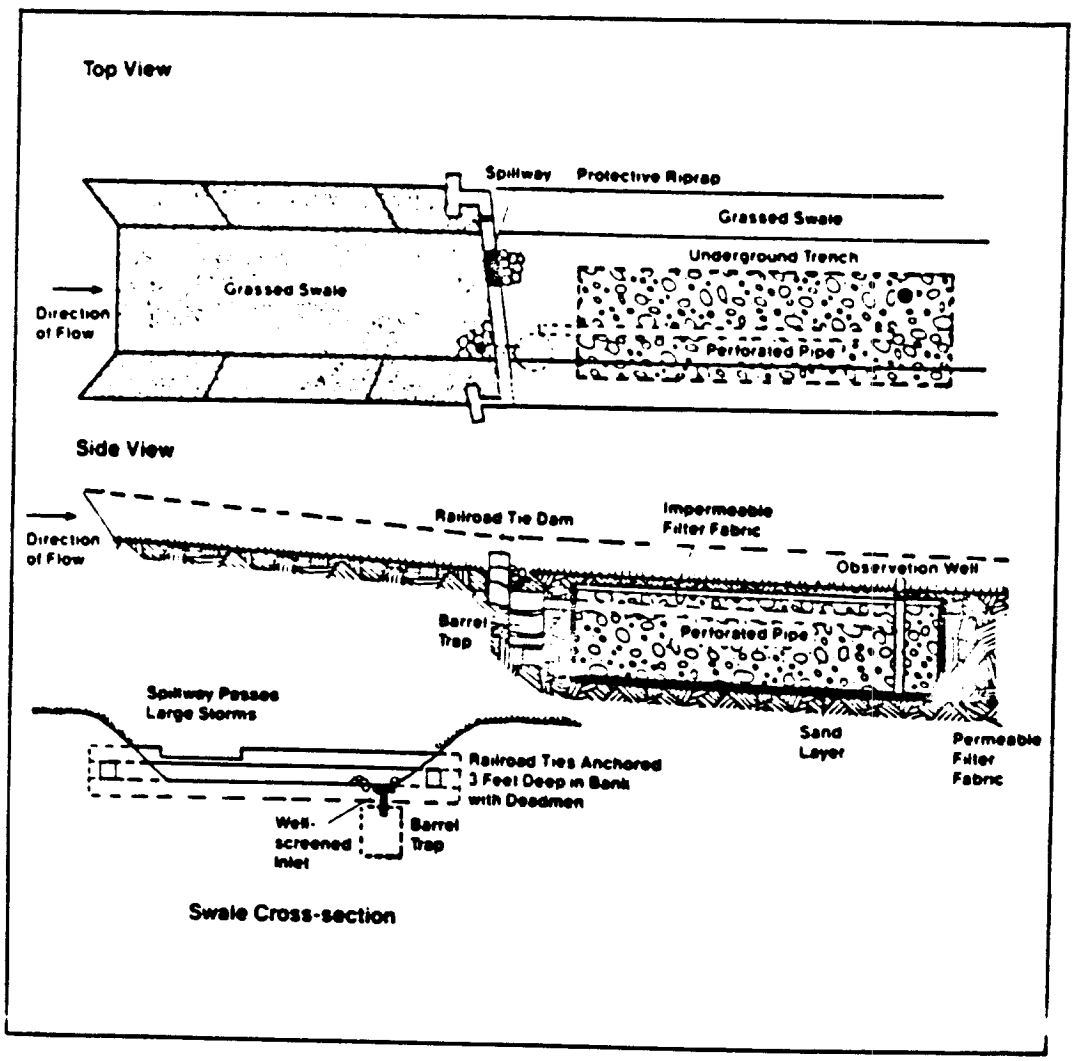

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Figure III-3.15 Underground Trench with Oil/Grit Chamber
(Reproduced with permission from Schueler (16))

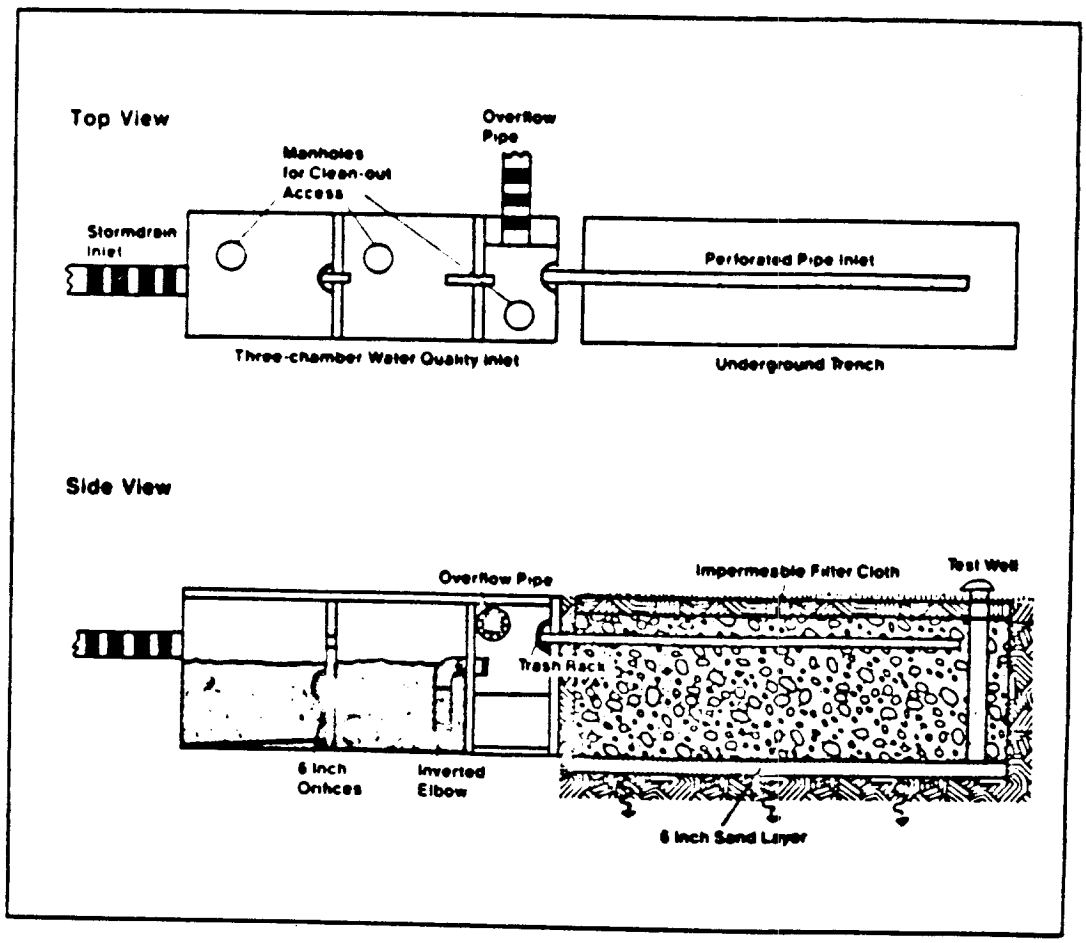

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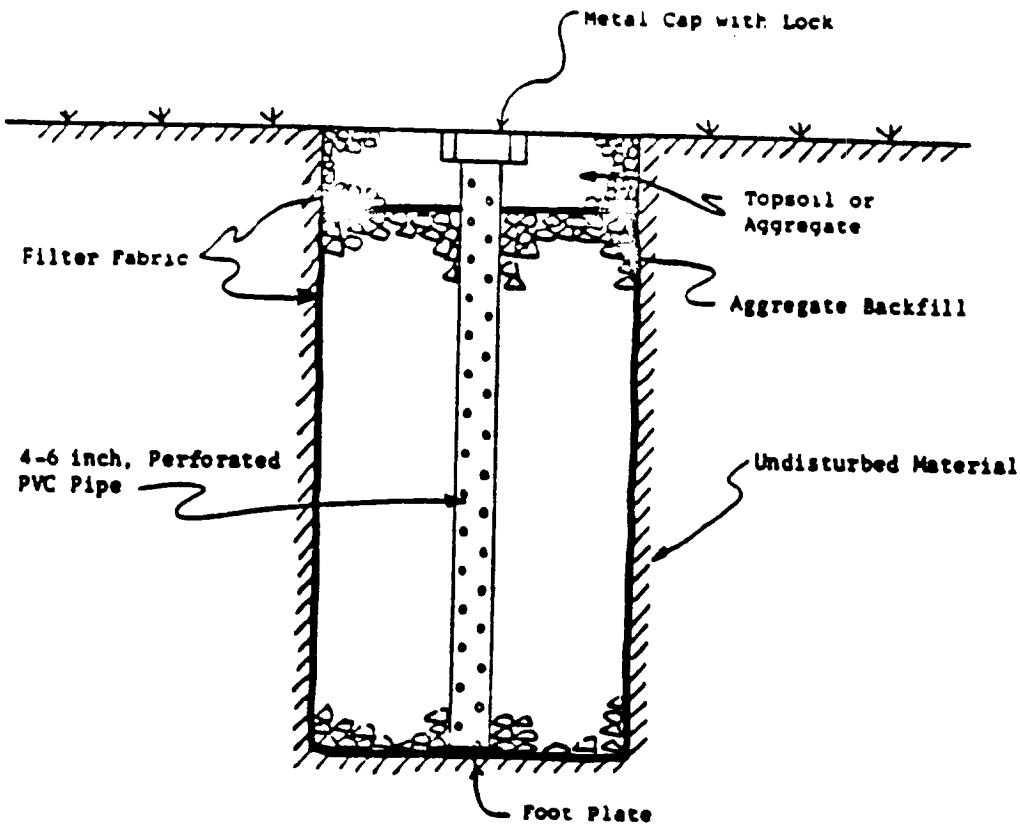
Figure III-3.16
Observation Well Details



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III-3.6.5 BMP RI.11 Streambank Erosion Control (SBEC) Infiltration Trench

Purpose and Definition

This BMP is a shallow excavated trench designed to provide streambank erosion control but not runoff treatment. The soils underlying this BMP will be too coarse for pollution removal and stormwater must be treated prior to discharge to this BMP. While physically resembling the Water Quality Infiltration Trench (BMP RI.10) the design criteria for this BMP more closely resembles that used for the Streambank Erosion Control Infiltration Basin (BMP RI.06).

Figures III-3.9 through III-3.15 illustrate infiltration trench designs.

Planning Considerations

Appropriate soil conditions and the protection of ground water are among the important considerations which may limit the use of this BMP. See Section III-3.3 for a description of General Limitations.

This BMP will typically be located on-line with the primary conveyance/detention system. The 6-month, 24-hour design storm must be completely treated prior to runoff being discharged to this BMP.

An infiltration trench will generally be used on relatively small drainage areas. This practice can be used in residential lots, commercial areas, parking lots and open space areas. Trenches are one of the few BMPs that are relatively easy to fit into the margin, perimeter, and other less-utilized areas of developed sites, making them particularly suitable for retrofitting. A trench may also be installed under a swale to increase the storage of the infiltration system.

Drainage areas are generally limited to less than 15 acres.

One advantage of trenches is that they have less tendency to become clogged with sediment than other infiltration BMPs.

Design Criteria

The procedure described in Section III-3.4 should be used to design an infiltration trench. Trenches are assumed to have rectangular cross-sections, thus the infiltration surface area (sides and bottom) can be readily calculated from the trench geometry. The storage volume of the trench must take into account the volume of backfill material placed in the trench (i.e., void ratio).

General Criteria

- Soils Investigation - A minimum of one soils log shall be required for every 50 feet of trench length, and in no case less than two soils logs for each proposed trench location. Each soils log should extend a minimum of 3 feet below the bottom of the trench, describe the SCS series of the soil, the textural class of the soil horizon(s) through the depth of the log, and note any evidence of high ground water level, such as mottling. In addition, the location of impermeable soil layers or dissimilar soil layers shall be determined.
- The design infiltration rate, f_d, will be equal to one-half the infiltration rate found from the soil textural analysis.
- Runoff Treatment - Runoff from the 6-month, 24-hour design storm is to be completely treated prior to discharge to this BMP.

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- Drawdown Time - Streambank Erosion Control Infiltration Trenches shall be designed to completely drain stored runoff within one day following the occurrence of the 10-year, 24-hour design storm and within two days of the 100-year, 24-hour design storm (with appropriate correction factors as discussed in Chapter III-1). Thus, a maximum allowable drawdown time of 48 hours is permissible.

- Surface Area - The infiltration surface area (A_s) used for sizing the trench shall be computed by measuring the surface area (plan view area) below the maximum design water surface.

- Slopes - Trenches should be a minimum of 50 feet from any slope greater than 15 percent. A geotechnical report should address the potential impact of the trench infiltration upon the steep slope.

- Backfill Material - The aggregate material for the infiltration trench shall consist of a clean aggregate with a maximum diameter of 3 inches and a minimum diameter of 1.5 inches. The aggregate should be graded such that there will be few aggregates smaller than the selected size. Void space for these aggregates is assumed to be in the range of 30 percent to 40 percent.

- Filter Fabric - The aggregate fill material shall be completely surrounded as shown in Figure III-3.9 with an engineering filter fabric. In the case of an aggregate surfaced trench, filter fabric should surround all of the aggregate fill material except for the top one foot, which is placed over the filter fabric. See Figure III-3.9 for details.

- Overflow route - An overflow route must be identified in the event that the trench capacity is exceeded. This overflow route should be designed to meet Minimum Requirement #2 (Preservation of Natural Drainage Systems).

- Spillways - The bottom elevation of the low-stage orifice should be designed to coincide with the one-day infiltration capacity of the trench. All other aspects of the principal spillway design and the emergency spillway shall follow the details provided for detention basins in Chapter III-4.

- Seepage Analysis and Control - An analysis shall be made to determine any possible adverse effects of seepage zones when there are nearby building foundations, basements, roads, parking lots or sloping sites. Developments on sloping sites often require the use of extensive cut and fill operations. The use of infiltration trenches on fill sites is not permitted.

- Buildings - Infiltration trenches shall be located 20 feet downslope and 100 feet upslope from building foundations.

- Observation Well - An observation well shall be installed for every 50 feet of infiltration trench length. The observation well will serve two primary functions: it will indicate how quickly the trench dewaters following a storm and it will provide a method of observing how quickly the trench fills up with sediments. Figure III-3.16 illustrates observation well details.

  The observation well should consist of perforated PVC pipe, 4 to 6 inches in diameter. It should be located in the center of the structure and be constructed flush with the ground elevation of the trench as shown in Figure III-3.9. The top of the well should be capped to discourage vandalism and tampering.

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Construction and Maintenance Criteria

Construction Timing

An infiltration trench shall not be constructed or placed into service until all of the contributing drainage area has been stabilized and approved by the responsible inspector.

Trench Preparation

Excavate the trench to the design dimensions. Excavated materials shall be placed away from the trench sides to enhance trench wall stability. Care should also be taken to keep this material away from slopes, neighboring property, sidewalks and streets. It is recommended that this material be covered with plastic if it is to be left in place for more than 30 days (see BMP E1.20 in Volume II).

Fabric Laydown

The filter fabric roll must be cut to the proper width prior to installation. The cut width must include sufficient material to conform to the trench perimeter irregularities and for a 12 inch minimum top overlap.

Place the fabric roll over the trench and unroll a sufficient length to allow placement of the fabric down into the trench. Stones or other anchoring objects should be placed on the fabric at the edge of the trench to keep the lined trench open during windy periods. When overlaps are required between rolls, the upstream roll should overlap a minimum of 2 feet over the downstream roll in order to provide a shingled effect. The overlap insures fabric continuity and allows the fabric to conform to the excavated surface during aggregate placement and compaction.

Stone Aggregate Placement and Compaction

The stone aggregate should be placed in lifts and compacted using plate compactors. As a rule of thumb, a maximum loose lift thickness of 12 inches is recommended. The compaction process ensures fabric conformity to the excavation sides, thereby reducing potential soil piping, fabric clogging, and settlement problems.

Overlapping and Covering

Following the stone aggregate placement, the filter fabric shall be folded over the stone aggregate to form a 12 inch minimum longitudinal overlap. The desired fill soil or stone aggregate shall be placed over the lap at sufficient intervals to maintain the lap during subsequent backfilling.

Potential Contamination

Care shall be exercised to prevent natural or fill soils from intermixing with the stone aggregate. All contaminated stone aggregate shall be removed and replaced with uncontaminated stone aggregate.

Voids Behind Fabric

Voids may be created between the fabric and excavation sides and shall be avoided. Removing boulders or other obstacles from the trench walls is one source of such voids. Natural soils should be placed in these voids at the most convenient time during construction to ensure fabric conformity to the excavation sides. Soil piping, fabric clogging, and possible surface subsidence will be avoided by this remedial process.

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Unstable Excavation Sites

Vertically excavated walls may be difficult to maintain in areas where the soil moisture is high or where soft or cohesionless soils predominate. These conditions require laying back of the side slopes to maintain stability; trapezoidal rather than rectangular cross-sections may result. This is acceptable, but any change in the size or the shape of the stone reservoir needs to be taken into consideration in size calculations.

Traffic Control

Heavy equipment and traffic shall be restricted from travelling over the infiltration areas to minimize compaction of the soil. The trench should be flagged or marked to prevent drive-on.

Observation Well

An observation well, as described in the previous section on design criteria and shown in Figure III-3.16 shall be provided. The depth of the well at the time of installation will be clearly marked on the well cap.

Maintenance

Inspection Schedule

- The observation well should be monitored periodically. For the first year after completion of construction, the well should be monitored on a quarterly basis and after every large storm. During the period October 1 through March 31 inspections shall be conducted monthly. A log book shall be maintained by the responsible person designated by the local government indicating the rate at which the facility dewaters after large storms and the depth of the well for each observation. Once the performance characteristics of the structure have been verified, the monitoring schedule can be reduced to an annual basis unless the performance data indicate that a more frequent schedule is required.

Sediment Removal

- Sediment buildup in the top foot of stone aggregate or the surface inlet should be monitored on the same schedule as the observation well. A monitoring well in the top foot of stone aggregate shall be required when the trench has a stone surface. Sediment deposits shall not be allowed to build up to the point where it will reduce the rate of infiltration into the trench.

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III-3.6.6 BMP RI.15 Roof Downspout System

Purpose and Definition

A roof downspout system is an infiltration trench system intended only for use in infiltrating runoff from roof downspout drains. This BMP is not designed to directly infiltrate any surface water that could transport sediment or pollutants such as from paved areas. Because runoff from rooftops is relatively clean, no treatment is required prior to its discharge to the soil. Figure III-3.17 illustrates a typical roof downspout system.

Planning Considerations - none.

Conditions Where Practice Applies

Roof downspout systems may be used in any situation where it is acceptable to dispose of this runoff by avoiding or replacing the use of direct connections to storm or sanitary sewers, or where such facilities do not exist. Because of their small size, they are well suited for a retrofit in areas where additional runoff control becomes necessary.

Advantages

- In areas where such practices can be used, they may cause a significant reduction in the need for installation of storm sewers and other stormwater runoff control facilities.
- Roof downspout systems are small and relatively simple to install and can be retrofit into subdivisions as necessary.

Disadvantages/Problems

- As with all underground infiltration systems, these systems are difficult to monitor, and may be difficult to replace if they are installed under paved areas.
- If used on single family residences, provisions should be made for maintenance responsibility, perhaps through the homeowner's association.

Specific Limitations

- Roof downspout systems are meant only to be used in areas where there is no significant depositional air pollution. Advice on this should be sought from Ecology or local agencies responsible for managing air quality if the residence is near major sources of air pollution.

Design Criteria

The design criteria for infiltration trenches also applies to roof downspout systems with the following exceptions and/or additions:

Trenches Installed Under Pavement

- Trenches may be located under pavement provided that a small yard drain\ catchbasin with a grate cover is placed at the end of the trench pipe such that if the trench infiltration capacity is exceeded, the overflow would occur out of the catchbasin at an elevation at least 1 foot below that of any overlying pavement, and in a location which can accommodate the overflow and meet the requirements of Minimum Requirement #2 (Preservation of Natural Drainage Systems).

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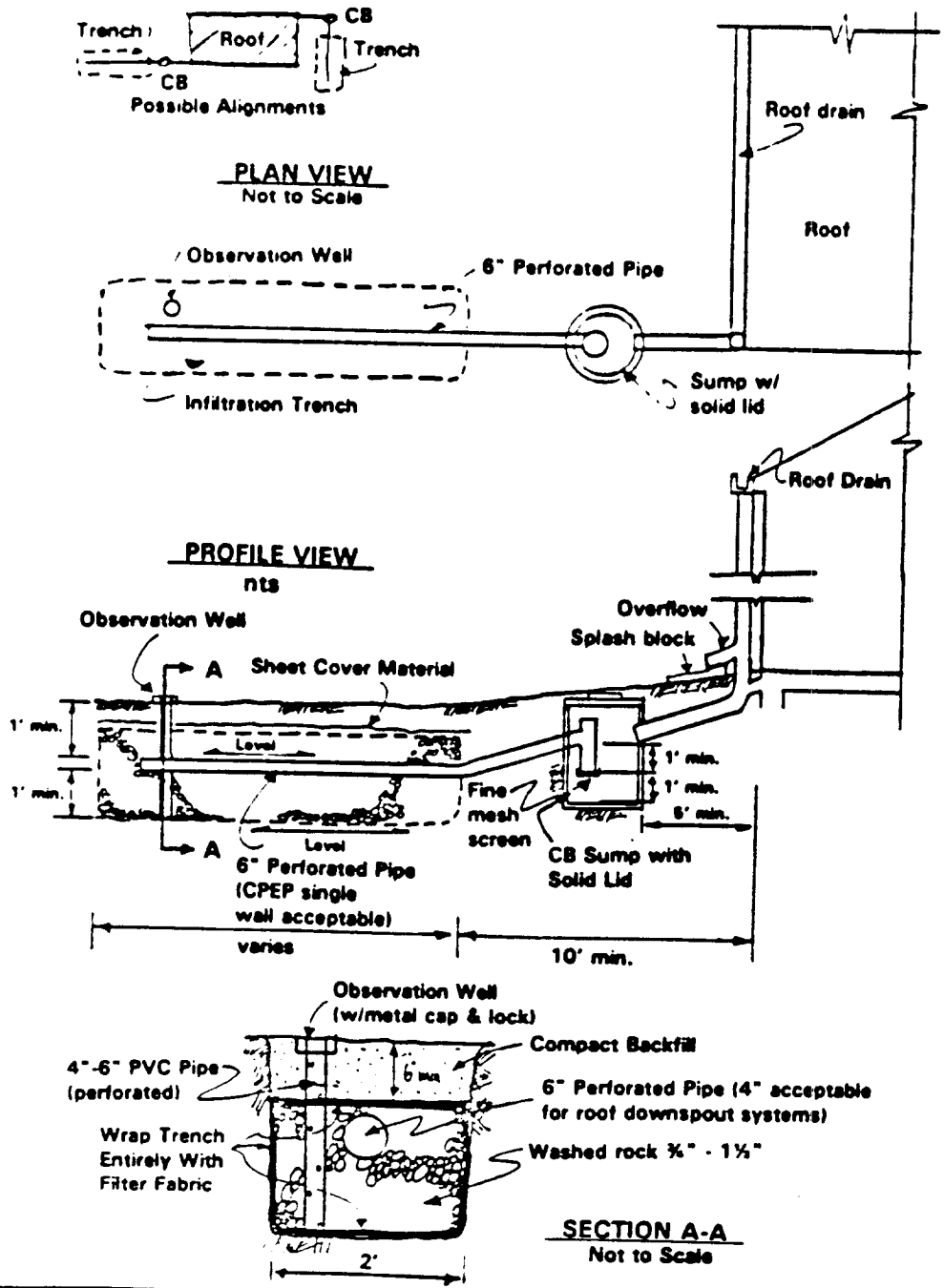
Figure III-3.17 Roof Downspout System



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Other Requirements

- Roof downspout systems shall be a minimum of 10 feet from any structure, property line, or NGPE, and 30 feet from any septic tank or drainfield.
- Roof downspout systems shall be a minimum of 50 feet from any steep slope.
- The length of a roof downspout system should not exceed 100 feet from the inlet sump.
- Each roof downspout system shall have an observation well similar to that described for an infiltration trench. It should extend to the bottom of the trench and be located at a point approximately halfway in length.
- Filter fabric shall be wrapped entirely around the aggregate rock prior to backfilling.

Construction and Maintenance Criteria

Construction Specifications

Construction specifications are identical to those for infiltration trenches.

Maintenance

Maintenance procedures are identical for those of an infiltration trench. It is important to consider the fact that since these facilities are installed on individual structures, provision needs to be made for the maintenance of these structures, especially when the systems are installed on single family dwellings.

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III-3.6.7 BMP RI.20 Water Quality (WQ) Porous Pavement

Purpose and Definition

This BMP is an open-graded asphaltic aggregate designed to primarily provide runoff treatment and not streambank erosion control and serves the same function as a Water Quality Infiltration Basin (BMP RI.05). The pavement is underlain by permeable soils capable of removing pollutants but which is unlikely to have sufficient permeability for streambank erosion control purposes. A typical porous asphalt paving cross section is presented in Figure III-3.18.

There are two types of porous pavement - porous asphalt pavement, and pervious concrete pavement.

Porous asphaltic paving material consists of an open graded coarse aggregate cemented together by asphalt cement into a coherent mass, with sufficient interconnected voids to provide a high rate of permeability to water. A typical porous asphalt paving cross section is presented in Figure III-3.18.

Pervious concrete consists of specially formulated mixtures of Portland Cement, uniform open graded coarse aggregate (WSDOT #8 or #89, ⅜ inch to no. 16 or no. 50 recommended), and potable water. This material may be combined with certain water reducing and retarding or accelerating admixtures along with air entraining agents. When properly handled and installed pervious concrete has a high percentage of void space which allows rapid percolation of liquids through the pavement. Figure III-3.20 illustrates a pervious concrete section.

Planning Considerations

This BMP serves a similar function as a Water Quality Infiltration Basin (BMP RI.05) and has similar planning considerations.

Appropriate soil conditions and the protection of ground water are among the important considerations which may limit the use of the BMP. See Section III-3.3 for a description of General Limitations.

This BMP will typically be located off-line from the primary conveyance/detention system because streambank erosion control is generally not provided. Water Quality Infiltration BMPs must always be preceded by a pretreatment BMP to remove suspended solids that could clog the infiltration soils. Drainage areas can be up to 15 acres for porous pavement. Additional information specific to porous pavement is provided below.

Conditions Where Practice Applies

This practice is applicable as a substitute for conventional asphalt pavement on parking areas and low-traffic volume roads provided that the grades, subsoil drainage characteristics and ground water table conditions are suitable for such use. In general the grades should be very gentle to flat, subsoil shall have moderately rapid permeability (f > 0.50 in/hr) and the depth to the water table or bedrock shall be at least 3 feet.

Possible areas for use of this paving material include:

(1) Parking lots, especially fringe or overflow parking areas;
(2) Parking aprons, taxiways, and runway shoulders at airports;
(3) Emergency stopping and parking lanes and vehicle cross-overs on divided highways; and
(4) Low-traffic volume roads.

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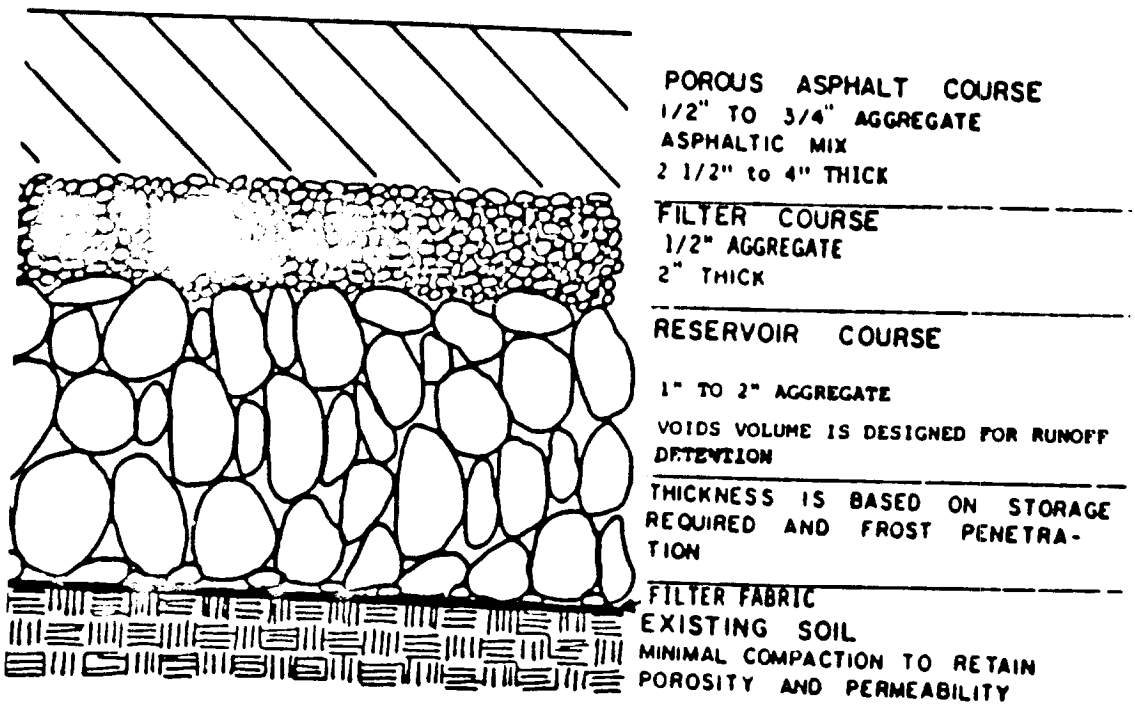
Figure III-3.18
Typical Section of Porous Asphalt Paving
(Modified after Diniz, 1980 and City of Rockville, Maryland, 1982)



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Advantages

- Generally, ground water recharge rates are slightly higher under porous pavement than under natural conditions, as vegetation is absent and soil water is not transpired during the summer months. Up to 60-90 percent of the annual rainfall volume deposited on porous pavement sites is diverted to ground water.
- Tests have shown that there is up to 15% less hydroplaning and skidding on porous pavement surfaces. This decrease in hydroplaning is particularly important on airport runways. One test showed that the friction coefficient on porous pavement increased under wet conditions.
- Because water is rapidly transferred from the surface of the pavement, there is less puddling, which is an advantage to motorists in parking lots. Also because of the reduced puddling, there is less headlight reflectivity off the surface and pavement markings are more visible.
- Tire noise is less on porous pavement.
- Construction costs may be reduced because of the partial or complete elimination of curbs, drains and storm sewers.
- Porous pavement helps to maintain natural drainage boundaries and patterns, and roadside vegetation because of increased soil moisture.

Disadvantages

- A drawback of porous pavement is its tendency to clog if improperly maintained. Once it is clogged, it is difficult and costly to rehabilitate, and often must be completely replaced. Clogging can be prevented most easily by not installing it in areas where erosion is a concern, and by waiting until all other phases of construction are complete and vegetation is stabilized to install the pavement.
- Another concern is the lack of expertise of most pavement engineers and pavement contractors. A very high level of workmanship is required throughout the construction process, as porous asphalt needs to be handled with great care in order for it to retain its porous qualities.
- Some building codes may not allow for the installation of porous pavement, if for example, curbs and gutters are arbitrarily required.
- If spills occur, they must be immediately vacuumed up followed by a jet wash. This treatment will restore permeability to almost prespill levels (95%). Gasoline spillages will break down the asphalt binder to greater depths than in conventional pavements. Tar binders may work better than an asphalt binder to help prevent breaking down.
- Tests in Arizona showed that there was a slightly higher amount of wheel rut deformation in porous pavement than in conventional pavement, but this stabilized after the first few months. There is also the potential for areas of collapsed pores due to constant vehicle braking in one spot, for example at the beginning of curves or in the entry way of a parking lot.
- Narrow porous strips should not be placed between areas of impervious pavement. Often the edges become very clogged, and there is distress to the impervious pavement due to differential support caused by the additional moisture content of the pervious subgrade.
- A potential problem, especially in the Pacific Northwest, is the possibility of development of anaerobic conditions in the underlying soils as soils are unable

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to dry out between storms. When this occurs, aerobic bacteria cannot reduce organic pollutants. Also in a wet subgrade, the soil may not support the design load. These problems can be solved by designing this BMP to drain the 6-month, 24-hour design storm within 24 hours and, if necessary, installing an underdrain system.

Design Criteria - General

As this BMP serves a similar function as the Water Quality Infiltration Basin (BMP RI.05) that BMP should be referenced for criteria. Basic design criteria is given in the following sections of this manual:

Hydrologic Analysis - Chapter III-1
General Infiltration Design Criteria - Section III-3.4

The following design criteria applies to all water quality infiltration BMPs:

- General - The construction of structures, materials allowed, accessibility for maintenance, safety measures, easements, and hydraulic design methods shall be the same as those required for detention basins in Chapter III-4.
- Soils Investigation - A minimum of one soils log shall be required for each 5,000 square feet of infiltration surface area (plan view area) and in no case less than three soils logs per basin. Each soils log shall extend a minimum of 3 feet in depth below the bottom of the proposed BMP, describe the SCS series of the soil, the textural class of the soil horizon(s) through the depth of the log, and note any evidence of high ground water level, such as mottling. In addition, the location of impermeable soil layers or dissimilar soil layers shall be determined.
- The design infiltration rate, f_d, will be equal to one-half the infiltration rate found from the soil textural analysis.
- Pretreatment - Water Quality Infiltration BMPs must be preceded by a pretreatment BMP. See Chapter I-4 to select appropriate pretreatment BMPs.
- Slopes - This BMP should be a minimum of 50 feet from any slope greater than 15 percent. A geotechnical report should address the potential impact of the BMP infiltration upon the steep slope.
- Buildings - This BMP should be a minimum of 100 feet upslope and 20 feet downslope from any building.
- Surface Area - The infiltration surface area (A_s) used for sizing the BMP shall be computed by measuring the surface area (plan view area) below the maximum design water surface.
- Drawdown Time - Water Quality Infiltration BMPs shall be designed to completely drain stored runoff within one day following the occurrence of the 6-month, 24-hour design storm. Thus, a maximum allowable drawdown time of 24 hours shall be used. This will ensure that the necessary aerobic conditions exists in order to provide effective treatment of pollutants. If a Presettling Basin (BMP RD.10) precedes the porous pavement, the *combined* drawdown time for both BMPs should be 24 hours.

The design procedures described in Sections III-3.4 and III-3.6.2 (Water Quality Infiltration Basin, BMP RI.05) should be used to design a Water Quality Porous Pavement system. A summary of several of the criteria is as follows:

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- Soils investigation must be conducted.
- Design infiltration rate should be ½ of that found by the soils investigation
- Pretreatment of the 6-month, 24-hour storm is necessary to control siltation
- Drawdown time should be a maximum of 24 hours for the 6-month, 24-hour design storm.

The six General Limitations must be satisfactorily met before porous pavement can be utilized (Section III-3.3).

Additional criteria specific to porous asphaltic paving and pervious concrete pavement is given below in separate sections.

Construction and Maintenance - General

Construction

See separate sections below for porous asphalt pavement and pervious concrete pavement.

Maintenance (for both types of porous pavement)

Routine maintenance involves removal of debris that is too coarse to be washed through the pavement system. Vacuuming pavement is required to remove particulates that are fine enough to be carried into the pavement but too large to pass through, thus clogging the void space. Porous pavements require no more repair maintenance than conventional pavements, so maintenance problems can generally be reduced to better "housekeeping" practices on the part of area residents and more efficient street cleaning procedure in municipalities.

To preserve the high filtration rate of pervious paving, routine inspection and maintenance is required. The surface should be routinely visually checked (preferably after a prolonged storm event) for evidence of debris, ponding of water, clogging of pores and other damage. Any debris should be immediately removed. An annual cleaning program should be instituted that requires a street sweeper with a vacuum to thoroughly cleanse the surface.

Cleaning

It has long been recognized that maintenance and cleaning of porous pavements to prevent or alleviate clogging would be a factor in the application of such pavements. Sections of porous pavement which have been clogged have been cleaned by various methods. No method has been found satisfactory on fully clogged pavements, however, and, only a superficially clogged section showing a water penetration rate of 0.1 inches per second compared to a normal water penetration of 0.38 inches per second can be restored to normal operation. The best method for cleaning is brush and vacuum sweeping followed by high pressure water washing of the pavement. In Maryland, it has been determined that vacuum cleaning alone, once the pavement is clogged, will be largely ineffective. The oils, especially in porous asphalt, bind dirt and only an abrading and washing technique can be effective in its removal. Clogging to a depth of 0.5 inch is sufficient to prevent water penetration.

If, during visual inspection, any ponding or clogging is noticed, the following program should be carried out to correct the problem. First, a street sweeper with a vacuum should be used. If ponding persists, steam cleaning with a biodegradable substance can be applied, then vacuuming done. If the clogging is at a depth greater than ½ inch, ½ inch diameter and one (1) foot on-center holes can be drilled through concrete pavement. Hand drilling or tandem drill rigs may be used. All drilling debris should be vacuumed from the pavement.

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Replacing Clogged Pavement

Once a large area of porous pavement is fully clogged and it cannot be adequately cleaned, the paving must be removed to a depth where the clogging is not evident and new porous paving filled in. In extreme cases, the affected area must be removed and new topping put down. Since these materials are relatively new, obtaining a patching mix suitable to match the installed pavement may be difficult. Available patching material is usually dense graded at present. If the subbase becomes clogged, the pavement must also be saw cut and removed. Six to twelve inches of the subbase will usually need to be replaced with clean sand, then proof rolled. Pervious paving will then need to be filled in.

Porous Asphalt Paving - Additional Planning, Design, and Construction Criteria

The nature of each individual site will determine the design of the porous paving to be placed on it. A thorough prior examination of the site is of primary importance to the proper functioning of the porous pavement. Each case is different depending upon the site and particularly: soil and climate conditions; the wear expected on the surface itself; and the objectives of the particular use of the porous surface. An overview of the steps to be taken is provided below:

- Examine the site to determine its drainage. Walk over it and the surrounding area; examine the topographic and soil maps and take soil cores and examine the horizons.
- Examine the various soils to determine their permeability. Run gradation tests of the soil cores to determine textural classification and use values in Table III-3.1 to obtain infiltration rates.
- Determine the load bearing capability of the soil by lab test or categorically from soil maps. Design a pavement to carry the load and meet frost conditions. For each possible design, calculate the required base course thickness, considering grades.
- Determine the design storm volume.
- Evaluate the level of control provided by the porous asphalt paving.
- Consider ways to augment percolation or flow of water from the base course, if soil percolation is slow.
- Compare the most attractive options for probable cost, and complete the design using the most favorable one.
- Prepare specifications for materials, product installation, and maintenance and test.

The logic of the design steps listed above is shown in Table III-3.3.

Soil Borings

Test soil borings should be taken to determine the character and permeability of the soil. The ability of the soil to percolate the water passing through the pavement will determine the thickness of the base reservoir required. In some cases where the infiltration rate is moderate, an alternate approach may be applicable for the removal of water from the base reservoir to the water table, such auxiliary drainage as described below under "Other Applications of Porous Asphalt Paving."

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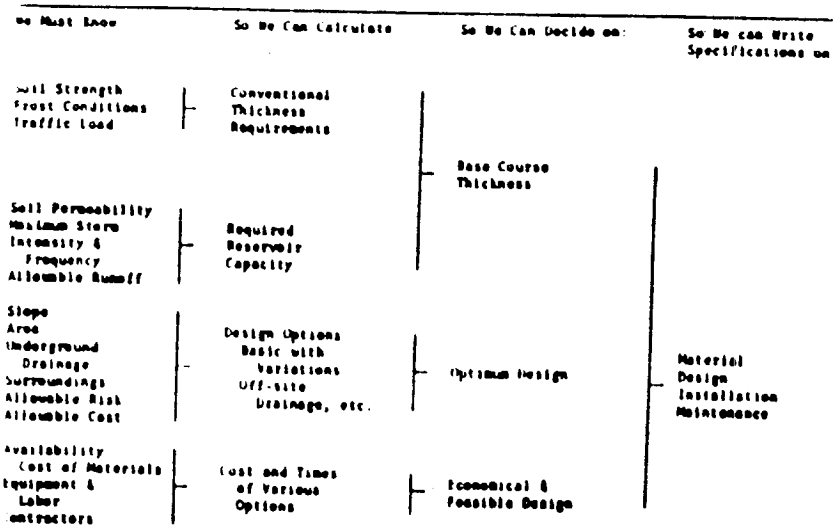
Table III-3.3
Design Scheme for Porous Paving



Source: Thelen and Howe, 1978 (2)

Storage Time (Drawdown Time)

All porous paving installations shall be designed to drain the runoff from the 6-month, 24-hour storm within 24 hours.

Frost Heave

Soils capable of resisting frost heaving have been defined by a triangular chart, Asphalt Institute Publication MS-15 (1966); essentially the total clay and silt content of the subgrade soil must be less than 40 percent by weight. If a soil with a high susceptibility to frost heaving is being considered, for example a silt loam, the reservoir base course must extend below the frost line to allow for adequate drainage. This depth below the frost line may actually exceed the depth of storage required to control the runoff volume from the site.

Pavement Design

The design of porous asphalt pavements equivalent to conventionally constructed pavements will depend primarily on the load-bearing capacity of the subgrade, the expected traffic volume, and the storage capacity of reservoir and base. Specifications of the Franklin Institute Research Laboratories have been used to design the porous asphalt pavement roadways illustrated in Table III-3.4.

The traffic intensity will be a factor in the design depth requirement of the porous pavement. The traffic intensity is defined by the average daily Equivalent Axle Load (EAL), based on the equivalent of 18,000 pounds (18 Kips) axle load in the design lane. In most cases, the application of porous asphaltic pavement will be restricted to light traffic and parking lots. Thus, a minimum pavement thickness, from the top of the pavement to the subgrade soil, will generally be 9 inches to handle traffic intensity.

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Table III-3.4 Minimum Thickness of Porous Paving for Various Loading Conditions

Traffic Group	General Character	15 +	10 - 14	6 - 9	<5*	EAL
1	Light Traffic	5"	7"	9"		5 - less
2	Medium Traffic (max 1000 VPD)	6"	8"	11"		6 - 20
3	Medium Traffic (max. 3000 VPD)	7"	9"	12"		21 - 75

* Studies indicated that for all traffic areas (1,2,3) with a CBR of 5 or less, the subgrade was improved to CBR 6 with crushed stone 2" size
VPD = vehicles per day
EAL = equivalent axle load (18 kips) average daily

Source: Thelen and Howe, 1978 (2)

Factor of Safety in Design

Some pavement designers have suggested that because open graded mixes are not as strong as dense graded mixes, the pavement thicknesses suggested in Table III-3.4 might be insufficient and need to be increased. However, with normal and proper construction practices, sufficient subgrade compaction should be achieved so that with a well-drained subgrade, a minimum CBR of 6 or 7 could be used quite safely. These higher CBR values permit pavements to be considerably thinner, so it is assumed that there is an adequate safety factor built into the specifications given in Table III-3.4. Further refinement of these designs is anticipated as a result of increased use of these materials.

Calculation of Void Space

Void space should be calculated according to the testing procedure recommended in Federal Highway Administration Report No. FHWA-RD-74-2, Design of Open-Graded Asphalt Friction Courses (4). The volume of the sample should be measured mechanically rather than calculated from a water displacement method because a great deal of water is absorbed.

Aggregate Gradation

Porous asphaltic concrete pavement requires gradation of the "open" graded type as contrasted to the "dense" graded type which is capable of close packing. Aggregate specifications are given in Table III-3.5. Open graded mixes, due to their relatively high permeability to air and water, provided good resistance and durability to freeze/thaw conditions and to asphalt film oxidation.

Type and Quality of Aggregate

The aggregates selected for porous pavement construction should meet requirements of the standard specification for "Crushed Stone, Crushed Slag, Pavements," ASTM D 693-77, with two exceptions. First, the gradation test must be of the open graded type described here. Second, a soundness test is required, as specified in ASTM D 692-79, Coarse Aggregate for Bituminous Paving Mixtures," to determine if the aggregate is susceptible to disintegration by water.

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Table III-3.5
Aggregate Specifications for Porous Asphalt Paving

U.S. Sieve Series Size	Opening (mm)	Specification: Percent Passing by Weight
½ inch	12.70	100
⅜ inch	9.51	95-100
#4	4.76	30-50
#8	2.38	5-15
#200*	0.074	2-5

* Aggregate should be uniformly graded between the #8 and #200 sieves.

Asphalt Cement Grade in Mix

The suggested viscosity grade of asphalt cement to be used is AC-20 of AASHTO M-226-73 I. This grade is to be considered a tentative starting point because test results obtained from the design process may produce either an advantage or a necessity to alter the asphalt grade.

Mixing Temperature

To ensure that the individual aggregate particles are completely surrounded by asphalt, and that the asphalt is tightly bound to each particle, temperature of mixing at the hot mix plant shall be rigidly controlled. Too low a mixing temperature will result in inadequate asphalt binding and coverage of the aggregate, while too high a mixing temperature will allow asphalt to drain from the mix, resulting in a lower asphalt content and decreased strength. Suitable mixing temperatures range from 230 to 260 degrees Fahrenheit, but the lower end of that range (230° to 240° F) is recommended.

Asphalt Content in Mix

For road paving durability and to prevent too rapid hardening of the asphalt, it is desirable to have the highest asphalt content possible in the mix. Too much asphalt would separate out under traffic, so the maximum asphalt content is generally limited by that factor. Experience has shown that 5.5 percent by weight is the minimum recommended asphalt content. Asphalt content should be determined according to the testing procedure recommended in Federal Highway Administration Report No. FHWA-RD-74-2, already cited. The Marshall Design method for determining mix content is not recommended. Using a 5.5 percent asphalt content and the Asphalt Institute's recommended 4-inch minimum surface course, a 0.6-inch rainfall reservoir capacity is obtained with an infiltration rate of 176 inches per hour.

Hydrologic Note

It should be noted that when porous asphalt paving is designed without a positive drain, the design situation is analogous to an infiltration trench. The porous paving may be designed as a subsurface detention system with hydrologic soil groups that have a slow infiltration rate.

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Other Applications of Porous Asphalt Paving

On sites where the subgrade soil infiltration rate is slow, porous asphalt paving has been used to provide subsurface detention of stormwater runoff. There are a number of available drainage designs capable of adequately removing the water remaining in the reservoir base course. Several of these are illustrated in Figure III-3.19 and described below:

(a) French Drain. This system utilizes coarse open-graded rock in relatively deep pits or trenches. This type of drain can be expanded out at the lateral edges of a roadway to provide a deeper system with more water holding capacity, so that the water has more time to percolate through a less permeable subgrade. Such a system is shown in Figure III-3.19(c).

(b) Sand Drain. This system is similar to the French Drain, but the coarse open-graded rock also contains enough fines to prevent intrusion of adjacent soil which may tend to clog the drain. This clogging is dependent upon the nature of the subgrade soil. Again this system could be expanded to provide more water holding capacity (see Figure III-3.19(d)).

(c) Two-Layer Systems. With this type of system a subbase is provided as a filter medium. The coarse open rock drain layer (base) is protected by a suitable filter layer (subbase) such as clean concrete sand. This system should provide excellent resistance to clogging and excellent drainage capacity even after numerous years of service. This system is shown in Figure III-3.19(e).

(d) V-Trench Water Removal to Pond. A positive method of removal of water contained in a French Drain type system is to use the base material as a drain for transport to a relatively shallow V-trench at a low point in the cross section of the roadway. If a heavy volume of water is expected, it may be advisable to obtain greater drain capacity by construction of a 2-layer system. If an appreciable gradient is involved, a cross drain should be placed at the downhill end of the cut. This will intercept any water flowing longitudinally which if not drained could saturate the fills and cause slumping of the fill slopes. The V-trench shown in Figure III-3.19(f) could be emptied into a storage pond or other suitable drainage system. The profile of a road showing cross drains that empty into the V-trench is shown in Figure III-3.19(g).

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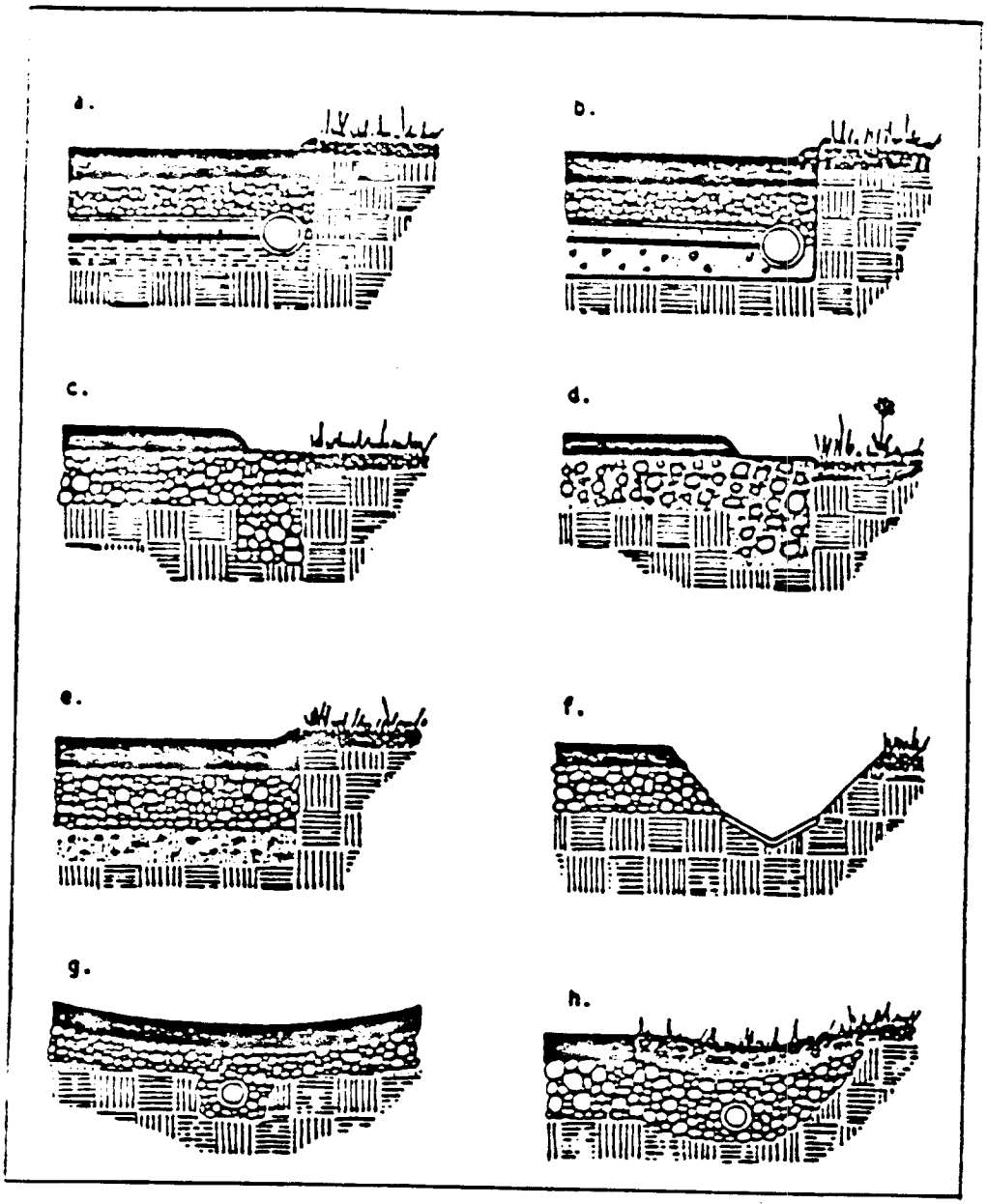
Figure III-3.19 Porous Asphalt Paving Drainage Systems



Source: Thelen, et al. (3)

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(e) Pipe Drains. Subgrade soils which are for all practical purposes impervious to water would necessitate the use of pipe drains. The pipe is generally perforated with ¼ to ⅜-inch diameter holes, placed in two or more double rows 90° to 120° apart running lengthwise on the bottom half of the pipe. Materials of construction include aluminum alloys, cast iron, clay, concrete and plastic. They are available in sizes ranging from 4 inches to 120 inches and larger in diameter. The sizes and type pipe to be used would be determined by the conditions set for drainage. Such a system is shown in Figures III-3.19(a), (b), and (h).

Alternative Construction Methods and Specifications Adapted from the Construction Specifications of the City of Rockville, Maryland

Stabilization

To preclude premature clogging and/or failure of this practice, porous asphalt paving structures shall not be placed into service until all of the surface drainage areas contributing to the pavement have been effectively stabilized in accordance with Erosion and Sediment Control Requirement (Minimum Requirement #1). See Chapter I-2.

Subgrade Preparation

Alter and refine the grades as necessary to bring subgrade to required grades and sections as shown in the drawings.

The type of equipment used in subgrade preparation construction shall not cause undue subgrade compaction. (Use tracked equipment or oversized rubber tire equipment; DO NOT use standard rubber tired equipment.) Traffic over subgrade shall be kept at a minimum. Where fill is required, it shall be compacted to a density equal to the undisturbed subgrade, and inherent soft spots corrected.

Aggregate Base Course

All stone used shall be clean, washed, crushed stone, meeting local highway department specifications.

Aggregate shall be of two sizes: the reservoir base course shall be to depth as noted on drawings of aggregate (maximum of 2-inch, minimum of 1 inch), and a 2-inch deep top course of ¼-inch aggregate (maximum of ⅜-inch, minimum #4-inch).

Aggregate base course shall be laid over a dry subgrade covered with engineering filter fabric to a depth shown in drawings, in lifts to lay naturally compacted. The stone base course shall be compacted lightly. Keep the base course clean from debris and sediment.

Porous Asphalt Surface Course

The surface course shall be laid directly over the ¼-inch aggregate base course and shall be laid in one lift.

The laying temperature shall be between 230° and 260°, with minimum air temperature of 50°F, to make sure that the surface does not cool prior to compaction.

Compaction of the surface course shall be done while the surface is cool enough to resist a 10-ton roller. One or two passes by the roller is all that is required for proper compaction. More rolling could cause a reduction in the surface course porosity.

Mixing plant shall certify the aggregate mix and abrasion loss factor and the asphalt content in the mix. The asphaltic mix shall be tested for its resistance to

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stripping by water using ASTM D 1664. If the estimated coating area is not above 95 percent, anti-stripping agents shall be added to the asphalt.

Transportation of mix to site shall be in clean vehicle with smooth dump beds that have been sprayed with a non-petroleum release agent. The mix shall be covered during transportation to control cooling.

Mix of asphalt shall be 5.5 to 6 percent of weight of dry aggregate.

Asphalt grade shall meet AASHTO Specification M-20 for 85 to 100 penetration road asphalt as a binder in the northern United States.

Aggregate grading shall be as specified in Table III-3.6.

Table III-3.6 Porous (Open-Graded) Asphalt Concrete Formulation

Material	Screen	Probable Particle Data				
		Weight (%)	Volume (%)	Width (mm)	Weight (g)	No. in 100g of asphalt concrete
Aggregate	Through ½	2.2	2.2	10.7	1.667	1.7
	Through ¼	59.6	46.3	8.0	0.697	85.5
	Through #1	17.0	13.3	4.0	0.087	195.4
	Through #6	2.8	2.2	2.0	0.0109	255.6
	Through #16	10.4	8.0	1.0	0.00136	7647.0
	Through #200	1.9	1.5	0.06	0.000294	6462.0
	Asphalt	5.5	10.5			
	Air	0	16.0			
Sub-total Coarse Aggregate (½ - #1)		79.4	61.8			282.6
Sub-total Other		20.6	38.2			14364.6
Total		100.0	100.0			14647.2

Source: City of Rockville, Maryland

Protection

After final rolling, no vehicular traffic of any kind shall be permitted on the pavement until cooling and hardening has taken place, and in no case less than 6 hours (preferably a day or two).

Workmanship

Work shall be done expertly throughout and without staining or damage to other permanent work.

Make transition between existing and new paving work neat and flush.

Finished paving shall be even, without pockets, and graded to elevations shown.

Iron smoothly to grade, all minor surface projections and edges adjoining other materials.

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Certification

A professional engineer, registered in the State of Washington, shall certify compliance with these specifications.

Pervious Concrete - Additional Planning, Design, and Construction Criteria

Introduction

Figure III-3.20 illustrates a typical pervious concrete pavement section.

Pervious concrete contains a large percentage by weight of aggregate larger than a number four sieve (0.185 inches). Pervious concrete is also referred to by several other names such as open graded mix, gap graded mix, draincrete, popcorn mix, no fines mix or porous concrete. Pervious concrete has a high void space, at least 15% is required and a coarse surface texture. The water-cement ratio is low, 0.20 - 0.40, and the slump is extremely low, often zero.

Excessive amounts of water yield a paste which is too fluid and flows off the aggregate particles, reducing cohesion and filling the voids in the lower part. Too little water results in a paste which does not adhere to the aggregate particles, leading to insufficient cohesion. The quantity of cement paste and water is considered sufficient when it coats the coarse aggregate with a shiny film, giving it a metallic gleam. A typical mix provides a permeability of about 2.3 gallons per minute per square foot. Higher percolation rates are possible with higher void contents, but higher void contents also produce lower strengths.

Compressive and flexural strengths of pervious concrete are somewhat lower than those of conventional portland cement concrete, due to the higher void content and lower unit weight. Compressive and flexural strengths are dependent on the water-cement ratio, aggregate-cement ratio, unit weight, void content and aggregate shape and size. The flexible nature of this pavement means that the subgrade condition is extremely important to the performance of the pavement.

The method of handling and placing are different from other types of concrete. Only concrete firms and contractors familiar with the intricacies of porous concrete should be used and then only if a Professional Engineer, with training and experience in porous concrete, is present during paving. Pervious concrete is placed into location and not poured as is conventional concrete. The time lapse between batching and placement should be kept as short as possible. Due to its low water-cement ratio, hydration of the cement will proceed faster and strengths may be impaired from delays in placement. Pervious concrete is placed with a minimum of handling. Best results have been obtained by using a vibratory screed, or vibratory bullfloat for small jobs. These may have to be modified by adding extra weight. For uniform compaction it is advisable to have an inch of material along the base of the screed, while moving it over the concrete surface. Hand troweling or finishing is neither required nor desirable, as this will close up the voids and impair the drainage characteristics.

When a vibratory screed is used, its forward movement over the concrete should not be stopped unless the vibrating mechanism is also stopped. Otherwise, there will be variations in the surface texture of the concrete. A straightedge for manual screeding should be available on jobs using a vibratory screed. In the event of machine breakdown, this will permit uninterrupted unloading of the mixer trucks and avoid extended mixing with attendant loss in voids and change in consistency.

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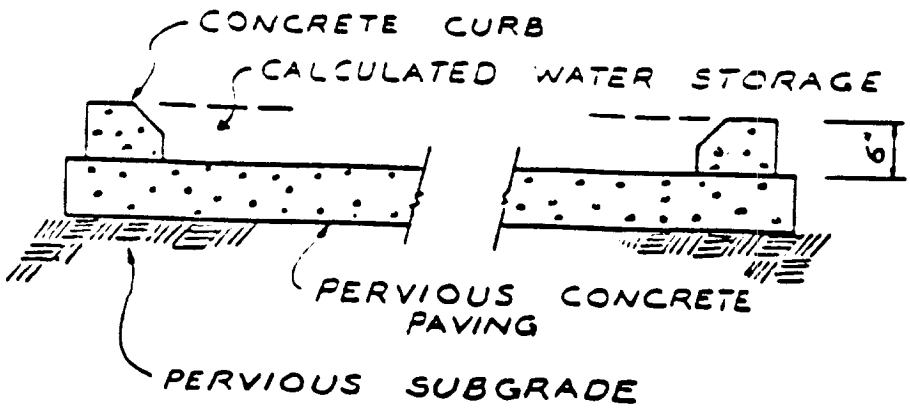
Figure III-3.20 Pervious Concrete Pavement Typical Section





A close-up view of no-fines concrete

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The screeding operation must be followed by two passes with a garden roller. This is to assure that any loose particles become well embedded in the pavement surface. Curing is a very important factor with pervious concrete. With the high void percentage, rapid drying is a far more serious problem because the dry paste fails to bond the aggregate particles together. Therefore, adequate moist curing is essential. The pervious concrete should be sprayed shortly after screeding with a light mist so as not to wash the cement paste off the aggregate. It is then covered with impervious sheets for at least the first three days, and preferably for a longer period.

A typical cross-section of pervious concrete is illustrated by Figure III-3.20. These installations are different from porous asphaltic pavement, primarily due to the type of cementing agent that is used in the surface course (e.g., portland cement as opposed to asphalt). However, it is also noticeable that the pavement may be placed directly on the shaped and graded existing sandy soil (pervious subgrade).

Retention storage of up to six inches maximum depth is provided on the surface of the pavement as well as within the voids in the concrete. The load bearing ½-inch aggregate base, the open graded coarse aggregate subbase, and filter fabric that were shown with the porous asphalt cross-section (Figure III-3.18) are often not used. When a subbase is required for stability, up to six inches of clean durable quartz sand (WSDOT 902 Fine Aggregate) or equivalent is substituted for crushed stone. The concrete is then placed directly on this lightly compacted subbase.

However, the manufacturer of the patented porous concrete paving process includes both the ½-inch bearing course and the open graded subbase in their design. A layer of compacted sand is used between the subbase and the existing soil to prevent the migration of fine material in the surrounding media from migration into the subbase. Certainly this design would provide for more strength and stability and would be preferred in anything exceeding light duty applications.

Design Manual

A manual relating to mixing, hauling, placing, testing and suggested design procedures for use of pervious concrete is available through the Florida Concrete and Products Association, 649 Vassar St., Orlando, FL, 32804 at a nominal fee. This comprehensive manual will assist material suppliers, contractors, specifying agencies and design professionals in the proper procedures used to place portland cement pervious pavements.

At a minimum, the following interim specifications should be followed for the manufacture and placement of pervious concrete pavement.

1) Materials

Locally available materials having a record of satisfactory performance are recommended.

a) The cement used for these facilities shall be Portland Cement Type I or II conforming to ASTM C-150 or Portland Cement Type IP or IS conforming to ASTM C-595. Fly ash conforming to ASTM C-618 may be used in amounts not to exceed 20% of total cementitious material. Ground iron blast-furnace slag conforming to ASTM C-989 may be used in amounts not to exceed 50% by weight of total cementitious material.

b) Use Washington Department of Transportation (WSDOT) No. 8 coarse aggregate (⅜ inch to No. 16) ASTM C-33 or No. 89 coarse aggregate (⅝ inch to No. 50) ASTM D-448. For designs incorporating fine aggregate, it shall conform to WSDOT Specifications 902. Other gradation of aggregate may be used, subject to approval of the local government.

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c) Air Entraining Agent: Shall comply with ASTM C-260.

d) Admixture: Type A water reducing; Type D water reducing and retarding; Type E water reducing and accelerating; In accordance with ASTM C-494

e) Water: Potable

2) Proportions

a) For pavements subjected to other than light vehicular traffic, the total cementitious material shall not be less than 600 lbs. per unit.

b) The volume of aggregate per unit shall be equal to 27 cu.ft. when calculated as a function of the rodded unit weight determined in accordance with ASTM C-29.

Fine aggregate, if used, should not exceed 3 cu.ft. (rodded unit weight in accordance with ASTM C-29) and shall be included in total aggregate volume.

c) Admixtures shall be used in accordance with the manufacturer's instructions and recommendations.

d) The quantity of mix water shall be such that the cement paste displays a "wet-metallic" sheen, without causing the paste to flow from the aggregate. Insufficient water will result in a dull appearing paste of inadequate consistency.

3) Subgrade Preparation and Formwork

a) The top 6 inches of the subgrade shall be composed of granular or gravelly soil that is predominantly sandy with no more than a moderate amount of silt or clay.

b) Prior to placement of Portland Cement Pervious Pavement, the subgrade shall be tested for rate of permeability by double ring infiltrometer, or another suitable test of subgrade soil permeability.

c) Subgrade Support: Material shall be placed and compacted in layers of a thickness that can be compacted to a minimum density of 94 ± 2% of maximum density as determined by AASHTOT-180.

d) Subgrade Moisture: The subgrade shall be in a moist condition with no free standing water prior to pavement placement.

e) Forms: Forms may be of wood or steel and shall be the depth of the pavement. Forms shall be of sufficient strength and stability to support mechanical equipment without deformation of plan profiles following spreading, strike-off and compaction operations.

4) Mixing, Hauling and Placing

a) Truck mixers shall be operated at the speed designed as mixing speed by the manufacturer for 75 to 100 revolutions of the drum.

b) The portland cement aggregate mixture may be transported or mixed on site and should be used within one (1) hour of the introduction of mix water, unless otherwise approved by an engineer.

c) Each mixer truck should be inspected for appearance of concrete uniformity according to preceding Section (2d). Water may be added to obtain the

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required mix consistency. A minimum of 20 revolutions at the manufacturer's designated mixing speed shall be required following any addition of water to the mix. Discharge shall be a continuous operation and shall be completed as quickly as possible.

d) Placing and Finishing Equipment: Unless otherwise approved by the Owner or Engineer in writing, the Contractor shall provide mechanical equipment of either slipform or form riding with a following compactive unit that will provide a minimum of 10 psi vertical force. The pervious concrete pavement will be placed to the required cross-section and shall not deviate more than ± ¼-inch in 10 feet from profile grade. If placing equipment does not provide minimum specified unit weight, a full width roller or other compaction device that will provide a compactive effort to meet unit weight requirement will be used immediately following strike-off operations. After mechanical or other approved strike-off and compaction operations, no other finishing operation will be allowed. If vibration, internal or surface applied, is used, it shall be shut off immediately when forward progress is halted for any reason. The Contractor will be restricted to pavement placement widths of a maximum of fifteen (15) feet unless the Contractor can demonstrate competence to provide pavement placement widths greater than the maximum specified to the satisfaction of the Engineer.

e) Curing procedures shall begin within twenty minutes after final placement operations. A fog mist shall be applied prior to covering all surfaces and exposed edges with a 6-mil thick polyethylene sheet for a period of five days. The covering shall be held down securely to prevent dislocation due to high winds or adjacent traffic conditions.

f) If required, control (contraction) joints shall be installed at 60 foot intervals to a depth of ¼ the pavement thickness. No raveling of the surface will be permitted during the joint installation procedure. Isolation (expansion) joints will not be used, except when pavement is abutting building slabs or other adjoining structures.

5) Testing and Inspection

a) It is strongly suggested that the owner retain an independent testing laboratory. The testing laboratory shall conform to the applicable requirements of ASTM E-329 "Standard Recommended Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction" and ASTM C-1077 "Standard Practice for Testing Concrete and Concrete Aggregates for Use in Construction, and Criteria for Laboratory Evaluation" and shall be inspected and accredited by the Concrete Materials Engineering Council, Inc., or by an equivalent recognized national authority.

The agent of the testing laboratory performing field sampling and testing of concrete shall be certified by the American Concrete Institute as a concrete field testing technician Grade I or by a recognized state or national authority for an equivalent level of competence.

b) A minimum frequency of one (1) test for each day of placement shall be conducted to verify the rodded weight of material as delivered. The test shall be conducted in accordance with ASTM C-172 and C-29. The mix shall be within (+5) five pcf of design unit weight. If outside this range, mix proportions shall be modified to comply.

c) At seven (7) days from placement, a minimum of three (3) cores for each placement shall be taken in accordance with ASTM C-42. The cores shall be used for verification of pavement thickness. Subsequent to thickness verification, core ends shall be trimmed to facilitate volume determination.

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Core unit weight shall be calculated based on weight results when tested in accordance with ASTM C-140 paragraph 14.1 (disregard suspended weight).

Pavement acceptance shall be based on the average unit weight of cores being within ±5 pcf of design weight. The thickness of the pavement recommended is five (5) inches for light traffic loadings. Additional thickness will be required for pavement subjected to frequent heavy axle loadings.

Porous Pavement References

(1) Virginia State Water Control Board, Best Management Practices Handbook: Urban, Planning Bulletin 321, Richmond, Virginia, 1979.

(2) Thelen, E. and L.F. Howe, Porous Pavement, The Franklin Institute Press, Philadelphia. PA, 1978.

(3) Thelen, E. et al., Investigation of Porous Pavements for Urban Runoff Control, prepared by the Franklin Institute Research Laboratories for the U.S. Environmental Protection Agency, NTIS PB-227-5, Springfield, VA, 1972.

(4) Smith, R.W., J.M. Rice and S.R. Spelman, Design of Open Graded Asphalt Friction Courses, Federal Highway Administration, U.S. Department of Transportation, FHWA-RD-74-2, 1974.

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III-3.6.8 BMP RI.21 Streambank Erosion Control (SBEC) Porous Pavement

Purpose and Definition

This BMP is similar to the Water Quality Porous Pavement (BMP RI.20) but is designed to provide only streambank erosion control. Thus, while it physically resembles Water Quality Porous Pavement it's function more closely resembles that of the Streambank Erosion Control Infiltration Basin (BMP RI.06). The soils underlying this BMP will be too coarse for pollution removal and stormwater must be treated prior to discharge to this BMP. There are two types of porous pavement; porous asphalt pavement and pervious concrete pavement.

Porous asphalt paving is presented in Figures III-3.18 and Figures III-3.19. Figure III-3.20 illustrates pervious concrete pavement.

Planning Considerations

Appropriate soil conditions and the protection of ground water are among the important considerations which may limit the use of this BMP. See Section III-3.3 for a description of General Limitations.

This BMP will typically be located "on-line" and be an integral part of the primary conveyance/detention system. The 6-month, 24-hour design storm must be completely treated prior to being discharged to this BMP.

Drainage areas up to 15 acres can be served by this BMP.

Design Criteria

See Water Quality Porous Pavement (BMP RI.20) for design criteria keeping in mind, however, that this BMP serves a different function than BMP RI.20 (i.e., no runoff treatment; streambank erosion control only). As this BMP serves a similar function as the Streambank Erosion Control Infiltration Basin (BMP RI.06), that BMP should be referenced for criteria. Basic design criteria are given in the following sections of this manual:

Hydrologic Analysis - Chapter III-1
General Infiltration Design Criteria - Section III-3.4

The following design criteria applies to all streambank erosion control infiltration BMPs:

- General - The construction of structures, materials allowed, accessibility for maintenance, safety measures, easements, and hydraulic design methods shall be the same as those required for detention basins in Chapter III-4.
- Soils Investigation - A minimum of one soils log shall be required for each 5,000 square feet of infiltration surface area (plan view area) and in no case less than three soils logs per BMP. Each soils log shall extend a minimum of 3 feet in depth below the bottom of the proposed BMP, describe the SCS series of the soil, the textural class of the soil horizon(s) through the depth of the log, and note any evidence of high ground water level, such as mottling. In addition, the location of impermeable soil layers or dissimilar soil layers shall be determined.
- The design infiltration rate, f_d, will be equal to one-half the infiltration rate found from the soil textural analysis.
- Overflow route - An overflow route must be identified in the event that the BMP capacity is exceeded. This overflow route should be designed to meet Minimum

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Requirement #2 (Preservation of Natural Drainage Systems).

- Runoff Treatment - Runoff from the 6-month, 24-hour design storm is to be completely treated prior to discharge to this BMP.
- Slopes - This BMP should be a minimum of 50 feet from any slope greater than 15 percent. A geotechnical report should address the potential impact of the BMP infiltration upon the steep slope.
- Buildings - the potential impacts of infiltration on building foundations must be evaluated.
- The infiltration surface area (A_s) used for sizing the BMP shall be computed by measuring the surface area (plan view area) below the maximum design water surface.
- Spillways - The bottom elevation of the low-stage orifice should be designed to coincide with the one-day infiltration capacity of the BMP. All other aspects of the principal spillway design and the emergency spillway shall follow the details provided for detention basins in Chapter III-4.
- Drawdown Time - Streambank Erosion Control Infiltration BMPs shall be designed to completely drain stored runoff within one day following the occurrence of the 10-year, 24-hour design storm and within two days of the 100-year, 24-hour design storm (with appropriate correction factors as discussed in Chapter III-1). Thus, a maximum allowable drawdown time of 48 hours is permissible.

Additional criteria specific to porous asphaltic paving and pervious concrete pavement is given above under "Water Quality Porous Pavement."

Construction and Maintenance Criteria

Same as for Water Quality Porous Pavement (BMP RI.20).

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III-3.6.9 BMP RI.30 Water Quality (WQ) Concrete Grid and Modular Pavement

Purpose and Definition

Concrete grid and modular pavement are primarily intended to provide runoff treatment in low-volume traffic areas. This BMP must be underlain by soils which have the capability of removing pollutants from runoff. These soils will likely have insufficient permeability to be used for streambank erosion control. Concrete grid and modular pavement consists of strong structural materials having regularly interspersed void areas which are filled with pervious materials, such as sandy loam. Types of concrete grid and modular pavement sections are illustrated in Figure III-3.21.

Planning Considerations

This BMP serves a similar function as the Water Quality Porous Pavement (BMP RI.20) and has similar planning considerations.

Appropriate soil conditions and the protection of ground water are among the important considerations which may limit the use of the BMP. See Section III-3.3 for a description of General Limitations.

This BMP will typically be located off-line from the primary conveyance/detention system because streambank erosion control is generally not provided. Water Quality Infiltration BMPs must always be preceded by a pretreatment BMP to remove suspended solids that could clog the infiltration soils.

Drainage areas up to 15 acres can be served by this BMP.

Conditions Where Practice Applies

Where pavement is desirable or required for low-volume traffic areas and the underlying soils allow for rapid drainage. This practice is most applicable for new construction, but it can be used in existing developments to expand a parking area or even to replace existing pavement if that is a cost-effective measure, or for aesthetic reasons.

Possible areas for use of these paving materials include:

- Parking lots, especially fringe or overflow parking areas.
- Parking aprons, taxiways, blast pads, and runway shoulders at airports (heavier loads may demand the use of reinforced grid systems).
- Emergency stopping and parking lanes and vehicle cross-overs on divided highways.
- On-street parking aprons in residential neighborhoods.
- Recreational vehicle camping area parking pads.
- Private roads, easement service roads and fire lanes.
- Industrial storage yards and loading zones (heavier loads may demand the use of reinforced grid systems).
- Driveways for residential and light commercial use.
- Bike paths, walkways, patios and swimming pool aprons.

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Advantages

- Normally impervious areas are able to accept stormwater runoff and infiltrate it.

Disadvantages

- Modular pavement costs are approximately double the cost of conventional pavement.
- Without good maintenance, the voids in the pavement may become plugged.
- If the soil is only marginally permeable, pollutants may build up near the soil surface, especially in an area such as a parking lot.

Design Criteria - General

For General Design Criteria see Water Quality Porous Pavement (BMP RI.20). Hydrologic design procedures described are in Section III-3.4. A summary of basic design criteria is as follows:

- Soils investigation must be conducted.
- Design infiltration rate should be ½ of that found by the soils investigation
- Pretreatment of the 6-month, 24-hour storm is necessary to control siltation
- Drawdown time should be a maximum of 24 hours for the 6-month, 24-hour design storm. If a Presettling Basin (BMP RD.10) precedes the modular pavement discharge area, the *combined* drawdown time for both BMPs should be 24 hours.

The six General Limitations must be satisfactorily met before this BMP can be utilized (Section III-3.3).

Additional Planning and Design Criteria

Pavement Types (see Figure III-3.21)

Modular pavement systems vary considerably in configuration. Categories include:

1. Poured-in-Place Concrete Slabs -- Reinforced concrete slabs covering large areas are poured in place on the ground to be covered. Special forms are used to shape the void areas, and a flat surface results. Because the slab is reinforced with steel, this pavement is suitable for heavy loads and has maximum resistance to movement caused by frost heave or settling.

2. Pre-Cast Concrete Grids -- Concrete paving units incorporating void areas are usually precast in a concrete products plant and trucked to a job site for placement on the ground. However, for large jobs these units can be formed and cast at the site. There are two types of grid pavers:

   a. Lattice Pavers -- generally flat and grid-like in surface configuration.

   b. Castellated Pavers -- distinguished by a more complex surface configuration characterized by crenels and merlons that are exposed when pervious materials are added. These units show a higher percentage of grass surface.

3. Modular Unit Pavers -- Smaller pavers which may be clay bricks, granite sets, or cast concrete of various shapes. These pavers are monolithic units which do not have void areas incorporated into their configuration. They are installed on the ground to be covered with pervious material placed in the gaps between the units.

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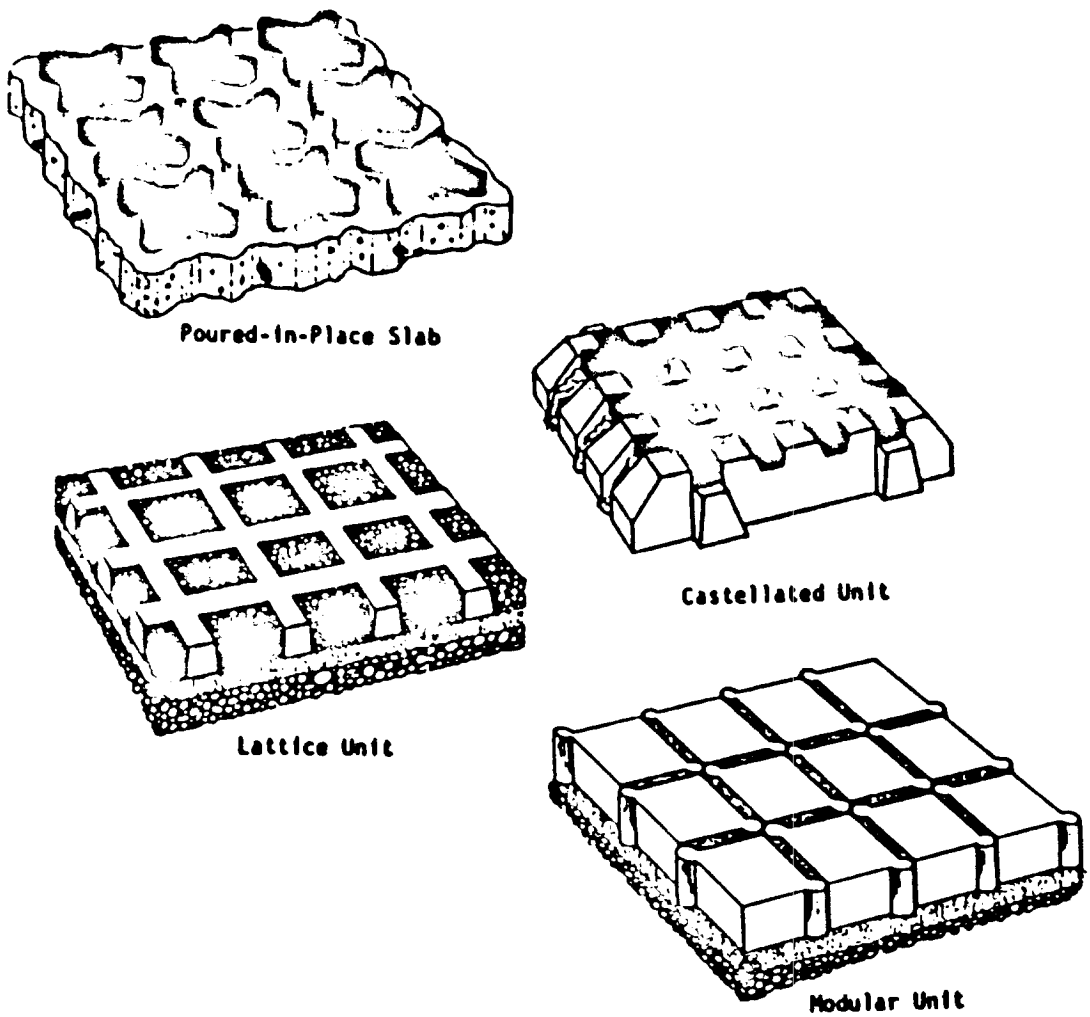
Figure III-3.21 Types of Grid and Modular Pavements



Source: Virginia Soil and Water Conservation Commission

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Production of Units

There are a number of manufacturers of precast concrete grids and unit pavers, and various styles can be purchased from distributors. Forms are required for poured-in-place systems. These systems should be installed by contractors who have been trained in the use of the forms.

Site Characteristics

To determine the suitability of the types of paving materials and to plan and design their installation, the following information about the site should be known:

1. Environmental data: Soil permeability and bearing capacity; slope; depth, direction of movement, natural quality, and confined or unconfined condition of ground water; and surface drainage conditions.

2. Pollution information: Types of pollutants generated by the prevailing and intended land uses and the effect of the practice on pollutants, generally and specifically. Pollution control effectiveness is not currently documented for these products, and applied research is needed.

3. The intended use of the area: This is a key determinant of the choice of paving material. Is the installation temporary or permanent? What type of maintenance will be necessary? Is pavement coloring desired? What type of performance will be required of the paving surface? Can the practice be coupled with other BMPs for increased effectiveness?

4. Pre-development and projected post-development runoff determinations and other hydrologic data: To determine the need for overflow or back-up stormwater facilities, when required by local agencies for flood control. Few manufacturers list runoff or infiltration coefficients for their products, and research on these factors is needed.

Construction and Maintenance Criteria

Construction

All installations of modular pavement should be designed and constructed according to the manufacturer's specifications. To be consistent with other forms of treatment, stored water must be percolated prior to the time limit specified for other on-site retention systems. However, facilities using vegetative cover in combination with pavers must be capable of disposing of stored waters within time limits necessary to avoid damage to the ground cover (24 to 36 hours for most grasses). Parking areas should avoid extensive ponding for periods exceeding more than an hour or two.

In the design of these systems, experience shows a definite potential for large margins of error involved in estimating the infiltration rate of the underlying soils for the purpose of evaluating the storage recovery period. Consequently the use of a safety factor of two or more is normally recommended. This allowance may be accomplished by reducing the percolation rate by one-half its original value.

Maintenance

Where turf is incorporated into these installations, normal turf maintenance -- watering, fertilizing and mowing -- will be necessary. Mowing is seldom required in areas of frequent traffic. It is documented that the hard surfaces in these installations require very little maintenance. However, fertilizers, pesticides and other chemicals may have adverse effects on concrete products. The use of such chemicals should be restricted as much as possible.

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III-3.6.10 BMP RI.31 Streambank Erosion Control (SBEC) Concrete Grid/Modular Pavement

Purpose and Definition

Concrete grid and modular pavement is designed to provide streambank erosion control by infiltrating runoff into the soil. It is not to be used for runoff treatment purposes and should only be used in low-volume traffic areas. Concrete grid and modular pavement is a pavement consisting of strong structural materials having regularly interspersed void areas which are filled with pervious materials, such as sod, gravel, or sand. Types of concrete grid and modular pavement are illustrated in Figure III-3.21.

Planning Considerations

Appropriate soil conditions and the protection of ground water are among the important considerations which may limit the use of this BMP. See Section III-3.3 for a description of General Limitations.

This BMP will typically be located "on-line" and be an integral part of the primary conveyance/detention system. The 6-month, 24-hour design storm must be completely treated prior to being discharged to this BMP.

Drainage areas up to 15 acres can be served by this BMP.

Design Criteria

For General Design Criteria see Streambank Erosion Control Porous Pavement (BMP RI.21). Hydrologic design procedures described are in Section III-3.4.

A summary of basic design criteria is as follows:

- Soils investigation must be conducted.
- Design infiltration rate should be ½ of that found by the soils investigation
- Runoff Treatment - Runoff from the 6-month, 24-hour design storm is to be completely treated prior to discharge to this BMP.
- Overflow route - An overflow route must be identified.
- Drawdown time should be a maximum of 24 hours for the 2-year and 10-year, 24-hour design storms; 48 hours for 100-year, 24-hour design storm (with appropriate correction factors).
- Slopes - potential effect of infiltration on slopes is to be evaluated.
- Buildings and facilities - potential effects of infiltration are to be evaluated.

The six General Limitations must be satisfactorily met before this BMP can be utilized (Section III-3.3).

Construction and Maintenance Criteria

See Water Quality Concrete Grid and Modular Pavement (BMP RI.30).

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III-3.7 STANDARDS AND SPECIFICATIONS FOR FILTRATION BMPs

III-3.7.1 Overview

This section presents detailed standards and specifications for the following filtration best management practices:

BMP RF.05	Sand Filtration Basin
BMP RF.10	Sand Filtration Trench
BMP RF.15E	Aquatard System (Experimental)

The standards and specifications for each of the above BMPs contains, where appropriate, information on the following topics:

- Purpose and Definition
- Planning Considerations
- Design Criteria
- Construction and Maintenance Criteria

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III-3.7.2 BMP RF.05 Sand Filtration Basin

Purpose and Definition

Sand filtration basins are open impoundments which filter runoff through a layer of sand into an underdrain system. Sand filtration provides runoff treatment, but not streambank erosion control and these basins are to be located off-line from the primary conveyance/detention system. While effective at treating conventional pollutants, sand filtration is not effective at removing nutrients. It's use for treating oil is being allowed on an interim basis and sand filtration may substitute for API and CPS-type oil/water separators.

The sand bed filtration system consists of an inlet structure, sand bed, underdrain piping and basin liner. The basin liner will only be required if the treated runoff is not to be allowed to percolate into the soil underlying the filtration basin. A liner would be necessary if the filtered runoff required additional treatment, such as in a wet pond for further nutrient removal, or in cases where additional ground water protection was mandated. Figures III-3.22 and III-3.23 illustrates sand filtration basin systems.

Planning Considerations

To improve the effectiveness of sand filtration basins and to protect the media from clogging, these basins are to be located off-line from the primary conveyance/detention system and must be preceded by a pretreatment BMP. Disturbed areas that are sediment sources in the contributing drainage area should be identified and stabilized to the maximum extent practicable. Because of the potential for clogging, sand filtration BMPs must never be used as sediment basins during construction.

If a sand filtration basin is used as a substitute for an API or CPS-type oil/water separator, then pretreatment may not be necessary if the contributing drainage area is small and completely impervious (the restrictions which apply to oil/water separators will also apply to sand filtration basins in this case - see Chapter III-7 for further details).

Design Criteria

Sand filtration BMPs are to be designed according the procedure described in Section III-3.4, using a Darcy's Law approach. Important design considerations are discussed below.

Off-line Isolation/Diversion Structure

By locating sand filtration systems off-line from the primary conveyance/detention system the long-term effectiveness of the treatment system can be maintained. Off-line systems are designed to capture and treat the 6-month, 24-hour design storm; this is typically achieved by using isolation/diversion baffles and weirs. A typical approach for achieving isolation of the water quality volume is to construct an isolation/diversion weir in the stormwater channel such that the height of the weir equals the maximum height of water in the filtration basin during the 6-month, 24-hour design storm. When additional runoff greater than the water quality storm enters the stormwater channel, it will spill over the isolation/diversion weir and mixing with already-isolated water quality volume will be minimal. Figures III-3.24 and III-3.25 illustrate two types of isolation/diversion structures which have been successfully used.

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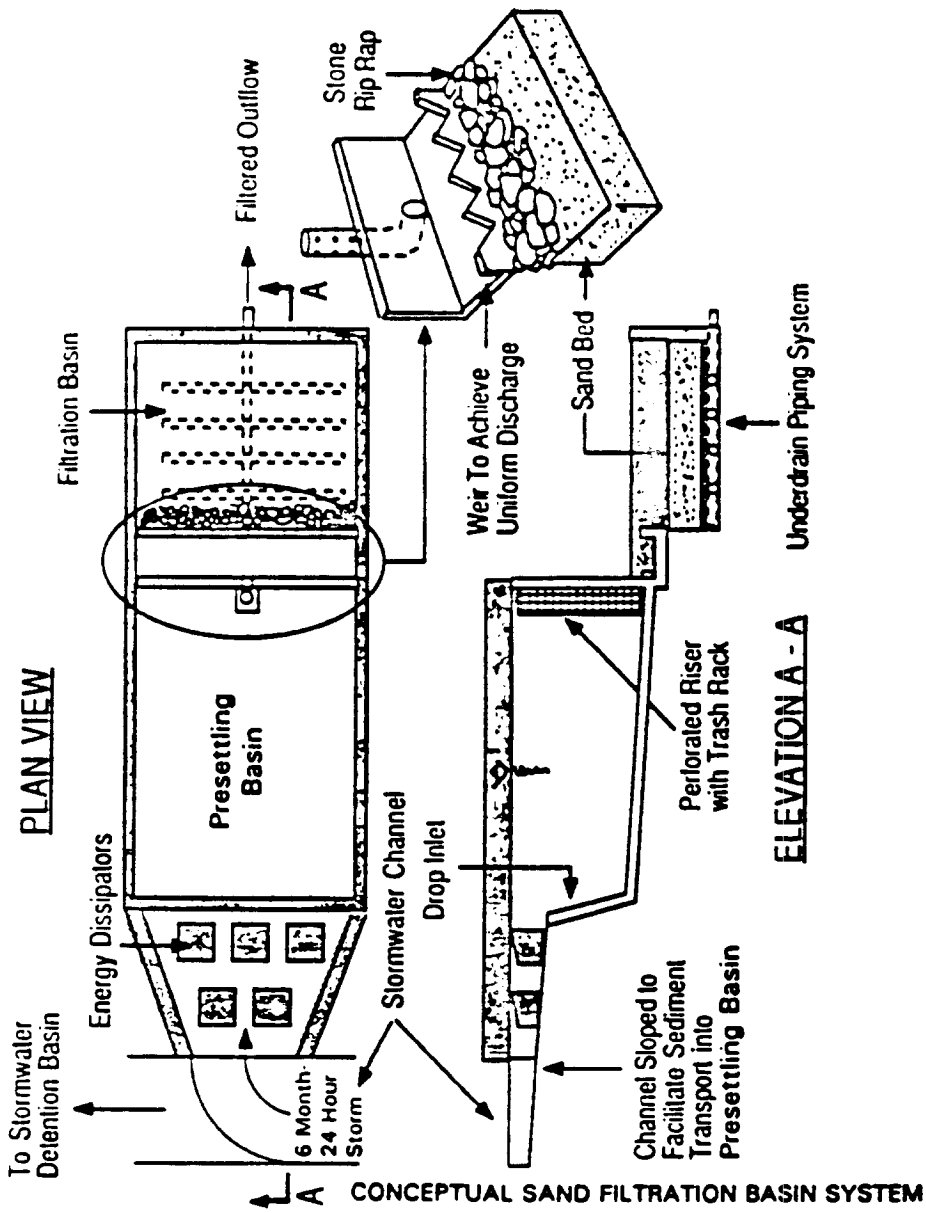
Figure III-3.22
Conceptual Sand Filtration Basin System



Source: City of Austin, 1988

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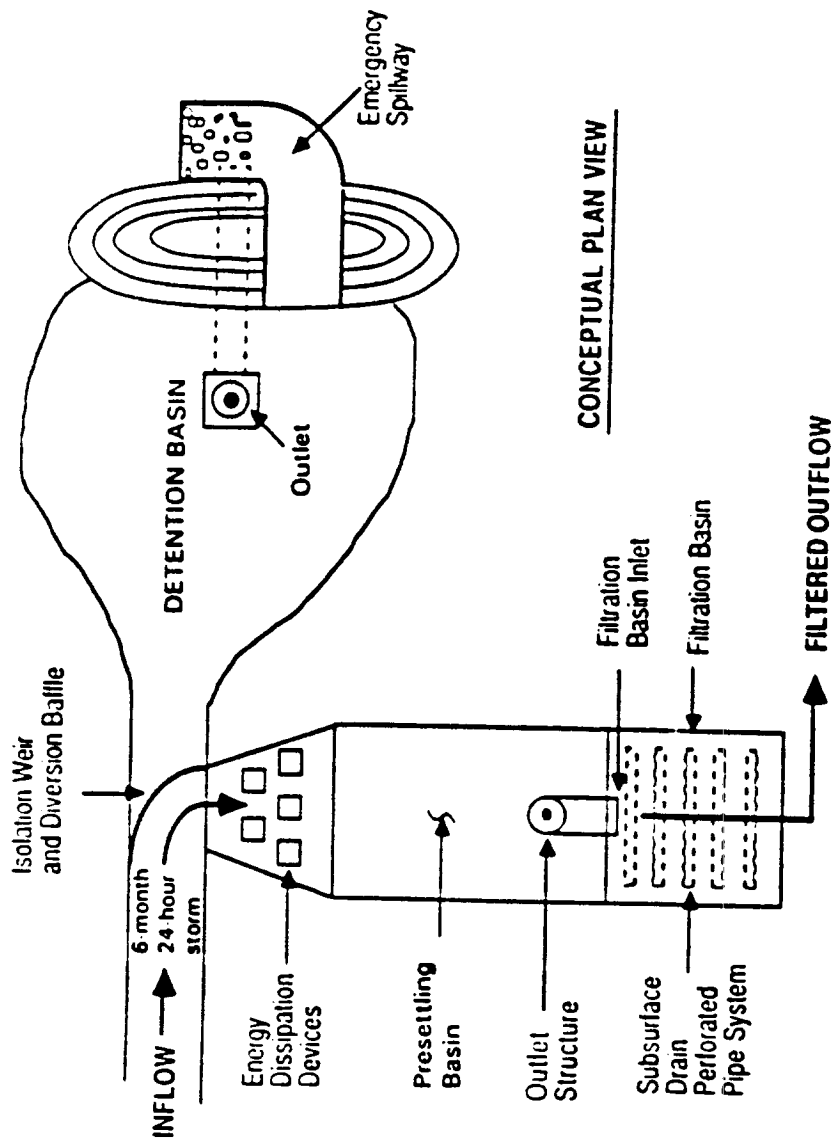
Figure III-3.23
Sand Filtration Basin Preceded by Presettling Basin



SAND FILTRATION BASIN PRECEDED BY PRESETTLING BASIN

Source: City of Austin, 1988

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Sizing Sand Filtration BMPs

The Darcy's Law method for sizing the BMP should be used:

$$Q = f * i * A_s$$

where f is the sand filtration rate, i is the hydraulic gradient, and A_s is the filtration bed surface area. The hydraulic gradient is given by the equation:

$$i = \frac{h}{h + L}$$

where h is the height of the water column over the top of the sand bed and L is the thickness of the sand bed (typically 18 inches).

A conservative value for the filtration rate (f) should be used. Design filtration rates of about two inches/hour are used in Austin, Texas, which are much lower than published values for sand but reflect actual field permeability rates. The lower rates reflect the effects of suspended solids and sediment on the sand's permeability.

Drainage Area

A maximum contributing drainage area of 50 acres is recommended for sand filtration basins.

Drawdown Time

Sand filtration basins are to be designed to completely empty (drawdown time) in 24 hours or less.

Inlet Structure

The inlet structure should spread the flow uniformly across the surface of the filter media. Flow spreaders, weirs or multiple orifice openings are recommended. Stone riprap or other dissipation devices should be installed to prevent gouging of the sand media and to promote uniform flow. The inset in Figure III-3.23 illustrates this.

Sand Bed

A sand bed depth of 18 inches is recommended. This is the <u>final</u> bed depth; consolidation of the sand is likely during construction.

Two sand bed configurations can be selected from; one with a gravel layer and the other a trench design which utilizes drainage matting as a substitute for the gravel layer. The top surface layer should be level so that equal distribution of runoff will be achieved in the basin.

1. Sand Bed with Gravel Layer (Figure III-3.26a)

   The top layer is to be a minimum of 18 inches of 0.02-0.04 inch diameter sand (smaller sand size is acceptable). Under the sand shall be a layer of ¼ to two (2) inch diameter gravel which provides a minimum of two (2) inches of cover over the top of the underdrain lateral pipes. No gravel is required under the lateral pipes. The sand and gravel must be separated by a layer of geotextile fabric meeting the specifications listed in Table III-3.7.

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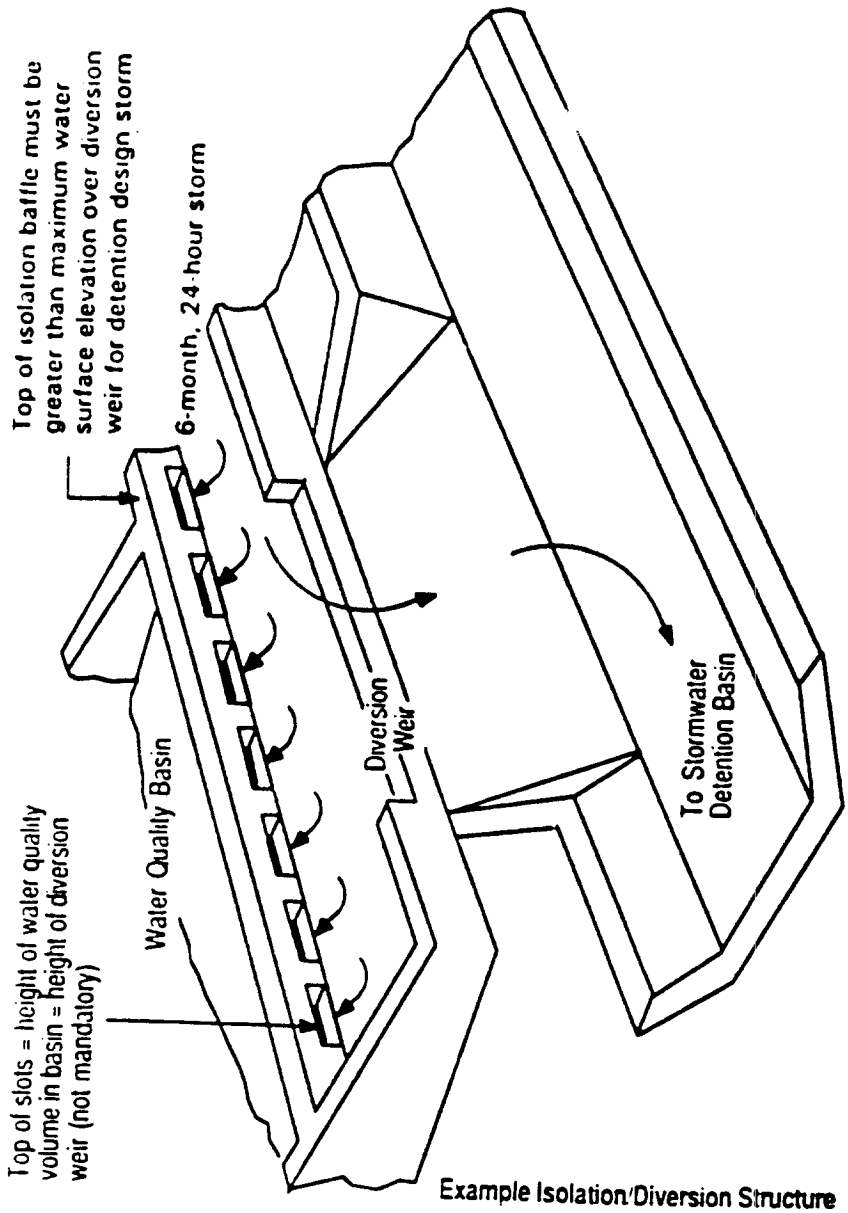
Figure III-3.24
Example Isolation/Diversion Structure



Source: City of Austin, 1988

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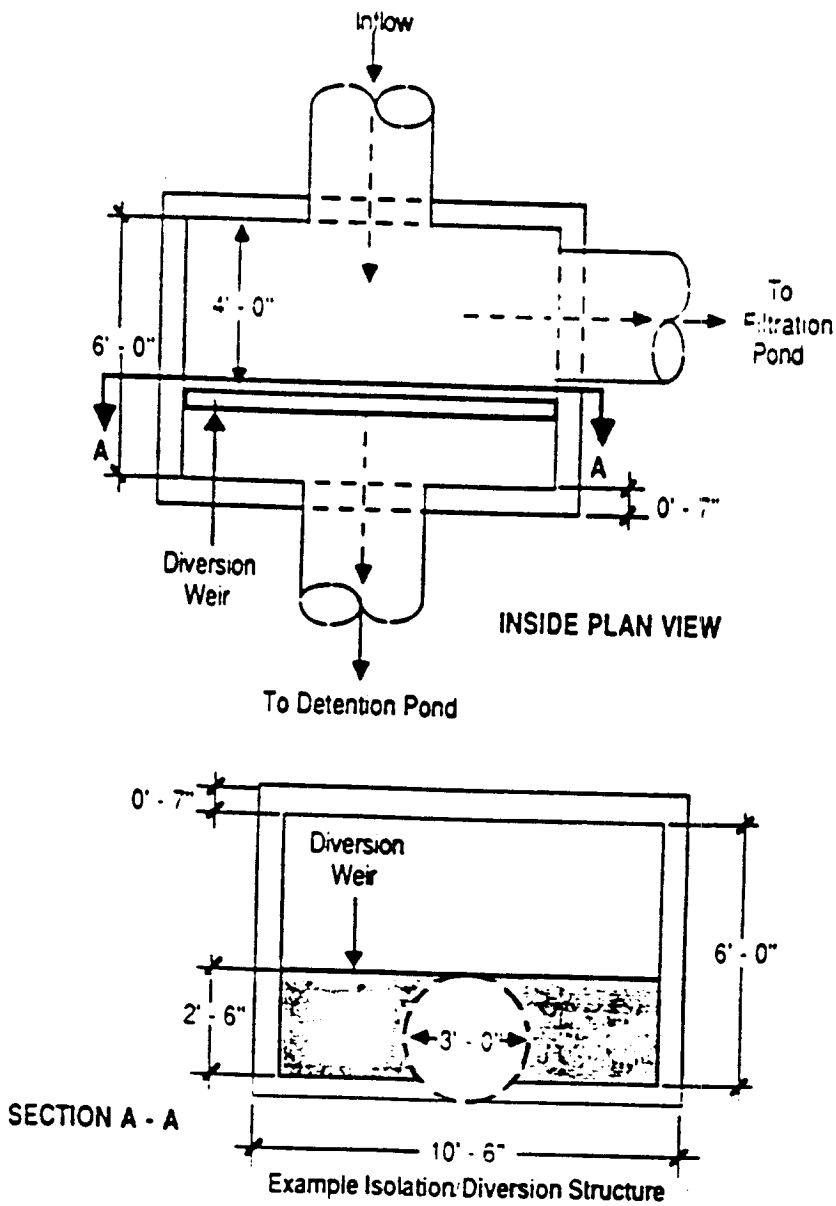
Figure III-3.25
Example Isolation/Diversion Structure



Example Isolation/Diversion Structure

Source: City of Austin, 1988

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2. Sand Bed with Trench Design (Figure III-3.26b)

This configuration can be used on flatter sites which may restrict the applicability of the previous design. The top layer shall be 12-18 inches of 0.02-0.04 inch diameter sand (smaller sand size is acceptable). Laterals shall be placed in trenches with a covering of ¼ to two (2) inch gravel and geotextile fabric. The lateral pipes shall be underlain by a layer of drainage matting. The geotextile fabric is needed to prevent the filter media from infiltrating into the lateral piping. The drainage matting is needed to provide adequate hydraulic conductivity to the laterals. Table III-3.7 provides the specifications for the geotextile fabric. Table III-3.8 provides the specifications for the drainage matting.

Table III-3.7
Geotextile Fabric Specifications

Property	Test Method	Unit	Specification
Material			Nonwoven geotextile
Unit Weight		oz/sq.yd.	8 (min.)
Filtration Rate		in/sec	0.08 (min.)
Puncture Strength	ASTM D-751 (modified)	lbs.	125 (min.)
Mullen Burst Strength	ASTM D-751	psi	400 (min.)
Tensile Strength	ASTM D-1682	lbs.	300 (min.)
Equiv. Opening Size	US Standard Sieve	No.	80 (min.)

Source: City of Austin, 1988

Underdrain Piping

The underdrain piping consists of the main collector pipe(s) and perforated lateral branch pipes. The piping should be reinforced to withstand the weight of the overburden. Internal diameters of lateral branch pipes should be four (4) inches or greater and perforations should be ⅜ inch. All piping is to be schedule 40 polyvinyl chloride or greater strength. A maximum spacing of ten (10) feet between laterals is recommended. Lesser spacings are acceptable. The maximum spacing between rows of perforations should not exceed six (6) inches.

The minimum grade of piping shall be ½ inch per foot (one (1) percent slope). Access for cleaning all underdrain piping is needed; this can be provided by installing cleanout ports which tee into the underdrain system and surface above the top of the sand filtration media.

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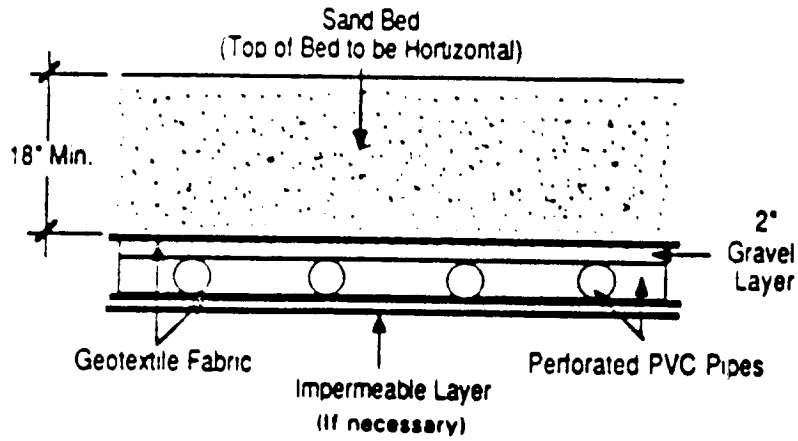
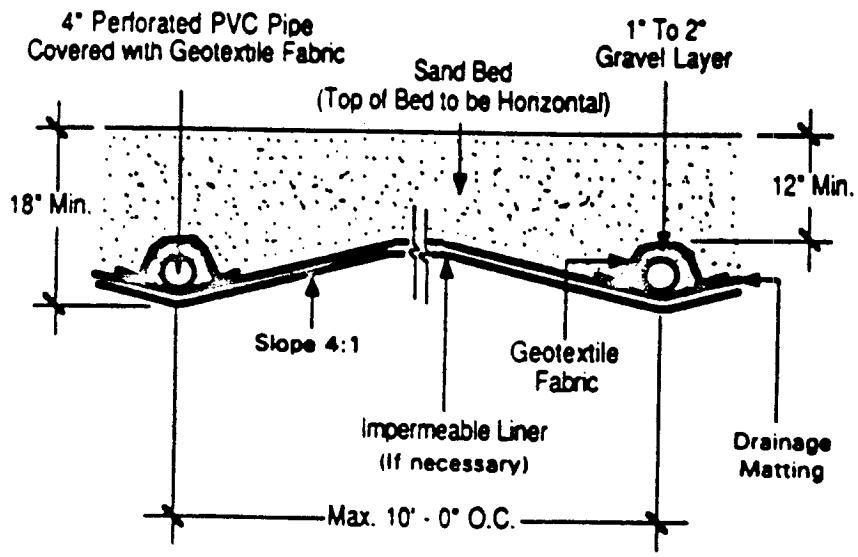
Figure III-3.26a Sand Bed Profile with Gravel Layer



A. SAND BED PROFILE (WITH GRAVEL LAYER)



B. SAND BED PROFILE (TRENCH DESIGN)

Sand Bed Filtration Configurations

Figure III-3.26b Sand Bed Profile with Trench Design
Source: City of Austin, 1988

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Table III-3.8
Drainage Matting Specifications

Property	Test Method	Unit	Specification
Material			Nonwoven geotextile fabric
Unit Weight		oz./sq.yd.	20
Flow Rate (fabric)		GPM/ft^2	180 (min.)
Permeability	ASTM D-2434	cm/sec	12.4 x 10^{-2}
Grab Strength (fabric)	ASTM D-1682	lbs.	Dry lg. 90 Dry wd. 70 Wet lg. 95 Wet wd. 70
Puncture Strength (fabric)	COE CW-02215	lbs.	42 (min.)
Mullen Burst Strength	ASTM D-1117	psi	140 (min.)
Equiv. Opening Size	US Standard Sieve	No.	100 (70-120)
Flow Rate (drainage core)	Drexel Univ. Test Method	GPM/ft. width	14

Source: City of Austin, 1988

Basin Liner

If an impermeable liner is required it should meet the specifications below. If an impermeable liner is not required then a geotextile fabric liner shall be installed which meets the specifications listed above in Table III-3.7 unless the basin has been excavated to bedrock. Impermeable liners may be either clay, concrete or geomembrane. Clay liners should meet the specifications give in Table III-3.9:

Table III-3.9
Clay Liner Specifications

Property	Test Method	Unit	Specification
Permeability	ASTM D-2434	cm/sec	1 x 10^{-6}
Plasticity Index of Clay	ASTM D-423 & D-424	percent	Not less than 15
Liquid Limit of Clay	ASTM D-2216	percent	Not less than 30
Clay Particles Passing	ASTM D-422	percent	Not less than 30
Clay Compaction	ASTM D-2216	percent	95% of Standard Proctor Density

Source: City of Austin, 1988

The clay liner should have a minimum thickness of 12 inches.

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If a geomembrane liner is used instead of clay, it should have a minimum thickness of 30 mils and be ultraviolet resistant. The geomembrane fabric should be protected from puncture, tearing, and abrasion by installing geotextile fabric on the top and bottom of the geomembrane (see Table III-3.7 for geotextile fabric specifications).

Equivalent methods for protection of the geomembrane liner will be considered. Equivalency will be judged on the basis of ability to protect the geomembrane from puncture, tearing, and abrasion.

Concrete liners may also be used for sedimentation chambers and for sedimentation and filtration basins less than 1,000 square feet in area. Concrete shall be five (5) inch thick Class A or better and shall be reinforced by steel wire mesh. The steel wire mesh shall be six (6) gage wire or larger and six (6) inch by six (6) inch mesh or smaller. An "Ordinary Surface Finish" is required. When the underlying soil is clay or has an unconfined compressive strength of 0.25 ton per square foot or less, the concrete shall have a minimum six (6) inch compacted aggregate base consisting of coarse sand and river stone, crushed stone or equivalent with diameter of 0.75 to one (1) inch. Where visible, the concrete shall be inspected annually and all cracks shall be sealed.

Pretreatment BMP

It is recommended that a presettling basin (BMP RD.10) and/or biofiltration swale (BMP RB.05) be used to pretreat runoff discharging to the sand filter. Descriptions of these two BMPs are provided in Chapters III-4 and III-6, respectively.

If a presettling basin is used for pretreatment, careful attention must be given to designing the inlet and outlet structures. The presettling basin consists of an inlet structure, outlet structure and basin liner if permeable soils underlay the basin. The presettling basin design should maximize the distance from where the heavier sediment is deposited near the inlet to where the outlet structure is located. This will improve basin performance and reduce maintenance requirements.

- Inlet Structure - The inlet structure design must be adequate for isolating the water quality volume from the larger design storms and to convey the peak flows for the larger design storms past the basin. The water quality volume should be discharged uniformly and at low velocity into the presettling basin in order to maintain near quiescent conditions which are necessary for effective treatment. It is desirable for the heavier suspended material to drop out near the front of the basin; thus a drop inlet structure is recommended in order to facilitate sediment removal and maintenance. Energy dissipation devices may be necessary in order to reduce inlet velocities which exceed three (3) feet per second.

- Outlet Structure - The outlet structure conveys the water quality volume from the presettling basin to the filtration basin. The outlet structure shall be designed to provide for a residence time of 24 hours for the 6-month, 24-hour storm. See Chapter III-4 for calculating residence time. A perforated pipe or equivalent is the recommended outlet structure. The residence time should be achieved by installing a throttle plate or other flow control device at the end of the riser pipe (the discharges through the perforations should not be used for drawdown time design purposes). The perforated riser pipe can be selected from Table III-3.10:

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Table III-3.10
Perforated Riser Pipe Specifications

Riser Pipe Nominal Dia. (inches)	Vertical Spacing Between Rows (center to center - inches)	Number of Perforations per Row	Diameter of Perforations (inches)
6	2.5	9	1
8	2.5	12	1
10	2.5	16	1

Source: City of Austin, 19[illegible]. This information is based on commercially available pipe. Equivalent designs are acceptable.

A trash rack shall be provided for the outlet. Openings in the rack should not exceed ¼ the diameter of the vertical riser pipe. The rack should be made of durable material, resistant to rust and ultraviolet rays. The bottom rowe of perforations of the riser pipe should be protected from clogging. To prevent clogging of the bottom perforations it is recommended that geotextile fabric be wrapped over the pipe's bottom rows and that a cone of one (1) to three (3) inch diameter gravel be placed around the pipe. If a geotextile fabric wrap is not used then the gravel cone must not include any gravel small enough to enter the riser pipe perforations. Figure III-3.27 illustrates a perforated riser outlet structure with trash rack.

- Basin Liner

The pretreatment BMP may need to have a basin liner to prevent runoff from being lost to soil infiltration prior to treatment by the filtration basin. If a basin liner is required then it shall meet the specifications in Table III-3.9 or equivalent, as discussed above.

Construction and Maintenance Criteria

Construction Requirements

- The <u>final</u> sand bed depth must be 18 inches; consolidation of sand will likely occur during installation and this must be taken into account. The sand should be periodically wetted, allowed to consolidate, and then extra sand added. Repeat this procedure until the bed depth has stabilized at 18 inches.

- Provisions must be made for access to the basin for maintenance purposes. A maintenance vehicle access ramp is necessary. The slope of the ramp should not exceed 4:1.

- The design should minimize susceptibility to vandalism by use of strong materials for exposed piping and accessories.

- Side slopes for earthen embankments should not exceed 3:1 to facilitate mowing.

- The erosion and sediment control plan must be configured to permit construction of the pond while maintaining erosion and sediment control. No runoff is to enter the sand filtration basin prior to completion of construction and site revegetation. Construction runoff may be routed to the sediment basin/chamber but outflow from this structure shall by-pass the sand filter basin.

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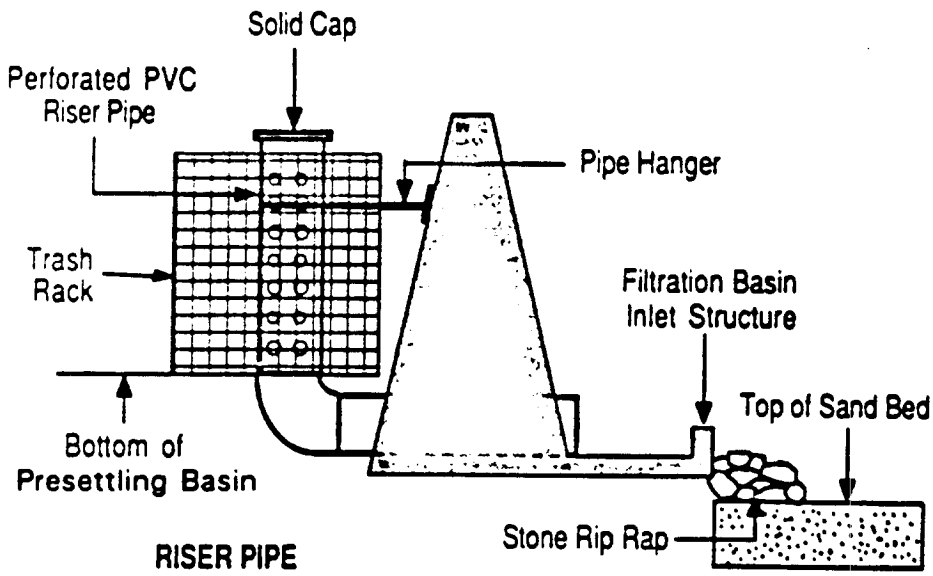
Figure III-3.27 Perforated Riser Outlet Structure



Perforated Riser Outlet Structure

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Maintenance Requirements

- Removal of silt when accumulation exceeds ½ inch.
- Removal of accumulated paper, trash and debris every six (6) months or as necessary.
- Corrective maintenance is required any time drawdown does not occur within 36 hours after the sedimentation basin has emptied.
- Annual inspection and, as necessary, repair of the structure.

Sand Media Rehabilitation and Replacement

Over time, a layer of sediment will build up on top of the filtration media which can inhibit the percolation of runoff. Experience has shown that this sediment can be readily scraped off during dry periods with steel rakes or other devices. Once sediment is removed the design permeability of the filtration media can typically be restored by then striating the surface layer of the media. Eventually, however, finer sediments which have penetrated deeper into the filtration media will reduce the permeability to unacceptable levels, thus necessitating replacement of some or all of the sand. The frequency in which the sand media must be replaced is not well established and will depend on the suspended solids levels entering the system (thus, the effectiveness of the pretreatment BMP can be a significant factor). Drainage areas which have disturbed areas containing clay soils will likely necessitate more frequent replacement. Properly designed and maintained sand filtration BMPs in Austin, Texas have functioned effectively, without complete replacement of the sand media, for at least five years and should have design lives of 10 to 20 years.

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III-3.7.3 BMP RF.10 Sand Filtration Trench

Purpose and Definition

A sand filtration trench is similar to a Water Quality Infiltration Trench (BMP RI.10) except that it is designed according to the same criteria used for a Sand Filtration Basin (BMP RF.05). Sand filtration trenches are generally used for smaller drainage areas than sand filtration basins. A typical use of a trench is along the perimeter of a parking lot. As with basins, pretreatment must be provided in order to protect the sand media from premature clogging. Trenches have experienced fewer problems with clogging than basins, perhaps because their use has been limited more to high impervious cover sites which may generate less suspended solids.

Figures III-3.8 through III-3.15 illustrate trench designs which can be adapted for use as sand filtration systems.

Sand filtration provides runoff treatment but not streambank erosion control, and trenches are to be located off-line from the primary conveyance/detention system. While effective at treating conventional pollutants sand filtration is not effective at removing nutrients. It's use for treating oil is being allowed on an interim basis and sand filtration may substitute for API and CPS-type oil/water separators.

The sand bed filtration system consists of an inlet structure, sand bed, underdrain piping and trench liner. The trench liner will only be required if the treated runoff is not to be allowed to percolate into the soil underlying the filtration basin. A liner would be necessary if the filtered runoff required additional treatment, such as in a wet pond for further nutrient removal, or in cases where additional ground water protection was mandated.

Planning Considerations

See Water Quality Infiltration Trench (BMP RI.10) and Sand Filtration Basin (BMP RF.05).

Design Criteria

See Water Quality Infiltration Trench (BMP RI.10) and Sand Filtration Basin (BMP RF.05).

Observation Well

An observation well should be installed every 50 feet for the length of the infiltration trench. See the Water Quality Infiltration Trench, BMP RI.10 for detailed specifications of the observation well.

Construction and Maintenance Criteria

See Water Quality Infiltration Trench (BMP RI.10) and Sand Filtration Basin (BMP RF.05).

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III-3.7.4 BMP RF.15E Aquatard System (Experimental)

Aquatard systems are filtration BMPs which utilize different treatment media than sand. These BMPs will likely provide runoff treatment but not streambank erosion control. Ecology is aware of at least two alternative treatment mediums being tested. One is a compost system which is described in Section I-1.12. The other is a peat-sand filter being tested by the State of Maryland. One of the primary objectives of these experimental filtration systems is to develop a treatment media capable of removing nutrients and other difficult-to-treat pollutants. Ecology will notify the public as developments occur.

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CHAPTER III-4 DETENTION FACILITIES

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CHAPTER III-4

DETENTION FACILITIES

III-4.1 INTRODUCTION

III-4.1.1 Background

Detention facilities, by design, provide storage of runoff resulting from development. Properly designed detention facilities can provide effective treatment of pollutants contained in stormwater, especially particulates which can settle out during quiescent conditions. In addition, detention BMPs can reduce streambank erosion and flooding by temporarily detaining runoff before releasing it at flowrates and frequencies similar to those occurring under natural hydrologic conditions. Detention facilities include ponds, vaults, and tanks.

III-4.1.2 Purpose and Scope

The purpose of this chapter is to present general and specific criteria for the evaluation, design, construction, and maintenance of detention facilities. In particular, this chapter provides guidance on how BMPs can be designed to accomplish two primary stormwater management objectives, *runoff treatment* and *streambank erosion control* (recall that *source control* is another objective which is required in all cases).

Sections III-4.2 and III-4.3 should be read first as they discuss important concepts and design criteria applicable to detention BMPs. Sections III-4.4 and III-4.5 provide detailed standards and specifications for the following detention BMPs:

BMP RD.05	Wet Pond (Conventional Pollutants)
BMP RD.06	Wet Pond (Nutrient Control)
BMP RD.09	Constructed Wetland
BMP RD.10	Presettling Basin
BMP RD.11	Extended Detention Dry Pond
BMP RD.15	Wet Vault/Tank
BMP RD.20	Extended Detention Dry Vault/Tank

III-4.2 RUNOFF TREATMENT AND STREAMBANK EROSION CONTROL

III-4.2.1 Background

Minimum Requirements #4 and #5 require development sites to provide runoff treatment and control streambank erosion, respectively (see Chapter I-2). The runoff treatment design storm is the 6-month, 24-hour event. The streambank erosion control standard is to limit peak flows discharged from the *developed* site to 50 percent of the *existing* condition 2-year, 24-hour event and maintain the *existing* condition peak flow rates for the 10-year and 100-year, 24-hour design storms, with appropriate correction factors (see Chapter III-1 for further details).

Runoff Treatment

Runoff treatment is accomplished by detention BMPs using a variety of pollutant removal mechanisms, including sedimentation, biological uptake, and vegetative filtration. Runoff treatment is to be provided for up to the 6-month, 24-hour design storm. The rationale for selecting this storm is that over 90 percent of the annual runoff events will be captured and treated by BMPs sized for this event. The 6-month, 24-hour storm is determined by multiplying the 2-year, 24-hour event by a factor of 0.64. The size of the 6-month storm averages about 2 inches in the Puget

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Sound Basin but will vary from about 0.65 inches to over 3 inches, depending on where a site is located (see the isopluvial maps in the appendix of Chapter III-1).

Streambank Erosion Control

Streambank erosion control is accomplished in detention BMPs by detaining runoff and then releasing it back to stream systems at reduced flowrates. The goal is to replicate, to the extent possible, the pre-development hydrologic regime. Streambank erosion control is required whenever discharges are made, directly or indirectly, to a stream system.

A typical detention BMP configuration maintains a permanent pool of water as a "dead storage" area for treatment purposes and a "live storage" area above the permanent pool in order to temporarily detain runoff for streambank erosion control purposes. Figure III-4.1 illustrates this configuration.

Limiting streambank erosion and the destruction of fish habitat can be achieved by limiting the rate of release of runoff from the 2-year design storm to 50 percent of the existing condition rate. This criterion is based on advice from the Washington Department of Fisheries (see Appendix AIII-4.1). For further technical details, please contact the Habitat Management Division of that Department. The rationale for this release rate is prevention of both the frequency and duration of flows at the highly erosive bankfull stage. This would occur if the runoff was released at 100 percent of the existing condition rate because of the increased volume of runoff associated with development. If all of the 2-year, 24-hour storm can be infiltrated the restrictive release rate is no longer necessary.

Note that a coincident benefit of this detention requirement is extended detention in many instances. Releasing the runoff from the 2-year storm at 50 percent of the existing condition rate may result in this runoff being detained for approximately 40 hours, or longer. Longer detention periods will be achieved on sites that have higher ratios of pre-developed to post-developed peak flows, lower SCS curve numbers, and longer times of concentration.

The rationale for controlling the large, infrequent storms (i.e., the 10-year and 100-year events) is to provide additional streambank erosion protection as well as flood protection.

***Note:** A correction factor must be applied to the detention volume for streambank erosion control in order to account for weaknesses in current hydrologic analysis methods. When using SCS hydrologic analysis methods to estimate runoff for 24-hour duration storms, the correction factor should vary from 20% for residential areas up to 50% for commercial areas. Until the work on the 7-day design storm, or other alternative methods for estimating runoff is complete the design engineer is advised to apply a correction factor. The correction factor is to be applied to the volume of the BMP without changing the BMP depth or design of the outlet device. See Chapter III-1 for a further discussion of this issue.*

(Note: An adopted and approved basin plan (Minimum Requirement #9 in Chapter I-2) may be used to develop streambank erosion control requirements that are tailored to a specific basin).

Additional Requirements

Additional requirements may apply if a development discharges into a natural or created (mitigated) wetland, lake, and other sensitive waterbodies (see Minimum Requirements #4 - #7 in Chapter I-2).

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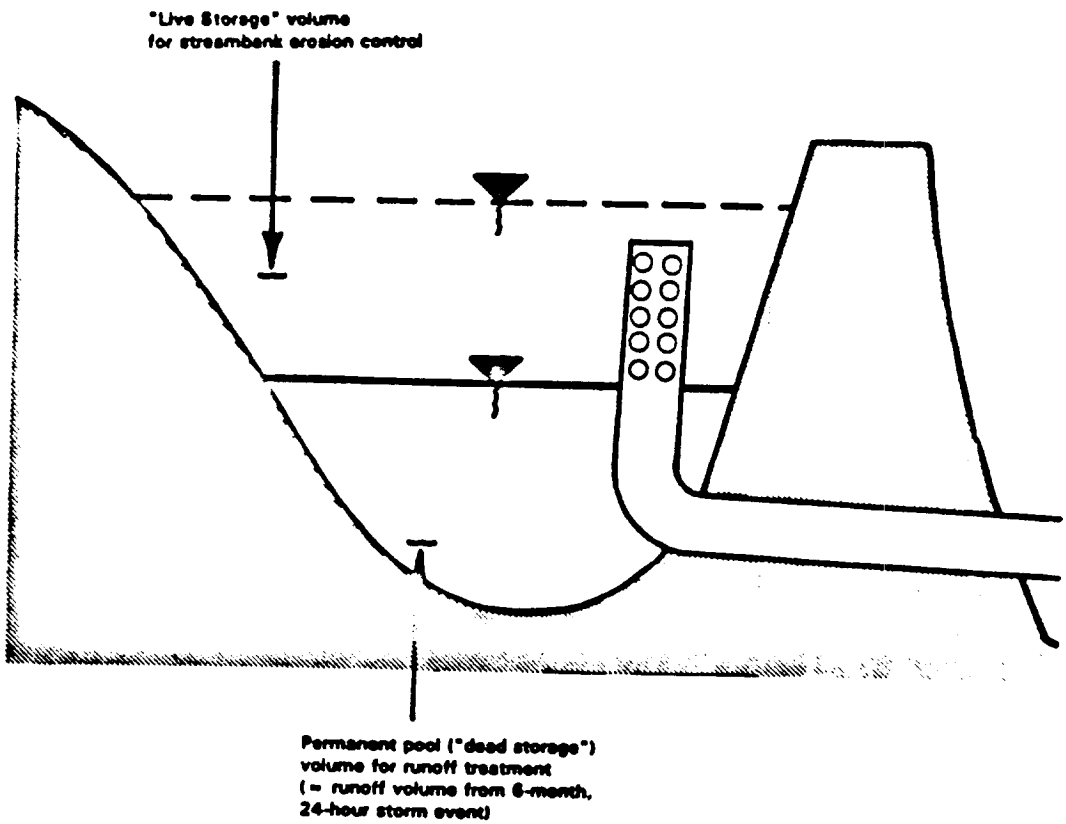
Figure III-4.1
Typical Wet Pond-type Detention BMP



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III-4.2.2 Mechanisms of Pollutant Removal

Detention BMPs utilize a variety of mechanisms to remove pollutants from stormwater. A primary mechanism is the removal of particulate pollutants using sedimentation; some detention BMPs may also remove particulates using filtration by vegetation. Biological uptake of dissolved pollutants is another mechanism which can be important for controlling nutrients. The type of facility used and the way it is designed will determine the degree to which each process operates, and its efficiency. The pollutants of concern in stormwater include heavy metals (such as lead, copper, zinc, and cadmium), nutrients (nitrogen and phosphorus), certain bacteria and viruses, organics (such as hydrocarbons and pesticides) and sediment. They may be present in water in both dissolved and particulate form. The particulate fraction includes sediment itself, as well as heavy metals, organics and nutrients that may be bound to it. Many of the pollutants of greatest concern are associated with smaller sediment sizes, such as silt and clay. Since the smaller size fractions are of most concern, conditions which promote quiescent settling and extended detention times will be the most effective in removing particulate pollutants. Similarly, long detention times will be necessary to reduce soluble pollutants by biological assimilation.

Detention BMPs which utilize a permanent pool of water are considered the most effective treatment BMPs. These BMPs are known as "wet" ponds, vaults, or tanks. The permanent pond improves the removal efficiency of particulate pollutants by:

- dissipating the inflow energy of the stormwater as it enters the basin
- preventing scour of material settled to the bottom
- allowing exchange of incoming stormwater with previously captured water, thus providing additional time between storms to settle pollutants

"Wet" detention BMPs which establish vegetation within the permanent pool volume can provide additional pollutant removal. The vegetation in such "shallow marsh" areas serves as a filtration media for removing particulate pollutants. Aquatic plants in the permanent pool can assimilate dissolved pollutants. Biological uptake and/or transformation of pollutants into less toxic materials can be an important method of pollutant removal.

Note: The effectiveness of "shallow marsh" detention BMPs at treating nutrients is under investigation. Because the majority of rainfall in the Northwest occurs in the winter months, when biological activity is low, wet pond BMPs which utilize biological removal mechanisms may not function as effectively as in other regions of the country. The need to control nutrients and other "non-conventional" pollutants may require changes in the current BMP selection strategy and design criteria. Many of the design details given below have been taken from work on the East Coast and elsewhere and will be subject to refinement after further experience is gained in this region. Nevertheless, the details presented in this manual represent the currently available information and should provide a sound basis for design of detention BMPs. For further details on the literature sources, see Stockdale (Reference 1 in Section III-4.4.3, "Constructed Wetlands").

In cases where a permanent pool cannot be established, the pollutant removal efficiency of detention facilities can be improved by extending the detention period of the runoff from the smaller, more frequent storms (up to the 6-month, 24-hour storm in the Puget Sound basin). Such facilities are called "extended detention" facilities. Some literature recommends that this detention period be from 32 to 40 hours in order to settle out substantial quantities of the common pollutants. However, this may not apply as well to the Pacific Northwest because of the rainfall characteristics of this region. Pollutant removal from runoff from larger storms is not necessary because these infrequent storms only account for a small percentage of the long-term, average annual runoff volume (see Appendix AI-2.1).

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III-4.2.3 Classification of Detention BMPs

Detention BMPs designed for runoff treatment are classified according to whether they provide *pretreatment* or *primary* treatment of pollutants. Pretreatment BMPs utilize sedimentation as the removal mechanism; runoff is temporarily detained in order settle out particulate pollutants. Where detention is used to provide *primary* treatment, a permanent pool of water ("dead storage") is established that is more effective at removing pollutants than the temporary detention mechanism used by pretreatment BMPs. Primary treatment BMPs are further classified as either those that provide treatment of "conventional" pollutants or those that treat nutrients in addition to conventional pollutants. Conventional pollutants tend to be particulate in nature whereas nutrients can exist in both particulate and dissolved form. Examples of nutrients are nitrogen and phosphorus. The primary difference between a detention BMP which controls "conventional" pollutants as compared to one that treats nutrients is that a nutrient control BMP has a shallow marsh system established within the permanent pool volume. The permanent pool in the conventional treatment BMP does not have to be vegetated. The determination as to when nutrient control is required, in addition to control of conventional pollutants, is made by the local Plan Approval Authority.

Detention facilities may be either "wet" or "dry," and be either above ground (ponds), or below ground (tanks or vaults). A wet pond, as the name implies, maintains a permanent pool of water (dead storage) for runoff treatment purposes. If streambank erosion control is required then a "live storage" volume is detained. In contrast, a "dry" facility, does not contain this dead storage (except for a few inches for sediment storage) and hence tends to dry out between storms. BMPs labeled as "extended detention" are "dry" facilities, as is the presettling basin (BMP RD.10).

Some detention BMPs can provide either runoff treatment or streambank erosion control while others can be designed to provide both. In general, "wet pond" BMPs can provide both while pretreatment BMPs cannot. Vaults are not considered to be as effective as basins for runoff treatment because the only treatment mechanism utilized by vaults is sedimentation. It should be noted that only "wet" vaults can be used for runoff treatment. The only application where a "dry" vault is permitted is to control streambank erosion after treatment has been provided, i.e., a *dry* vault (BMP RD.20) is always preceded by a treatment BMP.

The presettling basin (BMP RD.10) is a pretreatment BMP that is designed to treat runoff but not control streambank erosion. It will typically precede infiltration and filtration BMPs in order to protect the treatment media of those BMPs from siltation. The extended detention dry pond (BMP RD.11) is essentially a presettling basin that also has a live storage volume in order to control streambank erosion. This BMP may have limited application for new development as it cannot provide an equivalent level of runoff treatment as "wet" pond BMPs. However, it may be a viable option for retrofitting detention ponds which serve existing development. It could also be used in conjunction with a "partial" infiltration BMP for controlling streambank erosion (in which case detention of the water quality storm would not be necessary). Table III-4.1 presents a summary of detention BMP applications.

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Table III-4.1
Classification of Detention BMPs

Pre-treatment (No SBEC)	Pre-treatment with SBEC	Treatment of Conventional Pollutants (SBEC option)	Treatment of Nutrients (SBEC option)	SBEC Only
Presettling Basin (BMP RD.10)	Extended Detention Dry Pond (BMP RD.11)	Wet Pond (BMP RD.05)	Constructed Wetland (BMP RD.09)	Extended Detention Dry Vault-Tank (BMP RD.20)
		Wet Vault/ Tank (BMP RD.15)	Wet Pond (BMP RD.06)	

SBEC = Streambank Erosion Control

III-4.3 GENERAL DESIGN CRITERIA

This section provides the design engineer with general standards and criteria for the design of detention facilities to control surface water flow to reduce erosion and sedimentation, and to provide water quality protection in general.

Detention BMPs are to be designed to provide runoff treatment and/or streambank erosion control. Runoff treatment is required in all cases. Streambank erosion control is required if the development site discharges directly or indirectly to a stream system.

III-4.3.1 Hydrologic Analysis

All detention facilities shall be analyzed using the hydrograph methods and routing procedures described in Chapter III-1.

III-4.3.2 Sizing Detention BMPs for Runoff Treatment

Detention BMPs will vary in size, even though the runoff treatment volume will be the 6-month, 24-hour design storm in all cases. Wet pond-type BMPs will each have a different surface area-pool depth relationship. Wet pond-type BMPs designed for nutrient control will have the largest areas because of the need to establish shallow marsh areas. Pretreatment BMPs, which do not maintain a permanent pool, will have the smallest surface areas. The following is a list of detention BMPs, in order of decreasing surface area, that can be used for runoff treatment:

1. Constructed Wetland
2. Wet Pond (Nutrient Control)
3. Wet Pond (Conventional Pollutants) and Wet Vault/Tank
4. Presettling Basin

Sizing Constructed Wetlands, Wet Ponds and Wet Vaults/Tanks

The permanent pool volume is the same for constructed wetlands, wet ponds, and wet vaults/tanks, i.e., the permanent pool volume equals the runoff volume from the 6-month, 24-hour design storm. However, surface areas will vary with the type of BMP as each has a specific surface area-depth relationship. A constructed wetland, for example, has a large surface area because of the need to establish shallow pool areas (e.g., 50 percent of the surface area should be in pools whose depth is 6 inches or less). The maximum permanent pool depth should not exceed six feet in order to maximize effectiveness and to prevent anaerobic conditions from developing.

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Table III-4.2 presents the minimum recommended surface area/pool depth configurations for these BMPs, along with the *maximum* average depth for each.

Table III-4.2
Surface Area - Pool Depth Relationships
for Wet Pond-type BMPs

Detention BMP	Pool Depth (feet)	Surface Area (as percent of total BMP surface area)	Maximum Average BMP Depth (feet)*
Constructed Wetland	0 - 0.5 0.5 - 1 2 - 3 3 - 6	50% 15% 15% 20%	2.05
Wet Pond (Nutrient Control)	0 - 2 2 - 6	30% 70%	4.8
Wet Pond (Conventional) or Wet Vault/Tank	0 - 6	100%	6.0

* The average BMP depth is found by summing the products of the pool depthe and surface areas (as fraction of total surface area), e.g., for the Wet Pond (Nutrient Control), d = (2 ft * 0.30) + (6 ft. * 0.70) = 4.8 feet.

Using Table III-4.2, the size of each BMP can be found since the volume of the BMP is simply the product of the average surface area and the average pool depth. A sizing example is given below which illustrates this.

Sizing Example for Constructed Wetland (BMP RD.09)

A proposed development site will be 10 acres in size with 35 percent impervious cover. The runoff volume for the 6-month, 24-hour design storm (P = 2") is calculated to be 0.7-inch, or 0.292 acre-feet (12,705 square feet). Determine the minimum size of a constructed wetland used to treat the 6-month storm for this site.

The permanent pool volume of each of the BMPs is given by the equation:

$$V_{pp} = A_s * d \text{ where}$$

A_s is the average surface area for the BMP and
d is the average permanent pool depth of the BMP

Solving for A_s gives:

$$A_s = \frac{V_{pp}}{d}$$

V_{pp} is equal to the volume of the 6-month, 24-hour design storm (= 0.7-inch or 12,705 sq.ft.) and the maximum average depth, d, is 2.05 feet, as shown in Table III-4.2. Therefore the minimum surface area of the constructed wetland will be:

$$A_s = \frac{12{,}705 \text{ sq.ft.}}{2.05 \text{ ft.}} = \underline{6{,}198 \text{ sq.ft.}}$$

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The surface area and volume of each of the pool depths is then found, using Table III-4.2 for guidance:

Size of Constructed Wetland for Example Problem

Pool Depth (feet)	*Surface Area as a percent of Total Surface Area*	*Surface Area (sq.ft.)*	*Pool Volume (cu.ft.)*
0.5	*50%*	*3099*	*1550*
1.0	*15%*	*930*	*9303*
3.0	*15%*	*930*	*2788*
6.0	*20%*	*1239*	*7437*
	100%	*6198*	*12705*

Sizing of Presettling Basins

Presettling basins are designed to settle out particulate pollutants for a range of runoff volumes, up to the 6-month, 24-hour storm. Sizing is based on application of a settling equation; in this manual the Camp-Hazen equation is recommended:

$E = 1 - \exp(-wA_s/Q_o)$ where

E = fraction of particulates to remove; set equal to 0.8 (= 80% removal efficiency is recommended);
w = settling velocity of target particle; silt is recommended using a settling velocity of 0.0004 ft/sec.
A_s = surface area of presettling basin
Q_o = average release rate from the presettling basin.

Rearranging the Camp-Hazen equation and solving for A_s gives:

$A_s = -(Q_o/w) * Ln(1-E)$ where Ln is the natural logarithm

The average release rate, Q_o, is found by dividing the runoff treatment volume (maximum = runoff from 6-month, 24-hour storm) by the design detention time (maximum of 24 hours recommended).

A more complete discussion is provided under "Design Criteria" in Section III-4.4.4 (BMP RD.10, Presettling Basin). However, protection of beneficial uses in receiving waters will always be required. There may be instances, depending on the nature of pollutants to be controlled and the receiving waters, when a higher removal rate, and hence larger surface area, will be required by the local government and/or Ecology or other State agencies.

Ratio of Surface Area-to-Total Drainage Area for Detention BMP

The ratio of the BMP surface area to the total drainage area can be an important planning consideration for development projects. While the exact ratio will be site specific, a general range of values can be estimated for each of the detention BMPs used for runoff treatment. Four case studies were analyzed to compare the surface areas for each BMP, using the SBUH hydrologic analysis method presented in Chapter III-1. For wet pond-type BMPs the information in Table III-4.2 was used; for the Presettling Basin the Camp-Hazen equation was solved for the 6-month, 24-hour design storm. The results are shown in Table III-4.3. Note that the constructed wetland has a much larger surface area requirement than the other BMPs. Constructed wetlands should be considered as facilities which provide additional benefits beyond those needed for stormwater management (e.g., aesthetic amenity, recreational facility, wildlife habitat).

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Table III-4.3
Minimum Surface Area-to-Drainage Area Ratios
for Runoff Treatment Detention BMPs
(Example Case Studies)

Case No.	Site IC (%)	Treatment Volume (ac-ft)	A_s/A_d Constructed Wetland	A_s/A_d Wet Pond (Nutrient Control)	A_s/A_d Wet Pond (Conventional) or Wet Vault/Tank	A_s/A_d Presettling Basin
1	25	0.59	2.9%	1.2%	1.0%	0.27%
2	50	0.89	4.3%	1.8%	1.5%	0.41%
3	75	1.18	5.8%	2.5%	2.0%	0.55%
4	100	1.48	7.2%	3.1%	2.5%	0.69%

Notes: A_s = Surface Area of BMP
A_d = Drainage Area
IC = "Impervious Cover"
Treatment Volume = volume of runoff from the 6-month, 24-hour storm; for wet pond BMPs this is the "permanent pool" volume

Rainfall volume for the 6-month, 24-hour storm = 2.0 inches
Drainage area = 10 acres
Pervious Area CN = 74; Impervious Area CN = 98
Presettling Basin designed for 80% removal efficiency and 24 hour detention time.

III-4.3.3 Sizing Detention BMPs for Streambank Erosion Control

Detention BMPs can be designed to provide streambank erosion control by temporarily detaining runoff and releasing it such that the peak flows released from the *developed* site will be limited to 50 percent of the *existing* condition 2-year, 24-hour event while maintaining the *existing* condition peak flow rates for the 10-year and 100-year, 24-hour design storms, with appropriate correction factors (see Section III-4.2.1 for discussion of the correction factor). Detention BMPs which have permanent pools (i.e., "wet ponds") can provide streambank erosion control by including a "live storage" volume above the permanent pool ("dead storage") volume.

The "live storage" volume can be added to "wet pond" detention BMPs by simply increasing the depth of the BMP since there are no surface area-depth requirements for streambank erosion control. Thus, "wet pond" BMPs which provide streambank erosion control can have depths greater than six feet as long as the "permanent pool" volume used for *runoff treatment* does not exceed six feet.

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III-4.4 STANDARDS AND SPECIFICATIONS FOR DETENTION PONDS

III-4.4.1 BMP RD.05 Wet Pond (Conventional Pollutants)

Purpose and Definition

This BMP is designed to provide runoff treatment for conventional pollutants but not nutrients. It may also be designed to provide streambank erosion control. A wet pond is an open pond which treats runoff using a permanent pool of water ("dead storage"). As an option, a shallow marsh area can be created within the permanent pool volume to provide additional treatment (see BMP RD.06, Wet Pond for Nutrient Control). Streambank erosion control is provided in the "live storage" area above the permanent pool. Figure III-4.1 illustrates a typical wet pond BMP.

Planning Considerations

Wet ponds require careful planning in order to function correctly. Throughout the design process the designer should be committed to considering the potential impacts of the completed facility. Such impacts can be positive or negative and can be as broadly classified as social, economic, political, and environmental. Designers can often influence the positive or negative aspects of these impacts by their careful evaluation of decisions made in the design process. Generally speaking, the completed facility must provide for safety to people as well as protection of real property, water quality, and wildlife habitats.

Multiple Uses

Multi-purpose use of the facility and aesthetic enhancement of the general area should also be major considerations. Above all, the facility should function in such a manner as to be compatible with overall stormwater systems both upstream and downstream to promote a watershed approach to providing stormwater management as well as local flood control and erosion protection.

If the facility is planned as an artificial lake to enhance property values and promote the aesthetic value of the land, pretreatment in the form of landscape retention areas or perimeter swales should be incorporated into the stormwater management facility. If possible, catchbasins should be located in grassed areas. By incorporating this "treatment train" concept into the overall collection and conveyance system, the engineer can prolong the utility of these permanently wet installations and improve their appearance. Any amount of runoff waters, regardless how small, that is filtered or percolated along its way to the final detention area can remove oil and grease, metals, and sediment. In addition, this will reduce the annual nutrient load to prevent the wet detention lake from eutrophying.

Detention system site selection should consider both the natural topography of the area and property boundaries. Aesthetic and water quality considerations may also dictate locations. For example, ponds with wetland vegetation are more aesthetically pleasing than ponds without vegetation. Ponds containing wetland vegetation also provide better conditions for pollutant capture and treatment.

A storage facility is an integral part of the environment and therefore should serve as an aesthetic improvement to the area if possible. Use of good landscaping principles is encouraged. The planting and preservation of desirable trees and other vegetation should be an integral part of the storage facility design.

Water Quality Considerations

In planning new detention facilities, it should be kept in mind that the goal of improved water quality downstream may conflict with certain desired uses of the facility. It is only logical that if the basin is used to remove pollutants, the

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water quality within the basin itself will be lowered, thus reducing the applicability for uses such as water supply, recreation, and aesthetics. In planning the facility the engineer or planner should have a good knowledge of site-specific runoff constituents and an understanding of the possible effects on the quality of the stored water.

Basin Planning

The design of urban detention facilities should be coordinated with a basin plan for managing stormwater runoff. In a localized situation, an individual property owner can, of course, by his or her actions alone, provide effective assistance to the next owner downstream if no other areas contribute to that owner's problems. However, uncontrolled proliferation of impoundments within a watershed can severely alter natural flow conditions, causing compounded flow peaks or increased flow duration which can contribute to downstream degradation. In addition, upstream impacts due to future land use changes should be considered when designing the structure. Land use planning and regulation may be necessary to preserve the intended function of the impoundment. See Minimum Requirement #9 (Basin Planning) and the appendix in Volume I for a further discussion of basin planning.

Sediment and Debris

More often than not, detention ponds serve primarily as sedimentation basins during construction when erosion rates are particularly high. In and of itself, this situation does not present a problem. Unfortunately, these facilities are often installed without the benefit of the designer having evaluated the capacity of either the initial or the final (post-construction) design configuration to perform this type of function.

If a facility is to be used as the principal means to avoid having excessive levels of turbidity discharged from the site during construction, the engineer should evaluate the pond geometry in conjunction with the rate of outflow and grain size distribution of the soils and design the temporary sediment basin according to BMPs E3.35 or E3.40 in Volume II.

Heavy Metal Contamination

Studies have shown high accumulation rates of lead, zinc, and copper on and near heavily traveled highways and streets. Runoff from highways and streets can be expected to carry significant concentrations of these heavy metals. If a significant portion of the drainage area into a pond consists of highways, streets, or parking areas or other known sources of heavy metal contamination, there is a potential environmental health hazard. In such cases the multiple use functions of the pond should be limited and accessibility should be restricted. Additionally, liners may be required in order to prevent these types of pollutants from migrating into the underlying soil and ground water system.

This may require that sediment dredged out of the basins during maintenance cleaning be treated as a Dangerous Waste. Investigations of sediments removed from detention ponds to date have found that many pollutants are tightly bound with only a slight possibility of leaching. To be safe, sediments to be removed should be analyzed and elutriate tests performed to verify that the sediment can be safely disposed of by conventional methods (see Volume IV, Catchbasin Sediment Disposal Policy (to be written) which deals with disposal procedures).

Overflows

Detention facility design must take into consideration overflows and secondary overflow. Overflows include all facilities designed to bypass flows over or around the restrictor system. Overflow may result from higher intensity or longer duration storms than the design storm or result from plugged orifices or inadequate storage

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due to sediment buildup in the facility.

Secondary overflow occurs when the capacities of all conveyance facilities, and all overflow facilities are exceeded or are not functioning. In such instances, stormwater will often exit the conveyance system through catchbasin grates and flow down the corridor of least resistance. Careful consideration must be given to the impact of secondary overflows on public health, safety and welfare, property, and wildlife habitat. When secondary overflow occurs, design of secondary drainage facilities following careful analysis and planning can significantly reduce impacts. Street alignments and grades are the key components in developing secondary drainage design, and consideration should be given early in the planning stages to their use as secondary overflow facilities.

Site Constraints and Setbacks

Site constraints are any manmade restrictions such as property lines, easements, structures, etc. that impose constraints on development. Constraints may also be imposed from natural features such as requirements of the local government's Sensitive Areas Ordinance and Rules (if adopted). These should also be reviewed for specific application to the proposed development.

All facilities shall be a minimum of 20 feet from any structure, property line, and any vegetative buffer required by the local government, and 100 feet from any septic tank/drainfield (except wet vaults shall be a minimum of 20 feet).

All facilities shall be a minimum of 50 feet from any steep (greater than 15%) slope. A geotechnical report must address the potential impact of a wet pond on a steep slope.

Dam Safety

In urban or urbanizing areas, failure of an impoundment structure can cause significant property damage and even loss of life. Such structures should be designed only by professional engineers registered in the State of Washington who are qualified and experienced in impoundment design. Wherever they exist, local safety standards for impoundment design shall be followed. Where no such criteria exist, widely recognized design criteria such as those used by the USDA Soil Conservation Service, Ecology Dam Safety Standards, or U.S. Army Corps of Engineers are recommended.

Safety, Signage and Fencing

Ponds which are readily accessible to populated areas should incorporate all possible safety precautions. Steep side slopes (steeper than 3H:1V) at the perimeter shall be avoided and dangerous outlet facilities shall be protected by enclosure. Warning signs for deep water and potential health risks shall be used wherever appropriate. Signs should be placed so that at least one is clearly visible and legible from all adjacent streets, sidewalks or paths. A notice should be posted warning residents of potential waterborne disease that may be associated with body contact recreation such as swimming in these facilities.

If the pond surface exceeds 20,000 sq. feet, include a safety bench around the basin with a width of 5 feet, and with a depth not exceeding 1 foot during non-storm periods. Emergent vegetation such as cattails should be placed on the bench to inhibit entry by unauthorized people.

A fence is required at the maximum water surface elevation, or higher, when a pond slope is a wall. Local governments and Homeowners Associations may also require appropriate fencing as an additional safety requirement in any event.

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Design Criteria

Sizing Wet Ponds

Wet ponds designed for treatment of conventional pollutants utilize a permanent pool of water to provide treatment and are to be designed using the hydrologic analysis methods presented in Chapter III-1.

Permanent Pool Volume

The permanent pool volume shall be equal to the runoff volume of the 6-month, 24-hour design storm. It is not necessary to vegetate the permanent pool, but establishment of a shallow marsh system can provide additional pollutant removal capabilities.

Surface Area-Pool Depth Relationships

The pond surface area is found by dividing the permanent pool volume by the depth, with a maximum depth of six (6) feet recommended. A minimum depth of three (3) feet is recommended so that resuspension of trapped pollutants is inhibited. Permanent pools deeper than six (6) feet could potentially contaminate ground water (should they intersect the existing ground water level). Also, deeper ponds can stratify and create anaerobic condition that can cause pollutants which are normally bound in the sediment (e.g., metals and phosphorus) to resolubilize; their release back to the water column can seriously affect the effectiveness of the BMP and also create nuisance conditions.

See Table III-4.2 for the surface area-pool depth relationship. Table III-4.3 illustrates typical surface area-to-drainage area ratios for this and other detention BMPs.

If the wet pond is also designed to provide streambank erosion control, then additional surface area and depth will be required for the "live storage" volume located above the permanent pool. There is no specific surface area-pool depth relationship for the "live storage" volume.

Ponds designed to provide streambank erosion control may be deeper than six feet as long as the permanent pool volume provided for runoff treatment does not exceed six feet.

Outlet Structure

The outlet structure must be designed to accomplish an extended detention time so that runoff can be released at the flow rates established by Minimum Requirement #5, Streambank Erosion Control (see Chapter I-2). Figure III-4.3 illustrates methods for extending detention time in wet ponds.

Pond Configuration and Geometry

Wet ponds shall be multi-celled with a least two cells, and preferably three. The cells should be approximately equal in size. The first cell should be three feet deep in order to effectively trap coarser sediments and reduce turbulence which can resuspend sediments. It should be easily accessible for maintenance purposes.

Long, narrow, and irregularly shaped ponds are preferred, as these configurations are less prone to short-circuiting and tend to maximize available treatment area. The length-to-width ratio should be at least 3:1 and preferably 5:1. Irregularly shaped ponds may perform more effectively and will have a more natural appearance.

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The inlet and outlet should be at opposite ends of the pond where feasible. If this is not possible, then baffles can be installed to increase the flow path and water residence time (see BMP RD.10, Presettling Basin, for details).

Interior side slopes up to the maximum water surface shall be no steeper than 3H:1V. Exterior side slopes shall be no steeper than 2H:1V.

The pond bottom shall be level to facilitate sedimentation.

Pond walls may be retaining walls, provided that the design is prepared and stamped by a structural engineer registered in the State of Washington, that they are constructed of reinforced concrete per Section III-4.6.1, that a fence is provided along the top of the wall, and that at least 25 percent of the pond perimeter will be a vegetated soil slope of not greater than 3H:1V.

Other Design Considerations

Liner to Prevent Infiltration

Detention BMPs should have negligible infiltration rates through the bottom of the pond. Infiltration will impair the proper functioning of detention BMPs and can contaminate ground water. If infiltration is anticipated, then a detention facility must either not be used and an infiltration BMP used instead (see Chapter III-3) or a liner should be installed to prevent infiltration. If a liner is used, the specifications provided in Section III-3.7 (Filtration BMPs) can be used. When using a liner the following are recommended:

- A layer of (track) compacted top soil (minimum 18" thick shall be placed over the liner prior to seeding with an appropriate seed mixture (see BMP E1.35 in Chapter II-5).
- Other liners may be used provided the design engineer can supply support documentation that the material will provide the required performance.

Overflow and Emergency Spillway

If streambank erosion control is not required, a pond overflow system must provide controlled discharge of the 100-year, 24-hour design storm event for developed site conditions without overtopping any part of the pond embankment or exceeding the capacity of the emergency spillway. The design must provide controlled discharge directly into the downstream conveyance system. This assumes the pond will be full due to plugged control structure inflow pipe and/or plugged restrictor/orifices conditions.

Open Type 2 catchbasins can function as weirs when used as pond overflow structures to control overtopping. The overflow structure, as shown in Figure III-4.5, may be required in some circumstances to protect embankments from overtopping.

In addition to the above overflow requirements, an emergency overflow spillway (secondary overflow) must be provided to safely pass the 100-year, 24-hour design storm event (for developed site conditions and assuming the pond is full to the crest of the spillway) over the pond embankment in the event of control structure failure or for storm/runoff events exceeding design. The spillway must be located to direct overflows safely towards the downstream conveyance system and shall be located in existing soil wherever feasible. The emergency overflow spill shall be armored with riprap in conformance with Table III-2.4 and shall extend to the toe of each face of the berm embankment.

- Design of emergency overflow spillways requires the analysis of a broad-crested trapezoidal weir. The following weir section is required for the emergency overflow spillway, as per Figure III-4.4.

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Figure III-4.2 Methods for Extending Detention Time in Wet Ponds

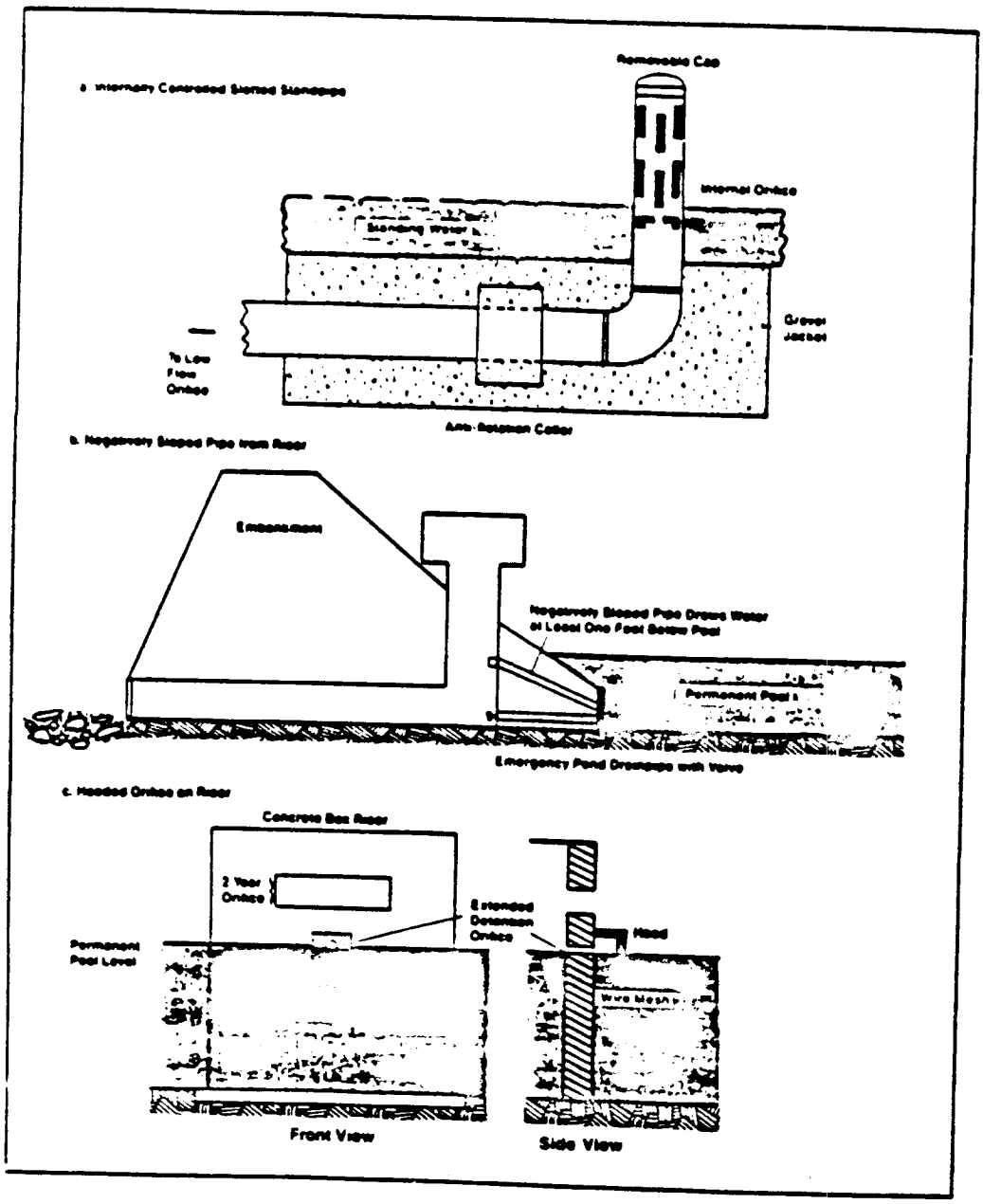

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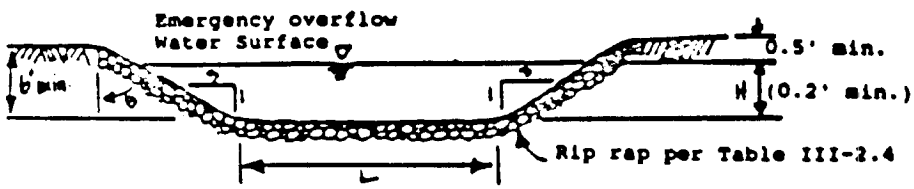
Figure III-4.3 Weir Section for Emergency Overflow Spillway



- The emergency overflow spillway weir section can be designed to pass the 100-year, 24-hour design storm event for developed conditions as follows:

  For this weir, $Q_{100} = C\ (2g)^{1/2}[(2/3)LH^{3/2} + 8/15\ Tan\ \theta\ H^{5/2}]$

  using: C = 0.6 (discharge coefficient);
  Tan θ = 3 (for 3:1 slopes);
  θ = 72°;

  The equation becomes: $Q_{100} = 3.21\ (LH^{3/2} + 2.4H^{5/2})$

  To find width L, the equation is rearranged to use the computed Q_{100} (peak flow for the 100-year, 24-hour design storm) and trial values of H (0.2 feet minimum).

  $L = (Q_{100}/(3.21H^{3/2})) - (2.4H^2)$;
  = 6 feet minimum

Berm Embankment/Slope Stabilization

Pond embankments higher than 6 feet shall require design by a geotechnical-civil engineer licensed in the State of Washington. The embankment shall have a minimum 15 foot top width where necessary for maintenance access; otherwise, top width may vary as recommended by the geotechnical-civil engineer.

The berm dividing the pond into cells shall have a 5 foot minimum top width, a top elevation set one foot lower than the design water surface, maximum 3:1 side slopes, and a quarry spall and gravel filter "window" between the cells (see Figure III-4.5).

For berm embankments of 6 feet or less than (including 1 foot freeboard), the minimum top width shall be 6 feet or as recommended by the geotechnical-civil engineer.

The toe of the exterior slope of pond berm embankment must be no closer than 5 feet from the tract or easement property line.

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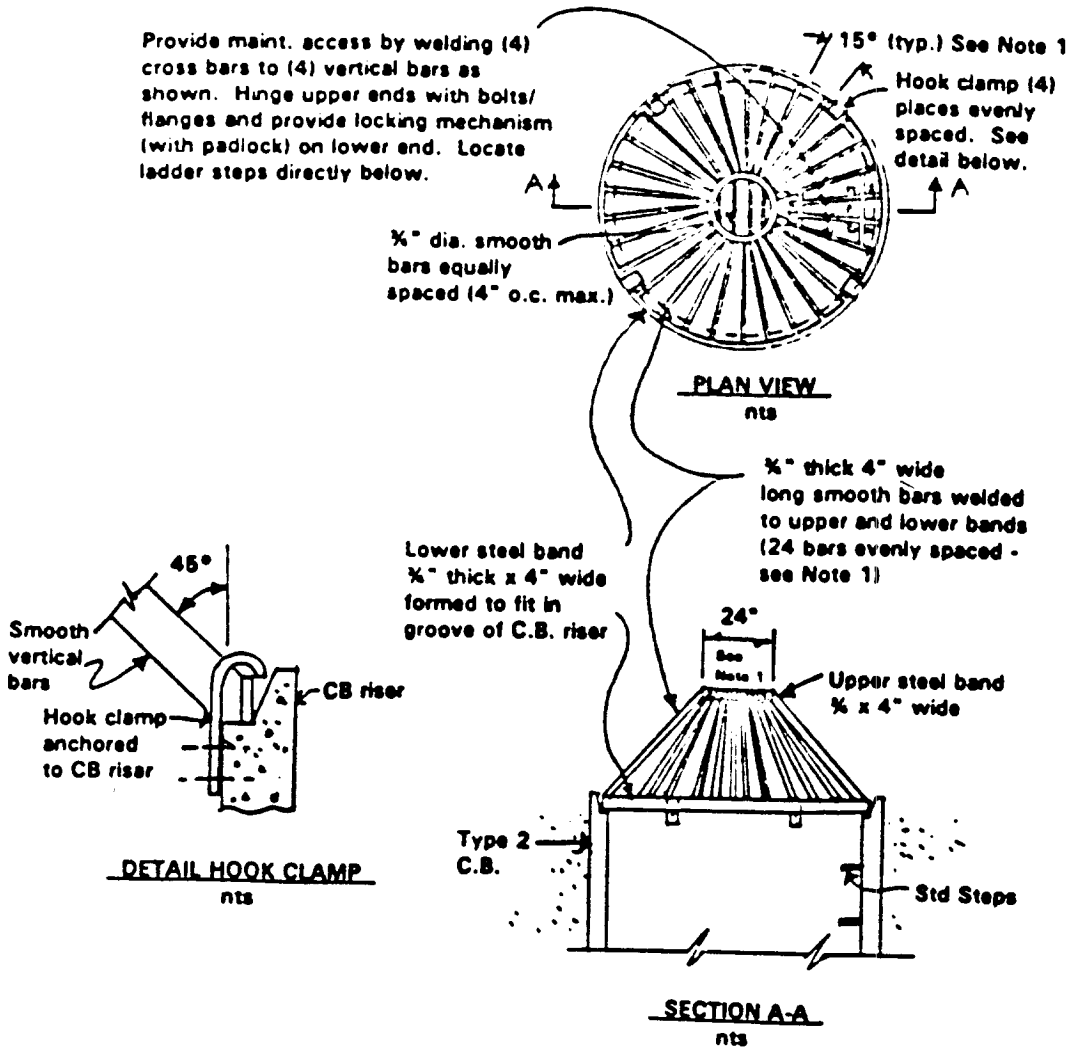
Figure III-4.4 Detention Pond Overflow Structure



Notes:

1. Dimensions are for installation on 54" dia. C.B. For different dia.C.B.'s adjust dimensions to maintain 45° angle on "vertical" bars and 7" O.C. max. spacing of bars around lower steel band.
2. Metal parts: corrosion resistant.
3. This debris barrier is also recommended for use on the inlet to roadway cross-culverts with high potential for debris collection (except on Class 2 streams).

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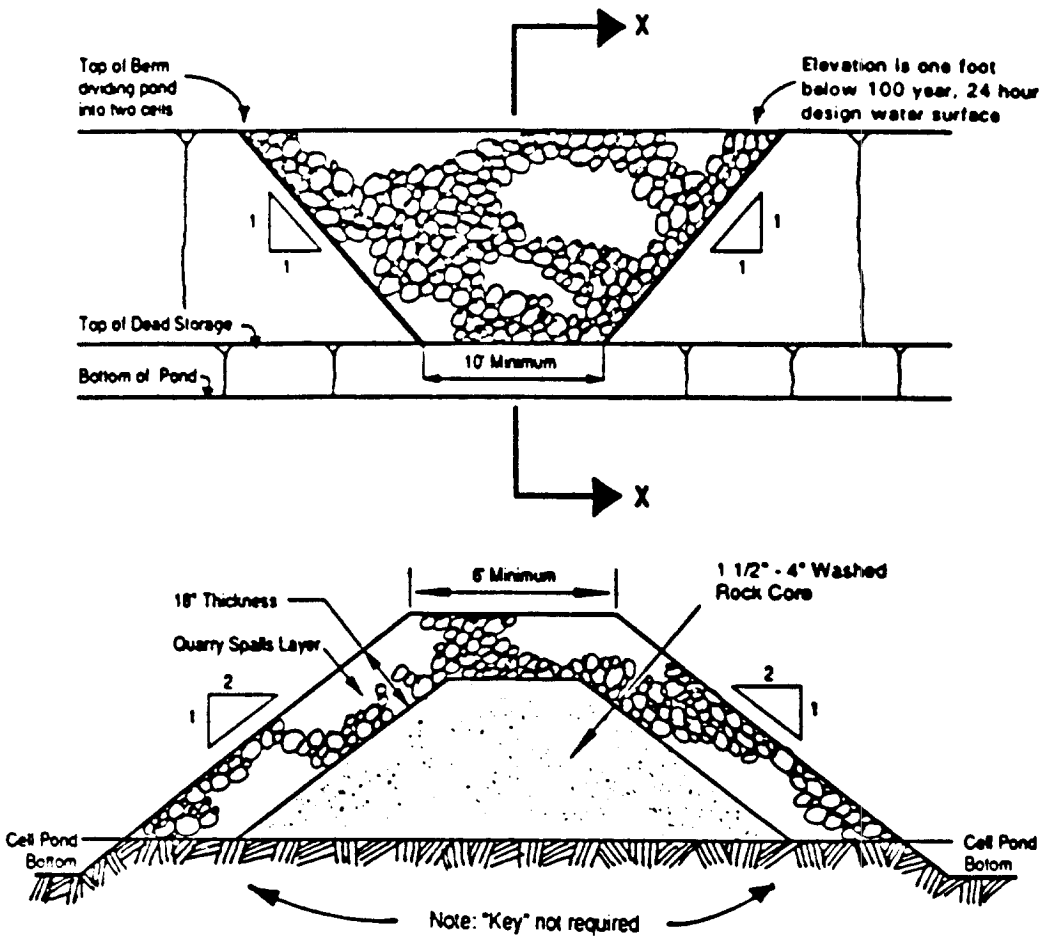
Figure III-4.5 Quarry Spall and Gravel Filter "Window"



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Pond berm embankments must be constructed on native consolidated soil (or adequately compacted and stable fill soils analyzed by a geotechnical report) free of loose surface soil materials, roots and other organic debris.

Pond berm embankments must be constructed by excavating a "key" equal to 50 percent of the berm embankment cross-sectional height and width (except on highly compacted till soils where the "key" minimum depth can be reduced to 1 foot of excavation into the till).

The berm embankment shall be constructed on compacted soil (95 percent minimum dry density, standard proctor method per ASTM D1557), placed in 6-inch lifts, with the following soil characteristics per the United States Department of Agriculture's Textural Triangle: a minimum of 30 percent clay, a maximum of 60 percent sand, a maximum of 60 percent silt, with nominal gravel and cable content (Note, in general, excavated glacial till will be well-suited for berm embankment material).

Anti-seepage collars must be placed on outflow pipes in berm embankments impounding water greater than 8 feet in depth at the design water surface.

Exposed earth on the pond bottom and side slopes shall be sodded or seeded with the appropriate seed mixture as soon as is practicable (see Erosion and Sediment Control BMP E1.35 in Volume II). Establishment of protective vegetative cover shall be ensured with jute mesh or other protection and reseeded as necessary (see Erosion and Sediment Control BMPs E1.15 and E1.35 in Volume II).

Gravity Drain

A gravity drain for maintenance shall provide an outlet invert of one foot above the bottom of the facility and shall be sized to drain the facility in four hours or less.

Erosion and Sediment

Bank erosion is often a significant problem during the initial stages of development. Stabilization with sod down to the permanent pool and preventing undue sediment deposition is required for the planting to survive.

Erosion and sediment control BMPs must be used to retain sediment on-site during construction (see Erosion and Sediment Control in Volume II). BMPs must be shown on the design plans and the engineer must provide instructions for proper O&M. Permanently stabilize all areas above the normal water level of ponds to prevent erosion and sedimentation of plantings (see Chapter II-5).

Littoral Zone Planting

For treating conventional pollutants a wet pond does not require the establishment of vegetation in its shallow areas, or "littoral zones." However, a shallow marsh system can provide additional treatment of runoff and bo aesthetically pleasing (see BMP RD.06, Wet Pond for Nutrient Control, for details). If littoral zone vegetation is planned it shall be planted according to the advice of a wetlands specialist. Nursery sources are recommended wherever possible. Small (2-4 inch) containers are encouraged to avoid transporting large amounts of potting soil to the pond. White roots and active basal budding indicate a healthy stock.

Most wetlands specialists prefer to have someone on-site during the construction phase to ensure that the littoral shelf is located and graded properly. Knowing exactly where the normal water level of the facility will reside after construction is absolutely essential to the success of this element of the system.

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Construction and Maintenance Criteria

Construction

Widely acceptable construction standards and specifications such as those developed by the USDA - Soil Conservation Service or the U.S. Army Corps of Engineers for embankment ponds and reservoirs should be followed to build the impoundment.

Chapter 17 of the SCS Engineering Field Manual provides guidance on construction methods for the various elements of a pond or reservoir. Specifications for the work should conform to methods and procedures for installing earthwork, concrete, reinforcing steel, pipe, water gates, metal work, woodwork, and masonry, that are applicable to the site and the purpose of the structure, and satisfy all requirements of the local government.

Maintenance

General

Maintenance is of primary importance if detention ponds are to continue to function as originally designed. A local government, a designated group such as a homeowners' association, or some individual shall accept the responsibility for maintaining the structures and the impoundment area. A specific maintenance plan shall be formulated outlining the schedule and scope of maintenance operations. Debris removal in detention basins can be achieved through the use of trash racks or other screening devices.

Design with maintenance in mind. Good maintenance will be crucial to successful use of the impoundment. Hence, provisions to facilitate maintenance operations must be built into the project when it is installed. Maintenance must be a basic consideration in design and in determination of first cost. See Table III-4.4 for specific maintenance requirements.

Any standing water removed during the maintenance operation must be disposed of to a sanitary sewer at an approved discharge location. Residuals must be disposed in accordance with current health department requirements of the local government.

Vegetation

If a shallow marsh is established, then periodic removal of dead vegetation will be necessary. The frequency of removal has not been established and Ecology requests comments on this issue. Since decomposing vegetation can release pollutants captured in the wet pond, especially nutrients, it may be necessary to harvest dead vegetation annually prior to the winter wet season. Otherwise the decaying vegetation can export pollutants out of the pond and also can cause nuisance conditions to occur. If harvesting is to be done in the wetland, a written harvesting procedure shall be prepared by a wetland scientist and will be submitted with the drainage design to the local government.

Sediment

Maintenance of sediment forebays and attention to sediment accumulation within the pond is extremely important. Sediment deposition should be continually monitored in the basin. Owners, operators, and maintenance authorities should be aware that significant concentrations of heavy metals (e.g., lead, zinc, and cadmium) as well as some organics such as pesticides, may be expected to accumulate at the bottom of these treatment facilities. Testing of sediment, especially near points of inflow, should be conducted regularly to determine the leaching potential and level of accumulation of hazardous material before disposal. For disposal procedures, refer to Volume IV - disposal requirements for catchbasin and pond sediments (to be written).

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Access

Pond access tracts and roads are required when ponds do not abut public right-of-way. Road(s) shall provide access to the control structure and along side(s) of the pond as necessary for vehicular maintenance. For ponds with bottom widths of 15 feet or more, the access road shall extend to the pond bottom and an access pad provided to facilitate cleaning. For ponds less than 15 feet in width, an access road must extend along one side.

Roads and pads shall meet the following criteria:

- Maximum Grade: 15 percent to control structure, 20 percent into pond.
- Provide 40 foot minimum outside radius on the access road to the control structure and the turn around to the pond bottom.
- Fence gates shall be provided for access roads at "straight" sections of road.
- Access roads shall be 15 feet in width.
- Access pads shall be 15 feet in width and 25 feet in length.
- Manhole and catchbasin lids must be at either edge of an access road or pad and be at least 3 feet from a property line.

Access shall be limited by a double-posted gate if a fence is required or by bollards. Bollards shall consist of two fixed bollards on each side of the access road and two removable bollards equally located between the fixed bollards.

Access roads and pads shall be constructed by utilizing one of the following techniques:

- Construct an asphalt surface meeting the same standard as residential minor access streets, as required by the local government.
- Construct a gravel surface road by removing all unsuitable material, laying a geotextile fabric over the native soil, placing quarry spalls (2"-4") six inches thick then providing a two-inch thick crushed gravel surface.
- Construct a landscape block (24"x24"x 6") surface by removing all unsuitable material, laying a geotextile fabric over the native soil, placing landscape blocks, filling the honeycombs with soil particles, and planting grass.

Nuisance Conditions

The presence of wet ponds and marshes in established urban areas is perceived by many people to be undesirable. They are often thought of as mud holes where mosquitoes and other insects breed. If the wet pond has a shallow marsh established (more likely in the cases of BMP RD.06 and BMP RD.09), the pond can become a welcomed addition to an urban community. Constructed fresh water marshes can provide miniature wildlife refuges, and while insect populations are increased, insect predators also increase, often reducing the problem to a tolerable level. Advice from the University of Washington (Rick Sugg, personal communication) suggests that in the Puget Sound lowlands, the extra breeding habitat provided by any wetponds would not be significant. Nevertheless, local governments and homeowners associations may wish to temporarily drain wet ponds during late spring (May) and summer if there is sufficient concern. However, it is imperative that vegetation in shallow marsh areas not die off during draindown periods. Otherwise, the pollutant removal effectiveness of the wet pond can be severely impacted. In addition, the decaying vegetation can create nuisance conditions.

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Table III-4.4 Specific Maintenance Requirements for Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
I. Ponds - General	Trash and debris	Any trash or debris which exceeds 1 ft^3/1000 ft^2 (equal to the volume of a standard size office garbage can) in general, there should be no evidence of dumping	Trash and debris cleared from site
	Poisonous vegetation	Any poisonous vegetation which may constitute a hazard to maintenance personnel or the public, e.g. poison ivy, poison oak, stinging nettles, devils club	No danger of poisonous vegetation where maintenance personnel or the public might normally be. Coordinate with the local county health dept.
	Pollutions	1 gallon or more of oil, gas or other contaminants or any amount found that could 1) cause damage to plant, animal or marine life, 2) constitute a fire hazard 3) be flushed downstream during storms or 4) contaminate ground water	No contaminants present other than a surface film. Coordinate with the local county health dept
	Unmowed grass/ground cover	In residential areas, mowing is needed when the cover exceeds 18 inches in height. Otherwise, maintain facility cover with adjacent ground cover and terrain as long as there is no decrease in facility function	When mowing is needed, grass or ground cover should be mowed down to 2 inches. A dense grass cover must be maintained on slopes, and in dry ponds on the bottom as well.
	Rodent holes	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes	Rodents destroyed and dam or berm repaired. Coordinate with the local county health dept.
	Insects	When insects such as wasps or hornets interfere with maintenance activities.	Insects destroyed or removed from site. Coordinate with people who remove wasps for anti-venom production
	Tree growth	Tree growth does not allow maintenance access or interferes with maintenance activity. If trees are not interfering with access, leave trees alone	Trees do not hinder maintenance activities. Selectively cultivate trees such as alders for firewood.
Side Slopes of Pond	Erosion	Eroded damage >2 inches deep where cause of damage is still present or where there is potential for continued erosion.	Slopes should be stabilized with appropriate erosion control BMPs e.g. seeding, plastic covers, riprap
Storage Area, Forebay	Sediment	Accumulated sediment that exceeds 10% of the designed forebay depth, or every three years	Sediment cleaned out to designed pond shape and depth, reseeded if necessary to control erosion
Pond Dikes	Settling	Any part of dike which has settled 4 inches lower than the design elevation	Dike should be built back to the design elevation.
Emergency Overflow, Spillway	Rock missing	Only 1 layer of rock above native soil in an area $\geq$ 5 ft^2 or any exposure of native soil.	Replace rock to design standards.
II. Debris Barriers - General	Trash and debris	Trash or debris that is plugging $\geq$ 20% of the openings in the barrier.	Barrier clear to receive capacity flow.

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Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Metal	Damaged/missing bars	Bars are bent out of shape ≥ 3 inches	Bars in place with no bend ≥ 3/4"
		Bars or entire barrier is missing	Bars in place according to design
		Bars are loose and rust is causing 50% deterioration to any part of the barrier	Repair or replace barrier to standards
III. Fencing - General	Missing or broken parts	Any defect in the fence that permits easy entrance to the facility	Parts in place to provide adequate security
		Parts broken or missing	Broken or missing parts replaced
	Erosion	Erosion ≥ 4 inches deep and 12 - 18 inches wide permitting an opening under the fence	No opening under the fence ≥ 4 inches in depth
Wire Fence	Damaged parts	Posts out of plumb more than 6 inches	Posts plumb within 1½ inches
		Top rails bent more than 6 inches	Top rail free of bends ≥ 1 inch
		Any part of fence (including posts, top rails and fabric) ≥ 1 foot out of design alignment	Fence in aligned and meets design standards
		Missing or loose tension wire	Tension wire in place & holding fabric
		Missing or loose barbed wire sagging more than 2½ inches between posts	Barbed wire in place with < 3/4 inch sag between posts
		Extension arm missing, broken or bent out of shape more than 1½ inches	Extension arm in place with no bends larger than 3/4 inch
	Deteriorated paint or protective coating	Part(s) that have a rusting or scaling condition which has affected structural adequacy	Structurally adequate posts or parts with a uniform protective coating
	Openings in fabric	Openings in fabric are such that an 8 inch diameter ball could fit through.	No openings in fence
IV. Gates - General	Damaged or missing members	Missing gate or locking device.	Gates and locking devices in place.
		Broken or missing hinges such that gate cannot be easily opened and closed by maintenance personnel	Hinges intact & lubed, gate working freely.
		Gate is out of plumb ≥ 6 inches and ≥ 1 foot out of design alignment.	Gate is aligned & vertical.
		Missing stretcher bar, stretcher bands and ties.	Stretcher bar, bands & ties in place.
		See "Fencing" standard, above.	See "Fencing" standard, above.
V. Access Roads, Easements - General	Trash and debris	Exceeds 1 ft³/1000 ft² or the amount that would fill a standard size garbage can.	Trash & debris cleared from site.
	Blocked roadway	Debris which could damage vehicle tires.	Roadway free of such debris.
		Obstructions which reduce clearance above road surface to < 14 feet.	Roadway overhead clear to 14 feet high.

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Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
V Access Roads, Easements, continued	Blocked roadway, continued	Any obstructions restricting access to a 10 - 12 foot width for a distance of ≥ 12 feet or any point restricting access to a < 10 foot width	Obstructions moved to allow at least a 12 foot access route
	Settlement, potholes, muddy spots, ruts	When any surface exceeds 6 inches in depth and 6 ft² in area. In general, any surface defect which prevents or hinders maintenance access	Road surface uniformly smooth with no evidence of potholes, settlement, muddy spots or ruts
	Vegetation in surface	Weeds growing in the road surface that are ≥ 6 inches tall and < 6 inches apart within a 400 ft² area	Road surface free of weeds taller than 2 inches
	Erosion damage	Erosion within 1 foot of the roadway ≥ 8 inches wide & 6 inches deep	Shoulder free of erosion & matching the surrounding road
	Weeds and brush	Weeds and brush exceed 18 inches in height or hinder maintenance access	Weeds and brush cut to 2 inches in height or cleared in such a way as to allow maintenance access

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III-4.4.2 BMP RD.06 Wet Pond (Nutrient Control)

Purpose and Definition

This BMP is similar to BMP RD.05 (Wet Pond for treatment of conventional pollutants) but has a shallow marsh area which provides additional treatment of pollutants, especially nutrients. The shallow marsh area is contained within the "permanent pool" volume. Streambank erosion control can be provided by detaining runoff in the "live storage" area above the permanent pool. Figure III-4.6 illustrates a wet pond for nutrient control.

Planning Considerations

See BMP RD.05, Wet Pond (Conventional Pollutants). The primary difference is that this BMP requires the establishment of a shallow marsh in order to provide additional treatment of runoff, particularly nutrients.

Marsh Establishment

Establishment of fresh water marshes in ponds can aid in water quality improvement. Marsh areas create a sink for many pollutants with a high degree of water treatment or purification, depending upon the runoff detention time and the availability of wetland plants and aquatic life to assimilate pollutants.

Wetland-associated plants will establish themselves naturally in shallow, wet ponds. It may be beneficial, however, to accelerate marsh establishment by planting appropriate native vegetation in shallow areas. Certain wetland plant species have a greater capacity for pollutant assimilation and are less maintenance intensive than others.

Marsh establishment for stormwater treatment is still in the investigational stages in Washington. One particular limitation is the fact that the major plant growing season (April - October) is largely out of phase with the times of greatest stormwater runoff. However, preliminary indications show that such measures can be appropriate for the following applications:

1. *At the perimeter of deep detention facilities to filter direct sheet flow runoff from the adjacent drainage area.*
2. *On shallow sills or shelves separating in-line tandem ponds or forebays to filter runoff before it enters the major impoundment from tributaries or storm drain inlets.*
3. *Surrounding the outflow of detention facilities to promote assimilation of dissolved pollutants before water exits the primary impoundment.*

Note: In any event, the value of the plant communities will depend upon how much untreated stormwater flows through them.

Marsh establishment in facilities that also serve as temporary sediment basins may be difficult during construction due to the need for frequent clean-out of accumulated sediment. Wet ponds should be designed with the need for periodic sediment removal in mind. To continue functioning, marshes also require periodic sediment removal. Sediment should be removed from the deepest parts of the basin where vegetation is sparse. Heavily vegetated areas should be disturbed as little as possible. Overhead scooping equipment works well for dredging selected portions of marsh areas.

The presence of marshes in established urban areas is perceived by many people to be undesirable. They are often thought of as mud holes where mosquitoes and other insects breed. Actually, once a marsh becomes fully established, it can become a

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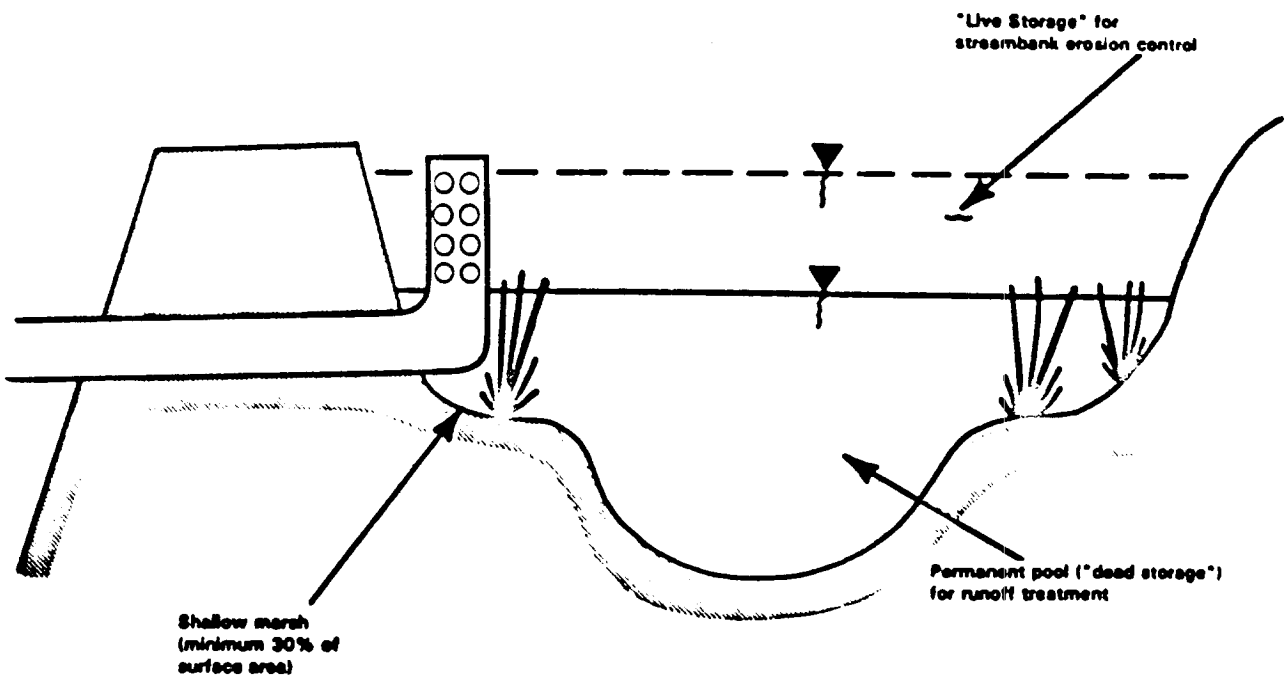
Figure III-4.6
BMP RD.06 Wet Pond for Nutrient Control



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welcomed addition to an urban community. Constructed fresh water marshes can provide miniature wildlife refuges, and while insect populations are increased, insect predators also increase, often reducing the problem to a tolerable level. However, allowance should be made to periodically drain the pond to help control mosquitoes (see Maintenance details). Also, ponds that are stocked with fish should also aid in control (2).

Design Criteria

See BMP RD.05, Wet Pond (Conventional Pollutants). The primary difference between this BMP and BMP RD.05 is that a larger surface area is required in order to establish a shallow marsh system in the littoral zone. Important design criteria, including the pond configuration and geometry, and other considerations are discussed above in BMP RD.05.

Sizing Wet Ponds for Nutrient Control

Wet ponds designed for treatment of nutrients utilize a permanent pool of water which has a shallow marsh established. Hydrologic analysis methods presented in Chapter III-1 are to be used for design purposes.

Permanent Pool Volume

The permanent pool volume shall be equal to the runoff volume of the 6-month, 24-hour design storm.

Surface Area-Pool Depth Relationships

The pond should be designed using the following surface area-depth relationship (for the permanent pool volume):

- 70% of the area @ 2 - 6 feet
- 30% of the area @ 0 - 2 feet

The maximum depth of the permanent pool should be six feet. Permanent pools deeper than six feet may contaminate ground water (should they intersect the existing ground water level). Also, deeper ponds can stratify and create anaerobic conditions that can cause pollutants which are normally bound in the sediment (e.g., metals and phosphorus) to resolubilize; their release back to the water column can seriously affect the effectiveness of the BMP and also create nuisance conditions.

The *maximum average* depth of this BMP is 4.8 feet. See Table III-4.2 for surface area-pool depth relationships for this and other detention BMPs and Table III-4.3 for typical surface area-to-drainage area ratios.

If the wet pond is also designed to provide streambank erosion control, then additional surface area and depth will be required for the "live storage" volume located above the permanent pool. There is no specific surface area-pool depth relationship for the "live storage" volume. Ponds designed to provide streambank erosion control may be deeper than six feet as long as the permanent pool volume provided for runoff treatment does not exceed six feet.

Pond Configuration and Geometry

See BMP RD.05, Wet Pond (Conventional Pollutants).

Littoral Zone Planting

Littoral zones shall be planted according to the advice of a wetlands specialist.

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Nursery sources are recommended wherever possible. Small (2-4 inch) containers are encouraged to avoid transporting large amounts of potting soil to the pond. White roots and active basal budding indicate a healthy stock.

Most wetlands specialists prefer to have someone on-site during the construction phase to ensure that the littoral shelf is located and graded properly. Knowing exactly where the normal water level of the facility will reside after construction is absolutely essential to the success of this element of the system.

Bank erosion is often a significant problem during the initial stages of development. Stabilization with sod down to the permanent pool and preventing undue sediment deposition is required for the planting to survive.

Other Design Considerations

See BMP RD.05, Wet Pond (Conventional Pollutants).

Construction and Maintenance Criteria

See BMP RD.05, Wet Pond (Conventional Pollutants).

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III-4.4.3 BMP RD.09 Constructed Wetland

Purpose and Definition

A Constructed Wetland is an artificial wetland intentionally constructed on a nonwetland site for the purpose of managing stormwater runoff. The primary function of a Constructed Wetland is to provide runoff treatment of both conventional pollutants and nutrients, using a permanent pool of water which has extensive shallow marsh areas. A secondary function will be to provide streambank erosion control by adding a "live storage" volume above the permanent pool volume; however, this feature must be more carefully planned than for other wet pond-type BMPs. A Constructed Wetland can provide other benefits as well and, due to its larger surface area compared to other BMPs, should be designed to provide recreational opportunities, wildlife habitat, and to be an aesthetic amenity.

Figures III-4.7 and III-4.8 illustrate a constructed wetland BMP.

Planning Considerations

See BMP RD.05 and BMP RD.06, wet ponds for treatment of conventional pollutants and nutrients, respectively, for the following considerations:

- *Multiple Uses*
- *Basin Planning*
- *Sediment and Debris*
- *Heavy Metal Contamination*
- *Overflows*
- *Site Constraints and Setbacks*
- *Dam Safety*
- *Safety, Signage, and Fencing*
- *Marsh Establishment*

Because of the larger surface area of constructed wetlands, and the greater potential for multiple uses, additional planning considerations are provided below.

General

Constructed wetlands are essentially a version of a wet pond (see BMPs RD.05 and RD.06). The difference is in the emphasis placed on vegetation, and depth-area considerations. The aim is to replicate the functions and values of natural wetlands as much as possible. They are therefore more complex to build than ordinary wet ponds, the most simple of which need very little if any planted vegetation. Compared to wet ponds, constructed wetlands are shallower and have greater surface area (see Table III-4.3 above for a comparison). Chapter III-5, "Natural Wetlands and Stormwater Management," should be read carefully if a primary objective is to replicate the functions of a natural wetland system.

The two most important considerations when planning for a constructed wetland are the hydrologic factors and selection of vegetation.

Hydrologic Factors

The following hydrologic factors need to be considered to ascertain whether the site being considered is suitable for a constructed wetland.

a) Flow. An analysis of flow is needed to determine depth-area relationships. See Chapter III-1 for hydrologic analysis methods. Section III-4.3.2 above for a discussion of depth-area relationships.

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Figure III-4.7 BMP RD.09 Constructed Wetland

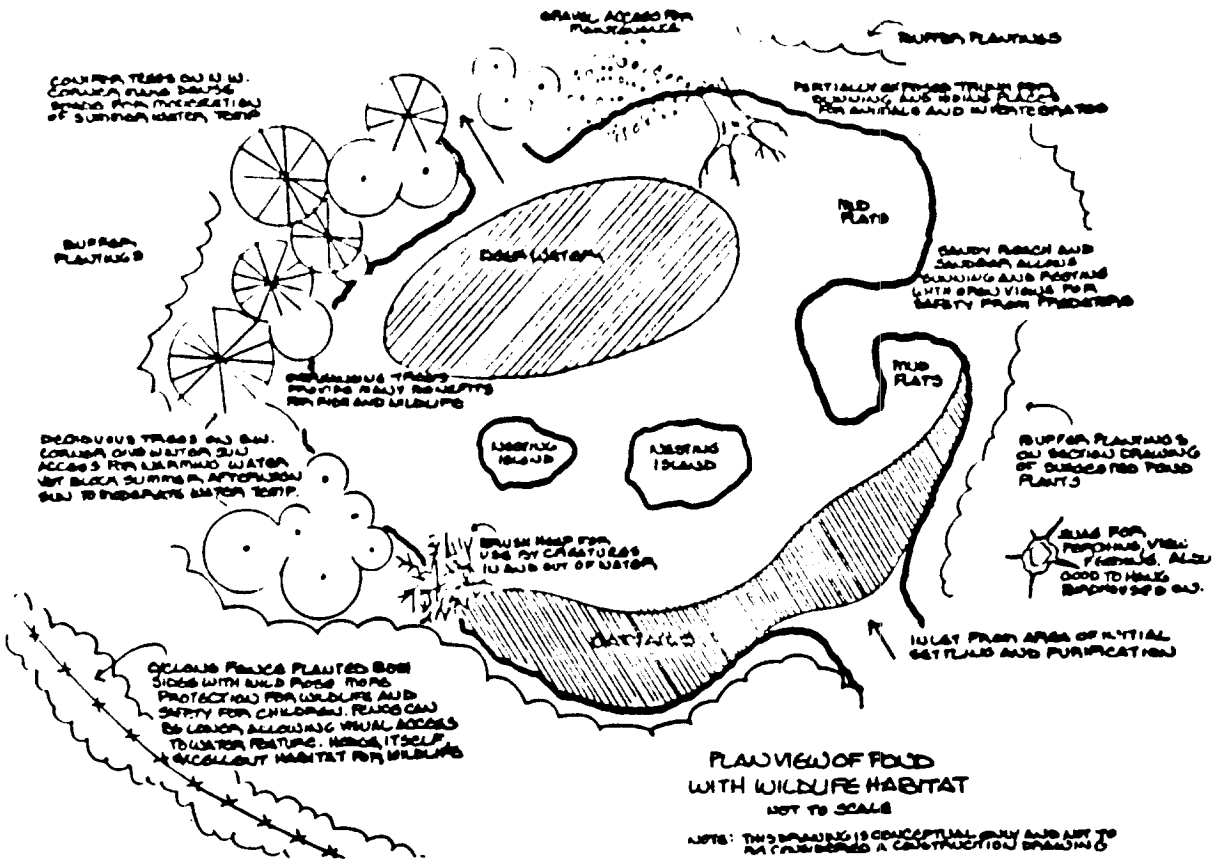

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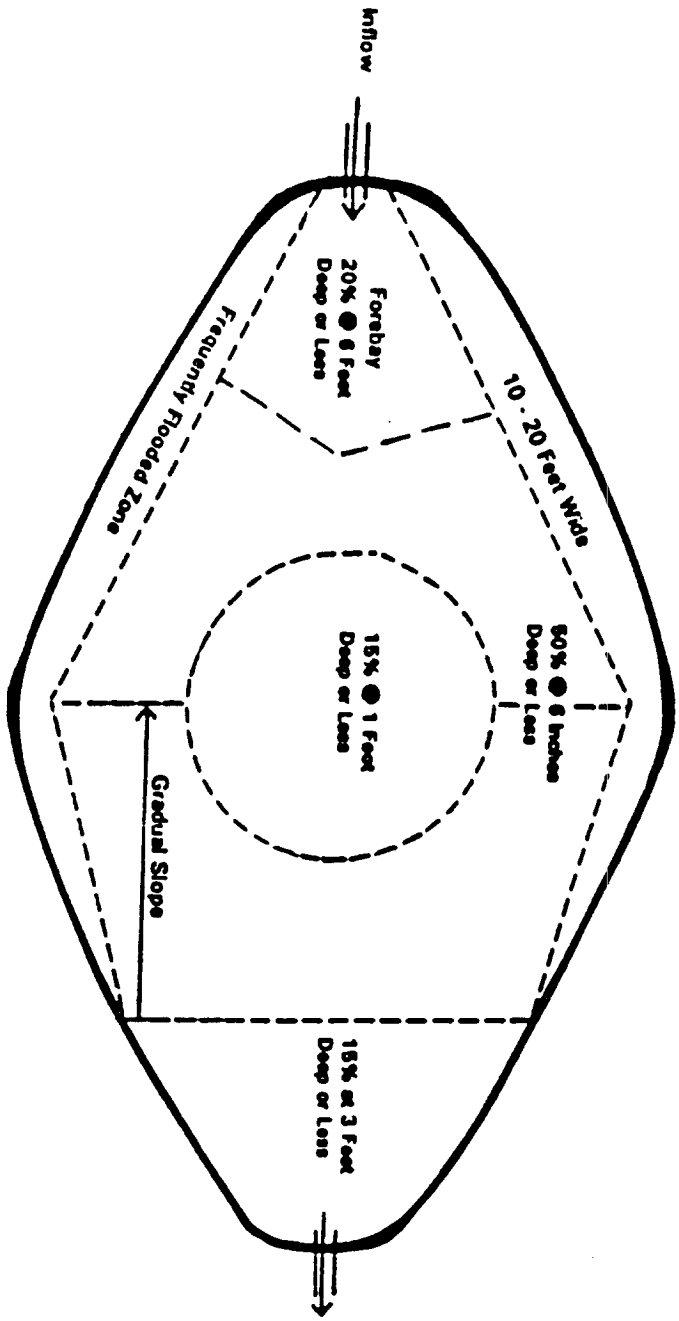
Figure III-4.8 Diagram of a Constructed Wetland



Adapted from "Guidelines for Constructing Wetland Stormwater Basins", 1987

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b) *Climatic Conditions. Overall climatic conditions determine the types of plants that may be used and the seasonality of flow rates.*

c) *Ground Water Conditions and Soil Permeability. These factors need to be considered to avoid pollution of ground water and to determine whether the wetland may need to be lined.*

Vegetation Selection

Selection of vegetation needs to be done by a wetlands specialist. The selection will be based on climate, hydroperiod of the wetland, sensitivity to pollution, and aesthetic appeal. Grazing pressures and detrimental effects of wind, waves, and water currents will also need to be taken into account. A well planned wetland will also need a diverse mixture of floating, emergent, and submergent plants. Above all, the plants will need to be able to withstand the pollutant concentration of the incoming water and tolerate some fluctuation in the water level of the wetland.

Artificial establishment of vegetation is done to influence future plant species composition and to establish a vegetated marsh as quickly as possible. Complete coverage and optimum treatment potential can often take five years or more. Constructed wetlands with a smaller vegetative cover can still significantly reduce pollution.

Soils testing should be conducted to determine soil type. Plant species should be chosen based on their ability to thrive in particular soil types. Plant types should be discussed with plant specialists and nurseries during the selection process.

Wildlife

The species of vegetation chosen should maximize heterogeneity and value to all types of wildlife. Although not required, measures to further enhance habitat for wildlife are encouraged. Maximizing vegetation density around the wetland will discourage the entry of domestic animals that would prey on wildlife. Provision of an island for nesting birds is encouraged (see Figures III-4.7 and III-4.9). Unless the constructed wetland is adequately maintained, with potentially contaminated sediment removed regularly, the possibility of pollutant contamination of the wildlife using the wetland does exist.

Impacts of Fluctuating Water Levels

Large sudden fluctuations in water levels of the wetland environment often destroy wetland/upland edge vegetation. Most edge vegetation cannot survive drought-saturation extremes, leaving stream, lake, and wetland banks exposed to potential erosion.

Water level extremes may result from urbanization through the clearing of vegetation and increased amounts of impervious surfaces. This causes large surges when it rains and low flows in the summer due to lack of ground water. It is therefore important to prevent surges whenever possible and design for gradual increases and decreases in water level. This can be done through the use of upstream detention and a controlled release of stormwater runoff from that facility. Constructed wetlands are better for polishing the quality of runoff and less useful for hydraulic detention purposes.

See Chapter III-5 for a further discussion of the impacts of fluctuating water levels.

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Design Criteria

Important design criteria applicable to all wet ponds is provided with BMP RD.05 and BMP RD.06, including:

- Liner to Prevent Infiltration
- Overflow and Emergency Spillway
- Berm Embankment/Slope Stabilization
- Gravity Drain
- Erosion and Sediment
- Littoral Zone Planting

Sizing of Constructed Wetlands

See BMP RD.06, Wet Pond (Nutrient Control). The primary difference is that a constructed wetland has different surface area-pool depth relationships for the permanent pool, as follows:

- 50% of the area = 0.5 feet (approximately)
- 15% of the area @ 0.5 to 1 foot
- 15% of the area @ 2 to 3 feet
- 20% of the area 3+ feet deep with a maximum depth of 6 feet

This relationship results in a *maximum average* permanent pool depth of 2.05 feet. See Table III-4.2 for surface area-pool depth relationships for this and other detention BMPs and Table III-4.3 for typical surface area-to-drainage area ratios.

Permanent Pool

To maintain a permanent pool of water in a wetland, inflow from stormwater, baseflow, and ground water must be greater than the outflow via infiltration, evapotranspiration, and discharge. If the rate of infiltration is high and a permanent pool cannot be maintained, a clay liner (or equivalent) will be necessary. The discharge rate may also be reduced to increase residence time.

"Live Storage" Volume

The "live storage" volume must be sufficient to meet the release requirements for streambank erosion control, i.e., 50% of the existing condition 2-year, 24-hour peak flow; maintain existing condition peak flow rates for 10-year and 100-year, 24-hour events. A correction factor must be applied to the calculated detention volume in order to account for weaknesses with current hydrologic analysis methods. See Chapter III-1 for a discussion.

Pond Configuration and Geometry

See BMP RD.05, Wet Pond (Conventional Pollutants).

A forebay, a deeper area where sediments can settle out, should be established along the wetland inflow points to capture sediment. The forebay should have a water depth of about 3 feet and may occupy up to 25 percent of the normal pool area.

Side Slopes

Side slopes shall not be steeper than 3:1. There should be an area of low slope surrounding the permanent pool which is temporarily flooded during most runoff events but drains as the runoff leaves the basin. It is recommended that this area be 10 to 20 feet in width.

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Length-to-Width Ratio

The length-to-width ratio should be at least 3:1 and preferably 5:1. If area constraints make this ratio unworkable, baffles, islands, or peninsulas may be installed to increase the flow path and prevent short-circuiting.

Other Criteria

Constructed wetlands can be constructed along a series of different elevations. Water passage from one level to the other can be over an aeration cascade to oxygenate the water. The increased oxygen will promote bacterial digestion of organic matter.

Soil and Vegetation Plan

Soil

The soil in which the vegetation is planted should be appropriate for the wetland plants selected. Either soil tests indicating the adequacy of the soil or a soil enhancement plan shall be submitted with the overall wetland design.

The soil substrate must be soft enough to permit easy insertion of the plants. If the basin soil is compacted or vegetation has formed a dense root mat, the upper 6 inches of soil should be disked prior to planting. If soil is brought in, it needs to be laid at least 4 inches deep in order to provide sufficient depth for plant rooting. Soil may be taken from another wetland or from ditch cleaning operations if available. However, if this type of soil is used, the plant species composition may be influenced by volunteer vegetation. Studies have shown up to 32,430 seeds per square meter in marsh soils. Enriching non-wetland soils with organic matter seems to increase vegetative yields.

Vegetation

A wetland scientist shall prepare that portion of a vegetation plan for the design that relates to vegetation selection and installation. Suggestions for wetland vegetation may be found in "Water Pollution Control Aspects of Aquatic Plants: Implications for Stormwater Quality Management" by Louise Kulzer of Metro in Seattle, and in Figures III-4.10 and III-4.11.

1. All plant materials shall conform to Ch. 16-432 WAC, "Rules Relating to Standards for Nursery Stock".

2. Prior to planting, plants located temporarily on-site must be kept moist, fresh, and protected from wind and sun.

Construction and Maintenance Criteria

Construction

See BMP RD.05, Wet Pond (Conventional Pollutants).

Maintenance

See BMP RD.05, Wet Pond (Conventional Pollutants).

If oil/water separators precede the wetland they must be cleaned regularly. Floatables must be removed annually from the forebay; surface sheen must also be removed. The forebay bottom should be cleaned once every five years, or when 6 inches of the permanent pool in the forebay is lost to accumulated material, whichever comes first. If solubilization of pollutants from accumulated bottom sediments is found to occur, annual cleaning may be necessary. Grass along the

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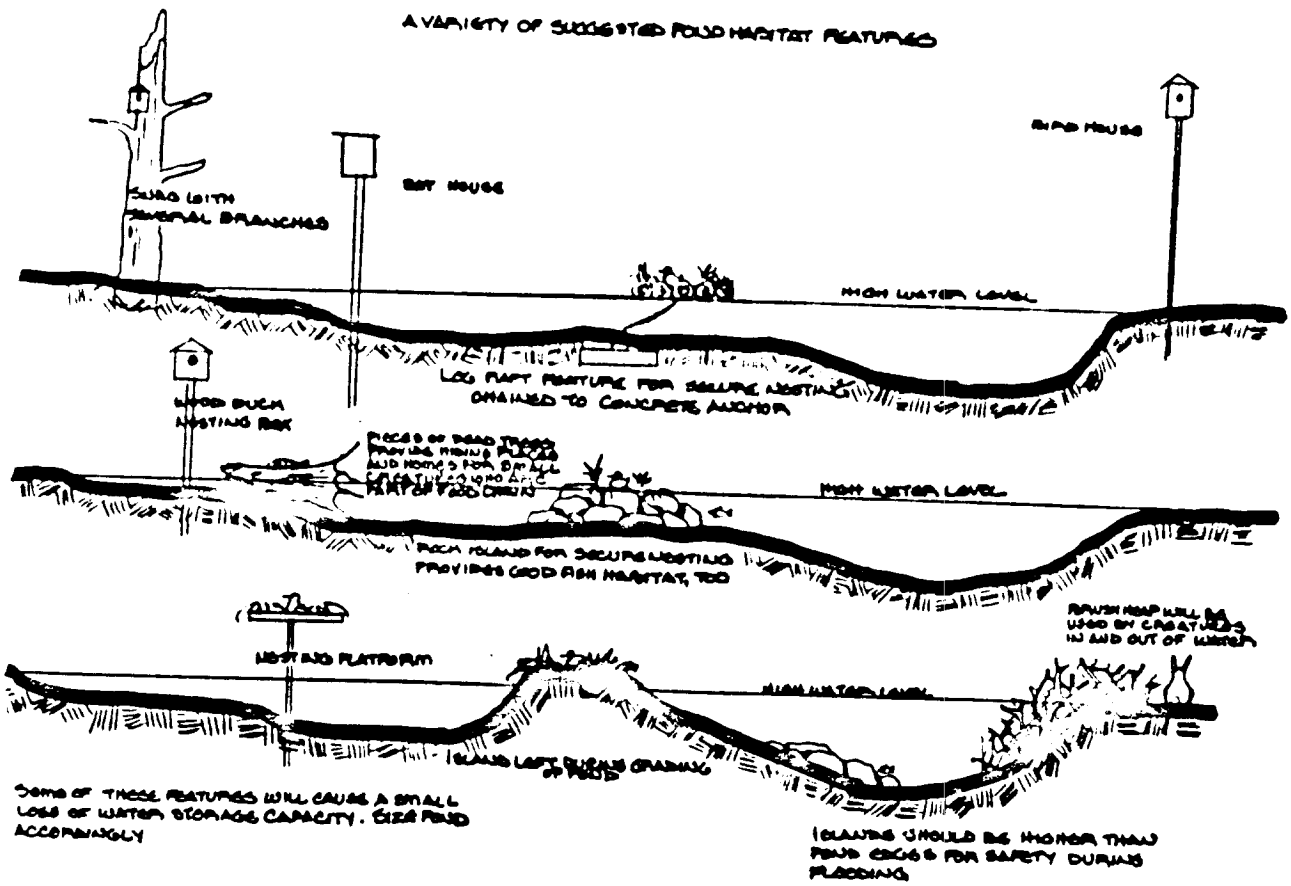
Figure III-4.9 Suggested Habitat Features for a Constructed Wetland



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basin slopes above the permanent pool must be well maintained to prevent erosion.

Any standing water removed during maintenance operations must be disposed of to a sanitary sewer at an approved discharge location. Residuals must be disposed in accordance with current health department requirements of the local government.

If harvesting is to be done in the wetland, a written harvesting procedure shall be prepared by a wetland scientist and will be submitted with the drainage design to the local government.

References

(1) Stockdale, Erik C., Freshwater Wetlands, Urban Stormwater, and Nonpoint Pollution Control: A Literature Review and Annotated Bibliography, Second Edition, King County Department of Parks, Planning and Resources, Seattle, Washington, February, 1991.

(2) Sediment and Stormwater Division, Water Resources Administration, Maryland Department of Natural Resources, Guidelines for Constructing Wetland Stormwater Basins, March, 1987.

(3) Sediment and Stormwater Division, Water Resources Administration, Maryland Department of Natural Resources, Wetland Basins for Stormwater Treatment: Discussion and Background, (undated)

(4) Kulzer, L., Water Pollution Control Aspects of Aquatic Plants: Implications for Stormwater Quality Management, METRO Office of Water Quality, Seattle, Washington, 1990.

(5) Stephenson, Marian, et.al., The Use and Potential of Aquatic Species for Wastewater Treatment - Appendix A The Environmental Requirements of Aquatic Plants, Publication No. 65, University of California, Davis, California, October, 1980.

(6) Canning, Douglas J., Urban Runoff Water Quality: Effects and Management Options, Second Edition, Shorelands Technical Advisory Paper No. 4, Washington State Department of Ecology, 1988.

(7) Hammer, David E., and Robert H. Kadlec, Design Procedures for Wetland Treatment Systems, EPA 600/2-83-026, April, 1983.

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Figure III-4.10 Suggested Plantings for Specific Depths of a Constructed Wetland

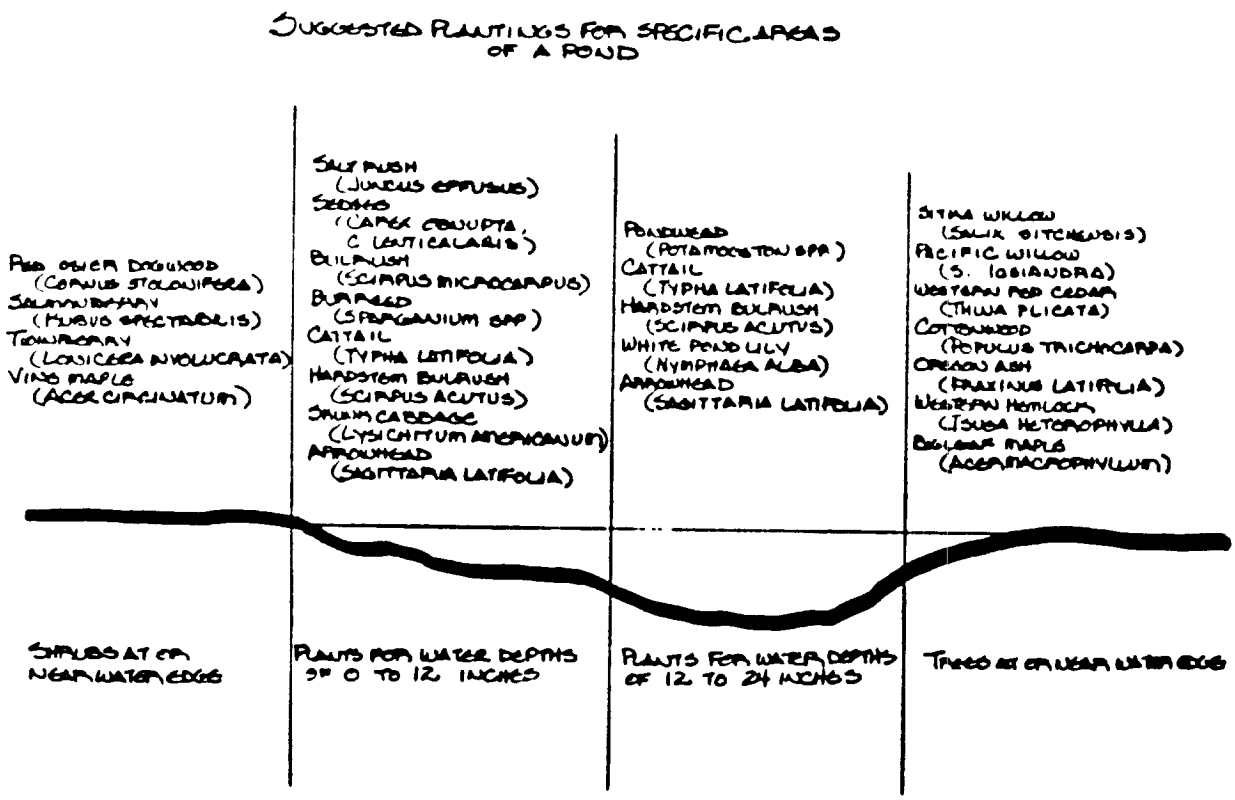

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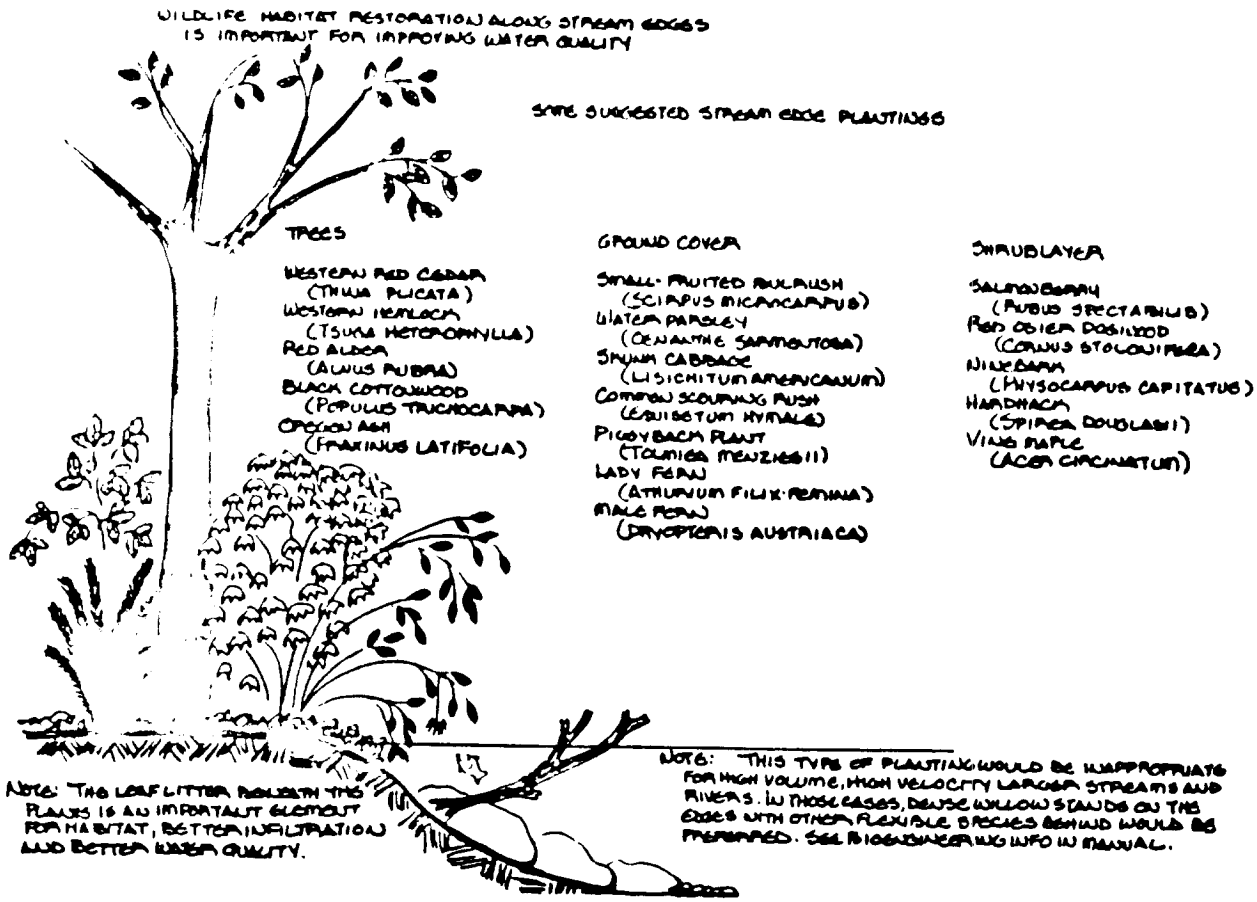
Figure III-4.11 Suggested Stream Edge Plantings for a Constructed Wetland



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III-4.4.4 BMP RD.10 Presettling Basin

Purpose and Definition

A Presettling Basin provides pretreatment of runoff in order to remove suspended solids which can impact other primary treatment BMPs. A presettling basin has no "permanent pool" volume; runoff is detained so that particulates can settle out before being discharged to a another BMP. Runoff treated by a Presettling Basin must be further treated by a water quality infiltration or filtration BMP, a wet pond-type BMP, or a biofilter. Presettling basins may need to be located "off-line" from the primary conveyance/detention system if used to protect infiltration or filtration BMPs from siltation.

Presettling Basins are not to be used to provide streambank erosion control. If pretreatment and streambank erosion control are to be combined into one structure, see BMP RD.11, Extended Detention Dry Pond (note, however, that such a facility may have limited application in the Puget Sound Basin).

Figure III-4.12 illustrates a presettling basin.

Planning Considerations

One of the major concerns with infiltration and filtration facilities is their tendency to clog with sediment. To minimize this, all runoff entering infiltration or filtration facilities is required to be pretreated to remove the majority of particulate material. Presettling basins can be used when there is no requirement to provide streambank erosion control.

In some cases there may be greater concern than usual about sediments entering an infiltration or filtration facility (e.g. highly erodible soils). In these instances a combination of a presettling basin with a biofilter or vegetative filter strip is recommended (see BMP RB.05 and BMP RB.06).

Sediment and Debris

More often than not, ponds serve primarily as sedimentation basins during construction when erosion rates are particularly high. In and of itself, this situation does not present a problem. Unfortunately, these facilities are often installed without the benefit of the designer having evaluated the capacity of either the initial or the final (post-construction) design configuration to perform this type of function.

If a facility is to be used as the principal means to avoid having excessive levels of turbidity discharged from the site during construction, the engineer should evaluate the pond geometry in conjunction with the rate of outflow and grain size distribution of the soils and design the temporary sediment basin according to BMPs E3.35 or E3.40 in Volume II.

Heavy Metal Contamination

Studies have shown high accumulation rates of lead, zinc, and copper on and near heavily traveled highways and streets. Runoff from highways and streets can be expected to carry significant concentrations of these heavy metals. If a significant portion of the drainage area into a pond consists of highways, streets, or parking areas or other known sources of heavy metal contamination, there is a potential environmental health hazard. In such cases the multiple use functions of the pond should be limited and accessibility should be restricted. Additionally, liners should be provided for ponds expected to accept these types of pollutants, for certain soil types, according to Section III-4.3.2.

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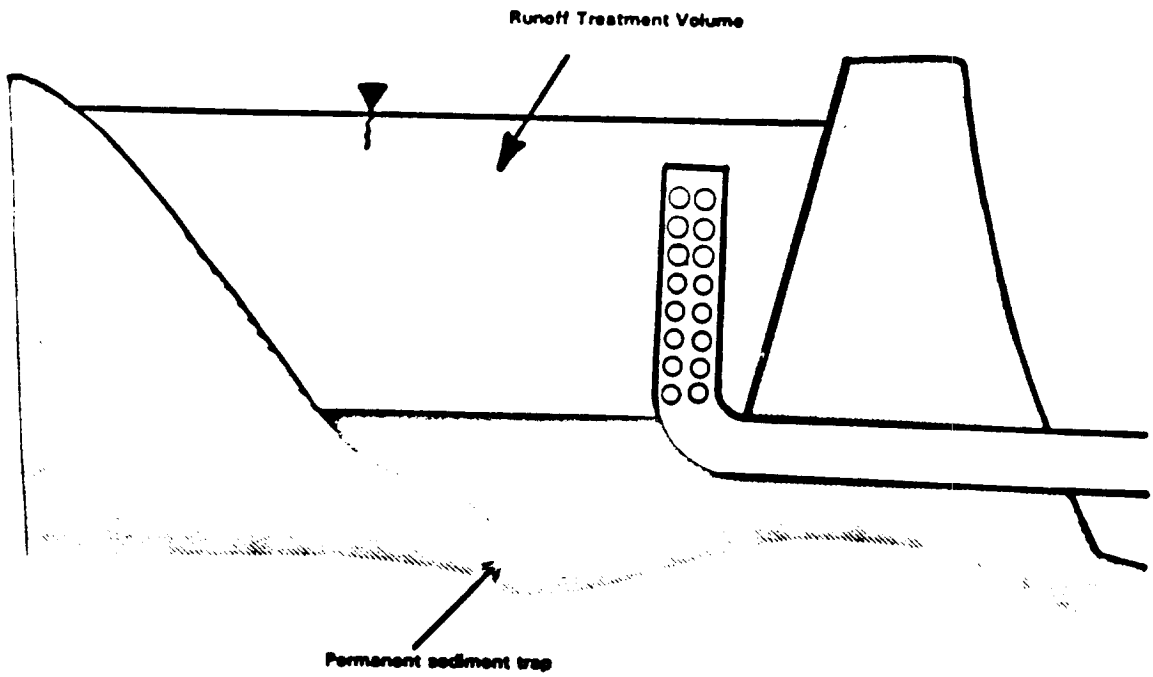
Figure III-4.12
BMP RD.10 Presettling Basin



Note: No streambank erosion control is provided by this BMP.

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This may require that sediment dredged out of the basins during maintenance cleaning be treated as a Dangerous Waste. Investigations of sediments removed from detention ponds to date have found that many pollutants are tightly bound with only a slight possibility of leaching. To be safe, sediments to be removed should be analyzed and elutriate tests performed to verify that the sediment can be safely disposed of by conventional methods (see Volume IV, Catchbasin Sediment Disposal Policy (to be written) which deals with disposal procedures).

Site Constraints and Setbacks

Site constraints are any manmade restrictions such as property lines, easements, structures, etc. that impose constraints on development. Constraints may also be imposed from natural features such as requirements of the local government's Sensitive Areas Ordinance and Rules (if adopted). These should also be reviewed for specific application to the proposed development.

All facilities shall be a minimum of 20 feet from any structure, property line, and any vegetative buffer required by the local government, and 100 feet from any septic tank/drainfield (except wet vaults shall be a minimum of 20 feet).

All facilities shall be a minimum of 50 feet from any steep (greater than 15%) slope. A geotechnical report must address the potential impact of a wet pond on a steep slope.

Dam Safety

In urban or urbanizing areas, failure of an impoundment structure can cause significant property damage and even loss of life. Such structures should be designed only by professional engineers registered in the State of Washington who are qualified and experienced in impoundment design. Wherever they exist, local safety standards for impoundment design shall be followed. Where no such criteria exist, widely recognized design criteria such as those used by the USDA Soil Conservation Service, Ecology Dam Safety Standards, or U.S. Army Corps of Engineers are recommended.

Safety, Signage and Fencing

Ponds which are readily accessible to populated areas should incorporate all possible safety precautions. Steep side slopes (steeper than 3H:1V) at the perimeter shall be avoided and dangerous outlet facilities shall be protected by enclosure. Warning signs for deep water and potential health risks shall be used wherever appropriate. Signs should be placed so that at least one is clearly visible and legible from all adjacent streets, sidewalks or paths. A notice should be posted warning residents of potential waterborne disease that may be associated with body contact recreation such as swimming in these facilities.

If the pond surface exceeds 20,000 sq. feet, include a safety bench around the basin with a width of 5 feet, and with a depth not exceeding 1 foot during non-storm periods. Emergent vegetation such as cattails should be placed on the bench to inhibit entry by unauthorized people.

A fence is required at the maximum water surface elevation, or higher, when a pond slope is a wall. Local governments and Homeowners Associations may also require appropriate fencing as an additional safety requirement in any event.

Design Criteria

The hydrologic analysis methods in Chapter III-1 shall be used for design purposes.

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Sizing Presettling Basins

Presettling basins are to be designed to settle out particulate pollutants for a range of runoff events, up to the 6-month, 24-hour design storm. The smaller storms (i.e., less than the 6-month, 24-hour storm) also need to be controlled because these frequently occurring events carry the majority of the annual pollution. Schueler (13) recommends that a maximum detention time for the maximum detention volume be 40 hours. Ecology recommends that 24 hours be used due to the Pacific Northwest rainfall pattern, with the exception of the case when presettling basins are used in tandem with water quality infiltration BMPs. For that case, the *total* detention time for *both* the presettling basin and the infiltration BMP should be 24 hours in order to maintain aerobic conditions in the infiltration BMP. Schueler also recommends that smaller events (0.1-0.2 inches) be detained no less than six hours. These are general recommendations but can be deviated from if the designer uses an appropriate equation to size the presettling basin. The Camp-Hazen equation (8) is recommended as it takes into account effects of turbulent flow, which is a typical condition during runoff events:

$E = 1 - \exp(-wA_s/Q_o)$ where

E = trap efficiency = fraction of suspended solids to remove; set equal to 0.8 (= 80% removal efficiency);
w = settling velocity of target particle; silt is recommended using a settling velocity of 0.0004 ft/sec.
A_s = surface area of presettling basin
Q_o = average release rate from the presettling basin.

The choice of a minimum 80 percent removal for suspended solids as the criterion for selecting the surface area is considered reasonable and cost-effective. However, protection of beneficial uses in receiving waters will always be required. There may be instances, depending on the nature of pollutants to be controlled and the receiving waters, when a higher removal rate, and hence larger surface area, will be required by the local government and/or Ecology or other State agencies.

Rearranging the Camp-Hazen equation and solving for A_s gives:

$$A_s = -(Q_o/w) * Ln(1-E)$$ where Ln is the natural logarithm

The average release rate, Q_o, can be calculated by dividing the runoff treatment volume (maximum = runoff from 6-month, 24-hour storm) by the detention time, t_d:

$$Q_o = \frac{V}{t_d}$$

The detention time will vary depending on the amount of runoff but should not exceed 24 hours for the 6-month, 24-hour storm. Longer detention times are not recommended because of the frequency of rainfall in the Northwest during the winter wet season (on the average it rains every two days from October to late March). The Camp-Hazen equation can be solved to determine the ratio of the presettling basin surface area to the total drainage area. Table III-4.5 presents the results of such an analysis and can be used for planning purposes. See Table III-4.3 for typical surface area-to-drainage area ratios for this and other detention BMPs for the maximum treatment storm (i.e., 6-month, 24-hour event).

Note that while Table III-4.5 gives recommended surface area-to-drainage area ratios it will still be necessary for the designer to size the outlet(s) for the presettling basin such that the drawdown times in Table III-4.5 are achieved for the runoff volumes shown. In some cases the minimum orifice size (0.5 inch diameter) may make it impossible to achieve the drawdown times presented. In such cases, the drawdown time can be decreased, which will increase the outflow rate and the size of

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the orifice, along with the surface area of the basin.

Table III-4.5
Presettling Basin Design Criteria to Treat a Range of Runoff Events*

Runoff Volume (inches)	Design Detention Time t_d (hours)	Ratio of Basin Surface Area to Drainage Area (A_s/A_d)
0.20	6	0.31%
0.50	12	0.39%
1.00	18	0.52%

* If the 6-month, 24-hour design storm runoff volume is less than the values in the first column of the table, a design detention time of 24 hours should be used.

Pond Configuration and Geometry

The shape of the presettling basin and the flow regime within this basin will influence how effectively the basin volume is utilized in the sedimentation process. The length to width ratio of the basin should be 3:1 or greater. Inlet and outlet structures should be located at extreme ends of the basin in order to maximize particle settling opportunities.

Short-circuiting (i.e., flow reaching the outlet structure before it passes through the sedimentation basin volume) flow should be avoided. Dead storage areas (areas within the basin which are by-passed by the flow regime and are, therefore, ineffective in the settling process) should be minimized. Baffles may be used to mitigate short-circuiting and/or dead storage problems. Figure III-4.13 illustrates basin geometry considerations, including the use of baffles to improve basin performance.

Interior side slopes up to the maximum water surface shall be no steeper than 3H:1V. Exterior side slopes shall be no steeper than 2H:1V.

The basin bottom shall be level to facilitate sedimentation.

Basin walls may be retaining walls, provided that the design is prepared and stamped by a structural engineer registered in the State of Washington, that they are constructed of reinforced concrete per Section III-4.6.1, that a fence is provided along the top of the wall, and that at least 25 percent of the pond perimeter will be a vegetated soil slope of not greater than 3H:1V.

Permanent Sediment Trap (Optional)

A sediment trap is a storage area which captures sediment and removes it from the basin flow regime. In so doing the sediment trap inhibits resuspension of solids during subsequent runoff events, improving long-term removal efficiency. Sediment traps may reduce maintenance requirements by reducing the frequency of sediment removal. It is recommended that the sediment trap volume be equal to ten (10) percent of the sedimentation basin volume. Water collected in the sediment trap shall be conveyed from the basin in order to prevent standing water conditions from occurring. Water collected in the sediment trap shall drain out within 60 hours. Access for cleaning the sediment trap drain system is necessary. Figure III-4.14 illustrates a permanent sediment trap.

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Inlet Structure and Isolation/Diversion Structure

The inlet structure design must be adequate for isolating the water quality volume (i.e., runoff volume from the 6-month, 24-hour storm) from the larger design storms and to convey the peak flows for the larger design storms past the basin. The water quality volume should be discharged uniformly and at low velocity into the presettling basin in order to maintain near quiescent conditions which are necessary for effective treatment. It is desirable for the heavier suspended material to drop out near the front of the basin; thus a drop inlet structure is recommended in order to facilitate sediment removal and maintenance. Energy dissipation devices may be necessary in order to reduce inlet velocities which exceed three (3) feet per second.

Note: On very small lots (approximately 1 acre) this design may result in an outlet orifice smaller than the minimum allowed (one-half inch). In this case, some of the design variables in the Camp-Hazen equation can be revised in order to increase orifice size (e.g., reduce detention time, increase treatment volume, increase trap efficiency (E)).

Off-line Isolation/Diversion Structure

Presettling basins may need to be located off-line when used to protect infiltration and filtration BMPs from siltation. Off-line systems are designed to capture and treat the 6-month, 24-hour design storm; this is typically achieved by using isolation/diversion baffles and weirs. A typical approach for achieving isolation of the water quality volume is to construct an isolation/diversion weir in the stormwater channel such that the height of the weir equals the maximum height of water in the infiltration/filtration basin during the 6-month, 24-hour design storm. When additional runoff greater than the water quality storm enters the stormwater channel it will spill over the isolation/diversion weir and mixing with the already-isolated water quality volume will be minimal. Figures III-3.24 and III-3.25 in Section III-3.4 (Filtration BMPs) illustrate two types of isolation/diversion structures which have been successfully used.

Outlet Structure

The outlet structure conveys the water quality volume from the presettling basin to the primary treatment BMP (e.g., infiltration basin, sand filtration basin). The outlet structure shall be designed to provide a range of detention times for different runoff volumes, as shown in Table III-4.5 with a maximum detention time of 24 hours for the 6-month, 24-hour design storm. A perforated pipe or equivalent is the recommended outlet structure. The 24 hour drawdown time should be achieved by installing a throttle plate or other flow control device at the end of the riser pipe (the discharges through the perforations should not be used for draw-down time design purposes). The perforated riser pipe can be selected from Table III-4.6.

A trash rack shall be provided for the outlet. Openings in the rack should not exceed 1/3 the diameter of the vertical riser pipe. The rack should be made of durable material, resistant to rust and ultraviolet rays. The bottom rows of perforations of the riser pipe should be protected from clogging. To prevent clogging of the bottom perforations it is recommended that geotextile fabric be wrapped over the pipe's bottom rows and that a cone of one (1) to three (3) inch diameter gravel be placed around the pipe (see Reference 75). If a geotextile fabric wrap is not used then the gravel cone must not include any gravel small enough to enter the riser pipe perforations. Figure III-4.15 illustrates these considerations.

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Table III-4.6
Perforated Riser Pipe Specifications

Riser Pipe Nominal Dia. (inches)	Vertical Spacing Between Rows (center to center - inches)	Number of Perforations per Row	Diameter of Perforations (inches)
6	2.5	9	1
8	2.5	12	1
10	2.5	16	1

Source: City of Austin. This information is based on commercially available pipe. Equivalent designs are acceptable.

Other Design Considerations

Liner to Prevent Infiltration

Detention BMPs should have negligible infiltration rates through the bottom of the pond. If infiltration is anticipated then a detention facility must either not be used and an infiltration BMP used instead (see Chapter III-3) or a liner installed to prevent infiltration. If a liner is used, the specifications provided in Section III-3.7 (Filtration BMPs) can be used. When using a liner the following are recommended:

- A layer of (track) compacted top soil (minimum 18" thick shall be placed over the liner prior to seeding with an appropriate seed mixture (see BMP E1.35 in Chapter II-5).
- Other liners may be used provided the design engineer can supply support documentation that the material will provide the required performance.

Berm Embankment/Slope Stabilization

Pond embankments higher than 6 feet shall require design by a geotechnical-civil engineer licensed in the State of Washington. The embankment shall have a minimum 15 foot top width where necessary for maintenance access; otherwise, top width may vary as recommended by the geotechnical-civil engineer.

The berm dividing the pond into cells shall have a 5 foot minimum top width, a top elevation set one foot lower than the design water surface, maximum 3:1 side slopes, and a quarry spall and gravel filter "window" between the cells.

For berm embankments of 6 feet or less than (including 1-foot freeboard), the minimum top width shall be 6 feet or as recommended by the geotechnical-civil engineer.

The toe of the exterior slope of pond berm embankment must be no closer than 5 feet from the tract or easement property line.

Pond berm embankment must be constructed on native consolidated soil (or adequately compacted and stable fill soils analyzed by a geotechnical report) free of loose surface soil materials, roots and other organic debris.

Pond berm embankments must be constructed by excavating a "key" equal to 50 percent of the berm embankment cross-sectional height and width (except on highly compacted till soils where the "key" minimum depth can be reduced to 1 foot of excavation into the till).

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Figure III-4.13 Use of Baffles to Improve Performance of Presettling Basins

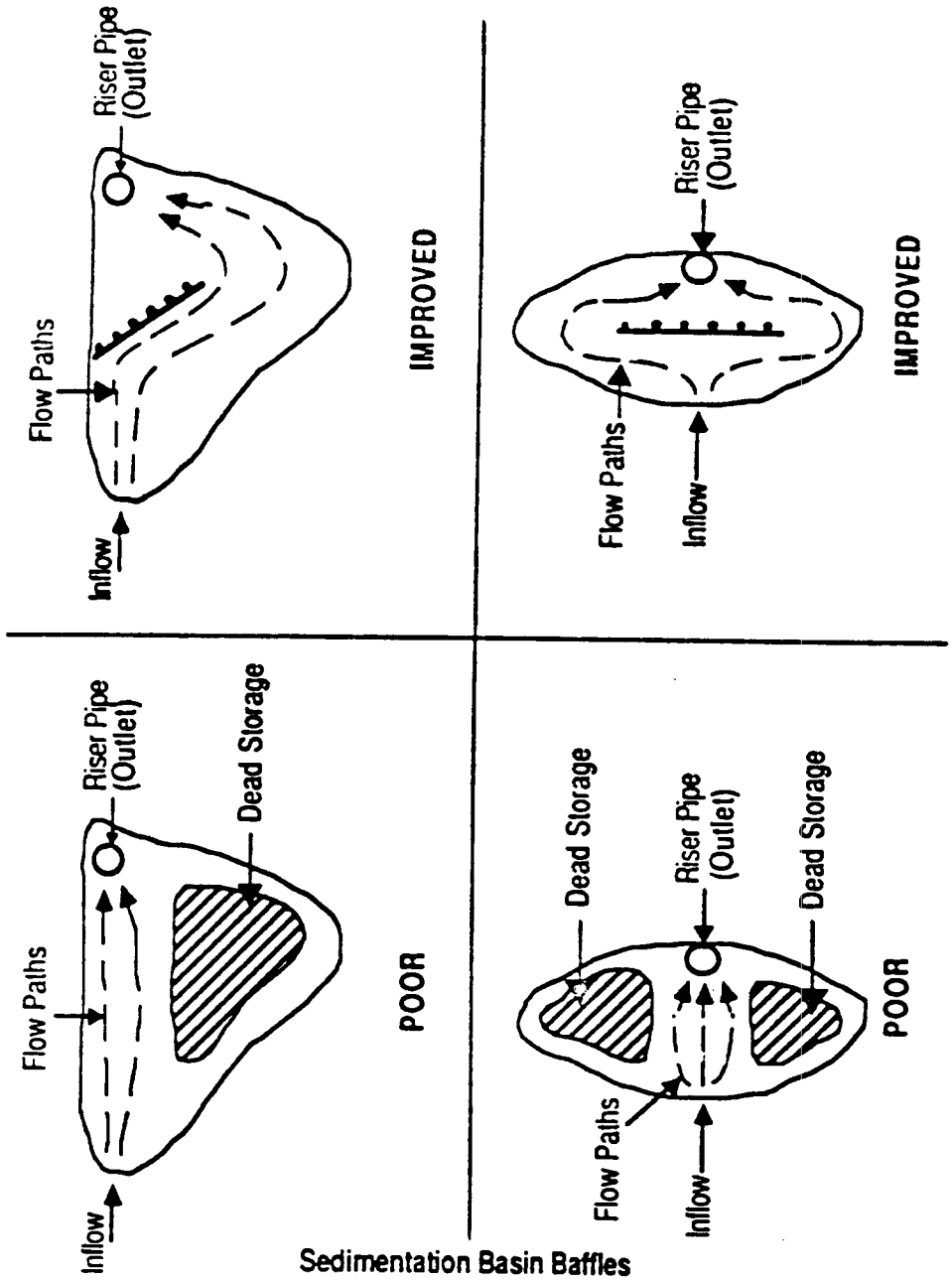

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Figure III-4.14 Permanent Sediment Trap for Presettling Basin

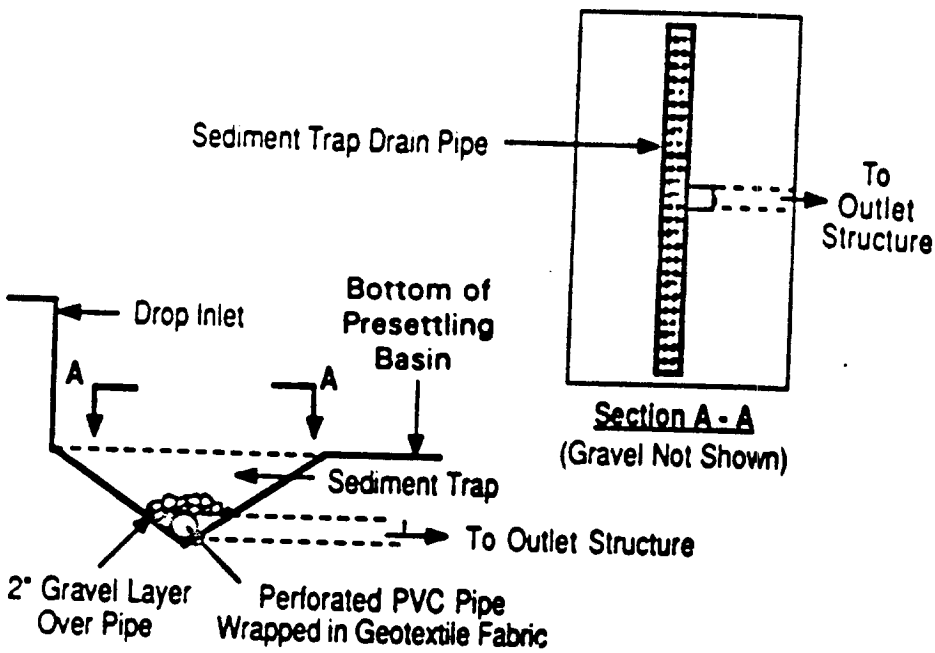

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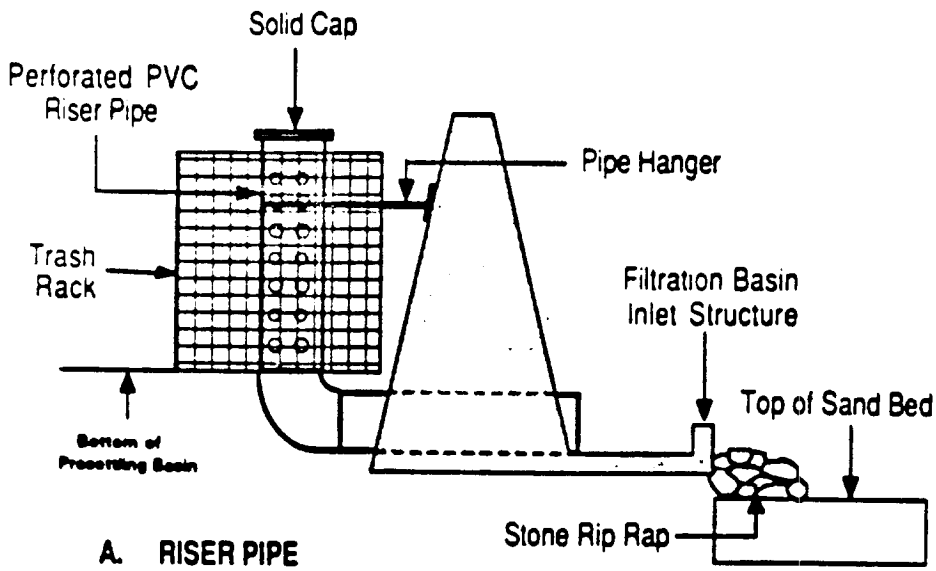
Figure III-4.15
Perforated Riser Pipe Outlet Structure with Trash Rack



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The berm embankment shall be constructed on compacted soil (95 percent minimum dry density, standard proctor method per ASTM D1557), placed in 6-inch lifts, with the following soil characteristics per the United States Department of Agriculture's Textural Triangle: a minimum of 30 percent clay, a maximum of 60 percent sand, a maximum of 60 percent silt, with nominal gravel and cable content (Note, in general, excavated glacial till will be well-suited for berm embankment material).

Anti-seepage collars must be placed on outflow pipes in berm embankments impounding water greater than 8 feet in depth at the design water surface.

Exposed earth on the pond bottom and side slopes shall be sodded or seeded with the appropriate seed mixture as soon as is practicable (see Erosion and Sediment Control BMP E1.35 in Volume II). Establishment of protective vegetative cover shall be ensured with jute mesh or other protection and reseeded as necessary (see Erosion and Sediment Control BMPs E1.15 and E1.35 in Volume II).

Erosion and Sediment

Erosion and sediment control BMPs must be used to retain sediment on-site during construction (see Erosion and Sediment Control in Volume II). BMPs must be shown on the design plans and the engineer must provide instructions for proper O&M. Permanently stabilize all areas of ponds to prevent erosion and sedimentation of plantings (see Chapter II-5).

Construction and Maintenance Criteria

See BMP RD.05, Wet Pond (Conventional Pollutants).

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III-4.4.5 BMP RD.11 Extended Detention Dry Pond

Purpose and Definition

An Extended Detention Dry Pond is designed to provide both pretreatment and streambank erosion control. It is similar to BMP RD.10 (Presettling Basin) except that it has an additional storage volume which provides an extended period of detention to control streambank erosion. Unlike the presettling basin, an extended detention dry pond will always be located "on-line" with the primary conveyance/detention system.

Planning Considerations

See BMP RD.10, Presettling Basin, for the following planning considerations:

- *Sediment and Debris*
- *Heavy Metal Contamination*
- *Site Constraints and Setbacks*
- *Dam Safety*
- *Safety, Signage and Fencing*

Other planning considerations are:

Multiple Uses

Multi-purpose use of the facility and aesthetic enhancement of the general area should also be major considerations. Above all, the facility should function in such a manner as to be compatible with overall stormwater systems both upstream and downstream to promote a watershed approach to providing stormwater management as well as local flood control and erosion protection.

If the facility is planned as an artificial lake to enhance property values and promote the aesthetic value of the land, pretreatment in the form of landscape retention areas or perimeter swales should be incorporated into the stormwater management facility. If possible, catchbasins should be located in grassed areas. By incorporating this "treatment train" concept into the overall collection and conveyance system, the engineer can prolong the utility of these permanently wet installations and improve their appearance. Any amount of runoff waters, regardless how small, that is filtered or percolated along its way to the final detention area can remove oil and grease, metals, and sediment. In addition, this will reduce the annual nutrient load to prevent the wet detention lake from eutrophying.

Detention system site selection should consider both the natural topography of the area and property boundaries. Aesthetic and water quality considerations may also dictate locations. For example, ponds with wetland vegetation are more aesthetically pleasing than ponds without vegetation. Ponds containing wetland vegetation also provide better conditions for pollutant capture and treatment.

A storage facility is an integral part of the environment and therefore should serve as an aesthetic improvement to the area if possible. Use of good landscaping principles is encouraged. The planting and preservation of desirable trees and other vegetation should be an integral part of the storage facility design.

Basin Planning

The design of urban detention facilities should be coordinated with a basin plan for managing stormwater runoff. In a localized situation, an individual property owner can, of course, by his or her actions alone, provide effective assistance to the next owner downstream if no other areas contribute to that owner's problems. However, uncontrolled proliferation of impoundments within a watershed can severely

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alter natural flow conditions, causing compounded flow peaks or increased flow duration which can contribute to downstream degradation. In addition, upstream impacts due to future land use changes should be considered when designing the structure. Land use planning and regulation may be necessary to preserve the intended function of the impoundment. See Minimum Requirement #9 (Basin Planning) and the appendix in Volume I for a further discussion of basin planning.

Overflows

Detention facility design must take into consideration overflows and secondary overflow. Overflows include all facilities designed to bypass flows over or around the restrictor system. Overflow may result from higher intensity or longer duration storms than the design storm or result from plugged orifices or inadequate storage due to sediment buildup in the facility.

Secondary overflow occurs when the capacities of all conveyance facilities, and all overflow facilities are exceeded or are not functioning. In such instances, stormwater will often exit the conveyance system through catchbasin grates and flow down the corridor of least resistance. Careful consideration must be given to the impact of secondary overflows on public health, safety and welfare, property, and wildlife habitat. When secondary overflow occurs, design of secondary drainage facilities following careful analysis and planning can significantly reduce impacts. Street alignments and grades are the key components in developing secondary drainage design, and consideration should be given early in the planning stages to their use as secondary overflow facilities.

Design Criteria

See BMP RD.10, Presettling Basin, for the following design criteria:

- **Pond Configuration and Geometry**
- **Outlet Structure**
- **Liner**
- **Berm Embankment/Slope Stabilization**
- **Erosion and Sediment**

Sizing Extended Detention Dry Basins

For pretreating runoff, see BMP RD.10, Presettling Basin. Pretreatment should be provided for a range of runoff volumes, up to the 6-month, 24-hour design storm.

For streambank erosion control, use the design methods and procedures provided in Chapter III-1. A multiple orifice design will be necessary in order to meet the three release requirements, i.e., 50% of the existing condition 2-year, 24-hour peak flow; maintain existing condition peak flow rates for the 10-year and 100-year, 24-hour events. A correction factor must be applied to the calculated detention volume, as discussed in Section III-1.2, in order to account for weaknesses in current hydrologic analysis methods.

Figure III-4.16 illustrates methods to provide extended detention for this BMP.

Construction and Maintenance Criteria

See BMP RD.05, Wet Pond (Conventional Pollutants).

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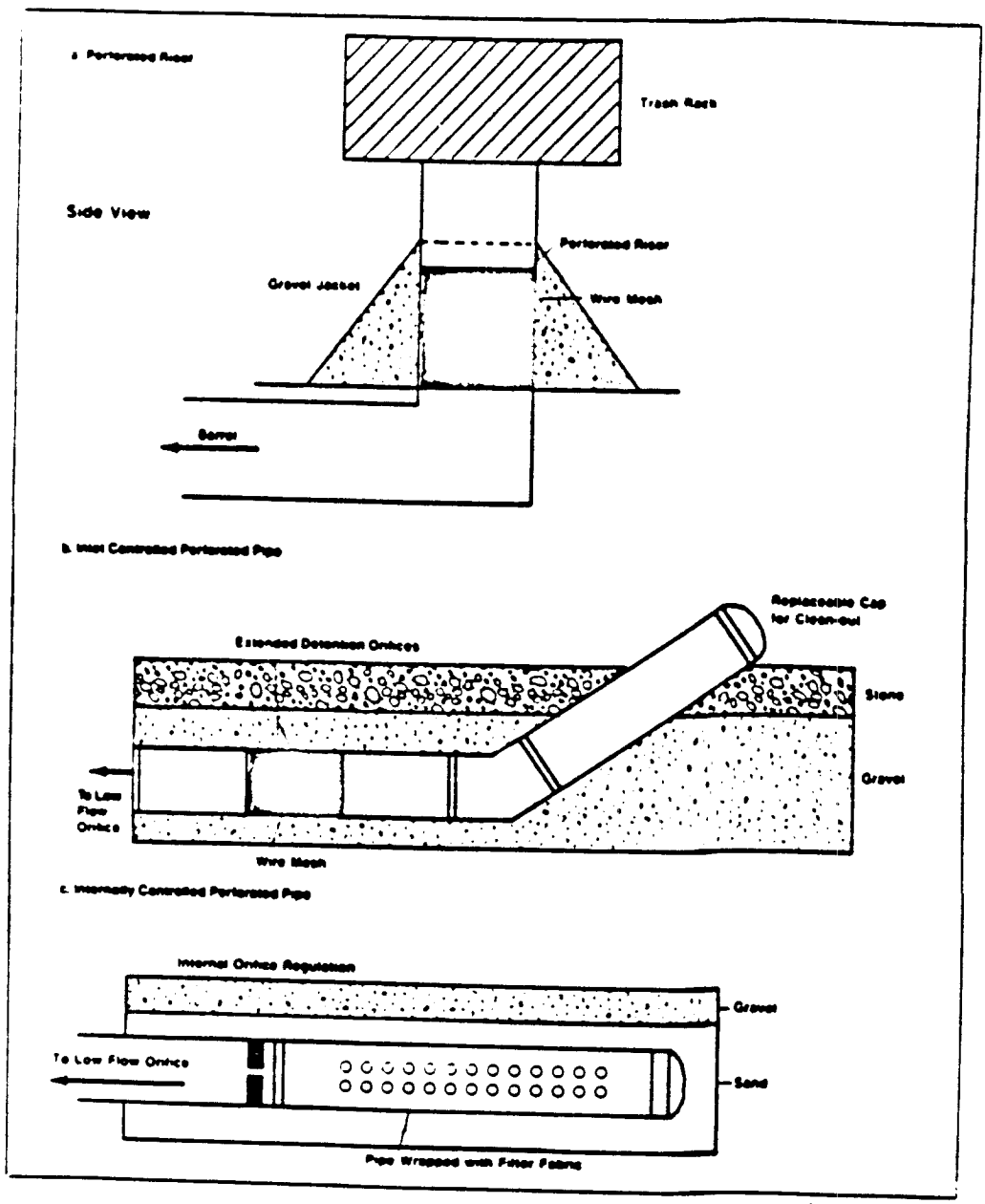
Figure III-4.16 Methods for Extending Detention Times for Dry Detention Ponds



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III-4.5 STANDARDS AND SPECIFICATIONS FOR VAULTS AND TANKS

III-4.5.1 BMP RD.15 Wet Vault/Tank

Purpose and Definition

Wet vaults and tanks are underground facilities used for the storage of surface water, and are typically constructed from reinforced concrete (vaults) or corrugated pipe (tanks). Wet vaults and tanks are typically concrete or structural facilities designed to provide runoff treatment through the use of a permanent pool of water. Streambank erosion control can also be provided by adding a "live storage" volume above the permanent pool. Figures III-4.17 and III-4.18 illustrate tank/vault systems.

Planning Considerations

See BMP RD.05, Wet Pond (Conventional Pollutants). Additional planning considerations are provided below.

If a wet vault/tank is designed to provide runoff treatment but not streambank erosion control it must be located "off-line" from the primary conveyance/detention system. Flows above the peak flow for the water quality design storm (i.e., 6-month, 24-hour event) must bypass the facility in a separate conveyance to the point of discharge. A mechanism must be provided at the bypass point to take the facility "off-line" for maintenance purposes (see Section III-3.7 for isolation/diversion structures).

Limitations

Wet vaults/tanks cannot provide the equivalent level of treatment accomplished by wet ponds and constructed wetlands because neither biological uptake nor vegetative filtration are available as pollutant removal mechanisms. Gravity-settling of suspended solids is the primary removal mechanism but vaults/tanks are unlikely to be as effective as open ponds in removing particulates because little or no soil layer exists in which to permanently stabilize trapped sediments. Also, being underground, vaults and tanks are more difficult to inspect and maintain. Therefore, they shall only be permitted for use on small sites, and then only after it has been demonstrated to the satisfaction of the local government that more desirable BMPs are not practicable, according to the BMP selection process outlined in Chapter I-4.

Other

Wet vaults/tanks shall be a minimum of 20 feet from any structure, property line, NGPE, and from any septic tank/drainfield. All facilities shall be a minimum of 50 feet from any steep slope. A geotechnical report must address the potential impact on a steep slope.

Design Criteria

The design criteria for a wet vault/tank shall be the same as for BMP RD.05, Wet Pond (Conventional Pollutants).

Sizing Wet Vaults/Tanks

Volume/outflow analysis shall be in accordance with the hydrologic methods outlined in Chapter III-1, with appropriate correction factors. Restrictor/orifice structure design shall be per Section III-2.4.

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- Permanent Pool for Water Quality Treatment - same as for wet ponds (BMP RD.05).

- Streambank Erosion Control ("Live Storage") - same as for wet ponds (BMP RD.05)

The length-to-width ratio at the design surface area shall be no less than 3:1.

Forebay

The vault shall be divided into 2 cells using a baffle, with the first cell, the forebay, occupying about 25 percent of the area. The top of the baffle wall must be coincident with the depth of the permanent pool.

Construction and Maintenance Criteria

See BMP RD.05, Wet Pond (Conventional Pollutants). Additional construction and maintenance criteria is provided below.

Construction

Standard vault details are shown in Figure III-4.17; standard tank details in Figures III-4.18 and III-4.19.

Materials

(a) Vaults

Minimum 3000 psi structural reinforced concrete. All construction joints must be provided with water stops. Pre-cast vaults shall be designed by a structural engineer.

(b) Tank

Pipe material, joints, and protective treatment for tanks shall be in accordance with WSDOT/APWA Standard Specifications Section 9.05, and AASHTO designations as noted below:

- Corrugated iron or steel pipe and pipe arch, Treatment 1 through 6.
- Aluminized Type 2 corrugated steel pipe and pipe arch (meets AASHTO designations M274 and M36).
- Steel spiral rib pipe, Treatment 1 through 6.
- Aluminum spiral rib pipe.
- Corrugated aluminum pipe and pipe arch.
- Reinforced concrete pipe.
- Corrugated high density polyethylene pipe (CPEP) - Smooth Interior

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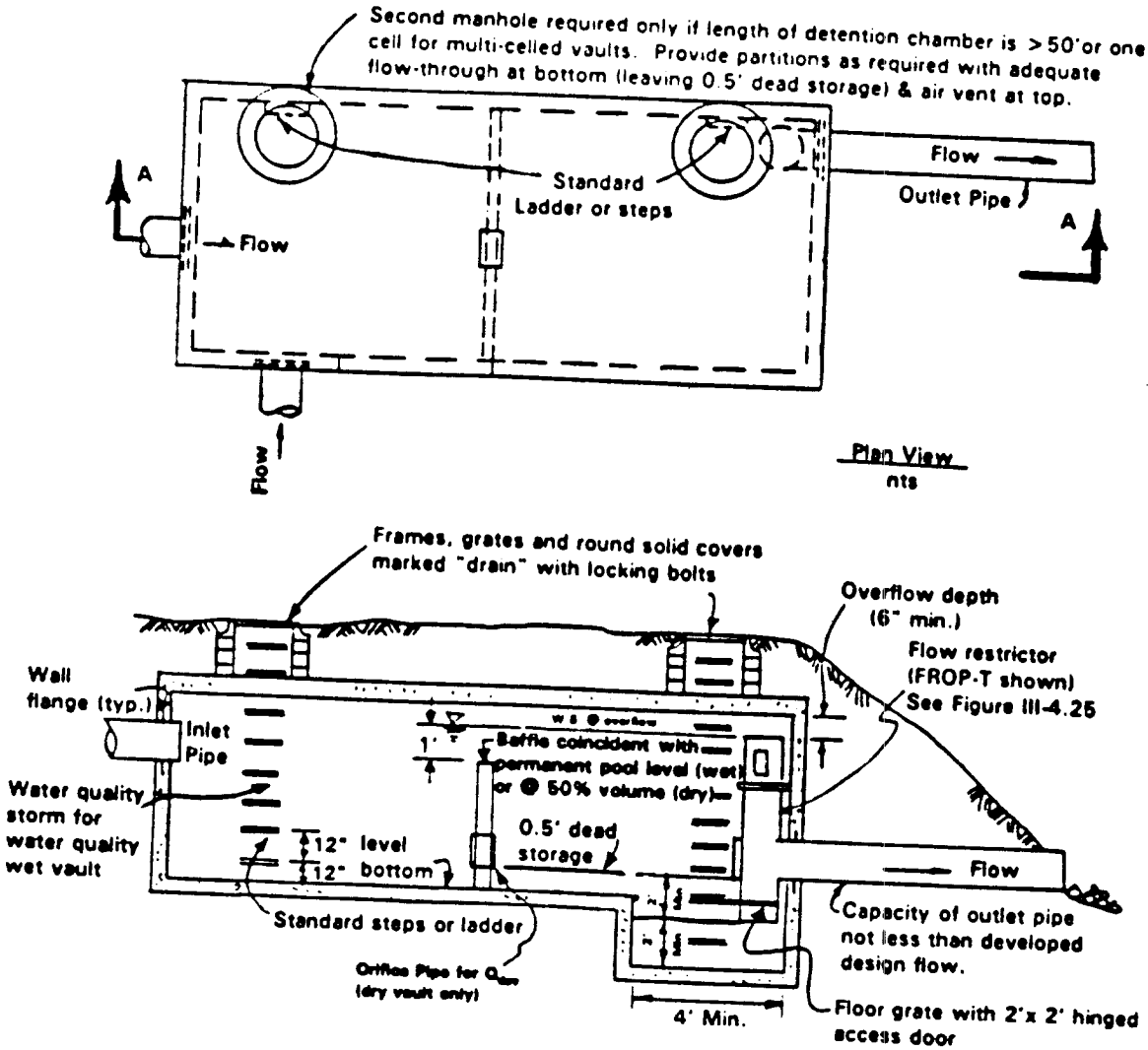
Figure III-4.17 Typical Detention Vault (Dry/Wet)



Notes:

1. Plans must be designed & stamped by a registered professional structural engineer.
2. All metal parts shall be corrosion resistant.
3. Provide water stop at all cast-in-place construction joints. Precast vaults shall have approved rubber gasket system.

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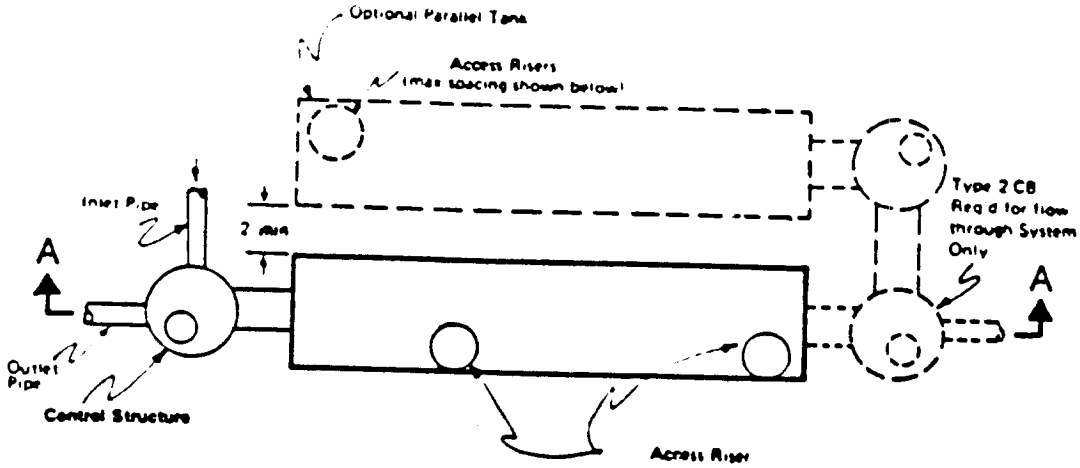
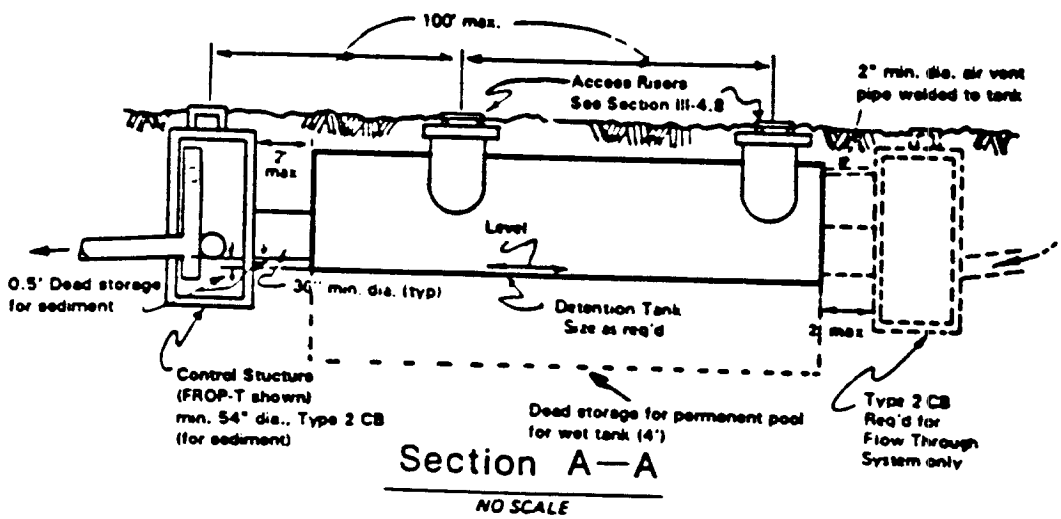
Figure III-4.18 Typical Detention Tank (Dry/Wet)



Plan View

NO SCALE

"Flow Back Up" System Shown
Optional Designs for "Flow Through" System and
Parallel Tanks Shown Dashed



Section A—A

NO SCALE

NOTE All metal parts corrosion resistant Steel parts galvanized and asphalt coated (Treatment 1 or better)

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Structural Stability

(a) Vaults

All vaults shall meet structural requirements for overburden support and HS-20 traffic loading. Cast-in-place wall sections shall be designed as retaining walls. All structural designs shall be stamped by a structural engineer licensed in the State of Washington. Structural designs for cast-in-place vaults may require a separate commercial building permit from the local government. Vaults shall be placed on native material with suitable bedding. Vaults shall not be allowed in fill slopes unless analyzed in a geotechnical report for stability and construction practices.

(b) Tanks

All tanks shall meet structural requirements for overburden support and traffic loading, if appropriate. HS-20 live loads must be accommodated for tanks lying under roadways or parking areas. Metal tank end plates must be designed for structural stability at maximum hydrostatic loading conditions. Flat end plates generally require thicker gauge material than the pipe and/or require reinforcing ribs. Tanks shall be placed on native material with a suitable bedding. Tanks shall not be allowed in fill slopes.

(c) Buoyancy (Tanks)

In moderately pervious soils where seasonal ground water may induce flotation, buoyancy tendencies must be balanced by ballasting with either backfill or concrete backfill, providing concrete anchors, increasing the total weight, or by providing subsurface drains to permanently lower the ground water table. Calculations must be submitted which demonstrate stability.

Minimum Access Requirements

(a) Vaults

Provide 1 access cover per 50 feet of length or width and at least 1 access cover with ladder to the bottom of the vault per cell. The minimum internal height shall be 7 feet and the minimum width shall be 4 feet. The maximum depth to the vault invert shall be 20 feet. (Note, concrete vaults may be a minimum of 3 feet in height and width if used as tanks with access manholes at each end).

(b) Tanks

The maximum depth to a tank invert shall be 20 feet. Spacing between access openings for tanks shall not exceed 100 feet. 36-inch minimum diameter CMP riser-type manholes of the same gauge as the tank material per Figures III-4.17 and III-4.18 may be used for access along the length of the tank and at the upstream terminus of the tank if the tank is designed with a common inlet/outlet so that it is a backup system rather than a flow-through system. Note, Figure III-4.17 is not allowed for use in roadways, driveways, parking stalls, or anywhere it would be subjected to vehicular loads. All tank access openings must be readily accessible by maintenance vehicles. See Figure III-4.19 for tank access details.

Locking Lids

All vault access openings shall have round, solid, locking lids using 1/2 inch diameter allen head screw locks.

Maintenance

See Wet Pond (BMP RD.05) and Table III-4.7.

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Access Roads

Access roads are required to at least one access cover for each cell. The access roads shall meet the requirements for access roads described in the maintenance details for wet ponds.

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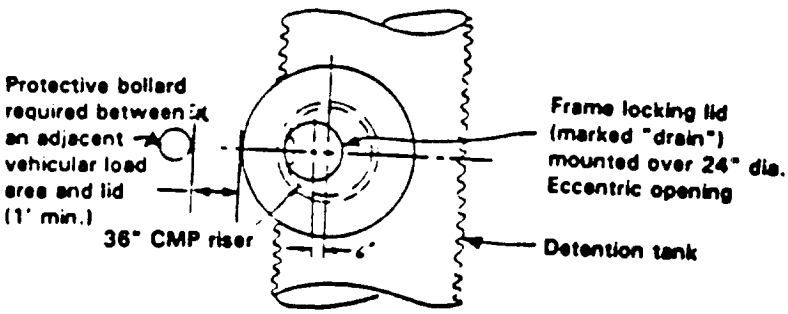
Figure III-4.19 Detention Tank Access Details

Restrictions for application: use only for access to detention tanks. Not allowed for use in roadways, driveways, parking stalls or where vehicular loads would occur.



PLAN VIEW
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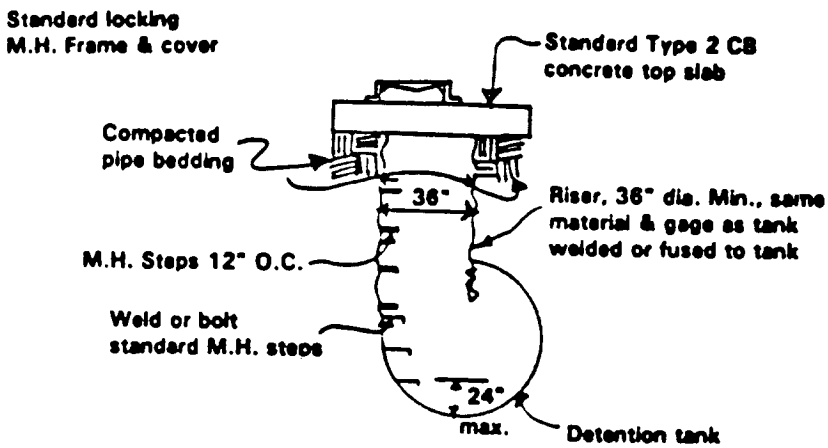

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Notes:
1. Use adjusting blocks as required to bring frame to grade.
2. All materials must be corrosion resistant.
3. Must be conveniently located for maintenance vehicle access.

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III-4.5.2 BMP RD.20 Extended Detention Dry Vault/Tank

Purpose and Definition

An Extended Detention Dry Vault/Tank is physically similar to BMP RD.15 (Wet Vault/Tank) but provides only streambank erosion control. Dry vaults/tanks are not to be used for runoff treatment purposes because of their limited pollution removal capabilities. Dry Vaults/Tanks must always be preceded by a BMP which has treated runoff up to the 6-month, 24-hour design storm.

This BMP accomplishes streambank erosion control by detaining runoff and then releasing it a reduced flows in order to meet the standards established by Minimum Requirement #5 (see Chapter I-2).

Figures III-4.17 and III-4.18 illustrate detention vault/tank systems.

Planning Considerations

Limitations

Dry vaults and tanks provide little water quality benefits compared to open ponds and wet vaults/tanks. Also, being underground, are more difficult to inspect and maintain. Therefore, they shall always be preceded by treatment BMPs. Vaults/tanks shall be permitted for use only on small sites, and then only after it has been demonstrated, to the satisfaction of the local government, that more desirable BMPs are not practicable, according to the BMP selection process outlined in Chapter I-4.

Design Criteria

An extended detention dry vault is designed only to provide streambank erosion control. The design methods and procedures provided in Chapter III-1 shall be used. A multiple orifice design will be necessary in order to meet the three release requirements, i.e., 50% of the existing condition 2-year, 24-hour peak flow; maintain existing condition peak flow rates for the 10-year and 100-year, 24-hour events. A correction factor must be applied to the calculated detention volume, as discussed in Section III-1.2, in order to account for weaknesses in current hydrologic analysis methods.

Construction and Maintenance Criteria

See BMP RD.15, Wet Vault/Tank and Table III-4.7.

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Table III-4.7 Specific Maintenance Requirements for Detention Vaults/Tanks

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
I Storage Area	Plugged air vents	One-half of the cross-section of a vent is blocked at any point with debris and sediment.	Vents free of debris and sediment.
	Debris and sediment	Accumulated sediment depth in ≥ 10% of the diameter of the storage area for ¼ the length of the storage vault or any point exceeds 15% of the diameter. Example: 72 inch storage tank would require cleaning when sediment reaches a depth of 7 in. or more than ¼ the length of the tank.	All sediment and debris removed from storage area.
	Joints between tank/pipe sections	Any crack allowing material to be transported into the facility.	All joints between tank/pipe sections are sealed.
II Manhole	Cover not in place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.
	Locking mechanism not working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have < ½ inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
	Cover difficult to remove	One maintenance person cannot remove lid after applying 80lb pounds of lift. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
	Ladder rungs unsafe	Local Government Safety Officer and/or maintenance person judge that ladder is unsafe due to missing rungs, misalignment, rust or cracks.	Ladder meets design standards and allows maintenance persons safe access.
III. Catchbasins	See "catchbasins" standard, Section III-4.8	See "catchbasins" standard, Section III-4.8	See "catchbasins" standard, Section III-4.8.

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CHAPTER III-5

WETLANDS AND STORMWATER MANAGEMENT

III-5.1 INTRODUCTION

The purpose of this chapter is to present preliminary guidelines for the discharge of pre-treated stormwater to natural wetlands.

The preliminary guidelines, prepared by Dr. Richard R. Horner, provide information on how the functions and values of natural wetlands may be preserved, and their possible use for hydraulic control of treated stormwater. Monitoring guidelines, definitions, references, and appendices are also included (see Section III-5.2).

Wetland ecosystems can be highly effective managers of stormwater runoff. They can remove pollutants and also attenuate flows and recharge ground water. However, natural wetlands may not be used as pollution control facilities, in lieu of treatment BMPs, such as constructed wetlands, infiltration facilities etc.

On the other hand, constructed wetlands that are built in upland areas for the specific purpose of treating stormwater can be viewed as analogous to wet ponds, and therefore are not subject to the same restrictions that are placed on natural wetlands. In addition, constructed wetlands by their very nature offer control over the design features which can maximize their water treating ability (see below). They may be lined to prevent pollution of ground water, where necessary, and can be configured to maximize ease of maintenance and general accessibility. Also, harvesting can be done, if necessary, to maintain the capability of the wetland to remove soluble pollutants. Harvesting natural wetlands is neither acceptable nor practical. Constructed wetlands as a BMP can be found in Chapter III-4.

III-5.1.1 Pollutant Removal Mechanisms

The major pollutant removal mechanisms operating in wetlands may be divided into physical, chemical, and biological. Physical mechanisms include sedimentation, filtration, and adsorption; chemical mechanisms include precipitation and adsorption; biological mechaniems include plant and bacterial uptake and metabolism, and plant absorption. The combination of these removal mechanisms can result in high removal efficiencies of pollutants - up to 90 percent or higher. However, high removal efficiencies are dependent on the exact nature of the wetland and how it has been designed and constructed.

Many studies have shown that wetlands, whether natural or artificial, remove pollutants both from stormwater runoff and wastewater effluent. While the results of those studies may vary, they generally achieved significant removal levels for nitrogen (N), total suspended solids (TSS), BOD, and heavy metals. The pollutant showing the most variability in removal rate was phosphorus (P), which was removed at high levels for the most part but in some studies showed net increases of concentration when measured at the outlet of the system.

Nutrient and pollutant uptake in wetlands varies considerably during the year but even seasonal removal has its benefits. If a wetland takes up nutrients during the summer growing season, positive recreational and wildlife benefits result even though those nutrients may be released during the winter months.

The details given below have been selected to maximize the operation of these pollutant removal mechanisms.

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III-5.2 NATURAL WETLANDS AND STORMWATER MANAGEMENT

The use of natural wetlands to manage stormwater runoff is not considered a BMP. Preliminary guidance on the management of natural wetlands is presented below. The guidelines were prepared by Rich Horner on behalf of the Puget Sound Wetlands and Stormwater Management Research Program. You will note that many of the guidelines and prerequisites are common to two or more of the guide sheets.

(PRELIMINARY GUIDELINES) DRAFT, 3/22/91

WETLANDS AND STORMWATER MANAGEMENT

INTRODUCTION

The Puget Sound Wetlands and Stormwater Management Research Program is performing comprehensive research with the goal of deriving strategies that protect wetland resources in urban and urbanizing areas, while also benefiting the management of urban stormwater runoff that can affect those resources. The research primarily involves long-term comparisons of wetland ecosystem characteristics before and after their watersheds urbanize, and between a set of wetlands that become affected by urbanization (treatment sites) and a set that remain unaffected (control sites). This work is being supplemented by shorter term and more intensive studies of pollutant transport and fate in wetlands, several laboratory experiments, and ongoing review of relevant work being performed elsewhere. These research efforts are aimed at defining the types of impacts that urbanization can cause and the degree to which they develop under different conditions, in order to identify means of avoiding or minimizing impacts that impair wetland structure and functioning. The program's scope embraces both situations where urban drainage incidentally affects wetlands in its path, as well as those in which direct stormwater management actions change wetlands' hydrology, water quality or both.

This document presents preliminary management guidelines for urban wetlands and their stormwater discharges based on the initial research results. The guidelines are being incorporated in a computer-based management model. The guidelines and the model will be the principal vehicles to implement the research findings in environmental planning and management practice. They will be refined as additional results become available and finalized at the program's conclusion.

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III-5.2.1 GUIDE SHEET 1

GENERAL APPROACH AND PROBLEM DEFINITION

1.1 If you are unfamiliar with these guidelines, read the description of the approach that follows. If you are familiar, proceed to Step 1.2.

(a) These provisions currently have the status of guidelines rather than requirements. Application of these guidelines does not fulfill assessment and permitting requirements that may be associated with a project. It is, in general, necessary to follow the stipulations of the State Environmental Policy Act and to contact such agencies as the local planning agency; the Washington Departments of Ecology, Fisheries, and Wildlife; the U.S. Environmental Protection Agency; and the U.S. Army Corps of Engineers.

(b) These guidelines are intended to be part of the Department of Ecology's Stormwater Management Manual for the Puget Sound Drainage Basin. Volume and chapter citations within the guidelines refer to other parts of the manual.

(c) The guidelines are organized in a branching decision-tree format. After using Guide Sheet 1 to define the management problems(s) to be resolved, you will be directed to Guide Sheet 2 for an initial consideration of wetland protection guidelines and then to additional sheets that guide the analysis of the selected problem(s). Refer to Figure III-5.1 for a diagram of the guideline application process.

(d) This system can be applied with whatever information concerning the problem(s) is available. Of course, the comprehensiveness and certainty of the outcome will vary with the amount and quality of information employed. The guidelines can be applied in an iterative fashion to improve management understanding as the information improves. Appendix AIII-5.1 lists the information needed to perform basic analyses by guide sheet, followed by other information that can improve understanding and analysis.

(e) The guidelines use certain terms that require definition to ensure that the intended meaning is conveyed to all users. Such terms are printed in boldface the first time that they appear, and are defined in Appendix AIII-5.2.

(f) These guidelines emphasize avoiding structural, hydrologic, and water quality modifications of existing wetlands to the extent possible in the process of urbanization and the management of urban stormwater runoff.

(g) In pursuit of this goal, the guidelines take a systematic approach to management problems that potentially involve both urban stormwater (quantity, quality, or both) and wetlands. The consideration of wetlands involves their areal extent, values, and functions. This approach emphasizes a comprehensive analysis of alternatives to solve the identified problem. The guidelines encourage conducting the analysis on a drainage catchment scale and considering all of the possible stormwater management alternatives, which may or may not involve a wetland. They favor on-site best management practices (located outside of a wetland or its buffer) and pretreatment of stormwater runoff prior to release to wetlands.

(h) Furthermore, the guidelines take a holistic view of managing wetland resources in an urban setting. Thus, they recognize that urban wetlands

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have the potential to be affected structurally and functionally whether or not they are formally designated for stormwater management purposes. Even if an urban wetland is not structurally or hydrologically engineered for such purposes, it may experience altered hydrology (more or less water), reduced water quality, and a host of other impacts related to urban conditions. It is the objective of the guidelines to avoid or reduce to the maximum extent possible the negative effects on wetland resources from both specific stormwater management actions and incidental urban impacts.

(i) The guideline provisions were drawn principally from the available results of the Puget Sound Wetlands and Stormwater Management Research Program. Where those results are the basis for a numerical criterion, no separate reference is given. Numerical provisions based on other work are referenced. See Appendix AIII-5.3 for references.

1.2 Refer to Guide Sheet 2 for wetland protection guidelines. Apply this guidance in developing the solution of your management problem(s) in order to protect the overall structure and functioning of any existing wetland(s).

1.3 If you have one or more of the management problems in the list below, proceed as directed. If you have a management problem that is not listed, guidelines are not currently available for its analysis. However, please communicate your needs for guidelines for consideration by the Puget Sound Wetlands and Stormwater Management Research Program (Richard Horner; telephone 206-543-7923).

(a) One or both of the following runoff quantity problems is associated with existing development, or expected with new development:

(i) Flooding

Flood control tends to target relatively infrequent (e.g., 5-year or less frequent recurrence), larger storms.

(ii) Stream channel erosion

Stream channel erosion prevention generally requires the control of relatively frequent (e.g.,< 2-year recurrence interval), smaller storms. Often, management is intended to mitigate both stream channel erosion and flooding. The guidelines are the same for both of these problem areas, except where the hydrologic differences affect the provisions.

If you have one or both of these management problems, proceed to Guide Sheet 3; otherwise, continue.

(b) Improving storm runoff water quality is an objective.

Use of Waters of the State and Waters of the United States, including wetlands, for the treatment or conveyance of wastewater (including stormwater) is prohibited under state and federal law. While the subject remains under policy review, it appears that regulations under development may allow the use of wetlands to improve stormwater quality under specific conditions on a case-by-case basis, *provided that the stormwater runoff has been pretreated by an infiltration facility, wet pond, or presettling basin with biofilter, sized to treat at least the 6-month 24-hour storm for the developed condition, and according to General Minimum Requirements #4 and #6 (see Chapters III-3 and III-4 for design details).* If you have this management problem, proceed to Guide Sheet 4 to evaluate the circumstances of your case; otherwise, continue.

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(c) A comprehensive management plan is needed for wetlands in a newly developing area.

Wetlands in newly developing areas will be impacted by development even if not specifically "used" in stormwater management. Therefore, the task is to ensure proper overall management of the resources and protection of their general functioning, including their role in storm drainage systems. Stormwater management in newly developing areas is distinguished from management in already developed locations by the existence of many more feasible stormwater treatment options prior to development. The guidelines emphasize appropriate selection among the options to achieve optimum overall resource protection benefits, extending to downstream receiving waters and ground water aquifers, as well as to wetlands.

If you have this management problem, proceed to Guide Sheet 5.

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III-5.2.2 GUIDE SHEET 2

GENERAL WETLAND PROTECTION GUIDELINES

2.1 Consult regulations issued under federal and state laws that govern the discharge of pollutants, specifically Ch. 173-200 WAC and Ch. 173-201 WAC. Wetlands are classified as "Waters of the United States" and "Waters of the State" in Washington.

2.2 Apply the following guidelines to protect the ecological structure and functioning of wetlands that are modified to supply runoff water quantity or quality control benefits or are incidentally subject to the effects of an urbanizing watershed.

(a) Require effective erosion control at any construction sites in the wetland's drainage catchment (refer to Volume II).

(b) Institute a program of source control BMPs to minimize the generation of pollutants that will enter storm runoff that drains to the wetland (refer to Volume IV).

(c) Maintain the wetland buffer required by local regulations or recommended by the Puget Sound Water Quality Authority's draft wetland guidelines.

(d) Provide oil/water separation according to the requirements of Chapter III-7.

(e) Provide a pretreatment system for all urban runoff entering the wetland. This system should consist of, at minimum, a presettling basin (forebay), followed by, a biofilter (vegetated swale or filter strip). Design the forebay and biofilter according to Chapters III-4 and III-6). Locate these facilities outside and upstream of the wetland and its buffer.

(f) Determine the existing and projected land uses of the contributing catchment by consulting land use and zoning maps and/or the applicable comprehensive plan, or by performing field reconnaissance. If the contributing catchment exhibits any of the following characteristics, then install a level of treatment in addition to the facilities specified above:

(i) More than 20 percent of the catchment area is committed to commercial, industrial, and/or multiple family residential land uses; or

(ii) The combination of all urban land uses (including single family residential) exceeds 50 percent of the catchment area; or

(iii) The concentration of total cadmium, copper, lead, or zinc in the open water of the wetland, as measured according to Guide Sheet 7, exceeds the U.S. Environmental Protection Agency (1986a) criteria (either four-day or one-hour average) more than once annually.

For the additional treatment consider infiltration (refer to Chapter III-3) and biofiltration (refer to Chapter III-6). In the analysis of the infiltration alternatives, pay particular attention to the selection criteria in Chapter III-3 to avoid ground water contamination.

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(g) If the wetland inlet will be modified for the stormwater management project, use a diffuse flow method, such as a spreader swale, to discharge water into the wetland in order to prevent flow channelization.

(h) Research has shown that wetlands that have experienced an increased mean annual water level fluctuation also lose species in their plant communities, especially when the mean annual fluctuation increases to more than 21 cm (8.4 inches). When a wetland in a relatively undisturbed condition normally has a mean annual fluctuation less than 21 cm, avoid increasing it beyond that level. When a wetland's hydrology has been disturbed so that it has apparently experienced a mean annual fluctuation greater than 21 cm, consider actions that restore the pre-disturbance hydrology. Such actions include the alternatives listed in Guide Sheet 3, Step 3.3, and reversal of steps taken to increase the depth, frequency, and duration of inundation.

Note: These provisions may not necessarily protect sensitive animal life stages; see Guidelines 2.2 (j) and (k) below.

(i) Protect priority peat systems, forested communities, and sensitive scrub-shrub and emergent wetland plant communities by:

(i) Limiting the frequency of water level rise above the maximum depth for the existing conditions on the site to no more than--

One occurrence in 5 years for priority peat systems and forested communities;

One occurrence per year for sensitive scrub-shrub and emergent communities;

Maximum depth can be measured by a continuous recording level gage or a series of crest stage gage (Reinelt and Horner 1990) readings over time or estimated by a locally calibrated, continuous simulation, hydrologic model, such as the HSPF model.

(ii) And, limiting the duration of flooding above the maximum depth for the existing conditions on the site to 48 hours.

(iii) And, avoiding water level rise above the maximum depth for the existing conditions on the site during the early plant growing season months March-May.

Note: These guidelines are based on general literature reports and best professional judgment, and are being evaluated in the research program. These provisions may not necessarily protect sensitive animal life stages; see Guidelines 2.2 (j) and (k) below.

(j) Protect animal inhabitants by avoiding water level rise above the pre-project maximum depth experienced by sensitive life stages, especially during breeding, egg-laying, and rearing periods. (Note: Guidelines for birds, mammals, and amphibians are being formulated as part of the ongoing comprehensive management model development under the Puget Sound Wetlands and Stormwater Management Research Program; these specific guidelines will be incorporated when they are ready.)

(k) Protect fish habitats by avoiding water velocities above tolerated levels (selected to protect fish in each life stage when they are present), siltation of spawning beds, etc. Habitat requirements vary substantially among fish species. If the wetland is associated with a larger water body, contact the Departments of Fisheries and Wildlife to determine the

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species of concern and the acceptable ranges of habitat variables.

(l) If it is expected that the runoff quantity or quality control objectives will require a greater frequency, a longer duration, or a different pattern of inundation than the limits stated above for the protection of sensitive plant communities and/or animal life stages allow, use an alternative such as selectively bypassing flow or providing supplementary storage.

(m) If stranding of protected commercial or sport fish is an issue, develop a strategy to avoid stranding that minimizes disturbance in the wetland (e.g., by making provisions for fish return to the stream as the wetland drains or avoiding use of the facility during fish presence).

(n) The research has shown that wetlands that have experienced a lengthened period in the summer without water standing above the soil surface also lose species in their plant communities, especially when the loss of standing water extends beyond two months. When a wetland in a relatively undisturbed condition normally has standing water for most of the summer, avoid increasing the period of drying, especially beyond two months. When a wetland's hydrology has been disturbed so that it has apparently experienced a lengthened period without standing water, consider actions that restore the pre-disturbance hydrology. Such actions include stormwater infiltration (refer to Chapter III- 3), restoration of surface inflow that has been bypassed around the wetland, and reversal of steps taken to drain the wetland.

(o) Avoid compaction of soil and introduction of exotic plant species during any work in a wetland.

(p) If a relatively high quality, diverse, or unique natural plant community was present before construction, restore and replant areas of construction disturbance with native vegetation that best replicates the pre-construction community. In cases where the plant community has been degraded, consists primarily of invasive weedy non-native or aggressive native species, and has low structural diversity, enhancing it with a greater variety of native species would, in general, be consistent with expanding wetland values and functions.

(q) Avoid the removal or damage of nurse logs and snags, which form important wildlife habitats, to the maximum extent possible. Replace any such materials that are removed or damaged under the guidance of a qualified wildlife biologist.

(r) Take specific site design and maintenance measures to avoid general urban impacts (e.g., littering and vegetation destruction). Examples are protecting existing buffer zones; discouraging access, especially by vehicles, by plantings outside the wetland; and encouragement of stewardship by a homeowners' association. Fences should not be used, because they interfere with wildlife movements.

2.3 Return to Guide Sheet 1, Step 1.3.

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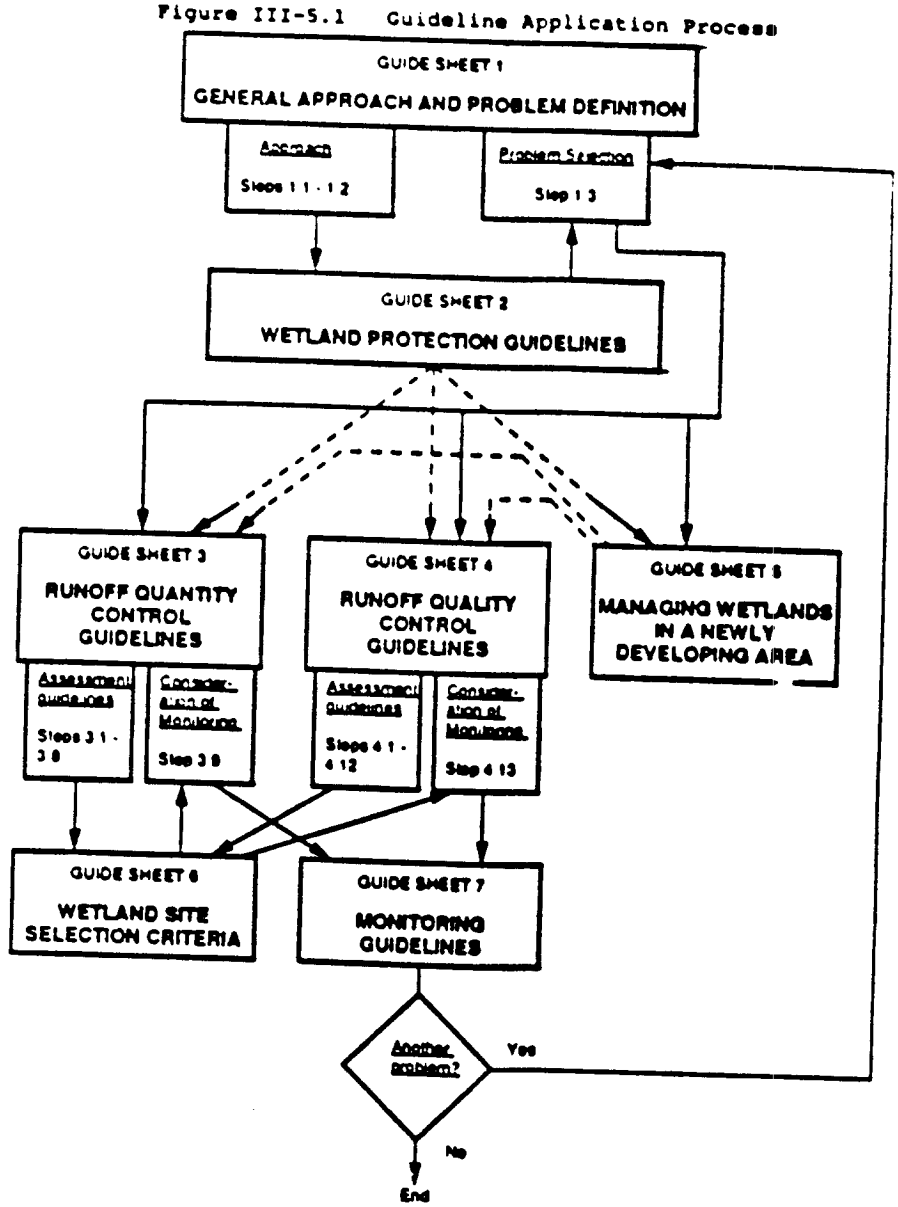
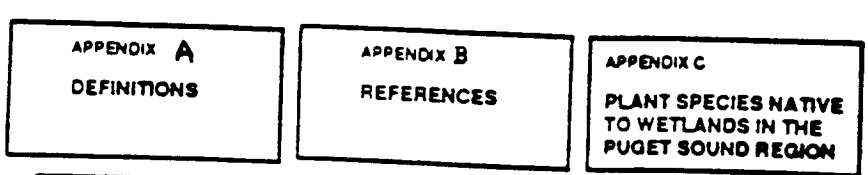
Figure III-5.1 Guideline Application Process





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III-5.2.3 GUIDE SHEET 3

RUNOFF QUANTITY CONTROL GUIDELINES

3.1 If the problem is attributable to existing development, assess possible alternative solutions that are applicable at the site of the problem occurrence, including:

(a) Protect health, safety, and property from flooding by removing habitation from the floodplain or installing a protective barrier at the point of flooding danger. Solutions must comply with existing ordinances and should be consistent with the protection of all beneficial stream uses to the extent possible.

(b) Prevent stream channel erosion by stabilizing the eroding bed and/or bank area with bioengineering techniques, preferably, or by structurally reinforcing it, if this solution would be consistent with the protection of aquatic habitats and beneficial uses of the stream (refer to BMPs E2.80, E2.85, and E2.90 in Chapter II-4).

3.2 If the potential problem is attributable to new development, assess possible regulatory and land use control alternatives, such as density controls, clearing limits, etc.

3.3 If the alternatives considered in Step 3.1 or 3.2 cannot solve an existing or potential problem, perform an analysis of the contributing drainage catchment to assess possible alternative solutions that can be applied on-site or on a regional scale. The most appropriate solution or combination of alternatives should be selected with regard to the specific opportunities and constraints existing in the drainage catchment. As an aid to selecting the appropriate BMP, refer to Chapter I-4.

(a) For new development, on-site facilities that should be assessed include, in order of preference:

(i) Infiltration basins or trenches (refer to Chapter III-3 and see Guide Sheet 2, Step 2.2(f), for cautions on the application of infiltration systems);

(ii) Retention/detention ponds (refer to Chapter III-4) stormwater detention volume shall not exceed 1 foot.

(iii) Below-ground vault or tank storage (refer to Chapter III-4);

Opportunities for the construction of on-site facilities for existing development are usually limited. In this situation the feasibility of below-ground and parking lot storage should be explored.

(b) Regional facilities that should be assessed for solving problems associated with either new development or existing development include:

(i) Infiltration basins or trenches (refer to Chapter III-3 and pay particular attention to the selection criteria for avoiding ground water contamination);

(ii) Detention ponds (refer to Chapter III-4);

(iii) Constructed wetlands (refer to Chapter III-4).

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3.4 Consider existing wetlands only if upland alternatives are inadequate to solve the existing or potential problem. First consider among existing wetlands those in Category IV in the Puget Sound Water Quality Authority's draft wetland guidelines. In general, Category IV wetlands have monotypic vegetation of similar age and class, lack special habitat features, and are isolated from other aquatic systems. A preferred selection is a wetland that has been drained, has experienced a lengthened summer dry period, or has been otherwise degraded, and that can be restored or enhanced to perform runoff quantity control and other functions. If an existing wetland alternative is being considered, evaluate it further according to the subsequent guidelines.

3.5 An existing wetland should not be modified for runoff quantity control and should be given maximum protection from overall urban impacts (see Guide Sheets 2 and 5) under any of the following circumstances:

(a) It is primarily an estuarine or forested wetland or a priority peat system.

(b) It is a rare or irreplaceable wetland type, as identified by the Washington Natural Heritage Program (telephone (206) 753-2449), the Puget Sound Water Quality Preservation Program (telephone (206) 438-7429), or local government.

(c) It provides rare, threatened, or endangered species habitat that could be impaired by the proposed action. Determining whether or not the conserved species will be affected by the proposed project requires a careful analysis of its requirements in relation to the anticipated habitat changes.

In general, the wetlands in these groups are classified in Categories I and II in the Puget Sound Water Quality Authority's draft wetland guidelines.

3.6 An existing wetland should not be modified for a stream channel erosion control project if an altered hydroperiod would affect priority peat system or forested zones. These zones are especially sensitive to frequent water level rises such as are expected with this type of project. An existing wetland may be modified for a flood control project that affects priority peat system or forested zones only if these zones are protected by application of the guidelines in Guide Sheet 2 and if all local, state, and federal permitting and regulatory requirements are met.

3.7 If more than one wetland in the drainage could be selected for the project, refer to Guide Sheet 6 for site selection criteria.

3.8 Review the wetland protection guidelines in Guide Sheet 2 and apply them to the project design.

3.9 Proceed to Guide Sheet 7 to develop a project monitoring plan.

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III-5.2.4 GUIDE SHEET 4

RUNOFF QUALITY CONTROL GUIDELINES

Editor's Note: Whenever considering the possible role of wetlands in stormwater quality control, the underlying principle is that, no matter what practices are adopted, water quality standards for wetlands (see Ch. 173-201 WAC) must be achieved, and the standards set in General Minimum Requirements #4 and #6 must be met (see Chapter I-2). As a general rule it can be said that in all instances where urban stormwater is discharging into wetlands, implementation of some combination of source control and treatment BMPs will be needed (see Chapter I-4 for guidance on BMP selection).

4.1 Perform an analysis of the contributing and receiving drainage catchments to define the type and extent of runoff water quality problems associated with existing or new development that require control to protect the beneficial uses of receiving waters, including wetlands (refer to Chapter 173-201 WAC for the definition of beneficial uses). This analysis should include a hydrologic assessment (refer to Chapter III-1); identification of key water pollutants, such as solids, oxygen-demanding substances, nutrients, metals, oils, trace organics, and bacteria; and evaluation of the potential effects of hydrologic conditions and water pollutants throughout the drainage system.

4.2 Perform an analysis of the contributing drainage catchment to assess possible alternative solutions that can be applied on-site or on a regional scale. The most appropriate solution or combination of alternatives should be selected with regard to the specific opportunities and constraints existing in the drainage catchment. As an aid to selecting the appropriate BMP, refer to Chapter I-4. Consider both source control BMPs (Step 4.2(a)) and treatment BMPs (Step 4.2(b)).

(a) Implementation of source control BMPs that prevent the generation or release of water pollutants at potential sources. This alternative usually offers the more feasible opportunity to control runoff water quality in existing developments (refer to Volume IV);

(b) Installation of facilities that capture water pollutants after their release (treatment BMPs). This alternative often has limited application in existing developments because of space limitations, although it can be employed when redevelopment occurs in already developed areas. Facilities that should be considered include:

(i) Infiltration basins or trenches (refer to Chapter III-3 and pay particular attention to the selection criteria for avoiding ground water contamination);

(ii) Wet or extended-detention ponds (refer to Chapter III-4);

(iii) Oil/water separators or their equivalent (refer to Chapter III-7);

(iv) Constructed wetlands (refer to Chapter III-4);

(v) Biofiltration facilities (vegetated swales or filter strips) (refer to Chapter III-6).

4.3 Consider existing wetlands only if upland alternatives are inadequate to solve the existing or potential problem. Use of Waters of the State and Waters of the United States, including wetlands, for the treatment or conveyance of wastewater (including stormwater) is prohibited under state and federal law. It appears that federal and state regulations now under development may allow

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the use of existing wetlands for improving stormwater quality, subject to analysis on a case-by-case basis and only if the following conditions are met:

(a) If restoration or enhancement of a previously degraded wetland is required, and if the upgrading of other wetland functions can be accomplished along with benefiting runoff quality control,

and

(b) If appropriate source control and treatment BMPs are applied in the contributing catchment on the basis of the analysis in Step 4.2 and water quality standards for wetlands are observed.

If these circumstances apply, first consider among existing wetlands those in Category IV in the Puget Sound Water Quality Authority's draft wetland guidelines. In general, Category IV wetlands have monotypic vegetation of similar age and class, lack special habitat features, and are isolated from other aquatic systems. If an existing wetland alternative is being considered, evaluate it further according to the subsequent guidelines.

4.4 An existing wetland should not be modified for runoff quality control and should be given maximum protection from overall urban impacts (see Guide Sheets 2 and 5) under any of the following circumstances:

(a) It is primarily an estuarine or forested wetland or a priority peat system.

(b) It is a rare or irreplaceable wetland type, as identified by the Washington Natural Heritage Program, the Puget Sound Water Quality Preservation Program, or local government.

(c) It provides rare, threatened, or endangered species habitat that could be impaired by the proposed action. Determining whether or not the conserved species will be affected by the proposed project requires a careful analysis of its requirements in relation to the anticipated habitat changes.

In general, the wetlands in these groups are classified in Categories I and II in the Puget Sound Water Quality Authority's draft wetland guidelines.

4.5 If more than one wetland in the drainage could be selected for the project, refer to Guide Sheet 6 for site selection criteria.

4.6 Water quality benefits to downstream receiving waters (lakes, streams, Puget Sound) can be gained in a wetland through one or a combination of three strategies. Assess these strategies in the order given below. Application of these strategies must be consistent with the wetland protection guidelines in Guide Sheet 2. The strategies are:

(a) Select the wetland according to criteria that promote water quality improvement (refer to Step 4.7).

(b) Engineer the drainage system at the entrance to the wetland to promote stormwater quality improvement (refer to Step 4.8).

(c) Modify the wetland to incorporate features that promote stormwater quality improvement (refer to Step 4.9).

Proceed to Step 4.7, 4.8, or 4.9, depending on your selection of strategy.

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4.7 Select a wetland to promote stormwater quality improvement according to the following criteria:

(a) The most important consideration in achieving water quality benefits is maximizing the actual water residence time. Therefore, select a site that provides the maximum possible actual water retention time. The following characteristics represent goals to which the site selection should come as close as possible:

(i) A retention time of approximately one week for good control of particulate pollutants and two weeks or more for control of nutrients and other relatively soluble pollutants (U.S. Environmental Protection Agency 1986b). The retention time is approximately the ratio of wetland water volume/average outflow rate, unless the soil infiltration rate is relatively high.

(ii) A relatively high wet pool area/watershed area ratio (the wet pool area is the surface area encompassed by the live and dead storage volumes). This ratio should be at least 0.01 and, preferably, 0.025 or higher (U.S. Environmental Protection Agency 1986).

(iii) A configuration that avoids short-circuiting of flow from the inlet to the outlet, featuring--

[a] An outlet remote from the inlet;

[b] A flow pattern that minimizes velocity at the water entrance point and between the inlet and outlet;

[c] A small outlet for the release of small storms and a large outlet or spillway for the discharge of large storms.

(b) The wetland should have a standing water pool during the seasons in which water quality benefits are desired, with a range of depths from < 15 cm to approximately 1 m (Schueler 1987).

(c) Water quality benefits are best promoted by a minimum of channelized flow. Therefore, flow should be in a sheet or in multiple channels.

(d) Water quality benefits are best promoted if pH is circumneutral (6-7) or alkaline.

(e) Select a wetland with surface soils of moderate-to-fine textured (e.g., soils in the loam classes) and with relatively high muck (highly decomposed organic matter) content to promote the functioning of water pollutant removal mechanisms.

(f) Select a wetland that offers substantial contact between water and dense, fine herbaceous plants with good winter viability to promote filtration and other pollutant removal mechanisms.

(g) If a project site can be selected according to these criteria to provide the required water quality benefits, proceed to Step 4.10; otherwise, proceed to Step 4.8 to assess another strategy.

4.8 Consider engineering the drainage system that routes runoff to a wetland to promote stormwater quality improvement. Possible drainage system modifications include:

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(a) Reduce the entrance velocity of the flow by enlarging the inlet conveyance, decreasing its slope, and/or installing baffling to reduce momentum.

(b) Spread the inlet flow rather than introduce it at a single point in order to get more widespread flow distribution and promote a long actual water residence time.

(c) Redirect the inlet flow to a different point if necessary to avoid short circuiting from inlet to outlet.

(d) If a project site can be selected according to these criteria to provide the required water quality benefits, proceed to Step 4.10; otherwise, proceed to Step 4.9 to assess another strategy.

4.9 Modification of the wetland to promote stormwater quality improvement should be considered only if the wetland is already highly disturbed and serves minimal ecological functions, and if opportunities exist for concurrently improving the ecological functioning of such wetlands and increasing their resource values. If modification is appropriate according to these guidelines, stormwater quality improvement can be promoted in the following ways:

(a) Enlarge the wet pool area (surface area encompassed by the live and dead storage volumes) to increase the wetland volume and wetland area/watershed area ratio. This ratio should be at least 0.01 and, preferably, 0.025 or higher (U.S. Environmental Protection Agency 1986). (Note: Wetland enlargement should not be at the expense of ecologically valuable uplands, especially forested systems.)

(b) Deepen to increase volume, or alter depth contours to achieve a range of depths such as advised for constructed wetlands in Chapter III-4.

(c) Raise the outlet to increase volume. Outlet works construction may require a Clean Water Act Section 404 permit; consult the U.S. Army Corps of Engineers.

(d) Control the outlet rate to increase water residence time. The water volume/average overflow rate ratio (under design flow conditions) should be approximately one week for good control of particulate pollutants and as much as two weeks for nutrient control (U.S. Environmental Protection Agency 1986).

(e) Revise the flow pattern to maximize sheet flow.

(f) Install baffling to reduce inlet velocities and aid in distributing flow.

(g) Plant dense, fine, native herbaceous plants (do not introduce invasive weedy species).

Proceed to Step 4.10.

4.10 Review the wetland protection guidelines in Guide Sheet 2 and apply them to the project design.

4.11 Certain maintenance operations may have to be performed to receive water quality benefits over the long term. Guidelines pertaining to maintenance are:

(a) Prevent sediment discharge to the wetland to the maximum extent possible through the use of effective erosion control in the drainage catchment (refer to Volume II).

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(b) Remove sediments when water residence time declines by about 25 percent and/or plant growth and the performance of other wetland functions are negatively affected. If other guidelines have been followed, the need for sediment removal should only be in the pretreatment facility and, occasionally, the inlet zone of the wetland. Time sediment removal so that sensitive life stages of wetland inhabitants are not affected. Enclose the area of work with silt fencing if necessary to prevent particle escape from that area (refer to BMP E3.10 in Chapter II-4).

(c) Plant harvesting should be evaluated under the following circumstances--

(i) Nutrient control is an important objective (plant uptake is more important for control of nutrients than other pollutants);

(ii) The wetland is already highly disturbed and has no other functions that would be impaired by the harvest;

(iii) Much of the vegetation is herbaceous with small root structures (harvesting wetland plants with extensive root structures is infeasible; without removing roots, much of the stored nutrients are left intact and can be released later).

(iv) Cutting or pulling woody species would stimulate herbaceous species that are superior in filtration and plant uptake.

Include a cost-benefit analysis in the harvesting evaluation.

(d) If harvesting is warranted on the basis of these guidelines and the results of the cost-benefit analysis, and if permission has been obtained from the local government regulatory unit, cut as much of the plant biomass as possible at the end of the growing season and before extensive senescence occurs (during the first month of the fall season). This timing will help to avoid soil compaction and stimulate vegetation vigor and vitality. Compost or dispose of the cuttings in a way so that no pollutants can enter surface waters or ground water.

4.12 Proceed to Guide Sheet 7 to develop a project monitoring plan.

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III-5.2.5 GUIDE SHEET 5

MANAGING WETLANDS IN A NEWLY DEVELOPING AREA

The guidelines in this sheet are based on two principles that are recognized to create the most effective environmental management: (1) the best management policies for the protection of wetlands and other natural resources are those that prevent or minimize the development of impacts at potential sources; and (2) the best management strategies are self-perpetuating, that is they do not require periodic infusions of capital and labor. To apply these principles in managing wetlands in a newly developing area, carry out the following steps.

5.1 Develop a basin or subbasin plan for the drainage catchment containing the wetlands to be managed. Important planning considerations include:

(a) Formulate the plan on the basis of clearly articulated community goals. Carefully identify conflicts and choices between retaining and protecting desired resources and community growth.

(b) Map and assess land suitability for urban uses. Include the following landscape features in the assessment: forested land, open unforested land, steep slopes, erosion-prone soils, foundation suitability, soil suitability for waste disposal, aquifers, aquifer recharge areas, wetlands, floodplains, surface waters, agricultural lands, and various categories of urban land use. When appropriate, the assessment can highlight outstanding local or regional resources that the community determines should be protected (e.g., a fish run, scenic area, recreational area, threatened species habitat, farmland). Mapping and assessment should recognize not only these resources but also additional areas needed for their sustenance.

5.2 Maximize natural water storage and infiltration opportunities within the basin and outside of existing wetlands, especially:

(a) Promote the conservation of forest cover. Building on land that is already deforested affects basin hydrology to a lesser extent than converting forested land. Loss of forest cover reduces interception storage, detention in the organic forest floor layer, and water losses by evapotranspiration, resulting in large peak runoff increases (Dunne and Leopold 1978; Stoker 1988) and either their negative effects or the expense of countering them with structural solutions.

(b) Maintain natural storage reservoirs and drainage corridors, including depressions, areas of permeable soils, swales, and intermittent streams. Develop and implement policies and regulations to discourage the clearing, filling, and channelization of these features. Utilize them in drainage networks in preference to pipes, culverts, and engineered ditches.

(c) In evaluating infiltration opportunities refer to Chapter III-3 and pay particular attention to the selection criteria for avoiding ground water contamination. If necessary, site developments with large amounts of impervious surfaces or a potential to produce relatively contaminated runoff away from ground water recharge areas.

5.3 Manage stormwater not only to prevent flooding and stream channel erosion, but also to maintain, to the maximum extent possible, the pre-development hydroperiod, hydrodynamics, and water quality in the wetlands of the urbanizing watershed. Specific considerations of this management task include:

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(a) This provision involves not only management of high runoff volumes and rates of flow during the wet season, but also prevention of water supply depletion during the dry season. The latter guideline may require flow augmentation if urbanization reduces natural surface or ground water inflows.

(b) Adopt standards to maintain peak runoff discharge rates from developed sites at no greater than the pre-development rates.

(c) Adopt zero-rise floodplain standards.

5.4 Establish and maintain buffers surrounding wetlands as required by local regulations or as recommended by the Puget Sound Water Quality Authority's draft wetland guidelines. Also, maintain interconnections among wetlands and other natural habitats to allow for wildlife movements.

5.5 Place strong emphasis on water resource protection during construction of the new development. Establish effective erosion control programs to reduce the sediment loadings to receiving waters to the maximum extent possible (refer to Volume II). No pre-existing wetland or other water body should ever be used for the sedimentation of solids in construction-phase runoff.

5.6 Stimulate public awareness of and interest in wetlands and other water resources in order to establish protective attitudes in the community. This program should include:

(a) Education regarding the use of fertilizers and pesticides, automobile maintenance, the care of animals to prevent water pollution, and the importance of retaining buffers;

(b) Descriptive signboards adjacent to wetlands informing residents of the wetland type, its functions, the protective measures being taken, etc.

(c) If beavers are present in a wetland, educate residents about their ecological role and value and take steps to avoid human interference with beavers.

5.7 Take specific management measures to avoid general urban impacts on wetlands (e.g., littering and vegetation destruction).

5.8 Assess alternatives for the control of runoff water quantities from the new development according to Guide Sheet 3.

5.9 Assess alternatives for the control of runoff water quality from the new development according to Guide Sheet 4.

5.10 Review the wetland protection guidelines in Guide Sheet 2 and apply them to the management plan.

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III-5.2.6 GUIDE SHEET 6

WETLAND SITE SELECTION CRITERIA

6.1 When more than one wetland is under consideration for a stormwater management project, the site selected should be the wetland that best advances the achievement of overall resource protection benefits. From the standpoint of protecting the wetland resources, the preferred site is the wetland that most exhibits the following characteristics:

(a) The wetland has been deprived of a significant amount of its water supply by draining or previous urbanization (e.g., by loss of ground water discharge), and stormwater can be used to augment the water supply. Consider specifically wetlands that have experienced an increased summer dry period, especially those where the drought has been extended from less than to more than two months.

(b) The wetland lies in the natural routing of the runoff.

(c) The wetland allows runoff discharge at the natural location.

(d) The wetland requires little construction activity for structural or hydrologic modification in order to solve the problem.

(e) If all wetlands under consideration would require some modification, the selection should consider the relative qualities of the candidate sites and the relative extent of alteration required. The preferred choice is the wetland that is most degraded or, if several alternatives are similar in that respect, the site requiring the least alteration.

(f) If a wetland can provide the required storage capacity by an outlet orifice modification to increase storage of water, it will probably require less construction activity and is therefore preferred to a wetland that requires raising the existing overflow to obtain adequate storage capacity.

(g) The wetland's existing hydrodynamic character is to experience a relatively high degree of water level fluctuation and a range of velocities (i.e., a wetland associated with substantially flowing water, rather than one in the headwaters or entirely isolated from flowing water).

(h) The wetland has been previously disturbed by human activity, as evidenced by agriculture, fill, ditching, and/or introduced or invasive weedy plant species.

(i) The wetland does not exhibit any of the following ecological features:

(i) Significant priority peat system or forested zones that will experience a substantially altered hydroperiod as a result of the proposed action;

(ii) Regionally unusual biological community types.

(iii) Animal habitat features of relatively high value in the region (e.g., a protected, undisturbed area connected through undisturbed corridors to other valuable habitats, an important breeding site for protected species).

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(iv) The presence of protected commercial or sport fish, or the wetland's configuration and topography are such that no significant modification to the wetland will be necessary to avoid fish stranding after the proposed project is installed.

(j) The wetland is not the subject of a relatively high degree of public interest as a result of, for example, offering valued local open space or educational, scientific, or recreational opportunities, unless the proposed action would enhance these opportunities.

(k) The wetland is threatened by potential impacts exclusive of stormwater management, and could receive greater protection if acquired for a stormwater management project than if left in existing ownership.

(l) The wetland lends itself to the effective application of the wetland protection guidelines in Guide Sheet 2.

6.2 Return to the guide sheet on which you were working and continue.

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III-5.2.7 GUIDE SHEET 7

MONITORING GUIDELINES

Note: Development of this guide sheet is not complete, pending analysis of what has been learned about cost-effective wetland monitoring during the Puget Sound Wetlands and Stormwater Management Research Program. When it is finished, Guide Sheet 7 will provide full details on the design and performance of a monitoring program. It is anticipated that the guide sheet will have the following characteristics:

1. Some level of monitoring will be specified for all projects that involve existing wetlands and stormwater, in order to ensure maintenance of water quality standards and wetland functions, values, and beneficial uses.

2. Monitoring objectives could encompass information gathering needed for stormwater management purposes, assessment of the effects of management actions on the wetland ecosystem, or both.

3. There will be several levels of monitoring, ranging from minimal to extensive requirements.

4. Baseline monitoring before the implementation of the stormwater management project will be specified when necessary to provide a basis for comparison to assess impacts. Tentatively being considered when baseline monitoring is required are:

   a. A minimum of one year of at least monthly measurements of wetland water stage and crest stage;

   b. Plant cover/abundance analysis during at least one summer;

   c. A minimum of one year of measurements of pH, total phosphorus, nitrate + nitrite-nitrogen, total suspended solids, turbidity, fecal coliform and total zinc concentrations in the wetland open water on at least eight occasions; and

   d. Measurement of sediment accretion and soil metal concentrations (at least arsenic, copper, and lead) once at several locations in the wetland during at least one year.

5. The minimum level of monitoring after project implementation might involve, for example, observations needed to determine the need for facility maintenance or, for impact assessment, periodic field observation of certain features of the wetland and a photographic record over time. A higher level of monitoring might involve the same measurements specified for baseline monitoring on a repeating schedule.

6. Examples of cases for which relatively little monitoring will be specified are:

   a. A similar case has already been monitored (e.g., in the Puget Sound Wetlands and Stormwater Management Research Program) and found to involve few or no effects on the wetland (criteria will be specified to judge the degree of similarity of cases);

   b. The wetland involved was highly degraded before the project;

   c. There will be very little structural, hydrologic, or water quality modification of the wetland; or

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d. There will be very little chance of violations of state water quality standards or accumulations of toxicants in the wetland.

7. Monitoring could involve the wetland only, the success of mitigation, or both.

8. The monitoring planning guidelines will include a feedback mechanism to apply monitoring results in fine-tuning management practices.

Do you wish to analyze another management problem? If so, return to Guide Sheet 1, Step 1.3 for directions. If not, the assessment is complete.

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AIII-5.1 APPENDIX A

INFORMATION NEEDED TO APPLY GUIDELINES

NOTE: The following information listed for each guide sheet is most essential for applying the Wetlands and Stormwater Management Guidelines. Information need be assembled only for the guide sheets that apply to the project. Additional information, listed at the end, would provide a more comprehensive basis for project analysis and planning. As a start, obtain the relevant soil survey; the National Wetland Inventory, topographic, and land use maps; and the results of any local wetland inventory.

Guide Sheet 1

1.1 Statement of project objectives (basin-wide and for specific wetland(s)).

1.2 Existing management and monitoring plans.

Guide Sheet 2

2.1 Existing and projected watershed land use in the following categories: commercial, industrial, multi-family residential, single-family residential, and undeveloped (expressed as percentages of the total watershed area).

2.2 Wetland type and zones present, with special note of estuarine, priority peat system, forested, sensitive scrub-shrub zone, sensitive emergent zone and other sensitive or critical areas designated by state or local government (with dominant plant species).

2.3 Maximum existing water level as measured according to the appropriate guidelines in Guide Sheet 7.

2.4 Frequency, duration, and timing of projected increase above maximum existing water level.

2.5 Fish and wildlife inhabiting the wetland.

Guide Sheet 3

3.1 Wetland category (I-IV in draft Puget Sound Water Quality Authority wetland protection guidelines); designation as rare or irreplaceable as defined in Guide Sheet 3. Refer to the Washington Natural Heritage Program data base. If the needed information is not available, a biological assessment will be necessary.

3.2 Rare, threatened, or endangered species inhabiting the wetland.

Guide Sheet 4

4.1 Water pollution assessment as described in Guide Sheet 4.

4.2 Wetland category (I-IV in draft Puget Sound Water Quality Authority wetland protection guidelines); designation as rare or irreplaceable as defined in Guide Sheet 3. Refer to the Washington Natural Heritage Program data base. If the needed information is not available, a biological assessment will be necessary.

4.3 Rare, threatened, or endangered species inhabiting the wetland.

4.4 Wetland water volume (live storage).

4.5 Outflow rate.

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4.6 Ground water recharge/discharge statue.

4.7 Wet pool area.

4.8 Contributing watershed area.

4.9 Inlet and outlet locations.

4.10 Winter water depths.

4.11 Flow pattern through wetland.

4.12 pH.

4.13 Surface soil characteristics (general texture, organic content).

Guide Sheet 5

5.1 A complete definition of goals.

5.2 The presence of various landscape features, as outlined in Guide Sheet 5.

5.3 Existing wetland hydroperiod and hydrodynamics.

Guide Sheet 6

No new information in addition to that required for preceding guide sheets.

Supplementary Information (to provide a more comprehensive basis for project analysis and planning).

8.1 Characteristics of other watershed wetlands.

8.2 Refined land use description (including agricultural categories, types of undeveloped land, different residential densities, and active and potential construction sites).

8.3 Hydrologic modeling to provide detailed analysis of existing and projected wetland hydroperiod characteristics.

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AIII-5.2 APPENDIX B

DEFINITIONS

Aggressive plant species: Opportunistic species of inferior biological value that tend to out-compete more desirable forms and become dominant; applied to native species in this manual.

Bioengineering: Restoration or reinforcement of slopes and stream banks with living plant materials.

Constructed wetland: Those wetlands intentionally created on sites that are not wetlands for the primary purpose of wastewater or stormwater treatment and managed as such. Constructed wetlands are normally considered as part of the stormwater collection and treatment system.

Created wetland: Those wetlands intentionally created from nonwetland sites to produce or replace natural habitat (e.g., compensatory mitigation projects).

Degraded (disturbed) wetland (community): A wetland (community) in which the vegetation, soils, and/or hydrology have been adversely altered, resulting in lost or reduced functions and values; generally, implies topographic isolation; hydrologic alterations such as hydroperiod alteration (increased or decreased quantity of water), diking, channelization, and/or outlet modification; soils alterations such as presence of fill, soil removal, and/or compaction; accumulation of toxicants in the biotic or abiotic components of the wetland; and/or low plant species richness with dominance by invasive weedy species.

Enhancement: To raise value, desirability, or attractiveness of an environment associated with surface water.

Estuarine wetland: Generally, an eelgrass bed; salt marsh; or rocky, sandflat, or mudflat intertidal area where fresh and salt water mix. (Specifically, a tidal wetland with salinity greater than 0.5 parts per thousand, usually semi-enclosed by land but with partly obstructed or sporadic access to the open ocean).

Existing site conditions means: (a) For developed sites with stormwater facilities that have been constructed to meet the standards in the Minimum Requirements of this manual, existing site conditions shall mean the existing conditions on the site.

(b) For developed sites that do not have stormwater facilities that meet the Minimum Requirements, existing site conditions shall mean the conditions that existed prior to local government adoption of a stormwater management program. If in question, the existing site conditions shall be documented by aerial photograph records, or other appropriate means.

(c) For all sites in water quality sensitive areas as identified under Minimum Requirement #7, Water Quality Sensitive Areas, existing site conditions shall mean undisturbed forest, for the purpose of calculating runoff characteristics.

(d) For all undeveloped sites outside of water quality sensitive areas, existing site conditions shall mean the existing conditions on the site.

Forested communities (wetlands): In general terms, communities (wetlands) characterized by woody vegetation that is greater than or equal to 6 meters in height; in these guidelines the term applies to such communities (wetlands) that represent a significant amount of tree cover consisting of species that offer wildlife habitat and other values and advance the performance of wetland functions

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overall.

Functions: The ecological (physical, chemical, and biological) processes or attributes of a wetland without regard for their importance to society (see also Values). Wetland functions include food chain support, provision of ecosystem diversity and fish and wildlife habitat, floodflow alteration, ground water recharge and discharge, water quality improvement, and soil stabilization.

Hydrodynamics: means the dynamic energy, force, or motion of fluids as affected by the physical forces acting upon those fluids.

Hydroperiod: The seasonal occurrence of flooding and/or soil saturation; encompasses the depth, frequency, duration, and seasonal pattern of inundation.

Invasive weedy plant species: Opportunistic species of inferior biological value that tend to out-compete more desirable forms and become dominant; applied to non-native species in this manual.

Mean annual water level fluctuation: Derived as follows--

(1) Measure the maximum water level (e.g., with a crest stage gage, Reinelt and Horner 1990) and the existing water level at the time of the site visit (e.g., with a staff gage) on at least eight occasions spread through a year.

(2) Take the difference of the maximum and existing water level on each occasion and divide by the number of occasions.

Modification, Modified (wetland): A wetland whose physical, hydrological, or water quality characteristics have been purposefully altered for a management purpose, such as by dredging, filling, forebay construction, and inlet or outlet control.

On-site - The entire property that includes the proposed development.

Priority peat systems: Unique, irreplaceable fens that can exhibit water pH in a wide range from highly acidic to alkaline, including fens typified by Sphagnum species, Ledum groenlandicum (Labrador tea), Drosera rotundifolia (sundew), and Vaccinium oxycoccos (bog cranberry); marl fens; estuarine peat deposits; and other moss peat systems with relatively diverse, undisturbed flora and fauna. Bog is the common name for peat syetems having the Sphagnum association described, but this term applies strictly only to systems that receive water income from precipitation exclusively.

Rare, threatened, or endangered species: Plant or animal species that are regional relatively uncommon, are nearing endangered status, or whose existence is in immediate jeopardy and is usually restricted to highly specific habitats. Threatened and endangered species are officially listed by federal and state authorities, whereas rare species are unofficial species of concern that fit the above definitions.

Regional: An action (here, for stormwater management purposes) that involves more than one discrete property.

Restoration: Actions performed to reestablish wetland functional characteristics and processes that have been lost by alterations, activities, or catastrophic events in an area that no longer meets the definition of a wetland.

Sensitive emergent vegetation communities: Assemblages of erect, rooted, herbaceous vegetation, excluding mosses and lichens, at least some of whose members have relatively narrow ranges of environmental requirements, such as hydroperiod, nutrition, temperature, and light. Examples include fen species such as sundew and,

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as well as a number of species of Carex (sedges).

Sensitive life stages: Stages during which organisms have limited mobility or alternatives in securing the necessities of life, especially including reproduction, rearing, and migration periods.

Sensitive scrub-shrub vegetation communities: Assemblages of woody vegetation less than 6 meters in height, at least some of whose members have relatively narrow ranges of environmental requirements, such as hydroperiod, nutrition, temperature, and light. Examples include fen species such as Labrador tea, bog laurel, and cranberry.

Unusual biological community types: Assemblages of interacting organisms that are relatively uncommon regionally.

Values: Wetland processes or attributes that are valuable or beneficial to society (also see Functions). Wetland values include support of commercial and sport fish and wildlife species, protection of life and property from flooding, recreation, education, and aesthetic enhancement of human communities.

Wetlands: Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. This includes wetlands created, restored or enhanced as part of a mitigation procedure. This does not include constructed wetlands or the following surface waters of the state intentionally constructed from sites that are not wetlands: Irrigation and drainage ditches, grass-lined swales, canals, agricultural detention facilities, farm ponds, and landscape amenities.

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AIII-5.3 APPENDIX C

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CHAPTER III-6

BIOFILTRATION SWALES AND VEGETATIVE FILTER STRIPS

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CHAPTER III-6

BIOFILTRATION SWALES AND VEGETATIVE FILTER STRIPS

Editor's Note: This edition of the manual has classified biofiltration swales and vegetative filter strips as two different BMPs. Though their pollutant removal mechanisms are similar, their planning and design criteria are different enough to warrant separation. However, this edition of the manual retains the previous edition's criteria; subsequent editions of this manual will likely reflect changes in planning and design criteria.

There are still uncertainties and differences of opinion on how to best design biofiltration swales and vegetative filter strips. In addition, the effectiveness of these BMPs, especially for the treatment of nutrients, is an unresolved issue. As a result of this and other issues, Ecology plans to convene a standing advisory group that will attempt to resolve key technical issues. A review of the latest findings from current biofilter monitoring projects will be conducted and recommendations made regarding the design methodology, planning considerations, construction, and maintenance of biofilters and vegetative filter strips. Subsequent editions of this manual will incorporate such findings.

III-6.1 INTRODUCTION

III-6.1.1 Background

Biofiltration swales and vegetative filter strips are two practices which have been used in stormwater management for some years. Only fairly recently have they been studied to determine their effectiveness at treating pollution from stormwater runoff and to assess their abilities to reduce peak flow rates. Because these two BMPs are non-structural, they are considered desirable alternatives to ponds, tanks, and vaults. At this time these two practices are assumed to provide runoff treatment but not streambank erosion control (the latter is an issue that needs further investigation, especially for less intensely developed sites).

III-6.1.2 Purpose and Scope

The purpose of this chapter is to present general and specific criteria for the evaluation, design, construction, and maintenance of biofiltration swales and vegetative filter strips. In particular, this chapter provides guidance on how BMPs can be designed to accomplish one of the two primary stormwater management objectives, *runoff treatment* and *streambank erosion control* (recall that *source control* is another objective which is required in all cases). While streambank erosion control is not generally provided by these BMPs, biofiltration swales can be designed to convey higher flows to BMPs used for streambank erosion control and thus may be incorporated into the primary conveyance/detention system.

Section III-6.2. should be read first as it gives a description of the pollutant removal mechanisms utilized by biofilters and vegetative filter strips to meet Ecology's runoff treatment standard. Sections III-6.3 and III-6.4 provide detailed planning, design, construction, and maintenance criteria for each BMP. A design procedure is described in Appendix AIII-6.1 for both BMPs with an example problem provided in Appendix AIII-6.2.

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Figure III-6.1 Biofiltration Swale

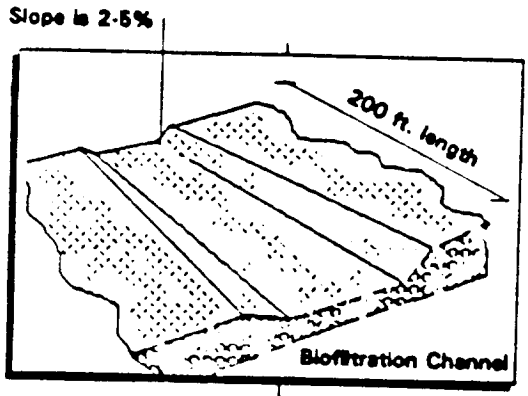
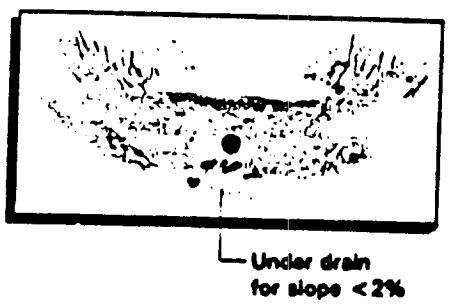


Figure III-6.2 Biofiltration Swale with Underdrain System



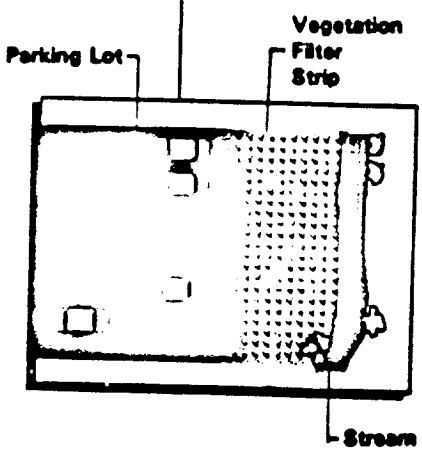


Figure III-6.3
Vegetated Filter Strip

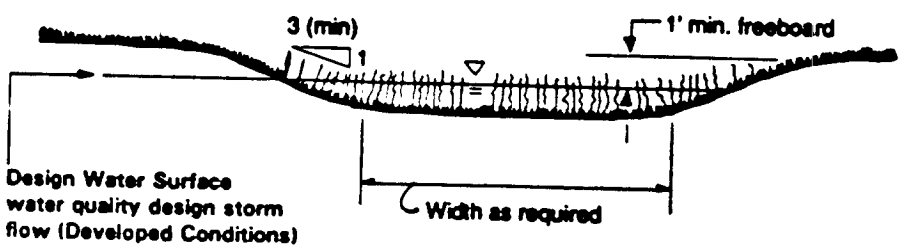


Figure III-6.4 Swale Design Showing Freeboard

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III-6.2 RUNOFF TREATMENT AND CONVEYANCE

III-6.2.1 Overview

There are two types of biofiltration-type BMPs: the biofiltration swale (BMP RB.05) and the vegetated filter strip (BMP RB.10). Figures III-6.1 through III-6.4 illustrate these BMPs. A biofiltration swale is a vegetated channel that is sloped like a standard storm drain channel; stormwater enters at one end and exits at the other with treatment provided as the runoff passes through the channel. With vegetated filter strips the flow is distributed broadly along the width of the vegetated area; treatment is provided as runoff travels as sheet flow through the vegetation.

Which method to use depends upon the drainage patterns of the site. A vegetated strip would function well where the water can be spread along the length of a parking lot. Gaps in the lot curb provide the entry points. Of course, the grade of the parking lot must be flat immediately parallel to the strip.

For runoff treatment purposes, biofiltration swales and vegetative filter strips are to be designed to treat the 6-month, 24-hour design storm, as required by Minimum Requirement #4 (see Chapter I-2). *Note: This is a change from the previous edition of this manual. Formerly the design storm for biofilters was the 2-year, 24-hour event. The change has been made so that all runoff treatment BMPs will be designed in a consistent manner.*

III-6.2.2 Mechanisms of Pollutant Removal

Biofiltration swales and vegetative filter strips use similar pollutant removal mechanism, i.e., "biofiltration." The term "biofiltration" has been coined to describe the more-or-less simultaneous processes of filtration, infiltration, adsorption and biological uptake of pollutants in stormwater that take place when runoff flows over and through vegetated treatment facilities. Vegetation growing in these facilities acts as both a physical filter which causes gravity settling of particulates by regulating velocity of flow, and also as a biological sink when direct uptake of dissolved pollutants occurs. The former mechanism is probably the most important in western Washington where the period of major runoff coincides with the period of lowest biological activity.

Another means of removing pollutants occurs as the stormwater contacts the soil surface and infiltrates into the underlying soil. Dissolved pollutants are adsorbed onto soil particles. This is a potentially important removal mechanism for both dissolved heavy metals and phosphorus by undergoing ion exchange with elements in the soil. In addition, biological activity in the soil can metabolize organic contaminants. However, in highly porous soils stormwater can be a threat to shallow ground water since these soils have little treatment capacity. In such instances, biofilter BMPs must meet the General Limitations for infiltration BMPs (see Chapter III-3) or it may be necessary to install a liner to prevent infiltration.

The degree to which the above mechanisms operate will vary considerably depending upon many factors such as the depth and condition of the vegetation, the velocity of the water, the slope of the ground, and the texture of the underlying soil. However, the most important criterion that can be developed from these variables is the residence time of the stormwater in the biofilter, provided there is an adequate stand of vegetation and the underlying soil is of moderate texture. Therefore, to be effective, the biofilter must be designed such that the residence time is sufficient to permit most if not all of the particulates and at least some of the dissolved pollutants to be removed from the stormwater.

Design criteria that will maximize the effectiveness of biofiltration swales and strips are still in the developmental stage because their use for treating

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stormwater locally has only been applied and investigated for a relatively short time. They have been largely based on work done in the early 1980s by researchers at the University of Washington for the Washington State Department of Transportation and have relied heavily on the finding that total suspended solids and lead were reduced by at least 80 percent in 200 feet of grass swale (1).

The most recent comprehensive publication dealing with biofiltration systems locally was prepared in 1988 by Horner (2) and the reader is referred to this document for further details including a review of the literature and a survey of operating biofilters.

III-6.3 BMP RB.05 BIOFILTRATION SWALE

Purpose and Definition

A biofiltration swale is designed to provide runoff treatment of conventional pollutants but not nutrients. It does not provide streambank erosion control but can be designed to convey runoff to BMPs designed for that purpose. Biofiltration swales, when used as a primary treatment BMP, should be located "off-line" from the primary conveyance/detention system in order to enhance effectiveness (they can also be made smaller when located "off-line"). If a biofiltration swale is used to protect a water quality infiltration BMP or a sand filtration BMP (see Chapter III-3), then it will be necessary to locate it "off-line."

In cases where a biofiltration swale is located "on-line" it must be sized as both a treatment facility and as a conveyance system to pass the peak hydraulic flows of the 10 and 100-year design storm. To be effective, the depth of the stormwater during treatment must not exceed the height of the grass.

Planning Considerations

1. *Local governments should maintain the necessary flexibility in ordinances and regulations to permit site-by-site assessment of biofiltration alternatives, and to allow for discretionary design, installation, operating, and maintenance requirements, as long as they do not conflict with the general intent of design and maintenance requirements stated below.*

2. *Biofiltration should be regarded as one possible element of an integrated stormwater management plan for any given site or class of sites. Selection and implementation of alternatives should be based on stated water quality objectives (see Chapter I-4).*

3. *With diverse opportunities existing to apply the variety of biofilter configurations, a creative approach is recommended to obtain the best match of system and conditions.*

4. *Since biofiltration is an on-site rather than a regional technique, localized commitments must be made to maximize its application and effectiveness.*

5. *Since flexibility exists in many design features, biofiltration success depends more on proper construction and maintenance than any other factors; effective inspection and enforcement programs should be emphasized to ensure that approved plans are implemented.*

General Technical Recommendations

1. Natural drainage courses should be regarded as significant local resources that are generally to be kept in use for stormwater management, including biofiltration.

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2. Roadside ditches should be regarded as significant potential biofiltration sites; road design standards and ditch maintenance programs should be developed to maximize their usefulness in biofiltration.

3. Local governments should resist proposals to enclose open channels in pipes. In addition to offering the opportunity for biofiltration, open channels generally have more capacity than pipes and are easier to inspect and maintain.

4. Retention/detention pond design requirements should recognize and assess the alternative of installing low-flow biofiltration swales within ponds where sufficient land does not exist for both.

5. Opportunities to fit biofiltration retroactively to areas already developed should be exploited whenever possible.

6. Biofilters should generally not receive construction-stage runoff; if they do, presettling of sediments should be provided (see BMPs E3.35 and E3.40 in Chapter II-5). Such biofilters should be evaluated for the need to remove sediments and restore vegetation following construction.

7. Biofilters should be protected from siltation by a permanent presettling basin when the erosion potential is high (see BMP RD.10 in Chapter III-4); otherwise, presettling is not generally needed for normal operation. However, a series arrangement of a retention/detention pond and biofilter has the ability to offer extra protection to a sensitive receiving water, due to the complementary pollutant removal mechanisms that can operate in the two devices.

8. Biofilters must be vegetated in order to provide adequate treatment of runoff. By definition, biofilters require vegetation, and rock-lined or vegetated channels are not biofilters.

Design Criteria

Overview

The design, planning, and operation and maintenance details that follow have been adapted directly from Horner's "general recommendations" with minor modifications, and while this is judged to be the best available information, it must be considered as interim and subject to modification. Alternative criteria is being investigated which may be reflected in future editions of this manual.

Questions remain about the nutrient-removing abilities of biofilters in the Pacific Northwest and further work needs to be done to resolve optimal geometry and slopes of swales (2). As this and other information becomes available, especially monitoring data and consequent new ideas on design, they will be incorporated into later editions of this manual.

In summary, the interim criteria have been selected to ensure that the velocity of water does not exceed 1.5 feet per second along a swale of 200 feet in length during the water quality design storm (the 6-month, 24-hour storm). Although the 1990 and 1991 versions of this manual used the 2-year, 24-hour storm, we have chosen to change it to the 6-month, 24-hour storm to make all BMP designs consistent. We do not feel that the decrease in cross-sectional area and residence time are such that the larger size storm design is necessary. An additional requirement for swales designed to convey larger storms (up to the 100-year, 24-hour event) is that the peak velocity for the maximum design storm is kept below erosive levels. Complete details of the criteria are given below, and the appendices give step-by-step procedures for designing strips and swales including an example calculation.

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General Criteria

1. For biofiltration, it is important to maximize water contact with vegetation and the soil surface. Gravelly and coarse sandy soils cannot be used for biofiltration unless the bottom of the swale is lined to prevent infiltration. (Note: Sites that have relatively coarse soils may be more appropriate for stormwater infiltration for streambank erosion control purposes after runoff treatment has been accomplished. In any case the General Limitations in Chapter III-3 will dictate the use of coarse soils for stormwater management purposes). Also, avoid very heavy clay soils that will not support good vegetative growth.

2. Select vegetation on the basis of pollution control objectives and according to what will best establish and survive in the site conditions. Also, consider whether wildlife habitat development can occur in concert with pollution control. If so, consider the needs of such development in vegetation selection. For general purposes, select fine, close-growing, water-resistant grasses. Alternatively, where some period of soil saturation is expected, where particular pollutant uptake characteristics are desired, or both, select emergent wetland plant species. Protect these plants from predation during establishment by netting. See Appendix III-6.1 for specific vegetation selection recommendations.

3. Establish grasses as follows (all weights are per 1,000 square feet):

   If hydro-seeding -
   5 lb. seed mix
   7 lb. 10-20-20 (N-P-K) fertilizer*
   50 lb. wood cellulose fiber mulch

   If broadcast seeding -
   5 lb. seed mix
   7 lb. 10-20-20 (N-P-K) fertilizer*
   70 lb. wood cellulose fiber mulch

   *Note: this is just an estimate of the amount of fertilizer necessary. Make certain that the proper amount of fertilizer for the soil type is used.

4. Based on observations in this area, select a grass height of 6 inches or less and a flow depth of less than 5 inches. Grasses over that height tend to flatten down when water is flowing over them, which prevents sedimentation. To attain this height requires regular maintenance.

5. Where grasses are to be cultivated, if possible, select an area where moisture is sufficient to provide water requirements during the dry season, but where the water table is not so high as to cause long periods of soil saturation. Irrigate if moisture is inadequate during summer drought. If saturation will be extended and/or the slope is minimal but grasses are still desired, consider subdrains. Alternatively, consider designing a constructed wetland or wet pond that has a substantially longer water residence time than a swale or filter strip (see Chapter III-4). Also see BMPs E1.35 and E1.40 in Chapter II-5 for more information on seeding and sodding.

6. The channel slope should normally be between 2 and 4 percent. A slope of less than 2 percent can be used if underdrains are placed beneath the channel to prevent ponding (Figure III-6.3). A slope of greater than 4 percent can be used if check dams (Figure III-6.4) are placed in the channel to slow the flows accordingly. (see Provisions for Swales #4, below).

7. If possible, divert runoff (other than necessary irrigation) during the period of vegetation establishment. This requirement can normally be met in the Pacific Northwest by planting during July or August. Sodding is an

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alternative when rapid establishment must occur. Where runoff diversion is not possible, cover graded and seeded areas with a suitable erosion control slope covering material (see Chapter II-5).

8. Prevent bare areas in biofilters by avoiding gravel, rocks, and hardpan near the surface; fertilizing, watering, and replanting as needed; and ensuring effective drainage. Note: Fertilizer must only be used at an application rate and formula which is compatible with plant uptake, and in relation to soil type. For example, high application rates of nitrogenous fertilizer in very permeable soils can result in leaching of nitrate into ground water.

9. If flow is to be introduced via curb cuts, place pavement slightly above the biofilter elevation. Curb cuts should be at least 12 inches wide to prevent clogging.

10. Attempt to avoid compaction during construction. If compaction occurs, till before planting to restore lost soil infiltration capacity.

Specific Criteria for Biofiltration Swales

1. Design swales for hydraulic capacity and stability according to the method detailed in Appendix AIII-6.1. Base the capacity design for biofiltration on the vegetation height equal to the design flow depth and the 6-month frequency, 24-hour duration storm. Unless runoff from larger events will bypass the swale, base the capacity design for flood passage on the 100-year frequency, 24-hour duration storm, plus 1 foot freeboard (Figure III-6.5).

2. Base the design on a trapezoidal cross-section for ease of construction. A parabolic shape will evolve over time. Make side slopes no steeper than 3 horizontal:1 vertical.

3. Provide a minimum of 200 feet of swale, using a wide-radius curved path, where land is not adequate for a linear swale (avoid sharp bends to reduce erosion or provide for erosion protection). If a shorter length must be used, increase swale cross-sectional area by an amount proportional to the reduction in length below 200 feet, in order to obtain the same water residence time.

4. Install log or rock check dams approximately every 50 feet, if longitudinal slope exceeds 4 percent. Adjust check dam spacing in order not to exceed 4 percent slope within each channel segment between dams.

5. Below the design water depth, install an erosion control blanket, at least four inches of topsoil, and the selected biofiltration seed mix. Above the design water line, use an erosion control seed mix with straw mulch or sod (see BMP E1.15 in Chapter II-5).

Construction and Maintenance Criteria

Construction

See Appendix AIII-6.1.

Maintenance

- Groomed biofilters planted in grasses must be mowed regularly during the summer to promote growth and pollutant uptake. Be sure not to cut below the design flow (maintenance personnel must be made aware of this requirement). Remove cuttings promptly, and dispose in a way so that no pollutants can enter receiving waters.

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- If the objective is prevention of nutrient transport, mow grasses or cut emergent wetland-type plants to a low height at the end of the growing season. For other pollution control objectives, let the plants stand at a height exceeding the design water depth by at least two inches at the end of the growing season.

- Remove sediments during summer months when they build up to 6 inches at any spot, cover biofilter vegetation, or otherwise interfere with biofilter operation. Use of equipment like a Ditch Master is strongly recommended over a backhoe or dragline. If the equipment leaves bare spots, re-seed them immediately.

- Inspect biofilters periodically, especially after periods of heavy runoff. Remove sediments, fertilize, and reseed as necessary. Be careful to avoid introducing fertilizer to receiving waters or ground water.

- Clean curb cuts when soil and vegetation buildup interferes with flow introduction.

- Perform special public education for residents near biofilters concerning their purpose and the importance of keeping them free of lawn debris.

- See that litter is removed in order to keep biofilters attractive in appearance.

- Base roadside ditch cleaning on an analysis of hydraulic necessity. Use a technique such as the Ditch Master to remove only the amount of sediment necessary to restore needed hydraulic capacity, leaving vegetative plant parts in place to the maximum extent possible.

III-6.4 BMP RB.10 VEGETATIVE FILTER STRIP

Purpose and Definition

A vegetative filter strip is designed to provide runoff treatment of conventional pollutants but not nutrients. This BMP is not designed to provide streambank erosion control. Also, unlike a biofiltration swale, a vegetative filter strip should not be used for conveyance of larger storms because of the need to maintain sheet flow conditions, plus the filter strip would likely be prohibitively large for this application.

Planning Considerations

See BMP RB.05, Biofiltration Swale. Additional planning considerations are provided below.

Application

Vegetative filter strips can be effective at pretreating runoff to protect infiltration and filtration BMPs from siltation. It may also be a viable treatment BMP for small, less intensely developed sites. The maximum recommended drainage area for a vegetative filter strip is 5 acres. Vegetative filter strips must not receive concentrated flow discharges as their effectiveness will be destroyed plus the potential for erosion could cause filter strips to become sources of pollution.

Slope

Vegetative filter strips should not be used on slopes greater than about 10 percent because of the difficulty in maintaining the necessary sheet flow conditions. Note: This does not mean that vegetated buffers are not suitable for slopes greater than

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10 percent; it simply means that effective treatment of runoff is unlikely for slopes greater than 10 percent. Do not confuse a "buffer zone," which is used to protect streams and other environmental resources, with a "vegetative filter strip," which is a runoff treatment BMP.

Design Criteria

The design, planning, and operation and maintenance details that follow have been adapted directly from Horner's "general recommendations" with minor modifications, and while this is judged to be the best available information, it must be considered as interim and subject to modification. Alternative criteria is being investigated which may be reflected in future editions of this manual. Questions remain about the nutrient-removing abilities of biofiltration BMPs in the Pacific Northwest and further work needs to be done. As information becomes available, especially monitoring data and consequent new ideas on design, they will be incorporated into later editions of this manual.

In summary, an interim criteria have been selected to ensure that a residence time of 20 minutes for the water as it flows across (perpendicular to) the strip. Complete details of the criteria are given below, and the appendices give step-by-step procedures for designing strips and swales including an example calculation.

General Criteria

See BMP RB.05, Biofiltration Swale.

Specific Criteria for Vegetative Filter Strips

1. Design vegetative filter strips according to the same method detailed in Appendix AIII-6.1 for biofiltration swales. Calculate the necessary filter strip width (perpendicular to flow) on the basis of the 6-month frequency, 24-hour duration storm and a hydraulic radius (R) approximately equal to the design flow depth (y). *Note: The design flow depth (y) will normally be no more than 0.5" (0.04 ft) because of the need to maintain sheet flow over the strip)*

2. Calculate the necessary length (parallel to flow) to produce a water residence time of at least 20 minutes (the length should normally be in the range of 100-200 feet).

3. Install a shallow stone trench across the top of the strip to serve as a level spreader or make use of curb cuts in a parking lot. Make provisions to avoid flow bypassing the filter strip.

4. Vegetative filter strips should not be used for slopes in excess of 10 percent, and preferably less, because of the difficulty in maintaining the necessary sheet flow conditions.

Construction and Maintenance

See BMP RB.05, Biofiltration Swale.

III-6.5 REFERENCES

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APPENDIX AIII-6.1
DESIGN PROCEDURE FOR BIOFILTRATION SWALE AND VEGETATIVE FILTER STRIP DESIGN

Introduction

This section has been adapted with minor modifications from Appendix D - Application Guide of "Biofiltration Systems for Storm Runoff Water Quality Control" by Dr. Richard R. Horner (2).

This guide provides biofilter design procedures in full detail, along with examples. It can be removed from the manual for convenient use alone, if desired. Refer to Sections III-6.3 and III-6.4 for design criteria and operation and maintenance details.

Procedure

Note: The procedures for swale and filter strip design are basically the same. The steps are given in full for swales, and notes are included to allow the procedure to be applied to filter strips as well. Unless specifically indicated, steps apply to both filter strips and biofilters.

Preliminary Steps (P)

Step #

P-1. Estimate runoff flow rate (Q) for the 6-month frequency, 24-hour duration storm, according to methods outlined in Chapter III-1.

P-2. Biofilters should normally be placed on slopes of 2 to 4 percent. If it can be demonstrated that adequate drainage to avoid persistent pooling will occur (using underdrains, if necessary), a slope less than 2 percent can be used. If the site slope exceeds 4 percent, the local government should make a determination of the site's suitability for a biofilter, and, if suitable, what special design features should be included. If the slope exceeds 6 percent, it is recommended that the biofilter traverse the slope or that the site topography be modified to produce a slope under 6 percent. If stepped, each section should slope at less than 6 percent. In any swale application with slope greater than 4 percent, check dams should be placed approximately every 50 feet.

P-3. Select a vegetation cover suitable for the site.

Refer to Table III-6.1 to select grasses. If the site will be persistently wet, consider wetland genera such as Typha (cattails), Scirpus (bulrushes), and Lemna (duckweed), which have relatively high rates of pollutant uptake. Other wetland plants that have been observed to serve well in biofilters are Carex (sedges), and water cresses (A. Levesque, King County, personal communication). If development of wildlife habitat is an objective, consider habitat needs in selecting vegetation.

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Table III-6.1.
Characteristics of Grasses Suitable for Lining Puget Sound Region Biofilters. (a)

Common Name	Persistence/ Growth Form	Description	Rating (b)
Annual ryegrass or Italian ryegrass	Annual/bunchgrass	Common erosion control grass; establishes rapidly on bare soils but does not reseed well.	3
Kentucky bluegrass	Perennial/sod-forming	Common turf grass; may require irrigation in dry season. May need regular reseeding.	3
Tall fescue	Perennial/ bunchgrass	Common turf grass; can be used alone; may require irrigation in dry season.	4
Western wheatgrass	Perennial/ sod-forming	Tolerates drought	3

a. Adapted from Goldman et al. (3). Other recommended grasses and legumes:

Meadow foxtail	Creeping red fescue	Annual ryegrasses
Tall fescue	Timothy	White clover
Redtop	Seaside colonial bentgrass	

Other water-resistant grasses that grow well in regional conditions are Poa trivialis (roughstalk bluegrass) and Lolium perenne (perennial ryegrass) (West. D., Seattle City Light, personal communication).

The seeding mix specified for the parking lot swales at the West Willows Technical Center in Redmond was as follows:

52% perennial rye
35% winter rye
13% clover

Shapiro and Associates recommends the following seeding mix for this application (Gorski A., Shapiro and Associates, personal communication):

40% redtop bentgrass
30% red fescue
20% tall fescue
5% perennial rye
5% Russian wild rye

b. Ratings are for erosion protection: 1 - fair; 2 - good; 3 - excellent; 4 - superior.

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Design for Biofiltration Capacity

Note: There are a number of ways of applying the design procedure introduced by Chow (4). These variations depend on the order in which steps are performed, what variables are established at the beginning of the process and which ones are calculated, and what values are assigned to the variables selected initially. The procedure recommended here is an adaptation appropriate for biofiltration applications of the type being installed in the Puget Sound region. This procedure reverses Chow's order, designing first for capacity and then for stability. The capacity analysis emphasizes the promotion of biofiltration, rather than transporting flow with the greatest possible hydraulic efficiency. Therefore, it is based on criteria that promote sedimentation, filtration, and other pollutant removal mechanisms. Since these criteria include a lower maximum velocity than permitted for stability, the biofilter dimensions usually do not have to be modified after a stability check.

Design Steps (D)

Step #

D-1. Establish the height of vegetation during the winter and the design depth or flow. Maximizing height advances biofiltration and allows greater flow depth, which reduces the width necessary to obtain adequate capacity. However, if nutrient capture is the principal objective, vegetation should be mowed at the end of the growing season to minimize nutrient release. The design depth of flow should be at least two inches less than the winter vegetation height. Note: Sheet flow (<1 inch deep) generally exists in vegetative filter strips (use 0.5 inch).

D-2. Select a value of Manning's n. Use one of the following values for an initial analysis (after U.S. Department of Commerce, (5)), or refer to Table III-2.8 in Chapter III-2.

Dense grass up to 6 inches tall - 0.07
Vegetation with coarser stems (e.g., wetland plants, woody plants) - 0.07

D-3. Select the swale shape. (Skip this step in filter strip design.) Use a trapezoidal shape for biofilter swales, as is feasible.

Rectangular and V-shapes are the least desirable from the stability standpoint. If one of these shapes is required by the site configuration, specify reinforcement for the side walls in conformance with the standards of the local government.

D-4. Use Manning's equation and first approximations relating hydraulic radius and dimensions for the selected shape to obtain a working value of a biofilter width dimension:

$$Q = \frac{1.486}{n} AR^{0.667} s^{0.5} \qquad (6\text{-}1)$$

Where:
- Q = design runoff flow rate (ft^3/s, cfs)
- n = Manning's n (dimensionless)
- A = Cross-sectional area (ft^2)
- R = Hydraulic radius = A/wetted perimeter (ft)
- s = longitudinal slope as a ratio of vertical rise/horizontal run (dimensionless)

Refer to Figure III-6.5 to obtain equations for A and R for the selected shape. In addition to these equations, for a rectangular shape:

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$$A = Ty \quad (6\text{-}2)$$

$$R = \frac{Ty}{T+2y} \quad (6\text{-}3)$$

where: T = width
y = depth of flow in feet, expressed as a decimal

If these expressions are substituted in Equation 6-1 and solved for T (for previously selected y), the results are complex equations that are difficult to solve manually. However, approximate solutions can be found by recognizing that T>>y and $z^2>>1$, and that certain terms are nearly negligible. The approximations for the various shapes are:

Parabolic: $R = 0.67\ y$ (6-4)

Trapezoidal: $R = y$ (6-5)

V: $R = 0.5\ y$ (6-6)

Rectangular: $R = y$ (6-7)
(Also use for vegetative filter strips)

Making these substitutions and those for A from Figure III-6.5, and then solving for T gives:

Parabolic: $T = \frac{Qn}{0.76\ y^{1.667}\ s^{0.5}}$ (6-8)

Trapezoidal: $b = \frac{Qn}{1.486\ y^{1.667}\ s^{0.5}} - 2y$ (6-9)

V: $T = \frac{Qn}{0.47\ y^{0.667}\ s^{0.5}}$ (6-10)

Rectangular: $T = \frac{Qn}{1.486\ y^{1.667}\ s^{0.5}}$ (6-11)

(Also use for vegetative filter strips.)

For trapezoidal and V-shapes, select a side slope Z of at least 3.

Solve the appropriate equation for T or b. For a V-shape, check if Z = T/2y is at least 3. For a trapezoid, compute b (Step D-4a) and then top width T, where T = b + 2yZ (Step D-4b).

D-5. Compute A using the appropriate equation from Figure III-6.5 or Equation 6-2.

D-6. Compute the flow velocity at design flow rate:

$$V = \frac{Q}{A} \quad (6\text{-}12)$$

This velocity should be less than 1.5 ft/s, a velocity that was found to permit the sedimentation of most particles in typical urban runoff (see (2)). However, the smallest particles (clay and much of the silt fraction) may not be removed. Also, it is not known what velocity will cause grasses to be knocked from a vertical position, thus reducing filtration. Therefore, the velocity should be as low as space allows.

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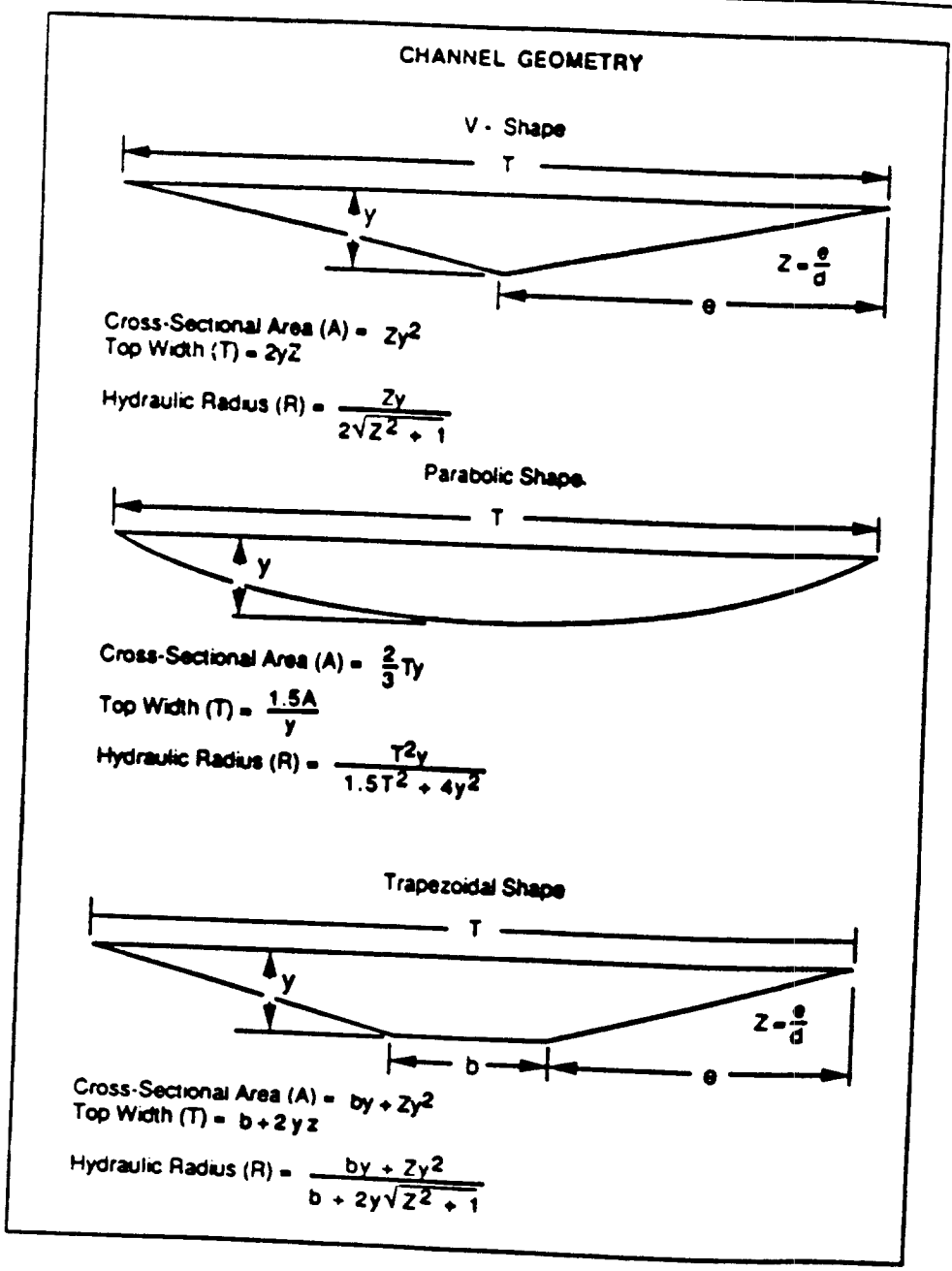

Figure III-6.5 Geometric Formula for Common Swale Shapes (from Livingston et al., 1984).

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If V > 1.5, repeat steps D-1 to D-6 until the condition is met.

D-7. This approximate analysis tends to produce a design that results in V < 1.5, often by a substantial margin. This situation is preferred if sufficient space is available. If that is the case, proceed to the stability check. IF NOT, perform a more exact analysis according to steps D-8 to D-15, otherwise go to Step D-16.

D-8. Estimate the degree of retardance to flow created by the selected vegetation from Table III-6.2. When uncertain, be conservative by selecting a relatively high degree.

Table III-6-2. Guide for Selecting Degree of Retardance (a).

Coverage	Average Grass Height (inches)	Degree of Retardance
Good	2-6	D. Low
	<2	E. Very low
Fair	2-6	D. Low
	<2	E. Very low

a. After Chow (4). In addition, Chow recommended selection of retardance D for a grass-legume mixture 4-5 inches high. No retardance recommendations have appeared for emergent wetland species. Therefore, judgment must be used. Since these species generally grow less densely than grasses, using a "fair" coverage would be a reasonable approach.

D-9. Refer to Figure III-6.6 and use the selected degree of retardance and Manning's n from step D-2 to obtain a first approximation of VR, the product of velocity and hydraulic radius.

D-10. Compute hydraulic radius, using V_{max} = 1.5 ft/s:

$$R = \frac{VR}{V_{max}} \qquad (6\text{-}13)$$

D-11. Use Manning's equation to solve for the actual VR associated with this R and n:

$$VR = \frac{1.486}{n} R^{1.667} s^{0.5} \qquad (6\text{-}14)$$

where VR is in units of ft^2/sec

D-12. Compare the actual VR from step D-11 and the first approximation of VR from step D-9. If they do not agree within 5 percent, select a new n and repeat steps D-9 to D-12 until acceptable agreement is reached.

D-13. Compute the actual V for the final design conditions (using the actual VR calculated in Step D-11):

$$V = \frac{VR}{R} \qquad (6\text{-}15)$$

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Check to be sure V <1.5 ft/s.

D-14. Use the continuity equation to calculate the flow cross-sectional area (A):

$$A = \frac{Q}{V} \qquad (6\text{-}16)$$

D-15. Use the appropriate equation in Figure III-6.5 or Equation 6-2 to compute T or b. For trapezoidal and V-shapes, use a Z of at least 3, and for trapezoids use T = b+2yZ.

D-16. If there is still not sufficient space for the biofilter, the local government and the project proponent should consider the following solutions (listed in order of preference):

a. Divide the site drainage to flow to multiple biofilters.

b. Use infiltration to provide lower discharge rates to the biofilter (only if the criteria and General Limitations in Chapter III-3 are met).

c. Increase vegetation height and design depth of flow (note: the design must ensure that vegetation remains standing during design flow).

d. Reduce the developed surface area to gain space for biofiltration.

e. Increase the longitudinal slope.

f. Increase the side slopes.

Proceed to the stability check.

Check for Stability (Minimizing Erosion)

Notes:

(1) The stability check must be performed for the combination of highest expected flow and least vegetation coverage and height.

(2) Maintain the same units as in the biofiltration capacity analysis.

Stability Check Steps (SC)

(Note: Not required for biofiltration BMPs which are located "off-line" from the primary conveyance/detention system, i.e., when flows in excess of the peak flow for the 6-month, 24-hour design storm bypass the biofilter. This is the desired configuration.)

Step #

SC-1. Unless runoff from events larger than the 6-month, 24-hour storm will bypass the biofilter, perform the stability check for the 100-year, 24-hour storm. Estimate Q for that event as recommended in Preliminary step P-1.

SC-2. Estimate the vegetation coverage ("good" or "fair") and height on the first occasion that the biofilter will receive flow, or whenever the coverage and height will be least. Attempt to avoid flow introduction during the vegetation establishment period by timing of planting or bypassing.

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SC-3. Estimate the degree of retardance from Table III-6.2. When uncertain, be conservative by selecting a relatively low degree.

SC-4. Establish the maximum permissible velocity for erosion prevention (V_{max}) from Table III-6.3.

Table III-6.3
Guide for Selecting Maximum Permissible
Swale Velocities for Stability Check (a)

Cover	Slope (%)	Maximum Velocity (ft/sec)
Kentucky Bluegrass Tall Fescue	0 - 5	5
Kentucky Bluegrass Tall Fescue Western Wheatgrass	5 - 10	4
Grass-legume Mixture	0 - 5 5 - 10	4 3
Red Fescue Redtop	0 - 5 5 - 10	2.5 Not Recommended

(a) Adapted from references 3, 4, and 6.

SC-5. Select a trial Manning's n. The minimum value for poor vegetation cover and low height (possibly, knocked from the vertical by high flow) is 0.033. A good initial choice under these conditions is 0.04.

SC-6. Refer to Figure III-6.6 to obtain a first approximation for VR.

SC-7. Compute hydraulic radius, using the Vmax from step SC-4:

$$R = \frac{VR}{V_{max}} \qquad (6\text{-}13)$$

SC-8. Use Manning's equation to solve for the actual VR:

$$VR = \frac{1.486}{n} R^{1.667} s^{0.5} \qquad (6\text{-}14)$$

SC-9. Compare the actual VR from step SC-8 and first approximation from step SC-6. If they do not agree within 5 percent, repeat steps SC-5 to SC-9 until acceptable agreement is reached.

SC-10. Compute the actual V for the final design conditions:

$$V = \frac{VR}{R} \qquad (6\text{-}15)$$

Check to be sure $V < V_{max}$ from step SC-4.

SC-11. Compute the required A for stability:

$$A = \frac{Q}{V} \qquad (6\text{-}16)$$

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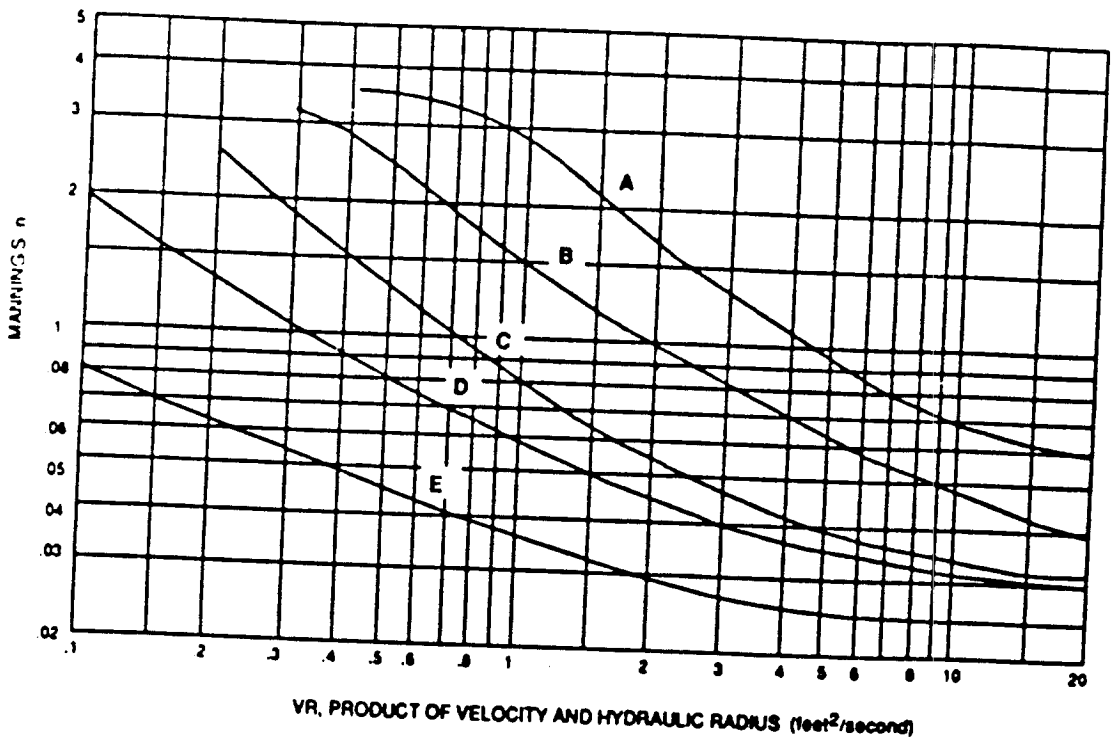
Figure III-6.6
The Relationship of Manning's n with VR for Various Degrees of Flow Retardance (from Livingston et al., 1984, after U.S. Soil Conservation Service, 1954)



SC-12. Compare the A computed in step SC-11 of the stability analysis with the A from the biofiltration capacity analysis (step D-5 or D-14).

If less area is required for stability than is provided for capacity, the capacity design is acceptable. If not, use A from step SC-11 of the stability analysis and recalculate channel dimensions (refer to Figure III-6.5 or Equation 6-2). Use y from Step D-1.

SC-13. Calculate the depth of flow at the stability check design flow rate condition for the final dimensions (refer to Figure III-6.5 or Equation 6-2). (For trapezoids use $y = (T-b)/2Z$)

SC-14. Compare the depth from step SC-13 to the depth used in the biofiltration capacity design (Step D-1). Use the larger of the two and add 1 foot freeboard to obtain the total depth (y_t) of the swale. Skip this step in filter strip design. (Editor's Note: If space is limited, calculate the depth needed for the 100-year, 24-hour storm then add thie depth again for freeboard, up to a maximum freeboard of 1 foot.)

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SC-15. Recalculate the hydraulic radius (trapezoidal channel - see Figure III-6.5):

$$R = \frac{by_t + zy_t^2}{b + 2y_t(z^2 + 1)^{0.5}}$$

(use b from Step D-4 or D-15 calculated previously for biofiltration capacity, or Step SC-12, as appropriate, and y_t = total depth from Step SC-14)

SC-16. Make a final check for capacity based on the stability check design storm and maximum vegetation height and cover (this check will ensure that capacity is adequate if the largest expected event coincides with the greatest retardance). Use Equation 6-1, a Manning's n of 0.1, and the calculated channel dimensions, including freeboard, to compute the flow capacity of the channel under these conditions. Use R from step SC-15, above, and $A = by_t + zy_t^2$ using b from Step D-4a, or D-15 or SC-12, as appropriate.

If the flow capacity is less than the stability check design storm flow rate, increase the channel cross-sectional area as needed for this conveyance. Specify the new channel dimensions.

Completion Steps (CO)

Step #

CO-1. If the biofilter is a swale, lay out the swale to obtain the maximum possible length. This length should be at least 200 feet. In limited spaces, attempt to attain that length by using a curved path. Use the widest radius bends possible to reduce the potential for erosion of the outside of curved sections. If a length shorter than 200 ft. must be used, increase A by an amount proportional to the reduction in length below 200 ft., in order to obtain the same water residence time. Recalculate channel dimensions from Figure III-6.5 or Equation 6-2.

If the swale is a vegetative filter strip, select a length for the calculated width that produces at least 20 minutes water residence time (normally 100-200 feet).

CO-2. If the swale longitudinal slope is greater than 4 percent, design log or rock check dams approximately every 50 feet.

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APPENDIX AIII-6.2
EXAMPLE PROBLEM SHOWING APPLICATION OF DESIGN PROCEDURE FOR BIOFILTRATION SWALES AND VEGETATIVE FILTER STRIPS

Preliminary Steps

P-1. Assume that Q for the 6-month, 24-hour storm was established by one of the recommended procedures to be 3 cfs.

P-2. Assume the slope (s) is 2 percent.

P-3. Assume the vegetation will be a grass-legume mixture, with the dominant grass being red fescue.

Design for Swale Biofiltration Capacity

D-1. Set the winter grass height at 6 inches and design flow depth (y) at 4 inches (i.e. 0.33 feet) (Eq. 6-9). Recall that the design flow must be at least two inches less than the winter grass height.

D-2. Use n = 0.07

D-3. Base the design on a trapezoidal shape, with side slope (Z) equal to 3.

D-4a. Calculate the bottom width (b)

Where: n = 0.07

Q = 3 cfs
y = 0.33'
s = 0.02
Z = 3

$$b = Qn/(1.486y^{1.667}s^{0.5}) - Zy \qquad (6\text{-}9)$$

or

b = 5.24 feet

D-4b. Calculate the top width (T)

$$T = b + 2yZ = 5.24 + [2(0.33)(3)] = 7.24 \text{ feet}$$

D-5. Calculate the cross-sectional area (A)

$$A = by + Zy^2 = (5.24)(0.33) + (3)(0.33^2) = 2.06 \text{ ft}^2$$

(from Fig. III-6.5)

D-6. Calculate the flow velocity (V)

$$V = Q/A = \frac{3}{2.06} = 1.46 \text{ ft/s} < 1.5, \text{ so OK} \qquad (6\text{-}12)$$

Proceed directly to stability check.

A top width of 6 to 10 feet is typical of many swales surveyed in the area, and should fit within most sites. For the example, assume that it does so. The calculation procedure of steps SC-8 through 15 will be demonstrated in the stability check.

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Check for Channel Stability

SC-1. Base the check on passing the 100-year, 24-hour storm runoff flow through the swale. Assume that Q for that storm was established by one of the recommended procedures to be 16 cfs.

SC-2. Base the check on a grass height of 3 inches with "fair" coverage (lowest mowed height and least cover, assuming flow bypasses or does not occur during grass establishment).

SC-3. Table III-6.2: Degree of retardance = D (low)

SC-4. From Table III-6.3, set V_{max} = 3 ft/sec since the vegetation is a combination of red fescue (V_{max} = 2.5 ft/sec) and legumes (V_{max} = 4 ft/sec).

SC-5. Select trial Manning's n = 0.04

SC-6. Figure III-6.6 VR = 3 ft^2/s

SC-7. Eq. 6-13 $R = \frac{VR}{V_{max}}$

$R = 1.0$ ft

SC-8. Eq. 6-14 $VR = \frac{1.486}{n} R^{1.667} s^{0.5}$

$VR = 5.25$ ft^2/sec

SC-9. VR from step SC-8 <VR from step SC-6 by > 5%.

Select new trial n = 0.047

from Figure III-6.6 VR = 1.7 ft^2/s

Eq. 6-13 R = 0.57 ft.

Eq. 6-14 VR = 1.75 ft^2/s (within 5% of VR = 1.7)

SC-10. Eq. 6-15 $V = VR/R = 1.75/0.57$

$V = 3.07$ ft/s <5 ft/s (OK)

SC-11. Eq. 6-16 $A = Q/V = 16/3.07 = 5.21$ ft^2

SC-12. For stability check, A = 5.21 ft^2 from Step SC-11, which is greater than the capacity from Step D-5 (2.06 ft^2). Therefore, recalculate channel dimensions using A from Step SC-11 and referring to Figure III-6.5.

$A = by + zy^2$

where: A = 5.21 ft^2
z = 3
y = ?
b = ?

(Note: both depth and width dimensions can be varied to obtain needed value of A, which is 5.21 ft^2 in this example.)

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For this example, choose y = 0.67 ft. (note that y was originally set at 0.33 ft. in Step D-1) then calculate value for b.

For y = 0.67 ft., b = 5.81 ft.
T = b + 2yZ = 9.81 ft.

SC-13. Calculate depth of flow at the stability design flow rate condition.

For trapezoids use y = (T-b)/2Z from Figure III-6.5, and b = 5.81 ft and T = 9.8 ft from Step SC-12.

y = (9.81 - 5.81)/6 = 0.67 ft.

SC-14. The value for y calculated in SC-13 (0.67 ft.) is greater than that used in Step D-1. Use the greater value, and add 1 foot freeboard to give a total depth (y_t) of 1.67 feet.

SC-15. Recalculate hydraulic radius (R) where

b = 5.81 ft (from Step SC-12)
y_t = 1.67 ft (from Step SC-14)
Z = 3 (from Step D-3)

$$R = \frac{by_t + Zy_t^2}{b + 2y_t\,(Z^2 + 1)^{0.5}} = 1.1 \text{ feet}$$

SC-16. Recalculate Q where:

$$Q = \frac{1.486}{n} AR^{0.667} s^{0.5} \qquad \text{(Eq. 6-1)}$$

where: n = 0.07
A = $by_t + Zy_t^2$, using b from Step SC-12
R = 1.1 feet (from Step SC-15)
s = 0.02 (from Step P-2)

$$A = (5.81)(1.67) + (3)(1.67^2) = 18.1 \text{ ft}^2$$

$$Q = \frac{1.486}{0.07}(18.1)(1.1)^{0.667}(0.02)^{0.5} = 57.9 \text{ cfs}$$

This is > 16 cfs for 100-year, 24-hour storm if it coincides with maximum flow retardance. Therefore, channel dimensions are okay.

Completion Steps

CO-1 Assume 200 feet of swale length is available. The final channel dimensions are:

Bottom width = 5.81 feet
Depth = 1.67 feet
Top width = b + 2yZ = 15.8 feet

CO-2 No check dams are needed for a 2% slope.

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CHAPTER III-7

OIL/WATER SEPARATORS

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CHAPTER III-7

OIL/WATER SEPARATORS

III-7.1 OVERVIEW

Oil/Water Separators have limited application in stormwater treatment because their treatment mechanisms are not well-suited to the "wastewater" characteristics of stormwater runoff (i.e., highly variable flow with high discharge rates, turbulent flow regime, low oil concentration, high suspended solids concentration). In addition, separators can require intensive maintenance, further restricting their desirability as a stormwater treatment BMP. The primary use of oil/water separators will be in cases where oil spills are a concern, in which case a spill control (SC-type) separator may be specified. There will be but a few other cases where an oil/water separator would be required, as other BMPs are more appropriate for controlling oil. Source control in particular should be the first option and may negate the need for special treatment. Other than to capture spills, the use of oil/water separators will be restricted to development sites that have high oil and grease loadings, such as petroleum storage yards and vehicle storage and/or maintenance facilities (see Chapters I-4 and IV-2 for land uses which require oil/water separators). There may be some cases that warrant the use of oil/water separators due to high vehicular traffic. These will have to be assessed on a case-by-case basis by the local government.

Sand filtration and oil absorbent materials are being investigated as alternatives to oil/water separators . While there is very limited data on the effectiveness of sand filtration for treating oil, this practice does have an established record of treatment of other pollutants and effective treatment of oil may also be accomplished. Sand filtration is to be considered an alternative to oil/water separators on an interim basis until further data is collected. See Chapter III-3 for details on sand filtration BMPs.

Absorbent materials are another alternative whose use has been pioneered by METRO in King County. Widely used for controlling spills, these "pillows" have been installed in storm drain inlets as a mechanism to absorb free oil from surface water runoff. Limited data is available to assess their effectiveness and some operational problems have occurred. The disposal of these pillows once they are exhausted can be a problem as well.

Three types of oil/water separators are discussed in this chapter:

BMP RO.05	Spill Control (SC-type) Separator
BMP RO.10	API Separator
BMP RO.15	Coalescing Plate Separator (CPS)

See Figures III-7.1, III-7.2, and III-7.3 for illustrations of these BMPs.

Because separators are usually manufactured units rather than constructed units, only limited details will be provided in this chapter. If oil/water separators are to be used, then an appropriate manufacturer or supplier should be contacted.

For a useful discussion of oil treatment of stormwater runoff the reader is referred to the publication "Oil and Water Don't Mix: The Application of Oil-Water Separation Technologies in Stormwater Quality Management" (METRO, October, 1990).

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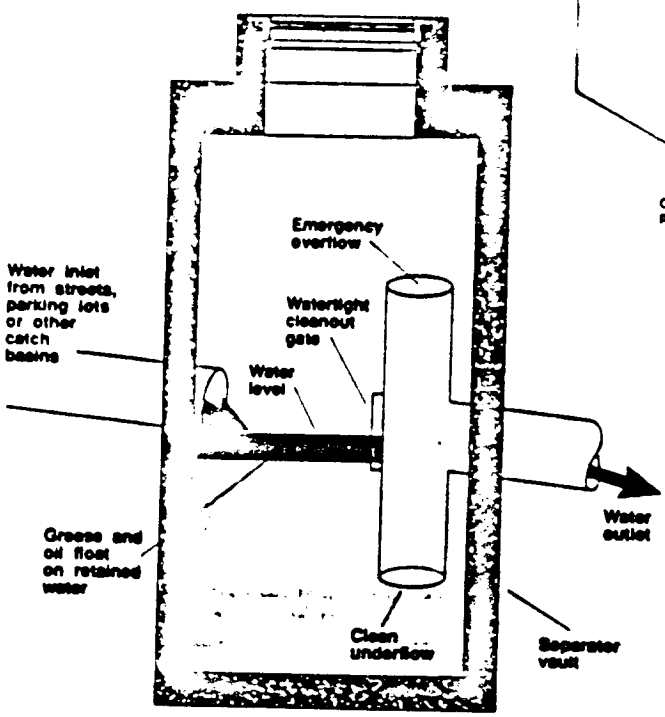

Figure III-7.1
SC-Type Separator

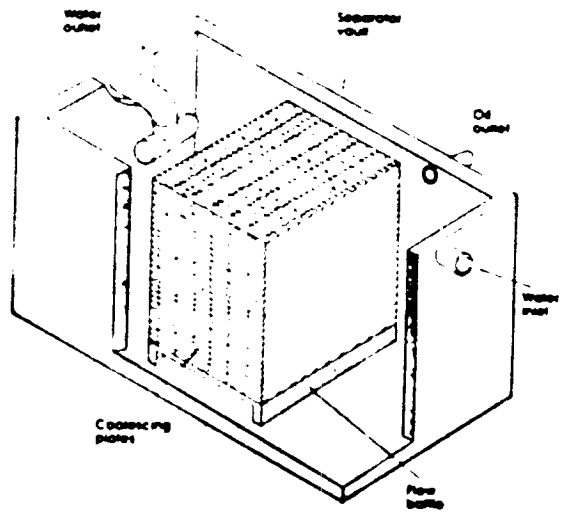

Figure III-7.3
CPS Separator

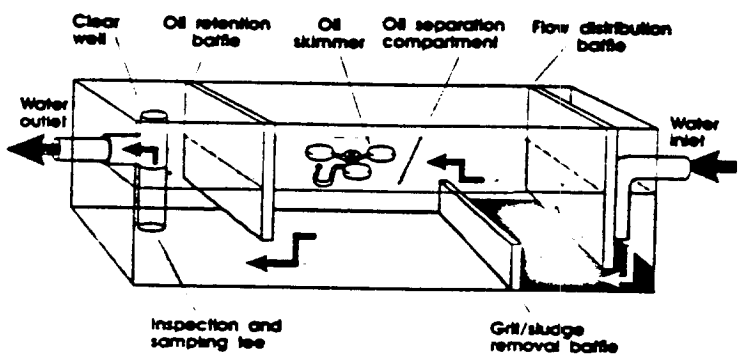

Figure III-7.2
API Separator

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III-7.2 PLANNING CONSIDERATIONS AND GENERAL DESIGN CRITERIA

If an oil/water separator is used primarily for treatment (and not spill control), it should be located off-line from the primary conveyance/detention system. The contributing drainage area should be completely impervious and as small as necessary to contain the sources of oil. Non-source contributing areas only increase the size (and cost) of the separator and do not improve effectiveness. Under no circumstances should any portion of the contributing drainage area contain disturbed pervious areas which can be sources of sediment.

Description There are three general types of separators. The first type is the spill control separator (SC). It is a simple underground vault or manhole with a "T" outlet (Figure III-7.1). The SC-separator is effective at retaining only small spills. The SC-separator will not remove diluted oil droplets spread through the stormwater from oil-contaminated pavement.

The other two types of separators can remove dispersed oil: the American Petroleum Institute (API) separator (Figure III-7.2) and coalescing plate separator (CPS - Figure III-7.3).

The API-separator is a long vault or basin with baffles to improve the hydraulic conditions for treatment. Large API-separators may have sophisticated mechanical equipment for removing oil from the surface and settled solids from the bottom. However, most applications will use the simple system as illustrated.

The CPS-separator contains a bundle of plates made of fiberglass or polypropylene. The plates are closely spaced. Depending on the manufacturer and/or application, the plates may be positioned in the bundle at an angle of 45 to 60° from the horizontal.

The closely spaced plates improve the hydraulic conditions in the CPS-separator promoting oil removal. The primary advantage of the CPS-separator is its ability to theoretically achieve equal removal efficiencies with one-fifth to one-half the space needed by the API separator, when designed to remove the same size droplets.

Type of Separator Required

Land uses that must use an API or CPS-separator are identified in Chapter I-4 and in Chapter IV-2. The owner may choose between the API or CPS-separator using the design criteria outlined below. Other land uses or businesses should use the SC-separator for spill control as needed.

Effluent Guideline

Ecology requires that stormwater have no visible sheen, average less than 10 mg/l daily and at no time exceed a daily maximum of 15 mg/l.

Design Criteria

Requirements regardless of separator type

1. Separators should precede all other treatment and streambank erosion control BMPs.

2. Appropriate removal covers must be provided that allow access for observation and maintenance.

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3. Stormwater from building rooftops and other impervious surfaces not likely to be contaminated by oil shall not discharge to the separator.

4. Any pump mechanism shall be installed downstream of the separator to prevent oil emulsification.

Additional requirements for API and CPS-separators

1. Separators are to be sized for the 6-month, 24-hour design storm. Larger storms shall not be allowed to enter the separator; the use of an isolation/diversion structure is recommended (see Chapter III-3 for details).

2. Separators shall have a forebay to collect floatables and the larger settleable solids. Its surface area shall not be less than 20 square feet (ft^2) per 10,000 ft^2 of the area draining to the separator.

Additional requirements for CPS-separators

1. Plates shall not be less than 3/4 inch apart.

2. The angle of the plates shall be from 45° to 60° from the horizontal.

Absorbent pillows may be used in separators. For API and CPS-type separators they should be placed in an afterbay. With the SC-separator, absorbent materials should be placed in the manhole/vault. Used absorbent pillows will need to be properly disposed of.

Sizing Procedure

Oil droplets exist in water in a wide distribution of sizes. The separator therefore is sized to remove all droplets of particular size and greater which will ensure that sufficient oil is removed to achieve the effluent standard.

API-separators are usually sized to remove oil droplets 150 micron in size and larger. Smaller droplets rise so slowly as to require a relatively large vault. CPS-separators are commonly sized to remove 60 or 90 micron and larger oil droplets.

There are no data on the size distribution of dispersed oil in stormwater from commercial or industrial land uses with the exception of petroleum products storage terminals. These data indicate that by volume, about 80 percent of the droplets are greater than 90 micron. Less than 30 percent are greater than 150 microns. For this manual both the API and CPS-separator are sized to remove 60 microns and larger droplets at a temperature of 10°C giving a rise rate of 0.033 feet per minute. The requirement for treatment of 60 micron and larger sized droplets may preclude the use of API separators.

API-Separator Sizing

API-separators are sized using these general guidelines.

- Horizontal velocity: 3 fpm or 15 times the rise rate whichever is smaller (rise rate of 0.033 ft/min is recommended)
- Depth of 3 to 8 feet
- Depth to width ratio of 0.3 to 0.5
- Width of 6 to 16 feet

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- Baffle height to depth ratios of 0.85 for top baffles and 0.15 for bottom baffles

The separator is first sized for depth using the equation:

$$\text{Depth} = (Q/2V_h)^{1/2}$$

where: Q = design flow (cfm)

V_h = design horizontal velocity (fpm) = 0.50 (15 times 0.033)

Calculate the width using the above ratios (i.e., 0.3 to 0.5 depth-to-width ratio).

Then calculate length using the equation:

$$\text{Length} = \frac{\text{Depth}}{\text{Rise Rate}} * V_h = \frac{(Q/2V_h)^{1/2}}{0.033} * 0.50 = \frac{(Q/2V_h)^{1/2}}{0.066}$$

CPS-Separator Sizing

Calculate the projected (horizontal) surface area of plates required using the following equation:

$$A_p = \frac{Q}{\text{Rise Rate}}$$

Where A_p = projected surface area of the plate ($ft.^2$); note that the actual surface area, $A_a = A_p *$ cosine H

H = angle of the plates with the horizontal in degrees, usually varies from 45-60 degrees.

Q = design flow (cfm).

Rise rate - recommend using 0.033 ft/min.

Manufacturers of plate packs provide standard size packages which are rated at a particular flow (usually in gpm). However, as the manufacturer's flow rating is for conditions different than used above, the engineer must compare the plate surface area with the above calculation. Do not confuse the projected plate area with actual plate area (see Figure III-7.4).

The width, depth, and length of the plate pack and the chamber in which the plate pack is placed is completely flexible and is a function of the plate sizes provided by the particular pack manufacturer and standard size vaults that are available for small sites.

III-7.3 CONSTRUCTION AND MAINTENANCE

Construction Specifications

There are no special construction considerations.

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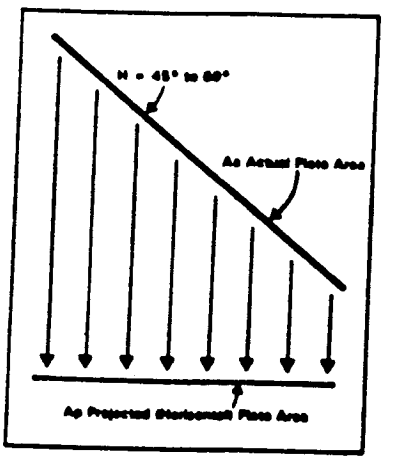
Figure III-7.4 Cross-Section of CPS Oil/Water Separator



Maintenance

Oil/water separators must be cleaned frequently to keep accumulated oil from escaping during storms. They must always be cleaned by October 15 to remove material that has accumulated during the dry season, and again after a significant storm. In addition:

1. The facility shall be inspected weekly by the owner.
2. Oil absorbent pads are to be replaced as needed but shall always be replaced in the fall prior to the wet season and in the spring.
3. The effluent shutoff valve is to be closed during cleaning operations.
4. Waste oil and residuals shall be disposed in accordance with current local government Health Department requirements.
5. Any standing water removed during the maintenance operation must be disposed to a sanitary sewer at a discharge location approved by the local government.
6. Any standing water removed shall be replaced with clean water to prevent oil carry-over through the outlet weir or orifice.

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CHAPTER III-8

STREAMSIDE STABILIZATION

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CHAPTER III-8

STREAMSIDE STABILIZATION

III-8.1 OVERVIEW

The streamside stabilization BMPs presented in Volume II for erosion and sediment control can also be considered as permanent BMPs that can be used to meet Minimum Requirement #5, "Streambank Erosion Control." Streambanks which have existing erosion problems will likely need to apply these techniques along with techniques described in Chapters III-3 and III-4 to control peak flow rates.

Three streamside stabilization BMPs are presented in this chapter; they are identical to those in Chapter II-5 and so noted in parentheses:

BMP RS.05 Vegetative Streambank Stabilization (BMP E2.80)
BMP RS.10 Bioengineering Methods of Streambank Stabilization (BMP E2.85)
BMP RS.15 Structural Streambank Stabilization (BMP E2.90)

Note that any of these methods may be adapted for use with unstable slopes; see BMP E2.45 in Chapter II-5.

A primary cause of stream channel erosion is the increased frequency of bank-full flows which results from upstream development. Most natural stream channels are formed with a bank-full capacity to pass the runoff from a storm with a 1.5 to 2-year recurrence interval. However, in a typical urbanizing watershed, stream channels may become subject to a 3 to 5-fold increase in the frequency of bank-full flows if stormwater runoff is not properly managed. As a result, stream channels that were once parabolic in shape and covered with vegetation may be transformed into wide rectangular channels with barren banks.

In recent years, a number of structural measures have evolved to strengthen and protect the banks of rivers and streams. These methods, when employed correctly, immediately ensure satisfactory protection of the banks. However, many such structures are expensive to build and to maintain. Without constant upkeep, they are exposed to progressive deterioration by natural agents. The materials used often prevent the reestablishment of native plants and animals, especially when the design is executed according to standard cross-sections which ignore natural variations of the stream system. Very often these structural measures destroy the appearance of the site. Additionally, structural stabilization and channelization can alter the hydrodynamics of a stream and only serve to transfer erosion potential and associated problems downstream.

In contrast, the utilization of living plants instead of or in conjunction with structures has many advantages. The degree of protection, which may be low to start with, increases as the plants grow and spread. The repair and maintenance of structures is minimal where self-maintaining streambank plants are established. The protection provided by natural vegetation is more reliable and effective when the cover consists of natural plant communities adapted to their site. However, care must still be taken not to alter the hydrodynamics of the stream.

In summary, vegetative stabilization techniques are strongly preferred over structural techniques. If streamside stabilization is required then the first priority shall be either BMP RS.05, Vegetative Streambank Stabilization, or BMP RS.10, Bioengineering Methods of Streambank Stabilization.

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III-8.2 BMP RS.05: VEGETATIVE STREAMBANK STABILIZATION

Definition and Purpose: Vegetative streambank stabilization is the use of vegetation as building material to stabilize streambanks against erosion and restore landscapes. This BMP is applicable to water areas and all land uses. It is to be used to stabilize banks in swales, creeks, streams, and rivers as well as man-made ditches, canals and impoundments, including ponds and storage basins.

See BMP E2.80 in Chapter II-5 for planning consideration, design criteria, construction and maintenance criteria, and other relevant information.

III-8.3 BMP RS.10: BIOENGINEERING METHODS OF STREAMBANK STABILIZATION

Definition and Purpose: Bioengineering methods combine vegetative and mechanical techniques to stabilize eroding streams. They provide protection of critical sections of streambank where ordinary vegetative means of protection are not feasible or offer insufficient protection. This BMP is to be used in streams with swift flow where the flow/soil conditions exceed the stabilizing effect of purely vegetative channel protection.

See BMP E2.85 in Chapter II-5 for planning consideration, design criteria, construction and maintenance criteria, and other relevant information.

III-8.4 BMP RS.15: STRUCTURAL STREAMBANK STABILIZATION

Definition and Purpose: Structural streambank stabilization methods utilize non-vegetative means to stabilize banks and streams. They do not provide the multiple benefits of other streamside stabilization BMPs and are to be used only when the erosive forces of moving water are such that vegetative or bioengineered methods are insufficient or infeasible.

See BMP E2.90 in Chapter II-5 for planning consideration, design criteria, construction and maintenance criteria, and other relevant information.

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(The Technical Manual)

Volume IV - Urban Land Use BMPs



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CHAPTER IV-1 INTRODUCTION

IV-1.1 STORMWATER POLLUTANTS AND THEIR EFFECTS

To appreciate the need for Best Management Practices to minimize pollution of urban stormwater runoff we begin with an overview of the types of pollutants commonly found in this runoff.

- Oil and grease: Concentrations in stormwater from commercial and industrial areas often exceed the Washington Department of Ecology (Ecology) guideline of 10 mg/l.

- Nutrients: Phosphorus and nitrogen can cause excessive or accelerated growth of aquatic vegetation. Such growth can significantly affect lakes and may also be of concern in Puget Sound.

- Oxygen demanding organics: Natural organic materials washed from paved surfaces are consumed by bacteria present in receiving waters. Oxygen may be depleted in the process, threatening higher organisms such as fish.

- Toxic organics: A recent study (4) found 19 of the U.S. Environmental Protection Agency's 121 priority pollutants present in the runoff from Seattle streets. The most frequently detected pollutants were pesticides, phenols, and polynuclear aromatic hydrocarbons (PAHs).

- Metals: Stormwater contains metals such as lead, zinc, cadmium, and copper at concentrations that often exceed water quality criteria.

Research in Puget Sound has found that metals and toxic organics concentrate in sediments and at the water surface (microlayer) where they interfere with the reproductive cycle of many biotic species as well as cause tumors and lesions in fish.

- Bacteria and viruses: Research has shown that stormwater contains disease-causing bacteria and viruses, although not at concentrations found in sanitary sewage. Shellfish along Puget Sound near urban areas are usually unsafe for consumption.

- Eroded soil: Erosion of soil during construction carries soil particles into streams. These sediments destroy the desired habitat conditions for fish. The sediment may be carried to lakes or Puget Sound where they may be toxic to marine life and make dredging necessary.

IV-1.2 TYPICAL POLLUTANT CONCENTRATIONS

Research in Western Washington has shown that the concentrations of pollutants in stormwater from residential, commercial, and industrial areas exceed Ecology's water quality standards and guidelines. Examples are shown in Table IV-1.1. Although little data exist for specific land uses such as shopping centers, it is expected that research would produce similar results.

IV-1.3 WHAT ARE BMPs?

In its long range plan, the Puget Sound Water Quality Authority has stormwater control as one of 12 key action programs. Their control strategy is to emphasize the use of Best Management Practices.

Best Management Practices (BMPs) are defined as physical, structural, and/or managerial practices, that when used singly or in combination, prevent or reduce pollution of water and have been approved by Ecology.

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Table IV-1.1 Comparison of Typical Stormwater Pollutant Concentrations to Water Quality Criteria[A]

Pollutant	CONCENTRATIONS (ug/l or ppb) Commercial[B]	Industrial	Residential	Highway	Particulate Fraction[C]	ECOLOGY/USEPA STANDARD[D] Freshwater Acute	Freshwater Chronic	Saltwater Acute	Saltwater Chronic
Cadmium	5	5	<3	<10	60	0.6	0.32	43.0	9.3
Copper	245	105	20	100	60	3.9	3.0	2.9	2.9
Lead	380	245	210	1780	90	10.5	0.41	140.0	5.6
Zinc	275	275	120	400	60	30.0	27.0	95.0	86.0
Oil/Grease	15	--	--	--	--	10.[E]	--	--	--
Fecal Coliform	980 orgs./ 100 mls	--	--	--	--	50orgs./100mls[F]		--	--

(A) See Chapter IV-5 for data sources.

(B) Geometric mean values for commercial areas; concentrations of individual samples often exceed the mean by a factor of 5 to 10.

(C) Particulate fraction values apply to concentration data for commercial and industrial land uses only.

(D) Acute criteria for freshwater at a hardness of 20 ppm.

(E) Ecology effluent guideline (mg/l); all other values are receiving water standards.

(F) Ecology criteria for class AA waters.

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BMPs may be placed into two general groups: source control BMPs and runoff treatment BMPs. The former group includes those BMPs which keep a pollutant from ever coming in contact with stormwater; the latter group consists of various methods of treating stormwater.

Source control BMPs are preferred as they are generally less expensive and frequently are very effective in eliminating the source of pollution prior to its entry into runoff.

IV-1.4 BMP STRATEGIES AND PREFERENCES

There are many types of BMPs, and some general strategies, listed below in order of preference:

Alter the activity: The preferred option is to alter any practice that may contaminate surface water or ground water by either not producing the pollutant to begin with or by controlling it in such a way as to keep it out of the environment. An example would be recycling used oil rather than dumping it down a storm drain.

Illicit or unintentional connection of indoor drains to the storm drain, rather than to the sanitary or process sewer is a significant source of stormwater contamination. Research and local experience have demonstrated the importance of identifying and correcting these connections.

Enclose the activity: If the practice cannot be altered, it should be enclosed in a building. Enclosure accomplishes two things. It keeps rain from coming into contact with the activity, and since drains inside a building must discharge to sanitary or process wastewater sewers or a dead-end sump, any contamination of runoff is avoided.

Cover the activity: Placing the activity inside a building may be infeasible or prohibitively expensive. A less expensive structure with only a roof may be effective although it may not keep out all precipitation. Internal drains must be connected to the sanitary sewer to collect water used to wash down the area as well as any rain that may enter along the perimeter.

Segregate the activity: Segregating an activity that is the most significant source of pollutants from other activities that cause little or no pollution may lower the cost of enclosure or covering to a reasonable level.

If the segregated activity cannot be covered, it may be possible in certain situations to connect the area to the public sanitary sewer subject to the approval of the local Sewer Authority. Or, drains may be connected to a business' own process wastewater system if the business operates independently of the local authority.

Discharge stormwater to the process wastewater treatment system: Many industries have their own process wastewater treatment system with final disposal directly to the receiving water. Here, stormwater from areas of significant pollution sources can be plumbed to the process treatment system as long as its capacity is not exceeded.

Discharge small, high frequency storms to public sanitary sewer: This BMP would be limited to those few outside activities that contribute unusually high concentrations of pollutants and/or pollutants of unusual concern. Limited entry of these few special cases may not overtax the public sanitary sewer. It is important, however, to first have the approval of the local Sewer Authority.

The entry of stormwater to the sanitary or combined sewer can be limited to the small high-frequency storms that carry off the majority of pollutants over time. Storm flows in excess of the hydraulic capacity of the sanitary or combined sewer would be discharged to the storm drain.

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Discharge small, high frequency storms to a dead-end sump: This BMP would be limited to those few activities which contribute unusually high concentrations of pollutants and/or pollutants of unusual concern. This option would be used when discharge into a sanitary sewer or process wastewater treatment is not available or feasible. This option requires the capability to have the sump pumped out regularly and the pumpage disposed of in an appropriate manner.

Treat the stormwater with a stormwater treatment BMP: The treatment of stormwater is the least-preferred option for several reasons. As noted previously, source control BMPs keep the pollutants completely away from stormwater. In contrast, stormwater treatment devices are not 100% effective. Note from Table IV-1.1 that even if a stormwater treatment system is 75 percent effective, freshwater criteria may still not be met for commercial areas. In addition, inadequate maintenance can reduce a system's expected efficiency.

IV-1.5 THE IMPORTANCE OF EFFECTIVE MAINTENANCE

BMPs require regular attention to ensure their effectiveness. For example, containers for Dangerous Wastes must be kept closed if they are stored outside. Allowing the entry of rain to an open container may cause the overflow of its contents to nearby street drains.

Stormwater treatment devices such as oil/water separators must be cleaned frequently. Unfortunately, due to lack of experience or oversight by the owner, inadequately maintained facilities are common.

King County has found that public and private storm drainage control systems must be inspected by the public authority at least annually to insure proper maintenance.

IV-1.6 THE REQUIREMENTS OF OTHER REGULATORY AGENCIES

It has been noted above that the local Sewer Authority has the responsibility to control all discharges to sanitary and combined sewers. It is one of several regulatory agencies or departments whose requirements must be taken into consideration when implementing Volume IV.

The requirements of agencies or departments of local government are introduced here, indicating their relationship to the possible actions to control stormwater pollution, with more detail presented in Chapter IV-5.

Public sanitary or combined sewers - local Sewer Authority: Drains located inside a building or covered area must connect to the public sanitary or combined sewer, except for businesses that discharge directly to a receiving water or a dead-end sump. Any discharge to a public system must meet the discharge requirements of the local Sewer Authority.

If the discharge is non-sanitary, that is, process wastewater, the discharge must comply with the USEPA/Ecology pretreatment requirements. The pretreatment requirements specify the allowable concentrations of particular pollutants (see R.1 in Chapter IV-5).

Peak-rate drainage control - local Public Works Department: All local governments in the Puget Sound drainage basin will require that new developments install facilities to control the rate of stormwater discharge as per Minimum Requirement #3 set out in Chapter I-2. If properly designed, peak-rate control and stormwater treatment can be achieved in the same facility (see Volume III, Runoff Control).

Flammable materials - Fire Department: Any business that stores a flammable, ignitable, or reactive material must comply with the local fire code (see R.2 in Chapter IV-5).

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Dangerous wastes - Ecology: The Washington State Department of Ecology is responsible for enforcing the state regulations on Dangerous Wastes. With few exceptions, Ecology's activities in this area encompass the federal laws on hazardous wastes. This volume provides BMPs for the temporary storage of accumulated wastes until it is removed to a hazardous waste treatment and disposal site.

As described in R.3 of Chapter IV-5, the requirements and Ecology's involvement in their implementation varies with the quantity generated and the length of the temporary storage period.

Under certain circumstances relating to the quantity of waste generated and the temporary storage period, the waste generator must obtain an identification number and a storage permit. Ecology can therefore specify the appropriate BMPs and make the appropriate inspections. However, as the permit requirements are stringent, generators are motivated to move their wastes within the specified time limits.

A recent survey found that small generators frequently do not properly store or dispose of Dangerous Wastes. Although the generators must still comply with Ecology requirements, Ecology will not see to their implementation because the Department is not aware of the activity. Therefore, with this manual local government can insure that the appropriate BMPs are implemented by the small generators.

Other solid wastes - Health Department: Regulations of the local Health Department provide specifications to insure the integrity of containers. Containers failing to meet these requirements must be replaced (see R.4 in Chapter IV-5).

Liquid transfer from marine vessels - Coast Guard: A system that transfers petroleum products to or from marine vessels to shore tanks must comply with Coast Guard requirements. Transfer of other liquid chemicals is not covered by current federal or state laws (see R.5 in Chapter IV-5).

Underground storage tanks - Ecology: Underground tanks for the storage of chemicals or petroleum must comply with federal and state requirements. Some tanks are excluded from this requirement as explained in R.6 in Chapter IV-5.

Spill control and cleanup plans: Businesses and public agencies that generate Dangerous Wastes and/or produce, transport or store petroleum products are required by state and federal law to prepare spill control and cleanup plans. Other types of liquids are not covered by state or federal law (see R.7 in Chapter IV-5).

Pesticide[1] use: Vegetation management, important in such diverse activities as golf courses and roads, commonly employs pesticides that can contaminate surface and ground waters. The Washington Department of Agriculture is the primary regulator of pesticide use (see R.8 in Chapter IV-5).

Air quality - Local Air Pollution Agency: Air pollution is a source of stormwater contaminants. Several areas in the Puget Sound region do not meet air standards with regard to fugitive particulates. Air authorities require some industries to pave or treat the surface of unpaved areas, and/or sweep. The air authority also regulates painting and abrasive blasting (see R.9 in Chapter IV-5).

Some heavy industries whose air emissions contaminate stormwater may find it cost-effective to achieve water quality objectives by further reducing air emissions beyond that required by air regulations.

Waste reduction - Ecology: As part of its solid waste program, Ecology encourages and provides technical guidance to reduce the quantity of solid and liquid wastes.

[1] The term pesticide as used here includes insecticides, herbicides, rodenticides and fungicides.

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Reducing the quantity reduces the potential for the contamination of stormwater by these wastes (see R.10 in Chapter IV-5).

NPDES Stormwater permits: On November 16, 1990, the U.S. EPA promulgated final NPDES regulations for stormwater discharges to waters of the United States from municipalities serving populations greater than 100,000 and certain industries. NPDES refers to the National Pollutant Discharge Elimination System, a Federal regulation administered by Ecology. The final regulations outline permit application requirements and identify which dischargers are required to apply for NPDES permits. NPDES permits for stormwater discharges may specify BMP requirements and/or allowable concentrations of particular pollutants (effluent limitations). In Chapter IV-2, all industries that are required to have NPDES permits are indicated by a double asterisk ("**"). Those who require permits only if potential pollutants are stored outside are indicated with a single asterisk ("*"). Further information can be found in Chapter IV-5 and Chapter II-4 (for construction sites).

IV-1.7 SUBJECTS THIS VOLUME DOES NOT COVER

The manual does not provide BMPs for the control of discharges to public sanitary sewers. This is the responsibility of the local Sewer Authority. However, there are BMPs in this volume that may also be appropriate for controlling pollutants discharged to sanitary sewers.

This volume also does not include BMPs for businesses that transport, treat, process and/or permanently store Dangerous or Extremely Hazardous Wastes. This topic is covered in other Ecology publications and regulations. For further information, contact the Hazardous Substance Information Hotline, 1-800-633-7585.

IV-1.8 WHERE BMPs ARE NOT REQUIRED

BMPs are not necessary where all business activities including parking, loading or unloading of liquids, or temporary storage of liquid or solid wastes are totally enclosed within a building.

Stormwater treatment is not required for parking lots with less than 20 stalls, except for a simple oil spill control separator (BMP RO.05 in Volume III, Runoff Control), unless it is a retail business that experiences a high turnover of vehicles. These exceptions are noted in Chapter IV-2.

IV-1.9 HOW TO USE THIS VOLUME

Figure IV-1.1 illustrates how this volume is to be used. Many land uses have similar activities. For example, general purpose gas stations are not the only type of business that dispense vehicle fuels. Fuel pumps are found at rental car agencies, 24-hour convenience stores, truck freight companies, public works shops and construction companies. Therefore, in STEP 1 the user identifies key activities that may result in stormwater contamination. These possible activities are listed in the enclosed checklist (Table IV-1.2).

If the user is a private business, STEP 2 is to examine the Table of Contents of Chapter IV-2, "Businesses and Required BMPs," to locate the particular grouping within which that business falls, then turn to the appropriate page in Chapter IV-2 to identify the required BMPs.

If the user is a public agency, STEP 2 is to examine the Table of Contents in Chapter IV-3 and then turn to the appropriate page in Chapter IV-3 to identify the required BMPs.

STEP 3 is to obtain details on each of the required BMPs by referring to the appropriate section of the Manual. Details on source control BMPs are provided in

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Chapter IV-5 of this volume. Details on stormwater treatment BMPs are provided in Volume III, Runoff Control. STEP 4 is to refer to Chapter IV-6 for the requirements of other agencies. An effort has been made to incorporate these requirements into the discussion of each BMP.

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Figure IV-1.1 How to Use This Volume

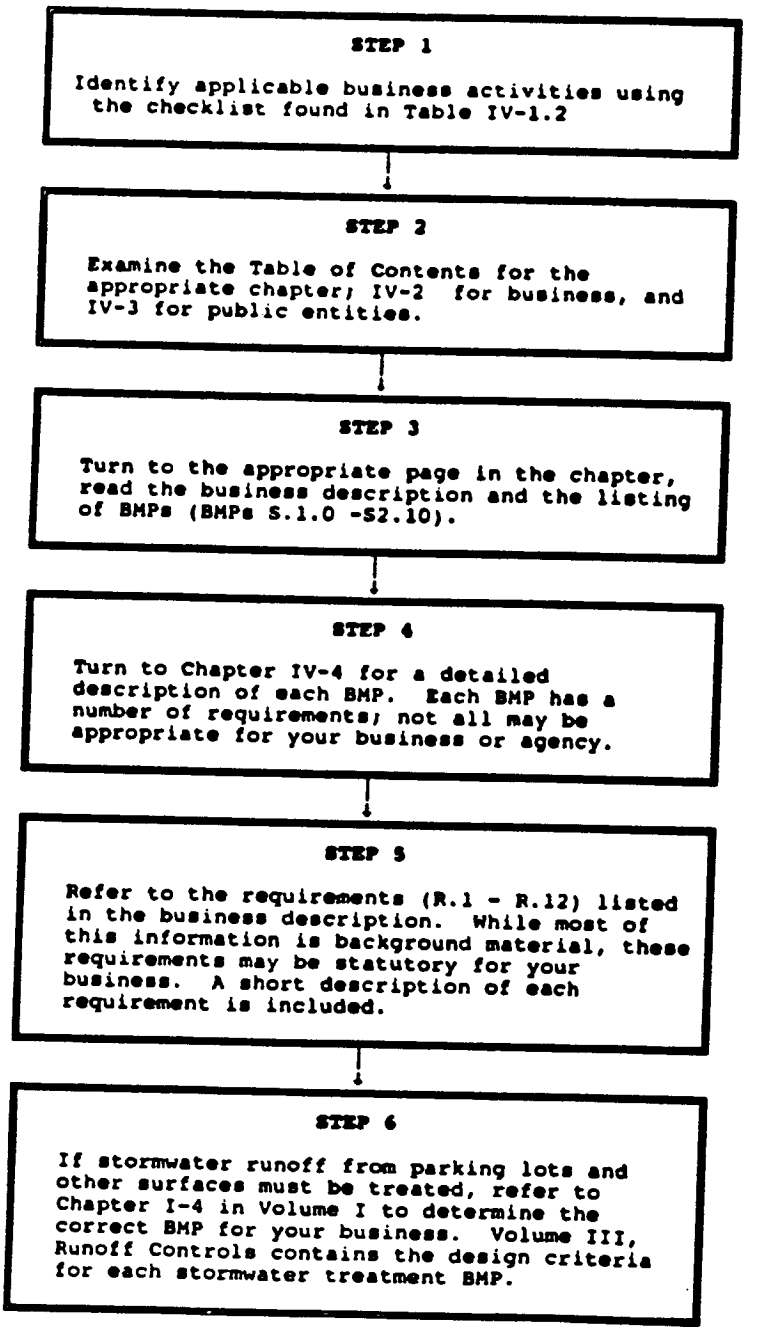

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Table IV-1.2 Activities Checklist

CHECK ACTIVITIES THAT ARE OCCURRING OR WILL BE OCCURRING
(see Chapter IV-2 for the appropriate land use, and Chapter IV-5 for relevant BMPs)

Uncovered vehicle parking ____

Indicate number of parking spaces ____

Washing of vehicles or equipment ____

Vehicle or equipment fueling ____

Loading or unloading of liquid materials ____

Storage of raw materials, byproducts or products of manufacturing processes ____

Above-ground bulk storage of fuel, petroleum or chemicals ____

Use of underground tanks ____

Use of pesticides or fertilizers ____

Livestock husbandry ____

Temporary storage of liquid or solid wastes ____

Indicate type of waste:

Dangerous/Extremely Hazardous waste ____

Food wastes ____

Used oil ____

Other (briefly describe)_____

_____

_____

Do you have or will you be obtaining a permit from the Department of Ecology to store Dangerous or Extremely Hazardous wastes?

____

Do you intend to connect inside drains to the public sanitary sewer? Will you be discharging process water directly to a surface water?

____

DESCRIBE ANY OTHER OUTSIDE ACTIVITIES NOT COVERED ABOVE _____

_____

_____

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CHAPTER IV-2

BUSINESSES AND REQUIRED BMPs

Chapter IV-2 provides descriptions of different business groups and their required BMPs. The source control BMPs referred to are found in Chapter IV-4 and are listed in numerical order for convenience. Descriptions of regulations that are specifically referred to can be found in Chapter IV-5. Again, these are listed in numerical order. If stormwater treatment BMPs are required, they will generally be found in Volume III, Runoff Control.

Each group of businesses is listed in the following way:

- Title of business group
- Standard Industrial Code (SIC) (note: a single asterisk ("*") indicates that a business may require an NPDES permit if it stores pollutants outside; a double asterisk ("**") indicates that a business or industry is required to obtain an NPDES permit.)
- Description of business activities
- Characteristics of materials used and wastes generated
- Required source control BMPs
- Required stormwater treatment BMPs

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IV-2.1 MANUFACTURING BUSINESSES

IV-2.1.1 CEMENT
SIC: 3241

DESCRIPTION: These businesses produce Portland cement, the binder used in concrete for paving, buildings, pipe and other structural products.

MATERIALS USED AND WASTES GENERATED: The raw materials vary with the particular plant but may be limestone, chalk, marl, or shale. Waste materials from other industries are often used such as slag, fly ash and spent blasting sand.

Raw materials are crushed, mixed and fed into a kiln, a long cylindrical shell, in which the material is heated to produce the correct chemical composition. Natural gas has generally replaced coal as the heat source. The kiln is angled and as it rotates the material passes through by gravity. The output of the kiln is a clinker which is ground to produce the final product.

The basic process may be wet or dry. In the wet process water is mixed with the raw ingredients in the initial crushing operation and in some cases is used to wash the material prior to use. Water may also be used in the air pollution control scrubber. The most significant by-product of cement production is the kiln dust. Kiln dust can be difficult to dispose of.

Stormwater may be contaminated by the raw materials, kiln dust or the product. Analysis of stormwater samples from cement plants in the Seattle area has found the pH to be above 10 and metals concentrations to exceed acute water quality criteria.

Concrete products may also be produced on site such as ready-mix concrete. Refer to "Concrete Products" for a description of the BMPs appropriate to these activities.

Source Control BMPs: ***See BMPs S1.20, S1.30, S1.40, S1.50, S1.60, S1.70, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine applicable actions.***

Regulatory Requirements: ***See R.1, R.3, R.4, R.9, R.10 and R.11 in Chapter IV-5.***

Stormwater Treatment BMPs: This industry is one of seven industrial groups for which effluent standards have been set for stormwater quality. According to Federal Regulation 40 CFR 411 the stormwater from a new cement plant is to have these characteristics: total suspended solids are not to exceed 50 mg/l and the pH shall range between 6.0 and 9.0. In addition, the stormwater treatment system must be sized to handle at least a 10-year, 24-hour storm.

Stormwater draining from the plant site (including parking lots) shall be treated by one of the treatment systems described in Volume III, Runoff Control. Cement plants may control the pH of stormwater runoff by adding sulfuric acid subject to site-specific approval by Ecology. Any design for a detention system should take this factor into consideration. An extended detention wet pond will likely be the most logical choice for efficient treatment of stormwater (see BMP III-RD.05, Chapter III-4 in the Runoff Control Volume).

Stormwater runoff from rooftops may be discharged to the storm drains below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.1.2 CHEMICALS
SIC: 2800**, 3861**

DESCRIPTION: This group involves the manufacturing of chemicals, or products based on chemicals. This includes the production of acids, alkalis, inks (2893)**, chlorine, industrial gases, pigments, chemicals used in the production of synthetic resins (2869**), fibers and plastics, synthetic rubber, soaps and cleaners (2840)**, pharmaceuticals (2834)*, cosmetics, paints (2850)*, varnishes and resins (2861)*. Included here are photographic materials and chemicals (3861). Also made in this region are organic chemicals (2869)**, agricultural chemicals (2879)**, adhesives and sealants (2891)**, and ink (2893)**.

MATERIALS USED AND WASTES GENERATED: The types of processes, materials and wastes generated are too numerous to catalog here. Wastewater can contain heavy metals and a variety of toxic organics.

Activities that may occur outside the manufacturing building include: bulk storage of liquid feedstock, other raw materials, by-products or products; loading and unloading of liquid materials from truck or rail; washing of equipment outside the building; waste oil and solvents from cleaning manufacturing equipment; used equipment temporarily stored on site that could drip oil and residual process materials; and temporary storage of Dangerous Wastes.

With few exceptions all of these industries require treatment of wastewater prior to disposal. Such processes produce contaminated sludges which must be properly stored until disposed of. The wastewater treatment processes may not be enclosed and therefore spillage to pavement and/or ground water contamination can occur.

Chemical businesses in the Seattle area surveyed for Dangerous Wastes have been found to produce caustic solutions and soaps, solutions with heavy metals, inorganic and organic chemicals, solvents, acid and alkaline wastes, waste paints and varnishes, waste pharmaceuticals and inks.

Source Control BMPs: See BMPs S1.20, S1.30, S1.40, S1.50, S1.60, S1.70, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine applicable actions.

Regulatory Requirements: See R.1, R.2, R.3, R.4, R.6, R.7, R.9, R.10, and R.11 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas where manufacturing processes occur shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater runoff from rooftops may be discharged to the storm drains below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

R0056197

IV-2.1.3 CONCRETE PRODUCTS
SIC: 3270

DESCRIPTION: Businesses that manufacture concrete blocks and bricks, concrete sewer or drainage pipe, septic tanks, and prestressed concrete building components. Concrete is prepared on-site and poured into molds or forms to produce the desired product.

This group also includes the production of ready-mix concrete and gypsum products.

MATERIALS USED AND WASTES GENERATED: The basic ingredients of concrete are sand, gravel, Portland cement, and reinforcing steel for some products. Most businesses do not produce their own concrete; it is produced and delivered by ready-mix concrete plants.

Sources of pollution can include the loss of raw materials from stockpiles, washing of waste concrete from trucks, forms, equipment and the general work area, and water from the curing of concrete products. Besides the basic ingredients for making concrete products, chemicals used in the curing of concrete and the removal of forms may end up in stormwater.

Trucks and equipment maintained on-site will generate waste oil and solvents, and other related waste materials.

Although there is no stormwater quality data from concrete product businesses, it is likely the quality will be similar to that found at cement plants. Analysis of stormwater samples from cement plants in the Seattle area has found the pH to be above 10 and metals concentrations to exceed chronic water quality criteria.

Source Control BMPs: See BMPs S1.10, S1.20, S1.30, S1.40, S1.50, S1.60, S1.70, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine applicable actions.

Regulatory Requirements: See R.1, R.3, R.4, R.9, R.10 and R.11 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from the general plant site and/or parking lots and outside areas where manufacturing processes occur shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater runoff from rooftops may be discharged to the storm drains below the treatment system as long as the local Public Works Department's drainage requirements are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

Ready-mix plants typically have settling basins to treat wash water from the cleaning of trucks. This function may be integrated with the treatment requirements specified above for stormwater depending on the requirements of the local government and/or other agencies.

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R0056198

IV-2.1.4 ELECTRICAL PRODUCTS

SIC: 3600*, 3800*

DESCRIPTION: In the Puget Sound region a variety of products are produced including electrical transformers and switchgear (3610)*, communications equipment for radio and TV stations and systems (3660)*, electronic components and accessories including semiconductors (3670)*, printed board circuits, electromedical and eletrotherapeutic apparatuses (3690)*, and electrical instrumentation (3800)*.

Specialized processing that can produce waste materials includes etching, acid and alkaline cleaning, and electroplating.

MATERIALS USED AND WASTES GENERATED: Materials used include metals, ceramics, quartz, silicon, oxides, acids, alkaline solutions, arsenides and phosphides, cyanides, solvents, and other inorganic liquid chemicals.

Wastewater consists of solutions and rinses from electroplating operations, and the cleaning waters described above. Water may also be used to cool saws and grinding machines. Sludges are produced by the wastewater treatment process.

Activities that may occur outside the manufacturing building include: bulk storage of raw materials, by-products or finished products; loading and unloading of liquid materials from truck or rail; temporary storage of waste oil and solvents from cleaning manufacturing equipment; used equipment temporarily stored on site that could drip oil and residual process materials; and temporary storage of Dangerous Wastes. Spillage from any of these activities can contaminate surface or ground waters.

Waste liquids that may be temporarily stored on site include spent acetone and solvents, ferric chloride solutions, soldering fluxes mixed with thinner or alcohol, spent acids, and oily waste. Several of these liquid wastes contain chlorinated hydrocarbons, ammonium, and metals such as chromium, copper, lead, nickel, and tin. Waste solids include soiled rags and sanding materials.

Source Control BMPs: See BMPs S1.20, S1.30, S1.40, S1.50, S1.60, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

Regulatory Requirements: See R.1, R.2, R.3, R.4, R.10 and R.11 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas where manufacturing processes occur shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.1.5 FOOD PRODUCTS
SIC: 2000

DESCRIPTION: Includes any business that produces a finished food product including meat packing plants, poultry slaughtering and processing, sausage and prepared meats, dairy products, preserved fruits and vegetables, flour, bakery products, sugar and confectioneries, vegetable and animal oils, beverages, canned, frozen or fresh fish, pasta products, snack foods, and manufactured ice.

MATERIALS USED AND WASTES GENERATED: With most food processors all processing occurs inside buildings. Exceptions are meat packing plants where live animals may be kept, and fruit and vegetable plants where the raw material may be temporarily stored outside. Storm runoff from animal containment or transit areas and vegetable storage areas will be contaminated, the latter from earth attached to the vegetables and vegetable wastes. The nature of contamination of stormwater passing over fruits is unknown but is not likely to be significant as fruit is usually picked clean.

Wine processors often crush grapes outside the process building and/or store equipment outside when not in use. Some wine producers use juice from grapes crushed elsewhere. Significant liquid transfer will occur with some processors. Some vegetable and fruit processing plants use caustic solutions.

Source Control BMPs: See BMPs S1.20, S1.30, S1.40, S1.50, S1.60, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

Regulatory Requirements: See R.1, R.2, R.3, R.4, R.10 and R.11 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas used to store food products shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

R0056200

VOL 12 2 2903

IV-2.1.6 GLASS PRODUCTS
SIC: 3210*, 3220**, 3230**

DESCRIPTION: Manufacturers of glass and glass products from raw materials and/or recycled glass. The glass form produced may be flat or window glass, safety glass, container glass, tubing, glass wool or fibers. Glass containers may also be produced on the same site.

The raw materials are mixed and heated in a furnace. The resulting molten material is shaped by processes that vary with the intended product. The cooled glass may be edged, ground, polished, annealed and/or heat treated to produce the final product. Air emissions from the manufacturing buildings are scrubbed to remove particulates.

MATERIALS USED AND WASTES GENERATED: The basic raw materials are sand mixed with a variety of oxides such as aluminum, antimony, arsenic, lead, and barium. Metal salts for coloring such as copper or cobalt oxide may be used.

Raw materials are generally stored in silos except for crushed recycled glass. Consequently, contamination of stormwater and/or ground water is limited to raw material lost during unloading operations, errant flue dust, and engine fluids from mobile lifting equipment that is stored outside. The maintenance of the manufacturing equipment will produce used lubricants and cleaning solvents. The flue dust is likely to contain heavy metals such as arsenic, cadmium, chromium, mercury, and lead.

Source Control BMPs: See BMPs S1.20, S1.30, S1.40, S1.50, S1.60, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

Regulatory Requirements: See R.1, R.2, R.3, R.4, R.10 and R.11 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from the general plant site including parking lots and outside areas where manufacturing processes occur shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

R0056201

IV-2.1.7 INDUSTRIAL MACHINERY AND EQUIPMENT, TRUCKS AND TRAILERS, AIRCRAFT, PARTS AND AEROSPACE, RAILROAD EQUIPMENT
SIC: 3500, 3713/14, 3720, 3740, 3760, 3800

DESCRIPTION: Businesses that manufacture a variety of equipment including engines and turbines, farm and garden equipment, construction and mining machinery, metal working machinery, pumps, computers and office equipment, automatic vending machines, refrigeration and heating equipment, and equipment for the manufacturing industries described elsewhere. This group also includes many small machine shops. Also included here is the manufacturing of trucks, trailers, and parts. Manufacturing processes will include various forms of metal working and finishing, and the production of plastic and fiberglass parts. This group also includes manufacturing of airplanes and parts, missiles, spacecraft, and railroad equipment and instruments.

MATERIALS USED AND WASTES GENERATED: Manufacturers of engines or engine-driven equipment can be expected to have fueling facilities. Larger equipment may be stored outside. Outside storage of gasoline, diesel, and cleaning fluids may occur. In contrast, smaller businesses may only have outside containers for temporary storage of waste products.

Businesses making equipment in the Puget Sound area that were surveyed for Dangerous Wastes have been found to produce waste acids, used solvents, paints, metal chips with machine oil, various chemicals, and used oil.

Source Control BMPs: See BMPs S1.10, S1.20, S1.30, S1.40, S1.50, S1.60, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

Regulatory Requirements: See R.1, R.2, R.3, R.4, R.6, R.7, R.9, R.10 and R.11 in Chapter IV-5.

Stormwater Treatment BMPs: Stormwater from outside equipment storage areas where dripping of oil or hydraulic fluids is likely to occur shall be treated by an API or CPI-type oil/water separator (BMP RD.35 in Volume III, Runoff Control).

Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas where manufacturing processes occur shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

VOL 12 2 2904

R0056202

IV-2.1.8 LOG STORAGE AND SORTING YARDS, DEBARKING
SIC: 2411 , 2499

DESCRIPTION: Although log yards are located at sawmills, and sometimes at pulp and paper mills, they are presented separately because of their unique BMP requirements. Log yards may exist as entirely separate businesses, for example at ports where exporting occurs.

Log storage and sorting yards can cover very large areas. Large mobile equipment is used to move the logs. The equipment is maintained on or within the vicinity of the site. The logs may be debarked.

MATERIALS USED AND WASTES GENERATED: Large amounts of bark are produced, either in the storage area from log handling or when it is removed by a debarking operation. Rain, if allowed to pool around bark and logs, may be a significant source of organic color, tannins, and BOD. Small pieces of bark are carried off by the stormwater.

In the past, debarking was done using high pressure water jets. However, because of the difficulty of handling the contaminated water, mechanical debarking has become the common procedure. The debarking operation may be located in the open and any oil which drips from the equipment can reach stormwater.

Breakage of hydraulic lines on the mobile equipment occurs and is another source of oil. Equipment maintenance generates by-products common to all vehicle and equipment maintenance operations. See "Vehicle Maintenance and Repair" (Section IV-2.4.9) for a complete description of waste products.

Source Control BMPs: See BMPs S1.10, S1.20, S1.30, S1.40, S1.50, S1.60, S1.80, S1.90, S2.00 and S2.20 in Chapter IV-4 to determine applicable actions.

Regulatory Requirements: See R.1, R.2, R.3, R.8, R.10, R.11 and R.12 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from log storage areas, parking lots and outside areas where manufacturing processes occur shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater from outside equipment storage, maintenance and debarking areas where dripping of oil or hydraulic fluids is likely to occur shall be treated by an API or CPI-type oil/water separator (BMP RD.35 in Volume III, Runoff Control).

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R0056203

IV-2.1.9 METAL PRODUCTS
SIC: 2514, 2522*, 2542*, 3312**, 3314-17**, 3320**, 3350**, 3360**, 3400*, 3590*

DESCRIPTION: This group includes mills that produce basic metals and primary products, as well as foundries, electroplaters, and fabricators of final metal products.

Basic metal production includes steel, copper, and aluminum. Mills that transform metal billets, either ferrous or nonferrous such as aluminum, to primary metal products are included. Primary metal forms include sheets, flat bar, building components such as columns, beams and concrete reinforcing bar, and large pipe.

Steel mills in the Pacific Northwest use recycled metal and electric furnaces. The molten steel is cast into billets or ingots which may be reformed on site or taken to rolling mills that produce primary products. As iron and steel billets may sit outside before reforming, surface treatment to remove scale may occur prior to reforming. The final product may also be stored outside.

Foundries pour or inject molten metal into a mold to produce a shape that cannot be readily formed by other processes. The metal is first melted in a furnace. The mold is made of sand or metal die blocks that are locked together to make a complete cavity. The molten metal is ladled in and the mold is cooled. The rough product is finished by quenching, cleaning and chemical treatment. Quenching involves immersion in a plain water bath or water with an additive.

Businesses that fabricate metal products from metal stock provide a wide range of products. The raw stock is manipulated in a variety of ways including machining of various types, grinding, heating, shearing, deformation, cutting and welding, soldering, sand blasting, brazing, and laminating. This group includes businesses that make metal furniture.

Fabricators may first clean the metal by sand blasting, descaling, or solvent degreasing. Final finishing may involve electroplating, painting, or direct plating by fusing or vacuum metalizing. Painting may involve paints, varnish, lacquer, shellac, or plastics. Finishing may occur on-site or at a specialized business.

MATERIALS USED AND WASTE GENERATED: Raw materials, in particular recycled metal, are stored outside prior to use as are billets before reforming. The descaling process may use salt baths, sodium hydroxide, or acid (pickling).

Primary products often receive a surface coating treatment. Prior to the coating the product surface may be prepared by acid pickling to remove scale or alkaline cleaning to remove oils and greases. The two major classes of metallic coating operations are hot and cold coating. Zinc, terne and aluminum coatings are applied in molten metal baths, while tin and chromium are usually applied electrolytically from plating solutions.

In rolling operations where various steel products are made wastewater is produced from immersing the steel into an oil/water emulsion.

In foundries, the metal may be steel, iron, aluminum, copper, magnesium, zinc, lead or brass. Wastewaters come from quenching, cooling and rinsing operations. Lubricants are also used, and are often recycled within the plant. Foundries use sand and bentonite to make molds. Chemicals may be used to set the molds.

Fabricators produce wastewater from the rinsing of work pieces, cooling and lubrication, spray booths, quenching, and general cleanup. This wastewater may receive pretreatment from which sludges are produced. Other waste products include scrap metal, used oil, acid and alkaline wastes, heavy metal and cyanide-bearing wastes, dyes, spent solvents, waste paints and other surface treatment materials.

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R0056204

Electroplating businesses produce acid and alkaline solutions, cyanide plating solutions and sludges.

Foundries and fabricators in the Puget Sound area were surveyed for Dangerous Wastes and have been found to produce waste acids, solvents, and various chemicals as well as used oil which is not a Dangerous Waste if properly recycled.

For all businesses in this group, activities that may occur outside include: bulk storage of chemicals, storage of metal feedstock, byproducts and finished products; unloading of chemical feedstocks and loading of waste liquids such as spent pickle liquor by truck or rail; quenching; waste oil and solvents from cleaning manufacturing equipment; and temporary storage of Dangerous Wastes, which may be either liquid or solid. Steel mills will produce slag and dust from the air scrubber.

Source Control BMPs: See BMPs S1.20, S1.30, S1.40, S1.50, S1.60, S1.70, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine applicable actions.

For more information on disposal requirements for solid and hazardous wastes, see Step By Step: Fact Sheets for Hazardous Waste Generators, publication 91-12, available from Ecology's Regional Offices.

Regulatory Requirements: See R.1, R.2, R.3, R.4, R.9, R.10 and R.11 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas where manufacturing processes occur or raw materials or products are stored shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

VOL 12 2 2907

R0056205

IV-2.1.10 PAPER AND PULP MILLS
SIC: 2610, 2620, 2630

DESCRIPTION: Large industrial complexes in which pulp, pulp and paper, or just paper or paperboard are produced. The chips for pulping may be produced on-site from logs, and/or imported.

Process wastewater is usually treated and discharged at the business site; a public sanitary sewer system is typically not used.

MATERIALS USED AND WASTES GENERATED: Logs may be stored, debarked and chipped on site. Stormwater runoff from these areas can be a significant source of pollution. Large quantities of chips are stored in the open. Although this can be a source of pollution, the volume of stormwater flow is relatively small because the majority of precipitation is retained by the chip pile.

Mobile equipment such as forklifts, log handlers, and chip dozers are a source of hydraulic fluids and oil from normal dripping as well as from hydraulic line breakage. The equipment is fueled and maintained on site.

The large process equipment used for pulping is not enclosed. Thus, precipitation falling over these areas will become contaminated. Maintenance of the process equipment produces waste products similar to that produced from vehicle and mobile equipment maintenance.

Air and process wastewater treatment systems produce sludges.

Source Control BMPs: See BMPs S1.10, S1.20, S1.30, S1.40, S1.50, S1.60, S1.80, S1.90, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

Regulatory Requirements: See R.1, R.2, R.3, R.4, R.8, R.10 and R.11 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas where manufacturing processes occur shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Log storage and process equipment areas should be covered where possible and their drainage channelled to a retention/detention facility and/or through a biofilter prior to discharge.

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

R0056206

IV-2.1.12 PETROLEUM PRODUCTS
SIC: 2911, 2950

DESCRIPTION: The petroleum refining industry manufactures gasoline, kerosene, distillate and residual oils, lubricants and other related products from crude petroleum. Also included here is the production of asphalt paving and roofing materials that use asphalt. Businesses that do the actual paving or seal roofs with asphalt roofing are discussed under "Construction Businesses" (Section IV-2.4.10).

MATERIALS USED AND WASTES GENERATED: Although petroleum is the primary raw material, petroleum refining also uses other materials such as natural gas liquids, benzene, toluene, chemical catalysts, caustic soda and sulfuric acid. Wastes may include filter clays, spent catalysts, sludges, and oily water.

Asphalt paving consists of sand, gravel and the petroleum-based asphalt that serves as the binder. Therefore located at such a business are stockpiles of sand and gravel. The asphalt emulsion is stored in above-ground tanks. The business may own trucks that are maintained on-site.

Waste products may include small dumps of unused asphalt and the usual materials from vehicle maintenance (see "Vehicle Maintenance and Repair", Section IV-2.4.9). Spillage of the asphalt emulsion could occur during transfer to the business site.

Source Control BMPs: See BMPs S1.10, S1.20, S1.30, S1.40, S1.50, S1.60, S1.70, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine applicable actions.

Regulatory Requirements: See R.1, R.2, R.3, R.4, R.5, R.6, R.7, R.10 and R.11 in Chapter IV-5.

Stormwater Treatment BMPs: Stormwater from areas where contamination is possible from asphalt materials (either raw materials or final products) shall be treated by an API or CPI-type oil/water separator or equivalent (Volume III, Runoff Control).

Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas where manufacturing processes occur shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

Effluent guidelines for stormwater discharges from these types of plants have been established under 40 CFR Part 419.

VOL 12 2 2910

R0056207

IV-2.1.13 PRINTING AND PUBLISHING
SIC: 2700

DESCRIPTION: Preparation of newspapers, periodicals, and commercial printing. This group includes both businesses that do their own printing as well as those that perform services for the printing industry, for example bookbinding. Processes include typesetting, engraving, photograving, and electrotyping.

MATERIALS USED AND WASTES GENERATED: Various materials used in modifying the paper stock include inorganic and organic acids, resins, solvents, polyester film, developers, alcohol, vinyl lacquer, dyes, acetates, and polymers. Waste products may include waste inks and ink sludges, resins, photographic chemicals, solvents, acid and alkaline solutions, chlorides, chromium, zinc, lead, spent formaldehyde, silver, and plasticizers. All of these waste products are Dangerous Wastes. Used lubricating oils are also produced.

As the printing operations occur indoors, the only likely points of potential contact with stormwater are the temporary storage of waste materials outside the business owner's building and offloading of chemicals through external unloading bays.

Printing and publishing businesses surveyed in the Puget Sound area for Dangerous Wastes were found to produce photographic chemicals and ink.

Source Control BMPs: See BMPs S1.20, S1.30, S1.40, S1.50, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

For more information on disposal requirements for solid and hazardous wastes, see Step By Step: Fact Sheets for Hazardous Waste Generators, publication 91-12, available from Ecology's Regional Offices.

Regulatory Requirements: See R.1, R.2, R.3, R.10 and R.11 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas where manufacturing processes occur shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.1.14 RUBBER AND PLASTIC PRODUCTS
SIC: 3000

DESCRIPTION: Although different in basic feedstocks and processes used, businesses that produce rubber, fiberglass and plastic products belong to the same SIC group and therefore are grouped in this manual.

The rubber industry includes a wide variety of production activities ranging from polymerization reactions to extrusion of a rubber product from natural or synthetic stock.

MATERIALS USED AND WASTES GENERATED: The industry may use natural or synthetic rubber, new or recycled. Other materials used include pigments, paints, various fillers and curing agents.

Activities that may occur outside the manufacturing building include: bulk storage of liquids, other raw materials or by-products; unloading of liquid materials from truck or rail; washing of equipment outside the building; waste oil and solvents produced by cleaning manufacturing equipment; used equipment temporarily stored on site that could drip oil and residual process materials; and temporary storage of Dangerous Wastes.

Producers of plastic products in the Puget Sound area surveyed for Dangerous Wastes have been found to generate waste oils, solvents, inks and paints.

Source Control BMPs: See BMPs S1.20, S1.30, S1.40, S1.50, S1.60, S1.70, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

Regulatory Requirements: See R.1, R.2, R.3, R.4, R.5, R.6, R.7, R.10 and R.11 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas where products are stored shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.1.15 SHIP AND BOAT BUILDING AND REPAIR YARDS
SIC: 3730

DESCRIPTION: Businesses that build or repair ships and boats. Some provide a mobile service in which they come and work on the boat at its moorage. Repairs occur to the vessel hull, interior and engines. Typical activities include hull scraping, sandblasting, finishing, metal fabrication, electrical repairs, engine overhaul, and welding, fiberglass repairs, hydroblasting and steam cleaning.

A draft NPDES permit for these facilities is currently under development. The following information is the text of the fact sheet.

As of this writing the permit is at EPA for review. Once that review is done, a series of public hearings will be held and a responsiveness summary compiled. The estimated date for completion is April 30, 1992. Further information and a copy of the draft permit can be obtained from Kevin Fitzpatrick, (206) 649-7037.

Draft of 12/18/91

FACT SHEET

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

GENERAL PERMIT NUMBER: WA-GXX 0000

FACT SHEET--FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) GENERAL PERMIT TO DISCHARGE POLLUTANTS FROM BOATYARDS TO STATE WATERS PURSUANT TO THE PROVISIONS OF CHAPTER 90.48, REVISED CODE OF WASHINGTON AND THE FEDERAL WATER POLLUTION CONTROL ACT AS AMENDED.

The Department of Ecology (WDOE) has tentatively determined to issue a general permit to boatyards operating in the State of Washington authorizing discharges by listed applicants subject to certain effluent limitations which may require the implementation of Best Management Practices, installation of treatment facilities, and other conditions necessary to carry out the provisions of state and federal law. These proposed limitations, schedules and conditions are tentative.

PUBLIC COMMENT AND INFORMATION

Interested persons are invited to submit written comments regarding the proposed permit. Comments should be submitted within thirty (30) days of the issuance date of the public notice for this application. Comments should be sent to:

Washington State Department of Ecology
Northwest Regional Office
3190 - 160th Avenue SE
Bellevue, Washington 98008-5452

Presuming that comments received will indicate significant public interest in the proposed permit and that useful information would be produced thereby, the director of Ecology intends to hold a public hearing(s) on the general permit. Public notice regarding any hearing will be circulated at least thirty (30) days in advance of the hearing.

The application, proposed permit, and related documents are available for inspection and copying between the hours of 8:00 a.m. and 4:30 p.m. weekdays at the aforementioned regional office of the Department. A copying machine is available for use at a charge of 20 cents per copy sheet.

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PERMIT GOAL: The goal of this general permit is to control the discharge of pollutants associated with Washington State boat yard activities. WDOE anticipates that boat yard facilities in Washington State which are covered and in compliance with the terms and conditions of this general permit should not violate state water quality standards.

> **RCW 90.48.080 Discharge of polluting matter in water prohibited.** "It shall be unlawful for any person to throw, drain, run or otherwise discharge into any of the waters of this state, or to cause, permit or suffer to be thrown, run, drained, allowed to seep or otherwise discharged into such waters any organic or inorganic matter that shall cause or tend to cause pollution of such waters according to the determinations of the Department, as provided for in this chapter."
>
> **RCW 90.48.160 Waste disposal permit -- Required--Exemptions.** "Any person who conducts a commercial or industrial operation of any type which results in the disposal of solid or liquid waste material into the waters of the state, including commercial or industrial operators discharging solid or liquid waste material into sewerage systems operated by municipalities or public entities which discharge into public waters of the state, shall procure a permit from either the Department or the thermal power plant site evaluation council as provided in RCW 90.48.262(2) before disposing of such waste material: ..."
>
> **RCW 90.48.520 Review of operations before issuance or renewal of wastewater discharge permits -- Incorporation of permit conditions.** "In order to improve water quality by controlling toxicants in wastewater, the Department of Ecology shall...incorporate permit conditions which require all known, available, and reasonable methods to control toxicant in the applicants wastewater. Such conditions may include, but are not limited to: (1) Limits on the discharge of specific chemicals, and (2) limits on the overall toxicity of the effluent. The toxicity of the effluent shall be determined by techniques such as chronic or acute bioassays. Such conditions shall be required regardless of the quality of receiving water and regardless of the minimum water quality standards. In no event shall the discharge of toxicant be allowed that would violate any water quality standard, including toxicant standards, sediment criteria, and dilution zone criteria."

The goals of this permit are to be achieved primarily through "Best Management Practices" (BMPs) designed to minimize or eliminate the discharge of pollutants.

TECHNICAL ADVISORY COMMITTEE: A technical advisory committee, which will be referred to in this document as TAC, was formed to assist WDOE in drafting this fact sheet and permit. TAC consisted of representatives from local, state and federal agencies, maritime associations and boatyard operators. The TAC members are listed in the acknowledgements section (last page of fact sheet).

TAC asked WDOE to make the following reminder, noting that criminal and civil violations of the Federal Water Pollution Control Act are more severe.

> **RCW 90.48.140 Penalty.** Any person found guilty of wilfully violating any of the provisions of this chapter, or any written orders or directive of the department or a court in pursuance thereof shall be deemed guilty of a crime, and upon conviction thereof shall be punished by a fine of up to ten thousand dollars and the costs of prosecution, or by imprisonment in the county jail for not more than one year, or both such fine and imprisonment in the discretion of the court. Each day upon which a willful violation of the provisions of this chapter occurs may be deemed a separate and additional violation.

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METRO TREATMENT STUDY: METRO (Municipality of Metropolitan Seattle) received a National Estuary Grant to do a treatment study of Puget Sound shipyard and boatyard waste and storm waters. The study involves sampling of pressure washing wastewater from a number of these facilities, and testing prototype collection and treatment systems to determine what methods can consistently meet state and local standards.

METRO will be producing an analytical report of their findings and developing a guidance manual which will be distributed to shipyards, boatyards and publicly owned treatment works (POTW). The manual will include options for treatment and discharge of pressure wash wastes, bilge and ballast water and contaminated storm water to either receiving waters, municipal treatment plants, or off-site treatment facilities.

METRO's work is expected to clarify and expand the list of options for treatment and disposal of boatyard wastewaters. The treatment study project has been closely aligned with the development of the general NPDES permit for boatyards. The study's project manager and project coordinator have made valuable contributions to the general permit development by assisting WDOE in establishing standards for best available technology practices for boatyards.

BACKGROUND: Under P-20 of the Puget Sound Water Quality Authority Plan WDOE was directed to carry out a program for detection and identification of unpermitted discharge sources. One of the significant point source unpermitted discharge groups found by the Elliott Bay and Lake Union Urban Bay Action Teams was the boat yard industry.

WDOE signed a Memorandum of Agreement with the United States Environmental Protection Agency (EPA) for development and issuance of a general permit for small shipyards. During the development of this permit it was decided to describe facilities in this segment of the Ship and Boat Building and Repairing industry as boatyards. There are approximately 500 - 600 boatyards in Washington State.

The principal focus of the proposed permit is to regulate wastewater discharges to waters of the state from water dependent facilities. During the development of this permit it has become evident that other facilities in the category but not located on a shoreline or near shore, could be covered with incidental additional effort. Application from all facilities in the category will be invited. The final decision on who is covered by the general permit will be based on the completed application.

Questions have also been asked about potential coverage for related facilities, such as a repair shop for marine engines. As originally conceived it was not the intention of WDOE or EPA that this permit provide coverage to ancillary or related industrial or commercial facilities. Those facilities may be covered under other wastewater discharge permits, if necessary.

The Standard Industrial Classifications, SIC, distinguishes between these related industries by type of work as follows:

> SIC No. 3731 Ship Building and Repairing: "Establishments primarily engaged in building and repairing all types of ships, barges, and lighters, whether propelled by sail or motor power or towed by other craft. This industry also includes the conversion and alteration of ships."
>
> SIC No. 3732 Boat Building and Repairing: "Establishments primarily engaged in building and repairing all types of boats."

Further distinctions between ships and boats are provided by others, such as the U. S. Coast Guard, which define boats as vessels of less than 65 feet. Shipyards and boatyards can also be distinguished by the prevalence of steel hulled vessels at shipyards versus the prevalence of fiberglass, wood and aluminum hulls at boatyards.

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With only a few exceptions, such as luxury yachts, it is appropriate to use the term boatyard for the industrial group covered by this general NPDES permit.

A boatyard, defined for purposes of this permit, is a service business primarily engaged in new construction and repair of small vessels 65 feet or less in length. Services provided may include, but are not limited to: pressure washing, bottom and top side painting; engine, prop, shaft, and rudder repair and replacement; hull repair, joinery, bilge cleaning, fuel and lubrication system repair or replacement, welding and grinding on the hull, buffing and waxing, top-side cleaning, MSD (marine sanitation device) repair or replacement, and other activities necessary to maintain a vessel.

A boatyard may employ one or more of the following to remove or return a vessel to the water: marine railway, crane, hoist, ramp, or vertical lift. Some yards may build a limited number of custom boats usually constructed of fiberglass or aluminum. Permanent moorage facilities are not usually a feature of a boatyard though a few boatyards do have such facilities. Nevertheless, they are still boatyards.

Historically boat repair has been done outdoors on the waterfront. The vessel was supported in a cradle, on barrels, or in a sling while work was done on the hull. Some facilities are endeavoring to change operations in order to do the boat repair under cover. This will contribute to quality control, reduce transportation of waste to the environment, and improve worker safety.

Not all work areas are paved and not all have drainage systems. When the work area is neither paved nor drained, storm water runoff is typically via sheet flow through a gravel surfacing. Some pollutants tend to adhere or get trapped in the gravel or crushed rock surfacing. Because there is a high potential for soil contamination with an unpaved work area, some facilities are using plastic sheeting and other materials to keep pollutants from intermingling with the soil.

Discussions within TAC indicate a need to define some terms for the benefit of laymen and people more familiar with shipyards. The draft EPA "Development Document for Shipbuilding and Repair," EPA 440/1-70/076-b uses the term hydroblasting to mean the use of a cold water pressure washer to remove paint from a vessels' hull. Generally, local shipyards use a pressure in excess of 2000 psi. The pressure washer commonly removes biological growth and the outermost coat of antifouling paint. If the pressure is high enough, hydroblasting may be used to remove all paint down to bare steel. If hydroblasting is used to remove paint down to bare steel, a light abrasive blast will follow to remove any rust and ensure proper surface texture. The paint system may involve several coats of paint, including primer, anticorrosive and antifouling paints.

Most boatyards do not "hydroblast." For boatyard applications, the water pressure is seldom above 2000 psi. The basic intent is to remove any biological growth on the vessel. Boatyard operators do not consider paint removal to be an objective of this type of pressure washing. The METRO treatment study has found that low pressure washing with scrubbing results in a greater concentration of metals in the wastewater and is less selective for marine growth removal than "hydroblasting."

If abrasive blasting is used to remove paint, walnut shells or other "soft" abrasives that won't damage fiberglass or aluminum are used for the abrasive. In addition, to control pollutant transport, a water spray forming a cone around the blasting nozzle is used at some yards. In the EPA document, this is referred to as "wet abrasive blasting."

<u>This document will use the generic terms pressure washing and pressure wash wastewater for all pressure washing activities (to include wastewater from hand washing of hulls).</u>

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POLLUTANT SOURCES: Wastes generated by boatyard activities include spent abrasive grits, spent solvent, spent oils, wash water, paint over spray, various cleaners and anti-corrosive compounds, paint chips, scrap metal, welding rods, wood, plastic, resins, glass fibers, and miscellaneous trash such as paper and glass. These pollutants may enter the wastewater stream through the application and preparation of paints and the painted surface; the handling, storage and accidental spills, leaks or drips of paints, solvents, thinners; the fracturing and breakdown of abrasive grits, and the repair and maintenance of mechanical equipment.

Hull preparation for painting will commonly be by sanding or scraping and some abrasive blasting. Boatyards are relatively small generators of spent grits, paint chips and particulate debris compared to a shipyard.

The primary source of wastewater is storm water runoff. Secondary sources are pressure washing, cooling water, pump testing, grey water, sanitary waste, washing down the work area, and engine bilge water. Engine room bilge water and oily wastes are typically collected and disposed of through a licensed contracted disposal company.

Pressure wash wastewaters have been sampled by WDOE, local shipyards and METRO. The effluent quality has been highly variable and frequently exceeds water quality criteria for copper, lead and zinc.

From monitoring results received to date, metal concentrations typically range from 5 to 10 mg/L, but have gone as high as 190 mg/L for copper. The average concentration for copper has been 55 mg/l. Two prime sources of copper are leaching of copper from anti-fouling paint and wastes from hull maintenance.

While the intent of pressure washing may not be to remove paint from a vessel hull, receiving water sampling by Ecology does substantiate that paint removal can occur.

RECEIVING WATER: State waters impacted by this permit and the activities of the permit applicants are the fresh and marine waters of the state of Washington.

WDOE has published "Lists of Waterbodies Required Under Section 304 (L)," Volume I and Volume II. Some boatyards intended to be covered by this general permit lie in several of the urban receiving waters listed for water quality violations of acute and chronic criteria for heavy metals such as copper, lead, zinc, and cadmium. While boatyards are not implicated in the report, it would be inappropriate to allow discharges with heavy metal concentrations above the respective water quality criterion from them.

Also cited for some receiving waters were other indicators such as high mortality in sediment bioassays, depressed benthic communities, and evidence of bioaccumulation of toxic compounds in some aquatic species. The indicators indirectly measure the impairment of the beneficial uses of the waterway.

In WAC 173-201-045 State waters are classified as AA (extraordinary), A (excellent), B (good), C (fair), and Lake. The characteristic beneficial uses of state waters are domestic, industrial and agricultural water supply; the spawning, rearing, migration and harvesting of fish; the spawning, rearing, and harvesting of shellfish; wildlife habitat, recreation (primary & secondary contact, sport fishing, boating, aesthetic enjoyment), commerce and navigation. Primary contact recreation, such as swimming, is not a beneficial use of class B or C waters.

WATER QUALITY IMPACTS - Pressure Wash Wastewater: WDOE (Elliott Bay and Commencement Bay Action Teams) has taken a few samples of wastewater plumes from untreated pressure washing of wood boat hulls in both marine and freshwater. Fresh water quality criteria were exceeded for arsenic, chromium, copper, lead, and zinc in the Lake Washington Ship Canal (Seattle). In the Shilshole (Seattle) area, copper and lead exceeded the marine criteria while zinc and selenium concentrations

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roughly matched the criteria.

Copper significantly exceeded the criterion with concentrations in the sampled discharge plumes being 1000 times the water quality criteria.

METRO has been sampling pressure washing wastewaters at both boatyards and shipyards. A summary of the analytical data from boatyards is given below.

PRESSURE WASHING ANALYTICAL DATA SUMMARY
BOATYARD DATA

Parameter	Untreated Maximum mg/l	Total Average mg/l	Treated Average mg/l	Dissolved Average mg/l
SS	840	520	---	---
Cd	0.009	0.004	0.002	0.002
Cr	2.7	0.45	0.081	0.024
Cu	72	43	2.3	1.7
Ni	0.07	0.04	0.01	0.01
Pb	14	2.2	0.1	0.05
Zn	22	6.2	3.2	1.12
Sn	1.4	0.61	0.1	0.067
As	0.05	0.05	0.05	0.05

Table-1

Comparing the Untreated Maximum data recorded above in Table-1 with the Acute Water Quality Criteria listed in Table-4 shows that without treatment and the benefit of a dilution zone in the receiving water, the discharges from the represented pressure washing wastewater would exceed water quality criteria. Fresh water criteria exceeded in the discharge would be for chrome, copper, lead and zinc. Acute criteria exceeded in marine waters would be copper, lead and zinc.

WATER QUALITY IMPACTS - Storm Water: The Commencement Bay Urban Bay Action Team has sampled storm water effluent from shipyards in Tacoma. Sampling for a NPDES permit application found that storm water had copper and zinc concentrations in the discharge exceeding both acute and chronic marine criteria. Concentrations of cadmium, lead, mercury and nickel also exceeded the chronic marine criteria. Once again, the most significant offender was copper.

Dr. Eric Crecelius[1] from Battelle did water quality, sediment and sediment trap sampling at Port Townsend and Cap Sante Marinas for the EPA Region X Estuary program. Both marinas have boat repair facilities associated with the marina. The mean concentrations of composite samples collected at the marinas' entrances as well as net flux of contaminants are summarized in Tables 2 & 3 below.

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PORT TOWNSEND*						
	TSS mg/l	Cu ug/l	Pb ug\l	Zn ug\l	PAH ug/l	TBT ug/l
Ebb	2.2	1.41	0.12	1.36	<25	7
Flood	3.65	1.10	0.10	0.94	<25	5
Ebb-Flood	-1.53	0.31	0.02	0.42	<25	2
Net Flux (g/day)	-0.000046	93	6	126	<8	0.6

Table-2 *Source: Winter 1990 Puget Sound Notes.

CAP SANTE*						
	TSS mg/l	Cu ug/l	Pb ug\l	Zn ug\l	PAH ug/l	TBT ug/l
Ebb	2.46	1.47	0.15	1.22	58	20
Flood	3.32	0.72	0.06	0.71	28	6
Ebb-Flood	-0.86	0.75	0.09	0.52	30	14
Net Flux (g/day)	-0.000046	400	48	270	16	7

Table-3 *Source: Winter 1990 Puget Sound Notes.

Despite the limited number of samples, the figures in the above table indicate that the receiving water in the vicinity of boatyard/marinas can be adversely impacted.

The EPA and state criteria, WAC 173-201-047(1), for acute toxic effects due to copper in marine water is 2.9 ug/L. EPA has not yet published criterion for chronic effects due to copper in marine water, but it can be expected to be less than 2.9 ug/L. The chronic criterion is presumed to be protective if the criterion is not exceeded by the four day average concentration more than once in three years on average and the acute criterion is not exceeded by the one hour average concentration more than once in three years on the average.

Dr Crecelius' reported mean copper concentration does not exceed currently published acute criterion. Nevertheless, if this sampling is representative of copper concentrations in the receiving water over the summer boating season, it at least indicates a need to minimize the input of copper to the receiving water.

This is particularly true if the assumptions about the frequency and duration of exposure of an organism to a toxicant are invalid for the local receiving water.

BENTHIC SURVEY AND RECEIVING WATER SEDIMENT QUALITY MANAGEMENT: Water quality standards specifically state that the department is to protect the beneficial use of state waters for shellfish. Washington's water pollution control law, Chapter 90.48.520 RCW also specifically directs the department to protect sediments. Sediment quality standards (WAC 173-204) have been adopted in order to assist in implementing this directive.

Clean up activities for existing sediment pollution is not appropriate to address under this permit. However, facilities covered and in compliance with this permit

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are not expected to add to current sediment pollution problems.

For this permit the issue is whether the permit requires the permittee to evaluate the status of the sediment. The evaluation would determine (1) if BMPs and structural controls including pressure wash water treatment are sufficient to protect sediment quality. Or, (2) if the assessment and verification deferred until maintenance dredging is performed, or (3) whether to defer assessment and verification until sediment testing and analysis has been performed at several other local shipyards having individual NPDES permits, or (4) whether to defer assessment and verification until the Toxics Cleanup Program has reason to look at a specific site.

WDOE prefers to wait until sediment sampling has been done at several shipyards having current NPDES permits. If there is sediment contamination and it is evident ongoing contamination is a problem, then WDOE will reassess whether sediment sampling should be done at boatyards.

If violations of water quality or sediment standards are found and determined to be due to insufficiently stringent permit conditions, WDOE retains the right to issue an individual NPDES permit for the "problem" facility.

TREATMENT: RCW 90.48.010, 90.52.040 and 90.54.020 require the use of all known, available and reasonable methods (AKART) to prevent and control the pollution of waters of the state. In a similar fashion EPA guidance for storm water permitting is emphasizing the use of structural controls and Best Management Practices (BMPs) to prevent the discharge of pollutants via storm water runoff.

The draft EPA "Development Document for Shipbuilding and Repair," EPA 440/1-70/076-b, recommends BMPs as the primary method of controlling waste discharges from shipyards to the waters of the state. BMPs achieve pollution control through careful management of the product streams, segregation of potential pollutants in waste streams, and prevent or minimize contact between water and waste material.

40 CFR 122.2 defines BMPs as schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce pollution of "waters of the United States." BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

EPA, in its draft "Development Document for Shipbuilding and Repair," has determined that BMPs constitute BPT (Best Practicable Control Technology) for the shipyard industry. WDOE has concluded that BMPs constitute BPT for the boatyard industry and that collection and treatment of pressure wash wastewaters constitutes BAT (Best Available Technology Economically Achievable). Further, it is WDOE's present determination that full implementation of BMPs and effective collection and treatment of pressure wash wastewaters will result in discharges in compliance with State water quality standards.

Under 40 CFR 125.3, compliance with BPT and BAT controls to achieve effluent limitations established on a case-by-case Best Professional Judgement (BPJ) basis is to be achieved no later then March 31, 1989. Regulatory agencies cannot establish compliance schedules in permits which go beyond the statutory deadlines for meeting technology-based limitations. WDOE has determined that the BMPs proposed in the draft permit represent application of BAT/BPT. However, discharges from this industry have not previously been regulated by NPDES permits in Washington State. Furthermore, WDOE anticipates that the industry as a whole will require a reasonable period of time to fully implement the BMPs and construct necessary wastewater collection and treatment facilities. Therefore, WDOE proposes to exercise prosecutorial discretion in enforcing compliance with permit conditions for a period of one year from permit issuance for implementation of BMPs and two years from permit issuance to provide collection and treatment of pressure wash waters.

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Facilities are required to apply for coverage under this permit within 9 months of permit issuance.

BMPs to collect, and contain wastes and minimize waste generation during vessel repair and maintenance work have been researched, compiled and distributed in Washington by WDOE, the Lake Union Association Water Quality Committee and the Puget Sound Shipbuilders Association with funding assistance from the Puget Sound Water Quality Authority. These BMPs are very similar to the BMPs published by the state of Virginia for it's shipyard industry.

WDOE has determined that for most wastewaters from the boatyard industry the BMPs, coupled with collection and treatment of pressure wash wastewater included in the proposed general permit, constitute AKART.

Many of the sources discussed in the Pollutant Sources section above can be contained, controlled or substantially reduced by the implementation of BMPs. BMPs are an essential component of the proposed general NPDES permit. Facilities to be covered by the general permit will be required to implement them as specified in the permit. The BMPs in the general permit will include requirements for:

Compliance with Best Management Practices
Education of Employees and Customers
Yard Cleaning and Sweeping
Sediment Traps
Dust and Overspray Control
Maintenance of Hoses and Piping
Bilge Water
Paint and Solvent Use
Use of Antifouling Paints
Prohibition on use of Tributyltin
Cleanup of Debris and Spent Paint
Chemical Storage
Waste Disposal
Dangerous Waste Handling & Reporting
Recycling of Spilled Chemicals and Rinse Water
Accidental Oil Discharge
Oil, Grease, and Fuel Transfers

To encourage the regulated industry to implement BMPs WDOE, EPA, and many local solid waste utilities provide waste information exchange with advice on pollution prevention, waste reduction and recycling options. In addition, a waste disposal exchange service, Industrial Materials Exchange Service (IMEX), is available to help industries find buyers for surplus/waste products, locate inexpensive materials, conserve energy, and otherwise promote waste reduction and recycling. An informational packet accompanying the permit will contain phone numbers for IMEX, technical assistance and hazardous waste disposal, reuse prevention and recycle.

Implementation of BMPs is anticipated to minimize or eliminate contamination of storm water from most areas of boatyards. But, contaminated wastewater may still be present from pressure washing of hulls. Therefore, collection and treatment of the pressure washing wastewater will be required to protect receiving waters.

Pressure washing, referred to as hydroblasting in the EPA "Development Document for Shipbuilding and Ship Repair," was researched and discussed minimally. Research was conducted for WDOE by the University of Washington to provide WDOE a basis to define "AKART" for pressure washing wastewaters. Until other research efforts are concluded, the present preference for treating and disposing of pressure washing wastewater are:

(1) recycle/conservation, (2) collect and discharge (with pretreatment

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as necessary) the wastewater to the sanitary sewer, (3) collect and treat the wastewater by sedimentation, or (4) collect and treat the wastewater by chemical (alum) addition followed by sedimentation.

Option 1 - Recycle/conservation

The preferred means of preventing pollution from pressure washing anti-fouling paint is recycling of pressure wash wastewater. This method is also referred to as "a total closed loop system" or "zero discharge". The recycled water does eventually become dirty, requiring disposal or treatment.

For boatyard facilities which have the ability to connect to a POTW (Publicly Owned Treatment Works) recycling, with occasional discharge of dirty recycle water to the POTW, would be the best treatment and conservation method.

For facilities which are unable to physically connect to a POTW, recycling is probably the only economically feasible option. The dirty recycle water must be hauled to a treatment facility.

The guidance manual being developed by METRO will give a more detailed discussion of recycling options for pressure wash wastewaters.

Also being discussed and evaluated is a means to avoid or minimize the leaching of copper ions from the boat bottom. This technique requires developing substitutes for cuprous oxide anti-fouling paint. Alternatives such as copper sheathing and imbedding the copper in an epoxy resin are available, but so far are used only on a limited basis. The alternatives to anti-fouling paints have proven to be problematic in their application and use.

Option 2 - Discharge to POTW

A few boat repair yards have received authorization to discharge a portion of their wastewater, including pressure wash wastewater and some storm water from a restricted work area, to the local POTW. Others are seeking to construct boat wash down facilities discharging to the POTW.

The POTW limits in Table-5 were adopted from METRO's limits.
Other POTW's are expected to have similar limit requirements for discharge to their systems.

Option 2 has some regulatory constraints. Sewerage authorities must protect their sludge quality while also protecting water quality. Proposed treatment plants and sludge quality regulations severely limit sludge disposal options for sludge containing excessive amounts of heavy metals. Therefore, it may be necessary to pretreat the pressure wash wastewater to meet the POTW limits.

Information on the effectiveness of the pretreatment options and experience with the operation and maintenance of pretreatment systems is minimal. The METRO treatment study should help the industry and local sewer authorities rectify this.

Other constraints include prohibitions regarding the disposal of tributyltin (TBT) paints. Basically, it is illegal to dispose of TBT except at regulated sanitary landfills and through thermal destruction or other approved equivalent processes. TBT use is allowed on aluminum vessels which are common in the local fishing fleets. Therefore care must be exercised to keep TBT out of the sludge to maintain inexpensive sludge disposal options.

Option 3 - Sedimentation/Filtration

Because of the low specific gravity of the solid particles removed (1.000 to 1.005) and the mean size (40 microns) sedimentation alone (option 3) as a treatment method

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is believed to have limited effectiveness. METRO's research should determine sedimentation's effectiveness.

Option 4 - Chemical Treatment

The main drawback to chemical (alum) treatment of the pressure washing wastewaters (option 4) is the lack of information on cost and effectiveness.

PERMIT REQUIREMENTS AND BASES FOR LIMITATION - General:

Effluent monitoring is used to verify that pollutants are not being discharged to a receiving water via direct process water discharges and storm water flows.

Typically effluent limits are determined from technology based standards of established effluent guidelines. Effluent limits for this permit are based on the water quality standards including the characteristic uses defined in WAC 173-201-045 and the toxicant control provisions of RCW 90.48.520.

Water quality criteria are established for heavy metals in saltwater and freshwater. Table-4 lists the water quality criteria for metals which have been identified as pollutants of concern for facilities covered under this general permit. In freshwater the criterion varies with the hardness. For this discussion a hardness of 50 mg/L as $CaCO_3$ is assumed. This conservative assumption has been selected because of the wide variety of (fresh water) receiving waters impacted by the boatyard industry.

WATER QUALITY CRITERIA for HEAVY METALS				
Metal*	Acute (ug/l)		Chronic (ug/l)	
	Fresh	Salt	Fresh	Salt
TR As	360.0	69.0	190.0	36.0
TR Cu	9.2	2.9	6.5	none
TR Pb	33.8	140.0	1.3	5.6
TR Zn	65.0	95.0	58.9	86.0

Table-4 *TR means total recoverable.

PERMIT REQUIREMENTS AND BASES FOR LIMITATION - Pressure Wash Waste Water: The primary source of the heavy metals in wastewater is from paint applied to the boat hull. In waste stream sampling to date, copper has exceeded the water quality criteria by several orders of magnitude. Compliance with effluent limits for copper are the clearest indicator that water quality has been protected. However, sampling and analysis of additional metals would provide increased quality assurance. The next most common metals, by frequency and in magnitude, in boatyard and shipyard wastewater (or contaminated storm water) are zinc and lead.

Effluent limits for heavy metals in boat wash down water or from pressure washing are intended to protect water quality. Treatment of the pressure wash wastewater from boat hulls is necessary to avoid pollution of local receiving waters. At a minimum, treatment will include sedimentation requiring a tank and possibly chemical addition. Therefore, it is feasible to discharge treated effluent at a low rate, such as 10 gpm or less, to allow for some dilution. Proposed permit effluent limits reflect a 10 to 1 dilution. This is based on low flows associated with pressure wash operations and (for the most part) large receiving waters associated with most boatyards. WDOE recognizes the conservative nature of this estimate dilution

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barring site specific dilution zone studies.
Previous analyses of ship/boat wash down water indicate that heavy metals in the waste stream are concentrated to approximately 1000 times the water quality criterion. WDOE finds it appropriate to monitor concentrations of heavy metals present in pressure wash water discharged to state waters by boatyards. Monitoring of pressure wash waters discharged to surface waters will be reduced over time. Reduction will only be allowed if monitoring demonstrates that pressure wash water treatment is effective in protecting water quality and the operation and maintenance of treatment facilities is effective.

PERMIT REQUIREMENTS AND BASES FOR MONITORING - Storm Water: The EPA has published a draft general permit for storm water discharges. Two industrial categories, "Primary Metal Industries" and "Other Facilities" provide guidance on additional parameters to be monitored. Both require monitoring for oil and grease; five day biological oxygen demand (BOD5); chemical oxygen demand (COD); total suspended solids (TSS); total kjeldahl nitrogen (TKN); nitrate plus nitrite nitrogen (NO_3+NO_2); total phosphorus and pH. At primary metal industries, the EPA is also interested in total copper, total lead, total arsenic, total chromium and total cadmium.

For the boatyard industry WDOE has determined that monitoring will be required for copper, TSS, and oil and grease.

Copper was selected as a monitoring parameter because it is often identified as a pollutant of industrial storm waters. Also, the METRO study has shown (to date) that copper is the most prevalent metal found in boatyard wastewaters. Therefore it is a prime indicator metal in determining if an individual boatyard has properly instituted BMPs.

Oil and grease monitoring is necessary because of the volume of petroleum products stored and handled at boatyards. For example routine boat maintenance and repair operations include: engine maintenance, fuel, hydraulic, and lube oil transfers.

TSS is defined as residual non-filterable solids (particulate matter) retained from a water sample by a glass-fiber filter and dried at a constant temperature at 103 to 105 degrees C. Particulate matter blankets the bottom of water bodies. It adsorbs contaminants, damages the invertebrate populations (resulting in high moralities), and blocks gravel spawning beds.

TSS is a parameter requiring monitoring because of grinding, sanding and sand blasting operations associated with boatyard activities. Without implementation of BMPs, boatyard activities contribute to the presence of TSS in storm water.

To satisfy EPA requirements, annual monitoring of storm water discharges (see table-5) will be required at boatyards covered under this permit. WDOE will compare the results of this monitoring with State water quality standards.

PROPOSED EFFLUENT LIMITS AND MONITORING REQUIREMENTS: Monitoring samples shall be taken at the waste water and storm water outfalls, but before these water streams have reached state receiving waters. Dilution of waste water and storm water samples will be prohibited under the requirements of this permit.

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PROPOSED LIMITS & MONITORING REQUIREMENTS for PRESSURE WASH WASTEWATER DISCHARGE				
PARAMETER	SAMPLE TYPE	TO MARINE WATERS[1] (daily maximums)	TO FRESH WATERS[1] (daily maximums)	TO POTW[2]
Flow	Meter or calculate	10 gpm	10 gpm	N/A
TR Cu[3]	Grab	30 ug/l	90 ug/l	2.4 mg/l
TR Zn	Grab	950 ug/l	650 ug/l	3.3 mg/l
TR Pb	Grab	1400 ug/l	340 ug/l	1.2 mg/l
TR As	Grab	690 ug/l	3600 ug/l	3.6 mg/l

Table-5

NOTES: (1) Weekly monitoring is required if the boatyard covered under this permit pressure washes more than 10 vessels per week; otherwise, monitoring frequency is every 10th vessel, whichever is less.
(2) Semi-annual monitoring is required. The sampling frequency may be more frequent at the discretion of the local sewerage authority.
(3) TR means total recoverable.

PROPOSED MONITORING REQUIREMENTS for STORM WATER DISCHARGE		
Parameter	Minimum Frequency	Sample Type
Flow	annually	estimate
Oil & Grease[1]	annually	grab
TSS	annually	grab
TR Copper	annually	grab

Table-6

Note: (1) Discharges shall not have, nor cause a visible oil sheen in the receiving waters.

IMPLEMENTATION: TAC has recommended that compliance verification rely on inspections by WDOE, imposition of BMPs and structural controls. Structural controls include catch basins and drains, berms, dikes and other containment for oils, chemicals and wastes; roofed storage areas, wastewater treatment facilities, etc. Some structural controls are required to implement the BMPs. Others are needed to collect and treat wastewater and some storm waters.

WDOE has determined that in most cases implementing the BMPs will be sufficient to prevent contamination of storm water. Some facilities that may need additional structural controls to supplement the BMPs in pollution prevention, will need cooperation from property owners, leasing agents, and local shoreline and building departments.

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WDOE anticipates it may take facilities requesting coverage under this general permit 9 months to 1 year to institute BMPs. WDOE will exercise discretionary enforcement during this time.

For the existing boatyards needing treatment facilities for pressure washing wastewater, a generic engineering report recommending several treatment options is feasible and desirable. The METRO treatment study will fulfil this need. Boatyard operators, individually or collectively, will be able to select a treatment option identified in the engineering report and procure an engineer to prepare plans and specifications locating and implementing the chosen option for each facility.

Individual facilities to be covered under this general permit will be required to obtain a spill control plan and keep a copy of it on site. Based on its experience with spill control plans for shipyards, WDOE believes a general spill control plan can be prepared for boatyards collectively.

In a similar manner it is WDOE's opinion that a generic solid waste disposal plan can be developed for the boatyard industry. A copy of the solid waste disposal plan shall also be kept on site.

ENFORCEMENT: The proposed permit intends to rely on BMPs to prevent negative water quality impacts. Effluent monitoring is provided for verifying the effectiveness of the BMPs. If routine inspections of boatyards identify recalcitrant businesses which have not fully implemented pollution prevention practices including BMPs and appropriate structural controls then enforcement actions will be taken as the situation warrants.

RECOMMENDATIONS: A general NPDES permit should be issued which requires implementation of BMPs and effluent monitoring to prevent or control pollution of the waters of the state from boatyards. Boatyards applying and eligible for coverage under this permit will be issued a general permit to expire at no more than five years after date of issuance.

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Fact Sheet Prepared by Richard A. Koch
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IV-2.1.16 WOOD PRODUCTS
SIC: 2420** - 2450**, 2434*, 2490**, 2511/12*, 2517*, 2519*, 2521*, 2541*

DESCRIPTION: This group includes sawmills, and all businesses that make wood products using cut wood, with the exception of wood treatment businesses. Wood treatment as well as log storage and sorting yards are covered separately in Sections IV-2.1.17 and IV-2.1.8, respectively.

Included in this group are planing mills, millworks, and businesses that make wooden containers and prefab building components, mobile homes, and glued-wood products like laminated beams, as well as office and home furniture, partitions, and cabinets.

All businesses employ cutting equipment whose by-products are chips and sawdust. Finishing occurs in many operations.

MATERIALS USED AND WASTES GENERATED: Primary sources of contaminants are the trucks transporting stock lumber into and products from the businesses. Maintenance and repair of manufacturing equipment will produce waste oil and cleaning solvents that may be temporarily stored outside. Businesses may have finishing operations that produce waste paints and paint thinners, turpentine, shellac, and varnishes.

Source Control BMPs: See BMPs S1.20, S1.30, S1.40, S1.50, S1.60, S1.70, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

Regulatory Requirements: See R.1, R.2, R.3, R.4, R.10, R.11 and R.12 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas where manufacturing processes occur or raw logs and/or products are stored shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.1.17 WOOD TREATMENT
SIC: 2491

DESCRIPTION: This grouping includes both anti-staining and wood preserving. The businesses usually work with wood stock purchased from a mill. The lumber is stored on-site, outside the process building. It must be brought to the proper moisture content prior to treatment, which is achieved by either air-drying or kiln drying. Some wood trimming may occur. After treatment, the product is typically stored outside. Forklifts are used to move both the raw and finished product.

Wood treatment consists of a pressure process using the chemicals described below. Anti-staining treatment is done using dip tanks or by spraying.

MATERIALS USED AND WASTES GENERATED: The wood preserving industry produces a special set of liquid wastes. The raw materials used to preserve wood are creosote, creosote/coal tar, or pentachlorophenol dissolved in a petroleum-based solvent, copper naphthenate or inorganic arsenicals such as chromated copper arsenate dissolved in water. The use of pentachlorophenol is declining in the Puget Sound region.

Potential sources of stormwater and/or ground water contamination include spills from around the retort area, drippings from treated wood, equipment leaks, and spills from the unloading and use of the preservative.

Source Control BMPs: See BMPs S1.20, S1.30, S1.40, S1.50, S1.60, S1.70, S1.80, S1.90, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions. In addition, the following BMPs are specifically required where wood treatment occurs:

- *Ground areas around dip tanks, spray booths, retorts, and any other process equipment shall be paved, and sloped and drained in a manner that allows the capture and return of treatment chemicals back to the wood treatment process.*
- *Dipped lumber shall be required to drip over the dip tank, or be placed on an inclined ramp for a minimum of 30 minutes to allow return of the excess chemical to the dip tank.*
- *Treated lumber either from dip tanks or retorts shall be placed in a covered paved storage area for at least 24 hours before placement in outside storage. A longer storage period shall be used during cold weather unless the temporary storage building is heated. The wood shall be drip free and surface dry before it is moved elsewhere.*
- *Eliminate non-process traffic on and off the drip pad. A fork lift should be dedicated to the drip pad.*
- *Remove and properly dispose of soils with visible surface contamination (green soil) to decrease the spread of chemicals to ground water and/or surface water via stormwater runoff. Take steps to prevent future occurrences.*
- *Keep treated wood out of areas where surface water drainage is apparent.*
- *Scrub down non-dedicated lift trucks on the drip pad.*
- *Design improved runoff and process water collection facilities for roofs/asphalt, and any ponding areas. Improvements may include segregating clean rain water (e.g. rain water from rooftops) from process water. Ensure all process water is collected and recycled to the process treatment system.*
- *If any wood is observed to be contributing chemicals to the environment in the treated wood storage area, relocate it on a concrete chemical containment*

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structure until the surface is clean and until it is drip free and surface dry. Clean up, remove and properly dispose of any contaminated soil from the treated wood storage area.

- *Seal any holes which can allow stormwater to migrate from the asphalted area to the soil.*

Regulatory Requirements: See R.1, R.2, R.3, R.7, R.10, R.11 and R.12 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas where manufacturing processes occur or lumber is stored shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.1.18 OTHER MANUFACTURING BUSINESSES
SIC: 2200*, 2300*, 2873/74**, 3100*, 3200**, 3250-69**, 3280**, 3290**

DESCRIPTION: Includes manufacturing of textiles and apparel, agricultural fertilizers, leather products, clay products such as bricks, pottery, bathroom fixtures; and nonmetallic mineral products.

All of the above manufacturers are represented in the Puget Sound region. The manufacturing businesses specifically excluded from consideration in this group were listed in Chapter IV-1.

MATERIALS USED AND WASTES GENERATED: A survey of businesses in the Seattle area found Dangerous Wastes being generated by all of the above types of manufacturers.

Source Control BMPs: See BMPs S1.10, S1.20, S1.30, S1.40, S1.50, S1.60, S1.70, S1.80, S1.90, S2.00 and S2.20 in Chapter IV-4 to determine what BMPs are applicable to the specific manufacturer.

Regulatory Requirements: See R.1, R.2, R.3, R.4, R.5, R.6, R.7, R.8, R.9, R.10, R.11 and R.12 in Chapter IV-5 as applicable.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas where manufacturing processes occur shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.2 TRANSPORTATION AND COMMUNICATION

IV-2.2.1 AIRFIELDS AND AIRCRAFT MAINTENANCE

SIC: 4513, 4515

DESCRIPTION: There are both public and private airfields in the Puget Sound basin. Aircraft maintenance at public airfields is usually a private business. Fueling of aircraft occurs.

MATERIALS USED AND WASTES GENERATED: The large areas used for taxiing takeoffs and landings are usually paved except at the smallest private airfields. Fueling is accomplished by tank trucks at the aircraft and is a source of spills. Dripping of fuel and engine fluids from the aircraft is a source of stormwater contamination.

Aircraft maintenance produces a wide variety of waste products, similar to those found with any vehicle or equipment maintenance: used oil and cleaning solvents, paints, oil filters, and soiled rags. Aircraft are washed producing soapy wastewater.

Source Control BMPs: See BMPs S1.10, S1.20, S1.30, S1.40, S1.50, S1.80, S2.00 and S2.20 in Chapter IV-4.

Additionally, the following BMPs shall be implemented.

- *Fueling of aircraft shall be done with the utmost care to avoid spillage. Large airfields where the fueling of large multi-engine aircraft occur shall have incorporated in their storm drainage system a low-flow collection system that allows for the separate collection and treatment (see Stormwater Treatment BMPs, below) of spilled fuel. Smaller airfields shall have suitable materials available for cleanup when spills occur.*
- *Drain oil filters while the oil is warm for as long as possible (24 hours) and at an angle. Collect the oil for recycling in a separate, labeled container. Drained filters should be kept in a suitable container or drum and sent to a scrap metal recycler or hazardous waste management facility. Don't put undrained filters in the dumpster, or put drained filters in the dumpster without first checking with your local health department.*
- *The airfield owner shall post in prominent locations or otherwise promulgate at least once a year to its tenants, both aircraft owners and maintenance businesses, the above list of BMPs that relate to the prevention of spillage and storage and disposal of waste products.*

Regulatory Requirements: See R.1, R.2, R.3, R.6, R.7, R.11 and R.12 in Chapter IV-5.

Stormwater Treatment BMPs: For small airfields, stormwater from the paved surfaces shall be treated using biofilters given that large grassed areas are typically available around such fields (Volume III, Runoff Control).

For large airfields, stormwater from parking and maintenance areas where dripping oil or hydraulic fluids is likely to be occurring shall be treated by an API or CPI-type oil/water separator (BMP RD.35 in Volume III, Runoff Control). Stormwater from employee parking lots shall be treated using one of the systems described in Volume III.

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no storm sewer to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.2.2 FLEET VEHICLE YARDS
SIC: 4100 , 4210 , 4230 , 7381/2, 7510

DESCRIPTION: Includes all businesses which own, operate and possibly maintain or repair large vehicle fleets, including taxis, buses, truck freight service, courier and armored car service, as well as the renting or leasing of cars, trucks, and trailers.

Such businesses are likely to maintain, wash and fuel their own vehicles on-site and therefore will possess many of the characteristics of general service gas stations or vehicle repair service shops. Washing may take place in enclosed and fully automated systems like commercial vehicle washers, or by hand in the parking area. Truck and bus engines and engine parts are often steam cleaned. Some fleet owners may store retired vehicles on site to be stripped for parts. A common practice with taxi fleets, this may result in the spilling of engine fluids.

MATERIALS USED AND WASTES GENERATED: Both solid and liquid wastes are produced. Waste materials generated by the various operations include: used oils, oil filters, antifreeze, solvents, brake fluid, and batteries, sulfuric acid, battery acid sludges, empty contaminated containers and soiled rags. Spillage of gasoline and diesel fuels occurs from pumps and during transfer from tanker trucks to underground storage tanks. Leaking underground storage tanks can cause ground water contamination and is a safety hazard.

Stormwater can be contaminated by: fuels and oil spilled on exposed paved surfaces; by solid and liquid wastes (noted above) that are not properly stored while awaiting disposal or recycling; dirt, oils and greases from steam cleaning and vehicle washing that occurs outside; and dripping of these same materials from parked vehicles. Stormwater contaminated by fuels may contain significant concentrations of dissolved organics that cannot be removed by an oil/water separator. Water is produced from vehicle and parts washing and steam cleaning.

Research by the Municipality of Metropolitan Seattle (Metro) of its bus bases indicates that mean concentrations of oil and grease typically range from 10 to 20 mg/l with individual samples commonly exceeding 50 mg/l. This level greatly exceeds Ecology's guideline of no more than 10 mg/l and indicates need for conscientious source control measures.

Deliberate disposal of materials to the storm sewer may occur, in particular used oils and brake fluid, used antifreeze and radiator flush. In many areas of the Puget Sound basin used oil and antifreeze are regularly recycled. Contact the appropriate local government for information on recycling of these wastes, or call Ecology's Recycling Hotline at 1-800-RECYCLE.

It is common practice to temporarily store used oils, brake fluid, and solvent in underground fixed tanks although the latter is usually stored in steel drums.

Source Control BMPs: See BMPs S1.10, S1.20, S1.30, S1.40, S1.50, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

- *In addition, retired vehicles kept on-site must be emptied of unused gas, transmission and hydraulic fluid, and radiator coolant. All fluids should be disposed of properly, preferably through recycling.*
- *Drain oil filters while the oil is warm for as long as possible (24 hours) and at an angle. Collect the oil for recycling in a separate, labeled container. Drained filters should be kept in a suitable container or drum and sent to a scrap metal recycler or hazardous waste management facility. Don't put undrained filters in the dumpster, or put drained filters in the dumpster without first checking with your local health department.*

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For more information on automotive repair and disposal requirements for solid and hazardous wastes, see Step By Step: Fact Sheets for Hazardous Waste Generators, publication 91-12, available from Ecology's Regional Offices.

Regulatory Requirements: See R.1, R.2, R.3, R.6, R.7, R.10 and R.11 in Chapter IV-5.

Stormwater Treatment BMPs: Stormwater from parking and maintenance areas where dripping oil or hydraulic fluids is likely to be occurring shall be treated by an API or CPI-type oil/water separator (BMP RD.35 in Volume III, Runoff Control). Stormwater from employee parking lots shall also be treated either in with or separately from the fleet vehicle parking areas using one of the systems described in Volume III.

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.2.3 RAILROADS
SIC: 4011 /13

DESCRIPTION: Railroad activities are spread over a large geographic area: along railroad lines, in switching yards, and in maintenance yards. Railroad activity occurs on both property owned or leased by the railroad and at the loading or unloading facilities of its customers. The BMPs presented here are for those activities that occur on property owned by the railroad, and therefore are its responsibility to implement. Employing BMPs at commercial or public loading and unloading areas is the responsibility of the particular property owner.

MATERIALS USED AND WASTES GENERATED: Along railroad lines and in switching yards, there are six potential sources of nonpoint pollution: herbicides used for vegetation management, dripping of vehicle fluids onto the road bed, leaching of wood preservatives from the railroad ties, human waste disposal, litter, and the erosion and loss of soil particles from the bed. The latter is both a source of sediment pollution and the mechanism by which vehicle fluids and wood preservatives reach a receiving water. The significance of each of these sources is not known. Human wastes may be disposed of while a train is enroute, over bridges or near water bodies.

Activities in the maintenance yards are similar to those found in businesses that maintain trucks and heavy construction equipment, and therefore the wastes are similar. In addition to the railroad stock, the maintenance shops service highway vehicles and other types of equipment. Waste materials can include waste oil, solvents, degreasers, antifreeze, radiator flush, acid solutions, brake fluids, soiled rags, oil filters, sulfuric acid and battery sludges, and machine chips with residual machining oil.

Source Control BMPs: See BMPs S1.10, S1.20, S1.30, S1.40, S1.50, S1.60, S1.80, S1.90, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions. In addition, the following specific BMPs shall be used:

- *Use railroad ties constructed with a material other than wood, or use ties that have been preserved with chemicals less toxic than creosote or pentachlorophenol, such as inorganic arsenicals and copper naphthelate.*
- *Develop a written policy with maintenance guidelines and an implementation schedule that insures erosion and/or loss of fine sediments from railroad beds is minimized, particularly in the vicinity of surface waters. The policy shall satisfy the General Criteria for Erosion and Sediment Control in Chapter II-4 of Volume II. Additionally, debris should not be discarded along the tracks during maintenance.*
- *Toilet tanks shall not be emptied while a train is in transit. Instead, pumpout facilities should be available to service these units.*

Regulatory Requirements: See R.1, R.2, R.3, R.7, R.8, R.10, and R.11 in Chapter IV-5.

Stormwater Treatment BMPs: Stormwater from parking and maintenance areas where dripping oil or hydraulic fluids are likely to occur shall be treated by an API or CPI-type oil/water separator (BMP RD.35 in Volume III, Runoff Control).

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.2.4 PRIVATE UTILITY CORRIDORS
SIC: 4610, 4922, 4941

DESCRIPTION: Utility corridors include lines for petroleum and petroleum products, natural gas, and electrical power.

MATERIALS USED AND WASTES GENERATED: Two potential sources of nonpoint pollution include herbicides used for vegetation management and the erosion and loss of soil particles from the unpaved access roads.

At pump stations waste materials generated during maintenance activities may be temporarily stored outside the station rather than being removed immediately for disposal. Storage facilities must be adequate to prevent both surface and/or ground water contamination.

Additional potential sources of stormwater and/or ground water contamination in electric transmission systems include the leaching of preservatives from wooden utility poles, PCBs in older transformers, and water that is removed from underground transformer vaults, and potential for leakage of petroleum products from pipelines.

Source Control BMPs: See BMPs S1.50, S1.90, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

In addition, the following BMPs also apply:

- *Develop a written policy with maintenance procedures and an implementation schedule to minimize bare or thinly vegetated ground surfaces within the corridor where erosion will result in the entry of sediments into adjacent surface waters.*
- *The above policy shall satisfy General Criteria for Erosion and Sediment Control (Chapter II-4 of Volume II).*
- *Do not temporarily store waste materials around pump stations and unstaffed electric substations.*
- *Electric utilities should use power poles made with a material other than wood, or use poles that have been preserved with chemicals less toxic than creosote or pentachlorophenol, such as inorganic arsenicals and copper naphthelate.*
- *Water removed from electric transformer vaults should first be analyzed for the presence of Dangerous Wastes. Water removed shall only be disposed of to a sanitary sewer consistent with pretreatment requirements imposed by the local Sewer Authority (R.1 in Chapter IV-5) if these wastes are uncontaminated by PCBs or other materials. If contaminated, they shall be treated as Dangerous Waste and disposed of appropriately.*
- *Remove all litter caused by wire changes etc.*
- *Maintenance practices shall insure that stormwater does not accumulate and drain across and/or onto roadways but instead through roadside ditches and culverts. The road shall be crowned, outsloped, water barred or otherwise left in a condition not conducive to accelerated erosion. Grass-lining and appropriately maintaining a roadside ditch discharging to surface water is an effective way of removing some pollutants associated with particulates carried by the stormwater.*

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- *Ditches and culverts shall be maintained at the appropriate frequency to insure that plugging and flooding across the roadbed does not occur.*
- *When applying pesticides, comply with Ch. 17.21 RCW and Ch. 16-228 WAC (see R.8 in Chapter IV-5 and BMP S1.90 in Chapter IV-4).*

Regulatory Requirements: See R.1, R.3, and R.7 in Chapter IV-5.

Stormwater Treatment BMPs: No stormwater treatment BMPs are required.

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IV-2.2.5 WAREHOUSES AND MINIWAREHOUSES
SIC: 4220

DESCRIPTION: Businesses that store goods.

MATERIALS USED AND WASTES GENERATED: Warehouse businesses that only provide storage will not produce any pollutants of concern except from the accidental spillage of liquids from containers that are dropped during loading and unloading. General stormwater contaminants will come from the paved areas surrounding the warehouse, especially if there are large areas of impervious surface or high amounts of vehicular traffic. Some warehouse businesses own their own fleet of trucks. Consequently, their characteristics will be similar to "Fleet Vehicle Yards."

Source Control BMPs: Mini-warehouses used by the public are not required to install any BMPs with two exceptions: A SC-type oil/water separator (BMP RD.35 in the Runoff Control Volume) and/or a biofilter (BMP RB.05 in the Runoff Control Volume) shall be installed, and the paved area surrounding the warehouse shall be swept at appropriate intervals to remove debris.

If the warehouse business owns a fleet of vehicles, refer to "Fleet Vehicle Yards" Section IV-2.2.2 for the appropriate BMPs. The following BMPs are for businesses that provide a warehouse service.

Commercial warehouses shall refer to the following BMPs found in Chapter IV-4: S1.30, S1.50, S1.60, S2.00 and S2.20.

Regulatory Requirements: See R.1, R.2, R.3, R.4, R.7, and R.11 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas where manufacturing processes occur shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater runoff from rooftops may be discharged to a storm drain or combined sewer below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.2.6 OTHER TRANSPORTATION AND COMMUNICATION
SIC: 4700-4900

DESCRIPTION: This group includes travel agencies, communication services such as TV and radio stations, cable companies, and electric and gas services. It does not include railroads, airplane transport services, airlines, pipeline companies, and airfields.

MATERIALS USED AND WASTES GENERATED: Gas and electric services are likely to own vehicles that are washed, fueled and maintained on site. A survey of communication service companies in the Puget Sound area has found the generation of used oils and Dangerous Wastes.

Source Control BMPs: See BMPs S1.10, S1.20, S1.30, S1.40, S1.50, S1.80, S1.90, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

Regulatory Requirements: See R.1, R.2, R.3, R.7, and R.10 in Chapter IV-5.

Stormwater Treatment BMPs: Stormwater from parking lots shall be treated by one of the treatment systems described in Volume III, Runoff Control.

Stormwater runoff from rooftops may be discharged to the storm drain or combined sewer below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.3 WHOLESALE AND RETAIL BUSINESSES

IV-2.3.1 GAS STATIONS
SIC: 5540

DESCRIPTION: Gasoline service stations primarily sell gasoline and lubricating oils. Most perform minor repair and maintenance including: servicing of engine hydraulic systems, brakes, transmission, and differential; replacement of engine coolant; lubrication of the body chassis and wheel bearings; engine cleaning; servicing of the air-conditioning system; and the servicing of tires and batteries.

Ancillary activities often present are: car washing and/or steam cleaning that may occur within the building or outside on the paved area; sale of food products; and the rental of trucks or trailers.

MATERIALS USED AND WASTES GENERATED: Both solid and liquid wastes are produced, as well as stormwater runoff from the paved surfaces. Waste materials generated by the various operations include: used oils, oil filters, antifreeze, solvents, brake fluid, and batteries, sulfuric acid, battery acid sludges, empty contaminated containers and soiled rags. Spillage of gasoline and diesel fuels occurs, from the pumps and during transfer from tanker trucks to the underground storage tanks. Leaking underground storage tanks can cause surface and/or ground water contamination as well as being a safety hazard.

Stormwater can be contaminated by: fuels and oil spilled on exposed paved surfaces; by solid and liquid wastes (noted above) that are not properly stored while awaiting disposal or recycling; dirt, oils and greases from steam cleaning and vehicle washing that occurs outside; and dripping of these same materials from parked vehicles. Stormwater and/or ground water contaminated by fuels may contain significant concentrations of dissolved organics that cannot be removed by an oil/water separator.

Deliberate disposal of materials to the storm drain can occur, in particular used oils and brake fluid, used antifreeze and radiator flush. It is currently common practice to temporarily store used oils, brake fluid, and solvent in underground fixed tanks although the latter is more frequently stored in steel drums.

Source Control BMPs: See BMPs S1.10, S1.20, S1.30, S1.40, S1.50, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

Additionally:

- *Drain oil filters while the oil is warm for as long as possible (24 hours) and at an angle. Collect the oil for recycling in a separate, labeled container. Drained filters should be kept in a suitable container or drum and sent to a scrap metal recycler or hazardous waste management facility. Don't put undrained filters in the dumpster, or put drained filters in the dumpster without first checking with your local health department.*

For more information on automotive repair and disposal requirements for solid and hazardous wastes, see Step By Step: Fact Sheets for Hazardous Waste Generators, publication 91-12, available from Ecology's Regional Offices.

Regulatory Requirements: See R.1, R.2, R.3, R.6, R.7, and R.10 in Chapter IV-5.

Stormwater Treatment BMPs: Stormwater from parking and maintenance areas where dripping oil or hydraulic fluids is likely to be occurring shall be treated by an API or CPI-type oil/water separator or equivalent (BMP RD.35 in Volume III, Runoff Control).

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Stormwater runoff from rooftops may be discharged to the storm sewer below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.3.2 RECYCLERS AND SCRAP YARDS
SIC: 5093**, 5015**

DESCRIPTION: Businesses that reclaim various materials for resale: construction materials, metals, beverage containers and papers. This group also includes businesses that strip and sell parts from automobiles, trucks, and construction equipment.

MATERIALS USED AND WASTES GENERATED: These businesses generally conduct their operations in uncovered areas. The type of waste materials and contamination of stormwater and/or ground water will vary widely with the type of business. However, in general it can be expected that both may be contaminated by metals, trace organics, BOD, suspended solids, and oil.

Source Control BMPs: See BMPs S1.20, S1.30, S1.40, S1.50, S1.70, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

Additionally,

- *Gas, oil, and other fluids shall be drained from vehicles being scrapped. These fluids shall be disposed of properly, preferably by recycling.*
- *Drain oil filters while the oil is warm for as long as possible (24 hours) and at an angle. Collect the oil for recycling in a separate, labeled container. Drained filters should be kept in a suitable container or drum and sent to a scrap metal recycler or hazardous waste management facility. Don't put undrained filters in the dumpster, or put drained filters in the dumpster without first checking with your local health department.*

For more information on disposal requirements for solid and hazardous wastes, see Step By Step: Fact Sheets for Hazardous Waste Generators, publication 91-12, available from Ecology's Regional Offices.

Regulatory Requirements: See R.1, R.2, R.3, R.4, R.7, R.10 and R.11 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside processing areas shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater runoff from rooftops may be discharged to the storm sewer below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.3.3 RESTAURANTS/FAST FOOD
SIC: 5800

DESCRIPTION: Businesses that provide food service to the general public.

MATERIALS USED AND WASTES GENERATED: Fast food restaurants experience very heavy usage. Two potential sources of stormwater contamination are the parking lots and garbage dumpsters exposed to precipitation. The cleaning of cooking vent filters in the parking lot can cause cooking grease to be discharged to the storm drains.

Source Control BMPs: See BMPs S1.30, S1.50, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

The following BMP is also required:

- *Air filters from cooking grills shall not be washed in a location where the cleaning water and grease can reach a storm drain. Discharge shall be to a sanitary sewer.*

Regulatory Requirements: See R.1, R.2, R.4, and R.10 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas where manufacturing processes occur shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater runoff from rooftops may be discharged to the storm drain or combined sewer below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.3.4 RETAIL GENERAL MERCHANDISE
SIC: 5300, 5600, 5700, 5900, 5990

DESCRIPTION: This group includes general merchandising stores such as department stores, shopping malls, variety stores, 24-hour convenience stores, and general retail stores that focus on a few product types such as clothing and shoes. It also includes furniture and appliance stores.

MATERIALS USED AND WASTES GENERATED: Of particular concern are the parking lots of shopping malls and 24-hour convenience stores. Because of heavy vehicle usage, the concentration of oil and grease in stormwater may exceed the Ecology guideline of 10 mg/l. Although there are no local data to confirm this view, limited research in the San Francisco Bay area found the mean concentration of oil and grease in stormwater to exceed 10 mg/l. Larger stores may own delivery vehicles. It is likely that servicing these vehicles occurs elsewhere and is not done by the owner.

Furniture and appliance stores may provide repair services in which Dangerous Wastes may be produced. Department stores and shopping malls may have restaurants that generate waste food.

Source Control BMPs: See BMPs S1.10, S1.20, S1.50, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

Regulatory Requirements: See R.1, R.2, R.3, R.4, and R.10 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas where manufacturing processes occur shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.3.5 RETAIL/WHOLESALE VEHICLE AND EQUIPMENT DEALERS
SIC: 5010, 5080, 5500 excluding gas stations (5540)

DESCRIPTION: This group includes all retail and wholesale businesses that sell cars, trucks, boats, trailers, mobile homes, motorcycles and recreational vehicles. It includes both new and used vehicle dealers. It also includes sellers of heavy equipment for construction, farming, and industry.

With the exception of motorcycle dealers, these businesses have large parking lots. Most retail dealers that sell new vehicles also provide repair and maintenance service. Sellers of large equipment may also provide maintenance and repair services.

MATERIALS USED AND WASTES GENERATED: Storm runoff from the parking areas will be contaminated by oil and other materials that have dripped from parked vehicles. Vehicles are washed regularly generating vehicle grime and detergent pollutants. The storm or washwater runoff will contain oils and various organics, metals, and phosphorus.

Repair and maintenance services generate a variety of waste liquids and solids including used oils and engine fluids, solvents, waste paint, and soiled rags, and dirty used engine parts. Many of these materials are Dangerous Wastes.

Source Control BMPs: See BMPs S1.10, S1.20, S1.30, S1.40, S1.50, S1.60, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

The following BMPs are also required:

- *If possible, vehicles should be washed in an area that is tied directly into the sanitary sewer per the guidelines of the local Sewer Authority. The detergents in wash water from vehicles which runs into the stormwater treatment systems will render oil/water separators useless otherwise.*
- *Drain oil filters while the oil is warm for as long as possible (24 hours) and at an angle. Collect the oil for recycling in a separate, labeled container. Drained filters should be kept in a suitable container or drum and sent to a scrap metal recycler or hazardous waste management facility. Don't put undrained filters in the dumpster, or put drained filters in the dumpster without first checking with your local health department.*

Regulatory Requirements: See R.1, R.2, R.3, R.4, R.7, and R.10 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas where manufacturing processes occur shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III). Areas of high traffic shall use an API or CPI-type oil/water separator.

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.3.6 RETAIL/WHOLESALE NURSERIES AND BUILDING MATERIALS
SIC: 5030, 5198, 5210, 5230, 5260

DESCRIPTION: These businesses are placed in a separate group as they are likely to store much of their merchandise outside of the main building. They include nurseries, and businesses that sell building and construction materials and equipment, as well as paint (5198, 5230) and hardware.

MATERIALS USED AND WASTES GENERATED: Storm runoff from exposed storage areas will contain suspended solids, oil and grease from vehicles and forklifts, and other pollutants. Runoff from nurseries may contain nutrients, pesticides and/or herbicides. Some businesses may have small fueling capabilities for forklifts and may also maintain and repair their equipment. They may have delivery vehicles.

Some businesses may have unpaved areas, offering the potential to contaminate surface and/or ground water thrcugh stormwater runoff or by leaching of nutrients, pesticides, and herbicides.

Businesses in this group surveyed in the Puget Sound area for Dangerous Wastes were found to produce waste solvents, paints and used oil.

Source Control BMPs: See BMPs S1.10, S1.20, S1.50, S1.60, S1.80, S1.90, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

For more information on pesticide application and disposal requirements for solid and hazardous wastes, see Step By Step: Fact Sheets for Hazardous Waste Generators, publication 91-12, available from Ecology's Regional Offices.

Regulatory Requirements: See R.1, R.2, R.3, R.4, R,7, and R.10 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas where products are stored shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.3.7 RETAIL/WHOLESALE CHEMICALS AND PETROLEUM
SIC: 5160, 5170

DESCRIPTION: This group of businesses sells plastic materials, chemicals and related products. The group also includes the bulk storage and selling of petroleum products such as diesel oil, automotive fuels, etc. Therefore, liquid transfer and storage are the major activities.

MATERIALS USED AND WASTES GENERATED: The general areas of concern are the spillage of chemicals or petroleum during loading and unloading, and the washing and maintenance of tanker trucks.

The concentration of oil in untreated stormwater is known to exceed the water quality effluent guideline for oil and grease. Runoff is also likely to contain significant concentrations of benzene, phenol, chloroform, lead, and zinc. There is great potential for contamination of surface and/or ground water. There are specific stormwater effluent guidelines for petroleum refineries found under 40 CFR Part 419.

A survey of these businesses in the Puget Sound area found waste oil and solvents from vehicle and equipment maintenance.

The fire code requires that vegetation be controlled within a tank farm to avoid a fire hazard; herbicides are typically used.

Source Control BMPs: See BMPs S1.10, S1.20, S1.30, S1.40, S1.50, S1.80, S1.90, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

Regulatory Requirements: See R.1, R.2, R.3, R.4, R.5, R.6, R.7, and R.10 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside loading/unloading areas shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

Stormwater from petroleum storage facilities shall be treated by an API or CPI-type oil/water separator (BMP RD.35 in Volume III, Runoff Control).

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IV-2.3.9 OTHER RETAIL/WHOLESALE BUSINESS
SIC: 5010 (not 5012), 5040, 5060, 5070, 5090

DESCRIPTION: This group includes all wholesale businesses not listed in any previous group. Examples are sellers of vehicle parts, tires, furniture and home furnishings, photographic and office equipment, electrical goods, sporting goods and toys, paper and paper products, and drugs and apparel.

MATERIALS USED AND WASTES GENERATED: The main source of stormwater pollutants is the parking lot. Some businesses own delivery vehicles which may be fueled, washed and maintained on premises.

Source Control BMPs: See BMPs S1.10, S1.20, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

Regulatory Requirements: See R.1, R.2, R.3, and R.10 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas where manufacturing processes occur shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.4 SERVICE BUSINESSES

IV-2.4.1 ANIMAL CARE SERVICES
SIC 0740,0750

DESCRIPTION: This group includes veterinaries and businesses that provide boarding services for animals such as horses, dogs and cats.

MATERIALS USED AND WASTES GENERATED: The primary sources of pollution include animal manures, waste products from animal treatment, and runoff from pastures where larger livestock are allowed to roam. These pastures may border streams and direct access to the stream may occur. Both surface water and/or ground water may be contaminated.

Source Control BMPs

- *Businesses bordering streams shall not allow the direct access of animals to the stream. This shall be achieved by fencing or the use of streamside vegetation which inhibits livestock entry. The fence should be set back at least 10 feet from the high-water line. The vegetation strip should be at least 25 feet wide and not accessible to animals. Greater setback widths are desired on steep-sloped properties. The vegetative buffer must consist of plant species that inhibit livestock entry.*
- *Pastures used by animals shall be located in an area with the minimum drainage impact possible and be maintained in a manner that avoids excessive erosion. This shall be achieved by the use of appropriate animal density and/or grazing activity (such as pasture rotation), proper fertilizer practices and reseeding as necessary. Portable electric fencing can be used to temporarily enclose portions of a pasture to allow time for reestablishment of vegetation.*
- *Barns and livestock buildings shall have roof drain systems. These systems shall discharge away from livestock holding areas thereby preventing the mixing of stormwater and manure.*
- *Drainage patterns from a pasture shall be controlled to prevent the direct entry of contaminated stormwater to public ditches, adjacent property or streams and lakes.*
- *Manures and manure contaminated wastes shall be collected on a regular basis and stored in a manner that prevents the entry of stormwater.*
- *Businesses should consult with the County Conservation District or Cooperative Extension Service for technical advice on fulfilling the above requirements.*

See the Supplemental Guidelines for other large animal management BMPs.

Stormwater Treatment BMPs: Concentrated flows of stormwater from animal roaming/grazing areas shall be treated with a biofilter as described in Chapter III-6, Volume III. Animal densities on pastures shall be such as to not result in overgrazing and excessive erosion. Runoff from parking lots shall be treated with applicable treatment BMPs from Volume III.

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IV-2.4.2 COMMERCIAL CAR AND TRUCK WASHES
SIC: 7542

DESCRIPTION: Facilities include automatic systems found at individual businesses or at gas stations and 24-hour convenience stores, as well as self-service. There are three main types: tunnels, rollovers and hand-held wands. The tunnel wash, the largest, is housed in a long building through which the vehicle is pulled. At a rollover wash the vehicle remains stationary while the equipment passes over. Wands are used at self-serve car washes. Some car washing businesses also sell gasoline.

MATERIALS USED AND WASTES GENERATED: The main ingredients are water and detergents. Waxes may be present in the commercial operations. Wastewaters are discharged to sanitary sewers. In self-service operations a drain is located inside each car bay.

Although these businesses discharge the wastewater to the sanitary sewer, some washwater can find its way to the storm drain, particularly with the rollover and wand systems. Rollover systems often do not have air drying. Consequently, as it leaves the enclosure the car sheds water to the pavement. With the self-service system, wash water with detergents can spray outside the building and be lost to the storm drain. Users of self-serve operations may also clean engines and change oil, dumping the used oil into the drain.

Source Control BMPs: See BMP S1.10, Fueling Stations, if gas is sold on premises. Also see BMPs S1.20, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

The following BMPs also apply:

- *With rollover systems that do not have air drying, a drain shall be located at the exit of the building to which extraneous wash water can drain. This drain shall be connected to the sanitary sewer.*
- *The solution preventing loss of water at self-service businesses is to construct an embayment of sufficient length. Observation of several such operations indicates the individual bay should be at least 30 feet in length.*
- *Vehicles should be washed in an area that is tied directly into the sanitary sewer per the guidelines of the local Sewer Authority. The detergents in wash water from vehicles which runs into the stormwater treatment systems will render oil/water separators useless otherwise.*

Regulatory Requirements: See R.1 and R.10 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas where manufacturing processes occur shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Downspouts from the wash building may be discharged downstream of any treatment BMP as long as the drainage control requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.4.3 EQUIPMENT REPAIR
SIC: 7353, 7600

DESCRIPTION: Includes several businesses that specialize in repairing different equipment including communications equipment, radio, TV, household appliances, and refrigeration systems. Also included are businesses that rent or lease heavy construction equipment (7353) as miscellaneous repair and maintenance may occur on site.

MATERIALS USED AND WASTES GENERATED: A survey of several of these businesses indicates they produce used oil and solvents.

Source Control BMPs: See BMP S1.10 if equipment fueling is done on-site. Also see BMPs S1.20, S1.30, S1.50, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

Regulatory Requirements: See R.1, R.2, R.3, and R.10 in Chapter IV-3.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas where manufacturing processes occur shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Businesses that repair, store, or resale used construction or other mobile industrial equipment such as fork lifts, log handling equipment, cranes, etc, shall treat stormwater from outside equipment and storage and maintenance areas with an API or CPI-type oil/water separator (BMP RD.35 in Volume III, Runoff Control).

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.4.4 LAUNDRIES AND OTHER CLEANING SERVICES
SIC: 7211 through 7217

DESCRIPTION: This category includes all types of cleaning services such as laundries, linen suppliers, diaper services, coin-operated laundries and dry cleaners, and carpet and upholstery services.

Materials used differ depending on whether wet or dry cleaning is used. Wet washing may involve the use of acids, bleaches and/or multiple organic solvents. Dry cleaners use an organic-based solvent, although small amounts of water and detergent are sometimes used. Solvents may be recovered and filtered for further use.

Carpet and upholstery cleaning may occur on location or at the plant. On-location is done with dry materials or by a hot water extraction process. In-plant processes usually use solvents followed by a detergent wash.

MATERIALS USED AND WASTES GENERATED: Wash liquids are discharged to sanitary sewers. Of concern is the loading and unloading of liquid materials, particularly at large commercial operations, and the disposal of spent solvents and solvent cans.

Source Control BMPs: See BMPs S1.30, S1.40, S1.50, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

The following BMPs also apply:

- *Mobile cleaning units shall not discharge the accumulated wash water to storm drains or to surface or ground water. Such water shall be discharged to the sanitary sewer according to local Sewer Authority requirements.*
- *A spill response plan must be developed for each facility. This plan should be implemented immediately upon the spill or release of any liquid.*
- *Spent solvent cans must be disposed of properly in an appropriate, covered container.*

For more information on dry cleaning and disposal requirements for solid and hazardous wastes, see Step By Step: Fact Sheets for Hazardous Waste Generators, publication 91-12, available from Ecology's Regional Offices.

Regulatory Requirements: See R.1, R.2, R.3, and R.10 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas where manufacturing processes occur shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater from roof-tops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.4.5 MARINAS AND BOAT CLUBS
SIC: 7999

DESCRIPTION: Marinas and yacht clubs provide moorage for recreational boats. Marinas may also provide fueling and maintenance services. Other activities include cleaning and painting of boat surfaces, minor boat repair, and pumping of bilges and sanitary holding tanks. Not all marinas have a system to receive pumped bilge water.

The 1991 Puget Sound Water Quality Management Plan calls for modification of state regulations to require the treatment of stormwater runoff; development of a model ordinance for sewer hookups by boats using public and private marinas, to be adopted voluntarily by local jurisdictions; and the formation of a task force that will prepare a comprehensive program to control the adverse effects of marinas.

MATERIALS USED AND WASTES GENERATED: Both solid and liquid wastes are produced as well as stormwater runoff from the parking lot. Waste materials include sewage and bilge water. Maintenance by the tenants will produce used oils, oil filters, solvents, waste paints and varnishes, used batteries, and empty contaminated containers and soiled rags.

Source Control BMPs: See BMPs S1.10, S1.20, S1.30, S1.40, S1.50, S1.60, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

The following BMPs also apply:

Marina/yacht club owners shall post the following BMPs in a prominent place, which are to be carried out by boat owners:

In marinas/yacht clubs where repair work is allowed:

- *Preparation of the hull of the boat for resurfacing which occurs over water requires that a tarp be affixed to the hull in a manner that traps any debris. The debris shall be collected from the tarp before the tarp is removed and properly disposed of.*
- *Paint burning or the use of spray guns shall not be allowed on topsides or above decks.*

Other BMPs:

- *Sanitary sewage shall be disposed of by the use of pump-out stations, portable on-site pump-outs, or commercial mobile pump-out facilities.*
- *Tenants shall be encouraged to place oil-absorbing materials in the bilge. These should be removed at appropriate intervals and disposed of properly. A sign shall be posted indicating the nearest oil collection and hazardous waste collection facilities. Bilge water should not be discharged unless it does not possess a sheen.*
- *Vessels with automatic bilge pumps shall be maintained in a manner that will prevent waste material from being pumped automatically into the surface water. The use of oil absorbent materials in the bilges should help to prevent such a discharge.*
- *Any spillage onto the docks or boat is to be cleaned up immediately and disposed of properly.*

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- *The marina owner is to be notified immediately of any spill. Also, in the event of an accidental discharge of oil or hazardous material into waters of the state or onto land with a potential for entry into state waters, the yard owner or manager and the Department of Ecology shall be notified immediately.*

  Locally, notify the regional Department of Ecology offices:

  Northwest Region - Redmond (206) 867-7000 (24-hour)
  Southwest Region - Olympia (206) 753-2353 (24-hour)

  Additionally, the National Response Center must be called; their number is 1-800-424-8802 (24-hour).

  If the spill is within salt water, the U.S. Coast Guard must be called at (206) 286-5440.

Regulatory Requirements: See R.1, R.2, R.3, R.4, R.5, R.7, and R.10 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater runoff from rooftops may discharge directly to the surface water as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.4.6 GOLF AND COUNTRY CLUBS, GOLF COURSES AND PARKS
SIC: 7992, 7997

DESCRIPTION: Establishments primarily engaged in the operation of golf courses open either to members and their guests or open to the general public on a contract or fee basis. Rather than separating public and private golf courses, they are combined here to prevent duplication of information. Public and private parks are also included here because of the similarity in uses and wastes produced.

MATERIALS USED AND WASTES GENERATED: Maintenance of grassed areas and landscaped vegetation has historically required the use of fertilizers and pesticides. Golf courses contain small lakes that are sometimes treated with algicides and/or mosquito larvicides.

The application process can lead to inadvertent contamination of nearby surface waters by overuse, misapplication, or the occurrence of storms shortly after application. Heavy watering of surface greens in golf courses may cause pesticides or fertilizers to migrate to surface and shallow ground water resources.

The application of pesticides and fertilizers generates waste containers. Equipment must be cleaned and maintained. Maintenance shops where the equipment is maintained must comply with the BMPs specified under "Vehicle Maintenance Shops" (see Section IV-2.4.9). The BMPs outlined below focus on the use of fertilizers and pesticides.

Source Control BMPs: The owner must comply with BMPS S1.90 AND S2.20 in Chapter IV-4 in the use of pesticides and herbicides.

Other BMPs:

- *Establish an Integrated Pest Management (IPM) Program (see BMP S1.90 in Chapter IV-4). IPM can help to minimize the need for chemical pest control measures by providing optimum growing conditions for turf grasses.*

Lawn Management

- *Select the appropriate turfgrass mixture for your climate and soil type. Certain tall fescues and rye grasses resist insect attack because of symbiotic endophytic fungi found naturally in their tissues which repel or kill common leaf and stem-eating lawn insects. They do not, however, repel root-feeding lawn pests, and are toxic to ruminants such as cattle and sheep. The fungus causes no known adverse effects to the host plant or to humans. Endophytic grasses are commercially available and can be used in areas such as parks or golf courses where grazing does not occur. The local Cooperative Extension office can offer advice on which types of grass are best suited to the area and soil type.*

- *Lawns should be aerated regularly in areas of heavy use where the soil tends to become compacted. Aeration should be done while the grasses in the lawn are growing most vigorously.*

- *Thatching should generally be done when the layer of thatch becomes greater than ½" deep.*

- *While grass clippings cannot be left on many parts of a golf course, they can be collected and dispersed in the rough or other undeveloped (but not buffer) areas adjacent to the golf course. Clippings are relatively high in N (4%) and are a good source of nutrients as they decompose.*

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- Mowing is a stress-creating activity for turfgrass. When grass is mowed too short its productivity is decreased and there is less growth of roots and rhizomes. The turf becomes less tolerant of environmental stresses, more disease prone and more reliant on outside means such as pesticides, fertilizers and irrigation to remain healthy. Set the mowing height at the highest acceptable level and mow at times and intervals designed to minimize stress on the turf. Increased mowing tends to increase shoot density and leaf succulence. Increased water use has been observed with increased mowing height, but this water use may be offset be increased mowing frequency.

Irrigation

- The depth from which a plant normally extracts water depends on the rooting depth of the plant. Appropriately irrigated lawn grasses normally root in the top 6 to 12 inches of soil; lawns irrigated on a daily basis often root only in the top 1 inch of soil. Improper irrigation can encourage pest problems, leach nutrients, and make a lawn completely dependent on artificial watering. The amount of water applied depends on the normal rooting depth of the turfgrass species used, the available water holding capacity of the soil and the efficiency of the irrigation system. Consult with either the local Soil Conservation office or Cooperative Extension office to help determine optimum irrigation practices.

Fertilizer Management

- Research suggests that turfgrass is most responsive to nitrogen fertilization, followed by potassium and phosphorus. Fertilization needs vary by site depending on plant, soil and climatic conditions. Evaluation of soil nutrient levels through regular testing ensures the best possible efficiency and economy of fertilization. For details on soils testing, contact the local Conservation District or Cooperative Extension Service.

- Fertilizers should be applied in the amounts appropriate to the vegetative requirements, and at the time of year that minimizes losses to surface and ground waters. Do not fertilize during a drought or when the soil is dry. Alternatively, do not apply fertilizers within three days prior to predicted rainfall. The longer the period between fertilizer application and either rainfall or irrigation, the less fertilizer runoff occurs. Use slow release fertilizers such as methylene urea, IDBU or resin coated fertilizers when appropriate, generally in the spring. Use of slow release fertilizers is especially important in areas with sandy or gravelly soils. Time the application to periods of maximum plant uptake. Research indicates that fall application of fertilizer nitrogen for the next growing season in cool moist climates should be discouraged.

- All fertilizer applications should be performed by properly trained persons. Fertilizers should not be applied to swales, filter strips, or buffer areas surrounding sensitive water bodies.

Use of Pesticides[1]

- Properly maintained and healthy turfgrass will tolerate the presence of low levels of pest populations without suffering permanent damage. Healthy turfgrass will also recover more rapidly from major pest or disease infestations. Chemical controls should only be used when other methods have not worked. Use the safest pesticide which can appropriately control the target pest. The pesticide should have low mobility, high adsorption and low

[1] The term "pesticide" here includes those substances commonly thought of as insecticides, fungicides, miticides, nemsticides, herbicides and rodenticides.

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persistence.

- Regular visual inspections should be done and spot pesticide applications then performed.
- All mixing and application should be done under the direct supervision of a licensed pesticide applicator. Applications should be performed in strict accordance with the instructions on the pesticide label. Contact the Pesticide Management Division of the Washington State Department of Agriculture if any questions arise.
- Prior to application, ascertain that no significant precipitation events are predicted within the next three days.
- Handle and store all pesticides according to the BMPs found in S1.30, S1.40 and S1.50 in Chapter IV-4. An emergency spill control plan should also be developed (see BMP S1.80 in Chapter IV-4).

For more information on pesticide application and disposal requirements for solid and hazardous wastes, see Step By Step: Fact Sheets for Hazardous Waste Generators, publication 91-12, available from Ecology's Regional Offices.

Weed Suppression

- Set weed tolerance levels for various areas of the golf course or park. Determine which weed species are currently growing in the area and how aggressively they are growing or spreading. Determine how much damage they are likely to cause to other plants, structures or the overall aesthetics of the area. Direct suppression efforts should be focused on weed populations that threaten to exceed tolerance levels rather than on all weeds growing in the area.
- A healthy lawn mowed regularly at the proper height is one of the best ways to suppress weeds. Regular mowing encourages lawn growth and discourages the growth of such species as crabgrass.

Regulatory Requirements: See R.1, R.3, and R.10 in Chapter IV-3.

Stormwater Treatment BMPs: Stormwater from parking lots shall be treated by one of the methods presented in Volume III, Runoff Control.

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(2) Fortunato, Philip D., Hydroseeding Specification Guide, Briargreen, Inc., January, 1992.

(3) Gaunt, Cary, Pollution Prevention Opportunities at the Fort Eustis Golf Course, Draft, SAIC, March, 1992.

(4) Spectrum Research, Inc., Environmental Issues Related to Golf Course Construction and Management: A Literature Search and Review, A final report submitted to the U.S. Golf Association: Green Section, August, 1990.

(5) Shapiro and Associates, Inc., Environmental Monitoring Program for the Proposed Remington Golf Course, prepared for Covington Creek Associates, January, 1991.

(6) Shapiro and Associates, Inc. and D.R. Strong Consulting Engineers, Inc., Site Management Manual for the Proposed Remington Golf Course, prepared for Covington Creek Associates, March, 1991.

(7) Virginia Division of Soil and Water Conservation, Ecological Turf Tips to Protect the Chesapeake Bay, Nutrient Management for Golf Course Managers, ETT #2, undated.

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IV-2.4.7 MISCELLANEOUS SERVICES
SIC: 4959, 7260, 7312, 7332, 7333, 7340, 7395, 7641, 7990, 8411

DESCRIPTION: Includes a mix of service businesses that generate Dangerous Wastes. Included here are photographic studios, commercial photography, funeral services, amusement parks, furniture and upholstery repair and pest control services.

MATERIALS USED AND WASTES GENERATED: Building maintenance businesses produce wash and rinse solutions, oils, and solvents. Pest control businesses produce rinsewater with residual pesticides from washing application equipment and empty containers.

Outdoor advertising businesses will produce photographic chemicals, inks, waste paints, organic paint sludges containing metals.

Funeral services are known to produce formalin, formaldehyde and ammonia, which is usually legally discharged to the sink.

Upholstery and furniture repair businesses produce oil, stripping compounds, wood preservatives and solvents.

Source Control BMPs: See BMPs S1.30, S1.40, S1.50, S1.60, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

For more information on photofinishing and disposal requirements for solid and hazardous wastes, see Step By Step: Fact Sheets for Hazardous Waste Generators, publication 91-12, available from Ecology's Regional Offices.

Regulatory Requirements: See R.1, R.2, R.3, R.4, and R.10 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.4.8 PROFESSIONAL SERVICES
SIC: 6000, 7000 and 8000, not listed elsewhere

DESCRIPTION: Included here are the remaining service businesses including theaters, hotels/motels, finance, banking, hospitals and medical services, nursing homes, schools and universities, and legal, financial and engineering services.

MATERIALS USED AND WASTES GENERATED: The primary concern is runoff from parking areas. Stormwater from parking lots will contain undesirable concentrations of oil and grease, suspended particulates, and metals such as lead, cadmium and zinc. It will also contain the organic by-products of engine combustion. Some also produce Dangerous Wastes, for example, hospitals, nursing homes and other medical services. These materials are stored within the building until disposal.

Source Control BMPs: See BMPs S1.20, S1.30, S1.50, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

Regulatory Requirements: See R.1, R.2, R.3, and R.10 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.4.9 VEHICLE MAINTENANCE AND REPAIR
SIC: 4000 , 7530

DESCRIPTION: Includes businesses that repair and maintain automobiles, trucks, and buses, excluding those businesses listed elsewhere in this manual. Businesses included here are lube and tune shops, auto and truck repair and painting shops; and battery, radiator, muffler, and tire shops. Excluded here are vehicle dealers and gasoline service stations that also repair vehicles.

MATERIALS USED AND WASTES GENERATED: Wastes generated are similar to those produced by general purpose gas stations, although businesses that provide specialized maintenance activities will not produce all the wastes listed below.

Materials include waste oil, solvents, degreasers, antifreeze, radiator flush, acid solutions with chromium, zinc, copper, lead and cadmium, brake fluid, soiled rags, oil filters, sulfuric acid and battery sludges, and machine chips with residual machining oil.

A large number of vehicles may be parked in and around the service buildings.

Source Control BMPs: See BMPs S1.10, S1.20, S1.30, S1.40, S1.50, S1.70, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

Additionally:

- *Drain oil filters while the oil is warm for as long as possible (24 hours) and at an angle. Collect the oil for recycling in a separate, labeled container. Drained filters should be kept in a suitable container or drum and sent to a scrap metal recycler or hazardous waste management facility. Don't put undrained filters in the dumpster, or put drained filters in the dumpster without first checking with your local health department.*

For more information on automotive repair and disposal requirements for solid and hazardous wastes, see Step By Step: Fact Sheets for Hazardous Waste Generators, publication 91-12, available from Ecology's Regional Offices.

Regulatory Requirements: See R.1, R.2, R.3, R.7, R.10 and R.11 in Chapter IV-5.

Stormwater Treatment BMPs: Stormwater from parking and maintenance areas where dripping oil or hydraulic fluids is likely to be occurring shall be treated by an API or CPI-type oil/water separator (BMP RD.35 in Volume III, Runoff Control).

Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators.

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

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IV-2.4.10 MULTI-FAMILY RESIDENCES
SIC: NA

DESCRIPTION: Multifamily residential buildings such as apartments and condominiums. The activities of concern are vehicle parking, vehicle washing and oil changing, and garbage containers.

MATERIALS USED AND WASTES GENERATED: Stormwater from parking lots will contain undesirable concentrations of oil and grease, suspended particulates, and metals such as lead, cadmium and zinc. It will also contain the organic by-products of engine combustion. These conditions will be exacerbated if car owners wash their cars and change their oil which they may dump down the nearest storm drain.

Source Control BMPs: See BMPs S1.20, S1.50, S1.90, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

Additionally,

- *Signed and designated containers for used oil and antifreeze shall be provided for residents. The containers shall be covered and shielded from the weather. Used oil and antifreeze shall be recycled whenever possible.*

Regulatory Requirements: See R.1, and R.10 in Chapter IV-5.

Stormwater Treatment BMPs: Stormwater from parking lots shall be treated using one of the treatment systems described in Volume III, Runoff Control.

Stormwater from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

Stormwater from parking and maintenance areas where dripping oil or hydraulic fluids is likely to be occurring shall be treated by an API or CPI-type oil/water separator (BMP RD.35 in Volume III, Runoff Control).

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IV-2.4.11 CONSTRUCTION BUSINESSES
SIC: 1500, 1600, 1700

DESCRIPTION: This section does not deal with construction sites, but rather the location of the businesses themselves. It includes builders of homes, commercial and industrial buildings. It also includes heavy equipment contractors who excavate, as well as construction specialties such as plumbing, painting and paper hanging, carpentry, electrical, roofing and sheet metal, wrecking and demolition, stonework and masonry.

Maintenance and repair of equipment can occur at the site of business owners. Heavy equipment contractors may park their equipment adjacent to their businesses. Repairs may occur in the parking area where contamination of the pavement or soil can occur. Demolition contractors may store reclaimed material before resale.

MATERIALS USED AND WASTES GENERATED: Although the vast majority of waste materials are generated at the construction site, they are also typically found in smaller quantities at the business sites where construction materials and equipment are temporarily stored. The storage yard may be located at the place of business or at a separate storage yard. Potential waste materials include solvents, paints, batteries, strong acid and alkaline wastes, paint and varnish removers. These are Dangerous Wastes. Used oil is also produced. Contractors frequently have their own fueling facilities for equipment.

The types of wastes generated by specialty contractors vary substantially. Painting contractors will generate paint and other finishing residues, spent thinners, paint containers, used oil, other lubricants and antifreeze from servicing their vehicles.

Roofing contractors generate residual tars and sealing compounds, spent solvents, kerosene, and soap cleaners, as well as non-hazardous waste roofing materials.

Sheet metal contractors produce small quantities of acids and solvent cleaners such as kerosene, metal shavings, adhesive residues and enamel coatings, and asbestos residues that have been removed from buildings.

Asphalt paving contractors are likely to store application equipment such as dump trucks, pavers, tack coat tankers and pavement rollers at their businesses. Stormwater passing through this equipment may be contaminated by the petroleum residuals. Maintenance of the equipment generates waste fluids and solvents.

Source Control BMPs: See BMPs S1.10 (if fueling is done on-site), S1.20, S1.30, S1.40, S1.50, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions. For additional information about managing work material at construction sites, refer to Chapter II-3 in Volume II.

Additionally:

- *Drain oil filters while the oil is warm for as long as possible (24 hours) and at an angle. Collect the oil for recycling in a separate, labeled container. Drained filters should be kept in a suitable container or drum and sent to a scrap metal recycler or hazardous waste management facility. Don't put undrained filters in the dumpster, or put drained filters in the dumpster without first checking with your local health department.*

Regulatory Requirements: See R.1, R.2, R.3, R.7, R.9, and R.10 in Chapter IV-5. Additionally, NPDES permits, while not required for business locations, will be required for construction sites larger than 5 acres in size. Please see Chapter IV-5 and Chapter II-2 in the Erosion Control Volume for more information.

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Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside storage areas shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

Asphalt paving contractors and contractors that maintain heavy equipment or vehicles on-site shall have stormwater from outside equipment storage areas treated by an API or CPI-type oil/water separator (BMP RD.35 in Volume III, Runoff Control).

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CHAPTER IV-3 PUBLIC AGENCIES AND REQUIRED BMPS

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CHAPTER 3

PUBLIC AGENCIES AND REQUIRED BMPs

Activities of many local governments and state and federal agencies in the Puget Sound basin are similar to many of the business activities listed in Chapter IV-2. Government activities, as well as those of other businesses, also contribute significantly to non-point pollution.

Local governments whose actions can affect water quality include cities and counties, and also single-purpose entities such as fire, sewer and water districts. With few exceptions, all state and federal agencies have some facility or activity that can contribute to non-point pollution via stormwater runoff.

Currently, large municipalities (Seattle and King County, urbanized population >250,000) and medium municipalities (Pierce County, Snohomish County, Spokane and Tacoma, urbanized population between 100,000 to 250,000) are required to apply for NPDES permits. Additionally, the Washington State Department of Transportation is considered to be a municipality and must obtain NPDES permits for its highway system, maintenance facilities and ferry system. See R.11 in Chapter IV-5 for more information on NPDES permits.

IV-3.1 PUBLIC BUILDINGS AND STREETS

DESCRIPTION: The construction of public facilities is an opportunity to include BMPs to improve the quality of stormwater. Included in this group are public buildings not discussed elsewhere in Chapter IV-3. Also included are streets and roads.

MATERIALS USED AND WASTES GENERATED: Materials such as concrete, asphalt, sheetrock, rebar, glass, and lumber are commonly used in buildings. Asphalt or port and cement and aggregate are used on streets as well as paint for marking street crossings, etc.

Wastes generated include solvents, paints, acid and alkaline wastes and paint and varnish removers. Large amounts of scrap materials are also produced throughout the course of construction and street repair.

Source Control BMPs: See BMPs S1.10, S1.30, S1.50, S1.80, S1.90, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

In addition, the following BMPs are required:

- *Open vegetated ditches, instead of storm drains, should be used where feasible along roads, streets, and highways. Design ditches to serve the dual functions of drainage and stormwater treatment. See Chapters III-2 and III-6 in Volume III for the design of conveyance and biofiltration systems.*
- *Disposal of construction wastes and pollutants is covered in detail in Chapter II-3 in Volume II.*

Regulatory Requirements: See R.1, R.2, R.3, R.7, R.8, R.9, R.10 and R.11 in Chapter IV-5.

Stormwater Treatment BMPs: Stormwater from parking lots and roads shall be treated using one of the systems described in Volume III, Runoff Control. Treatment BMPs shall be installed on new roads, and existing roads undergoing significant

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upgrading. Treatment BMPs shall be installed whenever an existing road is modified from open ditches to curbs and storm sewers.

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

IV-3.2 VEHICLE AND EQUIPMENT MAINTENANCE SHOPS

DESCRIPTION: Government maintenance shops are a potential source of non-point pollution since they are similar to general service gas stations or vehicle repair service shops. Maintenance shops may be owned and operated by city or county governments, state or federal agencies, as well as schools, colleges and universities.

In addition to engine and body maintenance, government maintenance shops are likely to wash and fuel the vehicles on-site. Washing may take place in enclosed and fully automated systems similar to commercial vehicle washers, or by hand in the parking area. Engines and engine parts are commonly steam cleaned. Retired vehicles may be kept on-site to be stripped for parts, or sold at auction to the public. Vehicles and equipment may be painted.

MATERIALS USED AND WASTES GENERATED: Solid and liquid wastes are produced, as well as stormwater runoff from paved surfaces. Wastes produced include: used oils, oil filters, antifreeze, solvents, brake fluid, batteries, sulfuric acid, battery acid sludges, empty contaminated containers and soiled rags. Gasoline and diesel fuels are spilled from pumps and during transfer from tanker trucks to underground storage tanks. Leaking underground storage tanks can cause ground water contamination and in addition, they are a safety hazard.

Stormwater can be contaminated by: spilled fuels and oil; solid and liquid wastes (noted above) that are not properly stored while awaiting disposal or recycling; dirt, oils and greases from steam cleaning and vehicle washing that occurs outside; and dripping of these same materials from parked vehicles. Stormwater contaminated by fuels may contain significant concentrations of dissolved organics that cannot be removed by an oil/water separator. Water is produced from vehicle and parts washing and steam cleaning.

Research by Municipality of Metropolitan Seattle (Metro) of its bus bases indicates that mean concentrations of oil and grease typically range from 10 to 20 mg/l with individual samples commonly exceeding 50 mg/l, exceeding the Ecology guideline.

Deliberate disposal of materials to the storm drain may commonly occur, in particular used oils and brake fluid, used antifreeze and radiator flush. It is common practice to temporarily store used oils, brake fluid, and solvent in underground tanks although the latter is more frequently stored in steel drums.

Source Control BMPs: See BMPs S1.10, S1.20, S1.30, S1.40, S1.50, S1.60, S1.80, S2.00 and S2.20 in Chapter IV-4 to determine appropriate actions.

- *In addition, any retired vehicles kept on-site for scrap parts shall be emptied of all gas, transmission and hydraulic fluids and coolant. Vehicles being held for resale should be periodically checked for leakage. Fluids should be recycled or otherwise properly disposed of.*

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Regulatory Requirements: See R.1, R.2, R.3, R.6, R.7, R.10 and R.11 in Chapter IV-5.

Stormwater Treatment BMPs: Stormwater from parking and maintenance areas where dripping fluids are likely to occur shall be treated by an API or CPI-type oil/water separator (BMP RD.35 in Volume III, Runoff Control).

Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators or equivalent (see Volume III).

Stormwater runoff from rooftops may be discharged to the storm drain below the treatment system as long as the drainage requirements of the local Public Works Department are met. If there is no stormwater drainage system (storm sewer) to discharge to, runoff from rooftops should be disposed of through the use of an infiltration facility wherever possible (see BMPs RI.15 and RI.16 in Chapter III-3 of the Runoff Control Volume).

IV-3.3 MAINTENANCE OF OPEN SPACE AREAS

DESCRIPTION: The maintenance of large open spaces that are covered by expanses of grass and landscaped vegetation. Examples are zoos and public cemeteries. Golf courses and parks are covered in Section IV-2.4.6.

MATERIALS USED AND WASTES GENERATED: Maintenance of grassed areas and landscaped vegetation has historically required the use of fertilizers and pesticides. Golf courses contain small lakes that are sometimes treated with algicides and/or mosquito larvicides.

The application process can lead to inadvertent contamination of nearby surface waters by overuse, misapplication, or the occurrence of storms shortly after application. Heavy watering, of surface greens in golf courses, may cause pesticides or fertilizers to migrate to surface and shallow ground water resources.

The application of pesticides and fertilizers generates waste containers. Equipment must be cleaned and maintained. Maintenance shops where the equipment is maintained must comply with the BMPs specified under "Vehicle Maintenance Shops" (see Section IV-2.4.8).

Source Control BMPs: The owner must comply with BMP S1.90 in Chapter IV-4 in the use of pesticides and herbicides.

BMPs covering lawn maintenance, fertilizer and pesticide application and irrigation are covered in Section IV-2.4.6.

Regulatory Requirements: See R.1, R.3, and R.10 in Chapter IV-5.

Stormwater Treatment BMPs: Stormwater from parking lots shall be treated by one of the methods presented in Volume III, Runoff Control.

IV-3.4 MAINTENANCE OF PUBLIC STORMWATER FACILITIES

DESCRIPTION: Proper maintenance is the key to insuring that stormwater facilities will continue to perform their intended function. Polluted water and sediments that

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are removed during the cleaning operation must be properly disposed of.

Facilities include roadside catchbasins on arterials and within residential areas, conveyance pipes, detention facilities such as ponds and vaults, and all other types of stormwater treatment systems presented in Volume III, Runoff Control.

Research has shown that roadside catchbasins can remove from 5 to 15 percent of the pollutants present in stormwater. However, to be effective they must be cleaned. Research has indicated that once catchbasins are about 60 percent full of sediment, they cease removing sediments. Generally in urban areas, catchbasins become 60 percent full within 6 to 12 months, and therefore they must be cleaned at this frequency.

Water and solids produced during the cleaning of stormwater systems can adversely affect both surface and ground water quality if disposed of improperly. Ecology has documented water quality violations and fish kills due to improper disposal of decant water and catchbasin sediments from maintenance activities.

Historically, decant water from trucks has been placed back in the storm drain. Solids have been disposed of in permitted landfills and in unpermitted vacant land including wetlands. Research has shown that these residuals contain pollutants at concentrations that may exceed water quality criteria.

For example, limited sampling by King County and the Washington Department of Transportation of sediments removed from catchbasins in residential and commercial areas has found the petroleum hydrocarbons to frequently exceed 200 mg/gram. Above this concentration, regulations require disposal at a lined landfill.

General requirements are listed below. Specific requirements for each type of hydraulic control and treatment facilities are presented in Volume III, Runoff Control, Chapters III-2 through III-6.

Source Control BMPs: The public agency is required to comply with BMPS S2.00 AND S2.20 in Chapter IV-4.

- *An interim policy for the disposal of catchbasin sediments will be developed within the next one to two years.*

Stormwater Treatment BMPs: See Volume III, Runoff Control for the maintenance requirements of specific systems. These requirements are listed at the end of the description of each BMP.

IV-3.5 MAINTENANCE OF ROADSIDE VEGETATION AND DITCHES

DESCRIPTION: Effective maintenance of vegetation in road rights-of-way can significantly improve the quality of stormwater from these areas. A good vegetative cover will reduce if not eliminate the erosion of slopes and drainage ditches that can be significant sources of sediment. The vegetation present in properly designed ditches and median swales can remove pollutants such as metals that are carried in particulate form in stormwater runoff.

Source Control BMPs: To minimize non-point pollution the following BMPs shall be employed.

- *Develop a written policy with maintenance procedures to minimize bare or thinly vegetated ground surfaces within the right-of-way particularly on potentially erosive slopes and in drainage ditches.*

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- *Maintenance of roadside ditches will be carried out in a manner that insures the vegetation will be reestablished by the next wet season thereby minimizing erosion of the ditch as well as making the ditch effective as a biofilter.*
- *In the area between the edge of pavement and the bottom of the ditch, commonly known as the "bare earth zone", use grass vegetation wherever possible; if not from the edge of pavement, at least from the top of the slope of the ditch.*
- *Maintain any diversion ditches constructed on top of cut slopes to prevent slope erosion by the interception of surface drainage (see BMP E2.55 in Volume II).*
- *Examine culverts on a regular basis for scour around the inlet and outlet, and repair as necessary. Give priority to those culverts carrying perennial and/or salmonid-bearing streams, and culverts near streams in areas of high sediment load, such as those near subdivisions during construction.*
- *When using pesticides, comply with Ch. 17.21 RCW and Ch. 16-228 WAC (R.8 in Chapter IV-5), and additional stipulations presented in BMP S1.90 in Chapter IV-4.*

Stormwater Treatment BMPs: No stormwater treatment BMPs are required. See "Public Buildings and Streets" (Section IV-3.1) and "Maintenance of Public Stormwater Facilities" (Section IV-3.4).

IV-3.6 MAINTENANCE OF PUBLIC UTILITY CORRIDORS

DESCRIPTION: The BMPs described herein are for the maintenance practices employed in large public utility corridors for the transmission of electrical power, gas and water from remote supply sources and less frequently for easements for major gravity and force main lines for sewage.

MATERIALS USED AND WASTES GENERATED: Two potential sources of non-point pollution include pesticides used for pest or vegetation management, and the erosion and loss of soils from improperly maintained right-of-way access roads and drainage.

Source Control BMPs: See BMPs S1.50, S1.90 and S2.00 in Chapter IV-4 to determine appropriate actions. Additionally, these BMPs shall be employed to minimize non-point pollution:

- *Develop a written policy with maintenance procedures and an implementation schedule that provide for a vegetative cover program which minimizes bare or thinly vegetated ground surfaces within the corridor, where erosion might result in the entry of sediments into adjacent surface waters. A grassed or gravel access road is preferred to bare dirt.*
- *Develop a written policy with maintenance procedures that insure erosion of the access road is minimized, particularly in the vicinity of surface waters. This policy shall satisfy the General Criteria for Erosion and Sediment Control (Chapter II-4 in Volume II).*
- *Maintenance practices shall insure that stormwater does not accumulate and drain across and/or onto roadways, but is conveyed through roadside ditches and culverts. The road shall be crowned, outsloped, water barred or otherwise left in a condition not conducive to accelerated erosion. Grass-lining and appropriately maintaining a roadside ditch discharging to a surface water is an effective way of removing some pollutants associated with sediments carried by stormwater.*

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- *Ditches and culverts shall be maintained at the appropriate frequency to insure that plugging and flooding across the roadbed, with attendant erosion, does not occur.*
- *When applying pesticides, comply with Ch. 17.21 RCW and Ch. 16-228 WAC (R.8 in Chapter IV-5), and BMP S1.90 in Chapter IV-4.*
- *Do not temporarily store waste materials around unstaffed pump stations and electric substations.*
- *Electric utilities should use power poles constructed with a material other than wood, or use poles that have been preserved with chemicals less toxic than creosote or penta, such as inorganic arsenicals and copper naphthenate.*
- *Remove all litter produced when cutting or replacing wires, etc.*
- *Water and sediments removed from electric transformer vaults should first be analyzed for the presence of Dangerous Wastes. Water removed shall only be disposed to a sanitary sewer consistent with BMP S2.00 in Chapter IV-4 and the requirements of the local Sewer Authority (R.1 in Chapter IV-5) if these wastes are uncontaminated by PCBs or other materials. If contamination is found, the water and sediments shall be treated as Dangerous Waste and disposed of appropriately.*

Stormwater Treatment BMPs: No stormwater-treatment BMPs are required.

IV-3.7 WATER AND SEWER DISTRICTS AND DEPARTMENTS

DESCRIPTION: The maintenance of water and sewer systems can produce residual materials which, if not properly handled, can cause short-term environmental impacts in adjacent surface and/or ground waters. Maintenance operations of concern include the cleaning of sewer and water lines, and water reservoirs, general activities around treatment plants, disposal of sludges, and the temporary shutdown of pump stations for either normal maintenance or emergencies.

Draining of large reservoirs, tanks or pipelines can involve large quantities of water. Depending upon allowable discharge rates they can require many hours or days to drain.

Larger water and sewer districts or departments may service their own vehicles. See "Vehicle and Equipment Maintenance Shops" (Section IV-2.4.9) for the required BMPs.

Easement corridors through which major transmission lines pass usually require ongoing maintenance. The reader is referred to "Maintenance of Public Utility Corridors" (Section IV-3.6) for the required BMPs.

With the exception of a few simple processes, both water and sewage treatment produce residual sludges that must be properly disposed of. However, this activity is controlled by other Ecology regulatory programs and is not discussed in this manual.

MATERIALS USED AND WASTES GENERATED: During the maintenance of water transmission lines and reservoirs, water district/departments must dispose of waste water, both when the line or reservoir is initially emptied, as well as when it is cleaned and then sanitized. Sanitization requires chlorine concentrations of 25 to 100 ppm, considerably above the normal concentration used to chlorinate drinking water.

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These waters are discharged to sanitary sewers where available. However, transmission lines from remote water supply sources often pass through both rural and urban-fringe areas where sanitary sewers are not available. In these areas, chlorinated water may have to be discharged to a nearby stream, particularly since the emptying of a pipe section occurs at low points that frequently exist at stream crossings. Although prior to disposal the water is dechlorinated using sodium thiosulfate or a comparable chemical, malfunctioning of the dechlorination system can severely impact stream fisheries.

The drain lines from reservoirs located in unsewered areas discharge to the stormwater drainage system. Sometimes after sanitary service is provided to the area, the drain line is not connected to the nearest sanitary sewer but remains connected to the storm drains.

The cleaning of sewer lines and manholes generates sediments. These sediments contain both inorganic and organic materials, are odorous and contaminated with microorganisms and heavy metals. Activities around sewage treatment plants can be a source of non-point pollution. Besides the normal runoff of stormwater from paved surfaces, grit removed from the headworks of the plant is stored temporarily in dumpsters that may be exposed to the elements. Normal maintenance may produce waste paints, used oil, cleaning solvents, and soiled rags.

Source Control BMPs: Water purveyors shall examine each reservoir located where sanitary sewers are available to determine if the discharge line for wash water is connected via air gap to the sanitary sewer and to make such connection if it is not. Also see BMPs S1.50 and S2.00 in Chapter IV-4.

The following BMPs are also required:

- *An understanding with the local sewer district is important so that sewer capacities are not exceeded. Special care should be taken to intercept heavy sediment before it enters the sewer system.*
- *Where sanitary sewers are not available for either reservoirs or major transmission lines when they are cleaned, the water purveyor should prepare a plan indicating the locations of discharge points. The plan should include a conceptual design and implementation schedule for the installation of a system, either permanent or portable, to be installed at each point that will provide delay time between the point of dechlorination and the entry point to an adjacent receiving water.*
- *Where the discharge point for wash water is not adjacent to any receiving water, nearby ditches or fields may be suitable.*
- *Waste water from the cleaning of reservoirs, if contaminated by bottom sediments, shall be discharged to a sanitary sewer or trucked to an appropriate disposal point as dictated by the local Sewer Authority. Sediments shall be intercepted and trapped to prevent their entry to the sewer.*
- *In sewage treatment plants, the storm drain leading from an open area in which wet grit is stored prior to final disposal shall discharge to the treatment plant.*

Regulatory Requirements: See R.1, R.2, and R.3 in Chapter IV-5.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas where manufacturing processes occur shall be treated using

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infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators.

In lieu of separate stormwater treatment, owners of public sewage treatment facilities may choose to use the sewage treatment plant to treat the stormwater, partially or totally.

The agency may choose to discharge stormwater without treatment via the plant outfall. If this approach is selected, the allowable concentrations and loadings for the entire discharge (sewage plus stormwater) shall not exceed what would have been allowed had a stormwater treatment system been installed. In effect, the allowable discharge from the sewage treatment plant must be reduced to compensate for the lack of treatment of the stormwater. Ecology regulations and permit conditions must be met prior to the use of this type of discharge.

Stormwater runoff from rooftops may be discharged to the storm drain below the stormwater treatment system as long as the drainage requirements of the local Public Works Department are met.

IV-3.8 PORT DISTRICTS

DESCRIPTION: Some port districts are very small and have only a few activities such as a marina and boat launches, while others are very large and are responsible for activities as varied as a city or town. For many ports, the majority of activities are carried out by private businesses who are leasing port facilities. Port officials need to list the various types of businesses and then refer to the appropriate pages in Chapter IV-2 to identify the required BMPs.

Types of business activities include: recreational boat marinas and launch ramps; boat maintenance and repair; airfields; container transhipment, bulk material import/export such as farm products, lumber, logs, alumina, and cement; break-bulk (piece) material such as machinery, equipment, and scrap metals. Ports provide warehouses, on or away from the shoreline for client use.

Port districts frequently have tenants whose activities are not marine-dependent. Therefore, the potential exists for the presence of any type of manufacturing or commercial business.

MATERIALS USED AND WASTES GENERATED: The types of materials used and wastes generated are very specific to the industrial activity. Marine terminals require extensive use of mobile equipment that may drip fluids. This equipment is usually maintained on site. Consequently, all of the waste materials associated with vehicle maintenance may be generated at a marine terminal. Cargo containers are frequently repaired and cleaned on port property.

A significant amount of debris can accumulate on loading/unloading or open storage areas, providing a source of stormwater contamination. Wooden debris from the crating of piece cargo crushed by passing mobile loading equipment leaches soluble pollutants when allowed to sit in pooled stormwater. Log sorting yards produce large quantities of bark that can be a source of fine suspended solids and leached soluble pollutants.

The types of activities, and potential waste materials generated at airfields are discussed in Chapter IV-2.

Source Control BMPs: Having identified the specific types of businesses and activities, port officials can refer to Chapter IV-2 to identify the required BMPs.

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There are some aspects that are unique to ports that require additional specification:

- Mobile cranes, like those used in construction, are frequently used to load barges. Although mobile, these cranes may sit for an extended period on a pad or wharf, adjacent to or over water. Drip pans shall be placed under these cranes.

- All steam cleaning or pressure washing of equipment or containers shall occur either in building or in a designated area that drains to a sanitary sewer. See BMP S1.20 in Chapter IV-4.

- All maintenance of mobile equipment shall occur in a building, except for refrigerated trailers and very large equipment. The maintenance of refrigeration engines in refrigerated trailers may occur in the parking area with due caution to avoid the spillage of engine or refrigeration fluids. Refrigerator coolants may be recyclable.

- Larger mobile equipment shall receive maintenance in a designated area. Mobile equipment may be idle for extensive periods of time. This equipment shall be parked in a designated paved area.

- The designated areas for maintenance and storage shall be curbed to prevent the runon of stormwater from outside the designated area. The stormwater within the designated area shall pass through an API or CPI-type oil/water separator see Volume III, Runoff Control). If the area is not too large, the drain shall connect to a sanitary sewer as long as it complies with the requirements of the local Sewer Authority (R.1 in Chapter IV-5).

- The designated areas shall be paved with Portland cement concrete rather than asphalt.

- Loading/unloading areas shall be paved and sloped to prevent the pooling of water. The use of catchbasins and drain lines within the interior of the paved area shall be minimized as they will frequently be covered by material, or they should be placed in designated "alleyways" that are not covered by material, containers or equipment. To the maximum extent possible, perimeter drain systems should be used.

- Large loading areas frequently are not curbed along the shoreline. As a result, stormwater passes directly off the paved surface into the surface water. Curbs shall be placed along the edge, or the edge shall be sloped such that the stormwater can flow to an internal storm drain system that leads to treatment.

- As noted above, a significant amount of debris can accumulate on loading/unloading areas. These surfaces shall be swept frequently to remove material that could otherwise be washed off by stormwater. An area may be covered for a period of time by containers, logs, or other material. As a particular area is cleared, it shall be swept; catchbasins shall be inspected regularly and cleaned if more than half full of sediment.

Stormwater Treatment BMPs: Source control BMPs such as good housekeeping should always be used to control stormwater pollution. Stormwater from parking lots and outside areas where manufacturing processes occur shall be treated using infiltration and/or detention as detailed in Volume III, Runoff Control. Those practices shall be used in combination with other appropriate pre-treatment and treatment BMPs such as biofiltration, pre-settling basins and oil/water separators.

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Stormwater runoff from rooftops may be discharged to the storm drain below the stormwater treatment system as long as the drainage requirements of the local Public Works Department are met.

The above requirements are limited to surfaces over firm ground. Staging areas located over open water are not required to have stormwater treatment systems as Ecology has not at this time identified a practical way in which such a system can be installed.

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CHAPTER IV-4 SOURCE CONTROL BMPs

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CHAPTER IV-4

SOURCE CONTROL BMPs

INTRODUCTION

Source control BMPs are organized by the activities found on the checklist in Chapter IV-1. Each of these BMPs include several different ways to improve runoff quality. Specific recommendations for each business are not made since the activities for each vary widely. The local government will make the final decision on appropriate BMPs for each business.

If possible, a pollution-creating activity should be altered to one which does not cause pollution. If the activity cannot be changed, then it should be enclosed. If it is too expensive to enclose the entire area, then perhaps the activity can be covered with just a frame and a roof. This area should also be provided with an impervious surface and drained to the sanitary sewer, process treatment or to a dead-end sump according to either local Sewer Authority or other permit requirements.

IV-4.1 BMP S1.10 FUELING STATIONS

In addition to general service gas stations, fueling may also occur at 24-hour convenience stores, construction firms, warehouses, car washes, and businesses with fleet vehicles. Fueling also occurs at port facilities and industrial complexes where mobile equipment is used. Fuels contain organic compounds and metals that adversely affect aquatic life.

<u>IF FUELING IS DONE ON-SITE, WHETHER AT A GAS STATION OR OTHER FUELING AREA, THE FOLLOWING BMPs ARE REQUIRED</u>

1. The fueling facility shall be built in compliance with the Uniform Fire Code and the National Electric Code.

2. The fuel island shall be paved using Portland cement concrete, not asphalt and be designed to contain fuel spills. The fuel island shall be designed as a spill containment pad and sized to prevent the runoff of spilled fuel and the runon of stormwater from surrounding pavement. Parking lot stormwater shall be discharged to the stormwater drainage system, not the sanitary sewer.

3. Liquids spilled on the fuel island shall be collected in drains; either trench drains or catchbasins. The pad shall be sloped towards the drains. The drain(s) shall be connected to the sanitary sewer, process treatment or a dead-end sump. To comply with the requirements of the local Sewer Authority and the Uniform Fire Code (R.1 and R.2 in Chapter IV-5) the drain shall have a valve to allow shutoff in the event of a large fuel spill.

4. The fuel island shall be covered to prevent the direct entry of precipitation onto the spill containment pad (see Figure IV-4.1). The roof/canopy shall, at a minimum, cover the spill containment pad and preferably extend several additional feet to prevent windblown rain from entering.

5. Spills should be prevented whenever possible. The owner or operator shall develop an emergency spill cleanup plan (per BMP S1.80) and have responsible designated person(s) available either on site or on call at all times. Suitable cleanup materials shall be kept on site to allow prompt cleanup should a spill occur.

5. Educate employees and customers on the proper use of fuel dispensers. Post signs in accordance with the Uniform Fire Code. Post "No Topping Off" signs;

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topping off gas tanks causes spillage and vents gas fumes to the air. Make sure that the automatic shutoff on the gas nozzle works.

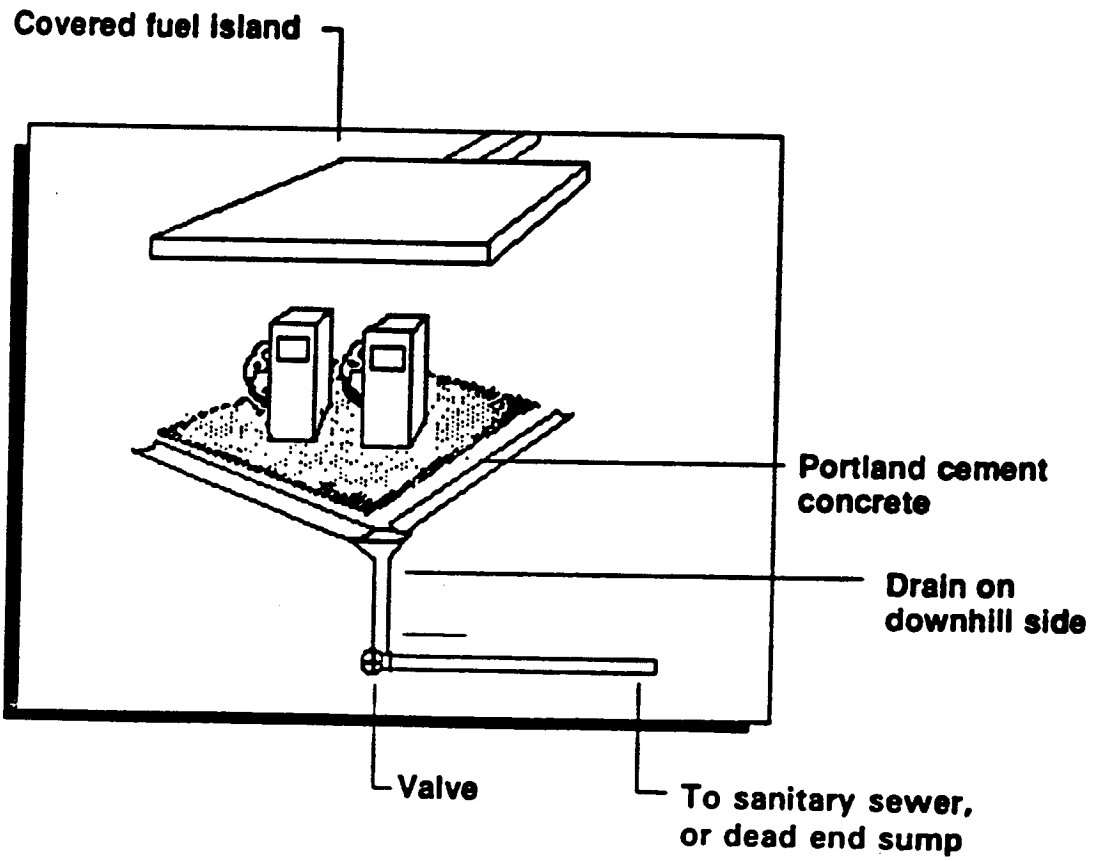
6. Temporary fuel tanks used to fuel vehicles in the field shall be placed in a bermed, impervious (using heavy mil plastic or portland cement) area. The bermed area shall be large enough to contain the greater of: 10% of the total enclosed combined tank volume or 110 percent of the largest tank's volume.

Exceptions

In industrial complexes or port facilities where very large mobile equipment is used such as log loaders, the fuel island need not be covered. However, the pad must be designed in a manner that prevents the run-on of stormwater from adjacent areas. The pad must also be designed in a manner that allows the collection of all rain that falls on the pad.

See BMP S1.30 for information or the transfer of fuels from a tanker to the fuel storage tanks and BMP S1.40 regarding the installation of the tanks.

IV-4.1 Details of Fuel Island



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IV-4.2 BMP S1.20 VEHICLE/EQUIPMENT WASHING AND STEAM CLEANING

If vehicle and/or equipment washing or steam cleaning is done on premises, the following measures are required.

Washing of highway vehicles, equipment and parts such as construction equipment, shall occur in a building or in a designated area such as that described below. This requirement refers to all methods of washing in which water is used including low-pressure water, high-pressure water and steam.

Wash water from cleaning activities contains significant quantities of oil and grease, suspended solids, heavy metals, and organics, as well as pollutants from the detergents.

Oil/water separators tend to be ineffective because the surfactants in detergents chemically stabilize free and dispersed oil.

GENERAL REQUIREMENTS

Wash water from vehicle and equipment cleaning shall be discharged to the sanitary sewer. All requirements of the local Sewer Authority and/or other permit requirements must be met prior to discharge. The owner shall conduct washing in one of the following locations in order of preference:

1. At a commercial washing business in which the washing occurs in an enclosure (see Chapter IV-2, "Car and Truck Washes") and drains to the sanitary sewer or;
2. Inside the owner's vehicle or equipment building which is plumbed to drain to the sanitary sewer or;
3. In a building the owner has constructed specifically for washing of vehicles and equipment which is plumbed to drain to the sanitary sewer or;
4. In an outside area without walls and/or roof designated by the vehicle owner as a wash area, meeting the requirements outlined below.

The use of mobile wash services is not allowed unless the wash water can be contained and discharged to a sanitary sewer per the requirements of the local Sewer Authority or discharged into and be treated by a closed-loop recycling system. Exceptions to these General Requirements are noted below.

REQUIREMENTS FOR UNCOVERED WASH AREAS

A wash area without walls and/or roof is the least desirable option. Building roofs and walls prevent entry of precipitation, and walls contain wash water. These standards are designed to prevent release of petroleum compounds and metals into the environment and minimize the discharge of precipitation to the sanitary sewer. If the owner chooses to conduct washing operations in an outside area the owner shall establish a designated wash area with the following features:

1. Paved, preferably with portland cement, and constructed as a spill containment pad to prevent the run-on of stormwater from adjacent pavement areas. The spill containment area shall be graded so that all water is collected in a containment pad drain system. The drain system may be perimeter drains, trench drains or catchment drains. The containment pad shall be sized to extend out a minimum of four feet on all sides of the vehicles and/or equipment being washed.

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2. All wash water shall discharge to the sanitary sewer, process treatment or a dead-end sump. All requirements of the local Sewer Authority and/or other permit requirements must be met prior to discharge;

3. The discharge shall be treated by one of the following methods:

   - Pass through an SC-type (spill control) oil/water separator (or an API or CPS oil/water separator as directed by the local Sewer Authority) and shall comply with the pre-treatment requirements of the local Sewer Authority (R.1 in Chapter IV-5). Although the detergents in the wash water will tend to disperse the oil, a well-maintained SC-type oil/water separator will protect against deliberate dumping. A positive control valve is required (see #4 below).

   - Discharge to a containment sump with a positive control valve (see #4 below), live containment volume and overflow with oil/water separation. The minimum live storage volume shall be sized for the 6-month, 24-hour storm for the area of the containment pad.

4. The discharge pipe shall have a positive control valve that is shut when washing is not occurring, thereby preventing the entry of stormwater. This valve may be manually operated but a pneumatic or electric valve system is preferable. Signs shall be posted to inform people of the operation and purpose of the valve. The valve may be on a timer circuit; where it is opened upon completion of a wash cycle. The timer would then close the valve after the sump or separator is drained. The recommended time period for the timer would be the time required to drain the sump live storage at the design oil/water separator inflow rate from the sump.

5. In areas where the wash water cannot be discharged to a sanitary sewer, wash water should be collected in a dead-end sump, tank, or other device and transported to the nearest sanitary facility for proper disposal.

6. A portland cement spill containment pad is recommended for steam cleaning.

7. The wash area shall be well marked at gas stations, multi-family residences and any other business where vehicles may be washed by non-employees. Included in the posting will be a statement forbidding the changing of oil in the wash area. The location of the nearest oil recycling facility should be posted. See Figure IV-4.2 for an illustration of these requirements.

EXCEPTIONS

1. At existing gas stations where it is not possible to have the designated area discharge to a sanitary sewer, the station can, whenever extensive vehicle washing is occurring (such as washing cars to raise charity funds), place a temporary plug in the storm drain and pump the accumulated water to the nearest sanitary sewer.

   Local governments can help this solution by making the equipment available and obtaining the approval of the local Sewer Authority if the sewers are not owned by the local government responsible for the public storm drains.

2. Dealerships of new and used automobiles or trucks may wash the vehicles in the parking stalls as long as only water is used. Soaps, detergents and cleaners shall not be used. Soaps, detergents and cleaners are all "biodegradable" to a certain extent, but the word "biodegradable" has no legal definition in this state. As a result, manufacturers can make claims which in some cases may be misleading. The dealership can also use the temporary plug system outlined above for gas stations.

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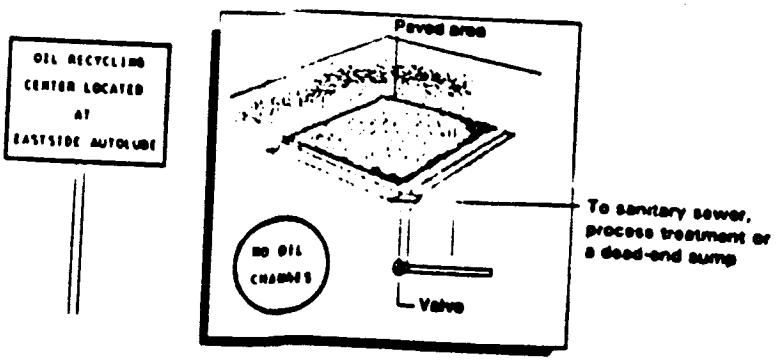
3. Truck washes at industrial sites which are used to prevent the tracking of dirt, sediment and floatable materials such as wood, onto public streets can discharge to the storm drain. However, the wash water shall pass through a catchbasin and oil/water separator. Soaps and other cleaners shall not be used if the wash water is discharged to the storm drain.

Figure IV-4.2 Requirements for an Uncovered Wash Area



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IV-4.3 BMP S1.30 LOADING AND UNLOADING LIQUID MATERIALS

If loading or unloading occurs of liquids in containers or direct liquid transfer occurs, then the following BMPs apply.

Consistent with Uniform Fire Code requirements (R.2 in Chapter IV-5) and to the extent possible, unloading or loading of liquids should occur in the manufacturing building so that any spills that are not completely retained can be discharged to the sanitary sewer, process treatment or a dead-end sump consistent with local Sewer Authority and permit requirements.

Practices are described below for areas where loading is done outside and loss to storm drains could occur.

CONTAINED LIQUIDS AT LOADING AND UNLOADING DOCKS

1. Loading/unloading docks shall have overhangs or door skirts that enclose the trailer end (see Figures IV-4.3 and IV-4.4).
2. The loading/unloading area is to be designed to prevent run-on of stormwater.
3. The owner shall retain on site the necessary materials for rapid cleanup of spills (see BMP S1.80).

RAIL TRANSFER TO ABOVE/BELOW-GROUND STORAGE TANKS

1. To minimize the risk of accidental spillage, the owner shall have a written "operations plan" that describes procedures for loading and/or unloading. Employees shall be trained in its execution and it shall be posted or otherwise made easily available to employees.
2. As a part of the operations plan, or as a separate document, the owner shall have an Emergency Spill Cleanup Plan (BMP S1.80).
3. Drip pans shall be placed at locations where spillage may occur such as hose connections, hose reels and filler nozzles. Drip pans shall <u>always</u> be used when making and breaking connections (see Figure IV-4.5).
4. A drip pan system as illustrated shall be installed within the rails to collect spillage from tank cars (see Figure IV-4.6).
5. An employee trained in spill containment and cleanup shall be present during loading/unloading.

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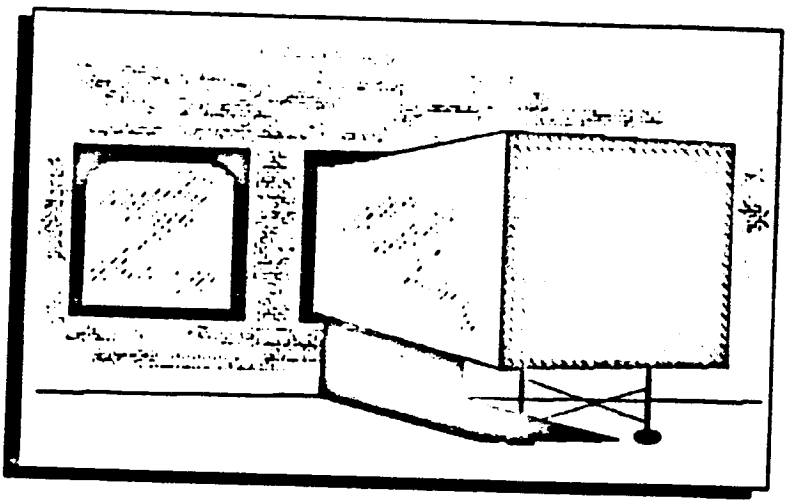
Figure IV-4.3 Dock With Door Skirt



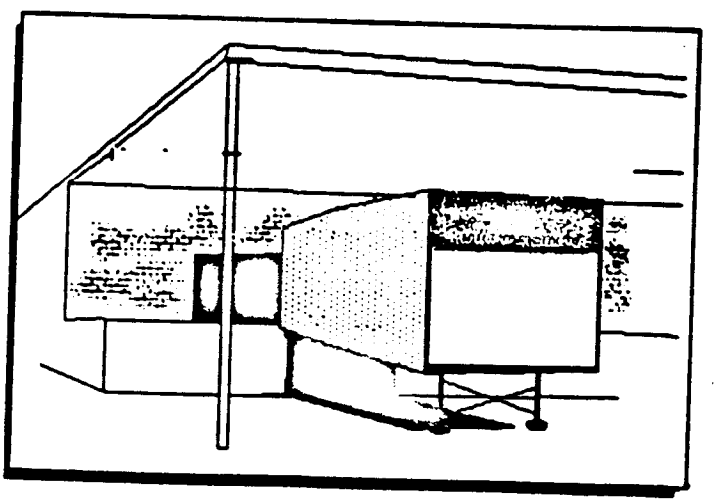


Figure IV-4.4 Dock With Overhang

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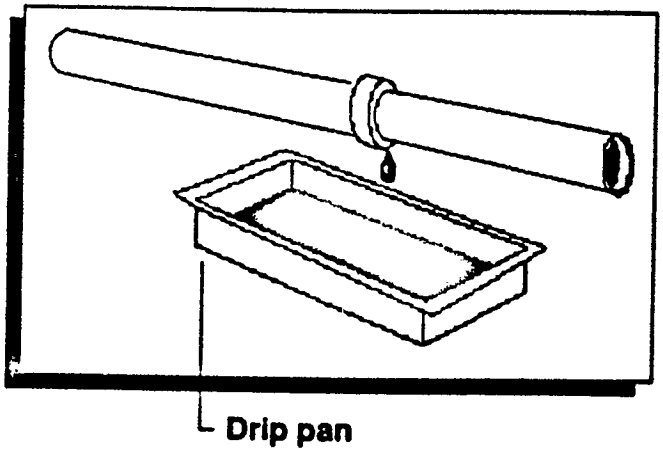
Figure IV-4.5



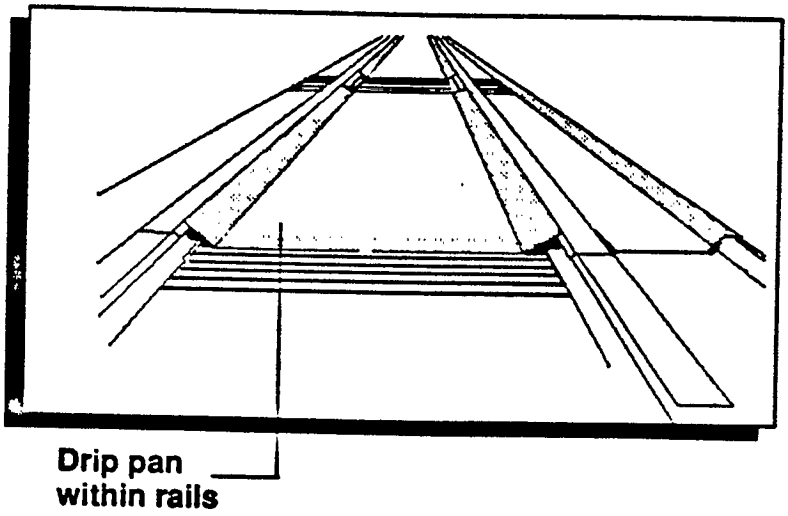


Figure IV-4.6

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TANKER TRUCK TO ABOVE/BELOW-GROUND STORAGE TANKS

1. To reduce the risk of spills, the owner shall have a written "operations plan" describing procedures for loading and/or unloading. Employees shall be trained in its execution.

2. The operations plan will include an emergency spill cleanup plan. (BMP S1.80). Cleanup materials shall be readily available and employees will be trained in their use.

3. The area on which the transfer takes place shall be paved. If the liquid is reactive with asphalt (for example, gasoline) Portland cement concrete shall be used to pave the area.

4. The transfer area shall be designed to prevent the run-on of stormwater from adjacent areas. This may be achieved by sloping the pad and surrounding area in a appropriate manner, or with a small, flattened curb (like a small speed bump) around the "uphill" side of the transfer area;

5. The transfer area shall be designed to prevent the runoff of any spilled liquids from the area. This can be accomplished by sloping the area to a drain. The drain shall be connected to a dead-end sump or to the sanitary sewer subject to the requirements of the local Sewer Authority. For the latter two situations, a positive control valve shall be installed.

6. If the transfer area is connected to the sanitary sewer, a spill containment sump should be installed between the spill containment pad and the sewer connection. The sump should be large enough to include 50 gallons of storage space, grit sedimentation volume and a manual drain shut-off valve. Instructions in its use should be prominently posted. Alternatively, an API or CPS oil/water separator sized for a 15 minute retention time at the greater flow rate of the: greatest fuel dispenser nozzle through-put rate of the peak flow rate of the 6-month, 24-hour storm event over the surface of the containment pad.

7. Drip pans shall be placed at locations where spillage may occur such as hose connections, hose reels and filler nozzles. Drip pans shall always be used when making and breaking connections (see Figure IV-4.5).

LOADING AND UNLOADING FROM OR TO MARINE VESSELS

Facilities and procedures for the loading or unloading of petroleum products must comply with Coast Guard requirements (R.5 in Chapter IV-5).

TRANSFER OF SMALL QUANTITIES FROM TANKS AND CONTAINERS

See BMPs S1.40 and S1.50 for requirements on the transfer of small quantities from tanks and containers, respectively.

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IV-4.4 BMP S1.40 LIQUID STORAGE IN ABOVE-GROUND TANKS

Any business which stores liquids in above-ground tanks shall comply with the following practices.

Storage of reactive, ignitable, or flammable liquids must comply with the Uniform Fire Code (R.2 in Chapter IV-5). The following practices are to complement, not conflict with the Uniform Fire Code. Below-ground tanks shall comply with Ecology requirements (R.6 in Chapter IV-5).

PERMANENT TANK STORAGE

1. The tank shall include an overfill protection system to minimize the risk of spillage during loading.
2. Permanently installed tanks shall be surrounded by dikes as illustrated in Figure IV-4.7. The dike shall be of sufficient height to provide a volume that is the greater of either 10% of the total enclosed tank volume or 110% of the volume contained in the largest tank.
3. The dikes and the surface within the dike area shall be sufficiently impervious to prevent loss of the stored material in the event of spillage.
4. Outlets from the tank area shall have positive control to prevent uncontrolled discharge from the tank area of spilled chemicals or petroleum products.
5. The outlet shall have a dead-end sump for the collection of small spills. It shall be cleaned weekly to minimize the potential for contamination of stormwater and/or ground water.
6. During the wet season, accumulated stormwater shall be released frequently.
7. For petroleum tank farms, the stormwater shall pass through an API or CPI-type oil/water separator (BMP RD.35, Volume III, Runoff Control).
8. If a tank is to be located in an area where firearms may be discharged, concrete encapsulation (or equivalent) should be used to protect the inner tank.
9. Tanks should be guarded against vehicles through the use of bollards or traffic barriers.
10. All installations shall be done per the Uniform Fire Code and the National Electric Code.
11. Double walled tanks do not need containment systems. All double-walled tanks should be UL approved.

SMALL PORTABLE TANK STORAGE

Where portable, double-hulled tanks are used to contain fuels for servicing vehicles, a diking system as described above need not be used.

1. A secondary containment system (or equivalent) similar to that shown shall be used whenever liquids are temporarily stored in a portable tank (see Figure IV-4.8).
2. The containment system should be a bermed impervious area (using either heavy mil plastic or portland cement). The minimum storage volume shall be 100% of the total tank volume.

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3. If a tank is to be located in an area where firearms may be discharged, concrete encapsulation (or equivalent) should be used to protect the inner tank.

4. Tanks should be guarded against vehicles through the use of bollards or traffic barriers.

5. All tank installations should be per the Uniform Fire Code and the National Electric Code.

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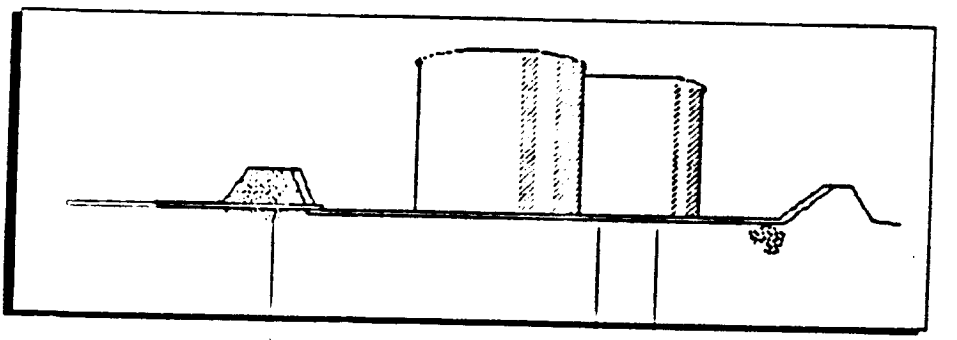
Figure IV-4.7 Above-Ground Tank Storage

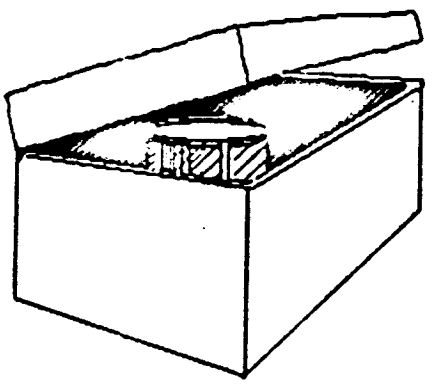


The dike shall provide a volume that is the greater of either 10% of the total enclosed tank volume or 110% of the volume contained in the largest tank.

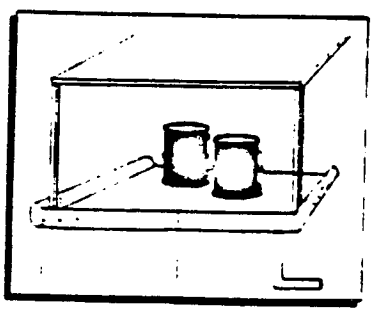
Impervious surface

Permanently installed tanks surrounded by dike system

Figure IV-4.8 Secondary Containment System



Container completely encloses storage tank



The dike shall provide a volume that is the greater of either 10% of the total enclosed tank volume or 110% of the volume contained in the largest tank.

Covered, designated area

Figure IV-4.9 Covered and Bermed Containment Area

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IV-4.5 BMP S1.50 CONTAINER STORAGE OF LIQUIDS, FOOD WASTES OR DANGEROUS WASTES

A container is any portable device in which material is stored. These practices apply to container(s) located outside a building used to temporarily store accumulated food wastes, vegetable or animal grease, used oil, liquid feedstock or cleaning chemical, or Dangerous Wastes (liquid or solid) unless the business is permitted by Ecology to store the wastes (R.4 in Chapter IV-5).

- Containers used to store Dangerous Waste, food waste, or other liquids shall be kept inside a building unless this is impracticable due to site constraints or Uniform Fire Code requirements. If the containers are placed outside, the requirements of this BMP must be met.

- Dumpsters used to store items awaiting transfer to a landfill (such as used oil filters) shall be placed in a lean-to structure. Dumpsters shall be in good condition without corrosion or leaky seams. See below for the exact requirements.

- If waste container drums are stored above ground, they shall be kept in an area such as a service bay. If drums are kept outside, they must be stored in a lean-to type structure to keep rainfall from reaching the drums. See below for the exact requirements.

- Garbage dumpsters shall be replaced if they are deteriorating to the point where leakage is occurring. They shall be kept under cover to prevent the entry of stormwater (see below).

Storage of reactive, ignitable, or flammable liquids must comply with the Uniform Fire Code (R.2 in Chapter IV-5). The following practices shall complement, not conflict, with current Uniform Fire Code requirements.

1. Containers shall be located in a designated area.

2. The designated area shall be paved, free of cracks and gaps and impervious in order to contain leaks and spills.

3. For liquid wastes, tanks shall be surrounded by dikes as illustrated in Figure IV-4.9. The dike shall be of sufficient height to provide a volume that is the greater of either 10% of the total enclosed tank volume or 110% of the volume contained in the largest tank.

4. The designated area shall be covered (see Figure IV-4.9).

5. The area inside the curb shall slope to a drain. If the material being stored is controlled by the Uniform Fire Code, or is used oil or Dangerous Waste a dead-end sump shall be installed.

   For all other liquids the drain shall be tied to the sanitary sewer if available. Otherwise, process treatment or a dead-end sump shall be used subject to local Sewer Authority or permit requirements. The drain must have positive control (for example, a locked drainage valve or plug) to prevent release of contaminated liquids.

6. If the business is using roll-containers (for example, dumpsters) that are picked up directly by the collection truck, a filet can be placed on both sides of the curb to facilitate moving the dumpeter.

7. Businesses accumulating Dangerous Wastes that do not contain free liquids need not carry out items #3 through #5 above if the designated area is sloped and

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the containers are elevated or otherwise protected from storm water run-on.

8. Where material is temporarily stored in drums, a containment system can be used as illustrated, in lieu of the above system (see Figure IV-4.10). If a tank is to be located in an area where firearms may be discharged, concrete encapsulation (or equivalent) should be used to protect the inner tank.

9. Containers mounted for direct removal of a liquid chemical for use by employees must be placed inside a containment area as described above. A drip pan shall be used at all times (see Figure IV-4.11).

10. Drums stored in an area where unauthorized persons may gain access must be secured in a manner that prevents accidental spillage, pilferage or any unauthorized use (see Figure IV-4.12).

11. If the material is a Dangerous Waste, the business owner shall comply with any additional Ecology requirements (See R.3 in Chapter IV-5) not presented above.

12. If a storage area is to be used on-site for less than 30 days, a portable secondary system like that shown in Figure IV-4.10 can be used in lieu of a permanent system as described above.

13. An employee trained in emergency spill cleanup procedures shall be present when Dangerous Wastes, liquid chemicals or other wastes are loaded or unloaded (see BMP S1.80).

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Figure IV-4.10
Temporary Drum Containment System

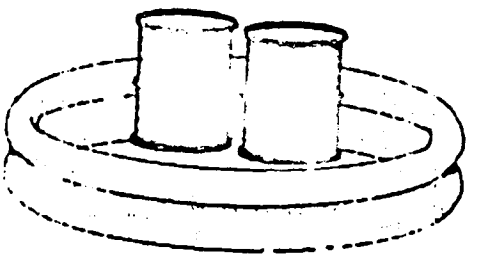
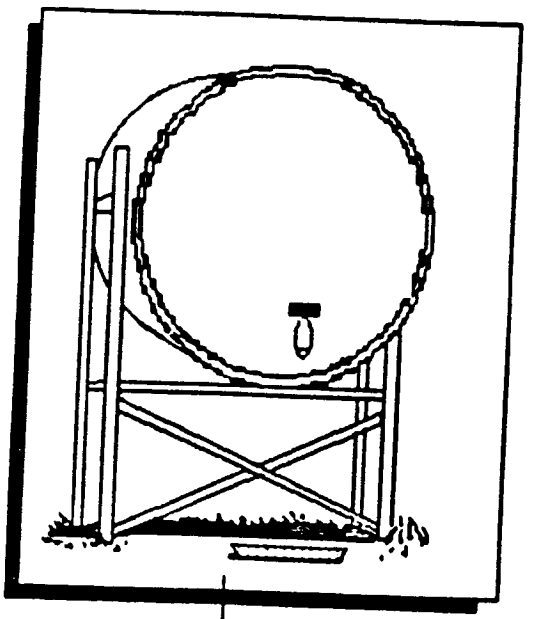


Figure IV-4.11
Mounted Container With Drip Pan



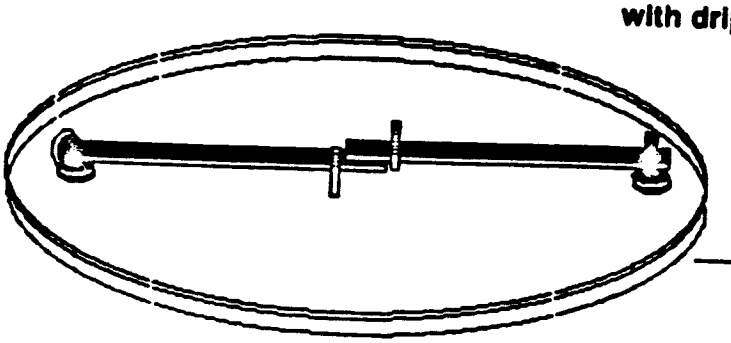


Figure IV-4.12
Locking System for Drum Lid

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IV-4.6 BMP B1.60 OUTSIDE STORAGE OF RAW MATERIALS, BY-PRODUCTS OR FINISHED PRODUCTS

If the raw material, by-product or product is a liquid see the previous BMP. This section covers solid material.

This BMP is for:

1. Material such as gravel, sand, topsoil, compost, logs, sawdust, wood chips;
2. Lumber and other building materials;
3. Concrete and metal products.

The business shall select one of the following practices appropriate to the type of material:

1. Build a covered area as shown in Figure IV-4.13. The area upon which the materials is stored shall be paved or;
2. Place temporary plastic sheeting over the material as illustrated (see Figure IV-4.14) or;
3. Pave the area and install a drainage system. Stormwater from the area shall be treated using one of the treatment systems presented in Volume III, Runoff Control. This is the preferred option for log storage.

With Option #3, the paved area shall be sloped in a manner that minimizes the pooling of water on the site, particularly with materials that may leach pollutants into stormwater and/or ground water such as compost, logs and wood chips. A minimum slope of 1.5 percent is recommended. Curbing shall be placed along the perimeter of the area to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of stormwater from the stockpile area.

The storm drainage system shall be designed to minimize the use of catchbasins in the interior of the area, as they tend to rapidly fill with the manufacturing material. Rather, the area should be sloped to drain stormwater to the perimeter where it can be collected, or to internal drainage "alleyways" where material is not stockpiled.

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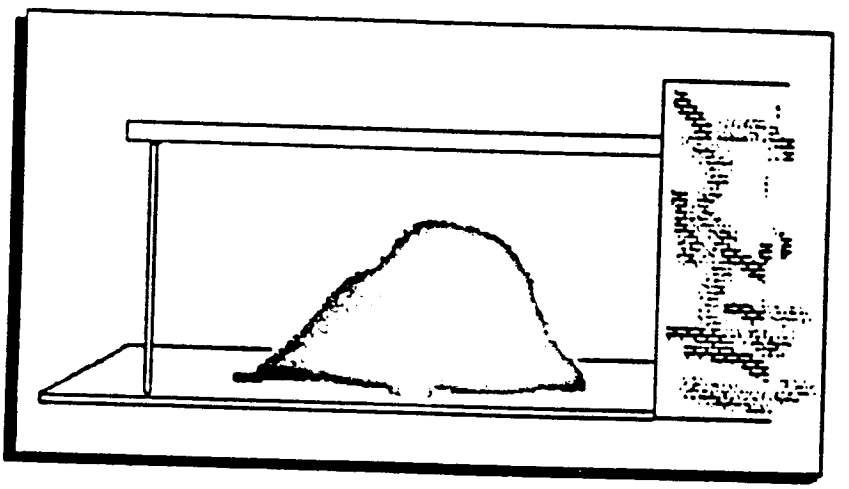
Figure IV-4.13 Covered Storage Area for Raw Materials



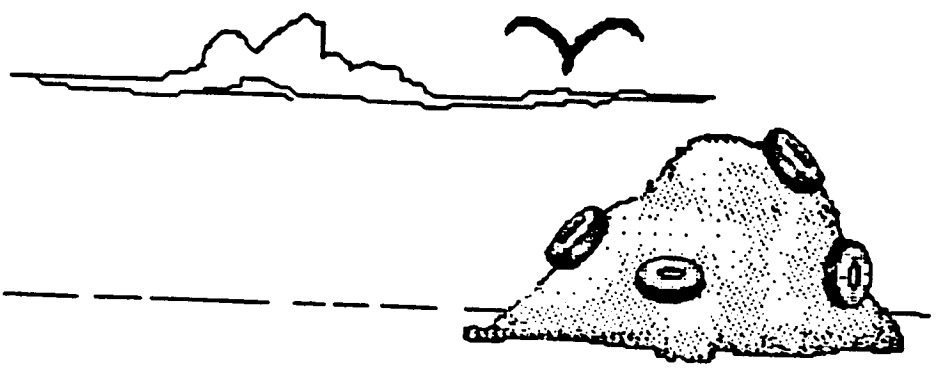


Figure IV-4.14 Material Covered with Plastic Sheeting

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IV-4.7 BMP S1.70 OUTSIDE MANUFACTURING ACTIVITIES

These practices should be used by those businesses identified in Chapter IV-2 that carry out manufacturing activities in an area exposed to precipitation.

ALTER THE ACTIVITY

The preferred option is to alter the activity so that pollutants are no longer discharged. If altering the practice will not significantly reduce the concentration of the pollutants, further actions as described below must be taken.

ENCLOSE THE ACTIVITY (see Figure IV-4.14)

If possible, the manufacturing activity should be completely enclosed in a building and the floor drains connected to the sanitary sewer. The allowable concentration of pollutants is then specified by the local Sewer Authority (R.1 in Chapter IV-5). The area used may be so great as to make enclosure prohibitively expensive.

Costs of this BMP may be increased if the building code of the local jurisdiction requires a certain number of parking spaces be provided with a building even though its construction will not alter the nature of the manufacturing activity and therefore the number of employees.

COVER THE ACTIVITY (see Figure IV-4.15)

The cost of a building can be significantly reduced by not covering the sides, thus eliminating the need for ventilating and lighting systems. Floor drains shall be connected to the sanitary sewer.

If rejected asphalt is temporarily stored on-site before disposal, it shall be covered.

SEGREGATE THE ACTIVITY

Certain parts of the activity may be the worst source of pollutants. Those parts can be segregated and enclosed or covered. Their drains can then be hooked to the sanitary sewer, process treatment or a dead-end sump depending upon available methods and applicable permit requirements.

A method commonly used in large industrial complexes where much of the process equipment is exposed is to place curbing around the immediate boundary of the individual processes. The storm drains from these interior areas discharge to the process wastewater treatment system.

DISCHARGE OF HIGH FREQUENCY STORMS TO THE PUBLIC SANITARY SEWER

Businesses that utilize the public sanitary sewer system for their process or sanitary discharges may be able to utilize the public sewer for stormwater treatment under the following conditions.

If the segregated area is very small (less than a hundred or so square feet), the local Sewer Authority may be willing to allow the area to remain uncovered with the drain connected to the sanitary sewer (R.1 in Chapter IV-5).

It may be possible under unusual circumstances to connect a much larger area to the sanitary sewer if the rate of stormwater discharge is matched to the capacity of the sewer. This approach will be limited to a small number of industries with outside activities that produce pollutants of particular concern.

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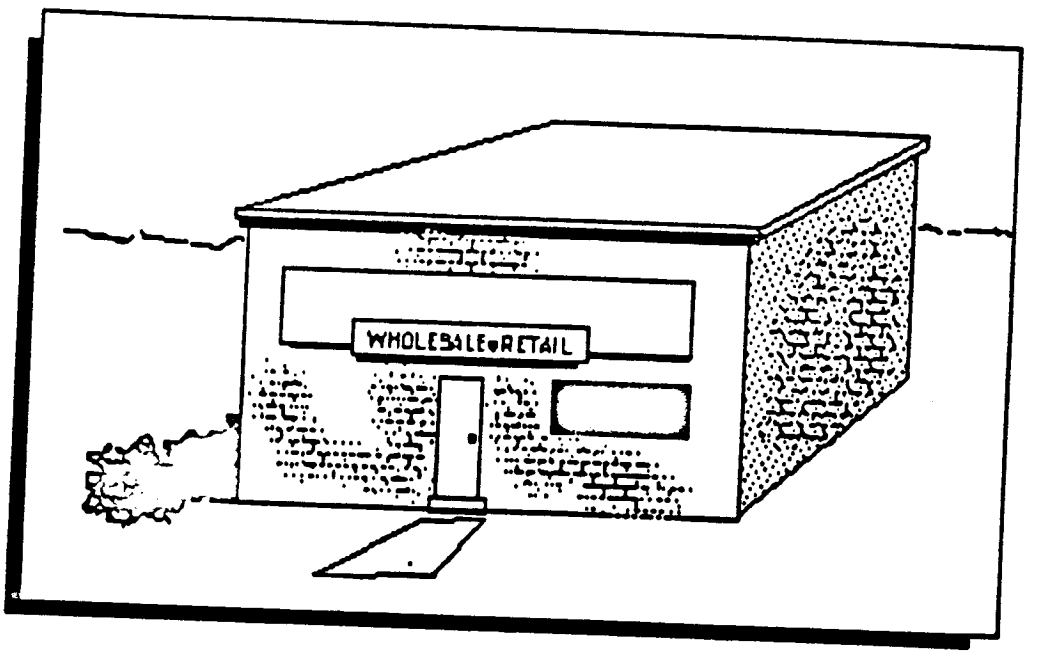
Figure IV-4.15 Enclose the Activity



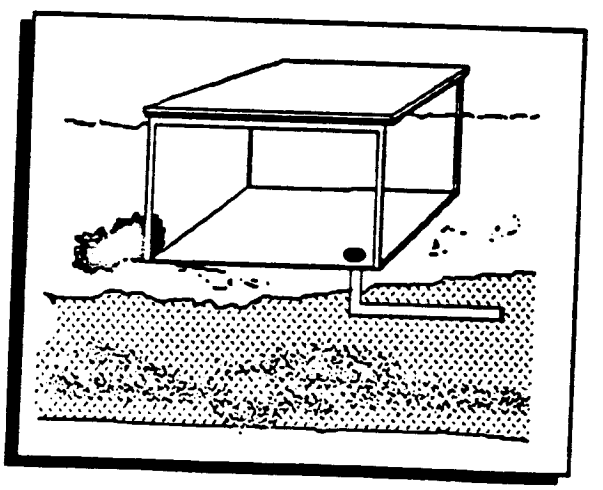


Figure IV-4.16 Cover the Activity

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Since the majority of the pollutants in stormwater are discharged over time by the small, high frequency storms, the excess runoff from the infrequent large storms can be bypassed to the storm drain. To comply with the goals of this manual the sanitary sewer must have sufficient capacity to take a peak stormwater flow equivalent to the runoff of the water quality design storm (the 6-month, 24-hour storm - See Appendix AI-2.1 in Volume I). Stormwater discharge rates in excess of this value are bypassed to the storm drain.

If the sewer does not have the capacity to handle the 6-month storm peak-rate, a detention facility can be installed with a volume sufficient to reduce the peak rate to the capacity of the sewer (Volume III, Runoff Control).

Any discharge to a public sanitary sewer must meet the requirements of the local Sewer Authority (R.1 in Chapter IV-5).

To implement this BMP a hydraulic evaluation of the "downstream" sewer system shall occur in consultation with the local Sewer Authority.

DISCHARGE TO THE BUSINESSES' PROCESS WASTEWATER TREATMENT SYSTEM

Industries that generate large volumes of process wastewater typically have their own wastewater treatment system that discharges directly to the nearest receiving water. These industries shall have the discretion to use their own wastewater treatment system to treat stormwater within the constraints of their NPDES permit requirements for process treatment.

The industry may also choose to discharge the stormwater directly to its effluent outfall without treatment as long as the total loading of the discharge process water and stormwater does not exceed the loading had a stormwater treatment device been used. In effect, the allowable discharge of pollutants from the process wastewater treatment system is reduced. This option would be subject to permit constraints and, potentially, regular monitoring.

STORMWATER TREATMENT

If none of the above BMPs can be implemented then one of the treatment methods presented in the Runoff Control Volume shall be installed.

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IV-4.8 BMP S1.80 EMERGENCY SPILL CLEANUP PLANS

Owners of facilities engaged in storing, processing, or refining oil and/or oil products are required by Federal Law to have a Spill Prevention and Control Plan (SPCC). Owners of businesses that produce Dangerous Wastes are required by State Law to have a spill cleanup plan. These businesses should also refer to R.7 in Chapter IV-5.

The businesses and public agencies identified in Chapters IV-2 and IV-3 of this manual that are required to have an Emergency Spill Cleanup Plan shall follow these general guidelines in its preparation.

1. The first part of the plan shall contain a description of the facility including the owner's name and address, the nature of the facility activity and the general types of chemicals used in the facility.

2. The plan shall contain a site plan showing the location of storage areas for chemicals, the locations of storm drains, and the direction of slopes towards those drains, and the location and description of any devices to stop spills from leaving the site such as positive control valves.

3. The plan shall describe notification procedures to be used in the event of a spill, such as key personnel, and agencies such as Ecology and the local Sewer Authority.

4. The plan shall provide instructions regarding cleanup procedures.

5. The owner shall have a designated person with overall spill response cleanup responsibility.

6. Key personnel shall be trained in the use of this plan. All employees should have basic knowledge of spill control procedures.

7. A summary of the plan shall be written and posted at appropriate points in the building, identifying the spill cleanup coordinators, location of cleanup kits, and phone numbers of regulatory agencies to be contacted in the event of a spill.

8. Cleanup of spills shall begin immediately. No emulsifier or dispersant shall be used.

9. In fueling areas: absorbent should be packaged in small bags for easy use and small drums should be available for storage of absorbent and/or used absorbent.

10. Absorbent material shall not be washed down the floor drain or storm sewer.

11. Emergency spill containment and cleanup kit(s) shall be located at the facility site. The contents of the kit shall be appropriate to the type and quantities of chemical liquids stored at the facility. The kit might contain appropriately lined drums, absorbent pads, and granular or powdered materials for neutralizing acids or alkaline liquids. Kits should be deployed in a manner that allows rapid access and use by employees. This plan shall be updated regularly.

12. Ecology and the local Sewer Authority shall be notified immediately if the spill may reach sanitary or storm sewers, or surface water.

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IV-4.9 BMP S1.90 VEGETATION MANAGEMENT/INTEGRATED PEST[1] MANAGEMENT

Two very different types of vegetation management are used by businesses. The first type of management is necessary for businesses such as public and private utilities. Their need is to minimize the growth of vegetation in undesirable locations such as utility corridors. Other businesses, such as public and private golf courses and parks need to manage desirable vegetation for luxuriant growth and beauty. Many businesses have at least a minimal amount of landscaping around their building that they wish to maintain.

In short, one type of business wants to minimize the presence of vegetation where the other wishes to maximize it. Both types of businesses, whether using herbicides to be rid of undesirable vegetation, pesticides to reduce pest infestations or fertilizers to promote vegetative growth need to implement these practices in an intelligent, environmentally sound fashion.

PRACTICES FOR BUSINESSES WISHING TO PROMOTE PLANT GROWTH

Seeding and Planting BMPs

Businesses who wish to use temporary or permanent seeding, or who intend to plant vegetation should refer to the following BMPs found in Volume II, Erosion and Sediment Control:

BMP E1.10 Temporary Seeding

BMP E1.15 Mulching and Matting

BMP E1.20 Clear Plastic Covering

BMP E1.35 Permanent Seeding and Planting

BMP E1.40 Sodding

These BMPs provide information on grass mixtures, temporary and permanent seeding, maintenance of a recently planted area and fertilizer application rates.

INTEGRATED PEST MANAGEMENT

Integrated Pest Management (IPM) is a long-term, ecologically based systems approach to controlling pest populations that utilizes a needs assessment based on decision-making criteria. IPM maximizes reliance on natural pest controls. IPM has two fundamental aims. The first is to steer pesticide[2] use away from prophylactic, broad spectrum use towards optimized selective use, using the various IPM components to guide decision-making and achieve an economically justifiable income. The second is to recognize that the non-economic consequences of pest control (and not just pesticide use) may be harmful to the environment, and so pesticide inputs should be reduced and natural controls maximized in order to minimize the environmental side effects (1).

Integrated control is a pest management system that utilizes all suitable techniques either to reduce pest populations and maintain them at levels below those causing economic injury, or to so manipulate the populations that they are prevented from causing such injury.

[1] As used in this BMP, pest is defined to mean any agent, whether insect, fungal, bacterial or vegetation which causes damage or as in the case of weeds, is in the wrong place at the wrong time.

[2] As used here, the term pesticide includes those chemicals commonly known as pesticides, rodenticides, fungicides, nematicides and herbicides unless otherwise specifically indicated.

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Integrated control achieves this ideal by harmonizing techniques in an organized way, by making the techniques compatible and blending them into a multifaceted, flexible system (2).

The major components of IPM are:

- Initial information gathering: The pest and/or problem needs to be identified. Information should be collected on the biology of the pest and its management, and previous methods used to manage the pest in the area. Records should be kept in some manner of on-going activities.
- Monitoring: Observe the plants or the site for potential pest problems at regular intervals. Each monitoring system needs to be tailored to the particular situation, and the level of effort should be appropriate to the amount of damage caused by the pest, the time available, and the skill level of the person making the inspections.
- Establishing injury levels: an injury or tolerance level is used to determine if the problem is serious enough to justify some kind of treatment. A trade-off needs to be made between the amount of damage done versus the cost of control. An injury level should be determined for each potential pest, and that level should be compared with field samples or observations before any action is taken.
- Record-keeping: Records should be kept of what is seen, decisions made, actions taken, and results. Records are the memory of the systems. When personnel leave, their experience is lost if there are no records.
- Least-toxic treatments: Treatment strategies should be chosen that are the least disruptive of natural controls, least hazardous to human or non-target organisms health, least damaging to the general environment, the most likely to produce a permanent reduction in the environment's ability to support that pest, and the most cost-effective in the short and long term. The most energy and cost-effective pest management strategy in the long term is to redesign the system to eliminate the life support systems required by the pests.
- Evaluation and adjustment: Inspect after the treatment action has been taken. Has the treatment been worthwhile? How can the whole process be improved to achieve the overall objectives of the program? (3)

Pesticides are used only where other techniques are not adequate or possible to use. Prevention is a major component of IPM and can be best addressed at the program design stage. (4).

Scouting can regularly be done by work and road crews for insect and weed infestations so that some sort of early action can be taken. Prompt action against a pest before it becomes established means that less toxic methods of control such as hand weeding can be used instead of an herbicide or pesticide.

BMPS FOR THE USE OF PESTICIDES

1. A pesticide-use plan should be formulated and shall include at a minimum: a list of selected pesticides and their specific uses; brands, formulations, application methods and quantities to be used; equipment use and maintenance procedures; safety, storage, and disposal methods; monitoring and record keeping procedures and public notice procedures. All procedures shall conform to the requirements of Ch. 17.21 RCW and Ch. 16-228 WAC (see R.8 in Chapter IV-5).

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2. Any control used should be done at the life stage when the pest is most vulnerable. For example, if it is necessary to use a Bacillus thuringiensis application to control tent caterpillars, it must be applied before the caterpillars cocoon or it will be ineffective. Any method used should be site-specific and not used wholesale over a wide area. Once an application is made, its effectiveness should be evaluated so that future treatment can be more finely tuned.

3. The pesticide chosen shall be the least toxic pesticide available that is capable of reducing the infestation to acceptable levels. The pesticide should readily degrade in the environment and/or have properties that strongly bind it to soil particles.

4. Documented evidence shall be provided showing the inapplicability of available alternatives.

5. An annual evaluation procedure should be developed and include a review of the effectiveness of treatments, buffers and sensitive areas, public concerns and complaints, and recent toxicological information on pesticides used or proposed for use.

6. Pesticides shall not be sprayed within 100 feet of open waters including wetlands, ponds, streams, sloughs and any drainage ditch or channel that leads to open water.

7. If required or recommended by the local government, public posting of the area to be sprayed shall be done prior to the application. All sensitive areas including wells, creeks and wetlands shall be flagged prior to spraying and a buffer strip of approximately 100 feet shall be used.

8. Spray application shall not occur during weather conditions indicated in the applicable WACs.

9. Spreader/stickers used shall be the least toxic and/or most target specific available.

10. Apply the pesticide according to label directions. Pesticides should be mixed, and equipment cleaned, in an area where accidental spills will not enter surface or ground waters, and will not contaminate the soil. Rinseate from equipment cleaning and/or triple-rinsing of pesticide containers should be used as product.

11. The application equipment used should be capable of immediate shutoff in the event of an emergency.

RESOURCES

Persons interested in finding out more information on IPM can contact the Bio-Integral Resource Center (BIRC), P.O. Box 7414, Berkeley, CA. 94707. They publish a number of reports and a periodical, "IPM Practitioner".

The Department of Ecology publishes "Hazardous Waste Pesticides" (#89-41) which can help to determine if a particular pesticide is a dangerous waste, and includes information on pesticide waste reduction.

EPA publishes "Suepended, Canceled and Restricted Pesticides" which lists all restricted pesticides and the specific uses which are allowed.

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IV-4.10 BMP S2.00 MAINTENANCE OF STORM DRAINAGE FACILITIES

Proper maintenance of public and private stormwater facilities is necessary to insure they serve their intended function. In a study recently completed by the King County Conservation District (3), almost one-half the BMPs installed on large construction sites were not maintained. Without adequate maintenance, sediment and other debris can quickly clog facilities, making them useless. Rehabilitation of such facilities is expensive, and in the case of infiltration systems may be impossible. Polluted water and sediments removed during the cleaning operation must be properly disposed of.

MAINTENANCE STANDARDS

Local governments shall develop standards for the maintenance of public and private stormwater facilities. These standards shall include but need not be limited to the following:

1. Catchbasins, stormwater detention and treatment systems shall be inspected at least annually. A representative of the local government shall also inspect private facilities at least annually to insure compliance by the owner of the following maintenance requirements.

2. Any deterioration threatening the structural integrity of the facilities shall be immediately repaired. These include such things as replacement of clean-out gates, catchbasin lids, and rock in emergency spillways.

3. A catchbasin shall be cleaned if the depth of deposits are equal to or greater than 1/3 the depth from the basin to the invert of the lowest pipe into or out of the basin. If a catchbasin is found during the annual inspections to significantly exceed this standard, it shall be cleaned every 6 months. If woody debris is likely to accumulate in a catchbasin, it should be cleaned on a weekly basis.

4. Warning signs (e.g. "Dump No Waste - Drains to Ground Water", "Streams", "Lakes" etc.) shall be painted or embossed on or adjacent to all storm drain inlets. They shall be repainted as needed.

5. Debris shall be regularly removed from surface basins used for either peak-rate control or stormwater treatment.

6. Stormwater treatment facilities shall be maintained according to criteria or procedures presented in Volume III. (Maintenance requirements are detailed at the end of each BMP description).

7. Parking lots shall be swept when necessary to remove debris.

FINAL DISPOSAL OF CONTAMINATED WATER

(Ecology policy regarding disposal is under development by the Urban Non-Point Management Unit and is not available at this time.)

FINAL DISPOSAL OF CONTAMINATED SEDIMENTS

(Ecology policy regarding disposal is under development by the Urban Non-Point Management Unit and is not available at this time.)

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IV-4.11 BMP S2.10 LOCATING ILLICIT CONNECTIONS TO STORM DRAINS

Illicit connections are sanitary or process wastewater drains located in a building that discharge to the storm drain, rather than to the sanitary sewer. An allowable exception is noncontact cooling water which may be discharged to a storm drain.

Experience has shown that illicit connections are very common, even in buildings constructed as late as the 1960's. Building owners are seldom aware that their drain lines are improperly connected since their sewer bills are tied to water use.

The following are general guidelines to assist local governments in establishing their programs.

1. Prioritize areas by age of structures. Give priority to buildings whose internal activities may cause water pollution if the drains are improperly connected.

2. Prepare a map of each area as it is to be surveyed. Show on the map the known location of storm drains and sanitary sewers. Aerial photos may be useful. Check records to identify known side sewer connections and show these on the map.

3. Conduct a field survey of the buildings to locate observable storm drains from buildings and paved surfaces. Note where these join the public storm drain.

4. Perform TV inspection of the storm drains and record with video tape that notes footage as the TV passes through the line.

5. Compare the observed locations of connections with the information on the map. Note suspect connections that are inconsistent with the field survey.

6. Remove significant accumulations of sediment from the storm drain system. Test the sediment before disposal (BMP R2.00, Section IV-5.10). Ask private property owners to clean their catchbasins and lines at the same time.

7. Determine whether each suspect connection is a storm drain or internal drain by inspection of the building and dye testing as necessary.

8. Inform private owners who have illicit connections of their obligation to connect to the sanitary sewer.

EPA is developing a "Draft Manual of Practice Identification of Illicit Connections", prepared by The Cadmus Group, Inc. and Triad Engineering, Inc. for Kevin Weiss at the USEPA Permits Division (EN-336), 401 M St. S.W., Washington D.C. 10460. The most current draft is dated September 7, 1990.

This USEPA manual covers outfall mapping, evaluation and analysis, identification of potential industrial sources, on-site investigation and field survey techniques in great detail.

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IV-4.12 BMP S2.20 STREET SWEEPING

Application: Street sweeping should be implemented for sites with high impervious cover. It should be implemented for programs designed to improve runoff quality from existing development sites. Sites which exhibit high levels of sediment on impervious surfaces should also implement aggressive source control measures to prevent accumulation of such sediments.

Street sweeping is a common maintenance method in most urban areas, but is seldom thought of as a means to control pollutants. Street sweeping refers to the removal of accumulated dust, dirt and debris from impervious streets surfaces with the use of mechanical cleaners. Street sweeping may be an effective method of pollutant control in highly urbanized areas where space is at a premium and retrofitting is difficult.

While traditional street sweeping has shown limited effectiveness at improving water quality there is evidence that it can be effective when better equipment and operating procedures are used. The City of Austin, Texas, (1) documented statistically significant improvements in water quality at a shopping mall located in a ground water recharge zone after implementation of an intensive sweeping program. Monitoring conducted before and after startup of the sweeping program documented that event mean concentrations dropped from 50 to 84 percent for particulate-type pollutants. The City concluded that pollutant concentrations from high-density development could be dropped with better maintenance and frequent parking lot sweeping.

Silverman and Stenstrom (3) argue that street sweeping could potentially be effective at removing oil and grease. They state that sweeping efforts would need to concentrate on locations which receive heavy deposits (e.g., curbs) and that innovative street sweeping technology needs to be developed.

The results of street sweeping in the Puget Sound basin seem to be less certain. The low intensity rains which occur in the Puget Sound basin rarely clear streets of all dirt and debris. Pitt and Bissonnette (2) found that in Bellevue, from 50 to 100 grams per curb-meter of street surface particulates remain on the streets after storms of about 6 mm or greater. Loading values would be much higher in areas with streets in poor condition. On the surface, it seems that sweepers used in this area would have a better opportunity to clean streets of all particulate pollutants.

However, Pitt and Bissonnette also concluded that street sweeping had little effect on water quality. A possible reason for this is that most pollutants adsorb on to silt and clay-size particles, which are the ones most likely to be removed by rainfall.

In order to remove these particles, the most efficient types of sweepers, such as regenerative air cleaners or vacuum sweepers must be used. No current conventional sweeper is effective in removing oil and grease (3).

METHODS TO MAXIMIZE SWEEPING EFFICIENCY (4)

1. Number of passes and frequency:

   - Increase the frequency of sweeping streets with high pollutant loadings, particularly in industrial areas
   - Generally speaking, one pass can remove 50% of available solids, two passes provides 75% removal.
   - Streets cleaned weekly will provide more removal efficiency; less frequent sweeping will accomplish little.

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2. Equipment type and operation:

   - As new sweepers are purchased, consider vacuum or regenerative air sweepers as these types are the most effective in removing the small particles most associated with pollutants.
   - Train operators to attain maximum sweeper performance such that sweeper speed, brush adjustment and rotation rate, sweeping pattern, maneuvering around parked vehicles, interim storage and disposal methods result in optimal pollutant removal.

3. Pollutant loading/source reduction on street surfaces:

   - Establish programs for prompt sweeping and removal of debris from special problem areas (special events, high litter or erosion zones).
   - Develop, implement and enforce regulations for alternate side parking during cleaning operations, litter control, trash and refuse storage and disposal (especially yard debris, waste oil, etc.).
   - Enforce construction site erosion controls.

4. Street maintenance:

   - Include water quality benefits in cost analysis for street repair, particularly in high traffic zones in order to reduce the amount of particulates shaken from vehicles travelling over rough roads, and the amount of particulates generated from the deteriorating street surface itself.
   - Consider improving street conditions in order to increase the effective of street sweeping.

5. Public awareness and support:

   - Educate citizens and public officials about the multiple benefits available from an improved street sweeping program.
   - Educate citizens about street pollutant source reduction by eliminating yard debris, oil and other wastes in street gutters.

References

(1) Austin, City of, Stormwater Pollutant Loading Characteristics for Various Land Uses in the Austin Area, July, 1989.

(2) Pitt, Robert and Pam Bissonnette, Bellevue Urban Runoff Program Summary Report, City of Bellevue, August, 1984.

(3) Silverman, Gary S. and Michael K. Stenstrom, "Source Control of Oil and Grease in an Urban Area", in Design of Urban Runoff Quality Controls, ASCE, 1988.

(4) Austin, City of, Inventory of Urban Nonpoint Source Pollution Control Practices: Application and Feasibility for Urban Watersheds Abatement Measures, Department of Environmental Protection, June, 1988.

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(1) Burns, A.J., T.H. Coaker and P.C. Jepson, editors, Integrated Pest Management, Academic Press-Harcourt Brace Jovanovich, 1987.

(2) Smith, Ray F. and Robert van den Bosch, "Integrated Control" in Pest Control - Biological, Physical and Selected Chemical Methods, Kilgore, Wendell W. and Richard L. Doutt, editors, Academic Press, New York, 1967.

(3) Olkowski, William, Helga Olkowski and Sheila Daar, "What is IPM?", in Common Sense Pest Control, Volume 3, Summer 1988.

(4) Huffaker, C.B., "Fundamentals of Biological Weed Control", in Biological Control of Insect Pests and Weeds, DeBach, Paul, editor, Reinhold Publishing Corp., New York, 1964.

(5) Letter to Stormwater Unit, Department of Ecology, from Washington Toxics Coalition dated January 31, 1990.

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FOREWORD

Purpose of This Volume

The purpose of this volume of the stormwater manual is to provide technical information on source control BMPs for many types of urban land uses. Runoff treatment BMPs referred to are not dealt with specifically in this volume, but are found in Volume III, "Runoff Quality and Quantity Control." Prior to the selection of BMPs in this volume, Chapter I-2, "Minimum Technical Requirements" and Chapter I-4, "Selection Process for Best Management Practices" should be read. These chapters provide an overview of the necessary requirements and the basis for the proper selection of BMPs to fit a particular site.

Chapter Contents

Chapter IV-1 provides an overview of the rest of this volume in addition to a review of information on typical pollutants found in stormwater, BMP preferences, the requirements of other regulatory agencies and instruction on how to use this volume.

Chapter IV-2 covers categories of manufacturing businesses, wholesale and retail businesses, transportation and communication, and service businesses. Many specific business types are included in each category. Business functions, materials used, wastes generated, source control BMPs and other applicable regulations are all included. Stormwater treatment BMPs are listed by the appropriate section in Volume III.

Chapter IV-3 covers the functions of public agencies in the same manner that businesses are covered. BMPs are also provided for each type of activity, such as vehicle and equipment maintenance shops, open space areas, and maintenance of roadside vegetation and ditches.

Chapter IV-4 provides specific information for the implementation of source control BMPs for businesses. Each source control BMP is described, and methods are given to implement the BMP. In some cases BMPs are required; in others there are choices given so that an individual business can tailor a set of practices which will be the most use for that individual business.

Chapter IV-5 provides brief explanations of other regulatory requirements which may have to be considered by a business or agency. General information is given on such regulations as air quality regulations, NPDES stormwater permits, WSDA pesticide regulations, fire code requirements, and hazardous waste generation.

This volume of the manual was compiled almost entirely by Dr. Gary Minton of Resource Planning Associates. It was expanded and adapted from the BMP manual which he prepared for the City of Seattle.

Other sources that were used are referenced at the end of each chapter or at the end of the volume. Members of the technical advisory group include:

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The time and expertise readily given by these people has been of considerable value when preparing this volume of the manual and is gratefully acknowledged.

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IV-5.1 R.1 STORMWATER DISCHARGES TO PUBLIC SANITARY SEWERS, SEPTIC SYSTEMS, SUMPS AND PROCESS TREATMENT

Discharging stormwater to a public sanitary sewer (BMP S1.70, Section IV-4.7) requires approval of the local Sewer Authority if Ecology has delegated the authority to set pretreatment requirements. If it has not yet received such authority, the business or public agency that wishes to discharge stormwater to the sanitary sewer must obtain the approval of the Pretreatment Program administrator at the regional Ecology office.

In setting pretreatment requirements, the local Sewer Authority or Ecology must operate within State Regulations Ch. 173-216 WAC (State Waste Water Discharge Permit Program) which in turn must comply with Federal Regulations 40 CFR Part 403.5 (National Pretreatment). Specific prohibitions include materials which:

1. Pass through the municipal treatment plant untreated or interfere with its operation;
2. Create a fire or explosion hazard, create a public nuisance or hazard to life, prevent entry into the sewer for maintenance and repair or is injurious in any other way to the operation of the system or the operating personnel;
3. Have a pH less than 5.0 or greater than 11.0 or have any corrosive property capable of causing damage or hazard to the system, equipment, or personnel;
4. Will cause obstruction to flows;
5. Will cause the sewage temperature to exceed 40°C or will in any case interfere with the biological activity in the municipal treatment plant.

Stormwater cannot be discharged to the sanitary sewer system except under extraordinary circumstances which are defined as the condition under which treatment by all known and available technology will not meet Ecology standards for discharge to receiving waters or will cause unreasonable financial burden. This can only be determined in consultation with Ecology.

The rate of stormwater entering the sanitary sewer cannot exceed the hydraulic capacity of the collection system or the treatment plant by the combined flow of sanitary sewage and stormwater.

The allowable concentrations of particular materials such as metals and grease may vary with the particular sewer system, since the responsibility of setting such limits rests with the local Sewer Authority, if delegated that authority by Ecology, or by Ecology where that delegation has not occurred.

To give some indication of typical limiting concentrations so they may be compared to a particular stormwater discharge of interest, the Municipality of Metropolitan Seattle (Metro) concentration limits are summarized below.

1. The concentration of fats, oils and greases of animal or vegetable origin, petroleum oil, non-biodegradable cutting oil or mineral oils shall not exceed 100 mg/l; (Note: the Ecology effluent guideline for oil and grease is 10 mg/l.)
2. Arsenic, 1 mg/l; cadmium, 3 mg/l; chromium, 6 mg/l; copper, 3 mg/l; lead, 3 mg/l; mercury, 0.1 mg/l; nickel, 6 mg/l; silver, 1 mg/l; zinc, 5 mg/l; cyanide, 2 mg/l.

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3. Prohibited substances include gasoline, kerosene, naphtha, benzene, toluene, xylene, ethers, alcohols, ketones, aldehydes, peroxides, chlorates, perchlorates, bromates, carbides, hydrides and sulfides.

PROCESS TREATMENT

Process treatment may be used to dispose of polluted stormwater depending on the NPDES permit constraints of the particular business. The total loading of discharged process treatment water and stormwater cannot exceed the loading had a stormwater treatment device been used.

USE OF DEAD-END SUMPS

Substances which cause a violation of water quality standards must not be discharged to a septic system, surface or ground water. Where either sewage systems or process wastewater treatment are not available, an alternative is the use of a dead-end sump. Sumps are tanks with drains which can be periodically pumped and disposed of by an appropriate waste disposal operator. Depending on the composition of the waste, it may or may not be considered Dangerous Waste.

For more information on disposal requirements for sumps, see Step By Step: Fact Sheets for Hazardous Waste Generators, publication 91-12, available from Ecology's Regional Offices.

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IV-5.2 R.2 UNIFORM FIRE CODE REQUIREMENTS

Storage of flammable, ignitable and reactive chemicals and materials must comply with the stricter of: local zoning codes, local fire codes, the Uniform Fire Code, Uniform Fire Code standards or the National Electric Code.

References:

Uniform Fire Code, International Conference of Building Officials and the Western Fire Chiefs Association, ISSN 0896-9736.

Uniform Fire Code Standards, National Fire Protection Association.

National Electric Code, National Fire Protection Association.

NFPA 30A Automotive and Marine Service Station Code, American National Standard Institute and the National Fire Protection Association.

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IV-5.3 R.3 ECOLOGY REQUIREMENTS FOR GENERATORS OF DANGEROUS WASTES

The State'e Dangerous Waste Regulations (Chapter 173-303 WAC) cover accumulation, etorage, transportation, treatment and disposal of Dangerous Wastes. Of interest to this manual are those businesses or public agencies that accumulate the waste at their building until taken from the site by a contract hauler. Conesequently, only those aspecte of the regulations that apply to waste generators and accumulation are considered here.

State regulations require generators of Dangerous Wastes to obtain an Ecology Identification Number if they generate more than 220 pounds per month (2.2 pounds if the waste is defined as Extremely Hazardous). In addition, under certain circumstances as described below the generator must obtain a permit to store Dangerous Wastes. Where storage permits are required Ecology has the responsibility of ensuring that technical requirements are met.

Local governments must be concerned about situations where an Ecology storage permit is not required (less than 220 pounds per month). Although these generators still fall under Ecology regulations, the technical requirements are general. The first opportunity for local government to enforce the regulations is when a generator requests a building permit.

A storage permit is not required by Ecology under the following circumstances:

1. If the business generates more than 2,200 pounds per month of Dangerous Waste but intends to store the accumulated material less than 90 days;
2. If the business generates between 220 and 2,200 pounds per month of Dangerous Waste but intends to store less than 180 days; or,
3. If the business produces less than 220 pounds per month regardless of the length of storage.

Generators that produce more than 220 pounds per month (See 1 and 2 above) and avoid the need for a permit must still fulfill these general regulations with regard to temporary storage:

IF PLACED IN CONTAINERS

1. If the container is not in good condition (e.g severe rusting, apparent structural defects) or if it begins to leak, the owner must replace the container.
2. The container must be labeled as to its contents.
3. The container must be lined with a material that does not react with the waste.
4. The container must always be closed except when adding or removing waste.
5. The container must not be opened, handled, or stored in a manner which may cause a rupture or leak.
6. Examine the containers for leakage at least weekly.
7. Containers storing reactive or ignitable waste must meet requirements of the Uniform Fire Code.

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8. Incompatible wastes must be stored separately.

9. Ecology may require secondary containment of the storage area. Specifically, the storage area must:

   a. Be capable of collecting and holding spills and leaks;

   b. If uncovered, be capable of handling a 25-year storm;

   c. Have a base which is free of cracks or gaps and is sufficiently impervious to leaks, spills and rainfall;

   d. Be sloped or designed such that liquids can drain to a point for removal;

   e. Have positive drainage control (e.g. a valve) to insure containment until any liquid is removed. Removal must occur in a timely manner;

   f. Have a holding capacity equal to 10 percent of the volume of all containers or 100 percent of the volume of the largest container whichever is greater;

   g. Not allow runoff of rainfall from areas adjacent to the storage area.

If the waste does not contain free liquids the above requirements need not be met provided that the area is sloped or the containers are elevated.

IF PLACED IN TANKS

1. The tank must be lined with a material that does not react with the waste.

2. The tank, tank area and its ancillary equipment must be inspected regularly according to a posted schedule.

3. If retired, the tank is be cleaned of all contents. Any wash waters should be disposed of in a manner similar to the disposal of the actual wastes.

4. Tanks storing reactive or ignitable waste must meet the Uniform Fire Code requirements. Incompatible wastes must be stored separately.

The above generators must also have a designated employee on site or on call with the responsibility for coordinating all emergency response measures. Any spills are to be contained and cleaned up as soon as practicable.

If the business produces less than 220[1] pounds per month it need not comply with the above regulations. It need only dispose of the waste in a manner acceptable to the local Health Department which is (generally):

1. Dispose of the waste to a permitted facility; or,

2. Dispose of the material to a recycling facility; or,

3. Dispose of the waste to a permitted municipal or industrial landfill.

4. Put the waste to a beneficial use, such as the use of sludge as fertilizer.

[1]Some wastes are designated "Extremely Hazardous" in which case the above controls are imposed if more than 2.2 pounds are produced per month.

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For more information on disposal requirements for solid and hazardous wastes, see Step By Step: Fact Sheets for Hazardous Waste Generators, publication 91-12, available from Ecology's Regional Offices.

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IV-5.4 R.4 MINIMUM FUNCTIONAL STANDARDS FOR CONTAINERS

The local health department or district establishes standards on the use and integrity of solid waste containers. These local regulations must meet or exceed the State Minimum Functional Standards, WAC 173-304-200, which state:

"Reusable containers, except for detachable containers, shall be: rigid and durable; corrosion resistant; nonabsorbent and water tight; rodent-proof and easily cleanable; equipped with a close fitting cover; suitable for handling with no sharp edges or other hazardous conditions ...".

Detachable containers are reusable containers that are mechanically loaded or handled such as a dumpster or drop box.

"Detachable containers shall be durable, corrosion-resistant, nonabsorbent, nonleaking and having either a solid cover or screen cover to prevent littering."

Other relevant requirements include:

"All persons collecting or transporting solid wastes shall avoid littering, or the creation of other nuisances at the loading point..."

" ... solid waste shall be moved in such a manner that the contents will not fall, leak in quantities to cause a nuisance, or spill therefrom. Where such spillage or leakage does occur, the waste shall be picked up immediately ..."

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IV-5.5 R.S COAST GUARD REQUIREMENTS FOR MARINE TRANSFER OF PETROLEUM PRODUCTS

Federal regulations 33 CFR Parts 153, 154 and 155 cover, respectively, general requirements on spill response, spill prevention at marine transfer facilities, and spill prevention for vessels.

These regulations specify technical requirements for transfer hoses, loading arms, closure and monitoring devices. The regulations also cover small discharge containment: they require the use of "fixed catchments, curbing, and other fixed means" at each hose handling and loading arm area, and each hose connection manifold area. Portable containment means can be used in exceptional situations where fixed means are not feasible.

The capacity of the containment area varies from the volume of 1 to 4 barrels depending on the size of the transfer hoses.

The regulations also require an operations plan and specifies its general contents. The plan shall describe the responsibilities of personnel, nature of the facility, hours of operation, sizes and numbers of vessels using the facility, nature of the cargo, procedures if spills occur, and petroleum transfer procedures. The plan must also include a description and location of equipment for monitoring, containment, and fire fighting.

See also, NFPA 30A Automotive and Marine Service Station Code, American National Standard Institute and the National Fire Protection Association.

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IV-5.6 R.6 USEPA REQUIREMENTS FOR UNDERGROUND TANK STORAGE

EXEMPT TANKS

Regulations are for underground tanks (tank systems having 10 percent or more of their volume underground) containing petroleum or listed hazardous substances. It covers all tanks except:

1. Farm and residential tanks holding 1,100 gallons or less of motor fuel;
2. Tanks storing heating oil used on premises;
3. Tanks on or above the floor of underground areas;
4. Septic tanks;
5. Tanks holding 110 gallons or less;
6. Emergency spill and overflow tanks.

NEW REQUIREMENTS FOR TANKS (INSTALLED AFTER DECEMBER 1988)

1. Certify that the tank and piping are installed properly according to industry codes;
2. Equip with devices that prevent spills and overfills;
3. Protect tank and piping from corrosion;
4. Equip the tank and piping with leak detection.

REQUIREMENTS FOR EXISTING TANKS (INSTALLED BEFORE DECEMBER 1988)

1. Equip with leak detection by these dates:

If tank was installed	Leak detection by
Before 1965	1989
1965-1969	1990
1970-1974	1991
1975-1979	1992
1980 to December 1988	1993

2. Implement tank filling procedures that will prevent spills and overfills.
3. By December 1998, tanks and piping shall be equipped with corrosion prevention; if the tank does not have corrosion protection or an internal lining and devices to prevent spills and overfill, a monthly inventory with tightness testing is required until December 1998.
4. By December 1998, equip to prevent spills and overfills.
5. Leak detection in piping shall be installed by December 1990.

   Pressure piping: devices to automatically shut off or restrict flow or have an alarm that indicates leak. Conduct annual tightness testing or use monthly monitoring methods for tanks.

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Suction piping: Monthly monitoring or tightness testing shall be done every 3 years on the same schedule as leak detection. If suction piping is sloped to draw back to storage tank when suction is released and only one check valve is included in each suction line directly below the suction pump then leak detection is not required.

6. If the existing tank has been upgraded with corrosion protection and a device to prevent spills and overfills, then a monthly inventory control and tank tightness test must be performed every 5 years. If the tank has not been upgraded, a monthly inventory control and tank tightness test must be performed every year.

REPORTING REQUIREMENTS

1. Notification of installation of tank and/or any suspected releases.
2. Confirmed release/corrective action.
3. Notification 30 days before permanent closure.

REPORTING OF SUSPECTED RELEASES

Owners/operators must report the leak within 24 hours, and follow the procedures outlined in the regulations for any of the following:

1. Discovery of release at the tank site or the surrounding area.
2. Unusual operating conditions such as sudden loss of product, equipment behavior, unexplained water in tank.
3. Monitoring results indicating a release may have occurred unless the monitoring device was found to be defective or, in the case of inventory control, if the second month does not confirm initial data.

RECORD KEEPING REQUIREMENTS

1. Records of leak detection performance and maintenance; previous year monitoring results and most recent tightness test results, including:
   a. leak detection manufacturing performance claims;
   b. records of maintenance, repair; and,
   c. calibration of leak detection.
2. Records of the last two corrosion protection system inspections.
3. Expert analysis of corrosion potential if corrosion protection equipment is not used.
4. Records of site assessment results are required when permanent closure occurs. Records shall be kept a minimum of 3 years after closure.
5. Records for repaired or upgraded tanks.
6. Check local regulatory requirements.

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IV-5.7 R.7 USEPA/ECOLOGY EMERGENCY SPILL CLEANUP REQUIREMENTS

USEPA - SPCC PLANS (40 CFR Part 112)

Federal Regulations require that owners or operators of facilities engaged in drilling, producing, gathering, storing, processing, refining, transferring, or consuming oil and oil products are required to have a Spill Prevention and Control Plan (SPCC), provided that the facility is non-transportation related; and, that the above-ground storage of a single container is in excess of 660 gallons, or an aggregate capacity greater than 1,320 gallons, or a total below-ground capacity in excess of 42,000 gallons.

The Plan must:

1. Be well thought out in accordance with good engineering;
2. Achieve three objectives - prevent spills, contain a spill that occurs, and clean up the spill;
3. Identify the name, location, owner, and type of facility;
4. Include the date of initial operation and oil spill history;
5. Name the designated person responsible;
6. Show evidence of approval and certification by the person in authority;
7. Contain a facility analysis.

ECOLOGY DANGEROUS WASTES (WAC 173-303-350)

Generators must have a Contingency Plan which must include:

1. Actions to be taken in the event of spill;
2. Descriptions of arrangements with local agencies;
3. The name of the owner's Emergency Coordinator;
4. A list of emergency equipment available;
5. An evaluation plan for business personnel.

For more information on disposal requirements for solid and hazardous wastes, see Step By Step: Fact Sheets for Hazardous Waste Generators, publication 91-12, available from Ecology's Regional Offices.

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IV-5.8 R.8 WSDA PESTICIDE REGULATIONS

Washington State pesticide laws are administered by the Department of Agriculture (WSDA), under the Washington Pesticide Control Act (Ch. 15.58 RCW), Washington Pesticide Application Act (Ch. 17.21 RCW), and regulations under Ch. 16-228 WAC. The requirements relevant to water quality protection are:

1. Persons who apply pesticides are required to be licensed except:
   a. people who use general-use pesticides on their own or their employer's property;
   b. grounds maintenance people using only general-use pesticides on an occasional basis not amounting to a regular occupation;
   c. governmental employees who apply general-use pesticides without utilizing any kind of motorized or pressurized apparatus;
   d. employees of a commercial applicator or a government agency who are under direct on-site supervision by a licensed applicator.
2. Licensed applicators must undergo 40 hours of continuing education to keep their license.
3. No person shall pollute streams, lakes, or other water supplies while loading, mixing or applying pesticides.
4. No person shall transport, handle, store, load, apply, or dispose of any pesticide, pesticide container, or apparatus in such a manner as to pollute water supplies or waterways, or cause damage or injury to land, including humans, desirable plants and animals.

For more information on pesticide application and disposal requirements for solid and hazardous wastes, see Step By Step: Fact Sheets for Hazardous Waste Generators, publication 91-12, available from Ecology's Regional Offices.

Another useful publication is Hazardous Waste Pesticides: A Guide for Growers, Applicators, Consultants and Dealers, publication #89-41, dated August, 1989. This brochure is available from Ecology's publications department, (206) 438-7472.

EPA also publishes a brochure, Suspended, Canceled and Restricted Pesticides, which is available from the EPA Region 10 Office in Seattle.

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IV-5.9 R.9 AIR QUALITY REGULATIONS

The Puget Sound region is under the jurisdiction of regional air quality authorities who in turn must function under Washington State and Federal air quality regulations.

The Northwest Air Pollution Agency covers Whatcom, Island and San Juan counties. The Puget Sound Air Pollution Control Agency covers Snohomish, King and Pierce counties. The Olympic Air Pollution Control Authority covers Clallam, Jefferson, Mason and Thurston counties.

Of direct interest to persons using this manual are air authority policies on fugitive dust and outside painting.

All three air authorities require that reasonable precautions be taken to prevent fugitive particulate material from becoming airborne when handling, loading, transporting or storing particulate material.

The Puget Sound Air Pollution Control Authority (PSAPCA) takes the above policy one step further by defining what reasonable precautions are such as: the paving of parking lots and storage areas; housekeeping measures (for example, sweeping) minimization of the accumulation of mud and dust and preventing its tracking onto public roads; and stabilization of storage piles with water spray, chemical stabilizers, tarps, or enclosures.

PSAPCA requires that abrasive blasting and spray painting operations be performed inside a booth designed to capture the blast grit and overspray. Outdoor blasting or painting of structures or items too large to be handled indoors are to be enclosed with tarps.

PSAPCA requires that reasonable precautions be taken to prevent the tracking of material onto public roads. One precaution is wheel-washing of trucks.

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IV-5.10 R.10 ECOLOGY WASTE REDUCTION PROGRAMS

Reducing the amount of wastes generated by a business or public agency also reduces the opportunity for their introduction to stormwater. The Washington Legislature established an Office of Waste Reduction and Recycling to "encourage voluntary reduction of solid wastes, hazardous wastes, hazardous substances, air and water pollutants by citizens, businesses and government agencies".

Local governments have been required since the early 1970's to prepare solid waste management plans. Now, cities and counties are required to include in those plans elements that address waste reduction.

Ecology conducts an annual survey to track progress and also conducts studies to identify waste reduction opportunities in specific industries. Example studies include wood treatment, paint manufacturing and metal plating.

Every business and public agency should conduct a waste reduction audit of its facilities and activities. Ecology has publications available from its Office of Waste Reduction and Recycling which detail the benefits and recommended procedures for conducting audits. Here is a brief summary:

Management initiative: the beginning point is commitment by management that waste reduction and recycling are important business or agency goals.

Use of an audit team: Creating a team representing various departments and all levels of seniority will result in many good ideas and commitment to the program. It is the role of the audit team to carry out the remaining planning steps.

Goal setting: Qualitative goals ("We would like to increase our use of recycled paper."), commensurate with the overall goals of the business or agency, should be established at the outset of the team's work. These can be modified as the plan is developed. They also may be modified to quantifiable goals ("We will increase our usage of recycled paper to 50% by the end of the year.") by the end of the process.

Review of operations: Next, a review "on (recycled) paper" of the various activities of the organization should be done as there are opportunities in every department to reduce waste. This includes purchasing, receiving, delivery, inventory, personnel, and manufacturing/ processing.

When the team is evaluating the processing area it should consider source reduction, scheduling procedures, waste segregation, and preventive maintenance. For example, preventive maintenance helps reduce leaks and wastes caused by unanticipated equipment breakdowns.

Conduct audit: Having identified general areas of opportunity, the team should conduct a physical audit of organization, with particular emphasis on processing.

Generate and evaluate list of reduction options: The next step is to generate a list of reduction options or alternatives. Do an evaluation to set priorities.

Implementation: Implement the options according to a realistic and agreed-upon schedule.

Followup evaluation: Management and the audit team should meet several times throughout the implementation period to evaluate progress.

Employee training: Employees should be trained in the various phases of the waste reduction program. New employees should be trained soon after they are hired. All

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important points of the program should be summarized and easily available to all employees.

IMEX - The Industrial Materials Exchange is issued by the Seattle-King County Department of Public Health. The publication contains lists of materials offered for recycling and manufacturers looking for specific products. This is a free service. To obtain a copy, call (206) 296-4899 or write: Industrial Materials Exchange, 172-20th Ave., Seattle, WA 98122.

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IV-5.11 R.11 NPDES STORMWATER PERMITS

SUMMARY

EPA's National Pollutant Discharge Elimination System Permit (NPDES) regulations for stormwater (40 CFR Parts 122, 123 and 124) became effective on November 16, 1990. Washington is a NPDES delegated state which requires Ecology to administer NPDES permits for designated industries and municipalities. Cities and counties with a population of 100,000 and greater that have separate storm sewer systems, most industries that discharge stormwater associated with industrial activities or storage of raw materials, and construction sites 5 acres in area and greater (including those parcels which are smaller than 5 acres but part of a development greater than 5 acres in size) are required to apply for NPDES permits. Stormwater from industrial uses that does not come in contact with industrial activities or storage of raw materials or products, such as runoff from roofs and parking lots, generally does not require a NPDES permit.

The goals of these new storm water NPDES regulations are to:

- Stop the illegal discharge of waste waters and other pollutants into storm sewers, which should be used only for storm water run-off;
- Reduce the amount of pollutants in storm water
- Establish a permit system for storm water discharged by municipalities over 100,000 in population;
- Establish a permit system for storm water discharged from industrial sites.

The Stormwater Management Program that Ecology and the Puget Sound Water Quality Authority are preparing for the Puget Sound Basin will be as consistent as possible with NPDES requirements. The thrust of the Stormwater Program is to direct the 112 cities and counties in the Basin to adopt and implement programs to prevent water pollution and enhance water quality for themselves and privately owned facilities in their jurisdiction. NPDES is a statewide permit program that Ecology will administer directly to cities, counties and regulated industrial facilities.

MUNICIPAL PERMITS

Large municipalities (Seattle and King County) are defined as having an urbanized population of 250,000 or more. Both named municipalities submitted Part 1 of the application by November 18, 1991. Part 2 is due November 16, 1992. Medium municipalities (Pierce County, Snohomish County, Spokane and Tacoma) are defined as having an urbanized population of at least 100,000 but less than 250,000 and are required to submit Part 1 of the application by May 18, 1992 with Part 2 due by May 17, 1993. For NPDES purposes, the Washington State Department of Transportation (WSDOT) is considered a medium municipality and will apply for a municipal stormwater NPDES permit for its 7,000 miles of highway throughout the state.

According to 1991 population estimates, additional counties (Clark, Kitsap and Spokane) may have more than 100,000 urbanized population in unincorporated areas. The city of Spokane is expected to redesignated as a medium municipality. These local governments will not be considered medium municipalities until the final federal 1990 census is published and the NPDES regulation is amended to include them. The deadlines for submission of Part 1 and Part 2 of these NPDES applications are expected to be 18 months and 30 months, respectively, from the date of the NPDES amendment. Detailed information on municipal stormwater NPDES permits can be found

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in the Stormwater Management Program Implementation Guidance, which is a separate document from this technical manual.

On October 1, 1992, EPA is scheduled to extend the regulation to additional stormwater discharges. No information is currently available about the contents of these regulations.

MUNICIPAL DEADLINES

November 18, 1991	King County and Seattle submitted Part 1 applications to Ecology
February 14 1992	Ecology completed review of King County and Seattle,s Part applications.
April/May 1992	EPA to amend stormwater NPDES regulations to include new medium municipalities[2] added by the 1990 census.
May 18, 1992	Tacoma, WSDOT, Pierce and Snohomish Counties to submit Part 1 applications to Ecology.
August 16, 1992	Ecology to complete review of Tacoma, WSDOT, Pierce and Snohomish Counties' Part 1 applications.
October 1, 1992[3]	EPA to issue NPDES regulations which designate additional stormwater discharges to be regulated.
November 16, 1992	Deadline for King County and Seattle's Part 2 applications to be submitted to Ecology.
No specific date	Ecology to review completeness of King County and Seattle's Part 2 applications.
May 17, 1993	Deadline for Tacoma, WSDOT, Snohomish and Pierce Counties' Part 2 applications to be submitted to Ecology.
No specific date	Ecology to review completeness of Tacoma, WSDOT, Pierce and Snohomish Counties' Part 2 applications.
October/November 1993[4]	Medium municipalities added by 1990 census to submit municipal Part 1 applications to Ecology.
November 16, 1993	King County and Seattle's municipal permits issued by Ecology.
January/February 1994[5]	Ecology to complete review of added medium municipality Part 1 applications.

[2] New medium municipalities expected to be designated are Clark, Kitsap and Spokane Counties and the city of Spokane which will be redesignated.

[3] EPA may not comply with this deadline.

[4] Assumed 18 months after EPA designation.

[5] Date approximate; 90 days after Part 1 application due.

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May 17, 1994	Tacoma, WSDOT, Pierce and Snohomish Counties' municipal permits issued by Ecology.
October/November 1994[6]	Added medium municipalities' Part 2 applications to be submitted to Ecology.
October/November 1995[7]	Added medium municipality permits issued by Ecology.

INDUSTRIAL PERMITS

Ecology intends to cover all storm water discharges associated with industrial activities with one "baseline" permit

The Washington Department of Ecology (Ecology) is responsible for implementing EPA requirements for storm water permits in Washington State. Ecology plans to write one permit which will cover most of the thousands of industries required to have a storm water permit. We refer to this permit as the Baseline General Permit for Industrial Storm Water, or more simply, the baseline permit.

In writing this baseline permit, Ecology plans to obtain input from advisory committees, and to conduct public workshops and public hearings. After completing the baseline permit, Ecology will decide which types of industries need more specific requirements for storm water control. We will write "industry-specific" general permits for those industry types. Industries for which an "industry-specific" permit is written, will no longer be covered under the baseline permit.

WHICH INDUSTRIAL ACTIVITIES NEED TO HAVE A STORM WATER NPDES PERMIT?

EPA regulations list those industrial activities which may need to have a storm water discharge permit (see page IV-5-22). During the development of the baseline permit, Ecology will consider requiring additional industries to have a permit.

The federal regulation applies only to "point source" storm water discharges to surface waters or municipal storm sewers. A "point source" discharge is defined in state regulations as "any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container,.....from which pollutants are or may be discharged."

For the industries identified in categories (1) through (10), a permit is necessary if there is a point source storm water discharge to a surface water or a municipal storm sewer from any of the following areas:

- industrial plant yards,
- immediate access roads and rail lines used or traveled by carriers of raw materials, manufactured products, waste material, or by-products used or created by the facility,
- material handling sites,
- refuse sites,
- sites used for the application or disposal of process waste waters (as defined at 40 CFR part 401),
- sites used for the storage and maintenance of material handling equipment,
- sites used for residual treatment, storage, or disposal,
- shipping and receiving areas,

[6] Date approximate; assumed 30 months after designation.

[7] Date approximate; assumed 42 months after designation.

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- manufacturing buildings,
- storage areas (including tank farms) for raw materials, and intermediate and finished products,
- areas where industrial activity has taken place in the past and significant materials remain and are exposed to storm water.

For the industries identified in category (11), a permit is required for point source discharges from any of the areas that are listed above (except access roads and rail lines of category 11 industries), only if material handling equipment or activities, raw materials, intermediate products, final products, waste materials, by-products, or industrial machinery are exposed to storm water.

SOME INDUSTRIES DO NOT HAVE TO APPLY FOR A STORM WATER PERMIT.

* Industries which have storm water management and treatment requirements in an existing NPDES permit do not have to apply for a storm water permit.

* Industries which discharge their storm water only to a municipal combined sewer or sanitary sewer do not have to apply. Cities which have combined sewers in a portion of their geographic area include:

Anacortes	Bellingham	Bremerton
Everett	Mount Vernon	Olympia
Port Angeles	Seattle	Snohomish
Spokane		

Industries located in these cities will need to determine if their storm water discharges to a combined sewer or a storm sewer.

* Industries which only have storm water discharges from office buildings and accompanying parking lots do not have to apply.

* For industries which must have a storm water permit for their industrial activities, permit requirements do not apply to storm water from office buildings and accompanying parking lots, as long as the storm water from these areas does not mix with storm water from the industrial area.

HOW AND WHEN DO I APPLY FOR A PERMIT?

Three types of permits are possible. Each has a different application process.

Baseline Permit:

Applications for coverage under the baseline permit should be submitted after Ecology adopts the permit (targeted for June 30, 1992), but before the current federal deadline of October 1, 1992. Applications will consist of filing a **NOTICE OF INTENT**. Ecology has not yet decided on the information requirements for a **NOTICE OF INTENT**. Proposed requirements for a Notice of Intent will be discussed at public workshops and hearings.

Individual Permit:

Industries which are required to have a storm water permit may apply for an individual permit. An individual permit is a permit which is written for and issued to a specific facility. EPA regulations require that industries not covered under a general (baseline) permit, or part of a group application to EPA (see below), must apply for an individual storm water permit by October 1, 1992. Individual permit applications for discharges composed entirely of storm water, must comply with 40 CFR 122.21, and complete EPA forms 1 and 2F.

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Ecology is prepared to issue individual permits for facilities not already under permit only for exceptional circumstances. As previously stated, Ecology plans to cover all facilities initially under the baseline permit. Facilities which Ecology determines need individual permits, will be addressed at a later date.

Therefore, facilities that file applications for an individual permit may not have their application acted on. All facilities are encouraged to participate in receiving coverage under the baseline permit by submitting a NOTICE OF INTENT.

Industry-Specific General Permits:

Ecology will consider development of several industry-specific general permits after the baseline general permit program is underway. An industry-specific permit is a permit which can apply to all industries of a similar type. Ecology will choose which industries will receive increased attention under industry-specific permits. Industries for which an industry-specific permit is written will no longer be covered under the baseline permit. Industry-specific permits may not be written for industries which have made a group application to EPA.

Some industrial facilities have jointly submitted group applications to EPA for coverage under a general permit to be developed specifically for their group. Except for industries owned or operated by municipalities under 100,000 in population, the deadline for formation of groups has passed. Those groups which have received approval from EPA for Part 1 of their application may choose to proceed with Part 2 of their application. However, group applicants should understand that Ecology is not required to issue group-specific general permits. Ecology intends to cover the industries in these groups, at least initially, under the baseline permit. During development of the baseline permit, we will consider group monitoring alternatives to reduce monitoring costs to dischargers.

MUNICIPALITIES WHICH OWN OR OPERATE INDUSTRIAL ACTIVITIES MAY HAVE TO APPLY FOR A STORM WATER PERMIT

Some municipalities own or operate an industrial activity listed in the addendum. If that industrial activity has a storm water discharge from one of the areas described above, the municipality should apply for a storm water permit, UNLESS the industrial activity is in category 11 and the area is not exposed to storm water.

Industrial activities by municipalities which may require a storm water permit include:

- Sand and gravel mining,
- Crushed and broken stone operations, and rip rap mining and quarrying,
- Landfills, land application sites, and open dumps that receive or have received industrial waste,
- Transportation services which have vehicle maintenance shops, equipment cleaning operations, or airport de-icing operations,
- Sewage treatment plants with a design flow above one million gallons per day,
- Construction activities, including clearing, grading, or excavating sites, which disturb five acres or more.

Recently, federal legislation extended the individual and "group" permit application deadlines for municipalities with industrial activities. In spite of these extensions, Ecology encourages all municipalities, including those which are part of a group application to EPA, to submit a NOTICE OF INTENT by October 1, 1992, for coverage under the baseline permit.

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WHAT WILL THE BASELINE PERMIT REQUIRE INDUSTRIES TO DO?

Ecology has not yet decided on the requirements of the baseline permit. EPA regulations include the following requirements which Ecology will consider putting in the permit:

Compliance with surface water, ground water, and receiving water sediment standards;
Monitoring of pollutants discharged;
Prohibiting the discharge of anything but storm water to storm sewers;
Submission of a NOTICE OF INTENT by October 1, 1992;
Development of a POLLUTION PREVENTION PLAN within 180 days after Ecology adopts the permit;
Implementation of the POLLUTION PREVENTION PLAN within one year after Ecology adopts the permit

The development of a POLLUTION PREVENTION PLAN by each industry is a key EPA requirement. Under a POLLUTION PREVENTION PLAN, an industry could be required to:

- Identify potential sources of pollution which may affect storm water quality;
- Describe how they will reduce the pollutants in their storm water and comply with their permit.

WILL I HAVE TO PAY A FEE TO ECOLOGY FOR A STORM WATER PERMIT?

Ecology charges a fee for permits as allowed under State regulation, Chapter 173-224 WAC. That regulation does not identify a fee for facilities which will be covered under the baseline permit for storm water. Ecology plans to seek an increased legislative appropriation for the next biennium (July 1, 1993-June 30, 1995) to administer storm water permits. Fees would be set by amending the fee rule. There will be opportunities for public comment on the fee proposals. Subject to the appropriation and adoption of the amended fee regulation, fees for storm water permits would become effective after July 1, 1993.

DO I NEED TO APPLY IF I DON'T HAVE A DISCHARGE TO SURFACE WATER?

EPA's storm water regulations apply only to discharges to surface water. In developing the state storm water permit program, Ecology will consider including industrial activities which have a point source discharge to seepage ponds, seepage pits, dry wells, injection wells and any other on-site disposal which could pollute ground water. Ecology does not encourage diversion of surface water discharges to on-site disposal systems because of the potential for ground water contamination.

INDUSTRIAL STORM WATER DEADLINES & TARGET DATES

5/15/91	Industrial facilities which discharge storm water to separate storm sewer systems operated by King Co., Seattle, Snohomish Co., Pierce Co., or Tacoma, must notify that local government.
5/18/92	Current deadline for submission of Part 2 group applications to EPA
6/30/92	Target date for Ecology to adopt baseline general permit. The permit is effective 30 days later.

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After 7/31/92 — New industries must submit a NOTICE OF INTENT (to Ecology), and develop a pollution prevention plan (to be retained by the industry), before commencement of construction of a storm water discharge. EPA has proposed that these be completed at least 30 days prior to commencement.

10/1/92 — Deadline for industries with an existing storm water discharge to submit a Notice of Intent (NOI) to Ecology for coverage under the baseline general permit; or to submit an individual permit application to Ecology.

10/1/92 — Proposed deadline for submission of most Part 2 group applications to EPA.

* * * * * *

ECOLOGY WILL HOLD PUBLIC WORKSHOPS AND HEARINGS CONCERNING THE BASELINE GENERAL PERMIT

We will hold **PUBLIC WORKSHOPS** to explain the issues surrounding the baseline general permit, and to provide opportunity for public comment. The **PUBLIC WORKSHOPS** will probably be held in the first part of May. Subsequently, we will hold **PUBLIC HEARINGS** on the permit.

FOR FURTHER INFORMATION

ECOLOGY CONTACTS:

Linda Matlock (206) 438-7614 INDUSTRIAL STORM WATER GENERAL PERMITS

Peter Birch (206) 438-7076 MUNICIPAL STORM WATER PERMITS

USEPA REGION X CONTACT: Steve Bubnick: (206) 553-8399

NATIONAL STORM WATER HOTLINE: (703) 821-4823

INDUSTRIES SUBJECT TO FEDERAL REGULATION:
(Reference: 40 CFR 122.26(b)(14)

The following categories (1 through 10) of facilities are considered to be engaging in "industrial activity." They are required by USEPA to have a storm water NPDES permit if they have a storm water discharge to surface water.

1) Facilities subject to storm water effluent limitations guidelines, new source performance standards, or toxic pollutant effluent standards under 40 CFR subchapter N (except facilities with toxic pollutant effluent standards under category 11 below).

2) Facilities classified by the Standard Industrial Classification (SIC) system as:

- 24 - Lumber and Wood Products Except Furniture (except 2434-Wood Kitchen Cabinets). PLEASE SEE FOOTNOTE.
- 26 - Paper and Allied Products (except 265-Paperboard Containers and Boxes; and except 267-Converted Paper and Paperboard Products except Containers and Boxes)
- 28 - Chemicals and Allied Products (except 283-Drugs; and 285- Paints, Varnishes, Lacquers, Enamels, and Allied Products)
- 29 - Petroleum Refining and Related Industries

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311- Leather Tanning and Finishing
32 - Stone, Clay, Glass and Concrete Products (except 323-Glass Products, made of Purchased Glass)
33 - Primary Metal Industries
3441 Fabricated Structural Metal Products
373- Ship and Boat Building and Repair

3) Facilities classified by the Standard Industrial Classification (SIC) system as:

10 - Metal Mining
12 - Coal Mining
13 - Oil and Gas Extraction
14 - Mining and Quarrying of Nonmetallic Minerals, except Fuels

(Includes active or inactive mining operations (except for areas of coal mining operations no longer meeting the definition of a reclamation area under 40 CFR 434.11(1)...or except for areas of non-coal mining operations which have been released from applicable state or federal reclamation requirements by December 17, 1990) and oil and gas exploration, production, processing or treatment operations, or transmission facilities that discharge storm water that has come into contact with any overburden, raw material, intermediate products, finished products, byproducts or waste products located on the site of such operation....

4) Hazardous waste treatment, storage, or disposal facilities, including those that are operated under interim status or a permit under subtitle C of RCRA.

5) Landfills, land application sites and open dumps that receive or have received any industrial wastes (waste that is received from any of the facilities described under this subsection) including those that are subject to regulation under subtitle D of RCRA.

6) Facilities involved in the recycling of materials including metal scrap yards, battery reclaimers, salvage yards and automobile junkyards, including but not limited to those classified as SIC 5015-Wholesale Trade Activities of Motor Vehicle Parts, Used; and SIC 5093-Scrap and Waste Materials.

7) Steam electric power generating facilities, including coal handling sites.

8) Transportation facilities classified under the following SIC codes, which have vehicle maintenance shops, equipment cleaning operations, airport deicing operations. (Only those portions of the facility involved in the above activities, or which are otherwise identified in one of the other 10 categories.)

40 - Railroad Transportation
41 - Local and Suburban Transit and Interurban Highway Passenger Transportation
42 - Motor Freight Transportation and Warehousing (except 4221- Farm Product Warehousing and Storage, 4222-Refrigerated Warehousing and Storage, and 4225-General Warehousing and Storage)
43 - United States Postal Service
44 - Water Transportation
45 - Transportation by Air
5171- Petroleum Bulk Stations and Terminals

9) Treatment works treating domestic sewage or any other sewage sludge or wastewater treatment device or system, used in the storage treatment,

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recycling, and reclamation of municipal or domestic sewage, including land dedicated to the disposal of sewage sludge that are located within the confines of the facility, with a design flow of 1.0 mgd or more, or required to have an approved pretreatment program under 40 CFR part 403.

Not included are farm lands, domestic gardens or lands used for sludge management where sludge is beneficially reused and which are not physically located in the confines of the facility, or areas that are in compliance with section 405 of the Clean Water Act.

10) Construction activity including clearing, grading and excavation activities except: operations that result in the disturbance of less than five acres of total land area which are not part of a larger common plan of development or sale.

11) Facilities under the following SIC classifications need to apply for a storm water NPDES permit only if they are engaged in an "industrial activity" which is exposed to storm water and they have a point source storm water discharge to surface water.

20 - Food and Kindred Products
21 - Tobacco Products
22 - Textile Mill Products
23 - Apparel and Other Finished Products Made From Fabrics and Similar Materials
2434 Wood Kitchen Cabinets
25 - Furniture and Fixtures
265- Paperboard Containers and Boxes
267- Converted Paper and Paperboard Products, Except Containers and Boxes
27 - Printing, Publishing and Allied Industries
283- Drugs
285- Paints, Varnishes, Lacquers, Enamels, and Allied Products
30 - Rubber and Miscellaneous Plastic Products
31 - Leather and Leather Products (except 311, Leather Tanning and Finishing)
323- Glass Products made of Purchased Glass
34 - Fabricated Metal Products, Except Machinery and Transportation Equipment (except 3441, Fabricated Structural Metal Products)
35 - Industrial and Commercial Machinery and Computer Equipment
36 - Electronic and Other Electrical Equipment and Components, Except Computer Equipment
37 - Transportation Equipment (except 373, Ship and Boat Building and Repair)
38 - Measuring, Analyzing, and Controlling Instruments, Photographic, Medical and Optical Goods, Watches and Clocks
39 - Miscellaneous Manufacturing Industries
4221 Farm Product Warehousing and Storage
4222 Refrigerated Warehousing and Storage
4225 General Warehousing and Storage

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IV-5.12 R.12 WASHINGTON STATE GROUND WATER QUALITY STANDARDS

In December, 1990, the state of Washington adopted a set of ground water standards to prevent ground water pollution. The public and private agencies, groups and people who developed and reviewed the standards intend them to protect ground water quality rather than react to ground water pollution.

The standards incorporate an existing part of state water quality law: the antidegradation policy. This policy strictly forbids degradation which would harm existing or beneficial use of ground water. Beneficial uses of ground water include drinking water, irrigation, and support of wildlife habitat.

During the next year or two, the Department of Ecology will develop guidance for implementing the standards, both for point sources and non-point sources of water pollution.

Implementing the Ground Water Standards

The standards provide numeric values which must not be exceeded to protect the beneficial use of drinking water. These values are called criteria. For example, the criterion for nitrate-nitrogen is 10 mg/l. The criteria are generally derived from health-based drinking water standards. The rule also provides for developing enforcement limits and early warning values that will allow preventative action or enforcement to be taken so that criteria will not be exceeded.

Washington law requires that all activities with the potential to contaminate water implement practices known as AKART -- short for "all known available and reasonable methods of prevention, control and treatment". AKART must be used regardless of the quality of the receiving waters. In other words, discharges must be as clean as it is possible to make them using AKART. As technology and preventive controls are refined to better protect water quality, AKART is also redefined. In individual cases where AKART fails to protect water quality, the activity must apply additional controls.

These standards apply to both point source and non-point source activities. Both federal and state law require point sources to operate under permits that set conditions for discharges. Guidance for permit development will describe how industry must conduct its activities in order to protect ground water quality. Each industry will be required to implement AKART specific to that industry.

Non-point source activities are diffuse in nature, and often consist of many small sources of pollution that have a cumulative effect. Some non-point sources, such as on-site septic systems, will be managed through the development of siting and design standards. In other cases, general permits will establish standards for management. General permits apply to all operators of a particular type of activity, such as stormwater management or confined animal feeding operations.

The standards apply to all underground waters in the saturated zone (generally at or below the water table), with few exceptions. One of these exceptions provides that the standards do not apply in the root zone of saturated soils where agricultural pesticides or nutrients have been applied at agronomic rates for agricultural purposes. The standards do apply below the crop's root zone. State approved BMPs may be considered one type of AKART for agriculture, and other point and non-point sources.

Contact Nancy Winters, (206) 438-7066, for more information about the standards.

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A Current Assessment of Urban Best Management Practices

Techniques for Reducing Non-Point Source Pollution in the Coastal Zone

Prepared by:

Metropolitan
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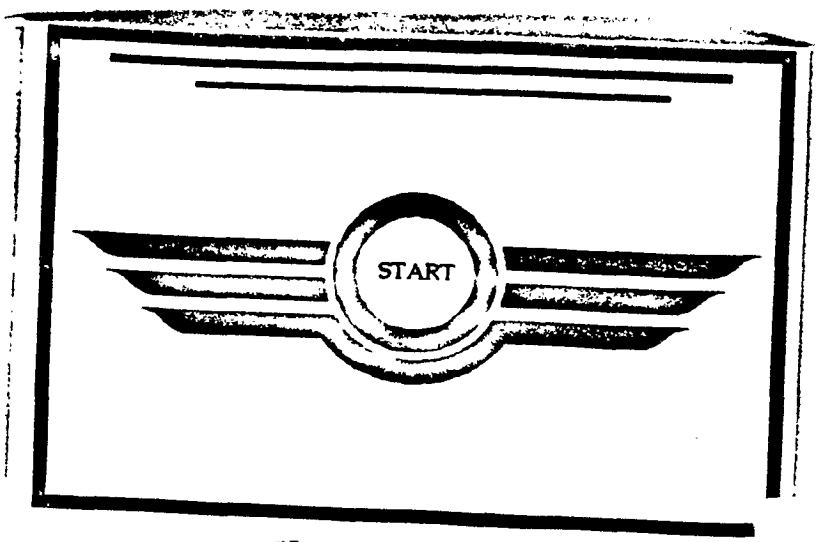

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A Current Assessment of Urban Best Management Practices

Techniques for Reducing Non-Point Source Pollution in the Coastal Zone

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Prepared for:

U.S. Environmental Protection Agency
Office of Wetlands, Oceans, and Watersheds

Technical Guidance to Implement Section 6217(g)
of the Coastal Zone Management Act

March, 1992

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ABSTRACT

TITLE: A Current Assessment of Urban Best Management Practices: Techniques for Reducing Nonpoint Source Pollution in the Coastal Zone.

DATE: March 1992

AUTHOR: Anacostia Restoration Team
Department of Environmental Programs
Metropolitan Washington Council of Governments

AGENCY: The Metropolitan Washington Council of Governments is the regional planning organization of the Washington, D.C. area's major local governments and their governing officials. COG works toward solutions to such regional problems such as energy shortages, traffic congestion, inadequate housing, air and water pollution. The US Environmental Protection Agency works toward the reduction and elimination of national pollution problems. It develops guidelines for the implementation of environmental legislation, enforces national pollution control programs, offers technical assistance to state and local programs, and provides guidance in determining future national pollution control priorities.

REPORT ABSTRACT: Summarizes the capabilities and limitations of structural best management practices in current use for the control of the quality of urban runoff. Addresses issues of particular concern to the coastal zone. Observations are derived from multiple field studies. Includes assessments of extended detention ponds, wet ponds, stormwater wetlands, multiple pond systems, infiltration trenches, infiltration basins, porous pavement, sand filters, grassed swales, vegetated filter strips and water quality inlets. For each practice, the report discusses pollutant removal capability, longevity, environmental impacts, construction and maintenance costs, feasibility in different development contexts, and adaptability to different geographic settings, particularly coastal. The report also suggests improvements under development for each practice, intended to correct notable design flaws or increase overall stormwater management capability.

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Tom Schueler, Peter Kumble and Maureen Heraty, principal authors
Illustrations by Peter Kumble and Mark Pfoutz

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Preface

This report has been prepared under Grant X-818188-01-1 from the Office of Wetlands, Oceans and Watersheds (OWOW) of the U.S. Environmental Protection Agency. Some data and graphics within the report were prepared from funding provided by the Water Resources Committee of the Council of Governments.

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COG Staff: Lorrie Herson, John Galli and Dave Shepp

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EXECUTIVE SUMMARY

This report is intended to define the capabilities and limitations of the current generation of urban best management practices (BMPs) in order to provide effective stormwater quality management within the coastal zone. These capabilities and limitations are extremely important to keep in mind as local communities and state agencies begin to develop stormwater management programs.

Table 1 provides a comparative assessment of eleven different BMP options. Several major conclusions can be made regarding the current generation of BMPs:

- Not all urban BMPs can reliably provide high levels of removal for both particulate and soluble pollutants. Effective BMP's include wet ponds, stormwater wetlands, multiple pond systems and sand filters. Infiltration BMP's are presumed to be effective in removing pollutants, but are not reliable given their poor longevity. Other BMPs, such as grassed swales, filter strips and water quality inlets, cannot provide reliable levels of pollutant removal until their basic design is significantly enhanced.

- The longevity of some BMPs is limited to such a degree that their widespread use is currently not encouraged. Of particular concern are the infiltration practices, such as basins, trenches and porous pavement. The poor longevity of these BMPs is attributable to a number of factors: lack of pretreatment, poor construction practices, application to infeasible sites, lack of regular maintenance, and in some cases, fundamental difficulties in basic design. Very often the life-spans of BMPs can be increased to acceptable lengths if local communities adopt enhanced designs and commit to strong maintenance and inspection programs.

- BMP options are adaptable to most regions of the country with the exception of extremely arid regions of the West and the colder climates of the North. In these regions, conventional BMP designs may need to be refined to account for high evaporation rates or subfreezing snowmelt conditions, respectively. New BMP options should also be explored.

- No single BMP option can be applied to all development situations and all BMP options require careful site assessment prior to design. Pond options are applicable to the widest range of development situations, but typically require a minimum drainage area. On the other hand, infiltration practices have very limited applications, requiring field verification of soils, water tables, slope and other factors.

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- Several BMPs can have significant secondary environmental impacts, although the extent and nature of these impacts is uncertain and site-specific. Pond systems, which offer reliable pollutant removal and longevity, tend to be associated with the greatest number and strongest degree of secondary environmental impacts. Careful site assessment and design are often required to prevent stream warming, natural wetland destruction and riparian habitat modification.

- Relatively limited cost data exists to aid in the assessment of the comparative cost-effectiveness of urban BMP options. Presently, the selections of BMPs is based more on longevity, feasibility, and local design factors than on comparative cost. It is expected that construction costs for all BMP's will increase in the future due to the enhanced designs needed for more reliable pollutant removal and longevity. Costs may also increase in response to increasingly complex permitting requirements. Maintenance costs may rival construction costs over the design life of many BMPs; however, many jurisdictions currently do not have very active BMP maintenance programs.

- Many of the conventional urban BMPs need to be enhanced to provide more reliable pollutant removal and greater longevity. In many cases, a systems approach to BMP design is warranted whereby multiple techniques for runoff attenuation, conveyance, pretreatment, and treatment are utilized. The report suggests some general directions for enhancing conventional urban BMP designs and a priority should be placed on demonstrating the performance of the enhanced BMPs in the field.

- Several fundamental uncertainties still exist with respect to urban BMPs and need to be resolved through basic research. These uncertainties include the toxicity of residuals trapped within BMPs; the interaction of groundwater and BMPs (both ponds and infiltration); and the long-term performance of urban BMPs.

- This report only discusses structural BMPs. Well-planned development sites usually incorporate non-structural BMPs as well. These non-structural BMPs are currently the subject of an ongoing study at COG which will be available in 1993.

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TABLE 1

A COMPARATIVE ASSESSMENT OF THE EFFECTIVENESS OF CURRENT URBAN BEST MANAGEMENT PRACTICES

URBAN BMP OPTIONS	RELIABILITY FOR POLLUTANT REMOVAL	LONGEVITY*	APPLICABLE	REGIONAL CONCERNS		COMPARATIVE COST	
Extended Detention Ponds	Moderate but always [illegible]	20+ years, but frequent clogging and short detention common.		Very few.		Lowest cost alternative in size range	
Wet Pond	Moderate [illegible]	20+ years		Arid and high ET regions.		Moderate to high compared to conventional stormwater detention	
Stormwater Wetlands	Moderate [illegible]	20+ years		Arid and high ET regions, short growing seasons		Marginally higher than wet ponds	
Multiple Pond Systems	Moderate [illegible] sedimentation increases reliability	20+ years		Arid regions.		Most expensive pond option	
Infiltration Trenches	Presumed moderate	40 % failure rate within five years.		Arid and cold regions sole-source aquifers		Cost-effective on smaller Rehab costs can be considerable	
Infiltration Basins	Presumed moderate, if working	60 - 100 % failure within five years.		Arid and cold regions sole-source aquifers		Construction cost moderate, but rehab cost high	
Porous Pavement	High [illegible]	75 % failure within five years.		Cold climates; arid regions; sole-source aquifers.		Cost-effective compared to conventional asphalt when working properly	
Sand Filters	Moderate [illegible]	20+ years		Few restrictions.		Comparatively high construction costs and frequent maintenance.	
Grassed Swales	Low [illegible] but [illegible]	20+ years		Arid and cold regions		Low compared to curb and gutter.	
Filter Strips	Unknown, but may be limited.	Unknown, but may be limited.		Arid and cold regions		Low.	
Water Quality Inlets	Presumed moderate	20+ years		Few.		High, compared to trenches and sand filters.	

*based on current designs and prevailing maintenance practices

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INTRODUCTION

This report presents a technical assessment on the capability of selected urban best management practices (BMPs) to provide effective control of stormwater quality. The report is intended to provide guidance in urban BMP selection for coastal communities that need to comply with Section 6217(g) of the 1990 Coastal Zone Management Reauthorization Act.

While urban BMPs have been applied in several areas of the country for the past decade (most notably in the mid-Atlantic region), surprisingly little information is available about their performance, cost and longevity. Quite simply, the design of urban BMPs is in its infancy, and improved and more reliable designs are constantly evolving.

As coastal communities develop stormwater quality management programs, they must choose a series of BMP options that can reliably achieve water quality goals. This report is intended to answer questions that decisionmakers must face in choosing a particular BMP or combination of BMP options. Those questions are:

Can the BMP reliably remove urban pollutants?

The report reviews available performance monitoring data for each BMP and outlines primary pollutant removal mechanisms. Design factors that are known or suspected to improve or degrade pollutant removal efficiency are noted.

How well does the BMP operate over time?

The report reviews studies that indicate the longevity of the BMP over time and identifies the critical factors that lead to premature failure.

When and where is the BMP feasible?

The use of nearly all BMPs is restricted by a number of site and land-use conditions. For each BMP, the report identifies key feasibility factors. In addition, it describes the potential use of a BMP for stormwater quantity, urban retrofits, or in ultra-urban areas.

How much will the BMP cost?

The economics of urban BMPs are sparsely documented and often depend on many site-specific factors. To answer this question, the report makes general observations with respect to the comparative construction and maintenance costs for BMPs. It also outlines differences in design and permitting

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requirements among different BMPs.

Can the BMP be adapted for all coastal areas?

A frequent concern has been that much of the performance and longevity data for urban BMPs has been generated within the mid-Atlantic region, and therefore, may not be applicable to all regions of the country. The report notes factors that may limit or restrict the application of an urban BMP to other regions of the country with different climates and/or vegetative cover.

Does the BMP have any environmental benefits or liabilities?

Urban BMPs often generate secondary environmental impacts at the site. Some of these impacts can be beneficial (such as the creation of wildlife habitat or wetlands) and others may be negative. Data is often sparse on negative impacts, but they can nevertheless be a critical factor in whether a BMP option is selected for a region. The report describes significant environmental benefits and concerns in relation to each BMP option.

What is not understood about the BMP?

Despite our experience with many BMPs, many aspects of BMP performance are not well understood. The report lists important gaps in our current understanding of the limits and capabilities of each BMP option. Further research to resolve these uncertainties is recommended.

To address these questions, COG staff thoroughly reviewed the extant literature, consulted with numerous local and state experts around the country, and analyzed data from ongoing studies. This report represents the conclusions resulting from that research.

In the report, we review eleven structural BMPs and make a general recommendation for each one on its application in coastal areas. The BMPs include:

1. Extended Detention Ponds
2. Wet Ponds
3. Stormwater Wetlands
4. Multiple Pond Systems
5. Infiltration Trenches
6. Infiltration Basins
7. Porous Pavement
8. Sand Filters
9. Grassed Swales
10. Filter Strips
11. Water Quality Inlets

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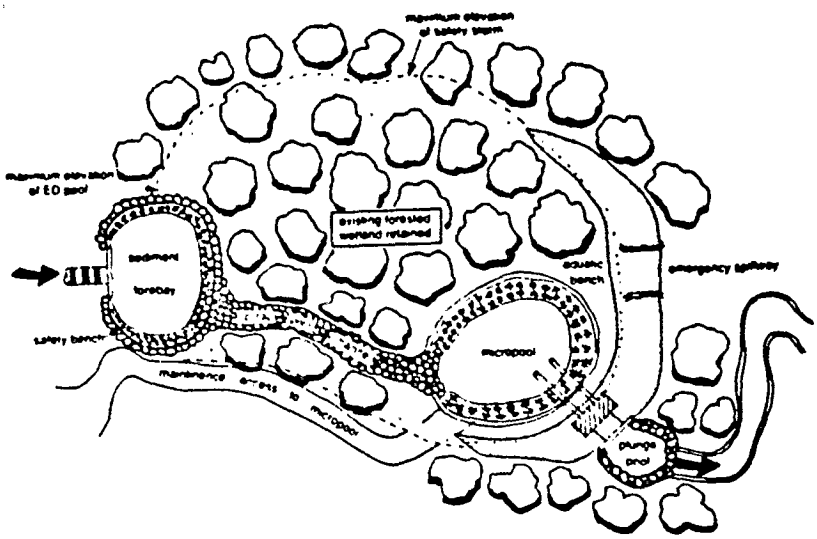
EXTENDED DETENTION PONDS

BMP Fact Sheet #1

Definition

Schematic Design of an Enhanced Dry ED Pond System



Source: Schueler, 1991.

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Extended Detention Ponds

Capsule Summary:

Pollutant Removal Capability: Conventional ED ponds provide moderate but variable removal of particulate pollutants, such as sediment, phosphorus and organic carbon, but provide negligible removal of soluble pollutants.

Longevity: While few conventional ED ponds built to date have totally failed, many do not operate as designed and a majority are not achieving target detention times.

Feasibility: The enhanced ED pond can be utilized in most low visibility development situations, as a retrofit practice, or in combination with wetlands or permanent pools.

Environmental Concerns: Poorly-maintained conventional ED ponds may create nuisances and are not popular with nearby residents. If not properly located, ED ponds can degrade forests, wetlands and other habitat areas.

Environmental Benefits: Enhanced ED ponds provide excellent protection for downstream channel erosion and, if landscaped properly, can create valuable wetland and wet meadow habitat.

Costs: ED ponds are generally the least costly stormwater quality ponds to construct, but also have the greatest regular maintenance burden of any stormwater ponds.

Adaptability: ED ponds are an adaptable BMP that can be applied to most, if not all, regions of the country.

Maintenance Burden: Conventional ED pond designs exhibit chronic clogging and are difficult to mow. Debris and sand deposits quickly accumulate.

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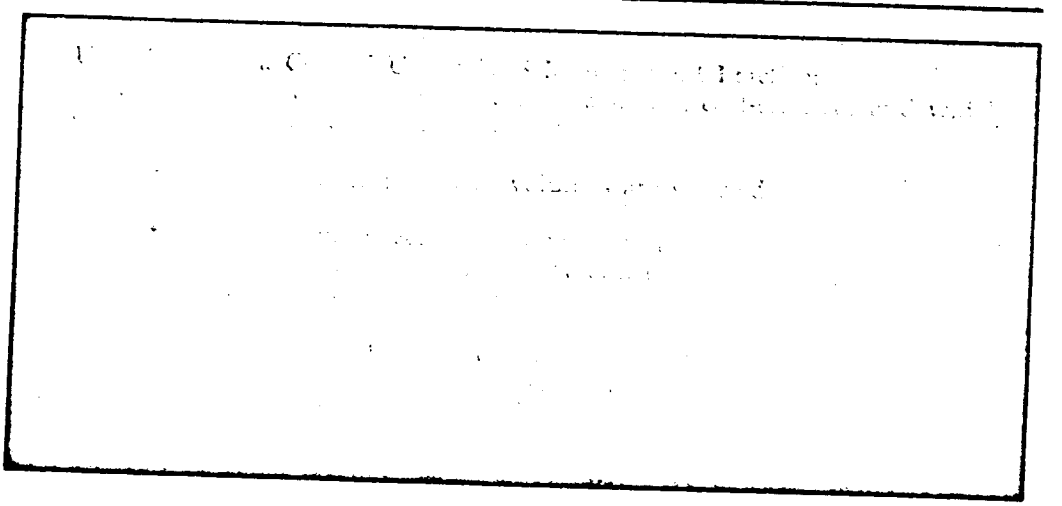

Can Extended Detention Ponds Reliably Remove Urban Stormwater Pollutants?

Pollutant Removal Mechanisms: Pollutant removal is primarily accomplished by gravitational settling that is dependent on the detention time and the fraction of the annual runoff volume that is effectively detained in the pond. (1)

Review of Monitoring Studies: Six performance monitoring studies have been conducted to date. (Appendix A) Reported removal for TSS ranges from 30 - 70 %, but is variable for smaller runoff events. For Total P, removal generally ranges from 10 - 30 %. For soluble nutrients, removal capability is estimated as low or negative. For COD, the removal rate ranges from 15 - 40 %. No data is yet available on the effectiveness of enhanced dry ED ponds.

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Factors Influencing Pollutant Removal:

Positive Factors

- Six to twelve hours of detention (minimum) (2)
- Smaller treatment volumes (e.g. 0.5 watershed inches) provide the best removal rates (3)
- Wetlands in lower stage can prevent resuspension and augment removal
- Use of a micropool to protect the ED pond orifice (4)

Negative Factors

- Resuspension of previously deposited pollutants from the pilot channel of pond floor (2) (5)
- Large treatment volumes: acceptable ED times cannot be achieved over the broad range of expected storms (6)
- Difficulty in predicting ED hydraulics (7)

How Well Do Extended Detention Ponds Operate over Time?

Failure Rates: Four of six conventional ED ponds were unable to achieve target detention times for the entire range of storms monitored. Preliminary field studies in Maryland suggest that most dry ED ponds constructed are partially clogged and have standing water and/or wetland plants. (8) Many ED ponds were not providing adequate ED for the range of expected runoff events.

Despite their clogging and short ED times, nearly all the conventional ED ponds surveyed were providing at least partial pollutant removal. (8) The oldest conventional ED ponds to date are ten to fifteen years old.

Factors Influencing Longevity: Greater longevity and reduced clogging can be achieved by:

- Two-stage design, utilizing wetlands in the lower stage (1)
- Smaller ED treatment volumes (i.e., avoid two-year ED) (6)
- Use of single orifices located within the permanent micropool
- Avoidance of concrete pilot channels
- Equipping the pond with a drain
- Adjustable ED gate valves to achieve target detention times (4)

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Where and When are Extended Detention Ponds Feasible?

Contributing Watershed Area: In most cases, ED ponds are not practical if the watershed area is less than ten acres. (1)

Development Feasibility: Can be useful for most development situations, but may not be appropriate in high visibility residential or commercial settings.

Depth to Bedrock: If bedrock is close to the surface, high excavation costs may make ED ponds infeasible.

Depth to Water Table: If the water table is within two feet of the bottom of the ED pond, it can create problems with standing water and also indicate potential wetland status.

Use in Ultra-urban Areas: Fairly limited due to space constraints.

Retrofit Capability: Frequently used for stormwater retrofits, particularly within dry stormwater management ponds and at culvert/channel intersections. Usually used in combination with a micropool, wetland or permanent pool. (9) (10)

Stormwater Management Capability: Frequently used in combination with two-year storm control.

What are the Costs Associated with Extended Detention Ponds?

Permitting/Review: Permitting costs are usually less than other stormwater quality pond options.

Construction: Generally, extended detention ponds are the least expensive stormwater quality pond option available. The addition of extended detention to conventional stormwater detention facilities adds zero to twenty-five percent additional cost. (11)

Maintenance: Estimated to be three to five percent of construction cost each year. (11) Primary maintenance activities include mowing; unclogging of the ED control device; and sediment cleanout in the lower stage. The ED pond has the highest routine maintenance burden of any stormwater quality pond system, due to mowing and clogging problems.

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R0056350

Can Extended Detention Ponds Be Easily Adapted for All Coastal Areas?

The basic ED pond can be adapted for use in most coastal areas, particularly if micropool, wetland or permanent pool features are incorporated into the basic design.

However, the size of the ED treatment volume and the selection of the target detention time must be established locally based on the annual rainfall/runoff frequency relationship for a region.

What are the Environmental Concerns and Benefits of Extended Detention Ponds?

Positive Impacts:

- Extended detention is the best technique available for reducing the frequency of bankfull and subbankfull flooding events, and thereby is very useful in protecting downstream channels (1)
- ED ponds can create both terrestrial and aquatic wildlife habitat with appropriate pondscaping and vegetation management
- They are less hazardous than other stormwater quality ponds with deeper permanent pools

Negative Impacts:

- ED ponds can contribute to downstream warming if pilot channels are not shaded (high delta-t) (12)
- Improper site selection can create wetland, forest and habitat conflicts (13)
- Poorly maintained ED ponds are not popular with adjacent residents (14)
- "Dry" ED ponds can create mosquito breeding conditions and other nuisances

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What is Not Known about Extended Detention Ponds?

Although the ED pond is a well-established BMP, some uncertainties remain. These include:

- The ability to consistently achieve target detention times across the broad range of expected storm events using existing hydrologic/hydraulic design models and existing ED control devices
- The ability to predict (and adjust) treatment volumes and detention times to best protect downstream channels
- The impact of chronic clogging in ED ponds on their long-term pollutant removal capability

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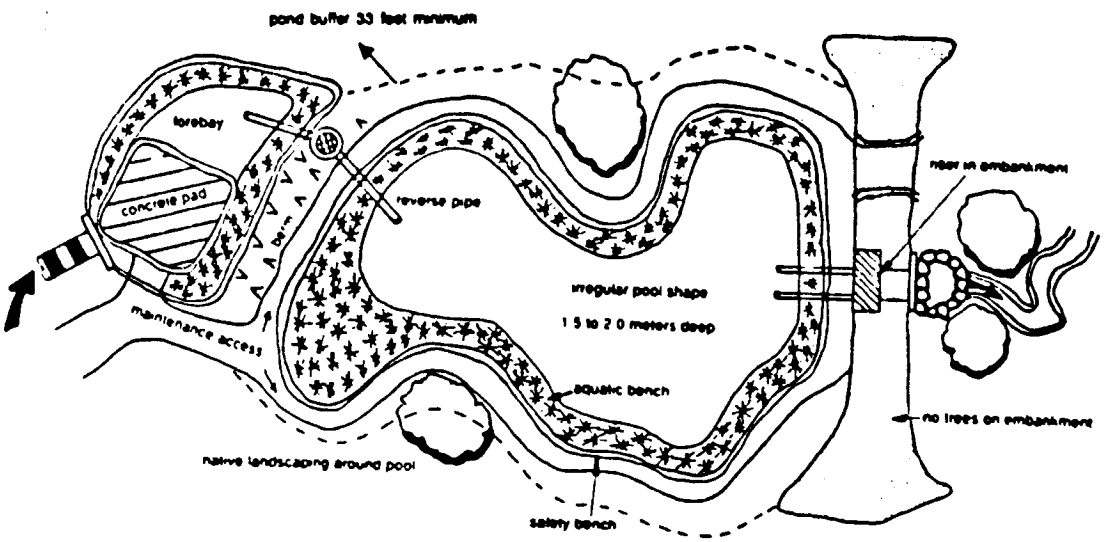
R0056352

WET PONDS

BMP Fact Sheet #2

Definition

Schematic Design of an Enhanced Wet Pond System



Source: Schueler, 1991.

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R0056353

Wet Ponds

Capsule Summary:

Pollutant Removal Capability: Conventional wet ponds provide moderate to high removal of both particulate and soluble urban stormwater pollutants. Reliable removal rates can be achieved with pool sizes ranging from 0.5 to 1.0 inches of runoff per impervious acre.

Longevity: Well-designed wet ponds can function for twenty years or more and very few conventional ponds have ever failed to provide some water quality benefit. Performance will decline over time, however, unless regular sediment cleanout is undertaken.

Feasibility: Wet ponds can be utilized in both low and high visibility development situations if contributing watershed area is greater than ten acres and/or a reliable source of baseflow exists.

Environmental Concerns: If located improperly, wet ponds can have several adverse environmental impacts, including downstream warming, trophic shifts, and a slight risk of poor quality pond effluent during dry weather. Local impacts include possible wetland and forest destruction, and slight risks of sediment and/or groundwater contamination. For larger wet ponds, sacrifice of upstream channels is a concern.

Environmental Benefits: An enhanced wet pond can be an attractive landscape and community feature, and create warm-water fishery, waterfowl habitat and wetlands in the urban scene.

Costs: Wet pond costs are twenty-five to forty percent greater than those reported for conventional stormwater detention. Maintenance costs range from three to five percent of construction costs annually.

Adaptability: Wet pond designs are not useful in arid regions where evapotranspiration significantly exceeds precipitation on an annual basis. Also, the size of the pool will need to reflect the prevailing climate and runoff frequency for a particular region. Ponds can be used in colder northern climates, but their performance declines slightly during ice and snowmelt runoff conditions.

Maintenance Burden: Wet ponds have a modest maintenance burden, consisting primarily of inspections, mowing of the embankment and buffers, and removal of trash and debris from the forebay.

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Can Wet Ponds Reliably Remove Urban Stormwater Pollutants?

Pollutant Removal Mechanisms: Achieved by gravitational settling, algal settling, wetland plant uptake and bacterial decomposition. (15) The degree of pollutant removal is a function of pool size in relation to contributing watershed area. Reliable removal can be achieved if the permanent pool is sized to store between 0.5 to 1.0 inch of runoff per contributing watershed area. (6)

Review of Monitoring Studies: The polllutant removal capability of conventional wet ponds is well documented with over twenty performance monitoring studies in publication. (Appendix A) Reported sediment removal typically ranges from 50 - 90 %. Total phosphorus removal ranges from 30 - 90 %. Removal of soluble nutrients ranges from 40 - 80 %. Moderate to high removals of trace metals, coliforms and organic matter are frequently reported.

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Wet Ponds

Factors Influencing Pollutant Removal:

Positive Factors

- Pretreatment by sediment forebay (16)
- Permanent pool, 0.5 - 1.0 inches per impervious acre treated (6) (15)
- Fringe wetlands
- Shallow wetlands and/or extended detention may improve removal efficiencies (14)
- High length to width ratios

Negative Factors

- Small pool size (15)
- Waterfowl populations (17)
- Short-circuiting and turbulence (18)
- Sediment phosphorus release
- Extremely deep pool depths (> than 10 feet)
- Snowmelt conditions and/or ice (19)

How Well Do Wet Ponds Operate over Time?

Failure Rates: Preliminary field assessments of conventional wet ponds indicate that most wet ponds are functioning as designed and few, if any, have actually failed. (8) However, pollutant removal capability over time may be diminished by sediment accumulation. Some wet ponds are still operating effectively fifteen years after construction.

Factors Influencing Longevity:

- Sediment forebay (6)
- Regular (2 - 5 year) sediment clean-outs
- Reverse-slope pipes (4)
- On-site sediment disposal area
- Use of concrete riser/barrels rather than corrugated metal pipe

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Where and When Are Wet Ponds Feasible?

Contributing Watershed Area: Contributing watershed areas greater than ten acres and less than one square mile are generally suitable for wet ponds.

Development Situations: Very useful in both low and high visibility commercial and residential development applications.

Baseflow: Dry-weather baseflow is needed to maintain pool elevations and prevent pool stagnation.

Available Space: Wet ponds and associated buffer/setbacks can consume from one to three percent of total site area.

Downstream Impacts: Wet ponds may not be advisable in cold water trout streams and may create wetland, forest and/or habitat conflicts.

Use in Ultra-urban Areas: Use in ultra-urban areas if fairly limited due to space constraints, but can provide an attractive urban amenity if open space or parkland is available.

Retrofit Capability: Occasionally used for stormwater retrofits, particularly within dry stormwater basins. (20) Often used in combination with wetlands or extended detention treatment techniques.

Stormwater Management Capability: Most wet ponds can provide two-year stormwater quantity control, in addition to quality control.

What are the Costs Associated with Wet Ponds?

Permitting/Review: Wet ponds require numerous permits and approvals, including wetlands permits, water quality certifications, dam safety, sediment and erosion control plans, and waterway permits. In some cases, permitting costs may rival design costs and may lead to a determination that a wet pond cannot be used at the site.

Construction: Little recent cost data is available for wet ponds. Earlier studies estimate that the addition of a permanent pool to a stormwater management facility can add twenty-five to forty percent to total construction costs. (11)

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Maintenance: Estimated to be three to five percent of construction cost per year. (11) (21) Mowing and sediment clean-removal are among the most costly maintenance activities. Ponds have a demonstrated positive impact on the value of adjacent land.

Can Wet Ponds Be Easily Adapted for All Coastal Areas?

The basic wet pond design is fairly adaptable to most regions of the country; however, problems may be encountered in climatic regions that:

- experience extremely long periods of dry weather
- have high evaporation rates
- undergo long periods of cold weather during which the pond is frozen
- experience low rainfall
- cannot sustain adequate vegetative cover in contributing watersheds.

Criteria for sizing the permanent pool should reflect the prevailing runoff frequency spectrum within a region

What are the Environmental Concerns and Benefits of Wet Ponds?

Positive Impacts:

- Creation of wetland features
- Creation of aquatic and terrestrial habitat (particularly for waterfowl)
- Creation of a warm-water fishery
- High community acceptance and landscaping values (14)
- Pollutant removal and downstream channel protection
- All studies to date indicate that pond sediments meet sludge toxicity limits and can be safely landfilled (23) (53) (54)

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Negative Impacts:

- Downstream warming (12)
- Upstream channels are heavily impacted when wet ponds serve large drainage areas (> 250 acres) (13)
- Potential loss of wetlands, forest and floodplain habitat associated with poor site selection for the pool (13)
- Downstream shifts in trophic status (24)
- Limited risk of ground water quality impacts over the long term; all studies to date indicate that wet ponds do not significantly contribute to ground water contamination (25)
- Potential hazard for nearby residents

What is Not Known about Wet Ponds?

Few fundamental uncertainties exist with respect to wet ponds. More research may be needed in the following areas:

- sediment nutrient release within ponds over the long term
- uptake of trace metals by biota (particularly fish)
- downstream impacts of ponds

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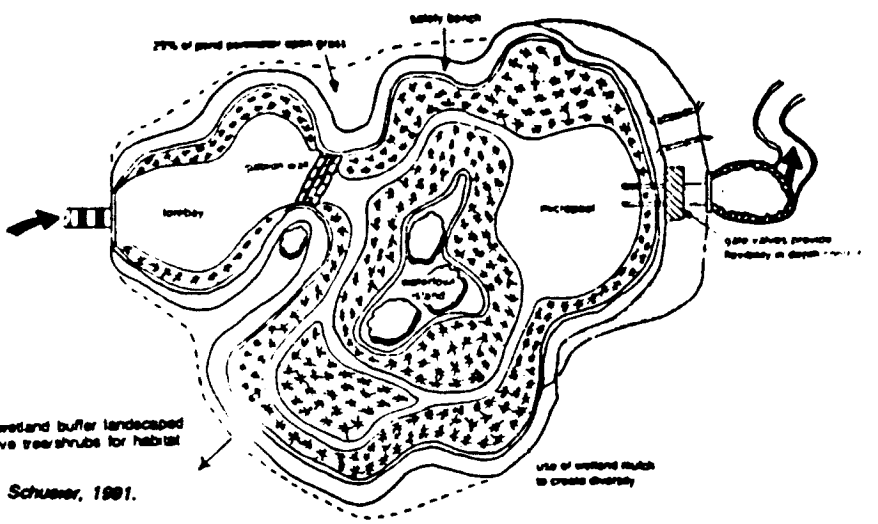
STORMWATER WETLANDS

BMP Fact Sheet #3

Definition

Schematic Design of an Enhanced Shallow Marsh System



Source: Schueler, 1991.

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Stormwater Wetlands

Capsule Summary:

Pollutant Removal Capability: In general, conventional stormwater wetlands have a high pollutant removal capability that is generally comparable to that of conventional wet ponds. Sediment removal may be greater in well designed stormwater wetlands, but phosphorus removal is more variable.

Longevity: Well-designed conventional stormwater wetlands should function for many years, but very few stormwater wetlands are yet ten years old.

Feasibility: Enhanced stormwater wetlands can be applied to most development situations where sufficient baseflow is available to maintain water elevations.

Environmental Concerns: If located improperly, the construction of stormwater wetlands may impact existing forests and natural wetlands; shallow wetlands can also contribute to downstream warming.

Environmental Benefits: With careful design and buffers, enhanced stormwater wetlands can create unique and valuable habitat for waterfowl and wildlife in the urban scene.

Costs: Construction costs for stormwater wetlands have not been systematically analyzed, but are expected to be marginally higher than wet ponds. Maintenance costs may average three to five percent of construction costs annually.

Adaptability: Enhanced stormwater wetlands can be adapted for most regions of the country that are not excessively arid.

Maintenance Burden: Stormwater wetlands require greater maintenance in the first three years to establish the marsh. Thereafter, the maintenance burden is similar to other pond systems.

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Can Stormwater Wetlands Reliably Remove Urban Stormwater Pollutants?

Pollutant Removal Mechanisms: Wetlands remove pollutants through gravitational settling, wetland plant uptake, adsorption, physical filtration and microbial decomposition. The degree of pollutant removal is a function of aquatic treatment volume, surface area to volume ratio, and the ratio of wetland surface area to watershed area. (16) (26) (27)

Review of Monitoring Studies: Eighteen studies of the performance of conventional natural and constructed wetlands are available. (Appendix A) Removal rates are generally comparable to those reported for conventional wet ponds of similar treatment volume; however, sediment removal rates are often slightly higher and nutrient removal rates are somewhat lower. Some cases of negative removal for ammonia and ortho-phosphorus were reported. Overall performance is greatest during the growing season and lowest during the winter months. (28)

Factors Influencing Pollutant Removal:

Positive Factors

- Constant pool elevations (6)
- Range of microtopography within the wetland (6)
- Sediment forebay (16)
- High surface area to volume ratio (28)
- Constructed wetland performs better than natural wetland
- Adding greater retention volume and/or detention time to the wetland (26) (28)

Negative Factors

- Low removal rate during non-growing season (29)
- Concentrated inflows (28)
- Wetland area less than two percent of watershed area
- Sparse wetland cover (5)
- Ice cover or snowmelt runoff (19)

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How Well Do Stormwater Wetlands Operate Over Time?

Failure Rates: While most conventional stormwater wetlands have persisted over time, the quality and coverage of wetland plants may not be optimal for pollutant removal. It should be noted that few stormwater wetlands meet the strict success criteria for wetland mitigation, but they are not intended to do so.

Factors Influencing Longevity:

- Sediment forebay
- Ability to regulate water depths
- Reinforcement plantings (6)
- Selection of an experienced wetland contractor for design (27)

Where and When are Stormwater Wetlands Feasible?

Contributing Watershed Area: Stormwater wetlands can be used in watersheds as small as five acres; however, these pocket wetlands can create nuisances and are hard to maintain. (8)

Presence of Baseflow: To maintain a constant water level, it is often necessary to have a reliable dry-weather baseflow to the wetland or a groundwater supply.

Permeable Soils: It is difficult to establish wetlands at sites with sandy soils, high soil infiltration rates or high summer evapotranspiration rates.

Available Space: Because of their shallow depths, stormwater wetlands can consume two to three times the site area compared to other stormwater quality options (in some cases, as much as five percent of total site area). The land requirements of stormwater wetlands can be sharply reduced by partially substituting vertical extended detention storage for horizontal wetland storage.

Use in Ultra-urban Areas: Limited due to space constraints; however, pollutant removal can be obtained by modifying existing degraded urban wetlands for stormwater control.

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Retrofit Capability: The addition of wetland features to older dry stormwater basins is an effective retrofit technique. (28) Many retrofits utilize a combination of extended detention, wetlands and a permanent pool.

Stormwater Management Capability: In most cases, stormwater detention can be provided in stormwater wetlands.

What are the Costs Associated with Stormwater Wetlands?

Design: Typically, design costs for wetland systems are slightly higher than for other ponds due to the need for environmental analysis of the proposed wetland site and the need for specialized planting techniques.

Permitting/Review: Wetland creation may require a 404 permit in some circumstances, thereby establishing a protected jurisdictional wetland. It is extremely difficult to construct a stormwater wetland within an existing natural wetland. (30)

Construction: Very little systematic cost data is available for the construction of stormwater wetlands. (21) The prevailing viewpoint is that stormwater wetland construction costs exceed those of wet ponds due to the more complex grading and wetland planting costs. Also, stormwater wetlands may require more space than other pond systems, thereby driving up land acquisition costs.

Maintenance: No reliable maintenance cost data is available. It has been assumed that maintenance costs are comparable to those of other pond systems over the long term. (6) However, costs may well be higher in the first few years after construction due to difficulties encountered in wetland establishment and the possible need for reinforcement plantings.

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Can Stormwater Wetlands Be Easily Adapted for All Coastal Areas?

Like other pond systems, the basic stormwater wetland design can be adapted to other regions of the country; however, alternative designs may be needed in northern regions with short growing seasons and hard winters. Conversely, regions with low rainfall, high evaporation and frequent droughts will require extensive modifications to the basic design in order to maintain the marsh system.

More information is needed on acceptable wetland plant species and on optimal depths for different areas of the country. Also, some regions may not have local wetland nurseries to supply wetland plant stock.

What are the Environmental Concerns and Benefits of Stormwater Wetlands?

Positive Impacts:

- Stormwater wetlands can provide an excellent urban habitat for wildlife and waterfowl, particularly if they are surrounded by a buffer and have some deeper water area (14) (26)

Negative Impacts:

- Possible impact on wetland biota from trace metal uptake (28)
- Stormwater wetlands have a positive delta-t (12)
- Construction may adversely impact existing wetland or forest areas (6) (30)
- Possible takeover by invasive aquatic nuisance plants (e.g., loosestrife, cattails and phragmites) (31)
- Bacterial contamination if waterfowl populations become very dense (17)

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What is Not Known About Stormwater Wetlands?

Stormwater wetlands are no longer an experimental technology. They have been proven to be effective and provide moderate to high levels of pollutant removal throughout the year. Stormwater wetland designs are numerous, however, and research needs to be done on the optimal combination of wetlands, ED and permanent pool storage.

Other uncertainties include:

- uptake of metals by wetland biota
- ability to maintain wetland target species over the long term
- whether the annual plant dieback exports a pulse of nutrients from the system
- the degree to which removal rates are reduced during the non-growing season
- the potential value of annual plant harvesting to increase removal rates

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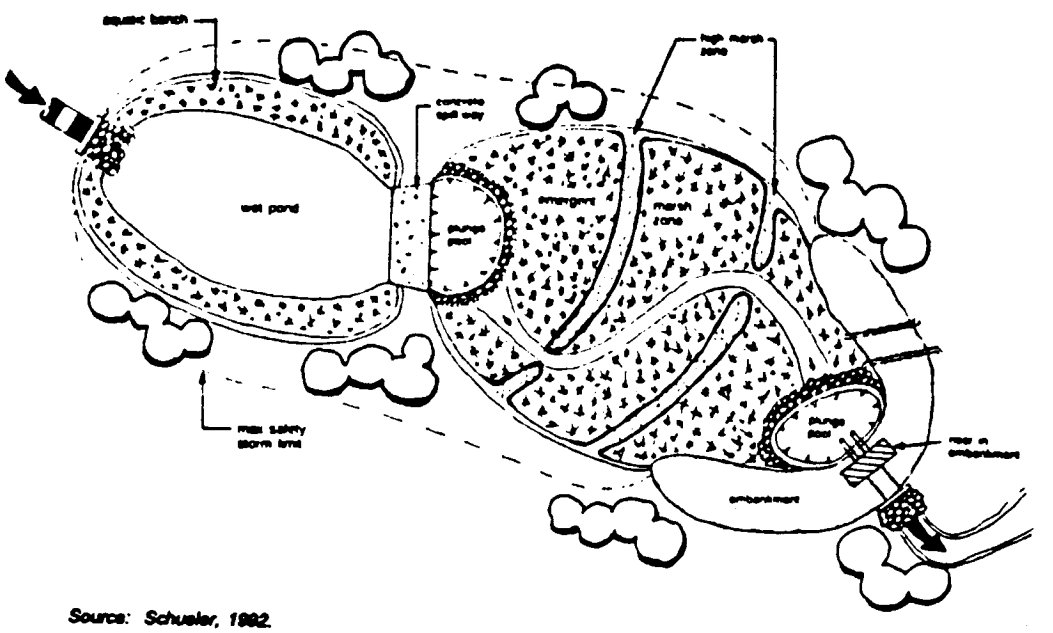
MULTIPLE POND SYSTEMS

BMP Fact Sheet #4

Definition

Schematic of a Multiple Pond System Design



Source: Schueler, 1992.

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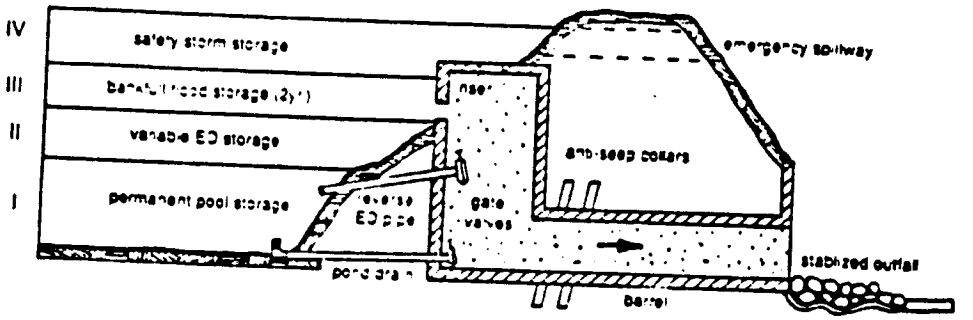
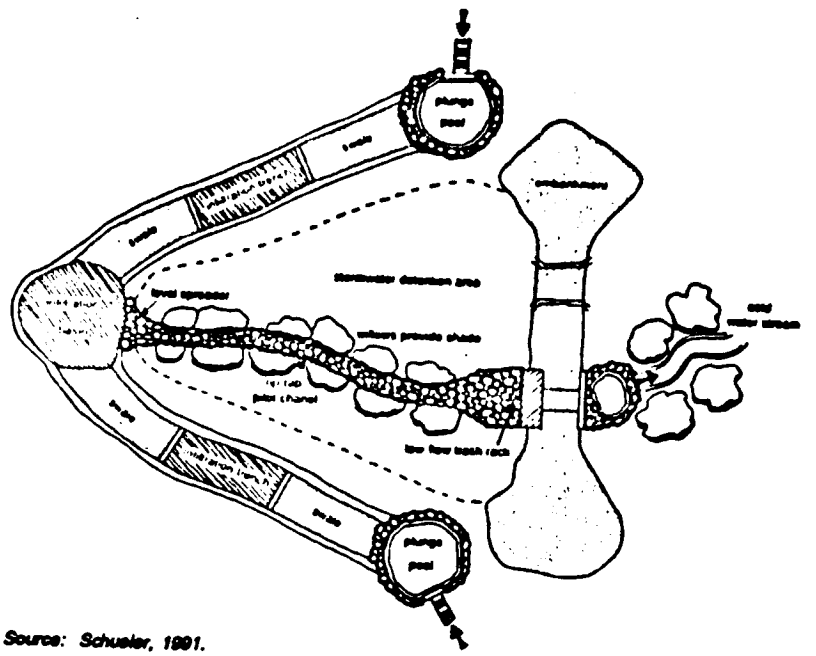
Multiple Pond Systems

Cross-section View of a Standard ED Pond System Design



Source: Schueler, 1991.

Schematic Design of a Dry In-filter System



Source: Schueler, 1991.

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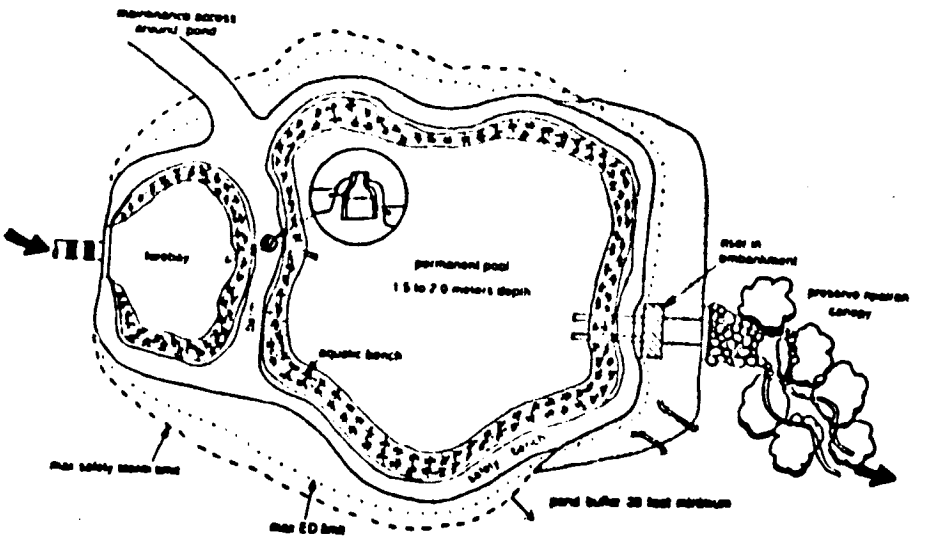
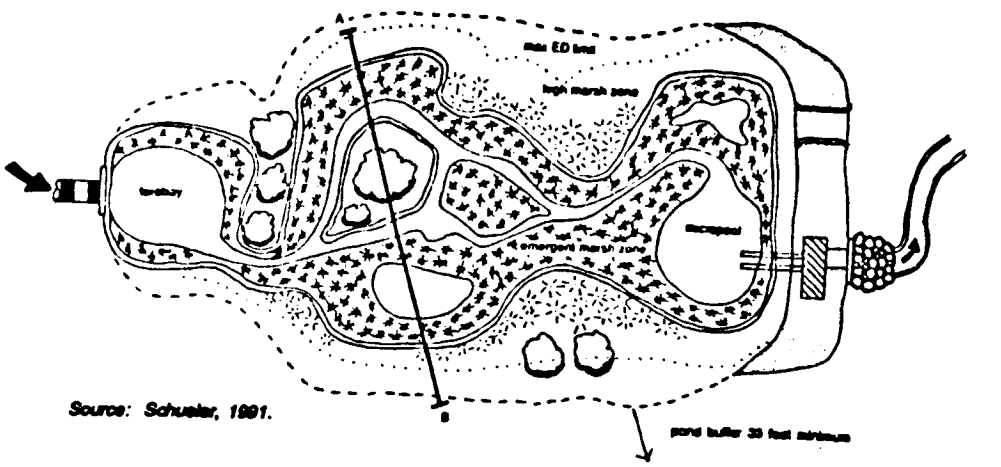
Schematic Design of an Enhanced Wet ED Pond



Source: Schueler, 1991.

Schematic Design of a Shallow ED Marsh System



Source: Schueler, 1991.

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Multiple Pond Systems

Multiple pond systems (MPS) have evolved as a common approach to provide stormwater quality control over the past five years. MPS is a collective term for a wide variety of approaches to stormwater pond design. While many aspects of their design are unique and site-specific, they do share several common features:

Redundancy: The MPS designs emphasize the use of multiple treatment mechanisms (such as a permanent pool, extended detention, wetlands, within a pond or series of ponds), rather than a single method of treatment. The redundancy helps to improve both the level and reliability of pollutant removal provided by the pond system.

Flexibility: Because the location and allocation of treatment mechanisms is not rigid, the designer of an MPS has a great deal of flexibility in responding to site-specific conditions. Additionally, the flexibility enables the designer to minimize or avoid negative environmental impacts that can be created by single ponds.

Complexity: MPS are inherently more complex in design than single treatment ponds. Typically, MPS systems have more sophisticated hydrologic control devices that are targeted toward different patterns of the annual runoff frequency spectrum. In addition, some MPS have interconnected cells within a pond.

Pollutant Removal Capacity:

As shown in Appendix A, many MPS are reported to provide incrementally higher and more consistent levels of urban pollutant removal in comparison to single treatment systems. This improvement is due to a number of factors:

Multiple-cell Ponds: Studies have shown that multiple cell ponds tend to have incrementally higher levels of pollutant removal when compared to single cell ponds. (32) The superior performance of multiple cell ponds can be attributed to a longer flow path, possible reductions in short circuiting, and increases in retention time.

Wet Pond/Wetland Systems: MPS that utilize a wet pond cell leading to a wetland cell have been reported to be very effective in removing pollutants from urban runoff. (19) (28) (33) (34) The wet pond cell is apparently very effective in pretreating the incoming runoff; it also reduces its velocity and distributes it more evenly across the marsh.

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Extended Detention/Wetland Systems: Wetlands are believed to improve the effectiveness of conventional extended detention (ED) in several ways. The plants help to stabilize deposited sediments, take up nutrients, and create more ideal settling conditions. The extent of the improved pollutant removal attributable to ED-wetland systems is not well documented, however. Four performance studies of ED-wetland systems have been reported (see Appendix A), and these indicate moderate to high removal of particulate pollutants, and low to moderate removal of soluble pollutants. However, all four systems that were studied had inadequate treatment volumes to provide for optimum pollutant removal (0.08 to 0.15 inches of runoff per contributing acre).

Wet Extended Detention Ponds: The wet extended detention pond system has been projected to have higher and more reliable pollutant removal than a wet pond or an ED pond acting alone. This superior performance is due to the role of the pool in acting as a barrier to resuspension and the role of ED in increasing retention times for the full range of storms. (4) Limited monitoring conducted to date (studies 33 - 34 in Appendix A) support this contention.

Longevity:

The longevity of MPS is expected to be at least comparable to conventional pond systems. Often, one treatment storage component can be used to protect the long term capacity of another component. For example:

Wet Pond/Wetland Systems: The wet pond cell traps the majority of the incoming sediment, thereby preserving treatment capacity in the wetland and maintaining optimum water depths.

Dry Infilter Systems: The plunge pool, grassed swale and filter cloth provide excellent pretreatment of runoff before it enters the trench, thereby enhancing its longevity. A dry infilter pond has been operating with only minor clogging for over six years in Maryland.

All Multiple Pond Systems: The basic design of all MPS has two features that promote greater longevity for ponds. The first is the subsurface reverse-slope pipe used as the hydrological control device. This design feature greatly reduces clogging. The second design feature is the forebay, or wet cell, which concentrates sediment deposition in an area where it can be easily removed without disturbing the entire system.

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Multiple Pond Systems

Feasibility:

MPS are generally subject to the same feasibility requirements associated with conventional pond systems.

Environmental Attributes:

The flexibility of MPS enables the designer to minimize or avoid many secondary impacts commonly associated with ponds. The ability to allocate treatment storage components, or locate them in series can aid the designer in "fingerprinting" the MPS to avoid disruption to forests and wetlands. Similarly, by allocating less storage to the permanent pool (and more to ED), one can reduce the potential delta-t of the pond. In addition, by combining wetlands with conventional wet ponds or extended detention ponds, it is possible to significantly enhance the habitat value. Finally, by adding ED to wetlands or wet ponds, one can provide a greater degree of downstream channel protection. Some of the comparative attributes of alternative pond designs are illustrated in Table 1.

Costs:

Due to the wide variety of designs, it is difficult to accurately project the construction costs associated with MPS. In most cases, they will be incrementally higher than conventional pond systems, if only because of their more complex design. However, costs can be somewhat reduced if extended detention is used as a partial substitute for more expensive wet pond or wetland storage.

Adaptability:

MPS are adaptable for use in most regions of the country. In arid or extremely cold regions, , more of the total storage in the MPS should be devoted to extended detention.

Maintenance:

MPS have a maintenance burden similar to that of conventional pond systems. While the MPS may have more complex operation (e.g., adjustment of valves), their

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design incorporates numerous features that can reduce routine and non-routine maintenance (e.g., mowing and sediment removal).

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INFILTRATION TRENCHES

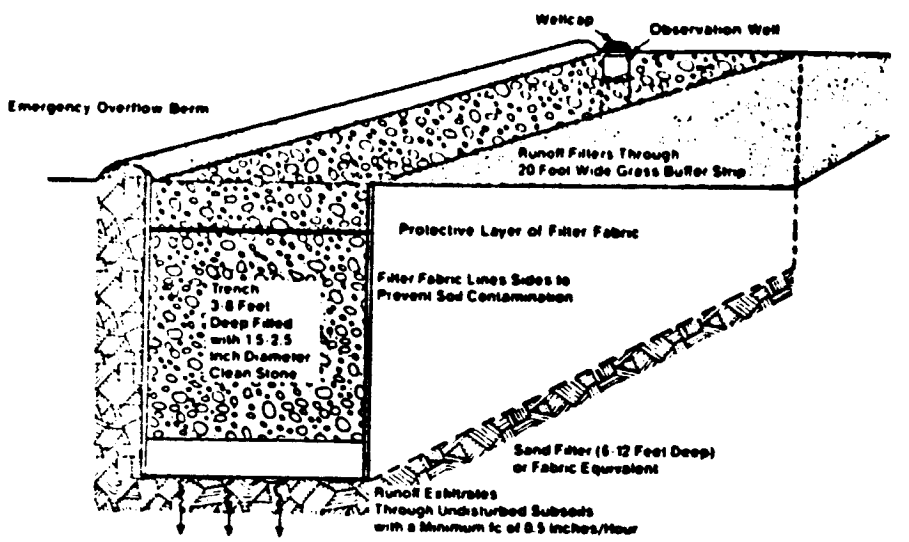
BMP Fact Sheet #5

Definition

A conventional infiltration trench is a shallow, excavated trench [illegible]

[illegible]

Schematic Design of a Conventional Infiltration Trench



Source: Schueler, 1987.

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Infiltration Trenches

Capsule Summary:

Pollutant Removal Capability: Although actual performance data on conventional infiltration trenches is rare, trenches are believed to have high capability to remove particulate pollutants and a moderate capability to remove soluble pollutants.

Longevity: Thus far, conventional trenches have proved to have short life spans. Slightly over half partially or totally fail within five years of construction. Longevity could be greatly improved through the utilization of enhanced trenches (i.e., runoff pretreatment, better geotechnical evaluation and regular maintenance).

Feasibility: The application of trenches, like other infiltration practices, is severely restricted by soils, water table, slope and contributing area conditions. These conditions must be carefully investigated in the field before proceeding with design.

Environmental Concerns: Concerns persist about the possibility of groundwater contamination by trenches. Studies to date do not indicate a major risk, but have noted migration of nitrate and chlorides.

Environmental Benefits: The widespread use of infiltration in a watershed helps to replicate predevelopment hydrology, increase dry-weather baseflow, and reduce bankfull flooding frequency. This benefit may not be realized in practice, however, given the short lifetimes of conventional trenches.

Costs: While infiltration trenches are more costly than pond systems in terms of cost per unit of runoff treated, they are a cost-effective option for smaller sites where ponds cannot be applied.

Adaptability: The widespread use of infiltration trenches may be limited in colder or more arid climates and in regions where soils are predominantly clays or silts.

Maintenance Burden: To enhance longevity and maintain performance, trenches and associated pretreatment systems do require significant maintenance. Most conventional trenches do not appear to be regularly maintained in the field and thus many will require costly rehabilitation or replacement to maintain their function.

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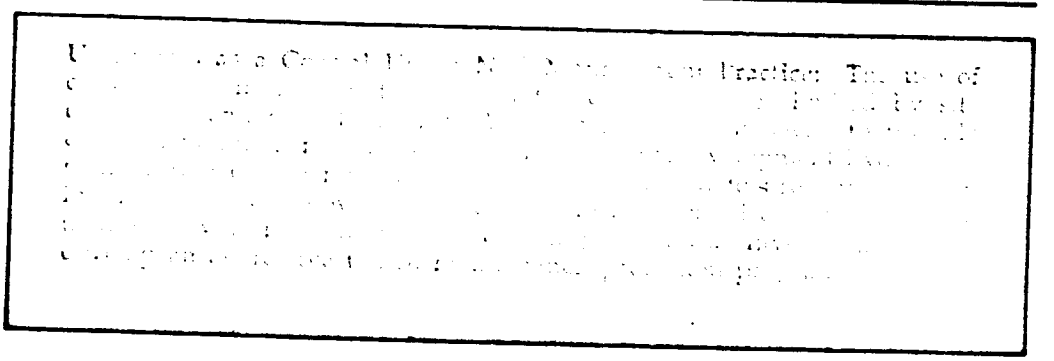
Infiltration Trenches



Can Infiltration Trenches Reliably Remove Urban Stormwater Pollutants?

Pollutant Removal Mechanisms: Include adsorption, straining and microbial decomposition in the soil below the trench and trapping of particulate matter within pretreatment areas (i.e., grass filter strips, sump pits and plunge pools). (1)

Review of Monitoring Studies: Very few studies monitoring the performance of conventional infiltration trenches have been conducted to date. (21) Estimates of performance have been inferred from studies of rapid infiltration land wastewater treatment systems or by modeling. (1) (21) For sediment removal, rates in excess of 90 % are cited; for phosphorus and nitrogen removal, the rate is estimated at 60 %. Removal rates for trace metals, coliforms and organic matter are estimated at 90 %. Lower rates are expected for nitrate, chlorides and soluble trace metals, particularly in sandy soils. (25) (35)

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Factors Influencing Pollutant Removal:

Positive Factors	Negative Factors
• Bank run or washed aggregate • High organic matter and loam content of subsoil (35) • Capture of a large fraction of annual runoff volume • Effective pretreatment system, e.g., a sump pit (20)	• Sandy soils • Trench clogging • High water table • Long de-watering times (8)

How Well Do Infiltration Trenches Operate over Time?

Failure Rates: According to data from Maryland, about one in five conventional trenches fails to operate as designed immediately after construction; furthermore, barely half of all conventional infiltration trenches operated as designed after five years. (Many of these had become partially or totally clogged.) Based on these data, it would appear that conventional trenches have a design life-span of less than five years without adequate pretreatment.

A second study of infiltration trench longevity in Maryland indicated that approximately fifty-five percent of trenches are not operating as designed. (8) According to the study, one-third of the trenches were partially or totally clogged; another twenty percent had significant inflow problems. The oldest trench surveyed was five years old.

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R0056377

Factors Influencing Longevity: The relatively short life span of conventional trenches could be significantly increased by the following:

- Field verification of soil infiltration rates and water table location (8)
- Use of pretreatment systems that provide some degree of storage (e.g. sump pits, swales with check dams, plunge pools) (8)
- A layer of filter fabric one foot below surface of trench (1)
- Use of a sand layer rather than filter fabric at the bottom of a trench (8)
- Avoiding construction until all contributing watershed disturbances and construction activities are completed (39)
- Rototilling of trench bottom to preserve infiltration rates (8)

Where and When are Infiltration Trenches Feasible?

Soils: Trenches are not practical in soils with field-verified infiltration rates of less than 1/2" per hour. (Soil borings should be taken well below the proposed bottom of the trench to identify any restricting layers.) (39)

Area: Maximum contributing drainage area to an individual trench should not exceed five acres.

Slope: The effectiveness of surface trenches is sharply reduced if slopes are greater than five percent.

Depth to Bedrock and Depth to Water Table: Three feet of clearance from bottom of trench is recommended.

Sediment Inputs: Conventional trenches may not be advisable on sites expected to provide high levels of sediment input.

Use in Ultra-urban Areas: Very limited due to unsuitable soils.

Retrofit Capability: Very limited due to unsuitable soils. (10)

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Stormwater Management Capability: Some trench designs can provide stormwater quantity requirements; however, most trenches function only as water quality BMPs.

What are the Costs Associated with Infiltration Trenches?

Permitting/Review: Relatively minor permitting and review requirements at present. An EPA groundwater injection permit, however, may be required in the future. Moreover, significant costs may be incurred conducting geotechnical and soils investigations to determine the feasibility of infiltration at the site.

Construction: On a unit of runoff per volume treated basis, infiltration trenches are not as cost-effective as pond systems; however, ponds cannot be used in small watershed areas. (11) Trenches are usually more cost effective than sand filters. (21)

Maintenance: Very limited data is available on the long-term maintenance costs associated with trenches. (21) Field studies indicate that regular maintenance is not being conducted on most infiltration trenches. (8) Sixty to seventy percent of trenches inspected were found to require maintenance. Few, if any of the trenches inspected in the field, appeared to ever have been maintained. (8)

Routine maintenance activities should include inspection and maintenance of the pretreatment system. Based on the longevity statistics for conventional trenches, trench replacement or rehabilitation may be required every ten years. The cost of this may be equal to the initial construction cost.

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Can Infiltration Trenches Be Easily Adapted for All Coastal Areas?

Trenches may not be easily adapted to perform in:

- regions with long cold winters and deep freeze thaw levels
- more arid regions with sparse vegetative cover in upland areas that might contribute high sediment levels
- regions where groundwater is used locally for human consumption.
- regions with clay or silty soils

What are the Environmental Concerns and Benefits of Infiltration Trenches?

Positive Impacts:

- Groundwater recharge
- Reduction in downstream bankfull flooding events

Negative Impacts:

- Slight to moderate risk of groundwater contamination depending on soil conditions
- No habitat is created
- High failure rates of conventional trenches sharply limit the ability to meet stormwater and water quality goals at the watershed scale

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R0056380

What is <u>Not</u> Known about Infiltration Trenches?

- The most effective pretreatment system(s) to protect infiltration capability over the long term
- The pollutant removal performance of trenches in sandy soils near the water table
- The performance of trenches in subfreezing weather and during snowmelt runoff conditions
- Maintenance programs and schedules that can be developed to improve trench performance
- Further development of experimental methods to accurately measure soil infiltration rates is also needed

VOL 12 2 3085

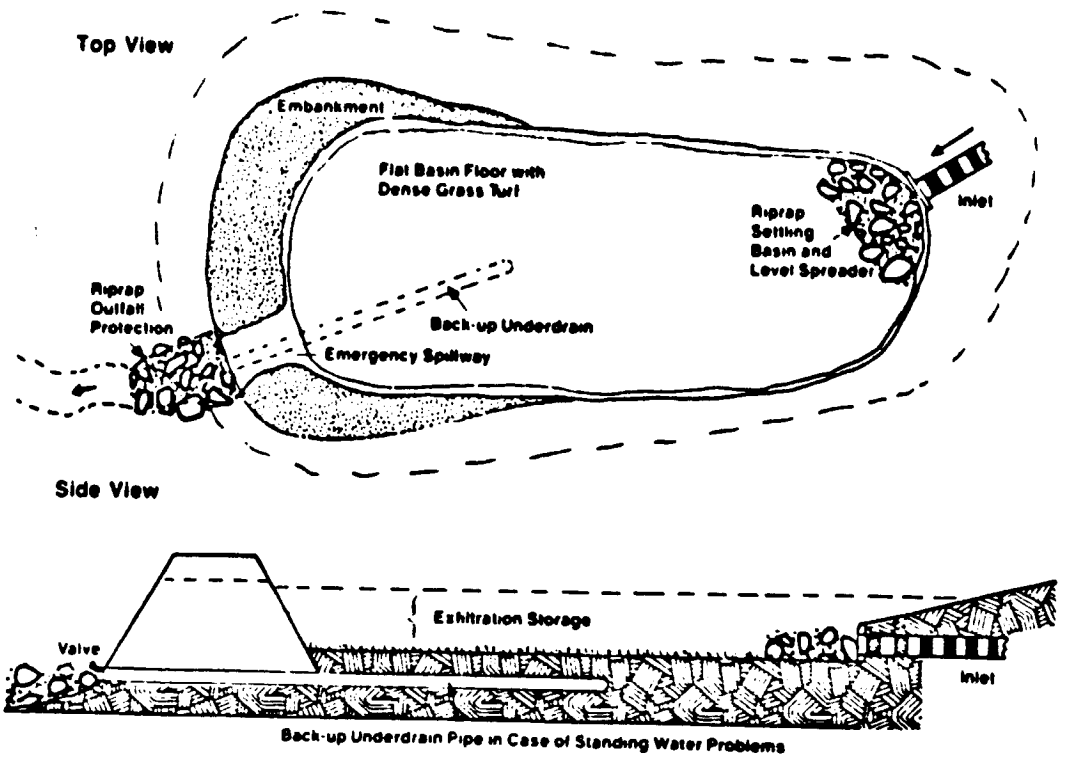
R0056381

INFILTRATION BASINS

BMP Fact Sheet #6

Definition

Schematic Design of an Infiltration Basin



Back-up Underdrain Pipe in Case of Standing Water Problems

Source: Schueler, 1987.

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R0056382

Infiltration Basins

Capsule Summary:

Pollutant Removal Capability: No performance data on infiltration basins is available; however, they are presumed to have the same general removal efficiencies reported for infiltration trenches: high removal for particulate pollutants and moderate removal for soluble pollutants.

Longevity: Infiltration basins do not have long life spans. Sixty to one hundred percent of basins studied could no longer exfiltrate runoff after five years. Major design refinement and site investigation will be required to achieve sufficient longevity.

Feasibility: The application of basins is restricted by numerous site factors (soils, slope, water table and contributing watershed area).

Environmental Concerns: The greatest environmental concern relative to infiltration basins is the fact that their environmental benefits may not be realized due to widespread failure. Groundwater contamination is frequently cited as a risk, yet studies to date indicate that pollutant migration is very localized in scope.

Environmental Benefits: When infiltration basins work, they can replicate predevelopment hydrology more closely than other BMP options. Basins also provide more habitat value than other infiltration systems (but less than pond systems).

Costs: An attractive feature of infiltration basins is their cost-effectiveness. They are projected to cost only ten to twenty percent more than dry detention ponds; however, the cost of an improved infiltration basin may be much higher.

Adaptability: Infiltration basin may not be applicable in areas of cold winters, arid growing seasons or impermeable soils.

Maintenance Burden: Regular maintenance activities apparently cannot prevent rapid clogging of infiltration basins. Once clogged, it has been very difficult to restore their original function; thus, many have been converted to retention basins or wetlands.

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Infiltration Basins

Can Infiltration Basins Reliably Remove Urban Stormwater Pollutants?

Pollutant Removal Mechanisms: As with other infiltration systems, removal is accomplished by adsorption, straining, and microbial decomposition in the basin subsoils as well as the trapping of particulate matter within pretreatment areas. (1)

Review of Monitoring Studies: No actual performance data is available to evaluate the pollutant removal capability of infiltration basins. (21) Estimates have been inferred from studies of rapid infiltration of land-applied wastewater effluent and from modeling studies. (1) Removal efficiencies are presumed to be high for particulate pollutants and moderate for soluble pollutants. Lower rates are expected for nitrate, chlorides and soluble trace metals, particularly in sandy soils. (25) Actual pollutant removal is projected to be related to the proportion of the annual runoff volume successfully exfiltrated into the subsoil.

Factors Influencing Pollutant Removal:

Positive Factors (8)

- Forebay
- Short dewatering times
- Back-up underdrain systems
- Small contributing watershed
- Dense vegetative cover
- Non-concentrated flow

Negative Factors

- Basin clogging
- High water tables
- Clay and silt soils
- High sediment inputs
- Large contributing watershed area
- Long dewatering times
- Algal growth
- Large depth of standing water (8)

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How Well Do Infiltration Basins Operate over Time?

Failure Rates: The failure rates for infiltration basins in the mid-Atlantic region range from sixty to one hundred percent in the first five years, according to two recent studies. (36) (37) (8) Up to fifty percent had failed shortly after construction. The primary reason for failure is clogging. Of twelve basins in Maryland, none were able to exfiltrate runoff after five years. (8) These basins had an average standing water depth of one foot.

Astonishingly, all these basins were partially covered by wetland vegetation and/or algal mats. The basins had become defacto-retention ponds; some sixty percent were still providing partial water quality treatment. About twenty percent of infiltration basins studied in Maryland have been retrofit into pond systems. (36)

Factors Influencing Longevity: Clearly, current infiltration basin designs do not perform adequately. The following factors appear to contribute heavily to improved life-span for infiltration basins (8):

- Shorter dewatering rate (24 hours rather than 72 hours)
- Pretreatment forebays to control sediment inputs
- Small contributing watershed areas
- Shallow basin depths (standing water appears to promote soil compaction)
- Off-line designs that bypass large storms and sediment inputs
- More efficient dewatering mechanisms in basins (e.g., stone trenches rather than soil)
- Careful geotechnical investigation of soil conditions prior to excavation (40)
- Use of sand as a surface layer in the basin
- Installation of underdrains into the basin

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R0056385

It is difficult to determine whether the design changes, as proposed above, would achieve sufficient longevity. Local communities should be cautious in promoting infiltration basins until:

- the longevity and performance of the new generation of infiltration basins is adequately demonstrated
- the basic infiltration basin design is readily convertible into a retention basin.

Where and When are Infiltration Basins Feasible?

Soils: Basins are not feasible at sites with field-verified soil infiltration rates of less than 0.5 inches/hour. Soil borings should be taken well below the proposed bottom of the basin to identify any restricting layers. (39)

Contributing Watershed Area: Normal contributing drainage area ranges from two to fifteen acres. Larger drainage areas are not generally recommended.

Depth to Bedrock/Seasonally High Water Table: Minimum of three feet.

Pretreatment: Basins are not recommended unless upland sediment inputs can be pretreated.

Land Use: Some caution should be exercised when applying a basin in a watershed with a risk of chronic oil spills.

Use in Ultra-urban areas: Not recommended.

Retrofit Capability: Not recommended. (20)

Stormwater Management Capability: In some instances, a basin can provide stormwater management detention, but it is not generally recommended.

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R0056386

What are the Costs Associated with Infiltration Basins?

Permitting/Review: At present, infiltration basins have few permitting problems, but there may be a need in the future to secure groundwater injection permits. Basins should not be approved until soil and water table behavior have been confirmed at the site through geotechnical investigation and a sound and redundant runoff pretreatment system has been devised.

Construction: Construction of infiltration basins has been estimated to cost ten to twenty percent more than a conventional dry stormwater pond; however, the design improvements needed to enhance basin longevity may significantly escalate cost figures. (1)

Maintenance: Regular maintenance for effective infiltration basins is estimated to be about five percent of initial construction cost; however, the actual maintenance cost of current designs is much higher, reflecting rehabilitation into retention or ED ponds. (11)

Can Infiltration Basins Be Easily Adapted for All Coastal Areas?

Infiltration basins are not widely recommended for other coastal areas outside the Mid-Atlantic region, until sufficient longevity can be demonstrated. In addition, basins may fare poorly in:

- regions with long cold winters and snowmelt/freeze thaw conditions
- arid regions where a dense vegetative cover in the contributing watershed cannot be reliably maintained
- regions with sole-source aquifers
- regions with predominantly clay or silt soils

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What are the Environmental Concerns and Benefits of Infiltration Basins?

Positive Impacts:

- Groundwater recharge helps to maintain dry-weather flows in streams
- Reduction in downstream bankfull flooding events

  (Note: The short lifetimes of basins as currently designed suggest that the positive hydrological and water quality impacts may not be realized in practice.)

Negative Impacts:

- Slight to moderate risk of local groundwater contamination (particularly if contributing watershed is industrial or has heavy vehicular petroleum washoff).
- Infiltration basins provide some habitat value, but this is quite modest in comparison to that provided by pond systems. Failed basins provide better habitat than functioning basins.

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R0056388

What is Not Known about Infiltration Basins?

Significant uncertainty exists as to the fundamental feasibility of the infiltration basin approach. The basic issue is whether the temporary but deep ponding in basins makes clogging inevitable. Other certainties include:

- what, if any, pretreatment system can assure basin longevity
- the impact of basins on the local water table and the risk of groundwater migration
- performance of basins in freezing conditions and during snowmelt conditions
- the accuracy of current field methods for estimating long-term local soil infiltration rates
- the actual monitored pollutant removal performance of a fully operational basin, particularly with respect to soluble nutrients

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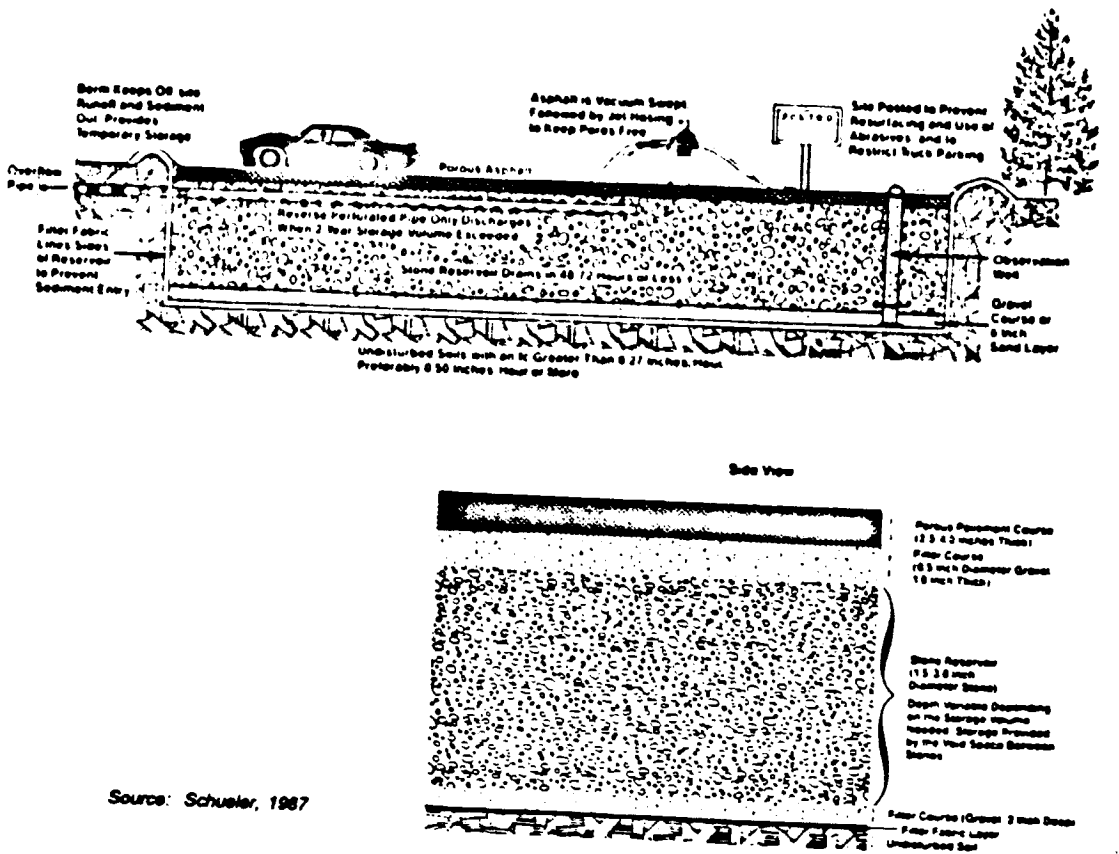
R0056389

POROUS PAVEMENT

BMP Fact Sheet #7

Definition

Schematic Design of a Porous Pavement System



Source: Schueler, 1987

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R0056390

Porous Pavement

Capsule Summary:

Pollutant Removal Capability: Operating porous pavement systems have been shown to have high removal rates for sediment, nutrients, organic matter, and trace metals. The majority of the removal occurs as the result of the exfiltration of runoff into the subsoil, and subsequent adsorption or straining of pollutants within the subsoil.

Longevity: Porous pavement sites have a high failure rate (75 %). Failure is due to partial or total clogging of the facility that occurs:

- Immediately after construction
- Over time, when porous asphalt is clogged by sediment and oil
- When pavement is resurfaced with non-porous materials

Feasibility: The use of porous pavement is highly constrained, requiring deep and permeable soils, restricted traffic, and suitable adjacent land uses.

Environmental Concerns: Concerns range from possible groundwater contamination (exacerbated by leaching of asphalt materials and hydro-carbons) to the loss of benefits due to premature failure.

Environmental Benefits: When operating properly, porous pavement can replicate pre-development hydrology, increase groundwater recharge, and provide excellent pollutant removal.

Costs: Porous pavement can be a very cost-effective BMP in the commercial areas where it can be applied. While the asphalt is more expensive than conventional pavement, porous pavement eliminates the need for stormwater drainage, conveyance, and treatment systems off-site.

Adaptability: Use of porous pavement may be restricted in regions with colder climates, arid regions or regions with high wind erosion rates, and in areas of sole-source aquifers.

Maintenance Burden: Quarterly vacuum sweeping and/or jet hosing is needed to maintain porosity. Field data however indicate that this routine maintenance practice is not frequently followed.

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Porous Pavement

Can Porous Pavement Reliably Remove Urban Stormwater Pollutants?

Pollutant Removal Mechanisms: Include adsorption, straining, and microbial decomposition in the sub-soil below the aggregate chamber, and trapping of particulate matter within the aggregate chamber. In addition, up to ninety of the annual rain fall volume is diverted to groundwater rather than surface runoff. (1)

Review of Monitoring Studies: Two monitoring studies have been conducted that indicate high long-term removal of sediment (up to 80 %), phosphorous (up to 60 %), and nitrogen (up to 80 %), as well as high removal rates for trace metals and organic matter. (39) (41) The majority of pollutant removal at porous pavement sites is due to the reduction of mass loadings via the groundwater. Measured concentrations of sediment, phosphorous, and nitrogen are only slightly reduced in the small, measured outflows from porous pavement.

Factors Influencing Pollutant Removal (1):

Positive Factors

- High exfiltration volumes
- Routine vacuum sweeping
- Maximum drainage time of two days
- Highly permeable soils
- Clean-washed aggregate
- Organic matter in subsoils
- Pretreatment of off-site runoff

Negative Factors

- Poor construction practices
- Inadequate surface maintenance
- Use of sand for snow removal
- Low exfiltration volumes

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How Well Does Porous Pavement Operate Over Time?

Failure Rates: Seventy-five percent of all porous pavement systems surveyed in Maryland have partially or totally clogged within five years. (36) Failure has been attributed to inadequate construction techniques, low permeable soils and/or restricting layers, heavy vehicular traffic, and resurfacing with non-porous pavement materials. Some fraction of the clogged porous pavement sites could be rehabilitated with drop inlets and daylighting from the aggregate chamber. The oldest operating porous pavement systems are about ten years old.

Factors Influencing Longevity:

- Routine vacuum sweeping
- Use in low intensity parking areas
- Restrictions on access by heavy trucks, use of de-icing chemicals and sand
- Resurfacing
- Inspection and enforcement of specifications during construction
- Pretreatment of off-site runoff
- Extra-ordinary sediment control during construction

Where and When is Porous Pavement Feasible?

Soils: Porous pavement is not practical in soils with field verified infiltration of less than 0.5 inches per hour. Soil borings must be taken two to four feet below the aggregate to identify any restricting layers.

Area: Most porous pavement sites are less than ten acres in size. This primarily reflects the perceived economic and liability problems associated with larger applications.

Slope: Less than five percent.

Depth to Bedrock and Water Table: Three feet minimum clearance from bottom of system.

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Traffic Volumes: Porous pavement is not recommended for most roadways and cannot withstand the passage of heavy trucks. Typically, porous pavement is recommended for lightly used satellite parking areas and access roads.

Sediment Inputs: Porous pavement is not advisable in areas expected to provide high levels of off site sediment input (e.g., upland construction, sparsely vegetated upland areas and areas with high wind erosion rates)

Cold Climates: While the standard porous pavement design is believed to withstand freeze/thaw conditions normally encountered in most regions of the country, the porous pavement system is very sensitive to clogging during snow removal operation (e.g., application of sand and de-icing chemicals and scrapping by snow plows).

Use in Ultra-urban Areas: Some possibilities exist for the use of porous pavement during infill development provided that suitable soils are present.

Retrofit Capability: Extremely limited. Most soils in urbanized watersheds have been previously modified and so are not capable of providing adequate infiltration rates.

Stormwater Management Capability: Porous pavement sites can meet stormwater management requirements in many cases.

What are the Costs Associated with Porous Pavement?

Permitting/Review: To prevent premature failure, local governments need to extensively review proposed porous pavement applications. In addition, the use of porous pavement may require a groundwater injection permit. Plans need to be reviewed to assure that:

- geo-technical data confirm exfiltration capability
- porous asphalt is correctly mixed and installed
- a long-term maintenance/resurfacing plan exists

Furthermore, local governments must conduct strict inspections during pavement installation with an emphasis on sediment control.

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Construction: The economics of porous pavement systems are difficult to evaluate. (38) On the positive side, porous pavement eliminates the need for most inlets, outlets, and some curb and gutters in the parking lot, as well as reducing off-site conveyance/stormwater treatment costs, and may preserve land with a high economic value for future use. (38) On the negative side, porous pavement has higher engineering and installation costs as compared to conventional pavement and may require greater excavation. In addition, porous asphalt can be up to fifty percent more expensive than conventional asphalt and may be difficult to obtain in some regions of the country.

Maintenance: The routine maintenance of porous pavement consists of quarterly vacuum sweeping and may constitute one to two percent of the initial construction costs. However, given the high rates of failure, the total maintenance costs must include rehabilitation of the clogged system. These costs can be extremely high. In addition, the costs and responsibility for periodic resurfacing of porous pavement sites must be addressed.

Can Porous Pavement be Easily Adapted for All Coastal Areas?

Porous pavement may not be easily adapted to reliably perform in:

- regions with long cold winters and deep freeze/thaw conditions
- arid regions with sparse vegetative cover and high wind erosion rates
- regions with predominantly high clay or silty soils
- sole-source aquifers

What are the Environmental Concerns and Benefits of Porous Pavement?

Positive Impacts:

- Porous pavement can divert large volumes of potential surface runoff to groundwater recharge and, in some cases, provide even greater recharge than pre-development conditions (41)
- Porous pavement can reduce downstream bank-full flooding
- Provides stormwater quantity and quality treatment on-site, thereby protecting woodland, wetland, and stream valleys elsewhere on the site (38)

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Negative Impacts:

- Slight to moderate risk of groundwater contamination depending on soil conditions and aquifer susceptibility
- Possible transport of hydrocarbons from vehicles and leaching of toxic chemicals from asphalt/or binder surface
- The high failure rate of porous pavement sharply limits the ability to meet watershed stormwater quality and quantity goals

What is Not Known About Porous Pavement?

- The ability to maintain pavement porosity over the long term, particularly with resurfacing needs and snow removal
- Pollutant removal capability of porous pavement during sub-freezing weather and snow removal conditions
- The interaction of porous pavement with groundwater in sandy soils and high water table conditions typical of coastal areas
- Low cost maintenance and rehabilitation options for restoration of porosity

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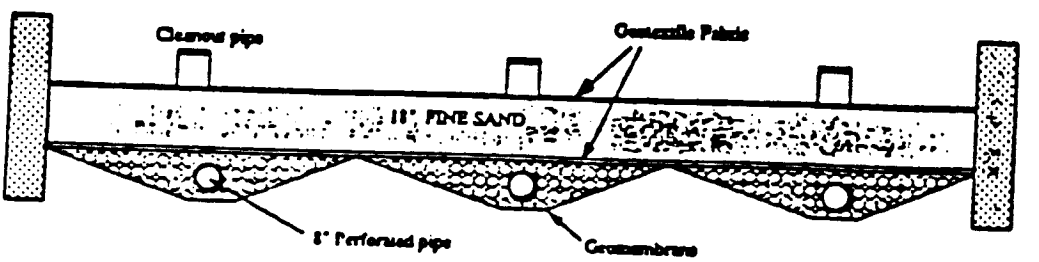
R0056396

SAND FILTERS

BMP Fact Sheet #8

Definition

Conceptual Design of a Sand Filter System



Source: Austin, Texas. 1991.

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R0056397

Sand Filters

Capsule Summary:

Pollutant Removal Capability: Sand filter removal rates are high for sediment and trace metals, and moderate for nutrients, BOD and fecal coliform. The untested peat sand filter is projected to achieve significantly higher removal rates.

Longevity: Sand filters appear to have excellent longevity due to their off-line design and the high porosity of sand as a filtering media; however, relatively simple but frequent maintenance is required to maintain performance.

Feasibility: Because sand filters are a self-contained man-made soil system, they can be applied to most development sites and have few constraining factors. Most sand filters have been used on small parking lots.

Environmental Concerns: Sand filters have very few environmental concerns because they are an off-line self-contained system. Surface sand filters can be an eyesore; hence, they may enjoy limited community acceptance in some regions.

Environmental Benefits: Particularly useful for groundwater protection. Little or no wildlife habitat value is provided.

Costs: Sand filters are more costly than infiltration trenches (by a factor of two or three), but have lower regular maintenance/rehab costs.

Adaptability: To date, sand filters have only been widely applied in one region of the country, and some localities may experience some initial problems in importing the technology. Performance of sand filters in colder climates is unknown.

Maintenance Burden: Sand filters require frequent manual maintenance, primarily raking, surface sediment removal, and removal of trash, debris and leaf litter.

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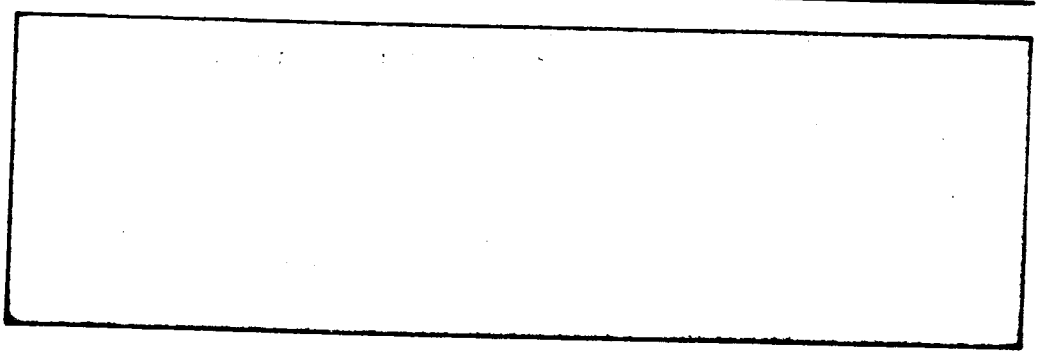

Can Sand/Peat Sand Filters Reliably Remove Urban Stormwater Pollutants?

Pollutant Removal Mechanisms: Pollutant removal is primarily achieved by straining pollutants through the filtering medium (i.e., sand or peat) and by settling on top of the sand-bed and/or pretreatment pool. Additional nutrient removal can be accomplished by plant uptake if the filter has a grass cover crop.

Review of Monitoring Studies: Performance monitoring has been conducted on three sand filter systems in the Austin, Texas area. (42) Average removal rates of 85 % for sediment, 35 % for nitrogen, 40 % for dissolved phosphorus, 40 % for fecal coliforms, and 50 to 70 % for trace metals were reported. Negative removal was reported for nitrate-N which may reflect the nitrification process.

Slightly higher pollutant removal performance has been projected for peat sand filters due to the adsorptive properties of peat. (43) These are an estimated 50 % for TN, 70 % for TP and 90 % for BOD. The use of grass on the surface of a sand filter may also augment pollutant removal.

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Sand Filters

Factors Influencing Pollutant Removal:

Positive Factors	Negative Factors
• Off-line systems (42) • Peat and/or calcitic limestone layer (43) • Grass cover (42) • Longer drawdown times (24 to 40 hours) (42) • Pretreatment pool (43) • Minimum depth of eighteen inches (42)	• On-line systems (42) • Freezing weather (43)

How Well Do Sand/Peat Sand Filters Operate over Time?

Failure Rates: Nearly one thousand sand filters have been installed in the Austin, Texas area. (44) According to the Austin Department of Public Works, the vast majority are working as designed and very few have failed. The oldest operating sand filter is almost ten years old. Sand filters have not been widely applied elsewhere in the country, although they have been used effectively in dense urban areas within the District of Columbia. (57)

Factors Influencing Longevity:

- Quarterly maintenance of the sand filter to maintain porosity
- Flow splitter designs that will not clog frequently
- Pretreatment pool
- Adequate access to the sand filter
- Regular removal of surface sediments (frequency variable)

Most of the maintenance for sand filters is done by manual rather than mechanical means; consequently, the design should be oriented to make access and manual sediment removal an easier proposition. (44)

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R0056400

Where and When are Sand/Peat Sand Filters Feasible?

Sand filters are a very adaptable practice; they can be used on areas with thin soils, high evaporation rates, low soil infiltration rates, and limited space. (45)

Watershed Size: The upper limit on sand filters appears to be about fifty acres; however, most have a contributing watershed between a half and ten acres. The Delaware parking lot sand trench (Shaver, 1991) is restricted to five acres or less.

Head Requirements: Two to four feet of available head needed for most off-line sand filter applications.

Use in Ultra-urban Areas: Sand filters and peat sand filters can be used to treat stormwater runoff from small infill developments and from small parking lots (i.e., gas stations, convenience stores). They are widely applied in ultra-urban areas within the District of Columbia. (57)

Retrofit Capability: Sand filters and peat sand filters have been designed as end-of-pipe retrofits in several applications. The Delaware sand filter system may be of particular value for older parking lots.

Stormwater Management Capability: Sand filters have a limited ability to reduce peak discharges; they are usually designed solely to improve water quality.

What are the Costs Associated with Sand/Peat Sand Filters?

Design: A number of standard sand filter designs are available; however, the technology is still developing. Sand filters have few permitting constraints. Sand filters with concrete walls, or parking lot designs, may require additional structural engineering.

Construction: $3 to $10 per cubic foot of runoff treated. (21) For comparison purposes, this is about two to three times the cost of constructing a similarly sized infiltration trench. Significant economies of scale exist as sand filter size increases.

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R0056401

Maintenance: Estimated to be approximately five percent of construction cost per year. (44) Much of the maintenance requires manual rather than mechanical labor, such as raking, disposal of contaminated sand, and trash and debris removal.

Can Sand/Peat Sand Filters Be Easily Adapted for All Coastal Areas?

The sand filter holds great promise as a BMP for coastal areas. It can be applied to smaller sites that cannot effectively be served by ponds or to regions where poor soil infiltration rates or groundwater concerns restrict the use of infiltration. The sand filter may not be applicable in regions of colder climate, however. Sand filters are useful in waterfront situations where limited space and small contributing watershed areas eliminate other BMP options.

What are the Environmental Concerns and Benefits of Sand/Peat Sand Filters?

Positive Impacts:

- Sand filters are useful in watersheds where concerns over groundwater quality prevent use of infiltration.
- Disposal of surface sediments from sand filters does not appear to be a problem. Testing by the Austin Department of Public Works indicates that the sediments are not toxic and can be landfilled.

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R0056402

Negative Impacts:

- Larger sand filter designs, without grass cover, may not be attractive in residential areas. The surface of sand filters can be extremely unattractive; some sand filters have caused odor problems.
- The concrete walls that surround the sand filter represent a safety hazard and thus should be fenced.
- Sand filters generally function only as a stormwater quality practice and do not provide detention for downstream areas.

What is Not Known about Sand/Peat Sand Filters?

- How well sand filters operate in colder climates and freezing conditions
- Recommended frequency for disposal of the surface sediments of a sand filter
- Whether the peat sand filter can improve pollutant removal
- Availability of appropriate peat materials in all areas of the country
- What types of filtering media, other than sand and peat, might promote greater nutrient removal
- Delta-t of the sand filters

Sand filters have only been extensively used in one region of the country. The basic design may need to be modified to suit local conditions. Initial performance of sand filters and peat sand filters may be limited until local governments and engineers gain more experience with them.

VOL 12 2 3107

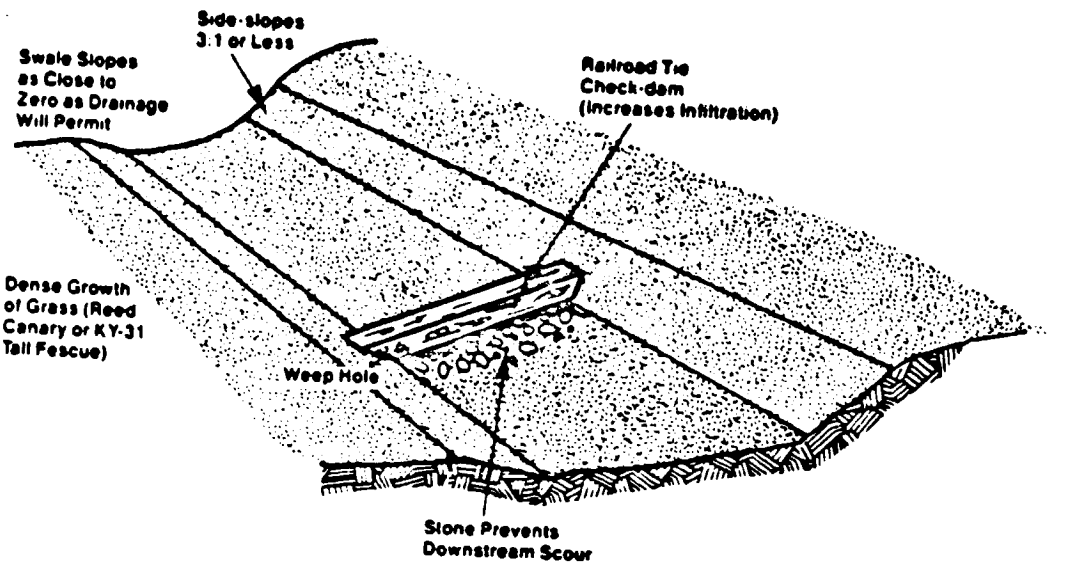
R0056403

GRASSED SWALES

BMP Fact Sheet #9

Definition

Schematic Design of an Enhanced Grassed Swale



Source: Schueler, 1987.

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R0056404

Grassed Swales

Capsule Summary:

Pollutant Removal Capability: Conventional grassed swale designs have achieved mixed performance in removing particulate pollutants such as suspended solids and trace metals. They are generally unable to remove significant amounts of soluble nutrients. Biofilters that increase detention, infiltration and wetland uptake within the swale have the potential to substantially improve swale removal rates.

Longevity: Conventional swales can last an indefinite period of time if properly designed, periodically mowed, and if sediment deposits are removed from time to time.

Feasibility: Swales can provide sufficient runoff control to replace curb and gutter in single-family residential subdivisions and on highway medians; however, their ability to control large storms is limited. Therefore, in most cases, swales must be used in combination with other BMPs downstream.

Environmental Concerns: Leaching from culverts and fertilized lawns may actually increase the presence of trace metals and nutrients, in some instances.

Environmental Benefits: Swales eliminate curbs and gutters and provide some infiltration and habitat benefits.

Costs: Swales are usually less expensive to construct than curb and gutter but may require more land.

Adaptability: Swale performance diminishes sharply in highly urbanized settings. Also, swales should generally not receive construction stage runoff.

Maintenance Burden: Mowing and periodic sediment cleanout are the primary maintenance activities. In residential subdivisions, adjacent homeowners will undertake these responsibilities.

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R0056405

Can Grassed Swales Reliably Remove Urban Stormwater Pollutants?

Pollutant Removal Mechanisms: Grassed swales act to remove pollutants by the filtering action of grass, by settling, and in some instances, by infiltration into the subsoil.

Review of Monitoring Studies: The pollutant removal capability of ten conventional residential and highway swale systems has been monitored by six researchers. (21) The results are mixed. Half of the swales studied demonstrated a moderate to high pollutant removal capability and the other half showed no removal or negative removal capability. (2)

The expected removal efficiency of a well-designed, well-maintained conventional swale is projected to 70 % for TSS, 30 % for TP, 25 % for TN, and 50 to 90 % for various trace metals. Swales appear to be more effective at removing metals than nutrients; a number of researchers have observed trace metal accumulation in swale sediments. (46) (47) Some evidence has also been offered that resuspension or remobilization of nutrients may occur. (46) No performance data exists on the effect of check dams in swales; however, the detention and trapping capability that they add is projected to be quite useful. (1)

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R0056406

Factors Influencing Pollutant Removal (32):

Positive Factors

- Check dams
- Low slopes
- Permeable subsoils
- Dense grass cover
- Long contact time
- Smaller storm events
- Coupling swales with plunge pools, infiltration trenches or pocket wetlands
- Swale length greater than two hundred feet

Negative Factors

- Compacted subsoils
- Short runoff contact storms
- Large storm events
- Snow melt events
- Short grass heights
- Steep slope (six percent or greater)
- Runoff velocities (1.5 fps or more)
- Peak discharge (5 cfs or more)
- Dry-weather flow

How Well Do Grassed Swales Operate over Time?

Failure Rates: Surveys by Horner (1988) and in the Washington area indicate that the vast majority of conventional swales operate as designed with relatively minor maintenance (grass mowing). The primary maintenance problem is the gradual build-up of soil and grass adjacent to roads which prevents entry of runoff in swales. Surprisingly, gully erosion is not a problem in well-designed swales in areas where climate permits the establishment of a dense turf.

Factors Influencing Longevity:

- Runoff velocity that is consistently high (i.e., > 5 fps) will increase the tendency for the swale to erode
- The rate of erosion also diminishes as side slopes become flatter (32)

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R0056407

Where and When are Grassed Swales Feasible?

Contributing Watershed Area: Grassed swales can only be applied in areas where maximum flow rates are not expected to exceed 1.5 fps. (32) The suitability of a swale at a site will depend on the area, slope and imperviousness of the contributing watershed as well as the dimensions and slope of the swale system.

Dry-Weather Flow: Pollutant removal will be reduced if dry-weather flow is present in the swale.

Peak Discharge: Swales generally do not have the capacity to control runoff effectively in areas where peak discharge exceeds 5 cfs or where velocity is over 3 fps. To decrease velocity, the swale should be designed to be as wide as available space allows.

Construction Areas: The high sediment loads from unstabilized construction sites can overwhelm the system.

Slope: To increase infiltration rates, longitudinal slopes should be as close to zero as possible and not greater than five percent. (1)

Grass Height: A vertical stand of dense vegetation higher than the water surface is most effective (a minimum of six inches). (48)

Swale Contact Time: In general, pollution removal capacity increases with contact time of runoff through the swale. Swale contact time varies with the depth, width and length of the swale as well as longitudinal slope and type of vegetation. Any one of these variables or sets of variables can be manipulated to meet water quality objectives. In addition, check dams can further increase contact time. (32)

Use in Ultra-urban Areas: It is very difficult to prevent erosion in swales located in highly impervious, ultra-urban area.

Retrofit Capability: Many residential developments and highways have existing grass channels. An attractive retrofit option is to install check dams to increase contact time and promote settling using ported weirs.

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R0056408

Stormwater Management Capability: Conventional grassed swales are primarily a stormwater conveyance system and rarely provide sufficient detention to attenuate storm flows. The exception is when detention storage is provided behind check dams in very long swale systems.

What are the Costs Associated with Grassed Swales?

Permitting/Review: Swale design is relatively standard and no special permits are required. During review, however, the plan reviewer should carefully evaluate the swale design to see if it will act as a BMP or merely as an open channel conveyance system.

Construction: Typically, grassed swales cost less to construct than curb, gutters, and underground pipe. Costs may run from $5 to $15 per linear foot, depending on swale dimensions and the degree of internal storage (check dams) provided. (1)

Maintenance: Regular maintenance costs for conventional swales are minimal. Cleanout of sediments, trapped behind check dams, and spot vegetation repair may be required.

Grassed swales also require general lawn maintenance such as mowing, watering and chemical application. In residential subdivisions, adjacent homeowners will manage this responsibility. Also, inspection after large storms for erosional failures and special maintenance should occur regularly.

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R0056409

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Can Grassed Swales Be Easily Adapted for All Coastal Areas?

Grassed swales can be used in all regions of the country where climate and soils permit the establishment and maintenance of dense vegetative cover. The performance of swales in removing pollutants may be reduced in:

- regions with long, cold winters and snowmelt conditions, particularly where salts and other de-icing chemicals are applied or where snow plowing scrapes the shoulder
- regions with sandy soils (Sandy soils make it difficult to maintain the side slopes of the swale.)

It should be noted that the highest removal rates for swales have been reported in Florida where the climate supports lush vegetation year-round.

What are the Environmental Concerns and Benefits Associated with Grassed Swales?

Positive Impacts:

- When grassed swales are substituted for curbs and gutters, they can slightly reduce impervious areas, and more importantly, eliminate a very effective pollutant collection and delivery system
- Low slope swales can create wetland acreage
- Unmowed swale systems that are not adjacent to roadways can provide valuable "wet meadow" habitat
- Swales can act to partially infiltrate runoff from small storm events if underlying soils are not compacted

R0056410

Negative Impacts:

- Culverts may leach trace metals into runoff
- Lawn fertilization may increase runoff nutrient levels
- Possible impact on local groundwater quality
- Standing water in residential swales will not be popular with adjacent residents for aesthetic reasons and because of potential safety, odor and mosquito problems.

What Is Not Known about Grassed Swales?

- The degree to which certain design factors can enhance removal capability
- The effect of combining swales with micropools, pocket wetlands and infiltration trenches on pollutant removal efficiency
- Whether pollutant removal rates of swales decline with age (e.g., when adsorption sites are used up)
- The effect of slope on the filtration capacity of vegetation
- The benefit of check dams in preventing downstream migration of pollutants

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R0056411

FILTER STRIPS

BMP Fact Sheet #10

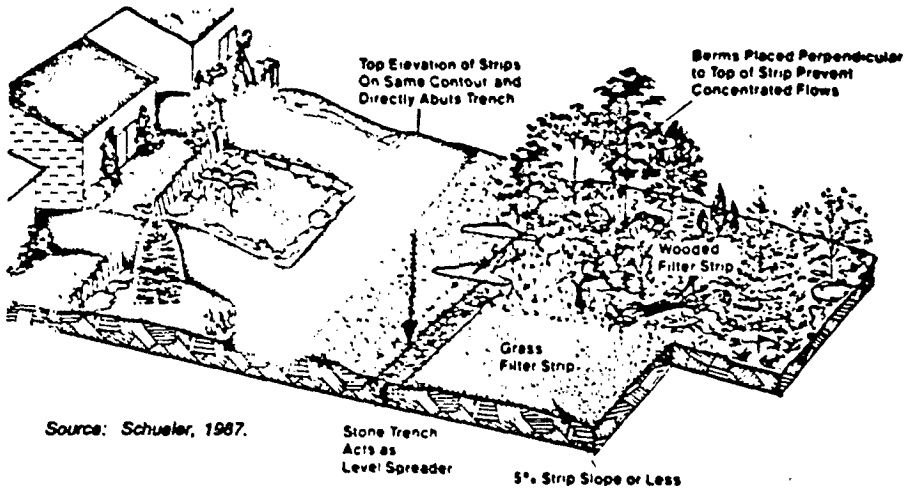
Definition

Filter strips are vegetated sections of land designed to accept runoff as overland sheet flow from upstream development. They may adopt any natural [illegible] and low density development.

Filter strips [illegible] from natural buffers in that [illegible]

[illegible]

Schematic Design of a Filter Strip



Source: Schueler, 1987.

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R0056412

Filter Strips

Capsule Summary:

Pollutant Removal Capability: Filter strips can effectively reduce particulate pollutant levels, e.g. sediment, organic materials and trace metals, in areas where runoff velocity is low to moderate; however, studies show that, under these same conditions, their ability to remove soluble pollutants is highly variable.

Longevity: Urban filter strips that are not regularly maintained may quickly become nonfunctional. Field studies indicate that strips tend to have short life spans because of lack of maintenance, improper location and poor vegetative cover.

Feasibility: Vegetated filter strips have limited feasibility in highly urbanized areas where runoff velocities are high and flow is concentrated. Therefore their use is primarily restricted to low and medium density residential areas where they can accept rooftop runoff and runoff from pervious areas such as lawns.

Environmental Concerns: Few.

Environmental Benefits: Filter strips can preserve the character of riparian zones and prevent erosion along streambanks. They also provide excellent urban wildlife habitat.

Costs: Low, almost negligible costs if established before site development.

Adaptability: Filter strips do not provide adequate pollutant removal on slopes over fifteen percent; moreover, they require climates that can sustain vegetative cover on a year-round basis.

Furthermore, contributing upland areas must be small (one to five acres) so that runoff arrives at the filter strip as overland sheet flow.

Maintenance Burden: Filter strips require periodic repair, regrading and sediment removal to prevent channelization.

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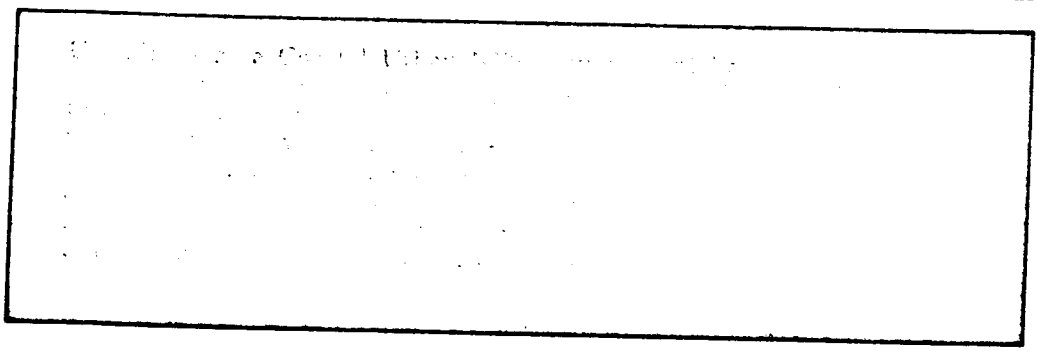
Filter Strips



Can Filter Strips Reliably Remove Urban Stormwater Pollutants?

Pollutant Removal Mechanisms: Pollutants are removed by the filtering action of vegetation, deposition in low velocity areas, or by infiltration into the subsoil.

Review of Monitoring Studies: Two studies of filter strips in urban areas have indicated that filter strips do not trap pollutants efficiently in urban settings due to high runoff velocity. (21) Of these studies, one is ongoing and final results are not yet reported. The other study indicated an average TSS removal rate of only 28 % and did not report removal rates for either TN or TP.

Research to date on vegetated filter strips has largely focused on filter strips in agricultural settings. Most of these studies indicate that, when functioning properly, filter strips can remove particulate pollutants with some reliability, but are less dependable for nutrient removal.

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Filter Strips

Factors Influencing Pollutant Removal:

Positive Factors

- Minimum strip width of fifty feet (1)
- Slope of five percent or less (1)
- Forested filter strips (1)
- Clay soil or organic matter matter surface (49)
- Contributing area of less than five acres (1)
- Grass height of six to twelve inches (48)

Negative Factors

- High runoff velocity (> 2.5 fps, depending on site conditions) (32)
- Slopes greater than fifteen percent (48)
- Hilly terrain
- Unmowed filter strips

How Well Do Filter Strips Operate over Time?

Failure Rates: Studies in agricultural settings (21) (51), where peak discharge rates tend to be much lower, show that filter strips have generally failed when:

- design slope has exceeded the recommended fifteen percent
- design width of slopes has been too narrow to adequately service the contributing area
- strips have poor vegetative cover
- uneven terrain has caused channelization.

In a study of thirty-three farms in Virginia, researchers found that the majority of filter strips in use were ineffective because most flow had become channelized. (32) The study suggests, moreover, that poor design or maintenance may cause a strip to fail within a fairly short period of time (six months or less).

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Factors Influencing Longevity (1):

- Use of a level spreader at the top of the strip will help to distribute flow evenly as well as protect the strip from man-made damage.
- Regular removal of sediment will help to maintain the original filtration capacity of the strip as well as assure that build-up of sediment does not alter design features such as contour or slope.
- Periodic repair of eroded areas and regrading around the strip may be necessary to assure that flows do not concentrate through or around the strip.
- Periodic weeding and replanting, particularly in the first few years of life, will allow the vegetative cover to stabilize and become permanent.
- If a filter strip is used for sediment control, it should be reseeded and regraded after construction.

Where and When are Filter Strips Feasible?

Contributing Watershed Area: To prevent concentrated flows from forming, maximum contributing area to an individual filter should be less than five acres. (1)

Land Use. In urban settings, it is likely that filter strips will be most effective in treating rooftop runoff and runoff generated from lawns and other pervious areas. Filter strips should not be used to control large impervious areas, such as parking lots.

Peak Discharge Rates: High flow velocity will prevent the strip from trapping pollutants and will cause erosion and channelization.

Soils: The ability of filter strips to remove nutrients from surface runoff improves where clay soils or organic matter surfaces are present.

Length: Minimum length should be no less than fifty to seventy-five feet plus four feet for any one percent increase in slope. (1)

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Depth to Water Table: Greater removal of soluble pollutants can be achieved where the water table is within three feet of the surface, i.e. within the root zone. (50)

Use in Ultra-urban Areas: The high percentage of impervious surface in urban areas creates high peak discharge rates, and thus, limits the usefulness of this practice as a water quality control in ultra-urban settings.

Retrofit Capability: Retrofit is relatively simple if enough land area is available to adequately service the contributing watershed area, and soil and slope conditions are favorable.

Stormwater Management Capability: Filter strips cannot reduce peak discharges to predevelopment levels. They function primarily as a water quality BMP. The limited ability of filter strips to control runoff and to remove nutrients suggests their most effective use is in combination with pretreatment and detention systems.

What are the Costs Associated with Filter Strips?

Permitting/Review: The creation of vegetated filter strips does not require any permits; however, it is important that the plan reviewer notes whether site conditions will permit the strip to remove the pollutants of concern effectively.

Construction: Low, especially if established before site development.

Maintenance: Routine maintenance activities include inspection, sediment removal, replanting and reseeding, and regrading. Mowing may be required for smaller strips. Inspections and corrective maintenance, such as weeding or replanting should take place more frequently in the first couple of years to assure stabilization. Removal of dead vegetation may also improve strip performance.

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Can Filter Strips Be Easily Adapted for All Coastal Areas?

Vegetated filter strips are adaptable in most climates where it is possible to grow a dense vegetative cover. Filter strips are not recommended for arid regions where vegetation in upland areas is sparse.

They may function adequately in regions with long, cold winters, but may be ineffective in treating runoff during snowmelt conditions.

What are the Environmental Concerns and Benefits of Filter Strips?

Positive Impacts:

- Filter strips can be combined with stream buffers to protect the riparian corridor
- Groundwater recharge
- Urban wildlife habitat
- Streambank stabilization
- Aesthetically pleasing
- Can serve as a buffer between incompatible uses

What is Not Known about Filter Strips?

- The relative effectiveness of forested filter strips versus grassed buffer strips
- Whether concentration of runoff through filter strips can be reduced by adding structural complexity or by employing level spreaders
- Effects of mowing on pollutant removal

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R0056418

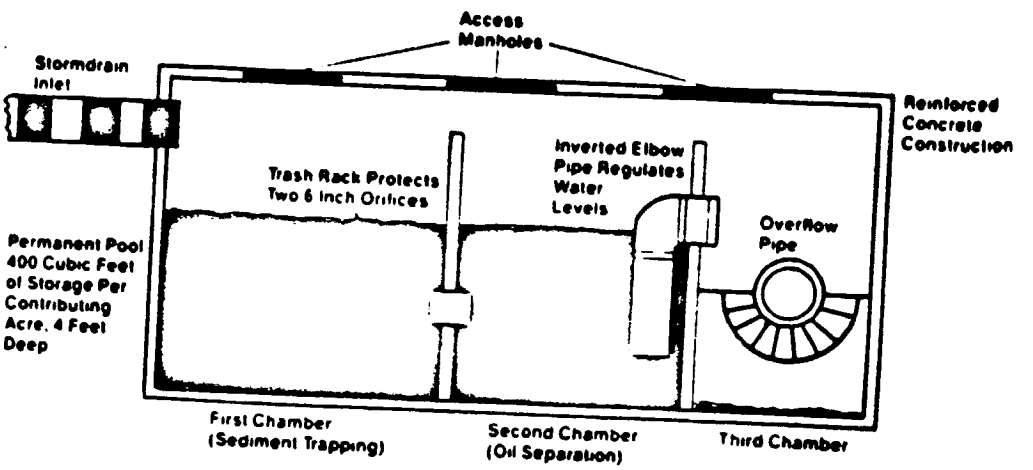
WATER QUALITY INLETS/ OIL GRIT SEPARATORS

BMP Fact

Fact Sheet #11

Definition

Schematic Design of a Water Quality Inlet/Oil Grit Separator



Source: Schueler, 1987.

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R0056419

Water Quality Inlets

Capsule Summary:

Pollutant Removal Capability: Current designs of water quality inlets have limited pollutant removal capability and only appear to trap coarse-grained sediments and some hydrocarbons. Removal of silt, clay, nutrients, trace metals, and organic matter is expected to be slight. Re-suspension also appears to limit long-term removal. Actual removal only occurs when inlets are cleaned out. Currently, a lack of effective clean-out and disposal methods prevents the required quarterly clean-out of trapped residuals.

Longevity: Longevity of water quality inlets is high. Over ninety-five percent of all inlets are operating as designed in their first five years of operation.

Feasibility: Inlets are restricted to small, highly impervious catchments of two acres or smaller (such as gas stations, parking lots, fast food outlets, and convenience stores).

Environmental Concerns: The greatest concern is the pollutant toxicity of trapped residuals and oily waters, and how the toxicity influences the ultimate disposal of the residuals. A secondary concern is the possibility of pulse loadings of the trapped residuals during longer storm events (due to re-suspension).

Environmental Benefits: Inlets show some capacity to trap trash, debris, and other floatables, thereby preventing their discharge to receiving waters.

Costs: The cost of inlets averages about $8,000 per unit. The inlets are costly on a runoff volume treated basis, averaging three to four times the unit cost of trenches or sand filters.

Adaptability: Inlets can be adapted to all regions of the country.

Maintenance Burden: Inlets require quarterly clean-outs. However, no acceptable clean-out and disposal techniques currently exist, rendering maintenance impossible.

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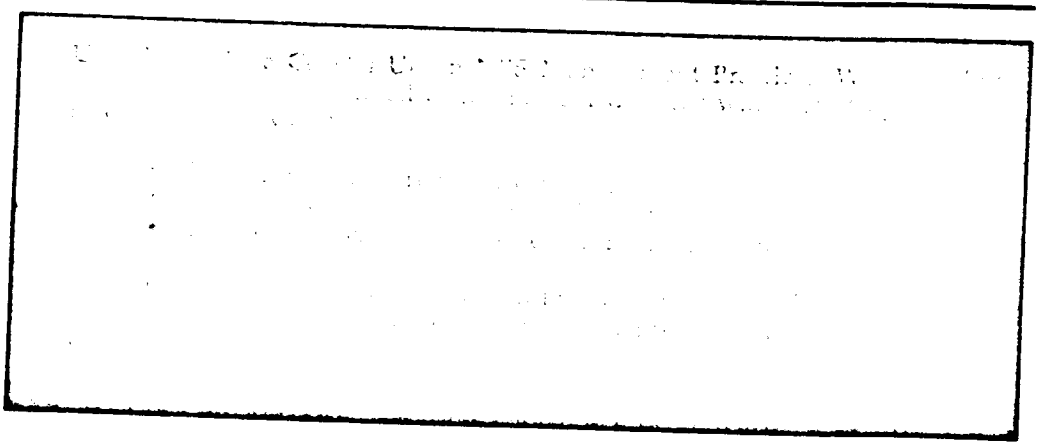

Can Water Quality Inlets Reliably Remove Urban Stormwater Pollutants?

Pollutant Removal Mechanisms: Gravitational settling within the first two chambers can achieve partial removal of grit and sediments. An inverted pipe elbow can remove oil; the pipe elbow keeps the less dense oil near the surface, where it can bind with sediments, and ultimately settle. It should be noted that actual pollutant removal is accomplished when trapped residuals are cleaned out of the inlet. (1)

Review of Monitoring Studies: The pollutant removal performance of water quality inlets has never been monitored in the field, however, design factors suggest that removal capability is limited. Recent field studies confirm the limited effectiveness of water quality inlets. (52) For example, the average depth of sediments trapped in over 120 water quality inlets was less than two inches, and more than eighty percent of the trapped sediments were coarse grained grit and organic matter. Disturbingly, sediment accumulation did not increase with age, suggesting that re-suspension was a significant problem. Water quality inlets did partially trap floatable debris, and the sediments trapped (average of 10 cubic feet per structure) were extremely oily in nature. (8)

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Factors Influencing Pollutant Removal (8):

Positive Factors	Negative Factors
• Off-line designs	• On-line systems
• Adsorptive media (peat, sand)	• Low volume
• Adsorptive pads (for oil)	• Low orifices
• Elevated orifices between chambers one and two	
• Baffle plates	
• Other methods to prevent re-suspension	
• Regular clean-out	

How Well Do Water Quality Inlets Operate Over Time?

Failure Rates: Nearly four hundred water quality inlets have been installed in the Baltimore/Washington area. Field studies of over one hundred water quality inlets indicated that over ninety-five percent are operating as designed, and very few clogging problems have been noted. (8) The oldest operating inlets are five years old.

Factors Influencing Longevity: The basic design is very robust, and very few structural or clogging problems appear to have occurred in the first five years of operation; however, regular clean-outs are not being performed at the vast majority of inlets. (8) Therefore, the actual pollutant removal is very low at present.

Where and When are Water Quality Inlets Feasible?

Physical Factors: Water quality inlets can be applied in most small development situations, such as parking lots, gas stations, convenience stores, and along some road-ways. The primary limitation is contributing area. Most systems are applied to contributing watershed areas of two acres or less. The contributing areas typically are mostly or entirely impervious. The inlet must be connected to the storm drain pipe.

Use In Ultra-Urban Areas: Water quality inlets are frequently applied in ultra-urban areas, where space or storage are not available for other, more effective urban BMPs.

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Retrofit Capability: Very limited. Low removal capability coupled with disposal problems limits the utility of the water quality inlets as a retrofit practice. If the current design is improved, it may become a better retrofit alternative.

Stormwater Management Capability: None. Limited storage of water quality inlets cannot meet stormwater requirements.

What Are the Costs Associated With Water Quality Inlets?

Permitting/Review: Permitting and design review for water quality inlets is minimal, and the basic design and construction had been standardized.

Construction: Costs for water quality inlets range from $5,000 to $15,000 per-inlet, with a range of $7,000 to $8,000. This translates to a cost of $10 to $40 per cubic foot treated. (53)

Maintenance: Since no acceptable clean-out and disposal methods currently exist for water quality inlets, it is impossible, at this time, to estimate the costs for this critically important maintenance function.

Can Water Quality Inlets be Easily Adapted for All Coastal Areas?

Because of the standardized design, the water quality inlet can be utilized in all regions of the country. Until the regular clean-out/disposal procedures are developed, however, the use of water quality inlets should not be promoted.

What are the Environmental Concerns and Benefits of Water Quality Inlets?

Positive Impacts:

- Trapping of floatable trash and debris
- Potential reduction of hydrocarbon load from areas with high traffic/parking use

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Negative Impacts:

- Toxicity of trapped residuals
- Possibility of pulse hydrocarbon loadings due to re-suspension during large storms
- In some regions, it may be difficult to find environmentally acceptable disposal methods. The slurry of oily water and trapped residuals cannot be land-filled, land-applied, or introduced into the sanitary sewer system due to hazardous waste, pretreatment or groundwater regulations

What is Not Know About Water Quality Inlets?

- The actual pollutant removal capability of water quality inlets
- Disposal methods that are environmentally acceptable, practical for small sites, rapid and cost-effective
- Actual toxicity of trapped residuals
- Degree of re-suspension and export of trapped residuals, and design methods that minimize this
- The effect of sand, peat, or other adsorbent media in improving pollutant removal efficiency
- Possibility of regional treatment of inlet slurries

Note: COG is currently conducting a long-term study to provide data on these questions. It will be completed in early 1993.

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APPENDIX A

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THE POLLUTANT REMOVAL CAPABILITY OF POND AND WETLAND SYSTEMS: A REVIEW

NOTE: The table below provides summary data on the pollutant removal capability of nearly sixty stormwater pond and wetland systems. Each study differs with respect to pond design, number of storms monitored, pollutant removal calculation technique, and monitoring technique, so exact comparisons between studies are not appropriate.

TYPE	NO.	NAME	STATE	NO. OF STORMS	WATER-SHED AREA (Acres)	TREAT-MENT VOL. (In./Acre)	REMOVAL EFFICIENCY (%)								
							TSS	TP	SP	TN	NO3	COD	Pb	Zn	OTHER
DRY ED	1	Lakeridge	VA	28	88.0	0.00	14.0	20.0	(-6.0)	10.0	9.0	(-1.0)		(-10.0)	
	2	London Commons	VA	27	11.4	0.22	A: 29.0 B: 74.0	40.0 56.0		25.0 60.0		17.0 41.0	39.0 25.0	24.0 40.0	
	3	Stedwick	MD	25	34.0	0.30	70.0	13.0		24.0		27.0	62.0	57.0	TKN: 30.0
	4	Maple Run III	TX	17	28.0	0.50	30.0	18.0		35.0	52.0	22.0	29.0	(-38.0)	TOC: 30.0 Cu 31.0 BOD 35.0 NH3 55.0 FC 28.0
	5	Oakhampton	MD		16.8	0.50*	87.0	25.0	(-12.0)		(-10.0)				NH4 53.5
	6	None given	KS	19	12.3	3.42	3.0	19.0	0.0		20.0	16.0	66.0	65.0	

Note: An asterisk (*) denotes an inferred value

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THE POLLUTANT REMOVAL CAPABILITY OF POND AND WETLAND SYSTEMS_

TYPE	NO.	NAME	STATE	NO. OF STORMS	WATER-SHED AREA (Acres)	TREAT-MENT VOL. (In./Acre)	REMOVAL EFFICIENCY (%)								
							TSS	TP	SP	TN	NO3	COD	Pb	Zn	OTHER
WET PONDS	7	Seattle	WA	5	0.75		86.7	78.4				64.4	65.1	65.2	Cu: 66.5
	8	Boynton Beach	FL	8			91.0		76.0		87.0				TKN: 58.0
	9	Grece Street	MI	18		VB/VR=.52	32.0	12.0		6.0	(-1.0)		26.0		TKN: 7.0
															BOD: 3.0
	10	Pitt-AA	MI	6	4872.0	VB/VR=0.52	32.0	18.0			7.0	23.0	62.0	13.0	TKN: 14.0
															BOD: 21.0
	11	Unqua	NY	8		VB/VR=3.07	60.0	45.0					80.0		TOC: 7.0
	12	Waverly Hills	MI	29		VB/VR=7.57	91.0	79.0		62.0	66.0	69.0	95.0	91.0	Cu: 57.0
															TKN: 60.0
															BOD: 69.0
	13	Lake Ellyn	IL	23		VB/VR=10.70	84.0	34.0					78.0	71.0	Cu: 71.0
	14	Lake Ridge	MN	20	315.0	0.08	A: 90.0	61.0	11.0	41.0	10.0		73.0		TKN: 50.0
							B: 85.0	37.0	8.0	24.0	17.0		52.0		TKN: 28.0
	15	West Pond	MN	8	76.0	0.15	65.0	25.0			61.0		8.0-79.0	66.0	TOC: 19.0
															TKN: 23.0
															Cr: 48.0-76.0
															Cd: 12.0-91.0
	16	McCarrons	MN	21	608.0	0.19	91.0	78.0		85.0		90.0	90.0		
	17	McKnight Basin	MN	20	725.0	0.22	A: 85.0	48.0	13.0	30.0	24.0		67.0		TKN: 31.0
							B: 85.0	34.0	12.0	14.0	11.0		63.0		TKN: 15.0
	18	Monroe Street	WI		238.0	0.26	90.0	65.0	70.0			70.0	70.0	65.0	Cu: 75.0
															FColl: 70.0
															Peat: 25-50.0
															Hydro: 75-90
	19	Runaway Bay	NC	5	437.0	0.33	54.0	24.0						42.0	TKN: 20.0

Note: An asterisk (*) denotes an inferred value

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THE POLLUTANT REMOVAL CAPABILITY OF POND AND WETLAND SYSTEMS...

TYPE	NO.	NAME	STATE	NO. OF STORMS	WATER-SHED AREA (Acres)	TREAT-MENT VOL. (In./Acre)	REMOVAL EFFICIENCY (%)								
							TSS	TP	SP	TN	NO3	COD	Pb	Zn	OTHER
WET PONDS (Cont'd)	20	Buckland	CT	7	20.0	0.40	61.0	45.0			22.0		18.0-59.0	51.0	Cd: < 0 TKN: 24.1 TOC: 33.0 Cu: 38.0
	21	Highway Site	FL	13	41.6	0.55	65.0	17.0		21.0		7.0	41.0	37.0	
	22	Woodhollow	TX	14	381.0	0.55	54.0	46.0		39.0	45.0	41.0	76.0	69.0	TKN: 26.0 NH3: 28.0 BOD: 39.0 FColi: 46.0
	23	SR 2A	WA	5	1.8	2.12	[illegible]	[illegible]				[illegible]	[illegible]	[illegible]	Cu: [illegible]
	24	Farm Pond	VA		51.4	1.13	85.0	86.0	73.0	34.0					NH3: (-107.0)
	25	Burke	VA	29	27.1	1.22	(-33.3)	39.0	77.0	32.0		21.0	84.0	38.0	
	26	Westleigh	MD	32	48.0	1.27	81.0	54.0	71.0	37.0		35.0	82.0	26.0	TKN: 27.0
	27	Mercer	WA	5	7.6	1.72	75.0	67.0				76.9	23.0	38.0	Cu: 51.0
	28	I-4	FL	6	26.3	2.35	54.0	69.0			97.0		41.0-94.0	69.0	TOC: 45.0 TKN: 68.0 Cd: 43.0-51.0 Cu: 66.0-81.0
	29	Timber Creek	FL	9	122.0	3.11*	64.0	60.0	80.0	15.0	80.0				
	30	Maitland	FL	30-40	49.0	3.65			90.0		87.0		95.0	96.0	PP: 11.0 Cu: 77.0 NH3: 82.0
	31	Lakeside	NC	5	65.0	7.16	91.0	23.0						82.0	TKN: 6.0

Note: An asterisk (*) denotes an inferred value

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THE POLLUTANT REMOVAL CAPABILITY OF POND AND WETLAND SYSTEMS_

TYPE	NO.	NAME	STATE	NO. OF STORMS	WATER-SHED AREA (Acres)	TREAT-MENT VOL. (In./Acre)	REMOVAL EFFICIENCY (%)								
							TSS	TP	SP	TN	NO3	COD	Pb	Zn	OTHER
WET ED	[illegible]														
STORMWATER WETLANDS	35	EWA3	IL				72.0	59.0			70.0				Fe: 48.0
	36	EWA4	IL				76.0	55.0			42.0				Fe: 43.0
	37	EWA5	IL				89.0	69.0			70.0				Fe: 50.0
	38	EWA6	IL				98.0	97.0			95.0				Fe: 92.0
	39	B31	WA	13	461.7	0.01	14.0	(-2.0)			4.0				
	40	PC12	WA	13	214.8	0.03	56.0	(-2.0)			20.0				
	41	McCarrons	MN	21	608.0	0.31	87.0	36.0		24.0		79.0	68.0		
	42	Queen Anne's	MD			0.50*	65.0	39.0	44.0	23.0	55.0				NH4: 55.0 ON: (-5.0) PP: 7.2
	43	Swift Run	MI	5	1207.0	0.60	85.0	3.0	29.0		80.0	2.0	82.0		BOD: 4.0
	44	Tampa Office Pond	FL	3 - 8	6.3	0.61	64.0	55.0	65.0					34.0	ON: (-3.7)
	45	Highway Site	FL	13	41.6	0.81	66.0	19.0		30.0		18.0	75.0	50.0	
	46	Palm Beach POA	FL		2340.0	2.00*	50.0	62.0			33.0				NH3: 17.0 BOD: 35.0 TOC: 10.0 TKN: 16.0
ED WETLANDS	47	[illegible]													

Note: An asterisk (*) denotes an inferred value

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THE POLLUTANT REMOVAL CAPABILITY OF POND AND WETLAND SYSTEMS...

TYPE	NO.	NAME	STATE	NO. OF STORMS	WATER-SHED AREA (Acres)	TREAT-MENT VOL. (In./Acre)	REMOVAL EFFICIENCY (%) TSS	TP	SP	TN	NO3	COD	Pb	Zn	OTHER
ED WETLANDS (Cont'd)	48	Tanner's Lake	MN	10	413.0	0.10	A: 62.0	24.0	10.0	36.0	23.0		63.0		TKN: 40.0
							[illegible]	7.0	(-14.0)	5.0	1.0		59.0		TKN: 7.0
	49	Mays Cl[illegible]	MN		[illegible]	[illegible]	[illegible]	[illegible]	24.0		35.0				NH3: 43.0
	50	Clear Lake	MN		[illegible]	0.15*	[illegible]	[illegible]	40.0						TKN: 25.0
															NH3: 55.0
NATURAL WETLANDS	51	Hidden Lake	FL		55.4	1.08*	83.0	7.0	(-109.0)	(-1.6)	80.2		54.0	40.0	ON: (-24.0)
															Cu: 40.0
															NH3: 62.0
															Cd: 70.0
															BOD: 81.0
	52	Wayzata	MN		73.0	1.25*	94.0	78.0					94.0	82.0	NH3: (-44.0)
															Cd: 67.0
															Cu: 80.0
POND/WETLAND SYSTEMS	53	Lake Munson	FL	3	23393.0		92.0	64.0		11.0	15.0	28.0	55.0	59.0	NH4: (-39.0)
															TKN: 11.0
															NO3: 15.0
															BOD: 42.0
	54	Carver Ravine	MN	15	170.0	.30*	A: 45.0	24.0	21.0	15.0	18.0		42.0		TKN: 14.0
							[illegible]	1.0	1.0	(-6.0)	9.0		6.0		TKN: (-10.0)
	55	McCarrons	MN	21	[illegible]	[illegible]	[illegible]	[illegible]		93.0		93.0	90.0		
	56	[illegible]	FL		[illegible]	[illegible]	[illegible]	[illegible]		75.0	[illegible]				NH4: 37.0
	57	[illegible]	FL	13	[illegible]	[illegible]	[illegible]	[illegible]		43.0			84.0	67.0	
	58	Long Lake	[illegible]	11	[illegible]	[illegible]	[illegible]	[illegible]							

Note: An asterisk (*) denotes an inferred value

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Pollutant Removal Capability Table: References, Notes and Notation

I. Notes and References

Study No.	Reference and Notes
1	MWCOG, 1983. Minor ED provided (1 - 2 hours). Frequent resuspension by clogging of lowflow orifice.
2	OWML, 1987. A: Pre-adjustment, less than 10 hours of ED (maximum). B: Post-adjustment, less than 20 hours of ED (maximum). Exfiltration of runoff accounts for some removal.
3	Schueler and Helfrich, 1988. Achieved ED times of 6 to 8 hours. Prone to suspension.
4	City of Austin, 1991. Originally a dry stormwater pond, but due to poor maintenance, 3 to 6 hours of ED was achieved.
5	Baltimore Department of Public Works, 1989.
6	Pope and Hess, 1988. Resuspension. ED volume was very high.
7	Horner et al., 1990.
8	Holler, 1987.
9	Driscoll, 1983. NURP pond.
10	Driscoll, 1983. NURP pond.
11	Driscoll, 1983. NURP pond.
12	Driscoll, 1983. NURP pond.
13	Driscoll, 1983. NURP pond.
14	Oberts et al., 1989. A: Rainfall only. B: Rainfall and snowmelt.
15	Dorman et al., 1989. Highway runoff.
16	Wotzka and Oberts, 1988. Some ED provided.
17	Oberts et al., 1989. A: Rainfall only. Rainfall and snowmelt.
18	Bannerman, forthcoming March 1992.
19	Wu et al., 1988.

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Study No.	Reference and Notes
20	Dorman et al., 1989. 8000 feet of grassed swale treatment prior to pond. Very shallow permanent pool.
21	Martin, 1988.
22	City of Austin, 1990. Negative removal for TDS off-line facility.
23	Horner et al., 1990.
24	OWML, 1983(b). Farm pond. No urban development.
25	OWML, 1983(b). TSS removal estimate appears to be a serious underestimate due to the use of the median storm EMC calculations.
26	Driscoll, 1986. High algal uptake.
27	Horner et al., 1990.
28	Dorman et al., 1989. Highway runoff.
29	Cullum, 1985. Commercial area.
30	Yousef et al., 1986. Multiple cell wet pond.
31	Wu et al., 1988. Goose excrement cited for poor nutrient removal.
32	Ontario Ministry of the Environment, 1991. No winter data. Manual ED.
33	Ontario Ministry of the Environment, 1991. No winter data. Manual ED.
34	Ontario Ministry of the Environment, 1991. No winter data. Manual ED.
35	Hey and Barrett, 1991. Cited in Strecker et al., 1990. Resuspension.
36	Hey and Barrett, 1991. Cited in Strecker et al., 1990.
37	Hey and Barrett, 1991. Cited in Strecker et al., 1990.
38	Hey and Barrett, 1991. Cited in Strecker et al., 1990. No surface discharge during 6 months of the year.
39	Reinelt et al., 1990. Cited in Strecker et al., 1990. Channelization reduced effectiveness.
40	Reinelt et al., 1990. Cited in Strecker et al., 1990. Chanellization reduced effectiveness.
41	Wotzka and Oberts, 1988. Runoff pretreated by pond.

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Pollutant Removal Capability Table: References, Notes and Notation

Study No.	*Reference and Notes*
42	Athanas and Stevenson, 1991.
43	Driscoll, 1983. Shallow pond with wetlands.
44	Rushton and Dye, 1990. Cited in Strecker et al., 1990.
45	Wotzka and Oberts, 1988. Runoff pretreated by pond.
46	Blackburn et al., 1986. Cited in Strecker et al., 1990. Residential golf course. Polish runoff to natural wetland.
47	OWML and GMU, 1990. Poor removal for large storm in excess of treatment capacity.
48	Oberts et al., 1989. A: Rainfall only. B: Rainfall and snowmelt.
49	OWML and GMU, 1990.
50	Barten, 1983. Cited in Strecker et al., 1990.
51	Harper et al., 1986. Cited in Strecker et al., 1990. Stormwater introduced to small wooded wetland.
52	Hickock et al., 1977. Cited in Strecker et al., 1990.
53	Maristany and Bartell, 1989. 30-year old lake wetland systems.
54	Oberts et al., 1989. A: Rainfall only. B: and snowmelt.
55	Wotzka and Oberts, 1988. Wetpond to wetland.
56	Esry and Cairns, 1988. Cited in Strecker et al., 1990. Pond to filter to wetland.
57	Martin, 1988. Wetpond to wetland.
58	Jolly, 1990. Study period did not cover periods of high phosphorus loading or spring thaw (snowmelt) and was primarily in an agricultural watershed.

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II. Notation

BOD:	Biological Oxygen Demand	FColi:	Fecal Coli	Pest:	Pesticides	TOC:	Total Organic Carbon
Cd:	Cadmium	Fe:	Iron	PP:	Particulate Phosphorus	TP:	Total Phosphorus
COD:	Chemical Oxygen Demand	Hydro:	Hydrocarbons	SP:	Soluble Phosphorus	TSS:	Total Suspended Solids
Cr:	Chromium	NH3:	Ammonium	TKN:	Total Kgeldahl Nitrogen	Zn:	Zinc
Cu:	Copper	NH4:	Ammonia	TN:	Total Nitrogen		
		NO3:	Nitrate				
		ON:	Organic Nitrogen				
		Pb:	Lead				

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APPENDIX B

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GLOSSARY

ADSORPTION - Adhesion of the molecules of a gas, liquid or dissolved substance to a surface. Adsorption differs from absorption in that absorption is the assimilation or incorporation of a gas, liquid or dissolved substance into another substance.

ADJUSTABLE GATE VALVE - A knife gate valve, activated by a handwheel, used to control the internal diameter of reverse slope pipes or allow rapid opening of the pond drain pipe.

AGGREGATE - Term for the stone or rock gravel needed to fill in an infiltration BMP such as a trench or porous pavement. Clean-washed aggregate is simply aggregate that has been washed clean so that no sediment is associated with.

AQUATIC BENCH - A ten to fifteen foot bench around the inside perimeter of a permanent pool that is approximately one foot deep. Normally vegetated with emergent plants, the bench augments pollutant removal, provides habitat, conceals trash and water level drops, and enhances safety.

ARTIFICIAL MARSH CREATION - Simulation of natural wetland features and functions via topographic and hydraulic modifications on non-wetland landscapes. Typical objectives for artificial marsh creation include ecosystem replacement or stormwater management.

BMP FINGERPRINTING - Term refers to a series of techniques for locating BMPs (particularly ponds) within a development site so as to minimize their impacts to wetlands, forest and sensitive stream reaches.

BACTERIAL DECOMPOSITION OR MICROBIAL DECOMPOSITION Microorganisms, or bacteria, have the ability to degrade organic compounds as food resources and to absorb nutrients and metals into their tissues to support growth.

BANK RUN - Gravelly deposits consisting of smooth round stones, generally indicative of the existence of a prehistoric sea. Such deposits are normally found in coastal plain regions.

BANK STABILIZATION - Methods of securing the structural integrity of earthen stream channel banks with structural supports to prevent bank slumping and undercutting of riparian trees, and overall erosion prevention. To maintain the ecological integrity of the system, recommended techniques include the use of willow stakes, imbricated riprap or brush bundles.

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Glossary

BANKFULL DISCHARGE - A flow condition where streamflow completely fills the stream channel up to the top of the bank. In undisturbed watersheds, the discharge condition occurs on average every one and a half to two years and controls the shape and form of natural channels.

BASEFLOW - The portion of stream flow that is not due to storm runoff, and is supported by groundwater seepage into a channel.

BERM, EARTHEN - An earthen mound used to direct the flow of runoff around or through a BMP.

BEST MANAGEMENT PRACTICE (BMP) - Structural devices that temporarily store or treat urban stormwater runoff to reduce flooding, remove pollutants, and provide other amenities.

BIOFILTRATION - The use of a series of vegetated swales to provide filtering treatment for stormwater as it is conveyed through the channel. The swales can be grassed, or contain emergent wetlands, or high marsh plants.

BIOLOGICAL MONITORING - Periodic surveys of aquatic biota as an indicator of the general health of a waterbody. Biological monitoring surveys can span the trophic spectrum, from macro-invertebrates to fish species.

CATCHMENT - See **CONTRIBUTING WATERSHED AREA.**

CHANNEL EROSION - The widening, deepening, and headward cutting of small channels and waterways, due to erosion caused by moderate to larger floods.

CHECK DAM - (a) A log or gabion structure placed perpendicular to a stream to enhance aquatic habitat. (b) An earthen or log structure, used in grass swales to reduce water velocities, promote sediment deposition, and enhance infiltration.

CONTRIBUTING WATERSHED AREA - Portion of the watershed contributing its runoff to the BMP in question.

DELTA-t - The magnitude of change in the temperature of downstream waters.

DESIGN STORM - A rainfall event of specified size and return frequency (e.g., a storm that occurs only once every 2 years) that is used to calculate the runoff volume and peak discharge rate to a BMP.

DE-WATERING - Refers to a process used in detention/retention facilities, whereby

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water is completely discharged or drawn down to a pre-established pool elevation by way of a perforated pipe. De-watering allows the facility to recover its design storage capacity in a relatively short time after a storm event.

DOWNSTREAM SCOUR - Downstream channel erosion usually associated with an upstream structure that has altered hydraulic conditions in the channel.

DROP STRUCTURE - Placement of logs with a weir notch across a stream channel. Water flowing through the weir creates a plunge pool downstream of the structure and creates fish habitat.

DRAWDOWN - The gradual reduction in water level in a pond BMP due to the combined effect of infiltration and evaporation.

DRY POND CONVERSION - A modification made to an existing dry stormwater management pond to increase pollutant removal efficiencies. For example, the modification may involve a decrease in orifice size to create extended detention times, or the alteration of the riser to create a permanent pool and/or shallow marsh system.

EXTENDED DETENTION (ED) PONDS - A conventional ED pond temporarily detains a portion of stormwater runoff for up to twenty-four hours after a storm using a fixed orifice. Such extended detention allows urban pollutants to settle out. The ED ponds are normally "dry" between storm events and do not have any permanent standing water.

An enhanced ED pond is designed to prevent clogging and resuspension. It provides greater flexibility in achieving target detention times. It may be equipped with plunge pools near the inlet, a micropool at the outlet, and utilize an adjustable reverse-sloped pipe at the ED control device.

ED CONTROL DEVICE - A pipe or series of pipes that extend from the riser of a stormwater pond that are used to gradually release stormwater from the pond over a 12 to 48 hour interval.

EMBANKMENT - A bank (of earth or riprap) used to keep back water.

EMERGENT PLANT - An aquatic plant that is rooted in the sediment but whose leaves are at or above the water surface. Such wetland plants provide habitat for wildlife and waterfowl in addition to removing urban pollutants.

END OF PIPE CONTROL - Water quality control technologies suited for the control of existing urban stormwater at the point of storm sewer discharge to a stream. Due

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to typical space constraints, these technologies are usually designed to provide water quality control rather than quantity control.

EXFILTRATION - The downward movement of runoff through the bottom of an infiltration BMP into the subsoil.

EXTENDED DETENTION - A stormwater design feature that provides for the gradual release of a volume of water (0.25 - 1.0 inches per impervious acre) over a 12 to 48 interval times to increase settling of urban pollutants, and protect channel from frequent flooding.

FILTER FABRIC - Textile of relatively small mesh or pore size that is used to (a) allow water to pass through while keeping sediment out (permeable), or (b) prevent both runoff and sediment form passing through (impermeable).

FLOW SPLITTER - An engineered, hydraulic structure designed to divert a portion of stream flow to a BMP located out of the channel, or to direct stormwater to a parallel pipe system, or to bypass a portion of baseflow around a pond.

FOREBAY - An extra storage area provided near an inlet of a BMP to trap incoming sediments before they accumulate in a pond BMP.

FREQUENT FLOODING - A phenomenum in urban streams whereby the number of bankfull and sub-bankfull flood events increases sharply after development. The frequency of these disruptive floods is a direct function of watershed imperviousness.

FRINGE WETLAND CREATION - Planting of emergent aquatic vegetation along the perimeter of open water to enhance pollutant uptake, increase forage and cover for wildlife and aquatic species, and improve the appearance of a pond.

GABION - A large rectangular box of heavy gauge wire mesh which holds large cobbles and boulders. Used in streams and ponds to change flow patterns, stabilize banks, or prevent erosion.

GEOMEMBRANE - Lining of filter fabric on the bottom and sides of porous pavement to prevent lateral or upward movement of soil into the stone reservoir.

GEOTEXTILE FABRIC - See **FILTER FABRIC.**

GRASSED SWALE - A conventional grass swale is an earthen conveyance system in which the filtering action of grass and soil infiltration are utilized to remove pollutants from urban stormwater. An enhanced grass swale, or biofilter, utilizes

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checkdams and wide depressions to increase runoff storage and promote greater settling of pollutants.

GRAVITATIONAL SETTLING - The tendency of particulate matter to "drop out" of stormwater runoff as it flows downstream when runoff velocities are moderate and/or slopes are not too steep.

HEAD - Pressure.

HIGH MARSH - Diverse wetland type found in areas that are infrequently inundated or have wet soils. In pond systems, the high marsh zone extends form the permanent pool to the maximum ED water surface elevation.

INFILTRATION BASIN - An impoundment where incoming stormwater runoff is stored until it gradually exfiltrates through the soil of the basin floor.

INFILTRATION TRENCH - A conventional infiltration trench is a shallow, excavated trench that has been backfilled with stone to create an underground reservoir. Stormwater runoff diverted into the trench gradually exfiltrates from the bottom of the trench into the subsoil and eventually into the water table.

An enhanced infiltration trench has an extensive pretreatment system to remove sediment and oil. It requires an on-site geotechnical investigation to determine appropriate design and location.

LEVEL SPREADER - A device used to spread out stormwater runoff uniformly over the ground surface as sheet flow (i.e., not through channels). The purpose of level spreaders are to prevent concentrated, erosive flows from occurring, and to enhance infiltration.

LOW MARSH - Wetland type with emergent plant species that require some depth of standing water throughout the year. The low marsh zone in pond systems is created in areas where the permanent pool is zero to twelve inches deep.

LOWFLOW CHANNEL - An incised or paved channel from inlet to outlet in a dry basin which is designed to carry low runoff flows and/or baseflow, directly to the outlet without detention.

MICROPOOL - A smaller permanent pool used in a stormwater pond due to extenuating circumstances, i.e. concern over the thermal impacts of larger ponds, impacts on existing wetlands, or lack of topographic relief.

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PEAT SAND FILTER - Best management practice, utilizing the natural adsorptive features of fabric or hemic peat, which consists of a vertical filter system with a grass cover crop, alternating layers of peat and sand and a sediment forebay feature. The peat sand filter is presently used for municipal waste treatment systems and is being adapted for use in stormwater management.

PERMANENT POOL - A three to ten foot meter deep pool in a stormwater pond system, that provides removal of urban pollutants through settling and biological uptake. (Also referred to as a wet pond).

PHYSICAL FILTRATION - As they pass across or through a surface, particulates are separated from runoff by grass, leaves and other organic matter on the surface.

PILOT CHANNEL - A riprap or paved channel that routes runoff through a BMP to prevent erosion of the surface.

PLUNGE POOL - A small permanent pool located at either the inlet to a BMP or at the outfall form a BMP. The primary purpose of the pool is to dissipate the velocity of stormwater runoff, but it also can provide some pre-treatment, as well.

PONDSCAPING - A method of designing the plant structure of a stormwater wetland or pond using inundation zones. The proposed wetland or pond system is divided into zones which differ in the level and frequency of inflow. For each zone, plant species are chosen based on their potential to thrive, given the inflow pattern of the zone.

POROUS PAVEMENT - An alternative to conventional pavement whereby runoff is diverted through a porous asphalt layer and into an underground stone reservoir. The stored runoff then gradually infiltrates into the subsoil.

RETROFIT - The creation/modification of stormwater management systems in developed areas through the construction of wet ponds, infiltration systems, wetland plantings, stream bank stabilization, and other BMP techniques for improving water quality and creating aquatic habitat. A retrofit can consist of the construction of a new BMP in the developed area, the enhancement of an older stormwater management structure, or a combination of improvement and new construction.

REVERSE SLOPE PIPE - A pipe that extends downwards from the riser into the permanent pool that sets the water surface elevation of pool. The lower end of the pipe is located up to 1 foot below the water surface. Very useful technique for regulating ED times, and it seldom clogs.

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RIPARIAN - A relatively narrow strip of land that borders a stream or river, often coincides with the maximum water surface elevation of the one-hundred year storm.

RIPARIAN REFORESTATION - The replanting of the banks and floodplain of a stream with native forest and shrub species to stabilize erodible soils, improve both surface and ground water quality, increase stream shading, and enhance wildlife habitat.

RIPRAP - A combination of large stone, cobbles and boulders used to line channels, stabilize banks, reduce runoff velocities, or filter out sediment.

RISER - A vertical pipe extending from the bottom of a pond BMP that is used to control the discharge rate from a BMP for a specified design storm.

ROTOTILLING - Mechanical means of tilling, or rotating, the soil.

RUNOFF CONVEYANCE - Methods for safely conveying stormwater to a BMP to minimize disruption of the stream network, and promote infiltration or filtering of the runoff.

RUNOFF FREQUENCY SPECTRUM - The frequency distribution of unit area runoff volumes generated by a long, term continuous time-series of rainfall events. Used to develop BMP and stormwater sizing rules.

RUNOFF PRETREATMENT - Techniques to capture or trap coarse sediments before they enter a BMP to preserve storage volumes or prevent clogging within the BMP. Examples include forebays and micropools for pond BMPs, and plunge pools, grass filter strips and filter fabric for infiltration BMPs.

SAFETY BENCH - A ten to fifteen foot bench located just outside the perimeter of a permanent pool. The bench extend around the entire shoreline to provide for maintenance access and eliminate hazards.

SAND FILTER - A relatively new technique for treating stormwater, whereby the first flush of runoff is diverted into a self-contained bed of sand. The runoff is then strained through the sand, collected in underground pipes and returned back to the stream or channel.

An enhanced sand filter utilizes layers of peat, limestone, and/or topsoil, and may also have a grass cover crop. The adsorptive media of an enhanced sand filter is expected to improve removal rates.

SEDIMENT FOREBAY - Stormwater design feature that employs the use of a small

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settling basin to settle out incoming sediments before they are delivered to a stormwater BMP. Particularly useful in tandem with infiltration devices, wet ponds or marshes.

SHORT CIRCUITING - The passage of runoff through a BMP in less than the theoretical or design treatment time.

SLURRY - Thin mixture of water and any of several fine, insoluble materials; therefore, an OIL SLURRY is a thin mixture of water and oil.

STORMWATER TREATMENT - Detention, retention, filtering or infiltration of a given volume of stormwater to remove urban pollutants and reduce frequent flooding.

STORMWATER WETLAND - A conventional stormwater wetland is a shallow pool that creates growing conditions suitable for the growth of marsh plants. A stormwater wetland is designed to maximize pollutant removal through wetland uptake, retention and settling.

A stormwater wetland is a constructed system and typically is not located within delineated a natural wetland. In addition, a stormwater wetland differs from an artificial wetland created to comply with mitigation requirements in that the stormwater wetland does not replicate all the ecological functions of natural wetlands.

An enhanced stormwater wetland is designed for more effective pollutant removal and species diversity. It also includes design elements such as a forebay, complex microtopography, and pondscaping with multiple species of wetland trees, shrubs and plants.

STREAM BUFFER - A variable width strip of vegetated land adjacent to a stream that is preserved from development activity to protect water quality, aquatic and terrestrial habitats.

SUBSOIL - The bed or stratum of earth lying below the surface soil.

SUBSTRATE AMENDMENTS - A technique to improve the texture, and organic content of soils in a newly excavated pond system. The addition of organic rich soils is often required to ensure the survival of aquatic and terrestrial landscaping around ponds.

SUMP PIT - A single-chamber oil/grit separator used to pretreat runoff before it enters an infiltration trench.

SWALE - A natural depression or wide shallow ditch used to temporarily store route, or filter runoff.

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TRASH AND DEBRIS REMOVAL - Mechanical removal of debris, snags, and trash deposits from the streambanks to improve the appearance of the stream.

UNDERDRAIN - Plastic pipes with holes drilled through the top, installed on the bottom of an infiltration BMP, or sand filter, which are used to collect and remove excess runoff.

VACUUM SWEEPING - Method of removing quantities of coarse-grained sediments from porous pavement in order to prevent clogging. Not effective in removing fine-grained pollutants.

VEGETATED FILTER STRIP - A vegetated section of land designed to accept runoff as overland sheet flow from upstream development. It may adopt any natural vegetated form, from grassy meadow to small forest. The dense vegetative cover facilitates pollutant removal.

A filter strip cannot treat high velocity flows; therefore, they have generally been recommended for use in agriculture and low density development.

A vegetated filter strip differs from a natural buffer in that the strip is not "natural"; rather, it is designed and constructed specifically for the purpose of pollutant removal. A filter strip can also be an enhanced natural buffer, however, whereby the removal capability of the natural buffer is improved through engineering and maintenance activities such as land grading or the installation of a level spreader.

A filter strip also differs from a grassed swale in that a swale is a concave vegetated conveyance system, whereas a filter strip has a fairly level surface.

WATER QUALITY INLET - Best management practice consisting of a three-stage underground retention system designed to remove heavy particulates and absorbed hydrocarbons. Also, known as an OIL/GRIT SEPARATOR.

WEIR - A structure that extends across the width of a channel and is intended to impound, delay or in some way alter the flow of water through the channel. A CHECK DAM is a type of weir as is any kind of dam.

A PORTED WEIR is a wall or dam that contains openings through which water may pass. Ported weirs slow the velocity of flow and therefore, can assist in the removal of pollutants in runoff by providing opportunities for pollutants to settle, infiltrate or be adsorbed.

WET POND - A conventional wet pond has a permanent pool of water for treating incoming stormwater runoff.

In enhanced wet pond designs, a forebay is installed to trap incoming sediments where thay can be easily removed; a fringe wetland is also established around the perimeter of the pond.

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WETLAND MITIGATION - Regulatory requirement to replace wetland areas destroyed or impacted by proposed land disturbances with artificially created wetland areas.

WETLAND MULCH - A technique for establishing low or high marsh areas where the top twelve inches of wetland soil form a donor wetland are spread thinly over the surface of a created wetland site as a mulch. The seedbank and organic matter of the mulch helps to rapidly establish a diverse wetland system.

WETLAND PLANT UPTAKE - Wetland plant species rely on nutrients (i.e., phosphorus and nitrogen) as a food source; thus, they may intercept and remove nutrients from either surface or subsurface flow.

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PUGET SOUND
WATER QUALITY
MANAGEMENT PLAN

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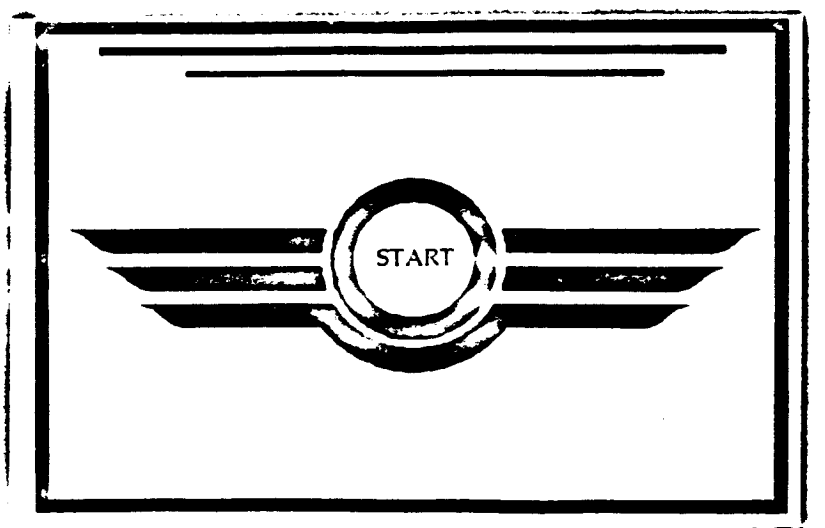

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1994 PUGET SOUND WATER QUALITY MANAGEMENT PLAN

Adopted May 18, 1994

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STATE OF WASHINGTON

PUGET SOUND WATER QUALITY AUTHORITY

PO Box 40900 • Olympia, Washington 98504-0900 • (206) 407-7300

January 1995

To Governor Lowry, the Legislature, and the Citizens of Washington State:

Publication of the 1994 Puget Sound Water Quality Management Plan launches us into our second decade of bringing the diverse interests in the region together to protect water quality in the Sound. This Plan reflects the fact that much has changed since we issued the first Plan in 1987. Needed improvements make the Plan more effective in guiding federal and state agencies, local governments and tribes as they take the steps necessary to resolve difficult water quality issues facing the region and its citizens. In response to comments from the public, cities and counties, we made the 1994 Plan more efficient, and we streamlined many of the programs, focusing our recommendations on practical solutions that build upon local efforts to protect Puget Sound.

Representing diverse perspectives, our unanimous support of the 1994 Plan is an important indication of the hard work, compromises and spirit of cooperation embodied in it. We are particularly appreciative of the outstanding work of local governments, tribal governments, federal agencies, businesses, organizations and individuals, both in taking actions called for in the 1991 Plan and in helping us to evaluate and improve the Plan.

The coming years will bring many challenges as we move forward in protecting water quality. A lack of funding coupled with public concern over how government can and should protect the environment have already slowed progress. We ask your full support as state, local and tribal governments face these challenges and carry out the recommendations in this Plan.

Mary Riveland
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STATE AND FEDERAL AUTHORITY FOR THIS PLAN

RCW 90.70.055 requires the Authority to prepare and adopt a comprehensive Puget Sound water quality management plan, as defined in RCW 90.70.060. Implementation of the plan is called for by RCW 90.70.070, which states, " (1) In conducting planning, regulatory, and appeals actions, the state agencies and local governments identified in the plan must evaluate, and incorporate as applicable, subject to the availability of appropriated funds or other funding sources, the provisions of the plan, including any guidelines, standards, and timetables contained in the plan."

The Authority is scheduled to sunset on June 30, 1995. Legislation to extend the Authority may be considered during the 1995 legislative session. Regardless, RCW 90.70.902 provides that the scheduled sunset of the Authority "shall affect the implementation and requirements of the Puget Sound water quality management plan existing on June 30, 1995, or such other effective date of repeal of the laws referenced in RCW 43.131.370. The implementation of the plan on and after that date shall be the responsibility of such entities as are provided by the legislature."

In March 1988 the Administrator of the Environmental Protection Agency formally designated Puget Sound as an estuary of national significance under Section 320 of the Clean Water Act, as amended by P.L. 100-4 (the Water Quality Act of 1987). This made Puget Sound part of a nationwide program to develop management plans for the protection of the nation's estuaries. The Puget Sound Water Quality Authority, together with EPA Region 10 and the Washington Department of Ecology, co-manage the Puget Sound Estuary Program. Section 320 requires the development of a comprehensive conservation and management plan (CCMP) for each designated estuary. This Puget Sound plan is the CCMP for Puget Sound.

ACKNOWLEDGEMENT

The Puget Sound Water Quality Authority acknowledges financial and technical support from EPA's Office of Marine and Estuarine Protection and the Region 10 Office of Puget Sound. These funds provided support for technical studies, development of management tools, and other projects which helped provide the basis for developing the Puget Sound Water Quality Management Plan. This support was provided under the authority of Section 320 (the National Estuary Program) of the Clean Water Act of 1987, as well as through Congressional appropriations in previous years to support the Puget Sound effort.

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Summary

Since 1987, the Puget Sound Water Quality Management Plan has guided the water quality protection efforts of state and local governments. The result has been a more comprehensive and effective strategy for preventing and managing pollution sources in Puget Sound.

The goal of the Puget Sound Water Quality Management Plan is to restore and protect the biological health and diversity of Puget Sound. The strategy for achieving this purpose is to protect and enhance Puget Sound's water and sediment quality; its fish and shellfish; and its wetlands and other habitats.

The 1985 statute directed the Authority to revise the Puget Sound Water Quality Management Plan (Plan) every two years, and to include within it an evaluation of progress toward achieving the Plan's goals and a discussion of additional concerns. The 1991 Plan originally was scheduled to be the final project for the Authority, which would cease to exist after June 1991. However, legislation approved by the 1990 Washington State Legislature (Chapter 115, Laws of 1990) retained the Authority as an independent agency; extended its work through June 1995; and changed the schedule for reviewing the Plan to a four-year cycle, with a review due by July 1994.

In 1991, the Plan was approved as the Comprehensive Conservation and Management Plan (CCMP) for the Puget Sound Estuary Program, as authorized by the federal Clean Water Act. As a CCMP, the Plan addresses federal actions affecting Puget Sound. The Puget Sound Plan has become a national model, providing a vision for other estuaries as they create their own plan.

Revisions to this Plan were necessary not only because of statutory requirements, but also because conditions that determine how governments protect water quality have changed. The revisions better reflect, among other things, public expectations and political and budgetary concerns.

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The 1994 PLAN

This 1994 Plan is the first in which no new programs were added. In fact, the program that called for establishing a Puget Sound Foundation has been eliminated due to the inability to secure funding from private or public sector sources. Other amendments incorporated into the 1994 Plan include making due dates in the Stormwater and Combined Sewer Overflows Program consistent with the state's Growth Management Act (GMA); coordinating other parts of the Plan with the GMA; requiring the Department of Ecology to develop a policy on alternatives to discharging sewer wastes into marine waters; coordinating the Plan with the federal Coastal Zone Act Reauthorization Amendments; expanding the role of local governments in managing nonpoint pollution; and updating and refining a number of program elements.

The Puget Sound Plan assigns local governments major roles in protecting wetlands, preventing water pollution, controlling storm water and protecting shellfish. These assignments include planning, regulation, education, remediation and enforcement activities.

Plan Organization

Previous versions of the Puget Sound Plan recognized the connection between land use and water quality, and assigned major roles to local governments for implementing the Plan. The Growth Management Act (GMA), which was adopted in 1990 and amended in 1991, further strengthened these linkages and required that local land-use plans include provisions for protecting water quality. The 1994 Plan clarifies and enhances local governments' opportunities for protecting water quality through GMA activities.

The 1994 Plan builds on the progress made in carrying out the 1987, 1989 and 1991 Puget Sound plans. The Plan updates and refines existing Plan programs to reflect the experience to date in implementing them. Status sections under each program have been eliminated in an effort to streamline the 1994 Plan. Instead, the Authority will periodically issue Plan status reports.

State law calls for the Puget Sound Water Quality Authority to terminate on June 30, 1995, but the Puget Sound Plan specifically is exempted from this "sunset." Unless the state Legislature directs otherwise, the 1994 Puget Sound Plan will become the final comprehensive plan for protecting Puget Sound, and "the implementation of the plan...shall be the responsibility of such entities as are provided by the Legislature" (RCW 90.70.902).

The Plan is organized into four chapters. Chapter 1 provides an introduction to the Plan, discusses strategies for Plan implementation, and describes coordination with other planning programs. Chapter 1 provides a characterization of Puget Sound's health based on data from the Puget Sound Ambient Monitoring Program. The expanded and updated action plan, and priorities for the Plan, are contained in Chapter 2. Chapter 3 discusses the unfinished agenda. A glossary, list of acronyms, key to program element numbers and index are provided at the end of the document.

PLAN HISTORY

The Authority based previous plans on a number of key findings about Puget Sound's water quality. Programs were developed to address major concerns,

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such as pollution from point and nonpoint pollution sources, loss of wetlands, and shellfish protection. While much progress has been made in implementing these programs, the Sound's problems are long term and the solutions will necessarily be long term as well. A list of key findings is included here as a reminder of the problems in Puget Sound that require continued attention.

Key findings upon which the Plan is based include:

- Most pollution is not "flushed" from the Puget Sound system. Water and pollutants are recirculated within Puget Sound, and some inlets and bays experience only limited tidal exchange.

- Since the Authority began its work in the mid-1980s, population in the Puget Sound region has grown by more than half a million people. By the year 2010, population is expected to grow by another million. Roughly 60 percent of this growth will come from in-migration and 40 percent from natural increase.

- Land-use forecasts suggest an increase of 62 percent for urban use and 73 percent for rural non-farm use by the year 2000. Most of this intensively used land is projected to be in the central Puget Sound region.

- Toxic contaminants bind to particles and settle out of sediments. Concentrations of toxicants in sediments in the Sound's urban bays are elevated 100 times or more over the levels in the cleanest rural bays.

- High concentrations of toxic contaminants in sediments have been associated with adverse biological effects in fish in urban bays, including fin erosion, liver tumors and reproductive failures.

- While substantial progress has been made toward limiting conventional pollutants in discharges, and progress is beginning to be made toward limiting toxic pollutants, the discharge of toxic substances is not yet effectively controlled.

- More than 1.5 trillion gallons of mostly untreated stormwater runoff flows into Puget Sound each year—five times the volume of treated discharges from sewage and industrial treatment plants. With the storm water comes approximately 4,800 tons of toxic substances. In addition, high volumes of storm water and the excess sediments it carries can wipe out fish habitat and bury shellfish beds.

- In the last decade, pollution claimed close to 40 percent of Puget Sound's commercial shellfish beds. Pollution sources include failing on-site sewage (septic) systems, animal wastes and contaminated storm water. The Department of Health estimates that there may be well over 450,000 on-site sewage systems in the Puget Sound basin; more than 10,000 are being added each year.

- Over half of the Sound's original wetlands have been lost. The Department of Ecology estimates that between 716 and 2,034 acres of wetlands

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are lost each year in Washington state. The rapid rate of population growth in the Puget Sound basin poses a great threat to remaining wetlands. In some watersheds, the only developable land left is not land at all—it is wetland.

MANAGEMENT SUCCESSES

Despite the problems cited, there are significant success stories where water quality has been improved around the Sound. Industrial and municipal pollution controls have had dramatically positive results. Individual and local efforts have also begun to reduce sources of nonpoint pollution in some areas. There has been considerable progress in implementing the Puget Sound Water Quality Management Plan. As a result:

- We are starting to see a turnaround in the health of shellfish beds; this after years of watching the Sound's valuable shellfish resources being lost to pollution.
- Nine cities are implementing programs to reduce overflows from combined sewers, which will significantly reduce pollution entering Puget Sound during storms. The results are clearly evident in the less contaminated sediments associated with these discharges.
- Stable, long-term sources of funding, such as clean water districts and stormwater utilities, are making it possible for cities and counties to abandon piecemeal efforts to protect water quality for a much more comprehensive approach.
- Prior to 1987, storm water was barely considered a threat and very little effort was made to manage it. By the end of 1994, 101 of the more than 120 jurisdictions in Puget Sound had started to control storm water.
- Local communities have taken charge of their watersheds and, as a result, we are starting to get a good handle on sources of nonpoint pollution from the watersheds that surround Puget Sound.

STATE OF THE SOUND

Nestled between the Cascade and Olympic Mountains in northwest Washington, the Puget Sound basin covers more than 16,000 square miles. Eighty percent of the area is land and the rest water. Puget Sound was carved by glaciers to depths of over 900 feet and has close to 2,250 miles of shoreline. The Sound receives its deep, salty water from the Pacific Ocean. Circulation is driven by an average annual fresh water input of 39 million acre-feet and mixed by a daily tide range of almost 12 feet.

The overall health of Puget Sound has not changed much since 1991. The fact that water quality, in general, has not worsened is due largely to the ongoing efforts of state and local governments, citizens, tribes, businesses and others to manage and prevent pollution sources. Left unprotected, the Sound's water quality would no doubt have continued the downward spiral it was in when the Authority was formed in 1985.

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This does not mean, however, that Puget Sound is free of problems. The Puget Sound Ambient Monitoring Program (PSAMP) has found that, as the human population expands, signs of contamination are emerging in places that were once considered immune to pollution—areas such as rural bays and the deep basins of the Sound. Closures of shellfish beds to harvesting, diseases in bottomfish, and decreases in the abundance of some seabirds and fish—it is hard to ignore the cumulative effects of human activities on Puget Sound's resources.

Chemical Contamination — Past monitoring has shown that chemical contamination poses a serious threat to Puget Sound. For example, birds show significant increases in tissue contaminants when feeding in Commencement Bay sediments, and salmon migrating through urban estuaries may retain toxic contaminants for considerable periods of time, leading to lowered growth and survival rates.

The worst chemical contamination occurs in the sediments of urbanized bays. Sediments in portions of four urban bays—Commencement Bay, Eagle Harbor Elliott Bay, and the area near the Naval Shipyard in Sinclair Inlet—are so contaminated that they have been declared Superfund sites by the Environmental Protection Agency (EPA). Throughout the Sound, most urbanized bays violate some sediment standards for metal or organic contaminants.

Fecal Contamination – Fecal coliform bacteria, found in mammal feces, indicate the possible presence of disease-causing bacteria and viruses in marine and fresh waters. Improperly sited or maintained on-site sewage systems (septic systems), sewage treatment plant malfunctions and combined sewer overflows, untreated boat-waste discharges, urban stormwater runoff, and marine mammal, improperly managed waste from pets and farm animals all have the potential to introduce fecal matter into nearby waters.

Fecal contamination is a tremendous problem that affects every part of the Sound, and sources of fecal coliform bacteria can be expected to increase as the population continues to grow. Increased monitoring in recent years has greatly expanded our knowledge of fecal contamination, enabling state, local and tribal governments to more effectively address problems in their communities. One of the first upgrades of shellfish beds closed during the past decade occurred in 1992 at North Bay in Case Inlet. Several other recent upgrades seem to mark a turning point in the struggle to reduce fecal contamination. Since 1989, the state Department of Health has upgraded more than 6,500 acres of commercial shellfish beds in Puget Sound.

Nearshore Habitat Composition and Coverage – Nearshore habitats are critical to the health of Puget Sound and its marine life. They provide shelter, and are used as spawning, rearing and feeding grounds for species that live in and around the Sound—including fish, shellfish, birds and marine mammals. In addition, nearshore habitats protect the shoreline from erosion, filter pollutants from the water, and, in the case of salt marshes, they reduce flooding by retaining storm water during high flow periods.

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Although not much data exists regarding the types and amounts of nearshore habitats, or the rate at which they are being destroyed, studies have documented a 73 percent decline in the area of Puget Sound covered by salt marshes, and that nearly all salt marsh habitats have been destroyed in river deltas within major urban areas.

Abundance of Biological Resources – Monitoring the abundance of biological resources is in the early stages. The limited data available, however, suggest that there is a wide degree of variation in the health of Puget Sound's marine populations. Salmon populations, for example, are seriously threatened by human activities, and require immediate protection. Nine Puget Sound salmon stocks have gone extinct, and many more are threatened. Many Puget Sound populations, such as the marbled murrelet, are on the federal endangered species list. On the other hand, a few populations are undergoing dramatic improvements in response to protection and management programs. The number of young bald eagles born each year in the Puget Sound basin has increased by over 400 percent since 1980.

Conventional Water Quality – Conventional water quality problems are generally caused by contaminants other than toxic compounds such as metals and organic chemicals. They include oxygen depletion, sedimentation, excessive acidity or alkalinity, and high water temperatures.

One of the most prevalent conventional water quality problems is eutrophication. In simple terms, eutrophication is the excessive organic enrichment, or overfertilization, of a water body. Fortunately, the large degree of water movement in Puget Sound has kept eutrophication to a minimum. In the open bays and basins of the Sound, waters tend to be well-mixed and exchange freely with the Pacific Ocean via the Strait of Juan de Fuca.

Within Puget Sound, signs of eutrophication are evident primarily in poorly-mixed bays, such as Budd Inlet and Hood Canal, and in some shallow nearshore areas. Evidence of eutrophication in these water bodies is primarily reflected in low dissolved oxygen concentrations.

THE ACTION PLAN

The purpose of this Plan is to restore and protect the biological health and diversity of Puget Sound. The strategy for achieving this purpose is to protect and enhance the Sound's water and sediment quality, its fish and shellfish, and its wetlands and other habitats.

Priorities

The Authority has established broad priorities for the Plan which are listed in alphabetical order:

- Assess the environmental conditions of Puget Sound, its resources, and the effects of human activities on them.
- Clean up existing toxic contamination where sources are controlled.

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- Continue Plan programs that have been started and maintain current funding levels for them.
- Control sources of toxic contaminants to Puget Sound.
- Enhance the protection of shellfish beds.
- Ensure the protection of wetlands and aquatic habitat. Stop losses of wetlands and other aquatic habitat.
- Improve the control and cleanup of nonpoint source pollution in the Sound.
- Prevent spills in the Sound and enhance the capability to respond to spills when they occur.
- Provide long-term support for research and education.
- Support and improve education and public involvement programs in order to inform, educate and involve citizens of the region and the state in the cleanup and protection of Puget Sound.

The Authority has also initiated the *Action for Puget Sound* campaign, which focuses additional attention on issues which require immediate action, such as degraded water quality in watersheds, failing on-site sewage systems, storm-water runoff and the loss of valuable wetlands. This campaign complements the 1994 Plan priorities.

PLAN PROGRAMS

The Plan's programs, and significant changes to the 1991 version of each program, are summarized below.

Estuary Management and Plan Implementation

Managing and protecting an estuary like Puget Sound is a complex undertaking. Federal, state, local and tribal governments, businesses, individuals and organizations all have roles, responsibilities and interests.

The Estuary Management and Plan Implementation Program establishes the framework coordinating this challenging task. It: (1) formalizes the existing Puget Sound Estuary Program management structure; (2) proposes several new financing options to provide adequate funding for the Puget Sound Estuary Program and the Plan; (3) requires accountability by implementing agencies; (4) provides for strong enforcement at all levels of government; and (5) seeks to ensure that federal activities, including the operation of large federal facilities, are consistent with the Plan.

The 1994 Plan makes the Puget Sound Plan's implementation tracking system more efficient and improves coordination of funding efforts.

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Fish and Wildlife Habitat Protection

No less than 22 federal and 20 state laws, along with tribal treaty rights, local laws and ordinances, and private programs help protect non-wetland aquatic fish and wildlife habitat. The Fish and Wildlife Habitat Protection Program attempts to coordinate these laws and ordinances. Program elements call for interagency sharing of habitat data, a broad-based education strategy, increased field investigations, and greater public involvement.

The 1994 Plan articulates the role of the Growth Management Act in protecting habitat at the local level; eliminates the habitat task force, but provides for an alternative method of coordination; and eliminates the call for public forums for hydraulic project approval permits.

Spill Prevention and Response

Modern industrial societies depend on large volumes of gasoline, motor and heating oils, solvents and other hazardous substances to function. These substances are routinely transported and stored in huge quantities, and can cause tremendous environmental damage when accidents happen. Puget Sound is no stranger to spills of oil and other hazardous substances. In addition to occasional large spills, such as the *Nestucca* spill in 1988, numerous small spills occur in the Sound every year.

The Spill Prevention and Response Program: (1) identifies the tools and resources needed to protect Puget Sound from spills and (2) sets forth a comprehensive spill prevention and response program using current regulations and enacting new legislation if necessary. Passage of the 1991 Oil Spill Prevention Act fulfilled several key elements of the Plan's spills program. The act established the Office of Marine Safety and the Marine Oversight Board, improving the state's expertise on vessel safety issues.

Numerous elements have been merged in the 1994 Plan to reflect completed assignments and ongoing activities that have been reassigned to newly established programs or agencies. The element addressing offshore oil and gas leasing was deleted, since no leasing can occur until at least the year 2000.

Monitoring

To assess the effects of human activities on Puget Sound and its resources, it is necessary to collect baseline and long-term data on the Sound's water, sediments, biological populations and habitat. Resource managers need accurate, up-to-date information on present conditions and changes over time to protect the resources from harm.

At the heart of the monitoring program is the Puget Sound Ambient Monitoring Program, which: (1) establishes an institutional structure to manage the monitoring program; (2) implements the monitoring program design, data management system and quality assurance plan recommended by the Monitoring Management Committee in April 1988; (3) collects, analyzes, interprets and reports data in a manner that is useful to water quality managers and to the public; and (4) reviews the monitoring program to ensure that the most appropriate and cost-effective monitoring elements are included.

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Changes from the 1991 Plan include: (1) restating program goals more clearly and include support of research as a goal; (2) amending language pertaining to the Monitoring Management Committee's involvement in the program; (3) clarifying procedures for revising implementation plans; (4) directing agency-intensive survey groups to use Puget Sound Ambient Monitoring Program data as a resource in defining problem areas in need of study; and (5) expanding the participants in the pesticides monitoring subcommittee.

Research

Research is essential for understanding Puget Sound and its associated watersheds, and for developing management options to protect the Sound in the future. The need to develop a comprehensive, coordinated program of research for Puget Sound was recognized in the earliest stages of developing the first Plan.

Current Research Program efforts: (1) maintain the Puget Sound Research Program in order to promote the coordination and funding of Puget Sound research; (2) establish a list of research priorities for Puget Sound which are periodically updated; and (3) assist in making the results of research available to decision-makers.

In the 1991 Plan, achieving the goals of the Research Program hinged on the establishment of the Puget Sound Foundation as the long-term means of funding and implementing program functions. The 1994 Plan replaces the Puget Sound Foundation with the Authority as an implementor of the program and reassigns to the Authority responsibilities for setting priorities and raising funds for the program. The 1994 Plan establishes a research grants program and calls for the continuation of results dissemination. It also expands the program to include research elements of other Plan programs.

Education and Public Involvement

Education and public involvement are necessary components of a long-term management strategy for Puget Sound because they inform and enable individuals to make choices about how to protect water quality. The Education and Public Involvement Program includes: (1) a public-involvement policy to be followed by agencies and local governments; (2) increased resources to state agencies and tribal governments for coordinated education programs on marine and freshwater habitats, on water quality policy issues, and on volunteer action; (3) field agents to coordinate among local and regional education and public involvement programs; and (4) a Public Involvement and Education Fund (PIE Fund) to support short-term public involvement and education efforts of both private and public sectors.

The 1994 Plan includes a number of changes to the Education and Public Involvement Program. The education guidelines and public involvement policy have been changed to reflect the need for greater racial and cultural representation. Field assignments have been simplified and the coordinated training teams have been eliminated. Roles for the Governor's Council on Environmental Education and the Office of the Superintendent of Public Instruction have been updated. A new element has been added for coordination of federal agencies.

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Puget Sound Foundation

Efforts to establish the Puget Sound Foundation have been unsuccessful and the Puget Sound Foundation Program has been removed from this Plan. Refer to the Research Program for more information.

Household Hazardous Waste

The Household Hazardous Waste Program, which seeks to ensure full implementation of the Hazardous Waste Management Act, including waste reduction through oil recycling and conservative use of pesticides, has been incorporated in the Nonpoint Source Pollution Program.

Nonpoint Source Pollution

Nonpoint sources of pollution are on the rise in Puget Sound. They include failing on-site sewage (septic) systems, improper agricultural and forest practices, boating activities and marinas, stormwater runoff, and other sources. This program addresses nonpoint pollution sources through two approaches: (1) cooperative watershed planning at the local level, and (2) basinwide by pollution source.

Four major categories of changes have been made to the local watershed action program portion of the Nonpoint Source Pollution Program. The first involves separating and adding a specific goal and strategy for the watersheds, on-site sewage systems, agricultural practices, forest practices and marina/boater portions of this program. The second involves refinements to the local watershed action program to facilitate planning and implementation. The third gives new assignments to local governments regarding local programs for operation and maintenance of on-site sewage systems and marine sewage disposal facilities, and regarding assistance to commercial and noncommercial farmers, watershed monitoring, and private forestlands. The fourth set of changes adds new policies and language on integrating new federal legislation and Growth Management Act requirements with nonpoint source pollution and prevention in Puget Sound.

Local Watershed Action Program

The 1994 Plan encourages counties to cluster their remaining watersheds for planning and to initiate countywide monitoring programs. There are two new elements on integrating efforts to control nonpoint source pollution with growth management planning and the Section 6217 coastal nonpoint program, and new language calling for restoration and protection of salmon habitat, riparian areas and wetlands in watershed plans.

On-Site Sewage Systems

The 1994 Plan calls for local implementation of the revised state on-site sewage regulations, developing local programs for operating and maintaining on-site systems, increased emphasis on alternative technologies, establishing operational permit programs for large systems, and developing rules for managing biosolids.

Agricultural Practices

Revisions have broadened the emphasis to management of animal waste and other farming practices on commercial and noncommercial farms. The program continues to promote technical assistance and education programs

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through conservation districts, the WSU Cooperative Extension and the Natural Resources Conservation Service (formerly the Soil Conservation Service).

Pest Management
The Puget Sound Plan first addressed pesticides in 1991 with a call for pesticide-usage surveys and a pest-management information program, including research and education on integrated pest management. The 1994 Plan acknowledges the Urban Pesticides Initiative, an association of state and federal agencies concerned with the issues of pesticide use in urban settings.

Forest Practices
Several new major state and federal forestry watershed initiatives have been started since 1991. The Department of Natural Resources, with the Department of Ecology, is administering the Jobs for the Environment Program. The DNR is collaborating with the Department of Fish and Wildlife on the Watershed Restoration Partnership, a multi-million dollar grants program focused on salmon restoration. The Timber/Fish/Wildlife Agreement has improved agency coordination and serves as a continuing forum for addressing remaining issues. The 1994 Plan calls for local governments to address forestland conversion as well as technical assistance for small-forestland owners on best management practices.

Marinas and Recrational Boating
Changes to the 1994 Plan expand sewage disposal concerns in marinas to include waste recycling, clarify requirements for boater education, ensure coordination of programs that place pumpout stations around the Sound, improve effectiveness of the monitoring program, and increase awareness of no-discharge area designations.

Household Hazardous Waste
Formerly a separate program, household hazardous waste is now included in the Nonpoint Source Pollution Program. Under the program, local governments are required to have a management plan for household hazardous wastes, although the specifics are left to the discretion of local governments.

Shellfish Protection

Puget Sound is one of the most productive shellfish growing areas in the country. This program focuses on better protection of both recreational and commercial shellfishing. The Shellfish Protection Program includes: (1) adopting shellfish policies that will ensure that programs aimed at controlling sources of pollution protect shellfish; (2) responding to existing and potential shellfish contamination with aggressive restoration and protection programs; (3) monitoring commercial and recreational shellfish areas for toxic contaminants and indicators of pathogenic organisms; and (4) increasing public involvement and education in shellfish protection.

Several changes have been made to the Shellfish Protection Program. References to the "shellfish protection and closure response strategy" (required when shellfish growing areas are downgraded) have been deleted and replaced with language that clarifies assignments and better targets efforts at priority shellfish areas. The element discussing closure-response also has been updated

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to reflect a memorandum of agreement between the departments of Health and Ecology for closure response strategies, and to reflect the passage of the 1992 shellfish protection legislation. In addition, the recreational shellfish program has been updated to emphasize implementation of the Recreational Shellfish Action Plan. New language has been added that places equal emphasis on protection and restoration of both commercial and recreational shellfish resources. The funding source assessment has been deleted, since it is complete.

Wetlands

Wetlands are economically, biologically and physically valuable. They provide critical habitat for Puget Sound's marine life, including salmon. They can prevent flooding in watersheds, and they act as natural filters that cleanse storm water before it enters Puget Sound. Despite their value, more than half the wetlands along the coasts and riverbanks of Puget Sound have been destroyed or degraded by human activity, including farming and urbanization. The greatest threat to wetlands is the rapid rate of population growth—as more people move to the region, development will be necessary to accommodate the growth.

The program in the 1991 Plan called for protection of significant wetlands through: (1) preservation (purchase and other mechanisms); (2) local government regulatory programs that meet minimum state standards; and (3) a program for protecting wetlands on state-owned uplands and aquatic lands.

The 1994 Plan combines three elements to make it easier to fund administration and to promote preservation activities; encourage greater flexibility in mitigation projects to better compensate for wetlands impacts; assign new tasks relating to wetlands inventories and tracking; encourage greater consistency in the design and monitoring of compensatory mitigation projects; and update and clarify the wetlands restoration program.

Municipal and Industrial Discharges

Industries and municipal sewage treatment plants release about 900 million gallons of waste water, or effluent, into Puget Sound every day. Municipal and industrial wastewater discharges are often referred to as point sources of pollution because they are discharged to water bodies at a specific point by a pipe or ditch.

The Municipal and Industrial Discharges Program calls for extensive improvement in the effectiveness of the state's program to control point sources of pollution (including the pretreatment program) and emphasizes control of toxicants from both industrial and municipal discharges. The program: (1) requires that all waste discharge permits include appropriate monitoring requirements and limitations on toxicants and other pollutants of concern, and (2) devotes substantially increased resources to the inspection and enforcement of waste discharge permits for industrial and municipal discharges throughout the Puget Sound basin and to the discovery and control of unpermitted or illegal discharges.

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There are a number of changes from the 1991 Plan. In some cases, requirements, such as the adoption of sediment standards, and changes in waste-discharge permit fees and pretreatment, are substantially under way or were completed. Other changes update tasks or clarify assignments. These include effluent limits, public notice, urban bay action teams, data management, enforcement, training, public outreach, and technical outreach to dischargers. Portions of two elements have been merged to more efficiently address industry self-monitoring. A new element that addresses alternatives to sanitary discharge to marine waters has been added.

Contaminated Sediments and Dredging

Toxic contaminants accumulate in sediments in the Puget Sound basin, causing harm to bottom-dwelling organisms and threatening the rest of the food web. Dredging to maintain navigation channels spreads and relocates these contaminated sediments.

The Contaminated Sediments and Dredging Program includes: (1) classifying sediments that cause adverse biological effects; (2) implementing Sound-wide controls on sources of contaminants causing sediments to fail the sediment standards; (3) providing rules and sites for disposal of dredged materials; and (4) expanding the Urban Bay Action Program to provide additional source control and consideration of cleanup actions for existing areas of high sediment contamination levels.

Changes to the 1991 Plan provide additional flexibility in establishing standards for confined disposal, direct the Department of Ecology to further investigate the feasibility of multi-user access to large disposal projects, and direct urban bay action team efforts to be coordinated with baywide planning initiatives.

Storm Water and Combined Sewer Overflows

Stormwater runoff is a widespread pollution problem. As urbanization of the Puget Sound basin continues, the problem is increasing. Pollutants in storm water can include sediments, nutrients, bacteria, oils, grease, metals and other toxicants.

The Stormwater and Combined Sewer Overflows Program includes: (1) development of stormwater programs in urbanized areas of Puget Sound in a phased program starting with the largest cities; (2) requirements for all cities and counties to develop operation and maintenance programs, adopt ordinances for new development, and develop programs to educate people about storm water; (3) development of stormwater controls for state highways and federal facilities; and (4) requirements for all cities with combined sewer overflows (CSOs) in the Puget Sound basin to develop and implement plans providing for the greatest reasonable reduction of CSO events.

A number of key changes have been made to the 1991 Plan. The program has been edited overall for cost effectiveness, regulatory coordination and streamlining. Cross-programmatic coordination within watersheds is enhanced, as are links with the Growth Management Act. Habitat protection is emphasized and the need for vactor-waste disposal solutions is strengthened. Performance

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criteria for best management practices are added. And the departments of Fish and Wildlife and Natural Resources are required to approve the stormwater manual and identify the most critical watersheds for fish protection.

Laboratory Support

Many of the Plan's programs, such as monitoring and shellfish protection, depend on accurate and timely laboratory analyses. The Laboratory Support Program includes: (1) establishing a laboratory certification program administered by the Department of Ecology; (2) assuring that adequate laboratory support exists for agency and other sampling programs; (3) developing, updating and encouraging the use of protocols and guidelines to standardize data collection, analysis and transfer within Puget Sound; and (4) developing and encouraging the use of uniform quality assurance guidelines for data collected under all Puget Sound programs, including formation of a quality assurance/quality control working group.

The only change to the 1991 Plan assigns update and maintenance of Puget Sound protocols and guidelines to agencies and organizations with expertise. The Department of Ecology is assigned oversight responsibility.

PLAN FUNDING

Fully implementing the 1994 Puget Sound Plan would cost federal and state agencies and tribal and local governments approximately $251 million during the 1995-97 Biennium, and $291 million during the 1997-99 Biennium.

The cost projections for the 1994 Plan represent a significant increase over the projections that were included in the 1991 Plan. Most of the increase can be found in the Stormwater and Combined Sewer Overflow Program and the Nonpoint Source Pollution Program. Within these programs most of the increase is attributed to activities to be undertaken by local governments and the state Department of Transportation.

The Authority is concerned about continued funding shortages at all levels of government, which could hamper efforts to protect water quality. As protection efforts continue to be delayed and pollution continues to flow into Puget Sound, the future cost of cleaning and protecting the Sound continues to increase.

Much of the money for implementing the Puget Sound Plan comes from the state's General Fund. During the early years of the Plan, state funding gradually increased, but the economic recession of the 1990s took its toll on state revenues, leading to a series of budget cuts that have reduced appropriations for water quality programs. Successfully restoring and protecting water quality in Puget Sound will require new or additional financial resources at the state level.

The Puget Sound Plan calls for significant participation by local and tribal governments to achieve the Plan's goals, including developing and implementing watershed action plans and on-site sewage system programs, controlling stormwater runoff, and protecting wetlands and shellfish resources.

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Local and tribal governments require a long-term commitment of staff and funding for these programs. Local governments, in particular, are hampered in meeting these goals by local opposition to increased taxes and fees and by competition from other programs such as crime control, the justice system and public schools. Local activities do receive funds through state programs, such as the Centennial Clean Water Fund, but these generally are provided as seed money to allow local governments to initiate programs that will be supported using local resources.

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Chapter 1. Introduction

What is Puget Sound?

Puget Sound is an estuary—a semi-enclosed, glacial fjord where salt water from the ocean is mixed with fresh water that falls as direct precipitation or drains from the surrounding land. Made up of a series of underwater valleys and ridges called basins and sills, Puget Sound is deep, with an average depth of 450 feet. Its maximum depth (930 feet) occurs just north of Seattle. A relatively shallow sill at Admiralty Inlet separates the waters of the Strait of Juan de Fuca from the waters of Puget Sound proper.

While salt water enters primarily through the Strait of Juan de Fuca, freshwater sources include surface runoff, groundwater discharge and direct precipitation. A network of more than 10,000 streams and rivers drain into Puget Sound. Nearly 85 percent of the basin's annual surface water runoff comes from 10 rivers: the Nooksack, Skagit, Snohomish, Stillaguamish, Cedar/Lake Washington Canal, Green/Duwamish, Puyallup, Nisqually, Skokomish, and Elwha.

The waters of Puget Sound move in a typical estuarine pattern—seaward at the surface and landward at the lower depths. Fresh water from land enters the estuary and tends to flow over the denser seawater. Friction and turbulence cause the two to mix, creating a brackish (moderately salty) layer at the surface. The two-layer circulation system is disturbed by shallow sills that circulate water from the surface back into the depths of the basin; islands, narrow passages and a substantial tidal range of about 12 feet also influence circulation in the Sound. While the waters eventually move seaward (it takes about 150 days to replace the waters around Admiralty Inlet and as many as 300 days for the Hood Canal to flush out), most particles are permanently trapped in the basin and eventually fall to the bottom of the Sound.

Puget Sound is bordered by about 1,300 miles of shoreline, with a mix of beaches, bluffs, deltas, mudflats and wetlands. Estuarine shorelines form a bridge between land and ocean and are among the most productive systems in nature, providing food and shelter for a wide variety of species, filtering pollutants from land runoff, storing flood waters, and recharging groundwater supplies.

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STATE OF THE SOUND

Keeping Puget Sound healthy is a difficult job in the best of circumstances. But we are not dealing with the best of circumstances. The Puget Sound region is witnessing tremendous change. Between 1991 and 1993 the region's population grew by almost eight percent—from 3.3 million to 3.56 million residents. Another million people are expected to settle along the shores of Puget Sound in the next 20 years. This population growth has not been without consequence. Rural settings are being overwhelmed by housing and commercial developments. Forests and meadows are being replaced by roads, homes, office buildings and shopping malls.

How is Puget Sound doing under this pressure? Although virtually no area of the basin has escaped the effects of contamination and degradation, the overall health of Puget Sound has not changed much since 1991. The fact that water quality, in general, has not worsened is due largely to the ongoing efforts of state and local governments, citizens, tribes, businesses and others to manage and prevent pollution sources. Left unprotected, the Sound's water quality would no doubt have continued the downward spiral it was in when the Authority was formed in 1985.

This does not mean, however, that Puget Sound is free of problems. The Puget Sound Ambient Monitoring Program (PSAMP) has found that, as the human population expands, signs of contamination are emerging in places that were once considered immune to pollution—areas such as rural bays and the deep basins of the Sound. Closures of shellfish beds to harvesting, diseases in bottomfish, and decreases in the abundance of some seabirds and fish—it is hard to ignore the cumulative effects of human activities on Puget Sound's resources.

The PSAMP has been gathering information about the Sound's health for the past five years. These data are not enough to draw conclusions about changes in the health of Puget Sound, but over the next decade PSAMP will provide crucial measurements about the long-term trends in pollution and habitat loss throughout the Sound.

Following is a brief summary of important findings from the PSAMP. Findings are based on annual monitoring of five key indicators which measure the extent to which human activities adversely affect different parts of Puget Sound's ecosystem.

Chemical Contamination

Past monitoring has shown that chemical contamination poses a serious threat to Puget Sound. For example, birds show significant increases in tissue contaminants when feeding in Commencement Bay sediments, and salmon migrating through urban estuaries may retain toxic contaminants for considerable periods of time, leading to lowered growth and survival rates.

Although municipal and industrial discharges contribute significantly less chemical contaminants today than two decades ago, no treatment method can completely remove all traces of pollutants. For example, the best available technologies cannot remove highly toxic chlorinated dioxins, produced during

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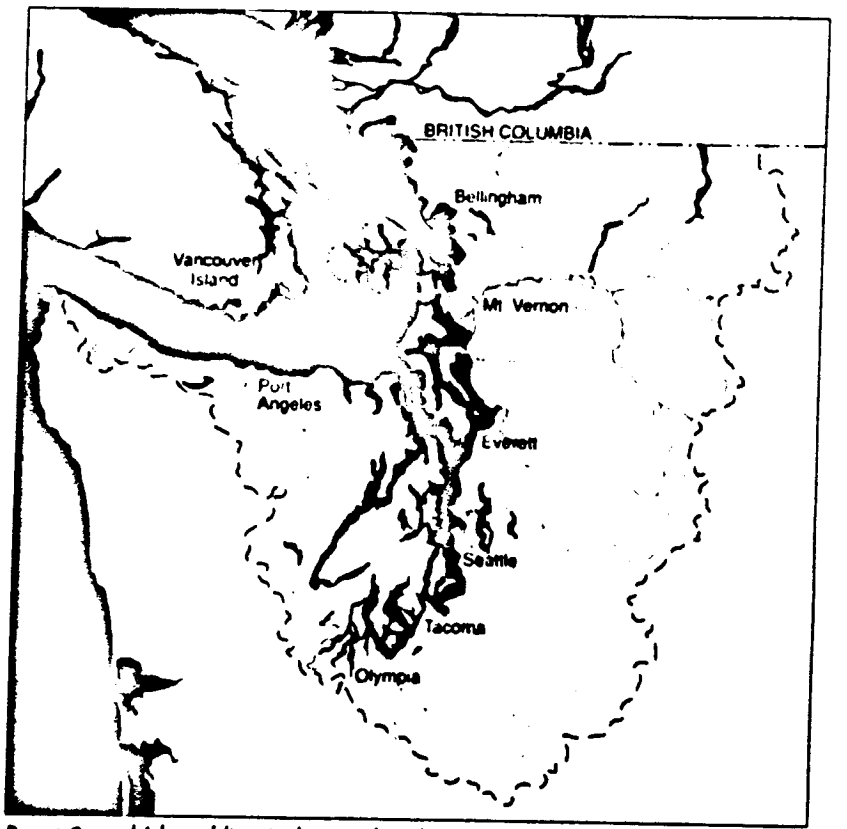

Puget Sound (dotted line indicates the planning area)

the paper bleaching process, in waste water to levels that are completely safe for the environment.

Improved environmental monitoring of potential chemical sources has revealed that many activities other than municipal and industrial discharges send significant amounts of metals and organic chemicals into Puget Sound every day. Improper disposal of household hazardous wastes and improper application of household pesticides and herbicides can contaminate the water. One of the biggest culprits is the automobile. Leaking oil, gasoline drips and spills, zinc and other metals contained in tires, and numerous compounds contained in exhaust are all deposited on roads and driveways. Rains then wash these compounds into storm drains, streams, and out to Puget Sound.

The worst chemical contamination occurs in the sediments of urbanized bays. Sediments in portions of four urban bays—Commencement Bay, Eagle Harbor Elliott Bay, and the area near the Naval Shipyard in Sinclair Inlet—are so contaminated that they have been declared Superfund sites by the Environmental Protection Agency (EPA). Throughout the Sound, most urbanized bays violate some sediment standards for metal or organic contaminants.

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Chemical contamination of these bays is especially troublesome because contaminants tend to settle rapidly, accumulating in sediments close to their sources. Contamination can be severe and long lasting in these areas because the toxic chemicals, for the most part, are not dissipating. However, because concentrations of contaminants diminish rapidly with distance from their source, the effects of toxic chemicals on the overall health of Puget Sound are not as severe. In recent years, however, PSAMP monitoring has found that low levels of contaminants are dispersing to sites far removed from their sources.

Another significant finding in recent years is that plant and animal life in Puget Sound can accumulate contaminants from sediments and in some cases experience adverse affects. Puget Sound harbor seals at one time had the highest measured levels of PCBs and DDTs (synthetic pesticides) in the world. These levels have decreased, but still remain high. English sole from several urban bays have an alarming prevalence of liver diseases. Birds wintering in Commencement Bay show significant increases in tissue contaminants over the four months in which they feed in Commencement Bay sediments.

Fecal Contamination

Fecal contamination is a tremendous problem that affects every part of the Sound, and sources of fecal coliform bacteria can be expected to increase as the population continues to grow. Fecal contamination has already claimed over 40 percent of Puget Sound's commercial shellfish beds. More than half of the harvest restrictions in commercial beds occurred during the last decade. Many of the recent shellfish bed closures or downgrades occurred because improved monitoring detected a problem that has existed for some time.

Fecal coliform bacteria, found in mammal feces, indicate the possible presence of disease-causing bacteria and viruses in marine and fresh waters. Improperly sited or maintained on-site sewage systems (septic systems), sewage treatment plant malfunctions and combined sewer overflows, untreated waste discharges from boats, urban stormwater runoff, and marine mammal, pet and farm animal wastes all have the potential to introduce fecal matter into nearby waters.

Increased monitoring in recent years has greatly expanded our knowledge of fecal contamination, enabling state, local and tribal governments to more effectively address problems in their communities. One of the first upgrades of shellfish beds closed during the past decade occurred in 1992 at North Bay in Case Inlet. Several other recent upgrades seem to mark a turning point in the struggle to reduce fecal contamination. Since 1989, the state Department of Health has upgraded more than 6,500 acres of commercial shellfish beds in Puget Sound.

The fact that many areas of Puget Sound continue to show historic levels of fecal coliform bacteria, however, indicates that contamination is still a problem. In a few of the 10 major rivers entering Puget Sound, bacteria levels are decreasing over time, but these decreases are not occurring in the rivers with the most serious, ongoing fecal contamination problems—the Nooksack River

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at Brennan, the Stillaguamish River at Silvana, the Sammamish River at Bothell, the Green River at Tukwila, and the Puyallup River at Tacoma.

Nearshore Habitat Composition and Coverage

Nearshore habitats are critical to the health of Puget Sound and its marine life. They provide shelter, and are used as spawning, rearing and feeding grounds for species that live in and around the Sound—including fish, shellfish, birds and marine mammals. In addition, nearshore habitats protect the shoreline from erosion, filter pollutants from the water, and, in the case of salt marshes, they reduce flooding by retaining storm water during high flow periods. Early in 1994, the marine science panel—a technical advisory panel to the governor of Washington and premier of British Columbia—ranked loss of nearshore habitats as the single highest priority affecting the health of Puget Sound.

Although not much data exists regarding the types and amounts of nearshore habitats, or the rate at which they are being destroyed, studies have documented a 73 percent decline in the area of Puget Sound covered by salt marshes, and that nearly all salt marsh habitats have been destroyed in river deltas within major urban areas.

While such studies provide important information about the extent of nearshore habitat losses in localized areas, there are still vast areas for which the present status of nearshore habitat coverage is unknown. The Washington Department of Natural Resources has been collecting data since 1991. As the information is processed and analyzed, a more comprehensive evaluation of Sound-wide habitat coverage will emerge, along with information about how this coverage changes over time.

Abundance of Biological Resources

Monitoring the abundance of biological resources is in the early stages. The limited data available, however, suggest that there is a wide degree of variation in the health of Puget Sound's marine populations. Salmon populations, for example, are seriously threatened by human activities, and require immediate protection. Nine Puget Sound salmon stocks have gone extinct, and many more are threatened. Many Puget Sound populations, such as the marbled murrelet, are on the federal endangered species list. Harbor porpoise—once abundant throughout the Sound—are rarely, if ever, seen in the central and southern portions of Puget Sound.

On the other hand, a few populations are undergoing dramatic improvements in response to protection and management programs. The number of young bald eagles born each year in the Puget Sound basin has increased by over 400 percent since 1980.

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Conventional Water Quality

Conventional water quality problems are generally caused by contaminants other than toxic compounds such as metals and organic chemicals. They include oxygen depletion, sedimentation, excessive acidity or alkalinity, and high water temperatures.

One of the most prevalent conventional water quality problems is eutrophication. In simple terms, eutrophication is the excessive organic enrichment, or overfertilization, of a waterbody. It is caused by excessive amounts of nutrients and organic matter, which stimulate the growth of algae or phytoplankton. When phytoplankton populations become very dense and die off, they may create problems such as depleted oxygen, fish kills and foul odors.

Fortunately, the large degree of water movement in Puget Sound has kept eutrophication to a minimum. In the open bays and basins of the Sound, waters tend to be well-mixed and exchange freely with the Pacific Ocean via the Strait of Juan de Fuca. Large tidal currents and the presence of sills prevent stratification (layering due to density differences) of the water column that promotes eutrophication.

Within Puget Sound, signs of eutrophication are evident primarily in poorly mixed bays, such as Budd Inlet and Hood Canal, and in some shallow nearshore areas. Evidence of eutrophication in these waterbodies is primarily reflected in low dissolved oxygen concentrations.

The rivers and streams within Puget Sound are highly susceptible to low concentrations of dissolved oxygen as well as other conventional water quality problems such as sediment loading, or high water temperatures. These problems take a high toll on salmon and trout populations, which are very sensitive to changes in water conditions.

Over the last several years, the Department of Ecology has found that many rivers in the Puget Sound basin do not comply with state water quality standards. However, Ecology also has evaluated the long-term trends in conventional water quality parameters, and found a number of improvements in the water quality of Puget Sound rivers over the last ten years.

MANAGEMENT EFFORTS

The 1980s marked a turning point for managing Puget Sound. After decades of rapid development, extensive habitat destruction, pollution-laden discharges, a population boom, and fragmented management efforts, the public became alarmed about the toll on the Sound.

Tumors and lesions were found in bottom-dwelling fish as sediments showed high levels of toxic contamination, particularly in urban bays. Salmon stocks were declining, or even becoming extinct, as crucial habitat and migration routes were altered or destroyed. Shellfish beds were closed due to bacterial pollution. Wetlands important for providing habitat, absorbing flood waters and recharging ground water were lost at alarming rates as land grew scarcer and more valuable.

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Compounding the problem was a poorly coordinated management framework in which numerous governmental agencies had resource management responsibilities in Puget Sound, but no single agency coordinated these activities. It was becoming increasingly clear that, despite significant public and private investment during the preceding decades, both a change in citizen behavior and a new management framework were needed.

In 1983, the governor appointed a 21-member board (known as the Puget Sound Water Quality Authority) to identify pollution-related threats to Puget Sound marine life, evaluate pollution threats to human health, and investigate the need to improve coordination among agencies responsible for protecting the quality of water in Puget Sound. In its 1984 annual report, the board recommended developing "a long-range coordinated plan...to protect and improve water quality throughout the Sound." In 1985, the Puget Sound Water Quality Act (Chapter 90.70 RCW) established the Authority as a state agency, restructured its board, and charged it with developing and overseeing implementation of a comprehensive management plan for Puget Sound and its related waterways.

In establishing the Puget Sound Water Quality Authority (the Authority), the Legislature found that:

- Puget Sound and related inland marine waterways of Washington state represent a unique and unparalleled resource.
- The consequences of carelessly handling estuarine resources have been dramatically illustrated elsewhere in the nation.
- The costs of restoring aquatic resources, where such restoration is possible, greatly exceed the costs of responsible preservation.
- Use of the Puget Sound resource carries a custodial obligation for preserving it.
- The large number of governmental entities that affect the water quality of Puget Sound have diverse interests and limited jurisdictions which cannot adequately address the cumulative, wide-ranging effects that contribute to the degradation of Puget Sound.

The goal of the Puget Sound Water Quality Management Plan is to restore and protect the biological health and diversity of Puget Sound. The strategy for achieving this purpose is to protect and enhance Puget Sound's water and sediment quality; its fish and shellfish; and its wetlands and other habitats.

The planning area includes Puget Sound south of Admiralty Inlet (including Hood Canal and Saratoga Passage); the waters north to the Canadian border, including portions of the Strait of Georgia; the Strait of Juan de Fuca south of the Canadian border; and all of the land draining into these waters. There are 12 counties in the planning area.

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The 1985 statute directed the Authority to revise the Puget Sound Water Quality Management Plan (Plan) every two years, and to include within it an evaluation of progress toward achieving the Plan's goals and a discussion of additional concerns. The 1991 Plan originally was scheduled to be the final project for the Authority, which would cease to exist after June 1991. However, legislation approved by the 1990 Washington State Legislature (Chapter 115, Laws of 1990) retained the Authority as an independent agency; extended its work through June 1995; and changed the schedule for Plan review to a four-year cycle, with a review due by July 1994. Upon reviewing the Plan, it is up to the Authority board to decide whether revisions are necessary.

The 1990 legislation expanded the Authority board to 11 members, all with voting privileges. Nine of the members are appointed by the governor, including one representative each from city, county and tribal governments, and one representative from each of the six Puget Sound-area congressional districts that existed prior to the 1992 redistricting. The director of Ecology, who presides at board meetings, and the commissioner of public lands are ex-officio members. The executive director is appointed by the governor and supervises the work of Authority staff, but no longer serves as a board member.

The 1990 statute also changed the structure of the Authority board. Previously, the board had nine members: seven voting members appointed by the governor (these included the executive director of the Authority and representatives of each of Puget Sound's six congressional districts), and two ex-officio, nonvoting members (the Department of Ecology's director and the commissioner of public lands). The executive director presided over board meetings.

HISTORY OF THE PUGET SOUND PLAN

The first Puget Sound Plan was adopted on December 17, 1986 (known as the 1987 Plan) and revised in 1989, 1991 and 1994.

Each edition of the Plan is developed with an extensive planning process that includes as many interested parties as possible. Informal consultations are held with representatives from local and tribal governments, state and federal agencies, industry, trade groups, community groups, environmental organizations, and citizens. Numerous public hearings and meetings are scheduled throughout each Plan-adoption period.

Some of the major issue areas addressed in the 1987 Plan included contaminated sediments and dredging, stormwater, protection of wetlands and shellfish, education and public involvement, and "point" and "nonpoint" sources of pollution. (Point sources generally come out of a pipe, nonpoint refers to pollution that comes from other sources, such as runoff, on-site sewage systems and boats.) A section was devoted to examining the "unfinished agenda"—issues for which the Authority lacked the time and resources to develop Plan programs. In 1987, those issues ranged from transboundary pollution to the effects of air pollution on the Sound.

The 1987 Plan also directed the Authority to develop three new programs that were crucial to implementing the Puget Sound Plan: 1) a comprehensive,

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ambient monitoring program for the Sound; 2) a long-range strategy for education and public involvement related to Puget Sound; and 3) a system of priorities and funding for research. The 1989 Plan, adopted on October 19, 1988, added these three issues as new Plan programs. Existing programs continued with minor modifications.

The 1991 Plan, adopted on November 21, 1990, built on the progress achieved under the 1987 and 1989 plans. Programs were added to address overall estuary management and to protect fish and wildlife habitat. In addition, the Plan called for creating a non-profit Puget Sound Foundation to provide centralized, long-term support for research and educational strategies.

This 1994 Plan is the first in which no new programs were added. In fact, the program that called for establishing a Puget Sound Foundation has been eliminated due to the inability to secure funding from private or public sector sources. Other amendments incorporated into the 1994 Plan include making due dates in the Stormwater Program consistent with the state's Growth Management Act (GMA); coordinating other parts of the Plan with the GMA; requiring the Department of Ecology to develop a policy on alternatives to discharging sewer wastes into marine waters; coordinating the Plan with the federal Coastal Zone Act Reauthorization Amendments; expanding the role of local governments in managing nonpoint pollution sources; and updating and refining a number of program elements.

State law calls for the Puget Sound Water Quality Authority to terminate on June 30, 1995, but the Puget Sound Plan specifically is exempted from this "sunset." Unless the state Legislature directs otherwise, the 1994 Puget Sound Plan will become the final comprehensive plan for protecting Puget Sound, and "the implementation of the plan...shall be the responsibility of such entities as are provided by the Legislature" (RCW 90.70.902).

NATIONAL ESTUARY PROGRAM

Puget Sound has long been considered a national treasure, and the degradation of its waters and resources has been of concern not just locally, but at the federal level as well.

In 1986, the U.S. Environmental Protection Agency (EPA), the Department of Ecology and the Authority formed the Puget Sound Estuary Program (PSEP), through which the three agencies co-manage protection efforts in the Sound. In 1987, Congress created the National Estuary Program in the Federal Clean Water Act to provide a framework for protecting significant estuaries throughout the country. In March 1988, Puget Sound was designated by EPA as a member of the National Estuary Program (NEP), and the PSEP was designated as the management body for NEP efforts in the Sound. Those efforts initially were to focus on developing a Comprehensive Conservation and Management Plan (CCMP) for Puget Sound.

The state-mandated Puget Sound Water Quality Management Plan, which had already been developed by the Authority, became the basis for the federal plan. After additional improvements were incorporated into the Authority's Plan in 1991, the EPA approved it as the federal CCMP for Puget Sound, making it

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the first estuary plan in the country to receive federal approval. Few estuaries encompass as many political jurisdictions (more than 120 cities and counties and 16 tribes in the Puget Sound basin), or involve as many different types and sources of pollution.

Puget Sound also is unique in having a state agency develop and oversee the comprehensive protection plan; the other NEP programs are coordinated by the EPA, with less state involvement. The Authority has pioneered programs for addressing the Sound's complexities. As a result, the Puget Sound Plan and the Authority have become models for other estuary programs, and Authority staff members frequently are called on to advise officials at those programs.

The PSEP committee continues to meet every other month. Federal law requires using a management group only for developing the management plan, but the Authority believes the committee has an important role in overseeing implementation and ensuring ongoing communications between the three lead agencies.

THE PLANNING FRAMEWORK

The Puget Sound Water Quality Management Plan is developed by the Puget Sound Water Quality Authority, but it is implemented by state and federal agencies, Indian tribes, and local governments. All are given specific assignments in the Plan, based on the nature of their missions and institutional authority. They work with industry, businesses, organizations, schools and private citizens to collectively achieve the goals of reducing pollution and protecting biological resources in Puget Sound.

There is a growing appreciation for how environmental issues are interconnected. Water quality is difficult to separate from issues related to water quantity, air quality, growth and development, endangered species, habitat preservation, farm practices, forest management, and hazardous wastes. The challenges to achieving the goals of the Puget Sound Plan are to gain the cooperation of the various government agencies and other groups, and to coordinate Plan actions with their ongoing related activities.

As a matter of practice, the Authority seeks to coordinate with other planning programs on issues that affect the overall water quality of Puget Sound (e.g., the Puget Sound Dredged Disposal Analysis, the Timber/Fish/Wildlife Agreement, and the proposal to establish a marine sanctuary in the northern waters of Puget Sound). Since adopting the 1991 Plan, the Authority has worked to coordinate with federal and state watershed initiatives, growth management, and efforts to control nonpoint pollution sources in coastal areas.

Watershed Management

In recent years, many agencies and governments have realized that they need better processes for making decisions about resources, including water quality. Primarily, their decisions and activities need to be better coordinated to reduce duplication and to provide comprehensive, rather than fragmented, protection for natural resources. In the search for common ground, agencies and governments are looking beyond the bounds of political jurisdictions and instead

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using nature's own watershed borders as the basis for planning and making decisions.

Watersheds provide a geographic, resource-based focus that often crosses political jurisdictions and encourages cooperation. Furthermore, "watershed-based management" can be used to address a number of resource issues, not just water quality. Using watersheds as the decision-making unit offers certain advantages:

- Watershed boundaries relate to major resource issues, such as habitat, water quality and quantity, fish and wildlife migration, and sediment flow and accumulation.
- Watersheds can provide a common basis for making decisions across agency, government and program lines, and for recognizing their cumulative effects.
- Watersheds present a logical basis for fostering citizen understanding and stewardship for their environment.

Using watersheds also presents a number of challenges:

- New, interagency planning and agreement processes are needed to support decision making across political jurisdictions.
- Citizens and governments may feel excluded by resource management processes that don't have clear lines of accountability and responsibility.
- Characterizing resources and their conditions, and sharing program data within watersheds, may require that common assessment methodologies and data management systems be developed (existing programs use a variety of assessment and characterization protocols).
- Watersheds are not natural units for dealing with some resources, such as groundwater aquifers, which can cross watersheds.
- Islands have many small drainages, rather than a few major watersheds.
- Existing program standards may prevent trade-offs between competing resource protection goals, such as wetlands versus stormwater management.
- Funding sources often are dedicated to specific solutions and may not support administering, monitoring, evaluating and refining a watershed-based program
- The term "watershed" is defined differently by each program, so the size of the analysis unit varies greatly.

Water quality is managed by a mix of federal, state and local authorities. In some cases, separate federal, state and local programs address similar water

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quality issues. Some programs address multiple issues, including water quality.

The Puget Sound Plan itself is a "watershed plan," encompassing the entire watershed draining into Puget Sound. As one of the tools to help implement the Plan, the Authority adopted a rule in 1988 calling on local communities to identify their watersheds, rank them in order of importance, and develop and implement "action plans" for each of them to protect water quality. The Authority works closely with local governments to support these processes and to help coordinate their efforts with state activities.

As state and federal agencies become more involved in watershed management, the Authority must participate in their discussions, both to ensure that local watershed efforts are appropriately recognized and respected and to adapt the Plan to make the most of new watershed-based decision-making opportunities. Since 1991, state and federal agencies have launched or continued a number of significant watershed-related efforts[1]:

- Integrated landscape management for fish and wildlife—launched by the Department of Wildlife (now the Department of Fish and Wildlife) to replace the agency's species-by-species management approach. Watersheds are being used as the geographic boundaries for assessing the needs of priority habitats, fish and wildlife.

- State Wetlands Integration Strategy—the departments of Ecology and Community, Trade and Economic Development received a grant from the EPA in 1992 to coordinate wetlands protection among federal, state and local agencies.

- Department of Ecology's watershed approach to resource management—intergovernmental teams are being convened in selected watersheds to develop planning processes appropriate to the issues in those watersheds.

- Total maximum daily load (TMDL)—in accordance with federal law, the Department of Ecology will establish limits for how much pollution can be discharged into streams that violate water quality standards. Ecology plans to conduct the TMDL review process within the framework of its watershed approach (see above).

- Chelan Agreement—the 1990 agreement established a Water Resources Forum, which selected the Methow and Dungeness-Quilcene as pilot planning areas for which Ecology is developing regional water-use plans.

- Wild stock initiative—launched in 1992 by the now combined Department of Fish and Wildlife to encourage restoration of fish stocks and their habitats. Recovery options are being prepared for priority basins.

1 Briefing papers that describe most of these projects in more detail may be obtained from the Authority.

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- Closure response strategy for shellfish bed downgrades—the Puget Sound Plan directs the departments of Ecology and Health to work with local communities to develop a closure response strategy whenever a shellfish growing area is downgraded.

- Stormwater basin planning—three different efforts exist in the Puget Sound basin, one launched by local governments, one established by the Authority under state rule (400-12 WAC), and one achieved by Ecology through National Pollutant Discharge Elimination System permits. The goals and activities required under each effort differ somewhat.

- Landscape planning—launched in 1992 by the Department of Natural Resources to establish timber and nontimber management objectives for landscapes, and to analyze the effects of past, present and foreseeable activities on water quality and quantity.

- Forest Practices Act watershed analysis—adopted by the Washington Forest Practices Board in 1992 (under legislative mandate) to provide a means for assessing the potential or cumulative effects of forestry activities within a watershed.

- Central Puget Sound water planning—initiated by the Governor's Office in 1993 to recommend ways to manage water resources in King, Pierce, Snohomish and Kitsap counties.

- Federal forest plan—the U.S. Forest Service has formed provincial teams (with representatives of federal, tribal, state and local governments and interest groups) to implement President Clinton's forest plan in targeted, forested watersheds.

- Puget Sound 400-12 Watershed Action Program—established by the Authority in 1987 and administered by the Department of Ecology. The 12 counties bordering Puget Sound have identified 131 local watersheds as priorities for protection, and gradually "action plans" are being developed and implemented for each of them. By December 1994, 20 plans had been approved by Ecology for implementation, and another 17 were being developed.

- Puget Sound Plan—the Nonpoint Source Pollution Program contains a watershed-based management program for reducing pollution in runoff; the Contaminated Sediments and Dredging and the Municipal and Industrial Discharges use "urban bay action teams" to control sediment contamination in urban bays; and the Stormwater and Combined Sewer Overflows Program recommends local basin planning for managing storm water.

While water quality is not the primary focus of all of the efforts listed above, each will directly affect water quality. The continuing challenge for the Authority is to ensure that new approaches to watershed management are coordinated with the Plan. The Plan should play a strong role in guiding and coordinating processes that take a watershed-based approach to protecting water quality.

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For example, water quantity is an emerging issue that has strong connections to water quality. Interbasin transfers, in-stream flows, and using conservation rather than reappropriation to enhance stream flows are all water quantity issues that directly affect water quality. The Authority will participate in new watershed programs and forums like these as appropriate.

The Authority is a member of the Watershed Coordinating Council that was established by the Legislature in 1994. The council is to present recommendations to the Legislature by December 15, 1994, on coordinating watershed planning and activities. Based on the council's recommendations and any legislative action on watershed management, the Authority will consider the need to revise the Plan before July 1995.

Growth Management

Local land-use decisions control where, what, when and how new development will occur, and they significantly influence water quality—in rivers, lakes, aquifers and Puget Sound. Given the growth trends in the Puget Sound basin, managing the effects of new development is critical to protecting or improving water quality in Puget Sound.

Previous versions of the Puget Sound Plan recognized the connection between land use and water quality, and assigned major roles to local governments for implementing the Plan. The Growth Management Act (GMA), which was adopted in 1990 and amended in 1991, further strengthened these linkages and required that local land-use plans include provisions for protecting water quality. The 1994 Plan clarifies and enhances local governments' opportunities for protecting water quality through GMA activities.

The GMA process directly and indirectly benefits water quality:

- The GMA requires that zoning and other development regulations be consistent with local governments' comprehensive plans. Consistency between planning and implementation will encourage consideration of the cumulative effects of development.

- The land-use elements of comprehensive plans are required to "...review drainage, flooding and stormwater runoff in the area and nearby jurisdictions and provide guidance for corrective actions to mitigate or cleanse those discharges that pollute waters of the state, including Puget Sound or waters entering Puget Sound." (RCW 36.70A.070)

- The GMA requires that critical areas and natural resource lands be protected. GMA regulations define critical areas to include wetlands, aquifer recharge areas, frequently flooded areas, geologically hazardous areas (including erosion hazard areas), and fish and wildlife habitat-conservation areas (including shellfish beds).

- The GMA requires that urban growth areas be established to control sprawl and to encourage cities and counties to coordinate their planning decisions. This will better protect open space and critical wetlands.

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- The GMA requires local governments to show how they will finance the level of development proposed in their comprehensive plans, including paying for stormwater controls.

The Puget Sound Plan assigns local governments major roles in protecting wetlands, preventing water pollution, controlling storm water and protecting shellfish. These assignments include planning, regulation, education, remediation and enforcement activities. Appendix D illustrates the link between the GMA process and Plan assignments.

The Puget Sound Water Quality Authority coordinates the Plan with the GMA process in several ways:

- Educating local governments about their Plan assignments and their relationship with the GMA process.
- Providing informal review and comment to local governments on preliminary GMA products.
- Coordinating with other state agencies to provide technical assistance to local governments.
- Providing formal comments on GMA products submitted to the Department of Community, Trade and Economic Development (DCTED) for state review.
- Helping the DCTED develop model comprehensive plans.

Coastal Zone Act Reauthorization Amendments (Section 6217)

In 1990, Congress revised the federal Coastal Zone Management Act (CZMA) through the Coastal Zone Act Reauthorization Amendments (CZARA). The amended law requires states with federally approved coastal zone management programs to develop additional programs for controlling nonpoint pollution sources in coastal areas. The purpose is to restore and protect coastal waters from pollution by implementing economically achievable management measures.

The EPA and the National Oceanic and Atmospheric Administration (NOAA) have provided official guidance to states describing what should be contained in their "coastal nonpoint pollution programs" and the process that will be followed in reviewing and approving them. States have until July 1995 to submit their implementation programs to the EPA and NOAA for review and approval. States that do not establish the programs will lose a percentage of their federal funding that is available through the federal Clean Water Act and the CZMA.

Implementation will be phased in over several years. Initially, the management measures are to be achieved by applying the best available technologies, practices, processes, siting criteria, operating methods or other alternatives. Six categories of management measures are covered by the EPA guidance: agriculture, forestry, urban (which includes storm water, on-site sewage

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systems, pesticides and household hazardous wastes), marinas and recreational boats, hydromodification (e.g., dams, dikes and measures to prevent bank erosion), and wetlands. In areas where the initial management measures fail to protect water quality or designated uses, the federal law calls for using additional management measures.

The Department of Ecology is responsible for developing Washington state's program and coordinating its implementation. The department also will assess the opportunities for using existing programs and whether new implementing authority is needed. At a minimum, Washington must show how the management measures will be implemented (the EPA encourages using technical assistance and public education rather than relying entirely on regulatory oversight); provide for using more stringent controls where the water quality standards and designated uses are not being adequately protected; and show that the state has the legal authority to ultimately enforce compliance.

The state's coastal nonpoint-pollution program will rely on a mix of state and local programs, including a wide variety of activities called for by the Puget Sound Plan. These activities are primarily in the Nonpoint Source Pollution, Stormwater and Combined Sewer Overflows, Wetlands Protection, and Public Involvement and Education programs.

The Puget Sound Plan's approach to nonpoint source pollution already has many similarities to the federal requirements, including an emphasis on using best available technologies in combination with technical assistance and public education. Appendix E illustrates which Plan program elements address the management measures called for by the CZARA. Many of the elements would directly implement the related management measure, some would indirectly implement them, and some would go beyond what is specified in EPA's management-measure guidance (e.g., extensive public education and involvement programs). Only a few of the management measures, such as dams, are not addressed at all by the Plan. It is expected that the state will rely on the Plan and other programs to implement the management measures.

The federal requirements apply statewide. The Puget Sound Water Quality Authority participates on Ecology's advisory committee and will recommend implementing the CZARA requirements in the Puget Sound basin through the Plan. Once the state finishes developing its program for protecting coastal areas from polluted runoff, the Authority will amend the Plan, if necessary, to improve consistency and coordination. Until the state's coastal nonpoint pollution program is in place, state and local agencies should consider incorporating the management measures into their land-development and land-use regulatory programs and watershed management efforts.

SUCCESSES FOR PUGET SOUND

Since the 1991 Puget Sound Water Quality Management Plan was adopted, the region has witnessed good news and bad news about Puget Sound. For example, shellfish harvesting has reopened in some areas, thanks to aggressive efforts by neighboring communities. In other areas, pollution has increased, causing shellfish beds to be closed. These events have illustrated the need for implementing the Plan throughout the Puget Sound basin, because the manage-

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ment and response strategies that have been linked most closely with upgraded water quality are contained in the Plan.

Numerous programs and activities to protect water quality have been launched during the past four years. Many are called for in the Plan, but some are "trickle-down" successes—legacies of the extensive public involvement and education efforts launched under the Plan that have raised public awareness about protecting Puget Sound. Following are many of the accomplishments of the past four years.

Laws, Regulations and Ordinances

- In 1991, the Legislature passed the Oil Spill Prevention and Response Act, requiring that plans be developed for preventing and, if necessary, quickly responding to spills in Washington's marine waters. The statewide Spill Contingency Plan was revised later that year; a damage assessment rule was adopted in 1992; and a policy on using oil dispersants was completed in 1993.

- To reduce the likelihood of boating and shipping accidents that could cause spills, regional marine-safety plans have been drafted and are being reviewed by the Office of Marine Safety. Also, the U.S. Coast Guard is preparing to adopt regulations that would allow "regulated navigation areas" to be established.

- In 1992, the Legislature adopted the Shellfish Protection Act, which was sponsored by the Authority. Among other things, the law requires that a county create a shellfish protection district any time a shellfish bed is downgraded. Within the district, property owners pay for services to eliminate sources of pollution and protect local waters. Several shellfish protection districts have been established, some voluntarily and others triggered by a shellfish bed closure.

- The Forest Practices Board, in 1992, revised its Forest Practices Rule to incorporate a new watershed analysis process, provisions to protect wetlands and streams, and limitations on the size and timing of clearcuts.

- In March 1994, the state Board of Health revised its regulations for on-site sewage systems. The new rules set standards for proper design, siting and installation of systems; call for installers and inspectors to be certified; and require that local governments establish programs to ensure that systems are routinely inspected and properly maintained.

- The Department of Ecology has improved its permits for point sources of pollution and its monitoring requirements, thereby reducing the amount of pollutants flowing into Puget Sound.

- As a Plan assignment, the Department of Ecology established state standards for sediments. They are the first of their kind in the country and are being used as a model in other states.

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- In accordance with the Plan, many local governments have strengthened their enforcement of existing water quality laws and have adopted new ordinances to protect water quality and wetlands, to control storm water, and to reduce pollution in runoff. The Growth Management Act has played a large role in stimulating action.

Funding

- The Office of the Superintendent of Public Instruction received $250,000 from the EPA to develop materials for environmental education in public schools.

- In 1993, Washington's congressional delegation won approval of a special $800,000 federal appropriation to implement actions called for in the Plan. The Authority distributed about half the money to local governments as Puget Sound Action Grants; the remaining money was distributed to state agencies to provide pass-through grants for specific activities to support the Plan.

- In compliance with the 1990 law that reauthorized the Authority, the agency developed a process to set funding priorities each biennium for all of the elements contained in the Puget Sound Plan.

Education and Technical Assistance

- The Authority has continued administering the Public Involvement and Education (PIE) Fund Program, which supports projects that educate and involve people in protecting water quality. More than $2 million was awarded to 106 projects during the 1991-93 and 1993-95 bienniums. More than 200 projects have been launched during the eight-year history of the program. A citizen advisory committee helped review and select the projects, and the Authority published two volumes of case studies about the results.

- Five water quality field agents have been hired to provide coordination and technical assistance to local governments and citizens to carry out the Puget Sound Plan. The program is managed jointly by the Washington State University Cooperative Extension, the University of Washington's Sea Grant and the Puget Sound Water Quality Authority.

- The Authority developed guidance for local governments to use in developing wetlands protection programs. This guidance builds on Ecology's model ordinance, and provides more detail about non-regulatory measures that can be taken.

- Ecology produced a guidebook and offers ongoing assistance to advise local governments and land trusts about their options for preserving wetlands.

- Ecology issued a revised Shoreline Master Program Handbook in September 1993. Ecology and the State Parks and Recreation Commission have developed design standards for boat pumpout facilities. The Department of Health is developing guidance for disposing of sewage at marinas.

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- The Authority updated the directory of water quality resources and programs in Puget Sound, and now makes it available on computer disk or hard copy.

- Ecology completed its permit writers manual to improve the consistency of discharge permits issued by the department, and increased public outreach to encourage dischargers to obtain the necessary permits. Technical assistance for dischargers is being developed.

- Ecology completed a stormwater manual and offered workshops to help local governments develop stormwater programs and ordinances called for by the Plan.

- The Authority developed handouts to describe how local governments can incorporate actions called for under the Puget Sound Plan into the county wide policies, comprehensive plans and development regulations required by the state Growth Management Act.

- The Authority and the Washington Department of Transportation cooperated in a pilot project to present water quality information aboard Washington ferries.

- Information about issues related to protecting Puget Sound are reported by the Authority throughout the year in the *Sound Waves* and *Puget Sound Notes* newsletters.

- The Authority developed and distributed a guidebook and offered workshops to local governments on how to finance water quality programs.

- The Authority maintained its commitment to education and outreach by devoting considerable staff time to working with local governments, community groups and businesses to educate them about the Plan and how to implement it.

Local Communities

- Since the 1991 Plan was adopted, 11 more local watershed committees have begun developing protection plans for their local watersheds, and the Department of Ecology has approved another nine for implementation. A total of 36 watersheds are being addressed under the Authority's Nonpoint Source Pollution Program. Nearly half have plans that are being implemented.

- About 65 percent of the more than 120 local governments in the Puget Sound basin have established stormwater programs.

- Restoration work is under way at three sites in the Duwamish River and on Spencer Island in Snohomish County. More than 50 acres of intertidal wetlands will be restored, using funds that were leveraged from federal, state, local and private sources.

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- Water quality improved in Burley Lagoon (Kitsap/Pierce counties), North Bay (Mason County), Dosewallips State Park, and South Skagit Bay, thus allowing commercial shellfish harvesting to reopen. Several more shellfish beds were reopened after potential pollution threats were eliminated.

State Agencies

- During the 1991-93 Biennium, the Department of Natural Resources acquired approximately 96 acres of wetlands using money appropriated for implementing the Plan.

- Ecology established a process for accrediting laboratories. More than 200 labs have applied to Ecology for accreditation, and major dischargers are now using accredited labs.

- Urban bay action teams established by Ecology have completed plans for addressing water quality and habitat problems in Elliott Bay, Commencement Bay, Sinclair and Dyes inlets, Port Gardner, Bellingham Bay and Budd Inlet. However, budget cuts have hampered efforts to implement those plans.

- The Department of Health annually produces an inventory of commercial and recreational shellfish areas in Puget Sound, but until this year had not issued classifications for the recreational beds. In May 1994, the department issued classifications for 71 of the 140 recreational shellfish beds located in Puget Sound.

- In accordance with the Plan, the departments of Ecology and Health completed an interagency agreement in January 1993 for responding to downgrades of shellfish beds. Under this system, strategies were completed for the lower Nisqually and lower Hood Canal watersheds in 1993.

- The State Parks and Recreation Commission is gradually installing boat waste pumpouts in state parks around Puget Sound, and is managing grant programs to install pumpouts in public and private marinas. The Authority, through the PIE Fund, supported a project to invent portable pumpouts to make it easier for boaters to dispose of their wastes properly. State Parks also conducts an ongoing education program. The Department of Health has conducted some monitoring to assess the effects of boating activities, and in 1993 completed a survey of the effectiveness of pumpout facilities.

The Authority

- In accordance with a requirement of the 1990 law that reauthorized the Authority, the agency coordinates the Puget Sound Ambient Monitoring Program and has published five annual reports (*Puget Sound Update*) on data that has been gathered. An advisory committee helps manage the program.

- A geographic information system (GIS) for centrally storing data about Puget Sound has been established and is being upgraded. So far, the

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Puget Sound Environmental Atlas and information about sediments, fish and shellfish have been loaded into the database.

- In June 1994, the Authority established a Puget Sound Hero awards program to recognize successful efforts to protect Puget Sound.
- The Authority developed a process for budgeting and reporting by state agencies; the process requires the agencies to prepare implementation plans and to report to the Authority every year on their progress in carrying out those plans. Compliance by the affected agencies has been mixed.
- The Authority started a project to gauge how much of the Puget Sound Plan has been implemented (the Measuring Results Project). The information was used by the board in deciding how to amend the 1994 Plan, how to set priorities as required by state statute, and how to best achieve implementation.
- In January 1994, the Authority adopted *Action for Puget Sound*, establishing an agenda of four priority issues that will be the focus of the agency's attention for the next two years. Through *Action for Puget Sound*, the Authority will seek progress toward repairing and eliminating failing on-site sewage systems, preserving wetlands, establishing stormwater programs, and implementing watershed plans and urban bay action plans.
- In 1992, the Authority created a citizens advisory committee to address marina and boating issues in Puget Sound.
- The Authority annually co-sponsors Washington Coastweeks (now Washington WaterWeeks), and sponsored a mini-grants program in 1993 and 1994 to help citizens carry out action-oriented projects as part of the month-long event ($6,000 was awarded over the two-year period).
- In accordance with state law, the Authority published a *State of the Sound Report* in June 1992.
- In 1993, the Authority produced a survey of citizen monitoring programs around Puget Sound.
- Key Bank and the Authority co-hosted a reception in December 1993 to celebrate the reopening of commercial shellfish harvesting in Burley Lagoon (Kitsap/Pierce County). The reopening was possible because water quality had improved following a 12-year effort by the community and local and state agencies to stem the flow of pollution into the lagoon.

Conferences

- In November 1992, the Authority hosted a conference about the Public Involvement and Education Fund (PIE Fund).
- In February 1993, the Authority hosted a conference on local watershed programs and how to improve planning and implementation. An advisory committee was formed to help plan the conference.

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- In January 1991, more than 1,000 people attended a Puget Sound research conference that was organized and hosted by the Authority. Another is scheduled in January 1995.
- The Authority, in cooperation with the law firm Heller, Ehrman, White & McAuliffe, hosted two Clean Water Act conferences, in June 1993 and June 1994.
- In 1992, the Authority helped organize a scientific conference in Bellingham entitled "Across the Border," addressing marine environmental conditions in Washington and British Columbia.
- The Authority helped organize the January 1994 "British Columbia/Washington Symposium on the Marine Environment," in Vancouver, B.C.

Other Accomplishments

- In 1991, the Puget Sound Water Quality Management Plan was approved by the U.S. Environmental Protection Agency as the Federal Comprehensive Conservation and Management Plan, making it the first estuary plan in the country to receive federal approval.

BARRIERS TO SUCCESS

Progress occurs one small step at a time, especially when it comes to protecting Puget Sound. Laws, programs and agencies already exist to control many of the principal sources of pollution and to protect wetlands and shellfish areas in Puget Sound. These efforts have reaped some success. For example, industry has significantly reduced its polluted discharges, families are doing a better job of properly disposing their household hazardous wastes, and the Legislature has authorized the use of shellfish protection districts to pay for eliminating pollution that harms local shellfish beds.

For the most part, the regulatory or statutory aspects of preventing pollution or protecting habitat have been enacted, and they have been used effectively to stanch the "easy" sources of pollution. But pollution continues to enter Puget Sound from many other sources, and habitat continues to be lost or degraded throughout the basin under the onslaught of rapid development.

Lack of funding continues to be a significant barrier. State support for implementing the Puget Sound Plan has dwindled as the state budget has shrunk. And although local governments have several options for generating revenues for water quality programs, such proposals frequently meet with opposition from local residents.

Such opposition is indicative of another major barrier: people's misperceptions. For example, there is a lingering belief that industry and oil tankers are the primary threats to Puget Sound; individuals frequently are unaware that their own daily activities collectively generate a large amount of the pollution that enters Puget Sound. Another example involves the salmon crisis; many people continue to blame the decline of salmon on overfishing, not understanding that habitat destruction also is a major factor. These misperceptions

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often manifest themselves in opposition to programs and policies (e.g., growth management, shellfish protection areas, stormwater programs, critical areas ordinances and forest-practices rules) that are designed to minimize or reverse the harm from these activities.

Education is critical to protecting Puget Sound—to help people understand the true causes of water pollution and the results of habitat destruction, to build a sense of personal responsibility among those who are privileged to live in the Puget Sound basin, and to generate long-term support for efforts to protect water quality and habitat.

The Authority devotes a significant portion of its resources to education and outreach, in addition to administering the innovative Public Involvement and Education (PIE) Fund Program (see "Successes" section on page 16). Other state and local agencies and community groups have sponsored educational efforts as well. But much more is needed on all fronts. Continued, or even increased, funding—for education and for implementing other aspects of the Puget Sound Plan—is of paramount importance.

FUNDING FOR THE PUGET SOUND PLAN

Cost Estimates for the 1994 Plan

As part of developing the Puget Sound Water Quality Management Plan, the Puget Sound Water Quality Authority has always developed projections of what it would cost to fully implement the Plan. These projections have included the costs of activities by federal and state agencies and by local and tribal governments. The estimates are developed by Authority employees, working closely with representatives of the various parties that are called on to perform tasks in the Plan.

These cost estimates become an important measure of how well progress is proceeding for implementing the Plan. If funding is far short of the estimate for implementing the Plan, then it is a reasonable conclusion that a significant amount is not being accomplished. Tables 1, 2 and 3 on pages 24 through 26 provide an estimate of Plan implementation costs for the 1995-97 and 1997-99 bienniums.

The cost projections for the 1994 Plan represent a significant increase over the projections that were included in the 1991 Plan. Most of the increase can be found in the Stormwater and Combined Sewer Overflows Program and the Nonpoint Source Pollution Programs; within them, most of the increase is attributed to activities to be undertaken by local governments and the state Department of Transportation. More detail on program costs can be found in the cost-summary narrative and charts that are included with each of the Plan programs.

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Table 1
ESTIMATES TO IMPLEMENT THE 1994 PUGET SOUND PLAN
By Program

PROGRAM ACTIVITY	95-97 Biennium	97-99 Biennium
Authority Activities	$ 2,787,444	$ 0
Estuary Management & Plan Implementation	4,117,994	4,267,520
Fish & Wildlife Habitat Protection	4,377,385	4,392,390
Spill Prevention and Response	4,557,875	3,161,801
Monitoring	8,630,629	8,355,988
Research	426,436	576,436
Education and Public Involvement	5,605,988	6,990,163
Nonpoint Source Pollution	72,767,576	75,771,954
Shellfish Protection	11,250,883	11,080,942
Wetlands Protection	26,707,256	26,432,592
Municipal and Industrial Discharges	12,605,920	12,463,709
Contaminated Sediments and Dredging	4,975,904	4,489,432
Stormwater and CSOs	90,834,184	130,771,368
Laboratory Support	1,667,938	1,888,688
PROGRAM TOTALS	$251,313,412	$290,642,983

It is a constant challenge for the Authority to track the amount of money that is spent for implementing the Plan. The task is more easily accomplished for spending by state agencies than for spending by federal agencies and tribal and local governments. It is difficult to collect and analyze budget information from these latter sources.

Funding Sources

Much of the money for implementing the Puget Sound Plan comes from the state's General Fund. During the early years of the Plan, state funding gradually increased, but the economic recession of the 1990s took its toll on state revenues, leading to a series of budget cuts that have reduced appropriations for water quality programs.

Tracking of water quality expenditures has improved somewhat since the 1991-93 Biennium, when the Legislature began specifying (through provisoes) how agencies are to spend their General Fund appropriations for implementing the Plan. The Office of Financial Management and the Legislature's budget committees also assist in the tracking process by keeping records that show how much is spent for implementing the Plan. Figures 1 and 2 show the projected implementation costs for state agencies compared to actual dollars spent by those agencies, for the last two biennia. Table 4 shows direct state and federal expenditures for the Plan since adoption of the 1987 Puget Sound Plan.

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Table 2
ESTIMATES TO IMPLEMENT THE 1994 PUGET SOUND PLAN
By Funding Source

FUNDING SOURCE	95-97 Biennium	97-99 Biennium
Aquatic Lands Enhancement Account	$ 10,000,000	$ 10,000,000
Centennial Clean Water Account	36,341,500	46,041,500
Coastal Zone Management grant (federal)	200,000	200,000
Federal Clean Vessel Act	400,000	400,000
Federal Forest Plan Initiative	2,000,000	2,000,000
Federal Funding Sources	3,975,730	3,661,342
Local Funding Sources	79,963,400	96,778,300
Motor Vehicle Fund	1,350,336	1,350,336
Oil Spills Administration Account	2,913,782	2,672,866
Permit Fee	8,349,554	8,714,850
Private Funding Sources	105,300	370,300
Puget Sound Grants Program (EM-6)	14,287,720	14,599,966
Section 319 Nonpoint Grants (Federal)	1,000,000	1,000,000
Special Local Assessent to Fund CDs	4,719,000	4,719,000
State Capital Funds	35,300,000	50,300,000
State General Fund	45,651,942	43,307,215
Toxics Accounts	4,028,548	3,670,708
Tribal Funding Sources	726,600	856,600
Washington Wilderness & Recreation Prog.	0	0
FUNDING TOTALS	$251,313,412	$290,642,983

As these figures demonstrate, funding has fallen far short of cost estimates for full implementation. Successfully cleaning and protecting water quality in Puget Sound will require new or additional financial resources at the state level.

The Puget Sound Plan calls for significant participation by local and tribal governments to achieve the Plan's goals. Their participation is especially critical in four of the Plan's programs: Nonpoint Source Pollution, including developing and implementing watershed action plans and on-site sewage system programs; Stormwater and Combined Sewer Overflows; Wetlands Protection; and Shellfish Protection.

Local and tribal governments require a long-term commitment of staff and funding for these programs. Local governments, in particular, are hampered in meeting these goals by local opposition to increased taxes and fees and competition from other programs such as crime control, the justice system and public schools. To some degree, they are also hampered by limited statutory authority to establish funding sources, although the Legislature has improved

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Table 3
ESTIMATES TO IMPLEMENT THE 1994 PUGET SOUND PLAN
By Implementing Agency

IMPLEMENTING AGENCY	95-97 Biennium	97-99 Biennium
Bureau of Land Management	$ 13,000	$ 13,000
Conservation Districts	7,769,000	7,769,000
Cooperative Extension (WSU)	2,245,220	2,557,152
Governor's Council on Env. Education	200,296	219,422
Interagency Comm. for Outdoor Recreation	6,250	6,000
Local Governments	123,162,400	149,677,300
National Marine Fisheries Service	13,000	13,000
Natl. Oceanic and Atmospheric Admin.	54,600	54,600
Northwest Indian Fisheries Commission	6,500	6,500
Office of Marine Safety	1,929,246	1,688,330
Private Groups	105,300	170,300
Puget Sound Water Quality Authority	8,324,062	5,497,254
Tribal Governments	2,125,100	2,385,100
U.S. Army Corps of Engineers	135,069	117,452
U.S. EPA Region 10	1,599,290	1,372,948
U.S. Fish and Wildlife Service	1,293,627	1,322,990
U.S. Forest Service	1,163,842	1,163,842
U.S. Geological Service	130,000	130,000
U.S. Navy	58,726	58,726
U.S. Natural Resources Conservation Service	1,288,300	1,288,300
University of Washington	130,000	130,000
Washington Conservation Commission	904,000	904,000
Washington Conservation Corps	900,000	900,000
WA Department of Agriculture	379,600	347,100
WA Department of Community, Trade & Economic Development	604,667	510,653
WA Department of Ecology	30,089,654	29,615,653
WA Department of Fish and Wildlife	6,154,271	6,080,150
WA Department of Health	6,823,671	6,663,187
WA Department of Labor and Industry	32,500	32,500
WA Department of Natural Resources	24,111,845	23,926,736
WA Department of Transportation	26,512,936	41,512,936
WA Parks and Recreation Commission	1,787,021	2,769,206
Washington Sea Grant	1,092,346	1,564,198
WA Superintendent of Public Instruction	165,473	172,848
Western Washington University	2,600	2,600
AGENCY TOTALS	$251,313,412	$290,642,983

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Figure 1. Direct State and Federal Funding Expenditures by Plan Program Activity 1991-93 Biennium

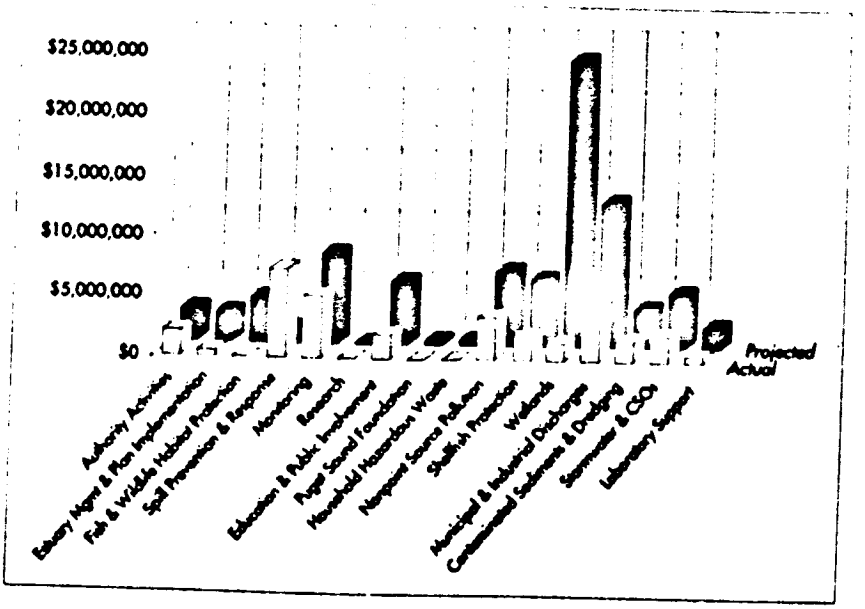
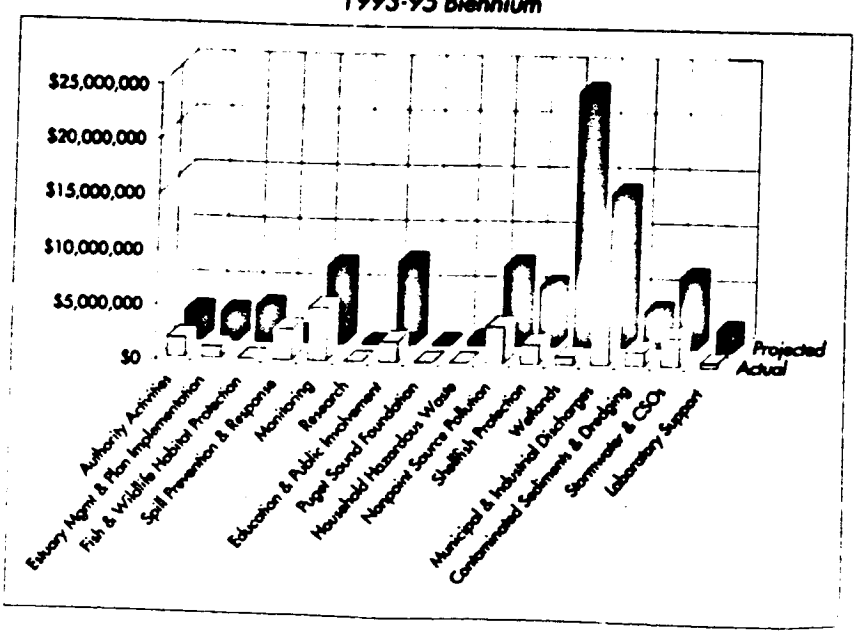


Figure 2. Direct State and Federal Funding Expenditures by Plan Program Activity 1993-95 Biennium



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local governments' flexibility in recent years. For example, they may create shellfish protection districts or stormwater utilities to generate funding for water quality programs, and they may levy impact fees on development to defray a variety of costs associated growth. Many local governments have already made use of one or more of these resources.

Local activities do receive funds through state programs, such as the Centennial Clean Water Fund, but these generally are provided as seed money to allow local governments to initiate programs that will be supported using local resources. In order for local governments to successfully pay for their share of implementing the Puget Sound Plan, alternative sources of funding may well be required. These need to include local funding options and additional state water quality grants.

Table 4
PUGET SOUND WATER QUALITY MANAGEMENT PLAN
Direct State and Federal Funding Expenditures by Program Activity

PROGRAM ACTIVITY	1987 - 89 Estimated Actual	1989 - 91 Estimated Actual	1991 - 93 Estimated Actual	1993 - 95 Estimated Actual
Authority Activities	$2,167,500	$2,905,934	$2,076,000	$1,774,400
Estuary Mgmt & Plan Implementation	320,933	439,960	508,036	1,028,680
Fish & Wildlife Habitat Protection	0	0	0	0
Spill Prevention & Response	160,000	129,048	7,233,000	2,903,952
Monitoring	728,608	1,851,025	5,116,411	4,960,757
Research	149,286	0	0	0
Education & Public Involvement	1,596,067	1,910,168	2,028,200	1,831,050
Puget Sound Foundation	0	0	0	0
Household Hazardous Waste	32,000	88,183	0	0
Nonpoint Source Pollution	2,821,863	2,592,715	3,516,460	3,294,993
Shellfish Protection	1,453,518	1,411,752	1,961,217	1,668,917
Wetlands	1,091,176	1,943,592	1,449,491	601,491
Municipal & Industrial Discharges	2,457,067	4,390,369	5,554,204	5,432,370
Contaminated Sediments and Dredging	1,410,546	1,412,176	1,725,250	1,335,924
Stormwater & CSOs	771,750	913,088	2,167,804	2,530,638
Laboratory Support	497,842	933,805	555,905	408,315
PROGRAM TOTALS	$15,160,314	$19,988,010	$33,336,073	$27,771,487

Puget Sound tribal governments play an important role in protecting the natural heritage and environmental resources of the region. Court decisions regarding treaty rights have affirmed that tribes have a right to participate in policy decisions that potentially could affect fish harvests. In this context, they are extremely interested in participating in the implementation of the Puget Sound Plan. They have conducted projects to monitor water quality and

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restore shellfish beds, and they have developed management plans for estuaries on their reservations.

However, tribes suffer from extremely limited resources to conduct these projects. Many of them are funded by grants from the state or federal agencies, but grant funds are becoming harder and harder to obtain. If the tribes are going to participate actively in restoring and protecting Puget Sound, they will have to develop new sources with which to finance their efforts.

The federal government, especially the Environmental Protection Agency, has provided money under the National Estuary Program (NEP), as authorized by Section 320 of the Clean Water Act, to support the development of a management plan for Puget Sound. This originally ranged from $1.3 million to $2.4 million annually and was used to fund special technical studies, the development of management tools, and assistance in developing the ambient monitoring program. However, since 1991, when the EPA approved the Puget Sound Plan as a Comprehensive Conservation and Management Plan, there has been less money available under the NEP. Efforts by the Authority did garner a special federal appropriation in 1993 to provide money for implementing the Puget Sound Plan; the EPA also was able to provide additional funds to support Puget Sound protection efforts. Together, these actions allowed the Authority to solicit proposals from state agencies and local and tribal governments to compete for approximately $800,000 that was distributed as "action grants."

Other federal agencies, including the U.S. Forest Service, U.S. Fish and Wildlife Service, the National Oceanic and Atmospheric Administration, and the Natural Resources Conservation Service, have funds that can be used to implement the Plan, either as federal grants to state and local agencies or to support federal activities. Puget Sound Plan programs clearly would benefit from more federal funds being made available.

The private sector, including individuals, may incur added costs as plan elements are implemented (e.g., the private costs of upgrading on-site sewage systems). These expenses are broadly identified, where possible, in the text of each program area, but it is not possible for the Authority to track private costs accurately or completely. Some private sector costs will come as direct expenses, and others will be in the form of various fees or other payments to local and state governments.

Private entities also may help finance certain Plan elements. For example, the Nature Conservancy and the Trust for Public Lands regularly assist in acquiring Puget Sound wetlands. Private consulting firms and research institutions helped finance the "First Annual Meeting on Puget Sound Research." Corporations and other private entities have participated extensively in supporting and carrying out public involvement and education activities. This kind of support is expected to continue and to grow.

Strategies to Secure More Funding

Fully implementing the 1994 Puget Sound Plan would cost federal and state agencies and tribal and local governments approximately $251 million during

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the 1995-97 Biennium, and $291 million during the 1997-99 Biennium. The Authority is concerned about continued funding shortages at all levels of government, which could hamper efforts to protect water quality. As protection efforts continue to be delayed and pollution continues to flow into Puget Sound, the future cost of cleaning and protecting the Sound continues to increase.

In an era of limited government revenues, it is going to require creativity and perseverance to successfully implement the Plan and protect Puget Sound for future generations. The Authority and the Puget Sound Estuary Program management committee will continue to explore funding options, as called for in the Estuary Management and Plan Implementation Program.

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Chapter 2. Action Plan

INTRODUCTION

In the past, the management of Puget Sound was handled by many different government entities with little coordination among each of their programs. Working alone and with inadequate resources and tools, these entities were unable to address the cumulative, wide-ranging impacts to water quality in Puget Sound. In 1985, the Washington State Legislature created the Puget Sound Water Quality Authority, whose main purpose is to develop, adopt and oversee the implementation of a comprehensive strategy to protect Puget Sound. Now guided by this comprehensive management plan, federal and state agencies, businesses, city, county and tribal governments, environmental groups, citizen groups, and individuals are working together to meet the challenges facing Puget Sound.

The Puget Sound Water Quality Management Plan was developed to fulfill the requirements of the Puget Sound Water Quality Act (Chapter 90.70 RCW) and Section 320 of the federal Clean Water Act (33 U.S.C. 1330). The state law calls for a comprehensive, water quality management plan prescribing the needed actions for the maintenance and enhancement of Puget Sound water quality. The federal Clean Water Act calls for a comprehensive conservation and management plan that recommends priority corrective actions and compliance schedules addressing point and nonpoint sources of pollution to restore and maintain the chemical, physical, and biological integrity of the estuary, including restoration and maintenance of water quality, a balanced indigenous population of shellfish, fish and wildlife, and recreational activities in the estuary, and to assure that the designated uses of the estuary are protected.

PLAN GOAL

To restore and protect the biological health and diversity of Puget Sound by preserving and restoring wetlands and aquatic habitats, preventing increases in the introduction of pollutants to the Sound and its watersheds, and reducing and ultimately eliminating harm from the entry of pollutants to the waters, sediments, and shorelines of Puget Sound. In seeking to achieve this goal,

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federal and state agencies and local and tribal governments shall take into consideration the net environmental effect of their decisions in order to minimize the transfer of pollutants from one environmental medium to another.

The Plan's emphasis on prevention recognizes the simple truth that it will cost far more to clean up pollution later than to prevent it now. The Plan is based on the premise that we all share responsibility for Puget Sound, and recognizes that fish, wildlife, water and pollutants cross jurisdictional lines. It establishes a framework based on a partnership among levels of government, each having a defined set of responsibilities in different program areas. The plan recognizes and includes actions by federal, state, local and tribal governments, the private sector, and citizens.

CRITERIA FOR SETTING PRIORITIES

The Authority has established priorities in the Plan using the following criteria. As in the past, the process of establishing Plan priorities involved considering the severity of the threat posed by different problems within Puget Sound and the options for preventing or curing the problems. The main considerations that were important for this process included:

- What is the magnitude of harm for the environment and human health?
- What is the persistence of the threat and the difficulty of mitigating or resolving the problem?
- How adequate are existing management programs?
- Is there a loss that could be construed as irreversible?
- What is the effect on current uses of the Sound?
- Is the action part of an ongoing Plan program?
- What is the most cost-effective approach to address a problem?

It is also important to ensure that the Puget Sound Plan be comprehensive and effective. This means that good use must be made of all the existing programs, funding sources and efforts that are already occurring. The Plan must also be regionally fair. Conditions vary greatly around the Sound. In one part of the Sound, nonpoint pollution with microorganisms may be the greatest problem; in another, it may be storm water carrying toxic compounds, and in another, loss of wetlands. For these reasons, the Authority considered these additional criteria in setting priorities for this plan:

- Are all threats to the Sound being addressed?
- Are the significant threats in each portion of the Sound being addressed adequately?
- Which programs have long start-up periods, and have these begun yet?

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- What funding sources exist to implement programs and are they being fully used?

Finally, the Authority considered the following additional factors when it set priorities within programs:

- Adopting preventive tools, such as standards and procedures for discharge permits, rather than proceeding on a case-by-case basis.
- Taking actions that will have a multiplier effect.
- Taking actions that will increase the likelihood of successful implementation of the Plan.
- Following a particular sequence which is necessary to implement a program's elements.

BROAD PRIORITIES

In general, the Authority believes that it is important to complete work which has been started. Using the criteria described above, the Authority has set broad priorities for the Plan. They are, in alphabetical order:

- Assess the environmental conditions of Puget Sound and its resources, and the effects of human activities on the Sound and its resources.
- Clean up existing toxic contamination where sources are controlled.
- Continue Plan programs that have been started and maintain current funding levels for them.
- Control sources of toxic contaminants to Puget Sound.
- Enhance protection of shellfish beds.
- Ensure the protection of wetlands and aquatic habitat. Stop losses of wetlands and other aquatic habitat.
- Improve the control and cleanup of nonpoint source pollution in the Sound.
- Provide long-term support for research and education.
- Prevent spills in the Sound and enhance the capability to respond to spills when they occur.
- Support and improve education and public involvement programs in order to inform, educate and involve citizens of the region and state in the cleanup and protection of Puget Sound.

Consistent with these broad priorities, the Authority may from time to time select portions of the Plan for additional emphasis. The Authority will seek

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public comment as part of its selection process. In addition, element EM-8 directs the Authority to make recommendations on state funding of state agency activities to carry out the Plan as part of each biennial budget process.

THE FINAL 1994 PUGET SOUND PLAN

The 1991 Puget Sound Water Quality Management Plan provided the basis for this final 1994 Plan. The Puget Sound Foundation Program, which was part of the 1991 Plan, was deleted from the 1994 Puget Sound Plan. The Household Hazardous Waste Program of the 1991 Plan has been merged into the Nonpoint Source Pollution Program of the 1994 Plan.

The programs that follow this introduction are organized in a consistent format. Each program is prefaced with a brief statement of the problem that led to the creation of the program. This is followed by the program goal, the strategy for achieving this goal, and the elements comprising the program. For each program, the major actions flowing from the program which the Authority intends to review are listed and any legislation required by the program is specified. Finally, the program's estimated cost is summarized. Chapter 1 contains a discussion of the costs and proposed financing for the Plan as a whole.

SEVERABILITY

If any portion of this Plan or its application to any person or circumstance is held invalid, the remainder of the Plan or the application of that portion to other persons or circumstances is not affected.

For the purposes of this provision, and in observing the procedural requirements set forth in RCW 90.70.075(2), Plan "portion" shall refer to any of the several subelements found with the various program elements of this Plan.

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ESTUARY MANAGEMENT AND PLAN IMPLEMENTATION PROGRAM

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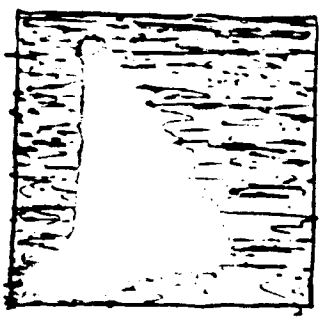
PROBLEM DEFINITION



Managing and protecting Puget Sound is a complex undertaking. Federal, state, local and tribal governments, businesses, individuals, and organizations all have individual roles, responsibilities, interests and mandates. This quantity of regulators, stakeholders and interested parties, combined with a historic lack of coordination among them, makes a comprehensive approach to long-term protection of Puget Sound difficult. Improved coordination is paramount to successfully and cost-effectively managing Puget Sound.

In 1985, the Puget Sound Water Quality Authority (Authority) was directed to develop and adopt a comprehensive management plan for Puget Sound to be implemented by federal and state agencies and local and tribal governments. The Authority, U.S. Environmental Protection Agency's (EPA) Region 10 office and state Department of Ecology (Ecology) formed the Puget Sound Estuary Program (PSEP) to oversee coordination and implementation.

In March 1988, Puget Sound was designated an estuary of national significance under the National Estuary Program (Section 320 of the federal Clean Water Act). A designation agreement signed between the state and the EPA defined a process for the PSEP to develop a comprehensive conservation and management plan (CCMP) for Puget Sound. PSEP co-managers all have roles in the process: the EPA provides federal funding, carries out technical studies, and oversees Plan implementation by federal agencies; Ecology is the lead state agency for most Plan elements; and the Authority prepared and adopted the actual CCMP. The 1991 Puget Sound Water Quality Management Plan (Plan) was approved by the EPA as the CCMP for Puget Sound.

Under treaties signed with the United States, federally recognized Indian tribes in western Washington possess important fishing rights in the Sound and rivers emptying into it. The state of Washington signed a government-to-government agreement with Puget Sound tribal governments recognizing their authority as

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co-managers of the natural resources. A tribal representative serves on the Authority board as a voting member.

Adopting a comprehensive water quality management plan is only the first step toward protecting Puget Sound. There are many competing priorities and divergent interests which make implementation of the Plan difficult. PSEP co-managers must continue to work to implement the Plan's many elements. Coordination is essential to ensure that limited resources are used most effectively. Implementation will not be easy, but it is necessary to protect Puget Sound for future generations.

Plan Funding

Since its initial adoption in December 1986, the Plan has been inadequately funded, which has hindered efforts to restore, protect and preserve Puget Sound. Although a number of potential funding sources exist—the state General Fund, Aquatic Lands Enhancement Account, Centennial Clean Water Fund, Toxics Account, permit fees, Oil-spills Administration Account and various capital budget accounts—the Puget Sound Plan must compete for these monies with a plethora of natural resource-related programs operated by other agencies. Acquiring federal funds poses similar problems.

Local governments face increasing mandates and limited funding. This creates an additional challenge because much of the effective action to protect and enhance the Sound needs to happen locally. Few local revenue options exist, and most of these are tied to specific programs or activities. For example, utilities can be used to support protection programs for both storm water and on-site sewage systems, but there is no direct authorization to establish and fund a comprehensive, local, water quality program. Although the state provides grants and loans for projects that protect water quality, these funds are not adequate to pay for needed projects.

Tribal governments also face obstacles because of their limited revenue sources. As a result of recent legal rulings, tribal governments have significant rights in all resource management decisions that may potentially affect their treaty-protected salmon fishing. Tribes have initiated and participated in watershed planning and estuary protection and restoration efforts. Due to their relatively small revenue base, tribal governments need additional funding for Plan activities.

Adequate funding is essential to protect Puget Sound. Yet, it is difficult to raise sufficient funds for government action. Washington must learn from the experiences of other estuaries around the country: Failing to spend money now on prevention will mean far greater costs later for restoration.

Enforcement

Many laws and programs designed to protect the Sound's water quality and resources are not fully enforced. This is true not only of state and federal laws, but also of city and county land-use ordinances, such as shoreline master programs, zoning and other land-use ordinances and local health codes governing on-site sewage systems. Jurisdictions face competing priorities, inadequate

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funding and lack of expertise. Local prosecuting attorneys have trouble enforcing laws due to inadequate penalties and insufficient staff.

Federal Facilities

There is a significant federal presence in the Puget Sound basin, including several major Department of Defense installations and numerous smaller facilities owned or operated by the National Park Service, the National Oceanic and Atmospheric Administration, the EPA and other federal agencies. The water quality effects of operating these facilities often resemble those resulting from industries, business, farm and household activities around Puget Sound.

The regulatory framework for federal facilities can be complex, making it difficult to ensure compliance with environmental laws. Although major federal laws require that federal entities are subject to the same federal, state and local environmental requirements as any nongovernmental entity, the President may exempt federal entities from environmental requirements. Further, the U.S. Justice Department has stated that the EPA is not authorized to bring suit against other federal agencies or issue unilateral orders to enforce environmental laws. The EPA has since adopted a federal-facilities compliance strategy that relies on administrative mediation of disputes.

Federal Superfund sites have been designated at several military installations around Puget Sound: Fort Lewis Army Base, McChord Air Force Base, Trident Submarine Base at Bangor, Whidbey Island Naval Air Station (NAS), and the Naval Undersea Warfare Engineering Station at Keyport. Eight of the installations have NPDES (National Pollutant Discharge Elimination System) permits from the EPA for industrial and/or domestic wastewater and stormwater discharges. Military bases regularly handle hazardous materials, and spills are a potential problem.

Other Federal Activities

Federal development projects, financial assistance and regulatory and permitting programs can have major effects on water quality, habitat and wetlands in the Sound. Examples include the U.S. Army Corps of Engineers' navigation improvement projects, the permit programs contained in Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act, Housing and Urban Development block grants for shoreline development, U.S. Forest Service timber management activities and EPA Region 10 NPDES permits for federal facilities.

Because the federal government retains authority over so many activities that affect Puget Sound, it is essential that federal agencies cooperate with state and local agencies in implementing the Puget Sound Plan.

PROGRAM GOAL

To provide adequate management, funding, enforcement and federal consistency during the implementation of the Puget Sound Water Quality Management Plan, the Comprehensive Conservation and Management Plan for Puget Sound.

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STRATEGY

The strategy for achieving this goal is to: (1) formalize and continue the existing Puget Sound Estuary Program management structure; (2) obtain adequate funding for the program, including new sources of state and federal revenue; (3) require accountability by implementing agencies; (4) provide strong enforcement at all levels of government; and (5) ensure that federal activities, including the operation of large federal facilities, are consistent with the Plan.

PROGRAM ELEMENTS

Management Structure

EM-1. Management Structure of the Puget Sound Estuary Program

The U.S. Environmental Protection Agency, the Puget Sound Water Quality Authority in cooperation with federally recognized Indian tribes of western Washington, and the Washington Department of Ecology shall continue to co-manage the Puget Sound Estuary Program (PSEP), as established under the provisions of Section 320 of the federal Clean Water Act as amended by the Water Quality Act of 1987.

The Puget Sound Water Quality Authority is responsible for preparing and adopting the Puget Sound Comprehensive Conservation and Management Plan (CCMP) for the program, which is also the Puget Sound Water Quality Management Plan provided for by Chapter 90.70 RCW. The Authority shall amend target dates and program tasks as necessary to ensure plan implementation.

The Environmental Protection Agency provides federal funding, carries out technical studies, and leads implementation by federal agencies. The EPA provides liaison with federal agencies and is responsible for oversight of programs that have been delegated to the state, such as discharger permits under the National Pollution Discharge Elimination System program.

Ecology, with state and delegated federal regulatory authority for water quality, air quality, and solid and hazardous waste, is the lead state agency for implementation of most Plan programs.

The three co-managers of the PSEP shall help review the activities of federal agencies as part of the federal consistency process developed by the PSEP Management Committee. This process is spelled out in EM-14.

EM-2. Management Committee

The three co-managers shall continue to jointly chair the Puget Sound Estuary Program Management Committee. This committee shall be composed of representatives of key federal and state implementing agencies and local and tribal governments. The management committee will advise the co-managers, provide a formal system of communication between the co-managers and those implementing the Plan, and review proposed revisions to the Plan. Other duties will include approving the work plans for EPA-funded implementation activities and reviewing urban bay action plans.

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EM-3. Technical Advisory Committee

The co-managers may from time to time establish a Puget Sound Estuary Program Technical Advisory Committee. This committee shall be composed of scientists and technical experts, and shall choose its own chair. The Technical Advisory Committee will advise the co-managers on scientific issues and review technical studies and reports and will meet on an as-needed basis.

Funding

EM-4. Increased Funding

The estuary program co-managers shall pursue funding for implementation of the Plan and related activities from all available federal, state and local government sources as well as private sources.

The EPA shall strive to ensure that federal programs that provide funding for water quality are used to fund Plan activities, including related tribal programs, to the maximum extent possible.

Federal and state agencies that provide water quality funding to local and tribal governments are encouraged to participate in a forum that allows them to coordinate their efforts and target assistance to ensure maximum benefit from their efforts.

EM-5. Implementation of Long-Term Funding Proposals

The Authority shall pursue establishment of new funding sources based on some of the recommendations of the Puget Sound Finance Committee. Revenues generated by these sources should be used for Puget Sound Plan implementation and other water quality activities.

The Authority shall work with the B.C.-States Task Force to encourage a higher and uniform marine fuels tax in all U.S. and Canadian West Coast ports.

Target Date: The development of additional funding proposals and work with the B.C.-States Task Force shall be ongoing.

EM-6. Puget Sound Grants Program

The Authority shall establish, administer, and monitor a grant funding program, similar in concept to the Public Involvement and Education Fund (PIE Fund), to assist local and tribal governments and other entities in implementing their responsibilities under the plan.

Target Date: Authority efforts to develop legislation to establish a funding source for these grants will be ongoing.

EM-7. Shellfish Funding Strategy

[Element Completed]

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Accountability

EM-8. Plan Implementation

8.1. Coordination of Plan Implementation

The Authority, in cooperation with EPA, Ecology, and the PSEP Management Committee, shall continue to coordinate implementation of the Puget Sound Plan. The Authority shall (1) inform federal and state agencies and local and tribal governments of their responsibilities under the Plan; (2) participate in committees and work groups; (3) provide formal and informal guidance; and (4) assist in obtaining funding.

To facilitate this process, Authority staff shall work closely with each federal agency, state agency, tribal government, and local government which is given responsibilities by the Plan. The Authority staff shall assure that the agency or government understands its responsibilities under the Plan, assist the agency or government in implementation, monitor progress, and assist in resolving problems that arise during program implementation.

As part of its coordination responsibilities, the Authority shall continuously review the Plan and amend program tasks as necessary to ensure Plan implementation.

The Authority shall monitor the implementation of Plan tasks by federal and state agencies and tribal and local governments. This monitoring will consider consistency with program goals and policies, with the intent of specific Plan elements, and with adopted target dates. Federal consistency review procedures are discussed in element EM-14.

8.2. Measuring Results

The Authority shall also undertake surveys and analyze available data to measure the results of the Puget Sound Estuary Program and the Puget Sound Plan. Results may include the establishment or improvement of programs, ordinances, regulations, education activities, and other institutional steps to protect Puget Sound, as well as measurable reductions in loadings to the Sound and reported improvements in environmental conditions in Puget Sound. The Authority's findings shall be made available to the public.

8.3. Agency Biennial Implementation Plans

Because of the key role played by state agencies, each state agency with major Plan responsibilities shall prepare a biennial implementation plan for major program responsibilities. This implementation plan shall be completed by October 1 of odd-numbered years and shall include: (1) a definition of the activities and products for the agency called for in the Puget Sound Plan; (2) target dates and work schedule for Plan activities given available resources; and (3) an explanation why any portions of an agency's responsibilities under the Plan will not be completed. Implementation plans shall be submitted to the Authority and the Office of Financial Management (OFM) for review for consistency with the Puget Sound Water Quality Management Plan and

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consistency with the purposes for which the Legislature had appropriated state funds. The plans will be submitted to the Authority by agency directors at one of the regularly scheduled monthly board meetings. In addition to the implementation plans, each state agency with major Plan responsibilities shall:

a. Notify the Authority and the OFM in writing whenever modifications are proposed to be made to Plan budget allocations or implementation plans to comply with agency budget cuts, funding transfers or shifts between funding sources. This notice shall be sent to the Authority prior to any irretrievable commitment of resources to allow the Authority an opportunity to comment. The notice shall include the dollar amount and a brief explanation of why the change is being made;

b. Submit a brief report to the Authority and the OFM by August 1 of every year evaluating progress toward completing the tasks and meeting the target dates specified in the implementation plan. The reports will be submitted to the Authority by agency directors at one of the regularly scheduled monthly board meetings; and

c. Provide the Authority copies of reports, interagency agreements, work plans and other significant work products developed pursuant to its implementation of each Plan element.

The Authority shall provide guidance to implementing agencies regarding the requirements under this element through interagency liaisons.

State agencies with major Plan responsibilities include:

Department of Ecology
Department of Natural Resources
Department of Health
Department of Agriculture
Department of Community, Trade and Economic Development
Department of Transportation
Department of Fish and Wildlife
Conservation Commission
State Parks and Recreation Commission
Washington Sea Grant (University of Washington)
Washington State University Cooperative Extension
Superintendent of Public Instruction

In addition to the review described above, the Authority may review Puget Sound related budgets and regulatory and enforcement activities of state and local implementing agencies as prescribed by RCW 90.70.055(5). The purpose of this review is to assist agencies in meeting timelines and other Plan requirements, to ensure that they have adequate resources to fulfill their responsibilities under the Plan, and to review the consistency of these activities with the Plan.

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8.4. Biennial Budget and Work Proposal

By March 1 of even-numbered years, the Authority shall provide appropriate agencies with Plan priorities and a cost estimate for fully implementing the Plan during the next biennium. In preparing its biennial budget request, each implementing agency shall consider the Authority's priorities and projected costs and the agency's implementation plans for the current biennium. By May 1, each implementing agency shall provide the Authority with preliminary descriptions and cost estimates for Puget Sound Plan projects proposed to be included in the agency's budget request. This step will facilitate interagency discussion during the development of Plan budget requests. The OFM shall use the product of these discussions, along with the Authority's implementation priorities called for in RCW 90.70.060(a), in developing the Governor's Puget Sound Plan budget proposal.

8.5. Biennial Reports

State agencies and local governments identified in the Plan shall submit written biennial reports to the Authority documenting and assessing their consistency with the Plan as required by RCW 90.70.070(3). The Authority shall provide instructions and work with implementing agencies for that purpose. The biennial reports shall be submitted to the Authority by September 15 of the second fiscal year of each biennium. Agency biennial reports shall include: (1) an assessment of the agency's progress toward achieving the goal of improving Puget Sound water quality; and (2) a discussion of the obstacles impeding this progress with recommendations of how these obstacles can best be overcome.

The Authority shall use the information gathered during the biennial review process to prepare revisions to the Plan as required by RCW 90.70.055(3) and to prepare the State of the Sound Report as required by RCW 90.70.055(4)(c). This report will be presented to the Legislature in January of odd-numbered years.

The state agencies that are required to submit biennial reports include, but are not limited to:

Department of Ecology
Department of Natural Resources
Department of Health
Department of Agriculture
Department of Community, Trade and Economic Development
Department of Transportation
Department of Fish and Wildlife
Department of Labor and Industries
Attorney General
Conservation Commission
State Parks and Recreation Commission
Washington Sea Grant (University of Washington)
Washington State University Cooperative Extension
Superintendent of Public Instruction

The Authority shall review the success of Plan implementation (including public and private actions) and submit the State of the Sound Report to the

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Legislature and the governor by January 1 of odd-numbered years. This report will provide a synthesis of the biennial reports submitted to the Authority by agencies and an analysis of the status and conditions of Puget Sound including a determination of the Sound's economic value. The report also addresses current and foreseeable trends in water quality and management of Puget Sound resources.

8.6. Review of Major Public Actions

As provided in RCW 90.70.070, the Authority shall continue to review major public actions being considered by federal and state agencies and local governments in order to determine whether the proposed action is consistent with the Puget Sound Water Quality Management Plan, with Authority goals and objectives, and with review criteria developed by the Authority.

In order to define the Authority's role in reviewing major public actions and to provide guidelines for determining an appropriate level of Authority response, the Authority establishes the following criteria governing its involvement:

- Whether the action is critical to implementation of the Puget Sound Water Quality Management Plan.
- Whether the action may be in direct and substantial conflict with the Plan.
- Whether the action entails significant adverse water quality effects which cannot be mitigated.
- Whether the action will have multiple effects or implications for various water quality issues or programs.

The Authority will use these criteria to determine which proposed actions are major.

As a result of such review the Authority may respond to a proposal in a variety of ways. Authority staff may respond to projects or documents which are not major public actions but where clarification of Plan requirements or technical comments would be of assistance to the responsible agency. The executive director of the Authority may submit comments on actions which are critical to Plan implementation or affect more than one program. The Authority shall submit comments where unmitigated water quality effects or substantial conflicts with the Plan are involved. The Authority shall maintain a record of its review and comment activities.

Cooperation among government entities is critical to implementation of the Puget Sound Plan and long-term protection of Puget Sound. To that end, the Authority may become involved in major public actions in the interest of improving intergovernmental coordination. In some cases, the Authority may offer to assist the parties find mutually agreeable solutions.

The Authority is authorized to intervene in administrative or judicial proceedings (RCW 90.70.070 (4)). While the Authority intends that intervention in judicial proceedings would be the least common form of response, reserved for very rare circumstances, the Authority may intervene in administrative proceedings as warranted.

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The Authority emphasizes that its review of major public actions does not replace the authority of the permit-issuing agency to make the substantive decision on a permit or other matter. Furthermore, Authority review of a proposed action does not in any sense constitute an appeal of an agency decision; the Authority does not intend to function as an appellate body.

The Authority will respond to a proposal within the established review period or within a timely period if no formal response period exists.

8.7. Notice of Actions Subject to Review

In order to ensure that the Authority is aware of activities which potentially merit its attention, the Authority will inform state and local agencies of the specific types of actions for which notice to the Authority should be given.

These actions may include program, policy and permit actions, including actions taken under the State Environmental Policy Act (SEPA). All state agencies and local governments shall provide SEPA documents to the Authority wherever water quality, wetlands or related issues within the Puget Sound Plan area are involved. The Authority will respond when the proposal being analyzed meets one of the criteria listed above.

Target Dates: Agency implementation plans shall be submitted to the Authority by November 1 of odd-numbered years. Agency budget estimates for implementing the Puget Sound Plan shall be submitted to the Authority by May 1 of even-numbered years. Agency biennial reports shall be delivered to the Authority by September 15 of the second fiscal year of each biennium. The Authority shall produce the State of the Sound Report by January 1 of odd-numbered years.

Enforcement and Legal Support

EM-9. Federal Enforcement

The EPA shall initiate federal enforcement actions when necessary to ensure implementation of the Puget Sound Plan and protection of Puget Sound. If situations arise where another federal agency has enforcement authority, the EPA shall request appropriate action by that agency. The EPA will also initiate federal enforcement actions on an independent basis, apart from requests of the Puget Sound Water Quality Authority.

EM-10. Enhanced Local Enforcement

Local governments are encouraged to strengthen the enforcement and wording of existing laws, and develop and implement new ordinances which protect the water quality and habitat functions of wetlands and which control specific sources of nonpoint pollution, including storm water. The state will provide matching funds to counties, cities or local health agencies to assist in the development or revisions of programs and to augment investigations and prosecutions under those laws.

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The enhanced enforcement of wetlands protection laws may encompass shoreline master programs, zoning ordinances or other land development or construction codes which protect water quality or habitat functions of wetlands. Efforts to enforce laws and ordinances aimed at reducing nonpoint source pollution that are eligible for state grants include on-site sewage systems, pumpout facilities at marinas, farm practices, or other sources which are identified as a result of the local nonpoint planning process. Local governments or health agencies are encouraged to use existing legal authority (including general police power, state health authority, or other legal tools) to adopt such ordinances or regulations as may be necessary to address nonpoint sources of pollution. Development and enforcement of stormwater regulatory programs are also eligible for funding, as are those activities related to local government compliance with the 1990 Growth Management Act.

Funds will be made available for development and revision of ordinances, as well as for investigation and prosecution of violations. Preference for grant awards shall be given to applicants whose enhanced enforcement program includes an educational component that publicizes enforcement actions. Efficient and innovative approaches to enforcement such as civil penalties, dedicated fines and community service shall be encouraged.

Funds made available through the Centennial Clean Water Fund (CCWF) for enforcement will be used for start-up costs or seed monies to develop enforcement programs and not for ongoing staff needs.

Target Date: Program established August 1988.

EM-11. Attorney General Support

The Attorney General shall make every effort to support the Puget Sound Plan by providing enough attorneys to assist in agency rulemaking, permit writing, and enforcement. Legal expertise shall be provided at all stages of environmental protection activities when a request is made to the Attorney General's office by one of the implementing agencies. Agency personnel shall report difficulties they might have in securing legal support to the Authority after they have first reported this problem to their management and to the Attorney General's office.

Target Date: Ongoing.

Federal Activities

EM-12. Memoranda of Understanding with the Department of Defense

The Region 10 office of the EPA, as a co-manager of the Puget Sound Estuary Program, shall work with Department of Defense facilities in Puget Sound to evaluate the need for specific Memoranda of Agreement that address consistency with the Puget Sound Plan. Target facilities include the following:

Puget Sound Naval Shipyard
Naval Submarine Base, Bangor
Naval Air Station Whidbey Island

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Fort Lewis Army Base
McChord Air Force Base
Keyport Naval Undersea Warfare Engineering Station
Indian Island Undersea Warfare Engineering Station
Manchester Naval Supply Center

The EPA shall also use other regulatory opportunities to achieve these same goals with these facilities. These opportunities include: ensuring that multi-media inspections cover consistency with the Puget Sound Plan, or CCMP, and evaluating projects that support the goals of the CCMP as potential candidates for designation as supplementary environmental projects during enforcement settlements.

Target Date: Completed agreements at appropriate facilities by January 1996; integrating regulatory opportunity efforts during fiscal year 1995.

EM-13. Review of Plan by Federal Agencies

Federal activities which directly or indirectly affect the quality of Puget Sound shall further the goals of the Plan. Federal agencies are requested to take action on any Plan element that specifically names the agency. All federal agencies are requested to review the Plan on a continuing basis to determine whether any of their projects or programs potentially assist or conflict with the goals of the Plan.

The following federal departments and agencies shall examine their programs for consistency with the Plan. Agencies not included in this list are still required to comply with this element.

Department of Agriculture:
- Agricultural Stabilization and Conservation Service
- Farmers Home Administration
- Forest Service
- Natural Resources Conservation Service

Department of Commerce:
- National Oceanic and Atmospheric Administration
- National Marine Fisheries Service

Department of Defense:
- Corps of Engineers
- Air Force
- Army
- Navy

Department of Energy
Environmental Protection Agency
Housing and Urban Development
Department of Interior:
- Bureau of Land Management
- Bureau of Reclamation
- Fish and Wildlife Service
- Minerals Management Service
- National Park Service
- Office of Surface Mining

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U.S. Geological Survey
Department of Transportation:
Coast Guard
Federal Highway Administration

The co-managers of the Puget Sound Estuary Program shall contact federal agencies, such as those listed, in writing to notify them of the requirements of the Puget Sound Comprehensive Conservation and Management Plan and to identify a PSEP contact for that agency.

If an agency finds that its programs or projects may adversely affect the implementation of a Plan goal, the agency shall notify the designated PSEP contact for that agency. Where appropriate, the PSEP co-managers shall negotiate memoranda of understanding (MOUs) with agencies to clarify expectations under the management plan agency commitments in order to best ensure Plan implementation.

Target Date: Agencies to comply on an ongoing basis.

EM-14. Federal Consistency Review Process

The co-managers of the Puget Sound Estuary Program, with the assistance of the Management Committee, shall implement a process to review federal activities for consistency with the Puget Sound Plan.

The purpose of the review process is to ensure that federal activities are consistent with and will further the purposes and objectives of the Puget Sound Comprehensive Conservation and Management Plan. This process is called for in Section 320(b)(7) of the Clean Water Act. The review process shall consider all federal activities that may significantly affect the goals of the Plan, including but not limited to federal financial assistance and development projects. The review process shall complement and not duplicate existing state-federal review processes, such as the Section 319 Nonpoint Source consistency review process. The consistency review process shall be implemented with assistance from the Coastal Zone Management (CZM) Program review process.

This process shall work as follows:

1. All appropriate policies resulting from the Plan shall be incorporated into the CZM review process. The CZM review committee will notify the PSEP co-managers of the federal activities that are submitted to them for review.

2. For the portions of the Plan that are not appropriate for CZM review, the PSEP Management Committee shall determine how to receive notice and conduct the necessary consistency review.

3. If there appears to be no consistency problem, the agency or the CZM office shall be notified. If there does appear to be a problem, the federal agency in question shall be notified along with the PSEP Management Committee. The committee shall consider the issue at a meeting. An

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initial attempt will be made by the management committee to work through the difficulties with the federal agency whose activities are assessed as being out of compliance with the Plan.

4. If the problem is resolved, the agency and the CZM office shall be notified. If the problem persists, the PSEP co-managers shall escalate their efforts to resolve the issues. These efforts shall include, but not be limited to, negotiations, interagency work groups, exercising of state powers, memoranda of understanding, letters of concurrence, and elevation of the issue to higher levels of government.

5. In cases where enforceable policies are not met and a resolution cannot be reached, the CZM office shall be expected to withhold its approval of the project.

6. The following conditions will hold true for all cases of dispute over Plan consistency:

   a. Each federal agency on the PSEP Management Committee shall abstain from any review of its own proposal.

   b. A single coordinator or convener shall be appointed to facilitate the attempts to resolve the disagreements.

   c. Appropriate opportunities for public participation shall be provided.

   d. A timeline for review will be followed, not to exceed 60 days for new projects and not to exceed 30 days for continuations and amendments.

The PSEP co-managers shall take any other actions necessary to ensure that federal agencies act consistently with the Plan. In accordance with the Puget Sound Designation Agreement, the EPA shall actively seek commitments from other federal agencies that may be needed to implement the Plan.

The EPA shall use any appropriate means to secure federal agency commitments, for example:

1. Developing formal agreements with other federal agencies to ensure compliance.

2. Developing or recommending federal policies, guidelines, rules or regulations to implement the Plan.

3. Convening interagency work groups to develop appropriate implementation schedules.

4. Providing financial assistance.

Target Date: The PSEP is to implement a consistency process on an ongoing basis. Other actions to ensure federal consistency shall be taken on a continuing basis.

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MAJOR PUBLIC ACTIONS

None.

LEGISLATION REQUIRED

None.

ESTIMATED COST

The estimated costs for fully implementing the Estuary Management and Plan Implementation Program are $4,117,994 for the 1995-97 Biennium and $4,267,520 for the 1997-99 Biennium.

The element EM-6, Puget Sound Grants Program, would provide funding through grants to local governments and other agencies to implement Plan elements. The administrative costs for this program is assumed to be between three and four percent of the expected grant base of $6.75 million per year. This program would be managed by the Authority.

Funding for the enforcement elements of this program is estimated to cost approximately $1.6 million per year. Of this, $1.33 million per year is estimated for enhanced local enforcement (element EM-10) to be funded by state matching grants to local governments from the CCWF and the Puget Sound Grants Program. No local funding sources are estimated for element EM-10. Local implementation costs that are funded by local sources are included in estimates for other programs, particularly storm water and nonpoint source pollution.

The cost of the federal activities program (elements EM-12 through EM-14) is about $113,000 per year. This does not include costs to federal agencies for participation in the review process established under this program, nor does it include costs that may arise from any new agreements, policies or regulations that may be developed as a result of the initiatives described in this program.

No private sector costs have been identified for this program.

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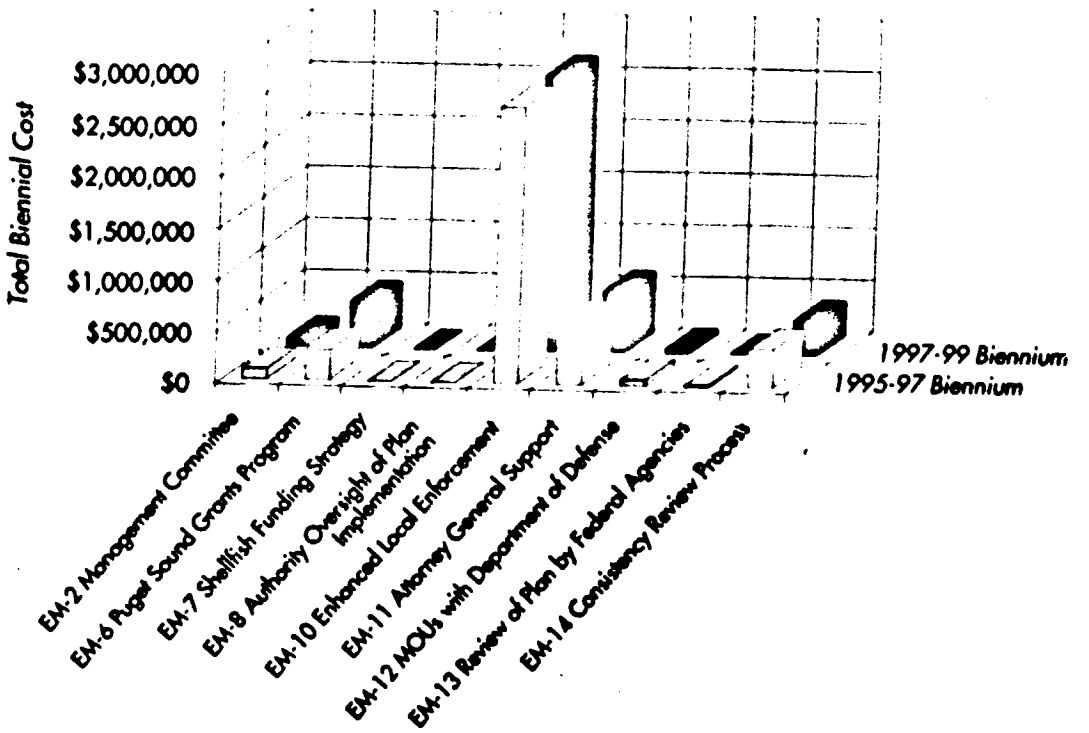
Estuary Management Program Implementation Estimates



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FISH AND WILDLIFE HABITAT PROTECTION PROGRAM

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PROBLEM DEFINITION



The Puget Sound basin comprises a unique diversity of habitat types, from deep-water marine areas to upland forests, that support a wide variety of plant, fish and wildlife species. These habitats provide plants, fish and wildlife with basic requirements for survival, such as food, water and shelter, as well as special seasonal requirements related to growth and reproduction. Open waters provide important habitat for thousands of organisms, including phytoplankton and zooplankton, subtidal macroalgae (kelp), benthic invertebrates, fish, and marine birds and mammals. Many species require a variety of habitats at different times in their life cycles. The Department of Fish and Wildlife estimates that up to 70 terrestrial species, plus all the anadromous fish species (salmon, steelhead trout, smelt, shad and sturgeon), rely on both marine waters of the Sound and upland habitats, usually riparian corridors.

Many types of habitat also protect water quality, control flood waters and preserve biological diversity. For example, riparian vegetation plays an important role in reducing turbidity, trapping sediment to prevent erosion, and providing thermal cover to prevent water temperature extremes. Marine shoreline vegetation absorbs wave energy and slows erosion. Floodplain habitat reduces the height and velocity of flood waters. Because the health of Puget Sound is dependent upon many interconnected relationships, it is critical to protect both aquatic and terrestrial habitat.

Rapid population growth and associated development are the greatest threats to fish and wildlife habitat in the region. Where and how growth occurs has direct implications on protecting fish and wildlife habitat. Activities that cause habitat loss are: (a) converting land to commercial or residential use; (b) draining or filling of wetlands; (c) improperly developing land; (d) improperly managing timber practices; (e) improperly managing agricultural practices; (f) disrupting water courses or surface- and groundwater sources; (g) improperly managing urban pollutants; and (h) spilling oil and other hazardous substances.

Some of these issues are addressed elsewhere in the Wetlands, Shellfish Protection, Spills and Nonpoint Source Pollution programs of the Puget Sound Water Quality Management Plan (Plan). Unfortunately, the cumulative effect of all these activities is rarely considered by local governments or state or federal agencies because of the difficulties involved with determining cumulative effects. Additionally, agencies have tended to focus on individual resources rather than on ecosystems or habitats. The result is a tremendous fragmentation of important habitat types.

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Lands with significant habitat often have multiple uses and frequently multiple owners, while important waterways that are held in public trust travel through a maze of adjacent land uses, usually beginning in forestlands and ending in an urban area.

At best, habitat protection is a complex undertaking, particularly in light of the rapid growth and development in the Puget Sound basin. As our knowledge of individual species and their specific habitat requirements has increased, we are just beginning to understand the requirements of an ecosystem and methods to protect habitat throughout a watershed.

INSTITUTIONAL FRAMEWORK

At least 22 federal and 20 state laws are aimed at some aspect of fish and wildlife habitat protection. Tribal treaty rights, local laws and private programs also deal with habitat protection through a variety of mechanisms (both regulatory and non-regulatory). While some federal laws are administered to protect specific species (e.g. Endangered Species Act), others have broader mandates (protection of navigable waters under the federal Clean Water Act (CWA) Section 404) that include some aspect of habitat protection. The state has many of its own laws and programs to identify and protect fish and wildlife habitat through regulation (e.g. the Natural Heritage Program). The Growth Management Act added a new requirement for local governments to get involved as well.

This complexity of programs does not necessarily indicate a successful framework for habitat protection. While some overlaps occur between federal and state efforts, gaps also exist. As some agencies have begun to manage at the watershed level, for example, new federal efforts through the Forest Service are managing "provinces."

Treaties in the Puget Sound area have been interpreted to establish a role for the tribes in fisheries management and may imply that the tribes have a right to ensure that fish habitat is protected to sustain tribal fisheries. Tribal governments have established programs to protect fish and wildlife habitat on tribal lands and, in conjunction with the Northwest Indian Fisheries Commission, work with federal, state and local agencies to protect fish and wildlife habitat.

Many valuable habitat sites have been protected through voluntary private sector programs. These include land trusts, conservation easements and the actions of individuals and citizen groups.

The Authority's role in habitat protection focuses on aquatic systems. However, the Authority recognizes that fish and wildlife protection extends beyond aquatic boundaries[1]. This program establishes a mechanism whereby the various federal, tribal, state and local entities that manage fish and wildlife can

1 For the purpose of this program, aquatic systems include the waters of the state as defined by the Forest Practices Board, including associated riparian zones and shorelands. Wetlands are aquatic systems and are addressed by the Wetlands Protection Program. This program addresses those systems that are not commonly considered wetlands, such as the deep or open waters of Puget Sound and stream corridors.

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coordinate their efforts so that habitat protection is accomplished from an ecosystem perspective.

AUTHORITY'S APPROACH

Protecting habitat in Puget Sound requires a regional, ecosystem perspective to ensure that diversity of habitat types is preserved. In addition, physical and hydrological connections among different habitat types need to be maintained to prevent habitats (and the species that depend on them) from becoming isolated. Generally, fragmenting and isolating habitats promotes the local extinction of species. In some cases, however, patches of habitat can be beneficial, if used appropriately, as in the case of artificial reefs. A regional habitat approach also allows entities and individuals with expertise and information to join together and focus management efforts to make the most of available resources and avoid overlaps and duplication.

As noted in the unfinished agenda chapter of the 1987 and 1989 plans, time and resource constraints have prevented progress toward protecting fish and wildlife habitat. The Authority found that the state lacked clear goals and policies for protecting habitat; issues needed to be addressed by all affected parties; resource agencies responsible for protecting habitat often lacked sufficient authority; public awareness and understanding of habitat issues and public involvement needed to improve; and existing resources were inadequate for inventorying, monitoring, enforcement and education efforts.

The Fish and Wildlife Habitat Program was established in the 1991 Plan. Program elements called for a broad-based habitat task force, interagency sharing of habitat data, a broad-based education strategy, increased field investigations and greater public involvement. The 1994 Plan calls for coordination of activities among federal and state agencies.

PROGRAM GOAL

To ensure that federal, state, local and tribal agencies coordinate fish and wildlife habitat protection programs so there is no net loss in the short term and, in the long term, there is a net gain of aquatic and riparian habitat and other habitat important to water quality protection in the Puget Sound basin.

STRATEGY

The strategy for achieving the goal is to: (1) encourage and support efforts by state and federal resource agencies, local governments, tribes, and private organizations to act aggressively and actively use existing mandates and authorities, including the Growth Management Act, to protect rapidly disappearing aquatic systems and related habitat in the near term; and (2) coordinate among existing agencies and governments in order to effectively protect and manage Puget Sound fish and wildlife habitat over the long term by providing integrated solutions for habitat protection at the watershed or sub-watershed level.

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PROGRAM ELEMENTS

H-1. Coordination with the DCTED

The Puget Sound Water Quality Authority shall coordinate with the Department of Community, Trade and Economic Development (DCTED) and the Department of Fish and Wildlife (WDFW) on issues related to habitat protection, as they work with local governments to implement the Growth Management Act.

Target Date: Ongoing.

H-2. Agency Coordination for Habitat Protection

All agencies involved in aquatic habitat restoration projects shall coordinate efforts in order to reduce duplication and maximize benefits to the resources. The U.S. Fish and Wildlife Service (USFWS) shall act as lead agency, in coordination with the departments of Natural Resources, Fish and Wildlife, and Ecology, the Environmental Protection Agency (EPA), the U.S. Forest Service (USFS), the Army Corps of Engineers, local and tribal governments, private organizations, landowners and the scientific community. The USFWS shall coordinate funding, planning and implementation of freshwater habitat protection and restoration activities within watersheds or sub-watersheds. Other agencies may take the lead to coordinate efforts in specific geographic areas as appropriate. The Department of Natural Resources (DNR) shall act as lead agency in coordinating restoration activities in estuarine and marine habitats. Coordination of restoration efforts among agencies and other groups should include: 1) establishing consistent or complementary habitat priorities; 2) establishing consistent data collection and inventory methods; 3) coordinating activities and goals with local habitat protection programs established under the Growth Management Act; and 4) establishing partnerships with local community groups. Habitat restoration projects should complement and expand efforts occurring through the wetlands restoration element (W-8) and other watershed restoration projects.

Target Date: The USFWS and participating agencies shall report to the PSEP management committee annually regarding freshwater activities. The DNR and participating agencies shall report to the PSEP Management Committee annually regarding marine and deep water activities.

H-3. Habitat Database and Inventory

3.1 State Agencies

The departments of Fish and Wildlife, Natural Resources, and Ecology, and other state agencies that collect data on Puget Sound habitats shall enter or continue entering existing data on non-wetland aquatic systems (deep- and open-water, riparian and shoreland habitats) onto existing geographic information systems (GIS) to be shared between systems. The data shall be provided to the Puget Sound GIS (element M-4) which will be used to update the Puget Sound Environmental Atlas, and they shall be made available to other agen-

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cies, governments and the public. These efforts shall be coordinated with the work of the Washington Geographic Information Council and with the DCTED as it guides data management related to regional growth management.

The Department of Fish and Wildlife and the Department of Natural Resources, shall increase their efforts to inventory Puget Sound fish and wildlife habitat relevant to this program, and coordinate the inventory with wetland inventories being done at the local level and with the compilation of inventories being prepared by Ecology under element W-4.

Finally, the departments of Fish and Wildlife, Natural Resources, and Ecology, and other state agencies that have habitat data on aquatic systems shall work cooperatively to develop a list describing the kind of data each agency has relating to these habitats.

3.2. Local and Tribal Governments

The Authority shall request state funding to establish a demonstration program of matching grants (in coordination with the DCTED and the Washington Department of Information Services) for local governments and tribes. The grants would be used to enhance existing computerized databases and to improve access to those databases for local governments or tribes without such databases. Funds could also be used to conduct inventories of local non-wetland aquatic habitats (including deep and open water, riparian zones and shorelands). Such inventories should be conducted according to current Puget Sound Estuary Program Guidelines and Protocols. Data should be provided to state agencies in a format specified by the granting committee.

Grant awards would be made through a committee comprised of representatives from the Department of Fish and Wildlife, DCTED, and the Authority. The grant program will promote efficient use of funds for regionwide data collection and will benefit the state by increasing available data.

3.3. Federal Agencies

In coordination with element W-5 (Wetlands Interagency Coordination) and the Puget Sound Estuary Program Management Committee, the USFWS shall work with other appropriate federal agencies, including the USFS, the National Park Service (NPS), EPA, NOAA, U.S. Geological Survey (USGS), Department of Defense (DOD), Army Corps of Engineers, and the Bonneville Power Administration, to share their data and information on Puget Sound fish and wildlife habitats with other Puget Sound agencies. A memoranda of understanding (MOU) could be developed among federal agencies to facilitate transfer of information.

Target Dates: The departments of Fish and Wildlife, Natural Resources, and Ecology, and federal agencies shall initiate work on subelements H-3.1 and H-3.3 by September 1, 1995. The government grant program for local governments and tribes shall be developed by January 1, 1996, with the first round of grants awarded in the summer of 1996.

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H-4. Habitat Education Strategy

4.1. State and Federal Agencies

In coordination with element W-7 (Wetlands Education Strategy), the departments of Fish and Wildlife, Natural Resources, and Ecology, and the USFWS shall develop and implement a long-range education strategy for protecting aquatic habitat (including deep- and open-water, riparian and shoreland habitat) that augments their existing education programs. This strategy shall build on and integrate elements in the Education and Public Involvement Program of this Plan, specifically subelement PI-1.2 (Technical Assistance), element EPI-2 (Coordination Mechanisms), subelement EPI-3.4 (Interpretive Centers), subelement EPI-3.3 (Wildlife Habitat Education), element EPI-4 (Volunteer Audiences), and subelement EPI-5.2 (Habitat Protection).

The strategy shall address the critical role of aquatic systems and associated habitat in maintaining fish and wildlife populations and other important ecosystem functions, such as water quality protection. The strategy shall address the need to manage and evaluate various habitats from a regionwide, ecosystem perspective. Other habitat issues, such as the effect of the projected growth in the region, shall also be addressed.

The strategy shall involve entities and individuals possessing expertise in the field of habitat protection education. These include staff from the WDFW, Ecology, State Parks, tribes, local governments, universities, and private nonprofit conservation groups. The departments of Fish and Wildlife, Natural Resources, and Ecology shall work with those state agencies and groups to implement the strategy and to coordinate with other ongoing water quality and habitat protection education efforts, such as those related to watershed planning and the Timber/Fish/Wildlife Agreement (TFW). Strategy components may include: (a) guidebooks on habitat protection techniques or on habitat descriptions and locations; (b) public workshops and field trips; (c) interdisciplinary workshops and conferences for government and agency staff, as well as elected officials; and (d) backyard wildlife enhancement projects. To the extent possible, public libraries shall be provided with educational material on Puget Sound aquatic systems and associated habitats and populations, and the need and methods to protect them.

Through the Puget Sound Estuary Program, federal agencies, including the Army Corps of Engineers, USFWS, USFS, NOAA, SCS and EPA, shall coordinate with and help support this education effort. The EPA shall be encouraged to use its Center of Excellence to coordinate federal agency information on aquatic habitat (including deep-water, riparian and shoreland habitats) protection for use by local governments.

4.2. Local and Tribal Government Habitat Enhancement and Public Education

With the Department of Fish and Wildlife as lead, the Authority, the state departments of Fish and Wildlife and Natural Resources and the USFWS shall work with tribal and local governments to establish a habitat enhancement and public education program. The Department of Fish and Wildlife shall invite tribal and local governments to apply for habitat enhancement projects for

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marine, stream, riparian, wetland or other habitats important to water quality protection, on the condition that they implement a public education program related to the project. Joint tribal and local government projects are encouraged. For tribes, the education will include habitat issues presented in the context of cultural heritage, cultural values and tribal rights. The Department of Fish and Wildlife will work with other state agencies and local and tribal governments to develop the application and selection process.

4.3. Wildlife Enhancement and Education, Private Sector

With the Department of Fish and Wildlife as lead, the DNR and USFWS shall work with developers, business and industry, local conservation groups, and local land trusts to implement joint habitat enhancement and education programs. Developers, business and industry, private conservation groups, or land trusts could apply for the funding or incentives on the condition that the project will provide public education on habitat, such as that envisioned at the Koll Center along North Creek in Bothell. The departments of Fish and Wildlife and Ecology and an interpretive specialist at State Parks shall be available to provide technical assistance on habitat enhancement or on educational activities if requested. The Department of Fish and Wildlife will form a steering committee to formulate funding and/or incentives for this program.

Target Dates: The WDFW, DNR, Ecology, State Parks, and federal agencies shall begin implementing work on subelement H-4.1 by September 1, 1995. The WDFW and the Authority will report on the funding mechanisms to establish subelement H-4.2 by January 30, 1996. The WDFW shall establish a steering committee for subelement H-4.3 by September 1995.

H-5. Public Involvement

The Authority's public involvement policy (PI-1.1) shall be followed by all state and local government agencies in implementing fish and wildlife habitat protection in Puget Sound. Specific actions to be implemented are:

5.1. Information on Hydraulic Project Approvals (HPAs)

The Department of Fish and Wildlife shall provide notice to agencies, local and tribal governments, and the public of current and pending Hydraulic Project Approval (HPA) permits for work in Puget Sound. Examples of ways to do this include a regular mailing of HPA lists to other agencies and governments and to public libraries. The notification is for informational purposes and is not a solicitation for public comment. The WDFW shall at a minimum make their computer listing of pending and recently issued HPAs available to the public. The WDFW and appropriate federal agencies are encouraged to promote interjurisdictional consistency by exploring ways to coordinate their permitting activities (such as the U.S. Army Corps of Engineer's issuance of 404 permits) with that of local governments.

Target Date: The WDFW shall, at a minimum, make their computer listing of HPAs available to the public by October 1, 1995. If funding becomes available, the WDFW shall develop a system to further distribute HPA listings so they are accessible to other agencies, governments and the public by June 30, 1996.

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H-6. Field Investigations

State resource agencies shall increase their efforts related to field work needed for management of habitats associated with aquatic systems. This effort is not designed to establish any new programs, but rather to support existing programs and help them more effectively protect Puget Sound fish and wildlife habitat. Federal agencies concerned with habitat management are encouraged to increase their work in the field and to coordinate with ongoing state and local efforts.

The Department of Natural Resources shall increase field investigations and environmental review related to the leasing of aquatic lands. Specific tasks include:

a. Review applications for NPDES (National Pollutant Discharge Elimination System) permits.

b. Perform SEPA (State Environmental Policy Act) review of lease applications.

c. Inspect and evaluate mitigation projects.

d. Ensure compliance with the environmental conditions stipulated in lease agreements.

The Department of Fish and Wildlife shall:

a. Research and evaluate the effects of permitted (HPA) activities on aquatic communities and fish habitat.

b. Devise standard requirements for HPA-permitted activities based on research results and monitor consistency of HPA requirements.

c. Inspect and evaluate mitigation projects.

d. Research and identify important marine habitats based on trophic studies.

e. Incorporate the research results in its HPA review process.

f. Conduct field inspections related to applications for HPA permits.

g. Ensure compliance to the environmental requirements of the HPA permit and monitor consistency of HPA requirements.

The Department of Ecology shall:

a. Coordinate efforts to protect aquatic habitat within its wetlands, shellfish and nonpoint pollution programs.

Target Date: Agencies shall begin work on this element on July 1, 1995.

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MAJOR PUBLIC ACTIONS FOR AUTHORITY REVIEW

1. Coordination with the DCTED and WDFW on critical areas guidelines (element H-1).

LEGISLATION REQUIRED

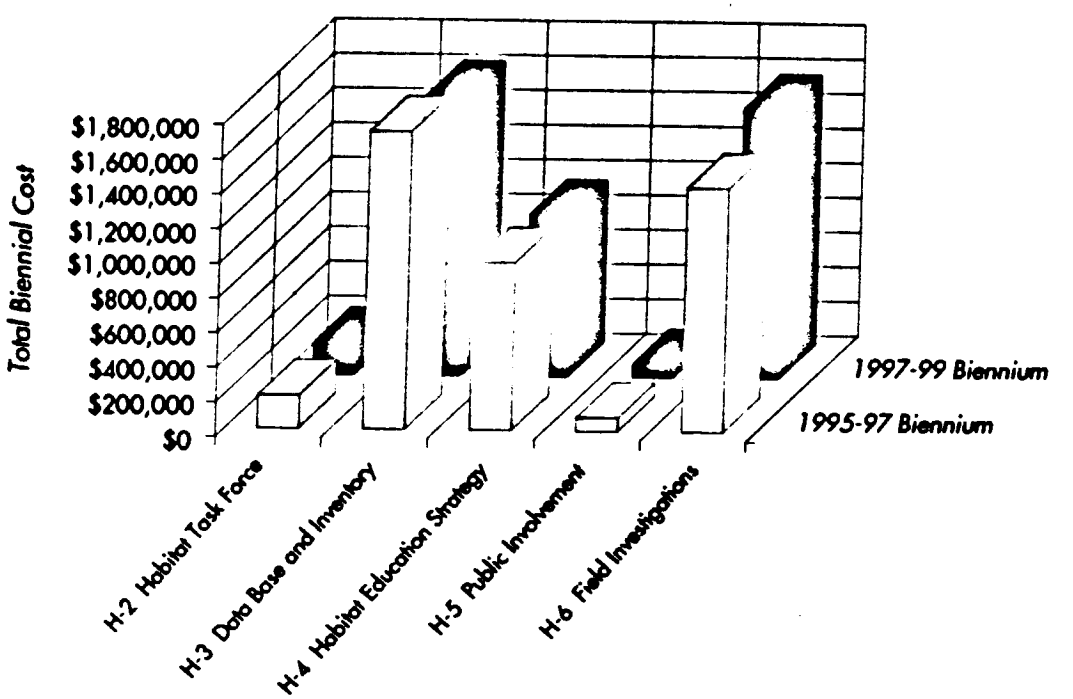
None.

ESTIMATED COST

Full implementation of the Fish and Wildlife Habitat Protection Program would cost an estimated $4.4 million during the 1995-97 Biennium and $4.4 million for the 1997-99 Biennium. Most of this cost is for the field investigations (element H-6) and to perform habitat inventories and enter what is learned into a geographic information system (GIS) (element H-3).

In order to perform the field investigations work in element H-6, the participating agencies would have to hire an estimated 13 full time employees. Once these employees were on board, the annual cost would be $781,000. Element H-4, Habitat Education Strategy, would cost an estimated $940,000 per biennium once the initial start-up costs for hiring new people had been met.

Fish and Wildlife Habitat Protection Program Implementation Estimates



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SPILL PREVENTION AND RESPONSE PROGRAM

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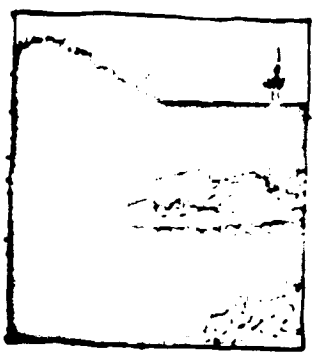
PROBLEM DEFINITION



Our society depends on large volumes of gasoline, motor and heating oils, solvents and other hazardous substances to function. These substances are routinely transported and stored in huge quantities, and can cause tremendous environmental damage when spilled or released on land or in water. Response capabilities would be overwhelmed by any large spill and would fail to significantly reduce environmental damage.

Puget Sound is no stranger to spills of oil and other hazardous substances. In November 1985, jet fuel spilled into Des Moines Creek, killing fish and other organisms in four miles of stream. The spill eventually reached Puget Sound. In that same year, more than 75,000 gallons of a toxic chemical spilled into Hylebos Waterway in Tacoma. In December 1985, the tanker *Arco Anchorage*, en route from Valdez, Alaska to a refinery at Cherry Point, Washington, ran aground near Port Angeles. The vessel spilled more than 200,000 gallons of crude oil, fouling Dungeness Spit and Ediz Hook. In 1988, the barge *Nestucca* collided with the tug *Ocean Services* and spilled 231,000 gallons of fuel oil off the coast of Washington at the mouth of Grays Harbor. The slick travelled as far north as Vancouver Island. Oil was found on Dungeness Spit and the San Juan Islands. More than 10,000 birds died as a result of the spill. Numerous minor spills occur every year in Puget Sound.

Small and large spills have potential for significantly harming water quality, both now and far into the future. When a spill occurs, the oil or other hazardous substance may remain at the surface of the water, where it affects marine birds, marine mammals, fish and shellfish eggs and larvae, and other organisms; it may be eaten or absorbed by aquatic life and enter the food web; it may sink to the bottom of the water body where it can contaminate sediments or, in the case of oil, smother organisms; and it may remain suspended in the water column where it can harm fish and other aquatic life. Dead birds, mammals and fish, as well as fouled beaches, are dramatic, acute effects of spills. The chronic and long-term effects to resources and the economy have not yet been determined.

INSTITUTIONAL FRAMEWORK

In 1986, state and federal laws were in place to require irresponsible parties to clean up spills and pay the costs of doing so. Contingency plans were also in place to guide coordination of a spill cleanup. These laws proved inadequate in practice, and many deficiencies were apparent in terms of prevention and response planning. Under the federal Clean Water Act, the party causing a petroleum spill is responsible for cleanup costs. The federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, or Superfund) assigns the same responsibilities for spilling other hazardous

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materials. Cleanup efforts are conducted pursuant to national, regional and state contingency plans, which identify what is to be done by whom in the event of a spill. The U.S. Coast Guard is the lead agency responsible for spill response in the marine waters of Puget Sound, with state and other federal agencies and local and tribal governments performing secondary roles. The U.S. Environmental Protection Agency (EPA) takes the lead for inland spills.

Some issues related to spill prevention and response have been addressed by recent state legislation. In 1989, the Washington State Legislature amended the state Water Pollution Control Act (90.48 RCW), to speed up damage assessment from an oil spill when damages cannot be quantified at a reasonable cost. In such an event, compensation will be assessed at between $1 and $50 per gallon of oil spilled. The 1989 Ocean Resources Management Act (RCW 88.40.020) requires that vessels over 300 gross tons which transport petroleum products as cargo have evidence of financial responsibility amounting to $1 million or $150 per gross ton, whichever is greater, to pay for spill cleanup and resource damage in the event of a spill.

AUTHORITY'S APPROACH

The 1987 Puget Sound Water Quality Management Plan (Plan) directed the Department of Ecology (Ecology) to revise its contingency plan for spills of oil and hazardous substances. The plan was to be based on a spill-response policy plan that specifies agency roles, responsibilities, communication and funding. Both the policy and contingency plans were to be completed in cooperation with other state and federal agencies and local and tribal governments.

Revisions to the Plan in 1989 directed the Authority to assess the adequacy of federal, state and local spill prevention measures. It also established a Spill Prevention and Response Advisory Committee, under the Puget Sound Estuary Program, to review contingency plan updates, review Ecology's progress reports and help review spill prevention issues. The committee completed its assignments and has been disbanded.

A number of new program elements were added to the 1991 Plan. Recommendations of the States/B.C. (British Columbia) Oil Spill Task Force were adopted. Ecology was encouraged to require spill control plans in wastewater discharge permits. The former Department of Community Development (now the Department of Community, Trade and Economic Development) was directed to design a training program for local fire departments to include in Article 80 of the Uniform Fire Code. The Authority was directed to establish a work group to identify gaps in current regulations, and fund a study of vessel safety issues in the Sound.

The 1994 Plan recognizes the significant progress made in oil spill prevention and deletes completed tasks and assignments.

PROGRAM GOAL

To emphasize spill prevention strategies and enhance response capability in Puget Sound and its tributaries, and to ensure that the spill prevention and

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response actions of state agencies are coordinated among themselves and with federal, local, tribal and private efforts.

STRATEGY

The strategy for achieving this goal is to: (1) identify the tools and resources needed to protect Puget Sound from spills, and (2) implement a comprehensive spill prevention and response program using current regulations and enacting new legislation if necessary

PROGRAM ELEMENTS

SP-1. Oil Spill Policy Implementation

Ecology and the Office of Marine Safety (OMS) shall address the issues described below and implement key recommendations contained in the 1986 Oil Spill Advisory Committee Report to the Legislature, the 1987 Ecology Spill Management Policy Recommendations report, the States/B.C. Task Force, and any further recommendations generated by continuing policy analyses.

Department of Ecology

Ecology shall continue to update and revise the state Contingency Plan for Spills of Oil and Hazardous Substances as necessary. Ecology shall continue to review, modify if necessary, and adopt appropriate recommendations from future efforts of the States/B.C. Task Force. Ecology shall continue ongoing efforts to require and enforce spill prevention and contingency plans from on-shore facilities handling oil. Ecology shall coordinate with Department of Fish and Wildlife (WDFW) on the review of contingency plans for adequacy in protecting sensitive habitats.

In updating the state Contingency Plan, Ecology shall develop policies for *in situ* burning and the use of dispersants for spill response in Puget Sound. Ecology shall brief the Authority on these policies prior to formal adoption.

Ecology, in coordination with the WDFW, shall continue to evaluate whether information on priorities for protecting critical resource areas in Puget Sound is available and accessible. The need for additional information and/or synthesis of existing information will be evaluated.

Office of Marine Safety

The OMS shall carry out programs for tank vessel spill-prevention plans, cargo and passenger-vessel screening, regional marine safety plans for Puget Sound, and field operations.

SP-2. Fire Fighting and Spill Prevention

The Department of Community, Trade and Economic Development's (DCTED) Fire Protection Services Division shall design and implement a program to train local fire department and fire district representatives, businesses, and industries in the provisions of Article 80 of the Uniform Fire Code. The program shall be designed to promote participation by appropriate volunteer fire departments. The focus of the training shall be on building

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design and storage requirements for hazardous substances which will prevent release of those substances into the environment in case of an accident.

The OMS shall design and implement a marine fire-fighting program for Puget Sound. The program shall be designed to: (1) inventory existing equipment, vessels and trained personnel in the Puget Sound region; (2) summarize existing marine fire-fighting plans for all parties likely to respond to a marine fire; (3) develop a comprehensive plan to establish a marine fire-fighting network; (4) clarify roles of potential participants; and (5) describe how existing marine fire fighting may be coordinated.

Target Dates: The DCTED shall submit an outline of the training program and a training program schedule to the Authority by December 1995. The DCTED shall implement the training programs according to the schedule and submit annual progress reports to the Authority. The OMS shall submit an outline of a marine fire-fighting program and a program implementation schedule to the Authority by December 1995. The OMS shall implement the marine fire fighting program according to the schedule and submit annual progress reports to the Authority.

SP-3. Vessel Safety

The Office of Marine Safety shall implement the recommendations concerning vessel safety of the Regional Marine Safety Plans for Puget Sound. As part of this effort, the OMS shall appoint a Tug Escort Standards Committee to establish standards and recommended operational speeds for tug escorts in Puget Sound. The OMS shall also appoint a Towboat Standards Committee to establish operational standards for towing tank barges. The OMS shall also investigate and prepare a report on the effect of speed on vessel maneuverability and safety. The recommendations and study shall be conveyed by the OMS to the State Pilotage Commission and the U.S. Coast Guard to be used as the basis for potential regulatory changes necessary to ensure vessel safety. The OMS shall report to the Authority annually on its progress under this element.

Target Dates: The Office of Marine Safety shall appoint the Tug Escort Standards Committee and the Towboat Standards Committee by December 1995. The committees shall complete their development of recommended standards by December 1996. The OMS shall complete a report on the effect of speed on vessel maneuverability and safety by December 1996.

SP-4. Spill Prevention Education

Washington Sea Grant shall develop and implement an education program targeting spill prevention for the commercial fishing industry and ports. The program shall target fishermen who fish or moor their boats in Puget Sound, and Puget Sound ports which support commercial fishing boat activity. Washington Sea Grant shall coordinate the program with spill prevention education of recreational boaters and marinas by the State Parks and Recreation Commission (element MB-4). The program shall illustrate ways to reduce oil contamination of bilge water, reduce accidental spills of hydraulic fluid and other hazardous substances during routine maintenance, reduce spillage during refueling, and encourage proper disposal of hazardous materials. In addition, the program will focus on ways to meet shoreside hazardous

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material handling and disposal needs of the targeted groups. This program shall be coordinated with actions taken by Sea Grant and the departments of Ecology and Fish and Wildlife to implement program element EPI-5.1.

Target Dates: The educational program shall be implemented according to the workplan schedule developed for this program. Washington Sea Grant shall submit semi-annual progress reports to the Authority.

MAJOR PUBLIC ACTIONS FOR AUTHORITY REVIEW

1. Training program outline and implementation schedule by the Department of Community, Trade and Economic Development (element SP-2). Marine fire-fighting program and implementation schedule by the Office of Marine Safety (element SP-2).

2. Vessel safety standards recommendations (element SP- 3).

ESTIMATED COST

Fully implementing the Spill Prevention and Response Program is estimated to cost $4.6 million during the 1995-97 Biennium and $3.2 million during the 1997-99 Biennium. The revised 1994 Spill Program will be almost entirely paid for by the Oil Spills Administration Account (a tax on crude oil brought into the state for refining), with minor contributions from federal, local and tribal funding sources and the state General Fund. Many of the costs will accrue due to actions to implement the policies agreed upon by the States/B.C. Task Force. These measures involve a large and complex array of costs which would be shared by numerous government agencies and private industries. Recommendations which involve general measures, such as increasing enforcement efforts, do not facilitate a simple calculation of costs. Therefore, the sum cost of implementing all of the recommendations remains unknown.

Private sector costs that may result from spill prevention and response activities are not included in the estimate of implementation costs. Improvements in spill prevention and response may also help counter private costs by reducing potential cleanup costs from spills.

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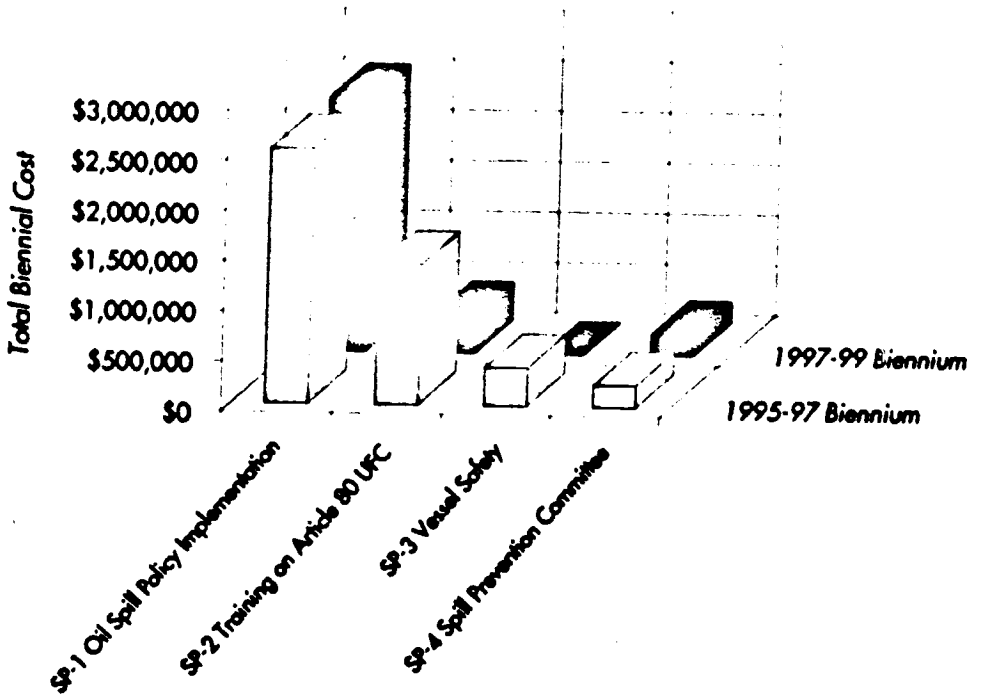
Spill Prevention and Response Program Implementation Estimates



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MONITORING PROGRAM

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PROBLEM DEFINITION



To assess the effects of human activities on Puget Sound and its resources, it is necessary to collect baseline and long-term data on the Sound's water, sediments, biological populations and habitat. Population growth and associated urbanization, industrialization and waste disposal have increasingly strained area resources. Resource managers need accurate, up-to-date information on present conditions and changes over time to protect the resources from harm. The public needs accurate information to remain aware and involved in the decision-making process. Managers can assess risks to human health from eating contaminated seafood only if they have sufficient information about contaminant levels in fish, shellfish and other seafood, and the rates at which those levels change.

In 1986, the Authority identified the need for a long-term, comprehensive program to monitor Puget Sound and its resources. Monitoring efforts by federal, state and local agencies generally were not Sound-wide and not well coordinated. A substantial amount of data was being compiled on fresh and marine waters, sediments, and biota as part of specific, project-related intensive surveys, short-term or localized monitoring, and compliance monitoring. Program activity, however, was narrowly focused and largely designed and implemented by numerous agencies. Improved coordination and integration of Sound-wide monitoring programs was badly needed.

A comprehensive monitoring program can measure the effectiveness of regulatory programs and the Puget Sound Water Quality Management Plan (Plan), evaluate long-term trends in environmental quality, improve decision making and help prevent overlaps and duplications.

AUTHORITY'S APPROACH

The Authority addressed monitoring issues in the 1987 Plan by forming a Monitoring Management Committee (MMC), comprised of representatives from federal and state agencies, local and tribal governments, Canadian agencies, industry, the scientific community, and the public. The MMC was charged with developing recommendations for the Authority regarding: (1) goals and objectives for an ambient Sound-wide monitoring program, (2) a technical design for ambient monitoring, (3) a data management system to handle all ambient monitoring data, (4) a cost estimate and identification of potential funding sources for the program, (5) opportunities for citizen monitoring, and (6) a strategy for updating and integrating the Puget Sound Envi-

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ronmental Atlas with the monitoring program. This committee was established in October 1986.

Prior to forming the MMC, a monitoring design was developed through the U.S. Environmental Protection Agency's (EPA) Region 10 office and refined through workshops involving the public and local and tribal governments. The workshops ensured that interested parties had a role in designing the committee. Members of the Puget Sound Estuary Program (PSEP), Technical Advisory Committee (TAC), and other scientists in the Puget Sound Area provided scientific review of the draft design.

The MMC presented its final report and recommendations to the Authority in April 1988. The committee's report and ongoing refinements provide the basis for the Monitoring Program. At the heart of this program is the Puget Sound Ambient Monitoring Program (PSAMP), which the Authority adopted in April 1988.[1]

The PSAMP Steering Committee was formed in August 1988 to manage and coordinate the program. It includes implementing state agencies, federal agencies, local and tribal governments, and the Authority. The majority of activities began in 1989.

As of 1994, a coordinated monitoring effort, which includes regular sampling, is in place. The departments of Ecology, Fisheries (now Fish and Wildlife) and Health have conducted regular sampling of marine and fresh waters, fish, sediments and shellfish since 1989. The state Department of Natural Resources (DNR) conducted habitat surveys in 1991-92. The U.S. Fish and Wildlife Service (USFWS) is conducting studies supporting future contaminant sampling of birds. Citizen monitoring activities are carried out regularly through the Authority's Public Involvement and Education (PIE) Fund, EPA and agency funds. The departments of Ecology, Health, and Fish and Wildlife all have operational data-management systems, and the DNR has loaded the Puget Sound Environmental Atlas onto the Puget Sound Geographic Information System (GIS).

PROGRAM GOAL

To implement the Puget Sound Ambient Monitoring Program. This program was designed to: (1) assess the health of Puget Sound and its resources; (2) identify existing environmental problems; (3) provide data and other information to assist the Authority and others in measuring the success of environmental programs; (4) document natural and human-caused changes over time in the ecological components of Puget Sound; and (5) support research activities by making available scientifically valid data.

1 Some of the environmental variables examined by the MMC were not included in the PSAMP recommendation due to high costs, lack of adequate protocols or logistical constraints. For example, sampling and analysis of freshwater sediments for toxics could not technologically be accomplished for a reasonable price and were therefore not included in the program. Many of the variables rejected for this initial PSAMP design should be given serious consideration in future iterations of the program. Funding levels and/or technological advances may allow for their addition to the program.

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PROGRAM ELEMENTS

M-1. PSAMP Management Structure

The management structure for the Puget Sound Ambient Monitoring Program shall consist of the PSAMP Steering Committee, the MMC and the Authority. Staff, housed at the Authority, shall provide technical and administrative support to the program.

The PSAMP Steering Committee shall be chaired by the Authority and shall be composed of one representative from each of the implementing agencies, the EPA, the USFWS, and tribal and local governments. Additional members shall be added in the future if deemed necessary by the Authority. The PSAMP Steering Committee shall be responsible for the overall coordination and management of the PSAMP; coordination of agency activities; the review of technical and interpretive reports of PSAMP information; approval of changes in program design or "task implementation plans"; and the sanction of protocols for use in the PSAMP. The PSAMP Steering Committee may, at its discretion, consult with appropriate experts from outside the program on technical issues. The PSAMP Steering Committee shall meet every month or as needed, and shall reach decisions by consensus. If the PSAMP Steering Committee cannot reach consensus on an issue, then it shall be decided by majority vote.

The MMC shall be chaired by the Authority and shall consist of representatives from: the state departments of Ecology, Fish and Wildlife, Natural Resources and Health, King County Department of Metropolitan Services (Metro), local water and sewer districts, local public health officials, tribal governments, federal agencies (including the National Oceanic and Atmospheric Administration, EPA, USFWS, U.S. Geological Survey, Natural Resources Conservation Service, and Army Corps of Engineers) Canadian agencies, industry, shellfish growers, the scientific community, and citizen organizations.

The MMC shall act as the advisory group to the PSAMP Steering Committee. Proposed major changes to the PSAMP shall be referred to the full MMC or to MMC subgroup appointed by the PSAMP Steering Committee. Major changes include, but are not limited to: (1) the addition or deletion of a PSAMP task or major sub-task; (2) change in assignment of an implementing agency; (3) setting funding priorities among PSAMP tasks; (4) changes in protocols, sampling design or criteria for locating sampling stations; (5) and any significant technical issue upon which the PSAMP Steering Committee cannot reach agreement. The MMC shall meet as needed. Representatives from the MMC may also be included in PSAMP Steering Committee meetings on an ad hoc basis to address specific technical issues not requiring review by the full MMC.

If the PSAMP Steering Committee cannot reach agreement on major changes to the PSAMP or other technical issues after consultation with the MMC, or on any other issue, the PSAMP Steering Committee as a whole, or any member individually, may refer the matter to the Authority for resolution.

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The PSAMP Steering Committee and the MMC shall review and reassess the design of the PSAMP on an as-needed basis.

The Authority shall facilitate agency cooperation among the state agencies implementing the PSAMP; provide arbitration for interagency disagreements concerning the PSAMP; provide and house the monitoring program staff; provide the central data-management functions; and distribute integrated, interpretive reports of PSAMP results.

The Authority shall: (1) implement PSAMP Steering Committee and Authority decisions; (2) coordinate the monitoring program; (3) manage a central database system; (4) provide technical review of field collection and laboratory analysis design; (5) provide quality assurance review of PSAMP data; (6) prepare technical assessments of PSAMP progress for the PSAMP Steering Committee; (7) ensure that program revisions are coordinated among agencies; (8) provide technical assistance to program participants in areas of data analysis and interpretation and field and laboratory activities; (9) organize outside technical assistance, where needed, to help in review of monitoring data and program revisions; (10) prepare integrated reports from data reports; (11) and coordinate with other monitoring and research efforts.

Memoranda of agreement shall be negotiated between each implementing agency and the Authority to: (1) ensure the implementation of the PSAMP; (2) allow for future modifications of the program, as needed; (3) secure long-term stable funding for the PSAMP; and (4) develop a permanent record of data for Puget Sound. These agreements shall include commitments of work to be performed by one agency to support products of another agency, product reviews, consultation, and technical support.

If the Authority sunsets, those Authority functions associated with the management of the PSAMP will be assumed by another organization. The PSAMP Steering Committee shall consult with the MMC and shall develop a recommendation for the long-term coordination and management of the PSAMP prior to the sunset date of the Authority.

Target Dates: Ongoing.

M-2. Puget Sound Ambient Monitoring Program (PSAMP)

The design of the PSAMP, completed by the MMC in April 1988, and subject to future amendment, has been adopted for use in Puget Sound, and defines the overall program design (program structure and task components) of the PSAMP. The 1988 PSAMP report, prepared by the MMC, also contains initial guidance on the specific design of each task. Implementation plans—prepared by the implementing agencies and approved by the PSAMP Steering Committee—shall provide detailed documentation of all components of task implementation. The implementation plans may update or amend the initial task guidance provided in the MMC 1988 report.

The Puget Sound Ambient Monitoring Program shall collect and analyze samples and carry out surveys to determine the quality of the water, sediments, biological populations, and habitats of the Puget Sound basin, using protocols,

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quality assurance checks, data storage and reporting procedures, as detailed in the MMC 1988 report and the task implementation plans. The implementing agencies shall carry out specific assignments for implementing the PSAMP, as defined in task implementation plans approved by the PSAMP Steering Committee.

Initially, the state departments of Ecology, Fish and Wildlife, Natural Resources and Health, and the U.S. Fish and Wildlife Service (USFWS) have been chosen as the implementing agencies. Other federal and state agencies, local and tribal governments, and other organizations may become implementing agencies in the future. Program tasks outlined in the 1988 MMC report have been assigned to the implementing agencies as follows:

Department of Ecology	Sediment, Marine Water Column, Fresh Water
Department of Fish and Wildlife	Fish, Birds, Marine Mammals
Department of Natural Resources	Nearshore Habitat
Department of Health	Shellfish
USFWS	Contaminants in Birds

Changes to the overall program design shall require approval of the PSAMP Steering Committee in consultation with the full MMC or MMC subgroup appointed by the Steering Committee. The program shall include, at the least, sampling for sediments, water quality variables, biological populations, and habitat, within the limits of available funding.

Location, timing and frequency of sampling stations in each program task shall follow the approach outlined in the MMC 1988 report as updated and detailed in the task implementation plans. Task implementation plans shall include detailed field sampling techniques, station locations, laboratory procedures, a quality assurance/quality control (QA/QC) program, and a data management plan, and shall indicate any arrangements made with agencies or organizations for carrying out portions of the work. Task implementation plans shall be approved by the PSAMP Steering Committee, in consultation with appropriate experts outside of the program and implementing agency. Any changes to the approved task implementation plans shall require approval by the PSAMP Steering Committee. If the PSAMP Steering Committee decides that these changes require additional technical review, the committee may consult with experts outside of the program and implementing agency.

Target Dates: Implementation of the PSAMP is ongoing for those tasks for which funding is currently available.

M-3. Citizens' Monitoring

The Authority shall develop a citizens' monitoring program to collect data which will supplement the PSAMP and act as an educational and public involvement tool (see element EPI-6 for further details on citizens' monitoring). At a minimum, at least one citizens' monitoring project shall be carried out each year.

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Citizen monitors shall be asked to carry out portions of PSAMP tasks deemed appropriate by the monitoring program staff in consultation with the PSAMP Steering Committee. Staff from the implementing agencies shall provide technical support and oversight for citizens' monitoring projects funded under this element. Authority staff shall provide volunteer-management support for citizens' monitoring projects funded under this agreement.

Data collected under citizens' monitoring programs shall be subject to the same protocols and quality assurance checks as all other portions of the PSAMP.

Target Date: Citizens' monitoring projects associated with the PSAMP will be carried out on a continuing basis.

M-4. Data Management and Quality Assurance

Data management and quality assurance for the PSAMP shall be carried out through a centrally coordinated data management system. Responsibility for data storage and analysis shall be distributed among the implementing agencies and the monitoring program staff.

Each implementing agency shall develop and use data management systems, as specified in the PSAMP report, to manage all data generated under those tasks of the PSAMP for which they are responsible. The monitoring program staff shall develop and maintain a central database of PSAMP data, as specified in the PSAMP report, including a computerized data inventory.

All data generated under PSAMP shall meet the quality assurance requirements specified in the PSAMP report and those subsequently ratified by the PSAMP Steering Committee.

The implementing agencies shall transfer data to the central database annually, following quality assurance checks. Standardized computer codes and formats specified by the PSAMP Steering Committee shall be used uniformly for all data transfers between and among the implementing agencies and the Authority.

The monitoring program staff, with the Department of Natural Resources' Division of Aquatic Lands, shall create a Puget Sound Geographic Information System (GIS) as recommended by the PSAMP Steering Committee and adopted by the Authority in June 1989. The Puget Sound GIS shall include information on Puget Sound resources and environmental conditions at a scale appropriate for regional planning and analysis. The Puget Sound GIS shall be used to update the Puget Sound Environmental Atlas and to prepare PSAMP reports and analyses, as appropriate. The implementation of the Puget Sound GIS shall be coordinated to the maximum extent possible with the data management activities of the 1990 Growth Management Act, SHB 2929.

Target Dates: The state departments of Fish and Wildlife and Natural Resources shall have operational data-management systems by September 1, 1996. The monitoring program staff shall have an operational central database with enhanced reporting capabilities by July 1, 1996.

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M-5. Monitoring Reports

The implementing agencies shall analyze and report data for those tasks of the program for which they are responsible, as specified in the PSAMP report, in consultation with the monitoring program staff.

The implementing agencies shall each prepare an annual technical report which shall include a compilation of data, statistical analyses, interpretation, and recommendations for changes in the monitoring program design.

The monitoring program staff shall prepare an annual *Puget Sound Update*, which will be an integrated report, written for a non-technical audience. The *Puget Sound Update* will include information supplied in reports from the implementing agencies and the monitoring databases. The PSAMP Steering Committee and the MMC shall review the Puget Sound Update prior to its release.

Agency-intensive survey groups shall use the findings of the PSAMP as a resource in setting priorities for problem areas in need of study.

Target Dates: Each agency implementing the PSAMP shall prepare an annual technical report for the Authority.

M-6. Additional Monitoring and Data Management Needs

The goals of the PSAMP will be enhanced by the addition of appropriate intensive survey, receiving water monitoring data collected by dischargers, and other environmental data that are compatible with the data collected under the PSAMP. The PSAMP Steering Committee shall consult with state and local agencies concerning the applicability of their intensive survey and other environmental data to the PSAMP. The state departments of Ecology and Health, and other state agencies; the EPA, the U.S. Navy, and other federal agencies; Metro and other local and tribal governments shall collect and store information from intensive surveys, to the maximum degree feasible, according to sampling and analysis protocols specified by the PSAMP Steering Committee. Ecology, DOH, and other agencies as appropriate, shall, to the maximum extent practical, transfer appropriate intensive survey results, ambient monitoring data, and other environmental information to the central database at the request of the monitoring program staff. Transfer of the information shall be accomplished using data transfer formats developed under element M-4.

Collection and storage of information in a manner compatible with the PSAMP is addressed for compliance monitoring surveys in elements P-8 and P-17; for contaminated sediment inventories in S-8.1; for nonpoint pollution monitoring in elements NP-7.2 and MB-7; for shellfish monitoring in elements SF-3 and SF-5; and for wetlands evaluation in elements W-1.2, W-4 and W-6.

Target Date: The departments of Ecology and Health, and other agencies shall use PSAMP protocols on an ongoing basis. Intensive-survey data shall be stored in compatible format by Ecology and the DOH by January 1, 1996, and by all other agencies by July 1, 1996.

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M-7. Evaluation of the PSAMP

In order to ensure that the PSAMP remains a necessary and cost-effective program that generates data useful to scientists and water quality managers, periodic evaluations of the program shall be conducted. Five years after the start of the program and every three years thereafter, the PSAMP Steering Committee shall identify an independent organization with appropriate technical expertise to evaluate the PSAMP. The independent organization shall prepare a report for the PSAMP Steering Committee which evaluates: (1) the effectiveness of PSAMP sampling, analyses and data management in meeting program goals; (2) the degree to which quality-assurance requirements are met and are effective in generating high-quality data; (3) the degree to which PSAMP reports are effective and appropriate in meeting the program goals; (4) the continuing need for the PSAMP sampling and analysis tasks, parameters, sampling frequencies, and station locations; (5) the degree to which PSAMP is being implemented according to the overall design strategy; and (6) the degree to which PSAMP results are used in making decisions about water quality management. The report shall also make recommendations for improvements to the program, including the addition or deletion of monitoring tasks.

Target Dates: First evaluation starts by July 1994 with the report due to the PSAMP Steering Committee by December 1994.

M-8. Pesticides Monitoring

A technical subcommittee to the MMC, consisting of representatives with expertise in pesticides from the departments of Ecology, Health, Fish and Wildlife, Agriculture, Transportation and Natural Resources; the University of Washington, Washington State University and Western Washington University research faculty; the EPA; the U.S. Geological Survey; the U.S. Fish and Wildlife Service; the National Oceanographic and Atmospheric Administration; the Natural Resources Conservation Service; conservation districts; public and private interests; and other organizations as appropriate, shall be convened. The technical subcommittee shall: (1) coordinate and focus ongoing pesticides monitoring activities in Puget Sound; (2) evaluate the need for additional monitoring of pesticides in Puget Sound; and (3) make recommendations to the Authority for the inclusion of pesticides monitoring in selected tasks of the PSAMP. Some pesticides monitoring needs that the technical subcommittee should consider include:

- The monitoring of potential point and nonpoint sources of pesticides including sewer and storm drain outfalls and highway, forestry and agricultural runoff.

- The monitoring of ambient levels of pesticides in Puget Sound sediments and organisms to determine long-term changes in environmental concentrations.

Target Dates: The technical subcommittee shall be convened by July 1, 1996, and shall make recommendations on pesticides monitoring to the Authority by November 1996.

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MAJOR PUBLIC ACTIONS

None.

LEGISLATION REQUIRED

None.

ESTIMATED COST

Fully implementing the Monitoring Program is estimated to cost $8.6 million during the 1995-97 Biennium and $8.3 million during the 1997-99 Biennium. Field sampling and laboratory analysis of sediment, water quality and biological population samples constitute the most costly element of the program, with an annual cost approaching $4 million. Cost estimates include costs for field sampling, laboratory analysis of samples, coordinating and managing the program, providing a central data-management system, developing a Puget Sound Geographical Information System (GIS), coordinating a citizens' monitoring program, developing and maintaining individual agency data management systems, implementing quality-assurance procedures, and producing reports for technical audiences and the public.

No significant private sector costs have been identified for this program, with the exception of staff time provided by representatives of the private sector on the Monitoring Management Committee. Other monitoring costs also appear in the Municipal and Industrial Discharges Program, where there are requirements for increased monitoring by dischargers.

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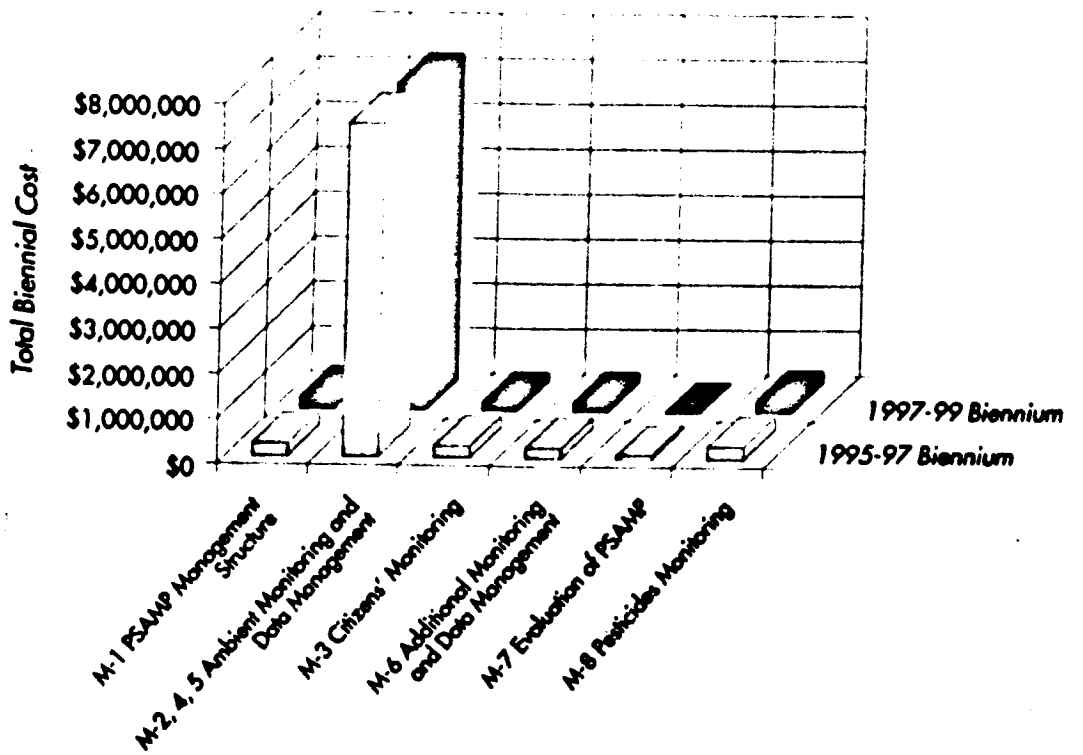
Monitoring Program Implementation Estimates



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RESEARCH PROGRAM

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PROBLEM DEFINITION



Research[1] and monitoring form the technical foundation for the Puget Sound Water Quality Management Plan (Plan). Research is essential for understanding Puget Sound and its associated watersheds, and for developing management options to protect the Sound in the future. It provides a basic understanding of conditions and processes, while monitoring establishes baseline data and tracks trends in conditions. Research explores and confirms findings made through monitoring. Finally, research helps develop accurate, practical and cost-effective methods for monitoring and for analyzing samples.

The need to include a comprehensive, coordinated program of research for Puget Sound was recognized in the earliest stages of Plan development. Comprehensive research was not being undertaken primarily because the system of funding promoted narrowly focused efforts. Funding for most research is administered either directly by federal agencies or through state programs that are set up as regional managers for federal funding. These agencies neither claim responsibility for Puget Sound as an ecosystem, nor see research as their primary objective. Research by agency staff or independent contractors is typically designed to provide specific information which supports an agency's ability to carry out its particular mission.

This approach to defining and funding research arose in part from a reactive, narrowly focused (e.g., "single-species") management perspective. Now, as awareness of the need to make well-informed management decisions from a wider, "systems" perspective (watershed, basin, ecosystem) grows, there is an increasing need to formulate research questions from a similar, broader perspective. Research must be focused on Puget Sound itself, on its unique physical and biological systems, and on the cumulative effects of management decisions on the Sound.

At the same time, the demand for highly focused, "applied" research has grown as state and local governments come under increased pressure to solve the complex problems of environmental protection. Issues affecting wetlands and other habitats (e.g., protection, restoration, mitigation for loss), storm water (best management practices for control and use of runoff), and on-site sewage systems (alternative systems) are driving research in innovative technical solutions.

1 Scientific investigation in which a hypothesis, idea or assumption is developed and tested through systematic collection and objective analysis of data.

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INSTITUTIONAL FRAMEWORK

Despite the need for a comprehensive approach to research in Puget Sound, with few exceptions research in the Puget Sound region has consisted of a patchwork of agency-sponsored, short-term studies. When coordinated research projects do occur, they lack a basinwide focus. Localized restoration projects, such as Superfund and urban bay action teams, have brought together federal, state and local agencies in site-specific associations that promote longer-term, integrated studies. On occasion, agencies involved in formal and informal arrangements, such as the Puget Sound Estuary Program (PSEP), have combined efforts on research projects. Interagency coordination by the PSEP's technical advisory committee, for example, has resulted in applied research that is widely recognized as essential to our understanding of water quality problems.

Established in 1993 to protect water quality and ecosystem health in marine, coastal and estuarine waters, and administered by the National Oceanic and Atmospheric Administration (NOAA) and the Environmental Protection Agency (EPA), the Pacific Northwest Regional Marine Research Program (RMRP) identifies research needs and sets priorities for research in the region encompassing Washington, Oregon and part of northern California. When funded, the RMRP should produce a program of research that is ecosystem-oriented, coordinates existing efforts and funds new research. Since it is the largest basin in the Pacific Northwest region, Puget Sound will receive a significant portion of the program's attention. On the other hand, given the regional scale of the RMRP, Puget Sound will receive only a small portion of the attention that its health and protection require.

In the Puget Sound region, providers, funders and users of research have been slow to address the need for a program of research that embodies shared goals and priorities with a basinwide perspective. A coordinated Puget Sound research program could:

(1) Provide a clear connection between the scientific community's research agenda and the information needs of resource managers, regulators and other policy-makers.
(2) Sponsor and highlight technical solutions required by other programs of the Puget Sound Plan.
(3) Promote investigations that increase our general knowledge of the Puget Sound system and are beyond the purview of any single agency.

Finally, discoveries relating to the delicate balance of biological systems in the Sound, and the development of creative and cost-effective solutions to Sound-wide water quality problems have little effect if the information never reaches people who can use it. Often, results are disseminated only to a select group within the scientific community, or in a form or time frame that prevents their usefulness to resource managers, policy-makers and the general public. Lack of public forums for exchanging information has caused difficulties and misunderstandings in both communities.

A coordinated, effective program of research for the Puget Sound region must address two needs: (1) to ensure that the effort and resources devoted to research are appropriate to and commensurate with problems that are confront-

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ed in managing the Sound's water quality, and (2) to ensure that the results of research are understood and incorporated into the decision-making process at all levels.

AUTHORITY'S APPROACH

In an effort to promote a coordinated program of research for Puget Sound, the Authority pursued two separate but closely related processes: (1) focusing institutional and financial resources on Puget Sound research, and (2) actively disseminating research information through a series of conferences, workshops and publications.

In the 1987 Plan, the Authority presented a strategy that called for developing a research committee, holding an annual Puget Sound research conference, and also adopting research needs and priorities. Established in 1987, the Committee on Research in Puget Sound, was comprised of representatives from academic institutions, state and federal agencies, business, agriculture, environmental groups and private research organizations. The committee was charged with making recommendations to the Authority on eight issues important to Puget Sound research, including: research priorities, institutional needs, data management, research reserves, and the publication and dissemination of research results.

In July 1987, the Subcommittee on Establishing Research Priorities generated a ranked list of research priorities. In an effort to devise an institutional structure which might address problems related to coordinating and paying for research, disseminating research results, and using research results in making decisions, the Subcommittee on Institutional Issues reviewed the structure, responsibilities and operation of existing institutions in the Puget Sound region and around the nation. Based on this analysis, the Committee on Research recommended that a Puget Sound Research Foundation should be established.

In the 1989 revision of the Plan, the Authority adopted long-term research goals and a list of six research priorities developed by the Committee on Research. This list was intended to guide support for research through a grants program for Fiscal Year 1989-91. A seventh area of research having to do with pesticides was identified by an issue paper released in 1990 and added to the list.

The 1994 Puget Sound Plan's Research Program calls for the Authority to establish a grants program to fund research on Puget Sound. The Foundation Program was eliminated after efforts to establish the Puget Sound Research Foundation were unsuccessful. The Authority has been actively disseminating research information through a series of conferences and publications—most notably the Puget Sound Research conferences and *Puget Sound Notes*.

PROGRAM GOAL

To establish and maintain a system of priorities and funding for, and dissemination of, research that: (1) adds to our knowledge of the physical and biological systems of Puget Sound; (2) identifies causes and solutions of pollution problems; and (3) assists decision-making activities of regulatory and management agencies while stimulating creativity and excellence in research.

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STRATEGY

The strategy for achieving this goal is to: (1) maintain the Puget Sound Research Program[2] in order to promote the coordination and funding of Puget Sound research; (2) maintain a renewable list of priorities for the program; and (3) assist in making the results of research available for use in making decisions.

PROGRAM ELEMENTS

R-1. Puget Sound Research Program

The Authority shall maintain the Puget Sound Research Program in order to provide a regional focus for the setting of research priorities, research sponsorship, and the dissemination of research findings related to Puget Sound and its watersheds. This task shall be carried out with the assistance of a Research Advisory Committee composed of representatives from academic institutions; state, federal, regional and local agencies; the business and consulting community; and private research organizations.

The Authority shall ensure that Research and Monitoring Program activities are coordinated. This includes reviewing the integrated technical report of the Puget Sound Ambient Monitoring Program (PSAMP) to identify research needs related to developing analytical and sampling methodologies or investigating questions raised by the monitoring results. In addition, the program shall coordinate, to the greatest extent possible, with other research and monitoring efforts, including the Puget Sound Estuary Program and other estuary programs, the NOAA's programs (Northwest Fisheries Science Center studies, activities of the Pacific Northwest Restoration Center and the National Estuarine Research Reserve, and the National Marine Sanctuary Program), the Pacific Northwest Regional Marine Research Program, watershed monitoring programs, the Timber/Fish/Wildlife Agreement process, and other grant programs.

R-2. Research Priorities

The Research Advisory Committee shall review, revise and recommend to the Authority a list of research priorities to serve as a guide to the Authority in decisions to fund research pertinent to Puget Sound. The advisory committee shall consider needs and priorities for research identified by other research and monitoring programs, such as the Pacific Northwest Regional Marine Research Program and the PSAMP, as well as by other Plan programs (e.g., elements H-6, PS-2, SP-3, SW-7 and W-9).

The Authority shall encourage agencies, industry and other organizations that fund research to consider the list of research priorities in their own processes for allocating research funds.

2 Portions of the Research Program are identified in elements of other programs of the Plan, including the Fish and Wildlife Habitat Protection Program, the Nonpoint Source Pollution Program, the Shellfish Protection Program, the Spill Prevention and Response Program, the Stormwater and Combined Sewer Overflows Program, and the Wetlands Protection Program.

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R-3. Research Grants Program

With the assistance of the Research Advisory Committee, the Authority shall establish and manage a competitive research grants program to support high-priority research that is not adequately funded by government agencies or other sources. The Research Advisory Committee shall review proposals with the assistance of appropriate experts, and select proposals on the basis of established criteria, including: current priorities, quality, significance of expected scientific contribution, and importance to an affected Puget Sound resource. The advisory committee shall annually recommend a slate of priority research projects to the Authority.

The Authority shall seek funding for research and award grants annually based on the recommendations of the advisory committee, current priorities for Plan implementation, and available funds. The Authority shall work cooperatively with agencies and tribal governments to allocate funds. At a minimum, the Authority shall seek to fund two students each year to enable them to pursue research related to Puget Sound resources and water quality issues. Support to scientists for research shall include appropriate funding and encouragement to ensure that research findings are communicated and translated into a form that is usable by decision makers. This should be accomplished through prompt publication of research reports (including short, non-technical summaries containing implications for management issues) in technical journals and in publications that are accessible to local government planners, agency staff and others.

The Authority shall pursue the development of a permanent and stable funding base from industry and other private sources as well as from federal and state entities for support of the Research Program, including basic or process-oriented research that may not be within a particular agency's mission but that is required to understand and use the results of applied research.

R-4. Translation and Dissemination of Research Results

The Authority shall support timely dissemination and translation of Puget Sound research results useful to the public and resource managers. Specifically, the Authority shall:

a. Establish a policy that research supported by the program should undergo peer review and, where appropriate, be published in technical and scientific journals.

b. Support preparation of synthesis or review papers on key Puget Sound issues.

c. Urge the preparation of short summaries for non-technical audiences of all reports arising from Puget Sound-related research.

d. Support the centralization and computerization of research findings by the submission of all research reports to recognized repositories and by updating and managing *Sound Access*, a computerized bibliography of Puget Sound literature.

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e. Publish an annual report summarizing progress on program-supported research and other activities.

f. Sponsor conferences on Puget Sound research that include presentations on current research, discussion of the implications of the research, and an assessment of research priorities for the coming year.

g. Sponsor technical forums for discussion of the scientific interpretation and management implications of research results, the forums should be designed to increase communication among researchers, resource managers, and other decision makers.

h. Communicate and provide educational opportunities to increase public understanding of how research contributes to the resolution of current and future issues related to water quality in Puget Sound.

R-5. Information Management

The Authority shall facilitate access to information dealing with Puget Sound that is not readily available through the open literature, particularly unpublished research and data. The Authority shall act as a broker between those having information and those needing it, including the public, the scientific community, regulatory and resource management agencies, and environmental and community groups. This function shall be coordinated with the data management functions of the Puget Sound Ambient Monitoring Program (PSAMP), which include the use of a central database of PSAMP data and the development of a computerized data inventory. The PSAMP data inventory will serve as a source of information on what computerized data are available and how they may be obtained.

The Authority shall maintain and periodically update the computerized bibliography, *Sound Access*.

R-6. Research Reserves

Agencies, universities and other scientific organizations shall seek opportunities to identify and establish additional research reserves if specific ecosystems or reference areas are missing or under-represented. Such reserves may be intended for research or as reference areas for monitoring. The Authority encourages any organization active in this area to prepare an inventory of existing reserves and to share that inventory with other organizations and the research and monitoring committees established under the Plan.

Target Date: This is an ongoing program.

MAJOR PUBLIC ACTIONS

None.

LEGISLATION REQUIRED

None.

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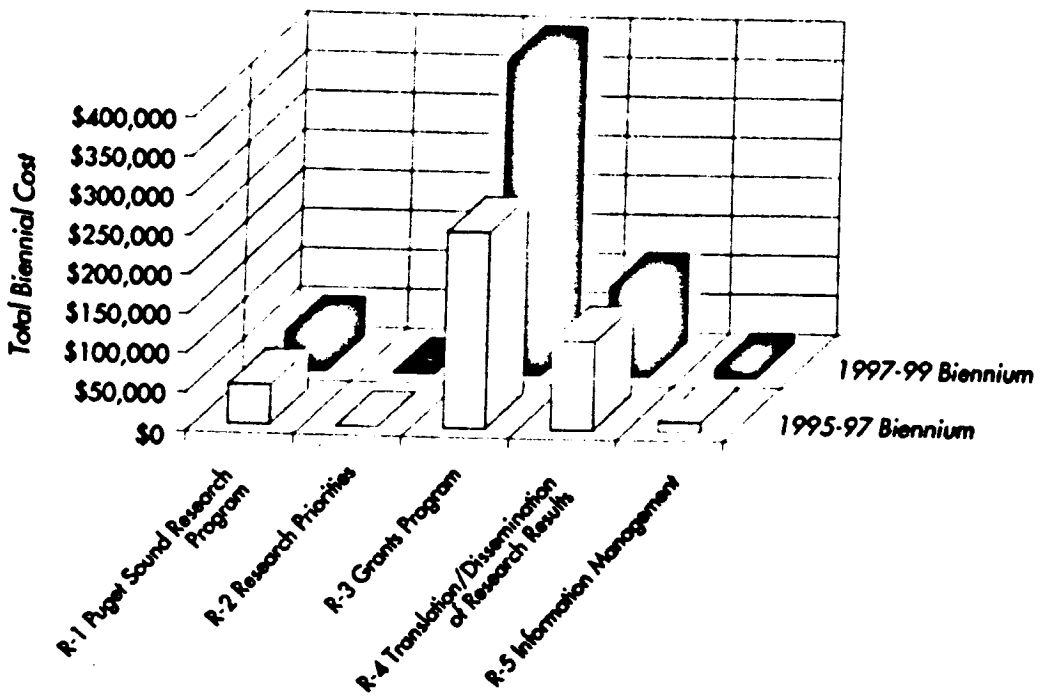
ESTIMATED COST

Fully implementing the Research Program is estimated to cost $426,000 for the 1995-97 Biennium and $576,000 for the 1997-99 Biennium. These costs would be for the Authority to administer a Puget Sound research program by holding a regular conference, disseminating research results, and awarding research grants. The 1995-97 costs would be mostly federal funds, with a small amount from the state. During 1997-99, federal funding would decrease, state funding would increase, and a major amount of private funding would be raised for funding research. This 1994 estimate reflects a significant down-scaling of this program. Previous versions of the Plan had projected research costs in the neighborhood of approximately $3.5 million per year.

Research Program Implementation Estimates



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EDUCATION AND PUBLIC INVOLVEMENT PROGRAM

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PROBLEM DEFINITION



Protecting water quality requires an ongoing commitment from everyone—as individuals at home, work and play, and as members of our communities, where we influence others on matters of common interest. Each of us has many roles in which we affect water quality and many opportunities each day to make choices involving the water quality of Puget Sound.

Education and public involvement are necessary components of a long-term management strategy for the Sound because they inform and enable us to make choices. Education and public involvement enrich our knowledge and experience of the Sound, encourage behavioral changes that protect the Sound, and give us a voice to act on the Sound's behalf.

In learning about the resources of the Sound, we may better understand what is needed to protect it, whether it's regulations, voluntary programs or other options. Education also provides motivation and skills, and helps individuals and organizations adopt new strategies for taking responsibility for Puget Sound.

Involving the public in protection and restoration activities is important because members of local communities, including tribes, schools, businesses and industry, can bring information, expertise, values, priorities and funding to the decision-making process. Public involvement is equally important to educate government officials about local issues and needs. Resource management programs that do not adequately educate or involve the public are often met with resistance or animosity, and sometimes fail as a result.

A survey conducted in 1986 by the Authority revealed some significant deficiencies in education related to Puget Sound. Most education programs on water quality of the Sound were found to be sporadic and without sustained funding. Very few agencies allocated employees or budget to education, and there was little coordination among institutions, agencies and programs in the region. This often resulted in conflicting or poorly targeted messages being sent and limited resources being used inefficiently. For example, although there were numerous educational curricula related to Puget Sound, there were limited funds to train teachers in how to use them.

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INSTITUTIONAL FRAMEWORK

In 1986, the Authority found that most citizens did not understand the nature of the pollution problems in the Sound. Although numerous education programs did exist, they were targeted at very specific audiences and selected issues. In addition, the Authority found that many requirements for public involvement in water quality issues were not being met and there was a lack of dedicated staff time and training devoted to public involvement.

Since 1986, agencies have allocated more resources toward education. They have also reorganized their education programs to better serve agency missions and resource management goals, and developed new opportunities for interagency cooperation. Authority programs, including the PIE Fund, staff outreach and nonpoint-source watershed planning under WAC 400-12, have created models for other agencies and local governments.

Citizen stewardship programs have been adopted by many local governments and state and tribal resource management agencies. Viewed with skepticism in the past, volunteers have been incorporated into many kinds of programs, including the Puget Sound Ambient Monitoring Program. Vigorous private sector efforts by Adopt a Beach, the Adopt-A-Stream Foundation and school-based programs through Project Green (Global Rivers Environmental Education Network) have complemented Authority programs.

Cooperative bridges have been formed using professional organizations like the Environmental Education Association of Washington and the Governor's Council on Environmental Education. In addition, various local and regional forums for environmental educators have been created to coordinate services and develop educational priorities.

Donations from private sources such as the Bullitt Foundation, Key Bank of Washington, and local funding sources such as stormwater utilities provide valuable funding for education projects and activities.

The 1994 Plan addresses the need for racial and cultural representation in public involvement policies.

AUTHORITY'S APPROACH

In 1987-89, the Authority focused more formally on public involvement than on education. The 1987 Plan included a public involvement policy to be followed by all state and local agencies for all Plan-related activities.

In the 1989 Plan, the Authority developed a long-range education strategy. To help develop the strategy, the Authority established the Education and Public Involvement Program advisory group. The committee is composed of educators, media experts and representatives of environmental and public interest groups, industry, business, agriculture, and local and tribal governments.

PROGRAM GOAL

To support, improve and sustain education and public involvement programs in the region over the long term in order to: (1) inform, educate and involve individuals, groups, businesses, industry and government in the cleanup and protection of Puget Sound; (2) increase understanding of the Sound's ecosys-

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tem; and (3) create the kind of commitment that will be necessary to sustain efforts to improve and protect water quality over the long term.

STRATEGY

The strategies for achieving this goal include: (1) a public involvement policy to be followed by agencies and local governments; (2) increased resources to state agencies and tribal governments for coordinated interagency/intergovernmental education programs on marine and freshwater habitats, on water quality policy issues, and on volunteer action; (3) field agents to coordinate among local and regional education and public involvement programs; and (4) a Public Involvement and Education Fund (PIE Fund) to support short-term public involvement and education efforts of both the private and public sectors.

PROGRAM ELEMENTS

PI-1. Public Involvement

1.1. Public Involvement Policy

The public involvement policies established in this element shall be followed by all state agencies and local and tribal governments in implementing the Puget Sound Plan. The Authority shall monitor public involvement activities of agencies implementing the Plan.

The policies are:

a. A broad representation of the public, including those being directly affected, members of economic, cultural or ethnic minorities typically not represented, business, and members of the general public, shall be consulted in developing and adopting rules, establishing criteria, setting guidelines, selecting sites or target areas, developing action plans, and carrying out other activities related to the Puget Sound Plan.

b. A variety of public involvement techniques shall be used. Where advisory or review committees are deemed helpful to provide public involvement in the implementation of the Plan, existing standing committees or commissions and established processes such as the SEPA (State Environmental Policy Act), the Shoreline Management Act and procedures for local comprehensive plans should be evaluated and improved where possible rather than creating new committees. However, new or additional committees or processes should be created if needed to achieve full public involvement. Agencies shall consider reimbursing travel expenses of members of advisory bodies.

c. Agencies shall allocate adequate staff resources to their public involvement programs. Agency staff responsible for public involvement shall receive training in public involvement techniques and skills.

d. State and federal agencies, and local and tribal governments shall use public information techniques that exceed requirements for legal notice or publication in the Federal or State Register to ensure that: (1) public informa-

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tion on decisions to be made or actions to be taken for the Puget Sound Plan is complete and understandable; (2) the effects, especially effects on special groups or geographic areas, of the proposed decision or action are fully described; (3) the ways in which the public might be affected by the decision or action are fully presented; and (4) the ways in which the public may influence the decision-maker and appeal the decision are explained.

e. To facilitate access to decision-making processes, state agencies and local and tribal governments shall send notification for public hearings or meetings as early as possible, shall seek to provide both day and evening meetings and hearings, and shall explain how public comment was incorporated into decisions and actions. For decisions affecting a large geographic area, meetings and hearings shall be held at locations throughout the area.

f. To facilitate understanding of decision making and Plan programs, the Authority and other agencies will communicate clearly and simply using lay language whenever possible.

g. Intergovernmental relations with tribal governments: To involve tribal governments in the decision-making process, agencies shall follow the Centennial Accord. Local governments shall communicate with tribal governments to determine the most effective mechanism for inter-government communication with tribes on any programs or projects related to the Puget Sound Water Quality Management Plan. Tribal governments shall follow the Centennial Accord.

Target Dates: Ongoing.

1.2. Technical Assistance on Public Involvement

The Authority, the Department of Ecology, Washington State University Cooperative Extension and the Department of Community, Trade and Economic Development shall provide technical assistance on public involvement for local governments to help them implement the Puget Sound Plan. Technical assistance shall include developing materials, providing training and making recommendations. Training shall include the topics of consensus-building, conflict management and how to use volunteers.

These agencies shall support citizen groups by opening their public involvement training sessions to citizens whenever possible; by notifying citizens of the opportunities to receive training in public involvement related to federal, state and local permit processes, and by conducting training on how to organize and maintain effective volunteer groups.

Target Date: The Authority's technical assistance and monitoring is ongoing. The Authority, WSU Cooperative Extension, the DCTED and Ecology shall be organized to provide coordinated technical assistance beginning as funding is available.

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1.3. Ecology Coordinator and Mailing List Brochure

Ecology shall maintain a public involvement coordinator who shall be responsible for coordinating public involvement activities related to Ecology's responsibilities under the Puget Sound Plan. Ecology shall periodically update the brochure describing the various mailing lists maintained within the agency, defining the purpose of each, and giving instructions on how to get on each list.

1.4. Short Course on Local Planning

The Department of Community, Trade and Economic Development and the Authority shall develop materials for use in the Short Course on Local Planning and other training programs. The materials shall include information about integrating water quality protection into comprehensive plans developed under the Growth Management Act and other land-use planning processes as appropriate.

Target Date: Materials shall be available by September 1994 and updated as necessary thereafter.

EDUCATION

EPI-1. Education Guidelines

The following guidelines shall be used in developing programs as part of the long-range strategy for education and public involvement:

a. Support activities that develop an ethic which promotes protecting Puget Sound as a treasure.

b. Move beyond the "us versus them" attitude and emphasize water quality as being in everyone's self-interest.

c. Develop mechanisms for cooperation among the public sector, private sector and educational institutions.

d. Focus on local issues and resources and how they relate to the larger picture, promoting a sense of place.

e. Emphasize interesting, innovative activities which involve people, put them in charge of decisions, and lead to local action.

f. Provide people with solutions and things they can do.

g. Include concrete goals toward which everyone can work and which will visibly demonstrate progress and success.

h. Include connection with an ongoing information base which provides accurate information on Puget Sound issues. Build on existing programs.

i. Improve coordination of and cooperation among the education and public involvement resources and activities of state and local governments.

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j. Design and organize activities, training and information which are tailored to the target audience.

k. Include youth.

l. Concentrate resources at the local level but include a Sound-wide entity or process which will provide common direction, standards and coordination for local actions.

m. Include an ongoing public awareness campaign which will support and connect education and public involvement activities.

n. Conduct educational activities in a variety of settings, both regulatory and non-regulatory.

o. Have clear goals and objectives and a built-in means of evaluating and modifying the strategy.

p. Include scientific review of materials and information when appropriate.

q. Reflect the diversity of existing and past cultural values for and uses of Puget Sound.

Target Date: Ongoing.

EPI-2. Coordination Mechanisms

2.1. Local Coordination: Field Agents

Together, the Washington Sea Grant Program, Washington State University Cooperative Extension and the Authority shall provide regional field agents to help coordinate and implement local and regional education and public involvement efforts to implement the Puget Sound Water Quality Management Plan with an emphasis on working with local governments and communities.

To accomplish this, the regional field agents shall:

a. Assist local governments and communities in developing, implementing and evaluating education and public involvement activities or programs which are related to Puget Sound water quality.

b. Provide assistance to Authority outreach efforts and local communities working on Puget Sound action campaigns.

c. Facilitate citizen participation in local, state and national water quality issues.

d. Assist local shellfish protection districts, clean water districts, and watershed committees.

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e. Coordinate local programs with regional and state programs.

f. Facilitate the transfer of university-based research and other appropriate information and technology to local communities.

g. Facilitate communication of community research needs to appropriate university programs.

Field agents will develop biennial work plans that reflect assignments in this subelement in consultation with local government agencies.

Field agents shall coordinate their work with tribal field agents described below in (element EPI-2.2).

Target Date: The Washington Sea Grant Program and Washington State University Cooperative Extension shall hire field agents when funding becomes available. By 1996 there shall be 18 field agents in the region.

2.2. Tribal Government Coordination: Field Agents

The Authority shall provide funds for tribal governments to establish field agents who will assist tribes in conducting education and public involvement programs related to implementation of the Puget Sound Plan and in coordinating with other education and public involvement programs. Specific responsibilities of the tribal field agents shall include those listed for Puget Sound field agents (element EPI-2.1) above: facilitating tribal involvement, facilitating funding for tribal governments, providing technical assistance and training, coordinating tribal programs with regionwide or statewide programs, working with watershed management committees, and evaluating programs. Tribal field agents under this program shall meet regularly with Puget Sound field agents.

The Authority, Washington Sea Grant, WSU Cooperative Extension and tribal governments shall meet to determine the guidelines for: (1) tribal applications to receive funds under this program, including provisions to ensure participation in the program by small tribes; and (2) coordination among tribal governments, Sea Grant and Cooperative Extension to implement and operate this program. The program shall be operated in conjunction with EPI-2.1 in order to meet the needs of specific tribal and local governments while accommodating some regionwide goals and activities. Implementation of the program shall be contingent upon Washington Sea Grant and WSU Cooperative Extension receiving funds to coordinate the local field agents with the tribal field agents.

Target Date: The equivalent of six full-time tribal field agents shall be hired by December 30, 1991.

2.3. State Coordination: Governor's Council on Environmental Education

The Governor's Council on Environmental Education, comprised of agency directors from the Washington departments of Agriculture, Ecology, Fish and Wildlife, and Health, the Interagency Committee for Outdoor Recreation, the State Parks and Recreation Commission, the Puget Sound Water Quality Authority, Washington State University Cooperative Extension, the Washing-

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ton State Energy Office, the Commissioner of Public Lands, and the Superintendent of Public Instruction, should:

- Establish a clearinghouse for education and public involvement information produced by state agencies that relates to Puget Sound and water quality.
- Serve as a forum for coordination of state agency programs that fund water quality and environmental education.
- Coordinate educational and interpretive services to the public on state-owned lands and at state facilities in Puget Sound, with emphasis on education about watersheds and opportunities for existing volunteer groups to work together in watershed stewardship activities.

Target Date: Program assistant position to serve as clearinghouse coordinator funded beginning July 1, 1995.

2.4. Agency Coordination and Education Coordinators

The departments of Ecology, Fish and Wildlife, and Natural Resources, State Parks, WSU Cooperative Extension, and Washington Sea Grant will hire education coordinators to coordinate education programs related to Puget Sound within each agency and among agencies. The coordinators will ensure that agency education programs related to Puget Sound are consistent with the direction of the statewide program of each agency. Specific responsibilities of the coordinators include coordinating the agency's education resources with those of other agencies to develop the training teams for volunteer audiences, the waste reduction and habitat protection programs for business and industry audiences, the cooperative interpretive programs for general audiences, programs for the schools, agency participation in the Governor's Council on Environmental Education (element EPI-2.3), and agency participation in the Puget Sound Plan Coordination and Evaluation Meetings (element EPI-2.6).

Target Date: Ecology and WSU Cooperative Extension have hired education coordinators. Other agencies shall hire coordinators as funding becomes available.

2.5. School Coordination: Office of Environmental Education

The Office of Environmental Education of the Superintendent of Public Instruction shall support and improve K-12 environmental education in the Puget Sound region. Specifically, the office shall: (1) Provide assistance to Puget Sound school districts and educational service districts to incorporate habitat, wetland, watershed, water quality and marine education into the K-12 curriculum as a way of complying with WAC 180-50-115 ("the Environmental Education Mandate"); (2) develop pre-service and in-service training opportunities for teachers emphasizing interdisciplinary curriculum design and adaptation of existing teaching materials to fit local educational goals and water quality issues; and (3) use the Superintendent of Public Instruction's Advisory Council on Environmental Education as a forum for developing strategies for meeting the water quality and environmental education needs of Washington students.

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Target Date: Ongoing.

2.6. Puget Sound Plan Coordination and Evaluation: Meetings

The Authority shall call two meetings a year in which educators and program staff will advise the agency on effective strategies for education and public involvement programs related to the Puget Sound Plan. The meetings will provide an opportunity for education and public involvement program staff to discuss: (1) program needs that might be met with resources or ideas from other programs; (2) timing and coordination issues; and (3) techniques for evaluating programs. The meetings will be widely advertised to local governments, tribal governments, nonprofit groups, and business and industry.

The meetings shall include the local field agents (element EPI-2.1) and appropriate staff from the Authority, Ecology and other agencies implementing the Plan's education and public involvement programs. Ecology representatives shall include: the public involvement coordinator (element PI-1.3), the education coordinator (element EPI-2.4), hazardous waste information office staff (element HHW-2), a member of the nonpoint technical-assistance team (element WP-6), wetlands education staff (element W-7), point-source outreach staff (element P-26), stormwater education staff (element SW-3), waste reduction staff (subelement EPI-5.1), shellfish education staff (element SF-8), contaminated sediments education staff (element S-9) and, where appropriate, other members of Ecology's education team. The meetings shall also include staff to the Governor's Council on Environmental Education (element EPI-2.3), staff for the State Agency Marina/Boaters Task Force (element MB-1), the coordinator for the DNR's Marine Plastic Debris Program, and staff from other appropriate educational programs of the departments of Fish and Wildlife, Health, and Natural Resources, and State Parks. In addition, representatives of staff from local watershed programs (elements WP-1 to WP-7) which include education, conservation district staff, and education staff for tribes shall be invited. The Authority shall encourage the participation of education and public involvement staff from private sector programs. Summaries of these meetings shall be provided to the PIE Fund, the agency education coordinators (subelement EPI-2.4), and the management group of the field agent program (subelement EPI-2.1).

Target Date: The Authority shall convene the first meeting when funding becomes available.

2.7. Coordination Among Federal Agencies

Implementors of Puget Sound education programs focused on water quality who work with one or more federal agencies should consult with agency representatives on the Federal Educators' Consortium. The Consortium is a regional forum created to improve education and public involvement coordination among federal agencies. Members include the National Park Service, Bonneville Power Administration, the Bureau of Land Management, the Environmental Protection Agency, USDA Forest Service, the U.S. Fish and Wildlife Service, NOAA, the Northwest Power Planning Council and the U.S. Army Corps of Engineers.

Target Date: Ongoing

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PROGRAMS TAILORED TO DIFFERENT AUDIENCES

EPI-3. General Audiences

3.1. State Interpretive Programs

For each topic or issue that would benefit from interpretive programs or projects (as opposed to major interpretive centers), the Governor's Council on Environmental Education (subelement EPI- 2.3) shall designate a lead agency to develop a pilot interpretive project. The purpose of the pilot interpretive project shall be to identify the issues, perspectives, controversies, expertise and educational approaches held across agencies on that topic or issue. After a comprehensive interpretive approach has been identified, agencies may subsequently undertake interpretive projects on their own, utilizing the knowledge gained through the pilot project.

The lead agency shall convene a committee including representatives from the private and public sectors and tribal governments. Lead agencies are already designated for those topics listed below:

1. *Watersheds and Fish Habitat.* The Department of Fish and Wildlife shall convene a committee to develop a model watershed interpretive program at hatcheries that are easily accessible to visitors.

2. *Shellfish.* The Department of Fish and Wildlife shall convene a committee to develop an interpretive program at an appropriate location in Puget Sound (see element SF-6).

3. *Wetlands.* The Department of Ecology shall convene a committee to develop a wetlands interpretive program. This program shall be integrated with Ecology's wetlands education program under element W-7.

4. *Contaminated Sediments.* Ecology shall convene a committee to develop an interpretive program for contaminated sediments. This effort shall be integrated with the public information and public involvement activities under elements S-4 and S-7, and with the education activities under element S-9. The resulting materials shall be maintained and made available, independent of those elements, to educators, the media and the public.

Target Dates: As funding becomes available.

3.2. Washington State Ferries

The Department of Transportation shall initiate a program on the Washington State Ferries system which will train volunteers to make presentations on topics directly related to Puget Sound such as the history of the ferry system, the history of ports, marine resources of the Sound and protection of Puget Sound.

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The display system implemented by the Washington State Ferries for the Centennial Celebration shall be continued and expanded.

Target Date: No target date established.

3.3. Wildlife Habitat Education

The Department of Fish and Wildlife (WDFW) shall implement a program to introduce wildlife education at state parks and other recreational settings. The program shall promote understanding of the habitats for marine, freshwater and upland wildlife by adapting hands-on activities from existing programs, many of them from K-12 curriculum such as Project Wild of the Department of Fish and Wildlife, FOR-SEA of the Poulsbo Marine Science Center, and programs from the Office of Environmental Education. The WDFW shall work with Washington State Parks and Recreation Commission to provide training to park rangers. The WDFW and State Parks shall provide stipends for facilitators of the various programs, such as Project Wild, so that teachers may be trained to implement these programs on weekends and in the summer. State Parks shall coordinate the educational activities of the rangers and the facilitators operating at state parks.

Target Dates: Ongoing as funding is available.

3.4. Interpretive Centers

The Authority shall provide funding to existing interpretive centers[1] around the Sound to support staff development and training, workshops, displays and interpretive activities on Puget Sound. The Authority shall provide interpretive centers with information such as the *State of the Sound Report* and *Puget Sound: Our Heritage At Risk*, from which interpretive centers can design displays or programs. The Authority and the Office of Environmental Education will publicize the schedules and activities of interpretive centers on a regionwide basis.

Using a geographic information system (GIS), the Authority may create three-dimensional representations of Puget Sound bays or marine water bodies portraying the local information from the Puget Sound Ambient Monitoring Program (PSAMP) and the past and/or current research efforts occurring in that location. These representations shall be distributed to a local interpretive center for its use, in order to educate citizens about the PSAMP and the Research Program.

Target Dates: Ongoing as funding becomes available.

1 Snake Lake Nature Center (City of Tacoma), Bellingham Maritime Heritage Center (non-profit), Padilla Bay (Department of Ecology), Nisqually Delta (U.S. Fish and Wildlife Service), Nisqually Reach Nature Center (non-profit), Poulsbo Marine Science Center (non-profit), Fort Worden Marine Science Center (non-profit), Feiro Marine Lab (Port Angeles), Seattle Aquarium (City of Seattle), Point Defiance Aquarium (City of Tacoma), Friday Harbor Whale Museum (non-profit), Jetty Island (City of Everett), Blaine Marine Resource Center (being developed; Blaine).

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3.5. New Interpretive Centers

The Authority may initiate a process to establish new interpretive centers which would fill both geographical and topical gaps in interpretive activities related to the Sound.

Target Date: None established.

EPI-4. Volunteer Audiences

State agencies and local governments shall support and utilize the interest and expertise of volunteers who wish to protect or enhance Puget Sound water quality and habitats, and who wish to educate their communities on related issues. Toward this purpose, state and local agencies shall fund and utilize the field agents described in subelement EPI-2.1 and shall notify volunteers of funding opportunities through programs such as the PIE Fund.

The Washington Sea Grant Program and WSU Cooperative Extension shall create an advanced program for Master Stewards for Puget Sound watersheds in which volunteers are certified. These volunteers will then be available to provide technical assistance to government and private sector programs. Washington Sea Grant and WSU Cooperative Extension shall meet with representatives of state agencies and local and tribal governments to design the criteria for certification.

Target Date: Washington Sea Grant and WSU Cooperative Extension shall offer a program for Master Stewards as funding becomes available.

EPI-5. Business and Industry Audience

5.1. Pollution Prevention

Ecology shall expand its waste reduction program where possible to coordinate with the waste reduction or pollution issues of the departments of Health, Agriculture, Fish and Wildlife, and Natural Resources, in order to provide audiences in business and industry with comprehensive messages on the actions necessary to prevent pollution generated by the particular activities of each audience. This program would integrate information for each group on issues such as municipal sewage treatment systems, pretreatment programs, discharge permits, stormwater systems, on-site sewage systems, solid waste landfills, hazardous waste disposal, waste reduction, and plastic marine debris. Where appropriate, referrals should be made to related local government programs such as those of Metro (King County Department of Metropolitan Services).

WSU Cooperative Extension shall coordinate the educational resources of conservation districts and the departments of Agriculture, Ecology, Fish and Wildlife, and Health to provide target agricultural audiences and pesticide applicators with a comprehensive message on the actions necessary to prevent their wastes from entering the water.

Washington Sea Grant shall coordinate the educational resources of the departments of Ecology, Fish and Wildlife, and Natural Resources, and the Coast

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Guard in order to organize a similar program to deliver coordinated messages to commercial fishing, aquaculture and marine-transport industry audiences.

The lead agencies designated above shall work with the Business Assistance Office of the Department of Community, Trade and Economic Development, local field agents, and members of the target audience to develop the information and materials, and to determine the best mechanisms to deliver the message (e.g., trade fairs, bulletins, trade association seminars or conferences, in-house training, community college classes, videos, agency programs, etc.). The lead agency, in consultation with members of the target audience, shall determine who should deliver the program (the state, the private sector, local field agents, local governments such as Metro, or educators).

Target Dates: As funding becomes available.

5.2. Habitat Protection

The Department of Fish and Wildlife shall coordinate with the educational resources of the departments of Ecology and Natural Resources to provide education on habitat protection and enhancement to developers, realtors, contractors, and business and industry. This program shall include the implementation of joint habitat enhancement and education programs as described in the Habitat Program (subelements H-4.2 and H-4.3).

Target Date: The Department of Fish and Wildlife shall initiate a program by as funding becomes available.

5.3. Water Quality Protection Through Peer Education

The Authority shall continue to encourage business and industry to use the PIE Fund (subelement EPI-8.1) in order to implement water quality education projects by peer education through their networks and associations.

EPI-6. Youth Audiences

6.1. School and Citizens' Monitoring Programs

The Office of Environmental Education shall provide water quality kits to schools to undertake pilot freshwater monitoring projects related to agency and citizen programs or to participate in the Michigan-based international program for monitoring water quality. When these programs have been operating for a year, the Office of Environmental Education shall consult with the Authority, Ecology, the PSAMP Steering Committee, community college faculty, elementary and high school teachers, and citizens to provide recommendations to the Authority on: (1) the feasibility of expanded citizens' and school monitoring programs; (2) the parameters for which citizens and students can best provide information for the PSAMP and freshwater programs; (3) appropriate laboratory support and training for such a program; (4) data access and feedback mechanisms for effective citizen and school participation in monitoring programs; and (5) the practicality of integrating monitoring into existing school curricula. (See element M-3 for more information on citizens' monitoring.)

Target Date: Ongoing.

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EPI-7. College and University Student Audiences

7.1. Puget Sound Internships and Credit

The Authority shall work with Ecology and other agencies to establish internships and opportunities for students to prepare case studies on issues related to Puget Sound.

Target Date: Possible internships will be developed when funding becomes available.

7.2. Post-Secondary Monitoring

Agencies and local governments involved in water quality monitoring through ambient monitoring, watershed or stormwater programs shall seek opportunities to involve universities and community colleges in monitoring projects through classes or internships or by utilizing community college laboratories.

Target Date: Possible internships will be identified as funding becomes available.

EPI-8. Funding

8.1. PIE Fund

The Authority shall continue to support the funding of local programs through the Public Involvement and Education Fund (PIE Fund). The Authority shall publish requests for proposals for local programs which:

a. Raise awareness of water quality issues by engaging people in actions to protect Puget Sound. These action projects could include such activities or projects as adopt-a-beach, adopt-a-stream, protect-a-wetland, household hazardous waste collection days, water quality monitoring, and biological surveys. To be effective, these programs often require funds for signs, equipment and brochures, and may require technical expertise and training.

b. Raise awareness of water quality issues through general and diverse education activities. These communications programs could include such activities as workshops, conferences, plays, poster projects, tours, festivals and brochures. To be effective, these programs often require funds for printed and audio-visual materials or staff and may require technical expertise and training.

Groups will apply for these funds through a request-for-proposals process which would include the criteria in element EPI-1. Funds will be awarded by contracts. Groups eligible for funding will include business and trade associations with special emphasis on peer education, local and tribal governments, conservation districts, community and environmental organizations, schools and school districts, community colleges, and universities. Projects eligible will include existing and new programs, as well as proposed activities related to any topic addressed in the Plan and any area of Puget Sound. The Authority shall issue guidelines, call for proposals, select participants, and administer

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contracts. The Authority shall invite other agencies to specify programs or categories for which to solicit proposals.

The proposals will be reviewed by an Education and Public Involvement Program advisory group which will make final recommendations on funding to the executive director of the Authority. The advisory group will be a 10- to 12-member group which includes educators, media experts, representatives of environmental and public interest groups, industry and business, agriculture, and local and tribal governments. At least half the membership will come from the private sector, business and industry, environmental non-profit groups and other non-government organizations.

A portion of the PIE Fund should be directed toward programs that specifically support the educational needs of local governments which are directly related to the Puget Sound Plan, particularly those governments that are not receiving direct support from the field agent program (subelement EPI-2.1). Contracts may also be awarded through competitive processes for conferences, evaluations, publications and projects which relate directly to the purpose of the PIE Fund.

Target Date: Ongoing: Round 8 contracts were awarded May 1994.

EPI-9. Puget Sound Water Quality Authority Activities

The Authority shall continue to use its planning and oversight process as a means to provide leadership in education and public involvement on water quality issues in Puget Sound region. Specifically, the Authority shall conduct the following activities:

1. *Public Outreach.* The Authority shall conduct a proactive public outreach program which includes:

   a. Seeking out parties interested in or affected by Plan implementation.

   b. Designating staff liaisons for:

   (i) County and tribal governments (staff and elected officials). Staff liaisons will work to ensure that program staff conduct planning, implementation and oversight with an awareness of local water quality programs, needs and issues.

   (ii) Constituency groups, including business, agriculture and environmental groups. Staff liaisons will work to ensure that program staff conduct planning, implementation and oversight with an awareness of the issues that different constituencies face as a program is introduced and implemented, and the role of a constituency in protecting water quality.

   c. Training Authority staff to provide general information on any program in the Puget Sound Plan.

   d. Developing concise, readable materials for the general public describing issues, programs and activities.

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2. *Public Education*. The Authority shall continue to educate the public through seminars, field trips, conferences, public meetings, publications, media, videos, and distribution of Authority information to local libraries.

3. *Publicity*. The Authority shall use its newsletter, slide shows and media contacts to publicize opportunities for the public to become involved in policymaking, monitoring, cleanup or educational activities related to the Sound. The Authority shall also use its newsletter and slide shows to give recognition to new and existing efforts and programs which are supportive of the goals of the plan.

4. *Coordination*. The Authority shall coordinate the integration of education and public involvement elements of all programs in the Plan in order to avoid duplication of resources (see subelements EPI-2.3, EPI-2.6 and EPI-2.7).

5. *Schools*. The Authority shall work with the Superintendent of Public Instruction and with the Governor's Council on Environmental Education to coordinate educational programs on water quality for K-12.

6. *Campaigns for Puget Sound*. The Authority shall initiate public awareness campaigns or activities which:

   - Focus on tangible results toward which individuals in both the private and public sectors can easily direct initiative and resources.

   - Provide an opportunity to show measurable results which present clear and visible feedback on our success in meeting a water quality goal or objective for Puget Sound.

Campaigns could address tangible results towards such goals as: reopening commercial and recreational shellfish beds; reducing plastic debris in Puget Sound; reducing the amount of oil in Puget Sound; reducing septage in Puget Sound; reducing contaminants in storm water; restoring wetlands or shoreline habitat; etc.

7. *Year of the Sound*. The Authority shall request that the Governor declare the Year of the Sound and appoint a Year of the Sound Committee which includes representatives of both the public and private sectors. The committee shall seek funding and support for schools, colleges, agencies and industry to work together to promote and create events which highlight the Sound and what people are doing to protect it, and which provide in-depth educational opportunities on the Sound and its management issues.

8. *Sound Waters Award Program*. The Authority shall work to develop an annual Sound Waters Award program which recognizes small or large businesses, trade associations, local governments or local government officials, developers, service clubs, youth groups, individuals, and others for positive action taken to protect water quality.

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Target Dates: Activities related to public outreach, public education, coordination, publicity, and schools are ongoing. Other activities as funding becomes available.

MAJOR PUBLIC ACTIONS FOR AUTHORITY REVIEW

The Authority will consider the adequacy of public involvement when reviewing major public actions identified in other programs. As part of its review of biennial reports of state and local agencies (see subelements EM 8.4 and EM 8.5), the Authority will consider implementation of the public involvement policy.

LEGISLATION REQUIRED

None.

ESTIMATED COST

A fully funded education program will cost approximately $5.6 million for the 1995-97 Biennium and $6.9 million during the 1997-99 Biennium. This includes $1.1 million each biennium for the PIE Fund. The major cost in the program is for the field agents. This element (element EPI-2) expands from $3.2 million in 1995-1997 to $3.3 million in 1997-99. The water quality field agent program, currently conducted jointly by Washington State University's Cooperative Extension and University of Washington's Washington Sea Grant Program, has been extremely beneficial for local governments. A fully funded program would expand upon the current successes and extend the program to include tribal water-quality field agents. The tribal agents would be funded out of the Puget Sound Grants Program, to be established under element EM-6.

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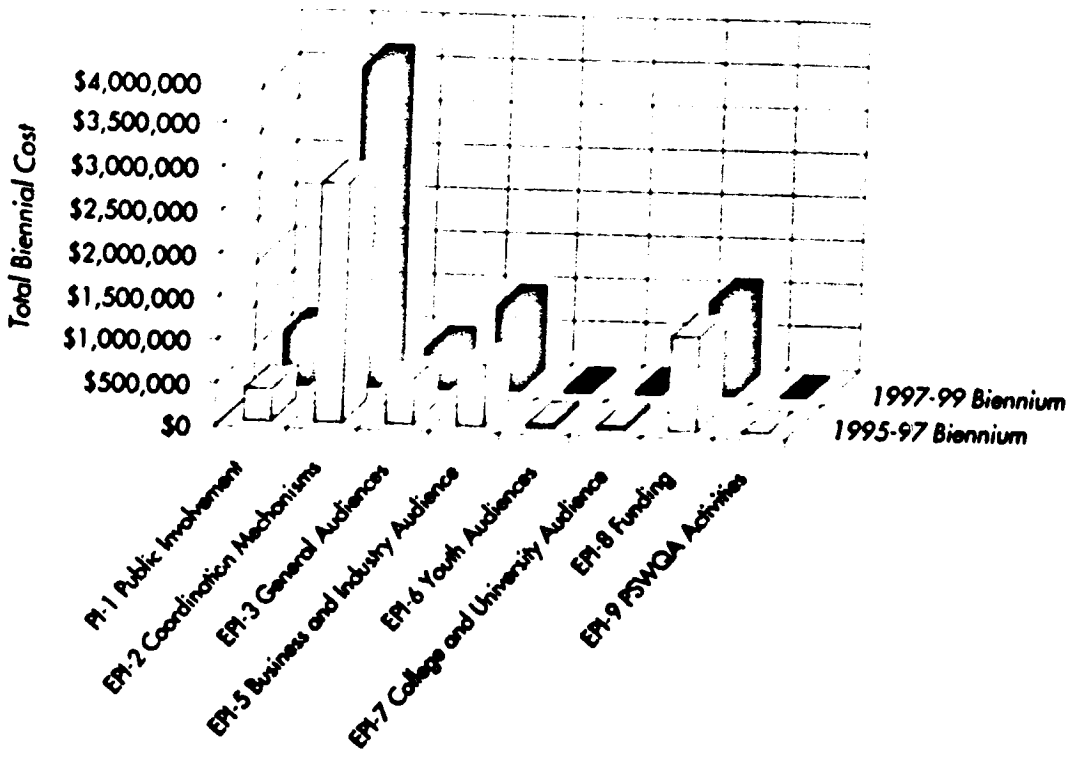
Education and Public Involvement Program Implementation Estimates



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NONPOINT SOURCE POLLUTION PROGRAM

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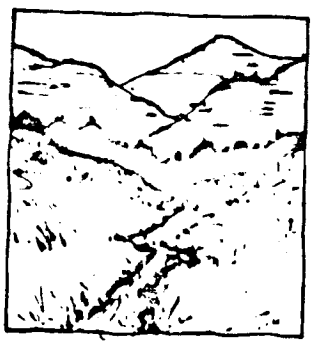
PROBLEM DEFINITION



Nonpoint source pollution is a general term for pollution that is not collected in and discharged through pipes. Instead, it originates from a multitude and variety of diffuse sources, the cumulative effects of which can result in major pollutant loadings into Puget Sound.

Nonpoint source pollutants include pathogens, sediments, toxic contaminants and nutrients. Sources of pathogens include failing on-site sewage systems, animal keeping practices on commercial and noncommercial farms, sewage discharge from boats, and wastes from pets in urban areas. Sedimentation results from timber harvesting, construction-related land clearing and destruction of stream banks by livestock. Excessive nutrients can stem from fertilizers and failing on-site sewage systems, while toxic contaminants come from stormwater runoff and improper disposal of oil and other household hazardous wastes. The problems associated with nonpoint source pollution are many, and often complex. Solutions to the problems are sometimes difficult as they involve raising people's awareness to make changes in individual behaviors and lifestyles that are more friendly to the water environment.

Nonpoint pollution was not considered a very big problem until recent years. Most of the attention in the past focused on addressing pollution from industry discharges and sewage treatment plants. The activities that cause nonpoint pollution are certainly not new, but as growth and development has increased in the Puget Sound basin, the amount of nonpoint source pollution has greatly increased. One dramatic example of the effect on Puget Sound is the contamination of shellfish beds. Approximately 40,000 acres of commercial shellfish beds have been restricted since 1981, due largely to nonpoint pollution. While water quality in some areas of Puget Sound has improved, restrictions and closures of fisheries (due in part to loss of habitat), algal blooms, and many other signs of poor water quality are evident.

INSTITUTIONAL FRAMEWORK

Since the 1970s problems related to nonpoint sources of pollution have been addressed in varying degrees through separate control programs, each one usually administered by a different government agency. While these programs produced some important local successes, overall control of nonpoint pollution in the Sound was generally inadequate in 1987. Agencies did not coordinate efforts and no integrated process existed to control nonpoint sources within a given bay or watershed.

Under Section 319 of the 1987 amendments to the Clean Water Act, Congress required all states to develop programs to manage nonpoint pollution. The state of Washington assessed its waters and produced the Nonpoint Source Pollution Assessment and Management Program in October 1989. The Puget Sound Plan's Nonpoint Source Pollution Program was adopted as the 319 plan for Puget Sound, with the local watershed action program identified as one of the top priorities.

In 1990, the Coastal Zone Management (CZM) Act was amended to address land use and nonpoint pollution for the first time. Section 6217 of the Coastal Zone Act Reauthorization Amendments calls for states with federally approved coastal-zone management programs to develop and implement state coastal

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programs to control nonpoint pollution. These institutional changes have greatly improved the way in which nonpoint source pollution is addressed.

In the past two years, many federal and state resource agencies have adopted various versions of a watershed management approach, partly driven by President Clinton's Forest Plan, dwindling salmon stocks, water quantity issues, and the expansion of the Department of Ecology's (Ecology) Total Maximum Daily Loads program to include nonpoint source loadings. The governor established the Watershed Coordinating Council in 1994 through which state resource agencies can coordinate their efforts on watershed management, particularly for salmon habitat restoration.

AUTHORITY APPROACH

The Nonpoint Program identified the need to address each type of nonpoint source basinwide, while it simultaneously recognized that solutions must occur at the local watershed level. The development and implementation of local watershed action plans is the heart of the Nonpoint Program because it uses community-based committees to cooperatively identify problems and solutions within watersheds. The Authority addressed nonpoint source pollution in the 1987 Plan through a local watershed planning process, countywide education and prevention elements, and statewide elements. The 1994 Plan strengthens the role for local government and others in addressing the different nonpoint problems on a more regional basis as well. The 1994 Plan also directs local governments to integrate growth management and watershed plans, and provides direction on integration of the EPA's 6217 program with the Plan programs.

Local Watershed Action Program

The 1987 Plan instigated a cooperative watershed action planning process that involves local governments and communities, tribes, state and federal agencies, and other interested and affected parties. Counties, or cities as appropriate, appoint watershed management committees. The committees are charged with writing an action plan that identifies problems stemming from nonpoint sources of pollution in the watershed and proposes solutions to reduce or prevent the pollution. The action plans address farm practices, storm water, on-site sewage systems, forest practices, marinas and recreational boats, and other issues of concern in the particular watershed. The control strategies are a mixture of educational, voluntary and regulatory approaches.

Twelve early action watersheds were selected for planning in 1987, and all twelve Puget Sound counties used ranking committees to rank 119 more watersheds in 1988. The Puget Sound Cooperative River Basin Team assisted with several of the ranking reports and prepared many of the characterizations for the watershed plans.

The Authority adopted a rule, WAC Chapter 400-12, in 1988 to guide local governments in the planning process. The rule, referred to as the Nonpoint Rule, was revised in 1991 to allow more flexibility in designing the plans and to shorten the review process.

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Overall, the watershed action plans have been successful because of the involvement of the local community and the commitment from local agencies, businesses and citizens to act on the plans. Twenty watershed plans have been completed in nine counties and are in various stages of implementation. Seventeen more plans are being developed—nearly half of these should be adopted and approved in 1995. Eleven of twelve Puget Sound counties are participating overall.

The 1994 Plan encourages counties to cluster their remaining watersheds for planning and to initiate countywide monitoring programs. There are two new elements on integration of efforts to control nonpoint sources of pollution with growth management planning and the Section 6217 coastal nonpoint program, and new language that calls for watershed plans to also address protection and restoration of salmon habitat, riparian areas and wetlands

On-Site Sewage Systems

On-site sewage systems "fail" for a variety of reasons—poor construction and installation, improper use, inadequate maintenance, improper siting and design related to soils, and high water tables. Although on-site sewage systems have clearly failed when effluent collects on the surface or when the system no longer passes waste water, environmental harm can occur long before these symptoms appear. As funding has increased to survey individual systems, failure rates of 40 percent and higher have been identified in some areas around the Sound.

Minimum regulations for on-site sewage systems were first set by the State Board of Health in 1974. Less stringent guidelines were in place for systems installed prior to that time. Systems installed after 1974, though subject to the stricter regulations are not necessarily providing satisfactory treatment of waste water. Limited funding, staffing and training have hampered application and enforcement of on-site sewage regulations by state and local health agencies. Additionally, there has been no state requirement for maintenance of systems, regardless of their age.

The 1987 Puget Sound Plan called for the Department of Social and Health Services (now the Department of Health) to evaluate the effectiveness of state standards and regulations for on-site systems, for legislation requiring disclosure of information regarding on-site systems at the time of property transfers, and a for certification program for on-site professionals. Since then, new regulations have been adopted by the Department of Health (DOH) for on-site systems, local health departments have begun certification programs, and legislation was passed to expand disclosure requirements when property is transferred. Despite this progress, further efforts are needed.

The 1994 Nonpoint Source Pollution Program calls for local implementation of the revised state on-site sewage regulations, development of local on-site operation and maintenance programs, increased emphasis on alternative technologies, establishing operational permit programs for large systems, and development of rules for managing biosolids.

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Agricultural Practices

Potential pollutants from commercial and non-commercial agricultural practices include sediments nutrients, toxic substances, and pathogens. Sediments enter water bodies as a result of livestock trampling in or near stream banks, soil erosion and poor cropping practices. Pathogens and toxic substances such as pesticides often bind to sediments and are carried into waterways. Increased sedimentation alone can damage fish habitat in streams by filling in gravel beds where fish spawn. Sediments carrying toxins from pesticides have an additional harmful effect.

Excessive nutrient loading from improper use of fertilizer can cause algal blooms, resulting in decreased oxygen levels which can be harmful to aquatic life. Pathogens from animal waste can run off into waterways if animals and manure are not managed properly. These pathogens pose risks to public health, including the contamination of shellfish beds around the Sound.

Efforts to curb pollution from agricultural runoff have been largely voluntary with an emphasis on education. Conservation districts have been successful at educating both commercial and noncommercial farmers about water quality issues and best management practices (BMPs).

While the focus of source control in the 1987 Nonpoint Source Pollution Program was on dairy waste management, subsequent revisions have broadened the emphasis to animal waste management and other farming practices on commercial and noncommercial farms. The program continues to promote technical assistance and education programs through conservation districts, the Washington State University (WSU) Cooperative Extension and the Natural Resource Conservation Service.

Pest Management

Pesticides from home, forest, agricultural or roadway use can contaminate streams, lakes, wetlands, ground water and, ultimately, Puget Sound. Homeowners account for approximately 20 percent of all pesticide use in the Puget Sound region. Unlike other pesticide users, household users are not trained in proper application procedures or in diagnosing whether a particular pesticide is needed. Urban and suburban use of pesticides often occurs directly adjacent to storm drains, ditches, streams and lakes. Pesticides applied excessively or improperly can flow or leach into local waterways or seep into ground water. Although pesticides are generally designed to be toxic to certain targeted organisms, they are sometimes toxic to organisms, such as fish and other aquatic life in streams and lakes which are receiving waters for polluted runoff.

The major regulatory and enforcement authority for pesticide use rests with the state Department of Agriculture. Ecology has authority for pesticide waste disposal. Ecology's hazardous waste and toxic reduction program targets commercial and public entities with an active education and compliance program on pesticide waste management. Washington State University research faculty and the WSU Cooperative Extension conduct the majority of research, training and education programs. These programs have traditionally targeted commercial agricultural and forestry pesticide use. In addition, some

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local governments and utilities have initiated integrated pest management (IPM) programs for roadside and utility rights-of-way.

Little was known about the extent of pesticide use (particularly in urban areas) or its effects on water quality in 1987. The Puget Sound Plan first addressed pesticides in 1991 with a call for pesticide-usage surveys and a pest-management information program, including research and education on IPM. The 1994 Plan acknowledges the Urban Pesticides Initiative, an association of state and federal agencies concerned with the issues of pesticide use in urban settings.

Forest Practices

Forestlands account for a large portion of land in Puget Sound, particularly in the upper watersheds. Timber harvesting and road construction can contribute large amounts of sediment to streams and rivers if precautions are not taken. Sedimentation has contributed significantly to the loss of fish habitat. Logging roads built prior to the Forest Practices Act and since abandoned (or orphaned) are of particular concern.

Forest practices are regulated by Washington's Forest Practices Act, RCW 76.09, administered by the Department of Natural Resources (DNR). Revised in 1992, the Forest Practices Rules contain additional requirements for wetlands and streams, clearcut size and timing, and introduced a new watershed analysis process. Other state agencies perform limited monitoring, review and advisory functions. Inadequate funding has slowed enforcement and monitoring.

Several new major state and federal forestry watershed initiatives have been created since 1991. The Department of Natural Resources, with the Department of Ecology, is administering the Jobs for the Environment Program, which has awarded millions of dollars to watershed restoration projects in forestlands. This funding has created many jobs for displaced timber workers. The DNR is collaborating with the Department of Fish and Wildlife (WDFW) on the Watershed Restoration Partnership, a multi-million dollar grants program focused on salmon restoration. In addition, the U.S. Forest Service, with the advice of local stakeholders, is conducting pilot watershed analyses and major restoration projects on federal forest lands in the Olympic and Mount Baker-Snoqualmie provinces.

The Timber/Fish/Wildlife Agreement has improved agency coordination and serves as a continuing forum for addressing remaining issues, such as coordination with Section 303(d) of the federal Clean Water Act, cumulative effects, further protection of wetlands, and conversion of forestland to other uses. The 1994 Plan calls for local governments to address forestland conversion as well as technical assistance to small forestland owners on best management practices.

Marinas and Recreational Boating

Contaminants from marinas and recreational boating include sewage (and associated pathogens) and the toxicants contained in petroleum products and other materials used to maintain and repair boats. Discharges of treated and untreated sewage from boats may especially be a problem in smaller bays with

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poor water circulation, near shellfish beds and public swimming areas, and at marinas.

Since passage of the federal Clean Water Act in 1972, any boat with a toilet installed must have a marine sanitation device (MSD) to treat and/or hold sewage. Effective enforcement of this regulation by the U.S. Coast Guard, however, has proven to be a logistical impossibility. Educational programs have proved to be the most promising approach to reducing pollution from boating activities.

Contamination from recreational boats may be greatest at marinas and popular destination areas, where the concentration and disposal of wastes, including treated and untreated sewage, trash, petroleum products, and bilge water, may be significant problems. Marinas themselves, if improperly designed and sited, may cause water quality problems through habitat destruction and restricted flushing. However, marinas, destination sites and other boating facilities can provide the services which are essential for safe and effective disposal of boat wastes, particularly sewage and petroleum products. Unfortunately, many marinas do not provide sewage pumpouts or recycling facilities.

In 1987, the Authority recognized the need for boater education, increased availability of pumpouts, and an examination of the need for regulating the disposal of boat waste at state and local levels. Since then, better guidelines for the design and siting of marinas and sewage disposal facilities have been developed, publically funded pumpouts have been placed in over 20 public and private marinas and state parks, and state and federal pumpout grant programs have been initiated. With the assistance of the recreational boating community, an ongoing boater education program was created, and a state agency task force meets regularly to coordinate boating-related activities and to implement other aspects of the boating program. The federal Clean Vessel Act was passed in 1993, creating a new federal grants program for installing pumpouts and other disposal facilities for boat sewage. The 1994 Plan emphasizes wastes other than sewage and a strategy for operation and maintenance of pumpouts has been added.

Household Hazardous Waste

Toxicants from household hazardous waste include paints, paint thinners, lawn and garden pesticides and fertilizers, cleansers, degreasers, medicines, cosmetics, transformers, dyes, and automotive products such as antifreeze, batteries and oil. Many are emptied down drains or toilets and passed to municipal sewage treatment plants. Metro (King County Department of Metropolitan Services) estimates that residential areas contribute seven to 11 percent of the metals, 31 to 36 percent of the volatile organics, and 55 to 64 percent of the extractable organics to Metro sewage treatment plants. The percent contribution of household toxicants to smaller treatment plants may be much larger. While secondary treatment degrades or dilutes some toxicants, others persist in sludge, evaporate into the air, or continue in suspension or solution through the discharge pipe. Those in sludge or in the air can then enter Puget Sound through rain and runoff.

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Many household wastes are disposed of at landfills, where they can reach the Sound through landfill leachate taken to municipal treatment plants, or when leachate in uncontained landfills contaminates surface runoff and groundwater. Incineration of household hazardous waste does not always destroy the toxics, and can subsequently cause contamination from rainfall, or improperly disposed ash.

In 1985, household hazardous wastes were included as moderate-risk waste under the state Hazardous Waste Management Act (RCW 70.105.220). Despite this, there were few legal, proper or practical disposal options available to homeowners and small businesses. The act addressed this issue by requiring local governments to identify local moderate-risk management options and implement a management program by December 31, 1991. Under the program, local governments are required to have a management plan for these wastes, although the specifics are left to the discretion of local governments.

PROGRAM GOAL

To reduce and ultimately eliminate harm from nonpoint sources of pollution to Puget Sound, including pathogens, toxic contaminants, sediment and nutrients.

STRATEGY

The strategy for achieving this goal is to: (1) target state, federal and local resources on priority watersheds through a cooperative process of local watershed planning and implementation; (2) provide technical and financial assistance and incentives to local governments for controlling and preventing nonpoint pollution; and (3) develop or enhance state programs or regulations for those nonpoint sources that are most effectively controlled at the state level.

PROGRAM ELEMENTS

NP-1. Section 6217 Federal Coastal Nonpoint Pollution Control Program

The Puget Sound Plan's Nonpoint Source Pollution Program activities shall be consistent with relevant management measures of the Coastal Nonpoint Pollution Control Program developed under Section 6217 of the 1990 Coastal Zone Act Reauthorization Amendments (CZARA Section 6217). Ecology shall develop the Coastal Nonpoint Pollution Control Program under Section 6217 of the federal CZARA consistent with the goals, objectives and strategies of the Nonpoint, Shellfish, Stormwater and Combined Sewer Overflows, Wetlands Protection, and Education and Public Involvement programs of the Puget Sound Plan. The Section 6217 program developed by Ecology shall help support implementation of the Puget Sound local watershed action plans. Using federal Clean Water Act Section 319 and Coastal Zone Management Act funds, the EPA and NOAA (National Oceanic and Atmospheric Administration) shall consider funding demonstration projects, as determined by the Puget Sound Estuary Program (PSEP) Management Committee, in priority watersheds for each category of management measures.

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NP-2. Integration with Growth Management Plans

Each local government shall fully use its growth management authority to protect the waters of the Puget Sound basin from the effects of nonpoint source pollution. Existing and potential nonpoint source pollution effects and mitigation strategies shall be analyzed and documented in Growth Management Act (GMA) environmental impact analyses. When a local government concurs with adopted, locally developed watershed action plans, the plan's goals, policies and control measures shall be incorporated into comprehensive plans, capital-facilities plans, critical areas ordinances, and other appropriate land-development regulations. Jurisdictions sharing common watersheds shall cooperate in analyzing the effects of nonpoint source pollution and adopting coordinated and consistent programs for managing nonpoint pollution sources.

LOCAL WATERSHED ACTION PROGRAM

WATERSHED PROGRAM GOAL

All ranked watersheds within the Puget Sound basin counties shall implement local watershed action plans which result in reduction and prevention of non-point pollution to Puget Sound.

STRATEGY

The strategy for achieving this goal is to to provide technical and financial assistance and incentives for local communities and governments both to convene watershed management committees in the ranked watersheds which do not yet have watershed action plans, and to support the implementation of completed watershed action plans.

WP-1. Selection of Priority Watersheds

[Completed portions of this element have been deleted.]

Round 1. Early Action Watersheds: (Element completed)

Round 2. Long-Term Watershed Selection Process:

Watershed action plans shall be developed on an ongoing basis in the order that watersheds appear on each county's ranked list. A county may develop several plans simultaneously for a group of watersheds with similar rural or urban land uses. Counties (or other appropriate lead agencies) are encouraged to help meet local goals for nonpoint pollution control by developing and implementing watershed action plans in the three highest ranked watersheds by 1996.[1] Ecology shall work with counties not actively participating in the watershed planning program to identify reasons they are not participating and to develop an appropriate strategy for addressing concerns about nonpoint source pollution.

The need to re-rank watersheds shall be reviewed at least every five years, and more frequently if a significant change occurs, as defined in Chapter 400-12

1 Counties pursuing other related programs such as ground water or storm water may need to delay this goal slightly.

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WAC, or if a jurisdiction is ready to proceed with planning. The county may develop a process for conducting the re-ranking that meets local needs, in accordance with the ranking criteria in this element and the public involvement policy (subelement PI-1.1) in the Puget Sound Plan. If changes are made in the county's ranking of watersheds, a summary of the changes and a brief rationale shall be prepared and submitted to Ecology.

Proposals to the Centennial Clean Water Fund (CCWF) for the development of watershed action plans according to Chapter 400-12 WAC shall be made in the order in which watersheds appear on each county's ranked list.[2] When a county chooses to plan in several watersheds at once, at least one of the watersheds shall be next on the ranked list. Once a completed watershed plan has been approved by Ecology, additional CCWF projects addressing nonpoint pollution in that watershed must be consistent with the approved watershed action plan. In each round of funding, Ecology shall consider proposals for projects in lower-ranked watersheds within a county, based on their merit, if funds are available after consideration of proposals in higher-ranked watersheds within that county. Ecology shall also consider funding proposals for projects to reduce nonpoint sources of pollution or restore streams from watershed action plans not yet completed under Chapter 400-12 WAC.

Ranking Criteria

Counties shall use the following criteria for reviewing the need to re-rank watersheds:

a. The watershed has a beneficial use such as recreational or commercial shellfish beds, fish habitat, or drinking water, that is impaired or threatened by pollution from nonpoint sources.

b. The watershed has a likelihood of intensified land or water use, including a likelihood of being developed and/or logged, in the next 10 years.

c. Environmental factors, such as soil, slope and precipitation on land and/or limited flushing in the Sound, increase the probability of future water quality or habitat degradation.

d. The watershed produces more contaminants or causes greater harm to a beneficial use than other watersheds.

e. Programs to control nonpoint pollution sources in the watershed are likely to succeed in protecting water quality in Puget Sound as evidenced by local community and political support, programs already under way, existing institutional arrangements for interjurisdictional cooperation such as the Hood Canal Coordinating Council, integration with comprehensive planning under the Growth Management Act, the federal forest plan and other major implementation activities, or other factors.

Target Date: Development and implementation of watershed action plans is ongoing. Counties shall prepare and implement at least three watershed action

2 This does not preclude a public body from applying to the CCWF to conduct a needed project addressing some component of a comprehensive watershed plan, such as storm water.

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plans by 1996. Counties shall review the need to re-rank their watersheds by June 1995.

Hood Canal

The Hood Canal Coordinating Council (HCCC) is an example of governmental coordination in a watershed. The HCCC is an intergovernmental group comprised of three counties and two tribes, and includes ex-officio members from state and federal agencies and local watershed management committees. Created through interlocal agreement in 1985, it was originally charged with planning and implementing a long-range action plan addressing water quality, coordinating governmental activities relating to water quality, and conducting educational programs. This resulted in the preparation of the 1986 Hood Canal Regional Planning Policy, which was used for several years to guide efforts addressing nonpoint pollution problems in Hood Canal. The HCCC is currently re-evaluating that document to assess the activities it should undertake in the future.

WP-2. Guidelines for Watershed Action Plans

[Completed portions of this element have been deleted.]

2.1. The Nonpoint Rule

The purpose of the Nonpoint Rule (Chapter 400-12 WAC) is to establish a process to identify and rank watersheds in the Puget Sound basin and to develop action plans to prevent nonpoint source pollution, enhance water quality and protect beneficial uses.

The Authority shall periodically review and revise the Nonpoint Rule. The Authority shall provide assistance to Ecology as necessary in interpreting the nonpoint rule.

Target Date: As needed.

2.2. Action Plan Contents[3]

The watershed action plan shall include a watershed characterization, problem definition, statement of goals and objectives, pollution control strategies, and an implementation strategy, including a schedule and costs for the actions, a financing strategy and a monitoring program.

The watershed characterization shall include: (1) a description of the biological conditions, habitat, and physical characteristics of the environment; (2) information on land use and population trends; (3) a water quality assessment; maps showing the action plan boundaries; (4) wetlands, shellfish beds and other critical areas, waterways and water bodies; (6) jurisdictional boundaries; and (7) a discussion of existing water quality and related programs in the area.

The goals of watershed action plans shall include meeting water quality, shellfish, and other appropriate standards in priority watersheds. The objectives of watershed action plans shall include reopening shellfish beds, prevent-

3 The Nonpoint Rule, Chapter 400-12 WAC, currently complies with this element, which will also be used to guide any subsequent rule revisions.

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ing further closures of shellfish beds, protecting fish habitat, protecting wetlands and riparian zones, and achieving other objectives appropriate to each watershed. Watershed action plans shall address nonpoint pollution, as applicable, from agricultural practices, on-site sewage systems, storm water, forest practices and any other potentially significant nonpoint sources in the watershed. Watershed committees shall also explore strategies, as needed, for the protection and restoration of wetlands, riparian areas and streams. The pollution control strategies contained in action plans shall be consistent, as appropriate, with the management measures guidance under the CZARA Section 6217.

The Nonpoint Rule shall permit watershed management committees to select regulatory, voluntary and/or educational approaches for addressing nonpoint pollution in the watershed. If regulatory programs are chosen, adequate enforcement must be provided; and if educational programs are chosen, agencies and/or individuals with expertise in education must be involved in program development and implementation. Watershed plans may be organized as appropriate to address the various pollutants of concern and/or their sources in the watershed.

Agricultural Practices. The use of conservation district and Natural Resource Conservation Service (NRCS) farm management plans is the preferred approach to controlling pollution from both commercial and noncommercial farms (the conservation districts' farm conservation planning and practices documents are the recommended standard.) Watershed management committees may address animal keeping and pasture management through other regulatory or educational approaches, but the rule shall specify that any farm which has fully implemented an approved farm management plan through the conservation district and NRCS program shall be exempt from further agricultural practices regulations under the watershed action plan process unless water quality violations occur. (See also AG-2, Animal Waste Management.) The selection of an educational approach to controlling pollution sources shall not be construed to overrule or prevent the enforcement of existing regulations and laws by local, state or federal agencies nor shall it be construed to exempt local governments from other requirements of this Plan.

On-Site Sewage Systems. Action plans shall include approaches for controlling nonpoint source pollution from on-site sewage systems, including regulation, education, programs for maintaining on-site sewage systems, and the use of alternative or community systems in appropriate areas. Compliance with Chapter 246-272 WAC is required.

Storm Water. Action plans addressing storm water shall be consistent with requirements under elements SW-1 and SW-2 of the Stormwater and Combined Sewer Overflows Program and applicable federal requirements.

Forest Practices. Watershed action plans which include forest practices must coordinate with the provisions of the Timber/Fish/Wildlife Agreement in cases where state law preempts local control of forest practices, especially in the areas of pre-planning and basin planning, watershed analysis, enforcement, data management, orphaned roads, and extended review. Action plans shall

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also address the role of local government in controlling the water quality effects of conversion of forested land to other uses.

Marinas and Boats. Action plans addressing marinas and boats shall be coordinated with activities taking place in the Marinas and Recreational Boating elements of the Puget Sound Plan (elements MB-1 through MB-9). Plans shall include education of individuals, marina operators and boaters, as well as the adoption of needed local policies and regulations.

Other Nonpoint Sources. Action plans shall include strategies for controlling and preventing other problems caused by nonpoint pollution sources or potential problems as identified, such as pesticides, household hazardous waste, landfills, mines, sand and gravel pits, septage disposal practices, contaminated sites, and others.

Overall, the strategies to control nonpoint source pollution contained in action plans shall be consistent with the relevant management measures in the CZARA 6217. The action plan implementation strategy shall include a description of the specific actions required of each implementing entity, a schedule with annual milestones, estimated costs and a budget, and a long-term local financing strategy. It shall also include the lead agency for coordinating implementation, a dispute resolution process, provisions for public involvement in the preparation and adoption of implementation plans, policies and ordinances, and the designation of a watershed management council to advise and assist in overseeing implementation. A process and strategy shall be developed for coordination and/or integration with ongoing local, state, federal or tribal natural resource management, land-use and watershed programs, including: local comprehensive plans under the Growth Management Act, wetlands and riparian area management and protection programs, local stormwater and highway runoff programs, flood control plans, groundwater management programs, drainage basin plans, the Shoreline Master Program, fisheries and shellfish programs, the federal forest plan initiative, and others as appropriate. A method shall be described for evaluating the overall effectiveness of the action plan in improving and protecting water quality and habitat, including setting up a long-term monitoring program and a process for annual review.

2.3. Nonpoint Handbook

The Authority, in coordination with the departments of Ecology and Health, shall revise and reprint the nonpoint handbook, as necessary.

2.4 Watershed Plan Compilation

Ecology, in cooperation with the Authority, shall compile strategies for controlling nonpoint source pollution and practices for use by watershed committees in developing future watershed action plans.

WP-3. Watershed Management Committees

When funding becomes available for each priority watershed or grouped watersheds, the appropriate lead agency(ies) is (are) responsible for convening a watershed management committee. If two or more counties share a watershed, the counties may agree on a temporary lead to convene the committee or may jointly convene the committee.

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The county is presumed to be the chair for each watershed management committee. However, the committee may designate a city, local health agency, conservation district or other agency if circumstances warrant.

It is the intent of the Authority that the watershed committee include all entities that have a legitimate role in the development and implementation of a watershed action plan. This includes affected local and tribal governments, special purpose districts, affected parties,[4] watershed residents, and appropriate state and federal agencies (if the watershed includes significant state or federal lands or regulatory role). Additional advisory committees may be established as necessary and agreed upon by the committee members.

The watershed management committee shall be responsible for developing the action plan. The lead agency shall be responsible for setting up the watershed committee, convening meetings, coordinating among local jurisdictions and other agencies, working with planning and implementing agencies[5] in preparation of the plan, compiling and publishing the plan, submitting the plan to Ecology for approval, and seeking funding opportunities. Lead agencies shall prepare the characterization, prior to convening the committee, for the committee's subsequent review and approval. Watershed management committees are encouraged, but not required, to use consensus in making major decisions relating to the watershed plan.

The watershed action planning process shall include public participation. In addition to representation on the watershed committee, the public shall be educated and involved in making decisions through such activities as public meetings and hearings, watershed events and tours, citizen workshops, open houses, and newsletters. Watershed committees are encouraged to take advantage of coordination and training opportunities under EPI-2.

Lead agencies shall initiate the concurrence process as soon as the draft plan is published for public review, and preferably sooner. Each potential planning and implementing entity shall evaluate those provisions of the draft action plan which require the entity's involvement, and provide any comments to the lead agency within 60 days. Within 60 days of publication of the final action plan, each implementing entity shall submit a statement of concurrence to the watershed management committee indicating its intent to adopt implementing policies, ordinances and programs as required, or a statement of nonconcur-

4 Affected parties are defined as both those whose beneficial use of water is being impaired, or potentially impaired, by nonpoint pollution and those groups associated with the various sources of nonpoint pollution. Examples of affected parties include agricultural groups, realtors, environmental groups, etc.

5 For the purpose of this program, a planning agency is the agency that prepares reports and makes recommendations, and an implementing agency is the agency that carries out the day-to-day activities of the plan once it is adopted by a county and/or city council. An agency could be both a planning agency and an implementing agency. For example, a health department could both propose regulations for on-site systems and enforce them after they have been adopted by the county council or commission. In watersheds with two or more counties or cities, there could be several implementing agencies for the same source, for example, two different health departments carrying out on-site programs prepared by a single planning agency and adopted by the two different county councils or commissions.

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rence, proposing necessary modifications to those sections requiring its involvement.

WP-4. Plan Adoption and Implementation

Each watershed action plan submitted to Ecology for approval shall meet the requirements specified in the nonpoint rule and shall be consistent with the goals and requirements of the Puget Sound Plan:

a. The plan must have been developed by a watershed management committee in accordance with the process described in the Nonpoint Rule.

b. The plan must contain a statement of goals and objectives, a summary of the watershed characterization, and a problem definition.

c. The plan must specify a set of measures and actions, consistent as appropriate with the CZARA Section 6217 management measures, to be carried out by implementing agencies to address the priority nonpoint source pollution problems in the watershed and to help meet the goals and objectives of the plan.

d. The plan must include an implementation strategy, budget, local financing strategy and implementation schedule.

e. The plan must include statements of concurrence from agencies responsible for implementing the recommendations made in the plan.

f. The plan must include a short- and long-term monitoring strategy, including provisions for annual reviews.

g. The plan must demonstrate that adequate public involvement and participation occurred during plan development, and will be provided for during implementation.

It is the intent of the Authority that watershed plans be developed in such a way that they are adapted to the unique needs of each watershed.

Ecology shall have 30 days to approve or disapprove the plan. Ecology shall approve final action plans that meet the minimum requirements of the nonpoint rule and other appropriate grant requirements. If a plan is not approved, the watershed management committee shall revise the plan as necessary and the lead shall negotiate with Ecology for final approval. If the lead agency and Ecology cannot reach agreement on approval, either entity may request review by the Authority. Ecology may approve portions of a plan before approving the entire plan and require those portions to be implemented during the revision process for the remainder of the plan.

Each implementing agency identified in the plan approved by Ecology shall be responsible for carrying out its portion of the watershed action plan using the approaches described in the plan. The lead implementing agency shall be responsible for coordinating among implementing agencies and for preparing reports to Ecology. Each local, state and federal implementing entity identified

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in an approved action plan shall be responsible for carrying out its portion of the action plan within the prescribed schedule.

Counties, or cities for those watersheds entirely within a city's boundaries, shall designate a watershed management council to advise and assist in overseeing implementation, and to help raise community awareness. Watershed action plans may be revised by watershed management councils following submission of revisions to and approval by Ecology. Ecology or the lead agency may initiate a revision process based on annual watershed reports and subject to available funding.

WP-5. Program Funding and Incentives

In addition to the following elements, new funding sources for managing nonpoint source pollution may be identified or proposed as opportunities arise.

5.1. Nonpoint Watershed Grants

The Department of Ecology shall administer programs for disbursing grant funds from the Centennial Clean Water Fund, the 319 Management Program and other sources to lead agencies and other implementing entities for preparing and implementing watershed action plans. Disbursal of grant funds to agencies may be funneled through the lead administrative agency or paid directly to implementing agencies according to procedures established in the Centennial Clean Water Fund (see element WP-1), or under the 319 Management Program. Lead agencies for watershed plans are also encouraged to apply to the State Revolving Loan Fund and other state and federal funding sources for eligible projects, and to identify local sources of funding.

To ensure full participation of tribal governments in watershed planning, tribes are encouraged to evaluate their desired level of participation in watershed management committees. Tribal governments may submit grant applications to Ecology either simultaneously with lead agency applications or as an integrated part of lead agency applications. Tribal governments are also encouraged to coordinate with other tribes in the grant application process.

5.2. Funding for Conservation Districts

Ongoing funding shall be provided by the Washington Conservation Commission to enable Puget Sound conservation districts to participate in planning and implementing watershed action plans. The Authority recognizes the need for ongoing funding to maintain districts' basic administrative functions and also to carry out water quality programs. The Authority expects that such funding will be made available, within the limitations of statewide responsibilities, from appropriations to the Commission for conservation district basic funding and Puget Sound Plan implementation, and from the 2.5 percent appropriation to the Commission from the Centennial Clean Water Fund.

5.3. Continued Funding for Washington Conservation Corps

The Department of Ecology shall request funds through its biennial budget process for the Washington Conservation Corps to allow it to continue to provide assistance in implementation of activities under the Puget Sound Plan.

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5.4. Local Financing Mechanisms

Financing for controlling nonpoint source pollution shall be coordinated with financing of other water quality improvements within the watershed. Establishment of utilities or other special-purpose districts such as on-site sewage maintenance districts, shellfish protection districts, and conservation assessments, shall be designed for maximum coordination and shall address implementation of water quality improvement and protection activities, monitoring and education.

In instances where property owners have fenced along streams as part of a watershed action plan, the Dairy Waste Management Plan, or an approved farm management plan through the NRCS conservation district program, counties should consider granting open-space tax status pursuant to the Open Space Act (Chapter 84.34 RCW) to lands with restricted use resulting from fencing.

5.5. Federal Funding

The Authority, Ecology and EPA shall actively seek ways to provide federal funding for the preparation and implementation of watershed action plans. Specifically, funding from Section 319 of the federal Clean Water Act shall be used to accelerate the implementation of local watershed action plans, as specified in the approved 319 Management Program. Priorities for 319 funding in the Puget Sound region shall be based on the Puget Sound Plan (as stated in the 319 Management Plan) and shall be developed jointly by the Authority, EPA and Ecology, as co-chairs of the Puget Sound Estuary Program Management Committee. If Ecology wishes to modify the Puget Sound Estuary Program Management Committee priorities, given the need to coordinate an overall statewide request and address lakes and ground water, the department shall work with the committee to develop a revised request. Other funding sources should include the federal Coastal Zone Management Act Reauthorization Amendments of 1990, federal forest and job restoration initiatives, and other federal watershed programs.

WP-6. Technical Assistance for Watershed Plans

[Completed portions of this element have been deleted.]

Ecology shall continue to coordinate among Interagency Technical Assistance Team (ITAT) members to keep them active and informed, and shall continue providing watershed committees with clear direction as to which individuals or agencies to call directly for specific types of assistance. Ecology shall convene the ITAT members annually to evaluate the effectiveness of this technical assistance program. Ecology shall ensure that technical information and assistance provided under this program is coordinated with the federal assistance provided by the Puget Sound Cooperative River Basin Team, other Ecology grant programs related to nonpoint source pollution (such as 604(b) grants), the Section 319 and 6217 programs, the boater education program (element MB-4), the Ecology and Health shellfish protection programs, the Department of Health's (DOH) on-site sewage program, and the Department of Natural Resources' (DNR) watershed analysis and forest practices prescriptions. Team members and watershed committees are encouraged to use resources provided through the Education and Public Involvement Program in the Puget Sound Plan in conducting education associated with watershed action plans.

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ITAT members are responsible for tracking development and implementation of watershed action plans in their areas of technical expertise, providing technical assistance to watershed committees throughout the watershed planning process, coordinating technical assistance within their agency and with other appropriate agencies, facilitating the statements of concurrence process for their agency, participating in plan review, and serving as an agency contact person. Information on actions which should not be proposed in watershed action plans because of state or federal preemption should be made available to watershed management committees early in the planning process.

The U.S. Department of Agriculture Natural Resource Conservation Service shall continue to act as lead for the Puget Sound Cooperative River Basin Team and shall provide continued funding, in coordination with cooperating agencies, beyond 1995 when the team's current funding is scheduled to terminate. The River Basin Team shall continue to provide technical assistance to local governments and watershed committees in developing, implementing and monitoring the watershed action plans, including assistance with implementing and evaluating management measures under Section 6217. The Authority, Ecology and EPA, as the Puget Sound Estuary Program co-managers, shall seek ways to involve federal agencies in addition to those on the River Basin Team in providing technical assistance to watershed planning and implementation activities. Federal agencies shall also work with local governments to resolve cases where federal programs may conflict with local goals in a watershed action plan (in accordance with Section 313 of the Clean Water Act).

WP-7. Program Management

7.1. Annual Watershed "Report Cards"

To ensure continued local support, each lead agency, in cooperation with the appropriate watershed council, shall annually report on the progress made under completed watershed action plans. These "report cards" shall address information such as key accomplishments, barriers to plan implementation, staff and financial resources dedicated to carrying out the plan, results of monitoring data, and other topics relevant to plan implementation. Copies of watershed "report cards" are to be sent to the Authority and Ecology.

7.2. Monitoring

Ecology (or Ecology and the Department of Health for watersheds in which shellfish or drinking water is an issue) shall assist lead agencies in monitoring water quality as appropriate in each watershed with an approved watershed action plan. The purpose of the monitoring shall be to provide information for measuring the success of action plans in achieving water quality goals. Additionally, Ecology shall assist counties in establishing baseline monitoring programs for upcoming watersheds on the ranked list. These programs may include the use of data from citizen monitoring and other volunteer monitoring programs. Watershed monitoring shall be coordinated with the Puget Sound Ambient Monitoring Program (PSAMP), including use of the Puget Sound Estuary Program Protocols and Guidelines. Counties shall, where applicable,

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use PSAMP protocols and transfer data to the PSAMP central database using data transfer formats developed under element M-4.

7.3. Default Watersheds

Ecology shall work directly with local governments which fail to prepare watershed action plans to identify reasons why and to develop an appropriate strategy for addressing nonpoint concerns. If local governments fail to prepare and implement nonpoint watershed action plans, the Authority shall follow procedures in Chapter 90.70 RCW and in element EM-8 of the Puget Sound Plan to seek action. Ecology shall use its regulatory authority under Chapter 90.48 RCW to require that water quality problems are corrected and, as a last resort, may prepare a watershed action plan. In the event of nonperformance or unsatisfactory completion of watershed action plans, Ecology may require repayment of grant funds disbursed to grantees.

7.4. Program Management and Evaluation

Ecology shall be responsible for overall Nonpoint Program management and shall provide ongoing oversight of watershed action plan development and implementation. Management shall include program planning, intra- and interagency coordination, financial monitoring, public outreach, technical assistance to watershed committees and councils, information management, enforcement, and evaluation activities for all Nonpoint Source Pollution Program elements except OS-1 through OS-5 and marinas and recreational boating elements for which Ecology is not lead. Ecology, in coordination with lead agencies, shall convene quarterly meetings of the local and tribal watershed planners to share information and experiences on the watershed action planning and implementation processes. The effectiveness of the nonpoint program, including the effectiveness of the watershed planning program and consideration of the need for more prescriptive standards, shall be evaluated by the Authority as part of each revision of the Puget Sound Plan.

Target Date: Ecology shall report progress on this element in its reports to the Authority. Counties shall begin baseline monitoring in at least one new watershed by 1996.

ON-SITE SEWAGE SYSTEMS

PROGRAM GOAL

To reduce and ultimately eliminate harm from wastes generated by existing and future on-site sewage systems.

STRATEGY

The strategy for achieving this goal is: (1) to establish comprehensive programs at the local level for the appropriate application of on-site sewage treatment and disposal technology, and for effective operation, maintenance and inspection, education, and financial and technical assistance regarding on-site sewage systems; (2) to provide effective state oversight, regulation and financial and technical assistance; and (3) to investigate, review, approve,

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promote and apply, as appropriate, alternative on-site sewage treatment technologies.

OS-1. On-Site Sewage Regulations and Programs

[Completed portions of this element have been deleted.]

The Department of Health (DOH) shall periodically review and, as appropriate, amend the state on-site sewage regulations, Chapter 246-272 WAC, including continued consideration of consistency with management measures of the Coastal Nonpoint Pollution Control Program and evaluation of issues related to the location and density of on-site sewage systems. The regulations shall maintain provisions requiring local on-site sewage operation and maintenance programs in the Puget Sound basin. The DOH shall provide technical assistance and program oversight for local implementation of the state regulations. Health shall periodically review and evaluate the effectiveness of local on-site sewage programs in: (1) protecting water quality through application of on-site sewage treatment and disposal technology; and (2) reducing pollution from failing or inadequately located, constructed, installed or maintained on-site sewage systems.

Target Date: Ongoing.

OS-2. Local On-Site Sewage Operation, Maintenance, Inspection and Education Programs

Local health jurisdictions shall create or assist with the creation of operation and maintenance programs for controlling pollution from on-site sewage systems. These programs shall provide for regular inspections, maintenance and pumping of systems, as well as education of system owners and users. Local governments, in conjunction with health jurisdictions, shall select and establish appropriate mechanisms for carrying out on-site sewage programs, such as on-site sewage maintenance utilities, clean water districts or shellfish protection districts, public/private partnerships, or other means.

Target Date: All counties shall have established local operation and maintenance programs by 1997.

OS-3. Certification of On-Site Professionals

The Department of Health shall develop a program, including any required legislation or amendments to WAC 246-272 and RCW 18.43.070, for state certification of designers, installers, pumpers, environmental health specialists, and others involved in the design, installation and maintenance of on-site sewage systems. The DOH shall require all on-site sewage systems to be installed, designed, given permit approval and inspected by certified professionals. As part of this program, the DOH, in cooperation with Washington State University (WSU) Cooperative Extension, shall conduct a continuing education program for certified professionals.

Target Date: Begin program implementation by December 1994.

OS-4. Large On-Site Sewage Systems and Septage

The Department of Health, with assistance from Ecology, shall expand its program for large on-site sewage systems. The DOH shall: (a) conduct an inventory of systems; (b) assess the need for new performance, siting or other

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requirements; (c) establish an operational permit program; and (d) maintain a database. The DOH shall provide technical assistance and training on such systems for local health agency staff and shall prepare design, performance and other manuals and materials as needed.

Ecology, with assistance from the DOH and other interests, shall continue to develop rules and guidelines for the management of biosolids, including holding-tank septage. The DOH, along with Ecology, shall conduct a literature review, develop a handbook, and provide training and technical assistance for local governments on the environmentally sound disposal of septage.

Target Date: Complete the inventory and establish an operational permit program for large on-site sewage systems by June 30, 1995. Complete rules and guidelines for biosolids management by March 31, 1995. Complete literature review and handbook development by December 31, 1995.

OS-5. Alternative and Experimental On-Site Sewage Systems

The Department of Health shall expand its program for alternative and experimental on-site sewage systems. The DOH shall: (a) investigate, evaluate, review, approve, guide and encourage the appropriate implementation of alternative and experimental on-site sewage system technologies; (b) assist in the development of coordinated systems for collecting and managing data at the state and local health agency levels to provide an inventory of alternative and experimental systems; (c) assess the need for new performance, siting or other requirements; (d) evaluate the effectiveness and status of local approval and application of alternative systems; and (e) maintain a database. The DOH shall provide technical assistance and training on such systems for local health agency staff and shall prepare design, performance and other manuals and materials as needed.

Target Date: Ongoing

AGRICULTURAL PRACTICES

PROGRAM GOAL

To reduce and ultimately eliminate harm from pollution stemming from agricultural practices on both commercial and noncommercial farms, including animal waste pathogens, pesticides, sediments and nutrients.

STRATEGY

The strategy for achieving this goal is to implement comprehensive programs through state and local agencies involving education, financial and technical assistance, and, as necessary, regulation and enforcement, to effectively implement farm management plans and management practices and measures.

AG-1. Local Conservation Programs

Conservation districts, local governments, and Washington State University (WSU) Cooperative Extension shall implement cooperative and comprehensive programs to assist commercial and noncommercial farmers in controlling and preventing pollution. Implementation of management practices and measures

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shall be consistent with conservation district and Natural Resource Conservation Service (NRCS) standards and recommendations and, as appropriate, management measures of the Coastal Nonpoint Pollution Control Program. Conservation districts and counties are encouraged to pursue the adoption of special assessments to finance ongoing conservation district activities under the provisions of Chapter 89.08.400 RCW.

Target Date: Ongoing.

AG-2. Animal Waste Management

Conservation districts, local governments, WSU Cooperative Extension, and state and federal agencies shall continue to work cooperatively with commercial and noncommercial farmers to provide comprehensive assistance on the proper management of wastes from farm animals.

Ecology shall institute a permit system for concentrated animal feeding operations, including commercial dairies, in accordance with requirements of the federal Clean Water Act and Chapter 90.64 RCW. In implementing the permit system and in responding to water quality violations caused by farm animal wastes, Ecology shall carry out timely inspections and enforcement actions to ensure compliance with the state Clean Water Act (Chapter 90.48 RCW). Any farm that has fully implemented a farm management plan through the conservation district and NRCS system shall be exempt from further regulations on animal keeping and pasture management under a watershed action plan unless water quality violations occur.

Target Date: Institute permit system by January 1995. Conduct inspections and enforcement actions as needed to ensure compliance with water quality standards.

AG-3. Cost-Sharing Programs

Ecology and the Washington Conservation Commission shall continue to establish adequately funded and accessible cost-sharing programs for animal keeping, pasture management and other situations where agricultural management practices or measures are required in priority watersheds. The Conservation Commission shall consider and, if appropriate, prepare legislation to establish a permanent funding source for agricultural management practices and measures.

Target Date: Ongoing.

PEST MANAGEMENT

PS-1. Pesticide Usage Surveys in Selected Watersheds

Washington State University (WSU) Cooperative Extension shall act as the lead to design pilot pesticide-usage surveys for selected watersheds in the Puget Sound basin. WSU Cooperative Extension shall include appropriate agencies, scientists and local governments in designing and conducting the surveys. The surveys should define spatial and temporal usage patterns, focus specifically on pesticides of concern in the watershed, include information

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from all major users (including homeowners), and identify storage and disposal practices.

Target Dates: WSU Cooperative Extension and the Department of Agriculture shall hire staff to design pilot pesticide-usage surveys for selected watersheds in the Puget Sound basin by September 30, 1995. Surveys will be completed and results compiled for two watersheds by March 30, 1997.

PS-2. Puget Sound Pest Management Information Program

WSU Cooperative Extension shall act as the lead to work with the Puget Sound Estuary Program, National Oceanic and Atmospheric Administration, and the Department of Ecology's Groundwater Program and Solid and Hazardous Waste Program, to find funding for and to establish a Puget Sound Pest Management Information Program. WSU Cooperative Extension will design and implement program activities with an advisory group consisting of representatives from appropriate agencies, local governments, nonprofit organizations, business and industry groups, and educational and media groups. The program will work through existing institutions and groups, including the King County Roads Division program on integrated pest management and the Thurston County Integrated Vegetation Management Program, to conduct research and education on integrated and targeted pest-management, promoting conservative use of pesticides and use of alternatives to pesticides. Targeted audiences for educational activities shall include home users, local government staff and retailers of pest management products.

WSU Cooperative Extension shall help develop or conduct collaborative demonstration research on pest management with local governments, state agencies and private sector groups. Local governments and state agencies shall identify the pest-management issues which should receive priority for research.

Local governments and state agencies shall adopt practices which are demonstrated to be effective by the program. The Authority shall establish a process to designate effective practices.

Priority will be given to research and promotion of pest-management practices which will ensure the greatest protection to water. The program shall coordinate with statewide needs for education and research on pest management in urban areas through participation of the signatory agencies (Ecology, WSU, DOH, Agriculture, the Authority and EPA) in the Urban Pesticide Initiative.

WSU Cooperative Extension shall provide resources to the local watershed management committees (element WP-3), the Ecology 1-800-RECYCLE hotline, and local plans for managing hazardous waste (elements HHW-1 and HHW-2).

Target Dates: WSU Cooperative Extension shall hire a person to initiate the program by November 30, 1995. The advisory group shall be formed by January 1996. By June 1996, work on a database and educational activities the Puget Sound region shall have started. By September 1996 two demonstration research projects will have been identified and begun. By January 1997,

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the program will be providing support to local governments as they implement plans for managing hazardous waste (element HHW-2). By September 1997, the Authority and WSU Cooperative Extension will have established a process for agencies and local governments to adopt practices which are demonstrated to be effective through this program.

FOREST PRACTICES

GOAL

To restore and protect water quality and fish habitat from effects connected with improper forest practices on federal, state and private lands and to restore water bodies and fish habitat already degraded by improper forest practices.

STRATEGY

The strategy for achieving this goal is to: (1) continue using the Timber/Fish/Wildlife (TFW) Agreement approach for reaching consensus on forestry management issues; (2) to implement the new forest practices rules; and (3) to develop and implement local programs addressing the effects of private forestland conversions and small forestry operations.

FP-1. Timber/Fish/Wildlife Agreement

The Authority endorses the Timber/Fish/Wildlife (TFW) Agreement and the revisions in 1992 to the Forest Practices Act and Regulations. In particular, the Authority supports the TFW approach of significantly increasing enforcement and monitoring of forest practices, preplanning and basin planning, interdisciplinary identification teams, data management, a comprehensive program for identifying and correcting problems with orphaned roads, regulations for managing riparian zones extended review period for forest practice applications (extended from 15 to 30 days), staff increases at the DNR, and continuing program evaluation.

The Authority will support statutory and regulatory actions, including any federal and state funding proposals, necessary to implement the TFW Agreement. The Authority also supports the watershed analysis requirements under the revised Forest Practices Rules of 1992 and encourages the DNR to expedite the analysis schedule.

The Authority will review and comment on major milestones and documents of the TFW Agreement as they relate to Puget Sound, both providing the Forest Practices Board with comments on regulatory and policy initiatives of the TFW Agreement and participating in the annual TFW evaluation process.

FP-2. Private Forestland Conversions

Local governments shall develop memorandums of agreement (MOAs) with the DNR to reduce and prevent effects to water quality from forest practice activities. These MOAs should clearly delineate and coordinate each agency's respective authorities and responsibilities in the processing, administration and enforcement of forest practice activities within the local government's jurisdiction, especially as they relate to the clearing of land for development purposes.

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In conjunction with MOAs, local governments shall make full use of the existing regulatory tools for managing and regulating forest practices. This would include: adopting clearing and grading ordinances; imposing six-year development moratoriums on lands harvested without a declaration of intent to convert (RCW 76.09.060); utilizing Conversion Option Harvest Plans (WAC 222-20-050); acting as the lead agency, as appropriate, for the SEPA (State Environmental Policy Act) on Class IV general forest practices; and working with the DNR in designating areas likely to convert.

The Authority encourages local governments; the departments of Natural Resources, Ecology, Fish and Wildlife; and Community, Trade and Economic Development; tribal governments; forestland owners; and environmental interests to work in cooperation through the TFW Conversion Committee to develop recommendations to the Legislature and appropriate rule-making authorities for improving the regulatory framework surrounding this issue. This would include an examination of the Forest Practices Act, SEPA and Growth Management Act to identify areas of conflict and unnecessary duplication.

Target Date: June 30, 1997

FP-3. Long-Term Forest Management in Mixed-Use Areas

WSU Cooperative Extension, in cooperation with the DNR, local governments, the departments of Community, Trade and Economic Development, Ecology, and Fish and Wildlife, conservation districts and tribal governments shall develop a program to encourage and promote the use of best management practices, consistent with 6217 management measures, by small forestland owners in mixed-use areas.

The program shall include technical assistance and education programs, as well as information on financial assistance, for small landowners who intend to keep their lands in long-term timber production.

Target Date: June 30, 1996

MARINAS AND RECREATIONAL BOATING

PROGRAM GOAL

To reduce and ultimately eliminate harm from wastes generated by recreational boating activities, including sewage, petroleum products and other pollutants stemming from boat maintenance and repair.

STRATEGY

The strategy for achieving this goal is to: (1) coordinate implementation of the program by state agencies and local governments; (2) simultaneously address the needs for waste disposal facilities and processes, education for appropriate constituencies, financial and technical assistance, and regulation and enforcement of boating-related activities which affect water quality; and (3) evaluate

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changes in both behavior and water quality that result from applying strategies, and evaluate the need for more extreme protective measures (no-discharge and no-anchorage areas).

[NOTE: The Marinas and Recreational Boating Program focuses on recreational boating because of its widespread occurrence throughout Puget Sound. However, small (less than 65 feet in length), uninspected commercial vessels using areas where nonpoint pollution from boats has been identified as a problem are the subject of education and enforcement programs. Education of the commercial fishing industry is also addressed in the Spill Prevention and Response Program (element SP- 4).]

MB-1. Coordination of Marinas and Boating Elements

1.1. State Agency Coordination

With the Authority as lead, the departments of Ecology, Health and Natural Resources, the State Parks and Recreation Commission, the Interagency Committee for Outdoor Recreation, and the Authority shall work as a task force on coordinated implementation of the following measures:

a. For new and expanded marinas and floating homes:[6] Shoreline Master Program amendments prepared by the Department of Ecology as described in element MB-2.

b. For existing marinas: (1) Educational activities addressing appropriate sewage disposal and other water quality effects at marinas in coordination with element MB-4 and (2) Information addressing sewage disposal options for public and private marinas as described in element MB-3.

c. Development of a means to evaluate the effectiveness of the actions to address water quality effects from boats and marinas as called for in elements MB-3, MB-5, MB-7 and MB-8. This shall include such measures as the number of pumpout stations sited around the Sound, data on pumpout use, etc.

1.2. Public Involvement

The development of Shoreline Master Program Guidelines (element MB-2), information on sewage disposal options for marinas, and operations and maintenance strategies (element MB-3), and other appropriate tasks shall be carried out with the assistance of an advisory committee or committees representative of local and tribal governments, ports, the boating community (liveaboards, day-use boaters and other recreational boaters), marina owners and operators, the marine trade industry, and appropriate state and federal agencies.

6 "Floating home" means a structure designed substantially as a permanently based structure and not as a vessel. It is typically characterized by permanent utilities and a semi-permanent anchorage/moorage design, and by the lack of adequate self-propulsion to operate as a vessel.

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Interested members of the public shall be kept informed of the activities under element MB-1.1.

Target Date: State agency task force meets every two months.

MB-2. Shoreline Master Program Amendments for Marinas

Ecology, in coordination with the Department of Health shall issue guidelines to include specific standards for siting, design, renovation or expansion of new marinas, existing marinas, and associated fuel docks and boat repair facilities. The guidelines shall include standards for new and expanded marinas to prevent any restriction in the use of commercial and recreational shellfish beds and specific regulations requiring best management practices to control pollutants from boat use, maintenance and repair. The revised guidelines shall also specify that local governments must, at a minimum, condition shoreline permits for marinas to require the use of best management practices, boater education, and proper sewage disposal facilities for boats, including specific provisions for ensuring that pumpouts are accessible and maintained. The guidelines shall also address means for controlling water quality effects from floating homes and barge homes not otherwise prohibited.

Local jurisdictions shall amend their shoreline master programs to be consistent with the revised guidelines.

Target Date: Update guidelines as needed. Local shoreline master programs amended by January 1996.

MB-3. Waste Disposal at Marinas

State agencies and local governments shall: (1) promote and coordinate the installation of sewage disposal facilities at new and existing, public and private marinas, launch ramps and other boating facilities, and (2) promote the installation of recycling facilities for petroleum products at new and existing, public and private marinas. These tasks shall be accomplished by use of proprietary authorities (Department of Natural Resources), funding opportunities (State Parks and Recreation Commission), and regulatory authorities (departments of Ecology and Health, and local governments).

The Department of Health shall assemble information on the range of sewage disposal options (technical, educational, regulatory and financial) available to those involved in marina sewage disposal programs. The DOH shall provide this information to operators of public and private marinas and other boating facilities, and shall update it every two years.

With the Department of Health as lead, the state agency task force shall develop a strategy for operating and maintaining marine sewage disposal facilities. This strategy shall include: 1) the option of petitioning Ecology to initiate an application for a no-discharge area designation for those areas in which water quality concerns persist after the installation of sufficient sewage disposal facilities, 2) surveys of pumpout facilities for reliability and usage, 3) technical assistance and training on such systems, and 4) maintenance manuals and other guidance materials as needed.

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State Parks shall allow public and private marinas that receive funding from the Clean Vessel Act grant program to recover operations and maintenance costs through user fees.

Target Date: Information regarding sewage disposal options prepared and distributed by July 1994. Operation and maintenance strategies designed by July 1995.

MB-4. Marina and Boater Education Program

[Completed portions of this element have been deleted.]

State Parks shall continue working with local governments and boating groups to encourage the use of state public-education materials and to develop local boater environmental education programs. State Parks shall also use funds under the state and federal boat-sewage pumpout grant programs to support this program. State Parks shall provide interpretive signs to marine state parks where pumpout and dumpout facilities are installed (element MB-5) and at marinas associated with areas where Ecology conducts its water quality studies under element MB-7. State Parks shall evaluate the effectiveness of the boater education program with the assistance of a qualified external, education program evaluator and other appropriate entities. The evaluation shall include an assessment of how frequently pumpout and dumpout facilities are being used and other measures of changes in boater behaviors. This evaluation shall be used by the departments of Ecology and Health in their consideration of no-discharge (element MB-8) and no-anchorage (element MB-9) areas, and by State Parks in its enforcement of marine sanitation device (MSD) regulations (element MB-6). State Parks representatives shall assist the Interagency Technical Assistance Team (element WP-6) in providing information on boats and water quality to watershed management committees.

Target Date: Complete first biennial program evaluation by December 1994.

MB-5. Construction of Pumpouts

The State Parks and Recreation Commission shall provide grants for the construction and renovation of facilities for boat sewage disposal to owners of public and private marinas, boat launches and other sites under state and federal grant programs as stipulated by relevant state administrative codes.

In consultation with interested parties, State Parks shall review progress made in installing sewage pumpouts and dump stations and in boater education under the state grant program and report to the Legislature on program status and needs for continued funding.

As administrator of the federal Clean Vessel Act grant program, State Parks shall prepare a comprehensive plan for the funding and installation of sewage disposal facilities for boaters with the assistance of an advisory group of interested parties. State Parks shall also prepare a guide for installing boat-sewage disposal facilities for public and private marina operators.

State Parks shall continue to install pumpout stations at selected state parks with priority given to parks located in poorly flushed bays with shellfish

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resources and without other nearby pumpout facilities. State Parks shall coordinate placement of pumpouts in state parks under this element with placement of sewage disposal facilities in other public and private marinas as funded by state and federal grant programs.

Target Date: State Parks shall report its findings on the state grant program by December 1994. State Parks shall install pumpouts in at least two parks per year until the need for pumpout services is met.

MB-6. Enforcement of MSD Regulations

The State Parks and Recreation Commission shall develop a comprehensive strategy to ensure compliance with federal marine sanitation device (MSD) installation and use. The strategy shall include methods to protect environmentally sensitive areas. In developing the strategy, State Parks shall consult with the U.S. Coast Guard, the Environmental Protection Agency, the departments of Health, Ecology, Natural Resources, and Fish and Wildlife, sheriff's departments, local governments, and the boating community to develop various options for such a strategy. The strategy could suggest one or a combination of options such as new legislation, a memorandum of understanding (MOU) with the Coast Guard, a model ordinance for local governments, or simply continuation of a boater environmental education program. Public meetings shall be held in several locations around Puget Sound to take comment on the options prior to the State Parks and Recreation Commission choosing an option. If State Parks and the consulted agencies and groups determine a memorandum of understanding with the Coast Guard is a preferred strategy, State Parks shall take early action to obtain an MOU with the U.S. Coast Guard and prepare any necessary legislation to permit state inspection of recreational vessels and other uninspected vessels under 65 feet in length for marine sanitation devices.

In developing the strategy, State Parks and the consulted agencies and groups shall consider including an inspection program coordinated with the accelerated education program (element MB-4) and focused on shallow-water bays and other sensitive areas. State Parks shall also consider including enforcement of no-anchorage areas and no-discharge areas if instituted under elements MB-8 and MB-9.

Target Date: State Parks options for a strategy to ensure compliance with federal MSD installation and use by boaters to be researched by June 1996. State Parks chooses option by September 1996. Submit any appropriate new legislation, draft an MOU with the U.S. Coast Guard, or develop other programs as necessary by January 1997. Begin implementation by July 1997.

MB-7. Monitoring Program for Boating Areas

The Department of Ecology, with the assistance of the Department of Health and State Parks, shall design and conduct a water quality monitoring program for boating areas to evaluate the effectiveness of control methods such as local programs to control boat waste, placement of sewage disposal facilities, and establishment of no-discharge areas. The program shall include baseline data, water and shellfish samples (where applicable) and boat counts. The monitor-

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ing program shall be consistent with the Puget Sound Ambient Monitoring Program.

Target Date: Ongoing.

MB-8. Study of No-Discharge Areas[7]

In some areas of Puget Sound, water quality and marine life may be degraded by the discharge of sewage from recreational boats, even when all vessels have federally approved functioning sewage treatment systems (MSDs). Section 312 of the Clean Water Act authorizes states to apply to the EPA for the authority to prohibit all such discharges, whether treated or untreated, in those areas.

The departments of Ecology and Health, in consultation with State Parks, shall evaluate the need for no-discharge designations in areas of Puget Sound. Their evaluation shall consider the effects and current status of the boater education program (element MB-4) and MSD enforcement strategy (element MB-6). In setting priorities for the areas to be considered for designation, the agencies shall draw upon the survey and planning work done by State Parks for the Clean Vessel Act and state pumpout placement programs, information assembled by the Puget Sound Marina/Boater Advisory committee, applications by local governments, and other sources.

In determining whether an area needs a no-discharge designation, the departments of Ecology and Health shall consider water circulation and other natural characteristics of the area, the presence of commercial and recreational shellfish beds and swimming areas, the sufficiency and rate of use of existing sewage disposal facilities, the number and type of boats using an area, and, if available, information from the inspection program (element MB-6) and the monitoring program for boating areas (element MB–7).

Ecology shall apply to the EPA for no-discharge area designations for those Puget Sound waters that are found to require greater environmental protection than currently afforded by law.

The Authority shall inform local governments of the option to designate no-discharge areas for controlling of sewage disposal from boats. Local governments shall petition Ecology to initiate applications for no-discharge areas for those areas in which water quality concerns persist after the installation of sufficient sewage disposal facilities.

Target Date: Evaluations begun by July 1995. Applications to the EPA begun by December 1995.

7 "No-discharge" areas are areas where the use of Type I and Type II MSDs (treatment devices as opposed to Type III holding tanks) is prohibited. Vessels with Type I and Type II devices are permitted in no-discharge areas but may not discharge. The process of designation may be initiated by the state or a local government and requires application by the governor or the Department of Ecology to the U.S. Environmental Protection Agency and a showing that sufficient pumpout facilities for all vessels exist.

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MB-9. No Anchorage Areas

The Department of Health shall provide ongoing evaluation of the results from the monitoring of boating areas and the success of the education program (element MB-4) in protecting commercial and recreational shellfish beds from closures due to pollution from anchored boats. The DOH shall develop information for use in the boater education program on areas where anchoring is discouraged. The education program shall warn boaters of the potential for anchorage prohibitions if the education program is unsuccessful in achieving standards for water quality and shellfish classifications in boating areas.

If the DOH finds that the education program has been unsuccessful in protecting commercial and recreational shellfish beds from such closures, it shall draft legislation with anchorage prohibitions to prevent any restriction in the use of commercial and recreational shellfish beds. No-anchorage areas shall be enforced as part of the MSD enforcement program (element MB-6), if applicable.

Target Date: If necessary, the Department of Health shall submit legislation with anchorage prohibitions to prevent any restriction in the use of commercial and recreational shellfish beds to the 1997 Legislature.

HOUSEHOLD HAZARDOUS WASTE

PROGRAM GOAL

To improve management of household hazardous waste through the provision of appropriate disposal options and through public education on proper waste disposal practices, waste reduction, alternatives to toxic substances, and pesticide management.

STRATEGY

The strategy for achieving this goal is to ensure full implementation of recent amendments to the Hazardous Waste Management Act, including waste reduction through oil recycling and conservative use of pesticides.

HHW-1. Phased Funding of Local Hazardous Waste Management Plans

[Element Completed]

HHW-2. Information and Education on Less-Toxic Alternatives for Household Products

Ecology and the Authority shall work with local governments, Washington State University Cooperative Extension, retailers, and groups such as the Washington Toxics Coalition and the Adopt-A-Stream Foundation to collect and make available information on less-toxic alternatives to household toxicants. Ecology and the Authority shall distribute this information through their newsletters, the nonpoint planning and stormwater programs, other environmental education programs, and the PIE Fund. Ecology shall continue to distribute this information through its 1-800-RECYCLE information line and through its waste reduction program. WSU Cooperative Extension shall work

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with the Department of Agriculture, local governments and local groups such as Tilth, the Washington Toxics Coalition, the Washington State Nurserymen's Association, the Center For Urban Horticulture, and garden retailers to make information and training available that promotes targeted and proper use and disposal of pesticides as part of the implementation of the local hazardous waste plans. WSU Cooperative Extension shall consult with these groups on the type of information and programs needed, and shall include these groups where possible in the development and distribution of information through a regional pesticide education program. The pesticide education program is to support local household hazardous waste plan implementation. Ecology, the Authority, the Department of Agriculture, and WSU Cooperative Extension shall assist with funding for participating groups through contract processes such as the PIE Fund or through joint grant proposals to foundations.

Target Date: Ecology and the Authority shall continue distribution of information through mechanisms available. WSU Cooperative Extension hires staff and begins joint development of regional pesticide education program with other groups by September 1995. By December 1996, the pesticide education program will be contributing to all local government household hazardous waste programs that want support.

MAJOR PUBLIC ACTIONS FOR AUTHORITY REVIEW[8]

1. The passage by the State Board of Health of revisions to WAC 246-272 for on-site sewage systems and any subsequent proposed revisions (element OS-1).

2. Ecology guidelines on shoreline master program requirements for marina siting and design (element MB-2).

3. Establishment of a cost-share program (element AG-3).

LEGISLATION REQUIRED

1. Legislation would be required to expand boating safety enforcement powers to allow inspections of marine sanitation devices on vessels (element MB-6).

2. If no-discharge areas are designated, legislation would be required to prohibit use of Type I and Type II MSDs in those areas (element MB-8).

3. Legislation would be required to prohibit anchorage near commercial and recreational shellfish beds (element MB-9).

4. Legislation may be required to establish a cost-sharing program (element AG-3).

8 Although the Authority will not be reviewing the actual selection of priority watersheds or the individual action plans adopted for each priority watershed as major public actions, the selection process and the plans will be reviewed by the Authority through its general oversight role, as part of the evaluation of the program described in element WP-7, and through the reports required of state agencies and local jurisdictions described in element EM-8.

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ESTIMATED COST

The Nonpoint Source Pollution Program elements are divided into seven distinct sections. These are the local watershed action program, on-site sewage systems, commercial and noncommercial agricultural practices, pest management, forest management practices, marinas and recreational boating, and household hazardous waste.

The estimated cost for the Nonpoint Program is approximately $73 million during the 1995-97 Biennium and about $76 million during the 1997-99 Biennium. About 80 percent of these expenditures are estimated to be made by local governments, with about half of this amount projected as coming from state and federal grants.

Most elements are projected to be financed from the Centennial Clean Water Fund, federal funds, the Puget Sound Grants Program (element EM-6), the State Toxics Control Account, state's General Fund and Capital Fund, and/or local and tribal government funds. Local and tribal funds might be generated through fees (e.g., for on-site system inspections and maintenance), rates (for watershed action plan components), and general fund taxes. Many costs for controlling nonpoint pollution will be borne by the private sector. For instance, watershed action plans (element WP-4) will result in costs for implementing agricultural and stormwater best management practices (BMPs) and for on-site sewage system pumpouts, repairs or possible replacements. These private costs are not directly included in the cost estimates, although we can assume that much of the local government funding will have to come from the private sector according to some rate, fee or tax structure.

Some of the costs projected for this program are based on certain assumptions that may turn out not to be applicable. For instance, during the 1997-99 Biennium, over $1 million is allotted for implementation of element MB-6, Enforcement of Marine Sanitation Device (MSD) Regulations. Ninety-five percent of this cost arises from the assumption that enforcement activities will be undertaken as part of the strategy for this element.

Some changes have been made in the Nonpoint Program for the 1994 Plan that affect the cost estimates. For example, the costs of preparing watershed action plans has been reduced by recommending that a county's watersheds with similar characteristics be grouped together for producing a single plan to control nonpoint pollution sources. The costs for the state Department of Health have been increased in element OS-5 by requiring them to actively research and test alternative on-site sewage systems to determine which ones will perform effectively. This is especially important given the more stringent on-site standards that have been adopted under element OS-1.

Total costs for implementing the household hazardous waste portion of the program one projected to come from the State Toxics Control Account. Local governments do incur costs developing moderate-risk assessment programs as required under the Hazardous Waste Management Act. In 1991, these programs were estimated to cost between $20,000 for less-populated counties, such as San Juan County, to $5,201,000 for larger and more populated counties, such as King County. Household hazardous waste collection and public education generally account for 50 to 90 percent of these costs.

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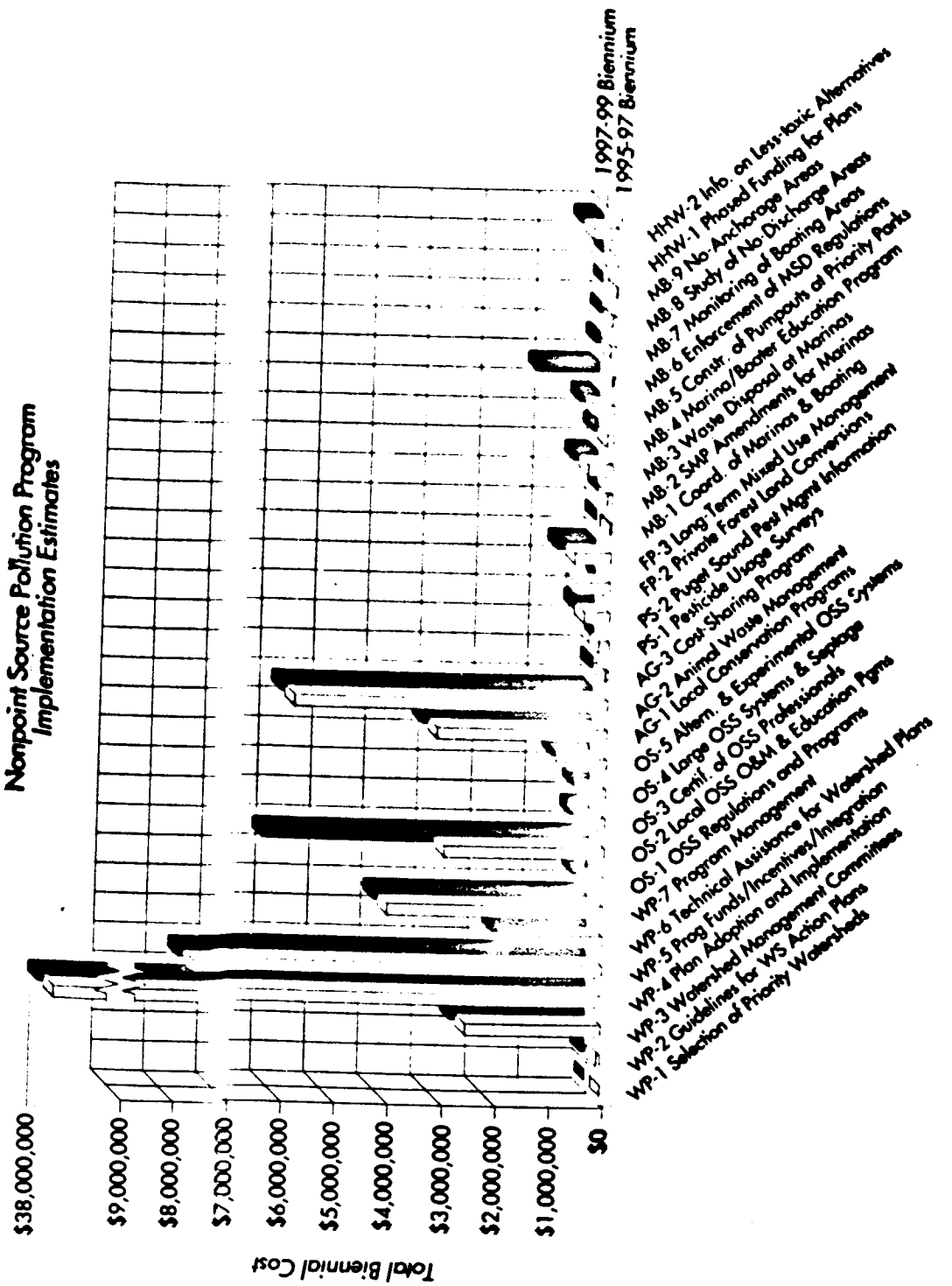

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SHELLFISH PROTECTION PROGRAM

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PROBLEM DEFINITION



Puget Sound is one of the most productive shellfish growing areas in the country. According to the Pacific Coast Oyster Growers Association, the combined value of all commercial shellfish production in Puget Sound was about $42 million for 1993. The association believes this figure could be doubled if the waters that were downgraded in the past two decades were reclaimed. The value of shellfish, however, extends far beyond economic numbers. Shellfish are a part of Puget Sound—a historical and cultural piece of the Sound integral to the region's quality of life. The Department of Fish and Wildlife estimates that during 1991-92, an average of 600,000 recreational shellfish trips were made each year to Puget Sound, yielding 1.7 million pounds of clams and 2.2 million pounds of oysters.

Some commercial shellfish beds in Puget Sound were closed to harvesting as early as the 1950s. These early closures occurred mainly in urban areas due to the beds' proximity to sewage treatment plants and other urban sources of pollution. A significant change in this pattern has occurred since 1981. Harvest restrictions are imposed when fecal coliform levels exceed certain standards. Fecal coliform are an indicator of potentially serious human-health disease organisms. Today, most restrictions placed on harvesting shellfish occur in rural, not urban, bays usually as a result of the cumulative effects of nonpoint source pollution (polluted runoff from many sources). Animal keeping practices, failing on-site septic systems, storm water, sewage treatment plants, marinas and boats are all sources of fecal coliform bacteria. In some cases, such as at Dosewallips State Park, marine mammal populations have contributed to the closure of shellfish harvesting.

Since 1981, the Department of Health (DOH) has restricted or prohibited shellfish harvesting from approximately 40,730 acres of commercial shellfish beds (38,770 acres were lost between 1986 and 1993 alone). This figure does not include the entire eastern shore of the central Puget Sound basin, from Everett to Tacoma, where commercial shellfish harvesting is prohibited due to point source discharges (discharges that originate from a distinct source, such as a pipe) and pollution associated with urbanization.

Most of the downgrades since 1981 are associated with nonpoint pollution sources, although many are also initiated for precautionary reasons due to close proximity to sewage treatment plants or other point sources. Two of the largest downgrades occurred in 1987 at Port Susan and in 1989 in North

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Skagit Bay. The Port Susan downgrade (11,900 acres) was a result of agricultural runoff and the proximity of the Warm Beach sewage treatment plant. The North Skagit Bay downgrade (9,540 acres) was due to rural nonpoint source pollution.

Since 1989, the DOH upgraded 5,530 acres of shellfish beds. The two largest upgrades of commercial harvest areas occurred in Oakland Bay in 1989 and in South Skagit Bay in 1993. Both upgrades were primarily due to improvements at local sewage treatment plants.

In 1994, the DOH classified 145 high-use recreational beaches where shellfish are harvested. Classification was carried out under WAC 246-280, Recreational Shellfish Beaches. Of the 145 beaches, about half are unclassified due to insufficient water quality information. Recreational beaches are classified as open, closed, conditionally open or unclassified. Thirty-eight beaches are closed to recreation harvesting, 28 are open and four are conditionally open.

The effects of nonpoint source pollution on shellfish resources means that, unless action is taken, harvest restrictions are likely to continue (and perhaps accelerate) as the region's population grows.

INSTITUTIONAL FRAMEWORK

Concern about contamination of shellfish beds gave rise to better monitoring and increased efforts to control pollution. In 1986, the monitoring of shellfish was incomplete. Monitoring focused solely on fecal contamination in commercial areas with no attention given to contamination at recreational areas or other types of contamination such as domoic acid or paralytic shellfish poisoning (PSP). The Department of Health was responsible for limited shellfish monitoring. No agency addressed the problem of shellfish habitat loss.

Currently, many more agencies are involved in protecting shellfish areas from pollution. Tribal and local governments play a significant role in pollution reduction.

The Department of Ecology (Ecology) enforces water quality standards in Puget Sound and provides financial assistance to local governments. Funds are used to identify and correct existing or potential pollution sources.

The Department of Health protects human health from consumption of contaminated shellfish through the National Shellfish Sanitation Program. As part of the program, the DOH classifies commercial and recreational shellfish growing and harvest areas. The DOH is also responsible for monitoring and reporting occurrences of paralytic shellfish poisoning (PSP) and other naturally occurring marine toxins that have human health implications. Both the departments of Ecology and Health supply technical assistance to local implementing agencies.

The Department of Natural Resources (DNR) is the subtidal and intertidal land steward, responsible for shellfish culture (aquaculture) and geoduck harvest. The DNR has an active management program for aquatic lands.

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Other agencies with shellfish responsibilities include the Department of Fish and Wildlife for overall resource management of the state's shellfish resources; the Department of Agriculture for promoting the state's aquaculture industry; and the State Parks and Recreation Commission for managing the more than 1,000 state parks adjacent to the Sound.

Because failing on-site sewage (septic) systems and poor agricultural practices cause shellfish bed downgrades in many areas, local governments play an important role in the management structure. Local health departments implement on-site ordinances, provide technical and financial assistance to homeowners, inspect systems and enforce for compliance. In addition, local health agencies cooperatively develop "joint plans of operation" with the DOH to assess the health and sanitary status of recreational shellfish harvest beaches. Harvest classification is then based on plan findings. Also, local conservation districts work with farmers to install management practices on their farm that protect water quality.

Local governments receive funding for water quality programs that address land-use issues related to shellfish downgrades. The programs, which may also be partially funded by local utility revenues, primarily develop and implement locally developed watershed action plans to prevent pollution from nonpoint sources (see the Nonpoint Source Pollution Program for greater detail). Threats to shellfish resources are also addressed in the Stormwater and Combined Sewer Overflows Program.

Most tribes in the Puget Sound basin have treaty rights outlining their usual and accustomed shellfish harvest areas and are becoming more involved in protection efforts beyond reservation boundaries.

AUTHORITY'S APPROACH

The Authority's 1987 Puget Sound Water Quality Management Plan (Plan) called for expanding Ecology's existing shellfish program and integrating it with the Plan's Nonpoint Source Pollution Program, improving the DOH's monitoring program to test for PSP (paralytic shellfish poisoning), fecal coliform and toxicants at selected sites, developing a recreational shellfish program, annually inventorying contaminated beds, developing a fund assessment, and improving public involvement and education.

Revisions to the Plan in 1989 and 1991 primarily called for ongoing implementation of the two main portions of the program: protecting commercial shellfish beds and implementing the recreational shellfish program, affording equal protection to both. In addition, these revisions called for Ecology and the DOH to develop a strategy to respond to shellfish bed downgrades.

PROGRAM GOAL

To protect water quality and prevent contamination of commercial and recreational shellfish beds so that shellfish are safe for human consumption; to reduce contamination of shellfish beds sufficiently to allow reopening of at least one contaminated shellfish bed each year; and to prevent human consumption of shellfish from contaminated beds until such time as the contamination is corrected.

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STRATEGY

The strategy for achieving this goal is to: (1) adopt shellfish policies which will ensure that programs that control pollution sources protect shellfish; (2) respond to existing and potential shellfish contamination with aggressive restoration and protection programs; (3) monitor commercial and recreational shellfish areas for toxic contaminants and indicators of pathogenic organisms; and (4) increase public involvement and education in shellfish protection.

PROGRAM ELEMENTS

SF-1. Shellfish Protection and Restoration Policy

State and local agencies shall ensure that the programs for nonpoint source pollution (including locally developed watershed action plans), stormwater and combined sewer overflows, and municipal and industrial discharges, and related funding programs meet these objectives:

a. Protect recreational and commercial shellfish beds from contamination and from reclassification to a more restrictive status;

b. Reduce contamination of commercial beds sufficient to allow lifting of harvest restrictions; and

c. Reduce contamination of recreational shellfish beds.

Target Date: Ongoing.

SF-2. Protection and Restoration of Recreational and Commercial Shellfish Beds

[Completed portions of this element have been deleted.]

The departments of Ecology, Health, Department of Natural Resources (DNR), Fish and Wildlife, and Agriculture, the State Parks and Recreation Commission (State Parks), and local and tribal governments, in cooperation with the Authority, shall continue and expand their existing shellfish protection and restoration programs.

Ecology has lead responsibility on water quality issues, including enforcement of the state Clean Water Act, Chapter 90.48 RCW. Ecology shall continue to provide policy guidance, financial aid, grants administration, resource characterizations, and technical assistance, in coordination with the Nonpoint Source Pollution Program, to local and tribal governments, conservation districts, or other entities carrying out shellfish protection and restoration programs. Ecology's technical assistance shall address such issues as shellfish protection districts and other funding sources; local land-use measures for shellfish protection; water quality monitoring to locate and control pollution sources; best management practices (BMPs) that reduce water pollution stemming from stormwater runoff, agricultural practices and other sources; appropriate management measures under the Coastal Nonpoint Pollution Control Program; and on-site sewage treatment systems with flows greater than 14,500 gallons per day.

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The Department of Health has lead responsibility on shellfish sanitation issues, including implementation and enforcement of the National Shellfish Sanitation Program. The DOH shall continue to: (a) expand and coordinate its investigations and monitoring program with the departments of Ecology, Natural Resources, Fish and Wildlife, State Parks, and local and tribal governments; (b) retest sites where harvest restrictions apply and meaningful progress has been made in improving water quality; (c) monitor sites being addressed by local shellfish protection projects; and (d) develop assessments of pollution sources, recommend corrective actions to local governments and/or state agencies, and provide technical assistance. The DOH's technical assistance shall address such issues as water quality monitoring to determine growing area classifications, shoreline investigations, and on-site sewage treatment systems with flows less than 14,500 gallons per day. The DOH shall provide data from water quality monitoring, trends and summary information on shellfish growing areas as soon as available to parties involved in restoration activities within the Puget Sound basin. Also, in conjunction with the publication of the annual inventory, the DOH shall provide local governments with information on priority watersheds, including watersheds threatened by potential for contamination.

The departments of Ecology, Health, Natural Resources, Fish and Wildlife, and Agriculture, the State Parks and Recreation Commission, and local and tribal governments shall continue to work cooperatively and aggressively to protect and restore water quality in recreational and commercial shellfish areas. These efforts shall target priority watersheds in the Puget Sound basin with valuable recreational or commercial shellfish areas that currently meet, or could be expected to meet, state water quality standards but are threatened with contamination from existing or projected land and water uses. State funding and technical assistance shall be provided to local and tribal governments to develop and implement programs aimed primarily at preventing any degradation or downgrade in the classification of the Sound's threatened shellfish growing areas.

Local governments shall fully implement provisions of the Growth Management Act (Chapter 36.70A RCW) and accompanying regulations (Chapter 365-190 WAC) to protect water quality in shellfish tidelands. Through use of countywide policies, comprehensive plans, development regulations, ordinances to protect critical areas, and the State Environmental Policy Act (Chapter 43.21C RCW, Chapter 197-11 WAC), local governments shall establish land-use measures that ensure compliance with water quality standards in commercial and recreational shellfish areas. Where existing or projected land uses or sources of contamination threaten the condition or classification of shellfish areas, local governments shall institute strategies to mitigate the effects. For example, water quality impacts and corresponding mitigation strategies shall be analyzed and documented in Growth Management Act environmental impact analyses.

When local governments concur with adopted, locally developed watershed action plans developed under Chapter 400-12 WAC of the Nonpoint Source Pollution Program (element WP-2), the goals, policies and control measures of the watershed plans shall be incorporated into appropriate comprehensive

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plans, capital facilities plans, critical areas ordinances and other local regulations and programs. Jurisdictions sharing watersheds shall cooperate in analyzing water quality threats and effects, and shall adopt coordinated programs for protecting and restoring shellfish areas. Local governments shall also pursue comprehensive funding for water quality and shellfish protection, considering such authorities as shellfish protection districts, stormwater utilities, on-site sewage system maintenance districts, and conservation district special assessments.

Target Date: Ongoing.

SF-3. Testing Selected Shellfish Beds for Toxicants

The Department of Health shall establish an ongoing program, consistent with the Puget Sound Ambient Monitoring Program and including use of the Puget Sound Protocols and Guidelines, to test for toxicants at commercial and recreational areas where recent studies have found toxicants to occur. The results of the tests shall be used to establish baseline and trend information on toxicants in shellfish around the Sound. Beds where toxicants exceed existing Federal Food and Drug Administration (FDA) action levels, or other accepted standards as they are developed (such as risk-assessment methodology based on the Water Quality Criteria document), shall be closed and routinely reevaluated. The Authority shall request the FDA to reconsider, in consultation with Environmental Protection Agency (EPA) and National Oceanic and Atmospheric Administration (NOAA), the need to establish standards and require testing for toxicants not covered by existing FDA action levels.

Target Date: Ongoing.

SF-4. Recreational Shellfish Program

[Completed portions of this element have been deleted.]

Representatives from the departments of Ecology, Health, Fish and Wildlife, and Natural Resources, State Parks, the Washington Sea Grant Program, tribal governments, a public interest group, and local health departments shall comprise the Recreational Shellfish Committee. With Ecology and the DOH serving as co-leads, the committee shall meet at least twice each year to coordinate implementation of the recreational shellfish action plan, and shall review the plan for possible revision at least every two years.

Based on recommendations of the recreational shellfish action plan and requirements of Chapter 246-280 WAC, Recreational Shellfish Beaches, the DOH shall continue to assist and distribute available funds to local health departments through joint plans of operation for developing and implementing local programs for public, recreational shellfish beaches. In cooperation with local health departments, the DOH shall evaluate the condition of, and establish and maintain classifications for public beaches. The initial focus should be on the approximately 145 targeted public beaches identified in the recreational shellfish action plan.

The departments of Health and Ecology, in cooperation with other state agencies and local and tribal governments, shall continue to implement protection

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and restoration activities described in elements SF-2 and SF-7 where necessary for recreational shellfish beaches.

Target Dates: Convene the Recreational Shellfish Committee every six months and revise the recreational shellfish action plan at least every two years starting January 1994. Distribute funds annually to local health departments for recreational shellfish programs. At a minimum, classify 30 public recreational beaches per year starting January 1994, and review the classifications on a regular basis.

SF-5. Annual Inventory and Information Management

The Department of Health shall publish an annual inventory of all shellfish beds, including sites in the Puget Sound basin where recreational and commercial shellfish beds have been found to be contaminated, indicating the types of contamination tested for and the types found. The inventory shall be distributed to local health departments, Ecology and other state resource agencies, the Puget Sound Estuary Program Management Committee, tribal governments, and local watershed management committees (see element WP-2). Health, in coordination with the Puget Sound Ambient Monitoring Program, shall prepare a guide to all existing databases and information sources on the shellfish resource. The DOH shall consult with the departments of Ecology, Fish and Wildlife and Natural Resources, the State Parks and Recreation Commission, tribal governments, and local health agencies and shall update and distribute the guide annually to watershed management committees, recreational shellfish restoration projects, and the entities named above. Activities under this element shall be coordinated with the Recreational Shellfish Program (element SF-4).

Target Dates: Annually distribute inventory by January 1.

[Element completed.]

SF-6. Public Involvement and Education

Ecology, in consultation with the Recreational Shellfish Program Committee, the departments of Health, Fish and Wildlife, and Natural Resources, and University of Washington Sea Grant specialists shall implement its Shellfish Education Strategy, a program for public involvement in and education on the protection of the shellfish resources of Puget Sound.

The program shall implement improved mechanisms for disseminating information among agencies and to the public on shellfish issues, especially regarding beach closures and health risks to consumers. The program shall also include procedures for coordinating workshops and the updating and distribution of agency shellfish publications, citizen involvement in shellfish protection projects, and the prevention of shellfish contamination. Ecology and the DOH shall jointly organize an annual low-tide event in early summer that publicizes concerns about shellfish and water quality.

The DOH and local health departments shall implement a program of posting, press releases, and other techniques to prevent harvesting of contaminated shellfish and to inform the public, including shellfish growers, of commercial

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and recreational shellfish contamination and closures and of programs addressing these issues.

The Department of Fish and Wildlife shall establish a work group that includes agencies, boaters, shellfish growers, and tribal governments to develop an interpretive program at an appropriate location in Puget Sound (subelement EPI-3.1).

Ecology, the DOH and other agencies shall include, as appropriate, information about shellfish and shellfish protection in other educational programs developed under the Puget Sound Plan. Education shall be a required element of all local programs under elements SF-2 and SF-4 and shall be included, as appropriate, in Nonpoint Source Pollution Program watershed action plans, the activities of teams providing technical assistance on nonpoint source pollution issues (element NP-6), and the boater education program (MB-4).

Target Date: Ongoing.

SF-7. Shellfish Closure Response Strategy

[Completed portions of this element have been deleted.]

Local governments are encouraged to create shellfish protection districts before downgrades to existing shellfish beach classifications occur. The departments of Ecology and Health shall continue to implement and update, as necessary, a memorandum of agreement which governs their responses to downgrades in classification of commercial and recreational shellfish beds caused by water quality degradation. This agreement specifies the general roles, responsibilities and a schedule for the two agencies to develop response strategies for correcting contamination of shellfish beds. Development of a closure response strategy shall be initiated within 30 days of a downgrade and an initial closure response plan shall be completed within 60 days. At a minimum, each strategy shall: (1) provide for the participation of all affected agencies, local and tribal governments, and growers, groups and individuals, and (2) include concise and aggressive assignments and compliance schedules for correcting the sources of contamination.

Chapter 90.72 RCW, Shellfish Protection Districts, requires counties to create shellfish protection districts and programs in response to downgrades of recreational or commercial shellfish beds caused by ongoing nonpoint source pollution. Creation of these districts shall be carried out in accordance with Chapter 90.72 RCW and shall be integrated with the closure response strategies. The response strategies shall also be coordinated with relevant land-use and water quality plans, such as Puget Sound local watershed action plans developed under Chapter 400-12 WAC of the Nonpoint Source Pollution Program, to ensure swift and effective restoration of water quality in shellfish areas and to avoid duplication of effort.

Ecology, the DOH and the Authority shall seek to fund implementation of each response strategy with monies from the Centennial Clean Water Fund, the Puget Sound Estuary Program, the federal Clean Water Act, Section 319, or other sources.

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Target Date: Response strategies prepared and implemented as needed.

MAJOR PUBLIC ACTIONS FOR AUTHORITY REVIEW

1. Recreational Shellfish Action Plan (element SF-4).
2. Shellfish closure response strategies (element SF-7).

LEGISLATION REQUIRED

None.

ESTIMATED COST

The Shellfish Program is estimated to cost approximately $11.2 million during the 1995-97 Biennium and $11 million during the 1997-99 Biennium. Most of the state agency costs are attributed to the state Department of Health's work monitoring shellfish-growing areas, helping local governments respond to shellfish-harvest downgrades, and providing grants to local governments; the Department of Ecology's assistance to local governments in protecting shellfish growing areas; the Authority's shellfish protection grants to local governments; and resources for the state Department of Agriculture and the State Parks and Recreation Commission to participate in restoration and protection efforts. Local government costs are mostly associated with protecting and restoring shellfish harvesting. This work is closely related to the work that they do in implementing watershed plans in the Nonpoint Source Pollution Program since these sources of pollution are major contributors to shellfish area degradation.

Private sector costs resulting from shellfish restoration and protection projects would primarily involve repairs and/or replacements of failed on-site sewage systems, implementation of programs to control waste from farm animals, and fees charged by local government shellfish protection districts. These private costs are not separately identified in the cost estimate for the shellfish program, although they would certainly contribute to the local government funding that is raised for this program.

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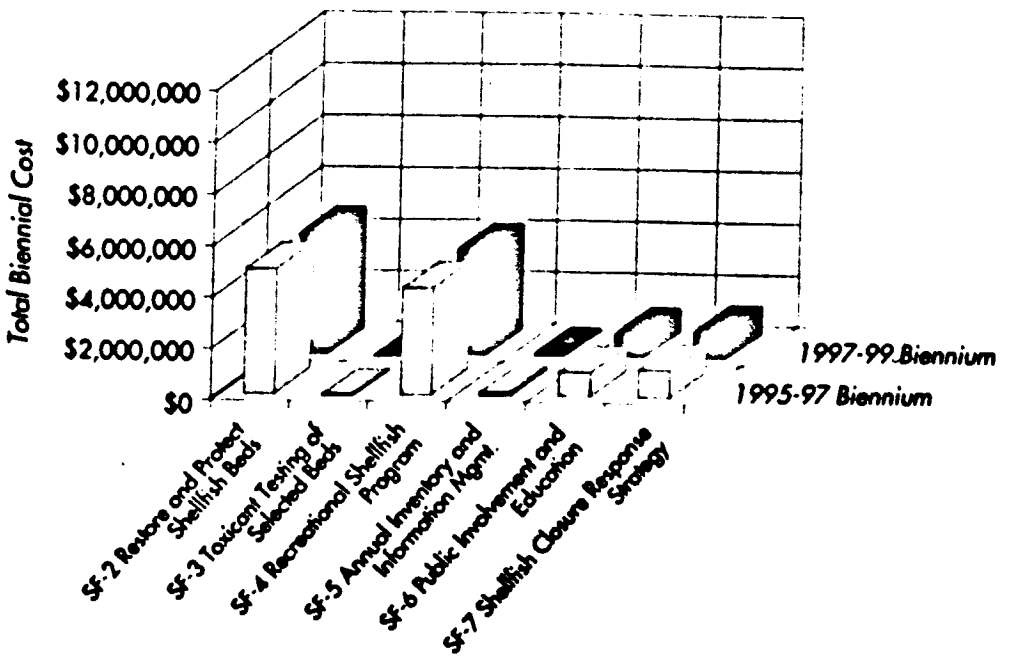
Shellfish Protection Program Implementation Estimates



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WETLANDS PROTECTION PROGRAM

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PROBLEM DEFINITION



Wetlands are important to the health of Puget Sound, helping to protect water quality by filtering pollutants and providing habitat for a diversity of species. Wetlands are the most biologically productive ecosystems in nature, anchoring the estuarine and freshwater food webs through photosynthesis and production of innumerable small organisms upon which larger creatures depend.

For a vast array of species from birds, fish, amphibians and reptiles to small and large mammals, wetlands provide essential habitat for feeding, nesting, cover and breeding. The Department of Fish and Wildlife lists over 175 wildlife species that use wetlands for primary feeding habitat and 140 species that use them for primary breeding habitat.[1] At least one-third of Washington's threatened and endangered species *require* wetlands for their survival.

Of the five Pacific salmon species, chum and chinook utilize estuaries, where salt water and fresh water meet, most extensively for nursery and rearing areas, and juveniles of all five species rely on estuaries to some degree. In the Puget Sound basin, nine salmon stocks are extinct and 55 are threatened. The loss of habitat, specifically estuarine wetlands, is thought to be a contributing factor to fisheries decline.

Wetlands provide other functions important to communities, including the slowing and storage of flood water, cleansing water of certain pollutants, recharging ground water and serving as an outlet for ground water to recharge streams (groundwater discharge) and providing recreational areas. In their natural state, wetlands help decrease the need for costly stormwater facilities and flood protection measures, such as levees and dikes. Recent studies show that where the ratio of wetland area to watershed area falls below five percent, the frequency of flooding increases and the length of the summer dry period increases.[2]

More than half the wetlands along the coasts and riverbanks of Puget Sound have been destroyed by human activity. In the Skagit Valley for example, 90

1 U.S. Department of Agriculture. Forest Service. Pacific Northwest Region. 1985. Management of Wildlife and Fish Habitats in Forests of Western Oregon and Washington. Part 2 - Appendices.

2 Puget Sound Wetlands and Stormwater Management Research Program. 1994. Research Summary No. H1. Topic: Wetland Hydrology.

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to 95 percent of the wetlands have been lost, primarily to agriculture. Commercial and residential development in such areas as the Green/Duwamish and Puyallup River basins has eliminated over 95 percent of the original wetlands. The largest cities in the Puget Sound basin, including Seattle, Everett and Tacoma, are built largely on fill in areas that used to be river deltas. Exact figures on wetland losses are not available for many of the freshwater wetlands, although estimates are generally around 50 percent.

Although the current regulatory system is more protective than it has ever been, wetlands continue to suffer from harmful activities associated with growth and development. These actions include increased stormwater runoff from nearby development, sedimentation from clearing and grading activities, littering (of everything from cans to tires and washing machines), invasion by exotic plant species (e.g., purple loosestrife) and general lack of good stewardship.

Solutions to these problems include: better regulations for activities which occur near wetlands and affect wetlands (stormwater management programs, better forest management practices, noxious weed control programs,etc.); improved enforcement of regulatory programs that use fines and penalties as disincentives; improved mitigation through better planning and monitoring of mitigation projects; education; and restoration of damaged wetlands.

INSTITUTIONAL FRAMEWORK

In 1986, wetlands were regulated at the federal level primarily through Section 404 of the Clean Water Act, administered by the U.S. Army Corps of Engineers and the Environmental Protection Agency (EPA). At the state level, the Hydraulic Code and Shoreline Management Act were the primary regulations for activities involving wetlands. In some areas, local regulations also applied. The State Environmental Policy Act (SEPA), Coastal Zone Management Act and Clean Water Act Section 401 certifications also were used to some extent to review activities that may effect wetlands. In spite of these regulations, wetlands were poorly protected due to gaps in regulations and overlaps that caused poor administration of regulations.

Several efforts to enact a state wetlands law to require state wetland standards failed. Subsequently, the 1990 Growth Management Act (GMA) and its amendments, required that local governments identify and protect critical areas, including wetlands, within their jurisdiction. Several problems arose with the creation of local ordinances. Each local government adopts its own ordinances—often lacking coordination with adjacent jurisdictions—leaving Puget Sound wetlands subject to varying levels of protection. Local governments have little funding and sometimes little expertise in administering and enforcing wetlands regulations.

Although the GMA increased local government involvement in wetlands regulations, it did not decrease the involvement of state and federal agencies. The additional involvement of local government added confusion to an already complex permit system.

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In 1992, the Corps of Engineers adopted regional conditions for nationwide permits, which established more restrictive regulations for the discharge of dredged or fill material which would affect more than one acre of headwaters or isolated wetlands.

Water quality protection for wetlands is authorized under the Water Pollution Control Act (RCW 90.48.020) and the antidegradation policy (WAC 173-201A-070). Although Washington state has not yet included wetlands in the water quality standards, a 1993 Superior Court decision clarified the Department of Ecology's authority over wetlands as waters of the state.[3]

In response to the confusion surrounding wetlands protection and the need to develop a better system of regulation, the EPA provided a grant to the departments of Ecology and Community, Trade and Economic Development (DCTED) for the State Wetland Integration Strategy (SWIS). The SWIS project gathered many stakeholders into six separate workgroups to address the most pressing issues surrounding wetlands protection—economics, education, regulatory reform, planning, technical issues and non-regulatory programs. Recommendations from the work groups will steer changes to improve the current system.

Wetlands protection continues to be complex, as new issues of water quality and quantity in wetlands arise, and fundamental tasks such as consistent definitions and delineation manuals remain. Growth and development continue to demand the conversion of natural landscapes for buildings, parking lots and other uses, making the preservation of wetlands a challenging task.

AUTHORITY'S APPROACH

The Authority determined that a comprehensive approach was necessary to protect Puget Sound wetlands. The 1987 Plan called for several actions to improve the regulatory system and to establish a non-regulatory program. It called for valuable wetlands to be identified and preserved in perpetuity through acquisition or other means, development of state standards for wetlands, local government wetland programs and protection of wetlands on state-owned lands.

Revisions in 1991 expanded the Wetlands Protection Program to call on local governments to adopt regulatory ordinances as required by the GMA, and to take additional measures such as using comprehensive planning to steer development away from wetlands, adopting preservation programs that include direct acquisition, financial incentives for landowners to preserve wetlands, restoration programs to restore lost functions of degraded wetlands, and education programs to gain community support for protection programs and to inspire stewardship.

Federal agencies are assigned a number of tasks associated with their respective programs and responsibilities towards Puget Sound wetlands in order to enhance their role in promoting wetlands protection.

3 Building Industry Association of Washington, et al. v. State of Washington, et al., Thurston Co. 91-2-02895-5, p. 13-14, 1993.

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The 1994 Wetlands Protection Program includes increased flexibility for mitigation projects, a call for improved consistency in the design and monitoring of mitigation projects, a strengthening of the inventory and tracking element and an expanded restoration program.

PROGRAM GOAL

To ensure that: (1) federal and state agencies and local and tribal governments establish and coordinate programs to protect wetlands, and (2) in the short term there is no net loss of wetlands function and acreage, and in the long term there is a measurable net gain of wetlands function and acreage in the Puget Sound planning area.

STRATEGY

The strategy for achieving this goal is to: (1) preserve wetlands, either through purchase or some other mechanism; (2) develop and implement local government programs that meet the Authority's standards for protecting wetlands; (3) develop and implement a program for protecting wetlands on state-owned uplands and aquatic lands, including nearshore habitats; (4) develop and implement a long-range wetlands education strategy; (5) inventory wetlands to measure whether the goal of no net loss of wetlands (and, in the future, a net gain) is being met; (6) encourage interagency coordination and assign specific actions to federal agencies; and (7) restore wetlands.

PROGRAM ELEMENTS

W-1. Wetlands Preservation

1.1 Agency Coordination and Technical Support

State and federal agencies involved in wetlands regulations, preservation or restoration shall actively support the development of local non-regulatory programs, as defined in element W-2.1. Support shall be given through technical assistance and funding, when feasible, of local programs. Ongoing technical assistance should include specific guidance to: a) enable local governments to make non-regulatory programs that protect wetlands compatible with growth management planning; b) identify local funding mechanisms; and c) share information from existing programs in place around Puget Sound. Ecology shall have the lead role in providing assistance to local governments and coordinating agency efforts. As part of the guidance, Ecology shall develop a list of federal and state grant and loan money available for preservation efforts to distribute to local and tribal governments. Local workshops or other means should be used to distribute and share information. Agencies shall also work closely with and support the wetland preservation activities of Puget Sound land trusts.

Target Date: Ecology provides information and technical assistance on non-regulatory programs to all Puget Sound counties by July 1996 and to 15 selected cities by January 1997. Support from all agencies is ongoing.

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1.2. Identification of Wetlands to be Preserved

Ecology shall form an ad hoc working group with the departments of Natural Resources (DNR) and Fish and Wildlife, the Interagency Committee for Outdoor Recreation, tribal governments, other agencies, land trusts, and interested groups to identify a list of known significant, high-quality wetlands to be preserved. This work group shall establish guidelines and criteria for sites to be listed and ranked. Primary criteria should include biological significance and long-term viability; secondary criteria should include ability to coordinate site-specific preservation with other watershed protection efforts (element W-8 and element NP-2). The working group shall coordinate with the Natural Heritage Program at the DNR and other programs that may have identified high-quality sites.

The list should be continuously revised as new sites are identified and others deleted. Ecology shall maintain the list and distribute it to other agencies and interested groups annually.

Documentation shall accompany the list describing the size, location and general functions and values of the selected wetlands. The Authority shall review the wetlands preservation list and documentation of wetlands selected for preservation annually.

The work group shall seek to have wetlands on the preservation list included in other agencies' and groups' acquisition priorities, such as those of the U.S. Fish and Wildlife Service (USFWS), the National Park Service, the Department of Fish and Wildlife, The Nature Conservancy, the Trust for Public Lands, local land trusts, and the Washington Wildlife and Recreation Coalition. The goal is to achieve protection for all of the sites on the list through acquisition, conservation easements or other preservation strategies.

Target Date: First revised preservation list submitted to the Authority by February 1996 and subsequent revisions annually thereafter.

1.3. Coordinated Preservation and Long-Term Management

All state, federal and local agencies shall take actions necessary, including a vigorous attempt to seek funding, to preserve and protect in perpetuity those wetlands identified under element W-1.2. This is an ongoing program in which specific sites are protected as funds and other means of preservation become available. Preservation includes acquisition, purchase of development rights, conservation easements, designations of open space and other available methods. Ecology shall take the lead to coordinate preservation efforts for the subelement W-1.2 site list and shall work to recommend a preservation strategy for each site.

The DNR, in coordination with Ecology, shall consider using available funds to secure some of the wetland areas identified under subelement W-1.2. The DNR and Ecology shall seek other funds for long-term maintenance of acquired areas. The DNR may make grants to local governments and other entities wishing to sponsor projects to preserve wetlands.

The DNR and Ecology shall recommend a preservation strategy for each site that includes: (a) a technical rating of the value of site preservation; (b) the

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urgency of the securing action; and (c) preliminary site management and preservation methods.

The DNR shall submit annual reports to the Authority and Ecology on its preservation and acquisition activities and, if necessary, make interim reports on areas where high-quality wetlands are known to be imminently threatened by degradation.

Funds appropriated to the DNR to carry out this program shall be expended consistent with the agencies' recommended strategy for preserving the site. All government and private entities are encouraged to use other appropriate funds available to them to acquire wetlands in accordance with each specific site preservation strategy.

After sites are secured, a detailed site management plan shall be developed and carried out by the owner or manager.

The DNR and Ecology shall provide technical advice and limited staff support to any agency, local government, tribal government, organization, or private party wishing to take the lead in preserving any site, including those not on the final list. State preservation actions should coordinate with and complement preservation programs of other federal and state agencies and private organizations such as The Nature Conservancy and Trust for Public Lands. Data on functions, values and acreages of all wetlands preserved under this program shall be provided to the Department of Ecology as sites are acquired for inclusion in the wetlands tracking system (element W-4) for measuring progress in achieving the wetlands program goal of no net loss of wetlands in Puget Sound.

Target Date: Initiate acquisition for most important sites as funds become available. Identify recommended preservation strategies for sites on the list by February 1996. Develop plans for site preservation and management as funding and other mechanisms become available. Ecology and the DNR shall submit annual progress reports to the Authority.

W-2. Puget Sound Local Government Wetlands Protection Programs

Each local government in the Puget Sound region should develop and implement a comprehensive wetlands protection program that includes regulatory and non-regulatory components and is consistent with the recommendations provided in this element.

Ecology and the DCTED shall assist local governments in their efforts to develop the necessary technical detail in their programs to achieve consistency with the Authority's recommendations.

The Authority, with technical assistance from Ecology, shall review and comment on wetlands protection programs established by local governments in order to encourage them to develop and implement effective programs to protect wetlands.

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Local governments should use Ecology's Model Wetland Protection Ordinance and any updated version thereof in developing their comprehensive, wetlands protection program.

The provisions in this element are designed to be consistent with the deadlines and criteria of the Growth Management Act.

2.1. Local Government Wetlands Protection Programs

The goal of comprehensive wetlands protection programs established by local governments should be to ensure that in the short term there is no net loss of wetlands function and acreage, and in the long term there is a measurable gain of wetlands function and acreage in the local government planning area.

"Functions" refers to the beneficial roles served by wetlands, which include control and storage of flood water and stormwater runoff; water quality enhancement by removal of pollutants; groundwater recharge; prevention of erosion; sediment trapping; critical fish and wildlife habitat; open space; areas for scientific study and education; and recreation. Wetland functions and values provide public benefits, and are the reason for protecting wetlands against damage and destruction. Loss of wetland acreage is often related to loss of function and is easier to quantify. Therefore, "acreage" should be included as a second dimension of wetland loss.

The no net loss goal has been embraced by national and state efforts to protect wetlands. The National Wetland Policy Forum (1988) established the following policy goal:

> *To achieve no overall net loss of the nation's remaining wetlands base and, in the long term, to increase the quantity of the nation's wetlands resource base.*

The goal was incorporated into Executive Order 89-10 and the 1991 Puget Sound Water Quality Management Plan. The no net loss goal reflects the widespread concern that too many wetlands have been, and continue to be, lost in the Puget Sound region.

The wetlands protection program established by local governments should include the following methods of protecting and preserving wetland resources:

1. Comprehensive land-use planning
2. Preservation
3. Restoration
4. Regulation
5. Education
6. Program evaluation

1. Comprehensive Land-Use Planning

Local governments should integrate protection of wetlands into the development of comprehensive plans required by the Growth Management Act (GMA). The following are examples of how this can be accomplished.

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Provisions for open space. Under the GMA, open space corridors must be identified within and between urban growth areas (UGA's). Open space should be located to protect wetlands whenever possible. In maintaining open space within UGA's, wetlands should be viewed as an incentive for achieving urban densities, not sacrificed to achieve them. Comprehensive plans should take special measures to protect wetlands in UGA's, including identification of prime wetland sites, providing policy protection, allocating funding for special costs, and designing compatible infrastructure.

Land-use element. The land-use element of the Growth Management Act calls for local governments to protect groundwater quality and quantity, and to provide for the cleansing of drainage, flooding and stormwater runoff which drain into the Puget Sound. Wetlands provide some of these functions naturally, and therefore should be protected from development. Local governments can achieve protection by excluding wetlands from the developable land base, or by using innovative land-use techniques to avoid impacts to wetlands within development zones. In addition, the comprehensive plan should include provisions for a wetland inventory. Wetlands may be components of identified recreation and open space lands, provided that allowed activities do not adversely affect wetlands and their protective buffers.

Capital facilities plan element. Funding should be provided to acquire prime wetlands which can not be adequately protected through other means.

Conservation plan element. Wetlands protection should be included as part of a conservation element. This element should survey available wetlands data and evaluate the potential for wetlands loss and needs for protection. Policies should be established for appropriate fee and less-than-fee open space acquisition, use of innovative land-use management techniques, public education about wetlands protection, restoration of degraded wetlands, and mitigation of development effects through project review.

Coordination among local governments. Comprehensive plans must be coordinated with adjacent jurisdictions, including tribes, and regional planning bodies. The plans should consider regional needs for wetlands protection. For example, the susceptibility of wetlands to degradation from excess stormwater and flood flows often requires interjurisdictional coordination.

Coordination with state and federal agencies. Local governments should coordinate wetlands protection programs with appropriate state and federal agencies, including those agencies that own or manage land within the local government's jurisdiction.

Coordination between mandatory functional plans. Comprehensive plans should consider interrelationships between shoreline master programs, locally developed watershed action plans, stormwater plans, comprehensive flood plain management plans, and other resource or issue-specific plans. These plans have land-use components which may impact wetlands protection.

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Assessment of cumulative benefits and effects. An analysis of the cumulative benefits and effects of the comprehensive plan on wetlands should be included as part of the State Environmental Policy Act (SEPA) evaluation.

2. Preservation

Each local government should develop a preservation program to address the protection of significant wetlands and their protective buffer areas. Securing the wetlands in perpetuity can be accomplished using methods that include public acquisition and land trusts. Providing economic incentives for private landowners to protect their wetlands is another effective preservation method.

It is important for the wetlands preservation program to be consistent with, and to the extent possible, incorporated into the local government's comprehensive land-use plan. Wetlands preservation may be considered an innovative management technique under Section 9 of the GMA. This section requires local governments to use innovative techniques to conserve and protect critical areas, such as wetlands. The GMA also requires local governments to ensure the existence of "open space corridors" in urban growth areas. The programs established by local governments to preserve wetlands should include a strategy for preserving wetlands of high quality by designating them as open space corridors and securing the titles or conservation easements to such lands.

The local government preservation program should address the following methods of protecting wetlands:

a. Public acquisition

Local government preservation programs should be consistent with and complement the state acquisition program under subelement W-1.3. Wetlands appropriate for public acquisition should be identified by each local government. These may include regionally significant wetlands which have not been included in the state acquisition program, wetlands not adequately protected through regulation, and wetlands that serve a special community function and/or are locally significant. Once identified, these wetlands can be acquired in whole or part, as the availability of funds allows. Public acquisition efforts should also include provisions for managing these acquired wetlands. Management objectives should include the protection of the values, functions and acreage of the wetlands and associated buffers as well as the control of exotic and invasive species (such as purple loosestrife) and protection of native wetland vegetation.

b. Land trusts

Local governments should encourage private land trusts to promote wetlands preservation. A land trust is a non-profit organization whose purpose is to preserve open space within a specific geographic area. A variety of options may be used to assure protective stewardship of valued lands, such as wetlands. There are many local land trusts engaged in acquiring wetlands in the Puget Sound region. Each local government should encourage its community to work with existing land trusts, or to establish a land trust for wetlands

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preservation, if needed. The success of land trusts will complement the efforts and reduce the financial burden to local governments with respect to wetlands acquisition.

c. Private stewardship

Landowners should be encouraged to protect wetlands by guarding against activities which may degrade wetland functions and values, by removing exotic and noxious plants which may damage the wetland ecosystem, and by enhancing degraded wetlands. Local governments may provide economic incentives to encourage and assist private stewardship of wetlands. This will reduce the financial burden that may be associated with ownership of undevelopable land, and help to ensure the continuation of public benefits from wetlands. Economic incentives may include reduced property taxes for wetland areas, density credits and transfer of development rights.

There are a number of state and federal agencies which can provide assistance to local governments in developing wetlands preservation programs, including the following: Department of Ecology[4], Department of Community, Trade and Economic Development, Washington Interagency Committee for Outdoor Recreation, Department of Fish and Wildlife, Department of Natural Resources, and U.S. Fish and Wildlife Service. Tribal governments may also be interested in forming active partnerships with local governments and in assisting in wetlands preservation. In addition, several non-profit, national organizations are promoting wetlands preservation efforts. Ducks Unlimited, Trout Unlimited, the Nature Conservancy, Land Trust Exchange, National Audubon Society, and the Trust for Public Land are a few of the more well-known organizations.

3. Restoration

Each local government should integrate restoration actions into its comprehensive, wetlands protection efforts to facilitate achievement of an overall gain of wetlands in its planning area. Restoration, although often considered a part of regulatory mitigation efforts, fills an equally critical, non-regulatory role. Wetlands restoration involves reestablishing a wetland's functional characteristics and processes that have been lost. Native vegetation should be used in all restoration projects, and provisions made for control of invasive and exotic species.

Assistance with the development of restorations programs can be obtained from Ecology, the EPA and USFWS. Actions should be consistent with and complement subelement W-8.2.

4 See "Wetlands Preservation, An Information and Action Guide," Department of Ecology publication No. 90-05. This booklet provides information on options for wetlands preservation, existing land trusts, and public organizations that can assist local governments. Pursuant to element W-1, a complete how-to-guide for establishing a local government wetlands-preservation program was published by Ecology in 1990.

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4. Regulation

Each local government in the Puget Sound region must develop a regulatory program for protecting wetlands to meet the mandates of the GMA. The program should regulate land development and mitigate effects on wetlands.

The regulatory program should be designed to fit the specific needs of the local community.[5] Existing local permit programs, where available, may be used to prevent redundancy and to make the best use of existing resources.

If no appropriate program is available, or if existing programs do not adequately protect wetland resources, a new permit system should be developed. Local governments should refer to Ecology's Model Wetland Protection Ordinance for guidance on developing a regulatory program.

The basic elements which should be included in regulation designed to protect wetlands include the following:

a. A "no net loss" goal

The local government ordinance for protecting wetlands should include a "no net loss of wetlands" goal. To be consistent with federal and state policy, wetlands loss should be stated in terms of functions and acreage.

b. A clear definition of "regulated wetlands"

Each local government should provide a clear definition of "regulated wetlands" in their wetlands protection ordinance. This definition is important in determining the scope of the regulatory program.

For purposes of consistency within the Puget Sound basin, local governments should adopt the following definition of "regulated wetlands," which is similar to that used in Ecology's Model Wetland Protection Ordinance.

- Regulated wetlands are areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.
- Swamps, marshes, bogs and similar areas are generally considered regulated wetlands.
- Wetlands created for mitigation and those modified for approved land-use activities are regulated wetlands.

5 Several local governments in the state have developed admirable wetlands-protection regulatory programs that are consistent with the Authority's recommendations. These programs may prove to be useful examples for local governments in the process of designing wetlands-protection regulation. Please contact the Authority's Wetlands Protection Program for more information regarding these existing programs.

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- Ponds under 20 acres, including their submerged aquatic beds, are regulated wetlands.[6]

Artificial wetlands intentionally created from sites that are not wetlands, such as irrigation and drainage ditches, grass-lined swales, canals, detention facilities, wastewater treatment facilities, farm ponds, and landscape amenities, should not be defined as "regulated wetlands."

This definition is consistent with the one used in the federal Clean Water Act and the state Growth Management Act, but has been broadened to include wetlands which are not adequately protected under the state Shoreline Management Act.

c. An established method of delineating wetlands

Local governments should incorporate into their wetlands protection ordinances, a method of determining the presence and establishing the boundaries of individual wetlands.

Ecology's Model Wetland Protection Ordinance references the "Federal Manual for Identifying and Delineating Jurisdictional Wetlands." The 1989 edition of the federal manual is currently being revised; until a new manual has been evaluated for use in Washington state, the 1989 manual should be used. The use of the 1989 edition is consistent with recommendations in the growth management regulations. Local governments in the process of designing regulations for wetland protection should contact Ecology for technical assistance regarding methods for delineating wetlands.

d. A method of categorizing wetlands

Local governments are required by the GMA to classify wetlands in their planning area. To meet this mandate, each local government should adopt a wetlands rating system which differentiates wetlands into categories according to specific characteristics (such as certain vegetative communities) or functional attributes (such as special habitat features). The wetlands rating system provides a basis for ranking efforts to protect wetlands and serves as a guideline for land-use management.

Management decisions that are based upon the rating system include the range of permitted activities, the width of the buffer zones, and the acreage replacement ratios for mitigation projects.[7] A wetlands rating reflects the sensitivity of an individual wetland, and thus provides developers with early notice of potential restrictions and limitations which may be placed upon a proposed

6 Wetlands (marshes, bogs and swamps) associated with lakes 20 acres or greater in size, streams with flows over 20 cfs, and all lands within 200 feet of Shorelines of the State (ordinary high water mark) are protected under the State Shoreline Management Act (SMA) (RCW 90.58). The SMA does not provide adequate protection to isolated wetlands and riparian wetlands associated with lakes and ponds less than 20 acres in size.

7 The wetlands rating system should also be used as a basis for selecting wetlands for acquisition, preservation and restoration purposes. The wetlands belonging in the category which reflects the highest value and function should be the primary targets for preservation efforts.

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project. It is important for the rating system to be supported by clear and concise guidelines on how rating decisions are made.

Local governments that do not have their own wetlands rating system are strongly encouraged to adopt the Washington State Wetlands Rating System. This system includes four tiers or categories to define relative wetlands values. Information on the Washington State Wetlands Rating System and guidance on the related field methodology are available from Ecology. Local governments that choose not to use this rating system must explain the rationale for their decisions in their next Biennial Report. This information will help the Authority to identify other useful rating systems.

e. A definition of "regulated activities"

Wetlands functions and values can be severely affected by poorly controlled construction and land-development activities. Each local government should identify activities which adversely affect wetlands and their associated buffers. These activities should be regulated through a permit system and enforced at the local level.

The Authority recommends that local governments adopt the definition of "regulated activities" used in Ecology's Model Wetland Protection Ordinance:

1. The removal, excavation, grading or dredging of soil, sand, gravel, minerals, organic matter, or material of any kind.
2. The dumping, discharging or filling with any material.
3. The draining, flooding or disturbing the water level or water table.
4. The driving of pilings.
5. The placing of obstructions.
6. The construction, reconstruction, demolition or expansion of any structure.
7. The destruction or alteration of wetlands vegetation through clearing, harvesting, shading or planting of vegetation that would alter the character of a regulated wetland, provided that these activities are not part of a forest practice governed under chapter 76.09 RCW and its rules.
8. Activities that result in a significant change of water temperature, a significant change of physical or chemical characteristics of wetlands water sources, including quantity, or the introduction of pollutants.

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f. Wetland buffer zones

A wetland buffer zone is an area that surrounds and protects a wetland from adverse effects of activities on adjacent lands. A buffer zone should be of adequate width to provide the following functions:

- Stabilize soil and prevent erosion.
- Filter suspended solids, nutrients and harmful or toxic substances.
- Moderate effects of stormwater runoff.
- Moderate system microclimate.
- Support and protect plant and animal species and their habitats.
- Discourage adverse human effects in wetlands.

Local governments should adopt standards which meet or exceed Ecology's Model Wetland Protection Ordinance standards for buffer-zone widths. Local governments which adopt different standards or allow case-by-case adjustment of buffer widths should explain the rationale of their decision in their next Biennial Report to the Authority. This explanation should address the concern that buffer-zone widths must provide the necessary functions listed above.

Local ordinances should also include provisions to discourage activities in wetland buffer zones, except where such activities are compatible with and have no adverse effects on the overall functions of the buffer zone. Wetland buffer zones should be retained in their natural condition unless revegetation is necessary to restore the functional value of the buffer zone.

g. Standards for use and protection of wetlands

Local governments should establish standards for use and protection of regulated wetlands. The order of preference for management options with respect to the control of regulated activities and their associated effects on wetlands should be as follows (per Executive Order 90-04):

1. Avoid the impact altogether by not taking a certain action or part of an action.
2. Minimize impacts by limiting the degree or magnitude of the action and its implementation, by using appropriate technology, or by taking affirmative steps to avoid or reduce impacts.
3. Rectify the impact by repairing, rehabilitating or restoring the affected environment.
4. Reduce or eliminate the impact over time through preservation and maintenance operations during the life of the action.

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5. Compensate for the impact by replacing, enhancing or otherwise providing equivalent or greater wetland functions.

6. Monitor the impact and take appropriate corrective measures.

The standards should require project applicants to compensate through mitigation for all negative impacts to regulated wetlands. "Compensatory mitigation" means replacing project-induced wetland losses, and the following should be considered:

1. Restoration - actions performed to reestablish a wetland's functional characteristics and processes that have been lost.

2. Enhancement - actions performed to improve the condition of existing degraded wetlands so that the functions they provide are of a higher quality.

3. Creation - actions performed to intentionally establish a wetland at a site where it did not formerly exist.

The standards which govern the permitting system should include provisions requiring (1) careful planning of compensation projects; (2) evidence that the project applicant has sufficient technical expertise and financial resources to satisfactorily complete the project; and (3) project monitoring, with corrective action when needed. Special care should be taken to ensure that native wetland vegetation is used in all mitigation projects, and that exotic and invasive species are controlled.

The standards also should specify acreage replacement ratios for projects involving compensatory mitigation. The acreage replacement ratio is used to indicate how many acres of wetlands must be created or restored to achieve full compensation for wetlands that are lost as a result of a permitted project. The following factors should be considered when developing these ratios:

- The type, function and wetlands rating of the original and the created or restored wetland.

- The size and location of the original and created or restored wetland.

- The length of time it takes for a created or restored wetland to approximate the characteristics of the original wetland.

- The probability of success of the mitigation efforts.

There is considerable scientific uncertainty with respect to the effectiveness of compensatory mitigation. Follow-up studies of wetlands restoration and creation projects indicate that about half of the projects fail to fully compensate for lost wetlands. Therefore, the acreage replacement ratios should be adjusted to reflect the risk of failure inherently involved in these projects.

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In establishing the standards for compensatory mitigation, local governments should address the timing problems inherent in creating and restoring wetlands. Significant time may elapse between the effect or destruction of the original wetland and completion of the compensation project. Time is also required for the created or restored wetland to become fully functional. Up-front compensation, which is completed before a wetland is destroyed, is the only way to avoid a loss for at least some period of time. Provisions for increasing the acreage replacement ratio in situations where there will be a significant period of time between destruction and replication of wetlands functions may also provide a partial solution.

Ecology's Model Wetland Protection Ordinance includes replacement ratios for creation or restoration which are "in-kind, on-site, timed prior to or concurrent with alteration, and has a high probability of success." The model ordinance also provides guidance on how to adjust these ratios to address specific circumstances. These replacement ratios are based upon the best available scientific information. Local governments seeking further guidance in developing acreage replacement ratios should consider those used in the model ordinance and contact Ecology for technical assistance.

Local governments should consider providing flexibility in local mitigation regulations to allow advanced mitigation (mitigation banking), joint mitigation projects, and off-site, out-of-kind projects where the proposed project can demonstrate a greater benefit to the wetlands resource than in-kind, on-site mitigation. Local governments are encouraged to identify potential off-site restoration projects in comprehensive plans. Off-site restoration projects should not promote trade-offs of function from lower to upper watershed or vice versa. Off-site, out-of-kind projects should be considered only after mitigation sequencing has been done, and where criteria for approval have been negotiated among regulatory agencies as per element W-3.

h. Enforcement

Regulatory programs should include provisions for enforcing local wetlands regulations as part of general land-use and growth management programs and local programs for protecting water quality. A combination of permit tracking and enforcement will allow for comprehensive protection of wetlands and monitoring of wetland losses. Local governments should include an educational component in their wetlands protection program to encourage residents to become involved in local preservation programs, and to help them to understand the need for wetlands regulations.

5. Education

Wetlands education can take many forms. Interpretive centers or trails can educate residents about local wetlands. A volunteer program can be used for many activities such as distributing educational materials, conducting wetland field trips or monitoring the health of wetlands. Wetlands education should also be brought into the local school system.

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Educational materials should provide information on the values and functions of wetlands, the importance of wetlands preservation, methods for landowners to protect and preserve wetlands, and a basic overview of the local regulations regarding wetlands. Local governments should make use of materials published by Ecology and materials created pursuant to element W-7, Wetlands Education Strategy.

6. Program Evaluation by Local Government

Each local government should develop means of determining the success of their wetlands protection program. The program evaluation may involve inspection and reporting requirements to monitor the success of mitigation projects; a permit tracking system; measurement of acreage and functions of wetlands lost, and those enhanced, restored and created; a method of calculating (in quantitative and qualitative terms) the wetland resources preserved; and a means of evaluating educational efforts in raising the community's awareness with respect to wetland values.[8]

2.2. Assisting Local Governments In Their Efforts to Achieve Consistency with the W-2 Recommendations

1. The Authority, Ecology and DCTED shall provide assistance to local governments in developing comprehensive wetlands protection programs that are consistent with the recommendations in this element.

2. Local governments should adopt comprehensive land-use plans that are consistent with the Authority's recommendations.

3. Each local government shall provide the Authority with a copy of its draft comprehensive land-use plan during the local public comment period. The Authority, with assistance from Ecology and the DCTED, will review the draft plan and provide comments in order to assist the local government in its effort to achieve consistency with the Authority's recommendations. The Authority's review of the draft plan will be completed within the public comment period.

4. Local governments should adopt comprehensive, wetlands protection programs which contain regulatory and non-regulatory elements and are consistent with the Authority's recommendations.

5. Each local government developing or revising a wetlands protection program shall submit a copy of its draft program or revisions to the Authority during the local public comment period.

6. The Authority and Ecology shall review each local government's wetlands protection program during the public comment period. The Authority, with technical assistance from Ecology, shall provide written comments that describe how the proposed wetlands protection program may be modified to achieve consistency with the Authority's recommendations.

8 See "Monitoring Guidelines" (Guide Sheet 7) in *Development of Guidance for Managing Urban Wetlands and Stormwater*, Final Report, May 1991. Prepared by King County Resource planning Section Environmental Division.

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7. Each local government that has enacted a wetlands protection program as of the date of adoption of this Plan element shall submit a copy of its program to the Authority within 90 days of the adoption date of this element. The Authority, with technical assistance from Ecology, shall provide recommendations for future revisions.

8. In the Biennial Report required by RCW 90.70.07(3), each local government shall describe its wetlands protection program and any revisions made during the relevant two-year period.

9. The Authority shall prepare periodic reports on local government efforts to protect wetlands in the Puget Sound region. In addition, the *State of Sound Report* shall include a comprehensive review of the wetlands protection programs established by local governments and their successes and failures. Local governments which are in compliance with the Plan, and those which are not, will be identified. Measures that must be taken to bring each local government into compliance will be specified.

2.3. Tracking Strategy for Local Government Wetlands Protection Programs

The Authority, Ecology and DCTED will work together to define local government responsibilities for providing information to contribute to Ecology's tracking system (see element W-4). This effort will include the development of reporting standards for local governments.

Target Dates: The Authority, with assistance from Ecology and the DCTED, will review and comment on draft comprehensive land-use plans, comprehensive wetlands protection programs and program revisions during the local public comment periods. The Authority will review all final programs established by local governments to protect wetlands for consistency with the Authority's recommendations set forth in this element.

W-3. State Agency Actions

The Authority, with assistance from Ecology, shall provide guidance where necessary to local governments in the preparation of development regulations for wetlands in relation to the Growth Management Act.

State agencies shall take the following actions in coordination with the implementation of Executive Order 90-04:

a. Ecology shall rigorously enforce authorities available to it under the federal Clean Water Act, including Sections 401, 402, 319, 320, and 305(b), and state laws and regulations, including but not limited to SEPA and the Shoreline Management Act, to protect wetlands in the Puget Sound basin to the maximum extent possible. This shall include granting, denying or conditioning of water quality certifications of all federal permits to protect wetlands.

b. Ecology, to the extent authorized by law, shall condition or deny water quality certifications under Section 401 of the federal Clean Water Act to prevent degradation of wetlands and shall re-evaluate Section 401 certification of nationwide permits affecting wetlands at such time as these permits are

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revised by the Army Corps of Engineers or when the existing certification expires in 1997, whichever comes first.

c. Ecology shall ensure that water in wetlands is included in the State Water Quality Standards (Chapter 173-201 WAC), and shall explore the feasibility of further application of existing laws (especially RCW 90.48, Water Pollution Act) to protect wetlands.

State agencies shall promote the use of consistent guidance for the design, monitoring and enforcement of compensatory mitigation projects.

The departments of Ecology and Fish and Wildlife shall consider greater flexibility in the review of compensatory mitigation projects to allow for advanced mitigation (mitigation banking), joint mitigation projects, and off-site, out-of-kind projects where the proposed project would result in a greater benefit to the wetlands resource than in-kind, on-site mitigation. Off-site projects should be geographically limited to prevent a cumulative trade-off of wetland functions from lower to upper watershed or vice versa. Off-site, out-of-kind projects should be considered only after mitigation sequencing has been done, and where consideration is given to the following: 1) project effects are proposed to low-quality wetlands with limited functions and values (e.g. monotypic stands of reed canarygrass); 2) on-site mitigation will be hydrologically isolated; and 3) critical habitat may be restored to a watershed through off-site mitigation. Agencies shall work with local governments to identify potential mitigation sites to be included in comprehensive plans.

W-4. Inventory and Tracking of Puget Sound Wetlands

In coordination with the Puget Sound Geographic Information System (element M-4), Ecology shall work with the departments of Natural Resources, Fish and Wildlife, Transportation, and Community, Trade and Economic Development, the Puget Sound River Basin Team, U.S. Fish and Wildlife Service, EPA, Corps of Engineers, and other appropriate entities and agencies to carry out the following tasks:

Establishing standards for inventories: Develop and promote a method for inventorying wetlands at the local level, and a standard for inventory data that is practical for use by local and tribal governments. The draft methodology and data standard shall be developed in collaboration with local and tribal governments and distributed widely for review before adoption. Once established, this inventory methodology should be promoted for use by those local and tribal governments in the Puget Sound basin that have not already done or are updating their wetlands inventories.

Local government training: Establish a training program for local and tribal governments to conduct wetlands inventories consistent with the standards developed. Workshops should be used to distribute and share information among local governments.

Compile inventory data: Inventory data developed at the local level and other agencies data will be compiled on Ecology's GIS (geographic information system) in order to evaluate Puget Sound wetlands resources. Inventory data

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that are in a different or incompatible format shall be incorporated where practicable.

Restoration and preservation site identification: Identify potential restoration (in coordination with element W-8) and preservation sites (in coordination with subelement W-1.2) using the GIS database.

Tracking system for no net loss: Use existing inventories, permit tracking systems and other relevant information to establish a pilot monitoring system for evaluating the net losses and gains of wetlands within a given region. Where possible, the system should track effects and mitigation under Hydraulic Permit Approvals, Section 404 and 401 permits, shoreline permits, and local development and land-conversion permits.

Ecology, and participating agencies, shall submit an annual report to the Puget Sound Estuary Program Management Committee on progress in achieving the inventory goal.

Target Date: Ecology to develop a standard method for inventorying wetlands and formatting data by September 1996. Training workshops to begin by December 1996. Compilation of existing compatible inventory data finished by April 1996. Development of watershed assessment model finished by July 1997. Identification of restoration and preservation sites to occur as they arise in the course of the other projects.

W-5. Interagency Coordination and Federal Role

The Interagency Wetlands Review Board (IWRB) shall act as an oversight body to the implementation of the State Wetland Integration Strategy. The IWRB shall ensure that the recommendations from the SWIS work groups are carried out, to the extent possible, by state resource agencies.

Federal agencies shall implement the recommendations of the State Wetland Integration Strategy and undertake the following activities in support of the Puget Sound Wetlands Protection Program:

1. The Seattle District of the U.S. Army Corps of Engineers shall, where feasible:

   a. Ensure that public notices for permits under Section 404 of the federal Clean Water Act and Section 10 of the Rivers and Harbors Act include specific information, such as (i) the size of the wetland to be affected and any associated stream or other body of water; (ii) possible cumulative effects from the proposal in the watershed or estuarine/ nearshore habitat; (iii) a mitigation plan summary based on the system of mitigation sequencing in Chapter 197-11 WAC; and (iv) whether an alternatives analysis is available.

   b. Address the cumulative effects of wetlands losses under the nationwide permit program, applying its discretionary authority to require individual permits for proposals in watersheds in the Puget Sound basin where wetland losses exceed wetland gains.

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c. Ensure that 404 permit applications are approved only when they are consistent with state wetlands guidelines and local government wetlands protection programs (element W-2), unless state and local regulations are less protective of wetlands than Corps requirements.

d. Develop partnerships with other federal and state agencies and local and tribal governments to conduct special-area management planning[9] and advanced identification in the Puget Sound basin.

e. Actively seek opportunities for creating and restoring wetlands in Puget Sound.

f. Take whatever action is possible to incorporate local and state comments into the products of the Nationwide Permit Task Force, which is currently considering revisions to the nationwide permit process, and where possible seek local and state involvement in the scheduled review of the nationwide, permit review process in 1997.

g. In administering Nationwide Permit #26, use its discretionary authority to require regional conditions, individual state water quality certifications, or individual Corps Section 404 permits for proposed wetland fills in the Puget Sound basin to ensure the goals of the Wetlands Protection Program are met.

2. The U.S. Fish and Wildlife Service shall, where feasible:

a. Provide challenge grants to state agencies and Puget Sound local governments and private entities for wetlands acquisition, restoration and enhancement projects in coordination with subelement W-1.3 and element W-8.

b. Provide challenge grants or funds for, and participate in, wetland inventories consistent with the state inventory strategy for the Puget Sound basin, and status and trends studies.

c. Provide technical assistance to other federal and state agencies, and local and tribal governments in Puget Sound on fish and wildlife use of wetlands habitats, impact assessment, and mitigation planning.

d. Participate with the Corps of Engineers in the development of special-area management plans in the Puget Sound basin.

e. Assist Ecology in the preparation of the biennial report to the Authority on progress in achieving the goals of no net loss of wetlands in the short term and a measurable net gain in the long term.

9 Special-area management planning is a term used by the U.S. Army Corps of Engineers to describe a collaborative, interagency planning process within a geographic area of special sensitivity. The planning process results in a detailed and comprehensive statement of policies, standards and criteria to guide public and private users of lands and waters.

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3. The Environmental Protection Agency shall, where feasible:

a. Provide technical assistance and funding to Ecology and other state, federal and local agencies in their wetlands protection activities, including the continuation of wetland conservation plans.

b. Promote Ecology's use of the water quality certification process under Section 401 of the federal Clean Water Act to protect wetlands in Puget Sound.

c. Develop partnerships with other federal and state agencies and local and tribal governments to conduct special-area management planning and advanced identification in Puget Sound.

d. Provide technical assistance to other federal and state agencies and local and tribal governments in Puget Sound on fish and wildlife use of wetlands habitats, impact assessment, non-regulatory protection measures, and mitigation planning, through the wetlands conservation grants and other grant programs.

e. Undertake a study of the implications and appropriateness of wetlands mitigation banking for the Puget Sound planning area. The study will identify the costs and benefits, from a resource conservation perspective, of wetlands mitigation banking, report on the overall potential of regional resources to achieve no net loss as a short term goal, and recommend strategies for mitigation banking. The EPA shall consult with federal and state natural resource agencies, local and tribal governments, and other groups and individuals as appropriate.

4. The Corps of Engineers, USFWS and EPA shall, where feasible:

a. Provide funds for local government inventories consistent with the state inventory strategy for the Puget Sound basin; identify high-threat areas for which to target funding; research restoration and creation techniques and monitoring protocols; and conduct other studies necessary to achieve the goals of this program.

b. Assist Ecology in preparing the biennial report to the Authority on progress in achieving the goals of no net loss of wetlands in the short term and a measurable net gain in the long term.

c. Work cooperatively with other federal and state agencies and local and tribal governments to develop techniques for addressing cumulative effects of wetlands degradation and/or loss and functional assessments of wetlands.

d. Participate with other agencies to educate the public about wetlands and provide wetlands delineation training.

e. Provide timely comments or technical assistance on Section 404 permits in Puget Sound to ensure that impacts on wetlands are first avoided, then

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minimized to the maximum extent possible prior to approval of compensatory mitigation.

f. Promote consistent guidance for the design and monitoring of compensatory mitigation projects to be used by state and federal regulatory and proprietary agencies.

g. Increase the level of enforcement of compensatory mitigation projects in order to achieve no net loss of wetland functions and values through the regulatory process.

h. Consider greater flexibility in the review of compensatory mitigation projects to allow for advanced mitigation (mitigation banking), joint mitigation projects, and off-site, out-of-kind projects where the proposed project would result in a greater benefit to the wetlands resource than in-kind, on-site mitigation. Off-site projects should be geographically limited in order to prevent a cumulative trade-off of wetland functions from lower to upper watershed or vice versa. Off-site, out-of-kind projects should be considered only after mitigation sequencing has been done, and where consideration is given to the following: 1) project effects are proposed to low-quality wetlands with limited functions and values (e.g. monotypic stands of reed canarygrass); 2) on-site mitigation will be hydrologically isolated; and 3) critical habitat may be restored to a watershed through off-site mitigation. Agencies shall work with local governments to identify potential mitigation sites to be included in comprehensive plans.

Target Date: Federal assignments are ongoing and should be implemented as feasible. Annual meetings should occur with Authority staff and federal agencies.

W-6. Program to Protect Wetlands on State-Owned Lands

For state-owned uplands and aquatic lands managed by the Department of Natural Resources (DNR), the DNR shall use its authorities and programs to ensure that existing wetlands are preserved and protected.

At a minimum, the DNR's program for protecting wetlands on state-owned uplands and aquatic lands managed by the DNR shall:

- Inventory nearshore habitats (element M-2) and wetlands, including wetlands that would benefit from restoration. The DNR shall use data management systems for the inventory that are consistent, to the maximum extent possible, with the Puget Sound Geographic Information System Database management, the Wetlands Protection Program and the Ecology wetlands inventory under element W-4.

- Study the laws, regulations, policies and programs and their implementation pertaining to the DNR's upland and aquatic land management responsibilities to determine their effectiveness in protecting wetlands on lands under DNR management. The DNR shall propose amendments if needed.

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- Coordinate with the Authority and Ecology to ensure that the DNR management programs for state-owned uplands and aquatic lands are at least as protective of, and consistent with, the Authority's local government wetlands protection programs (element W-2).

- Be consistent with local government development regulations and comprehensive plans adopted pursuant to the Growth Management Act.

- Consider the use of appropriate wetlands for educational purposes including development of interpretive programs and displays.

- Prepare a strategy and implement a management program for wetlands on state-owned uplands and aquatic lands in the Puget Sound basin. This program shall: (a) be implemented through the DNR's proprietary authorities for state-owned aquatic lands; (b) be based on the element W-4 wetlands inventory and the nearshore habitat inventory under element M-2, and on the Department of Fish and Wildlife's Marine Fish Program results, where appropriate; (c) address habitat protection; (d) consider use of appropriate wetlands for educational purposes, including development of interpretive programs and displays (in coordination with element W-1 and with the wetlands education strategy (element W-7)); and (e) include review of key regulatory actions of other agencies, use of appropriate conditions in aquatic lands leases, and withdrawal of critical aquatic-land areas from leasing.

Progress Report. The DNR shall submit a biennial progress report to the Authority that describes its program for preserving and protecting wetlands on lands managed by the DNR. At a minimum, the report shall include:

- A summary of the programs for protecting wetlands on state-owned uplands and aquatic lands managed by the DNR.

- The types and values of wetlands inventoried on state-owned aquatic lands.

- A description of the procedures developed for complying with local wetlands programs and subelement W-2.1 in the DNR's management of wetlands on state-owned uplands.

- The results of the study of laws, regulations, programs and policies pertaining to the DNR's land management responsibilities, including recommendations, if needed, for strengthening provisions for wetlands protection.

- An estimate of funding required to implement the overall Wetlands Protection Program for state-owned lands under DNR management.

Target Date: The DNR submits biennial progress reports to the Authority beginning April 1, 1995.

W-7. Wetlands Education Strategy

Ecology shall develop and implement a long-range wetlands education strategy that augments Ecology's existing wetlands education program. The strategy

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shall involve entities and individuals possessing expertise in the field of wetlands education. These include staff from the U.S. Fish and Wildlife Service, the state departments of Natural Resources and Fish and Wildlife, the Governor's Council on Environmental Education, local and tribal government, and private non-profit conservation groups. The EPA shall assist Ecology in developing the strategy, shall carry out EPA programs consistent with the strategy, and shall use its enforcement program as an educational tool.

The strategy shall target local governments, as well as schools and the general public, groups such as landowners, professional and civic organizations, and interest groups. It shall address wetlands characteristics, functions, values, the Wetlands Protection Program, the need for training wetlands educators, and other important wetlands issues.

Ecology shall work with those federal and state agencies and groups mentioned above to implement the components of the strategy, which may include (a) guidebooks on wetlands protection techniques; (b) wetland resource teams; (c) model and site-specific interpretive programs in coordination with element W-1; and (d) public workshops and field trips. To the extent possible, public libraries shall be provided with wetlands education materials for their patrons.

Target Date: Ongoing.

W-8. Wetlands Restoration Program

8.1. Restoration Projects

Ecology, the EPA and USFWS, in consultation with other agencies, shall take action to implement, concurrently with the overall element W-8 program, an ongoing restoration program for specific wetland sites in Puget Sound. Potential restoration projects shall be assessed, in part, on each site's potential to:

- Contribute to the replacement of critical wetland systems within a watershed.
- Contribute to the enhancement of overall watershed system function.
- Address the removal of exotic plant species (reed canarygrass, *Spartina alterniflora*, purple loosestrife).
- Develop partnerships with a diverse group of public and private interests.
- Contribute to solving nonpoint sources of pollution.
- Remain protected in its natural state as evidenced by local government wetlands protection policies.

8.2 Program Development and Implementation

The departments of Ecology, Natural Resources, and Fish and Wildlife, shall coordinate with the EPA, USFWS, the U.S. Army Corps, tribes, and others to form a work group to develop and implement a program to restore wetlands in

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the Puget Sound basin. The goal of the program is to solve appropriate watershed problems (including flooding, habitat loss, water quality degradation, stormwater management, nonpoint source pollution, etc.) through the restoration of natural wetland systems that have been lost or degraded as a result of human activities.

Puget Sound watersheds shall be assessed for restoration needs and potential based on a method established by the existing restoration work group. The methodology shall include:

- Assessment of specific ecological problems associated with human development which have led to a loss of watershed system function.
- Development of a list of sites that are appropriate for restoration projects, including those sites identified by local governments under the local planning process established in subelement W-2.1.
- Identification of potential wetland restoration activities that would contribute to solving identified problems.
- Development of a diverse base of public and private support for wetland restoration.
- Consideration of the long-term potential for protection through local government ordinances and policies.

High-quality sites identified within a watershed as potential preservation sites should be referred to the preservation work group (subelement W-1.2). Watershed-level restoration efforts should be coordinated with habitat protection and restoration activities (element H-2) and local watershed planning (element WP-2).

Target Date: The departments of Ecology, Fish and Wildlife, and Natural Resources, the EPA, USFWS, and Army Corps of Engineers to present the overall program progress to the Authority by May 1, 1995. Watershed assessment in targeted watersheds will be ongoing. Restoration projects will be undertaken as funding becomes available.

W-9. Wetlands Research

A technical working group, comprised of wetland researchers, agency representatives, members of professional wetlands groups such as the Society of Wetland Scientists, and other interested persons shall convene on a regular basis to address issues of needs and priorities for wetlands research.

Some prioritization of research has occurred through the Puget Sound Research Committee and the Society of Wetland Scientists. These efforts should be reviewed, updated and recirculated more broadly to establish consensus and to promote priority needs to funding sources.

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The working group shall also consider a process for adopting a standardized functional assessment methodology for Puget Sound wetlands, and promote this effort.

The efforts of this working group should be coordinated with the efforts of the Research Program, which focuses more broadly on research priorities for Puget Sound.

MAJOR PUBLIC ACTIONS FOR AUTHORITY REVIEW

1. Ecology's preservation list (subelement W-1.2).
2. The DNR's program for wetlands on state-owned land (W-6).
3. Ecology's wetlands education strategy (element W-7).
4. Wetlands restoration program (element W-8).

LEGISLATION REQUIRED

Some amendments to existing statutes may be recommended to provide funding for local government wetlands programs and to implement other aspects the program.

ESTIMATED COST

Fully implementing the Wetlands Protection Program is estimated to cost $26.7 million during the 1995-97 Biennium and $26.4 million during the 1997-99 Biennium. Twenty million dollars of these costs are targeted to acquire priority wetlands. The remainder would be directed at managing the wetlands acquired and those located on state lands, assisting local governments in developing and implementing wetlands-preservation strategies, developing and maintaining an inventory of Puget Sound wetlands, educating the public about wetlands, and conducting wetlands restoration efforts. Much of the planning by local governments to preserve wetlands that is called for in the Plan is expected to occur under their growth management planning efforts.

The private sector will also experience costs associated with this program. For instance, there will be costs associated with performing wetlands mitigation projects as part of construction permits and there will be some land that will be undevelopable as a result of wetlands being present. These private sector costs are not estimated as part of the program costs. There are also certain financial advantages of having wetlands on ones property that are also not included. For instance, the City of Bellevue provides a major stormwater fee reduction for property owners who preserve wetlands, and wetland owners can also qualify for conservation easements to reduce their property taxes.

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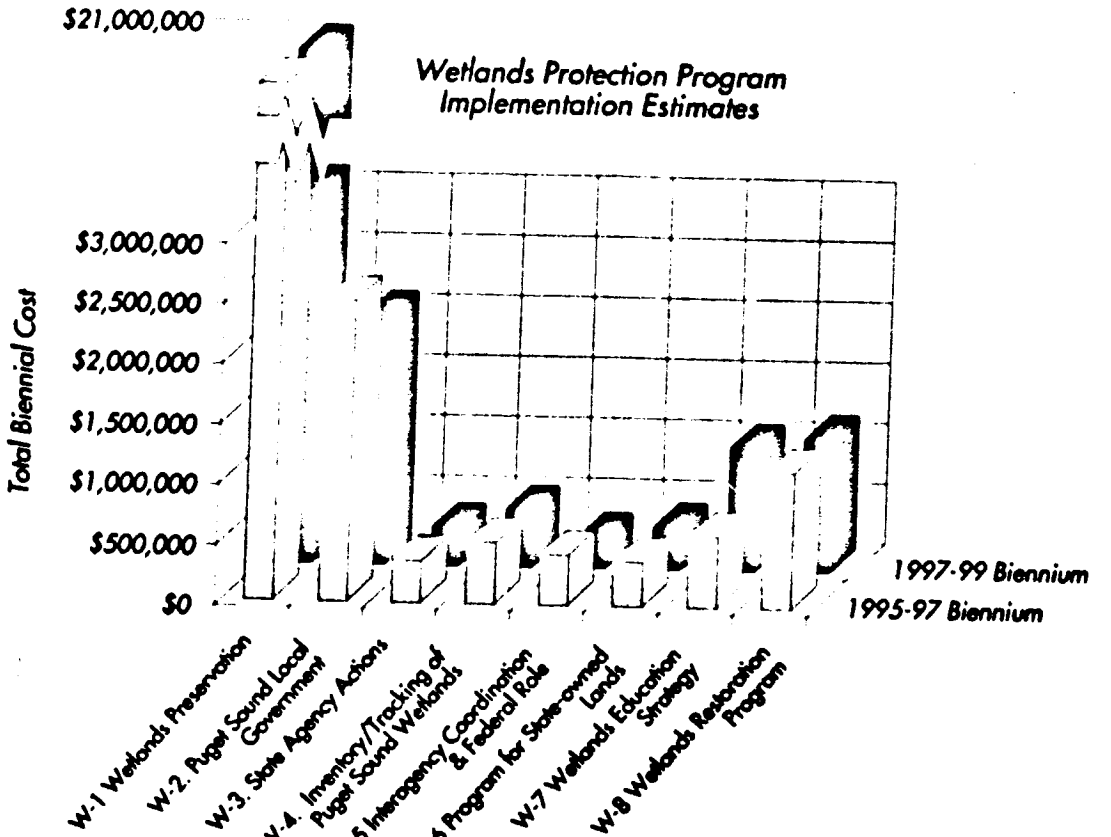

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MUNICIPAL AND INDUSTRIAL DISCHARGES PROGRAM

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PROBLEM DEFINITION

Industries and municipal sewage treatment plants release about 900 million gallons of waste water, or effluent, to Puget Sound every day.[1] Municipal and industrial wastewater discharges are often referred to as "point sources" of pollution because they are discharged to water bodies at a specific point by a pipe or ditch.

1 This volume would cover an area of 4.3 square miles to a depth of one foot. It is approximately equal to the average daily discharge of the Green/Duwamish River.

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Continuing efforts to control conventional pollutants from point sources[2] with wastewater discharge permits have proved increasingly successful. Water quality problems related to these pollutants are now relatively rare in Puget Sound.[3]

Toxic pollutants are a greater threat to Puget Sound. Of greatest concern are toxicants that are persistent (existing long enough to accumulate and cause harm) and those that concentrate in sediments and organisms and are passed through the food chain.

Many toxicants discharged by point sources bind to particles and settle out to become part of the sediment layer. The concentration of toxicants found in recent sediments from Puget Sound's urban bays is up to 100 times the levels in the cleanest rural bays. Toxicant concentrations in sediments from the central basin and rural bays are much lower but are still elevated over pre-industrial levels. Lesions, tumors, inhibited reproductive cycles and other adverse biological conditions have been associated with high concentrations of toxic contaminants in urban bays. Because humans are part of the food web, toxic substances may also pose health risks to those who eat Puget Sound seafood.

Current effluent monitoring is insufficient to accurately estimate toxicant contamination from point source discharges relative to other sources such as storm water, combined sewer overflows (CSOs) and nonpoint sources of pollution. Approximately half the toxics loading in Puget Sound is estimated to be from municipal and industrial point sources, while the other half may be related to nonpoint pollution sources such as storm water, household hazardous waste and runoff from improper agricultural activities.

Industrial pretreatment programs are designed to remove many of the toxicants before they enter municipal treatment plants. Without pretreatment, toxicants can interfere with plant operation, expose workers or equipment to damaging substances, and pass through the system to contaminate a water body, the air or sludge.

While toxic pollution of sediments has become a dominant concern, recent reports show that the surface of marine waters, or the microlayer, may be contaminated with toxicants in sufficient concentrations to kill or cripple larvae and fish eggs[4]. The water column also sometimes shows toxicant concentrations that exceed the U.S. Environmental Protection Agency's (EPA) criteria for protecting marine life from adverse chronic effects.

2 The federal Clean Water Act divided pollutants into categories with varying requirements. Conventional pollutants are oxygen-depleting substances, suspended solids, fecal coliform bacteria, pH, and oil and grease. Toxic pollutants include 13 heavy metals, 111 organic compounds (such as pesticides and polychlorinated biphenyls, or PCBs), asbestos, and cyanide. All other pollutants are classified as nonconventional pollutants.

3 Water quality problems related to conventional pollutants from point sources in Budd Inlet are an example of an exception to this generalization. Overflows from combined sewers are another exception. Where such problems do occur, they are generally localized and transient.

4 EPA, 1990. Puget Sound Microlayer Workshop: Summary Report. EPA 910/9-90-008.

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The rate of sediment contamination by some highly regulated toxicants (e.g., lead, pesticides such as DDT and industrial compounds such as PCBs) is decreasing. However, the same cannot be said for all toxicants. Without continuing efforts to address this problem, toxic contamination may become more severe as population and industrial activity increase. The persistence of many toxic substances makes restoration or contaminated waters difficult.

INSTITUTIONAL FRAMEWORK

The 1972 federal Clean Water Act established the institutional framework for controlling municipal and industrial discharges by declaring national water quality goals and creating the National Pollutant Discharge Elimination System (NPDES) permit process. The Department of Ecology was delegated authority to administer NPDES permits in 1973.

Under the system to control point sources of pollution: (1) a permit is required for any point source discharge; (2) the permit establishes specific limits on the quantity and concentration of contaminants allowed to be discharged (or on the overall toxicity of the effluent), together with other requirements (for monitoring, spill prevention and others); (3) dischargers must monitor their effluent and report compliance with the conditions of the permit; and (4) the administering agency periodically inspects the facility and takes enforcement action as necessary. Effluent limits in permits must include minimum technology-based limits (generally based on criteria of best available technology from federal law or all known, available and reasonable methods of treatment from state law) plus more stringent limits where necessary to meet state water quality standards.

In 1986, the permit system for point source discharges was in place, but not working effectively because of weaknesses at many points in the regulatory system. The problems ranged from poorly trained permit writers to lack of enforcement and a need for improved regulations and guidelines.

As of 1994, many of the problems in the permit system have been addressed, with a few exceptions, such as a lack of felony provisions for serious, intentional violations. Ecology's activities have emphasized: (1) developing criteria, guidance and procedures necessary to set new standards and improve permits; (2) initiating more frequent sampling inspections for certain types of dischargers; (3) training permit writers; (4) implementing new permit-free laws that increase program resources; and (5) managing major and complex changes to the program.

The federal Clean Water Act (CWA) and Washington state law have established a strong institutional framework for controlling municipal and industrial discharges. Direct dischargers must obtain a NPDES permit from the Department of Ecology (Ecology) for nonfederal facilities or the EPA for federal facilities. Ecology also administers state permits for discharges to sewers (and related pretreatment requirements) and to the ground.

Protection against toxic releases is called for under Section 101 (a) (3) of the Clean Water Act, which states that, "it is the national policy that the discharge of toxic pollutants in toxic amounts shall be prohibited." The CWA and EPA

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(2) biocriteria which are consistent with EPA national guidance. Ecology shall submit draft biocriteria to the Authority for comment.

Target Date: Updates to be completed as appropriate for Ecology's triennial reviews.

P-2. Standards for Classifying Sediments Having Adverse Effects

Ecology shall develop and adopt, by regulation, standards for identifying and designating sediments that have acute or chronic adverse effects on biological resources or that pose a significant health risk to humans. The sediment standards will establish the levels of sediment contamination that are acceptable throughout the Sound over the long term. The standards may use physical, chemical and biological tests, and shall clearly identify pass and fail standards for the prescribed tests. Because methodologies to assess the human health risks of chemical contamination of sediments are not well developed, the initial standards may deal only with adverse effects on biological resources. The standards shall be revised to incorporate information on human health risks as it becomes available. Ongoing work by the EPA and the Puget Sound Dredged Disposal Analysis (PSDDA) to develop sediment quality values may be used as the technical basis for these standards.

Various technical and legal issues will be considered by Ecology during the development of these standards, including the selection of appropriate methods for measuring or predicting harm, the relationship of these standards to existing state and federal permit programs, and the possible need to allow sediment mixing (or impact) zones.

In developing these sediment standards, Ecology shall form an advisory committee which shall include representatives of environmental and public interest groups, ports, industry, appropriate state and federal agencies, and local and tribal governments.

The standards shall be reviewed and updated as necessary, at least every three years. If apparent effects threshold (AET) values are used as a basis for establishing the standards, the AET values shall be recomputed periodically to incorporate new data.

Ecology shall use these standards as the desired goal for sediment quality in implementing the Municipal and Industrial Discharges Program (see element P-7), the Stormwater and Combined Sewer Overflows Program (element SW-2), and the Nonpoint Source Pollution Program. These standards shall also be used as a basis to manage the disposal of dredged material (elements S-3 and S-4), and to identify locations with sediment contamination (elements S-7 and S-8). In implementing these programs, Ecology will consider other appropriate factors, including the availability and reasonableness of treatment and control methods. This consideration of other factors may prevent this goal from being achieved in the near term. In particular, municipal, industrial, and stormwater discharges, and combined sewer overflows (CSOs) may not be able to meet these standards initially without the application of sediment mixing (or impact) zones (elements P-3 and P-6).

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Sediments that exceed the sediment standards are undesirable in Puget Sound. When they are dredged, they may only be disposed of by meeting the requirements for use of PSDDA open-water disposal sites (element S-3) or the requirements for confined disposal to be developed under element S-4 (which may include in-water as well as upland disposal methods). Sediments that exceed the sediment standards shall not be used as cap material for dredged-material disposal or remedial actions.

Ecology may determine that it is not cost-effective to cap, treat or remove all sediments that exceed the standards developed under this element. Ecology may identify higher (more contaminated) levels that would result in cleanup actions or define cleanup levels (element S-7).

Target Date: Human health criteria for sediments shall be adopted by December 31, 1995. Implementation of the standards shall be ongoing.

P-3. Water Column and Sediment Mixing-Zone Criteria

[This element has been completed. Water column mixing-zone requirements have been adopted in Chapter 173-201A WAC and sediment impact-zone requirements have been adopted in Chapter 173-204 WAC.]

P-4. Discharger Fees

4.1. Revised Permit Fee Rule

Ecology shall evaluate the adequacy of funding for municipal and industrial permits, review the municipal fee cap, and make recommendations, if appropriate, to address any shortfalls. Ecology shall also consider the economic effect of fees on small dischargers and the economic effect of fees on public entities required to obtain permits for stormwater runoff and shall make appropriate adjustments.

4.2. Variable Permit Fee Study

[This subelement has been completed.]

4.3. Efficiency Report

Ecology shall continue efforts to improve efficiency and streamline the permit program while still ensuring a high degree of environmental protection.

4.4. Aquatic-Lands Leasing Rate

The Authority encourages the Department of Natural Resources (DNR) to review policies and laws for leasing aquatic lands as they relate to contamination of state-owned aquatic land. The purpose of the review is to determine whether changes in laws or policies might provide better proprietary management of historical and current particulate contamination and allow for proper compensation to the state for storage of that material on state-owned aquatic lands. In developing any changes to the leasing program, affected groups, including ports, municipal and industrial discharges, and stormwater dischargers, shall be consulted.

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Target Date: Subelement 4.3: Ecology submits efficiency reports per schedule set by Efficiency Commission. Subelement 4.4: Authority encourages the DNR to review the aquatic lands leasing program by December 31, 1994.

P-5. Permit Writers Manual, Permit Quality Control, and Internal Technical Assistance for Permit Writers

Several comprehensive policies must be implemented to ensure overall coordination and quality assurance of the permit program. In order to fulfill this objective, Ecology shall build upon existing efforts and establish a centralized mechanism which ensures: (1) development of consistent policies and communication of them to all permit writers in the Puget Sound basin; (2) implementation quality assurance reviews of permits prior to issuance; (3) coordination and resolution of cross-program issues; (4) acceptance of permit applications from dischargers only if they are fully complete; (5) equally stringent requirements for municipal and industrial permits to the extent practicable; and (6) implementation of pollution prevention through waste minimization.

5.1. Permit Writers Manual and Checklist

Ecology shall revise, as necessary, a procedures manual for permit writers (referred to as the permit writers manual). In preparing all NPDES permits in the Puget Sound basin, permit writers shall use the permit writers manual.

This manual shall include examples, guidelines and procedures to ensure that all pertinent information is made available and used by permit writers in determining appropriate effluent limits, particulate contamination limits (element P-7), measures to control pollution sources monitoring schemes, best professional judgment, fact sheets, and other conditions in NPDES and state permits. Such information may be derived from documents already available to the department (e.g., the applicant's most recent hazardous waste annual reports) or additional information that would be requested from the applicant (e.g., information on the overall distribution of contaminants between the dissolved and suspended phases of the effluent).

The permit writers manual shall require that all NPDES permits include appropriate conditions addressing all stormwater runoff from permitted facilities. Procedures for coordination of permits with the urban bay action plans (element P-13) shall also be included. The permits shall also address any significant issues raised in the fact sheet (subelement P-6.2).

The permit writers manual shall incorporate other requirements of the 1994 Plan related to permit writing, including water quality and sediment standards (elements P-1 and P-2); enhanced information in public notices and fact sheets pertaining to draft permits (element P-6); particulates and solids (element P-7); monitoring requirements, including provisions for tiering (element P-8); spill control (element P-9); explanation of changes in discharge limitations (element P-10); 401 certifications (element P-11); assuring inspection access, assuring that inspection results are provided to permit writers and that permit modifications are made if necessary (element P-14); pretreatment program enhancements (element P-22); and pollution prevention through waste minimization (element P-27). The permit writers manual shall encourage Ecology staff to make the best possible use of municipal and industrial expertise and resources in carrying out permit writing and appropriate related activities.

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The permit writers manual shall also include guidelines for permit writers to use in evaluating the potential for cross-media transfer of pollutants. These guidelines shall emphasize mechanisms available to permit writers to encourage waste reduction at the source rather than end-of-pipe treatment if such treatment results in cross-media transfer of pollution. Ecology is encouraged to develop such effluent guidelines and technical standards as may be necessary to assist in the efficient administration of the permit program.

Ecology shall provide opportunity for review and comment on the draft permit writers manual and any significant updates to it by an advisory committee made up of interested stakeholders.

A checklist shall accompany each public draft and final issued permit. The checklist shall document that all appropriate requirements of the Puget Sound Plan were met and procedures in the permit writers manual were followed during preparation of the permit.

5.2. Technical Assistance and Quality Control

Ecology shall establish an internal "technical assistance team" to assist permit writers in researching and writing appropriate conditions for NPDES and state permits. Ecology shall build upon initial efforts and develop a comprehensive permit quality control and internal, "technical assistance plan."

5.3. Inspector's Manual

Ecology shall periodically update, as necessary, the inspector's manual to ensure the most current EPA or other appropriate information is being used.

5.4. Permit Review

The Washington departments of Natural Resources, Health, and Fish and Wildlife, appropriate federal agencies, and tribal governments shall review and comment on selected NPDES permits with regard to protecting the respective resources for which they have responsibility. Ecology shall provide training for these departments upon request for the purpose of reviewing permits (element P-26).

5.5. NPDES Rule Revision

Ecology shall revise or adopt rules governing NPDES permits (WAC 173-220, WAC 173-205) to include the Plan's permit improvements as appropriate.

Target Dates: Subelement 5.1: Permit writers manual updated as necessary. Subelement 5.2: Complete and submit to the Authority for approval the comprehensive permit quality control and internal, technical assistance plan by June 30, 1995. Complete implementation by June 30, 1996. Subelement 5.4: Agencies and tribal governments initiate review of permits by December 31, 1995.

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P-6. Toxicant Effluent Limits in Permits

6.1. Discharge Limits

The objective of toxicant effluent limits in permits is to control the sources of toxicants in wastewater discharges through the use of all known, available and reasonable methods of treatment.[5] In issuing or reissuing NPDES or state waste discharge permits, Ecology permit writers shall follow the procedures set out in the permit writers manual developed under element P-5, and shall review the dischargers' operations and incorporate permit conditions which require all known, available and reasonable methods to control toxicants in the dischargers' waste water. Such conditions may include, but are not limited to, limits on the discharge of specific chemicals and/or limits on the overall toxicity of the effluent. Where possible, permit writers shall incorporate a combination of concentration and mass limits into permits. The toxicity of the effluent shall be determined by techniques such as chronic or acute bioassays. Such conditions shall be required regardless of the quality of receiving water and regardless of the minimum water quality standards. In no event shall the discharge of toxicants be allowed that would violate any water quality standard, including toxicant standards, sediment criteria and mixing zone criteria.

Wastewater discharge permits shall have quantitative discharge limits for all toxicants present in significant amounts.[6] At a minimum, discharge limits, including an appropriate mixing zone, shall be established for all toxicants which would exceed applicable ambient water-quality standards at the end-of-the-pipe (based on all known, available and reasonable methods of treatment, AKART). Similarly, discharge limits, including a mixing zone if appropriate, shall be established if monitoring results show that applicable ambient water-quality standards are exceeded at the end-of-the-pipe based on AKART.

Permit writers shall take into consideration, subject to Ecology policy, the background levels of pollutants in setting discharge limits. For stormwater runoff, Ecology shall determine appropriate discharge limits which are based on best management practices implemented to the maximum extent practicable and consistent with state and federal law.

6.2. Fact Sheets and Public Involvement

The objective of enhancing the fact sheets is to facilitate meaningful public review. In the fact sheet accompanying each draft major permit, Ecology shall clearly explain how the draft permit fulfills the goal of reducing and eventually eliminating harm from toxic contaminants in Puget Sound, including a summary of the information used to determine which limits on specific toxicants

5 Ecology has considered the following criteria, among others, in determining reasonable methods: (1) status of planning needed to proceed with the proposed method, (2) environmental or siting constraints, and (3) economic factors. The Pollution Control Hearings Board has upheld Ecology's use of these criteria and confirmed that water quality considerations are irrelevant to the selection of the technology to be imposed (see PCHB Nos. 84-178, 84-206, 84-211).

6 Significant amounts may be determined from the permit application or monitoring results, or may be expected from land-use types, pretreatment evaluations, best professional judgment, technical literature, and sediment, water quality or ambient environmental problems.

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and/or overall effluent toxicity should be included in the permit (also see element P-28, Reporting Requirements). It is the Authority's intent that the fact sheet information be as concise, consistently presented and efficiently prepared as possible, making use of computerized information and focusing on the issues addressed in this program. Fact sheets shall be written in language which can be understood by the general public.

Ecology shall ensure that the dischargers and the public have equal opportunity for access to and involvement in the permit decisions pertaining to discharge limits, mixing zones, monitoring schemes or other negotiable requirements of the permits.

The EPA shall provide a similar explanation for any draft major permit issued by the EPA.

Target Date: Subelements 6.1 and 6.2: Ongoing activity.

P-7. Particulate Contamination and Solids Handling

7.1. Particulate Contamination in Effluents

For purposes of addressing particulate contamination in NPDES permits, Ecology shall research and shall obtain and review information on particulate contamination in the applicants' effluents (looking at similar data for comparable effluents) and shall include specific conditions which address particulate contamination, appropriate to each case, sufficient to assure that the ambient sediment standards will not be violated, subject to any authorized sediment impact or mixing zones. Such conditions may include measures to control pollution sources, best management practices, numeric limits on toxicity of the particulate fraction of the effluent, numeric limits on the concentration or mass of specific chemicals discharged, or other conditions deemed appropriate by Ecology. Major permits shall be written with conditions that address particulate contamination consistent with the procedures contained in the chapter of the permit writers manual on sediments.

The EPA shall carry out this element with respect to every NPDES permit issued by the EPA in the Puget Sound basin (see also element P-11).

7.2. Solids Handling and Disposal

NPDES, pretreatment and federal facilities permits shall include solids handling and disposal plans which prevent pass-through of excessive solids. For municipal permits, these plans shall also address disposal of solids generated from cleaning out sanitary and combined sewer collection systems. Stormwater permits (including general or group permits) shall include solids handling and disposal plans for maintenance and cleaning.

Ecology shall evaluate the current disposal and utilization mechanisms, laws, policies and issues relating to municipal and industrial dischargers' sludge, including biosolids and solid by-products. For material to be managed as

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biosolids, Ecology shall develop guidelines for managing biosolids and shall promulgate a "biosolids management rule" that incorporates changes needed to implement federal standards for the use or disposal of sewage sludge. Ecology shall also prepare a report to ensure proper handling of other types of sludge. In preparing the report, Ecology shall involve local governments and other interested parties. The report shall address: (a) municipal sludge not managed as biosolids; (b) pretreatment sludges; (c) land disposal of contaminated sediments (element S-5); (d) vactor waste solids recovered when maintaining stormwater drainage (element SW-3); (e) changes needed to state statutes and rules; (f) coordination with NPDES, pretreatment and stormwater permitting programs; (g) technical assistance to landfill permitting authorities and NPDES and pretreatment permit writers; and (h) adequately overseeing and enforcing proper solid waste disposal and utilization.

Target Date: Subelement 7.1: This element shall be initiated by June 30, 1992 and shall be ongoing thereafter. Subelement 7.2: Complete biosolids management guidelines by March 31, 1995. Complete biosolids management rule adoption by March 31, 1995. Submit report to Authority by June 30, 1996. Continue phasing into permits and complete by June 30, 1999.

P-8. Monitoring Requirements in Permits

In issuing, modifying or reissuing NPDES permits (municipal, industrial and storm water), Ecology shall consider the need for each of the five types of monitoring listed below and shall include requirements in permits for all types of monitoring that are appropriate to each permittee. Monitoring requirements included in permits shall be tiered so that if initial (baseline) sampling discloses no problems, a reduced monitoring schedule may then apply. Likewise, if initial (baseline) sampling indicates the possibility of problems, a more frequent and/or more comprehensive monitoring schedule would apply. Initial monitoring schemes shall be set to ensure that enough data is collected to determine if additional discharge limits should be set.

Ecology shall develop (and revise as necessary) guidelines for the frequency and methodology of these tests and for reporting requirements and format. The guidelines shall include the tiered approach described above.

The guidelines shall focus the monitoring resources of dischargers on the mandatory monitoring of effluent and the receiving environment and leave most of the in-plant, process-control monitoring to the discretion of the discharger except in cases of significant non-compliance, as necessary to meet permit effluent limits. Ecology shall minimize the mandatory in-plant, process-control monitoring to only what is necessary to verify that the appropriate technology is being used and to characterize influents as appropriate.

The guidelines shall use the Puget Sound Estuary Program Protocols and Guidelines when available and data management systems compatible with the Puget Sound Ambient Monitoring Program. The guidelines shall also define triggers for determining when action is necessary to modify a permit. Ecology shall develop the guidelines in consultation with municipal and industrial dischargers, laboratories, the EPA, the Authority, and others as appropriate.

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In order to provide an opportunity for meaningful public review, monitoring requirements shall be fully described in the draft permit.

The fact sheet accompanying each draft major permit shall include a brief discussion of how the draft permit has dealt with each of the five types of monitoring specified below and shall explain those situations where any of these types of monitoring have not been required or otherwise addressed in the draft permit. Although these monitoring requirements shall be primarily directed toward the detection of effects from individual wastewater discharges, as a second priority, and to the extent practicable, Ecology shall develop monitoring requirements for permits that will facilitate the calculation of the total quantity of contaminants discharged to Puget Sound.

The five types of monitoring are as follows:

1. Monitor specified parameters in the sediment in the vicinity of every significant outfall.

2. Separately analyze samples of the particulate fraction of the effluent from each significant outfall.

3. Conduct periodic acute and chronic toxicity bioassays on a sample of the effluent from each outfall and on the sediment near each outfall.

4. Conduct periodic surveys of the population, species composition and health of biota in the vicinity of each significant outfall.

5. Monitor water quality at the boundary of the mixing zone. Mixing zone modeling may suffice, provided that appropriate field verification determined by Ecology is carried out.

All major municipal dischargers shall perform priority-pollutant scan analyses on their effluent at least annually and more frequently if appropriate. The permit writer may exclude groups of chemicals (e.g., pesticides) from the priority-pollutant scan requirements of dischargers with a capacity less than five million gallons per day, if there is recent monitoring data or literature documenting that the particular group of chemicals is not of concern for that discharge.

If, for a given test, Ecology finds that there is no analytical protocol reasonably available, or if there is no public or private laboratory capable of carrying out the test, Ecology may suspend the testing requirement for that test until such time as such a protocol and/or laboratory capability becomes available. Ecology shall promote the development of protocols and laboratory capability in cases where these are not available for the types of monitoring tests listed earlier (see also elements L-1 and L-2). If a discharger believes there is no protocol reasonably available, they may request a review of it by Ecology. Ecology shall then report the results of the review to the Authority.

Ecology, in cooperation with the EPA, shall prepare a list of the highest priority permits (based on the probability of effluent containing a significant

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quantity of toxic pollutants of concern) to be reopened prior to expiration for inclusion of these monitoring requirements. Ecology shall submit this list to the Authority with a schedule for completion of permit modifications to include these requirements.

Every major and minor permit issued or reissued by Ecology before the monitoring guidelines are implemented shall include a "reopener provision" allowing modification of the permit to incorporate monitoring requirements in accordance with this element. Every permit issued or reissued by Ecology shall include a reopener clause allowing Ecology to modify, based on monitoring results or other causes consistent with state and federal regulations, the effluent limitations, monitoring requirements or other conditions in the permit. the EPA shall include similar reopener provisions in every NPDES permit issued by the EPA in the Puget Sound basin.

Target Dates: Include reopener language in all permits issued or reissued after March 31, 1987. Continue to include appropriate monitoring requirements in permits issued or reissued after December 31, 1988. Submit a list of high-priority permits and a schedule for completing modifications by June 30, 1995. Review the monitoring guidelines and update annually as necessary.

P-9. Spill Control Plans Required

Every major permit issued or reissued, and minor permits as appropriate, shall include conditions requiring the development or updating of spill control plans. At a minimum, such plans shall apply to both oil and hazardous substances. Ecology, in consultation with the EPA, shall actively review and comment on the plans and shall require the permittee to implement the approved plan. Spill plans shall include the provisions of WAC 173-303-630 regarding secondary containment.

Consistent with other state and federal requirements, Ecology shall: (1) track and improve requirements in dischargers' spill control plans; (2) follow up on and improve upon dischargers' compliance with spill control plans; and (3) ensure adequate staff to perform on-site compliance inspections for spill control plans and to update spill control plans in permits as appropriate.

Ecology shall take enforcement action, consistent with its enforcement guidelines, against any permittee found out of compliance with its spill control plan (refer to the Spill Prevention and Response Program).

Target Date: Ecology shall incorporate improved spill control plan requirements into new and revised permits on an ongoing basis.

P-10. Explanation of Relaxed and Increased Limits in Permits

For any draft permit whose effluent limitations are in any way less stringent than those in the preceding permit, Ecology shall include a conspicuous notice and clear explanation of the reasons for such limits in the public notice of the draft permit. This requirement shall apply to all effluent limitations that are, or appear to be, a relaxation of limits in comparison to the previous permit. This requirement for notice and written explanation shall also apply to any draft permit proposing to allow a greater amount of effluent to be discharged

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due to increases in production. In every such explanation, Ecology shall report on measures available to and undertaken by the discharger to reduce the production of pollutants per unit of product. Ecology shall adopt a formal policy implementing this program element. (See also element P-28)

Target Dates: The notification and explanation process are ongoing activities.

P-11. Enhanced Requirements for EPA-Issued Permits and Ecology Certifications

11.1. EPA-Issued Permits

The conditions in EPA-issued permits in the Puget Sound region shall be at least as stringent as those required under this Plan in permits issued by Ecology. This applies to all toxicant and particulate limits, and to monitoring, spill control, frequency of inspection and public notice requirements. The EPA shall also review existing EPA-issued permits and modify any permit as necessary to include such limits and requirements.

11.2. Ecology Certifications

Ecology shall not issue an NPDES permit or certify the issuance or renewal of any NPDES permit for a federal facility under Section 401 of the Clean Water Act, unless the permit includes numeric limits and other conditions required to comply with all applicable water quality and sediment standards and other elements of this Plan. Before considering a permit or 401 certification for a federal-facility permit, Ecology shall seek to be familiar with the facility site, through site visits, inspections or other means.

Target Date: This element shall be applied to Ecology 401 certifications in a phased manner, beginning April 30, 1988. All appropriate guidance from the permit writers manual (element P-5), monitoring guidelines (element P-8), and sediment standards (element P-2) shall be used as those products are completed.

P-12. Reevaluate Allocation of Permits into Major and Minor Categories

The EPA shall give special consideration to early completion of its re-evaluation of the major and minor permit classification for permits in the Puget Sound basin. Ecology shall communicate to the EPA any discrepancies it is aware of in the classification of permits in the Puget Sound basin. As soon as is feasible, Ecology shall use its discretionary authority to reclassify, where appropriate, minor dischargers to majors and upgrade their permits, along with EPA-reclassified majors.

Target Date: Complete upgrading of reclassified major permits by June 30, 1996.

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Compliance Assurance

P-13. Urban Bay Action Teams (UBATs)

The Authority recognizes the urban bay approach as an essential part of a comprehensive strategy to control sources of toxic pollution and requests the EPA to continue providing resources for the urban bay programs. Additional support for the sediment-related tasks of the urban bay action teams is contained in the Contaminated Sediments and Dredging Program (element S-8).

For each area where an urban bay program is undertaken, an urban bay action plan shall be prepared that describes conditions and problems in the study area and contains an integrated program of actions to be undertaken by federal and state agencies, local and tribal governments, and dischargers to solve problems (see also subelement S-8.4). Federal and state agencies and local and tribal governments shall implement their portion of the adopted UBAT plans. Each urban bay action plan shall be reviewed by the Puget Sound Estuary Program (PSEP) Management Committee, and following such review, the plan shall be transmitted to the Authority. Ecology shall report on the progress of the UBAT programs in the written and verbal reports required in element P-28.

Ecology shall track progress toward implementation of each UBAT program. For those UBAT programs for which Ecology is the lead agency, Ecology shall ensure coordination and consistent implementation among the programs. UBAT coordination shall include an evaluation and resolution of barriers to the success of the UBATs.

Target Dates: Submit each urban bay action plan to the PSEP Management Committee when completed.

P-14. Inspections

Ecology shall conduct a significant number of Class I inspections[7] on an unannounced basis. Similarly, a significant number of Class II inspections shall include an unannounced sampling visit. Ecology shall assure that appropriate permits include such conditions as may be necessary to provide a prearranged means for Ecology inspectors to obtain unannounced samples of effluent on a 24-hour basis.

Ecology shall conduct inspections in accordance with the following minimum schedule:

Type of permit	Number of inspections per year per permit	
	Class I	Class II
Major	2	1
Significant minor	1	0.5
State and minor NPDES	1	0.1

7 Class I inspections are walk-through inspections, including a visual inspection of the facility and some examination of records (self-monitoring reports, procedures manuals, operation and maintenance records, etc.). Class II inspections include all of the Class I activities plus effluent and some sediment sampling and analyses to determine compliance with the permit.

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Additional inspections (both announced and unannounced) shall be conducted based on the permittee's record of compliance. Ecology is encouraged to frequently perform quick surprise walk-through visits where a grab sample of the effluent is taken and obvious permit violations are addressed on the spot. Ecology inspectors shall ensure that they notify dischargers prior to leaving the facility of any obvious permit violations and any immediate corrective actions required. Ecology shall also ensure that copies of the results of the inspections reports (including lab data, see element P-16) are sent to permit writers and the dischargers within 90 days of the inspection date for Class I inspections and within 120 days for Class II inspections. Ecology shall ensure that discharge permits are modified as necessary to incorporate appropriate monitoring requirements, effluent limits or other conditions to correct problems identified through inspections.

In conjunction with reporting requirements under element P-28, Ecology shall submit a report to the Authority on the number and types of inspections (including unannounced inspections) undertaken. The report shall also describe a system for tracking inspection information, including the number and types of inspections (including unannounced inspections), inspection results, the number and types of violations discovered, actions initiated in response to violations, lab data and inspection report turnaround times, and occasions on which an authorized inspector was denied access to a facility.

Target Date: Ecology to meet the inspection schedule when full funding becomes available.

P-15. Study of Independent Verification of Self-Monitoring

Ecology shall submit an assessment report to the Authority on the adequacy of self-monitoring by dischargers based on review and comparison of monitoring data reported by dischargers and similar data obtained from effluent samples collected during Class II inspections of major dischargers. The report shall conclude whether or not there are major discrepancies in self-monitoring data.

If major discrepancies are found, Ecology shall submit to the Authority the results of a study evaluating alternative methods of carrying out independent verification of self-monitoring reports submitted by dischargers, together with Ecology's proposed plan, schedule and estimated costs for implementing a verification program. Possible methods to be evaluated may include combining the independent verification function with the quality assurance and quality control procedures specified under the laboratory certification program (see elements L-1 and P-16).

The study should also examine the possibility of arranging for an independent organization to conduct some or all of the monitoring activities (especially those involving sampling outside the effluent pipes—e.g., monitoring types 1, 4 and 5 listed under element P-8) for some dischargers in lieu of the individual dischargers performing this monitoring themselves, to be funded by a surcharge on the NPDES permit fee paid by these dischargers. The study shall estimate the amount of the fee surcharge that would be necessary to support this alternative and whether the overall cost to dischargers would be reduced. The study shall also address whether the quality of information derived under

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such an alternative would be improved. This study shall not be construed as authorizing any delay in the implementation of the monitoring requirements described in this element.

Target Date: Submit assessment report by December 31, 1995; if applicable, submit alternatives study by June 30, 1996.

P-16. Lab Support and Certified Labs for Self-Monitoring

Ecology shall ensure that its own laboratory adheres to the Quality Assurance Management Plan described in element L-4.1 and provides timely turnaround of samples to inspectors on all compliance samples associated with the discharge permit program, as specified in the laboratory capacity plan (element L-2).

Ecology shall adopt regulations requiring all permittees to use a certified laboratory for their compliance and self-monitoring wastewater analyses and requiring all certified laboratories to use specified protocols and comply with specified quality assurance and quality control (QA/QC) procedures (see Laboratory Support Program). Before implementing this requirement of permittees, Ecology shall ensure that the laboratory certification program is operational (element L-1) and that a sufficient number of certified labs are available to carry out needed analyses. Labs owned and operated by individual industrial and/or municipal dischargers shall be eligible for certification. Ecology shall report to the Authority (element P-28) and the Lab QA/QC Working Group (subelement L-4.2) on the progress in meeting the lab support goals associated with the permit program.

Target Dates: Dischargers to use labs participating in the accreditation program in accordance with Chapter 173-50 WAC.

P-17. Data Management

Ecology shall evaluate its data management needs to implement the Puget Sound Plan's Municipal and Industrial Discharges Program and its current data management system and submit to the Authority a plan to upgrade the system as appropriate.

Ecology shall complete the initial loading of data related to state (pretreatment) and minor NPDES permits and begin incorporating routine self-monitoring data for these permits into the Wastewater Permit Life Cycle System (WPLCS). Ecology shall ensure that the WPLCS system incorporates results of Class I and Class II inspections.

Ecology shall store monitoring data of the five types outlined in element P-8 submitted by dischargers in a manner compatible with information in the Puget Sound Ambient Monitoring Program (element M-6). In addition, Ecology shall maintain accurate records of outfall locations (and other useful information pertaining to mapping the effluent effects of discharges as additional funds become available) in the WPLCS as appropriate, and provide this information to the Puget Sound Geographic Information System (GIS) (element M-4).

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This data management program shall include features which simplify public access to permit tracking and discharge information.

Target Dates: Continue to load as much data as is possible with the current system and resources.

Enforcement

P-18. Adopt Enforcement Policies as Regulations; Report on Enforcement; Encourage Compliance

The objective of this element is to develop a more effective enforcement program which is consistently, efficiently and fairly applied to the regulated community for the purposes of protecting the water and sediment quality of Puget Sound.

Ecology shall provide a regular program of enforcement training for agency staff involved in enforcement actions.

Ecology shall continue to prepare and submit to the Authority quarterly lists of all water-quality related civil and criminal enforcement actions taken, together with statistics on the percentage of Ecology enforcement actions that were appealed and the dollar amounts of penalties assessed versus those sustained. Where possible, Ecology may include statistics on cases in which the Pollution Control Hearings Board has considered the post-penalty behavior of a violator in determining the amount of penalty to be sustained. In order to examine the relationship between penalties and compliance, Ecology shall establish a settlement reporting system. Ecology shall use the reporting system to better evaluate settlements throughout the agency, to assure that settlements are negotiated consistently, and to track settlement compliance. Ecology shall also develop comprehensive settlement guidelines to help staff make informed decisions and promote consistency agency-wide. Guideline topics shall include: (a) differences between simple and innovative settlements; (b) what types of proposed activities are appropriate for innovative settlements; (c) procedures for completing settlement agreements; and (d) Ecology and Attorney General Office roles in the settlement process.

The Pollution Control Hearings Board is encouraged to process appeals cases related to water quality permit issues within six months through the use of sufficient staff resources such as administrative law judges.

Target Date: Enforcement training and reporting shall be ongoing.

P-19. Training for Inspectors and Permit Writers

In addition to the technical assistance provided under element P-5.2, Ecology shall establish an ongoing, vigorous program of training for inspectors and permit writers, including cross-training in other environmental regulatory programs, recognition of problems related to cross-media transfer of pollution, and opportunities to reduce or recycle waste at the source. Ecology shall assure that an appropriate percentage of inspectors' and permit writers' time is allocated to training activities. Ecology shall provide specialized training sessions on checklist items of the permit writers manual, setting discharge

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limits for toxicants, setting sediment standards, biomonitoring, pretreatment, conducting inspections, taking samples, data management, enforcement procedures, and waste minimization. Ecology shall establish minimum training requirements for permit writers, inspectors and staff involved in enforcement and ensure that all staff complete these requirements before assuming their duties. Ecology shall take advantage of existing training programs, such as those offered by the EPA, to the maximum extent practicable.

Target Date: This program is ongoing.

P-20. Search for Unpermitted or Illegal Discharges

In coordination with the urban bay action teams, Ecology shall carry out a program for detecting illegal dischargers or wastewater discharges not covered by permits. This shall apply to both direct and indirect wastewater discharges and to direct discharges of storm water from industrial facilities. Ecology shall ensure that its enforcement guidelines incorporate appropriate automatic penalty provisions for instances when dischargers without permits are discovered. Ecology shall submit a report to the Authority on the number and characteristics of unpermitted discharges discovered though this element and through the urban bay action teams, together with any analysis and recommendations that the department may have.

Target Date: Ecology to submit report by June 30, 1996.

P-21. Felony Provisions

The Authority shall submit proposed legislation to the Legislature to amend appropriate sections of the state Water Pollution Control Act (RCW 90.48) to provide for felony penalty provisions. The proposed legislation shall ensure that accidental or emergency bypasses are not subject to the felony penalty, but rather shall target willful violators with demonstrated knowledge and intent to commit the violation.

Target Date: Resubmit to 1993 or subsequent Legislature.

Pretreatment

P-22. Pretreatment Program Enhancements

Ecology shall assign sufficient staff to fully carry out the pretreatment program, including permitting (with appropriate conditions for monitoring and control of toxicants in accordance with elements P-5 through P-8), compliance tracking, inspections, spill control, public notice, auditing of local programs, and enforcement as needed. Ecology is encouraged to develop such effluent guidelines and technical standards as may be necessary to assist in the efficient administration of state and local pretreatment programs.

With the involvement of local governments; delegated and non-delegated agencies that manage municipal sewage systems which accept pre treated industrial waste water; federal and other state agencies; tribal governments; and

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interested citizens, Ecology shall coordinate and implement the pretreatment program and address the following issues:

1. Ensuring program consistency across jurisdictions in order to eliminate the creation of pollution-tolerant zones for indirect dischargers.

2. Ensuring the adequacy of staffing and funding resources.

3. Coordinating with the pretreatment, sludge-disposal program developed as part of element P-7.

4. Setting minimum pretreatment program requirements for municipal NPDES and pretreatment permits and establishing a quality review mechanism to ensure that those requirements are being included in permits.

5. Developing mechanisms to ensure that local governments (via comprehensive plans, etc.) identify new indirect dischargers resulting from regional growth and conversion of rural land use to urban uses including coordination with the state Growth Management Act, and evaluating the cost impacts and enforcement issues for municipalities.

6. Developing computerized tools for tracking and managing program data to effectively track compliance with minimum pretreatment program requirements.

7. Consulting with Ecology staff, the regulated community, the public, and other state and federal agencies as appropriate to identify and resolve any other barriers to success.

8. Submitting to the Authority for approval recommendations and an implementation schedule for further pretreatment program enhancements.

Ecology shall report to the Authority twice a year on the status of the pretreatment program and the progress in implementing the enhancements.

Target Dates: Complete program enhancements by June 30, 1996.

P-23. Municipal Operator Training

The Waterworks and Wastewater Certification Board shall ensure that each wastewater treatment plant operator-certification examination covers basic issues and facts about industrial discharges, pretreatment laws and regulations, treatment technologies, maintenance and troubleshooting, and recognition of pretreatment-related problems. The Board shall consult with the Authority and affected groups of wastewater treatment plant operators in drafting any additional test questions related to these topics. The Board shall also assist the Department of Ecology in the preparation of handouts identifying up-to-date pretreatment rules, regulations, and technology. Such handouts shall be mailed to all certified operators at least annually. The Board shall encourage certified operators to attend pretreatment workshops, conferences and courses for credit toward the mandatory professional growth requirement.

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The Board is encouraged to review its testing and certification methodology to reflect the level of responsibility of the operator for pretreatment programs.

Target Date: Annual mailings are ongoing.

P-24. Certify Industrial Treatment Plant Operators

In conjunction with its technical outreach to dischargers under element P-27, Ecology shall explore and facilitate the development of a voluntary process for certifying operators of both direct and indirect discharger industrial treatment plants through a private trade or professional association or other appropriate entity. Certification shall initially be voluntary and evolve into a mandatory process. In exploring this approach, Ecology shall consult with industrial dischargers and treatment plant operators, private trade and/or professional organizations, appropriate labor unions, the Authority, and other interested individuals and groups in Washington and other states.

Target date: Phase in implementation of voluntary program by June 30, 1996. Phase in mandatory program by June 30, 1997.

P-25. Employee Education Assistance

(See also subelement EPI-5.1.) In connection with the current employee education programs required under the state Worker Right-to-Know law (Chapter 49.70 RCW), the departments of Ecology and Labor and Industries shall prepare and implement a coordinated plan for developing and distributing educational materials for employees to appropriate employers in the Puget Sound basin. This plan shall establish a schedule for distribution of such materials to these employers and shall establish a schedule for any necessary rule making by the departments of Ecology or Labor and Industries. Educational materials to be prepared shall provide information on the environmental consequences of waste disposal decisions typically made by employees of the firms and/or agencies included in the program.

Target Dates: Begin implementation by December 31, 1995.

Public Involvement

P-26. Public Outreach

Ecology shall establish a public outreach position to act as a central clearinghouse for the public to contact regarding permits, and to actively contact and assist groups and individuals regarding the NPDES and state waste-discharge permit program and related activities. For each permit or action under consideration, this person shall seek out those who may be interested or affected, inform them of the significance of the action, highlight key decision-making points, and provide technical assistance in working through the process. The public outreach person shall take an active role in reviewing permit fact sheets for completeness and understandability by the public and publicizing which permits are open for public comment. This position shall also assist citizens and environmental groups, as well as federal and state agencies and local tribal governments upon their request (Washington departments of Natural Resources, Fish and Wildlife, and Health, State Parks, etc.) in reviewing NPDES

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permits (subelement P-5.4), and shall ensure that they get copies of draft permits for dischargers that may affect their jurisdiction or areas of interest.

Ecology shall also expand its permit mailing lists to achieve broad circulation, regularly provide program information in general publications (e.g., newsletters, brochures), provide informative and widespread public notice of draft permits, and establish criteria for deciding when a public hearing will be held on a permit. Public information efforts shall include dissemination of both positive and negative information, as it is available, on pollution compliance by permittees. In establishing criteria, adopting guidelines and developing rules, Ecology shall actively seek and provide opportunity for meaningful public involvement in accord with the public involvement policy (element EPI-3) of this plan.

Target Date: Centralized outreach mechanisms for permits shall be ongoing. Establish criteria for deciding when a public hearing will be held for a permit by June 30, 1995.

P-27. Technical Outreach to Dischargers, and Prevention, Reduction and Minimization Strategies

(This element constitutes a part of subelement EPI-5.1. The target audience is municipal and industrial dischargers.)

Ecology shall develop (or contract with an appropriate organization to develop), and submit to the Authority for approval, a program plan to provide technical outreach to dischargers on the new permit improvements required by the permit writers manual, with which they are expected to comply, including the requirements of pollution prevention, reduction and minimization and other Ecology programs. Ecology shall establish a regular discharger newsletter to inform all dischargers of the upcoming changes in permitting requirements and the reasons for them, along with other useful information such as pollution prevention, reduction and minimization strategies. To the maximum extent possible, Ecology shall consolidate information related to controlling water pollution with other environmental requirements to provide useful, timely, coordinated and accessible information and one-stop answers regarding multiple environmental programs. For maximum efficiency, the program shall emphasize delivery of information through existing mechanisms such as trade and professional organizations rather than to individual dischargers. In developing the program, Ecology shall consult with staff who operate similar functions in other states. Ecology shall coordinate this program with the business assistance (pollution prevention pays) program and other Ecology programs as appropriate that provide information to businesses.

In coordination with Ecology's Office of Waste Reduction and Recycling and Point Source Section, the Authority shall initiate the development of a Technology Institute at the University of Washington or other appropriate state universities (pursuant to RCW 28B.20.420 and 422). The institute shall identify, develop and promote the latest pollution control technologies (emphasizing field-tested, cost-effective waste recycling, reduction and minimization strategies, as well as treatment technologies or combinations thereof) for the applied purpose of determining all known and available technology for use in the regulatory process for direct and indirect dischargers. The Authority shall

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coordinate efforts to disseminate the results of the technology institute's work. In conjunction with Ecology, the Authority shall investigate appropriate mechanisms for long-term funding of the institute including the State General Fund, taxes or permit fees. The Authority shall also research funding mechanisms to assist businesses with implementation of strategies for controlling pollution.

Experience gained in providing consolidated information to dischargers shall be transmitted to agency staff responsible for program development to ensure that environmental programs are consistent with each other.

Target Date: Authority to initiate the Technology Institute by September 30, 1997.

P-28. Ecology Reporting Requirements

In addition to the biennial reporting requirement under RCW 90.70.070, Ecology shall publish a report annually on the NPDES and state permits in the Puget Sound basin that it has considered for issuance, renewal or modification.

In the report, Ecology shall briefly summarize for the previous 12 months the following items and compare them to goals and historical trends when such data are available:

a. Permit quantity: The number of permits issued (major, minor, state, 401 certifications); the number of backlog expired permits; comparison to state/EPA agreement; the amount of permit fees collected.

b. Permit quality: The number and percent of issued permits which fully met the minimum checklist requirements (subelement P-5.1 and element P-22).

c. Inspections performance: The number and types of inspections (element P-14); the average and maximum turnaround times for inspection reports to dischargers and permit writers, and for compliance-sample lab data (element P-16).

d. Compliance and enforcement trends: Rates for significant noncompliance among direct and indirect dischargers, and enforcement actions and trends.

e. High-priority elements: Major accomplishments toward implementing elements P-1 through P-4.1 (rules), P-4.3 (efficiency improvements), P-5.2 (quality assurance), P-9 (spill plans), P-13 (UBATs), P-16 (lab support), P-17 (data management), P-19 (training), P-22 (pretreatment), P-26 (public outreach, and P-27 (discharger outreach).

Ecology is encouraged to include other information that may be useful, to present the information in tabular, comparative or other form that facilitates review and analyses, to comment on its experience in implementing these elements, and to provide appropriate recommendations.

Target Date: Submit report by June 30, 1991, and annually thereafter.

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P-29. Alternatives for Reducing Effects of Sanitary Discharge to Marine Waters

Ecology shall adopt a policy promoting alternatives in the treatment and disposal methods practiced for sewage treatment plant discharges to marine water whenever such alternatives are feasible, economically achievable and environmentally preferable (for example, when discharge and/or disposal of effluent from sewage treatment plants could result in shellfish bed closures due to potential pollution.) Alternatives to be considered shall include, but not necessarily be limited to, the following: land application, reuse, additional treatment and the use of constructed wetlands. The policy shall be used in state financial-assistance programs for sanitary treatment projects.

Target Date: Ecology to adopt the policy by June 30, 1995.

MAJOR PUBLIC ACTIONS FOR AUTHORITY REVIEW

1. Revision to water quality standards rule (element P-1).
2. Adoption of sediment standards rule (element P-2).
3. Revisions to the permit writers manual and permit quality-control plan. (element P-5).
4. Revisions to monitoring guidelines (element P-8).
5. Employee education program (element P-25).
6. Report on waste discharge permits (element P-28).

LEGISLATION REQUIRED

1. Ecology to consider making recommendations to the Legislature for removing the municipal permit-fee cap (subelement P-4.1).
2. The DNR encouraged to recommend legislation that would modify leasing rates for aquatic lands.
3. Ecology to consider recommending legislation to revise revisions to solid waste and hazardous waste statutes (element P-7).
4. Authority to resubmit felony provisions (element P-21) in 1993 or subsequent legislative sessions.

ESTIMATED COST

Fully implementing the Municipal and Industrial Discharges Program is estimated to cost $12.6 million during the 1995-97 Biennium and $12.5 million during the 1997-99 Biennium. Approximately two-thirds of these costs would be eligible for the permit fee account. Activities that are not fee-eligible as defined in RCW 90.48.465, as well as any fee-eligible activities that exceed the fee revenues collected, would be funded from other sources such as the State General Fund. The elements with the largest costs include strengthening effluent limits and monitoring requirements in permits (elements P-6 through P-10), increased staffing for the urban bay action program (element P-13),

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inspections (element P-14), pretreatment (element P-22), and adopting and implementing enforcement policies (element P-18).

The cost estimates for this program do not include private sector costs for complying with the more stringent monitoring requirements, permit limits, and other elements of the Plan. Most dischargers would incur increased costs for the additional monitoring required under element P-8. Some dischargers would also have new or more stringent limits imposed on the discharge of specific toxicants (in the dissolved or particulate phase) or on the overall toxicity of the effluent. The cost of meeting more stringent limits would depend not only on the specific limits that are chosen by Ecology, but also on the particular circumstances of the plant involved.

Other elements of the program may also affect costs to dischargers. Permit fees under this program have increased substantially. Many financial incentives are included which would significantly increase costs for polluters and decrease costs for those in compliance. Laboratory costs will increase due to the requirement to use certified labs. Operators of industrial treatment plants would incur some cost in complying with certification requirements to be established and in paying certification costs. Some dischargers would incur costs as a result of enforcement action taken when violations are detected through increased inspections and compliance review efforts by Ecology. Finally, dischargers would incur some increased costs to comply with requirements for controlling spills and stormwater at plant sites.

A new element has been added to the 1994 Plan—element P-29, Alternatives for Reducing Effects of Sanitary Discharge to Marine Waters. It requires Ecology to develop a policy for alternatives to sanitary discharges to marine waters, such as land disposal and wastewater reuse. It is intended to help communities select the optimal choice for wastewater treatment effluent.

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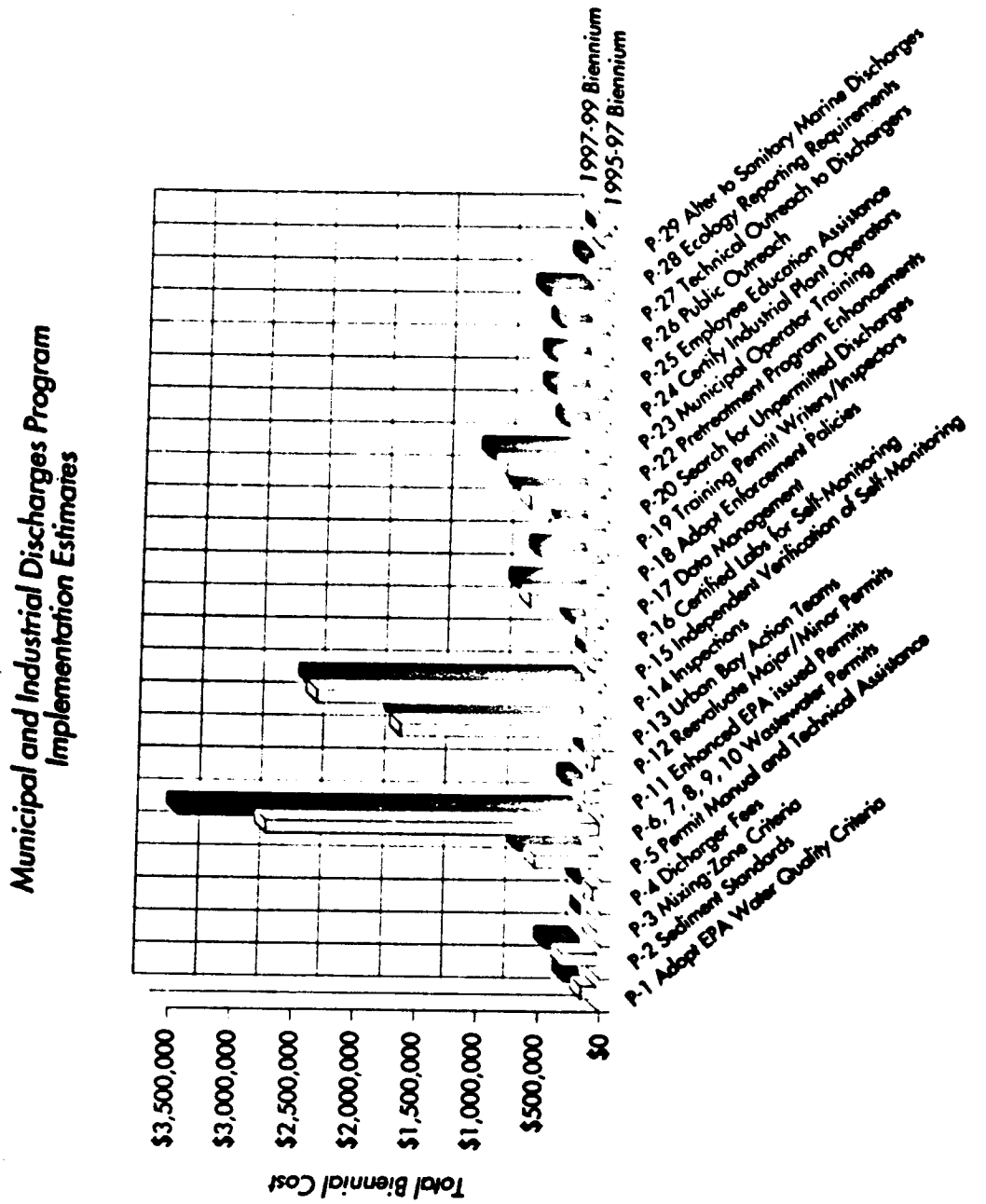

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CONTAMINATED SEDIMENTS AND DREDGING PROGRAM

PROGRAM ELEMENT DIRECTORY

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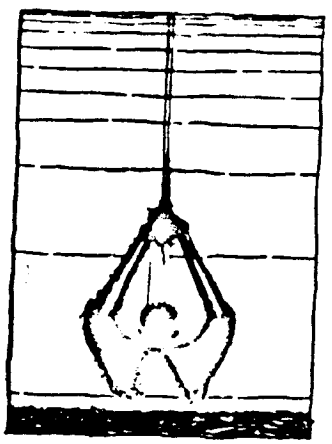
PROBLEM DEFINITION



Toxic contaminants bind to particles and are retained as sediments. Toxic compounds are found in a wide range of concentrations in recently deposited surface sediments around Puget Sound. Although contaminant levels in some surface sediments have started to decrease since pollution controls were established in the last few decades, contamination levels in the deep central Puget Sound basin are still significantly higher than estimated pre-industrial levels. In urban areas, present levels of contamination are much higher—up to 100 times the levels in the cleanest rural bays. As a result, accumulation of toxicants in sediments and the resulting damage to natural populations are recognized as serious threats to marine and estuarine ecosystems.

The Department of Ecology (Ecology) compared chemical concentrations in sediments at 1,054 Puget Sound stations with chemical criteria in the Interim Sediment Quality Evaluation Process for Puget Sound Sediments[1]. According to the report, more than 400 stations contained contaminants exceeding the sediment quality criteria[2]. Forty-eight different chemicals exceeded the allowable levels of chemical substances at one or more stations.

Sediment samples collected in recent years from many locations in Puget Sound, such as Bellingham Bay, Commencement Bay, Port Gardner Bay, Elliott Bay and Eagle Harbor, were very toxic to bioassay organisms. These samples were usually collected from the top two centimeters of sediment—the material that had accumulated within the past one to five years—indicating recent or ongoing sources of contamination.

The benthic (bottom-dwelling) populations at many locations are also considered damaged (significantly altered in composition or seriously reduced in total abundance) by sediment pollution.

Toxicants reach the water from many sources, but principally from unpermitted discharges, stormwater runoff, raw sewage discharges (e.g., combined sewer overflows), and permitted point source discharges (industrial and municipal

1 Issued December 1989.

2 The sampling stations are concentrated in urban bays and are not representative of the overall distribution of contaminants in Puget Sound.

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outfalls). Air pollution appears to be a large contributor of toxicants to Puget Sound. Some of the airborne contaminants enter the water directly; others are washed off the land by runoff. In addition, dredging and disposal can disturb and redistribute materials.

INSTITUTIONAL FRAMEWORK

Dredging and the disposal of dredged material are regulated through state and federal permit systems. The U.S. Army Corps of Engineers regulates dredging, filling and construction in U.S. waters under Section 404 of the federal Clean Water Act and Section 10 of the Rivers and Harbors Act. The U.S. Environmental Protection Agency's (EPA) Region 10 office, the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA) review permits issued by the Army Corps of Engineers. Ecology administers the state's Shoreline Master Program, regulating coastal development. The Department of Natural Resources (DNR) is the state's trustee for submerged and intertidal lands. The federal Fish and Wildlife Coordination Act and the National Environmental Policy Act require agency coordination and environmental review of proposed activities.

Sediment contamination is generally regulated by programs aimed at protecting water quality. But because toxicants tend to concentrate in sediments rather than the water column, harmful sediment contamination can occur even when the water is not seriously contaminated. Prior to adopting the 1987 Puget Sound Water Quality Management Plan (Plan), regulatory programs lacked clearly stated goals or policies for preventing sediment contamination.

Sediment standards were developed under the Plan's Municipal and Industrial Discharges Program in order to regulate discharges, manage dredging and the disposal of dredged material and identify and rank contaminated sediment sites for cleanup. Contaminated sediment particles suspended in effluent also need to be addressed through sediment standards.

Dredged material with low levels of contamination may be disposed of at open-water sites, while material with higher levels must be disposed of at confined-disposal sites. The Puget Sound Dredged Disposal Analysis (PSDDA), a cooperative effort by the Army Corps of Engineers, the EPA, Ecology and the DNR, has developed evaluation procedures and established new sites for unconfined open-water disposal. However, disposing of sediments that are too contaminated for unconfined open-water sites is still being evaluated on a case-by-case basis without uniform standards. Additional work is needed to establish multi-user disposal sites for sediments containing more contaminants.

Areas identified as having serious sediment contamination are being addressed through the EPA-Ecology Urban Bay Action Program and Superfund investigations. The NOAA has notified a number of dischargers and property owners around Puget Sound that they may be held liable for natural resource damages associated with sediment contamination. Although it is now possible to inventory areas with contaminated sediments, funding remains a problem.

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AUTHORITY'S APPROACH

The 1987 Plan introduced a comprehensive, sediment-quality program that included sediment-quality goals and criteria, directions for contaminant source controls, dredging and disposal goals, steps for developing of a requirement to conduct dredged-material disposal standards, a feasibility study of multi-user disposal sites for sediments, and an expanded urban bay program that included guidelines to identify and respond to sites with high levels of sediment contamination. The program was designed to be implemented in concert with elements of the Municipal and Industrial Discharges Program and the Stormwater and Combined Sewer Overflows Program.

Revisions to this Plan program in 1989 and 1991 were few; only a public involvement, education and technical assistance element was added. The majority of the Authority's effort so far has focused on implementation.

PROGRAM GOAL

To reduce and ultimately eliminate adverse effects on biological resources and humans from sediment contamination throughout the Sound by reducing or eliminating discharges of toxic contaminants and by capping, treating or removing contaminated sediments.

STRATEGY

The strategy for achieving this goal is to: (1) classify sediments that cause adverse biological effects and significant human health risks; (2) implement Soundwide controls on sources of contaminants causing sediments to fail the sediment standards; (3) provide rules and sites for disposal of dredged materials; and (4) expand the urban bay program to provide for additional source control and consideration of cleanup actions for existing areas of high sediment contamination levels.[3]

PROGRAM ELEMENTS

S-1. Sediment Program Policies

The following policies shall be followed by all state and local agencies in actions affecting sediment quality, including rule making, setting priorities for funding and actions, and developing permit programs:

a. All government actions will lead toward eliminating the presence of sediments in the Puget Sound basin that cause adverse effects to biological resources or pose a significant health risk to humans.

b. Programs for managing the dredging and disposal of sediments should result in a net reduction in the exposure of organisms to adverse effects.[4]

3 The first two elements of this strategy—classification of contaminated sediments and source controls—are included in the Municipal & Industrial Discharges Program and the Stormwater & Combined Sewer Overflows Program.

4 The intent of this policy is that dredging and disposal contribute to cleanup of the Sound by allowing unconfined open-water sites to have only low levels of contamination and to dispose of more contaminated sediments in a manner that prevents continued exposure of organisms to adverse effects. For proposals where dredging will expose contaminated sediments, project-specific mitigation measures may be required.

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c. Sediment cleanup programs (which may include capping in place) shall be undertaken when reasonable to reduce, with the intent of eliminating, the exposure of aquatic organisms to sediments having adverse effects.[5]

S-2. Program for Unconfined Open-Water Disposal

[Element Completed]

S-3. Unconfined Open-Water Disposal Sites

The Authority adopts by reference the following portions of the "Management Plans for Unconfined Open Water Disposal Phase I and Phase II".

- Selection of dredged-material disposal sites at or near Everett, Seattle, Bellingham, Port Angeles, Port Townsend, Rosario Strait, Anderson and Ketron Islands, and Tacoma to serve as regional sites for disposal of dredged material that meets the PSDDA evaluation procedures (page 4-5 of the PSDDA Phase I Management Report and Chapter 5 of the PSDDA Phase II Management Report).

- Selection of disposal guidelines based on site condition I for the dispersive sites at Rosario Strait, Port Angeles and Port Townsend and less restrictive disposal guidelines based on site condition II for the remaining non-dispersive sites (page 4-5 and Chapter 5 of the PSDDA Phase I Management Report and Chapter 4 and Exhibit A of the PSDDA Phase II Management Report).

It is the Authority's long-term goal that dredged-material disposal sites have no chemical adverse effects. The Authority concurs with the PSDDA selection of site condition II (minor adverse effects) at the non-dispersive sites for the near term because: (1) the sites were selected to minimize the resources affected; (2) the sites will receive large of amounts of material that would be cleaner than the dispersive site guidelines of site condition I, which will moderate the potential effects of the material that falls between conditions I and II; and (3) the program of monitoring and reevaluation will allow protective adjustments to the evaluation procedures if problems develop. The Authority also adopts the following portions of the management plans.

- Evaluation procedures (Chapter 5 and Appendix A of the PSDDA Phase I Management Report and Chapter 5 and Exhibit A of the PSDDA Phase II Management Report).

- Management plans for disposal sites (Chapter 6 of both the PSDDA Phase I and Phase II Management Reports). The Authority supports model shoreline master program language proposed by the PSDDA for adoption by local governments and suggests that local governments consider amending their programs but is not requiring them to do so.

5 Element S-7 directs Ecology to develop a decision process which will resolve the question of when cleanup actions are reasonable.

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- Environmental monitoring of disposal sites (Chapter 7 of both the PSDDA Phase I and Phase II Management Reports).
- Data management (Chapter 8 of both the PSDDA Phase I and Phase II Management Reports).
- Annual review and program update (page 9-6 of both the PSDDA Phase I and Phase II Management Reports).

Each federal and state agency, local and tribal government, and port is required to manage dredged material disposal in open water according to the PSDDA program and the goals of the Puget Sound Plan.

Changes to any of these PSDDA recommendations are considered major public actions subject to Authority review.

Target Dates: As described in PSDDA Management Reports.

Confined Disposal

S-4. Confined-Disposal Standards for Sediments

Ecology shall develop an approval process and technical manual of standards for confined disposal of dredged material. Ecology shall adopt regulations necessary to implement the approval process and use of these standards. The standards shall address reuse or disposal of dredged material that exceeds the sediment standards developed under element P-2 and that will not be disposed of at unconfined open-water disposal sites established by the PSDDA process. These standards for confined disposal will be used by Ecology, shoreline jurisdictions and local health departments in approving or denying permits for the use or disposal of dredged material that exceeds the P-2 standards. The objective of these disposal standards is to prevent the exposure of aquatic or terrestrial organisms, including humans, to adverse effects from the contaminants in the sediments.

In developing the standards Ecology shall consult with agencies and other parties with technical expertise and shall provide a public education/public involvement program. The standards shall address treatment as well as in-water and upland confined-disposal methods.

Target Dates: Complete the approval process, technical manual and required rule making by June 30, 1995.

S-5. Revision of Rules and Programs

After the adoption by Ecology of disposal standards for sediments that exceed sediment standards (S-4), the Authority shall review the standards and consider the degree to which local governments and other state agencies should conform their programs to the Ecology standards so that the use or disposal of sediments in compliance with the disposal regulations is not unreasonably precluded. Shoreline master programs, solid waste rules, and the hydraulics permit rules may be affected. The Authority may then amend the Puget Sound Water

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Quality Management Plan to direct state agencies and local governments to revise their programs. If required, these revisions shall occur no later than two years after final action by the Authority. Any agency or local government that cannot meet this deadline shall request, at the earliest possible time, an extension from the Authority.

Target Dates: Begin review of the standards on July 1, 1995. Propose new plan language, if necessary, by December 1, 1995. Complete state and local revisions by March 1, 1998.

S-6. Multi-User Confined-Disposal Sites Study

[Completed portions of this element have been deleted.]

Ecology shall convene an interagency management committee consisting of representatives from the departments of Ecology, Health and Natural Resources, the Puget Sound Water Quality Authority, tribes, the Army Corps of Engineers, the EPA, and other appropriate agencies. The management committee shall direct the development of the Puget Sound Sediment Disposal Action Plan. This action plan will be prepared for development of a multi-user disposal site, and shall be completed within one year of funding. The action plan shall: 1) detail the disposal siting process; 2) define the means for managing site liabilities; 3) include provisions for evaluating human health considerations; 4) provide a management agreement listing institutional responsibilities; 5) define stakeholder and public participation roles; and 6) identify funding sources and mechanisms for future siting and construction steps.

The siting process addressed in the action plan should establish the following: (1) criteria for identifying potential disposal sites; (2) procedures for screening and ranking these potential sites; (3) an outline of technical studies required to ensure site technical viability; (4) a preliminary inventory of potential candidate sites that have not been screened or ranked; (5) a plan for public participation; and (6) an outline of any needed siting authorities.

In addition to the management committee, Ecology shall convene an advisory group to be involved in development of the action plan and to facilitate widespread review and comment on the action plan. The advisory group shall provide comments on the scope of the action plan to the management committee prior to development of the action plan, and will review and comment on draft products. The advisory group shall, at a minimum, consist of representatives from local environmental health agencies, local solid waste agencies, the Department of Fish and Wildlife, ports, tribes, environmental groups, the Office of the Attorney General, and the potentially affected private sector. The National Oceanic and Atmospheric Administration, the U. S. Fish and Wildlife Service, and the U.S. Coast Guard shall be invited to send representatives to the advisory group.

The management committee shall review the need for draft legislation that should be developed as an essential feature of the action plan. The legislation should clarify the state's interest in addressing the sediment disposal problem and should address liability management, siting and funding as required. The

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management committee shall coordinate development of legislation with appropriate legislators and their staffs.

As an interim measure to address confined-disposal needs, Ecology shall facilitate multi-user disposal access to appropriate disposal projects. In facilitating such access, Ecology shall investigate options for liability management and indemnification of landowners. Such access should be promoted if it is compatible with the development schedule of projects, if liability management and indemnification issues can be addressed, and if such access results in more expedient and cost-effective cleanup actions.

Target Dates: Convene interagency management committee and advisory group by July 1, 1995. Submit final action plan to the Authority for review and approval prior to implementation by June 30, 1996. Propose draft legislation, if needed, by September 30, 1996.

S-7. Guidelines for Sediment Cleanup Decisions

To establish a uniform decision process concerning what to do about sediment contamination, Ecology shall develop guidelines for deciding whether existing sediments that exceed the sediment standards developed under element P-2 should be capped, excavated or otherwise treated, or whether no action should be taken. In developing the guidelines, Ecology shall consult with agencies and parties with expertise in these issues and provide a public education and public involvement program. Development of the guidelines shall include consideration of deadlines for making decisions on cleanup actions. As a guide in deciding whether to wait for natural processes to cap or dilute the sediments or to undertake cleanup actions, the guidelines shall also include consideration of a time by which surface sediments should no longer have adverse effects. Because of the high cost of treatment or removal of contaminated sediments, the guidelines shall include a process and criteria for establishing priorities for such actions, including consideration of the cost of cleanup. Development of the guidelines should include a process for ranking sediments with high levels of contamination by relative potential risk posed to human health and the environment.

Target Dates: Guidelines for sediment cleanup decisions are contained in the sediment management standards adopted in 1991. Implementation of the guidelines shall be ongoing.

S-8. Investigations and Cleanup of Contaminated Sediments

This element constitutes an expansion of the ongoing EPA and Ecology program of investigations and pollution source-control efforts in urban bays and other areas of the Sound where sediment contamination is known or suspected. This element deals with sediment contamination in three tiers. In subelement 8.1, specific sample locations that exceed sediment standards are inventoried. In subelement 8.2, Ecology uses the inventory and other information to identify bays or other similarly sized areas for further investigation under subelements 8.3 and 8.4. In subelement 8.6, Ecology identifies specific sites that should be considered for cleanup actions under subelements 8.6 and 8.7, using ranking criteria developed in subelement 8.5.

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Element P-13 in the Municipal and Industrial Program provides additional detail on the Urban Bay Action Program.

Although this element contains specific directives and assignments, the Authority intends that the EPA, Ecology and other agencies and local governments exercise flexibility in resolving contaminated sediment problems. The EPA is requested to continue or increase existing support for this effort through various programs including the national funding for estuary programs, federal Superfund activities and federal funding for Ecology's water quality and hazardous waste programs. To organize and coordinate the program, Ecology, in cooperation with the EPA, shall undertake an integrated program consisting of the guidelines called for in element S-7 and the following components:

8.1. Inventory of Locations with Contaminated Sediments

To provide information to the Authority and the public and to allow for tracking of increases or decreases in the extent of sediment contamination, Ecology shall maintain an inventory of points or locations in the basin where sediment samples have been taken which violate the sediment standards developed under element P-2. The inventory should consist of graphic displays with locations of contamination indicated. All available sources of data, including monitoring, permit applications and published research studies, should be used in developing the inventory. The inventory shall be integrated into the Puget Sound Geographic Information System (GIS) and used to update the Puget Sound Environmental Atlas if possible. This inventory shall be updated every two years and made available using the data transfer formats developed under element M-4. The Authority shall assist in distributing the inventory and include a summary of the inventory in the State of the Sound Report. As an aid in targeting pollution source-control activities, Ecology's inventory shall identify the chemicals or other characteristics for each location that causes it to be on the inventory.

Target Date: Establish computerized inventory and make data available to the Puget Sound GIS annually or when required for specific projects.

8.2. Contaminated Sediment Area[6] Priority List and Investigation Schedule

Ecology shall develop decision criteria for identifying areas of Puget Sound where locations with sediment contamination have been identified or are suspected and where investigations should be undertaken to control sources and consider cleanup actions. These criteria will be used to establish a priority list of areas to be investigated, allocate resources for contaminated sediment investigations, and establish a schedule for these investigations. (Under element P-13, Ecology is to prepare a long-term implementation plan for the Urban Bay Action Program.) Every effort should be made to investigate each area on this priority list within five years of its first appearance on the list. Ecology shall reevaluate both the area priority list and the investigation schedule every two years. Ecology shall provide the Puget Sound Estuary Program

6 An "area" is a bay or similar-sized region where sediment contamination might be studied and an effort made to control sources of contamination. A "site" is smaller than an "area" and defines a specific "hot spot" that might be caused by a single source and considered for cleanup action.

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Management Committee an opportunity to review and comment on the priority list of areas.

Although this element focuses urban bay action programs on areas with sediment contamination, Ecology may include other factors in selecting areas for inclusion in the plan for urban bay action programs.

Target Date: The priority list of areas to be investigated is to be completed within 12 months of final adoption of sediment standards under element P-2.

8.3. Investigations of Contaminated Sediment Areas

Ecology, in cooperation with federal and state agencies and local and tribal governments, shall carry out investigations of contaminated sediment areas identified and listed under element 8.2. Investigations shall be designed on a case-by-case basis using Elliott Bay and Commencement Bay studies as the models. The investigations shall include reviews of existing information on contamination and sources as well as field investigations designed to refine information on levels and distribution of contamination and probable sources.

8.4. Action Teams and Source Control

For each contaminated sediment area being investigated, Ecology, the EPA, local governments and other appropriate agencies will form a team of investigators to work on source controls. The teams should include Ecology regional office inspectors and permit writers who normally handle the area. The DNR shall participate in each urban bay action team as part of its efforts to reduce contamination of state-owned aquatic lands. Each team's activities shall be integrated with the Municipal and Industrial Discharges Program by focusing activities under that program in areas associated with contaminated sediment areas. Also, in some urban bays, bay wide planning efforts are being promoted by the Department of Natural Resources. Bay-wide planning is encouraged as a tool to balance cleanup, habitat development and other water dependent activities. Because the urban bay action teams include representatives of many of the appropriate parties, the bay wide planning efforts shall be integrated with the activities of the urban bay action teams. The lead for a baywide planning initiative however, might be a public port or the Department of Natural Resources.

Urban bay action teams shall carry out various source control, cleanup and investigative actions including:

- Review existing discharge permits and compliance with them.
- Reopen and modify discharge permits of sources in the vicinity to control toxicants identified at problem levels in the sediments.
- Search for unpermitted discharges and take enforcement actions.
- Investigate contamination in storm drains or ground water and search for sources of such contamination.

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- Take other actions to control sources of sediment contamination by seeking to achieve full compliance with applicable laws and regulations in locations that drain into the contaminated area.
- Identify sites within the area that should be considered for cleanup.
- Assist in ensuring that cleanup actions take place.
- Develop urban bay action plans for each urban bay. (The development and adoption of action plans is described in element P-13.)
- Coordinate with applicable baywide planning efforts.

Ecology and the EPA are encouraged to make use of industry scientists, engineers and other experts to assist in these efforts.

8.5 Ranking Method Study

[This subelement has been completed.]

8.6. Sediment Site-Cleanup Actions

Following the guidelines developed under element S-7, when sites with high levels of sediment contamination are identified, Ecology shall consider the feasibility and reasonableness of sediment cleanup actions, coordinating with the DNR on actions that affect state-owned aquatic lands. Ecology, as part of this element, shall develop decision criteria for determining when sediment cleanup actions should be taken pursuant to laws regulating water quality and discharge permits (sediment restoration activities) and when cleanup actions should be taken pursuant to the Model Toxics Control Act (sediment remedial actions). If sediment cleanup actions are necessary, funds for such actions will be sought first from responsible parties and then from public sources. All cleanup actions shall be consistent with the guidelines developed under element S-7. Ecology shall maintain a priority list of specific sediment sites where cleanup will be considered.

Target Date: Establish initial priority list of sites by January 1, 1995.

8.7. Responsible Parties

The Authority recognizes that identifying the parties responsible for sediment contamination is generally difficult. Often neither the underlying property owner nor the abutting property owner is responsible for the contamination. But cases have occurred and will occur where responsible parties can be identified. Where treatment or removal of contaminated sediments is recommended, Ecology shall attempt to have such cleanup actions, including investigations and feasibility studies, undertaken and paid for by responsible parties, whether they are dischargers under water quality laws or liable persons pursuant to the Model Toxics Control Act. The DNR shall utilize state proprietary authority to secure, to the extent possible, site cleanup, natural resource damages, and cost recovery from responsible parties whose contamination is located on state-owned aquatic lands. Every reasonable attempt will be made to recover cleanup costs from responsible parties, including study costs.

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Target Date: Ongoing activity.

S-9. Public Involvement, Education and Technical Assistance

Ecology shall increase staffing for public involvement for sediment program issues including sediment standards (element P-2). A staff person will be assigned to coordinate Ecology's public outreach and education on sediment issues and improve the response to technical inquiries. This element will be coordinated with the development of educational materials on sediments under element EPI-3.1.

Target Date: Establish staff position by December 1995.

MAJOR PUBLIC ACTIONS FOR AUTHORITY REVIEW

1. Changes to PSDDA recommendations adopted by reference in element S-3.
2. Adoption of sediment management standards which include the sediment quality standards (element P-2) and maximum allowed cleanup levels and site-specific cleanup requirements (element S-7 and subelement S-8.6).
3. Adoption of disposal standards for contaminated sediments (element S-4).
4. Priority list for investigation of contaminated sediment areas (subelement S-8.2).

LEGISLATION REQUIRED

New legislation may eventually be required to allow the establishment of multi-user disposal sites for dredged material.

ESTIMATED COST

Full implementation of the Contaminated Sediments and Dredging Program is estimated to cost close to $5 million during the 1995-97 Biennium and $4.5 million during the 1997-99 Biennium. The program's largest cost, comprising over 80 percent of the total, is the investigation and cleanup of contaminated sediments (element S-8). Funding at this level would allow some progress on site investigations and source control but does not include public funds that might be needed to clean up contaminated sediments. Such costs could run in excess of $100,000 per acre for removal or treatment and at least $5,000 per acre for capping. Estimates of costs to dredge and dispose of sediment hot spots in Commencement Bay ranged from $8 to $79 per cubic yard depending on the type of disposal required.

Large public and private sector costs are currently associated with dredging or disposal of dredged material. In 1984, dredging and open-water disposal of clean material cost only $2 to $3 per cubic yard. Now testing of material suspected of being contaminated has cost an additional $1 per cubic yard. In addition, disposal fees have increased and will increase more in the future. Disposal of dredged material that cannot go to open water now costs anywhere from $15 to $40 per cubic yard. Disposal of highly contaminated material has been estimated, as discussed above for cleanup actions, at up to $79 per cubic yard. Since annual dredging volumes are in the hundreds of thousands of cubic yards, most of it clean material, these are significant costs for the region.

Private sector costs associated with investigating and dealing with contaminated sediments sites may also increase. This would occur when responsible

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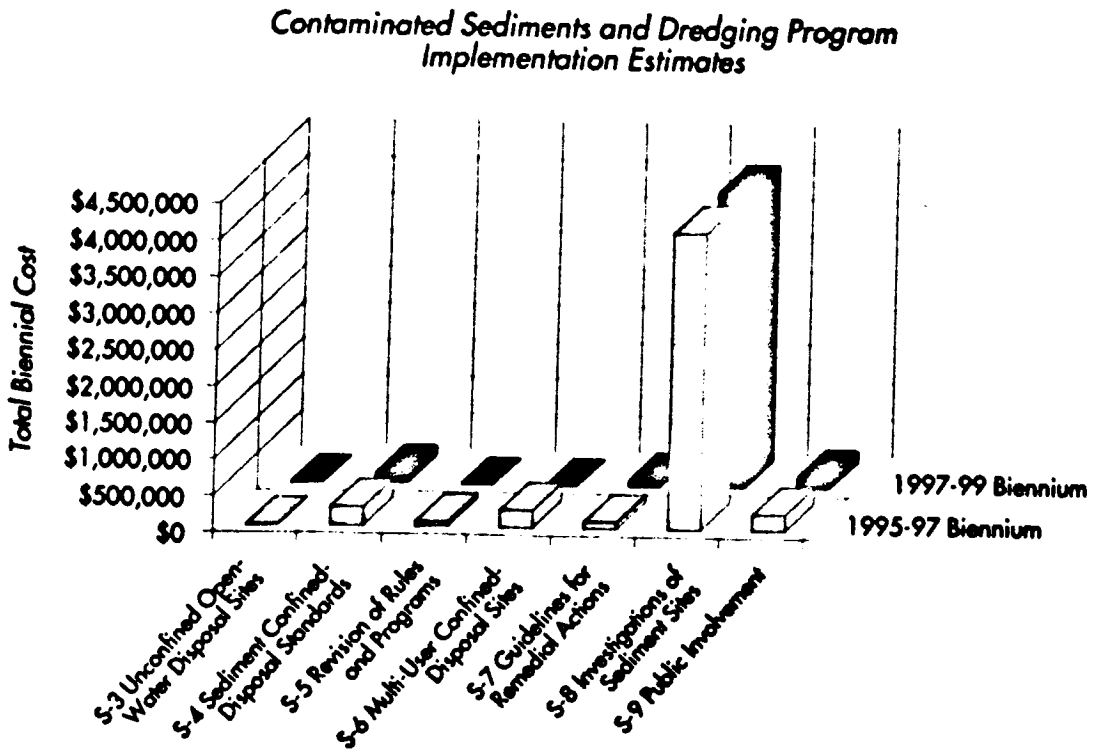
parties are required to investigate and remedy sediment hot spots resulting from their discharges. These costs are not included in the overall cost estimates.



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STORMWATER AND COMBINED SEWER OVERFLOWS PROGRAM

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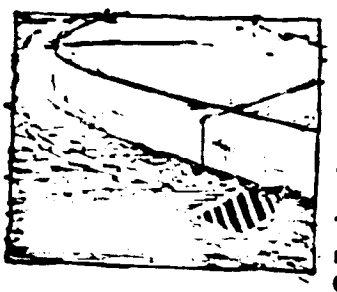
PROBLEM DEFINITION

Storm Water



Storm water, or urban runoff, is defined as rainfall that falls on impervious surfaces and is routed into natural or artificial drainage systems.[1] Pollutants in storm water can include sediments, nutrients, bacteria, oils, grease, metals and other toxicants. These contaminants can harm biological populations, destroy fish and wildlife habitat, contribute to restrictions on shellfish harvesting and swimming, and contaminate sediments. Sources include motor vehicles; fertilizers, pesticides and herbicides; runoff from urban development; construction sites; businesses and industries; pet feces; and poor management of other wastes.

The potential for significant pollution from storm water has been increasingly recognized. The Environmental Protection Agency's (EPA's) 1992 Water Quality Inventory (Clean Water Act Section 305b) stated that urban runoff impairs 43 percent of estuarine miles, 11 percent of river miles, and 24 percent of lake acreage in the United States. The average stormwater concentrations exceeded chronic water quality criteria for cadmium, copper, lead, nickel and zinc. The concentrations of metals did not appear to be different among the three basic land-use types sampled—residential, commercial and industrial.

Runoff from freeways, however, was consistently higher for most metals. Compared to effluent from secondary sewage treatment, urban runoff in Bellevue contained higher concentrations of lead and zinc. Runoff data from the Nationwide Urban Runoff Program[2] showed that average concentrations of total suspended solids, chemical oxygen demand, and nitrate/nitrite were higher

1 Impervious surfaces include rooftops, driveways, streets, parking lots and highways. Lawns are found to be almost as impervious as some paving.

2 The Nationwide Urban Runoff Program was a five-year study (1978-82), sponsored by the EPA and many cooperating federal, state, regional and local agencies, which addressed the quality of urban runoff, the significance of the urban runoff problem, and the effectiveness of best management practices.

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than the annual mean concentrations in secondary treated effluent from the Renton treatment plant.

Runoff is greatest in urban and suburban areas due to population density and the high percentage of impervious surface area that prevents absorption. The atmosphere in urban areas contains particles and associated contaminants from cars, factories and wood stoves. When it rains, these particles—and pollutants—may be deposited on the water, or they may be deposited on the land and washed into the nearest stream, lake, or bay. Not surprisingly, storm water is a significant source for pollutants concentrated in the sediments of urban bays. Some storm drains in Seattle were found to be major sources of lead and PCBs (a group of industrial compounds banned in the 1970s) in the sediments of Puget Sound.

Without controls, stormwater volume and peak flows can impair the ability of anadromous species to migrate through obstructions and changes in flows. Peak flows scour gravel beds needed for spawning. Natural and artificial wetlands are being used to store and treat storm water. Preliminary data from Puget Sound Wetlands and Stormwater Management Research Program shows that unmanaged storm water has a detrimental effect on wetlands in certain areas.[3]

Population in the Puget Sound basin is projected to grow by more than one million people by the year 2010. Development associated with this growth requires adequate stormwater control. Without proper management, storm water will continue to degrade water quality and harm biological resources.

Combined Sewer Overflows (CSOs)

Combined sewer systems collect sanitary sewage, industrial waste water and storm water in a single sewer system. During large storms, part of the system's effluent is discharged before being treated because the system's pipes and sewage treatment plant cannot handle the full volume of waste water. Nine cities around Puget Sound have combined sewer systems that discharge directly into Puget Sound during large storms. Metro (King County Metropolitan Services) in King County handles waste water from combined sewers but does not own a combined system.

Except for Metro and Seattle, basic information about frequency, quantity and effects has been lacking for most CSOs discharging into Puget Sound. In an average year, Metro and Seattle have discharged about 2.8 billion gallons of raw sewage, untreated storm water and industrial effluents from about 110 CSOs in the Seattle area. This volume is approximately six percent of the annual discharge from the West Point treatment plant. Although the volume of effluent of CSOs is relatively small compared to the discharge of sewage treatment plants, CSO discharges are untreated and many are in close proximity to sensitive shoreline areas. Metro and Seattle are working to reduce their CSO discharges.

3 Puget Sound Wetlands and Stormwater Management Research Program, 1993. Research Summary V1. Sensitive Plant Communities in the Puget Sound Region: Forested Wetlands, Bogs/Fens, and Sedge Meadows.

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The discharges from CSOs frequently contain large amounts of fecal coliform bacteria, nutrients, suspended solids, and sometimes toxicants. Sediment samples around the Denny Way CSO in Seattle showed highly elevated concentrations of heavy metals and organic toxicants. Metro has since capped those sediments. The biota around the CSO was harmed by the discharge, and the area is closed to swimming due to high concentrations of fecal coliform.

INSTITUTIONAL FRAMEWORK

Since the mid-1950s, the U.S. Environmental Protection Agency's (EPA) policy, and standard engineering practice, has been to install separate sanitary and storm sewers for newly developed areas. CSOs are now regulated under the National Pollutant Discharge Elimination System (NPDES) program, with discharges required to meet all applicable requirements. In 1985, the Washington State Legislature passed a law requiring all municipalities with CSOs to develop plans for the greatest reasonable reduction at the earliest possible date. Implementation of those plans is under way.

In 1986, a handful of local governments had established stormwater utilities based on their general legal authorities, but at that time storm water was primarily addressed as an issue of water quantity in permits. The 1987 Clean Water Act reauthorization and subsequent revisions established new procedures, requirements and deadlines for regulation of storm water. The Department of Ecology (Ecology) established a stormwater program in 1988.

The federal Clean Water Act, and state statutes RCW 90.70 and RCW 90.48 establish federal and state authority for stormwater management in the Puget Sound basin. Ecology administers (NPDES) stormwater permits for municipal and industrial dischargers, and the state Department of Transportation. The EPA issues NPDES permits to federal facilities and tribal lands located in the state. The Authority, under RCW 90.70, directs local governments to adopt stormwater regulatory programs. Ecology developed minimum standards for stormwater programs, a technical guidance manual and a model ordinance for local governments implementing stormwater programs.

AUTHORITY'S APPROACH

The Authority recognized that because of the pervasiveness of stormwater problems, any viable solutions would require the cooperation of diverse segments of society: the development community, government, businesses and individuals. Programs to control and prevent storm water needed to be developed at the local level, with guidance and assistance from state and federal agencies.

The 1987 Puget Sound Water Quality Management Plan (Plan) called for: (1) stormwater programs to be developed in urbanized areas of the Sound in a phased program, starting with the largest cities; (2) all cities and counties to develop operation and maintenance programs, adopt ordinances for new development, and develop stormwater education programs; and (3) all cities with CSOs to develop and implement plans providing for the greatest reasonable reduction of overflows each year.

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The Plan called for Ecology to develop technical manuals, guidelines, regulations and model ordinances; the Department of Transportation to develop a program to control highway runoff; and the EPA to include stormwater controls in NPDES permits issued to federal facilities.

Revisions to the Plan in 1989 added no new program elements; effort was focused instead on implementing existing elements. However, amendments to the 1991 Plan included several key changes, including: recognizing the importance of implementing the most effective best management practices; calling on Ecology to include minimum requirements in its "stormwater technical manual"; coordinating stormwater programs with Growth Management Act planning; and increasing technical assistance and outreach to local governments.

The 1994 Plan calls for the departments of Natural Resources and Fish and Wildlife to adopt the stormwater technical manual, adds performance criteria for BMPs (best management practices) to help track performance, emphasizes coordination among watersheds, addresses vactor waste, and better integrates stormwater controls with Growth Management Act (GMA) requirements.

PROGRAM GOAL

To protect shellfish beds, fish habitat and other resources; to prevent the contamination of sediments from urban runoff and combined sewer overflows; and to achieve standards for water and sediment quality by reducing and eventually eliminating harm from pollutant discharges from storm water and combined sewer overflows (CSOs) throughout Puget Sound.

STRATEGY

The pollution control strategy for achieving the program's goal is to implement the most appropriate best management practices first, assess their effectiveness, and as necessary, require further water quality controls.

The implementation strategy for achieving this goal is to: (1) require that all cities and counties meet minimum requirements for a basic stormwater program; (2) develop stormwater programs in urbanized areas of Puget Sound in a phased program starting with the largest cities; (3) develop NPDES permits for municipal storm water that incorporate the Plan's stormwater requirements and federal requirements, and phase in additional NPDES permits for municipal storm water for smaller jurisdictions as further U.S. Environmental Protection Agency EPA regulations are promulgated; (4) schedule the development of additional Puget Sound stormwater programs on a priority basis; (5) provide technical assistance to both local governments and businesses; and (6) require all cities with CSOs in the Puget Sound basin to develop and implement plans which provide the greatest reasonable reduction of CSO events.

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PROGRAM ELEMENTS

SW-1. Basic Stormwater Programs for All Counties and Cities

The pollution control strategy for achieving the program's goal is to implement the most appropriate best management practices (BMPs) first, assess their effectiveness, and, as necessary, require further water quality controls.

1.1. Minimum Requirements for Basic Stormwater Programs

All cities and counties shall adopt stormwater programs which include the minimum requirements for new development and redevelopment[4] and other basic stormwater controls contained in the Plan and in guidance developed by Ecology. All counties and cities in the Puget Sound basin shall adopt ordinances requiring stormwater controls for new development and redevelopment.

The basic stormwater program shall include ordinances that address, at a minimum: (1) the control of off-site water quality and quantity effects; (2) the use of best management practices for source control and treatment; (3) the effective treatment, using best management practices, of the storm size and frequency (design storm) as specified in the manual for proposed development; (4) the use of infiltration, with appropriate precautions and maintenance, as the first consideration in stormwater management; (5) the protection of stream channels, fish, shellfish habitat, other aquatic habitat; and wetlands; (6) control of erosion and sedimentation for new construction and redevelopment projects; and (7) local enforcement of these stormwater controls.

Local governments should monitor compliance with stormwater requirements and publish the results of the monitoring in watershed "report cards" or in other forms.

Ecology shall publish guidance, as required under element SW-4, for meeting these requirements.

This program shall not affect Ecology's authority to require appropriate corrective action (pursuant to Chapter 90.48 RCW) whenever existing facilities cause or contribute to violations of state water quality standards.

1.2. Operation and Maintenance Programs

Each county and city shall also develop and enforce, within local governments' authority, operation and maintenance programs and ordinances for new and existing public and private stormwater systems. Each county and city shall maintain records of public and private storm drainage systems and appurtenances. Counties are responsible for the stormwater programs in unincorporated residential, commercial and industrial areas. Ecology's guidance shall ensure that all appropriate areas are included in these programs.

All programs and ordinances developed under this subelement shall be consistent with the plan guidance and model ordinances developed under elements SW-3 and SW-4. Each city and county shall adopt ordinances consistent with

4 Ecology shall define re-development in the technical manual.

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the model ordinances (element SW-4) requiring stormwater controls for new development and redevelopment and requiring and enforcing maintenance of privately owned stormwater systems.

1.3. Technical Manuals

In conjunction with the runoff control ordinances for new development and redevelopment, each jurisdiction shall adopt a stormwater management manual containing best management practices. A local government may adopt the manual prepared by Ecology under element SW-3 or prepare its own manual as long as it has substantially equivalent technical standards to those in Ecology's manual. Ecology shall review alternative manuals of local governments for substantial consistency with the Plan and Ecology's manual and guidance.

When Ecology updates its manual, local governments must, within one year of receipt, make any appropriate changes to their manuals.

1.4. Education Programs

Basic stormwater programs should include education programs to inform citizens and businesses about storm water and its effects on water quality, flooding, and fish/wildlife habitat, and to discourage dumping of waste material or pollutants into storm drains. When possible, these program should coordinate with the Education and Public Involvement Program the Household Hazardous Waste Program and the Nonpoint Source Pollution Program. Compliance and monitoring "report cards" (subelements SW-1.1 and SW-3.1.2) should be used to publicize progress in controlling storm water.

1.5. Growth Management Planning and Interlocal Coordination

Each city or county which adopts a comprehensive land use plan and development regulations under the provisions of Chapter 36.70A RCW (the Growth Management Act) shall incorporate its local stormwater program into the its comprehensive plan and shall incorporate the ordinances required by this program into its development regulations. Accordingly, cities and counties shall also incorporate and implement the provisions of the stormwater program through: ordinances to protect critical areas, capital facilities plans, concurrency strategies, watershed action plans, drainage or basin plans, urban bay action tasks, the State Environmental Policy Act (SEPA) reviews, environmental priorities, or utilities. Any utilities which are developed should be designed to address a broad spectrum of stormwater- and nonpoint source pollution-related water quality problems.

Consistent with the Growth Management Act and RCW 90.70, and in keeping with the intent of Chapter 39.34 (the Interlocal Cooperation Act), each local jurisdiction in the Puget Sound basin shall cooperate with neighboring jurisdictions in stormwater, growth management, and basin or watershed planning. Jurisdictions sharing common watersheds should cooperate in analyzing the effects and control of stormwater runoff and adopt coordinated and compatible programs for stormwater management. This coordination should also achieve the most efficient and effective protection of fish, shellfish, aquatic habitat, wetlands, and other aquatic resources within their shared watersheds.

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In setting priorities for stormwater control, cities and counties should consider the list of critical watersheds prepared by the Department of Fish and Wildlife (WDFW) under subelement SW-7.2 as well as information from approved, watershed action plans, basin plans, and urban bay action plans. Based on these priorities, cities and counties should identify sensitive areas that may need even stronger stormwater controls.

Ecology, the Authority, and the Department of Community, Trade and Economic Development (DCTED) shall provide local governments with technical assistance on managing stormwater runoff during the growth management planning required under the Growth Management Act.

1.6. Compliance Monitoring

Ecology shall monitor compliance with these requirements, reviewing the status of city and county basic stormwater programs every two years to ensure consistent and adequate implementation and report to the Authority. When Ecology finds that a local program is not in compliance with these requirements, Ecology is encouraged to provide technical suggestions to improve implementation and to allow maximum flexibility and creativity for local governments to resolve site-specific stormwater problems in accordance with their land-use and other local policies.

1.7. Enforcement

If local governments fail to prepare and implement the required programs under this element, the Authority shall follow procedures in RCW 90.70 and request written explanations for the shortfalls, together with their proposed remedies. After monitoring compliance under subelement SW-1.6, Ecology may take enforcement actions against stormwater discharge violations under RCW 90.48 (the State Clean Water Act) or by issuing NPDES discharge permits (see subelement SW-2.3).

Target Date: All cities and counties shall incorporate the Puget Sound Plan's stormwater considerations into critical areas ordinances, countywide policies, comprehensive plans and implementation regulations; adopt ordinances and stormwater manuals, and comply with the basic stormwater program requirements by January 1, 1995. By the same date, cities and counties with ordinances and operation and maintenance programs predating Ecology guidance under element SW-4 shall bring their ordinances and programs into compliance with provisions of this element. By May 1, 1997, Ecology shall complete the first round of biennial reviews.

SW-2. Comprehensive, Urban[5] Stormwater Programs

Starting with the larger cities in the basin that are named in the EPA stormwater NPDES regulation and eventually expanding to cover all urbanized areas, each city and unincorporated urbanized area shall develop and implement a stormwater management program consistent with the requirements of elements SW-1 and SW-2, guidance under element SW-4, and appropriate

5 Urbanized areas are as defined by the United States Bureau of the Census. Counties are responsible for the comprehensive, urban stormwater programs (element SW-2) in unincorporated urbanized areas. Ecology shall ensure that all appropriate areas are included in these programs.

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stormwater NPDES regulations. This program shall not affect the Ecology's authority to require appropriate corrective action (pursuant to Chapter 90.48 RCW) whenever existing facilities cause or contribute to violations of state water quality standards. The local government stormwater program shall be submitted to Ecology for review for consistency with the Plan and compliance with stormwater NPDES regulations. Ecology shall provide appropriate assistance to correct local program deficiencies. Ecology shall schedule the development of stormwater management programs by the remaining cities and counties.

The pollution control strategy for achieving the program's goal is to implement the most appropriate best management practices first, assess their effectiveness, and, as necessary, require further water quality controls.

2.1. Purposes of the Urban Stormwater Program

The purposes of the comprehensive programs for managing storm water in urban areas shall be:

1. To control erosion and manage the quantity and quality of stormwater runoff from public and private activities and to protect stream channels, aquatic habitat, wetlands, fish, shellfish, and other aquatic resources.

2. To protect and enhance water quality, and achieve water quality and sediment quality standards.

3. To reduce the discharge of pollutants and eliminate harm to the environment.

4. To protect beneficial uses, as described in Washington state's water quality standards, 173-201 WAC.

5. To achieve purposes 1 through 4 in a manner that makes efficient use of limited resources to address the most critical problems first.

2.2. Scheduling

Ecology shall use the following ranking criteria to schedule development of additional stormwater programs for urbanized areas:

1. Population size.

2. Rate of growth, in absolute numbers.

3. NPDES regulations developed by the U.S. EPA for storm water.

4. Water quality and quantity considerations, including but not limited to, sediment quality, beneficial uses of clean water, shellfish protection, priorities identified by watershed action plans developed pursuant to WAC 400-12 and other watershed planning programs, groundwater management areas, aquifer protection areas, sensitive areas for fish, shellfish, and other aquatic resources, wetlands, or flooding (see subelement SW 7.2).

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Ecology shall notify affected jurisdictions at least one year prior to the scheduled start date. Comprehensive programs for managing storm water in urbanized areas shall be completed and fully implemented within five years after notification by Ecology to proceed.

2.3. Coordination with Stormwater NPDES Permits

Starting with the Puget Sound areas designated under the EPA's NPDES Permit Application Regulation for Storm Water Discharges (40 CFR Parts 122, 123 and 124), Ecology shall review permit applications and write watershed-based permits for urbanized areas of Puget Sound that are consistent with these regulations and the requirements of elements SW-1 and SW-2. Permits will be issued using procedures identified in the state's permit writers manual (see element P-5). Additional permits shall be written and phased in as EPA issues additional stormwater regulations under NPDES.

Ecology will assess the federal regulations and the requirements of the Plan and determine whether the state's NPDES rule should be amended or a new rule written to implement these requirements.

When EPA promulgates stormwater regulations for smaller jurisdictions, Ecology shall write NPDES permits for these jurisdictions consistent with the state's permit writers manual, federal regulations, and element SW-1 and SW-2 requirements.

Ecology shall write permits for stormwater discharges associated with industrial activities, including land-disturbing activities of five acres or more, according to requirements of the EPA's NPDES regulation for storm water. These permits shall be consistent with procedures under Ecology's state permit writers manual (see P-5).

2.4. Program Requirements

Each urban stormwater program shall seek to control the quality and quantity of runoff from public facilities and industrial, commercial and residential areas, including streets and roads, consistent with manuals and guidance provided by Ecology under elements SW-3 and SW-4. Where local programs are not effectively solving stormwater problems, Ecology shall ensure compliance with elements SW-1 and SW-2 through its oversight role or through issuance and enforcement of individual or watershed-based NPDES permits.

Ecology shall coordinate development of its stormwater program with other state programs and activities affecting storm water, i.e., the Coastal Nonpoint Pollution Control Program, wetlands protection, floodplain management, nonpoint source pollution programs, underground injection control, growth management planning, and the sediment management-standards program.

Each city or urban area shall have the flexibility to design its own program, but the content, priorities and deadlines for compliance with the program shall be subject to review by Ecology for consistency with provisions of the Plan and the NPDES regulations.

In addition to the provisions of element SW-1, each urban stormwater program shall, at a minimum, include:

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a. Identification and ranking of significant pollutant sources and their relationship to the drainage system and water bodies through an ongoing assessment program.

b. Investigations and corrective actions of problem storm drains, including sampling.[6]

c. Programs for operation and maintenance of storm drains, detention systems, ditches and culverts.

d. A water quality response program, to investigate sources of pollutants, and respond to citizen complaints or emergencies such as spills, fish kills, illegal hookups, dumping, and other water quality problems. These investigations should be used to support compliance and enforcement efforts.

e. Assurance of adequate local funding for the stormwater program through surface-water utilities, sewer charges, fees or other revenue-generating sources.

f. Local coordination arrangements within watersheds, such as interlocal agreements, joint programs, consistent standards, or regional boards or committees to address the requirements of subelement SW-1.5.

g. Ordinances requiring implementation of stormwater controls for new development and redevelopment as defined by elements SW-3 and SW-4.

h. A program aimed at educating residents, businesses and industries in the urban area about storm water.

i. Inspection, compliance and enforcement measures.[7]

j. An implementation schedule.

k. If, after implementation of the control measures listed in a-j, there are still discharges that cause significant environmental problems, retrofitting of existing development and/or other water quality controls of discharges from new and existing development may be required.

The quality of storm water in public stormwater systems in commercial and industrial areas shall have a high priority in city and county programs. Ecology shall determine, in compliance with EPA regulations and in consultation with local governments, the appropriate approach to controlling stormwater discharges from industrial and commercial facilities that are not currently required to have stormwater NPDES or point-source discharge permits.

Jurisdictions which annex an area from another jurisdiction shall manage stormwater runoff consistent with the standards designated for the area prior to the annexation. Any new development or retrofitting of existing systems shall

6 The Elliott Bay Revised Action Program: Storm Drain Monitoring Approach, March 1988, Tetra Tech, for EPA Region 10 presents an approach particularly suited to industrial areas.

7 Local governments may request Ecology's assistance with enforcement measures.

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meet the most stringent standards. Areas that incorporate shall adopt standards at least as strict as those in place prior to incorporation.

Target Dates: Schedules for stormwater NPDES permits are established by the EPA. By the year 2000, all urbanized areas in the Puget Sound basin identified by Ecology shall implement urban stormwater programs. Ecology shall review and track the ordinances, manuals and other program requirements for each city or county program for substantial progress toward implementation of the elements listed above within two years of its initiation and report to the Authority every two years.

SW-3. Technical Manuals and Assistance on Stormwater and Erosion Controls

3.1. Technical Manual

Ecology shall maintain a technical manual that implements the requirements in elements SW-1 and SW-2 for use by local jurisdictions in stormwater planning. In updating this manual Ecology shall use existing information where possible. The technical manual shall also incorporate the requirements of the Coastal Nonpoint Pollution Control Program and shall provide technical guidance and define minimum requirements for implementing local programs (elements SW-1 and SW-2). The technical manual shall include, but is not limited to:

a. Best management practices for controlling erosion and sedimentation from construction sites, including guidance for operation, maintenance and inspection procedures.

b. Procedures for hydrologic analysis, including selection of design storms and estimates of runoff.

c. Design, operation and maintenance standards for public and private retention/detention facilities and conveyance systems. Emphasis shall be placed on systems that will maximize water quality benefits as well as water quantity control, such as the inclusion of biofiltration techniques where practicable.

d. Techniques for reducing or eliminating pollutants in runoff from problem land uses.

The manual should encourage the use of innovative technologies which have been adequately tested. The manual shall be closely coordinated with the guidance and model ordinances for stormwater programs (element SW-4). Ecology shall review the manual and revise it as needed. Ecology is encouraged to publish supplemental guidelines relating to new technologies for managing storm water when new information becomes available between manual revisions. Ecology shall promptly notify local jurisdictions of changes

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to the manual and shall provide technical assistance on its contents to local jurisdictions, citizens and businesses.

Updates of the manual shall incorporate performance standards (percentage of pollutant removal) for best management practices for stormwater runoff and information on the effectiveness of BMPs. The performance standards are intended to promote the most effective stormwater controls through selection, design, operation and maintenance. The failure of a best management practice to meet its performance standards may indicate the need for additional controls, but should not be considered a water quality violation.

Ecology shall establish a review board or use appropriate existing groups composed of representatives from interested and affected entities to review innovative BMPs, and to provide feedback on the manual, its revisions and its implementation.

3.1.1. Vactor Waste

Ecology shall incorporate into the manual a workable, coordinated program for stormwater maintenance (vactor) waste disposal for local governments, the Washington State Department of Transportation (WSDOT), private contractors and others. Ecology shall include reasonable, affordable disposal options for jurisdictions in both sewered and unsewered areas. The program should address testing, classification, disposal and reuse of decant water and solids from stormwater systems in sewered and unsewered areas. Ecology shall seek to resolve any conflicting regulations. The vactor waste program shall be developed in consultation with state, local and tribal governments, and contractors. Local governments shall implement Ecology's guidance on vactor-waste disposal procedures. Ecology shall provide technical and financial assistance to local governments for the handling and disposal of vactor wastes.

3.1.2. Monitoring Guidance

Ecology shall incorporate guidance into the manual on how to monitor stormwater runoff compliance and the effectiveness of best management practices. Ecology shall provide technical assistance to local governments and private industry. The guidance shall be developed using EPA and other related guidelines in cooperation with local governments and private industry. Monitoring guidance should be coordinated with NPDES requirements and be targeted to respond to specific local concerns about water quality and to minimize administrative burdens and costs. When appropriate, the guidance shall include protocols that are consistent with the Puget Sound Ambient Monitoring Program (PSAMP) and related data entry methods. The guidance should include recommendations on publicizing the resulting information, including the use of watershed "report cards" (subelement WP-7.2).

Local governments are encouraged to submit stormwater monitoring results and data on the effectiveness of best management practices to Ecology and the University of Washington Center for Urban Water Resources.

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3.1.3. Stormwater Manual Concurrence and Regulatory Streamlining

To ensure state coordination and to simplify requirements, Ecology shall submit drafts of the manual for review and approval to the departments of Fish and Wildlife, Health, and Natural Resources. This review and approval is to ensure that the manual is adequate to protect fish and shellfish habitats, wetlands, and other aquatic habitats and resources and to prevent sediment contamination from stormwater runoff.

After consulting with interest groups, and other agencies, Ecology shall include in the manual, guidance to state and local stormwater permitting agencies, on how to coordinate stormwater permits. The guidance shall minimize overlapping or differing requirements for industrial and municipal NPDES permits, Hydraulics Project Approval permits (HPAs), aquatic land-use authorizations, and local permits. Ecology, the Authority, and the Department of Community, Trade and Economic Development (DCTED) shall also develop guidance to encourage coordinated requirements within a shared watershed, as outlined in subelement SW 1.5. Local governments and other permitting agencies shall make every effort to follow this guidance and defer to other agencies' permits when those permits already provide adequate stormwater controls.

3.2. Stormwater Assistance Service for Local Governments

Ecology shall develop a technical assistance service for storm water. The service should assist local governments, tribes and private industry with: (1) the design and implementation of stormwater programs at the local level; (2) current best management practices for storm water; (3) local basin characteristics; (4) coordination with local government growth management planning activities; (5) vactor waste handling; and (6) habitat protection. The service should be staffed with people who have up-to-date, hands-on experience.

The Authority, Ecology, the Department of Fish and Wildlife, and other agencies, as appropriate, shall offer briefings to elected officials, citizens and other interested and affected groups on the effects of stormwater runoff on stream channels, wetlands, fish and other aquatic habitats and resources.

Ecology, in consultation with local governments, the Association of Washington Cities, the Washington State Association of Counties, the Center for Urban Resources Management, the County Road Engineers Group, and other interested parties, shall develop curricula to train local government and Ecology staff. Training shall include an explanation of state requirements, development and implementation of local programs, and use of the state technical manual. Ecology shall provide the curricula to interested public and private schools.

3.3. NPDES Coordination

Ecology shall provide technical assistance to local governments that are required to obtain stormwater NPDES permits, and to WSDOT and industrial stormwater permittees. Technical assistance shall cover coordination of federal stormwater requirements, the Plan's Stormwater and Combined Sewer Overflows Program, and Ecology's watershed permits for storm water, as well as coordination with other related programs such as HPA permits, the Coastal Nonpoint Pollution Control Program, and locally developed watershed action plans.

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Ecology is encouraged not to require stormwater permits for Puget Sound cities or counties unless the following apply: (1) they are subject to the element SW-2 program; (2) a specific water quality problem related to stormwater runoff is identified; or (3) federal laws or regulations require a permit. Ecology shall give each city or county adequate notice of its intent to require a permit. Where Ecology chooses to include more than one local government in a watershed-based permit, it should give the affected local governments a reasonable time to negotiate interlocal agreements.

Target Dates: Ecology completed the first stormwater manual in June 1992 and shall regularly update the manual as necessary. The Vactor Waste Program shall be established by June 30, 1995. Technical assistance is ongoing.

SW-4. Guidance and Model Ordinances for SW-1 and SW-2

Ecology shall review and update guidance and model ordinances for the basic stormwater programs for all cities and counties (element SW-1) and for comprehensive urban stormwater programs (element SW-2) consistent with the Plan.

Ecology shall consult with cities, counties, the Association of Washington Cities, the Washington State Association of Counties, the Municipal Government Research Center, developers, citizens' groups, and other interested parties when it updates the guidance and model ordinances. The guidance shall provide minimum program requirements and shall be consistent with NPDES requirements. Ecology shall develop, as appropriate, additional supplemental guidance for stormwater programs to remain consistent with applicable NPDES requirements. The model ordinances shall be developed with local government assistance and shall be accompanied by useful methods and examples which will assist local governments in adopting these minimum requirements into their regulations. Ecology shall also provide technical assistance to local jurisdictions (element SW-3) during preparation and implementation of their stormwater programs.

Ecology's Water Quality Financial Assistance Program shall ensure that stormwater-related projects are awarded state grants only if they are consistent with the goals of this program and include design elements that implement best management practices consistent with Ecology guidance. The Authority encourages Ecology to offer financial assistance to projects that meet these criteria.

4.1. Guidance for SW-1 and SW-2

The guidance for elements SW-1 and SW-2 shall include:

a. Procedures for developing local programs, including procedures for review of programs and manuals.

b. Minimum requirements for runoff controls and system maintenance required in local ordinances.

c. Minimum requirements for control of private sector maintenance of private drainage systems.

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d. Minimum requirements for the operation and maintenance programs, including record-keeping for new drainage systems and facilities, and handling of vactor waste.

e. Methods to assure practical and appropriate disposal procedures for decant water, solids and other substances from cleaning out and maintaining drainage systems. Methods shall address catch basins, oil/water separators, pipelines, swales, detention/retention basins, and other related drainage elements.

Additionally, the guidance for the comprehensive, urban stormwater programs (element SW-2) shall include:

f. Procedures for identifying and ranking significant pollutant sources and their relationship to the drainage system and water bodies.

g. Procedures for source-tracing investigations, including sampling of problem storm drains.

h. Procedures for investigations, implementing spill control measures, enforcement, and remedial actions.

i. Methods to assure adequate local funding for the urban stormwater program.

j. Provisions for agreements with neighboring jurisdictions when storm water and watersheds do not follow jurisdictional boundaries.

k. Requirements for public education programs.

l. Requirements for retrofitting and/or treatment measures, if necessary.

m. Procedures for inspection, compliance and enforcement measures.

n. Requirements for implementation schedules.

o. Methods to coordinate stormwater management with other watershed, habitat protection, and growth management activities.

The guidance shall lay out approaches to control storm water from new development and redevelopment, such as water quality policies for use in SEPA, NPDES and other permit decisions; density controls to limit development in sensitive areas; development standards to limit the amount of impervious surfaces; regional detention ponds; oil separators or other treatment facilities; grading and drainage ordinances; erosion control programs; buffers next to waterways; preservation of wetlands; and other appropriate elements.

In the guidance for elements SW-1 and SW-2, Ecology shall address the issue of responsibility and procedures for dealing with direct discharges of storm water from industrial and commercial facilities into the waters of the state.

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4.2. Model Ordinances

The model ordinances for elements SW-1 and SW-2 should describe how local governments can meet or exceed the minimum requirements and shall include at least the following elements:

1. A drainage element which: (a) sets policy; (b) defines the role of surface-water management; (c) defines water quality criteria and standards; (d) provides local enforcement authority; (e) provides for inspection and maintenance of private drainage facilities; (f) authorizes administrative development of operation and maintenance standards, development standards, and spill response procedures; and (g) generally integrates the management of surface waters with other appropriate codes affecting water quality (i.e., the Uniform Fire Code, public health codes, and land-use codes).

2. A clearing and grading element which defines authority to control erosion and provides for inspection and enforcement.

3. An element which ensures protection of streams and wetlands.

Target Date: Ecology has completed the guidance and model ordinances. Regular updates are required as necessary.

SW-5. Puget Sound Highway Runoff (WSDOT)

The Washington State Department of Transportation (WSDOT) shall carry out a program to control runoff from freeways and highways in the Puget Sound basin. This program shall continue to be consistent with Ecology's Puget Sound Highway Runoff Rule (Chapter 173-270 WAC) as described below.

Ecology shall maintain the rule for the Puget Sound Highway Runoff Program and shall continue to coordinate with the WSDOT in its development of a runoff program. Ecology shall provide technical assistance to the WSDOT and local jurisdictions during development and implementation of this program.

Any revisions to this rule shall maintain requirements for:

a. Controlling and/or treating runoff from highways in the Puget Sound basin.

b. Implementing best management practices (BMPs) and/or treatment facilities for new construction.

c. Using BMPs that address the control of water quality and quantity using pesticides in highway rights-of-way, and using de-icing chemicals.

d. Complying with Ecology and local stormwater programs. Ecology shall seek to provide consistent requirements for the highway program in different jurisdictions.

e. Phasing in the runoff program. A priority ranking system will be developed in consultation with Ecology and local and tribal governments for retrofitting water quality BMPs so they factor in vehicle use and site-specific constraints of implementing best management practices. Additional criteria

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may be considered. Opportunities for public involvement in the process shall be provided.

f. WSDOT funding of construction and operation and maintenance of local or private stormwater systems receiving highway runoff. Such funding shall be in accordance with RCW 90.03.525, which governs financial contributions from state highway rights-of-way to stormwater facilities. The WSDOT is encouraged to negotiate its appropriate share of specific or private stormwater facilities receiving highway runoff, as allowed for in RCW 90.03.525.

g. Determining site-specific constraints in implementing best management practices and/or treatment measures for existing highways.

h. An implementation schedule.

Ecology shall, consistent with federal stormwater regulations, write a general Puget Sound basinwide permit for the WSDOT highway system to implement the requirements of the Puget Sound Highway Runoff Rule.

Ecology shall evaluate the WSDOT's existing operation and maintenance programs to ensure that measures are taken by the WSDOT to implement high-priority measures first.

Target Date: Puget Sound Highway Runoff Rule (Chapter 173-270 WAC) was completed June 21, 1991. Implementation is ongoing.

SW-6. Runoff from Federal Facilities

As part of the state certification process under Section 401 of the federal Clean Water Act, Ecology shall require that all NPDES permits for federal facilities, including military bases, written by the EPA contain stormwater controls that: (1) are at least as stringent as those required for industrial facilities in Municipal and Industrial Discharges Program (element P-5), including all toxicant and particulate limits and requirements for monitoring, spill control and public notice; and (2) are consistent with the wetlands protection policies under the Plan. The EPA shall review existing EPA-issued permits and modify any permit as necessary to include such limits and requirements. (See Municipal and Industrial Discharges Program elements P-5 through P-11.) Before considering a Clean Water Act Section 401 certification for a federal facility permit, Ecology shall seek to be familiar with the facility site through joint site visits or inspections with the EPA or through other means (for discharges of waste water from federal facilities, see Municipal and Industrial Discharges Program, element P-11).

Target Date: Ongoing as federal permits are prepared.

SW-7. Stormwater-Related Research and Sensitive Areas

Ecology shall conduct a comprehensive search of the literature to identify and rank stormwater research needs, in collaboration with the Research Program (see element R-1), and report the results.

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7.1. Stormwater-Wetlands Research

Using the expertise of state universities and local governments as appropriate, Ecology, in coordination with the wetlands inventory element, shall continue to fund and participate in research on short- and long-term effects of stormwater quality and quantity on wetland values and functions. Ecology shall cooperate with state and local agencies that are participating in the Puget Sound Wetlands and Stormwater Management Research Program developed by King County, and in the Urban Water Resources Management Program. Ecology shall encourage a research program designed to obtain the data necessary to develop and support policy and regulatory decisions regarding water quality and the management of stormwater discharges entering wetlands that are consistent with wetlands protection policies in the Plan. Results from this research shall be integrated in the updates of the technical manual (element SW-3) and the model ordinances (element SW-4).

7.2. Stormwater-Related Habitat Damage and Sensitive Areas

The Department of Fish and Wildlife, in consultation with the departments of Health and Natural Resources, local governments, and tribes, shall periodically prepare a listing of habitats of fish, shellfish and other aquatic resources that have been damaged by stormwater runoff and combined sewer overflows, and shall identify the most sensitive areas for stormwater and CSO controls. Where possible, sensitive areas should be identified by stream segment. The Department of Fish and Wildlife shall provide this information to the Authority, Ecology and local governments.

7.3. Stormwater, Wetlands, Fisheries, Growth Policy Assessment

In consultation with the EPA, the state departments of Ecology, Transportation, Fish and Wildlife, Natural Resources and Community, Trade & Economic Development, and local and tribal governments the Authority shall promote the development of policies to resolve conflicts regarding competing stormwater management, wetlands protection, and fishery protection program mandates.

Target Date: Ecology's participation in the wetlands research project is ongoing. The Department of Fish and Wildlife shall provide the first listing of sensitive areas by June 30, 1995, and update it as frequently as necessary.

SW-8. CSO Reduction Guidelines

The goal of the guidelines for reducing CSOs shall remain to achieve the greatest reasonable reduction of pollutants from both storm water and sanitary sewage in CSOs. If local governments choose stormwater separation as a CSO reduction technique, best management practices, including a pollution source-control program, shall be required and the effects of storm water on receiving waters shall be monitored by the municipality as required by Ecology. Ecology shall also update the guidelines as necessary and provide technical assistance to local governments implementing the guidelines (element SW-9).

SW-9. CSO Reduction Plans by Cities (or Sewer Districts)

As required by the state Clean Water Act (RCW 90.48.480), each city, sewer jurisdiction or other entity with CSOs[8] shall carry out its plan to achieve

8 Deadline set by current state law. All CSO deadlines in this program are based upon the need to comply with current state law requiring CSO reductions. Cities known to have CSOs, and therefore affected by this requirement, are Seattle (and Metro), Anacortes, Bellingham, Bremerton, Everett, Mount Vernon, Olympia, Port Angeles and Snohomish.

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greatest reasonable reduction of CSOs consistent with Ecology guidelines. The plans should include priority ranking of CSOs, implementation schedules, and provisions for funding the corrections. Ecology will continue to review the plans, develop compliance schedules and modify NPDES permits.

Target Dates: The controls are to be implemented according to a compliance schedule negotiated between Ecology and each jurisdiction. Ecology will ensure compliance as necessary.

MAJOR PUBLIC ACTIONS FOR AUTHORITY REVIEW

1. Ecology guidance for urban stormwater programs (element SW-4).

2. Ecology's model ordinances and guidance (element SW-4) and technical manual (element SW-3).

3. Program for Puget Sound highway runoff (element SW-5).

4. Compliance with the Stormwater and Combined Sewer Overflows Program by local governments, tribes, businesses, industries and federal facilities.

5. Listings of sensitive areas and damaged habitats under subelement SW-7.2.

LEGISLATION REQUIRED

None.

ESTIMATED COSTS

The incremental cost beyond other Clean Water Act requirements of fully implementing the Stormwater and Combined Sewer Overflows (CSOs) Program is estimated to be $90.8 million during the 1995-97 Biennium and $130.8 million during the 1997-99 Biennium. This makes it the most expensive program in the Plan. It should be noted that local governments, industry and business have already made substantial investments to address their stormwater problems. The costs are greatest for elements SW-1, Basic Program and Ordinances, SW-2, Urban Stormwater Management Program, and SW-5, the Puget Sound Highway Runoff Program. Most of these costs are borne by local governments and the state department of transportation.

Although some of the local costs may be supported by the Centennial Clean Water Fund, the bulk of the costs are expected to be funded through the formation of local drainage or utility districts. Comprehensive control of storm water from non-NPDES permitted industrial or commercial facilities is a potentially expensive task, not currently included in cost estimates for the stormwater or municipal and industrial discharges programs. Some additional costs would be borne by private industry and developers ranging from a few thousand dollars for simple erosion and source controls to hundreds of thousands of dollars for stormwater detention and treatment systems.

CSOs

The CSO control programs are expensive. Metro, Seattle and Everett estimated the costs of eliminating their CSOs. Total costs for these cities to control

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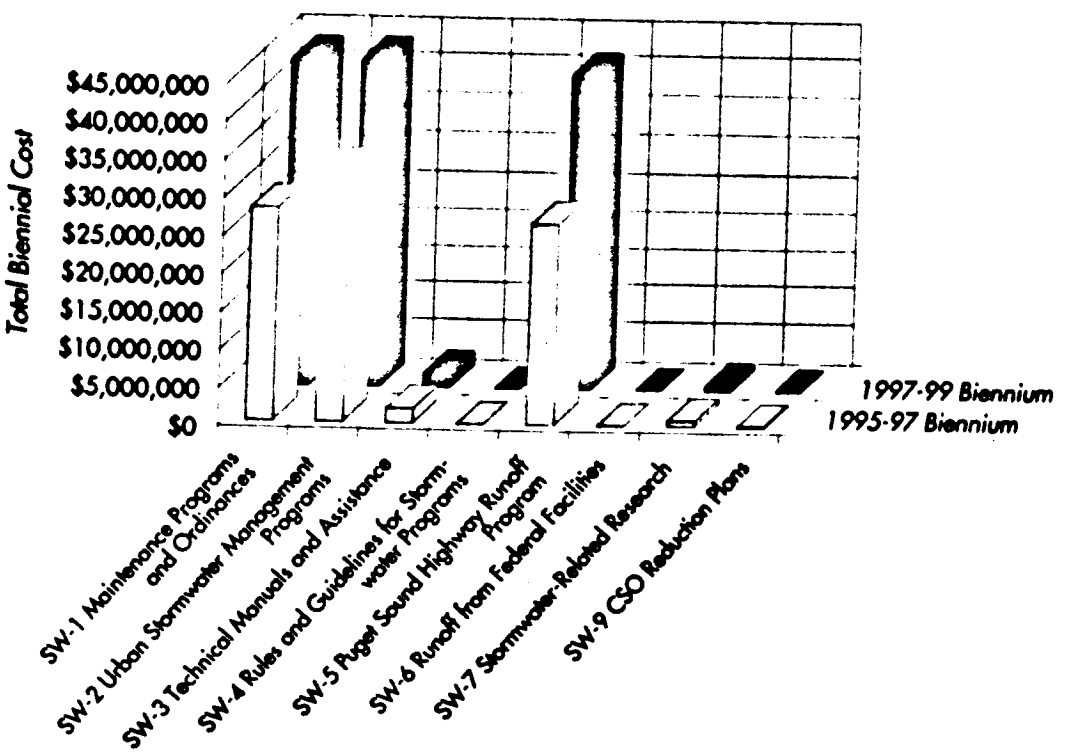
CSOs to the ultimate goal of one overflow per year would be approximately $425 million, of which $289.5 million would be for Metro. Ecology estimated the cost of eliminating CSOs in other cities at $230 million. These costs are a result of existing legal requirements; this Plan does not impose new requirements on CSOs.

Growth Management and NPDES

Many of the costs associated with the Stormwater and Combined Sewer Overflows Program are also called for in growth management planning requirements and under the stormwater NPDES permit program. Both of these factors have resulted in more jurisdictions using Ecology stormwater guidance to comply with the Puget Sound Plan stormwater requirements.

Stormwater and CSOs Program Implementation Estimates



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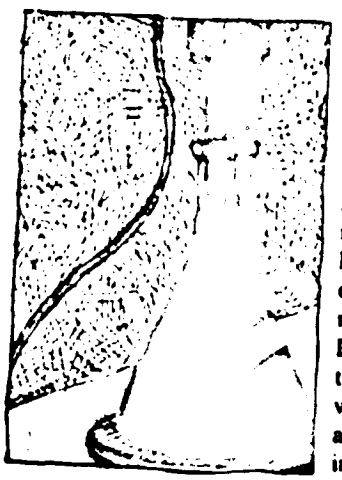
PROBLEM DEFINITION



Many of the programs in the Puget Sound Water Quality Management Plan (Plan), such as Monitoring and Shellfish Protection, depend on accurate and timely laboratory analyses. Laboratories provide information on the presence, concentrations and effects of contaminants in Puget Sound. Lab information is needed to design programs that remedy the effects of contaminants and prevent or limit future contamination.

Many lab analyses are conducted pursuant to federal, state or local laws designed to prevent water quality degradation and threats to human health. For example, the federal Clean Water Act requires routine monitoring of municipal and industrial wastewater discharges. The state Department of Ecology (Ecology) and the U.S. Environmental Protection Agency (EPA) rely on lab results to assess compliance with the law and specific permit requirements, and to determine whether enforcement action is necessary. The state Department of Health (DOH) relies on results of water quality and shellfish tissue analyses to determine whether levels of fecal coliform bacteria are within specific levels designed to protect human health. Laboratory analyses also are conducted for routine ambient monitoring to establish trends and for investigations associated with specific research projects.

Standardized protocols (procedures) for collecting and analyzing many types of environmental samples within Puget Sound exist, but their use is not uniform. The Puget Sound Estuary Program Protocols and Guidelines (PSEP Protocols and Guidelines) were developed to standardize sample collection and analysis within the Sound so that data may be compared and long-term environmental trends determined. Although many agencies increasingly are using the protocols and guidelines, data are still collected that are not comparable.

Standardized, clearly defined quality assurance and quality control (QA/QC) procedures are necessary for many types of analyses. However, when they exist, there is no method for determining the extent to which they are followed, or whether the procedures are uniformly applied across different programs and among different agencies. Consequently, lab results may come into question and may not be helpful.

Analyses of environmental samples within Ecology are performed or contracted by Ecology's environmental laboratory at Manchester. Improvements have been made in sample tracking, management systems, turnaround time, information flow and training of lab users and personnel at the laboratory. However, additional improvements are needed in areas such as predicting how many employees are needed. Samples exceeding laboratory capacity are sent to private (and sometimes public) laboratories for analysis.

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AUTHORITY'S APPROACH

The 1987 Plan called for developing a laboratory certification program to certify the accuracy of laboratory sample collections, and laboratory support for agency sampling programs. A laboratory certification plan would be developed to certify labs in a phased manner.

Revisions to the Plan in 1989 and 1991 directed the Authority, with EPA and Ecology, to develop Puget Sound protocols to assure quality and consistency in handling samples. In addition, Ecology was directed to develop a QA/QC plan and program for sampling and analyses and establish a QA/QC work group to provide continuing oversight.

PROGRAM GOAL

To assure the quality and timeliness of physical, chemical and biological laboratory tests necessary to support the protection and enhancement of the waters of Puget Sound.

PROGRAM STRATEGY

The strategy for achieving this goal is to: (1) establish a laboratory certification program administered by Ecology that will review the capability of environmental laboratories to generate data of known quality; (2) assure that adequate laboratory support exists for agency and other sampling programs; (3) develop and update protocols and guidelines to standardize data collection, analysis and transfer within Puget Sound, and to encourage their use uniformly for all data collected in Puget Sound; and (4) develop and encourage the use of uniform quality assurance guidelines for data collected under all Puget Sound programs.

PROGRAM ELEMENTS

L-1. Laboratory Certification Program

[Completed portions of this element have been deleted.]

Ecology shall continue to implement a laboratory certification (also referred to as "accreditation") program. As a part of the certification program Ecology shall adopt rules requiring all certified laboratories to use approved field and laboratory protocols and to comply with specified quality assurance and quality control procedures. Ecology shall inform all certified labs that the use of adopted PSEP Protocols and Guidelines (element L-3) is required for many Puget Sound plan programs. Ecology shall implement the PSEP Protocols and Guidelines in the Ecology laboratory at Manchester.

Target Dates: Ecology is to continue its ongoing efforts to carry out the lab accreditation program.

L-2. Laboratory Capacity

Ecology shall prepare a biennial laboratory plan that addresses the short- and long-term needs, capacity, and data management of Ecology and other state agencies and of local and tribal governments, and make recommendations regarding means to rectify shortfalls in the ability of the labs to support agency programs. The plan shall: identify target turnaround times and specify accept-

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able holding times[1] for analyses; assess available means to assure that all samples are analyzed within those times while meeting the highest possible quality standards; describe sample tracking and data management systems; include a consideration of the need for additional staff, including night shifts, to fully utilize existing agency lab equipment and facilities; and fully explore the use of lab capacity possessed by other agencies and the use of contract labs before recommending establishment of new lab facilities.

Ecology shall biennially submit to the Authority an updated laboratory plan that includes: (1) a revised estimate of the number and types of analyses needed to support Ecology programs, (2) a review of the services provided by Ecology laboratories including holding and sample turnaround times, data quality and data management during the preceding two years; and (3) an updated analysis of the additional laboratory capacity needed to carry out these analyses within the target turnaround times which Ecology shall specify.

In preparing the laboratory plan, Ecology shall consult with other state agencies, including the departments of Health, Agriculture, and Labor and Industries, and tribal and local governments to incorporate their laboratory needs and capabilities related to the Puget Sound Plan in the reports.

Target Dates: Ecology to submit biennial updates to the laboratory plan.

L-3. Puget Sound Estuary Program Protocols and Guidelines

Ecology, in consultation with the EPA and the Authority, shall develop and implement a process for the review and adoption of PSEP Protocols and Guidelines (element L-1). The process shall provide for development of new protocols and guidelines, for review and revision of existing protocols and guidelines, for assignments to agencies with expertise, and for formal adoption of the protocols and guidelines.

The development and review of the protocols and guidelines shall be assigned to agencies and organizations with technical expertise in fields relevant to the individual protocols and guidelines. The technical experts shall prepare recommendations which shall undergo extensive peer review. Experts from federal and state agencies, local and tribal governments, the private sector, the academic community, and the public shall review protocol development and revisions. In addition, the review group shall outline QA/QC needs for the use of each updated protocol. Ecology shall recommend the PSEP Protocols and Guidelines to the Puget Sound Estuary Program Management Committee for adoption.

New protocols and guidelines shall be developed and existing protocols and guidelines revised as needed and reviewed biennially.

Target Dates: Ecology shall ensure that the existing Puget Sound Estuary Management Protocols and Guidelines are reviewed and revised by July 1995.

1 Turnaround time is the time between submittal of sample to laboratory and receipt of results (after quality assurance) by the requester.

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L-4. Quality Assurance/Quality Control

Ecology has prepared a Quality Assurance Management Plan that addresses quality assurance and quality control issues related to the collection of environmental data in support of Ecology programs and projects. The plan shall be used to ensure uniform quality assurance practices are incorporated into all of Ecology's activities to develop data. Implementation of the plan should include requirements for (1) QA project plans; (2) training in, and technical assistance with, QA/QC principles and practices; and (3) QA audits of selected projects. Ecology QA project plans shall require the use of PSEP Protocols and Guidelines and of data qualifiers and formats for data transfer specified in element M-4 where appropriate.

The QA/QC program shall include the following:

- Establishment of guidelines for the preparation of quality assurance project plans as required by the state/EPA agreement.[2] The guidelines shall include establishment of specific objectives and development of sampling and analysis plans commensurate with objectives for major surveys.
- Audits of data quality (based on selected QA project plans), including checks that sampling and analytical procedures have been correctly performed, and reviews of data to verify that they meet user requirements including data-quality objectives.
- Training for Ecology staff, including training needed to determine the appropriate number and type of samples and analyses for areas of investigation commonly encountered. Training needs will build upon information gained during the planning process and during implementation and oversight of the resulting program.
- QA/QC assistance to the Ecology staff, including guidelines for use by regional office and industrial section staff in reviewing discharge monitoring report (DMR) data, guidelines for use by regional and environmental investigations staff in their evaluation of environmental laboratories, and technical guidance to Ecology staff concerning QA/QC in general.
- Other appropriate measures resulting from issues identified during the planning process.

Target Dates: Ecology provides annual reports on the implementation of the Quality Assurance Management Plan to the Authority beginning July 1, 1994.

MAJOR PUBLIC ACTIONS FOR AUTHORITY REVIEW

1. Revisions to Ecology's QA/QC management plan (element L-4).

LEGISLATION REQUIRED

None.

2 An agreement negotiated annually between the Department of Ecology and the EPA (known as the State/EPA agreement).

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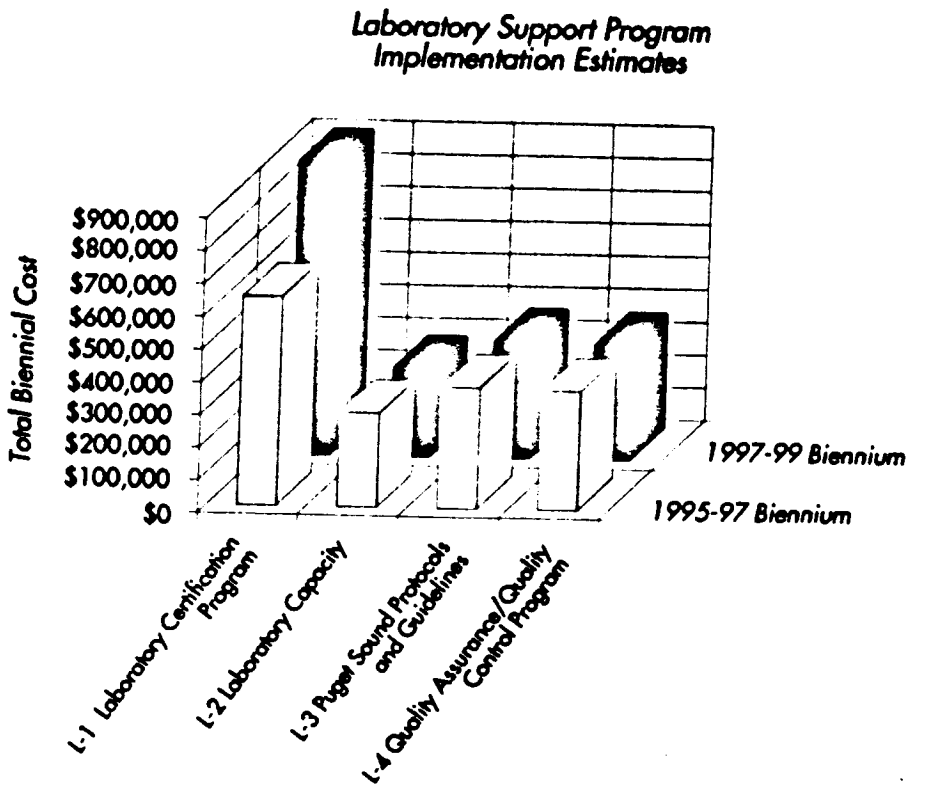
ESTIMATED COST

To fully implement the Laboratory Support Program would cost an estimated 1.7 million during the 1995-97 Biennium and $1.9 million during the 1997-99 Biennium. This money will cover the lab accreditation (certification) program, conducting an ongoing assessment of the needs for laboratory capacity and making recommendations on how to provide for this, and maintaining and updating lab protocols and a quality assurance and quality control program.

Ideally the costs for conducting the certification program (element L-1) will be raised charging fees for lab accreditation reviews. These fees currently generate about $1.3 million statewide. Any increase in fees will be subject to Initiative 601 limitations.

The laboratory certification program may entail private sector costs (beyond the certification fees) to those NPDES (National Pollutant Discharge Elimination System) permit holders not participating in an EPA-approved quality assurance program, to private laboratories and to others who utilize private laboratories. These costs will vary depending upon several factors, including the current quality of the equipment and staff of the lab applying for certification and the protocols called for in the certification program.



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Chapter 3.
The Unfinished Agenda

INTRODUCTION

The action plan contained in Chapter 2 of this document represents a comprehensive program to protect Puget Sound. The Plan consists of 13 programs that address the major threats to the Sound. A number of other issues affecting the health of the Puget Sound environment were reviewed by the Authority as part of the initial scoping of the Puget Sound Plan and during public reviews of the 1989, 1991 and 1994 Puget Sound Water Quality Management Plan. This chapter contains a complete list of unfinished agenda items to be considered by the Authority and the public in the future.

UNFINISHED AGENDA ISSUES, DECISIONS AND CURRENT STATUS

The following topics have been identified as issues the Authority should consider for possible inclusion in future Puget Sound plans:

Aquaculture

Aquaculture in the state of Washington involves the controlled cultivation and harvest of aquatic animals and plants such as shellfish, finfish and edible "sea vegetables" (marine algae). This industry utilizes a number of different methods to produce a wide variety of species, including tideland cultivation, off-bottom culture (for oysters), open-water suspension, net-pen rearing, and pond or tank culture.

There has been substantial public controversy over some aspects of the aquaculture industry, particularly over the floating culture of salmon, shellfish and nori. Opposition to the siting of these aquaculture facilities has focused on potential conflicts with boating, fishing and aesthetic values (such as residential views). Other concerns are related to the potential effects on water quality and bottom organisms. There have been some additional questions about the introduction of disease, antibiotics and competition with natural fishery stocks.

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Contamination of the Sea-Surface Microlayer

The sea-surface microlayer, located at the interface between the water and the air, is only about 0.002 inches (50 micrometers) thick. It is composed of a complex mixture of natural and (sometimes) synthetic substances which float on the surface of the water. The sea surface is a highly productive habitat, supporting an abundance of bacteria, microalgae and planktonic animals that feed on these sources of food. At certain times in their development, the eggs and larvae of many marine animals (e.g., crabs, sole, flounder, cod and hake) are buoyant and may be exposed to contaminants in the sea-surface microlayer.

Contaminants with low solubility in water and contaminants associated with floating particles can become concentrated at the sea surface. Concentrations of contaminants can be orders of magnitude greater in the microlayer than the concentrations of the same contaminants in the underlying water. Substances that have been found to concentrate in the microlayer in Puget Sound include both natural and anthropogenic PAHs, PCBs, pesticides, metals, oils, greases, inorganic nitrogen compounds, and bacteria. Sources of contamination to the sea-surface microlayer may include the atmosphere, petroleum or fuel spills, disposal of dredged material, recreational and commercial boating activities, stormwater runoff and other nonpoint pollution sources, and the water column (e.g., floatable oil and grease and organic matter from wastewater treatment plants or industrial outfalls).

The Environmental Protection Agency (EPA) sponsored a microlayer workshop in 1989. Since being released, the results of that workshop have guided further research.

Effects of Air Pollution on Water Quality

Examples of sources of air pollution include industrial smokestacks, motor vehicle exhausts, woodstoves, aerial spraying of pesticides, evaporation from waste treatment plants, slash burning, landfill gases, incinerator emissions, and release of volatile substances from dry cleaners. Pollutants may enter Puget Sound waters through precipitation or direct fallout. Pollutants may also enter Puget Sound via surface-water runoff that picks up air pollution contaminants that have been deposited on the ground.

Recent studies indicate that atmospheric deposition is a major pathway by which toxic pollutants, such as metals, pesticides, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs) enter the upper Great Lakes. In some coastal areas (such as the southern California Bight) measurements show that up to half of the PAHs and particulate metals entering the water come from direct atmospheric deposition. An EPA-funded study to evaluate atmospheric deposition of toxic contaminants to Puget Sound was completed in 1991 but no immediate actions were recommended.

Freshwater Use and Availability

There are many competing interests for the use of fresh water. Some interests require that water remain in the streams or rivers. For example, fish production depends on adequate in-stream flows and habitat conditions. Hydroelectric power and some recreational activities (such as boating and fishing) also depend on adequate in-stream water supplies. Other activities require diver-

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sion of the water for out-of-stream uses. Industrial, commercial, residential and agricultural users compete for the water that is withdrawn from the stream.

Authority activities have been limited to reviewing and commenting on significant activities, such as the recommendations of the Joint Select Committee on Water Resource Policy and the Water Use Efficiency Study Committee.

Groundwater Contamination

Contaminated groundwater can carry pollutants to the waters of Puget Sound. Groundwater basins can be hydrogeologically linked both to surface waters in the basin and to the Sound itself. Thus, pollutants in ground water can affect water quality in the Sound. Contaminants can reach ground water from a variety of sources including improper disposal of solid or hazardous wastes, failing on-site sewage disposal (septic) systems, spills and accidents, and other activities that allow potential contaminants to migrate underground.

Ground water carrying contaminants to Puget Sound has been confirmed in Commencement Bay, Eagle Harbor and Budd Inlet. Both sites involve wood preserving operations where creosote and other organic compounds have built up in the ground over time and are now visibly seeping into Puget Sound. The direct link between contamination of surface water and ground water is illustrated in the Nooksack River where applications of the pesticide EDB to farm fields has contaminated both surface and ground water.

Hazardous Materials Spill Prevention and Response

Large quantities of petroleum and other hazardous substances are produced, stored and used in the Puget Sound basin. There are thousands of shipments of these substances every year by barge and tanker on Puget Sound, and by air, tank, truck, rail car, and pipeline over and around the Sound. Although the Plan's Spill Prevention and Response Program was revised in the 1994 Plan, the issues related to upland spills have not been addressed in the Plan.

Human Health Risks

Human health risks associated with Puget Sound and its resources can be categorized into two general areas: (1) human health implications associated with direct physical contact with the shorelines or waters of the Sound and (2) health implications associated with the recreational and commercial harvest and ingestion of sea vegetables, shellfish and fish from the Sound.

Concentrations of biological and chemical contaminants are typically highest in urbanized embayments around the Sound. Algae, shellfish and groundfish living near these polluted areas have been found to contain high levels of certain contaminants. While most of the seafood captured in the Sound is probably consumed with no unpleasant or dangerous side effects, the routine ingestion of large quantities of contaminated seafood over a lifetime may pose a health risk to a consumer of Puget Sound resources.

Northwest Straits Marine Sanctuary

By direction of Congress, the National Oceanic and Atmospheric Administration (NOAA) is conducting a study of northern Puget Sound for possible designation as a national marine sanctuary. The study area under consideration

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includes, in general, the waters surrounding the islands of San Juan County; waters off Cherry Point and Lummi Bay in Whatcom County; waters surrounding Cypress Island in Skagit County; waters surrounding Smith and Minor islands and Partridge Banks in Island County; waters surrounding Protection Island in Jefferson County; and waters up to the high-water mark in Discovery Bay, Sequim Bay, and Dungeness Bay and surrounding Dungeness Spit in Clallam County. The proposed western boundary of the study area follows longitude 123° 10' west to the Canadian border. Some or all of the study area could be included if a sanctuary is established.

Title III of the Marine Protection, Research and Sanctuaries Act of 1972 authorizes the Secretary of Commerce to designate specific marine areas as national marine sanctuaries to protect their distinctive conservation, recreational, ecological, historical, research, educational, and aesthetic qualities. The Act is administered by the NOAA through the Office of Ocean and Coastal Resource Management, Marine and Estuarine Management Division.

The planning process for a national marine sanctuary involves the preparation of a draft environmental impact statement/management plan (DEIS/MP) and specific regulations. The DEIS/MP will examine the impacts of designation of northern Puget Sound as a sanctuary, including an analysis of alternatives for protecting and managing the proposed sanctuary's resources. Subsequent steps in the designation process include public hearings on the DEIS/MP and preparation and submission of a prospectus to Congress. If the prospectus is approved by Congress, the final step will include the preparation of a final management plan/environmental impact statement and the development and issuance of sanctuary designation determination and findings. All final terms of the plan must be approved by the governor of Washington.

The proposed boundaries of the Northern Puget Sound Marine Sanctuary lie within the planning area of the Puget Sound Water Quality Management Plan. These overlapping state and federal jurisdictions raise a number of important questions regarding management authorities, responsibilities, and coordinating functions.

Nutrient Effects

Sewage effluent discharged into the fresh and marine waters of the Puget Sound area contains high levels of both organic and inorganic forms of nitrogen and phosphorus. Other sources of excess nutrients include fertilizers, animal wastes, and on-site sewage disposal systems. These nutrients can, in certain instances, stimulate the growth of phytoplankton, sediment microalgae, macroalgae, kelp, seagrasses, and marsh plants, particularly in vertically stratified bays and inlets and along shorelines where nutrients might otherwise be limiting. Excessive phytoplankton growth from human-caused introduction of nutrients can lead to oxygen depletion in the bottom waters. Fish kills and other biological effects may occur as a result of this depleted oxygen.

Although there have been few recent reported fish kills in the marine waters of the Sound, there may be other biological effects from nutrient enrichment that are currently not well understood or are not being detected. For example, there is some evidence that the growth and population dynamics of the plank-

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tonic dinoflagellate *Gonyaulax catenella*, the organisms that causes paralytic shellfish poisoning (PSP), may be influenced in some cases by anthropogenic additions of nutrients. Nutrient inputs may shift the natural population patterns of phytoplankton species and have effects further up the food chain. In addition, macro-algal growth may be enhanced by nutrient additions in the nearshore and shoreline areas of the Sound.

Nutrients may be contributed to the Sound from a variety of sources other than sewage treatment plants. These include storm water, on-site sewage disposal systems, nonpoint runoff from heavily fertilized agricultural and forestlands, industrial discharges (e.g., pulp and paper mills), and atmospheric deposition.

The increased population projected for the Puget Sound area will result in increased nutrient loadings to Puget Sound. Nutrient effects in shallow, stratified bays and inlets around the Sound may increase unless sources of excess nutrients are detected and controlled.

Plastic Debris in Marine Waters

Because of their durability, plastics are causing substantial pollution of marine waters. Plastics have become the most common objects sighted at sea. They typically comprise one-half to two-thirds or more of all surface objects sighted. Studies have indicated that the coasts of Oregon and Washington have one of the highest concentrations of marine plastic debris in the world. In fact, a Japanese survey concluded that the Washington coast had a higher percentage of floating debris than anywhere else in the Pacific.

The most serious concern of plastic debris in marine waters, however, is the harm to marine life though entanglement or ingestion. Entanglement can lead to drowning, starvation, strangulation or predation. Loss of limbs through infection from entanglement is also common.

In December 1988, the Marine Plastic Debris Action Plan for Washington state was released by the Department of Natural Resources. Prepared by the Marine Plastic Debris Task Force, it contains 20 action recommendations for how to reduce and respond to plastic marine debris. The Authority is committed to continuing work on this issue, including possibly adding program language in future plans.

Transboundary Pollution

Washington state and the Canadian province of British Columbia share the Strait of Juan de Fuca and part of the Strait of Georgia. Contaminants entering British Columbia's waters from point and nonpoint sources often end up in the Strait of Georgia and can be transported into Puget Sound. It is unclear exactly how much pollution is transported either way between British Columbia and Washington, but the 1994 report of the B.C./Washington Marine Science Panel identifies increasing threats to the marine waters of British Columbia and Washington.

Treatment of Domestic Wastes

Many elements of the Puget Sound Plan and regulatory programs administered by Ecology and the EPA deal with the treatment of domestic wastes. Howev-

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er, there are a number of issues that deserve further review. Some of these include: the production, treatment, use, and disposal of domestic sludge; the use and effects of chlorine in the wastewater treatment process; and water reuse.

Municipal sewage sludge is the semi-solid material left over after treatment of sewage, while septage is the semi-solid material pumped from septic tanks and marine holding tanks. Sludge may be treated to reduce its volume and to lessen risks to public health and the environment. Treated sludge is a useful fertilizer, and most sludge in the Puget Sound area is applied to the land for silviculture, land reclamation, and composting. Certain risks are associated with the use of sludge due to its contamination with heavy metals, pathogens, and toxic organic compounds. Cadmium in sludge can be taken up by plants and potentially could poison animals or humans. Excessive use of sludge can also contaminate ground water or surface water with nitrates.

Chlorine is applied to waste water in the final stages of treatment to kill bacteria, viruses and protozoans that may be harmful to humans. However, chlorination of sewage effluent may create other problems in the fresh and marine waters where treated waste water is discharged. Chlorine can chemically combine with organic substances in the effluent and form highly toxic chlorinated organic compounds. Chronic toxicity effects have been detected in fish exposed to low concentrations of residual chlorine compounds in water.

Chlorination may kill the microbial organisms (usually fecal coliform and fecal streptococci bacteria) that serve as indicators of the potential presence of harmful organisms while allowing pathogenic viruses and other microorganisms to pass through the treatment process unharmed by the chlorine and undetected (depending on the degree and type of chlorination treatment used). Researchers have found that chlorine-treated wastewater effluent may contain viruses even though no fecal coliform bacteria are present. This is a public health concern because viruses cause many of the diseases that are spread through the presence of domestic waste water, and most of the more dangerous viruses cannot be easily measured with existing technology.

Urban water supply and disposal systems generally take in drinking water from the mountains or from ground water and, after treatment, discharge it to salt water. This water bypasses the rivers, streams, wetlands, lakes and aquifers of the freshwater system with poorly understood effects. Additional consideration should be given to opportunities for reuse and for putting treated wastewater back into the freshwater system.

INCENTIVES

As environmental regulations have become more common, their cost has become apparent to two major groups. Businesses have found that it is very expensive to comply with regulations, particularly when they are very rigid, allowing for little in terms of innovative responses. Government regulators have also found that enforcement of the regulations and the monitoring of compliance is costly. In fact, inadequate resources to fund these activities is a chronic difficulty for government.

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This situation has caused many regulators, environmental planners and business groups to seek new approaches to environmental policy that are at least as effective as traditional regulatory approaches to preventing degradation of the environment. One approach is using market-based incentives to reach predetermined pollution abatement goals. Environment 2010 prepared an issue paper on this topic.

This approach, also called environmental economics, is a way of harnessing the forces of the marketplace in order to most effectively and efficiently achieve specific environmental goals and standards. Government regulators (and the public) establish specific environmental goals. Then mechanisms are brought into play which take advantage of the forces of the marketplace in our economy.

Two types of market-based incentives that have been used or proposed elsewhere are subsidies, to provide a positive inducement to do something, and taxes or fees, which provide a negative incentive.

Subsidies

Subsidies can be both direct and indirect. Government can provide direct financial backing or technical assistance to businesses as they work to develop more efficient and cost-effective practices which generate less waste. This direct form of assistance can be tailored so that it will not be provided unless the business first makes a "good faith" effort on its own. The proposal for a university-based institute to develop pollution control technologies included in the Municipal and Industrial Discharges Program (element P-27) represents a proposed state subsidy of technology development. Indirect subsidies can be provided through various sorts of tax breaks for costs associated with waste reduction. Washington state provides tax benefits for pollution control equipment in certain cases.

Taxes and Fees

Taxes and fees are a way of providing a negative incentive so that a business will be motivated to seek a way of decreasing the amount of wastes that are being generated. The fees would be levied by government in addition to the costs that have to be paid for treatment, storage, or disposal of the waste. Economic theory would hold that this fee or tax should be high enough that it would reasonably cover all of the social costs incurred as a result of the long-term environmental effects of the existence of the waste. The business decision to produce, or continue producing, the waste would then be based on the true costs controlled by the decision. Many of these costs are not normally accounted for today.

It is important to recognize that a market-based incentive system cannot be successful without a major commitment by regulators to enforce the program. Since permits would be for a set quantity of discharge, and the marketable system gives a significant economic value to the exact quantity discharged, monitoring the exact amount discharged by each outfall would be more necessary than with the current technology-based permit system. The method also includes an assumption that it is the total quantity discharged, regardless of its location or form, that affects the environment. Yet in Puget Sound we

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have a pattern of sediment "hot spots" associated with individual discharge points. So a system of marketable discharge permits for Puget Sound would need an additional mechanism to account for the locations of discharges.

OTHER ISSUES

Other issues that have been identified include the special needs of islands, improved and expanded public access to Puget Sound shorelands, protection of sole-source aquifers, and the issue of fecal coliform bacteria contamination generated by seal populations.

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Appendix A. Acronyms

AET—apparent effects threshold

AKART—all known, available, and reasonable treatment

BMP—best management practice

BOD—biochemical oxygen demand

CAO—critical areas ordinance

CCMP—Comprehensive Conservation and Management Plan

CERCLA—Comprehensive Environmental Response, Compensation, and Liability Act (also known as "Superfund")

CFR—Code of Federal Regulations

CSO—combined sewer overflow

CWA—Clean Water Act

CZARA—Coastal Zone Act Reauthorization Amendments

CZM—coastal zone management

CZMA—Coastal Zone Management Act

DCTED—Department of Community, Trade and Economic Development

DEIS/MP—draft environmental impact statement/management plan

DMR—Discharge Monitoring Report

DNR—Washington Department of Natural Resources

DOD—Department of Defense

DOH—Washington Department of Health

DSHS—Washington Department of Social and Health Services (currently known as Washington Department of Health)

EIS—environmental impact statement

EPA—U.S. Environmental Protection Agency

FDA—U.S. Food and Drug Administration

FTE—full-time equivalent

FY—fiscal year

GIS—geographic information system

GMA—Growth Management Act

HCCC—Hood Canal Coordinating Council

HPA—Hydraulic Project Approval

IPM—Integrated Pest Management

ITAT—Interagency Technical Assistance Team

K-12—kindergarten through 12th grade

MGD—millions of gallons per day

MMC—Monitoring Management Committee

MOU—memorandum of understanding

MSD—marine sanitation device

MTCA—Model Toxics Control Act

NEP—National Estuary Program

NEPA—National Environmental Policy Act

NOAA—National Oceanic and Atmospheric Administration

NPDES—National Pollutant Discharge Elimination System

NPS—National Park Service

NRCS—U.S. Natural Resource Conservation Service

OFM—Office of Financial Management

OMS—Office of Marine Safety

OSC—Outer continental shelf

PAH—polycyclic (polynuclear) aromatic hydrocarbon

PCB—polychlorinated biphenyl

PCHB—Pollution Control Hearings Board

PIE FUND—Public Involvement and Education Fund

POTW—publicly-owned treatment works

PSAMP—Puget Sound Ambient Monitoring Program

PSDDA—Puget Sound Dredged Disposal Analysis

PSEP—Puget Sound Estuary Program

PSP—Paralytic Shellfish Poisoning

PSWQA—Puget Sound Water Quality Authority

QA/QC—quality assurance and quality control

RCRA—Resource Conservation and Recovery Act

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RCW—Revised Code of Washington

RMRP—(Pacific Northwest) Regional Marine Research Program

SAO—sensitive areas ordinance

SEPA—State Environmental Policy Act

SMA—Shoreline Management Act

SPCC—spill prevention control and countermeasure

SPI—Superintendent of Public Instruction

TAC—technical advisory committee

TFW—Timber/Fish/Wildlife Project

TMDL—total maximum daily load

UBAT—urban bay action team

USC—United States Code

USFS—U.S. Forest Service

USFWS—U.S. Fish and Wildlife Service

UW—University of Washington

WAC—Washington Administrative Code

WDFW—Washington Department of Fish and Wildlife

WDIS—Wastewater Discharge Information System

WSDOT—Washington Department of Transportation

WPLCS—Wastewater Permit Life Cycle System

WSU—Washington State University

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Appendix B. Glossary

ACUTE TOXICITY
Any toxic effect that is produced within a short period of time, generally 96 hours or less. Although the effect most frequently considered is mortality, the end result of an acute effect could be any harmful biological effect.

AEROBIC
Living, active or occurring only in the presence of oxygen. For example, soil microorganisms which degrade sewage effluent from septic systems need oxygen in order to function.

ALGAE
Aquatic, nonflowering plants that lack roots and use light energy to convert carbon dioxide and inorganic nutrients such as nitrogen and phosphorus into organic matter by photosynthesis. Common algae include dinoflagellates, diatoms, seaweeds and kelp. An algal bloom can occur when excessive nutrient levels and other physical and chemical conditions enable the algae to reproduce rapidly.

AMBIENT MONITORING
Monitoring that is done to determine existing environmental conditions, contaminant levels, rates, or species in the environment, against which future conditions can be compared. This type of monitoring occurs in waters not located in close proximity to direct discharges of pollutants.

AMPHIPODS
Small shrimp-like crustaceans such as sand fleas and related forms. Many live on the bottom (i.e., are benthic) and feed on algae and detritus.

ANADROMOUS FISH
Species, such as salmon, which hatch in fresh water, spend a large part of their lives in the ocean, and return to freshwater rivers and streams to reproduce.

ANTHROPOGENIC
Effects or processes that are derived from human activity, as opposed to natural effects or processes that occur in the environment without human intervention.

APPARENT EFFECTS THRESHOLD (AET)
The highest sediment concentration of an individual chemical contaminant which is not associated with adverse biological effects. Samples with concentrations of contaminants above the AET have always shown adverse biological effects.

AQUACULTURE
The controlled cultivation and harvest of aquatic plants or animals (e.g., edible marine algae, clams, oysters and salmon).

AQUIFER
The underground layer of rock or soil in which ground water resides. Aquifers are replenished or recharged by surface water percolating through soil. Wells are drilled into aquifers to extract water for human use.

AROMATIC
A chemical substance characterized by the presence of at least one benzene ring. These substances may have a strong smell and are often persistent in the environment due to the stability of the benzene ring.

BASELINE STUDY
A study that documents the existing state of an environment to serve as a baseline against which future changes are measured.

BENTHIC ORGANISMS
Organisms that live in or on the bottom of a body of water.

BEST MANAGEMENT PRACTICE (BMP)
A method, activity, maintenance procedure, or other management practice for reducing the amount of pollution entering a water body. The term originated from the rules and regulations developed pursuant to Section 208 of the federal Clean Water Act (40 CFR 130).

BIENNIUM
The Washington State Biennium. WA adopts a two-year budget, which runs from July 1 of odd-numbered years to June 30 of the next odd-numbered year.

BIOACCUMULATION
The process by which a contaminant accumulates in the tissues of an organism. For example, certain chemicals in food eaten by a fish tend to accumulate in its liver and other tissues.

BIOASSAY
A test procedure that measures the response of living plants, animals or tissues to potential contaminants. For example, marine worms have been exposed to the sediments of Puget Sound, and their responses have been used to determine areas in the Sound where the sediments may be harmful to life.

BIOCHEMICAL OXYGEN DEMAND (BOD)
The quantity of oxygen-demanding materials present in a sample as measured by a specific test. A major objective of conventional wastewater treatment is to reduce the biochemical oxygen demand so that the oxygen content of the water body will not be significantly reduced. Although BOD is not a specific compound, it is defined as a conventional pollutant under the federal Clean Water Act.

BIODEGRADATION
The conversion of organic compounds into simpler compounds through biochemical activity. Toxic compounds can sometimes be converted into nontoxic compounds through biodegradation. In some cases complex compounds are first converted into intermediate substances that can

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be more toxic than the original substance.

BIOMAGNIFICATION
The process by which concentrations of contaminants increase (magnify) as they pass up the food web such that each animal in the food web has higher tissue concentrations than did its food. For example, concentrations of certain contaminants can increase as they are passed from plankton to herring to salmon to seals.

BIOTA
The animals, plants and microbes that live in a particular location or region.

BIVALVE
An aquatic invertebrate animal of the class *Bivalvia*. Bivalves, such as clams and oysters, have two shells (valves) and most are filter feeders.

CARCINOGENIC
Capable of causing cancer.

CENTENNIAL CLEAN WATER FUND (CCWF) also known as the WATER QUALITY ACCOUNT
In 1986, legislation was passed creating the Water Quality Account in the state treasury (RCW 70.146). The purpose of the account is to provide financing of water pollution-control facilities and activities. The account receives revenue from a tax on tobacco products. The Department of Ecology, in adopting rules for administration of the account, has named it the Centennial Clean Water Fund.

CERTIFIED SHELLFISH BED
An area where commercial shellfish harvesting is approved by the Washington Department of and Health (DOH), based on measurements of fecal coliform bacteria in the overlying waters. Fecal coliform bacteria are used as an indicator of pathogens that could pose a human-health risk.

CHRONIC TOXICITY
Any toxic effect on an organism that results after exposure of long duration (often 1/10th of the life span or more). The end result of a chronic effect can be death, although the usual effects are sublethal (e.g., inhibited reproduction or growth). These sublethal effects may be reflected by changes in the productivity and population structure of the community.

CLEAN WATER ACT (CWA)
Also known as the federal Water Pollution Control Act (33 U.S.C. 1251 et seq.).

CLEANUP ACTIVITIES
Actions taken by a public agency or a private party to correct an environmental problem. Activities generally consist of the treatment or removal from the environment of contaminants introduced by past practices (for example, capping part of a public park contaminated with carcinogenic compounds or digging up and incinerating soil contaminated with dioxin).

CODE OF FEDERAL REGULATIONS (CFR)
The compilation of federal regulations adopted by federal agencies through the rule-making process. For example, pretreatment regulations are found in 40 CFR 403.

COLIFORM BACTERIA
A type of bacteria that is coil or helix shaped. Fecal coliform bacteria are those coliform bacteria that are found in the intestinal tracts of mammals. The presence of high numbers of fecal coliform bacteria in a water body can indicate the recent release of untreated waste water and/or the presence of animal feces. These organisms may also indicate the presence of pathogens that are harmful to humans. High numbers of fecal coliform bacteria therefore limit beneficial uses of water such as swimming and shellfish harvesting.

COMBINED SEWER OVERFLOW (CSO)
A pipe that discharges untreated waste water during storms from a sewer system that carries both sanitary waste water and storm water. The overflow occurs because the system does not have the capacity to transport, store or treat the increased flow caused by stormwater runoff.

COMBINED SEWER SYSTEM
A wastewater collection and treatment system where domestic and industrial waste water is combined with storm runoff. Although such a system does provide treatment of storm water, in practice the systems may not be able to handle major storm flows. As a result, untreated discharges from combined sewer overflows may occur.

CONFINED DISPOSAL
A dispositional method that isolates dredged material from the environment. Confined disposal may be in aquatic, nearshore, or upland environments.

CONTAMINANT
A substance that is not naturally present in the environment or is present in amounts that can, in sufficient concentration, adversely affect the environment.

CONVENTIONAL POLLUTANT
Conventional pollutants as specified under the Clean Water Act are total suspended solids, fecal coliform bacteria, biochemical oxygen demand, pH, and oil and grease. Today a large number of nonconventional and toxic contaminants are of concern in addition to the conventional pollutants.

CUMULATIVE EFFECTS
The combined environmental impacts that accrue over time and space from a series of similar or related individual actions, contaminants, or projects. Although each action may seem to have a negligible effect, the combined effect can be severe.

DETENTION
The process of collecting and holding back storm water for delayed release to receiving waters.

DISCHARGE, DIRECT OR INDIRECT
The release of waste water or contaminants to the environment. A direct discharge of waste water flows directly into surface waters while an indirect discharge of waste water enters a sewer system.

DISINFECTION
The destruction of infectious agents such as bacteria or viruses.

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Most wastewater treatment plants use chlorine or bromine for disinfection.

DISPOSAL
Methods by which unwanted materials are relocated, contained treated, or processed. Unless contaminants are converted to less harmful forms or removed from the material before disposal, they may be released again into the environment.

DISSOLVED OXYGEN
Oxygen that is present (dissolved) in water and therefore available for fish and other aquatic animals to use. If the amount of dissolved oxygen in the water is too low, then aquatic animals may die. Waste water and naturally occurring organic matter contain oxygen-demanding substances that consume dissolved oxygen.

DOMESTIC WASTEWATER (SEWAGE)
Human-generated waste water that flows from homes, businesses and industries.

DREDGING
Any physical digging into the bottom sediment of a water body. Dredging can be done with mechanical or hydraulic machines, and it changes the shape and form of the bottom. Dredging is routinely done in many parts of Puget Sound in order to maintain navigation channels that would otherwise fill with sediment and block ship passage.

ECOSYSTEM
A community of living organisms interacting with one another and with their physical environment, such as a rain forest, pond or estuary. Damage to any part of a complex system, such as Puget Sound, may affect the whole. A system such as Puget Sound can also be thought of as the sum of many interconnected ecosystems such as the rivers, wetlands, and bays. Ecosystem is thus a concept applied to communities of different scale, signifying the interrelationships that must be considered.

EFFLUENT
The liquid that flows out of a facility or household into a water body or sewer system. For example, the treated liquid discharged by a wastewater treatment plant is the plant's effluent.

ENVIRONMENTAL IMPACT STATEMENT (EIS)
A document that discusses the likely significant impacts of a development project or a planning proposal, ways to lessen the impacts, and alternatives to the project or proposal. EISs are required by the national and Washington state environmental policy acts.

EROSION
Wearing away of rock or soil by the gradual detachment of soil or rock fragments by water, wind, ice and other mechanical and chemical forces.

ESTUARY
A coastal water body where ocean water is diluted by out-flowing fresh water.

FECAL COLIFORM see *COLIFORM BACTERIA*

FECES
Waste excreted from animals.

FOREST PRACTICE
Any activity conducted on or directly pertaining to forestland related to growing, harvesting or processing timber. These activities include but are not limited to: road and trail construction, final and intermediate harvesting, precommercial thinning, reforestation, fertilization, prevention and suppression of disease and insects, salvage of trees, and brush control. Forest practices are subject to regulation by the Washington Department of Natural Resources.

FULL-TIME EQUIVALENT (FTE)
The work one person does in one year—used to estimate costs and people needed to perform certain actions.

FUNGICIDE
A substance that destroys or inhibits growth of fungus.

GEOGRAPHIC INFORMATION SYSTEM
A computer system that allows the display and analysis of geographic information. A GIS could, for example, display wetland boundaries on a city map.

GROUNDFISH
Fish (also known as bottomfish) that live on or near the bottom of water bodies, for example, English sole.

GROUND WATER
Underground water supplies stored in aquifers. Ground water is created by rain that soaks into the ground and flows down until it is collected at a point where the ground is not permeable. Groundwater then usually flows laterally toward a river, lake or the ocean. Wells tap the ground water for use. (See AQUIFER)

GROWTH MANAGEMENT ACT
The state law (RCW 36.70A) that directs local governments to adopt revised comprehensive land-use plans and development regulations. Local governments can incorporate many water quality and habitat protections into their growth management program.

HABITAT
The specific area or environment in which a particular type of plant or animal lives. An organism's habitat must provide all the basic requirements for life and should be free of harmful contaminants. Typical Puget Sound habitats include beaches, marshes, rocky shores, the bottom sediments, intertidal mudflats, and the water itself.

HAZARDOUS WASTE
Any solid, liquid or gaseous substance which, because of its source or measurable characteristics, is classified under state or federal law as hazardous and is subject to special handling, shipping, storage and disposal requirements. Washington state law identifies two categories, dangerous and extremely hazardous. The latter category is more hazardous and requires greater precautions.

HERBICIDE
A substance used to destroy or inhibit growth of vegetation.

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HOLDING TANK
An enclosed container used as part of a sewage disposal system on a boat. The tank is used to temporarily store sewage for later pumpout at a marina pumpout facility.

HUMAN-HEALTH RISK
The risk or likelihood that human health will be adversely affected. Estimating health risks is a complex and inexact practice.

HYDRAULIC PROJECT APPROVAL (HPA)
Under the Hydraulic Code Rules, approval is required from Washington State Department of Fish and Wildlife for certain activities in state waters that support fish life. A project approval is required for activities affecting state waters such as certain forest practices; culvert construction; bridge, pier, and piling construction; bulkheads; boat launches; dredging; etc.

HYDROCARBON
An organic compound composed of carbon and hydrogen; for example, petroleum compounds.

HYDROLOGIC CYCLE
The continual cycling of water between the land, the sea and the atmosphere through evaporation, condensation, precipitation, absorption into the soil, and stream runoff.

IMPERVIOUS SURFACE
A surface that cannot be easily penetrated. For instance, rain does not readily penetrate asphalt or concrete pavement.

INSECTICIDE
A substance, usually a chemical, that is used to kill insects.

INTERFERENCE
A contaminant can interfere with the normal sewage treatment plant process by diminishing the efficiency of the treatment process. For example, a toxic chemical can kill the beneficial bacteria in a treatment plant and interfere with the biological treatment process, thus causing the release of excessively contaminated effluent.

INTERTIDAL AREA
The area between high and low tide levels. The alternate wetting and drying of this area makes it a transition between land and water and creates special environmental conditions and habitats.

LAND USE
The way land is developed and used in terms of the types of activities allowed (agriculture, residences, industries, etc.) and the size of buildings and structures permitted. Certain types of pollution problems are often associated with particular land-use practices, such as sedimentation from construction activities.

LEACHATE
Water or other liquid that has washed (leached) from a solid material, such as a layer of soil or debris. Leachate may contain contaminants such as organics or mineral salts. Rainwater that percolates through a sanitary landfill and picks up contaminants is called the leachate from the landfill.

LIVEABOARD
Those using a boat, other than a houseboat, as a primary dwelling.

LOADING
The total amount of material entering a system from all sources.

MARINE SANITATION DEVICE (MSD)
A device installed on a boat to treat or hold sewage. Section 312 of the federal Clean Water Act requires all vessels with installed toilets to have approved MSDs. Federal regulations describe three types of MSDs: Type I and Type II MSDs are treatment devices, while Type III MSDs are holding tanks.

MARSH
A wetland where the dominant vegetation is non-woody plants such as grasses and sedges, as opposed to a swamp where the dominant vegetation is woody plants like trees.

METABOLISM
All chemical processes occurring within an organism, including both synthesis and breakdown of organic materials.

METALS
Metals are elements found in rocks and minerals that are naturally released to the environment by erosion, as well as generated by human activities. Certain metals, such as mercury, lead, nickel, zinc and cadmium, are of environmental concern because they are released to the environment in excessive amounts by human activity. They are generally toxic to life at certain concentrations. Since metals are elements, they do not break down in the environment over time and can be incorporated into plant and animal tissue.

MICROLAYER, SEA-SURFACE MICROLAYER
The extremely thin (usually estimated as 50 microns) layer at the top of the water. Contamination of this layer is of concern because many contaminants, such as oil, grease, organic toxicants and pathogens, are buoyant in seawater and therefore may concentrate at much higher concentrations in the microlayer than in the water column. The atmospheric deposition of toxicants into the microlayer is also of concern. These contaminant concentrations may pose a danger to fish eggs and other organisms that may come into contact with the water surface.

MICROORGANISMS
Microscopic organisms, (e.g., bacteria, viruses and protozoans) that are not visible to the unaided eye. Some cause diseases in humans, animals and plants; some are important because they are involved in breaking down and stabilizing sewage and solid waste.

MODEL ORDINANCE
A sample ordinance which contains elements and language necessary to achieve a desired regulatory effect.

MONITOR
To systematically and repeatedly measure conditions in order to track changes. For example, dissolved oxygen in a bay might be

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monitored over a period of several years in order to identify trends in concentration.

MUNICIPAL DISCHARGE
Effluent from a municipal sewage treatment plant.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
A part of the federal Clean Water Act, which requires point-source dischargers to obtain discharge permits. These permits are referred to as NPDES permits and are administered by the Washington Department of Ecology.

NONPOINT SOURCE POLLUTION
Pollution that enters water from dispersed and uncontrolled sources (such as surface runoff) rather than through pipes. Nonpoint sources (e.g., forest practices, agricultural practices, on-site sewage disposal, and recreational boats) may contribute pathogens, suspended solids, and toxicants. While individual sources may seem insignificant, the cumulative effects of nonpoint source pollution can be significant.

NUTRIENTS
Essential chemicals needed by plants or animals for growth. If other physical and chemical conditions are optimal, excessive amounts of nutrients can lead to degradation of water quality by promoting excessive growth, accumulation, and subsequent decay of plants, especially algae. Some nutrients can be toxic to animals at high concentrations.

OXYGEN-DEMANDING MATERIALS
Materials such as food waste and dead plant or animal tissue that use up dissolved oxygen in the water when they are degraded through chemical or biological processes. Biochemical oxygen demand (BOD) is a measure of the amount of oxygen consumed when a substance degrades.

PARALYTIC SHELLFISH POISONING (PSP)
An illness, sometimes fatal to humans and other mammals, caused by a neuro-toxin produced by a type of plankton called *Gonyaulax*. During certain times of the year and at certain locations, these organisms proliferate in "blooms" (sometimes called red tides) and can be concentrated by clams, mussels, and other bivalves. The nervous system of affected shellfish is unaffected. Consumption of the shellfish can cause acute illness in humans and other mammals.

PARAMETER
A quantifiable or measurable characteristic. For example, height, weight, sex and hair color are all parameters that can be determined for humans. Water quality parameters include temperature, pH, salinity, dissolved oxygen concentration, and many others.

PATHOGEN
An agent such as a virus, bacterium or fungus that can cause diseases in humans. Pathogens can be present in municipal, industrial and nonpoint-source discharges to the Sound.

PELAGIC
Associated with or living in the water column as opposed to the bottom or the shoreline.

PERCOLATE
To pass through a permeable substance. For instance, septic effluent and rainfall percolates through soil.

PERSISTENT
Compounds that are not readily degraded by physical, chemical, or biological processes.

PERSISTENT MARINE DEBRIS (PMD)
Plastic, glass, metal, rags and other refuse accidentally or purposely put into the marine environment. The plastic component is often referred to as Marine Plastic Debris (MPD). Marine debris can injure or kill marine life and threatens the safety of swimmers, divers and watercraft.

PESTICIDE
A general term used to describe chemical substances that are used to destroy or control pest organisms. Pesticides include herbicides, insecticides, algicides, fungicides, and others. Many of these substances are manufactured and are not naturally found in the environment. Others, such as pyrethrum, are natural toxins which are extracted from plants and animals.

pH
The degree of alkalinity or acidity of a solution. A pH of 7.0 indicates neutral water while a pH of 5.5 is acid. A reading of 8.5 is alkaline or basic. The pH of water influences many of the types of chemical reactions that will occur in it. For instance, a slight decrease in pH may greatly increase the toxicity of substances such as cyanides, sulfides and most metals. A slight increase may greatly increase the toxicity of pollutants such as ammonia.

PHOTOSYNTHESIS
The process by which plants use light energy to make simple sugars and carbohydrates from carbon dioxide and water.

PLANKTON
Small plants (phytoplankton) and animals (zooplankton) that are suspended in the water and either drift with the currents or swim weakly.

POINT SOURCE
A source of pollutants from a single point of conveyance such as a pipe. For example, the discharge pipe from a sewage treatment plant or a factory is a point source.

POLLUTANT
A contaminant that adversely alters the physical, chemical or biological properties of the environment. The term includes pathogens, toxic metals, carcinogens, oxygen-demanding materials, and all other harmful substances. With reference to nonpoint sources, the term is sometimes used to apply to contaminants released in low concentrations from many activities which collectively degrade water quality. As defined in the federal Clean Water Act, pollutant means dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment,

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rock, sand, cellar dirt, and industrial, municipal and agricultural waste discharged into water.

POLYCHLORINATED BIPHENYLS (PCBs)
A group of manufactured chemicals including about 70 different but closely related compounds made up of carbon, hydrogen and chlorine. If released to the environment, they persist for long periods of time and can biomagnify in food webs because they have no natural usage in the food web. PCBs are suspected of causing cancer in humans. PCBs are an example of an organic toxicant.

POLYCYCLIC or POLYNUCLEAR AROMATIC HYDROCARBONS (PAHs)
A class of complex organic compounds, some of which are persistent and cancer-causing. These compounds are formed from the combustion of organic material and are ubiquitous in the environment. PAHs are commonly formed by forest fires and by the combustion of gasoline and other petroleum products. They often reach the environment through atmospheric fallout and highway runoff.

PRETREATMENT
The treatment of industrial wastewater to remove contaminants prior to discharge into municipal sewage systems.

PRIMARY TREATMENT
A wastewater treatment method that uses settling, skimming and (usually) chlorination to remove solids, floating materials, and pathogens from waste water. Primary treatment typically removes about 35 percent of the BOD and less than half of the metals and toxic organic substances.

PRIORITY POLLUTANTS
Substances listed by the EPA under the federal Clean Water Act as toxic and having priority for regulatory controls. The list currently includes 12 metals, two inorganic compounds, and a 111 natural and artificial organic compounds (111). The list of priority pollutants includes some substances which are not of immediate concern in Puget Sound, and it does not include all known harmful compounds.

PROTOCOL
A standardized procedure for field collection, laboratory analysis, and/or interpretation of samples. Good protocols improve the quality of data and make data from different sources comparable. The Puget Sound Estuary Program protocols were developed under contract to EPA to standardize sample collection and analysis within the Sound, allowing for comparability of data and determination of long-term environmental trends.

PUGET SOUND, WATERS OF
As defined in RCW 90.70.005, all salt waters of the state of Washington inside the international boundary line between Washington and British Columbia, and lying east of 123° 24' west longitude (east of Port Angeles).

PUGET SOUND WATER QUALITY AUTHORITY (AUTHORITY)
The state agency which is responsible for development and oversight of the Puget Sound Water Quality Management Plan.

REGULATED WETLANDS
See section W-2.1.

REGULATORY FRAMEWORK
A particular set of laws, rules, procedures, and agencies designed to govern a particular type of activity or solve a particular problem.

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)
The federal law that classifies and regulates solid and hazardous waste.

REVISED CODE OF WASHINGTON (RCW)
The compilation of the laws of the state of Washington published by the Statute Law Committee. For example, the law that created the Puget Sound Water Quality Authority is incorporated in the code as Chapter 90.70 RCW.

RIPARIAN HABITAT
Riparian ecosystems include the transitional areas between aquatic and terrestrial environments and contains all of the environmental elements that directly contribute to the structural and functional processes of a body of water..

SALINITY
A measure of the quantity of dissolved salts in water.

SALMONID
A fish of the family Salmonidae (as distinct from a salmonoid which is merely a fish that resembles a salmon). Fish in this family include salmon and trout. Most Puget Sound salmonids are anadromous.

SANITARY WASTE WATER
Waste water which includes domestic sewage and may contain pathogens. Sanitary waste water is not sanitary.

SECONDARY TREATMENT
A wastewater treatment method that usually involves the addition of biological treatment to the settling, skimming, and disinfection provided by primary treatment. Secondary treatment may remove up to 90 percent of BOD and significantly more metals and toxic organics than primary treatment.

SEDIMENT
Material suspended in or settling to the bottom of a liquid, such as the sand and mud that make up much of the shorelines and bottom of Puget Sound.

SEPARATED SEWER SYSTEM
A wastewater collection and treatment system where domestic and industrial waste water is separated from storm runoff. A separated system consists of independent sanitary wastewater and stormwater systems. The storm water is generally discharged directly into open water and the sanitary waste water goes to a treatment plant.

SEPTAGE
The sludge and scum material that is pumped out of a septic tank.

SHELLFISH
An aquatic animal, such as a mollusc (clams and snails) or crustacean (crabs and shrimp), having a shell or shell-like exoskeleton.

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SHELLFISH CONTAMINATION
The contamination of certain bivalves (clams, mussels, oysters) which filter water to feed and tend to collect or concentrate waterborne contaminants in their tissues.

SHORELINE DEVELOPMENT
As regulated by the Shoreline Management Act (Chapter 90.58 RCW) the construction over water or within a shoreline zone (generally 200 feet landward of the water) of structures such as buildings, piers, bulkheads, and breakwaters, including environmental alterations such as dredging and filling, or any project which interferes with public navigational rights on the surface waters.

SHORELINE MANAGEMENT ACT (SMA)
The state law (90.58 RCW) that requires local governments to develop a shoreline master program, and requires permits for water and associated land uses. Many local governments promote the protection of wetlands, habitat, and water quality through their shoreline master program.

SLUDGE, WASTEWATER TREATMENT SLUDGE
Semi-solid matter resulting from the treatment of waste water. Some of the contaminants (especially toxic metals) that were in the waste water remain in the sludge after treatment. The treated waste water can be discharged to the Sound, but the sludge must be disposed of elsewhere. Sludge is usually at least partially dried before disposal and if relatively uncontaminated may be added to soil to increase plant growth.

SOLE SOURCE AQUIFER
The single source of ground water for human use in any one area. Areas with a sole source aquifer have no other source of ground water; any contamination of the aquifer could contaminate the entire water supply.

SOURCE CONTROL
A practice, method or technology that is used to reduce pollution from a source; for example, best management practices or end-of-pipe treatment.

STATE ENVIRONMENTAL POLICY ACT (SEPA)
A state law (Chapter 43.21C RCW) that requires state agencies and local governments to consider environmental factors when making decisions on activities, such as development proposals over a certain size, and comprehensive plans. As part of this process, environmental impacts are documented and opportunities for public comment are provided.

STORM DRAIN
A system of gutters, pipes or ditches used to carry storm water from surrounding lands to streams, lakes or Puget Sound. In practice storm drains carry a variety of substances such as sediments, metals, bacteria, oil and antifreeze which enter the system through runoff, deliberate dumping or spills. This term also refers to the end of the pipe where the storm water is discharged.

STORM WATER
Water that is generated by rainfall and is often routed into drain systems in order to prevent flooding.

SUSPENDED SOLIDS
Organic or inorganic particles that are suspended in and carried by the water. The term includes sand, mud and clay particles as well as solids in waste water.

TECHNOLOGY-BASED STANDARDS
Technology-based effluent standards are developed by considering the effluent quality that can be achieved using various process or treatment technologies, and the costs of those technologies, rather than basing effluent standards on the environmental effects of different loadings of pollutants.

TIMBER/FISH/WILDLIFE AGREEMENT (TFW)
An agreement between timber, fish and wildlife interests that promotes the monitoring and protection of fish and wildlife resources as an integral component of forestry management practices.

TOTAL SUSPENDED SOLIDS (TSS)
The weight of particles that are suspended in water. Suspended solids in water reduce light penetration in the water column, can clog the gills of fish and invertebrates, and are often associated with toxic contaminants because organics and metals tend to bind to particles.

TOXIC
Poisonous, carcinogenic or otherwise directly harmful to life.

TOXIC SUBSTANCES AND TOXICANTS
Chemical substances such as pesticides, plastics, detergents, chlorine and industrial wastes that are poisonous, carcinogenic or otherwise directly harmful to life.

TREATMENT
Chemical, biological or mechanical procedures applied to an industrial or municipal discharge or to other sources of contamination to remove, reduce or neutralize contaminants.

TRIBUTYL TIN (TBT)
An organic-metal compound used as an additive in many marine antifoulant paints used to prevent algal and barnacle growth. Tributyl tin is highly toxic to many marine organisms.

TURBIDITY
A measure of the amount of material suspended in the water. Increasing the turbidity of the water decreases the amount of light that penetrates the water column. High levels of turbidity are harmful to aquatic life.

UNCONFINED, OPEN-WATER DISPOSAL
Discharge of dredged material into an aquatic environment, usually by discharge at the surface, without restrictions or confinement of the material once it is released.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (EPA)
The federal agency which administers many federal environmental laws. EPA Region 10, which includes Puget Sound, is headquartered in Seattle.

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UPLAND MANAGEMENT AREA
A mandatory unharvested area for wildlife use and protection in a forest clearcut. These areas typically represent two percent or more of the clearcut area. This term originated from the Timber/Fish/Wildlife Agreement.

VOLATILE
Can be readily vaporized at a relatively low temperature.

WASHINGTON ADMINISTRATIVE CODE (WAC)
Contains all state regulations adopted by state agencies through the rulemaking process. For example, Chapter 173-201 WAC contains water quality standards.

WASHINGTON DEPARTMENT OF ECOLOGY (ECOLOGY)
The state agency which is responsible for developing, implementing, and enforcing many environmental protection laws and policies, including the state Clean Water Act and the Shoreline Management Act. Note that the abbreviation DOE is confusing because the federal Department of Energy uses the same term. Ecology is the preferred term for referring to the Department of Ecology.

WATER COLUMN
The water in a lake, estuary or ocean which extends from the bottom sediments to the water surface. The water column contains dissolved and particulate matter, and is the habitat for plankton, fish and marine mammals.

WATER QUALITY ACCOUNT see CENTENNIAL CLEAN WATER FUND

WATER TABLE
The upper surface of ground water or the level below which the soil is saturated with water.

WATERSHED
The geographic region within which water drains into a particular river, stream or body of water. A watershed includes hills, lowlands and the body of water into which the land drains. Watershed boundaries are defined by the ridges of separating watersheds.

WELLHEAD
The immediate area around the top of a well. Contamination of the aquifer may occur from surface water if the wellhead is not sealed to prevent flow down the well casing.

WETLANDS
Wetlands are defined on the first page of the Wetlands Protection Program.

ZONING
To designate by ordinances areas of land reserved and regulated for different land uses.

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Appendix C.

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Appendix D.

Links between the Growth Management Act and the Puget Sound Plan

Growth Management Act (direction on water quality)	1994 Puget Sound Water Quality Management Plan Element (direction on land use)
Comprehensive Plan "Where applicable, the land-use element shall review drainage, flooding and stormwater run-off in the area and nearby jurisdictions and provide guidance for corrective actions to mitigate or cleanse those discharges that pollute waters of the state, including Puget Sound or waters entering Puget Sound." (RCW 36.70A.070) Identify lands useful for public purposes, such as stormwater management, and a list of lands and their estimated acquisition dates, all to be reflected in the capital budget. (RCW 36.70A.150) Identify open space corridors, including lands useful for wildlife habitat and connecting critical areas. (RCW 36.70A.160)	Wetlands 2.1—Guidance on protecting wetlands through comprehensive plans. Nonpoint 2—Guidance on using the GMA to protect water quality from nonpoint pollution and for incorporating watershed action plans into comprehensive plans. Storm Water 1.5—Guidance for incorporating the local stormwater program into the comprehensive plan. Shellfish 2—Guidance on using comprehensive plans to protect commercial and recreational shellfish areas.
Development Regulations Each county and city shall adopt development regulations that protect critical areas, including wetlands, critical aquifer-recharge areas, fish and wildlife habitat conservation areas, frequently flooded areas, and geologically hazardous areas. (RCW 36.70A.060) Critical areas are to be designated by adopting a policy statement and locating them (classifying, describing general distribution, location and extent) or describing them through performance standards and identified during the permit process. (WAC 365-190-040)	Wetlands 2.1—Guidance on adopting development regulations to protect wetlands. Nonpoint 2—Guidance on implementing watershed action plans by using development regulations. Storm Water 1.5—Guidance for incorporating local stormwater programs into development regulations. Shellfish 2—Guidance on protecting commercial and recreational shellfish areas through development regulations.
Public Involvement Counties and cities shall involve the public in classifying and designating critical areas. (WAC 365-190-040)	Public Involvement 1—Guidance for local governments on public involvement in implementing the Puget Sound Plan.

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Growth Management Act (direction on water quality)	1994 Puget Sound Water Quality Management Plan Element (direction on land use)
Interjurisdictional Coordination "The comprehensive plan of each county or city...shall be coordinated with, and consistent with, the comprehensive plans...of other counties or cities with which the county or city has, in part, common borders or related regional issues." (RCW 36.70A.100)	Nonpoint 2—Guidance for jurisdictions sharing common watersheds to cooperate in analyzing the effects of pollution coming from diffuse sources and to adopt coordinated and consistent programs. Storm Water 1.5—Guidance for jurisdictions sharing common watersheds to cooperate in analyzing the effects of stormwater runoff and to adopt coordinated and consistent programs for managing storm water.

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Appendix E

Section 6217 Coastal Nonpoint Management Measures Addressed through the Puget Sound Water Quality Management Plan

Management Measure	Related Puget Sound Plan Elements*
Agriculture	
Sediment/erosion control	AG-1, AG-3, WP-2, WP-4, WP-5, WP-6, EPI-2, EPI-8
Confined animal facility	AG-1, AG-2, AG-3, WP-2, WP-4, WP-5, WP-6, SF-2, SF-8, EPI-2, EPI-8
Nutrient management	AG-1, AG-3, WP-2, WP-4, WP-5, WP-6, EPI-2, EPI-8
Pesticide management	AG-1, AG-3, PS-2, WP-2, WP-4, WP-5, WP-6, EPI-2, EPI-8
Livestock grazing	AG-1, AG-3, WP-2, WP-4, WP-5, WP-6, EPI-2
Irrigation	AG-1, AG-3, WP-2, WP-4, WP-5, WP-6
Forestry	
Preharvest planning	FP-1, FP-2, FP-3, WP-2, WP-4, WP-6
Streamside Management Areas	FP-1, FP-3, WP-2, WP-4, WP-6, H-4
Road construction/repair	FP-1, WP-2, WP-4, WP-5, WP-6
Road management	FP-1, WP-2, WP-4, WP-6
Timber harvesting	FP-1, FP-3, WP-2, WP-4, WP-6
Site preparation/forest regeneration	FP-1, FP-3, WP-2, WP-4, WP-6
Fire management	N/A
Revegetation of disturbed areas	FP-1, FP-3, WP-2, WP-4, WP-6
Forest chemical management	FP-1, FP-3, WP-2, WP-4
Wetland forest management	WP-2, WP-4, WP-6
Urban	
New development	SW-1, SW-2, SW-3, SW-5, WP-2, WP-4, WP-6, SF-2
Watershed Protection/Site Development	WP-1 through WP-7, SW-1 through SW-5, SF-2, SF-8, FP-2, FP-3, NP-2, EPI-8
Construction erosion/sediment control	SW-1, SW-2, SW-3, SW-4, WP-2, WP-4, WP-6, EPI-5
Construction site chemical control	SW-1, SW-3, WP-2, WP-4
Existing development	SW-1, SW-2, SW-3, SW-4, WP-1 through 7, SF-8
New on site treatment systems	OS-1, OS-3, OS-4, OS-5, SF-2, WP-2, WP-4, WP-6, NP-2
Operating on-site treatment systems	OS-1, OS-2, OS-3, OS-4, OS-5, SF-8, WP-2, WP-4, EPI-2, EPI-5, EPI-8
Pollution prevention	EPI-1, EPI-2, EPI-5, EPI-8, HHW-1, HHW-2, OS-2, OS-3, PS-1, PS-2, WP-2, WP-3, WP-4, WP-6

* See Appendix C. Alphabetical Guide to Elements on page 257 for a description and location of element numbers.

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Management Measure	Related Puget Sound Plan Elements*
Siting roads, highways and bridges	SW-5
Construction projects for roads, highways and bridges (RHBs)	SW-5
Construction-site chemical control - RHBs	SW-5
Operation/maintenance for RHBs	SW-5
Runoff systems for RHBs	SW-5
Marinas & Recreational Boating	
Marina flushing	MB-2
Water quality assessment	MB-2, MB-7
Habitat assessment	MB-2, MB-7
Shoreline stabilization	N/A
Stormwater runoff	MB-2
Fueling station design	N/A
Sewage facilities	MB-2, MB-3, MB-4, MB-5, EPI-8
Solid waste	MB-3, MB-4, EPI-5, EPI-8
Fish wastes	N/A
Liquid material	MB-3, MB-4, EPI-2, EPI-8
Petroleum control	MB-4, EPI-2, EPI-8
Boat cleaning	MB-2
Public education	MB-1, MB-3, MB-4, EPI-1, EPI-2, EPI-8
Maintaining sewage facilities	MB-2, MB-3, MB-5
Boat operation	N/A
Hydromodification *Channel modification (dams, dikes, dredging, etc.)*	
Physical and chemical characteristics of surface waters	W-3, H-5, WP-2, WP-4
In-stream and riparian habitat restoration	W-8, H-2, H-5, H-6, SW-7, WP-2, WP-4
Dams	
Erosion and sediment control	N/A
Chemical and pollutant control	N/A
Protection of surface water quality and in-stream and riparian habitat	N/A
Streambank and Shoreline Erosion	
Streambank and shoreline erosion	W-1 through W-9, H-1 through H-6, M-2, WP-2, WP-4
Wetlands	
Protection of wetlands and riparian areas	W-1 through W-9, WP-2, WP-4
Restoration of wetlands and riparian areas	W-8, H-2, WP-2, WP-4
Engineered vegetated treatment systems	SW-3, SW-7, WP-2, WP-4

* See Appendix C. Alphabetical Guide to Elements on page 257 for a description and location of element numbers.

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URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

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TO: All Holders of Volume 3 of the Urban Storm Drainage Criteria Manual

FROM: Chief, Master Planning Program

SUBJECT: Comments and Address Changes

DATE: September 28, 1992

Although much effort was spent on compiling this manual and in checking it for accuracy, invariably errors and inconsistencies were likely missed. Should you discover what you believe to be errors or would like to suggest changes, additions or improvements, we as you to write us at:

Urban Drainage and Flood Control District
2480 West 26th Avenue, Suite 156B
Denver, Colorado 80211-5500

Attention: Chief, Master Planning Program

As corrections and changes are made to this manual, the District will send them to all manual holders of record. Should your mailing address or the name of your organization change, please be sure to notify us. Most of the revisions will be sent to you free of charge, or for mailing cost only. But we will need your current address in order to provide you with our updates to this manual.

BRU/dm

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STATE OF CALIFORNIA
California Regional Water Quality Control Board
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URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
DENVER, COLORADO

URBAN STORM DRAINAGE CRITERIA MANUAL

VOLUME 3–Best Management Practices

STORMWATER QUALITY

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PREFACE

The purpose of Volume 3 of the *Urban Storm Drainage Criteria Manual (USDCM)* is to provide design guidance for local jurisdictions in selecting and designing best management practices (BMPs) for stormwater quality improvement. The guidance is intended for use by the public, local governments, builders, and land developers in commercial and residential areas and, to a somewhat limited degree, for use in industrial areas.

This volume of the USDCM covers an array of topics related to stormwater quality BMPs and is arranged to contain the following:

- An introduction to stormwater quality management that includes an overview of the manual and explains the selection and use of nonstructural and structural BMPs
- A discussion on stormwater quality and hydrology, urban runoff, and pollutant loadings
- Technical criteria for the structural BMPs recommended for consideration and use in developing residential and commercial areas in the Denver metropolitan area and other areas with similar climate and meteorology
- Technical guidance for structural BMPs that can be used in light industrial and certain commercial establishments (to be developed)
- A description of various nonstructural BMPs and how they may be implemented
- A collection of example structures and their details that could be used in stormwater quality facilities (to be developed)
- Guidance in the selection and use of erosion control practices during construction
- A section discussing ancillary uses of stormwater facilities and potential issues surround them (to be developed)

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The combined Bibliography section for this volume includes references for each chapter to show where additional materials on the topics presented in this manual may be found

The first volume of structural BMP criteria described in this manual is targeted at developing and redeveloping residential and commercial areas. As a result, the 1992 edition of this manual does not address BMPs for light industrial, or other types of land uses, which are being permitted directly by the State of Colorado or the U.S. Environmental Protection Agency. However, as BMPs for these land uses are evaluated and refined, or are promulgated by the State, they may be added to this manual. As a result, Volume 3 is expected to grow and change as the technology of stormwater BMPs matures and is refined over the coming years.

The format of Volume 3 was selected to permit incorporation of revisions and additions as they occur in the future. You can help by sending to us your comments about any changes or additions you would like to see and any corrections that need to be made. We look forward to hearing from you. In the meantime, we hope you find this document useful and of a benefit in your stormwater management endeavors.

The Urban Drainage and Flood Control District

Ben Urbonas, P.E.
Chief, Master Planning Program

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Executive Director

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ACKNOWLEDGEMENTS

The Urban Drainage and Flood Control District (District) wishes to acknowledge all individuals and organizations that contributed to the development and publication of the first edition, dated September, 1992, of the *Urban Storm Drainage Criteria Manual, Volume 3 - Best Management Practices (Manual)*. The list is too numerous to acknowledge everyone individually, for which we apologize. In addition to the organizations listed here, technical guidance and review were provided by many of the members of the Joint Task Force (see list) working or advising on, or assisting with, the preparation of municipal separate storm sewer discharge permit applications for the City and County of Denver, City of Aurora and City of Lakewood. We wish to acknowledge the assistance rendered by the members of this group, not only in the preparation of the *Manual*, but in helping to formulate an approach in how to pursue the development of municipal stormwater discharge permit applications.

The District specifically acknowledges the following organizations and individuals who contributed to the development and publication of this *Manual*:

Urban Drainage and Flood Control District - *Manual*

Ben R. Urbonas, P.E.	Editor-in-Chief and co-author of *Manual*
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LIST OF ABBREVIATIONS

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LIST OF ABBREVIATIONS

>	greater than
<	less than
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
BMPs	Best Management Practices
CSO	Combined Sewer Overflow
DCIA	Directly Connected Impervious Areas
DO	dissolved oxygen
DRCOG	Denver Regional Council of Governments
DRURP	Denver Region Urban Runoff Program
EMCs	event mean concentrations
EPA	Environmental Protection Agency
fps	feet per second
ft	foot/feet
FHWA	Federal Highway Administration
H:V	horizontal to vertical ratio of a slope
mg/L	milligrams per liter
MWCOG	Metropolitan Washington Council of Governments
N/A	not available
NTIS	National Technical Information Service
NURP	Nationwide Urban Runoff Program
NVDPC	Northern Virginia District Planning Commission
ppm	parts per million
SCS	Soil Conservation Service
SEWRPC	Southeastern Wisconsin Regional Planning Commission
TSS	Total Suspended Solids
UDFCD	The Urban Drainage and Flood Control District
USDCM	Urban Storm Drainage Criteria Manual
USGS	United States Geological Survey
WQCV	Water Quality Capture Volume

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STORMWATER QUALITY
MANAGEMENT

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1. STORMWATER QUALITY CHARACTERISTICS AND SOURCES

1.1 General

Urban runoff contains many types and forms of pollutants – some occurring in higher concentrations than found in runoff before development and some that are not naturally present in surface runoff from undeveloped land. Runoff from undeveloped basins contains sediment particles, oxygen-demanding compounds, nutrients, metals, and other constituents. Once developed, pollutant loads increase because surface runoff volumes increase and the sources of many of these pollutants also increase. Also, additional sources of pollutants exist in a basin and find their way into runoff. They may include the following:

- Metals, lubricating compounds, and other constituents originating from vehicles, machinery, and industrial and commercial activities
- Pesticides, herbicides, and fertilizers
- Household solvents, paints, roofing materials, and other such materials
- Pet litter, garbage, and other debris
- Suspended solids washed off impermeable surfaces
- Increased soil erosion during construction activities

A phenomenon termed *first flush* has been discussed for a number of years resulting in mixed conclusions. The first flush represents the higher levels of initial concentrations of constituents that are washed off from a surface at the very beginning of a rainfall event. Some reports include a first flush because of atmospheric fallout that accumulates before a storm occurs. Other reports conclude that there is no first flush, or an insignificant first flush of pollutants in separate, namely, not combined sewer, stormwater runoff. However, by designing facilities to capture and treat the majority of runoff events, first flush becomes irrelevant because it will be captured if it exists. At the same time, most storms will be captured in total if it does not exist.

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1.2 Typical Constituent Concentrations in Urban Runoff

The most recent urban stormwater runoff data for the Denver metropolitan area were collected under an Environmental Protection Agency (EPA)-funded effort by the U.S. Geological Survey (USGS) in 1979 and 1980 (EPA, 1983). The summary of findings is reported in the Denver Regional Council of Governments report, *Urban Runoff Quality in the Denver Area*, dated September 1983. Table 1-1 summarizes the findings for the average event mean concentrations (EMCs) for 15 constituents from residential, commercial, and undeveloped land uses. These results may be somewhat different in stormwater runoff sampled today and will probably need to be revised when new data are available.

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Table 1-1

Average Event Mean Concentrations by Land Use

Constituent	Land Use		
	Residential (mg/L)[a]	Commercial (mg/L)[a]	Undeveloped (mg/L)[a]
Total Phosphorus	0.8	0.8	0.4
Dissolved Phosphorus	0.2	0.2	0.1
Ortho Phosphorus	0.3	0.3	0.1
Total Nitrogen	4.1	5.7	3.4
Total Kjeldahl Nitrogen	3.4	4.3	2.9
Ammonia (as nitrogen)	0.8	1.3	0.1
Nitrate and Nitrite	0.9	1.6	0.5
Lead (Total)[b]	0.3	0.2	0.1
Zinc (Total)[b]	0.3	0.4	0.1
Copper (Total)[b]	0.05	0.07	0.04
Manganese (Total)[b]	0.3	0.4	0.5
Chemical Oxygen Demand	194	260	72
Total Organic Carbon	39	56	26
Dissolved Organic Carbon	19	35	16
Total Suspended Solids	398	370	400

[a]mg/L = milligrams per liter. Concentrations of nitrogen species reported as nitrogen equivalent.
[b]All metals reported as "Total" are the result of a "total recoverable" digestion method.

Source: DRCOG, 1983.

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2. OVERVIEW OF BEST MANAGEMENT PRACTICES

2.1 Nonstructural and Structural BMPs

Urban stormwater runoff has been documented to contain a variety of constituents that originate from a number of different sources. When certain constituents are present in harmful amounts, the potential exists for adverse effects on receiving waters.

Studies such as the Nationwide Urban Runoff Program (EPA, 1983) and the Denver Regional Urban Runoff Program (DRCOG, 1983) have documented concentrations of various constituents in urban stormwater. To reduce the concentrations and the loads of these constituents that reach the receiving waters, various BMPs have been suggested. These BMPs fall into the following two primary categories that include erosion controls during construction:

- Nonstructural–Including the subcategories of pollution prevention BMPs and source control BMPs
- Structural–Including facilities constructed to passively treat urban stormwater runoff before it enters the receiving waters.

The most cost-effective nonstructural BMP is to prevent the disposal of pollutants on the urban landscape and to minimize the migration of pollutants offsite from the point where they are being used, stored, or otherwise being exposed to stormwater. Measures that can prevent deposition of pollutants include public education to reduce improper disposal of household toxics, trash, pet droppings, and used oil. Nonstructural source controls include administrative programs, preventing and controlling erosion during construction, street sweeping, and modified street maintenance practices. Nonstructural source controls used to isolate pollutants from stormwater include covering contaminated areas such as service center gasoline pump islands. Source control BMPs are sometimes termed as "good housekeeping" measures because a clean site will produce less stormwater contamination than will a dirty one. These and other nonstructural BMPs are further addressed in a separate section of this volume.

Structural BMPs are facilities used to reduce runoff and/or remove pollutants from runoff. Examples of structural BMPs are erosion control and sediment entrapment facilities during construction, water

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quality detention (both dry basins and wet ponds), wetlands, porous pavement, and the use of vegetated zones. These BMPs may treat small volumes of stormwater on development sites or serve larger regional drainage areas. Removal is accomplished by adsorption, settling, precipitation, infiltration, filtration, and/or biological activity.

2.2 Stormwater Quality Management Strategy

The selection of the most appropriate BMP categories within a municipality is, for the most part, determined by whether development is in place or has yet to occur. In areas with existing development, relying on nonstructural BMPs is most cost-effective because retrofitting structural controls into a developed area can be very expensive; that is, $3,000 to $20,000 per acre of tributary watershed. Structural controls are more appropriate for new development and significant redevelopment, particularly when they are integrated into the initial planning and design of municipal infrastructure and private development. Figure 2-1 provides a decision flow chart to help one decide when to consider structural and nonstructural BMPs.

Structural BMPs are most cost-effective when included in the planning stages of development. It is recommended that the structural BMPs presented in this manual be integrated into stormwater management planning by public entities and into the site planning process by land developers. Structural BMPs can also be used, in a cost-effective manner, whenever redevelopment or significant improvement occurs within fully developed areas.

An effective strategy for reducing stormwater pollution loads is to use multiple BMPs, including nonstructural measures, source controls, and structural BMPs. A single practice and/or facility cannot generally provide significant reductions in stormwater pollutant loads because these pollutants come from many sources within a municipality. Also, multiple BMPs can provide complementary water quality enhancement to achieve desired results. A multilevel BMP approach, schematically depicted in Figure 2-2, deals with the many pollutant and runoff sources throughout a watershed and shows that whenever feasible, combining most effective BMPs in a series can be an effective strategy to reduce pollutant loads being transported to the receiving waters by stormwater.

2.3 Erosion Control During Construction

Control of construction activities are critical in stormwater quality management. During the relatively short period of time when land is converted from undeveloped to urban uses, a significant amount of

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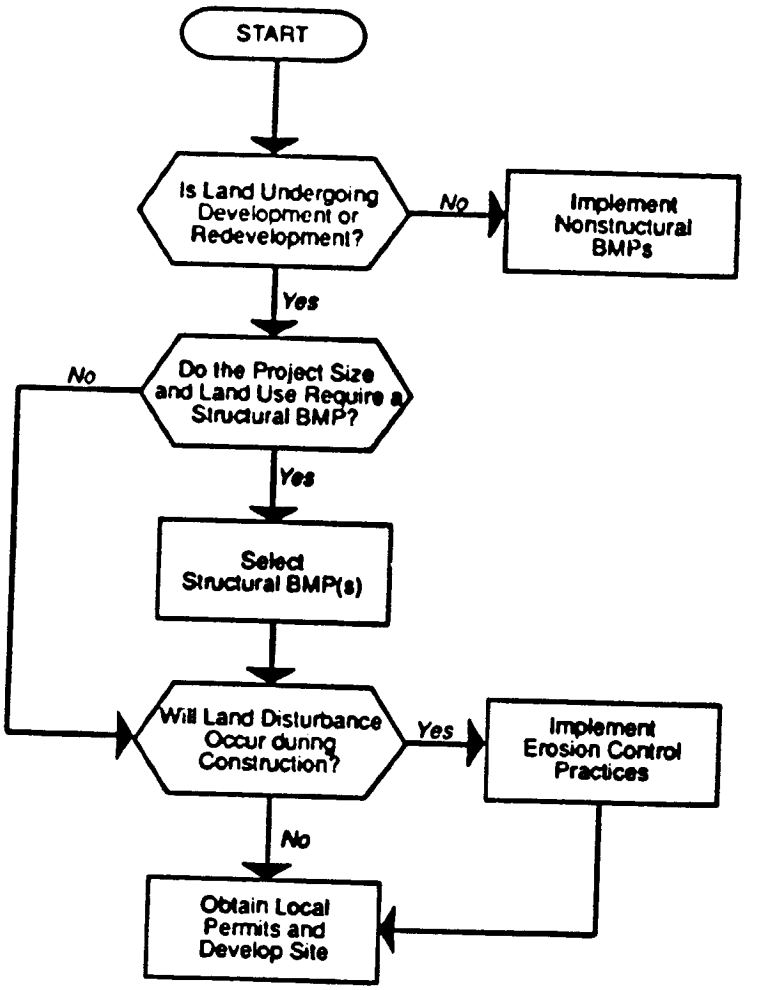

FIGURE 2-1. STORMWATER POLLUTION CONTROL SELECTION FLOW DIAGRAM

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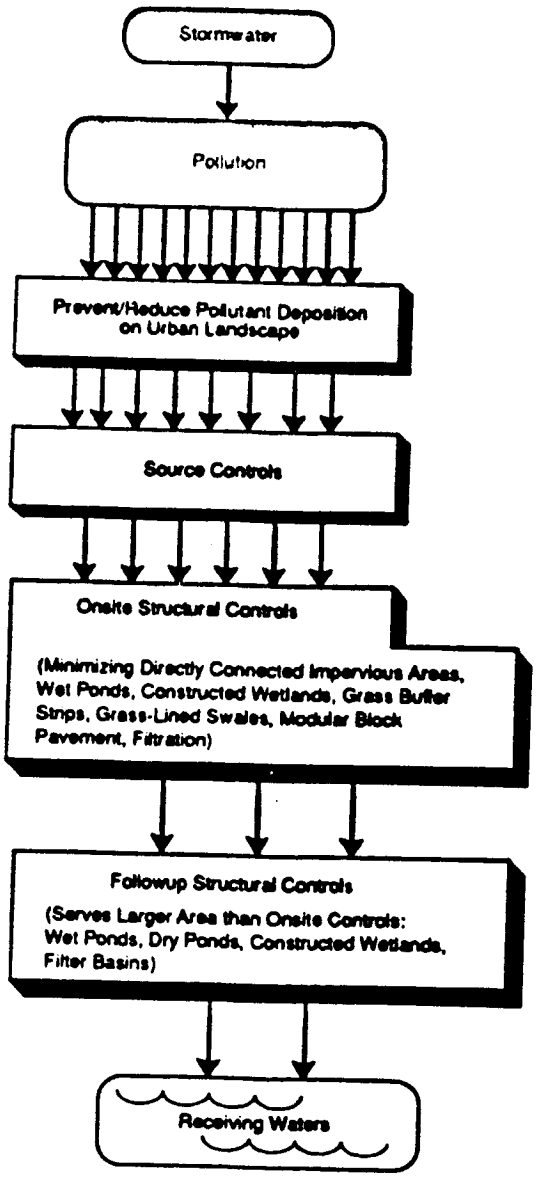

FIGURE 2-2. MULTI-LEVEL STORMWATER QUALITY MANAGEMENT STRATEGY

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sediment can erode from a construction site and be transported to adjacent properties and to receiving waters. If measures are not taken to reduce erosion and to capture sediment in runoff from construction sties, damage can occur to offsite areas and to aquatic habitats in the receiving water system.

Methods are available to limit erosion and sediment losses from a construction site. One of the most effective is to prevent erosion from occurring. Oftentimes large areas are excavated or graded at one time in preparation for construction of site facilities and buildings. By limiting the amount of disturbance that occurs to the landscape at any given time, soil erosion is reduced. Prevention, along with the application of erosion control practices to all areas disturbed during construction, can significantly reduce soil erosion. Finally, the installation of sediment trapping devices at construction sites will ensure that soil erosion and sediment transport offsite is controlled to the maximum extent practicable.

There are many structural and nonstructural options available in the design of an erosion and sediment control plan. It is recommended, however, that the erosion and sediment control plan be developed consistent with the postdevelopment stormwater management goals of the site. Opportunities often exist for converting temporary sediment control structures into permanent structural stormwater BMPs at the end of the construction phase. These options should be explored by the designer of an erosion control plan, final site BMPs, and their eventual owners.

Regardless of the specific details used in an erosion control plan, the goal is to implement erosion and sediment control as a standard practice at all construction sites, and to incorporate it as an integral part of any stormwater quality management strategy. To facilitate sound erosion and sediment control practices during construction, technical criteria were developed, along with a model ordinance for their implementation by local municipalities. These criteria and the model ordinance are contained in the *Erosion Control* chapter of Volume 3 of this Urban Storm Drainage Criteria Manual (USDCM).

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3. USE OF STRUCTURAL BMPs

3.1 Primary Structural BMPs

The structural BMPs listed below were selected after an exhaustive screening of known structural BMPs with representatives of a number of cities and counties in the Denver metropolitan area. Final selection by this group was based on the review of documentation on potential effectiveness in a semiarid climate, local applicability, maintenance considerations and cost. The following BMPs were the ones selected for initial use in the Denver metropolitan area:

- Minimizing directly-connected impervious areas
- Grass buffer strips (irrigated)
- Grass-lined swales
- Extended-detention basins (dry)
- Retention ponds (wet)
- Constructed wetlands
- Modular block porous pavement

Several of the other BMPs that were investigated showed promise, but need further studies to determine their pollutant removal effectiveness in a semiarid climate and to develop cost-effective design criteria to insure that they are properly designed, constructed, and maintained. As additional BMPs are field tested, and as supporting information becomes available, they may be added to this manual. Additional structural BMPs that were also considered, but not included in the September 1992 edition, were sand filters, infiltration basins, and percolation trenches.

The experience in structural BMP design, construction, and maintenance, and the resulting cost per pound of pollutants removed, are limited. The seven structural BMPs presented in this manual are known to be effective in reducing the pollutant loads being transported to the receiving water system. Their true effectiveness, however, will depend on a number of variables, some of which have yet to be identified. As the performance of these and other BMPs are documented and assessed over the coming years, more cost-effective selection, design, and maintenance guidance will be possible.

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3.2 Objectives in the Use of Structural BMPs

The goal of this chapter is to provide planners, engineers, and developers with guidance on how to select structural BMPs for specific projects. Specific BMPs should be implemented with the following objectives in mind:

- An effective level of urban pollutant removal
- An appropriate BMP for the site, given the site's physical constraints
- A reasonably cost-effective BMP in comparison with other BMPs
- A reasonable (that is, not excessive) future maintenance burden
- Minimize, to the maximum extent practical, impacts on receiving waters
- Whenever possible, provision for multiuse benefits, such as parks, green spaces, and landscaping features

3.3 Structural BMP Effectiveness

When selecting the BMPs that are appropriate for a particular site, one needs to consider their pollution-removal efficiencies. Table 3-1 presents the ranges of the removal efficiencies reported in literature for a number of structural BMPs. Although combinations of nonstructural/structural BMPs can improve the overall water quality of the runoff, the effectiveness of several BMPs in their ability to reduce influent pollutant concentrations as a group are not directly additive.

Removal rates by an individual structural BMP are related to the influent stormwater characteristics and the initial concentrations of the constituents in stormwater. For instance, Figure 3-1 shows that in laboratory settling tube experiments with stormwater, the percentage of removed total suspended solids (TSS) increased as the influent concentration increased. Although not shown on Figure 3-1, removal of TSS reaches its lowest point when the initial concentration of TSS is about 10 parts per million (ppm) and it is virtually not possible to discharge water with lower TSS concentrations. At the

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same time, the greatest percent removal in the least amount of time is achieved when initial TSS concentrations are 100 milligrams per liter or more.

3.4 Pollutant Removal Mechanisms

Although runoff may contain many individual pollutants, pollutants are grouped into two general categories in this manual: particulate and soluble. Even though the exact boundary between the two does not need to be defined at this level of design, the boundary lies somewhere around the equivalent particle diameter of 0.4 micron (for example, very fine clays). In many cases, constituents (such as metals and oxygen demand compounds) become adsorbed or attached to particulate matter. Therefore, if the particulate matter is removed, so are the adsorbed or attached constituents.

One, or a combination of up to four basic pollutant removal or immobilization mechanisms, are used by the suggested BMPs to treat stormwater runoff for water quality enhancement. The following is a brief overview of each mechanism:

1. **Sedimentation**–Particulate matter is, in part, settled out of urban runoff. Smaller particles under 60 microns in size (fine silts and clays) (Stahre and Urbonas, 1990) can account for approximately 80 percent of the metals in stormwater attached or adsorbed along with other contaminants and can require long periods of time to settle out of suspension. Fortunately, extended detention allows smaller particles to agglomerate into larger ones (Randall et al, 1982), and for some of the dissolved and liquid state pollutants to adsorb to suspended particles, thus removing a larger proportion of them through sedimentation.

2. **Filtering**–Particulates are removed, in part, from water by filtration. Filtration removes particles by attachment to small-diameter collectors such as sand.

3. **Infiltration**–Pollutant loads in surface runoff are removed or reduced as surface runoff infiltrates or percolates into the ground. Particulates are removed at the ground surface by filtration, while soluble constituents can be adsorbed into the soil, at least in part, as the runoff percolates into the ground. Site-specific soil characteristics, such as permeability, cation exchange potential, and depth to groundwater or bedrock limit the number of sites where this mechanism can be used effectively.

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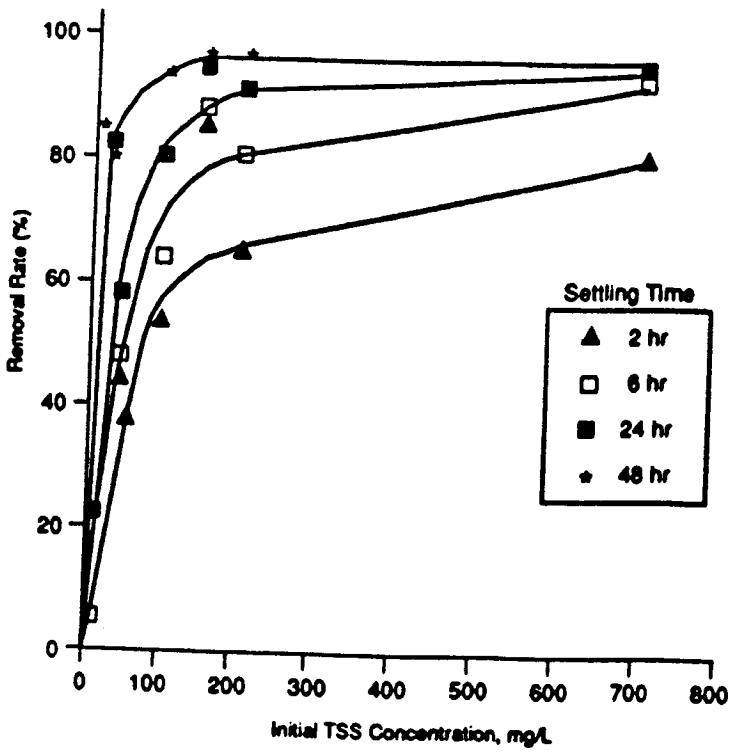

Source: Randall et al, (1982)

FIGURE 3-1. EFFECTS OF INITIAL TSS CONCENTRATION ON REMOVAL RATES

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Table 3-1

Observed BMP Pollutant Removal Efficiencies

Control Alternative	Removal (Percent)[a]				
	SS	T-P	T-N	Zinc	Bacteria
Minimizing Directly Connected Impervious Areas[b]	NA	NA	NA	NA	NA
Grass Buffer Strips (Irrigated)[c]	10-20	0-10	0-10	0-10	N/A
Grass Lined Swales[d]	20-40	0-15	0-15	0-20	N/A
Extended Detention Pond (Dry)[e]	50-70	10-20	10-20	30-60	50-90
Retention Pond (Wet)[d]	60-95	0-80	0-80	0-70	N/A
Constructed Wetlands[d]	41	9-58	0-21	56	N/A
Modular Block Porous Pavement[f]	80-95	65	80-85	99	N/A

Note: N/A = not available.

Sources:

[a]Reported ranges in literature of removal efficiencies.
[b]Removal efficiency depends on combinations of BMPs used. No data reported.
[c]EPA (1983), Grizzard et al. (1982), Whipple and Hunter (1982). Based on field and laboratory data.
[d]EPA (1983). Based on NURP data without regard to design. Shop creek data.
[e]USGS for all constituents except Total P. Based on average performance from 13 sampled runoff events in Orlando, Florida. Lakatos and McNerner (1987) for Total P only. Summary of field data from eight study sites in the eastern United States.
[f]Reported data for porous pavement (Schueler, 1987) are based on computer modelling.
[g]Educated guess; insufficient data to quantify confidence limits.

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4. **Biological Uptake**–Plants and microscopic animals require soluble constituents such as nutrients and minerals for growth. Soluble constituents are ingested or taken up from the water column and concentrated through bacterial action and phytoplankton growth. In some instances, plants could be harvested to remove the constituents permanently. In addition, certain biological activities can reduce toxicity of some pollutants and/or possible adverse effects on higher aquatic species. Unfortunately, not much is understood yet about how biological uptake or activity interacts with stormwater during the relatively brief periods it is in contact with the biological media in most BMPs, with the possible exception of retention ponds between storm events (Hartigan, 1989).

3.5 Structural BMP Selection and Use Guidance

Not all of the structural BMPs presented here are suitable for application at all locations and sites. Their applicability depends on the following:

- The permeability and types of soil underlying the BMP
- The size of the watershed area served and the generated runoff volume in relation to the size of the BMP
- The slopes and geometry of the site
- The amount of base flow (surface water or groundwater)
- The proximity to bedrock to the surface
- The proximity to the seasonal high groundwater table to the surface
- Land uses
- The ability to handle high sediment loads
- The presence or absence of turf irrigation

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Table 3-2 compares the benefits for the primary structural BMPs. The table can be used for general guidance on structural BMP selection. More specific guidance for selecting a particular BMP is presented in the *Structural BMPs* chapter of this volume. It is suggested that the designer complete Worksheet 3-1 before attempting to select the BMPs to use in final design.

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Table 3-2

Comparative Applicability of Structural BMPs

Management Measure	Potential for Use[a]		Relative Capital Cost per Acre Served[b]	Relative O&M Cost[b]		Potential Overall Pollutant Removal Capability	Primary Treatment Mechanism(s)
	Onsite	Followup		Routine	Nonroutine		
Minimize Directly Connected Impervious Areas	Y	N	Low	Low	Low	Low to High[c]	Infiltration Sedimentation
Grass Buffer Strips (Irrigated)	Y	N	Low	Low	Moderate	Low	Sedimentation Infiltration
Grass-Lined Swales	Y	Y	Low	Low	Moderate	Low	Sedimentation Infiltration
Extended Detention Basin	Y	Y	Moderate	Low	Moderate	Moderate/High	Sedimentation
Water Quality Pond	Y	Y	Moderate	Low	Moderate	Moderate/High	Sedimentation Biological Uptake
Wetland Basins	N	Y	Moderate to High	Moderate	High	Moderate/High	Sedimentation Biological Uptake
Wetland Channels	Y	Y	Moderate	Low	Moderate	Low/Moderate	Sedimentation Biological Update
Modular Block Porous Pavement	Y	N	Moderate	Low to Moderate	High	High[c]	Infiltration Filtration

[a]Depends on the size of watershed served if an onsite or a followup treatment BMP will be used.
[b]Based on companion cost analysis report.
[c]Dependent on design, degree of use, local soil, and topography.

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Worksheet 3-1

Site Characteristics Summary Worksheet
For Use As An Aid In Selecting Structural BMPs

A. Contributing basin area = _____ acres

B. Predominant soil in basin is:

_____ Sand
_____ Loamy Sand
_____ Sandy Loam
_____ Loam
_____ Silt Loam
_____ Sandy Clay Loam
_____ Clay Loam
_____ Silty and Clay Loam
_____ Sandy Clay
_____ Silty Clay
_____ Clay

C. Average slope in basin (see Section 2) is: _____ ft/ft

D. Land use (estimate percent of each)

_____ Commercial
_____ Natural Grass Land
_____ Single Family Residential
_____ Multi-family Residential

E. Estimated depth to water table is _____ ft.

F. Estimated depth to impermeable soil layer or bedrock is ___ feet.

Notes:

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4. USE OF NONSTRUCTURAL BMPs

4.1 Primary Nonstructural BMPs

A number of nonstructural BMPs for potential use in urban areas were identified. After evaluating these for effectiveness, feasibility of implementation, cost, and maintenance, a group of local government representatives recommended the following as the nonstructural BMPs for inclusion in this manual:

- Stormwater quality control planning for new developments and redevelopment
- Adoption of stormwater BMP criteria and standards, including standards for erosion and sediment control during construction
- Guidelines and educational programs covering the proper disposal of household waste, litter, pet waste, yard waste, and toxic waste
- Guidelines of pesticides, herbicides, and fertilizer application
- Suggestions on monitoring and elimination of illicit discharges, management of spills, and illegal connections to storm sewer systems
- Landscaping and vegetation practices

The first two items above address the practices and standards associated with new developments and areas undergoing redevelopment. The remainder are applicable to developed areas, whether new or old.

Other nonstructural BMPs were considered for inclusion in this manual, but were deemed at this time to be inappropriate to use, for local governments to require their use by others, or were judged to be ineffective in controlling sources of pollution. Additional nonstructural measures will be examined in the future, and if they prove to be promising in reducing the amount of pollutants being delivered by stormwater to the receiving water system, they will be included in future editions of this manual.

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4.2 Objectives in the use of Nonstructural BMPs

To be effective, nonstructural BMPs need to prevent or reduce the sources of stormwater pollution. They fall into the general categories of prevention and source controls as listed in Figure 2-2. Preventing and controlling the source of pollutants that come in contact with stormwater requires a change in the behavior of the urban population and in the waste disposal practices they employ.

The objectives for promoting the use of nonstructural BMPs are as follows:

- Improve the quality of receiving waters
- Consistency with stormwater quality objectives
- Consistency with structural BMPs
- Cost effectiveness
- Widespread applicability in all urban areas
- Widespread public acceptance

4.3 Nonstructural BMP Effectiveness

The effectiveness of nonstructural BMPs is very difficult, if not impossible, to assess in quantitative terms. Data is unavailable on the baseline amounts of chemical usage in residential and commercial areas, the amounts attributable to improper usage or disposal, the amounts that are washed off by stormwater from these sources, and the level of public participation that will result from implementation of nonstructural programs. As a result, the assessment of their effectiveness is only as accurate as the assumptions made by those making such assessments. It is anticipated that with time, sufficient research will take place to provide data and statistical correlations addressing these questions, which will provide guidance for more quantitative assessments.

The recommendations for the use of nonstructural practices included in this manual are based on the intuitive presumption that some level of water quality improvement will be realized if these practices are implemented. In addition, preventing or reducing the amount of pollutants on the urban landscape have to be more cost effective than attempting to remove these from stormwater using structural controls. It can also be argued that aggressive use of nonstructural measures will reduce concentrations and loads of various pollutants in stormwater being conveyed to downstream structural BMPs or to the receiving waters. This is especially the case in existing urban areas where structural

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controls cannot be easily built, or are extremely expensive to retrofit into the fully-developed urban landscape.

4.4 Pollutant Removal Mechanisms

Nonstructural BMPs can, to some degree, prevent the deposition of pollutants on the urban landscape or remove pollutants at their source. The source of pollutants for assimilation into stormwater is the land surface itself, especially the impervious surfaces in the urban area. Thus, it is hoped that when nonstructural measures are effectively implemented, they will reduce the amount of pollutants being deposited on land surfaces for eventual contact with stormwater and transport to the receiving water system.

4.5 Nonstructural BMP Selection and Use Guidelines

Most nonstructural BMPs are applicable for use in residential, commercial, and industrial areas. This can be said for newly developing areas, recently redeveloped areas, and old neighborhoods as well.

For newly developing and redeveloping areas, nonstructural BMPs include municipal programs to ensure that new urban development and redevelopment incorporates appropriate erosion and sediment control during construction and also construct structural BMPs as a part of the development. Such municipal programs include institutional mechanisms that require the proponents of a new development to prepare and submit stormwater quality control management plans in accordance with the municipality's stormwater BMP design criteria and standards, including the erosion control and stormwater management during construction. These programs need adequate staff and fiscal resources to review and approve development plans and to ensure that the approved stormwater quality provisions of these plans are properly implemented.

The remaining nonstructural BMPs described in this manual, namely those targeted at developed areas, rely primarily on public education and possible enforcement programs. In selecting the appropriate nonstructural pollutant reduction programs to adopt, each municipality needs to evaluate its current land-use condition and the potential for removal of pollutants offered by each of these practices. The specifics for selection and use of each nonstructural BMP effort are described in the *Nonstructural Best Management Practices* chapter of this manual.

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5. STORMWATER QUALITY HYDROLOGY

5.1 Overview

Urbanization affects stormwater runoff by increasing the following:

- The volumes and rates of surface runoff
- The concentrations and the types of pollutants found in stormwater
- The loads of pollutants carried and their transfer rates to receiving waters

Urbanization leads to a decrease in pervious land areas, an increase in impervious areas, and enhanced efficiency of surface runoff. The influx of commercial, residential, and industrial products into an urban area often brings new pollutants that result in concentrations of these pollutants in stormwater greater than before urbanization has occurred. Additional impervious areas can make pollutants more easy to wash off the surface and quicken their conveyance through the watershed. The cumulative effect is that urbanization results in much larger loads of all constituents being washed off than would otherwise occur from nonurbanized land (with the possible exception of nutrients found in runoff coming from irrigated agricultural land), and in the delivery of certain pollutants, such as petroleum-based products not normally found in nonurban and nonindustrial runoff.

The rate of runoff and the extent of pollutant loads depend on the hydrologic conditions that lead to stormwater runoff. Some investigators hypothesize that pollutant loads being delivered by the urban stormwater system are affected by the period between storms (storm separation). They suggest that this period provides time for pollutants in the atmosphere and from other sources to build up on impervious areas. However, the Denver Urban Runoff Evaluation Program studies (Mustard et al., 1985) conducted by the USGS did not support this hypothesis beyond a 2- to 5-day dry buildup period. This is not to say that the above-mentioned hypothesis is not true for other regions of United States.

5.2 Denver Area Precipitation Statistics

Studies of the precipitation records for 36 years from the Denver Stapleton Raingauge have revealed several pertinent hydrologic features. Analyses show that the average storm has an 11-hour duration and that the average time interval between storms (storm separation) is 11.5 days. However, the

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great majority of storms are less than 11 hours in duration. The limited number of extended rainfall periods within the data base tend to increase this average. Table 5-1 summarizes the relationship between total storm depth and the annual number of storms. As the table shows, about 46 of a total of 75 storm events that occur on an annual average basis, or 61 percent, have less than 0.1 inch of precipitation. These storms produce practically no runoff. The table also shows that about 22 of the 30 remaining runoff-producing events, or 75 percent, total between 0.1 inches and 0.5 inches of depth. If runoff can be controlled from most of the storms that range 0.1 inches to 0.5 inches in precipitation, the overall treatment of stormwater runoff in the Denver region should be very effective.

Table 5-1

Number of Rainfall Events in the Denver Area

Total Rainfall Depth (inches)	Average Annual Number of Storm Events
0.0 to 0.1	46.
0.1 to 0.5	22.
0.5 to 1.0	4.7
1.0 to 1.5	1.5
1.5 to 2.0	0.60
2.0 to 3.0	0.30
3.0 to 4.0	0.19
4.0 to 5.0	0.028
>5.0	0
Total	75.318

5.3 Diminishing Returns with Increasing Size of Design Storms

The above analysis and other studies indicate that small-sized, frequently occurring storm events account for the predominate number of events that result in stormwater runoff and the pollution of receiving waters. Consequently, these frequent storms also account for a significant portion of annual pollution loadings from an urban watershed. Capture and treatment of the stormwater from these small and frequently occurring storms is the recommended design approach for water quality enhancement, as opposed to flood control facility designs that focus on less frequent, larger events. Incorporating both sets of criteria into a single stormwater management facility is not only possible,

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but is encouraged. Whenever practicable, combining several objectives, such as water quality enhancement and flood control, maximizes the cost-effectiveness of stormwater management facilities.

The analysis of precipitation data collected from 1948 through 1984 (36 years) at the Denver Stapleton Rain Gauge revealed a relationship between the percent imperviousness of a basin, and the capture volume needed to significantly reduce stormwater pollutants (Urbonas, Guo, and Tucker, 1990). As a result of these studies, water quality facilities are recommended to capture and treat the 80th percentile runoff event. Capturing and properly treating this volume was estimated to remove between 80 and 90 percent of the annual TSS load, while doubling the capture volume was estimated to increase the removal rate by only 1 to 2 percent.

While bigger may appear to be better in the case of stormwater quality, larger basins can provide less holding time for the predominant number of smaller storms. Larger basins can result in less net reduction of pollutants than is obtained when using the recommended 80th percentile capture volume obtained from Figure 5-1. Storms larger than the 80th percentile events still receive some treatment when their capacity is exceeded by larger storms, but at a somewhat lower efficiency. Thus, the law of diminishing returns for cost-effective pollutant removal takes effect, not only because of the large number of small storms found in the total population of storms, but because pollutant removal continues to occur in in-line capture basins when the runoff exceeds their design capacity.

5.4 Determining the Water Quality Capture Volume

5.4.1 Use of Directly Connected Impervious Area. The procedures described in the *Rainfall* and in the *Runoff* chapters of Volume 1 of the *USDCM* are intended for the design of drainages and flood facilities that prevent damage to property and help protect human life. These procedures show that the depth of rainfall produced from a design storm varies somewhat throughout the Denver region and that runoff is a function of total imperviousness. Water quality enhancement focuses more on the smaller events that deliver frequent flow pulses and pollutant loads to the receiving waters. The runoff volume for smaller events is especially sensitive to the impervious area that is hydraulically connected to the stormwater runoff system.

The impervious portion of a watershed determines the runoff volume that needs to be used for the design of water quality facilities, and the percentage of impervious surface therefore becomes important in the design of structural BMPs. The methodology for calculating basin imperviousness is presented in the *Runoff* chapter of Volume 1 of the *USDCM*. This procedure needs to be modified,

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however, when using the practice of *minimizing directly connected impervious areas* in combination with *extended detention basins, retention ponds, wetlands*, and other practices depended on a design capture volume. Whenever applicable, the needed modifications are described in the appropriate *Structural BMP* section.

5.4.2 Water Quality Capture Volume. Extended detention facilities (dry), retention ponds (wet), and wetland basins should be designed to capture and treat runoff equal to the 80th percentile event. This is achieved by draining the design capture volume over a specified time. Extended detention basins need to be designed to drain their design volume in approximately 40 hours. Retention ponds require only a 12-hour drain time because the sedimentation process is more efficient and some mixing and dilution between a permanent dry weather pool and storm runoff occurs. The wet pond also provides for treatment between storms, which provides long periods of time for fine particles to settle out and for biological activity to occur. Wetland basins should be designed to drain the design capture volume in no less than 24 hours, thereby providing for some biological uptake during the contact time with wetland media.

Infiltration-type structural BMPs such as porous pavement shall be designed to capture and treat the runoff from at least a 2-year storm. The use of a 2-year storm is also recommended for the design of slow-moving grass-lined swales and of wetland channels.

The following is a step-by-step procedure for determining the water quality capture volume needed to size extended detention basins, retention ponds, and wetland basins:

1. Determine basin imperviousness.

2. Select either a 12- or 40-hour brim-full volume drain time for the proposed facility. Use a 40-hour detention time for extended detention basins and a 12-hour detention time for retention ponds. For wetland basins, use the arithmetic average of the 12- and 40-hour drain time volumes.

3. Estimate the brim-full storage volume in watershed inches of runoff from Figure 5-1.

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4. Determine the water quality capture volume (WQCV) in acre-feet as follows:

$$WQCV = \left(\frac{\text{Required Storage}}{12}\right)(\text{Area})$$

In which,

Required Storage = Required storage from Figure 5-1 in watershed inches

Area = The tributary drainage area upstream of the water quality enhancement facility in acres

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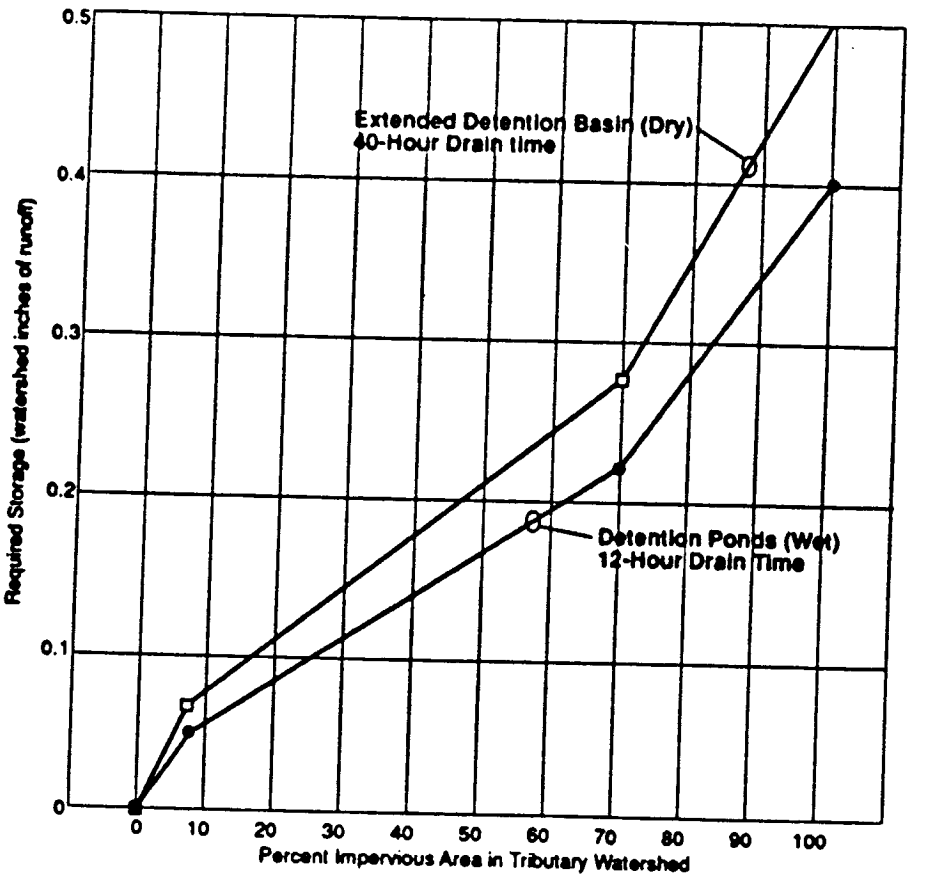

Source: Urbanos, Guo, Tucker (1989)

Note: Watershed inches of runoff shall apply to the entire watershed tributary to the BMP Facility.

FIGURE 5-1. WATER QUALITY CAPTURE VOLUME (WQCV)

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STRUCTURAL BMPs

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1. INTRODUCTION

1.1 Overview

This chapter contains guidance for the design of structural BMPs. This guidance addresses the following items for each BMP:

- Description of the practice
- General application
- Advantages and disadvantages
- Site suitability
- Potential pollutant removal rates
- Design considerations and criteria
- Maintenance requirements
- Cost estimating guidelines

The following BMPs are covered in this chapter:

- Minimizing Directly Connected Impervious Areas
- Irrigated Grass Buffer Strips
- Grass-Lined Swales
- Extended-Detention Basins (dry basins)
- Retention Ponds (wet ponds)
- Constructed Wetlands
- Modular Block Porous Pavement

1.2 Advantages of Using Structural BMPs

Structural BMPs offer the following advantages in newly developing and redeveloping urban areas:

- Enhance stormwater runoff quality
- Can sometimes reduce runoff volumes through infiltration and interception

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- Can reduce peak rates of runoff, especially for smaller storms, by capturing and slowly releasing urban runoff
- Can often be combined with drainage and flood control facilities at very little added cost over the cost of providing facilities for drainage and flood control alone
- Can be constructed first and then be used to control erosion and sedimentation during construction of the remainder of the site
- Can often be combined with other municipal uses such as active and passive recreation, open space, and wildlife habitat
- Can sometimes integrate BMPs into site landscaping to supplement irrigation of vegetation

1.3 Disadvantages of Structural BMPs

The following disadvantages can be associated with structural BMPs:

- Structural BMPs require land and can sometimes limit the density of a new development or redevelopment
- BMPs require ongoing maintenance and will need to be regularly inspected and regulated by each city and county to insure they are properly maintained and are performing as designed
- The use of structural BMPs requires a change in well-established traditional design practices, which will require training and a change in attitudes by municipal officials, planners, engineers, and developers
- BMPs require increased initial capital expenditures to incorporate into a development
- Standing water in BMPs can lead to nuisance problems, such as odors, breeding of mosquitos, and nesting areas for water fowl, as well as potential safety concerns

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- Disposal of deposited sediments will be needed. Unless the sediments are known to be badly contaminated and require disposal to appropriate types of landfills, they probably could be disposed of as land applications at less formal sites.

- When used for erosion and sedimentation control during construction, BMPs will need to be cleaned out and restored to their original design configuration after construction is completed.

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2. MINIMIZING DIRECTLY CONNECTED IMPERVIOUS AREAS

2.1 Description

Minimizing directly connected impervious areas (DCIAs) is a structural BMP strategy that requires a basic change in drainage design philosophy. This change in drainage strategy directs stormwater runoff to landscaped areas, grass buffer strips, and grass-lined swales to slow down the rate of runoff, reduce runoff volumes, attenuate peak flows, and encourage filtering and infiltration of stormwater. Traditional land development practices that do not focus on water quality enhancement promote runoff from rooftops, parking lots, driveways, and roads to quickly flow to a curb and gutter and to a formalized stormwater conveyance system. This practice concentrates runoff quickly, which results in a fast responding system and relatively large peak runoff rates. Minimizing DCIAs can reduce the size of onsite and regional water quality enhancement facilities and the size of downstream conveyance systems. When integrated into new landscaping plans, minimizing DCIAs can divert some of the rainwater to irrigate vegetation by using the runoff from impervious areas.

2.2 Levels of Minimized DCIA Application

Minimizing DCIAs is an onsite stormwater management technique to help improve water quality and to reduce the pollutant load being flushed downstream. It can be made an integral part of drainage planning for any development. Roof collection systems can direct flow to landscaped areas, infiltration areas, grassed buffer strips, and to grass swales. Instead of using solid curbing, slotted curbing could be used along with stabilized grass shoulders and swales. Residential driveway runoff can be redirected from flowing directly into the street. Large parking lots can reduce DCIAs by using modular block porous pavement in less used portions of the lot to encourage local infiltration or storage.

Minimizing DCIAs can be implemented in varying degrees. Three general levels associated with minimizing DCIAs have been identified for the purpose of this manual and are described below:

- Level 1. The primary intent is to direct the runoff generated by impervious surfaces to flow over grass-covered areas, and to provide sufficient travel time so as to encourage the removal of suspended solids before runoff leaves the site, enters a curb and gutter, or enters another stormwater collection system. Thus, at Level 1, *all* impervious

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surfaces are made to drain over grass buffer strips before reaching a stormwater conveyance system.

- Level 2. As an adjunct to Level 1, this level replaces street curb and gutter systems with low-velocity grass-lined swales and pervious street shoulders. Conveyance systems and storm sewer inlets will still be needed to collect runoff at downstream intersections and crossings where stormwater flow rates exceed the capacity of the swales. Small culverts will be needed at street crossings and at individual driveways until inlets are provided to convey the flow to a storm sewer.

- Level 3. In addition to Levels 1 and 2, this level oversizes swales and configures driveway and street crossing culverts to use the grass-lined swales as elongated detention basins having at least the water quality capture volume, but preferably to have additional volume sufficient to also detain the 2-, 5-, 10-, or 100-year runoff. This further slows runoff and provides an added opportunity for infiltration.

By minimizing the DCIAs, runoff volumes from the site should decrease. This decrease translates into reduced demands on downstream stormwater capture basins and stormwater conveyance facilities, at least for storms with return periods of 2 years or less. Initial studies by the Urban Drainage and Flood Control District resulted in the development of Figure 2-1, which relates the total imperviousness in a tributary watershed to the "effective" imperviousness when the DCIAs are minimized within a development to the greatest extent possible, namely Level 3. Figure 2-1 may be used when performing hydrologic calculations and when estimating the required capture volume using Figure 5-1 of the *Stormwater Quality Management* chapter of this volume.

The use of Figure 2-1 is limited to the 2-year and lesser storm events. It should not be used for estimating runoff for larger events. Also, if less than Level 3 of minimizing DCIAs is being used, the *net reduction in imperviousness* shall be reduced using the multiplier provided in Table 2-1.

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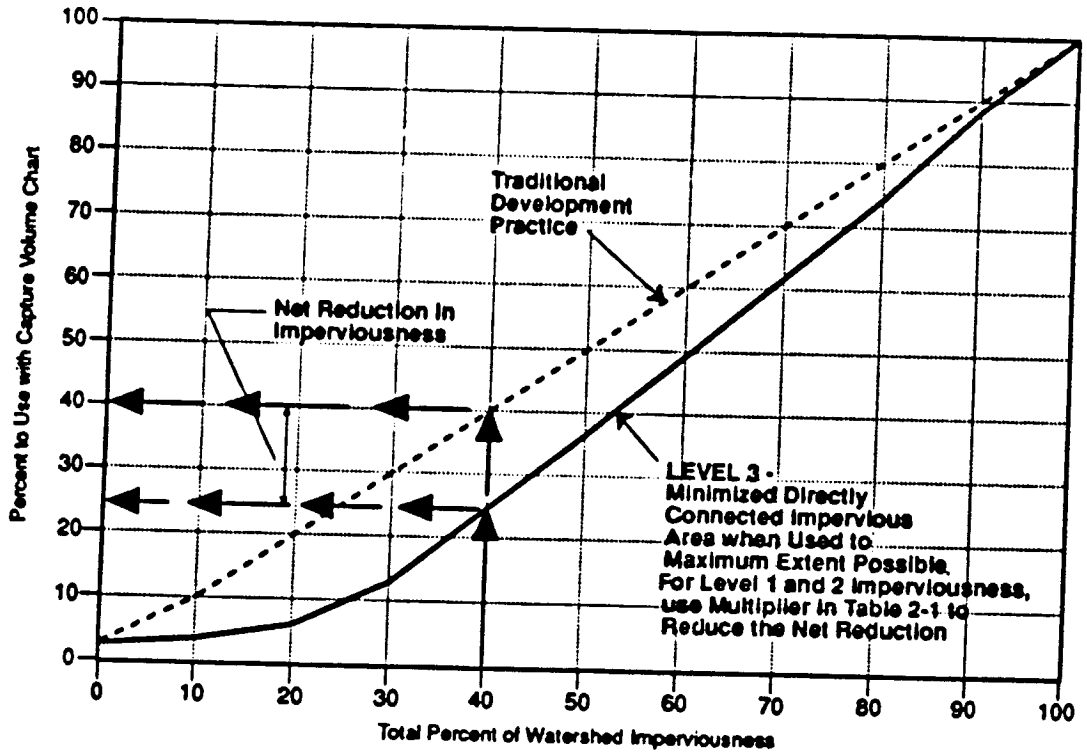

Source: UDFCD BMP STUDIES, 1992.

Note: Use this figure in conjunction with Figure 5-1 of the *Stormwater Quality Management Chapter.*

FIGURE 2-1. IMPERVIOUSNESS TO USE WITH WATER QUALITY CAPTURE VOLUME CHART

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Table 2-1

Multiplier to Apply Against *Net Reduction in Imperviousness* for Levels 1 and 2

Level of Minimized DCIA Practice	Factor by which the *Net Reduction in Imperviousness* Needs to be Multiplied
Level 1	0.25
Level 2	0.50

As an example, if a single-family residential site with a total imperviousness of 40 percent is minimizing DCIA, the effective imperviousness is 24 percent and the *net reduction in imperviousness* for Level 3 is 40% - 24% = 16%. For Level 1 practice, this then becomes 0.25 x 16 = 4%, and for Level 2 practice, this becomes 0.5 x 16 = 8%. Thus, the final effective imperviousness of the development for use in the design of downstream followup structural BMPs and storm drainage systems conveying up to the 2-year floods become as follows:

Practice Level	Effective Imperviousness
Level 1	36% (i.e., 40% - 4%)
Level 2	32% (i.e., 40% - 8%)
Level 3	24% (i.e., directly from Figure 2-1)

As the storm size increases, the effects of reducing DCIAs diminishes, and in Denver's semi-arid climate, probably disappears around the 10-year storm. Thus, some credit for minimizing DCIAs can be taken for up to a 5-year storm. To do so for a 5-year storm, calculate the peak flow using the effective imperviousness obtained from the above described procedure and do so again using total imperviousness of the watershed. For the design of a 5-year system, use the average of the two peak flows.

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2.3 Advantages/Disadvantages

2.3.1 General. A primary advantage of minimizing DCIA is that it decreases runoff peaks, volumes, and pollutant loads at their source. It has a low capital cost. Its use has the potential for decreasing the size of downstream conveyances and treatment facilities through volume reductions and attenuation of flow rates.

The primary disadvantage of minimizing DCIAs is the potential increase in site open space requirements over the traditional development systems and the introduction of a nonconventional development design strategy. Infiltration of water near building foundations and parking lots is a concern that also needs to be considered for certain types of soils and sites.

This practice will likely result in increased maintenance along the swales, which may be offset somewhat by the reduced capital cost of downstream drainage system and its maintenance.

2.3.2 Physical Site Suitability. Site slopes should be capable of directing stormwater runoff by gravity in a sheet flow away from buildings, roads, and parking lots toward grass-covered areas. The runoff then needs to flow as a sheet over these grassed areas before it reaches swales, storage, stormwater collection, and stormwater conveyance systems. As a result, in areas of high permeability soils (Hydrologic Soil Class A and B soils), the ground can provide for infiltration of significant portions of surface runoff.

Steep sites with average terrain slopes exceeding 3 to 4 percent may not lend themselves well to implementing this BMP. Some of the difficulties can be dealt with by using terracing and retaining walls, which can increase costs, however, most sites with general terrain slopes flatter than 3 to 4 percent should be suitable for this BMP; the flatter the better.

2.3.3 Pollutant Removal. The amount of pollutant removed by the use of this BMP is not measurable. It is related, however, to the degree that this practice is employed. Projects with less impervious areas have the greatest potential for reducing pollutant loads. Combining this BMP with a number of other structural BMPs can result in the greatest potential for minimizing pollutant loads. Implementation of this BMP can also help reduce the erosion potential in downstream channels.

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2.4 Planning Considerations and Design Criteria

As discussed above, minimizing DCIA is a design strategy. Figure 2-2 compares traditional site and street drainage design and the strategy of minimizing DCIA. Traditional designs often convey water offsite as quickly as possible and by the shortest route. Minimizing DCIA slows down the rate of runoff leaving the site by directing flow onto grass-covered surfaces before runoff leaves the site.

Specific design guidance for grass filter strips and grass-lined swales that are an integral part of minimizing DCIA are presented in Sections 3 and 4 of this chapter. The following are some of the specific site layout and landscaping considerations that need to be used when minimizing DCIA:

- Design the site drainage flow path to maximize flow over vegetated areas before leaving a site and entering the street gutter or other collection system. Occasional check dams, berms, terracing, and maximized infiltrating areas can enhance water quality leaving a site.

- Minimize ground slopes to limit erosion and slow down the flow, especially around areas with exposed soil such as flower beds or gardens. Stepped terraces with small retaining walls can help to achieve this. Limit ground slopes in accordance with the values tabulated in Table 2-2.

- Select vegetation that will not only survive but also enhance water quality. Dense grasses and other beneficial vegetation will typically require irrigation in semi-arid regions.

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Table 2-2

Maximum Allowable Slopes for Grassed Area When Using Minimized DCIA Site Design

Type of Cover	Maximum Allowable Slope
Irrigated Grass Cover:	
General Site Lot Areas	10H:1V (10%)
Sheet Flow over Swale Sideslope	4H:1V
Nonirrigated Grass Cover:	
General Site Lot Areas	20H:1V (5%)
Sheet Flow over Swale Sideslope	Not Permitted as Part of BMP
Dense Flower Beds	Zero Slope
Sparsely Covered Flower Beds	Not Permitted as Part of BMP

2.5 Maintenance Considerations

Requirements associated with this BMP include maintaining grass and other vegetation, picking up debris, and conducting ongoing inspections to observe possible unintended site erosion and changes in drainage patterns. Sediment buildup in grass swales and grass buffers receiving deicing materials from roads and parking lots will eventually require removal and replacement of damaged grass cover. Refer to Sections 3 and 4 in this chapter on grass-filter strips and grass lined swales for additional guidance and criteria on maintenance needs and practices.

2.6 Cost-Estimating Guidelines for Minimizing DCIAs

The actual costs for minimizing DCIA are difficult to estimate since they depend on the level of action selected for this BMP and how the action may affect the actual cost of site development. A procedure for evaluating costs would be to compare costs of a development area designed using traditional site

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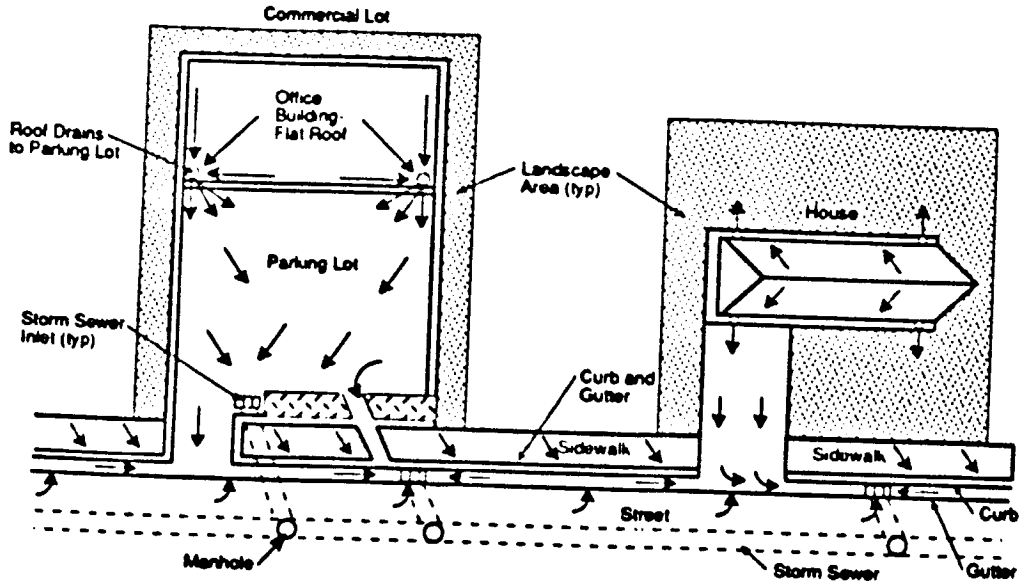
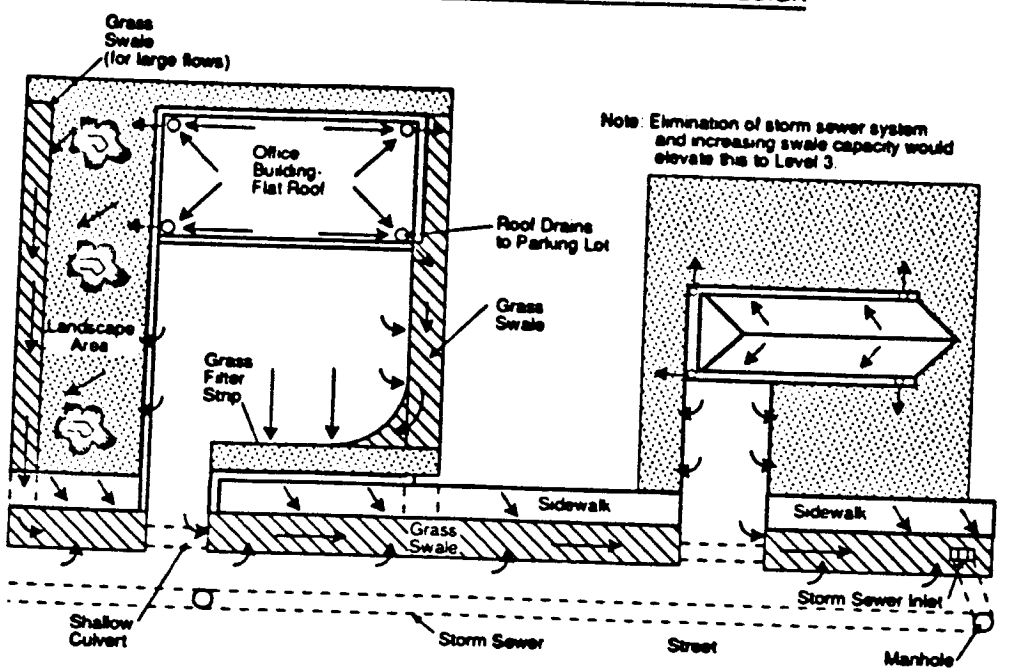


TRADITIONAL SITE & STREET DRAINAGE DESIGN



MINIMIZING DIRECTLY CONNECTED IMPERVIOUS AREAS (LEVEL 2 PRACTICES SHOWN)

FIGURE 2-2. EXAMPLES OF MINIMIZING DIRECTLY CONNECTED IMPERVIOUS AREAS

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drainage to with the one designed to minimize DCIA. Differences in development costs will be related to the following:

- Increased open-space land requirements and right-of-ways, which could possibly be somewhat offset if the additional open space is accepted in part, or in total, by the city or county as part of the open space requirements of the site.

- Decreased peak runoff flow rates and volumes for downstream conveyance and stormwater best management facilities (that is, regional or other onsite BMPs). The cost of installing curbs and gutters is eliminated by this BMP, and the reduced cost of a smaller storm sewer system, smaller follow-up detention/retention BMPs, and narrower residential street pavement can help to either offset the cost of lost right-of-way or may even reduce the total cost of developing a site.

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3. IRRIGATED GRASS BUFFER STRIPS

3.1 Description

Grass buffer strips are uniformly graded and densely vegetated areas of irrigated turf grass. They require sheet flow to promote filtration, infiltration and settling to reduce runoff pollutants. Grass buffer strips differ from grass-lined swales as they are designed to accommodate overland sheet flow rather than concentrated or channelized flow. They can be used to remove larger sediment from sheet flow runoff flowing off impervious areas.

Whenever concentrated runoff occurs, it should be evenly distributed across the width of the buffer strip via a porous pavement strip or another type of structure to achieve sheet-flow conditions. Grass buffers can also be combined with riparian zones in treating sheet flows and in stabilizing channel banks adjacent to major drainageways and receiving waters. Buffer strips can be interspersed with shrubs and trees that can take up nutrients and provide shading. In a semiarid climate, irrigation is required to maintain a healthy and dense grass on the grass buffer strip to withstand runoff from impervious areas.

3.2 General Application

Grass buffer strips can be used in residential and commercial areas and are located adjacent to impervious areas of the site. When used, they should be incorporated into site drainage, street drainage, and master drainage planning. Because their effectiveness depends on having an evenly distributed sheet flow over their surface, the size of the contributing area, and the associated volume of runoff have to be limited. Flow can be directly accepted from an impervious area such as from a parking lot and building roofs, provided the flow is distributed uniformly over the strip with a level spreader device. Grass buffer strips provide only marginal pollutant removal and require that followup structural BMPs be provided. They do, however, help to reduce some of the runoff volume from very small storms.

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3.3 Advantages/Disadvantages

3.3.1 General. The grass and other vegetation provide aesthetically pleasing green space, which can be incorporated into a development landscaping plan. In addition, their use adds little cost to a development that has to provide open space, and their maintenance should be no different than routine maintenance of the site's landscaping. Eventually, the grass strip next to the spreader will have accumulated sufficient sediment to block runoff. At that point in time, a portion of the strip will need to be removed and replaced.

The grass and optional trees can provide wildlife habitat and help reduce runoff through runoff infiltration. If infiltration occurs to any extent, it can reduce the size of downstream facilities. Even though, in some cases, gravel underdrains can be used to provide infiltration, they are being recommended only as an optional feature at this time until more is learned on how such an arrangement operates and how long it will function.

When buffer strips are used over unstable slopes, soils, or vegetation, they can lead to the formation of rills and gullies that disrupt sheet flow. The resultant short-circuiting will invalidate the intended water quality benefits. Grass buffer strip areas should be protected from excessive pedestrian or vehicular traffic that can damage the grass cover and affect even sheet-flow distribution. A mixture of grass and trees may offer benefits for increased slope stability.

3.3.2 Physical Site Suitability. The site, after final grading, should have a uniform slope and be capable of maintaining an even sheet flow throughout. Typical slopes of the site before final grading can range from 2 to 10 percent. (For more guidance, see Table 2-2.) The allowable tributary area depends on the width, length, and the soils that lay under the buffer strip. Hydrologic Soil Groups A and B provide the best infiltration capacity, while Soil Groups C and D provide best site stability. The swelling potential of underlying soils should also be taken into account in how the soils may affect adjacent structures and pavement when water is delivered to the grassed areas.

3.3.3 Pollutant Removal. Pollutant removal depends on many factors such as soil permeability, site slope, the flow path length along the buffer strip, the characteristics of drainage area, runoff volumes and velocities, and the type of vegetation. The general pollutant removal of both particulate and soluble pollutants is projected to be low to moderate. Grass buffer strips rely primarily upon the 781 settling and interception of solids, and to only a minor degree, on biological uptake and runoff infiltration.

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3.4 Planning Considerations and Design Criteria

Grass buffer strip design is based primarily on maintaining sheet-flow conditions across a uniformly graded, irrigated, dense grass cover strip. Figure 3-1 shows potential grass filter strip configurations. Design guidance is presented in Table 3-1. General sizing requirements are used to determine the design width and length of the continuous grass buffer strip.

3.5 Maintenance Considerations

Grass buffer strips require general maintenance of the turf grass cover and repair of any rill or gully development. Table 3-2 presents a summary of specific maintenance requirements and a suggested frequency of action.

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Table 3-1

Grass Buffer Strip Design Considerations and Criteria

Criteria	Design Considerations
Design Length	General guidance suggests applying a hydraulic load no greater than 0.05 cfs/linear foot of buffer strip during a 2-year storm to maintain a sheet flow of less than 1 inch throughout dense grass that is at least 2 inches high.
Design Width	The design width (W_o) (the distance along the sheet flow direction) shall be the greater of the following: $W_o \geq 8$ feet $W_o \geq 0.2\ L_t$ Where: L_t = The length of flow path of the sheet flow over the upstream impervious surface.
Geometry	A rectangular shape strip is preferred and should be free of gullies or rills that concentrate the overland flow.
Flow Distribution	Runoff must be evenly distributed onto the grass strip. Slotted curbing or other spreader devices can be used to apply flows. Concentrated flow needs to use a level spreader to evenly distribute flow onto the strip.
Site Slopes	Slopes can vary and should be selected in accordance with Table 2-1 found in Section 2.0.
Vegetation	Dense turf is needed to promote sedimentation and entrapment and to protect against erosion. Irrigated turf grass should be maintained to a blade height of 2 to 4 inches. The strip typically needs to be irrigated during dry weather. Although trees and other vegetation can increase infiltration, they can cause uneven sheet flow across the strip.
Outflow Collection	Most of the runoff during significant events will not be infiltrated and will require a collection and conveyance system. A grass-lined swale can be used for this purpose and can provide another BMP level. The buffer strip can also drain to a storm sewer or to a street gutter.

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Table 3-2

Irrigated Grass Buffer Strip Maintenance Considerations

Required Action	Maintenance Objective	Frequency of Action
Lawn mowing	Maintain a dense grass cover at a recommended length of 2 to 4 inches. Collect and dispose of cuttings offsite or use a mulching mower.	Routine–As needed or recommended by inspection.
Lawn care	Use the minimum amount of biodegradable, nontoxic fertilizers and herbicides needed to maintain dense grass cover, free of weeds. Reseed and patch damaged areas.	Routine–As needed.
Irrigation	Adjust the timing sequence and water cover to maintain the required minimum soil moisture for dense grass growth. Do not overwater.	As needed.
Litter removal	Remove litter and debris to prevent gully development, enhance aesthetics, and prevent floatables from being washed offsite.	Routine–As needed by inspection.
Inspections	Inspect irrigation, turf grass density, flow distributuon, gully development, and traces of pedestrian or vehicular traffic and request repairs as needed.	Annually and after each major storm (that is, larger than 0.75 inches in precipitation).
Turf replacement	To lower the turf below the surface of the adjacent pavement, use a level flow spreader, so that sheet flow is not blocked and will not cause water to back up onto the upstream pavement.	As needed when water padding becomes too high or too frequent a problem. The need for turf replacement will be higher if the pavement is sanded in winter to improve tire traction on ice. Otherwise, expect replacement once every 5 to 15 years.

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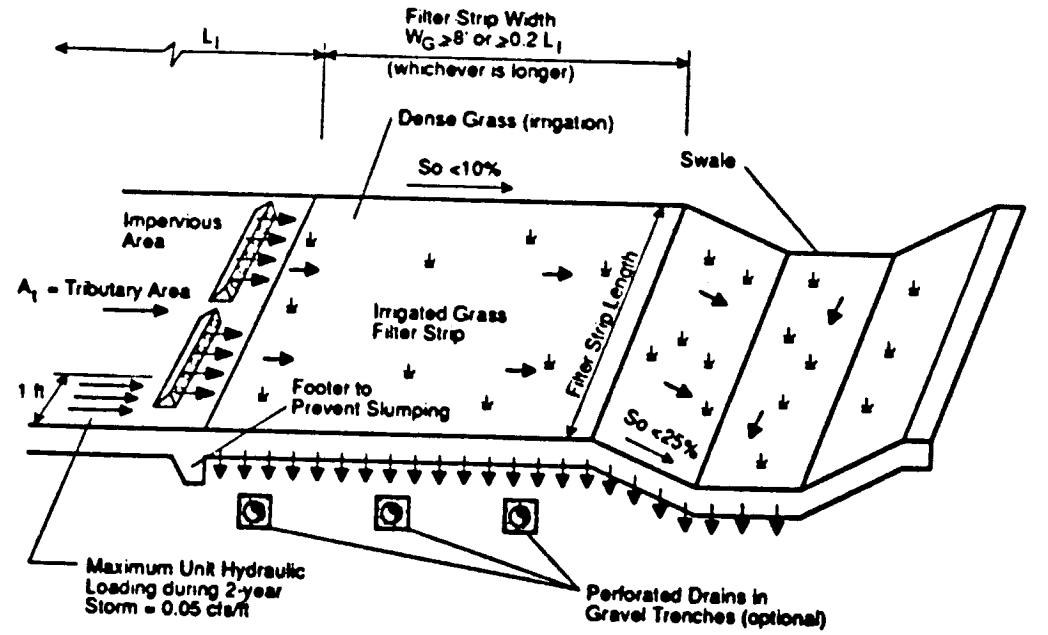
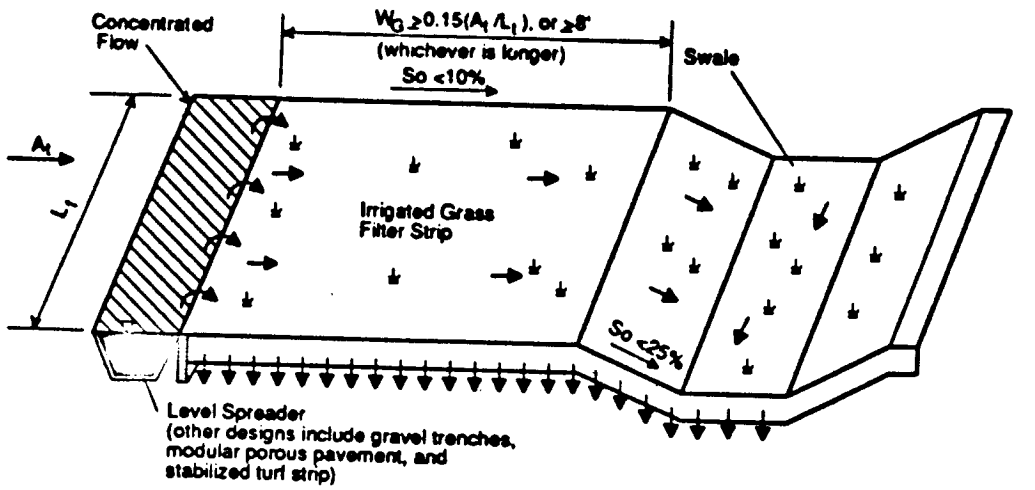


ONSITE FLOW CONTROL



CONCENTRATED FLOW CONTROL

Note: Not to Scale

FIGURE 3-1. ONSITE AND OFFSITE APPLICATIONS OF IRRIGATED GRASS FILTER STRIPS

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4. GRASS-LINED SWALES

4.1 Description

Grass-lined swales are densely vegetated drainageways with low-pitched sideslopes that collect and slowly convey runoff. Design of their longitudinal slope and cross-section size forces the flow to be slow and shallow, thereby facilitating sedimentation while limiting erosion. Berms or check dams should be installed perpendicular to the flow as needed to slow it down and to encourage settling and infiltration.

4.2 General Application

Swales can be located to collect overland flows from areas such as parking lots, buildings, residential yards, roadways and grass buffer strips. They can be made a part of the plans to minimize a directly connected impervious area. Grass-lined swales can be used as an alternative to curb-and-gutter systems. Swales are set below adjacent ground level, and runoff enters the swales over grassy banks. The potential exists for wetland vegetation to become established if the swale experiences standing water or if there is a base flow. A site with a base flow should be managed as either a swale with an unlined trickle channel, or as a wetland bottom channel, the latter providing an additional BMP to stormwater runoff.

In most applications, a followup BMP will be needed to enhance water quality to the maximum extent practicable. However, if a swale is designed to act as an extended detention basin for adjacent runoff, followup BMPs may not be needed, *provided the runoff from adjacent public streets is also intercepted by the swale.*

4.3 Advantages/Disadvantages

4.3.1 General. A grass-lined swale, which can be more aesthetically pleasing than concrete or rock-lined drainage systems, is generally less expensive to construct. Although limited by the infiltration capacity of local soils, this BMP can also provide some reduction in runoff volumes from small storms. Dense grasses can reduce flow velocities and protect against erosion during larger storm events. Swales in residential and commercial settings can also be used to limit the extent of directly connected impervious areas.

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The disadvantages of using grass swales include the possibility of soggy and wet areas in front yards, the potential for mosquito breeding areas, and the potential need for more right-of-way than is needed for a storm sewer.

4.3.2 Physical Site Suitability. Grass swales are practical only at sites with general ground slopes of less than 3 to 4 percent and are definitely not practical for sites steeper than 6 percent. The longitudinal slopes of a swale should be kept to less than 1.0 percent, which often necessitates the use of grade control checks or drop structures. Where the general terrain slope exceeds 3 percent, a grass swale is often practical only on the upslope side of the adjacent street.

When soils with high permeability (for example, Class A or B) are available, the swale can be used to infiltrate a portion of the runoff into the ground, but such soils are not required for effective application of this BMP.

4.3.3 Pollutant Removal. Removal rates reported in literature vary and fall into the low to medium range. Under good soil conditions and low flow velocities, moderate removal of suspended solids and associated other constituents can be expected. If soil conditions permit, infiltration can remove low to moderate loads of soluble pollutants when flow velocities are very low. As a result, small frequent storms can benefit the most. See Table 3-1 in the *Stormwater Quality Management* chapter for known ranges in pollutant removal rates by this BMP.

4.4 Planning Considerations and Design Criteria

Figure 4-1 shows trapezoidal and triangular grass-lined swale configurations; Table 4-1 discusses the design criteria. Swales should be sized to maintain a low velocity during small storms and to collect and convey larger runoff events – all for the projected fully developed land use conditions. If the design flows are not based on fully developed land conditions, the swales will be undersized and will not provide the intended pollutant removal or flow attenuation.

A hearty turf grass must be used so that it will foster dense vegetation, because many storm events occur in early spring when the grass may still be dormant and prone to erosion. Irrigation, fertilization, and erosion protection of newly planted grass or sod are also necessary. Permanent irrigation in some cases may also be necessary. Using swales can possibly replace both curb-and-gutter systems and storm sewer systems in the upper portions of each watershed when properly designed to meet local criteria for the "initial storm" (for example, a 2- or a 5-year storm). However, if one or both sides

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of the swale are to be used as grass buffers also, their design has to follow the requirements of Section 3, *Irrigated Grass Buffer Strips*.

4.5 Maintenance Considerations

Table 4-2 summarizes maintenance needs and related issues and shows the recommended frequency of various maintenance activities.

Healthy grass can generally be maintained without using fertilizers because runoff from lawns and other areas contains the needed nutrients. Occasionally inspecting the grass over the first few years will help to determine if any problems are developing and to plan for long-term restorative maintenance needs.

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Table 4-1

Grass-Lined Swale Design Considerations and Criteria

Criteria	Design Considerations
Velocity	Maintaining low velocities in a swale during small, frequent storms encourages sedimentation and infiltration. Design the swale for a velocity of 2 fps or less during the 2-year event. Use a Mannings roughness coefficient of n=0.035 and set the longitudinal channel slope and channel cross-section dimensions to limit the flow velocity.
Swale Geometry	A shallow trapezoidal or triangular channel cross-section is preferred. A maximum depth of 3 feet is recommended during a 2-year storm. Swale side slopes should be no steeper than 4:1 and preferably 5:1 or flatter.
Longitudinal Slope	Providing a mild slope helps maintain the flow velocities recommended above. Typically, longitudinal slopes will be between 0.2 percent and 0.5 percent, but shall not exceed 1.0 percent. Sites with greater slopes should use grade control checks or small drop structures to maintain the required longitudinal slope.
Grade Checks	Slow velocities down through the use of grade control checks in a swale to promote sedimentation and infiltration. Provide them as needed to maintain the longitudinal slope and to limit maximum flow velocity.
Vegetation	Dense turf grass cover is recommended to promote sedimentation, filtration, and nutrient uptake, to limit erosion, and to help maintain low flow velocities.
Street and Driveway Crossings	Small culverts at each street crossing and driveway crossings may be used to provide onsite stormwater capture and to use the swale, if adequate volume is available, as an extended detention basin.
Drainage and Flood Control	Check the water surface during larger storms such as the 5-year through the 100-year floods to ensure that drainage from such events is being handled without flooding critical areas or residential, commercial, and industrial structures.

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Table 4-2

Grass-Lined Swale Maintenance Considerations

Required Action	Maintenance Objective	Frequency of Action
Lawn mowing and lawn care	Maintain irrigated grass at 2 to 4 inches tall and nonirrigated native grass at 6 to 8 inches tall. Collect cuttings and dispose of them offsite or use a mulching mower.	Routine–As needed.
Debris and litter removal	Keep the area clean for aesthetic reasons, which also reduces floatables being flushed downstream.	Routine–As needed by inspection, but no less than two times per year.
Sediment removal	Remove accumulated sediment near culverts and in channels to maintain flow capacity. Replace the grass areas damaged in the process.	Routine–As needed by inspection. Estimate the need to remove sediment from 3 to 10 percent of total length per year, as determined by annual inspection.
Grass reseeding and mulching	Maintain a healthy dense grass in channel and side slope.	Nonroutine–As needed by annual inspection.
Inspections	Check the grass for uniformity of cover, sediment accumulation in the swale, and near culverts.	Routine–Annual inspection is suggested.

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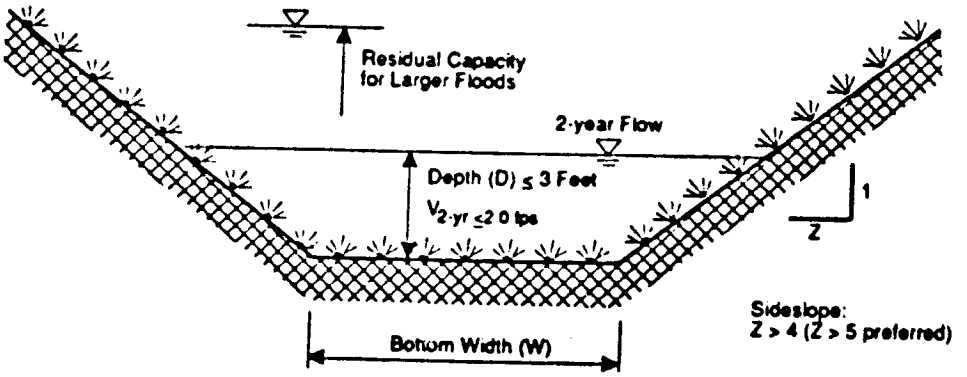
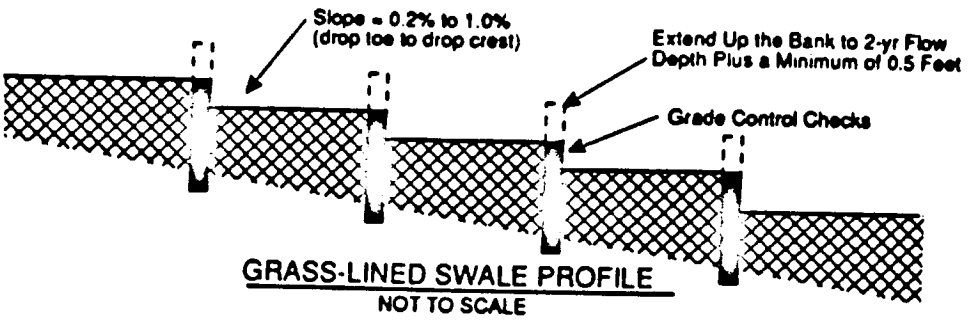


TRAPEZOIDAL GRASS-LINED SWALE SECTION
NOT TO SCALE



GRASS-LINED SWALE PROFILE
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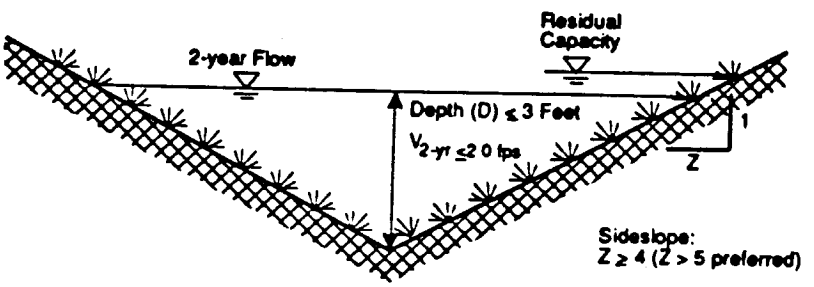

TRIANGULAR GRASS-LINED SWALE SECTION
NOT TO SCALE

FIGURE 4-1. PROFILE AND SECTIONS OF A GRASS-LINED SWALE

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5. EXTENDED DETENTION BASINS (DRY)

5.1 Description

Extended detention basins are designed to totally empty out sometime after stormwater runoff ends. They are adaptations of the detention basins used for flood control. The primary difference is in the outlet design. The extended basin uses a much smaller outlet that extends the emptying time of the more frequently occurring runoff events to facilitate pollutant removal. A drain time of the brim-full capture volume of 40 hours is recommended to remove a significant portion of fine particulate pollutants found in urban stormwater runoff. Soluble pollutant removal can be somewhat enhanced by providing a small wetland marsh or ponding area in the basin's bottom to promote biological uptake. The basins are considered to be "dry" because they are designed not to have a significant permanent pool of water.

5.2 General Application

Extended detention basins can be used to enhance stormwater runoff quality and reduce peak stormwater runoff rates. If these basins are constructed early in the development cycle, they can also be used to trap sediment from construction activities within the tributary drainage area. The accumulated sediment will need to be removed, however, before the basin is placed into final long-term use. Also, extended detention basins can sometimes be retrofit into existing flood control detention basins.

Extended detention basins can be used to improve the quality of urban runoff from roads, parking lots, residential neighborhoods, commercial areas, and industrial areas and are generally used as regional or followup treatment BMPs. They can also be used as an onsite BMP. Extended detention basins work well in conjunction with other BMPs, such as upstream onsite source controls and downstream filter basins or wetland channels. If desired, a flood routing detention volume can be provided above the water quality capture volume (WQCV) of the basin.

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5.3 Advantages/Disadvantages

5.3.1 General. Extended detention basins can also be designed to provide multiuse benefits by reducing peak runoff flow rates and by improving water quality while incorporating recreation and open space opportunities. They can be effective in removing particulate matter and associated heavy metals and other pollutants. As with other BMPs, safety issues need to be addressed through proper design.

5.3.2 Physical Site Suitability. Normally, the land required for an extended detention basin is approximately 0.5 to 2.0 percent of the total tributary development area. Although the soil types beneath the pond seldom prevent the use of this BMP, they should be considered during design. Any exfiltration capacity should be considered a short-term characteristic because exfiltration will decrease over time as the soil is clogged with fine sediment and as the groundwater beneath the basin develops a mound that can eventually surfaces into the basin.

High groundwater should not preclude the use of this BMP or its performance. Groundwater, however, should to be considered during design and construction, and the outlet design must account for any base flows that result from groundwater surfacing or that arrive from upstream. In high groundwater areas, consider the use of retention ponds to avoid many of the problems associated when a basin bottom is located below the seasonal high water table.

Construction costs may be high if bedrock excavation of the pond is required. Soil maps should be consulted, and soil borings should be conducted to establish geotechnical parameters.

5.3.3 Pollutant Removal. The performance range of an extended detention pond was presented in Table 3-2 in the *Stormwater Quality Management* chapter of this volume. Removal of suspended solids and metals can be moderate to high, and removal of nutrients is low to moderate. When a small shallow wetland is included as part of the basin's bottom or the basin is followed by BMPs more efficient at removing soluble pollutants, such as constructed wetlands or wetland channels, the removal of nutrients can be improved.

The major factor controlling the degree of pollutant removal is the emptying time provided by the outlet. The rate and degree of removal will also depend on influent particle sizes. Metals, oil and grease, and some nutrients have a close affinity for suspended sediment and will be removed partially through sedimentation.

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5.3.4 Aesthetics and Multiple Uses. Since an extended detention basin is designed to drain very slowly, its bottom and lower portions will be inundated frequently and for extended periods of time. Grasses in this frequently inundated zone will tend to die off, with only the species that can survive the specific environment at each site eventually prevailing. In addition, the bottom will be the depository of all the sediment that settles out in the basin. As a result, the bottom can be muddy and can have an undesirable appearance. To reduce this problem and to improve the basin's availability for other uses (such as passive recreation), it is suggested that the designer provides a lower-stage basin as suggested in Table 5-1 under Two Stage Design. As an alternative, a retention pond could be used, in which the settling occurs primarily within the permanent pool.

5.4 Planning Considerations and Design Criteria

Extended detention basins rely on an outlet designed to extend the emptying time of the basin's capture volume. Figure 5-1 shows a representative layout of an extended detention basin; Figure 5-2 shows some of the basin outlet details. Table 5-1 summarizes extended detention design criteria. Although flood control storage can be provided by a storage volume above the water quality storage, how to accomplish this is not included in this discussion. Whether or not flood storage is incorporated, embankments should be protected from catastrophic failure when runoff exceeds the design event. The State Engineer's regulatory requirements for larger embankments and storage volumes must be followed whenever regulatory height and/or volume thresholds are exceeded. Below those thresholds, the engineer should design the embankment-spillway-outlet system so that catastrophic failure will not occur.

For a perforated pipe outlet configuration, similar to the one shown in Figure 5-2, the number of perforations per row can be determined with the aid of Figure 5-3. The relationship in Figure 5-3 equates the WQCV, which needs to be emptied over 40 hours, to the total area of perforations required per row in the riser. The chart is based on the rows being equally spaced vertically at 4-inch centers. This total area of perforation per row is then used to determine, with the aid of Figure 5-2, the number of uniformly sized holes per row. Multiple perforated pipes or a perforated plate located at the front of an outlet can be used instead of a single riser. Other types of outlets may also be used, provided they control the release of the WQCV in a manner consistent with the *Emptying Time* requirements of Table 5-1.

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5.5 Maintenance Considerations

Dry extended detention basins have low to moderate maintenance requirements. Routine and nonroutine maintenance is necessary to assure performance, enhance aesthetics, and protect structural integrity. The dry basins can result in nuisance complaints if not properly designed or maintained. Bio-degradable pesticides may be required to limit insect problems. Frequent debris removal and grass-mowing can reduce aesthetic complaints. If a shallow wetland or marshy area is included, mosquito breeding and nuisance odors could occur if the water becomes stagnant. Access to critical elements of the pond (inlet, outlet, spillway, and sediment collection areas) must be provided. The basic elements of the maintenance requirements are presented in Table 5-2.

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Table 5-1

Extended Detention Basin Design Considerations and Criteria

Criteria	Design Considerations
Basin Volume (WQCV)	Provide a storage volume for 120 percent of the WQCV above the lowest outlet in the basin. The WQCV should be determined following the procedure described in *Stormwater Quality Management* chapter of this manual using a 40-hour drain time. The additional 20 percent of storage volume provides for sediment accumulation and the resultant loss in storage volume.
Emptying Time	A 40-hour emptying time should be used for the WQCV, with no more than 50 percent of the WQCV being released in 12 hours.
Flood Control Storage	Combining the water quality facility with a flood control facility is recommended. The 10-year, 100-year, or other floods may be detained above the WQCV.
Basin Geometry	Shape the pond with a gradual expansion from the inlet and a gradual contraction toward the outlet, thereby limiting short circuiting. The basin length to width ratio should be no less than 2, with a ratio of 4 recommended where feasible.
Two-Stage Design	A two-stage design with a lower frequency pool that fills often with frequently occurring runoff minimizes standing water and sediment deposition in the remainder of the basin. The top stage should be 2 to 5 feet deep with its bottom sloped at 2 percent toward the low flow channel. The bottom stage should be 1.5 to 3 feet deeper than the top stage and store 10 to 25 percent of the WQCV.
Low-Flow Channel	Conveys low flows from the forebay to the bottom stage. Erosion protection should be provided where the low-flow channel enters bottom stage.
Basin Side Slopes	Slopes should be stable and gentle enough to limit rill erosion and facilitate maintenance access and needs. Side slopes should be no steeper than 4:1, preferably flatter.
Inlet	Dissipate flow energy at pond's inflow point(s) to limit erosion and promote particle sedimentation. Inlets should be designed in accordance with UDFCD drop structure criteria or as another type of an energy dissipating structure.
Forebay Design	Provide the opportunity for larger particles to settle out in an area that has a solid surface bottom to facilitate mechanical sediment removal. A rock or an earthen berm should be constructed with a minimum top width of 4 feet and side slopes no steeper than 4:1. The forebay volume of the permanent pool should be 5 to 10 percent of the WQCV. A trapezoidal outlet throughout the berm should be offset from the inflow streamline to prevent short circuiting, and the bottom width should be no wider than the low flow channel width.

Note: WQCV = water quality capture volume. Refer to Section 5 of the *Stormwater Quality Management* chapter of this volume.

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Table 5-1 (Continued)

Extended Detention Basin Design Considerations and Criteria

Outlet Design	Use a water quality outlet that is capable of slowly releasing the WQCV over a 40-hour period. A perforated riser can be used in conjunction with a weir box opening above it to control larger storm outflows. A cutoff collar should be considered for the outlet pipe to control seepage. A sample outlet is illustrated in Figure 5-2, however, any other outlet that can meet the *Emptying Time* requirements stipulated above should be acceptable.
Trash Rack	If the outlet is not protected by a gravel rack, similar to one shown on Figure 5-2, provide a trash rack of sufficient size to prevent clogging of the primary water quality outlet while not interfering significantly with its hydraulic capacity. As a minimum, use Figure 5-4 as a guidance to size all trash racks.
Dam Embankment	The embankment should be designed not to fail during a 100-year and larger storm. Embankment slopes should be no steeper than 3:1, preferably 4:1, and flatter, and planted with turf forming grasses. Poorly compacted native soils should be excavated and replaced. Embankment soils should be compacted to at least 95 percent of their maximum density according to ASTM D 698-70 (Modified Proctor). Spillway structures and overflows should be designed in accordance with local drainage criteria and should consider UDFCD drop-structure design guidelines.
Vegetation	Bottom vegetation provides erosion control and sediment entrapment. Pond bottom, berms, and side sloping areas may be planted with native grasses or with irrigated turf, depending on the local setting.
Maintenance Access	Access to the forebay and outlet area shall be provided to maintenance vehicles. Maximum grades should be 6 percent, and a solid driving surface of gravel, rock, concrete, or gravel-stabilized turf should be provided.
Multiple Uses	Whenever desirable and feasible, incorporate the water quality within a larger flood control basin. Also, whenever possible try to provide for other urban uses such as active or passive recreation, and wildlife habitat. If multiple uses are being contemplated, consider first the issues discussed in Section 5.3.4 and use the multiple-stage detention basin to limit inundation of passive recreational areas to one or two occurrences a year. Generally, the area within the WQCV is not well suited for active recreation facilities such as ballparks, playing fields, and picnic areas, which are best located above this pool level.

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Table 5-2

Extended Detention Basin Maintenance Considerations

Required Action	Maintenance Objective	Frequency of Action
Lawn mowing and lawn care	Occasional mowing to limit unwanted vegetation. Maintain irrigated turf grass as 2 to 4 inches tall and nonirrigated native turf grasses at 4 to 6 inches.	Routine - Depending on aesthetic requirements.
Debris and litter removal	Remove debris and litter from the entire pond to minimize outlet clogging and improve aesthetics.	Routine - Including just before annual storm seasons (that is, April and May) and following significant rainfall events.
Erosion and sediment control	Repair and revegetate eroded areas in the basin and channels.	Nonroutine - Periodic and repair as necessary based on inspection.
Structural	Repair pond inlets, outlets, forebays, low flow channel liners, and energy dissipators whenever damage is discovered.	Nonroutine - Repair as needed based on regular inspections.
Inspections	Inspect basins to insure that the basin continues to function as initially intended. Examine the outlet for clogging, erosion, slumping, excessive sedimentation levels, overgrowth, embankment and spillway integrity, and damage to any structural element.	Routine - Annual inspection of hydraulic and structural facilities. Also check for obvious problems during routine maintenance visits, especially for plugging of outlets.
Nuisance control	Address odor, insects, and overgrowth issues associated with stagnant or standing water in the bottom zone.	Nonroutine - Handle as necessary per inspection or local complaints.

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Table 5-2 (Continued)

Extended Detention Basin Maintenance Considerations

Required Action	Maintenance Objective	Frequency of Action
Sediment removal	Remove accumulated sediment from the forebay and the bottom of the basin.	Nonroutine–Performed when sediment accumulation occupies 20 percent of the WQCV. This may vary considerably, but expect to do this every 5 to 15 years, as necessary per inspection. The forebay will require more frequent cleanout than other areas of the dry pond.

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FIGURE 5-1. PLAN AND SECTION OF A DRY EXTENDED DETENTION BASIN

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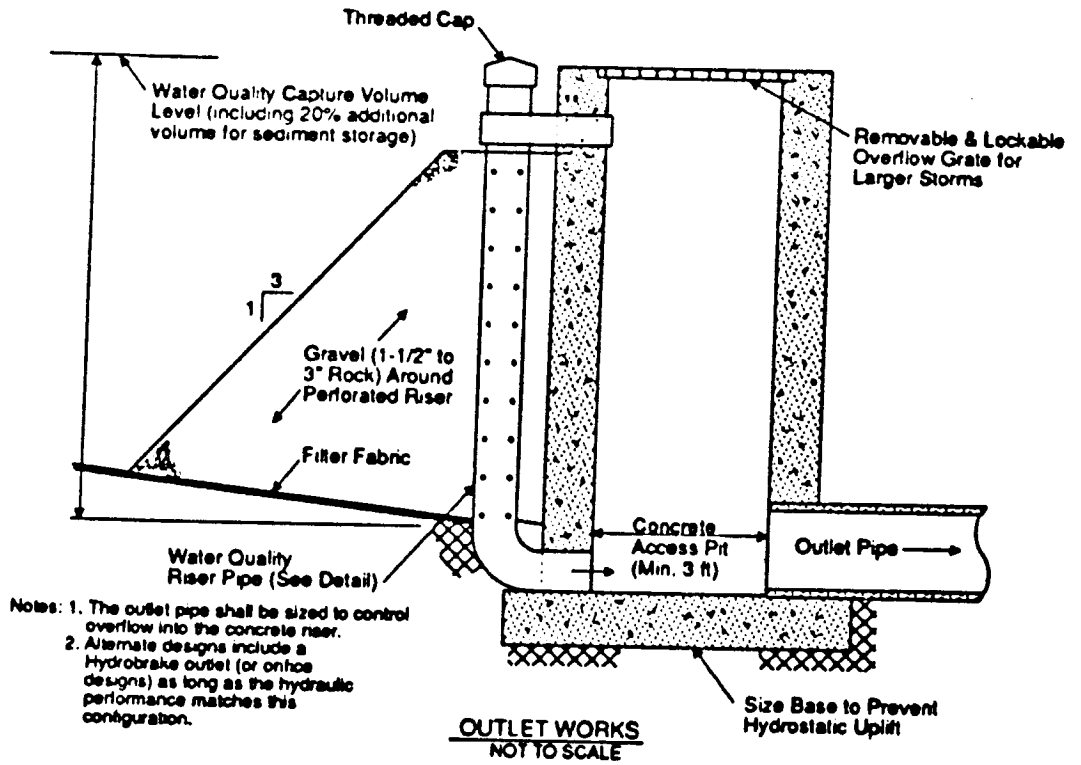
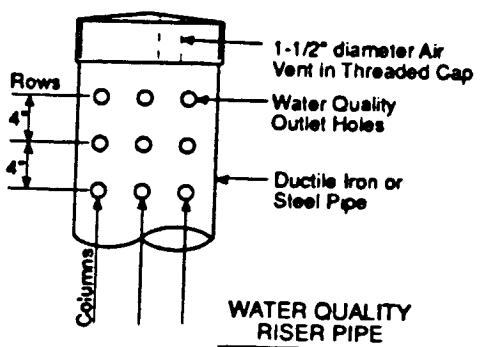


Notes: 1. The outlet pipe shall be sized to control overflow into the concrete riser.
2. Alternate designs include a Hydrobrake outlet (or orifice designs) as long as the hydraulic performance matches this configuration.

OUTLET WORKS
NOT TO SCALE

Notes: 1. Minimum number of holes = 8
2. Minimum hole diameter = 1/8" dia.



WATER QUALITY RISER PIPE
NOT TO SCALE

Maximum Number of Perforated Columns				
Riser Diameter (in.)	Hole Diameter, in.			
	1/4"	1/2"	3/4"	1"
4	8	8	--	--
6	12	12	9	--
8	16	16	12	8
10	20	20	14	10
12	24	24	18	12

Hole Diameter (in.)	Area of Hole (in.2)
1/8	0.013
1/4	0.049
3/8	0.110
1/2	0.196
5/8	0.307
3/4	0.442
7/8	0.601
1	0.785

FIGURE 5-2. WATER QUALITY OUTLET FOR A DRY EXTENDED DETENTION BASIN

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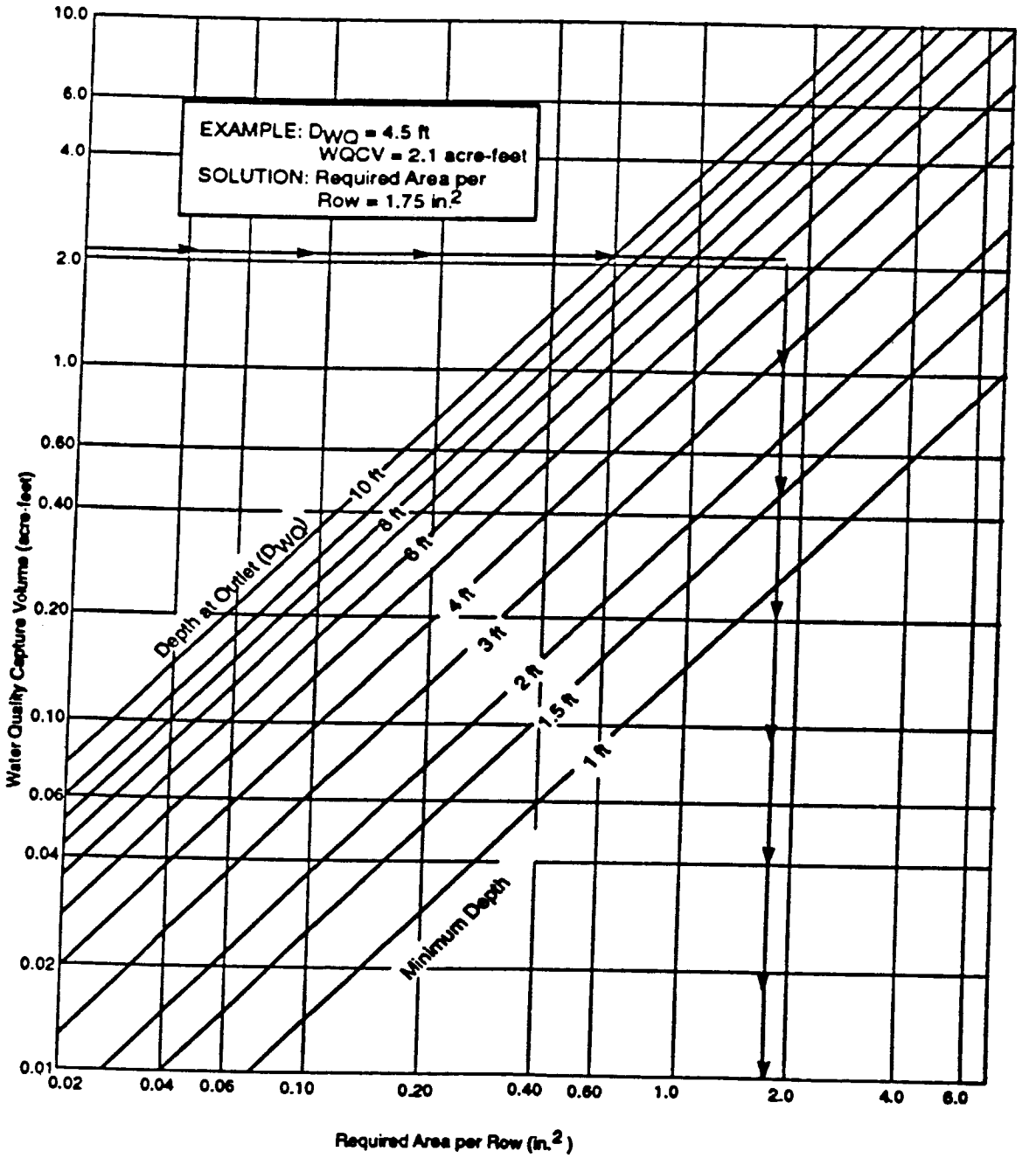

Source: *Douglas County Storm Drainage and Technical Criteria*, 1986.

FIGURE 5-3. WATER QUALITY OUTLET SIZING: DRY EXTENDED DETENTION BASIN WITH A 40-HOUR DRAIN TIME OF THE CAPTURE VOLUME

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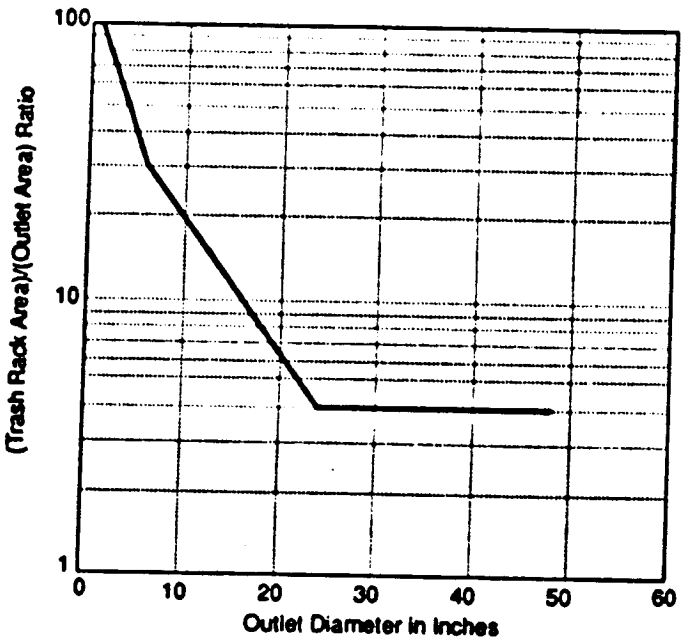

FIGURE 5-4. MINIMUM TRASH RACK AREA

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6. RETENTION PONDS (PONDS WITH A PERMANENT POOL)

6.1 Description

A retention pond has a permanent pool of water that is replaced with stormwater, in part or in total, during storm runoff events. Temporary detention is provided above this permanent pool to allow more sedimentation. Retention ponds are similar to extended detention basins because they are designed to capture in total and detain a volume of runoff from frequently occurring storms. However, detention ponds differ from extended detention basins because the influent water mixes with the permanent pool water as it rises above the permanent pool. The captured volume above the permanent pool is then released over 12 hours.

Retention ponds require a dry-weather base flow to maintain the permanent pool. They can be very effective in removing pollutants, and, under the proper conditions, can satisfy multiple objectives.

6.2 General Application

Retention ponds can be used to improve the quality of urban runoff from roads, parking lots, residential neighborhoods, commercial areas, and industrial sites and are generally used as regional or followup treatment because of the base-flow requirements. They can be used as an onsite BMP if the owner provides sufficient water to keep the pond full between storms. Retention ponds work well in conjunction with other BMPs, such as upstream onsite source controls and downstream filter basins or wetland channels. The required design volume of a retention pond includes the volume needed for a permanent pool plus a water quality capture volume (WQCV) above the permanent pool. If desired, a flood routing detention volume can be provided above the WQCV.

If retention ponds are constructed in the early phase of development, they can be used to trap sediment from construction activities within the tributary drainage area.

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6.3 Advantages/Disadvantages

6.3.1 General. Retention ponds can be cost-effective for larger tributary watersheds. They can be used in providing the following:

- Achieving moderate to high removal rates of many urban pollutants
- Creating wildlife habitat
- Providing recreation, aesthetics, and open space areas
- Incorporation into a larger flood control basin

The primary disadvantages include safety concerns, more difficult sediment removal than for extended detention basins when needed, floating litter, scum and algal blooms, nuisance odors, and possible mosquito problems. Aquatic plant growth can be a factor in clogging outlet works. The permanent pool can attract water fowl, which can add to the nutrient load entering and leaving the pond.

6.3.2 Physical Site Suitability. Although site suitability concerns are similar to those stated for an extended detention basin, a retention pond has one primary difference–it requires sufficient continuous base flow to maintain the pool. A complete water budget under the projected urbanized watershed conditions should be performed to assure that the base flow will exceed evaporation, evapotranspiration, and seepage losses.

Land requirements are typically 0.5 to 2 percent of the tributary watershed's area. High exfiltration rates can initially make it difficult to maintain a permanent pool in a new pond, but the bottom can eventually seal with fine sediment and become relatively impermeable over time. It is best, however, to seal the bottom and the sides of a permanent pool if the pool is located on permeable soils and to leave the areas above the permanent pool unsealed.

6.3.3 Pollutant Removal. Retention ponds achieve moderate to high removal rates for particulate matter through sedimentation during and shortly after the runoff event. During a storm event, a portion or all of the permanent pool water is displaced and the pool becomes a mixture of the former pool water and new runoff. The period between storms allows biological uptake of soluble nutrients and metals from the water column in the permanent pool while also providing time for quiescent settling of fine sediment particles that remain in the pool after a storm. Some of the sediment can resuspend and soluble compounds can remobilize if a large storm event causes intense mixing or when unfavorable chemical conditions exist in the pool (such as low dissolved oxygen [DO] or pH). Also,

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algal growth and other biological activity can produce suspended solids and increased concentrations of certain forms of phosphates and nitrogen compounds in base flow discharges from the pond.

Without a sufficient continuous base flow, a wet pond can, through evaporation, concentrate levels of salts and algae between storm events. Besides contributing to nuisance problems, the water quality of the pool is very important. A storm event will displace any concentrated pond water, and in some instances, can result in a discharge of water with pollutant concentrations exceeding the inflow – exactly the opposite of the intent for providing this BMP.

6.3.4 Aesthetics and Multiple Uses. Retention ponds can offer improved aesthetics and multiple-uses beyond those typically found at extended detention basins. The bulk of the capture volume occurs as a surcharge above the permanent pool, with some of it occurring above the dry-weather bank areas. As a result, most of the sediment deposits are left behind within the permanent pool zone, where they are not seen by the public. Also, the permanent pool offers some aquatic habitat and is a habitat for water fowl. However, water fowl can be a nuisance because of the fecal matter they deposit on the banks and in the pool.

6.4 Planning Considerations and Design Criteria

There are two primary differences in design between a retention pond and an extended detention basin:

- The first is that the retention pond requires a base flow to maintain and to flush a permanent pool.
- The second major difference is the emptying time; retention ponds are designed to empty the water quality capture volume over a 12-hour period, instead of the longer 40 hours needed for an extended detention basin. The reason for this is that the sediment removal process is more efficient when the outflow occurs above the bottom of the basin. Sediments become trapped below the outlet and sedimentation continues in the pool after the captured surcharge volume is emptied.

Figure 6-1 shows a representative layout for a retention pond; Figure 6-2 shows the configuration for one type of outlet. Table 6-1 presents design criteria for retention ponds. Although flood storage has not been addressed in these recommendations for the same reasons mentioned under extended

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detention basins, it can be easily provided for above the WQCV. Embankment design and safety design considerations for a retention pond are identical to those discussed for an extended detention basin, except more attention should be given to cutoff collars on the outlet pipe to safeguard against piping along the outlet.

For the perforated pipe outlet configuration shown in Figure 6-2, the number of columns of holes per row can be determined with the aid of Figure 6-3. The relationship in Figure 6-3 equates the WQCV that should be drained over 12 hours to the total area of the holes installed per row in the perforated riser. This relationship is based on the rows being equally spaced vertically at 4 inches on center. The total area of holes obtained from Figure 6-3 is then used to determine, with the aid of Figure 6-2, the number of holes per row that will need to be drilled in the perforated riser. Multiple perforated pipes or perforated steel plate in an outlet may be used instead. Other types of outlets may also be used, provided they control the release of the WQCV in a manner consistent with the *Emptying Time* requirements of Table 6-1.

6.5 Maintenance Requirements

The amount of construction activity within a basin, the erosion control measures implemented, and the size of the basin will influence the frequency of sediment removal from the pond. With aggressive erosion control is practiced in the tributary watershed, it is estimated that accumulated sediment will need to be removed at 5- to 20-year intervals. Table 6-2 summarizes the required maintenance activities and their frequency for retention ponds.

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Table 6-1

Retention Pond Basin Design Considerations and Criteria

Criteria	Design Considerations and Design Criteria
Capture Volume	Provide storage for the WQCV above the permanent pool level. The WQCV should be calculated following the procedure described in Volume 3 of this Manual using a 12-hour drain time.
Emptying Time	A 12-hour emptying time should be used for the WQCV.
Permanent Pool	The permanent pool provides stormwater quality enhancement between storms through biological uptake and continuing sedimentation. The volume of the permanent pool should be 1.0 to 1.5 times the WQCV and shall have two depth zones: (1) a littoral zone 6 to 18 inches deep that accounts for 25 to 50 percent of the permanent pool surface area for aquatic plant growth along the perimeter of the permanent pool, and (2) a deeper zone of 4 to 8 feet average depth in the remaining pond area to promote sedimentation and nutrient uptake by phytoplankton, with a maximum depth in the pond of no more than 12 feet.
Base Flow	A net influx of water must be available through a perennial base flow and must exceed the losses. The following equation and parameters can be used to estimate the net quantity of baseflow available at a site: $$Q_{Net} = Q_{Inflow} - Q_{Evap} - Q_{Seepage} - Q_{ET}$$ Where: Q_{Net} = Net quantity of base flow (acre-ft/year) Q_{Inflow} = Estimated base flow (acre-ft/year) (Estimate by seasonal measurements and/or comparison to similar watersheds) Q_{Evap} = Loss because of evaporation less the precipitation (acre-ft/year) (Computed for average water surface) $Q_{Seepage}$ = Loss (or gain) because of seepage to groundwater (ac-ft/year) Q_{ET} = Loss because of plant evapotranspiration (additional loss through plant area above water surface not including the water surface)
Basin Geometry	Shape the pond with a gradual expansion from the inlet and a gradual contraction toward the outlet, thereby limiting short circuiting. The basin length to width ratio should be no less than 2:1, with 4:1 being preferred. Combining the water quality facility with a flood control facility is recommended. The 10-year, 100-year, or other flood may be detained above the WQCV.
Basin Side Slopes	Side slopes should be stable and sufficiently gentle to limit rill erosion and to facilitate maintenance. Side slopes above the permanent pool should be no steeper than 4:1, preferably 5:1 or flatter. The littoral zone should be very flat (that is, 20:1 or flatter) with the depth ranging from 6 inches near the shore and extending to no more than 18 inches at the furthest point from the shore. The side slope below the littoral zone shall be 3:1 or flatter.

Note: WQCV=water quality capture volume. See Section 5 of the *Stormwater Quality Management* chapter to this volume.

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Table 6-1 (Continued)

Retention Pond Basin Design Considerations and Criteria

Criteria	Design Considerations and Design Criteria
Inlet	Dissipate flow energy at the inlet to limit erosion and to diffuse the inflow plume where it enters the pond. Inlets should be designed in accordance with USDCM drop-structure and energy-dissipating structure criteria in Volume 2.
Forebay Design	To provide an opportunity for larger particles to settle out, install an area that has a solid driving surface bottom to facilitate sediment removal. A protected earthen berm should be part of the littoral bench to create the forebay and have a minimum top width of 8 feet and side slopes no steeper than 4:1. The forebay volume of the permanent pool should be 5 to 10 percent of the WQCV.
Outlet Design	Use a water quality outlet that is capable of slowly releasing the WQCV over a 12-hour period. A perforated riser can be used with a weir box located at a higher elevation to control the permanent pool level and provide for storm outflows, respectively. Cutoff collars should be used along the outlet pipe to prevent piping. Other types of outlets may be used, provided they achieve a reasonably uniform outflow rate.
Trash Rack	The outlet shall be protected against clogging by a stiff steel coarse screen that also acts as a surface skimmer. The skimmer screen openings shall be smaller than the perforations in the riser and shall extend to the top of the WQCV and no less than 2 feet below the permanent water surface.
Dam Embankment	See Table 5-1 for discussion. Use Figure 5-4 to size trash racks.
Vegetation	The embankment should be designed not to fail during a 100-year and larger storms. Embankment slopes should be no steeper than 3:1, preferably 4:1 and flatter, covered with turf-forming grasses to limit erosion. Poorly compacted native soils should be removed and replaced. Embankment soils should be compacted to 95 percent of their maximum density according to ASTM D 698-70 (modified proctor).
Maintenance Access	Vegetation provides erosion control and enhances site stability. Berms and side-sloping areas should be planted with native turf-forming grasses or irrigated turf, depending on the local setting. The shallow littoral bench should be first covered with organic topsoil and then vegetated with aquatic species.
Multiple Uses	Access to the forebay and outlet area must be provided to maintenance vehicles. Maximum grades should be 8 percent, and a solid driving surface of gravel, rock, concrete, or gravel stabilized turf should be provided.
	Whenever desirable and feasible, incorporate the water quality pond within a larger flood control basin. Also, whenever possible try to provide for other urban uses such as active or passive recreation, and wildlife habitat. If multiple uses are being contemplated, consider first the issues discussed in Section 6.3.4. Try to locate recreational areas to limit the frequency of inundation to one or two occurrences a year. Generally, the area within the WQCV is not well suited for active recreation facilities such as ballparks, playing fields, and picnic areas. These should be located above this pool level.

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Table 6-2

Retention Pond Basin Maintenance Considerations

Required Action	Maintenance Objective	Frequency of Action
Lawn mowing and lawn care	Mow occasionally to limit unwanted vegetation. Maintain irrigated turf grass 2 to 4 inches tall and nonirrigated native turf grasses at 4 to 6 inches.	Routine - Depending on aesthetic requirements.
Debris and litter removal	Remove debris and litter from the entire pond to minimize outlet clogging and aesthetics. Include the removal of floatable material from the pond's surface.	Routine—Including just before annual storm seasons (that is, April and May) and following significant rainfall events.
Erosion and sediment control	Regrade and revegetate eroded and slumped areas above the pond and along channels. Repair damaged inlet and outlet energy dissipators.	Nonroutine—Periodic and repair as necessary based on inspection.
Inspections	Inspect the retention pond for functioning as initially intended. Pay attention to outlet clogging. Also note erosion, slumping, sedimentation levels, overgrowth, embankment and spillway integrity, and damage to structural elements of the facility.	Routine—Annual inspection of hydraulic and structural facilities. Biannual performance and maintenance inspections.
Nuisance control	Address odor issues, insects, and overgrowth with appropriate measures.	Nonroutine–As necessary per inspection or local complaints.
Structural repairs	Repair such items as inlet/outlet works and energy dissipator liners. Stabilize banks and berms. Repair damage caused by larger storm events.	Nonroutine–As necessary per inspection.
Sediment removal	Empty the pond, divert the base flow, and dry out bottom sediments in fall and winter months to allow access with backhoe.	Nonroutine–As indicated per inspections and sediment accumulation.
Aquatic Growth Harvesting	Remove aquatic plants such as cattails or reeds, which also permanently removes nutrients. Use an aquatic harvester and dispose of the material offsite.	Nonroutine–Perform every 3 to 10 years or as needed to control their accumulation.

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FIGURE 6-1. PLAN AND SECTION OF A WET EXTENDED DETENTION BASIN

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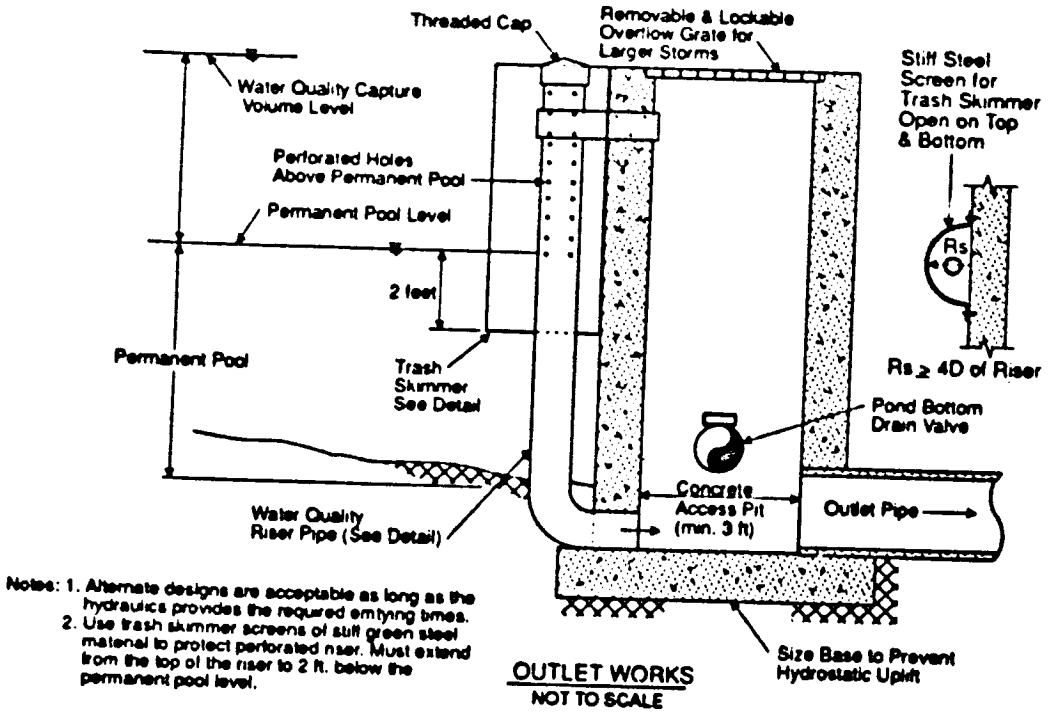
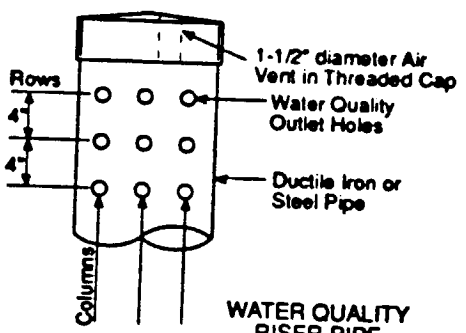


Notes: 1. Alternate designs are acceptable as long as the hydraulics provides the required emtying times.
2. Use trash skimmer screens of stiff green steel material to protect perforated riser. Must extend from the top of the riser to 2 ft. below the permanent pool level.

OUTLET WORKS
NOT TO SCALE

Notes: 1. Minimum number of holes = 8
2. Minimum hole diameter = 1/8" Dia.



WATER QUALITY RISER PIPE
NOT TO SCALE

Maximum Number of Perforated Columns				
Riser Diameter (in.)	Hole Diameter, inches			
	1/4"	1/2"	3/4"	1"
4	8	8	--	--
6	12	12	9	--
8	16	16	12	8
10	20	20	14	10
12	24	24	18	12

Hole Diameter (in.)	Area (in. 2)
1/8	0.013
1/4	0.049
3/8	0.110
1/2	0.196
5/8	0.307
3/4	0.442
7/8	0.601
1	0.785

FIGURE 6-2. WATER QUALITY OUTLET FOR A WET EXTENDED DETENTION BASIN

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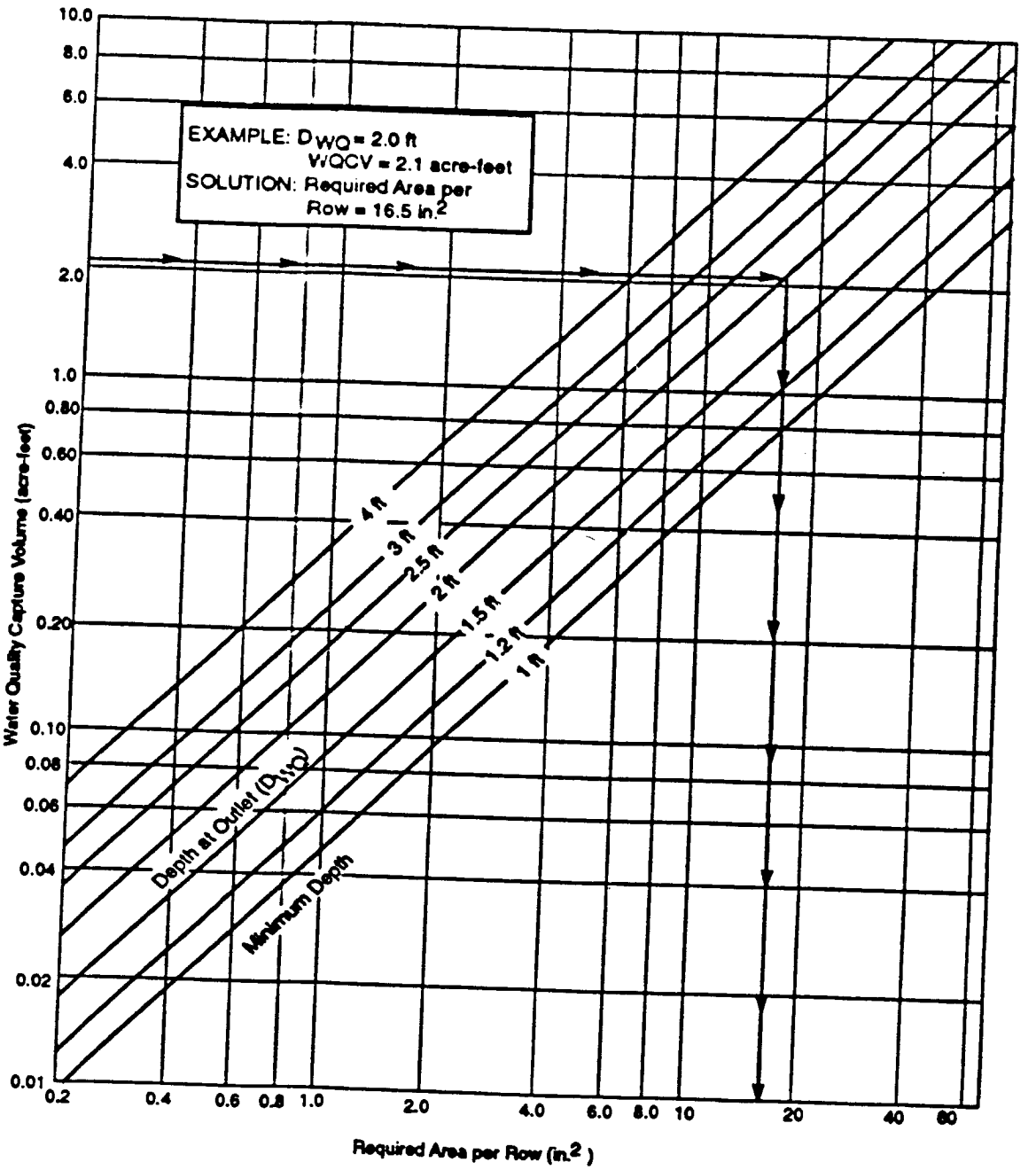

Source: *Douglas County Storm Drainage and Technical Criteria, 1986.*

FIGURE 6-3. WATER QUALITY OUTLET SIZING: WET EXTENDED DETENTION BASIN RETENTION POND WITH A 12-HOUR DRAIN TIME OF THE CAPTURE VOLUME

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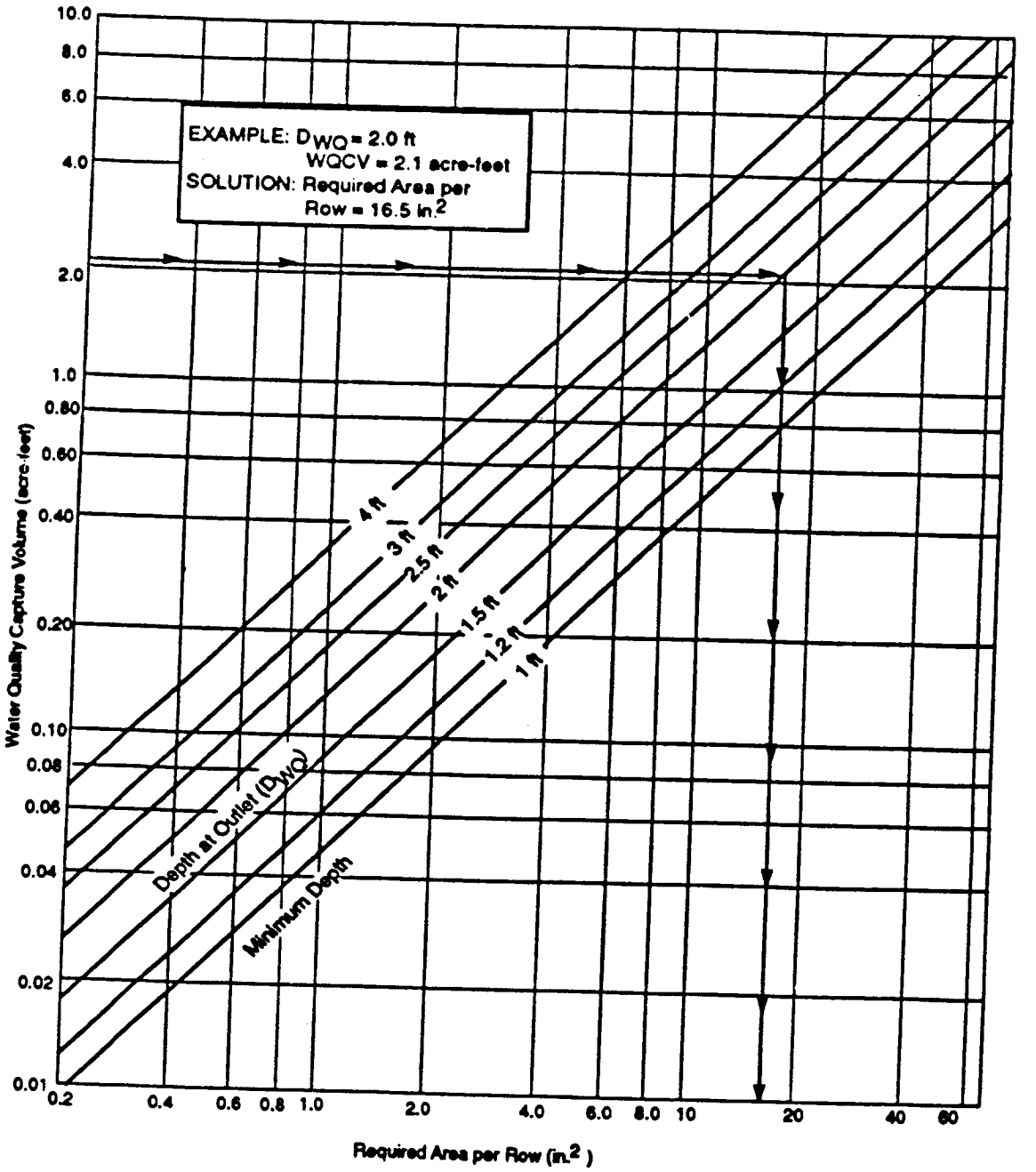

Source: *Douglas County Storm Drainage and Technical Criteria, 1986.*

FIGURE 6-3. WATER QUALITY OUTLET SIZING: WET EXTENDED DETENTION BASIN RETENTION POND WITH A 12-HOUR DRAIN TIME OF THE CAPTURE VOLUME

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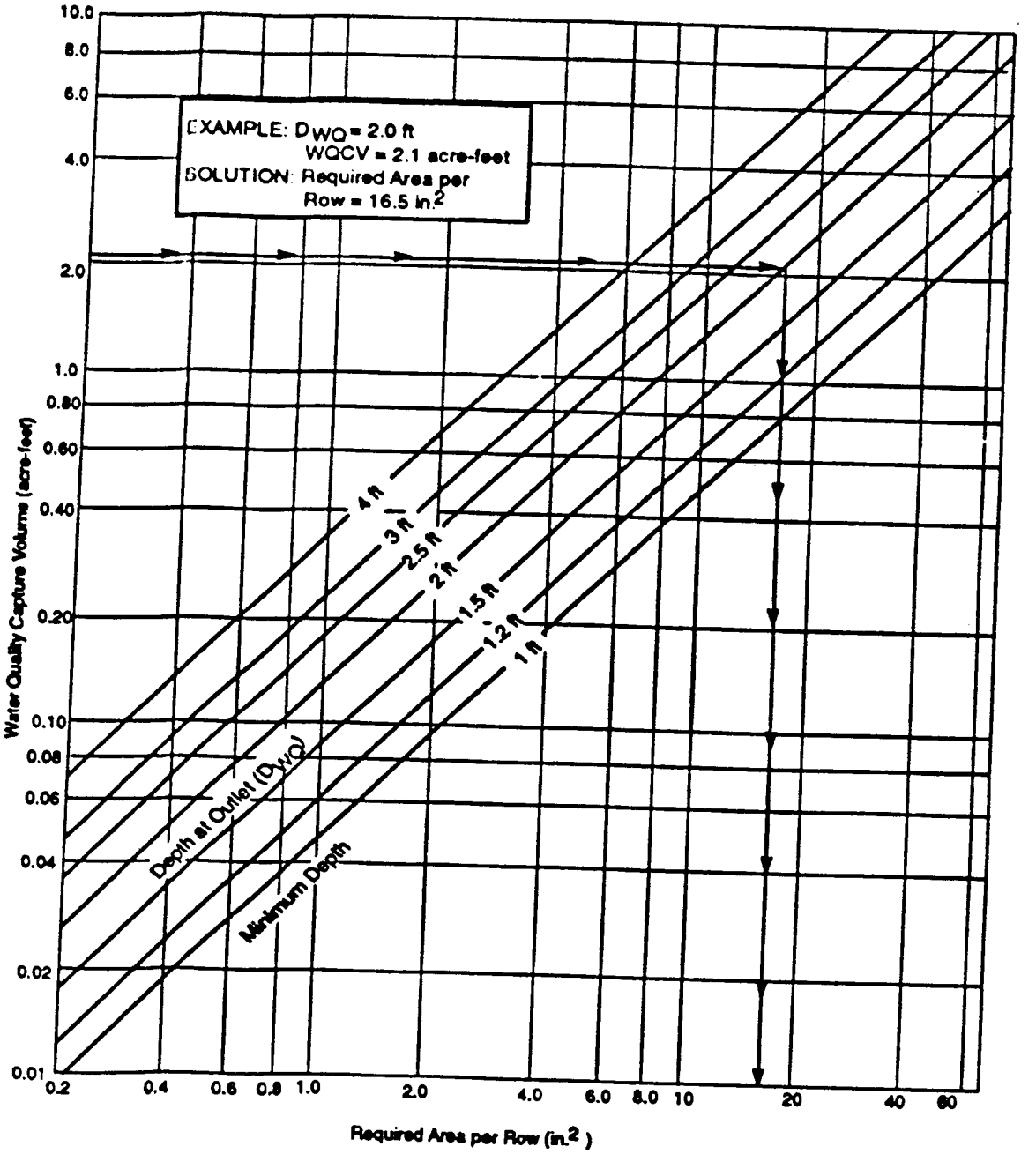

Source: *Douglas County Storm Drainage and Technical Criteria, 1986.*

FIGURE 6-3. WATER QUALITY OUTLET SIZING:
WET EXTENDED DETENTION BASIN RETENTION POND
WITH A 12-HOUR DRAIN TIME OF THE CAPTURE VOLUME

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7. CONSTRUCTED WETLANDS

7.1 Description

Two types of constructed wetlands are described in this section - very shallow retention ponds and wetland-bottomed channels. Both configurations require a perennial base flow to permit the growth of rushes, willows, cattails, and reeds to slow down runoff and allow time for settling and biological uptake.

Constructed wetlands differ from "natural" wetlands as they are artificial and are built to enhance stormwater quality. Sometimes small wetlands that exist along ephemeral drainageways on Colorado's high plains could be enlarged and incorporated into the constructed wetland system. Such action, however, requires the approval of federal and state regulators.

Regulations intended to protect natural wetlands recognize a separate classification of wetlands constructed for a water quality treatment. Such wetlands generally are not allowed to be used to mitigate the loss of natural wetlands but are allowed to be disturbed by maintenance activities. Therefore, the legal and regulatory status of maintaining a wetland constructed for the primary purpose of water quality enhancement is separate from the disturbance of a natural wetland.

7.2 General Application

Wetland basins can be used as a followup BMP in a watershed, or as an onsite facility if the owner provides sufficient water to sustain the wetland. Flood control storage can be provided above the wetland basin's water quality capture volume (WQCV) pool to act as a multiuse facility.

Wetland bottom channels can be used in the following two ways:

- First, a wetland can be established in a man-made channel and can act as a conveyance system and water quality enhancement facility. This design can be used along wide and gently sloping channels.

- The second use of a wetland bottom channel, and perhaps the most effective, is to locate the channel downstream of a stormwater detention facility (water quality and/or

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flood control) where a large portion of the sediment load can be removed. The wetland channel then receives stormwater and base flows as they drain from the detention facility, provides water quality enhancement, and at the same time conveys it downstream. This application of a wetland channel is recommended upstream of receiving waters and within lesser (ephemeral) receiving waters, thereby delivering better quality water to the more significant receiving water system.

For either application, wetlands require a net influx of water to maintain their vegetation and microorganisms. A complete water budget analysis is necessary to ensure the adequacy of the base flow.

7.3 Advantages/Disadvantages

7.3.1 General. Constructed wetlands offer several potential advantages, such as natural aesthetic qualities, wildlife habitat, erosion control, and pollutant removal. Constructed wetlands provide an effective followup treatment to onsite and source control BMPs that rely upon settling of larger sediment particles. In other words, they offer yet another effective BMP for larger tributary basins.

The primary drawback to wetlands is the need for a continuous base flow to ensure their presence. In addition, salts and scum can accumulate and unless properly designed and built, can be flushed out during larger storms.

Other disadvantages include the need for regular maintenance to provide nutrient removal. Regular harvesting and removal of aquatic plants, cattails, and willows is required if the removal of nutrients in significant amounts has to be assured. Even with that, recent data puts into question the net effectiveness of wetlands in removing nitrogen compounds and some form of phosphates. Periodic sediment removal is also necessary to maintain the proper distribution of growth zones and of water movement within the wetland.

7.3.2 Physical Site Suitability. A perennial base flow is needed to sustain a wetland, and should be determined using a water budget analysis. Loamy soils are needed in wetland bottom to permit plants to take root. Infiltration through a wetland bottom cannot be relied upon because the bottom is either covered by soils of low permeability or because the groundwater is higher than the wetland's bottom. Both wetland ponds and channels require a near-zero longitudinal slope. A single wetland

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basin can be developed using an embankment, while a multistage wetland or a wetland channel needs drop structures to create and maintain a flat grade.

7.3.3 Pollutant Removal. Removal efficiencies of constructed wetlands vary significantly. Primary variables influencing removal efficiencies include design, influent concentrations, hydrology, soils, climate, and maintenance. With periodic sediment removal and plant harvesting, expected removal efficiencies for sediments, organic matter, and metals can be moderate to high; for phosphorous, low to moderate; and for nitrogen, zero to low. Pollutants are removed primarily through sedimentation and entrapment, with some of the removal occurring through biological uptake by vegetation and microorganisms. Without a continuous dry-weather base flow, salts and algae can concentrate in the water column and can be released into the receiving water in higher levels at the beginning of a storm event as they are washed out.

Harvesting aquatic plants and periodic removal of sediment also removes nutrients and pollutants associated with the sediment. Researchers still do not agree that routine aquatic plant harvesting affects pollutant removals. Until research documents these effects, periodic harvesting for the general upkeep of wetland, and not routine harvesting of aquatic plants, is recommended.

7.4 Planning Considerations and Design Criteria

Wetlands can be constructed either as a wetland basin (see Figure 7-1), or set into a drainageway to form a wetland bottom channel (see Figure 7-2). Table 7-1 presents the design criteria for a wetland pond, and Table 7-2 pertains to a wetland bottom channel. The criteria for a wetland bottom channel presented here differs somewhat from the criteria presented in Volume 2 of the *USDCM* under the *Major Drainage* chapter. This is because of the water quality focus of this BMP. An analysis of the water budget should show a net inflow of water after accounting for all the projected losses (such as evaporation, evapotranspiration, and seepage). An insufficient base flow could cause the wetland to become saline or to die because of lack of water.

7.5 Maintenance Considerations. To achieve and maintain a healthy wetland for water quality enhancement, the proper depth and the spatial distribution of growth zones must be maintained. Table 7-3 summarizes suggested activities and their frequencies to maintain an operational wetland.

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Table 7-1

Wetland Pond Design Considerations and Criteria

Criteria	Design Considerations
Capture Volume and Depth	Provide the full WQCV above the permanent pool level. The WQCV should be calculated following the procedure in this manual by averaging the volume obtained using the 12- and 40-hour drain times. The depth of this WQCV shall not exceed 2.0 feet.
Emptying Duration	A 24-hour emptying time should be used for the WQCV above a wetland pond.
Flood Control Storage	Although a wetland pond can be used as a flood storage facility in addition to being a water quality enhancement facility, an alternate to this approach is to use a flood control detention facility upstream of the wetland. This separation can reduce resuspension of pollutants within the wetland and extend the life of a wetland by settling large amounts of sediment in the upstream detention basin.
Basin Geometry	Shape the pond with a gradual expansion from the inlet and a gradual contraction to the outlet, thereby limiting short circuiting. The basin length to width ratio should be 2:1 to 4:1 with 3:1 recommended.
Water Budget	A net influx of water must be available through a perennial base flow and must exceed all of the losses. The following equation and parameters can be used to estimate the net quantity of base flow available at a site:

$$Q_{net} = Q_{inflow} - Q_{Evap} - Q_{Seepage} - Q_{E.T.}$$

Where:

Q_{net} = Net quantity of base flow (acre-ft/year)

Q_{inflow} = Estimated base flow (acre-ft/year) (Estimate by seasonal measurements and/or comparison to similar watersheds)

Q_{Evap} = Loss attributed to evaporation less the precipitation (acre-ft/year) (Computed for average water surface)

$Q_{Seepage}$ = Loss (or gain) attributed to seepage to groundwater (ac-ft/year)

$Q_{E.T.}$ = Loss attributed to plant evapotranspiration (computed for average plant area above water surface, not including the water surface)

Note: WQCV = water quality capture volume. See Section 5 of the *Stormwater Quality Management* chapter to this volume.

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Table 7-1 (Continued)

Wetland Pond Design Considerations and Criteria

Criteria	Design Considerations
Wetland Depths and Volume	The volume of the water in the wetland pool shall be no less than three-fourths of WQCV. Also, the proper distribution of wetland habitat is required to establish a diverse ecology. General area requirements and the water depths of the permanent pool are presented below:

Components	Percent of Permanent Pool Area	Water Depth
Forebay outlet and free water surface areas	30% to 50%	2 to 4 feet deep
Wetland zones with emergent vegetation	50% to 70%	6 to 12 inches deep[a]

[a]One-third to one-half of this zone should be 6 inches deep.

Basin Side Slopes	Slopes should be stable and gentle enough to limit rill erosion and facilitate maintenance access and needs. Side slopes should be no steeper than 4:1, preferably 5:0 or flatter.
Inlet/Outlet Protection	Dissipate flow energy entering the basin to limit sediment resuspension. Inlets should correspond to UDFCD drop-structure and energy-dissipating structure criteria. Outlets should be placed in a offbay that is at least 3 feet deep. The outlet should be protected from clogging by a skimmer shield that starts approximately one-half of the depth below the permanent water surface and extends above the maximum capture volume depth. Skimmers can be fabricated from a stiff steel screen material that has smaller openings than the outlet orifice or perforations.
Forebay Design	Provide the opportunity for larger particles to settle out in an area that has a solid driving surface bottom for vehicles to facilitate sediment removal. The forebay volume of the permanent pool should be 5 to 10 percent of the WQCV.
Outlet Design	Use a water quality outlet that is capable of slowly releasing the WQCV in no less than a 24-hour period. A perforated riser can be used with a weir box to control the permanent pool level and storm outflows. A cutoff collar should be used on the outlet culvert. See the inlet/outlet protection discussion above for a need to install a skimmer.

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Table 7-1 (Continued)

Wetland Pond Design Considerations and Criteria

Criteria	Design Considerations
Trash Rack	See Table 5-1 for discussion. Use Figure 5-4 for design.
Vegetation	Cattails, sedges, reeds, and wetland grasses should be planted in the wetland bottom. Berms and side-sloping areas should be planted with native or irrigated turf-forming grasses. Initial establishment of the wetlands requires control of the water depth. After planting wetland species, the permanent pool should be lowered 3 to 4 inches to allow growth and to help establish the plants, after which the pool can be raised to its final operating level.
Maintenance Access	Access to the forebay and the outlet area shall be provided for vehicles for maintenance and vegetation harvesting. Maximum grades should be 8 percent, and a solid driving surface needs to be provided.

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Table 7-2

Wetland Channel Design Considerations and Criteria

Criteria	Design Considerations
Longitudinal Slope and Channel Capacity	Design the channel to have a longitudinal slope that provides for a maximum 2-year flow velocity of 2.5 feet per second or less using channel Mannings n-value of 0.03 and a flow depth of 3 to 5 feet. Assume a Mannings n-value of 0.08 to calculate its final (or mature) capacity during a 2-year flood at the same depth and slope used when initially designing the channel with n=0.03. In setting the channel's longitudinal slope, use the peak runoff rate from the tributary watershed *without* reducing it for any upstream ponding or flood routing effects.
Channel Geometry	The channel should have a bottom width-to-depth ratio greater than 8:1 during the 2-year event. Drop structures should be used to maintain the design slope whenever it exceeds the slope of the terrain. Limit side slopes to 4:1 or flatter.
Drop Structures	Drop structures should be designed to satisfy the drop structure criteria of the *Major Drainage* chapter in Volume 2 of the *USDCM*.
Vegetation	Vegetation provides solids entrapment and biological nutrient uptake. Cover the channel bottom with loamy soils upon which cattails, sedges, and reeds should be established. Side slopes should be planted with native or irrigated turf grasses.
Maintenance Access	Access to the channel length should be provided for maintenance. Maximum grades for maintenance vehicles should be 8 percent and provide a solid driving surface.

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Table 7-3

Constructed Wetlands Maintenance Considerations

Required Action	Maintenance Objective	Frequency of Action
Lawn mowing and lawn care	Mow occasionally to limit unwanted vegetation. Maintain irrigated turf grass at 2 to 4 inches tall and nonirrigated native turf grasses at 4 to 6 inches.	Routine–Depending on aesthetic requirements.
Debris and litter removal	Remove debris and litter from entire pond to minimize outlet clogging and aesthetics. Include removal of floatable material from the pond's surface. Also remove debris and litter from the channel.	Routine–Including just before annual storm seasons (that is, in April and May) and following significant rainfall events.
Sediment removal	Remove accumulated sediment and muck. Maintain growth zone depths and spatial distribution.	Nonroutine–Every 5 to 15 years as needed by inspection.
Aquatic plant harvesting	Cut and remove plants growing in wetland (such as cattails and reeds) to remove nutrients permanently with manual work or specialized machinery.	Nonroutine until further evidence indicates such action would provide significant nutrient removal. In the meantime, perform this task once every 5 years or less frequently as needed to clean the wetland zone out.
Inspections	Observe inlet and outlet works for operability. Verify the structural integrity of all structural elements, slopes, and embankments.	Routine–At least once a year, preferably once during one rainfall event resulting in runoff.

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FIGURE 7-1. PLAN AND PROFILE OF A WETLAND POND

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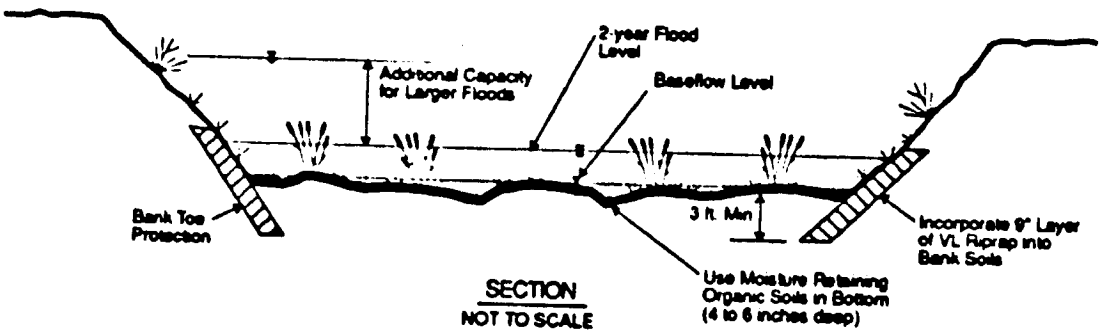

SECTION
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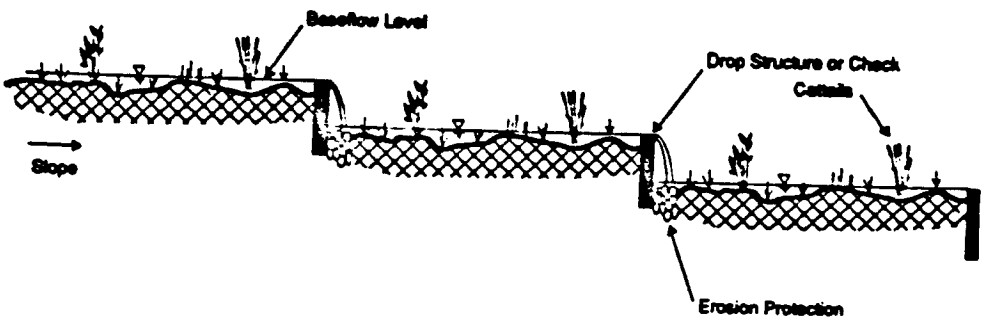

SECTION
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FIGURE 7-2. PLAN AND SECTION OF A WETLAND CHANNEL

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8. MODULAR BLOCK POROUS PAVEMENT

8.1 Description

Modular block porous pavement consists of perforated concrete slab units underlain with gravel. The surface perforations are filled with coarse sand, or sandy turf. This BMP is intended to be used in low traffic areas to accommodate vehicles while facilitating stormwater infiltration near its source. Modular block porous pavement has been in use since the mid-1970s. Although it lacks field data that quantify its long-term performance as an infiltration device, the episodal record indicates it is reliable and has experienced few problems. Modular-block porous pavement should be placed in a poured-in-place concrete grid that restricts horizontal movement of infiltrated water through the underlying gravels.

8.2 General Application

Modular block porous pavement is best used in low traffic zones. Where underlying soils permit infiltration and the high seasonal groundwater and impermeable soil layers are at least 4 feet below the surface of the gravel bedding infiltration of stormwater is possible. Otherwise, porous pavement can be installed with underdrain pipes and outlets that control the release rate of the water stored in the rock media. Although this BMP is commonly used for less frequently occupied zones of parking lots, the following are other applications:

- Low traffic airport zones
- Crossover/emergency stopping/parking lanes on divided highways
- Residential street parking lanes
- Driveways
- Maintenance roads and trails

Although grass can be used in the modular block voids, it requires irrigation and lawn care in a semi-arid climate. Even though stormwater infiltration is often the goal when underlying soils and geology permit, it is not necessary for the use of this BMP.

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8.3 Advantages/Disadvantages

8.3.1 General. Aside from the potential for high particulate pollutant removal, modular block porus pavement can reduce the flooding potential by infiltrating or slowing down runoff. Modular block patterns, colors, and materials can serve functional and aesthetic purposes to provide variety in a sometimes uniform site.

The primary disadvantages for use of modular block are its cost and the lack of specific performance data in semi-arid areas that are subject to severe freeze-thaw cycles; however, episodal descriptions indicate this type of pavement, when properly installed, functions well in under freeze-thaw cycles. Other disadvantages could be associated with snow removal, uneven driving surfaces, and potential traps for the high heels of women's shoes. Also, the cost of restorative maintenance can be very high when the system seals with sediment and no longer functions as permeable pavement.

8.3.2 Physical Site Suitability. If infiltration is the goal, the soils underlying the modular blocks should have good infiltrating capacities when saturated. As a minimum, underlying soils need to be equivalent to SCS Hydrologic Group B or better. Also, the bottom of the gravel layer of the pavement section needs to be at least 4 feet above seasonal high groundwater table and the top of any impermeable soil level.

8.3.3 Pollutant Removal. Specific field data on pollutant removal rates are not available for modular block porous pavement. When the pavement is designed to infiltrate runoff into the ground, removal rates are projected to be high for both suspended sediment and associated constituents, such as metals, oil, and grease are moderate to high for soluble constituents. Runoff filtration through the sand, gravel, or sandy sod turf of the modular block voids and entrapment are the primary removal mechanisms of pollutants along with the filtration, adsorption, and ion exchange that occur as stormwater travels through the underlying soils before the stormwater reaches groundwater. When this BMP is designed with underdrains, the removal rates for suspended constituents are still projected to be high, but the removal rates for dissolved constituents are expected to be only low to moderate.

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8.4 Planning Considerations and Design Criteria

Although modular block porous pavement is untested as a stormwater BMP in the Denver area, initial (or interim) design guidance is presented in Table 8-1, while Figure 8-1 shows two commonly used modular block units and a cross-section of modular block installation and its subgrades. Schematic representations of various uses are shown in Figure 8-2. Specific manufacturers make precast units or molds, and their specifications can be used in addition to the criteria listed in Table 8-1. Upon installation, every effort should be made to assure even flow distribution over the entire porous surface.

For the purpose of sizing downstream drainage systems and followup BMPs, assume that the permeable pavement areas are 30 percent impervious when infiltration into subsoil is possible and is provided for, and assume that the permeable pavement areas are 60 percent impervious if infiltration is not possible at the site and the pavement has a subdrain outlet.

8.5 Maintenance Considerations

Modular block porous pavement requires little routine maintenance. On the other hand, when the top filter layers seal or the rock media fills with fine sediment, expensive nonroutine maintenance may be necessary. Table 8-2 presents suggested maintenance guidance and frequency.

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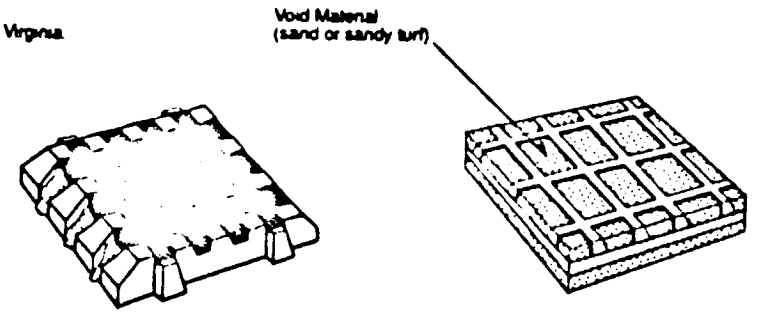
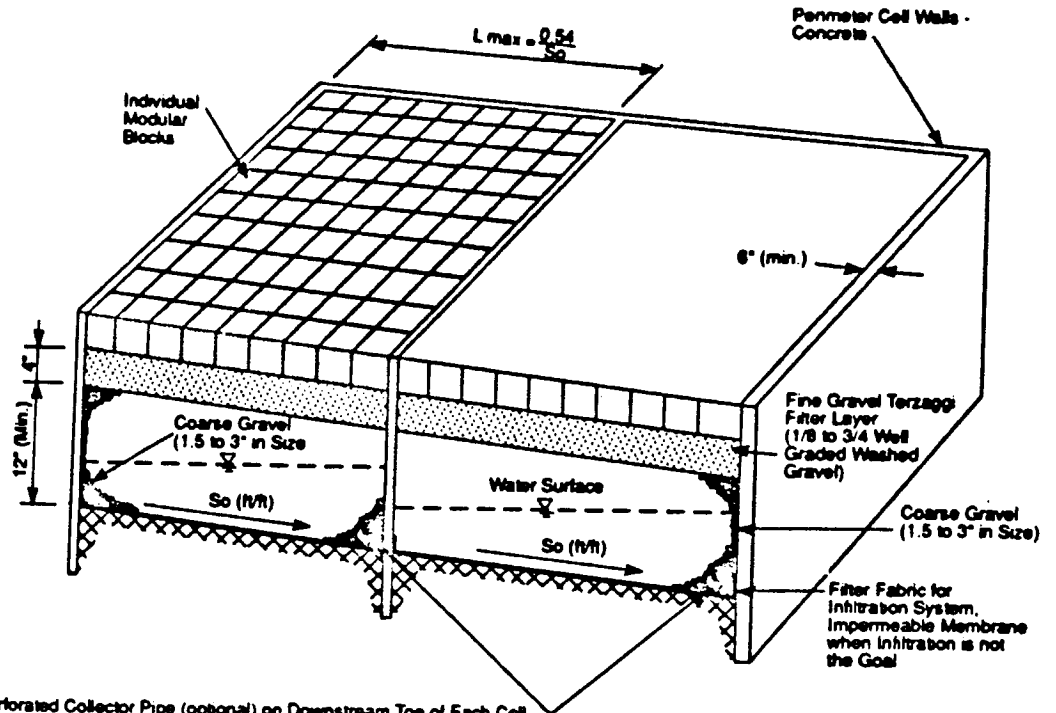
Source: State of Virginia



TWO EXAMPLES OF INDIVIDUAL CONCRETE MODULAR PAVING BLOCK



Perforated Collector Pipe (optional) on Downstream Toe of Each Cell, Connected to an Outfall Pipe. Use only when Infiltration is not Possible or Desired. Each cell's collector Pipe should have a Constricted Outlet to limit the drainage of the pore space volume in the Coarse Gravel Layer in 12-hours.

PERSPECTIVE OF SIDE-BY-SIDE MODULAR BLOCK CELLS

FIGURE 8-1. MODULAR BLOCK POROUS PAVEMENT

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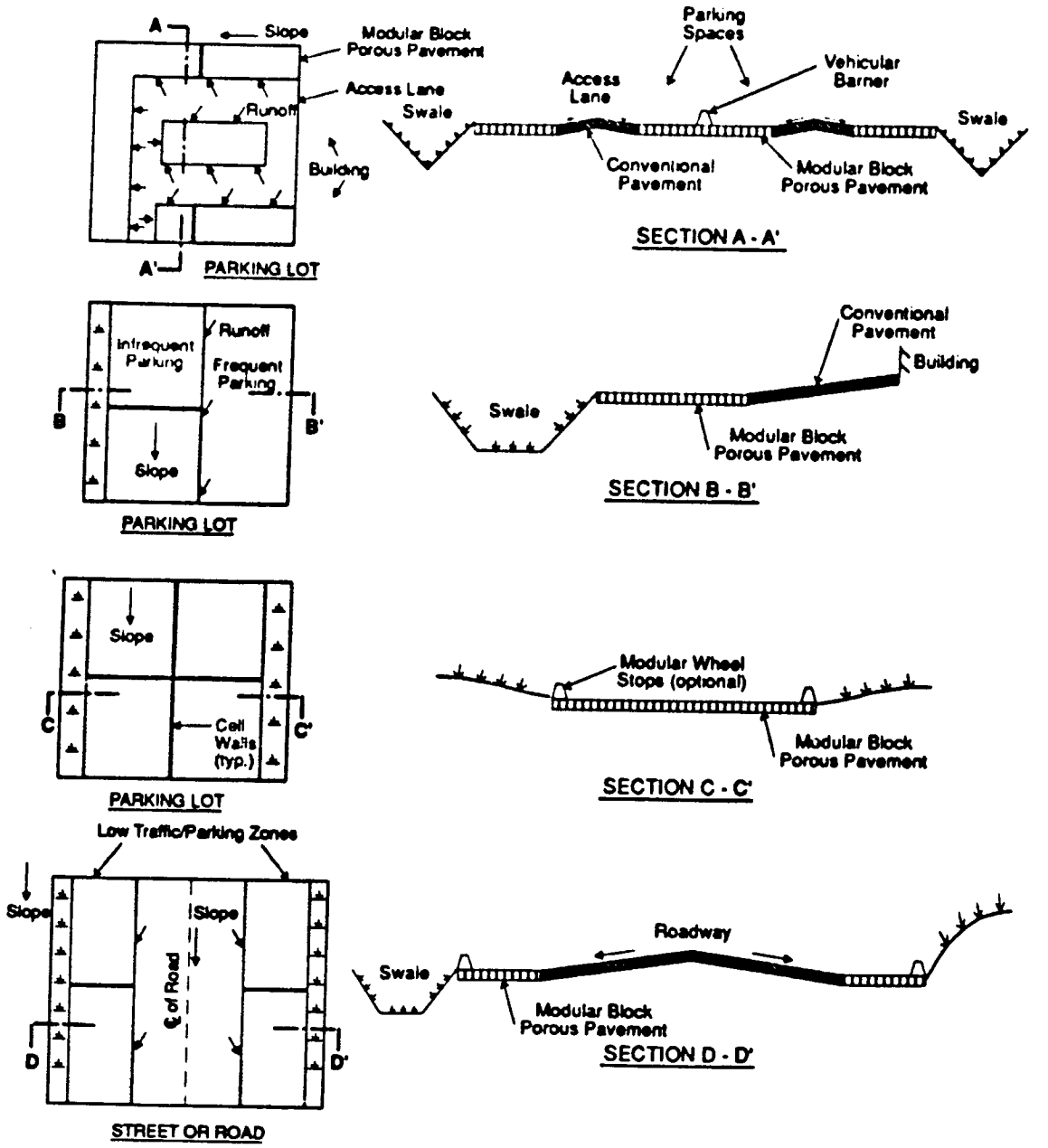

FIGURE 8-2. TYPICAL APPLICATIONS OF MODULAR BLOCK POROUS PAVEMENT

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Table 8-1

Modular Block Porous Pavement Design Considerations and Criteria

Criteria	Design Considerations
Rock Media Pore Volume	The facility should provide, as a minimum, sufficient pore volume in the large gravel layer to store 85 to 90 percent of the runoff volume from a 2-year storm (assume 85 to 90 percent of the runoff from 1.15 inches of rainfall for a 100 percent impervious basin tributary to porous pavement). Assume that 30 percent of the rock layer is open pore space. Available pore storage volume can be increased by installing perforated concrete or clay tile in the coarse gravel layer. Limit impervious tributary area to less than two times the pervious pavement area.
Design Selection	1. Soil infiltration can be considered for Hydrologic Soil Classes A and B soils provided the seasonal groundwater table or any impervious layer is at least 4 feet below the top of the subgrade. Reduce the available infiltration rate by a safety factor of 2 to assure sufficient drainage. 2. Use a perforated collection pipe in each cell for poorly infiltrating soils or to augment poor infiltration conditions.
Inlay Material	The modular block should be filled with coarse sand or sandy sod (sod will require irrigation) to form a smooth firm driving surface.
Base Coarses	The filter coarse layers should be a minimum of 4 inches, clean, well-graded, crushed stone (1/8 to 3/4 inch in size). (Do not use geotextile filter fabric in this location). The stone reservoir layer shall be at least 12 inches deep of clean crushed 1.5- to 3-inch-size stone. If offsite drainage from adjacent impervious surfaces occurs, increase this rock layer thickness to provide needed *Rock Media Pore Volume* as required above in this table.
Modular Block Units	The manufacturer's installation requirements for stormwater quality enhancement shall be followed with the exception that *Rock Media Pore Volume Inlay Material*, and *Base Course* dimension, and requirements in this section shall be adhered with.
Concrete Cells	Provide vertical, poured-in-place concrete walls to separate porous cells and to cut off horizontal flow of water. Space the walls so that the distance along the subgrade slope L_{max} does not exceed: $$L_{max} = \frac{0.54}{S_o} \text{ ft}$$
Subbase	Native soil subbase shall be brought to grade by excavation only if infiltration is to be used. In such cases, excavate by using light equipment, and do not roll or compact the exposed subbase to protect the native soil's infiltrating capacity. No such restrictions apply when infiltration into the underlying soils is not the goal or when site conditions do not permit infiltration into the ground. Install a geotextile filter fabric on top of the subbase if the installation is being designed to infiltrate stormwater into underlaying soils. Otherwise install impermeable membrane. Place the base coarse on top of the fabric or the membrane.

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Table 8-2

Modular Block Porous Pavement Maintenance Considerations

Requires Action	Maintenance Objective	Frequency of Action
Debris and litter removal	Accumulated material should be removed as a source control measure.	Nonroutine–As needed.
Sod maintenance	Lawn care, the irrigation system, and inlay depths should be inspected and maintained as needed.	Routine–As dictated by inspection.
Inspection	Inspect representative areas of surface filter sand, fine gravel, and sandy turf.	Routine and during a storm event to ensure that water is not running off these surfaces.
Replacement of Surface Filter Layer	Remove individual blocks, remove, dispose, and replace surface filter media.	Nonroutine–when it becomes evident that runoff doese not rapidly infiltrate into the surface.

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LIGHT INDUSTRIAL AND COMMERCIAL BMPs

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LIGHT INDUSTRIAL AND COMMERCIAL BEST MANAGEMENT PRACTICES

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WATER QUALITY FACILITY
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WATER QUALITY FACILITY STRUCTURES

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NONSTRUCTURAL BMPs

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NONSTRUCTURAL BEST MANAGEMENT PRACTICES

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Appendix A - Example Drainage Planning Submittals

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1. INTRODUCTION TO NONSTRUCTURAL BMPs

1.1 Overview

This section contains guidance on the evaluation, selection and use of nonstructural Best Management Practices (BMPs). Each BMP is described and discussed as to its general application in an urban area. The following nonstructural BMPs are considered to be appropriate and effective in stormwater quality enhancement and are described in following sections of this chapter:

- Stormwater quality control planning
- Adoption of criteria and standards (including erosion control during construction)
- Disposal of household waste and toxics
- Use of pesticides, herbicides, and fertilizer
- Illicit discharge controls
- Landscaping and vegetation practices

1.2 Advantages of Nonstructural BMPs

Pollution of stormwater originates from many sources in urban areas. Structural controls reduce the amounts of pollutants that migrate off the urban landscape by reducing runoff and by providing facilities to remove pollutants from stormwater. Nonstructural BMPs prevent or limit the entry of pollutants into stormwater at their source. Prevention is desirable and can be cost effective because it avoids pollution in the first place and thereby reduces the amounts that need to be removed by subsequent treatment. In urbanized portions of the municipality, it may be one of the few affordable methods for stormwater quality enhancement.

The advantages of nonstructural BMPs, among others, are:

- The quality of stormwater runoff is improved

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- The volume of sediment, debris and other pollutants deposited in receiving waterbodies is reduced
- Operation and maintenance of structural controls is reduced
- Attendent benefits to air quality, ground water quality, and solid waste control
- Enhanced open space and wildlife habitat
- Heightened public awareness of water-quality problems and involvement in solutions
- Increased public awareness of stormwater quality issues
- Most require only a modification of existing practices, are simple to understand, and make good sense
- Implementation can occur rapidly
- Do not require major capital construction financing

1.3 Disadvantages of Nonstructural BMPs

The effectiveness of most nonstructural BMPs depends on the public's attitude, its willingness to accept information, and its willingness to put BMPs into practice. Low participation will result in little or no measurable benefit. A high percentage of participation has the potential for noticeable changes in water quality.

Disadvantages to the use of nonstructural BMPs include:

- Public information is expensive to develop and distribute, and must be updated and redistributed on an ongoing basis
- Effectiveness of good housekeeping measures is determined primarily by voluntary participation on the part of community residents
- Initial public/private expenditures are needed to remove impediments to participation and encourage development of information and infrastructure improvements such as recycling centers and household toxics collection programs

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- Effectiveness of vegetative practices is determined by how successfully permanent ground cover is established
- Requires a dedicated workforce and funds to maintain viable programs and to continue citizen participation
- Effects on stormwater quality are virtually impossible to quantify and to measure accurately without long-term data. On the other hand, the amounts of materials collected and recycled are quantifiable and could serve as an indirect measure of overall success

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2. STORMWATER QUALITY CONTROL PLANNING

2.1 Description

Stormwater management planning is an established practice with a long history of use by municipalities in Colorado. Its primary focus prior to the end of the 1980s was the prevention and mitigation of flood damages and loss of life. Emphasis in planning was on storm runoff events with return periods of 2- through 100-years with very little attention paid to stormwater quality enhancement.

As a result of the 1987 Clean Water Act (CWA) requirements, stormwater quality planning is a required practice. These requirements extend to planning for water quality enhancement whenever conducting flood control and floodplain management planning activities.

Planning for stormwater quality can take several forms such as planning for an individual site, a new subdivision, overall planning for an urban watershed or a portion thereof, or overall planning for an entire municipality. As the planning area expands, less specific detail can be addressed and the plans become more conceptual in scope. A well developed citywide or watershed conceptual plan is useful because it provides guidance on how to deal with stormwater runoff and its quality as changes occur in land use. On the other hand, site-specific plans can clearly describe the types of BMPs to use, the phasing for their installation, and the type of long-term maintenance that will be required to keep them operational.

This nonstructural BMP identifies the stormwater planning needs for individual developments and the general nature of the review and approval process of local governments. Municipalities should consider development and adoption of a stormwater quality planning process. It is recommended that the proponent of any new development or redevelopment contact the local government of jurisdiction to determine the exact steps to be taken to obtain final approval of their site plans. The process begins with the preparation and submittal of a stormwater management plan by the proponent to the local government as a part of local zoning, subdivision, or other applicable development review process.

Section 2.2 contains example stormwater management planning requirements that a municipality may employ. It should not be viewed as the only process to follow by every local jurisdiction. It is

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provided, however, as an example and a checklist of some of the many features individual local governments could use in establishing municipal stormwater site-planning requirements.

2.2 General Applicability

As a first step in managing stormwater quality from new development, local governments are encouraged to require all new development and significant redevelopment to prepare and obtain approval of a drainage report for the site that contains a *Stormwater Quality Control Plan*.

For clarification, the local jurisdiction must define what constitutes "new development" and "significant redevelopment." Clearly there is also a need for exemptions for very small sites and infill such as individual lots that are part of existing subdivisions.

The requirement for the preparation of and compliance with a *Stormwater Quality Control Plan* is a nonstructural BMP. The implementation of this BMP is in the form of adoption or promulgation of ordinances, resolutions, or executive orders granting authority to municipal staff to review such plans and to either approve or present recommendations for approvals to elected officials. In addition, implementation of this BMP requires the commitment of staff and fiscal resources of the municipality to follow through with the review, approval, and enforcement of the site-specific plans. Regulations must also be adopted that specify the content of stormwater quality information required for inclusion in the drainage report.

2.2.1 Plan Requirements. A *Stormwater Quality Control Plan* is developed as part of the overall drainage plan. The primary stormwater quality design elements to be addressed in the drainage report are as follows:

- Description of water-quality objectives contained in master plans adopted for the basin or subbasin
- Description of the stormwater quality management planning concept for the specific site and how this is designed to meet basin objectives
- Map showing locations of drainage features
- Drawings of drainage features including structural BMPs in the drainage facility design

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- Hydrologic and hydraulic calculations to document adequate sizing and stability of drainage features
- Description of maintenance access and responsibilities

Appendix A is provided as an example of drainage plan submittal requirements that cities and counties in the Denver metropolitan area may consider for adoption. These requirements include both stormwater quality and quantity considerations in the definition of drainage criteria. Appendix A can be used as a model and checklist for local governments in developing their own submittal requirements.

2.2.2 Plan Review Procedures. A drainage report is prepared as part of the overall development review process. The report is prepared as a three-step process:

1. Preliminary drainage report
2. Final drainage report
3. Construction drawings

At the initial stage of planning, a preliminary report is prepared that identifies the general project location, the location relative to major basins and subbasins, and a conceptual design for drainage facilities. After review and comment by the municipality, a final drainage report is prepared that includes details of the drainage facility design. After approval of the final report, construction drawings are prepared that describe the configuration of the site, design of drainage features, and details of structures as appropriate.

2.2.3 Exemptions and Variances. Exemptions and variances may be considered appropriate under certain circumstances. The following examples are noted for consideration by municipalities in making a determination on possible exemptions. For areas of new development, the only criteria may be to establish a minimum area exempt from the requirement to prepare a drainage report. This determination must be made by each individual municipality. For areas being redeveloped, the following criteria can be considered as to what constitutes "significant redevelopment" for the purposes of defining exemptions:

- Minimum Area. A minimum area of 2 lots or 1 acre, whichever is smaller

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- Change in Zoning. A change in zoning of a parcel of land
- Change in Use. A change in use within a major zoning classification
- Change in Plan. A change in the development plan from that originally approved
- Demolition. The total demolition of a site prior to planned redevelopment, or partial demolition dependent on a minimum size of the area being demolished, such as 1 acre
- Asphalt Removal. Removal of greater than 1 acre of asphalt from an existing site is considered significant redevelopment

Variances may also be included as a provision in the municipal drainage planning submittal requirements. This provision would allow a variance from specific information required in the submittal of a drainage plan where this information is unavailable or reasons for its exclusion are justified. If a variance provision is included, each municipality should consider the terms presented by the proponent for requesting a variance on a case-by-case basis.

2.3 Advantages and Disadvantages

New development can incorporate elements of drainage design that reduce impacts on stormwater quality. The requirement to prepare a drainage report that addresses stormwater quality is a method to include structural BMPs in any new development within the municipality. This ensures that all proposed land development includes BMPs that are consistent with technical criteria and the stormwater permit issued by the State of Colorado to the municipality.

2.3.1 Advantages. The primary advantages of stormwater quality management planning are:

- Provides a clear written statement of municipal drainage planning submittal requirements
- Provides guidance on municipal procedures for review of development and redevelopment proposals
- Provides for consistency in achieving municipal stormwater quality goals and objectives

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- Can serve as a basis for compliance with a municipal stormwater discharge permit issued by the State of Colorado

2.3.2 Disadvantages. The major disadvantages of stormwater quality control planning include:

- Requires commitment of additional administrative and fiscal resources to develop regulations addressing stormwater quality aspects of drainage planning on the part of municipal government
- Can expand the time and expense required on the part of a developer and municipality to implement new development and redevelopment

2.4 Implementation

Implementation of this nonstructural BMP is accomplished as follows:

- Provide staff and fiscal resources to implement review of drainage plans
- Develop review procedures, guidance documents, and coordination mechanisms among various municipal departments
- Adopt drainage planning submittal requirements
- To support full implementation of stormwater quality management planning, a municipality should also consider *Adoption of Criteria and Standards* as described in Section 3 of this chapter

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3. ADOPTION OF CRITERIA AND STANDARDS

3.1 Description

The adoption by a municipality of criteria and standards for the selection, planning, and design of stormwater quality facilities can be considered a nonstructural Best Management Practice (BMP). Criteria and standards establish the requirements for the design, construction, operation and maintenance of structural stormwater quality BMP facilities that the municipality considers to be the minimum it will accept. Their formal adoption or promulgation must occur before these minimum standards have a legal basis within the community. Since the criteria set forth the minimum standard, their use should not preclude innovation, or the use of detail other than presented in the criteria as long as the basic technology and sound engineering practice are not violated and the goals are being met.

When combined with the municipality's legislative authority and its comprehensive planning process, the adoption of criteria and standards supports the review and approval of zoning, plat-filing, and construction actions for land development and redevelopment. This also ensures that the structural BMPs being used are based on sound technical and engineering design principles that should provide the intended stormwater quality enhancement.

3.2 General Application

Once adopted, a set of technical criteria and engineering design standards for structural BMPs serve to identify structural BMPs that are considered useful for pollutant removal or reduction. The land developer is responsibile for preparing a stormwater management plan as a part of the overall site development plan as described in Section 2. The adopted criteria then provide general guidelines on BMP selection, direction on their intended purpose and function, applicability in various settings, design details and guidance, operation and maintenance needs, pollutant load reduction potential, and initial guidance for estimating their cost. These criteria and standards can also ensure that BMPs are applied uniformly within the municipality.

The success of BMPs for stormwater management is dependent not only on their original design. Subsequent construction, operation, and maintenance are key to their implementation. If structural

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controls are not operated or maintained properly, then the adopted criteria and the designs are ineffectual and their use will have a greatly diminished impact on improving stormwater quality.

3.3 Advantages and Disadvantages

Adoption of technical criteria and standards for BMPs has many advantages and some disadvantages in pursuing runoff quality enhancement by a city or county. Each municipality must evaluate these and the specific criteria and standards prior to adoption.

3.3.1 Advantages. The primary advantages of adopting local stormwater quality criteria and standards are:

- Provides a clear written minimum design standard for a municipality
- Identify structural BMPs suitable for use under local conditions
- Provides a written standard for review and approval of development and redevelopment proposals and designs
- Provides a primary reference source for information
- Provides a basis for considering alternative proposals and designs by the municipality
- Provides for consistency in achieving municipal stormwater quality goals and objectives
- Serves as a basis for compliance with a municipal stormwater discharge permit issued by the State of Colorado
- Serves as a basis for presumptive effectiveness in compliance, thereby reducing or eliminating the need for end-of-pipe compliance monitoring
- Reduces the time and expense needed to implement new development and redevelopment

3.3.2 Disadvantages. The often-stated disadvantages of adopting municipal standards and criteria are:

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- Requires commitment of administrative and fiscal resources for plan review, field inspection, and eventual acceptance of completed facilities on the part of municipal government
- Expands the time and expense on the part of developers and the municipality to implement new development or redevelopment
- Requires periodic updating
- Can stifle innovation or use of designs that differ significantly in detail from the standards if municipal staff are inflexible

3.4 Implementation

The implementation of this nonstructural BMP consists of the following:

- Research known BMPs and identify those considered appropriate for use under local conditions
- Develop clear technical criteria and design standards for the selected BMPs
- Publish and adopt criteria and standards as the minimum standards of the municipality
- Provide staff and fiscal resources to implement the adopted criteria through review, construction, and final acceptance of facilities

Model criteria for structural and nonstructural BMPs were developed by UDFCD in cooperation with many municipalities in the Denver metropolitan area. These are described in detail in the *Structural Best Management Practices* chapter in Volume 3 of this Manual. These model criteria will be updated in the future as more information becomes available on effective stormwater quality BMPs. As a result, the adoption of these or other local criteria should provide for eventual changes as technology or legislation change over time.

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4. DISPOSAL OF HOUSEHOLD WASTE AND TOXICS

4.1 Description

Improperly disposed waste materials are a source of stormwater pollution. This is especially true when wastes are placed on impervious surfaces directly connected to the storm drainage system, such as streets, alleys, parking lots and sidewalks.

The development of public education programs and dissemination of information that promotes proper disposal of household waste, litter, pet waste, yard waste, used oil, and toxic waste is a nonstructural Best Management Practice (BMP) that can be employed by the state, municipalities, civic groups and industry. The passage of municipal ordinances prohibiting improper disposal of these materials, and their enforcement, is another step in this management practice; however, an on-going education program; along with facilities for such disposal, has been judged to be most effective at this time.

4.2 General Application

Waste materials deposited on the urban landscape, especially the impervious surfaces, can be washed off by stormwater runoff and delivered to the receiving water system. Thus, all measures that help to minimize the presence of these materials on the urban landscape can improve water quality. Proper disposal of household waste and toxics can reduce the deposition of solids, organics, nutrients, oxygen-demanding substances, solvents, caustics, paints, automotive fluids, toxic substances and fecal material on the land and reduce their presence in the stormwater reaching receiving waters.

Public education can be used to raise the level of understanding in the general public on how improper disposal of wastes can degrade stormwater quality, and how proper disposal can help to protect the quality of receiving waters. Several categories of waste materials were identified where public education can be effective in reducing the amounts of pollutants entering municipal stormwater runoff. Each of these are discussed below.

4.2.1 Household Waste. Household waste includes materials discarded on the land surface or into the stormwater system from residential and commercial areas. Wastes from commercial businesses are generated by stores, restaurants, hotels, offices, and other nonmanufacturing activities. Commercial waste is considered to be similar to residential waste and is addressed collectively

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under this definition. Toxic wastes from residential and commercial areas are considered a subcategory of household waste.

Refuse is solid waste that is contained, whereas litter is uncontained. Refuse is controlled through existing programs of solid waste collection and disposal. The goal of household waste disposal is to contain all refuse, reduce litter, and encourage proper waste disposal through public education.

4.2.2 Litter. Most litter is biodegradable and can create an oxygen demand in water as it decomposes. Research by Keep America Beautiful, Inc. (1990) has shown that people litter where litter has already accumulated. Also according to Keep America Beautiful, Inc. (1987), pedestrians and motorists account for less than 25% of litter, the other sources being household waste, commercial and industrial waste, haulage vehicles, loading docks, and construction sites. Reduction of litter through proper disposal can reduce its accumulation on the urban landscape and its eventual entry into the stormwater system.

4.2.3 Pet Waste. Pet waste deposited on impervious surfaces can be transported by the stormwater drainage system to receiving waters. Fecal matter contains pathogenic bacteria and also creates an oxygen demand in water.

The majority of improperly disposed pet waste occurs in public areas, such as streets and parks. Pet waste ordinances are common in municipalities, however, these are difficult to enforce especially with limited municipal resources. Public education can help bring this problem to the public's attention, and can thereby reduce deposition of pet waste on urban surfaces.

4.2.4 Yard Waste. Yard waste is also a category of household waste. It is distinguished from other categories of household waste in that it can be disposed of by composting. Composting is the aerobic decomposition of plant and other organic materials.

Yard waste accounts for 18% of the municipal waste stream on a weight basis (Keep America Beautiful, 1987). Fallen tree leaves, grass clippings and garden detritus can become water pollutants when they are disposed of in alleys, driveways, parking lots, streets, street gutters and drainage channels. Public education efforts on the benefits of composting and on proper disposal of yard waste can help to reduce the volume of yard waste entering the stormwater system and receiving waters.

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4.2.5 Used Oil and Automotive Fluids. Used oil and automotive fluids including antifreeze, brake fluid, transmission fluid, grease, other lubricants, and petroleum-based cleaning solvents are wastes generated during automobile maintenance by residential households and commercial businesses. These can enter the storm drainage system if poured directly into storm inlets or disposed on concrete or asphalt exposed to precipitation.

Improper disposal of used oil and automotive fluids cause receiving waters to become contaminated with hydrocarbons and residual metals that can be toxic to stream organisms. Used oil and other petroleum products can be recycled. A number of different recycling centers presently exist in the metropolitan area. Public education on the location of these centers, the benefits of recycling, prevention of fluid leaks, and the importance of proper disposal for improving stormwater quality, can reduce the amounts of oil and used automotive fluids reaching receiving waters.

4.2.6 Toxic Wastes. Toxic wastes are generated by residential households and commercial businesses. These primarily consist of certain types of used and unused consumer products. Included among these are paint, solvents, putties, cleaners, waxes, polishes, oil products, aerosols, acids, caustics, pesticides, herbicides, and certain medicines or cosmetics. These products and their containers should always be disposed of properly. Some of these unused toxic materials can also be recycled.

Improper disposal of toxic substances cause stormwater to become contaminated by these wastes. This occurs when toxic substances are dumped into street gutters or storm inlets. This also happens when stormwater comes in contact with toxic substances or where they have been improperly disposed on land surfaces.

There is no need for improper disposal of toxic substances since, according to legislation passed by the U.S Congress (1976), small amounts of toxic materials can legally be disposed of in landfills. Educational efforts to heighten public awareness of the environmental damage due to improper disposal, and to encourage proper disposal and recycling can reduce the amounts of these pollutants entering stormwater, provided the public as a whole actively participates.

4.3 Advantages and Disadvantages

It is unknown at present the extent of runoff contamination due to improper disposal of various household waste materials. The amount of water quality improvement that can result from public

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education on proper disposal methods and opportunities for recycling have yet to be quantified. Intuitively, there should be some benefit if the amount of these wastes is reduced.

4.3.1 Advantages. Major advantages of public education on proper disposal of household waste and toxics can include:

- Reduction in the quantities of solids, metals, floatable materials, oxygen-consuming materials, nutrients, fecal matter, oil and toxic substances transported by stormwater to receiving waters
- Improved aesthetics of parks and public areas
- Appropriate disposal of more wastes at landfills
- Reduced littering on the urban landscape
- Increased recycling and resource recovery
- Heightened awareness and public understanding of how each person can pollute receiving waters and how each person can help to prevent their pollution

4.3.2 Disadvantages. Some disadvantages associated with the use of this BMP include:

- Its success and effectiveness depends on voluntary efforts
- Places an increased demand on recycling facilities and products
- Extremely difficult to quantify pollutant load reduction
- Requires an on-going effort to continuously provide public education through distribution of educational materials
- May require ordinances and enforcement actions in some cases to address the more difficult and persistent activities generating pollutants

4.4 Implementation

The implementation of a public education and information program can include one or more of the following:

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- Development, publication and distribution of brochures
- Utility bill inserts, flyers and handbills
- Newspaper articles and/or advertisements
- Development and distribution of educational videos
- Public workshops, including field demonstrations
- Developing school curricula
- Developing and installing posters and signs

The following are examples that may be considered for use:

- Signs, including graphics, on dumpsters and other locations encouraging proper waste disposal
- Brochures and utility bill inserts on separation of wastes and recycling
- Advertising the locations of existing toxic disposal sites and waste recycling centers
- Advertising the locations of existing automobile used oil disposal sites
- Establishing and maintaining household toxics disposal sites
- Annual or curbside collection of household toxics
- Signs in parks and along streets on pet waste control and ordinances
- Pet waste disposal bags in public parks
- Voluntary neighborhood clean-up efforts
- Waste containers in problem litter areas
- Requiring waste-haulage truck covers
- Seasonal collection programs for tree branches and leaves

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- On-going collection program, or disposal sites, for grass clippings and other yard waste
- Distribution programs to recycle compost as mulch
- Advertisements or notices of private locations accepting yard waste for composting
- Information on backyard or neighborhood composting and proper disposal of yard waste

All of these examples are not likely to be used by a municipality at any given time. Local conditions, public attitudes, and fiscal constraints will determine what combination is most appropriate and effective for use in each municipality.

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5. USE OF PESTICIDES, HERBICIDES AND FERTILIZER

5.1 Description

Pesticides, herbicides, and fertilizers are used to maintain landscaping in residential and commercial areas. These substances are toxic and can contaminate surface runoff if not properly used. This nonstructural BMP consists of the development and dissemination of public information that encourages proper use and application of pesticides, herbicides, and fertilizers.

5.2 General Application

Pesticides, herbicides, and fertilizers are chemicals used in landscape maintenance. Pesticides are used for insect control, herbicides are used for weed control, and fertilizers are used to promote growth of grasses, flowers, trees, shrubs, and other vegetation. While pesticides and herbicides are toxic to aquatic life at low concentrations, fertilizers can be toxic at high concentrations. Fertilizers, however, are more commonly a problem because of their nutrient-enrichment effect on receiving waterbodies. An oversupply of phosphorus and nitrogen will promote algal growth that can lead to a depletion of dissolved oxygen needed for fish and other aquatic organisms. These chemicals are applied on urban landscape areas and, when improperly applied or used, can be transported to receiving waters in surface runoff.

The rate and timing of application of pesticides, herbicides, and fertilizer are important to minimize transport by surface runoff, as well as to optimize their intended purpose in landscape maintenance. Overapplication and overspraying of pesticides, herbicides, and fertilizers onto impervious areas, such as streets and sidewalks, need to be avoided as well as excessive or too frequent use of these chemicals. Use of these chemicals in accordance with manufacturer's recommendations can prevent most of the surface water contamination being attributed to their use.

Public education can be an effective method. Raising the general level of understanding of how individual action in the use of these chemicals can contaminate surface runoff and the receiving waterbodies can make each citizen aware of the problem. Whether this awareness will translate into an improved use of these products will then depend on individual attitudes. Thus, dissemination of information to the public on the impacts of improper use and how to use landscape maintenance chemicals is the basis for this nonstructural BMP.

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5.3 Advantages and Disadvantages

Although it is possible to quantify the amounts of pesticides, herbicides, and fertilizers used in residential and commercial areas within a given market zone, it is not known what amounts are improperly used. There should be some amount of overall benefit, however, if educational efforts result in a general increase in the number of people properly using and applying these chemicals in urban areas.

5.3.1 Advantages. Major advantages of the use of this BMP include:

- Can reduce the source of pesticides and herbicides eventually entering receiving waters
- Can help reduce the level of phosphorus and nitrogen in receiving waters, thereby positively affecting the problem of nuisance growth of algae, and eutrophication of small lakes and tributary streams
- Encourage the use of less toxic or substitute methods of pest and weed control that, if followed, further reduce the supply of pesticides and herbicides for contact with surface runoff
- Heighten the awareness and public understanding of how individual actions can add to or reduce stormwater pollution

5.3.2 Disadvantages. Some disadvantages associated with the use of this BMP include:

- Difficult to reach and influence all commercial and residential users of these chemicals
- Difficult to present technical information in simplified form to all users
- Extremely difficult to quantify extent of how implementation of this BMP translates into water quality effects in receiving waters
- Requires on-going educational activities an the distribution of information

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5.4 Implementation

The development of an ongoing educational program is the basis of this nonstructural BMP. The audience to be targeted is residential homeowners and small businesses.

As a first step, technical information on pesticides, herbicides and fertilizers and their proper use must be developed. The following sources can be consulted:

- Existing state regulations on pesticide application, certification, and weed control,
- Federal legislation, regulations and technical reports,
- Chemical manufacturer's technical manuals, product labels and use directions, storage and proper disposal guidelines, and material safety data sheets,
- Sprayer manufacturer's calibration guides,
- Sorbent manufacturer's spill management guides,
- University and County Agricultural Extension Service horticultural guides,
- Rocky Mountain Poison Center safety guidelines, and
- Other studies and available information.

Methods available for public education on the use of pesticides, herbicides and fertilizers are very similar to those described in Section 4.4 of this chapter and the reader is referred to that section for details.

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6. ILLICIT DISCHARGE CONTROLS

6.1 Description

Activities that reduce the entry of pollutants into the municipal storm sewer system during dry-weather periods can enhance the quality of receiving waters. These include controls on illegal dumping of toxic substances and petroleum products, responses to contain accidental spills, measures to locate and disconnect illicit connections of wastewater sewers from storm sewers, and measures to prevent additional illicit wastewater sewer connections in the future. To their credit, many municipalities already have programs in place to address all of these concerns. Measures that limit these types of illicit discharges to the storm drainage system are considered nonstructural best management practices (BMPs).

6.2 Illegal Dumping

Illegal dumping can occur at various times and places whenever toxic substances or other pollutants are dumped into or disposed of directly into storm inlets, other storm drainage facilities, or onto the urban landscape. Prohibitions against such activity have been enacted by many municipalities, however, enforcement is difficult because of the often clandestine nature of illegal dumping and the large areas over which such activities can take place.

Nonstructural BMPs that can be considered for implementation by local municipalities are based on efforts to increase surveillance of illegal dumping. These include developing educational materials for the public about these illegal practices and the hazards they create to the public health and the environment, encouraging increased public reporting, possibly establishing a "hotline" telephone number for citizens to call to report dumping incidents, or making illegal dumping a part of the 911 reporting network. Strong enforcement action against violations, accompanied by publicity, could discourage such activities by others.

6.3 Accidental Spill Response

The storage, transport and disposal of hazardous and toxic substances is a regulated activity under state and federal laws. Response procedures for management of accidental spills of pollutants are practiced presently by many municipalities. As a result, many local police and fire departments are

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equipped to respond to such spills. Nevertheless, most spills have the potential to contaminate receiving waters via transport by the storm sewer system.

Additional measures that might be considered by local governments include mapping of storm sewer systems to identify the locations of stormwater inlets for each sewer line. Such maps can then be used by the emergency response crews to help identify which inlets, areas, or sewers to protect or block off in the event of a spill. Once a spill occurs, it should be monitored to determine when the area of the spill has been adequately cleaned up. All of these measures, as well as on-going practices, need periodic updating and refresher training to be current. Training, updating of procedures, field exercises and proper equipment are all part of a spill response program.

6.4 Illicit Connections

Illicit connections of wastewater sewers to the storm runoff system in new developments can be prevented by an aggressive and competent inspection program by municipal or utility personnel. Illicit connections can exist, however, in older developments. Some municipalities have taken steps in the past to identify these and have disconnected those that were found. A well-organized program to find illicit wastewater connections also requires accurate mapping of the sanitary and storm sewer systems and a thorough understanding of these systems.

To isolate likely sources, personnel first need to look for visual signs of illicit connections at storm sewer outfalls, relying on sight and smell. If the initial screening indicates a possible illicit connection, random dry-weather sampling and testing for indicator constituents can help to further identify if there may be illicit connections in the system. These then need to be investigated further with a well-planned "seek and destroy" effort that is designed to address the specific nature of the storm drainage and wastewater systems. Occasional random dry-weather screening can also be conducted, especially in areas where the greatest potential exists for illicit connections. These tests may identify illicit connections that discharge occasionally and in a random manner, a typical scenario for individual wastewater discharges. Excavation of sewer lines at the point of connection, and reconnection of the wastewater line to the appropriate system is the final step to correct the problem.

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6.5 Advantages and Disadvantages

The question whether actions to reduce illegal dumping, contamination from accidental spills and illicit discharges have advantages or disadvantages is immaterial. This is evidenced by the fact that many municipalities have one or more programs in place. Pollutants entering the storm sewer systems by illegal dumping, spills, and illicit connections can contribute public health problems that deserve on-going attention. Thus, mitigation efforts can provide benefits to water quality in the receiving system while protecting public health and welfare. However, there are costs associated with these activities.

6.6 Implementation

The following actions, if not already in place, can be considered for use by local jurisdictions:

- Enactment of ordinances prohibiting illegal dumping and illicit connections
- Developing a public education program advising the residents of potential problems that can result from illegal dumping, illicit connections and accidental spills. Section 4 of this chapter describes elements of a public education program
- Install a "hotline" telephone number, or make 911 a part of this program to handle calls from citizens reporting illegal dumping or accidental spills
- Review and update training procedures, equipment and material inventories, and administrative procedures for spill containment and management
- Conduct random field screening of stormwater outfalls to find illicit wastewater connections to storm drainage systems. All illicit connections that are discovered should be eliminated
- Train field inspectors and develop field inspection procedures that prevent new illicit connections of wastewater lines to storm sewers

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7. LANDSCAPING AND VEGETATIVE PRACTICES

7.1 Description

Establishment and maintenance of landscaping and vegetation in existing urban areas can assist in reducing stormwater runoff rates and volumes, sediment loads, and pollutants associated with sediment from entering streams and lakes. In any urban area, many areas of land exist that are devoid of vegetation for long periods of time. Efforts to revegetate these areas and those experiencing soil disturbance activities, or otherwise provide stabilization from erosion during storm runoff, will improve the quality of stormwater runoff entering receiving waters. This nonstructural Best Management Practice (BMP) encourages the establishment and maintenance of urban landscaping and vegetation through the development of public education programs, dissemination of information, and the adoption of erosion control ordinances.

7.2 General Application

A vegetative cover on soil will reduce the volume of runoff, reduce soil erosion, and encourage deposition of sediments, as stormwater flows through the vegetated area. Vegetation acts to reduce raindrop impact on soil, slows runoff rates, and encourages infiltration of precipitation into the soil. Additional pollutants, such as metals, nutrients, and bacteria that are attached to sediment will also be removed. The overall volume of runoff from a vegetated area is less than from an area of bare soil. Although bare soil will also allow some infiltration, its surface has a tendency to seal and erode. The eroded soils are a source of sediment transported to streams and lakes.

Soil erosion and transport from urban areas, except during construction activities, produces only a fraction of total sediment arriving at streams and lakes as wash load. Agricultural activities by far exceed the quantities from urban areas. Nevertheless, it is a problem that can be addressed in urban areas through education and can thus be reduced.

A number of areas within an existing urbanized portion of a city or a county can remain non-vegetated for prolonged periods of time. These can occur on vacant lots, edges of roadways and other transportation corridors, utility corridors, equipment storage areas, overflow parking areas, and other parcels of land. Also, areas that are undergoing, or have recently experienced construction, grading, or other soil disturbance activity are of particular concern.

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Most homeowners and commercial businesses attempt to landscape areas within a short period of time after building on their property. However, some areas may be neglected and remain bare of vegetation for long periods of time. Areas may also exist where no attempt was made initially to establish a permanent cover of vegetation.

The need for erosion control and its technology for all new construction activities are described in the *Erosion Control* chapter of this Manual. It is a need that also has to be addressed through state regulations, municipal ordinances, and their enforcement. Section 2 of this chapter describes the local government review and approval process for stormwater quality planning for new development, while the *Erosion Control* chapter contains technical guidance and a model erosion control ordinance.

Development of guidelines and educational materials on landscaping and vegetation for existing urban areas are recommended under this nonstructural BMP. In addition, fugitive dust and bare-ground revegetation ordinances are recommended for local consideration. The dissemination of educational materials to the public can be accomplished by a number of methods, as described in Section 4. This BMP, however, is targeted primarily at existing urbanized portions of metropolitan areas.

7.3 Advantages and Disadvantages

7.3.1 Advantages. The primary advantages to the use of landscaping and vegetation include:

- Reduction of sediment in stormwater runoff
- Potential for improvement in receiving water quality during storm events
- Potential for reduced deposition of sediment in receiving waters, drainageways, and detention facilities
- Reduced maintenance of storm sewers and facilities
- Potential for improved aquatic habitat
- Improved aesthetics of vacant lands

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- Potential for reduced wind erosion and windblown dust
- Possible to document area of revegetated lands

7.3.2 Disadvantages. The major disadvantages to the use of this BMP include:

- Cost to revegetate bare soil areas
- Cost of landscape maintenance
- Limited voluntary effort on the part of homeowners and businesses
- Extremely difficult to document water-quality improvement
- Enforcement actions are costly and politically unpopular

7.4 Implementation

The development and dissemination of public education materials are very similar to those described in Section 4.4. The reader is referred to this section for further guidance. The specifics of this activity, namely the need to establish permanent vegetative cover on vacant lands and lands undergoing construction, can be incorporated into a separate set of brochures, booklets, and guidelines. Some methods in particular that might be effective and could be pursued for this BMP include:

- Booklets describing revegetation methods
- Brochures showing "before and after" photographs of successful revegetation or landscaping efforts
- Demonstration areas and field workshops
- Earth Day activities or similar public involvement campaigns

Each local jurisdiction needs to determine which of these, or combination thereof, is most effective for use in their community. At the same time, the city or county may want to adopt and enforce ordinances requiring owners of bare, or poorly vegetated, vacant land to establish a permanent vegetative cover. Reasons that can be used to justify such ordinances are fugitive dust concerns

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regarding air quality, and effects of sediment on the municipal stormwater system and state receiving waters. Such ordinances can include provisions for timely compliance on the part of a landowner, with a requirement that noncompliance be subject to action by the municipality to revegetate the area with charges assessed to the landowner.

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APPENDIX A

Example Drainage Planning Submittals

(Model Local Criteria Section)

The following is an example of criteria for submittal of information required on storm drainage planning and design during the zoning and subdivision platting process for an individual site of proposed development or significant redevelopment. These submittal requirements present only those specific to stormwater drainage facilities. In addition to these, the proponent of a land-use change typically has to also provide information addressing water and sanitary sewer service, streets, other utilities, site planning, grading, emergency access, traffic, building construction, and many others needed to integrate the new development, or a redevelopment, into the municipality.

In the example presented in this appendix, various sections refer to CRITERIA. This term is used as a generic reference to only the storm drainage design and technical criteria of the municipality, of which this sample section is only one part. At the same time, all references to MANUAL in this example refer to the *Urban Storm Drainage Criteria Manual*, Volumes 1, 2 and 3.

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EXAMPLE SITE DEVELOPMENT
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

CITY (COUNTY) OF _____

CHAPTER (x) DRAINAGE PLANNING SUBMITTAL REQUIREMENTS

x.1 REVIEW PROCESS

All subdivisions, resubdivisions, Planned Unit Developments or any other development or redevelopment done within the jurisdiction of these CRITERIA shall be required to submit drainage reports, plans, construction drawings, specifications and as-constructed information in conformance to the requirement of these CRITERIA.

x.1.1 Subdivision Process

The general requirements for the subdivision of land in the City (County) of _____, and conditions requiring subdivision, are set forth in (reference subdivision rules, or land development code, ordinance, resolution, etc.). Readers are referred to the (reference subdivision rules) for standards and procedures for the review and approval of subdivision plats.

x.1.2 Permit Process

Any structure, or other development or redevelopment, which requires a building permit under the City (County) of _____ and (name of rules) may also require a (name of other permit) to be issued by the Department of (department name). These permits will only be issued upon conformance to requirements contained in these and other applicable CRITERIA as evidenced by approval of the Final Drainage Report.

x.2 DRAINAGE REPORT

(____) copies of the drainage report, prepared and signed by a Professional Engineer registered in the State of Colorado, shall be submitted to the (Department Name) for review. Reports shall be cleanly and clearly reproduced and legible throughout. Blurred or unreadable portions of the report will be deemed unacceptable and will require resubmittal. Incomplete or absent information may require resubmittal of the report.

A pre-submittal conference is suggested in cases involving large development or redevelopment or where special conditions or problems have become apparent during the development review process.

x.2.1 Preliminary Drainage Report

At the time of land zoning, rezoning, or proposal for development or redevelopment, a preliminary drainage report is required in advance of the final drainage report.

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x.2.2 Preliminary Drainage Report Contents

The purpose of a preliminary report is to define on a conceptual level the nature of the proposed development or project and to describe all existing conditions and propose facilities needed to conform to the requirements of these CRITERIA. Each preliminary drainage report shall provide the following:

I. GENERAL LOCATION AND DESCRIPTION

A. Location

1. City, County, State Highway and local streets within and adjacent to the site, or the area to be served by the drainage improvements.
2. Township, range, section, 1/4 section, (subdivision, lot and block).
3. Major drainageways and facilities.
4. Names of surrounding developments.
5. Name of receiving water(s) and I.D. number(s).

B. Description of Property

1. Existing ground cover (type and vegetation).
2. Area in acres.
3. Existing major irrigation facilities such as ditches and canals.
4. Proposed land use and ground cover.

II. DRAINAGE BASINS AND SUB-BASINS

A. Major Basin Description

1. Reference to major drainageway planning studies such as flood hazard delineation report, major drainageway planning reports, and flood insurance rate maps.
2. Major basin drainage characteristics, and existing and planned land uses within the basin, as defined by the (department name).
3. Identification of all nearby irrigation facilities that will influence or be influenced by the local drainage.

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B. Sub-Basin Description

1. Describe historic drainage patterns of the property.

2. Describe offsite drainage flow patterns and impact on development under existing and fully developed basin conditions.

III. DRAINAGE FACILITY DESIGN

A. General Concept

1. Discuss proposed drainage concept and how it fits existing drainage patterns.

2. Discuss how offsite runoff will be considered and how expected impacts will be addressed.

3. Discuss anticipated and proposed drainage patterns.

4. Discuss stormwater quantity and quality management concept and how it will be employed.

5. Describe the content of tables, charts, figures, plates, drawings and design calculations presented in the report.

6. Discuss maintenance and maintenance access.

B. Specific Details (Optional Information)

1. Discussions of drainage problems, including stormwater quality, and solutions at specific design points.

2. Discussion of detention storage and outlet design.

3. Discussion of impacts of concentrating flow on downstream properties.

IV. REFERENCES

Reference all criteria, master plans, and technical information used in support of concept.

x.2.3 Preliminary Report Drawing Contents

(a) General Location Map: All drawings shall be 22" x 34" in size. A map shall be provided in sufficient detail to identify drainage flows entering and leaving the development and general drainage patterns. The general location map should be at a scale of 1" = 500' to 1" = 4000' and show the path of all drainage from the upper end of any offsite basins to the defined major drainageways. The map shall identify all major facilities (i.e., irrigation ditches, existing detention facilities, stormwater quality facilities, culverts, storm sewers) downstream of the property along the flow path to the nearest major drainageway. Basins, along with basin identification numbers, and divides are to be identified and topographic contours are to be included. An annotated copy of the enlarged USGS maps maintained by the Urban Drainage and Flood Control District can be used as a base map.

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(b) Floodplain Information: A copy of any published floodplain maps (i.e., flood hazard area delineation, flood insurance rate maps) showing the location of the property shall be included with the report as outlined in Section x.2.2. All major drainageways shall have the defined floodplain shown on the report drawings.

(c) Drainage Plan: Map(s) of the proposed development at a scale of 1" = 20' to 1" = 200' on a 22" x 34" drawing shall be included. The plan shall show the following:

1. Existing topographic contours at 2-feet (or less) intervals. In mountainous areas, the maximum interval may be extended to 5 feet. The contours shall extend a minimum of 100-feet beyond the property lines.
2. All existing drainage facilities within map limits.
3. Flooding limits based on available information.
4. Conceptual major drainage facilities including proposed stormwater quality BMPs, detention basins, storm sewers, swales, riprap, and outlet structures in the detail consistent with the proposed development plan.
5. Major drainage basin boundaries and sub-boundaries.
6. Any offsite feature including drainage that influences the development.
7. Proposed drainage patterns and, if available, proposed contours.
8. Legend to define map symbols.
9. Project name, address, engineering firm and seal, and date in Title block in lower right corner.
10. North arrow, scale and available bench mark information and location for each benchmark.

x.3 FINAL DRAINAGE REPORT

The final drainage report serves to define and expand the concepts shown in the preliminary report or is sufficient of itself to assure conformance to these CRITERIA. The final report may be submitted at any point during the permitting and platting process, but must be reviewed and approved prior to issuance of any permit.

(_____) copies of the report shall be submitted to the _____ Department. Reports shall be typed and bound on 8-1/2" x 11" paper with pages numbered consecutively. Drawings, figures, tables, etc., shall be bound with the report or contained in an attached pocket. The report shall include a cover letter presenting the design for review prepared or supervised by a Professional Engineer licensed in the State of Colorado. The report shall contain a certification that reads as follows:

"This report for the drainage design of (Name of Development) was prepared by me (or under my direct supervision) in accordance with the provisions of City (County) of _____ Storm Drainage Design and Technical Criteria, and was designed to comply with the provisions thereof.

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I understand that the City (County) of _____ does not and will not assume liability for drainage facilities design.*

_____
Registered Professional Engineer
State of Colorado
No. _____
(Affix Seal)

x.3.1 Final Drainage Report Contents

The report shall be in accordance with the following outline and contains the following applicable information:

I. GENERAL LOCATION AND DESCRIPTION

A. Location

1. Township, range, section, 1/4 section.
2. Local streets within and adjacent to the subdivision.
3. Major drainageways, facilities, and easements within and adjacent to the site.
4. Names of surrounding developments.
5. Name of receiving water(s) and number(s).

B. Description of Property

1. Area in acres.
2. Existing ground cover (type of trees, shrubs, vegetation, general soil conditions, topography, and slope).
3. Major drainageways.
4. General project description.
5. Irrigation facilities.
6. Proposed land use and ground cover.

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II. DRAINAGE BASINS AND SUB-BASINS

A. Major Basin Description

1. Reference to major drainageway planning studies such as flood hazard delineation reports, major drainageway planning reports, and flood insurance rate maps.

2. Major basin drainage characteristics, existing and planned land uses.

3. Identification of all irrigation facilities within the basin that will influence or be influenced by proposed site drainage.

B. Sub-Basin Description

1. Discussion of historic drainage patterns of the property.

2. Discussion of offsite drainage flow patterns and impact on development under existing and fully developed basin conditions, as defined by the (department name).

III. DRAINAGE DESIGN CRITERIA

A. Regulations: Discussion of the use of optional provisions and any deviation from the CRITERIA and justification for such actions.

B. Development Criteria Reference and Constraints

1. Discussion of previous drainage studies (i.e., project master plans) for the site that influence or are influenced by the drainage design and how implementation of the plan will affect drainage and stormwater quality for the site.

2. Discussion of the effects of adjacent drainage studies.

3. Discussion of the drainage impact of site constraints such as streets, utilities, transitways, existing structures, and development or site plan.

C. Hydrologic Criteria

1. Identify design storm rainfall and its return period(s).

2. Identify runoff calculation method(s).

3. Identify detention discharge and storage calculation method(s).

4. Discussion and justification of other criteria or calculation methods used that are not presented in or referenced by the CRITERIA.

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D. Hydraulic Criteria

1. Identify various capacity references.

2. Discussion of other drainage facility design criteria used that are not presented in these CRITERIA.

E. Stormwater Quality Criteria

1. Identify BMPs to be used for stormwater quality control.

2. Identify, as appropriate, water-quality capture volume and drain time for extended-detention basins, retention ponds and constructed wetland basins.

3. Identify, as appropriate, runoff volume and flow rates for design of water-quality swales, wetland channels and porous pavement.

4. Discussion of other drainage facility design criteria used that are not presented in these CRITERIA or the MANUAL.

F. Waivers from Criteria

1. Identify provisions by section number for which a waiver is requested.

2. Provide justification for each waiver requested.

IV. DRAINAGE FACILITY DESIGN

A. General Concept

1. Discussion of proposed concept and typical drainage patterns.

2. Discussion of compliance with offsite runoff considerations.

3. Discussion of anticipated and proposed drainage patterns.

4. Discussion of proposed stormwater quality management strategy.

5. Discussion of the content of tables, charts, figures, plates, or drawings presented in the report.

B. Specific Details

1. Discussion of drainage problems encountered and solutions at specific design points.

2. Discussion of detention storage and outlet design.

3. Discussion of stormwater quality BMPs to be used.

4. Discussion of maintenance access and aspects of the design.

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5. Discussion of easements and tracts for drainage purposes, including the conditions and limitations for use.

V. CONCLUSIONS

A. Discussion of Compliance with Standards by Proposed Drainage Facility Plan.

1. "CRITERIA"

2. "Major Drainageway Planning Studies"

3. "MANUAL"

B. Discussion of Final Drainage Concept

1. Effectiveness of drainage design to control damage from storm runoff.

2. Effectiveness of design to remove pollutants from storm runoff.

3. Influence of proposed development on the Major Drainageway Planning Studies recommendation(s).

VI. REFERENCES

Reference all criteria and technical information used.

VII. APPENDICES

A. Hydrologic Computations*

1. Land use assumptions regarding adjacent properties.

2. Initial and major storm runoff at specific design points.

3. Historic and fully-developed runoff computations at specific design points.

4. Hydrographs at critical design points.

5. Time of concentration and runoff coefficients for each basin.

6. Stormwater quality BMP sizing calculations including runoff adjustments for minimizing directly-connected impervious areas.

B. Hydraulic Computations*

1. Culvert capacities.

2. Storm sewer capacity, including energy grade line (EGL) and hydraulic grade line (HGL) elevations.

3. Gutter capacity as compared to allowable capacity.

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4. Storm inlet capacity including inlet control rating at connection to storm sewer.

5. Open channel design.

6. Check and/or channel drop design.

7. Detention area/volume capacity and outlet capacity calculations for flood detention and water quality basins; depths of detention basins.

8. Wetland area and area/depth distribution for constructed wetland basins.

9. Infiltration rates and volumes for porous pavement or release rates where underdrains or infiltration is not possible.

10. Flow rates, velocities, longitudinal slopes and cross-sections for wetland channels and water quality swales.

11. Downstream/outfall system capacity to the Major Drainageway System.

- Include any input and output listings for any computer models used.

x.3.2 Final Report Drawing Contents

(a) General Location Map: All drawings shall be 22" x 34" in size. A map shall be provided in sufficient detail to identify drainage flows entering and leaving the development and general drainage patterns. The location map should be at a scale of 1" = 500' to 1" = 4000' and show the path of all drainage from the upper end of any offsite basins to the defined major drainageways. The map shall identify any major construction (i.e., development, irrigation ditches, existing detention facilities, culverts, storm sewers) along the entire path of drainage. Basins, along with basin identification numbers, and divides are to be identified and topographic contours are to be included.

(b) Floodplain Information: A copy of applicable published floodplain maps showing the location of the property shall be included with the report. All major drainageways shall have the floodplain defined and shown on the report drawings in accordance with the provisions of this and other sections of these CRITERIA.

(c) Drainage Plan: Map(s) of the proposed development at a scale of 1" = 20' to 1" = 200' on a 22" x 34" drawing shall be included. The plan shall show the following:

1. Existing and proposed contours at 2-feet (or less) intervals. In areas of little relief, 1-foot contours shall be shown. In mountainous areas, the maximum interval may be extended to 5 feet The contours shall extend a minimum of 100-feet beyond the property lines.

2. Property lines, existing easements, and easements proposed for dedication, with purposes noted.

3. Streets, indicating ROW width, flowline width, curb or roadside swale type, sidewalk, and approximate slopes.

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4. Existing drainage facilities and structures, including irrigation ditches, roadside ditches, crosspans, drainageways, gutter flow directions, and culverts. Also show pertinent information such as material, size, shape, slope, and locations.

5. Overall tributary drainage basin area boundary, basin identification number, if appropriate, and drainage sub-area boundaries.

6. Proposed type of street flow (i.e., vertical or combination curb and gutter), roadside ditch or swale, gutter, slope and flow directions, and cross pans.

7. Proposed storm sewers and open drainageways, including inlets, manholes, culverts, and other appurtenances, including riprap or other erosion protection.

8. Proposed structural water-quality BMPs, their location, sizing, and design information.

9. Proposed outfall point for runoff from the developed area and, if required, facilities to convey flows to the final outfall point without damage to downstream properties.

10. Routing and accumulation of flows at various critical points for the initial and water-quality storm runoff events.

11. Routing and accumulation of flows at various critical points for the major storm runoff events.

12. Volumes and release rates for detention storage and water-quality capture volume for facilities and information on outlet works.

13. Location and water surface profiles or elevations of all previously defined floodplains affecting the property. If floodplains have not been previously published, they shall be defined and shown on the drainage plan.

14. Location, and measured or estimated elevations, of all existing and proposed utilities affected by or affecting the drainage design.

15. Routing of upstream offsite drainage flow through the development.

16. Location of any improvements included in the appropriate or accepted outfall system plan, major drainage plan, and/or storm drainage plan.

17. Definition of flow path leaving the development through the downstream properties ending at a major drainageway or receiving water.

18. Legend to define map symbols as accepted or recognized by these CRITERIA.

19. Title block in lower right hand corner.

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x.4 CONSTRUCTION PLANS

For on-site drainage improvements, the final construction plans (22" x 34") shall be submitted after approval of the Final Drainage Report. (____) sets of plans shall be submitted for approval. Upon approval, four sets, stamped and signed, will be returned to the design engineer for use by the contractor, owner and design engineer. However, before any construction work begins, appropriate bonds, letters-of-credit, or other surety as required by these CRITERIA should be issued to the City (County) of _____. The construction plans as a minimum and as appropriate will include:

1. Plan and profile of proposed pipe installations, inlets and manholes with pertinent elevations, dimensions, type and horizontal control shown.
2. Property and right-of-way lines, existing and proposed structures, fences and other land features.
3. Plan and profile of existing and proposed channels, ditches, swales, and on-site water-quality BMPs with construction details, cross-sections and erosion controls.
4. Detention and water quality (if separate) facility grading, trickle channels (if any), outlet and inlet locations, cross-sections or contours sufficient to verify volumes, etc..
5. Details of inlet and outlet control devices and of all structural components being constructed.
6. Maintenance access.
7. General overlot grading and the erosion and sediment control plan prepared in accordance with applicable provisions of these CRITERIA and the MANUAL.
8. Areas of modular block porous pavement, if any, and installation details.
9. Landscaping and revegetation plans and details.
10. Proposed finish floor elevations of structures.
11. Relation of site to current and, if appropriate, modified floodplain boundaries.
12. A statement agreeing to maintain and operate all privately-owned facilities (if any) in a working manner and/or in accordance with the requirements of the Colorado Water Quality Control Division specified in the stormwater discharge permit issued to the City (County) of _____:
13. Signature and seal of a professional engineer preparing these plans.

Approval by the City (County) of _____ does not constitute an approval or the issuance of permits by the State of Colorado, which approval and/or permits shall be obtained prior to initiating any construction activities on the site

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x 4.1 As-Built Drawings and Certification

Upon completion of construction, the professional engineer that prepared the design plans (or one that assumes the responsibility for the inspection if the design engineer is no longer available) shall provide the City (County) of _____ with a signed and sealed Certification of Inspection verifying that all work was performed in accordance with the approved plans and in compliance with all applicable criteria of the City (County) of _____. Special circumstances may require that as-built reproducible drawings of the drainage improvements also be provided. Certification of Inspection and as-built drawings (if required) will be required prior to the issuance of a final sewer connection permit or the issuance of a Certificate of Occupancy.

x.5 PUBLIC DRAINAGE IMPROVEMENTS

If the project requires that drainage improvements be constructed that will be turned over and owned and maintained by the City (County) of _____, the following process must also be followed:

1. Two sets of plans (22" x 34") submitted for initial review.
2. An application to design, plan, construct, re-construct or remodel a public improvement must be filed with the (department name).
3. A bond or letter of credit guaranteeing payment and performance must be executed prior to commencing with work on the project.
4. Upon completion of the project, a set of reproducible as-constructed plans, certified by a licensed engineer, must be submitted before the bond or other guarantee is released.
5. After approval of the initial review set, (specify number of copies) sets of plans must be supplied which will be distributed by the City (County) for review by all departments and utility companies. After comments are received and addressed, (specify number of copies) final sets will be stamped as approved and returned to the design engineer for use by the contractor and owner.

The information required for the plans shall be in accordance with sound engineering principles, the technical provisions of the MANUAL (as modified by these CRITERIA where appropriate), these CRITERIA, and other applicable City (County) of _____ ordinances, regulations, criteria or design guidelines. The plans may also be subject to review by outside agencies such as the Urban Drainage and Flood Control District, Federal Emergency Management Agency, U.S. Army Corps of Engineers, Environmental Protection Agency, Colorado Water Quality Control Division, or other agencies as required. The plans shall be signed and sealed by a Professional Engineer registered in the State of Colorado.

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EROSION CONTROL
DURING CONSTRUCTION

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EROSION CONTROL

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1. INTRODUCTION

This section of Volume 3 of the *Urban Storm Drainage Criteria Manual* (*Manual*) provides a set of criteria and technical guidance for erosion and sediment control at construction sites. In addition, it describes suggested plan submittal requirements, planning considerations, general exemptions, and variances that cities and counties may wish to follow. The practices contained in this document should be viewed as suggested minimum requirements. A model erosion control ordinance is included in Appendix A. An example erosion and sediment control plan is included in Appendix B.

1.1 General

These criteria were developed to help mitigate the increased soil erosion and subsequent deposition of sediment off-site during the period of construction from start of earth disturbance until final landscaping and stormwater quality measures are effectively in place.

An *Erosion and Sediment Control Plan* must be developed and submitted to the local jurisdiction to obtain a construction or site grading permit. Site planning and drainage planning should, whenever possible, occur concurrently with site grading and erosion control planning. When site grading precedes final development, an erosion and sediment control plan for site grading must be submitted. This plan may have to be modified at the time a final site development plan is prepared. This modified plan must be submitted for review and approval prior to final development.

Implementation and maintenance of erosion control measures are ultimately the responsibility of the property owner. Because site conditions will affect the suitability and effectiveness of erosion control measures, a plan specific to each site is required. In addition, should the approved plan not function as intended, and it is determined by the city or county that additional measures are needed, the owner will have to provide additional measures needed to reduce soil erosion and sediment discharged from the construction site.

Nothing in these criteria limit the right of individual cities and counties to impose additional or more stringent standards.

1.2 Performance Objectives

The objectives for erosion control during construction include the following:

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1. Conduct all land disturbing activities in a manner that effectively reduces accelerated soil erosion and reduces sediment movement and deposition off-site.

2. Schedule construction activities to minimize the total amount of soil exposed at any given time to reduce the period of accelerated soil erosion.

3. Establish temporary or permanent cover on areas that have been disturbed as soon as possible after final grading is completed.

4. Design and construct all temporary or permanent facilities for the conveyance of water around, through, or from the disturbed area to limit the flow of water to non-erosive velocities.

5. Remove sediment caused by accelerated soil erosion from surface runoff water before it leaves the site.

6. Stabilize the areas of land disturbance with permanent vegetative cover or stormwater quality control measures.

1.3 Erosion and Sediment Control Plan

An *Erosion and Sediment Control Plan* consisting of a written narrative report and a site plan map must be submitted to the appropriate local government for review and approval. Figures 1-1A and 1-1B provide standard symbols that can be used on such plans. An example plan is given in Appendix B.

1.3.1 Narrative Report. The narrative report must contain, or refer to, the drainage report and should contain the following:

1. Name, address, and telephone number of the applicant. The name, address, and telephone number of the professional engineer preparing the *Erosion and Sediment Control Plan* should also be included if different from the applicant.

2. Project description - A brief description of the nature and purpose of the land disturbing activity, the total area of the site, the area of disturbance involved, and project location

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including township, range, section, and quarter-section, or the latitude and longitude, of the approximate center of the project.

3. Existing site conditions - A description of the existing topography, vegetation, and drainage; and a description of any wetlands on the site.

4. Adjacent areas - A description of neighboring areas such as streams, lakes, residential areas, roads, etc., which might be affected by the land disturbance.

5. Soils - A brief description of the soils on the site including information on soil type and names, mapping unit, erodibility, permeability, hydrologic soil group, depth, texture, and soil structure. (This information may be obtained from the soil report for the site, or, if available, from soils reports from adjacent sites if acceptable to the local jurisdiction).

6. Areas and Volumes - An estimate of the quantity (in cubic yards) of excavation and fill involved, and the surface area (in acres) of the proposed disturbance.

7. Erosion and sediment control measures - A description of the methods described in this chapter of the *Manual* which will be used to control erosion and sediment on the site.

8. Timing schedule indicating the anticipated starting and completion time periods of the site grading and/or construction sequence, including the installation and removal time periods of erosion and sediment control measures, and the time of exposure of each area prior to the completion of temporary erosion and sediment control measures.

9. Permanent stabilization - A brief description, including specifications, of how the site will be stabilized after construction is completed.

10. Stormwater management considerations - Explain how stormwater runoff from and through the site will be handled during construction. Provide a brief description of the post-construction stormwater quality control measures to be included as a part of the site development.

11. Maintenance - A schedule of regular inspections during construction and repair of erosion and sediment control structures should be described. A description of routine sediment basin maintenance should also be included.

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12. The estimated total cost (installation and maintenance) of the required temporary soil erosion and sediment control measures to assist the city or county determine surety or bonding requirements for the proposed plan.

13. Calculations - Any calculations made for the design of such items as sediment basins, diversions, waterways; and calculations for runoff and stormwater detention basin design (if applicable).

14. Other information or data as may be reasonably required by the local jurisdiction.

15. A surety, bond, letter-of-credit, escrow account or other financial arrangement acceptable to the local jurisdiction submitted in an amount sufficient to install and maintain for a period of one year the temporary and permanent erosion and sediment control measures described in the plan.

16. The following note - "This *Erosion and Sediment Control Plan* has been placed in the (insert name of local jurisdiction) file for this project. The plan appears to fulfill the Urban Drainage and Flood Control District's technical criteria and the criteria for erosion control and requirements of (insert name of local jurisdiction). I understand that additional erosion control measures may be needed if unforeseen erosion problems occur or if the submitted plan does not function as intended. The requirements of this plan shall run with the land and be the obligation of the land owner until such time as the plan is properly completed, modified or voided.".

17. Signature page for owner/developer acknowledging the review and acceptance of responsibility, and a statement by the Professional Engineer acknowledging responsibility for the preparation of the *Erosion and Sediment Control Plan*.

1.3.2 Site Plan. The site plan must show:

1. A general location map at a scale of 1-inch to 1000-feet to 1-inch to 8000-feet indicating the general vicinity of the site location.

2. The property lines for the site on which the work will be performed.

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3. The *Erosion and Sediment Control Plan* at a scale of 1-inch to 20-feet up to 1-inch to 200-feet. The plan may be placed on the site drainage plan if it can be clearly presented. The plan must include:

   a. Existing topography at one- or two-foot contour intervals. The map should extend a minimum of 100-feet beyond the property line.

   b. Proposed topography at one- or two-foot contour intervals. The map should show elevations, dimensions, location, extent, and the slope of all proposed grading, including building site and driveway grades, if known.

   c. Location of any existing structures or hydrologic features on the site.

   d. Location of all structures or natural features on the land adjacent to the site and within a minimum of 100 feet of the site boundary line. The map must show the location of the street gutter, storm sewer, channel, or other waters receiving storm runoff from the site.

   e. Location of all proposed structures and development on the site, if known.

   f. Limits of clearing and grading - Areas which are to be cleared and graded.

   g. Location of soil stockpiles - Areas designated for topsoil and subsoil storage.

   h. Location of storage areas - Areas designated for equipment, fuel, lubricants, chemical and waste storage.

   i. Location of temporary roads designated for use during the construction period.

   j. Plans of all drainage features, paved areas, retaining walls, cribbing, planting, temporary or permanent soil erosion control measures, or other features to be constructed in connection with, or as a part of, the proposed work together with a map showing the drainage area of land tributary to the site and estimated 2-year runoff of the area served by all drains. All erosion control measures should be depicted using the standard map symbols given in Figures 1-1A and 1-1B.

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k. Detail drawings - Design drawings of sediment controls, temporary diversions, and any practices used that are not referenced in these criteria.

l. Other information or data as may be reasonably required by the local jurisdiction.

m. The following note: "This *Erosion and Sediment Control Plan* has been placed in the (insert name of local jurisdiction) file for this project and appears to fulfill applicable erosion control criteria. I understand that additional erosion control measures may be required of the owner and his or her agents due to unforeseen erosion problems or if the submitted plan does not function as intended. The requirements of this plan shall run with the land and be the obligation of the land owner until such time as the plan is properly completed, modified or voided".

n. Signature block for owner (or agent) acknowledging the review and acceptance of responsibility, and a signed and stamped statement by the Professional Engineer acknowledging responsibility for the preparation of the *Erosion and Sediment Control Plan*.

1.3.3 Approval of Erosion and Sediment Control Plan. An *Erosion and Sediment Control Plan* must be approved prior to issuance of an Overlot Grading or Site Disturbance Permit by the city or county. The final *Erosion and Sediment Control Plan* must be consistent with a Drainage Report considered acceptable to the approving jurisdiction. Approval of the *Erosion and Sediment Control Plan* does not imply acceptance or approval of Drainage Plans, Utility Plans, Street or Road Plans, Design of Retaining Walls, or any other aspect of site development.

1.3.4 Exemptions and Variances. A provision for exemptions and variances may be provided by a city or county. These are generally processed according to the applicable subdivision regulations and reviewed on a case-by-case basis.

1. Exemptions from the erosion control planning process will be considered for any of the following; however, exempting the owner from preparing an erosion control plan and applying for a grading permit does not exempt the owner from controlling erosion of soil at each construction site through the use of the techniques described in this Manual:

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a. Agricultural use of land.

b. Grading or an excavation below finished grade for basements, footings, retaining walls, or other structures on plots zoned R1 - R3 of less than five (5) acres in size unless required otherwise.

c. A sidewalk or driveway authorized by a valid permit.

d. Land-disturbing activities involving less than five (5) acres of disturbed area. Individual lots involving less than five (5) acres of disturbed area in a larger subdivision project shall not be considered separate development projects, but rather as a part of the subdivision development as a whole. It will be the responsibility of the homeowner or homebuilder to conform to all requirements of the locally-approved *Erosion and Sediment Control Plan* for the subdivision. As part of any Building Permit for which a specific erosion control plan is not required, the following statement must be included: "We have reviewed the *Erosion and Sediment Control Plan* for (subdivision name) and agree to conform to all requirements contained therein and all erosion control requirements of the (insert name of local jurisdiction). We further agree to construct and maintain all erosion and sediment control measures required on the individual lot(s) subject to this Building Permit and/or in accordance with the provisions of the Erosion Control section of the *Manual* of the Urban Drainage and Flood Control District."

e. Underground utility construction including the installation, maintenance, and repair of all utilities under hard-surfaced roads, streets, or sidewalks provided such land-disturbing activity is confined to the area which is hard-surfaced and provided that runoff and erosion from soil stockpiles are confined and will not enter the drainage system.

f. Gravel, sand, dirt or topsoil removal as authorized pursuant to approval of the Colorado Mined Land Reclamation Board, provided said approval includes an erosion and sediment control plan that meets the minimums specified.

g. Projects having a period of exposure (from time of land disturbance until permanent erosion control measures are installed) of less than 14 days.

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h. Where the owner certifies in writing to local jurisdiction and the local jurisdiction agrees in writing that the planned work and the final structures or topographical changes will not result in or contribute to soil erosion or sedimentation and will not interfere with any existing drainage course in such a manner as to cause damage to any adjacent property or result in the deposition of debris or sediment on any public way, will not present any hazard to any persons or property, and will have no detrimental influence upon the public welfare or upon the total development of the watershed.

2. Variances - Cities and counties may consider waiving or modifying any of the criteria which are deemed inappropriate or too restrictive for site conditions by granting a variance. Variances may be granted at the time of plan submission or request for plan revision. Variances must be requested in accordance with the subdivision regulations and must define:

   a. The criteria from which the applicant seeks a variance.

   b. The justification for not complying with the criteria.

   c. Alternate criteria or standard measures to be used in lieu of these criteria. The criteria and practices specified within this section of the *Manual* relate to the application of specific erosion and sediment control practices. Other practices or modifications to specified practices may be used if approved by the local jurisdiction prior to installation. Such practices must be thoroughly described and detailed to the satisfaction of the local city or county reviewing and approving the erosion control plan.

To expedite the review and decisions on variance requests, it is suggested that a variance request be included with, or submitted prior to, the initial *Erosion and Sediment Control Plan* submittal.

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RECOMMENDED PLAN SYMBOLS:

Existing Contour

Finished Contour

Drainage Divide

Limit of Grading

Storm Sewer

Boundary of a Control Measure

TITLE	KEY	SYMBOL
VEHICLE TRACKING CONTROL WITH WASH RACK	WR	WR
MULCHING	MU	MU
SURFACE ROUGHENING	SR	SR
TEMPORARY SEEDING	TS	TS
PERMANENT SEEDING	PS	PS
CONSTRUCTION ROAD STABILIZATION	CRS	CRS
STRAW BALE BARRIER	STB	
SILT FENCE	SF	

After: Virginia Soil and Water Conservation Commission, 1985

Figure 1-1A Map Symbols

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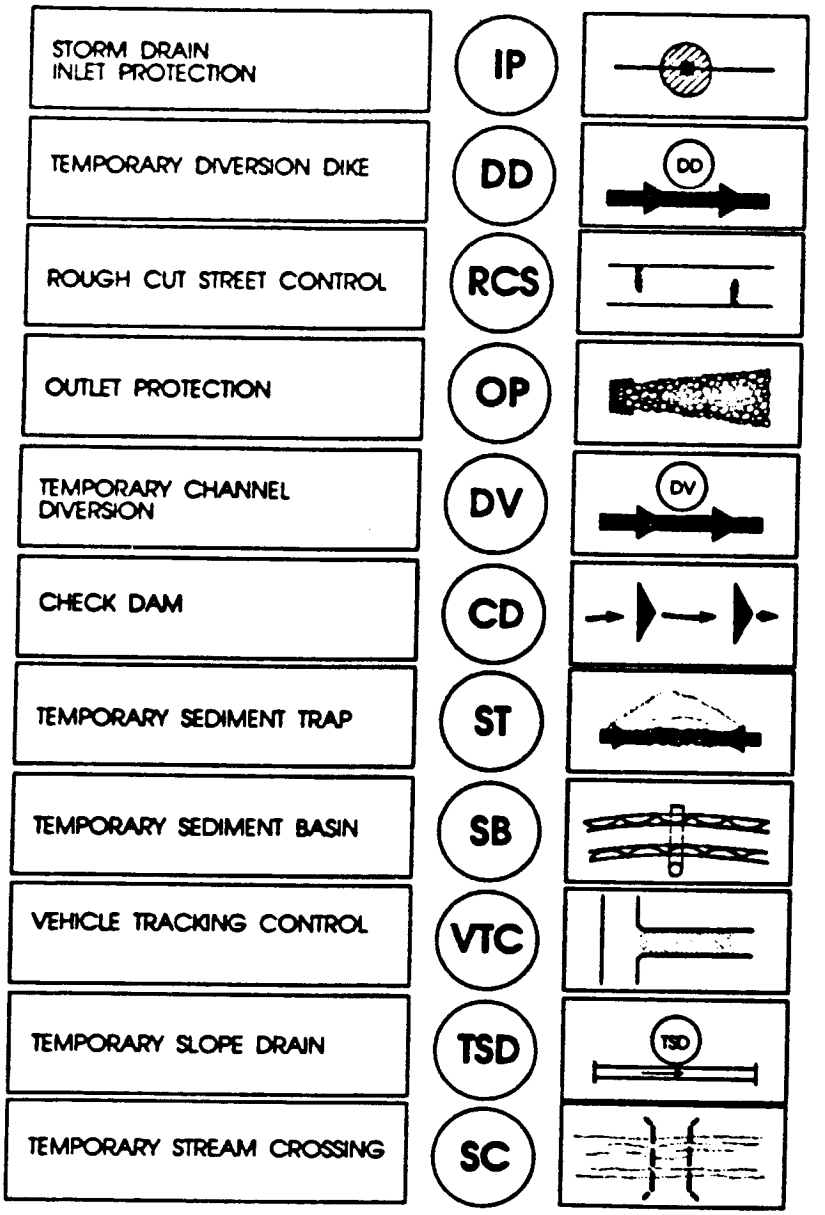

After: Virginia Soil and Water Conservation Commission, 1985

Figure 1-1B Map Symbols (continued)

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2. EROSION CONTROL PLANNING

2.1 Erosion and Sedimentation

2.1.1 Erosion. Soil erosion is the process by which the land surface is worn away by the action of wind, water, ice, and gravity. This section of the manual addresses erosion caused by wind and water. Erosion is a natural process and has occurred since the earth was formed. The shape of the land as we know it was created, in large part, by erosional processes. The natural rate of erosion is increased greatly by many urban activities--especially construction activities. Any activity that disturbs the natural soil and vegetation has the potential to increase erosion because bare, loose soil is easily moved by wind or water.

Wind erosion is caused when winds of sufficient velocity create movement of soil particles. The potential for wind erosion is dependent upon soil cover, soil particle size, wind velocity, duration of wind, and unsheltered distance. Within the Denver metropolitan area winds often exceed 60 miles per hour (mph), and occasionally exceed 100 mph. Wind erosion can begin at a wind velocity as low as 10 mph, and can even result from turbulence created by passing vehicles.

Water erosion has five primary mechanisms: raindrop erosion, sheet erosion, rill erosion, gully erosion, and channel erosion. Raindrops detach soil particles and splash them into the air. These detached particles are then vulnerable to stormwater runoff or snowmelt. Shallow surface flows rarely move as a uniform sheet for more than several feet before concentrating in surface irregularities, known as rills. As the flow changes from a shallow sheet to a deeper rill flow, the velocity and turbulence of the flow increase. The energy of the concentrated flow is able to detach and transport soil particles. This action begins to cut into the soil mantle and form tiny to large channels. Rills are small, but well-defined channels which are only a few inches deep. Gullies occur as the flows in rills come together into larger and larger channels. The major difference between rill and gully erosion is size. Rills caused by erosion can be smoothed out by standard surface treatments such as harrowing. Gully erosion on the other hand cannot be repaired with standard farming equipment and requires heavy equipment to regrade and stabilize the gullies.

2.1.2 Sedimentation. During a rainstorm, runoff normally builds up rapidly to a peak and then diminishes. Because the amount of sediment a watercourse can carry is dependent upon the velocity and volume of runoff, sediment is deposited as runoff decreases. The deposited sediments

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may be resuspended when future runoff events occur. In this way, sediments are moved progressively downstream in the waterway system.

Windblown silt and sand particles are deposited whenever the force of the wind lessens. Much of the wind-eroded material is deposited behind fences, in landscaped areas or downwind of buildings or other obstructions to the wind. (Dust will form "drifts" just like snow.) Materials transported by bouncing or creeping along the surface are often trapped in surface irregularities near the point of initial movement.

2.1.3 Factors Influencing Erosion. Factors affecting the erosion potential of any site include soil type, geology, vegetative cover, topography, climate, and land use. Physical properties of soils such as particle size, cohesiveness, and density affect its erodibility. Loose silt and sand-sized particles are more susceptible to erosion than "sticky" clay soils. Rocky soils are also less susceptible to wind erosion, but are often found on steep slopes that are subject to water erosion. Most of the soil types found locally are calcareous in nature and are susceptible to either wind or water erosion, or both.

When surface cover and soil structure are disturbed, the soil's erodibility potential increases. Construction activities disrupt the soil structure and it's vegetative cover. Examples are excavation and grading for construction of homes, roads, utilities, commercial and industrial areas. In some parts of the Denver metropolitan area, overgrazing by livestock also contributes to increased erosion.

Vegetation plays an extremely important role in controlling erosion. Roots bind particles together and the leaves or blades of grass reduce raindrop impact forces on the soil. Grass, forest floor litter and other ground cover traps rain which allows infiltration and reduces runoff velocity. Vegetation reduces wind velocity at the ground surface, and provides a rougher surface which will trap particles moving along the ground. Once vegetation is removed, erosion can proceed unchecked.

2.1.4 Principles of Erosion and Sediment Control. The objective of erosion control is to limit the amount and rate of erosion occurring on disturbed areas. The objective of sediment control is to capture the soil that has been eroded before it leaves the construction site. Despite the use of both erosion control and sediment control measures, it is recognized that some amount of sediment will remain in runoff leaving the construction site.

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An erosion and sediment control plan is comprised of three major elements:

1. The erosion control measures that will be used to limit erosion of soil from disturbed areas at a construction site;

2. The sediment control measures that will be used to limit transport of sediment to off-site properties and downstream receiving waters; and,

3. The drainageway protection measures that will be used to protect streams and other drainageways located on the construction site from erosion and sediment damages.

Erosion controls are surface treatments that stabilize soil exposed by excavation or grading. Erosion control measures, or Best Management Practices (BMPs) are variously referred to as source controls, vegetative controls or non-structural controls.

Sediment controls capture soil that has been eroded. Soil particles suspended in runoff can be filtered through a porous media or deposited by slowing the flow and allowing the natural process of sedimentation to occur. Sediment controls (or BMPs) are facilities built to perform this function, and are also referred to as structural controls.

Drainageway control measures (or BMPs) protect channels or storm sewers during site construction. This can be accomplished by limiting equipment travel across a stream, constructing a temporary channel crossing, or diverting a stream into a temporary channel while work is done on the permanent channel. Where storm sewers are used, sediment can be filtered prior to entry of runoff into the storm drainage system.

Non-sediment impacts to water quality can be managed by controls (or BMPs) on equipment, material storage, or use of chemicals at construction sites. These additional practices are included for discussion in the *Manual* because they occur commonly at construction sites.

2.2 Summary of Criteria

The list below is a summary of erosion and sediment control activities as described in this manual:

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Erosion Control. Permanent or temporary soil surface stabilization must be applied to disturbed areas and soil stockpiles as soon as possible but no later than 14 days after final grade is reached on any portion of the site. Soil surface stabilization should also be applied within 14 days to disturbed areas that may not be at final grade but will remain dormant (undisturbed) for longer than an additional 30 days. (Section 3.0).

Surface Roughening. Surface roughening should be performed after final grading to create depressions two to four inches deep and four to six inches apart. (Section 3.1).

Mulching. All disturbed areas must be properly mulched, or seeded and mulched, within 14 days after final grade is reached on any portion of the site not otherwise permanently stabilized. (Section 3.2).

Revegetation. A viable vegetative cover should be established within one year on all disturbed areas and soil stockpiles not otherwise permanently stabilized. Vegetation is not considered established until a ground cover is achieved which, in the opinion of the city or county of jurisdiction, is sufficiently mature to control soil erosion and can survive severe weather conditions. (Section 3.3).

Temporary Revegetation. Temporary revegetation is required on all disturbed areas having a period of exposure prior to final stabilization of one year to two years. All temporary seeding shall be properly mulched. (Section 3.3.2).

Permanent Revegetation. Permanent revegetation is required on all disturbed areas having a period of exposure greater than two years, or for an indeterminate length of time. A perennial grass mix should be planted and mulched. (Section 3.3.3).

Roads and Soil Stockpiles. Road cuts, road fills, and parking lot areas should be covered as early as possible with the appropriate aggregate base course where this is specified as part of the pavement. This practice is not needed when final construction of roads will take place within 30 days of reaching final subgrade level.

All non-paved portions of roads should be seeded and mulched as soon as possible after final grading has occurred, but in no case later than 14 days after grading has been completed.

Soil stockpiles expected to be in place longer than 60 days should be seeded with a temporary grass cover and mulched within 14 days after completion of stockpile construction.

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If stockpiles are located within 100 feet of a drainageway, additional sediment controls, such as a diversion dike or silt fence, should be provided. (Section 3.4).

Sediment Control. Properties and roadways adjacent to a construction site should be protected from eroded sediment being transported to them. (Section 4.0).

Vehicle Tracking. Whenever construction vehicles enter onto paved roads, provisions must be made to prevent the transport of sediment (mud and dirt) by vehicles tracking onto the paved surface. Whenever sediment is transported onto a public road, regardless of the size of the site, the roads shall be cleaned at the end of each day. (Section 4.1).

Slope Diversion Dikes. Temporary diversion dikes shall be provided as required by the provisions of Section 4.2. Diversion dikes located above disturbed areas may be discharged to a permanent or temporary channel. Diversion dikes located midslope on a disturbed area must discharge to temporary slope drain. Diversion dikes located at the base of a disturbed area must discharge to a sediment trap or basin. (Sections 4.2.1 and 4.3).

Roads and Roadside Swales. For road areas that are not paved within 30 days of final grading, and have not received early application of roadbase, rough-cut street controls should be provided. (Section 4.2.2).

Sediment Entrapment Facilities. Sediment entrapment facilities include straw bale barriers, silt fences, sod filter strips, sediment traps and sediment basins. The criteria for selection and use of sediment entrapment facilities are given in Table 4-1 and design criteria are described in Section 4.3.

All runoff leaving a disturbed area shall pass through at least one sediment entrapment facility before it exits the site. (Section 4.3).

Working Within or Crossing a Waterway. Construction vehicles shall be kept out of waterways to the maximum extent practicable. Where an actively-flowing watercourse must be crossed regularly by construction vehicles, a temporary stream crossing or channel diversion must be provided. (Sections 5.1 and 5.2).

Outlet Protection. The outlets of temporary slope drains, culverts, sediment traps, and sediment basins must be protected from erosion and scour. (Section 5.3).

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Inlet Protection. All storm sewer inlets made operable during construction must have sediment entrapment facilities installed to prevent sediment-laden runoff from entering the inlet. (Section 5.4).

Chemicals, Oils and Material Storage. Areas used for storage of chemicals, petroleum-based products and waste materials, including solid and liquid waste, shall be designed to prevent discharge of these materials in the runoff from a construction site. (Section 6).

Underground Utility Construction. Construction of underground utility lines that are not exempted is subject to the provisions of Section 7. (Section 1.3.4 for exemptions and Section 7).

Disposition of Temporary Measures. All temporary erosion and sediment control measures shall be removed within 30 days after final stabilization is achieved, or after the temporary measures are no longer needed, whichever occurs earliest, or as authorized by the city or county of local jurisdiction. (Section 8).

Maintenance. All temporary and permanent erosion and sediment control practices shall be maintained and repaired by the owner during the construction phase as needed to assure continued performance of their intended function. All facilities must be inspected and replaced if necessary, following each precipitation or snowmelt event that results in runoff. (Section 9).

2.3 Planning Process

Erosion control planning should occur early in the site development process. The planning process can be divided into five separate steps:

1. Gather information on topography, soils, drainage, vegetation and other predominant site features.
2. Analyze the information in order to anticipate erosion and sedimentation problems.
3. Devise a plan which schedules construction activities and minimizes the amount of erosion created by development.
4. Develop an *Erosion and Sediment Control Plan* which specifies effective erosion and sediment control measures.

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5. Follow the *Erosion and Sediment Control Plan* and revise it when necessary.

2.3.1 Site Assessment. Topography is the primary factor to be considered in developing an *Erosion and Sediment Control Plan*. Soils, vegetation, and hydrologic features must also be considered.

Final grading will determine slope gradient and slope length of the disturbed area. Small areas, or subbasins, will be created that have relatively uniform characteristics of slope and slope length. After grading is completed, areas that remain exposed to precipitation and runoff will require erosion control, and the overall size of subbasin areas will determine what sediment controls are appropriate for each area.

Soil conditions should be assessed as to their potential for erosion and suitability for revegetation. A detailed analysis of soil-erosion potential is not necessary because all soils will be subject to erosion and can be generalized as equivalent for the design of control measures recommended in the *Manual*.

Most vegetation will be removed from a construction site during clearing and grading operations. An assessment of existing vegetation on the site is of limited use when post-development landscaping and irrigation are planned, but can be useful in selecting grasses when non-irrigated revegetation is planned. Analysis of soil is useful to determine fertilizer requirements for vegetation establishment.

Analysis of waterbodies and other hydrologic features of a site is important in the design of sediment controls. The drainage basins upslope and within the site should be assessed. The configuration of hillslope areas and drainageways, in the context of planned roads and buildings, will determine what erosion and sediment controls will be needed. The location of permanent drainage channels and other elements of the drainage system should be defined as a part of the plan.

2.3.2 Selection of Controls. The following guidelines are recommended in developing the erosion and sediment control plan:

1. Determine the limits of clearing and grading. If the entire site will not undergo excavation and grading, the boundaries of cut-and-fill operations should be defined. Buffer strips of natural vegetation may be utilized as a control measure.

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2. Define the layout of buildings and roads. This will have been decided previously as a part of the general development plan. If building layout is not final, the road areas stabilized with pavement and the drainage features related to roads should be defined as they relate to the plan.

3. Determine permanent drainage features. The location of permanent channels, storm sewers, roadside swales, and stormwater quality controls such as ponds, wetlands, grassed-lined swales, buffer strips, and areas of porous pavement, if known, should be defined.

4. Determine extent of temporary channel diversions. If permanent channel improvements are a part of the plan, the route, sizing, and lining needed for temporary channel diversions should be determined. Location and type of temporary channel crossings can be assessed.

5. Determine the boundaries of watersheds. The size of drainage basins will determine the types of sediment controls to be used. Areas located off the site that contribute overland flow runoff must be assessed. Measures to limit the size of upland overland flow areas, such as diversion dikes, may be initially considered at this stage.

6. Select sediment controls. Areas greater than five acres will require that sediment basins be installed. Division of large drainage basins into subareas each served by a sediment basin can also be considered.

   Areas smaller than five acres can utilize other sediment controls. Limitations on the size of areas served by individual controls are defined in these criteria. (Section 4.3).

7. Determine staging of construction. The schedule of construction will determine what areas must be disturbed at various stages throughout the development plan. The opportunity for staging cut-and-fill operations to minimize the period of exposure of soils can be assessed. The sequence for installing sediment controls and erosion controls can also be determined at this time.

8. Identify locations of topsoil stockpiles. Areas for storing topsoil should be determined.

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9. Identify location of temporary construction roads, vehicle tracking controls, and material storage areas. These three elements can be determined in the context of previously defined aspects of the plan.

10. Select Erosion Controls. All areas of exposed soil will require a control measure be defined dependent on the duration of exposure. These can be selected based on the schedule of construction.

An example erosion and sediment control plan for a small commercial development has been included as Appendix B. Figure 2-1 shows an oblique view of an example highway construction project and the sediment controls used. Figure 2-2 illustrates how these measures are described on a site plan map.

2.4 Consistency with Other Plans

2.4.1 Drainage Plans. The *Erosion and Sediment Control Plan* should be prepared consistent with the final drainage plan for a development. All of the hydrologic features of the drainage plan must be incorporated into the site at the time of development. Permanent drainage features will be built during the construction phase. Temporary sediment controls can be located and designed to take advantage of the final drainage design features. All temporary controls should be staged and removed at the appropriate time relative to the construction of permanent drainage features.

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2.4.2 Stormwater Quality Plans. New developments will incorporate elements of stormwater quality control into their design. The erosion and sediment control plan must be prepared consistent with these structural and nonstructural controls. Many of the temporary controls used for sediment control can be modified into permanent structural controls. Where possible, permanent stormwater quality controls can be constructed at the initial stages of construction, or modified at the end of construction.

Where local regulations have not been developed, stormwater quality plans should be developed consistent with the guidelines in the *Stormwater Quality* section of Volume 3 of the *Manual*.

2.4.3 Air Quality Plans. All of the erosion and sediment control measures specified in this section will perform as well to control wind erosion. The surface stabilization measures identified for control of precipitation-induced erosion act also to prevent soils from becoming windborne.

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Although these guidelines were developed to control erosion by rainfall and snowmelt, they are consistent with design principles for wind erosion and will be effective for this purpose.

The Air Pollution Control Division, Colorado Department of Health, has passed air quality regulations consistent with federal legislation. Regulation No. 3 requires submittal of an Air Pollutant Emission Notice (APEN) for sources of fugitive dust from construction sites, as well as other sources. Regulation No. 1 defines particulate emission control regulations for haul roads and roadways. Additional controls, such as road watering, may be necessary to fully comply with these regulations at a construction site.

In certain counties in Colorado, the local health department administers these regulations. This agency, or CDH, should be contacted about APENs and other air quality requirements.

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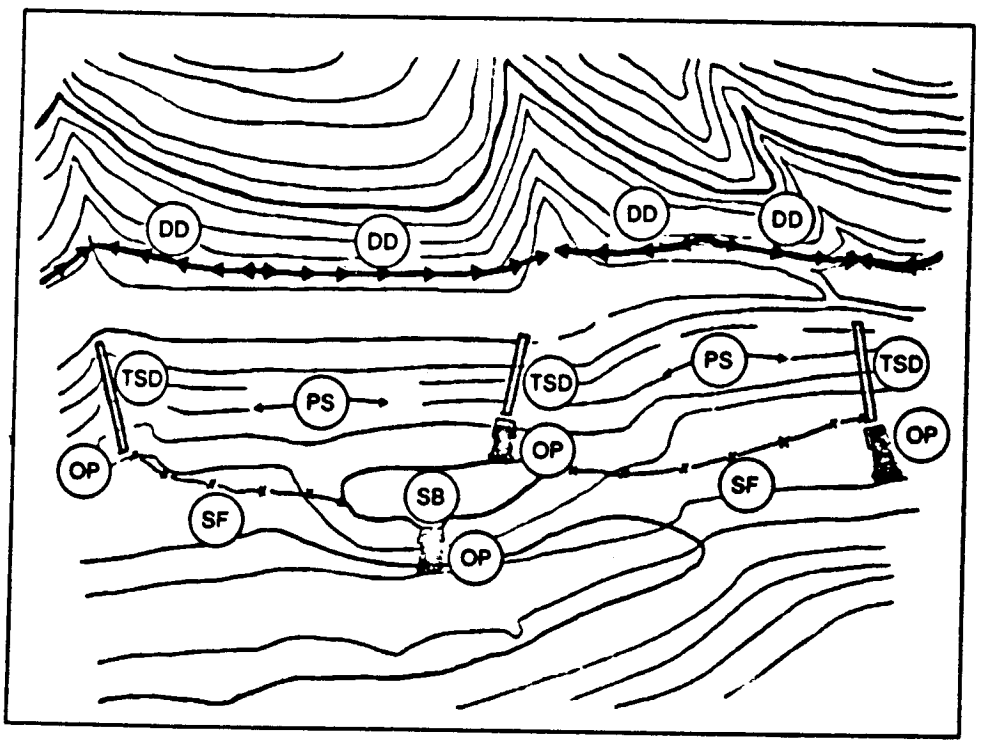

From: Adapted from Colorado Department of Highways, 1978

Figure 2-2 Site Plan Map for Example Construction Site

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3. EROSION CONTROL

The planning for the installation of permanent or temporary soil erosion controls needs to begin in advance of all major soil distrubance activities on the construction site. After construction begins, soil surface stabilization shall be applied within 14 days to all disturbed areas that may not be at final grade but will remain dormant (undisturbed) for periods longer than an additional 30 calendar days.

Soil surface stabilization protects soil from the erosive forces of raindrop impact, flowing water, and wind. Erosion control practices include surface roughening, mulching, establishment of vegetative cover, and the early application of gravel base on areas to be paved. Stabilization measures to be used should be appropriate for the time of year, site conditions and estimated duration of use. The maximum time limits of land exposure for selection of erosion controls are summarized in Table 3-1.

Table 3-1

Maximum Time Limits of Land Exposure
for Selection of Erosion Controls

Erosion Control Method	Maximum Allowable Period of Exposure (months)
Surface Roughening	1
Mulching	12
Temporary Revegetation	12-24
Permanent Revegetation	24 or more
Soil Stockpile Revegetation	2
Early Application of Road Base	1

3.1 Surface Roughening

Surface roughening provides temporary stabilization of disturbed areas from wind and water erosion. It is particularly useful where temporary revegetation cannot be immediately established due to seasonal planting limitations.

The soil surface is considered roughened if depressions are created two to four inches deep and are spaced approximately four to six inches apart. If slopes are sufficiently rough after final grading, no further treatment is required. The surface of exposed soil can be roughened by a number of

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techniques and equipment. A chisel or ripping implement can be used in most soil conditions. Roughening cannot be performed in very sandy or rocky soil.

Surface roughening, also referred to as scarification, should be performed after final grading. Fill slopes can be constructed with a roughened surface. Cut slopes that have been smooth graded can be roughened as a subsequent operation. Roughening of ridges and depressions should follow along the contours of the slope. On slopes steeper than 2:1, the tracks left by a dozer working perpendicular to the contour can leave acceptable horizontal depressions. A diagram illustrating surface roughening is shown on Figure 3-1.

Care should be taken not to drive vehicles or equipment over areas that have been scarified. Tire tracks will smooth the roughened surface and encourage runoff to collect into channels. As surface roughening is only a temporary control, additional treatments may be necessary to maintain the soil surface in a roughened condition.

3.2 Mulching

All disturbed areas must be mulched, or seeded and mulched, within 14 days after final grade is reached on any portion of the site not otherwise permanently stabilized. Areas that will remain in an interim condition for more than one year should also be seeded (See Section 3.3.2). An example of mulching is shown on Figure 3-2.

To protect newly seeded areas and to provide temporary cover on other disturbed areas which will not require temporary revegetation, or which cannot be seeded due to seeding date limitations, a mulch should be applied consisting of:

1. Clean, weed- and seed-free, long-stemmed grass hay (preferred) or cereal grain straw. Hay is preferred as it is less susceptible to removal by wind. Mulch should be applied evenly at a rate of two tons per acre. At least 50 percent of the mulch, by weight, should be ten inches or more in length.

   Mulch must be anchored. This can be accomplished mechanically by crimping or with the aid of tackifiers or nets. Anchoring with a crimping implement is preferred, and is the recommended method for all areas equal to or flatter than 3:1. Mechanical crimpers must be capable of tucking the long mulch fibers into the soil four inches deep

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without cutting them. An agricultural disk, while not an ideal substitute, may work if the disk blades are dull or blunted and set vertically. However, the frame may have to be weighted to afford proper soil penetration.

On small areas sheltered from the wind and from heavy runoff, spraying a tackifier on the mulch is satisfactory for holding it in place. For steep slopes and other special situations, blankets, anchored with staples, may be required instead of mulch.

2. Hydraulic mulching shall be limited to those situations where it is too difficult to apply and anchor a mulch of long-stemmed grass hay or cereal straw; namely, slopes steeper than 3:1 or where access is limited. Wood cellulose fibers must be mixed with water and a tackifying agent and applied at a rate of 1500 pounds per acre with a hydraulic mulcher.

3. Mats, blankets, and nets are available to help stabilize steep slopes and drainage channels. Depending on the product, these may be used alone or in conjunction with grass or straw mulch. Normally, use of these products will be restricted to relatively small areas. Mats made of jute, coconut fiber, or various geosynthetic fibers can be used instead of mulch. Blankets are straw mulch that have been woven and oftentime include a synthetic layer or net. Plastic netting can be used to anchor mulch. Two diagrams showing installation and orientation of these materials are provided as Figures 3-3 and 3-4.

4. Some synthetic tackifiers or binders may be used to anchor mulch. Caution should be used to prevent the introduction of any potentially harmful material into the environment. Manufacturer's recommendations should be followed at all times.

5. Rock can also be used as a mulch. It provides protection of exposed soils to wind and water erosion and allows infiltration of precipitation. Rock of aggregate base-coarse size can be spread on disturbed areas for temporary or permanent stabilization. Rock must be removed from those areas planned for vegetation establishment.

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3.3 Revegetation

A viable vegetative cover should be established within one year on all disturbed areas and soil stockpiles not otherwise permanently stabilized. Vegetation is not considered established until a ground cover is achieved which, in the opinion of the city or county of jurisdiction, is sufficiently mature to control soil erosion and can survive severe weather conditions.

3.3.1 Seedbed Preparation. Areas to be revegetated should have soil conditions capable of supporting vegetation. Overlot grading will oftentimes bring to the surface subsoils that have low nutrient value, little organic matter content, few soil microorganisms, and conditions less conducive to infiltration of precipitation. Under certain conditions, soil amendments and treatments may be necessary to provide an adequate growth medium to sustain vegetation.

Whenever possible, topsoil should be salvaged for respreading on areas to be revegetated. The depth of soil stripping is determined by the depth of available topsoil. Areas near drainageways may have a considerable depth of topsoil, whereas lesser amounts may be available on the crowns of hills and flat slopes. Topsoil can be viewed as a resource to be utilized for vegetation establishment, primarily due to its water-holding capacity.

The rooting zone of most semi-arid grasslands evident in the Denver metropolitan area is 6 - 18 inches. At a minimum, the upper six (6) inches of topsoil can be stripped and stockpiled, and respread to a thicker depth on surfaces not planned for buildings or impervious areas. If the surface is compacted, ripping of subsoils prior to topsoiling is recommended. Scarification will assist in placement of a stable topsoil layer on steeper slopes, and allow percolation and root penetration to greater depth.

Where topsoil is not available or utilized, subsoils can be treated to provide a plant-growth medium. Fertilizer can be added to improve nutrient levels necessary for plant growth. Other treatments, such as liming, can be used to adjust soil conditions as necessary with amendments. Soil testing is recommended to determine appropriate amendments required.

A suitable seedbed will enhance the success of revegetation efforts. The surface should be rough and the seedbed should be firm, but neither too loose or compacted. The upper layer of soil should be in a condition suitable for seeding at the proper depth and conducive to plant growth.

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3.3.2 Temporary Revegetation. Temporary revegetation is required on all disturbed areas having a period of exposure prior to final stabilization of one year or longer. All temporary seeding shall be protected with mulch.

To provide temporary vegetative cover on disturbed areas which will not be paved, built upon, or fully landscaped within 12 months but will be completed within 24 months, plant an appropriate annual grass and mulch the planted areas. The annual grasses generally suitable for the Denver metropolitan area are listed in Table 3-2. These are to be considered only as a general recommendation whenever specific design guidance for a particular site is not available.

3.3.3 Permanent Revegetation. To provide vegetative cover on disturbed areas not paved or built upon for a period of 2 years or longer, or for an indeterminate length of time, a perennial grass mix should be planted. Each site will have different characteristics, and a landscape professional should be contacted to determine the most suitable seed mix for a specific site. In lieu of a specific mix and for planning purposes, one of the perennial grass mixes listed in Table 3-3 can be used. The pure live seed (PLS) rates of application recommended in these tables are considered to be absolute minimum rates for seed applied using proper drill-seeding equipment. All permanent seeding shall be protected with mulch. See Table 3-4 for appropriate seeding dates.

If desired for wildlife habitat or landscape diversity, shrubs such as rubber rabbitbrush (*Chrysothamnus nauseosus*), fourwing saltbush (*Atriplex canescens*) and skunkbrush sumac (*Rhus trilobata*) could be added to the upland seedmixes at .25, .5 and 1 pounds per acre, respectively. In riparian zones, planting root stock of such species as American plum (*Prunus americana*), woods rose (*Rosa Woodsii*), plains cottonwood (*Populus sargentii*), and willow (*Populus spp.*) may be considered. On non-topsoiled upland sites, a legume such as Ladak alfalfa at 1 lb. PLS per acre can be included as a source of nitrogen for perennial grasses.

3.4 Roads and Soil Stockpiles

Road cuts, road fills, and parking lot areas should be covered with the appropriate aggregate base course on the surfaces to be paved in lieu of mulching. Early application of road base is suitable where a layer of course aggregate is specified for final road or parking lot construction. This practice may not be desirable in all instances, and is not needed when final pavement construction will take place within 30 days of grading to final contours. All non-paved portions of road cut, fill,

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and parking lot areas should be seeded and mulched as soon as possible after final grading has occurred, but in no case later than 14 days after grading has been completed.

Soils stockpiled for more than 60 days should be seeded with a temporary or permanent grass cover within 14 days after completion of stockpile construction. Mulching is recommended to ensure vegetation establishment. If stockpiles are located within close proximity to a drainageway (i.e., 100 feet), additional sediment control measures, such as a temporary diversion dike or silt fence, should be provided (see Section 4).

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Table 3-2

Minimum Drill Seeding Rates for Annual Grasses[a]

Species	Growth Season[b]	Pounds of Pure Live Seed (PLS)/acre[c]
Annual ryegrass	Cool	20
Cereal rye	Cool	30
Winter wheat/barley	Cool	30
Spring wheat/barley	Cool	30
Millet	Warm	20

a Successful seeding of annual grass resulting in adequate plant growth, will usually produce enough dead-plant material residue to provide protection from wind and water erosion for an additional year. This assumes that the cover is not disturbed or mowed closer than 8 inches.

Hydraulic seeding may be substituted for drilling only where slopes are steeper than 3:1 or where access limitations exist. When hydraulic seeding is used, hydraulic mulching should be done as a separate operation to prevent the seeds from being encapsulated in the mulch.

b See Table 3-4 for seeding dates.

c Seeding rates should be increased by 50 percent if seeding is done by hydraulic seeding or using a Brillion Drill; or doubled if seed is broadcast.

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Table 3-3

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Minimum Drill Seeding Rates for Perennial Grasses[1]

Alakali Soil Seed Mix

Common & Botanical name	Growth Season[b]	Growth Form	Seeds/ Pound	Pounds of PLS/acre
Alkali sacaton *Sporobolus airoides*	Cool	Bunch	1,750,000	0.25
Basin wildrye *Elymus cinereus*	Cool	Bunch	165,000	2.5
Sodar Streambank wheatgrass *Agropyron riparium 'Sodar'*	Cool	Sod	170,000	2.5
Jose tall wheatgrass *Agropyron elongatum 'Jose'*	Cool	Bunch	79,000	7.0
Arriba western wheatgrass *Agropyron smithii 'Arriba'*	Cool	Sod	110,000	5.5
			Total:	17.75

Fertile Loamy Soil Seed Mix

Common & Botanical name	Growth Season[b]	Growth Form	Seeds/ Pound	Pounds of PLS/acre
Ephriam crested wheatgrass[c] *Agropyron cristatum 'Ephriam'*	Cool	Sod	175,000	2.0
Dural hard fescue *Festuca ovina 'duriuscula'*	Cool	Bunch	565,000	1.0
Lincoln smooth brome *Bromus inermis leyss 'Lincoln'*	Cool	Sod	130,000	3.0
Sodar Streambank wheatgrass *Agropyron riparium 'Sodar'*	Cool	Sod	170,000	2.5
Arriba western wheatgrass *Agropyron smithii 'Arriba'*	Cool	Sod	110,000	7.0
			Total:	15.5

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Table 3-3 (continued)

High Water Table Soil Seed Mix

Common & Botanical name	Growth Season[b]	Growth Form	Seeds/ Pound	Pounds of PLS/acre
Meadow foxtail *Alopecurus pratensis*	Cool	Sod	900,000	0.5
Redtop *Agrostis alba*	Warm	Open sod	5,000,000	0.25
Reed canarygrass *Phalaris arundinacea*	Cool	Sod	68,000	0.5
Lincoln smooth brome *Bromus inermis leyss 'Lincoln'*	Cool	Sod	130,000	3.0
Pathfinder switchgrass *Panicum virgatum 'Pathfinder'*	Warm	Sod	389,000	1.0
Alkar tall wheatgrass *Agropyron elongatum 'Alkar'*	Cool	Bunch	79,000	5.5
			Total:	10.75

Transition Turf Seed Mix

Common & Botanical name	Growth Season[b]	Growth Form	Seeds/ Pound	Pounds of PLS/acre[d]
Ruebens Canadian bluegrass *Poa compressa 'Ruebens'*	Cool	Sod	2,500,000	0.5
Dural hard fescue *Festuca ovina 'duriuscula'*	Cool	Bunch	565,000	1.0
Citation perennial ryegrass *Lolium perenne 'Citation'*	Cool	Sod	247,000	3.0
Lincoln smooth brome *Bromus inermis leyss 'Lincoln'*	Cool	Sod	130,000	3.0
			Total:	7.5

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Table 3-3 (continued)

Sandy Soil Seed Mix

Common & Botanical name	Growth Season[b]	Growth Form	Seeds/ Pound	Pounds of PLS/acre
Blue grama *Bouteloua gracilis*	Warm	Sod-forming bunchgrass	825,000	0.5
Camper little bluestem *Schizachyrium scoparium 'Camper'*	Warm	Bunch	240,000	1.0
Prairie sandreed *Calamovilfa longifolia*	Warm	Open sod	274,000	1.0
Sand dropseed *Sporobolus cryptandrus*	Cool	Bunch	5,298,000	0.25
Vaughn sideoats grama *Bouteloua curtipendula 'Vaughn'*	Warm	Sod	191,000	2.0
Arriba western wheatgrass *Agropyron smithii 'Arriba'*	Cool	Sod	110,000	5.5
			Total:	10.25

Heavy Clay, Rocky Foothill Seed Mix

Common & Botanical name	Growth Season[b]	Growth Form	Seeds/ Pound	Pounds of PLS/acre
Ephriam crested wheatgrass[c] *Agropyron cristatum 'Ephriam'*	Cool	Sod	175,000	1.5
Oahe intermediate wheatgrass *Agropyron intermedium 'Oahe'*	Cool	Sod	115,000	5.5
Vaughn sideoats grama[e] *Bouteloua curtipendula 'Vaughn'*	Warm	Sod	191,000	2.0
Lincoln smooth brome *Bromus inermis leyss 'Lincoln'*	Cool	Sod	130,000	3.0
Arriba western wheatgrass *Agropyron smithii 'Arriba'*	Cool	Sod	110,000	5.5
			Total:	17.5

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Table 3-3 (continued)

FOOTNOTES:

a All of the above seeding mixes and rates are based on drill seeding followed by crimped hay or straw mulch. These rates should be doubled if seed is broadcast and should be increased by 50 percent if the seeding is done using a Brillion Drill or is applied through hydraulic seeding. Hydraulic seeding may be substituted for drilling only where slopes are steeper than 3:1. If hydraulic seeding is used, hydraulic mulching should be done as a separate operation.

b See Table 3-4 for seeding dates.

c Crested wheatgrass should not be used on slopes steeper than 6H to 1V.

d If site is to be irrigated, the transition turf seed rates should be doubled.

e Could substitute 0.5 lbs PLS of Blue grama for the 2.0 lbs PLS of Vaughn sideoats grama.

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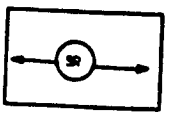


SR

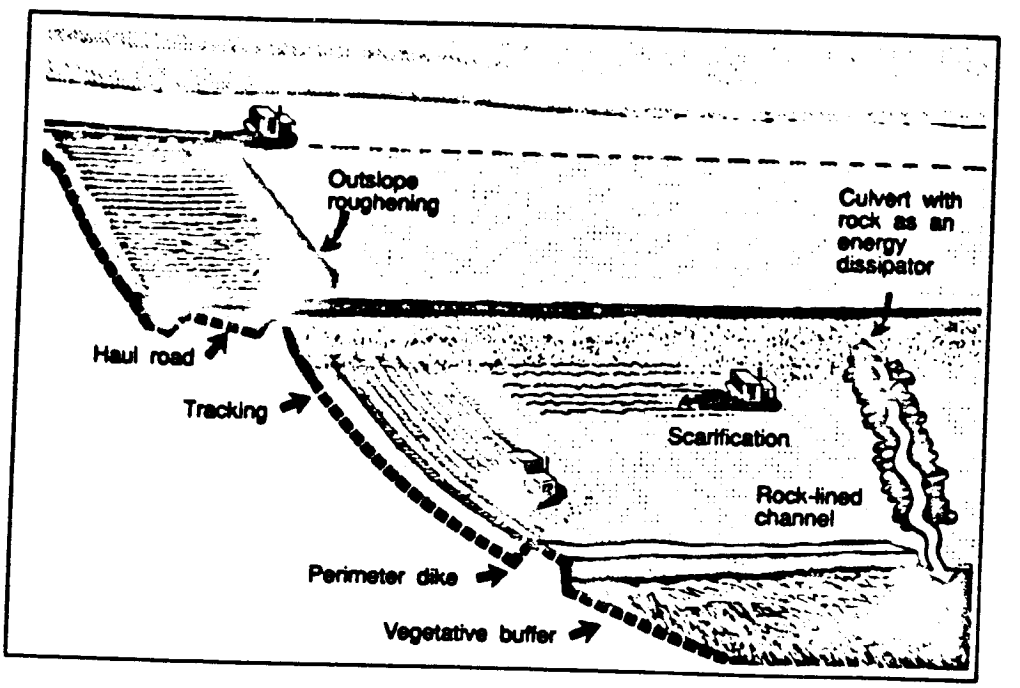
SURFACE ROUGHENING

Definition

Provide a rough soil surface with horizontal depressions created by operating a tillage or other suitable implement on the contour, or by leaving slopes in a roughened condition by not fine-grading them.

Purposes

1. To aid in seed bed preparation and establishment of vegetative cover.
2. To reduce runoff velocity and increase infiltration.
3. To reduce runoff and wind erosion and provide for sediment trapping.



From: Environmental Protection Agency, 1976

Figure 3-1 Surface Roughening

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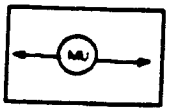


MU

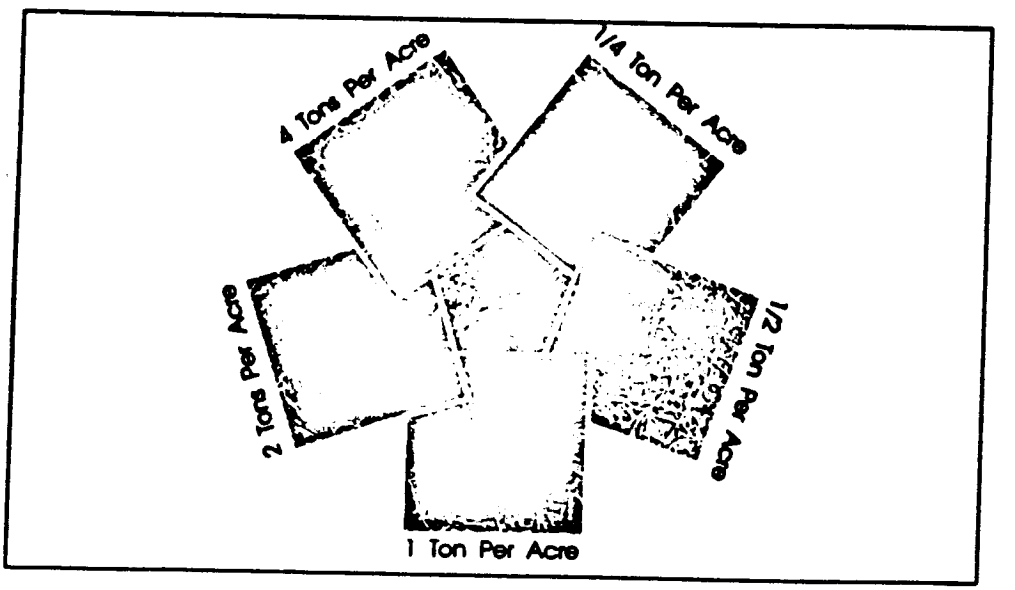
MULCHING

Definition

Application of plant residues or other suitable materials to the soil surface.

Purposes

1. To prevent erosion by protecting the soil surface from raindrop impact and reducing the velocity of overland flow.
2. To foster the growth of vegetation by increasing available moisture and providing insulation against extreme heat and cold.



From: Environmental Protection Agency, 1976

Figure 3-2 Mulching

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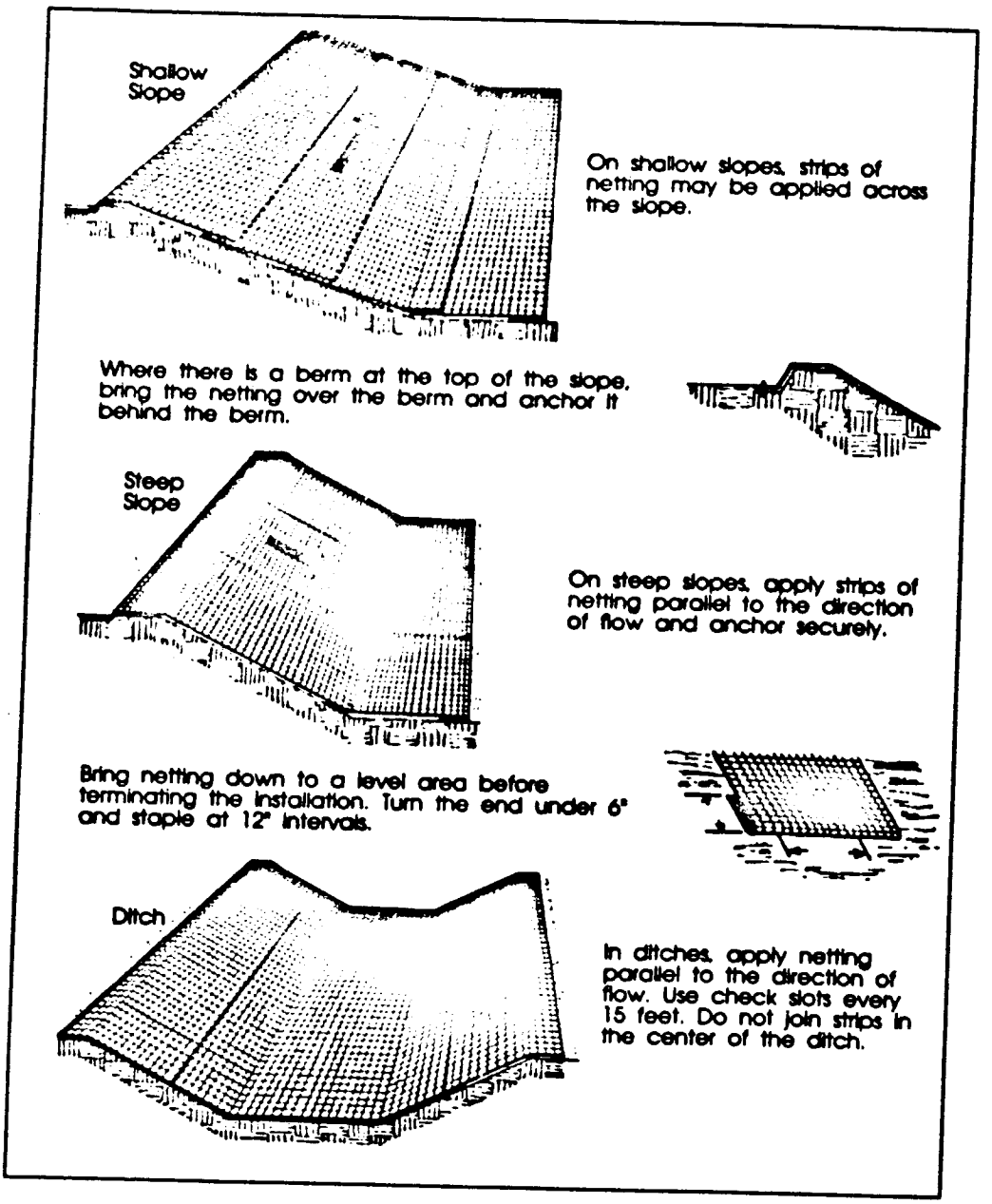

From: Virginia Soil and Water Conservation Commission, 1985

Figure 3-3 Orientation of Blankets, Netting and Matting

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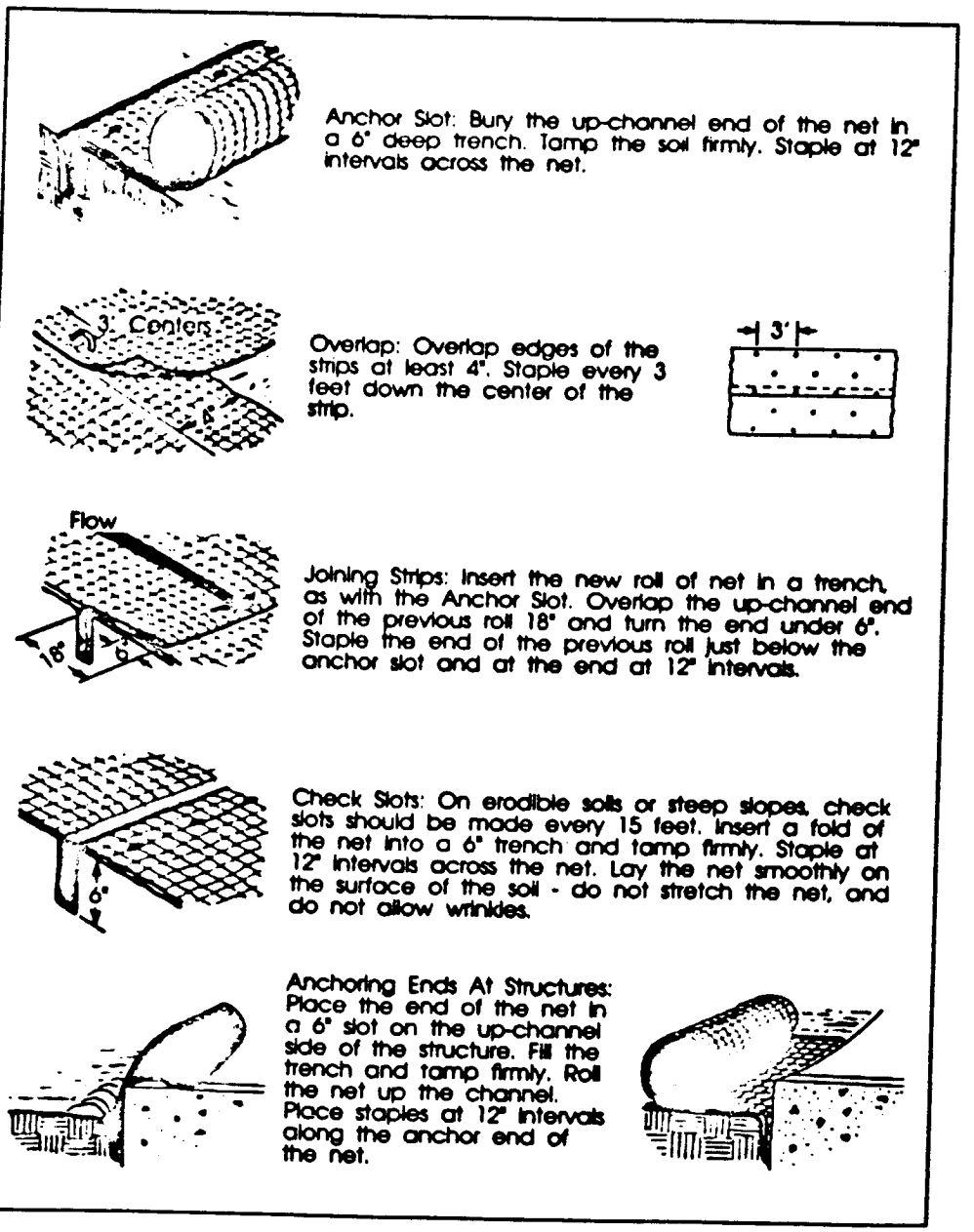

From: Virginia Soil and Water Conservation Commission, 1985

Figure 3-4 Installation of Blankets, Netting and Matting

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4. SEDIMENT CONTROL

The installation of sediment entrapment and control facilities has to begin before major land distrubance activities begin on a construction site.

Sediment control will be site specific and jcan include vehicle tracking controls; sod buffer strips around the lower perimeter of the land disturbance; sediment barriers, filters, dikes, traps or sediment basins; or a combination of any or all of these measures.

Sediment controls must be constructed before land disturbance takes place. Earthen structures such as dams, dikes, and diversions should be mulched within 14 days of installation. Earthen structures that are expected to remain in place for more than one year must be seeded and mulched.

Dams must address stable embankment design and water rights considerations. Consult with the State Engineer's Office on these requirements prior to constructing any dam.

4.1 Vehicle Tracking

Wherever construction vehicles enter onto paved public roads, provisions must be made to prevent the transport of sediment (mud and dirt) by runoff or by vehicles tracking onto the paved surface. For sites greater than two (2) acres, a stabilized vehicle tracking control must be constructed (see Figure 4-1A). Whenever deemed necessary by the city or county of jurisdiction, wash racks shall be installed to remove mud and dirt from the vehicle and its tires before it enters onto public roads (see Figure 4-1B).

Whenever sediment is transported onto a public road, regardless of the size of the site, the road shall be cleaned at the end of each day. Sediment shall be removed from roads by shoveling or sweeping and be transported to a controlled sediment disposal area. Street washing shall not be allowed until after sediment is removed in this manner. Storm sewer inlet protective measures should be in place at the time of street washing.

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4.2 Slope-Length and Runoff Considerations

Cut-and-fill slopes must be designed and constructed to minimize erosion. This requires consideration of the length and steepness of the slope, the soil type, upslope drainage area, groundwater conditions and other applicable factors. Slopes which are found to be eroding excessively will require additional slope stabilization until the problem is corrected. The following guidelines should assist site planners and plan reviewers in developing an adequate design:

1. Rough soil surfaces are preferred over smooth surfaces on slopes (Section 3.1).

2. Temporary diversion dikes (Section 4.2.1) can be constructed at the top of long or steep slopes, or hillslopes that have an upslope tributary drainage area over five acres. Diversion dikes or terraces (Section 4.2.3) may also be used to reduce slope length within the disturbed area.

   Temporary diversion dikes shall be provided whenever:

   $$S^2L > 2.5$$

   where: S = slope of the upstream tributary area (in feet/foot); and,
   L = length of the upstream slope (in feet).

3. Concentrated stormwater should not be allowed to flow down cut or fill slopes unless contained within an adequately-sized temporary channel diversion, a permanent channel, or temporary slope drain (Section 4.2.4).

4. Wherever a slope face crosses a water seepage plane which endangers the stability of the slope, adequate drainage should be provided.

5. Provide sediment traps, basins or barriers (silt fences or straw bale dikes) below slopes to reduce offsite sediment transport or to reduce slope lengths (Section 4.3).

4.2.1 Slope Diversion Dikes. A temporary diversion dike is a horizontal ridge of soil placed perpendicular to the slope and angled slightly to provide drainage along the contour. Temporary diversion dikes can be constructed by excavation of a V-shaped trench or ditch and placement of the fill on the downslope side of the cut. A design of a temporary diversion dike is shown on Figure 4-2.

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There are two types of temporary slope diversion dike:

1. A diversion dike located at the top of a slope to divert upland runoff away from the disturbed area. The discharge from undisturbed or previously-developed upland areas collected by these diversion dikes may be directed to a permanent channel or temporary channel diversion (Section 5.2).

2. A diversion dike located at the base or midslope of a disturbed area to divert sediment-laden water to a sediment trap or basin. The discharge from these diversion dikes may be directed to a temporary slope drain or sediment basin.

4.2.2 Roads and Roadside Swales. The drainage system provided for roads will define to some extent the length and area of individual slope segments within the disturbed area. A number of smaller hillslope segments will be created by construction of roads. These areas will require erosion control as described in Section 3.4, and sediment controls dependent on the size of upslope tributary area (Section 4.3).

For road areas that are not paved within 30 days of final grading, and have not received early application of roadbase (Section 3.4), rough-cut street controls should be used. These are runoff barriers that are constructed at intervals down the road. The barrier projects perpendicular to the longitudinal slope from the outer edge of the roadside swale to the crown of the road. The barriers are positioned alternately from the right and left side of the road to allow construction traffic to pass in the lane not barred. The design and spacing of temporary rough-cut road controls are shown on Figure 4-3.

4.2.3 Terracing. Sediment can be controlled on slopes that are particularly steep by the use of terracing. During grading, relatively flat sections, or terraces, are created and separated at intervals by steep slope segments. The steep slope segments are prone to erosion, however, and must be stabilized in some manner. Retaining walls, gabions, cribbing, deadman anchors, rock-filled slope mattresses and other types of soil retention systems are available for use. These should be specified in the plan and installed according to manufacturer's instructions.

4.2.4 Slope Drains. There are certain instances when runoff must be directed down a slope within the disturbed area. A temporary slope drain can be used to protect these hillslope areas from scour and additional erosion. A number of alternative designs and materials can be used for a slope drain. These are illustrated in Figures 4-4A and 4-4B.

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The sizing of temporary slope drains must be defined but do not need rigorous hydraulic analysis. Criteria for sizing are given in the design criteria. The discharge from all slope drains must be directed to a stabilized outlet (Section 5.3).

4.3 Sediment Entrapment Facilities

Sediment entrapment facilities are necessary to reduce sediment discharges to downstream properties and receiving waters. Sediment entrapment facilities include straw bale barriers, silt fences, sod filter strips, sediment traps and sediment basins. The type of sediment entrapment facility to be used depends on the tributary area, basin slope and slope length of the upstream area. Table 4-1 summarizes the recommended maximum tributary areas, slope lengths and slopes for five types of sediment entrapment facilities.

All runoff leaving a disturbed area shall pass through a sediment entrapment facility before it exits the site and flows downstream.

Table 4-1

Sediment Entrapment Facility Limitations

Sediment Control Facility	Allowable Maximum Limit		
	Tributary Drainage Area (ac)	Tributary Slope Length (ft)	Tributary Slope Gradient
Sod Filter Strips	n/a	50	6:1 (17%)
Straw Bale Barrier or Silt Fence	0.5 per 100 lineal ft	150	2:1 (50%)
Sediment Trap	5.0	n/a	n/a
Sediment Basin	n/a	n/a	n/a

For small sites a sod filter strip may be adequate provided the limits for tributary slope are not exceeded and the flow is not concentrated. Straw bale barriers or silt fences may be used for somewhat larger areas depending on the upslope drainage area. When the tributary area is less than five acres but greater than that allowed for straw bale barriers or silt fences, runoff shall be collected in diversion swales and routed through temporary sediment traps.

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4.3.1 Straw Bale Barriers. Straw bales can be placed at the base of a hillslope to act as a sediment barrier. These are not recommended for use within a swale or channel. Straw bales are temporary in nature and may only perform for a period of weeks or months. Proper installation and maintenance is necessary to ensure their performance. Guidance on design and installation of straw bales is given on Figures 4-5A and 4-5B.

4.3.2 Silt Fence. A silt fence is made of a woven synthetic material and acts to filter runoff. Silt fence can be placed as a temporary barrier at the base of a disturbed area but is not recommended for use in a channel or swale. The material is durable and will last for more than one season if properly installed and maintained. Silt fence design criteria, construction techniques, and example applications are shown on Figures 4-6A and 4-6B.

4.3.3 Filter Strips. Vegetated filter strips act to cause deposition of sediment within the area of vegetation. Buffer strips of natural vegetation can be left at the time of site grading, or can be created by using sod. A dense ground cover is necessary or runoff will channelize within the area. A minimum width of 20 feet is recommended.

4.3.4 Sediment Traps. A sediment trap is a temporary structure that is designed to fill with sediment. A sediment trap can be constructed by either excavating below grade or building an embankment across a swale. Excavated traps are less prone to failure than embankments. No pipe is used at the outlet, as in a sediment basin, and an open-channel spillway must be included in the design. A minimum of 900 cubic feet of storage volume must be provided for each tributary acre. A generalized design for a sediment trap is provided on Figure 4-7.

4.3.5 Sediment Basins. Areas draining more than five acres must be routed through a sediment basin. A temporary sediment basin is shown in Figure 4-8 and is similar to a permanent retention pond shown in Figure 6-1 in the *Structural BMPs* chapter.

If the site is to include a stormwater quality or flood detention basin, the permanent detention facility may be used as the temporary sediment basin, provided the outlets are modified upon completion for this purpose (Figure 6-2 in the *Structural BMPs* chapter). Such permanent detention facilities shall be restored to design grades, volumes, and configurations after site development is completed and the project is finalized.

Temporary sediment basins shall be designed to provide a minimum 900 cubic feet of sediment storage volume per tributary acre, and a minimum of 900 cubic feet of runoff storage volume per tributary acre

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(i.e., a total of 1800 cubic feet per acre). The outlet from a sediment basin should be designed to empty the runoff storage volume in no less than 12 hours. The basin's length shall be no less than twice the basin's width. The inflow structures at the entrance of the basin should be designed to dissipate inflow energy and to spread the flow so as to achieve uniform flow throughout the basin's width.

4.3.6 Example Design: Sediment Basin

Given: Tributary Area = 10 acres

Required: Minimum Sediment Storage Volume = 10 acres x 900 cubic feet per acre
= 9000 cubic feet

The dimensions of the sediment storage area will be determined by site conditions. In this example, if a depth of 3 feet is selected, a 75 feet long by 40 feet wide area will provide the required 9000 cubic feet of sediment storage volume.

Required: Minimum Runoff Storage Volume = 10 acres x 900 cubic feet per acre
= 9000 cubic feet
= 0.207 acre-feet

The runoff storage volume is designed to be located vertically above the sediment storage volume. In this example, try a 4-inch diameter riser with the design pond maximum water surface elevation being two-feet above the sediment storage level. From Figure 6-3 of the *Structural BMPs* chapter, using a surcharge depth of 2.0 feet and a runoff storage volume of 0.207 acre-feet, it is determined that 1.60 square inches of outlet area is required for each row of outlet holes in the riser. From Figure 6-2 of the *Structural BMPs* chapter, it is determined that either eight 1/2-inch diameter holes or two 1-inch holes per row have a total area of 1.57 square inches and that these rows are spaced vertically four inches apart. Selecting 1/2-inch holes, this means that the riser will have six rows with eight 1/2-inch holes per row over a two-foot height. The uppermost row will be four inches below the top of the riser and the lowest row will be two feet below the top of the riser. The lowest row corresponds in elevation to the top of the sediment storage level.

See Figure 4-9 for guidance on the locations of baffles to make length-to-width ratio 2:1 or greater. See Figure 6-1 in the *Stormwater BMPs* chapter for guidance on embankment and emergency spillway design.

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VTC

VEHICLE TRACKING CONTROL

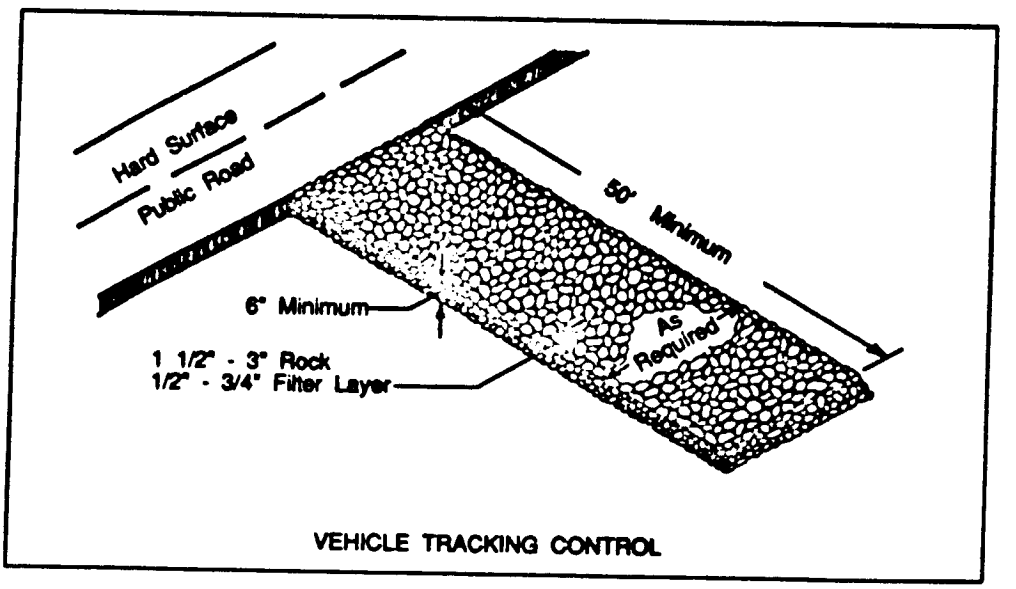
Definition

A stone stabilized pad located at points of vehicular ingress and egress on a construction site.

Purposes

To reduce the amount of mud transported onto public roads by motor vehicles or runoff.

Note: Only applicable for sites greater than 2 acres in size



VEHICLE TRACKING CONTROL

From: Virginia Soil and Water Conservation Commission, 1985

Figure 4-1A Temporary Vehicle Tracking Control

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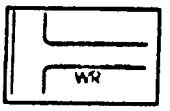


WR

VEHICLE TRACKING CONTROL

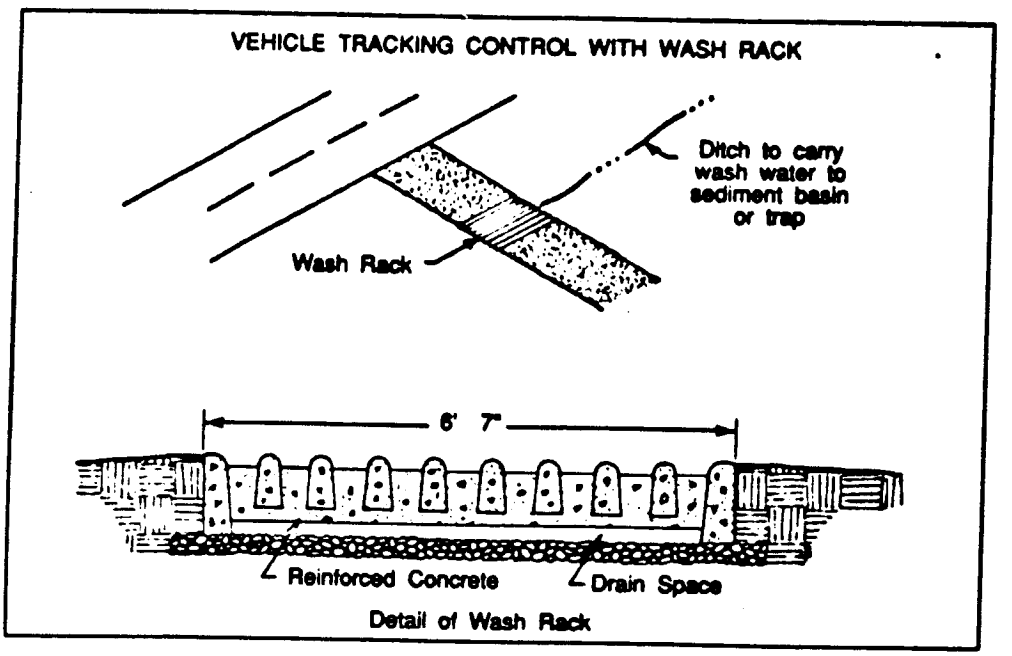
Definition

A stone stabilized pad located at points of vehicular ingress and egress on a construction site equipped with a concrete wash rack.

Purposes

To reduce the amount of mud transported onto public roads by motor vehicles or runoff.

Note: Only needed when required by local City or County of jurisdiction. May be precluded from use if no water supply is available.



From: Virginia Soil and Water Conservation Commission, 1985

Figure 4-1B Temporary Vehicle Tracking Control With Wash Rack

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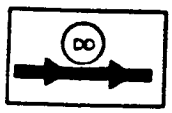


DD

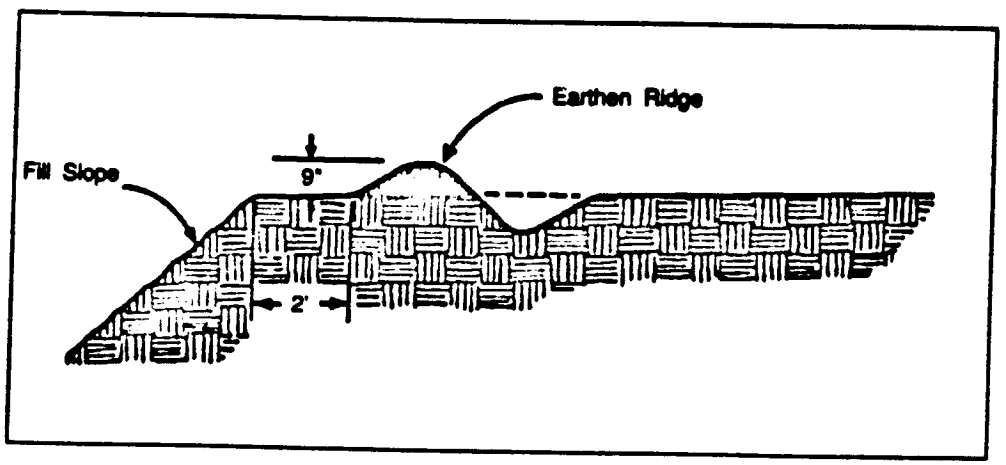
TEMPORARY DIVERSION DIKE

Definition

A temporary ridge of compacted soil located at the top, midslope, or base of a disturbed area.

Purposes

1. To divert storm runoff from higher drainage areas away from unprotected slopes to a permanent channel or temporary channel diversion.
2. To divert sediment-laden runoff from the midslope of a disturbed area to a temporary slope drain.
3. To divert sediment-laden runoff from the base of a disturbed area to a sediment trapping facility.



From: Virginia Soil and Water Conservation Commission, 1985

Figure 4-2 Temporary Diversion Dike

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RCS

ROUGH-CUT STREET CONTROL

Definition

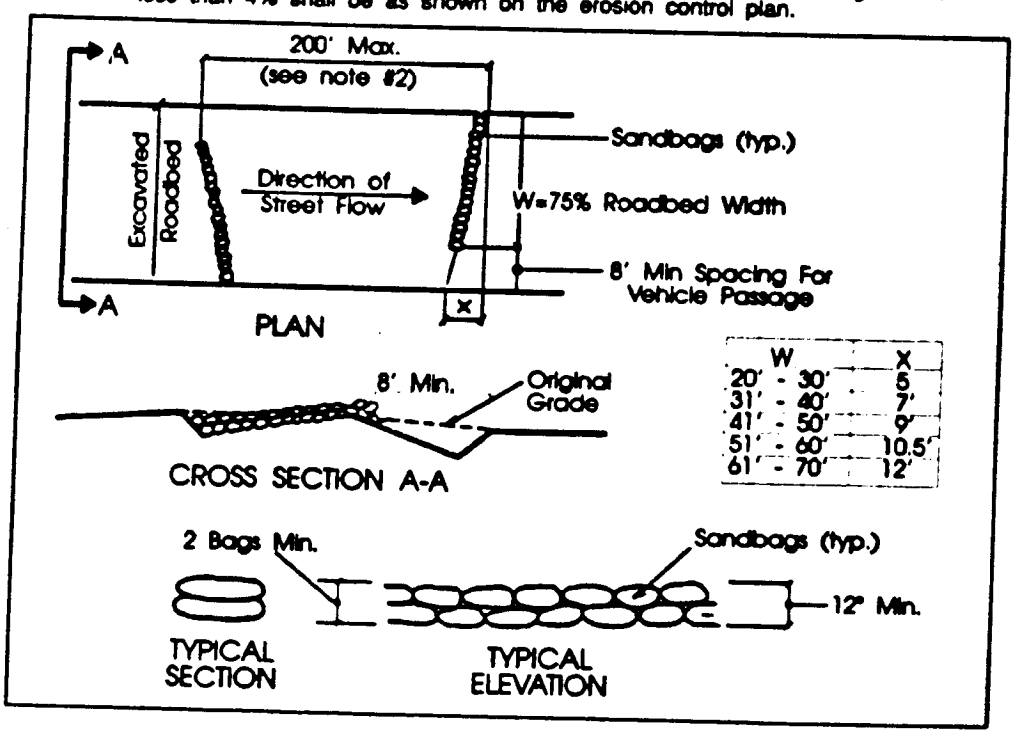
A temporary sediment barrier placed on alternate sides of a rough cut street.

Purposes

To divert sediment-laden runoff from rough-cut streets and slow the velocity of storm runoff.

Note: 1. Alternate materials such as straw bale barriers or silt fences may be used where large flows are not expected.

2. Requirements for and spacing of velocity reducers for streets with grades of less than 4% shall be as shown on the erosion control plan.



From: Orange County, California Department of Environmental Quality, 1981

Figure 4-3 Rough-Cut Street Control

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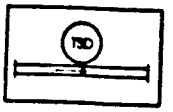


TSD

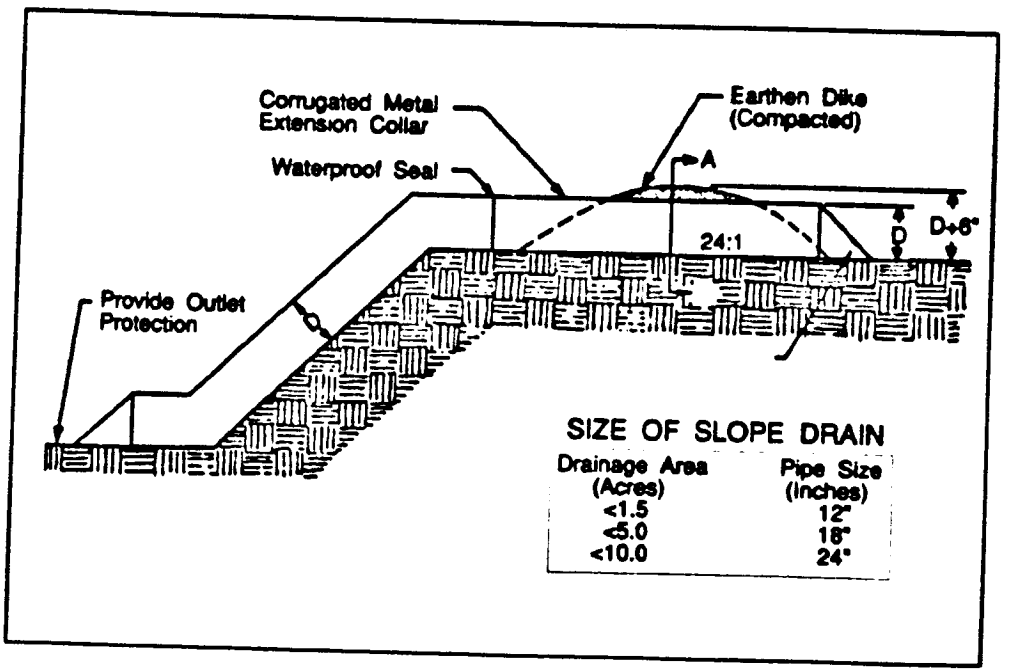
TEMPORARY SLOPE DRAIN

Definition

A flexible tube or conduit extending from the top to the bottom of a cut or fill slope.

Purposes

To temporarily conduct concentrated stormwater runoff safely down the face of a cut or fill slope without causing erosion problems on or below the slope.



From: Virginia Soil and Water Conservation Commission, 1985

Figure 4-4A Temporary Slope Drain

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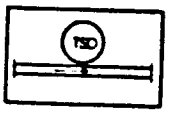
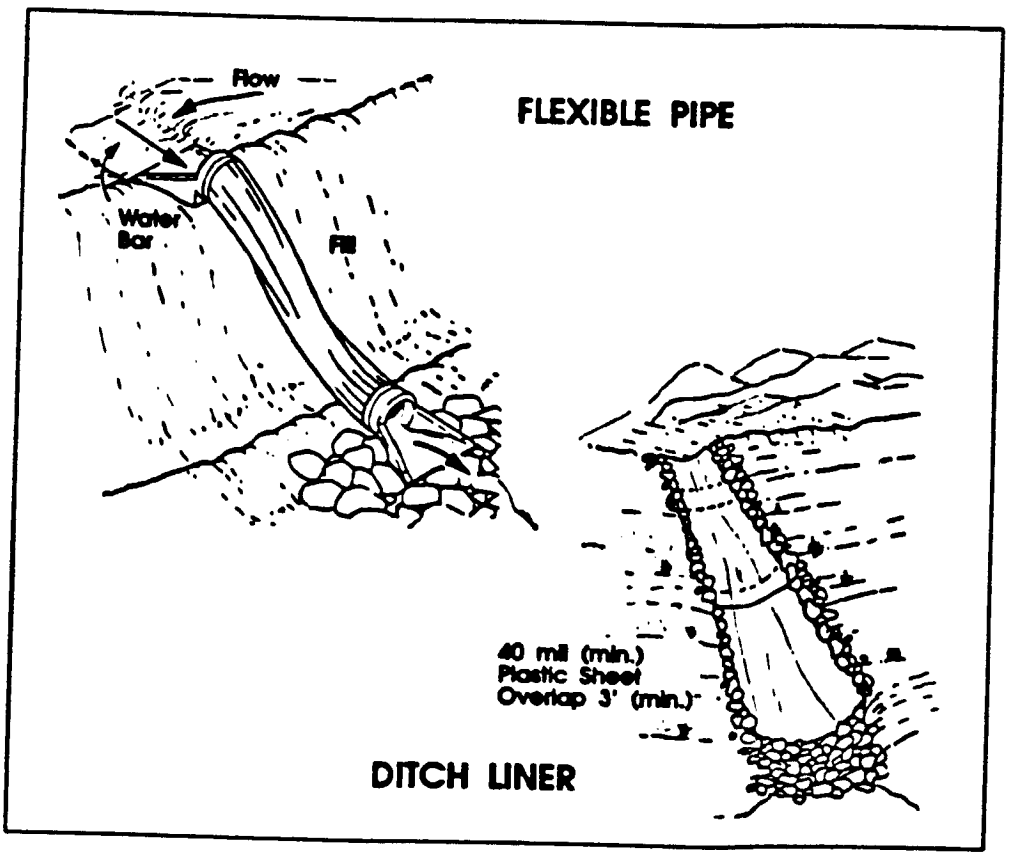


TSD

TEMPORARY SLOPE DRAINS



From: Colorado Department of Highways, 1978

Figure 4-4B Temporary Slope Drain Applications

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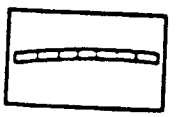


STB

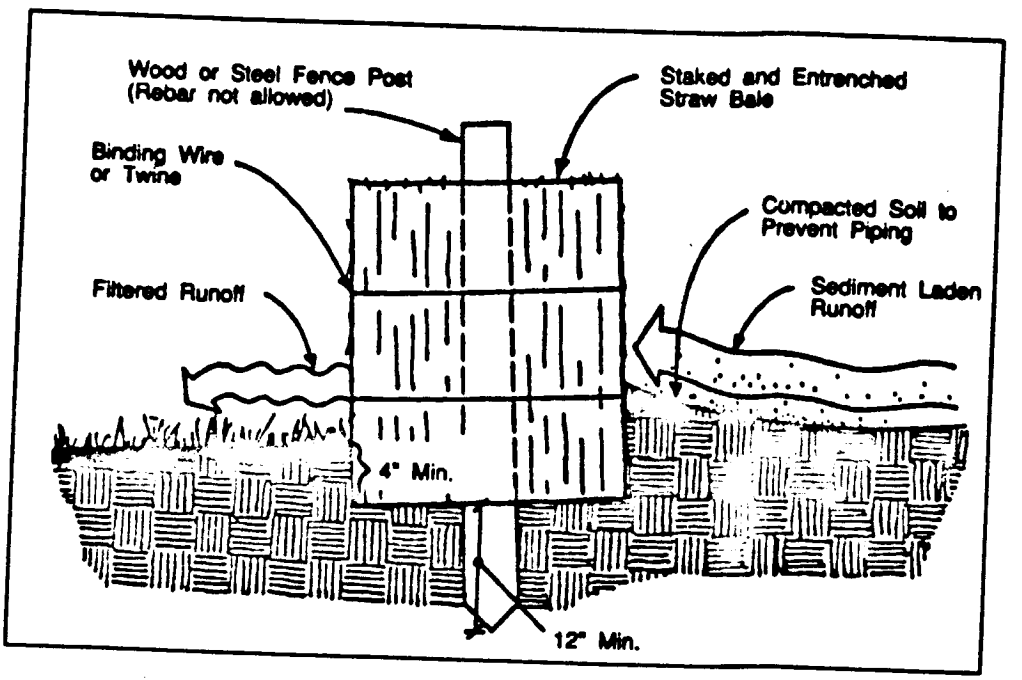
STRAW BALE BARRIER

Definition

A temporary sediment barrier consisting of a row of entrenched and anchored straw bales.

Purposes

1. To intercept and detain small amounts of sediment from disturbed areas of limited extent in order to reduce sediment in runoff from leaving the site.
2. To decrease the velocity of sheet flows from hillslope areas



From: Virginia Soil and Water Conservation Commission, 1985

Figure 4-5A Straw Bale Barriers

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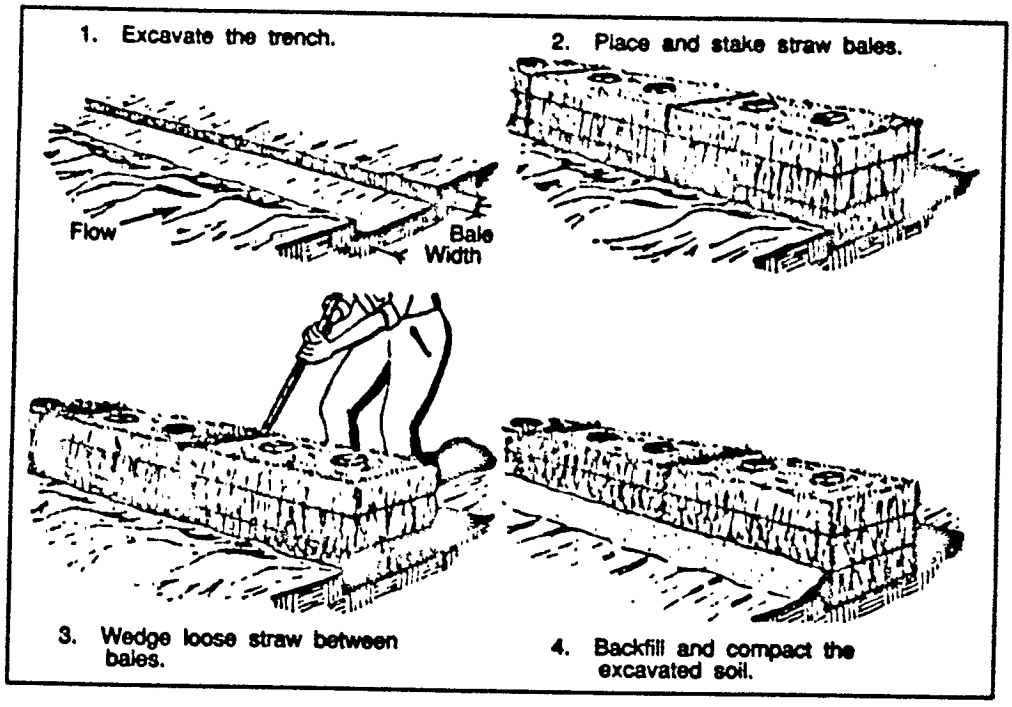
STRAW BALE BARRIER INSTALLATION



From: Virginia Soil and Water Conservation Commission, 1985

Figure 4-5B Straw Bale Barrier Installation

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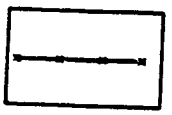


SF

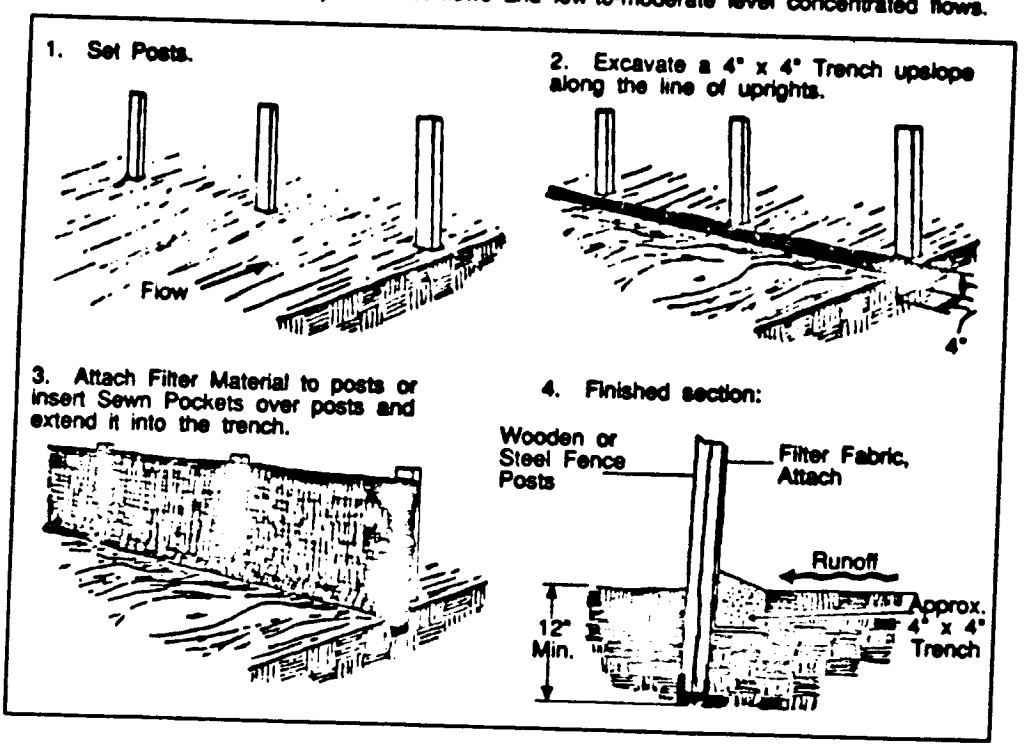
SILT FENCE

Definition

A temporary sediment barrier consisting of a filter fabric stretched across and attached to supporting posts and entrenched. The silt fence is a temporary linear filter barrier constructed of synthetic filter fabric and supported by wooden or steel posts.

Purposes

1. To intercept and detain small amounts of sediment from disturbed areas during construction operations in order to reduce sediment in runoff from leaving the site.
2. To decrease the velocity of sheet flows and low-to-moderate level concentrated flows.



From: Virginia Soil and Water Conservation Commission, 1985

Figure 4-6A Silt Fence

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SF

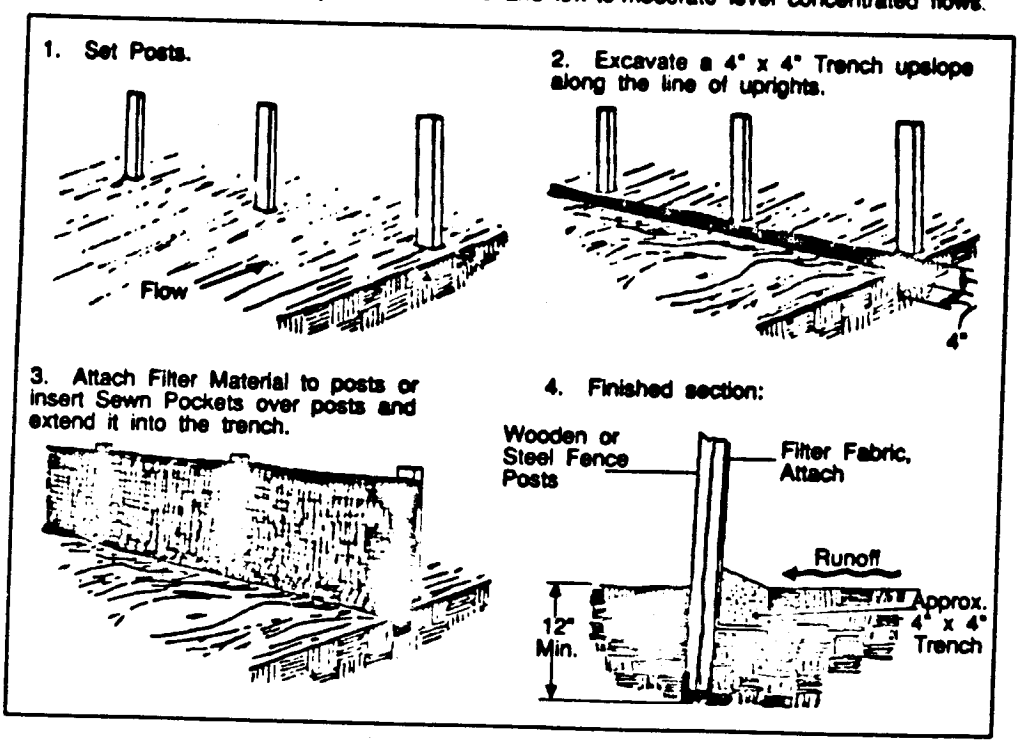
SILT FENCE

Definition

A temporary sediment barrier consisting of a filter fabric stretched across and attached to supporting posts and entrenched. The silt fence is a temporary linear filter barrier constructed of synthetic filter fabric and supported by wooden or steel posts.

Purposes

1. To intercept and detain small amounts of sediment from disturbed areas during construction operations in order to reduce sediment in runoff from leaving the site.
2. To decrease the velocity of sheet flows and low-to-moderate level concentrated flows.



From: Virginia Soil and Water Conservation Commission, 1985

Figure 4-6A Silt Fence

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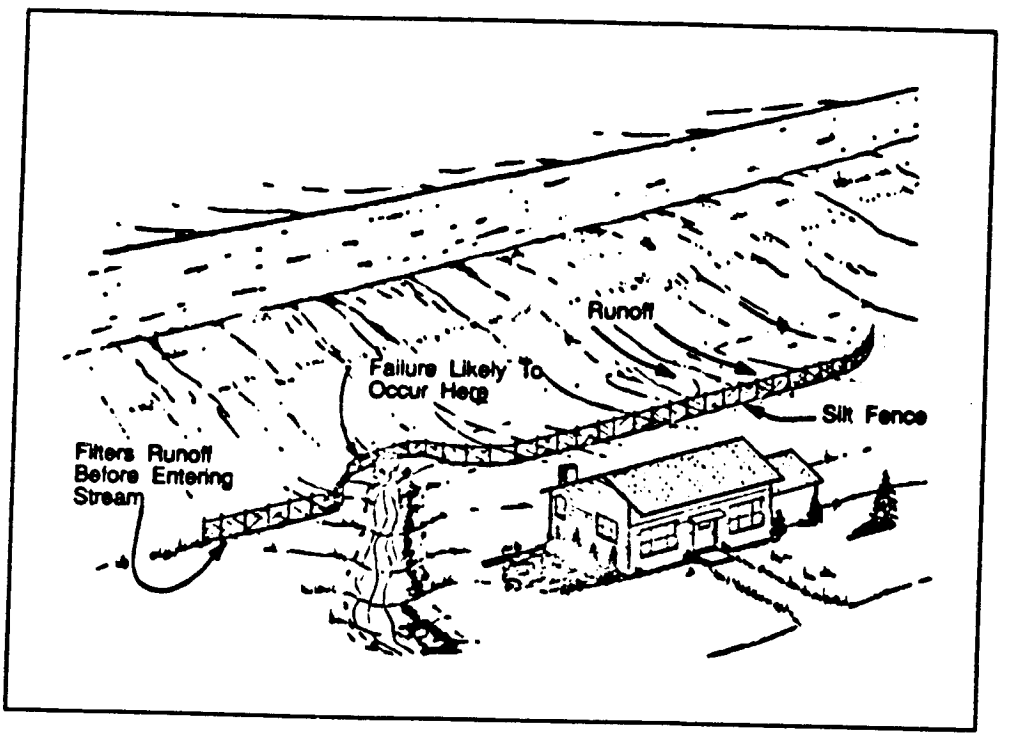
SF

Silt Fence Applications



From: Colorado Department of Highways, Erosion Control Manual, 1978

Figure 4-6B Silt Fence Applications

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ST

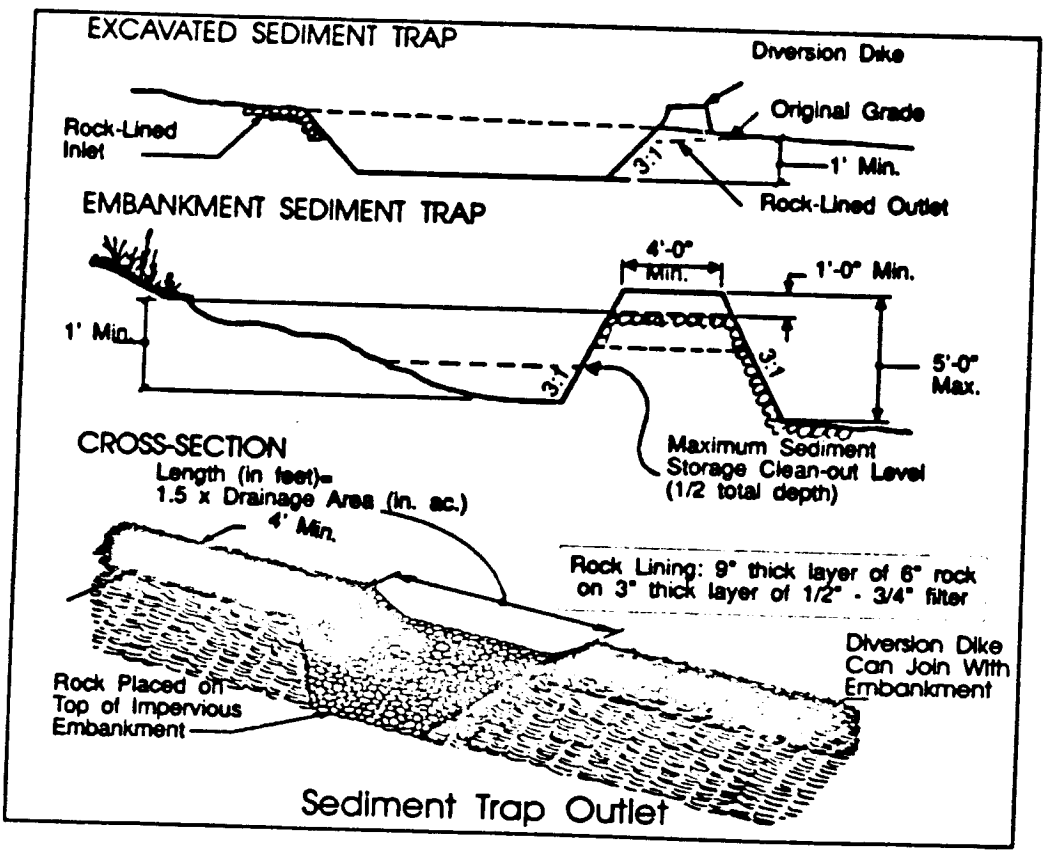
TEMPORARY SEDIMENT TRAP

Definition

A small temporary ponding area, formed by constructing an earthen embankment with a rock-covered outlet across a drainage swale, or by excavation of a depression below original grade. Relative elevations should contain all runoff within the trap area.

Purposes

To detain sediment-laden runoff from disturbed areas long enough to allow the majority of the sediment to settle out.



From: Virginia Soil and Water Conservation Commission, 1985

Figure 4-7 Temporary Sediment Trap

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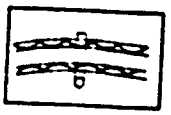


SB

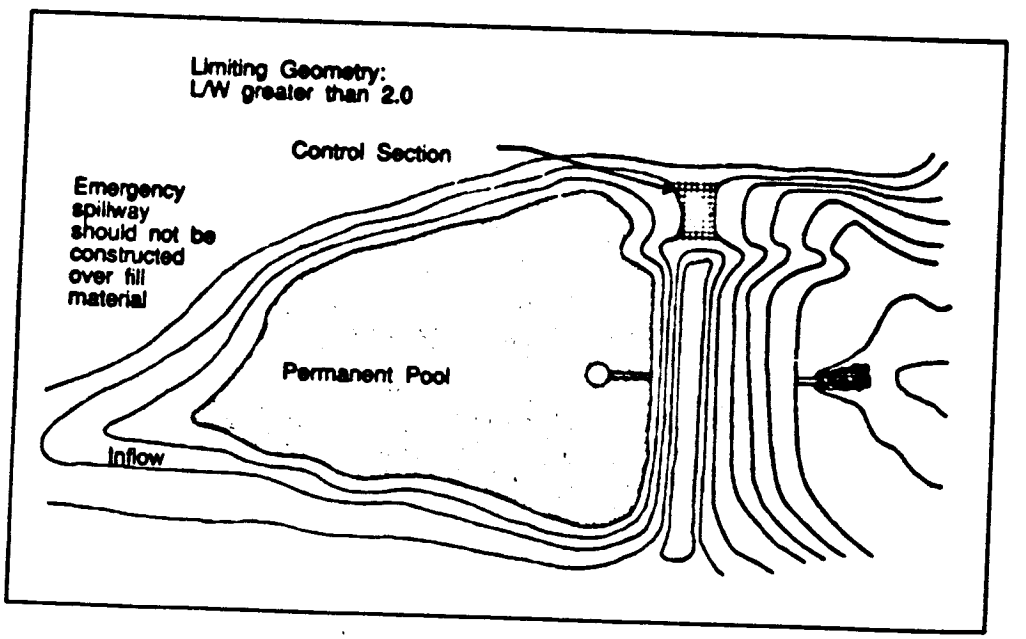
TEMPORARY SEDIMENT BASIN

Definition

A temporary basin with a controlled stormwater release structure, formed by constructing an embankment of compacted soil across a drainageway.

Purposes

To detain sediment-laden runoff from disturbed areas long enough to allow the majority of the sediment to settle out.



From: Virginia Soil and Water Conservation Commission, 1985

Figure 4-8 Temporary Sediment Basin

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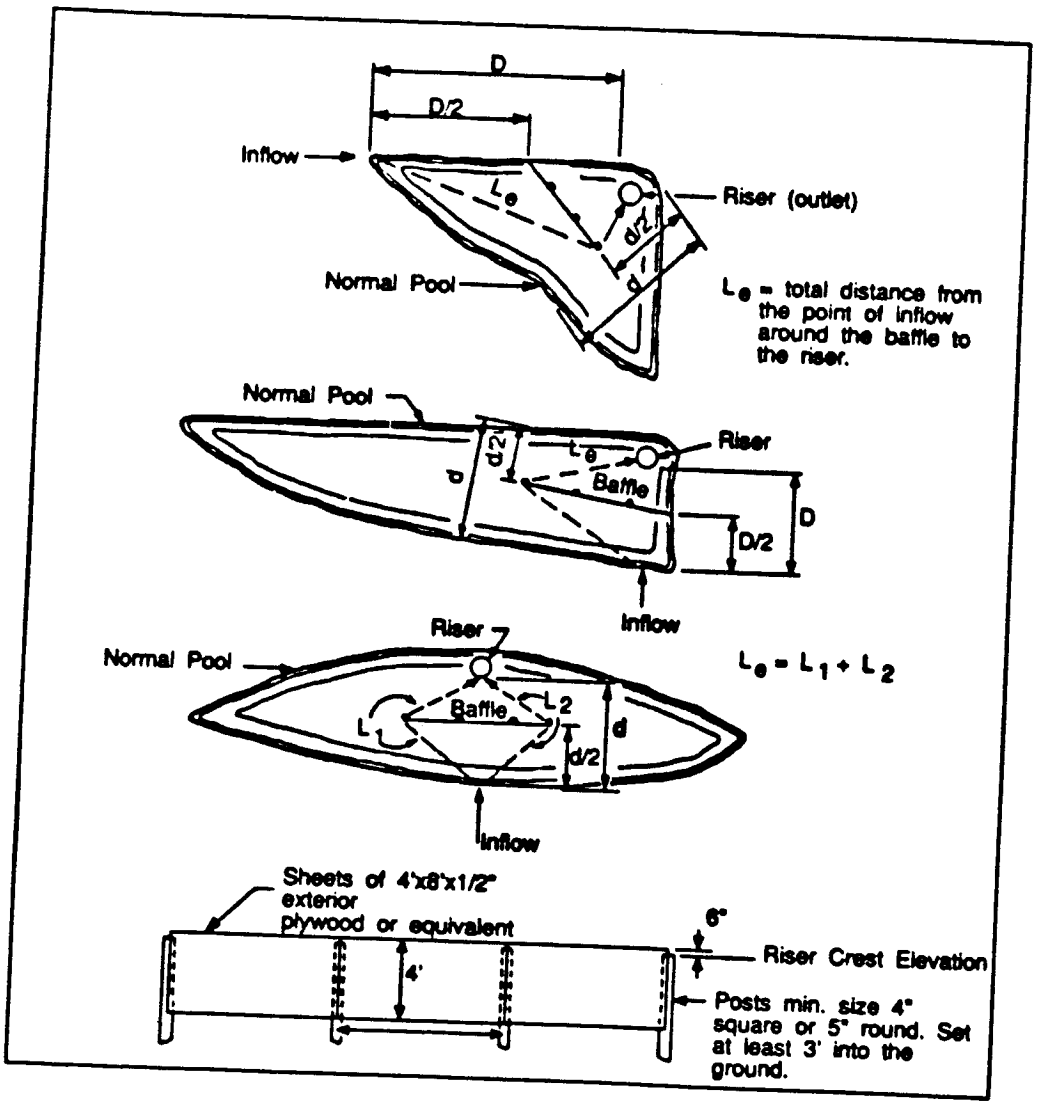
BAFFLE LOCATIONS IN SEDIMENT BASINS



From: Environmental Protection Agency, 1976

Figure 4-9 Baffle Locations in Sediment Basins

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5. DRAINAGEWAY PROTECTION

At times construction activities must occur adjacent to or within a drainageway. Whenever this occurs, bottom sediments will be disturbed and transported downstream. The goal of these criteria is to minimize the movement of sediments resulting from construction activities that take place within any drainageway. Temporary facilities can be installed to divert flowing water around such sediment-generating construction activities within drainageways.

Some construction activities within a waterway are short lived, namely a few hours in duration, and are minor in nature. These are typically associated with maintenance of utilities and stream crossings and minor repairs to outfalls and eroded banks. In these cases, construction of temporary diversion facilities may cause more soil disturbance than the maintenance activity itself. If it can be reasonably determined that any channel work is maintenance related, is of very short duration, and will result in only a small disturbance of bottom sediment, it is reasonable to exempt these from the requirement to construct temporary diversion facilities.

5.1 Working Within or Crossing a Waterway

Whenever work occurs within a waterway, the following should be considered as appropriate:

1. Construction vehicles should be kept out of a waterway to the maximum extent practicable. Where in-channel work is necessary, steps, such as temporary channel diversions, must be taken to stabilize the work area during construction to control erosion. The channel (including bed and banks) must be restabilized immediately after in-channel work is completed.

2. Where an actively-flowing watercourse must be crossed regularly by construction vehicles, a temporary crossing should be provided. Two primary methods are available: (1) a culverted crossing; and, (2) a stream ford.

   A culverted crossing should be designed to pass the 2-year design flow. A typical temporary stream crossing is shown on Figure 5-1. For additional discussion on design of box culverts and pipes, see Sections 3 and 4, *Major Drainage*, of this *Manual*.

   A ford should be lined with a minimum six-inch thick layer of 1-1/2 inch diameter rock. A typical stream ford is shown on Figure 5-2.

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statistical foundation for Figure 5-3. The designer of a temporary diversion facility and the construction contractor must recognize that the design flows taken from Figure 5-3 are for sediment control and not job-site protection from large runoff events, since these flow values are not representative of major or minor floods. However, all temporary channel diversions shall be sized to convey no less than the flows provided by Figure 5-3. Since each construction project is unique, it is recommended that the contractor consider the use of larger temporary water diversion facilities to protect the job site from higher runoff.

While Figure 5-3 suggests minimum design flows for April through September, the chances of high runoff decrease substantially during the months of October through Merch. During these months, much of the precipitation is snow that produces snowmelt runoff rates that are low when compared to runoff from rainstorms. As a result, it is suggested that temporary channel diversion structures for projects scheduled to be performed and completed during October through March be designed to carry no less than one-half of the flow values taken from Figure 5-3.

5.2.2 Stability Considerations. Temporary channels are not likely to be in service long enough to establish adequate vegetative lining. Temporary channel diversions must be designed to be stable for the design flow with the channel shear stress less than the critical tractive shear stress for the channel lining material. Unlined channels should not be used unless it can be demonstrated that an unlined channel will not erode during the design flow. Table 5-1 gives allowable channel lining materials for a range of slope and flow depth. Table 5-2 gives Mannings 'n' values for lining materials. Design procedures for temporary channels are described in detail in the Hydraulic Engineering Circular No. 15 published by the Federal Highway Administration. The methods presented in this section are greatly simplified and are based on information developed using only the most commonly used erosion control materials.

5.2.3 Example: Temporary Diversion Design. A simplified method for designing a non-erosive channel is given as follows:

Step One:

Using the tributary area A (in acres) determine peak flow according to Figure 5-3.

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A permit is required for placement of fill in a waterway under Section 404 of the Clean Water Act. The U.S. Army Corps of Engineers has issued nationwide general permit Number 14 for Minor Road Crossing Fills. This is defined as placement of less than 200 cubic yards of fill material below the plane of ordinary high water. The local office of the Corps should be contacted about the requirements for obtaining a 404 permit. The city or county of jurisdiction should also be consulted and can provide assistance. A further discussion on the need for 404 permits is included in Section 2.1, *Major Drainage*, of this *Manual*.

3. Whenever feasible, use a temporary water diversion (Section 5.2) to bypass the work areas when work takes place within a channel itself.

4. Whenever possible, construction in a waterway should be sequenced to begin at the most downstream point and work progressively upstream installing required channel and grade control facilities.

5. Complete work in small segments, exposing as little of the channel at a time as possible.

6. Where possible, perform all in-channel work between September 15 and April 15.

5.2 Temporary Channel Diversions

Limiting construction activities within actively-flowing water will significantly reduce sediment movement downstream from these activities. This can be done by using a temporary diversion facility that carries water around construction activities taking place within a waterway.

Permanent drainage channels should be constructed at the earliest possible stage of development. Temporary channel diversions should not remain in place for more than two years prior to removal or replacement by permanent facilities.

5.2.1 Temporary Diversion Sizing. Figure 5-3 must be used to determine the minimum design discharge to size temporary diversions. The two curves in Figure 5-3 were developed using monthly peak flow data for the months of April through September collected at 17 watersheds within the Urban Drainage and Flood Control District. Data for these watersheds were collected over periods that ranged from six years to eleven years and, as a result, provide reasonable

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statistical foundation for Figure 5-3. The designer of a temporary diversion facility and the construction contractor must recognize that the design flows taken from Figure 5-3 are for sediment control and not job-site protection from large runoff events, since these flow values are not representative of major or minor floods. However, all temporary channel diversions shall be sized to convey no less than the flows provided by Figure 5-3. Since each construction project is unique, it is recommended that the contractor consider the use of larger temporary water diversion facilities to protect the job site from higher runoff.

While Figure 5-3 suggests minimum design flows for April through September, the chances of high runoff decrease substantially during the months of October through March. During these months, much of the precipitation is snow that produces snowmelt runoff rates that are low when compared to runoff from rainstorms. As a result, it is suggested that temporary channel diversion structures for projects scheduled to be performed and completed during October through March be designed to carry no less than one-half of the flow values taken from Figure 5-3.

5.2.2 Stability Considerations. Temporary channels are not likely to be in service long enough to establish adequate vegetative lining. Temporary channel diversions must be designed to be stable for the design flow with the channel shear stress less than the critical tractive shear stress for the channel lining material. Unlined channels should not be used unless it can be demonstrated that an unlined channel will not erode during the design flow. Table 5-1 gives allowable channel lining materials for a range of slope and flow depth. Table 5-2 gives Mannings 'n' values for lining materials. Design procedures for temporary channels are described in detail in the Hydraulic Engineering Circular No. 15 published by the Federal Highway Administration. The methods presented in this section are greatly simplified and are based on information developed using only the most commonly used erosion control materials.

5.2.3 Example: Temporary Diversion Design. A simplified method for designing a non-erosive channel is given as follows:

Step One:

Using the tributary area A (in acres) determine peak flow according to Figure 5-3.

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Step Two:

Determine depth of flow, one foot maximum for flows less than 20 cfs and three feet maximum for flows less than 100 cfs. (Flows in excess of 100 cfs should be designed in accordance with the *Major Drainage* Section of the *Manual*).

Step Three:

Determine channel slope based on existing and proposed site conditions.

Step Four:

Select lining material from Table 5-1.

Step Five:

Determine the channel geometry and check the capacity using Manning's Equation and the "n" value given in Table 5-2. The steepest side slope allowable for a temporary channel is two horizontal to one vertical (i.e., 2:1). It is suggested that the design for temporary bypass channels include an additional 0.5 feet of freeboard.

5.3 Outlet Protection

To protect adjacent downstream properties from erosion due to concentrated flows, a stable outlet or channel is necessary. If there is no stable outlet, one may have to be constructed. In lieu of constructing a temporary or permanent outlet to the storm drainageway system, temporary total retention of the runoff from a 24-hour, 100-year storm may be provided. Written approval by the local city or county must be obtained for total retention of stormwater.

The outlets of slope drains, culverts, sediment traps, and sediment basins must be protected from erosion and scour. Outlet protection should be provided where the velocity of flow will exceed the maximum permissible velocity of the material where discharge occurs. This may require the use of a riprap apron at the outlet location. Design guidance on outlet protection is provided on Figure 5-4.

Check dams can be used in ditches or swales and downstream of the outlets of temporary slope drains, culverts, sediment traps, and sediment basins. Check dams reduce the velocity of

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concentrated flows and trap sediment eroded from the upstream ditch or swale. They are not a primary sediment trapping facility and are a temporary flow-control structure.

Check dams may be used under the following conditions:

- In temporary or permanent swales that need protection during the establishment of grasses
- In permanent swales that need protection prior to installation of a non-erodible lining
- In temporary ditches or swales that need protection where construction of a non-erodible lining is not practicable.

Check dams should be constructed of four- to six-inch angular rock to a maximum height of two-feet. The center of the top of the dam should be six-inches lower than the sides to concentrate the flow to the channel center. Where multiple check dams are used, the top of the lower dam should be at the same topographical elevation as the toe of the upper dam. Cross-sections of a loose-rock check dam and the spacing between a series of check dams are illustrated on Figure 5-5.

Sediment that collects behind a check dam shall be removed when the sediment reaches the spillway level. Check dams constructed in permanent swales should be removed when perennial grasses have become established, or immediately prior to installation of a non-erodible lining. All of the rock and accumulated sediment should be removed, and the area seeded and mulched, or otherwise stabilized.

5.4 Inlet Protection

All storm sewer inlets which are made operable during construction must be protected to prevent sediment-laden runoff from entering the conveyance system without first being filtered or otherwise treated to remove sediment. A number of alternate inlet protection designs are available for use as shown on Figures 5-8 through 5-12.

Inlets may be temporarily blocked to prevent sediment-laden runoff from entering storm sewers. Inlet protection measures may be removed after upstream disturbed areas are stabilized.

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Table 5-1
Lining Materials for Temporary Channels*

SLOPE RANGE	MAXIMUM FLOW DEPTH	
	1 FT.	3 FT.
0% - 0.005%	Jute Netting	Straw or Wood Fiber Erosion Control Netting or Plastic Membrane
0.005% - 1.0%	Straw or Wood Fiber Erosion Control Netting or Plastic Membrane	Straw or Wood Fiber Erosion Control Netting
1.0% - 2.0%	Straw or Wood Fiber Erosion Control Netting	Type VL Riprap
2.0% - 3.0%	Type VL Riprap	Type L Riprap
3.0% - 4.0%	Type VL Riprap	Type M Riprap

* See Table 5-2 for channel design parameters.

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Table 5-2
Temporary Channel Design Criteria

Manning's "n" Values for Channel Linings		
Lining Material	Flow Depth 0 ft to 1.0 ft	Flow Depth 1.0 ft to 3.0 ft
Plastic Membrane	0.011	0.010
Jute Netting	0.028	n/a
Straw or Curled Wood Mats	0.035	0.025
Riprap, Type VL	0.070	0.035
Riprap, Type L	0.073	0.037
Riprap, Type M	0.075	0.040

NOTES:

Determine flow rates with FIGURE 5-1.

Maximum Depth is 1 foot for flows less than 20 cfs.

Maximum Depth is 3 feet for flows equal to or greater than 20 cfs but less than 100 cfs (flows than 100 cfs should be designed in accordance with the Major Drainage Section of the USDCM).

Determine the channel bottom width by using Manning's Equation and the "n" value given above.

See Table 5-1 in the Major Drainage Section of the USDCM for riprap gradation

Unless structurally reinforced, side slopes shall be two horizontal to one vertical (2:1) or flatter.

Erosion protection should extend to 0.5 feet above the design depth.

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SC

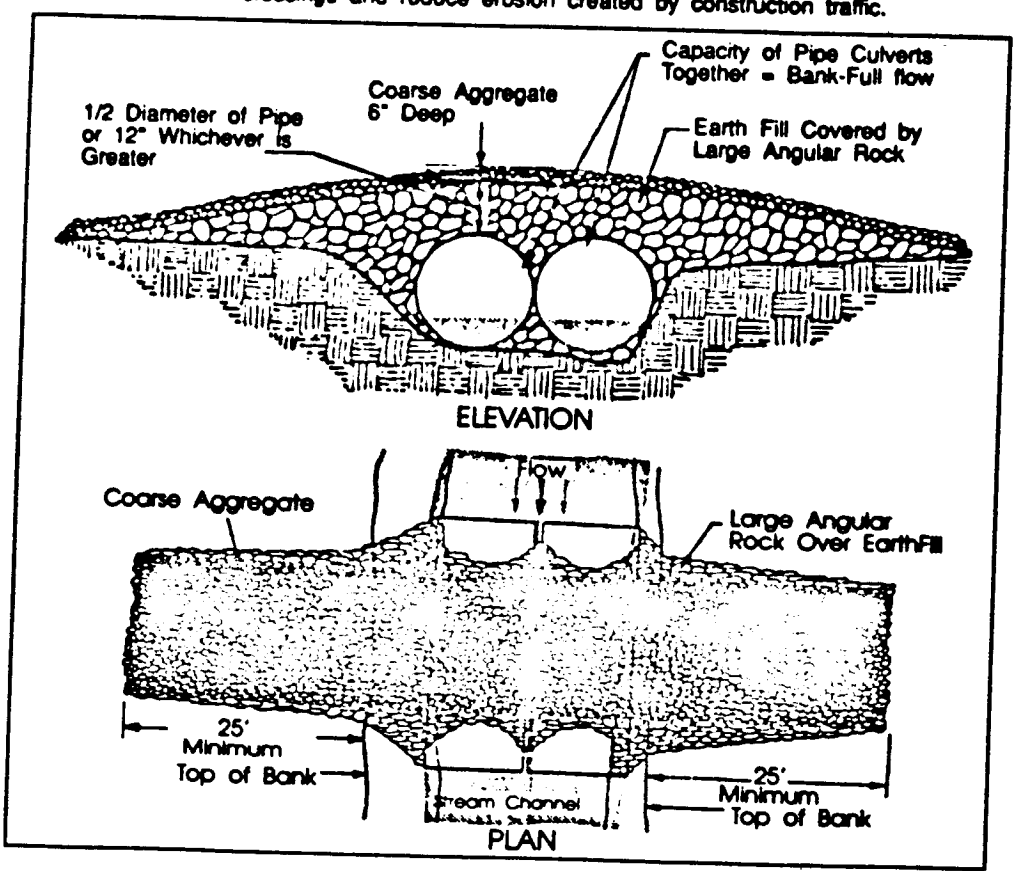
TEMPORARY STREAM CROSSING

Definition

A temporary structural span installed across a flowing watercourse for use by construction traffic. Structures may include bridges, round pipes or pipe arches.

Purposes

To stabilize stream crossings and reduce erosion created by construction traffic.



From: Virginia Soil and Water Conservation Commission, 1985

Figure 5-1 Temporary Culvert Stream Crossing

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SC

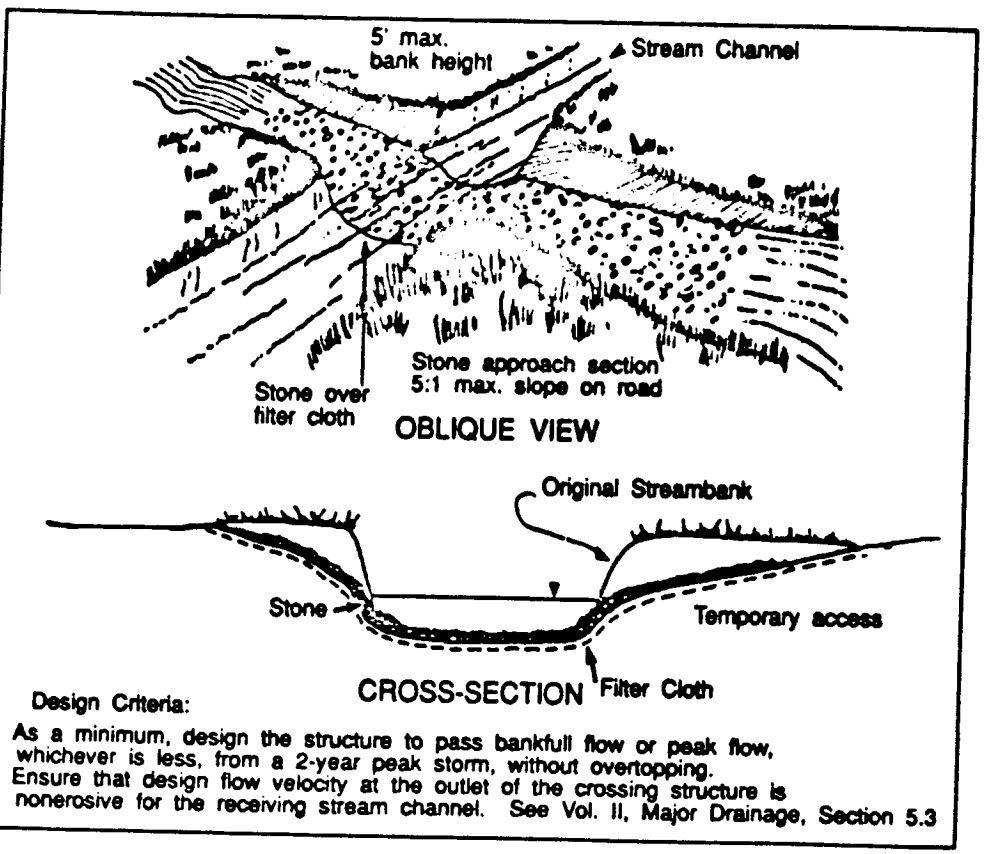
TEMPORARY STREAM CROSSING

Definition

A temporary at-grade stream crossing installed across a normally dry watercourse for use by construction traffic.

Purposes

To stabilize stream crossings and reduce erosion created by construction traffic.



Design Criteria:

- As a minimum, design the structure to pass bankfull flow or peak flow, whichever is less, from a 2-year peak storm, without overtopping.
- Ensure that design flow velocity at the outlet of the crossing structure is nonerosive for the receiving stream channel. See Vol. II, Major Drainage, Section 5.3

From: North Carolina Sediment Control Commission, 1988

Figure 5-2 Typical Ford Stream Crossing

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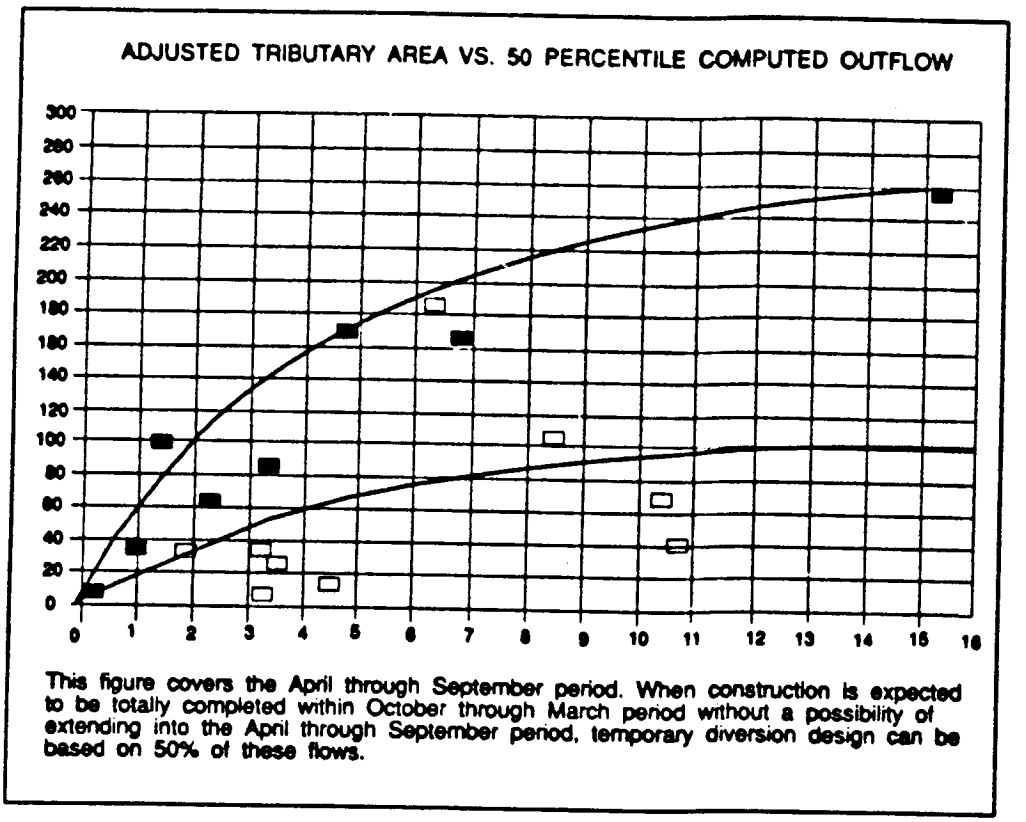

Figure 5-3 Temporary Diversion Facility Sizing Nomograph for Denver Region

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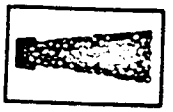


OP

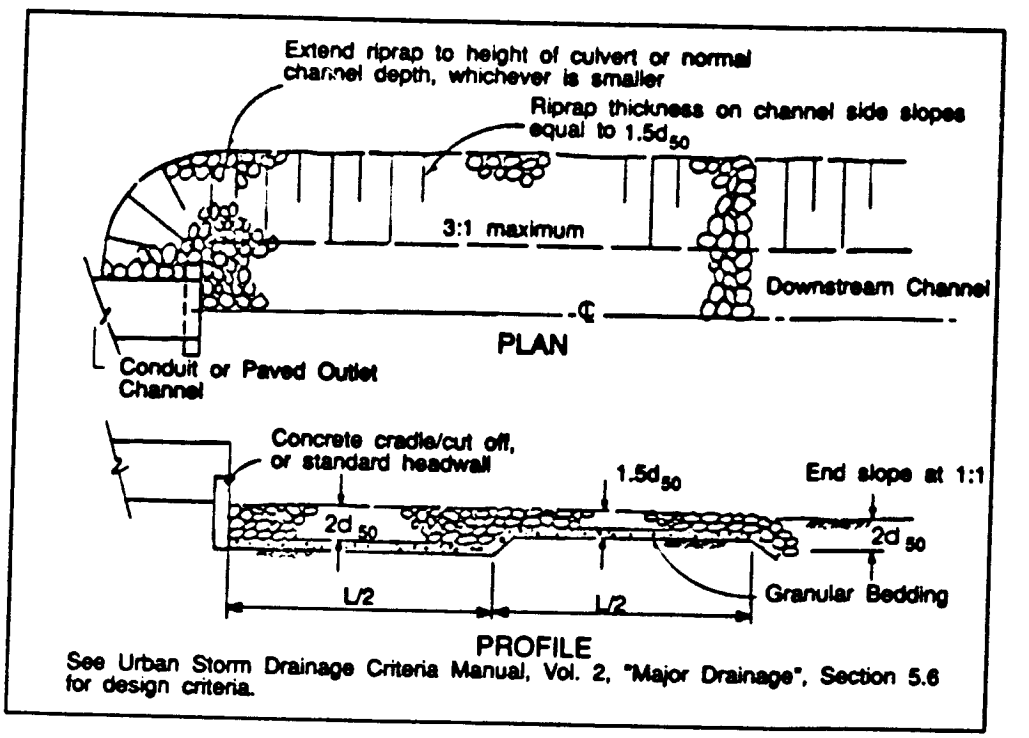
OUTLET PROTECTION

Definition

Structurally lined aprons or other acceptable energy dissipating devices placed at the outlets of pipes or paved channel sections.

Purposes

To prevent scour at stormwater outlets and to minimize the potential for downstream erosion by reducing the velocity of concentrated stormwater flows.



From: Urban Drainage and Flood Control District, 1969

Figure 5-4 Outlet Protection

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CD

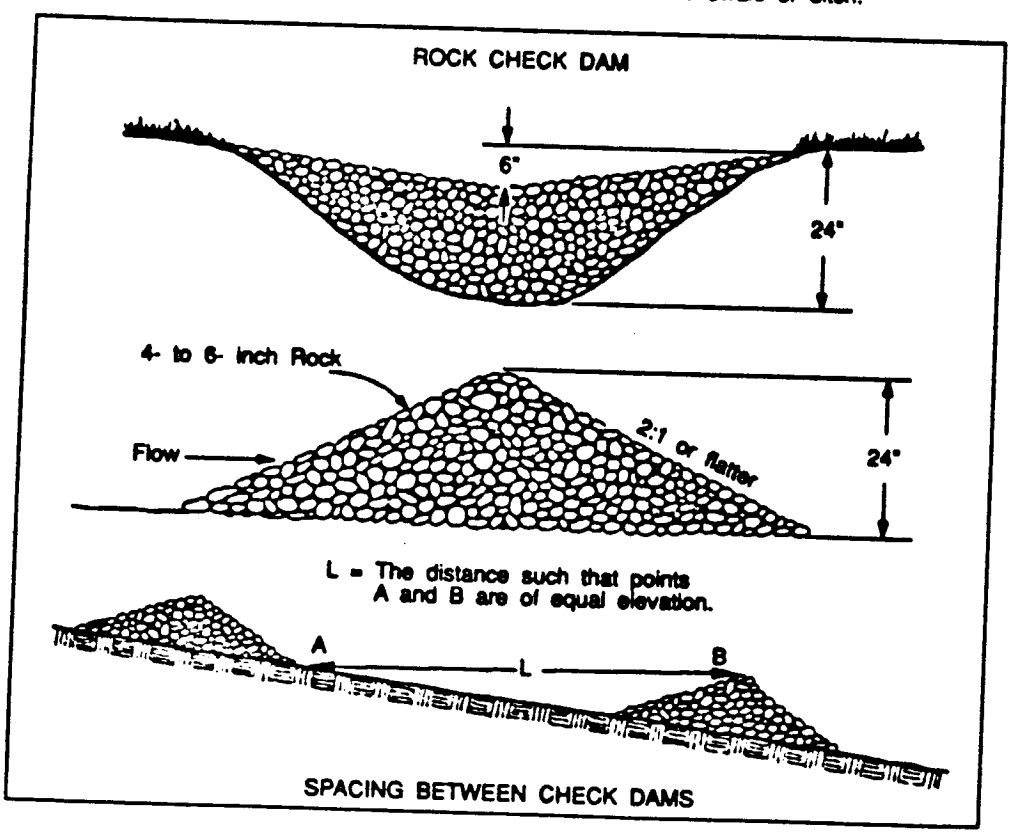
CHECK DAM

Definition

Small temporary dam constructed across a swale or drainage ditch.

Purposes

To reduce the velocity of stormwater flows and erosion of the swale or ditch.



From: Virginia Soil and Water Conservation Commission, 1985

Figure 5-5 Check Dam

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IP

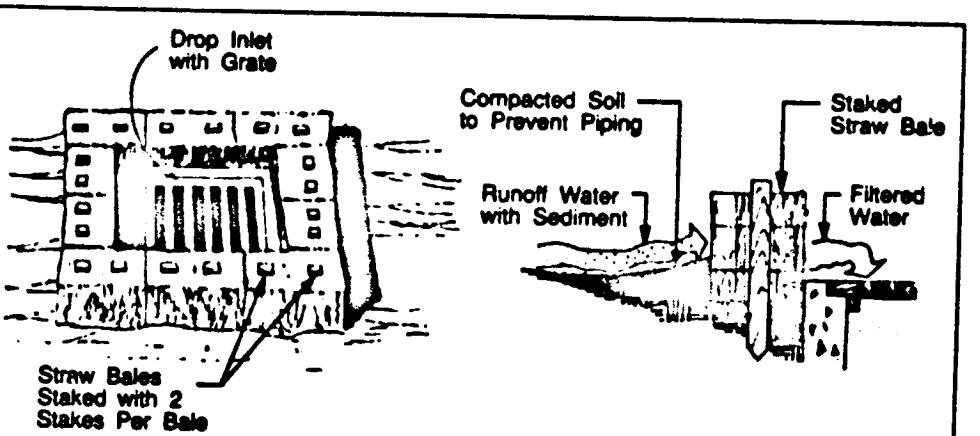
INLET PROTECTION

Definition

A sediment filter or an excavated impounding area around a storm drain drop inlet or curb inlet.

Purposes

To reduce sediment from entering storm drainage systems prior to permanent stabilization of disturbed areas.



Specific Application

This method of inlet protection is applicable where the inlet drains a relatively flat area (slopes no greater than 5 percent) where sheet or overland flows (not exceeding 0.5 cfs) are typical. The method shall not apply to inlets receiving concentrated flows, such as in street or highway medians.

STRAW BALE DROP INLET SEDIMENT FILTER

From: Virginia Soil and Water Conservation Commission, 1985

Figure 5-6 Inlet Protection - Straw Bales

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IP

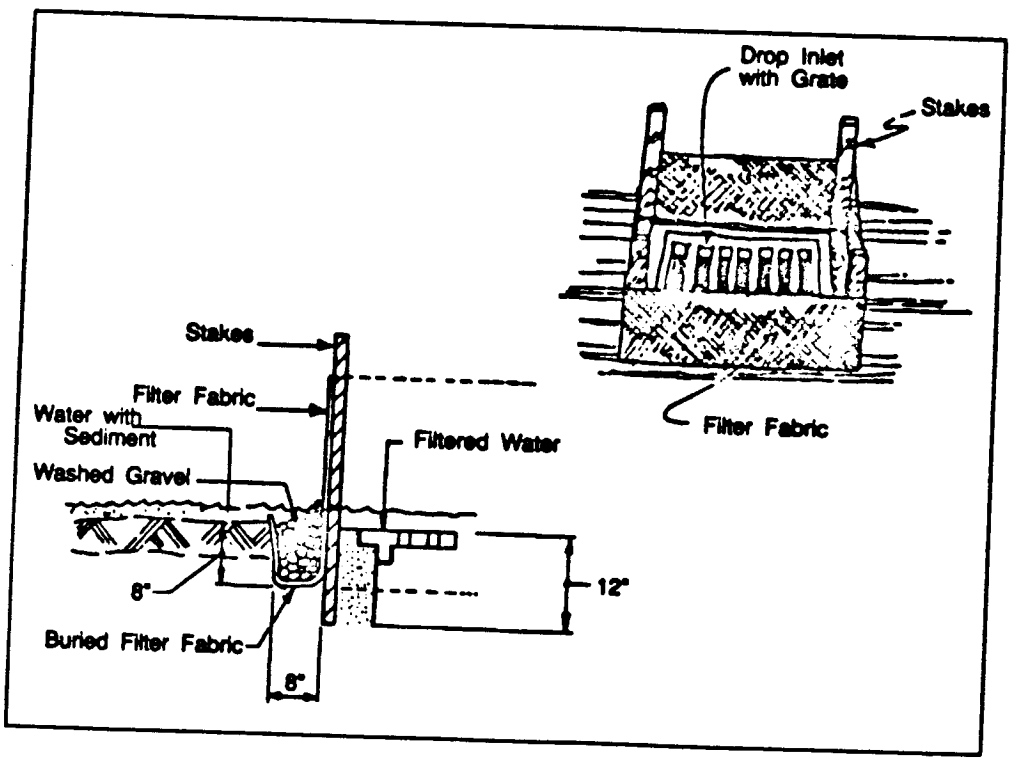
INLET PROTECTION

Definition

A sediment filter or an excavated impounding area around a storm drain drop inlet or curb inlet.

Purposes

To reduce sediment from entering storm drainage systems prior to permanent stabilization of disturbed areas.



From: Washington State Department of Ecology, 1991

Figure 5-7 Inlet Protection - Filter Fabric

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IP

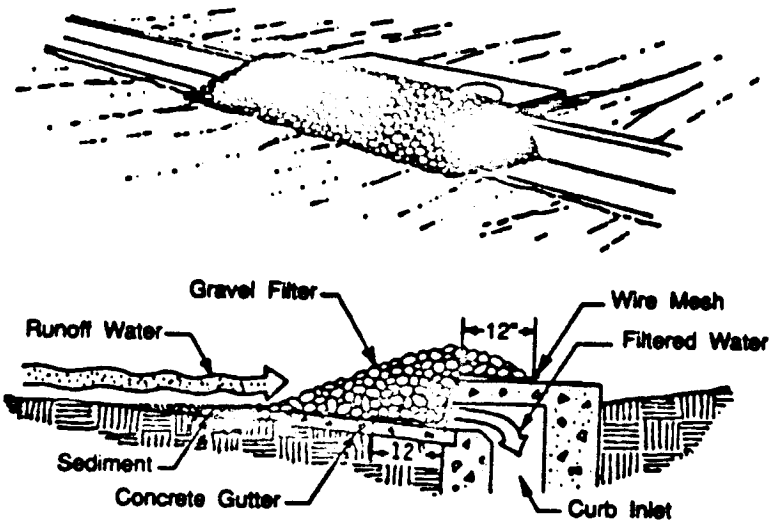
INLET PROTECTION

Definition

A sediment filter or an excavated impounding area around a storm drain drop inlet or curb inlet.

Purposes

To reduce sediment from entering storm drainage systems prior to permanent stabilization of disturbed areas.



Specific Application

This method of inlet protection is applicable at curb inlets where ponding in front of the structure is not likely to cause inconvenience or damage to adjacent structures and unprotected areas.

Note: Alternate design could utilize gravel filled bags.

From: Virginia Soil and Water Conservation Commission, 1985

Figure 5-8 Curb Inlet Protection - Gravel and Wire Mesh Filter

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IP

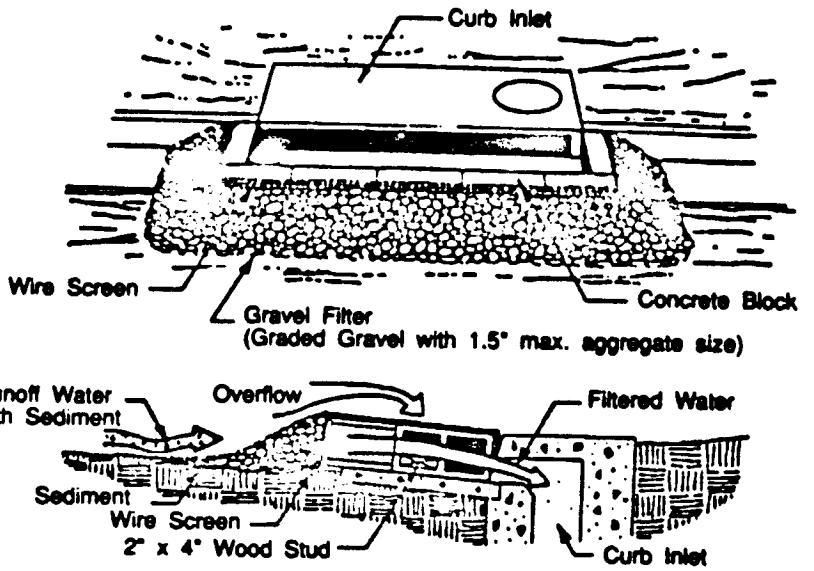
INLET PROTECTION

Definition

A sediment filter or an excavated impounding area around a storm drain drop inlet or curb inlet.

Purposes

To reduce sediment from entering storm drainage systems prior to permanent stabilization of disturbed areas.



Specific Application

This method of inlet protection is applicable at curb inlets where an overflow capability is necessary to prevent excessive ponding in front of the structure.

Note: Alternate design could utilize gravel filled bags.

From: Virginia Soil and Water Conservation Commission, 1985

Figure 5-9 Curb Inlet Protection - Block and Gravel Filter

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IP

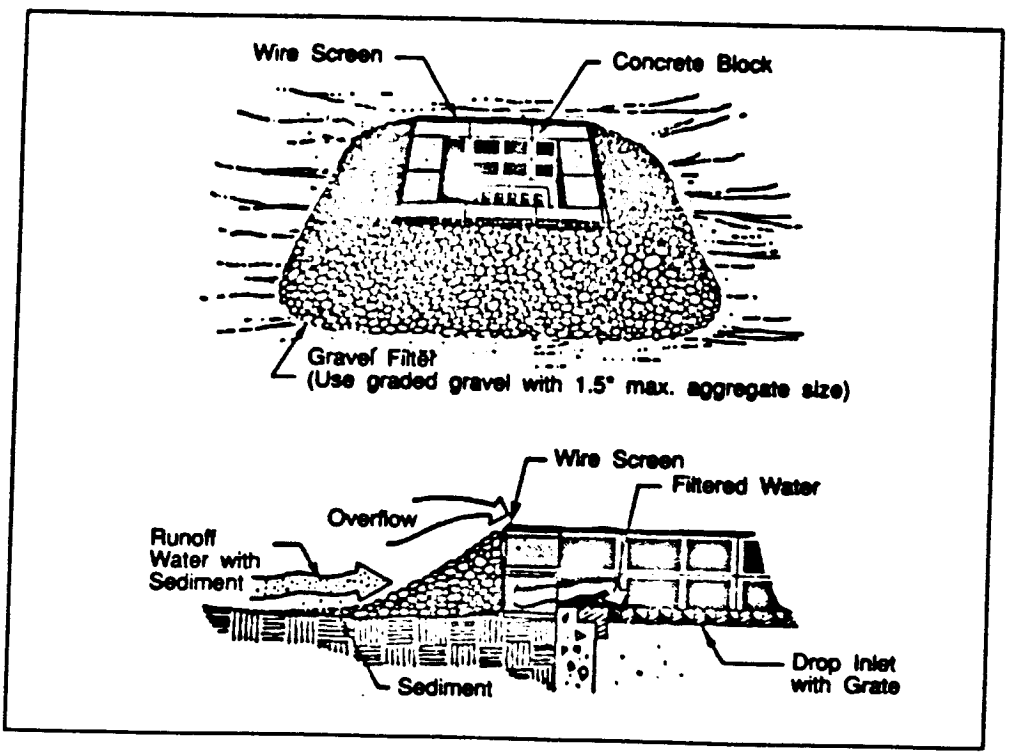
INLET PROTECTION

Definition

A sediment filter or an excavated impounding area around a storm drain drop inlet or curb inlet.

Purposes

To reduce sediment from entering storm drainage systems prior to permanent stabilization of disturbed areas.



From: Virginia Soil and Water Conservation Commission, 1985

Figure 5-10 Drop Inlet Protection - Block and Gravel Filter

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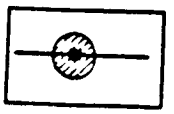


IP

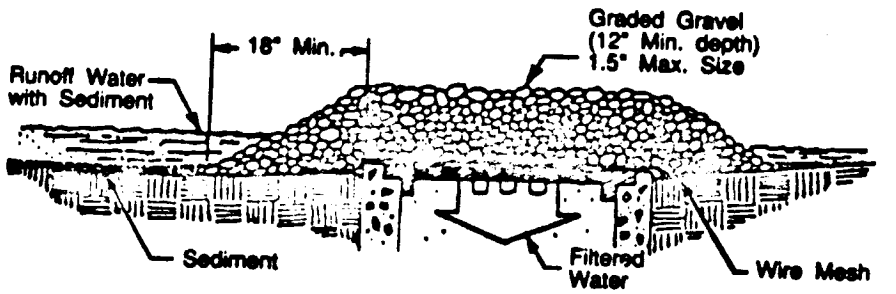
INLET PROTECTION

Definition

A sediment filter or an excavated impounding area around a storm drain drop inlet or curb inlet.

Purposes

To reduce sediment from entering storm drainage systems prior to permanent stabilization of disturbed areas.



Specific Application

This method of inlet protection is applicable where heavy concentrated flows are expected, but not where ponding around the structure might cause excessive inconvenience or damage to adjacent structures and unprotected areas.

Note: Alternate design could utilize gravel-filled bags.

From: Virginia Soil and Water Conservation Commission, 1985

Figure 5-11 Drop Inlet Protection - Gravel and Wire Mesh

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IP

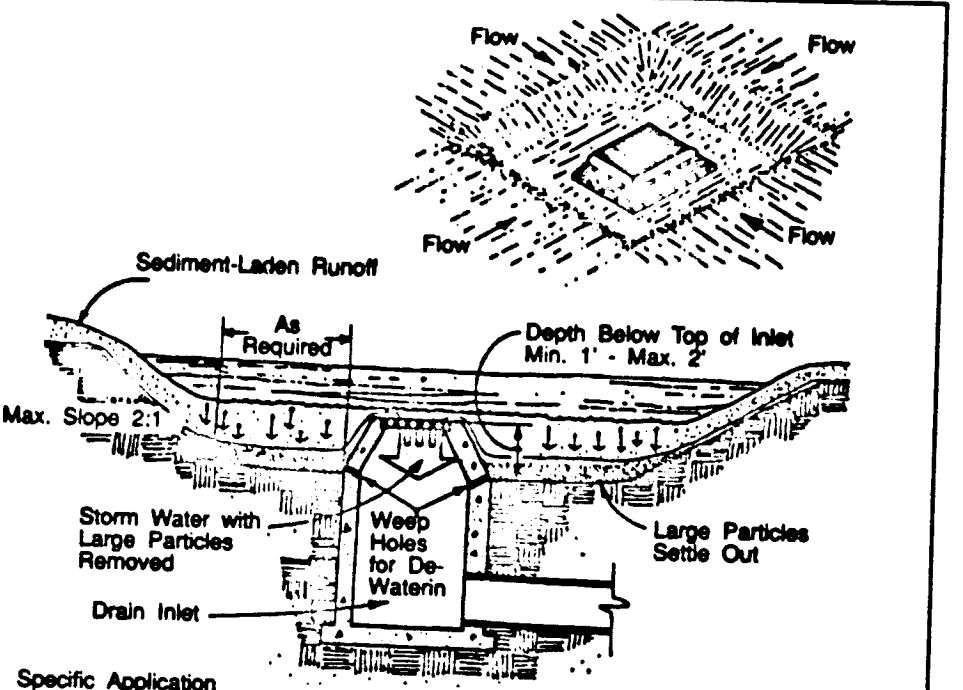
INLET PROTECTION

Definition

A sediment filter or an excavated impounding area around a storm drain drop inlet or curb inlet.

Purposes

To reduce sediment from entering storm drainage system prior to permanent stabilization of disturbed areas.



Specific Application

This method of inlet protection is applicable where heavy flows are expected and where an overflow capability and ease of maintenance are desirable.

From: Virginia Soil and Water Conservation Commission, 1985

Figure 5-12 Inlet Protection - Excavated Drop Inlet Sediment Trap

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6. MATERIAL STORAGE

Materials are sometimes used at a construction site that present a potential for contamination of stormwater runoff. These include fuel, oil, lubricants, paints, solvents, concrete-curing compounds and other liquid chemicals such as fertilizers, herbicides and pesticides. Practices that can be used to prevent or minimize toxic materials in runoff from a construction site are described in this section.

6.1 Chemical and Petroleum Products Storage

Areas at the construction site that are used for storage of toxic materials and petroleum products should be designed with an enclosure, container, or dike located around the perimeter of the storage area to prevent discharge of these materials in runoff from the construction site. These barriers will also function to contain spilled materials from contact with surface runoff.

Measures to prevent spills or leaks of fuel, gear oil, lubricants, antifreeze, and other fluids from construction vehicles and heavy equipment should be considered to protect groundwater and runoff quality. All equipment maintenance should be performed in a designated area and measures, such as drip pans, used to contain petroleum products. Spills of construction-related materials, such as paints, solvents, or other fluids and chemicals, should be cleaned up immediately and disposed of properly.

6.2 Waste Storage

Areas used for collection and temporary storage of solid or liquid waste should be designed to prevent discharge of these materials in runoff from the construction site. Collection sites should be located away from the storm drainage system. Consideration should be given to covering waste storage areas, fencing these areas, if necessary, to contain windblown materials, and construction of a perimeter dike to exclude runoff. These measures may not be necessary if all waste is placed immediately in covered waste containers at the site and is otherwise controlled in an effective manner. All waste should be disposed at an approved landfill.

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8. DISPOSITION OF TEMPORARY MEASURES

All temporary erosion and sediment control measures shall be removed and disposed within 30 days after final site stabilization is achieved, or after the temporary measures are no longer needed, whichever occurs earliest, or as authorized by the city or county of local jurisdiction. For example, a site containing only one building will have temporary erosion control measures removed after building construction is complete and final landscaping is in place. Temporary erosion control measures may be removed from a commercial construction site or residential subdivision only after streets are paved and all areas have achieved final stabilization. Trapped sediment and disturbed soil areas resulting from the disposal of temporary measures must be returned to final plan grades and permanently stabilized to prevent further soil erosion.

The Professional Engineer preparing the erosion and sediment control plan shall submit, as part of the narrative report, a schedule of removal dates for temporary control measures. The schedule should be consistent with key construction items such as street paving, final stabilization of disturbed areas, or installation of structural stormwater controls.

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7. UNDERGROUND UTILITY CONSTRUCTION

The construction of underground utility lines that are not exempted (see Section 1.3.4) shall be subject to the following criteria:

1. No more than 200 feet of trench are to be opened at one time (local criteria may be more restrictive).

2. Where consistent with safety and space considerations, excavated material is to be placed on the uphill side of trenches.

3. Trench dewatering devices must discharge in a manner that will not adversely affect flowing streams, wetlands, drainage systems, or off-site property. Site dewatering permit requirements should be discussed with the Colorado Department of Health.

4. Provide storm sewer inlet protection (Section 5.4) whenever soil erosion from the excavated material has the potential for entering the storm drainage system.

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8. DISPOSITION OF TEMPORARY MEASURES

All temporary erosion and sediment control measures shall be removed and disposed within 30 days after final site stabilization is achieved, or after the temporary measures are no longer needed, whichever occurs earliest, or as authorized by the city or county of local jurisdiction. For example, a site containing only one building will have temporary erosion control measures removed after building construction is complete and final landscaping is in place. Temporary erosion control measures may be removed from a commercial construction site or residential subdivision only after streets are paved and all areas have achieved final stabilization. Trapped sediment and disturbed soil areas resulting from the disposal of temporary measures must be returned to final plan grades and permanently stabilized to prevent further soil erosion.

The Professional Engineer preparing the erosion and sediment control plan shall submit, as part of the narrative report, a schedule of removal dates for temporary control measures. The schedule should be consistent with key construction items such as street paving, final stabilization of disturbed areas, or installation of structural stormwater controls.

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9. MAINTENANCE

All temporary and permanent erosion and sediment control practices shall be maintained and repaired by the owner during the construction phase as needed to assure continued performance of their intended function. Straw bale barriers or silt fences may require periodic replacement and all sediment accumulated behind them must be removed and disposed of properly. Sediment traps and basins will require periodic sediment removal when the design storage level is one-half full. All facilities must be inspected by the owner or owner's representative following each heavy precipitation or snowmelt event that results in runoff.

The Professional Engineer preparing the erosion and sediment control plan shall submit, as part of the narrative report, a schedule of planned maintenance activities for temporary and permanent erosion and sediment control measures. The schedule should be consistent with the level of maintenance required for the control measures proposed in the plan.

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APPENDIX A

MODEL ORDINANCE FOR EROSION AND SEDIMENTATION CONTROL
(Revised August 28, 1991)

AN ORDINANCE TO AMEND THE CODE OF THE CITY (COUNTY) OF _____ BY ADDING A NEW CHAPTER RELATING TO EROSION AND SEDIMENT CONTROL, AND ADOPTING BY REFERENCE THE PUBLISHED CRITERIA FOR "EROSION AND SEDIMENT CONTROL FOR CONSTRUCTION ACTIVITIES" OF THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT, BY ADDING A NEW CHAPTER, WHICH NEW CHAPTER SHALL BE DESIGNATED AS CHAPTER ____ OF TITLE _____ OF SAID CODE.

THE CITY (COUNTY) OF _____, ORDAINS:

Title _____ of the Code of the City (County) of _____, is amended by adding a new Chapter _____ - Grading and Soil Erosion Control, which shall read as follows:

CHAPTER NO.

GRADING AND SOIL EROSION CONTROL

Section 1. Legislative Findings. The City Council (Board of County Commissioners) hereby finds that excessive quantities of soil are eroding from certain areas that are undergoing development for non-agricultural uses such as housing and commercial developments, industrial areas, recreational facilities, and roads. This erosion makes necessary costly repairs to gullies, washed out fills, roads and embankments. The resulting sediment clogs storm sewers and road ditches, and leaves deposits of silt in streams, lakes and reservoirs and is considered a significant water pollutant.

Section 2. Purposes. The purpose of this Ordinance (Resolution) is to prevent soil erosion and sedimentation from leaving construction sites that occur from non-agricultural development and construction activities within the City (County) by requiring proper provisions for water disposal and the protection of soil surfaces during and after construction, in order to promote the safety, public health, convenience and general welfare of the community (County).

Any person who undertakes or is responsible for an undertaking which involves earth disturbance is ultimately responsible to see that soil erosion and sedimentation as well as changed water flow characteristics resulting therefrom are controlled to the extent necessary to avoid damage to property and to avoid pollution of receiving waters. Nothing in this Ordinance (Resolution) shall be taken or construed as lessening or modifying the ultimate responsibility of such persons. Nor do the permit requirements of this Ordinance (Resolution) imply the assumption of any liability therefor on the part of the City (County). The standards, criteria and requirements of this Ordinance (Resolution) are to be seen as minimum standards which are not necessarily adequate to meet the highly variable conditions which must be covered by effective control measures. Compliance with the requirements of this Ordinance (Resolution) may not, therefore, of itself discharge such person's responsibility to provide effective control measures.

Section 3. Definitions. The following definitions shall apply in the interpretation and enforcement of this Chapter.

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(1) "Accelerated soil erosion" - The increased migration and movement of soils on all land surfaces that occur as a result of man's activities.

(2) "Inspector" - The chief of the _____ Department (insert department title) of the City (County) or his duly authorized representative.

(3) "Certificate of completion" - A signed written statement by a licensed professional engineer working for the applicant stating that all construction, all earth disturbance work, and all permanent soil erosion control measures were inspected by the engineer and were installed in strict compliance with the approved plans and specifications.

(4) "City (County) Engineer" - The City (County) Engineer of the City (County) or his duly authorized representative.

(5) "Earth disturbance" - A man-made change in the natural cover or topography of land, including all grading, cut and fill, building, paving and other activities, which may result in or contribute to soil erosion or sedimentation of the waters of the State.

(6) "Erosion" - The process by which the ground surface is worn away by action of wind, water, gravity, or a combination thereof.

(7) "Excavation" - Any act by which soil or rock is cut into, dug, quarried, uncovered, removed, displaced, relocated, or stockpiled, and also included shall be the conditions resulting therefrom.

(8) "Filling" - Any act by which soil, rock or other construction materials are placed, stockpiled, dumped, or a combination thereof onto the surface of the earth that may exposed to rain or wind.

(9) "Flood plain" - An area adjacent to a watercourse, which area is subject to flooding as the result of the occurrence of the 100-year flood and which area thus is so adverse to past, current, or foreseeable construction or land use as to constitute a significant hazard to public health and safety or property.

(10) "Grading" - Any stripping, excavating, filling, stockpiling, or any combination thereof, and also included shall be the land in its excavated or filled condition.

(11) "Grading permit" - A permit issued to authorize work to be performed under this Ordinance.

(12) "Land use" - A use of land which may result in an earth disturbance, including, but not limited to, subdivision, residential, commercial, industrial, recreational, or other development, private and public highway, road and street construction, drainage construction, logging operations, agricultural practices, and mining.

(13) "Limits of allowable erosion" - The natural or historic rate of soil loss.

(14) "Permanent soil erosion control measures" - Those control measures which are installed or constructed to control soil erosion and which are maintained after completion of all grading and earth disturbance activities.

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(15) "Person" - A natural person, firm, corporation, partnership, or association.

(16) "Slope" - Slope of land measured in horizontal distance necessary for the land to fall or rise one foot, expressed by horizontal distance in feet to one vertical foot.

(17) "Stripping" - Any activity which removes or significantly disturbs the vegetative surface cover including clearing and grubbing operations.

(18) "Temporary soil erosion control measures" - Interim control measures which are installed or constructed and maintained whenever grading or other earth disturbance is to occur for the purpose of control soil erosion until permanent soil erosion control is effected.

Section 4. Compliance with Chapter Required for Site Plan or Plat Approval. No site plan, plot plan, or plat shall be approved under Chapters _____ and _____ of this Code unless said site plan, plot plan, or plat shall include soil erosion and sediment control measures consistent with the requirements of this Chapter and related land development regulations.

Section 5. Compliance with Chapter Required for Occupancy. No certificate of occupancy for any building shall be issued under Chapter _____ of this Code unless the applicant for said Certificate of Occupancy submits a Certificate of Completion to the City (County) and said Certificate of Completion is approved by the City (County) Engineer.

Section 6. Adoption by reference of Erosion and Sediment Control Criteria. There is hereby adopted by reference, as a part of this ordinance (resolution), as if fully set forth herein, that certain code consisting of the published criteria of The Urban Drainage and Flood Control District, adopted by said District on _____ 1991, effective on the _____ day of _____, 1991, known as "Erosion and Sediment Control for Construction Activities," published on _____, 1991, which shall be known and referred to in this ordinance (resolution) by that name. The Inspector and the City (County) Engineer shall be guided by and shall apply the criteria contained in said code in the administration of this ordinance (resolution).

Section 7. Permits and Fees.

(1) Permit requirement. Except as exempted by sections of this ordinance (resolution), no person shall do any grading, stripping, excavating, or filling, or undertake any earth disturbance, unless a valid grading permit is issued by the City (County). Issuance by City (County) does not exempt the parties from obtaining any permits required by State of Colorado or the Federal Government.

(2) Permit application. A separate application shall be required for each grading permit, along with plans, specifications, and timing schedules for all earth disturbance. The plans shall be prepared under the supervision of a professional engineer licensed in the State of Colorado experienced in soil erosion and sedimentation control methods and techniques.

(3) Application data required. The plans and specifications shall include an Erosion and Sedimentation Control Plan and a Site Plan, which shall include and contain all of the requirements of Section 1.4 of the "Erosion and Sediment Control for Construction Activities".

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(4) Fees. At the time of filing an application for a grading permit, a non-refundable filing fee of _____ Dollars $_____ shall be paid to the City (County) Treasurer. An additional non-refundable fee of _____ Dollars per acre of site area involved will be charged for plan review and site inspections (with a minimum fee of _____ Dollars $_____ for such review and inspection).

Section 8. Bond Requirement. A grading permit shall not be issued unless the permittee shall first post with the City (County) Engineer a bond executed by the landowner and a corporate surety with authority to do business in this State as a surety, or at the option of the City (County) Engineer, secured by a letter of credit drawn upon a bank doing business in Colorado, or having a Colorado correspondent bank at which such letter of credit may be collected.

The bond and letter of credit, whichever is used, shall be in a form approved by the City (County) Attorney, payable to the City (County), and in the amount of the estimated total cost of all temporary or permanent soil erosion control measures. The total cost shall be estimated by the City (County) Engineer or Building Inspector. The bond, and letter of credit, whichever is used, shall include penalty provisions for failure to complete the work on schedule as specified on the grading permit. In lieu of a surety bond or letter of credit, the applicant may file with the City (County) a cash bond or other instrument of credit which gives the City (County) at least equal security protection, approved by the City (County) Attorney in the amount equal to that which would be provided for in the surety bond or letter of credit.

Every bond and letter of credit or other instrument of credit shall include and every cash deposit shall be made on the conditions that the permittee shall comply with all of the provisions of this ordinance (resolution) and all of the terms and conditions of the grading permit, and shall complete all of the work contemplated under the grading permit within the time limit specified in the grading permit, or if no time limit is specified, within 180 days after the date of issuance of the grading permit.

A bond and surety thereon, or letter of credit, whichever is used, will be released to applicant four hundred ten (410) days after the Certificate of Completion has been approved by the City (County) Engineer, provided the City (County) Engineer, after field inspection, is satisfied the work completed under the grading permit is functioning as represented by applicant, or in the event defects are identified by the City (County) Engineer the applicant satisfactorily corrects all the defects identified in writing by the City (County) Engineer and said corrections are accepted in writing by the City (County) Engineer.

Section 9. Extension of Time. If the permittee is unable to complete the work within the specified time, at least ten (10) days prior to the expiration of the permit, a written request to the City (County) Engineer for an extension of time shall be submitted setting forth the reasons for the requested extension. In the event such an extension is warranted, the City (County) Engineer may grant additional time for the completion of the work, but no such extension shall release the owner or surety on the bond or the issuer of the letter of credit, or the person furnishing the instrument of credit or cash bond.

Section 10. Failure to Complete the Work. In the event of failure to complete the work or failure to comply with all the requirements, conditions, and terms of permit, the City (County) Engineer may order such work as is necessary to eliminate any danger to persons or property and to leave the site in a safe condition and he may authorize completion of all necessary temporary or

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permanent soil erosion control measures. The permittee and the surety executing the bond or the issuer of the letter of credit, or person issuing the instrument of credit or making the cash deposit shall continue to be firmly bound under a continuing obligation for the payment of all necessary costs and expenses that may be incurred or expended by the City (County) in causing any and all such work to be done. In the case of a cash deposit, any unused portion thereof shall be refunded to the permittee.

Section 11. Denial of Permit. Grading permits shall not be issued where:

(1) The proposed work would cause hazards to the public safety and welfare; or

(2) The work as proposed by the applicant will damage any public or private property or interfere with any existing drainage course in such a manner as to cause damage to any adjacent property or result in the deposition of debris or sediment on any public way or into any waterway or create an unreasonable hazard to persons or property; or

(3) The land area for which grading is proposed is subject to geological hazard to the extent that no reasonable amount of corrective work can eliminate or sufficiently reduce settlement, slope instability, or any other such hazard to persons or property; or

(4) The land area on which the grading is proposed may lie within the designated flood plain of any stream or watercourse (not specifically designated by the City (County) as an area subject to flood hazard), unless a hydrologic report, prepared by a professional engineer, is submitted to certify that the proposed grading will have, in his professional opinion, no detrimental influence on the public welfare or upon the total development of the watershed and is also consistent with flood plain ordinances and Federal Emergency Management Agency regulations.

Section 12. Modifications of Approved Plans. All proposed modifications of the approved grading plan must be submitted along with all supporting materials, to the City (County) Engineer. No work in connection with the proposed modifications shall be permitted without prior approval of the City (County) Engineer, approval for which may be issued if the applicant can demonstrate that the modifications will provide soil erosion controls equivalent to, or better that the originally approved soil disturbance plans.

Section 13. Responsibility of Permittee. During grading operations the permittee shall be responsible for:

(1) The prevention of damage to any public utilities or services within the limits or grading and along any routes of travel of the equipment;

(2) The prevention of damage to adjacent property (No person shall grade on land so close to the property line as to endanger any adjoining public street, sidewalk, alley, or any public or private property without supporting and protecting such property from settling, cracking, or other damage which might result).

(3) Carrying out the proposed work in accordance with the approved plans and in compliance with all the requirements of the permit and this ordinance (resolution);

(4) The prompt removal of all soil, miscellaneous debris, materials applied, dumped, or otherwise deposited on public streets, highways, sidewalks, or other public

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thoroughfares or any other non-authorized offsite location, during transit to and from the construction site, or otherwise, where such spillage constitutes a public nuisance, trespass or hazard in the determination of the City (County) Engineer or a Court of competent jurisdiction.

Section 14. General Requirements.

(1) All temporary erosion control facilities and all permanent facilities intended to control erosion of any earth disturbance operation shall be installed before any earth disturbance operations take place.

(2) Any earth disturbances shall be conducted in such a manner so as to effectively reduce accelerated soil erosion and resulting sedimentation, and should not exceed the erosion expected to occur for the site in is totally undeveloped state.

(3) All persons engaged in earth disturbances shall design, implement, and maintain acceptable soil erosion and sedimentation control measures, in conformance with the erosion control technical standards adopted by the City.

(4) All earth disturbances shall be designed, constructed and completed in such a manner so that the exposed area of any disturbed land shall be limited to the shortest possible period of time.

(5) Sediment cause by accelerated soil erosion shall be removed from runoff water before it leaves the site of the earth disturbance.

(6) Any temporary or permanent facility designed and constructed for the conveyance of water around, through, or from the earth disturbance area shall be designed to limit the water flow to a non-erosive velocity.

(7) Temporary soil erosion control facilities shall be removed and earth disturbance areas graded and stabilized with permanent soil erosion control measures pursuant to standards and specifications prescribed in accordance with the provisions of the "Erosion and Sediment Control for Construction Activities" and in accordance with the permanent erosion control features shown on the soil stabilization plan approved by the City (County).

(8) Permanent soil erosion control measures for all slopes, channels, ditches, or any disturbed land area shall be completed within fourteen (14) calendar days after final grading or the final earth disturbance has been completed. When it is not possible to permanently stabilize a disturbed area after an earth disturbance has been completed or where significant earth disturbance activity ceases, temporary soil erosion control measures shall be implemented within fourteen (14) calendar days. All temporary soil erosion control measures shall be maintained until permanent soil erosion measures are implemented.

Section 15. Maintenance Requirements. Persons carrying out soil erosion and sediment control measures under this Chapter, and all subsequent owners of property concerning which such measures have been taken, shall maintain all permanent erosion control measures, retaining wall, structures, plantings, and other protective devices. Should the applicant or any of the subsequent property owners fail to adequately maintain the permanent erosion control facilities, retaining walls,

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structures, plantings, and other protective devices, the City (County) reserves the authority, after properly notifying the owner of needed maintenance and the owner failing to respond to the City's (County's) demand for such maintenance to enter affected property, provide needed maintenance and to charge the owner for the work performed by the City (County) or its contractors.

Section 16. Minimum Design Standards for Erosion and Sediment Control. All erosion control plans and specifications including extensions of previously approved plans shall include provisions for erosion and sediment control in accordance with the "Erosion and Sediment Control for Construction Activities". Erosion control plans are required on sites which are:

(1) Five (5) acres in size or larger, and all sites smaller than five (5) acres if they are a part of a total development or subdivision that is larger than five (5) acres in size; or

(2) Any development containing 15 dwelling units; or

(3) Where physical features have a cumulative effect and will create erosion problems such as:

a. Steep slopes - 8-feet (horizontal) to 1-foot (vertical) or steeper, and

b. Significantly erodible soils - "K" in the universal soil loss equation is greater than or equal to 0.25;

Section 17. Variances and Exceptions.

(1) No permits shall be required for the following:

(a) Agricultural use of land zoned agricultural.

(b) Grading or an excavation below finished grade for basements, footings, retaining walls, or other structures on plots zoned R1 - R3 of less than five (5) acres in size unless required otherwise under Section 16 above.

(c) A sidewalk or driveway authorized by a valid permit under Chapters _____ of _____.

(d) Gravel, sand, dirt or topsoil removal as authorized pursuant to approval of the Colorado Mined Land Reclamation Board, provided said approval includes an erosion plan that meets the minimums specified by this ordinance.

(e) Sites smaller than five (5) acres which are not a part of a larger development and which constitute an infill of an established older development within the City.

(f) Where the City (County) Engineer certifies in writing that the planned work and the final structures or topographical changes will not result in or contribute to soil erosion or sedimentation and will not interfere with any existing drainage course in such a manner as to cause damage to any adjacent property or result in the deposition of debris or sediment on any public way, will not present any hazard to any persons or property and will have no detrimental influence upon the public welfare or upon the total development of the watershed.

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(g) Even though no permits are required under subsections (1)(a), (b), (c), (d), and (e) of this section, those operations and construction activities which are exempted from obtaining permits must comply with the rules and regulations concerning grading and erosion specified in this Chapter, and shall provide appropriate controls to retain soil erosion on the construction site.

(2) Where it is alleged that there is error or misinterpretation in any order, requirements, decisions, grant or refusal made by the City (County) Engineer, the (chose as appropriate: Deputy City Manager, Manager of Public Works, Public Works Director, County Manager, Chairman of the Board of County Commissioners) may appoint a technical hearing board that shall have the power to hear specific applications and all complaints regarding the decisions of the City (County) Engineer and to determine if the decisions of the City (County) Engineer were based on a misinterpretation of the requirements of this Chapter and referenced criteria. Whenever it is determined that an interpretation error was made, the case will be returned to City (County) Engineer, along with the board's recommendations on how the Engineer's decision could be modified to made consistent with the provisions of this Chapter.

• *In absence of this, or another similar appeals process, resort directly to court would be the only remedy, which may not be desired as a matter of policy. If such policy is desired, however, it is suggested it be spelled out by substituting for (2) above, the following, or a similar subsection:*

(2) Review of any order, requirement, decision, grant or refusal made by the City (County) Engineer, and claimed to be illegal, shall be by the District Court pursuant to the Colorado Rules of Civil Procedure.

Section 18. Inspection. The requirements of this Chapter shall be enforced by the City (County) Engineer. The City (County) Engineer shall inspect the work and shall require the owner to obtain services to provide adequate on-site inspection and/or compaction testing by a soil engineer, approved by the City (County) Engineer, unless he determines that such inspection requirements may be waived due to the non-hazardous nature of the grading.

Upon satisfactory execution of all approved grading plans and other requirements, the City (County) Engineer shall issue a certification of completion. If the City (County) Engineer finds any existing conditions not as stated in any application, grading permit or approved plan, he may refuse to approve further work until a revised grading plan which will conform to the existing condition has been prepared and approved.

If the City (County) Engineer finds that eroded soils are leaving the construction site, the City (County) Engineer may direct the owner(s) or his agents or his contractor on the site by written order to install any and all erosion controls that are deemed necessary to prevent said soil erosion from migrating off site. It shall be the duty of the owner(s) and his agent(s) and contractor(s) immediately to take all necessary steps to comply with such order and otherwise to take all necessary steps to prevent such migration off premises or entering receiving waters. Delivery of such a written order by the City (County) Engineer to the owner's agent or contractor shall be deemend to be notice thereof to and binding upon the owner.

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Section 19. Enforcement. Notwithstanding the existence or pursuit of any other remedy, the City (County) may maintain an action in its own name in any court of competent jurisdiction for an injunction or other process against any person to restrain or prevent violations of this ordinance (resolution).

The City (County) Engineer, or his duly authorized agents, may enter at all reasonable times in, or upon, any private or public property for the purpose of inspecting and investigating conditions and practices which may be a violation of this ordinance (resolution).

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APPENDIX B

EXAMPLE EROSION AND SEDIMENT CONTROL PLAN

PREPARED FOR:

C.D. DEVELOPMENT INC.
1234 A STREET
DENVER, COLORADO 80200
PHONE (303)555-0000

PREPARED BY:

ESC CONSULTANTS, INC.
43560 SQUARE FEET STREET
SUITE 640
DENVER, COLORADO 80200
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SEPTEMBER, 1992

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9-1-92
Urban Drainage and Flood Control District

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I. Introduction

Name, Address and Telephone Number

Owner:

C.D. DEVELOPMENT INC.
1234 A STREET
DENVER, COLORADO 80200
PHONE (303)555-0000

Erosion Control Consultant

ESC CONSULTANTS, INC.
43560 SQUARE FEET STREET
SUITE 640
DENVER, COLORADO 80200
PHONE: (303) 555-1212

Project Description

The Project consists of the development of a 6.2 acre parcel with two office buildings. The project is located in the SW quarter of Section #, Township, Range of the 6th principal meridian located in County, Colorado. The project involves grading of 5.2 acres of the parcel, constructing two office buildings, two parking lots, an access road, a box culvert over Dry Creek and associated site utilities.

Existing Site Conditions

Most of the existing site is vegetated with native grass. The plant density is estimated to be 50% coverage of the ground surface. Cottonwood trees and other riparian vegetation are found adjacent to Dry Creek. The site drains to Dry Creek except the southeast portion which drains offsite to the southeast. About 0.2 acres of wetlands are found next to Dry Creek. The riparian and wetland vegetation will not be disturbed by the site development. The existing slopes on the site range from 2% to 19% adjacent to the Creek.

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Adjacent Areas

Surrounding development consists of office and commercial development. The site is bounded by Broadway and Monroe Streets. Dry Creek bisects the site. The proposed improvements to Dry Creek are limited to a box culvert and preservation of the 100-year floodplain (Refer to the Drainage Report for the Site).

Soils

Existing site soils consists of Ascalon sandy loam and Nunn sandy clay loam on the uplands and alluvial soils next to Dry Creek. Ascalon sandy loam is well drained with moderate permeability (Hydrologic soil group B) and has a slight erosion hazard. Nunn sandy clay loam is well drained with moderately slow permeability (Hydrologic soil group C) and presents a moderate erosion hazard. The alluvial soils adjacent to the Creek will not be disturbed.

II. Erosion and Sediment Control Plan

Volumes and Areas Impacted

The site will be graded with topsoil stripped and stockpiled. The total quantity of cut and fill is 3,500 cubic yards. The cut and fill is balanced, that is, no fill will be imported to the site. The access road, building site and parking areas will be graded, then covered with granular base course. Other graded areas will be mulched until permanent landscaping is installed.

Erosion and Sediment Control Measures

The erosion control measures for the site are shown on the "Sample Erosion and Sedimentation Control Plan." (Note: Proposed contours are not shown on this example plan for clarity; however, proposed contours are required to be shown on the site plan.) Offsite drainage from the north is diverted to the east along Broadway Avenue. Offsite drainage from the west is diverted to the south along Monroe Road. The area southeast of the proposed parking lot for Building "B" drains offsite. This area will remain undisturbed and will be protected with a silt fence. A stabilized construction entrance will be provided at the access point off Monroe Road. Diversion channels will be constructed near Dry Creek to collect runoff from the building areas and route flows to sediment traps. Each sediment trap collects runoff from 2.0 acres and will be excavated below grade. The sediment traps will be about 30 feet square and about two feet deep (show details) below the outlet. Sediment traps will have a surcharge volume of 1,800 cubic feet above the outlet. Straw

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bale barriers will be anchored next to the creek for the areas where runoff is not intercepted by the diversion channels.

Schedule

The construction schedule is as follows:

Install Construction Entrance, Sediment traps and Straw Bale Barriers:	September 15 - September 30
Site Grading:	September 30 - October 15
Install Base Course and Mulch All Exposed Soil Areas:	October 15 - October 20
Utility and Building Construction:	October 20 - April 1
Paving and Landscaping:	April 1 - April 15
Removal of Erosion Control Measures:	April 15 - April 20

The schedule will minimize the exposure of unprotected areas to less than 30 days. The perimeter controls will be installed prior to site grading.

Permanent Stabilization Measures

Permanent landscaping will include bluegrass sod, zeriscape plantings and trees and shrubs. The two sediment traps will be converted to the site detention ponds after sod is installed (Refer to the site Drainage Report for the detention requirements). The box culvert will be constructed early in the construction period to provide access across the creek during construction.

Stormwater Management Considerations

Stormwater will sheet flow from the building areas towards the creek, then be intercepted and routed to sediment traps during construction. All areas that will not be intercepted by the diversions will be protected with straw bale barriers. Post-development stormwater quality control will be provided by the vegetated filter strip adjacent to Dry Creek.

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Construction Materials and Equipment

The contractor shall store all construction materials and equipment and shall provide maintenance and fueling of equipment in confined areas on site from which runoff will be contained and filtered.

Maintenance

The erosion control measures will be inspected weekly during construction. Sediment traps will be cleaned of excessive sediment if necessary. Erosion control blankets in the diversion channels will be checked after runoff events. Straw bale barriers will be checked for undermining and bypass and repaired or expanded as needed. Mulching of bare soils will be checked regularly and areas where it was lost or damage will be remulched within seven working days when needed.

Cost Estimate

The estimated cost of the erosion control measures is $7,320. A total of 780 linear feet of silt fences and straw bale barriers will be constructed at an estimated cost of $4.00 per foot. The two sediment traps involve excavation at a cost of $250 each. The diversion channels will be lined with a coconut fiber blanket at an estimated cost for grading and the blanket of $7.50 per linear foot for the 400 linear feet to be installed. The construction entrance will require 10 cubic yards of material at $10 per cubic yard. Site mulching and it maintenance prior to final revegetation is estimated to cost $500,000.

Calculations

Calculations for the diversion channels and sediment traps are provided herein. Details for the erosion control measures can be found in Figures 3-2, 3-3, 3-4, 4-1, 4-2, 4-5, 4-6 and 4-7 of the *Erosion Control Chapter* of Volume 3 of the *Urban Storm Drainage Criteria Manual*. (The figures are not included with this example to save space but shall be included with the erosion and sediment control plans submitted to the local jurisdiction.)

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Slope Diversion Channel Sizing:

$Q = C I A$

$C = 0.2$ (From Table 3-1, USDCM, Runoff)

(Weighted average of undeveloped and parking areas.)

$I_{2\text{-}yr} = 2.6$"/hour (From Fig. 5-1, USDCM, Rainfall)

$A = 2.0$ acres each

$Q = 0.2 \times 2.6 \times 2.0 = 1.04$ cfs

Try a triangular channel with depth of 0.5 ft and four to one sideslopes. (Actual depth will be 1.0 ft. allowing 0.5 ft. as freeboard.)

Proposed Slope = 0.75%

$A = 1$ ft^2, $P = 4.47$ ft. $R = 0.224$ ft.

Use a fiber blanket for erosion control.

$n = 0.035$

from Manning's Equation:

$V = 1.486/0.035 \times (.0075)^{1/2} = 1.35$ feet per second

$Q = A V = 1.35$ cfs

(more than 1.04 so this channel section is acceptable)

Check Erosion potential:

$t = g d s$ (Shear Stress Formula)

$t = 62.4 \times 0.5 \times 0.0075 = 0.23$ lb/ft^2

from HEC-15, $t_{allowable} = 0.65$ lb/ft^2

t_{actual} is less than $t_{allowable}$ so the diversions should be stable.

Sediment Traps

Tributary Area = 2.0 acres

Required Volume = 900 ft^3/acre x 2.0 acres = 1,800 ft^3

Use a 30 ft. x 30 ft. x 2.0 ft. deep sediment trap

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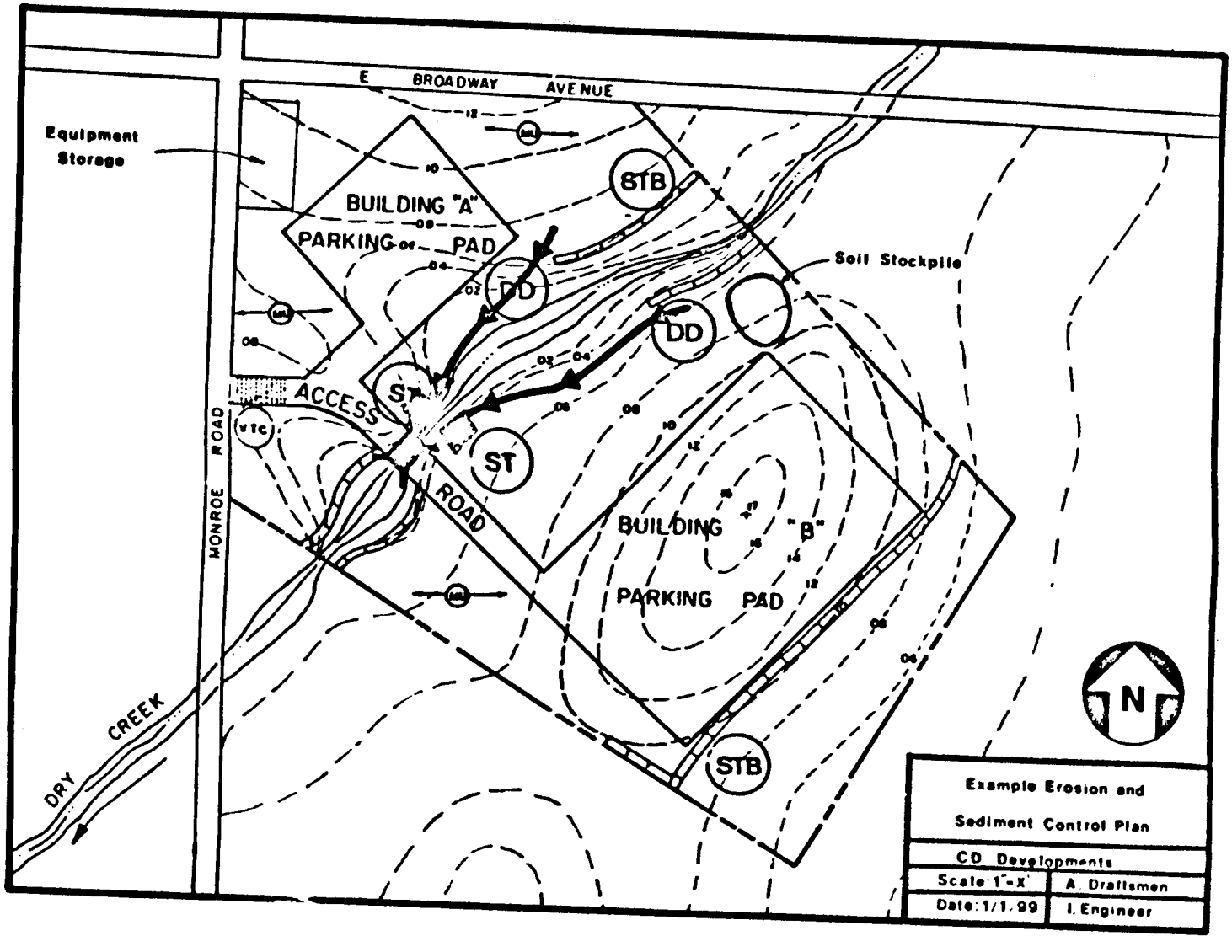
E BROADWAY AVENUE
Equipment Storage
BUILDING "A" PARKING PAD
STB
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Soil Stockpile
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ROAD
BUILDING "B" PARKING PAD
STB
DRY CREEK
N
Example Erosion and Sediment Control Plan
CD Developments
Scale: 1"=x'
A. Draftsmen
Date: 1/1/99
I. Engineer

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APPENDIX C

GLOSSARY OF TERMS

Erodibility - The susceptibility of a particular soil type to erosion by water or wind.

Erosion - The wearing away of the land surface by water, wind, ice or other geological agents, including the detachment and movement of soil or rock fragments by water, wind, ice, or gravity.

Erosion Control Measures - Practices that slow or stop erosion.

Final Stabilization - Completion of all land disturbing activities, removal of all temporary sediment controls, establishment of vegetative cover on exposed soil areas, and installation of permanent roads and structural stormwater quality best management practices.

Land Disturbing Activity - Grading, cut, fill, stockpiling of dirt, removal of vegetation, or any other alteration or disturbance of the ambient land surface.

Mapping Unit - Soil name and symbol given in the Soil Conservation Service Soil Survey for each soil type. Most areas of the Denver metropolitan area are included in a soil survey. In older urban portions of the City and County of Denver, soils analysis will be needed to determine soil types.

Permanent - Installation of land-surface cover, or erosion and sediment control measures, that will remain in place for a long period of time.

Sedimentation - The process of solid materials, both inorganic (mineral) and organic, coming to rest on the earth's surface either above or below sea level.

Sediment - Particulate solid material, either inorganic or organic, that will settle or be deposited in a liquid under the force of gravity.

Sediment Barrier - Straw bale barrier (dike) or a silt fence.

Sediment Basin - A depression, either excavated or formed by a dam, that holds water and debris and facilitates sedimentation of soil particles. Normally used for drainage areas equal to and greater than 5.0 acres.

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Sediment Trap - A small depression that holds water and debris and facilitates sedimentation. Normally used for drainage areas less than 5.0 acres.

Temporary - Installation of erosion or sediment control measures, either structural or nonstructural, that are planned to be removed or inactivated after a period of time.

Viable Vegetative Cover - A measure of performance for establishment of appropriate vegetative cover (or density) on sites planned for revegetation for the period of duration of successful growth as approved by the city and county of jurisdiction.

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The bibliography that follows contains more than 120 listings of papers, proceedings, reports and books, all of which relate to stormwater, stormwater quality and erosion control engineering and management. The text of Volume 3 of the *Urban Storm Drainage Criteria Manual* (*Manual*) specifically refers to some of these listings, while others are included to provide the reader with literature sources in these areas of technology. Although many of the listings in this bibliography were not specifically cited in the text, all of this literature was reviewed and considered by the Urban Drainage and Flood Control District, its advisors and consultants in the selection of practices included in Volume 3 of this *Manual* and in the development of the technical criteria for these practices.

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AMERICAN PUBLIC WORKS ASSOCIATION

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STORM WATER COMPLIANCE:
Municipal Techniques and Strategies

A ONE-DAY TRAINING SEMINAR

December 10, 1993
San Francisco, California

Sponsors

American Public Works Association
California Chapter
Education Foundation

in consultation with the

Office of Wastewater and Enforcement Compliance
Permits Division
U.S. Environmental Protection Agency

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R0057027

Stormwater Compliance: Municipal Techniques and Strategies

8:00 Final Registration

8:30 **What the Regulations Say . . . and the Missing Pieces**
Similarities, differences and overlap between municipal stormwater regulations and the non-point source program.

9:00 **Pieces of the Puzzle**
- EPA regulatory requirements for a storm water plan;
- Identifying and addressing the primary areas of concern: municipal separate storm sewers; industrial facilities operated by the municipality; industrial operations and land disturbances within a municipality.

9:30 **The Impact of Industry and Land Development on Municipal Storm Water Compliance**
A critical first step is understanding the regulatory requirements affecting industrial operations and land development, and the responses of the municipality.

Challenges from industrial operations:
- identifying illicit discharges;
- obtaining access to storm water monitoring data;
- identifying industrial facilities which are out of compliance;
- program enforcement at the municipal level.

Challenges from land development:
- erosion control;
- program enforcement at the municipal level.

10:15 **Break**

10:30 **Best Management Practices (BMP) for Achieving Program Objectives**
Practical best management practices which have been designed to reduce loads on storm water discharges; examples will be selected based on most common applications, cost effectiveness, and the ability to achieve desired results.

11:30 **Evaluation and Development of a Municipal Storm Water Management Program: A Case Study (Local Speaker)**
- Typical challenges when conducting storm water monitoring;
- Ordinances to address industrial and construction activities;
- Activities within cities that have been identified as primary pollutant sources;
- Challenges to identifying illicit discharges;
- Time, staff and cost requirements for program development and implementation;
- Relying on outside assistance.

12:00 **Lunch**

1:00 **Legal Issues**
A city or local attorney will provide an overview of the potential pitfalls for municipalities concerning stormwater regulatory compliance.

1:30 **Implementing the Storm Water Management Plan**
- City ordinances which address storm water management; what are other cities doing and why?
- Fees, permits, inspections and enforcement;
- Monitoring out-fall locations: number, frequency and staffing levels;
- Testing parameters: cost, common mistakes, results of first round of testing, program modifications.
- Illicit discharges: where to focus and how to perform tests;
- Identifying activities and discharges that have a negative impact on storm water discharge quality;
- Reducing receipt of pollutants from municipal landfills, hazardous waste treatment, disposal and recovery facilities, construction runoff.
- Common reporting and recordkeeping mistakes.
- Periodic re-evaluation and update to meet changing needs and methodologies.

3:15 **Break**

3:30 **Current and Future Priorities for EPA's Clean Water Program**
To be presented by an EPA representative.

4:30 **Questions and Answers**
State regulatory agency representatives have been invited to participate in roundtable discussions with municipalities in their respective states.

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Stormwater Compliance:

Municipal Techniques and Strategies



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What the Regulations Say . . . and the Pieces of the Puzzle

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Putting the Puzzle Together





What are the primary components of the program?



Key Components of the Regulations

- Municipal Separate Sewers.
- Municipal activities such as maintenance areas, landfills, airports, and salt piles.
- Land disturbances greater than 5 acres.
- Industrial operations that have manufacturing SIC codes.

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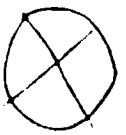
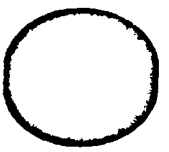
How and why do these regulations fit together?







If you are responsible for the discharge, you should look closely at the waters that enter your system.



What responsibilities does industry have to the municipality?

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AS SPECIFIED IN
40 CFR 122.26 (a)(4)

By May 18, 1991, or 180 days prior to commencing such discharge, industry must submit:

- The name of the facility;
- a contact person and phone number;
- the location of the discharge;
- a description, including Standard Industry Code, which best reflects the principal products and services provided by each facility; and
- any existing NPDES permit number.

Why was this requirement put into place?

40 CFR 122.26 (a)(4)

Provides a legal means for collecting important information about industrial facilities and identifying pollution sources.

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WHO IS RESPONSIBLE?

The operator of the municipal separate storm water system is ultimately responsible for storm water discharges.



What role is the Municipality being forced to assume?



REGULATORY ENFORCEMENT

for industrial and land disturbance activities.

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How can we spread load the enforcement burden?

Consider a watershed management approach rather than a program that relies on political boundaries and subdivisions.

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STORM WATER COMPLIANCE: MUNICIPAL TECHNIQUES AND STRATEGIES

SECTION I WHAT THE REGULATIONS SAY AND THE MISSING PIECES

First point to realize is that municipal storm water management is a long-term and never ending project.

The primary objective of the application process was to collect information and to establish a foundation for the development of long term program strategy which will lead to the improvement of surface water discharges from the municipal separate storm sewer system.

The municipal storm water management program, if properly implemented, will evolve with time and address new, best available technologies, new pollutant sources, and changing land uses. Regardless of how effective the program is today, it is imperative that it be under constant review and revision.

SECTION II PIECES OF THE PUZZLE

What are the primary components of the program?

According to the current National Pollutant Discharge Elimination System (NPDES) Storm Water Regulations, their are two primary types of municipalities involved in the NPDES program:

1) municipalities, greater than 250,000 persons
2) municipalities, greater than 100,000 persons

Within each of these municipalities, there exist several key areas which ultimately impact the compliance effort:

a) municipal separate sewers
b) municipal activities such as maintenance areas, landfills, airports, and salt piles.
c) land disturbances greater than 5 acres
d) industrial operations which have manufacturing SIC Codes

How do they fit together?

Since municipalities are responsible for all discharges from the separate storm sewer system, each one indirectly becomes responsible for all waters received from land disturbance activities, industrial operations, and other activities occurring within the city limits.

What responsibilities does industry have to the municipality?

As specified in 40 CFR 122.26 (a)(4)

...an operator of a storm water discharge associated with industrial activity which discharges through a large or medium municipal separate storm sewer system shall submit, to the operator of

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the municipal separate storm sewer system receiving the discharge no later than May 15, 1991, or 180 days prior to commencing such discharge:

- the name of the facility;
- a contact person and phone number;
- the location of the discharge;
- a description, including Standard Industry Code, which best reflects the principal products and services provided by each facility; and
- any existing NPDES permit number.

Who is ultimately responsible for storm water discharges?

The operator of the municipal storm water system.

What role is the municipality being forced to assume?

The writing is on the wall. Congress has passed on an unfunded mandate that has forced municipal government into the role of enforcement of the NPDES Storm Water Regulations.

Political vs. Watershed Boundaries of Responsibility

The most effective programs that have been developed to this point have relied on a shared program development that includes all municipal governments within a common watershed. Political boundaries do not provide an effective means for addressing storm water management issues.

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Impact of Industry and Land Development

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Notes

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Compliance action taken by industry and land developers should be an integral part of the overall municipal program.

WHAT IS REQUIRED OF INDUSTRIAL OPERATIONS AND LAND DEVELOPERS?

WHICH INDUSTRIES ARE INVOLVED?

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LIST
OF
SIC CODES

WHAT ARE THE PROGRAM DEADLINES FOR INDUSTRY?

Programs administered by the US EPA require that:

1) By October 1, 1992 most industries were required to submit a permit application for permit coverage under the NPDES Storm Water Program.

WHAT ARE THE PROGRAM DEADLINES FOR INDUSTRY? (continued)

Programs administered by the US EPA require that:

2) By April 1, 1993 most industries throughout the country (some states had different deadlines and approaches) were required to develop a formal Storm Water Pollution Prevention Plan.

Individual state managed programs may vary.

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WHAT IS REQUIRED OF
INDUSTRY THAT MAY BE HELPFUL
TO MUNICIPALITIES?

STORM WATER
MONITORING

According to the EPA's
General Permit
monitoring requirements for
industry

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INDUSTRY MUST INVENTORY ALL SIGNIFICANT MATERIALS EXPOSED TO STORM EVENT ACTIVITY



INDUSTRY MUST IDENTIFY SPILLS AND LEAKS THAT OCCURRED DURING THE PAST 3 YEARS



INDUSTRY MUST CONDUCT AN ASSESSMENT FOR ILLICIT DISCHARGES

The industrial facility provide a certification that includes the following information:

- Identification of potential non-storm water discharges.
- The evaluation criteria or test method used.
- The date of testing and/or evaluation.
- The on-site drainage points that were directly observed during the test and/or evaluation.

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INDUSTRY MUST IDENTIFY ALL POLLUTANT SOURCES

Each plan should provide a description of potential sources which may be reasonably expected to add significant amounts of pollutants to storm water discharges or which may result in the discharge of pollutants during dry weather from separate storm sewers draining the facility. Each plan shall identify all activities and significant materials which may potentially be significant pollutant sources.



INDUSTRY MUST IMPLEMENT

SPECIFIC BEST MANAGEMENT PRACTICES THAT WILL AID IN THE REDUCTION OF POLLUTANTS IN STORM WATER DISCHARGES.



INDUSTRY MUST PROVIDE EMPLOYEE TRAINING

The training program must inform personnel at all levels of responsibility of the components and goals of the facilities Storm Water Pollution Prevention Plan. Topics will include:

- Spill prevention and response;
- Good housekeeping; and
- Material management practices.

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TRAINING REQUIREMENTS FOR SECTION 313 FACILITIES

- Preventive measures, including spill prevention and response and preventative maintenance;
- Pollution control laws and regulations;
- The facility's Storm Water Pollution Prevention Plan; and
- Features and operations of the facility which are designed to minimize discharges of Section 313 water priority chemicals, particularly spill prevention procedures.

A FACILITIES SWPPP MUST BE CONSISTENT WITH OTHER ENVIRONMENTAL MANAGEMENT PLANS

Other programs include:

- Preparedness Prevention and Contingency Plan (40 CFR 264 and 265)
- Spill Control and Countermeasure Plans (40 CFR 112)
- Facility Response Plans (OPA-90)
- NPDES Toxic Organic Management Plan (40 CFR 413, 433, 469)
- OSHA Emergency Action Plan (29 CFR 1910)

WHAT KIND OF LAND DISTURBANCES REQUIRE PERMITTING?

Land disturbances of greater than 5 acres.

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› Relatively speaking, municipalities seem to have a greater understanding of the potential impact from land disturbance activities, mainly because of citizen complaints with mud in streets and the siltation of lakes and storm sewers.

CHALLENGES FOR LOCAL GOVERNMENTS DEALING WITH LAND DEVELOPERS

Challenges for Local Governments Dealing with Land Developers

› Many citizen complaints are the result of erosion from properties smaller than 5 acres. What can be done about the development of smaller lots?

› How big of a problem is erosion, for land disturbances?

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Challenges for Local Governments Dealing with Land Developers (continued)

- Besides erosion, what other areas of concern should be considered?
- How do you hold the developer responsible for large residential development areas, once the developer has sold many of the lots to builders?

Challenges for Local Governments Dealing with Land Developers (continued)

- Is the State or EPA actively enforcing the regulatory requirements placed on those responsible for the land disturbances?

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SECTION III THE IMPACT OF INDUSTRY AND LAND DEVELOPMENT ON MUNICIPAL STORM WATER COMPLIANCE

A municipality's ability to comply with storm water permit provisions will be directly impacted by storm water discharges received from industrial facilities and land disturbance activities.

The provisions of the permits issued to industrial operators and land developers should be clearly understood and integrated into the Municipal Storm Water Management Program.

The compliance actions taken by private industry and land developers should be considered a viable portion of the overall municipal compliance effort.

NPDES Storm Water Regulatory Requirements for Industry

WHO IS INVOLVED?

Industries listed in one of eleven Standard Industry Code (SIC) categories, identified in attachment A which is reprinted from the Federal Register, September 9, 1992.

WHAT ARE THE OBLIGATIONS OF AN INDUSTRY TO THE OPERATOR OF A MUNICIPAL STORM WATER SYSTEM?

In accordance with the 40 CFR Section 122.26(a)(4), an operator of a storm water discharge associated with industrial activity which discharges through a large or medium municipal separate storm sewer system shall submit, to the operator of the municipal separate storm sewer system receiving the discharge no later than May 15, 1991, or 180 days prior to commencing such discharge: the name of the facility; a contract person and phone number; the location of the discharge; a description, including SIC which best reflects the principal products or services provided by each facility; and any existing NPDES permit number.

WHAT WERE THE PROGRAM DEADLINES FOR INDUSTRY?

Programs administered by the US Environmental Protection Agency (EPA) required that:

1) By October 1, 1992, most industries were required to submit an application for permit coverage under the NPDES Storm Water Program.

2) By April 1, 1993, most industries throughout the country (some states had different deadlines and approaches) were required to develop a formal storm water pollution prevention plan.

Individual state managed programs may vary.

WHAT IS SPECIFICALLY REQUIRED?

As stated in the EPA General Permit:

A storm water pollution prevention plan (SWPPP) shall be developed for each facility covered by this permit. Storm water pollution prevention plans shall be prepared in accordance with good

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engineering practices. The plan shall identify potential sources of pollution which may reasonably be expected to affect the quality of storm water discharges associated with industrial activity from the facility. In addition, the plan shall describe and ensure the implementation of practices which are to be used to reduce the pollutants in storm water discharges associated with industrial activity at the facility and to assure compliance with the terms and conditions of this permit. Facilities must implement the provisions of the storm water pollution prevention plan required under this part as a condition of this permit.

WHO IS RESPONSIBLE FOR DEVELOPING AND IMPLEMENTING AN INDUSTRIAL FACILITIES SWPP PLAN?

The facility is responsible for developing a storm water pollution prevention plan that addresses all of the regulatory requirements provided in their NPDES Storm Water Permit.

Once the program is developed the facility should establish a storm water pollution prevention team. The people designated for the team should be made responsible for developing the SWPPP and assisting the facility in this implementation, maintenance, and revision of the plan.

Effective organization of the pollution prevention team is important in order for it to be able to accomplish the task of developing and implementing a comprehensive storm water pollution prevention plan. The plan should clearly identify the responsibilities of each team member.

A FACILITIES SWPPP MUST BE CONSISTENT WITH OTHER ENVIRONMENTAL MANAGEMENT PLANS (PART IV.D.6)

The SWPPP must be consistent with other plans. SWPPPs may reflect requirements for spill prevention control and countermeasure (SPCC) plans developed for the facility under Section 311 of the Clean Water Act or best management practices (BMP)programs otherwise required by an NPDES permit for the facility as long as such requirement is incorporated into the SWPPP.

Other programs include:

* Preparedness Prevention and Contingency Plan (40 CFR 264 and 265)
* Spill Control and Countermeasure Plans (40 CFR 112)
* Facility Response Plans (OPA-90)
* NPDES Toxic Organic Management Plan (40 CFR 413, 433, 469)
* OSHA Emergency Action Plan (29 CFR 1910)

ENFORCEMENT OF SPILL PREVENTION CONTROL AND COUNTERMEASURE (SPCC) PLAN REGULATIONS

Part 112 of the 40 CFR details the current requirements for SPCC Planning. The basic requirement for determining if a facility requires a SPCC plan is based upon the volume of petroleum product stored at a facility. Two thresholds have been established: (1) any single container with capacity equal to or greater than 660 gallons, and (2) the combined total storage of equal to or greater than 1320 gallons.

Currently the EPA is developing new regulations for SPCC planning.

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FACILITY RESPONSE PLAN REQUIREMENTS

In addition to Phase I modifications for SPCC, the EPA is developing the draft regulations for facility response plans. In accordance with the Oil Pollution Act of 1990, these plans are required by February 18, 1993. However, without final regulations to use as a guide for plan development, it seems impractical to expend a lot of effort attempting to comply with the deadline.

SARA TITLE III, SECTION 313 FACILITIES, A POTENTIAL HOT SPOT IN THE MUNICIPAL STORM WATER SYSTEM

Special consideration must be given to those facilities that report SARA Title III, Section 313 chemicals on Form R. If these materials have potential for being exposed to storm water runoff, they pose a significant threat to receiving waters. For this reason, the EPA has established special monitoring requirements which must be conducted twice each calendar year.

INDUSTRY MUST HAVE A MATERIAL INVENTORY OF ALL SIGNIFICANT MATERIALS EXPOSED TO STORM EVENT ACTIVITY.

An inventory of all hazardous substances utilized and/or generated at the facility should be kept with the plan. More significant to the SWPPP than the material inventory is the identification of those materials which are exposed to storm water.

IDENTIFICATION OF SPILLS AND LEAKS

It is only necessary to describe those spills which occurred during the three year period preceding the effective date of the permit.

NON-STORM WATER DISCHARGE ASSESSMENT AND CERTIFICATION

The SWPPP shall include a certification that the discharge has been tested or evaluated for the presence of non-storm water (illicit) discharges. The certification shall include the identification of potentially significant sources of non-storm water at the site, a description of the results of any test and/or evaluation for the presence of non-storm water discharges, the evaluation criteria or testing methods used, the date of any testing and/or evaluation, and on-site points that were directly observed during the test.

Methods for identifying illicit discharges include:

* visual inspections conducted during dry weather conditions.
* review of sewer maps.
* dye testing.

The certification shall include the following information:

* identification of potential non-storm water discharges.
* the evaluation criteria or test method used.
* the date of testing and/or evaluation.
* the onsite drainage points that were directly observed during the test and/or evaluation.

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POLLUTANT SOURCE IDENTIFICATION

Each plan should provide a description of potential sources which may be reasonably expected to add significant amounts of pollutants to storm water discharges or which may result in the discharge of pollutants during dry weather from separate storm sewers draining the facility. Each plan shall identify all activities and significant materials which may potentially be significant pollutant sources.

This section is designed to help you target the most important pollutant sources for corrective and/or preventive action, thus using a "risk-based" approach to environmental protection.

A successful approach to developing this portion of the plan could break the site description into the following categories:

LAND DEVELOPMENT

The EPA and many state agencies have developed NPDES Storm Water Permits for land disturbances of greater than five acres. The primary focus of the permit is to control erosion during construction.

Many municipalities have adopted strict ordinances and design standards that address land development concerns. Strict enforcement of these ordinances is necessary if they are to be effective.

COMMON QUESTIONS AND CHALLENGES FOR LOCAL GOVERNMENTS DEALING WITH LAND DEVELOPERS

- Many citizen complaints are the result of erosion from properties smaller than five acres. What can be done about the development of smaller lots?
- Is erosion a significant problem of land disturbances?
- Besides erosion, what other areas of concern should be considered?
- How do you hold the developer responsible for large residential development areas once the developer has sold many of the lot to builders?
- Is the state or EPA actively enforcing the regulatory requirements placed on those responsible for the land disturbances?
- What have other municipalities done to address this problem?

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Best Management Practices

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Notes

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WHAT WERE THE REQUIREMENTS FOR BEST MANAGEMENT PRACTICES IN PART II OF THE MUNICIPAL STORM WATER APPLICATION?

Part II of the Storm Water Permit Application

Required municipalities:

1) A description of structural and source control measures to reduce pollutants from runoff from commercial and residential areas.

2) A description of maintenance activities and a maintenance schedule.

Part II of the Storm Water Permit Application (continued)

3) A description of the planning procedures including a comprehensive master plan to develop, implement and enforce controls to reduce the discharge of pollutants from municipal separate storm sewers which receive discharges from areas of new development and significant redevelopment.

R0057054

Part II of the Storm Water Permit Application (continued)

4) Describe a program to implement and maintain structural and non-structural best management practices to reduce pollutants in storm water runoff from construction sites to municipal storm sewer system.

WHAT DO THE REGULATIONS SAY?

The final regulations indicate that the management programs shall be based on structural and source controls, or non-structural controls.

Management Program

Should include:

1) Maintenance activities for existing and future structural controls;

2) Institutional and structural controls which can be incorporated into permits for new developments;

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Management Program

Should include:

3) Institutional and structural controls to reduce pollutant loads from streets;

4) Evaluation procedures to modify operations or structures of existing and future flood control projects to reduce pollutant loadings;

Management Program

Should include:

5) Programs to reduce pollutants from herbicides, pesticides, or fertilizers;

6) Monitoring programs for municipally-owned waste facilities; and

7) Programs to detect and eliminate illicit discharges.

BEFORE YOU INVEST ADDITIONAL MONEY AND RESOURCES, TAKE A SECOND LOOK AT YOUR PROGRAM AND ASK SOME QUESTIONS.

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QUESTION:
What is it that you want to achieve?

A good objective would be to maintain and/or improve the quality of storm water discharges from the municipal separate storm water system.

QUESTION:
Do we fully understand the problem?

It is strongly recommended that the problem is understood before large amounts of money are spent on the solutions. This can be done by evaluating the results of the monitoring program.

QUESTION:
What are the primary concerns?
(worst areas of pollution)

- Illicit discharges
- Specific industrial facilities
- Household hazardous waste

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R0057057

QUESTIONS:

What kind of funding is available?

What kind of resources do you have to work with?

- Manpower (city employees and/or volunteers)

QUESTION:

What types of programs does the city already have that can be slightly modified to help us achieve our overall objectives?

- Street sweeping
- Household hazardous waste collection program
- Used oil recycling program

QUESTION:

What are others doing in the community, that can be dovetailed into the municipal program?

- Private citizen;
- Private industry; and
- Civic groups.

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QUESTIONS:

What other government agencies have a shared interest in this type of program?

- United States Geologic Service
- Soil Conservation Service

What are other local governments doing?

CATEGORIZATION OF BEST MANAGEMENT PRACTICES

Categorization

- INSTITUTIONAL SOURCE CONTROLS
- NON-STRUCTURAL SOURCE CONTROLS

Intended to eliminate pollutants at the source and prevent storm water pollution

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R0057059

EXAMPLES OF INSTITUTIONAL SOURCE CONTROLS

- Public education (billing inserts, news releases, radio public service announcements, school programs and pamphlets;
- Litter control;
- Recycling programs;
- "No Littering" and "Pooper Scooper" Ordinance;

EXAMPLES OF INSTITUTIONAL SOURCE CONTROLS (continued)

- Develop and enact Spill Response Plan to prevent hazardous chemicals from entering the storm drain;
- Require that spills are cleaned up from vehicle accidents;
- Clean-up vacant lots;

EXAMPLES OF INSTITUTIONAL SOURCE CONTROLS (continued)

- Prohibit illegal and illicit connections and dumping into storm drain systems;
- Identify, locate, and prohibit illegal or illicit discharge to storm drain system;

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EXAMPLES OF INSTITUTIONAL SOURCE CONTROLS (continued)

- Require proper storage, use and disposal of fertilizers, pesticides, solvents, paints and varnishes, and other household chemicals (oil, grease, and antifreeze, etc.); and
- Restrict paving and use of non-porous cover materials in recharge areas.

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EXAMPLES OF NON-STRUCTURAL SOURCE CONTROLS

- Street sweeping & sidewalk cleaning
- Clean and maintain storm drain channels annually
- Clean and inspect storm inlets and catch basins annually
- Clean and inspect debris basins annually
- Inspect and maintain sewer system

MINOR AND MODERATE STRUCTURAL CONTROLS

The moderate cost categories are designed to remove pollutants from local storm water flows, and thereby minimize the amount of storm water which must be treated.

EXAMPLES OF MINOR STRUCTURAL SOURCE CONTROLS

- Storm drain inlet protection to prevent debris from entering storm drain;
- Outlet protection to prevent erosion at the outlet of pipes or paved channels;
- Slope stabilization and erosion control measures;

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EXAMPLES OF MINOR STRUCTURAL SOURCE CONTROLS (continued)

- Interceptor swale to shorten length of exposed slopes;
- Improve and maintain natural channels;
- Diversion channels;
- Grass-lined channels;
- Riprap and gabions;
- Vegetative control;
- Filter strips; and
- Fence open channels.

EXAMPLES OF MINOR STRUCTURAL DISCHARGE ELIMINATION METHODS

- French drains and subsurface drains;
- Infiltration trench and dry wells;
- Porous pavement ; and
- Retention basins.

MODERATE STRUCTURAL CONTROLS FOR FLOATABLES AND OILS REMOVAL

Moderate structural controls provide for pollutant removal from stormwater which flows from local areas, such as parking lots.

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EXAMPLES OF MODERATE STRUCTURAL CONTROLS

FOR THE REMOVAL OF FLOATABLES AND OILS:

- Clarifiers and oil/water separators on parking structures;
- Oil and grit separators; and
- Sediment/grease traps.

MAJOR STRUCTURAL CONTROLS

The most expensive controls (Major Structural Controls) are designed to physically, chemically, or biologically treat large storm water flows after pollutants have entered the main stream channels.

EXAMPLES OF MAJOR STRUCTURAL CONTROLS

FOR SOLIDS REMOVAL:

- Detention basins;
- Bar screens; and
- Wetlands.

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EXAMPLES OF MAJOR STRUCTURAL CONTROLS

FOR MICROORGANISMS REMOVAL:

- Conversion of wastewater treatment plants to wet weather facilities;
- Swirl concentrators and chlorination/dechlorination;
- Primary clarifiers; and
- Filters.

EXAMPLES OF MAJOR STRUCTURAL CONTROLS

FOR METALS REMOVAL:

- Primary clarifiers and lime precipitation; and
- Detention basins and wetland treatment.

WHAT INNOVATIVE BEST MANAGEMENT PRACTICES ARE OTHER MUNICIPALITIES PLANNING TO USE?

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DEVELOP A BMP CREDITING SYSTEM

As an incentive for developers of new areas to build and maintain approved structural BMP's, the City of Charlotte is planning to develop a crediting mechanism for the reduction of pollutants from non-single-family-residential sites.

DEVELOP PRIVATE BMP INSPECTION AND ENFORCEMENT

This program element will enable the City to both inspect and bring enforcement action against any BMP and other privately owned and operated storm water structure which is not built or maintained in accordance with city standards.

DEVELOP PRIVATE BMP INSPECTION AND ENFORCEMENT (continued)

IT INCLUDES:

- Setting design and maintenance standards;
- Monitoring;
- Hiring and training inspectors;
- Modifying ordinances for enforcement capability; and
- Developing the appropriate forms, procedures and policies to implement ordinances.

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DEVELOP A BMP PILOT PROGRAM

Charlotte will institute a pilot program to design, construct and evaluate the effectiveness of both structural and non-structural BMP's targeted toward the commercial and residential land use types.

FOR INDUSTRIAL CONCERNS:

- Industrial Facilities Database Development
- Develop Inspection Procedures
- Industrial Monitoring Program

FOR CONSTRUCTION CONCERNS:

- Establish Design Criteria for Developers
- Require Self-Inspections
- Conduct Yearly Education Seminars for Construction Site Operators

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STORM WATER INLET STENCILING

With the support of civic action groups, the City of Independence, Missouri has begun stenciling storm water inlets with information that encourages the general public not to dump oils and other household waste.

DEICING SALTS

Since deicing salts are the main source of pollutants in runoff of urban snow melt, explore ways to minimize the salt content, such as reducing the amount of liquid calcium chloride used, or reducing the content and rates of sand/salt mix, or use alternative deicing materials.

In my opinion the top 5 best management practices that exist are:

1) The establishment of adequate legal authority and effective ordinances;
2) Public education;
3) Illicit discharge evaluation and termination;
4) Monitoring of industrial compliance with state or EPA requirements; and
5) Future land use planning.

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SECTION IV BEST MANAGEMENT PRACTICES

As is now commonly known among municipal staff involved in the permit application process, Part II of the Storm Water Permit Application required municipalities to:

1) describe structural and source control measures to reduce pollutants from runoff from commercial and residential areas.

2) describe maintenance activities and a maintenance schedule.

3) describe the planning procedures including a comprehensive master plan to develop, implement and enforce controls to reduce the discharge of pollutants from municipal separate storm sewers which receive discharges from areas of new development and significant redevelopment.

4) describe a program to implement and maintain structural and non-structural best management practices to reduce pollutants in storm water runoff from construction sites to municipal storm sewer system.

WHAT DO THE REGULATIONS SAY?

The final regulations for the stormwater NPDES permit application, as listed in 40 CFR 122.26 (d)(2)(iv), indicate that the management programs shall be based on structural and source controls, or non-structural controls.

The regulations indicate that the management program should include:

1) maintenance activities for existing and future structural controls;

2) institutional and structural controls which can be incorporated into permits for new developments;

3) institutional and structural controls to reduce pollutant loads from streets;

4) evaluation procedures to modify operations or structures of existing and future flood control projects to reduce pollutant loadings;

5) programs to reduce pollutants from herbicides, pesticides, or fertilizers;

6) monitoring programs for municipally-owned waste facilities; and

7) programs to detect and eliminate illicit discharges.

GETTING STARTED

When a municipality first begins to look at BMPs that they will want to utilize, it is critical that first questions are answered.

1) What is it that we want to achieve?

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A good objective would be to maintain and/or improve the quality of storm water discharges from the municipal separate storm water system.

2) Do we fully understand the problem?

It is strongly recommended that the problem is understood before large amounts of money are spent on the solutions. This can be done by evaluating the results of the monitoring program.

3) What are the primary concerns (worst sources of pollution)?

- illicit discharges
- specific industrial facilities

4) What kind of funding is available?

Currently, in many communities there is not a fund for financing storm water management and pollution control. However, some communities have adopted users' fees that pay for the operation of a storm water utility. This can be a politically difficult situation which many people may view as an additional tax.

- Does the city operate a storm water utility? If not, would such a program provide a future benefit?

5) What kind of resources do I have to work with?

- manpower (city employees)
- manpower (volunteers)

6) What types of programs does the city already have that can be slightly modified to help us achieve our overall objectives?

- street sweeping
- household hazardous waste collection program
- used oil recycling program

7) What are others doing in the community, that can be dovetailed into the municipal program?

- private citizen groups organized to pick up trash in parks and along roads.
- private industry incorporating BMPs to address their storm water requirements.
- League of Women Voters
- 4H Group
- local scouts
- high school organizations

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8) What other government agencies have a shared interest in this type of program?

- United States Geologic Service
- Soil Conservation Service

9) Does the city need to bring in outside consultants and contractors to help develop programs and construct structural control systems?

10) What are other local cities doing?

BUILDING ON CURRENT MANAGEMENT PRACTICES

1) Enforce the requirements of the regulations currently addressing industrial operations and land disturbance activities (e.g. request results of illicit discharge investigations, copies of SWPPPs, and monitoring data).

2) Enforcement of current city ordinances that serve as a best management practice (e.g. erosion control, anti-littering).

3) Manage street sweeping program in a manner that targets the greatest impact for removing pollution from the streets.

BEST MANAGEMENT PRACTICES CATEGORIZATION

One of the key concerns of municipalities when evaluating BMPs is the cost for implementation.

Many types of best management practices exist that have the ability to reduce pollutant loads in discharged storm water.The following is a list of a wide array of options.

- institutional source controls
- non-structural source controls
- minor structural source controls
- minor structural discharge elimination methods
- moderate structural controls for floatables and oils removal
- major structural controls for solids removal
- major structural controls for microorganism removal
- major structural controls for metals removal

Institutional Source Controls: Implementation of institutional source controls prevents pollutants from entering the stormwater flows. It cana be done through the adoption and enforcement of local ordinances, the expansion of existing recycling programs, and implementation of public education programs. Many of these programs, such as recycling programs, may need to be implemented to comply with other regulations. Therefore, the costs can be applied to two or more programs. This type of cost allocation may improve the feasibility of the program.

Types of practices:

- public education (billing inserts, news releases, radio public service announcements, school programs and pamphlets;
- litter control;
- recycling programs;

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- "no littering" ordinance;
- "pooper scooper" ordinance;
- develop and enact a spill response plan to prevent hazardous chemicals from entering the storm drain;
- require that spills are cleaned up from vehicle accidents;
- clean-up vacant lots;
- prohibit illegal and illicit connections and dumping into storm drain systems;
- identify, locate, and prohibit illegal or illicit discharge to storm drain system;
- require proper storage, use and disposal of fertilizers, pesticides, solvents, paints, and varnishes, and other household chemicals (oil, grease, and antifreeze, etc.); and
- restrict paving and use of non-porous cover materials in recharge areas.

Non-Structural Source Controls: These controls also prevent pollutants from entering the stormwater flows through the expansion of clean-up programs, such as street sweeping, sidewalk sweeping, cleaning of storm drains, and enforcement actions against illicit dischargers. These controls could be implemented without construction of new facilities.

- street sweeping;
- sidewalk cleaning;
- clean and maintain storm drain channels annually;
- clean and inspect storm inlets and catch basins annually;
- clean and inspect debris basins annually;
- storm drains cleaned and maintained every 3 to 6 years;
- storm system pump stations cleaned and maintained annually; and
- inspect and maintain sewer system.

Minor Structural Source Controls: These controls provide for a reduction in sediment loads and associated pollutants that enter the receiving waters. The controls include improved diversion channels, grass swales and grass lined channels, improved natural channel banks, and planting of vegetation on exposed soils. These minor structural source controls could be included as part of development projects or when other improvements are being completed.

- storm drain inlet protection to prevent debris from entering storm drain;
- outlet protection to prevent erosion at the outlet of pipes or paved channels;
- slope stabilization and erosion control measures;
- interceptor swale to shorten length of exposed slopes;
- improve and maintain natural channels;
- diversion channels;
- grass-lined channels;
- riprap;
- gabions;
- vegetative control;
- filterstrips; and
- fence open channels.

Minor Structural Discharge Elimination Methods: These methods will eliminate storm water discharges, and thereby reduce the levels of pollutants discharged to the receiving waters. The controls, including recharge areas and porous pavement, have been installed by many communities throughout the United States as part of flood controls projects or water augmentation projects. However, to provide water quality improvements, many facilities would require increased maintenance to prevent pollutants from being discharged.

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- french drains and subsurface drains;
- infiltration trench and dry wells;
- porous pavement; and
- retention Basins.

Moderate Structural Controls for Floatables and Oils Removal: Moderate structural controls provide for pollutant removal from stormwater which flows from local areas, such as parking lots. The controls, such as parking lot oil and grease separators, generally are constructed close to the pollutant source. They treat a small volume of stormwater with a concentrated pollutant level. These controls have been constructed in manufacturing sections of many metropolitan areas. However, increased maintenance may be required to ensure continued performance. To improve water quality further, these facilities could be constructed throughout all light industrial and commercial areas of the communities.

- clarifiers and oil/water separators on parking structures;
- oil and grit separators; and
- sediment/grease traps.

Major Structural Controls for Solids Removal: Major structural controls,. such as detention basins or wetlands, remove solids, oils, and greases of large stormwater flows prior to discharge into receiving waters. These controls would require construction of major facilities. These controls also may remove nutrients associated with solids, such as animal droppings or litter. Operation and maintenance costs for these facilities are higher than for theminor or moderate structural controls. These facilities generally are designed to be operated passively, and therefore do not require expensive instrumentation equipment.

- detention basins;
- bar screens; and
- wetlands.

Major Structural Controls for Microorganisms Removal: These controls provide for removal of microorganisms in large stormwater flows prior to discharge into receiving waters. Implementation would require construction of major sedimentation facilities and disinfection facilities.

- Conversion of wastewater treatment plants to wet weather facilities;
- Swirl concentrators and chlorination/dechlorination;
- Primary clarifiers; and
- Filters.

Major Structural Controls for Metals Removal: These controls remove metals in large stormwater flows prior to discharge into receiving waters. These controls would require construction of sedimentation facilities followed by either wetlands or lime precipitation. Operation and maintenance costs for these facilities are high.

- primary clarifiers and lime precipitation; and
- detention basins and wetland treatment.

The categories with the least expensive controls (institutional and non-structural source controls)

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will eliminate pollutants at the source and prevent stormwater pollution. The moderate cost categories (minor and moderate structural controls) are designed to remove pollutants from local stormwater flows, and thereby minimize the amount of stormwater which must be treated. These controls are constructed close to the pollutant source to reduce or prevent pollutants from entering larger stream channels. The most expensive controls (major structuralcontrols are designed to physically, chemically, or biological treat large stormwater flows after pollutants have entered the main stream channels.

WHAT INNOVATIVE BEST MANAGEMENT PRACTICES ARE OTHER MUNICIPALITIES PLANNING TO USE?

This information has been taken from Part II of the applications from various cities, throughout the United States:

Develop a BMP Crediting system. As an incentive for developers of new areas to build and maintain approved structural BMPs the City of Charlotte is planning to develop a crediting mechanism for the reduction of pollutants from non-single-family-residential sites.

Develop private BMP inspection and enforcement. This program element will enable the city to both inspect and bring enforcement action against any BMP and other privately owned and operated storm water structure which is not built or maintained in accordance with City of Charlotte standards. It includes:

- setting design and maintenance standards;
- monitoring;
- hiring and training inspectors;
- modifying ordinances for enforcement capability; and
- developing the appropriate forms, procedures and policies to implement ordinances.

Develop a BMP Pilot Program. Charlotte will institute a pilot program to design, construct and evaluate the effectiveness of both structural and non-structural BMPs targeted toward the commercial and residential land use types.

Industrial Facilities Database Development. A database of industrial and related facilities that are or will be subject to regulatory inspections and/or monitoring programs.

Develop Inspections Procedures. The industrial and related facilities inspection procedures must be developed. The procedures will include: review of on-site SWPPPs, materials management plans, and/or spill response plans, depending on the facility; review and inspection procedures to determine the status of plan implementation; and, inspection of locations for compliance monitoring (if any) and potential illegal connections to the storm drainage system.

Industrial Monitoring Program. A random monitoring program designed to monitor compliance with the state's storm water permitting program for industrial activities. The results of the random monitoring program will be entered into the GIS-based database of the City of Charlotte's storm water program.

Self-Inspections for Construction Activities. The city will place a self-inspection requirement on all new construction in accordance with the general permit. Records of the inspections must be maintained by the operator and shall be available to city inspectors upon request.

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Yearly Education Seminars for Construction Site Operators. A seminar once every two years will be held to educate all construction site operators and plan preparers on the available (and accepted) technologies for erosion and sedimentation controls.

Storm Water Inlet Stenciling. With the support of civic action groups, the City of Independence has begun stenciling storm water inlets with information that encourages the general public not to dump oils and other household waste.

Deicing Salts. Since deicing salts are the main source of pollutants in runoff of urban snow melt, the city, during the life of the Permit, will explore or study ways to minimize the alt content, such as reducing the amount of liquid calcium chloride used, or reducing the content and rates of sand/salt mix, or use alternative deicing materials.

PRIORITY BEST MANAGEMENT PRACTICES

Establishment of adequate legal authority and effective ordinances
Education
Illicit Discharge Evaluation and Termination
Monitoring of Industrial Compliance with state or EPA requirements
Future land use planning

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Municipal Storm Water Management Program: A Case Study

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Implementing the Storm Water Management Plan

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GOING FROM
THE PLANNING STAGE
TO IMPLEMENTATION

REALIZE
YOUR LIMITATIONS

YOU DO NOT HAVE THE
MANPOWER OR MONEY
TO GO AFTER IT ALONE

YOU MUST BE WILLING
TO SHARE IDEAS

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WHERE POSSIBLE

POOL RESOURCES

AND

WORK TOGETHER

THE FIRST PRIORITY IS

EDUCATION

TOPICS FOR PUBLIC AND CITY EMPLOYEE TRAINING

- Household hazardous waste disposal
- Used oil recycling
- Septic tank maintenance
- Hazardous material/waste management

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TOPICS FOR PUBLIC AND CITY EMPLOYEE TRAINING (continued)

- Proper use of pesticides, herbicides and fertilizers
- Erosion and sediment control
- Illicit discharge evaluation
- Spill response and prevention
- Inspection techniques for city staff

COMMON METHODS FOR REACHING THE PUBLIC

1) Fact sheets,
2) Pamphlets,
3) Radio/television,
4) Newspaper/magazines,
5) Displays models/posters and
6) Group presentation/one-on-one/community events.

EXAMPLES OF SPECIFIC TRAINING RESOURCES

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THE STORM WATER POLLUTION PREVENTION COMMITTEE

Suggested participants:

- Business owners
- Members of professional, civic and environmental organizations
- Representatives of home owners associations
- City staff
- Elected officials

POTENTIAL BENEFITS OF THE POLLUTION PREVENTION COMMITTEE

- General awareness and understanding should be developed;
- A sense of ownership should develop;
- New ideas may be brought to the table; and
- A resource of volunteers may come forward to help put the plan to work.

WHAT PERMIT CONDITIONS ARE PERMIT WRITERS PLANNING TO REQUIRE?

The Model Municipal Permit developed by EPA Region VI

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POLLUTION PREVENTION REQUIREMENTS

Shall consider water quality impacts of new and significant redevelopment in their comprehensive master planning process.

POLLUTION PREVENTION REQUIREMENTS (continued)

Shall utilize a comprehensive master planning process to develop, implement, and enforce controls to reduce the discharge of pollutants from areas of new development and significant redevelopment after construction is completed.

HOW IS THIS APPROACHED?

Need to work with the Planning Commission and the City Council. Identify those sensitive areas that should be protected during future development.

Do an overlay on the City's long term master plan.

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POLLUTION PREVENTION REQUIREMENTS (continued)

Shall insure the establishment or availability of a program to collect used motor vehicle fluids (including oil and antifreeze) for recycle or reuse.



POLLUTION PREVENTION REQUIREMENTS (continued)

Shall insure the establishment or availability of a program to collect household hazardous waste materials (including paint, pesticides, herbicides, and other hazardous wastes) for recycle, reuse, or safe disposal.



POLLUTION PREVENTION REQUIREMENTS (continued)

Shall implement controls to reduce the discharge of pollutants related to application of pesticides, herbicides, and fertilizers applied by municipal employees or contractors to public right of ways, parks, and other municipal facilities.

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POLLUTION PREVENTION REQUIREMENTS (continued)

Shall implement an ongoing program to detect and remove (or require the discharger to the MS4 to remove or obtain a separate NPDES permit for) illicit discharges and improper disposal into the storm sewer.

WHAT IS AN ILLICIT DISCHARGE?

Residential and Commercial Sources of Illicit Discharges

Sanitary waste water :

- Improper sewerage connections or leakage
- Effluent from improperly operating or improperly designed septic tanks

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Residential and Commercial Sources of Illicit Discharges (continued)

- Household chemicals
- Laundry waste water
- Car wash waste waters
- Radiator flushing waste waters
- Engine de-greasing wastes
- Improper oil disposal
- Leaking underground storage tank

Industrial Sources of Illicit Discharges

- Leaking tanks and pipes
- Floor drains within industrial facilities
- Wash waters
- Boiler blow down water
- Cooling water discharge
- Miscellaneous process waters

SCREENING PROCEDURES

Screening methodology may be developed and/or modified based on experience gained during actual field screening activities and need not conform to the protocol of 40 CFR 122.26(d)(1)(iv)(D).

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POLLOW-UP ON DRY WEATHER SCREENING RESULTS

Shall implement a program to locate and eliminate suspected sources of illicit connections and improper disposal identified during dry weather screening activities.

Follow-up Activities

May be prioritized on the basis of :

1) Magnitude and nature of the suspected discharge;
2) Sensitivity of the receiving water; and
3) Other relevant factors.

Follow-up with INDUSTRY

Have they done their investigations?

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UNITED STATES GEOLOGIC SERVICE (USGS)

They have a shared interest in gathering information about the quality of urban storm water discharges.

UNITED STATES GEOLOGIC SERVICE (USGS)

What can they do to help?

- Conduct dry and wet weather monitoring
- Map storm sewer system
- Identify illicit discharges
- Conduct analytical testing in the field and the lab

If you plan to use city staff for evaluating illicit discharges,

TRAIN YOUR PERSONNEL !

Make sure they know what they are looking for !

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SECTION IV IMPLEMENTING THE STORM WATER MANAGEMENT PLAN

HOW DO YOU GO FROM A PLANNED PROGRAM TO A PROGRAM THAT IS FULLY IMPLEMENTED?

The answer is simply, one step at a time.

THE FIRST STEP IS EDUCATION

TOPICS FOR PUBLIC AND MUNICIPAL EMPLOYEE TRAINING AND EDUCATION

Effective and specific training on issues that impact storm water quality will go a long way toward the success of the storm water management program. The collective involvement of multiple cities will reduce the cost for each that participates and will enhance the overall effectiveness in the field. The following is a short list of possible topic areas:

- household hazardous waste disposal;
- used oil recycling;
- septic tank maintenance
- hazardous material/waste management
- proper use of pesticides, herbicides and fertilizers
- erosion control
- illicit discharge evaluation
- spill response and prevention
- inspection techniques for city staff

The effectiveness of the city's storm water management staff will hinge on the ability to educate the public.

The development and implementation of an education and information program is critical to having a successful urban non-point pollution project. The reason is twofold. First, public awareness of urban nonpoint pollution is low. The public is inundated daily with a barrage of potential risks by the press ranging from the threat of war, crime and violence, etc.

Second, the education and informational program is important to having a successful project because most of the urban non-point pollution can be directly attributed to people. It is the actions of people at both home and work that affect the type and amount of non-point pollution from their community. A 1989 study by the Michigan Department of Natural Resources found that more oil is illegally released annually into the environment in Michigan than was released in the Exxon Valdez accident.

The first step in developing a successful urban non-point education and information program is to define your target audience. The one rule that must always be remembered is to provide understandable and useful information. The better you understand your target audience (education, background and industry type) the more effective will be your education program.

The second step in developing a successful urban education program is to define the types of media available for use in your programs. Among the common methods are: (1) fact sheets, (2) pamphlets, (3) radio/television, (4) newspaper/magazines, (5) displays models/posters and (6) group presentation/one-on-one/community events.

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In Ann Arbor, Michigan, the Huron River Pollution Abatement Project (HRPAP) education program was designed after reviewing the pilot program and analyzing the community. It was noted during this phase that the community was mainly urban, well educated and generally supportive of environmental issues; it had many industrial shops versus one main plant; and it had numerous organized and influential civic and professional groups.

Based on this analysis, the education and information program was developed with three main components. They were business and industry, community and civic groups, component, and the schools.

THE STORM WATER POLLUTION PREVENTION COMMITTEE

In order to effectively implement the Storm Water Management Plan it is important to solicit the dedicated cooperation of those within your community.

It is suggested that persons from various sectors of the population be invited to attend. The following is a partial list of suggested participants:

- business owners
- members of professional, civic and environmental organizations
- representatives of home owners associations
- municipal staff
- elected and appointed officials.

The development of the storm water pollution prevention committee will potentially provide several important accomplishments:

- general awareness and understanding should be developed;
- a sense of ownership should develop;
- new ideas may be brought to the table; and
- and volunteers may come forward to help put the plan to work.

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Pollution Prevention Requirements

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POLLUTION PREVENTION REQUIREMENTS (continued)

Shall implement a program to prevent, contain, and respond to spills that may discharge into the MS4. The spill response program may include a combination of spill response actions by the municipal government or private entity, and legal requirements for private entities within the co-permittee's municipal jurisdiction.

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Talk with Spill Response Personnel

Include a representative in the Storm Water Pollution Prevention Committee.

Work with the Spill Response team to evaluate potential impacts that Standard Operating Procedures may have on receiving streams.



Is private industry holding up their end of the bargain?

Do they have Spill Prevention, Control and Countermeasure Plans?

Are they developing Facility Response Plans, as required by the EPA, DOT, and U.S. Coast Guard?



Random inspections and swift enforcement will go a long way to improve the level of compliance by industry.

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CONSTRUCTION SITE RUNOFF

Shall implement a program to reduce the discharge of pollutants from construction sites, including:

- Requirements for the use and maintenance of appropriate structural and nonstructural best management practices to reduce pollutants discharged to the MS4 during the time construction is under way;



CONSTRUCTION SITE RUNOFF (continued)

Including:

- Procedures for site planning which incorporates considerations for potential short and long term water quality impacts, and minimizes these impacts;



CONSTRUCTION SITE RUNOFF (continued)

Including:

- Prioritized inspection of construction sites and enforcement of control measures;
- Appropriate education and training measures for construction site operations; and

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CONSTRUCTION SITE RUNOFF (continued)

Including:

- Notification of all construction permit applicants of their potential responsibilities under the NPDES permitting program for construction site runoff.

NOTE: Notification can be accomplished through the building permit approval or platting processes.

Storm Water Management Plan REVIEW AND MODIFICATION Requirements

ANNUAL REVIEW

Shall participate in an annual review of the current SWMP in conjunction with preparation of the annual report required under Part II. G. This annual review shall include:

- A review of the status of program implementation and compliance (or non-compliance) with all schedules of compliance contained in the permit;

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ANNUAL REVIEW
(continued)

This annual review shall include:

- An assessment of the effectiveness of controls established by the SWMP;
- A review of monitoring data and any trends in estimated cumulative annual pollutant loadings; and

ANNUAL REVIEW
(continued)

This annual review shall include:

- An assessment of any SWMP modifications needed to comply with the CWA § 402(p)(3)(iii) requirement to reduce the discharge of pollutants to the maximum extent practicable (MEP).

PROGRAM MODIFICATION

The approved SWMP program shall not be modified by the permittee without the prior approval of the EPA, unless in accordance with the items that follow :

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PROGRAM MODIFICATION (continued)

- Modifications adding (but not subtracting or replacing) components, controls, or requirements to the approved SWMP may be made by the permittee at any time upon written notification to the permitting authority.

PROGRAM MODIFICATION (continued)

- Modifications replacing a failing BMP identified in the SWMP with an alternate BMP may be requested in conjunction with the annual report.

ANNUAL REPORT

An annual system-wide report shall be submitted by no later than the anniversary of the date the permit is issued.

The report shall include the following separate sections, with an overview for the entire MS4 and subsections for each co-permittee:

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ANNUAL REPORT (continued)

- The status of implementing the components of the storm water management programs that are established as permit conditions (status of compliance with any schedules established under this permit shall be included in this section);

ANNUAL REPORT (continued)

- Proposed changes to the storm water management programs that are established as permit conditions, including an update on areas added to the MS4 due to annexation or other legal means;

ANNUAL REPORT (continued)

- Revisions, if necessary, to the assessments of controls and the fiscal analysis reported in the permit application under 40 CFR 122.26(d)(2)(iv) and (d)(2)(v);

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ANNUAL REPORT (continued)

- A summary of the data, including monitoring data, that is accumulated throughout the reporting year ;
- Annual expenditures and budget for the year following each annual report ;

ANNUAL REPORT (continued)

- A summary describing the number and nature of enforcement actions, inspections, and public education programs; and
- Identification of water quality improvements or degradation.

RECORD KEEPING

The permittee shall retain records of all:

- Monitoring information including all calibration and maintenance records and all original strip chart recordings for continuous monitoring;
- Copies of the reports required by this permit; and

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RECORD KEEPING
(continued)

- Records of all data used to complete the application for this permit

The records must be maintained for a period of at least 3 years from the date of the sample, measurement, report or application.

RECORD KEEPING
(continued)

Records of monitoring information shall include:

- The date, exact place, and time of sampling or measurements;
- The initials or name(s) of the individual(s) who performed the sampling or measurements;

RECORD KEEPING
(continued)

- The date(s) analyses were performed;
- The time(s) analyses were initiated;
- The initials or name(s) of the individual(s) who performed the analyses;

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RECORD KEEPING
(continued)

- References and written procedures, when available, for the analytical techniques or methods used; and
- The results of such analyses, including the bench sheets, instrument read outs, computer disks or tapes, etc., used to determine these results.

Penalties for Violations of Permit Conditions

Criminal

1. Negligent Violations : Subject to a fine of not less than $2,500 nor more than $25,000 per day of violation, or by imprisonment for not more than 1 year, or both.

Penalties for Violations of Permit Conditions
(continued)

2. Knowing Violations: Subject to a fine of not less than $5,000 nor more than $50,000 per day of violation, or by imprisonment for not more than 3 years, or both.

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Penalties for Violations of Permit Conditions (continued)

3. Knowing Endangerment: Subject to a fine of not more than $250,000, or by imprisonment for not more than 15 years, or both.
4. False Statement: Shall upon conviction, be punished by a fine of not more than $10,000 or by imprisonment for not more than 2 years, or by both.

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WHAT PERMIT CONDITIONS ARE PERMIT WRITERS PLANNING TO REQUIRE?

A well developed Part II application may very well be approved in its entirety. However, Region VI of the EPA has developed a model permit for municipalities that has several key requirements. You may find that these stipulations are added to your permit conditions if they were not included in the Part II you submitted.

I. POLLUTION PREVENTION REQUIREMENTS

The co-permittees shall develop and implement the following pollution prevention measures (PPMs):

A. Each co-permittee with jurisdiction over land use shall include requirements to consider water quality impacts of new and significant re-development in their comprehensive master planning process. The goal of such requirements shall be limiting, to the maximum extent practicable (MEP), the discharge of pollutants to pre-development levels.

B. The co-permittees shall insure the establishment or availability of a program to collect used motor vehicle fluids (including oil and antifreeze) for recycle or reuse. Such program shall be readily available to all private residents. This program shall be publicized and promoted on a regular basis .

C. The permittee shall insure the establishment or availability of a program to collect household hazardous waste materials (including paint, pesticides, herbicides, and other hazardous wastes) for recycle, reuse, or safe disposal. Such program shall be readily available to all private residents and include information on locations accepting such wastes on a continuous basis. This program shall be publicized and promoted on a regular basis (including mailouts to individual residences).

D. The co-permittees shall insure the establishment of a program, including structural controls where necessary, to reduce the discharge of floatable (including solid wastes) to the maximum extent practicable.

E. *Structural Controls:* Each co-permittee shall operate and maintain any storm water structural controls over which they have jurisdiction, in a manner so as to reduce the discharge of pollutants (including floatable) to the MEP.

F. *Areas of New Development:* Each co-permittee shall utilize a comprehensive master planning process to develop, implement, and enforce controls to reduce, to the MEP, the discharge of pollutants from areas of new development and significant redevelopment after construction is completed.

G. *Roadways:* Each co-permittee shall operate and maintain public streets, roads, and highways under its jurisdiction in a manner so as to reduce, to the MEP, discharge of pollutants (including those related to deicing or sanding activities).

H. *Flood Control Projects:* Each co-permittee shall insure any flood control projects it

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undertakes assess, and minimize to the MEP, the impacts on water quality of receiving waters. Each co-permittee shall also evaluate the feasibility of retro-fitting existing structural flood control devices to provide additional pollutant removal from storm water.

I. *Pesticide, Herbicide, and Fertilizer Application:* Each co-permittee shall implement controls to reduce, to the MEP, the discharge of pollutants related to application of pesticides, herbicides, and fertilizers applied by municipal employees or contractors to public right of ways, parks, and other municipal facilities. Co-permittees with jurisdiction over lands not directly owned by that entity (ex. incorporated city) shall implement controls to reduce, to the MEP, discharge of pollutants related to application and distribution of pesticides, herbicides, and fertilizers by commercial and wholesale distributors and applicators .

J. *Illicit Discharges and Improper Disposal:* Each co-permittee shall implement an ongoing program to detect and remove (or require the discharger to the municipal separate storm sewer system (MS4) to remove or obtain a separate NPDES permit for) illicit discharges and improper disposal into the storm sewer.

1. Each co-permittee shall prohibit the discharge or disposal of all used motor vehicle fluids and household chemical wastes into separate storm sewers.

2. Each co-permittee shall require the elimination of illicit connections as expeditiously as possible and the immediate cessation of improper disposal practices upon identification of responsible parties. Where elimination an illicit connection within seven (7) days is not possible, the municipality shall require an expeditious schedule for removal of the discharge. In the interim, the co-permittee shall require the operator of the illicit connection to take all reasonable and prudent measures to minimize the discharge of pollutants to the MS4. Elimination schedules should not exceed ninety (90) days, except for capital intensive projects which should not exceed one (1) year.

K. *Spill Prevention and Response:* Each co-permittee shall implement a program to prevent, contain, and respond to spills that may discharge into the MS4. The spill response program may include a combination of spill response actions by the co-permittee (and/or another municipal or private entity), and legal requirements for private entities within the co-permittee's municipal jurisdiction.

L. *Industrial & High Risk Runoff:* Each co-permittee shall implement a program to identify, monitor, and control pollutants in storm water discharges to the MS4 from municipal landfills; hazardous waste treatment, storage and disposal facilities that are subject to EPCRA Title III, Section 313; and any other industrial or commercial discharge the co-permittee determines are contributing a substantial pollutant loading to the MS4. The program shall include:

1. priorities and procedures for inspections and establishing and implementing control measures for such discharges;

2. a monitoring (or self-monitoring) program for facilities identified under this section, including the collection of quantitative data on the following constituents:

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a. any pollutants limited in an existing NPDES permit for an identified facility;
b. oil and grease;
c. chemical oxygen demand (COD);
d. pH;
e. biochemical oxygen demand, five-day (BOD_5);
f. total suspended solids (TSS);
g. total phosphorous;
h. total Kjeldahl nitrogen (TKN);
i. nitrate plus nitrite nitrogen; and
j. any information on discharges required under 40 CFR 122.21(g)(7)(iii) and (iv).

Note: Data collected by the industrial facility to satisfy the monitoring requirements of an NPDES or state discharge permit may be used to satisfy this requirement. Municipalities may require the industrial facility to conduct self-monitoring to satisfy this requirement.

M. *Construction Site Runoff:* Each co-permittee shall implement a program to reduce, to the MEP, the discharge of pollutants from constructions sites, including:

1. requirements for the use and maintenance of appropriate structural and nonstructural best management practices to reduce pollutants discharged to the MS4 during the time construction is underway;

2. procedures for site planning which incorporates considerations for potential short and long term water quality impacts and minimizes, to the MEP, these impacts;

3. prioritized inspection of construction sites and enforcement of control measures;

4. appropriate education and training measures for construction site operators; and

5. notification of all construction permit applicants of their potential responsibilities under the NPDES permitting program for construction site runoff.

Note: Notification can be accomplished through the building permit approval or platting processes.

N. *Public Education:* Each co-permittee shall implement a public education program including:

1. a program to promote, publicize, and facilitate public reporting of the presence of illicit discharges or improper disposal of materials into the MS4;

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2. a program to promote, publicize, and facilitate the proper management and disposal of used oil and household hazardous wastes,

3. a program to promote, publicize, and facilitate the proper use, application, and disposal of pesticides, herbicides, and fertilizers by commercial and private applicators and distributors.

II. SWMP REVIEW AND MODIFICATION

A. *Program Review:* Each co-permittee shall participate in an annual review of the current SWMP in conjunction with preparation of the annual report required under Part II.G. This annual review shall include:

1. A review of the status of program implementation and compliance (or non-compliance) with all schedules of compliance contained in this permit;

2. An assessment of the effectiveness of controls established by the SWMP;

3. A review of monitoring data and any trends in estimated cumulative annual pollutant loadings; and

4. An assessment of any SWMP modifications needed to comply with the Clean Water Act (CWA) § 402(p)(3)(B)(iii) requirement to reduce the discharge of pollutants to the maximum extent practicable (MEP).

Note: Information collected can be used in the annual report required by Part V.C.

B. *Program Modification:* The approved SWMP program shall not be modified by the permittee without the prior approval of the EPA, unless in accordance with items a. through c. below:

1. Modifications adding (but not subtracting or replacing) components, controls, or requirements to the approved SWMP may be made by the permittee at any time upon written notification to the permitting authority.

2. Modifications replacing a failing BMP identified in the SWMP with an alternate BMP may be requested in conjunction with the annual report required by Part II.I. below. Such requests must be made in writing, provide an analysis of why the BMP is failing or ineffective (including cost prohibitive), expectations on the effectiveness of the replacement BMP, and why the replacement BMP is expected to provide at least the same level of performance as originally expected of the BMP to be replaced.

3. Modifications made under this paragraph shall not become enforceable permit conditions until such time as the modifications are approved by EPA.

C. *Modifications Required by the Permitting Authority:* The permitting authority may require any or all co-permittees to modify the SWMP as needed to:

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1. Address contributions by the MS4 discharges to impacts on receiving water quality;

2. Include more stringent requirements necessary to comply with new state or federal statutory or regulatory requirements; or

3. Include such other conditions deemed necessary by the Director to comply with the goals and requirements of the Clean Water Act.

Modifications requested by the Director shall be made in writing, set forth the time schedule for the co-permittee(s) to develop the modification(s), and offer the co-permittee(s) the opportunity to propose alternative program modifications to meet the objective of the requested modification.

III. ANNUAL REPORT

Each co-permittee shall contribute to the preparation of an annual system-wide report to be submitted by no later than the anniversary of the date this permit is issued. The report shall include the following separate sections, with an overview for the entire MS4 and subsections for each co-permittee:

A. The status of implementing the components of the storm water management programs that are established as permit conditions (status of compliance with any schedules established under this permit shall be included in this section);

B. Proposed changes to the storm water management programs that are established as permit conditions, including an update on areas added to the MS4 due to annexation or other legal means;

C. Revisions, if necessary, to the assessments of controls and the fiscal analysis reported in the permit application under 40 CFR 122.26(d)(2)(iv) and (d)(2)(v);

D. A summary of the data, including monitoring data, that is accumulated throughout the reporting year;

E. Annual expenditures and budget for the year following each annual report;

F. A summary describing the number and nature of enforcement actions, inspections, and public education programs; and

G. Identification of water quality improvements or degradation.

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IV. IMPLEMENTATION OF POLLUTION PREVENTION MEASURES

An example of permit requirements:

POLLUTION PREVENTION MEASURE	ACTIVITY	DATE DUE
Part II A.1 - New & Re-Development	Implement construction-phase storm water runoff control program	January 1, 1994
	Modify comprehensive land use planning process to require controls for storm water quality.	January 1, 1995
	Implement requirements for post-construction storm water quality controls for new and significant re-development.	July 1, 1996
Part II A 2 - Vehicle Fluids	Implement public education program.	January 1, 1994
	Develop collection/recycling program.	January 1, 1994
	Implement collection/recycling program.	July 1, 1994
Part II A 3 - Household Hazardous Waste	Implement public education program.	January 1, 1994
	Develop collection/recycling/safe disposal program	July 1, 1994
	Implement collection/recycling/safe disposal program	January 1, 1995
Part II A 4 - Floatable	Implement public education program.	January 1, 1994
	Implement litter control program.	January 1, 1994
	Install two floatable monitoring locations (See Part V A.2)	January 1, 1994
	Complete study for targeting of structural controls.	January 1, 1995
	Complete installation of structural controls on 50 % of targeted storm sewer-sheds.	January 1, 1995
	Complete installation of structural controls on 100% of targeted storm sewer-sheds.	January 1, 1996

Part II.B.7 - Illicit Discharges and Improper Disposal	Implement public education program.	January 1, 1994
	Complete screening of the MS4.	January 1, 1997
	Complete follow up investigations based on screening results.	January 1, 1999

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V. MONITORING AND REPORTING REQUIREMENTS

A. Storm Event Monitoring. The co-permittees shall implement a wet-weather monitoring program for the MS4 to provide data necessary to assess the effectiveness and adequacy of control measures implemented under the SWMP; estimate annual cumulative pollutant loadings from the MS4; estimate event mean concentrations and seasonal pollutants in discharges from major outfalls; identify and prioritize portions of the MS4 requiring additional controls, and identify water quality improvements or degradation.

B. *Representative Monitoring:* The co-permittees shall monitor representative outfalls and/or in stream monitoring locations to characterize the quality of storm water discharges from the MS4.

1. Monitoring Requirements: (See Table V.A.1.a)

2. Outfall Descriptions

3. Alternate representative outfalls may be substituted for just cause during the term of the permit. Alternate wet weather monitoring locations may not be used until approved by the Director. Four samples shall be collected during the first year of monitoring at substitute outfalls.

NOTE: Details of wet weather screen would be contained in the SWMP. Region 6 anticipates use of a combination of in-system and in-stream sampling locations where appropriate, and a combination of inexpensive field kit sampling and non-sampling techniques to accomplish the wet weather screening. The goal of this portion of the permit is to actively look for areas of the system with poorer quality discharges during storm events.

C. *Wet Weather Screening Program:* The co-permittees shall implement a program to screen all major storm sewer-sheds for the presence of excessive pollutants in discharges from the MS4. The wet weather screening program:

D. Shall screen the entire MS4 at least once during the permit term.

1. Shall specify the sampling and non-sampling techniques, parameters, collection techniques, and analytical methods to be used for initial screening purposes. For screening samples only, sample collection and analysis need not conform to the requirements of 40 CFR Part 136 and are not subject to the requirements of Paragraphs 3, 4, and 5 below..

2. Shall establish two monitoring locations for removal of floatable material in discharges from the MS4. The amount of material collected shall be estimated in cubic yards. Floatable material shall be measured periodically as necessary for maintenance of the removal device.

3. Shall submit, along with the annual report required by Part II.I, the following information:
   a. Percent of MS4 screened during the year and the cumulative percent of system screened;

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b. An estimate of the amount of floatable material collected (cubic yards);

c. A summary of results and actions taken or proposed based on the results of the wet weather screening program.

E. *Storm Event Data:* Quantitative data shall be collected to estimate pollutant loadings and event mean concentrations for each parameter sampled. In addition to the parameters listed above, the permittee shall maintain records of the date and duration (in hours) of the storm event(s) sampled; rainfall measurements or estimates (in inches) of the storm event which generated the sampled runoff; the duration between the storm event sampled and the end of the previous measurable (greater than 0.1 inch rainfall) storm event; and an estimate of the total volume (in gallons) of the discharge sampled.

F. *Sample Type, Collection, and Analysis:*

1. For discharges from holding ponds or other impoundments with a retention period greater than 24 hours, (estimated by dividing the volume of the detention pond by the estimated volume of water discharged during the 24 hours previous to the time that the sample is collected) a minimum of one grab sample may be taken.

2. Grab samples taken during the first two hours of discharge shall be used for the analysis (if required) of pH, temperature, cyanide, oil & grease, fecal coliform, fecal streptococcus, total phenols,residual chlorine, and (at the co-permittee's option) volatile organics. For all other parameters, data shall be reported for flow weighted composite samples of the entire event or, at a minimum, the first three hours of discharge.

Note: adding volatile organics to the "grab" list avoids the problems associated with composite collection for these parameters.

3. All such samples shall be collected from the discharge resulting from a storm event that is greater than 0.1 inches in magnitude and that occurs at least 72 hours from the previously measurable (greater than 0.1 inch rainfall) storm event. Composite samples may be taken with a continuous sampler or as a combination of a minimum of three sample aliquots taken in each hour of discharge for the entire discharge or for the first three hours of the discharge, with each aliquot being separated by a minimum period of fifteen minutes.

4. Analysis and collection of samples shall be done in accordance the methods specified at 40 CFR Part 136. Where an approved Part 136 method does not exist, any available method may be used.

G. *Sampling Waiver.* When a discharger is unable to collect samples due to adverse climatic conditions, the discharger must submit in lieu of sampling data a

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description of why samples could not be collected, including available documentation of the event. Adverse climatic conditions which may prohibit the collection of samples includes weather conditions that create dangerous conditions for personnel (such as local flooding, high winds, hurricane, tornadoes, electrical storms, etc.) or otherwise make the collection of a sample impracticable (drought, extended frozen conditions, etc.). Dischargers are precluded from exercising this waiver more than once during a two year period.

VI. DRY WEATHER MONITORING.

A. *Dry Weather Screening Program:* Each co-permittee shall continue ongoing efforts to detect the presence of illicit connections and improper discharges to the MS4. All portions (but not necessarily all outfalls) of the MS4 must be screened at least once during the permit term, in accordance with the schedule set forth in PART III.A.2.

B. *Screening Procedures:* Screening methodology may be developed and/or modified based on experience gained during actual field screening activities and need not conform to the protocol at 40 CFR 122.26(d)(1)(iv)(D).

C. *Follow-up on Dry Weather Screening Results:* Each co-permittee shall implement a program to locate and eliminate suspected sources of illicit connections and improper disposal identified during dry weather screening activities. Follow-up activities may be prioritized on the basis of:

1. magnitude and nature of the suspected discharge;
2. sensitivity of the receiving water; and
3. other relevant factors.

VII. MONITORING AND RECORDS.

A. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.

B. The permittee shall retain records of all monitoring information including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of the reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least 3 years from the date of the sample, measurement, report or application. This period may be extended by request of the Director at any time.

C. Records of monitoring information shall include:

1. The date, exact place, and time of sampling or measurements;
2. The initials or name(s) of the individual(s) who performed the sampling or measurements;
3. The date(s) analyses were performed;
4. The time(s) analyses were initiated;

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5. The initials or name(s) of the individual(s) who performed the analyses;

6. References and written procedures, when available, for the analytical techniques or methods used; and

7. The results of such analyses, including the bench sheets, instrument readouts, computer disks or tapes, etc., used to determine these results.

VIII. Penalties for Violations of Permit Conditions.

A. Criminal

1. Negligent Violations The CWA provides that any person who negligently violates permit conditions implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Act is subject to a fine of not less than $2,500 nor more than $25,000 per day of violation, or by imprisonment for not more than 1 year, or both.

2. Knowing Violations The CWA provides that any person who knowingly violates permit conditions implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Act is subject to a fine of not less than $5,000 nor more than $50,000 per day of violation, or by imprisonment for not more than 3 years, or both.

3. Knowing Endangerment The CWA provides that any person who knowingly violates permit conditions implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Act and who knows at that time that he is placing another person in imminent danger of death or serious bodily injury is subject to a fine of not more than $250,000, or by imprisonment for not more than 15 year, or both.

4. False Statement The CWA provides that any person who knowingly makes any false material statement, representation, or certification in any application, record, report, plan, or other document filed or required to be maintained under the Act or who knowingly falsifies, tampers with, or renders inaccurate, any monitoring device or method required to be maintained under the Act, shall upon conviction, be punished by a fine of not more than $10,000 or by imprisonment for not more than 2 years, or by both. If a conviction is for a violation committed after a first conviction of such person under this paragraph, punishment shall be by a fine of not more than $20,000 per day of violation, or by imprisonment of not more than 4 years, or by both. (See Section 309(c)(4) of the Clean Water Act).

B. Civil Penalties - The CWA provides that any person who violates a permit condition implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Act is subject to a civil penalty not to exceed $25,000 per day for each violation.

C. Administrative Penalties - The CWA provides that any person who violates a permit condition implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Act is subject to an administrative penalty, as follows:

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1. Class I penalty Not to exceed $10,000 per violation nor shall the maximum amount exceed $25,000.

2. Class II penalty Not to exceed $10,000 per day for each day during which the violation continues nor shall the maximum amount exceed $125,000.

D. Penalties for Falsification of Reports

Section 309(c)(4) of the Clean Water Act provides that any person who knowingly makes any false material statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including reports of compliance or noncompliance shall, upon conviction, be punished by a fine of not more than $10,000, or by imprisonment for not more than 2 years, or by both.

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storage, loading and unloading, transportation, or conveyance of any raw material, intermediate product, finished product, by-product or waste product. The term excludes areas located on plant lands separate from the plant's industrial activities, such as office buildings and accompanying parking lots as long as the drainage from the excluded areas is not mixed with storm water drained from the above described areas. Industrial facilities (including industrial facilities that are Federally, State or municipally owned or operated that meet the description of the facilities listed in this paragraph (i)–(xi) of this definition) include those facilities designated under 122.26(a)(1)(v). The following categories of facilities are considered to be engaging in "industrial activity" for purposes of this subsection:

(i) Facilities subject to storm water effluent limitations guidelines, new source performance standards, or toxic pollutant effluent standards under 40 CFR subchapter N (except facilities with toxic pollutant effluent standards which are exempted under category (xi) of this definition);

(ii) Facilities classified as Standard Industrial Classifications 24 (except 2434), 26 (except 265 and 267), 28 (except 283), 29, 311, 32 (except 323), 33, 3441, 373;

(iii) Facilities classified as Standard Industrial Classifications 10 through 14 (mineral industry) including active or inactive mining operations (except for areas of coal mining operations no longer meeting the definition of a reclamation area under 40 CFR 434.11(l) because the performance bond issued to the facility by the appropriate SMCRA authority has been released, or except for areas of non-coal mining operations which have been released from applicable State or Federal reclamation requirements after December 17, 1990) and oil and gas exploration, production, processing, or treatment operations, or transmission facilities that discharge storm water contaminated by contact with or that has come into contact with, any overburden, raw material, intermediate products, finished products, byproducts or waste products located on the site of such operations; inactive mining operations are mining sites that are not being actively mined, but which have an identifiable owner/operator;

(iv) Hazardous waste treatment, storage, or disposal facilities, including those that are operating under interim status or a permit under Subtitle C of RCRA;

(v) Landfills, land application sites, and open dumps that have received any industrial wastes (waste that is received from any of the facilities described under this subsection) including those that are subject to regulation under Subtitle D of RCRA;

(vi) Facilities involved in the recycling of materials, including metal scrapyards, battery reclaimers, salvage yards, and automobile junkyards, including but limited to those classified as Standard Industrial Classification 5015 and 5093;

(vii) Steam electric power generating facilities, including coal handling sites;

(viii) Transportation facilities classified as Standard Industrial Classifications 40, 41, 42 (except 4221–25), 43, 44, 45 and 5171 which have vehicle maintenance shops, equipment cleaning operations, or airport deicing operations. Only those portions of the facility that are either involved in vehicle maintenance (including vehicle rehabilitation, mechanical repairs, painting, fueling, and lubrication), equipment cleaning operations, airport deicing operations, or which are otherwise identified under paragraphs (i)-(vii) or (ix)-(xi) of this subsection are associated with industrial activity;

(ix) Treatment works treating domestic sewage or any other sewage sludge or wastewater treatment device or system, used in the storage treatment, recycling, and reclamation of municipal or domestic sewage, including land dedicated to the disposal of sewage sludge that are located within the confines of the facility, with a design flow of 1.0 mgd or more, or required to have an approved pretreatment program under 40 CFR 403. Not included are farm lands, domestic gardens or lands used for sludge management where sludge is beneficially reused and which are not physically located in the confines of the facility, or areas that are in compliance with 40 CFR 503;

(x) Construction activity including clearing, grading and excavation activities except: operations that result in the disturbance of less than five acres of total land area which are not part of a larger common plan of development or sale;

(xi) Facilities under Standard Industrial Classifications 20, 21, 22, 23, 2434, 25, 265, 267, 27, 283, 285, 30, 31 (except 311), 323, 34 (except 3441), 35, 36, 37 (except 373), 38, 39, 4221–25, (and which are not otherwise included within categories (i)–(x)).[8]

[8] On June 4, 1992, the United States Court of Appeals for the Ninth Circuit remanded the exclusion for manufacturing facilities in category (xi) which do not have materials or activities exposed to storm water to the EPA for further rulemaking (Nos. 90-70671 and 91-70200).

Time-weighted composite means a composite sample consisting of a mixture of equal volume aliquots collected at a constant time interval.

Upset means an exceptional incident in which there is unintentional and temporary noncompliance with the numeric effluent limitations of part V of this permit because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

Waste pile means any noncontainerized accumulation of solid, nonflowing waste that is used for treatment or storage.

Waters of the United States means:

(a) All waters which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;

(b) All interstate waters, including interstate "wetlands";

(c) All other waters such as interstate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce including any such waters:

(1) Which are or could be used by interstate or foreign travelers for recreational or other purposes;

(2) From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or

(3) Which are used or could be used for industrial purposes by industries in interstate commerce;

(d) All impoundments of waters otherwise defined as waters of the United States under this definition;

(e) Tributaries of waters identified in paragraphs (a) through (d) of this definition;

(f) The territorial sea; and

(g) Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (a) through (f) of this definition.

Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA are not waters of the United States.

Part XI. State Specific Conditions

The provisions of this part provide modifications or additions to the applicable conditions of parts I through

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that I am no longer the operator of the industrial activity. I understand that by submitting this notice of termination, that I am no longer authorized to discharge storm water associated with industrial activity under this general permit, and that discharging pollutants in storm water associated with industrial activity to waters of the United States is unlawful under the Clean Water Act where the discharge is not authorized by a NPDES permit. I also understand that the submittal of this notice of termination does not release an operator from liability for any violations of this permit or the Clean Water Act."

B. Addresses

All Notices of Termination are to be sent, using the form provided by the Director (or a photocopy thereof),[4] to the Director of the NPDES program in care of the following address: Storm Water Notice of Termination, PO Box 1185, Newington, VA 22122.

Part X. Definitions

Best Management Practices ("BMPs") means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control facility site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

Bypass means the intentional diversion of waste streams from any portion of a treatment facility.

Coal pile runoff means the rainfall runoff from or through any coal storage pile.

CWA means Clean Water Act (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control Act Amendments of 1972).

Director means the Regional Administrator or an authorized representative.

Flow-weighted composite sample means a composite sample consisting of a mixture of aliquots collected at a constant time interval, where the volume of each aliquot is proportional to the flow rate of the discharge.

Landfill means an area of land or an excavation in which wastes are placed for permanent disposal, and which is not a land application unit, surface impoundment, injection well, or waste pile.

Land application unit means an area where wastes are applied onto or incorporated into the soil surface (excluding manure spreading operations) for treatment or disposal.

Large and medium municipal separate storm sewer system means all municipal separate storm sewers that are either: (i) located in an incorporated place (city) with a population of 100,000 or more as determined by the latest Decennial Census by the Bureau of Census (these cities are listed in Appendices F and G of 40 CFR Part 122); or (ii) located in the counties with unincorporated urbanized populations of 100,000 or more, except municipal separate storm sewers that are located in the incorporated places, townships or towns within such counties (these counties are listed in Appendices H and I of 40 CFR Part 122); or (iii) owned or operated by a municipality other than those described in paragraph (i) or (ii) and that are designated by the Director as part of the large or medium municipal separate storm sewer system.

NOI means notice of intent to be covered by this permit (see Part II of this permit.)

NOT means notice of termination (see Part II of this permit.)

Point source means any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharges. This term does not include return flows from irrigated agriculture or agricultural storm water runoff.

Section 313 water priority chemical means a chemical or chemical categories which: 1) Are listed at 40 CFR 372.65 pursuant to Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA) (also known as Title III of the Superfund Amendments and Reauthorization Act (SARA) of 1986); 2) are present at or above threshold levels at a facility subject to EPCRA Section 313 reporting requirements; and 3) that meet at least one of the following criteria: (i) Are listed in Appendix D of 40 CFR 122 on either Table II (organic priority pollutants), Table III (certain metals, cyanides, and phenols) or Table V (certain toxic pollutants and hazardous substances); (ii) are listed as a hazardous substance pursuant to section 311(b)(2)(A) of the CWA at 40 CFR 116.4; or (iii) are pollutants for which EPA has published acute or chronic water quality criteria. See Addendum B of this permit.

Significant materials includes, but is not limited to: raw materials; fuels; materials such as solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances designated under section 101(14) of CERCLA; any chemical the facility is required to report pursuant to EPCRA Section 313; fertilizers; pesticides; and waste products such as ashes, slag and sludge that have the potential to be released with storm water discharges.

Significant spills includes, but is not limited to: releases of oil or hazardous substances in excess of reportable quantities under section 311 of the Clean Water Act (see 40 CFR 110.10 and CFR 117.21) or section 102 of CERCLA (see 40 CFR 302.4).

Storm water means storm water runoff, snow melt runoff, and surface runoff and drainage.

Storm water associated with industrial activity means the discharge from any conveyance which is used for collecting and conveying storm water and which is directly related to manufacturing, processing or raw materials storage areas at an industrial plant. The term does not include discharges from facilities or activities excluded from the NPDES program. For the categories of industries identified in paragraphs (i) through (x) of this definition, the term includes, but is not limited to, storm water discharges from industrial plant yards; immediate access roads and rail lines used or traveled by carriers of raw materials, manufactured products, waste material, or by-products used or created by the facility; material handling sites; refuse sites; sites used for the application or disposal of process waste waters (as defined at 40 CFR 401); sites used for the storage and maintenance of material handling equipment; sites used for residual treatment, storage, or disposal; shipping and receiving areas; manufacturing buildings; storage areas (including tank farms) for raw materials, and intermediate and finished products; and areas where industrial activity has taken place in the past and significant materials remain and are exposed to storm water. For the categories of industries identified in paragraph (xi) of this definition, the term includes only storm water discharges from all areas (except access roads and rail lines) listed in the previous sentence where material handling equipment or activities, raw materials, intermediate products, final products, waste materials, by-products, or industrial machinery are exposed to storm water. For the purposes of this paragraph, material handling activities include the:

[4] A copy of the approved NOT form is provided in Appendix D of this notice.

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Table V.A.1.a. - Representative Monitoring Requirements

PARAMETER	MONITORING FREQUENCY				
	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Biochemical Oxygen Demand (BOD_5) (mg/l)	Two/year	Two/year	Two/year	Six/year	Two/year
Chemical Oxygen Demand (COD) (mg/l)	Two/year	Two/year	Two/year	Six/year	Two/year
Total Suspended Solids (TSS) (mg/l)	Two/year	Two/year	Two/year	Six/year	Two/year
Total Dissolved Solids (TDS) (mg/l)	Two/year	Two/year	Two/year	Six/year	Two/year
Total Nitrogen (mg/l)	Two/year	Two/year	Two/year	Six/year	Two/year
Total Kjeldahl Nitrogen (TKN) (mg/l)	Two/year	Two/year	Two/year	Six/year	Two/year
Total Phosphorus (mg/l)	Two/year	Two/year	Two/year	Six/year	Two/year
Dissolved Phosphorus (mg/l)	Two/year	Two/year	Two/year	Six/year	Two/year
Oil & Grease (mg/l)	Two/year	Two/year	Two/year	Six/year	Two/year
Total Cadmium (ug/l)	Two/year	Two/year	Two/year	Six/year	Two/year
Total Copper (ug/l)	Two/year	Two/year	Two/year	Six/year	Two/year
Total Lead (ug/l)	Two/year	Two/year	Two/year	Six/year	Two/year
Total Zinc (ug/l)	Two/year	Two/year	Two/year	Six/year	Two/year
Ph (S.U.)	Two/year	Two/year	Two/year	Six/year	Two/year
Hardness (as $CaCO_3$) (mg/l)	Two/year	Two/year	Two/year	Six/year	Two/year
Temperature (°C)	Two/year	Two/year	Two/year	Six/year	Two/year
Other Water Quality Parameters[1]	One/year	One/year	One/year	Six/year	One/year

[1] Other Water Quality Parameters to be monitored include any parameter for which the State has established numeric water quality criteria applicable to the receiving waters of the MS4 and which was detected in the wet weather monitoring required by the permit application.

3. Shall establish two monitoring locations for removal of floatable material in discharges from the MS4. The amount of material collected shall be estimated in cubic yards. Floatable material shall be measured periodically as necessary for maintenance of the removal device.

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3) EPA, Ubran Targeting and BMP Selection, November 1990

4) Charlotte, North Carolina; Storm Water Discharge Permit Application: Part II

5) Urban Runoff Managment Information/Education Products; Developed by the USEPA, Region 5 Water Division, Wetlands and Watershed Section Watershed Management Unit. Call Kim Hankins at (404) 260-8328 for information.

6) Water Quality Urban Runoff Solutions, APWA Special Report #61.

7) Storm Water Management For Industrial Activities, Developing Pollution Prevention Plans and Best Management Practices; EPA-R-92-006.

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10) Storm Water Quality Best Management Practices for Industrial Activities; North Central Texas Council of Governments; February 19, 1993.

11) Investigations of Inappropriate Pollutant Entries into Storm Drainage Systems; A Users Guide; EPA; EPA/600/R-12/238; January 1993

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American Public Works Association
106 West 11th Street, Suite 1800
Kansas City, Missouri 64105
(816) 472-6100

Storm Water Publications

Stormwater: Issues and Answers (APWA) 1989. 16 pp.

Members $20 per order; Non-Members $30 per order; (Sold in groups of 10)

Why does every community need a drainage management plan? What are the options? Whose responsibility is it? And how will you pay for it? Here are the answers. This insightful booklet is designed to provide elected and appointed officials, as well as concerned citizens, with a better understanding of the issues involved in managing urban stormwater drainage. Public officials will find it to be an indispensable resource when developing their own management plans.

Water Quality: Urban Runoff Solutions. Spec Report 31. (APWA) 1991. 32 pp. ISBN 0-917084-18-7

Members $25; Non-Members $35

The title says it all: this practical information-packed manual offers solutions to challenging stormwater problems. Get the inside story on pre-tested programs, an learn how they can fit into your own comprehensive plan for stormwater management. This practical report will clue you into best management practices, as well as correct ways to conduct a fiscal analysis and coordinate an effective stormwater program.

A Study of Nationwide Costs to Implement Municipal Stormwater Best Management Practices. Final Report. (Water Resources Committee, APWA, Southern California Chapter) 1992. 105 pp. ISBN)-017084-10-5

Members $15; Non-Members $20 This comprehensive study was conducted to determine the order-of-magnitude of costs that municipalities would incur under several different stormwater management program scenarios. Over 100 agencies were contacted to obtain information on current programs and projected costs for developing and maintaining best management programs. An invaluable planning tool, this report examines regulatory history, the existing permit process, monitoring costs, the cost of controls, and costs to implement best management practices.

NEW NEW NEW NEW NEW NEW

Available late 1993

Operations and Maintenance: Stormwater Practices (APWA) 1993. 100 pp.

This thorough resource explores all aspects of maintenance and operations of urban storm water facilities, including preventive maintenance functions, organization of operations and maintenance departments, facility inventory, financing operations and maintenance, and management of contract services. Review storm water problems and priorities and learn how to avoid the costly consequences of ill-managed facilities. Learn methods that have worked for other agencies, and select the best approaches for you.

INFORMATION SERVICES

Information Services provides comprehensive information on a wide variety of topics. Recently the department acquired stormwater best management practices documents from several agencies. There are two ways you can obtain information:

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For more information about the new publication and other APWA information services, please fax your request to (816) 472-1610, attention: Information Services or mail it to Information Services, American Public Works Association, 106 West 11th Street, Kansas City, Missouri 64105. Questions? Call (816) 472-6100.

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APWA EDUCATION FOUNDATION

American Public Works Association
106 W. 11th St., Suite 1800
Kansas City, MO 64105-1806
816 472-6100 Ext._____
(Fax) 816 472-1610

TO: Stormwater Management Registrants

FROM: Lani Himegarner
Director of Education

RE: APWA Education Foundation Programs

Welcome to the program, **Stormwater Management: Municipal Techniques and Strategies.**

It is very important to us that you find the information useful and the day worthwhile. Please fill out the evaluation form to help us continually improve the program.

On the next page is a list of the seminars and workshops which are currently available. Other seminars are under development. Also available are packaged programs which provide an instructor's guide and student manuals. If you wish to receive brochure(s) for one or more of the listed programs, please return a copy of that page to us.

The APWA Education Foundation is also able to present these programs at your site. By working cooperatively, we can provide education and training for your staff members at a reasonable fee. Additional benefits are that you save time away from the job for travel as well as travel costs.

If you have questions or comments, please call me at (816) 472-6100, extension 534.

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City, County and State *December, 1990*

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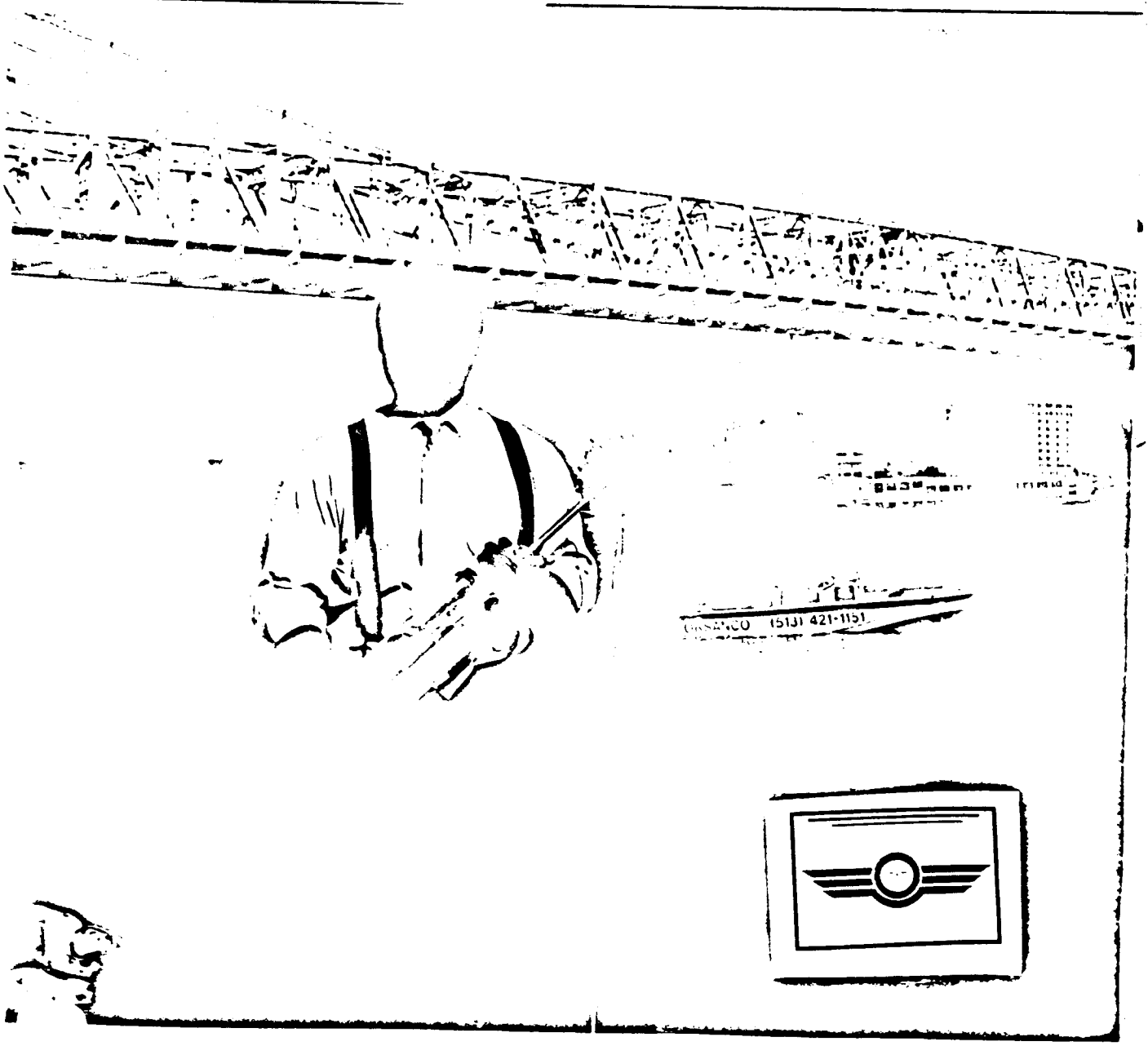

Alan H. Vicory, Jr., is the Executive Director and Chief Engineer of the Ohio River Valley Water Sanitation Commission. *More on page 13.*

Featuring Erosion Control

R0057133

Urban Stormwater: An Overview for Municipalities

GAIL BOYD
Vice President
and
NANCY GARDINER
Assistant Project Scientist,
Water Pollution Control Group,
Woodward-Clyde,
Oakland, California

Editor's Note: This is the first of three articles PUBLIC WORKS will present over the next several months to help our readers understand and deal with a recently-issued set of federal water quality regulations (i.e., EPA's new NPDES stormwater requirements) in a practical manner. This article covers the following:

- A description of the major processes that typically contribute to or result in stormwater quality problems.
- A description of typical urban stormwater characteristics.
- A historical review of the regulatory efforts to control urban stormwater quality problems.
- An overview of the NPDES regulations that apply to most large- and medium-size U.S. cities (and many smaller communities as well.).

Future PUBLIC WORKS issues will present articles on the following topics:

- Descriptions of strategies that municipal stormwater dischargers may wish to consider when planning their efforts to develop the information required for NPDES permit applications.
- Descriptions of strategies for evaluating and selecting among candidate stormwater controls (i.e., best management practices [BMPs] and associated implementation programs).
- Discussions of some technical and institutional issues that public works engineers and planners have found especially challenging in their efforts to develop and implement practical stormwater quality control programs.

In addition, a Woodward-Clyde team is presently writing a full-length book on municipal and industrial stormwater pollution and control strategies.

DURING the past 20 years, the findings from several major research and demonstration programs have shown that urban stormwater typically contains pollutants that limit its subsequent use as a resource and or may lead to impacts when it is discharged to receiving waters. The control of stormwater-related pollution is a new field of endeavor for many public works engineers and planners, and it is sure to present challenges as well as opportunities.

The increased recognition of the pollution potential of urban stormwater has led to several important regulatory developments, including the following:

- EPA has developed regulations that require municipalities and industries to apply for and obtain stormwater discharge permits under amended provisions of the National Pollutant Discharge Elimination System (NPDES). These regulations were circulated in draft form for public review (via the *Federal Register*, December 7, 1988), have evolved through a process of revision and refinement for nearly two years, and were recently released in final form. Municipalities (and or flood control or drainage agencies) in most sizeable urban areas are required to compile certain existing information and to conduct prescribed field studies. In effect, municipal dischargers will be required to file permit applications in which they describe themselves (and any co-applicants), describe their stormwater conveyance systems, and characterize their systems' flows and discharges during dry weather and wet weather. The applicants will also be required to describe their present efforts and facilities for controlling stormwater quality, and to supplement their present capabilities by obtaining adequate regulatory authority and implementing appropriate BMPs to the "maximum extent practicable."
- Several EPA regional offices and state-level water quality control agencies have also initiated focused programs (under other provisions of federal and or state water quality laws) that have required certain designated municipal and industrial stormwater dischargers to define and describe their stormwater conveyance systems, conduct studies to characterize wet-weather and dry-weather discharges from stormwater systems, and develop and implement practical programs for controlling stormwater quality.

Although these other programs derive from different legal institutional origins and impose somewhat different requirements, they are important in that they collectively will encompass many U.S. communities (well beyond just the cities that are over 100,000 population). In fact, the combined effect of the final NPDES regulations and these other programs (i.e., under Sections 304(l), 319, and 402(p)(2)(E) of the Federal Clean Water Act and state and local initiatives) is that many public works engineers and planners will be faced with the need to characterize and control stormwater-related water quality problems. The list of such communities will go well beyond those inferred by the original definitions provided in the draft NPDES stormwater regulations (i.e., December 7, 1988).

Many municipal officials and public works professionals have anticipated federal and or state stormwater regulations of some type for several years and have tracked their evolution with interest. Nonetheless, the specific requirements of the final NPDES stormwater regulations and other state and or local stormwater regulatory programs will still present challenges because of the breadth and degree of detailed investigation and planning they entail. Perhaps even more significant in the long term are the commitments municipalities will be required to make regarding their implementation and continuing support of various BMPs, some of which may be somewhat foreign to their routine public works programs.

This article provides a general background description of the major processes that lead to stormwater-related water quality problems. It continues with a discussion of how the resultant problems can be considered and prioritized in planning and decision-making context. It concludes with an overview of the historical development of the new NPDES regulations and a brief summary of what they require. Subsequent PUBLIC WORKS articles will describe the regulations in greater detail.

Major Stormwater Processes

When it rains in an urban area, the rain collects pollutants from many sources, and the runoff carries these pollutants and eroded sediments through stormwater conveyance sys-

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Table 2 – Information Required for Part 2 of the NPDES Permit Application

(i) **Adequate Legal Authority:**
Demonstration that the Applicant will be able to exercise adequate legal authority to control discharges to the municipal separate storm sewer system

(ii) **Source Identification:**
Description of any major outfalls not fully described in the Part 1 application

(iii) **Characterization Data:**
Sampling and analysis of selected major outfalls (to identify and characterize illicit connections and illegal dumping)
Sampling and analysis of 5 to 10 representative outfalls to characterize overall system
Extrapolation of measured data to estimate annual pollutant load for overall system
Plans for continuing monitoring program to develop loading data and event mean concentrations

(iv) **Proposed Management Program:**
Description of proposed structural and non-structural control measures
Description of proposed program for detecting and eliminating illicit connections and illegal dumping
Description of proposed program to monitor industrial runoff
Description of proposed program to implement and maintain structural and non-structural BMPs

(v) **Assessment of Controls:**
Estimate of the anticipated overall effectiveness of the proposed control measures (reductions in loadings)

(vi) **Fiscal Analysis:**
Estimate of the capital, operating, and maintenance costs of the proposed characterization and control programs (fiscal year by fiscal year projections)

(vii) **Roles/Responsibilities:**
Description of the roles and responsibilities of the various entities that may have joined together to submit an NPDES application

eration of local conditions, processes, and public sentiments; and/or were established to guard against chronic (rather than short-term) effects of pollutants. This latter point is important, because stormwater-borne pollutants usually cause only short-term exceedances of criteria in most flowing receiving waters.

The new NPDES stormwater regulations require municipal dischargers to collect and report a broad variety of information on their respective agencies, systems, and discharges. However, they do not specifically require municipal permit applicants to define or evaluate local water quality "problems," or to establish their respective share of the responsibility for causing or rectifying "problems." This lack of specificity in the regulations will be welcomed by some dischargers, but it may cause others difficulties because experience has repeatedly shown the need for some evaluation of this type before a public agency can implement strategic control plans or commit to a large-scale control program (such as using BMPs, as called for by the new regulations).

History of Water Quality Regulations

In 1972, Congress passed significant amendments to the Federal Water Pollution Control Act (commonly referred to as the Clean Water Act or CWA). These amendments were provisions that were specifically focused on controlling point sources of pollutants that were being discharged to navigable waters of the U.S. The newly formed EPA then implemented the NPDES permit program, which provides administrative and legal mechanisms for issuing conditional discharge permits and enforcing their respective stipulations.

The NPDES program has focused almost entirely on the goal of reducing pollutants from municipal sanitary sewage and industrial process wastewater, because these point sources were identified as being responsible for poor, often drastically degraded, water quality conditions.

As noted previously, many engineers, the public, and most environmental lawmakers were inclined to deal with stormwater runoff as though it were a lesser priority, even though it was known to contain significant quantities of pollutants in most locations. However, during the past 20 years or so, attitudes have changed considerably, for example:

We now understand the need to control the concentrations of certain toxic pollutants to very low levels (in the interest of protecting human health and sensitive aquatic life).

We now recognize that rainfall picks up a multitude of pollutants as a result of falling on and draining off of urban surfaces, and that the runoff also transports pollutants that are dumped or improperly discharged into stormwater systems.

We now know that stormwater-borne pollutants can (and do) cause problems for water supply, recreation, and other beneficial uses, because they threaten human health and interfere with aquatic ecosystems.

We now see the need to shift priorities somewhat and begin to employ control strategies that apply to both traditional point sources (i.e., municipal and industrial wastewater) and to stormwater-borne pollutants.

The history of federal rulemaking regarding stormwater discharges has been long and complex. Although EPA has had sustained interest and involvement in exploring the technical issues surrounding urban stormwater problems and control strategies, it has experienced difficulties in establishing a nationwide regulatory program. As summarized in the preamble of the new NPDES stormwater program (published in the December 7, 1988 *Federal Register*), EPA has long been both stimulated and frustrated by the efforts of several environmental activist groups. Nonetheless, it has managed to issue a set of final regulations. On February 4, 1987, Congress passed the Water Quality Act of 1987 (WQA), which (among many other things) amended the CWA by adding a new subsection "p" to existing Section 402 of the CWA. The amendments call for a phased approach to control pollutants that are mobilized by and carried by stormwater discharges. Section 402(p) established phased permit application requirements, permit issuance deadlines, and permit compliance conditions for different categories of stormwater discharges.

Overview of Regulations for Municipalities

Section 402(p) of the CWA required EPA to establish regulations governing stormwater discharge permit application requirements under the NPDES program. It is interesting to note that for the purposes of most technical assessments, stormwater from urban and industrial areas traditionally have been thought of as being diffuse sources or "nonpoint" sources of pollution. However, from the legal standpoint, most municipal stormwater is now considered by EPA to be a "point" source, because it is discharged through conveyance facilities (such as separate

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the new NPDES Stormwater Permit program.

Pollutants in Stormwater

The principal types of pollutants found in stormwater and their resultant potential adverse effects on receiving waters are typically as follows:

- Sediment. Suspended sediment in itself is often not considered to be a pollutant, but it can lead to numerous adverse effects on aquatic ecosystems. Biological impacts of high sediment levels include reduced light penetration, interference with sight feeding and photosynthesis, and clogging of gills and filter systems in aquatic organisms. General aquatic habitat can be degraded if streambed accumulations of sediment bury benthic organisms and or interfere with egg deposition and hatching. Sediments in runoff from developed areas can also serve as "carriers" of pollutants, because pesticides, heavy metals, and other toxic chemicals tend to bind to clay and organic particles.
- Oxygen demanding substances. Decomposition of oxidizable organic matter (typically measured as BOD, COD, or TOC) depletes dissolved oxygen levels in receiving waters, especially in slower moving streams, estuaries, and lakes. However, urban runoff is generally not a primary cause of problems associated with depressed dissolved oxygen levels.
- Nutrients. The levels of phosphorus and nitrogen in runoff can lead to accelerated eutrophication in downstream receiving waters. Phosphorus is generally the controlling nutrient in freshwater systems. Surface algal scums, algal blooms, water discoloration, unpleasant tastes and odors, depressed oxygen levels (as the bloom decomposes), and release of toxins are among the problems encountered.
- Toxic substances. Heavy metals are observed in stormwater more frequently and at more significant levels than organic toxic compounds. Both are concerns, however, because of their potential toxic effects on aquatic life and their potential to contaminate drinking water supplies. The heavy metals having the highest concentrations in urban runoff are typically copper, lead, and zinc, with cadmium a distant fourth. Organic compounds most commonly found in urban stormwater are those associated with herbicides, pesticides, and wood preservatives.
- Oil and grease. Oil and grease have both esthetic and ecosystem implications. The category includes a wide variety of hydrocarbon compounds, some of which (e.g., polynuclear aromatic hydrocarbons, PAHs) are known to accumulate in sediments and to be toxic to aquatic life at low concentrations. Hydrocarbons often show up as a film or sheen on the water's surface, but other forms (especially weathered crankcase oil) tend to be present in solution or in emulsion and may produce no sheen.
- Bacteria. Fecal coliform levels in urban runoff can usually be expected to exceed public health standards for water contact recreation and shellfish harvesting, and they frequently impair these uses.

Assessment of Stormwater Problems

Because every pollution control strategy must begin with an assessment of the problems themselves, it is important to formally define what constitutes a problem. In the area of stormwater quality planning, this task can be challenging, because (ideally) it involves structuring the problem well enough to adequately identify sources, define appropriate clean-up goals, select effective control strategies, and quantify the costs and associated benefits. As noted, the problems associated with urban stormwater runoff vary considerably in type, severity, and duration; and these in turn vary from location-to-location and from time-to-time at any given location. Because of this inherent variability, it is often difficult to classify and prioritize problems.

Stormwater-borne pollutants can be defined as causing a "problem" if they result in any of the following impacts:

- Interference with the desired *beneficial uses* of the receiving waters (i.e., at the point of discharge and or within the zone of influence of the discharge). Examples include impacts on water quality that interfere with water supplies and or restrict recreational uses.
- A significant adverse impact on *aquatic ecosystems* resulting from degradation of water quality and/or changes in essential habitat characteristics. Examples include direct effects on biota due to water quality and/or indirect physical effects on habitat (e.g., sediment deposition).
- A significant increase in the frequency, duration, and or degree of exceedances of applicable *water quality standards or criteria*.

This approach of using three different definitions of a "problem" may be especially useful in cases where prescribed water quality standards or criteria are over-protective or under-protective for a specific location. It should be noted that over-protective criteria are not uncommon, especially in cases where the official criteria were established several years ago; were established without taking adequate consid-

Table 1—Information Required for Part 1 of the NPDES Permit Application

(i) **General Information:**
- Name
- Address
- Telephone number
- Ownership status
- Institutional status

(ii) **Legal Authority:**
- Description of existing legal authority to control discharges to the municipal system
- Description of additional authority required to control discharges
- Schedule and commitment to seek additional authority

(iii) **Source Identification:**
- Description of historic use of controls to limit discharges
- Maps of municipal system and surrounding locale
- Location of "outfalls" to "waters of the U.S."
- Description of corresponding watersheds for each major outfall (e.g., land uses, industrial activities, NPDES permittees, waste facilities, existing NPS controls)

(iv) **Discharge Characterization:**
- Precipitation data
- Existing data on stormwater from municipal outfalls (quality and quantity)
- Descriptions of receiving waters (condition and regulatory status)
- Field screening analysis for illicit connections and/or illegal dumping (visual observations plus non-standard methods of chemical analysis)
- Description of proposed characterization plan (workplan to guide Part 2 studies)

(v) **Management Programs:**
- Description of existing control measures (structural and non-structural)
- Description of existing program for identifying illicit connections

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tems and into the local receiving waters. There, the pollutants and sediments can degrade water quality and or impact aquatic ecosystems. The specific pollutants involved, the washoff and transport mechanisms, and the extent and importance of the resultant impacts vary considerably from city-to-city, from location-to-location within a given city, and from time-to-time at any given location—depending upon numerous physical, chemical, and biological factors. The major processes and pertinent factors are summarized here.

The major processes that collectively can lead to stormwater-related impacts at a given location include the following:

♦Atmospheric scrubbing. Airborne particles (e.g., dust, soot, aerosols) can be scrubbed out of the atmosphere by falling rain. Therefore, rain itself contains more than clean water.

♦Surface washoff. Rainfall washes pollutants off of virtually all urban surfaces (e.g., roadways, parking lots, buildings, storage and equipment areas, landscaped areas, construction sites, vacant lots, parklands, open space).

♦Other sources. Pollutants from illicit sewer connections and illegal dumping have been found to be important additional sources in most urban areas.

♦Erosion and scour. Rainfall and runoff erode pollutants, soil, and finely-divided minerals from exposed land surfaces and scour them from stream banks and streambeds.

♦Transport. Depending upon their physical and chemical form, pollutants may float, dissolve, or become suspended and move with the main volume of runoff.

♦Deposition. Pollutants are carried with the storm runoff until they are deposited by adhering to surrounding surfaces, settling out, and or interacting with one another or with other processes that remove them from the runoff. During periods of intense runoff, some of these previously-deposited pollutants can be re-mobilized and transported to other locations.

Some major factors that influence the above processes (and, hence the extent and severity of any stormwater-related impacts at a given location) include the following:

♦Meteorological conditions. These include storm intensity, storm volume and duration, the time period between storm events (during which some pollutants can accumulate in parts of the watershed, and soils can dry out), and local air quality.

♦Watershed characteristics. The most important physical characteristics of the watershed usually include topography, soil types, vegetative cover, amount of impermeable areas (e.g., pavement, buildings), land uses (and the associated activities), and the effects of various stormwater management facilities and practices.

♦Conveyance system characteristics. Important factors governing runoff quantities and characteristics in natural stream channels and improved or man-made channels are the channels' hydraulic capacities at key locations, their corresponding slopes, the stability of their banks (regarding erosion), the physical and chemical properties of bottom sediments, and the amounts and types of vegetation that are present.

♦Available pollutants. The types of pollutants commonly found in urban runoff include sediments, oxygen demanding substances, nutrients, toxic substances (e.g., heavy metals and complex organic compounds), oil and grease, and bacteria.

♦Receiving water characteristics. The impacts of stormwater runoff on receiving waters depend on the type of water body (e.g., wetlands, creeks, rivers, lakes, estuaries, ocean), local hydrographic and hydrodynamic conditions, cumulative pollutant loadings (i.e., pollutant contributions from other sources), and the beneficial uses and types of aquatic ecosystems that the water body is expected to support.

Sources of Pollutants

The principal sources of pollutants that are discharged from municipal separate stormwater conveyance systems generally include the following:

Atmospheric deposition. A significant source of pollutants in urban areas, and some industrial sites, is atmospheric deposition in the form of both wetfall and dryfall. Some atmospheric pollutants attach to and remain on urban surfaces, but a significant fraction may wash off during storm events. Areas with poor control of general or fugitive air emissions can contribute significant loads to runoff from this source.

Erosion. Soil erosion can be an important source of pollutants in runoff. Erosion can result from stream bank erosion produced by high runoff flow rates, and from the disturbance of land surfaces during construction or renovation. For example, site clearing and grading operations during construction can expose large areas of erodable surface soils. Unless adequate erosion controls are implemented and maintained, large quantities of sediment can be delivered to storm sewers, drainage channels, streams, and receiving waters. Such soil-derived sediment typically carries attached nutrients, organic matter, and often other adsorbed pollutants.

Construction materials. Materials used in the construction and maintenance of buildings and infrastructure are major sources of pollutants. Various heavy metals, for example, are common materials in many structures (e.g., flashing and shingles, gutters and downspouts, copper and galvanized piping, metal plating, paints, wood preservatives). Over time, these surfaces corrode, flake, dissolve, decay, or are subject to leaching, thereby allowing various potentially-harmful heavy metals to be carried away in urban runoff. The process can be exacerbated by the acidity of the rainfall.

Manufactured products. Manufactured products used in developed areas and exposed to the elements are major sources of pollutants in urban runoff. Some examples include heavy metals and synthetic organic compounds present in the following types of products: fertilizers, insecticides, algicides, and fungicides; automobile brake linings, clutch facings, and tire compounds; lubricants, hydraulic fluids, combustion products, and automotive coolants; and solvents, detergents, and other cleaning compounds.

Plants and animals. Other sources of pollutants that accumulate and subsequently wash off of urban surfaces include plant debris and animal excrement (which are normally recycled in natural systems). Trees and shrubs deposit pollen, fruit, bark, twigs, and leaves which enter into stormwater runoff. During the growing season, nutrients leach from tree leaves and stems during storms and are quickly conveyed to the storm sewers, drainage channels, or streams, if the ground is saturated or if the tree's drip lines extend over impervious areas.

Accidental spills and unintended discharges. Another source of pollutants in stormwater systems is accidental spills. This could include virtually any pollutant, depending upon the nature of the spill. Leaking underground storage tanks, faulty septic systems, leachate from sanitary landfills, and improperly managed hazardous waste treatment, storage, and disposal sites can also contribute to pollutants in storm sewers.

Although the above focuses on urban runoff related pollutant sources, there are two other very important sources of pollutants that are carried through urban stormwater conveyance systems. They are designated by EPA as "illicit connections" and "illegal dumping." Illicit connections include both deliberate and inadvertent discharges of sanitary sewage or industrial process or wash waters to storm drains. Illegal dumping refers to the dumping of solid or liquid wastes (e.g., the illegal dumping of spent motor oil and antifreeze is very common in most urban areas). These pollutant sources have been identified as a widespread and serious problem, and the detection and elimination of such discharges are major focuses of

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storm sewers or flood control channels) which, at their respective points of discharge to receiving waters, are regarded as point sources under the CWA.

The new regulations regard urban stormwater as a point source to be controlled using the provisions of NPDES. The newly-established NPDES permit application requirements pertain to the following: stormwater discharges associated with industrial activity, discharges from large municipal separate stormwater systems (i.e., systems serving a population of 250,000 or more); and discharges from medium municipal separate stormwater systems (i.e., systems serving a population of 100,000 or more, but less than 250,000).

The general philosophy guiding the municipal stormwater regulations is that control strategies and programs should be site-specific, rather than generalized in their approach. Furthermore, the philosophy appears to stress and encourage the applicants' introspection and self-initiation, rather than their compliance with a rigid set of water quality criteria or the implementation of some externally prescribed set of controls. In effect, the regulations pose a series of questions that municipal applicants are to answer in a stepwise manner, over the course of the application process. Responses to these questions will draw upon both existing factual information and the results of studies that are to be performed in the applicants' study area. Stated very simply, these questions deal with the following kinds of information:

- Who are you?
- What is your storm drainage system like?
- What pollutants get into your system?
- Where do these pollutants come from, where do they go, and what is the condition status of the receiving waters?
- What do you presently do to minimize pollution problems?
- What else do you need to do?
- What additional authority do you need to obtain to take effective action?

The NPDES stormwater regulations specify a series of pointed requirements grouped within two separate parts of the permit application. Large municipalities are to submit Part 1 of the application within one year of the publication of the final regulations, and Part 2 within two years of publication. Medium municipalities are to submit both parts at a later time.

Tables 1 and 2 provide a more accurate summary of the information required by Part 1 and Part 2 of the NPDES stormwater permit application process, respectively. Subsequent issues of PUBLIC WORKS will provide additional information on the requirements and practical strategies for obtaining the required information. □□□

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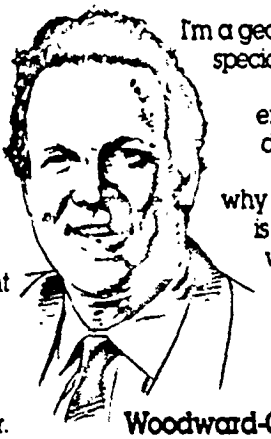

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Historically, pollution from separate storm sewers has received little attention by the general public on a national scale. Indeed, a handful of comprehensive stormwater management programs has been implemented in recent years. But a lack of widespread attention has existed to date primarily because water quality problems associated with stormwater discharges have not been readily apparent to the general public, and are usually less dramatic than more visibly detrimental effects such as flooding. In addition, efforts to improve water quality under the National Pollutant Discharge Elimination System (NPDES) program have traditionally focused on reducing pollutants in discharges from municipal wastewater treatment plants and industrial process wastewater.

However, pollution from separate stormwater discharges has negatively affected U.S. waters in a variety of ways, including increased sediment loads, nutrient enrichment, decreased dissolved oxygen concentrations, bacterial contamination, discharges of high levels of metals and organics, thermal effects, and aesthetic impacts such as trash and other debris in the receiving water. Also important is the effect of increased volumes of stormwater runoff that is generated during storms. Large intermittent volumes of runoff can reduce the diversity of aquatic organisms by changing the hydraulics and chemistry in receiving waters.

As a first step to address stormwater problems, 173 cities, 47 counties, and an estimated 100,000 industries will be required to submit NPDES permit applications during the next 2 to 3 years for their stormwater discharges. The purpose of the regulations is to begin the process of reducing nonpoint-source (NPS) pollutants associated with urban stormwater.

The clock started ticking for cities and industries when the NPDES permit application regulations for stormwater discharges were published in the November 16, 1990, *Federal Register*. The deadlines for municipalities and industries are different (see Table). These dates are later than the statutory deadlines established by Congress in the Water Quality Act (WQA) of 1987—a reauthorization of the Clean Water Act (CWA). EPA has indicated that, while the CWA deadlines remain enforceable, the deadlines established in the final rule are necessary for the development of enforceable and sound stormwater permits. EPA's advice regarding deadlines was published in the November 16, 1990, *Federal Register* as part of the preamble to the final rule: "Dischargers concerned with complying with the statutory deadline should submit a permit application as required under this rulemaking as expeditiously as possible."

The final regulations are far-reaching in that they significantly affect U.S. cities serving millions of people. The requirements for obtaining permits, especially for municipalities, are not trivial. Some cities have anticipated the new regulations and have already begun the permit application process. Many cities and counties have not adequately prepared themselves, financially or technically, to prepare the stormwater permit applications. Indeed, many cities are facing reduced revenues as the economy slips into a recession.

URBAN RUNOFF PROGRAM

An important element in the development of the stormwater regulations was the Nationwide Urban Runoff Program (NURP). This program was conducted between 1978 and 1983 and received funding and guidance from EPA. Twenty-eight cities across the U.S. generated data used to characterize stormwater discharges from residential, commercial, and light industrial areas. NURP data indicated that annual suspended solids loads from separate storm sewers sampled during the study were about an order of magnitude greater than effluent from secondary wastewater treatment plants. Chemical oxygen demand was comparable in magnitude to that found in effluent from secondary wastewater treatment plants. Data collected in NURP showed that fecal coliform counts in urban runoff were in the tens to hundreds of thousands per mL of

An infiltration system, previous page, under sod near the White House in Washington, D.C., reduces the volume of stormwater runoff. [illegible]

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jurisdiction that they are covered by the permit. In addition, the permit authority could require some group members in its jurisdiction to submit individual applications. It may be appropriate for a potential group member to contact the respective permit authority before becoming part of a group application. As of mid-January 1991, Missouri indicated that it will not accept group permit applications because the Missouri Clean Water Law makes group applications illegal.

An advantage of using the group application approach over the baseline general permit is that the group would be able to negotiate the terms of its model permit with EPA. The baseline general permit is not negotiable.

The third option for industrial dischargers is to apply for the baseline general permit, also known as the notification of intent to be covered by the baseline general permit (NOI). The baseline general permit would include permit conditions for many types of industries. This permit application approach is potentially the easiest for an industrial stormwater discharger to use. The general permit application is expected to require only basic information about a discharger and does not require any sampling. The problem with this approach is that the application requirements, which are actually part of the baseline general permit itself, have not been finalized yet. While it would be desirable to see the baseline general permit conditions before applying for the permit, timing is a problem.

As of mid-January 1991, the proposed baseline general permit was still being reviewed by the Office of Management and Budget (OMB). After this review is complete, the proposed baseline general permit will be published in the *Federal Register*. EPA will take comments on the proposed general permit and then develop the final draft general permit, which will probably require OMB review again. If industries choose the baseline general permit option, they are banking on the final baseline general permit being available before November 18, 1991. If the baseline general permit is not available by November 18, 1991, a discharger who intended to use this application method could conceivably be in noncompliance after that date.

As of mid-January 1991, only 17 states had general permit issuing authority: Arkansas, Colorado, Illinois, Kentucky, Minnesota, Missouri, Montana, New Jersey, North Dakota, Oregon, Rhode Island, Utah, Washington, West Virginia, and Wisconsin. An industrial discharger that is considering applying for the general permit should contact its permit authority to find out whether the permit authority has or intends to get general permit authority.

COOPERATION PAYS OFF

The new regulations contain methods for characterizing a separate stormwater system and developing a stormwater management plan. Fifteen jurisdictions in the south San Francisco Bay area have had experience in developing and implementing a successful stormwater management plan.

Numerous field studies have shown that there are a variety of water-quality problems in various parts of the San Francisco Bay Estuary system, including the Lower South Bay. In these areas, elevated concentrations of several classes of water pollutants cause a variety of adverse effects on beneficial uses. The water-quality issues that have triggered the most concern are those related to toxic pollutants and their acute and chronic effects on aquatic ecosystems. The substances of particular concern in this area include heavy metals, pesticides and herbicides, and oil and grease. Coliform bacteria and sediments are also often cited as being related to water-quality and ecosystems issues in the receiving waters.

Thirteen cities, a county, and a water district in Santa Clara Valley, Calif., joined together to respond to NPS requirements promulgated as a result of the San Francisco Regional Water Quality Control Board's 1986 basin plan. The Santa Clara Valley stormwater management program was initiated by these jurisdictions to provide a sound technical basis for developing effective plans for reducing water-quality problems attributed to NPS runoff. An *ad hoc* NPS task force was formed to guide their collective efforts to develop an action plan that included conducting the required NPS studies and developing a strategy for selecting and implementing effective control measures.

As a result of numerous strategy meetings, members of the participating jurisdictions made the following decisions regarding implementation of the stormwater management program.

Cooperative approach. Members agreed to work together and function as a unified entity to effectively address the present and emerging NPS regulations and policies. The water district agreed to be the lead agency for the unified entity. All participants agreed to provide support in the form of personnel time, in-kind services, and actual funding. The task force serves as a steering committee for the control programs affecting all the jurisdictions.

Budgeting. Participants dedicated short- and long-term funding for the stormwater program.

Permit process. The participants agreed to act as co-applicants to obtain a NPDES permit for stormwater discharges.

More than 120 separate NPS control measures were considered during development of the stormwater management program. Of these, 68 control measures were judged to be most appropriate for Santa Clara Valley and were included in the final stormwater management plan. A monitoring program was also developed to help characterize NPS water quality and loads, to evaluate the effectiveness of the control measures, and to improve understanding of the cause and effect relationships affecting runoff water quality and loads.

The control strategy developed by the unified entity included permit application development, liaison with the regulatory agencies leading to the permit issuance, and compliance with the stipulations of the permit to be carried out over the 5-year term of the permit in accordance with an agreed-upon implementation schedule. The areawide stormwater management program is currently being implemented.

CLOSING REMARKS

The momentum for the promulgation of new federal stormwater regulations has been growing over the last 2 decades, and now we have reached the "end of the beginning" of federal regulations that address water quantity and water-quality aspects of stormwater discharges. It's the end of a long process to finalize a set of comprehensive requirements for some stormwater dischargers. But, there are still a lot of questions to be answered through guidance materials and creative problem-solving, and many issues are yet to be addressed in future stormwater regulations.

Although the 1990 stormwater regulations will be challenging to implement, the rewards will ultimately benefit the public. ■

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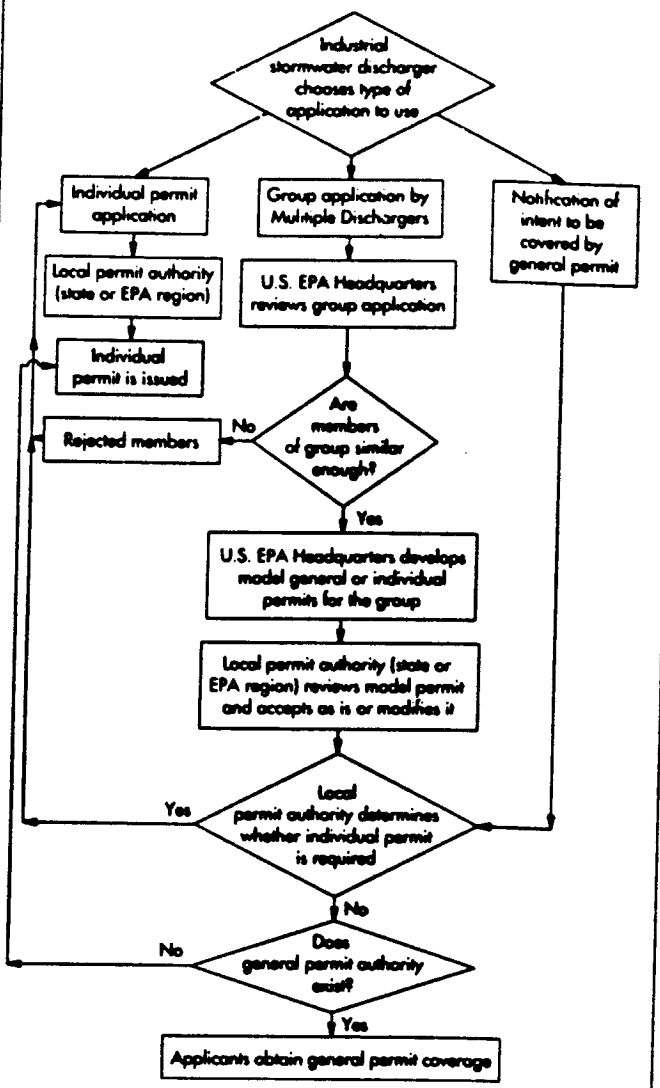
Figure 1—Obtaining an Industrial Storm Permit



runoff during warm-weather conditions. At selected NURP sites, stormwater discharges were analyzed for 120 priority pollutants. Results indicated that 77 priority pollutants were present, with 24 priority pollutants detected in at least 10% of the discharges sampled.

Although NURP resulted in a large database on the characterization of stormwater discharges across the nation, other studies, before and after NURP, have also made significant contributions, especially in local areas.

BRIEF HISTORY

In 1972, the CWA was passed, which prohibited the discharges of any pollution to navigable waters from a point source unless the discharge was authorized by a NPDES permit. Some exceptions applied. In 1973, EPA promulgated regulations exempting stormwater dischargers from permit requirements unless their discharges were identified as significant contributors to pollution. After court action, EPA issued a new rule in 1976 that provided for general permits for separate storm sewers in urban areas. No permit applications would be required in these cases, only notification of intent to be covered by the general permit. After additional court action, the stormwater rule was revised in 1979 and 1980 to require individual permit applications from all stormwater dischargers.

Between 1980 and 1987, several more rounds of proposed regulations and court actions ensued until Congress passed the WQA. This law is the basis for the current regulations. On December 7, 1988, EPA issued the proposed rule, and after reviewing more than 3000 pages of comments, the rule was revised and the final version was signed on October 31, 1990 (see Box).

MUNICIPAL VS. INDUSTRIAL

To satisfy the intent of the WQA, the new NPDES permit application regulations for stormwater discharges specify two types of stormwater permits: municipal and industrial. EPA defines a municipal separate storm sewer as municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains that discharge into U.S. waters. Industrial stormwater discharges include any conveyance that collects and conveys stormwater and that is directly related to manufacturing, processing, or raw materials storage areas at an industrial plant.

Industries affected include many industrial categories called standard industrial classifications. Along with industries, most municipalities will be required to obtain industrial permits, because several types of facilities typically owned and operated by municipalities are involved in industrial activities and, therefore, will be subject to this regulation. These facilities include, but are not limited to, wastewater treatment plants serving more than .04 m^3/s (1 mgd), certain kinds of recycling centers, certain transportation facilities, landfills that accept or have accepted industrial waste, and construction sites with an area of disturbance greater than 2 ha (5 ac). Because industrial facilities have no lower size limit, all municipalities that have these kinds of operations will be required to submit industrial permit applications, regardless of their population. It is likely that if municipalities have these kinds of operations and are also classified as medium or large, two different permits may be required because there are different philosophies regarding the types of stormwater controls municipalities and industries will be required to implement.

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Municipal separate storm sewer systems will have to reduce the discharge of pollutants to the maximum extent practicable (MEP). A MEP program would use management practices, control techniques and system, design and engineering methods, and other appropriate provisions to accomplish this goal. EPA has indicated that, given the material management problems associated with end-of-pipe controls, management programs that are directed at pollution sources are more practical than end-of-pipe controls. Municipal systems must also prohibit non-stormwater discharges into storm sewers and, where necessary, have water-quality-based controls.

On the other hand, industrial dischargers must implement best available technology (BAT) and best conventional pollutant control technology (BCT) to control their stormwater discharges. BAT treatment requires maximum economically achievable pollution reduction, and primarily applies to priority pollutants—metals and organics. BCT is similar to BAT, but is applied primarily to conventional pollutants such as biochemical oxygen demand, total suspended solids, pH, and fecal coliform. Industrial discharges must also have water-quality-based controls where necessary.

All industrial dischargers must now obtain their own permits rather than be included as part of a municipal permit. This is a major change in the final regulations from the proposed version. However, because stormwater from industrial facilities may be a major pollutant contributor to municipal separate storm sewer systems, municipalities must develop controls for industrial stormwater discharges in their stormwater management program.

All industrial dischargers covered by these regulations must notify the operator of the municipal separate sewer system receiving the discharge no later than May 15, 1991. The municipality is required to list the industrial dischargers to its system in its own permit application. EPA anticipates that the municipal stormwater management plans will include controls on industrial stormwater discharges to the municipal system, but that as with all NPDES permits, responsibility and liability is determined by the discharger's compliance with the terms of the permit. A municipality's responsibility for industrial stormwater discharged through their system is governed by the terms of the permit issued. Alas, municipalities have not been completely absolved of their responsibility for industrial stormwater discharges.

NPDES Permit Application Deadlines for Discharges

	Part 1 Application	Application Part 2 Review	Application
Municipal			
Large municipalities	November 18, 1991	90 days	November 16 1992
Medium municipalities	May 18, 1992	90 days	May 17, 1993
Industrial			
Individual	One-part application—due November 18, 1991		
Group	March 18, 1991	60 days	12 months after Part 1 application is approved
General permit, notification of intent to be covered	The general permit, when issued, will establish a date when a discharger must submit a notice of intent to be covered by the general permit.		

Documents Expected from EPA

- Municipal and industrial permit application guidance is expected to be released in February 1991.
- At press time, the implementation rule, which is to include a proposed baseline general permit and other materials related to permit applications, was still under review by the Office of Management and Budget. The implementation rule will be published in the *Federal Register*.
- Implementation guidance, or permit writer's guidance, is not expected before the end of 1991.

EPA is planning to issue a guidance document addressing municipal permit applications that may address this issue further.

MUNICIPAL APPLICATIONS

There are two types of municipal permit applications covered by the new regulations: one is for large municipalities with a population greater than or equal to 250,000, and another is for medium municipalities with a population between 100,000 and 250,000. The only difference in applications for these two categories is the deadline for submittal; medium municipalities are allowed 6 months longer than large municipalities to complete Part 1 of the application. Forty-seven counties that have urban characteristics are included on the list of jurisdictions that must submit municipal applications.

A permit authority—an EPA region or a NPDES authorized state—can designate additional municipal separate storm sewer systems to submit permit applications. This decision would be based on such criteria as the interrelationship with other systems currently required to submit permit applications, or whether a system is part of a larger, regional stormwater management authority.

If the 1990 Census reveals that additional municipalities have a population greater than or equal to 100,000, these cities will be required to submit permit applications for their stormwater discharges. Notification will appear in the *Federal Register*. These cities will have 1.5 years to complete the Part 1 application and another year to complete the Part 2 application. Their clock starts ticking after notification in the *Federal Register*. Cities with a population of less than 100,000 when results from the 1990 Census are finalized can petition their permit authority to be removed from the rule.

Part 1. Part 1 of the stormwater permit application includes a description of legal authority to address separate storm sewer systems, an inventory of outfalls and details about drainage areas, a field screening program to detect illicit discharges, a plan for a representative sampling program to be implemented in Part 2 of the application, and a description of existing stormwater controls.

For the field screening program, two options are available for determining where to look for illicit dischargers. One method is to select major outfalls

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Changes From the December 7, 1988 Proposed Rule

Significant items that have changed from the proposed version are as follows:

- The definition of a municipality was changed to include additional jurisdictions such as counties. In addition, the EPA Regional Director may at any time add other municipalities to the list that require stormwater discharge permits, such as smaller municipalities that discharge their stormwater to a larger system.
- No field screening is required in the Part 2 permit application for municipalities.
- Industrial dischargers are to obtain separate permits, even if they discharge into a municipal separate stormwater system.
- The number of standard industry codes (SICs) requiring permits was reduced to try to focus attention on sources that have more potential for contributing to water-quality degradation.
- Increased flexibility was incorporated into the monitoring programs, such as the number of sites that need to be monitored.
- Construction activities requiring permits are now for projects greater than 2 ha (5 ac) instead of projects greater than 0.4 ha (1 ac).
- Oil and gas activities were clarified.
- Deadlines for permit application submittal were changed.

for screening. The other is to place a 0.25-mi square grid over a map of the area in question and select the most downstream location in each box. If flow is detected during dry weather at a screening location, sampling is required. Colorimetric analysis methods may be used. The maximum number of locations to be screened is 250 for medium municipalities and 500 for large municipalities.

Part 2. Part 2 of the stormwater permit application includes a list of industrial dischargers to the municipal separate storm sewer system, even though they will have separate NPDES permits; quantitative data from the representative sampling program developed in Part 1; and a stormwater management plan to be implemented during the term of the permit. An assessment of effectiveness of the stormwater management plan and a fiscal analysis of necessary capital and operations and maintenance expenditures are also included in Part 2.

EPA has indicated that it will not develop application forms for municipal permit applications. However, this does not preclude permit authorities from developing forms.

If a municipality has combined sewer overflows, it can petition the permit authority (the NPDES authorized state or EPA region) to effectively reduce its population proportional to the length of combined sewers as a fraction of the total of combined sewers plus separate sewers (see final rule for procedure). A change in population could affect how or whether a municipality is regulated.

INDUSTRIAL APPLICATIONS

Industries that are required to obtain permits include manufacturing facilities where stormwater comes into contact with raw materials or wastes, construction sites disturbing greater than 5 ac of land, landfills that accept industrial waste, junkyards, wood treaters, power plants, mining operations, some oil and gas operations, airports, and certain other transportation facilities. Industries that discharge stormwater to combined sewers are excluded from the rule. As shown in the Figure, industries can apply for stormwater discharge permits in one of three ways: an individual permit application, a group permit application, and notification of intent to be covered by a general permit (hereinafter called a general permit application).

The one-part individual permit application is the most straightforward option. An applicant would conduct the necessary sampling, collect the required information, and fill out the necessary forms. After permit authority review of the application, permit conditions would be negotiated and a permit would be issued. Significant items required in an individual permit application include a site map, estimate of impervious area and total area drained by each outfall, narrative description for current and historical (3 years) significant materials usage, description of existing structural and nonstructural controls, certification that outfalls have been tested or evaluated for non-stormwater discharges, information on significant leaks or spills of toxic or hazardous materials in the last 3 years, and comprehensive sample data for one storm.

A group permit application is more complex administratively than an individual application, but it may be less costly because of reduced sampling requirements. To implement a group application, industrial stormwater dischargers with sufficiently similar process characteristics would form a group and appoint an administrator. The administrator would collect basic information from members of the group and prepare the Part 1 permit application. The Part 1 application would identify each member, summarize the industrial activities of each member, significant materials stored outside and materials management practices of each member. In addition, 10% of the members for a group with more than 10 members would be required to conduct a sampling program, to be implemented during Part 2 of the application, equal to that required for an individual permit application. A group must have at least four members to submit a group permit application. For groups between four and ten members, 50% of the members must conduct sampling programs during the Part 2 application.

The Part 1 group application is to be submitted directly to EPA headquarters by March 18, 1991, for review. EPA would send copies of the Part 1 permit application to the respective EPA region or state permit authorities and has 60 days to review the Part 1 application. During this review, some members may be rejected from the group if EPA determines that they are not similar enough to the majority of the group members. If this happens, rejected members then have 12 months to submit an individual application. If certain members who were designated to do sampling during Part 2 are rejected during Part 1, or if they have to withdraw from the group for some other reason, this could create a problem for the group. Therefore, it may be in the group's interest to identify more than 10% of the members to do sampling in case these types of problems are encountered.

After the group members designated to sample finish their data collection and the Part 2 application is complete and submitted to EPA headquarters, EPA would develop a model general and/or individual permit for the group, as appropriate. This model permit would then be forwarded to the appropriate permit authorities. The state or EPA region would use the model permit as is or modify it before notifying the group members in their

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Public Works

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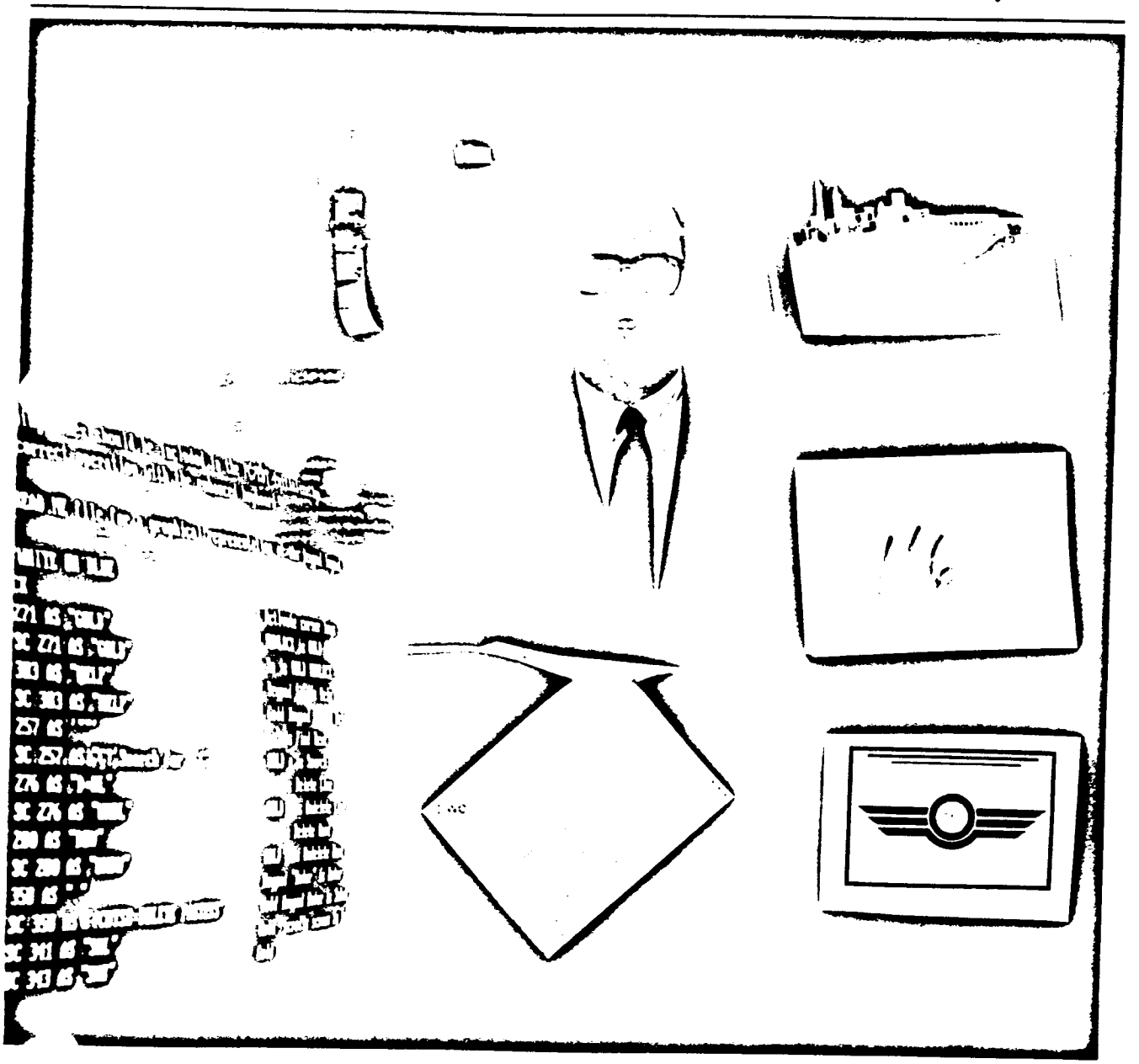

...ace J. Dull, P.E., is an Associate Member and CADD Systems Manager for Woolpert Consultants, Dayton, Ohio. More on page 18.

■ *Featuring Computer Applications*

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The New Federal Stormwater Regulations

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Editor's Note: This is the third in a series of PUBLIC WORKS articles on EPA's new National Pollutant Discharge Elimination System (NPDES) permitting requirements for municipal separate storm sewer systems. The first article (December 1990) described the physical processes that combine to cause stormwater related pollution problems, and it presented an overview of EPA's emerging regulatory program for controlling stormwater quality problems on a nationwide basis. The second article (January 1991) article described EPA's new regulations that apply to municipal stormwater conveyance systems, and suggested a step-wise approach that municipal NPDES permit applicants can use to structure their efforts to develop the information and plans required to apply for and comply with stormwater discharge permits. This third article discusses the final version of the new federal NPDES stormwater regulations and the challenges that municipalities will face as they develop stormwater management programs and control measures.

EPA will soon provide guidance documents that will explain the new federal stormwater regulations' requirements and will suggest methods for developing the information required from permit applicants. The purpose of this article is to provide municipal permit applicants with some insights that will help put EPA's guidance in perspective for a given community.

The articles in the December and January issues of PUBLIC WORKS discussed various aspects of municipal stormwater pollution assessment and control in the context of both technical/environmental problems and EPA's new nationwide initiative to require permits for discharges from stormwater conveyance systems. At the time those articles were written, the new regulations had not been finalized or signed into effect. Now that they have been, it is possible to discuss the following topics in more detail:

- What cities and counties will be affected?
- What do the new regulations intend to accomplish?
- When are the affected municipalities required to act?
- How do the final regulations differ from the draft that was published in December 1988?
- How are the results of the required studies to be used by the applicants and the regulatory agencies?

Who will be affected? The 1987 revisions of the Federal Clean Water Act required EPA to develop and implement regulations that apply to both "municipal" and "industrial" dischargers of stormwater. The regulations for municipal and industrial dischargers differ from one another in several significant ways, although both make use of EPA's NPDES, which has been used primarily for permitting wastewater and treatment plant dischargers. Here, we will deal only with municipal stormwater systems. However, it is important to note that EPA uses the term "municipal" in ways that differ from common usage, so it is necessary to make direct reference to the regulations (*Federal Register*, November 16, 1990, pages 47990 through 48091) to determine whether and/or how a given city, county, or other type of urbanized area is likely to be included. This article focuses on municipally owned and operated stormwater conveyance systems that meet EPA's definition of "separate storm sewer systems." Combined sewer systems (i.e., those that are intended to convey both stormwater and municipal sewage) are dealt with by other regulations and programs.

The new regulations will apply first to "large" and "medium" municipal systems, where the population served by the system is used to classify dischargers and to define both the corresponding regulatory requirements and the schedule for filing permit applications and implementing compliance programs. In general, large municipal separate storm sewer systems are those serving populations of 250,000 of more, whereas medium systems serve populations of 100,000 or more but less than 250,000. Again, the definitions in the regulations are complex and must be consulted directly. This will be especially important for smaller communities that might become recruited to participate as co-applicants by neighboring medium or large cities, and for smaller cities that discharge stormwater into receiving water bodies that are known to be suffering water pollution problems. Communities that have medium or large municipalities as neighbors or that share the use of regional-scale drainage systems should review the regulations carefully to develop an understanding of the pros and cons of joining as co-applicants. EPA regional offices and most state-level water pollution control agencies have developed their view of which cities, counties, and other urban areas are affected and how they plan to deal with them. It is incumbent upon the potential applicants to be strategic here, as well.

What do the regulations intend to accomplish? EPA's published notices in the December 7, 1988, and November 16, 1990, editions of the *Federal Register* provided valuable insights regarding their intentions in establishing programs for assessing and controlling water quality effects of municipal stormwater system discharges. At the risk of introducing some unintended bias through the process of abbreviating and simplifying EPA's lengthy commentaries, it would appear that the following are three important intentions:

- Applicants are intended to develop an elementary understanding of their respective stormwater conveyance systems and the associated water pollution problems.
- Applicants are intended to develop some of the basic information they need to begin what, for most communities, will be a long-term process of planning and implementing various types of control measures to reduce pollutant discharges.
- Applicants are intended to begin the process of working with regulatory agencies to monitor and control pollutants carried by stormwater conveyance systems.

Review of EPA's published commentary and the language of the regulations themselves indicate that the agency recognizes that, in most communities, the first steps toward implementing effective stormwater controls on a large scale will require a considerable degree

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of introspection—i.e., getting to know the local system at several levels (e.g., legal, institutional, physical, environmental). These new regulations require many municipalities to begin that process.

Introspective Questions

Again, at the risk of introducing some bias through the process of abbreviation and simplification, the new regulations can be viewed as requiring applicants to respond to the following introspective questions:

- Who are you? This will involve developing a clear, concise description of the applicant agency and its relevant legal institutional characteristics. This will be fairly straight-forward for single-city applicants, but it could be challenging in cases where there are many co-applicants and where there are complex physical and/or legal/institutional relationships among neighboring cities, counties, flood control agencies, and/or special districts. In many cases, neighboring agencies will want to pull together and function as co-applicants. There are some distinct advantages to doing so, but there may be some important disadvantages as well. This is certainly an area where it will pay to be thoughtful and strategic, especially in the light of scheduling constraints. Municipalities that have joined together as co-applicants have found the process of developing prudent inter-agency agreements to be challenging indeed.
- What is your storm drainage system like? This will involve defining and mapping watersheds and corresponding major storm drainage facilities. This is usually fairly straight-forward, but it could be challenging in areas that have little topographic relief, in systems that serve numerous communities, and in very old parts of some cities (e.g., where existing maps are inadequate or virtually non-existent). In typical cities, it will be necessary to field check maps to verify their credibility.
- What pollutants get into your system? Where do they come from? Where do they go? Such questions are easy to address in general terms but will generally be difficult to answer in specific terms. In fact, the corresponding answers are central to EPA's overall program, so simplistic, generic responses will not suffice. The regulations (and EPA's forthcoming guidance manuals) provide suggestions on how to survey municipal stormwater conveyance systems and their respective watersheds to identify and characterize potential sources of pollutants (including certain land uses and activities, illicit connections of wastewater sewers, and illegal dumping of contaminants).
- What do you presently do to minimize stormwater related pollution problems? Here, applicants are given the opportunity to take credit for various facilities, programs, and activities that help control potential water quality problems associated with stormwater discharges. Most cities have a variety of facilities, programs, and or activities that provide some degree of stormwater quality control, despite the fact that they were intended for some other purpose. Examples might include various public programs regarding hazardous materials disposal, recycling and litter control programs, street cleaning programs, erosion control and grading ordinances and inspection programs, storm sewer inspection and maintenance programs, and catch basin cleaning programs. Also, the detention, retention, and or infiltration facilities that are provided in some drainage systems to alter runoff hydrographs (for flood control and or stream channel protection) can often provide water quality benefits, as well (or might be easily modified to do so).
- What else do you need to do? This is perhaps the most challenging question of all. On the one hand, applicants have the freedom to suggest control strategies that they believe will be well suited to local conditions and needs. On the other hand, the scale of the studies required by the regulations will generally not be adequate to provide enough information or stimulate the insights that are needed to develop and evaluate good control strategies. Some cities and counties have responded pro-actively by beginning with the question: "What do I have to know to come up with practical, effective, and well-balanced strategies for stormwater pollution control?" They have then conducted studies designed to answer that basic question. Another basic un-asked question is "How much control is enough?" Neither the Clean Water Act nor the new stormwater regulations provide much guidance to applicants or to regulators. Yet this is the crucial question for people who are charged with managing limited public works budgets. We anticipate that the next several years will see much debate over that question.
- What additional authority do you need to obtain? This will involve determining the applicant's present level of authority and developing a strategy for supplementing any pertinent shortcomings. Upon surveying their local charters and ordinances, some cities and counties have found that they have all the authority they need. For example, some have dredged up long- forgotten codes that were originally intended to protect urban drainage courses from impacts by horses, or creeks from impacts by livestock and farming practices. On the other hand, some cities and counties have been surprised to discover that they do not have the ability to control improper discharges or dumping into their stormwater conveyance systems.
- What is the schedule? "Large" municipalities (as defined by the regulations) are required to act first. They have one year (from November 16, 1990, the official date of publication in the *Federal Register*) to prepare and submit their Part 1 permit applications and a second year to prepare and submit their Part 2 applications. "Medium" municipalities are on a parallel track, but the corresponding due dates for Part 1 and Part 2 submittals are delayed by six months. Figure 1 summarizes the respective schedules.

The final regulations reflect a few specific changes in the information required for Parts 1 and 2 of the permit applications, as outlined in Tables 1 and 2 of the first article of this series, which ran in the December 1990 PUBLIC WORKS. Information Required for Part 1, as listed in Table 1, is amended as follows:

Under (iii) **Source Identification**, "Description of corresponding watersheds for each major outfall" is changed to read "Description of watersheds."

Added to the information required is:

(vi) **Fiscal Resources:** Description of financial resources available for completing Part 2 of permit application. Description of overall financial resources for existing stormwater programs (e.g., budget, assets, indebtedness, funding sources).

Information for Part 2, as listed in Table 2, is amended as follows:

Under (iii) **Characteristics Data**, "Sampling and analysis of 5 to 10 representative outfalls to characterize overall system" is changed to read "Sampling and analysis to characterize overall system."

Not Enough Time?

The regulations indicate that the NPDES administering agency (which will be an officially-designated state water pollution control agency in most cases, or the Regional office of EPA in other cases) will have a period of 90 days to review the Part 1 application and to approve or deny the applicants' proposed sampling plan. Because this sampling plan is intended to guide the Part 2 activities, it would appear that the agency's review period could effectively detract from the applicants' performance schedule. This could be problematic for applicants that are pressed for time (e.g., those that begin their Part 1 programs late, those that have complex institutional arrangements and or numerous co-applicants, those that have especially complex systems, those that have systems that are not well understood and or well documented at present, those that are located in areas with challenging meteorological/

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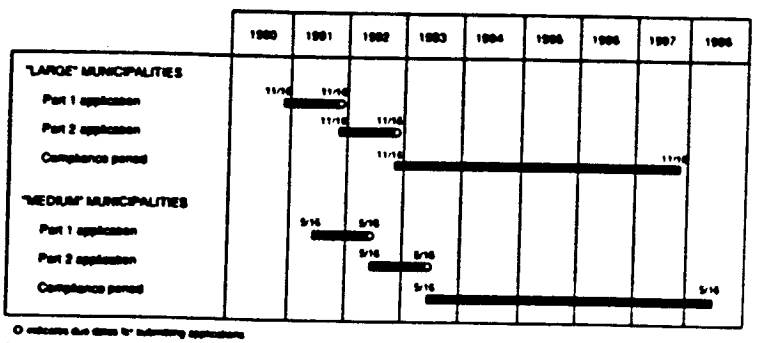
hydrological conditions, and those that are using relatively inexperienced personnel to obtain the required technical, institutional, and legal information). Such applicants will need as much time as possible to do the work called for in Part 1 and to prepare a good sampling plan to guide Part 2 activities. Most applicants will also need a full year to conduct the field work, data analyses, and planning efforts required for the Part 2 application. Therefore, the loss of up to 90 days anywhere in the schedule could pose a significant problem for many municipal applicants. Given the fact that most state water pollution control agencies and EPA Regional offices are not well prepared to respond to this new regulatory program, it is difficult to imagine how applicants will be able to stay on schedule and obtain the necessary degree of regulatory oversight and guidance.

How do the final regulations differ from the 1988 draft? When EPA published its draft stormwater NPDES regulations (*Federal Register*, December 7, 1988), it provided a great deal of historic, technical, philosophical, and legal/institutional background information. It also solicited review and comments on numerous major and minor points, in the interest of developing final regulations that would be clear, concise, reasonable, practical, and as free as possible from inconsistencies and ambiguities. During the official 90-day review period, EPA received about 3,200 pages of comments from municipal and industrial dischargers, technical and professional organizations, industrial associations, environmental groups, and other special interest groups. Most of these were critical, but some provided good suggestions for modifications. As a result of these official comments and continuing commentary from interested parties, EPA worked to respond to comments and to revise and improve the regulations leading toward the final version that was published in the November 16, 1990, edition of the *Federal Register*.

People familiar with the 1988 draft regulations will see that most of the changes are in the preamble materials and that there are some important procedural changes in the sections pertaining to industrial stormwater dischargers. The requirements that apply to operators of municipal separate storm sewer systems were revised in several important ways, but still less than many people had expected. Some useful clarification was provided in several important areas, but the general content and even the schedules of the two-part application process were changed very little. Perhaps the most important changes in the municipal regulations were the following:

- The definitions of "municipalities" that are required to apply were expanded to include 47 designated counties that have major urban populations and certain other communities that are logical extensions of the designated municipalities. This change is, of course, very important to communities that had thought they would not be involved.
- The final regulations require less data on land uses and population (e.g., the data can be compiled for the municipality as a whole, not for each respective watershed).
- The final regulations provide a "cap" on the maximum number of sampling locations for the field screening analyses (500 locations for large municipalities, 250 for medium).
- An alternative (optional) scheme for defining sampling locations was provided for use by applicants in conducting the field screening analyses called for in Part 1. The originally-defined scheme required applicants to study "major outfalls," but the technical complexities of identifying sampling locations could have posed a challenge to applicants and regulators alike. The newly-described optional scheme might be viewed as being rather arbitrary in some ways, but it is likely to lead to better investigative results in many systems, especially those where the original definitions of major outfalls would have led to inappropriate selections of sampling locations.
- Applicants are now required (in Part 1) to describe the financial resources that are currently available to conduct the work called for by the Part 2 application. Applicants are also required to describe their budget for existing stormwater programs, including financial resources, sources of stormwater funds, and overall assets and indebtedness.
- Some of the field studies that had been required in Part 2 were moved to the permit compliance period (for example, the requirement for a second-phase screening for illicit connections was deferred). Other requirements for Part 2 field studies were also changed somewhat (e.g., first flush samples will not be required at most sampling stations, the number of locations and storm events to be sampled was increased).
- The relationship between the municipal applicants and the industrial facilities that discharge stormwater into their respective municipal separate storm sewer systems was revised significantly. Now industries will be required to obtain permits directly from EPA or state water pollution control agencies, but not from the municipalities. However, such industries will be required to notify municipalities of their discharges and designated activities.
- The industrial inventory that had been required in the Part 1 application was moved to Part 2, thus giving applicants more time to compile the lists.



■ **FIGURE 1. Permit application and compliance schedule.**

How will applicants and regulators use the results of the required studies to select and implement water quality control measures? This is perhaps one of the most challenging aspects of the municipal stormwater programs that will derive from this new regulatory initiative. In an ideal case, the applicant would do the following:

- Follow EPA's requirements and collect the information called for by the regulations.
- Collect whatever additional information is needed to develop an understanding of water pollution problems, pollutant sources and other causative factors, and relevant legal/political/institutional information that would help define local opportunities.
- Evaluate and select among a variety of control measures that appear to be relevant to the identified causes, problems, and practical constraints in the specific area.
- Develop strategic plans that define which measures will be implemented, when and where they will be imple-

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mented (perhaps in a phased manner), and who will be the responsible parties.

The above-listed planning steps are idealized. Most municipalities will need to perform them, but will also have to deal with other issues that are not required by the regulations and are not explicitly dealt with in EPA's guidance documents. The following are examples of issues that most municipal applicants will have to deal with in their efforts to develop practical management plans for improving stormwater quality:

- Applicants will have to make some partly-technical, partly-subjective decisions about the focus, scale, and timing of the management plan they will offer to implement. Existing information and new information developed through field studies will help define pollutant sources, quantities, and impacts, but there is no prescribed process for determining "how much is enough" in terms of controls. At present, EPA has no target values to guide municipal applicants (i.e., there are no discharge standards, there are no specified control technologies). Applicants are merely told to implement "Best Management Practices" (which are not clearly defined) and to employ them to the "Maximum Extent Practicable" (which is also not clearly defined). Applicants will have to decide which pollutant control measures and which sources are the most likely to be practical and cost-effective, and what level of intensity of control (which translates to budget) is appropriate. This will require subjective judgment, because it implies striking a balance between controlling program costs and satisfying the expectations of regulatory personnel and interested environmental groups.
- Applicants will have to develop strategic ways to monitor their proposed control programs to be sure that they are being properly implemented/operated/maintained and to be sure that they will get credit for complying with NPDES permit stipulations. This matter of what to monitor, how to obtain relevant information, and how to use that information to demonstrate regulatory compliance will be a challenge. Most stormwater controls (i.e., Best Management Practices) do not lend themselves to being monitored in simple "before and after" terms, except perhaps at great expense. Therefore, applicants will want to be strategic in collecting indirect evidence of their control efforts.
- What control measures are available? Experience has shown that most municipalities could significantly reduce stormwater borne pollutant loads by implementing a variety of non-structural control measures, and supplementing these with structural controls only in specific locations where local conditions present special opportunities. In most cases these non-structural controls should be carried out by the general public, commercial institutional/industrial interests, and public agencies working together in a well-guided program. Controls can be categorized in different ways; it is useful to categorize them in terms of how they work, but also in terms of how they are to be implemented.

Important Categories

If one were to categorize controls in terms of how they work, two important categories would be:

- Source controls. These work in a pre-emptive way. Pollutants are prevented from getting into the stormwater in the first place. Examples would include educational programs that tell people not to dispose of spent oil and antifreeze via the storm sewer inlet, and programs to clean pollutants out of catch basins before they can be carried away by storm runoff.
- Treatment-based controls. These work after-the-fact. They involve treating stormwater to remove pollutants that have already contaminated the runoff. They are inherently expensive, but they are more predictable in their overall performance, because they do not rely as much on human behavior.

EPA has repeatedly expressed the view that it will look favorably upon stormwater management programs that aggressively implement source controls, and it does not expect municipalities to implement treatment-based controls as a first step in pursuing improved stormwater quality.

If one were to categorize controls in terms of how they are to be implemented, three important categories would be:

- Education. This involves telling people what to do and what not to do to prevent stormwater pollution. The effectiveness of such controls depends heavily upon identifying the right "audience," convincing them of the need to change their behavior, and explaining what they are to do (and not do). Some educational programs can be very general and can cover a broad spectrum of people and deal with a broad spectrum of recommended practices. It will usually be necessary to supplement the general program(s) with additional educational efforts that target specific audiences and provide very specific recommendations. Experience has shown the need to use all types of media (e.g., brochures, posters, lectures, TV, radio, events).
- Regulatory controls. This generally involves passing new or more specific municipal regulations, conducting inspections/surveillance to identify cases of non-compliance, and enforcing applicable regulations. Some such controls would focus on existing problems (e.g., illicit connections with wastewater sewers, illegal dumping); some would be preventive (e.g., controls on new construction).
- Public agency activities. This category would include activities by public works programs (e.g., catch basin cleaning, storm sewer cleaning, litter control, street sweeping), planning and building departments (e.g., erosion and grading controls, land use and zoning controls, environmental impact studies), park departments (e.g., leaf and debris disposal, application of pesticides and fertilizers), and general services agencies (e.g., vehicle repair, building maintenance, management of wastes from all types of maintenance activities).

At the present state of the art, it will be very difficult for applicants to select among the many specific controls that might be useful in their area. This is partly because of the previously mentioned problem of not being told "how much is enough," and partly because there are so few sources of information concerning the unit costs of such controls and their corresponding effectiveness in solving pollution problems. □□□

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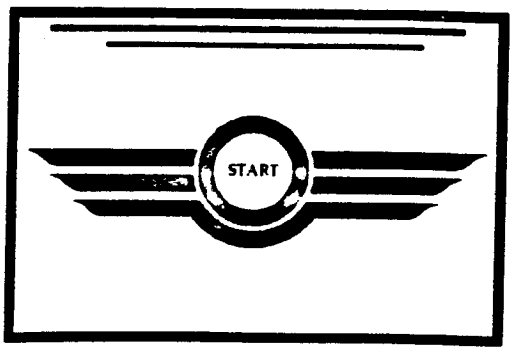
IMPERVIOUS SURFACE REDUCTION STUDY

FINAL REPORT

May 1995



CITY OF OLYMPIA • PUBLIC WORKS DEPARTMENT • WATER RESOURCES PROGRAM

City of OLYMPIA

WASHINGTON STATE DEPARTMENT OF ECOLOGY

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This study could not have been completed without the hard work and dedication of the following people. Project staff would especially like to acknowledge the time and thoughtfulness dedicated to the study by the Ad Hoc Citizen Advisory Committee members. Their volunteer work is greatly appreciated.

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Reader's Note:

An extensive glossary has been included in this report to assist the reader in understanding technical terms.
Glossary words are bolded their first occurrence in the text.

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EXECUTIVE SUMMARY

WHAT ARE IMPERVIOUS SURFACES?

Impervious surfaces are surfaces which cannot be effectively (easily) penetrated by water. Examples include pavement, buildings, and compacted soils.

WHY STUDY IMPERVIOUS SURFACES?

As part of our development pattern in the Northwest, we replace natural land covers with new surfaces such as buildings, streets, parking lots, driveways, and sidewalks. These new surfaces are impervious to our rains. They block the rain (stormwater) from soaking into the ground and increase the amount of water running off into streams, lakes, and the marine waters of Puget Sound (Figure 1, page 2).

A growing body of scientific evidence indicates that there is a direct link between impervious surface coverage and degradation of streams (Schueler, 1994). Even relatively low levels of impervious surface coverage (10 to 15 percent of the total land area) in a watershed (drainage basin) can make it difficult to maintain stream quality. Greater impervious surface coverage (15 to 20 percent of total land area in a watershed) has been linked to dramatic changes in the shape of streams, water quality, water temperature, and the health of insects, amphibians, and fish that live in these streams. Based on zoning and population estimates, the total amount of impervious surface coverage in three of our local drainage basins (Figure 2, page 3) is expected to increase from an estimated 14 percent to 29 percent of the total land area, with corresponding impacts to our local water resources.

Keeping the rain (stormwater) on the surface instead of letting it soak into the ground depletes the groundwater supplies upon which Olympia and other Thurston County communities (Figure 2, page 3) depend for drinking water. When less water soaks into the ground, groundwater levels drop, less groundwater is available to supplement summer flows in streams, and stream levels may fall below the minimum needed to support fish or recreation and other uses. In order to minimize the consequences of impervious surfaces, we build expensive stormwater runoff storage and treatment systems. Most current development practices and local policies and regulations aim to deal with and reduce the impacts of impervious surfaces, but fail to address the source of the problem.

As the Northwest's population grows, impervious surfaces also will increase. It's important to act now to identify feasible and practical ways to reduce impervious surfaces. Acting now can reduce the long-term development and environmental costs of growth and help keep our water resources healthy for the future.

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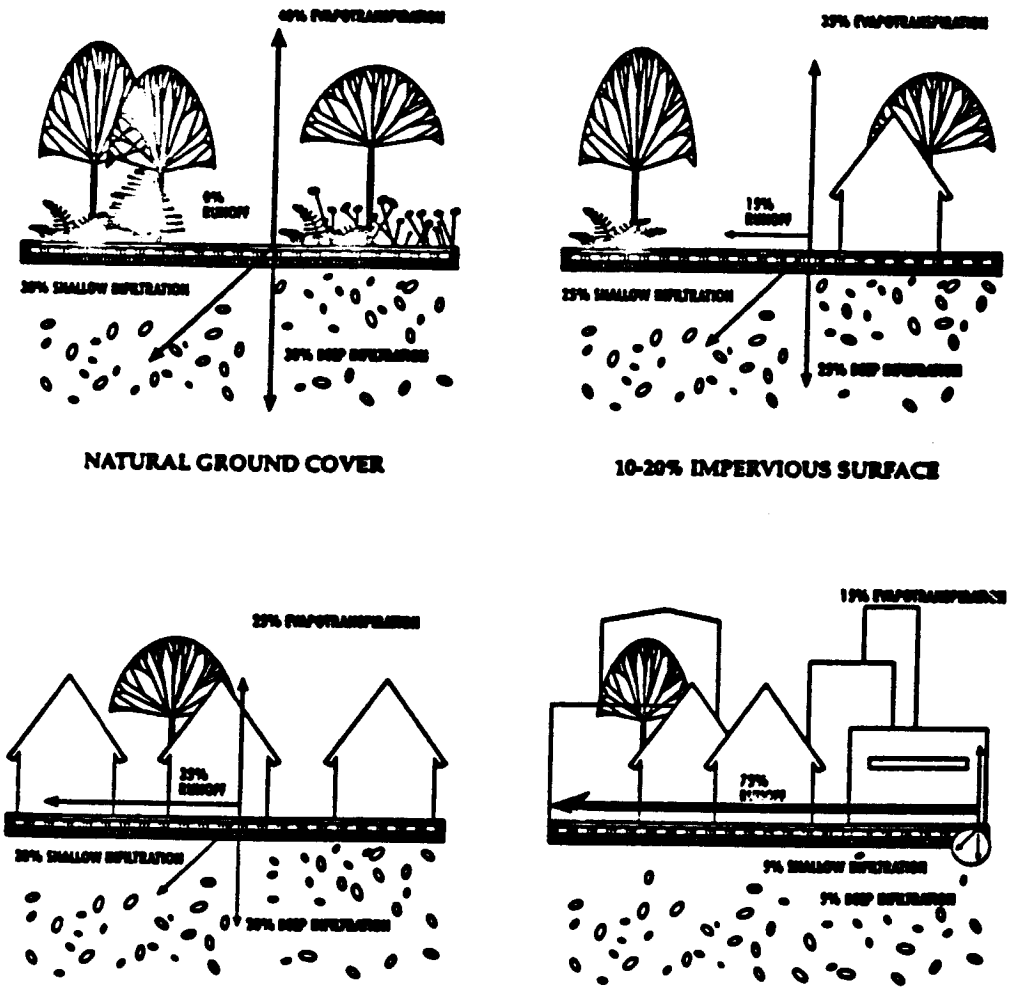
Figure 1: Hydrological Changes Associated with Increased Impervious Surfaces



NATURAL GROUND COVER

10-20% IMPERVIOUS SURFACE

35-50% IMPERVIOUS SURFACE

75-100% IMPERVIOUS SURFACE

Adapted from NEMO Project Fact Sheet #3, Cooperative Extension Center, 1994.

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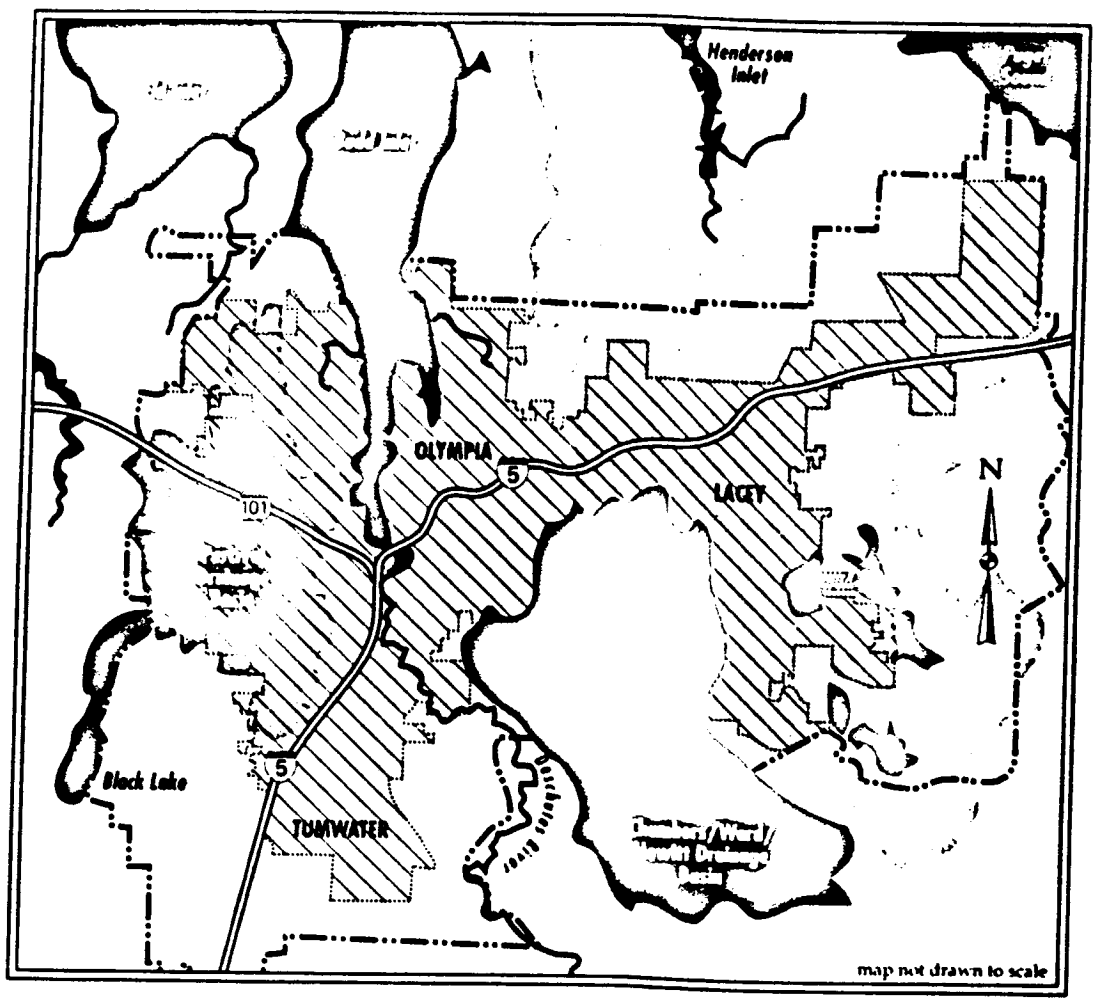
Figure 2: Olympia Washington and the Surrounding North Thurston County Urban Growth Management Area



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ELEMENTS OF THE STUDY

The Impervious Surface Reduction Study (ISRS) was conducted to identify possible strategies for impervious surface reduction in Olympia, the surrounding North Thurston County Urban Growth Management Area (North Thurston UGMA) (Figure 2, page 3), and other locations. This report summarizes the results of the study and offers recommendations based on study results. The study consisted of three basic tasks: project management, involvement and education, and technical and policy analysis.

Project Management

The City of Olympia's Public Works Department, Water Resources Program, provided project leadership with support and participation from the cities of Lacey and Tumwater, and Thurston County. Funding for the study was provided by the Washington Department of Ecology through a Centennial Clean Water Fund grant and Olympia residents through their Storm and Surface Water Utility.

Involvement and Education

The study was guided by both steering and citizen advisory committees. These committees were comprised of neighborhood, development, and business representatives, and natural resource management experts from both the public and private sectors of the Olympia area community (Project Team, page i). Other avenues for involving and educating the local community and interested parties included a needs assessment; community forums, displays, conferences, and presentations; distribution of fact sheets, buttons, reports, and research summaries; and media coverage. Approximately 50 people were directly involved in the research and development of the study's recommendations. Approximately 1,600 people from all over the United States were informed about the study and invited to participate or receive more information.

Technical and Policy Analysis

In order to better understand the problems with impervious surfaces and the costs, benefits, and incentives associated with possible reduction strategies, various technical and policy issues were analyzed. The analysis consisted of several tasks including: literature and policy review, demonstration projects, basin and site coverage assessment, parking analysis, and other research (Chapter 2, page 31).

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STUDY RESULTS

Summary of Results

Changes in attitudes, policies, and regulations were perhaps the greatest results of the study. Early on, the project team realized that impervious surface reduction was not an explicit goal of Olympia's policies and regulations, nor was it an explicit goal for many other local governments. Although there was some recognition that impervious surface reduction would occur as a result of growth management and regional transportation planning, it became apparent that changing attitudes, policies, and regulations could be a significant first step in reducing impervious surfaces.

Increased Awareness of Impervious Surfaces

Through public involvement and education, technical assistance, and sharing of the study's results, it is expected that the local community's awareness of the problems and solutions associated with impervious surfaces has increased. Local, regional, and national media coverage has brought the study to the attention of local jurisdictions in other Washington communities, as well as in other states. Ten presentations to local groups and two community forums were conducted to share the study's findings with members of the local community. In addition, eight briefings were given to other departments or groups within Olympia's city government to explore and coordinate policy changes resulting from the study.

Policies Changed

Staff participated in the revision of the city's parking, street, and development standards and shared early results of the study with other local jurisdictions. By taking advantage of these implementation opportunities before the study was complete, many lessons were learned about balancing impervious surface reduction with other public goals. The public goals considered during development of the recommendations are listed under the incentives and barriers sections of Chapter 3, Recommendations for Olympia, North Thurston County Urban Growth Management Area, and Other Locations (page 59).

Opportunities for Reduction Identified

In order to identify what types of land use and impervious surfaces provided the greatest potential for reduction, the basin and site coverage assessment was conducted. The assessment demonstrated that vehicle-oriented pavement, including streets, driveways, and parking lots, offer the greatest opportunity for reduction. It also demonstrated that commercial/industrial and high density residential land uses in the Olympia area contain the most vehicle-oriented impervious surfaces.

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EXECUTIVE SUMMARY

To further determine practical ways to reduce vehicle-oriented impervious surfaces, a parking analysis was conducted. Informational interviews and field visits expanded our understanding about how to reduce the overall area dedicated to parking, without compromising the viability of local businesses or increasing development costs. In recognition of the coverage assessment and parking analysis findings, several of the study recommendations address streets and parking. (Recommendations for Reduction, page 7).

Data Gaps Identified

In the Thurston County area, we currently have limited knowledge about our impervious surface coverage, aquifer recharge areas, and groundwater system. This lack of data limited the scope of the study and the ability to provide location-specific recommendations. The study brought to light additional reasons for making better use of development tracking systems and for funding and conducting groundwater and other research.

Recommendations to Achieve a 20 Percent Reduction in Future Impervious Surfaces

A 20 percent reduction in impervious surfaces associated with new development is expected in Olympia and the North Thurston UGMA if the study's recommendations are implemented by the cities of Olympia, Lacey, and Tumwater, and Thurston County. However, each community needs to determine for themselves the recommendations and specific strategies that work for them, given their specific mix of public goals and community character. Other jurisdictions are highly encouraged to involve citizens, businesses, and members of the development community in reducing impervious surfaces. A 20 percent reduction is a feasible and practical goal for Olympia and will not require exceptional changes in the Olympia community.

It is important to remember that a 20 percent reduction does not solve the long-term problems with impervious surfaces. This study's recommendations only address future development, and do not address existing impervious surfaces or problems. A 20 percent reduction in the total amount of effective impervious surface coverage that is expected in the Percival, Woodard/Woodland, and Chambers/Ward/Hewitt drainage basins at 80 percent buildout (Figure 3, page 7), could result in approximately 600 fewer acres of impervious surface coverage by the year 2012. Strategies such as narrower streets and creating smaller building footprints are expected to reduce the per capita amount of impervious surfaces for the region.

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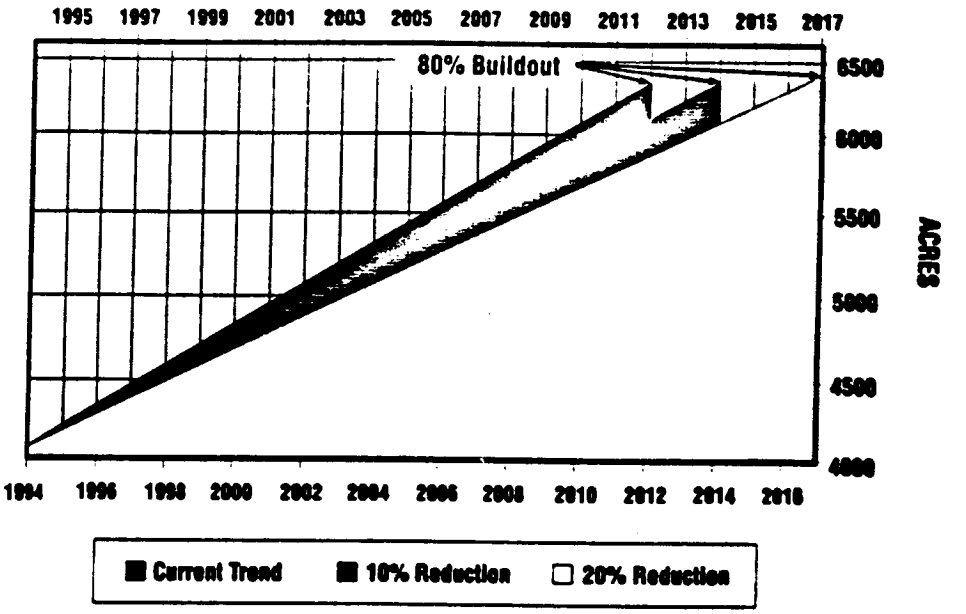
Figure 3: Current and Potential Future Trends in Acres of Impervious Surfaces in the Percival Creek, Woodard/Woodland, and Chamber/Ward/Hewitt Drainage Basins



Need for Cumulative Impact Assessment Realized

Many of the problems with impervious surfaces are not linked to water resources. For example, asphalt absorbs and releases heat from the sun differently from vegetation. Replacing existing vegetation with pavement can significantly alter local temperatures. These changes in local temperatures can negatively affect the health of remaining vegetation and contribute to an overall warming trend. It is suggested that future research of impervious surfaces be in the form of a cumulative impact assessment. This would provide an opportunity to consider all the costs and benefits of impervious surface reduction, rather than just those related to water resources.

Recommendations for Reduction

It was recognized early on that recommendations suitable for Olympia may not work for other communities, and that ideas not suitable for Olympia may work elsewhere. As one reviews the recommendations, keep in mind that this report summarizes a study, not a planning process. The information and recommendations contained in this report are provided as guidance to Olympia and other communities, and will not necessarily be adopted by the City Council. For specific information on actions that

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Olympia has or will be taking to reduce impervious surfaces, the reader should refer to the detailed Implementation Actions sections under each recommendation in Chapter 3 (page 59) and Chapter 4, Implementation Strategy (page 125).

This study signifies a new emphasis on impervious surface reduction for the Olympia community, and has left as many unanswered questions as it has answered. More research could be conducted to better define hydrological relationships, costs and incentives, and water quality impacts (Chapter 3, Strategies Considered and In Need of Further Analysis, page 60). It is important to keep in mind that impervious surface reduction is still an experiment—one that needs to begin so that we can discover real-world solutions.

Overall Recommendations

The project team developed three overall recommendations. Recommendation 1 recognizes that changing attitudes, policies, and regulations are a significant first step in impervious surface reduction. Recommendations 2 and 3 are reminders that growth management and transportation planning can be used to reduce impervious surfaces. The project team included these recommendations to encourage Olympia and other jurisdictions to consider policies and regulations, growth management, and transportation planning as tools for impervious surface reduction.

Recommendation 1.
Integrate impervious surface reduction into policies and regulations.

Recommendation 2.
Establish growth management policies that encourage infill of urban areas and reduce urban sprawl.

Recommendation 3.
Provide a public transit system and other alternative modes of transportation that reduce the need for streets and parking.

Recommendations for Vehicle-Oriented Pavement

Seven of the 19 recommendations address vehicle-oriented pavement such as streets and parking areas. According to the basin and site coverage assessment (Chapter 2, page 34), streets and parking areas make up a significant portion of Olympia's impervious surfaces. Reducing vehicle-oriented pavement can result in impervious surface reduction, but needs to be done in cooperation with the local business and development community in order to identify cost-effective strategies.

Recommendation 4.
Develop standards for narrower residential streets with reduced, but adequate, parking opportunities.

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Recommendation 5.
Use pavers and other pervious surfaces for low use areas such as overflow parking and emergency access roads.

Recommendation 6.
Narrow alley widths, use alternative surfaces for alleys, and/or design alleys to drain to vegetated strips or central drains.

Recommendation 7.
Encourage cooperative parking such as joint (combined), shared, and coordinated parking.

Recommendation 8.
Encourage underground or under-the-building parking and the construction of multi-storied parking structures.

Recommendation 9.
Develop flexible parking regulations related to parking region-wide that limit the amount of impervious surface, while still providing for parking needs.

Recommendation 10.
Gently slope sidewalks away from streets and other impervious surfaces towards vegetated strips or gravel catchments.

Recommendations for Construction Practices and Landscaped Areas

Naturally occurring, undisturbed areas typically infiltrate 60 percent of rain, depending on soil type (Figure 1, page 2). Clearing and grading a site typically removes existing vegetation and compacts the soils, greatly reducing the infiltration capacity of the site.

For the purpose of this study, the project team considered compacted soils an impervious surface. The team recommends reducing soil compaction and the clearing of vegetated areas to retain the inherent infiltration capacity of undisturbed areas.

Recommendation 11.
Limit soil compaction on newly developed residential and commercial sites, especially those sites with sensitive features. Reduce soil compaction and restore infiltration capacity on already cleared sites whenever practical.

Recommendation 12.
Limit land clearing on newly developed residential and commercial sites, especially those sites with sensitive features.

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Recommendation 13.
Encourage measures such as homeowner association covenants, plat map conditions, and/or conservation easements that protect existing vegetation and undisturbed areas.

Recommendations for Design and Placement of Buildings

In recognition that our current development pattern plays a large role in how much impervious surface we create, the project team recommends two key strategies for reducing building-related impervious surfaces: clustering and taller buildings.

Recommendation 14.
Encourage cluster development that minimizes impervious surfaces.

Recommendation 15.
Encourage the building and use of taller structures to reduce the size of building footprints.

Recommendations for Community Involvement and Education

Involvement and education of the community is a high priority for Olympia. The city and project team recognized that community participation in the study was essential to accomplishing implementation of the study's recommendations, and was necessary to ensure that policy and regulatory changes reflected the community's values, needs, and interests. Community members helped identify incentives and brought a real-world perspective to reduction strategies.

Recommendation 16.
Develop and distribute printed materials that complement the study's recommendations.

Recommendation 17.
Develop and provide training and technical assistance to the region's development and business community.

Recommendations for Study Evaluation

Evaluation is an essential step for learning from past experiences and recognizing successes. For the project team, this study raised as many questions as it answered. It also identified the need for better information concerning impervious surfaces and local groundwater hydrology. The following recommendations, if implemented, would not only continue the research efforts begun with this study but would help us measure success and identify areas for improvement. These recommendations would provide information and data for evaluating the overall success of the study,

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as well as the specific policy and regulatory changes made as a result of study recommendations.

Recommendation 18.
Monitor the increase in impervious surfaces in Percival, Woodard/Woodland, and Chambers/Ward/Hewitt drainage basins to determine effective impervious surface coverage trends.

Recommendation 19.
Assess the results of the study's recommendations in Olympia, North Thurston UGMA, and other locations.

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CHAPTER 1
INTRODUCTION

STUDY OVERVIEW

As urban areas develop, more and more land is covered with impervious surfaces such as buildings, streets, driveways, and parking lots. Historically, these impervious surfaces have created several well-documented water resources problems. These are illustrated on Figure 1 (page 2) and are summarized below.

The 84-square-mile North Thurston County Urban Growth Management Area (North Thurston UGMA) (Figure 2, page 3) is already experiencing water quality and stream habitat degradation. The entire area depends on groundwater for its drinking water which is vulnerable to contamination from the surface. In addition, the Squaxin Island Tribe and others are concerned that loss of groundwater recharge is affecting fish habitat by reducing summer stream flows.

Impervious surfaces and inadequate stormwater management have been linked to an increase in excessively high stream flows during winter and harmful low flows during summer (Booth and Reinelt, 1994; Booth, 1990; Hammer, 1972). Local drainage basins (watersheds) such as Woodard Creek and Percival Creek (Figure 2, page 3) currently exhibit instream habitat losses as a result of relatively high density development and impervious surface coverage of 17 percent and 25 percent, respectively. The habitat offered by other basins such as Woodland Creek and Chambers/Ward/Hewitt (Figure 2, page 3), which have 12 percent impervious surface coverage in each, reflect the relatively low density residential and commercial development in these basins. While many human actions affect and degrade local instream habitat conditions, the affects of excess stormwater runoff is pronounced. Future growth will require efforts beyond current stormwater management practices if we wish to preserve our local urban creeks.

Over the next 20 years, the population of the North Thurston UGMA is projected to increase by 66 percent to a total of 184,000 people (Thurston Regional Planning Council, 1993a). If that growth occurs and is accommodated with the current pattern of urban sprawl, the total amount of impervious surface in the Percival, Woodard/Woodland, and Chambers/Ward/Hewitt basins could increase from an estimated 14 to 29 percent of the land area, with corresponding increases in stormwater runoff and water quantity and quality problems. At 80 percent of buildout (full development) in these basins, it is estimated that the total amount of impervious surface would displace enough water to flood Olympia two-feet deep. At 80 percent of buildout, it is also estimated there would be 6,200 acre feet of stormwater added to the runoff we currently manage. This new stormwater would be enough to create a 62-acre lake that is 100 feet deep, and would need to be

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managed to ensure recharge of our groundwater supplies and long-term preservation of water resources.

To address these challenges, the Impervious Surface Reduction Study (ISRS) was conducted by the City of Olympia in cooperation with the neighboring governments of Lacey, Tumwater, and Thurston County as part of an overall stormwater management strategy. Funding for the study was provided by the Washington Department of Ecology through a Centennial Clean Water Fund grant and Olympia residents through their Storm and Surface Water Utility. The study was initiated in March 1993, and was originally scheduled to be completed December 1994. In order to accommodate construction of demonstration projects, the grant deadline has been extended to June 1996. At this time, all study tasks except for the demonstration projects are complete. A separate technical report summarizing the results of the demonstration project will be completed May 1996.

GOALS AND OBJECTIVES

Goals

The goal of the study was to *identify and gain community support for future impervious surface reduction techniques that result in increased stormwater treatment and groundwater recharge in the Thurston County region, without causing appreciable increases in development costs.*

Another goal established for the study was a 20 percent reduction in impervious surfaces throughout the North Thurston UGMA stemming from implementation of the recommendations. Based on study results, it seems that a 20 percent reduction could be achieved.

Objectives

Objectives of the study were to:

1. Inform the public of the need for alternatives to impervious surfaces and foster support for necessary policy and development changes.

2. Develop standards to encourage reduction in impervious surfaces in future construction, and develop and initiate policies to support these standards.

3. Provide technical assistance to members of the development community interested in incorporating alternative techniques into proposed site and building plans.

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4. Work with other local governments and members of the development community to apply alternative development practices at one or more highly visible sites.

5. Present information to the development and business community, professional organizations, government entities, and other interested parties concerning results of the study.

STUDY APPROACH

In September 1991, the study goal and tasks were conceptualized during an early scoping meeting for a Centennial Clean Water Fund grant application (Figure 4, page 16). The meeting was attended by staff from Olympia, Lacey, Thurston County, and the Squaxin Island Tribe. Olympia convened an additional meeting of local jurisdictions once the grant application was selected for funding. In August 1992, about 25 private and public sector representatives participated in a brainstorming session that identified constraints and opportunities, and provided additional feedback on the study's approach.

It was decided early on that Olympia's Water Resources Program would be the agency responsible for administering the study, and that Lacey, Tumwater, and Thurston County would be involved as advisors to ensure that the study contributed to regional impervious surface reduction. It was also asked by Olympia City Council that the study be used as a model to test Olympia's sustainability criteria. These guiding parameters of the study are discussed in more detail below.

Regional Perspective

Washington's Growth Management Act of 1990 and 1991 (Revised Code of Washington 36.70A) requires Thurston County and cities within the county to plan cooperatively to accommodate the additional people expected to live here by 2015. The four local governments in north Thurston County are currently updating their comprehensive plans to meet Growth Management Act (GMA) requirements and coordinating their efforts based on county-wide growth management policies. A major result of growth management would be a shift in the development pattern in north Thurston County from one of low density suburban sprawl to a denser urban pattern, as illustrated in Figure 5, page 17.

The new development pattern would reduce the per person amount of impervious surfaces for the Olympia, Lacey, Tumwater, and Thurston County area because there would be:

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Figure 4: Impervious Surface Reduction Study Flow Diagram

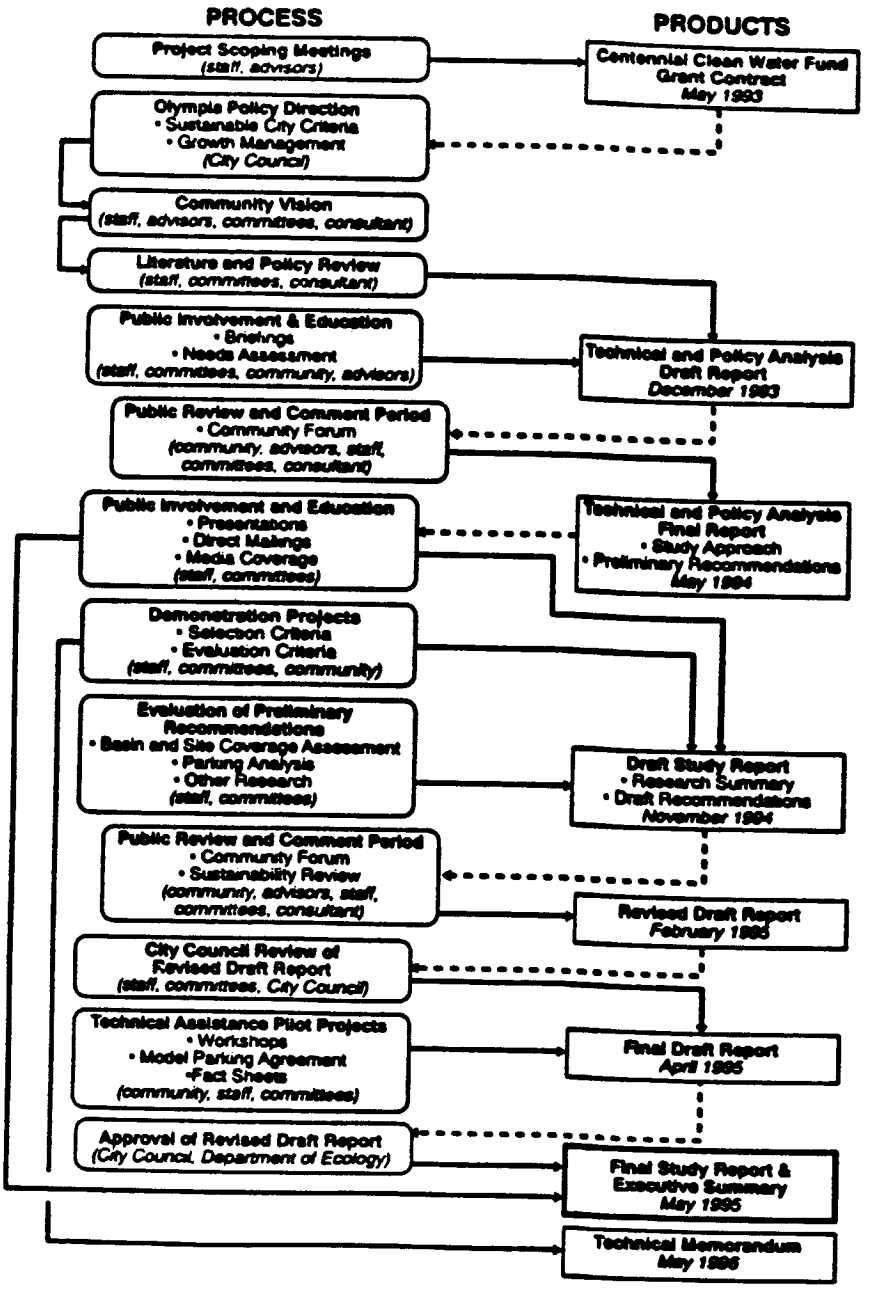

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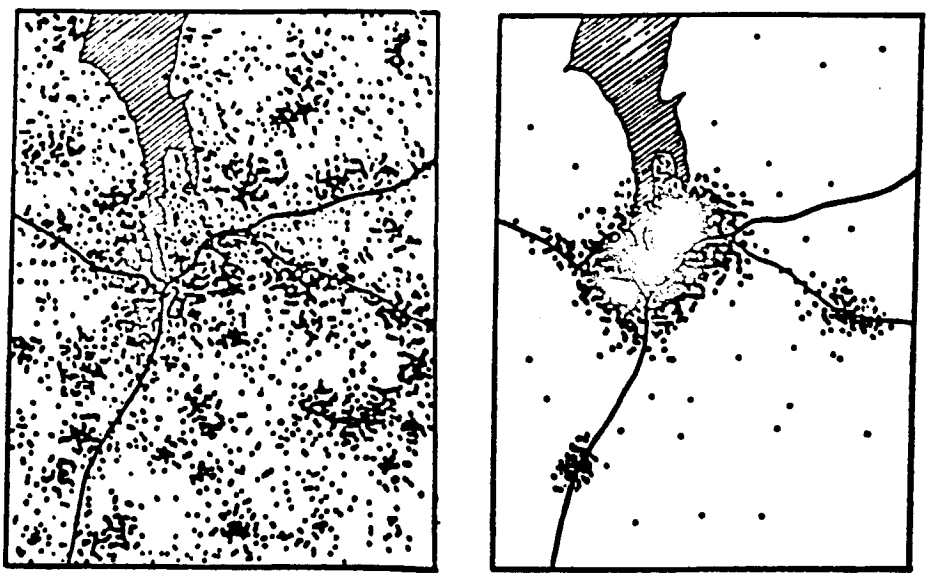
Figure 5: Current and Future Development Patterns



Source: R/UDAT, 1990.

Current pattern.

- Low density sprawl
- Separate zones
- Strip commercial
- Underdeveloped downtowns
- Fewer connected roads

Future pattern if the growth management strategy is implemented.

- High density in urban areas
- Mixed use zones
- Vital city centers
- Low density rural and resources lands
- More connected roads

- Less impervious surface in outlying rural and low density areas due to the concentration of development in urban areas.
- More efficient use of impervious surface in the urban areas (more total impervious surface in Olympia, Lacey, and Tumwater due to higher densities, but less impervious surface per person or unit of development for the whole county).

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However, the high population growth for the area is expected to result in an ever increasing total amount of impervious surface. This is expected to jeopardize availability of clean groundwater, instream flows, and drinking water supplies for future generations.

Policy Focus and Early Implementation

From the beginning of the study, it was clear that water resources problems associated with impervious surfaces could not be addressed without considering policy issues such as urban sprawl and transportation management. Therefore, the study initially took a broad look at water resources concerns and proposed preliminary recommendations for reducing impervious surfaces that mirrored the regional growth management planning efforts of the four local governments.

It also became clear that a policy approach would be complementary to other research efforts in the Puget Sound region. During the study, project staff met twice with staff from a Centennial Clean Water Fund grant project administered by the University of Washington's Center for Urban Water Resources Management and King County's Department of Public Works. The meetings' purpose was to coordinate efforts and reduce duplication. As a result of the meetings, Olympia choose to take more of a policy focus that could complement the construction practices focus of the Seattle-based project. Results of the Center's research of onsite infiltration capacity, including mulching techniques and pavers, will be available in 1995 and will be reviewed by Olympia staff for local applicability.

Staff and some Ad Hoc Citizen Advisory Committee members (Project Team, page i) also participated in the revision of Olympia's street, parking, and development standards being conducted concurrently with the study. The revisions were driven by the need to have local policies and regulations comply with the Growth Management Act and Olympia's comprehensive plan. The revisions posed an opportunity to incorporate key recommendations of this study into existing policies. This early implementation of the study's findings provided an arena for considering impervious surface reduction along with other issues, and provided an opportunity to immediately implement reduction strategies.

Olympia's Sustainable City Philosophy

In March 1992, the Olympia City Council formally decided to evaluate its actions based on two sustainability criteria:

- Criteria 1: *Future generations*

  City actions will meet present needs without jeopardizing future generations.

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- Criteria 2: *Interrelationships*

  City actions will take into account the environmental, economic, social, and political requirements for their success and the impact on the natural environment and human activities.

These criteria are intended to help guide Olympia towards actions that will help create a sustainable community, one that "persists over generations and is far-seeing enough, flexible enough, and wise enough to maintain its natural, economic, social, and political support systems" (City of Olympia, 1993d).

The Impervious Surface Reduction Study was used as a model to see how these criteria could be applied to a complex issue. A sustainability analysis of the study was conducted in two parts. Part one was an initial analysis at the beginning of the study and part two was a more in-depth analysis affiliated with the January 1995 Community Forum. The basic steps for both parts of the analysis were:

Step 1. Define the problem.

Step 2. Define the proposed solution.

Step 3. Envision a future if the solution is successfully implemented (related to Criteria 1).

Step 4. Assess interrelated future impacts of the proposed solution (related to Criteria 1 and 2).

Step 5. Assess what would be required for the proposed solution to be successful (related to Criteria 2).

Part One: Initial Analysis

Early in the study, members of the project team conducted an initial analysis. The members went through all five steps of the analysis with the following results:

Step 1.

The problem was generally defined as water quality and flooding impacts of increased stormwater runoff from impervious surfaces.

Step 2.

The solution was generally defined as reducing impervious surfaces associated with new development.

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Step 3.

The vision for the future was defined very broadly and reflected a wide range of transportation, housing, land use, economic, and social issues. The vision included higher densities, clustered housing, taller buildings, neighborhoods with services within walking distances, more transportation options, fewer cars, smaller parking lots, multi-storied and unpaved parking, narrower sidewalks, alternative surfaces, and more green spaces.

This broad vision was the basis of the study's preliminary recommendations which overlapped with several growth management planning strategies. During additional committee meetings, the focus of the preliminary recommendations was narrowed to address a few general growth management strategies, streets and parking, construction practices and landscaped areas, design and placement of buildings, community involvement and education, and study evaluation.

Steps 4 and 5.

Discussion of future impacts and requirements for success was constrained by time, the committee members' confusion over sustainability concepts, and the general difficulty of analyzing a topic connected to such a wide range of issues.

The initial analysis was complemented by a technical and policy analysis (Chapter 2, page 31) conducted by staff and the policy consultant (Project Team, page i). The analysis yielded a number of examples of innovative land use and regulatory practices in other communities, as well as the results of other impervious surface research.

Part Two: Community Forum Roundtable Exercise

Part two of the sustainability analysis included a roundtable exercise. The exercise involved the five attendees of a Community Forum, and was facilitated by the policy consultant. The roundtable exercise consisted of a brief presentation on sustainability concepts and Olympia's two criteria, followed by a group discussion that reviewed the main goal of the study—a 20 percent reduction in new impervious surfaces. Objectives of the exercise included:

- Expand citizen understanding of key sustainability concepts.
- Receive input from citizens for use in this final study report.
- Test one method for conducting sustainability analyses.

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The roundtable exercise was designed to assess future impacts of and requirements for a 20 percent reduction in impervious surfaces associated with new development. The exercise consisted of figuratively placing the 20 percent goal at the center of a table and the Community Forum participants considering two questions. The questions were:

1. What changes will be needed in natural, social, economic, and political systems to achieve a 20 percent reduction in new impervious surfaces by the year 2012?

2. What will be the impacts on natural, social, economic, and political systems if a 20 percent reduction is achieved by the year 2012?

After a group discussion, the participants wrote responses to the questions on a handout illustrating key natural and human systems (Figure 6, page 22). Following a break, the participants shared their responses to the sustainability presentation and exercise. As a follow up to the Community Forum, the policy consultant summarized the participants' responses and performed a more in-depth analysis.

Results of the Sustainability Analysis

Table 1 (page 23) summarizes a variety of impacts and requirements that were identified for the success of a 20 percent reduction in impervious surfaces. Feedback from Community Forum participants indicated that the concepts of sustainability were relatively clear and that looking at something from a new perspective was useful. Feedback also indicated that the roundtable exercise was good, but the link between the exercise and impervious surface reduction was unclear.

To contribute significantly to Olympia becoming a sustainable community, there would need to be a greater effort to reduce impervious surfaces than is laid out in this report, and the effort would need to be maintained over several generations. Such an effort would require greater agreement among sectors of the community about strategies. New information and technology would be needed to enhance groundwater infiltration and minimize impacts on water resources. Such information and technology would need to be complemented by economic incentives and relatively stable climatic conditions (e.g., rainfall).

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Figure 6: Sustainability Interrelationships—
Natural and Human Systems

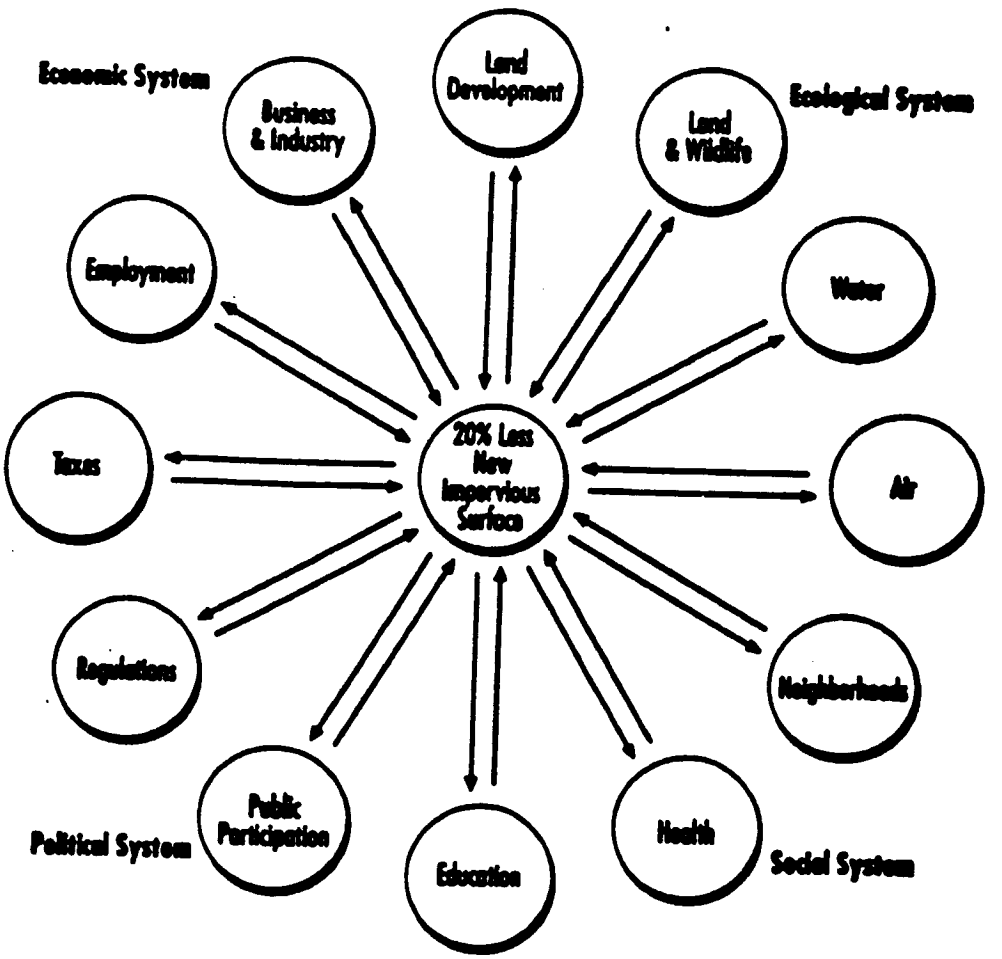

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Table 1: Sustainability Interrelationships—Impacts and Requirements for Success

IMPACTS	REQUIREMENTS FOR SUCCESS	
NATURAL ECOSYSTEM **Land/Wildlife** **Water** **Air**	• More runoff and related impacts. • Urban watersheds highly managed to collect, treat, reuse, or infiltrate runoff. • Rural watersheds protected (short term). • Density may create opportunities for neighborhood-scale technology (e.g., solar cars/solar heating that improve air quality).	• Climate relatively stable (e.g., increase in rainfall could counteract effect of reduced impervious surface.)
ECONOMIC SYSTEM **Land Development** **Business/Industry** **Employment**	• More efficient use of land. • Reduced development costs due to reduced parking requirements. • More ground space for commercial use from less surface parking. • Cooperation on shared parking could lead to further cooperation. • New businesses—development and sale of alternative products and services. • New employment resulting from labor-intensive high maintenance technology and value-added manufacturing.	• Changes in development technology become common practice. • New technology to replace natural recharge, manage, and treat surface runoff and create new transportation and construction methods. • Prices for alternative products and services become competitive. • Availability of workers skilled in new technology and willing to work at maintenance jobs.
SOCIAL SYSTEM **Housing** **Health** **Education**	• People living closer together, potential for more neighborhood vitality or more crime, violence, and stress. • Schools and jobs closer to home, more time for family and community. • More attractive public urban spaces. • More playground space due to multi-story school buildings. • Improved general health due to better air quality. • Improved health among people working outdoors in maintenance jobs.	• People adapt to living in more compact neighborhoods. • People preferences shift to "small is beautiful," values on neighborhood interaction. • More public awareness of water resources and impacts of development. • More development community awareness of benefits of alternative land use/construction practices.
POLITICAL SYSTEM **Public Participation** **Taxes** **Regulations**	• More awareness/concern from community leaders and more public participation and responsibility. • Potentially less need for regulation based on public participation and consensus. • More careful review of development permits. • Better feedback from monitoring used to adjust policy. • Revenue impacts unclear.	• High level of consensus to sustain implementation over time. • More neighborhood involvement in decision making. • Regulations create incentives for denser development (e.g., parking, higher buildings). • Taxes create incentives for denser development (e.g., two-tier tax system for land and buildings, taxes on gas and parking).

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INVOLVEMENT AND EDUCATION

Broad-based involvement and education of the local and regional community was important to meeting the study's goals. Education was an important avenue for citizens and local jurisdictions to become well-informed of the problems addressed by the study. In addition, the education process was used as a two-way street, providing an opportunity to discover community concerns and generate innovative, workable solutions.

Strategy for Involving and Educating Audiences

Olympia used a multi-faceted strategy for gaining broad-based support for the study's impervious surface reduction recommendations. The strategy was initially summarized in a public involvement and education plan (Appendix A, page 159). The plan contains goals, objectives, activities, and evaluation measures, and was implemented consistent with the grant agreement for the study. The strategy focused on a variety of audiences and included many opportunities for citizens and neighboring local governments to influence the direction and outcome of the study.

Audiences included the local development community (developers, contractors, landscapers, architects, realtors, etc.); individual homeowners and neighborhood associations; small business owners and retail and commercial businesses; and city and county governments, including their planning, public works, and parks department staff, management, and elected officials. Completed involvement and education activities are summarized below.

Committees

Public and private sector representatives were involved in defining the study from its inception (Project Team, page i). Community, business, and local government representatives assisted in the study through two committees.

Steering Committee

Since long-term success depends on cooperation and coordination among the four local governments in the North Thurston UGMA, Olympia managed the study with the assistance of a Steering Committee comprised of planning, community development, and public works staff from Olympia, Lacey, Tumwater, and Thurston County. The Steering Committee met four times, helped refine the scope of the study, and provided technical review of reports and other products. The committee also shared the results of the study with their management and elected officials and participated in technical assistance activities.

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Ad Hoc Citizen Advisory Committee

A six-member committee of community representatives met 14 times during the course of the study. The committee advised staff by reviewing drafts, discussing ideas, and assessing the environmental, economic, social, and political implications of various recommendations. Committee members included a consulting engineer, architect, commercial realtor, soils scientist, private utility manager, and neighborhood association representative. The committee's second meeting (July 1993) consisted of a visioning exercise with the Steering Committee members based on Olympia's sustainability criteria (Figure 4, page 16). The Ad Hoc Citizen Advisory Committee subsequently met to review comments on the draft report and provide input to this final report.

Needs Assessment

An informal needs assessment (Appendix B, page 165) was conducted over a three-month period (January through May 1994) to identify communication tools and incentives appropriate for reducing impervious surfaces. A secondary purpose was to inform members of the community about the study. The assessment results were incorporated into the Public Involvement and Education Plan (Appendix A, page 159).

Of the approximately 125 assessment forms distributed to local business and development community representatives, and planning and public works staff, 41 (33 percent) were returned. Survey responses indicate that, with the exception of tours and field trips, technical assistance and education tools developed for the public sector may not be suitable for the private sector. However, newspapers are a good media format for reaching both sectors.

The survey results also indicate that the public sector is more willing to participate in demonstration projects than the private sector. Responses indicate that the private and public sectors agree on the incentives for participating in demonstration projects: training, streamlined permit process, and reduced development costs.

Community Forums

Two community forums were held to discuss the study's recommendations (Figure 4, page 16). A meeting with the attendees of the early scoping meetings and additional members of the community was convened to discuss the Technical and Policy Analysis Report (City of Olympia, 1994b) in January 1994. Another meeting was held in January 1995 to present the draft study report, provide an opportunity to discuss the draft recommendations, and involve the public in a sustainability review. The comments from the community forums were incorporated into this final study report.

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Technical Assistance

To encourage further understanding and actual reduction of impervious surfaces, technical assistance was offered to the local and regional community. Information and training on how to identify and take advantage of impervious surface reduction opportunities was provided to citizens, policymakers, developers, business owners, builders, and others. Technical assistance consisted of two workshops, an alternative surfaces fact sheet (Appendix C, page 169), and a model legal agreement for shared parking (Appendix D, page 179). In January 1995, information on alternative surfaces and impervious surface reduction techniques was presented to the local chapter of the Ecobuilders Guild. In March 1995, an Exploring and Understanding Soils Workshop was offered to builders, contractors, excavators, and interested citizens. Both workshops were successful in expanding understanding about impervious surface reduction techniques (Study Results, page 5, and Appendix E, page 181).

The alternative surfaces fact sheet was distributed to 30 soils workshop attendees. An additional 600 copies are scheduled to be printed and distributed during 1995. A model legal agreement for shared parking (Appendix D, page 179) is distributed through the Olympia permit counter and was distributed to local governments throughout Washington, via the Association of Washington Counties' and Association of Washington Cities' mailing lists.

Sharing the Results

Information was shared with citizens, professional groups, and various jurisdictions within Thurston County, Washington State, and across the United States to encourage application of the studies results. A shared parking fact sheet was developed and over 500 were distributed to local jurisdictions throughout the United States. Nineteen articles about the study were published, including two in national publications and three professional papers. Twelve news releases, one radio announcement, two professional papers, and two ads were also completed.

Printed materials distributed or scheduled to be distributed include approximately 1,575 reports, 1,000 buttons, and 2,000 copies of three different fact sheets (Appendix C, page 169). Printed materials were disseminated at two national conferences, at 23 presentations and briefings, and in response to requests. The project mailing list contains 431 names and addresses, including 183 local, 139 within Washington State, 104 out-of-state, and five names and addresses outside the United States.

An informational display board with illustrations of alternatives and a flip book with photos of example designs were used at the two national conferences and several of the presentations.

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STUDY EVALUATION

An evaluation of the study and whether or not it met its goals and objectives was conducted by project staff March and April 1995. Evaluation of the public involvement and education plan (Appendix A, page 159) was an important part of the overall evaluation because it provided data on the amount and distribution of printed materials, numbers of people informed about the study, and knowledge gained from technical assistance workshops. However, actual behavior changes resulting from printed materials, presentations, or other methods were not measured. Without measuring behavioral change, crediting the study with actual impervious surface reduction is difficult. Staff assume that some reduction will occur given the policies that have been changed as a result of the study, and because citizens, businesses, development community members, and several jurisdictions nationwide have learned more about impervious surface reduction strategies.

Public Involvement and Education Plan Results

The Public Involvement and Education Plan (Appendix A, page 159) contains nine evaluation measures. According to evaluation results, four of the measures were clearly met, three were partially met, one is no longer applicable, and one is difficult to evaluate because it is based on future actions. The evaluation measures and results are listed below.

1. At least 1,000 people were informed of the study through briefings, presentations, etc.

This objective was met. Approximately 2,190 people attended briefings, presentations, and technical assistance workshops, or received printed materials. If 25 percent of these people were at one or more presentations or received printed materials and attended a presentation, then approximately 1,650 different people were informed of the study.

2. Demonstration projects included private-public partnerships.

This objective was partially met. Although the project team was not successful at constructing a demonstration project on private property, Olympia School District No. 111 is participating in a demonstration project. The school district is a separate entity from the city and, thus, a special letter of agreement was required for construction of the project. The Olympia High School project was brought to the team's attention by a citizen and utilized private contractors for soils analysis and sod replacement.

3. At least five site plans submitted to Olympia during 1995 integrated techniques recommended by the study.

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This objective is no longer applicable for two reasons. First, when written, this objective assumed the study would be completed in 1994 rather than 1995. Second, because many of the policy changes that occurred as a result of the study have yet to be adopted, it is too early to see study results reflected in site plans. This evaluation measure has been folded into Olympia's implementation actions for Recommendation 19 (page 121).

4. At least 20 people were involved in training.

This objective was met. Forty-six people attended the two training workshops.

5. Results of workshop evaluations indicated that the training workshops were useful.

Written evaluations were distributed at both training workshops (Appendix E, Workshop Evaluations, page 181). Participants' responses to both workshops were favorable. Eight of the nine respondents to the Ecobuilders Guild evaluation indicated that "they would reduce impervious surfaces associated with their next construction project." The twelve respondents to the Soils Workshop evaluation rated the overall quality of the workshop a 4.42 out of 5.00 possible points. Nine of the respondents from that workshop indicated they "certainly did" learn new facts or new ideas that would be helpful on their job.

6. At least 75 percent of the study's recommendations were adopted by Olympia and 50 percent by other local governments.

This objective will be partially met if draft policies are adopted as proposed. It is expected that at least nine recommendations will be wholly or partially incorporated into Olympia's policies. Three of the study's recommendations were incorporated into city policy prior to the study, and are included as guidance for other local jurisdictions outside the North Thurston UGMA. Four additional recommendations may be implemented depending on funding. If funding is provided for these four recommendations and policies are adopted as proposed, Olympia will implement all or part of 81 percent of the study's recommendations not already implemented.

Only a few of the recommendations are proposed for adoption by Lacey, Tumwater, and Thurston County. As with Olympia, some recommendations had already been wholly or partially incorporated into policy prior to the study, while other recommendations have been incorporated into proposed street standards and other policies. Staff estimate that approximately 10 to 20 percent of the recommendations will be adopted by other local governments in the North Thurston UGMA.

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7. At least 10 jurisdictions requested study results.

It is difficult to determine the exact number of requests from jurisdictions because phone calls and personal contacts were not always documented. However, those that requested materials were added to the project mailing list. As of March 15, 1995, the mailing list contained 165 names of representatives from various jurisdictions, including five tribal representatives, 18 representatives from federal agencies, 47 from state agencies or universities, 44 from county agencies, and 51 from city agencies or ports. Project staff continue to get requests for information. These requests are expected to continue throughout 1995.

8. At least one letter of support for the study was received from a leading business organization.

Staff did not request a letter of support from local business organizations. Informal verbal support of the study was given by the Olympia/Thurston County Chamber of Commerce.

9. The Ad Hoc Citizen Advisory Committee and Steering Committee members generally support the study's recommendations.

The Ad Hoc Committee members have indicated that they support most or all of the study's results and recommendations. Committee members worked well together, sharing ideas and wrestling with challenging issues. The committee came to general consensus concerning many elements of the study's approach and recommendations. Steering Committee support also was achieved, although to a lesser degree. More frequent meetings or direct contact with Steering Committee members could have resulted in greater support for and implementation of the study's recommendations.

Overall Study Evaluation Results

Evaluation measures were not established for the overall study. However, results of an evaluation of the study's goals and objectives (Goals and Objectives, page 14) are summarized below.

The study's two goals were generally met.

Goal 1: The Ad Hoc Citizen Advisory and Steering Committees generally support the impervious surface reduction techniques recommended by the study. Many of the recommendations are proposed as part of new street, parking, and development standards. Results of the cost analysis indicate savings associated with some recommendations. However, there will be some costs incurred for alternative surfaces, taller buildings, and other recommendations depending on individual site factors.

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Goal 2: Based on the basin and site coverage assessment and expected results from the proposed street, parking, and development standards, an estimated 20 percent reduction in future impervious surfaces is likely to occur. This reduction will be complemented by additional reduction from infill and other growth management strategies currently being implemented.

The study's five objectives (Goals and Objectives, page 14) were clearly met.

Objective 1: Over 1,600 people were informed of the need for alternatives to impervious surfaces and encouraged to support impervious surface reduction in their local community. Nineteen articles, 12 news releases, one radio announcement, two professional papers, and two ads were used to inform the public about study results or invite participation. In addition, approximately 1,000 buttons were distributed with a "Save It–Don't Pave It" message, 2,000 fact sheets were distributed, and 23 presentations or briefings were provided to the local and regional community.

Objective 2: Street, parking, and development standards were modified to encourage impervious surface reduction in future construction.

Objective 3: Although not as extensive as initially proposed in the Public Involvement and Education Plan (Appendix A, page 159), technical assistance was provided to the development community during the study and will be continued to some degree into the future.

Objective 4: Two demonstration projects are underway. Both are at highly visible sites (Olympia City Hall and Olympia High School) and utilize alternative development practices.

Objective 5: Many of the presentations and briefings noted under Objective 1 were designed specifically to share results. As of March 15, 1995, approximately 875 copies of the Technical and Policy Analysis Report and Impervious Surface Reduction Study Draft Report had been distributed. Approximately 200 copies of this final report and 1,500 copies of a separate Executive Summary will be distributed nationwide.

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CHAPTER 2
TECHNICAL AND POLICY ANALYSIS

Research of technical and policy issues was important to understanding the problems caused by impervious surfaces and developing feasible and practical recommendations. The technical and policy analysis element of the study included five main tasks:

1. Literature and Policy Review
2. Demonstration Projects
3. Basin and Site Coverage Assessment
4. Parking Analysis
5. Other Research

LITERATURE AND POLICY REVIEW

The literature and policy review was conducted early in the technical and policy analysis (Figure 4, page 16) and helped define the study approach (Chapter 1, page 15). The review included the following activities.

- A survey of the literature and interviews with knowledgeable people to determine quantifiable relationships between impervious surface and the quality and quantity of stormwater runoff.
- Development of recommendations for reducing impervious surfaces based on 1) Olympia City Council policy direction; 2) initial visioning (brainstorming) and lengthy discussions by the Steering and Ad Hoc Citizen Advisory Committees; 3) a review of literature on sustainable communities and alternative development techniques; 4) input from a forum of select community leaders; and 5) public review and comment.
- Analysis of stormwater runoff quantity, water quality, groundwater recharge, and stream flow information.

The literature and policy review culminated in the publication of the Technical and Policy Analysis Report (City of Olympia, 1994b). For the sake of continuity, some of the early analysis has been incorporated into Chapter 3 (page 59) of this report.

DEMONSTRATION PROJECTS

A key task of the technical and policy analysis was to demonstrate the feasibility and practicality of the recommendations at one or more new development sites. Numerous proposed developments in the Olympia area were investigated in light of

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the goals of the study. These proposed developments were evaluated for suitability as demonstration projects by staff and the Ad Hoc Citizen Advisory Committee using the following nine selection criteria:

1. Project provides an opportunity for techniques that are not readily familiar to the development community, and at a size that demonstrates their applicability to the local community.

2. Project has high visibility and accessibility to the development and business community.

3. Project provides useful information for an urbanized, intensely used setting.

4. Project provides an opportunity to use techniques that meet stormwater detention and treatment goals.

5. Project provides an opportunity to demonstrate cost-effective techniques.

6. Project provides an opportunity for a public/private partnership.

7. Project provides an opportunity to demonstrate several recommendations.

8. Project provides an opportunity to monitor it long-term.

9. Project costs are no more than $50,000.

Recommendations considered the most practical for demonstration included Recommendation 4 (narrow residential streets); Recommendation 5 (use pavers or alternative surfaces); Recommendation 11 (limit soil compaction); and Recommendation 12 (limit land clearing).

Both commercial and residential, private and public sites were considered for demonstration of the recommendations. Considerable effort was spent investigating potential projects. Barriers associated with identifying a viable demonstration construction project included:

- Many of the recommendations focus on changes in current policies or regulations. A variance would have been required for almost every potential project in order to legally construct an alternative or innovative design that is not currently allowed. Most projects did not come to the attention of staff or the committee until it was too late in the design phase and would have required a construction delay for the developer or builder.

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- Because there were only a few techniques identified for demonstration through the study, many of the potential projects offered limited opportunities. Pavers and alternative surfaces were the most obvious items suitable for demonstration, but they are suitable for low-use areas which contradicts with high-visibility and other selection criteria.

- Many of the potential projects offered only minor improvements in the infiltration or treatment of stormwater due to site specific limitations (e.g., soils) and were therefore not pursued.

- Potential projects tended to lack long-term viability of the demonstration techniques and/or an opportunity for long-term monitoring of the project.

The above barriers delayed starting the projects until early 1995. Since that time, two projects have been pursued: a sidewalk renovation project at Olympia City Hall and a soil restoration project at Olympia High School.

The Olympia City Hall sidewalk renovation project will consist of using pavers for bike rack facilities and for replacing segments of existing sidewalk. Approximately three different types of pavers will be used and displayed with information about costs, installation methods, and expected benefits.

The Olympia High School soil restoration project will consist of reducing the soil compaction along one side of a dirt and gravel parking lot in order to increase infiltration of surface water runoff. Runoff is currently flowing from the parking lot into an adjacent soccer field, limiting use of the field. A trench approximately three to six feet wide, four feet deep, and 100 feet long will be dug. Rock and other materials will replace the soil removed from the trench. The soils will be reinforced with a layer of plastic cellular confinement material (e.g., Geoweb) just below the surface. The added rock and materials, and the cellular confinement layer are expected to help protect the deeper soil from compaction and increase infiltration capacity.

The following six criteria will be used to evaluate the demonstration projects:

1. The new techniques can be implemented without causing appreciable increases in development costs.

2. The amount of impervious surface is less with new techniques than with standard development practices.

3. The new techniques are acceptable to users and provide a safety, aesthetic, or other advantage compared to standard development practices.

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4. The new techniques are acceptable to contractors and builders and are easier to construct than standard development practices.

5. The new techniques increase the ease of maintenance and reduce maintenance costs compared to standard development practices.

6. The new techniques increase stormwater treatment and infiltration and reduce flooding compared to standard development practices.

The study grant was recently extended to June 1996 to accommodate completion of the demonstration projects. Because the demonstration projects are not complete in time for this report, a separate technical report that summarizes lessons learned and monitoring results will be submitted to the Washington Department of Ecology in April 1996. Readers interested in information about the demonstration projects are encouraged to contact the study coordinator.

BASIN AND SITE COVERAGE ASSESSMENT

Project staff conducted a basin and site coverage assessment to better understand the level of impervious surface reduction that could be expected in the North Thurston UGMA from key study recommendations. The assessment consisted of a site-specific analysis and a two-part analysis of impervious surface coverage at predicted buildout conditions in the Percival, Woodard/Woodland, and Chambers/Ward/Hewitt drainage basins (Figure 2, page 3). The three drainage basins total 37,000 acres and were selected for the assessment because:

- Land use and impervious surface coverage information was readily available and fairly current;
- They represent an area that overlaps with the North Thurston UGMA and is equivalent in size to almost 69 percent of the North Thurston UGMA (Figure 2, page 3); and
- It is expected that the three basins will experience less development and lower growth rates than the North Thurston UGMA as a whole, and thus, the analysis results are a conservative estimate of reduction we can expect from the study's recommendations in the UGMA.

Information for the assessment was obtained from engineering plans for 11 Olympia-area developments and Hydrological Simulation Program - Fortran (HSPF) models created for the three basins. The engineering plans provided information on typical coverage for high-density residential (three to seven units/acre), multifamily (seven to 30 units/acre), and commercial/industrial land uses. The HSPF models are predictive hydrologic computer models for surface water that provided information on existing and potential future land use. The models also provided information on

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the effectiveness of various impervious surface types (i.e., streets, sidewalks) at producing runoff from a site. The engineering plan and HSPF information was evaluated to answer the following questions:

- How much impervious surface is associated with typical developments in the North Thurston UGMA?
- What is the amount of impervious surface we can expect at buildout in the three basins given current development regulations and patterns, as a representation of North Thurston UGMA development trends?
- What reductions in impervious surfaces can be expected with implementation of key study recommendations?

Site-specific Analysis

The quantity of streets, sidewalks, parking/driveways, roofs, lawn/landscaping, and open space associated with recent Olympia area developments was calculated from the engineering plans. Numerous developments exhibiting typical, but varied, site opportunities and constraints were used. The following developments were chosen for the analysis:

- Residential development:

Springfield	16 units; 6 units/acre
Mapleview II	49 units; 4 units/acre
North Pointe	38 units; 6 units/acre
Bigelow Park	71 units; 4 units/acre

- Multifamily development: Homeport, Fern Ridge, Cambridge II, Creekwood
- Commercial development: Safeway, Home Depot, Eastside Office Building

The approximate composition of site coverage for the 11 developments is shown in Table 2 (page 36). The average coverages are also presented graphically in Figure 7 (page 36).

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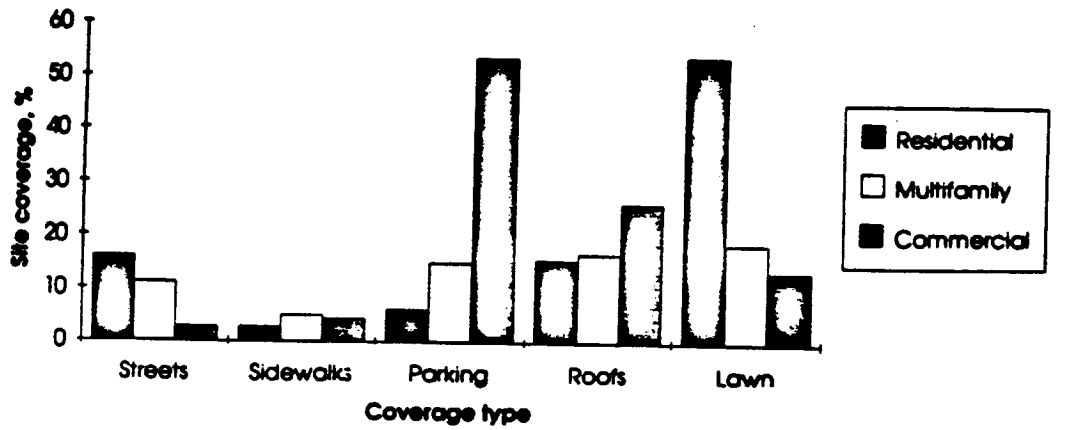
Table 2: Site Coverage for Three Land Uses

Surface Coverage Type	Approximate Site Coverage, % Residential Average	Range	Multifamily Average	Range	Commercial Average	Range
Streets	16	11-22	11	7-17	3	2-4
Sidewalks	3	2-4	5	2-11	4	2-9
Parking/driveways	6	4-9	15	10-20	53	39-64
Roofs	15	10-18	17	15-17	26	25-27
Lawns/landscaping	54	44-65	19	14-22	13	4-26
Open space		n/a[1]	34	25-40	n/a[1]	
Total impervious surface	40		48		86	

(1) Open space typically represents a small portion of residential and commercial developments.

Figure 7: Site Coverage for Three Land Uses



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The total impervious surface for each land use category is generally in agreement with accepted Puget Sound values used in the HSPF program (Aqua Terra, 1994). Table 3 compares the estimated HSPF coverage values with the coverage of Olympia area developments.

Table 3: Comparison of HSPF and Olympia Area Development Coverage Values

Land Use	Impervious Surface, % HSPF Model	Olympia Developments
Low-density residential (<1 unit/acre)	10	n/a[1]
High-density residential (3-7 units/acre)	40	40
Multifamily (7-30 units/acre)	60	48
Commercial/industrial	90	86

(1) Low density residential developments were not evaluated.

Impervious surfaces can also be evaluated with respect to their effectiveness at producing runoff. For example, a residential roof may be similar in size to a commercial roof, but given the presence of permeable landscaping around the typical residential roof and the presence of impervious surface around the commercial roof, the commercial roof is more effective at producing runoff (produces more runoff) than the residential roof. This evaluation approach can be helpful in defining stormwater problems and opportunities. Commonly accepted HSPF relationships between impervious surface and effective impervious surface (Aqua Terra, 1994) in the Puget Sound area are presented in Table 4.

Table 4: Comparison of Total Impervious Surface and Effective Impervious Surface for Several Land Uses

Land Use	Total, %	Effective, %
Low-density residential (<1 unit/acre)	10	4
High-density residential (3-7 units/acre)	40	26
Multifamily (7-30 units/acre)	60	48
Commercial/industrial	90	86

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Table 5 indicates that a given unit of impervious surface will produce appreciably more runoff in a commercial setting than in a low-density residential setting. However, these assumed values do not, as stand-alone numbers, reflect the importance of soil type and slope on the effectiveness of the surface. Impervious surfaces discharging to highly pervious soil are ineffective. This evaluation does not address the effect of soil type on effectiveness, and, therefore, provides generalized rather than site-specific results.

Table 5: Estimated Impervious Surface Effectiveness for Residential Development

Surface Coverage Type	Surface Type, %	Effective Fraction	Effective Surface, %
Streets	16	.8	12.8
Sidewalks	3	.7	2.1
Parking/driveways	6	.6	3.6
Roofs	15	.35	5.3
Lawns/landscaping	54	.05	2.7
Total			26.5

Effective impervious surface estimates have also been developed for low-density residential, multifamily, and commercial/industrial land use. Multifamily and commercial/industrial impervious surfaces were assumed to be entirely effective. Lawns and landscaping for all development land uses were assigned an effective fraction of 0.05. Table 6 presents the estimates; Figure 8 (page 39) illustrates the estimates.

Table 6: Estimated Effective Impervious Surface Coverage for Residential, Multifamily, and Commercial Development

	Effective Impervious Surface, %			
Land Cover	Low-Density Residential	High-Density Residential	Multifamily	Commercial
Streets	3.5	13	11	3
Sidewalks	0	2	5	4
Parking/driveways	0.5	4	15	53
Roofs	0	5	17	26
Lawns/landscaping	0	2	1	1
Total	4	26	49	87

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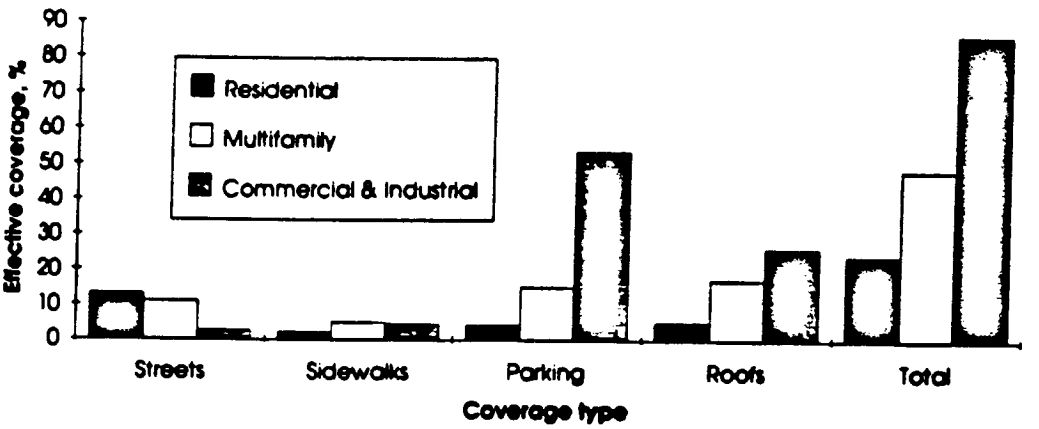
Figure 8: Estimated Effective Impervious Surface Coverage for Residential, Multifamily, and Commercial Development



The estimated effective impervious surface values for the four land uses closely approximate values used in HSPF modeling (Table 4, page 37).

The results of the site-specific analysis include:

- Streets are the primary producers of stormwater runoff in residential areas.
- Sidewalks and lawns/landscaping contribute minimally to effective impervious surface.
- Parking lots are highly effective impervious surface.
- Streets, parking lots, and roofs generate similar quantities of runoff in multifamily developments.

Analysis of Potential Impervious Surfaces in Three Olympia Area Drainage Basins

Like most areas adjacent to the urban core of Olympia, Lacey, and Tumwater, the three representative drainage basins can expect considerable development growth in the near future. The extent of the basins' growth potential has been thoroughly evaluated through basin plans developed by the local governments and is presented below in Table 7 and Figure 9.

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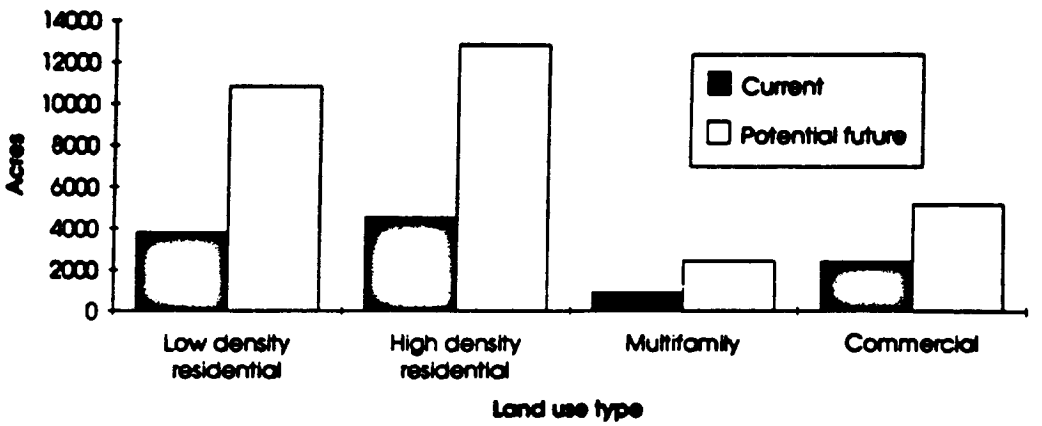
Table 7: Current and Potential Future Land Use in Three Olympia Area Drainage Basins

Land Use Category	Land Use, Acres Current	Potential Future
Undeveloped	24,663	791
Sparse residential	3,805	12,592
Suburban residential	3,448	12,492
Medium residential	1,559	2,409
High residential	869	2,807
Light commercial	1,527	2,963
High commercial	868	2,854

Figure 9: Current and Potential Future Land Use in Three Olympia Area Drainage Basins



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The HSPF model requires consolidation of the seven land uses shown in Table 7 (page 40) into the categories of undeveloped, low- and high-density residential, multifamily, and commercial/industrial land uses. Successful computer modeling and calibration is feasible with the broad level of detail provided by the consolidated land uses. The categories of low-density residential, high-density residential, multifamily, and commercial/industrial are the same categories used on the previous evaluation of total and effective impervious surfaces. The consolidated land uses are presented in Table 8. Additionally, potential future development acreage (expected buildout) in Table 9 has been reduced by 20 percent compared to zoning allowances because sites in the Olympia area typically develop at lower densities than are allowed by zoning.

Table 8: Consolidation of Current and Potential Future Land Use in Three Olympia Area Drainage Basins at 80 Percent Buildout

Land Use, Acres

Land Use	Current	Potential future
Low-density residential (<1 unit/acre)	3,805	10,835
High-density residential (3-7 units/acre)	4,507	12,838
Multifamily (7-30 units/acre)	869	2,419
Commercial/industrial	2,395	5,133

Table 9: Potential Future Increases in Total and Effective Impervious Surfaces in Three Olympia Area Drainage Basins

Impervious Surface Increases, Acres

Land Use	Total	Effective
Low-density residential (<1 unit/acre)	703	281
High-density residential (3-7 units/acre)	3,332	2,166
Multifamily (7-30 units/acre)	915	732
Commercial/industrial	2,464	2,354

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Given these values for current and potential future land use in the drainage basins (Table 8, page 41), and total and effective impervious surfaces associated with different development types (Table 4, page 37, and Table 6, page 38), we can expect the following increases in impervious surfaces for full development conditions (20 percent less than buildout) in the basins.

Tables 10 and 11 show total and effective surfaces in the basins under full development conditions. The information is also presented graphically on Figures 10 (page 43) and Figure 11 (page 43). Due to its relatively minor contribution to runoff, lawns and landscaped areas have been omitted from these analyses.

Table 10: Total Impervious Surfaces for Future Potential Development in Three Olympia Area Drainage Basins

Total Impervious Surface, Acres

Surface Coverage Type	Low-density Residential	High-density Residential	Multifamily	Commercial	Total
Streets	225	1333	168	73	1799
Sidewalks	37	222	76	119	455
Parking/Driveways	85	506	225	1460	2276
Roofs	216	1281	252	712	2460

Table 11: Effective Impervious Surface for Future Potential Development in Three Olympia Area Drainage Basins

Effective Impervious Surface, Acres

Surface Coverage Type	Low-density Residential	High-density Residential	Multifamily	Commercial	Total
Streets	211	1066	168	73	1518
Sidewalks	0	89	76	119	284
Parking/driveways	70	304	225	1460	2059
Roofs	0	512	252	712	1476

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Figure 10: Acres of Total Impervious Surface for Future Potential Development in Three Olympia Area Drainage Basins

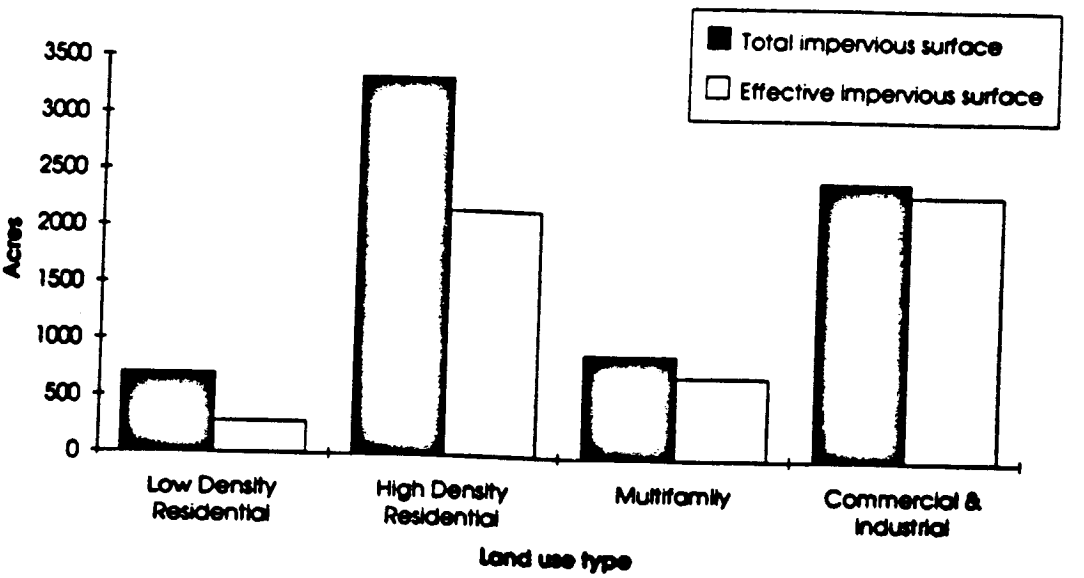
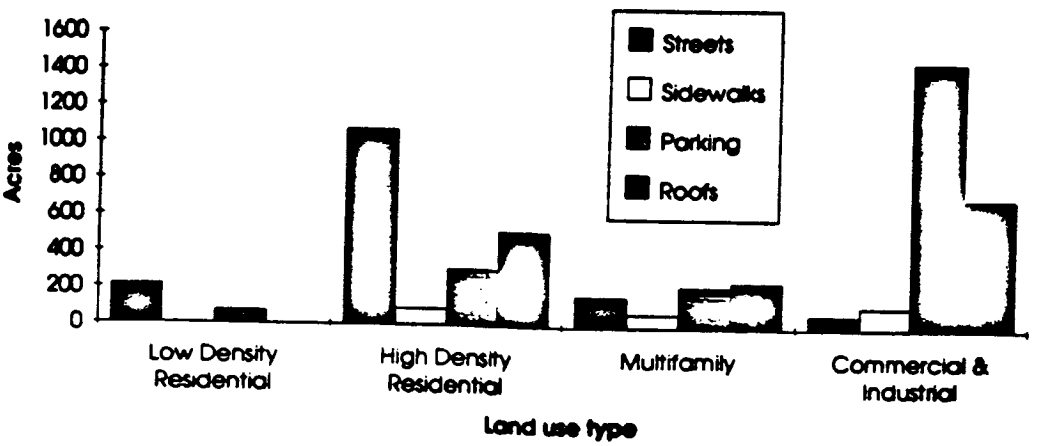


Figure 11: Acres of Effective Impervious Surface for Future Potential Development in Three Olympia Area Drainage Basins



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Reduction Analysis

Based on the previous analysis, six potential strategies for impervious surface reduction were evaluated. The six strategies included:

1. Reduce residential sidewalks by 50 percent by installing sidewalks on only one side of the street.
2. Reduce residential sidewalks from five feet to four feet in width.
3. Reduce local access street widths from 32 feet to lesser widths.
4. Reduce commercial parking by five, ten, or 20 percent.
5. Reduce multifamily parking by five, ten, or 20 percent.
6. Reduce commercial, industrial, and multifamily roof areas by 10 or 20 percent.

For each strategy, two questions were asked:

- What percent of total and effective impervious surface would be reduced for a given development site?
- What percent of total and effective impervious surface would be reduced in the three drainage basins at 80 percent buildout?

The results of the reduction analysis calculations are summarized in Table 12 (page 45). Results of the reduction analysis include:

- Reducing sidewalks offers minor, possibly insignificant, reductions in total and effective impervious surfaces.
- Major reductions in residential street widths are needed before significant reductions in impervious surfaces can be expected.
- Reducing commercial, industrial, and multifamily parking could readily reduce impervious surfaces.
- Roof reductions imply constructing taller buildings with associated reductions in impervious surfaces.

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Table 12: Basin and Site Coverage Assessment Reduction Analysis Results

Potential Strategy	Impervious Surface Reduction Percentages			
	Site-Specific		Basin-Wide	
	Total	Effective	Total	Effective
1. Reduce residential sidewalks by 50 percent by installing the walks on one side of the street only.	1.33	1.00	1.59	0.83
2. Reduce residential sidewalks from 5 feet width to 4 feet width.	0.53	0.40	0.64	0.33
3. a. Reduce local access street widths from 32 feet to 27 feet.	2.50	2.00	2.98	3.12
b. Reduce local access street widths from 32 feet to 25 feet.	3.50	2.80	4.17	4.37
c. Reduce local access street widths from 32 feet to 20 feet.	6.00	4.80	7.15	7.49
4. a. Reduce commercial parking by 5 percent.	2.67	2.67	1.04	1.37
b. Reduce commercial parking by 10 percent.	5.33	5.33	2.09	2.74
c. Reduce commercial parking by 20 percent.	10.67	10.67	4.18	5.47
5. a. Reduce multifamily parking by 5 percent.	0.74	0.74	0.16	0.21
b. Reduce multifamily parking by 10 percent.	1.48	1.48	0.32	0.42
c. Reduce multifamily parking by 20 percent.	2.95	2.95	0.64	0.84
6. a. Reduce commercial, industrial, and multifamily roof areas by 10 percent.	4.25	4.25	1.38	0.94
b. Reduce commercial, industrial, and multifamily roof areas by 20 percent.	8.50	8.50	2.76	1.89

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Assumptions of the Basin and Site Coverage Assessment

Results of the basin and site coverage assessment should be considered in light of several important assumptions.

- The street width reduction calculation assumed that all streets in residential areas were minor local access roads and would, therefore, be considered for width reduction. Since all residential streets are not local access roads, this assumption leads to an overestimate of impervious surface reduction.
- The analysis assumes that the area surplused by the parking reduction or other strategies would be landscaped rather than covered by impervious surfaces (i.e., building).
- The estimate of the effective fraction of impervious surfaces was based entirely upon best judgement. The subsequent analysis of impervious reduction strategies for residential sites is directly affected by these estimates.
- The effect of soil type on the effectiveness of impervious surfaces has not been addressed. Sites with highly permeable soils may have no effective impervious surfaces even though site coverage is high.
- Impervious surfaces associated with multifamily land use are assumed to be entirely (100 percent) effective at producing runoff.
- Full development conditions were assumed to be 20 percent less than allowed by zoning. This assumption has been commonly used in computer modeling of urban hydrology. It acknowledges that full development at zoning levels is unlikely, especially for residential development.

Even with these assumptions, the methodology used in this assessment provides a justifiable basis for investigating the performance of various impervious surface reduction strategies. Strategies investigated offer basin-wide impervious surface reductions ranging from 0.16 to 10.67 percent (Table 12, page 45). Once implemented, the performance of the new strategies could be easily quantified.

PARKING ANALYSIS

Special Parking Capacity Study

In order to better understand the parking situation in Olympia, a special parking capacity study was conducted. The purpose of the Special Parking Capacity Study was to assist Olympia's Community Planning and Development Department in revising the parking ordinance and to determine if proposed changes in Olympia's parking ratios (standards) would reduce impervious surfaces. The draft ordinance

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(City of Olympia, 1994g), if adopted by the Olympia City Council, would replace the current "minimum" parking ratios with "median" parking ratios.

Methodology

Determining parking ratios for various land uses is not an exact science. The method most often used is to modify ratios from other local governments. Another method is to use the Institute of Transportation Engineers handbook (ITE, 1992). The handbook provides parking ratios that are based on national surveys of select land uses.

These two common methods normally establish the minimum parking ratios necessary to provide sufficient onsite parking, to prevent traffic congestion and overflow into residential neighborhoods. However, they do not provide parking ratios that avoid excess parking or allow for specific needs of individual communities.

Direct observation of parking stall occupancy during peak operating hours, though labor intensive, is an effective approach for determining if there is insufficient or excess parking in a community. This method is most helpful when trying to establish parking medians and was the one selected for the Impervious Surface Reduction Study's Special Parking Capacity Study.

Three tasks comprised the Special Parking Capacity Study:

1. Informational survey
2. Field survey
3. Reduction analysis

These tasks are described in detail below.

Informational Survey:

The first task was to administer an informational survey through phone and personal interviews (Appendix F, Parking and Informational Survey, page 187). Conducted from August 1 to August 14, 1994, this survey was administered to owners or managers of 31 selected sites in the North Thurston UGMA.

The sites were chosen by Olympia's Community Planning and Development Department, which identified them as representative of 15 different land uses that would be most affected by adoption of the proposed parking revisions. Six sites were located in the cities of Lacey and Tumwater. The remaining sites were located in Olympia. No sites in downtown Olympia were chosen. A committee convened in 1994 will be developing and reviewing a separate Downtown Olympia Parking Management Strategy.

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Several respondents indicated that summertime was not the peak season for their respective activities. Caution was used when drawing conclusions about peak occupancy rates for churches, retail stores, schools, and movie theaters since the counts were not made during their self-defined peak season. Due to the limited scope of this survey, further surveys using larger samples throughout the year are recommended.

Field Survey:

The second task was a field survey of 15 land uses conducted from August 1 through August 9, 1994 (Appendix G, Parking Field Survey Data Results, page 189). All existing parking spaces were counted at each site, for each land use. Occupied spaces were counted four times for each site, with the exception of the general office site which was counted only once. Counts were taken during peak hours, twice on weekdays, and twice on weekends.

Peak hours were determined by consulting the Transportation - Traffic Engineering Handbook (ITE, 1992), consultation with planning staff, and field observations. Peak hours for each land use and the number of occupied spaces during peak hours are listed in Appendix G (page 189).

Reduction Analysis:

The third task was to analyze what effect the proposed parking ordinance would have on impervious surfaces. To determine if median parking ratios would reduce impervious surfaces in Olympia, information from 11 of the field survey sites was combined with information taken from plans for four additional sites. The number of parking stalls for the 15 sites was determined (Table 13, page 49). Then, the number of parking stalls that would exist if they were constructed under the median parking ratios of the draft ordinance was calculated (Table 14, page 50).

Parking Capacity Study Results

Results of the surveys and reduction analysis overlap and are divided into three general categories: excess parking, parking deficiencies, and parking reductions.

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Table 13: Selected Sites for Comparison of Existing, Proposed, and Actual Amount of Parking Stalls

Development Name/Type	Number of Existing Stalls	Number of Stalls Required Under Existing Minimum Regulations	Number of Stalls Required Under Proposed Median Regulations
Home Depot/Commercial Retail	544	324	520
Safeway/Commercial Retail	323	308	248
Top Foods/Commercial Retail	526	148	259
Costco/Commercial Retail	616	588	468
Best/Commercial Retail	211[1]	217	209
Windermere Offices/General	21	15	20
Eastside Office/General	29	23	18
McDonald's Downtown/Restaurants	44[2]	73	44
McDonald's West Side/Restaurants	83	76	46
Brewery City/Restaurants	37	37	37
Lacey Cinema Theaters/ Entertainment	425[1]	497	442
Pac West Health Club/Entertainment	117	—[3]	260
Kolb Storage/Warehouse	9	7	10
Homeport/Multifamily	180	96	134
Cambridge Court/Multifamily	316	240	238

(1) Shared parking arrangements skew the totals.
(2) The downtown McDonald's site was allowed to have 29 fewer parking stalls than the minimum required because of its downtown location.
(3) There are no existing regulations specific to health clubs.

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Table 14: Comparison of Existing Stalls to Required Stalls Under Existing Regulations and Proposed Regulations

Type of Land Use/ Development	Number of Existing Stalls per Site Calculated From Site Visit or Plans	Number of Stalls Required Under Existing Minimum Regulations	Number of Stalls Required Under Proposed Median Regulations
Commercial Retail	2,220	1,585	1,704
General Office	50	38	38
Restaurants	164	186	127
Entertainment—Theaters/Health Clubs (1)	—	—	—
Storage Warehouse	9	7	10
Multifamily	496	336	372
Total Development	2,939	2,152	2,251

(1) Theaters are not included in the comparison because shared parking arrangements skew the number of existing stalls. Health clubs are not included because there are no existing regulations specific to health clubs.

Excess Parking:

- The majority of respondents (71 percent) indicated that the amount of available onsite parking was adequate (Appendix G, page 189).
- Despite parking capacity numbers that indicated as much as 60 and 70 percent vacancy rates, no respondent defined excess parking as a problem (Appendix G, page 189).
- Eighteen of the 31 representative sites had less than 75 percent occupancy rates during their busiest peak hour surveyed (Appendix G, page 189).
- Respondents from sites with more traditional daytime uses, such as a medical clinic, retail store, and service station, indicated that parking was inadequate even though occupancy ranged from 46 to 67 percent (Appendix G, page 189).

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- The majority of sites have more parking than the minimum parking ratios require. There are a total of 809 more parking stalls at 12 of the survey sites than required (Table 15, page 52).

- The multifamily and large retail sites have the greatest percentage of parking in excess of the existing minimum parking ratios (Table 15, page 52).

Parking Deficiencies:

- Definitions of inadequate parking varied among respondents. Inadequate parking seems to be occurring at developments serving seniors, including both senior housing and institutional care facilities. Interview results indicate that there are more senior drivers now than in previous years, and that seniors receive more visitors and care providers in these facilities now than in the past (Appendix G, page 189).

- Seven representative sites exceeded 75 percent parking occupancy rates during their busiest peak hour surveyed (Appendix G, page 189).

- Churches, theaters, health clubs, and motels all had above 75 percent peak occupancy, yet reported that parking was adequate for their needs the majority of the time. Each of these land uses have evening peak hours (Appendix G, page 189).

- Prior to August 1994, health clubs were not included as a land use under Olympia's parking ordinance. The health club that was surveyed had an 87 percent occupancy rate at peak hours with six cars choosing to park on the street (Appendix G, page 189).

- Parking for storage warehouses would increase by 11 percent under the proposed median parking ratios (Table 16, page 53).

Parking Reductions:

- If the proposed median parking ratios had been applied instead of the existing minimum parking ratios, there would be fewer parking stalls and less impervious surface at 10 of the 15 sites used in the analysis (Table 13, page 49).

- Four of the six land use categories analyzed would have fewer parking stalls and less impervious surface associated with them if the proposed median parking ratios had been applied instead of the existing minimum parking ratios (Table 14, page 50).

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Table 15: Difference in the Number and Percent of Parking Stalls Built Compared to Existing Minimum Requirements

Type of Land Use/Development	Number of Existing Stalls in Excess of Minimum Required	Percent of Existing Stalls in Excess of Minimum Required	Total Number of Stalls Fewer Than Minimum Required	Total Percent of Stalls Fewer Than Minimum Required
Commercial Retail	635	40%	—	—
General Office	12	32%	—	—
Restaurants (1)	—	—	29	16%
Entertainment—Theaters/Health Clubs (2)	—	—	—	—
Storage Warehouse	2	29%	—	—
Multifamily	160	48%	—	—
Total Development	809	38%	29	1%

(1) The downtown McDonald's site (Table 13, page 49) was allowed to have 29 fewer parking stalls than the minimum required because of its downtown location.

(2) Theaters are not included in the comparison because shared parking arrangements skew the number of existing stalls. Health clubs are not included because there are no existing regulations specific to health clubs.

- If the proposed median parking ratios had been applied instead of the existing minimum parking ratios, the parking for the multifamily, general office, commercial retail, and restaurant sites would have been reduced by 23 to 25 percent (Table 16, page 53).

Parking Capacity Study Conclusions

The results of the parking analysis indicate that most land uses have more parking than currently required. This finding confirms what planners have known for some time—that current parking ratios are artificially low and do not accurately reflect the parking needs of various land uses. The results also indicate that the majority of sites have excess parking stalls under the minimum parking ratios. However, due to the limitations of this analysis, further studies of median parking ratios are recommended. Future studies should include a greater number of observations conducted throughout the year.

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Table 16: Change in Number and Percent of Parking Stalls Built Under Proposed Regulations Versus Existing Stalls

Type of Land Use/ Development	Number of Stalls Reduced	Percent of Reduction	Number of Stalls Increased	Percent of Increase
Commercial Retail	516	23%	—	—
General Office	12	24%	—	—
Restaurants	37	23%	—	—
Entertainment— Theaters/Health Clubs [1]	—	—	—	—
Storage Warehouse	—	—	1	11%
Multifamily	124	25%	—	—
Total Development	689	23%	1	<1%

(1) Theaters are not included in the comparison because shared parking arrangements skew the number of existing stalls. Health clubs are not included because there are no existing regulations specific to health clubs.

Using minimum parking ratios has encouraged planners and developers to think of parking as negative only when there is not enough. This "bigger is better" view of parking lots has created excess impervious surface, particularly at large commercial retail and multifamily sites. This preliminary parking analysis indicates that using median parking ratios is an effective strategy for reducing impervious surfaces while providing parking ratios which are neither too high nor too low. Further studies are recommended for continued analysis of median parking ratios.

Cooperative Parking Survey

Smaller and fewer parking lots can result when separate land uses share parking. The Cooperative Parking Survey of Local Jurisdictions was used to assess existing local cooperative parking policies or regulations, and to identify incentives that may increase the use of shared parking.

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The informal survey was administered through phone interviews of five selected jurisdictions during the month of August 1994. The survey tool used can be found in Appendix H, Cooperative Parking Survey, page 205. The jurisdictions surveyed included the Cities of Olympia, Tumwater, Lacey, and Bellevue, and Thurston County. Respondents were planners in Community Development Departments. Responses to Questions 1 through 7 are summarized in the Results Summary (Appendix H, page 205). Responses to Question 7 were used to generate a list for a separate Cooperative Parking Participant Survey (City of Olympia, in preparation).

Results

Results of the Cooperative Parking Survey can be divided into two categories: incentives and barriers. Incentives for participating in cooperative parking that were mentioned by the respondents included:

- Reduced construction, landscaping, and maintenance costs.
- Decreases in required parking, ranging from five to 25 percent, if developers agree to share parking.
- An increased ability for developers to complete projects that would otherwise have been denied due to parking deficits.

Barriers to cooperative parking that were mentioned by the respondents included:

- Inflexible regulations and rigid regulatory language that limit locations appropriate for some cooperative parking and require a shared property line.
- Developer's perceptions that large parking lots are a necessity, particularly for large retail and commercial uses.
- The lack of model cooperative parking agreements. Local governments require legal agreements between some cooperative parking partners, but do not provide prototypes as part of technical assistance.
- Local governments do not document the benefits from cooperative parking or maintain records of cooperative parking arrangements.
- Though regulatory language allows cooperative parking, it is not highly promoted.
- Participation or exploration of cooperative parking options is not required as an option to building excess parking.

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Cooperative Parking Survey Conclusions

Smaller and fewer parking lots can result from cooperative parking regulations. Developers and local governments can reduce parking by joining, sharing, or coordinating parking facilities. Parking ordinances that contain cooperative parking policies are an excellent avenue for jurisdictions to promote the reduction of impervious surfaces. Parking ordinances that require the exploration of cooperative parking, such as shared parking, can prove an effective educational tool, moving public thinking towards reducing impervious surfaces.

Language used for cooperative parking varies from local government to local government. Developing common language for the various types of cooperative parking arrangements may facilitate a clearer understanding of parking options for developers. Some suggested language and accompanying parking reductions are as follows:

- Shared parking reduces parking for land uses with noncompeting hours of operation. Suggested parking reductions are 100 percent reduction of the smaller parking requirement for complimentary daytime and nighttime land uses, and 50 percent of the smaller parking requirement for land uses with some overlap of hours.

- Joint parking reduces the total parking required for multi-tenant retail and commercial facilities. The possibility of captured trips and increased overflow parking allows for overall reductions for each land use at these sites. Suggested parking reductions are 10 percent for developments with two buildings, and 25 percent for developments with three or more buildings.

- Coordinated parking reduces total parking by using large retail or commercial overflow parking for safe, convenient park-and-ride or trail head locations.

OTHER RESEARCH

In addition to the literature and policy review, demonstration projects, basin and site coverage assessment, and parking analysis, staff also researched other issues related to the recommendations.

Cost Analysis

The study goal includes a commitment to determine strategies that don't increase development costs (Chapter 1, page 14). In order to compare recommended strategies with current practices, staff researched costs for many of the recommendations. The resulting information is summarized in Chapter 3 in the incentives and barriers sections for each recommendation.

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A formal cost/benefit analysis was not conducted due to the breadth of the recommendations and complexity of the issue. Although a formal cost/benefit analysis was not conducted, the information contained in this report does provide some useful guidance. However, the cost calculations reflect a large measure of best professional judgment and are based on numerous assumptions. In a real-world development, soils and other site characteristics would greatly influence actual costs. Any conclusions or application of the costs to other locations or uses should be done with caution.

Paver Places and Faces Survey

During the study, several citizens, members of the development community, and others noted their support for using pavers as a solution to the infiltration blockage caused by impervious surfaces. However, there is widespread misunderstanding about the limited usefulness of pavers. Pavers have limited usefulness for three main reasons. First, the use of pavers should be restricted to low use areas because of the need to infiltrate only clean water and avoid groundwater contamination. Second, pavers are two to four times as costly as asphalt, making widespread use of pavers an expensive alternative. Third, most pavers do not meet Americans with Disabilities Act (ADA) standards and pose a liability problem for local governments and businesses.

Appropriate applications for pavers include emergency or stormwater facility access roads, overflow parking areas, and non-handicapped parking stalls. Residential driveways, walkways, patios, and other areas are some of the most appropriate locations for pavers. Residential areas generally do not receive extensive use or pollutants. Residential applications do not need to meet ADA standards.

In order to better understand how well pavers have worked in residential settings, staff conducted an informal survey of homeowners. Residential applications of pavers were identified during staff field activities. Six homeowners were sent letters requesting they contact the study coordinator for a phone interview. The three homeowners that responded were asked six questions concerning how long the pavers had been installed; ease of installation, costs, and source of materials; use of the area; maintenance required or problems encountered; the motivation for putting in pavers; and willingness to recommend pavers to others. The results include:

- The period of time that the pavers had been installed range from one month to 10 years.
- All three homeowners said the pavers were easy to install and required no professional assistance. All three installed them on a sand base and purchased the pavers from Mutual Materials Company, Tumwater. Exact costs were unavailable but were estimated at $600 to $3,000, depending on size and type of paver used.

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- All three homeowners are using the pavers for parking. One homeowner used them to replace a center area of his driveway, where a tree was removed. The area is now used for washing cars and parking. The two other homeowners use the pavers for overflow parking of boats and extra cars.

- All three homeowners had not experienced significant maintenance problems.

- The main motivation for installing the pavers for all three homeowners was aesthetics. All three had seen pavers in other locations (Tumwater Falls Park, South Puget Sound Community College, Thurston County Courthouse) and liked the look of them. Two homeowners also installed the pavers to increase infiltration due to poor soils or topography of their yard.

- All three homeowners would recommend pavers to others. One homeowner has integrated pavers into his new house plan.

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CHAPTER 3
RECOMMENDATIONS FOR OLYMPIA, NORTH THURSTON COUNTY URBAN GROWTH MANAGEMENT AREA, AND OTHER LOCATIONS

This chapter summarizes study results and presents 19 recommendations. The recommendations are grouped into six categories:

- Overall Recommendations
- Vehicle-Oriented Pavement
- Construction Practices and Landscaped Areas
- Design and Placement of Buildings
- Community Involvement and Education
- Study Evaluation

The information contained in this chapter is derived from the technical and policy analysis described in previous chapters, interviews with representatives of local governments, input from the Ad Hoc Citizen Advisory and Steering Committees, and input received through community forums and other public involvement and education activities. Each recommendation is presented, followed by discussion of technical and policy issues, incentives and barriers to implementation, policy trends, specific actions for implementation, and implementation costs for Olympia.

SCOPE OF RECOMMENDATIONS

It was recognized early on by the project team that recommendations designed for Olympia may not work for all of the North Thurston County Urban Growth Management Area (North Thurston UGMA) or other locations because of the specific mix of public goals in Olympia. It also was recognized that recommendations not suitable for Olympia may work elsewhere. Consequently, efforts have been made to document the process and results so others may learn from Olympia's successes and challenges, and to provide useful policies and techniques that can be readily applied in Olympia, the North Thurston UGMA, or other locations throughout the state and nation.

As you review the recommendations, please keep in mind that this report summarizes a study, not a planning process. The recommendations and information contained in this report are provided as guidance to Olympia and other communities and will not necessarily be adopted by the City Council. Integration of most recommendations into policies or regulations will occur or have occurred through separate processes—such as revision of the parking, street, and development standards. These processes will provide or have provided opportunities for the public to weigh impervious surface reduction with other public goals, and ensure

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that recommendations are applied in a reasonable and practical manner. Other local governments that implement some or all of the recommendations are highly encouraged to solicit early and abundant involvement from the community.

This report signifies a beginning for reducing impervious surfaces in Olympia, and leaves as many unanswered questions as it has answered. More research could be done to better define hydrological relationships, costs, and incentives. When applying the recommendations to Olympia, North Thurston UGMA, or other locations, it is important to keep in mind that impervious surface reduction is still an experiment—one that needs to begin so that we can find real-world solutions. Evaluation is an essential step to understanding the success and limitations of the study (Recommendations for Study Evaluation, page 119). Communities working to reduce impervious surfaces are encouraged to contribute to a study evaluation by contacting the study coordinator and sharing their experience.

STRATEGIES CONSIDERED AND IN NEED OF FURTHER ANALYSIS

The Ad Hoc Citizen Advisory Committee and project staff spent several meetings exploring possible impervious surface reduction strategies. Many of these strategies are summarized in the Technical and Policy Analysis Report (City of Olympia, 1994b), which contains 11 more recommendations then this report. Many of the preliminary recommendations were dropped due to conflicts with other public goals or because of overlap with other planning processes. The substantial changes made to the recommendations during the course of the study reflect the lessons learned by the committee and project staff concerning community goals.

Many strategies contained in the initial recommendations and resulting from recent committee discussions may have value for other locations, depending on site-specific public goals, soils, precipitation, and population or community structure. However, these strategies are not recommended at this time because they require further discussion and research. To assist other local governments in applying the study's findings, these strategies are briefly described below. More detail is available from the study coordinator.

- In recognition that impervious surface reduction strategies are new and will need refinement, develop performance-based standards for sidewalks, parking, and landscaping to encourage innovation and provide flexibility in meeting impervious surface reduction goals.

- Provide public support and sponsorship of private developments meeting impervious surface reduction goals such as higher-density development, reduction in vehicle-oriented pavement, use of pervious surfaces, and less land clearing and soil compaction. Use tax increment financing, redevelopment loans, density credits and other public funding mechanisms, and encourage

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private funding of such developments. Meet with the development and business community to identify practical incentives.

- Use zero or narrower setbacks, consolidate landscaped areas and perimeter plantings into one large area, count undisturbed areas and native vegetation towards landscaping requirements, and/or give density credits for pocket parks to encourage large blocks of undisturbed areas that infiltrate runoff. Convert parking lots into parks and restore infiltration capacity (where possible).

- Identify opportunities for retrofitting existing paved areas. Some suggestions include placing vegetated islands designed to treat stormwater in cul-de-sacs and intersections where safety will not be jeopardized; reducing the size of parking areas, using pervious surfaces, or building taller buildings when redeveloping a site; and reducing street widths by replacing existing pavement with street trees.

OVERALL RECOMMENDATIONS

Several of the recommendations reflect the growth management planning being done in the North Thurston UGMA. Growth management strategies are being applied or considered to varying degrees by Olympia, Lacey, Tumwater, and Thurston County through their comprehensive plans (Thurston County, 1988; City of Tumwater, 1993; City of Lacey, 1994c; City of Olympia, 1994d) and the Regional Transportation Plan (Thurston Regional Planning Council, 1993b). During the study, several growth management strategies were evaluated to determine their effectiveness in reducing impervious surfaces and to ensure that study recommendations are consistent with the local policy direction.

In the early stages of the study, the project team developed preliminary recommendations that overlapped the growth management planning occurring in the North Thurston UGMA. Several of the preliminary recommendations restated transportation and land use planning decisions being made in larger public forums, rather than providing new or specific direction to reducing impervious surfaces. To reduce duplication of planning efforts, many of the preliminary recommendations were grouped into the following three, overall recommendations.

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Recommendation 1.
Integrate impervious surface reduction into policies and regulations.

Discussion

Local stormwater management practices are designed to manage stormwater runoff and remove pollutants but don't directly address a significant source of runoff—impervious surfaces. A whole host of development, transportation, urban design, and other policies and regulations affect the land use pattern in our communities, and the resulting amount of impervious surfaces. General review of local policies and regulations, and conversations with other jurisdictions revealed that it is unusual to find impervious surface reduction mentioned or considered in local government policies or regulations.

Although most city and county staff contacted during the study seemed aware of the water resources problems related to impervious surfaces, reduction of impervious surfaces generally has not been implemented through formal policies and regulations, or considered an explicit public goal by local governments. Integrating impervious surface reduction into several policies and regulations ensures that it will be put before the public for comparison with other public goals, and with other strategies for achieving water resource protection and enhancement.

Incentives and Barriers

Most policies and regulations address a single issue, such as parking, streets, or clearing and grading practices. Even though this may be practical for other reasons, this poses a barrier to implementing impervious surface reduction strategies. Because the problems with impervious surfaces are not related to just one issue, it is important to make lots of small changes to several policies and regulations in order to achieve a measurable reduction. The common practice of revising only a few policies or regulations a year requires several years to accomplish a significant level of implementation and results, and vigilance on the part of staff and concerned citizens to keep the issue "on the table."

Inadequate involvement of the business and development community in decisions that directly affect them is a barrier to successful policies and regulations. Having the development and business community involved in land use decisions that reduce impervious surfaces is important. What may intuitively sound feasible and rational on paper may not always work in the real world given financing and construction constraints. The development and business community can help identify incentives and barriers to specific strategies.

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Policy Trends

Local comprehensive drainage basin plans contain a recommendation to revise development standards to minimize impervious surfaces by such measures as requiring narrower streets, increasing the use of porous pavements, reducing parking requirements, and revising landscaping requirements. The plans recommend adoption of common standards by the four local governments in Thurston County (City of Olympia, 1993b).

Olympia

The Olympia City Council has pledged to evaluate all city policy decisions based on the city's Sustainable City Criteria (see Olympia's Sustainable City Philosophy, page 18). The criteria ask that policies and regulations not jeopardize future generations, and take into account environmental, economic, and social implications. Applying the criteria results in taking a long-term view of decisions and using an integrated or holistic approach to community planning. Having impervious surface reduction as a stated goal or objective of policies and regulations reminds decision-makers, staff, and the public of one way to achieve sustainability.

During the study, project staff have participated in the revision of parking, street, and development standards as a means to implement early findings of the study. Many of the recommendations contained in this report have already been incorporated into versi[illegible] Olympia's parking, street, and development standards (City of Olympia, 1994e; 1994g; 1994h). These regulations will be or have been presented for public review and comment in separate forums.

Olympia's Community Planning and Development Department (CPDD) is considering conducting a consolidated annual review of proposed revisions to city policies and regulations. A consolidated review would be more cost effective and time efficient and allow an opportunity to resolve inconsistencies. An annual review would give Water Resources Program staff and citizens an opportunity to identify economic incentives and additional areas where impervious surface reduction could be integrated.

Lacey

Current comprehensive plan policies do not explicitly refer to impervious surface reduction as a goal (Carr, pers. comm.).

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Tumwater

The transportation element of the comprehensive plan includes policies to reduce the amount of impervious surface to the extent practicable, and to use alternative surfaces and natural design methods to reduce total surface runoff, slow concentrations, and capture pollution (Bauer, pers. comm.).

Thurston County

Adopted city/county joint comprehensive plans will apply city policies on parking and development to appropriate locations within the unincorporated portion of the North Thurston UGMA (Dosherry, pers. comm.). The current comprehensive plan, adopted in 1988, and proposed revisions now being considered do not explicitly refer to impervious surface reduction. However, the natural environment chapter includes a policy that existing and new development should minimize increases in total runoff quality and maximize infiltration. A proposed revision would discourage increases in peak stormwater runoff and alteration of natural drainage systems to prevent flooding and water quality degradation (Morrison, pers. comm.).

Implementation Actions

Olympia

Many policies and regulations are being revised to bring them into compliance with Olympia's comprehensive plan (Chapter 1, Policy Focus and Early Implementation, page 18). The commercial, multifamily, and residential development standards; landscaping ordinance; parking ordinance; and street standards are currently being revised. Such revisions have provided or will provide a cost effective opportunity to integrate impervious surface reduction.

Several changes to the parking ordinance's goals statement, ratios (standards), shared parking section, and variance requirements are being proposed as a direct result of this study. Proposed changes to the draft street standards include narrower residential streets and alleys (Table 17, page 65). If these regulations are adopted as proposed, Olympia should experience an almost immediate reduction in future impervious surfaces from what is expected under the current trend (Figure 3, page 7).

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Table 17: Olympia Proposed and

Federal Min

DESIGN STANDARDS	PROPOSED (1)		CURRENT		PROPOSED (1)				
	ARTERIAL BLVD	ARTERIAL	PRINCIPAL ARTERIAL	MINOR ARTERIAL	MAJOR INDUS COLL	MAJOR COMM COLL BLVD	MAJOR COMM COLL	MAJOR COLL BLVD	MAJ COL
Lane Widths	2 lane = 18' per lane; 4 lane = 11' per lane; 5 lane = 11' per lane	2 lane = 11' per lane	4 lane = 12-16' per lane (4)	4 lane = 12' per lane	2 lane = 11' per lane	2 lane = 18' per lane; 4 lane = 11' per lane	2 lane = 11' per lane	2 lane = 18' per lane; 4 lane = 11' per lane	2 lane 11' pe lane
Parking Lanes	None	None	None	None	None	8' Both Sides	8' Both Sides	None	None
Total Travel and Parking Lane Width (2)	2 lane = 36' per lane; 4 lane = 64' per lane; 5 lane = 82' per lane;	2 lane = 22' per lane	4 lane = 52' per lane	4 lane = 48' per lane	2 lane = 22' per lane	2 lane = 52' per lane; 4 lane = 68' per lane	2 lane = 36' per lane	2 lane = 36' per lane; 4 lane = 64' per lane	2 lane 22' pe lane
Sidewalks	8' Both Sides 10' Both Sides in CBD	8' Both Sides 10' Both Sides in CBD	8' Both Sides in CBD	5' Both Sides	6' Both Sides	5' Plant Area 5' Awning Area	5' Plant Area 5' Awning Area	6' Both Sides	6' Bo Sides
Federal Minimum Design Standards (3)	2 lane = 11-12' per lane	2 lane = 11-12' per lane	2 lane = 11-12' per lane	2 lane = 11-12' per lane	2 lane = 11-12' per lane	2 lane = 11-12' per lane	2-12' lane = 11-12' per lane	2 lane = 11-12' per lane	2 lane 11-12' lane

(1) Proposed as of October 1994.
(2) Does not include Class II (bike lane) or Class III (bike routes) bicycle facilities.
(3) Federal minimum standards for lane widths must be used on larger streets to access Federal funding sources. All classifications of arterials and major
(4) Lane widths may vary depending upon whether they are interior or exterior lanes and if they are curbed.

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1 Current Street and Sidewalk Design Standards
and
inimum Design Standards

	CURRENT	PROPOSED (1)		CURRENT		PROPOSED (1)		CURRENT		PROPOSED (1)	
JOR OLL	COLL ARTERIAL	NGHB HOOD COLL BLVD	NGHB HOOD COLL	NGHB HOOD COLL	COMM COLL	LOCAL ACCESS BLOCK >350	LOCAL ACCESS BLOCK <350	LOCAL ACCESS COMM	LOCAL ACCESS RES	ALLEYS	
										COMM	RES
ne = per	2 lane = 12-14' per lane	2 lane = 18' per lane	2 lane = 10' per lane	2 lane = 9-10' per lane	2 lane = 12-14' per lane	1 lane = 13' per lane	2 lane = 9' per lane	2 lane = 12-14' per lane	2 lane = 9-10' per lane	1 lane = 12' per lane	Two 20 - 26' Elm
	8' One or Two Sides or None	None	7' One Side	6-8' Both Sides	8' One or Both Sides or None	7' One Side	7' One Side	8' One or Two Sides or None	8' Two Sides	None	None
	2 lane = 28-40' per lane	2 lane = 36'	2 lane = 27'	2 lane = 32'	2 lane = 24-40'	1 lane = 20'	2 lane = 28'	2 lane = 24-40'	2 lane = 32'	1 lane = 12'	Two 20 - 26' Elm
	5' Both Sides 8' Core	5' Both Sides	5' Both Sides	5' Both Sides	5' Both Sides 8' Core	5' Both Sides	5' Both Sides	5' Both Sides 8' Core	5' Both Sides 8' Core	None	None
= per	2 lane = 10-12' per lane	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

collectors shall have Class II or Class III facilities as designated on Comprehensive Plan bikeways maps.

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North Thurston UGMA and Other Locations

Lacey, Tumwater, Thurston County, and many other Washington local governments are currently required by state law to bring their policies and regulations into compliance with their new comprehensive plans. This presents an opportunity for many communities in the state to implement impervious surface reduction in the near future.

Because every community adopts policies and regulations as a way to define its character and land use, every community could consider impervious surface reduction regardless of its size or growth management framework. Public hearings and meetings, document review and comment periods, and other community involvement and education activities are readily-available opportunities for involving the public in impervious surface reduction issues. Even if a community is not currently creating or revising regulations, it may want to conduct a one-time review of all policies and regulations to see how local laws or practices could be changed to encourage impervious surface reduction. Important to successful impervious surface reduction is the early participation and collaboration of all segments of the community in identifying strategies and avenues for implementation.

Implementation Costs for Olympia

No additional costs.

Recommendation 2.
Establish growth management policies that encourage infill of urban areas and reduce urban sprawl.

Discussion

The recommendations in this report are designed to raise awareness and complement the growth management policies being developed and implemented for Olympia and the rest of the North Thurston UGMA. The local growth management strategies encourage, among other things, infill of urban areas and use of congestion reduction programs, public transit, and other alternative modes of transportation. Infill reduces the amount of impervious surfaces per capita (person) and complements the goal and objectives of this study.

The basic premise of infill is that higher densities in urban areas allow rural areas to remain in low density or resource-based land uses, requiring fewer roads and other impervious surfaces region-wide. Successful implementation of this recommendation would increase total impervious surface in the region, but at a slower rate than with

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the current development trend (Figure 3, page 7). In rural areas, impervious surfaces would increase less than the current trend because the current low density land uses would not be replaced with suburban or commercial development. In urban areas, more impervious surfaces such as buildings would occur to accommodate higher commercial and residential densities. However, there would be less impervious surface per capita (person) or per development unit.

This recommendation includes developing vacant residential or commercial lots in the urban growth management area and redeveloping underused areas to a higher density. Possibilities include redevelopment of lots with deteriorating structures to higher density, and building in parking areas or vacant lots.

Water quality and quantity impacts depend on several factors, including soil type, previous site disturbance, population, and traffic levels. Building on a vacant lot that has been largely undisturbed usually results in more runoff from the site, requiring installation of a stormwater management system. Redeveloping a previously developed lot usually does not appreciably change the amount of runoff unless the amount of impervious surface is increased.

Incentives and Barriers

Reducing the costs of public services is a community-wide incentive for infill. Infill results in reduced impervious surfaces and less low-density residential sprawl into previously rural areas. The costs of sprawl have been documented in certain studies (American Farmland Trust, 1986). These studies have concluded that the public economic and environmental costs are higher for low-density development than for high-density development.

The costs of public services required to serve low-density residential areas usually exceeds the tax revenues generated by them. For example, a study in Loudoun County, Virginia concluded that the net public cost to the county would be approximately 40 percent more for low-density residential (1 unit per 5 acres) than for high-density residential (4.4 units per acre). The higher public cost for low-density residential development primarily results from inefficient use of schools and transportation services, and higher liabilities for roads and future water and sewer services. Annual road maintenance costs were estimated to be four times greater for low-density residential than for high-density residential (American Farmland Trust, 1986).

Higher densities are a key to infill and reducing urban sprawl. However, infill may change the existing character of neighborhoods or other areas. Such change is a barrier to public acceptance of increasing densities. Undeveloped lots in urban areas are often the most expensive to develop, creating a barrier to infill. Developers may avoid infill projects because they anticipate neighborhood resistance or because lots located elsewhere are less expensive to develop.

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When encouraging infill, it is important to have coordination among neighboring cities and counties. Such coordination reduces the chances that one community will concentrate its urban growth next to another community's rural area, and create a patchwork land use pattern. The long history of independent legal authority of local governments may be a barrier to region-wide growth management planning that result in impervious surface reduction. Incentives for coordination include saving money by providing joint public services such as arterial streets and regional stormwater, sewer, and water systems; and providing consistent regulations for the development and business community.

Policy Trends

Olympia

The existing Planned Residential Development ordinance is intended to promote infill and more economic, efficient use of urban land by allowing more site coverage than would normally be allowed by the zoning code (City of Olympia, 1991). The ordinance is being revised to encourage both infill and mixed use development, and it is intended to be easier to implement (City of Olympia, 1994j).

Consistent with the Growth Management Act requirements and urban design strategy recommendations, the recently adopted comprehensive plan (City of Olympia, 1994c) encourages infill development and redevelopment that is compatible with the surrounding area. Policies for maximum and minimum densities and allowing accessory units, zero lot line development, and small conventional lots support this goal.

Plan policies also support infill strategies such as mixed uses and cluster housing. Plan policies allow increased building heights, reduced parking, and increased site coverage, especially in downtown Olympia and along high density corridors. Olympia is currently updating its zoning code and other regulations to implement these policies.

The current zoning code (City of Olympia, 1991) disallows accessory dwelling units in single family zones. Minimum lot sizes and setback requirements also restrict the possibility of infill. For example, the zoning code allows only 35 to 50 percent site coverage in residential zones.

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Lacey

The housing element of the comprehensive plan (City of Lacey, 1994c) allows accessory units in all residential areas and higher density in exchange for providing affordable housing. The transportation element of the comprehensive plan encourages development of parking that can be redeveloped later to a more intense use.

Tumwater

The comprehensive plan (City of Tumwater, 1993) proposes to prohibit development at less than the minimum net densities for a given area in order to promote cost-efficient services, affordable housing, and alternative transportation. The plan also recommends allowing accessory units in all residential zones.

Thurston County

City polices allowing accessory units, small lot sizes, and minimum densities in residential districts are also proposed for the unincorporated portion of the North Thurston UGMA as part of the city/county joint plans (Dosherry, pers. comm.).

Implementation Actions

Olympia

Complete growth management planning process and implementation. Adopt the Draft Unified Development Code (City of Olympia, 1995) as proposed.

North Thurston UGMA and Other Locations

Complete growth management planning process and implementation. If a growth management framework is not in place, consider conducting a comprehensive land use planning process that designates areas for infill and urban growth concentration, and increases densities and building heights where possible as a way to reduce sprawl. Consider relaxing setback standards and modifying other policies or regulations to encourage infill.

Implementation Costs for Olympia

No additional costs.

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Recommendation 3.
Provide a public transit system and other alternative modes of transportation that reduce the need for streets and parking.

Discussion

The basin and site coverage assessment (Chapter 2, page 34) identified streets and parking as key contributors of impervious surfaces. Providing public transit and other alternative modes of transportation, promoting parking management, and using other strategies can reduce our reliance on cars and the need for more vehicle-oriented impervious surfaces in the future.

Reducing the current growth trend of vehicle-oriented impervious surfaces (Figure 3, page 7) depends upon having facilities that support public transit and alternative transportation such as buses, carpools, and bikes. Facilities such as park and ride lots, bike lanes, sidewalks, bus stops, and trails will contribute to the total amount of impervious surface. However, pollution from these facilities is expected to be less than from streets and parking areas because of the low or non-existent use by cars.

Incentives and Barriers

There are numerous incentives and barriers to providing, maintaining, and using a public transit system and alternative transportation. Increased use of public transit would reduce the number of single-occupant vehicles and auto-related contaminants in stormwater and maximize use of existing streets. Achieving reduced auto dependence will take a full range of actions including land use changes, incentives, and disincentives. Specific actions include infill of city centers and high density corridors, carpool and vanpool programs, and parking management. The Regional Transportation Plan (Thurston Regional Planning Council, 1993b) for the North Thurston UGMA presents detailed discussion on incentives and barriers.

Providing positive incentives is essential to encouraging the use of public transit and alternative transportation. Also essential is providing alternatives that are convenient, safe, and practical that will provide adequate access by customers to businesses. Ensuring the viability of businesses, especially in city centers like downtown Olympia, is crucial to community support and use of transportation alternatives.

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Policy Trends

The Regional Transportation Plan (Thurston Regional Planning Council, 1993b) recommends emphasizing the needs of pedestrians, transit riders, cyclists, and carpoolers in urban core areas and high density areas.

Olympia

Comprehensive plan (City of Olympia, 1994c) policies encourage development of transit and bicycle/pedestrian facilities on arterials and off-street bicycle/pedestrian trails. The land use and transportation elements of the comprehensive plan emphasize land use patterns, densities, site designs, and facilities that encourage public transit and alternative transportation.

Several draft policies or regulations encourage alternative transportation. The draft parking ordinance (City of Olympia, 1994g) includes incentives to encourage use of mass transit, bicycles, pedestrian, and carpool facilities. Draft street standards require bicycle facilities (Class II or Class III) on all major collectors and arterials (City of Olympia, 1994d). The draft zoning ordinance (City of Olympia, 1994f, 1994g, 1994i) encourages alternative transportation.

A Transportation Demand Management (TDM) Ad Hoc Committee was convened in 1994 to guide the application of TDM measures to the 4th/5th Avenue Corridor. The committee will complete the following tasks:

1. Develop a TDM strategy for the corridor;

2. Develop and review the Downtown Olympia Parking Management Strategy Update Study; and

3. Coordinate and participate in efforts by Intercity Transit, the Olympia Bicycle/Pedestrian Advisory Committee, Washington State Department of General Administration, and Energy Outreach Center to implement commute trip reduction and TDM measures. The TDM measures applied to the 4th/5th Avenue Corridor will serve as a model for further TDM efforts the city may undertake in the future (Stimson, pers. comm.).

Lacey

Existing zoning for the Lacey Central Business District requires pedestrian and transit facilities and site designs that cluster buildings to reduce walking distance between each building. The recently adopted comprehensive plan requires and encourages alternative transportation (Carr, pers. comm.).

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Tumwater

The transportation element of the comprehensive plan emphasizes a mixed transportation system, including roadways, transit, bicycle, and pedestrian facilities, as well as policies promoting TDM and non-motorized transportation. A system of bicycle lanes is included in the draft transportation element, and an urban trails system is included in the parks and recreation element of the comprehensive plan (Bauer, pers. comm.).

Thurston County

Adopted city/county joint comprehensive plans will apply city policies on alternative transportation to the unincorporated portion of the North Thurston UGMA (Dosheery, pers. comm.).

Implementation Actions

Olympia

Implement the Regional Transportation Plan and complete the TDM Ad Hoc Committee's tasks (Downtown Parking Management Strategy).

North Thurston UGMA and Other Locations

Implement the Regional Transportation Plan. If no regional plan is in place, consider working with the local and neighboring communities in the planning and implementation of regional public transit and facilities for alternative transportation.

Implementation Costs for Olympia

No additional costs.

The following seven recommendations address vehicle-oriented pavement such as streets and parking areas. According to the basin and site coverage assessment (Chapter 2, page 31), streets and parking areas make up a significant portion of Olympia's impervious surfaces. Reducing vehicle-oriented pavement can result in impervious surface reduction, but needs to be done in cooperation with the local business and development community in order to identify cost-effective strategies.

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RECOMMENDATIONS FOR VEHICLE-ORIENTED PAVEMENT

According to the basin and site coverage assessement (Chapter 2, page 31), streets and parking areas make up a significant portion of Olympia's impervious surfaces. Reducing vehicle-oriented parvement can result in impervious surface reduction.

Recommendation 4.
Develop standards for narrower residential streets with reduced, but adequate, parking opportunities.

Discussion

Since residential streets make up a large portion of impervious surfaces in north Thurston County, narrowing residential streets could appreciably reduce stormwater runoff and increase infiltration.

Reducing the widths of new residential streets from 32 feet to 25 feet could result in approximately a 4.4 percent reduction in effective impervious surfaces for the North Thurston UGMA at 80 percent of buildout (Table 12, page 45). Reducing widths from 32 feet to 20 feet could result in a 7.5 percent reduction. However, significant increases in water quality are not expected from reducing the amount of vehicle-oriented impervious surfaces unless there also is a reduction in the source of pollution: cars and other vehicles.

Residential streets should be wide enough to allow access by emergency response vehicles, city maintenance and garbage trucks, and transit buses and vans. Several options exist to accommodate narrower streets and the need for adequate access. For example, installing sprinkler systems in buildings and spacing hydrants closer together could compensate for narrower streets. However, fire suppression systems and other options are more expensive than current requirements. Having an interconnected grid system of streets (interconnected streets), minimizing cul-de-sacs and dead end streets, and shortening the length of city blocks allows easier access by emergency response vehicles.

Incentives and Barriers

The incentives for narrowing streets include reduced vehicle speeds, construction costs, stormwater runoff, and need for public right-of-way. However, narrowing arterials or high use streets such as those in downtown Olympia can decrease safety and contribute to congestion if narrowed too much. Such congestion can become inconvenient and act as barrier to business. Consequently, this recommendation to narrow streets is limited to residential streets only.

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Residents like narrower streets because they slow traffic, as long as there is adequate parking for visitors. Grid patterned streets can be designed with jogs, islands, or other devices to slow drivers and enhance safety on residential streets.

Narrowing residential streets could result in a cost savings to developers, builders, and local governments. The cost of asphalt paving is typically $1.00 per square foot. Given a residential lot with 75 feet of street frontage, the cost savings from narrowing the asphalt street would be $7.00 per linear foot if the residential street is narrowed from 32 feet to 25 feet in width. The total cost savings would be $525 per residential lot. For a 40 unit subdivision, the cost savings would be approximately $21,000. In addition, narrowing the street would provide 21,000 square feet of land for other purposes.

Policy Trends

Olympia

Current comprehensive plan policies aim to ensure that local streets are as narrow as practical for providing adequate emergency access, minimizing stormwater runoff, and other purposes. The plan encourages a "dense pattern of interconnected streets," and limiting cul-de-sacs and dead-ends. The interconnected streets policy promotes a modified grid that includes curved streets and some dead ends and cul-de-sacs where topography precludes connections. This new policy will likely increase the total amount of vehicle-oriented impervious surface, but will result in fewer arterial streets being widened (City of Olympia, 1994c).

Standards for all street classifications are currently being evaluated (Table 17, page 65). The city is proposing to base street widths on projected function, need, or volume in the next 20 years, rather than solely on street classification (e.g., arterial, local access). This strategy will provide more options to build narrower streets where appropriate.

The city is proposing to narrow local access streets to 20 or 25 feet, depending on block length, and narrowing neighborhood collector streets from 32 to 27 feet. The city also is proposing narrowing arterial lane widths from a typical 12 feet to the acceptable federal standard of 11 feet. This narrowing will occur where the lane is not immediately adjacent to a curb, and where there is a bike facility (Class II or Class III) or parking lane. High-use streets do not accommodate on-street parking safely, and require wider lanes for safe travel and emergency access (City of Olympia, 1994d).

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Lacey

Current policy allows private streets to be 24 feet wide in **Planned Residential Developments (PRDs)**. The land use element of the comprehensive plan recommends a grid system for planning areas that are relatively undeveloped (Carr, pers. comm.). Most of these planning areas are outside the current city limits. The housing element of the comprehensive plan recommends interconnected residential streets no more than 24 to 32 feet wide with planter strips and sidewalks. The transportation element includes several major arterial widening projects and new arterials that include bike lanes (City of Lacey, 1994b).

Tumwater

The comprehensive plan housing element calls for a review of the city development standards to identify requirements such as residential street widths which may unnecessarily increase the cost of housing (Bauer, pers. comm.). The Capitol Campus Plan for the future town center builds on the existing Tumwater grid of interconnected streets (Washington Department of General Administration, 1992).

Thurston County

Adopted city/county joint plans will apply the street design strategies in the city comprehensive plans to the unincorporated portion of the North Thurston UGMA (Dosheery, pers. comm.).

Implementation Actions

Olympia

Adopt the street standards as proposed (City of Olympia, 1994g).

North Thurston UGMA and Other Locations

Because Lacey, Tumwater, and Thurston County will be revising their streets standards in the near future to comply with their comprehensive plans, they will have an opportunity to narrow residential and other streets where practical. Several other cities and counties planning under Washington's Growth Management Act also have an immediate opportunity to narrow residential and other streets where practical. Before narrowing streets, it is recommended that discussions be held with the local fire department to ensure adequate access for fire fighting equipment, and with the local businesses to ensure that narrower commercial streets do not act as a deterrent for customers.

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Implementation Costs for Olympia

No additional costs.

Recommendation 5.
Use pavers and other pervious surfaces for low use areas such as overflow parking and emergency access roads.

Discussion

Porous pavement, pavers, and alternative surfaces such as bark and gravel can be used for recreational bike and jogging trails, walkways, alleys, overflow parking, emergency access roads, and other low-use areas to increase infiltration and decrease stormwater runoff.

The most common form of pervious surface for roadway use is a coarse asphalt (porous pavement) which has more open pore space than typical asphalt. Porous pavement has been used in numerous research and investigative settings over the past 15 years. By diverting rainfall through a porous pavement into an underground rock reservoir, the need for traditional stormwater conveyance and treatment may be reduced or eliminated, depending on site-specific factors. Potentially, porous pavement could provide stormwater quality control, flow moderation, and groundwater recharge, and could reduce the need for stormwater facilities. When performing properly, porous pavement is comparable in cost and effectiveness to traditional paving techniques and associated stormwater management systems (Schueler et al., 1992).

Porous pavement has been used successfully in some large, commercial parking lots in the eastern United States (Cahill Associates, 1995). However, problems can arise if porous pavement is not designed, constructed, or maintained properly (Field et al., 1982; Gogorth et al., 1983; Schueler, 1987). According to one source, if moisture is allowed to intrude the aggregate base and subgrade, the ability of porous pavement to bear weight is weakened. The pavement will fail unless it is thick enough to compensate for the weak base. Thickening the pavement can be very expensive. Placing an impermeable membrane between the porous pavement and base and redirecting water out and away from the pavement can help keep moisture from intruding into the aggregate base and subgrade (Asphalt Institute, 1994). However, this potentially negates the purpose of using porous pavement in some situations.

The following constraints should be kept in mind when using porous pavement:

- High susceptibility to siltation and subsequent clogging.

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- Need to infiltrate clean water and reduce risk of groundwater contamination.
- Feasible only where soil is permeable, water table is deep, slopes are gentle, and traffic levels are very low.
- Need to provide a high level of care in design, construction, and maintenance to ensure proper performance.

Using porous pavement is supportable only after site-specific feasibility studies are conducted and regular inspections can ensure very high levels of workmanship (Schueler, 1987). Although not appropriate for widespread use, porous pavement may be suitable for the following applications (Washington Department of Ecology, 1991):

- Parking areas, especially fringe and overflow areas.
- Emergency lanes and vehicle cross-overs on divided highways.
- Low-traffic volume roads such as maintenance and emergency access roads.

Various types of pavers in numerous shapes and sizes also can be used for infiltrating stormwater while providing a rigid surface. Many of these are aesthetically pleasing alternatives to concrete, but typically cost two to four times as much as conventional pavement (Washington Department of Ecology, 1991). Grass can often be grown within the pavers. Several different types of pavers are available:

- Lattice pavers are generally flat with a grid-like appearance. Grass is commonly encouraged to grow within the grids, although some pavers are designed for gravel and thus avoid the historic maintenance and siltation problems of grass-filled pavers.
- Modular unit pavers such as solid bricks and cast concrete can accommodate infiltration if installed in a loose configuration.
- Subsurface plastic rings are capable of supporting substantial weight while allowing full grass coverage.

Many of the same concerns and limitations described for porous pavement apply to use of pavers. Appropriate sites for pavers include:

- On-street parking in residential neighborhoods.
- Parking pads in camping areas for recreational vehicles.
- Private roads, easement service roads, and fire lanes.

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- Industrial storage yards and loading zones.
- Residential and light commercial driveways.
- Bike paths, walkways, patios, and swimming pool aprons.

Alternative surfaces such as gravel, bark, and rock provide some infiltration compared to asphalt and concrete. The amount of infiltration depends on the type of underlying soils, the amount of soil compaction, and the thickness of the materials. Initial installation of most alternative surfaces are less expensive than asphalt or concrete. Like porous pavement and pavers, use of alternative surfaces should be restricted to reduce possible risk of groundwater contamination and only if a high level of maintenance can be guaranteed.

Incentives and Barriers

The Drainage Design and Erosion Control Manual for Olympia (City of Olympia, 1994a) currently provides some cost incentives for using pavers. The runoff volume stored in paver interstices (openings) can be deducted from stormwater storage and other management requirements if the interstices are 0.75 inches or more deep. This can result in smaller stormwater facilities.

If a typical two-acre commercial development used pavers for fringe and overflow parking amounting to 20 percent of the total parking area, the stormwater detention pond (facility) could be reduced by approximately seven percent or 850 square feet of land area. This could potentially provide space for additional density or leasable commercial space and be an incentive in some cases. Though a savings in stormwater detention may be gained by using pavers, a preliminary cost analysis indicates that the additional cost incurred for pavers exceeds the savings.

Results of a small, informal survey (Chapter 2, Paver Places and Faces Survey, page 56) indicate that increased aesthetics and infiltration are key incentives for using pavers in residential uses. Because homeowners may utilize pavers that are slightly flawed (factory seconds) and not suitable for commercial or industrial use, the costs for small residential applications of pavers may be less than for other applications.

The greatest barrier to using porous pavement or pavers is the initial installation costs. Pavers cost two to four times as much as asphalt, averaging $2.00 to $4.00 per square foot compared to $1.00 per square foot for asphalt. A parking area with 20 percent of the area in $4.00 per square foot pavers would be approximately 60 percent more expensive to install than a traditional asphalt parking area.

If 10 years of replacement and maintenance costs are figured into the equation, pavers are less costly but still more expensive than asphalt. For example, the cost of installation ($1,979) and 10 years of replacement and maintenance costs ($2,164) of 10

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typical asphalt parking stalls is estimated to be $414 per stall over a 10-year period. The cost of installation ($6,173) and replacement and maintenance costs ($1,000) for 10 paver parking stalls is estimated to be $717 per stall over a 10-year period (Lonsbery, pers. comm.). The main reason that paver parking areas are expensive is the high price of pavers themselves. Over time, if the market demand for pavers increases, the pavers may become more feasible for widespread application.

Any porous pavement, pavers, or alternative surface used in public areas need to meet Americans with Disabilities Act (ADA) requirements, industry standards, and local government safety policies. ADA requires surfaces to be stable, firm, and slip resistant, which poses a barrier to using pavers and other pervious surfaces. When using pavers, it is important to remember that the ADA requires depths no greater than one-half inch. Paving of handicapped parking stalls and the route between the parking stalls and building entrance is mandatory, precluding use of pavers or pervious surfaces in these areas (Allen and Moffett, 1992; Washington State, 1992).

Policy Trends

Olympia

The Drainage Design and Erosion Control Manual (City of Olympia, 1994a) supports and encourages the use of "lattice blocks, geotextiles, or other such semi-pervious pavements" for offstreet areas of pavement. The manual states that pavers can improve runoff quality, reduce drainage system investment, reduce stormwater utility rates, and improve aesthetics. The city will deduct the storage provided by the pavers from storage requirements for the development and count grass areas as pervious, given certain constraints and the completion of a maintenance plan. Current development policy indicates a preference for pervious surfaces on the required 15-foot maintenance access roads for stormwater facilities (City of Olympia, 1994a).

The revised draft zoning ordinance provides incentives for commercial projects that include porous pavement in parking lots (City of Olympia, 1994f). The revised draft parking ordinance would allow porous surfaces for reserve parking or other approved uses, and offers an incentive to use porous surfaces if increased parking is requested (City of Olympia, 1994g).

Lacey

The Drainage Design and Erosion Control Manual for Lacey is very similar to Olympia's drainage design manual, and the policies concerning pavers for offstreet parking areas are the same (City of Lacey, 1994a). Olympia, Lacey, Tumwater, and Thurston County worked together to develop regional consistency in their manuals.

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The Development Guidelines and Public Works Standards require permanent all-weather surfaces for parking areas. Gravel surfaces are not acceptable or approved. Combination grass/paving systems are allowed following approval of a paving plan and description of how the system will be irrigated and maintained (Carr, pers. comm.).

Tumwater

The transportation element of the comprehensive plan includes a policy to use alternative surface materials where practical.

Drainage Design and Erosion Control Manual requirements are similar to those described above for Olympia. In calculating impervious surface as the basis for stormwater utility rates for a recent school development project, grasscrete was counted as a "disturbed pervious surface" rather than an impervious surface (Webb, pers. comm.). The parking ordinance allows use of turfstone as well as asphalt or concrete for parking areas and fire lanes (Booth, pers. comm.).

Thurston County

Following adoption of the Drainage Design and Erosion Control Manual (Thurston County, 1991a), county road standards were revised to allow parking areas to be surfaced with lattice blocks as well as asphalt or concrete. The county engineer may require a surface of grass reinforced with geotextiles in parking areas that are used lightly enough to allow the survival of such a surface. Proposed revisions to the Thurston County Comprehensive Plan include a policy requiring use of pervious pavement devices such as lattice blocks "to the extent practical" to reduce runoff from lightly-used off-street parking and other areas of commercial and industrial sites (Swanson, pers. comm.).

Current zoning regulations require parking areas within urban growth areas to be surfaced with asphaltic concrete or concrete. This does not apply to single-family detached homes or to duplexes with attached garages. Porous pavement or gravel is currently allowed for parking areas in rural areas only (outside urban growth areas).

Implementation Actions

Olympia

Develop and distribute a model maintenance plan for sites using pervious surfaces. Print and distribute the alternative surfaces fact sheet.

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North Thurston UGMA and Other Locations

Consider developing a model maintenance agreement. Consider replicating Olympia's agreement for sites using pervious surfaces. Consider revising policies and regulations to encourage installation of pervious surfaces in low use areas where groundwater contamination can be avoided. Work with other local jurisdictions to sponsor workshops and training for public works personnel, development and building community representatives, businesses, and homeowners on porous pavement, pavers, and alternative surfaces.

Implementation Costs for Olympia

Development and initial distribution of the model maintenance plan and distribution of the alternative surfaces fact sheet will be completed as part of the study's technical assistance. After June 1996, additional printing and distribution of the fact sheet on an as-needed basis would cost $100 a year and could be included in the Water Resources Program budget.

Recommendation 6.
Narrow alley widths, use alternative surfaces for alleys, and/or design alleys to drain to vegetated strips or central drains.

Discussion

Olympia's street standards are currently being revised (Table 17, page 65). The revisions will include a design standard for alleys. The design standard recommends an alley width of 12 feet and two 30 or 36-inch concrete ribs (strips) bounded by gravel or grass. With the proposed changes, approximately 500 to 600 square feet of concrete would be created for every 100-foot length of alley. Gravel surfaces and the soils underneath them can become highly compacted from cars and other vehicular traffic depending on soil type, traffic volumes, and initial construction practices. If gravel surfaces are used and assumed 100 percent impervious, there is no real benefit from leaving alleys unpaved.

Incentives and Barriers

Several barriers to the use of mixed surface alleys exist. These include:

- Traffic levels may exceed the survival capacity of grass. The result could be muddy alleys that could contribute sediment to stormwater runoff. Gravel may be a better alternative to grass if clean gravel is used and sized to resist compaction.

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- Constructing and maintaining two surfaces could be difficult. The edges of the concrete ribs would be exposed to wear and could tend to break down faster than a larger, continuous surface. Continuous gravel would probably be easier and less expensive to maintain in the long run.

- A paved alley could be crowned and sloped to swales for infiltration of runoff.

Reducing alley widths too much can limit the turning radius for residents who access their homes and garages from alleys, and be a barrier to practical use. Too narrow of alleys also could pose problems for garbage haulers and other large utility vehicles that require access.

Policy Trends

Olympia

See discussion above for information on current and pending street standards for alleys. The comprehensive plan encourages the use of alleys for access to residences (City of Olympia, 1994c).

Lacey

Alleys are now allowed only in Planned Residential Developments (PRDs). Under the newly adopted comprehensive plan, alleys will be allowed in the new village center overlay areas. St[illegible]tandards may be revised this year to implement comprehensive plan policies supporting streets no wider than 20 to 32 feet (Carr, pers. comm.).

Tumwater

The draft Development Guide Manual (City of Tumwater, undated) includes standards for alley construction. Alleys must be paved and 16 feet wide (Bauer, pers. comm.).

Thurston County

The county is in the process of updating its road standards. Currently, alleys are treated as roads; there are no separate standards for alleys (Payton, pers. comm.). Adopted city/county joint comprehensive plans will apply city policies on parking and development to appropriate locations within the unincorporated portion of the North Thurston UGMA (Dosheery, pers. comm.).

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Implementation Actions

Olympia

Adopt the street standards as proposed (City of Olympia, 1994g).

North Thurston UGMA and Other Locations

Consider narrowing alley widths and allowing use of pervious surfaces. Revise street standards to encourage drainage of alleys into vegetated strips or central drains.

Implementation Costs for Olympia

No additional costs.

Recommendation 7.
Encourage cooperative parking such as joint (combined), shared, and coordinated parking.

Discussion

Cooperative parking can help provide more parking capacity with less impervious surface. The three types of cooperative parking are shared, joint, or coordinated parking. Shared parking reduces the parking area for land uses with noncompeting hours of operation, such as a church and a school or office. Joint parking reduces the total parking area required for multi-tenant retail and commercial facilities, especially those with little overlap of hours such as a movie theater and paint store.

Coordinated parking reduces the total parking area by using churches, large retail, and commercial overflow parking areas for commuter park-and-ride locations. For example, the infrequently used parking areas at Olympia area malls or large retail outlets could be used by commuters or by visitors to the state capitol during the week, and used by shoppers in the evenings or on the weekends. Churches also have infrequently used parking areas that could be used for joint and shared parking or other parking needs.

Incentives and Barriers

An incentive for large commercial or retail stores to include park-and-rides in their parking lots is the increased sales they may receive because commuters are encouraged to shop at the stores. These captured morning and evening trips are an incentive for both joint and coordinated parking facilities.

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Shared parking tends to work best for long-term tenants with consistent parking needs. Where needs for parking fluctuate over time, shared parking agreements may limit flexibility in use of the property and act as a barrier.

In order to achieve reductions and still provide adequate parking for businesses and their customers, legal agreements between neighboring or cooperating businesses would be needed to ensure long-term availability of parking, avoid disagreements over maintenance, and provide leasing options to realtors and building owners. In order to avoid future problems with new tenants or property owners, legal agreements need to clarify issues such as leasing arrangements or be based on a fee-simple exchange. The agreements also need to be nonrevocable to ensure that parking capacity stays with the building.

Local governments can create an alternative to nonrevocable agreements for cooperative parking by establishing an in-lieu-of-parking fees program. Under the program, developers would have the option to contribute to a fund for the development, maintenance, and operation of off-street parking areas rather that constructing their own parking areas. Such a program can be an incentive for participating in cooperative parking.

Because shared parking and coordinated parking are not that prevalent, examples of legal agreements are not abundant and presents a barrier to implementation. Local governments could encourage cooperative parking by providing example agreements and facilitating arrangements.

Local government policies tend to limit the proximity of shared parking partners. Most policies require close proximity which becomes a barrier to possible partnerships. There could be an increase in shared parking opportunities if farther proximity was allowed. Shuttle buses could provide a link between users and the parking area.

Policy Trends

Olympia

The comprehensive plan includes policies that allow and encourage shared parking (City of Olympia, 1994c). The revised draft zoning ordinance includes incentives for shared parking in some commercial and residential zones (City of Olympia, 1994g, 1994i).

The draft parking ordinance encourages cooperative parking whenever developments with complementary hours are proposed; developments with some overlap of hours are proposed; developments with multiple retail or commercial facilities are proposed; and whenever more than five percent additional parking above the standard is requested by the developer or builder

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(City of Olympia, 1994g). The Site Plan Review Committee (SPRC) reserves the right to require a developer to explore joint (combined) and shared parking opportunities (Davis, pers. comm.).

Lacey

Current policy allows a reduction in on-site parking requirements for properties that share parking. Legal agreements are required to ensure continued shared use when ownership changes. Several churches share parking with nearby schools or businesses (Carr, pers. comm.).

Tumwater

No parking reductions are currently allowed for shared parking (Bauer, pers. comm.). The Capitol Campus Plan includes construction of shared, multi-storied parking structures in the town center to reduce the need for surface parking areas and on-street parking (Washington Department of General Administration, 1992).

Thurston County

Under current policy, use of joint parking facilities is encouraged. Adopted city/county joint comprehensive plans will apply city policies on parking to appropriate locations within the unincorporated portion of the North Thurston UGMA (Dosheery, pers. comm.).

Implementation Actions

Olympia

Adopt the parking ordinance as proposed in the Draft Unified Development Code (City of Olympia, 1995). Print and distribute the model legal agreement for shared parking (Appendix D, page 179).

North Thurston UGMA and Other Locations

Consider modifying parking ordinances to encourage cooperative parking. Develop and distribute a model legal agreement for shared parking to those submitting development plans.

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Implementation Costs for Olympia

No additional costs for revising the parking ordinance. Copies of the model legal agreement will be printed and distributed as part of this study's technical assistance. It is recommended that the Community Planning and Development Department (CPDD) will need to provide copies once the study is completed in 1996.

Recommendation 8.
Encourage underground or under-the-building parking and the construction of multi-storied parking structures.

Discussion

Stormwater quantity is directly related to the quantity of impervious surface exposed to rain and would therefore be reduced by placing parking underground or within buildings, or by building multi-storied parking structures.

Incentives and Barriers

Consolidating parking into one, tall building or incorporating it into a building results in less of the site dedicated to parking (Recommendation 15, page 110, for related discussion on taller buildings). Such consolidation or incorporation could be an incentive for developers and builders if the area once dedicated to parking could be used for additional leasable space or residences. Policies and regulations could be modified to allow increased densities or building coverage and provide incentives. Increased densities would contribute to a per capita reduction in impervious surfaces for the region (Recommendation 2, page 67).

In-lieu-of-parking fees could be used as an incentive for multi-storied parking structures. Part or all of parking requirements prescribed by local regulations could be waived upon the applicant's request in lieu of paying a fee into a parking improvement fund. The fund could be established and used for construction of public parking facilities, such as a multi-storied parking structure.

Concerns about vandalism and personal safety may affect public support of parking structures and is a barrier to construction. The Olympia Police Department recommends that parking structures be constructed with adequate **defensible space** that area around an individual that allows for a feeling of safety.

The high water table in downtown Olympia and Lacey, and other locations, is a barrier to underground or tall parking structures. Constructing underground parking

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or tall buildings on the fill material that exists under much of downtown Olympia would be difficult and costly.

A group of public and private partners, including the City of Olympia, completed a feasibility study in 1993 for a mixed use parking and transit facility, including a multi-storied parking structure alternative for downtown Olympia. The study evaluated a variety of public, public/private, and private development options and concluded that current parking demand is not sufficient to financially support a parking garage. Lease rates for the two Olympia options were estimated at $126.68 per month and $135.22 per month per stall, both well above current market rates. However, state government employment may increase and eventually create more parking demand (City of Olympia, 1993c).

Policy Trends

Olympia

The comprehensive plan supports development of multi-storied parking structures in commercial areas to enable redevelopment of surface parking into more intensive use (City of Olympia, 1994c). The commercial and residential development standards are currently being revised to bring them into compliance with the comprehensive plan. Under the draft standards, additional building height may be added when parking is incorporated into buildings located in certain zones. The draft standards also allow a 45 percent increase from the 40 percent impervious surface coverage base for under-the-building parking in the Arterial Commercial zone (Harrison Avenue and Division Street area). Impervious surface coverage in the rest of the zones is based on a maximum. In General Commercial zones, an additional story may be added if at least 50 percent of the parking is under the building (City of Olympia, 1994h; 1994i; McCormick, pers. comm.). In the draft language for the Urban Village and Community Oriented Shopping Center zone, an additional story may be added if at least 50 percent of the parking is under the building. Seventy percent site coverage by a building is allowed in this zone if parking is not put under the building (McCormick, pers. comm.).

A TDM Ad Hoc Committee was formed in 1994 to, among other things, update the Downtown Olympia Parking Management Strategy. The update will provide an opportunity to revisit the feasibility of multi-storied parking structures (Stimson, pers. comm.).

Lacey

Current downtown zoning regulations allow parking garages in the Downtown Central Business District. Understructure parking or parking garages would be encouraged, but no such proposals have been made. The

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only understructure garage approved in Lacey is a townhouse project in the Lakepointe subdivision (Carr, pers. comm.).

Tumwater

The Capitol Campus Plan includes construction of shared, multi-level parking structures in the town center to reduce the need for surface lots and on-street parking (Washington Department of General Administration, 1992).

Thurston County

Adopted city/county joint comprehensive plans will apply city policies on parking and development to appropriate locations within the unincorporated portion of the North Thurston UGMA (Dosherry, pers. comm.).

Implementation Actions

Olympia

Adopt the commercial and residential development standards as proposed in the Draft Unified Development Code (City of Olympia, 1995).

Update the Downtown Parking Management Strategy in 1995. Consider strategies such as in-lieu-of-parking fees that could help fund multi-storied parking structures. Continue to involve the Olympia Downtown Association in developing strategies.

North Thurston UGMA and Other Locations

Consider revising commercial, multifamily, and other development standards to allow taller buildings and greater densities if parking is incorporated into buildings. Explore with local development and business representatives potential public/private partnerships and policy changes that will result in less surface parking and impervious surface reduction.

Implementation Costs for Olympia

No additional costs.

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Recommendation 9.
Develop flexible parking regulations related to parking region-wide that limit the amount of impervious surface, while still providing for parking needs.

Discussion

According to the parking analysis and basin and site coverage assessment (Chapter 2, page 34), parking areas comprise a significant amount of the existing impervious surfaces in Olympia area watersheds.

The results of the parking analysis (Chapter 2, page 46) suggest that the amount of impervious surface used for parking could be reduced by encouraging cooperative use of parking areas (Recommendation 7, page 84); use of an average of several peak days instead of just one or two; use of diagonal parking, single lanes between stalls, and smaller parking stalls; and/or construction of underground, under-the-building parking, or multi-storied parking structures (Recommendation 8, page 87).

Parking policies are local governments' key method for determining the size and amount of parking, and the resulting amount of parking-related impervious surfaces. Parking policies have traditionally adopted the "bigger is better" view of parking. Regulations need to provide enough parking to sustain businesses while avoiding traffic congestion or overflow into residential neighborhoods, but have resulted in too much parking in some cases.

Typically, parking policies are based on artificially low "minimum" parking ratios that do not accurately reflect true parking needs. Based on a limited review of Olympia area developments, developments average 38 percent more parking than the minimum ratios require in the Olympia area (Chapter 2, Parking Analysis, page 46). Median parking ratios or minimums combined with maximums provide a limit to the amount of impervious area dedicated to parking.

If medians or maximums are used, some flexibility in the standards would have to be provided to allow for exceptional cases. Median ratios combined with the option to build five percent more or less than the ratio would provide flexibility for developers to tailor parking to individual site or business conditions in most cases.

Parking policies also generally allow parking areas to be constructed using peak-day projections. The day and amount of highest parking demand, such as Christmas Eve or the day after Thanksgiving, is determined and the parking area is designed to accommodate this single-day demand. Using a peak-day projection results in under-utilized parking areas for most of the year, although much of a business' gross income is generated during the holiday or other peak seasons.

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Ratios that limit the amount of parking-related impervious surface work best if combined with technical assistance, Transportation Demand Management (TDM), and other strategies that assist the development and business community in meeting impervious surface reduction goals without jeopardizing the local economy.

An example strategy is the leasing of on-street parking. On-street parking is sometimes leased to businesses as an alternative to building new parking areas, or to provide parking in city centers where space for new parking areas is limited.

The size of parking stalls varies, but typical dimensions are 9.0 feet by 18.5 feet. During a two-year rain event (2.8 inches in 24 hours), approximately 38 cubic feet of runoff is generated by a typical parking stall. Reducing a commercial parking lot of 526 stalls (Top Foods, Table 13, page 49) by 20 percent, or 105 stalls, could reduce runoff from a typical two-year event by almost 4,000 cubic feet. Reducing the parking area of any commercial site by 20 percent could reduce the total effective impervious surface coverage of the site by an estimated 11 percent (Table 12, page 45).

The quantity of pollutants in parking lot runoff is a function of vehicular traffic, vehicular condition (i.e., well or poorly maintained vehicles), and atmospheric deposition. However, reducing the amount of parking-related impervious surface may reduce the volume of polluted runoff, and the size and costs of stormwater facilities needed to store and treat the runoff, depending on site-specific factors.

Incentives and Barriers

Construction cost savings are one incentive for smaller parking areas. Smaller parking areas can reduce development costs, but not substantially. Asphalt typically costs $1.00 per square foot to install. If a 1,000 square foot parking lot was reduced by 20 percent, the cost savings would be approximately $200. Some additional cost savings would occur over time because of reduced fees for parking lot maintenance, which averages $216 per asphalt stall for a 10-year period (Lonsbery, pers. comm.). A greater incentive may be the decreased percentage of the site dedicated to parking. The area once dedicated to parking could be used for additional leasable space or residences if parking and development standards allow increased densities or building coverage as an incentive. Increased densities would contribute to a per capita reduction in impervious surfaces for the region (Recommendation 2, page 67).

Although smaller parking areas reduce development costs, too little parking may be a barrier to successful businesses and cause spillover into adjacent neighborhoods.

Lot designs that reduce the size of parking areas without compromising the number of stalls include diagonal parking with one-way aisles, and narrower stalls. Both can significantly increase the capacity of parking areas and reduce costs. However, a barrier to narrower stalls is the possible increase in accidents, dented doors, and

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number of inefficiently parked vehicles that may occur. Narrower than recommended stalls occasionally reduce the availability of parking due to overlapping of vehicles into two stalls.

Policy Trends

Olympia

The current zoning code (City of Olympia, 1991) specifies offstreet minimum or absolute parking requirements for various uses, and disallows joint use of parking facilities unless used at different times of the day or week. By contrast, the draft revised parking ordinance is designed to avoid excess parking by establishing median parking requirements for various uses. Increases or decreases from the median would be allowed by administrative variance if certain criteria are met. Criteria are designed as incentives to support alternative transportation, and encourage shared parking and designs that reduce impervious surface (City of Olympia, 1994g).

If an improved public transit system is provided, it is expected that parking requirements in the downtown and high-density corridors could be reduced to the minimum needed to accommodate average demand. In neighborhood and urban villages, parking requirements would be reduced by 10 to 15 percent (City of Olympia, 1994).

The recently-adopted comprehensive plan reflects a shift in parking policy in order to encourage travel by bus, carpool, bicycle, and foot. While the previous comprehensive plan encouraged "ample," or "adequate, convenient parking," the new plan policy supports parking requirements designed to meet actual demand (City of Olympia, 1994c).

The current proposed revisions to the parking ordinance will not apply to downtown Olympia. The new downtown zoning ordinance (City of Olympia, 1993f) does not include revisions in parking standards. A TDM Ad Hoc Committee was formed in 1994 to, among other things, conduct a needs assessment and update the Downtown Olympia Parking Management Strategy. Revisions in downtown Olympia parking policies will be deferred until completion of the needs assessment and update in 1995 (Stimson, pers. comm.).

Lacey

Under the downtown element of the comprehensive plan adopted in 1989 (City of Lacey, 1989), maximum parking standards took effect in 1994. Maximums will be reduced in three year intervals. For example, a 1,200-

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square-foot retail business would be allowed a maximum of seven parking stalls in 1994-1997, six in 1998-2001, and five in 2002 and beyond.

Tumwater

Under current policy, parking requirements are determined case-by-case based on a needs assessment that takes into account the number of customers, length of stay, peak use, and number of employees. The housing element of the new comprehensive plan calls for reduced parking requirements for residential development. The transportation element promotes several TDM techniques that could reduce parking-related impervious surfaces (Bauer, pers. comm.).

Thurston County

Adopted city/county joint comprehensive plans will apply city policies on parking and development to appropriate locations within the unincorporated portion of the North Thurston UGMA (Dosherry, pers. comm.).

Implementation Actions

Olympia

Adopt the parking ordinance as proposed (City of Olympia, 1994g).

North Thurston UGMA and Other Locations

Explore using median parking ratios that reflect true parking needs. Provide density credits such as increased densities or building coverage instead of parking-related impervious surfaces where appropriate. Assist developers whenever possible in the exploration of TDM options and meeting parking needs while reducing impervious surfaces. Consider leasing onstreet parking to businesses.

Implementation Costs for Olympia

No additional costs.

Recommendation 10.
Gently slope sidewalks away from streets and other impervious surfaces towards vegetated strips or gravel catchments.

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Discussion

As a result of the basin and site coverage assessment (Chapter 2, page 34), it is clear that sidewalks are not a significant source of effective impervious surface in the Olympia area when compared with streets and parking areas. Sidewalks generate less contaminants than streets and parking areas because sidewalks do not accommodate vehicular traffic.

In residential developments, yards typically border one side of the sidewalk. Lawns and other vegetated areas can be expected to provide some treatment and infiltration if sidewalk runoff is directed into these areas. However, sidewalks can contribute to stormwater runoff problems when they are sloped to streets, parking areas, or other impervious surfaces.

To avoid stormwater runoff problems associated with sidewalks, various strategies can be used and include:

- Install sidewalks at a two percent slope. Add vegetative strips adjacent to sidewalks designed to detain and infiltrate runoff.
- Install sidewalks at a two percent slope and install washed rock percolation strips adjacent to the sidewalk. Design the strips to provide 50 to 75 cubic feet of storage for every 500 square feet of sidewalk.
- Provide drywells at certain intervals of the sidewalk. Slope the sidewalk one percent towards the drywells.

Incentives and Barriers

Sidewalk slopes, widths, and surfaces must comply with the ADA, industry standards, and safety policies of local governments. The ADA requires surfaces to be stable, firm, and slip resistant. Vertical changes in grades can be no more than one-half inch (Allen and Moffett, 1992; Washington State, 1992).

Policy Trends

Olympia

Comprehensive plan policies encourage development of pedestrian facilities on arterials and off-street pedestrian trails, and require sidewalks on both sides of the street. The plan calls for landscaping and trees to create pedestrian-friendly streets and allow infiltration (City of Olympia, 1994c). The zoning code's design review provisions and design guidelines encourage pedestrian walkways and amenities (City of Olympia, 1991). The new downtown zoning

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ordinance includes a pedestrian overlay district that requires a variety of design features and facilities for pedestrians (City of Olympia, 1993f).

Olympia's proposed street standards require sidewalks on both sides of the street (Table 16, page 53). New transportation and development policies will result in higher density commercial and residential development and narrower local access streets that make sidewalks essential. The requirement for two-sided sidewalks is strongly supported by most of Olympia's neighborhood associations and the City Council. The proposed street standards widen sidewalks for some streets and incorporate planting strips or street trees between curbs and sidewalks on certain streets (City of Olympia, 1994d).

Lacey

Existing zoning for the Lacey Central Business District requires pedestrian facilities such as designated pedestrian lanes within parking areas; planter strips between the sidewalk and street; and site designs which cluster buildings to reduce walking distance between each building and transit facilities (Carr, pers. comm.).

Sidewalks are currently required on both sides of all public streets. Required sidewalk widths are five feet for neighborhood collectors and local streets. For boulevards, major and minor arterials, and commercial collectors, required sidewalk widths are six feet except in pedestrian corridors (eight feet) and neighborhoods with zero setbacks (10 feet) (Carr, pers. comm.).

Tumwater

The adopted comprehensive plan emphasizes pedestrian-oriented development in the Capitol Campus, mixed-use, and high-density corridor areas. The transportation element of the comprehensive plan emphasizes pedestrian facilities and policies promoting TDM and non-motorized transportation. Under current regulations, sidewalks are required on both sides of the street. Sidewalk width standards vary from four to six feet (Bauer, pers. comm.).

Thurston County

Adopted city/county joint plans will apply city policies on alternative transportation to the unincorporated portion of the North Thurston UGMA. The city/county plan with Tumwater does not specifically mention sidewalk standards (Dosheery, pers. comm.).

The county currently requires four foot sidewalks on one side of local Section C roads and on both sides of local collectors. No sidewalks are required on local Sections D and E roads. Sidewalks are required on both

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sides of arterials; four to five feet wide for residential areas and six feet wide for commercial areas. Projects in the county are currently required to meet all city standards (including sidewalks) if they receive city water and sewer services (Payton, pers. comm.).

Implementation Actions

Olympia

Adopt the street standards as proposed (City of Olympia, 1994g).

North Thurston UGMA and Other Locations

Encourage developers and builders to reduce runoff by sloping sidewalks towards vegetated areas designed to infiltrate runoff. Explore new designs and ideas with the development and business community.

Implementation Costs for Olympia

No additional costs.

RECOMMENDATIONS FOR CONSTRUCTION PRACTICES AND LANDSCAPED AREAS

Naturally occurring, undisturbed areas typically infiltrate 60 percent of rain, depending on soil type. Clearing and grading a site typically removes existing vegetation and compacts the soils, greatly reducing the infiltration capacity of the site. For the purpose of this study, the project team considered compacted soils are an impervious surface. The following three recommendations address reducing soil compaction and the clearing of vegetated areas to retain the inherent infiltration capacity of undisturbed areas.

Recommendation 11.
Limit soil compaction on newly developed residential and commercial sites, especially those sites with sensitive features. Reduce soil compaction and restore infiltration capacity on already cleared sites whenever practical.

Discussion

In naturally occurring undisturbed soil and vegetated conditions, many local soils do not produce runoff even during severe storms. A lesser number of local soils will infiltrate the vast majority of rainfall regardless of the degree of soil compaction and the type or condition of the vegetation.

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Certain construction practices can increase the amount of stormwater runoff generated by a site. The amount and quality of runoff is affected by the extent of soil compaction created by clearing of a site, heavy equipment traffic, and other factors.

This recommendation aims to preserve wherever possible the infiltration and pollutant removal capacity provided by soil under natural conditions. The majority of disturbed, compacted, and subsequently landscaped soils in north Thurston County are contributors to stormwater runoff. Current stormwater management policies require calculations for the conveyance and storage of runoff from both impervious and landscaped areas of the site. Given that many residential developments have extensive landscaped areas, the calculated stormwater contribution from landscaped areas can approach or exceed the contribution from impervious surfaces.

The practice of removing, storing, and replacing the original topsoil found at a building site greatly modifies or destroys the naturally occurring soil structure, increases compaction, and decreases infiltration capacity. Mixing (discing or rototilling) mulch into the sub-soil before replacing the topsoil can dramatically increase infiltration capacity (Jensen, pers. comm.). Adequate mixing of organic mulches is essential. Simply turning organic mulches into the soil can create a barrier to infiltration (Gillian, pers. comm.).

Various research indicates that most precipitation can be directed into the soil and subsequently to groundwater by mixing compacted soils with mulches. Research also indicates that adding gravel and sand mulches has the potential to increase aquifer recharge from its present range of 0 to 30 percent, up to 60 to 90 percent of precipitation in most areas of the United States (Kemper et al., 1994).

Wheeled vehicles such as trucks and backhoes compact forest soils. Depending on soil type, soil density can be reduced as deep as two to three feet. This can create a barrier to infiltration and create runoff problems. Construction practices for reducing soil compaction of forest soils includes lower tire pressures (using floating tires on vehicles), concentrating traffic patterns, and roping off areas where traffic and storage can occur. Skilled operators are more aware of soil compaction than in the past, which may increase the acceptance of new practices (Harrison, pers. comm.).

On small urban sites, avoiding soil compaction may be difficult because the whole site may need to be cleared and used for maneuvering heavy equipment. In this case, infiltration can be achieved through use of organic mulches and drywells in certain cases.

Incentives and Barriers

The economic feasibility of using mulches to restore infiltration capacity depends on the cost of the mulch and time and equipment for mixing. Olympia and other local

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governments currently provide the mulch created from trimming street trees to developers and builders for erosion control purposes. This practice of providing free mulch is an incentive for developers and builders to restore infiltration capacity. Many developers or builders also chip existing trees and use the mulch for erosion control on site and for mixing into the soil.

Policy Trends

Olympia

The Uniform Building Code (UBC) currently does not require restoring disturbed soils to their predisturbance condition (Washington State, 1992). However, several existing ordinances include provisions that have the effect of limiting soil compaction. One purpose of the Tree Protection and Replacement Ordinance (City of Olympia, 1993g) is to minimize adverse effects of land disturbance on surface drainage and other factors. The ordinance requires protection of the root zone around trees during clearing and grading.

Olympia's Drainage Design and Erosion Control Manual describes a number of standard erosion control methods that prevent or mitigate soil compaction. These include net or mat blankets, mulch, seeding, topsoil, and sod. Mulch is described as providing immediate protection to exposed soils during construction delays or over winter, and is required on slopes greater than two to one. Recommendations for application rates vary depending on the material used (City of Olympia, 1994a).

The Drainage Design and Erosion Control Manual also specifies practices to avoid soil compaction during construction of stormwater infiltration facilities. Project plans and specifications must describe construction procedures, barricades, and other practices that prevent heavy equipment from crossing over the area that is going to be used for the infiltration facility.

The Drainage Design and Erosion Control Manual requires that for additions or remodels of an existing development, the entire site must be brought up to current drainage standards if (a) the project would result in the addition of new impervious surface of 25 percent or more of the existing impervious surface, and the new impervious surface is at least 5,000 square feet, or (b) the construction cost of the project is 25 percent or more of the assessed value excluding land value, providing that the construction cost of the project is at least $250,000. The cumulative square footage and cost of all additions or remodels during the past five years (through 1996) shall apply to this retrofit "trigger" requirement.

The draft Landscaping and Screening Ordinance (City of Olympia, 1994i) includes a provision to increase landscaping in parking lots when a

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redevelopment project is more than 50 percent of the assessed value of the property. In such cases, the ordinance would require an eventual 40 percent tree canopy and an increase in pervious surface. The ordinance is designed to discourage large parking lots by a formula that increases the *percentage* of landscaping as the size of the parking area increases.

Lacey

Lacey's requirements on soil compaction during construction of drainage facilities are similar to those described above for Olympia. The tree ordinance regulates when and how clearing can occur. Grading is regulated by the Uniform Building Code (Carr, pers. comm.).

The landscape ordinance requires landscaping of all disturbed areas in development projects. Natural vegetation can count towards required landscaping it if is retained and undisturbed. In naturally vegetated areas, all cleanup must be by hand to prevent compaction by equipment. No irrigation is required for natural vegetation, which acts as an incentive to retain existing vegetation. Under current regulations for major redevelopment projects, parking lot landscaping must be increased if the project exceeds 25 percent of the assessed value of the existing improvements (Carr, pers. comm.).

Tumwater

Tumwater's requirements on soil compaction during construction of drainage facilities are similar to those described above for Olympia (Webb, pers. comm.). The city's new tree protection ordinance requires fencing around the drip line of trees to protect them during construction. The sensitive areas ordinance restricts development on or near steep slopes (Booth, per. comm.).

Thurston County

The drainage provisions described above for Olympia also apply in unincorporated Thurston County. The County currently has no land clearing ordinance. Grading is regulated through the Uniform Building Code and permits are required if the duff (leaves, twigs) layer of soil is disturbed. Fill permits are required for fill of more than 50 cubic yards (Swanson, pers. comm.).

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Implementation Actions

Olympia

Promote sources of mulch for construction practices through technical assistance materials and activities. Offer a soils workshop to the development community every other year. Require the identification or categorization of the degree of soil compactability at a site as part of the currently required soils report.

North Thurston UGMA and Other Locations

Continue to implement on-site chipping and mulching, and provide technical assistance and/or free mulch to encourage "retrofitting" soil compacted during construction. Encourage less soil compaction by providing free mulch and technical assistance, and modifying existing policies and regulations.

Implementation Costs for Olympia

Minimal staff time will be needed to coordinate implementation. Organizing a soils workshop would cost approximately $750 per workshop and could be included in the Water Resources Program budget. Promoting sources of mulch and construction practices could be integrated into current activities and would cost approximately $50 a year.

Recommendation 12.
Limit land clearing on newly developed residential and commercial sites, especially those sites with sensitive features.

Discussion

Clearing and grading practices greatly affect the infiltration capacity of a site. Clearing eliminates valuable vegetation and compacts soils, especially under wet soil conditions or during the rainy season (Recommendation 11, page 96). The less disturbance of existing vegetation, the less stormwater runoff generated and the greater the treatment of pollutants. However, many small sites that are good candidates for infill are too small to maneuver large equipment, and require clearing the whole site.

Increasing urban densities in the North Thurston UGMA may require sacrificing small undisturbed areas in order to preserve larger tracts in the outlying, rural areas. However, many of the undisturbed areas in cities and towns are wetlands and stream corridors.

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Incentives and Barriers

Costco's Tumwater outlet is one local example of preserving an undisturbed area. Costco reserved a large block of evergreen trees in the middle of the parking area at the request of Tumwater's Planning Department. The incentives for reserving the block of trees included the following:

- The large trees offset the large size of the building, creating a more aesthetically pleasing appearance to the local community.
- The trees were a compromise with the local community, and created a more positive response towards Costco from the store's future customers.
- The trees provide a location for the hot dog stand and picnic area that is pleasant for the customers.
- The large trees provide an amenity that would take 50 to 75 years to attain.

Setting aside the trees has caused some minor problems with vehicle traffic flow. However, the architect that designed the store feels the benefits far outweigh the problems, even though the adjustments to accommodate the trees cost $10,000. Costs for accommodating the trees included handclearing underneath the trees, limbing, and curbing the area. Other communities are requesting similar large blocks of undisturbed areas as part of Costco's store design (Smith, pers. comm.).

Commercial developers usually try to keep costs down by utilizing all of a site for parking and other needs. This makes it difficult for them to aside blocks of undisturbed areas. The current practice of appraising property based on its development value rather than open space or natural area value is an economic disincentive and barrier to limiting land clearing. Open space tax incentives encourage preservation in the short term, but apply only to parcels larger than five acres.

Trees and shrubs can provide places for thieves or assailants to hide, and create a barrier to pedestrian safety. Adequate lighting can increase safety in areas of trees and shrubs in public or private parking areas and walkways.

Policy Trends

Local comprehensive drainage basin plans contain a recommendation to establish uniform standards for land clearing and grading within the North Thurston UGMA. Preservation of soil infiltration capacities is considered one of the primary benefits of such standards (City of Olympia, 1993b).

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Olympia

Comprehensive plan policies call for preservation of existing vegetation, retaining natural open space and wildlife habitat in urban villages, preserving trees on hillsides near multifamily developments, and incorporating water bodies in landscaping (City of Olympia, 1994c).

Olympia currently has no open space requirement except for planned residential developments, no payment of open space impact fees, and no policy on acquisition of open space other than parks. The new downtown zoning ordinance requires multifamily zoned sites to include 15 percent landscaping and/or outdoor recreation area that is not covered by impervious surface. This area could be existing vegetation or undisturbed area (City of Olympia, 1993f). The revised residential zoning ordinance includes development standards that require open space (City of Olympia, 1994h).

Land clearing is regulated by a Land Clearing Ordinance which requires a permit prior to clearing, and a Tree Protection and Replacement Ordinance intended to protect and preserve trees and woodlands (City of Olympia, 1984a, 1993g). The later ordinance establishes minimum tree density for different zones to be accommodated by existing or newly planted trees. It also requires submission of a tree plan showing trees to be preserved and planted. A new Landscaping and Screening Ordinance, that complements the Tree Protection and Replacement Ordinance, is proposed for adoption by City Council. It would require retaining all unused portions of a lot in native or undisturbed vegetation (City of Olympia, 1992). The interim Critical Areas Ordinance restricts development in or near designated critical areas such as wetlands and steep slopes, (City of Olympia, 1994i).

Lacey

The comprehensive plan includes policies aimed at protecting open space. Development proposals are reviewed to determine the best location for open space. In order to create larger consolidated park areas, open space is required to be located such that, when surrounding properties develop, the open space can be contiguous (Carr, pers. comm.).

The tree ordinance regulates when and how clearing can occur. No clearcutting is allowed. The landscaping ordinance allows high quality existing trees and other native vegetation to be retained and counted as landscaping if left undisturbed and undamaged during construction. No irrigation is required for natural vegetation, which is an incentive for retaining existing vegetation (Carr, pers. comm.).

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In new residential developments, native vegetation must be retained until preliminary plat approval is received. Lots may only be cleared once a building permit application for that lot has been received by the city. The developer or builder may then clear for the driveway, building footprint, and a 10-foot perimeter around the house. Any further clearing requires additional city review (Carr, pers. comm.).

Tumwater

The adopted comprehensive plan includes a system of open space and an open space preservation program including parks, critical areas, urban trails, and shorelines. Commercial landscaping standards are currently being developed (Bauer, pers. comm.).

Tumwater's new tree protection ordinance allows no more than 30 percent of the trees on a site to be removed during a five-year period unless a development project is proposed. If there is a proposed project, tree removal is limited to 20 percent or 12 trees per acre, whichever is greater. Tumwater will be considering a landscaping ordinance in 1995 (Booth, pers. comm.).

Tumwater's recently adopted land clearing ordinance restricts land clearing until a building permit application for that lot has been received by the city, similar to Lacey's policy (Booth, pers. comm.).

Thurston County

Existing county regulations require protection of wetlands, stream corridors, and important wildlife habitat areas. The Thurston County Comprehensive Plan refers to joint city/county comprehensive plans for policies that apply within the unincorporated portion of the North Thurston UGMA (Dosheery, pers. comm.).

Implementation Actions

Olympia

Adopt the landscaping requirements and policies as proposed in the Draft Unified Development Code (City of Olympia, 1995). Revise the clearing and grading ordinance (City of Olympia, 1984a) to require phased clearing similar to Lacey's and Tumwater's current policies.

North Thurston UGMA and Other Locations

Continue use of buffers to protect sensitive features and incremental clearing to reduce soil compaction. Encourage less land clearing through technical assistance,

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policies, and regulations. Work with the development community to identify incentives for reducing land clearing. If a clearing and grading ordinance is not in place, consider replicating Lacey's policy as guidance for the development community.

Implementation Costs for Olympia

Community Planning and Development Department and Water Resources Program staff time are already scheduled to revise the clearing and grading ordinance.

Recommendation 13.
Encourage measures such as homeowner association covenants, plat map conditions, and/or conservation easements that protect existing vegetation and undisturbed areas.

Discussion

Protection of an undisturbed area that has been set aside by a developer or builder is not guaranteed. Such protection often becomes the responsibility of a home or business owner, or homeowners association. Protection of undisturbed areas could be accomplished through homeowner association covenants, plat map conditions, conservation easements, or other measures.

Homeowner association covenants are agreements that are tied to the land title and are enforceable by homeowner associations, but are not enforceable by local governments. Homeowner association covenants generally address such issues as fence heights, display of campaign signs, parking, landscaping, building design, and care and maintenance of commonly-owned areas. Covenants present an opportunity for homeowners to agree to protect undisturbed areas and enforce protection among it's members.

Plat maps are official documents approved by city councils or county commissioners that prescribe the subdivision of a specific piece of land. The plat map is filed and recorded with the auditor and usually contains wording that designates the location and dimensions of sensitive areas, stormwater facilities, dedicated open space, or other features. Wording could also be added to plat maps that "condition" the use or activities for these features, including limiting the removal of existing vegetation in undisturbed areas (Boettcher, pers. comm.).

Conservation easements are voluntary written agreements between landowners and non-profit land trusts that protect special features of private property, such as wildlife habitat, agricultural land, wetlands, and forests. The agreement is tailored to the landowner and to meet special preservation needs of the land. Restrictions set

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forth in the agreement run with the property title. The land trust does not usually assume ownership, but does assume the long-term responsibility for stewardship and enforcement of the easement (Capitol Land Trust, undated).

Incentives and Barriers

Providing funding to homeowner associations could be an incentive for long-term protection. In Olympia, homeowner associations are eligible for funding from the city's Neighborhood Matching Grant Program. Grants are available for commonly held land such as open space areas. Projects such as tree planting and education programs are eligible for up to 50 percent of costs (City of Olympia, undated).

Incentives for using conservation easements include federal income, estate, and/or property tax reductions. For example, Thurston County allows a 90 percent reduction in property taxes if a conservation easement is associated with a piece of property. Another incentive is that the conservation easement runs with the title, which provides permanent (in perpetuity) preservation of the land even beyond the life of the land trust (Wells, S., pers. comm.).

Barriers that limit the enforceability of homeowner association covenants include the costs of litigation and the uncomfortableness of confronting neighbors not in compliance. Even if protection measures are added to the covenant when the homeowner association is first established, there is no assurance of long-term protection because covenants can be changed with the member's approval and are not enforceable by local governments.

In comparison to homeowner association covenants, plat map conditions may have fewer barriers to being effective measures for protection because they are enforceable by local governments. However, if plat map conditions that protect undisturbed areas are not added to the original plat map, it may be difficult to change at a later time because such changes require approval of all the property owners in a subdivision. The cost of changing the plat maps in Olympia is approximately $1,500 per request at the present time (Boettcher, pers. comm.).

When undisturbed areas are set aside, informing homeowners and others about property lines and designations is needed. Without such knowledge, encroachment by homeowners, dumping of yard waste, and other problems arise and create a barrier for maintaining undisturbed areas.

Policy Trends

Olympia

For urban villages, the new comprehensive plan requires a legally binding site plan which is to include provisions for environmental protection and

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maintenance of parks and open space (City of Olympia, 1994c). The subdivision ordinance requires final plat maps to designate areas reserved for public use. For plats having commonly-owned tracts, plats must contain a restriction stating that such tracts are owned and maintained for the benefit of all lot owners (City of Olympia, 1984b).

Lacey

As a condition of plat approval, the city requires protection of land that is to be retained as forested open space. These conditions may be recorded on the plat map, making them enforceable by the city. The city requires homeowner associations to adopt covenants covering maintenance of common parcels and facilities; however, these are not enforceable by the city (Carr, pers. comm.).

Tumwater

If land is reserved as open space, a homeowner association is required as a condition of plat approval to accept responsibility for maintaining that open space (Booth, pers. comm.).

Thurston County

For subdivisions in excess of ten gross acres, ten percent of the site must be devoted to open space. Conditions of approval require the open space to be owned and maintained by the lot owners in common or by a homeowners association and is so noted on the final recorded map. As a condition of plat approval, the county requires homeowner associations to accept responsibility for maintaining open space, including the maintenance of stormwater facilities (Knostman, pers. comm.).

Implementation Actions

Olympia

Continue support of the Capitol Land Trust's work on conservation easements. Consider reducing plat map revision fees for homeowner associations or community groups. Develop and distribute model language for homeowner association covenants geared toward preserving existing vegetation and undisturbed areas.

North Thurston UGMA and Other Locations

Identify opportunities for educating homeowners, developers, and builders for retaining existing vegetation and undisturbed areas beyond current levels as time and budget allow. Review property tax policies and modify if necessary to allow a reduction in property tax for dedicated open space areas. Review other policies to

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identify practical incentives for promoting homeowner association covenants, plat map conditions, and conservation easements.

Implementation Costs for Olympia

Annual support of the Capitol Land Trust is currently $50. Approximately $750 of city attorney, Community Planning and Development Department, and Water Resources Program staff time would be needed to develop the model language for covenants. The $100 fee for the initial development, printing, and distribution of the model language could be covered under the study grant if completed before June 1996. It is recommended that subsequent printing and distribution be the responsibility of the Community Planning and Development Department, as part of general services provided through the permit review process. Cost of subsequent printing and distribution would be approximately $50 a year.

RECOMMENDATIONS FOR DESIGN AND PLACEMENT OF BUILDINGS

Our current development pattern plays a large role in how much impervious surface we create. The following recommendations address two key strategies for reducing building-related impervious surfaces: clustering and taller buildings.

Recommendation 14.
Encourage cluster development that minimizes impervious surfaces.

Discussion

The basic principle of cluster development is to group, or "cluster" development onto one part of a site. Although the developed area is more compact, gross density of the site remains the same.

Cluster development can be utilized in a rural setting to provide resource protection, such as farms and timberlands, and in urban areas for the protection of environmentally sensitive areas. Cluster development also can be used to provide subdivisions such features as recreation areas, trails, or other amenities. Clustering also can be used to provide greater development potential on a site while protecting a resource, providing open space, or to save infrastructure costs (City of Lacey, 1994b).

By retaining a large undisturbed area, clustering can substantially reduce the amount of runoff from the site. This technique may be especially appropriate as a way to

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reduce the amount of land clearing and soil compaction (Recommendation 11, page 96 and Recommendation 12, page 100).

Incentives and Barriers

One incentive for clustering is the reduction in development costs and site disturbance that can be achieved. Fewer roads and shorter driveways can be used, and less area needs to be disturbed to put in utilities. Another incentive for clustering is the potential for neighborhood enhancement by setting aside open space for trails, recreation areas, or other amenities.

One barrier to clustering is the close proximity of homes that may result. Some people may not find having close neighbors an amenity, reducing the marketability of clustered housing.

Policy Trends

The Growth Management Act encourages local governments to provide for cluster housing and other innovative techniques in their comprehensive plans. The North Thurston Ground Water Management Plan (Thurston County, 1992b) encourages cluster development, particularly in wellhead protection areas and aquifer recharge areas.

Olympia

The new comprehensive plan allows clustering as an option in all zones. It requires clustering in unsewered portions of the urban growth area to leave room for future infill at urban densities and to protect ground and surface water, environmentally sensitive areas, and significant wildlife habitat (City of Olympia, 1994c). Current regulations relevant to clustering are the Critical Areas Ordinance and Planned Residential Development Ordinance. The Critical Areas Ordinance allows reduced lot sizes or clustering, encourages planned residential developments, and requires calculation of density to be based on net acreage (City of Olympia, 1992). The Planned Residential Development Ordinance contains procedures and requirements for clustering on parcels four acres and larger (City of Olympia, 1991).

Lacey

The current municipal code allows clustering in single- and multi-family Planned Residential Developments, leaving consolidated open space for recreation. Clustering is also required to a certain extent through the open space requirements for conventional subdivisions. The new comprehensive plan's land use element encourages clustering to retain open space, and to

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ensure that land in the long-term urban growth area is available for future development at urban densities (Carr, pers. comm.).

Tumwater

The current municipal code establishes an overlay zoning district in certain environmentally sensitive areas in which Planned Unit Developments (PUDs) are required. PUDs allow more design flexibility than conventional development and therefore make clustering possible. Previous policies required clustering within the overlay zoning district and did not allow clustering in other zones. The new comprehensive plan for the city limits encourages clustering in all residential zones to protect sensitive areas while accommodating residential development. These same policies have been proposed in the draft city/county joint plan for Tumwater's growth area, along with a policy that would make clustering mandatory in the long-term growth area to ensure potential for future infill at urban densities (Bauer, pers. comm.).

Thurston County

In planning under the Growth Management Act, Thurston County has adopted policies for clustering in the rural/resource area, long-term growth area, and unincorporated short-term growth area. In areas designated for long-term rural residential and resource use, clustering is intended to permanently preserve farm and forestry resource lands (Dosheery, pers. comm.).

New zoning classifications also encourage clustering through density bonuses in the Rural Residential/Resource Zone (one unit/five acres) and Rural Residential Zone (one unit/two acres). Clustering is allowed in the long-term Agriculture and Forestry Zones but with no density bonuses. In areas designated for long-term future growth, clustering in the new Urban Resource Zone (one unit/five acres) is intended to facilitate redevelopment at urban densities when urban services (sewer and water) are extended in the future. In areas designated for short-term growth, clustering is intended primarily to protect sensitive areas (Dosheery, pers. comm.).

Clustering also is allowed to provide for future infill in areas not now served by sewers. Within the unincorporated short-term urban growth areas, clustered single-family and multifamily subdivisions are allowed within Planned Residential Developments (PRDs). The PRD ordinance emphasizes maximum efficiency in the layout of streets and utilities and preservation of unique natural features of the site (Dosheery, pers. comm.).

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Implementation Actions

Olympia

Complete current growth management planning activities that encourage clustering.

North Thurston UGMA and Other Locations

Complete current growth management planning activities that encourage clustering. If clustering isn't currently encouraged, consider providing density credits or other incentives for clustering.

Implementation Costs for Olympia

No additional costs.

Recommendation 15.
Encourage the building and use of taller structures to reduce the size of building footprints.

Discussion

Multi-story buildings have less impervious surface coverage per occupant unit than single story buildings. Reducing the "footprint" of a building while increasing its height allows a parcel to accommodate the same density use with less impervious surface, or accommodate greater densities with the same amount of impervious surface.

Taller buildings are considered appropriate primarily in urban centers where site coverage tends to be very high. Given the high pedestrian and vehicular traffic associated with high density developments, the area around the building is typically dominated by streets, sidewalks, and small landscaped areas. Effective stormwater management in these areas can be more challenging than on lots with less developed area.

Incentives and Barriers

One incentive for taller buildings is the panoramic view generally provided to occupants and the increase in value from such views. However, proposals to construct taller buildings often raise neighborhood concerns about view obstruction and unattractive architecture. Neighborhood involvement in the designing of taller buildings could help address such concerns.

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Construction costs increase exponentially with a jump from two to five stories, partially because of the need for elevators in tall buildings. According to the ADA as outlined in the Washington State Building Code (Washington State, 1992), elevators are not required in facilities that are less than three stories or that have less than 3,000 square feet per story unless the building is a shopping center, professional office of a health care provider, or another type of facility as determined by the Attorney General. However, if an elevator is nonetheless planned, the elevator must meet ADA requirements.

Providing elevators and stairways (vertical circulation) uses up leasable space, reducing the viability of a project and the economic incentive for taller buildings. Typically, 90 percent of a commercial building should be leasable space (Wells, G., pers. comm.).

Taller buildings are currently economically infeasible in Olympia because of a combination of relatively low land values and higher construction costs per occupancy unit. Land values are low because of the current property tax structure, because market demand is relatively low, and because state government occupies so much office space at below-market lease rates.

Policy Trends

Olympia

The current zoning code restricts building height to two stories in most residential and neighborhood commercial zones, and five to six stories in commercial zones and downtown Olympia. The zoning code allows taller buildings in planned residential developments than in underlying zones. However, most development in Olympia is below these maximum allowed building heights. The zoning code also requires buildings to be "harmonious in scale" with existing nearby buildings, which discourages taller buildings (City of Olympia, 1991, 1993*f*).

Lacey

In Lacey's downtown area, maximum building height ranges from 60 to 250 feet, but most new development is much lower. In residential areas, maximum building heights are 35 feet in low and medium density zones, and 80 feet in high density zones. No changes are planned in these height limits. Lacey's design review ordinance requires buildings to be "harmonious in scale" with nearby buildings (Carr, pers. comm.).

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Tumwater

Development codes will be updated in 1995 to reflect the new comprehensive plan. No existing policies encourage taller buildings at this time (Bauer, pers. comm.).

Thurston County

Adopted city/county joint plans will apply city policies regarding building height to the unincorporated portion of the North Thurston UGMA (Dosheery, pers. comm.).

Implementation Actions

Olympia

Adopt the development standards for residential and commercial zones as proposed in the Draft Unified Development Code (City of Olympia, 1995).

North Thurston UGMA and Other Locations

Consider allowing taller buildings under commercial and residential zone development codes. Consider involving the development and business community in the identification of incentives and policies for taller buildings.

Implementation Costs for Olympia

No additional costs.

RECOMMENDATIONS FOR COMMUNITY INVOLVEMENT AND EDUCATION

Improving public involvement and education opportunities for residents is an important part of local government strategies for managing water resources. Olympia, Lacey, Tumwater, and Thurston County coordinate public involvement and education efforts wherever possible. Programs are designed to raise citizens' awareness and knowledge of water quality and quantity issues, provide skills to take personal action, and provide citizens a way to influence decisions. Study accomplishments required changes in public policy, as well as cooperation and coordination among neighboring local governments and community members. To continue the implementation that has been started, involvement and education recommendations are proposed below.

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Recommendation 16.
Develop and distribute printed materials that complement the study's recommendations.

Discussion

Studies can produce useful results but may never affect development practices or other activities because the information isn't shared with decisionmakers, citizens, and others who can apply it. Implementation can be limited due to lack of funds or staff to distribute results or provide supporting materials for carrying out recommendations.

To help avoid this problem with the Impervious Surface Reduction Study, the Department of Ecology and Olympia set aside approximately nine percent of the study's funds for dissemination of results. It is expected that inquiries for printed materials will continue after the grant has expired and will require additional funding and staffing.

Incentives and Barriers

An incentive for developing and distributing printed materials is the ability to complement local planning activities. The printed medium typically is used to communicate information to the development and business community during the site plan review and permit process. Providing impervious surface reduction information in printed form will make it easy for city planning staff to incorporate the study's findings into their general routine.

Another incentive is the ease with which you can provide new ideas to audiences with written materials that complement technical assistance, site plan review, and other "face-to-face" interactions.

Policy Trends

Local comprehensive drainage basin plans contain a recommendation to create a storm and surface water public information program to provide consistent, accurate information to the media and increased educational outreach to the public (City of Olympia, 1993a,b).

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Olympia

The new comprehensive plan includes a chapter on public involvement, with the goal of establishing and maintaining city decision processes that include the informed, active participation of all those affected. The environmental chapter includes a goal of public education about environmental protection (City of Olympia, 1994c).

The city currently distributes general information to the public via a quarterly newsletter mailed to all residents. More detailed information is distributed through various departments. For example, the Department of Planning and Community Development distributes information on development regulations through the permit counter and at workshops on growth management planning. The Water Resources Program distributes information on storm and surface water management, groundwater management, and drinking water supply issues; and the Waste Management Program distributes information on recycling and waste reduction. This is done through direct mailings, utility inserts, community workshops, outreach and education programs, and on request.

Lacey

Lacey's new comprehensive plan (City of Lacey, 1994c) contains several goals and policies related to public involvement. These goals and policies are intended to incorporate a wide range of public participation techniques in order to encourage public input and to disseminate information on a range of land use issues.

The city currently distributes general information to the public through *Lacey Life*, a city newsletter published nine times a year. This publication is put out by the Department of Public Affairs and Community Relations which also distributes information on solid waste reduction and recycling, neighborhood associations, special events, and community issues. This is done through special presentations to neighborhood associations, live call-in shows with the city council, direct mailings, workshops, and utility inserts. The Water Resources Unit distributes information on storm and surface water management, groundwater management, and drinking water supply issues. The Department of Community Development distributes information on development regulations through the permit counter and at special workshops (Carr, pers. comm.).

Tumwater

Tumwater's Comprehensive Plan (City of Tumwater, 1993) emphasizes public participation throughout the plan. The city produces a monthly newsletter

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that is mailed to all residents. This newsletter, the *Pioneer*, alerts people to public meetings and emerging projects and issues (Matlock, pers. comm.).

Thurston County

Thurston County's comprehensive plan identifies the need for public education activities to support policies on environmental quality and stormwater management (Thurston County, 1988). In 1992, the Board of County Commissioners adopted a set of policies and procedures for public participation aimed at consistent public notification and involvement in the development of plans and regulations. Procedures include publications and distribution of fact sheets about new plans and regulations (Thurston County, 1992a).

County agencies that currently distribute public information are: Development Services, which distributes printed materials about development standards and regulations through the Permit Assistance Center; Community and Environmental Programs, which prepares and distributes information and educational materials for most county resource management programs; and the Storm and Surface Water Management Program, which distributes the Drainage Manual and other printed materials on stormwater management techniques (Alexander, pers. comm.).

Implementation Actions

Olympia

Respond to requests for the final study report and executive summary. Print and distribute copies of the model legal agreement for shared parking, alternative surfaces fact sheet, and other training and technical assistance materials.

Use established avenues of distribution such as permit counters, site plan review, and informational displays. Work with Lacey, Tumwater, and Thurston County; local businesses; building, development, and business organizations; and neighborhood and homeowner associations to identify and utilize established avenues of distribution. Coordinate with other City of Olympia departments, other local jurisdictions, and existing involvement and education programs in the region.

North Thurston UGMA and Other Locations

Provide information to Olympia concerning needs for and distribution opportunities of printed materials. If interested, request written materials from Olympia for distribution or replication.

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Implementation Costs for Olympia

The $150 annual cost of printing and distributing materials will be covered under the study grant until June 1996 After June 1996, minimal Water Resources Program funding and staff time would be needed to print and distribute materials.

Recommendation 17.
Develop and provide training and technical assistance to the region's development and business community.

Discussion

A key success of this study is the raised awareness among local governments and the development and business community. However, the task of sharing the study's findings, identifying incentives for action, and implementing changes in practices and designs is not complete. Without a clear understanding about the problems with impervious surfaces and possible solutions and incentives, actual reduction may not occur. Consequently, ongoing training and technical assistance are essential for implementing impervious surface reduction techniques "on the ground."

Incentives and Barriers

Some of the recommendations should result in cost savings to the development and business community. Learning about how to reduce construction costs and use sites more efficiently should be an incentive to participate in training and technical assistance.

Policies and regulations will be changed as a result of this study. Policies and regulations often change so frequently that business people feel they can't keep up. Training and technical assistance, if well-designed, can help the development and business community understand current policies and regulations, reducing frustration and increasing compliance. Reduced frustration and increased compliance are key incentives for sponsoring and participating in technical assistance and training. However, if the training and technical assistance are ineffective, they could increase frustration and act as a barrier to future government-sponsored educational processes designed for the development and business community.

Policy Trends

Local comprehensive drainage basin plans include a recommendation to provide education and training opportunities for business and industry, including workshops on new regulations, technical support on best management practices, and

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coordination with business organizations. Another recommendation is to train local government staff to implement and enforce basin plan recommendations such as new drainage standards and land use regulations (City of Olympia, 1993b). Olympia, Lacey, Tumwater, and Thurston County staff are participating in training for regional drainage manual implementation.

Olympia

The new comprehensive plan includes a chapter on public involvement, with the goal of establishing and maintaining city decision processes that include the informed, active participation of all those affected. The environmental chapter includes a goal of public education about environmental protection (City of Olympia, 1994c).

The Water Resources Program works cooperatively with Lacey and Thurston County, Lacey Area and Olympia/Thurston Chambers of Commerce, and the Washington Department of Ecology to offer education and technical assistance to local businesses through the Operation: Water Works program. Workshops, onsite visits, and assistance with developing a pollution prevention plan are provided to businesses whose activities have the potential to pollute surface and groundwater (City of Olympia, 1993e).

Olympia's waste management section provides ongoing technical assistance to businesses including free waste audits, and advice and assistance on recycling and waste reduction. The City also works with businesses to help identify useful products made from recycled materials (Guttchen, pers. comm.).

Lacey

Lacey has jointly participated with Olympia, Tumwater, and Thurston County in staff training for regional drainage manual implementation. Staff will in turn provide guidance to the development community. The Water Resources Unit works cooperatively with others to implement the Operation: Water Works program (Carr, pers. comm.).

Tumwater

Tumwater has jointly participated with Olympia, Lacey, and Thurston County in staff training for regional drainage manual implementation. Staff will in turn provide guidance to the development community (Bauer, pers. comm.).

Thurston County

Thurston County participates in the Operation: Water Works Program, which provides business-specific training workshops for owners and managers on

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best management practices. The County also provides informational materials and consultations to the development community through its "one-stop" permit counter. Technical assistance is also provided at pre-submission conferences and through code enforcement or site inspections (Alexander, pers. comm.).

Thurston County Health Department sponsors the Business Pollution Prevention Program. The program provides technical assistance designed to gain regulatory compliance from small quantity hazardous waste generators, and complements the technical assistance and regulatory compliance goals of the Thurston County Moderate Risk Waste Plan (Thurston County, 1991b). From winter 1993 to spring 1994, the program focused on printing, photography, and medical facilities as a pilot project for further technical assistance. The high rate of voluntary compliance and increased management of hazardous wastes resulting from the pilot project indicates that the program may be a good model for impervious surface technical assistance.

Implementation Actions

Olympia

Share information with Lacey, Tumwater, and Thurston County and encourage the replication of materials. Make materials available to others upon request. Offer a soils workshop to the development community every other year (Recommendation 11, page 96).

North Thurston UGMA and Other Locations

If appropriate, request copies of Olympia's training and technical assistance materials or develop ones for the local situation.

Implementation Costs for Olympia

The $150 annual cost of printing and distributing materials will be covered under the study grant until June 1996. After June 1996, minimal Water Resources Program funding and staff time would be needed to print and distribute materials. The cost for a soils workshop is included in Recommendation 11 (page 96).

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RECOMMENDATIONS FOR STUDY EVALUATION

Evaluation is an essential step for learning from past experiences and recognizing successes. For the project team, this study raised as many questions as it answered. It also identified the need for better information concerning impervious surfaces and local groundwater hydrology. The following recommendations, if implemented, would not only continue the research efforts begun with this study but would help us measure success and identify areas for improvement. These recommendations would provide information and data for evaluating the overall success of the study, as well as the specific policy and regulatory changes made as a result of study recommendations.

Recommendation 18.
Monitor the increase in impervious surfaces in Percival, Woodard/Woodland, and Chambers/Ward/Hewitt drainage basins to determine effective impervious surface coverage trends.

Discussion

One outcome of the study has been the realization that we have limited impervious surface information for the Olympia area, and north Thurston County. The information that is available for Percival Creek, Woodard/Woodland Creeks, and Chambers/Hewitt/Ward basins (Chapter 2, Basin and Site Coverage Assessment, page 34) has been a foundation for this study. Many of the recommendations are based on growth and related impervious surface coverage projections. It would be useful to verify the accuracy of these projections and adjust policies and regulations accordingly.

Incentives and Barriers

Community Planning and Development Department currently uses a Howard Technology Enterprise System (HTE System) that tracks development information and could be modified to better track impervious surfaces. Impervious surface coverage information is acquired from permit applications, but is not kept up to date on the system because of a lack of staff time for data entry. This is a barrier to getting current and accurate data.

Policy Trends

Thurston Regional Planning Council maintains a Geographic Information System for the region. The GIS mapping and information services are available to other local jurisdictions.

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Olympia

As mentioned above, the city currently has a tracking system in place that could be used for monitoring impervious surfaces. Monitoring is supported through informal policies of the Water Resources Program and Public Works Department.

Lacey

Lacey's Department of Community Development uses a permit tracking system to monitor and store development information. Information regarding impervious surfaces is contained within the system for some properties. If information regarding impervious surfaces were consistently entered, this system would be an excellent tool for monitoring impervious surfaces within the city.

Lacey's comprehensive plan contains numerous goals and policies related to water resources issues. These include a policy that strives to ensure coordination between the Puget Sound Water Quality Management Plan, North Thurston County Ground Water Management Plan, Henderson Inlet and Budd/Deschutes Watershed Action Plans, various basin plans, and other water resources plans.

Lacey also has a stormwater utility that charges commercial developments a stormwater fee based on percentage of impervious surface. This may be used to track the total amount of impervious surfaces. At this time, the utility information is stored in a different system than the above-mentioned permit tracking system (Carr, pers. comm.).

Tumwater

Tumwater is currently not equipped to track impervious surfaces associated with new development. This may be possible in the future as staffing and equipment are added (Matlock, pers. comm.).

Thurston County

Thurston County is currently not equipped to track impervious surfaces associated with new development. Similar to Olympia and Lacey, Thurston County has a stormwater utility for the northern, more urbanized part of the county. The utility charges a stormwater fee based on percentage of impervious surface (Knostman, pers. comm.).

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Implementation Actions

Olympia

Consider providing a dedicated staff person for HTE System data entry. Every five years, generate a digitized land use map of the three drainage basins used in the basin and site coverage assessment. Calculate the increase in impervious surfaces and compare to Impervious Surface Reduction Study projections. Make corrections to policies and regulations as needed to achieve a 20 percent reduction in future impervious surfaces.

North Thurston UGMA and Other Locations

Consider monitoring impervious surfaces. Provide information to Olympia for calculating the increase in impervious surfaces, as staff time and budget allows.

Implementation Costs for Olympia

A few days of Water Resources Program and Transportation Division staff time and approximately $1,000 in map fees would be needed to analyze and produce the needed information. Staff time also would be needed to review the HTE system and information periodically. Total cost is estimated at $1,500.

Recommendation 19.
Assess the results of the study's recommendations in Olympia, North Thurston UGMA, and other locations.

Discussion

The study will be a success if it results in less impervious surface than expected under the current growth scenario (Figure 3, page 7). Evaluating results of the study's recommendations would provide important information for adjusting reduction strategies and techniques. The information could be used to adjust policies, regulations, technical assistance, and incentives to achieve a 20 percent reduction.

Incentives and Barriers

Effective study evaluation would require the cooperation of all four local governments. Impervious surface evaluation may not be as high a priority for Lacey, Tumwater, or Thurston County as for Olympia, and thus prove a barrier to completing a useful analysis.

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Policy Trends

Olympia

Olympia's Water Resources Program is committed to integrating evaluation into existing and new programs. Annual evaluation of the Stream Team volunteer program is conducted, and periodic evaluation of Operation: Water Works and other programs also are conducted.

Lacey

In 1996, Lacey will participate with Olympia's Water Resources Program in evaluation of the Stream Team volunteer program. Periodic evaluation of policies and programs occurs as needed.

Tumwater

Tumwater conducts periodic policy and program evaluation as needed.

Thurston County

In 1996, Thurston County will participate with Olympia's Water Resources Program in evaluation of the Stream Team volunteer program. Periodic evaluation of policies and programs occurs as needed.

Implementation Actions

Olympia

Document changes in regulations and policies for Olympia, the North Thurston UGMA, and other locations that occurred as a result of the study. Conduct an analysis using developments that are constructed under the revised Olympia parking ordinance, to see if projections of the study's parking analysis (Chapter 2, Parking Analysis, page 46) were accurate. Adjust policies and regulations if a 20 percent reduction is not being achieved.

North Thurston UGMA and Other Locations

Cooperate with Olympia in conducting an evaluation, as staff time and budget allows. Consider tracking developments that incorporate reduction strategies. When policies and regulations come up for revision, consider modifying them as needed to increase incentives and achieve impervious surface reduction.

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Implementation Costs for Olympia

Several days of staff time would be required to conduct the evaluation. Minimal printing and other costs would be incurred. The total cost is estimated to be $1,000. Documenting the changes in regulations and policies should be conducted in early 1996. The cost for this portion of the evaluation could be covered under the study grant.

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CHAPTER 4
IMPLEMENTATION STRATEGY

Successful implementation of the study's recommendations relies on the commitment of the community and its decision-makers, and the existing policy framework of Olympia and other local governments. Some of the study's recommendations were partially or wholly incorporated into the local policy framework prior to the study and are included as guidance for others. Some have been incorporated into Olympia's Draft Unified Development Code (City of Olympia, 1995) and draft street standards that are being considered for adoption. The code includes the parking ordinance, landscaping ordinance, and development standards. If the Unified Development Code and draft street standards are adopted as proposed, many of the recommendations will be integrated into Olympia's existing policy framework during 1995. It is expected that Olympia will implement approximately 81 percent of the study's recommendations not already incorporated into city policy.

As with Olympia, some recommendations were partially or wholly incorporated into Lacey, Tumwater, and Thurston County policy prior to the study. Only a few additional recommendations are proposed for adoption. It is estimated that 10 to 20 percent of the recommendations will be adopted by neighboring local governments during 1995.

SCHEDULE

One challenge in developing an implementation schedule is that several recommendations are already implemented or will be in the near future. Another challenge is documenting implementation that has occurred or will occur in other locations, both within the North Thurston UGMA and across the nation. The many requests for information that originated outside the North Thurston UGMA indicates that some implementation is probably underway in other locations. Completing Olympia's implementation actions for Recommendation 19, Assessing Results (page 121), will provide a better indication of study implementation than what we can currently estimate. In response to these challenges, Table 18 (page 127) contains information pertaining only to Olympia.

RESOURCES NEEDED

Implementation in Olympia would require a minimum of staff time and materials because many of the recommendations would be implemented through existing programs and site plan review. Some staff time would be needed to participate in implementation. In particular, distribution of materials designed for the development community (Recommendation 16, page 113 and Recommendation 17, page 116) would primarily occur through the permit counter and site plan review activities

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conducted by Community Planning and Development Department (CPDD) staff. Water Resources Program staff would develop the materials for CPDD staff to pass on to the development community and would be involved in site plan reviews from a stormwater management perspective. Water Resources Program staff also would be responsible for completing the study evaluation.

Completing the study evaluation would require some staff and material resources of Lacey, Tumwater, and Thurston County. Because the study is not being officially adopted by the other local governments, they are not legally bound to implement the study's recommendations. However, project staff expect that the cooperation offered by the other local governments during the study will continue into the future.

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Table 18: Implementation Strategy for Olympia

Recommendation	Council Action Requested	Participation in Implementation and Costs			
		1995[1]	1996[1]	1997	1998
1. Integrate impervious surface reduction into policies and regulations.					
Implementation Actions:					
Adopt the Draft Unified Development Code (UDC) as proposed.	Action is requested. See Rec. 4 and Recs. 6 through 15.	See Rec. 4 and Recs. 6 through 15 for details.	See Rec. 4 and Recs. 6 through 15 for details.	See Rec. 4 and Recs. 6 through 15 for details.	See Rec. 4 and Recs. 6 through 15 for details.
Identify opportunities for further integration into policies and regulations as part of ongoing policy review process.	No action is requested at this time. Adopt policy revisions when proposed.	P^2D^2, CPDD	P^2D^2, CPDD	P^2D^2, CPDD	P^2D^2, CPDD
2. Establish growth management policies that encourage infill of urban areas and reduce urban sprawl.					
Implementation Action:					
Complete growth management planning process and implementation.	Adopt the UDC as proposed.	CPDD	CPDD	CPDD	CPDD

P^2D^2: Policy and Program Development Division staff would be involved in implementation.
CPDD: Community Planning and Development Department staff would be involved in implementation.
TRANS: Transportation Division staff would be involved in implementation.
PARKS: Parks, Recreation, and Cultural Services Department staff would be involved in implementation.
LEGAL: The City Attorney's office would be involved in implementation.

(1) Most actions listed for P^2D^2 under 1995 and 1996 are eligible for funding under the Impervious Surface Reduction Study grant which expires June 1996.

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Recommendation	Council Action Requested	Participation in Implementation and Costs			
		1995[1]	1996[1]	1997	1998
3. Provide a public transit system and other alternative modes of transportation that reduce the need for streets and parking.					
Implementation Action:					
Implement the Regional Transportation Plan and complete TDM Ad Hoc Committee tasks (Downtown Parking Management Strategy).	Adopt the updated Downtown Parking Management Strategy and policies that implement the transportation plan when proposed.	P^2D^2, CPDD, TRANS	P^2D^2, CPDD, TRANS	P^2D^2, CPDD, TRANS	P^2D^2, CPDD, TRANS
4. Develop standards for narrower residential streets with reduced, but adequate, parking opportunities					
Implementation Action:					
Adopt the street standards as proposed.	Adopt the street standards as proposed.	TRANS	No action.	No action.	No action.

P^2D^2: Policy and Program Development Division staff would be involved in implementation.
CPDD: Community Planning and Development Department staff would be involved in implementation.
TRANS: Transportation Division staff would be involved in implementation.
PARKS: Parks, Recreation, and Cultural Services Department staff would be involved in implementation.
LEGAL: The City Attorney's office would be involved in implementation.

(1) Most actions listed for P^2D^2 under 1995 and 1996 are eligible for funding under the Impervious Surface Reduction Study grant which expires June 1996.

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Recommendation	Council Action Requested	Participation in Implementation and Costs			
		1995[1]	1996[1]	1997	1998
5. Use pavers and other pervious surfaces for low use areas such as overflow parking and emergency access roads.					
Implementation Actions:					
Develop and distribute a model maintenance plan for sites using pervious surfaces.		P^2D^2 ($1,000), CPDD, TRANS	P^2D^2 ($100), CPDD, TRANS	P^2D^2 ($200), CPDD	P^2D^2 ($100), CPDD
Print and distribute the alternative surfaces fact sheet.		P^2D^2 ($200), CPDD	P^2D^2 ($100), CPDD	P^2D^2 ($100), CPDD	P^2D^2 ($100), CPDD
6. Narrow alley widths, use alternative surfaces for alleys, and/or design alleys to drain into vegetated strips or central drains.					
Implementation Action:					
Adopt the street standards as proposed.	Adopt the street standards as proposed.	TRANS	No action.	No action.	No action.

P^2D^2: Policy and Program Development Division staff would be involved in implementation.
CPDD: Community Planning and Development Department staff would be involved in implementation.
TRANS: Transportation Division staff would be involved in implementation.
PARKS: Parks, Recreation, and Cultural Services Department staff would be involved in implementation.
LEGAL: The City Attorney's office would be involved in implementation.

(1) Most actions listed for P^2D^2 under 1995 and 1996 are eligible for funding under the Impervious Surface Reduction Study grant which expires June 1996.

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Recommendation	Council Action Requested	Participation in Implementation and Costs			
		1995[1]	1996[1]	1997	1998
7. Encourage cooperative parking such as joint (combined), shared, and coordinated parking.					
Implementation Actions:					
Adopt the parking ordinance as proposed in the Draft Unified Development Code (UDC).	Adopt the UDC as proposed.	CPDD	No action.	No action.	No action.
Print and distribute the model legal agreement for shared parking.		P^2D^2 ($200), CPDD	P^2D^2 ($100), CPDD	CPDD ($50)	CPDD ($50)
8. Encourage underground or under-the-building parking and the construction of multi-storied parking structures.					
Implementation Actions:					
Adopt the commercial and residential development standards as proposed in the Draft Unified Development Code (UDC).	Adopt the UDC as proposed.	CPDD	No action.	No action.	No action.
Update the Downtown Parking Management Strategy. Consider in-lieu-of-parking fees. Involve the Olympia Downtown Association in process.	Adopt the updated Downtown Parking Management Strategy when proposed.	P^2D^2, CPDD, TRANS	P^2D^2, CPDD, TRANS	No action.	No action.

P^2D^2: Policy and Program Development Division staff would be involved in implementation.
CPDD: Community Planning and Development Department staff would be involved in implementation.
TRANS: Transportation Division staff would be involved in implementation.
PARKS: Parks, Recreation, and Cultural Services Department staff would be involved in implementation.
LEGAL: The City Attorney's office would be involved in implementation.

(1) Most actions listed for P^2D^2 under 1995 and 1996 are eligible for funding under the Impervious Surface Reduction Study grant which expires June 1996.

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Recommendation	Council Action Requested	Participation in Implementation and Costs			
		1995[1]	1996[1]	1997	1998
9. Develop flexible parking regulations related to parking region-wide that limit the amount of impervious surface, while still providing for parking needs.					
Implementation Action:					
Adopt the parking ordinance as proposed in the Draft Unified Development Code (UDC).	Adopt the UDC as proposed.	CPDD	No action.	No action.	No action.
10. Gently slope sidewalks away from streets and other impervious surfaces towards vegetated strips or gravel catchments.					
Implementation Action:					
Adopt the street standards as proposed.	Adopt the street standards as proposed.	TRANS	No action.	No action.	No action.

P^2D^2: Policy and Program Development Division staff would be involved in implementation.
CPDD: Community Planning and Development Department staff would be involved in implementation.
TRANS: Transportation Division staff would be involved in implementation.
PARKS: Parks, Recreation, and Cultural Services Department staff would be involved in implementation.
LEGAL: The City Attorney's office would be involved in implementation.

(1) Most actions listed for P^2D^2 under 1995 and 1996 are eligible for funding under the Impervious Surface Reduction Study grant which expires June 1996.

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Recommendation	Council Action Requested	Participation in Implementation and Costs			
		1995[1]	1996[1]	1997	1998
11. Limit soil compaction on newly developed residential and commercial sites, especially those sites with sensitive features. Reduce soil compaction and restore infiltration capacity on already cleared sites whenever practical.					
Implementation Actions:					
Promote sources of mulch and construction practices through technical assistance materials and activities.		P^2D^2 ($100), CPDD	P^2D^2 ($100), CPDD	P^2D^2 ($100), CPDD	P^2D^2 ($100), CPDD
Offer a soils workshop to the development community every other year.		No action.	P^2D^2 ($750), CPDD	No action.	P^2D^2 ($750), CPDD
Require the identification or categorization of the degree of soil compactability at a site, as part of the currently required soils report.		P^2D^2 ($200), CPDD	P^2D^2, CPDD	P^2D^2, CPDD	P^2D^2, CPDD

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P^2D^2: Policy and Program Development Division staff would be involved in implementation.
CPDD: Community Planning and Development Department staff would be involved in implementation.
TRANS: Transportation Division staff would be involved in implementation.
PARKS: Parks, Recreation, and Cultural Services Department staff would be involved in implementation.
LEGAL: The City Attorney's office would be involved in implementation.

(1) Most actions listed for P^2D^2 under 1995 and 1996 are eligible for funding under the Impervious Surface Reduction Study grant which expires June 1996.

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Recommendation	Council Action Requested	Participation in Implementation and Costs			
		1995[1]	1996[1]	1997	1998
12. Limit land clearing on newly developed residential and commercial sites, especially those with sensitive features.					
Implementation Actions:					
Adopt the landscaping requirements and policies as proposed in the Draft Unified Development Code (UDC).	Adopt the UDC as proposed.	CPDD	No action.	No action.	No action.
Revise the clearing and grading ordinance to require phased clearing similar to Lacey's and Tumwater's current policies.	No action requested at this time. Adopt the revised ordinance when proposed.	P^2D^2, CPDD	P^2D^2, CPDD	No action.	No action.

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P^2D^2: Policy and Program Development Division staff would be involved in implementation.
CPDD: Community Planning and Development Department staff would be involved in implementation.
TRANS: Transportation Division staff would be involved in implementation.
PARKS: Parks, Recreation, and Cultural Services Department staff would be involved in implementation.
LEGAL: The City Attorney's office would be involved in implementation.

(1) Most actions listed for P^2D^2 under 1995 and 1996 are eligible for funding under the Impervious Surface Reduction Study grant which expires June 1996.

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Recommendation	Council Action Requested	Participation in Implementation and Costs			
		1995[1]	1996[1]	1997	1998
13. Encourage measures such as homeowner association covenants, plat map conditions, and/or conservation easements that protect existing vegetation and undisturbed areas.					
Implementation Actions:					
Continue support of the Capitol Land Trust's work on conservation easements.		PARKS[2]	PARKS ($50)	PARKS ($50)	PARKS ($50)
Consider reducing plat map revision fees for homeowner associations and community groups.	No action requested at this time. Adopt revised fee schedule if proposed.	CPDD	CPDD	No action.	No action.
Develop and distribute model language for homeowner association covenants geared toward preserving existing vegetation and undisturbed areas.		P^2D^2 ($750), CPDD, LEGAL	P^2D^2 ($100), CPDD	CPDD ($50)	CPDD ($50)

P^2D^2: Policy and Program Development Division staff would be involved in implementation.
CPDD: Community Planning and Development Department staff would be involved in implementation.
TRANS: Transportation Division staff would be involved in implementation.
PARKS: Parks, Recreation, and Cultural Services Department staff would be involved in implementation.
LEGAL: The City Attorney's office would be involved in implementation.

(1) Most actions listed for P^2D^2 under 1995 and 1996 are eligible for funding under the Impervious Surface Reduction Study grant which expires June 1996.

(2) Fifty-dollars in annual support has already been provided to the Capitol Land Trust by Parks, Recreation, and Cultural Services Department for 1995.

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Recommendation	Council Action Requested	Participation in Implementation and Costs			
		1995[1]	1996[1]	1997	1998
14. Encourage cluster development that minimizes impervious surfaces.					
Implementation Action:					
Complete current growth management planning activities that encourage clustering.	Adopt the UDC as proposed.	CPDD	No action.	No action.	No action.
15. Encourage the building and use of taller structures to reduce the size of building footprints.					
Implementation Action:					
Adopt the development standards for residential and commercial zones as proposed by the Draft Unified Development Code (UDC).	Adopt the UDC as proposed.	CPDD	No action.	No action.	No action.

P^2D^2: Policy and Program Development Division staff would be involved in implementation.
CPDD: Community Planning and Development Department staff would be involved in implementation.
TRANS: Transportation Division staff would be involved in implementation.
PARKS: Parks, Recreation, and Cultural Services Department staff would be involved in implementation.
LEGAL: The City Attorney's office would be involved in implementation.

(1) Most actions listed for P^2D^2 under 1995 and 1996 are eligible for funding under the Impervious Surface Reduction Study grant which expires June 1996.

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Recommendation	Council Action Requested	Participation in Implementation and Costs			
		1995[1]	1996[1]	1997	1998
18. Monitor the increase in impervious surfaces in Percival, Woodard/Woodland, and Chambers/Ward/Hewitt drainage basins to determine effective impervious surface coverage trends.					
Implementation Actions:					
Consider providing a dedicated staff person for HTE System data entry.[3]		CPDD	CPDD	CPDD	CPDD
Every five years, generate a digitized land use map of the three drainage basins used in the basin and site coverage assessment. Calculate the increase in impervious surfaces and compare to study projections.		No action.	No action.	No action.	P^2D^2 ($1,500), TRANS
Make corrections to policies and regulations as needed to achieve a 20 percent reduction.	No action requested at this time. Adopt policy revisions if proposed.	P^2D^2, CPDD, TRANS	P^2D^2, CPDD, TRANS	P^2D^2, CPDD, TRANS	P^2D^2, CPDD, TRANS

P^2D^2: Policy and Program Development Division staff would be involved in implementation.
CPDD: Community Planning and Development Department staff would be involved in implementation.
TRANS: Transportation Division staff would be involved in implementation.
PARKS: Parks, Recreation, and Cultural Services Department staff would be involved in implementation.
LEGAL: The City Attorney's office would be involved in implementation.

(1) Most actions listed for P^2D^2 under 1995 and 1996 are eligible for funding under the Impervious Surface Reduction Study grant which expires June 1996.

(3) The HTE System is currently underutilized. The responsibility for data entry is dispersed among staff and not always up to date. Consolidating the responsibility into one person's workload may ensure data is completed and allow it to be effectively used for impervious surface coverage analysis.

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Recommendation	Council Action Requested	Participation in Implementation and Costs			
		1995[1]	1996[1]	1997	1998
19. Assess the result of the study's recommendations in Olympia, North Thurston UGMA, and other locations.					
Implementation Actions:					
Document changes in regulations or policies for Olympia, North Thurston UGMA, and other locations that occurred as a result of the study.		No action.	P²D² ($500)	No action.	No action.
Conduct an analysis using developments that are constructed under the revised Olympia parking ordinance to see if projections of the study's parking analysis were accurate.		No action.	No action.	CPDD ($500), P²D²	No action.
Adjust policies and regulations if a 20 percent reduction is not being achieved.	No action is requested at this time. Adopt policy revisions if proposed.	No action.	P²D², CPDD, TRANS	P²D², CPDD, TRANS	P²D², CPDD, TRANS

P²D²: Policy and Program Development Division staff would be involved in implementation.
CPDD: Community Planning and Development Department staff would be involved in implementation.
TRANS: Transportation Division staff would be involved in implementation.
PARKS: Parks, Recreation, and Cultural Services Department staff would be involved in implementation.
LEGAL: The City Attorney's office would be involved in implementation.

(1) Most actions listed for P²D² under 1995 and 1996 are eligible for funding under the Impervious Surface Reduction Study grant which expires June 1996.

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GLOSSARY

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accessory units
A second dwelling unit added to, created within, or separated from a single family dwelling with provision for cooking, eating, sanitation and sleeping. Commonly called "mother-in-law" units.

alternative surfaces
Surfaces other that conventional asphalt or concrete. Examples include bark and gravel.

alternative modes of transportation
Modes of transportation other than the single passenger automobile, such as transit, bicycling, carpooling, and walking.

amenity
Something that increases material or physical comfort.

Americans with Disabilities Act (ADA)
Federal legislation passed in 1990 to provide comprehensive protection of the civil rights of people with disabilities.

atmospheric deposition
Deposits on land and water from the atmosphere (air), often referring to pollutants.

arterial street
A street that provides a direct route for long-distance travel within the region and also to different parts of the city. Traffic on an arterial street is given preference at intersections, and some control of access may be used when arterials carry high volumes of traffic.

aquifer
The underground layer of rock or soil in which groundwater resides. Aquifers are replenished or recharged by surface water percolating through soil. Wells are drilled into aquifers to extract water for human use.

basin plans
A plan to identify and correct current and potential surface water problems within a creek system and surrounding drainage area including flooding, erosion, degraded water quality, and diminishing aquatic and wildlife habitat. Public involvement is one aspect of plan development and adoption.

best management practices
A method, activity, maintenance procedure, or other management practice for reducing the amount of pollution entering a water body.

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buildout
Full development at the maximum densities allowed by zoning.

building footprint
Commonly used term to describe the ground area that a building covers.

calibration
To correlate readings from a system of measurement with a standard.

conservation easement
An agreement (grant of a property right) stating that land will remain in its natural condition precluding future or additional development.

Centennial Clean Water Fund
A common name for the Water Quality Account administered by the Washington Department of Ecology. In 1986, legislation was passed creating the Water Quality Account in the Washington State Treasury (RCW 70.146). The purpose of the account is to provide financing of water pollution control facilities and activities.

clearing and grading practices
Clearing practices refer to the destruction or removal of vegetation from a site by physical, mechanical, chemical, or other means. Grading practices refer to any excavating or filling of earth materials or natural covers.

cluster development
A development design technique which groups buildings on one part of a site so as to preserve another part of the site for common open space, recreation, or preservation of environmentally sensitive areas.

comprehensive land use plans (comprehensive plans)
A plan adopted by the local government to guide the physical growth and improvement of a city or county, including any future amendments and revisions.

cooperative parking
A term to describe various methods to increase the use of available parking areas including shared, joint, and coordinated parking.

coordinated parking
Use of large commercial or retail overflow parking areas for park-and-rides or other parking needs.

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cumulative impact assessment
Cumulative impacts are the effects that accumulate over time and space from a series of similar or related individual actions, pollutants, or projects. Although each action may seem to have a minimal impact, the combined effect can be severe. A cumulative impact assessment studies and summarizes these impacts.

defensible space
The space around an individual that allows for a feeling of safety. The amount of necessary space to be considered defensible varies according to the situation. For instance, in a crowded elevator defensible space is less than in a parking lot.

density
The number of dwelling units per acre.

density credits
An increase in density provided to a developer or builder as a result of certain adjustments to the plan or layout of the development.

drainage basin (see watershed)
A land area bounded by high points, which drains all surface water into a single stream or other body of water.

drywell
A pit in the ground often filled with gravel into which stormwater is routed. The dry well holds the stormwater until it percolates into the ground.

effective impervious surface
The portion of impervious surface that generates stormwater runoff which must be managed or directed to a stormwater conveyance system, rather than infiltrating into the ground.

erosion
The wearing away of land surface by water, wind, ice or other chemical and mechanical forces, including human activities.

groundwater
Water stored underground that fills the spaces between soil particles or rock fractures. A zone underground with enough water to withdraw and use for drinking water or other purposes is called an aquifer.

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Growth Management Act (GMA)
Washington state law enacted in 1990 that requires local governments in rapidly growing counties to plan for the projected population. Growth management planning typically addresses land use, transportation, housing, economic development, open space, recreation, and environmental issues.

habitat
The specific area or environment in which a particular plant or animal lives. A plant or animal's habitat must provide all of the basic requirements for life.

Hydrologic Simulation Program - Fortran (HSPF)
A specific computer program which simulates (models) land surface and in-stream hydrology on a continuous basis.

hydrology
The science of the behavior of water in the atmosphere (air), on the surface of the earth, and underground.

homeowner association covenants
A binding agreement or contract between a group of homeowners that typically contains criteria for behavior and home appearance in a subdivision.

impervious surface
Any surface which cannot be effectively (easily) penetrated by water. Examples include pavement, buildings, and compacted soils.

Impervious Surface Reduction Study (ISRS)
A study administered by the City of Olympia to recommend strategies for the reduction of impervious surfaces.

infill
Developing vacant parcels or redeveloping existing property to achieve higher density in urban areas as an alternative to development in outlying rural areas.

infiltration
The downward entry of water into the surface of the soil, as contrasted with percolation which is movement of water through soil layers.

infrastructure
The basic facilities needed for the functioning of a city or county, or other system. Examples include roads, schools, and hospitals.

in-lieu-of-parking fees
A mechanism to place money into a parking improvement fund administered by a city, county, or other governing body. Offered as an option to developers instead of furnishing required parking spaces.

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interconnected streets
A street system that allows traffic to circulate between neighborhoods instead of a system of cul-de-sacs and dead end streets that results in disconnected residential areas. A grid pattern of blocks is a typical example.

interstices
Portions of generally impervious material that facilitate the movement of water into the soil.

joint parking
Mutual use of a parking area at multi-tenant retail and commercial facilities.

local access streets
Streets that provide passage between adjacent land uses and carry local traffic to collector streets.

local governments
The governing organizations of cities and counties.

local jurisdictions
The governing organizations with legal authority over specific territories, including but not limited to cities and counties. For example, the Port of Olympia or Thurston County Conservation District.

major collector streets
Streets that connect arterials to residential and commercial areas.

model agreements
Examples of written agreements that include sample language and content.

neighborhood collector streets
Streets which collect (or distribute) traffic within a neighborhood and provide connections to an arterial or major collector. They serve neighborhood traffic and also provide access to abutting land uses. Streets designed to be compatible with residential neighborhoods and neighborhood commercial centers.

needs assessment
A survey to determine the requirements or desires of a particular audience.

North Thurston County Urban Growth Management Area (North Thurston UGMA)
The area designated by Thurston County pursuant to RCW 36.7A.10. Includes land area sufficient to accommodate the urban growth projected to occur in the northern part of the county over the next 20 years.

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offstreet parking
Any parking areas not on the street, including parking lots and parking garages.

open space
Any parcel or area of land or water essentially unimproved and set aside, dedicated, designated, or reserved for public or private use or enjoyment. These lands may include but are not limited to wetlands; wetland buffers; creek, stream or river corridors; forested areas; ravines, bluffs or other geologically hazardous areas; and undeveloped areas within existing parks or neighborhoods.

ordinance
A statute enacted by a government, such as the parking ordinance approved by Olympia's City Council and codified in the Unified Development Code.

organic mulches
A material derived from plant or animal matter used to enrich or amend a soil.

parking ratios
Parking required for a particular land use, stated as a ratio of "x" spaces per "y" units. Typical units are square footage, dwelling units, persons, and seats.

pavers
Concrete grid and modular pavement whose spaces are filled with pervious materials such as sod, sand, or gravel.

peak-day projections
Projections of parking demand during the day and time of highest use. Commonly used to determine the number of parking stalls needed for individual land uses.

performance-based standards
Technical standards for operation or appearance that are based on meeting objectives rather than specific sizes, widths, or other detailed requirements.

permeable
A type of soil or other material that allows passage of water or other liquid.

pervious
A soil or material that has the specific quality of allowing the passage of water or other liquid.

Planned Residential Developments (PRDs)
A type of development characterized by comprehensive planning for the project as a whole, clustering of structures to preserve usable open space and other natural features, and a mixture of housing types within the prescribed densities.

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Planned Unit Developments (PUDs)
Similar to Planned Residential Developments except they can include a commercial land use component along with the residential land uses.

plat map
A map showing the division of a tract or parcel of land into lots, blocks, streets and alleys, or other divisions or dedications.

policies
A course of action adopted by local jurisdictions or organizations.

pollutants
A chemical or other additive that adversely alters the physical, chemical, or biological properties of the environment.

porous pavement
Asphalt or concrete paving material consisting of a coarse mixture cemented together with sufficient interconnected voids to provide a high rate of permeability.

recharge
Infiltration of surface water to groundwater.

regulations
A particular set of laws, rules, or procedures designed to govern a particular type of activity or solve a particular problem.

retrofitting
To provide or add new equipment, parts, or techniques unavailable at the time of original construction.

runoff (see stormwater runoff)

setback
A zone or distance between buildings and the lot line designated to protect areas or neighboring activities from negative impacts associated with development.

shared parking
Mutual use of a parking area by land uses with noncompeting hours of operation, such as a theater and office building.

siltation
The process by which a river, lake, or other body of water becomes clogged with excess soil or sediment.

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sprawl
Haphazard, dispersed, or spread-out growth. Commonly refers to urban sprawl which is the spread of cities into rural areas.

standards
A regulation that contains specified amounts, widths, or sizes for streets, buildings, or other development.

stormwater conveyance
A system of gutters, pipes, or ditches used to carry stormwater from surrounding land areas to constructed or natural drainage systems.

stormwater facilities
Private or public infrastructures designed to collect, treat, and/or store rainfall and runoff.

stormwater runoff
Rain that flows off the surface of the land without entering the soil.

stormwater treatment
Mechanical, chemical, or biological removal of pollutants from stormwater runoff.

stormwater utility
A public service program to manage stormwater and collect fees to pay for such management.

surface water
Water on the surface of the land that has not infiltrated the soil including streams, lakes, rivers, and ponds.

sub-soil
Layers of soil beneath the surface layer (topsoil).

sustainability criteria
Criteria used to gauge the effectiveness of projects, plans, and new regulations in achieving a sustainable community. A sustainable community is one that persists over generations and is far-seeing enough, flexible enough, and wise enough to maintain its natural, economic, social, and political support systems.

swales
A shallow drainage ditch with relatively gentle side slopes, generally with flow depths less then one foot.

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technical assistance
A combination of information, education and training activities that provide specific audiences with "face to face" learning and skill building opportunities. Often linked with a regulatory program as an incentive for compliance.

topsoil
The fertile layer of soil at the surface of the ground.

Uniform Building Code (UBC)
A Washington state code that regulates building practices.

variance
A license to engage in an act contrary to law.

watershed (see drainage basin)
The geographic region within which water drains into a particular river, stream or body of water. A watershed includes hill, lowlands, and the body of water into which the land drains. Watershed boundaries are defined by the ridges of separating watersheds.

water table
The upper surface of groundwater or the level below which the soil is saturated with water. The water table indicates the uppermost extent of groundwater.

wellhead protection areas
A protected surface and subsurface zone surrounding a well or wellfield supplying a public water system. Used as a planning tool to keep pollutants from reaching the well water.

wetlands
Habitats where the influence of surface or groundwater has resulted in development of plant or animal communities adapted to aquatic or intermittently wet conditions.

zero lot line
The location of a structure on a lot in such a way that one or more sides of the structure rests directly on the lot line.

zoning
A set of regulations and requirements governing the use, placement, spacing, and size of land and buildings in a specific area (zone).

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APPENDICES

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APPENDIX A
PUBLIC INVOLVEMENT AND EDUCATION PLAN

January 27, 1994

A. Goal

To identify and gain community and local government support for impervious surface reduction recommendations resulting from the study.

B. Objectives

1. Provide a broad array of forums for clarification and integration of the community's vision, interests, needs, concerns, and ideas.
2. Build on the existing cooperation and coordination among local jurisdictions.
3. Enhance private and public partnerships.
4. Involve all affected parties in such a way that technically and politically feasible recommendations are generated.

C. Recommended Activities

1. Needs Assessment

A needs assessment would be used to identify public involvement and education strategies suitable for reaching the goal. A secondary outcome of the needs assessment would be identification of barriers and incentives for implementation of the recommendations.

The assessment would consist of informal surveys of individuals, organizations, and local jurisdiction and agency representatives affected and involved in development activities and resource management. Examples of survey questions include:

a. Do you believe impervious surfaces pose a problem or problems? If so, what do you see as the problem or problems?

b. Do you see reducing impervious surfaces as beneficial?

c. How can reducing future amounts of impervious surface in developed areas benefit you?

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d. What do you see as the barriers to reducing the amount of impervious surface?

e. What incentives would help overcome these barriers?

f. What would entice you to be involved in a model demonstration project that tests some new techniques and policies for reducing impervious surfaces?

g. How do you like to have information shared with you?

2. Community Strategies

a. Mailing and Contact Lists: As a basis for broad-based community involvement and education activities, mailing and contact lists of interested individuals and local, regional, and state-wide associations and groups representing the business and development community would be created. These lists would be used to schedule project briefings and presentations, send mailings, and build community interest and participation in the study. Sources include the Operation: Water Works landscaping and construction lists; referrals from permit counters in all four jurisdictions; business licenses; and others. The lists would be separated into primary and secondary levels of contact.

b. Visual Tools: Three or four visual tools would be developed to aid in the dissemination of information. Possible tools include slideshows, displays, schedule boards, three-D models and architectural renderings, photo albums, and a training video.

c. Briefings: Six to eight briefings would be provided to community and business groups, professional organizations, and local governments to introduce and spark interest in the study.

d. Multi-Media Presentations: More detailed presentations would be provided as a follow-up to the briefings or to reach additional audiences. These presentations also could serve as a forum for the needs assessment and for sharing community responses and opinions.

e. Workshops and Community Forums: At least two workshops or community forums would be convened to review the recommendations and the study's policy implications. These forums would target the business and development community and local jurisdictions to solicit reactions to the technical and economic feasibility of recommendations. The January 6 Community Forum is one of these meetings.

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f. Tours and Open Houses: There currently exist examples of housing, landscaping, and commercial development where alternative strategies for reducing impervious surfaces have been used. In addition, the demonstration projects will provide an excellent opportunity for education (see No. 4 below). One or two tours or an open house co-sponsored by the development community for peers, elected officials, and planning and development staff from local jurisdictions would be organized. These events would encourage discussion concerning the benefits and constraints of alternative strategies, brainstorming innovative approaches, and viewing of the demonstration projects during construction.

g. Public Events and Conferences: Linkages with other jurisdictions and the business and development community would be expanded by participating in two or three public events and/or conferences. In particular, we would contact the Olympia Master Builders, the local Chambers of Commerce, and Thurston County concerning opportunities for linkages.

h. News Releases, Articles, and Interviews: Three or four news releases would be submitted to business publications and local papers. The purpose would be to inform affected parties and generate participation in the demonstration projects and study. Media coverage also would be used to acknowledge participation in demonstration projects and announce training on the new policies and techniques.

i. Recognition: Plaques or certificates would be presented to businesses participating in the demonstration projects. Signs also would be placed at the project site(s) to acknowledge participation. Over the long-term, notices to realtors also would be used to acknowledge homes or commercial construction projects that integrate the new policies and techniques.

3. Technical Assistance

a. Demonstration Project Training: One training workshop would be provided to those contractors, developers, and other private sector partners in the demonstration project(s) (see No. 4 below). This training would serve as a model for future training (see "c" below). Evaluations would be conducted to determine what worked and didn't work about this training.

b. Technical and Policy Assistance Materials: A packet of materials would be developed that explains the technical requirements of incorporating alternative strategies into proposed site and building plans, and the

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policy changes that occurred and are recommended as a result of the study. Permit counter staff at the four local jurisdictions and key development community representatives would be invited to help develop training materials.

c. Training Workshops: Two training workshops would be offered to present the technical and policy assistance materials and encourage implementation of the study's final recommendations "on-the-ground." The development community would be invited to co-sponsor the training. A video or slideshow of the demonstration projects would be used to demonstrate the steps taken. Tours of the completed projects, a photobook of "desirable" architecture and landscaping, and 3-D renderings of alternative designs also could be included as part of the training. Training would emphasize the do-ability and cost-savings of the new policies and techniques.

4. Demonstration Projects

At least one demonstration project would be constructed that tests some of the alternative development techniques recommended in the study. In order to meet the time constraints of the Centennial grant, the project would most likely consist of an existing proposal that is modified to include some alternative techniques. Project staff are currently soliciting model project proposals and will be selecting one or more projects during January 1994, with the assistance of the Ad Hoc Citizen Advisory Committee and Steering Committees.

5. Dissemination of the Results

a. Professional Presentations and Papers: Information would be disseminated to other jurisdictions who may be interested in the study's results and replication of the project. Staff would present a paper at one regional conference. Staff also would look for opportunities to submit articles to professional journals and present at additional conferences, water resource forums, workshops, and meetings. The emphasis of the presentations and papers would be the integration of impervious surface reduction into a sustainability criteria framework, and tools and strategies for planners, architects, landscape architects, and developers.

b. Local, Regional, and National Publications: Professional organizations' publications would be used to invite study involvement and spread the word about the study's results. In printing of brochures, fact sheets, the final report, or other materials, we would print an additional 50 of each for distribution to other jurisdictions and advertise within at least two

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professional publications the availability of the materials. Possible publications include Soundwaves and Puget Sound Notes.

D. **Public Involvement and Education Plan Evaluation**

Several forms of evaluation would be used, including written workshop evaluations, levels of participation and support for the project, implementation of the study's recommendations, and requests for information. In addition to evaluating completion of the activities listed under section "C" above, measures of evaluation could include:

a. at least 1,000 people informed of the study through briefings, presentations, etc.

b. demonstration project(s) that include private-public partnerships

c. at least five site plans integrating results of the study submitted to Olympia during 1995

d. at least 20 people involved in the training(s)

e. results of evaluation forms from training(s) indicate training was useful

f. at least 75 percent of the study's recommendations adopted by Olympia and 50 percent by the other local jurisdictions

g. at least 10 jurisdictions request study results

h. at least one letter of support for the study received from a leading business organization

i. support of the Ad Hoc Citizens Advisory Committee and Steering Committee members for the study's recommendations

E. **Schedule**

The schedule for implementation of the Public Involvement and Education Plan will change within the next few months to reflect Ad Hoc Citizens Advisory Committee and Steering Committee input, and results of the needs assessment. The tentative schedule as of December 1993 is:

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November and December 1993:

- develop PIE plan proposal and submit to committees for review
- create mailing and contact lists
- prepare and begin briefings
- begin to develop project "identity" with graphics staff
- refine needs assessment strategy

January-March 1994:

- conduct needs assessment
- finalize PIE plan and submit to Ecology for approval
- identify recommendation implementation strategy with Ad Hoc Committee
- select demonstration project(s) and submit to Ecology for approval
- continue with briefings
- develop and conduct presentations
- solicit participation in demonstration project(s)
- develop training materials and provide training
- advertise study and encourage involvement (events, news releases, etc.)

April-June 1994:

- erect signs at demonstration project(s)
- conduct tours of demonstration project(s)
- continue to give presentations and solicit involvement
- identify possible publication and presentation opportunities

July-September 1994:

- revise recommendations based on demonstration project(s) and additional public input
- hold tours or open house of demonstration project(s)
- present at regional conferences and other forums

October-December 1994:

- prepare draft final report and solicit public review and comments
- evaluate PIE plan and demonstration project(s) for final report
- award plaques and certificates to demonstration project(s) participants
- present at regional conferences and other forums
- publish study results

January-March 1995:

- submit final report to Ecology for approval
- publicize and disseminate study results and information

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APPENDIX B
NEEDS ASSESSMENT

July 1994

OVERVIEW

The purpose of the Impervious Surface Reduction Study (ISRS) needs assessment was to identify communication tools and incentives appropriate for reducing impervious surfaces. A secondary purpose was to inform members of both the public and private sectors of our community about the study. The assessment results have been incorporated into the ISRS public involvement and education strategy and will help guide technical assistance activities.

The informal assessment was conducted over a three-month period (January through May 1994). Forms were distributed at events to some members of the community and mailed to others. The form was slightly changed after it was initially distributed at the ISRS Community Forum in January 1994. The form was distributed at the following events:

- ISRS Community Forum (January 6)
- Olympia City Council meeting (March 22)
- Lacey Chamber of Commerce, Monthly Membership Meeting (April 6)
- American Society of Civil Engineers, Seattle Chapter Monthly meeting (April 21)
- Olympia Community Planning and Development staff meetings
- Various individual development and business community briefings
- ISRS Steering and Ad Hoc Citizen Advisory Committee meetings

RESULTS

Of the approximate 125 forms distributed, 41 (33 percent) were returned. Responses are summarized according to three groupings: (1) all respondents; (2) private sector respondents; and (3) public sector respondents. Responses by all the respondents to Questions 1 through 7 are summarized in Attachment A, Results Summary. Responses to Question 8 are summarized separately for the private and public sector and also are part of Attachment A. Private and public sector responses to Questions 3 through 7 are summarized in Attachment B, Tables 1 through 3.

Survey responses indicate that, with the exception of tours and field trips, technical assistance and education tools for the public sector may not be suitable for the private sector. However, newspapers are a good media format for reaching both

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sectors. The survey results also indicate that the public sector is more willing to participate in demonstration projects than the private sector. Responses indicate that the private and public sectors agree on the incentives for participating in demonstration projects: training, streamlined permit process, and reduced development costs.

Questions 1 and 2: Characteristics of Respondents

Twenty-six (63 percent) of the 41 returned forms were from members of the private sector, and 15 (37 percent) were from the public sector. Nineteen occupations were represented. Each occupation category had at least one respondent. "Engineer" was the occupation best represented, with 12 (29 percent) respondents in this category.

Question 3: Technical Assistance and Public Education Tools

Table 1, Attachment B, summarizes the responses to Question 3. Tours and field trips were ranked high by all three groupings, while presentations and speakers were ranked low by all three groupings. The private and public sector respondents felt differently about some tools. The responses indicated that guidebooks, technical manuals, and one-on-one technical assistance are helpful tools for integrating ISRS recommendations into private sector activities, while demonstration projects and visual media are not very helpful. The responses also indicate that for the public sector, demonstration projects and visual media are helpful, while publications, seminars and training, guidebooks and technical manuals, and one-on-one technical assistance are not very helpful.

Question 4: Media Formats

Table 2, Attachment B, summarizes the responses to Question 4. There was more consistency among the private and public sector responses to Question 4 than to Question 3. Newsletters and newspaper articles were ranked "high" for reaching the respondents to the survey. Newspaper announcements were also ranked "high" by the private sector, but were ranked medium by the public sector. Television was ranked "low" by both sectors. Radio was ranked "medium" by all respondents and the private sector respondents, and ranked "low" by the public sector.

Questions 5a and 5b: Publications and Stations

The responses to Questions 5a and 5b were many and varied, indicating that there is no one newspaper, magazine, newsletter, television or radio station that will reach all respondents. However, most respondents did mention *The Olympian* newspaper. The most frequently given responses are listed in Attachment A.

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Question 6: Presentation or Publication Opportunities

The varied responses to Question 6 are summarized in Attachment A.

Questions 7a and 7b: Participation in Demonstration Projects

The responses given by all respondents to Question 7a are summarized in Attachment A. Responses to Question 7b are grouped according to all respondents, private sector, and public sector and are summarized in Table 3, Attachment B.

Question 7a

Out of the 34 respondents who answered Question 7a, 6 (18 percent) indicated a definite interest in participating in demonstration projects. Another 19 (56 percent) indicated they may be interested in participating, and 9 (26 percent) indicated they definitely are not interested. Of the six positive responses, three were from the private sector and three from the public sector. Of the 19 "maybe" responses, 12 (63 percent) were from the private sector and seven (37 percent) from the public sector.

Question 7b

The private and public sector respondents ranked incentives for participating in demonstration projects the same. Highly ranked incentives include training in alternative techniques, streamlined permit process, and reduced development costs. Medium-ranked incentives include media coverage, signs, and sharing accomplishments with peers. Low-ranked incentives include plaques or awards, and letters of appreciation.

Question 8: General Ideas and Recommendations

The responses to Question 8 are summarized according to the private and public sectors in Attachment A.

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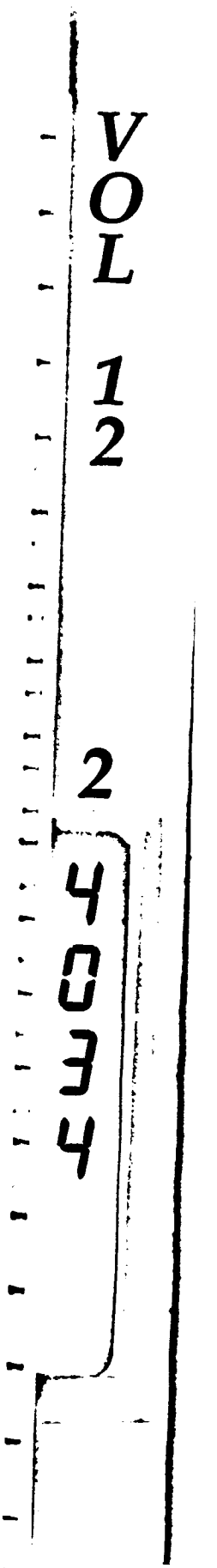

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APPENDIX C
FACT SHEETS

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IMPERVIOUS SURFACE REDUCTION STUDY

City of Olympia Public Works Department • P.O. Box 1967 • Olympia, WA 98507-1967

FACT SHEET #1: STUDY OVERVIEW

Why Study Impervious Surfaces?

As the North Thurston urban region continues to grow, impervious surfaces such as streets and parking lots will also increase. With increasing amounts of impervious surfaces, we also increase flooding and erosion problems, decrease recharge of our groundwater and drinking water supplies, and degrade fish and wildlife habitat of our local streams and lakes. Local development practices aim to reduce these impacts, but fail to address a key source of the problem—impervious surfaces.

Goal Of The Study?

The goal of the Impervious Surface Reduction Study is:

"...to identify and gain community support for development techniques and policies that result in increased stormwater treatment and groundwater recharge without causing appreciable increases in development costs."

Benefits Of The Study?

Successful completion of the study will result in the following community benefits:

- Policy and regulatory changes that result in less impervious surfaces in the North Thurston Urban Growth Management Area.
- Construction of innovative projects that model the effectiveness of techniques and policies identified by the study.
- Technical information and training provided to the development community that makes incorporation of the new techniques and policies easier and more cost effective.

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Project Schedule And Major Tasks?

The project began in Spring 1993 and will be completed Spring 1995. Major tasks include:

- Analysis of technical and policy issues related to impervious surfaces.
- Development of recommendations to reduce the amount of impervious surfaces.
- Construction of demonstration projects that test recommendations.
- Involvement and education of the local community.
- Sharing of the study's results.

Who Participates In The Study?

The study is being guided by both steering and citizen advisory committees. These committees are composed of neighborhood, development, and business representatives, and natural resource management experts from both the public and private sectors of the local community.

The City of Olympia's Public Works Department Water Resources Program provides project leadership with support and participation from Lacey, Tumwater, and Thurston County. Funding is provided by the Washington Department of Ecology through a Centennial Clean Water Fund Grant and by Olympia residents through their Storm and Surface Water Utility.

How Can You Get Involved?

You are invited to:

- Review and comment on products and reports of the study.
- Become a demonstration project partner.
- Participate in technical assistance and training.
- Call Cedar Wells (753-8454 or 753-8598, 24-hour line) for more information.

Cedar Wells Study Coordinator • City of Olympia Public Works Department • Water Resources Program • (206) 753-8454 • (206) 753-8598 (24-hour)

City of OLYMPIA

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IMPERVIOUS SURFACE REDUCTION STUDY

City of Olympia Public Works Department • P.O. Box 1967 • Olympia, WA 98507-1967

FACT SHEET #2: STRATEGIES FOR REDUCING PARKING

Why Reduce Parking?

Parking lots provide an important opportunity to reduce impervious surfaces—those hard surfaces that don't let water soak through to the ground. The more commercial and multifamily development you have in your watershed, the more important it is to reduce parking to achieve the goal of reducing impervious surfaces.

For example, parking lots cover approximately 53 percent of commercial sites and 15 percent of multifamily sites in the Olympia area. Reducing Olympia's commercial parking by 20 percent can reduce the impervious surface by almost 11 percent per site.

Shifts In Thinking

Parking policies have traditionally adopted the "bigger is better" view of parking lots. Regulations have focused on providing enough parking to avoid traffic congestion or overflow into residential neighborhoods, but have resulted in too much parking in some cases. Although smaller parking lots reduce development costs, developers need to provide adequate parking for customers and tenants. Parking lots can be reduced in creative ways that are good for both business and the environment.

Strategies For Local Jurisdictions To Reduce Parking

<u>Make reduction of impervious surfaces a goal of parking policies and regulations.</u>
Use site plan reviews and policy revisions as opportunities for addressing the problem of excess parking.

<u>Establish parking requirements that accurately reflect parking needs for various land uses.</u>
Typically, parking regulations are based on artificially low "minimum" parking ratios that do not accurately reflect parking needs. Developers have built up to 51 percent above these ratios in the Olympia area. Parking regulations should accurately reflect parking needs for various land uses and be based on a high average use—instead of single peak day projections.

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Strategies (continued) Suggested ways to accomplish this goal include:

- Establish "median" parking ratios that reflect parking needs.
- If "minimum" ratios are used, establish "maximum" ratios in conjunction with minimums.
- Encourage the use of transportation demand management techniques as an alternative to exceeding "median" or "maximum" ratios.

Establish cooperative parking regulations to reduce impervious surfaces.

Smaller and fewer parking lots can result from cooperative parking. Developers and local jurisdictions can reduce the size of parking lots through shared, joint, or coordinated parking.

- Shared parking reduces the parking area for land uses with noncompeting hours of operation. Suggested parking reductions are a 100 percent reduction of the smaller parking requirement for complimentary daytime and nighttime land uses, and 50 percent of the smaller parking requirement for land uses with some overlap of hours.
- Joint parking reduces the total parking area required for multi-tenant retail and commercial facilities. The possibility of captured trips and increased overflow parking allows for overall reductions for each land use at these facilities. Suggested parking reductions are 10 percent for developments with two buildings and 25 percent for developments with three or more buildings.
- Coordinated parking reduces the total parking area by using large retail or commercial overflow parking for safe, convenient Park and Ride locations.

Water Resources Program mission:
To provide regional leadership towards a sustainable community by ensuring the protection and enhancement of Olympia's water resources.

This study is funded by the Department of Ecology through a Centennial Clean Water Fund Grant and Olympia residents through their Storm and Surface Water Utility.

Cedar Wells Study Coordinator • City of Olympia Public Works Department • Water Resources Program • (360) 753-8454 • (360) 753-8598 (24-hour)

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IMPERVIOUS SURFACE REDUCTION STUDY

City of Olympia Public Works Department • P.O. Box 1967 • Olympia, WA 98507-1967

FACT SHEET #3: GUIDANCE FOR USING ALTERNATIVE SURFACES

Impervious Surface Reduction Hits The Streets!

Olympia's Water Resources Program is conducting an Impervious Surface Reduction Study (ISRS) to identify alternatives to hard, water resistant surfaces such as asphalt, concrete, and compacted soils. Impervious surfaces block rain from recharging our groundwater and drinking water supplies, increase the potential for flooding and erosion, and contribute to the degradation of our local streams and lakes.

'Perkin' To The Ground...Helps Puget Sound!

As long as we depend on cars, we will need roads, streets, and driveways. Asphalt and concrete are the most common types of driving surfaces, but are very impervious (hard and water resistant). Alternative surfaces are more pervious than asphalt or concrete. Some let a little rain seep (infiltrate) into the ground, while others let 100 percent of the rain infiltrate. The more rain we infiltrate, the less runoff we create. The less runoff, the fewer pipes and storage systems we need to build in order to prevent flooding.

Types of Alternative Surfaces

Alternative surfaces include paving blocks, plastic matting, gravel, bark, and similar materials.

Paving Blocks: Interlocking, high-strength blocks made of cement or recycled plastic with open areas for grass or gravel are commonly referred to as paving blocks. These blocks are typically set on a compacted base of sand or a mix of sand and gravel. No mortar is required. Sand is vibrated into the space between the units causing them to interlock and form a tough, attractive surface that provides easy access to underground utilities. Their structural behavior and load spreading ability is similar to asphalt. These systems can be a solution for highly used lawn areas, overflow or low use parking areas, or emergency access roads. They support fairly heavy traffic and concentrated loads, reduce stormwater runoff, enhance groundwater recharge, and increase infiltration.

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Types of Alternative Surfaces (Continued)

Plastic Matting: This type of system is usually a form of easily laid locking tiles made from recycled rubber tires and PVC, permitting thick grass to grow up through holes in the matting. It is often used to create safer, more natural playground, recreational, and sport surfaces, and can be an excellent application for pedestrian walkways. It typically infiltrates 100 percent and can be easily disassembled and relocated. Some plastic matting meets the Americans with Disabilities Act guidelines for wheelchairs.

Gravel, Bark, and Similar Materials: As long as these are placed over soil that is not already compacted, they will allow water to infiltrate back into the ground. Gravel, bark, and similar materials are practical for trails, bike paths, and walkways.

Where Can Alternative Surfaces Be Used?

Alternative Surfaces are appropriate for low traffic areas where there are few sources of pollutants, including:

- Fringe or overflow parking areas.
- Emergency parking and stopping lanes.
- Private roads, easement service roads, and fire lanes.
- Driveways in residential or light commercial zones.
- Bike paths, walkways, and patios.

Ways to Avoid Common Problems With Alternative Surfaces

There are some common problems that can arise if alternative surfaces are not installed and maintained properly. To avoid problems:

- Select the appropriate alternative surface to meet your objective (infiltration; reduce runoff, flooding, and erosion; aesthetics; soil stabilization; etc.).
- Locate paving blocks where they will not become clogged with dirt. If it is a new site, make sure the soil is stabilized before installing the blocks.

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Ways to Avoid Common Problems With Alternative Surfaces (Continued)

- Use alternative surfaces where there are few pollutants and where the water table is well below the ground surface. This will keep our groundwater and drinking water free from pollutants.
- Use alternative surfaces on gentle slopes and where the soils is porous or loose enough to let water soak in.
- Avoid using alternative surfaces for high-traffic walkways and handicapped parking areas. Select paving blocks or plastic matting with small holes and locate them in "low traffic areas."

How Much Do Alternative Surfaces Cost?

Material and installation costs for paving blocks are typically more expensive than conventional asphalt or concrete. However, some manufacturers or vendors will sell discounted seconds that are suitable for home use. Plastic matting is typically more expensive than asphalt, concrete, and paving blocks. When comparing prices, one must consider the costs associated with man-made stormwater systems, which in some cases can be reduced if alternative surfaces are used.

Where Can I See Alternative Surfaces On-the-Ground?

Public Locations: Thurston County Courthouse, Tumwater Historical Park, Cambridge Court Apartments, and South Puget Sound Community College.

Private Locations: Many homeowners in Thurston County have installed alternative surfaces in their driveways. Of three local residents interviewed, all thought their alternative surfaces work great!

Where Can I Purchase Alternative Surfaces?

Most building supply and home improvement stores carry a variety of paving blocks. Gravel, bark, and similar materials can be purchased from local dealers. See the attached for some sources. Please note that the list does not represent all possible sources. Homeowners and builders are encouraged to explore additional sources of these materials.

Water Resources Program Mission:
To provide regional leadership towards a sustainable community by ensuring the protection and enhancement of Olympia's water resources.

This study is funded by the Department of Ecology through a Centennial Clean Water Fund Grant and Olympia residents through their Storm and Surface Water Utility.

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SELECTED SOURCES OF ALTERNATIVE SURFACES

Paving Blocks:

H.D. Fowler Company, 3011 Marvin Road, NE, Olympia, WA 98516
(360) 459-7300 Product: GeoBlock (concrete)

Mutual Materials Company, 3150 29th Avenue, SW, Olympia, WA 98501
(360) 357-3343 Product: Westcon Pavers, Turfstone (concrete)

Bayview Building Materials, 3520 Martin Way, Olympia, WA 98506
(360) 491-5440 Product: Holland-Stone (concrete)

Trendset Custom Pavers, 6820 176th Avenue, NE, Redmond, WA 98052
(206) 869-1632 Product: Eco-Stone*, Turfstone, Holland-Stone (concrete)

Local firms that are familiar with installation of paving blocks:

Sun & Rain Landscaping
(360) 866-9749

Organic Land & Water Works
(360) 754-4050

Western Washington Landscape Service
(360) 459-5711

Hulbert Landscaping
(360) 786-0486

Plastic Matting:

SiteLines, 626 128th Street, SW, #104-A, Everett, WA 98204
(206) 775-6822 Product: safety deck* (recycled plastic)

Gravel, Bark, and Similar Materials:

Holroyd Co. Inc., 828 Pacific Highway, SE, Olympia, WA 98503
(360) 491-2600 Product: gravel

Mike Todd Construction, Site Delivery Only
(360) 352-7412 Product: gravel, bark

Great Western Supply, 9418 Old 99 Highway, SE, Olympia, WA 98501
(360) 754-3722 Product: gravel, bark

Olympia Sand & Gravel, 1838 Carpenter Road, Lacey, WA, 98503
(360) 491-7777 Product: gravel

Alpine Sand & Gravel, 7141 Rixie Road, SE, Olympia, WA 98503
(360) 491-2822 Product: gravel

*Infiltrates 100 percent and meets ADA standards

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APPENDIX D
MODEL LEGAL AGREEMENT FOR SHARED PARKING

NOTE: What follows is a shared parking easement which is offered as an example of an agreement which may be acceptable to the City of Olympia under the provisions of Section 18.38.180 - Shared Parking Facilities of the Olympia Municipal Code. This is not to say that other methods and approaches would not be acceptable to the City of Olympia, however, such agreements need to be reviewed by the City Attorney's office.

EASEMENT FOR SHARED PARKING

WHEREAS, the parties to this easement wish to take advantage of the shared parking provisions of Chapter 18.38 of the Olympia Municipal Code.

1. For consideration of Ten Dollars ($10.00) paid in hand, present and future benefits to be derived by Grantor and other good and valuable consideration, receipt of which is hereby acknowledged, Grantor, _____ (Name),
doing business as _____ (Name),
hereby conveys and warrants to Grantee, _____ (Name),
doing business as _____ (Name),
its successors, heirs and assigns, a nonexclusive, perpetual easement for motor vehicle parking on the following described real property:

[Legal Description of Servient Estate]

situated in the City of Olympia, Thurston County, Washington for the benefit of Grantee's property described as:

[Legal Description of Dominant Estate]

situated in the City of Olympia, Thurston County, Washington.

Such parking easement shall be applicable only to the following parking lot(s) located on the above-described servient estate. *[Include a map or sketch of the lots or parking facilities applicable to this easement, should more than one exist upon the subject property.]*

SUBJECT TO THE FOLLOWING:

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1. This easement shall not be altered or terminated without the express written permission of the Director of Community Planning and Development of the City of Olympia or his/her designee.

2. Grantor covenants that there are ___(#)___ of motor vehicle parking spaces on the above-described property and that Grantor shall not decrease that number of parking spaces without the express written permission of the Director of Community Planning and Development of the City of Olympia or his/her designee.

3. Grantee shall post and maintain signage on the dominant and servient estates directing its customers and employees to parking.

4. Grantor may temporarily close the subject parking lot(s) for maintenance and repair. Cost of repair and maintenance shall be paid by _____ _____.

5. Neither Grantee nor Grantor shall change, alter or expand the use of their respective properties described above so as to require additional parking under the provision of the Olympia Municipal Code in excess of existing parking spaces without the express written permission of the Director of Community Planning and Development of the City of Olympia or his/her designee.

DATED this _____ day of _____, 199___.

GRANTOR

_____
(Signature)

_____
(Print Name)

GRANTEE

_____
(Signature)

_____
(Print Name)

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APPENDIX E
WORKSHOP EVALUATIONS

ECOBUILDERS GUILD EVALUATION RESULTS
January 23, 1995

There were 11 surveys (44 percent) returned at the presentation, and of those 11, seven were incomplete.

1. The following technical assistance and public education tools were rated as **High** (3 points), **Medium** (2 points) or **Low** (1 point) in their potential for helping integrate impervious surface reduction or water conversation strategies into new construction.

   - **Presentations and speakers (7 High, 3 Medium = 27 points)**
   - **Publications (brochures/fact sheets) (5 High, 2 Medium = 19 points)**
   - **Workshops, forums, open houses (5 High, 1 Medium, 1 Low = 18 points)**
   - **Demonstration projects (5 High, 1 Medium, 1 Low = 18 points)**
   - **Visual Media (slideshows/videos) (3 High, 4 Medium, 1 Low = 18 points)**
   - **Seminars and training (3 High, 3 Medium = 15 points)**
   - **One-on-one technical assistance (3 High, 3 Medium = 15 points)**
   - **Guidebooks, technical manuals (3 High, 2 Medium, 1 Low = 14 points)**
   - **Tours and field trips (1 High, 3 Medium, 2 Low = 11 points)**

2. The following media formats were rated as **High** (3 points), **Medium** (2 points), or **Low** (1 points) according to their potential to reach the participants.

   - **Newspaper announcements (4 High, 3 Medium, 1 Low = 19 points)**
   - **Newsletter articles (4 High, 3 Medium, 1 Low = 19 points)**
   - **Newspaper articles (4 High, 3 Medium, 1 Low = 19 points)**
   - **Radio announcements (2 High, 6 Medium = 10 points)**
   - **Local public access (TCTV) (2 Medium, 6 Low = 10 points)**
   - **Network television channels (1 Medium, 7 Low = 9 points)**

3.a. Specific publications listed that would effectively reach participants are listed as follows.

   - Newspapers, magazines and newsletters:
     The Olympian (5)
     Green Pages (4)

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EOC (4)
NW Ecobuilding Guild (2)
Cooper Point Journal
No Sweat News
Home Education Press
Co-Op
Energy Outreach Center
Washington Association of Realtors

3.b. Specific radio and TV stations that would effectively reach participants are listed as follows:

- Radio Stations:
  KAOS (6)
  KPLU (4)
  KMTT (2)
  KGY (2)
  KGBS
  KVOW
  KING

- TV Stations:
  KCTS channel 9

4.a. When asked if they would reduce the impervious surfaces associated with their next construction project as a result of this presentation, their answers were as follows.

- Yes (8)
- Not Sure (1)

Reasons given were as follows:

- Concerns for the earth
- Water resources concerns
- Groundwater/environmental protection
- Recharge the aquifer
- Control run off

4.b. When asked if they would modify the landscaping associated with their next construction project as a result of this presentation, their answers were as follows.

- Yes (3)

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- Not Sure (3)

Reasons given were as follows:

- Protect and/or preserve water resources
- Protect and/or preserve groundwater
- Easy maintenance
- Conserve water
- Protect and/or preserve Mother Earth

5. When asked what changes, additions or improvements would be recommended for presentation, the following responses were recorded.

- Survey bad idea, too long.
- A video or a slide show of completed projects would be helpful.
- Excellent!
- No changes (2)

6. Sharing of general ideas they had concerning impervious surface reduction or landscaping for water conservation.

- It's all pretty new to me.
- Get this info to the real estate industry.
- More workshops and education!

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APPENDIX E

EXPLORING AND UNDERSTANDING SOILS
WORKSHOP EVALUATION
March 11, 1995

1. **Did you learn any new facts or get any new ideas that will be helpful on your job?** Certainly did 9 Probably did 3 Maybe 0 Not at all 0

2. **What information or activities were the most useful?**

   (5) Soil terminology; water molecule movement characteristics; review of soil creation/setup; better understanding of soil formations; soil structure and physics

   (4) Hands on soil comparison examples; texturing; on hand soils

   (3) Discussion of what participants could do in field; discussion after lunch; "round robin" discussion of residential stormwater treatment

   (2) Good overall; all

   (1) Field trip
   (1) Learned a lot to look into and seek out more information than what I knew before
   (1) Slides were great and overheads were useful but out and out boring
   (1) Product demonstration was great and more of this would be useful
   (1) Sheet spreader

3. **Was there enough opportunity for questions and participation?**
   Too much 0 All that was needed 11 Should have been more 1

4. **How did you hear about the workshop?**
   Work 3 Direct mailing of flyer 7 Friend 2

5. **What suggestions do you have for future workshops (content, techniques, materials)?**

   (3) More discussion of solutions to dealing with different types of soils, i.e., what to do if you have X soil type on Y soil; since I'm new, I felt that some of the individuals in the room had input that would be useful to the city, contractors exploring new avenues to see if they work over time; expand time frame to slightly to allow more enforcement/private sector interaction

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(1) More hands on equipment per person, and more in depth and guided soil [tax] program
(1) Wastewater treatment, native vegetation, and sources for landscaping, wildlife enhancement, and erosion control
(1) Lower calories of lunch
(1) Would like more decompaction information

Note: Six evaluations didn't contain a response to this question.

6. **Please evaluate the quality of the following based on your expectations, using a scale of 1 (poor quality) to 5 (excellent quality).**

Average Score		#Score and (Number of Responses)
4.25	Day and time of the workshop	#1 (0) #2 (0) #3 (3) #4 (3) #5 (6)
4.33	Workshop location	#1 (0) #2 (0) #3 (2) #4 (4) #5 (6)
4.25	Handouts and materials	#1 (0) #2 (0) #3 (1) #4 (7) #5 (4)
4.28	Field trip and presentation	#1 (0) #2 (1) #3 (0) #4 (2) #5 (4)
4.58	Classroom presentation	#1 (0) #2 (0) #3 (1) #4 (3) #5 (8)
4.83	Instructor(s)	#1 (0) #2 (0) #3 (0) #4 (2) #5 (10)
4.42	Overall quality of the workshop	#1 (0) #2 (0) #3 (0) #4 (7) #5 (5)

7. **Additional comments or suggestions?**

- As I mentioned, I really liked the informal discussion that developed about what some of the participants had done on their own projects in the field. Incorporating and expanding on this part may be a useful and interesting addition.
- Follow ups or further information dealing with soil in regards to construction and water (wells).
- Good lunch delivery company.
- Usually I fill a sheet with suggestions, but frankly, I can't think of any!
- Erosion control techniques could be expanded with more solicited input from contractors on their needs.
- Materials and content excellent. Facility, directions, and service very good.

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APPENDIX F
PARKING AND INFORMATIONAL SURVEY

September 26, 1994

PARKING SURVEY

Type of unit/address?

Date and time of observation?

Number of parking spaces?

Number of parking spaces occupied?

Interviewee's name?

Job title?

Length of time employed?

How long has the business been at this location?

1. How does the amount of parking work for you and your tenants/customers?

   Too little? Too much?

2. What is your experience with employee parking?

   Adequate, too much, too little?

3. Do any other people, besides employees or customers, use your parking lot?

   How do you feel about this use? Problem/no problem?

   Is this a formal arrangement? With whom? Copy of agreement?

   Can we add you to our mailing list for shared parking survey?

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APPENDIX G
PARKING FIELD SURVEY DATA RESULTS

September 26, 1994

TS = total parking spaces on site
%TS = percent of total spaces occupied by maximum cars

RESIDENTIAL/LODGING

Apartments

Peak Hours: 6:00 a.m., 10:00 p.m. weekdays,
6:00 a.m., 10:00 p.m. weekends

Breckenridge Apartment Homes
2820 Tuscany Lane, SW
Tumwater

TS = 420 with 36 garages assumed full
Maximum Cars = 283 %TS = 67%
Average Cars = 275

Site visits: Date-Time-Count
8/5-6:00 a.m.-275; 8/6-6:30 a.m.-264;
8/8-11:00 p.m.-283; 8/9-6:00 a.m.-279

Comment: 2 vacancies
Location: 3 years
Manager: 3 years

Responses to Survey Questions:

1. Adequate number of spots but located in places that the tenants won't use (around the clubhouse and office); so often forced to tow visitors and threaten tenants parking in fire lanes and nondesignated parking areas. Felt that this was a site plan problem that has developed into a concept of inadequate parking.

2. Adequate parking for employees.

3. No other parking in lot.

The Crowne Pointe Apartments
2800 Limited Lane, NW
Olympia

TS = 275 with 14 garages assumed full
Maximum Cars = 187 %TS = 68%
Average Cars = 180

Site visits: Date-Time-Count
8/5-6:00 a.m.-167; 8/6-6:00 a.m.-180;
8/8-10:30 p.m.-187; 8/9-5:30 a.m.-184

Location: 7 years
Manager: 3 years

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Responses to Survey Questions:

1. Adequate spots, but inadequate site plan for actual use. Guests won't park in visitor spots located around the clubhouse when visiting apartments up the hill.

2. Adequate parking for employees.

3. Other than previously mentioned visitor problem, no others use the parking lot.

Seniors

Peak Hours: 8:00 a.m., 5:00 p.m. weekdays
10:00 a.m., 6:00 p.m. weekends

Casa Madrona
3948 Martin way E
Olympia

TS = 37
Maximum Cars = 29 %TS = 78%
Average Cars = 26

Site visits: Date-Time-Count
8/5-7:45 a.m.-26; 8/6-7:00 a.m.-24;
8/8-9:00 p.m.-29; 8/9-6:30 a.m.-26

Location: 20 years
Manager: 2 years

Responses to Survey Questions:

1. Barely adequate for tenants, currently more senior drivers than ever before, but the visitors that this population requires (visiting nurses, chore workers, relatives, etc.) have no parking provisions. They are parking regularly in fire lanes.

2. No onsite employees.

3. Service providers and family members, but no shared parking with other facilities.

Mobile Home/Trailer Parks

Peak Hours: 7:00 a.m., 7:00 p.m. weekdays
10:00 a.m., 9:00 p.m. weekends

De Tray's - Colonial Estates
3700 Elizabeth Avenue
Olympia

TS = 221
Maximum Cars = 116 %TS = 53%
Average Cars = 114

Site visits: Date-Time-Count
8/5-6:20 a.m.-116; 8/6-6:45 a.m.-110;
8/8-9:00 p.m.-114; 8/9-6:00 a.m.-114

Comments: 18 extra spaces, 10 full
Location: 9 years
Manager: 3 years

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R0057347

Responses to Survey Questions:

1. Adequate spaces for parking.
2. No onsite employees.
3. No other people using parking facilities.

Single Room Occupancy — Peak Hours: 7:00 a.m., 7:00 p.m. weekdays; 10:00 a.m., 9:00 p.m. weekends

Six Mailboxes
403 Ninth Street
Olympia

Site visits: Date-Time-Count
8/8-7:00 p.m.-only street parking available

COMMERCIAL

Retail — Peak Hours: 10:00 a.m., 6:00 p.m. weekdays; 11:00 a.m., 4:00 p.m. weekends

Ernst Home Centers
3000 Pacific Avenue
Olympia

TS = 140 + 30-45 used as storage
Maximum Cars = 64 cars/30 storage
%TS = 46
Average Cars = 55

Site visits: Date-Time-Count
8/5-10:00 a.m.-47; 8/6-12:00 p.m.-64;
8/8-4:00 p.m.-56; 8/8-7:30 p.m.-54

42,000 square feet
Location: 18 months
Manager: 18 months

Responses to Survey Questions:

1. Not enough parking on busy weekends in spring. Currently negotiating for additional parking.
2. Employees have to park on the street during the spring peak hours.
3. No one else uses the parking lot, and they are not interested in exploring shared parking arrangements for parking increase.

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Furniture and Appliance Stores — Peak Hours: 10:00 a.m., 4:00 p.m. weekdays; 11:00 a.m.; 4:00 p.m. weekends

Desco Electronics Inc.
2306 Harrison Road, NW
Olympia (Westside)

TS = 15
Maximum Cars = 12 %TS = 80%
Average Cars = 10

Site visits: Date-Time-Count
8/5-1:00 p.m.-11; 8/5-4:00 p.m.-12;
8/6-10:30 a.m.-6; 8/6-3:00 p.m.-10

Location: 15 years
Owner: 15 years

Responses to Survey Questions:

1. Parking is adequate for customers.

2. Parking is a little inadequate for employees, they park in the nearby Westside Shopping Center. This is an informal arrangement between the shopping center and Desco.

3. No other people park in lot.

Hotels/Motels — Peak Hours: 12:00 p.m., 6:00 p.m. weekdays same for weekends

Westwater Inn
2300 Evergreen Park Drive
Olympia

TS = 380
Maximum Cars = 321+2 busses %TS = 85%
Average Cars = 285

Site visits: Date-Time-Count
8/6-10:30 p.m.-308; 8/8-9:00 p.m.-276;
8/6-7:00 a.m.-273 (dog show in lot)

Location: 27 years
Manager: 15 years

Responses to Survey Questions:

1. Adequate parking for hotel guests, but conflicts arise when there is a large banquet. Customers park in courthouse and nearby business parking lots and vice versa. Feels more parking and more enforcement is needed, though they have tried several solutions.

2. Adequate employee parking, but hard to enforce because the parking is so far away.

3. Courthouse customers and people visiting area businesses. There is no agreement that this can go on and is considered problematic.

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Comfort Inn Motel
4700 Park Center Avenue, NE
Lacey

TS = 65
Maximum Cars = 62 %TS = 95%
Average Cars = 58

Site visits: Date-Time-Count
8/6-8:00 p.m.-62; 8/8-9:00 p.m.-54

Location: 1 year
Manager: 3 months

Responses to Survey Questions:

1. Adequate parking.
2. Also adequate parking for employees.
3. No other parkers.

Markets, Shopping Centers, Large Retail Wholesale

Peak Hours: 12:00pm, 6:00pm and weekdays
10:00am, 4:00pm weekends

Top Food and Drug
1313 Cooper Point Road
Olympia

TS = 526
Maximum Cars = 286 %TS = 54%
Average Cars = 254

Site visits: Date-Time-Count

8/6-3:15 p.m.-286; 8/4-2:00 p.m.-242;
8/4-5:15 p.m.-233; 8/6-6:00 p.m.-253

Comments: Freeway construction removing spaces and recycling on others (20)
73,960 square feet

Location: 7 years
Manager: 2 years

Responses to Survey Questions:

1. Adequate parking.
2. Adequate parking, but rapidly reaching maximum capacity, especially during peak hours.
3. No other people use their parking lot.

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Best Products Co. Inc.
1120 Cooper Point Road
Olympia

TS = 211
Maximum Cars = 52 %TS = 25%
Average Cars = 40

Site visits: Date-Time-Count
8/6-3:15 p.m.-38; 8/4-2:15 p.m.-52;
8/4-6:00 p.m.-29

Comment: Continuous parking lot with furniture store
Location: 15 years
Manager: 9 years

Responses to Survey Questions:

1. Adequate parking, if necessary customers can overflow into surrounding lots.
2. No problems with parking for employees.
3. No other people use the lot.

Costco
5500 Littlerock Road
Tumwater

TS = 616
Maximum Cars = 365 %TS = 59%
Average Cars = 280

Site visits: Date-Time-Count
8/6-3:30 p.m.-365; 8/4-4:00 p.m.-241;
8/4-1:30 p.m.-233

Location: 3 years
Manager: 3 years

Responses to Survey Questions:

1. Adequate parking spaces.
2. Adequate employee parking.
3. No other people use the lot.

Medical and Dental Clinics

Peak Hours: 10:00 a.m., 3:30 p.m. weekdays
10:00 a.m., 1:00 p.m. weekends

Westcare Clinic
3000 Limited Lane, NW
Olympia

TS = 55
Maximum Cars = 32 %TS = 58%
Average Cars = 32

Site visits: Date-Time-Count
8/4-2:00 p.m.-31; 8/4-4:30 p.m.-32;
8/6-12:00 p.m.-32

Location: 4 years
Manager: 2 years

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Responses to Survey Questions:

1. Not enough parking. Customers complain during peak afternoon hours about lack of parking.

2. There are no designated employee parking spots, which could be part of the problem for customers.

3. Sporting events held in the school behind the building (Capital High School playing field) on weekends and evenings generate prohibited parking. There is no agreement about this parking.

Capital Medical Center
3900 Capital Mall Drive, SW
Olympia

TS = 335
Maximum Cars = 96 %TS = 29%
Average Cars = 78

Site visits: Date-Time-Count
8/6-3:00 p.m.-96; 8/8-6:45 p.m.-59

Location: 10 years
Engineer: 4 years

Responses to Survey Questions:

1. Adequate. There is extra parking most of the time.

2. Plenty of employee parking, though enforcement is an issue.

3. Unknown. Because of the amount of extra parking, it's hard to tell if neighboring businesses are using the parking lot.

Offices General

Peak Hours: 9:00 a.m., 3:00 p.m., weekdays
10:00 a.m., 3:00 p.m., weekends

DNR
1111 Washington Street
Olympia

TS = 1255
Maximum Cars = 787 %TS = 63%

Site visits: Date-Time-Count
8/8-3:00 p.m.-787

Location: 2 years
Supervisor: 2 years

Responses to Survey Questions:

1. Adequate parking, some confusion about where visitors are supposed to park, but clearly enough spaces.

2. Adequate employee parking, largest percentage of parking is employee parking.

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3. No other people use the lot. There are no arrangements.

Windermere Real Estate
2312 Pacific Avenue
Olympia

TS = 21
Maximum Cars = 14

Site visits: Date-Time-Count
8/8-2:30 p.m.-14

Location: 16 years
Manager: 10 years

Responses to Survey Questions:

1. Not enough parking, too little parking for customers. They sometimes have to park on the street.

2. Employee parking is inadequate. Employees park on the street.

3. No one else uses the parking lot.

Service Station and Public Garage

Peak Hours: 8:00 a.m., 4:00 p.m. weekdays
10:00 a.m., 4:00 p.m. weekends (Sat.)

Brazel's Chevron
1018 Plum, SE
Olympia

TS = 18
Maximum Cars = 12 %TS = 67%
Average Cars = 9

Site visits: Date-Time-Count
8/5-8:00 a.m.-8; 8/8-3:30 p.m.-12;
8/6-10:00 a.m.-9; 8/8-8:00 a.m.-8

Location: 15 years
Tech: 8 years

Responses to Survey Questions:

1. Not enough parking spots, often they have to double park cars.

2. Employee parking is adequate, they park on the side of the building.

3. People try to use this area as a park and ride, but they are informed or towed. There is no arrangement for other parkers.

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Jackpot Food Mart
927 4th Avenue East
Olympia

TS = 7
Maximum Cars = 4 %TS = 57%
Average Cars = 2

Site visits: Date-Time-Count
8/5-7:35 a.m.-0; 8/7-4:30 p.m.-2;
8/8-5:00 p.m.-4; 8/8-11:30 a.m.-3

Location: 2+years
Owner: 2 years

Responses to Survey Questions:

1. Plenty of parking, the lot is rarely full because gas customers don't require parking to pay or shop.

2. Employee parking works.

3. No other use of the parking lot.

Foreign Autoworks
3044 Pacific Avenue, SE
Olympia

TS = 19
Maximum Cars = 14 %TS = 74%
Average Cars = 13

Site visits: Date-Time-Count

8/5-7:45 a.m.-14; 8/6-4:00 p.m.-12;
8/8-1:00 p.m.-13

Comment: Has a small used car lot on location, may not be the best example.
Location: 5 years
Owner: 5 years

Responses to Survey Questions:

1. Adequate parking, there is lots of room. (He actually has a small used car lot on the premise, which is why his numbers were up.)

2. Employee parking is in back of shop and is adequate.

3. Sometimes Ernst customers will park in their lot, though this is not a common problem. There is no arrangement for serving as an overflow parking area.

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Warehouse, Storage

Peak Hours: 9:00 a.m., 4:00 p.m. weekdays and weekend (Sat.)

DART
600 Israel Rd. SE
Tumwater 98501

TS = 17
Maximum Cars = 12 %TS = 71%
Average Cars = 11

Site visits: Date-Time-Count
8/5-3:00 p.m.-11; 8/6-10:00 a.m.-0;
8/8-2:00 p.m.-12

Comment: Closed on weekends
Location: 8 years
Manager: 5 years

Responses to Survey Questions:

1. Parking is adequate.
2. Plenty of employee parking available.
3. No other use for parking lot; in an isolated rural area and the lot is fenced.

Churches

Peak Hours: 11:00 a.m., 7:00 p.m. weekdays (Wed), 11:00 a.m. Sundays

Church of Living Waters
1613 Chambers, SE
Olympia

TS = 358
Maximum Cars = 202 %TS = 56%
Average Cars = 136

Site visits: Date-Time-Count
8/7-11:30 a.m.-202; 8/8-2:00 p.m.-70

Comment: Summer enrollment down
130 spaces in gravel 3200 square feet
Location: 40 years
Pastor: 5 years

Responses to Survey Questions:

1. Adequate for summer, but need more parking in fall, for peak periods ---Sunday and Wednesday.
2. Employee parking is not a problem.
3. State office had made inquiries about leasing space, but church was worried about tax exemption status and managing irregular events (like weddings and camps).

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- They have a gravel parking lot which they are attempting to pave because the "Building Dept of the City" says gravel makes dust and Public Works says no more impervious surface.

Evergreen Christian Center
1100 Black Lake Boulevard
Olympia

TS = 340 spaces
Maximum Cars = 270 %TS = 79%
Average Cars = 165

Site visits: Date-Time-Count
8/5-1:00 p.m.-60 cars;
8/7-11:00 a.m.-270

Comment: 32 cars were shared parking at furniture store and 11 cars were associated with church school
Location: 17 years
Manager: 6 years

Responses to Survey Questions:

1. Parking is adequate.

2. Employee parking is adequate.

3. There is an informal agreement with the beauty school and furniture store, letting their employees park in the church parking lot. As the church school expands, there is some concern about safety. In the past, State employees used their lot.

Movie Theaters

Peak Hours: 12:00 a.m., 7:30 p.m. weekdays (Fri.)
12:00 p.m., 9:00 p.m. Sat.

Lacey Cinemas
4431 Martin Way East
Lacey

TS = 425
Maximum Cars = 382 %TS = 90%
Average Cars = 335

Site visits: Date-Time-Count
8/6-8:30 p.m.-382; 8/7-12:00 p.m.-270

Comment: Parking lot shared with Goofey Golf, tavern, and pizza place
Location: 15 years
Manager: 9 years

Responses to Survey Questions:

1. Adequate parking. Sometimes during peak movies (Jurassic Park) there is a shortage.

2. Employee parking is adequate.

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3. No formal agreements, but informally overflow can park in adjacent restaurant and tavern parking.

Restaurants — Peak Hours: 12:30 p.m., 6:00 p.m. Friday; Same on Saturday

Fast Food Restaurants

McDonald's of Downtown Olympia
715 Plum
Olympia

TS = 44
Maximum Cars = 23 %TS = 52%
Average Cars = 18

Site visits: Date-Time-Count

8/6-11:30 a.m.-19; 8/5-12:30 p.m.-23; 8/8-7:00 p.m.-13

Comment: 4362 sq. ft. for downtown location?
Location: 2 years
Manager: 2 years

Responses to Survey Questions:

1. Adequate parking, though a little tight during peak hours.
2. Employees are supposed to park on street; no onsite parking for employees except managers.
3. No other people use the lot.

McDonald's of Olympia
2611 Harrison Avenue, NW
Olympia

TS = 83
Maximum Cars = 44 %TS = 53%
Average Cars = 35

Site visits: Date-Time-Count
8/6-12:30 p.m.-44; 8/5-1:00 p.m.-37; 8/8-7:00 p.m.-24

Location: 14 years
Manager: 4 years

Responses to Survey Questions:

1. Adequate parking.
2. Plenty of onsite employee parking.
3. No other people use the parking lot.

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Sit Down Restaurants

Brewery City
2705 Limited Lane
Olympia

TS = 37
Maximum Cars = 30 %TS = 81%
Average Cars = 19

Site visits: Date-Time-Count
8/5-12:40 p.m.-9; 8/5-7:30 p.m.-30;
8/6-12:00 p.m.-11; 8/6-7:00 p.m.-27

Comment: 3588 square feet
Location: 5 years
Manager: 5 years

Responses to Survey Questions:

1. Not enough parking on busy nights (Tuesday, Wednesday, Friday, and Saturday); customers have to park on the street.
2. Adequate parking for employees.
3. Lease parking to Telepage Co. until 6:00 p.m. for last three years. No conflict, and it's a formal lease.

Health Clubs

Peak Hours: 10:00 a.m., 6:00 p.m. weekdays and weekends (Saturday)

Pac West Health Club
200 Sleater Kinney
Lacey

TS = 117
Maximum Cars = 102 %TS = 87%
Average Cars = 75

Site visits: Date-Time-Count
8/7-12:50 p.m.-48; 8/8-8:30 p.m.-102

Comment: Cars parked on the street
Location: 10 years
Manager: 2 years

Responses to Survey Questions:

1. Adequate parking.
2. Employee parking is also adequate.
3. No other people use the parking lot.

R0057358

Industrial — Peak Hours: 9:00 a.m., 4:00 p.m. weekdays; 10:00 a.m., 3:00 p.m. Saturday

Crown, Cork and Seal Co Inc.
1202 Fones Road, SE
Olympia

TS = 141
Maximum Cars = 81 %TS = 57%
Average Cars = 64

Site visits: Date-Time-Count
8/5-3:00 p.m.-72; 8/6-12:00 p.m.-51;
8/5-9:30 a.m.-81; 8/6-7:00 a.m.-50

Location: 35 years
Manager: 14 years

Responses to Survey Questions:

1. Adequate parking because work force is divided in half, with each half working four 12-hour shifts.
2. Most of the parking is employee parking and that is adequate.
3. No other people use the parking lot.

Institutional Care Facility — Peak Hours: 9:00 a.m., 4:00 p.m. weekdays; 10:00 a.m., 3:00 p.m. weekends

Mother Joseph Care Center
3333 Ensign Road, NE
Olympia

TS = 101
Maximum Cars = 91 %TS = 90%
Average Cars = 59

Site visits: Date-Time-Count
8/5-9:30 a.m.-91; 8/6-7:00 a.m.-36;
8/6-8:00 p.m.-27

Comment: 2 cars were parked on driveways; 6 cars were parked on street at peak weekday time
Location: 3 years
Manager: 1 year

Responses to Survey Questions:

1. Not enough parking; lot is filled to capacity and there is street parking daily.
2. Most employees park in lot with overflow parking in street. The problem is visiting doctors and other service providers having inadequate parking and parking in fire lanes and yellow zones.
3. No other people use the parking lot.

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Puget Sound Health Care Center
4001 Capital Mall Drive, SW
Olympia

TS = 74
Maximum Cars = 50 %TS = 68%
Average Cars = 36

Site visits: Date-Time-Count
8/4-3:30 p.m.-50; 8/8-7:00 p.m.-21

Location: 9 years
Nurse: 8 years

Responses to Survey Questions:

1. Parking is at capacity, just adequate. They have added a classroom component and that puts them over. People park in the street and use the driveway.

2. Not enough parking for employees; they use the driveway as a parking area.

3. No one else uses the parking lot.

Schools

Capital High School
2707 Conger West
Olympia

TS = 360+25 new spaces
Maximum Cars = Full during school year

Comment: 157,000 square feet
Location: 18 years
Maintenance Manager: 3 years

Responses to Survey Questions:

1. Adequate parking in the fall, but in the spring a fresh batch of sophomores who have completed drivers education (approximately 70 more vehicles) make the parking lot inadequate. Students park in fire lanes and by the water tower.

2. Employees use the upper parking lot, which is filled to overflowing. If the teacher leaves, the spot is gone when they come back.

3. Parks Department uses parking in the summer and evenings when they are using the sports fields.

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APPENDIX H
COOPERATIVE PARKING SURVEY

September 26, 1994

Date: _____
Name: _____
Affiliation: _____
Phone: _____
Address: _____

1. Do you have regulations or policies for shared parking? For how long? Could we have a copy?

2. Do you have a legal instrument for parties involved in shared parking?

   If yes, can you fax us a copy?

   If no, what do you recommend to shared parking participants? Are you aware of their formal arrangements? Informal?

3. Which land uses do you promote as good partners for successful shared parking?

4. Are developers and builders required to explore or participate in shared parking arrangements, or is it optional?

5. What do you see as the incentives for developers? Roadblocks?

6. Have you documented benefits from shared parking?

7. Do you have a list of shared parking participants that I could interview?

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APPENDIX H

RESULTS SUMMARY

Date: August 12 through August 16, 1994
Name: All survey respondents were senior planners in their respective jurisdictions.
Location: Thurston County and the cities of Bellevue, Lacey, Olympia, and Tumwater were surveyed.
Note: The responses for all respondents are summarized below.

1. **Do you have regulations or policies for shared parking?**

   For how long? Could we have a copy?
   Five jurisdictions have shared parking regulations ranging in date from 1982 to 1989. Four jurisdictions provided copies of their regulations.

   If yes, are they promoted or successfully used in practice?
   Planners do not "promote" the practice in any of the surveyed jurisdictions. Interested developers self-identify their need for shared parking, and no follow-up on successful use has been pursued. Two jurisdictions felt that peak hours needed to be used as a focus of potential success, and used restaurants as an example of uses that could experience a reduction in parking.

2. **Do you have a legal instrument for parties involved in shared parking?**

   If yes, can you fax us a copy?
   None of the jurisdictions had a legal instrument.

   If no, what do you recommend to shared parking participants? Are you aware of their formal arrangements? Informal?
   Five jurisdictions recommended that interested developers have a lawyer draft a document.

3. **Which land uses do you promote as good partners for successful shared parking?**

   Three jurisdictions responded with "unknown" or "site specific." Other responses included mixed use retail, offices adjacent to retail traffic, and retail uses adjacent to restaurants.

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4. **Are developers and builders required to explore or participate in shared parking arrangements, or is it optional?**

   Five jurisdictions had optional participation only. One jurisdiction specified optional participation through enabling regulatory language. Two jurisdictions mentioned the SEPA process as an additional opportunity for developers to explore shared parking.

5. **What do you see as the incentives for developers?**
   Five jurisdictions identified cost reductions as an incentive and two identified project completion as an incentive.

   Roadblocks?
   One jurisdiction identified rigid regulatory language and limiting regulations as a roadblock and one jurisdiction identified "perceived need for additional parking." Three jurisdictions could not identify any roadblocks.

6. **Have you documented benefits from shared parking?**
   None of the jurisdictions have documented benefits.

7. **Do you have a list of shared parking participants that I could interview?**
   The ones provided by the survey participants included:
   Martin Village-Lacey
   Nova School-Lacey
   Southgate Shopping Center-Tumwater
   Burger King and Bank-Tumwater
   K-Mart and Chehalis Western Trail-Thurston County
   Evergreen Christian Center and Furniture Store-Olympia

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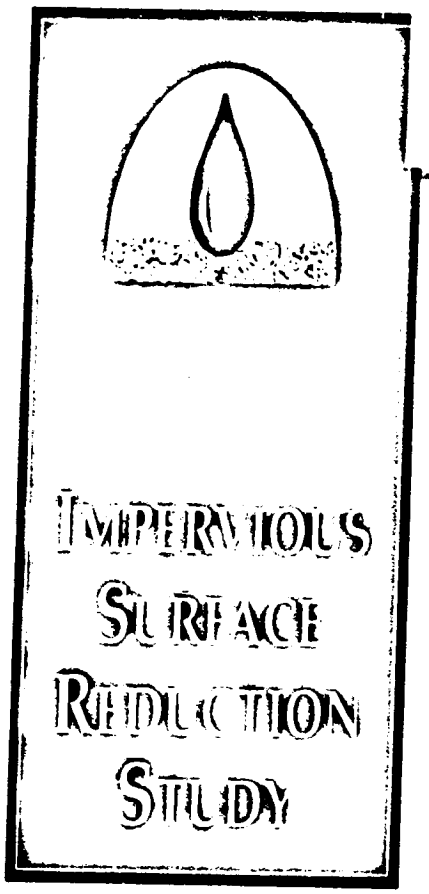

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IMPERVIOUS SURFACE REDUCTION STUDY

EXECUTIVE SUMMARY

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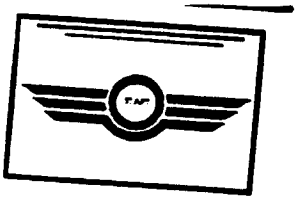

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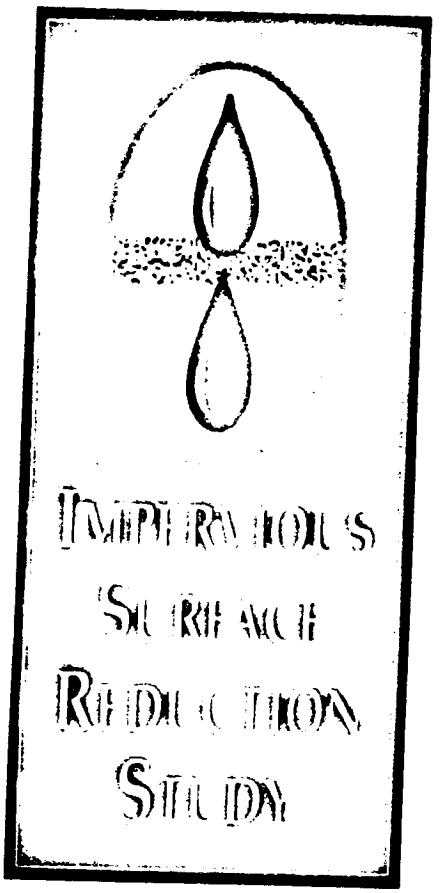
R0057365



IMPERVIOUS SURFACE REDUCTION STUDY

EXECUTIVE SUMMARY

January 1996

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PROJECT TEAM

This study could not have been completed without the hard work and dedication of the following people. Project staff would especially like to acknowledge the time and thoughtfulness dedicated to the study by the Ad Hoc Citizen Advisory Committee members. Their volunteer work is greatly appreciated.

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Scott Merriman, Westside Neighborhood Association
Lisa Palazzi, Pacific Rim Soil and Water
David Putman, Southeast Neighborhood Association
Priscilla Terry, Prime Locations, Inc.
Glenn Wells, Glenn Wells and Associates, Inc.
Tom Yates, Washington Natural Gas

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Kathy Callison, City of Tumwater Public Works Department
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Winner of a 1995 U.S. Environmental Protection Agency
Second Place National Stormwater
Control Excellence Award

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Reader's Notes:

An extensive glossary has been included in this report to assist the reader in understanding technical terms.
Glossary words are **bolded** their first occurrence in the text.

Study recommendations are summarized in this document.
Refer to the complete *Impervious Surface Reduction Study Final Report* for the full text of recommendations.

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EXECUTIVE SUMMARY

WHY STUDY IMPERVIOUS SURFACES?

Impervious surfaces are surfaces which cannot be effectively (easily) penetrated by water. Examples include pavement, buildings, and compacted soils.

As part of the development pattern in the North Thurston County Urban Growth Management Area (North Thurston UGMA; *Figure 1, page 2*), we replace natural land covers with new surfaces such as buildings, streets, parking lots, driveways, and sidewalks. These new surfaces are impervious to our rains. They block the rain (stormwater) from soaking into the ground and increase the amount of stormwater running off into streams, lakes, wetlands, and the marine waters of Puget Sound (*Figure 2, page 3*).

Keeping the rain on the surface instead of letting it soak into the ground reduces the amount of groundwater upon which Olympia and other Thurston County communities (*Figure 1, page 2*) depend on for drinking water. When less stormwater soaks into the ground, groundwater levels drop, less groundwater is available to keep streams flowing in the summer, and streams may fall below the minimum levels needed to support fish, recreation, and other uses.

A growing body of scientific evidence indicates that there is a direct link between impervious surface coverage and degradation of streams. Even relatively low levels of impervious surface coverage (10 to 15 percent of the total land area) in a watershed or drainage basin can make it difficult to maintain stream quality. Greater impervious surface coverage (15 to 20 percent of total land area in a watershed) has been linked to dramatic changes in the shape of streams, water quality, water temperature, and the health of insects, amphibians, and fish that live in these streams (Schueler, 1994).

Over the next 20 years, the population of the North Thurston UGMA is projected to increase by 66 percent to a total of 184,000 people (Thurston Regional Planning Council, 1993). If that growth occurs and is accommodated with the current pattern of urban sprawl, the total amount of impervious surface in local watersheds (Percival, Woodard/Woodland, and Chambers/Ward/Hewitt drainage basins) could increase from an estimated 14 to 29 percent of the land area,

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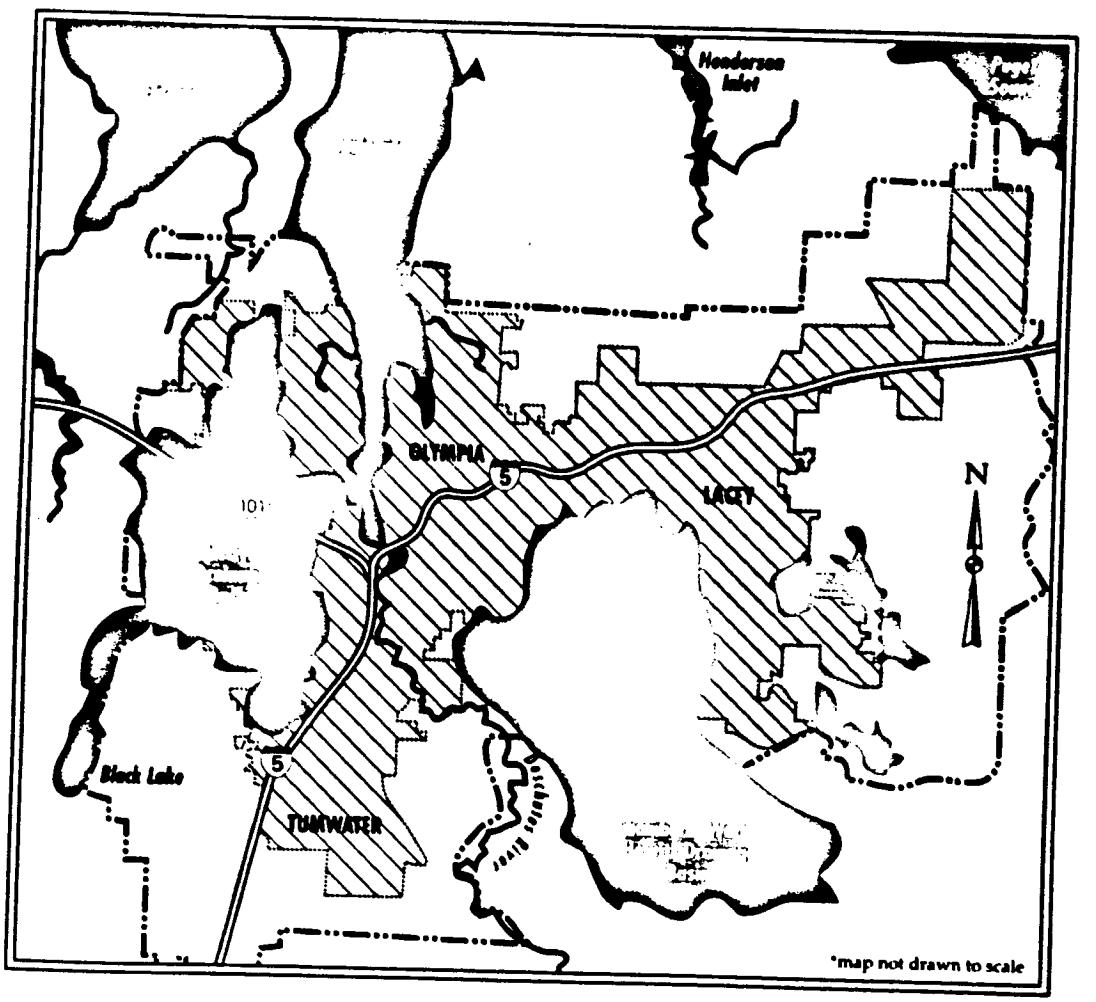
Figure 1: Olympia, Washington and the Surrounding
North Thurston County Urban Growth Management Area



Cities of Lacey, Olympia, & Tumwater
Urban Growth Management Boundary
Water
Woodard/Woodland Drainage Basin
Percival Drainage Basin
Chambers/Ward /Hewitt Drainage Basin

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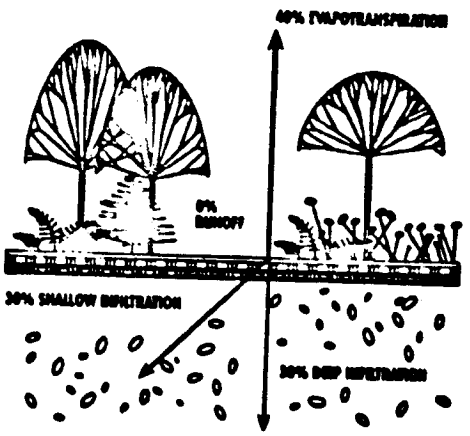
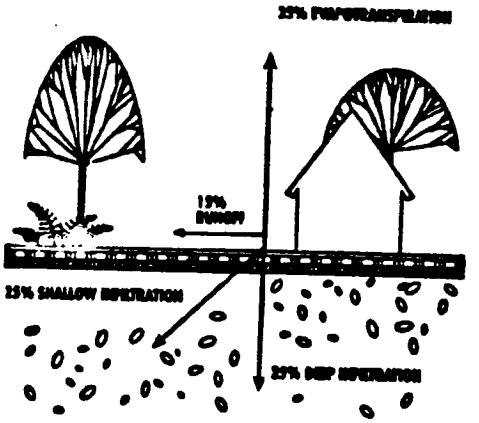
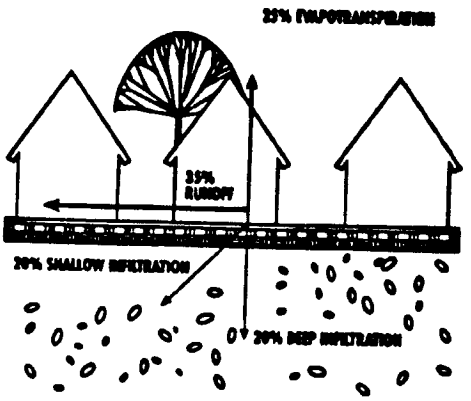
Figure 2: Hydrological Changes Associated with Increased Impervious Surfaces



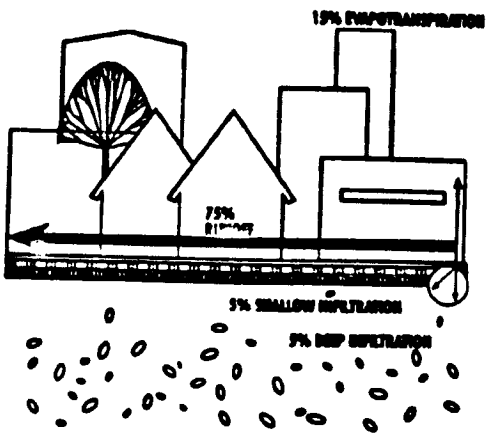
NATURAL GROUND COVER



10-20% IMPERVIOUS SURFACE



35-50% IMPERVIOUS SURFACE



75-100% IMPERVIOUS SURFACE

Adapted from NEMO Project Fact Sheet #3, Cooperative Extension Center, 1994.

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with corresponding increases in stormwater runoff and water quantity and quality problems. Estimates indicate there would be 6,200 acre feet of stormwater runoff added to the amount Olympia currently manages. This new stormwater would be enough to create a 62-acre lake that is 100 feet deep, and would need to be managed to ensure recharge of local groundwater supplies and long-term preservation of local water resources.

Most local government policies and regulations require stormwater runoff storage and treatment systems and other development practices that reduce the impacts of impervious surfaces, but fail to directly address the source of the problem. To better address this issue, the Impervious Surface Reduction Study was conducted by the City of Olympia in cooperation with the neighboring cities of Lacey and Tumwater, and Thurston County as part of an overall stormwater management strategy for the North Thurston UGMA.

GOALS AND OBJECTIVES

"I firmly believe in the intent of the project—alternatives to reduce and mitigate for stormwater problems."
—Scott Merriman, Ad Hoc Citizen Advisory Committee member

Goals

The goal of the study was to *identify and gain community support for future impervious surface reduction techniques that result in increased stormwater treatment and groundwater recharge in the Thurston County region, without causing appreciable increases in development costs.*

Another goal established for the study was a 20 percent reduction in impervious surfaces throughout the North Thurston UGMA stemming from implementation of the recommendations. Based on study results, it appears that a 20 percent reduction could be achieved.

Objectives

Objectives of the study were to:

1. Inform the public of the need for alternatives to impervious surfaces and foster support for necessary policy and development changes.

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2. Develop standards to encourage reduction in impervious surfaces associated with future construction, and develop and initiate policies to support these standards.

3. Provide technical assistance to members of the development community interested in incorporating alternative techniques into proposed site and building plans.

4. Work with other local governments and members of the development community to apply alternative development practices at one or more highly visible demonstration projects.

5. Share study results with the development and business community, professional organizations, government entities, and other interested parties.

A staff evaluation of whether the study's goals and objectives were achieved was conducted in 1995. The study's goals were generally achieved and the study's objectives were clearly achieved. See the Impervious Surface Reduction Study Final Report (City of Olympia, 1995) for details of the evaluation. Copies are available from the study coordinator (*Project Team, page i*).

STUDY APPROACH

"The timing is really good. We're working in conjunction with new comprehensive land use plans, water resource management plans, and critical areas ordinances."
—Tom Yates, Ad Hoc Citizen Advisory Committee member

Policy Focus and Early Implementation

From the beginning of the study, it was clear that water resources problems associated with impervious surfaces could not be addressed without considering policy issues such as urban sprawl and transportation management. Therefore, the study proposed policy changes as a way to reduce impervious surfaces. The study's policy focus also complemented other research in the Puget Sound region and local growth management planning.

Washington's Growth Management Act (GMA) of 1990 and 1991 requires Thurston County and the cities within the county to plan cooperatively to accommodate 20 years of population growth. As part of growth management planning, the local comprehensive plans,

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ordinances, and development regulations were revised during the past few years, with some revisions still underway. A new development pattern consisting of less sprawl and denser urban development is expected as a result of these revisions.

The new development pattern should reduce the amount of impervious surface per person in Olympia, Lacey, Tumwater, and Thurston County because there should be:

- Less impervious surface in rural areas of Thurston County due to the concentration of development in the urban areas of north Thurston County.
- More efficient use of impervious surfaces in the urban areas due to higher concentrations of people using the roads, parking lots, and other impervious surfaces.

However, the high population growth expected for the southern Puget Sound region will result in an ever increasing amount of housing and other development and impervious surfaces. This is expected to threaten the future availability of clean groundwater, stream flows, and drinking water supplies.

"The study is a good opportunity to review and evaluate alternative development styles that will reduce runoff and improve groundwater recharge, while weighing barriers against the potential benefits."
—Dick Binn, Ad Hoc Citizen Advisory Committee member

Staff and some Ad Hoc Citizen Advisory Committee members (*Project Team, page i*) participated in the revision of Olympia's street, parking, and development regulations being done as part of growth management activities. The revisions provided an opportunity to have key study recommendations adopted into existing policy. The revisions also allowed consideration of impervious surface reduction along with other community goals, and provided an opportunity to immediately implement reduction strategies.

Olympia's Sustainable City Philosophy

In March 1992, the Olympia City Council formally decided to evaluate its actions based on two sustainability criteria:

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- Criteria 1: *Future generations*

  City actions will meet present needs without jeopardizing future generations.

- Criteria 2: *Interrelationships*

  City actions will take into account the environmental, economic, social, and political requirements for their success and the impact on the natural environment and human activities.

These criteria are intended to help guide Olympia towards actions that will help create a sustainable community, one that "persists over generations and is far-seeing enough, flexible enough, and wise enough to maintain its natural, economic, social, and political support systems" (City of Olympia, 1993).

The study was used as a model to see how these criteria could be applied to a complex issue. A sustainability analysis of the study was conducted in two parts. Results of the analysis indicated that to contribute significantly to Olympia's sustainability, there would need to be a greater effort to reduce impervious surfaces than is recommended in this study, and the effort would need to be maintained over several generations. Such an effort would require greater agreement among sectors of the community about strategies. New technology would be needed to enhance groundwater infiltration and minimize impacts on water resources. Such information and technology would need to be complemented by economic incentives and relatively stable climatic conditions (e.g., rainfall in order to succeed).

Need for Cumulative Impact Assessment Realized

Many of the problems with impervious surfaces are not linked to water resources. For example, asphalt absorbs and releases heat from the sun differently from vegetation. Replacing existing vegetation with pavement can significantly alter local temperatures. These changes in local temperatures can negatively affect the health of remaining vegetation and contribute

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to an overall warming trend. It is suggested that future research of impervious surfaces be in the form of a cumulative impact assessment. This would provide an opportunity to consider all the costs and benefits of impervious surface reduction, rather than just those related to water resources

ELEMENTS OF THE STUDY

The study consisted of several tasks: project management, technical and policy analysis, involvement and education, technical assistance, demonstration projects, and sharing of results.

Project Management

The City of Olympia's Public Works Department, Water Resources Program, provided project leadership with support and participation from the cities of Lacey and Tumwater, and Thurston County. Funding for the study was provided by the Washington Department of Ecology through a Centennial Clean Water Fund grant and Olympia residents through their Storm and Surface Water Utility. The study was initiated in March 1993 and was originally scheduled to be completed December 1994. In order to accommodate construction of demonstration projects, the grant deadline was extended to June 1996. As of December 1995, all study tasks except for three technical assistance tasks (research symposium, soils workshop for builders and developers, and model maintenance plan for alternative surfaces) and the demonstration projects were complete. A separate technical report summarizing the results of the technical assistance elements and the demonstration projects will be completed spring 1996.

Technical and Policy Analysis

"When we started the policy analysis, we realized we would need to look at a whole host of issues, from land use and transportation policies to urban design and development standards, since they all affect the amount of impervious surface."
—Dorothy Craig, Policy Consultant

Research of technical and policy issues was important to understanding the problems caused by impervious surfaces and developing feasible and practical recommendations. The technical and policy analysis task included five elements:

1. Literature and Policy Review
2. Basin and Site Coverage Assessment
3. Parking Analysis

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4. Cost Analysis
5. Paver Survey

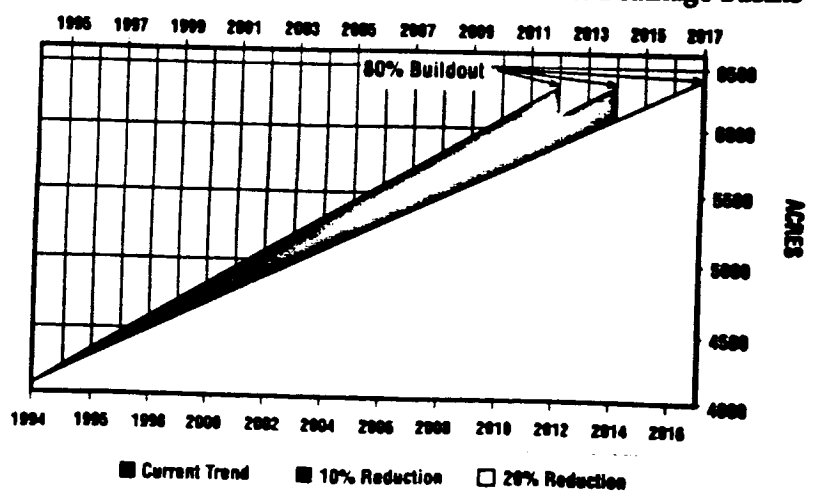
Literature and Policy Review

The literature and policy review was conducted early in the study and helped define the study approach. The literature and policy review culminated in the publication of the Technical and Policy Analysis Report (City of Olympia, 1994). For the sake of continuity, some of the early analysis has been incorporated into this Executive Summary and the final report (City of Olympia, 1995).

Basin and Site Coverage Assessment

Project staff conducted a basin and site coverage assessment to better understand the level of impervious surface reduction that could be expected in the North Thurston UGMA from key study recommendations. The assessment consisted of a site-specific analysis and an analysis of impervious surface coverage at 80 percent of predicted buildout (*Figure 3, below*) in three local watersheds (Percival, Woodard/Woodland, and Chambers/Ward/Hewitt drainage basins).

Figure 3: Current and Potential Future Trends in Acres of Impervious Surfaces in the Percival Creek, Woodard/Woodland, and Chamber/Ward/Hewitt Drainage Basins



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Information for the assessment was obtained from engineering plans for 11 Olympia-area developments and Hydrological Simulation Program - Fortran (HSPF) models created for the three watersheds. The engineering plans and HSPF information was used to answer the following questions:

- How much impervious surface is associated with typical developments in the North Thurston UGMA?
- What is the amount of impervious surface we can expect at 80 percent of buildout in the three watersheds given current development regulations and patterns?
- What reductions in impervious surfaces can be expected with implementation of key study recommendations?

Results of the assessment include:

- Reducing sidewalks offers minor, possibly insignificant, reductions in total and effective impervious surfaces.
- Major reductions in residential street widths are needed before significant reductions in impervious surfaces can be expected.
- Reducing commercial, industrial, and multifamily parking could readily reduce impervious surfaces.
- Roof reductions can be achieved by constructing taller buildings with associated reductions in building footprints.
- Key study recommendations could offer potential impervious surface reductions ranging from 0.16 to 10.67 percent (*Table 1, page 11*).

The methodology used in the basin and site coverage assessment was based on several assumptions that should be considered if used elsewhere (see the final report for details). The outcome is highly influenced by

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Table 1: Basin and Site Coverage Assessment Reduction Analysis Results

Potential Strategy	Impervious Surface Reduction Percentages			
	Site-Specific		Area-Wide	
	Total	Effective	Total	Effective
1. Reduce residential sidewalks by 50 percent by installing the walks on one side of the street only.	1.33	1.00	1.59	0.83
2. Reduce residential sidewalks from 5 feet width to 4 feet width.	0.53	0.40	0.64	0.33
3. a. Reduce local access street widths from 32 feet to 27 feet.	2.50	2.00	2.98	3.12
b. Reduce local access street widths from 32 feet to 25 feet.	3.50	2.80	4.17	4.37
c. Reduce local access street widths from 32 feet to 20 feet.	6.00	4.80	7.15	7.49
4. a. Reduce commercial parking by 5 percent.	2.67	2.67	1.04	1.37
b. Reduce commercial parking by 10 percent.	5.33	5.33	2.09	2.74
c. Reduce commercial parking by 20 percent.	10.67	10.67	4.18	5.47
5. a. Reduce multifamily parking by 5 percent.	0.74	0.74	0.16	0.21
b. Reduce multifamily parking by 10 percent.	1.48	1.48	0.32	0.42
c. Reduce multifamily parking by 20 percent.	2.95	2.95	0.64	0.84
6. a. Reduce commercial, industrial, and multifamily roof areas by 10 percent.	4.25	4.25	1.38	0.94
b. Reduce commercial, industrial, and multifamily roof areas by 20 percent.	8.50	8.50	2.76	1.89

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local land use patterns and the amount of impervious surface coverage per site. If implemented in other areas, the performance of certain recommendations should be assessed to better understand how impervious surface reduction strategies work under specific soil and site conditions.

Parking Analysis

A parking analysis was conducted to assist Olympia's Community Planning and Development Department in revising the city's parking ordinance. The analysis helped determine if changing Olympia's minimum parking ratios at to median parking ratios would reduce the amount of impervious surfaces.

The analysis consisted of a Special Parking Capacity Study and a Cooperative Parking Survey of Local Jurisdictions. The Special Parking Capacity Study consisted of the following tasks:

1. Informational survey: Owners or managers of 31 selected sites in the North Thurston UGMA were surveyed about parking capacity at their site.

2. Field survey: The parking spaces at each of 15 sites representing a variety of land uses were counted. Counts were taken during peak hours of use, twice on weekdays and twice on weekends, during August 1994.

3. Reduction analysis: Information from 11 field survey sites was combined with information taken from plans for four additional sites. The number of parking stalls for the 15 sites was determined. Then, the number of parking stalls that would exist if they had been constructed under median parking ratios instead of minimum parking ratios was calculated.

Results of the Special Parking Capacity Study indicated that most sites had more parking than required under Olympia's minimum parking ratios. This finding confirmed what Olympia's planners had suspected for

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some time—that the City's minimum parking ratios did not accurately reflect actual parking needs of various land uses. The results also indicated that the majority of sites had parking stalls that were being used inefficiently. However, there were some limitations to the parking analysis. Additional studies should be conducted and include field surveys throughout the year and a greater number of observations.

The Cooperative Parking Survey of Local Jurisdictions was used to assess existing local cooperative parking policies and regulations, and to identify incentives that may increase the use of shared parking. Planning staff at five local governments (the Cities of Olympia, Tumwater, Lacey, and Bellevue, and Thurston County) were interviewed over the phone. Results of the informal survey indicated that smaller and fewer parking lots can result from cooperative parking policies. Developers and local governments can reduce parking by joining, sharing, or coordinating parking facilities. Parking ordinances that contain cooperative parking policies are an excellent avenue for jurisdictions to promote the reduction of impervious surfaces. Incentives for developers and local governments to participate in cooperative parking include:

- Reduced construction, landscaping, and maintenance costs.
- Decreased required parking, ranging from five to 25 percent, if parking is shared.
- Increased ability to complete projects that would otherwise have been denied due to lack of space for parking.

Cost Analysis

The study goal includes a commitment to determine strategies that don't appreciably increase development costs. In order to compare recommended strategies with current practices, staff researched costs for some of the recommendations. The results are presented in detail in Chapter 3 of the final report (City of Olympia, 1995). In general, the cost analysis indicated that some

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of the obvious and practical strategies to reduce impervious surfaces are more expensive than traditional building methods, while other strategies are less expensive. For example, pavers (*Recommendation 5, page 20*) are two to four times more expensive than asphalt to install due to the cost of materials. Over time, if market demand for pavers increases, these materials may become a more feasible alternative surface. On the other hand, narrowing residential streets by seven feet (*Recommendation 4, page 19*) is estimated to save $21,000 in road costs per average 40 unit subdivision.

A formal cost/benefit analysis was not conducted due to the challenges in determining the value of clean water, fisheries, and healthy streams to the local community. Although the cost analysis provided some useful guidance, in a real-world development, soils and other site characteristics would greatly influence actual costs and benefits.

Paver Survey

During the study, several people noted their support for pavers as an alternative to paved driveways and parking areas. In order to better understand how well pavers work in residential settings, staff searched the North Thurston UGMA for homeowners who had installed pavers or other alternative surfaces. Staff discovered that only a few homes in the North Thurston UGMA have alternative surfaces. An informal survey of three homeowners indicated:

- The main motivation for installing the pavers was aesthetics. All three had seen pavers in other locations and liked the look of them. Two homeowners installed the pavers to increase infiltration due to poor soils or topography of their yard.

- The pavers had been installed for parking. The period of time since the pavers had been installed ranged from one month to 10 years. All three homeowners found the pavers required little maintenance.

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- All three homeowners said the pavers were easy to install and required no professional assistance. Exact costs were unavailable but were estimated at $600 to $3,000, depending on size and type of paver used.

- All three homeowners would recommend pavers to others. One homeowner has integrated pavers into his new house plan.

Involvement and Education

Approximately 50 people were directly involved in the research and development of the study's recommendations. Approximately 1,600 people from all over the United States were informed about the study and invited to participate or receive more information.

"We want to make the study useful on the ground, in the field, by builders and developers in an urbanizing watershed. We're insisting on using real-life situations and finding solutions that are cost-effective."

—Priscilla Terry, Ad Hoc Citizen Advisory Committee member

The study was guided by both steering and citizen advisory committees. These committees were comprised of neighborhood, development, and business representatives, and natural resource management experts from both the public and private sectors of the North Thurston UGMA (*Project Team, page i*). Additional methods for involving and educating the local community and interested parties included a **needs assessment**; two community forums; and other activities detailed in the following sections.

Technical Assistance

To encourage further understanding and actual reduction of impervious surfaces, technical assistance was offered to the local and regional community. As of December 1995, technical assistance consisted of two workshops for the building community; three fact sheets (study overview, strategies for reducing parking, and alternative surfaces); and a model legal agreement for shared parking. Evaluation of the two workshops indicated they were successful in expanding understanding about impervious surface reduction techniques.

Technical assistance that will be provided in early 1996 includes a research symposium; a soils workshop for the

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local building community; and a model maintenance plan for using alternative surfaces.

Demonstration Projects

"Local development practices such as stormwater detention ponds and swales are designed to manage increased runoff and remove pollutants, but don't do anything to reduce the amount of runoff. With this study, we're trying to get at the source of the problem."

—Joanne Richter, Supervisor of Olympia's Water Resources Program

Three demonstration projects either have been constructed or are under construction. The purpose of the demonstration projects is to test the practicality and feasibility of study recommendations. Because of delays in finding suitable sites, the demonstration projects were not started until early 1995. Since that time, significant progress has been made on a sidewalk renovation project at Olympia City Hall; a soil restoration project at Olympia High School; and an alternative surfaces test site at the King County Maintenance Center in Renton, Washington.

The sidewalk renovation project used pavers for bike rack facilities and sidewalks. The soil restoration project reduced the soil compaction along one side of a high school dirt and gravel parking lot in order to increase infiltration of stormwater runoff. A trench of existing compacted soils was replaced with better draining soils and reinforced with a layer of plastic cellular confinement material (Geoweb) just below the surface. The cellular confinement layer is expected to help protect the deeper soil from compaction and increase infiltration capacity.

The alternative surfaces project at Renton is a cooperative project with the University of Washington's Center for Urban Water Resources Management and King County Public Works Department. The project consists of eight parking stalls of alternative surfaces. The surfaces will be monitored for up to two years for infiltration capacity, stormwater treatment, and maintenance requirements.

A separate technical report that summarizes lessons learned from the demonstration projects will be available in spring 1996. Readers interested in information about the demonstration projects are encouraged to contact the study coordinator.

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Sharing of Results

"This study is generating interest from Alaska to Washington, DC. The problems related to impervious surfaces are universal, and we hope to generate universal solutions."
—Cedar Wells, Study Coordinator

Information was shared with citizens, professional groups, and various jurisdictions throughout the United States to encourage application of the study's results. As of December 1995, 20 articles about the study were published, including three in national publications. Ten news releases, one radio announcement, and two ads were also completed. In 1996, additional new releases and other media coverage will be used to announce the research symposium and soils workshop.

Printed materials already distributed or scheduled to be distributed include approximately 2,600 draft and final reports, 1,500 buttons, and 2,000 copies of three fact sheets. Printed materials were disseminated at two national conferences, at 23 presentations and briefings, and in response to many requests. An informational display board with illustrations of alternatives and a flip book with photos of example designs were used at the two national conferences and several of the presentations. As of December 1995, the project mailing list contained approximately 500 names and addresses, including over 100 from outside Washington state.

RECOMMENDATIONS

It was recognized early on that recommendations suitable for Olympia may not work for other communities, and that ideas not suitable for Olympia may work elsewhere. As one reviews the recommendations, keep in mind that this report summarizes a study, not a planning process. The information and recommendations contained in this report were provided as guidance to Olympia and other communities, and were not formally adopted by the Olympia City Council. However, revised policies and regulations that integrate many of the study's recommendations have been formally adopted or are being considered for adoption by Olympia, Lacey, Tumwater, and Thurston County. For specific information on actions that Olympia has or will be taking to reduce impervious surfaces, the reader should refer to the full final report (City of Olympia, 1995) or contact the study coordinator (*Project Team, page i*).

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Overall Recommendations

The project team developed three overall recommendations. Recommendation 1 recognizes that changing attitudes, policies, and regulations are a significant first step in impervious surface reduction. Recommendations 2 and 3 are reminders that growth management and transportation planning can be used to reduce impervious surfaces. The project team included these recommendations to encourage Olympia and other jurisdictions to consider policies and regulations, growth management, and transportation planning as tools for impervious surface reduction.

Recommendation 1.

Integrate impervious surface reduction into policies and regulations.

A whole host of development, transportation, urban design, and other policies and regulations affect the land use pattern in our communities, and the resulting amount of impervious surfaces. General review of local policies and regulations, and conversations with other jurisdictions revealed that it is unusual to find impervious surface reduction mentioned or considered in local government policies or regulations. Integrating impervious surface reduction into key policies and regulations ensures that it will be put before the public for comparison with other public goals, and with other strategies for achieving water resource protection and enhancement.

Recommendation 2.

Establish growth management policies that encourage infill of urban areas and reduce urban sprawl.

Growth management strategies in the North Thurston UGMA encourage infill of urban areas and use of congestion reduction programs, public transit, and other alternative modes of transportation. The basic premise of infill is that higher densities in urban areas allow rural areas to remain in low density or resource-based land uses, requiring fewer roads and other impervious

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surfaces region-wide. Infill reduces the amount of impervious surfaces per person and complements the goal and objectives of this study.

Recommendation 3.

Provide a public transit system and other alternative modes of transportation that reduce the need for streets and parking.

According to the basin and site coverage assessment, streets and parking areas make up a significant portion of Olympia's impervious surfaces. Providing public transit and other alternative modes of transportation and promoting parking management and other strategies can reduce our reliance on cars and the need for more vehicle-oriented impervious surfaces.



Recommendations for Vehicle-Oriented Pavement

Seven of the 19 recommendations address vehicle-oriented pavement such as streets and parking areas. Reducing vehicle-oriented pavement can result in impervious surface reduction, but needs to be done in cooperation with the local business and development community in order to identify cost-effective strategies.

Recommendation 4.

Develop standards for narrower residential streets with reduced, but adequate, parking opportunities.

Since residential streets make up a large portion of impervious surfaces in north Thurston County, narrowing residential streets could appreciably reduce stormwater runoff and increase infiltration.

Reducing the widths of new residential streets from 32 feet to 25 feet could result in approximately a 4.4 percent reduction in effective impervious surfaces for the North Thurston UGMA at 80 percent of buildout (*Table 1, page 11*). Reducing widths from 32 feet to 20 feet could result in a 7.5 percent reduction. However, significant increases in the quality of stormwater runoff are not expected from reducing the amount of vehicle-

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oriented impervious surfaces unless there also is a reduction in the source of pollution—cars and other vehicles.

Recommendation 5.

Use pavers and other pervious surfaces for low use areas such as overflow parking and emergency access roads.

Porous pavement, pavers, and alternative surfaces such as bark and gravel can be used for recreational bike and jogging trails, walkways, alleys, overflow parking, emergency access roads, and other low-use areas to increase infiltration and decrease stormwater runoff.

Recommendation 6.

Narrow alley widths, use alternative surfaces for alleys, and/or design alleys to drain to vegetated strips or central drains.

Gravel surfaces and the soils underneath them can become highly compacted from cars and other vehicular traffic depending on soil type, traffic volumes, and initial construction practices. If gravel surfaces are compacted and essentially 100 percent impervious, there is no real benefit from leaving alleys unpaved. Narrowing paved alleys, using alternative surfaces that allow more infiltration, or draining alleys to vegetated strips or drains would reduce stormwater runoff and enhance stormwater treatment.

Recommendation 7.

Encourage cooperative parking such as joint (combined), shared, and coordinated parking.

Cooperative parking can help provide more parking capacity with less impervious surface. The three types of cooperative parking are shared, joint, or coordinated parking. Shared parking reduces the parking area for land uses with noncompeting hours of operation, such as a church and a school or office. Joint parking reduces the total parking area required for multi-tenant retail and commercial facilities, especially those with little overlap of hours such as a movie theater and paint

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store. Coordinated parking reduces the total parking area by using churches, large retail, and commercial overflow parking areas for commuter park-and-ride locations.

Recommendation 8.

Encourage underground or under-the-building parking and the construction of multi-storied parking structures.

Stormwater quantity is directly related to the quantity of impervious surface exposed to rain and would therefore be reduced by placing parking underground or within buildings, or by building multi-storied parking structures. Consolidating parking into one, tall building or incorporating it into a building results in less of the site dedicated to parking. Such consolidation or incorporation could be an incentive for developers and builders if the area once dedicated to parking could be used for additional leasable space or residences.

Recommendation 9.

Develop flexible parking regulations related to parking region-wide that limit the amount of impervious surface, while still providing for parking needs.

Parking policies are local governments' foremost method for determining the size and amount of parking, and the resulting amount of parking-related impervious surfaces. The results of the parking analysis suggest that the amount of impervious surface used for parking could be reduced by encouraging cooperative use of parking areas; using an average of several peak days to determine the amount of parking needed instead of just one or two peak days; using diagonal parking, single lanes between stalls, and smaller parking stalls; and/or construction of underground, under-the-building parking, or multi-storied parking structures.

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Recommendation 10.

Gently slope sidewalks away from streets and other impervious surfaces towards vegetated strips or gravel catchments.

As a result of the basin and site coverage assessment, it is clear that sidewalks are not a significant source of impervious surface in the Olympia area when compared with streets and parking areas. Sidewalks generate less contaminants than streets and parking areas because sidewalks do not carry cars and other vehicles. However, sidewalks can contribute to stormwater runoff problems when they are sloped to streets, parking areas, or other impervious surfaces. In residential developments, yards typically border one side of the sidewalk. Lawns and other vegetated areas could provide some treatment and infiltration if sidewalk runoff is directed into these areas.



Recommendations for Construction Practices and Landscaped Areas

Naturally occurring, undisturbed areas in western Washington typically infiltrate 60 percent of rain, depending on soil type (*Figure 2, page 3*). Clearing and grading a site typically removes existing vegetation and compacts the soils, greatly reducing the infiltration capacity of the site.

For the purpose of this study, the project team considered compacted soils an impervious surface. The team recommended reducing soil compaction and the clearing of vegetated areas to retain the inherent infiltration capacity of undisturbed areas.

Recommendation 11.

Limit soil compaction on newly developed residential and commercial sites, especially those sites with sensitive features. Reduce soil compaction and restore infiltration capacity on already cleared sites whenever practical.

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Certain construction practices can increase the amount of stormwater runoff generated by a site. The amount and quality of runoff is affected by the extent of soil compaction created by clearing of a site, heavy equipment traffic, and other factors. This recommendation aims to preserve wherever possible the infiltration and pollutant removal capacity provided by soil under natural conditions.

Recommendation 12.

Limit land clearing on newly developed residential and commercial sites, especially those with sensitive features.

Clearing and grading practices greatly affect the infiltration capacity of a site. Clearing eliminates valuable vegetation and compacts soils, especially under wet soil conditions or during the rainy season. The less disturbance of existing vegetation, the less stormwater runoff generated and the greater the removal of pollutants from stormwater.

Recommendation 13.

Encourage measures such as homeowner association covenants, plat map conditions, and/or conservation easements that protect existing vegetation and undisturbed areas.

Protection of an undisturbed area that has been set aside by a developer or builder is not guaranteed. Such protection often becomes the responsibility of a home or business owner, or homeowners association. Protection of undisturbed areas could be accomplished through homeowner association covenants, plat map conditions, conservation easements, or other measures.



Recommendations for Design and Placement of Buildings

In recognition that our current development pattern plays a large role in how much impervious surface we create, the project team recommended two key

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strategies for reducing building-related impervious surfaces—clustering and taller buildings.

Recommendation 14.

Encourage cluster development that minimizes impervious surfaces.

The basic principle of cluster development is to group, or "cluster" development onto one part of a site. Although the developed area is more compact, gross density of the site remains the same. Cluster development can be used to provide subdivisions with such features as recreation areas, trails, or other amenities. Clustering also can be used to provide greater development potential on a site while protecting a natural resource, providing open space, or to save road or utility installation costs. By retaining a large undisturbed area, clustering reduces soil compaction and the amount of stormwater runoff.

Recommendation 15.

Encourage the building and use of taller structures to reduce the size of building footprints.

Multi-story buildings have less impervious surface coverage per occupant unit than single story buildings. Reducing the "footprint" of a building while increasing its height allows a parcel to accommodate the same density use with less impervious surface, or accommodate greater densities with the same amount of impervious surface.

Recommendations for Community Involvement and Education

Involvement and education of the community is a high priority for Olympia. The city and project team recognized that community participation in the study was essential to accomplishing implementation of the study's recommendations, and was necessary to ensure that policy and regulatory changes reflected the community's values, needs, and interests. Community members helped identify incentives and brought a real-world perspective to reduction strategies.

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Recommendation 16.

Develop and distribute printed materials that complement the study's recommendations.

The Department of Ecology and Olympia set aside approximately nine percent of the study's funds for dissemination of results. It is expected that inquiries for printed materials will continue after the grant has expired and will require additional funding and staffing.

Recommendation 17.

Develop and provide training and technical assistance to the region's development and business community.

A key success of this study is the raised awareness among local governments and the development and business community. However, the task of sharing the study's findings, identifying incentives for action, and implementing changes in practices and designs is not complete. Consequently, ongoing training and technical assistance will be provided to ensure implementation of impervious surface reduction techniques "on the ground."

Recommendations for Study Evaluation

Evaluation is an essential step for learning from past experiences and recognizing successes. The following recommended actions would provide information and data for evaluating the study's achievements or shortcomings and the policy changes made as result of the study.

Recommendation 18.

Monitor the increase in impervious surfaces in Percival, Woodard/Woodland, and Chambers/ Ward/Hewitt drainage basins to determine coverage trends.

One outcome of the study has been the realization that we have limited impervious surface information for the Olympia area and north Thurston County. Many of the recommendations are based on growth and related

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impervious surface coverage projections used in the Basin and Site Coverage Assessment. It would be useful to verify the accuracy of these projections as growth occurs, and adjust policies and regulations accordingly.

Recommendation 19.

Assess the results of the study's recommendations in Olympia, North Thurston UGMA, and other locations.

The study will be a success if it results in less impervious surface than was previously expected under current growth projections. Evaluating results of implementing the study's recommendations would provide important information. The information could be used to adjust policies, regulations, technical assistance, and incentives to achieve a 20 percent reduction.

CONCLUSION

This study signifies a new emphasis on impervious surface reduction for the Olympia community, and has left as many unanswered questions as it has answered. It is important to remember that a 20 percent reduction does not solve the long-term problems with impervious surfaces. This study's recommendations only address future development, and do not address existing impervious surfaces or problems. More research could be conducted to better define hydrological relationships, costs and incentives, and water quality impacts.

The Project Team invites anyone conducting research or implementing reduction strategies to contact the study coordinator and share information. Impervious surface reduction is still an experiment—one that needs to continue so that we can discover real-world solutions.

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GLOSSARY

building footprint
Commonly used term to describe the ground area that a building covers.

buildout
Full development at the maximum densities allowed by zoning.

cooperative parking
A term used to describe various methods to increase the use of available parking areas including shared, joint, and coordinated parking.

cumulative impact assessment
Cumulative impacts are the effects that accumulate over time and space from a series of similar or related individual actions, pollutants, or projects. Although each action may seem to have a minimal impact, the combined effect can be severe. A cumulative impact assessment studies and summarizes these impacts.

drainage basin (see watershed)
A land area bounded by high points, which drains all surface water into a single stream or other body of water.

effective impervious surface
The portion of impervious surface that generates stormwater runoff which must be managed or directed to a stormwater conveyance system, rather than infiltrating into the ground.

groundwater
Water stored underground that fills the spaces between soil particles or rock fractures. A zone underground with enough water to withdraw and use for drinking water or other purposes is called an aquifer.

Hydrologic Simulation Program - Fortran (HSPF)
A specific computer program which simulates (models) land surface and instream hydrology on a continuous basis.

infill
Developing vacant parcels or redeveloping existing property to achieve higher density in urban areas as an alternative to development in outlying rural areas.

needs assessment
A survey to determine the requirements or desires of a particular audience.

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North Thurston County Urban Growth Management Area (North Thurston UGMA)
The area designated by Thurston County pursuant to RCW 36.7A.10. Includes land area sufficient to accommodate the urban growth projected to occur in the northern part of the county over the next 20 years.

parking ratios
Parking required for a particular land use, stated as a ratio or "x" parking spaces per "y" units. Typical units are square footage, dwelling units, persons, and seats.

pavers
Concrete grid and modular pavement whose spaces are filled with pervious materials such as sod, sand, or gravel.

shared parking
Mutual use of a parking area by land uses with noncompeting hours of operation, such as a theater and office building.

stormwater
Rain that flows off the surface of the land without entering the soil.

sustainability criteria
Criteria used to gauge the effectiveness of projects, plans, and new regulations in achieving a sustainable community. A sustainable community is one that persists over generations and is far-seeing enough, flexible enough, and wise enough to maintain its natural, economic, social, and political support systems.

watershed (see drainage basin)
The geographic region within which water drains into a particular river, stream, or body of water. A watershed includes hills, lowlands, and the body of water into which the land drains.

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Impervious cover is a powerful indicator of future stream quality

The Importance of Imperviousness

The emerging field of urban watershed protection often lacks a unifying theme to guide the efforts of its many participants—planners, engineers, landscape architects, scientists, and local officials. The lack of a common theme has often made it difficult to achieve a consistent result at either the individual development site or cumulatively, at the watershed scale.

In this article a unifying theme is proposed based on a physically defined unit—imperviousness. Imperviousness here is defined as the sum of roads, parking lots, sidewalks, rooftops, and other impermeable surfaces of the urban landscape. This variable can be easily measured at all scales of development, as the percentage of area that is not "green".

This research has yielded a surprisingly similar conclusion—stream degradation occurs at relatively low levels of imperviousness (10-20%).

Imperviousness is a very useful indicator with which to measure the impacts of land development on aquatic systems. Reviewed here is the scientific evidence that relates imperviousness to specific changes in the hydrology, habitat structure, water quality and biodiversity of aquatic systems. This research, conducted in many geographic areas, concentrating on many different variables, and employing widely different methods, has yielded a surprisingly similar conclusion—stream degradation occurs at relatively low levels of imperviousness (10-20%). Most importantly, imperviousness is one of the few variables that can be explicitly quantified, managed and controlled at each stage of land development. The remainder of this paper examines in detail the relationship between imperviousness and stream quality.

The Components of Imperviousness

Imperviousness represents the imprint of land development on the landscape. It is composed of two primary components—the *rooftops* under which we live, work and shop, and the *transport* system (roads, driveways, and parking lots) that we use to get from one roof to another. As it happens, the transport component now often exceeds the rooftop component in terms of total impervious area created. For example, transport-related imperviousness comprised 63% to 70% of total impervious cover at the site in 11 residential, multifamily and commercial areas where it had actually been measured.[6] This phenomenon is observed most often in suburban areas and reflects the recent ascendancy of the automobile in both our culture and landscape. The sharp increases in per capita vehicle ownership, trips taken, and miles travelled have forced local planners to increase the relative size of the transport component over the last two decades.

Traditional zoning has strongly emphasized and regulated the first component (rooftops) and largely neglected the transport component. While the rooftop component is largely fixed in density zoning, the transport component is not. As an example, nearly all zoning codes set the maximum density for an area, based on dwelling units (rooftops). Thus, in a given area, no more than one single family home can be located on each acre of land, and so forth.

Thus a wide range in impervious cover is often seen for the same zoning category. For example, impervious area associated with medium density single family homes can range from 25% to nearly 60%, depending on the layout of streets and parking. This suggests that significant opportunities exist to reduce the share of imperviousness from the transport component.

Imperviousness and runoff

The relationship between imperviousness and runoff may be widely understood, but it is not always fully appreciated. Figure 1 illustrates the increase in the site runoff coefficient as a result of site imperviousness, developed from over 40 runoff monitoring sites across the nation. The runoff coefficient ranges from zero to one and expresses the fraction of rainfall volume that is actually converted into storm runoff volume. As can be seen, the runoff coefficient closely tracks percent impervious cover, except at low levels where soils and slope factors also become important. In practical terms this means that the total runoff volume for a one-acre parking lot ($R_v = 0.95$) is about 16 times that produced by an undeveloped meadow ($R_v = 0.06$).

To put this in more understandable terms, consider the runoff from a one-inch rainstorm (see Table 1). The total runoff from a one-acre meadow would fill a standard size office to a depth of about two feet (218 cubic feet). By way of comparison, if that same acre was completely paved, a one-inch rainstorm would completely fill your office, as well as the *two* next to it. The peak discharge, velocity and time of concentration of stormwater runoff also exhibit a striking increase after a meadow is replaced by a parking lot (Table 1).

Because infiltration is reduced in impervious areas, one would expect groundwater recharge to be proportionately reduced. This, in turn, should translate into lower dry weather stream flows. Actual data, however, that demonstrate this effect is rare. Indeed, Evett et al.[8] could not find any statistical difference in low stream

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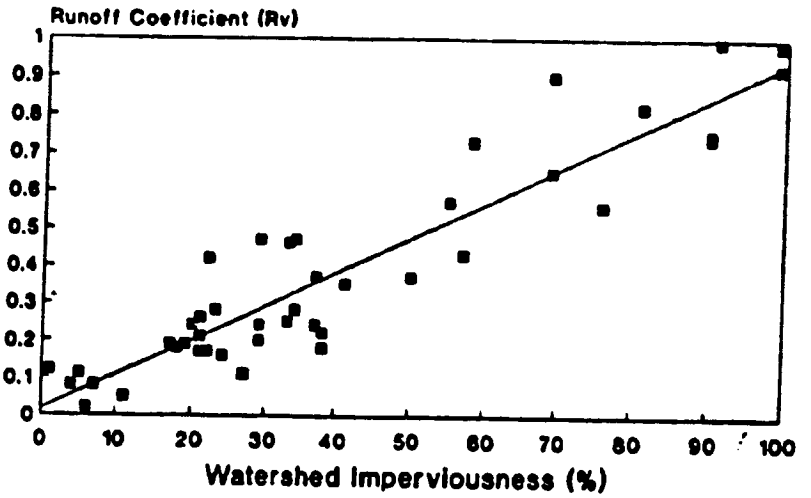
Figure 1: Watershed imperviousness and the storm runoff coefficient



flow between urban and rural watersheds after analyzing 16 North Carolina watersheds. Simmons and Reynolds[26] did note that dry weather flows dropped 20 to 85% after development in several urban watersheds in Long Island, New York.

It should be noted that transport-related imperviousness often exerts a greater hydrological impact than the rooftop-related imperviousness. In residential areas, runoff from rooftops can be spread out over pervious areas, such as backyards, and rooftops are not always directly connected to the storm drain system. This may allow for additional infiltration of runoff. Roads and parking lots, on the other hand, are usually directly connected to the storm drain system.

Imperviousness and the Shape of Streams

Confronted by more severe and more frequent floods, stream channels must respond. They typically do so by increasing their cross-sectional area to accommodate the higher flows. This is done either through widening of the stream banks, downcutting of the stream bed, or frequently, both. This phase of channel instability, in turn, triggers a cycle of streambank erosion and habitat degradation.

The critical question is at what level of development does this cycle begin? Recent research models developed in the Pacific Northwest suggest that a threshold for urban stream stability exists at about 10% imperviousness[3,4] (Figure 2). Watershed development beyond this threshold consistently resulted in unstable and eroding channels. The rate and severity of channel instability appears to be a function of sub-bankfull floods, whose frequency can increase by a factor of 10 even at relatively low levels of imperviousness.[14,19,23]

A major expression of channel instability is the loss of instream habitat structures, such as the loss of pool and riffle sequences and overhead cover, a reduction in the wetted perimeter of the stream and the like. A number of methods have been developed to measure the structure and quality of instream habitat in recent

Table 1: Comparison of one acre of parking lot versus one acre of meadow in good condition

Runoff or Water Quality Parameter	Parking Lot	Meadow
Curve number (CN)	98	58
Runoff coefficient	0.95	0.06
Time of concentration (minutes)	4.8	14.4
Peak discharge rate (cfs), 2 yr., 24 hr. storm	4.3	0.4
Peak discharge rate (cfs), 100 yr. storm	12.6	3.1
Runoff volume from one-inch storm (cubic feet)	3450	218
Runoff velocity @ 2 yr. storm (feet/second)	8	1.8
Annual phosphorus load (lbs/ac./yr.).	2	0.50
Annual nitrogen load (lbs/ac./yr.).	15.4	2.0
Annual zinc load (lbs/ac./yr.)	0.30	ND

Key Assumptions:
Parking lot is 100% impervious with 3% slope, 200 feet flow length, Type 2 Storm, 2 yr. 24 hr. storm = 3.1 inches, 100 yr. storm = 8.9 inches, hydraulic radius = 0.3, concrete channel, and suburban Washington 'C' values.
Meadow is 1% impervious with 3% slope, 200 foot flow length, good vegetative condition, B soils, and earthen channel.

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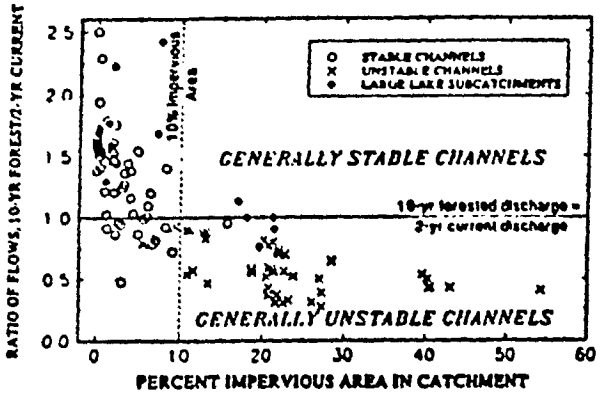
Figure 2: Channel stability as a function of imperviousness
(Booth and Reinelt, 1993)



years.[6,11,21] Where these tools have been applied to urban streams, they have consistently demonstrated that a sharp threshold in habitat quality exists at approximately 10 to 15% imperviousness.[4,11,23] Beyond this threshold, urban stream habitat quality is consistently classified as poor.

Imperviousness and water quality

Impervious surfaces collect and accumulate pollutants deposited from the atmosphere, leaked from vehicles or derived from other sources. During storms, accumulated pollutants are quickly washed off and rapidly delivered to aquatic systems.

Habitat assessment tools have consistently demonstrated that a sharp threshold in habitat quality exists at approximately 10 to 15% imperviousness.

Monitoring and modeling studies have consistently indicated that urban pollutant loads are directly related to watershed imperviousness. Indeed, imperviousness is the key predictive variable in most simulation and empirical models used to estimate pollutant loads. For example, the Simple Method assumes that pollutant loads are a direct function of watershed imperviousness[21], as imperviousness is the key independent variable in the equation.

Threshold limits for maintaining background pollutant loads

Suppose that watershed runoff drains into a lake that is phosphorus-limited. Also assume that the present background load of phosphorus from a rural land use amounts to 0.5 lbs/ac/yr. The Simple Method predicts that the postdevelopment phosphorus load will exceed background loads once watershed imperviousness (I) exceeds 20 to 25% (Figure 3), thereby increasing the risk of nutrient overenrichment in the lake.

Urban phosphorus loads can be reduced when urban best management practices (BMPs) are installed, such as stormwater ponds, wetlands, filters or infiltration practices. Performance monitoring data indicates that BMPs can reduce phosphorus loads by as much as 40 to 60%, depending on the practice selected. The impact of this pollutant reduction on the postdevelopment phosphorus loading rate from the site is shown in Figure 3. The net effect is to raise the phosphorus threshold to about 35% – 60% imperviousness, depending on the performance of the BMP we install. Therefore, even when effective practices are widely applied, we eventually cross a threshold of imperviousness, beyond which we cannot maintain predevelopment water quality.

Imperviousness and stream warming

Impervious surfaces both absorb and reflect heat. During the summer months, impervious areas can have local air and ground temperatures that are 10 to 12 degrees warmer than the fields and forests that they replace. In addition, the trees that could have provided shade to offset the effects of solar radiation are absent.

Water temperature in headwater streams is strongly influenced by local air temperatures. Galli[9] reported that stream temperatures throughout the summer are increased in urban watersheds, and the degree of warming appears to be directly related to the imperviousness of the contributing watershed. He monitored five headwater streams in the Maryland Piedmont over a six-month period, the streams having differing levels of impervious cover (Figure 4). Each of the urban streams had mean temperatures that were consistently warmer than a forested reference stream, and the size of the increase (referred to as the delta-T) appeared to be a direct function of watershed imperviousness. Other factors, such as lack of riparian cover and ponds, were also demonstrated to amplify stream warming, but the primary contributing factor appeared to be watershed impervious cover.[9]

Imperviousness and stream biodiversity

The health of the aquatic ecosystem is a strong environmental indicator of watershed quality. A number of research studies have recently examined the links between imperviousness and the biological diversity in streams. Some of the key findings are summarized in Table 2.

Aquatic insects

The diversity, richness and composition of the benthic or streambed community has frequently been used to evaluate the quality of urban streams. Not only are aquatic insects a useful environmental indicator, but they also form the base of the stream food chain in most regions of the country.

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Figure 3: The effect of impervious cover on urban phosphorus load under several scenarios, as computed by the Simple Method

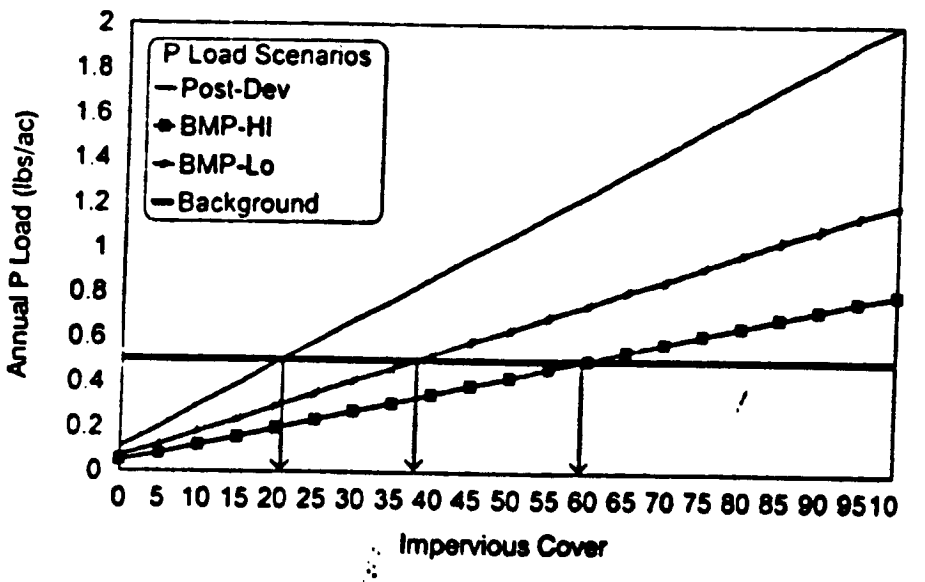
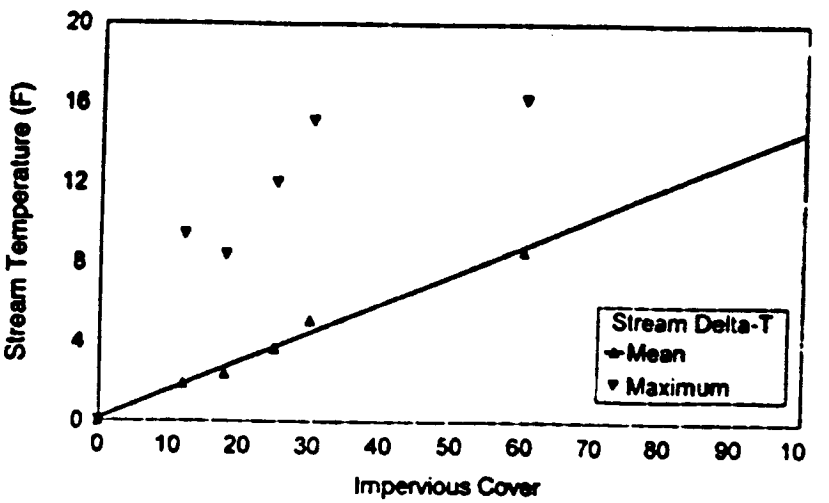


Figure 4: The effect of impervious cover on stream temperature *(Galli, 1991)*



Delta-t is the difference in mean or max stream temperature from a developed stream, compared to an undisturbed stream.

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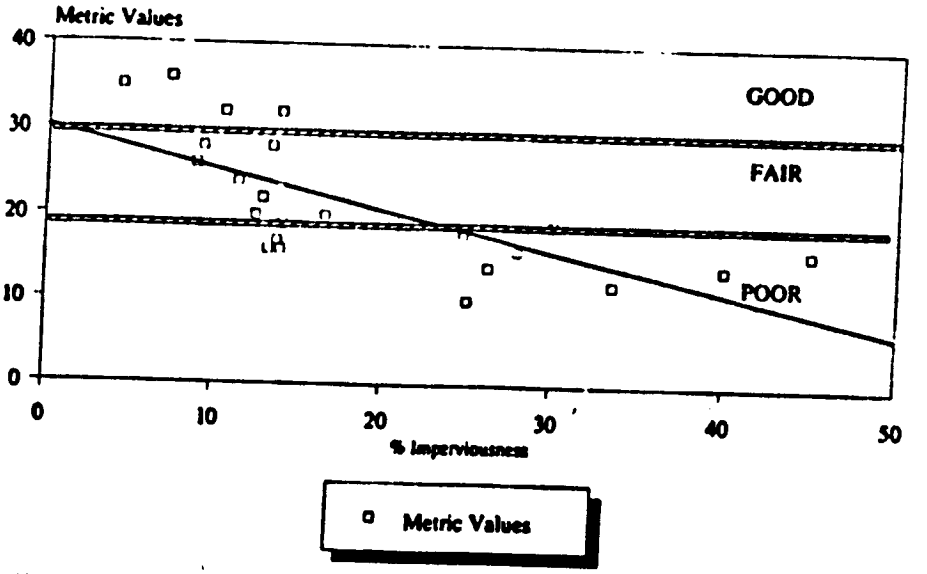
Figure 5: Impacts of imperviousness on macroinvertebrate communities in the headwater streams of the Anacostia River *(Schueler and Galli, 1992)*



Metric Values are based upon the sum of scores assigned for the following categories: EPTC balance, EPT Index, Average Generic Diversity, Chironomid Abundance, Taxonomic Richness (Family and Generic)

Klein[16] was one of the first to note that macroinvertebrate diversity drops sharply in urban streams in Maryland. Diversity consistently became poor when watershed imperviousness exceeded 10 to 15 percent. The same basic threshold has been reported by all other research studies that have looked at macroinvertebrate diversity in urban streams (Table 2).

It is clear that few, if any, urban streams can support diverse benthic communities at moderate to high levels of imperviousness (25% or more).

In each study, sensitive macroinvertebrates were replaced by ones that were more tolerant of pollution and hydrologic stress. Species such as stoneflies, mayflies, and caddisflies largely disappeared and were replaced by chironomids, tubificid worms, amphipods, and snails. Species that employ specialized feeding strategies—shredding leaf litter, grazing rock surfaces, filtering organic matter that flows by, and preying on other insects—were lost.

A typical example of the relationship between imperviousness and macroinvertebrate diversity is shown in Figure 5. The graph summarizes diversity trend for 23 sampling stations in headwater streams of the Anacostia watershed.[24] While good to fair diversity was noted in all headwater streams with less than 10% imperviousness, nearly all stations with 12% or more impervious cover recorded poor diversity. The same sharp drop in macroinvertebrate diversity at around 12 to 15% imperviousness was also observed in streams in the coastal plain and piedmont of Delaware.[25]

Other studies have utilized other indicators to measure the impacts of urbanization on stream insect communities. For example, Jones and Clark[15] monitored 22 stations in Northern Virginia and concluded that benthic insect diversity composition changed markedly after watershed population density exceeded four or more individuals per acre. The population density roughly translates to half-acre or one acre lot residential use, or perhaps 10 to 20 percent imperviousness.

Steedman[27] evaluated 208 Ontario stream sites, and concluded that benthic diversity shifted from fair to poor at about 35% urban land use. Since "urban land" includes both pervious and impervious areas, the actual threshold in the Ontario study may well be closer to 7 to 10% imperviousness.[4] Steedman also reported that urban streams with intact riparian forests had higher diversity than those that did not, for the same level of urbanization.

While the exact point at which stream insect diversity shifts from fair to poor is not known with absolute precision, it is clear that few, if any, urban streams can support diverse benthic communities at moderate to high levels of imperviousness (25% or more). Four different studies all failed to find stream insect communities with good or excellent diversity in any highly urban stream.[1,2,3,12]

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Table 2: Review of key findings of urban stream studies examining the relationship of urbanization on stream quality

Ref.	Year	Location	Biological Parameter	Key Finding
3	1991	Seattle	Fish habitat/ channel stability	Channel stability and fish habitat quality declined rapidly after 10% imperv.
11	1994	Maryland	Brown trout	Abundance and recruitment of brown trout declines sharply at 10-15% imperv.
1	1981	Atlanta	Aquatic insects	Negative relationship between number of insect species and urbanization in 21 streams
15	1987	Northern Virginia	Aquatic insects	Urban streams had sharply lower diversity of aquatic insects when human population density exceeded 4 persons/acre. (estimated 15-25% imperv. cover)
17	1990	New York	Fish spawning	Resident and anadromous fish eggs and larvae declined sharply in 16 tributary streams greater than 10% imperv.
25	1994	Delaware	Aquatic insects	Insect diversity at 19 stream sites dropped sharply at 8 to 15% imperv.
25	1994	Delaware	Habitat quality	Strong relationship between insect diversity and habitat quality; majority of 53 urban streams had poor habitat
24	1992	Maryland	Fish	Fish diversity declined sharply with increasing imperv., loss in diversity began at 10-12% imperv.
24	1992	Maryland	Aquatic insects	Insect diversity metrics in 24 subwatersheds shifted from good to poor over 15% imperv.
2	1994	Maryland	Fish/insects	Fish, insect and habitat scores were all ranked as poor in 5 subwatersheds that were greater than 30% imperv.
16	1979	Maryland	Aquatic insects/fish	Macroinvertebrate and fish diversity declines rapidly after 10% imperv.
18	1993	Seattle	Fish	Marked shift from less tolerant coho salmon to more tolerant cutthroat trout populations noted at 10-15% imperv. at 9 sites
27	1988	Ontario	Aquatic insects	Strong negative relationship between biotic integrity and increasing urban land use/ riparian condition at 209 stream sites. Degradation begins at about 10% imperv.
20	1986	Seattle	Aquatic insects	Macroinvertebrate community shifted to chironomid, oligochaetes and amphipod species tolerant of unstable conditions.
28	1983	Seattle	Salmon	Marked reduction in coho salmon populations noted at 10-15% imperv. at 9 sites
29	1993	Seattle	Wetland plants/ amphibians	Mean annual water fluctuation was inversely correlated to plant and amphibian density in urban wetlands. Sharp declines noted over 10% imperv.
12	1986	NewJersey	Aquatic insects	Drop in insect taxa from 13 to 4 noted in urban streams
30	1991	Ohio	Aquatic insects/ fish	100% of 40 urban sites sampled had fair to very poor index of biotic integrity scores

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Fish Surveys

The abundance and diversity of the fish community can also serve as an excellent environmental indicator. Surprisingly, relatively few studies have examined the influence of imperviousness on fish communities in headwater streams. The results of one study is illustrated in Figure 6. Four similar subwatersheds in the Maryland Piedmont were sampled for the number of fish species present. As the level of watershed imperviousness increased, the number of fish species collected dropped. Two sensitive species (trout and sculpin) were lost as imperviousness increased from 10 to 12% and four more were lost when impervious cover increased to 25%. Significantly, only two species remained in the fish community at 55% imperviousness. Sensitive species, defined as those with a strong dependence on the substrate for feeding and/or spawning, showed a more precipitous decline. Klein[10] found a similar relationship between fish diversity and watershed imperviousness in several dozen headwater streams in the Maryland Piedmont.

Salmonid fish species (trout and salmon) and anadromous fish species appear to be most negatively impacted by imperviousness. Trout have stringent temperature and habitat requirements, and seldom are present in mid-Atlantic watersheds where imperviousness exceeds 15%.[11] Declines in trout spawning success are evident above 10% imperviousness.[11] In the Pacific Northwest, Luchetti and Feurstenburg[12] seldom found sensitive coho salmon in watersheds beyond 10 or 15% imperviousness. Booth and Reinelt[4] noted that most urban stream reaches had poor quality fish habitat when imperviousness exceeded 8 to 12%.

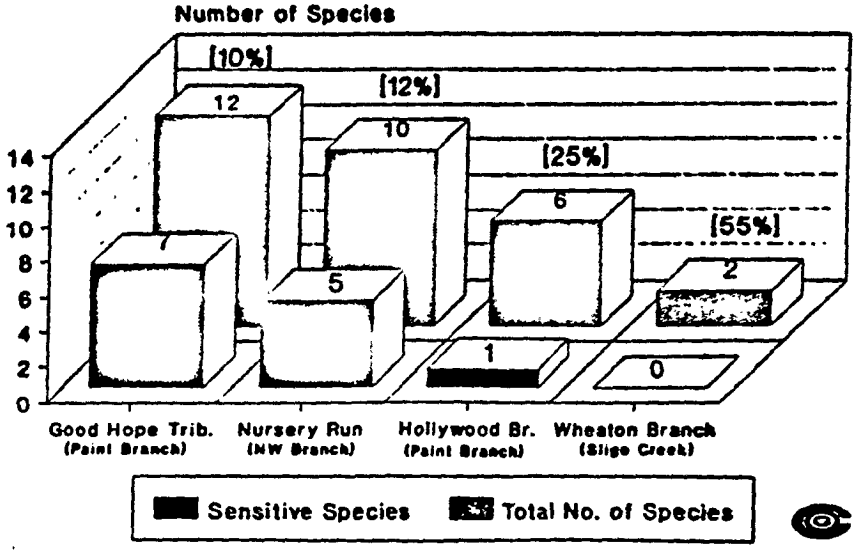
Fish species that migrate from the ocean to spawn in freshwater creeks are also very susceptible to impacts of urbanization such as fish barriers, pollution, flow changes, and other factors. For example, Limburg and Schmidt[13] discovered that the density of anadromous fish eggs and larvae declined sharply after a 10% imperviousness threshold was surpassed in 16 subwatersheds draining into the Hudson River.

The influence of imperviousness on other urban water resources

Several other studies point to the strong influence of imperviousness on other important aquatic systems such as shellfish beds and wetlands.

Even relatively low levels of urban development yield high levels of bacteria, derived from urban runoff or failing septic systems. These consistently high bacterial counts often result in the closure of shellfish beds in coastal waters and it is not surprising, that most closed shellfish beds are in close proximity to urban areas. Indeed, it may be difficult to prevent shellfish closure when more than one septic drain field is present per seven acres—a very low urban density.[7] Although it is widely believed that urban runoff accounts for

Figure 6: Fish diversity as a function of watershed imperviousness in four subwatersheds in the Maryland Piedmont *(Schueler and Galli, 1992)*



Numbers in brackets represent levels of watershed imperviousness.

Sources: 1) MdDNR, 1983 2) MdDNR, 1988 3) ICPRB, 1989

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many shellfish bed closures (now that most point sources have been controlled), no systematic attempt has yet been made to relate watershed imperviousness to the extent of shellfish bed closures.

Taylor[28] examined the effect of watershed development on 19 freshwater wetlands in King County, Washington, and concluded that the additional stormwater contributed to greater annual water level fluctuations (WLF). When the annual WLF exceeded about 8 inches, the richness of both the wetland plant and amphibian community dropped sharply. This increase in WLF began to occur consistently when upstream watersheds exceeded 10 to 15% imperviousness.

Implications at the Watershed Level

The many independent lines of research reviewed here converge toward a common conclusion— that it is extremely difficult to maintain predevelopment stream quality when watershed development exceeds 10 to 15% impervious cover. What implications might this apparent threshold have for watershed planning?

Should low density or high density development be encouraged?

At first glance, it would seem appropriate to limit watershed development to no more than 10% total impervious cover. While this approach may be wise for an individual "sensitive" watershed, it is probably not practical as a uniform standard. Only low density development would be feasible under a ten percent zoning scenario, perhaps one-acre lot residential zoning, with a few widely scattered commercial clusters. At the regional scale, development would thus be spread over a much wider geographic area than it would otherwise have been. At the same time, additional impervious area (in the form of roads) would be needed to link the community together.

Paradoxically, the best way to minimize the creation of additional impervious area at the regional scale is to concentrate it in high density clusters or centers. The corresponding impervious cover in these clusters is expected to be very high (25% to 100%), making it virtually impossible to maintain predevelopment stream quality. A watershed manager must then confront the fact that to save one stream's quality it may be necessary to degrade another.

A second troubling implication of the impervious/stream quality relationships involves the large expanses of urban areas that have already been densely developed. Will it be possible to fully restore stream quality in watersheds with high impervious cover? Some early watershed restoration work does suggests that biological diversity in urban streams can be partially restored, but only after extensive stormwater retrofit and habitat structures are installed. For example, fish and macroinvertebrate diversity has been partially restored in one tributary of Sligo Creek, Maryland.[11] In other urban watersheds, however, comprehensive watershed restoration may not be feasible, due to a lack of space, feasible sites, or funding.

Paradoxically, the best way to minimize the creation of additional impervious area at the regional scale is to concentrate it in high density clusters.

A proposed scheme for classifying urban stream quality potential

The thresholds provide a reasonable foundation for classifying the potential stream quality in a watershed based on the ultimate amount of impervious cover. One such scheme is outlined in Table 3. It divides urban streams into three management categories based on the general relationships between impervious cover and stream quality:

1. Stressed streams (1 to 10% impervious cover)
2. Impacted streams (11 to 25% impervious cover)
3. Degraded streams (26 to 100% impervious cover)

The resource objective and management strategies in each stream category differ to reflect the potential stream quality that can be achieved. The most protective category are "stressed streams" in which strict zoning, site impervious restrictions, stream buffers and BMPs are applied to maintain predevelopment stream quality. "Impacted streams" are above the threshold and can be expected to experience some degradation after development (i.e., less stable channels and some loss of diversity). The key resource objective for these streams is to mitigate these impacts to the greatest extent possible, using effective BMPs.

The last category, degraded streams, recognizes that predevelopment channel stability and biodiversity cannot be fully maintained, even when BMPs or retrofits are fully applied. The primary resource objective shifts to protect downstream water quality by removing urban pollutants. Efforts to protect or restore biological diversity in degraded streams are not abandoned; in some priority subwatersheds intensive stream restoration techniques are employed to attempt to partially restore some aspects of stream quality. In other subwatersheds, however, new development (and impervious cover) is encouraged to take place so as to protect stressed and impacted streams.

Watershed-based zoning

Watershed-based zoning is based on the premise that impervious cover is a superior measure to gauge the impacts of growth, compared to population density, dwelling units or other factors. The key steps in

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Table 3: A possible scheme for classifying and managing for headwater urban streams based on ultimate imperviousness

Urban Stream Classification	Stressed (0-10% Imperv.)	Impacted (11-25% Imperv.)	Degraded (26-100% Imperv.)
Channel stability	Stable	Unstable	Highly Unstable
Water quality	Good	Fair	Fair-Poor
Stream biodiversity	Good-Excellent	Fair-Good	Poor
Resource objective	Protect biodiversity and channel stability	Maintain critical elements of stream quality	Minimize downstream pollutant loads
Water quality objectives	Sediment and temperature	Nutrient and metal loads	Control bacteria
BMP Selection Factors	Secondary environmental impacts	Removal efficiency	Removal efficiency
Land Use Controls	Watershed-wide imp. cover limits (ICLs), site ICLs	Site imp. cover limits (ICLs)	Additional infill and redevelopment encouraged
Monitoring and enforcement	GIS monitoring of imp. cover, biomonitoring	Same as "Stressed"	Pollutant load modeling
Development rights	Transferred out	None	Transferred in
Riparian buffers	Widest buffer network	Average bufferwidth	Greenways

watershed-based zoning are as follows. *First*, a community undertakes a comprehensive physical, chemical and biological monitoring program to asses the current quality of its entire inventory of streams. The data are used to identify the most sensitive stream systems and to refine impervious/stream quality relationships. *Next*, existing imperviousness is measured and mapped at the subwatershed level. Projections of future impervious cover due to forecasted growth are also made at this time.

The *third* step involves designating the future stream quality for each subwatershed based on some adaptation of the urban stream classification scheme presented earlier. The existing land use master plan is then modified to ensure that future growth (and impervious cover) is consistent with the designated stream classification for each subwatershed.

The *final* step in the watershed-based zoning process involves the adoption of specific resource objectives for each stream and subwatershed. Specific policies and practices on impervious cover limits, BMPs, and buffers are then instituted to meet the stream resource objective, and these practices directly applied to future development projects.

Watershed-based zoning should provide managers with greater confidence that resource protection objectives can be met in future development. It also forces local governments to make hard choices about which streams will be fully protected and which will become at least partially degraded. Some environmentalists and regulators will be justifiably concerned about the streams whose quality is explicitly sacrificed under this scheme. The explicit stream quality decisions which are at the heart of watershed-based zoning, however, are preferable to the uninformed and random "non-decisions" that are made every day under the present zoning system.

A cautionary note

While the research on impervious cover and stream quality is compelling, it is doubtful whether it can serve as the sole foundation for legally defensible zoning and regulatory actions at the current time. One key reason is that the research has not been standardized. Different investigators, for example, have used different methods to define and measure imperviousness. Second, researchers have employed a wide number of techniques to measure stream quality characteristics that are not always comparable with each other. Third, most of the studies have been confined to few ecoregions in the country. Little research has been conducted in the Northeast, Southeast, Midwest, and semi-arid Western regions. Lastly, none of the studies has yet examined the effect of widespread application of BMPs on impervious cover/stream quality relationships. Until studies determine how much BMPs can "cheat" the impervious cover/stream quality relationship, it can be argued that structural practices alone can compensate for imperviousness effects.

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On the positive side, it may be possible for a community to define the impervious cover/stream quality relationship in a short time and at relatively low cost. A suggested protocol for conducting a watershed monitoring study is presented in Table 4. The protocol emphasizes comparative sampling of a large population of urban subwatersheds of different increments of imperviousness (perhaps 20 to 50).

A rapid sampling program collects consistent data on hydrologic, morphologic, water quality, habitat and biodiversity variables within each subwatershed. For comparison purposes, series of undeveloped and undisturbed reference streams are also monitored. The sampling data are then statistically and graphically analyzed to determine the presence of imperviousness/stream quality relationships.

The protocol can be readily adapted to examine how BMPs can shift the stream quality/imperviousness relationship. This is done by adjusting the sampling protocol to select two groups of study subwatersheds—those that are effectively served by BMPs and those that are not.

Site designers can use a wide range of techniques to minimize impervious cover by 10 to 50%.

Minimizing impervious cover

Reducing impervious cover can be an effective element of the overall BMP system for a development site. As noted earlier, imperviousness need not be a fixed quantity. A site designer can utilize a wide range of techniques to minimize impervious cover at development site (Table 5) that collectively can reduce imperviousness by 10 to 50%. *(See Technical Notes 38 and 39 in this issue.)*

Table 4: Proposed protocol for defining functional relationships between watershed imperviousness and stream quality

- **General study design**
  A systematic evaluation of stream quality for a population of 20 to 50 small subwatersheds that have different levels of watershed imperviousness. Selected field measurements are collected to represent key hydrological, morphological, water quality, habitat and biodiversity variables within each defined subwatershed. The population of subwatershed data is then statistically analyzed to define functional relationships between stream quality and imperviousness.
- **Defining reference streams**
  Up to 5 non-urban streams in same geo-hydrological region, preferably fully forested, or at least full riparian forest coverage along same length. Free of confounding NPS sources, imperviousness less than 5%, natural channel and good habitat structure.
- **Basic Subwatershed Variables**
  Watershed area, standard definition and method to calculate imperviousness, presence/absence of BMPs.
- **Selecting subwatersheds**
  Drainage areas from 100 to 500 acres, known level of imperviousness and age, free of confounding sources (active construction, mining, agriculture, or point sources). Select three random non-overlapping reaches (100 feet) for summer and winter sampling of selected variables in each of five key variables groups:
  1. **Hydrology variables:** summer dry weather flow, wetted perimeter, cross-sectional area of stream, peak annual storm flow (if gaged).
  2. **Channel morphology variables:** channel alteration, height, angle and extent of bank erosion, substrate embeddedness, sediment deposition, substrate quality.
  3. **Water quality variables:** summer water temperature, turbidity, total dissolved solids, substrate fouling index, EP toxicity test, wet weather bacteria, wet weather hydrocarbon.
  4. **Habitat Variables:** pool- riffle ratio, pool frequency, depth and substrate, habitat complexity, instream cover, riffle substrate quality, riparian vegetative cover, riffle embeddeness
  5. **Ecological Variables:** fish diversity, macroinvertebrate diversity, index of biological integrity, EPA Rapid Bioassessment Protocol, fish barriers, leaf pack processing rate.

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Table 5: Twenty-four strategies to minimize impervious area at the site level ***(adapted from City of Olympia, 1994; Schueler. 1995; and PZC, 1992)***

1. Narrower residential road widths
2. Reduced road lengths
3. Hourglass streets
4. Cluster development
5. Shared driveways
6. Angled parking with one way traffic flow
7. Smaller parking stalls
8. Reduced parking space ratios for some uses
9. Shared parking facilities in commercial areas
10. Shorter residential driveways
11. Reduced cul-de-sac radii
12. Cul-de-sac donuts
13. Vertical parking structures
14. Two and three story buildings
15. Stream buffers
16. Grass swales rather than curb/gutters
17. Open space requirements (residential)
18. Open space landscaping requirements (comm).
19. Sidewalks only on one-side of street
20. Reduced side and rear yard setbacks
21. Decrease distance between lots (frontage)
22. Hammerhead-shaped turnarounds
23. Rear yard grading to buffer
24. Permeable spillover parking areas

Conclusion

Research has revealed that imperviousness is a powerful and important indicator of future stream quality and that significant degradation occurs at relatively low levels of development. The strong relationship between imperviousness and stream quality presents a serious challenge for urban watershed managers. It underscores the difficulty in maintaining urban stream quality in the face of development.

At the same time, imperviousness represents a common currency that can be measured and managed by planners, engineers and landscape architects alike. It links activities of the individual development site with its cumulative impact at the watershed scale. With further research, impervious cover can serve as an important foundation for more effective land use planning decisions.

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CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS

BEST MANAGEMENT PRACTICES STUDY

Prepared by

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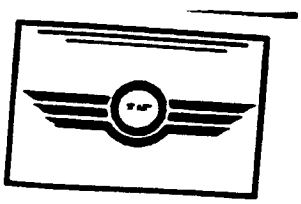
August 1992



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EXECUTIVE SUMMARY

... sewer systems. ... Best Management Practices Study was prepared by James M. Montgomery, Consulting Engineers, Inc. and Uribe & Associates for CCSF's Bureau of Environmental Regulation and Management (BERM).

STUDY OBJECTIVES

The principal objectives of this study were as follows:

- Comply with San Francisco Bay Basin Regional Water Quality Control Board (Regional Board) Order No. 90-093 to evaluate the cost-effectiveness of implementing eight optional Best Management Practices (BMPs).
- Determine CCSF's primary constituents of concern by comparing the discharge concentrations with existing and pending water quality limitations for San Francisco Bay and the Pacific Ocean.
- Identify the probable sources of CCSF's constituents of concern and develop an estimate of pollutant mass loadings from industrial, residential, and commercial discharge sources.
- Develop and evaluate additional dry and wet weather source control BMPs to reduce the sewer loadings of problem pollutants as close to their source as possible.
- Determine whether recommended BMP implementation measures would provide sufficient reductions of targeted pollutants to comply with effluent discharge limitations without installation of costly end-of-pipe treatment facilities.

PROJECT BACKGROUND

CCSF operates and maintains a combined sewer overflow (CSO) system and three treatment facilities to handle its wastewater and wet weather flows. The sewer system is divided into two drainage basins, referred to as the Bayside and Westside drainage basins. The Richmond-Sunset Water Pollution Control Plant (RSWPCP), which services the Westside drainage area, is designed to provide primary treatment for an average dry weather flow (ADWF) of 22 million gallons per day (mgd), and discharges to the Pacific Ocean via a 4.5-mile outfall. The Southeast Water Pollution Control Plant (SEWPCP) has a capacity to provide primary and secondary treatment for a design ADWF of 85 mgd in the Bayside drainage area. The SEWPCP secondary effluent is discharged to San Francisco Bay through a deep water outfall at Pier 80 (Army Street terminal). The North Point wet weather treatment facility, which also discharges to the Bay, can provide up to 150 mgd of primary treatment for wet weather overflows exceeding the dry weather treatment capacities. A new Oceanside WPCP will replace the RSWPCP in 1994 and provide secondary treatment prior to discharging to the ocean outfall. A layout of the CCSF service area is illustrated in Figure ES-1.

In June 1990, RSWPCP received a revised NPDES discharge permit (EPA Permit No. CA0037681/Regional Board Order No. 90-093). Among the new permit conditions, CCSF was required to implement ten BMPs (referenced in this study as "Mandated BMPs"), to study the cost-

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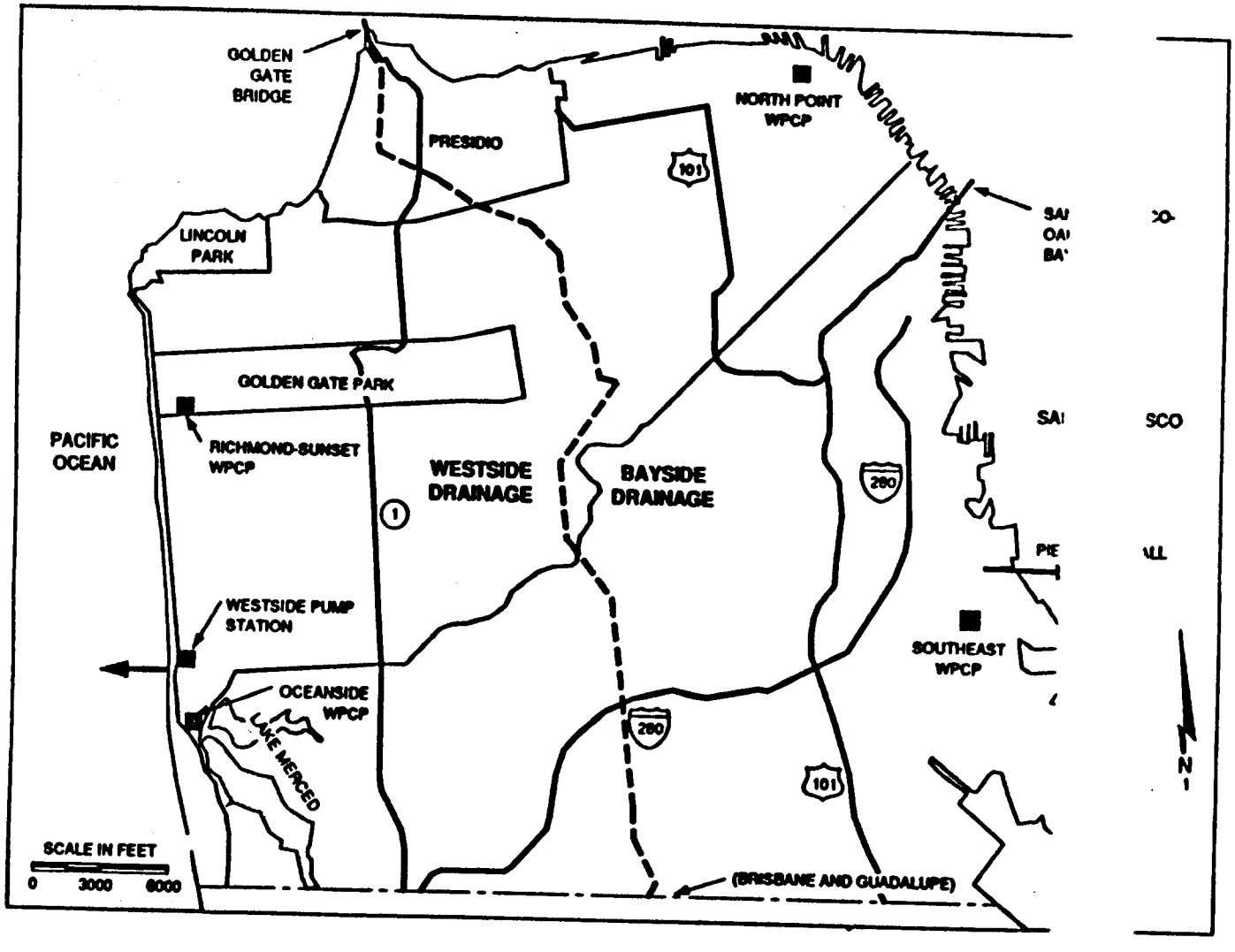

CCSF SERVICE AREA

FIGURE ES-1

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effectiveness of implementing eight other BMPs suggested by the Regional Board (termed "Optional BMPs"), and to investigate additional measures to minimize the amount of pollutants in the wet weather overflows. These Mandated and Optional BMPs were originally intended to

In December 1991, the Regional Board adopted stringent effluent limits for toxic pollutants into the revised Basin Plan. The California State Water Resources Control Board (SWRCB) has not yet approved the Basin Plan. However, no changes to the numerical limits are expected prior to approval. In general, CCSF will have until April 2001 to comply with the Basin Plan. Before constructing costly end-of-pipe treatment facilities, dischargers are required to implement source control measures and BMPs designed to reduce the discharge of pollutants to the maximum extent possible. Dischargers are allowed until April 1996 to implement these measures and evaluate their effectiveness. The evaluations and recommendations for both the dry weather and wet weather BMP programs are described together in this report in order to consolidate the information and to present a unified and cohesive program.

EXISTING SERVICE AREA CONDITIONS

The CCSF service area consists of an approximately 900-mile underground sewer collection and conveyance system. All but one percent of CCSF's collection system serves as a combined sanitary-stormwater system, collecting stormwater runoff in the same set of pipes that transport sanitary waste. Commercial and industrial wastewaters are also serviced by this combined system.

Influent Flow Characteristics

Although the zoning characteristics of the two drainage basins are different, the composition of the influent wastewaters at the two treatment facilities is fairly similar. Table ES-1 lists the average 1991 concentrations of nine heavy metals in the SEWPCP and RSWPCP influents. No cyanide data were available from the RSWPCP facility.

The influent concentrations of the nine metals observed at RSWPCP and SEWPCP demonstrated a similar trend. In general, the two influents are fairly similar in terms of both average concentration and degree of variability throughout the year. Overall, the SEWPCP influent concentrations tend to be slightly higher and are characterized by more variability for the metals typically associated with commercial and industrial activities; such as silver, zinc, and lead.

Effluent Discharge Requirements

Table ES-2 presents the expected NPDES effluent discharge requirements for constituents of concern from the SEWPCP and the RSWPCP/OWPCP outfalls. The ocean discharge limits are currently in place, while the proposed Basin Plan limits (addressing Bay discharges) are expected to be incorporated into SEWPCP's 1994 NPDES permit revision. As seen from this table, the effluent limitations for Bay discharge are significantly lower than those required for ocean discharge. The SEWPCP effluent discharge requirements will therefore be the driving force behind CCSF-wide source reduction measures. Numerical limitations currently do not exist in San Francisco Bay for stormwater overflows of the CCSF combined sewer storage and transport system.

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TABLE ES-1

1991 AVERAGE INFLUENT METALS CONCENTRATIONS

	RSWPCP Influent (µg/L)	SEWFCP Influent (µg/L)	Percent Difference (%)
Arsenic	3.1	3.2	3
Cadmium	8.5	6.7	21
Chromium (t)	16.1	10.4	35
Copper	89.8	115.8	22
Lead	18.4	34.1	46
Mercury	0.93	1	7
Nickel	18.3	16	13
Silver	8.3	15.4	46
Zinc	218	352	38

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TABLE ES-2

COMPARISON OF EFFLUENT LIMITS FOR POLLUTANTS

Parameter	Basin Plan Effluent Limits (a)	Ocean Discharge Effluent Limits (b)	
	Daily Average (µg/L)	6-month Median (µg/L)	Daily Maximum (µg/L)
Arsenic	360	388	2236
Cadmium	92	77	308
Chromium (VI)	500	154	616
Copper	17	79	772
Lead	53	154	616
Mercury	0.21 (c)	3	12
Nickel	65	385	1540
Silver	23	42	203
Zinc	840	932	5552
Cyanide	10	77	308
PAHs	0.31 (c)	--	0.68

(a) Limits will be implemented in 1994.
(b) Based on June 20, 1990 updated waste discharge requirements for CCSF's Oceanside treatment facility and southwest ocean outfall.
(c) Limit applies to the 30-day average concentration.

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Focus of BMP Efforts on SEWPCP Requirements

Bayside drainage basin and the SEWPCP. Where applicable, the BMP implementation steps resulting from analysis of these data will be applied to CCSF as a whole.

ENVIRONMENTAL AWARENESS SURVEY

To assess the general knowledge of the CCSF public about Bay water quality and pollution issues, Public Affairs Management (PAM), in association with Public Research Institute (PRI) of San Francisco State University, conducted an environmental awareness telephone survey of CCSF households. To insure adequate representation of the city's diverse population, the survey employed random digit dialing and interviews were conducted in English, Spanish, and Cantonese. The survey response rate was 51 percent.

Survey Findings

The survey results generally suggested that a broad-based, CCSF-wide educational program aimed at increasing overall awareness about water quality issues and improving waste disposal practices would be quite effective. With a few notable exceptions, there was remarkably little variation seen in the neighborhood and demographic breakdowns in how the citizens who were surveyed responded to many questions. It was determined that a special targeting strategy aimed at specific groups or particular neighborhoods would not yield substantially better results than a broad based, CCSF-wide strategy. The findings from each of the survey focus areas are summarized below.

Household Use of Toxic Materials. The most commonly used toxic materials were nail polish removers (51%), motor oil (47%), and house paint (42%). Relatively small numbers of households used root eradicators (3%) and photographic chemicals (3%). Households that maintain a yard or garden were more likely than those that do not to report use of weedkillers, yard fertilizers, root eradicators, house paint, motor oil, antifreeze, and metal polishes. Households that have a garage used for storage were more likely than those that do not to report use of yard fertilizers, solvents, house paint, motor oil, antifreeze, metal polishes, and nail polish removers. Those with garages used as workshops reported highest use of solvents, paint, motor oil, nail polish removers, and art materials. In general, homeowners were much more likely than renters to report high rates of using various toxic materials, including house paint and motor oil.

Perceived Health Risks of Using Toxic Materials. More than two out of five respondents associated great health risks with solvents, drain cleaners, and pesticides. The smallest health risks were associated with yard fertilizers, metal polishes, and nail polish removers. Respondents admitted considerable ignorance regarding the health risks of certain products, particularly photographic chemicals and root eradicators. Nearly one in four respondents said they did not know the health risks of using motor oil. In general, female respondents were much more likely than male respondents to perceive great health risks in using various toxic materials. Age and education proved to be very weak predictors of perceived health risks.

Levels of Environmental Awareness. Overall, survey respondents displayed a very high level of awareness and concern for the environment. Three out of five respondents who regularly use public transportation said that one very important reason for doing so was to reduce pollution. Majorities or near-majorities of respondents said that they always read product labels for warnings, are aware of the provisions of Proposition 65, use the curbside recycling pickup services in their

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neighborhoods, and are aware of the Bay and Ocean pollution caused by disposal of toxic substances down the drains. Sizable numbers of respondents reported that they always make an effort to purchase non-toxic and environmentally safe products and that they are aware of the

as "inappropriate" if they involved dumping such materials down the drains, on the ground, or in the trash. The percentages of product users who employed such inappropriate disposal practices ranged from 8% in the case of antifreeze to 48% in the case of art materials. More than one in five house paint users practiced inappropriate disposal methods, and 10% of motor oil users said that they did so. No strong or consistent predictors of inappropriate disposal practices were found in the case of motor oil and house paint, although nonwhite race (African American, Latino, Asian and Other) and lower education were weak predictors of using such methods. Under the heading of inappropriate disposal practices, reported rates of drain or ground disposal were relatively low compared with rates of disposal in the trash. More than 70% of those who used inappropriate methods to dispose of motor oil and house paint said that they did so by using the trash. More than 40% of respondents said they were aware of the HHWCF, and nearly 20% said they had used that facility at least once during the past year. White respondents and homeowners who live in the southern parts of CCSF were most likely to report awareness and use of the HHWCF.

Willingness to Pay for New Disposal Services and Educational Programs. More than 70% of survey respondents said that they definitely would use a curbside pickup service for disposing of motor oil and latex paint if such a new service were offered. A large majority of those who would use such a service claimed to be willing to pay at least 25 cents/month in fees for it, and many would pay as much as 50 cents/month. The desire for this service appears to be very broad-based and CCSF-wide in its scope. Respondents also displayed overwhelming majority support for greater CCSF efforts to educate the public about toxic materials and their proper disposal and for more stringent regulatory policies. Most of those who expressed support for such initiatives said they would be willing to pay at least 25 cents/month to finance them. The desire for these new programs also is very broad-based and citywide in its scope.

Perceived Sources of Water Pollution. Majorities of survey respondents assigned greatest blame for water pollution to manufacturers, commercial businesses, and auto shops. Fewer than one in four respondents identified households themselves as a major source of water pollution. Although these opinions appear to be broad-based and CCSF-wide in scope, affluent and college-educated respondents were most likely to assign blame to government offices, manufacturers, and commercial businesses.

Sources of Information about Environmental Problems and Issues. Most household respondents (41%) said they rely mainly on newspapers as their primary source of information about environmental problems and issues, followed by television (21%), magazines (7%), word of mouth (3%), and radio (2%). A significant number of respondents (21%) said they rely mainly on "other" sources for such information. Analysis reveals that many of these respondents are members of environmental organizations and have access to valuable informational resources which are unavailable to nonmembers. Nonwhite respondents (African American, Latino, Asian and Other) and homeowners were most likely to depend on television for information about the environment, whereas upper-income and college-educated respondents were most inclined to use newspapers.

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SELECTION OF DRY WEATHER BMPs

1) The problem pollutants for the CCSF service area were identified by comparing the SEWPCP effluent concentrations of eleven pollutants to the proposed Basin Plan limits. Table ES-3 compares the SEWPCP effluent concentrations in 1991 against the Basin Plan limits. Four pollutants were identified as exceeding the Basin Plan limits, and thus termed "primary pollutants of concern." These pollutants are listed below.

   - Copper.
   - Mercury.
   - Cyanide.
   - Polynuclear aromatic hydrocarbons (PAHs).

   In addition to the above pollutants, four other metals (lead, nickel, silver, and zinc) have also been considered in the evaluation of BMPs as their effluent concentrations were generally within 30 percent of the Basin Plan limits.

2) Extensive information collection efforts were undertaken, consisting of nation-wide telephone interviews of public agencies and a computerized literature search. CCSF sought to learn from the experiences of other municipalities facing similar permit conditions and requirements. While most of the agencies contacted conducted or planned to implement one or more BMPs or other source control measures, relatively few have comprehensive programs in place. The BMPs being implemented were targeted primarily at wet weather and non-point source runoff.

3) Contributions of problem pollutants to the SEWPCP influent loading from four major source categories (water supply, residential, industrial, and commercial/other businesses) were estimated. The percentages of influent loadings from each of these sources are presented in Figure ES-3. Review of contributions from these source categories indicated that source reduction efforts geared towards residential and commercial/other business sources would likely result in the greatest loadings reductions at the SEWPCP. Unidentified sources are included in the commercial/other businesses category.

4) Dry weather BMPs were selected for further evaluation based on an examination of the specific water supply, residential, and commercial/other business sources that needed targeting to obtain the greatest reduction in the identified problem pollutants. Table ES-4 lists the principal identified sources for the seven pollutants of concern with respect to the four major source categories. Industrial sources are already regulated very effectively by BERM. They were not considered for the detailed BMP investigations.

The eight Optional BMPs suggested by the Regional Board were divided between the dry and wet weather evaluations. Four of these Optional BMPs were included among the 13 dry weather BMPs, while the other four were evaluated among the wet weather BMPs.

CCSF is conducting a separate concurrent study to investigate the sources of cyanide in its wastewater streams. This effort included an extensive sampling of CCSF businesses for cyanide. However, this sampling effort did not identify any major contributors of cyanide that are currently unregulated. Potential cyanide sources considered in this BMP selection process were photoprocessing facilities, scrubber operations, and paint products.

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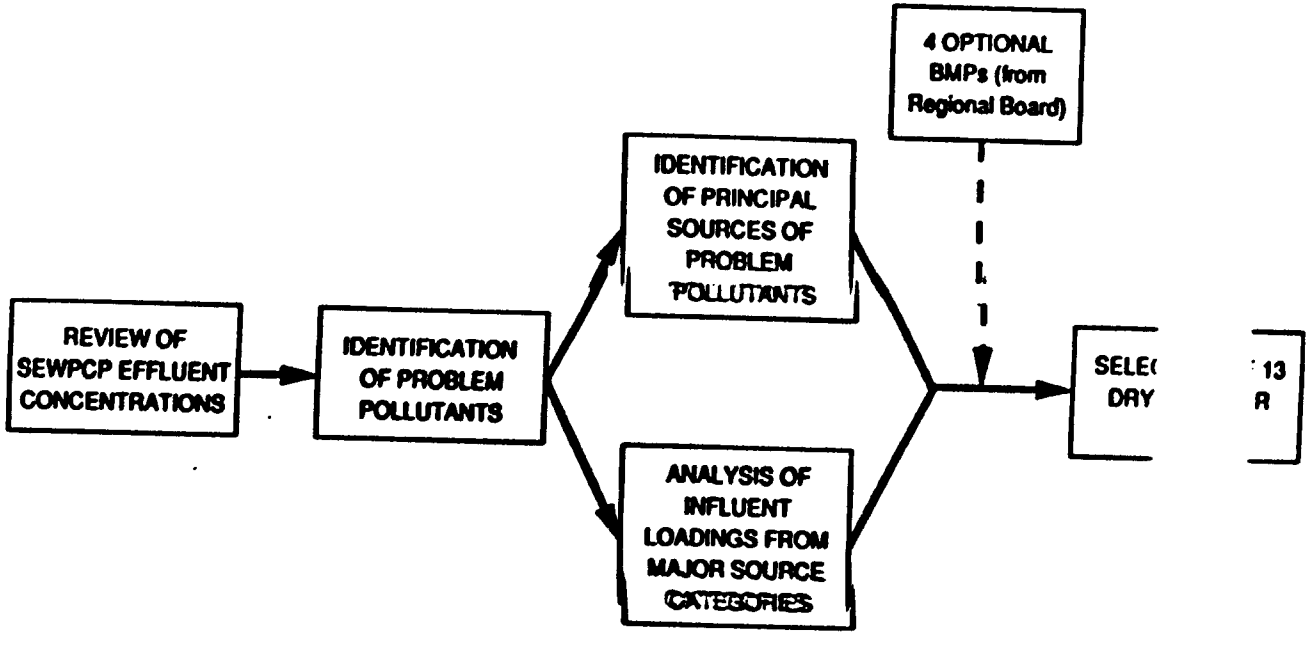

DRY WEATHER BMP SELECTION PROCESS

FIGURE ES-2

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TABLE ES-3

SEWPCP 1991 EFFLUENT POLLUTANT CONCENTRATIONS VERSUS BASIN PLAN LIMITS

Constituents	Southeast WPCP Effluent Concentrations (µg/l)				Basin Plan Effluent Limits (µg/L)
	Average	95th Percentile	99th Percentile	Maximum	
Arsenic	2.6	5	6.6	6.6	360
Cadmium	6.4	15.3(b)	15.3(b)	15.3	92
Chromium	3.3	6	7.6	9.1	500
Copper	22.5	53	70(b)	70	17
Lead	4.7	12.1	19.6	32.8	53
Mercury	0.2	0.7	1.2	1.8	0.21
Nickel	7.1	14.5	20.4	35.4	65
Silver	2.2	5.7	9.1	15	23
Zinc	67.8	189.6	309	450	840
Cyanide	15.4	26.4	33.1	35	10
PAHs	<1.7	(c)	(c)	7.3	0.31

(a) Limits will be implemented in 1994.
(b) Probability-based percentile values exceed the maximum observed value due to the wide range of values in the data set.
(c) A probability-based analysis of the PAH data was not conducted due to the low number of samples where PAH was detected during 1991.
Note: Shading denotes constituents exceeding Basin Plan Limits.

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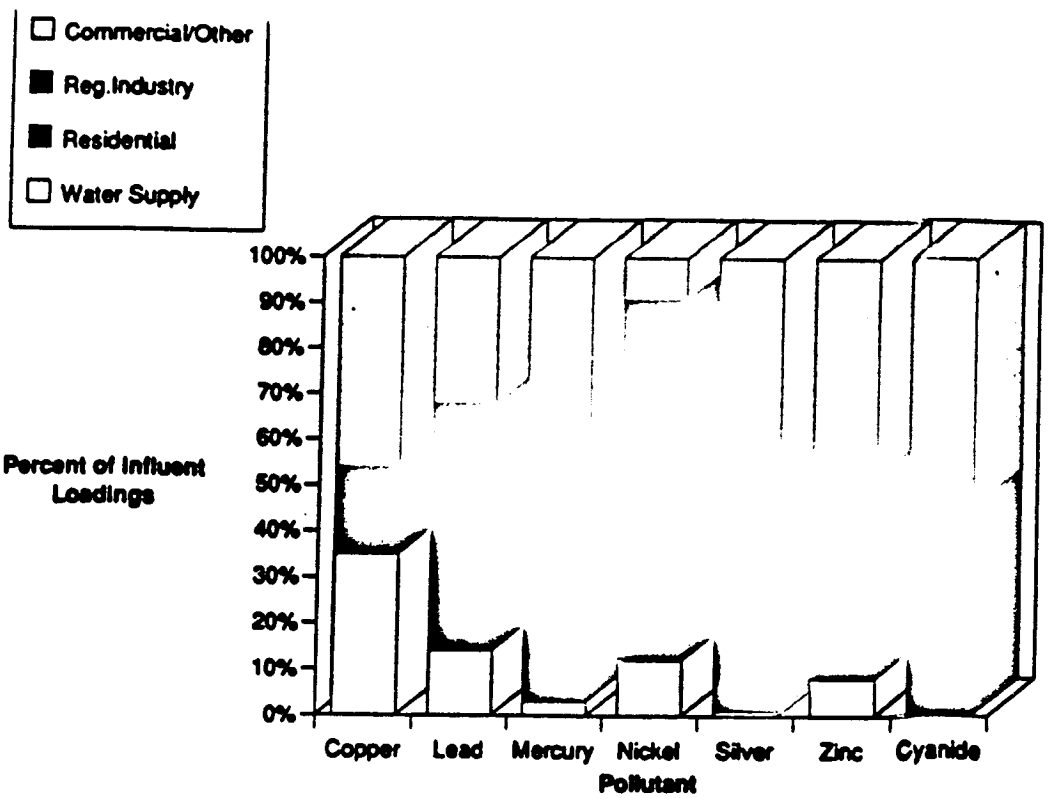

SOURCES OF TARGETED POLLUTANTS IN SEWPCP INFLUENT

FIGURE ES-3

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TABLE ES-4
PRINCIPAL SOURCES OF TARGETED POLLUTANTS(a)

	Water Supply	Residential	Industrial	Commercial	Unesses
Copper	Raw water supply Pipeline corrosion Copper sulfate addition	Root killer products Algicides (pools, ponds) Foods - Dairy/meats/veg. Paints	Hospital Linen Supply Combination Utility Flavoring extract	Cooling Auto Cleanr Paints/fi Electrica	C)
Mercury		Paints Photo wastes Auto fluids Foods - meats/veg./fruits	Hospital Photo Lab Lamp Manufacturers	Painting/f Auto Medical/l Metal ma Labo De	g ur ng es g
Lead	Raw water supply Pipeline corrosion	Paints Photo wastes Auto fluids Home plumbing Foods (fruits/veg./grains)	Hospital Radiator repair Linen supply Car wash	Sheet m Auto - Equipm Painting	
Nickel	Raw water supply Pipeline corrosion	Paints Foods (grains/veg./fruits)	Metal plating Hospital Combination Utility	Auto s Cleaner	
Silver		Photoprocessing Personal care products Polishing	Photochemical Hospital Motion picture labs Printing	Photo/pr Auto s Labor: Dent	
Zinc	Corrosion prevention Raw water supply	Paints Auto fluids Water heaters Cleaners Foods (meats/grains/veg.)	Hospital Sausage Manufacture Laundry Linen supply Flavoring extract	Auto se Print	
Cyanide		Paints Personal Care Products Polishing	Hospitals Newspaper Printing Fabric/Textile Manufacturing	Auto Se Cleaners/l Laborat Resear Paint	

(a) Shading denotes two principal source categories for each pollutant.

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Formation of PAHs may occur by the oxidation of saturated cyclic hydrocarbons in vegetative fuels, such as wood, foliage, and agricultural crop residues. Other sources may include: crude oil

PAHs may be present in some of the identified activities such as automotive service facilities, scrubber operations, and illegal dumping of used oil.

DEVELOPMENT OF DRY WEATHER BMPs

For the thirteen BMPs listed below; the targeted pollutants of concern, implementation measures required, estimated loading reductions, and estimated implementation costs were evaluated.

- BMP No.1 (Optional BMP E2) - Educate public regarding the potential environmental impacts of common household products and the availability of alternatives.
- BMP No.2 (Optional BMP P1) - Develop and implement an aggressive public program to report and prevent dumping of toxic pollutants into sewers and drainage channels.
- BMP No.3 - Ban the use of copper sulfate root killer and educate the public on alternative products.
- BMP No.4 - Educate residents and contractors on metals and cyanide in home improvement products and proper cleaning methods.
- BMP No.5 - Further regulate discharge of photographic wastes.
- BMP No.6 - Regulate automotive service facilities.
- BMP No.7 - Regulate commercial and medical laboratories.
- BMP No.8 - Coordinate with San Francisco Water Department to optimize corrosion control.
- BMP No.9 - Regulate cooling tower and scrubber discharges.
- BMP No.10 - Provide temporary storage of recycle flows during wet weather.
- BMP No.11 (Optional BMP P3) - Develop and implement a program which provides a means of recording the observations of field inspection and maintenance personnel, so this information can be used to help locate the source(s) of pollutants.
- BMP No.12 - Minimize impurities in treatment plant chemicals.
- BMP No.13 - Construct reverse osmosis facilities.

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The sum of these scores for each BMP would form an overall picture of its advantages and disadvantages. Based on their importance to the success and value of a given BMP, the evaluation criteria were divided into two tiers, Tier I and Tier II. The Tier I criteria are considered to be of greater importance in establishing the value of the BMPs.

Minimal empirical data were available on the reduction potential of BMPs. To estimate pollutant reductions, numerous suppliers, vendors, service contractors, business owners, CCSF staff, and Federal, State and local agencies were contacted. Any pertinent literature information was reviewed. Finally, best engineering judgement and reasonable assumptions were used to estimate the potential reductions. The estimates should be considered as reasonable for a cost-effectiveness comparison, but should not be used as definitive loadings. As more experience is gained from working with these sectors, their reduction estimates should be revised accordingly.

Agency cost estimates were prepared at current day value. They are order-of-magnitude estimates that are consistent with planning level analysis. Costs to businesses are expected to be highly variable, and will depend on specific compliance methods selected. These business costs were not included in this analysis.

Cost Effectiveness

Table ES-5 summarizes the estimated loadings and reductions for the thirteen dry weather BMPs. Reverse osmosis (BMP No.13) would have the highest reduction potential, approximately 27,000 pounds per year (lbs/yr) from the effluent loading. BMPs 11 (recording field observations) and 12 (treatment plant chemicals) would not reduce influent loadings to the plant. BMP No.11 would be extremely beneficial for implementation of other BMPs but would not directly result in any influent loading reductions. Among the other BMPs, the following observations on the primary pollutants of concern can be drawn.

- Copper Reduction - The BMPs with the highest reduction potential are water supply (No.8), cooling towers (No.9), public education (No.1), automotive service facilities (No.6), root killers (No. 3) and laboratories (No.7); in that order.
- Mercury Reduction - The BMPs that are expected to reduce mercury loadings are medical and commercial laboratories (No.7), public education (No.1), and home improvement products (No.4). CCSF's efforts to regulate dental facilities should provide additional mercury reduction.
- Cyanide Reduction - BMPs with cyanide reduction potential are public education (No.1), home improvement products (No.4), automotive service facilities (No.6), and laboratories (No.7). In general, the BMPs evaluated were not found to be major sources of cyanide. This concurs with CCSF's Cyanide Evaluation Study. Cyanide was not found in the wastewaters of many small quantity dischargers sampled.

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TABLE ES-5

SUMMARY OF ESTIMATED LOADINGS AND REDUCTIONS
(lbs/yr)

BMP No.(a)	Copper		Lead		Mercury		Nick-
	Total Loadings	Estimated Reductions	Total Loadings	Estimated Reductions	Total Loadings	Estimated Reductions	Total Loadings
1	8,000	400	2,800	140	110	6	2,260
2	15	15	60	60	0.2	0.2	90
3	200	200					
4	40	10					
5					10	2	
6	1,300	260	2,900	580	1	0.1	200
7	370	190	20	10	28	14	310
8	10,000	2,800	800	200			
9	1,600	800					
10	10	10	30	30			
12	15	0	10	0			
13	5,800	5,100	1,200	1,100	40	20	4 1,800

BMP No.(a)	Silver		Zinc		Cyanide	
	Total Loadings	Estimated Reductions	Total Loadings	Estimated Reductions	Total Loadings	Estimated Reductions
1	260	10	34,500	1,720	1,000	50
2			2,850	2,850		
3						
4			3,500	700	30	10
5		500				
6			1,700	350	10	2
7	30	15	300	150	4	2
8						
9			4,600	2,300		
10			50	50		
12	1	0	10	0		
13	600	500	17,600	16,800	4,000	1,800

(a) BMP No. 11 would not directly reduce pollutants of concern.

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- PAHs Reduction - There are minimal data available on the reduction and treatment of PAHs. PAHs are essentially by-products of combustion. The major source of PAHs is

been noted in the literature. However, there is no documentation of quantities in the literature or at other POTWs. In addition, since PAHs are by-products of the combustion process; reduction measures, other than reducing the sources of combustion, may not be readily available.

The cost effectiveness of the BMPs was evaluated in terms of the expected costs of BMP implementation measures per pound of pollutants expected to be removed. The total reductions of each BMP could be calculated as simply the sum of the expected reductions of the individual pollutants. However, this method would not account for the different degrees of toxicity for these compounds. As an example, zinc may be present in higher concentrations than copper prior to exerting the same level of health effects on certain aquatic organisms. This is reflected by their respective effluent limits: 840 µg/l for zinc and 17 µg/l for copper. Therefore, removal of the same quantities of these two compounds would not have the same environmental benefit. This disparity is further compounded by the fact that zinc is generally present in higher concentrations and is more easily removed.

In order to account for the differences in toxicity among the seven pollutants, the total reductions of the BMPs are normalized to a common standard. For this cost effectiveness analysis, copper is arbitrarily selected as the standard reference pollutant. The expected mass reductions of the six other (i.e., non-copper) pollutants analyzed were converted to a copper-equivalent mass reduction by scaling the reductions according to a toxicity conversion factor. The conversion factors used were based on the effluent concentration limits for each pollutant (relative to copper) as contained in the Basin Plan.

Once the expected mass reductions were normalized relative to the copper toxicity "standard," cost effectiveness of the BMPs was evaluated in two ways:

- Annual costs of each BMP were divided by the estimated annual (normalized) reductions of copper, cyanide, lead, mercury, nickel, silver, and zinc.
- Annual costs of each BMP were divided by the estimated annual (normalized) reductions of copper, cyanide, and mercury. These three pollutants are of primary concern for CCSF.

Table ES-6 presents a summary of the annual costs and the cost-effectiveness calculated for the thirteen BMPs. The two most costly options are the two structural BMPs, reverse osmosis (No. 13) and recycle flow storage (No. 10). At an annual cost of $86,900,000; reverse osmosis is the most expensive BMP evaluated. Due to the extremely high costs of BMP No. 13, it is important to note that if it were selected for implementation, fundings for the other BMPs would not be available. Therefore, the annual costs of BMP No. 13 can be used as the benchmark against which the costs of other BMPs can be compared. BMPs 3 (root killer) and 11 (record field observations) are expected to impose the lowest annual costs.

The cost-effectiveness of the non-structural BMPs can be directly compared in Table ES-6. These BMPs would reduce the influent loadings to the SEWPCP. The cost-effectiveness of BMP No.13 can not be directly compared to the non-structural BMPs since the reverse osmosis pollutant removals occur in the effluent loadings rather than by influent source reduction. The BMP cost-effectiveness evaluation is summarized below.

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TABLE ES-6

COST EFFECTIVENESS SUMMARY

BMP No.	Description	Annual Cost ($/yr)	Cost Effectiveness ($/lb removed)(a)	
			7 Pollutants (b)	3 Pollu
1	Educate Public on Household Products	360,000	331	?
2	Program to Report and Prevent Dumping	172,000	1,315	5.
3	Root Killers	7,000	35	
4	Home Improvement Products	37,000	182	1
5	Photographic Wastes	76,000	205	1
6	Automotive Service Facilities	89,000	187	?
7	Commercial and Medical Laboratories	81,000	58	
8	Corrosion Control with SFWD	320,000	112	1
9	Cooling Tower	101,000	119	1
10	Temporary Storage of Recycle Flows	552,000	26,699	55
11	Program to Record Field Observations	11,000	NA	1
12	SEWPCP Chemicals	150,000	NA	1
13	Reverse Osmosis	86,900,000	(d)	

(a) Pollutant reductions used for this ratio were normalized according to toxicity.
(b) Cost effectiveness calculated based on estimated reduction of all 7 pollutants of concern: copper, cyanide, lead, mercury, nickel, silver, and zinc.
(c) Cost effectiveness calculated based on estimated reduction of the 3 primary pollutants of concern: copper, cyanide, and mercury.
(d) The BMP No. 13 unit costs were not included in this comparison since the pollutant removals occur in the effluent loadings rather than by influent source reduction.
NA - Not Applicable. No reductions in this category are expected.

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Based on Reduction of All Seven Pollutants:

- BMPs 1 (public education), 2 (used oil collection), and 5 (photographic wastes) are slightly less cost-effective. However, their unit costs are still significantly less than the unit costs of the structural BMPs (10 and 13).
- A unit cost for BMPs 11 (record field observations) and 12 (SEWPCP chemicals) cannot be calculated. These BMPs would not reduce any of the pollutants of concern.

Based on Reduction of Three Primary Pollutants:

- BMPs 3 (root killer), 4 (home improvement products), 7 (medical and commercial laboratories), 8 (corrosion control), and 9 (cooling towers) are very cost effective.
- BMPs 1 (public education) and 6 (automotive service facilities), are slightly more costly. However, their unit costs are still significantly less than the unit costs of the structural BMPs.
- Unit costs for BMPs 5 (photographic wastes), 11 (record field observations), and 12 (SEWPCP chemicals) cannot be calculated. These BMPs would not reduce any of the primary pollutants of concern.
- The unit cost of BMP No. 2 (curbside oil collection) would be similar to that of reverse osmosis. However, BMP No. 2 would also reduce PAHs, organics, oil and grease to the treatment plants. In addition, the cost of this BMP could be reduced with a direct user fee. The environmental awareness survey determined that the public would be willing to pay directly for this service.

The cost effectiveness of these BMPs is shown graphically in Figures ES-4 and ES-5.

Non-Economic Evaluation

In accordance with the BMP Study Plan (CCSF 1991E), the BMP evaluation criteria were divided into two tiers, Tier I and Tier II, based on their importance to the success and value of a given BMP. These Tier 1 and Tier II non-economic criteria are listed below.

Tier I Non-Economic Criteria:

- Time to achieve results.
- Compatibility with other CCSF programs.
- Legal changes required.
- Effluent limits.

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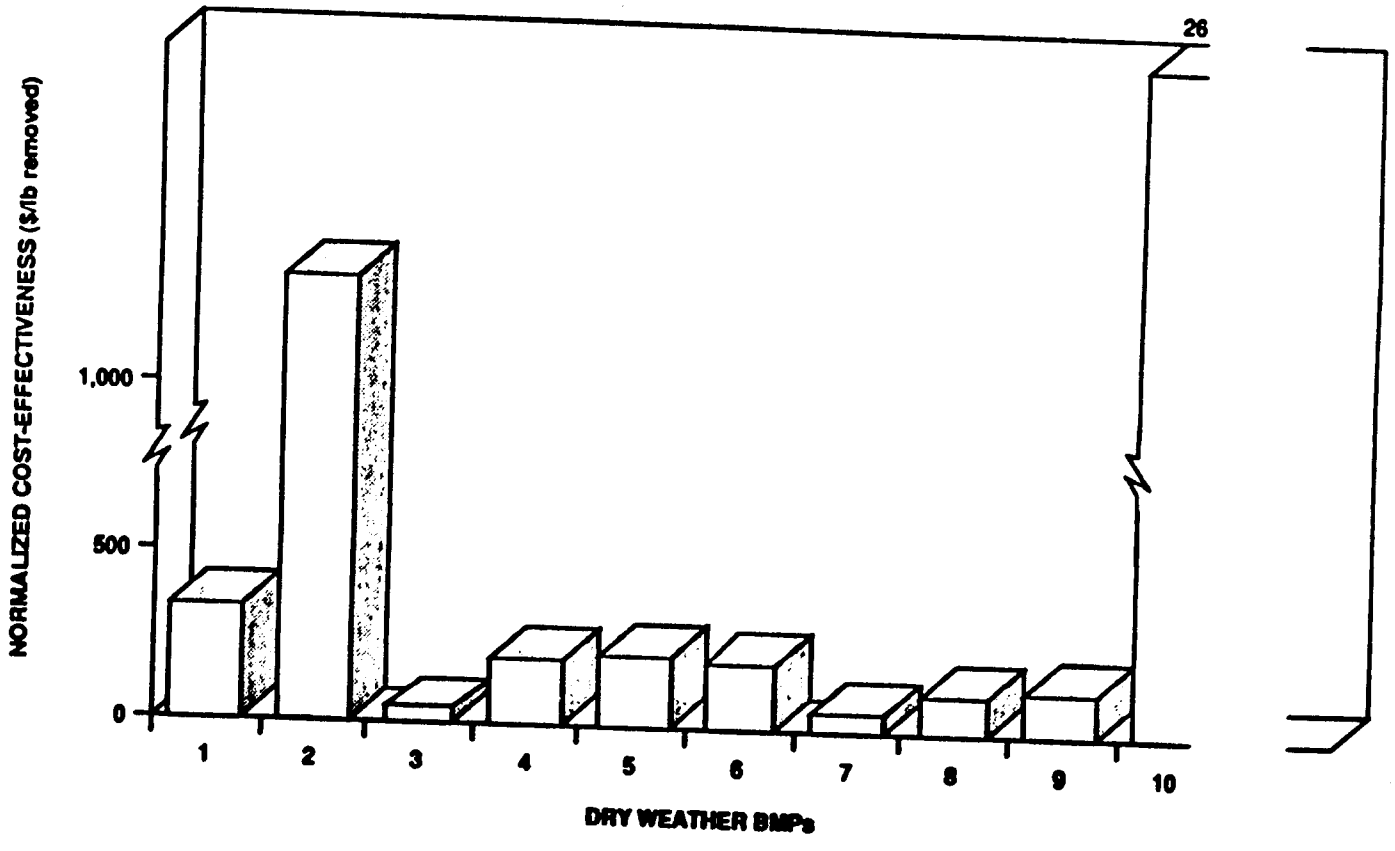

BMP COST EFFECTIVENESS
(Based on Seven Pollutants of Concern and Normalized by Copper-Equivalent Toxicity)

FIGURE ES-4

R0057442

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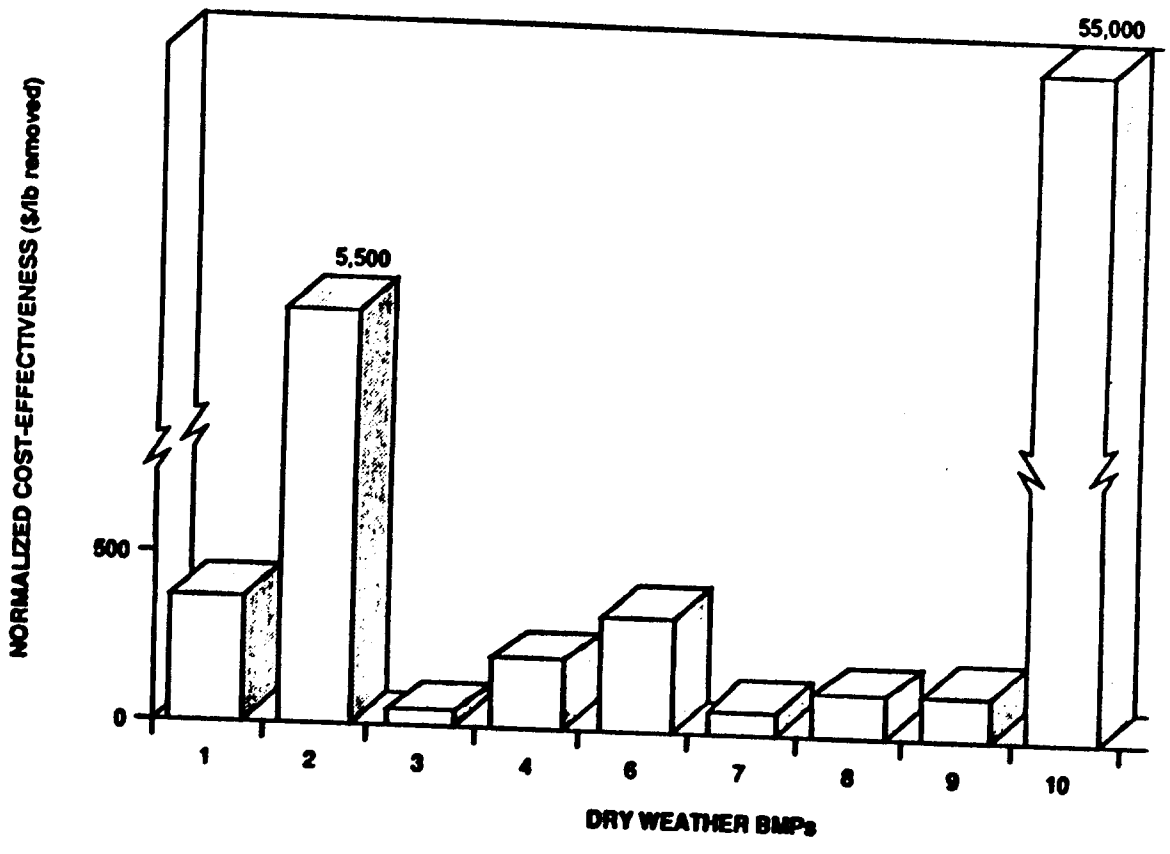

BMP COST EFFECTIVENESS
(Based on Three Primary Pollutants of Concern and Normalized by Copper-Equivalent Toxicity)

FIGURE ES-5

R0057443

Tier II Non-Economic Criteria:

- Environmental impacts
- Cross-media impacts
- Potential to reduce other pollutants

The results of the evaluations of the BMPs versus the Tier I and Tier II non-economic criteria are summarized in Tables ES-7 and ES-8, respectively.

RECOMMENDED DRY WEATHER BMPS

The results of the cost effectiveness and non-economic evaluation are summarized in Table ES-9. Based on the above evaluation, it is recommended that CCSF implement the following BMPs in a two-phased approach. The first phase BMPs should be implemented by the end of Fiscal Year 1993-94. The second phase BMPs should be implemented by the end of Fiscal Year 1995-96. This two-phased approach would allow CCSF to focus on measures that would have the most impacts. The experience gained from these initial BMPs can then be easily applied to subsequent BMPs.

The BMPs selected for Phase I implementation are cost effective and/or are rated as highly favorable among the non-economic criteria. These BMPs include the following:

- BMP No. 8 (corrosion control). This BMP would have the highest potential for significant reduction of copper. The unit cost of this BMP could increase depending on the results of the corrosion control study by SFWD.

- BMPs 6 (automotive service facilities), 7 (medical and commercial laboratories) and 9 (cooling towers). Laboratories and cooling towers are currently unregulated and may be significant contributors of copper and mercury. Radiator repair and car washes are currently regulated by BERM. However, many other businesses related to automotive service (auto dealers, body shops, gas stations, general repair, trucking, buses, and fleet services) may also be significant contributors.

- BMP No. 3 (copper sulfate root killer). This BMP represents the most easily identifiable residential contribution. Cost of implementation would be extremely low.

- BMPs 1 (public education), 2 (used oil collection), and 11 (record field observations). Although these BMPs are not considered especially cost effective in terms of pollutant reductions, they should be applied as general measures rather than to target specific pollutants. Additionally, a strong program focusing on residential contributions and reductions is an integral part of an overall source reduction program.

The single Phase II BMP will be BMP No.4 (home improvement products). This BMP is slightly more cost effective than some of the Phase I BMPs, but had slightly lower non-economic ratings. As part of BMP No. 4, boatyards within CCSF should be inspected and considered for regulation. This BMP should be initiated approximately two years after the Phase I BMPs.

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TABLE ES-7

TIER I NON-ECONOMIC EVALUATION

BMP	Description	Other Tier I Criteria				
		Time to Achieve Results	Compatibility with Other CCSF Programs	Legal Changes Required	Effluent Limits	tal(a)
1	Educate Public on Household Products	-	+	+	0	2.5
2	Program to Report and Prevent Dumping	+	+	-	+	3.0
3	Root Killers	+	+	+	+	4.0
4	Home Improvement Products	-	+	+	0	2.5
5	Photographic Wastes	-	+	0	-	1.5
6	Automotive Service Facilities	+	+	+	+	4.0
7	Commercial and Medical Laboratories	+	+	+	+	4.0
8	Corrosion Control with SFWD	0	+	+	+	3.5
9	Cooling Tower	+	+	+	+	4.0
10	Temporary Storage of Recycle Flows	0	-	+	-	1.5
11	Program to Record Field Observations	+	+	+	0	3.5
12	SEWPCP Chemicals	-	0	+	-	1.5
13	Reverse Osmosis	0	-	-	+	1.5

(a) Total is the average of Tier I Criteria, multiplied by a factor of 2; where "+" is assigned a value of 2, "0" is assigned a v and "-" is assigned a value of 0.

R0057445

TABLE ES-8

TIER II NON-ECONOMIC EVALUATION

BMP	Description	Tier II Criteria							Total(a)
		Ease of Implementation CCSP	Ability to Measure Results	Public Acceptance	Promote Public Awareness	Environmental Impacts	Cross Media Impacts	Pot to R Other P	
1	Educate Public on Household Products	0	-	◆	◆	◆	◆		1.6
2	Program to Report and Prevent Dumping	◆	-	◆	◆	◆	◆		1.7
3	Root Killers	◆	-	◆	◆	◆	◆		1.6
4	Home Improvement Products	0	-	◆	◆	◆	0		1.4
5	Photographic Wastes	◆	0	-	◆	◆	◆		1.6
6	Automotive Service Facilities	◆	0	◆	◆	◆	0		1.7
7	Commercial and Medical Laboratories	◆	0	◆	0	◆	0		1.6
8	Corrosion Control with SFWD	◆	-	◆	0	◆	◆		1.4
9	Cooling Tower	◆	0	◆	0	◆	◆		1.6
10	Temporary Storage of Recycle Flows	-	-	0	-	0	0		0.6
11	Program to Record Field Observations	◆	-	◆	-	0	◆		1.1
12	SEWPCP Chemicals	◆	-	0	-	0	◆		1.0
13	Reverse Osmosis	-	◆	-	-	-	-		0.6

(a) Total is the average of Tier II Criteria, where "◆" is assigned a value of 2, "0" is assigned a value of 1, and "-" is assigned a value of 0.
Example: Average of BMP No.1 scores (1 "0", 1"-", and 5"◆") = 11/7 = 1.6.

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TABLE ES-9

EVALUATION SUMMARY

BMP No.	Description	Cost Effectiveness ($/lb removed)(a) 7 Pollutants	3 Pollutants	Non-E Evalu
1	Educate Public on Household Products	331	371	[illegible]
2	Program to Report and Prevent Dumping	1,315	5,513	[illegible]
3	Root Killers	35	35	[illegible]
4	Home Improvement Products	182	196	[illegible]
5	Photographic Wastes	205	NA	[illegible]
6	Automotive Service Facilities	187	328	[illegible]
7	Commercial and Medical Laboratories	58	61	[illegible]
8	Corrosion Control with SFWD	112	114	4
9	Cooling Tower	119	126	[illegible]
10	Temporary Storage of Recycle Flows	26,699	55,000	[illegible]
11	Program to Record Field Observations	NA	NA	4
12	SEWPCP Chemicals	NA	NA	[illegible]
13	Reverse Osmosis	(c)	(c)	[illegible]

NA - Not Applicable. No reductions in this category are expected.
(a) Normalized to a copper-equivalent.
(b) The sum of the Tier II and Tier I criteria scores.
(c) The BMP No. 13 unit costs were not included in this comparison since the pollutant removals occur in the effluent loadings rather than by influent source reduction.

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The following BMPs are not recommended for implementation by CCSF.

- BMP No.10 (recycle flow storage). This BMP would require significant physical facilities for minimal reduction. Implementation of this BMP would also reduce site availability at SEWPCP and limit future expansion flexibility.
- BMP No.12 (SEWPCP chemicals). The reduction potential of this BMP would be very minor. Depending on the results of the other BMPs, this BMP may be reviewed after several years for implementation.
- BMP No.13 (reverse osmosis). Capital and operating and maintenance (O&M) costs of this BMP are extremely high. Even with these expenditures, compliance with all the Basin Plan limits would be uncertain. There is no information on cyanide removal efficiency with reverse osmosis, and compliance with this limit may not be achievable. This BMP would generate significant negative impacts associated with high energy usage and generation of residual chemical sludge and concentrated brine that would require alternative disposal. Finally, due to its high annual costs, implementation of this BMP would likely eliminate the CCSF funding available for implementation of the source control BMPs discussed above.

Effluent Quality

Final effluent concentrations are dependent upon the influent loadings and the removal efficiencies at the treatment facilities. In general, removal efficiency is expected to decrease as influent concentration decreases. It is postulated that, at higher concentrations, a larger percentage of the pollutants is in the particulate form rather than the soluble form and is, therefore, more readily removed. For soluble pollutants such as cyanide, lower influent concentrations would result in less opportunities for adsorption and biodegradation. The influent concentrations of copper, cyanide, and mercury are plotted against their removal efficiencies in Figures ES-6 to ES-8. A logarithmic curve fit is shown for each pollutant. While the correlation of these variables are not very strong, the plots generally illustrate the trend of decreasing removal efficiency with lower influent concentrations.

Table ES-10 compares the current effluent 95th percentile concentrations of copper, mercury, and cyanide; their estimated concentrations after the implementation of the recommended BMPs; and the proposed Basin Plan limits. As shown on the table, the implementation of the BMPs may not reduce copper, mercury, and cyanide concentrations to below the Basin Plan limits. Due to the variability inherent in estimating loadings and reductions, the ability to comply with the proposed limits will only become apparent after implementation of these BMPs. However, it must be pointed out that these source reduction measures are the most environmentally acceptable methods to deal with the water quality requirements. There are no direct controls over effluent quality with influent source reduction measures. Final effluent quality is dependent upon influent concentrations and removal efficiencies at the treatment plant. Both factors are known to vary significantly on a day-to-day basis.

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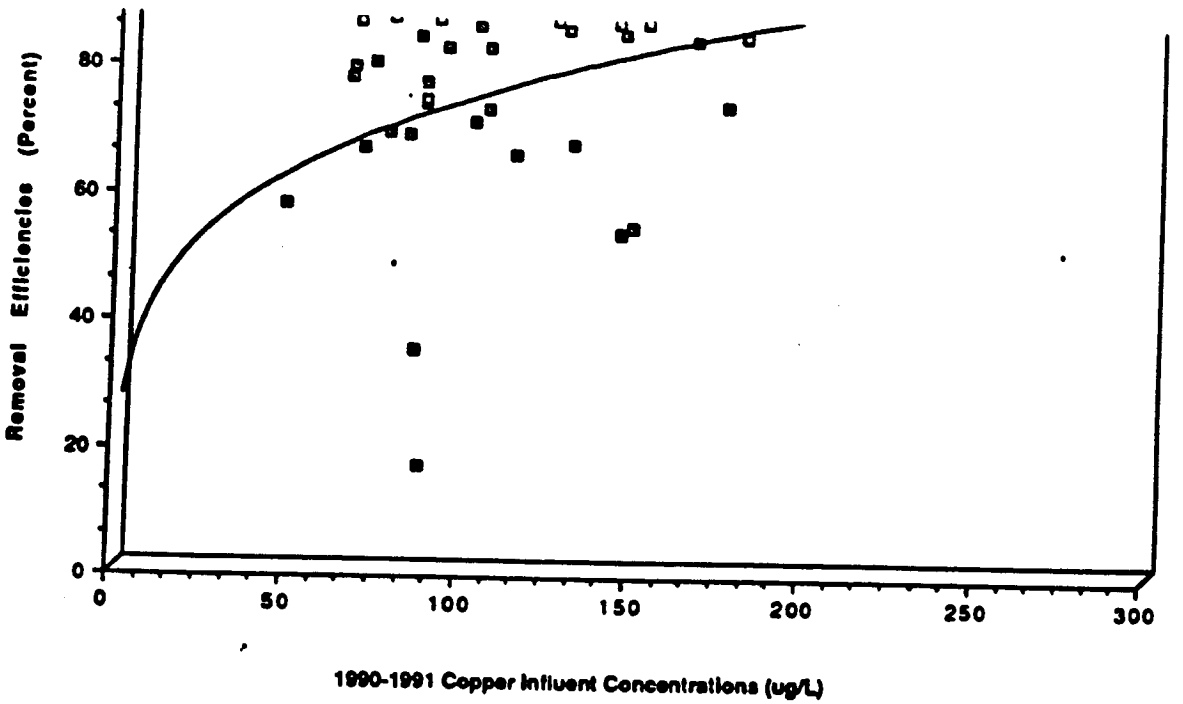

1990-1991 Copper Influent Concentrations (mg/L)

COPPER INFLUENT VS. REMOVAL EFFICIENCY

FIGURE ES-6

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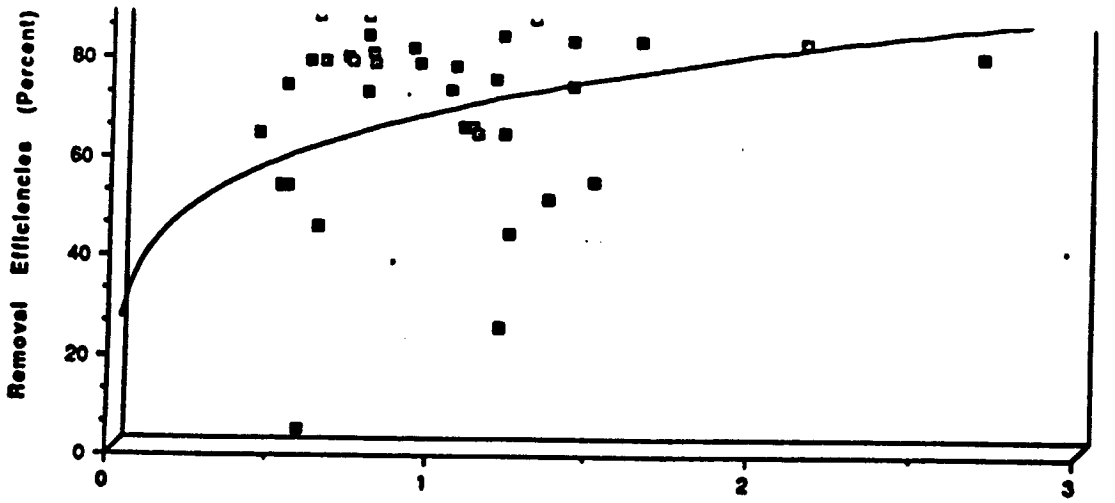

1990-1991 Mercury Influent Concentrations (mg/L)

MERCURY INFLUENT VS. REMOVAL EFFICIENCY

FIGURE ES-7

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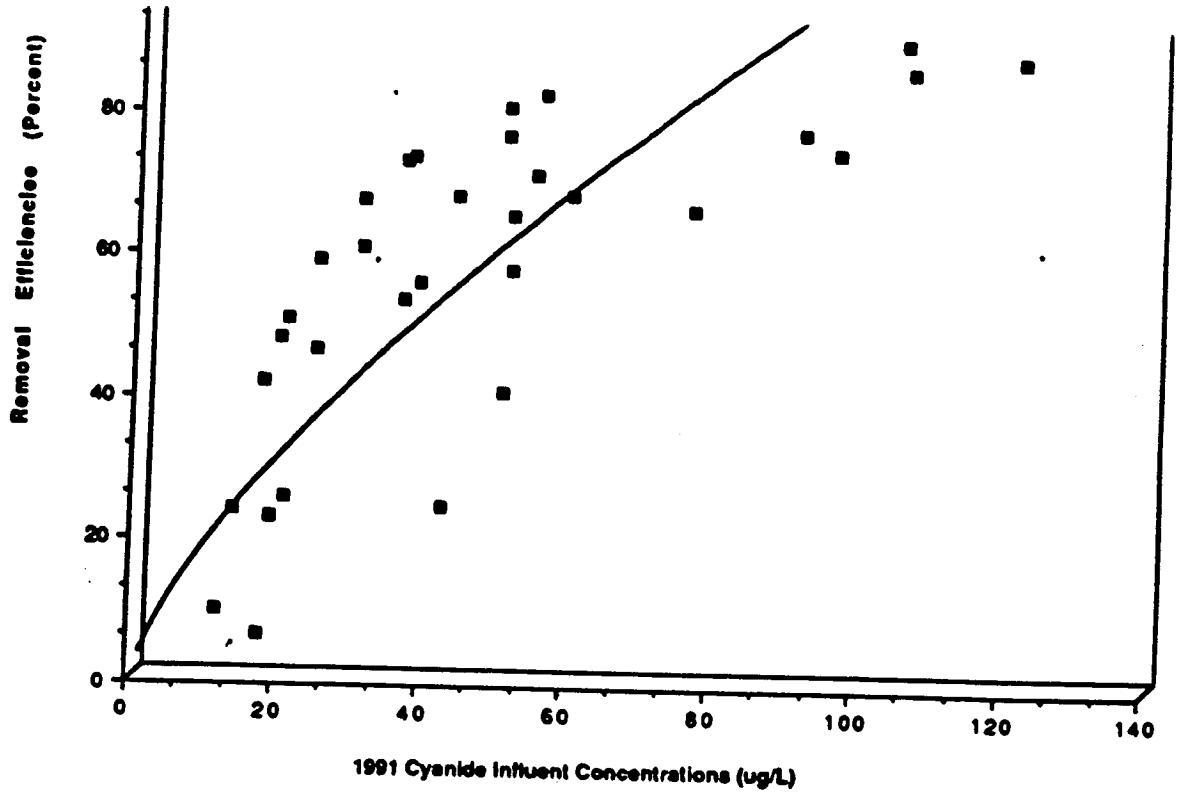

CYANIDE INFLUENT VS. REMOVAL EFFICIENCY

FIGURE ES-8

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TABLE ES-10

ESTIMATED EFFLUENT CONCENTRATIONS (ug/L)

Pollutant	Current Effluent Concentrations (a)	Estimated Effluent Concentrations (a)	Basin Plan Limits
Copper	53	45	17
Mercury	0.7	0.6	0.2
Cyanide	26.4	26	10

(a) Effluent concentrations listed represent the 95th percentile value.

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In addition to implementing source reduction measures, CCSF staff are also investigating other means to comply with the Basin Plan limits. These other potential means are listed below.

approach would consider all significant sources of pollutants (both point and non-point) and would focus on the sources that can most effectively be reduced to comply with the water quality objectives.

- Evaluation of a water reuse master plan to export wastewater from the greater Bay area to the central valley for irrigation reuse. If successful, this project would completely eliminate the discharge of toxic pollutants to San Francisco Bay.
- Evaluation of cross-town tunnel to deliver the entire SEWPCP effluent to an ocean outfall. As indicated earlier in this report, treated effluent from the CCSF wastewater treatment facilities would comply with the Ocean discharge requirements.

CCSF staff is actively participating in the development and evaluation of the above activities. These compliance options will continued to be pursued in conjunction with the implementation of the recommended BMPs.

Cost and Staffing Requirements

The total annual costs and staffing requirements for the recommended Phase I and Phase II BMPs are summarized in Tables ES-11 and ES-12, respectively. The total annual costs to implement all the recommended Phase I BMPs would be approximately $1.2 million per year. Implementation of Phase II (BMP No.4) would impose an additional annual cost of approximately $37,000. Additional staff would be required to implement these BMPs. A public education coordinator and a public education assistant have been listed for BMP No.1. In actuality, they will be providing public participation services for all the recommended BMPs.

Additional Recommendations

CCSF adopted new local limits for its pretreatment program in December 1991. These local limits were developed on a technical basis in accordance with EPA guidelines. However, the effluent limits used in that evaluation were based on the existing NPDES permits and the 1986 Basin Plan discharge limits. As discussed above, the 1991 Basin Plan has proposed significantly more stringent effluent limits. Although these limits are not currently in any CCSF permit, they are expected to be included in the SEWPCP permit when it is scheduled for renewal in 1994. Additionally, imminent changes to the 503 Sludge regulations may also have some impacts on the local limits.

Several of the recommended BMPs would require utilizing local limits as the means for regulation. Since these BMPs have been developed in response to the new Basin Plan, local limits should be re-evaluated. Notification of potential local limits revisions would be beneficial to businesses that are selecting treatment or disposal methods for their wastes.

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TABLE ES-11

DRY WEATHER BMP ANNUAL COST SUMMARY

BMP No.	Description	Annual Cost ($/yr)
Phase I		
1	Educate Public on Household Products	360,000
2	Program to Report and Prevent Dumping	172,000
3	Root Killers	7,000
6	Automotive Service Facilities	89,000
7	Commercial and Medical Laboratories	81,000
8	Corrosion Control with SFWD	320,000
9	Cooling Tower	101,000
11	Program to Record Field Observations	11,000
	Subtotal	**$1,141,000**
Phase II		
4	Home Improvement Products	37,000
	Subtotal	**$37,000**
Total		**$1,178,000**

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TABLE ES-12

STAFFING SUMMARY

BMP No.	Description	Staff (Person/Year)			
		Source Reduction Specialist	Public Education Coordinator	Public Education Assistant	C S
1	Educate Public on Household Products		1	1	
2	Program to Report and Prevent Dumping	0.25			
3	Root Killers	0.08			
4	Home Improvement Products	0.25			
6	Automotive Service Facilities	0.5			
7	Commercial and Medical Laboratories	0.25			
8	Corrosion Control with SFWD	0.04			
9	Cooling Tower	1			
11	Program to Record Field Observations	0.04			
Total		2.5	1	1	

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SELECTION OF WET WEATHER BMPs

their sources. In order to establish its pollutants of concern, San Francisco uses the following general set of criterion, ranked in order of importance:

1. Pollutants exceeding NPDES permit limits;
2. Pollutants potentially contributing to general receiving water problems (e.g. exceedances of water quality standards in either the Ocean Plan, the Enclosed Bays and Estuaries Plan, or the Region II Basin Plan);
3. Pollutants in compliance but near permit limits;
4. Pollutants contributing to bioaccumulation, and/or biomagnification; and
5. Pollutants contributing to existing and potential sediment toxicity problems.

The pollutants of most concern in the wet weather discharges are those that cause a violation of the City's discharge permits. These permits are issued by the Regional Water Quality Control Board (RWQCB) or, in the case of the discharge through the Southwest Ocean Outfall, by the U.S. Environmental Protection Agency (USEPA). Presently, none of the City's discharges during dry or wet weather violate permits or the associated compliance orders.

Although the City's wet weather discharges are currently in compliance, this situation may change as new water quality objectives are incorporated into permits in the coming years. There is an ongoing debate at both the national and state level as to whether and how these water quality objectives should apply to storm water discharges and combined sewer overflows. If these objectives are applied as written to the City's wet weather discharges, the City would be in significant noncompliance with several numerical limits.

To assess the potential for future noncompliance, several monitoring data sources were reviewed to compare pollutant concentrations in the overflow discharges to the selection criterion. The City compared Bayside overflow concentrations from 1989 to 1992 to water quality objectives in the Amendments of the Water Quality Control Plan for Enclosed Bays and Estuaries of California (SWRCB, 1992). As a result of this review, pollutants of concern were grouped into three tiers, in descending order of concern:

Tier 1 **Significant concern** - Three year mean pollutant concentration 10 times greater than potential water quality objective without dilution.

- Polynuclear Aromatic Hydrocarbons (PAHs)
- Copper
- Lead
- Cyanide

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Tier 2 Moderate concern - Three year mean pollutant concentration greater than potential water quality objective without dilution.

- Nickel
- Silver
- Zinc

Tier 3 Little concern - Three year mean pollutant concentration less than potential water quality objective without dilution.

- Chromium
- Arsenic

It is clear that if the water quality objectives are included in the permits and applied to San Francisco's wet weather discharges, then the City will have a serious compliance problem. Therefore, the wet weather portion of the BMP Study focussed on reducing the Tier 1 and Tier 2 pollutants of concern namely PAHs, heavy metals, and cyanide.

Identification of Pollutant Sources

A literature search was conducted to identify the sources of these pollutants. The City reviewed City-specific reports as well as general literature sources on storm water runoff. In addition, City staff from the Bureau of Environmental Regulation and Management (BERM), the Bureau of Street Cleaning and Urban Forestry (BSCUF), and the Bureau of Street and Sewer Repair (BSSR) were interviewed regarding potential sources. As a result of the literature review and information gathering process, the City has identified two broad source classes, primary and secondary. The distinction between primary and secondary sources has been made to help focus the discussion of source control strategies. Pollutants of concern may be reduced more effectively by addressing each of the various pathways by which the pollutants may enter storm water. Primary and secondary sources are defined below.

Primary Sources - These are materials or material uses which provide the first opportunity in an urban setting for pollutant contact with rainfall or runoff. Examples of primary sources are automobiles (which contribute oil, grease, and metals through leaks, exhaust, metal corrosion, and tire wear), waste disposal practices, and raw products exposed to storm water.

Secondary Sources - Some sources of pollutants, termed secondary sources, are difficult to isolate and quantify. These include air-borne particulates and sediments which accumulate throughout CCSF's infrastructure (streets, catch basins, storage/transports, and low-flow sections of sewerage system). Some primary sources become secondary sources when they are not afforded direct entry into stormwater. For example, air-borne pollutants from automobile exhaust may become associated with road dust particules and eventually settle as sediments onto streets and in catch basins. These sediments become a source of pollutants in and of themselves because they may adsorb a certain amount of heavy metals and hydrocarbons under one set of chemical conditions (e.g., pH), and release these pollutants later as a result of changing conditions.

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Primary Sources. Table ES-13 summarizes the primary sources of the City's wet weather pollutants of concern, including both general wet weather sources and commercial/industrial sources. The primary sources of pollutants of concern during wet weather may be grouped into

vehicle emissions are flushed away by rainfall and eventually end up in the sewer system.

- **Paints/Wood preservatives** - Paint and wood preservative products contain a number of heavy metals.
- **Businesses with outside exposure** - Other potential primary sources include businesses with outside storage or manufacturing yards. Businesses that generate and/or discharge pollutants of concern, which may come into contact with rainfall or runoff, are also potential primary sources. These businesses include those that use automotive or paint/wood preservative products such as auto repair shops, painting contractors, and equipment rental shops that often clean their equipment outside with water that later enters the sewer system as runoff.

Secondary Sources. The major secondary source of pollutants in San Francisco is sediment. Sediments occur in the following places throughout the City's wastewater and storm water collection system:

- streets and sidewalks,
- catch basins,
- sewer pipes,
- storage/transports,
- treatment plants, and
- outfalls.

The principal sources of the wet weather pollutants of concern are automotive-related activities, paint/wood preservative uses, businesses with outside exposure, and infrastructure sediments. Of these sources, automotive-related and paint/wood preservatives are discussed by specific best management practices in the dry weather sections (4-6) of this report. Therefore, the target sources for further development of wet weather BMPs are:

- Businesses with outside exposure, including those which use automotive or paint/wood preservative products, and
- Secondary sources (i.e., infrastructure sediments).

Selection of Wet Weather BMPs for Study

As described in the Study Plan, the Optional BMPs were selected from a list of BMPs developed by other Bay Area municipalities. Best management practices were determined to be more effective if based on information specific to San Francisco, including pollutants of concern, sources, and existing programs. Therefore, a screening process was applied to the Optional BMP

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TABLE ES-13

PRIMARY WET WEATHER SOURCES OF POLLUTANTS OF CONCERN

Pollutants of Concern	General	Businesses with
	Gasoline Oil and grease Tar shingles Tires Wood preservatives	
Copper	Algicides Brake linings Paints/wood preservatives Vehicle metal corrosion	Auto Service/Repair Electrical Equipment Manufacturing Metal Finishing Paints/Inks/Printing
Lead	Batteries Paints Vehicle exhaust	Auto Service/Repair Equipment Rental
Cyanide	Animal wastes Cyanogenic insects Microorganisms Vehicle exhaust	Printing/Publishing Metal Finishing Silverware Manufacturing
Cadmium	Gasoline Oil Tires	Auto Service/Repair Metal Finishing
Mercury	Paints	Printing/Paper Hanging Contractors
Nickel	Paints	Wholesale Equipment & Machinery Local Trucking Auto Service/Repair
Zinc	Atmospheric fallout Galvanized iron and steel Paints Tires	Auto Service/Repair Commercial Printing Equipment Rental Local Trucking
Chromium	Vehicle metal corrosion	Auto Service/Repair Metal Finishing

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list to determine if any best management practices should be added or dropped from the original list. The data considered in the selection were primarily qualitative. The steps followed in the selection process are outlined below.

by comparing the Optional BMPs in the context of the City's existing BMP Implementation Program (CCSF, 1990b). The Optional BMPs were reviewed for their ability to compliment the Mandated BMPs for the pollutants of concern and their sources.

2. Data collection - The City gathered qualitative data on the Optional BMPs from City agencies, supported by quantitative data which were easy to gather, reliable, and complete.

3. Data analysis - The information collected was discussed with personnel from the Bureau of Water Pollution Control (BWPC), the Department of Public Health (DPH), the Solid Waste Management Program (SWMP), and the inter-agency BMP Review Committee.

4. BMP selection - Based on the screening process and discussions with City agencies, the City selected five best management practices for further study.

Table ES-14 lists the BMPs that emerged from the selection process and are reviewed in sections 8 and 9. The list includes the four Optional BMPs from the permit as well as an additional best management practice, P6, shown in italics. Each of these five wet weather best management practices appeared to complement the existing BMP Implementation Program either by addressing pollutant sources not covered by the existing program or by using a different means of implementation (e.g., public agency action versus education) to address a source.

DEVELOPMENT OF WET WEATHER BMPs

Having identified the pollutants of concern, their sources, and wet weather BMPs, the following information was developed for each BMP:

- A clear definition and purpose of the best management practice is given.
- Linkages between this best management practices and other BMPs are shown and described. The other BMPs may be Mandated BMPs and/or other Optional BMPs. The linkages may be in the form of target source and/or implementation method.
- A description of the pollutants of concern which the BMP addresses.
- Existing conditions in San Francisco related to this BMP are described. The best management practice is evaluated in part by the need for the BMP and by its "fit" with existing programs.
- Means of implementing the BMP are listed and described.
- Cost and expected reduction information is provided (if available).

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TABLE ES-14

WET WEATHER

Educational Control Measures

E1 - Educate re: the environmental impacts which result from leaks and spills from gasoline, fuel oil, and chemical tanks (above and below ground).

Regulatory Control Measures

R1 - Develop and implement program to reduce the risk of toxic pollutant spills from commercial, industrial, and public facilities.

Public Agency Control Measures

P2 - Establish program to regulate cleaning of sewer inlets, catch basins, and drainage channels in areas where sediments and/or debris tend to accumulate.

P4 - Develop and implement an aggressive field program to search for, detect, and correct situations which rainfall and/or runoff presently contact potential contaminants.

P6 - Determine the effectiveness of various street cleaning practices and implement improved street cleaning programs where appropriate.

EVALUATION OF WET WEATHER BMPs

Evaluation Methodology

The non-economic criteria previously described and used for evaluating the dry weather BMPs was used to evaluate the wet weather BMPs. A ranking system was developed consisting of three possible values: "+", "0", and "-", defined as:

- "+" = Data indicates a positive outcome
- "0" = Insufficient data to determine outcome or criteria not applicable
- "-" = Data indicates a negative outcome

For example, if data indicates that a best management practice is particularly cost-effective, that BMP would be valued a "+" in the evaluation. Conversely, if data indicated that implementation would be relatively expensive, the best management practice would receive a value of "-". Inconclusive data would yield a value of "0". Values of "+" and "-" were only given when data was relatively conclusive, otherwise a value of "0" was recorded. For ranking purposes, the values were assigned the following numerical scores:

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- "+" = 2 points

Each BMP was evaluated against each of the criteria and assigned one of the three possible values. The values were then tallied using the numerical scores. Scores on Tier 1 criteria were weighted twice as heavily as Tier 2 criteria scores. After the scoring, best management practices were ranked in order of decreasing final score. The higher the score, the higher priority a BMP is given for implementation. Table ES-15 is an evaluation matrix showing the scores assigned to each best management practice for the Tier 1 and Tier 2 criteria.

The scores for best management practices P4 and R1, as well as those for BMPs P6 and P2, were very close. As discussed in section 8, these two pairs of BMPs are closely linked, so it may not be surprising that their scores are similar. The reason for their linkage is that they are designed to achieve the same ends using different but complementary means.

Recommended Wet Weather BMPs

Based on the evaluation, the ranking of the BMPs and a recommendation is presented in Table ES-16. The BMPs are listed in order of decreasing overall benefit.

Cost and Staffing Requirements

The annual costs and staffing requirements for the recommended wet weather BMPs are presented in Tables ES-17 and ES-18, respectively. The total annual cost to implement the recommended best management practices would be approximately $200,000 per year. One additional BERM staff person would be required to implement these BMPs. The BERM inspector and the BSCUF operator are not expected to be new staff, instead, this staff time would be divided among the existing inspectors and operators.

Additional Recommendations

The City has limited knowledge regarding the concentrations of some of the pollutants of concern as they pass through the City's storm water runoff collection system prior to treatment at the Water Pollution Control Plants (WPCPs) and/or discharge to the Bay and ocean. An important issue to resolve is whether the pollutants of concern that are adsorbed to sediments are a threat to water quality. If much of the pollutants remain attached to sediments, increased cleaning of streets and catch basins may not be cost-effective, especially if most of the sediments travelling through the collection system end up in the grit chambers at the WPCPs and then are disposed of at a landfill. However, if pollutants of concern adsorbed to sediments are later released in significant amounts into runoff because of changing chemical conditions, then minimizing the amount and the residence time of sediments in the collection system may be an effective pollution prevention strategy.

In order to evaluate the effectiveness of wet weather BMPs P2 (Catch Basin Cleaning) and P6 (Street Cleaning), a long-term sampling study designed to gather meaningful quantitative data should be conducted. The resulting data would be used to analyze the effectiveness of street and/or catch basin cleaning in reducing the concentrations of the pollutants of concern in the overflow discharges.

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Table ES-15 BMP Evaluation Matrix

Tier 1 Evaluation Criteria					
Cost -effectiveness	+	+	-	-	-
Time to results	+	+	-	-	-
Compatibility with other programs	+	+	+	+	+
Legal changes required	-	-	+	+	0
Effluent limits	+	+	0	0	-
Tier 1 Score	1.6 x 2 3.2	1.6 x 2 3.2	1 x 2 2	1 x 2 2	0.6 x 2 1.2
Tier 2 Evaluation Criteria					
Ease of implementation (CCSF)	+	+	0	0	+
Ease of impl. (affected parties)	0	0	0	0	0
Ability to measure results	+	+	+	+	0
Public acceptance	+	0	+	+	0
Promote public awareness	+	+	0	0	+
Acceptance by affected parties	0	0	+	0	0
Environmental impacts	+	+	+	+	+
Cross media impacts	+	+	0	0	0
Potential to reduce pollutants	+	+	+	+	-
Tier 2 Score	1.8	1.7	1.6	1.4	1.2
TOTAL SCORE	5	4.9	3.6	3.4	2.4

Scoring System:
"+" (2)
"0" (1)
"-" (0)

Note: Tier 1 scores are weighted twice as heavily as Tier 2 scores.

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TABLE ES-16

1)	P4-Rainfall/Runoff Protection	Implement
2)	R1-Spill Risk Prevention	Implement
3)	P6-Street Cleaning	Consider further study
4)	P2-Catch Basin Cleaning	Consider further study
5)	E1-Leak/Spill Impacts	Discontinue consideration

TABLE ES-17

ANNUAL COST SUMMARY

BMP No.	Description	Annual Cost ($/yr)
E1	Leak/Spill Impact	10,000
R1	Spill Risk Prevention	92,500
P2	Catch Basin Cleaning	NA
P4	Rainfall/Runoff Contact	245,800
P6	Improved Street Cleaning	NA
Total		348,300

NA= Not Available

TABLE ES-18

STAFFING SUMMARY

BMP No.	Description	Source Reduction Specialist	BERM Inspector	BSCUF Operator
E1	Leak/Spill Impact	0	0	0
R1	Spill Risk Prevention	0	1	0
P2	Catch Basin Cleaning	NA	NA	NA
P4	Rainfall/Runoff Contact	1	0	1
P6	Improved Street Cleaning	NA	NA	NA
Total		1	1	1

NA= Not Available

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SECTION 1

INTRODUCTION

that are not readily removed by conventional wastewater treatment methods, the City and County of San Francisco (CCSF) has undertaken a proactive effort to reduce the level of toxicants entering its sewer systems. This Best Management Practices Study was prepared by James M. Montgomery, Consulting Engineers, Inc. and Uribe & Associates for CCSF's Bureau of Environmental Regulation and Management (BERM).

STUDY OBJECTIVES

The principal objectives of this study are listed below.

- Comply with San Francisco Bay Basin Regional Board Order No. 90-093 requiring an evaluation of the cost-effectiveness of implementing eight optional Best Management Practices (BMPs).
- Determine CCSF's primary constituents of concern by comparing the historic discharge concentrations with existing and pending water quality limitations for San Francisco Bay and the Pacific Ocean.
- Identify the probable sources of CCSF's constituents of concern and develop an estimate of pollutant mass loadings from industrial, residential, and commercial discharge sources.
- Develop and evaluate additional dry and wet weather source control BMPs to reduce the sewer loadings of problem pollutants as close to their source as possible.
- Determine whether recommended BMP implementation measures would provide sufficient reductions of targeted pollutants to comply with effluent discharge limitations without installation of costly end-of-pipe treatment facilities.

PROJECT BACKGROUND

CCSF operates and maintains a combined sewer overflow (CSO) system and three treatment facilities (Southeast Water Pollution Control Plant, Richmond-Sunset Water Pollution Control Plant, and North Point) to handle its wastewater and wet weather flows. The Richmond-Sunset Water Pollution Control Plant (RSWPCP) provides primary treatment for an average dry weather flow of 22 million gallons per day (mgd). After primary treatment, the effluent is discharged to Pacific Ocean through a 4.5 mile long ocean outfall. Currently, CCSF is constructing the new Oceanside Water Pollution Control Plant, which is expected to be operational in 1994. When operational, the new Oceanside facility will treat all the flows currently routed to the RSWPCP. The Southeast Water Pollution Control Plant (SEWPCP) provides primary and secondary treatment for a design ADWF of 85 mgd. The secondary effluent is discharged to San Francisco Bay through a deep water outfall at Pier 80 (Army Street terminal).

During dry weather, all wastewater flows are treated at RSWPCP and SEWPCP prior to discharge at their respective outfalls. During wet weather, when the combined sewage and stormwater exceed the capacities of the treatment and sewer transport facilities, overflows are discharged to shallow water, near-shore locations. Overflows from the RSWPCP service area are discharged via

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8 shoreline stations. Overflows from SEWPCP service area are discharged to Islais Creek via a near shore outfall at Quint Street.

Elimination System (NPDES) permits in accordance with EPA requirements. In June 1990, RSWPCP received a revised NPDES permit (EPA Permit No. CA0037681/Regional Board Order No. 90-093) to operate. Among the new permit conditions, CCSF was required to implement ten best management practices (BMPs), to study the cost-effectiveness of implementing eight other BMPs suggested by the Regional Board, and to investigate additional measures to minimize the amount of pollutants in the wet weather overflows.

The eighteen BMPs identified by the Regional Board for implementation or further evaluation are educational, regulatory, and public agency source control measures designed to minimize the amount of pollutants from entering the waste streams. On October 1, 1990, CCSF submitted an Implementation Plan for the ten BMPs required by the Regional Board. These ten BMPs are referenced in this report as the "Mandated BMPs." An annual report has since been submitted in August 1991.

A study plan to evaluate the eight additional BMPs (referenced as "Optional BMPs" in this report) was submitted to the Regional Board on February 1991. The study plan described the methodology to evaluate these BMPs and a schedule for the evaluation process. This report is being submitted to the Regional Board in compliance with the study plan schedule. It includes an evaluation of the BMPs and recommendations for additional implementation measures.

The eighteen BMPs were originally intended to focus on wet weather overflows in the RSWPCP service area. However, subsequent developments have caused CCSF to expand the scope of this evaluation to include both wet and dry weather flows for the entire CCSF service area. First, in October 1991, a Regional Board order (Order No. 91-153) was issued to implement interim measures for the wet weather overflows at Islais Creek. These interim measures include expanded source control activities and stormwater BMPs for the SEWPCP service area. Therefore, CCSF decided to implement the appropriate BMPs for the entire service area.

Secondly, several recently adopted State and local statues have acted to focus the attention on dry weather concerns. In April 1991, the State Water Resources Control Board (SWRCB) adopted water quality control plans for inland surface waters (fresh water) and enclosed bays and estuaries (salt water). These water quality control plans were adopted in response to the 1987 Amendment of the Clean Water Act. Of these two plans, the Enclosed Bays and Estuaries Plan (EBEP) directly affects the SEWPCP discharge. The RSWPCP discharge is already regulated by the Ocean Plan and is not directly affected by either newly adopted plans.

A major element of these state-wide water quality control plans is the adoption of numerical water quality objectives for toxic substances mandated by the Clean Water Act. Section 303 (c) (2) (B) of the Clean Water Act requires the State to adopt water quality criteria for the Section 307 (a) priority pollutants for which EPA has published criteria. For 10 trace metals and 30 organic compounds, the EBEP adopted the EPA criteria to protect aquatic life and human health. The State Board is currently revising the EBEP to include numerical objectives for the other compounds on EPA's Section 307 list. Of the compounds currently on and being included in the EBEP, the metals and cyanide objectives would have the greatest impacts on SEWPCP.

In December 1991, the Regional Board revised the San Francisco Bay Basin Plan to include the provisions of the state water quality plans and to establish effluent limits based on the numerical water quality objectives. The Basin Plan has not yet been approved by the SWRCB. However,

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the numerical limits established in the Basin Plan are unlikely to change prior to approval, and are expected to be incorporated into the SEWPCP NPDES permit at its next renewal in June 1994.

source control measures and BMPs designed to reduce the discharge of pollutants to the maximum extent possible. Dischargers are allowed until April 1996 to implement these measures and evaluate their effectiveness. The utilization of BMPs to comply with these new effluent limits is similar to the approach for the wet weather overflows. Therefore, CCSF expanded the scope of this study to include an evaluation of BMPs to reduce specific pollutants of concern in the dry weather flows.

CCSF retained two consultants to prepare this report. James M. Montgomery, Consulting Engineers, Inc. (JMM) was retained to evaluate BMPs relating to dry weather flows and compliance with the new Basin Plan limits. Uribe & Associates (U&A) was retained to evaluate BMPs relating to wet weather overflows. The results and recommendations of both the dry weather and wet weather programs are described together in this report in order to consolidate the information and to present a unified and cohesive program.

REPORT ORGANIZATION

Following this introduction, Sections 2 and 3 of this report provide additional background information relevant to this source control evaluation study. Section 2 describes the existing CCSF wastewater service area conditions, including descriptions of the drainage basins and wastewater treatment facilities, and a discussion of the influent and effluent flows and pollutant loadings observed at these facilities. Section 3 describes the methodology and results of an environmental awareness telephone survey designed to provide insight into the need for, and the most effective means of, dispersing educational information vital to source control efforts.

Sections 4 through 6 discuss the selection, development, and evaluation of the dry weather BMPs. Section 4 describes the BMP selection process, which was based on a mass balance analysis of identified CCSF problem constituents, and extensive information collection efforts. Section 5 presents a detailed discussion of each of the selected BMPs. Section 6 presents an evaluation and ranking of the dry weather BMPs on the basis of cost-effectiveness and 11 non-economic evaluation criteria. Similarly, Sections 7 through 9 present the selection, development, and evaluation of the wet weather BMPs.

Finally, Appendices A through F contain the literature references, background materials, and supplementary information utilized during the BMP Study effort. The applicability of these supplementary materials is referenced within the text of this report.

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SECTION 2

EXISTING SERVICE AREA CONDITIONS

compartments of up to 44 feet by 25 feet. The majority of the sewer lines are composed of clay pipe with mortared joints, while the larger transport structures are reinforced concrete. All but one percent of the CCSF's collection system serves as a combined sanitary-stormwater system, collecting stormwater runoff in the same set of pipes that transport sanitary waste. (JMM 1990) Commercial and industrial wastewaters are also serviced by this combined system.

This section presents background information on the CCSF service area, including a description of the sewer drainage basins and wastewater treatment facilities, an assessment of the influent pollutant loadings at the treatment facilities, and an evaluation of CCSF's historic effluent discharge performance relative to recently proposed water quality standards.

DESCRIPTION OF CCSF DRAINAGE BASINS

San Francisco's combined sewer system is divided into two drainage basins, referred to as the Bayside and Westside drainage basins. These basins correspond to the natural topographical drainage patterns of CCSF, and are serviced year-round by separate wastewater treatment facilities. The Southeast Water Pollution Control Plant (SEWPCP) services the Bayside drainage basin, while Westside drainage flows currently enter the Richmond-Sunset Water Pollution Control Plant (RSWPCP). During wet weather, a third treatment plant (the North Point plant), located in the Bayside drainage area, provides treatment for flows exceeding the capacity of the SEWPCP and CCSF's extensive new wet weather storage and transport combined sewer overflow (CSO) facilities. Figure 2-1 presents a layout of the CCSF service area, including the two drainage basins and their respective wastewater treatment facilities.

Bayside Drainage

The Bayside drainage, composed of the North Point and Southeast drainage areas, consists of nearly 19,000 acres, extending from the former marsh areas along the Bay to the steep hilly areas in the central and southern regions of the CCSF service area. The wastewater flow generated in this basin averaged approximately 62.2 million gallons per day (mgd) during 1991. This flow is composed of residential, industrial, and commercial discharges in addition to stormwater, groundwater, and bay water infiltration/inflows. During dry weather periods, the entire Bayside flows enter the SEWPCP for secondary treatment prior to discharge to San Francisco Bay. Wet weather flows in the north shore area of CCSF receive primary treatment at the North Point plant prior to Bay discharge once the capacities of the SEWPCP and the CSO storage and transport facilities are exceeded.

The Bayside drainage basin collects wastewater from 50 significant industrial users (SIUs). SIUs are defined under CCSF's industrial waste sewer use ordinance as being either subject to federal categorical standards; discharging greater than 25,000 gallons per day; contributing greater than 5 percent of the hydraulic or organic plant capacity; or discharging a wastestream that may otherwise impact the treatment facilities. These SIUs are regulated under CCSF's Industrial Waste Pretreatment Program (IWPP) and contribute approximately 4.35 mgd, or seven percent of the Bayside flow. (CCSF 1991A) The bulk of CCSF's unregulated industrial and commercial establishments are also located in this drainage basin, contributing an estimated 32.3 mgd (52

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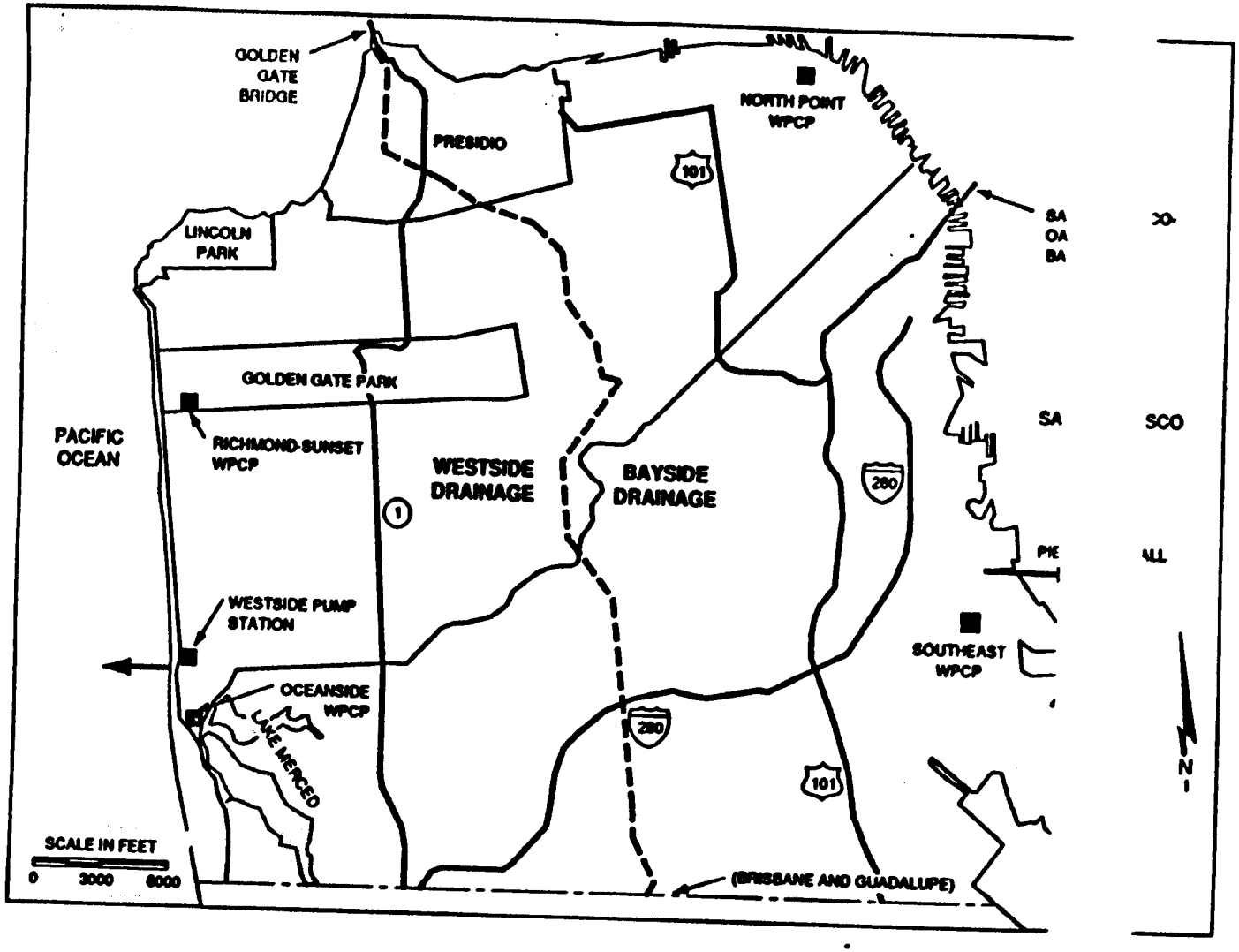

CCSF SERVICE AREA

FIGURE 2-1

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percent), of the Bayside flow. The remaining 41 percent of the Bayside flow (approximately 25.5 mgd) is estimated to be residential flow.

Ocean and past Lake Merced in the south. The average wastewater flow generated in this area was approximately 16.6 mgd in 1991. This flow currently enters the Richmond-Sunset WPCP for primary treatment prior to discharge via the 4.5 mile-long Southwest Ocean Outfall to the Pacific Ocean. This flow will soon be diverted to the new Oceanside Treatment Plant, scheduled for completion in 1994, which will replace the Richmond-Sunset Plant and provide secondary treatment prior to discharge out the same outfall.

Wastewater generated in this drainage area is principally residential flow. Based on a residential population of approximately 228,000, the residential flow is estimated to be 11.4 mgd, or 69 percent of the total influent flow into the RSWPCP. Only ten regulated SIUs (all hospitals) are located in the Westside basin, contributing less than 4 percent (0.6 mgd) of the influent flow. (CCSF 1992) A review of the June 1990 City zoning maps indicated that the commercial zones in this area are mostly limited to neighborhood commercial businesses and fast food restaurants. These businesses contribute an estimated 4.6 mgd (28 percent) of the RSWPCP influent.

REVIEW OF CCSF WASTEWATER TREATMENT PLANTS

This section describes the treatment processes and effluent requirements of the dry and wet weather wastewater treatment facilities. During dry weather conditions, wastewater flows are treated at the Southeast Water Pollution Control Plant (SEWPCP) and the Richmond-Sunset Water Pollution Control Plant (RSWPCP). A new Oceanside facility, currently under construction, will replace the RSWPCP in 1994. Wet weather flows in excess of dry weather treatment capacities are treated at the North Point wet weather treatment facility. Each of these facilities are described below along with a discussion of CCSF's staged response to increasing wet weather flow levels.

Southeast Water Pollution Control Plant (SEWPCP)

The SEWPCP is located near Hunters Point in the southeast section of CCSF (See Figure 2-1). The largest dry weather treatment plant in CCSF, the SEWPCP provides primary and secondary treatment for a design dry weather capacity of 85 mgd. During wet weather, the plant can provide primary treatment for a maximum flow rate of 210 mgd. In addition to serving CCSF, this plant treats flows from the Bayshore Sanitary District, Guadalupe Valley Municipal Improvement District, and a portion of the North San Mateo County Sanitation District.

The SEWPCP primary treatment process train consists of screening, grit removal, and sedimentation. Following these steps, secondary treatment consists of a high purity oxygen activated sludge system followed by final clarification and effluent disinfection with sodium hypochlorite (chlorination) and sodium bisulfite (dechlorination). Sludge treatment consists of dissolved air flotation (DAF) thickening, anaerobic digestion, chemical conditioning, and centrifuge dewatering. Figure 2-2 presents a schematic flow diagram of the treatment processes and the major recycle streams at the SEWPCP.

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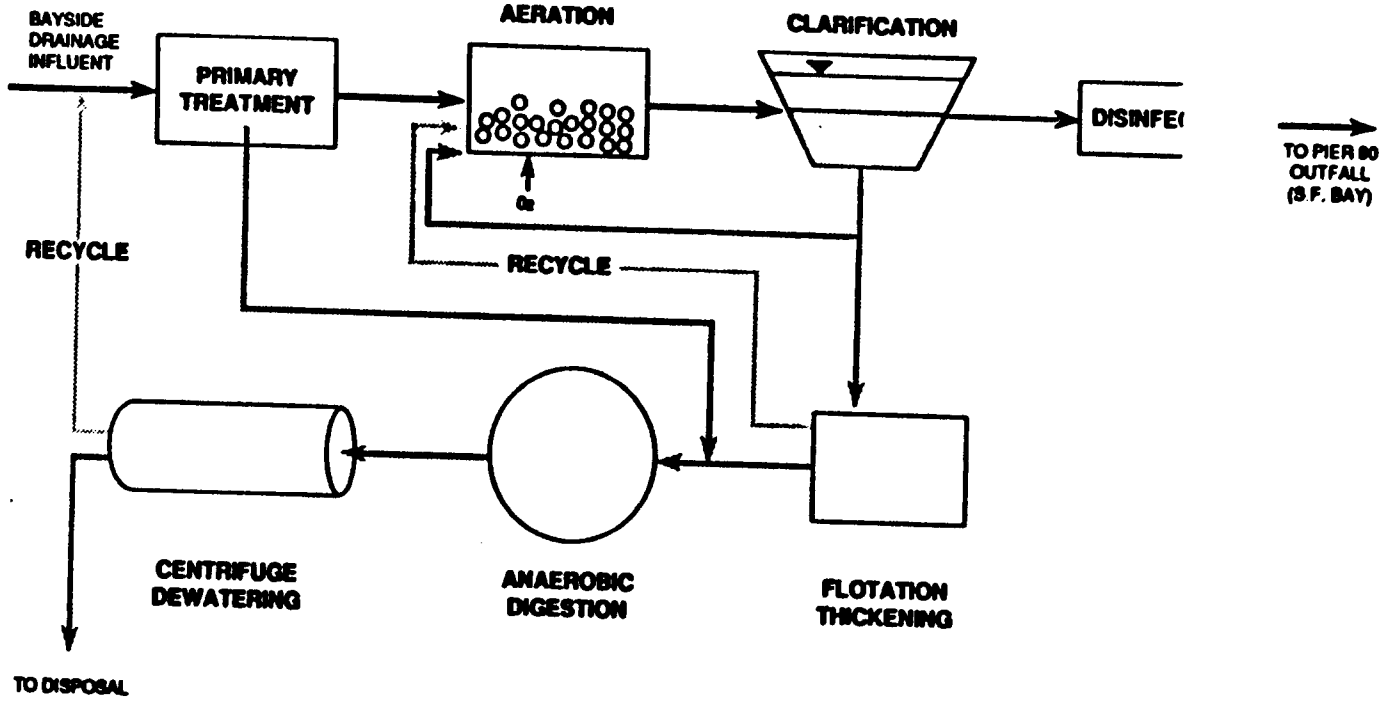

SCHEMATIC FLOW DIAGRAM FOR SOUTHEAST WPCP

FIGURE 2-2

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Richmond-Sunset Water Pollution Control Plant (RSWPCP)

Westside Transport to the Southwest Ocean Outfall for deep-water ocean discharge. Built in 1936, the RSWPCP is scheduled to be replaced in 1994 by the Oceanside plant, described below.

Oceanside Water Pollution Control Plant (OWPCP)

The OWPCP will be located directly south of the San Francisco Zoo, near the head of the Southwest Ocean Outfall. This plant will provide primary and secondary treatment for all of the Westside flow currently entering the RSWPCP and will have a design dry weather capacity of 43 mgd. (JMM 1990)

The process flow at the OWPCP will be very similar to that occurring at the SEWPCP. Primary treatment will include grit removal, screening, and sedimentation; secondary treatment will consist of high purity oxygen activated sludge followed by final clarification and effluent chlorine disinfection using sodium hypochlorite and sodium bisulfite. Sludge treatment at the OWPCP will consist of gravity belt thickening, anaerobic digestion, chemical conditioning, and belt press dewatering. (CH2M HILL 1988) Similar to the SEWPCP, the recycle streams at the OWPCP will return liquids from the sludge thickening and dewatering steps to the aeration basins and primary treatment facilities, respectively.

Wet Weather Flow Facilities

Due to CCSF's combined stormwater-sanitary sewer collection system, significant increases in wastewater flows occur during wet weather storm events. In the past, peak wet weather events have overloaded the collection systems and treatment plants, resulting in the discharge of untreated sewage to CCSF's shorelines. These overflows pose a potential human health risk from the release of pathogen-containing untreated sewage, and a potential threat to Bay and ocean water quality due to the significant quantities of particulates and toxicants, including heavy metals and organic compounds, that are contained in stormwaters.

To address these potential impacts from increased flows that occur during wet weather periods, CCSF has undertaken an extensive construction effort to prevent combined sewer overflows by installing pump stations and long, underground box-like storage/transport structures along the shorelines of CCSF. The CSO facilities are over 60 percent complete, and are expected to be completely operational by 1996. However, over 30 shoreline discharge events still occur each year. These discharges are primarily in areas where new CSO facilities have not yet been constructed. The following wet weather response measures occur at the onset of a storm:

- **Wet weather pump station startup.** Pump stations move the combined flows toward the treatment plants or to available storage/transports. Pumping rates are adjusted according to the specific patterns of individual rainfall events.
- **Increased treatment rates at SEWPCP and OWPCP.** The treatment rates at these facilities are increased to a wet weather (maximum) rate until the storm is over and the stored wastewater from the storage/transport structures has been treated.
- **Activation of North Point Facility.** This facility goes online during the storm and provides primary-level treatment and disinfection for northern area flows.

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- **Storage in the Storage/Transports.** Up to 193 million gallons of combined sewage and storm water is stored in these structures and in the sewer lines for later treatment.

discharge occurs to the ocean outfall. This decant discharge has received flow-through treatment within the storage/transport structure.

- **Shoreline Discharge from Storage/Transport Structures.** When all storage elements are full and rain continues, shoreline discharge occurs. This discharge consists of approximately 6 percent sewage and 94 percent stormwater, and has received flow-through treatment in the storage/transports. This flow-through treatment incorporates weirs and decant structures to minimize the suspended solids and floatable materials passing to the Bay or ocean.

INFLUENT FLOW CHARACTERISTICS

Although the zoning characteristics of the two drainage basins differ considerably, with the Westside drainage handling the bulk of the industrial and commercial flow, the composition of the influent wastewaters at the two treatment facilities is fairly similar. Table 2-1 lists the average 1991 concentrations of nine heavy metals and cyanide contained in the influent wastestreams of the SEWPCP and RSWPCP facilities. No cyanide data were available from the RSWPCP facility.

Based on approximately 25 data points taken at each facility during 1991, less than a fifty percent difference in the influent concentrations was observed for each of the nine metals at the two facilities. Arsenic and mercury concentrations were particularly comparable, with only a 3 and 7 percent difference, respectively. Lead, silver, and zinc concentrations were 38 to 46 percent higher at the SEWPCP, likely due to the greater industrial and commercial contributions of these metals. Chromium, nickel and cadmium concentrations at RSWPCP are slightly higher than at SEWPCP. This is somewhat unexpected given the lower commercial and industrial flows in the Westside drainage basin. However, the differences between the actual values are relatively minor and may not be statistically significant.

The influent concentrations of the nine metals observed at the RSWPCP and SEWPCP facilities during 1991 demonstrate a similar trend. In general, the two influents are fairly similar in terms of both average concentration and degree of variability throughout the year. Overall, the SEWPCP influent concentrations tend to be slightly higher and are characterized by more variability for the metals typically associated with commercial and industrial activity, such as silver, nickel, and lead. The data plots used for this comparison are contained in Appendix E for reference.

EFFLUENT DISCHARGE REQUIREMENTS

Wastewater discharges from the Bayside and Westside treatment facilities described above are required to meet the numerical effluent limitations contained in their respective National Pollutant Discharge Elimination System (NPDES) permits. Permit limitations are developed and enforced by the San Francisco Bay Regional Water Quality Control Board in consideration of the objectives and beneficial uses of the receiving waters. NPDES permits for Bay discharges from the SEWPCP are regulated in accordance with the San Francisco Bay Basin Plan (Basin Plan), while ocean discharges from the RSWPCP are subject to the California Ocean Plan.

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TABLE 2-1

1991 AVERAGE INFLUENT METALS CONCENTRATIONS

	RSWPCP Influent (µg/L)	SEWPCP Influent (µg/L)	Percent Difference (%)
Arsenic	3.1	3.2	3
Cadmium	8.5	6.7	21
Chromium (t)	16.1	10.4	35
Copper	89.8	115.8	22
Lead	18.4	34.1	46
Mercury	0.93	1	7
Nickel	18.3	16	13
Silver	8.3	15.4	46
Zinc	218	352	38

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Table 2-2 presents the NPDES effluent discharge requirements for constituents of concern from the SEWPCP and the RSWPCP/OWPCP outfalls. The Bay discharge limits were proposed by the

requirements will therefore be the driving force behind CCSF-wide source reduction measures. These daily average Bay discharge limits are geared towards dry weather discharge practices. There are currently no numerical limits for stormwater discharges from overflows of the CCSF CSO facilities.

Focus of BMP Efforts on SEWPCP Requirements

In light of the higher density of commercial and industrial facilities and the typically higher metals concentrations in Bayside influent flows, combined with the more stringent NPDES discharge standards applied to Bay discharges, the BMP investigative efforts focused on data obtained from the Bayside drainage basin and the SEWPCP. Where applicable, the BMP implementation steps resulting from analysis of these data will be applied to CCSF as a whole. Pollutant removal efficiencies occurring at the Bayside and Westside treatment plants can be expected to be similar as the treatment processes at the SEWPCP and the new OWPCP are identical.

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TABLE 2-2

COMPARISON OF EFFLUENT LIMITS FOR POLLUTANTS

Parameter	Basin Plan Effluent Limits (a)	Ocean Discharge Effluent Limits (b)	
	Daily Average (µg/L)	6-month Median (µg/L)	Daily Maximum (µg/L)
Arsenic	360	388	2236
Cadmium	92	77	308
Chromium (VI)	500	154	616
Copper	17	79	772
Lead	53	154	616
Mercury	0.21 (c)	3	12
Nickel	65	385	1540
Silver	23	42	203
Zinc	840	932	5552
Cyanide	10	77	308
PAHs	0.31 (c)	--	0.68

(a) Limits will be implemented in 1994.
(b) Based on June 20, 1990 updated waste discharge requirements for CCSF's Oceanside treatment facility and southwest ocean outfall.
(c) Limit applies to the 30-day average concentration.

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SECTION 3

ENVIRONMENTAL AWARENESS SURVEY

This is a report of results obtained from the Public Research Institute's telephone sample survey of San Francisco households on the general topics of environmental awareness, perceptions of health risk awareness, perceptions of health risks associated with household toxic materials, the use and disposal of such materials, levels of support and willingness to pay for new disposal services and educational programs, sources of information on environmental problems, and views on the causes of water pollution. These survey findings should be useful in developing new educational programs, disposal services, and targeting strategies that meet Best Management Practices guidelines serving the needs of San Francisco residents.

SAMPLING AND METHODOLOGY

A random-digit sample of 2801 San Francisco telephone numbers was obtained from Survey Sampling, Inc. This sample provided a representative cross-section in our survey of all residential households with phones in the City of San Francisco. To increase the participation of non-English speaking households in the survey, the questionnaire instrument was translated into Spanish and Cantonese. Four bilingual interviewers were hired to conduct foreign language interviews by callback or appointment when initial contact with household respondents produced language difficulties in communication.

The interviewing took place during the period April 8-25, 1992. Interviews were conducted at the Public Research Institute's Computer Assisted Telephone Interviewing (CATI) facility. The questionnaire was programmed with the Sawtooth Software Ci2/CATI system for complete automation of data collection and call scheduling. Interviewing took place on weekdays from 10:00 AM to 1:00 PM and from 4:30 PM to 8:30 PM; and on Saturdays from 10:00 AM to 4:00 PM. The following table presents cumulative disposition codes at the end of the survey. Please note that the numbers in the table refer to numbers of calls, which may or may not be the same as the number of telephone numbers or households in a category. Each telephone number was called a maximum of 10 times.

Final Call Dispositions

	Count	Percent
No Answer/Busy/Answering Machine	3940	58.8
Call Back	691	10.3
Interview Complete	602	8.9
Not a Household	289	4.3
Refused Interview	566	8.4
Disconnected Number	526	7.8
Other	84	1.2
Total	6698	100.0

The final response rate was calculated by dividing the number of completed interviews by the total number of eligible respondents (completes plus refusals):

$$602 / (602 + 566) = .51$$

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The approximate numbers of interviews conducted in Chinese and Spanish were, respectively, 61 (10%) and 25 (4%). These were interviews that almost certainly would have been missed if the interviews had been conducted only in English.

Sampling Error

Given a total sample size of 602, the estimated sampling error for percentages is plus or minus 4% at the 95% confidence level. This means that we can be 95% sure that all San Francisco households would produce responses to survey questions within plus or minus 4 percentage points of the statistics for the total sample reported here. Sampling errors are larger for sample subgroups. Non-sampling errors that might result from poor question wording, non-response bias, data entry mistakes, etc., were minimized by means of extensive pre-testing of the questionnaire instrument, numerous callbacks, foreign language interviewing, and quality control supervision.

Comparisons of sample statistics with 1990 Census data for San Francisco indicate that sample respondents are demographically representative of the city's population in terms of gender, housing tenure, and race/ethnicity. For example, 48% of the sample respondents are male, 52% female -- virtually identical to the male/female ratio reported in the 1990 Census. Also, 35% of sample respondents are homeowners and 65% are renters. These figures exactly match the owner/renter ratio of 35/65 reported in the 1990 Census. Further, 55% of sample respondents are white and 45% are non-white, the latter group including 6% African Americans, 9% Latinos, 23% Asians, and 7% other or unknown. Comparable 1990 Census figures are 47% white and 53% non-white, the latter including 11% African Americans, 14% Latinos, 28% Asian, and less than 1% other or unknown. Since the racial/ethnic breakdown for the sample is based on adult respondents while the Census figures are for the total population, and since the total population includes higher proportions of non-whites among children, we are confident that the racial/ethnic composition of sample respondents is very similar to that of San Francisco's adult population.

To allow a breakdown of survey results by geographic area, sample respondents were coded into one of six (consolidated) Pacific Bell central station jurisdictions defined by telephone prefix numbers. In the Map that follows, the city neighborhoods located within each area are shown in the accompanying legend.

The raw counts and percentages obtained for each question asked in the survey are provided in the Appendix along with the complete text of the questionnaire itself. In this main report we provide an overview of the survey results and summarize the findings of crosstabulations and logistic regression analyses under the following headings: (1) use and perceived risk of household toxic materials; (2) levels of environmental awareness; (3) disposal practices; (4) willingness to pay for disposal services and educational programs; (5) perceived sources of water pollution in San Francisco; (6) sources of news and information about environmental issues and problems; (7) neighborhood differences in survey response, and (8) implications of the survey results for educational programming and targeting strategies.

Before discussing those findings, however, it is necessary to provide a brief explanation of logistic regression and of the odds-ratios it produces as output for analysis. (The reader who is familiar with these methods can skip directly to the next section.)

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A Note on Logistic Regression and Odds-Ratios

Logistic regression is a powerful statistical method that allows one to measure the separate and

A major advantage of logistic regression over standard two-variable cross-tabulation is that it allows multivariate analysis with rigorous statistical controls. Thus the effects of a given factor (e.g., homeownership) on opinion or behavior can be estimated from the data while statistically controlling for the potentially confounding effects of other factors (e.g., race, gender, age, income). For example, consider the possible confounding effects of race on an analysis of the relationship between house paint use and homeownership. Cross-tabulations might show (a) that whites are more likely than nonwhites to use house paint, and (b) that homeowners are more likely than renters to use house paint. If the cross-tabulation analysis also shows (c) that whites are more likely than nonwhites to be homeowners, it could be that racial differences are only indirectly linked to variations in house paint use as a result of the links between race and homeownership and between homeownership and house paint use. In other words, whites tend to be homeowners, and homeowners tend to use house paint, thus interpreting the relationship between race and house paint use. But it could also be that race has a direct effect on house paint use separate from its indirect effect via homeownership. Cross-tabulation analysis is an unwieldy tool for sorting out the separate effects of race and homeownership in this example. Multivariate logistic regression is superior to cross-tabulation because it allows estimation of the independent direct effects of many different factors simultaneously.

One measure of effect that can be estimated from survey data using logistic regression is the "odds-ratio." Analogous to betting odds at the race track, the *odds* that something will happen are calculated simply by dividing the probability (P) that it will happen by the probability (1-P) that it will not happen. For example, if there is a 20% probability that John Q Resident uses house paint and an 80% probability that he does not, the odds that he uses house paint are .25 (i.e., .2/[1-.2] =.2/.8 = .25). In the case of dichotomous variables such as gender (female/male) or housing tenure (own/rent), the *odds-ratio* is simply the ratio of the odds that a member of one group (e.g., females) does something to the odds that a member of the complementary group (i.e., males) does that same thing. For example, if the odds that females use house paint are .25 and if the odds that males use house paint also are .25, then the odds-ratio for females (versus males) is .25/.25 = 1.00. In other words, the odds are exactly the same for females as for males, i.e., there is no correlation between house paint use and gender. An odds-ratio less than 1.00 would indicate (in this example) that females are less likely than males to use house paint. An odds-ratio greater than 1.00 would indicate that females are more likely than males to use house paint.

If the logistic regression model includes several predictors simultaneously (e.g., gender and race and housing tenure), the odds-ratio estimated for a given predictor is statistically adjusted for the possible confounding effects of other predictors in the model. In such a multivariate logistic regression, for example, an odds-ratio of 2.00 for the predictor "female" would indicate that females are twice as likely as males to use house paint whether they are white or non-white, homeowners or renters.

Since the odds-ratios reported below are estimated from sample survey data, sampling error must be taken into account when evaluating their statistical significance. The so-called "null hypothesis" is that the (unknown) odds-ratio for a given predictor for all households in the survey population is 1.00 and that a sample odds-ratio different from 1.00 merely reflects the luck of the draw. Only if $p < .10$ for the sample odds-ratio can we reject the null hypothesis. In what follows, odds-ratios that appear with an asterisk (*) are considered statistically significant at the $p < .10$ level. In non-

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technical terms, an asterisk means there is less than a 10% chance that an odds-ratio of that magnitude could have been obtained for a sample of this size drawn randomly from a population of households in which the odds-ratio is in fact 1.00. Although the odds-ratio reported for some

USE AND PERCEIVED RISK OF HOUSEHOLD TOXIC MATERIALS

As shown in Figure 3-1, the toxic materials most commonly found in San Francisco households are nail polish removers (51% of households), motor oil (47%), drain cleaners (47%), and house paint (42%). Least common are root eradicators (3%) and chemicals for photography (3%). Given the potent toxicity of photographic chemicals, it is worth noting that even this small incidence of household use can produce a large problem of waste management when aggregated over all San Francisco households. For example, although only 3.3% of sample households (20 respondents) reported use of photographic chemicals, that same proportion multiplied by San Francisco's 305,584 households yields an estimated aggregate total of 10,084 household users of such chemicals. Placing 95% confidence intervals around that estimate, we can be very confident that at least 5,500 households use such chemicals and possibly as many as 14,900.

What types of San Franciscans are most likely to use each of these household toxic products and materials? Here and throughout this report we systematically examine the impacts of seven different sociodemographic factors in shaping patterns of product use and perceptions of health risk. These factors are: gender, age, housing tenure (owner/renter status), education, income, race, and area of residence. (One additional factor we considered, length of residence, is strongly correlated with respondents' age and so was dropped from analysis.) The respondent's area of residence is an important predictor of some practices and opinions, and we discuss these findings at different places in the text and in the next to last section of this report. On the whole, however, few significant geographic differences were observed in our survey findings.

Table 3-1 summarizes the results of a multivariate logistic regression analysis of reported levels of use of household toxic products and materials.

As shown in Table 3-1, the use level predictors analyzed are gender (female=1, male=0), age (40+ years=1, less than 40=0), housing tenure (owner=1, renter=0), education (college degree or graduate work=1, high school or some college=0), income ($40,000 or more=1, less than $40,000=0), and race (each non-white race [African American, Latino, Asian, and Other] also measured by so-called "dummy" variables -- i.e., those measured as 0 or 1). This same set of predictor variables will be used repeatedly in the analyses that follow here and throughout the text.

To illustrate how to "read" the odds-ratios produced by the logistic regression analysis, look at the row for "Motor Oil" use. Reading across the row of numbers, females are about seven-tenths as likely as men (odds-ratio=.71) to report using motor oil; older respondents are about one-third as likely as younger respondents (odds-ratio=.37) to report using motor oil; and home owners are nearly twice as likely as renters (odds-ratio=1.79) to report using motor oil. These are the only odds-ratios shown for motor oil use that are statistically significant (i.e., are unlikely to be the result of sampling variation). These estimated effects of gender, age, and housing tenure on motor oil use are statistically adjusted for the possible confounding effects of other variables in the model. Thus we can be confident in this case that the odds-ratio for "40+ years" is not merely masking the effects of some other variable, such as race. For any race, for any gender, for any housing tenure, the estimated odds-ratio for respondents who are "40+ years" remains .37 in this case. With this discussion as background, we turn now to interpret the results of Table 3-1.

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TABLE 3-1: Reported Use of Various Household Products During Last Year. Estimated Odds-Ratios Showing Relative a Survey Respondent of Specified Type Used a Product During Last Year[a]

PRODUCTS	PREDICTORS: Female	40 Years+	Home Owner	College Degree+	$40K+	Hispanic	Black	Asian	(	Pseudo-R^2
Pesticides	.78	1.07	1.80 *	.86	1.11	.59	.98	1.66 *		.036
Weedkillers	.38 *	2.40 *	2.25 *	1.59	1.07	2.49	(drop)	5.08 *	(c	.141
Yard Fertilizers	.93	1.25	4.10 *	.50 *	1.27	1.69	.73	1.28		.102
Root Eradicators	.63	.79	.60	.65	2.29	6.07 *	6.41	4.64	(c	.082
Solvents	.46 *	.98	3.77 *	1.28	1.31	1.41	.59	.46 *		.098
House Paint	.52 *	.95	3.75 *	.86	1.03	1.40	.51	.49 *		.082
Motor Oil	.71 *	.37 *	1.79 *	.74	1.38	.92	1.13	1.30		.058
Antifreeze	.69	.58	1.61	.85	1.80	1.11	1.52	1.24		.044
Metal Polish	1.36	1.90 *	2.11 *	1.01	1.15	.61	.13 *	.30 *		.100
Nail Polish Rem.	3.18 *	.71	1.81 *	.77	1.32	1.23	1.15	1.15		.072
Drain Cleaners	1.21	.74	1.22	1.65 *	.80	2.10 *	1.30	.89		.023
Photo Chemicals	.25 *	.42	2.08	.77	.76	.43	(drop)	.60	(c	.069
Art Materials	.72	.74	1.29	1.69 *	1.27	1.00	(drop)	.72		.028

[a]Note: The general model tested is Prob { Y = "Yes, used" } = 1/(1+exp(-(XB))), where Y = estimated probability reported using mentioned product during the last year, X is a vector of dummy variable predictors, and B is a ve regression coefficients estimated using maximum likelihood methods on sample survey data. Entries are estimated specified groups indicating the likelihood that members of a specified group (e.g., females) reported using the me relative to that of a reference group (e.g., males). An odds-ratio of 1.0 indicates that the relative likelihoods of grou group are equal. The odds-ratios shown are for females vs. males, older vs. younger, home owners vs. renters, hi lower income, Hispanics vs. Whites, Blacks vs. Whites, Asians vs. Whites, Other Races vs. Whites. The odds-ratios racial reference group) are 1.00 in all cases. These estimated odds-ratios are statistically adjusted for the effects of all The Pseudo-R^2 measures the model's goodness-of-fit. Sample n = 439. For some products, certain predictors are drop total numbers using the product, making estimation impossible.

* $p < .10$

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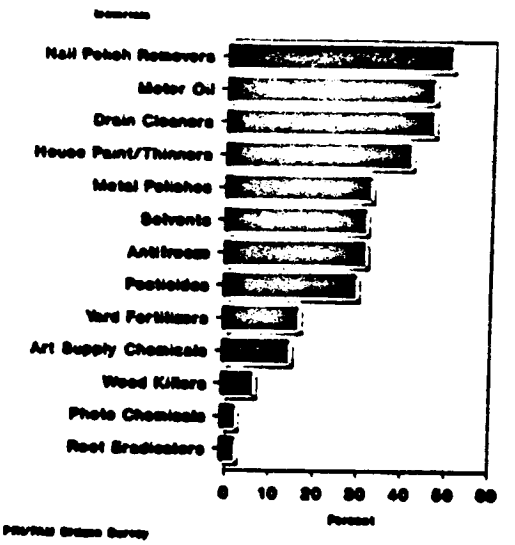
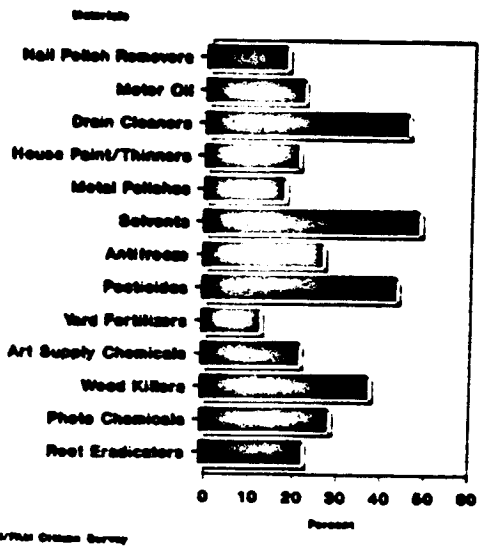


Figure 3-2: Perceived Risk of Materials
Percent of San Francisco Households
That Perceived a "Great" Risk



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With a focus on statistically significant predictors, we see in Table 3-1 that: (1) Homeowners are more likely to use pesticides than are renters, and Asians more than Whites. (2) Females are less likely than males to use weedkillers, older respondents more likely than younger ones, homeowners more than renters, and Asians more than Whites. (3) More educated respondents are

solvents, homeowners are nearly four times as likely as renters to use such products, and Asians are about half as likely as Whites to use them. (6) Females also are much less likely than males to use house paint, homeowners are much more likely than renters, and Asians are less likely than Whites. (7) As discussed in the example above, females are less likely than males to use motor oil, older respondents much less likely than younger ones, and homeowners more likely to do so than renters. (8) No statistically significant predictor is found for antifreeze use, which might suggest that patterns of antifreeze use are very diffuse throughout all social classes, races, etc. (9) Older respondents are more likely than younger ones to use metal polish, homeowners more than renters, and Blacks, Asians, and Other Races much less likely to do so than Whites. (10) Females are about three times more likely than males to use nail polish, homeowners nearly twice as likely as renters, and there are no other predictors. (11) College-educated respondents are more likely to use drain cleaners than are the non-college-educated, and Hispanics more than Whites. (12) Females are about one-fourth as likely as males to use photochemicals, and that is the only significant predictor. (13) College-educated respondents are more likely than the non-college-educated to report using arts materials. Reviewing these findings as a whole, we see that gender, housing tenure, and Asian race are the most consistent predictors, followed by age and education. Interestingly, income differences are a consistently poor predictor of use of these products.

Are use levels of household toxic products higher in households that have gardens and yards, or that have garages used for storage or workshops? Table 3-2 provides some answers from our sample survey data. Maintaining a yard or garden appears to be linked to greater use of weedkillers, yard fertilizers, root eradicators, house paint, motor oil, antifreeze, and metal polish. Having a garage that is used for storage is linked to greater use of yard fertilizers, solvents, house paint, motor oil, antifreeze, metal polish, and nail polish remover. Garage owners who say they use their garage as a workshop are more likely than those who do not to make greater use of solvents, paint, oil, antifreeze, nail polish remover, and art materials. It should be noted here that all three sets of findings are bound to be linked to homeownership: 88% of homeowners have garages compared to only 31% of renters, and 81% of homeowners have yards and gardens compared to only 49% of renters. (Interestingly, renters with garages are nearly as likely as homeowners with garages to use them as workshops: 23% versus 26%.)

Figure 3-2 shows the variation among respondents in assessing the health risks associated with product use. Survey respondents perceived that "great risk" was associated most with solvents (49%), drain cleaners (46%), pesticides (44%), and weed killers (38%). Figure 3-2 also reveals that many respondents felt completely ignorant or uninformed about the risks associated with some products and materials. For example, although only 22% of the total sample perceived a "great" risk in using motor oil, 24% admitted they simply did not know what the risks might be. In the case of risks associated with photographic chemicals, fully 41% of sample respondents said they did not know. Although only 29% of the total sample said the risk was great, that figure jumps to 41% if the "don't knows" are excluded from the calculations.

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TABLE 3-2: Percentages of Survey Respondents Reporting Use of Mentioned Product During Last Year: Broken Down by Possession/Use of (1) Garden or Yard, (2) Garage

PRODUCT	Garden/Yard?		Garage for Storage?		Garage Used as Workshop?	
	Yes	No	Yes	No	Yes	No
Pesticides	35%	27%	31%	30%	29%	32%
Weedkillers	11%	4% *	8%	6%	10%	8%
Yard Fertilizers	32%	5% *	24%	8% *	27%	23%
Root Eradicators	5%	1% *	3%	3%	2%	3%
Solvents	35%	30%	38%	23% *	52%	33% *
House Paint	52%	32% *	49%	30% *	63%	45% *
Motor Oil	53%	44% *	53%	40% *	66%	49% *
Antifreeze	40%	26% *	39%	23% *	47%	36% *
Metal Polish	40%	28% *	38%	28% *	47%	35%
Nail Polish Rem.	55%	49%	56%	44% *	66%	53% *
Drain Cleaners	47%	47%	50%	43%	49%	50%
Photo Chemicals	4%	2%	2%	5%	4%	2%
Art Materials	17%	14%	17%	12%	32%	12% *

*Percentage differences are statistically significant at $p < .05$ (two-tailed test) using Chi-Square test on all cells and data.

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Table 3-3 summarizes information from our survey about perceptions of health risks associated with different household toxic products. Regarding each product, respondents were asked whether they thought it posed a very slight, moderate, or great health risk. Table 3-3 shows the odds-ratios obtained from logistic regressions predicting the probability that respondents would say "don't

Females are about half as likely as males to see only a "slight" risk in the use of pesticides, weedkillers, motor oil, and antifreeze, and are about two-thirds as likely to do so with yard fertilizers. Age differences are not linked to variations in perception of risk by this measure. Homeowners are more likely than renters to see only a "slight" risk in the use of pesticides and house paint. Educational differences do not appear to be much of a factor in shaping risk evaluations, except in the case of solvents. College-educated respondents see less risk in using root eradicators than do the non-college educated. Upper-income respondents are more likely than lower-income respondents to see only a slight risk in using yard fertilizers and nail polish removers, but they are less likely to do so in use of solvents and drain cleaners. Racial differences in risk perception are not apparent except for the case of Asians, who are more inclined than Whites to see only a slight risk in using pesticides, root eradicators, drain cleaners, and photo chemicals. It is interesting and also somewhat surprising that age and education appear to play hardly any role in risk perception regarding use of these products.

Survey respondents had the option of simply saying "don't know" in making risk assessments of these products. In the case of some products the percentage saying "don't know" was large: 45% said this about root eradicators, for example, and 41% admitted ignorance about the risks of photo chemicals. As a check on the correlates of self-admitted ignorance about health risks, Table 3-4 shows the odds-ratios obtained from logistic regressions predicting the probability that respondents would say "don't know" when asked to assess the risk of using each product.

Several conclusions can be drawn from the results shown in table 3-4. For example, upper-income respondents are consistently less likely than lower-income respondents to say "don't know." (Conversely, this means that lower-income respondents are more likely than upper-income respondents to do so.) Further, older respondents are much more likely than younger ones to say "don't know" when assessing risks, particularly in the case of weedkillers, fertilizers, root eradicators, solvents, paint, motor oil, art materials, and especially antifreeze. Homeowners are three times as likely as renters to express ignorance about the risks of pesticides. Females are more likely than males to say they did not know the risks associated with paint, motor oil, antifreeze, and drain cleaners. Although all but one of the odds-ratios for college-educated are below 1.00, none is significant. Once again, racial differences are not a factor predicting this response, except for Asians, who are consistently more likely than Whites to express uncertainty about the risks associated with pesticides, weedkillers, yard fertilizers, solvents, antifreeze, nail polish remover, drain cleaners, and art materials. In our interpretation of these results, we cannot rule out the possibility that certain groups of respondents are simply more honest than others about admitting a degree of ignorance which others might feel, yet are afraid to divulge.

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TABLE 3-3: Perception of Risk Associated with Various Household Products. Estimated Odds-Ratios Showing Rel: ·lihood that a Survey Respondent of Specified Type will Perceive that a Product has only a "Slight" Health Risk

	PREDICTORS:								
PRODUCTS	Female	40 Years+	Home Owner	College Degree+	$40K+	Hisp-anic	Black	Asian	Pseudo-R^2
Pesticides	.59 *	1.59	1.83 *	.99	.73	.99	1.02	2.06 *	.054
Weedkillers	.57 *	1.02	1.59	1.30	1.29	1.06	1.74	1.64	.032
Yard Fertilizers	.64 *	.85	1.00	.98	1.64 *	1.55	.71	1.22	.025
Root Eradicators	.49 *	.63	1.70	1.85 *	1.08	1.50	1.67	1.84 *	.048
Solvents	1.07	1.05	1.55	1.65	.48 *	2.09	.99	1.69	.033
House Paint	.78	.95	1.58 *	.96	.68	1.05	.73	1.15	.015
Motor Oil	.53 *	1.42	.77	1.39	1.22	.53	.44	.93	.038
Antifreeze	.55 *	.85	1.20	1.07	1.10	.89	.80	.74	.020
Metal Polish	1.01	1.12	1.48	1.12	1.16	.83	.87	.77	.015
Nail Polish Rem.	1.22	1.03	1.15	1.31	1.47 *	1.28	1.28	1.28	.017
Drain Cleaners	.67	.82	1.44	1.41	.53 *	.87	1.82	1.87 *	.036
Photo Chemicals	.67	.82	.44	1.19	.86	.97	.84	1.85 *	.024
Art Materials	.71	.87	1.40	1.37	1.47	.29	.49	1.00	.043

[a]Note: The general model tested is Prob { Y = "Slight Risk" } = 1/(1+exp(-(XB))), where Y = estimated probability that nt will associate a specified product with only a slight health risk, X is a vector of dummy variable predictors, and B is a ve regression coefficients estimated using maximum likelihood methods on sample survey data. Entries are estimated ogistic specified groups indicating the likelihood that members of a specified group (e.g., females) will perceive a slight risk r ios for a reference group (e.g., males). An odds-ratio of 1.0 indicates that the relative likelihoods of group and reference grou that of odds-ratios shown are for females vs. males, older vs. younger, home owners vs. renters, higher income vs. ıl. The Hispanics vs. Whites, Blacks vs. Whites, Asians vs. Whites, Other Races vs. Whites. The odds-ratios for Whites (the ·come, group) are 1.00 in all cases. These estimated odds-ratios are statistically adjusted for the effects of all other predictors. erence measures the model's goodness-of-fit. Sample n = 439. ıdo-R^2

* p < .10

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TABLE 3-4: Perception of Risk Associated with Various Household Products. Estimated Odds-Ratios Showing Rel: that a Survey Respondent of Specified Type will Answer "Don't Know" when Asked to Assess the Products.[a]

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PRODUCTS	PREDICTORS: Female	40 Years+	Home Owner	College Degree+	$40K+	Hisp-anic	Black	Asian	Pseudo-R^2
Pesticides	1.40	.98	3.05 *	.82	.38 *	1.26	1.04	3.80 *	.130
Weedkillers	1.27	1.79 *	.92	.76	.52 *	1.94	1.75	2.85 *	.085
Yard Fertilizers	1.02	2.00 *	.93	.87	.42 *	1.18	1.97	2.01 *	.070
Root Eradicators	1.34	1.59 *	.92	.89	.94	1.19	1.35	1.50	.022
Solvents	1.57	2.23 *	1.45	.57	.30 *	1.06	1.01	2.64 *	.135
House Paint	1.63 *	2.03 *	1.10	.71	.57 *	.79	.38	1.30	.057
Motor Oil	1.72 *	2.65 *	1.39	.81	.57 *	.99	1.55	1.15	.080
Antifreeze	2.29 *	3.51 *	1.32	.69	.43 *	1.74	1.30	2.52 *	.154
Metal Polish	1.37	1.45	1.49	.89	.59 *	.68	.58	1.48	.043
Nail Polish Rem.	.71	1.48	1.48	1.10	.65	.45	.96	2.14 *	.052
Drain Cleaners	2.01 *	1.55	1.33	.96	.42 *	1.05	.24	2.22 *	.087
Photo Chemicals	1.33	1.38	1.45	.72	.88	1.01	.61	.97	.022
Art Materials	1.19	2.08 *	1.42	.98	.48 *	1.59	1.69	2.99 *	.089

[a]Note: The general model tested is Prob { Y = "Don't Know" } = 1/(1+exp(-(XB))), where Y = estimated probability will answer "Don't Know" to a question about a product's health risk, X is a vector of dummy variable predictors, and logistic regression coefficients estimated using maximum likelihood methods on sample survey data. Entries are estim for specified groups indicating the likelihood that members of a specified group (e.g., females) will answer "Don't K that same likelihood for a reference group (e.g., males). An odds-ratio of 1.0 indicates that the relative likelihoo reference group are equal. The odds-ratios shown are for females vs. males, older vs. younger, home owners vs. income vs. lower income, Hispanics vs. Whites, Blacks vs. Whites, Asians vs. Whites, Other Races vs. Whites. The Whites (the racial reference group) are 1.00 in all cases. These estimated odds-ratios are statistically adjusted for the ef predictors. The Pseudo-R^2 measures the model's goodness-of-fit. Sample n = 439.

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* $p < .10$

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LEVELS OF ENVIROMENTAL AWARENESS

Based on the evidence of our survey results, the level of environmental awareness and concern about pollution is very high in San Francisco. Examples:

important reason for doing so.

2. 59% of respondents said that they "always" read the product label for warnings and directions when using products like pesticides, house paint, and cleaners -- and another 15% reported that they do so "most of the time."

3. 27% of respondents said they "always" make a special effort to purchase items that are non-toxic or environmentally safe, and an additional 33% claimed to do so "most of the time".

4. Nearly half (48%) of all respondents said they were aware of Proposition 65, which required producers to place warning labels on products containing chemicals known to cause cancer.

5. Nearly two out of five respondents (39%) said they were aware of the Household Hazardous Waste Collection Facility (HHWCF). Of those who were aware of the HHWCF, 41% reported that they had taken something to that facility over the last year. (Note: these figures include the 63 respondents who spontaneously mentioned taking materials to the HHWCF as a method of disposal in answers to Questions 5-11.)

6. Nearly nine out of ten respondents (88%) said they were aware of the curbside recycling pick-up in their neighborhoods. Of those who were aware of that program, 91% reported that they normally put things out to be picked up.

7. 70% of respondents said they were aware of the fact that materials such as used motor oil and paint cannot be removed by water treatment plants and that these materials end up in the Bay or Ocean if poured down the drain or otherwise improperly disposed of.

8. Nearly one out of six respondents (16%) said that at least one household member belonged to an environmental organization.

9. One final indicator of environmental awareness and concern is the fact that 56% of respondents said "yes" when asked whether they would like the phone number of the City's Hazardous Waste Hotline to get information on proper disposal of household toxic materials.

DISPOSAL METHODS; APPROPRIATE AND INAPPROPRIATE

Respondents who reported that they used certain products around the home during the past year were asked how they "normally" disposed of old, excess or leftover quantities of that product. This follow-up question was asked specifically about six products: motor oil, antifreeze, house paints, pesticides, art supplies, and photographic chemicals. Figures 3-3A through 3-3F visually summarize the frequency distribution of disposal practices for each of these products.

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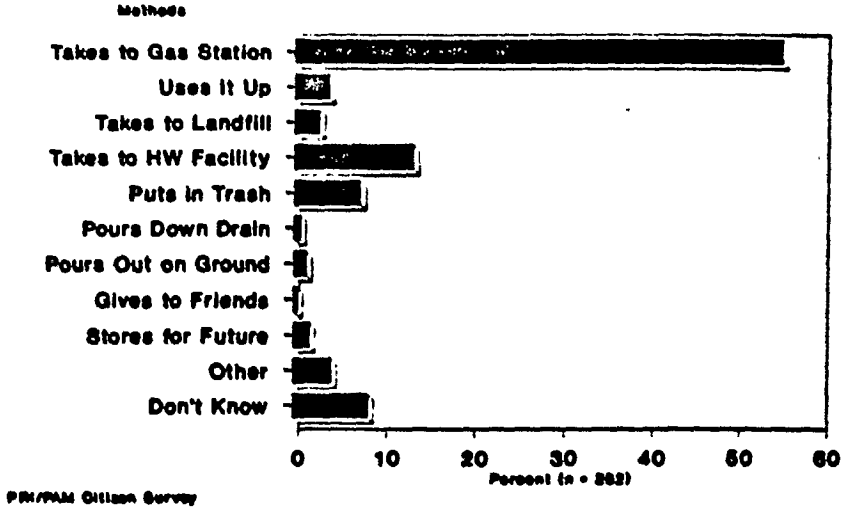
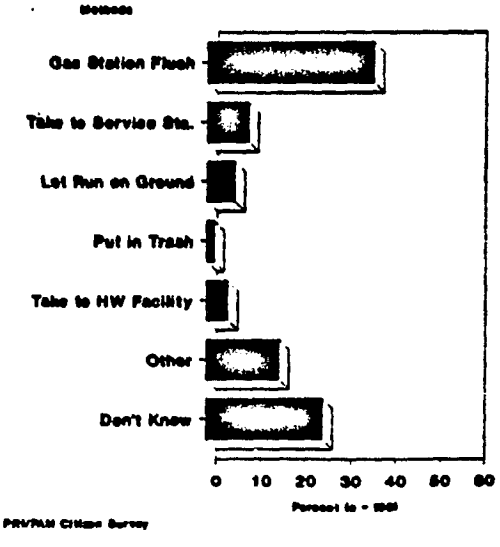


Figure 3-3B: Disposal of ANTIFREEZE
Percent of San Francisco Households
Normally Using Specified Disposal Method



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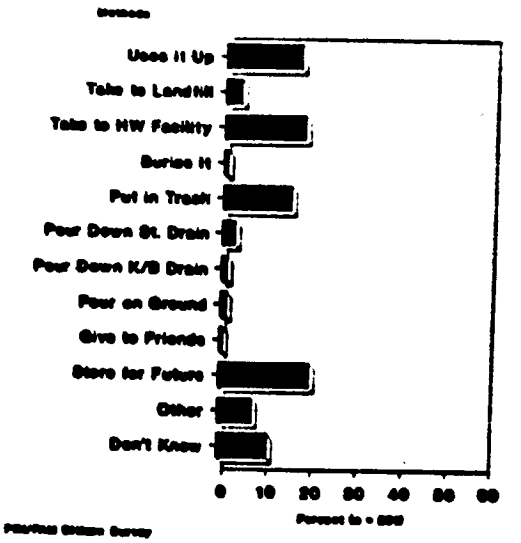

Figure 3-3D: Disposal of PESTICIDES
Percent of San Francisco Households
Normally Using Specified Disposal Method

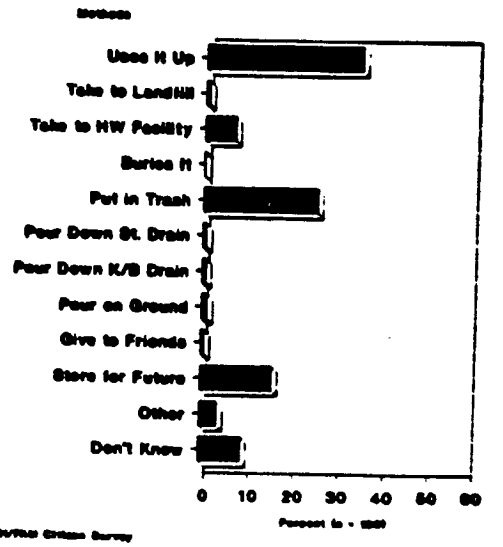

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Figure 3-3F: Disposal of ART CHEMICAL

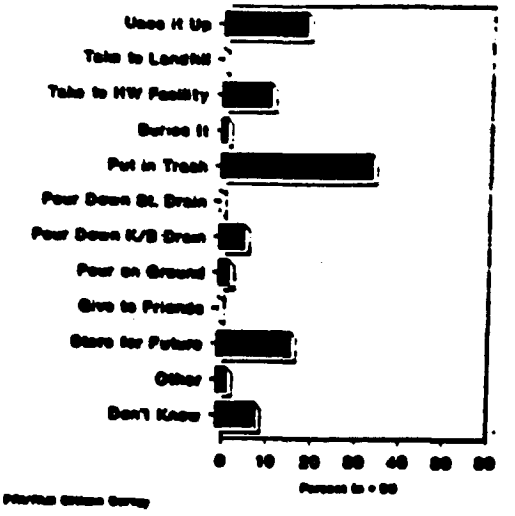
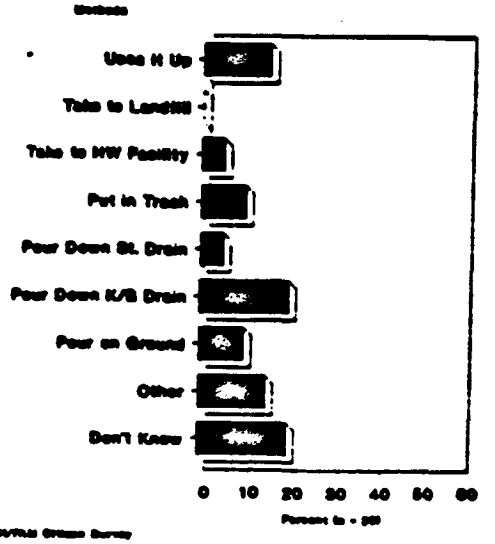


Figure 3-3F: Disposal of PHOTO CHEMICAL
Percent of San Francisco Households
Normally Using Specified Disposal Method



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Cross-tabulation Results: A Summary:

Cross-tabulations were calculated to detect variations in disposal practices according to housing tenure. There was statistically significant variation in motor oil disposal practices only with regard to neighborhood location, race, and gender. There was no statistically significant variation with regard to income, education, age, length of residence, or housing tenure.

With regard to motor oil disposal and neighborhood location, residents in neighborhoods 3 and 4 were more likely to take their used motor oil to the hazardous waste facility than were residents in other neighborhoods. Twenty-seven percent in neighborhood 3 and eighteen percent in neighborhood 4 used the facility in comparison with the fourteen percent overall average.

With regard to motor oil disposal and race, whites were more likely to use the hazardous waste facility than were members of other racial groups. Whites were also more likely to take used oil to a gas station. With regard to gender, men were more likely to use the hazardous waste facility than women.

Question 6 asked how used anti-freeze was disposed of, and responses to this question were broken down according to the same neighborhood and demographic characteristics. There was no statistically significant variation in anti-freeze disposal practices with regard to neighborhood location, income, education, race, age, length of residence, or housing tenure. With regard to gender, women were much more likely not to know how their household disposed of anti-freeze than were men.

Question 7 asked how used paints and thinners were disposed of, and responses to this question were broken down according to the same neighborhood and demographic characteristics. There was statistically significant variation in paint and thinner disposal practices according to income and housing tenure status, but there was no statistically significant variation according to neighborhood location, education, gender, race, age, or length of residence. Households with higher incomes and homeowners were more likely to use the hazardous waste facility than were households with lower incomes or renters.

Other questions were asked about the disposal practices for pesticides, yard fertilizers, art supplies, and photographic chemicals, but in all of these cases there were not enough responses to calculate statistically meaningful cross-tabulations.

Patterns and correlates of "inappropriate" disposal practices:

"Inappropriate" disposal methods include pouring excess or leftover materials on the ground, down the street drain, down the kitchen or bathroom drains, burying such materials, or placing them in the trash. Forty-eight percent of survey respondents who used art products reported one of these inappropriate practices in normally disposing of excess of leftover materials; 45% of photo chemical users reported the same (but note the very small n of 20), 28% of pesticide users, 22% of paint users, 10% of motor oil users, and 8% of those who used and disposed of antifreeze.

Table 3-5 reports breakdowns of the incidence of inappropriate disposal practices of motor oil and house paint by area of residence and by selected sociodemographic categories.

Based on these cross-tabulations, no clear pattern can be seen linking housing tenure, length of residence, income, or gender to inappropriate disposal practices in the case of oil and paint. Sample respondents living in Area 5 appear to show an unusually high rate of using inappropriate practices

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TABLE 3-5: Rates of Reported "inappropriate" Practices in Disposing of Motor Oil and Paint Among Users of These Products, by Area of Residence and Selected Sociodemographic Categories[a]

BREAKDOWNS	MOTOR OIL	HOUSE PAINT
Area 1	9%	30%
Area 2	4%	35%
Area 3	9%	23%
Area 4	9%	13%
Area 5	24%	25%
Area 6	16%	29%
Owners	11%	24%
Renters	11%	30%
18-29 Years Old	17%	27%
30-39 Years Old	%	27%
40-54 Years Old	7%	25%
55+ Years Old	3%	26%
0-5 Years Residence	9%	18%
6-15 Years Residence	16%	28%
16-30 Years Residence	9%	38%
31+ Years Residence	9%	20%
Less than $15,000/Yr	13%	50%
$15-25,000	0%	33%
$25-40,000	12%	24%
$40-60,000	11%	25%
$60-80,000	12%	11%
$80,000+	10%	35%
Male	10%	27%
Female	13%	27%
High School or Less	7%	35%
Some College	11%	26%
College Degree	14%	25%
Graduate Work +	10%	19%
White	9%	24%
Hispanic	22%	33%
Black	22%	31%
Asian	11%	39%
Other	7%	8%

[a] Note: "inappropriate" practices include disposal in trash, on ground, or down drains. Calculations exclude "other" and "don't know."

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to dispose of motor oil, and those in Area 4 show an unusually low rate of using inappropriate practices to dispose of house paint. The cross-tabulations also suggest that race, age, and education are predictors of inappropriate disposal practices in the case of oil or paint or both. Multivariate

likely to do so than younger respondents. In the case of paint, older respondents are more likely than younger ones to use inappropriate disposal practices, and college educated respondents are less likely to do so than those who lack a college degree. None of these results is statistically significant at $p < .10$, however, because of the small sample sizes involved. (The estimated odds-ratio of .51 for the College Degree + comes closest to statistical significance [$p < .102$] in predicting inappropriate practices in disposing of house paint.

Drain/ground disposal versus trash disposal:

Inappropriate disposal methods that pose a particular danger to the Bay and Ocean include pouring hazardous substances down the drains or on the ground. Relatively small fractions of survey respondents reported using these particular disposal methods. Only 2% of users said they practiced such methods to dispose of motor oil and pesticides; 5% in disposing of paints; 6% in disposing of antifreeze; and 8% in the case of art materials. Although 35% of photo chemical users reported using these methods, the actual number doing so is small (7 out of 20 in the sample).

Under the category of inappropriate disposal practices, trash disposal is the method used most often by users to dispose of unwanted motor oil and house paint in unsafe ways. Of the 282 responses received from motor oil users regarding disposal practices, 27 reported "inappropriate" disposal practices as defined above, and 21 of those 27 (78%) said they used trash disposal as their normal method. Of the 251 responses received from house paint users regarding disposal practices, 54 reported "inappropriate" disposal practices, and 39 of those 54 (72%) said they used trash disposal as their normal method. To convey a rough estimate of the aggregate numbers of households using these inappropriate practices in disposing of motor oil and house pain, we can use the sample proportions as multipliers on the total population of 305,584 households. Here are the results (with 95% confidence intervals) for inappropriate disposal practices generally and for trash disposal in particular:

MOTOR OIL:

Proportion of total sample respondents (602) who:

use inappropriate disposal methods: .045.
use trash disposal methods: .035.

Estimated number of households that:

use inappropriate disposal methods: 13,706 (8,679 to 18,824).
use trash disposal methods: 10,660 (6,173 to 15,157).

HOUSE PAINT:

Proportion of total sample respondents (602) who:

use inappropriate disposal methods: .090.
use trash disposal methods: .065.

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Estimated number of households that:
use inappropriate disposal methods: 27,411 (20,444 to 34,378).
use trash disposal methods: 19,797 (13,782 to 25,822).

[illegible] questions about normal disposal methods.

As noted earlier, 71% of survey respondents said that they were aware that materials like motor oil and paint cannot be removed by water treatment plants when poured down any drain and that these substances eventually flow into the Bay or Ocean. Is such awareness linked to safer disposal practices as reported by our respondents? Table 3-6 compares rates of "inappropriate" disposal practices for those who said they were aware of the consequences with those for respondents who admitted they were not aware.

As shown in Table 3-6, the differences in rates are small but are all (with one exception) in the right direction. These results suggest that educational programs promoting environmental awareness have the potential to make at least marginal improvements in reducing the incidence of dangerous disposal practices. Further, although the rate differences are small, they could have a sizeable aggregate impact on the city's 305,000 households. (To illustrate, if we assume that the rates shown in Table 3-6 hold for all the city's households, and if we assume that educational programs could reduce the rate of drain/ground disposal of motor oil from the rate of 4.48% to a rate of 1.42% (see Table 3-6), calculations reveal that more than 1,000 households would cease this dangerous practice.)

Use of HHWCF

Of particular interest under the heading of disposal practices are reports of use of San Francisco's new Household Hazardous Waste Collection Facility (HHWCF). The percentages of survey respondents who reported disposing of excess or leftover materials at the HHWCF range from a low of 5% (photo chemicals) to a high of 18% in disposing of house paints. Seven percent of pesticide users reported that they "normally" use the HHWCF to dispose of unwanted pesticides, 11% of those using arts materials, and 13% of motor oil users. These utilization rates were obtained from spontaneous open-ended answers to questions about normal disposal practices. Respondents who did not mention the HHWCF in describing normal disposal methods were asked later in the interview whether they were aware of the HHWCF and, if so, whether they had used it for anything during the past year. Combining these two sets of responses (spontaneous open-ended plus follow-up), the actual level of awareness of the HHWCF is 41% and the reported utilization rate is 19% for the entire sample.

Table 3-7 reports these HHWCF awareness and utilization rates broken down by area of residence (see Map later in this report) and by various sociodemographic categories. As shown in Table 3-7, there are significant variations in awareness and use of the HHWCF by area, owner/renter status, length of residence, and race. Figure 3-4 shows a stacked bar graph indicating the percentage of respondents in each of the six city areas who reported (1) using the HHWCF, (2) being aware of the HHWCF but not using it, and (3) being unaware of the facility. It is clear that respondents living in Areas 3 and 4 in the southern part of the city nearer the facility are both more aware of it and are more likely to use it than are those living in other parts of the city.

Of the three factors found to be linked to awareness and use of the HHWCF, those of housing tenure and race hold up even controlling for area of residence. Table 3-8 breaks down awareness and utilization rates (1) by owner/renter status and (2) by white/non-white race (African American, Latino, Asian and Other) within each area. As shown, independent of the area of residence,

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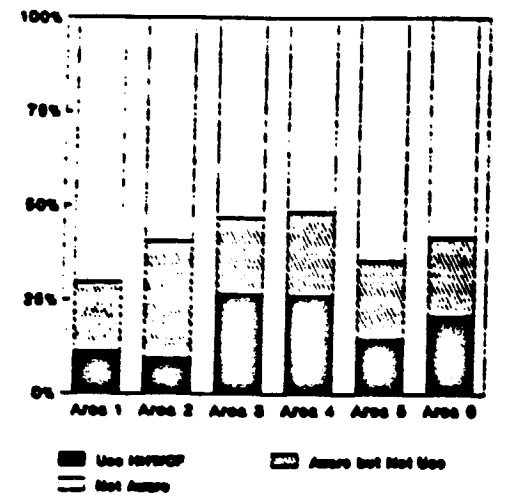

Figure 3-5: Sources of Pollution
Magnitude of Contribution to Water Pollution as Viewed by San Franciscans

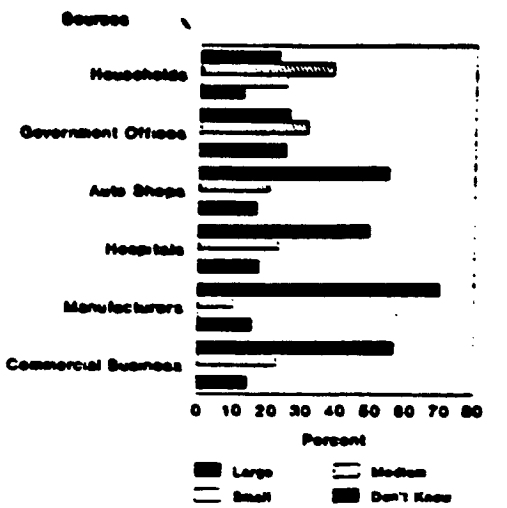

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TABLE 3-6: Percentages of Specified Product Users Who Normally Pour Excess or Leftover Materials Down Drains or On the Ground: Broken Down by Level of Knowledge

PRODUCT	Rate for all users	(n)	Rates for respondents who are aware (Yes) and who are not aware (No) that such methods pollute the Bay and Ocean: Yes	(n)	No	(n)
Motor Oil	2.13%	(282)	1.42%	(211)	4.48%	(67)
Antifreeze	6.06%	(198)	5.59%	(143)	7.55%	(53)
Paints/Thinners	5.19%	(251)	4.42%	(181)	7.58%	(66)
Pesticides	2.23%	(180)	3.01%	(129)	0.00%	(48)
Art Materials	7.69%	(91)	5.97%	(67)	8.70%	(23)
Photo Chemicals	35.00%	(20)	33.33%	(15)	50.00%	(4)

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TABLE 3-7: Rates of Awareness and Use of the Household Hazardous Waste Collection Facility (HHWCF) by Area of Residence and by Selected Sociodemographic Categories

BREAKDOWNS	% of HHWCF	HHWCF	(n)
Area 1	20%	11%	(152)
Area 2	41%	9%	(74)
Area 3	47%	27%	(94)
Area 4	48%	26%	(95)
Area 5	35%	15%	(48)
Area 6	42%	21%	(91)
Owners	52%	29%	(205)
Renters	36%	13%	(378)
18-29 Years Old	31%	15%	(144)
30-39 Years Old	39%	18%	(145)
40-54 Years Old	51%	23%	(146)
55+ Years Old	48%	18%	(119)
0-5 Years Residence	28%	12%	(155)
6-15 Years Residence	40%	21%	(150)
16-30 Years Residence	46%	17%	(150)
31+ Years Residence	54%	26%	(122)
Less than $15,000/Yr	31%	10%	(70)
$15-25,000	41%	12%	(76)
$25-40,000	40%	22%	(114)
$40-60,000	50%	19%	(98)
$60-80,000	42%	22%	(45)
$80,000+	48%	27%	(54)
Male	42%	21%	(283)
Female	40%	16%	(308)
High School or Less	41%	17%	(149)
Some College	38%	18%	(131)
College Degree	40%	18%	(191)
Graduate Work +	47%	22%	(110)
White	49%	26%	(316)
Hispanic	29%	8%	(51)
Black	33%	11%	(36)
Asian	34%	11%	(132)
Other	33%	15%	(33)

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TABLE 3-8: Rates of Awareness and Use of the Household Hazardous Waste Collection Facility (HHWCF) by Housing Tenure (Own/Rent) and by Race (White/Non-White [African American, Latino, Asian and Other]), Controlling for Area of Residence

Area 1			
	Own	45%	21%
	Rent	26%	9%
	White	34%	16%
	Non-White	24%	5%
Area 2			
	Own	57%	21%
	Rent	38%	5%
	White	51%	14%
	Non-White	30%	5%
Area 3			
	Own	58%	36%
	Rent	33%	15%
	White	51%	31%
	Non-White	44%	24%
Area 4			
	Own	54%	38%
	Rent	47%	18%
	White	63%	43%
	Non-White	33%	9%
Area 5			
	Own	44%	22%
	Rent	33%	13%
	White	42%	19%
	Non-White	24%	6%
Area 6			
	Own	43%	19%
	Rent	42%	23%
	White	52%	28%
	Non-White	31%	13%

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respondents who are homeowners and/or who are white are more likely to be aware of the HHWCF and to use it than are renters and/or non-whites (African Americans, Latinos, Asians and Other).

When asked whether they would use a curbside pick up service for motor oil and latex paint if it were offered, 71% of the survey respondents said that they definitely would use it and another 5% said maybe. Of those who said they definitely would use it, 83% said they would be willing to pay the city and extra 25 cents each month for this new service. And of those who would be willing to pay the 25 cent/month fee, 71% said they would be willing to go as high as 50 cents/month. These results indicate solid support for such a new expanded pick up service backed up by a substantial willingness to pay for it.

The breakdowns shown in Table 3-9 reveal that the popular support for such a new service (and the willingness to pay for it) is spread fairly evenly throughout the city, although owners appear to be a bit more enthusiastic than renters, and men appear more supportive than women.

Survey respondents also were quite supportive of greater efforts on the part of the city to do more to improve water quality in the Bay and Ocean (77%), to do more to promote awareness of toxic materials and their disposal (84%), and to do more to regulate practices involving toxic materials and their disposal (77%). Further, 80% of those who support these programs would be willing to pay 25 cents each month for them, and of those who would pay this much, 76% would be willing to pay 50 cents a month.

The breakdowns in Table 3-10 show that these levels of support are high in all parts of the city and in all sociodemographic groups, although older respondents were noticeably less enthusiastic than were younger ones.

Given the importance of the community's willingness to pay for these kinds of new services and educational programs, a more rigorous multivariate analysis of the responses is required before drawing any firm conclusions. The logistic regression analyses reported in Table 3-11 provide this. As shown by the odds-ratios under each "model" in Table 3-11, respondents who live in Area 5 are particularly more likely than those who live in Area 1 (the reference group) to support and pay for these various programs. The only other factor that predicts support or opposition is age (see results under models 1 and 3), in this case indicating that older residents (everything else the same) are about two-thirds as likely as younger residents to be willing to pay the 25 cents/month fee. On the whole, the results shown in Table 3-11 corroborate the evidence presented earlier indicating citywide support for these programs in almost all areas and in almost all social classes and racial/ethnic groups.

PERCEIVED SOURCES OF WATER POLLUTION

To provide a different perspective on the community's environmental awareness, survey respondents were asked to estimate the contribution of several different entities (households, government offices, auto mechanic and body shops, hospitals, manufacturing business, and commercial businesses) to water pollution. Figure 3-5 shows clearly that respondents view household residents themselves as a relatively minor contributor to water pollution compared to the perceived importance of manufacturers, commercial businesses, auto shops, and hospitals.

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TABLE 3-9: Rates of Likely Use and Willingness to Pay for Curbside Pick Up of Motor Oil and Latex Paint by Area of Residence and by Selected Sociodemographic Categories

BREAKDOWNS	% Likely to Use	who would pay 25 cents/month	25 cents who would pay 50
Area 1	63%	81%	72%
Area 2	74%	85%	79%
Area 3	81%	83%	65%
Area 4	74%	79%	75%
Area 5	77%	89%	73%
Area 6	65%	83%	61%
Owners	80%	81%	70%
Renters	68%	85%	71%
18-29 Years Old	76%	84%	72%
30-39 Years Old	74%	93%	74%
40-54 Years Old	76%	81%	67%
55+ Years Old	65%	82%	73%
0-5 Years Residence	72%	91%	72%
6-15 Years Residence	71%	86%	78%
16-30 Years Residence	77%	82%	67%
31+ Years Residence	68%	73%	64%
Less than $15,000/Yr	66%	80%	76%
$15-25,000	75%	84%	63%
$25-40,000	75%	85%	77%
$40-60,000	72%	90%	73%
$60-80,000	73%	91%	83%
$80,000+	80%	84%	64%
Male	77%	82%	70%
Female	67%	84%	72%
High School or Less	66%	81%	75%
Some College	76%	84%	64%
College Degree	73%	88%	71%
Graduate Work +	74%	80%	75%
White	69%	87%	70%
Hispanic	71%	83%	73%
Black	83%	73%	73%
Asian	78%	81%	73%
Other	64%	90%	63%

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TABLE 3-10: Rates of Support and Willingness to Pay for "More" Effort to (1) Improve Water Quality, (2) Promote Awareness of Toxic Materials, and (3) Regulate Toxic Materials and Disposal, by Area of Residence and Selected Sociodemographic Categories

BREAKDOWNS	more effort on all three	more effort who would pay 25 cents/month	25 cents who would also pay 50 cents/month
Area 1	64%	78%	74%
Area 2	68%	73%	71%
Area 3	64%	80%	78%
Area 4	67%	84%	75%
Area 5	79%	88%	74%
Area 6	59%	81%	81%
Owners	63%	80%	76%
Renters	69%	82%	76%
18-29 Years Old	77%	84%	81%
30-39 Years Old	72%	88%	75%
40-54 Years Old	64%	79%	78%
55+ Years Old	58%	73%	72%
0-5 Years Residence	70%	90%	81%
6-15 Years Residence	67%	82%	78%
16-30 Years Residence	73%	82%	75%
31+ Years Residence	57%	65%	63%
Less than $15,000/Yr	70%	77%	74%
$15-25,000	70%	78%	82%
$25-40,000	68%	87%	81%
$40-60,000	65%	83%	82%
$60-80,000	80%	87%	69%
$80,000+	65%	86%	79%
Male	64%	83%	77%
Female	68%	79%	74%
High School or Less	63%	79%	74%
Some College	74%	80%	74%
College Degree	64%	81%	80%
Graduate Work +	69%	85%	76%
White	65%	82%	76%
Hispanic	78%	80%	82%
Black	78%	77%	67%
Asian	67%	81%	73%
Other	61%	80%	83%

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TABLE 3-11: Logistic Regression Models Predicting Probabilities of: (1) Using Curbside Pick Up of Oil and Paint and Being Willing to Pay 25 Cents/Month, (2) Using Curbside Pick Up and Being Willing to Pay 50 Cents/Month, (3) Supporting "More" Education and/or Regulation and Being Willing to Pay 25 Cents/Month, and (4)

PREDICTOR	Model (1) (+ Curb + 25 cents)	Model (2) (+ Curb + 50 cents)	Model (3) (+ Support + 25 cents)	Model (4) (+ Support + 50 cents)
Area 2	1.48	1.81	1.68	1.81
Area 3	1.42	.95	1.67	.95
Area 4	1.55	1.56	1.56	1.56
Area 5	2.36 *	2.00 *	2.39 *	2.00 *
Area 6	.76	.70	.88	.70
Hispanic	1.01	1.13	.88	1.13
Black	1.60	1.26	1.31	1.26
Asian	1.49	1.48	1.54	1.48
Other Race	1.76	1.84	1.73	1.84
Female	.80	.87	.72	.87
Homeowner	1.32	1.49	1.28	1.49
40 Years +	.64 *	.73	.68 *	.73
$40,000 +	1.36	1.21	1.27	1.21
College Degree +	1.11	1.09	1.11	1.09
Chi-Square(14)	20.4	18.5	19.6	18.5
Pseudo-R^2	.037	.033	.037	.033
n of cases	407	407	407	407

[a]Note: The general model tested is Prob {Y=1} = 1/(1+exp(-(XB))), where Y=1=existence of support/willingness to pay, X are dummy variable predictors, and B are logistic regression coefficients estimated using maximum likelihood techniques on sample survey data. Reference group for Area odds-ratios is Area 1 (odds-ratio = 1.0); reference group for Race odds-ratios is White (odds-ratio = 1.0).

* $p < .05$

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Table 3-12 shows the results of a logistic regression analysis predicting the probability a respondent would consider a given entity's contribution to be "large." As seen in Table 3-12, no factor predicts in the case of households as contributors to pollution -- i.e., the perception that

likely than Whites to blame hospitals. Females are less likely than males to blame manufacturing businesses, as is true of Asians compared to Whites. On the other hand, upper-income respondents are more likely than lower-income ones to blame manufacturers for the pollution. Upper-income respondents are more likely than lower-income respondents to blame commercial businesses, and Asians are less likely than Whites.

SOURCES OF INFORMATION ABOUT ENVIROMENTAL PROBLEMS

When asked about their primary source of information on environmental problems and issues, 42% of survey respondents mentioned newspapers, 21% television, 7% magazines, 3% word of mouth, 2% radio, and 21% "other." The large "other" category certainly includes information gained through participation in environmental groups and organizations, a category which we now realize should have been included in the questionnaire. Evidence for this is the fact that 34% of the 95 respondents who said they belonged to an environmental organization picked "other" as their main source of information as compared with only 20% of those who do not belong to such organizations.

Table 3-13 reports the results of a logistic regression analysis predicting choice of newspapers, television, and "other," respectively, as the primary source of information. An analysis also is shown predicting membership in environmental organizations. Non-white respondents, particularly Hispanics and Asians, are less inclined to rely upon newspaper than are Whites and are much more inclined than Whites to rely upon television for information about the environment. Homeowners are less likely than renters to rely upon newspapers and more likely to use television. Upper-income and college-educated respondents are more likely to rely upon newspapers than are lower-income and non-college-educated respondents, respectively. Members of environmental organizations are less likely than non-members to rely either upon newspapers or television and are three times more likely to rely upon "other" sources of information. Based on the results shown in the last column of Table 3-13, Asians are only a fifth as likely as Whites to join environmental organizations (also note the low odds-ratios for Hispanics and Blacks), college-educated respondents are nearly three times more likely than the non-college-educated to join such organizations, and upper-income are more than twice as likely than lower-income respondents to join.

NEIGHBORHOOD DIFFERENCES IN THE SURVEY RESPONSE

Six areas of the city were studied in this survey (see map below). Table 3-14 gives each area's profile of descriptive social statistics and illustrates considerable variation among the six areas in social and ethnic composition. Table 3-15 gathers together the main survey results that appeared to be correlated with area of residence. These include area variations in use of weedkillers, yard fertilizers, and house paints (clearly linked to high levels of homeownership in Areas 3 and 4), in methods normally used to dispose of motor oil (greater use in Areas 3 and 4 of the HHWCF due to its proximity), and greater awareness in Areas 3 and 4 of the polluting effects of dumping toxic substances down drains. Other findings linked to area of residence were discussed earlier in this report.

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TABLE 3-12: Perception of Various Water Users' Contribution to Water Pollution. Odds-Ratios Showing Relative Li that a Survey Respondent of Specified Type will Perceive a User's Contribution to Water Pollution as "Large"[a]

	PREDICTORS:									
USERS	Female	40 Years+	Home Owner	College Degree+	$40K+	Hispanic	Black	Asian	O	Pseudo-R^2
Households	.83	.89	.76	.92	1.30	1.07	1.12	.98		.008
Government Offices and Facilities	1.01	1.00	1.01	1.67 *	1.59 *	1.26	2.56 *	1.24	1	.027
Auto Mechanics and Body Shops	.85	.62 *	1.10	1.49	1.00	1.44	1.80	1.07	1	.020
Hospitals	1.17	1.34	.84	1.09	1.39	3.00 *	1.28	.86	1	.026
Manufacturing Businesses	.65 *	.76	.82	1.31	2.38 *	1.37	1.12	.55 *		.066
Commercial Businesses	1.10	1.02	.96	1.18	2.13 *	1.78	1.02	.60 *	1	.043

[a]Note: The general model tested is Prob { Y = "Large" contribution } = 1/(1+exp(-(XB))), where Y = estimated p y that respondent views specified water user as a "large" contributor to water pollution, X is a vector of dummy variable predi B is a vector of logistic regression coefficients estimated using maximum likelihood methods on sample survey data. Entrie mated odds-ratios for specified groups indicating the likelihood that members of a specified group (e.g., females) will "large contribution" relative to that same likelihood for a reference group (e.g., males). An odds-ratio of 1.0 indicates t lative likelihoods of group and reference group are equal. The odds-ratios shown are for females vs. males, older vs. younge wners vs. renters, higher income vs. lower income, Hispanics vs. Whites, Blacks vs. Whites, Asians vs. Whites, Other Ra hites. The odds-ratios for Whites (the racial reference group) are 1.00 in all cases. These estimated odds-ratios are statistically for the effects of all other predictors. The Pseudo-R^2 measures the model's goodness-of-fit. Sample n = 439.

* p < .10

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TABLE 3-13: Primary Source of Information about Environmental Problems. Estimated Odds-Ratios Showing Relative Likelihood of Respondents in Specified Groups or Areas Relying Primarily on (1) Newspapers, (2) Television, or (3) "Other" Sources for Information About Environmental Problems. Also Shown is Model

	Information Sources			
PREDICTOR	Newspapers	Television	"Other"	Membership in environmental Organizations
Area 2	.96	.87	1.01	·1.51
Area 3	.71	1.27	1.47	1.00
Area 4	1.62	.60	1.14	.92
Area 5	.81	.92	1.24	1.31
Area 6	1.44	.90	1.04	1.47
Hispanic	.44 *	4.42 *	.69	.50
Black	.73	3.16 *	.77	.22
Asian	.53 *	2.25 *	1.24	.16 *
Other Race	.69	1.99	1.55	1.56
Female	.91	1.00	1.00	1.54
Homeowner	.62 *	2.13 *	.70	.74
40 Years +	1.11	1.03	.75	1.08
$40,000 +	1.76 *	.57 *	.98	2.85 *
College Degree +	1.78 *	.65	.59 *	2.31 *
Member Env. Organ.	.39 *	.84	3.32 *	--
Chi-Square(15)	42.5	45.5	22.9	59.3
Pseudo-R^2	.077	.111	.052	.157
n of cases	407	407	407	407

[a]Note: The general model tested is Prob {Y = "Primary Source" } = 1/(1+exp(-(XB))), where Y = specified primary information source, X are dummy variable predictors, and B are logistic regression coefficients estimated using maximum likelihood techniques on sample survey data. Reference group for Area odds-ratios is Area 1 (odds-ratio = 1.0); reference group for Race odds-ratios is White (odds-ratio = 1.0).

* $p < .10$

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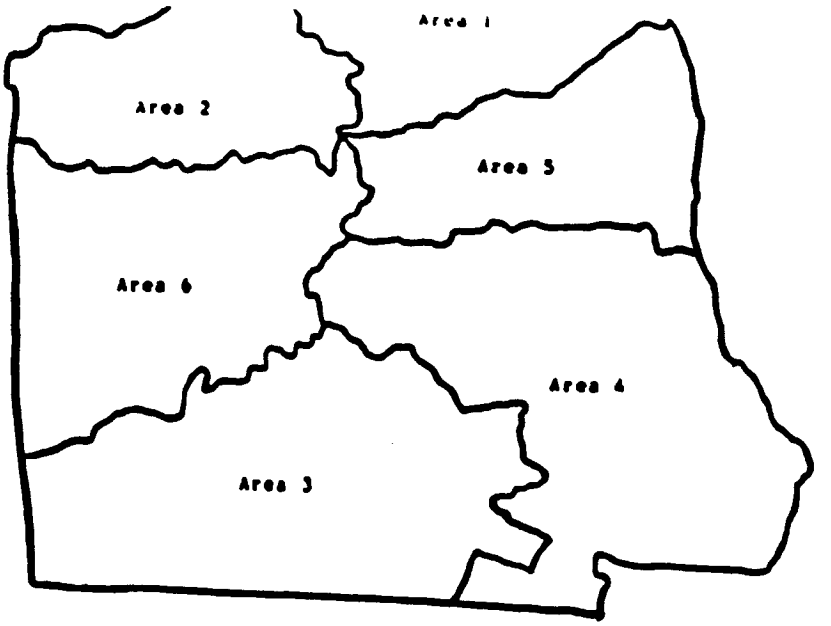
Figure 3-6: Map of Six San Francisco Areas with Legend



MAP LEGEND: San Francisco neighborhoods contained within six Pacific Bell central station area jurisdictions. (Neighborhood boundaries taken from The Coro Handbook, 1979.)

AREA 1: Telegraph/North Beach, Chinatown, Nob Hill, Pacific Heights, Marina/Russian Hill, Polk Gulch, Civic Center, Western Addition

AREA 2: Inner Richmond, Middle Richmond, Outer Richmond, Jordan Park

AREA 3: Portola, Visitacion Valley, Crocker-Amazon, Excelsior, Miraloma/Mt. Davidson, Ingleside, Lake Merced, Glen Park, West of Twin Peaks (partial)

AREA 4: Bayview/Hunters Point, Bernal/Holly, Potrero Hill, Inner Mission, Noe/Eureka

AREA 5: Downtown/China Basin, South of Market, Haight Ashbury, Buena Vista/Duboce

AREA 6: Outer Sunset, South Outer Sunset, Middle Sunset, Inner Sunset, Twin Peaks, Parkside, West of Twin Peaks (partial).

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TABLE 3-14: Demographic Characteristics of Survey Respondents Living in Six San Francisco Areas*

1. Mean number of persons living in household	2.4	2.6	3.4	2.8	2.2	3.0
2. % with children under 18 yrs living at home	23%	25%	45%	44%	20%	37%
3. % own their own homes	22%	20%	58%	43%	19%	47%
4. % keep yard or garden	30%	41%	73%	55%	38%	55%
5. % have garage used for storage	45%	55%	78%	71%	48%	75%
6. % use garage as workshop	18%	16%	26%	31%	22%	25%
7. Mean number of years lived in S.F.	18.3	20.6	24.9	21.4	14.9	24.6
8. % member of environmental organization	15%	20%	11%	18%	19%	18%
9. % College Degree +	53%	69%	37%	43%	52%	52%
10. Mean age in years	45.6	46.4	44.8	45.1	41.8	47.6
11. % Households earning less than $25,000	25%	23%	20%	31%	23%	23%
12. % White	57%	50%	41%	52%	65%	51%
13. (Sample n)	(152)	(74)	(94)	(95)	(48)	(91)

* Consolidated from 10 Central Headquarters prefix service areas. Information provided by Pacific Bell Business Service Office.

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TABLE 3-15: Differences in Use and Disposal of Toxic Materials: Survey Responses from Six Francisco Areas*

1. % Used WEED KILLERS last year	1.8%	7.7%	17.7%	10.5%	5.9%	4.1%
2. % Used YARD FERTILIZERS last year	10.5%	14.9%	29.8%	20.6%	10.4%	17.6%
3. % Used PAINTS/THINNERS last year	34.2%	37.8%	61.7%	39.0%	39.6%	39.6%
4. % Choosing Methods normally used to dispose of MOTOR OIL						
Takes to gas station	64%	69%	47%	49%	53%	49%
Uses it up	5%	0%	2%	4%	0%	7%
Takes to landfill disposal site	0%	0%	2%	10%	0%	2%
Takes to Household HW Facility	6%	9%	27%	18%	11%	17%
Puts it in trash	6%	3%	6%	8%	16%	9%
Pours down street drain	0%	0%	2%	0%	0%	0%
Pours down kitchen/bathroom drain	2%	0%	0%	0%	5%	5%
Gives it to neighbors/friends	0%	0%	0%	0%	5%	0%
Stores it for future use	2%	0%	2%	4%	0%	0%
Other	8%	6%	2%	2%	0%	2%
Don't know	8%	14%	10%	6%	11%	9%
(Sample n)	(64)	(35)	(49)	(51)	(19)	(43)
5. % Who have seen hazardous chemicals dumped down drains in neighborhood	11%	14%	24%	24%	25%	19%
6. % Who are aware that chemicals dumped in sewage system can pollute the Bay or Ocean	65%	73%	78%	81%	60%	65%

* Consolidated from 10 Central Headquarters prefix service areas. Information provided by Pacific Bell Business Service Office.

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IMPLICATIONS FOR EDUCATIONAL PROGRAMMING AND TARGETING STRATEGIES

questions. We conclude that a special targeting strategy aimed at specific groups or particular neighborhoods would not yield substantially better results than a broad based, city-wide strategy.

While San Franciscans generally have a high level of environmental awareness as indicated in this report, many respondents are still unsure about the degree of risk associated with the handling and disposal of common household products. Small percentages of respondents appear to dispose of household toxic products in particularly harmful ways, but as shown earlier in this report, awareness of the consequences of improper disposal tends to reduce its occurrence. Clearly there is potential here to increase public awareness and improve practices through a broad based educational program.

In a few limited instances, special targeting might be appropriate. As noted earlier, respondents who reside in Areas 3 and 4 in the southern part of the city were both more likely to be aware of the HHWCF and to dispose of toxic materials there. Figure 4 showed that more than half of the residents in the other areas of the city were unaware of the HHWCF and over 80% said they had never used it. If unused capacity exists, an educational outreach program to make residents aware of the HHWCF could increase use of that facility.

There is little apparent variation throughout the city in the generally high level of enthusiasm for curbside pick up of oil and paint. Nor is there much variation in the willingness of residents to pay additional fees for this added service. Consistent with this, there is also little variation by area or demographics in the tendency of residents to support "more" city efforts to improve water quality and promote environmental awareness. Our survey demonstrates an evident willingness to pay for these efforts. Again, this suggests that a broad based, city-wide educational effort would be most effective, and that there are no particular neighborhoods or groups in need of special targeting.

When it comes to choosing which media to use to reach certain demographic groups in educational outreach programs, the survey results do provide some guidance. In terms of where respondents received news and information on environmental issues, there was meaningful variation according to social class, race/ethnicity, and environmental activism. Respondents who reported higher income and education levels are more likely to read newspapers for information on environmental issues; those reporting lower levels of income and education rely more upon television. The environmental activists interviewed in our survey clearly rely on neither of these, preferring the information channels provided by their environmental organizations and activities. This suggests that both print and broadcast media should be used selectively, perhaps in joint efforts with environmental groups, to promote citywide awareness of environmental problems.

Whatever educational programs are developed to promote best management practices in San Francisco, we strongly recommend that follow-up studies and surveys be conducted at regular intervals to assess the impacts of such programs on attitudes and behavior relative to the baseline results reported here.

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SECTION 4

SELECTION OF DRY WEATHER BMPs FOR EVALUATION

below.

- Identify the CCSF constituents for which dry weather source control efforts are most critical based on effluent discharge water quality criteria.
- Review BMPs developed elsewhere for these constituents based on telephone interviews with public agencies and a computerized literature search.
- Develop pollutant loading estimations from CCSF's four major source categories (water supply, residential, industrial, and commercial/other businesses).
- Identify the potential specific sources of the identified constituents of concern in each of the four source areas.
- Incorporate the appropriate Optional BMPs suggested by the Regional Board.

A schematic illustration of the dry weather BMP selection process is presented in Figure 4-1.

Previous CCSF efforts (CCSF, 1991E) evaluated a variety of organic and inorganic constituents contained in CCSF's influent wastewaters in relation to several effluent discharge water quality criteria. These criteria included: effluent concentrations at or approaching discharge limits, and the potential for bioaccumulation, biomagnification, sediment toxicity, and/or other general receiving water problems. As a result of these efforts, eight constituents were identified as "targeted constituents" by CCSF. These eight targeted constituents are listed below.

- Copper
- Lead
- Mercury
- Nickel
- Silver
- Zinc
- Cyanide
- Polynuclear aromatic hydrocarbons (PAHs)

IDENTIFICATION OF PROBLEM CONSTITUENTS

To confirm the selection of these targeted constituents, the 1991 SEWPCP effluent discharge concentrations of these constituents plus three other heavy metals (arsenic, cadmium, and chromium) were examined relative to Basin Plan limits recently proposed by the Regional Board. This examination also provided a baseline for establishing the necessity of certain source reduction efforts and determining the expected impacts of proposed BMPs.

Table 4-1 compares the average, 95th percentile, 99th percentile, and maximum effluent concentrations in 1991 for the eleven constituents against the Basin Plan limits. The 95th and 99th percentile data represent the effluent concentration values that are statistically not expected to be exceeded 95 and 99 percent of the time, respectively. The Basin Plan limits are calculated based on water quality objectives in the receiving water, ambient levels, and a dilution factor of 10:1 for deep water outfalls. These water quality objectives, as published by EPA, theoretically should not be exceeded more than once every three years. Currently, the Regional Board has not specified whether this guideline will be used as the measuring device for discharge non-compliance.

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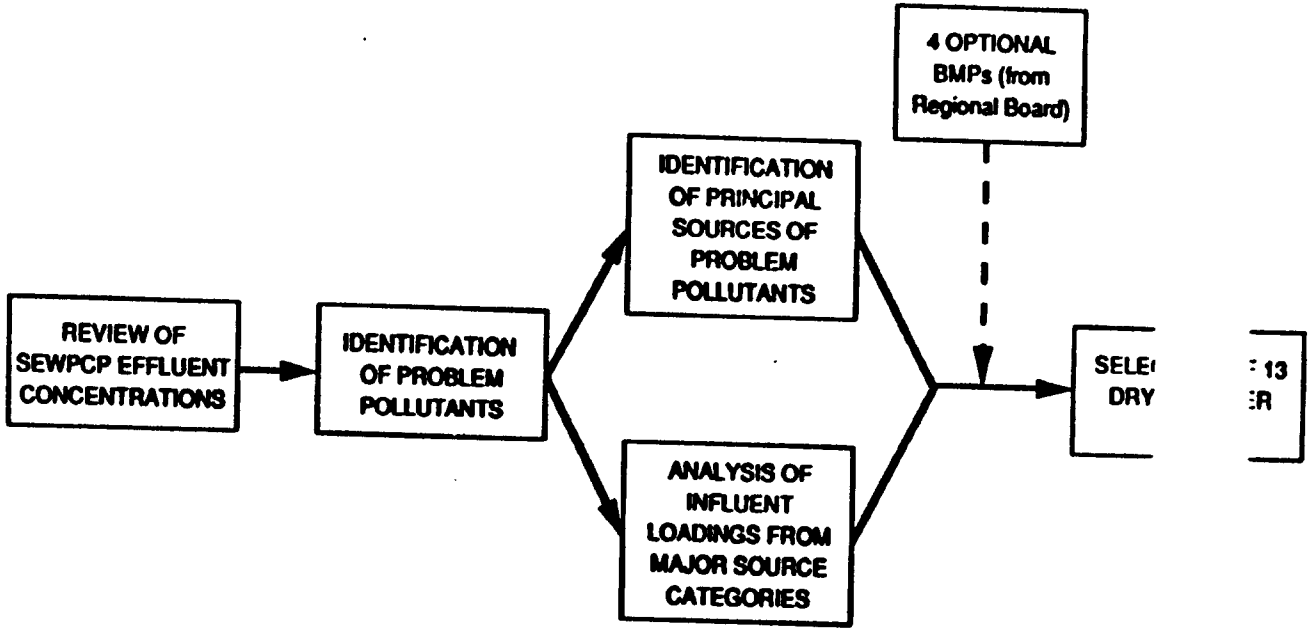

DRY WEATHER BMP SELECTION PROCESS

FIGURE 4-1

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TABLE 4-1

SEWPCP 1991 EFFLUENT POLLUTANT CONCENTRATIONS VERSUS BASIN PLAN LIMIT

Constituents	Southeast WPCP Effluent Concentrations (µg/l)				San Francisco Daily Avera Effluent Limit (µg/L)
	Average	95th Percentile	99th Percentile	Maximum	
Arsenic	2.6	5	6.6	6.6	360
Cadmium	6.4	15.3	15.3	15.3	92
Chromium	3.3	6	7.6	9.1	500
Copper	22.5	53	70	70	17
Lead	4.7	12.1	19.6	32.8	53
Mercury	0.2	0.7	1.2	1.4	0.21
Nickel	7.1	14.5	20.4	35.4	65
Silver	2.2	5.7	9.1	15	23
Zinc	67.8	189.6	309	450	840
Cyanide	15.4	26.4	33.1	35	10
PAHs	<1.7	(b)	(b)	7.3	0.31

(a) From San Francisco Bay Basin Plan, Deep Water Effluent Limitations, revised 12/11/91.
(b) A probability-based analysis of the PAH data was not conducted due to the low number of samples where PAH was detected during 1991.
Note: Shading denotes constituents exceeding Basin Plan Limits.

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However, it is likely that a high compliance rate, such as 95 to 99 percent of the time, will be required. Therefore, the 95th and 99th percentile values are listed in Table 4-1 for comparison

compliance roughly 99 percent of the time. As seen from Table 4-1, SEWPCP's 1991 95th and 99th percentile data for copper, mercury, and cyanide would exceed the Basin Plan limits. The standard for PAHs would also be exceeded on occasion. Interpretation of the PAH data is more difficult, however, due to the prevalence of data points approaching their detection limits (approximately 1 to 2 µg/L), while the effluent limit is at 0.31 µg/L. Effluent concentrations for the other targeted metals identified by CCSF (lead, nickel, silver, and zinc) would be significantly less than their respective Basin Plan limits.

Based on this evaluation of SEWPCP effluent concentrations and discussions with CCSF staff, it was decided that BMP efforts should focus on copper, mercury, cyanide, and PAHs as the primary pollutants of concern. While these constituents would be the primary focus, in evaluating the benefits of various BMPs, the impacts on the previously identified targeted pollutants (lead, nickel, silver, and zinc) would also be considered since their effluent concentrations are generally within one-third of the Basin Plan limits. Incidental reductions would occur for these previously targeted pollutants as a result of specific BMP efforts aimed at reducing copper, mercury, cyanide, and PAH. Effluent concentrations of arsenic, cadmium, and chromium are significantly below their Basin Plan limits; they are not considered as pollutants of concern.

INFORMATION COLLECTION EFFORTS

In the next step in selecting BMPs for detailed evaluation, two tasks were conducted concurrently to determine whether specific BMPs had already been implemented by other agencies for these identified problem constituents. These two information collection efforts consisted of a nation-wide telephone survey of public agencies, and a computerized literature search of two scientific databases. CCSF sought to learn from the experiences and operations of other municipalities facing similar permit conditions and requirements. The results of the telephone survey and literature search are described below.

Public Agency Telephone Survey

As a first step in this effort, a survey questionnaire was developed to be asked of public agency staff and/or serve as a guideline for the telephone interviews. The questionnaire focused on the five following areas of concern:

- Whether the public agency faced environmental and regulatory conditions similar to those confronting CCSF (e.g. regulatory requirements and/or mandates, discharge procedures, pollutant priorities and constituents of concern, infrastructure conditions, etc).
- Specific BMPs and other source control measures implemented by the public agency.
- Effectiveness and costs associated with these measures.
- Public education and outreach efforts conducted.
- Effectiveness and costs of public education measures and the level of public response and receptiveness to these measures.

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The initial list of pubic agencies to be contacted consisted of those known by JMM and CCSF staffs to have established source control programs. Additional contacts were recommended by the

Protection Agency were consulted as well. In total, contact was made with 42 separate municipal agencies and private organizations. Appendix F contains a list of the contact names and telephone numbers of the agencies and organizations contacted, as well as a copy of the interview questionnaire.

Summary of Telephone Survey Results. The information collected from the telephone surveys is outlined below under three categories that were determined to be of concern to CCSF.

Regulatory Issues. Most of the agencies contacted did not face National Pollutant Discharge Elimination System (NPDES) BMP requirements similar to those facing CCSF. Those with NPDES mandated requirements included St. Johns Michigan, Portland Oregon, Massachusetts Water Resources Authority, Los Angeles County, Seattle Washington, and Milwaukee Wisconsin. Municipality of Metropolitan Seattle and Los Angeles County appear to have the most comprehensive BMP programs in place. Los Angeles County's program targets urban and stormwater runoff pollution and is being implemented in three phases over three years. The three phases include: data collection, storm drain mapping and early action BMPs; additional BMPs and ordinance changes necessary for strengthened legal authority; and re-evaluation and refinement of the program based on data collection. Several agencies expected to receive new requirements in the near future, and the majority already conducted or were planning and/or implementing source control measures. With the exception of those listed above, most agencies did not face a major problem with heavy metals. Mercury, silver, lead, copper, zinc, chrome and cyanide were mentioned as constituents of concern. Most agencies divided responsibility for storm drain and sanitary sewer efforts.

BMPs and other Source Control Measures. Virtually all of the agencies contacted conducted or were planning to implement source control and related BMP efforts. The importance of frequent and accurate monitoring of influent was commonly mentioned. Several agencies reported that problem industries were monitored frequently and were charged for the cost of the monitoring. The importance of setting up a comprehensive database was emphasized, as was the value of assuring that all data collected is consistent to maximize its value. Several agencies reported that periodic dry weather monitoring at various points throughout the system helped to identify illegal dumping. Besides such monitoring and storm drain stencilling programs (which were common among the agencies contacted), most agencies did not have a specific program to identify illegal dumping. As part of its BMP program, Los Angeles County will map its storm drain system with geographic information system. Once completed, the County will be able to identify illegal hook-ups and problem discharges.

Many of the agencies had programs to work with businesses, including workshops, waste minimization materials and cooperative procedures for reaching compliance. Several agencies emphasized the importance of establishing positive and cooperative relationships with businesses. If compliance is not achieved, however, most of the agencies had the authority to issue citations and impose compliance schedules. The County Sanitation District of Orange County reported having reduced heavy metals in its influent by 50 percent since 1984 through waste minimization efforts, which were cited as a valuable tool for bringing businesses into compliance.

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Spill reporting requirements (with accompanying monitoring and spill "hot lines") were cited by several agencies as important programs for reducing and treating the discharge of

Santa Monica, Portland, Santa Clara, Palo Alto, Seattle, Alameda County and the City of Los Angeles cited efforts to control erosion and run-off as important parts of their programs. Emphasis was placed on prohibiting any substances from entering the storm drain system except for wet weather run-off. Specific measures included requiring parking lots and car washes to have tanks to collect wash water. Santa Monica and Alameda County have urban run-off ordinances and Los Angeles issues a stormwater pollution abatement charge to all properties, which averages $17 per year and is reported to cover most of the City's wet weather BMP costs. The Alameda County Ordinance requires businesses to prepare Stormwater Management Plans, and fines and inspections are additional parts of the program.

Several agencies expressed the desire to extend their enforcement authority to additional classes of businesses producing point source pollution, and to modify ordinances and codes to better address non-point source pollution. Enforcement was cited as being expensive, however, and most of those interviewed emphasized public education as a means of raising public awareness and reducing non-point source pollution.

Public Education and Outreach. Most of the agencies contacted conducted some form of public education or outreach on pollution control. Several mentioned new efforts or programs that were being implemented or planned.

Most agencies had in place or were implementing a storm drain stenciling program to reduce wet weather non-point source pollution. This was considered important both to prevent toxic substances from entering the storm drain system and to educate the public on the effects of illegal dumping into storm drains. Working with Boy and Girl Scout troops and other youth and/or environmental organizations was cited as one approach to storm drain stenciling.

Most agencies also produced one or more forms of educational materials, including guides to household hazardous waste (HHW) and alternatives, brochures, flyers and utility bill inserts notifying residents of HHW and/or oil collection facilities or events, school curriculums and videos. Several agencies reported that such materials were obtained from a state agency. Most of those interviewed did not feel that there was a high level of public awareness concerning HHW and other source control issues, and that education and outreach efforts were necessary and effective. One or more staff were often devoted solely to these programs.

HHW and waste oil collection efforts were a part of most agency's programs. Due to the higher cost and danger associated with HHW, permanent waste oil collection sites were more common than permanent HHW collection sites. Temporary (e.g. one day or week per year) HHW collection efforts were cited by many agencies. Spring was cited as the best time of the year for HHW collection days, and one agency coordinated its collection of large solid waste items with its HHW collection day. While such efforts were well-utilized by the public, they were also reported as being very expensive, with Rockford, IL spending $250,000 for a one-day effort. Several agencies expressed a desire and preference for a permanent HHW collection facility, both to reduce costs and raise public

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awareness. Many agencies have conducted surveys to assess public awareness of non-point source pollution and methods and alternatives for reducing it. Surveying residents using collection facilities was cited by several agencies.

county by county, will promote the issue as one that should be of concern to all Bay area residents. In addition, funds could be pooled together to conduct larger scale projects such as major media advertising.

The majority of the agencies contacted felt that the best approach to public education is to implement a campaign aimed at raising the general public's awareness of the need for source control efforts. Using a range of communication techniques (newsletters, ads, public service announcements (PSAs), etc.) will maximize the opportunity to reach all target audiences. By reaching the general public first, specific target audiences will already be aware of the need and purpose for the project when they are contacted, and will be more amenable to changing their habits in a manner which will enhance source control efforts.

Computerized Literature Searches

Based on the identified pollutants of concern and general source categories for these pollutants, a list of key words was developed for use in the computerized database search. The National Technical Information Service (NTIS) database was selected due to its diversity and comprehensiveness relative to the broad areas of interest potentially encompassed by BMPs. This database consists of government sponsored research, development, and engineering, plus analyses prepared by federal agencies, their contractors, and grantees. NTIS is considered to be a multi-disciplinary database covering a wide spectrum of subjects, including administration and management, agriculture and food, behavior and society, building, business and economics, chemistry, civil engineering, materials science, and transportation.

Various combinations of keywords were utilized in multiple database searches, with each search incorporating the pollutants of concern. The primary keywords used for the literature search are listed below.

- Pollutants (copper, cyanide, lead, mercury, nickel, silver, and zinc.
- Best management practices or source reduction or waste minimization.
- Household products or consumer products or commercial products.
- Water supply piping or plumbing or faucets.
- Human diet or food or human waste.
- Residential contributions or grey water or laundry.
- Commercial contributions.
- Environmental awareness surveys.

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The NTIS search examined sources dating from 1980 to the present. During the search, it was determined that numerous extraneous sources were being recovered. In response, additional computer literature search. The bulk of the literature pertaining to BMPs focused on non-point source controls; little has been written about the development of point-source, dry weather BMPs. Documents were obtained discussing waste minimization efforts at industries and commercial businesses of concern to this study, but these often pertained primarily to solid waste efforts. The most applicable documents referenced in the literature searches were, for the most part, already available through in-house material gathering efforts. The most valuable result of the literature search was to verify that source reduction efforts, such as this one undertaken by CCSF, have not been implemented to a significant extent elsewhere.

Conclusion of Information Collection Efforts

The public agency interviews and computer literature search provided a solid overview of the elements to be found in other source control programs as well as the general views and concerns of agency staff working in the area of water pollution control. The amount of specific data and cost figures received was very limited. While most of the agencies contacted are planning to implement one or more BMPs or other source control measures, few of the agencies has a comprehensive BMP program in place. In addition, the BMPs being implemented were targeted primarily at wet weather, non-point source runoff. Finally, a wide variety of public education materials were gathered on pollution control efforts. These materials should be of particular value as CCSF proceeds with its own public education program.

In light of the little concrete information available from literature sources and other agencies, the BMP selection process focused more on researching specific industries and commercial businesses that were identified as potentially contributing to the CCSF influent pollutant loadings. This process began with an evaluation of constituent source contributions.

EVALUATION OF CONSTITUENT SOURCE CONTRIBUTIONS

An evaluation of the contributions of targeted constituents to the SEWPCP influent loadings from four principal sources (water supply, residential, regulated industrial, and unregulated commercial/other businesses) was performed. Category-specific data were unavailable for PAHs, thus this analysis was limited to the six targeted heavy metals (copper, lead, mercury, nickel, silver, and zinc) and cyanide. Assessing the metals contributions from each of these sources provided a means of identifying the significant sources of problem constituents on which to focus the BMP investigative efforts.

An analysis of influent loadings of the targeted metals to the SEWPCP was prepared in conjunction with CCSF staff. This analysis attempted to determine the origins of the observed SEWPCP influent metals loadings (on a pounds per day basis) from among the four principal sources: water supply, residential, industrial, and commercial/other business sources. The SEWPCP performs 24-hour composite analyses of the influent heavy metals concentrations once every two weeks; effluent heavy metals are measured on a weekly basis. All of the 1991 concentration data were averaged and multiplied by the annual average flow of 62.2 mgd to determine influent and effluent mass loadings.

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each compound. The commercial/other businesses category includes any unidentified influent loading sources that were not accounted for by the water supply, residential, and industrial loading estimates. A breakdown of the cyanide commercial/other businesses contribution into commercial sources and unidentified sources is contained in CCSF's Cyanide Evaluation Study, which is being submitted under separate cover.

Interpretation of sample data where the concentration of a pollutant was lower than the analytical detection limit, and thus not detected in the sample (termed "non-detects") was handled as follows:

- Residential and industrial sample non-detects were considered equal to the detection limit for all of the pollutants examined.
- Water supply sample non-detects were considered equal to one-half the detection limit for each pollutant with the exception of cyanide. Cyanide was not sampled in the tap water analyses and is assumed to not be present in the CCSF water supply.

As seen in Figure 4-2, contributions from the commercial/other business sources may represent at least 30 percent of the influent mass loadings of each of the targeted metals with the apparent exception of nickel. Nearly 50 percent of the copper, silver, zinc, and cyanide influent loadings may stem from these sources. Regulated industrial sources seem to contribute most heavily to the silver, nickel, lead, and cyanide loadings at SEWPCP (approximately 46, 29, 28, and 27 percent respectively), but only represent a minor portion of the copper, mercury, and zinc loadings. Residential sources seem to contribute most heavily to the influent mass of mercury, nickel, and zinc, comprising roughly 50 percent of the influent nickel loadings. The CCSF water supply appears to provide a substantial (35 percent) contribution to the influent copper loadings, but appears to be only a minor source of the other targeted metals. The methodology used to estimate the influent loading contributions from each of these sources is summarized below.

Water Supply. An examination of San Francisco Water Department sampling data, consisting of raw water and tap water samples, indicated that CCSF's potable water supply may be a significant source of copper and potentially other metals found in the SEWPCP influent wastewater. CCSF analyzed tap water samples from 38 locations within its service area. At each of these locations, "initial flush" and "running" water samples were taken for both cold and hot tap waters. The initial flush samples represented the first flow out of the taps after over six hours of no flow. The running samples were taken after three minutes of continuous flow. A composite water supply concentration for each metal was determined from the 186 total samples by applying the following weighting factors to the tap water data:

- Cold water, initial flush: 0.2
- Cold water, running: 0.3
- Hot water, initial flush: 0.2
- Hot water, running: 0.3

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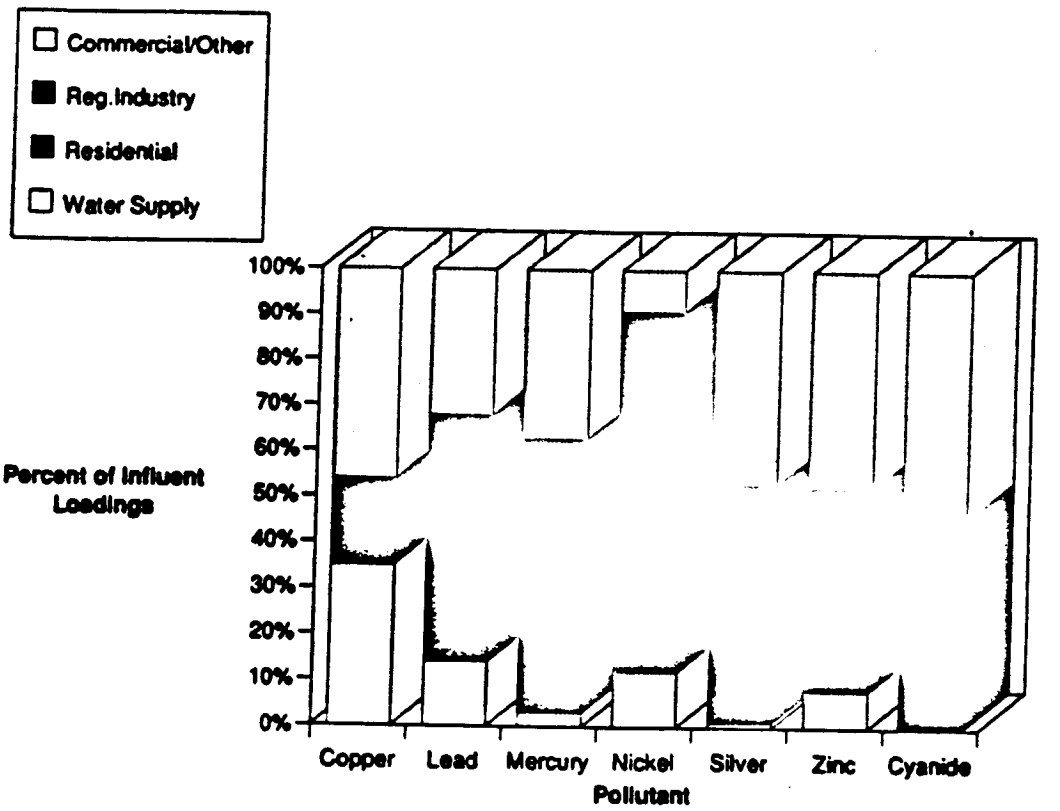

SOURCES OF TARGETED POLLUTANTS IN SEWPCP INFLUENT

FIGURE 4-2

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These weighting factors assume equal hot and cold water usage, and that 40 percent of water used are "initial flush". Analyses of alternate weighting factors did not have a significant impact on the resultant composite concentrations determined. A total water supply flow value equal to the

filtration plants in the system, and 2) pipeline corrosion occurring in the distribution system itself. Together, these sources make up between 1 and 35 percent of the influent loadings of six targeted metals at the SEWPCP. It is important to attempt to delineate between the contributions from these two sources in order to effectively direct any potential BMP efforts. Each of these sources are discussed below.

Raw Water Supply. CCSF's raw water supply is derived primarily from the Hetch-Hetchy reservoir, which is supplied by snow melt and rainfall in the Sierra Mountains, and a minor contribution arrives from local reservoirs located in Alameda County and on the San Francisco Peninsula. Roughly 70 percent of San Francisco's water typically arrives directly from the Hetch-Hetchy project, having only received in-line treatment consisting of pH control and disinfection. The remaining 30 percent stems from the local reservoirs (some of which can be fed by the Hetch-Hetchy aqueduct) and passes through one of two local water filtration plants. The Sunol Valley and San Andreas water filtration plants filter and disinfect the water from the local reservoirs prior to mixing it with the remaining San Francisco supply. Figure 4-3 presents a schematic illustration and typical flow breakdown of the sources supplying water to CCSF. In addition to naturally occurring metals in the raw source waters, CCSF's Water Department adds approximately 62,000 pounds of copper sulfate per year to the Alameda and peninsula local reservoirs for algae control. This issue is discussed further in Section 5 of this Study.

Distribution Pipeline Corrosion. Corrosion in San Francisco's water distribution system is likely a principal source of copper, lead, and zinc appearing in the CCSF water supply, and contributes ultimately to the metals loading in CCSF's wastewaters. Many different forms of corrosion processes can occur in distribution systems, including: uniform corrosion, erosion corrosion, galvanic corrosion, and rapid pitting corrosion. The corrosivity of a given system may depend on the piping materials present and numerous water quality parameters, including: pH, alkalinity, water temperature, conductivity, dissolved oxygen, hardness, and free chlorine. Water velocity may also play an important role, particularly in erosion corrosion. (AWWA 1985, EOA 1991) Corrosion-induced metals loadings to the wastewater system can be calculated by subtracting the loadings of the raw source water metals from the total tap water metals loading previously calculated by CCSF staff. This issue is discussed further in Section 5.

Estimated Water Supply Loadings. Table 4-2 lists the estimated mass loadings of the six targeted metals and cyanide contained in the CCSF water supply along with their estimated percentage contribution to the total mass of each metal contained in the SEWPCP influent. These loadings are based on tap water data collected by CCSF staff. As seen from this table, only copper in the water supply appears to contribute a significant percentage (35 percent) of the SEWPCP influent wastewater loadings. Lead in the water supply contributes approximately 14 percent of the influent SEWPCP loadings. Cyanide was not analyzed in the tap water supplies.

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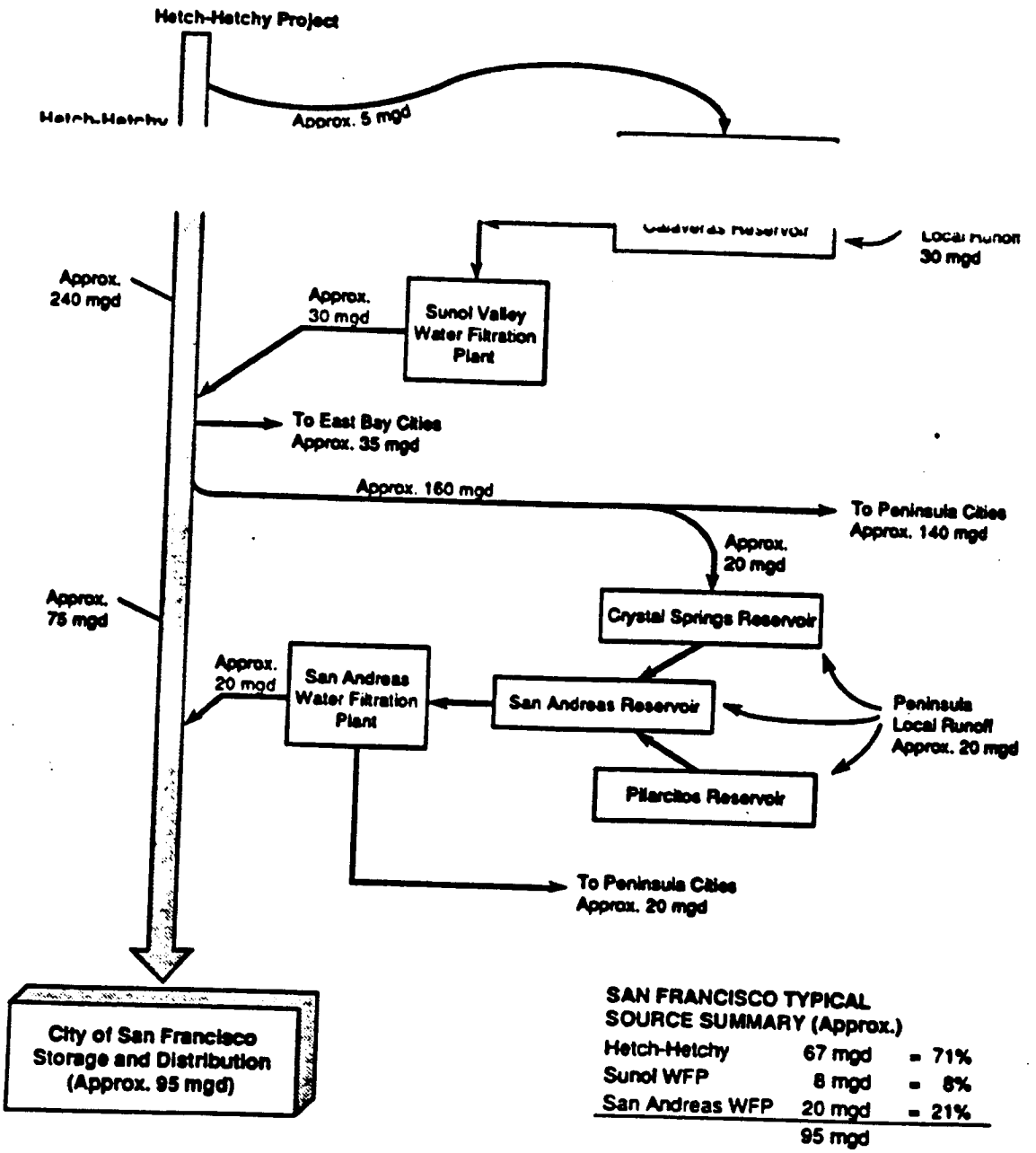

SAN FRANCISCO WATER SUPPLY SOURCES SCHEMATIC
(1987 Pre-Drought Conditions)

FIGURE 4-3

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TABLE 4-2

ESTIMATED SEWPCP LOADING FROM CCSF WATER SUPPLY

Parameter	Average Concentration (a) (µg/L)	Estimated Water supply Loadings (b) (ppd)	Percent of Influent Loadings (%)
Copper	40.60	21.06	35
Lead	4.70	2.44	14
Mercury	0.03 (c)	0.02	3
Nickel	1.90	0.99	12
Silver	0.15 (c)	0.08	1
Zinc	28.00	14.52	8
Cyanide	NA	–	0

(a) Based on a weighted average of 1991 CCSF tap water data.
(b) Assumes water supply equals SEWPCP 1991 average influent flow of 62.2 mgd.
(c) Concentration represents one-half the analytical detection limit. These constituents were not detected in nearly all tap water samples tested.
NA = Not Analyzed

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Residential Sources. Residential contributions to the SEWPCP's influent loadings of problem constituents stem primarily from human excrements and the use and sewer-disposal of household

flow occurring in the lower Vicente district of CCSF since November 1990. Vicente is the only area where sanitary flow is not combined with stormwater runoff, and therefore provides the best available sample of residential metals contributions to SEWPCP influent flow. Although only two years of data are available, comparisons performed by CCSF staff have determined the Vicente data to closely match results from historic residential sampling efforts conducted throughout CCSF during the last five (relatively dry) years.

Residential metals mass loadings have been calculated by multiplying the concentrations found in the Vicente sewer samples by a per capita residential flow rate of 49.9 gallons per capita per day. Assuming roughly 512,000 people in the SEWPCP service area, this amounts to an estimated daily flow of 25.5 mgd. These residential samples consist of pollutants derived from home consumption and product disposal as well as contributions from the water supply. To account for the overlap of water supply and residential metals contributions, net residential mass loadings were calculated by subtracting the estimated water supply contribution from these calculated total residential loadings. Table 4-3 lists the estimated residential total and net residential metals and cyanide contributions relative to the influent loadings received at SEWPCP. Cyanide loadings were determined based on separate data collected by CCSF as part of their Cyanide Source Evaluation efforts.

As seen from Table 4-3, residential loadings appear to account for between 6 and 50 percent of the influent loadings for the six targeted metals and cyanide found in the SEWPCP influent. Of the targeted metals, mercury, nickel, and zinc have the highest percentage of residential influent loadings. As depicted in Figure 4-2, residential sources appear to account for the greatest percentage (44 percent) of the mercury influent loadings.

Based on CCSF's "Consumer Products Heavy Metals Inventory Report" (CCSF 1991B), a substantial portion of the residential loadings (derived from a previous mass loadings analysis similar to the one conducted for this study) remained unaccounted for among the three source categories of water supply, human excrement, and household products. Greater than fifty percent of the residential loadings were unaccounted for among all of the targeted metals, with the exception of mercury for which only 18 percent was unaccounted. Further research in this area may be necessary if residential sources are determined to be significant in this BMP development effort.

Regulated Industries. Major industrial dischargers to the CCSF sewer system are regulated under CCSF's Industrial Waste Pretreatment Program (IWPP), which was approved by the U.S. Environmental Protection Agency (EPA) in 1983, and is under the jurisdiction of CCSF's Bureau of Environmental Regulation and Management (BERM). The Bayside drainage basin, feeding the SEWPCP, contains 50 significant industrial users (SIUs) regulated under this program, of which 13 are regulated under federal categorical standards and 37 are considered "significant non-categorical" industries. Major industries in CCSF include hospitals, linen supply, metal plating, and food-related industries. The regulated industries account for approximately seven percent of SEWPCP's average influent flow.

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TABLE 4-3

ESTIMATED SEWPCP LOADING FROM RESIDENTIAL SOURCES

Parameter	Total Residential Loadings (a) (ppd)	Net Residential Loadings (b) (ppd)	Net Percentage of Influent Loadings (%)
Copper	16.1	7.45	12
Lead	5.63	4.63	26
Mercury	0.23	0.23	44
Nickel	4.57	4.17	50
Silver	0.49	0.46	6
Zinc	69.06	63.1	35
Cyanide	2.2	2.2	19

(a) Assumes an average residential flow rate of 25.5 mgd.
(b) Net loadings exclude the estimated contribution from the water supply to the total residential loadings.

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As part of the IWPP, regulated industries are required to report metals concentration and flow data to CCSF on a quarterly basis. As a result, the metals contributions from these sources are the most

loadings contributed by the industries. Industrial cyanide loadings were based on separate data collected by CCSF as part of its cyanide source evaluation efforts.

Table 4-4 lists the estimated SEWPCP targeted metals and cyanide loading from industrial sources, including their percentage contribution to the total influent loading. This table depicts significant industrial contributions of lead, nickel, and silver. Detection limits used in analyzing industrial samples have historically been higher than those used to analyze tap water samples and plant influent wastestreams. As a result, when concentrations below these high detection limits are present, interpretation of these "non-detects" as representing concentrations at the detection limit or even one-half the detection limit can result in misleading data values. CCSF staff have indicated that in the upcoming year, metals concentrations for all sample types (i.e., industrial, residential, commercial/other businesses, and influent samples) will be measured by the same technique to assure consistent analysis and interpretation of detection limits.

Unregulated Commercial/Other Business sources. Based on the influent pollutant loadings observed at SEWPCP, and the associated estimated contributions from residential and industrial discharges, it appears that significant mass loadings of pollutants stem from commercial businesses, smaller industries, and other non-residential small quantity dischargers (SQDs) of wastewater that are not regulated under CCSF's IWPP. For the purposes of this Study, these contributors were collectively categorized under the unregulated commercial/other businesses source category, which includes such dischargers as vehicular service facilities, photo finishing shops, painters, and print shops.

Due to the unregulated nature of, and relatively recent concern over, discharges from these SQDs, very little data are available describing their contribution of problem pollutants. CCSF's "Targeting Small Quantity Generators of Toxic Waste" (Spring 1991) presents a first-cut effort at identifying the types of SQDs that are likely to be significant metals contributors. This initial screening was based on metals concentration sampling at commercial dischargers and review of a data base containing information on the types and amounts of products used by businesses in CCSF. However, no data were available on the flows of wastewater from these businesses, and therefore a mass loadings estimation was not possible. Furthermore, the total number of SQDs in the CCSF service area is not yet known to estimate the total loading from this source category.

CCSF/BERM staff have developed a strategy to refine the estimate of mass loadings from these sources. This strategy, contained in the "Islais Creek Interim Measures Implementation Plan" (January 1992), includes taking the following important actions towards implementing source control for these dischargers:

- Developing a comprehensive SQD database to identify potentially significant dischargers of problem constituents; and
- Collecting mass loadings data by sampling concentrations and flow rates at targeted SQDs.

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TABLE 4-4

ESTIMATED SEWPCP LOADING FROM INDUSTRIAL SOURCES

Parameter	Total Industrial Loadings (a) (ppd)	Net Industrial Loadings (b) (ppd)	Net Percentage of Influent Loadings (%)
Copper	5.6	4.1	7
Lead	5.2	5.0	28
Mercury	0.1	0.1	16
Nickel	2.4	2.4	29
Silver	3.7	3.7	46
Zinc	19.1	18.1	10
Cyanide	2.0	2.0	27

(a) Assumes an average industrial flow rate of 4.35 mgd.
(b) Net loadings exclude the estimated contribution from the water supply to the total industrial loadings.

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Until these actions are completed, contributions from these unregulated commercial/other business sources will be estimated by subtracting the (more defined) estimated net loadings of industrial and

copper, silver, and zinc having the highest percentages.

Table 4-5 also depicts the estimated average concentrations derived from these mass loadings from unregulated commercial/other business sources. These concentrations are low relative to the maximum concentrations obtained in the sampling effort conducted as part of the "Targeting Small Quantity Generators of Toxic Waste" report (CCSF 1991C). This may indicate that high volume SQDs are discharging a relatively dilute wastestream.

Conclusion of Source Identification Evaluation

The principal conclusions of this review of CCSF's source control data can be summarized as follows:

- Of the four primary source categories contributing problem pollutants to the CCSF sewer system, the most significant data deficiencies exist for the unregulated commercial/other business sources. Without any mass loading data describing these sources, the influent contributions related to commercial/other business sources can only be estimated by subtracting the contributions of the water supply, regulated industries, and residential loadings from total influent loadings observed at the treatment plant.

- The estimated pollutant loadings from regulated industries are fairly well documented due to the IWPP reporting requirements. Future implementation of consistent sampling analytical methods and detection limits interpretation will increase the value of industrial sampling data efforts.

- Residential and water supply pollutant loading data for CCSF are more sparse than the IWPP data, but appear sufficiently representative of these contributions for the purposes of this BMP development effort. By comparing raw water supply metals data to the tap water samples, it is be possible to delineate between corrosion-induced metals loadings and metals originating at the raw water sources.

- Few data appear to exist describing the likely contribution of pollutants from infiltration and inflow into the CCSF collection system. Refinements of inflow estimates would refine the flow breakdown for the SEWPCP and thus influence the projected (flow-based) water supply and commercial/other businesses loadings contributions. Additionally, groundwater sampling from operating wells in the CCSF service area could determine if CCSF should be concerned with metals leaching from the soils into the combined sewer system. However, these adjustments to the "mass balance" are unlikely to significantly impact the existing data or alter the focus of BMP efforts.

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TABLE 4-5

ESTIMATED SEWPCP LOADING

Parameter	Estimated Average Concentration (a) (µg/L)	Estimated Comm./Other Bus. Loadings (ppd)	Percent of Influent Loadings (%)
Copper	102	27.5	46
Lead	21	5.6	32
Mercury	0.7	0.2	37
Nickel	3	0.8	9
Silver	14	3.7	47
Zinc	322	86.9	48
Cyanide	11	2.9	54

(a) Back-calculated from the estimated commercial/other business loadings assuming a total flow of 32.3 mgd (equal to average influent flow minus residential and industrial flows).

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SPECIFIC SOURCE TARGETS

Based on the preceding analyses of the effluent concentrations observed at the SEWPCP relative to the Basin Plan limits (see Table 4-1) and the sources of SEWPCP's influent metals loadings (see Figure 4-2), target sources for BMP development were identified. Of the pollutants previously targeted by CCSF (copper, lead, mercury, nickel, silver, zinc, cyanide, and PAHs), copper, mercury, cyanide, and PAHs are the only compounds that are expected to exceed the effluent water quality limits established by the Basin Plan. The sources of these "primary" pollutants should thus be given the highest priority for BMP development. However, since higher effluent concentrations of other targeted metals (e.g., silver) have previously been reported, and BMP efforts typically address many metals simultaneously, the BMPs developed as a result of this study would also encompass the other four metals previously targeted.

The primary and other targeted pollutants are listed below with the principal categories contributing the highest percentage of their respective influent loadings:

Primary Pollutants

- Copper -- water supply and commercial/other businesses
- Mercury -- residential and commercial/other businesses
- Cyanide -- commercial/other businesses and industrial
- PAHs -- Unknown (No data available)

Other Targeted Pollutants

- Lead -- residential and commercial/other businesses
- Nickel -- residential and industrial
- Silver -- commercial/other businesses and industrial
- Zinc -- residential and commercial/other businesses

This listing indicates that residential and commercial/other businesses BMP source reduction efforts would likely impose the greatest overall reductions in metals loadings to the SEWPCP. The implementation of metals reduction measures from these sources would likely have more far reaching impacts on the reductions of other metals than minor improvements to CCSF's already established industrial pretreatment program. However, much is still unknown about residential and commercial/other business sources; a large percentage of the residential loadings for these six metals are yet unaccounted for, and significant data deficiencies exist describing the unregulated commercial/other businesses source category.

CCSF is conducting a separate concurrent study to investigate the sources of cyanide in the its wastewater streams. This effort consists of an extensive literature review examining cyanide sources, an analysis of SEWPCP treatment process chemicals that contribute to cyanide concentrations in the effluent wastestream, and an extensive sampling of CCSF businesses for cyanide. The *Cyanide Source Evaluation Study* is being submitted separately by CCSF to the Regional Board in August 1992. The sampling effort did not identify any major contributors of cyanide that is currently unregulated. Potential cyanide sources considered in this BMP selection process were photoprocessing facilities, scrubber operations, and paint products. These potential sources are discussed in detail in Section 5.

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Polynuclear aromatic hydrocarbons (PAHs) may be present in wastewaters via the surface runoff of byproducts of combustion processes (e.g., automobiles) and other applications. Direct

expected to be related in any significant degree to dry weather discharges to the SEWPCP. Accordingly, PAHs were excluded from consideration in the selection of the dry weather BMPs. PAHs are addressed to a more substantial degree by the wet weather BMPs discussed in Sections 7 through 9 of this Study. However, PAHs may be present in some of the identified activities such as automotive service facilities, scrubber operations, and illegal dumping of used oil.

Based on the information collection efforts described earlier in this section, Table 4-6 lists the principal identified sources for each of the six targeted heavy metals with respect to the four CCSF source areas: water supply, residential, regulated industrial, and commercial/other businesses. Shaded areas of this table mark the two source areas that contribute the greatest percentage of the influent loading for each metal (See Figure 4-2). For the reasons discussed above, the sources of copper and mercury listed in this table were given the highest priority in selecting the BMPs for further evaluation. Incidental loading reductions for the other targeted pollutants can be expected through BMPs focusing on the primary pollutants.

DRY WEATHER BMPs SELECTED FOR DETAILED EVALUATION

Based on the screening steps described at the beginning of this section, the thirteen dry weather BMPs selected for detailed evaluation are listed in Table 4-7. Four of the Optional BMPs have been included for detailed evaluation. Where appropriate, the wording of the Optional BMPs was modified slightly to streamline the focus of the evaluation process. Optional BMP P5 was not directly evaluated; it was expanded into multiple BMPs to evaluate currently unregulated sources of toxic pollutants.

These BMPs have been primarily targeted towards reducing the dry weather influent loadings of copper, mercury, and cyanide in light of the SEWPCP effluent discharge limits discussed previously. In addition to impacting these three pollutants, it is expected that "incidental" reductions in the loadings of the other heavy metals and PAHs will occur as a result of these BMPs. A detailed discussion of each of the BMPs is presented in Section 5.

Other Potential Sources

The thirteen selected BMPs address nearly all of the principal sources identified in Table 4-6. Five other sources were identified, but not addressed specifically as part of the detailed BMP development effort. These other sources are briefly described below.

Cleaners/laundry facilities. Industrial laundering facilities are currently regulated under CCSF's Industrial Pretreatment Program. The smaller commercial cleaning/laundry facilities were viewed as a potential pathway to the sewer, but not a major source of problem pollutants in themselves. To conform with the idea of source control, control measures should be implemented as close to their source as possible. Pathways such as these facilities may be considered as part of secondary source control efforts if reductions at the primary sources prove insufficient. A recent study on heavy metals in household cleaning products (REED, 1990) indicated that laundry products are not a major source of heavy metals.

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TABLE 4-6

PRINCIPAL SOURCES OF TARGETED POLLUTANTS(a)

	Water Supply	Residential	Industrial	Commercial/Oth	ses
Copper	Raw water supply Pipeline corrosion Copper sulfate addition	Root killer products Algicides (pools, ponds) Foods - Dairy/meats/veg. Paints	Hospital Linen Supply Combination Utility Flavoring extract	Cooling tow Auto ser Cleaners/I. Paints/inks/ Electrical eq	
Mercury		Paints Photo wastes Auto fluids Foods - meats/veg./fruits	Hospital Photo Lab Lamp Manufacturers	Painting/pape Auto ser Medical/Healt Metal manuf Laborat Denti	
Lead	Raw water supply Pipeline corrosion	Paints Photo wastes Auto fluids Home plumbing Foods (fruits/veg./grains)	Hospital Radiator repair Linen supply Car wash	Sheet meta Auto ser Equipmen Painting s	
Nickel	Raw water supply Pipeline corrosion	Paints Foods (grains/veg./fruits)	Metal plating Hospital Combination Utility	Auto ser Cleaners/I.	
Silver		Photoprocessing Personal care products Polishing	Photochemical Hospital Motion picture labs Printing	Photo/prin Auto ser Laborat Denti	
Zinc	Corrosion prevention Raw water supply	Paints Auto fluids Water heaters Cleaners Foods (meats/grains/veg.)	Hospital Sausage Manufacture Laundry Linen supply Flavoring extract	Auto ser Printi	
Cyanide		Paints Personal Care Products Polishing	Hospitals Newspaper Printing. Fabric/Textile Manufacturing	Auto Ser Cleaners/L Laborat Restaur Paint	

(a) Shading denotes two principal source categories for each pollutant.

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TABLE 4-7

BMP No.1 (Optional BMP E2) - Educate public regarding the potential environmental impacts of common household products and the availability of alternatives

BMP No.2 (Optional BMP P1) - Develop and implement an aggressive public program to report and prevent dumping of toxic pollutants into sewers and drainage channels

BMP No.3 - Ban the use of copper sulfate root killer and educate the public on alternative products

BMP No.4 - Educate residents and contractors on metals and cyanide in home improvement products and proper cleaning methods

BMP No.5 - Further regulate discharge of photographic wastes

BMP No.6 - Regulate automotive service facilities

BMP No.7 - Regulate commercial laboratories

BMP No.8 - Coordinate with San Francisco Water Department to optimize corrosion control

BMP No.9 - Regulate cooling tower and scrubber discharges

BMP No.10 - Provide temporary storage of recycle flows during wet weather

BMP No.11 (Optional BMP P3) - Develop and implement a program which provides a means of recording the observations of field inspection and maintenance personnel, so this information can be used to help locate the source(s) of pollutants

BMP No.12 - Minimize impurities in treatment plant chemicals

BMP No.13 - Construct reverse osmosis facilities for NPDES compliance

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Foods. Metals and cyanides are present in small concentrations in many foods. However, reductions in the consumption of any particular food items were not considered as a feasible

potential source of metals to the wastewaters. The data from this report were considered uncertain, and were believed to be taken from small machine shops. To the extent these facilities are present in CCSF, they should be regulated as part of CCSF's expanded pretreatment program efforts.

Dentists. Dentists are a potential source of silver and mercury to the influent wastestream. BERM recently completed a separate study of these facilities (CCSF, 1992I), and the results of BERM's sampling efforts are discussed under BMP No.7 in Section 5.

Equipment Rental. Although not specifically covered by the selected BMPs, educational measures at paint equipment rental facilities are incorporated into the BMP No.4 implementation measures.

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SECTION 5

DEVELOPMENT OF DRY WEATHER BMPs

and then each of the dry weather BMPs are discussed in detail. For each of the BMPs, the targeted pollutants of concerns, the implementation measures required, the estimated reductions, and the estimated costs are described. Detailed calculations and pertinent information relating to the BMPs are included in Appendix C for reference. The 8 Optional BMPs suggested by the Regional Board have been separated between dry and wet weather analysis. Four of these BMPs are evaluated in this section. The other four are evaluated in Sections 7 through 9 of this report.

The methodology for estimating reductions and costs requires some discussion. As discussed in the previous section, there is minimal empirical data available on reduction potential of BMPs. Most of the BMPs discussed in this report are directed at the residential and commercial sectors of the communities. Up to now, little attention has been paid to these sectors in terms of pollutants loadings, pollutant sources, and reduction potential. CCSF's "Small Quantity Generators" and "Household Products Inventory" studies have advanced the understanding and knowledge of these newly recognized sectors. Other agencies and POTWs are beginning to focus in these areas also. Central Contra Costa Sanitary District is initiating an aggressive Residential Metals Study in August 1992. Several other POTWs are regulating automotive service facilities and photofinishers. However, most of these programs have only been recently initiated. No information on their effectiveness in reducing pollutant loadings is available.

To estimate the reductions described below, numerous suppliers, vendors, service contractors, business owners, CCSF staff, and Federal, State and local agencies were contacted. Any pertinent literature information was reviewed. Finally, best engineering judgement and reasonable assumptions were used to estimate the potential reductions. The estimates should be considered as reasonable for a cost-effectiveness comparison, but should not be used as definitive loadings. As more experience is gained from working with these sectors, their reduction estimates should be revised accordingly.

Agency cost estimates were prepared at current day value. They are order-of-magnitude estimates that are consistent with planning level analysis. Costs to businesses are expected to be highly variable, and will depend on specific compliance methods selected. These business costs were not included in this analysis.

In order to have a common basis for comparison, annual agency costs have been prepared for each BMP. Where appropriate, the capital or startup costs have been amortized at an interest rate of 8 percent over 20 years. Estimates have been prepared for the ADWF design capacity of 85 mgd for the SEWPCP.

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BMP NO. 1 (OPTIONAL BMP E2)

EDUCATE THE PUBLIC REGARDING THE POTENTIAL ENVIRONMENTAL...

Any effort to reduce the level of toxic pollutants entering the combined sewer system -- and ultimately the San Francisco Bay and the Pacific Ocean -- must address the general public as a source of such pollutants. The general public uses a wide variety of products which contain toxic substances, ranging from common household cleaners; personal hygiene products; paints and solvents; pesticides; insecticides; fertilizers; and auto products such as oil, antifreeze, steering and brake fluid; and gasoline. In normal usage, or when disposed of improperly, these products have the potential to enter the combined sewer system. This results in the introduction into the treatment system of heavy metals and other compounds identified as constituents of concern to CCSF..

The types of products listed above are widely available and are found in most households. While such products are known to contain toxic substances, addressing them is particularly challenging given their widespread use by the general public. Beyond noting that they are used by the "general public," the source of household products, which are a source of copper and zinc, can not be more specifically identified. Thus, addressing the general public as a source of toxic pollutants requires a more broad based program aimed at raising general awareness and changing behavior patterns related to the use and disposal of household cleaners and other products containing toxic substances.

Education is the most fundamental component of any effort which seeks to change public behavior patterns. With regard to household hazardous waste (HHW) and other products containing toxic substances found in the home, the public must be educated in at least four key areas:

- Water pollution issues in general and the need to preserve the environment of the San Francisco Bay and the Pacific Ocean.
- Sewers and storm drains have a pathway to the Bay and Ocean and that the treatment plants cannot remove 100 percent of toxic pollutants before discharging into the Bay and Ocean.
- Many common household products contain highly toxic chemicals which are potentially harmful to both human health and the environment.
- The safe alternatives to both the use of products containing toxic substances and their improper disposal.

A successful public education effort must rely upon a heightened awareness and sensitivity to water pollution control and environmental preservation. This awareness and sensitivity will serve as the foundation upon which more specific educational messages and activities are built. The environmental survey conducted of CCSF residents (see Section 3 of this report) found, for example, that respondents reporting a higher level of knowledge about toxic pollutants were less likely to improperly dispose of such pollutants. It is also important that feasible and convenient alternatives be provided for the behavior being discouraged. In short, the public must be made to realize that their use and disposal of HHW has a direct impact on water pollution in the Bay and Ocean and that alternatives are available to avoid practices which cause such pollution. The public must clearly view the connection between their activities and pollution in the Bay and Ocean, and they must understand how they can make a difference.

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The environmental survey found a relatively high level of awareness of environmental and water pollution related issues. The survey results suggest that a broad based, city-wide educational program aimed at further increasing overall awareness about water quality issues and improving neighborhoods or groups would not produce substantially better results than a broad based, city-wide program.

Finally, the environmental survey found a high level of support for City-sponsored efforts to address environmental issues. Survey respondents supported greater efforts on the part of CCSF to improve water quality (77 percent), to promote awareness of toxic materials and their disposal (84 percent), and to regulate practices involving toxic materials and their disposal (77 percent). Of those supporting additional efforts, 80 percent said they were willing to pay 25 cents per month for them, and of those, 76 percent were willing to pay 50 cents a month. This support was found in all areas of the City and in all sociodemographic groups, although older residents were less supportive than younger residents. It thus can be expected that the public will be receptive to the activities included in BMP No. 1 and in the broader Public Education Plan.

BMP No. 1 will address the full range of products which contain toxic pollutants. These measures are included in the Public Education Plan currently being developed for the Department of Public Works (DPW). The overall goal of the Public Education Plan is to design a program which educates and informs the public and the business community regarding the importance of protecting the environment and public health from the improper use, storage and disposal of toxic products and wastes produced by households, businesses, Small Quantity Generators (SQG) and Conditionally Exempt Small Quantity Generators (CESQG). The Plan focuses on promoting safe waste management, including source reduction, waste minimization, recycling and proper waste disposal.

POLLUTANTS OF CONCERN

The activities recommended as part of BMP No. 1 will address the full range of products containing toxic pollutants. The public education measures would likely address most of the constituents of concern. Because of the volume consumed and disposed of by the public, certain products, such as paints, solvents, and oil, can be expected to be impacted by the public education program more than others. The pollutants contained in these products; mercury, lead, and nickel; may achieve greater percentage reductions than pollutants found in other HHW. For example, the CCSF Household Hazardous Waste Collection Facility (HHWCF) reported that paint and oil products accounted for 57 and 12 percent, respectively, of the containers received at the facility (CCSF 1992B). Cleaners accounted for only 2 percent of containers received.

EXISTING CONDITIONS

CCSF currently conducts several efforts to educate the public about HHW. A brochure entitled "Your Guide to Less Toxic Shopping" explains what HHW is and discusses safer alternatives to products containing toxic substances. The pamphlet is distributed by the Chief Administrators Office (CAO) by request and at environmental fairs and other special events. CAO also operates a HHW hotline through which residents can request information and obtain the address of the HHWCF. An additional pamphlet entitled "Garbage Cans and Can'ts" explains which products and substances should not be disposed of through the solid waste stream and directs residents to the HHWCF. An agrichem brochure is currently being developed which will address pesticides.

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Materials promoting recycling are also produced and distributed by the CAO. A quarterly newsletter is produced which assists small businesses in reducing and properly disposing of hazardous waste. Finally, CCSF schools use a "4th R Recycling Curriculum" to teach K-5th

Existing CCSF programs and materials can be modified to emphasize the specific impacts of certain toxic products on the sewer system and human health and the environment. The promotion and distribution of the materials would be enhanced to reach a broader segment of the general public and presentations to community groups would be expanded. Whenever possible, community organizations and special interest groups will be used to distribute program materials. These, and other efforts, are addressed in the Public Education Plan. Elements of the Plan which apply to BMP No. 1 are listed below.

The Public Education Plan provides a comprehensive program for raising general awareness and reaching out to and educating the general public, small businesses, and selected target audiences on the environmental impacts of the improper use and disposal of toxic substances. The activities listed below are components of the Plan which address the general public and non-permitted businesses and commercial establishments, and which could be used to address household cleaners and other sources of HHW. A brief description of each activity is provided. The Public Education Plan should be consulted for a complete explanation of the activities, the schedule for their implementation, and the materials and organizational support needed.

Program Theme and Logo

A program theme and logo graphic will be designed and will be integrated into all written and promotional materials. The graphic will ensure that all materials have a consistent, positive and compelling image.

Toxic Free Neighborhood Program

The Toxic Free Neighborhood Program will involve the targeting of specific neighborhoods and aggressive promotion of the program's message and accompanying educational materials. This will include media advertising in neighborhood newspapers and publications, presentations to community groups and distributing materials at special events. Neighborhood targeting may be an effective means of reaching home owners, as opposed to renters. The environmental survey found that home owners are more likely to use a number of products containing toxic substances, such as motor oil, house paint and solvents. Thus, neighborhoods with a high rate of home ownership can be targeted with materials addressing these products.

Publications

Fact sheets, brochures, newsletters and informational folders will be developed addressing key issues. These materials will provide general and targeted information to both the general public and selected audiences. Fact sheets will target specific topics and brochures will give general information about specific programs. A bi-annual newsletter will update CCSF staff working on environmental issues on the BMP program and other related activities. The informational folder will be used to distribute program information and materials in an organized and attractive manner.

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appropriate locations. One component proposed for the Environmental Booth is an "Environmental Kitchen" display discussing safe alternatives to products containing toxic substances commonly used in the kitchen.

A Toxic Free Home Tour exhibit is being developed for the Department of Public Works by the Clean Water Fund. The Toxic Free Home Tour will consist of a portable, 3-dimensional home display explaining the problems associated with toxic and environmentally harmful products found in each room. The display exhibit will be accompanied by educational materials discussing safe, non-damaging alternatives to products containing toxic substances as well as the proper disposal methods for household hazardous waste. The Toxic Free Home Tour display exhibit will be made available for display in libraries, schools, government and corporate buildings, conventions, street fairs and community meetings.

Home Toxics Checklist

A self conducted Home Toxics Checklist will be distributed to school children and at special events. The Checklist will make residents aware of toxic substances used and stored around the home. The proper use, storage and disposal of the substances will also be explained. Encouraging reduction in the amount of products used which contain toxic substances will be emphasized.

Speaker's Bureau/Informational Presentations to Special Groups

A Speaker's Bureau Program will be developed and coordinated between the Department of Public Works and the Chief Administrator's Office. The Speaker's Bureau will make educational presentations to groups and organizations such as the League of Women Voters, Kiwanis Clubs, Boy and Girl Scouts and the Chamber of Commerce. The presentation made will be tailored to the groups being addressed, but will generally explain the purpose and need for the BMP program and discuss actions that residents and businesses can take to reduce the amount of toxic substances entering the City's treatment system.

Point of Purchase (POP) Displays

POP displays will be designed targeting specific products of concern (e.g. paints and solvents, pesticides and lawn and garden products, motor oil, photography products and household cleaning products) and will be distributed to stores that specialize in selling these products. The POP displays will educate consumers on the proper use and disposal of the specific product addressed and will provide the address and directions to the HHWCF.

Grocery Bag Program

Grocery bags containing an educational message about water pollution prevention and toxic waste disposal will be produced and distributed to major grocery retailers in CCSF.

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School Education Program

with an early education concerning the need to reduce the amount of products used containing toxic substances as well as the potential harm they can cause to human health and the environme

Poster Calendar Contest

A poster contest will be held in September of each school year with all CCSF elementary schools. Children will be asked to graphically illustrate the activities that contribute to pollution in the Bay and Ocean and what can done to prevent such pollution. The posters will be judged and the 12 winning entries will be incorporated into a calendar. Businesses will be asked to co-sponsor the program.

CCSF Employee Training Programs

Training will be provided to all CCSF employees on the need to reduce and eliminate the use of products containing toxic substances, both on the job and at home. Employees who work with toxic substances will be provided with specialized training as appropriate. BERM, DPH, DPW, Fire and Police Department employees will be taught to identify and report hazardous spills and illegal dumping.

Green Ribbon Program

San Francisco Green Ribbon Panel was formed under the guidance of the City's Small E ness Advisory Commission to help business owners contribute to the overall health and pr uctivity of the Bay region. The Department of Public Works will work with the Green Ribbon Panel to develop a "Green Business" program. The program will provide merchants, small businesses and offices with the educational materials necessary to reduce their use of products containing toxic constituents. Participating businesses will be provided with a decal promoting them as a "Green Business." The program is intended to educate and reach out to businesses and offices in a similar manner as activities aimed at residents. The Department of Public Works will ensure that all information distributed by the Green Ribbon Panel incorporates the message of the BMP Program.

Cable Television

Educational videos on HHW and other environmental issues will be produced and aired on local cable television channels, such as SFCityTV. Videotexts will be used to advertise the HHWCF and other programs and materials. CCSF staff can arrange to appear on community interest programs, such as "Inside City Limits," to discuss water pollution prevention and promote program activities and materials. Public service announcements (PSAs) will also be prepared for cable TV, broadcast TV and radio.

Promotion s

Each activity will be accompanied by the necessary promotion and publicity through special inte: groups, business and trade organizations, and community/neighborhood groups. Overall prog: publicity and general public educational messages will be conducted through media advertising.

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PSAs, and billboards. The majority of respondents to the environmental survey reported receiving information on environmental issues through newspapers and television (42 and 21 percent, respectively). Non-whites, particularly Hispanics and Asians, are more inclined to receive

Can'ts"

Using survey data, monitoring data, and mailing lists developed through other program activities and special events, these and other educational materials will be distributed to target areas and/or groups. A special effort will also be made to make educational materials available at large supermarkets and grocery stores. All materials will be translated into foreign languages as appropriate.

The survey results suggest that environmental organizations are an important source of information for many residents. Sixteen percent of the survey respondents reported that at least one member of the household was a member of an environmental organization. Thus, environmental organizations will be used as a means of distributing program materials and promoting program activities. Given their interest in environmental issues, these organizations can be expected to be cooperative in this regard.

EXPECTED REDUCTIONS

The estimated reductions of BMP No. 1 are summarized in Table 5-1A. Detailed calculations are included in Appendix C-1. The estimates are based on the assumptions that 50 percent of the public will be reached by the public education program, 50 percent of those reached will participate in the reductions, and 20 percent reductions can be achieved on an individual basis. These assumptions equate to an overall 5 percent reduction in the pollutants contributed by residential sources. At this time, the specific products, their pollutants of concern, and reduction potential are uncertain.

ESTIMATED AVERAGE ANNUAL COSTS

Estimating a precise implementation cost for BMP No. 1 is difficult as it depends on a number of variable factors. The activities included in BMP No. 1 are drawn from the Public Education Plan being developed for the Department of Public Works, which recommends a three year public outreach program. An average annual cost estimate is provided below for production, distribution, promotion and staffing costs. A detailed list of the materials and staffing needed for each activity and their estimated average annual costs is provided in cost tables included in the Appendix C-1. In this listing, the budgetary contributions of other departments participating in specific activities are noted and subtracted from the total. The estimated costs are summarized in Table 5-1B. Each of the cost components are described below.

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TABLE 5-1A

ESTIMATED ANNUAL REDUCTIONS

Pollutant	Reductions (lb/yr)
Copper	400
Lead	140
Mercury	6
Nickel	110
Silver	10
Zinc	1720
Cyanide	50

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TABLE 5-1B

ESTIMATED ANNUAL COSTS

Implementation Measures	Cost
Annual Operating Costs:	
Staffing	$193,000
Promotion	$94,000
Production	$66,000
Distribution	$7,000
Total Annual Cost	$360,000/yr

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Staffing

multiplier of 2.2 is used to account for benefits, office space, materials and other overhead costs. Staffing costs will depend on the size and scope of the public education program ultimately adopted by DPW. The use of outside consultants will decrease the staff needed for the program.

Promotion

Average annual promotional costs for BMP No. 1 are estimated to be approximately $94,000. Staff and labor costs are not included in this estimate. Advertising and promotional costs may vary widely depending on the amount of paid advertising used to promote activities. The costs for major media advertising that reaches the entire Bay region may be divided with other municipalities. The use of smaller, neighborhood newspapers will further reduce promotional costs.

Production

Average annual production costs for BMP No. 1 are estimated to be approximately $66,000. This includes the design and production of all written materials and literature, decals, videos and other materials needed. The number of each type of publication produced (different brochures and fact sheets), their size, format, and graphic content, and the number printed will affect production costs. Materials produced for one program may be used for other programs, thus reducing costs.

Distribution

Average annual distribution costs for BMP No. 1 are estimated to be approximately $7,000 per year. Distribution costs may vary for specific materials. The cost of distributing materials through existing organizations and at special events may be minimal. Postage costs for mailed materials could be significant.

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BMP NO. 2 (OPTIONAL BMP P1)

DEVELOP AND IMPLEMENT AN AGGRESSIVE PUBLIC PROGRAM TO REPORT AND PREVENT DUMPING OF TOXIC POLLUTANTS INTO SEWERS

A key goal of this study is to examine ways of preventing toxic substances from entering the sewer and storm drain systems. Illegal dumping is one way in which toxic substances are afforded a pathway to the treatment plants, and ultimately, the Bay and Ocean. BMP No. 2 seeks a means by which the general public can prevent illegal dumping and report it to the proper authorities when it is witnessed.

Illegal dumping can stem from either private citizens disposing of used or excess toxic materials such as oil or paint, or businesses disposing of chemicals or substances which are byproducts of their production process. The cost of properly disposing of industrial hazardous waste can be high for some businesses. As such, illegal dumping may be viewed by some as a means of disposing of waste material, even with the attendant risk of being caught and fined. Illegal dumping by private citizens may result from ignorance of the adverse environmental impacts of dumping toxic substances into sewers or storm drains, lack of awareness of the availability of proper disposal options such as the Household Hazardous Waste Collection Facility (HHWCF), or a simple unwillingness to make the extra effort to properly dispose of toxic products or waste.

Public education and outreach are the appropriate means of addressing instances where citizens are unaware of safe alternatives to products containing toxic substances, the adverse environmental impacts of dumping toxic substances into sewers or storm drains, or the availability of proper disposal options. Proper reporting and enforcement procedures are necessary to address illegal dumpers who do not wish to pay the cost or make the effort to properly dispose of toxic substances. The educational activities needed to discourage and prevent illegal dumping have been outlined in BMP No. 1. The activities discussed below provide a means of preventing illegal dumping by providing the public with convenient disposal alternatives, and a mechanism through which the public may report illegal dumping.

POLLUTANTS OF CONCERN

Any variety of toxic pollutants can potentially enter sewers and storm drains as a result of illegal dumping. As a practical matter, however, certain toxic substances are dumped illegally more often than others. An audit conducted of spill investigations and retrieval reports from the Department of Public Health (DPH) and the Bureau of Environmental Regulation and Management (BERM) found that oil and paint are the substances most commonly dumped or spilled in the City and County of San Francisco. Between 1990 and 1992 paint and oil accounted for 22 and 21 percent, respectively, of BERM's spill investigations. In the case of DPH, oil accounted for 39 percent of spill retrievals and paint for 22 percent. BERM also reported a high incidence (21 percent of investigations) of dumping of cement and/or concrete. The Bureau of Street Cleaning and Urban Forestry (BSCUF) has also reported that containers of oil and paint, or spilled oil, are often found in certain parts of the City. Paint and oil also represent the vast majority of containers received at the City's HHWCF (57 and 12 percent, respectively; CCSF, 1992B).

This data, and the experiences of City workers, suggest that oil and paint are the products that will be most affected by efforts to prevent and reduce illegal dumping of toxic substances. Thus, to the degree that BMP No. 2 and related efforts are effective in reducing illegal dumping, it can be expected that the pollutants found in paints, oil and other automotive products (mercury, copper, lead and nickel) will be affected.

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Industrial, Small Quantity Generators (SQG) and Conditionally Exempt Small Quantity Generators (CESQG) can potentially be the source of a wide variety of illegally dumped substances. San

metal platers; and medical and dental wastes. Businesses were the source of over two thirds (68 percent) of the spill investigations conducted by BERM.

Data provided by the Metropolitan Water Reclamation District of Greater Chicago, which established a public illegal dumping hotline in 1989, shows that a wide variety of substances are reported to be illegally dumped (MWRD, 1991). All of the substances listed above were illegally dumped, as well as several incidents in which acids and septic material were dumped into sewers or storm drains.

The greater Chicago area is not similar to CCSF in terms of the mixture of businesses and industries represented, however. As stated above, San Francisco has a smaller percentage of large industries, and a larger percentage of SQGs than most cities. Thus, it can be expected that non-residential illegal dumping would result most commonly from the City's many printing, photographic, automotive service facilities and restaurants that improperly dispose of oil and grease. The pollutants of concern found in wastes produced by these businesses include copper, silver, nickel, zinc, and lead.

EXISTING CONDITIONS

CCSF does not currently have a formal illegal dumping hotline. The CAO operates hotlines on composting, recycling, the HHWCF and informational requests. The CAO receives approximately two to four calls per month reporting illegal dumping. These calls are referred to DPH.

The Bureau of Street and Sewer Repair (BSSR) has an emergency service telephone number which is staffed 24 hours a day (7:00 am to 4:00 pm at the Maintenance Yard at 2323 Army Street and 4:00 pm to 7:00 am at the Fire Department Central Dispatch at 1003 Turk Street). Periodically, this telephone number has received calls reporting illegal dumping and hazardous spills. These reports are referred to BERM or the Fire Department, which in turn contact DPH as necessary. Whenever staff is available, BERM sends an inspector to investigate illegal dumping incidents. A report is completed on the investigation, although no further action is taken.

The majority of the calls received on this line involve requests for other telephone numbers and the staff responsible for answering the line is simultaneously responsible for several other phone lines as well as radio dispatch for BSSR. Significant delays in responding to calls to this line have been reported.

The Fire Department has the authority to issue citations for illegal dumping. The possibility of giving BERM inspectors with citation authority is being investigated. Issuing citations for illegal dumping is considered difficult because the individual must actually be caught "in the act." BERM staff believes that, even if citing the alleged violator is not always possible, making a "show of force" is effective in showing residents that illegal dumping is taken seriously by the City.

In addition to education, the most effective means of preventing and reducing illegal dumping is to provide the public with a convenient means of properly disposing of toxic substances. Proper disposal alternatives must be made available and the public must be made aware of them.

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A convenient means of properly disposing of HHW is provided to San Francisco residents by the HHWCF operated by the Sanitary Fill Company. The facility is located at 501 Tunnel Avenue, within ten miles of any residence in the City. It is open from 8 am to 4 pm, Thursday through

increase of between 19 and 27 percent (CCSF, 1992B). The HHWCF has been a highly e..ective means of providing a proper disposal option for hazardous substances for San Francisco residen Had the facility not been available, it can be assumed that at least some portion of the wast disposed there would have been dumped illegally into sewers or storm drains or the solid waste stream.

The CAO also plans to sponsor a Household Hazardous Waste collection day once per year in different parts of the City. One such collection day has been held to date. Approximately 500 people participated in the one day collection effort, which cost $65,000. One collection day per year is currently budgeted. No additional household collection effort will be included as part of this BMP.

IMPLEMENTATION MEASURES

Implementation measures for this BMP include establishing a curbside waste oil collection program, an illegal dumping hotline, and investigating authorizing citation authority for BERM inspectors.

Curbside Motor Oil Collection Program

Implementing a curbside collection program for used motor oil will be a major focus of BMP No. 2. This type of program has been succes..ul in other Bay area counties and, as indicated above, will address one of the most common sources of illegal dumping. The City of San Jose's experience with curbside oil collection is illustrative: The program collects an average of 495 gallons of used oil per day with a total of 53,562 gallons of used motor oil collected between January 2 and July 29, 1991. The program currently collects used motor oil only from single family residences, and enjoys a participation rate of 45 to 50 percent. It is estimated that an average of one gallon of used motor oil is collected per year from each household.

Public participation in a curbside collection program is expected to be high. An environmental survey was conducted of CCSF residents (see Section 3 of this report) concerning their attitudes and habits with regard to environmental awareness, hazardous waste, and disposal alternatives. The survey found that 88 percent of respondents were aware of curbside recycling in their neighborhood and that, of those, 91 percent normally put things out to be picked up. Addit..nally, over 70 percent said they would use curbside motor oil collection and, of those, 83 percent said they wo..d be willing to pay an extra amount for the service.

Once in place, the curbside oil collection program can be expanded to include other recyclable products, such as anti-freeze and latex paint. In addition to ensuring the proner disposal of the products involved, the curbside collection program has the added benefit of reinforcing the message that using non-toxic or recyclable products is the preferred approach to pollution contr The high cost of final disposal of non-recyclable toxic materials dictates that non-toxic or recyclab.e products be emphasized whenever possible.

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The curbside oil collection program will be promoted through news stories, utility bill inserts and paid advertisements in local newspapers. With regard to promotion, 67 percent of participants

San Jose program uses brochures, door hangers and paid advertisements in local neighborhood newspapers to promote the program. Route audits are conducted to determine areas with low participation. These areas are subsequently targeted for aggressive promotional efforts, such as door hangers and additional advertising in local newspapers. The use of neighborhood newspapers was found to be particularly effective.

Illegal Dumping Hotline

Members of the general public commonly report spills and illegal dumping of toxic substances. The public was the source of 43 percent of the illegal dumping/spill incidents investigated by BERM and 24 percent of those investigated by DPH. San Francisco does not, however, currently operate an illegal dumping hotline specifically oriented to the general public. Such a hotline will be established as part of BMP No. 2. During normal working hours, the hotline will be answered at BERM, with referrals to DPH, Fire Department, and the Bureau of Street Cleaning and Urban Forestry, as necessary. Being answered first at BERM will allow an appropriate response to be coordinated, while maximizing the possibility of catching the dumper "in the act" and citing them. A standard procedure will be established through which illegal dumping reports received by other City agencies are transferred to BERM. Other citys' experiences with illegal dumping hotlines suggest that once established and publicized, fewer public calls will come through other lines.

The illegal dumping hotline will be aggressively publicized and promoted. Whenever possible, the hotline number and message (e.g. "Report All Illegal Dumping!") will be integrated with other program activities. All public education materials produced will prominently list the hotline number and to encourage its use. Environmental groups, community organizations and other groups will be notified of the hotline and asked to promote it through their newsletters and activities. Neighborhood watch groups will be provided with background materials on illegal dumping and the hotline and encouraged to watch out for illegal dumping as part of their activities. (Neighborhood watch groups must be reached through the Police Department.) Senior citizens groups will also be educated about the hotline. Finally, a bumper sticker will be developed which prominently displays the hotline number with an accompanying message to report illegal dumping. Bumper stickers will be applied to all City vehicles and distributed to environmental groups, schools, community organizations and at special events.

Additional publicity, in the form of Public Service Announcements (PSAs) on local TV and radio stations, and paid advertisements in print media, on billboards, bus stops and in mass transit vehicles will also be arranged as practicable. One means of funding such advertising is to arrange for fines levied against businesses for illegal dumping or other hazardous materials-related violations to be "set aside," with the guilty party sponsoring a billboard or other form of advertising carrying the hotline number and message. This program is used successfully in Sacramento County and allows the fines to be used directly for program-related advertising rather than going into the general fund where they might not be readily available for the public education program.

A potential option that has been suggested for an illegal dumping hotline would be to develop an integrated "environmental hotline" to which residents could call concerning the full range of environmental issues. The integrated environmental hotline would consolidate hotlines currently being operated by the CAO as well as the new illegal dumping hotline. Callers would be provided

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with a menu through which they would be transferred to either existing recordings, voice mail, or, as with the illegal dumping hotline, to staff at either BERM or the Fire Department. Consolidating the existing hotlines into a single "environmental hotline" would reduce confusion among the

Several factors undermine the feasibility of an integrated "environmental hotline," however. The public may not be receptive to an extended menu, especially when calling for a specific purpose. Additionally, the cost of such a system could be prohibitive. The CCSF's Bureau of Telecommunications has reported that such a system would have to be arranged through Pacific Bell's California Call Management Program. This program charges $250 per month for every incoming and outgoing phone line, or "port." Multiple incoming lines would be necessary to ensure that residents do not receive a busy signal. Transfers to a recording or voice mail cost only $8.50 per month. While a traffic survey of existing lines would be needed to determine the exact number of incoming lines necessary for an integrated "environmental hotline," it can be assumed that at least four lines would be needed as well as one outgoing line for transferring illegal dumping reports to BERM or the Fire Department. This arrangement alone would cost at least $1250 per month. Given the level of use that could be expected for an integrated "environmental hotline," the actual cost could be much higher. It is thus assumed that this option would be infeasible for cost reasons.

Citation Authority for BERM Inspectors

BERM will investigate providing its inspectors with the authority to cite illegal dumpers. The legal authority, fining structure, and appeal process will be similar to the Fire Department procedures and will be based on advice from CCSF's legal departments. Even if citation is not possible, BERM should respond to major illegal dumping reports with an appropriate "show of force" to convey to residents the seriousness of dumping toxic substances into sewers and storm drains and to warn the violator against repeating the action.

EXPECTED REDUCTIONS

Reductions due to the illegal dumping hotline and the citation authority for BERM inspectors would be highly variable. Reductions from this BMP would be primarily due to the proper disposal of used motor oil. Based on the San Jose program results (one gallon per household per year with 50 percent of households participating), approximately 157,000 gallons of used oil per year would be collected. Some of that oil would normally have been disposed of properly. California Integrated Waste Management Board estimated that approximately 46 percent of used oil was disposed of illegally in 1990. Therefore, approximately 70,000 gallons per year would have been illegally disposed if curbside collection were not available. Table 5-2A summarizes the reductions of toxic pollutants by collecting the illegally disposed used oil. The amounts of metals in used oil were estimated based on discussions with a local used oil recovery company and are summarized in Appendix C-2. In addition to the metals shown on Table 5-2A, PAHs and other organic compounds present in used oil would also be reduced. However, their loadings are unknown at this time.

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TABLE 5-2A

ESTIMATED ANNUAL REDUCTIONS

Pollutant	Reductions (lb/yr)
Copper	15
Lead	60
Mercury	<0.2
Nickel	90
Zinc	2850

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ESTIMATED COSTS

collection program. The other activities included in BMP No. 2 are relatively low in cost. Costs of the Curbside Motor Oil Collection Program can be offset by garbage collection bill increases or other funding mechanisms independent of the budget for the BMP program.

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TABLE 5-2B

ESTIMATED ANNUAL COSTS

Implementation Measures	Cost
Program Startup Costs:	
Legal Authority for Citation	$15,000
Annualized Startup Cost(a)	$2,000
Annual Operating Costs:	
Illegal Dumping Hotline	$13,000
Curbside Motor Oil Collection Program	$157,000
Subtotal	$170,000
Total Annual Cost	**$172,000/yr**

(a) Amortization factor = 20 years @ 8% = 0.102

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BMP NO. 3

BAN THE USE OF COPPER SULFATE ROOT KILLERS AND EDUCATE THE PUBLIC ON ALTERNATIVE PRODUCTS

Generally speaking, most of these products do not have a direct pathway to the treatment plants. Some of these compounds used in CCSF may contribute to the wet weather loadings. An exception in this regard are root killers.

Chemical root killers are used to kill or retard roots which, attracted by moisture, have grown into sewer lines through small cracks, fissures, or separations at joints. The majority of chemical root killer products sold to the general public are composed of copper sulfate and are applied directly to the sewer line by flushing the product down the toilet. Product directions recommend using an entire two pound bottle in each application with one application per year suggested. Given that copper sulfate is approximately 40 percent elemental copper, approximately 0.5 pound of copper would be added for each application.

The use of copper sulfate root killers can be found in three areas: consumers who purchase and use the product themselves; plumbing and sewer repair businesses that use the product as part of their work or sell it to customers following mechanical removal of roots, and; CCSF's Department of Public Works which may use the product in municipal sewer lines.

An informal survey of plumbing and sewer repair businesses suggests that copper sulfate root killers are not widely used. Most of the businesses contacted reported that mechanical cutting is the primary means of removing roots from sewers. Copper sulfate is sometimes recommended as a secondary or maintenance treatment to retard roots that have already been cut. This conclusion confirms a study conducted in Palo Alto, CA, which interviewed 13 sewer clearing and plumbing businesses. Of the 13, only one reported using copper sulfate, with only ten pounds used during 1990 (SRI, 1991B). Commercial plumbers and sewer repair companies are thus not considered a major contributor of copper sulfate root killers.

Copper sulfate root killers are widely available to consumers at hardware and plumbing shops. The ease with which the product can be applied suggests that it could be widely used by consumers. Without conducting a detailed survey of hardware and plumbing stores in CCSF, it is impossible to know exactly how much copper sulfate root killer is sold and used. In the public awareness survey conducted, root killers were reported to be used by 3 percent of CCSF households. Copper sulfate had the lowest usage rate reported for any of the toxic materials covered by the survey. If 3 percent of CCSF's approximately 300,000 households each made one, two-pound application of copper sulfate root killer per year, over 7,200 pounds of copper would enter the sewer system. The accuracy of this figure may be questionable, however. Survey respondents may have associated "root eradicators" (the term used in the survey questionnaire) with weed killers and other products applied directly to plants in the lawn or garden. This is supported by the survey's finding that having a yard or garden was linked to greater use of root eradicators. Lawn and garden root killers and related products do not have a direct pathway to the sewer system during dry-weather conditions and thus are not addressed by BMP No. 3.

The SRI study cited above estimated that copper sulfate root killers contributed between 36 and 42 pounds of elemental copper in Palo Alto in 1990. By projecting this usage based on population, copper sulfate root killers may be the source of 300 to 400 pounds of elemental copper entering the SEWPCP system in 1990. This range is likely to be an over-estimate, however, as Palo Alto residents may use more of this product due to the area's higher percentage of detached single family homes and garden landscaping. A more realistic loading may be 50 percent of the above

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estimate, or 200 pounds per year. The west coast distributor of a prominent brand of root killer (Roebic Root Killer K-77) was contacted and suggested that the relative scarcity of trees in CCSF minimized sales of the product. A rough estimate was given that approximately 400 to 500, two

The Bureau of Street and Sewer Repair was interviewed with regard to its use of the product and it was reported that no copper sulfate root killers are used. The Bureau has a Vaporooter machine which uses a foaming herbicide containing sodium methyldithiocarbamate and dichlorobenzonitrile. Due to employee complaints, this technique is not used. Mechanical cutting is the primary method used for removing roots which have grown into municipal sewer lines.

POLLUTANTS OF CONCERN

The most commonly used chemical root killers are composed of copper sulfate, which is 25 percent elemental copper. Thus, copper is the only pollutant of concern addressed by BMP No. 3.

Dichlorobenzonitrile, used in Vaporooter machines, may contribute a slight amount of cyanide. However, based on residential sampling results, cyanide from root killers and other residential sources appears to be minimal. This process is also not widely used by sewer clearing companies. Therefore, cyanide is not expected to be reduced by controlling root killers.

EXISTING CONDITIONS

The "Guide to Less Toxic Shopping" produced and distributed by the CAO's office discourages the use of copper sulfate-based root killers. The Guide recommends that roots be removed through mechanical cutting and non-metallic foaming herbicides, and that breaks in sewer lines be repaired to prevent further entry of roots. The agrichem brochure being developed does not address roots in sewers.

IMPLEMENTATION MEASURES

After its investigation into copper sulfate root killers, Palo Alto banned the use of this product in its sewer system. Its sewer use ordinance was modified to implement this practice. Several other agencies in the Bay area, including Central Contra Costa Sanitary District, will be implementing the same policy. It is recommended that CCSF ban the use of copper sulfate root killers as the primary measure of this BMP.

A ban of the use of this product would require educating the potential users. It is apparent that the use of copper sulfate root killers stems predominantly from residential sources, which are thus the focus of BMP No. 3. With regard to municipal use of such products, CCSF should maintain its current practice and ensure that it is not used by DPW or its contractors. Due to the low use of copper sulfate root killers by plumbers and sewer repair businesses, minimal outreach would be required in this area. If resources permit, a minimal outreach effort to this group will include a mailing explaining the adverse environmental impacts of copper sulfate root killers and the use of non-toxic alternatives only, such as mechanical cutting or sodium hydroxide root killers.

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With regard to education and outreach to the general public, the agrichem brochure being developed will be modified to include information banning the use of copper sulfate root killers and

and where root obstruction of sewers could be expected to be most common. The "Guide to Less Toxic Shopping" or educational material specifically focused on copper sulfate root killers can be distributed in these areas. Finally, when residents contact CCSF concerning problems with their sewer line, they will be instructed to utilize non-toxic alternatives. CCSF staff, such as in the Bureau of Street and Sewer Repair, will be educated on the issue and instructed to recommend non-toxic alternatives for root control when speaking with residents.

Workshops conducted for lawn and garden shops, hardware stores, nurseries and plumbing and sewer maintenance businesses will include a discussion of non-toxic approaches to root control and educational materials will be provided encouraging the promotion of non-toxic alternatives to copper sulfate root killers. Sodium hydroxide-based root killers, for example, should be recommended to their customers.

EXPECTED REDUCTIONS

The data discussed above suggests that the amount of copper entering SEWPCP from copper-based root killers may be approximately 200 pounds per year. By banning the use of this product, the entire loading could be eliminated.

ESTIMATED COSTS

The estimated costs for BMP No. 3 are summarized in Table 5-3A. The implementation costs include expenditures for revising the existing sewer ordinance to ban the use of copper sulfate root killers. The program of outreach to businesses, nurseries, and residences are expected to continue for two years after the ban is in order to fully implement this BMP. The total costs over these two years are amortized for direct comparison with other BMPs. The detailed cost estimates are included in Appendix C-3 for reference.

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TABLE 5-3A

ESTIMATED ANNUAL COSTS

Implementation Measures	Cost
Revise Ordinance for Ban	$18,000
Outreach to Businesses	$4,000
Education Materials to Nurseries and Hardware Stores	$10,000
Workshops	$18,000
Promotion and Publicity	$18,000
Subtotal	$68,000
Total Annual Costs(a)	$7,000/yr

(a) Amortization factor = 20 years @ 8% = 0.102

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BMP NO.4

Metals and cyanide compounds contained in paints and other home improvement products (e.g., spackling paste, wallpaper adhesives, etc.) may be discharged to the sewer through routine cleanup and disposal procedures practiced by commercial contractors and residents. Of the pollutants targeted in this BMP study; copper, mercury, zinc, and cyanide compounds are commonly used in paints and/or other home improvement applications such as preservatives, biocides, mildewicides, and in paint and pigment formulation. This BMP would attempt to reduce the pollutant loadings from these sources by implementing educational measures and suggesting alternatives to specific products and disposal practices.

POLLUTANTS OF CONCERN

CCSF's "Small Quantity Generators" report identified painting and wallpaper hanging contractors as a potentially high sources of toxic pollutants, especially mercury and zinc. The uses of mercury, copper, zinc, and cyanide compounds in home improvement products are discussed below.

Mercury

Historically, mercury in the form of phenyl mercuric acetate (PMA) was commonly used as an in-can preservative to prevent bacterial and fungal growth and as a mildewicide for interior and exterior paints, spackle and wall paper adhesives. Prior to June 1990, mercury limitations in paint were set at 200 ppm in interior paints and 1500 ppm in exterior paints. Following an incident of mercury poisoning in a four-year old child resulting from mercury in paint, EPA promulgated the following regulatory restrictions on mercury sales and uses:

- As of August 20, 1990, mercury was banned in paints intended for interior use, but could still be used on exterior surfaces in concentrations of up to 200 ppm. Paint distributors were required to re-label all mercury-containing paints "for exterior use only." (55 FR 26754)

- As of September 30, 1991, the use of mercury was banned by EPA for all interior and exterior applications. Paint manufacturers were allowed to purchase mercury until this date, and were permitted to subsequently deplete their stocks through continued use in the manufacturing process.

According to a Kelly-Moore representative, this PMA stock depletion phase would last approximately 9 to 12 months from September 1991, assuming normal paint sales and consumption. Therefore, exterior paint sold in stores today would likely contain mercury. In response to the regulatory measures, paint manufacturers have switched to organic-based mildewicides. (H. Champeny, pers. comm. 1992)

The common spackling and wallpaper materials currently being sold in California do not appear to contain mercury or any of the other targeted compounds. Conversations with several manufacturers of leading spackling and wallpaper adhesive products (Synkoloid Co., Custom Building Products, and Wall Tite, Inc.) indicate that these products used to contain mercury until a

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few years ago, but have since switched to organic, amine-based biocides such as azoniaadamantane chloride. (J. Avelar, pers. comm. 1992)

cupric acetoarsenate and copper phthalocyanine, which are used in formulating deep blue and green paint pigments, and cupric sulfide, which is used to form a copper blue coloring in linseed oil varnishes. (Gosselin, et. al. 1984; D. Radke, pers. comm. 1992)

Copper is also used in the form of cuprous oxide (Cu_2O) as a biocide in marine paints. These marine paints are designed to slowly release copper in ionic form in order to prevent the growth of organisms such as barnacles on the underside of boats. These paints may consist of 20 to 70 percent by weight of cuprous oxide (Datta, personal comm., 1992).

Zinc

Zinc oxide is a common ingredient for many oil-based and water-based (latex) house paints, with weight percentages reportedly ranging between 0 and 25 percent (Gosselin, et. al. 1984). Zinc oxide contributes to the hardness and gloss retention of the paint film, as well as enhancing ultraviolet light protection, chalk control, and mildew resistance (Patton, 1973).

Cyanide

Cyanide compounds such as ferrocyanide are used in the formulation of certain deep blue pigments such as iron blue. (Gosselin, et. al. 1984) Little data are available describing the percentage of paints that contain these pigments. However, pigment manufacturing information (Patton, 1973) indicates that the cyanide weight percentage contained in certain deep blue pigments may be between 5 and 30 percent. Paint contractors and sales persons contacted could not provide information on sales of paints containing cyanide.

Other Compounds

Lead is the only other metal banned by EPA for use in paints. Lead restrictions were passed in 1978. Regulations may be forthcoming for tributyl tin oxide, but no other intended metals restrictions are known at this time. (B. Edwards, pers. comm. 1992)

EXISTING CONDITIONS

Painting contractors, distributors, and homeowner "do-it-yourselfers" practice a wide range of disposal methods for their paint-related products. Sink and storm-drain disposal of excess paints; brush, roller, and spray equipment rinsewaters; and home laundering of paint-covered materials are common pathways for pollutant-laden paints to enter the sewer system.

Although waste minimization is widely practiced by painting contractors as a cost-savings measure, proper paint cleanup procedures with respect to minimizing sewer loadings are not as common. Many contractors are unaware that paints contain metals and other pollutants of concern, and are unaware that storm drain/sewer disposal is not appropriate. Some contractors contacted were unsure of the precise equipment cleaning procedures of their work teams and reported various improper procedures such as rinsing equipment into the soil and evaporating paints for disposal as a solid waste rather than paying for hauling of liquid hazardous wastes. Rinsing of equipment to

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the soil, "work" sinks, or storm drains was also reported "so as not to leave a noticeable mess". While some contractors are careful to dispose of their thinners that are used in cleaning oil-based paints, others are less aware of proper disposal procedures. Residential "do-it-yourself" painters

residential "do-it-yourselfers." Educational materials describing proper waste minimization and cleanup/disposal procedures are not readily available.

In light of the high cuprous oxide content of marine paints, boatyards were identified as a potential source of copper to the SEWPCP. Boat scraping and painting operations at the yards may provide a potentially significant source of copper through routine, dry weather rinsing and cleaning operations.

BERM recently conducted inspections at each of the boatyards in the CCSF for the Port of San Francisco in anticipation of upcoming stormwater permitting requirements. Based on information gathered through these inspections, the boatyards are typically in a state of severe disrepair with very few measures taken to prevent or minimize the disposal of paints and related pollutants into facility storm drains. However, of the 10 boatyards inspected, only two currently are equipped to pump facility rinse and washwater to the SEWPCP collection system from the waterfront. Most facilities only have sanitary hookups to the SEWPCP, but drain all of their working washwaters directly to the Bay. Most of these boatyards, therefore, do not comprise a current source of copper to the SEWPCP. However, as a result of pending stormwater permitting actions, CCSF's boatyards may be discharging to the SEWPCP in the future. Boatyard operating personnel should thus be included in the educational measures conducted for this BMP.

Estimated Loadings From Home Improvement Products

Little data are available to estimate the quantities of paints and pollutants entering the sewer as a result of painting contractor and residential disposal practices. Paints are typically shipped to the stores as a white paint and then mixed with colorants according to customer preference. The liquid colorants are often produced at a paint manufacturer from dry pigments purchased from a pigment supplier. The highest degree of uncertainty in these loading estimates relates to the portion of the sewer bound paints that contain each metal. For copper and cyanide, loadings from house paints would depend on the pigments used and the weight percentage of pigments mixed into the paints. The weight percentage of pigments in paints tends to vary between 10 and 50 percent, depending on the coating type and color, and the strength of the pigment used. Copper and cyanide compounds, in turn, may comprise between 5 and 30 percent by weight of the pigment. (Patton, 1973)

A detailed market analysis of paint and pigment sales was not conducted for this study. Such an analysis would be necessary to more accurately refine the loading estimates of metals and cyanides from paints. Representatives from two national painting trade associations, National Paint and Coatings Association (NPCA) and Painting and Decorating Contractors of America (PDCA), would not supply information to non-members for use in this study.

Based on discussions with paint contractors regarding the approximate number of commercial painters operating in CCSF and the amount of paint being discharged to the sewer from typical disposal practices, nearly 60,000 pounds of paint per year are estimated to be disposed of to the SEWPCP. Metals loadings were estimated from the portions of these paints that are believed to contain the targeted pollutants. These estimated loadings are listed below.

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- Copper 40 pounds per year
- Mercury 10 pounds per year

derived from residents equal one-half of the loadings derived from contractors. Other specific assumptions used to estimate paint loadings to the SEWPCP are included in Appendix C-4 for reference.

IMPLEMENTATION MEASURES

The implementation of this BMP will focus on educating painting contractors and residents. Paint contractors pose a problem for dispensing educational measures due to the decentralized worker population, and the large number of unlicensed (unregistered) working contractors. Contractors contacted during this study estimated that as many as half of the commercial painters operating in CCSF could be unlicensed.

Due to the high number of unlicensed contractors, the high turnover of businesses, the mobility of the business, and the number of residential contributors, traditional regulation relying on permitting and sampling for compliance would not be appropriate. Education of both businesses and residents would be more effective. The Green Business Program, discussed under BMP No.1, would be extremely effective. The implementation measures recommended for this BMP are listed below.

- **Develop Database.** Compile a comprehensive, current database of all licensed painting contractors, equipment rental shops, boatyards, home improvement/hardware stores, and home improvement classes operating in CCSF. This database would define the target audience for this BMP. It should be developed based on a review of CAO's existing database, the yellow pages, the Construction Blue Book, the East Bay Painting Contractor Association, and other available listings.

- **Compile Technical Information.** Information would be compiled on problem paint types, recommended cleanup techniques and disposal procedures, recycling of paint thinners, and waste hauling options. Recommended cleanup measures would need to be catered to specific coating types and working environments. For example, recommendations for proper painting procedures may include the following:

  -- Avoid exterior paints and finishes containing mercury.
  -- Minimize use of paint (e.g., only buy what you need; use water-based paints and whitewash where possible; explore reuse options).
  -- Practice proper paint stripping and removal (e.g., use heat gun or hook scraper).
  -- Practice proper cleanup procedures (e.g., use brush "spinners" and rags to remove excess paint from brushes; designate an "initial rinse" bucket to be hauled to a hazardous waste facility; separate and reuse paint thinner; wash clothes at industrial laundry facility; etc.)

- **Coordinate with other POTWs that are Regulating the Painting Industry.** Most painters, by necessity, are highly mobile and may work in and out of CCSF. To facilitate compliance for this industry, requirements among different POTWs should be as similar as possible.

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- **Identify Workshop Participants.** Identify contractors, hardware/paint store managers, equipment rental shops, and boatyard managers to invite to the educational workshops. Prepare and mail workshop invitations, providing two alternative dates for

describe the concerns associated with improper paint disposal, and provide simple instructions as to proper cleanup and disposal methods. References to CAO literature such as "Your Guide to Less Toxic Shopping," and directions to the household hazardous waste facility will be provided on these materials.

- **Conduct Workshops.** BERM would provide two educational workshops for painting contractors, hardware store managers, boatyard managers, and paint equipment rental shops to discuss recommended waste minimization, cleanup, and disposal practices.

- **Distribute Fact Sheets and POP Displays.** Fact sheets and point of purchase displays will be finalized following review at the workshops. These will be distributed to hardware stores, paint stores, and equipment rental shops. Retain extra fact sheets for distribution at fairs, community events, and/or as utility bill inserts.

- **Implement a Green Business Program.** Contractors employing proper cleanup and disposal practices can promote themselves as a "Green Business." The Mayor's "Green Ribbon Panel" will be used to promote and coordinate this program. Permitting and inspection procedural details will need to be coordinated to ensure continued practice of the proper procedures.

- **Educate Residents on Proper Cleanup Practices and also on Selecting Green Business Contractors.** As part of the public education tasks described under BMP No.1 and the point of purchase displays at paint and hardware stores, residents will be instructed to follow proper cleanup and disposal procedures, and to only select certified "Green Business" contractors.

EXPECTED REDUCTIONS

Table 5-4A presents the expected mass loading reductions to occur through the implementation of BMP No.4. These reductions assume a 60 percent reduction of mass loadings from paint contractors, and a 50 percent reduction from residents. These reduction estimates assume that the painting contractors are an easier group to reach with the educational measures than the resident "do-it-yourselfers." However, since contractors tend to waste less paint than residents, the difference in expected future reductions is fairly small.

ESTIMATED COSTS

The implementation costs for this BMP are summarized in Table 5-4B. Detailed cost estimates are included in Appendix C-4 for reference. Costs for implementing this BMP are estimated to be nearly $37,000 annually. These costs assume one-time costs of presenting the four workshops and developing 1,000 point of purchase displays, and annual production of 10,000 fact sheets.

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TABLE 5-4A

ESTIMATED ANNUAL REDUCTIONS

Pollutant	Estimated Mass Loadings (lbs/yr)	Reductions (lbs/yr)
Copper	40	10
Mercury	10	2
Zinc	3,500	700
Cyanide	30	10

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TABLE 5-4B

ESTIMATED ANNUAL COSTS

Implementation Measure	Cost
Program Startup Costs:	
Develop Database of Businesses	$30,000
Define Proper Procedures	$20,000
Contractor Workshops	$15,000
Fact Sheet Mailings	$8,000
Subtotal	$73,000
Annualized Startup Costs(a)	$7,000
Annual Operating Costs:	$30,000
Total Annual Cost	**$37,000/yr**

(a) Amortization factor = 20 years @ 8% = 0.102

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BMP NO.5

FURTHER REGULATE DISCHARGE OF PHOTOGRAPHIC WASTES

Quality Control Plant. In addition to silver, a number of other pollutants are also present in various photographic wastes. CCSF has been regulating the larger photofinishers within its service area for a number of years. This BMP evaluates implementing additional regulations on this business category.

Photographic materials (film, paper, etc.) and solutions contain a number of organic and metallic compounds. Table 5-5A lists some of the chemicals found in photographic solutions. Many of these solutions are discharged into the sewer system and have a direct pathway to the environment. The negative impacts of these wastes into the environment have been recognized. For a number of years, the photographic industry has reformulated certain products with less toxic components and has developed various recycle and treatment schemes to reduce the loadings of these toxic pollutants.

POLLUTANTS OF CONCERN

The pollutants of concern identified at CCSF that are typically associated with the photographic processes include silver and cyanide. Mercury was initially thought to be a compound used in photographic processing. Chromium and selenium are also present in some of the solutions. The use of these pollutants are briefly discussed below.

Silver

Silver is the most prominent pollutant of concern from the photographic processes. It is contained within the film and prints in the forms of silver chloride, silver bromide, and silver iodide. The use of silver in photography is briefly described below.

The initial step in photography is the exposure of a film to a light source. The plastic film is covered with a light-sensitive coating called a photographic emulsion. This emulsion is usually composed of silver halide salts in gelatin. Silver halides include silver chloride, silver bromide, and silver iodide. Most photographic films are made of polyester or cellulose acetate. To produce the photographed image, the film is commonly developed into a negative and then into prints. The major steps in film processing include developing, bleaching, fixing, and washing.

Developing. Chemical oxidation and reduction reactions develop an exposed photographic emulsion. Black and white (B/W) and color processing are different and are described separately. The photoactive medium used for black and white processing is an emulsion composed of a dispersion of silver halide crystals in a gelatinous matrix. Brief exposure to light produces a chemical change in the silver halide crystals. When the film is subsequently immersed in the developing solution, the exposed silver molecules are converted to metallic silver. The metallic silver is dark in color and produces a negative image.

Film and paper used for color photography consist of three separate layers of photoactive emulsion with intermediate layers. Each layer is sensitive to either red, green, or blue light due to the presence of selective dyes in the emulsion. Intermediate layers filter out other wavelengths, so that the silver halides in each layer are only exposed by the light of the specific color. A colorless dye-forming coupler is present along with the silver halide crystals in each emulsion layer. When

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TABLE 5-5A

COMPOUNDS PRESENT IN
PHOTOGRAPHIC PROCESSING

Activators	Amines, Potassium Hydroxide, Sodium Bisulfite, Sodium Hydroxide
Antistatic Solutions	Ethyl Alcohol, Isopropyl Alcohol
Backing Removal Solution	Potassium Hydroxide, Sodium Hydroxide
Bleach, Dichromate, & Precursor Cleaners	Acetic Acid, Aluminum Sulfate, Ammonia, Ammonium Sulfamate, Potassium Dichromate, Sodium Hydroxide
Bleach, EDTA (Color)	Acetic Acid, Ammonia, Borates
Bleach, Ferricyanide	Cyanide
Bleach, Persulfate	Sulfuric Acid
Bleach, Reversal	Ammonia, Ammonium Sulfamate, Potassium Dichromate, Sodium Dichromate, Sulfuric Acid
Bleach-Fixers	Acetic Acid, Ammonia, Borates, Formaldehyde, Sodium Bisulfite
Clearing Baths, Hypo Eliminators and Washing Agents	Ammonia, Borates, Hydroquinone, Sodium Bisulfite
Developers, Black and White	Acetic Acid, Amines, Ammonia, Borates, Formaldehyde, Hydroquinone, Potassium Hydroxide, Sodium Bisulfite, Sodium Hydroxide
Developers, Color	Acetic Acid, Amines, Borates, Ethylenediamine, Hydroquinone, Potassium Hydroxide, P-Phenylenediamines, Sodium Bisulfite, Sodium Hydroxide
Fixers	Acetic Acid, Aluminum Sulfate, Ammonia, Borates, Sodium Bisulfite, Sulfuric Acid
Film Hardener and Prehardeners	Aluminum Sulfate, Ammonia, Borates, Chromium Compounds, Formaldehyde, Sodium Bisulfite, Sodium Hydroxide, Sulfuric Acid
Stabilizers and Deactivators	Acetic Acid, Aluminum Sulfate, Ammonia, Formaldehyde, Sodium Bisulfite, Sulfuric Acid
Soup Bath	Acetic Acid, Ammonia, Borates, Sodium Bisulfite
Liquid Photographic Toners	Selenium

Source: Waste Audit Study, Photoprocessing Industry, California DOHS, Alternative Technology Section

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processed in the developer solution, the exposed silver molecules are converted to metallic silver, while simultaneously producing oxidized developer molecules. These developer molecules react

Stopping. A stop bath is used immediately after the developer bath for B/W film development and print making. If the film were kept in the developer bath, even the silver molecules not exposed to light can be converted to metallic silver by the developer solution. To prevent this from happening, the chemical reaction of the developer is arrested by the stop bath. The stop bath is a weak acid solution (usually acetic acid) which neutralizes any of the alkaline developer carried over on the surface of the film or in the wetted gelatin layer.

Bleaching. A bleach solution is rec only with color processing. It renders the color image visible by removing the b ack metallic r from the photographic emulsion. The bleach converts the metallic silver back into silver halides. All of the silver halides on the film, whether a part of the exposed image or not, can then be dissolved and removed in the fixing step. The dye is retained in each layer of the film so that a negative color image exists.

Fixing. After the developing and bleaching steps, the photographic image on the negative is visible but very perishable. If exposed to light, the entire negative will turn dark. To prevent this, the fixer sets the image permanently on the film. The fixing agent is needed because the negative image contains unexposed silver halides from the black and white processing and reconverted silver halides from color processing. These crystals are still light sensitive and, if allowed to remain, would cloud the image.

The fixing solution is usually comprised of sodium thiosulfate (hypo). Ammonium thiosulfate or sodium hyposulfate is also used. The fixing solution converts the silver halides to soluble complexes and dissolves them out of the emulsion into the solution. The majority of the silver from photographic processing is contained in the fix and bleach-fix (blix) solutions.

Washing. After a film is fixed some of the chemical, including hypo, remain on the gelatin emulsion layer. If it is not removed, it can react with any remaining silver to form yellowish-brown silver sulfide, which impairs the quality of the image. To prevent sulfide formation, fixing chemicals are washed from the emulsion. Films are washed in a water bath that dissolves the hypo from the emulsion. Usually, a hypo neutralizing agent and a wetting agent, to prevent water from spotting the film, are added to the wash water.

Mercury

Mercury was initially identified as a potential pollutant from the photographic process. In a review of the "Clinical Toxicity of Commercial Products" (Gosselin et al., 1981), a Kodak intensifier with a mercury concentration of 16,650 mg/l was listed. An intensifier is used to increase the contrast between light and shadow areas in B/W photography. It is typically used in artistic photography rather than in general consumer photographic processing.

The Eastman Kodak Company was contacted to verify whether this product is still used. Based on discussions with the manager of the Kodak Imaging Environmental Support Services, Eastman Kodak does not currently, and has never, marketed a mercury intensifier. Kodak apparently reported a formula for the mercury intensifier in a trade journal in the 1970's (Dagon, 1992). The unavailability of a mercury intensifier was confirmed in discussions with the environmental manager of Fuji Photo Film U.S.A. Inc. Based on the current regulations limiting the use of

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mercury in general and an absence of demand, photographic processing is not expected to be a source of mercury.

photographic industry has switched to alternative bleach solutions. The majority of bleach solutions used today contain ferric EDTA (ethylenediaminetetraacetic acid) as the oxidizing agent. Currently, there are only three processes that require the use of ferricyanide bleach:

- Kodachrome K-6 (slide film).
- Aerial Ektachrome EA-5 (aerial photography and satellite pictures).
- VNF (video news film).

Certain motion picture and cinemagraphic processing still utilize ferricyanide bleach; however, most of that processing is performed with a persulfate (sulfuric acid) bleach. Based on discussion with BERM's Pretreatment Enforcement Section (PES) staff, none of the major photoprocessors within CCSF utilizes ferricyanide bleach.

Other Chemicals

Although not identified as pollutants of concern at CCSF, chromium and selenium are present in other chemicals used in photographic processing. Table 5-5B lists certain products reported in the "Clinical Toxicity of Commercial Products" and their expected concentrations. These compounds are not used extensively in consumer photographic processing and their overall usage may be small. However, as shown on the table, the working concentrations of pollutants in these products are significantly above their respective local limits.

EXISTING CONDITIONS

BERM's PES has been sampling and regulating photographic processing businesses since the 1970s. This sampling and regulating effort has been directed towards the significant industrial users (SIUs). Recently, PES staff has performed a comprehensive survey to identify all photographic processing operations within CCSF. This survey includes commercial photographic finishers, printers, and micro-filming operations. A complete listing of the 291 establishments that are in the PES photographic data base is included in Appendix C-5 for reference.

BERM adopted new technically-based local limits December 18, 1991. The new limit of 0.5 mg/l of silver is being imposed on all silver dischargers within CCSF. So far, the PES has utilized this transition period to educate dischargers on treatment and disposal methods available to comply with the new limits.

Of the 291 establishments identified in the database, 67 have been sampled for compliance and another 94 dischargers have been inspected by PES staff at least once since 1991.

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TABLE 5-5B

POLLUTANTS IN PHOTOGRAPHIC CHEMICALS

Trade Name	Chemical of Concern	Chemical Formula	Amount of Chemical (grams)	Solution Size (liter)	Chemical Conc. (mg/l)	Ratio Pollutar Chemi.	lutant onc. g/l)
Kodak Chromium Intensifier In-4	Potassium dichromate	K2Cr2O7	90	1	90,000	0.35	.500
Kodak Farmer's Reducer R-4a, stock solution A	Potassium ferricyanide	K2Fe(CN)6	37.5	0.5	75,000	0.54	.500
Kodak Farmer's Reducer R-4b, stock solution A	Potassium ferricyanide	K2Fe(CN)6	7.5	1	7,500	0.54	050
Kodak Gold Protective Solution GP-1	Sodium thiocyanate	NaSCN	15.2	1	15,200	0.32	864
Kodak Gold Toner T-21, stock solution A	Silver nitrate	AgNO3	5	4.064	1,230	0.64	87
Kodak Hardening Bath SB-4	Potassium chrome alum	KCr(SO4)2	30	1	30,000	0.18	100
Kodak Hypo Alum Sepia Toner T-1a	Silver nitrate	AgNO3	4	4	1,000	0.64	40
Kodak HypoTest Solution HT-2	Silver nitrate	AgNO3	7.5	1	7,500	0.64	800
Kodak Quinone-Thiosulfate Intensifier In-6, solution A	Potassium dichromate	K2Cr2O7	22.5	1	22,500	0.35	875
Kodak Silver Intensifier In-5, stock solution No. 1	Silver nitrate	AgNO3	60	1	60,000	0.64	.400
Kodak Sulfide Sepia Toner T-7a, stock bleaching solution A	Potassium ferricyanide	K2Fe(CN)6	75	1	75,000	0.54	500
Kodak Tray Cleaner TC-1	Potassium dichromate	K2Cr2O7	90	1	90,000	0.35	500

Reference: Clinical Toxicology of Commercial Products, 5th Edition, 1984

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continued. In addition, several additional measures could be added to the existing program. However, it should be noted that silver is not currently a major pollutant of concern for CCSF. The 99th percentile effluent in 1991 was 9.1 µg/l as compared to the new Basin Plan limit of 23 µg/l. However, as the SEWPCP effluent already would comply with the new limit, regulation of these additional minor sources would have no effect on compliance.

- **Regulate Dental Offices and X-Ray Laboratories.** The PES staff has done an exemplary job in the identification, sampling, and inspection of a large number of photographic waste dischargers. An expansion of the current program could include the regulation of dentist offices, dental laboratories, and x-ray laboratories. A review of the PacBell Yellow Pages indicated that there are over 900 dentists and dental laboratories within CCSF. X-ray laboratories could expand this listing considerably. Prior to regulating these businesses, a comprehensive survey of these businesses would have to be performed

- **Regulating and Monitoring.** The current local limits would be used as the mechanism for regulating these businesses. As many of these businesses are small, off-site hauling may be the more appropriate means of disposal than treatment. Therefore, most facilities would not require sampling, but rather, periodic inspection of hauling records and education assistance would be required. Due to the potentially large number of these facilities, a comprehensive computer scheduling program to schedule sampling/inspection and to track violation notices/responses would be a necessity.

- **Regulate Other Photographic Wastes.** In addition to bleach and fix, other photographic solutions (toners, reducers, and tray cleaners) contain pollutants with concentrations higher than their respective local limits. The pollutants in these solutions include chromium, selenium, and silver. They should be regulated in a similar manner to silver. Since most of these solutions are used infrequently or in smaller quantities, expected reductions may be minimal. As there is no residual value for the non-silver wastes, cost of its off-site hauling could be significantly higher than the bleach and fix solutions.

- **Provide Residential Drop-Off Locations.** Based on discussion with PES staff, a major improvement to the existing silver control program would be to have more drop-off locations available. The existing Hazardous Waste Collection Center is located at the southern boundary of CCSF and is not convenient for many residents. Availability of drop-off sites at the SEWPCP and RSWPCP would facilitate proper disposal. An area at each plant could have to be constructed for accepting the silver wastes. Staffing of the disposal areas would also be required. In order to maximize convenience, the drop-off sites should be open to the public for at least six days a week. Silver wastes collected at these sites would be hauled off-site for reclamation and proper disposal.

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EXPECTED REDUCTIONS

approximately 62 percent, from 34 µg/l to 13 µg/l. The PARWQCP silver reduction program regulates dentists and x-ray laboratories as well as commercial photofinishers.

Implementation of the above measures would achieve lower percent reductions, primarily due to the silver waste control practices that are already in place. The average SEWPCP influent silver concentrations have decreased from 25 µg/l to 15 µg/l from 1990 to 1991. The results indicate that the current program (regulating the largest discharges) is already very successful. Further regulation, as recommended by this BMP, may not result in noticeable reductions. Assuming an additional 5 percent reduction, silver loadings would be reduced by 500 pounds per year. Reductions in other pollutants such as chromium and selenium would be very limited.

ESTIMATED COSTS

The estimated costs of BMP No.5 are summarized in Table 5-5C. A larger number of small businesses would be regulated under the new measures described above. After these businesses are identified, one PES source reduction specialist would be required on a half-time basis to develop specific regulatory steps, educate and assist business operators, and inspected and monitor these facilities.

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TABLE 5-5C

Implementation Measure	Cost
Program Startup Costs:	
Develop Database of Additional Businesses	$30,000
Residential Drop-off	$20,000
Subtotal	$50,000
Annualized Startup Costs(a)	$5,000
Annual Operating Costs:	
Inspection	$62,000
Residential Dropoff Program	$9,000
Subtotal	$71,000
Total Annual Cost	$76,000/yr

(a) Amortization factor = 20 years @ 8% = 0.102

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number of pollutants to sanitary sewers. The term "automotive service facilities" encompasses many types of businesses: general automotive repair shops: brake, radiator, or transmission repair facilities; automotive detailing facilities; car washes; engine steam cleaning facilities; automotive body repair shops; automotive upholsterers; air conditioning servicing shops; and gasoline/service stations. As described in a subsequent subsection, CCSF is currently regulating all radiator repair and car washing facilities. For the purpose of this evaluation for CCSF, "automotive service facilities" is used collectively to designate all of the above facilities, with the exception of radiator repair shops and car washes.

Most of these businesses generate some of the following types of waste: waste oil, used lubricants and transmission fluids, spent solvents, spent caustic parts washing solution, parts cleaning tank sludge, oily waste sump sludge, used antifreeze, and used lead acid batteries. Improved control of waste from automotive service facilities can be achieved by implementing several straightforward management practices and shop operating procedures. Included in this section are a summary of background information on CCSF's current source control efforts in this area including automotive service facilities inventory and education efforts, a description of the sources of pollutant loading from automotive service facilities, an estimate of pollutant loading, guidance for implementing specific procedures to minimize loading, and an estimate of expected pollutant loading reductions.

POLLUTANTS OF CONCERN

A variety of activities are carried out in automotive service facilities. If not managed carefully, these activities provide routes for commonly used products to reach the storm drains or sanitary sewers. For example, if, while performing engine repairs, used motor oil is allowed to drip onto the shop floor, the floor is washed down, and the wash-water flows to the floor drain which discharges to the sewer, a route is established for used motor oil to reach the sewer. Automotive service facilities therefore represent potential sources of heavy metals, oils, grease and other pollutants to San Francisco's sewer collection system. A number of common activities and associated wastes are summarized in Table 5-6A.

Many of the products used in automotive service facilities are petroleum products or distillates distilled from crude oil and chemically treated with additives. Automotive oil is usually refined from base or crude petroleum, often with additives such as heavy metals, mono- and polycyclic aromatic hydrocarbons, halogenated hydrocarbons, phthalates, phosphates, phenols, amines, and amine derivatives, detergents and dyes (Municipality of Metropolitan Seattle, 1982) In addition, waste oil contains heavy metals as contaminants from engine wear and combustion. Gasoline is composed of hydrocarbons derived from distilled crude petroleum. It is chemically modified and blended, and may contain additives such as anti-knock agents, anti-rust agents detergents, and dyes. Transmission fluid also has a hydrocarbon base. In addition, several non-petroleum based products are commonly used, such as antifreeze and brake fluids. Antifreeze is used in radiators to prevent overheating or freezing, and the major ingredient is ethylene glycol. Brake fluids are composed primarily of glycol ethers. (Municipality of Metropolitan Seattle, 1982) Environmental problems associated with antifreeze and brake fluids appear to be with the used product, which can often be contaminated by heavy metals.

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TABLE 5-6A

AUTO SERVICE FACILITY ACTIVITIES AND ASSOCIATED WASTES

Activity	Associated Materials Potentially Discharged
Changing automotive fluids	Motor oil, coolant, antifreeze, brake fluid, transmission fluid, radiator flushing fluid, freon other refrigerant
Fueling vehicles	Fuel
Removing and storing batteries	Acid and lead
Parts cleaning	Solvents, cleansers, degreasers
Metal grinding and finishing	Metal filings
Brake shoe filing	Asbestos filings
Engine cleaning and automotive steam cleaning	Oil and grease, volatile organic compounds
Engine and transmissions work, miscellaneous repairs	Leaking or dripping oil, etc.
Auto body work	Paints, thinners, solvents

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mailed questionnaires. Several follow-up mailings were necessary to obtain responses from all but approximately 200 businesses. These 200 businesses were notified by registered mail that they would be considered as zero-dischargers. The facilities that provided information were classified as one of three groups: non-applicable, zero-dischargers, or permitted. Between 500 and 1000 facilities are regulated as zero-dischargers. Facilities classified as zero-dischargers would be restricted from discharging any process-related wastes to the sewer system. The permitted facilities are issued standard industrial permits, requiring testing and self-monitoring. All radiator shops are permitted.

Santa Rosa permits all facilities related to automotive service. They have issued between 140 and 200 permits. Every permit has discharge limits and a set of special conditions pertaining to the specific type of facility. Santa Rosa has been primarily concerned with the discharge of organic compounds from these facilities. Metals and cyanide discharged from these facilities are not being regulated at this time.

Palo Alto is currently revising their sewer use ordinance to include BMPs for automotive service facilities. The revised ordinance will be finalized in October 1992. Each of the approximately 400 automotive service facilities in Palo Alto Regional Water Quality Control Plant's service area will be visited to provide free consultation and information, and to be evaluated. Those shops in compliance by 1 October 1992 will be recognized as "Clean Bay Shops." All automotive service facilities will be required to either become a zero discharger or to obtain a discharge permit. The permit will require self-monitoring to meet discharge limits. Sampling information is not yet available.

EXISTING CONDITIONS

Currently, CCSF regulates radiator shops and car washes. Radiator shops are permitted for zero discharge and are required to have closed-loop treatment/recycling systems. BERM's Pretreatment Enforcement Section (PES) staff have inspected and sampled all CCSF's radiator shops to confirm that they have achieved zero-discharge. Car washes are also permitted. Discharge from car washes is required to meet local industrial limits, and all car wash discharge permits are currently being updated accordingly. The car washes are inspected and sampled regularly.

The CAO is currently undertaking a program to provide information to automotive repair businesses to help them manage their waste, and to assess how wastes are generated in the automotive service sector. As a part of this program, an inventory of CCSF automotive repair facilities has been developed. Based on the current inventory, there are 149 fuel and/or service stations, and 500 general automotive repair shops, which include automotive body shops, machine shops, and transmission and brake repair facilities.

In addition to developing the inventory, automotive service facilities workshops have been conducted. At these workshops and in newsletters and mailers, the automotive service facilities were offered waste consultations. The consultations are provided at no charge by the CAO staff to those automotive service facilities requesting assistance. The purposes of the consultations are to educate and provide information to automotive repair facility staff, and gather information about the manner in which wastes are generated. A copy of the Waste Consultation Form used for the

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automotive service sector is included in Appendix C-6. The summary of information developed through consultations is not yet available. Approximately 60 facilities have requested the consultation to date.

facilities. Flow data were not available at these sites, and thus no mass loadings were calculated as part of the SQG Report.

Estimated Loadings

There are minimal published information on the waste characteristics and loadings from automotive service facilities. Several Bay area POTWs (East Bay Municipal Water District, San Jose/Santa Clara, Palo Alto, Central Contra Costa Sanitary District, and Santa Rosa) currently regulating automotive service facilities were contacted. However, as many of these programs have only been recently implemented; information on waste characteristics, flow rates, and reduction potential was generally not yet available.

As mentioned previously, mass loading data from automotive service facilities were not available from the sampling efforts conducted to date in CCSF. The San Jose/Santa Clara Water Pollution Control Plant (CH_2MHill, 1989) reported sampling results from an automotive repair facility. Table 5-6B represents a compilation of the concentration data from the CCSF and San Jose/Santa Clara sampling efforts. Concentrations of copper, lead, nickel, and zinc for this table were taken from CCSF SQD Report data (CCSF, 1991C). The remaining concentrations are based on data from San Jose/Santa Clara.

The facility sampled in San Jose was a large automobile dealership that sells and services automobiles. There were two automobile washing stations that discharge wash water through a four-stage grease trap and then to the sanitary sewer. Samples were collected from the bottom of the fourth stage just before the water enters the sewer. Waste water flow was estimated to be approximately 4,000 gallons per day (gpd), which is much higher than that of a typical automotive repair shop. As the majority of the discharge water is from the car washing activities, these concentrations should not be totally representative of all automotive service facilities. However, in the absence of extensive sampling data, the concentrations listed in Table 5-6B were used to develop a preliminary estimate of the loadings. As site-specific sampling information becomes available, this loading estimate should be refined and reevaluated.

Flow data for specific automotive facilities were not available from the CAO inventory. The San Jose/Santa Clara study reported a flow rate of 450 gpd for a radiator repair shop. This flow rate is more likely to represent the average flow from automotive repair facilities. The loading calculation was based on 649 automotive service facilities identified in the CAO inventory. The preliminary loading estimates for CCSF automotive service facilities are presented in Table 5-6C.

IMPLEMENTATION MEASURES

Under this BMP, CCSF would regulate the remaining automotive service facilities in its service area. The mechanism for regulations would be the existing local limits. The specific implementation measures are discussed below.

- **Update Existing List.** Utilizing CAO inventory as a starting point, BERM would utilize the current PacBell Yellow Pages to update the list of automotive service facilities.

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TABLE 5-6B

AUTOMOTIVE REPAIR FACILITY WASTE CHARACTERISTICS

Concentration (µg/L)

As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn
10	38	89	1,455	3,254	1	256	12	12	1,955

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TABLE 5-6C

ESTIMATED LOADINGS

Pollutant	Loading (lbs/yr)
Copper	1,300
Lead	2,900
Mercury	1
Nickel	200
Zinc	1,700
Cyanide	10

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- **Survey Identified Businesses.** A mail survey would be developed and mailed out to

  - Types and amounts of chemicals used.
  - Types and amounts of wastes generated.
  - Current waste disposal practices.
  - Water usage.

- **Develop Regulatory Strategy.** A regulatory strategy will be developed. It is expected that many facilities may qualified as zero-dischargers. These may include gas stations that do no perform any repair services and service facilities that dispose of their waste by hauling offsite. For these zero-dischargers, a set of BMPs would be required. These BMPs will focus on the following:

  - Clean up leaks, drips and other spills without water.
  - Seal off floor drains in service areas.
  - Use recyclable or reusable materials whenever possible.
  - Train all employees so that they understand and implement the BMPs.

  Zero-dischargers will also be required to submit hauling records. They will be also inspected periodically to review records and for compliance with the required BMPs. Dischargers would be issued permits for compliance. Permitting, monitoring, and reporting procedures will be established. Dischargers will be required to self-monitor to demonstrate compliance.

- **Prepare Information Packets.** BERM will prepare information packets that contain detailed BMP procedures, disposal services and recyclers, emergency telephone numbers, information on pollution control agencies, and pretreatment information. The packets will be distribute to all automotive service facilities by mail and through the workshops. The packet developed for Santa Clara Valley Nonpoint Source Pollution Control Program has been included in the Appendix C-6 for reference.

- **Conduct Workshops.** BERM staff will conduct workshops to explain regulatory strategy, compliance requirements, and compliance schedules. The other main reason for the workshops is to obtain input, comments, and suggestions from the regulated community.

- **Confirm Status of Automotive Service Facilities.** BERM staff will inspect all facilities to confirm their status. For example, if a facility is to be designated as a zero-discharger, confirm that floor drains in work areas are sealed. During these visit, BERM's PES staff will also serve as the avenue of information exchange. Suggestions on methods to comply (opting for zero-discharge or treatment methods) with the new requirements will be provided to the facility owners at their requests.

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- **Perform Periodic Site Inspections.** BERM staff will inspect all automotive service facilities on a periodic basis. Zero-discharge facilities will be inspected to ensure

facilities, and confirm BMP implementation and zero discharge status. Prepare inspection to provide information and guidance, as requested, to automotive service facilities regarding BMP implementation.

EXPECTED REDUCTIONS

The wastewater characteristics shown in Table 5-6B were compared against the CCSF local limits. The wastewater concentrations reported would comply with the current local limits. Therefore, significant reductions may not be achieved by regulating these additional automotive service facilities. As expected, the categories that are expected to discharged the highest loadings, radiator repair and car washing, are already regulated. A smaller reduction potential of 20 percent was assumed for this analysis. Table 5-6D presents the expected reduction in mass loading from regulating automotive service facilities.

ESTIMATED COSTS

The estimated costs for BMP No. 6 are shown in Table 5-6E. A breakdown of the specific tasks and level of effort associated with this cost are included in Appendix C-6 for reference. Due to the large number of automotive service facilities, an equivalent time of one source reduction specialist working for twelve months would be required to implement the program. After implementation, a source reduction specialist working on a half-time basis would be required.

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TABLE 5-6D

ESTIMATED ANNUAL REDUCTIONS

Pollutant	Reductions (lbs/yr)
Copper	260
Lead	580
Mercury	0.1
Nickel	50
Zinc	350
Cyanide	2

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TABLE 5-6E

ESTIMATED ANNUAL COSTS

Implementation Measure	Cost
Program Startup Costs:	
Survey of Additional Businesses	$30,000
Define Regulatory Procedures	$20,000
Information Packets	$2,000
Workshops	$17,000
Subtotal	$69,000
Annualized Startup Costs(a)	$7,000
Annual Operating Costs:	
Inspections/Sampling	$82,000
Total Annual Cost	**$89,000/yr**

(a) Amortization factor = 20 years @ 8% = 0.102

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throughout CCSF. Laboratory wastewater flows may contain metals and cyanide as a result of routine analyses performed. Certain analyses may require metal or cyanide containing reagents or may involve the testing of samples containing the targeted pollutants. Additionally, spills and equipment breakages in the laboratory may result in the discharge of concentrated stock solutions or rinsewaters.

This BMP would minimize the pollutant loadings from CCSF laboratories through the implementation of "good housekeeping" requirements that would include recommended practices for proper chemical handling, storage, disposal, and waste minimization. Proposed source control measures would include educational workshops to be conducted for medical laboratory personnel, and development of an informational packet to be distributed to each known CCSF laboratory. This packet will be designed to provide education and guidance for implementing the recommended procedures.

POLLUTANTS OF CONCERN

Analytical procedures often require sample standards of a given pollutant in order to test for its presence in a water or wastewater sample. Additionally, some pollutants (e.g., mercury) are commonly used as sample preservatives and/or chemical reagents in the testing for other compounds, and thus would be expected in higher concentration in laboratory wastestreams. All of the targeted metals and cyanide are expected to be present in laboratory discharges.

A review of the water and wastewater analytical test methods that involve the use of mercury, cyanide, or copper indicated that pollutant concentrations used in the preparation of reagent stock solutions often exceed 1 gram per liter (g/L), and the pollutant mass used in some single tests may exceed 500 milligrams. An example of a common test that involves substantial quantities of mercury is the Closed Reflux Colorimetric Method for measuring chemical oxygen demand, as described in *Standard Methods for the Analysis of Water and Wastewater*.(Clesceri, L.S., et. al. 1989) This method utilizes a 33.3 g/L stock solution of mercuric sulfate ($HgSO_4$), with an estimated mass loading of 33.8 mg per analysis. Direct discharge of solutions would violate CCSF's local limits. Table 5-7A lists some standard analytical test methods that use copper, mercury, and cyanide reagents.

In addition to the reagents, other types of laboratories also utilize heavy metals and cyanide in their test procedures. For example, cyanide is used in medical labs for such practices as determining hemoglobin content and identifying iron deficiency anemia. Both of these tests involve the staining and coloring characteristics of ferrocyanide. Medical laboratories also use a mercury-containing Thimerosal solution, which is a preservative used to inhibit the growth of bacteria in protein-based reagents used in most biological testing (e.g., blood bank typing). Thimerosal typically contains approximately 0.01 percent mercury (100 ppm). (B.Brunell, 1992)

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TABLE 5-7A

ANALYTICAL LABORATORY TESTS USING COPPER, MERCURY, OR CYANIDE

TESTING FOR	ANALYTICAL METHOD	NUMBER OF DIFFERENT TESTS	COMPOUND USED	CHEMICAL FORMULA	COMPOUND QUANTITY USED (g)	SOLUTION QUANTITY USED (L)	COMPOUND CONC. (mg/L)	POLLUTANT CONC. (mg/L)	SOLUTION VOLUME USED PER TEST (L)		MASS IN	VOLUME ADDED (mg)
Arsenic	Mercury Bromide Stain Method	3	Mercuric Bromide	$HgBr_2$	4.5	0.1	45000	29250				
Chloride	Mercuric Nitrate Method	3	Mercuric Nitrate	$Hg(NO_3)_2 \cdot H_2O$	3.5	1	3500	1430	0.001	50		130.0
	Automated Ferricyanide Method		Mercuric Thiocyanate	$Hg(SCN)_2$	1.35	1	1350	791	0.001	50		450.0
COD	Open Flux Method	3		$Hg(SCN)_2$	1.35	1	1350	788	0.001	50		791.0
	Closed Reflux Colorimetric Method		Mercuric Sulfate	$HgSO_4$	1		1000	588	0.001	50		350.0
Copper	Atomic Absorption Method	4	Mercuric Sulfate	$HgSO_4$	20.3	1	20300	11900				675.0
	Neocuproine Method		Copper Strips	Cu	0.1	1	100	100	0.0015			2000.0
	Bathocuproine Method		Copper Strips	Cu	0.02	1	20	20	0.02	50		100.0
Cyanide	Colorimetric Method	16	Copper Strips	Cu	0.005	1	5	5	0.075	50		20.0
	Cyanide Selective Electrode Method		Potassium Cyanide	KCN	0.00251	1	2.5	1	0.075	50		5.0
	Cyanide Amenable to Chlorination after Distillation		Potassium Cyanide	KCN	0.0251	1	25	10	0.075	50		1.0
	Cyanide Amenable to Chlorination after Distillation		Potassium Cyanide	KCN	0.00251	1	2.5	1	0.075	50		10.0
	Amenable to Chlorination w/o Distillation		Potassium Cyanide	KCN	0.0251	1	25	10	0.075	50		1.0
	Weak & Dissociable Cyanides		Potassium Cyanide	KCN	0.00251	1	2.5	1	0.075	50		10.0
	Cyanogen Chloride		Potassium Cyanide	KCN	0.0251	1	25	10	0.1	50		1.0
	Spot Test for Sample Screening		Potassium Cyanide	KCN	0.00251	1	2.5	1	0.075	50		10.0
	Thiocyanate		Potassium Cyanide	KCN	0.00251	1	2.5	1	0.075	50		1.0
			Thiocyanate Solution	KSCN	1.69	1	2.51	1.69	0.05			1.0
Manganese	Permidate Method	3	Mercuric Sulfate	$HgSO_4$	70	1	1670	437	0.03	50		117.0
Mercury	Dithizone Method	2	Mercuric Chloride	$HgCl_2$	0.0135	1	72000	31000	0.005			4000.0
Nitrate	Cadmium Reduction Method	7	Copper Sulfate	$CuSO_4 \cdot 5H_2O$	20	1	14	10	0.03	50		10.0
	Automated Cadmium Reduction Method		Copper Sulfate	$CuSO_4 \cdot 5H_2O$	20	1	20000	3000	0.1			100.0
	Automated Hydrazine Reduction Method		Copper Sulfate	$CuSO_4 \cdot 5H_2O$	0.003	1	20000	3000	0.1			100.0
Organic Nitrog.	Macro-Kjeldahl	2	Mercuric Oxide	HgO	2	1	20	6	0.0016			0.3
Oxygen	Copper Sulfate-Sulfamic Acid Flocculation	5	Copper Sulfate	$CuSO_4 \cdot 5H_2O$	20	1	2000	1040	0.02			540.0
Selenium	Determination of non-volatile organic	4	Copper Sulfate	$CuSO_4 \cdot 5H_2O$	20	1	20000	12725	0.01			7725.0
Vanadium	Gallic Acid Method	3	Mercuric Nitrate	$Hg(NO_3)_2 \cdot H_2O$	0.35	1	350000	63000	0.1	65		100.0
Zinc	Dithizone Method II	5	Potassium Cyanide	KCN	3	0.006	30000	31000	0.006			700.0
	Zincon Method		Potassium Cyanide	KCN	1	0.1	10000	4000	0.002			995.0
												400.0

(a) Solution used for soaking paper strips, not dosed directly for sample.
(b) Solution used is diluted to obtain desired color, exact quantity unknown.
(c) Solution used is titrated on subjects. Time consumed is unknown.
(d) Solution used depends on the concentration of standardization to bracket the concentration of sample.
(e) Quantity of solution used is the summation of volumes obtained from the solution to get the various standardization concentrations bracketed in the test.
(f) Solution used is not bracketed, quantity used was the volume of solution prepared.

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have just been adopted for these facilities in December 1991. Discussions with personnel at medical and analytical laboratories, in coordination with a desk-top review of laboratory methods for examining water and wastewater samples, indicate that the potential exists for significant pollutant discharge to the sewer as a result of routine or accidental laboratory disposal practices. Over 70 commercial laboratories operate in the CCSF service area, of which nearly 60 service hospital or other medical facilities.

Some laboratories in CCSF may already be practicing proper chemical handling and disposal procedures. For example, the SEWPCP analytical laboratory provides storage for all standards, spent reagents, and analyzed samples in plastic containers (segregated into COD, heavy metals, and trace organics testing wastes) prior to hauling the liquid wastes to a hazardous waste disposal facility. Little is known as to how many of the CCSF labs are disposing of their liquid wastes in this manner, or whether these wastes are commonly discharged to the sanitary sewer.

Estimated Loadings

Estimated loadings from CCSF laboratories were calculated based on sampling data obtained as part of CCSF's SQD Report (CCSF, 1991C), sampling data obtained from the Palo Alto Regional Water Quality Control Plant (PARWQCP), and water metering data from CCSF laboratories. The SQD Report only contained concentration data for mercury and silver. The remaining concentrations used for the loading estimates were based on PARWQCP data. The water metering data typically represented the total flow from a facility (i.e., including sanitary and process flow), therefore estimates were made as to the portion of total flow that was composed of the (potentially metal-containing) process flow. Some available laboratory process flow data from PARWQCP sampling efforts also helped to define these estimates. (Ghaffari, J., pers. comm. 1992)

In general, higher metals concentrations and higher discharge flow rates were observed at medical laboratories compared to non-medical (e.g., analytical) laboratories. Table 5-7B compares the estimated pollutant loadings from medical versus non-medical laboratories. The substantially greater loadings apparent at medical facilities indicate that more attention should be focused on these sources. It should be noted that these estimates are very preliminary. Many details such as the specific tests being conducted and the extent to which these laboratories utilize similar disposal practices are unknown. No cyanide data were recorded from the PARWQCP laboratory discharge sampling efforts.

The metals loadings observed through the PARWQCB sampling efforts do not, on average, exceed existing CCSF local limits. However, in light of the high potential for spills or routine discharges of concentrated stock solutions, BMP requirements at medical laboratories would likely result in substantial metals loading reductions to the SEWPCP.

Dental Facilities. In a separate effort, CCSF (in association with the Worcester Polytechnical Institute) examined the mass contributions to the SEWPCP from dental facilities within its service area (CCSF, 1992I). CCSF's study determined that dental wastes contribute a significant portion (eight percent) of the SEWPCP influent mercury loadings. Based on these results, dental facilities should be incorporated into the implementation program for the BMPs recommended as part of this study.

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TABLE 5-7B

COMPARISON OF ESTIMATED LOADINGS

	Medical Laboratory Loadings(a) (lb/yr)	Non-Medical Laboratory Loadings(b) (lb/yr)
Copper	353	12
Lead	17	3
Mercury	8	0.1
Nickel	303	2
Silver	29	1
Zinc	256	43
Cyanide	3.5	0.2

(a) Based on an average estimated discharge of 116,000 gpd from 58 laboratories.
(b) Based on an average estimated discharge of 16,500 gpd from 15 laboratories.

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IMPLEMENTATION MEASURES

Given the specialization within laboratory facilities, it would be impractical to restrict the reagent used or alter any specific analytical methods. Such steps would be met with considerable resistance by laboratory personnel (from whom cooperation is fundamental for effective source control) and, more importantly, are not necessary for effective source control at these laboratories.

Metals discharge at laboratories can be effectively controlled by controlling the handling of the chemicals before, during, and after experimentation. This includes proper storage measures to reduce the likelihood of spills and to prevent spills from entering the drain, combined with disposal measures that involve collection of all sample preparations, spent reagents, and unused sample portions for off-site hauling as a hazardous waste. Each of these measures would, in some cases, replace the practice of routine sewer discharge, and thus reduce the overall metals and cyanide loading from these facilities. The implementation measures recommended for this BMP are listed below.

- **Develop Laboratory Database.** The first step in this BMP is to develop a database of of all licensed laboratories operating in CCSF. A preliminary review of laboratories in the PacBell Yellow Pages indicated that there are approximately 80 laboratories operating in CCSF. Special emphasis should be placed on identifying all medical and hospital related laboratories.

- **Develop Regulatory Strategy.** A regulatory strategy for laboratories will be developed. Some laboratories may qualify as zero dischargers, while others will need to be issued permits for compliance with local limits. Permitting, monitoring, and reporting procedures will be established. Dischargers will be required to self-monitor to demonstrate compliance. Preexisting permits for medical laboratories will be modified to include metals and cyanide.

- **Prepare information packets.** BERM will prepare information packets for distribution/review at the educational workshops. These packets will contain information describing the origin and importance of local limits compliance requirements, and BMPs for proper storage and cleanup procedures, available disposal methods, and potential waste haulers to be contacted. These BMPs will focus on the following:

  -- Avoid storage of chemicals above sinks or drains.
  -- Provide secondary containment of chemicals.
  -- Seal off floor drains.
  -- Provide plastic containers for segregated liquid waste disposal.
  -- Practice dry cleanup techniques for chemical spills.
  -- Train all employees to understand and implement the BMPs.

- **Conduct Workshops.** BERM staff will provide two educational workshops with personnel from hospital and other medical laboratories. These workshops will stress the importance of reduced metals and cyanide discharges, and allow discussion of recommended storage and disposal practices at medical and other laboratories. BERM will present the recommended practices, perhaps with the assistance of a laboratory manager that has established, or is in the process of establishing, a "model" laboratory.

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- **Distribute information packets.** The information packets will be revised as necessary following input from the workshops, and distributed to all medical and non-medical facilities on a periodic basis. Zero-discharge facilities will be inspected to ensure compliance with the housekeeping BMPs and to verify hauling records. Dischargers will be inspected for compliance with the general pretreatment program. Prepare a program for regular site inspections of all laboratory facilities to conduct sampling of permitted facilities, and confirm BMP implementation and zero-discharge status. Prepare inspectors to provide information and guidance, as requested, to facilities regarding BMP implementation.

EXPECTED REDUCTIONS

Table 5-7C presents the estimated reductions of BMP No.7. These reductions assume a 50 percent mass reduction from medical and non-medical facilities for each targeted pollutant. This estimate assumes that many labs would elect to be zero dischargers to avoid self-monitoring and reporting requirements. As seen from this table, over 150 pounds per year of each copper, nickel, and zinc loadings are expected to be removed through the implementation of this BMP. Such high reductions appear feasible due to the simplicity, low capital cost requirements, and potential for near-zero discharge available with proper storage and disposal practices.

ESTIMATED COSTS

The implementation costs for this BMP are estimated to be roughly $81,000 annually. These costs assume one-time expenditures for workshop presentations and informational packet distributions, and regular semi-annual inspections of medical laboratories. The itemized costs for the proposed measures listed above are shown in Table 5-7D.

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TABLE 5-7C

ESTIMATED REDUCTIONS FROM BMP NO. 7

Pollutant	Estimated Mass Loadings(a) (lbs/yr)	Expected Mass Reductions(b) (lbs/yr)
Copper	370	190
Lead	20	10
Mercury	28(c)	14(c)
Nickel	310	160
Silver	30	15
Zinc	300	150
Cyanide	4	2

(a) Represents total of Medical and Non-medical facility mass loadings.
(b) Assumes a 50 percent reduction in loadings from medical and non-medical laboratories.
(c) Mercury values include estimated dental facility mass loadings of 20 pounds per year and reductions of nearly 10 pounds per year.

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TABLE 5-7D

ESTIMATED ANNUAL COSTS

Implementation Measure	Cost
Program Startup Costs:	
Develop Database	$20,000
Regulatory Strategy	$13,000
Information Packets	$3,000
Workshops	$12,000
Subtotal	$48,000
Annualized Startup Costs(a)	$5,000
Annual Operating Costs:	$76,000
Total Annual Cost	**$81,000/yr**

(a) Amortization factor = 20 years @ 8% = 0.102

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BMP NO.8

REVIEW METHODS OF CORROSION CONTROL

Metals in the water supply distribution system stem from three potential sources: 1) background concentrations present in the raw water supply; 2) chemicals added for water treatment or for corrosion protection; and 3) corrosion in the distribution system piping, service connections, and customer plumbing systems. As discussed in Section 4, the water supply could be a significant contributor of the copper loadings to the SEWPCP. Of the three potential sources listed above, metals in the raw water are generally considered as uncontrollable. However, metals added as part of treatment or corrosion control and metals resulting from pipeline/plumbing corrosion may be controllable, and should be evaluated.

POLLUTANTS OF CONCERN

Copper, lead, nickel, and zinc are CCSF's primary pollutants of concern in the water supply (from a wastewater treatment perspective). In addition to being naturally present in the raw water supply, these chemicals can also be added as part of treatment chemicals. Copper sulfate is commonly used as an algicide in water storage reservoirs. Zinc orthophosphate is used by many purveyors as a corrosion protection agent. All four pollutants may be present in tap water from pipeline/plumbing corrosion.

Algae Control

Although a number of other compounds can be used as algicides, copper sulfate almost exclusively dominates the field of potable water treatment. Presently, copper sulfate and chlorine are the only effective algicides that satisfy all necessary legal requirements. Other synthetic algicides involve the use of mercury or tertiary and quaternary amines. Algicides are added on an as-needed basis, during periods of algal bloom.

Based on field experience, a copper residual between 0.1 mg/l and 0.2 mg/l for several hours is necessary for algae control. In order to maintain this residual, ordinarily a copper dose of 0.5 mg/l is required. One of the principal problems in copper sulfate treatment is very little of the copper added is present as free copper ion; the majority settles to the bottom as a precipitate.

Copper and other heavy metals kill algae by combining with the sulhydryl (SH) groups of many enzymes that play an important role in cell catalysis and energy-yielding metabolism. In order to accomplish this, copper must diffuse through the cell wall. It is most likely that only the soluble copper species directly participate in this activity. Thus, the efficiency of algal control with copper sulfate addition is limited since most of the copper added is lost through precipitation and sedimentation.

Chlorine may also be used for the control of algal growth in water storage reservoirs. Its usefulness, however, is impaired by difficulty in maintaining adequate residuals and the potential for forming chlorinated organic compounds (e.g., trihalomethanes) in the treated water. Residuals are difficult to maintain because the chlorine reacts rapidly with naturally occurring aquatic humus and spontaneously decomposes in the presence of light. Artificial mixing of storage reservoirs (e.g., with compressed air) is another potential means of preventing algal blooms, and thus minimizing the need for copper sulfate use.

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Corrosion Control

Corrosion occurs when corrosive anions (such as dissolved oxygen and chloride ion) in a water supply attack and oxidize the metallic cations at the surface of water pipes and other fixtures. Most metals are not stable when exposed to water and are subject to corrosion. Oxidation-reduction (electrochemical) reactions are the primary reactions involved in corrosion. Once these reactions have begun, metal ions enter the water and attempt to reach chemical equilibrium with the other ions in solution. Chemical equilibrium reactions determine whether the soluble or insoluble forms of a metal are the most stable form under a given set of chemical conditions. If a soluble species is stable, metals may corrode rapidly into an aqueous form. If an insoluble species is stable, a natural scale may form inhibiting corrosion.

Corrosion leads to the dissolution of metals into the drinking water and reduces drinking water quality. Four commonly used corrosion control measures are listed and briefly described below.

- pH adjustment and carbonate addition
- Zinc orthophosphates addition
- Polyphosphates addition
- Silicate addition

pH Adjustment and Carbonate Addition. Adjustment of pH is effective for corrosion control in some waters because the electrochemical potential between the metal surface and the surrounding solution (the driving force behind the corrosion reaction) is a function of pH. SFWD practices pH adjustment. Hydrated or slaked lime ($Ca(OH)_2$) or caustic soda (NaOH) are used to raise the pH of water for corrosion control. A small amount of protective calcium carbonate scale can thus form inside of water pipes, which prevents contact between the pipe and the anions in the water. Equilibrium between calcium and carbonate ions also helps prevent dissolution of materials from reinforced concrete pipes.

The pH range of lowest solubility for most metal species is pH 8 to 10. If pH slightly above 7.0 (neutral) can be maintained, the ability of water to dissolve metals in piping is diminished. Copper corrosion is particularly pH dependent in soft, low mineralized water, and corrosion decreases substantially at pH levels above 7.0. However, for utilities using chlorine for disinfection, elevated pH levels can encourage the formation of trihalomethanes.

Zinc Orthophosphates Addition. Zinc orthophosphates form a thin film on the inside of water pipes to prevent corrosion by the oxygen and hydroxide ions. This type of inhibitor has been used in industrial systems since the 1930's and has been used in drinking water systems since 1970. A number of zinc orthophosphates blends are available on the market, varying in their zinc:orthophosphate ratio. Typical dose rates are 0.3 to 0.6 mg/L as zinc. These compounds are considered by AWWA to be the most effective corrosion inhibitor. Zinc and orthophosphates can be used separately for corrosion control in certain water supplies.

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Polyphosphates Addition. Polyphosphates are a third type of corrosion inhibitor. This class of compounds sequesters, or ties up, ferric ions in drinking water and forms a protective coating

One main application of this corrosion inhibiting chemical is recirculating industrial water systems. Manufacturers of corrosion inhibitors are beginning to promote the use of polyphosphates for municipal water supplies. Polyphosphates are not an effective corrosion inhibitor in still waters, however; its corrosion protection properties increase with water velocity. Polyphosphates may not be effective in dead ends of water distribution systems. In some waters, the compound may increase corrosion rates. Another concern with polyphosphates is that they have not yet been proven useful for reducing the solubility of lead. Reducing lead corrosion must be one of the goals of any effective corrosion control strategy.

Silicate Addition. Sodium silicate addition, like other corrosion inhibitors, prevents corrosion by forming a thin protective colloidal film inside of pipes. Metal ions from the water supply can be incorporated in this film. Diffusion of oxygen to the surface of metal pipes and corrosion is inhibited once the film forms. This compound was first used in the 1920's to reduce the corrosion of lead piping. Typical dose rates are 8 to 12 mg/L as SiO_2. The effectiveness of silicate as a corrosion inhibitor is enhanced by calcium ions in the water supply, but its effectiveness is decreased by magnesium ions. For silicates to be effective, a pH near 8.5 is the most appropriate. The evidence for the effectiveness of silicate inhibitors is mixed, but recent investigations indicate that silicates provide little or no benefits in reducing corrosion of copper, zinc, iron, or lead piping materials. However, silicate inhibition is well documented in protecting asbestos/cement (A/C) pipes. Dosage rates are very important for silicates; underdosing with silicates can increase corrosion while overdosing can produce taste and color problems.

EXISTING CONDITIONS

Water supply data were analyzed to estimate the uncontrollable (raw water) and the controllable (algicide and corrosion) portions of the pollutants. As discussed in Section 4, water in CCSF is provided by the Hetch-Hetchy aqueduct, the Sunol Water Filtration Plant, and the San Andreas Water Filtration Plant. Unfortunately, the database for metals in the raw water supply is not very extensive. SFWD is only required to sample Hetch-Hetchy supply and its local reservoirs once annually. Several local reservoirs were sampled as part of this study to determine metals concentrations in the raw water supply. Utilizing these data, weighted average concentrations of metals from the three sources are calculated and shown in Table 5-8A. Actual raw water data are included in Appendix C-8 for reference.

Based on discussions with SFWD staff, approximately 62,000 pounds of copper sulfate were added to local reservoirs for algae control in 1991. Assuming that five percent of the copper added remains in the soluble form, approximately 1,200 pounds of elemental copper were added to the water used within CCSF. Copper contributed by algicide would be approximately 3 pounds per day.

Metal loadings in the raw water supply and algicides were subtracted from the point-of-use water supply data. The point-of-use concentrations are a composite of hot/cold water and standing/running water data. The composite method was previously discussed in Section 4. Table 5-8B summarizes the various contributions. As shown in the table, approximately 85 percent of the copper in the tap water may be controllable, either by substitution of alternative algicides or by

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TABLE 5-8A

RAW WATER SUPPLY CONCENTRATIONS
(µg/L)

Parameters	Hetch-Hetchy Reservoir	Sunol Valley WFP	San Andreas WFP	Composite Concentration
Copper	0.3 (a)	10	4	1.9
Lead	2	0.5 (a)	0.5 (a)	1.6
Mercury	0.3	0.5 (a)	0.5 (a)	0.4
Nickel	0.3 (a)	NA	NA	0.3
Silver	0.3 (a)	0.5 (a)	0.5 (a)	0.4
Zinc	0.2	65	4	6.2

(a) Parameter was not detected. Value is asumed to equal one-half of detection limit.
(b) Composite concentration is calculated based on 71% from Hetch-Hetchy, 8% from Sunol WFP, and 21% from San Andreas WFP.
NA - Not nnalyzed

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TABLE 5-8B

METAL CONTRIBUTIONS IN WATER SUPPLY

SF WEIGHT Parameters	Point of Use		Raw Water		Algicide Loadings (ppd)	C Con
	Concentration (ug/l)	Loadings (ppd)	Concentration (ug/l)	Loadings (ppd)		
Copper	40.6	28.8	1.9	1.3	3.0	
Lead	4.7	3.3	1.6	1.1		
Mercury	0.0	0.0	0.4	0.3		
Nickel	1.9	1.3	0.3	0.2		
Silver	0.0	0.0	0.4	0.3		
Zinc	28.0	19.8	6.2	4.4		

Loadings calculated based on 85 mgd design flow at SEWPCP
NA - not analyzed in the raw water supply.

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improved corrosion control. Approximately 75 percent of the zinc may be contributed by corrosion of galvanized piping. Household plumbing is likely the major source of lead and copper

On May 6, 1991 EPA finalized drinking water regulations for lead and copper as mandated by the Safe Drinking Water Act of 1986.(56 FR 26460) According to these regulations, all large systems (serving greater than 50,000 people) will be required to perform corrosion control studies and installation of optimized control system, unless either of the following conditions, which demonstrate that corrosion control has already been optimized, are met:

- Demonstrates that the difference between the highest level of lead measured in source water and the 90th percentile level measured at taps in homes is less than the practical quantitation level (5 ug/L) during two consecutive six-month monitoring periods. This system would be considered to have optimized corrosion control.

- Demonstrate that it has already conducted steps equivalent to the corrosion control steps outlined in the regulation, thus demonstrating it has optimized corrosion control.

According to the compliance schedule set by EPA, if a large system must perform the corrosion control treatment steps, then the following dates would apply:

- By January 1, 1993 the system must have completed two monitoring periods of tap sampling (lead and copper) and two six-month monitoring periods for water quality parameters (pH, alkalinity, calcium, conductivity, water temperature, orthophosphate, when an inhibitor containing phosphate compound is being used, and silica, when an inhibitor containing silicate is being used). Samples for analyzing water quality parameters are to be collected from entry points to distribution system and from within the distribution system (EPA suggests using same sites where coliform samples are collected).

- System must complete corrosion control studies and recommend to the State (or primary agency) what constitutes optimal corrosion control for that system by July 1, 1994.

- Based on results of system's monitoring and system's recommendation, the State must designate optimal corrosion control treatment by January 1, 1995.

- System must install optimal corrosion control treatment by January 1, 1997.

- After installation, the system must complete follow-up sampling by January 1, 1998 (two consecutive six-month monitoring periods for lead and copper at taps and water quality parameters in distribution system).

- By July 1, 1998 the State must designate optimal water quality control parameters. These optimal water quality control parameter may include: 1) minimum or range of values for pH, 2) a minimum or range of values for corrosion inhibitor, 3) a minimum or range of values for alkalinity, 4) minimum or range of values for calcium, and 5) state may designate other parameters for monitoring.

- The system must operate in compliance with the State-specified optimal water quality control parameters.

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BERM and SFWD recently completed separate testing programs for lead and copper in tap water at residences throughout CCSF. The average and 90th percentile concentrations detected from these

negotiating potential variances from EPA's requirements. If implementation of these regulations is delayed due to these negotiations, the schedule listed above may be altered. Nevertheless, it appears that performance of corrosion control studies ultimately will be required by SFWD.

It is also noteworthy that with optimized corrosion protection (e.g., with zinc orthophosphate), there may be a trade-off between elevated zinc loadings and elevated loadings of lead and copper. However, it is possible that corrosion reductions could be achieved through the application of the non-metallic corrosion inhibitors (carbonates, silicates, polyphosphates) discussed above. Cooperation between BERM and SFWD will be necessary in this regard.

IMPLEMENTATION MEASURES

The SFWD must assume the lead role in the implementation of this BMP. SFWD will likely be proceeding with an evaluation of lead control measures. In order to promote and demonstrate an overall commitment to environmental health, it will have to also evaluate methods for maximum reduction of copper at the same time. Implementation measures for this BMP are described below.

- **Sample Raw Water Supplies.** The raw water supply concentrations estimated in the analysis were based on only a few data points. To better define the raw water characteristics, additional samples should be taken and analyzed. BERM should assume the sample collection and analysis. The raw water data would be analyzed with the same test methods and analytical detection limits as the point-of-use data, and would allow a direct comparison.

- **Review Results With SFWD.** Using the new raw water data, the contributions of controllable and uncontrollable portions of the metals should be re-analyzed. BERM should then meet with the SFWD to discuss areas of cooperation and coordination.

- **Perform Corrosion Control Study.** This implementation task must be performed by the SFWD. BERM may assist in the study, where appropriate and at the request of the water department. SFWD must balance the reduction of copper and lead against increases in other pollutants.

- **Evaluate Alternative Algicides and Algae Prevention Techniques.** This implementation task must also be performed by the SFWD. Practical effects of other algicides (e.g., chlorine) or artificial mixing methods should be investigated.

- **Implement Recommended Measures.** SFWD should implement the recommended measures to comply with the SDWA and to assist in compliance with the Basin Plan limits.

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TABLE 5-8C

TAP WATER DATA (a)

	Safe Drinking Water Act Limits(μg/L)	BERM Sampling (μg/L)	SFWD Sampling (μg/L)
Lead			
Average	--	8	8
90th percentile	15	17	16
Copper			
Average	--	56	105
90th percentile	1300	206	177

(a) Both BERM and SRWD samples were cold, first draw samples taken from consumer taps. Non-detects were interpreted as equal to the detection limit.

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ESTIMATED REDUCTIONS

of the algae control and corrosion practices. For the purpose of this evaluation, it is assumed that copper input from algicides can be reduced by one-half, assuming that some degree of substitute algicides or algae-prevention techniques could be used. Metals loadings from corrosion are assumed to be reduced by one-quarter. The estimated reductions are summarized on Table 5-8D.

ESTIMATED COSTS

Costs of this BMP will include the expenditures for evaluation and implementation of corrosion control measures and alternative algicides. Implementation costs cannot be determined until the evaluation has been completed. Costs for a comprehensive evaluation study will be in the range of $500,000. Since SFWD will likely have to perform the corrosion study to comply with the lead limit in the SDWA, the full cost should not be assigned to this BMP. For this evaluation, it is assumed that half of the cost, $250,000, will be assigned to this BMP. The amortized cost is about $25,000 per year. This cost will increase substantially if new corrosion control systems are required. The actual corrosion control system required will depend on the results of the corrosion studies. The potential costs of a new chemical addition system is shown in Table 5-8E.

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TABLE 5-8D

ESTIMATED REDUCTIONS FROM CORROSION

	Reductions (lb/yr)
Copper	2,800
Lead	200

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TABLE 5-8E

ESTIMATED ANNUAL COSTS

Implementation Measure	Cost
Program Startup Costs:	
Corrosion Control Study	$500,000
Chemical Addition System	$5,000,000
Subtotal	$5,500,000
Annualized Startup Costs(a)	$560,000
Annual Operating Costs:	
Chemicals	$40,000
Subtotal Annual Cost	$600,000/yr
BERM's Share	$300,000/yr
BERM Staff Coordination	$20,000/yr
Total Annual Cost	$320,000/yr

(a) Amortization factor = 20 years @ 8% = 0.102

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buildings and hotels that have a significant air conditioning or refrigeration demand. They are also a standard component of industrial processes that require the cooling of air or process waters. The primary metals of concern in cooling tower discharges are copper and zinc, though low concentrations of other metals have also been detected. Cooling tower blowdown may contain copper and zinc corrosion by-products as well as ions derived from metal-based chemicals added for water treatment purposes. Scrubber processes use recirculated water or a caustic solution to remove airborne particulates from incineration emissions. Metals, cyanides, and PAHs are removed from the air by the scrubber waters and discharged as part the scrubber water blowdown.

This BMP would minimize the pollutant loadings from scrubbers and cooling towers. Discharge limits from these sources would be included in sewer use permits, and specific testing, operating, and corrosion-prevention procedures would be required under the permit. Educational workshops would be conducted for cooling tower and scrubber operators, and service personnel. Prior to implementation of these measures, CCSF would need to sample a series of cooling towers and scrubbers to verify the loading assumptions used for this analysis.

POLLUTANTS OF CONCERN

Pollutants of concern from cooling tower and scrubber discharges are described below.

Cooling Towers

Cooling towers may increase the pollutant loadings discharged to the sewer system in three ways:

- Corrosion of zinc-galvanized piping and/or the copper piping in the heat exchange units of cooling tower systems.
- Concentration of the cooling tower source water (which contains trace levels of pollutants) through evaporation and recirculation of the process waters through numerous cycles of concentration.
- Addition of water treatment chemicals for biocidal, corrosion-prevention, and/or scale-prevention purposes.

The operations of a typical cooling tower system are described below.

Operations. Cooling towers operate by running water counter-current with air in a packed column containing assorted media that provide high surface area to enhance water evaporation. As water passes down through the tower, heat is transferred to the air (flowing upward). Cooled water exits the bottom of the cooling tower, from which it is recirculated through the industrial process, and warm, moist air exits the top of the cooling tower. Heat is transferred from the water to warm the air and, mainly, as a result of water evaporation. Due to the high heat of evaporation of water, the evaporation of one gallon of water will lower the temperature of 100 gallons by approximately 10 °F. Figure 5-9A presents a schematic illustration of a typical cooling tower system.

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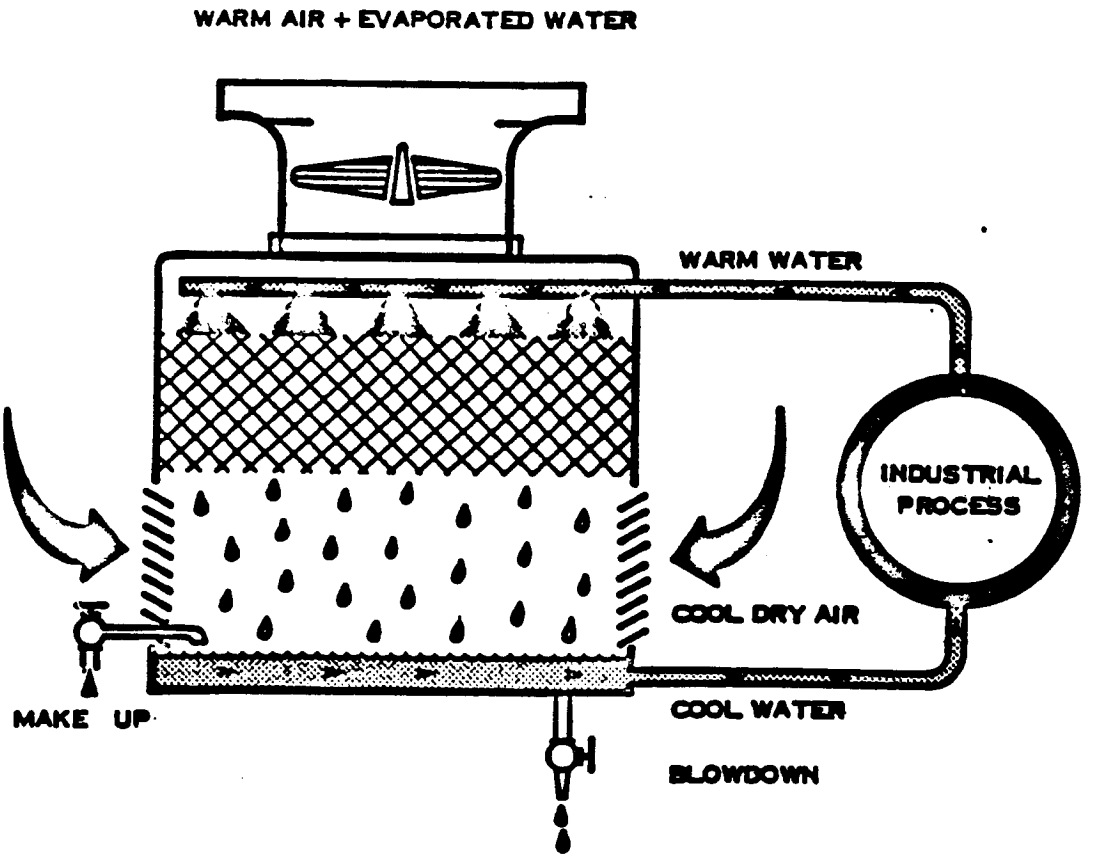

SCHEMATIC DIAGRAM OF COOLING TOWER SYSTEM

FIGURE 5-9A

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The loss of relatively pure water through evaporation reduces the cooling water volume, causing a buildup of the total dissolved solids (TDS) concentration, including metals, in the remaining water. To prevent overly high concentrations of dissolved solids (leading to potential precipitation/scaling

typically run 4 to 6 cycles of concentration, while commercial air conditioning systems often run 8 to 10 cycles.

Three types of chemicals are typically added to the cooling tower makeup water:

- Dispersants, which prevent the precipitation of minerals in the system piping.
- Biocides, to prevent microbiological growth.
- Corrosion control chemicals.

Of primary significance to this study are the biocides, which may be copper-based products, and the corrosion control agents, which may contain zinc. Additionally, the typically organic dispersant additives could contain trace levels of pollutants such as organically-bound cyanides (e.g., nitriles). However the presence of cyanide in these organic chemicals has not been verified at this time.

EXISTING CONDITIONS

Cooling tower discharges are not currently regulated by CCSF and minimal data on flows and pollutant characteristics are available. The population of cooling towers in CCSF is largely unknown. Based on conversations with cooling tower service vendors, cooling towers are present in nearly every large office building, hotel, and supermarket in the City to handle office air conditioning and/or refrigeration demands, which can vary according to the number of persons or machines (e.g., computers) served. Hotels may have significant cooling demands; the largest hotel in the City, the San Francisco Hilton, has four cooling towers.

Flow estimates from commercial and industrial cooling towers were based on estimates of the number of facilities in the City likely to have high cooling demands. Discussions with the San Francisco Hotel Council, the Building Owners and Management Association, and a review of the PacBell yellow pages formed the basis for an estimated 610 office buildings, hotels, and supermarkets that had cooling towers discharging to the SEWPCP. For industrial cooling tower flow estimates, it was assumed that 60 cooling towers existed at 50 SIUs monitored under the Industrial Pretreatment Program. Flow estimates supplied by service vendors dictated that the estimated 670 cooling towers in CCSF discharge a total of approximately 2.5 mgd of blowdown water to the SEWPCP.

Sampling data from industrial cooling tower facilities in Palo Alto was used to estimate the pollutant loadings at CCSF. Using these data to estimate CCSF loadings is considered reasonable as the source waters for both Palo Alto and CCSF are very similar (Palo Alto is almost entirely supplied by SFWD) and industrial cooling tower operations are expected to be similar. CCSF has recently sampled the blowdown from five cooling towers in the SEWPCP service area; when made available, data from these samples will be used to confirm the loading estimates applied in this analysis. Blowdown concentrations may vary significantly among cooling towers, depending on the level of service and appropriateness of design for each system. For example, many of the

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smaller cooling systems (e.g., supermarkets) reportedly spend little effort in maintaining efficient, corrosion-free systems.

pounds per year of total copper loading estimated, the net copper loadings comprise approximately 55 percent (1,600 lbs/year). The remainder is inherent in the raw water supply. In contrast, the net zinc loadings constitute nearly 80 percent of the roughly 6,000 lbs/year of zinc estimated. The primary source of zinc in these discharges is likely the use of zinc-containing corrosion inhibitors. If non-zinc inhibitors (sodium orthophosphates) or pH adjustment chemicals were used, corrosion may still be controlled without increasing zinc loadings. Cyanide data were not available for consideration in this analysis. The estimated net loadings of zinc and copper from cooling tower blowdown water are presented in Table 5-9A.

An examination of the net loadings provides an indication of the portion of the total metals loadings that can be controlled through improved cooling tower operations. Efforts to reduce the levels of metals in the water supply are addressed under BMP No.8. Boilers located at industrial and commercial facilities may contribute to the metals loadings in a similar fashion to that observed with cooling tower blowdown. Although these facilities were not investigated in detail as part of this BMP, consideration of these facilities during cooling tower inspection and monitoring efforts may be worthwhile.

Scrubbers

There appears to be less than five scrubber facilities in the CCSF service area. While the number of these facilities is minimal, they may be one of the few potential dry weather sources of combustion products such as cyanides and PAHs to the sewer. Data from scrubber water blowdown at the PARWQCP sludge incineration facility indicate that cyanides and heavy metals are present in scrubber water blowdown. No PAH data were available from Palo Alto, but as a combustion product, its presence in these discharges is considered likely.

Similar to cooling tower operations, periodic blowdowns from incinerator scubbers are the origin of contaminants from these sources. Unlike cooling towers, where the air running countercurrent to the water is relatively clean and is intended to expedite evaporation, scrubber facilities are designed to transfer particulates, heavy metals and other pollutants into the liquid stream.

Little data are available from scrubber facilities in CCSF. Given the small number of scrubbers expected, these facilities are not considered a major source of the pollutants of concern and have not been included in this analysis. However, they should be identified during the implementation phase of this BMP.

IMPLEMENTATION MEASURES

The implementation of this BMP will focus on regulating the operation and maintenance of CCSF cooling tower and scrubber systems to reduce targeted pollutant loadings. The implementation of educational and operational BMPs with regard to diagnostic indicators of excessive corrosion, proper chemical treatment additives, and appropriate operating strategies will minimize the metals loadings from these sources.

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TABLE 5-9A

Pollutant	Estimated Mass Loadings(a) (lbs/yr)
Copper	1,600
Zinc	4,600

(a) Based on an estimated 670 cooling towers discharging 2.5 mgd to the SEWPCP.

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The implementation measures recommended for this BMP are listed below.

group.

- **Develop Database.** Develop a database of facilities with cooling towers and scrubbers based on the survey results, a search of the Bay Area Air Quality Management District databases, a review of the PacBell yellow pages and business licensing boards, and discussions with labor organizations and service vendors.

- **Compile Technical Information.** Compile information in preparation for workshops on the causes and extent of cooling tower metals loadings, and educational information describing proper system diagnostic measures, water treatment methods, safe chemical usage, and water sampling and analytical methods.

- **Develop Regulatory Strategy.** A regulatory strategy will need to be developed to determine the population of facilities to be regulated, as well as the optimum sampling, reporting, and monitoring requirements. Since cooling tower discharges are likely to be well within local limits, permit requirements may require that certain diagnostic measures are performed regularly, copper-based biocides are not used, and that corrosion prevention steps are taken as necessary.

- **Prepare Guidance Packets.** Easy-to-use guidance packets will be prepared to instruct operators on how to evaluate their systems for excessive corrosion or improper chemical usage. Drafts of these items will be available for review at the workshops.

- **Conduct Workshops.** BERM will provide two educational workshops to stress the importance of reduced metals and cyanide discharges from cooling towers and scrubbers, and to discuss recommended operational practices. Invitees will include service vendors, industrial cooling tower and scrubber operators, and large hotel and commercial building engineers. These personnel will represent the managers of larger cooling systems in CCSF. Two alternative dates for attendance will be provided. Additional information from each facility will be requested at the workshops (e.g., flows, chemicals added, etc.). Each of these large system operators will be requested to review their system for diagnostic indicators of a poorly running system (e.g., high blowdown metals concentrations, high pH, high water velocities). Assistance from a service vendor may be useful in developing and presenting these workshops. Feedback on the guidance materials will be obtained during the workshop.

- **Distribute Guidance Packets.** Guidance packets (modified based on feedback obtained at the workshops) will be mailed to all cooling tower and scrubber system operators identified by CCSF/BERM. These operators will be informed of local limits compliance requirements, diagnostic indicators, proper operational procedures, and available information resources.

- **Additional Scrubber System Monitoring.** Monitoring of scrubber systems should occur through an expansion of the routine inspections carried out as part of the industrial pretreatment program. Permitted facilities with scrubber systems will be asked to periodically sample their blowdown water and report the results as part of their self-monitoring reporting effort. This should involve little additional effort on the part of CCSF/BERM.

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- **Perform Periodic Site Inspections.** Periodic inspections of cooling tower and scrubber facilities identified by CCSE should be conducted to verify that the recommended

EXPECTED REDUCTIONS

Table 5-9B presents the expected mass loading reductions to be obtained at cooling towers through the implementation of BMP No.9. Improved corrosion reduction measures and reduced usage of copper-based biocides are estimated to result in a 50 percent reduction in the copper net loadings and a 50 percent reduction in the zinc net loadings. These high reductions may be possible given that no attention has previously been paid to discharges from these facilities. Total estimated copper and zinc mass reductions from cooling tower implementation measures are expected to be approximately 800 and 2,300 pounds per year, respectively.

ESTIMATED COSTS

The implementation costs for this BMP are shown in Table 5-9C. The annual cost of $101,000 for the BMP No.9 implementation measures assume one-time expenditures for workshop presentations and informational packet distributions, and additional inspections and sampling of 100 cooling towers annually. The itemized costs for the proposed measures listed above are contained in Appendix C-9.

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TABLE 5-9B

Pollutant	Reductions(a) (lbs/yr)
Copper	800
Zinc	2,300

(a) Reductions assume a 50 percent reduction in net cooling tower loadings for each pollutant.

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TABLE 5-9C

Implementation Measure	Cost
Program Startup Costs:	
Develop Database of Cooling Facilities	$30,000
Regulatory Strategy	$20,000
Information Packets	$4,000
Workshops	$12,000
Subtotal	$66,000
Annualized Startup Costs(a)	$7,000
Annual Operating Costs:	$94,000
Total Annual Cost	$101,000/yr

(a) Amortization factor = 20 years @ 8% = 0.102

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BMP NO.10

PROVIDE TEMPORARY STORAGE OF RECYCLE FLOWS DURING WET

Although a conventional wastewater treatment plant like SEWPCP is not designed for removal of metals and other toxic pollutants, a significant portions of these pollutants in the influent wastewater is removed through the treatment units. The basic mechanisms for removal are sedimentation of insoluble metals in the primary clarifiers; biological uptake, degradation, and adsorption in the aeration basins; and subsequent sedimentation of the biological flocs in the secondary clarifiers. However, since pollutants removal are incidental to the treatment processes, there are no direct operating strategies to control their removal efficiencies.

This BMP would maximize the pollutant removal efficiency at the SEWPCP. Metals and other pollutants are typically found in the recycle flows at SEWPCP. During periods of high wet weather flows into the plant, these recycle flows would be routed to temporary storage tanks. After the higher flow rates have passed, the stored recycle flow would be returned to the plant to take advantage of presumably higher removal efficiencies that are expected to occur during periods of lower flow. This BMP assumes that metals removal efficiency is a function of hydraulic flow rate, with longer hydraulic detention time in the treatment processes translating to greater metals removal across the SEWPCP. Although hydraulic detention time is likely to be one of the factors, multiple inter-related factors are expected to ultimately affect the removal efficiency.

EXISTING CONDITIONS

Figure 5-10A is a flow schematic of the existing recycle flow system at SEWPCP. Overflow from the anaerobic digesters is routed to the old pumped plant recycle (PPR) sump and is then piped by gravity to the Quint Street sewer at the influent to the plant. Centrate, building washdown, and drainage flows are routed to the new PPR sump and are then pumped to the primary sedimentation tanks. Total recycle flows at SEWPCP are approximately 0.6 mgd.

The recycle flows were sampled periodically between 1985 and 1988. Table 5-10A summarizes the average concentrations and loadings of metals in the recycle flows. The entire recycle flow data is included in Appendix C-10 for reference. The available sampling data were collected prior to the construction of the new PPR sump. However, there has been no major process change at SEWPCP and the characteristics of the recycle flows should be similar.

Evaluation of Wet Weather Removal Rates

The removal rates of six metals (copper, lead, mercury, nickel, silver, and zinc) were plotted against their respective effluent flow rates in Figures 5-10B to 5-10G. 1991 data are used in the analysis. As shown in the figures, there are no discernible correlations between removal rates and flows. The data exhibit a wide range of scatter and suggest that other factors are involved in the removal of metals at SEWPCP.

The metals removal rates were also compared with the dry and wet weather conditions at SEWPCP. For this analysis, a wet weather condition is defined as the day(s) that rain was actually measured at SEWPCP and the day immediately following. In 1991, both influent and effluent concentrations were available for 24 days. Of these 24 days, rainfall was measured on six separate days at SEWPCP. Table 5-10B compares the metals removal rate for the dry and wet weather conditions. A complete analysis of the data is also included in Appendix C-10 for reference. The results shown in Table 5-10B indicate slightly higher removal rates during the non-rainfall condition.

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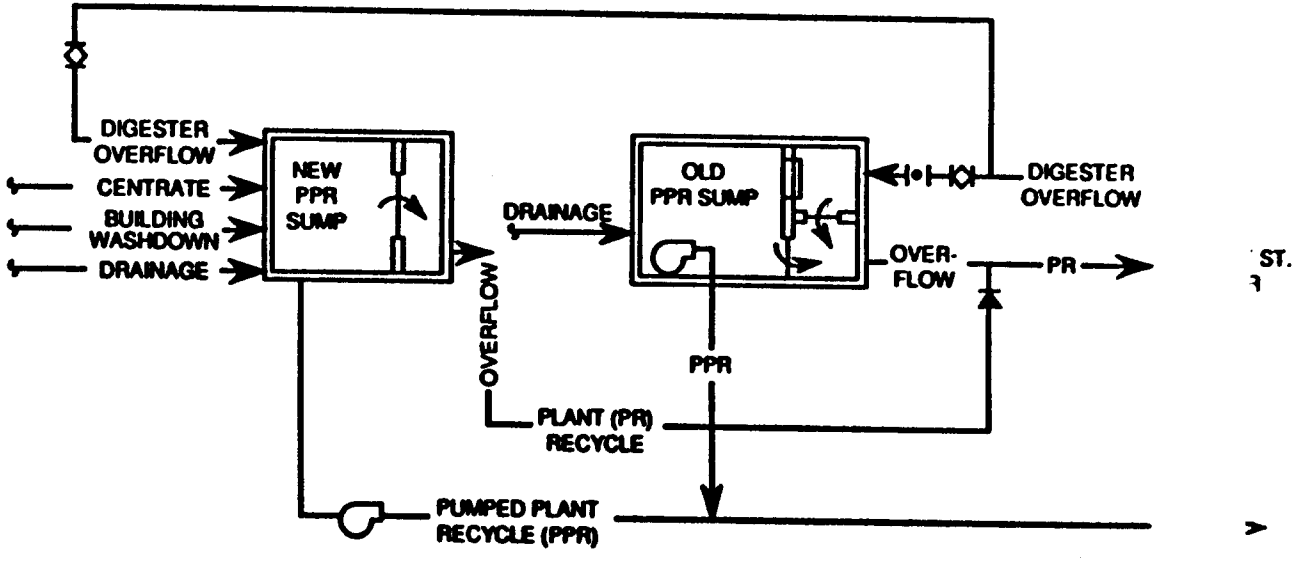

SOUTHEAST WPCP RECYCLE FLOW SCHEMATIC

FIGURE 5-10A

R0057613

TABLE 5-10A

Parameter	Average Concentrations(a) (µg/l)	Average Loadings(b) (ppd)
Copper	824	3.9
Lead	386	1.8
Mercury	4	0.02
Nickel	80	0.4
Silver	206	1.0
Zinc	1,100	5.2

(a) Based on sampling data from May 1985 through January 1988.
(b) Based on averaged flow of 0.6 mgd.

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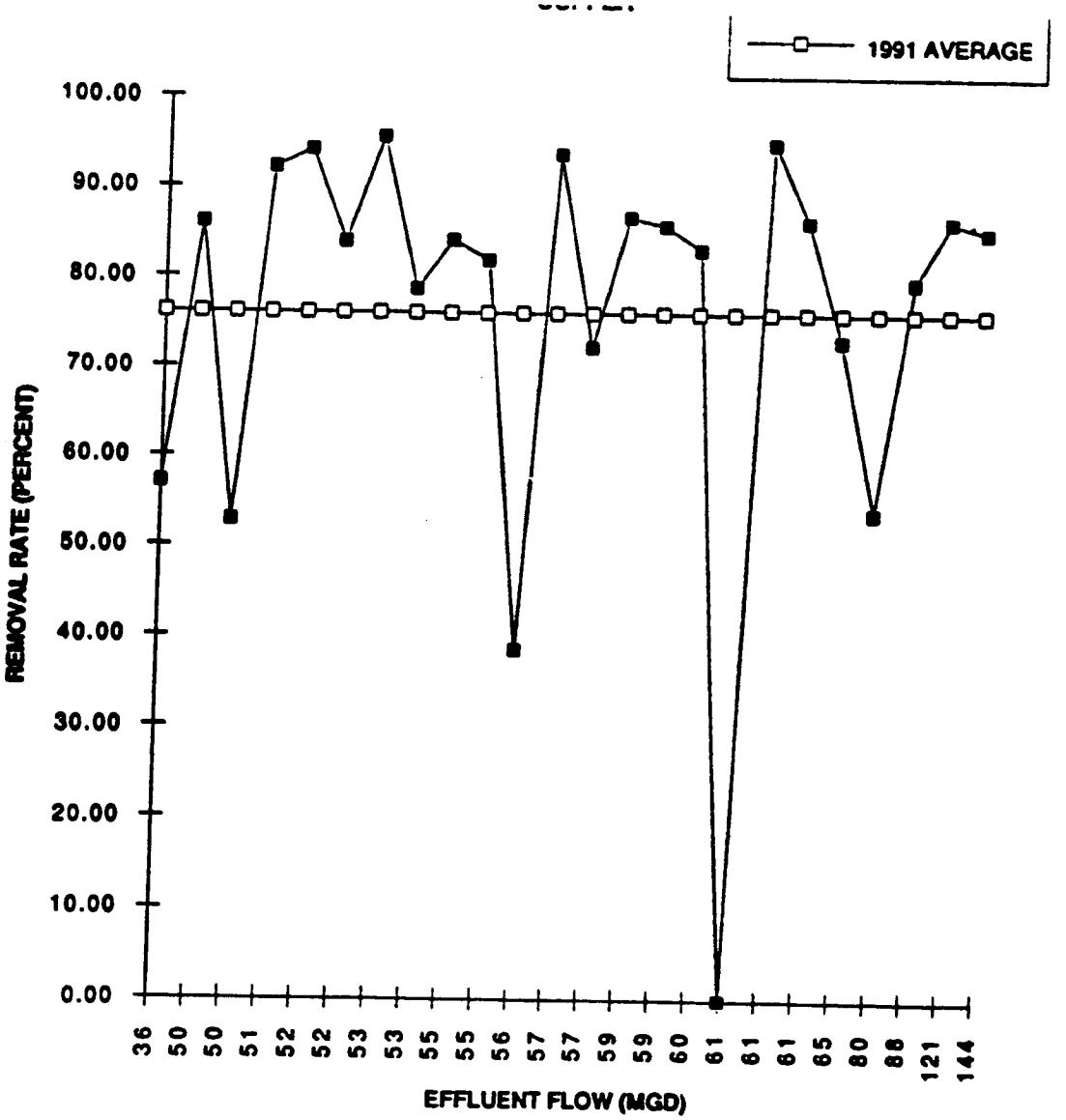
R0057614

File: Copper Chart



Note: Negative removal rates were assumed to be zero.

FIGURE 5-10B

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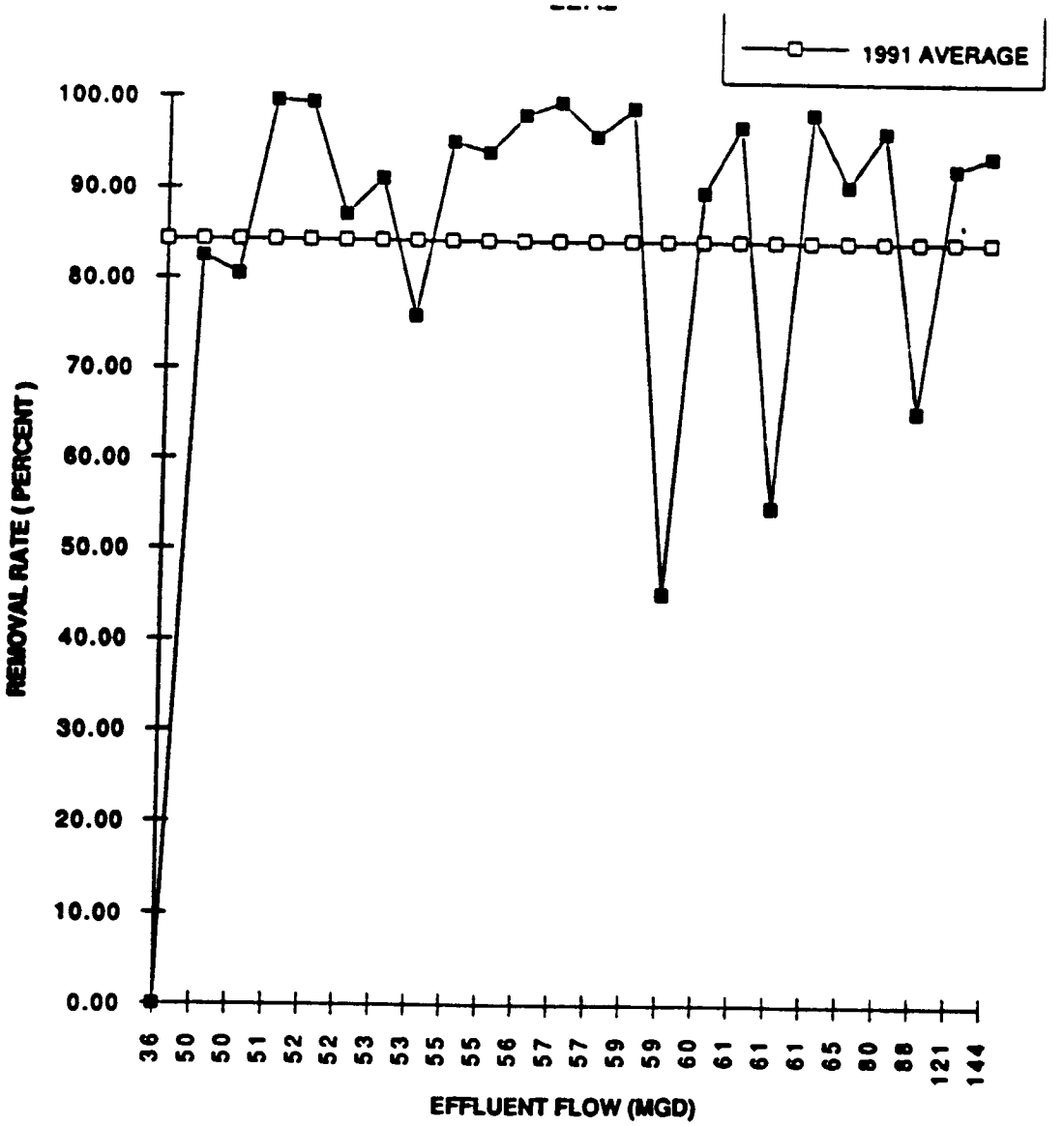
File: Lead Chart



Note: Negative removal rates were assumed to be zero.

FIGURE 5-10C

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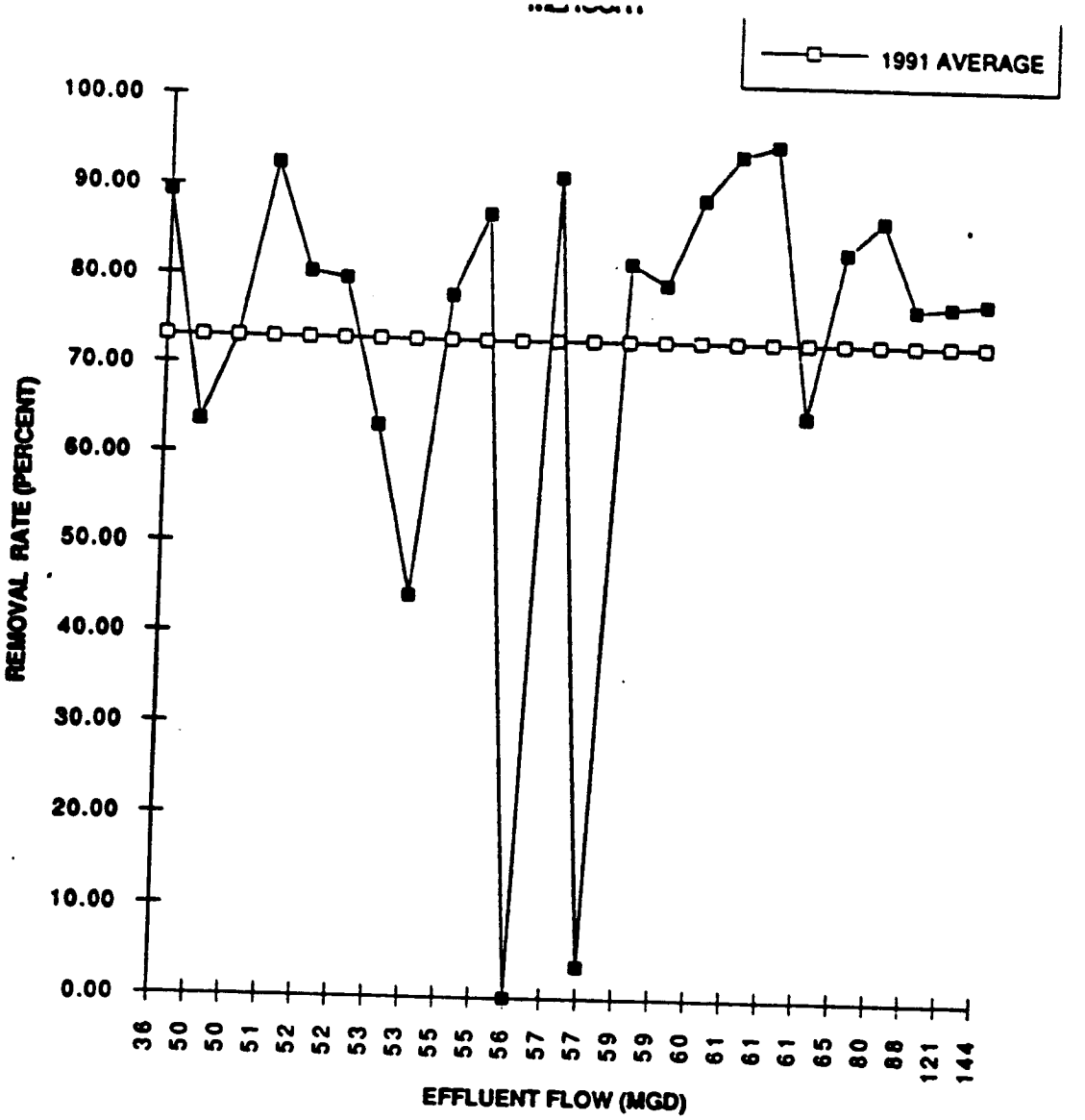
R0057616

File: Mercury Chart



Note: Negative removal rates were assumed to be zero.

FIGURE 5-10D

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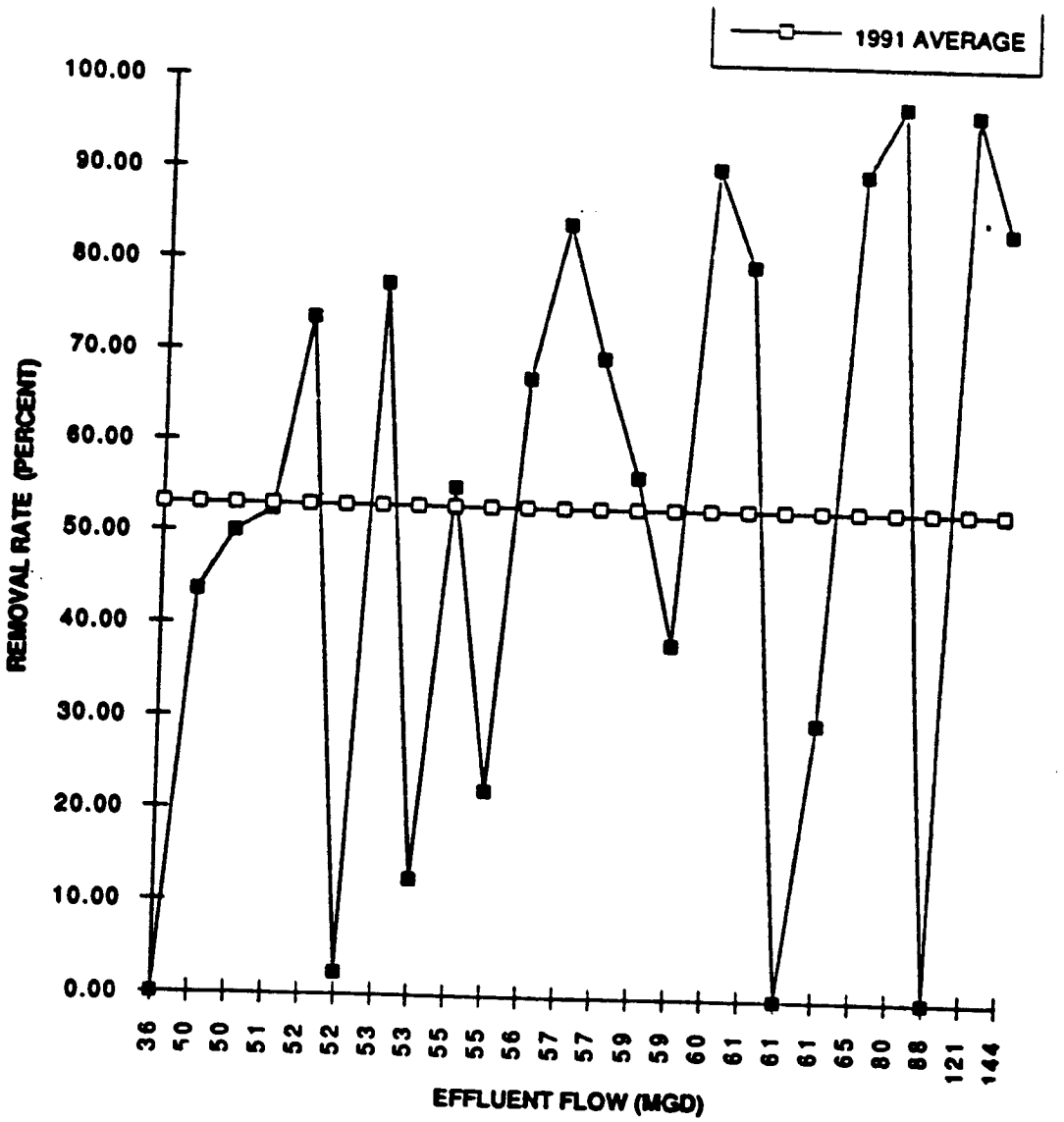
File: Nickel Chart



Note: Negative removal rates were assumed to be zero.

FIGURE 5-10E

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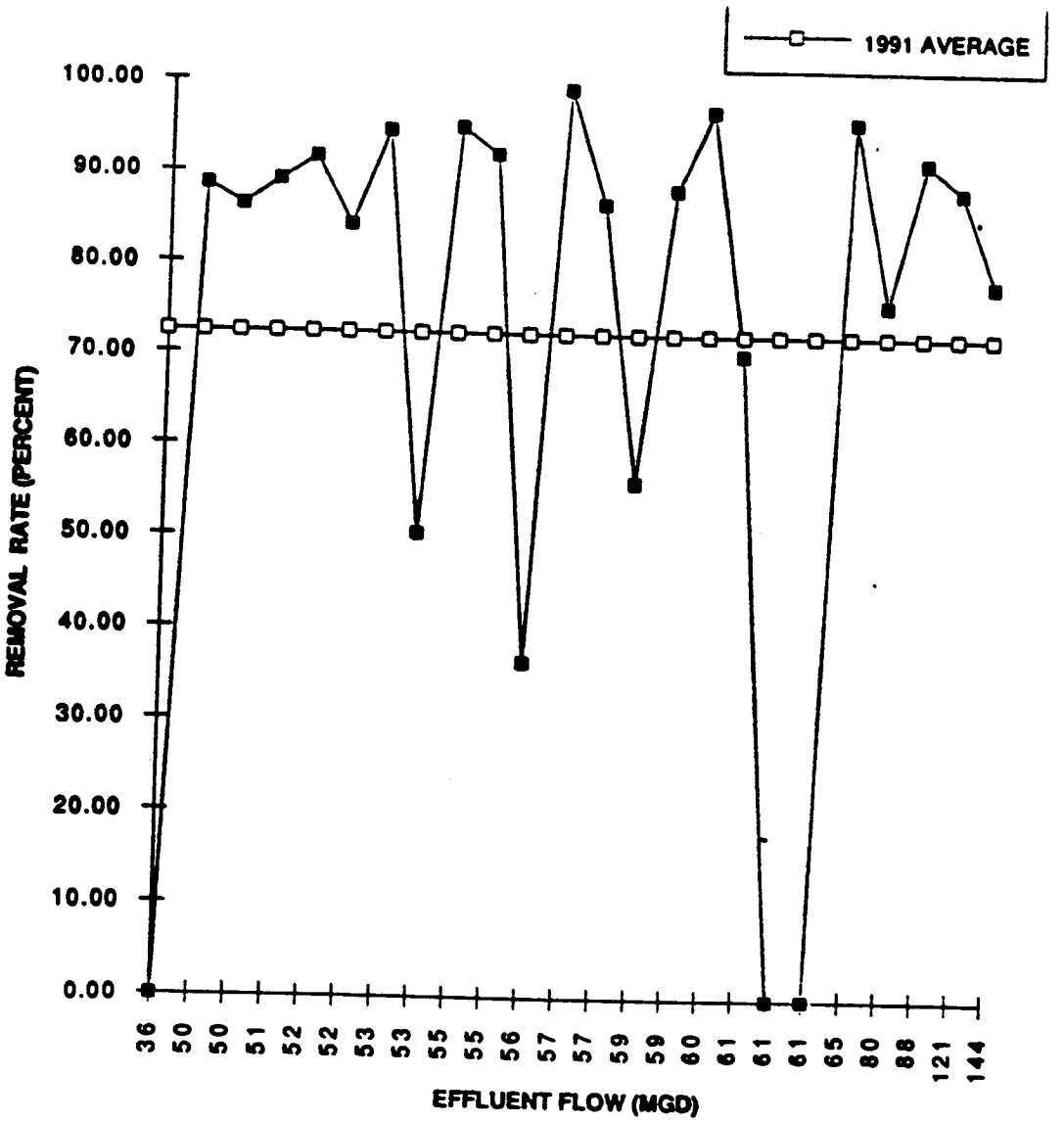
File: Silver Chart



Note: Negative removal rates were assumed to be zero.

FIGURE 5-10F

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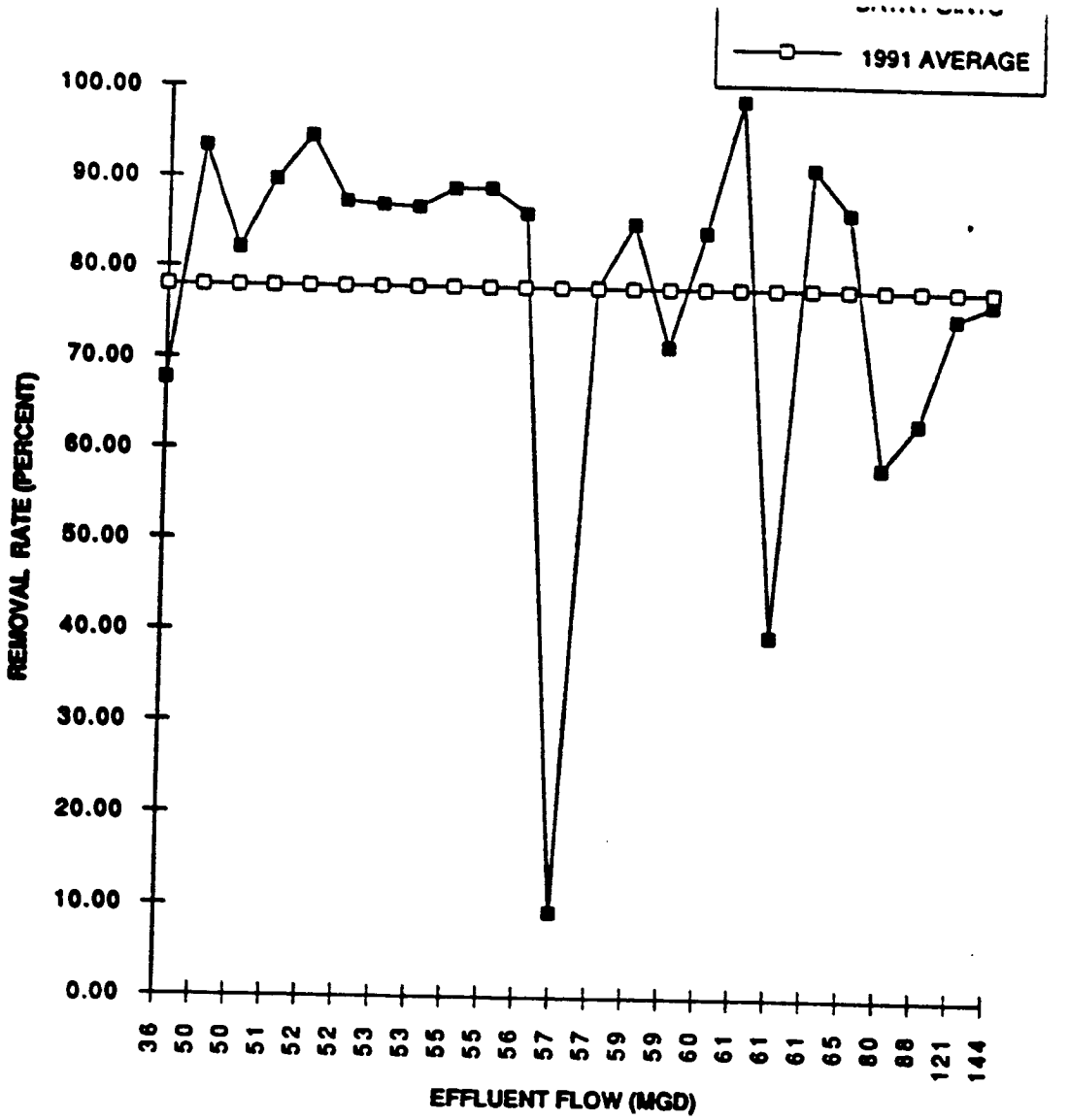
File: Zinc Chart



Note: Negative removal rates were assumed to be zero.

FIGURE 5-10G

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TABLE 5-10B

METAL REMOVAL RATES

Parameter	Average Removal Rates (Percent)		
	Dry Weather	Wet Weather(a)	Historical(b)
Copper	77	73	55
Lead	88	73	80
Mercury	70	82	65
Nickel	50	61	55
Silver	73	72	75
Zinc	80	71	70

(a) For this analysis, wet weather is defined as the day with measurable rainfall at SEWPCP.

(b) Historical removal rates as reported in "Final Report on Local/General Discharge Limitation Development" (REED 1991)

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Both sets of removal rates are comparable to the historical removal rates reported in the Final Report on Local/General Discharge Limitation Development report (REED, 1991) and are

A schematic diagram of the recycle flow storage system is shown in Figure 5-10H. As shown in the figure, the existing PPR facilities would be used to deliver recycle flows to the new storage tanks. After wet weather flows has passed, the recycle flows would be pumped back into the primary sedimentation tanks for treatment. The recycle flow storage system would be based on the following design conditions.

- Three-day storage capacity (1.8 million gallons) would be provided.
- Four 70-feet diameter steel tanks would be used for storage.
- Tanks would be located in the area north of the existing oxygen generation facilities.
- Aeration at the storage tanks would be required to minimize anaerobic conditions.

The cost estimated in also included in Appendix C-10 for reference.

ESTIMATED REDUCTIONS

If the recycle flows at SEWPCP were stored during wet weather and then returned to the liquid stream after the flow has decreased and the plant operation has stabilized, some additional removal of the metals in the recycle streams can be expected to occur. Table 5-10C summarizes the expected increased reductions for the six parameters of concern. The estimated reductions are based on the following assumptions.

Existing Conditions:

- On a wet weather day, the influent and recycle metals loadings would be removed at the wet weather removal rate.
- On the subsequent dry day, the influent and recycle metals loadings would be removed at the dry weather removal rate.

After Construction of the Recycle Flow Storage Facilities:

- On a wet weather day, the influent metals loadings would be removed at the wet weather removal rate. The recycle flows would be stored.
- On the subsequent dry weather day; the influent loadings, the normal recycle metals loadings, and the stored recycle metals loadings would be removed at the dry weather removal rate.

As shown in Table 5-10C, the expected reductions would be minimal. The increased reductions would be less than one percent of the average influent loadings for the six parameters of concerns. For mercury, nickel, and silver, their wet weather removal efficiencies were equal to or higher than their dry weather efficiencies. Therefore, no reductions would be expected. It should be noted that there is no empirical evidence that storage of recycle flow would directly result in the increased

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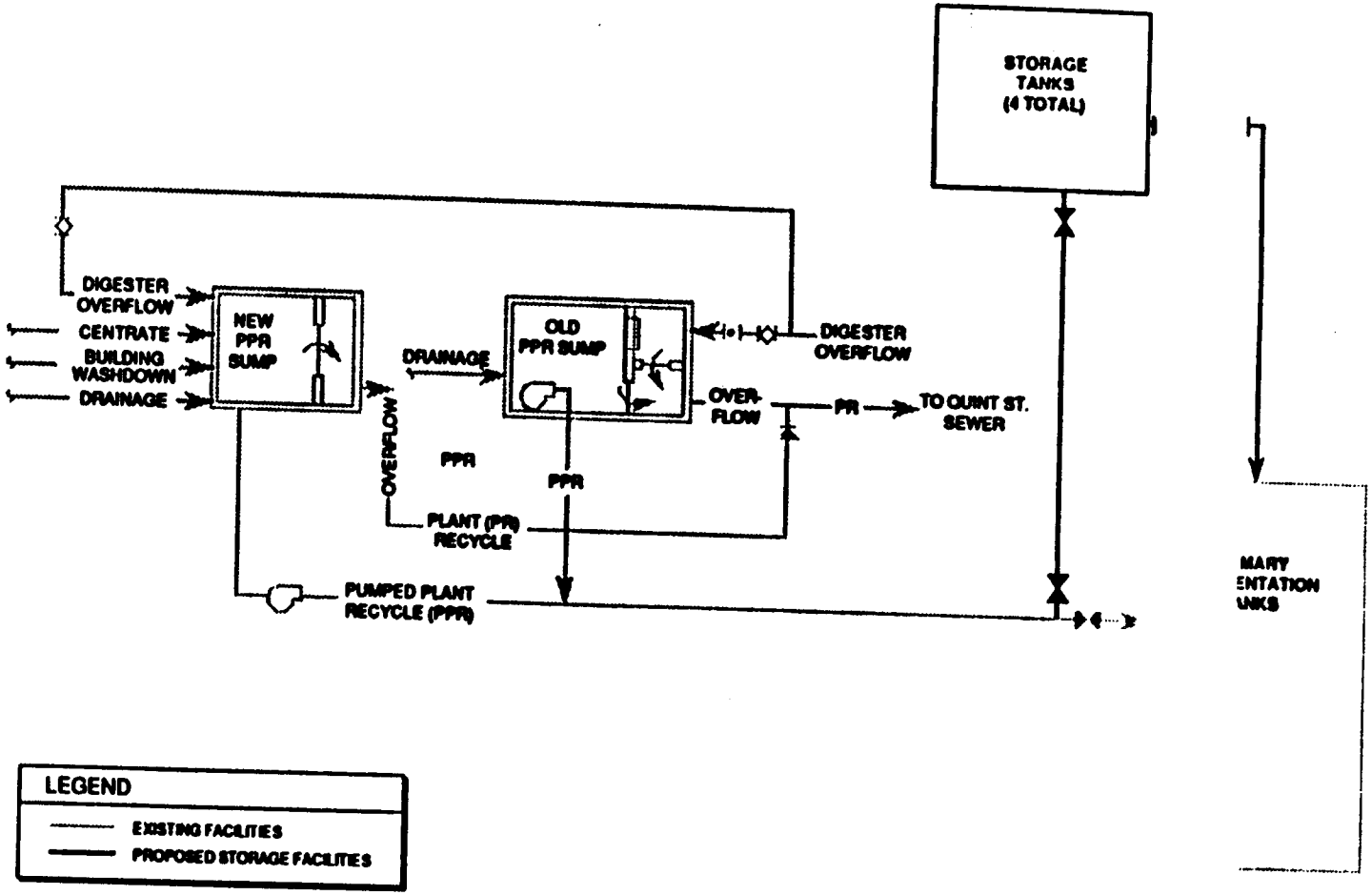

FLOW SCHEMATIC FOR STORAGE OF RECYCLE FLOWS

FIGURE 5-10H

R0057623

TABLE 5-10C

Parameter	Estimated Reduction (pounds/year)
Copper	10
Lead	30
Zinc	50

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metal removal. The complete calculations of the estimated reductions are included in Appendix C-10 for reference.

The estimated costs of constructing and operating the recycle flow storage system are summarized in Table 5-10D. The annualized costs of this BMP is approximately $550,000 per year.

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TABLE 5-10D

ESTIMATED ANNUAL COSTS

Component	Cost
Construction Costs(a)	
Piping	$140,000
Pump Modifications	$13,000
Storage Tanks	$3,340,000
Site Modifications	$880,000
Subtotal	$4,370,000
Annualized Construction Costs(b)	$450,000
Annual O&M Costs:	
Electrical	$1,000
Labor	$58,000
Maintenance	$43,000
Subtotal	$102,000
Total Annual Costs	$552,000

(a) Estimated 1991 cost including 25% contingency and 20% contractor overhead and profit.
(b) Amortization factor = 20 years at 8% = 0.102

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R0057626

BMP NO. 11 (OPTIONAL BMP P3)

[illegible] LOCATE THE SOURCES OF POLLUTANTS

Identifying and addressing pollutant sources which can not be traced to a specific business or type of business is particularly challenging. Knowing the sources of pollutants, however, would greatly contribute to efforts to reduce both the amount of toxic substances used and the amount discharged into the sewer system. The efficiency of public education and outreach will be enhanced if specific target audiences and areas of CCSF can be identified as significant or frequent sources of toxic pollutants.

Personnel from various CCSF departments have daily contact with the sewers, storm drains and city streets and have the potential to observe incidents of illegal dumping. These individuals represent a valuable source of information concerning spills and illegal dumping of toxic substances. If this information were consistently and systematically collected, and centrally compiled and analyzed, it could be used to target educational or enforcement efforts accordingly. BMP No. 11 establishes a process through which this can be accomplished.

POLLUTANTS OF CONCERN

The pollutant sources addressed by BMP No. 11 are similar to those addressed by BMP No. 2. Any pollutant or combination of pollutants that can potentially be addressed by BMP No.2 will be included in BMP No. 11. Certain toxic substances are dumped illegally more often than others and thus can be expected to be more commonly observed and reported by City staff. Personnel from the Bureau of Street Cleaning and Urban Forestry (BSCUF) report finding discarded or spilled motor oil and paint in certain parts of the City. Personnel from the Bureau of Street and Sewer Repair (BSSR) may observe a wider variety of illegally dumped substances, such as toxic wastes dumped directly into the sewer system from within a business. As discussed in BMP No. 2, paint and used motor oil are the two substances that are most commonly dumped illegally.

EXISTING CONDITIONS

There currently is no centralized reporting procedure or database for illegal dumping or spill reports observed or addressed by various CCSF departments. The Department of Public Health (DPH) maintains a file of reports involving toxic spills and is currently developing a central database for use by the Fire Department in tracking spills. The Fire Department files standard incident forms recording spills and has separate forms for fires and hazardous materials incidents. A computer is being installed in the Department's Emergency Response Vehicle through which the DPH spill database will be accessed. Potentially hazardous pollutant spills encountered by BSCUF and the BSSR are reported to DPH or the Fire Department. Non-hazardous spills or chemicals are retrieved, however reports of these incidents are not maintained. Illegal dumping reports received by BERM are recorded and filed, although no further action is taken. Unless BERM requests such records or responds to incidents along with DPH or the Fire Department, reports are not normally forwarded to its offices.

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Under existing conditions, records of emergency spill reports and hazardous materials incidents are maintained. Records concerning the retrieval of non-hazardous pollutants, such as used motor oil

In July, 1992 a special report was prepared on spill investigations and retrievals conducted by BERM and DPH between 1990 and 1992. Analysis of BERM's records (a total of 68 complaints) indicated that the majority of reports were received in the Summer and Fall; 37 percent and 31 percent, respectively. Approximately two thirds (64 percent) of the incidents involved paint, oil and cement/concrete (approximately 21 percent each). Illegal dumping of paints was most frequently reported in the spring, summer and fall; oils in the summer and fall; and cement/concrete in the summer, fall and winter. Geographically, most illegal dumpings occurred in the Channel Basin area. The Oceanside District had the most instances of illegal discharges, but is so much larger than other districts that it is not considered equal to the other districts. The sub-basin with the highest number of illegal discharges was the North Point Sub-basin, and the specific district with the most illegal discharges is the South of Market district. A general trend was identified in which the largest number of illegal discharges took place in business/industrial areas, while the least amount of illegal discharges were found in residential areas.

The DPH data analysis (1429 spill retrievals) revealed similar patterns in several instances. Close to two thirds of DPH spill retrievals involved oil or paint (39 and 22 percent, respectively) and most were in the Channel Basin and South of Market areas. In contrast to the BERM data, however, DPH reported the majority of its retrievals in the Fall and Winter (30 and 27 percent, respectively).

As is clear from the above discussion, valuable information can be obtained by analyzing the illegal dumping/spill reports of CCSF departments. This type of analysis is not routinely conducted, however, and reports from various CCSF departments are not standard in format nor are they automatically forwarded to a centralized database.

IMPLEMENTATION MEASURES

A procedure will be established through which all reports concerning toxic spills and illegal dumping are compiled into a centralized database. This can be accomplished either by forwarding copies of each department's incident reports to BERM once a year, or forwarding a copy of each individual report as they are produced. Regardless of which procedure is followed, incident reports must contain consistent and useful information. This will include, at a minimum, the date, time, substance spilled or illegally dumped, the quantity of the substance and its source, the location, response and the source of the report. BERM, CAO and other CCSF staff involved in educational and enforcement efforts will determine what additional information will be included so that an annual analysis, or audit, of incident reports can be used effectively in addressing problem areas, substances, or target audiences. Appropriate computer software will be used in establishing a database.

Reports will be also be filed when non-hazardous spills or illegal dumping incidents are observed. This will include situations where BSCUF or BSSR personnel retrieve spilled motor oil or abandoned cans of paint or other non-hazardous substances, or otherwise observe or encounter improper disposal practices which do not require the involvement of DPH or the Fire Department. While such situations are not currently recorded, such information can help in directing educational and enforcement actions and should be included in the centralized database.

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Personnel from BERM, DPH, BSCUF, BSSR, and the Fire Department will be trained to identify and report toxic spills and illegal dumping. The special report on BERM and DPH illegal dumping/spill reports cited above found that CCSF personnel are an important source of such

ensure not only that such incidents are consistently reported but also that the personnel themselves understand the need and purpose of the broader public education program. DPH currently conducts education and training programs for all CCSF employees and will integrate spill and illegal dumping reporting accordingly. Employees not directly involved with environmental or maintenance work will be encouraged to use the illegal dumping hotline. Other employees will receive more specific training as appropriate.

The spill/illegal dumping database will be analyzed on an annual basis. This analysis will determine if patterns exist with regard to the following:

- Toxic substances which are spilled or dumped illegally.
- The season and time of day when spills and illegal dumping incidents occur.
- Areas of CCSF where incidents are most common.
- The source of reports.
- The response taken to the reports.

Using this information, BERM and other appropriate staff will determine what targeted educational or enforcement actions are necessary. This may involve the targeted distribution of educational materials to certain audiences or neighborhoods, enhanced surveillance of areas where illegal dumping is common, improved disposal alternatives, or increased outreach and regulation of businesses involved in illegal dumping or spill incidents.

EXPECTED REDUCTION

This BMP, in and of itself, would not directly result in any reduction of pollutants into the CCSF sewer collection system. However, it would be extremely beneficial to BMPs 1 and 2 and most of the wet weather BMPs. For this purpose, the expected reductions from this BMP are designated as zero.

ESTIMATED COSTS

The implementation costs of BMP No. 11 are shown in Table 5-11A. The estimated annual cost is $11,000 per year. This cost stems entirely from the development of a centralized spill/illegal dumping report database, regular data entry, and data analysis.

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R0057629

TABLE 5-11A

ESTIMATED ANNUAL COSTS

Implementation Measure	Cost
Program Startup Costs:	
Develop Database	$26,000
Annualized Startup Costs(a)	$3,000
Annual Operating Costs:	
Data Entry and Analysis	$8,000
Total Annual Cost	**$11,000/yr**

(a) Amortization factor = 20 years @ 8% = 0.102

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R0057630

Five chemicals are used at the CCSF wastewater treatment plants: sodium hypochlorite for disinfection; sodium bisulfite for dechlorination; ferric chloride; and two different polymers for sludge conditioning. This BMP investigate whether the pollutants of concern are present in these chemicals and contribute to the effluent loadings.

POLLUTANTS OF CONCERN

Hypochlorite is one of the first known uses of chlorine for disinfection. The application of hypochlorite in wastewater treatment achieves the same results as does that of chlorine gas: sodium hypochlorite or calcium hypochlorite. The active ingredient is the hypochlorite ion, which hydrolyzes to form hypochlorous acid. For reasons relating to safety, CCSF has been utilizing sodium hypochlorite and sodium metabisulfite for disinfection and neutralization.

Sodium hypochlorite is generally used in the liquid form; the dry chemicals are very difficult to handle and store. The stability of hypochlorite solutions is greatly affected by heat, light, pH, and the presence of heavy metals. Iron, copper, nickel, and cobalt catalyzes the rate of deterioration of hypochlorite. Copper is generally present in concentrations of 1 mg/l or less. It is present because of the flexible copper connections and brass body line valves used in the chlorine supply system. Liquid chlorine is commonly used to generate sodium hypochlorite.

Ferric chloride and polymers are commonly used for sludge conditioning in the thickening and dewatering processes. The fundamental objective of conditioning is to aggregate the fine solids by coagulation with inorganic chemicals and flocculation with organic polymers. Ferric chloride hydrolyzes in water, forming charged soluble iron complexes. It is postulated that the ionized iron will enter the outer layer of the negatively charged sludge solid, neutralize surface charges, and thereby allow solids to aggregate.

Organic polymers used for sludge thickening and dewatering are long-chained, water-soluble, synthetic organic chemicals. Due to the organic nature of these compounds, it was postulated that forms of cyanide may be present. The chemical reactions involving organic polymers are similar to those for ferric chloride. Neutralization of the negative electrical charges of the sludge particle by the positive charge of the polymer leads to a reduction of the electrostatic repulsion between particles and thus encourages aggregation. Because most sludge solids are negatively charged, the cationic polymers are most commonly used for sludge applications. In polymer bridging, the long polymer molecule attaches itself by adsorption to two or more sludge particles at the same time. Flocs formed by particle bridging tend to have a higher resistance to shear than flocs formed by charged by charged neutralization.

EXISTING CONDITIONS

The approximate amounts of these chemicals used in 1991 are presented in Table 5-12A. These chemicals are industrial grade quality. In order to assess the presence of metals and cyanide, samples of these five chemicals were collected by SEWPCP staff and delivered to Montgomery Laboratories for analysis.

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TABLE 5-12A

CHEMICAL USAGES AT SEWPCP

Chemicals	1991 Usage (lbs/yr)
Sodium Hypochlorite $NaOCl$	3,246,700
Sodium Bisulfite Na_2SO_3	1,564,200
Ferric Chloride $FeCl_3$	2,214,526
Clarifloc C-321 Polymer DAF units	36,300
Clarifloc LA-1681 Polymer Centrifuges	179,400

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R0057632

The results of the laboratory analysis are shown in Table 5-12B. As shown on the table, cyanide and metals were found to be present in some of these chemicals. However, most of the these

Table 5-12C summarizes the amount of pollutants that may be added to the SEWPCP influent and effluent by the chemicals. Sodium hypochlorite and sodium bisulfite, and their associated contaminants, are added directly to the effluent stream. However, ferric chloride and the two polymers are used in the sludge handling processes. These chemicals are used in the binding of the sludge flocs. Therefore, it is expected that the majority of these chemicals, and their associated contaminants, would remain with the sludge solids. For this analysis, 80 percent of chemicals are assumed to be bounded with the sludge. The remaining pollutants, 20 percent, are returned to the headworks as part of the recycle flows.

IMPLEMENTATION MEASURES

Of the five chemicals used at the CCSF wastewater treatment plants, ferric chloride is the only notable contributor; the copper and lead contributions would be 20 lbs/yr and 10 lbs/yr, respectively. The other chemicals contribute minimal amounts of pollutants. These contributions are calculated based on the assumption that 20 percent of the copper and lead (and ferric chloride) would be returned to the plant headworks as part of the recycle flow. The other 80 percent is assumed to be bound with the sludge solids.

The chemical supplier, Imperial West Chemical Company, was contacted about alternative grades of ferric chloride. The grade used at SEWPCP is formulated in accordance with American Water Works Association (AWWA) Standard B-407. It is widely used for coagulation in water treatment applications. A copy of AWWA Standard B-407 is included in Appendix C-12 for reference. In general, the amounts of contaminants added by the chemicals cannot exceed 10 percent of the drinking water maximum contaminants levels (MCLs). An electronics grade of ferric chloride is available in the market. This grade has a higher iron content and is used for etching circuit boards in the electronics industry. There are no differences between the two grades in terms of metals concentration. On the other hand, several manufacturers recycle used ferric chloride and a lower quality product, with higher contaminant levels, is available.

EXPECTED REDUCTIONS

Using a different grade of ferric chloride would not reduce the amount of pollutants of concern.

ESTIMATED COSTS

The electronics grade of ferric chloride is about $100 per ton more expensive than the grade currently used at SEWPCP. Based on a project ultimate usage of 1500 tons per year, the estimated cost of using a different grade of ferric chloride would be $150,000 per year.

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TABLE 5-12B

RESULTS OF STUDGE CHEMICAL TESTING

Compound	FeCL3 (42% soln.) (mg/L)	Bisulfite (38% soln.) (mg/L)	Hypochlorite (13% soln.) (mg/L)	Centrifuge Polymer (mg/kg)	DAF Polymer (mg/kg)
Arsenic	3.8	<0.5	<0.05	<0.1	<0.1
Cadmium	<0.5	<0.05	<0.05	<0.05	<0.05
Chromium	4.5	0.21	<0.1	0.11	<0.1
Copper	12	<0.1	<0.1	0.63	1.5
Lead	7	<1	<1	<1	1
Mercury	<0.02	0.0075	<0.004	<0.02	<0.02
Nickel	<4.0	<0.4	<0.4	<0.4	<0.4
Silver	<1	<0.1	<0.1	<0.1	<0.1
Zinc	6.7	0.58	<0.2	0.24	21
Cyanide	<0.05	NA	NA	0.3	0.2

NA = Not Analyzed

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TABLE 5-12C

IMPACT OF METALS AND CYANIDE IN SEWPCP CHEMICALS

Parameter	SEWPCP Chemicals Loading to Influent(a) (lbs/yr)	Percentage of Total Influent Loadings (%)	SEWPCP Chemicals Loading to Effluent(b) (lbs/yr)	Percentage of Total Effluent Loadings (%)
Copper	17	0.1	<4	0.1
Lead	10	0.1	<40	3
Mercury	0	0	0.2	<0.4
Nickel	<6	0.1	<16	0.9
Silver	<1	0.1	<4	0.7
Zinc	10	0	10	0.1
Cyanide	0.1	0	-	-

(a) Influent loadings from SEWPCP chemicals were based on 20 percent of loadings contained in ferric chloride and polymers (added for solids conditioning) would be returned to influent stream.

(b) Effluent loadings consist of 100 percent of chemicals contained in hypochlorite and bisulfite solutions.

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facilities. The treatment facilities, when designed and operated properly, would provide a positive means of controlling the quality of effluent discharged to the Bay. The other BMPs discussed above have varying effectiveness and also would have no direct control over the effluent quality.

Based on the levels of pollutants in the SEWPCP wastewater, a lime precipitation process would be required in combination with the reverse osmosis (RO) process in order to reduce pollutants to the levels required by the Basin Plan. The lime precipitation process would be installed upstream of the RO process for two reasons:

- Additional removal of the metals due to the extremely stringent discharge requirements.
- Pretreatment step for the RO process.

RO has been successfully used in industrial applications for metals removal and recovery in highly concentrated waste streams. Its use in municipal wastewater treatment, and for metals removal from dilute waste streams in general, is extremely limited. There are several small RO facilities in California treating secondary effluent for irrigation. However, their emphasis is removing total dissolved solids (TDS) rather than metals. Only one full-scale facility in the United States; Water Factory 21 in Orange County, California; provides a basis for estimating the process performance of RO and lime precipitation. Water Factory 21 utilizes lime precipitation and RO to treat 5 million gallons per day (mgd) of secondary effluent.

PROCESS DESCRIPTION

Figure 5-13A is a flow schematic of the full scale treatment option for metals reduction at SEWPCP. Secondary effluent (85 mgd ADWF design capacity) would be routed to the lime precipitation process for coagulation, flocculation, and clarification. The clarified effluent would then be recarbonated and routed to new dual media filters for additional solids removal. The filtered effluent would then be treated by the RO process. The purified water (permeate) would be routed for discharge at the current outfall location.

The concentrated brine stream from the RO process would be sent through a smaller lime precipitation unit to transfer the majority of the metals into a solid phase. The clarified supernatant from lime precipitation would be recarbonated to lower the pH, filtered and then sent through a secondary RO unit for further metals and volume reduction. Permeate from the secondary RO system would be blended with permeate from the main RO system. The volume of the concentrated brine from the secondary RO unit would be transported via a fifteen-inch diameter pipeline traversing west through the City. At the Oceanside WPCP, the brine would be combined with the secondary effluent and pumped to the deep-water ocean outfall for disposal.

The solids generated from both lime precipitation processes would be sent through a solids handling process for volume reduction. The dewatered chemical sludge cake would then be hauled off-site for disposal in a landfill. Filtrate removed by the dewatering processes would be routed back to the SEWPCP headworks.

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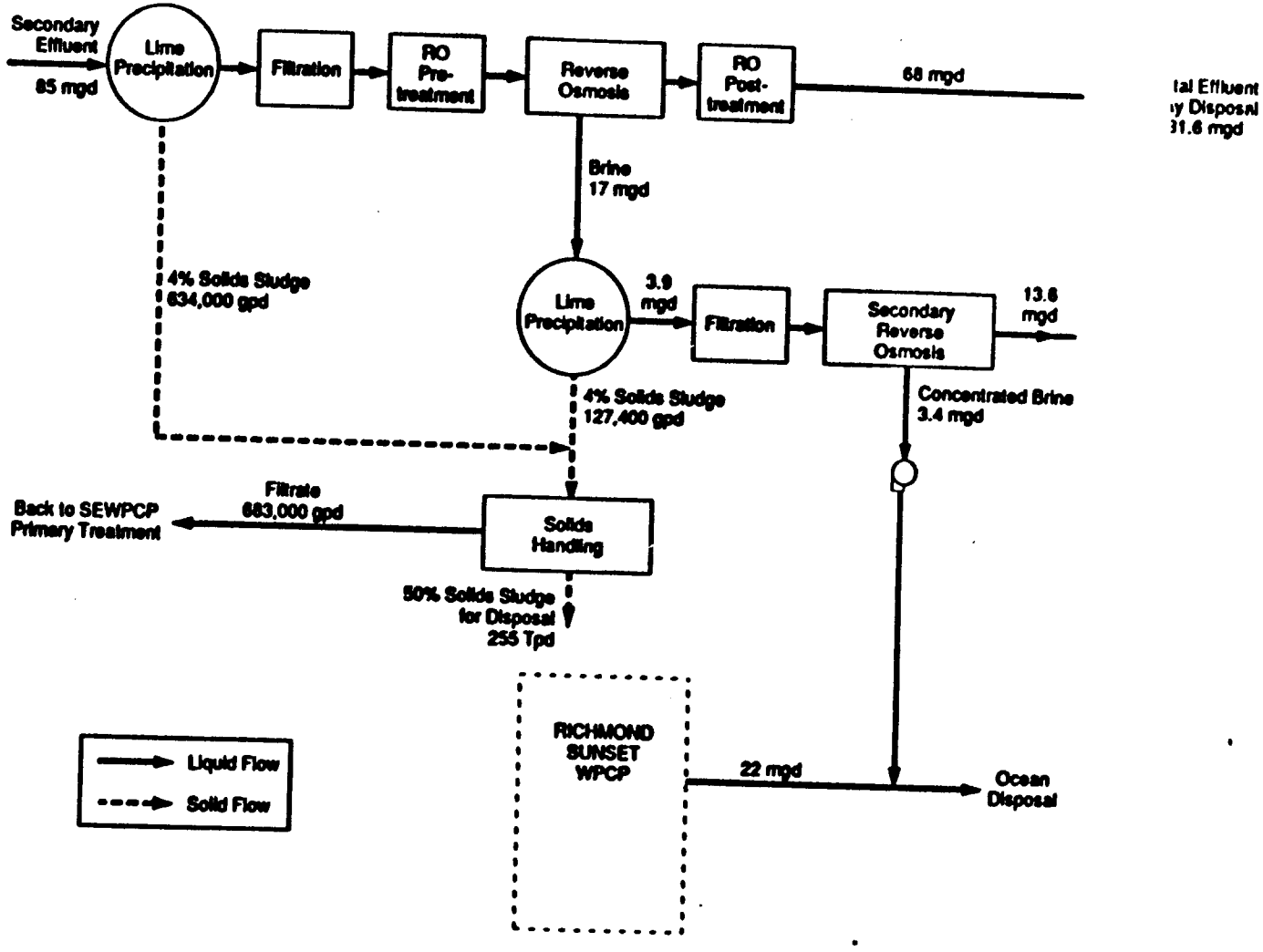

FLOW SCHEMATIC FOR FULL SCALE REVERSE OSMOSIS TREATMENT

FIGURE 5-13A

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The lime precipitation, RO, and residual handling processes are discussed in more detail in the following subsections.

heavy metals. It is a physical/chemical treatment method that separates and removes metallic contaminants by altering the ionic equilibrium of a metallic compound to produced an insoluble precipitate. Typically, the wastewater solution is made alkaline by adding lime to lower the solubility of metallic constituents. At high pH levels (9 to 11), dissolved heavy metals ions may be chemically precipitated as insoluble hydroxides and removed by physical means such as sedimentation or filtration. The metal precipitates settle out in a sludge that must be dewatered prior to disposal. The clarified product water is neutralized to an acceptable pH level and routed to downstream process for filtration.

The preliminary design criteria is shown in Table 5-13A. The primary components include a lime addition and pH control system to adjust the pH for optimal precipitation of the metals. This can be done in a precipitation reactor or a separate tank. A sedimentation unit must follow the precipitation reactor to remove the metal precipitates. Final pH adjustment (recarbonation) and polishing with filters are then required for the clarified effluent. A flow equalization tank is also necessary if wide variations in wastewater flow or pollutant concentrations are expected. A typical flow schematic for the lime precipitation process is shown in Figure 5-13B. The removal efficiency for the pollutants of concern are summarized in Table 5-13B. Since this process removes metals through the formation of metal precipitates, it is not expected to have any effect on the cyanide concentration. The removal efficiencies are estimated based on data from Water Factory 21 and pilot studies performed by JMM.

The calcium carbonate and metal hydroxide sludge formed in the lime precipitation process would be dewatered and hauled off-site for disposal. A flow schematic of the solids dewatering system is shown in Figure 5-13C. Approximately 2,500 pounds of sludge (dry weight) would be produced per million gallons of wastewater. Filter presses would be used for dewatering the lime sludge. Operating at higher pressures, filter presses have been reported to dewater lime sludges to about 50 percent solids. A 45 to 50 percent solids concentration is required for waste disposal in a Class III landfill in California. At a capacity of approximately twenty (20) tons per truck, approximately thirteen truckloads per day would be necessary to transport this solid waste product off-site.

The metals concentrations in the resulting sludge are estimated in Table 5-13C. This dewatered sludge (50 percent solids) would have significant volume but would be low enough in metals to be classified as non-hazardous. Lime sludge from both lime precipitation processes would be combined and disposed of in a Class III landfill.

The exact location for disposal of this material is unknown at this time. Identifying a landfill that is willing to accept this magnitude of waste on a long-term basis will be difficult. A determination of the exact location for disposal was not attempted in this evaluation.

Reverse Osmosis

RO treatment uses a semi-permeable membrane perforated with microscopic pores to separate the larger soluble ions and molecules from the water. The RO removes dissolved solids from solution by forcing water through a semi-permeable membrane under high pressure. The pressure required to permit passage of water through a membrane is a function of the osmotic pressure of the solution, which in turn is a function of the solute concentration. In order to reverse this natural phenomenon, a pressure greater than the osmotic pressure must be applied to the high

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TABLE 5-13A

	Units	Quantity
Lime Precipitation		
Average Dry Weather Flow	mgd	85
Lime Dosage	mg/L	380
pH	---	11 to 11.5
Clarifier Overflow Rate	gpd/ft(2)	1,200
Recarbonation		
Detention Time	mins	70
Sludge Dewatering		
Sludge Production	lbs/mil gal	2,500
Percent Solids, Dewatered Cake	Percent	40

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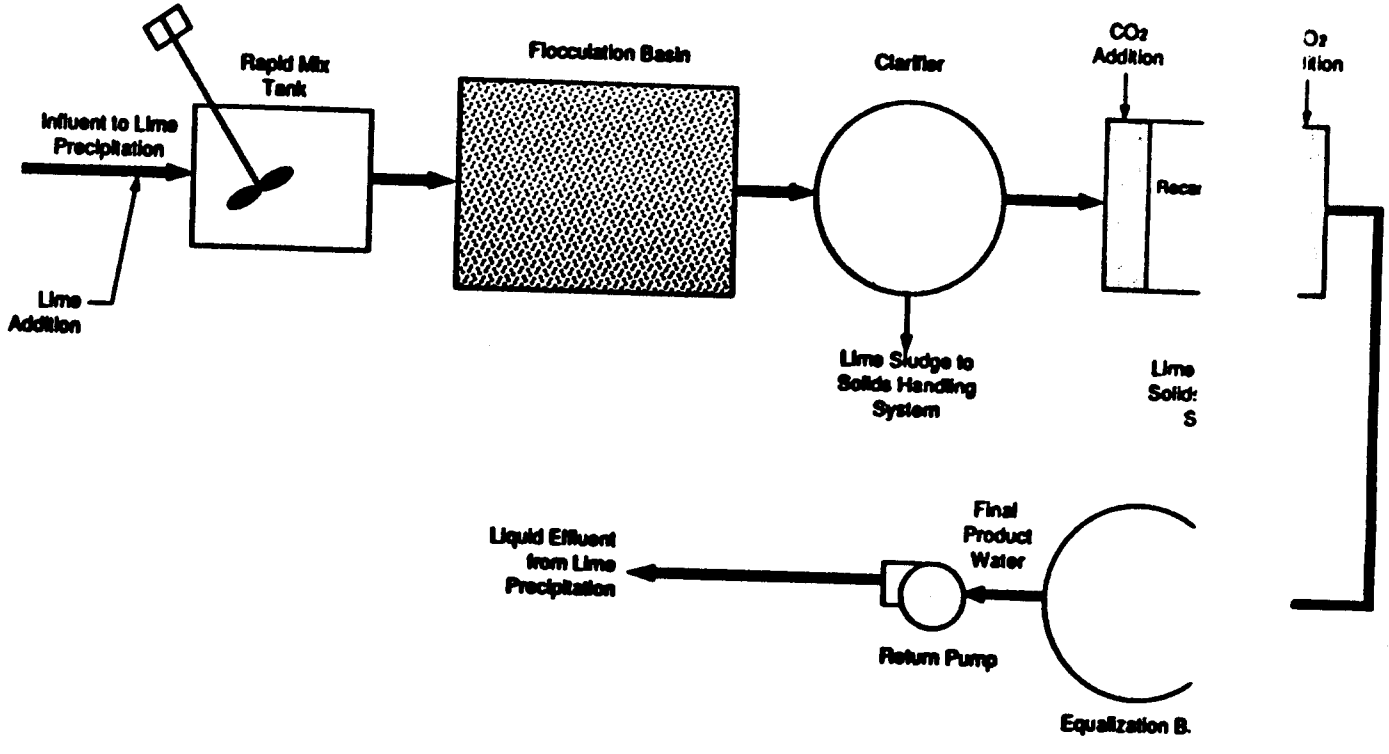

TYPICAL PROCESS FLOW SCHEMATIC FOR LIME PRECIPITATION

FIGURE 5-13B

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TABLE 5-13B

Metal	Removal Efficiency (%)
Copper	65
Lead	85
Mercury	50
Nickel	55
Silver	75
Zinc	80
Cyanide	0

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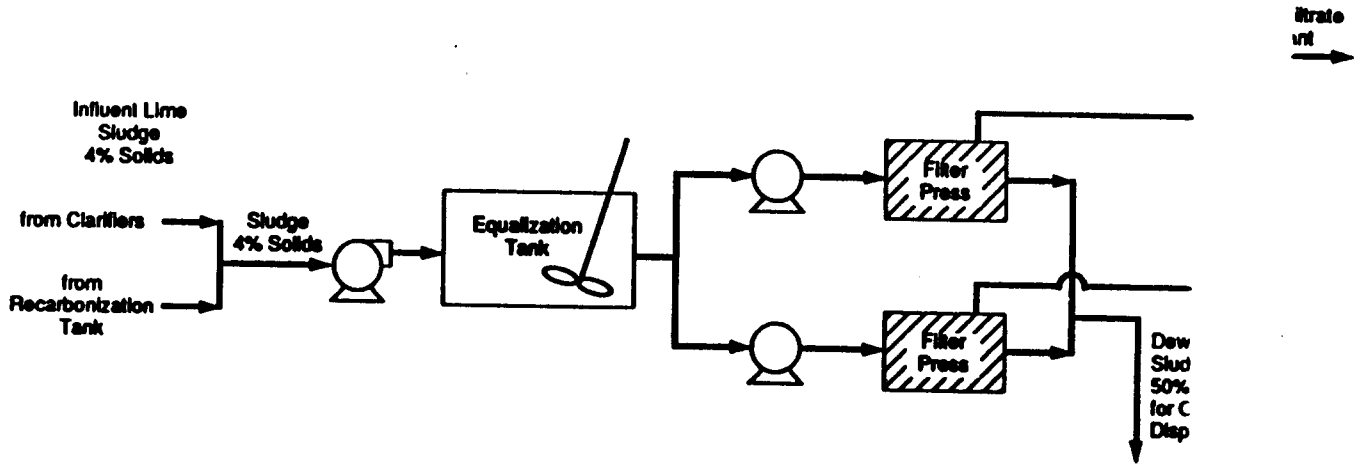

SOLIDS DEWATERING SYSTEM FLOW SCHEMATIC

FIGURE 5-13C

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TABLE 5-13C

FULL SCALE TREATMENT OPTION

Metal	Dewatered Sludge (mg/Kg)	Hazardous Waste Standard(a) (mg/Kg)
Copper	60	2,500
Lead	16	1,000
Mercury	1	20
Nickel	15	2,000
Silver	7	500
Zinc	246	5,000

(a) California Department of Health Services. Title 22 of the California Administrative Code, Division 4, Chapter 30, "Minimum Standards for Management of Hazardous and Extremely Hazardous Wastes".

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concentration side of the membrane before any flow through the membrane in a reverse direction will occur.

scaling, clogging, fouling by colloids, metal oxides, and microorganisms. Salts with low solubilities could precipitate on the membrane during the treatment process, resulting in decreased efficiency. Therefore, the RO treatment requires extensive pretreatment and post treatment. The influent to the RO units must be low in suspended solids and turbidity to prevent clogging of the membranes. Typically, feedwater to the RO units should have less than 1 turbidity unit. Therefore, microfiltration is required to polish the influent. The lowest fouling rate generally occurs on cellulose acetate membranes when a total chlorine residual of 5 to 10 mg/L is maintained in the RO feed water. Depending on the type of membranes selected, chlorinated wastewater may be routed to the RO units to ensure that the feed water contain the necessary chlorine residual. To control metal oxide formation, pH adjustment to levels between 4 and 6 would be necessary. This would be accomplished by adding sulfuric acid to the feed water. Scale inhibition would be achieved by adding complexing agents, such as sodium hexametaphosphate.

The RO process would consist of 30 parallel trains treating 85 mgd. Each train would consist of 140 pressure vessels arranged in three stages to form an 80:40:20 array of vessels. Each vessel would contain 4 membranes in 60-inch lengths. Downstream of the existing filters, the entire influent flow would be routed to the first 80 vessels in Stage 1. The brine generated from the Stage 1 vessels would be routed to the next 40 vessels in Stage 2. The Stage 2 brine would be subsequently routed to the last 20 vessels in Stage 3 for further concentration. The concentrated brine from the Stage 3 vessels would be approximately 20 percent of the total influent flow, resulting in 80 percent recovery of the influent flow. The percent recovery is dependent on the amount of dissolved solids (calcium sulfate, barium sulfate, and silicates, in particular) in SEWPCP wastewater and the effectiveness of the lime precipitation process in removing these ions.

The RO treatment train would have an operating pressure of approximately 250 to 300 pounds per square inch (psi), at a minimum wastewater temperature of 17 degrees Celsius (°C). The proposed design membrane flux rate, or surface loading rate is 9 to 10 gallons per square foot of membrane per day (gfd). A membrane cleaning system would be required for periodic cleaning and to maximize membrane life. In general, the useful life of the membrane is approximately 2 to 5 years. They must be replaced at the end of that period. The estimated removal rates for the pollutants of concern are shown in Table 5-13E. These removal efficiencies are estimated based on data from Water Factory 21 and pilot studies performed by JMM.

The RO effluent would be acidic, have very little hardness, and be almost mineral free. Lime addition may be a convenient way to de-acidify the RO effluent while also increasing the alkalinity and hardness of the final product water, thereby reducing its corrosiveness and attraction to minerals, and creating a more stable final effluent.

Brine Disposal

The quantity of concentrated brine generated from the RO process would be significant. Assuming a maximum product recovery of 80 percent, approximately 17 mgd would be rejected by the membranes as brine. This brine must be further treated for volume reduction and to facilitate final disposal.

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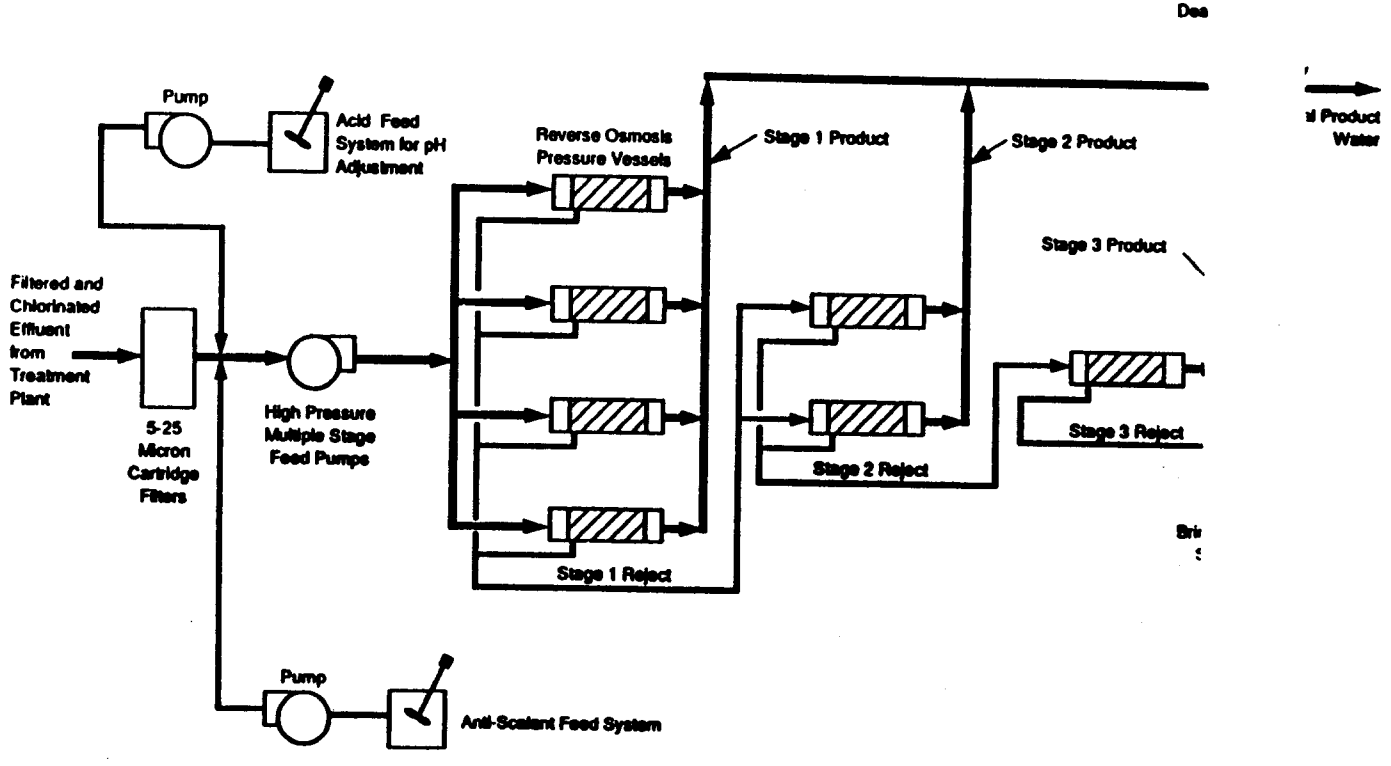

TYPICAL REVERSE OSMOSIS FLOW SCHEMATIC

FIGURE 5-13D

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TABLE 5-13D

PRELIMINARY DESIGN CRITERIA

	Units	Quantity
Average Dry Weather Flow	mgd	85
No. of Trains	No.	30
Vessel Arrangement per Train	--	80:40:20
Cartridge Filters		5,400
Membranes	No.	16,800
Membranes Flux Rate	gfd	10
Product Recovery	percent	80

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TABLE 5-13E

Metal	Removal Efficiency (%)
Copper	65
Lead	75
Mercury	60
Nickel	80
Silver	75
Zinc	80
Cyanide	45

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Secondary Lime precipitation. The RO brine would be treated by lime precipitation to remove a majority of the metals. For this application, the lime precipitation process would be could be lower than normally expected. Additionally, highly solubilized metals in the brine, such as nickel, would not be affected by the precipitation process. The metals remaining in the clarified effluent cannot be returned directly to mix with SEWPCP effluent. The clarified effluent must be filtered and then routed to a secondary RO process for additional metals removal.

The calcium carbonate and metal hydroxide sludge formed in the lime precipitation process would also be dewatered and hauled off-site for disposal. Water removed by the filter presses would be routed back to the SEWPCP headworks.

Secondary RO. The secondary RO unit is designed to remove the residual metals from the lime precipitation step and to further concentrate the volume of brine for disposal. Approximately 13.6 mgd of product water and 3.4 mgd of a secondary brine would be produced in this process. The product water would be routed to mix with product water from the main RO process, and then discharged to the Bay.

Brine Disposal. The 3.4 mgd of brine produced by the secondary RO system could be transported through a 15-inch diameter pipeline, traversing approximately 37,400 feet westward across the City, to mix with the new Oceanside WPCP effluent for discharge via the 4.5-mile long Southwest Ocean Outfall to the Pacific Ocean. The estimated concentrations of pollutants in this mixture are shown in Table 5-13F. They are expected to be below the limits for ocean discharge. The 1991 data from Richmond-Sunset were used for estimating the concentrations of the brine/effluent mixture. Since the new Oceanside facility will produce a secondary effluent, the actual concentrations would likely be lower than shown on Table 5-13F.

A full-scale RO treatment process at SEWPCP would require major construction. Based on the capacity requirements, a total area of 300, 000 square feet of space would be needed. However, the only space available at the existing site is about 36,000 square feet. CCSF would have to acquire significant amount of the adjacent areas in order to implement this structural BMP.

EXPECTED REDUCTIONS

Table 5-13G summarizes the capabilities of full-scale lime precipitation and RO to remove pollutants from the current SEWPCP effluent. The Basin limits for most of the target pollutants can be met with the exception of cyanide and mercury. Because of the minimal to low cyanide reduction potential of the RO and lime precipitation processes, the 10 µg/L effluent limit for cyanide may not be achievable. Compliance with the mercury limit would also be marginal. However, that may be an artifact of the limits of detection for mercury.

ESTIMATED COST

The estimated costs of the full scale lime precipitation and RO facilities are summarized in Table 5-13H. In addition to the capital costs, this BMP would also require significant annual operating and maintenance (O&M) expenditures. The major O&M costs would be for electrical energy and chemicals (lime and sulfuric acid).

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TABLE 5-13F

CHARACTERISTIC OF FINAL OCEAN DISCHARGE

Pollutants	CONCENTRATIONS (ug/l)(a)				
	Brine	RSWPCP Effluent	Brine/ Effluent Mixture(a)	Oceanside Discharge Limits	
				6 Mo. Median	Maximum
Copper	111	165	158	79	772
Lead	7	46	41	154	616
Mercury	4	2	2	3	12
Nickel	73	60	61	385	1540
Silver	9	91	80	42	203
Zinc	218	504	465	932	5552

(a) Concentration in brine effluent mixture are estimated based on 3.4 mgd of brine and 22 mgd of Richmond Sunset WPCP effluent. 95th percentile values were used for estimates.

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TABLE 5-13G

Parameters	Concentrations (ug/l)		
	Influent(a)	Final Effluent	Basin Plan Limits
Copper	53	10	17
Lead	12	1	53
Mercury	0.7	0.2	0.2
Nickel	15	5	65
Silver	6	1	23
Zinc	190	10	840
Cyanide	26	15	10

(a) Influent values for this BMP are 95th percentile of SEWPCP effluent concentrations in 1991.

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TABLE 5-13H

FULL SCALE TREATMENT OPTION: ESTIMATED ANNUAL COSTS

Component	Cost
Construction Costs(a)	
Reverse Osmosis	$110,100,000
Lime Precipitation	$45,000,000
Filtration	$32,600,000
Sludge Dewatering	$25,800,000
Brine Reduction	$41,600,000
Subtotal	**$255,100,000**
Annualized Construction Costs(b)	**$26,000,000**
Annual O&M Costs:	
Electrical	$17,700,000
Labor	$3,400,000
Chemicals	$18,600,000
Membranes and Filters	$10,800,000
Maintenance	$3,100,000
Brine Disposal	$7,300,000
Subtotal	**$60,900,000**
Total Annual Costs	**$86,900,000**

(a) Estimated 1992 cost including 25% contingency and 20% contractor overhead and profi
(b) Amortization factor = 20 years at 8% = 0.102

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SECTION 6

EVALUATION OF DRY WEATHER BMPs

and non-economic criteria. These evaluation criteria were developed to provide a quantitative system of ranking the BMPs such that favorable BMPs could be recommended for implementation.

Cost-effectiveness is measured by the cost of each BMP to reduce the pollutants of concern. The non-economic evaluation is based on an assessment of whether a BMP would have a positive effect ("+"), a negative effect ("-"), or no effect ("0") on eleven non-economic criteria. The sum of these scores for each BMP would form an overall picture of its advantages and disadvantages.

In accordance with the BMP Study Plan (CCSF 1991E), the BMP evaluation criteria were divided into two tiers, Tier I and Tier II, based on their importance to the success and value of a given BMP. Each of the criteria in these tiers is discussed below in relation to the thirteen BMPs. A summary of the evaluation, the recommended BMPs, their cumulative effect on SEWPCP's final effluent, and the costs and staffing requirements are presented at the end of this section.

TIER I EVALUATION CRITERIA

The Tier I evaluation criteria are considered to be of greater importance to the success and value of a BMP. These criteria include cost-effectiveness, time to achieve results, compatibility with other CCSF source reduction programs, requirement for legal changes, and effect on effluent limits.

Cost Effectiveness

Table 6-1 summarizes the estimated loadings and reductions for the thirteen dry weather BMPs. Reverse osmosis would have the highest reduction potential, approximately 27,000 pounds per year (lb/yr) from the effluent loading. BMPs 11 (recording field observations) and 12 (treatment plant chemicals) would not reduce influent loadings to the SEWPCP. BMP No.11 would be extremely beneficial for implementation of other BMPs, but would not directly result in any influent loading reductions. Among the other BMPs, the following observations on the primary pollutants of concern can be drawn.

- Copper Reduction - The BMPs with the highest reduction potential are water supply (No. 8), cooling towers (No. 9), public education (No. 1), automotive service facilities (No. 6), root killers (No. 3) and laboratories (No. 7); in that order.

- Mercury Reduction - The BMPs that are expected to reduce the mercury loadings are medical and commercial laboratories (No. 7), public education (No. 1), and home improvement products (No. 4). CCSF's efforts to regulate dental facilities should provided additional mercury reduction.

- Cyanide Reduction - BMPs with cyanide reduction potential are public education (No.1), home improvement products (No. 4), automotive service facilities (No. 6), and laboratories (No.7). In general, the BMPs evaluated were not found to be major sources of cyanide. This concurs with CCSF's Cyanide Evaluation Study. Cyanide was not found in the wastewaters of many small quantity generators sampled.

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TABLE 6-1

SUMMARY OF ESTIMATED LOADINGS AND REDUCTIONS
[lbs/yr]

BMP No.(a)	Copper		Lead		Mercury		Nicke
	Total Loadings	Estimated Reductions	Total Loadings	Estimated Reductions	Total Loadings	Estimated Reductions	Total Loadings
1	8,000	400	2,800	140	110	6	2,260
2	15	15	60	60	0.2	0.2	90
3	200	200					
4	40	10			10	2	
5							
6	1,300	260	2,900	580	1	0.1	200
7	370	190	20	10	28	14	310
8	10,000	2,800	800	200			
9	1,600	800					
10	10	10	30	30			
12	15	0	10	0			4
13	5,800	5,100	1,200	1,100	40	20	1,800

BMP No.(a)	Silver		Zinc		Cyanide	
	Total Loadings	Estimated Reductions	Total Loadings	Estimated Reductions	Total Loadings	Estimated Reductions
1	260	10	34,500	1,720	1,000	50
2			2,850	2,850		
3						
4			3,500	700	30	10
5		500				
6			1,700	350	10	2
7	30	15	300	150	4	2
8						
9			4,600	2,300		
10			50	50		
12	1	0	10	0		
13	600	500	17,600	16,800	4,000	1,800

(a) BMP No. 11 would not directly reduce pollutants of concern.

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- PAHs Reduction - There are minimal data available on the reduction and treatment of PAHs. As stated in Section 4, PAHs is essentially a by-product of combustion. The major

scrubbers (No. 9) could potentially reduce PAHs. Of these three potential sources, the presence of PAHs has been noted in the literature. However, there is no documentation of quantities in the literature or at other POTWs. In addition, since PAHs are by-products of the combustion process; reduction measures, other than reducing the sources of combustion, may not be readily available.

Table 6-2 presents a summary of the pollutant reductions expected from the implementation of the source reduction BMPs (Nos. 1 through 12). This table indicates that source reduction measures would have the greatest impacts on the copper, lead, and zinc influent loadings.

The cost effectiveness of the BMPs was evaluated in terms of the expected costs per pound of pollutants expected to be removed. The total reductions of each BMP could be calculated as simply the sum of the expected reductions of the individual pollutants. However, this method would not account for the different degrees of toxicity for these compounds. As an example, zinc may be present in higher concentrations than copper prior to exerting the same level of health effects on certain aquatic organisms. This is reflected by their respective effluent limits: 840 µg/l for zinc and 17 µg/l for copper. Therefore, removal of the same quantities of these two compounds would not have the same environmental benefit. This disparity is further compounded by the fact that zinc is generally present in higher concentrations and is more easily removed.

In order to account for the differences in toxicity among the seven pollutants, the total reductions of the BMPs are normalized to a common standard. For this cost effectiveness analysis, copper is arbitrarily selected as the standard reference pollutant. The mass reductions of the six other pollutants analyzed were converted to a copper-equivalent mass reduction by scaling the reductions according to a toxicity conversion factor. The conversion factors used were based on the effluent concentration limits of each pollutant (relative to copper) as contained in the Basin Plan. These conversion factors are listed in Table 6-3. For example, the lead conversion factor of 0.32 is derived from the effluent limit for copper (17 µg/L) divided by that for lead (53 µg/L). This ratio is then multiplied by the expected lead mass reductions for a given BMP to obtain the expected copper-equivalent mass reductions.

Once the expected mass reductions were normalized relative to the copper standard, cost-effectiveness was calculated as follows:

- Annual costs of each BMP were divided by the estimated annual normalized reductions of copper, cyanide, lead, mercury, nickel, silver, and zinc. These seven pollutants are all of some concern to CCSF.

- Annual costs of each BMP were also divided by the estimated annual normalized reductions of copper, cyanide, and mercury. These three pollutants are of primary concern for CCSF to comply with the proposed Basin Plan limits. This second method was used to eliminate biases in the unit cost calculations due to certain pollutants such as zinc. Certain BMPs may reduce high amounts of zinc but would not significantly reduce copper, mercury, or cyanide.

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TABLE 6-2

SUMMARY OF POLLUTANT REDUCTIONS

Pollutant	Source Reduction BMPs (BMP Nos. 1-12)
Copper	4,685
Lead	1,020
Mercury	22
Nickel	410
Silver	525
Zinc	8,120
Cyanide	64

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TABLE 6-3

TOXICITY BASED CONVERSION FACTORS

Pollutant	Conversion Factor
Copper	1
Cyanide	1.7
Lead	0.32
Mercury	81
Nickel	0.26
PAHs	55
Silver	0.74
Zinc	0.02

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Table 6-4 presents a summary of the annual costs and the cost-effectiveness calculated for the thirteen BMPs. The two most costly options are the two structural BMPs, reverse osmosis (No

available. Therefore, the annual costs of BMP No. 13 can be used as the benchmark against which the costs of other BMPs can be compared.

The cost-effectiveness of the non-structural BMPs can be directly compared in Table 6-4. These BMPs would reduce the influent loadings to the SEWPCP. BMPs 3 (root killer) and 11 (record field observations) are expected to impose the lowest annual costs. The cost-effectiveness of BMP No.13 can not be directly compared to the non-structural BMPs since the reverse osmosis pollutant removals occur in the effluent loadings rather than by influent source reduction. The BMP cost-effectiveness evaluation is summarized below.

Cost effectiveness Based on Reduction of All Seven Pollutants:

- BMPs 3 (root killer), 4 (home improvement products), 6 (automotive service facilities), 7 (medical and commercial laboratories), 8 (corrosion control), and 9 (cooling towers) are very cost effective.
- BMPs 1 (public education), 2 (used oil collection), and 5 (photographic wastes) are slightly less cost effective.
- A unit cost for BMPs 11 (record field observations) and 12 (SEWPCP chemicals) cannot be calculated. These BMPs would not reduce any of the pollutants of concern.

Cost effectiveness Based on Reduction of Three Primary Pollutants:

- BMPs 3 (root killer), 4 (home improvement products), 7 (medical and commercial laboratories), 8 (corrosion control), and 9 (cooling towers) are very cost effective.
- BMPs 1 (public education) and 6 (automotive service facilities), are slightly less cost effective.
- Unit costs for BMPs 5 (photographic wastes), 11 (record field observations), and 12 (SEWPCP chemicals) cannot be calculated. These BMPs would not reduce any of the primary pollutants of concern.
- The unit cost of BMP No. 2 (curbside oil collection) would be similar to that of reverse osmosis. However, BMP No. 2 would also reduce PAHs, organics, oil and grease to the treatment plants. In addition, the cost of this BMP could be reduced with a direct user fee. The environmental awareness survey determined that the public would be willing to pay directly for this service.

A comparison of the cost effectiveness of the BMPs is shown graphically in Figures 6-1 and 6-2.

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TABLE 6-4

COST EFFECTIVENESS SUMMARY

BMP No.	Description	Annual Cost ($/yr)	Cost Effectiveness ($/lb removed)(a)	
			7 Pollutants (b)	3 Pollut
1	Educate Public on Household Products	360,000	331	3
2	Program to Report and Prevent Dumping	172,000	1,315	5,5
3	Root Killers	7,000	35	3
4	Home Improvement Products	37,000	182	1
5	Photographic Wastes	76,000	205	N
6	Automotive Service Facilities	89,000	187	3
7	Commercial and Medical Laboratories	81,000	58	6
8	Corrosion Control with SFWD	320,000	112	1
9	Cooling Tower	101,000	119	1
10	Temporary Storage of Recycle Flows	552,000	26,699	55,(
11	Program to Record Field Observations	11,000	NA	N
12	SEWPCP Chemicals	150,000	NA	N
13	Reverse Osmosis	86,900,000	(d)	(

(a) Pollutant reductions used for this ratio were normalized according to toxicity.
(b) Cost effectiveness calculated based on estimated reduction of all 7 pollutants of concern: copper, cyanide, lead, mercury, nickel, silver, and zinc.
(c) Cost effectiveness calculated based on estimated reduction of the 3 primary pollutants of concern: copper, cyanide, and mercury.
(d) The BMP No. 13 unit costs were not included in this comparison since the pollutant removals occur in the effluent loadings rather than by influent source reduction.
NA - Not Applicable. No reductions in this category are expected.

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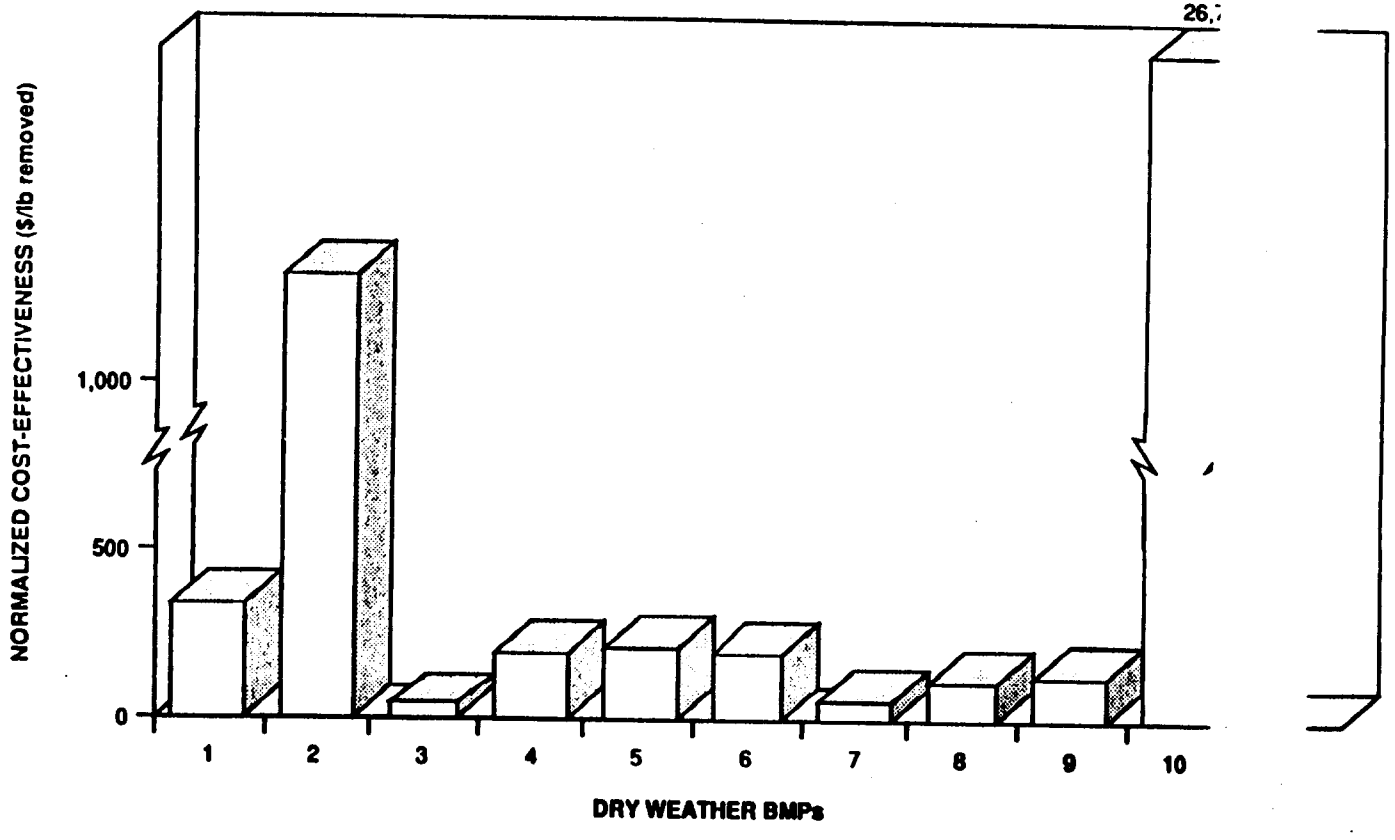

BMP COST EFFECTIVENESS
(Based on Seven Pollutants of Concern and Normalized by Copper-Equivalent Toxicity)

FIGURE 6-1

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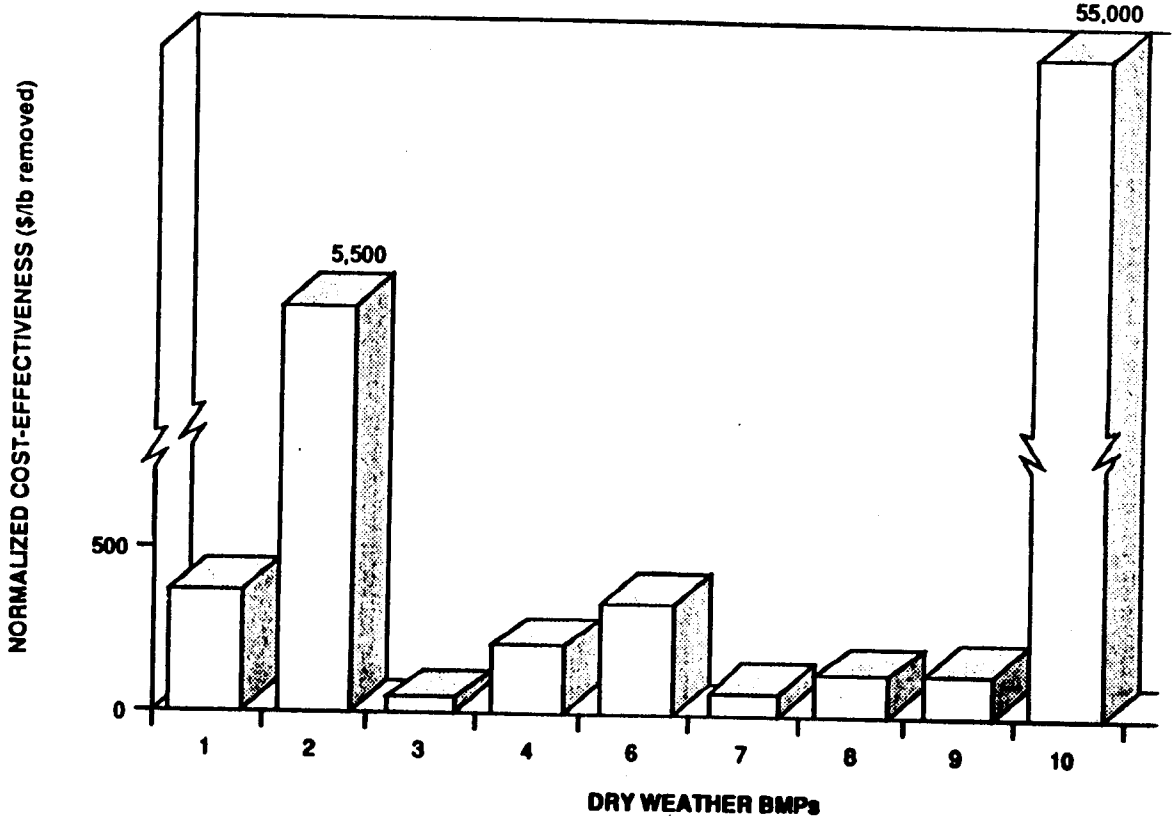

BMP COST EFFECTIVENESS
(Based on Three Primary Pollutants of Concern and Normalized by Copper-Equivalent Toxicity)

FIGURE 6-2

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Time to Achieve Results

BERM decides to proceed with the implementation of a given BMP (i.e., beginning to compile mailing lists, or arranging for design efforts to be initiated). For this criterion, a "+" score was given if results (i.e., reduced loadings) could be expected to be achieved within a year or two of implementing the BMP. Longer term reduction measures were scored with a "-" sign. Table 6-5 presents the evaluation and comparison of the thirteen BMPs in terms of this criterion.

BMPs 2, 3, 6, 7, 9, and 11 would all achieve some level of reductions within a short time of implementation. BMP No. 2 would be effective as soon as a curbside program is in place. Banning of copper sulfate in BMP No. 3 would also have an immediate effect on copper loadings from this source. For BMPs 6, 7, and 9; reductions would be expected within a year after regulation of these businesses. It is expected that identifying businesses for regulation, establishing detailed criteria, and educating the business operators would be performed within the first year. While BMP No. 11 would not directly result in any reduction, its implementation would be very valuable to the other BMPs (1, 2, 3, and 4). Therefore, it is considered to have a positive impact with respect to this criterion.

BMPs 8, 10, and 13 would require a moderate time period for results to be achieved. For BMP No. 8, SFWD is required to monitor its water supply and then perform corrosion control studies to comply with the Safe Drinking Water Act, . Based on the results of corrosion control studies, design and construction of new facilities or replacement pipelines may be required. The whole process may require three or more years to complete. Design and construction of storage facilities (BMP No. 10) or reverse osmosis facilities (BMP No. 13) would take two to four years. Once these facilities were in place, however, results would be achieved immediately.

Longer response times could be expected from BMPs 1, 4 and 5. BMPs 1 and 4 would rely upon increasing public awareness, educating public on environmentally beneficial alternatives, and modifying behavior patterns. It is expected longer time frame would be necessary implement these measures and to achieve significant results. Current regulation of photographic discharger have already reduces SEWPCP loadings significantly. Further regulation of the smaller dischargers in BMP No. 5 would have minimal impact. An extensive effort to control all these minor dischargers may be required before any notable reductions.

BMP No. 12 would not achieve any reductions.

Compatibility with Other CCSF Programs

The evaluation of the BMPs in terms of this criterion is also shown in Table 6-5. Of all of the BMPs, only BMPs 10 and 13 would be considered as incompatible with the other ongoing CCSF programs. The storage facilities proposed in BMP No. 10 would reduce the flexibility for expansion or addition of new facilities at SEWPCP by taking up valuable space on a limited site.

CCSF agencies is implementing a well-developed source reduction program that covers several medium (water, sludge, and solid waste). Due to its high costs, BMP No. 13 would necessarily result in the abandonment of these waste reduction programs that are favored by CCSF as environmentally-sound solutions. Due to its high cost and amount of residuals generated, BMP No. 13 would be incompatible with the source reduction and waste minimization approach recommended by EPA, the State Board, and the Regional Board.

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TABLE 6-5

TIER I NON-ECONOMIC EVALUATION

BMP	Description	Other Tier I Criteria				al(a)
		Time to Achieve Results	Compatibility with Other CCSF Programs	Legal Changes Required	Effluent Limits	
1	Educate Public on Household Products	-	+	+	0	.5
2	Program to Report and Prevent Dumping	+	+	-	+	.0
3	Root Killers	+	+	+	+	.0
4	Home Improvement Products	-	+	+	0	.5
5	Photographic Wastes	-	+	0	-	.5
6	Automotive Service Facilities	+	+	+	+	.0
7	Commercial and Medical Laboratories	+	+	+	+	.0
8	Corrosion Control with SFWD	0	+	+	+	.5
9	Cooling Tower	+	+	+	+	.0
10	Temporary Storage of Recycle Flows	0	-	+	-	.5
11	Program to Record Field Observations	+	+	+	0	.5
12	SEWPCP Chemicals	-	0	+	-	.5
13	Reverse Osmosis	0	-	-	+	.5

(a) Total is the average of Tier I Criteria, multiplied by a factor of 2; where "+" is assigned a value of 2, "0" is assigned a v: and "-" is assigned a value of 0.

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The educational and administrative activities included in BMPs 1, 2, 3, and 11 would be compatible with other CCSF programs. The public outreach efforts, illegal dumping/spill

would have no negative impacts on other CCSF programs. BERM is currently conducting the

discharge of large photographic dischargers. This BMP would add additional resources to expand the current program. BMPs 6, 7, and 9 would also include additional facilities for regulation. These additional facilities can be easily regulated under BERM's existing requirements. BMP No. 8 would be compatible with the SFWD's corrosion reduction efforts as part of complying with the Lead and Copper Rule in the SDWA.

BMP No. 12 would have no effect on other CCSF source reduction programs.

Requirement for Legal Changes

The evaluation of the BMPs in terms of this criterion is also shown in Table 6-5 Of the 13 BMPs, legal changes would only potentially be required for BMPs 2, 5, and 13. Providing citation authority for BERM inspectors as part of BMP No. 2 would require statutory changes to CCSF ordinances with regard to which personnel are permitted to issue citations. The curbside motor oil collection program may require revisions and/or coordination with CCSF Fire, Building and Safety, and Health Codes. Contractual arrangements will be needed with private collection companies hired to operate the programs. For BMP No. 5, regulatory changes would be required in order to allow the collection of residential photographic wastes at the two treatment plants. However, regulatory approval has already been given to a similar collection facility at the Palo Alto Regional Water Quality Control Plant. Approval from the Department of Toxic Substances Control would also be required as part of this BMP.

BMP No. 13 would require large increases in sewer charges or a bond issue. Significant permitting requirements or legal changes would be required for construction for a cross-town brine pipeline, disposal of a concentrated brine in the ocean outfall, and disposal of large quantities of chemical sludge.

Impact on Effluent Limits

The evaluation of the BMPs in terms of this criterion is also shown in Table 6-5. This criterion addressed the effectiveness a BMP would have on complying with the new Basin Plan effluent limits. By design, all of the BMPs would contribute towards compliance; but some would have more impacts than others. SEWPCP is currently meeting effluent limits for all pollutants except for copper, mercury, cyanide, and PAHs. This criterion specifically looks at whether BMPs have a high mass reduction potential for these pollutants.

Of the 13 BMPs, reverse osmosis would have the most reliable, directly controllable mechanisms for reducing the pollutants of concern. However, even the implementation of this BMP may not result in full compliance with the cyanide and mercury limits. Currently, adequate data is not available to verify the performance of the reverse osmosis at these extremely low effluent concentrations.

BMPs 2, 3, 6, 7, 8, and 9 would have positive impacts on complying with the effluent limits. All these BMPs would utilize direct measures, either by providing alternative disposal methods, or by permitting and monitoring, to reduce their targeted pollutants of concern. Corrosion in the water

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supply piping has been identified as the largest single source of copper; BMP No. 8 would have significant impacts on meeting the Basin Plan limits for copper.

The BMPs least likely to impact effluent limit compliance would be BMPs 5, 10, and 12. Silver is the only pollutant affected by BMP No. 5. Since SEWPCP would already comply with the new Basin Plan limit, this BMP would have no impact on this criterion. Due to its low reduction potential, BMP No. 10 would not contribute to meeting the new effluent limits. It would also contribute minimally even in conjunction with other BMPs. The main reason being that removal efficiencies at SEWPCP are not directly controllable. Finally, there is no reduction potential for BMP No. 12.

TIER II EVALUATION CRITERIA

The Tier II evaluation criteria are considered to be of secondary importance to the ranking of a BMP. These criteria include ease of implementation, ability to measure results, public acceptance, promote public awareness, environmental impacts, cross media impacts, and potential to reduce other pollutants. Each of these Tier II criteria are discussed below.

Ease of Implementation by BERM

The evaluation of the BMPs in terms of this criterion is shown in Table 6-6. BMPs 2, 3, 5, 6, 7, 8, 11, and 12 would all be easily implemented by BERM. The BMP No. 2 illegal dumping/spill report hotline and database, and citation authority for BERM inspectors can be implemented relatively easily. Coordination among the departments receiving illegal dumping and spill reports will be required for the database to be comprehensive and effective. The curbside motor oil collection program would require significant preparation, planning and coordination with private collection companies. Publicity and promotion would be required. The activities included in BMP No. 3 will be relatively easy to implement. The activities are consistent with and can be coordinated with other public education and outreach efforts. BMPs 5, 6, 7, and 9 would require significant staffing but could be implemented relatively simply. All the procedures for businesses identification, survey, permitting, monitoring, and enforcement are already in place and being practiced by all PSE staff. BERM would have reduced involvement with BMP No. 8. However, BERM must coordinate between the SFWD and the Regional Board to establish the importance of the potable water quality in complying with the copper. The procedures for data entry and analysis in BMP No. 11 are already established and can be implemented relatively easily. BMP No. 12 can also be easily implemented. Different grade chemicals can be ordered directly from suppliers. There should be no effect on SEWPCP operations; the same chemical feed systems would be used for the new chemicals.

BMPs 1 and 4 would be moderately difficult to implement. Implementing the activities in these BMPs would entail significant amount of time and effort. Numerous individual activities must be organized, planned and implemented and a variety of educational materials must be produced. The activities are part of an ongoing program that will require full time staff support and budgetary resources for materials production, distribution and publicity.

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TABLE 6-6

TIER II NON-ECONOMIC EVALUATION

BMP	Description	Tier II Criteria							Total(a)
		Ease of Implementation CCSF	Ability to Measure Results	Public Acceptance	Promote Public Awareness	Environmental Impacts	Cross Media Impacts	Pote to Re Other P	
1	Educate Public on Household Products	0	-	+	+	+	+	+	1.6
2	Program to Report and Prevent Dumping	+	-	+	+	+	+	+	1.7
3	Root Killers	+	-	+	+	+	+	0	1.6
4	Home Improvement Products	0	-	+	+	+	0	+	1.4
5	Photographic Wastes	+	0	-	+	+	+	+	1.6
6	Automotive Service Facilities	+	0	+	+	+	0	+	1.7
7	Commercial and Medical Laboratories	+	0	+	0	+	0	+	1.6
8	Corrosion Control with SFWD	+	-	+	0	+	+	0	1.4
9	Cooling Tower	+	0	+	0	+	+	0	1.6
10	Temporary Storage of Recycle Flows	-	-	0	-	0	0	0	0.6
11	Program to Record Field Observations	+	-	+	-	0	+	0	1.1
12	SEWPCP Chemicals	+	-	0	-	0	+	0	1.0
13	Reverse Osmosis	-	+	-	-	-	-	+	0.6

(a) Total is the average of Tier II Criteria, where "+" is assigned a value of 2, "0" is assigned a value of 1, and "-" is assigned a value of 0.
Example: Average of BMP No.1 scores (1 "0", 1"-", and 5"+") = 11/7 = 1.6.

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BMPs 10 and 13 would be difficult to implement. Both BMPs would require significant space at the SEWPCP site which is not available. In addition to normal construction-related disruptions,

considerable attention.

Ability to Measure Results

The evaluation of the BMPs in terms of this criterion is also shown in Table 6-6. For many of the BMPs, it would be difficult to positively measuring their effects on the effluent limits. There are two factors that would prevent easy measurement of results:

- Quantifying reduced loadings from numerous small sources.
- Establishing the effects on these reduced loadings on effluent concentrations.

Only BMP No. 13 (reverse osmosis) would allow definitive measurements of results. The reductions from BMP No. 12 can be easily quantified by tracking the amounts of chemicals used on an daily basis. The reductions from BMP No. 13 can be easily quantified by monitoring pollutants concentrations at the influent and effluent of the lime precipitation and RO facilities. BMP No. 12 (SEWPCP chemicals) would not reduce any pollutants.

Other "point source" BMPs; such as those regulating photoprocessing facilities (BMP No. 5), auto service facilities (BMP No. 6), laboratories (BMP No. 7), and cooling towers (BMP No. 9) would allow some level of compliance measurement. They would have sampling points for compliance monitoring or documentation for zero discharge. However, it would be difficult to correlate reductions at these sources to lower influent loadings.

It will be very difficult to measure results from the BMPs that focus on the residential sources (BMPs 1, 2, 3, 4, and 11). Successful implementation of these BMPs would result in small reductions across the entire CCSF. Although the amount of used oil collected in BMP No. 2 can be easily quantified, the amount that would have been illegally discharged, if curbside collection were not available, cannot be accurately measured. As stated previously, BMP No. 11 would not result in any direct reductions. Therefore, its successful must be evaluated as part of the effectiveness of the public education programs. Long-term sampling of solely residential areas may be the only means of determining the effectiveness of these BMPs. A periodic (every 3 to 5 years) environmental awareness survey would also be another measure of their success.

Results from BMP No. 8 would be difficult to measure. Direct measure would require a periodic sampling of tap water at the point-of-use. The sampling effort would have to be similar in scope to the recently completed program. Reductions in the water supply would result in lower influent concentrations; however, whether the reductions are due to the water supply or other source reduction measures would be difficult to differentiate.

The results or effectiveness of BMP No. 10 would be difficult to measure. Pollutant removal efficiencies at a treatment plant depend upon a number of operational factors. Typically, removal efficiencies can vary on a daily basis. Any reductions noted in the final effluent cannot be attributed directly to the storage of the recycle flows.

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Public Acceptance

impact as it would provide further reduction of a pollutant that is not of concern at this time. The expenditures of this BMP could be better utilized for other measures. BMP No. 13 would have a very low public acceptance due to its high cost, high consumption of chemicals and electrical energy, high volume of solids waste generated, and negative impact on the Oceanside discharge.

With the exception of providing citation authority to BERM inspectors, the public can be expected to readily accept the activities included in BMPs No. 1, 2, and 3. Survey results show widespread public support for increased city-sponsored pollution prevention efforts. Over 70 percent of respondents in the environmental survey said that they would use a curbside motor oil collection program. The public may not be receptive to being issued citations by BERM inspectors for improper disposal of toxic substances into storm drains. BMPs 4, 6, 7, and 8 would also have positive impacts as they are concrete steps to reduce pollution and to protect the sensitive Bay environment.

BMPs 10 and 12 would have no impact on public acceptance.

Promote Public Awareness

The evaluation of the BMPs in terms of this criterion is also shown in Table 6-6. BMPs 1 through 6 are expected to have a positive overall effect on promoting public awareness of pollutant loadings to the San Francisco Bay and the positive steps that CCSF are undertaking to control these sources. These BMPs involve direct public and residential outreach activities. The are also associated with businesses (photoprocessing and auto service) that the public has a great deal of contact with.

The more esoteric BMPs, such as those addressing medical labs and cooling towers (BMPs 7 and 9), would have very little impact on public awareness. Similarly, the corrosion control activities under BMP No. 8 will have little impact on public awareness.

The BMPs that only involved BERM and SEWPCP personnel (BMPs 10, 11, 12, and 13) would not promote public awareness of the BMP or source reduction program.

Environmental Impacts

The evaluation of the BMPs in terms of this criterion is also shown in Table 6-6 With the exception of reverse osmosis (BMP No. 13), most of the BMPs, by design, are expected to have a positive impact on the environment. BMP No. 13 would have severe negative environmental impacts due to its high consumption of chemicals and electrical energy, high volume of solids waste generated, and negative impact on the Oceanside discharge. Due to their low reduction potential, BMPs 10, 11, and 12 would have no impact on the environment.

Cross-Media Impacts

The evaluation of the BMPs in terms of this criterion is also shown in Table 6-6. Some BMPs, by reducing the amount of pollutants in the wastewater discharges, could result in increases of pollutants to other media (air or solid wastes).

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BMPs 1, 2, 3, 5, 8, 9, 11, and 12 are not expected to have any cross media impacts. All these BMPs would result in reduced usage of pollutants. No additional pollutants would be transferred or generated. In BMP No. 2, the curbside motor oil collection program would collect used oil that

processed for silver recovery, they would be no significant additions to the other media.

The activities of BMPs 4, 6, 7, and 10 could increase loadings to the solid waste stream. BMPs 4, 6, and 7 could result in additional wastes to be transported and disposed of as liquid hazardous waste. BMP No. 10 would have a small negative impact on cross-media concerns. Any reduction in the liquid streams would be added to the solids stream. However, since the reduction potential is low, any negative impact would be minimal.

BMP No. 13 would have significant cross media impacts. Pollutants removed from the SEWPCP liquid streams would be transfer to the chemical sludge and to the Oceanside outfall. There would be no overall reduction in pollutants discharge to the environment.

Potential to Reduce Other Pollutants

The evaluation of the BMPs in terms of this criterion is also shown in Table 6-6 BMPs 1, 2, 4, 5, 6, 7, and 13 have the potential to reduce compounds other than copper, mercury, cyanide, and PAHs. BMP No. 1 has the potential to reduce the amount of all constituents of concern entering the CCSF treatment system. BMP No. 2 would reduce organics, oil and grease, and PAHs as a result the curbside motor oil collection program. BMPs 4, 6, and 7 have the potential to reduce other organic and inorganic pollutants entering the SEWPCP from paints, automotive shops, and various laboratory reagents, respectively. In addition to being a copper source, automotive shops are expected to be significant contributors of organics and oil and grease. BMP No. 5 would have the potential to reduce other pollutants such as chromium and selenium from photoprocessing operations. However, the potential reduction would be fairly small. Reverse osmosis activities as a result of BMP No. 13 could be expected to remove many other pollutants from the effluent wastestream. The RO membranes remove the soluble pollutants by size, so any larger organics or metal compounds comparably sized to the targeted compounds would be likewise removed.

BMPs 3, 8, and 9 are targeted to specific pollutants, with a particular focus on copper. BMPs 8 and 9 may result in reductions in the loadings of some other corrosion by-products (e.g., iron and lead), but these reductions are expected to be minimal. BMP No. 9 may have substantial impacts on zinc loadings, but will have little impact on other compounds.

Reductions from BMPs 10, 11, and 12 are expected to be so low that the potential to reduce other pollutants should be considered as negligible.

RECOMMENDED DRY WEATHER BMPs

The results of the cost effectiveness and non economic evaluation are summarized in Table 6-7. Based on the above evaluation, it is recommended that CCSF implement the following BMPs in a two-phased approach. The first phase BMPs should be implemented by the end of Fiscal Year 1993-94. The second phase BMPs should be implemented by the end of Fiscal Year 1995-96. This two-phased approach would allow CCSF to focus on measures that would have the most impacts. The experience gained from these initial BMPs can then be easily applied to the subsequent BMPs. Table 6-8 lists the total reductions expected from all of the recommended dry weather BMPs.

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TABLE 6-7

EVALUATION SUMMARY

BMP No.	Description	Cost Effectiveness ($/lb removed)(a)		Non-Ec Evalua
		7 Pollutants	3 Pollutants	
1	Educate Public on Household Products	331	371	4.
2	Program to Report and Prevent Dumping	1,315	5,513	4.
3	Root Killers	35	35	5.
4	Home Improvement Products	182	196	3.
5	Photographic Wastes	205	NA	3.
6	Automotive Service Facilities	187	328	5.
7	Commercial and Medical Laboratories	58	61	5.
8	Corrosion Control with SFWD	112	114	4.
9	Cooling Tower	119	126	5.
10	Temporary Storage of Recycle Flows	26,699	55,000	2.
11	Program to Record Field Observations	NA	NA	4.
12	SEWPCP Chemicals	NA	NA	2.
13	Reverse Osmosis	(c)	(c)	2.

NA - Not Applicable. No reductions in this category are expected.

(a) Normalized to a copper-equivalent.

(b) The sum of the Tier II and Tier I criteria scores.

(c) The BMP No. 13 unit costs were not included in this comparison since the pollutant removals occur in the effluent loadings rather than by influent source reduction.

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TABLE 6-8

TOTAL REDUCTIONS

BMP No.	Description	Reductions (lbs/yr)						
		Copper	Lead	Mercury	Nickel	Silver	[illegible]	Cyanide
1	Educate Public on Household Products	400	140	6	110	10	1	50
2	Program to Report and Prevent Dumping	15	60	0.2	90		2	
3	Root Killers	200						
4	Home Improvement Products	10		2				10
6	Automotive Service Facilities	260	580	0	50			2
7	Commercial and Medical Laboratories	190	10	14	160	15		2
8	Corrosion Control with SFWD	2,800	200					
9	Cooling Tower	800					2	
Total		4,675	990	22	410	25	8	64
Influent Loadings (85 mgd)		30,000	9,000	260	4,000	4,000	91	8,600

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The BMPs selected for Phase I implementation are cost effective and/or are rated as highly favorable among the non-economic criteria. These BMPs include the following:

the corrosion control study by SFWD.

- BMPs 6 (automotive service facilities), 7 (medical and commercial laboratories) and 9 (cooling towers). Laboratories and cooling towers are currently unregulated and may be significant contributors of copper and mercury. Radiator repair and car washes are currently regulated by BERM. However, many other businesses related to automotive service (auto dealers, body shops, gas stations, general repair, trucking, buses, and fleet services) may also be significant contributors.

- BMP No. 3 (copper sulfate root killer). This BMP represents the most easily identifiable residential contribution. Cost of implementation would be extremely low.

- BMPs 1 (public education), 2 (used oil collection), and 11 (record field observations). Although these BMPs are not considered especially cost effective in terms of pollutant reductions, they should be applied as general measures rather than to target specific pollutants. Additionally, a strong program focusing on residential contributions and reductions is an integral part of an effective overall source reduction effort.

The single Phase II BMP will be BMP No.4 (home improvement products). This BMP is slightly more cost effective than some of the Phase I BMPs, but had slightly lower non-economic ratings. As part of BMP No. 4, boatyards within CCSF should be inspected and considered for regulation. This BMP should be initiated approximately two years after the Phase I BMPs.

The following BMPs are not recommended for implementation by CCSF.

- BMP No.5 (photographic wastes). CCSF already has a successful program in place to regulate the large photographic waste dischargers. SEWPCP would easily comply with the new Basin Plan limit for silver. Additional regulations as part of this BMP would have minimal benefits.

- BMP No.10 (recycle flow storage). This BMP would require significant physical facilities for minimal reduction. Implementation of this BMP would also reduce site availability at SEWPCP and limit future expansion flexibility.

- BMP No.12 (SEWPCP chemicals). The reduction potential of this BMP would be very minor. Depending on the results of the other BMPs, this BMP may be reviewed after several years for implementation.

- BMP No.13 (reverse osmosis). Capital and operating and maintenance (O&M) costs of this BMP are extremely high. Even with these expenditures, compliance with all the Basin Plan limits would be uncertain. There is no information on cyanide removal efficiency with reverse osmosis, and compliance with this limit may not be achievable. This BMP would generate significant negative impacts associated with high energy usage and generation of residual chemical sludge and concentrated brine that would require alternative disposal. Finally, due to its high annual costs, implementation of this BMP would likely reduce the CCSF funding available for implementation of the source control BMPs discussed above.

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pollutants is in the particulate form rather than the soluble form and is, therefore, more readily removed. For soluble pollutants such as cyanide, lower influent concentrations would result in less opportunities for adsorption and biodegradation. The influent concentrations of copper, cyanide, and mercury are plotted against their removal efficiencies in Figures 6-3 to 6-5. A logarithmic curve fit is shown for each pollutant. While the correlation of these variables are not very strong, the plots generally illustrate the trend of decreasing removal efficiency with lower influent concentrations.

Table 6-9 compares the current effluent 95th percentile concentrations of copper, mercury, and cyanide; their estimated concentrations after the implementation of the recommended BMPs; and the proposed Basin Plan limits. As shown on the table, the implementation of the BMPs may not reduce copper, mercury, and cyanide concentrations to below the Basin Plan limits. Due to the variability inherent in estimating loadings and reductions, the ability to comply with the proposed limits will only become apparent after implementation of these BMPs. However, it must be pointed out that these source reduction measures are the most environmentally acceptable methods to deal with the water quality requirements. There are no direct controls over effluent quality with influent source reduction measures. Final effluent quality is dependent upon influent concentrations and removal efficiencies at the treatment plant. Both factors are known to vary significantly on a day-to-day basis.

In addition to implementing source reduction measures, CCSF staff are also investigating other means to comply with the Basin Plan limits. These other potential means are listed below.

- Development of a watershed management approach to toxicity control as proposed jointly by the League of California Cities, California Association of Sanitation Agencies, and the California Water Pollution Control Association (Tri-TAC). The watershed management approach would consider all significant sources of pollutants (both point and non-point sources) and would focus on the sources that can most effectively be reduced to comply with the water quality objectives.

- Evaluation of a water reuse master plan to export wastewater from the greater Bay area to the central valley for irrigation reuse. If successful, this project would completely eliminate the discharge of toxic pollutants to San Francisco Bay.

- Evaluation of cross-town tunnel to deliver the entire SEWPCP effluent to an ocean outfall. As indicated earlier in this report, treated effluent from the CCSF wastewater treatment facilities would comply with the Ocean discharge requirements.

CCSF staff is actively participating in the development and evaluation of the above activities. These compliance options will continued to be pursued in conjunction with the implementation of the recommended BMPs.

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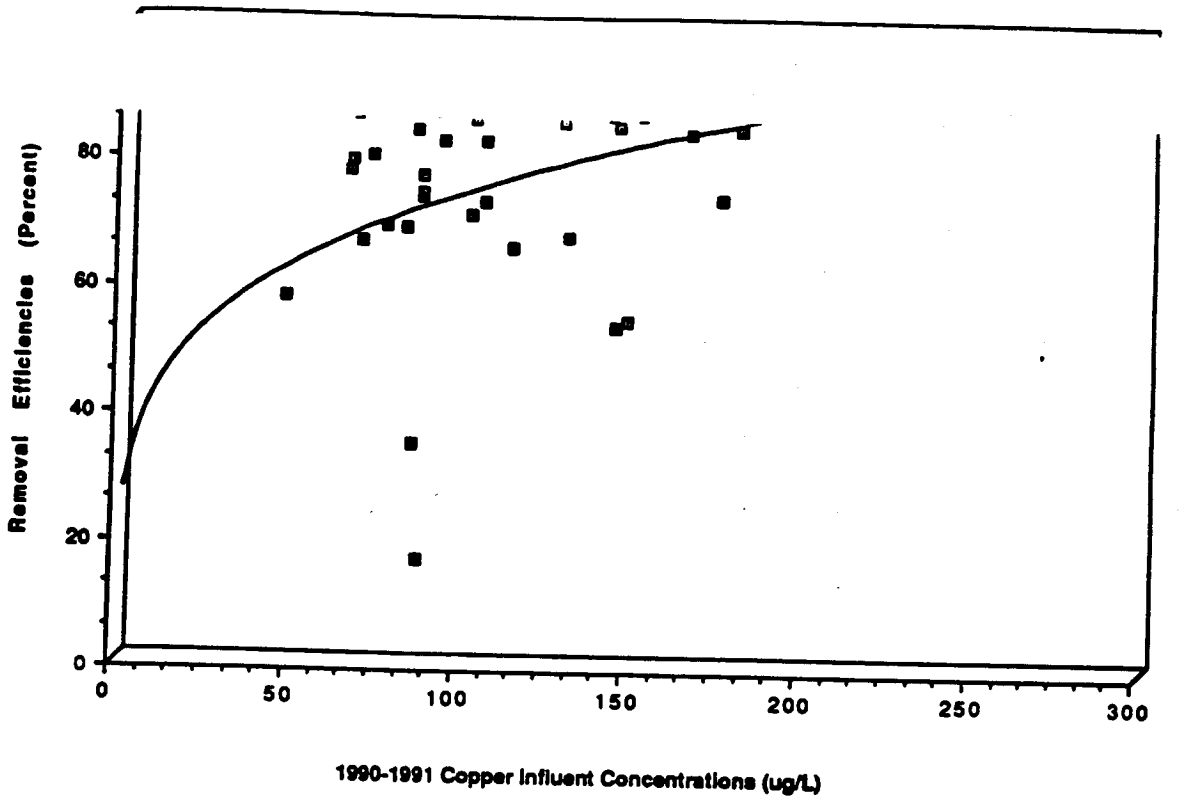

COPPER INFLUENT VS. REMOVAL EFFICIENCY

FIGURE 6-3

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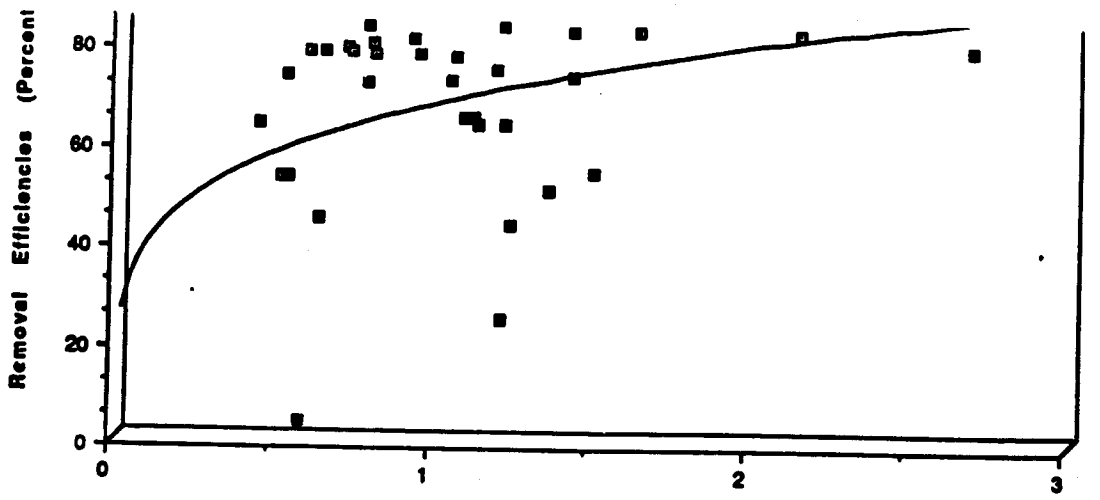

MERCURY INFLUENT VS. REMOVAL EFFICIENCY

FIGURE 6-4

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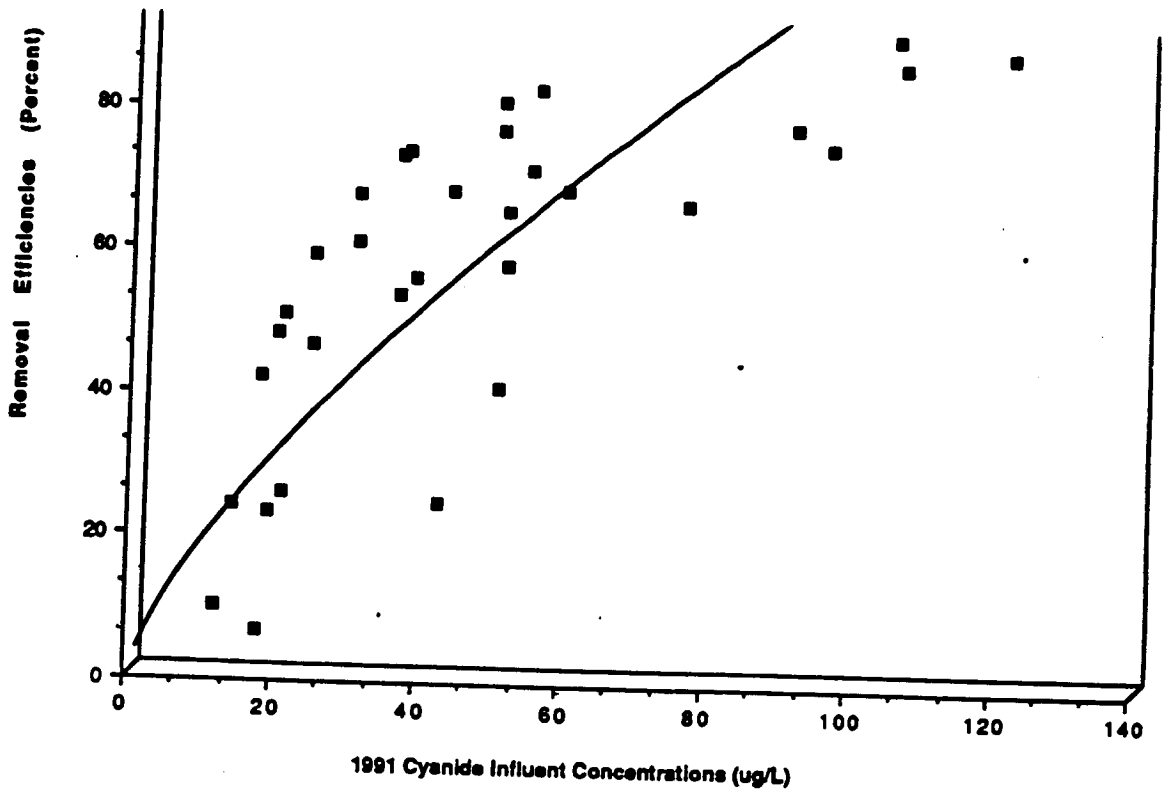

CYANIDE INFLUENT VS. REMOVAL EFFICIENCY

FIGURE 6-5

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TABLE 6-9

Pollutant	Current Effluent Concentrations (a)	Estimated Effluent Concentrations (a)	Basin Plan Limits
Copper	53	45	17
Mercury	0.7	0.6	0.2
Cyanide	26.4	26	10

(a) Effluent concentrations listed represent the 95th percentile value.

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recommended Phase I BMPs would be approximately $1.2 million per year. Implementation of Phase II (BMP No.4) would impose an additional annual cost of approximately $37,000. Approximately 2.5 source reduction specialists would be required to implement these BMPs. A public education coordinator and a public education assistant have been listed for BMP No. 1. In actuality, they will be providing public participation services for all the recommended BMPs.

ADDITIONAL RECOMMENDATIONS

CCSF adopted new local limits for its pretreatment program in December 1991. These local limits were developed on a technical basis in accordance with EPA guidelines. However, the effluent limits used in that evaluation were based on the existing NPDES permits and the 1986 Basin Plan discharge limits. As discussed above, the 1991 Basin Plan has proposed significantly more stringent effluent limits. Although these limits are not currently in any CCSF permit, they are expected to be included in the SEWPCP permit when it is scheduled for renewal in 1994. Additionally, imminent changes to the 503 Sludge regulations may also have some impacts on the local limits.

Several of the recommended BMPs would require utilizing local limits as the means for regulation. Since these BMPs have been developed in response to the new Basin Plan, local limits should be re-evaluated. Notification of potential local limits revisions would be beneficial to businesses that are selecting treatment or disposal methods for their wastes.

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TABLE 6-10

DRY WEATHER BMP ANNUAL COST SUMMARY

BMP No.	Description	Annual Cost ($/yr)
Phase I		
1	Educate Public on Household Products	360,000
2	Program to Report and Prevent Dumping	172,000
3	Root Killers	7,000
6	Automotive Service Facilities	89,000
7	Commercial and Medical Laboratories	81,000
8	Corrosion Control with SFWD	320,000
9	Cooling Tower	101,000
11	Program to Record Field Observations	11,000
	Subtotal	**$1,141,000**
Phase II		
4	Home Improvement Products	37,000
	Subtotal	**$37,000**
Total		**$1,178,000**

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TABLE 6-11

STAFFING SUMMARY

BMP No.	Description	Staff (Person/Year)			
		Source Reduction Specialist	Public Education Coordinator	Public Education Assistant	C St
1	Educate Public on Household Products		1	1	
2	Program to Report and Prevent Dumping	0.25			
3	Root Killers	0.08			
4	Home Improvement Products	0.25			
6	Automotive Service Facilities	0.5			
7	Commercial and Medical Laboratories	0.25			
8	Corrosion Control with SFWD	0.04			
9	Cooling Tower	1			
11	Program to Record Field Observations	0.04			
Total		2.5	1	1	

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SECTION 7

SELECTION OF WET WEATHER BMP FOR EVALUATION

This is the first of three sections (7-9) addressing wet weather best management practice (BMP) selection and evaluation. The content and format of these wet weather sections generally follows that of dry weather sections 4-6. Section 7 discusses the initial selection of BMPs; section 8 describes the best management practices in more detail; and section 9 presents the results of the final evaluation, including BMPs recommended for implementation.

This section accomplishes the following:

- Identifies the City's wet weather pollutants of concern;
- Identifies the principal sources of the pollutants of concern; and
- Selects best management practices for further development (section 8) and evaluation (section 9).

BACKGROUND

San Francisco has a system of underground sewer lines that collect domestic sewage and industrial wastewater and transport it to the City's Water Pollution Control Plants (WPCPs) for treatment. As in most older cities in the United States, these sewer lines also receive street runoff and other storm water. During rainy periods, the storm water flow rate can reach 60 times the dry weather rate. To handle this huge storm water flow combined with sewage, San Francisco's combined system includes a series of long, underground box-like structures known as storage/transports which ring the City like a moat.

By 1996, when San Francisco completes its wastewater facility improvement program, approximately 66% of the storm flow will be held for secondary level treatment at the Southeast or Oceanside WPCPs. The remaining 34% of the storm flow will receive flow-through treatment within the storage/transports or primary treatment and disinfection at the North Point WPCP. Flow-through treatment is accomplished by passing the storm flow through a baffle and weir system within the storage/transports before discharging the flow either through the Southwest Ocean Outfall or as combined sewer overflows (CSOs) via shoreline overflow points. These wet weather overflows and their associated pollutants are the focus of the wet weather portion of this BMP Study. The wet weather best management practices being studied focus on preventing pollutants of concern from entering the combined sewer system via storm water runoff.

IDENTIFICATION OF POLLUTANTS OF CONCERN

Studies in many urban areas have shown that urban runoff typically contains significant quantities of the same general types of pollutants that are found in wastewaters discharged by Publicly-Owned Treatment Plants (POTWs) and industries, and that they cause similar water quality problems. The National Urban Runoff Program (NURP) has shown that storm water from residential and commercial areas can contain a variety of pollutants, including heavy metals, fecal coliforms, pesticides, suspended solids, nutrients, and floatables (USEPA, 1983A).

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A recent study conducted by Santa Clara County indicated that storm water is a significant contributor of sediment and heavy metals such as chromium, copper, lead, nickel, and zinc (Santa Clara Valley Nonpoint Source Control Program, 1990).

1. Pollutants exceeding NPDES permit limits;
2. Pollutants potentially contributing to general receiving water problems (e.g. exceedances of water quality standards in either the Ocean Plan, the Enclosed Bays and Estuaries Plan, or the Region II Basin Plan);
3. Pollutants in compliance but near permit limits;
4. Pollutants contributing to bioaccumulation, and/or biomagnification; and
5. Pollutants contributing to existing and potential sediment toxicity problems.

The pollutants of most concern in the wet weather discharges are those that cause a violation of the City's discharge permits. These permits are issued by the Regional Water Quality Control Board (RWQCB) or, in the case of the discharge through the Southwest Ocean Outfall, by the U.S. Environmental Protection Agency (USEPA). Presently, none of the City's discharges during dry or wet weather violate permits or the associated compliance orders.

Although the City's wet weather discharges are currently in compliance, this situation may change as new water quality objectives are incorporated into permits in the coming years. There is an ongoing debate at both the national and state level as to whether and how these water quality objectives should apply to storm water discharges and combined sewer overflows. If these objectives are applied as written to the City's wet weather discharges, the City would be in significant noncompliance with several numerical limits.

To assess the potential for future noncompliance, several data sources (SWRCB, 1991; SWRCB, 1992; City and County of San Francisco (CCSF, 1990A; CCSF, 1991D; CCSF, 1992) were reviewed to compare constituent concentrations in the overflow discharges to the selection criterion (Appendix D). The City compared Bayside overflow concentrations from 1989 to 1992 to water quality objectives in the Amendments of the Water Quality Control Plan for Enclosed Bays and Estuaries of California (SWRCB, 1992). As a result of this review, pollutants of concern were grouped into three tiers, in descending order of concern:

Tier 1 **Significant concern** - Three year mean pollutant concentration 10 times greater than potential water quality objective without dilution.

- Polynuclear Aromatic Hydrocarbons (PAHs)
- Copper
- Lead
- Cyanide

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Tier 2 **Moderate concern** - Three year mean pollutant concentration greater than potential

- **Mercury**
- **Nickel**
- **Silver**
- **Zinc**

Tier 3 **Little concern** - Three year mean pollutant concentration less than potential water quality objective without dilution.

- **Chromium**
- **Arsenic**

It is clear that if the water quality objectives are included in the permits and applied to San Francisco's wet weather discharges, then the City will have a serious compliance problem. Therefore, the wet weather portion of the BMP Study focussed on reducing the Tier 1 and Tier 2 pollutants of concern namely PAHs, heavy metals, and cyanide.

IDENTIFICATION OF POLLUTANT SOURCES

Source Identification Methodology

A literature search was conducted to identify the sources of these pollutants. The City reviewed City-specific reports as well as general literature sources on storm water runoff (City of Puyallup, 1988; City of Seattle, 1989; Minnesota Pollution Control Agency, 1989; Natural Resources Defense Council and Chesapeake Bay Foundation, 1990; USEPA, 1990; USEPA, 1991; Citizens for a Better Environment, 1991; Santa Clara Valley Nonpoint Source Control Program, 1990; Washington Department of Ecology, 1992). In addition, City staff from the Bureau of Environmental Regulation and Management (BERM), the Bureau of Street Cleaning and Urban Forestry (BSCUF), and the Bureau of Street and Sewer Repair (BSSR) were interviewed regarding potential sources.

Review of Pollutant Sources

As a result of the literature review and information gathering process, CCSF has identified two broad source classes, primary and secondary. The distinction between primary and secondary sources has been made to help focus the discussion of source control strategies. Pollutants of concern may be reduced more effectively by addressing each of the various pathways by which the pollutants may enter storm water. Primary and secondary sources are defined below.

Primary Sources - These are materials or material uses which provide the first opportunity in an urban setting for pollutant contact with rainfall or runoff. Examples of primary sources are automobiles (which contribute oil, grease, and metals through leaks, exhaust, metal corrosion, and tire wear), waste disposal practices, and raw products exposed to storm water.

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Secondary Sources - Some sources of pollutants, termed secondary sources, are difficult to isolate and quantify. These include air-borne particulates and sediments which accumulate throughout CCSF's infrastructure (streets, catch basins, storage/transports, and low-flow sections of sewerage system). Some primary sources become secondary sources when they are not

because they may absorb a certain amount of heavy metals and hydrocarbons under one set of chemical conditions (e.g., pH), and release these pollutants later as a result of changing conditions.

Primary Sources. Table 7-1 summarizes the primary sources of the City's wet weather pollutants of concern, including both general wet weather sources and commercial/industrial sources. The primary sources of pollutants of concern during wet weather may be grouped into three general categories:

- **Automotive-related** - Motor vehicles deposit oil and grease, tire particles, and metals directly on the roadways. These pollutants and others, such as cyanide and PAHs, from vehicle emissions are flushed away by rainfall and eventually end up in the sewer system.
- **Paints/Wood preservatives** - Paint and wood preservative products contain a number of heavy metals.
- **Businesses with outside exposure** - Other potential primary sources include businesses with outside storage or manufacturing yards. Businesses that generate and/or discharge pollutants of concern, which may come into contact with rainfall and/or runoff, are potential primary sources. These businesses include those that use automotive or paint/wood preservative products such as auto repair shops, painting contractors, and equipment rental shops that often clean their equipment outside with water that later enters the sewer system as runoff.

Secondary Sources. The major secondary source of pollutants in San Francisco is sediment. Sediments occur in the following places throughout the City's wastewater and storm water collection system:

- streets and sidewalks,
- catch basins,
- sewer pipes,
- storage/transports,
- treatment plants, and
- outfalls.

The principal sources of the wet weather pollutants of concern are automotive-related activities, paint/wood preservative uses businesses with outside exposure, and infrastructure sediments. Of these sources, automotive-related and paint/wood preservatives are discussed and include specific best management practices in the dry weather sections (4-6) of this report. Therefore, the target sources for further development of wet weather BMPs are:

- Businesses with outside exposure, including those using automotive or paint/wood preservative products, and
- Secondary sources (i.e., infrastructure sediments).

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TABLE 7-1

PRIMARY WET WEATHER SOURCES OF POLLUTANTS OF CONCERN

Pollutants of Concern	General Wet Weather Sources	Businesses with Potential Outside Exposure
	Oil and grease Tar shingles Tires Wood preservatives	
Copper	Algicides Brake linings Paints/wood preservatives Vehicle metal corrosion	Auto Service/Repair Electrical Equipment Manufacturing Metal Finishing Paints/Inks/Printing
Lead	Batteries Paints Vehicle exhaust	Auto Service/Repair Equipment Rental
Cyanide	Animal wastes Cyanogenic insects Microorganisms Vehicle exhaust	Printing/Publishing Metal Finishing Silverware Manufacturing
Cadmium	Gasoline Oil Tires	Auto Service/Repair Metal Finishing
Mercury	Paints	Printing/Paper Hanging Contractors
Nickel	Paints	Wholesale Equipment & Machinery Local Trucking Auto Service/Repair
Zinc	Atmospheric fallout Galvanized iron and steel Paints Tires	Auto Service/Repair Commercial Printing Equipment Rental Local Trucking
Chromium	Vehicle metal corrosion	Auto Service/Repair Metal Finishing

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SELECTION OF WET WEATHER BMP FOR STUDY

The Best Management Practices Study Plan for Water Pollution Prevention (Study Plan) (CCSF, 1991B) describes the City's plan for this study of eight best management practices (referred to as Optional BMPs) in addition to the ten best management practices already being implemented (referred to as Mandated BMPs) by San Francisco. The Mandated BMPs were described in Provision E.8.a of RWQCB Order 90-093, while Provision E.8.b described the Optional BMPs. Of the eight Optional BMPs, four are targeted primarily at wet weather conditions (Table 7-2). The other four best management practices focus on dry weather conditions and are discussed in sections 4-6 of this report.

As described in the Study Plan, the Optional BMPs were selected from a list of BMPs developed by other Bay area municipalities. Best management practices were determined to be more effective if based on information specific to San Francisco, including pollutants of concern, sources, and existing programs. Therefore, a screening process was applied to the Optional BMP list (Table 7-2) to determine if any best management practices should be added or dropped from the original list.

Selection Methodology

The data considered in the selection were primarily qualitative. The steps followed in the selection process are outlined below.

1. Review Optional BMPs against Mandated BMPs - Because the Mandated BMPs required in the permit and now being implemented were focussed primarily on wet weather conditions, the City began the screening process by comparing the Optional BMPs in the context of the City's existing Best Management Practices Implementation Program (CCSF, 1990E). The Optional BMPs were reviewed for their ability to compliment the Mandated BMPs for the pollutants of concern and their sources.

2. Data collection - The City gathered qualitative data on the Optional BMPs from City agencies, supported by quantitative data which were easy to gather, reliable, and complete.

3. Data analysis - The information collected was discussed with personnel from the Bureau of Water Pollution Control (BWPC), the Department of Public Health (DPH), the Solid Waste Management Program (SWMP), and the inter-agency BMP Review Committee.

4. BMP selection - Based on the screening process and discussions with City agencies, the City selected five best management practices for further study.

Wet Weather BMPs Selected for Detailed Review

Table 7-3 lists the five BMPs that emerged from the selection process and are reviewed in sections 8 and 9. The list includes the four Optional BMPs from the permit as well as an additional best management practice, P6, shown in italics. Each of these five wet weather best management practices appeared to complement the existing BMP Implementation Program either by addressing pollutant sources not covered by the existing program or by using a different means of implementation (e.g., public agency action versus education) to address a source.

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TABLE 7-2

Educational Control Measures

E1 - Educate re: the environmental impacts which result from leaks and spills from gasoline, fuel oil, and chemical tanks (above and below ground).

Regulatory Control Measures

R1 - Develop and implement program to reduce the risk of toxic pollutant spills from commercial, industrial, and public facilities.

Public Agency Control Measures

P2 - Establish program to regulate cleaning of sewer inlets, catch basins, and drainage channels in areas where sediments and/or debris tend to accumulate.

P4 - Develop and implement an aggressive field program to search for, detect, and correct situations which rainfall and/or runoff presently contact potential contaminants.

SUMMARY

1. The wet weather portion of the BMP Study focussed on reducing the Tier 1 and Tier 2 pollutants of concern namely PAHs, heavy metals, and cyanide.

2. The target sources for further development of wet weather best management practices are:

   - Businesses with outside exposure, including those which use automotive or paint/wood preservative products, and
   - Secondary sources (i.e., infrastructure sediments).

3. The five wet weather best management practices selected for in depth review include the four Optional BMPs, plus a best management practice directed at improved street cleaning.

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TABLE 7-3

SELECTED FOR DETAILED REVIEW

Educational Control Measures

E1 - Educate re: the environmental impacts which result from leaks and spills from gasoline, fuel oil, and chemical tanks (above and below ground).

Regulatory Control Measures

R1 - Develop and implement program to reduce the risk of toxic pollutant spills from commercial, industrial, and public facilities.

Public Agency Control Measures

P2 - Establish program to regulate cleaning of sewer inlets, catch basins, and drainage channels in areas where sediments and/or debris tend to accumulate.

P4 - Develop and implement an aggressive field program to search for, detect, and correct situations which rainfall and/or runoff presently contact potential contaminants.

P6 - Determine the effectiveness of various street cleaning practices and implement improved street cleaning programs where appropriate.

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SECTION 8

DEVELOPMENT OF WET WEATHER BMPs

This section defines and describes each of the five wet weather best management practices (BMPs) selected for detailed review. The following information is provided for each BMP:

- A clear definition and purpose for the best management practice is given.
- Linkages between the best management practice and other BMPs are shown and described. These other BMPs may be Mandated BMPs and/or Optional BMPs. The linkages may be in the form of target source and/or implementation method. Figure 8-1 shows the linkages between some of the wet weather Optional BMPs and other best management practices.
- A description of the pollutants of concern which the BMP addresses.
- Existing conditions in San Francisco related to each BMP are described. The best management practice is evaluated in part by the need for the BMP and by its "fit" with existing programs.
- Means of implementing the BMP are listed and described.
- Cost and expected reduction information is provided (if available).

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BEST MANAGEMENT PRACTICE E1 - LEAK/SPILL IMPACT

EDUCATE THE PUBLIC REGARDING THE ENVIRONMENTAL IMPACTS THAT

INTRODUCTION AND PURPOSE

The purpose of this best management practice is to implement an education program to increase awareness among the general public about the environmental impacts that result from leaks and spills of gasoline, fuel oil, and chemicals from above and below ground tanks. CCSF did not address ground water contamination from leaking underground storage tanks (USTs), as this issue is adequately addressed by other regulatory programs. In CCSF, the Department of Public Health (DPH) oversees cleanup activities through implementation of the Local Oversight Program (LOP).

CCSF evaluated this BMP on its cost-effectiveness in protecting surface water during wet weather conditions. The focus of this best management practice is defined by the City as exposure of rainfall and runoff to leaks and spills from above-ground storage tanks.

LINKS TO OTHER BMPs

This BMP is linked to the following best management practices (see Figure 8-1):

- *P3- Hazards Tracking (dry weather BMP No. 11 in this report):* Develops a centralized database for tracking hazards from spills, exposed contaminants, and illegal dumping incidents. This helps to identify the biggest problems and to target programs accordingly.
- *E4-Rainfall/Runoff Protection (Implementation Program BMP):* Educates the public regarding the need to keep rainfall and/or runoff from contacting potential contaminants.
- *R1-Spill Risk Prevention:* Increases inspection and monitoring of facilities with potential to contribute pollutants of concern in their storm water discharge through spills or lack of physical barriers to keep contaminants from contacting storm water and/or runoff.

POLLUTANTS OF CONCERN

This BMP addresses the following sources of pollutants of concern:

- Gasoline - lead and PAHs, and
- Motor oil - zinc (USEPA, 1975).

Gasoline, motor oil, and diesel fuel also contain trace amounts (< 20 ug/g) of other heavy metals as shown in Table 8-1. It should be noted that lead concentrations in gasoline have been reduced significantly with the mandated introduction of unleaded fuels in the late 1970s.

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Figure 8-1 Linkages Between BMPs to Protect Water Quality of SF Bay

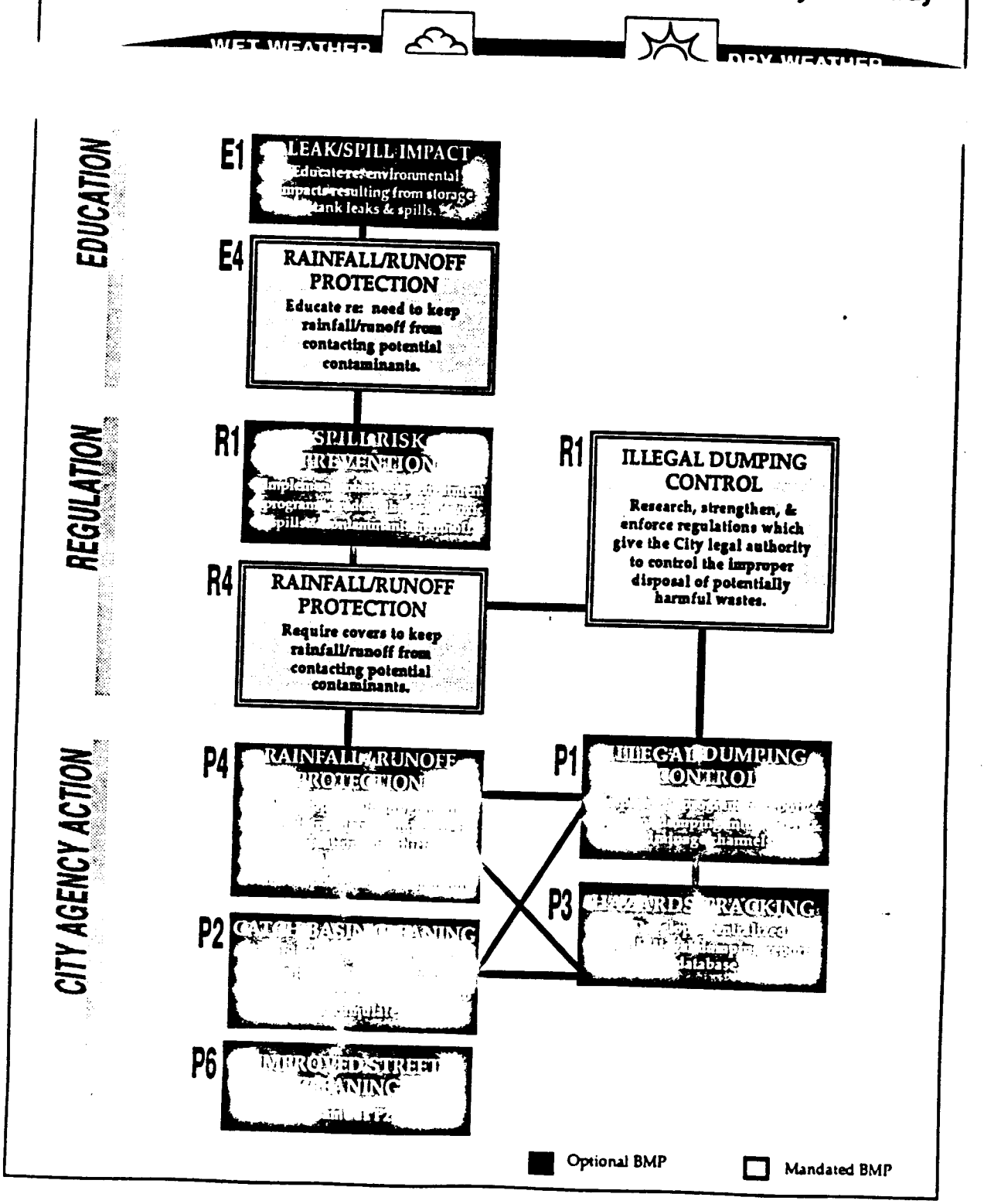

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TABLE 8-1

Metal	Gasoline	Motor Oil	Diesel Fuel
Chromium	15	<2	15
Copper	4	3	8
Lead	660	9	12
Nickel	10	17	8
Zinc	10	1,100	12

Source: USEPA, 1975

EXISTING CONDITIONS

The following information summarizes current findings regarding storage tanks:

- There are 1,500-1,600 active tanks being used throughout CCSF, but no readily available information on how many tanks are above-ground versus below ground, or on the materials contained in these tanks (Lum, 1992).
- There are an estimated 15,000 inactive USTs formerly used for home heating fuel oil (Lum, 1992).
- The Office of the Chief Administrative Officer (CAO), distributes a brochure to underground storage tank owners through workshops and direct mailings.
- Operating permits, pursuant to the Hazardous Materials Ordinance, are required for all underground storage tanks, and for above-ground storage tanks whose capacity exceeds 10,000 gallons (Lum, 1992).
- Secondary containment is required for above-ground tanks (Grey, 1992).
- Storage permits, issued by DPH and approved by the Fire Department, are required for all facilities storing hazardous materials (CCSF, 1991E).
- Most above-ground tanks contain diesel or motor oil, although gasoline is stored in limited quantities (Lum, 1992).

IMPLEMENTATION MEASURES

Implementation of this BMP would involve a public outreach to the owners and operators of above and below ground chemical storage tanks. CCSF would employ a targeted approach to reach the small number of storage tank owners, as opposed to a broad public education campaign. Outreach materials would be developed and CCSF's list of owners and operators would be used to distribute these materials.

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EXPECTED REDUCTIONS

Information gathered during the screening procedure revealed that this BMP may be favored as

quantity the expected reductions from implementing this BMP. However, the following existing conditions seem to indicate that leaks and spills from above-ground tanks are adequately addressed and that expected pollutant reductions from an educational outreach would be minimal:

- Operating permits for large above-ground tanks;
- Secondary containment required for above-ground tanks; and
- Storage permits required for hazardous materials.

It appears that training CCSF employees as part of R1 (Spill Risk Prevention) and recording spill information (Dry Weather BMP P3 (No. 11)-Hazards Tracking) may be more cost-effective means for increasing awareness among groups who come into direct contact with leaks and spills from storage tanks.

ESTIMATED COSTS

The cost to develop an outreach piece, to maintain an accurate mailing list, and to conduct a one time mailing to about 1,500 addressees would be on the order of $5,000 to $10,000, depending on the sophistication of the outreach piece and the initial condition of CCSF's owner/operator list. No additional staff would be required to implement this BMP.

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BEST MANAGEMENT PRACTICE R1 - SPILL RISK PREVENTION

DEVELOP AND IMPLEMENT A PROGRAM TO REDUCE THE RISK OF TOXIC

INTRODUCTION AND PURPOSE

The original purpose of this best management practice was to develop and implement a regulatory program that would reduce the risk of toxic pollutant spills from commercial, industrial, and public facilities, and was therefore fairly limited in scope. For this study, CCSF expanded the scope to investigate the potential of implementing an Enhanced Pretreatment Program supported by an amended wastewater discharge permit application (CCSF, 1992D). The Enhanced Pretreatment Program would require storm water controls on commercial, industrial, and public facilities to reduce pollutants of concern in urban runoff. The implementation of R1 complements BMP R4 of the Implementation Program, which requires covers to prevent runoff from contacting potential pollutants, and P4 of the present study, which implements a field program to search for, detect, and correct situations where rainfall and/or runoff contact potential pollutants (see Figure 8-1).

LINKS TO OTHER BMPs

This BMP is linked to the following best management practices (Figure 8-1):

- *R4-Rainfall/Runoff Protection (from the Implementation Program)*: Requires landowners and/or tenants to provide covers to keep rainfall/runoff from contacting potential contaminants; and to keep runoff from draining through areas that contain contaminants.
- *P1-Illegal Dumping Control (dry weather BMP No. 2 in this report)*: Is designed to prevent the dumping of pollutants of concern into the sewer system through the implementation of an aggressive reporting campaign. By extension, this best management practice helps keep litter off the streets where storm water and/or runoff could come into contact with potential pollutants.
- *P3-Hazards Tracking (dry weather BMP No. 11 in this report):* Develops a centralized database for tracking hazards from spills, exposed contaminants, and illegal dumping incidents. This helps to identify the biggest problems and to target programs accordingly.
- *P4-Rainfall/Runoff Protection:* Implements a field program to search for, detect, and correct situations in which rainfall or runoff contact potential contaminants. Combines elements of education (employee training), hazards tracking (recording observations of field personnel), and enforcement.

POLLUTANTS OF CONCERN

This best management practice addresses all the wet weather pollutants of concern; metals, PAHs, and cyanide. In a city the size of San Francisco, with the diversity of businesses present, it is likely that all of the pollutants of concern are at risk of being spilled or otherwise contacting rainfall and/or runoff. Without doing an inventory of the amounts and types of chemicals used

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and/or stored outdoors in the City, it is impossible to determine for which pollutant(s) of concern this BMP may have the greatest impact.

The following is a summary of current findings on existing spill prevention activities:

- The Hazardous Materials Ordinance, enforced by DPH, has provisions for spill prevention, containment, and reporting of hazardous materials (CCSF, 1991E).
- A spill prevention plan is required in CCSF's industrial wastewater discharge permit application (CCSF, 1992D).
- CCSF inspects approximately 700 industrial dischargers annually in its current pretreatment program (CCSF, 1992E).

IMPLEMENTATION MEASURES

CCSF has developed the following ways to implement this best management practice:

- **Enhanced Pretreatment:** Develop an Enhanced Pretreatment Program directed at facilities already in CCSF's pretreatment program and others likely to contribute pollutants to runoff. The program will add spill prevention and runoff protection requirements to more traditional pretreatment requirements.
- **Enforcement Authority:** Invest CCSF inspectors with the authority to issue citations to enforce the enhanced pretreatment requirements.

Following is a more detailed discussion of these implementation measures.

Enhanced Pretreatment

The Enhanced Pretreatment Program proposed by CCSF introduces industrial storm water runoff controls similar to those that are required in municipalities with separate storm sewer systems pursuant to the requirements from the State's General Industrial Storm Water Permit (SWRCB, 1991E). San Francisco's combined sewer system is not subject to the storm water regulations (40 CFR 122.26(a)(7)). However, CCSF has determined that regardless of the type of sewer system, commercial, industrial, and public facilities are likely to contribute pollutants to runoff. Table 8-2 lists businesses, identified by their Standard Industrial Classification (SIC) Code, that are targeted by CCSF's Enhanced Pretreatment Program. The list is divided into tiers based on priority for inclusion in the program. The tiers listed in descending priority are:

- Tier 1 - Businesses that are already in CCSF's pretreatment program and would be covered under the Federal regulations for storm water if the City were not exempt. As indicated in Table 8-2, some of the businesses would be subject to Federal storm water regulations only if their pollutants are exposed to storm water. Therefore, these businesses should undergo an initial inspection to determine whether or not there is storm water exposure.

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- **Tier 2** - Businesses in CCSF's pretreatment program which, although they would not be covered under Federal regulations if the City were not exempt and that are not in CCSF's pretreatment program, but have the potential to contribute pollutants of concern to storm water.

- **Tier 3** - Businesses that would be covered under Federal regulations if the City were not exempt and that are not in CCSF's pretreatment program, but have the potential to contribute pollutants of concern to storm water.

CCSF's Enhanced Pretreatment Program would address both dry weather and wet weather sources of pollutants. Figure 8-2 illustrates the relationship between the dry weather and wet weather portions of CCSF's program. The dry weather aspects are discussed in the Waste Minimization Program Plan (CCSF, 1992F). The wet weather portions would include requirements similar to those in the State General Industrial Storm Water Permit (SWRCB, 1991E). A Storm Water Pollution Prevention Plan (SWPPP) would be required from some of CCSF's Significant Industrial Users (SIUs) and other Industrial Users (IUs), depending on the which tiers are included in the program. Table 8-3 is a checklist of requirements that will be incorporated into each facility's SWPPP, or Storm Water Plan. This checklist may also be used by CCSF inspectors to document compliance and as a guide to help businesses complete the industrial discharge permit application. CCSF proposes to require Storm Water Pollution Prevention Plans to be developed, implemented, and available for review on-site by October 1, 1993.

Enforcement Authority

CCSF inspectors would have the primary responsibility of ensuring the proper implementation of the Enhanced Pretreatment Program, since they would have the capability and training necessary to detect storm water violations. In addition, by citing illegal dumpers, CCSF inspectors would also be enforcing dry weather BMP P1 (No. 2 in this report)-Illegal Dumping Control, which involves developing an aggressive public program to report and prevent dumping of toxic pollutants into sewers and drainage channels. In order to ensure that new potential storm water quality threats do not develop, it is advisable for CCSF inspectors to monitor the businesses determined to be exempt from the Enhanced Pretreatment Program. Businesses that repeatedly violate their waste minimization or storm water plan requirements should be prosecuted by the City Attorney.

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TABLE 8-2

STANDARD INDUSTRIAL CLASSIFICATIONS TO BE TARGETED BY THE ENHANCED PRETREATMENT PROGRAM

Under Any Circumstance:	*Only if Exposed to Storm Water:*
2851-Paints, varnishes,etc. 2893-Printing ink 3273-Ready mixed concrete 3281-Cut stone and stone products 3731-Ship building and repair 4111-Local and suburban transit 4119-Local passenger transportation 4121-Taxicabs 4141-Local bus and charter service 4212-Local trucking, w/o storage 4213-Trucking, except local 4311-U.S. Postal Service 4953-Refuse systems 5015-Motor vehicle parts, used	20##-Food and kindred products 2211-Broadwoven fabric mills, cotton 2261-Finishers of broadwoven fabrics of cotton 2711-Newspapers:publishing and/or printing 2759 (old 2751)-Commercial printing, N.E.C 2752-Commercial printing, lithographic 2796-Platemaking and related services 3429-Hardware 3442-Metal doors, sash, frames, moldings, and trim 3448-Prefabricated metal buildings and components 3462-Iron and steel forging 3469-Metal stampings 3471-Electroplating, plating, polishing, anodizing, and coloring 3599-General manufacturing, industrial and commercial machinery and computer equipment

TIER 2-(Included in current Pretreatment Program and likely to contribute pollutants to storm water)

Under Any Circumstance:	*Only if Exposed to Storm Water:*
2711-Newspapers 7513-Truck rental 7538-Automotive repair, general 7539-Automotive repair 7542-Car washes	7211-Power laundries, family and commercial 7221-Photographic studios, portrait 7335 (old 7333)-Commercial photography 7342-Disinfecting and pest control services 7353-Heavy construction equipment rental and leasing 7384 (old 7395)-Photofinishing laboratories 8731 (old 7391)-Commercial physical research

TIER 3-(Would be covered by federal regulations if CCSF were not exempt and likely to contribute pollutants to storm water)

1721-Painting and paper hanging contractors
3732-Boat building and repair
4952-Sewerage systems
5093-Scrap and waste materials

Sources: CCSF, 1992E; 40 CFR 122.26 (b) (14 (i) - (x))

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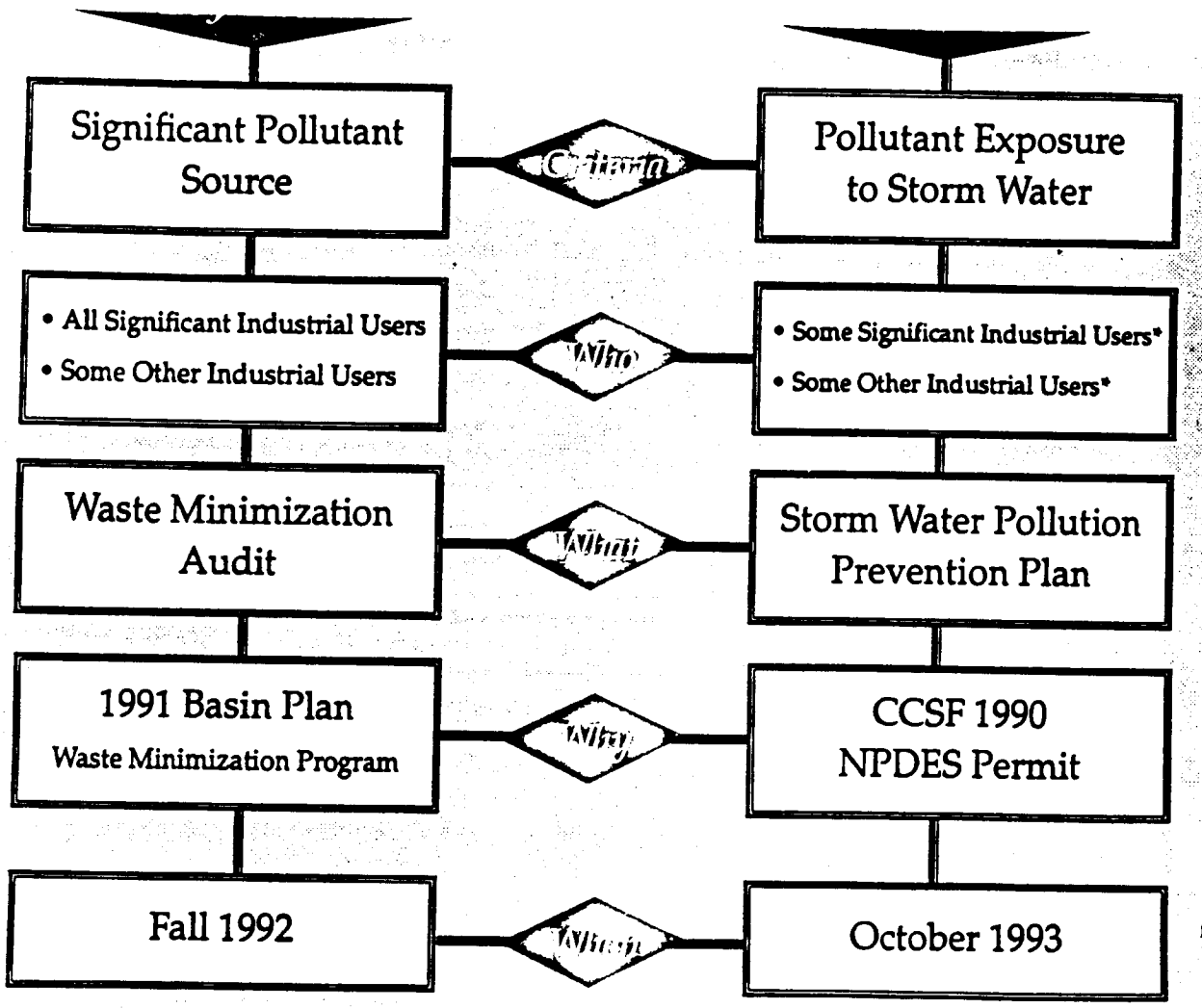
Figure 8-2 Enhanced Pretreatment Program



** see lists shown in Table 8-1*

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TABLE 8-3 STORM WATER POLLUTION PREVENTION PLAN CHECKLIST

ELEMENTS	COMPLETED? (Check if yes)
* Paved areas and buildings;	
* Areas of pollutant contact, actual or potential;	
* Location of existing storm water structural control measures;	
* Surface water locations;	
* Areas of existing and potential soil erosion;	
* Vehicle service areas.	
(2) A narrative description of the following: * Materials and practices used to minimize contact of significant materials with storm water discharge;	
* Material loading, unloading, and access areas;	
* Existing structural and non-structural control measures (if any) to reduce pollutants in storm water discharge;	
* Industrial stom water discharge treatment facilities (if any);	
* Methods of onsite storage and disposal of significant materials;	
* Outdoor storage, manufacturing, and propcessing activities.	
(3) A list of pollutants likely to be present in significant quantities, and an estimate of the annual quantities of these pollutants in storm water discharge.	
(4) An estimate of the size of the facility (in acres or sq. ft.) and the percent of the facility that has impervious area.	
(5) A list of significant spills or leaks of toxic or hazardous pollutants to storm water that have occurred after Oct. 1, 1990. The list must include: * Toxic chemicals (listed in 40 CFR 372) that have been discharged as reported on EPA Form R;	
* Oil or hazardous substances in excess of reportable quantities (see 40 CFR 110, 117 or 302).	
(6) A summary of existing sampling data (if any) describing pollutants in the storm water discharge.	
DESCRIPTION OF STORM WATER MANAGEMENT CONTROLS	
(1) Identify specific individuals (and job titles) who are responsible for developing, implementing, and revising the Storm Water Plan.	
(2) Describe preventive maintenance measures, including inspection and maintenance of storm water conveyance system devices and inspection and testing of plant equipment and systems that could fail and result in discharges of pollutants to storm water.	
(3) Describe housekeeping practices, which include: * Maintenance of clean, orderly facility areas that discharge storm water;	
* Inspection and cleaning of material handling areas.	

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TABLE 8-3 STORM WATER POLLUTION PREVENTION PLAN CHECKLIST (Continued)

ELEMENTS (continued)	COMPLETED? (Check if yes)
(4) Identify areas where significant materials can spill into or otherwise enter	
* Establish internal reporting procedures for spills of significant materials.	
(5) Describe storm water management practices, which include:	
* Installation of oil and grit separators;	
* Diversion of storm water into retention basins, etc.;	
* Additional measures based on an assessment of the potential of various sources to contribute pollutants to storm water discharges.	
(6) Describe employee training program for all personnel responsible for the Implementation of the Storm Water Plan, and identify periodic dates of training. Training should address:	
* Spill response,	
* Good housekeeping,	
* Material management practices,	
(7) Describe inspection practices, which should include:	
* Assurance that all inspections shall be done by trained personnel,	
* Use of a tracking or follow-up procedure;	
* Documentation of all inspections and maintenance activities;	
* Statement that all inspection records shall be retained for five years.	
ANNUAL FACILITY INSPECTION	
An annual facility inspection shall be conducted to:	
* Verify that all elements of the Storm Water Plan are accurate;	
* Retain any observations and responses as part of the Plan.	
REFERENCE OTHER PROGRAM REQUIREMENTS	
The Storm Water Plan may incorporate, by reference, the appropriate elements of other program requirements, such as the SPCC plans under Section 311 of the CWA.	
INCLUDE SIGNATURE AND TITLE OF AUTHOR(s), DATES OF INITIAL PREPARATION AND AMENDMENTS	

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... ... the pollutants of concern from implementing this BMP are difficult to calculate. There is little or no baseline data available on the types and concentrations of pollutants in runoff from particular industrial sites. Instead, reductions would be demonstrated primarily by nonconventional monitoring as opposed to traditional water quality monitoring. Nonconventional monitoring would consist of recording information on the following:

- Number of businesses with pollutant exposure to rainfall/runoff,
- Volume and types of materials/wastes with exposure to rainfall/runoff,
- Concentrations of materials/wastes with exposure to rainfall/runoff, and
- Level of compliance with the amended sewer use ordinance.

CCSF would gather data in the first year of the Enhanced Pretreatment Program to establish a baseline. Information from subsequent years would be used to document pollutant reductions. Nonconventional monitoring would include noting any decreases in the volume and concentration of pollutants exposed to rainfall/runoff as a result of best management practice implementation. Reductions noted would be compared with the implementation costs to calculate cost-effectiveness.

ESTIMATED COSTS

The program's effectiveness would be significantly enhanced by ensuring that program staff have the time and training necessary to provide useful storm water protection advice. Consequently, the major costs associated with an Enhanced Pretreatment Program are estimated below.

Staff Time

Legal staff time is needed to prosecute offenders. The incremental cost of City Attorney time is estimated as $6,000 (40 hours * $150/hr).

The incremental cost to add storm water exposure to a compliance inspection depends on several factors including:

- Which tiers in Table 8-2 to inspect for storm water exposure,
- Number of businesses in selected tier(s),
- Size of facilities,
- Frequency of inspections, and
- Length of inspection.

To help determine costs, CCSF has made the following assumptions:

- Tier 1 and tier 2 businesses will be inspected for storm water exposure,

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- An additional 30 minutes per inspection will be requ... exposure and to provide technical assistance when needed, and
- Cost of inspector including benefits is $90,000/year.

Calculation: 750 businesses * 2 inspections/year * 0.5 hours/inspection = 750 hours
750 hours / 2,080 hours/year * $90,000 = $32,500

Training Costs

Training costs can involve staff participation in workshops and seminars, self-study time, observation sessions in the field, and preparation time prior to inspections. An Enhanced Pretreatment Program would require an increased understanding of processes, chemical usage, point and nonpoint source wastestreams, and waste minimization technologies on an industry and process-specific basis. To reduce training and program costs, larger POTWs have suggested that individual staff specialize in one particular industry or process and then serve as a resource for their fellow workers (Local Government Commission, 1988). CCSF estimates the training time required by this new program will require about 15% of each inspector's time in the first year.

Calculation: 15% * $90,000 * 4 inspectors = $54,000

The estimated annual cost to implement this best management practice is shown in Table 8-4.

TABLE 8-4

ESTIMATED ANNUAL COST - BMP R1

Implementation Measure	Cost
Annual Operating Costs:	
Legal Staff	$6,000
Inspectors	$32,500
Training	$54,000
Total Annual Cost	**$92,500**

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BEST MANAGEMENT PRACTICE P2 - CATCH BASIN CLEANING

INTRODUCTION AND PURPOSE

The purpose of this BMP is to establish a program that will regulate the cleaning of catch basins in areas where sediment concentrations of pollutants of concern are sufficiently high for the sediments to potentially act as a secondary source. Catch basins are chambers or sumps installed in a storm sewer, usually at the curb, which allow surface runoff to enter the sewer. Many catch basins have a low area intended to retain sediment. By trapping coarse sediment, the catch basin prevents trapped solids from clogging the sewer or being washed into receiving waters. However, these low areas must be cleaned periodically to maintain their sediment-trapping abilities and to prevent resuspension of sediment. It is also important to clean catch basins to provide liquid storage capacity, since the volume of storm water detained in a catch basin will reduce the amount of wet weather flow by that amount.

LINKS TO OTHER BMPs

This BMP is linked to the following best management practices (Figure 8-1):

- *P1-Illegal Dumping Control (dry weather BMP No. 2 in this report):* Is designed to prevent the dumping of pollutants of concern into the sewer system through the implementation of an aggressive reporting campaign. By extension, this best management practice helps keep litter off the streets where storm water and/or runoff could come into contact with potential pollutants.

- *P3-Hazards Tracking (dry weather BMP No. 11 in this report):* Develops a centralized database for tracking hazards from spills, exposed contaminants, and illegal dumping incidents. This helps to identify the biggest problems and to target programs accordingly.

- *P6-Street Cleaning:* Street and catch basin cleaning have the common function of removing sediments, including bound metals and PAHs, from CCSF's combined sewer system. Removing sediments reduces their residence time in the system and eliminates the possibility of their acting as a secondary source. The optimal coordination of sweeping, flushing, and catch basin cleaning to remove sediments in the most effective and timely manner, may protect water quality and reduce unnecessary treatment costs.

POLLUTANTS OF CONCERN

This best management practice addresses those pollutants of concern that may adsorb to sediments in the catch basins including PAHs and heavy metals. Various studies of marine sediments indicate that lead, copper, and zinc tend to precipitate out of the water column more rapidly than nickel, arsenic, and cadmium (Jones, 1992). Although it is not possible to directly extrapolate from this information how bound metals would behave in the catch basins, it is likely that metals may be released to some degree into storm water runoff under changing chemical or physical conditions.

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over the course of seven years (O'Neil, 1992). The cleaning operation involves vacuuming sediments, leaves, and street debris out of catch basins and disposing of the debris at Sunset Scavenger Co. facilities in CCSF. Following is a summary of findings regarding the cleaning of catch basins and drainage channels:

- CCSF's 50,000 catch basins are cleaned over the on a schedule of 1-7 years (O'Neil, 1992).
- Although sizes vary, the typical catch basin in San Francisco is six feet deep and 33 inches wide, with the outlet pipe located 24 inches from the top and 48 inches from the bottom of the catch basin (O'Neil, 1992).
- The current cost to clean a catch basin is approximately $42 (O'Neil, 1992).
- Westside Storage Transport (considered to be a "drainage channel") is flushed on an as-needed basis to remove sediments left behind by storms (Kenck, 1992).

The following is a discussion of catch basin effectiveness, based on a review of available studies.

Pollutant Removal

Although it is not possible (based on the data currently available) to quantify the water quality benefits of catch basin cleaning, such cleaning does provide benefits. These benefits include removing pollutant loads from the sewer system, reducing high pollutant concentrations during the "first flush" of a storm, preventing clogging of the downstream storm water conveyance system, and restoring the sediment trapping capacity of the catch basin.

Typical catch basins have been estimated to retain up to 57 percent of coarse solids and 17 percent of equivalent biological oxygen demand (BOD) (a measure of the relative oxygen requirement of a sample as determined by its biological composition). A study conducted in the West Roxbury section of Boston showed that catch basins retained 54-88% of BOD, 10-56% of chemical oxygen demand (COD) (a measure of the relative oxygen requirement of a sample as determined by its chemical composition), 48-97% of volatile suspended solids, and 60-97% of suspended solids (Moffa, 1990). Two large sumps installed in storm sewers as part of the Lake McCarron wetland treatment system retained as much as 75 percent of solids in runoff although the typical efficiency was much less (Minnesota Pollution Control Agency, 1989).

In the absence of cleaning, catch basins may actually make water quality conditions worse. It has been reported that once a sump is 40-50 percent full, any inflow could have a flushing effect and actually generate a sediment loading while passing through the catch basin. Also, the material which accumulates in catch basins undergoes decay, and the first flush of stagnant water and debris by storm water runoff in the sewer system may contain a high concentration of pollutants (Minnesota Pollution Control Agency, 1989). The average concentration of pollutants in catch basin liquid discharged during storms is similar to concentrations of untreated sewage (Minnesota Pollution Control Agency, 1989).

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Frequency of Cleaning

might become blocked. Recommended catch basin cleaning frequencies vary from once to twice a year, depending upon conditions (Moffa, 1990, USEPA, 1983B). In general, if the contributing watershed has active construction or other land uses creating high sediment loads, the catch basin should be cleaned more often than in stabilized areas. In order to minimize the quantity of dirt collecting in catch basins, a recommended practice is to sweep the streets just prior to flushing or wet weather. In that case, the sweeper collects the bulk of the litter while the flusher truck or rainfall moves the fine materials into the drainage system (Federal Water Quality Administration, 1971).

IMPLEMENTATION MEASURES

CCSF is already implementing catch basin cleaning; however, the frequency of cleaning varies from once a year to once every seven years, which may or may not be sufficient to maintain the optimal efficiency of the catch basins. Given that catch basin cleaning is costly and labor-intensive, CCSF began a study of existing conditions in order to design a site-specific program of catch basin cleaning that will meet CCSF's goal of reducing pollutants of concern. CCSF sampled two sets of catch basins one for quantity and the other for quality of sediments.

Sediment Quantity

CCSF conducted a preliminary assessment of sediment loading by measuring the level of sediments accumulated in the sumps of 35 residential and industrial catch basins chosen on the basis on their last cleaning. This selection method did not necessarily result in a random selection of catch basins versus land use type. However, as indicated in Table 8-5 and Figure 8-3, there is a general correlation between the sediment levels and number of wet seasons since cleaning.

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TABLE 8-5

SINCE CLEANING		SEDIMEN	LAST CLEANING
0	21st St/Bryant (SE)	5	5-26-92
	21st St/Bryant (SW)	1	5-26-92
	21st St/Bryant (NE)	1	5-26-92
	21st St/Bartlett (SW)	16	5-22-92
	21st St/Capp (SW)	22	5-22-92
	Mean	9	
	Std. Dev.	10	
1	Anza and Collins (S)	21	3-4-92
	Anza and Cook (NW)	15	3-4-92
	Anza and Cook (S)	14	3-4-92
	Anza and Blake (NW)	35	3-4-92
	Anza and Blake (NE)	13	3-4-92
	Anza and Blake (S)	20	3-4-92
	Army/Connecticut (NE)	13	9-11-91
	Army/Connecticut (NW)	22	9-11-91
	Army/Illinois (SW)	4	9-10-91
	Army/Illinois (NW)	16	9-10-91
	Army/Evans (SW)	11	9-9-91
	Mean	21	
	Std. Dev.	8	
2	Alabama/26th St (NE)	7	3-2-91
	Alabama/26th St (NW)	8	3-2-91
	Alabama/26th St (SW)	1	3-2-91
	Alabama/18th St (NW)	2	3-2-91
	Alabama/18th St (SW)	3	3-2-91
	Alabama/18th St (SE)	3	3-2-91
	Alabama/18th St (NE)	1	3-2-91
	Balboa and 8th Ave (NW)	24	11-6-90
	Balboa and 8th Ave (SW)	32	11-6-90
	Balboa and 8th Ave (SE)	29	11-6-90
	Alabama/Ripley (NW)	15	9-17-90
	Balboa and 9th Ave (SE)	13	8-10-90
	Balboa and 9th Ave (SW)	35	8-10-90
	Balboa and 9th Ave (NW)	32	8-10-90
	Army and Noe (SW)	25	8-9-90
	Army and Noe (SE)	38	8-9-90
	Army and Sanchez (SW)	28	1990
	Mean	17	
	Std. Dev.	13	
3	Tapia and Holloway (N)	29	8-14-89
	Tapia and Holloway (S)	23	8-14-89
	Mean	26	
	Std. Dev.	4	

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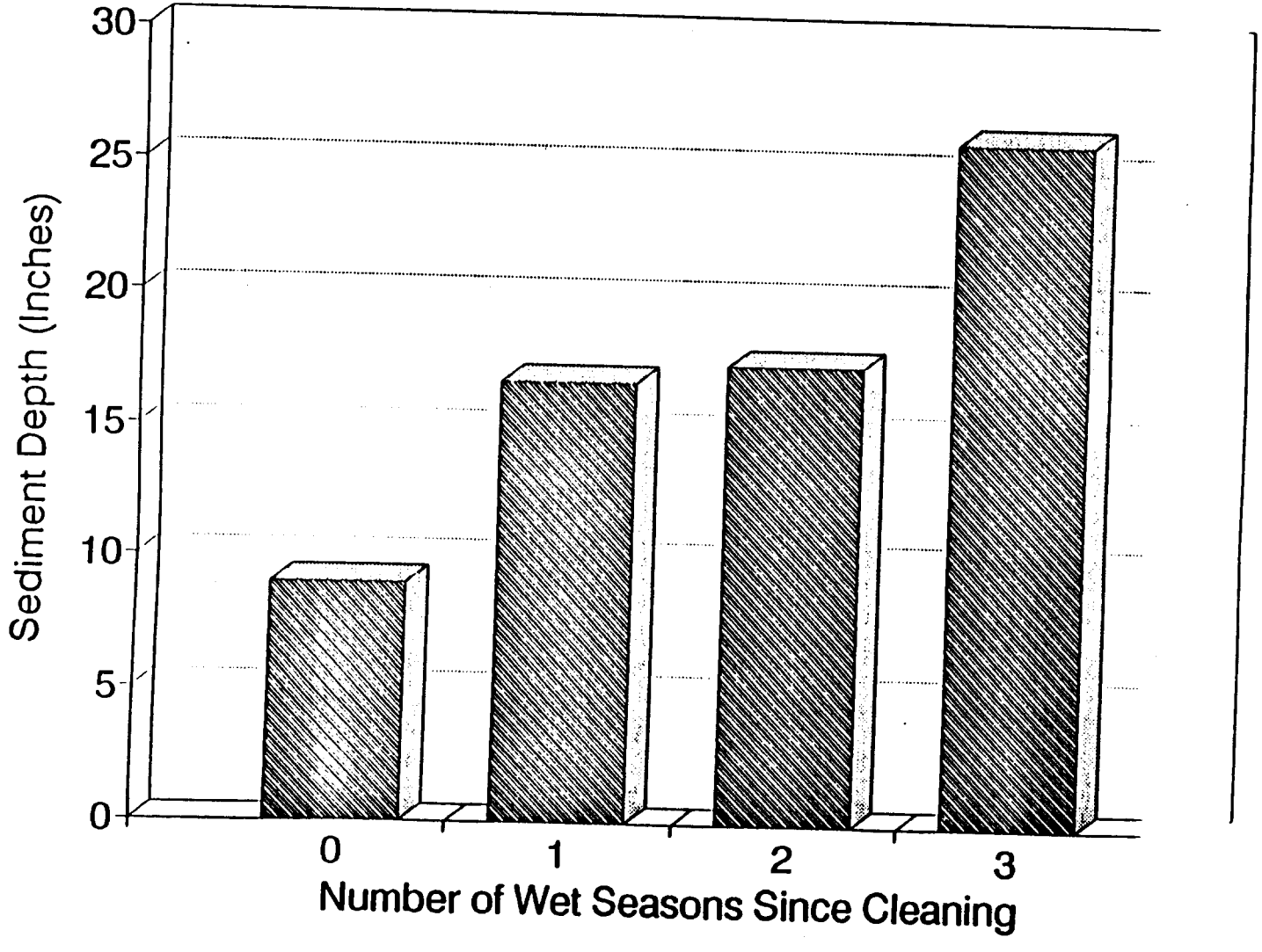
FIGURE 8-3

Sediment Levels in Catchbasins



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The preliminary data, as shown in Table 8-6, also indicate that a more frequent cleaning schedule may be appropriate for some areas of the City to maintain catch basin effectiveness. If

TABLE 8-6

PERCENT OF CATCH BASINS WITH SEDIMENT ACCUMULATION GREATER THAN 40% OF SUMP CAPACITY

Number of Wet Seasons Since Cleaning	Percent of Catch Basins with Sediment Loads Greater than 40% of Sump Capacity
0	20
1	36
2	47
3	100

Source: CCSF, 1992G

Sediment Quality

CCSF also collected some preliminary data on sediment quality for a set of fourteen catch basins (different from the data set above) in residential, transportation, commercial, and industrial land use areas in the City. Table 8-7 presents the data for oil, cyanide, and heavy metals. No clear trends were established. There was wide variation across pollutants within a single catch basin, and within land use categories. In addition, the results were further skewed by data indicating particularly high levels for one or more pollutants from some catch basins.

EXPECTED REDUCTIONS

As is the case for most source controls, the expected reductions in the pollutants of concern from implementing this BMP are difficult to calculate. San Francisco has only preliminary data on the types and concentrations of pollutants of concern in catch basin sediments in the City. Furthermore, little data exists to describe the quantity or chemistry of sediments in catch basins under varying conditions. It is not clear if and when sediments act as a secondary source by leaching out previously bound pollutants into storm water runoff. If this BMP were chosen for further study, CCSF would gather initial data to establish a baseline, conduct experiments, and then compare subsequent data to document any concentration changes.

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LOCATION	Concentration (mg/kg) Oil	Chromium	Copper	Lead	Nickel	Zinc	Cyanide
Residental							
Ulloa/47th Ave	2,300	26	300	110	14	540	0.05
47th Ave/Vincente SE	9,500	16	150	100	15	300	ND
47th Ave/Vincente SE	9,600	25	120	350	31	340	ND
Great Hwy/Ulloa SE	17,0000	ND	70	75	7	290	0.07
Mean	4,7850	22	99	159	17	368	0.06
Std. Dev.	81,505	6	99	128	10	117	0.01
Transportation							
19th Ave/Judah	2,200	13	110	440	19	1,400	0.07
19th Ave/Rivera 008	4,500	30	70	340	38	450	0.07
19th Ave/Kirkham	11,000	14	72	160	11	360	ND
19th Ave/Rivera NE	85,000	17	87	870	95	920	ND
Mean	25675	19	85	453	41	783	0.07
Std. Dev.	39725	8	18	301	38	479	0
Commercial							
Sacramento/Davis SW	6,300	33	67	170	39	430	ND
Sacramento/Davis N	8,600	31	69	170	39	520	ND
Sacramento/Davis NE	15,000	29	140	1,000	41	1,500	ND
Mean	9,967	31	92	447	40	817	ND
Std. Dev.	4,508	2	42	479	1	593	ND
Industrial							
Bayside	10,000	85	880	890	99	270	0.23
Quint/Evans	11,000	14	49	130	18	280	0.13
Rankin/Davidson	14,000	20	68	1,400	34	870	0.09
Mean	11,667	40	332	607	50	473	0.15
Std. Dev.	2,082	39	474	639	43	343	0.07

Source: CCSF, 1992H

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which make it difficult to calculate the cost of implementing this BMP. These cost factors include:

- Number of additional catch basins,
- Location of additional catch basins,
- Sediment loading characteristics,
- Type of sediment and debris accumulated, and
- Time since last cleaning.

If this BMP were chosen for further study, the data gathered on these cost factors would help determine the actual the cost of implementing this best management practice.

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BEST MANAGEMENT PRACTICE P4 - RAINFALL/RUNOFF CONTACT

DEVELOP AND IMPLEMENT AN AGGRESSIVE FIELD PROGRAM TO SEARCH

INTRODUCTION AND PURPOSE

The purpose of this best management practice is to develop and implement an aggressive program to search for, detect, and correct situations in which rainfall and/or runoff presently contact potential contaminants. To distinguish this best management practice from BMP R1, CCSF has defined this best management practice's focus to be pollutants encountered on CCSF streets and other public areas. The focus of BMP R1 is pollutants from commercial, industrial, and public facilities.

LINKS TO OTHER BMPs

This BMP is linked to the following best management practices (Figure 8-1):

- *R1-Spill Risk Prevention:* Increases inspection and monitoring of facilities with potential to contribute pollutants of concern in their storm water discharge through spills or lack of physical barriers to keep contaminants from contacting storm water and/or runoff.
- *R4-Rainfall/Runoff Protection (from the Implementation Program):* Requires landowners and/or tenants to provide covers to keep rainfall/runoff from contacting potential contaminants; and to keep runoff from draining through areas that contain contaminants.
- *P1-Illegal Dumping Control (dry weather BMP No. 2 in this report):* Is designed to prevent the dumping of pollutants of concern into the sewer system through the implementation of an aggressive reporting campaign. By extension, this best management practice helps keep litter off the streets where storm water and/or runoff could come into contact with potential pollutants.
- *P3-Hazards Tracking (dry weather BMP No. 11 in this report):* Develops a centralized database for tracking hazards from spills, exposed contaminants, and illegal dumping incidents. This helps to identify the biggest problems and to target programs accordingly.

With its three components: search, detect, and correct, BMP P4 links other best management practices together into a comprehensive program of education, regulation, and monitoring that effectively addresses the source and elimination of wet weather pollution. The *search* component involves training CCSF employees and the public to recognize potentially harmful situations and to report them. The *detect* component involves recording observations of field personnel and public complaints into a centralized database for tracking hazards from spills or illegal dumping incidents. The *correct* component involves granting key CCSF personnel the authority to cite people for illegal dumping and/or for creating situations where rainfall and/or runoff can contact pollutants of concern.

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rainfall and/or runoff. Without doing an inventory of the amounts and types of chemicals used and/or stored outdoors in CCSF, it is impossible to determine for which pollutant(s) of concern this BMP may have the greatest impact.

EXISTING CONDITIONS

Following is a summary of findings regarding rainfall/runoff protection:

- Currently there is no consistent reporting procedure or centralized database for illegal dumping or spill reports handled by various CCSF departments (Lum, 1992).
- The Bureau of Street Cleaning and Urban Forestry (BSCUF) directs hazards to DPH and only picks up used batteries and paint containers (Shaw, 1992).
- DPH identifies and hauls hazardous waste (Shaw, 1992).
- The Fire Department responds to spills threatening public safety and has the authority to issue citations for illegal dumping, although it rarely receives calls reporting illegal dumping (Grey, 1992).
- A force of three Environmental Patrol Officers (working in the Department of Public Works (DPW) issues citations enforcing municipal litter codes (Shaw, 1992).
- The Bureau of Environmental Regulation and Management (BERM) inspects chemical storage areas for secondary containment as part of its existing pretreatment program (Rourke, 1992).

Currently, CCSF addresses the problem of rainfall or runoff contacting pollutants of concern in two ways, one reactive and one proactive. The first means is by picking up and removing abandoned hazardous waste from CCSF streets and other CCSF property. In January 1989, CCSF, at its own request, received a variance from the vehicle inspection and manifest requirements of the California Department of Health Services, contained in Title 22, Section 66310(a)(1) California Code of Regulations (CCR). This variance allows CCSF employees to use CCSF vehicles to remove abandoned hazardous waste instead of licensed hazardous waste haulers. By allowing CCSF employees to remove wastes soon after their discovery, wastes are removed several hours and often days faster than if the CCSF used licensed haulers. As a result, during the rainy season, the potential for contact between rainfall and/or runoff with abandoned wastes (which even when contained are often leaking) is significantly reduced (CCSF, 1991E).

Hazardous wastes are removed from CCSF streets by personnel from the Fire Department, the Department of Public Health or the Bureau of Street Cleaning and Urban Forestry. Hazardous spills or abandoned hazardous materials are usually detected by BSCUF personnel during their street cleaning routines. BSCUF staff cleans up minor spills of diesel and paint, and also picks up used batteries and paint containers. The Bureau of Street Cleaning and Urban Forestry reports that oil and paint spills or containers are often found in busy parts of CCSF, such as around Selby and Mission streets. All other reported spills are cleaned up by the Fire

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Department and all hazardous materials are ...

approximately 750 regulated industrial users. BERM checks to see that these areas are surrounded by a berm which, although it may not prevent rainfall/runoff from contacting potential contaminants, does restrict any potentially contaminated runoff from moving off-site (Rourke, 1992). The implementation of an Enhanced Pretreatment Program under best management practice R1 would further ensure that rainfall and/or runoff does not contact pollutants of concern.

IMPLEMENTATION MEASURES

Best management practice P4, along with its related best management practices, would be implemented via the following three measures targeted at situations in which rainfall and/or runoff contact pollutants of concern:

- search,
- detection, and
- correction.

These measures are described below.

Search for Potential Hazards

CCSF employees who have daily contact with the City's sewers, catch basins, and streets are in the best position to observe incidents in which toxic substances are illegally dumped or improperly discharged. These personnel could be trained via the following steps to search for and to recognize situations in which rainfall and/or runoff could contact potential contaminants:

- Materials and wastes containing pollutants of concern (e.g, batteries, tire weights) would be identified on a material "hit list".
- Effects of these pollutants to the CCSF's sewer system and the environment would be defined.
- The above information would be incorporated into the current training schedule for DPW personnel.

In addition, the community could be involved in the detection of potential hazards through a neighborhood watch program. Citizens could be encouraged to report the improper use, storage, or disposal of materials/wastes containing the pollutants of concern. CCSF could implement the program by:

- Developing a door knob hanger to be placed on doors near a spill,
- Distributing the hanger to interested neighborhood, school, and community groups, and/or

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... concerns into the "Neighbors for Neighborhoods" ... report spills

Detect Potential Hazards

CCSF employees would be trained to forward their observations to a centralized database, developed as part of dry weather BMP P3 (No. 11 in this report). As part of another dry weather BMP, P1 (No. 2 in this report), the community would be encouraged to report the improper use, storage, or disposal of pollutants by calling a "hotline" telephone number. Information provided by the caller would also be entered into the centralized database.

Correct Potential Hazards

Correcting potential hazards involves educational outreach coupled with enforcement action. Although current CCSF practices address the cleanup of spills and hazards before they reach storm drains, improved search and detection methods would further ensure timely and efficient cleanup. Adequate prevention of hazards may be achieved by granting more CCSF personnel with the authority to cite for environmental infractions, such as dumping waste in a catch basin, and by prominently publicizing the consequences of committing environmental infractions. The DPW force of uniformed Environmental Patrol Officers, who currently cite for littering, could be increased and their authority expanded to address a wider range of environmental infractions. In addition, BSCUF, BSSR, and BERM personnel could also be invested with enforcement authority. Even though issuing citations is not always practical (individuals must be caught "in the act"), making a "show of force" may be an effective way of showing residents and municipal staff that illegal dumping is taken seriously by CCSF.

EXPECTED REDUCTIONS

As is the case for most source controls, the expected reductions in the pollutants of concern from implementing this BMP are difficult to calculate. There is little or no baseline data available on the types and concentrations of pollutants in runoff from CCSF streets and public areas. Instead, reductions would be demonstrated primarily by nonconventional monitoring as opposed to traditional water quality monitoring. Nonconventional monitoring would consist of recording information on the following:

- Number of reports from CCSF personnel of incidents in which toxic substances are illegally dumped or improperly discharged,
- Number of reports from citizens of incidents in which toxic substances are illegally dumped or improperly discharged,
- Number of requests for additional door knob hangers, and
- Number of environmental citations.

CCSF would gather data in the first year of the program to establish a baseline. Information from subsequent years would be used to document pollutant reductions. Nonconventional monitoring would include noting any increases in the number of reports or violations as a result of BMP implementation. Reductions would be calculated from the number of reported/cited incidents that were cleaned up. The assumption would be that the level of pollutant reduction is dependent on the volume and type of spill reported and cleaned up. CCSF would have to conduct some research and perform some calculations to establish that relationship. Reductions

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noted would be compared with the implementation costs to retroactively calculate cost-effectiveness.

The major costs associated with implementation are estimated below.

- Development of a material hit list and additional training for City personnel is expected to require an additional one-half time staff person at BERM for the first year at a cost of about $15,000.
- Development and distribution of a door knob hanger would be on the order of $5,000.
- Incorporating pollution prevention concerns into the "Neighbors for Neighborhoods" program is expected to require an additional one-quarter time staff person at BERM for the first year at an incremental cost of about $7,500.
- Expanding environmental citation authority to other CCSF personnel would require training as well as implementation costs. The training costs would be incurred primarily in the first year and are estimated to be the equivalent of one-quarter time staff person at about $7,500. The continuing cost of implementation is estimated to require about 2.5% of each participating staff person's time at BERM (5 people), BSSR (5 people), and BSCUF (125 people). The average cost of a staff person at the three bureaus including benefits is $90,000/year.

  Calculation: 2% * $90,000 * 135 staff = $243,000

The total cost to implement this best management practice is shown in Table 8-8.

TABLE 8-8

ESTIMATED ANNUAL COST - BMP P4

Implementation Measure	Cost
Program Startup Costs:	
Inspector Training	$7,500
Door Knob Hanger	$5,000
Neighborhood Program	$7,500
Citation Training	$7,500
Subtotal	$27,500
Annualized Startup Cost(a)	$2,800
Annual Operating Costs:	
Environmental Citation	$243,000
Total Annual Cost	**$245,800**

(a) Amortization factor = 20 years @ 8% = 0.102

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BEST MANAGEMENT PRACTICE P6 - IMPROVED STREET CLEANING

INTRODUCTION AND PURPOSE

The purpose of this best management practice is to implement an improved street cleaning program in areas where sediment concentrations of pollutants of concern are sufficiently high for the sediments to potentially act as a secondary source. Streets may be cleaned by sweeping and/or flushing. Street sweeping, which may be conducted with mechanical brooms or a vacuum system, removes grit, debris, and trash from urban impervious areas such as streets, parking lots, and sidewalks. Street flushing is the process of washing the pavement and forcibly pushing the street dirt toward the curb.

The specific pollutants generally reduced by street sweeping and flushing include sediments (to which PAHs and metals are often bound), nutrients, and oxygen-demanding substances. The effectiveness of sediment removal depends on particle size, with the concentration of pollutants in sediments varying inversely with particle size (American Public Works Association, 1978). Vacuum sweeping and flushing are both more effective than mechanical sweeping at removing the finer sediments (less than 43 microns), which are less susceptible to broom action. Limited testing of a conventional flusher truck resulted in overall particle removal rates of about 30 percent for a single pass and 80 percent for a sweeper followed by a flusher truck (American Public Works Association, 1978).

LINKS TO OTHER BMPs

This best management practice is linked to the following BMPs (Figure 8-1):

- *P2-Catch Basin Cleaning* - Street and catch basin cleaning have the common function of removing sediments, including bound metals and PAHs, from CCSF's combined sewer system. Removing sediments reduces their residence time in the system and eliminates the possibility of their acting as a secondary source. The optimal coordination of sweeping, flushing, and catch basin cleaning to remove sediments in the most effective and timely manner, may protect water quality and reduce unnecessary treatment costs.

POLLUTANTS OF CONCERN

This best management practice addresses those pollutants of concern that may adsorb to sediments in the catch basins including PAHs and heavy metals. Various studies of marine sediments indicate that lead, copper, and zinc tend to precipitate out of the water column more rapidly than nickel, arsenic, and cadmium (Jones, 1992). Although it is not possible to directly extrapolate from this information how bound metals would behave in the catch basins, it is likely that metals may be released to some degree into storm water runoff under changing chemical or physical conditions.

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- Vacuum sweepers are used during the day and mechanical sweepers are used at night (Dahl, 1992).
- Sweeping is conducted on the following schedule (Dahl, 1992):
  - residential: once a week
  - commercial: 2-3 times a week
  - industrial: once a week (only at night)
- Flushing is conducted regularly, but not coordinated with sweeping (Dahl, 1992).
- Annual curb-miles swept is 105,341 (CCSF, 1991F).
- Approximate cost per curb-mile swept is $109 (Busher, 1992).

The status of CCSF programs is further discussed below, followed by a discussion of street sweeping effectiveness as investigated by several studies.

Status of Street Sweeping

CCSF's Bureau of Street Cleaning and Urban Forestry is responsible for the removal of litter from streets. Litter is collected from three sources; illegal dumpings, trash receptacles, and street sweeping. The average annual weight of material collected from these three sources is between 40,000 and 50,000 tons. Of that total, about 21,000 tons comes from the street sweeping operations. Approximately 12,000 tons or 60% of the street sweeping material is classified as sediments (Busher, 1991). The Department of Public Works enforces litter codes with a three-person force of uniformed Environmental Patrol Officers, who issue citations to anyone caught littering the streets and sidewalks of CCSF (Shaw, 1992).

Of CCSF's 40 street sweepers, 75% are of the vacuum type and 25% are of the mechanical type. During the day, CCSF uses vacuum sweepers in residential and commercial areas because they generate less dust and are more effective for removing fine particles than mechanical sweepers. In addition, vacuum sweepers retain their cleaning capacity on crests and depressions of the street surface. However, vacuum sweepers have the disadvantage of being ineffective at cleaning wet surfaces and at removing large debris such as wood, cardboard, and miscellaneous trash. Vacuum sweepers usually have to be preceded by litter trucks to ensure the removal of bulky debris that can impair the vacuum mechanism (Dahl, 1992).

In industrial areas and certain sections where sweeping during the day is impractical, CCSF sweeps at night using mechanical sweepers. Mechanical sweepers, although more costly to maintain than vacuum types, are more effective than vacuum sweepers at picking up trash and other large debris. By eliminating the need for an accompanying litter truck, mechanical sweepers have the advantage or requiring less personnel and generating less noise than vacuum sweepers (Dahl, 1992). Table 8-9 summarizes the status of CCSF's street sweeping practices.

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TABLE 8.0

Total Miles of CCSF Streets:	850
Frequency of Cleaning	
Residential:	1/week
Commercial:	2-3/week
Industrial:	1/week
Methods:	Vacuum Mechanical broom
Persons/Crew:	1
Annual Curb Miles Cleaned:	105,341 (1990-91)
Tons of Debris Removed	18,763 (1990-91)
Cost ($/Curb Mile):	$109

Sources: Dahl, 1992; CCSF, 1991H; Busher, 1992

Status of Street Flushing

CCSF also uses flusher trucks on a regular basis, although flushing is not coordinated with sweeping. A flusher truck consists of a tank mounted on a truck or trailer, for holding a supply of water; an engine driven pump for supplying pressure; and three or more nozzles for spreading the water as directional sprays. The capacity of the water tank on a street flusher varies from 800 to 3,500 gallons, and the nozzle pressure of the water is usually between 30 and 55 pounds per square inch. The amount of water delivered must be proportional to the speed of the vehicle and the pumps must be capable of supplying sufficient water at suitable pressures.

Effectiveness of Street Sweeping

Street sweeping effectiveness is a function of 1) initial sediment loadings and erosion conditions, 2) pavement type and condition, 3) cleaning frequency, 4) number of passes, 5) equipment speed, 6) sweeper efficiency, and 7) equipment type. In general, if the contributing watershed has active construction or other land uses creating high sediment loads, the streets should be cleaned more often than in stabilized areas. It is also true that the less sediment there is on the street to begin with (sediment load), the harder it is to remove a high percentage of it. Pavement type and condition affect performance more than do differences in equipment. In general, smooth asphalt streets are easier to keep clean than those consisting of loosely bound aggregate in a thick, oily matrix; and the poorer a pavement's condition, the more difficult it is to keep it clean.

Street sweeping has been shown to be an effective but limited method of attacking the source of storm water-related pollution problems. A street sweeping experiment in San Jose, California

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showed that sweeping once or twice per day on smooth asphalt streets can remove up to 50% of the total solids and heavy metal mass loading of urban runoff, whereas typical street sweeping frequencies of once or twice per month remove less than 5% of the total solids and heavy metals per week provided only a very small additional benefit (Motta, 1990).

Effectiveness of Street Flushing

It is possible that under the right conditions street flushing could achieve significant pollutant reductions. Flushing appears to have several advantages over sweeping. A survey of street cleaning personnel from cities around the country identified parked cars as the major deterrent to effective street cleaning (American Public Works Association, 1978). However, flushing can be effective with cars parked at the curbs. In addition, flushing may be more effective than sweeping in moving smaller sediments (less than 43 microns) which are reported to bind a larger proportion of heavy metals than larger sediments. Despite these advantages, flushing fell out of favor in the mid 1970s because its ability to move sediments into catch basins and storm drain inlets was perceived to cause greater storm water pollution (American Public Works Association, 1978). San Francisco's combined sewer system may provide an opportunity to use flushing to push sediments into the collection system where they may be removed either in the catch basins or in the sedimentation chambers at the WPCPs.

IMPLEMENTATION MEASURES

Street cleaning not only affects water quality but has multiple benefits, including the improvement of air quality, aesthetic conditions, and public health. CCSF is already implementing regular street sweeping, at frequencies that vary between one to three times a week. Flushing is conducted on an as needed basis and is not coordinated with sweeping. Since the efficiency of sweeping depends on site-specific variables (sediment loadings, pavement type, equipment type, etc.), existing practices may or may not be adequate to achieve maximum efficiencies for pollutant removal. Given that indiscriminately increasing street cleaning would be costly and labor-intensive, CCSF should first study existing conditions in order to design a site-specific program of street cleaning that will meet CCSF's goal of reducing pollutants of concern. However, since street cleaning alone will probably not ensure that water quality objectives are met, the street cleaning program may need to be incorporated into a coordinated program of best management practices, including catch basin cleaning to remove accumulated sediments.

In addition, San Francisco's combined sewer system may provide an opportunity to use flushing for pollutant removal. CCSF could proactively flush streets in the late summer and early fall when the maximum amount of pollutants have accumulated on the roadways. CCSF would in effect be creating its own wet weather, on its schedule, and at a low enough flow rate to receive secondary treatment at the Water Pollution Control Plants during dry weather.

EXPECTED REDUCTIONS

As is the case for most source controls, the expected reductions in the pollutants of concern from implementing this BMP are difficult to calculate. There is little or no baseline data available on the types and concentrations of pollutants of concern on street sediments in CCSF. Furthermore, little data exists to describe the quantity or chemistry of sediments on the streets under varying conditions. It is not clear if and when sediments act as a secondary source by leaching out

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previously bound pollutants into storm water runoff. If this BMP were chosen for further study, CCSF would gather initial data to establish a baseline, conduct experiments, and then compare subsequent data to document any concentration changes.

The most important measure of street cleaning effectiveness is "pounds of pollutant removed per curb-mile" for a specific protocol. This removal value, in conjunction with the unit curb-mile cost, allows the cost for removing a pound of pollutant for a specific street cleaning protocol to be calculated. Costs of street cleaning around the country have been reported to range from $7.92-$30.61/curb-mile (Moffa, 1990). The wide variation in these costs was attributed to differences in labor rates and equipment costs. As seen in Table 8-9, the cost of San Francisco's current street cleaning program is estimated at $109/curb-mile (Busher, 1992). However, there is no information on the pounds of pollutant removed per curb-mile, so current costs cannot be calculated.

The costs to increase street cleaning depend on a number of undecided factors which make it difficult to calculate the cost of implementing this BMP. These cost factors include:

- Frequency of additional street cleaning,
- Location of additional street cleaning,
- Sediment loading characteristics of streets receiving additional cleaning,
- Type of sediment and debris accumulated,
- Type of equipment (mechanical broom vs. vacuum), and
- Use of flusher trucks (e.g., frequency, number, procedure).

If this BMP were chosen for further study, the data gathered on these cost factors would help determine the actual the cost of implementing this best management practice.

SUMMARY

This section has described the five wet weather BMPs in detail including means of implementation and costs (when available). The annual costs and staffing requirements for those wet weather BMPs for which data is available are presented in Tables 8-10 and 8-11, respectively. One additional BERM staff person would be required to implement these BMPs. The BERM inspector and the BSCUF operator are not expected to be new staff, instead, this staff time would be divided among the existing inspectors and operators. In section 9 this information is used to compare these best management practices against a set of evaluation criteria.

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TABLE 8-10

BMP No.	Description	Cost ($/yr)
E1	Leak/Spill Impact	10,000
R1	Spill Risk Prevention	92,500
P2	Catch Basin Cleaning	NA
P4	Rainfall/Runoff Contact	245,800
P6	Improved Street Cleaning	NA
Total		**348,300**

NA= Not Available

TABLE 8-11

STAFFING SUMMARY

BMP No.	Description	Source Reduction Specialist	BERM Inspector	BSCUF Operator
E1	Leak/Spill Impact	0	0	0
R1	Spill Risk Prevention	0	1	0
P2	Catch Basin Cleaning	NA	NA	NA
P4	Rainfall/Runoff Contact	1	0	1
P6	Improved Street Cleaning	NA	NA	NA
Total		**1**	**1**	**1**

NA= Not Available

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SECTION 9

EVALUATION OF WET WEATHER BMPs

This section describes the evaluation of the five wet weather best management practices (BMPs) using a matrix of evaluation criteria. The evaluation procedure follows that used in evaluating the dry weather BMPs in section 6. The evaluation produces a ranking of the five best management practices. Based on the ranking, a recommendation is made for each of the best management practices to either discontinue consideration, implement, or consider further study of the BMP.

EVALUATION METHODOLOGY

The City developed an evaluation matrix based on 14 criteria. The criteria were grouped into two tiers based on their perceived importance to successful best management practice implementation. The Tier 1 criteria reflect the primary goal of reducing the level of the pollutants of concern in a cost-effective manner. The Tier 2 criteria include issues related to logistics and implementation. In the ranking system described below, the Tier 1 criteria are weighted more heavily than the Tier 2 criteria. The evaluation matrix is designed so that best management practices which address the pollutants of most concern and have the greatest source reduction potential are given the highest priority for implementation.

A ranking system was developed consisting of three possible values: "+", "0", and "-", for each criterion. These values are defined as:

- "+" = Data indicates a positive outcome
- "0" = Insufficient data to determine outcome or criteria not applicable
- "-" = Data indicates a negative outcome

For example, if data indicates that a best management practice is particularly cost-effective, that BMP would be valued a "+" in the evaluation. Converseiy, if data indicated that implementation would be relatively expensive, the best management practice would receive a value of "-". Inconclusive data would yield a value of "0". Values of "+" and "-" were only given when data was relatively conclusive, otherwise a value of "0" was recorded. For ranking purposes, the values were assigned the following numerical scores:

- "+" = 2 points
- "0" = 1 point
- "-" = 0 points

Each BMP was evaluated against each of the criteria and assigned one of the three possible values. The values were then tallied using the numerical scores. Scores on Tier 1 criteria were weighted twice as heavily as Tier 2 criteria scores. After the scoring, best management practices were ranked in order of decreasing final score. The higher the score, the higher priority a BMP is given for implementation.

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Tier 1 Evaluation Criteria

The five Tier 1 evaluation criteria and a definition of the values are listed below:

- Time to achieve results (+ = immediate / - = long-term)
- Compatibility with other CCSF programs (+ = high / - = low)
- Legal changes required (+ = no / - = yes)
- Ability to achieve effluent limits (+ = high / - = low)

Tier 2 Evaluation Criteria

The nine Tier 2 evaluation criteria and a definition of the values are listed below:

- Ease of implementation - CCSF (+ = easy / - = difficult)
- Ease of implementation - affected parties (+ = easy / - = difficult)
- Ability to measure results (+ = easy / - = difficult)
- Public acceptance (+ = high / - = low)
- Promote public awareness (+ = yes / - = no)
- Acceptance by affected parties (+ = high / - = low)
- Environmental impacts (+ = no / - = yes)
- Cross media impacts (+ = no / - = yes)
- Potential to reduce other pollutants (+ = high / - = low)

RANKING OF WET WEATHER BMPs AND RECOMMENDATIONS

Table 9-1 is an evaluation matrix showing the scores assigned to each best management practice for the Tier 1 and Tier 2 criteria. Based on the evaluation, the ranking of the BMPs and a recommendation is presented in Table 9-2. The best management practices are listed in order of decreasing overall benefit.

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Table 9.1 RMP Evaluation Matrix

Tier 1 Evaluation Criteria					
Cost -effectiveness	+	+	-	-	-
Time to results	+	+	-	-	-
Compatibility with other programs	+	+	+	+	+
Legal changes required	-	-	+	+	0
Effluent limits	+	+	0	0	-
Tier 1 Score	1.6 x 2 3.2	1.6 x 2 3.2	1 x 2 2	1 x 2 2	0.6 x 2 1.2
Tier 2 Evaluation Criteria					
Ease of implementation (CCSF)	+	+	0	0	+
Ease of impl. (affected parties)	0	0	0	0	0
Ability to measure results	+	+	+	+	0
Public acceptance	+	0	+	+	0
Promote public awareness	+	+	0	0	+
Acceptance by affected parties	0	0	+	0	0
Environmental impacts	+	+	+	+	+
Cross media impacts	+	+	0	0	0
Potential to reduce pollutants	+	+	+	+	-
Tier 2 Score	1.8	1.7	1.6	1.4	1.2
TOTAL SCORE	5	4.9	3.6	3.4	2.4

Scoring System:
"+" (2)
"0" (1)
"-" (0)

Note: Tier 1 scores are weighted twice as heavily as Tier 2 scores.

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TABLE 9-2

RANKING		RECOMMENDATION
1)	P4-Rainfall/Runoff Protection	Implement
2)	R1-Spill Risk Prevention	Implement
3)	P6-Street Cleaning	Consider further study
4)	P2-Catch Basin Cleaning	Consider further study
5)	E1-Leak/Spill Impacts	Discontinue consideration

The scores for best management practices P4 and R1, as well as those for BMPs P6 and P2, were very close. As discussed in section 8, these two pairs of BMPs are closely linked, so it may not be surprising that their scores are similar. The reason for their linkage is that they are designed to achieve the same ends using different but complementary means. Following is a description of why the best management practices achieved the ranking shown above. The BMPs that are linked are discussed together.

BMPs	P4-Rainfall/Runoff Protection / R1-Spill Risk Prevention
Ranking	1 and 2
Purpose	Prevent rainfall or runoff from contacting pollutants of concern

These two best management practices are the most effective because they address the issue of storm water pollution by targeting two major sources:

- industries and commercial businesses, and
- streets and public areas.

BMP R1 uses the City's pretreatment program to regulate industrial dischargers which have been determined to contribute pollutants of concern to runoff. This best management practice is directly linked to Implementation Program BMP R4 (Rainfall/Runoff Protection) and to best management practice P4. While BMP R1 specifically targets industry, best management practice P4 targets all situations in which rainfall and/or runoff may contact pollutants of concern. Both BMP R1 and BMP P4 are linked to Implementation Program best management practices, so that their implementation could be coordinated with ongoing efforts, thus saving resources and increasing the efficiency of the Best Management Practices Program.

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BMPs	P6-Street Cleaning / P2-Catch Basin Cleaning
Purpose	Remove sediments from the collection system

Street and catch basin cleaning have the common function of removing sediments, which may act as secondary sources, from the City's runoff collection system. There is no question that street and catch basin cleaning are effective at removing a large portion of sediments, and that they have other side benefits of improving air quality, aesthetic conditions, and public health. It is not clear however, that street sweeping can effectively remove the very fine sediments, which are believed to adsorb a higher proportion of metals than larger sediments, and whether catch basin cleaning every 1-7 years is sufficient to maintain the optimal effectiveness of the catch basin sumps. Therefore, before best management practices P2 and P6 can be implemented in any meaningful manner, these questions need to be answered through a carefully designed, long-term sampling program.

BMP	E1-Leak/Spill Impacts
Ranking	5
Purpose	Educate the public on the environmental impacts of leaking storage tanks.

As discussed in section 8 and confirmed in the evaluation, BMP E1 is not cost-effective for the following reasons:

- this best management practice was originally targeted at the general public, very few of which own or operate storage tanks in a heavily urbanized and densely populated environment like San Francisco;
- there is limited potential for spills to threaten runoff quality since above ground tanks are required to have secondary containment;
- underground storage tank leaks would not normally contact storm water runoff; and
- leaking underground tanks are adequately addressed through other educational and regulatory programs.

POTENTIAL AREAS OF FURTHER EVALUATION

The City has limited knowledge regarding the concentrations of some of the pollutants of concern as they pass through the City's storm water runoff collection system prior to treatment at the Water Pollution Control Plants (WPCPs) and/or discharge to the Bay and ocean. An important issue to resolve is whether the pollutants of concern that are adsorbed to sediments are a threat to water quality. If much of the pollutants remain attached to sediments, increased cleaning of streets and catch basins may not be cost-effective, especially if most of the sediments travelling through the collection system end up in the grit chambers at the WPCPs and then are disposed of at a landfill. However, if pollutants of concern adsorbed to sediments are later released in significant amounts into runoff because of changing chemical conditions, then

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minimizing the amount and the residence time of sediments in the collection system may be an effective pollution prevention strategy.

and/or catch basin cleaning in reducing the concentrations of the pollutants of concern in the overflow discharges.

In designing a combined street and catch basin cleaning study, the following recommendations should be considered:

- Estimate the effectiveness of current street sweeping practices by selecting two similar areas, sweeping only one of these areas, and comparing the sediment loads leaving the two areas (USEPA, 1985).
- Monitor sediment levels in catch basins over time (keeping in mind the individual capacities of catch basins), and without sweeping, in order to determine the rate at which sediments accumulate in a particular area of the City.
- Coordinate flushing and sweeping to maximize sediment removal by sweeping just prior to flushing (Federal Water Quality Administration, 1971).

SUMMARY

In conclusion, the City recommends the following actions for the wet weather BMPs:

Implement

- P4-Rainfall/Runoff Protection
- R1-Spill Risk Prevention

Consider further study

- P6-Street Cleaning
- P2-Catch Basin Cleaning

Discontinue Consideration

- E1-Leak/Spill Impacts

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Cal/EPA

State Water Resources Control Board

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MEMORANDUM

Pete Wilson
Governor

TO: Regional Water Board
Executive Officers

FROM: William R. Attwater
Chief Counsel
OFFICE OF CHIEF COUNSEL

DATE: NOV 18 1996

SUBJECT: WATER QUALITY LEGISLATION: NOTICES TO COMPLY

At the November 5, 1996 Management Coordinating Committee meeting, there was a short discussion of recently-enacted legislation dealing with the subject matter of minor water quality violations. This memorandum is intended to summarize the legislation.

Overview

Effective January 1, 1997, a new Chapter 5.8 (commencing with section 13399) is added to Division 7 of the Water Code. The purpose of this new law is to provide an expedited approach for dealing with minor violations of the Porter-Cologne Water Quality Control Act. Commonly referred to as the "fix-it ticket" legislation, the new law will require the use of field-issued notices to comply as the sole enforcement option in given situations.

Minor Violations

The notice to comply approach will be limited to minor violations. The term "minor violation" is not defined in the new law. Rather, the State Water Board is required to adopt regulations or state policy to determine the types of violations that are minor violations. In determining what are minor violations, the following factors are to be considered:

* The magnitude, scope, and severity of the violation.
* The degree of risk to human health or the environment.
* The impact of the violation on programs.
* The degree to which the violation hinders other enforcement actions.

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The legislation also provides that a minor violation is not:

* Any knowing, willful, or intentional violation.
* A violation which gives an economic benefit or competitive advantage.
* A chronic violation or a violation committed by a recalcitrant violator.
* A violation that cannot be corrected in 30 days.

Notices to Comply

The vehicle for handling minor violations is the notice to comply (NOC). NOCs have certain elements:

* They must be in writing.
* They must state the nature of the alleged minor violation.
* They must state a means to comply.
* They must set a time limit in which to comply, not to exceed 30 days.

Issuance of NOCs

The process for issuing NOCs is as follows:

* NOCs are to be written during the course of an inspection by an authorized representative of the State or Regional Water Board.[1]
* NOCs are to be issued upon detection of a minor violation if the inspector finds that an NOC is warranted. In other words, the inspector has discretion not to issue an NOC.
* The NOC is presented to a representative of the facility being inspected.
* An NOC is not required if there is immediate correction.

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[1] *As an exception, NOCs may be mailed to the violator if testing is required.*

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* A single NOC is used to cite all minor violations detected during the same inspection.

* The NOC must inform the violator that the facility is subject to reinspection at any time.

Compliance with NOCs

* The violator is required to comply within the time specified for correction.

* The NOC must be signed and returned to the State or Regional Water Board within five working days of achieving compliance.

* The person receiving an NOC may appeal in writing to the State or Regional Water Board.

Other Provisions

* The law contains significant penalties for false statements of compliance.

* A minor violator may be required to submit documentation to support a claim of compliance.

* An NOC is the sole means by which an inspector may cite a minor violator.

* The State or Regional Water Board may take other enforcement actions upon a failure to comply or if necessary to prevent harm to public health or the environment.

* The new law does not limit criminal enforcement nor restrict the State or Regional Water Boards from cooperating in such proceedings.

* Civil penalties may still be assessed for minor violations if warranted or required by federal law.

* On or before January 1, 2000, the State Water Board is required to file a report to the Legislature regarding implementation of the law.

* The law sunsets on January 1, 2001, unless extended by statute.

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To conclude, the major points of this legislation are as follows:

* The breadth of the NOC approach will be determined by how broadly the term "minor violation" is defined.

* The State and Regional Water Board's enforcement discretion regarding minor violations will be limited.

* If an NOC is violated, there will be a good record for using more severe enforcement options.

A copy of the new legislation is attached. To ensure consistency, a model NOC form will be prepared by this office before the end of the year. If you have any questions, please call your attorney or Craig M. Wilson at 657-2403.

Attachment

cc: Barbara Evoy, Chief
Office of Statewide Consistency

bc: Regional Water Board
Attorneys

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To conclude, the major points of this legislation are as follows:

* The breadth of the NOC approach will be determined by how broadly the term "minor violation" is defined.

* The State and Regional Water Board's enforcement discretion regarding minor violations will be limited.

* If an NOC is violated, there will be a good record for using more severe enforcement options.

A copy of the new legislation is attached. To ensure consistency, a model NOC form will be prepared by this office before the end of the year. If you have any questions, please call your attorney or Craig M. Wilson at 657-2403.

Attachment

cc: Barbara Evoy, Chief
Office of Statewide Consistency

bc: Regional Water Board
Attorneys

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(c) Any person discharging hazardous waste, as defined in Section 25117 of the Health and Safety Code, knowingly failing or refusing to furnish technical or monitoring program reports as required by subdivision (b) of Section 13267, or knowingly falsifying any information provided therein, is guilty of a misdemeanor and may be civilly liable in accordance with subdivision (d).

This subdivision shall not be applicable to any waste discharge which is subject to Chapter 5.5 (commencing with Section 13370).

(d) (1) Civil liability may be administratively imposed by a regional board in accordance with Article 2.5 (commencing with Section 13323) of Chapter 5 for a violation of subdivision (c) in an amount which shall not exceed five thousand dollars ($5,000) for each day in which the violation occurs.

(2) Civil liability may be imposed by the superior court in accordance with Article 5 (commencing with Section 13350) and Article 6 (commencing with Section 13360) of Chapter 5 for a violation of subdivision (c) in an amount which shall not exceed twenty-five thousand dollars ($25,000) for each day in which the violation occurs.

SEC. 4. Chapter 5.8 (commencing with Section 13399) is added to Division 7 of the Water Code, to read:

CHAPTER 5.8. MINOR VIOLATIONS

13399. (a) The Legislature hereby finds and declares that the purpose of this chapter is to establish an enforcement policy for violations of this division that the enforcement agency finds are minor when the danger they pose to, or the potential that they have for endangering, human health, safety, or welfare or the environment are taken into account.

(b) It is the intent of the Legislature in enacting this chapter to provide a more resource-efficient enforcement mechanism, faster compliance times, and the creation of a productive and cooperative working relationship between the state board, the regional boards, and the regulated community while maintaining protection of human health and safety and the environment.

(c) This chapter applies solely to the actions of the state board and the regional boards in administering this division and has no application to the administrative enforcement actions of other public agencies.

(d) The state board and each regional board shall implement this chapter by determining the types of violations of this division, or of the regulations, rules, standards, orders, permit conditions, or other requirements adopted pursuant to this division that the state board or the regional board finds are minor violations in accordance with subdivisions (e) and (f). The state board shall implement this chapter through adoption of regulations or state policy for water quality

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control pursuant to Article 3 (commencing with Section 13140) of Chapter 3.

(e) In determining the types of violations that are minor violations, the state board or regional board shall consider all of the following factors:

(1) The magnitude of the violation.

(2) The scope of the violation.

(3) The severity of the violation.

(4) The degree to which a violation puts human health, safety, or welfare or the environment into jeopardy.

(5) The degree to which a violation could contribute to the failure to accomplish an important goal or program objective as established by this division.

(6) The degree to which a violation may make it difficult to determine if the violator is in compliance with other requirements of this division.

(f) For purposes of this chapter, a minor violation of this division shall not include any of the following:

(1) Any knowing, willful, or intentional violation of this division.

(2) Any violation of this division that enables the violator to benefit economically from noncompliance, either by realizing reduced costs or by gaining a competitive advantage.

(3) Any violation that is a chronic violation or that is committed by a recalcitrant violator.

(g) In determining whether a violation is chronic or a violator is recalcitrant, for purposes of paragraph (3) of subdivision (f), the state board or regional board shall consider whether there is evidence indicating that the violator has engaged in a pattern of neglect or disregard with respect to the requirements of this division or the requirements adopted pursuant to this division.

13399.1. For purposes of this chapter, "notice to comply" means a written method of alleging a minor violation that is in compliance with all of the following requirements:

(a) The notice to comply is written in the course of conducting an inspection by an authorized representative of the state board or regional board. If testing is required by the state board or regional board to determine compliance, and the testing cannot be conducted during the course of the inspection, the representative of the state board or regional board shall have a reasonable period of time to conduct the required testing. If, after the test results are available, the representative of the state board or regional board determines that the issuance of a notice to comply is warranted, the representative shall immediately notify the facility owner or operator in writing.

(b) A copy of the notice to comply is presented to a person who is an owner, operator, employee, or representative of the facility being inspected at the time that the notice to comply is written. If offsite testing is required pursuant to subdivision (a), a copy of the

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notice to comply may be mailed to the owner or operator of the facility.

(c) The notice to comply clearly states the nature of the alleged minor violation, a means by which compliance with the requirement cited by the representative of the state board or regional board may be achieved, and a time limit in which to comply, which shall not exceed 30 days.

(d) The notice to comply shall contain the information specified in subdivision (h) of Section 13399.2 with regard to the possible reinspection of the facility.

13399.2. (a) An authorized representative of the state board or regional board, who, in the course of conducting an inspection, detects a minor violation shall issue a notice to comply before leaving the site at which the minor violation is alleged to have occurred if the authorized representative finds that a notice to comply is warranted.

(b) A person who receives a notice to comply pursuant to subdivision (a) shall have the period specified in the notice to comply from the date of receipt of the notice to comply in which to achieve compliance with the requirement cited on the notice to comply. Within five working days of achieving compliance, the person who received the notice to comply shall sign the notice to comply, and return it to the representative of the state board or regional board, stating that the person has complied with the notice to comply. A false statement that compliance has been achieved is a violation of this division pursuant to subdivision (a) of Section 13268, Section 13385, or subdivision (e) of Section 13387.

(c) A single notice to comply shall be issued for all minor violations cited during the same inspection and the notice to comply shall separately list each cited minor violation and the manner in which each minor violation may be brought into compliance.

(d) A notice to comply shall not be issued for any minor violation that is corrected immediately in the presence of the inspector. Immediate compliance in that manner may be noted in the inspection report, but the person shall not be subject to any further action by the representative of the state board or regional board.

(e) Except as otherwise provided in subdivision (g), a notice to comply shall be the only means by which the representative of the state board or regional board shall cite a minor violation. The representative of the state board or regional board shall not take any other enforcement action specified in this division against a person who has received a notice to comply if the person is in compliance with this section.

(f) If a person who receives a notice to comply pursuant to subdivision (a) disagrees with one or more of the alleged violations cited in the notice to comply, the person shall give written notice of appeal to the state board or regional board.

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(g) Notwithstanding any other provision of this section, if a person fails to comply with a notice to comply within the prescribed period, or if the state board or regional board determines that the circumstances surrounding a particular minor violation are such that immediate enforcement is warranted to prevent harm to the public health or safety or to the environment, the state board or regional board may take any needed enforcement action authorized by this division.

(h) A notice to comply issued to a person pursuant to this section shall contain a statement that the inspected facility may be subject to reinspection at any time. Nothing in this section shall be construed as preventing the reinspection of a facility to ensure compliance or to ensure that minor violations cited in a notice to comply have been corrected.

(i) Nothing in this section shall be construed as preventing the state board or regional board, on a case-by-case basis, from requiring a person subject to a notice to comply to submit reasonable and necessary documentation to support a claim of compliance by the person.

(j) Nothing in this section restricts the power of a city attorney, district attorney, county counsel, or the Attorney General to bring, in the name of the people of California, any criminal proceeding otherwise authorized by law. Furthermore, nothing in this section prevents the state board or regional board, or a representative of the state board or regional board, from cooperating with, or participating in, such a proceeding.

(k) Notwithstanding any other provision of this section, if the state board or regional board determines that the circumstances surrounding a particular minor violation are such that the assessment of a civil penalty pursuant to this division is warranted or required by federal law, in addition to issuance of a notice to comply, the state board or regional board shall assess a civil penalty in accordance with this division, if the state board or regional board makes written findings that set forth the basis for the determination of the state board or regional board.

13399.3. (a) On or before January 1, 2000, the state board shall report to the Legislature on actions taken by the state board and the regional boards to implement this chapter and the results of that implementation. Each regional board shall provide the state board with the information that the state board requests to determine the degree to which the purposes described in subdivision (a) of Section 13399 have been achieved.

(b) This chapter shall remain in effect only until January 1, 2001, and as of that date is repealed, unless a later enacted on or statute, which is enacted on or before January 1, 2001, deletes or extends that date.

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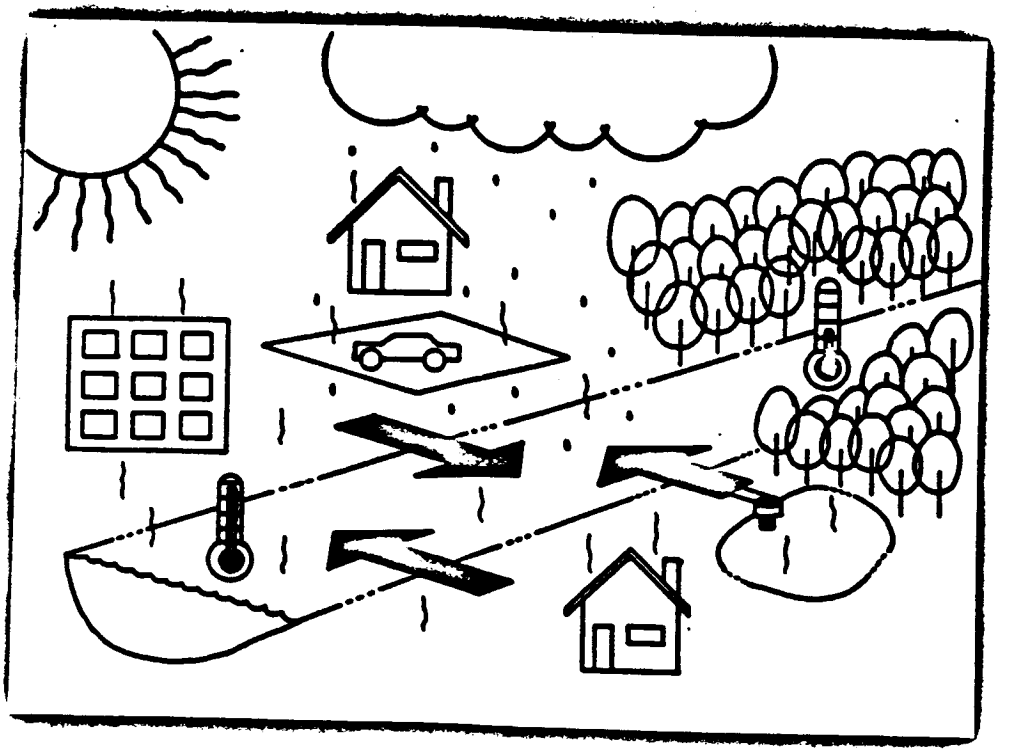
Thermal Impacts Associated With Urbanization and Stormwater Management Best Management Practices



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Thermal Impacts Associated with Urbanization and Stormwater Management Best Management Practices

-Final Report-

Prepared for:

Sediment and Stormwater
Administration of the
Maryland Department of
the Environment

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Metropolitan Washington Council of Governments
777 N. Capitol Street, N.E.
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December, 1990

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Title: Thermal Impacts Associated with Urbanization and Stormwater Management Best Management Practices

Date: December, 1990

Author: John Galli, Anacostia Restoration Team
Department of Environmental Programs
Metropolitan Washington Council of Governments

Agency: The Metropolitan Washington Council of Governments is the regional organization of the Washington, D.C. area's major local governments and their governing officials. COG works towards solutions to such regional problems as energy shortages, traffic congestion, inadequate housing, air and water pollution. COG is also the areawide wastewater management agency for the Washington area and is involved with regional policy issues related to provision of adequate wastewater treatment, sludge disposal, nonpoint source pollution control, and municipal water supplies.

Report Abstract:

Study evaluates thermal and dissolved oxygen (DO) impacts to aquatic life associated with urbanization and various representative stormwater management Best Management Practices (BMP's). Continuous water temperature monitoring and grab sampling was performed at six headwater urban streams and four stormwater BMP sites in the Piedmont portion of Maryland's Anacostia River basin. The streams studied spanned the entire watershed imperviousness spectrum and featured undeveloped, as well as, 60 percent impervious sites. The four representative BMP's monitored included: an infiltration facility, artificial wetland, extended detention dry pond, and a wet pond. In addition, a comprehensive literature review was performed to evaluate potential temperature and DO impacts at major levels of the aquatic food chain. Thermal requirement data for 63 species of fish known or expected to occur in Maryland freshwater streams is included among the biological information presented.

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Executive Summary

A two-part study was undertaken in 1989 to evaluate the thermal and dissolved oxygen (DO) impacts to aquatic life associated with urbanization and various representative stormwater management Best Management Practices (BMP's). Part one of the study involved both continuous water temperature monitoring and water quality grab sampling at six headwater streams and four stormwater management BMP sites located in the Piedmont portion of the Anacostia River basin. The urban streams studied spanned the entire watershed imperviousness spectrum, and featured undeveloped, as well as, 60 percent impervious sites. The four representative BMP's monitored in the study included: an infiltration facility, artificial wetland, extended detention dry pond, and a wet pond.

Fourteen paired thermograph thermometers were employed to characterize both BMP inflow-outflow temperature relationships, as well as, spatial variations along streams. In addition, a 55 station grab sampling network was established for the purpose of monitoring DO, streamflow and temperature conditions at discrete longitudinal intervals in and along the streams in the study area.

In the second part of the study a comprehensive literature review was performed to evaluate potential temperature and DO impacts at major levels of the aquatic food chain. Major findings of the study are described in the following five sections.

I. Effect of Meteorological and Watershed Land Use Conditions On Free-Flowing Stream Temperatures

Results from the study indicated that the temperature regime of small, free-flowing headwater Piedmont streams is largely determined by the following interrelated factors:

1. Air Temperature and Other Local Meteorological Conditions.

   - Local air temperature had approximately 90 - 95 percent of the time, a greater influence on stream temperature than did stormflow. Notably, the potential for major stream temperature increases grew dramatically when air temperatures remained at or above 80°F for long periods of time. In general, the critical thermal loading season for the streams studied was late May to late September.

   - The amount and intensity of precipitation was an important, though somewhat smaller factor. During the study, small storms which produced little or no runoff generally had little effect on receiving stream temperatures. Sharp, rapid increases in stream temperature were not observed under steady, light precipitation conditions. They were, however, closely associated with warm air conditions which included heavy shower activity.

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2. Watershed Imperviousness.

- Imperviousness together with local meteorological conditions had the largest influence on urban stream temperatures. In general, the average water temperature of the urban streams increased in a linear fashion with increasing levels of watershed imperviousness. Results indicated that the average rate of increase was 0.14°F per one percent increase in imperviousness.

- Stream temperatures at the undeveloped watershed responded to storm events by becoming slightly cooler. This was largely due to the drop in air temperatures which accompanied most rainfall events. While this was also generally true of urban streams, as the level of watershed imperviousness increased the streams became progressively more responsive to inputs of stormwater runoff. With increasing imperviousness, the storm-size needed to produce large, stream temperature fluctuations decreased. At a 12 percent watershed imperviousness level over 0.7 inches of rainfall was generally required. In contrast, at a 60 percent imperviousness level, less than 0.2 inches of precipitation was needed to produce a comparable temperature change. It should be noted that stormwater inflow generally produced positive stream Delta-T's. In addition, the potential thermal impact of stormwater runoff on receiving streams increased as the runoff (Q_{in}) to receiving stream flow (Q_r) ratio increased.

- Even at the relatively low 12 percent watershed imperviousness level, neither MDE Class III (68.0°F) or IV (75.0°F) temperature standards could be met 100 percent of the time. Both the frequency and magnitude of temperature standards violations increased with increasing levels of watershed imperviousness.

3. Riparian Canopy Coverage.

- Riparian vegetation plays a key role in insulating small streams from the warming effect of solar radiation. Other studies have shown that the removal of riparian vegetation can raise the summer water temperature of small streams by 11 - 20°F, and can lower winter water temperatures by 5 - 7°F. Results from this study revealed an average positive stream Delta-T of 1.5°F per 100 feet of flow through either open or poorly-shaded reaches.

4. Stream Order/Size.

- It is well known that stream temperature naturally increases in a downstream direction with increasing stream order/distance from the source. In urban watersheds a variety of anthropogenic factors, such as the removal of riparian vegetation, micro-climate changes, and reduction of groundwater inflow, add to the so-called "watershed Delta-T" effect. Monitoring results indicated that the watershed Delta-T effect for a 18 percent

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Table 1

Summary: BMP Temperature Performance 1/

Parameter	BMP Type: Infiltration-Dry Pond	Extended Detention Wetland	Extended Detention Dry Pond	Wet Pond
Average Baseflow Delta-T (°F)	2.6	3.9	5.5	9.7
Maximum Baseflow Delta-T (°F)	7.6	8.7	9.7	15.1
Average Stormflow Delta-T (°F)	2.3	2.4	5.2	8.5
Maximum Stormflow Delta-T (°F)	5.0	7.8	11.2	14.0
Average Total Delta-T (°F)	2.5	3.2	5.3	1.1
Maximum Total Delta-T (°F)	7.6	8.7	10.9	9.1
Percent Baseflow - Class III (60°F)	0	60	50	77
Violation of MDE - Class IV (75°F)	1*	15	18	35
Temperature Stds. - Class I (90°F)	0	0	0	0
Percent Stormflow - Class III (60°F)	10	97	88	64
Violation of MDE - Class IV (75°F)	0	5	15	25
Temperature Stds. - Class I (90°F)	0	0	0	0
Maximum observed outflow water Temp (°F)	77.7	80.0	81.9	82.6

1/ - Total Delta-T values shown represent combined baseflow and stormflow temperatures (i.e., all flow conditions).

* - Class IV violation result of defacto extended-detention control.

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impervious, urban third order stream system, is on the order of 1 - 2°F per stream mile. In addition, smaller lower-order urban streams are more responsive to this background watershed effect.

II. Effect of Urban Stormwater Management BMP's On Water Temperature

One of the more revealing findings was that none of the four BMP's monitored where thermally neutral. All four BMP types had positive average total Delta-T's and each violated MDE Class III and IV temperature standards some of the time. Temperature standards violations occurred under both baseflow and stormflow conditions. Wet permanent pools, long periods of extended detention, and poorly shaded pilot and outflow channels contributed greatly to the problem. Specific findings for each BMP type are described below and are additionally summarized in Table 1.

1. Infiltration - Dry pond

- Of the four BMP's, this hybrid facility (which had average and maximum BMP Delta-T's of 2.5 and 7.6°F) produced the smallest Delta-T increases. The infiltration trench portion of the BMP, designed for 0.25 inches of street runoff, worked well during small storms. However, large storm events (i.e., $\geq$ 1.0 inches precipitation) and/or 2 - 3 consecutive days of moderate rainfall generally overtaxed the capacity of the infiltration trench system. This often resulted in the ponding of several feet of runoff in the dry pond area. The facility's defacto extended detention control combined with high incoming solar radiation on the unshaded rip-rap pilot channel, storage pool, and outfall area, produced a 4.0°F Delta-T increase.

- From a water temperature standards perspective, this BMP had the lowest frequency of Class III (68.0°F) and IV (75.0°F) violations. Standards violations were more frequently associated with stormflow conditions. Under stormflow conditions, Class III and IV temperature standards were exceeded 18 and 0 percent of the time, respectively. The BMP's single Class IV violation was a product of a large storm and 53 hours of extended detention.

2. Extended Detention Artificial Wetland

- The average and maximum BMP Delta-T's associated with the wetland were 3.2 and 8.7°F, respectively. Delta-T stormflow temperatures at the wetland were typically lower than baseflow Delta-T temperatures. However, approximately two-thirds of the time the difference between baseflow and stormflow Delta-T's was relatively small (i.e., $\leq$ 3.0°F).

- The shallow depth (mean depth is approximately 18 inches) and small permanent pool volume, relative to the 140 acre contributory watershed, made the wetland and its outflow station

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very responsive to air temperature fluctuations. The wetland's small permanent pool did, however, give it a limited ability to moderate outflow temperatures during certain small storm events. In addition, because the wetland's extended detention capability was extremely limited, it had little influence on outflow station temperature behavior.

- Under baseflow conditions, wetland outflow station temperatures exceeded Class III and IV temperature standards 60 and 15 percent of the time, respectively. In contrast, the same standards were violated approximately 57 and 5 percent of the time, respectively under stormflow conditions. Outflow stations were higher than inflow station temperatures 95 percent of the time.

3. Extended Detention Dry Pond

- The average and maximum BMP Delta-T's associated with the ED dry pond were 5.3 and 11.2°F, respectively. The maximum Delta-T produced by this BMP was slightly higher under stormflow conditions (11.2°F) than under baseflow conditions (9.7°F). The higher stormflow Delta-T's were the product of : a) the influx of relatively warm stormwater runoff into the facility, b) the partially shaded pilot channel's heat contribution, and c) additional heating of detained waters via solar radiation. In addition, the highest Delta-T's were noted during hot weather. This BMP's 500 foot long pilot channel produced an average positive stream Delta-T of 3.7°F.

- Under stormflow conditions, the ED dry pond violated Class III and IV temperature standards 48 and 15 percent of the time, respectively.

4. Wet Pond

- The wet pond's large permanent pool served as an effective heat regulator. In general, the pond had a major warming effect on baseflow temperature. However, during most storm events, both pond and outflow station temperatures were depressed. The relatively large permanent pool volume resulted in the pond slowly storing and releasing solar radiation/heat; thus making it slow to respond to air temperature fluctuations. Average summer pond surface water temperatures remained generally over 77°F. Pond waters were noticeably slow to cool-down in late summer/early fall.

- Of the four BMP's, the wet pond had the highest recorded maximum Delta-T (15.1°F). Delta-T baseflow temperatures at the wet pond were higher than stormflow Delta-T's 99 percent of the time. The average baseflow Delta-T (9.7°F) was slightly higher than the average stormflow Delta-T (8.5°F). The pond's rip-rap outflow channel produced an average positive Delta-T increase of 2.0°F.

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- From a water temperature standards perspective, this BMP had the highest frequency of Class III and IV temperature standards violations. Under baseflow conditions, Class III and IV standards were exceeded 77 and 35 percent of the time. In contrast, under stormflow conditions the same standards were violated 64 and 25 percent of the time, respectively.

5. Dissolved Oxygen

Results from the dissolved oxygen monitoring portion of the study revealed the following:

- Baseflow DO levels generally do not appear to be a problem in urban streams; even in those draining highly impervious watersheds
- Some oxygen depletion was noted within the artificial wetland, as well as downstream of both it and the wet pond. However, no anoxia was evident.
- DO levels recovered within relatively short distances of the wet BMP's; generally, within 200 - 500 feet.
- No discernible DO sag was observed during stormflow conditions.

III. Biological Implications

In an effort to identify the potential biological impacts associated with temperature regime modification, COG staff conducted a comprehensive two-part literature survey of the water temperature requirements of freshwater biota known or expected to occur in Maryland streams. Part one examined both the principal environmental factors and various human activities which influence the thermal regime of streams. Part two investigated the general thermal requirements of stream biota as well as the potential biological affects associated with thermal regime modification. Potential biological consequences occurring at all general levels of the aquatic food chain were reached. Over 200 references were collected. Special emphasis was placed on identifying the temperature requirements of Maryland freshwater fish. In addition, because of the general controversy surrounding watershed urbanization and trout streams, a separate subsection on trout was included.

Literature review information together with results from the water temperature monitoring portion of the study were subsequently synthesized. Major findings are presented starting at the bottom of the food chain with algae, and progressing sequentially to fish. In addition, to facilitate reader understanding results have been graphically summarized in Figure 1.

1. Algae.

- Water temperature monitoring results suggest that subtle shifts in the periphyton (attached algae) community species composition would have been expected to have occurred in some of the urban

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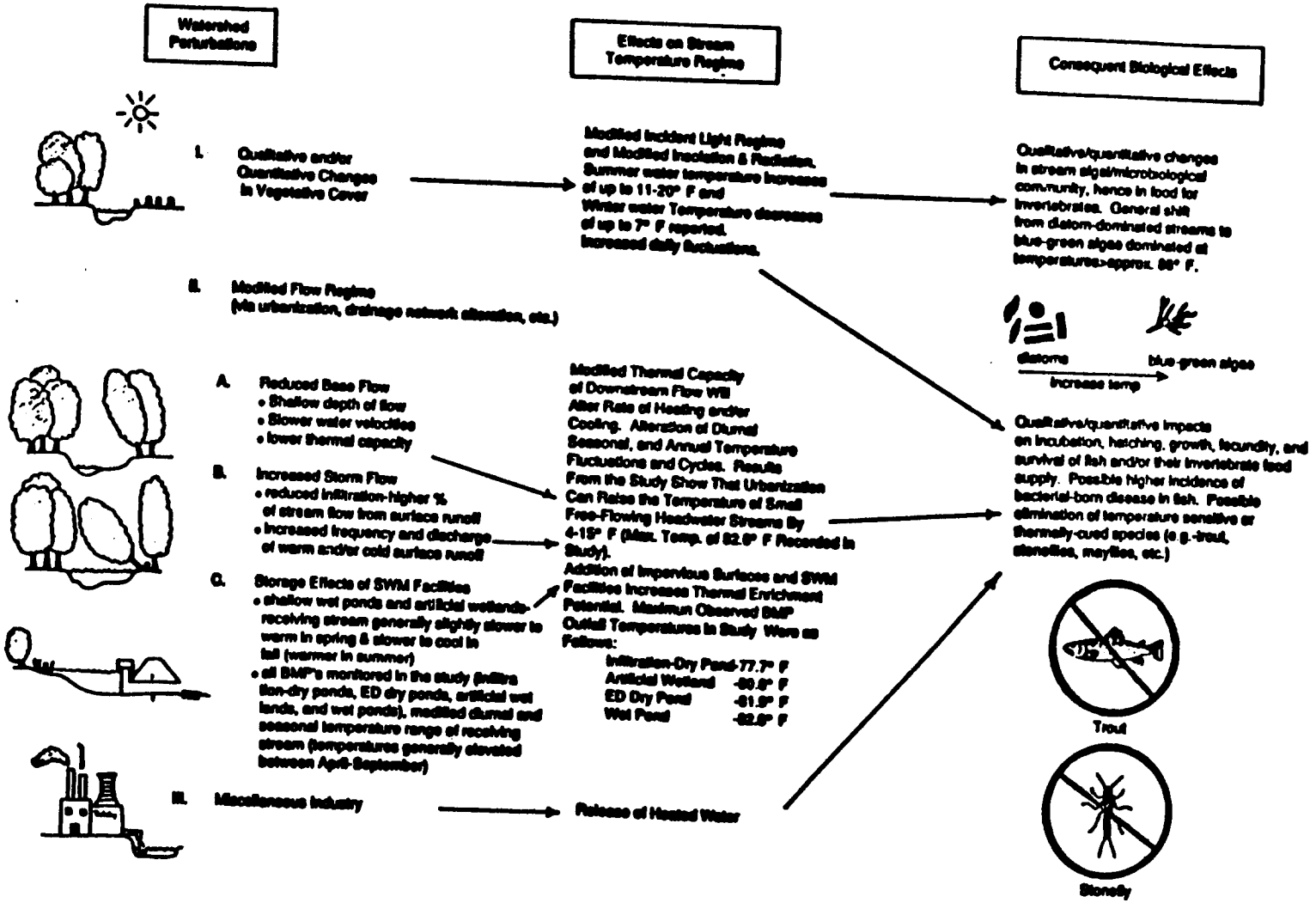
Figure 1

Summary: General Impacts of Human Activities on Stream Temperature and Biota



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streams studied. At all developed watershed and BMP sites, diatoms would have continued to remain the dominant overall algal group. However, certain coldwater and/or light sensitive species may have either declined in numbers and/or been replaced by other, more temperature or light-tolerant species. The scenario would have occurred most likely in stream reaches where considerable thermal enrichment and/or removal of riparian vegetation took place (e.g., wet pond outflow, ED wetland outflow, highly developed urban stream site, and ED dry pond outflow station). In addition, it is probable that green and blue-green algal species would have been represented in greater numbers in the warmer, open-lit sections of these streams.

- While some temperature-related shifts in algal community species composition undoubtedly occurred, it is unlikely that they would have in themselves had a major effect on either the resident macroinvertebrate or fish communities of these urban streams.

2. Macroinvertebrates - Aquatic Insects.

- Results indicate that the thermal enrichment effects produced either through urbanization and/or associated BMP's, would severely effect coldwater aquatic insects. It is most likely that sensitive groups, such as stoneflies, would either be eliminated or severely restricted (for much of the year) at temperature levels comparable to those observed at the moderately and highly developed watershed sites and at the wet pond, ED wetland, and ED dry pond outflow stations. While collectively more temperature tolerant, many mayfly and caddisfly species would similarly be eliminated, severely restricted and/or stressed at the preceding temperature levels.

- Restructuring of the macroinvertebrate community would also occur, with intolerant species and/or groups of insects being replaced by thermally-tolerant ones. It would be expected that tolerant groups such as Diptera (flies & midges) would gain greater dominance in these stream systems. In addition, non-insect species would probably become more abundant. The preceding changes could, if particularly extensive, have a negative impact on the resident fish community.

3. Fish

- Results show that the vast majority of resident fish species would not be affected by the temperature increases produced either through urbanization and/or construction of BMP's. However, coldwater species such as trout would not be expected to survive at temperature levels observed at either the moderately or highly developed watershed sites or at any of the four BMP outfall locations. While generally regarded as being slightly more temperature tolerant than trout, sculpins would only be expected to survive at temperature levels observed at either the lightly developed watershed sites, or below the infiltration -

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dry pond. The findings from this study underscore the point that moderate levels of watershed imperviousness and/or the improper introduction of associated BMP's, can have a devastating impact on sensitive coldwater streams and the fish communities which they support.

- All trout species are extremely sensitive to thermal pollution/stress. Sustained elevated water temperatures over 70° F are generally considered to be stressful, while those at or above 77°F are usually lethal. Water temperature monitoring results from the 12 percent impervious Gum Springs tributary indicate that baseflow water temperatures remain safely below levels considered to be stressful to trout. However, under stormflow conditions water temperature exceeds 70°F. The frequency and magnitude of these stress-producing episodes were more severe in Lower Gum Springs, where the temperature regime is negatively affected by the stormwater discharge from the Oak Springs ED wetland. Results further indicate that the thermal regime of Lower Gum Springs may, under stormflow conditions, be approaching the trout supporting temperature threshold for young-of-year and juvenile trout.

IV. Land Use Control Program Implications

Through the process of urbanization, vegetation is removed from watersheds, formerly pervious surfaces are converted to hard, impermeable ones such as rooftops, streets and parking lots, and natural drainage networks are modified to convey runoff more efficiently. These processes act together to alter the thermal regime of urban, headwater streams.

Among the more enlightening results of the study, was the finding that the level of watershed development had the single, greatest anthropogenic influence on the temperature regime of urban, headwater streams. This, as well as other land use control program implications, are briefly described below.

1. Watershed Imperviousness Factor

For urban headwater streams, the level of watershed imperviousness largely determines the magnitude of change from the pre-development thermal regime. As previously noted, results from this study show that mean, summer stream temperatures increase linearly with increasing watershed imperviousness. Importantly, watershed imperviousness has a negative influence on stream temperatures under both baseflow and stormflow conditions.

As seen in Table 2, the frequency of MDE temperature standards violations generally increases with increasing levels of imperviousness. This phenomenon occurs regardless of whether watershed stormwater management controls are present or absent. Reduction of groundwater flows, the urban heat island effect, removal of riparian vegetation, and drainage network alteration are primary causes of the problem.

2. Conflicting Stream Protection and Watershed Development Goals

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Table 2. Summary: MDE Water Temperature Standards Violations Versus Watershed Imperviousness

Watershed Development Level	Percent Imperviousness (%)	Percent of Time MDE Temperature Std. Violated (%)			
		Class III (68°F)		Class IV (75°F)	
		Baseflow	Stormflow	Baseflow	Stormflow
Light	12.0	10	5	0	1
Moderate	30.0	25	1	25	1
High	60.0	67	57	12	10

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All too often the goal of stream protection conflicts with land use development. Many of the environmental problems caused by urbanization, stream warming for one, cannot be completely mitigated by engineering means. Thus, far greater emphasis on land use control measures is required in sensitive streams.

Results from this study show that stream temperature regime changes occur at relatively low levels of watershed imperviousness (i.e., $\leq$ 12 percent). They also strongly suggest that trout and other coldwater biota will most likely be lost when watershed imperviousness exceeds 12 - 15 percent.

3. Thermal Regime Protection Strategy

It is clear that the long-term protection of thermally sensitive streams requires a holistic watershed management approach which includes, at a minimum, the following water temperature protection elements:

- Land use controls (which govern type, density and location of development within a watershed);
- Riparian/stream buffer requirements;
- Employment of temperature sensitive BMP's and stormwater conveyance systems.
- Long-term water temperature and biological monitoring at strategic stream locations within the watershed; and
- Routine long-term maintenance of BMP's and other associated infrastructure.

Not surprisingly, extraordinary land use, riparian management and stormwater management controls are needed to properly protect the resident aquatic life of MDE Class III streams. The same watershed protection approach is also generally needed, on a case-by-case basis for thermally sensitive Class I and IV stream areas. This stream protection strategy requires that many difficult, and potentially costly, land use decisions be made.

V. Implications for Stormwater Management Programs

Aquatic community species composition and activity in freshwater stream systems is largely regulated by water temperature. In urban streams, the composition and structure of the aquatic community is generally affected by thermal regime modification, as well as, by flow regime, water quality and physical/structural habitat changes.

The results of the water temperature monitoring study have several major implications with regard to current stormwater management practice selecion, design and policy. These implications are outlined below.

1. Stormwater Management Practice Selection

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The four BMP's tested were, in ranked order of both Delta-T and outflow temperatures standards performance: 1.) infiltration-dry pond, 2.) artificial wetland, 3.) extended detention dry pond, and 4.) wet pond. By a wide margin the infiltration facility outperformed all other BMP types. The preceding findings strongly support the current MDE stormwater management practice prioritization policy. Clearly, infiltration generally remains the best BMP choice in thermally sensitive watershed areas. At low levels of watershed imperviousness, improper BMP selection can have a major negative effect on the water temperature regime of small, headwater Piedmont streams. This is particularly the case in coldwater stream systems, where the selection of conventional wet and/or extended detention BMP's could conceivably eliminate temperature sensitive species such as trout.

However, results from the study also show that at moderate levels of watershed imperviousness the potentially negative influence of BMP's on the receiving stream's temperature regimes is reduced. This is due to the fact that the temperature regimes of these streams have been (or will be modified by the background level of urbanization. Consequently, temperature sensitive biota will, even in the absence of BMP's, most likely be reduced and/or eliminated from these streams. At high levels of watershed imperviousness, the general impact of BMP's on the receiving stream temperature regime is minimal. In these streams, the need for providing high levels of water quality and stream channel erosion control may outweigh temperature concerns. In MDE Class III watershed areas, both extraordinary land use and stormwater management controls are necessary to protect resident stream biota. A similar watershed protection strategy is also generally needed, on a case-by-case basis, for thermally sensitive Class I and IV stream areas. It is also understood that the absence of water temperature and biologicl data, together with the lack of rapid assessment guidelines often makes the BMP selection process difficult in these areas.

2. BMP Design Feature Considerations

- The thermal performance of the infiltration - dry pond could have been improved had its infiltration design treatment capacity been sized to handle more than 0.25 inches of runoff from roadway areas. Although infiltration systems which are to be located in thermally sensitive watersheds should, as a general rule, be intentionally over-sized there is a finite storm-size which can be treated in this manner. Because of the high probability of large storms and/or several consecutive days of precipitation overtaxing infiltration system design capacity, it is extremely unlikely that 100 percent compliance with MDE Class III standars can be achieved in the field.

- Results from the study revealed that unshaded (and/or poorly shaded) pilot and rip-rap outflow channels produced maximum positive Delta-T's of 8.5°F. Shading of these structures via landscaping, or other means, would have improved the overall performance of every BMP type tested in the study. In addition,

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results further indicated that the practice of employing long, wide rip-rap outflow channels should be seriously re-examined. Whenever possible, outflow channels should be heavily shaded. They should also include a deep, narrow baseflow channel to quickly return this water back to the natural stream channel.

- One of the more revealing findings was that long periods of extended detention control can produce BMP Delta-T increases on the order of 4 - 12.0°F. For this reason, the use of extended detention BMP's in thermally sensitive areas should be carefully evaluated. It is further recommended that a 6 - 12 hour detention period limit be established for these areas and that shading of the storage pool area be required.

3. Ability of Current MDE Class I Temperature standards to Protect Aquatic Life

- Results from the literature review portion of the study indicate that the 90°F MDE Class I discharge temperature standard is inadequate to protect a large portion of the biota normally present in headwater Piedmont streams. At the 90°F level, wholesale changes at all levels of the aquatic food chain would be expected to occur. Therefore, it is strongly recommended that new criteria be developed to better protect the aquatic life of Class I streams.

4. Future Research Needs

- The current water temperature class designations are not a reliable guide to the existing or future thermal regime status of headwater Piedmont streams. This is particularly the case for urban streams. Consequently, there is a strong need to develop holistic guidelines and stream assessment procedures for defining appropriate stormwater management options within any Maryland watershed area.

- Water temperature monitoring of parallel pipe and baseflow diversion systems, multiple-port release wet ponds, sand filters, and other promising thermally sensitive conveyance/stormwater management practices is urgently needed.

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Introduction

The growing concern over the potential thermal impacts to Maryland's freshwater streams, from both urban stormwater runoff and the various Best Management Practices (BMP's) employed for its control, led the Maryland Sediment and Stormwater Administration to contract the Metropolitan Washington Council of Governments to perform a comprehensive evaluation. As a result, a two-part study was undertaken in 1989 to evaluate the thermal and dissolved oxygen (DO) impacts to aquatic life associated with both urbanization and representative stormwater management BMP's.

Part one of the study involved both continuous water temperature monitoring and water quality grab sampling at six headwater streams and four stormwater management BMP sites located in the Piedmont portion of the Anacostia River basin. The urban streams studied spanned the entire watershed imperviousness spectrum, and featured undeveloped, as well as, 60 percent impervious sites. The four representative BMP's monitored in the study included: an infiltration facility, artificial wetland, extended detention dry pond, and a wet pond. In the second part of the study a comprehensive literature review was performed to evaluate potential temperature and DO impacts at major levels of the aquatic food chain.

For organizational purposes this report has been divided into four main chapters. Chapter one describes study, design, and methodology. The second chapter examines the general thermal effects associated with watershed urbanization, removal of riparian vegetation, increase in stream order/stream size and stormwater management BMP's. In addition to providing detailed information on the thermal characteristics and performance of each

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of the four BMP's, the chapter provides supplemental information on: thermal loading as a function of flow ratio, stormwater management features which increase water temperature, and results from the dissolved oxygen grab sampling monitoring. In the third chapter, both water temperature monitoring results and literature review findings are synthesized in a comprehensive evaluation of potential biological impacts. The fourth and final chapter, discusses the implications of the study's findings on both stormwater management and land use control programs.

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Chapter I. Study Design and Methodology

The study was designed to evaluate potential thermal and dissolved oxygen (DO) impacts associated with representative stormwater management BMP's currently in use throughout the state (i.e., wet ponds, artificial wetlands, extended detention dry ponds, and infiltration). In addition, the general effects of both the level of watershed urbanization and riparian management practices on stream temperature were investigated, together with potential biological implications.

In order to meet the preceding objectives, a study design featuring three major elements, or tasks, was developed. Under the first task, a continuous water temperature monitoring network was created to provide necessary baseline data. Second, a water quality grab sampling network was established to provide baseline dissolved oxygen, stream flow, and air/water temperature data. Last, a comprehensive literature search was performed to identify water temperature requirements of freshwater biota, at all general levels of the food chain, and relate them to water temperature monitoring results.

The following sections describe in greater detail the study design, sampling techniques, and calculations employed in the study.

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Development of a Comprehensive Field Monitoring Network

A. Site Selection

Metropolitan Washington Council of Governments staff (COG) in consultation with MDE, MdDNR, and local agency staff identified the following six representative study categories for monitoring:

1. Wet pond;

2. Artificial wetland;

3. Extended detention dry pond;

4. An innovative stormwater management facility which incorporates temperature mitigation features;

5. An urban stream draining a small, highly impervious and uncontrolled watershed; and

6. A reference stream draining a small undeveloped watershed.

An inventory of possible candidate sites for each of the preceding six categories was conducted within the Maryland portion of the Anacostia River basin. Each candidate site was carefully screened and ranked according to the following criteria: MDE water use class designation, drainage area,

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watershed land uses, stream discharge, stormwater and stormdrain conveyance system, and representativeness and access. After consultation with MDE, COG staff selected a total of six sites from the inventory for subsequent continuous water temperature monitoring and water quality grab sampling. Study area locations are shown in Figure 2, and the general characteristics of each site are summarized in Table 3. Additional information on each BMP site can be found in Appendix A. A brief description of each study site is provided as follows:

1. Lakemont tributary. This reference Piedmont stream is located in the headwaters of Northwest Branch, an MDE Class IV recreational trout stream area. The Lakemont tributary drains an undeveloped watershed area of approximately 400 acres. During the late 1970's much of the subwatershed was used as a sludge trenching area. However, since 1978 the disturbed portions of the watershed have remained fallow. Forest and old abandoned fields are now the predominant land uses in the study area. The Lakemont tributary, which is approximately 8-9 feet wide is heavily shaded by the mixed-age hardwood forest through which it flows. Average stream baseflow during the study period was 0.9 cfs.

2. Oaksprings/Gum Springs tributaries. The Oaksprings tributary is a small feeder branch of the Gum Springs tributary. Both streams are designated by MDE as Class III natural trout waters. The Oaksprings tributary, which flows through a mixed-age hardwood forest, drains a developed 140 acre watershed. Principal land uses in the catchment include 0.25-0.5 acre lot single family residential development and

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FIGURE 2

WATER TEMPERATURE MONITORING LOCATIONS

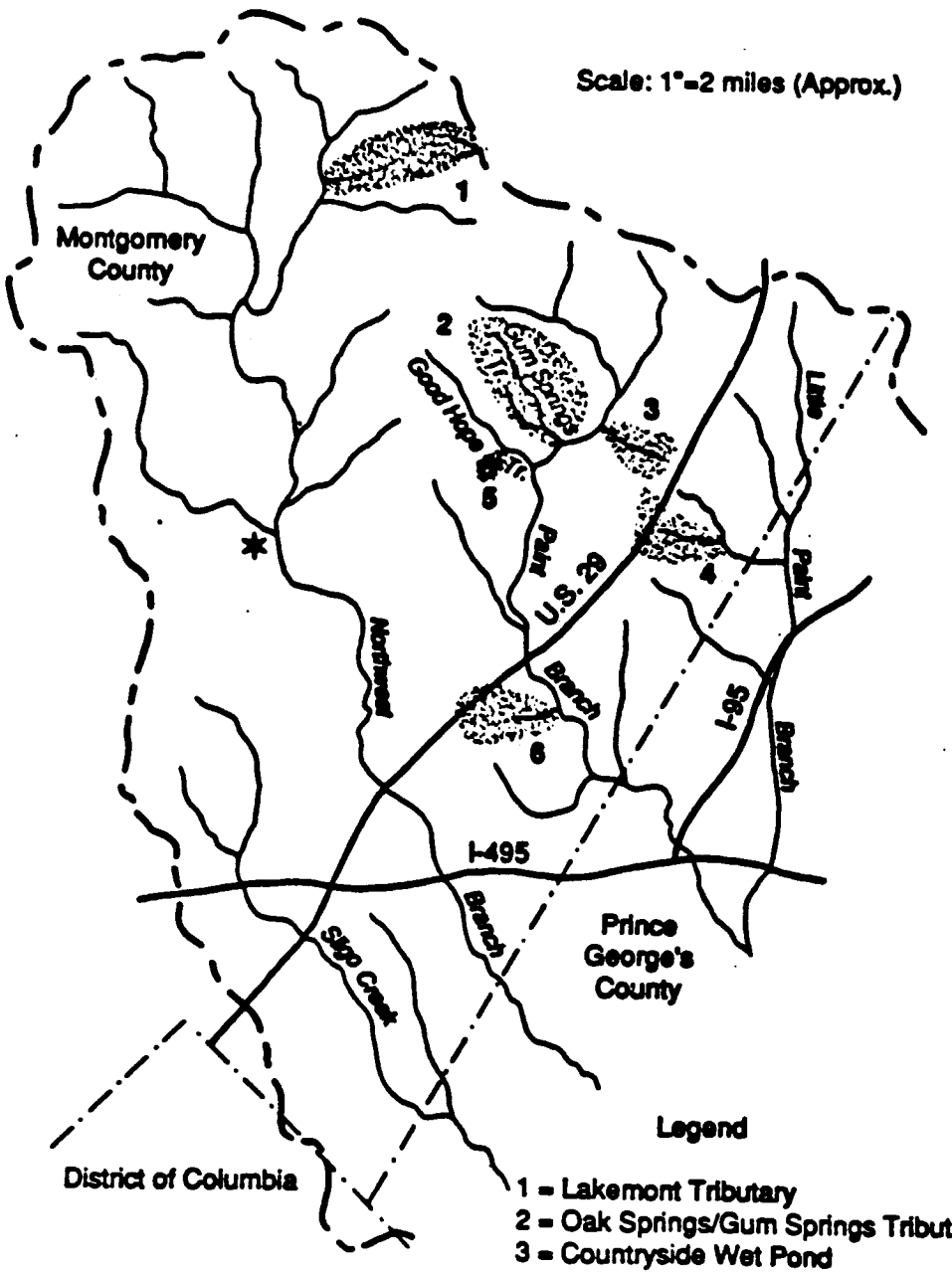

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Table 3. Summary: General Study Site Characteristics

Study Location	Station Type	Watershed	MDE Water Use Class	Physio-graphic Province	Watershed Drainage Area	Major Land Uses	Watershed Imperviousness (%)	Stream Gradient (%)	Avg. Stream Width (ft.)	Avg. Baseflow (cfs)	Pond Surface Area (ac))	Max. Depth of pond (ft.)	Method of Extended Detention Control
1. Lakemont Tributary	Reference Stream	Northwest Branch	IV	P	900.0	F, OF	1.0	1.5	8 - 9	0.86	-	-	-
2. Oaksprings/ Gumsprings													
a. Oakspring Trib.	Artificial wetland	Paint Br.	III	P	140.0	TH, SFR	18.0	2.7	3 - 6	0.11	1.0	4.0	Notched, wood weir flashboard
b. Gum Springs Trib.	Trout Stream	Paint Br.	III	P	620.0	SFR, F, OF TH	12.0	2.0	8 - 10	0.99	-	-	-
3. Countryside	Wet Pond	Paint Br.	III	P	165.0	SFR, LE, F, C	12.0	2.3	3 - 6	0.25	1.5	8.0	-
4. Tanglewood	ED Dry Pond	Little Paint Br.	I	P/C	195.0	TH, SFR O, F	30.0	2.3	5 - 10	0.26	3.0	-	gate valve
5. Fairland Ridge	Dry Pond w/Infiltration Trenches	Paint Br.	III	P	25.0	SFR	18.0	8.7	2 - 3	0.05	0.5	-	*
6. White Oak Tributary	Urban Stream	Paint Br.	III	P/C (fall-line)	225.0	C, GA, F	60.0	3.9	8 - 12	0.35	-	-	-

Key Appreviations:

1/ P = Piedmont; C = Coastal Plain
F = Forest; OF = Old Field; TH = Townhouse; SFR = Single Family Residential (0.25 -. 05 ac. lot);
C = Commercial; GA = Garden Apts;
LE = Large Estates (> 2 ac); O = Office Park

* = Defacto extended detention control.

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townhouses. In addition, two SWM facilities, which are separated by a distance of approximately 1800 ft., are located on the stream. The upper Oaksprings pond is an old farm pond that has a surface area of approximately 0.5 acres. The lower Oaksprings pond which was monitored in the study, is a 1.0 acre artificial wetland with extended detention control. A notched wooden weir - flashboard system provides approximately 1.0 acre-foot of extended detention storage. The Oaksprings wetland, which was constructed in 1986, supports a diverse wetland plant community and includes numerous emergent and submerged species. This wetland is located approximately 500 feet upstream of the confluence with the Gum Springs tributary. The Oaksprings tributary enters Gum Springs approximately 1900 feet upstream from the Gum Springs/Paint Branch confluence.

Gum Springs, which drains a 620 acre watershed area, is well-known for its ability to support a natural self-sustaining brown trout population. Principal land uses in this subwatershed include 0.25 - 0.5 acre lot single family residential development, townhouses, old abandoned fields, and mixed-age hardwood forest. Overall watershed imperviousness is approximately 12.0 percent. The stream, which has an average baseflow of approximately 1.0 cfs, is well-shaded along its entire length.

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3. **Countryside Wet Pond.** The Countryside wet pond drains a 165 acre MDE Class III watershed area consisting of large residential estates, 0.25 - 0.5 acre single family residential development, mixed-age hardwood forest, and a small commercial shopping area. Watershed imperviousness is approximately 12.0 percent. The pond, which has a surface area of approximately 1.5 acres, underwent a major retrofit in 1988. Retrofit work included the replacement of the original rusted-out metal riser and barrel with a concrete structure, dredging, and establishment of fringe marsh habitat. It should be noted that pond waters are released approximately 2.5 feet below the normal pool elevation via a reverse sloping 8 inch diameter pipe. Baseflow to the pond is approximately 0.25 cfs. The Countryside tributary is well-shaded both upstream and downstream of the pond. Waters discharged from the pond flow through approximately 1200 feet of mixed-age hardwood forest before entering Paint Branch.

4. **Tanglewood Extended Detention Dry Pond.** Constructed in 1983, the Tanglewood SWM facility is a 3.0 acre, extended detention dry pond serving a 195 acre MDE Class I watershed area. Principal land uses in the catchment include townhouses, 0.25 - 0.5 acre single family residential development, office park development, pasture/old fields, and mature hardwood forest. Watershed imperviousness is approximately 30 percent. The Tanglewood tributary is well-shaded both upstream and downstream of the SWM facility. The stream, which has an average baseflow of approximately 0.26 cfs, is a tributary of the Little Paint Branch.

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5. Fairland Ridge Stormwater Management Facility. This innovative dry SWM facility, which became operational in 1987, provides both water quantity and quality control for a 25 acre, MDE Class III watershed area. Water quality control for the existing 0.25 - 0.5 acre lot residential development is provided through a series of stilling basins, grass swales, and infiltration trenches located in the terraced side slopes of the pond. The three infiltration trenches present in the pond were sized to treat the first 0.25 inches of runoff from the street portion of the development.

During the course of the study it became obvious that one of the three infiltration areas present was incapable of infiltrating any runoff. In fact, this bowl-shaped infiltration area was observed to pond water for months at a time. A second observation made during the study was that the pond provides, via its 8 inch diameter low-flow orifice, defacto extended detention storage for the larger storm events which exceeded the infiltration trench system's capacity.

The Fairland Ridge SWM facility also includes a spring, bearing the same name, which originates in the vicinity of the pond's lowflow orifice. Waters form the spring flow approximately 600 feet whereupon they join the Good Hope tributary of Paint Branch. The small 2 - 3 foot wide spring meanders through a partially forested riparian area. Baseflow produced by the spring is a relatively constant 0.05 cfs.

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6. White Oak Tributary. This severely degraded, urban stream drains an intensively developed 225 acre MDE Class III watershed. Principal land uses in the contributory drainage basin include a major commercial shopping center area, garden apartments, and mature hardwood forest. For all intents and purposes this watershed area has no SWM controls. Although the headwaters of the fall-line stream have been piped, approximately 2500 feet of open stream channel remain. The majority of the remaining lower open section of stream flows through a mature hardwood forest. In character with fall-line streams, the White Oak tributary is boulder-strewn and contains numerous rock outcroppings and ledges. Stream width averages 8 - 12 feet and baseflow is approximately 0.35 cfs.

B. Continuous Water Temperature Monitoring

Characterization of the thermal regime of each of the six study areas was accomplished via the systematic employment of paired Ryan TempMentor recording thermograph thermometers. COG staff, with assistance from MdDNR Freshwater Fisheries, developed a continuous water temperature monitoring network consisting of 14 thermograph thermometer stations. The stations were strategically located so as to measure inflow-outflow temperature conditions, at the four BMP study sites, and identify spatial temperature variations along the streams. The general location of the 14 continuous temperature monitoring stations is shown in Figure 3.

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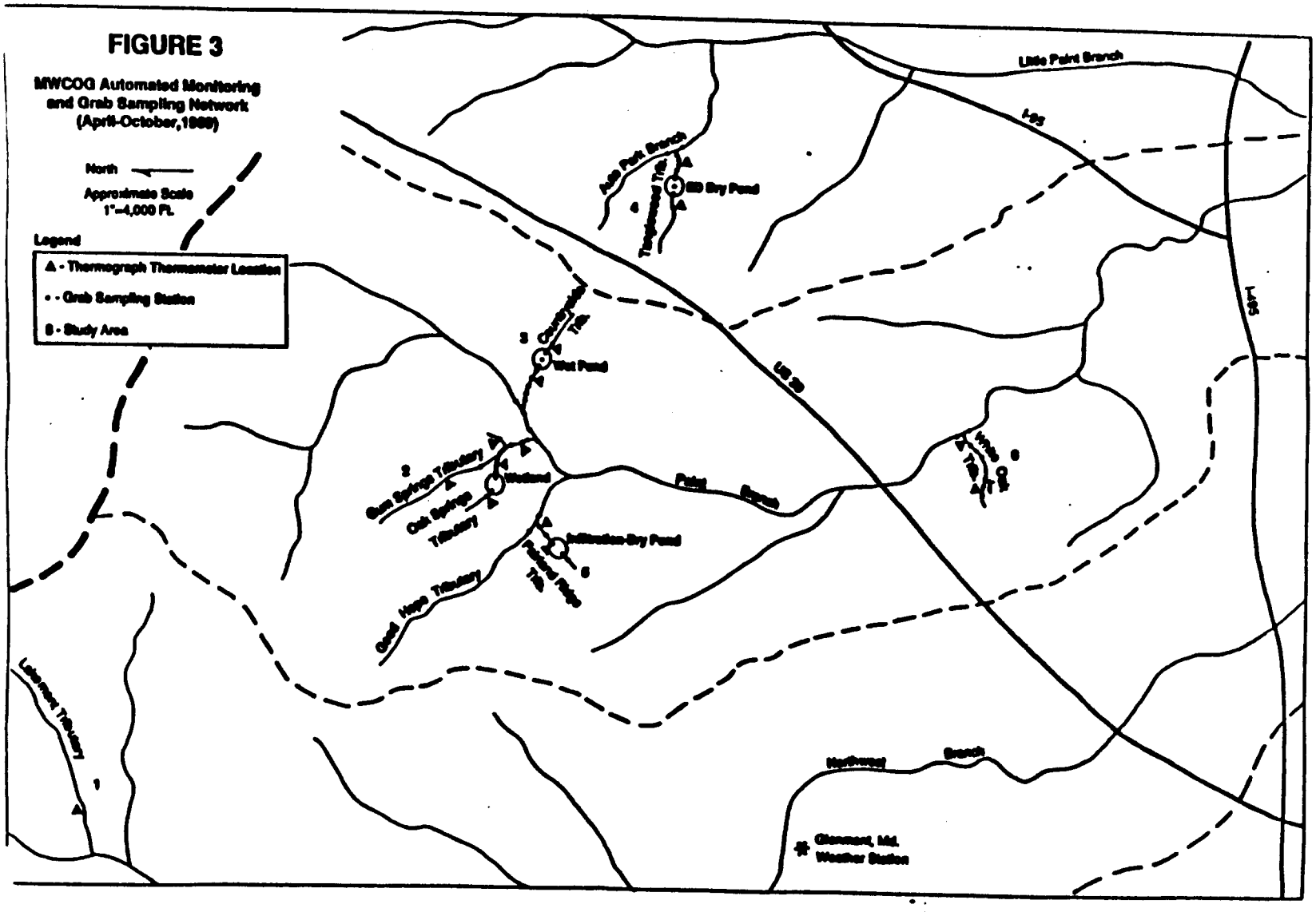

FIGURE 3

MWCOG Automated Monitoring and Grab Sampling Network (April-October, 1989)

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Monitoring Period

All 14 thermograph thermometers were installed and operated, by COG staff, for the April 25 through September 20, 1989 period. Each unit was programmed to record water temperatures on a 20 minute time interval. This time interval was selected so as to measure and characterize stream temperature responses to small storm events in a uniform manner. Units were allowed to remain in the field for as long as 64 days before being removed. Stored temperature data was retrieved from each unit via downloading into an IBM compatible personal computer. The 14 thermograph thermometers were subsequently redeployed and returned to their original field locations within 48 hours. This process was repeated for each of the three deployment periods used in the study. Specific information for each of the three deployment periods is contained in Appendix B.

Equipment Selection and Field Installation

Ryan thermograph thermometers were selected for use in the study on the basis of the following attributes: 1.) the units feature an easily programmable sampling time interval ranging from one second to two hours, 2.) the units may be left unattended in the field for months at a time, and 3.) stored data can be quickly downloaded from the unit into a computer for further processing and analysis.

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Each thermograph thermometer was placed into a silicone-sealed, screw-top Lexan plastic jar, then tightly sealed in two or more plastic garbage bags. The units were carefully buried, 4 - 6 inches below ground level, in an overbank area so as to reduce the risk of damage or loss from flooding and/or vandalism. Actual stream water temperature readings were made via an associated 15 foot long sensor cable that extended from the buried unit into the stream. The buried sensor cables were attached to steel rebars driven into the stream bottom. All cables were located in well-shaded undercut bank areas of the stream, where depth of flow was sufficient to keep the sensor tip completely submerged at all times. The basic sampling configuration used during the study is depicted in Figure 4. Each site was inspected by COG staff on a weekly basis.

C. Climatological Information System and Data Summary

Due to budgetary constraints rainfall, air temperature, and other pertinent climatological data was obtained from the National Oceanic and Atmospheric Administration (NOAA) Independent Weather Station Network. After careful review of existing NOAA stations in the vicinity of the six study areas, COG staff selected the Glenmont, Md. station as its primary reference weather station (Figure 3.). This decision was based upon the following: 1.) of the 14 stations examined, the Glenmont station's location was closest to the center of the six study areas, 2.) the station has provided comprehensive and reliable meteorological data for over 10-years, and 3.) the physical setting of the station, i.e., elevation and stream valley location, is similar to those of the study sites. Furthermore, it should be noted that meteorolgical data for a select group of storm events

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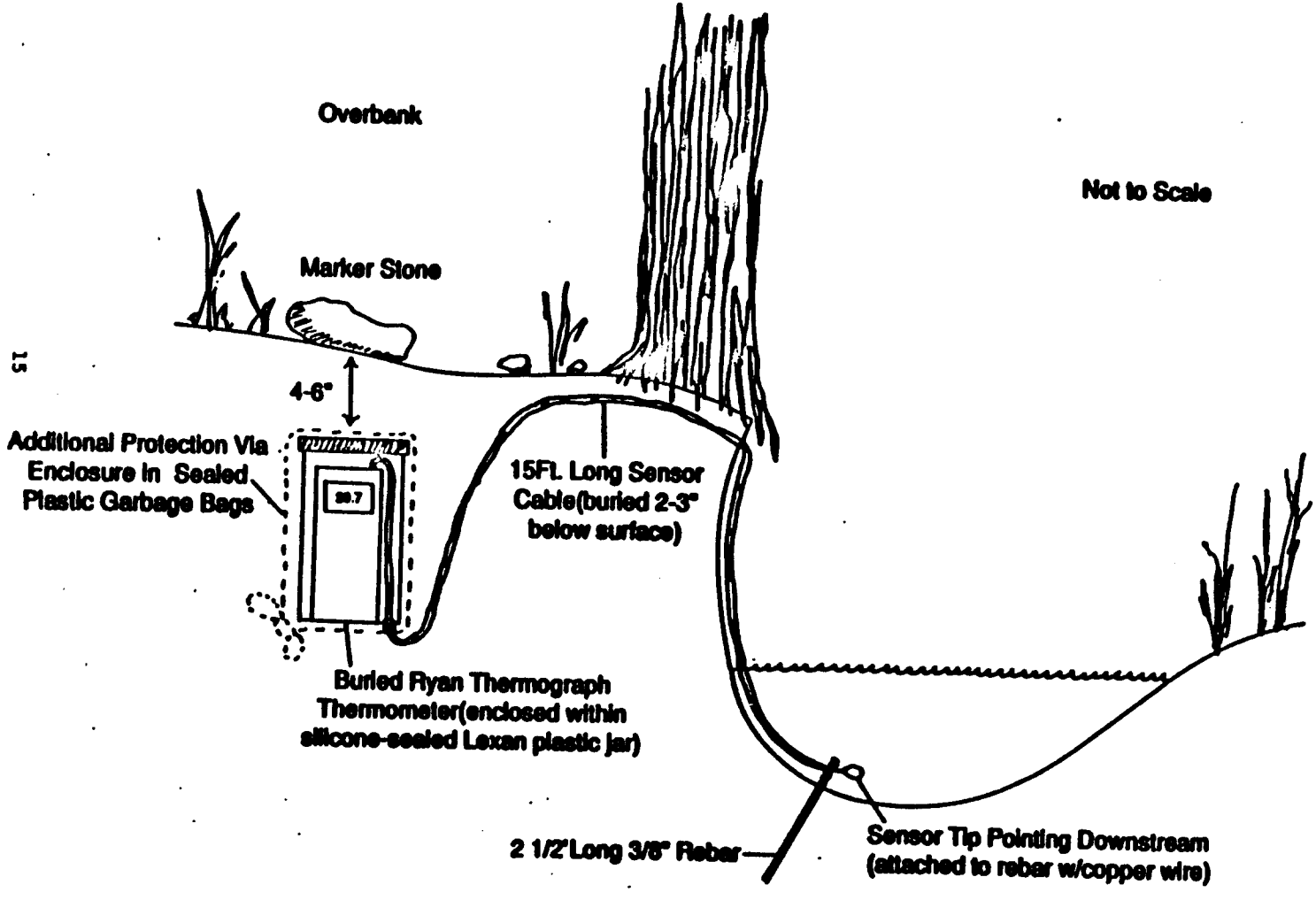
FIGURE 4

THERMOGRAPH THERMOMETER SAMPLING CONFIGURATION



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was obtained from one or more of the neighboring, 13 sister stations.

April - October, 1989 Climatological Summary

A comparative summary of climatological conditions, April - October 1989, at both the Glenmont station and Washington National Airport (DCA) is presented in Table 4. Included for reference in the table are 30-year historical levels for DCA. Additional climatological information may be found in Appendix D.

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Table 4. Summary: 1989 Climatological Data

Parameter	Month						
	April	May	June	July	Aug.	Sept.	Oct.
1. Max. Temperature (°F)							
Glenmont	78.0	87.0	91.0	92.0	92.0	90.0	83.0
DCA	80.0	87.0	95.0	96.0	94.0	96.0	83.0
DCA (30-yr)	95.0	97.0	101.0	104.0	103.0	101.0	94.0
Avg. Maximum (°F)							
Glenmont	63.1	70.7	80.7	82.2	80.5	75.6	67.9
DCA	64.8	72.8	84.7	85.7	84.7	79.5	70.4
DCA (30-yr)	67.1	75.9	84.0	87.9	86.4	86.4	68.9
2. Min. Temperature (°F)							
Glenmont	27.0	37.0	53.0	54.0	50.0	38.0	34.0
DCA	35.0	44.0	60.0	62.0	57.0	46.0	38.0
DCA (30-yr)	24.0	34.0	47.0	54.0	49.0	39.0	29.0
Avg. Minimum (°F)							
Glenmont	40.3	51.0	64.5	66.9	64.9	58.0	45.0
DCA	45.9	55.3	68.9	70.8	69.4	63.2	50.5
DCA (30-yr)	46.2	56.1	65.0	69.9	68.7	62.0	49.7
3. No. Days Max. Temp. ≥ 90 °F							
Glenmont	0	0	2	2	2	1	0
DCA	0	0	4	9	7	2	0
DCA (30-yr)	-	1.4	7.4	13.1	10.3	4.2	0.1

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Table 4. - Cont'd -

Parameter	Month						
	April	May	June	July	Aug.	Sept.	Oct.
4. No. Days Max. Temp. 80 - 89°F							
Glenmont	0	9	15	19	16	8	3
DCA	1	10	21	18	18	15	3
DCA (30-yr)	-	-	-	-	-	-	-
5. Days Precip. ≥ 0.01"							
Glenmont	9	17	14	9	10	12	10
DCA	9	15	13	12	5	10	8
DCA (30-yr)	9.8	11.2	9.5	9.8	9.2	7.6	7.4
Days Precip. ≥ 1.0"							
Glenmont	0	3	3	2	0	1	0
DCA	0	3	1	2	0	2	1
DCA (30-yr)	-	-	-	-	-	-	-
Normal or Total Precip. (in.)							
Glenmont	3.39	10.93	6.09	5.58	0.89	4.51	5.00
DCA	3.50	7.77	6.02	5.66	1.15	6.68	5.48
DCA (30-yr)	2.93	3.46	3.35	3.88	4.40	3.22	2.90
Greatest Precip. in 24 hrs (in.)							
Glenmont	0.65	4.68	1.21	1.53	0.58	1.06	0.98
DCA	0.99	2.24	1.40	1.41	0.95	1.84	1.83
DCA (30-yr)	3.08	3.43	7.19	4.69	6.39	5.31	4.98

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Table 4. - Cont'd -

Parameter	Month						
	April	May	June	July	Aug.	Sept.	Oct.
No. Days Clear Skies							
Glenmont	-	-	-	-	-	-	-
DCA	4.0	2.0	7.0	4.0	4.0	6.0	13.0
DCA (30-yr)	7.1	7.3	7.8	7.7	9.1	10.1	11.0
No. Days Cloudy Skies							
Glenmont	-	-	-	-	-	-	-
DCA	12.0	17.0	15.0	12.0	16.0	17.0	10.0
DCA (30-yr)	14.0	13.8	11.3	11.4	11.8	11.7	12.5

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From a historical perspective, the April-July portion of the study was notably cooler and wetter than normal. In particular, the month of May was exceptionally wet with 10.93 inches of rain recorded at the Glenmont Station. Of this total amount, 4.6 inches of rain fell during one 24-hour period (May 6-7). Runoff from this near 10-year frequency storm event resulted in severe flooding of both study area and local streams. Flood waters severely damaged one of the 14 thermograph thermometers, requiring replacement of the unit. The storm also damaged two other thermographs thermometers resulting in the loss of stored water temperature data.

While the spring and early summer months were wetter than normal, extremely dry and cloudy conditions occurred in August. Precipitation in August totalled only 0.89 inches at Glenmont. This amount was 3.51 inches below reported 30-year historical averages for the WMA. Precipitation, temperature, and cloudiness were generally higher than normal in September. As seen in Table 4, monthly average temperatures, precipitation, and the number of clear days in October were also above 30-year historical averages for the WMA.

D. Water Quality Sampling

Under this task, COG staff developed and operated a 55 station water quality grab sampling network (Figure 3). The network was specifically designed to measure DO, stream flow, and air and water temperature conditions at discrete longitudinal intervals in and along the streams in the study area. Grab sampling was conducted, on a weekly basis, during the June 16 - October 20, 1989 period. In addition, limited stormflow monitoring was

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performed during the same period.

DO measurements were made in the field via the employment of a YSI-57 (Yellow Springs Instrument) dissolved oxygen meter. Instrument accuracy was maintained during the four month sampling period through weekly calibration and spot checks against Winkler-titration sampling results.

Stream discharge was determined via the Embody Float Method (Embody, 1927). This technique uses the following equation for calculating flow:

$$\text{Discharge } (Q) = \frac{W \times D \times a \times T}{L}$$

where:

W = stream width (ft.)
D = stream depth (ft.)
a = roughness coefficient for stream bed (0.9 rough bottom, 0.8 smooth bottom)

T = travel time of float (sec.)
L = distance travelled by float (5 ft.)

Twelve flow measuring stations, each having a standard five foot flow length were established. Station locations were selected on the basis of representativeness of stream flow condition, ease of access, and ability to maintain relatively uniform cross-sectional areas. At each station, nine or more depth measurements, three wetted perimeter measurements, and three timed-floats were made per stream flow calculation. Because of the similarity in stream bed roughness, an 'a' value of 0.9 was used at all stations throughout the study.

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E. Delta-T Water Temperature Analysis and Calculation

In order to quantify the degree of change in water temperature resulting from either the passage of stormwater runoff through a BMP, or from an undeveloped reference stream to a highly urbanized stream, a uniform comparative approach was required. Since these site specific changes may be expressed as a Delta-T value, water temperature analyses in the study were performed using this approach. The Delta-T method features direct comparisons of observed temperatures between a subject station(s) and some known reference at specific points in time.

For reasons already stated, the Lakemont tributary was chosen as the standard reference station against which all other study stations were compared. In addition, in order to quantify the inflow-outflow temperature relationships for a particular BMP, a second series of Delta-T comparisons was required. This second series involved the establishment of the SWM inflow station as the reference station. An example of the possible water temperature comparisons under the study's Delta-T approach is illustrated in Figure 5.

Delta-T Calculation

The Delta-T temperature, which can be either positive or negative, was calculated by taking the mean hourly temperature for both the subject and reference stations, then subtracting the reference station temperature from that of the subject station. An example of a standard one-hour Delta-T

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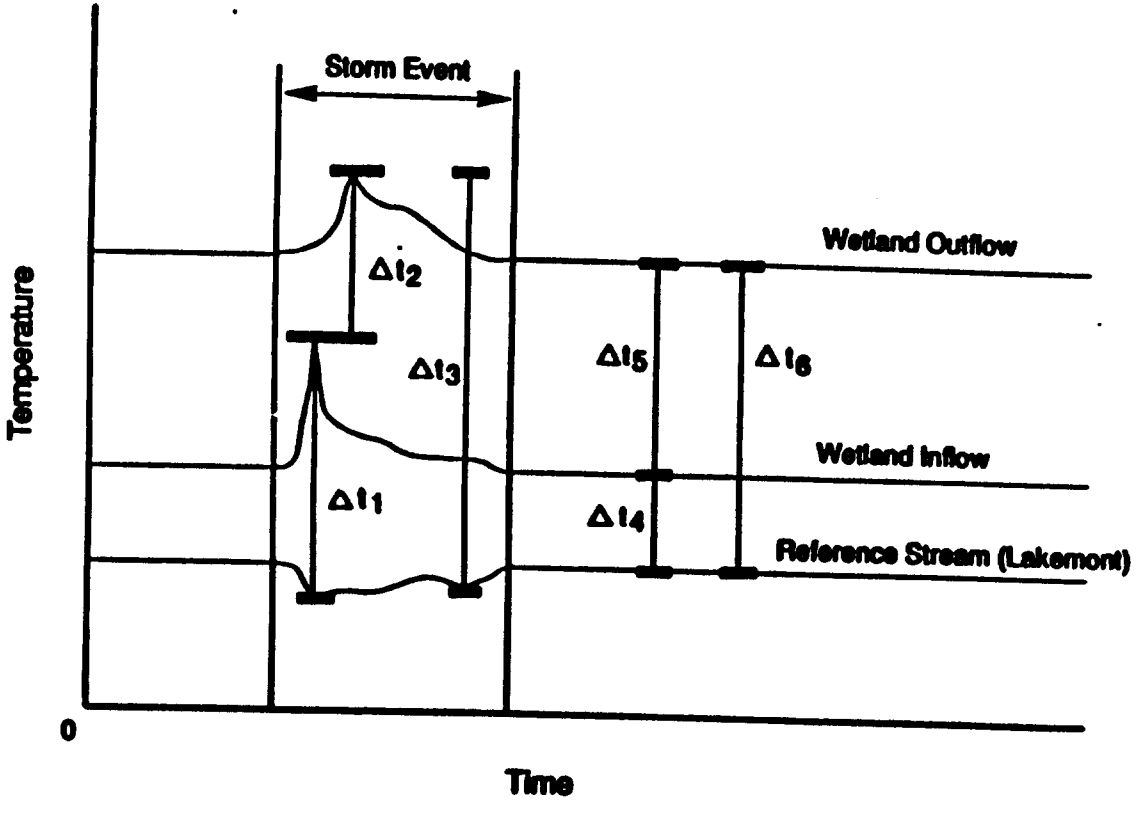
FIGURE 5

Δt SCENARIOS FOR OAKSPRINGS ARTIFICIAL WETLAND



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calculation for the Countryside Inflow station is presented below:

Station	20 Minute Temperature Readings (°F)	Mean Hourly Temp. (°F)	Difference Btwn. Reference & Subj. Station (°F)
Lakemont (Reference)	64, 65, 66	65	+ 4.0
Countryside Inflow (Subject)	68, 69, 70	69	

The one-hour Delta-T for the Countryside Inflow station is positive 4.0 °F.

A minimum of 24 hourly Delta-T's, per day, were calculated for each subject station. Where possible, efforts were made to relate Delta-T values to environmental conditions such as rainfall, air temperatures, and stream discharge.

F. Percent of Time Plots

In addition to the Delta-T analyses, data from each continuous monitoring station were statistically analyzed and graphically depicted to show the percent of time water temperatures remained at, above, or below some particular temperature of interest (e.g., 68 °F MDE Class III temperature standard). Percent of time plots were generated for baseflow, stormflow, BMP performance, and climatological influence scenarios. These plots, along with the Delta-T analyses, served as the analytical backbone of the study.

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G. Data Manipulation - SAS Architecture

The Statistical Analysis System (SAS), which is a mainframe computer system for data analysis, was used to statistically analyze and graphically depict water temperature and climatological data. A series of SAS programs was specifically written to accomplish the following general objectives:

1. Organize data by date, time, sampling station location, station type, and stream system;

2. Develop, through the integration of water temperature and precipitation data, baseflow and streamflow water temperature data sets;

3. Compute BMP and stream Delta-T's under baseflow, stormflow, and/or total flow conditions;

4. Statistically analyze, via the PROC UNIVARIATE (procedure analysis package), water temperature data sets; and

5. Graphically depict data.

H. Literature Review of Water Temperature Stress and Aquatic Communities

In an effort to identify the potential biological impacts associated with

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temperature regime modification, COG staff conducted a comprehensive literature survey of the water temperature requirements of freshwater biota known or expected to occur in Maryland streams. Over 200 references, in one or more of the following categories, were collected:

- The thermal regime of natural streams - their general characteristics and the environmental factors which influence them;
- The general impact of human activities, particularly urbanization, on the temperature regime of streams; and
- Potential water temperature-related effects on the aquatic food chain of streams.

Special emphasis was placed on identifying the temperature requirements of Maryland freshwater fish. One of the major accomplishments of this subtask was the gathering and summarizing of water temperature-related findings for 63 fish species. The major findings of this overall effort are included in Appendix C. of the report.

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Chapter II. Monitoring Results

A. General Effects of Watershed Urbanization, Riparian Cover, Stream Order, and Stormwater Management BMP's

Water temperature in natural streams is greatly influenced by factors such as climate, riparian vegetation, hydrology, topography, and stream order/distance from source. Development within natural watersheds sharply increases average stream temperatures in summer and depresses them in winter (Gray & Eddington, 1969; Hewlett & Forston, 1982). Concurrent temperature differences between sites along urban streams have been shown to vary by as much as 14 - 20°F on hot, sunny summer days (Pluhowski, 1970). These large temperature differences have been attributed to a wide variety of urban factors, including the removal of vegetation from stream banks, reduction in the amount of groundwater input to streams, construction of lakes and ponds, increased stormwater runoff to streams, and micro-climate changes associated with increased levels of impervious surfaces such as streets, parking lots, and roof tops (Klein, 1979; Pluhowski, 1970).

The following sections examine in varying detail the general influence of watershed urbanization, riparian cover, stream order and stormwater management BMP's on the temperature of small, headwater streams (stream order 1 - 3).

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1. Influence of Watershed Imperviousness

The water temperature of small, heavily shaded, free-flowing Piedmont streams generally increases with increasing percentages of watershed imperviousness. As seen in Figure 6, no violation of MDE Class I, III, or IV temperature standards occurred at the undeveloped Lakemont station during the course of this study. However, both the frequency and magnitude of Class III and IV violations increased directly with corresponding increases in watershed imperviousness. Figure 6 also provides several other interesting insights into the relationship between imperviousness and stream temperature.

- The consistently cold water temperatures reported at the undeveloped Lakemont tributary station strongly suggest that, from a historical perspective, most headwater Piedmont streams in Maryland were once cold enough to support naturally reproducing trout populations and/or their associated support organisms.

- The impact of watershed development on stream temperatures was still evident in lightly developed watersheds. Even at the relatively low 12 percent watershed imperviousness level (Countryside inflow station), neither MDE Class III or IV temperature standards could be met 100 percent of the time (Class III and IV violations occurred 10 and 1 percent of the time, respectively). As previously noted, the frequency and magnitude of Class III and IV violations rose steadily with associated increases in the level of imperviousness. For

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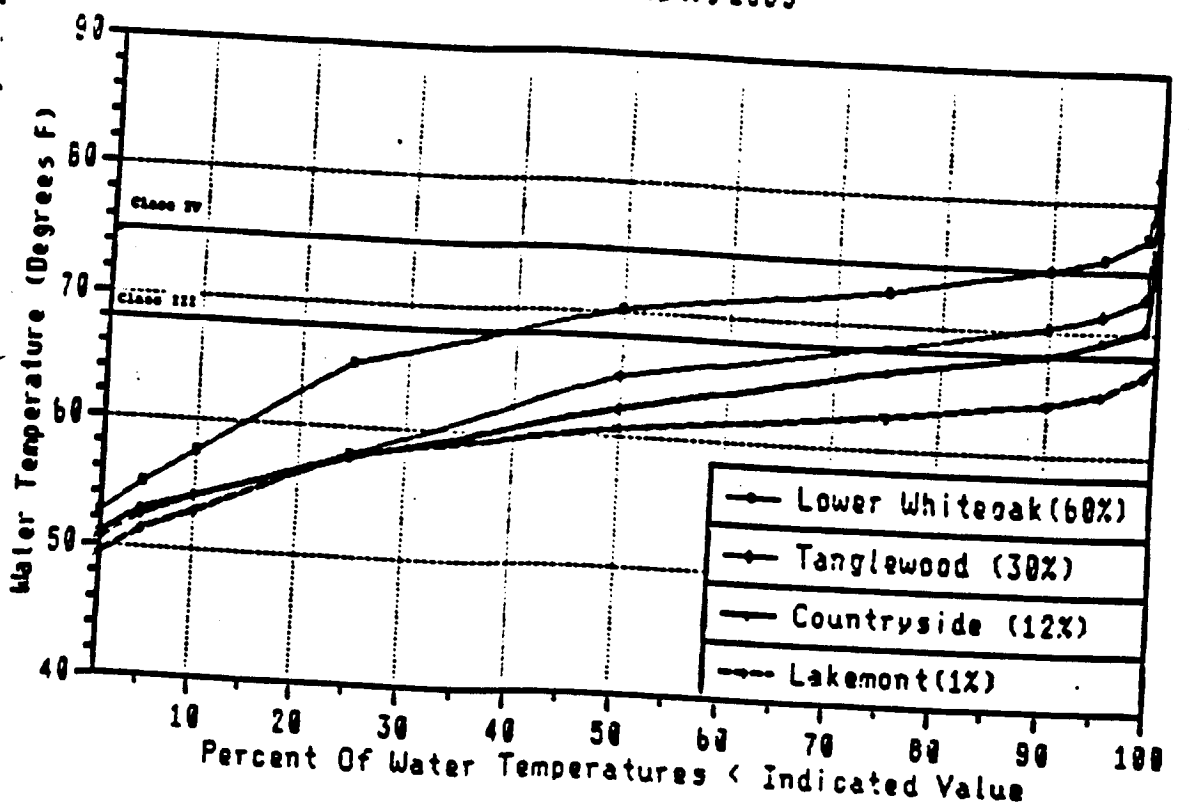
FIGURE 6

UNDEVELOPED VERSUS URBAN STREAM TEMPERATURES

Undeveloped, Light, Moderate, and Highly Developed Watersheds
April-Sept., 1989



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example, at the moderately developed, 30 percent impervious Tanglewood inflow station the frequency of Class III and IV violations occurred 25 and 1 percent of the time, respectively. However, at the heavily developed 60 percent impervious level (Lower White Oak tributary) Class III and IV standards were violated 60 and 10 percent of the time, respectively. The preceding findings bolster Klein's (1979) contention that sensitive coldwater fish, such as trout, may be negatively affected when watershed imperviousness exceeds 10 percent.

- Only about one percent of all recorded water temperatures at the Tanglewood inflow and Lower White Oak stations equalled or exceeded 80°F. Although representing only a very small percentage of all recorded temperatures, these temperatures are significant in that they exceed the temperature tolerance of most coldwater organisms.

- No violation of the 90°F MDE Class I water temperature standard was reported, at any stations during the study. However, a recently completed study of the urban Anacostia River basin (Kumble, 1990) indicates that this temperature standard is frequently violated by large streams during summer months.

Further analysis of the data revealed a strong linear relationship between mean late spring-summer water temperatures and watershed imperviousness. As seen in Figure 7, an estimate of the mean, late spring-summer water temperature of small, heavily shaded, headwater Piedmont streams was derived from the following equation:

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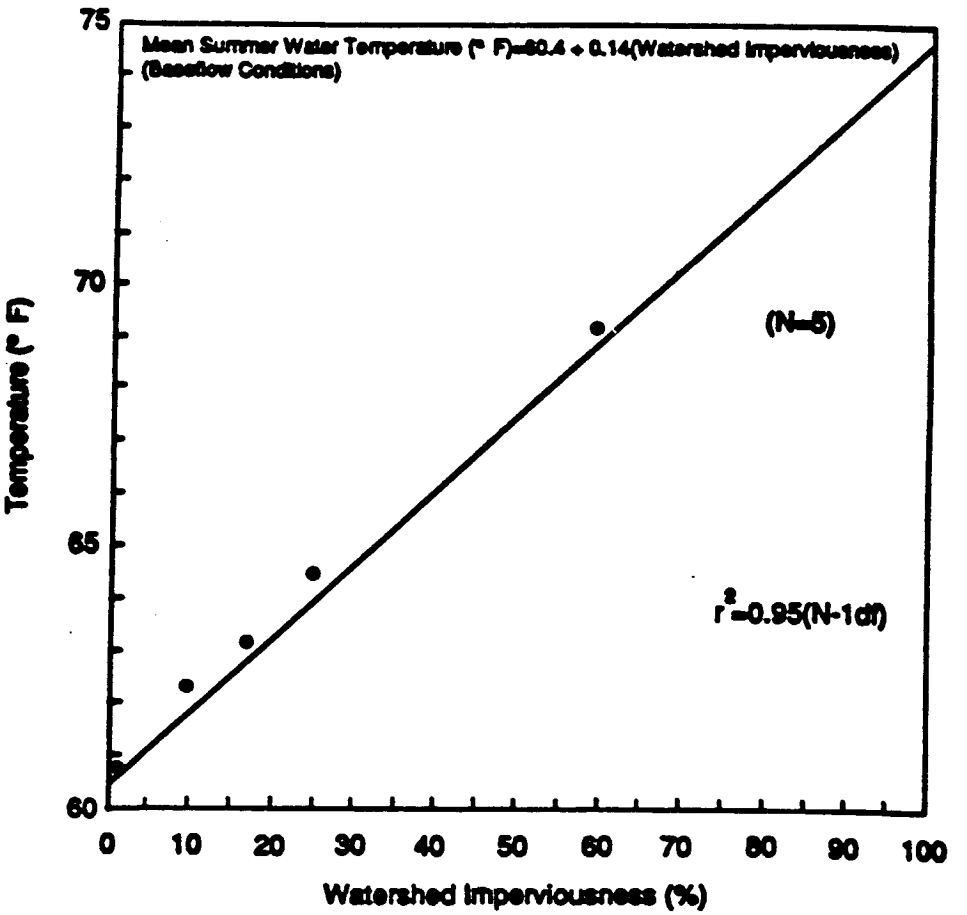
FIGURE 7

RELATIONSHIP BETWEEN WATERSHED IMPERVIOUSNESS AND WATER TEMPERATURE



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Mean Water Temperature (^{o}F) = 60.4 + 0.136 (percent watershed imperviousness)

This least squares linear regression yields a correlation coefficient (r2), adjusted for degrees of freedom, of 0.95; indicating a strong general relationship between water temperature and watershed imperviousness.

The preceding equation indicates that for each one percent increase in watershed imperviousness there is a corresponding stream Delta-T increase of about $0.14^{o}F$. It is further noted that this equation pertains to streams in the study area under a slightly cooler than normal air temperature scenario.

Results supported the findings of Pluhowski (1970) that urbanization can markedly increase the average summer temperature of small streams. For example, closer examination of the Lower White Oak versus Lakemont water temperature distributions (Figure 8) revealed that Lower White Oak was typically 4 - 15 ^{o}F warmer than the undeveloped, forested Lakemont tributary. The average Delta-T increase for this highly urbanized stream was 8.6 ^{o}F. Maximum daily instantaneous water temperatures at the Lower White Oak station reached a high of $82.6^{o}F$. This represented the highest recorded free-flowing stream temperature in the study. In contrast, the highest maximum daily instantaneous water temperature at the Lakemont station was $67.8^{o}F$.

As expected, maximum daily water temperatures for all monitoring stations were recorded in July and August, the warmest months during the study. Figure 9, provides an interesting examination of the relationship between

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FIGURE 8

COMPARISON OF UNDEVELOPED VERSUS HIGHLY DEVELOPED STREAM TEMPERATURES

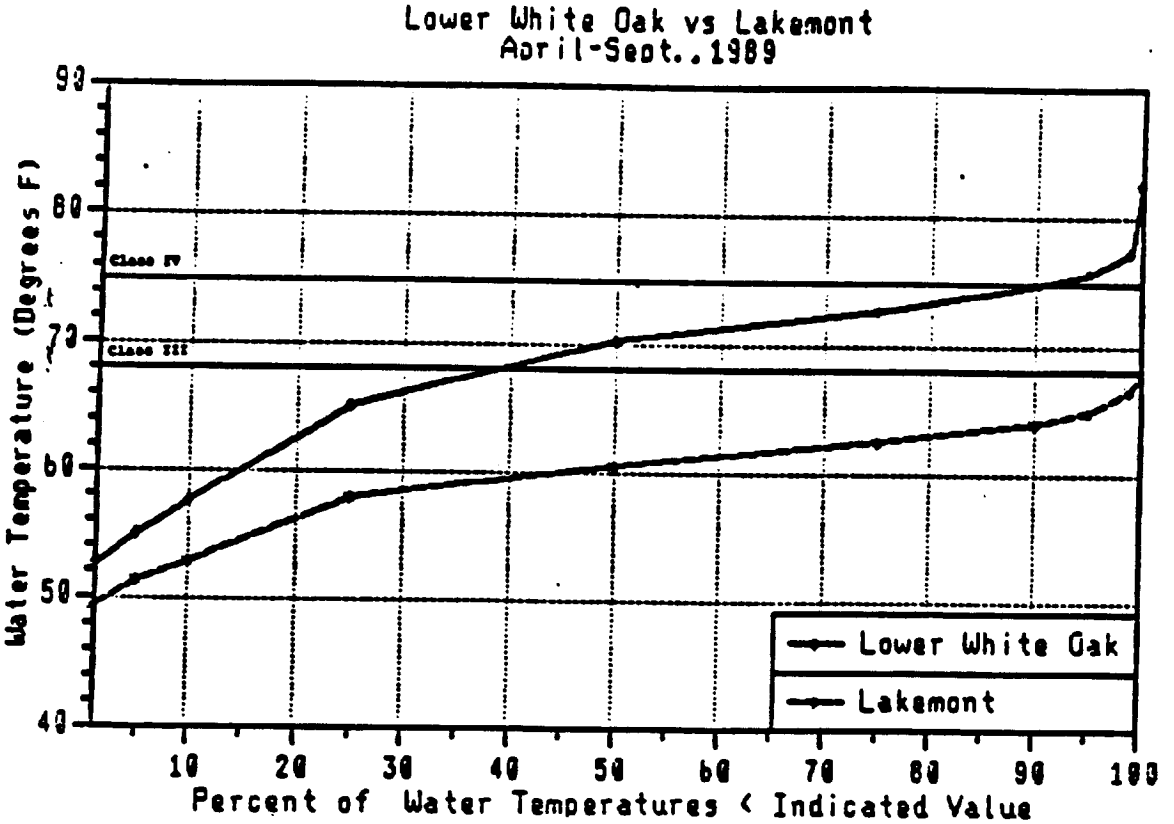

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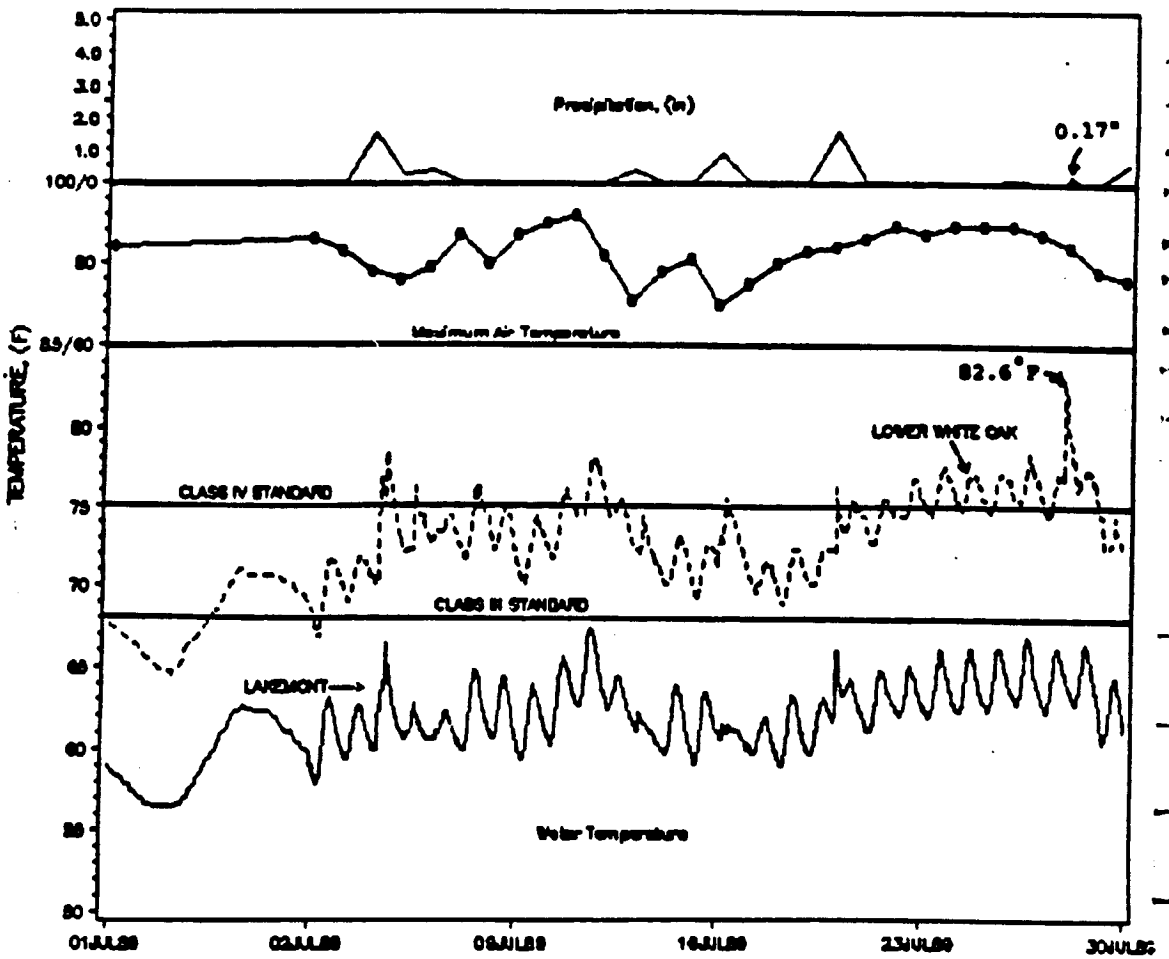
FIGURE 9

GENERAL RELATIONSHIP BETWEEN MAXIMUM AIR TEMPERATURE, PRECIPITATION AND UNDEVELOPED AND HIGHLY DEVELOPED STREAM TEMPERATURES



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water temperature and climatological conditions at the Lakemont and Lower White Oak stations during the July period. Major findings are as follows:

- Both sites exhibited similar daily (or diurnal) stream Delta-T temperature fluctuations of between 2 and 8°F. The daily range in water temperatures generally followed the late afternoon (maximum) and early morning (minimum) pattern common to most North American streams.

- High maximum daily Delta-T stream temperatures at both stations, corresponded closely to periods of high maximum daily air temperatures. MDE Class IV temperature standard violations at the Lower White Oak tributary occurred on a regular basis during periods of sustained high air temperature (i.e., air temperatures $\geq$ 85 °F). Water temperatures in the mid to upper 70's were common at the White Oak tributary station during these high air temperature periods.

- In general, the stream temperatures were more responsive to daily air temperature fluctuations than to rainfall-runoff events.

- Approximately one percent of all storms produced major daily Delta-T increases at the heavily developed White Oak tributary. The highest water temperature recorded at this site (82.6°F) was the result of a brief, intense local shower which dropped 0.17 inches of rain. Delta-T stream temperatures responded to the influx of warm stormwater runoff by increasing 5.8°F in 20 minutes (Figure 9).

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Interestingly, the maximum instantaneous water temperature of 82.6°F was reached at 10:00 p.m. (some 35 minutes after the start of the storm).

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2. Baseflow versus Stormflow Conditions

In order to determine what general effect(s) rainfall-runoff events had on free-flowing streams draining watershed areas of different background levels of imperviousness, a series of simplified baseflow versus stormflow plots were made for the Lakemont, Countryside inflow, Tanglewood inflow, and Lower White Oak stations. For the purposes of the study, baseflow conditions were simply defined as dates in which no rainfall fell at the Glenmont, MD weather station. All other non-baseflow dates were considered to be, to some extent, under the varying influence of stormflow conditions (i.e., precipitation, cooler air temperatures, and/or increased cloud cover). Stormflow days were further defined as dates in which $\geq$ 0.01 inches of precipitation fell at the Glenmont, MD station. During the study, stormflow and baseflow dates respectively comprised 48.5 and 51.5 percent of the record. Results from this portion of the study are graphically presented as Figures 10 - 13. Major findings are summarized below:

- During the entire study period, baseflow and stormflow water temperatures in the undeveloped watershed (Figure 10) were within four degrees Fahrenheit of one another. Stormflow water temperatures never exceeded baseflow temperatures, and in fact were cooler approximately 95 percent of the time. This finding strongly suggests that the increased cloud cover and cooler air temperatures associated with most rainy day - stormflow conditions generally depress the water temperature of small, heavily-shaded headwater streams. In addition, an increase in groundwater inflow, from

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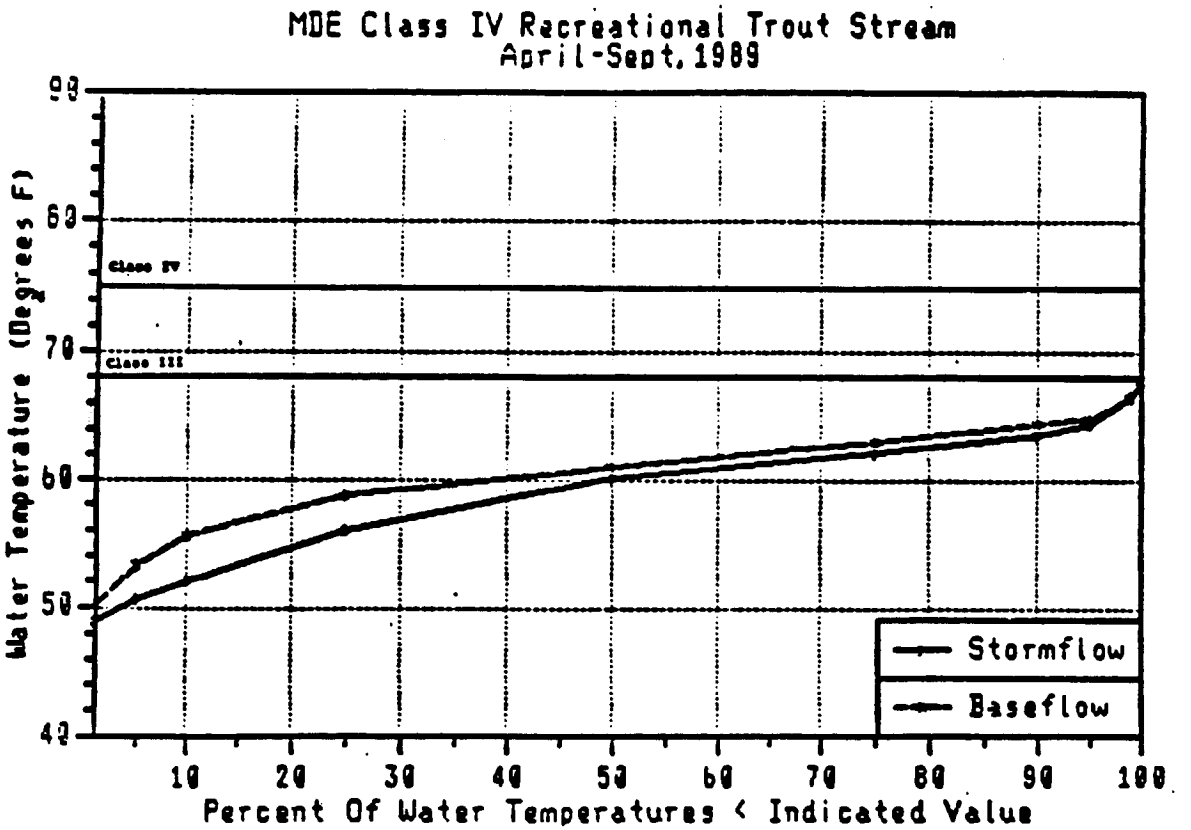
FIGURE 10

EFFECT OF STORMFLOW ON UNDEVELOPED LAKEMONT TRIBUTARY STREAM TEMPERATURES



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infiltration of rainfall, may also contribute to overall stream temperature reduction.

- Results from both the lightly developed watershed (12 percent impervious) and moderately developed (30 percent impervious) watersheds stations were generally similar to those from the undeveloped Lakemont tributary. Countryside stormflow temperatures (Figure 11) were cooler than baseflow temperatures approximately 94 percent of the time. As seen in Figure 11, approximately 5 percent of the stormflow temperatures at this lightly developed watershed site exceeded the 68°F Class III standard; whereas, only 1 percent exceeded the 75°F Class IV standard. In contrast, Countryside baseflow temperatures exceeded the Class III and IV standards 10 and 0 percent of the time, respectively. At the moderately developed Tanglewood site (Figure 12), both stormflow and baseflow temperatures exceeded the Class III and IV standards 25 and 1 percent of the time, respectively.

- Although we expected stormflow temperatures at the highly developed watershed site to be much higher than baseflow temperatures and to exhibit large temperature spikes, this was generally not the case. In fact, stormflow temperatures at the Lower White Oak station (Figure 13) were equal to or cooler than baseflow temperatures 99 percent of the time. Air temperature seemed to be a more important factor than storms, about 90 - 95 percent of the time. Under stormflow conditions, Class III and IV standards were violated 57 and 10 percent of the time, respectively. Baseflow water temperature

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FIGURE 11

EFFECT OF STORMFLOW ON LIGHTLY DEVELOPED COUNTRYSIDE INFLOW STREAM TEMPERATURES

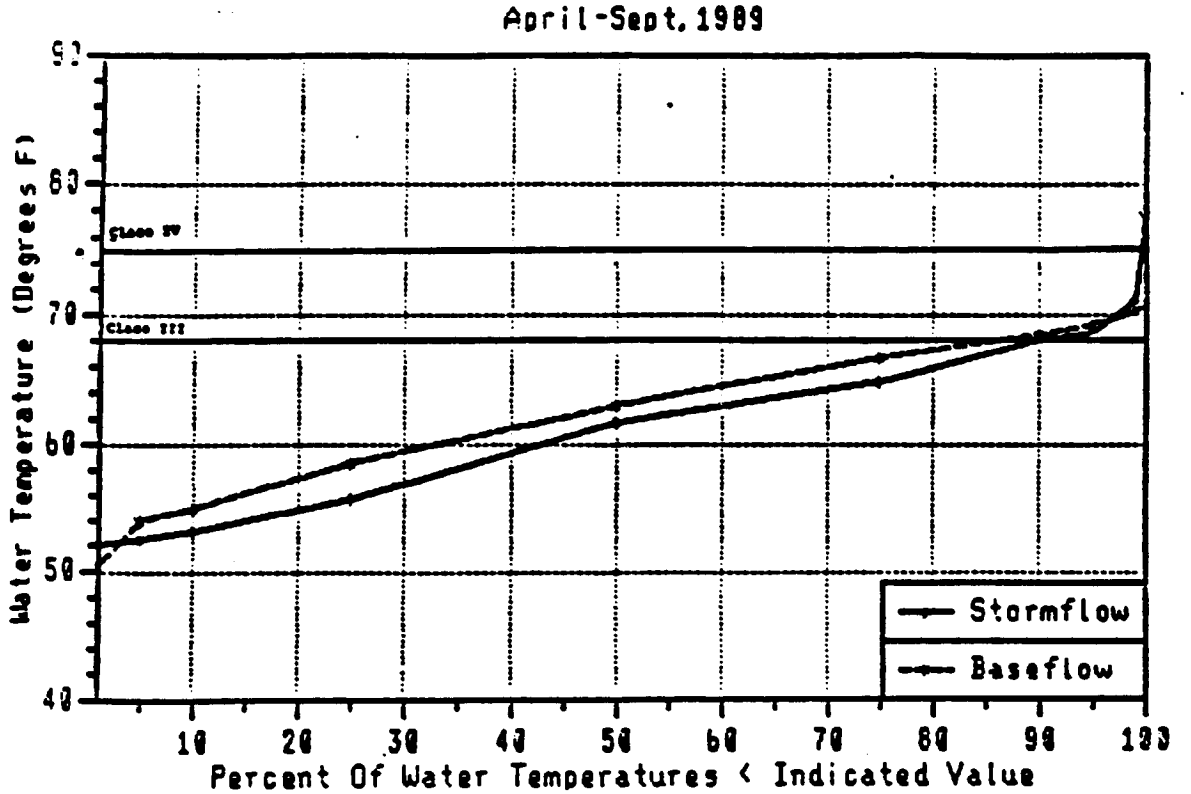

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FIGURE 12

EFFECT OF STORMFLOW ON MODERATELY DEVELOPED TANGLEWOOD INFLOW STREAM TEMPERATURES

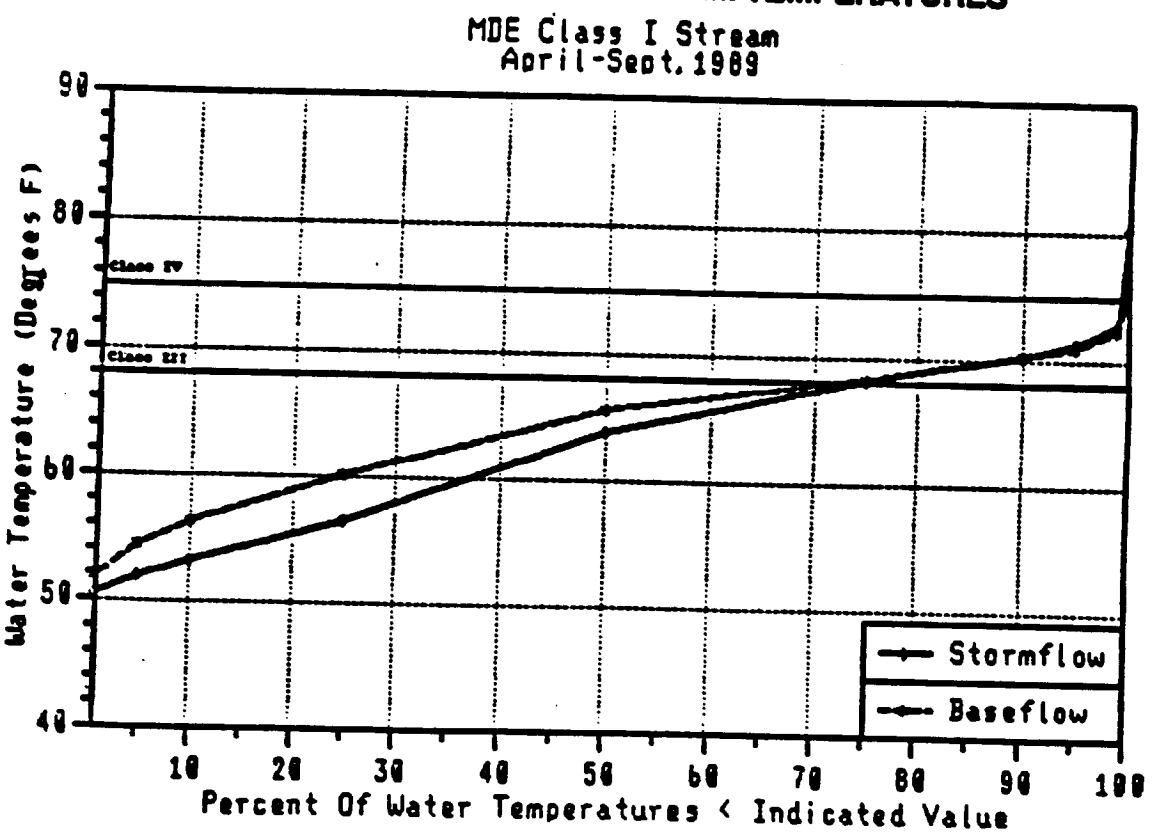

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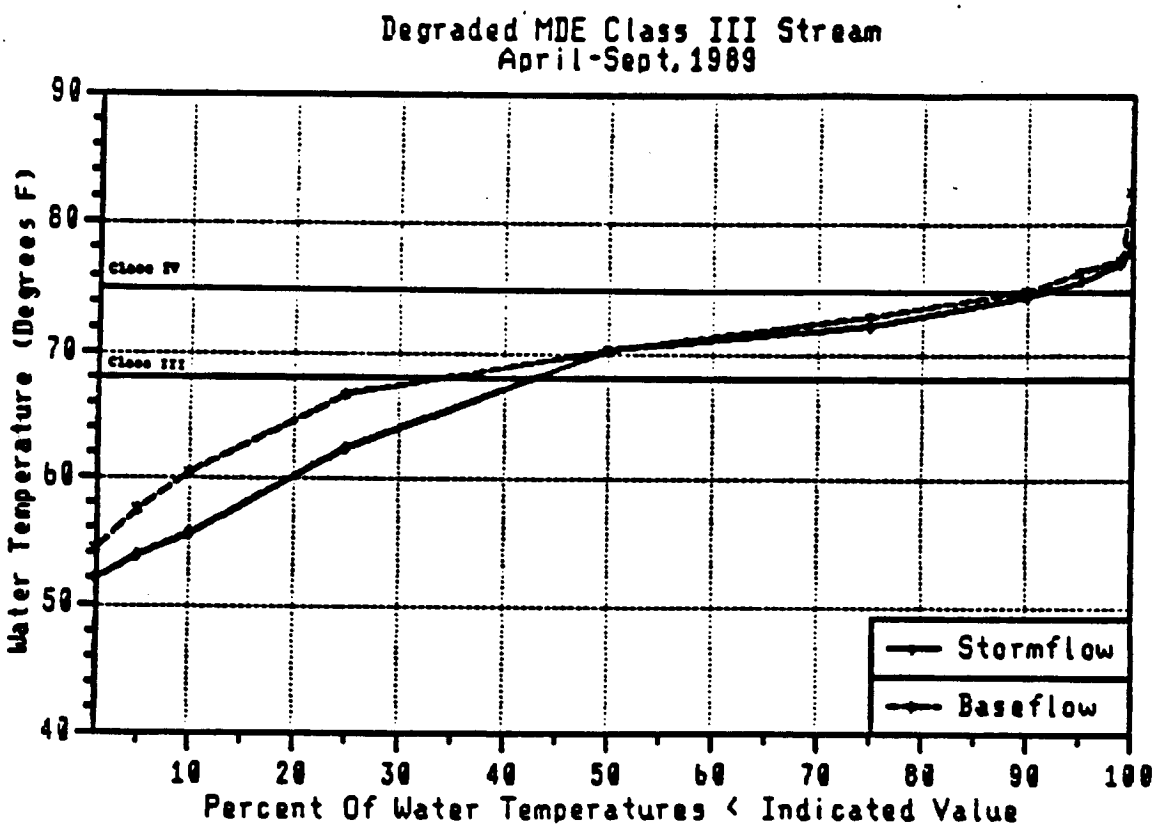
FIGURE 13

EFFECT OF STORMFLOW ON HIGHLY DEVELOPED LOWER WHITE OAK STREAM TEMPERATURES



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violated the preceding standards 67 and 12 percent of the time, respectively.

In summary, results show that stormflow temperatures are generally cooler than baseflow temperatures. However, in developed watersheds stormflow temperatures will be higher, roughly 1-5 percent of the time, when certain conditions are met. The three principal conditions are:

1. The storm event occurs during a high air temperature period, or date;

2. Precipitation occurs mainly as the result of heavy shower activity; and

3. The amount of precipitation is sufficient to generate significant runoff. In highly developed watersheds the amount of rainfall needed to generate significant volumes of runoff can be as little as 0.1 inches.

The preceding conditions or factors explain the rapid, "J-"shaped curve increase evident in the upper right hand corner of the plots for the developed watersheds (Figures 11, 12, and 13). They do not, however, adequately explain the flatter temperature curve response observed at the Lakemont site (Figure 10).

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3. Role of Riparian Vegetation

Studies have shown that the partial and/or complete removal of stream-side vegetation can raise summer stream temperatures by as much as 11 - 20°F and can reduce winter water temperatures by up to 5 - 7 °F (Gray and Edington, 1969; Hewlett and Forston, 1982; Lynch et al., 1980). The importance of riparian vegetation as a thermal insulator of small, headwater streams cannot be overemphasized. In particular, during summer months, an umbrella of dense vegetation typically shields natural streams from solar radiation; thereby reducing daily temperature fluctuations. Unfortunately, the common practice of removing riparian vegetation can greatly alter the temperature regime of small streams. Even relatively short open, or partially shaded stream reaches can produce a major elevation of downstream water temperatures.

Limited instantaneous grab sampling results from both the White Oak and Tanglewood tributaries revealed a maximum stream Delta-T increase of 8.5°F after the streams flowed through 150 foot long unshaded reaches (Figure 14). On average, a Delta-T increase of 3.5 - 3.7°F occurred when water flowed through relatively short (approximately 150 - 300 feet long), open or partially-shaded stream reaches. Although stream depth, current velocities, and discharge were comparable in both tributaries, the White Oak tributary had the highest observed temperature increase.

Physical factors such as stream channel width, depth of flow, current velocity, and volume of flow are known to play key roles in determining to what extent exposed stream reaches will be warmed by increased solar

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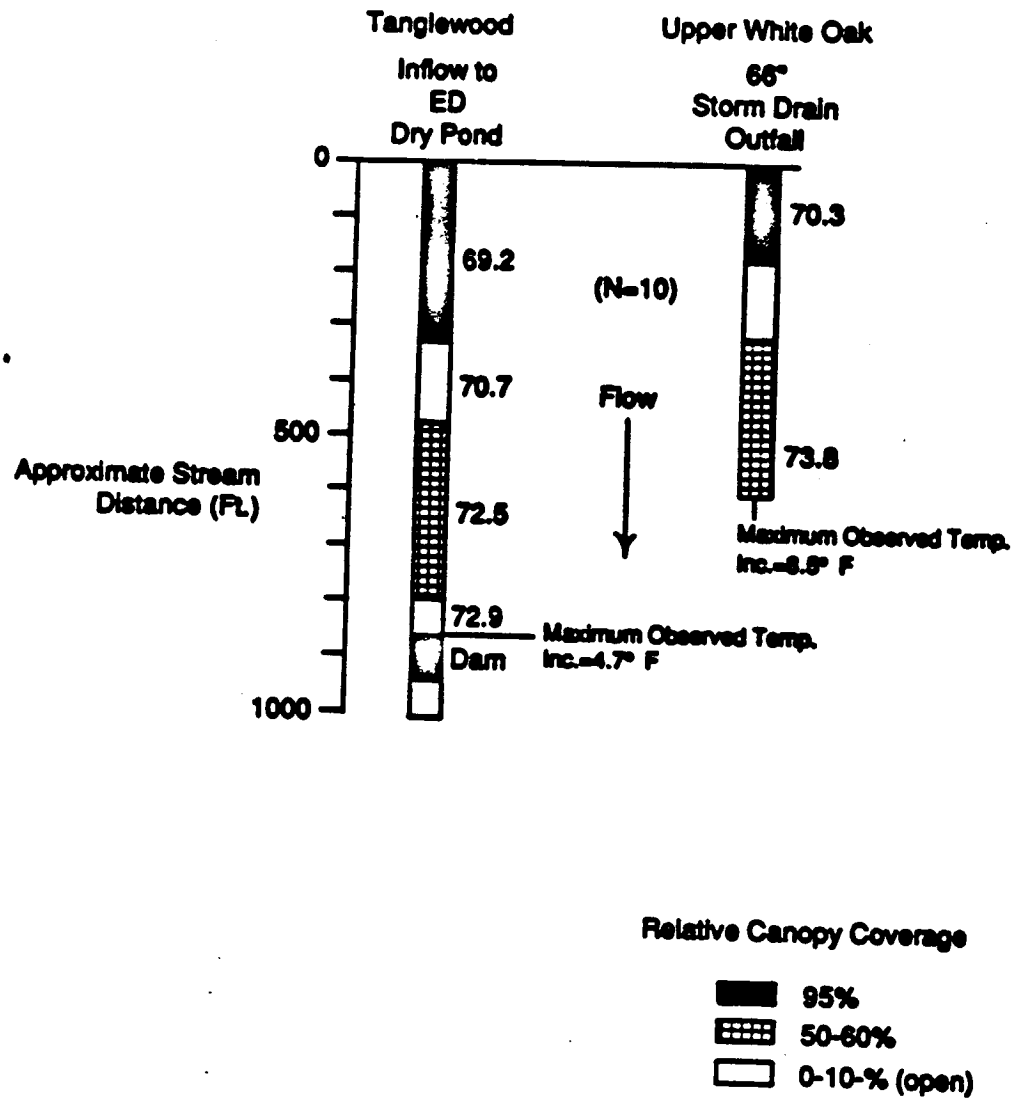
Figure 14

Influence of Canopy Coverage on Mean Baseflow Temperature (° F) [1/] June-August, 1989



1/-The mean baseflow for Tanglewood & Upper White Oak during this period was 0.28 and 0.35 cfs, respectively.

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radiation. In general, the smaller the discharge, and the greater the amount of exposed stream surface area and travel time, the higher the potential temperature increase. Given that the 12 foot wide White Oak tributary is 2 to 3 times wider than the Tanglewood tributary, it appears that the greater amount of exposed surface area per unit volume of flow was primarily responsible for the observed higher temperature increases.

As seen in Figure 15, once elevated by the addition of warm water from the Oaksprings tributary, Gum Springs tributary baseflow temperatures did not demonstrably cool-down within the 1200 foot long test reach. In fact, temperatures remained elevated all the way downstream to the confluence with Paint Branch (a distance of approximately 1900 feet). While initially experiencing a stream Delta-T increase of 11.4°F after flowing through the Countryside wet pond, the smaller Countryside tributary did cool down slightly over a similar distance. However, the stream still posted a net stream Delta-T increase of 8.3°F. Since both test stream reaches were heavily shaded and air temperature along each respective tributary was constant, factors other than riparian canopy coverage apparently were responsible for the 3.1°F cooling-effect observed at the Countryside site.

Research has demonstrated that the temperature of small streams can be significantly reduced upon passage through heavily shaded reaches (Klein, 1979; Karr and Schlosser, 1977). However, it is widely acknowledged that as stream flow increases, the influence of riparian vegetation on stream temperature decreases. Once warmed, considerable energy must be expended to cool-down streams. Whether or not the small observed decrease in Countryside

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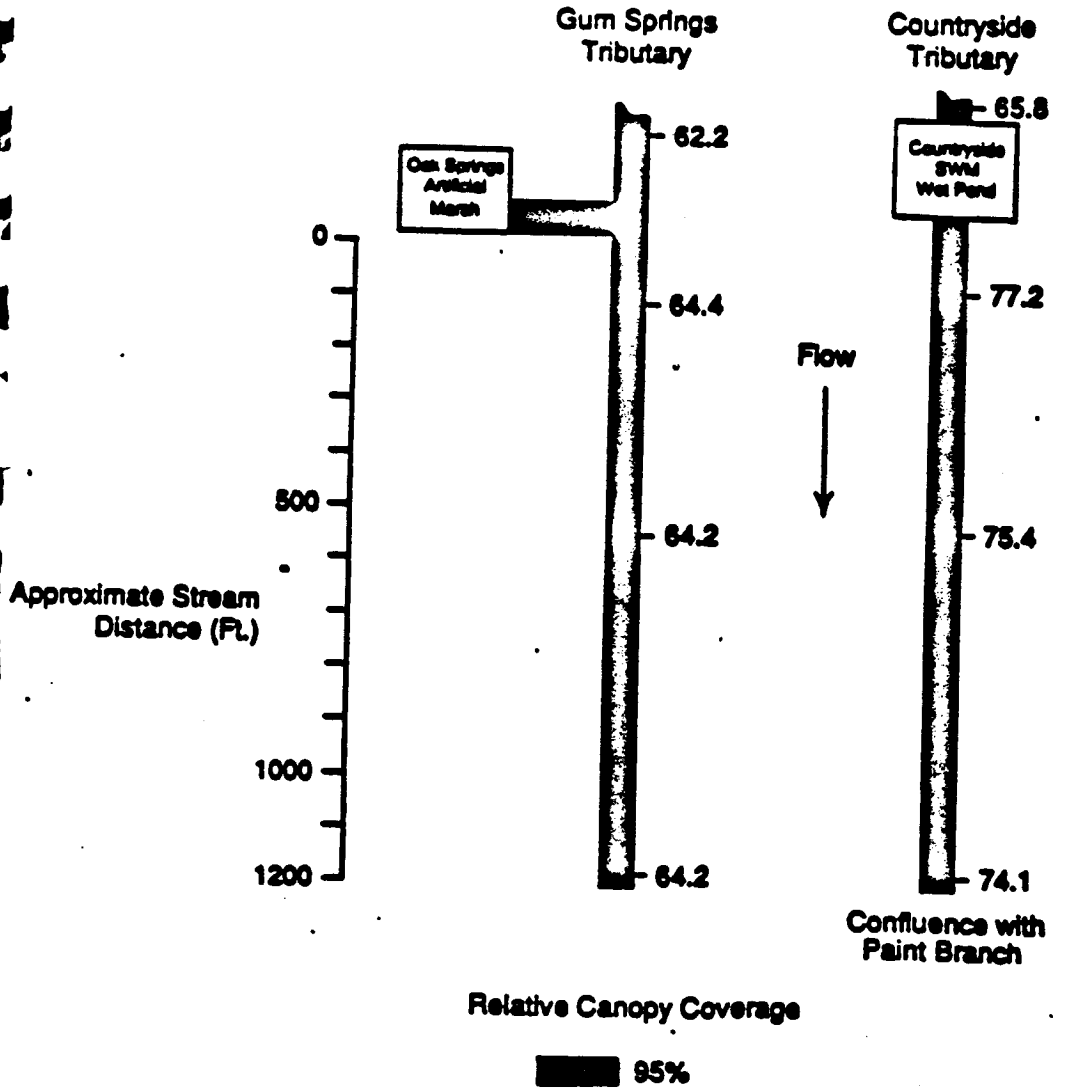
FIGURE 15

RELATIONSHIP BETWEEN CANOPY COVERAGE AND STREAM SIZE ON MEAN WATER TEMPERATURE

June-August, 1989 Baseflow Conditions[v]

(N=10)



1/-The mean baseflow for Countryside & Gum Springs during this period was 0.25 and 0.99 cfs, respectively.

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water temperature was attributable to the influence of groundwater inputs, greater conduction of heat to the streambed and banks, higher convection rates, or some other means of thermal energy reduction remains unclear.

The preceding results show that on hot, sunny days the water temperature of small, poorly shaded streams can experience Delta-T increases on the order of 1.0 - 3.0°F per 100 feet of open or lightly-shaded channel length. Results also indicated that even after flowing through 1000 or more feet of forested stream buffer, stream temperatures are likely to remain elevated. This is particularly the case for larger-sized streams.

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4. Stream Temperature As a Function of Stream Order

Macan (1958) reported that the temperature of small headwater streams warmed up and reached equilibrium within relatively short distances from their source. This is primarily attributed to the response of small streams to both air temperature variations and riparian canopy coverage. In addition, stream temperatures generally increase in a downstream direction with increasing stream order and/or distance from the source.

The premise that a temperature continuum normally exists within urban stream systems is supported by findings from the grab sampling portion of the study. As illustrated in Figure 16, stream temperatures along the mainstem of Paint Branch (a third-order stream) increased in a downstream direction. Over the course of approximately 4.3 stream miles, an average mainstem stream Delta-T increase of 5.0°F occurred. However, when compared to cooler first-order tributary areas such as the Upper Gum Springs, the average Lower Paint Branch increase was actually 14.0°F.

The observed 14.0°F stream continuum temperature increase, which represents the "watershed Delta-T effect," is the result of a combination of natural phenomena and anthropogenic factors. In the case of the urban Paint Branch, the watershed's Delta-T effect produces a 1.0 - 2.0°F baseflow temperature increase per stream mile. Results further suggest that smaller, low-order urban streams are most sensitive to this watershed Delta-T effect.

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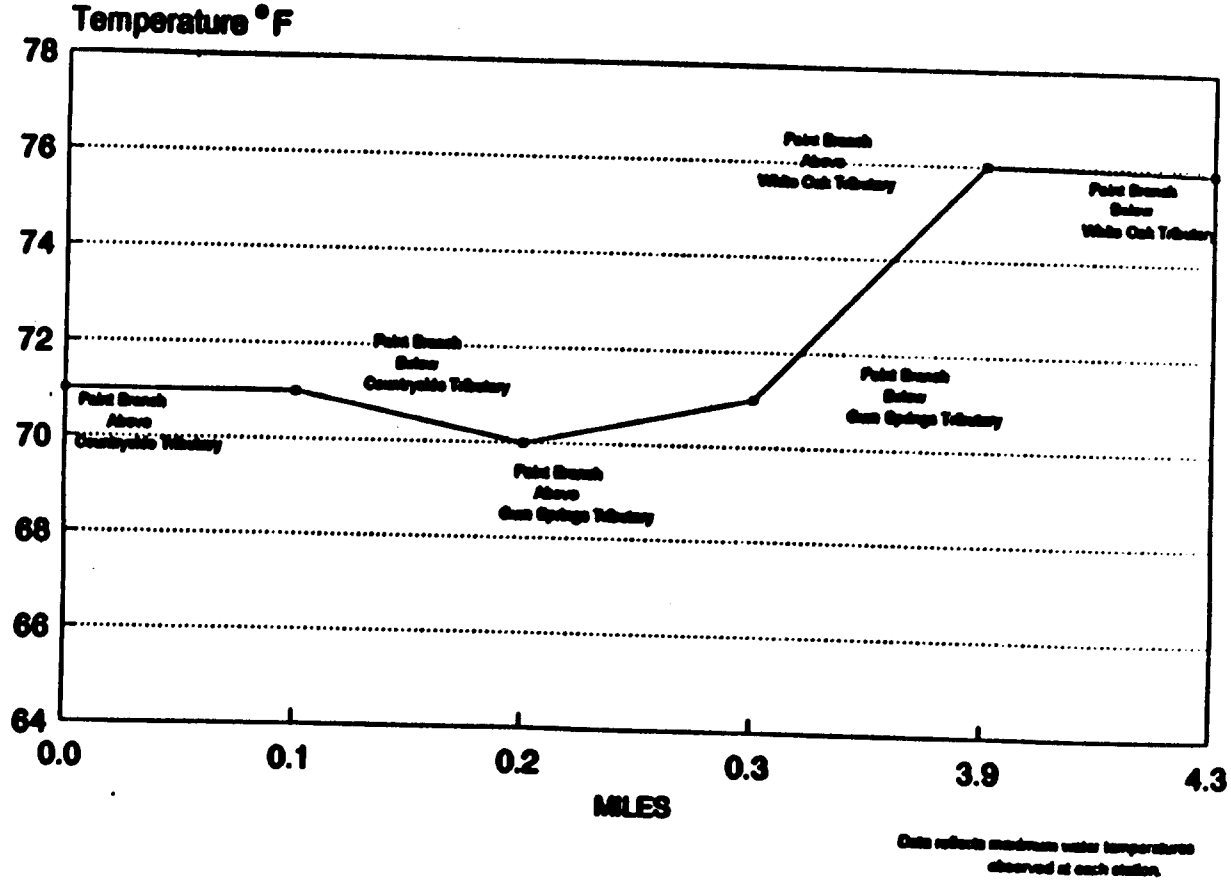
Figure 16

Paint Branch
Stream Temperature Continuum
Summer, 1989



Data reflects maximum water temperature observed at each station.

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5. Effect of Stormwater Management BMP's on Water Temperature Distribution: MDE Water Temperature Standard Performance Series

None of the four urban BMP sites were thermally neutral. While no violation of MDE Class I temperature standards were recorded during the study, outflow from all four of the monitored stormwater management BMP sites violated either Class III or IV standards some of the time. As seen in Figure 17, the Fairland Ridge infiltration - dry pond facility had the lowest recorded BMP outflow temperatures. This hybrid BMP site violated Class III and IV standards 8 and 1 percent of the time, respectively. The highest outflow station temperatures were recorded at the Countryside wet pond. This BMP violated Class III and IV standards 75 and 50 percent of the time, respectively. Temperatures at the Countryside pond outflow station were, in comparison to the other three BMP sites, higher 75 percent of the time. Major findings are presented below. In addition, the BMP Delta-T performance for each site is summarized in Table 5 and described in greater detail in the following sections.

- All four BMP's increased receiving stream temperatures during baseflow conditions. The average BMP baseflow Delta-T increase ranged from a low of 2.6°F at the infiltration-dry pond site, to a high of 9.7°F at the wet pond (Table 5).

- During stormflow conditions, all four BMP's raised downstream water temperatures. Once again, the infiltration-dry pond produced the

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FIGURE 17

COMPARISON OF STORMWATER MANAGEMENT BMP OUTFLOW TEMPERATURES: INFILTRATION-DRY POND, ARTIFICIAL WETLAND, EXTENDED DETENTION DRY POND AND WET POND

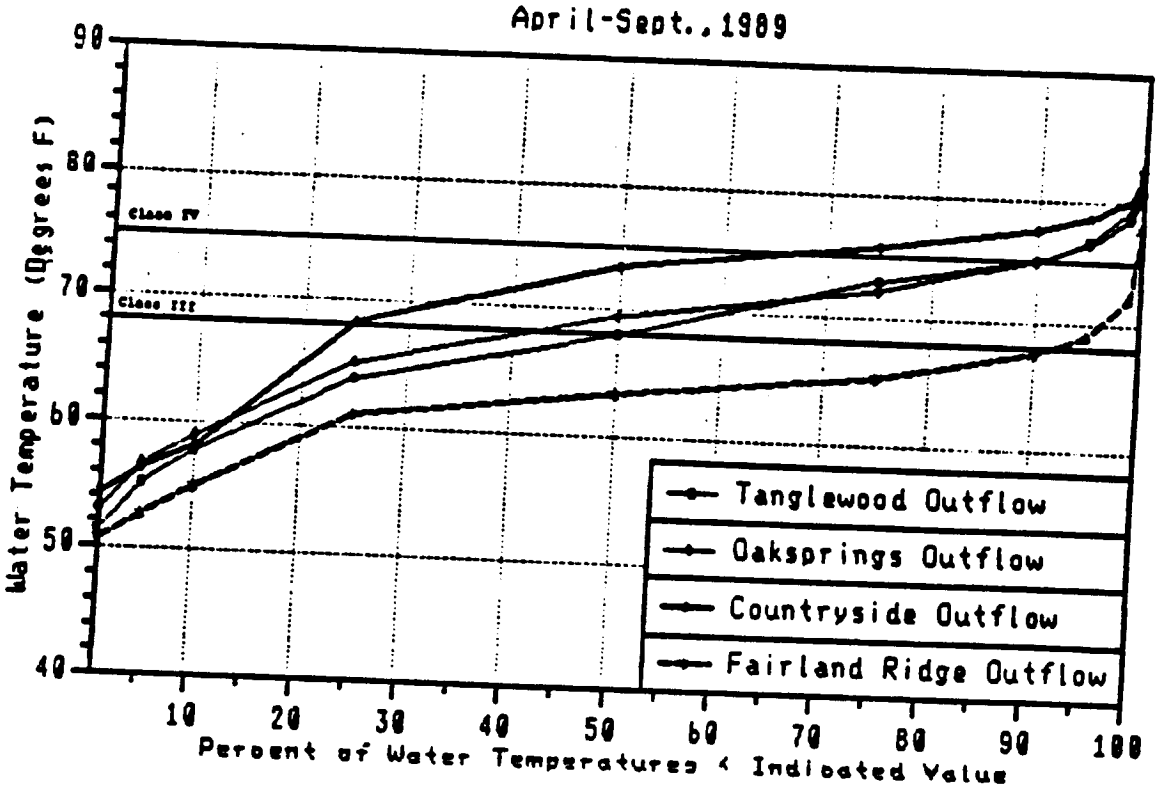

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Table 5. Summary: Stream and BMP Delta-T Temperatures (°F)

	Location	Representative Type	Baseflow Max.	Baseflow Avg.	Stormflow Max.	Stormflow Avg.	Total (Base & Stormflow) Max.	Total (Base & Stormflow) Avg.
STREAM	Countryside Inflow	Lightly Developed Watershed (12% Impervious)	6.5	1.9	9.6	2.0	9.6	1.9
STREAM	Tanglewood Inflow	Moderately Developed Watershed (30% Impervious)	14.0	5.0	16.1	5.2	15.0	5.1
STREAM	Lower White Oak	Highly Developed Watershed (60% Impervious)	16.2	8.7	15.5	8.5	16.2	8.6
BMP	Fairland Ridge	Infiltration-Dry Pond	7.6	2.6	5.0	2.3	7.6	2.5
BMP	Oaksprings	ED Wetland	8.7	3.9	7.8	2.4	8.7	3.2
BMP	TangleWood	ED Dry Pond	9.7	5.5	11.2	5.2	10.9	5.3
BMP	Countryside	Wet Pond	15.1	9.7	14.0	8.5	15.1	9.1

1/ Lakemont used as reference to calculate stream Delta-T; Inflow station used as reference to calculate BMP Delta-T.

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smallest average BMP Delta-T increase (2.3°F). The wet pond had the largest average Delta-T increase (8.5°F). In addition, all four BMP's raised stormflow temperatures in the "J" section of the temperature curve.

- BMP Delta-T's were sufficient to dramatically increase the frequency and magnitude of temperature standards violations, and in some cases, were high enough to have severely impacted downstream coldwater organisms (had they been present).

- Outflow from the Tanglewood extended detention (ED) dry pond violated Class III and IV temperatures standards 50 and 10 percent of the time, respectively. This station had the second highest percentage of Class IV violations recorded (by any station) in the entire study.

- The Oaksprings ED wetland outflow station violated Class III and IV standards 58 and 10 percent of the time, respectively.

Figure 18 provides additional comparative information on the influence of both stormwater management BMP's and background levels of watershed imperviousness on receiving stream temperatures. Not surprisingly, high levels of watershed imperviousness and/or introduction of BMP's into headwater stream areas can produce average total stream Delta-T increases of 2.5 - 9.1°F. Closer examination of the data indicated that the average total stream Delta-T increase was 9.1°F for the wet pond, versus 8.6°F for the highly developed watershed. In addition, both scenarios reported identical

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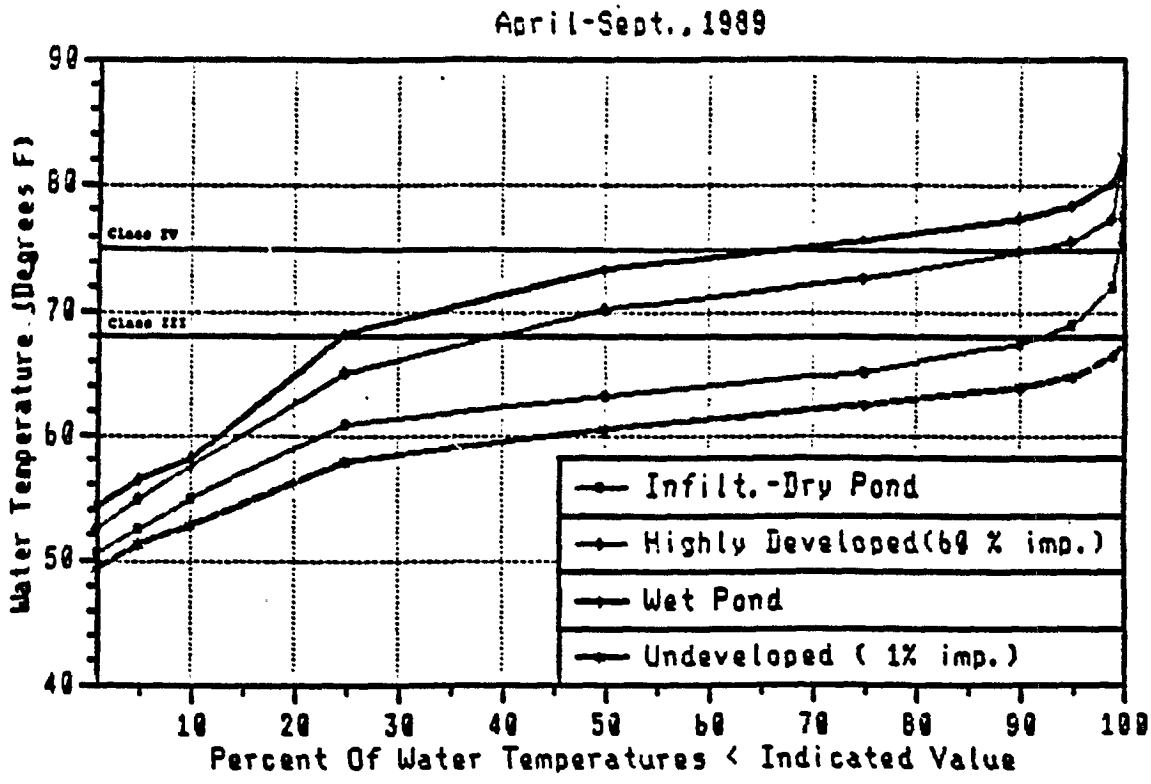
FIGURE 18

COMPARITIVE THERMAL IMPACTS OF URBANIZATION AND STORMWATER MANAGEMENT BMP'S: UNDEVELOPED, HIGHLY DEVELOPED, INFILTRATION-DRY POND AND WET POND



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highly developed watershed produced an average total Delta-T increase which was 6.1°F higher than the infiltration - dry pond BMP.

A comparison of both the highly developed watershed and ED wetland outflow stream temperatures (Figure 19) reveals that the thermal regime of the two sites are virtually identical. The preceding results provide compelling evidence that at high levels of watershed imperviousness, the thermal impacts to the receiving stream system closely resemble those produced by wet and/or extended detention stormwater management BMP's.

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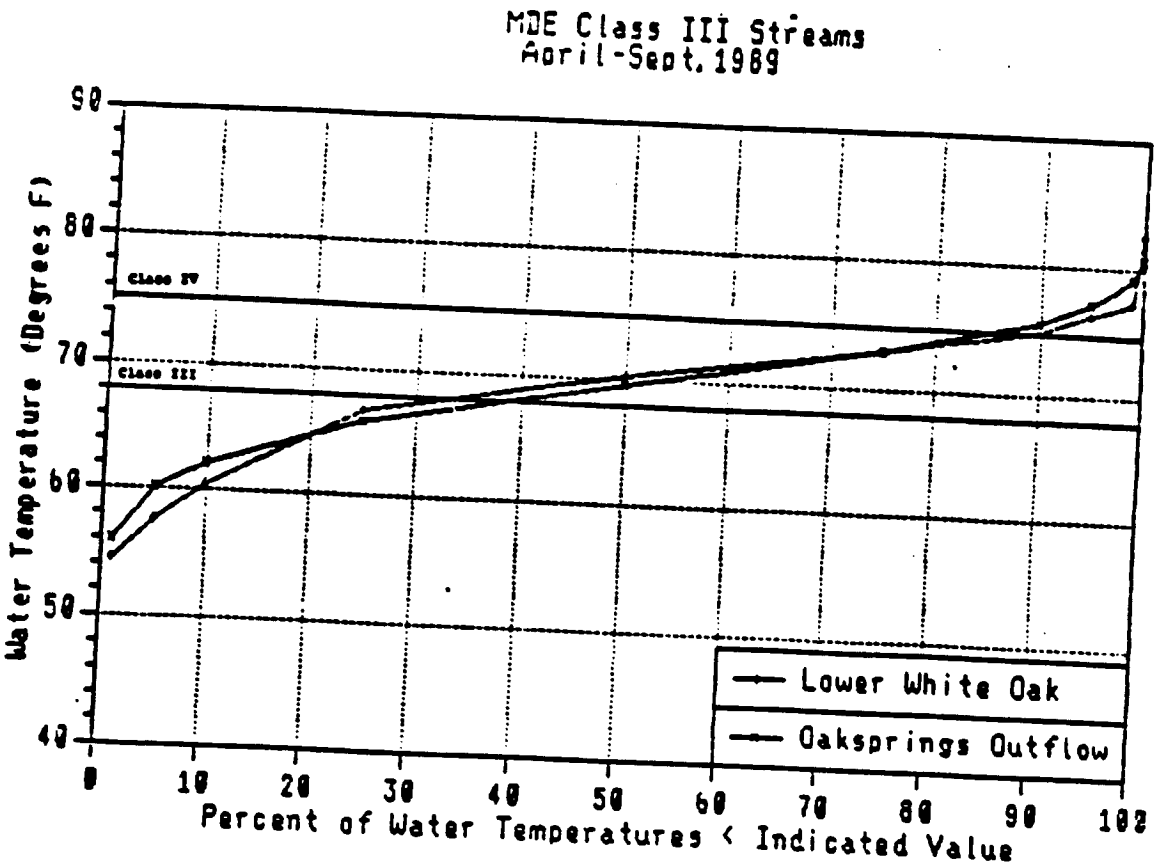
FIGURE 19

COMPARISON OF HIGHLY DEVELOPED AND ARTIFICIAL WETLAND OUTFLOW STREAM TEMPERATURES



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Summary

Results from the study indicate that the temperature regime of small, urban headwater streams is greatly influenced by the five following factors:

1. Degree of watershed urbanization. Imperviousness, together with local meteorological conditions, generally had the largest influence on urban stream temperatures. Results from the study indicate that the average water temperature of urban streams increases on the order of 0.14°F per one percent increase in watershed imperviousness. When compared against the undeveloped watershed, the average total stream Delta-T increase at the 12 percent impervious watershed was 1.9°F, versus 8.6°F at the 60 percent impervious one. In addition, a general inverse relationship exists between watershed imperviousness and storm-size needed to produce large, rapid stream temperature increases.

2. Meteorological conditions. During the study the observation was made that air temperature was a more important factor than storms approximately 90 - 95 percent of the time. It was further noted that forested, undeveloped headwater streams such as the Lakemont tributary generally respond to storm events by becoming slightly cooler. This is largely due to the drop in air temperatures which accompanies most rainfall events. While this is also normally true of small urban streams, as the level of watershed imperviousness increases these streams become progressively more responsive to

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inputs of stormwater runoff. In addition, the potential for large stream temperature increases is greatest during prolonged, hot weather periods which include heavy shower activity.

3. Riparian canopy coverage. Riparian vegetation plays a key role in insulating small streams from the warming effect of solar radiation. Results show that stream Delta-T's can increase an additional 1 - 3°F per 100 feet of flow through either open or poorly-shaded stream reaches.

4. Stream order. It is well known that stream temperature naturally increases in a downstream direction with increasing stream order/distance from the source. In urban watersheds a variety of anthropogenic factors, such as the removal of riparian vegetation, micro-climate changes, and reduction of groundwater inflow, add to the so-called "watershed Delta-T" effect. Monitoring results indicate that the watershed Delta-T effect for the urban, third order, Paint Branch stream system is on the order of 1 - 2 °F per stream mile. In addition, lower-order urban streams are, because of their generally smaller volume of flow, more sensitive to this background watershed effect.

5. Urban BMP's. As previously noted, all four types of stormwater management practices monitored in the study imparted additional heat to the receiving stream. The average total BMP Delta-T increase ranged from 2.5°F for the infiltration - dry pond to 9.1°F for the wet pond. Out of the four BMP's studied, the wet pond produced the

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highest maximum BMP Delta-T increase.

B. Factors Influencing Stormwater Management Facility Temperature Performance

From a water temperature perspective, the performance of stormwater management wet ponds, artificial marshes, ED dry ponds, and infiltration facilities is strongly influenced by a large number of interrelated variables. These factors include, but are not limited to, the following: BMP surface area, volume and mean depth of the permanent pool, release depth (which changes relative to the facility's water surface elevation), hydraulic residence time, design storm storage capacity, infiltrative capacity of underlying soils, size and frequency of storm events, type and condition of stormwater conveyance system, BMP outfall design, watershed imperviousness, and baseflow/stormflow water temperatures. While it is beyond the scope of the study to examine each of these factors, a comprehensive examination of associated water temperatures under baseflow and stormflow conditions was performed to characterize general temperature relationships and BMP performances under field conditions.

The following sections examine baseflow-stormflow water temperature relationships, BMP baseflow-stormflow Delta-T's, thermal loading as a function of flow ratio, and stormwater management design features which contribute to thermal loading.

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1. Stormwater Management BMP Performance Under Baseflow and Stormflow Conditions

Fairland Ridge Infiltration - Dry Pond

Results from the preceding section demonstrated that the Fairland Ridge infiltration - dry pond Delta-T water temperatures were the lowest of the four BMP-types monitored. The general performance of this BMP under both baseflow-stormflow and inflow versus outflow conditions is shown in Figures 20 and 23. Major findings are presented below and summarized in Tables 6 and 7.

1. As previously noted, all four BMP's had positive average total Delta-T's. However, Fairland Ridge, which had an average total BMP Delta-T increase of 2.5°F, produced the smallest Delta-T increase.

2. On one occasion, Fairland Ridge outflow station temperatures were actually slightly lower than inflow station temperatures. This occurred during a cool, small storm event. The unexpected result suggests the possibility of: a) higher associated stormflow conduction and/or convection rates downstream of the BMP, and/or b) an increase in groundwater inflow downstream of the facility.

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3. Larger storms (i.e., $\geq$ 1.5 inches precipitation) raised downstream temperatures considerably. The lengthy detention of stormwater runoff, together with high solar radiation levels associated with the unshaded storage pool, rip-rap pilot channel and outfall areas, were co-contributors. The maximum recorded outflow temperature of this BMP site (77.7°F) was attributed to the preceding factors.

4. The thermal behavior at Fairland Ridge was unique. No other BMP monitored during the study displayed such well-pronounced extended detention effects. During large storms, this facility was capable of maintaining elevated outflow station temperatures for over 48 continuous hours.

Baseflow Versus Stormflow Delta-T's

As seen in both Figure 20 and Table 6, under baseflow conditions this BMP raised outflow station temperatures an average 2.6°F. It should be noted that the maximum observed Delta-T increase of 7.6°F was the combined product of stormwater runoff from 1.5 inches of rainfall and the BMP facility's defacto extended detention control. Therefore, a more realistic baseflow maximum Delta-T was probably on the order of 5.0 - 6.0°F.

With regard to stormflow Delta-T conditions, the infiltration dry pond raised outflow station temperatures an average 2.3°F. The maximum stormflow Delta-T for this BMP was 5.0°F. Approximately 65 percent of the time the

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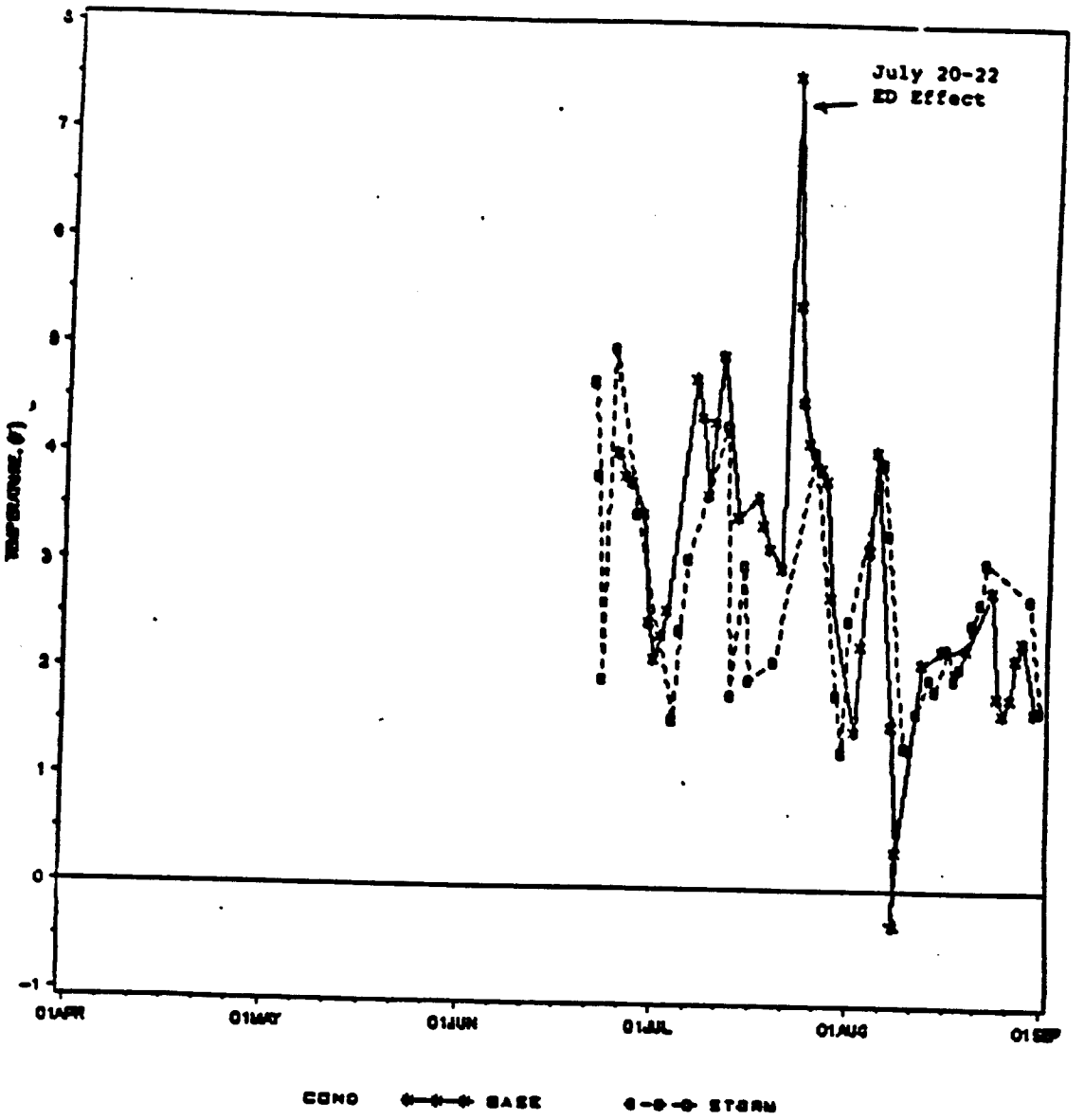
FIGURE 20

INFILTRATION-DRY POND THERMAL CHARACTERIZATION:
BASEFLOW VERSUS STORMFLOW DELTA-T'S *



*Values shown are daily mean Delta-T's

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Table 6 Summary: Fairland Ridge Infiltration - Dry Pond Delta-T's

Percent of Temperatures < Indicated Value	Delta-T(^{o}F) Baseflow	Stormflow	Total
0 (minimum)	-0.3	-0.3	-0.3
1	-0.3	-0.3	-0.3
5	0.2	0.1	0.3
10	0.6	1.3	0.6
25	1.5	1.5	1.5
50 (median)	2.4	2.0	2.3
75	3.8	3.1	3.5
90	4.5	4.1	4.3
95	5.1	4.7	4.8
99	7.6	5.0	7.6
100 (maximum)	7.6	5.0	7.6

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Delta-T difference between baseflow and stormflow conditions was less than 1.0°F (Table 6). Eighty-two percent of the time the positive Delta-T effect produced by this BMP was insufficient to cause a violation of the 68.0°F Class III standard. Exceedance of Class III standards was generally associated with periods of high rainfall. Only one violation of the Class IV standard was noted at this BMP site during the study.

Temperature Standard Performance

Monitoring results indicated that approximately one-fifth of all stormflow discharges from this BMP produced an increase in downstream water temperatures. They also revealed that Class III temperature standards were violated under both baseflow and stormflow scenarios, but that a 10 percent higher violation rate existed under stormflow conditions.

Under stormflow conditions (Figure 21) outflow temperatures exceeded the Class III and IV temperature standards 18 and 0 percent of the time, respectively. In contrast, baseflow outflow temperatures violated the same standards 8 and 1 percent of the time, respectively. As seen in both Figure 22 and Table 7, under stormflow conditions outflow station temperatures were slightly higher than inflow temperatures 100 percent of the time. Short, open and partially shaded reaches below this facility were primarily responsible for the slight stormflow temperature increase.

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FIGURE 21

INFILTRATION-DRY POND THERMAL CHARACTERIZATION: BASEFLOW VERSUS STORMFLOW CONDITIONS

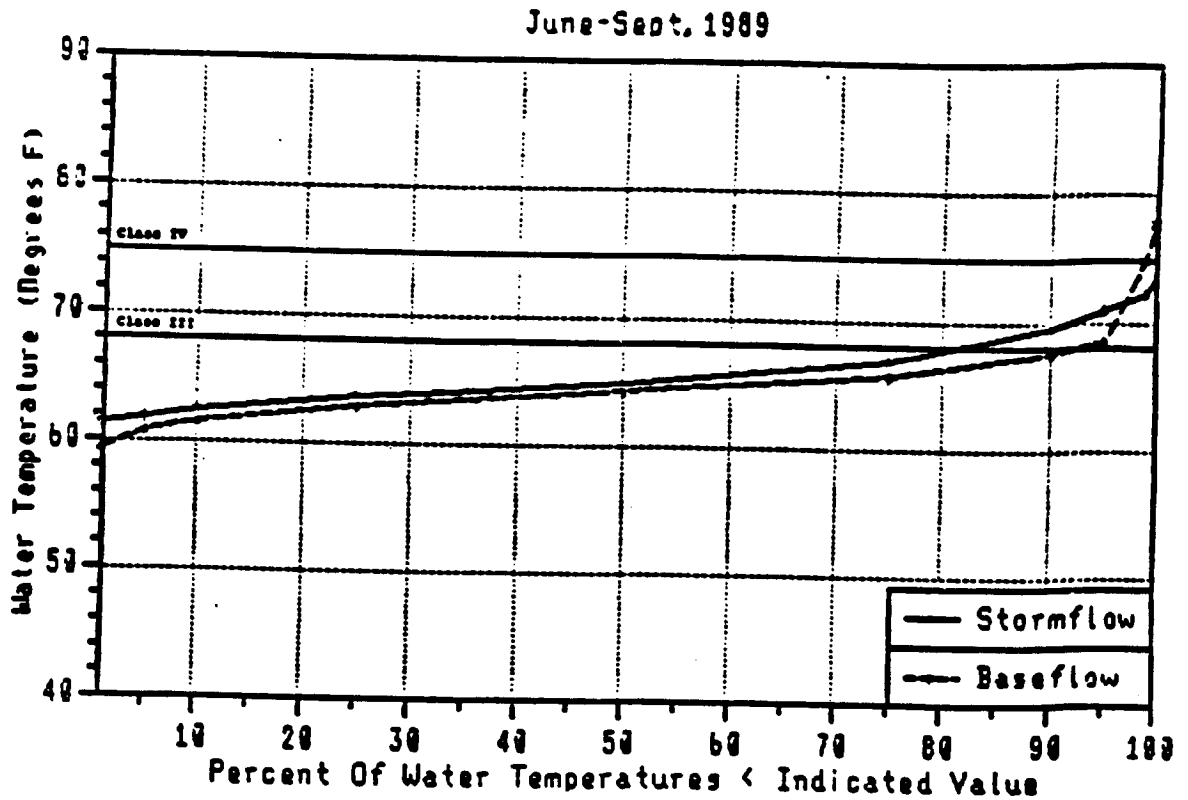

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FIGURE 22

INFILTRATION-DRY POND INFLOW-OUTFLOW TEMPERATURE RELATIONSHIP DURING STORMFLOW

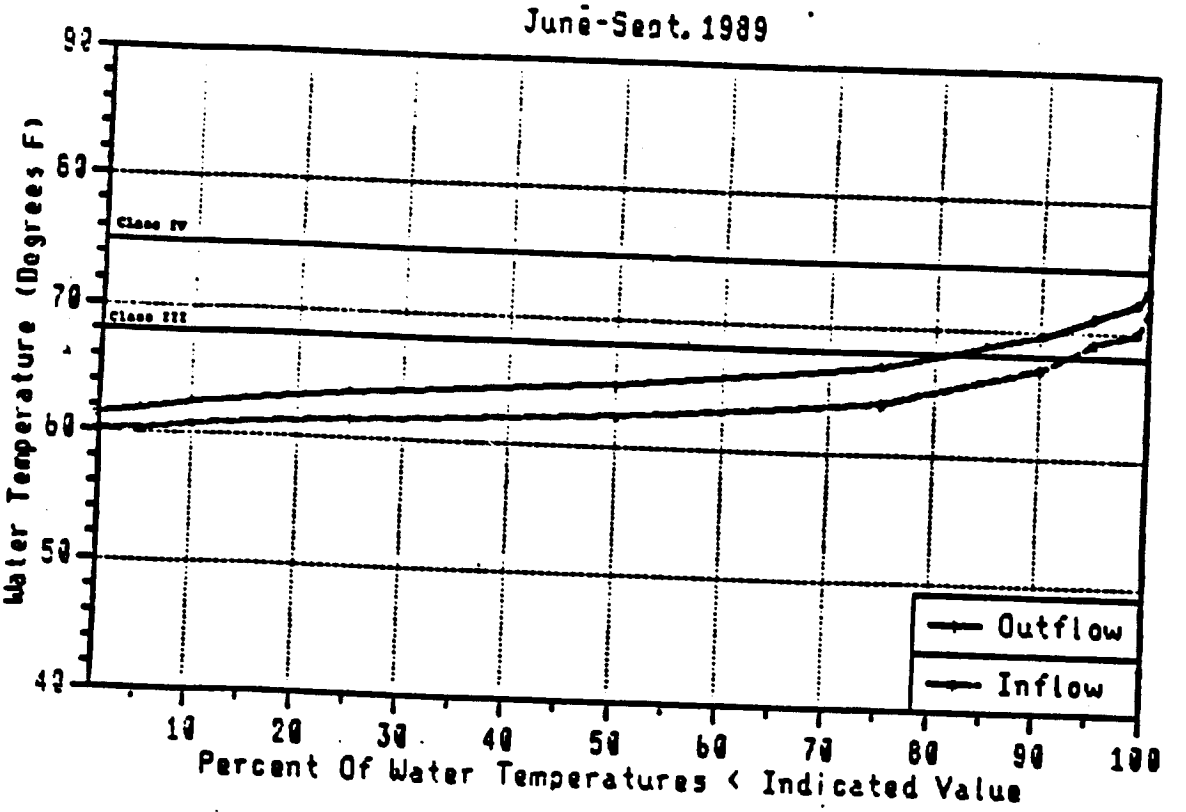

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Table 7 Summary: Fairland Ridge Infiltration - Dry Pond Performance, June - Sept., 1989

Percent of Water Temperatures ≤ Indicated Value (%)	Temperature(°F)			
	Baseflow		Storeflow	
	Inflow	Outflow	Inflow	Outflow
0 (minimum)	58.3	59.0	59.9	61.3
1	58.6	59.5	60.1	61.5
5	59.8	60.9	60.3	61.8
10	60.3	61.6	60.7	62.4
25	61.0	62.8	61.5	63.6
50 (median)	61.7	64.3	62.4	64.8
75	62.7	65.7	64.0	66.9
90	63.2	67.5	67.0	69.6
95	63.4	68.6	68.9	71.0
99	70.5	74.9	70.0	72.3
100 (maximum)	73.8	77.7	71.5	73.4

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Example of Extended Detention Effect

One of the study's more interesting findings was that the infiltration-dry pond was the only BMP observed to produce a distinct extended detention temperature effect. Although this effect occurred infrequently and was clearly associated with large precipitation events (i.e., those dropping ≥ 1.5 inches of rainfall), it resulted in markedly higher downstream water temperatures.

Described below is the chronology of events for the July 20, 1989 storm; which was responsible for Fairland Ridge's maximum recorded outflow station water temperature of 77.7°F.

- As seen in Figure 23, Fairland Ridge inflow-outflow temperatures rose steadily in response to the 1.5 inches of precipitation which fell between 12:30 - 5:00 a.m., July 20, 1989. Within approximately three hours after the start of the storm, both inflow and outflow station water temperatures began to rise. The increase was caused by the large influx of stormwater runoff which had overwhelmed the 0.25 inch design capacity of the infiltration trenches. By the end of the storm, several feet of runoff had been impounded in the dry pond portion of the facility.

- The facility's 8 inch diameter low flow orifice, which provided the

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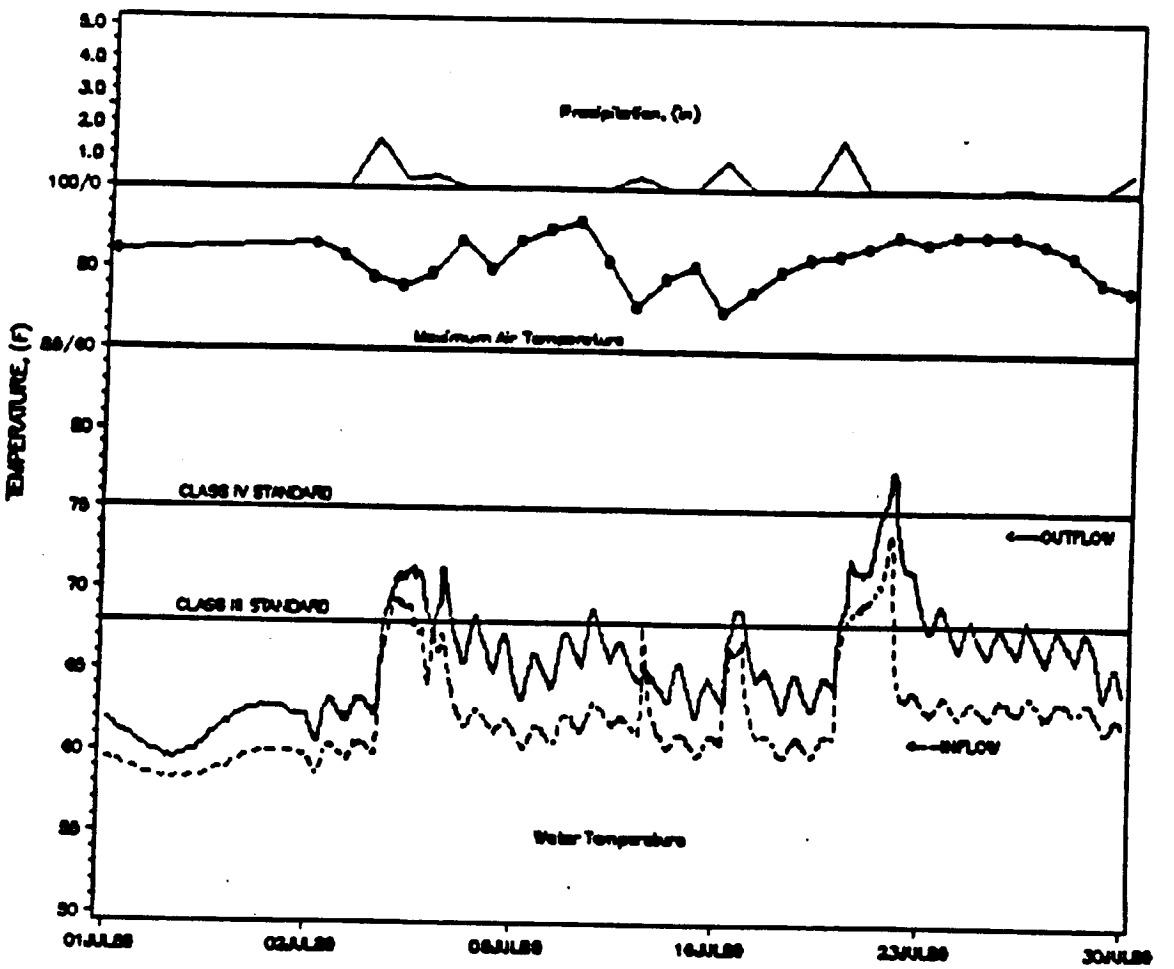
FIGURE 23

GENERAL RELATIONSHIP BETWEEN MAXIMUM AIR TEMPERATURE, PRECIPITATION AND WATER TEMPERATURE: FAIRLAND RIDGE INFILTRATION-DRY POND, JULY, 1989



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defacto extended detention control, stored and slowly released this stormwater over a two-day period. In response to both the detention of relatively warm stormwater runoff and solar radiation, the July 20, 1989 inflow station posted a 4.0°F Delta-T increase (water temperature increased to 69.3°F). It is further noted that during the approximate 53 hour detention period, maximum daily air temperatures of 86 and 89°F were recorded.

- The combination of high daily maximum and minimum air temperatures, lack of shade, large rip-rap pilot channel and relatively shallow depth of stored runoff, raised July 21-22, 1989 inflow station temperatures some 4.5°F (to a high of 73.8°F). Results also showed that an additional 3.9°F Delta-T increase occurred between the lowflow orifice area and the downstream outflow station. Much of this increase is believed to have been caused by flow through warmer, open or partially shaded areas below the BMP facility. Surprisingly, the maximum outflow temperature of 77.7°F was recorded at approximately 11:40 p.m. on July 21, 1990. Inflow and outflow station temperatures both returned to normal around 5:00 a.m., July 22, 1989; some 53 hours after the start of the storm. The net Delta-T increase associated with the subject storm was 12.4°F.

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Oaksprings ED Artificial Wetland

The general performance of the Oaksprings wetland under both baseflow-stormflow and inflow versus outflow conditions is graphically illustrated in Figures 24 - 27. Major results are described below and summarized in Tables 8 and 9.

1. The shallow depth (mean depth is approximately 18 inches) and small permanent pool volume, relative to the 140 acre contributory watershed, made the Oaksprings wetland and outflow station very responsive to air temperature fluctuations. The wetland's small permanent pool did, however, give it a limited ability to moderate outflow temperatures during certain small storm events.

2. Both inflow and outflow stations exhibited similar diurnal Delta-T temperature fluctuations of between 3 and 8°F. In addition, the similarity in diurnal temperature profile response during and after rainfall events suggests that the wetland's limited extended detention capability generally had little effect on outflow station temperature behavior.

3. Delta-T stormflow temperatures at the Oaksprings wetland were typically lower than Delta-T baseflow temperatures. However, approximately 65 percent of the time the difference between baseflow and stormflow Delta-T's was relatively small (i.e., $\leq 3.0^{\circ}F$).

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4. Inflow station temperatures were negatively affected by the Upper Oaksprings wet pond. Warm water released from the upper pond site, located approximately 1700 feet upstream, frequently produced periods of extended temperature elevation at the Oaksprings inflow station.

5. The average June - August grab sampling surface water temperature (measured approximately one foot below the surface) for the Oaksprings wetland was 74.2°F.

Baseflow Versus Stormflow Delta-T's

During baseflow conditions the Oaksprings wetland had both an average and maximum positive Delta-T effect of 3.9 and 8.7°F, respectively. As seen in Figure 24, maximum baseflow Delta-T's speaked in early June, and gradualy declined thereafter. Results indicated that seasonal trends in Oaksprings BMP Delta-T performance, under both baseflow and stormflow conditions, generally paralleled seasonal air temperature fluctuations. Approximately one percent of the time, the artificial wetland had a small negative Delta-T effect.

As seen in both Figure 24 and Table 8, stormflow Delta-T's were generally smaller than baseflow Delta-T's. Average and maximum stormflow Delta-T's for the BMP were 3.2 and 7.8°F, respectively. In addition, nearly 100 percent of all stormflow Delta-T temperatures were cooler than baseflow Delta-T's. The preceding findings indicate that the artificial wetland has a limited capacity to moderate outflow station temperatures during small storm events.

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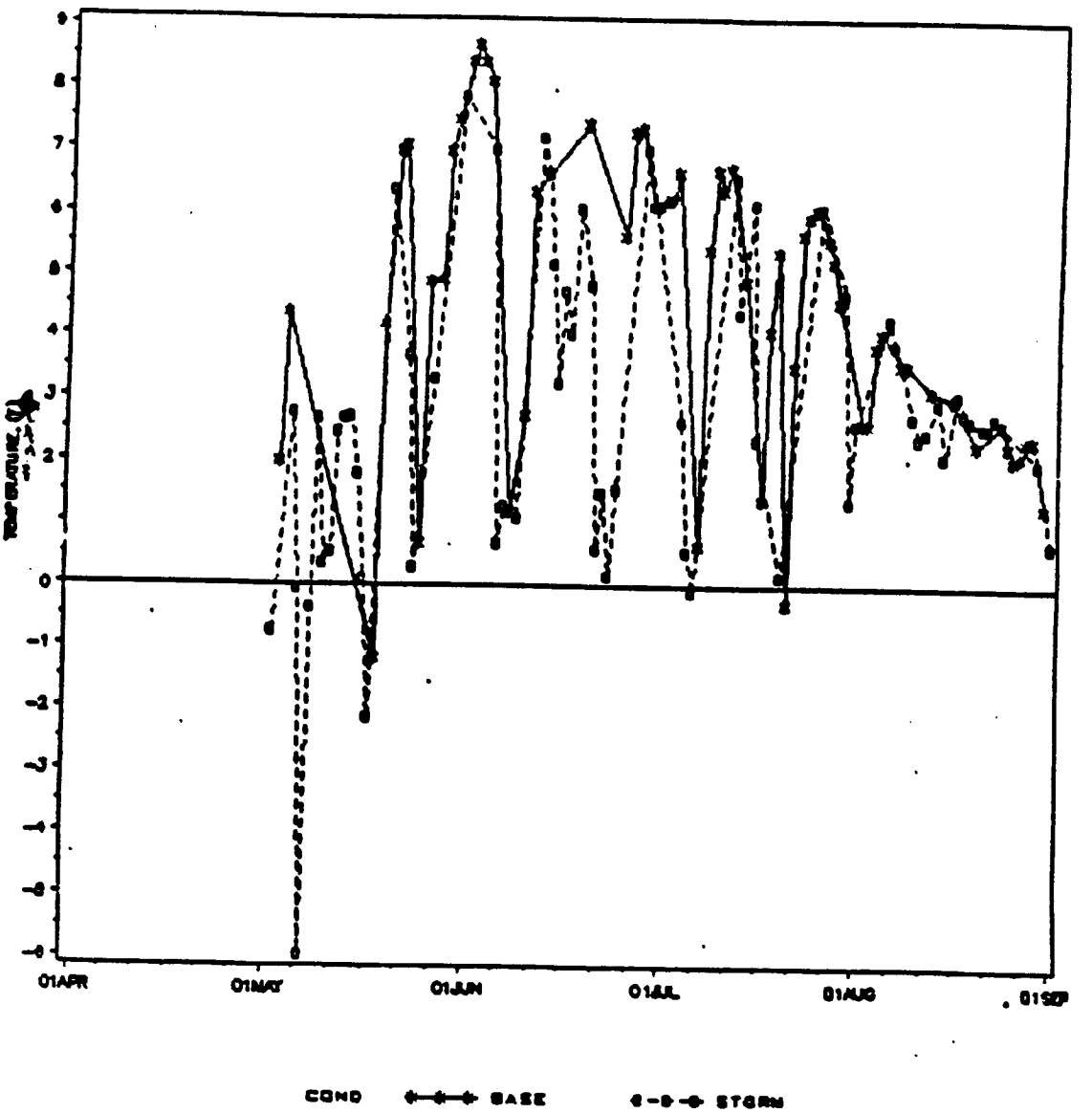
FIGURE 24

ARTIFICIAL WETLAND THERMAL CHARACTERIZATION:
BASEFLOW VERSUS STORMFLOW DELTA-T'S *



*Values shown are daily mean Delta-T's

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Table 8 Summary: Oaksprings ED Wetland Delta-T's

Percent of Temperatures < Indicated Value	Delta-T(^{o}F) Baseflow	Stormflow	Total
0 (minimum)	-1.2	-6.0	-6.0
1	-1.2	-6.0	-4.3
5	0.1	-0.9	-0.4
10	0.4	-0.3	0.1
25	1.3	0.7	1.1
50 (median)	3.8	2.5	2.7
75	6.2	3.9	5.4
90	7.3	6.3	7.0
95	8.2	7.0	7.4
99	8.7	7.8	8.6
100 (maximum)	8.7	7.8	8.7

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Because of the wetland's small permanent pool volume, this moderating ability was highest for smaller storm events occurring during cool air temperature periods. It is further noted that the -6.0°F stormflow Delta-T recorded in the second week of May was the result of unseasonably cool, wet weather during that period.

Temperature Standard Performance

As seen in Figure 25, trends in maximum daily inflow-outflow station water temperature generally paralleled those of maximum air temperature. The same figure also shows that inflow station temperatures were more responsive to inputs of stormwater runoff than were outflow station temperatures.

Under baseflow conditions, outflow station temperatures (Figure 26) exceeded Class III and IV temperature standards 60 and 15 percent of the time, respectively. In contrast, the same standards were violated approximately 57 and 5 percent of the time, respectively under stormflow conditions.

Outflow station temperatures were higher than inflow station temperatures 95 percent of the time (Figure 26). While the stormflow Delta-T temperature difference between the two stations was generally less than 3.0°F, outflow temperatures during the warmest month of the study (July) were as much as 7.8°F higher than inflow station temperatures.

During stormflow conditions, inflow station temperatures violated Class III and IV temperature standards approximately 35 and 4 percent of the time,

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FIGURE 25

GENERAL RELATIONSHIP BETWEEN MAXIMUM AIR TEMPERATURE, PRECIPITATION AND WATER TEMPERATURE: OAKSPRINGS ARTIFICIAL WETLAND, APRIL-SEPTEMBER, 1989

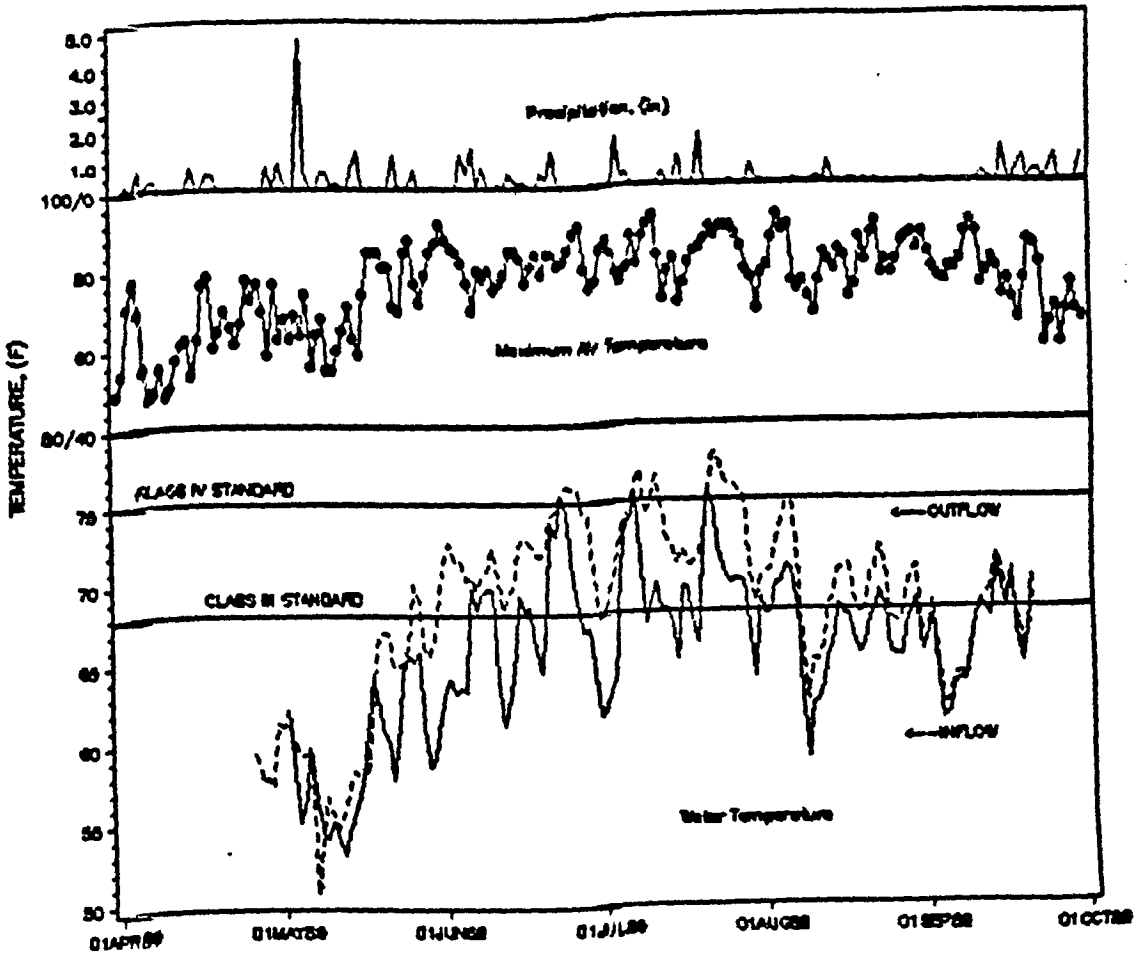

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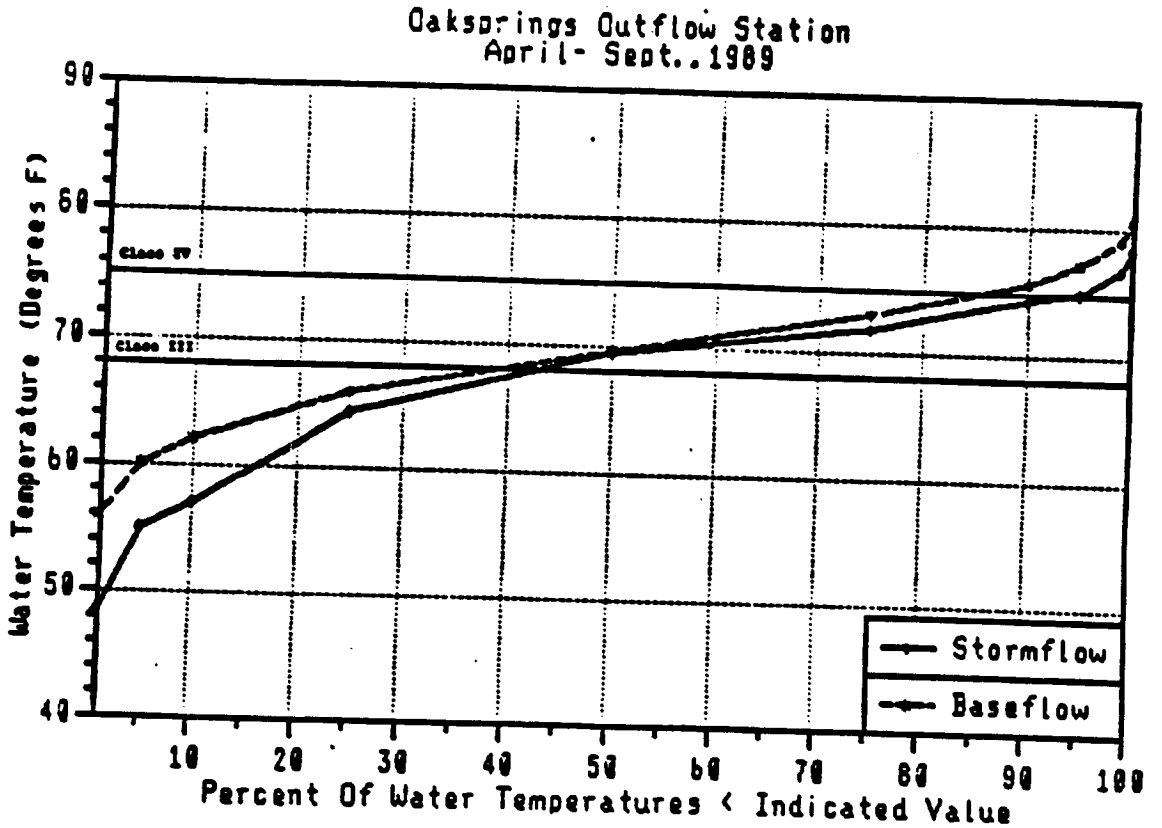
FIGURE 26

ARTIFICIAL WETLAND TEMPERATURE STANDARD PERFORMANCE: BASEFLOW VERSUS STORMFLOW CONDITIONS



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respectively. In contrast, under stormflow conditions, outflow station temperatures exceeded these standards 57 and 5 percent of the time, respectively (Figure 27 and Table 9).

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FIGURE 27

ARTIFICIAL WETLAND INFLOW-OUTFLOW TEMPERATURE RELATIONSHIP DURING STORMFLOW

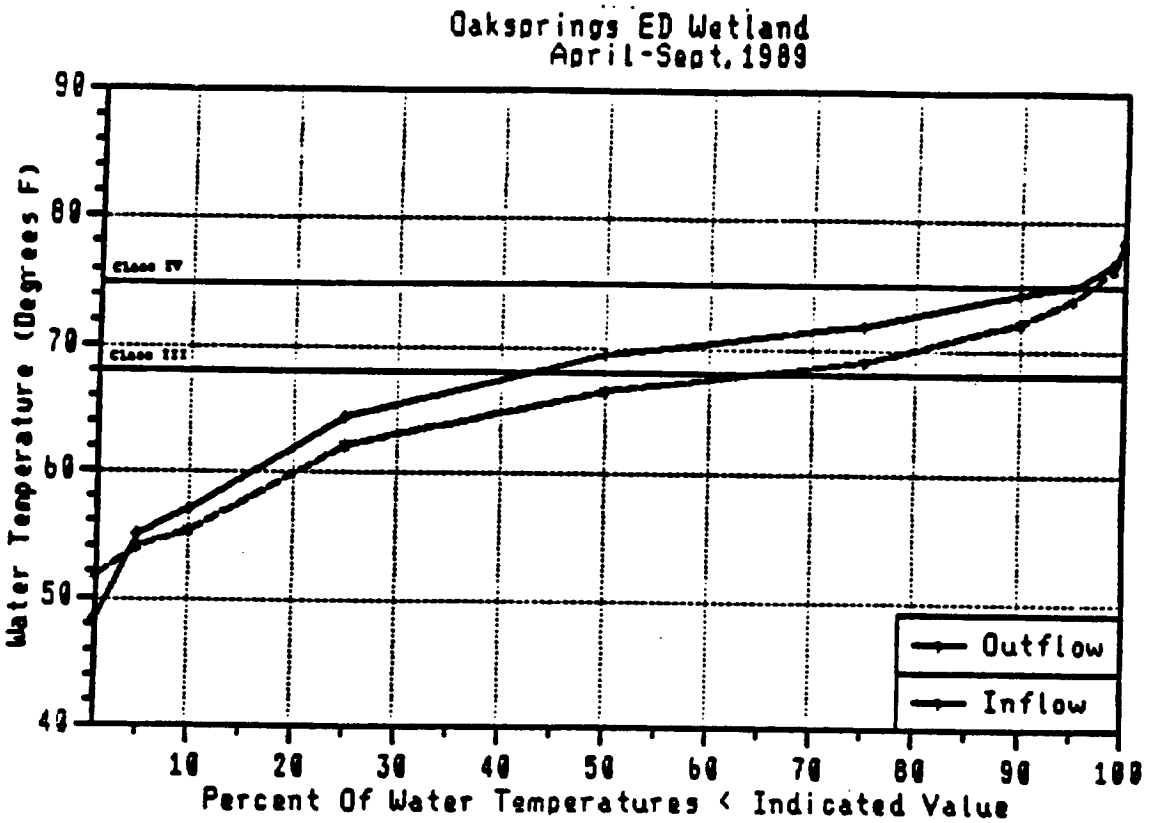

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Table 9
Summary: Oaksprings ED Wetland Performance, April - Sept., 1989

Percent of Water Temperatures ≤ Indicated Value (%)	Temperature(°F) Baseflow Inflow	Baseflow Outflow	Stormflow Inflow	Stormflow Outflow
0 (minimum)	50.0	52.9	50.9	44.8
1	55.2	56.1	51.8	48.4
5	58.5	60.1	54.1	55.0
10	60.3	62.2	55.4	57.0
25	63.1	66.0	62.1	64.4
50 (median)	66.2	69.6	66.6	69.4
75	69.1	73.0	68.9	71.8
90	71.1	75.7	72.1	74.5
95	72.5	77.2	73.9	75.0
99	77.4	79.2	76.3	76.8
100 (maximum)	80.2	80.8	78.1	78.4

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Tanglewood ED Dry Pond

As previously noted, the Tanglewood ED dry pond had both high maximum Delta-T temperatures and a high percentage of MDE Class III temperature standard violations. In addition, maximum outflow water temperatures associated with this facility were second only to those of the Countryside wet pond. The general performance of this BMP under both baseflow-stormflow and inflow versus outflow scenarios are presented in Figures 28-31. Major findings are described below and are additionally summarized in Tables 10 and 11.

1. The maximum Delta-T produced by this BMP was higher under stormflow conditions (11.2°F) than under baseflow conditions (9.7°F). The higher stormflow Delta-T's were the product of: a) the inflow of relatively warm stormwater runoff into the facility, b) pilot channel heat contributions, and c) additional heating of detained waters via solar radiation. In addition, the highest Delta-T's were noted during warm weather.

2. The Tanglewood outflow station had large daily Delta-T temperature swings, which were amplified by the BMP. Over the course of the monitoring period, average diurnal Delta-T temperature fluctuations at the inflow and outflow stations were, respectively, 3.6°F and 5.6°F. The generally wider daily Delta-T temperature range observed at the outfall station was largely the result of water being heated

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by its passage through the pond's partially shaded pilot channel. It should also be noted that, of the four BMP outflow stations monitored, the Tanglewood station's diurnal temperature flux was consistently the highest.

3. During the study COG staff observed, on three separate occasions, evidence of impounded stormwater within the Tanglewood facility. However, it appeared that runoff from most small storm events either was not detained, or detained for only very brief periods of time. Examination of the outflow station diurnal temperature response during and after storm events, did not reveal obvious extended detention effects.

4. Under baseflow conditions, this BMP's partially shaded pilot channel had an average positive stream Delta-T effect of 3.7°F.

Baseflow Versus Stormflow Delta-T's

Under baseflow conditions, the Tanglewood ED dry pond had both an average and maximum positive Delta-T effect of 5.5 and 9.7°F, respectively. In general, maximum baseflow and stormflow Delta-T's coincided with warm air periods (Figure 28).

Stormflow Delta-T's were generally higher than baseflow Delta-T's approximately 25 percent of the time (Table 10). Average and maximum stormflow Delta-T's for the ED dry pond were 5.2 and 11.2°F, respectively. The 11.2 °F maximum stormflow Delta-T observed at this BMP site occurred

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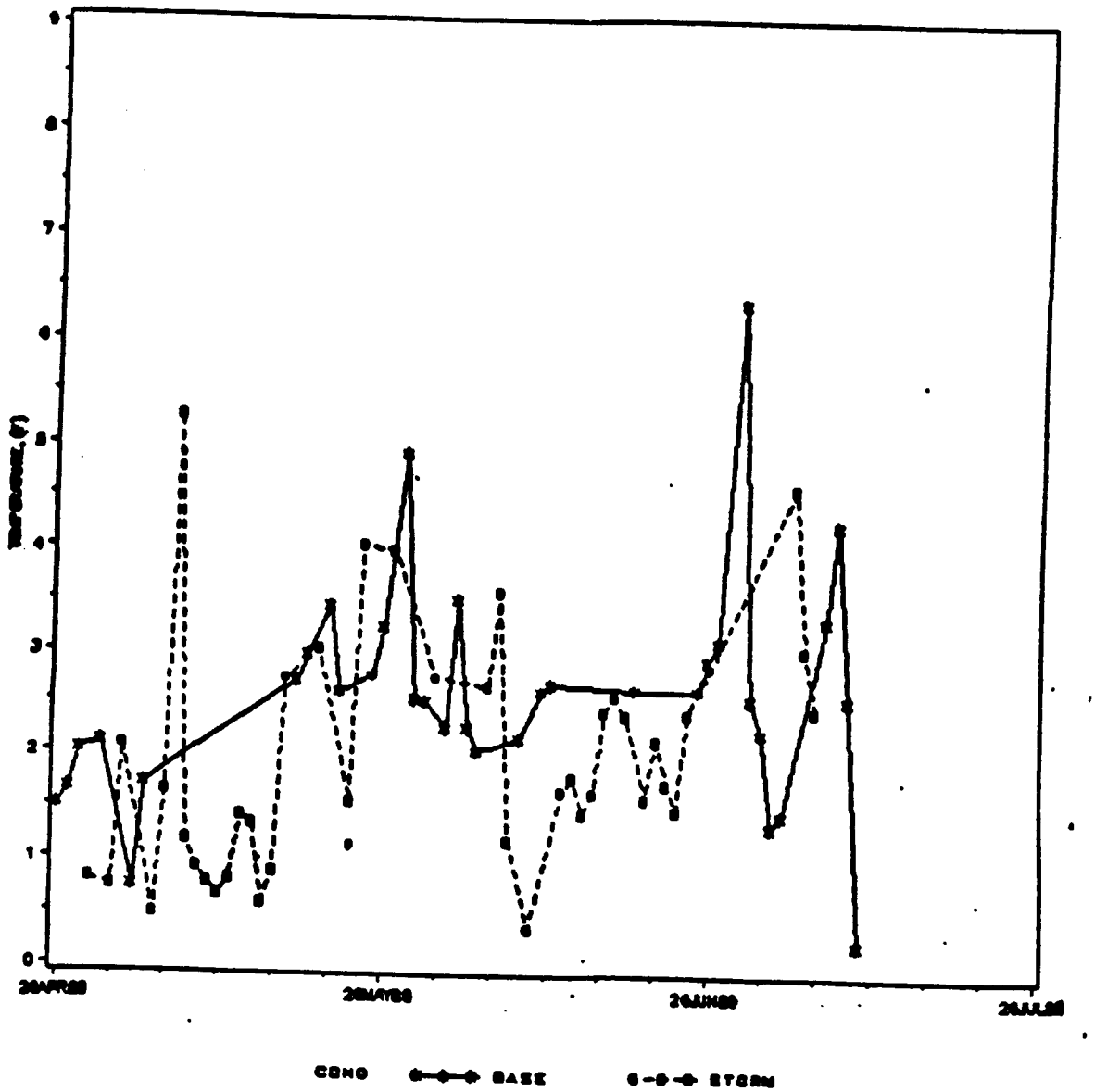
FIGURE 28

EXTENDED DETENTION DRY POND THERMAL CHARACTERIZATION: BASEFLOW VERSUS STORMFLOW DELTA-T'S *



*Values shown are daily mean Delta-T's

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Table 10 Summary: Tanglewood ED Dry Pond Delta-T's

Percent of Temperatures < Indicated Value	Delta-T(°F) Baseflow	Stormflow	Total
0 (minimum)	2.3	1.4	1.4
1	2.3	1.4	1.4
5	2.4	1.5	1.5
10	2.6	1.9	1.9
25	3.2	2.5	3.1
50 (median)	6.1	5.3	5.9
75	7.0	7.3	7.1
90	8.0	8.6	8.6
95	8.6	9.8	9.7
99	9.7	10.9	10.9
100 (maximum)	9.7	11.2	10.9

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during a warm air period which included 0.52 inches of precipitation.

Temperature Standard Performance

Outflow station temperatures (Figure 29 and Table 11) were, under stormflow conditions, slightly higher than baseflow temperatures 20 percent of the time. In addition, the frequency of MDE Class III and IV water temperature standard violations was similar under both flow scenarios. Stormflow outfall temperatures violated Class III and IV standards 48 and 15 percent of the time, respectively. The same standards, under baseflow conditions were exceeded 50 and 10 percent of the time, respectively.

Among the more revealing findings (Figure 30) was that 99 percent of all Tanglewood outflow station temperatures were, under stormflow conditions, warmer than inflow station temperatures. Examination of these two stations, under baseflow conditions, yielded similar results. As seen in Table 11, stormflow outflow station temperatures ranged from 0.0 - 5.8°F higher than inflow temperatures.

A comparison of inflow versus outflow station temperatures, under stormflow conditions (Figure 30), revealed that inflow temperatures violated Class III and IV temperature standards 25 and 1 percent of the time. In contrast, Tanglewood outflow station temperatures violated the same standards 50 and 10 percent of the time, respectively. Outflow station temperature profiles did not exhibit signs of artificially produced periods of prolonged temperature elevation, reduction, or stasis. In fact, outflow temperature profiles closely paralleled those of the inflow station. The

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FIGURE 29

EXTENDED DETENTION DRY POND TEMPERATURE STANDARD PERFORMANCE: BASEFLOW VERSUS STORMFLOW CONDITIONS

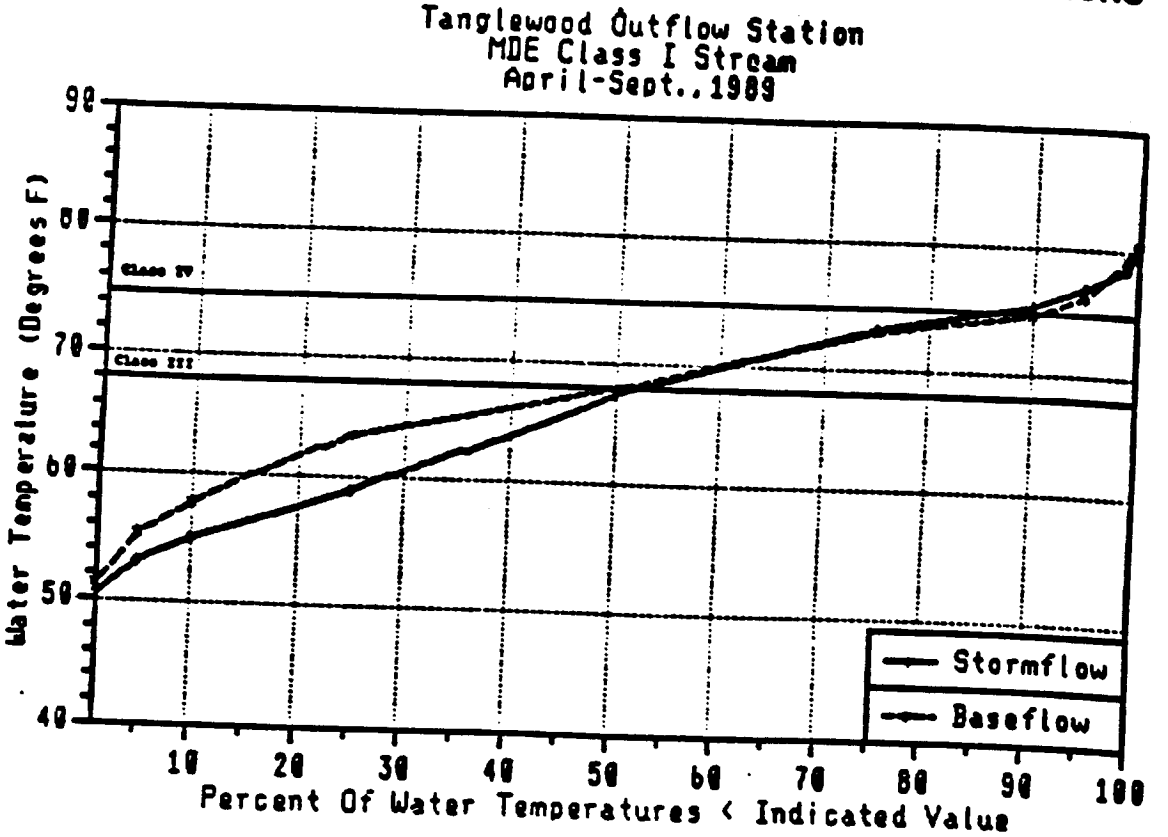

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Table 11 Summary: Tanglewood ED Dry Pond Performance, April - Sept., 1989

Percent of Water Temperatures ≤ Indicated Value (%)	Temperature(°F) Baseflow Inflow	Baseflow Outflow	Stormflow Inflow	Stormflow Outflow
0 (minimum)	49.6	48.6	48.9	49.1
1	51.6	51.4	50.5	50.5
5	54.1	55.4	52.0	53.2
10	55.9	57.9	53.2	55.0
25	59.7	63.9	56.5	59.0
50 (median)	65.5	68.0	63.9	67.5
75	68.1	72.9	68.2	73.2
90	70.2	74.7	70.3	75.3
95	71.1	76.3	71.2	76.9
99	72.3	79.2	72.7	78.5
100 (maximum)	80.8	81.9	80.4	80.4

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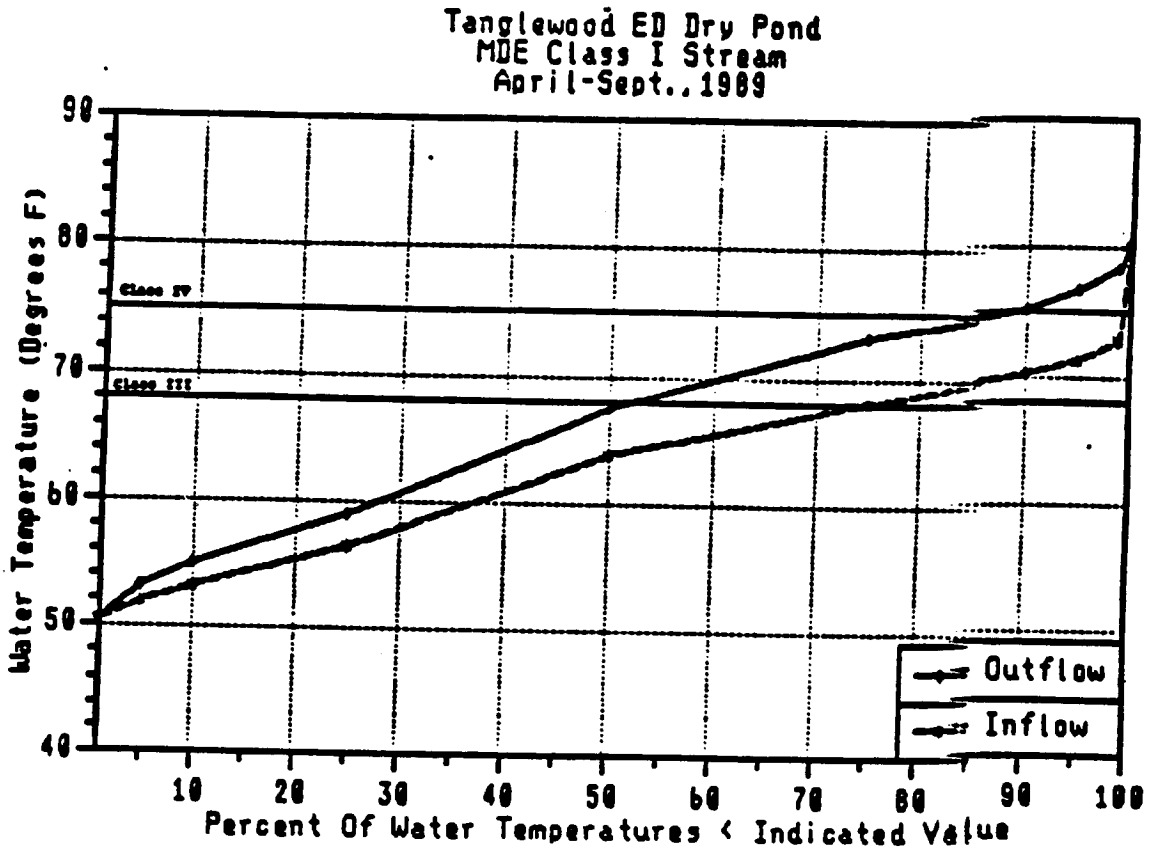
FIGURE 30

EXTENDED DETENTION DRY POND INFLOW-OUTFLOW TEMPERATURE RELATIONSHIP DURING STORMFLOW



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general trends in April - July, 1989 maximum air temperature, precipitation, and Tanglewood inflow-outflow water temperatures are graphically summarized in Figure 31.

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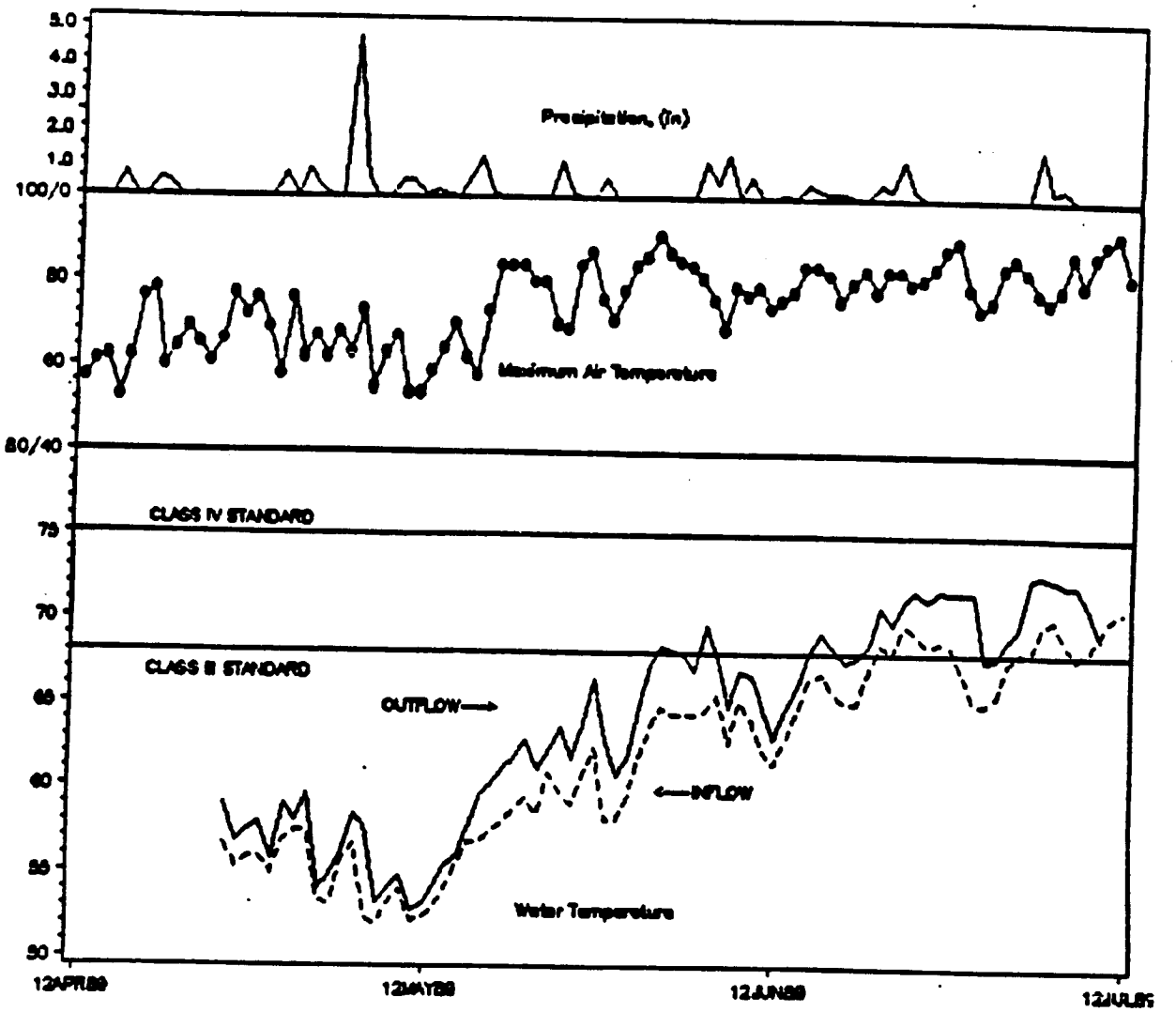
FIGURE 31

GENERAL RELATIONSHIP BETWEEN MAXIMUM AIR TEMPERATURE, WATER TEMPERATURE AND PRECIPITATION: TANGLEWOOD ED DRY POND, APRIL-JULY, 1989



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Countryside Wet Pond

Shallow, surface release impoundments are often credited with raising, especially during the warmer months of the year, the water temperature of small receiving streams. During summer months it is not unusual to see the surface water temperature of lakes and ponds in the Middle-Atlantic States occasionally hovering near the 90°F mark. This is particularly the case during extended hot weather periods and/or for small, shallow ponds which are heavily sheltered from the mixing-effect of the wind.

While much of the study period was cooler than normal, the Countryside outflow station proved to be the warmest of the four BMP outflow stations monitored. The general performance of this eight foot-deep, surface release wet pond under both baseflow-stormflow and inflow versus outflow conditions is graphically summarized in Figures 32-35. Significant findings from both the grab sampling and automated monitoring portions of the study are discussed below and additionally summarized in Tables 12-14.

1. The wet pond's large permanent pool served as an effective heat regulator. In general, the pond had a major warming effect on baseflow temperatures. However, during most storm events, the pond depressed the already elevated outflow station temperatures.

2. Delta-T baseflow temperatures at the Countryside wet pond were higher than stormflow Delta-T's 99 percent of the time. The average

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baseflow Delta-T (9.7°F) was slightly higher than the average stormflow Delta-T (8.5°F). As previously noted, the pond's rip-rap outflow channel produced an average positive Delta-T increase of 2.0°F.

3. The average June - August, 1989 grab sampling surface water temperature in the Countryside pond was 77.8°F. This temperature was 3.6°F higher than the average temperature recorded, during the same period, in the Oaksprings wetland. The higher summer water temperatures associated with the wet pond are primarily a function of its larger permanent pool volume. The larger volume of water resulted in the Countryside pond storing and releasing heat from solar radiation more slowly; thus making it less responsive to air temperature fluctuations. Consequently, wet pond water temperatures remained generally higher throughout the summer (Table 12). In addition, the larger permanent pool volume resulted in the pond being noticeably slower to cool-down in late summer/early fall.

4. The maximum Countryside outflow station temperature, under stormflow conditions was 82.6°F. This temperature was only 1.3°F higher than the maximum outflow temperature recorded under base flow conditions (81.3°F). It should also be noted that the maximum surface water temperature observed in the pond during the grab sampling portion of the study was 86.9°F.

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Table 12 Countryside Wet Pond Versus Oaksprings Wetland Surface Water Temperatures(°F), June - October, 1989

Month	Average Surface Temperature(°F)[1/]			
	Date	Countryside Wet Pond	Date	Oaksprings Wetland
6	15	78.4	15	70.7
	21	76.7	20	73.9
	27	86.3	27	77.4
7	6	75.3	5	75.2
	11	74.0	11	80.6
	20	76.4	13	75.2
	25	73.1	21	75.2
			26	79.3
8	2	80.6	1	69.5
	9	77.7	9	68.3
	16	76.3	17	73.0
	22	80.9	22	72.4
9	1	77.5	1	73.0
	7	72.4	7	68.9
	14	79.2	14	73.7
	20	73.0	20	67.6
	29	66.2	29	55.0
10	6	62.3	6	55.4
	13	60.8	13	51.8
	20	55.1	18	61.3

[1/]Water temperatures were measured at 2 or more locations at each BMP site.

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Baseflow Versus Stormflow Delta-T's

As seen in both Figure 32 and Table 13, under baseflow conditions the wet pond raised outflow station temperatures an average 9.7°F. Not surprisingly, the maximum baseflow Delta-T (15.1°F) occurred during one of the warmest periods of the study (i.e., late June - early July). By the end of the automated monitoring period (September 20, 1989), maximum baseflow Delta-T's had declined to around 8.0°F.

Both baseflow and stormflow Delta-T's were always positive during the study. However, stormflow Delta-T's were smaller than baseflow Delta-T's approximately 99 percent of the time. This indicates that most storm events lowered both pond and outflow station temperatures. Most likely, the temperature reductions were caused by cool air temperatures and/or an influx of stormwater runoff (whose temperature was lower than ambient pond temperatures). The average and maximum stormflow Delta-T's during the study were 8.5 and 14.0°F, respectively.

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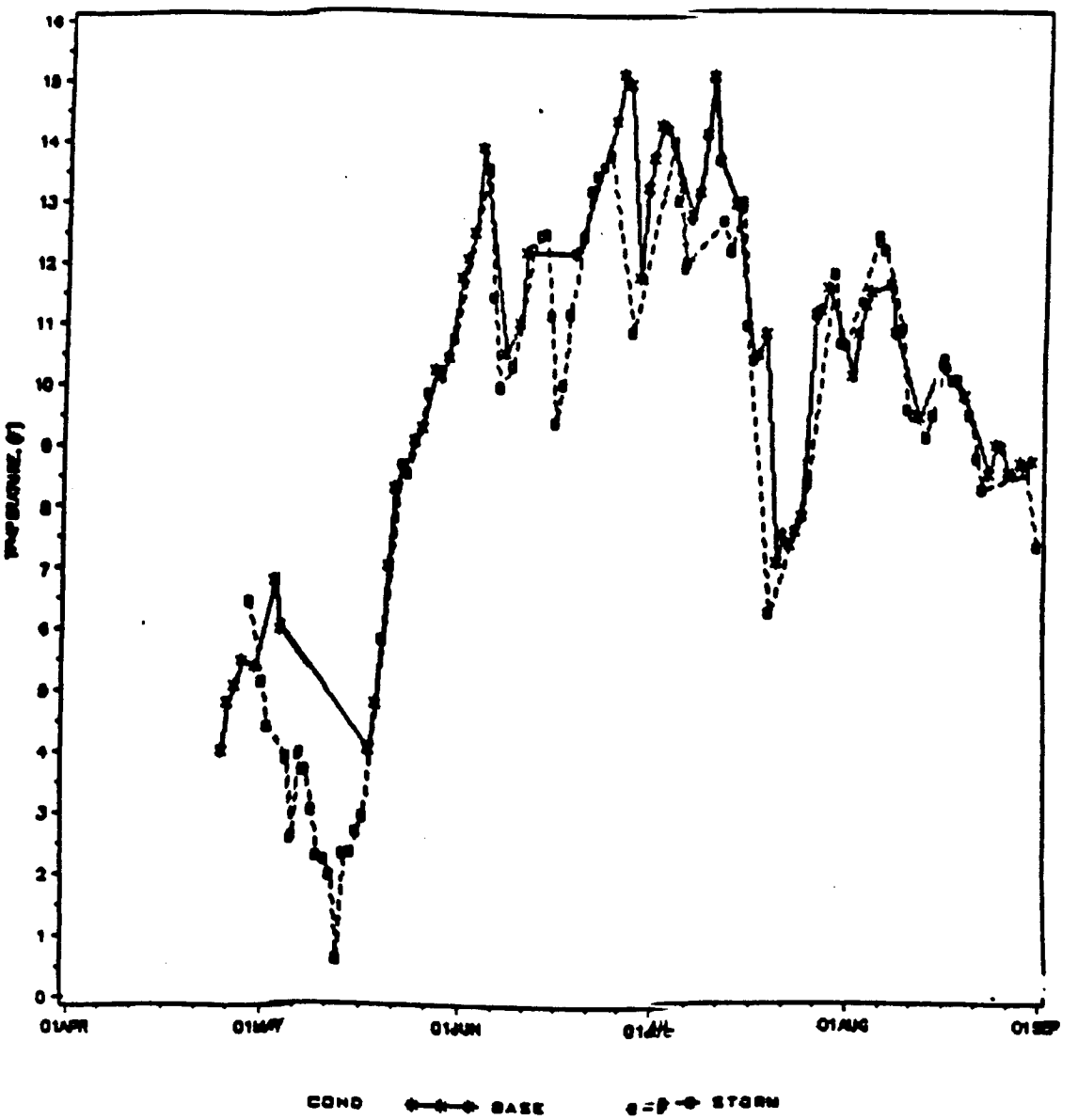
FIGURE 32

WET POND THERMAL CHARACTERIZATION:
BASEFLOW VERSUS STORMFLOW DELTA-T'S *



*Values shown are daily mean Delta-T's

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Table 13 Summary: Countryside Wet Pond Delta-T's

Percent of Temperatures < Indicated Value	Delta-T(°F) Baseflow	Stormflow	Total
0 (minimum)	4.0	0.6	0.6
1	4.0	0.6	1.3
5	4.8	2.2	2.6
10	6.0	2.6	4.0
25	7.3	5.7	6.7
50 (median)	9.6	9.5	9.5
75	11.8	11.7	11.8
90	13.9	13.0	13.4
95	14.4	13.6	14.1
99	15.1	14.0	15.1
100 (maximum)	15.1	14.0	15.1

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Temperature Standard Performance

Under stormflow conditions (Figure 33), Countryside outflow station temperatures were typically 0.5 - 5.9°F lower than under baseflow conditions. In addition, both MDE Class III and IV temperature standards were more frequently exceeded under baseflow conditions. Outflow station temperatures violated Class III and IV temperature standards (under baseflow and stormflow conditions) 77 and 35 percent, and 64 and 25 percent of the time, respectively.

Outflow station temperatures (under stormflow conditions) were higher than inflow station temperatures 100 percent of the time. As seen in Figure 34, the much cooler Countryside inflow station (under stormflow conditions) violated Class III and IV temperature standards 10 and 1 percent of the time, respectively. The median outflow station temperature under both baseflow and stormflow conditions (Table 14) was approximately 11.0°F higher than the median inflow station temperatures.

Examination of the water temperature data also revealed that the maximum stormflow outflow station temperature occurred on a date (August 6, 1989) in which a maximum of only 0.05 inches of rain fell in the vicinity of the Countryside pond. Additional review of air temperature data indicated that this maximum outflow water temperature coincided with a warm to hot air temperature period.

During this warm air period, maximum air temperatures ranged between 86

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FIGURE 33

WET POND TEMPERATURE STANDARD PERFORMANCE: BASEFLOW VERSUS STORMFLOW CONDITIONS

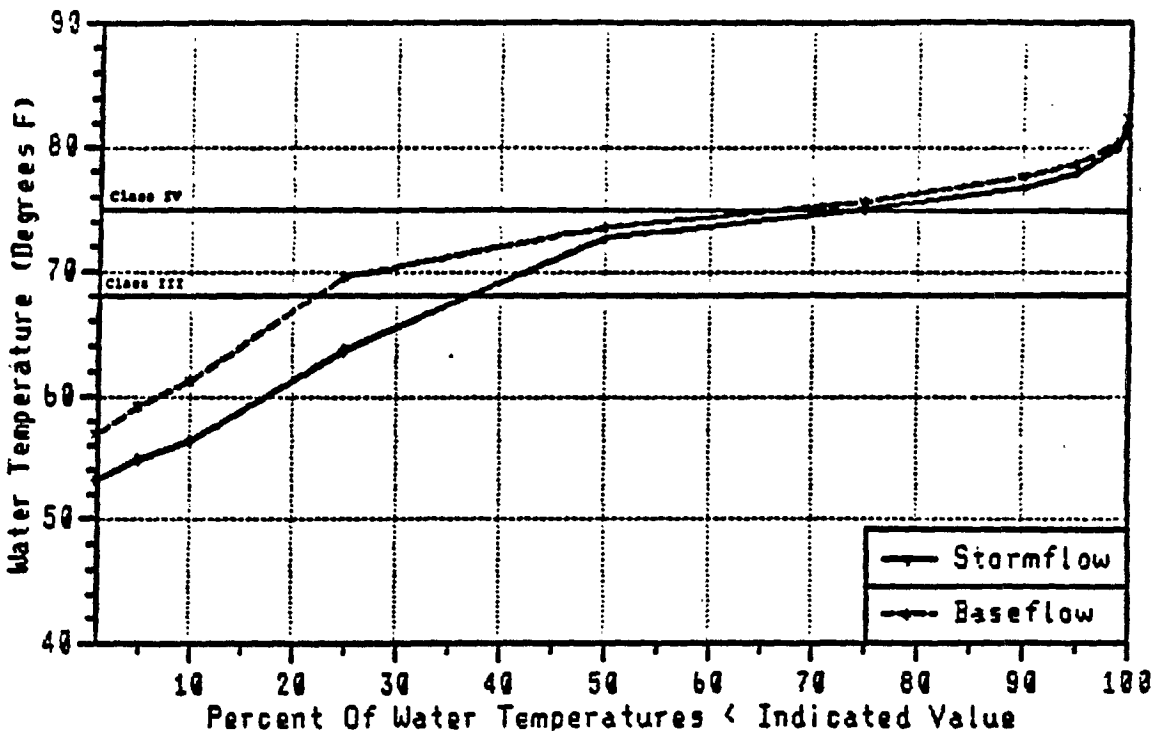

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FIGURE 34

WET POND INFLOW-OUTFLOW TEMPERATURE RELATIONSHIP DURING STORMFLOW

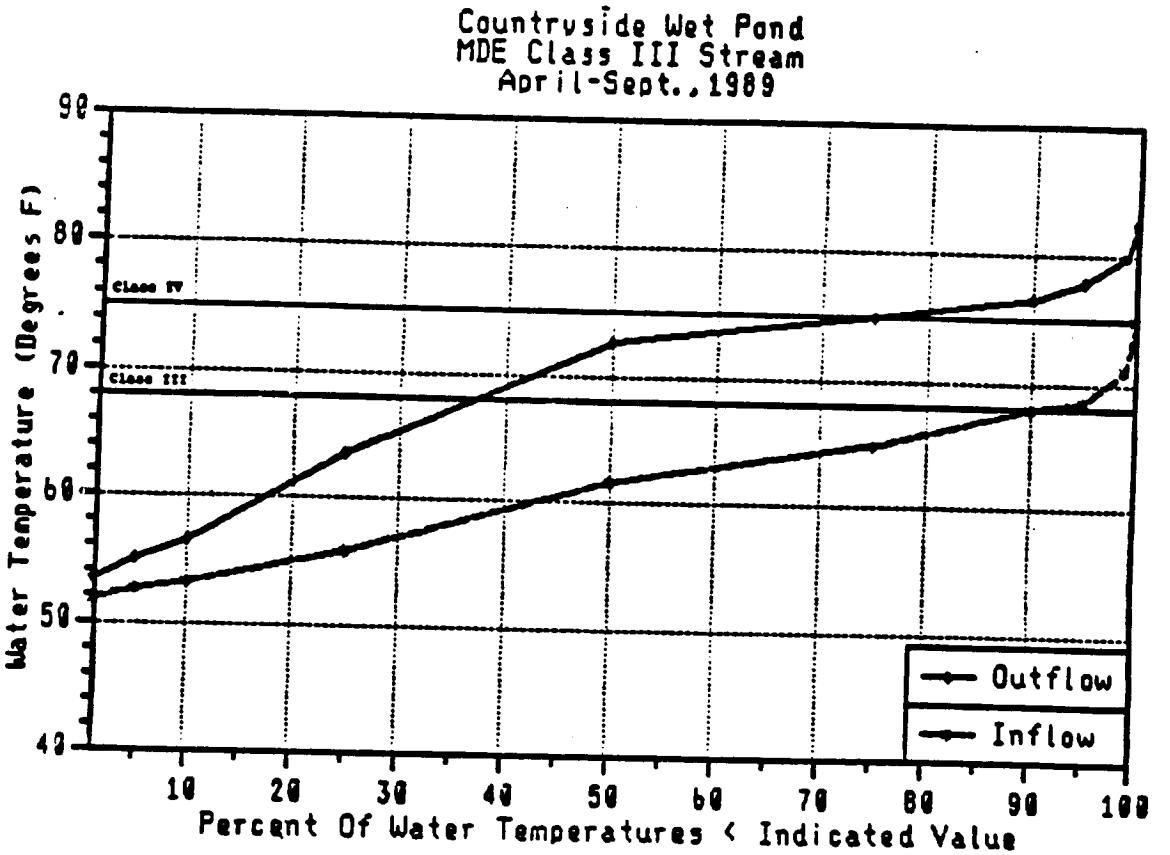

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Table 14 Summary: Countryside Wet Pond Performance, April - Sept., 1989

Percent of Water Temperatures ≤ Indicated Value (%)	Temperature (°F)			
	Baseflow		Stormflow	
	Inflow	Outflow	Inflow	Outflow
0 (minimum)	47.7	55.9	49.6	50.5
1	50.0	57.0	52.0	53.4
5	54.1	59.2	52.7	55.0
10	55.0	61.3	53.2	56.3
25	58.6	69.6	55.8	63.7
50 (median)	63.0	73.8	61.7	72.7
75	66.7	75.9	64.9	75.0
90	68.4	77.7	68.0	76.8
95	69.1	78.6	68.5	77.9
99	70.2	80.4	71.1	79.9
100 (maximum)	70.7	81.3	77.9	82.6

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and 92°F for four straight days. Therefore, in all likelihood the 82.6°F outflow station temperatures was the result of high air temperatures raising pond water temperatures, rather than a discharge of warm stormwater runoff-pond spillover.

2. Example of Summer Thunderstorm Effect

Thermograph thermometer results indicated that the Countryside inflow station exceeded the 75°F Class IV temperature standard on only one occasion. The violation, which occurred on July 26, 1989 (Figure 35), coincided with an intense afternoon thunderstorm. During this storm event, water temperatures at the inflow station rose 9.0°F within two hours, to a high of 77.9°F. The principal factors which are thought to have contributed to this high stream temperature are briefly outlined below:

- The high stream temperature occurred on a date in which the air temperature in the study area was a hot, 91°F. In addition, five consecutive warm days and nights preceded the storm date. Average daily high and low air temperatures during this five-day period were 88.0 and 72.2°F, respectively. As seen in Figure 35, stream temperatures during the same period responded to the warm air temperatures by also becoming warmer. It is also quite probable that ground temperatures responded in an analogous fashion.

- While only a trace amount of rainfall was reported at the Glenmont, MD weather station, intense local thunderstorms were reported in the

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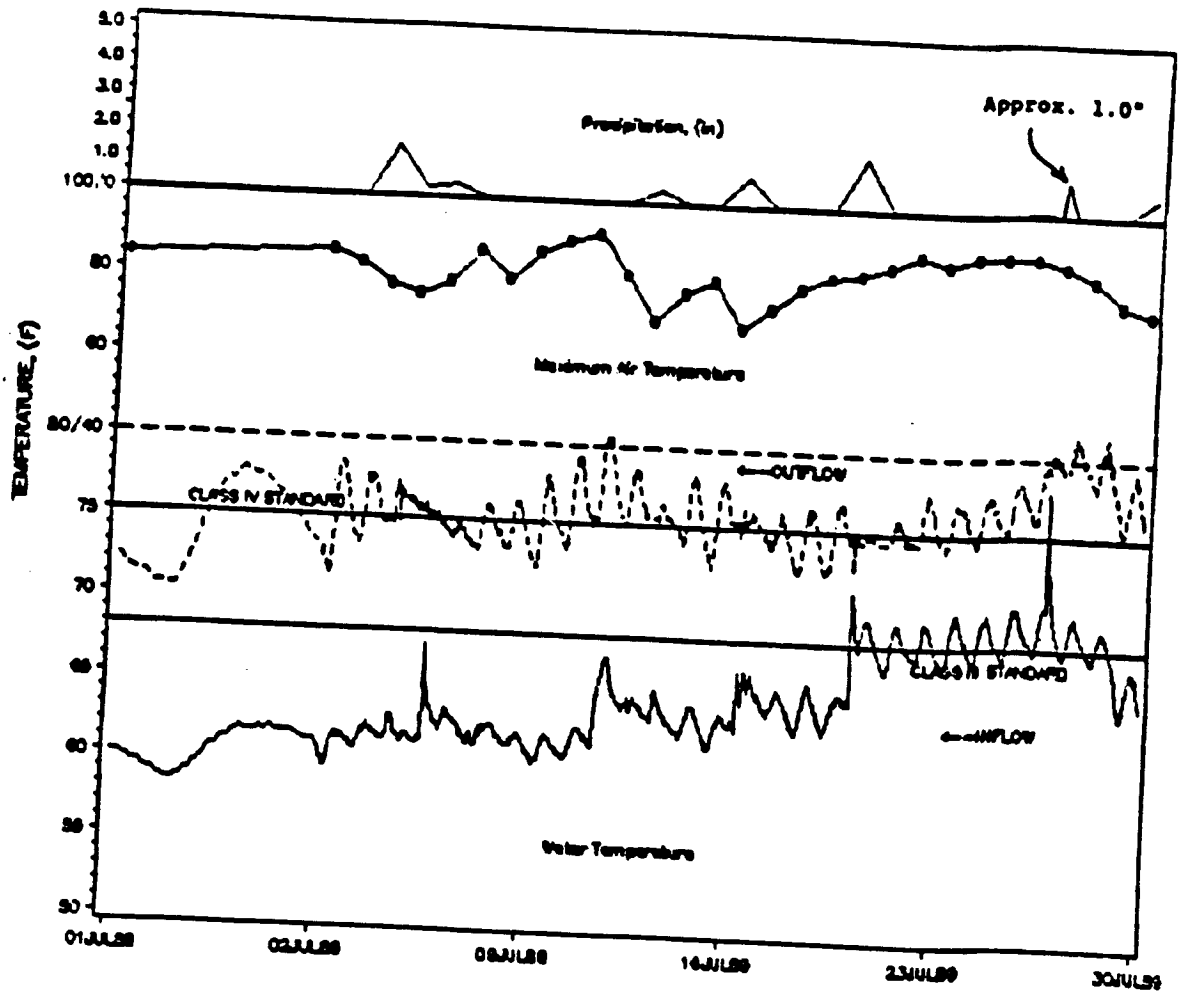
FIGURE 35

GENERAL RELATIONSHIP BETWEEN MAXIMUM AIR TEMPERATURE, PRECIPITATION AND WATER TEMPERATURE: COUNTRYSIDE WET POND, JULY, 1989



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vicinity of the Countryside pond. Reports from Messrs. Friedman and Swanson, two independent NOAA weather reporters whose stations are both located approximately 1.5 miles from the pond site, indicated that between 0.70 and 1.28 inches of precipitation was associated with this 5:00 - 7:00 p.m. storm. Thus, significant volumes of stormwater runoff were quickly generated from the 12 percent impervious catchment area.

- In a recent study of a small, urban Maryland stream system, Galli (1988), reported that the temperature of stormwater runoff during hot weather periods can exceed 84°F. The study also noted that even after 55 minutes of steady rain from a 1.0 inch storm the temperature of stormwater runoff did not decrease substantially. As such, large quantities of warm stormwater runoff would have been expected to have been generated from the residential and commercial portions of the Countryside subwatershed.

- Baseflow at the Countryside inflow station was, on July 25th, only 0.16 cfs. This flow, which was approximately one-third below the station's average discharge of 0.25 cfs, would have comprised a minor portion of the total stream flow during the July 26th storm event.

Although a large number of the storm events which took place during the study had an overall cooling effect on stream temperatures, the preceding result demonstrates that moderately-sized rainfall events which occur during hot weather periods are capable of markedly increasing the temperature of small, lightly developed urban streams.

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3. Thermal Loading As A Function of Flow Ratio

It has already been shown that the introduction of large quantities of stormwater runoff into small, urban headwater streams, can under certain meteorological conditions, sharply alter normal diurnal stream temperature patterns. For instance, the mixing of relatively large quantities of stormwater runoff with baseflow on July 26 and 27, 1989, quickly raised stream temperatures 9.0°F and 5.8°F, respectively, at the Countryside inflow and Lower White Oak stations. According to Pluhowski (1970), the impact of stormwater runoff on receiving stream temperature patterns increases as the ratio of runoff to total streamflow increases.

To test the validity of this theory, COG staff examined the effect of thermal discharges from the Oaksprings artificial wetland on the Delta-T temperature response of the Gum Springs tributary. Water temperature and stream discharge grab sampling data collected from the Lower Oaksprings, Upper Gum Springs, and Gum Springs stations, were used to perform a simple linear regression of thermal loading versus flow ratio. In this test, the Upper Gum Springs station served as the reference station against which Delta-T temperature responses at the more downstream Gum Springs station were calculated. Data from a total of 10 separate sampling dates, collected between June - October, 1989 were used in the regression calculation. It is further noted that seven of these sampling dates were under the influence of stormwater discharge from the Oaksprings wetland.

Results from the analysis revealed that a distinct linear relationship exists between the Delta-T temperature response of the Gum Springs tributary

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and the flow ratio of the two streams. An approximation of the thermal response of the Gum Springs tributary to different Oaksprings tributary outflow conditions can be made from the following equation:

Gum Springs Delta-T(^{o}F) = 0.27 + 2.81(Flow Ratio)(between Gum Springs & Oaksprings tributary)
(thermal response)

The least squares linear regression yielded a correlation coefficient (r2), adjusted for degrees of freedom, of 0.63; indicating a moderately strong general relationship between water temperature response and flow ratio. Although the predicted Delta-T temperature increases were somewhat lower than observed Gum Springs values, both supported the previously stated findings of Pluhowski, (1970).

As seen in Figure 36, when the Oaksprings-Gum Springs tributary flow ratio is 1:1, a 3.0^{o}F Gum Springs Delta-T increase would be expected. At a 2:1 flow ratio, the expected Delta-T increase is doubled to 6.0^{o}F. The preceding results demonstrate that the potential thermal impact of stormwater runoff on receiving streams increases as the runoff (Q_{in}) to receiving stream flow (Q_{r}) ratio increases.

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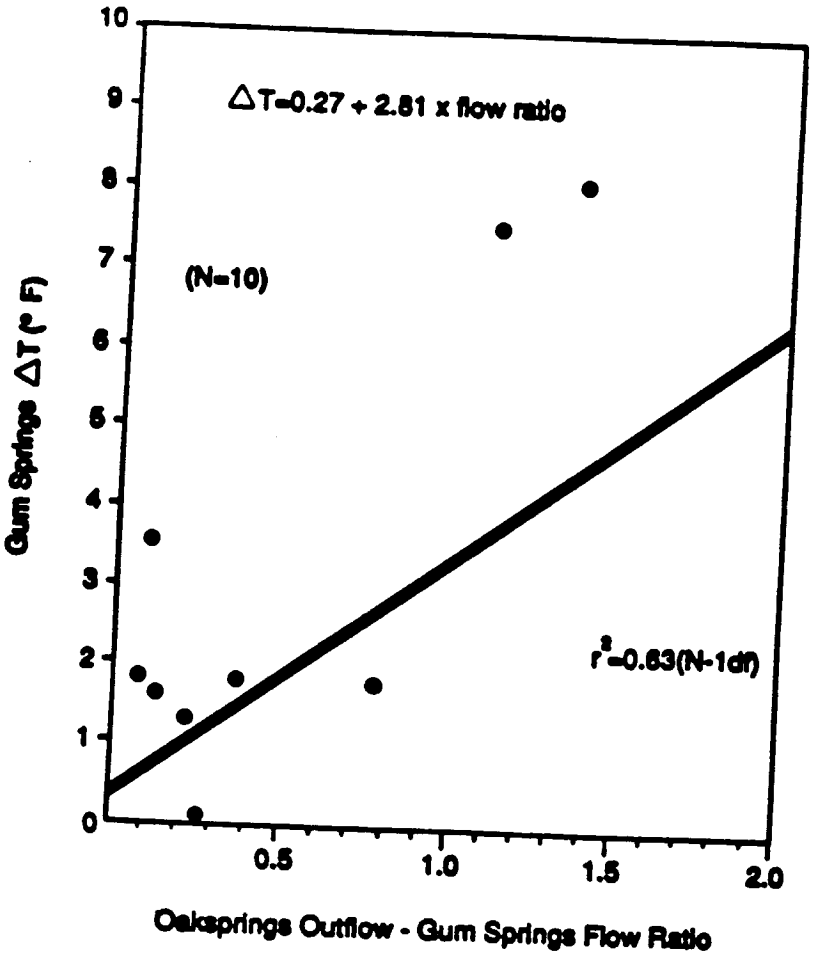
FIGURE 36

THERMAL LOADING AS A FUNCTION OF RUNOFF TO RECEIVING STREAM FLOW RATIO



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4. Stormwater Management Design Elements Which Add To Thermal Load

During the grab sampling portion of the study it became very clear that basic BMP facility design elements, such an inflow - outflow channels can add measurably to downstream thermal loading. This is particularly the case when these conveyance channels are unshaded, heavily rip-rapped, or both. Major findings from two BMP test sites, Tanglewood ED dry pond and Countryside wet pond, are described in detail in the following sections.

Tanglewood Pilot Channel

One of the noteworthy features of the Tanglewood facility is its rather long, flat pilot channel. Both base and storm flows are carried by the 4 - 8 foot wide x 500 foot long rip-rapped channel. As depicted in Figure 37, the pilot channel is partially shaded along its length by a narrow strip of 8 - 12 foot high black willow (Salix nigra) trees. Approximately 175 feet of the channel is open and only marginally shaded by herbaceous vegetation. The lack of adequate shading along the channel results in a net mean baseflow Delta-T increase of almost 4.0°F at the riser. Although a slight decrease in mean baseflow temperature occurred as water flowed through the 60 foot long, 48 inch diameter RCP barrel, lower Tanglewood tributary baseflow temperatures remained elevated (even after flowing through 800 feet of forested buffer).

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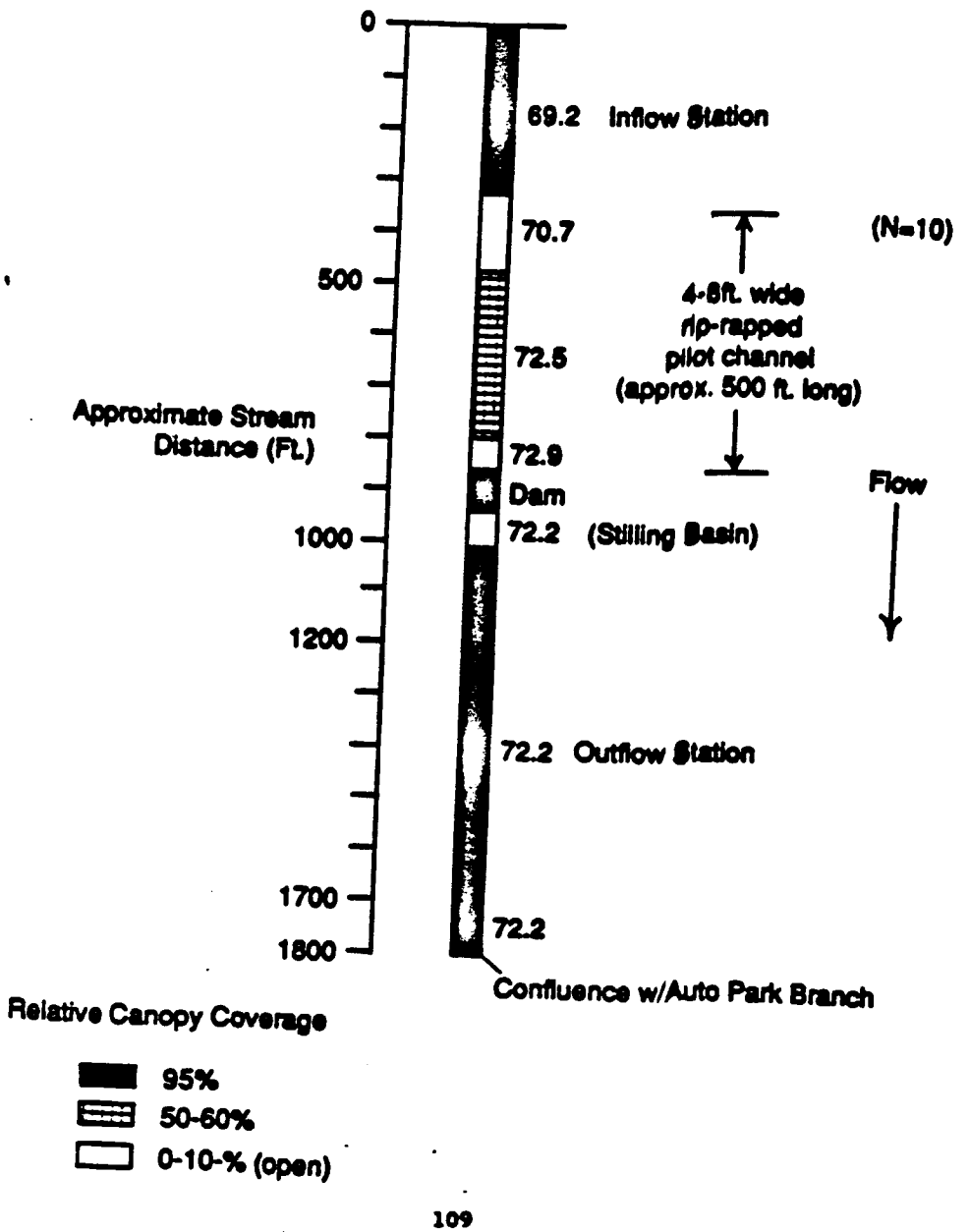
Figure 37

Effect of Partially Shaded Pilot Channel on Tanglewood ED Dry Pond Mean Baseflow Temperature(° F) (June-August, 1989)



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Countryside Barrel - Outflow Channel Temperature Relationship

The Countryside wet pond features a 60 foot long, 72 inch diameter RCP barrel which discharges into a 75 foot long by 30 foot wide rip-rap outflow channel. This unshaded, trapezoidal shaped channel has a bottom width of approximately 12 feet. Under normal conditions, baseflow completely fills the bottom of the rock strewn channel. The average depth of flow, under baseflow conditions, is approximately 1 - 3 inches.

Both the length and unshaded nature of the outflow channel raised COG staff's suspicions that it may have been additionally increasing downstream water temperatures. Grab sampling results (Table 15) revealed that mean baseflow temperatures were raised as much as 8.5°F after flowing through the outflow channel. On average, a 2.0°F Delta-T increase was produced by the combination of lack of shade, shallow depth of flow, and presence of large, heat absorbing rip-rap associated with this channel.

It should also be noted that, on one occasion, a Delta-T decrease of 9.9°F was observed between pond waters (at the dam) and flow at the end of the barrel. The average Delta-T temperature difference between these two locations was a negative 3.3°F. Based on limited sampling results, it appears that the 10 foot fall of water between the pond's eight inch diameter pipe outlet and invert of the riser, together with cool barrel and air temperatures in these structures, were responsible (through convection and conduction forces) for the temperature decrease.

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Table 15 Countryside Wet Pond Outflow Channel Temperature Study

June - August 1989

GRAB SAMPLE LOCATION	SAMPLE SIZE	WATER TEMPERATURE (degrees F) MAX	MIN	MEAN	MAX OBSERVED TEMP INCREASE
End of 72" RCP barrel	10	76.6	71.2	74.1	-
End of 75' rip-rap outfall channel	9	79.7	72.5	76.1	+ 8.5

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Summary

Results from the study indicated that all four of the BMP facilities had positive average total Delta-T's and each violated MDE Class III and IV temperature standards some of the time. Wet permanent pools, long periods of extended detention, and poorly shaded pilot and outflow channels contributed greatly to the problem. The thermal performance of each BMP is summarized in Table 16. Specific findings are presented below.

1. Infiltration-Dry pond

- Of the four BMP's, the infiltration-dry pond produced the smallest Delta-T increases (Table 16). The infiltration trench portion of the BMP, designed for 0.25 inches of street runoff, worked well during small storms. However, large storm events (i.e., $\geq$ 1.0 inches precipitation) and/or 2 - 3 consecutive days of moderate rainfall generally overtaxed the capacity of the infiltration trench system. This often resulted in the ponding of several feet of runoff in the dry pond area. The facility's defacto extended detention control combined with high incoming solar radiation on the unshaded rip-rap pilot channel, storage pool, and outfall area, produced a 4.0°F Delta-T increase.

- From a water temperature standards perspective, this BMP had the lowest frequency of Class III (68.0°F) and IV (75.0°F) violations (Table 16). Standards violations were more frequently associated with stormflow conditions. The BMP's single Class IV violation was

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Table 16

Summary: BMP Temperature Performance1/

Parameter	BMP Type: Infiltration-Dry Pond	Extended Detention Wetland	Extended Detention Dry Pond	Wet Pond
Average Baseflow Delta-T (°F)	2.6	3.9	5.5	9.7
Maximum Baseflow Delta-T (°F)	7.6	8.7	9.7	15.1
Average Stormflow Delta-T (°F)	2.3	2.4	5.2	8.5
Maximum Stormflow Delta-T (°F)	5.0	7.0	11.2	14.0
Average Total Delta-T (°F)	2.5	3.2	5.3	1.1
Maximum Total Delta-T (°F)	7.6	8.7	10.9	9.1
Percent Baseflow Violation of MDE Temperature Stds. - Class III (68°F)	8	60	50	77
- Class IV (75°F)	1*	15	10	35
- Class I (90°F)	8	0	8	0
Percent Stormflow Violation of MDE Temperature Stds. - Class III (68°F)	18	57	48	64
- Class IV (75°F)	0	5	15	25
- Class I (90°F)	0	0	0	8
Maximum observed outflow water Temp (F)	77.7	80.0	81.9	82.6

1/ - Total Delta-T values shown represent combined baseflow and stormflow temperatures (i.e., all flow conditions).

* - Class IV violation result of defeate extended-detention control.

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a product of a large storm and 53 hours of extended detention.

- The thermal performance of the infiltration - dry pond could have been improved had its infiltration design treatment capacity been sized to handle more than 0.25 inches of runoff from roadway areas. For thermally sensitive watersheds, such as those which support naturally reproducing trout populations, infiltration systems should be intentionally oversized. Results also showed that the infiltration-dry pond's lengthy extended detention control was a major thermal loading factor. For this reason, the use of extended detention BMP's in thermally sensitive areas should be carefully evaluated. It is further recommended that a maximum 6-12 hour detention period limit be established for these areas and that shading of the storage pool area be required.

2. Extended Detention Artificial Wetland

- The average and maximum BMP Delta-T's associated with the wetland were 3.2 and 8.7°F, respectively. As seen in Table 16, Delta-T stormflow temperatures at the wetland were typically lower than baseflow Delta-T temperatures. However, approximately two-thirds of the time the difference between baseflow and stormflow Delta-T's was relatively small (i.e., $\leq 3.0^{\circ}F$).

- The shallow depth (mean depth is approximately 18 inches) and small permanent pool volume, relative to the 140 acre contributory

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watershed, made the wetland and its outflow station very responsive to air temperature fluctuations. The wetland's small permanent pool did, however, give it a limited ability to moderate outflow temperatures during certain small storm events.

In addition, because the wetland's extended detention capacity was extremely limited, it had little influence on outflow station temperature behavior.

- Under baseflow conditions, wetland outflow station temperatures exceeded Class III and IV temperature standards 60 to 15 percent of the time, respectively. In contrast, the same standards were violated approximately 57 and 5 percent of the time, respectively under stormflow conditions. Outflow stations were higher than inflow station temperatures 95 percent of the time.

3. Extended detention Dry Pond

- Surprisingly, the ED dry pond had the second highest recorded Delta-T's (Table 16). The maximum Delta-T produced by this BMP was slightly higher under stormflow conditions (11.2°F) than under baseflow conditions (9.7°F). Higher stormflow Delta-T's were the product of: a) the influx of relatively warm stormwater runoff into the facility, b) the partially shaded pilot channel's heat contribution, and c) additional heating of detained waters via solar radiation. In addition, the highest stormflow Delta-T's were

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noted during hot weather. This BMP's 500 foot long pilot channel produced an average positive stream Delta-T of 3.7°F.

- Under stormflow conditions, the ED dry pond violated Class III and IV temperature standards 48 and 15 percent of the time, respectively.

4. Wet Pond

- The wet pond's large permanent pool served as an effective heat regulator. In general, the pond had a major warming effect on baseflow temperature. However, during most storm events, both pond and outflow station temperatures were depressed. The relatively large permanent pool volume resulted in the pond slowly storing and releasing solar radiation/heat; thus making it slow to respond to air temperature fluctuations. Average summer pond surface water temperatures remained generally over 77°F. Pond waters were noticeably slow to cool-down in late summer/early fall.

- Delta-T baseflow temperatures at the wet pond were higher than stormflow Delta-T's 99 percent of the time. The average baseflow Delta-T (9.7°F) was slightly higher than the average stormflow Delta-T (8.5°F). The pond's rip-rap outflow channel produced an average positive Delta-T increase of 2.0°F.

- From a water temperature standards perspective, this BMP had the highest

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frequency of Class III and IV temperature standards violations. As seen in Table 16, violations were more frequent under baseflow conditions.

5. Storm-Size/Watershed Imperviousness Factor

- Results indicated that with increasing levels of watershed imperviousness, the storm-size needed to produce large stream temperature fluctuations decreased. At a 12 percent watershed imperviousness level over 0.7 inches of rainfall was generally required. In contrast, at a 60 percent imperviouness level less than 0.2 inches of precipitation was needed to produce a comparable temperature change. It should be noted that stormwater inflow generally produced positive stream Delta-T's.

6. Thermal Loading As A Function of Flow Ratio

Results revealed that a linear relationship exists between the positive Delta-T response of the receiving stream and the runoff (Q_{in}) to streamflow (Q_r) ratio. The potential thermal impact of stormwater runoff on receiving streams increased as the ratio of runoff (Q_{in}) to receiving stream flow (Q_r) increased. Not surprisingly, small headwater streams with low baseflow rates are at greatest risk from large inputs of stormwater runoff.

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C. Dissolved Oxygen Monitoring Results

The two-fold purpose of the dissolved oxygen (DO) monitoring portion of the study was to: 1.) determine whether or not the four BMP's and/or their associated discharges were violating MDE water quality standards, and 2.) quantify any "downstream effect" if they in fact existed. As part of its water quality grab sampling effort, COG staff took (at its 55 station network) nearly 800 DO readings. Dissolved oxygen measurements were taken at discrete longitudinal intervals both upstream and downstream of BMP sites, as well as, within each BMP facility. While the majority of these readings were taken during baseflow conditions, approximately 100 were made under the influence of stormwater discharge. Dissolved oxygen monitoring results are summarized in Table 17. A brief general description of the major findings are presented below.

General Findings

Dissolved oxygen concentrations at the 55 sampling stations were normally well-above the state standard for their respective water use class. In general, cold well-aerated streams, such as the Lakemont tributary, had the highest DO concentrations. During the study, the DO levels in these stream areas were frequently at or above 10.0 mg/L. Even relatively warm, heavily urbanized stream reaches such as the Lower White Oak tributary remained well-oxygenated. Much of this is attributable to the excellent aeration/mechanical turbulence associated with the stream's high gradient character. Not surprisingly, DO levels were generally lower below wet BMP

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facilities. This was due to a combination of higher associated water temperatures and higher biochemical oxygen demand (BOD). Average surface DO levels in the Countryside wet pond were an excellent 10.9 mg/L. In addition, because of the generally larger volume of flow, hence higher stream velocity and aeration, no reduction in DO levels were observed under stormflow discharge conditions.

Out of a total of 781 measurements taken, 14 readings (1.8 percent) violated the 6.0 mg/L MDE Class III/IV dissolved oxygen standard. Another 11 readings (representing 1.4 percent of the total) violated the 5.0 mg/L MDE Class I dissolved oxygen standard. As seen in Table 17, 13 out of the 14 Class III/IV violations and 10 out of the 11 Class I violations occurred within the Oaksprings wetland-tributary system. The only other observed MDE Class III/IV violation occurred downstream of the Countryside pond. One MDE Class I violation (DO concentration of 4.2 mg/L) was also recorded immediately upstream of the Tanglewood ED pond's riser.

Oaksprings

Almost half of the observed DO standard violations (12) occurred within the Oaksprings wetland. In addition, the study's lowest DO concentration (3.9 mg/L) was recorded a short distance upstream of the wetland's riser. Throughout the monitoring period, the wetland's average DO levels were consistently lower than those recorded at other sites. The principal causal factor behind this appears to have been the large amount of decaying organic material trapped within the wetland's extensive emergent and submerged aquatic plant beds.

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Table 17 Summary: Dissolved Oxygen Monitoring Results
June-October, 1989

LOCATION	STATION NUMBER	MDE Water Use Class	DO(mg/l) MAX	MIN	MEAN	Sample Size	No. of Violations Cl.I std (5.0mg/l)	Cl.III&IV (4.0mg/l)
1)Lakemont Trib.	1	IV	11.8	9.5	10.8	14	0	0
2)a)Oaksprings Inflow	1	III	10.4	4.9	8.5	20	1	1
ED wetland	all	III	12.5	3.9	7.2	48	6	6
outflow	1	III	10.0	5.3	7.6	19	0	2
	2	III	9.5	4.8	7.2	19	1	2
	3	III	8.9	6.8	7.4	20	0	1
	4	III	9.8	3.8	7.4	19	2	1
b)Upper Gum Springs	1A	III	11.8	9.8	10.3	20	0	0
c)Gum Springs	1B	III	13.0	8.9	10.3	20	0	0
	2B	III	11.6	8.2	9.7	13	0	0
	3B	III	11.8	9.1	10.3	19	0	0
	4B	III	11.8	8.1	9.8	19	0	0
	5B	III	11.8	8.7	10.1	19	0	0
d)Lower Gum Springs	1C	III	12.2	8.4	10.3	20	0	0
	2C	III	11.8	9.5	10.5	13	0	0
e)Paint Branch above Gum Springs	3C	III	11.9	9.1	10.4	13	0	0
below Gum Springs	4C	III	12.8	9.3	10.3	13	0	0
3)a)Countryside inflow	1	III	10.8	6.8	9.2	19	0	0
pond	all	III	20.8	6.5	10.9	56	0	0
outflow	1	III	13.5	7.1	9.4	18	0	0
	2	III	9.5	8.2	7.9	17	0	0
	3	III	10.4	5.5	8.1	19	0	1
	4	III	10.4	6.5	8.1	13	0	0
	5	III	11.4	7.1	8.3	13	0	0
	6	III	10.6	6.8	8.6	13	0	0
b)Paint Branch above Countryside	7	III	12.0	9.4	10.2	13	0	0
below Countryside	8	III	11.4	9.1	10.0	13	0	0

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Table 17 cont'd:

LOCATION	STATION NO.	MDE CLASS	DO MAX	DO MIN	DO MEAN	SAMPLE SIZE	VIOLATIONS I std	VIOLATIONS III&IV
4)a)Tanglewood Inflow	1	I	10.8	7.4	8.9	13	0	0
ED Dry Pond	all	I	14.3	4.2	9.1	34	1	0
Outflow	1	I	13.3	6.8	9.1	13	0	0
	2	I	10.4	6.7	8.7	13	0	0
	3	I	11.2	7.4	9.8	13	0	0
	4	I	11.4	8.7	9.6	10	0	0
b) Auto Park Br. above Tanglewood	5	I	10.8	8.8	9.4	10	0	0
below Tanglewood	6	I	11.4	8.8	9.6	10	0	0
5)a)Fairland Ridge Inflow	1	III	10.8	7.7	9.2	13	0	0
outflow	1	III	12.2	6.3	9.4	12	0	0
	2	III	11.0	7.8	9.0	13	0	0
b)Good Hope Trib. above Fairland Ridge	3	III	11.8	8.2	10.4	14	0	0
below Fairland Ridge	4	III	11.6	8.4	10.1	14	0	0
6)a)Upper White Oak	1	III	10.3	6.3	8.6	13	0	0
	2	III	10.3	7.4	8.7	7	0	0
	3	III	10.0	7.2	8.7	7	0	0
	4	III	11.6	6.7	9.6	4	0	0
	5	III	9.6	6.3	8.4	4	0	0
b)Lower White Oak	1	III	11.6	8.3	10.2	6	0	0
	2	III	10.9	7.8	9.3	14	0	0
	3	III	11.3	9.3	10.6	4	0	0
c)Paint Branch above White Oak trib	4	III	12.4	9.6	11.0	7	0	0
below White Oak trib	5	III	12.9	9.9	11.3	7	0	0
					TOTAL	781	11	14

TOTAL NUMBER OF CLASS I,III,&IV VIOLATIONS= 25

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Of all the stream areas sampled, the Lower Oaksprings tributary consistently had the lowest DO levels. Average dissolved oxygen concentrations in the 500 foot long stream reach ranged between 7.2 and 7.6 mg/L. These concentrations were typically 1.0 mg/L less than the Oaksprings inflow station, and are reflective of both warmer stream temperatures and the wetland's oxygen demand on the receiving stream system. Downstream DO levels generally improved, as a result of reaeration/mechanical turbulence, within 200-500 feet of the wetland. Results further showed that the Oaksprings tributary had no discernible effect on DO levels in the larger Gum Springs tributary (located 500 feet downstream of the wetland).

Summary

Results from the dissolved oxygen monitoring portion of the study revealed the following:

1. Baseflow DO levels generally do not appear to be a problem in urban streams; even in those draining highly impervious watersheds.

2. Some oxygen depletion was noted within the artificial wetland, as well as, downstream of both it and the wet pond. However, no anoxia was evident.

3. DO levels recovered within relatively short distances of the wet BMP's; generally, within 200 - 500 feet.

4. No discernible DO sag was observed during stormflow conditions.

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Chapter III. Water Temperature - Biological Implications

This chapter represents a synthesis of major findings from both the water temperature monitoring and literature review portions of the study. Wherever possible, an attempt was made to relate monitoring results to potential effects on biota known or expected to occur in Maryland freshwater streams. In order to accomplish this objective, a holistic approach which examined the general temperature requirements of representative biological groups at all major levels of the aquatic food chain was used. Results are presented in a sequential manner, starting at the bottom of the food chain (Figure 38) with algae, and progressing to fish.

Because of the general controversy surrounding watershed urbanization and trout streams, a separate sub-section on trout (which also contains temperature monitoring results from the Gum Springs tributary area) has been included. For a more comprehensive overview of water temperature and stream biota the reader is referred to Appendix C. In addition, because of the absence of comprehensive, stream-specific biological data, the biological implications described herein should be viewed with a certain degree of caution.

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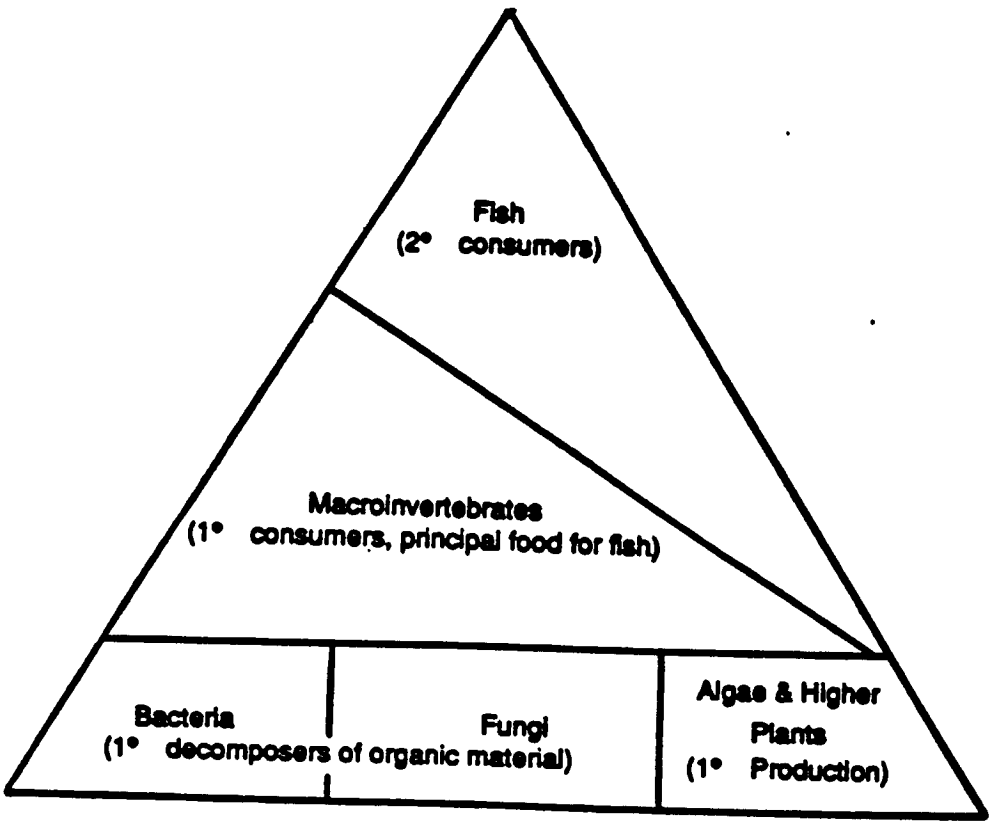
FIGURE 38

Conceptual Food Chain for Freshwater Ecosystems



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1. Algae: General Temperature and Light Requirements

Light, water temperature, and flow are generally considered to be the primary factors regulating algal communities (Patrick, 1977). Most freshwater algae cannot grow at very low light intensities and appear to also be inhibited by high light intensity (Whitford & Schumacher, 1968). In addition, "every species of algae has a range of temperature tolerance, which is generally fairly wide, and a narrower range, typically near the upper end of the tolerance range in which optimum growth occurs" (Patrick, 1974).

The general temperature and light requirements and classification of the major groups of freshwater algae are summarized in Figure 39. As seen in Figure 39, oligothermal algae are coldwater forms which are generally restricted to waters ranging between 32 and 59°F. Mesothermal algae inhabit cool-warm temperature habitats between 59 and 86°F. The euthermal algae, which are characteristically warmwater forms, exhibit their greatest abundance at temperatures $\geq$ 86°F.

As a rule, diatoms dominate at temperatures between 68 - 86°F, green algae dominate between 86 and 95°F and blue-green algae dominate in waters $\geq$ 95°F (Patrick 1974). It is also important to note that, in most streams, diatoms are the overall dominant algal group. Red, brown and yellow-green algae typically comprise a relatively small portion of the stream algal community. Yellow-green algae are the dominant low temperature group (Whitford & Schumacher, 1986). They are typically restricted to cold streams and/or where present in warmer streams, to winter months.

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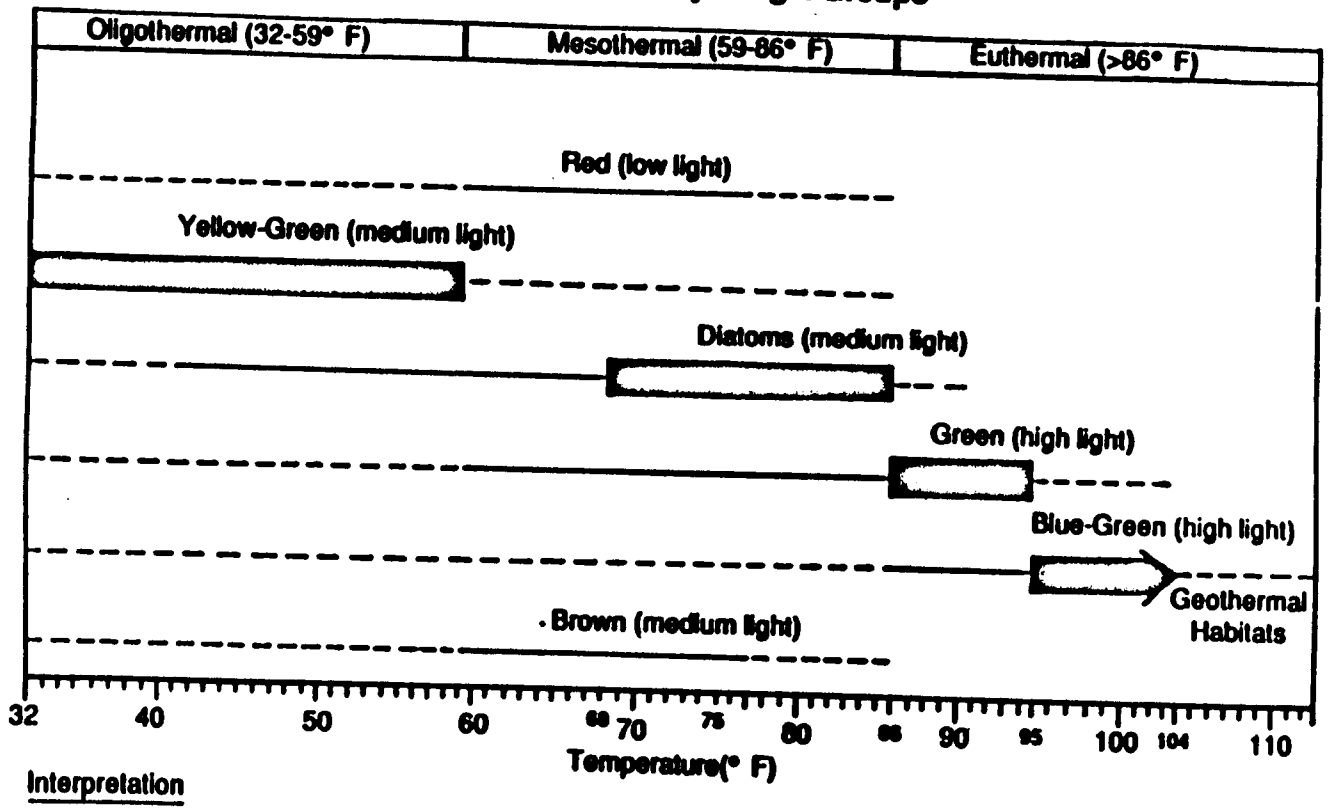
Figure 39

Summary: General Temperature and Light Requirements and Classification of Major Algal Groups



Interpretation

——— = Greatest number of representative species
– – – = Upper and lower temperature limits
▭ = Temperature range in which group is dominant
Oligothermal = Cold water forms, generally occuring between 32-59° F
Mesothermal = Temperate water forms, generally occuring between 59-86° F
Euthermal = Warm water forms, generally occuring at temperatures >86° F

Low Light = 200 foot candles
Medium Light = 500-1000 foot candles
High Light = >1000 foot candles

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Thermal Enrichment

In a study of the algae of White Clay Creek, PA, Patrick (1971) found that water temperatures averaging 86.7°F caused a major shift from a diatom-dominated community to one dominated by a mixture of greens, diatoms and blue-greens. Galli (1988) observed minor shifts in diatom community composition, as well as, an increase in both green and blue-green algae downstream of a small stormwater management wet pond. Maximum summer stream temperatures below this pond were in the 77.0 to 84.9°F range. Wilde and Tilly (1981), who conducted experiments on algal communities in artificial streams, concluded that sustained Delta-T increases of between 9.0 - 13.5°F (above ambient stream temperatures) may be sufficient to cause a significant species composition shift in a stream's algal community. In most streams, temperature shifts towards the upper limit and beyond bring about a shift in species composition; generally from diatom-dominated communities to those dominated by blue-green algae.

Temperature Monitoring Assessment

A review of water temperature monitoring results suggests that subtle shifts in the periphyton (attached algae) community species composition would have been expected to have occurred in some of the urban streams studied. At all developed watershed and BMP sites' diatoms would have continued to remain the dominant overall algal group. However, certain coldwater and/or light sensitive species may have either declined in numbers and/or been replaced by other, more temperature or light-tolerant species.

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The scenario would most likely have occurred in stream reaches where considerable thermal enrichment and/or removal of riparian vegetation took place (e.g., Countryside outflow, Lower Oaksprings, White Oak tributary, and Tanglewood tributary). Also, it would be expected that green and blue-green algal species would have been represented in greater numbers in the warmer, open-lit sections of these streams.

While some temperature-related shifts in algal community species composition undoubtedly occurred, it is unlikely that they would have in themselves had an appreciable effect on either the macroinvertebrate or fish communities of these small urban streams. The principal reasons for this are: 1.) from an energy or food utilization perspective, the macroinvertebrate communities of eastern headwater streams are heavily dependent upon leaf litter. Macroinvertebrates which rely largely upon attached algae (periphyton) for a food source, generally comprise a small portion of this community and 2.) by in large, macroinvertebrates, not algae, are the principal food for fish inhabiting these headwater streams.

2. Macroinvertebrates: General Temperature Requirements of Aquatic Insects

Macroinvertebrates are frequently defined as animals without backbones that are large enough to be retained on a U.S. standard No. 30 sieve, 0.595 mm openings (Weber, 1973). In addition to serving as a major food source for fish, macroinvertebrates are an integral part of the normal energy/organic material processing system of streams. Aquatic insects, which in most environments comprise the largest portion of this heterogeneous group, were

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examined in the study. General findings are described below.

Temperature - Physiological Relationships

As a group, aquatic insects demonstrate little ability to acclimate or compensate for temperature changes. Thus, when exposed to a new thermal regime, metabolic response is immediate and in the direction of the temperature change (Trapp & Hendricks, 1983).

While many aquatic insects can successfully complete their life cycles over a broad range of temperature conditions, many have very narrow and/or specific temperature requirements. As such, even relatively small temperature regime changes may have serious implications. For example, Sweeny and Vannote (1978) observed that changes of only 2.8 - 3.6°F, either warmer or cooler, from the normal temperature regime can reduce adult insect size and fecundity (the ability to produce viable off-spring), they both suggested that temperature increases of 3.6 - 5.4°F could eliminate sensitive species. Limited data also suggests that aquatic insects are adversely affected by exposure to high shock temperatures which approach their upper lethal limit. Thermal shocks may also interfere with the normal molting process and hence, may negatively effect insect growth and long-term survivability.

Temperature Requirements of Key Insect Groups

In general, water temperatures greater than 63.0°F have often been considered to be above the optimum for many stoneflies, mayflies, and

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caddisflies, and temperatures exceeding 70.0°F have been shown to stress severely most coldwater organisms (Gaufin and Nebeker, 1973; Ward and Stanford, 1979; Fraley, 1979).

As a group, stoneflies are the least temperature tolerant and are generally restricted to cold-cool flowing waters. Conversely, dragonflies and damselflies are generally associated with warmer streams and/or lakes and ponds. Mayflies and caddisflies, as well as Diptera (flies & midges), display considerable adaptivity and have successfully invaded all three of the major aquatic habitats depicted in Figure 40.

In addition, as a result of temperature regime alteration, mayflies, stoneflies, and other temperature sensitive or thermally-cued invertebrates are often reduced or eliminated below impoundments (Petts, 1984; Ward and Stanford, 1979; Fraley, 1979; Kondratieff and Voshell, 1981). All too frequently, only those forms with broad tolerance levels exist. Macroinvertebrate groups without aerial adults, such as snails, oligochaetes, amphipods, isopods, and turbellarians often increase in relative abundance in these streams (Ward and Stanford, 1979).

Temperature Monitoring Assessment

Results indicate that the thermal enrichment effects produced either through urbanization and/or associated BMP's, would severely effect coldwater aquatic insects. As seen in Figure 41, it is most likely that sensitive groups, such as stoneflies, would either be eliminated or severely restricted (for much of the year) at temperature levels comparable to those

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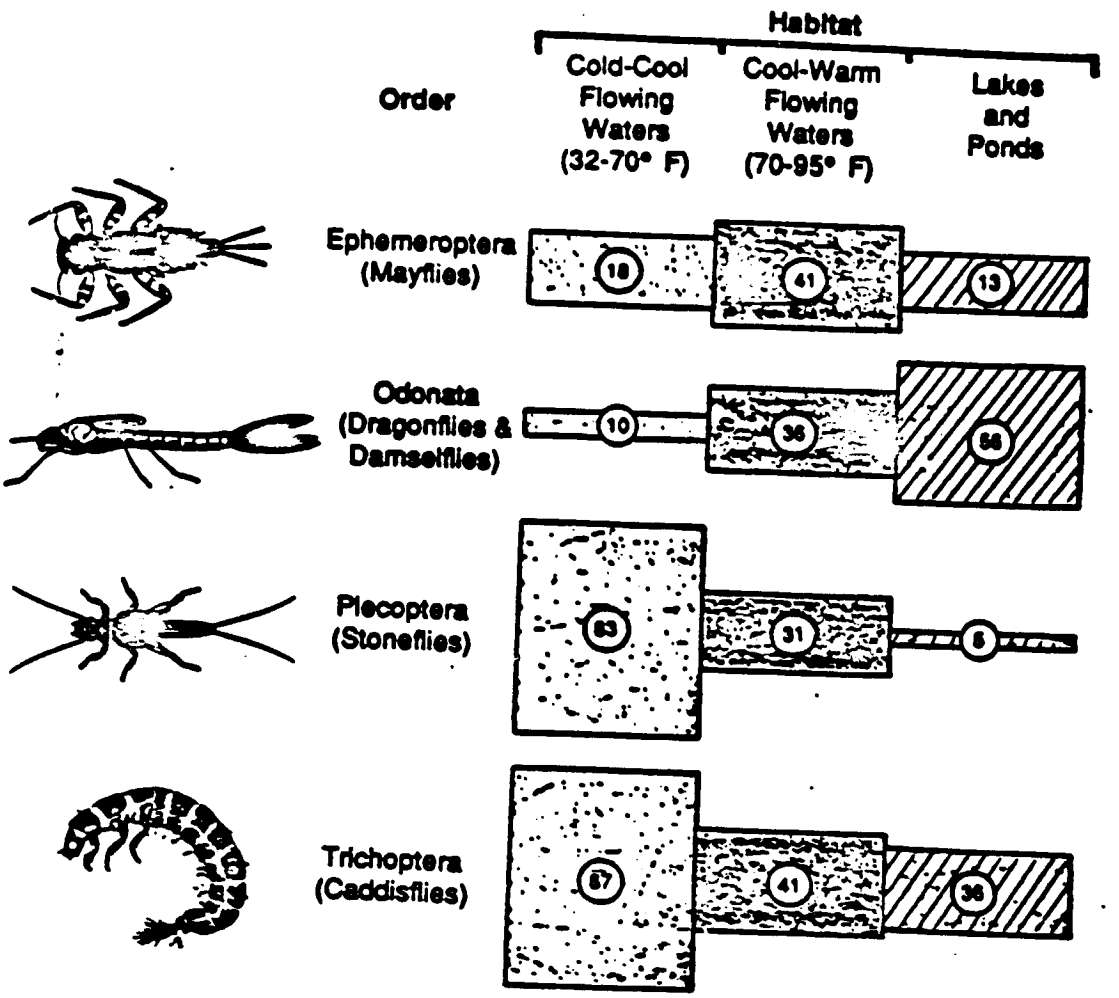
Figure 40

General Habitat of Four Orders of North American Aquatic Insects [1/] (modified from Wiggins & Mackay, 1978)



1/ Number of genera per habitat is shown within each block.

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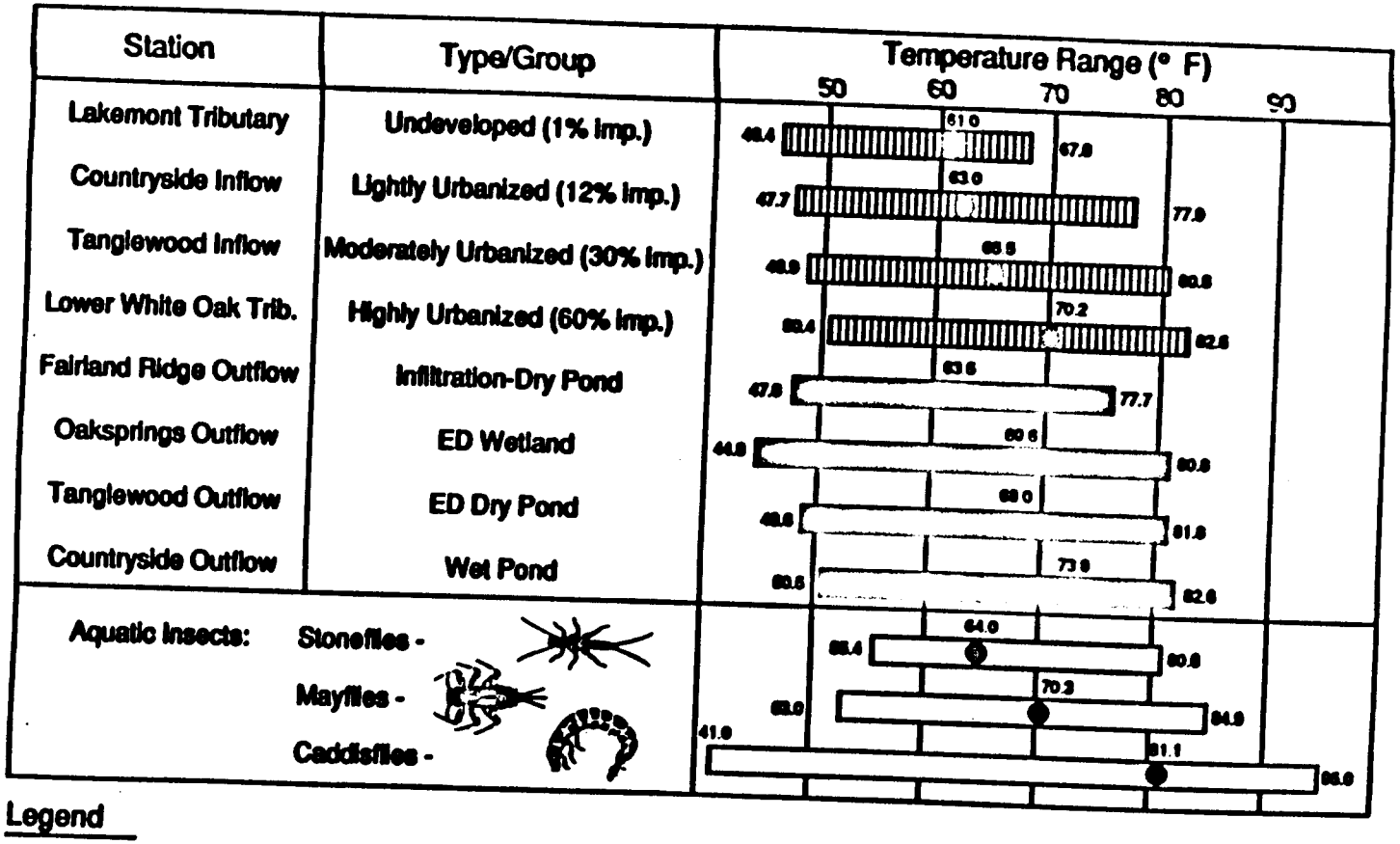
FIGURE 41

GENERAL RELATIONSHIP BETWEEN URBANIZATION, BMP'S, AND UPPER LIMITING TEMPERATURES FOR KEY AQUATIC INSECT GROUPS[1/]



1/ Upper limiting temperature defined as temperature above which death is extremely likely.

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observed at the moderately and highly developed watershed sites and at the wet pond, ED wetland, and ED dry pond outflow stations. While collectively more temperature tolerant, many mayfly and caddisfly species would similarly be eliminated, severely restricted and/or stressed at the preceding temperature levels.

Consequently, restructuring of the macroinvertebrate community would occur, with intolerant species and/or groups of insects being replaced by thermally-tolerant ones. It would also be expected that tolerant groups such as Diptera (flies & midges) would gain greater dominance in these stream systems. In addition, non-insect species would probably become more abundant. The preceding changes could, if particularly extensive, have a negative impact on the resident fish community.

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3. Fish: General Temperature Requirements, Classification and Tolerance

Although fish may be found in waters with temperatures ranging from around zero to 111.0°F, no species can survive over this entire range. Each species has a characteristic range with upper and lower lethal limits and preferred temperature optima, which changes according to the age (or life cycle stage) of the fish. Furthermore, when water temperature changes, the rate of thermal equilibration in fish is generally rapid (Elliot, in Pickering, 1981). Owing to their smaller body mass and proportionately higher surface area, juveniles are far more vulnerable to the effect of rapid temperature changes than are adult fish.

Temperature Classification

Freshwater fish in temperate regions generally live within the 32.0 - 86.0°F temperature range. Maximum summer temperatures may exceed 86°F in shallow lakes, ponds and marshes, warmer southern streams, and/or in waters that receive a thermal discharge. Based on their thermal requirements, fish are generally placed into one of three categories:

- Stenotherm - coldwater fish, which have a physiological optimum < 68°F and an upper lethal temperature of ≤ 79°F. Representative examples include salmon, trout, and certain sculpins.

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- Mesotherm - coolwater fish, which have a physiological optimum in the 68 - 84.4°F range and an upper lethal temperature of 82.4 - 93°F. Representative examples include pikes, perch, darters, and most species of minnows.

- Eurytherm - Warmwater fish, which have a physiological optimum > 82.4°F and an upper lethal temperature generally over 93°F. Representative examples include carp, goldfish, catfish, sunfish, and bass.

General Temperature Requirements of Maryland Freshwater Fish

Water temperature together with the volume of flow, water quality, and physical or structural habitat are the major factors which determine the fish community characteristics of streams. While it was beyond the scope of the study to examine all of these variables, an attempt was made to identify the general temperature requirements for Maryland freshwater fish. Thermal requirement data for 63 species of fish known or expected to occur in Maryland freshwater streams is presented in Appendix C. In addition, this information together with water temperature monitoring results have been graphically summarized in Figure 42.

The upper and lower critical temperature limits depicted in Figure 42 represent reasonably well-defined physiological temperature boundaries, beyond which, death is extremely likely. Also, temperatures outside of the optimum range may generally be viewed as being stressful. Finally, it is

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Figure 42

General Temperature Requirements of Maryland Freshwater Fish Versus Maximum Observed BMP Outflow Temperatures

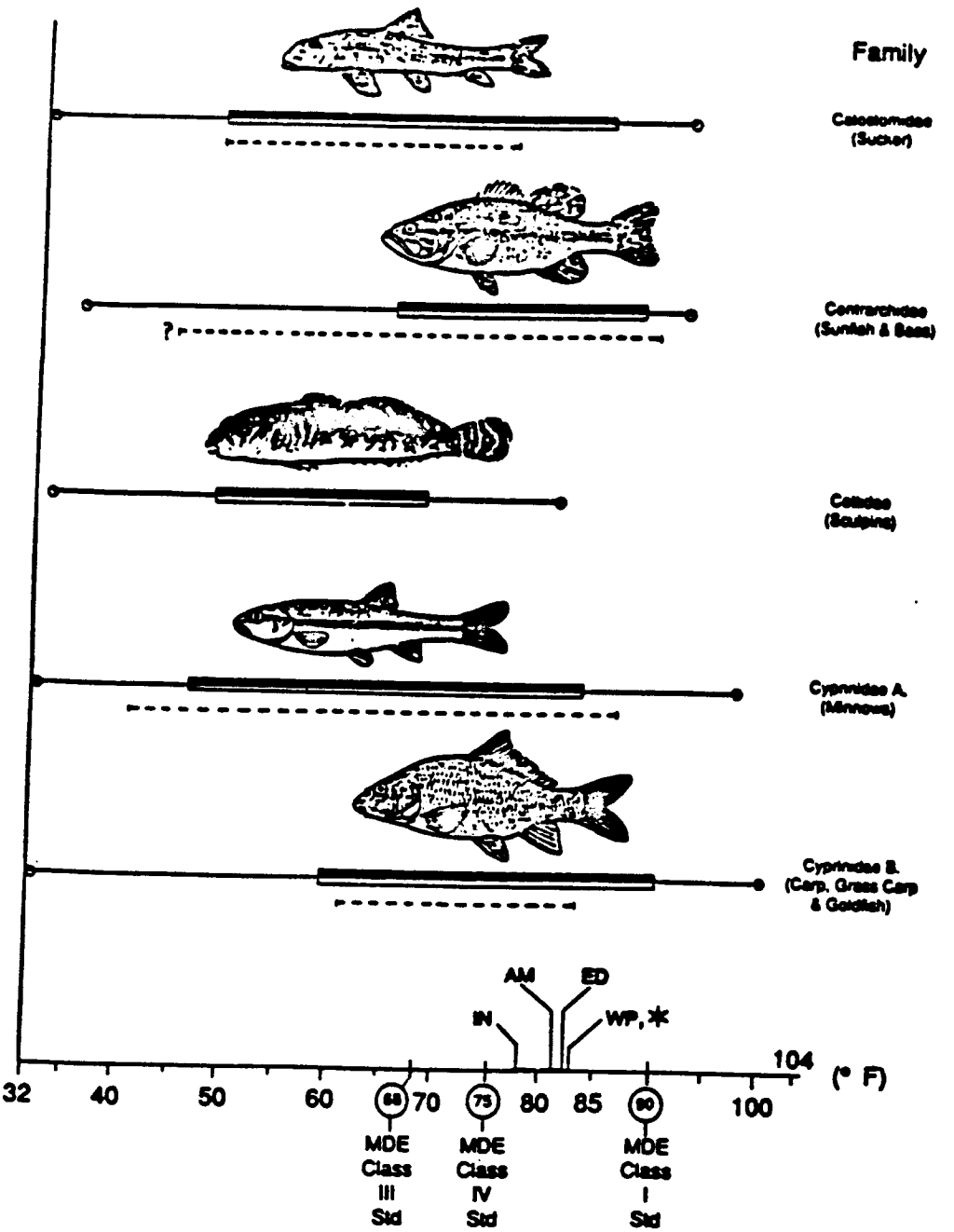

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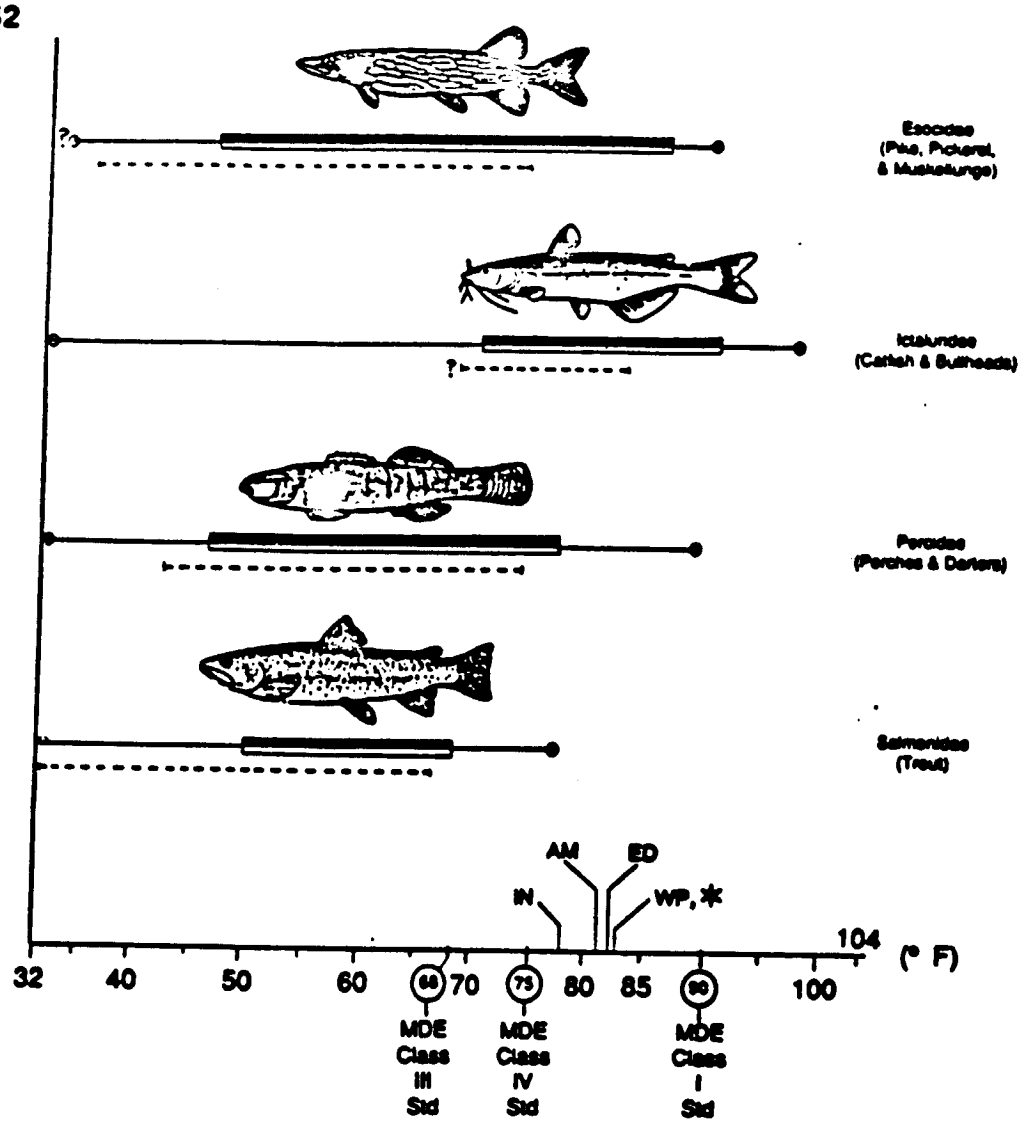
Figure 42
(cont)



Temperature(° F)

Legend

- ——○—— - Upper and lower critical temperature limits
- ▬▬ - General optimum temperature range
- ·------· - Temperature limits for egg development
- IN - Fairland Ridge Infiltration Dry Pond (77.7° F)
- AM - Oakspring Artificial Marsh (80.8° F)
- ED - Tanglewood Extended Detention Dry Pond (81.9° F)
- WP - Countryside Wet Pond (82.6° F)
- * - Lower White Oak Trib., 60% Impervious, (82.6° F)

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important to note that a fish's ability to withstand thermal stress is largely a function of acclimation temperature, its age and vigor, and length of exposure.

Temperature Monitoring Assessment

Results presented in Figure 42 show that the vast majority of fish species would not be affected by the temperature increases produced either through urbanization and/or construction of BMP's. However, coldwater species such as trout would not be expected to survive at temperature levels observed at either the moderately or highly developed watershed sites or at any of the four BMP outflow locations. While generally regarded as being slightly more temperature tolerant than trout, sculpins would also be negatively impacted. As seen in Figure 42, sculpins would only be expected to survive at temperature levels observed at either the lightly developed watershed sites, or below the infiltration - dry pond.

The preceding findings underscore the point that moderate levels of watershed imperviousness and/or the improper introduction of BMP's, can have a devastating impact on sensitive coldwater streams and the fish communities which they support.

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4. Trout and Thermal Stress

A. General Findings

With only one or two notable exceptions, natural coldwater stream fish communities in Maryland are generally restricted to higher altitude and/or spring-fed streams of the Appalachian and Piedmont provinces. The fish assemblage in these streams is often highly variable, but typically includes one or more species of trout (brook, and/or brown or rainbow), as well as, sculpins, and several minnow species. Maximum summer water temperatures in coldwater streams are normally less than 70°F (Winger, in Krumholz, 1981).

While the temperature requirements for brook, brown and rainbow trout are quite similar, the brown trout is generally regarded as being the more temperature tolerant and the brook trout the least. It is important to note that even within a given species the difference in thermal tolerance is often surprisingly large. Much of this is due to inherent genetic or racial differences within the species and adaptation to different thermal regimes.

All trout species are extremely sensitive to thermal pollution/stress. Sustained elevated water temperatures over 70°F are generally considered to be stressful, while those at or above 77°F are usually lethal. As previously noted, a fish's ability to withstand or resist the effects of thermal stress is heavily influenced by the acclimation temperature. Trout can, depending on the acclimation temperature, survive for varying periods of time at temperatures which are ultimately lethal. As seen in Figure 43, brown trout

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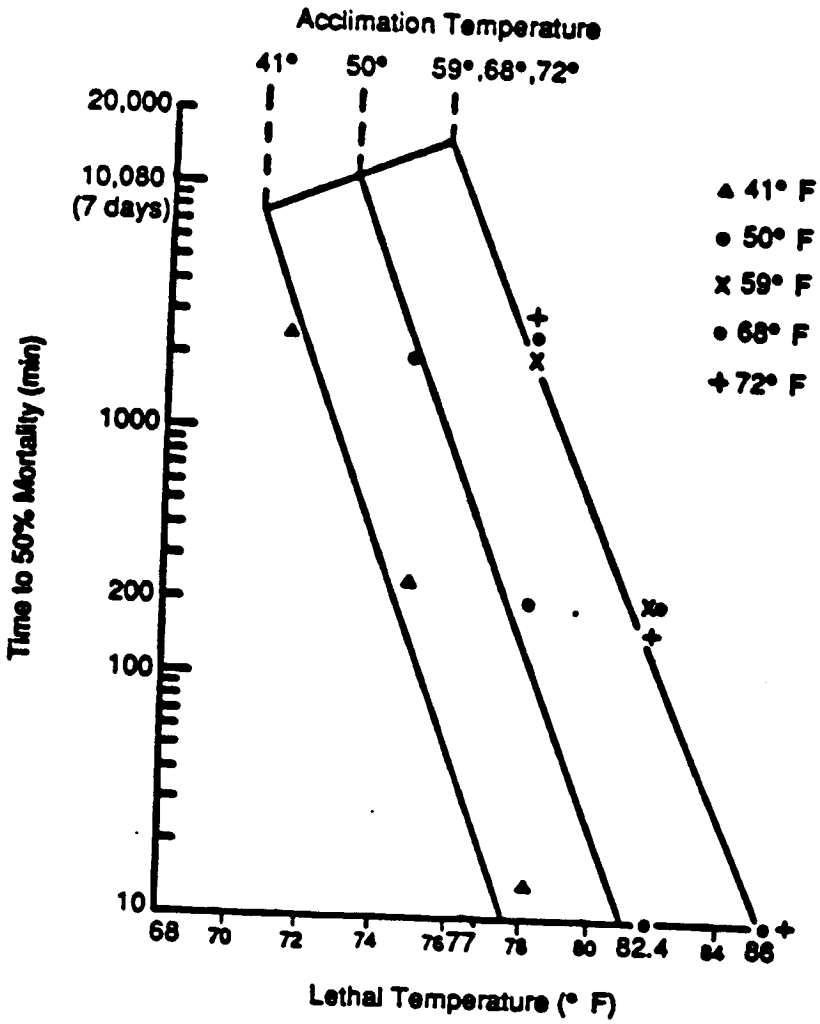
Figure 43

Relationship Between Time, Acclimation Temperature and 50% Mortality of Brown Trout, Salmo trutta (from Elliot, 1981)



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acclimated at 59, 68, or 72°F survived slightly over 7 days at 77°F, 100 minutes at 82.4°F, and only 10 minutes at 86°F.

B. Gum Springs Thermal Regime

From a historical perspective, the Gum Springs tributary has supported a naturally reproducing brown trout population since at least the mid-1950's. During the past 10 - 12 years the Gum Springs tributary subwatershed has experienced considerable watershed development activity. Presently, this residentially developed basin, which includes the Oaksprings ED wetland - tributary system, is approximately 12 percent impervious.

Despite this background level of watershed imperviousness the Upper Gum Springs continues to support a healthy brown trout population. Unfortunately, this is no longer the case in Lower Gum Springs. Over the past 6 - 7 years, the resident trout population downstream of the Oak Springs tributary confluence has steadily declined (Gougeon, 1990). While much of this decline has been attributed to construction-related sediment pollution and increased stormflows, temperature regime alteration has been repeatedly implicated (Gougeon, 1990).

In an effort to document longitudinal thermal regime differences, thermograph thermometers were strategically located in both Upper and Lower Gum Springs. Water temperature monitoring results confirmed that under both baseflow and stormflow conditions Lower Gum Springs is warmer. They also revealed that the two stations behave very differently under large stormflow conditions. Major findings are described below.

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1. While baseflow temperatures at Lower Gum Springs were typically 1 - 2°F warmer than those recorded at Upper Gum Springs, they were safely below levels considered to be stressful to trout (Figure 44).

2. Under stormflow conditions (Figure 45) both stations exceed the Class III temperature standards. Whereas only one percent of all storm events at Upper Gum Springs resulted in a temperature standard violation, 8 percent did so at Lower Gum Springs. Moreover, Lower Gum Springs stormflow temperatures reached a high of 74.5°F. This value was 3.1°F higher than the maximum stormflow temperature recorded at Upper Gum Springs.

3. The temperature regimes of both stations were generally unresponsive to runoff produced by small-medium size storm events (i.e., $\leq$ 1.0 inch of precipitation). Larger storms (those dropping $\geq$ 1.0 inches of rain), however, produced sharp temperature increases at both stations. Under these large stormwater inflow conditions, Gum Springs stream temperatures were observed to increase at rates of 4.3 - 9.7°F per hour. It should also be noted that the single largest 20 minute temperature increase, 7.2°F, occurred at the Upper Gum Springs station.

4. The principal differences between the two stations, under the large storm event scenario, were the magnitude of the temperature increase and the recovery rate. Results showed that temperature increases were higher and recovery slower at Lower Gum Springs. During these storm events, Upper Gum Springs temperatures typically remained

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FIGURE 44

UPPER VERSUS LOWER GUM SPRINGS WATER TEMPERATURES UNDER BASEFLOW CONDITIONS

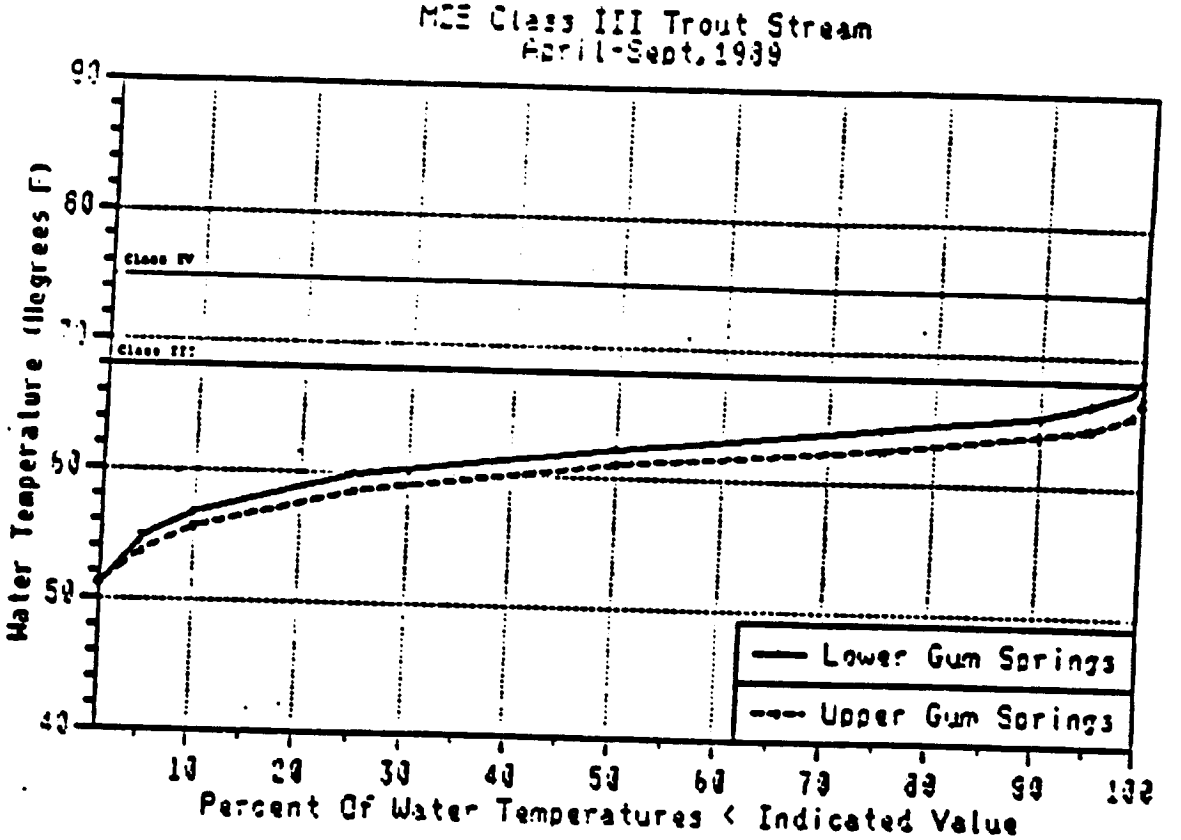

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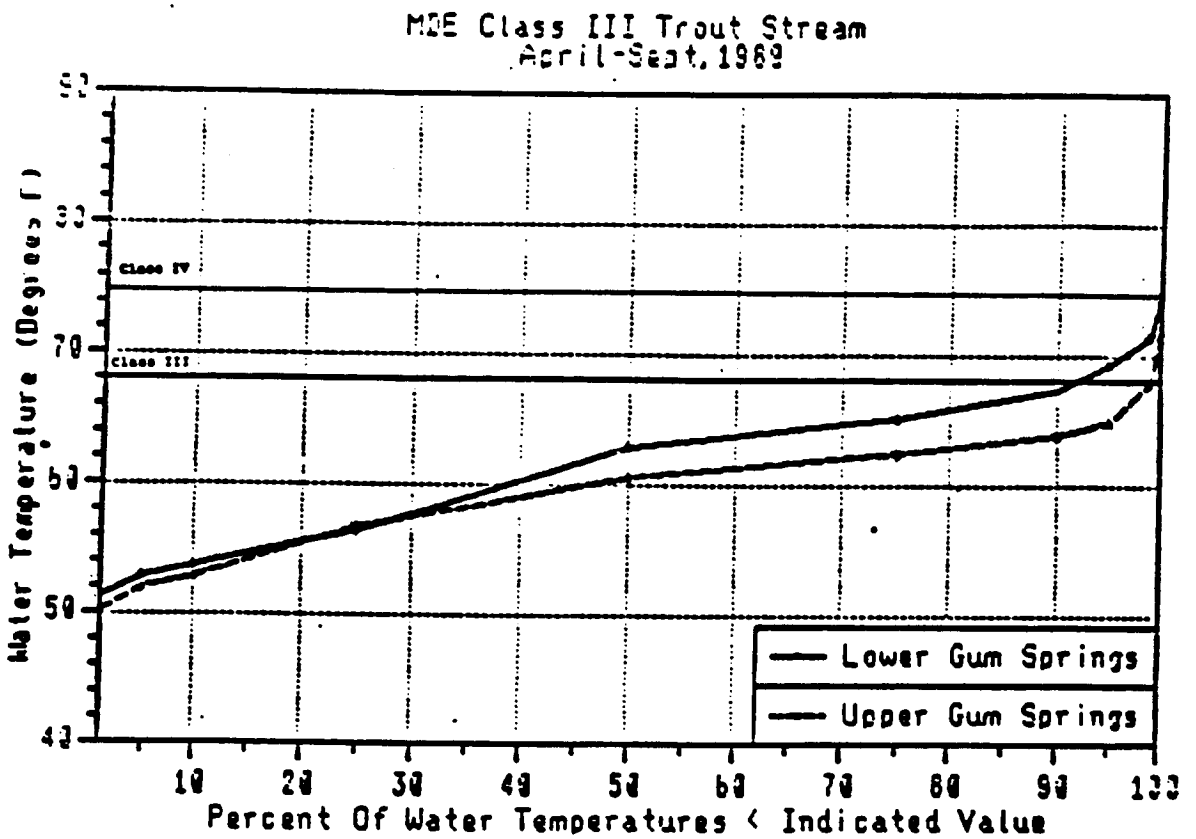
FIGURE 45

UPPER VERSUS LOWER GUM SPRINGS WATER TEMPERATURES UNDER STORMFLOW CONDITIONS



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elevated for 6 - 12 hours before returning to normal. In contrast, water temperatures at Lower Gum Springs remained elevated for up to 2 - 3 days at a time. The long, Lower Gum Springs recovery period is attributable to the relatively slow release of large volumes of stormwater from the Oaksprings Ed wetland. During the study it was not unusual to see Lower Gum Springs temperatures remain at or above 70°F for periods of 30 - 40 hours. As previously noted, sustained temperatures $\geq$ 70°F are generally considered to be stressful to trout, especially young-of-year and juvenile trout, who are least tolerant of high temperatures and are first affected by thermal shock.

The preceding findings underscore the fragile nature of urban trout streams and their vulnerability to large inputs of stormwater runoff. Although the water temperature regimes of both Upper and Lower Gum Springs are still quite capable of supporting trout, the Lower Gum Springs is far more thermally stressed. It is also quite likely that additional watershed development, particularly in the headwaters, will cause further deterioration of the Gum Springs tributary thermal regime. This could conceivably result in the elimination of all trout from the stream.

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Chapter IV. Land Use Control and Stormwater Management Program Implications

Through the process of urbanization, vegetation is removed from watersheds, formerly pervious surfaces are converted to hard, impermeable ones such as rooftops, streets and parking lots, and natural drainage networks are modified to convey runoff more efficiently. These processes act together to alter the thermal regime of urban, headwater streams. The extent to which the thermal regime of these streams is modified is largely a function of three major interrelated factors: 1.) watershed imperviousness levels, 2.) integrity of riparian canopy coverage, and 3.) the employment of stormwater BMP's. These factors, as related to land use and stormwater management control programs, are discussed in greater detail in the following sections.

Land Use Control Implications

1. Watershed Imperviousness Factor

For urban headwater streams, the level of watershed imperviousness largely determines the magnitude of change from the pre-development thermal regime. Results from this study show that a linear relationship exists between the level of imperviousness and mean, summer stream temperatures. In general, the mean summer water temperature of these streams will increase 0.14°F per one percent increase in watershed imperviousness. Other important findings are described below:

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- Watershed imperviousness has a negative influence on stream temperatures under both baseflow and stormflow conditions. As seen in Table 18, the frequency of MDE temperature standards violations generally increases with increasing levels of imperviousness. This phenomenon occurs regardless of whether watershed stormwater management controls are present or absent. Reduction of groundwater flows, the urban heat island effect, removal of riparian vegetation, and drainage network alteration are primary causes of the problem;

- As the level of watershed imperviousness increases, the ratio of stormwater runoff to receiving stream flow increases. Consequently, the potential for large inputs of biologically harmful warm stormwater to urban stream increases. Because small urban streams have relatively low volumes of baseflow discharge, these streams are most susceptible to the effects of thermal loading;

- With increasing watershed imperviousness, the rainfall volume required to produce large storm temperature fluctuations decreases. As previously noted, at a 12 percent watershed imperviousness level over 0.7 inches of rainfall is generally required to produce a temperature "spike." Conversely, at a 60 percent imperviousness level, less than 0.2 inches of rainfall are needed to produce a comparable temperature spike.

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Table 18. Summary: MDE Water Temperature Standards Violations Versus Watershed Imperviousness

Watershed Development Level	Percent Imperviousness (%)	Percent of Time MDE Temperature Std. Violated (%)			
		Class III (68°F)		Class IV (75°F)	
		Baseflow	Stormflow	Baseflow	Stormflow
Light	12.0	10	5	0	1
Moderate	30.0	25	1	25	1
High	60.0	67	57	12	10

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2. Riparian Vegetation Removal Factor

Riparian vegetation plays a key role in insulating small streams from the warming effect of solar radiation. Other studies have shown that the removal of riparian vegetation can raise the summer water temperature of small streams by 11 - 20°F, and can lower winter water temperatures by 5 - 7°F. Results from this study revealed an average positive stream Delta-T of 1.5°F per 100 feet of flow through either open or poorly-shaded reaches.

The need for maintaining vegetated riparian buffers is critical for the protection of thermal regime in urban headwater streams; and particularly so, for trout streams.

3. Conflicting Stream Protection and Watershed Development Goals

All too often the goal of stream protection conflicts with land use development. Many of the environmental problems caused by urbanization, stream warming for one, cannot be completely mitigated by engineering means. Thus, far greater emphasis on land use control measures is required in sensitive streams.

Results from this study show that stream temperature regime changes occur at relatively low levels of watershed imperviousness (i.e., ≤ 12 percent). They also strongly suggest that trout and other coldwater biota will most likely be lost when watershed imperviousness exceeds 12 - 15 percent.

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4. Thermal Regime Protection Strategy

Current water temperature class designations are not a reliable guide to the existing or future thermal regime status of headwater Piedmont streams. This is particularly the case for urban streams. In addition, it is clear that the long-term protection of thermally sensitive streams requires a holistic watershed management approach which includes, at a minimum, the following water temperature protection elements:

- Land use controls (which govern type, density and location of development within a watershed);
- Riparian/stream buffer requirements;
- Employment of temperature sensitive BMP's and stormwater conveyance systems;
- Long-term water temperature and biological monitoring at strategic stream locations within the watershed; and
- Routine long-term maintenance of BMP's and other associated infrastructure.

Not surprisingly, extraordinary land use, riparian management and stormwater management controls are needed to properly protect the resident

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aquatic life of MDE Class III streams. The same watershed protection approach is also generally needed, on a case-by-case basis for thermally sensitive Class I and IV stream areas. This stream protection strategy requires that many difficult, and potentially costly, land use decisions be made.

Stormwater Management Program Implications

Stormwater management controls are employed in an attempt to mitigate the undesirable changes in watershed hydrology, water quality and stream ecology produced by urbanization. Unfortunately, the improper employment of these BMP's can exacerbate the thermal regime problems caused by watershed development. In thermally sensitive watersheds, the selection of appropriate stormwater management controls is often a difficult decision, fraught with potential water quality/quantity and environmental trade-offs. Major stormwater management program implications are discussed below.

1. BMP Thermal Performance

As previously noted, none of the four types of stormwater BMP's monitored were thermally neutral. Of the four practices, the infiltration-dry pond produced the smallest total Delta-T increases and had the fewest MDE Class III and IV temperature standards violations. The artificial wetland was next, with intermediate total Delta-T increases and temperature standards violations. The second highest Delta-T increases were associated with the extended detention dry pond. From a temperature performance standpoint, the wet pond finished last. This BMP produced the largest Delta-T increases,

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maintained elevated downstream temperature conditions for months at a time, and had the highest percentage of Class III and IV temperature standard violations.

The preceding results strongly suggest that all of the major stormwater management practices commonly in use will generally amplify, to some extent, baseflow and/or stormflow Delta-T's. It is further evident that infiltration BMP's provide the greatest level of water temperature protection and are the most appropriate practice for use in thermally sensitive watersheds.

2. BMP Contribution to Stream Warming Problem

At low levels of watershed imperviousness, improper BMP selection can have a major negative effect on the water temperature regime of small, headwater Piedmont streams. This is particularly the case in coldwater stream systems, where the selection of conventional wet and/or extended detention BMP's could conceivably eliminate temperature sensitive species such as trout.

However, results from the study also show that at moderate levels of watershed imperviousness the potentially negative influence of BMP's on the receiving steam's temperature regime is reduced. This is due to the fact that the temperature regimes of these streams have been (or will be) modified by the background level of urbanization. Consequently, temperature sensitive biota will, even in the absence of BMP's, most likely be reduced and/or eliminated from these streams. At high levels of watershed imperviousness, the general impact of BMP's on the receiving stream temperature regime is minimal. In these streams, the need for providing high

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levels of water quality and stream channel erosion control may outweigh temperature concerns.

3. BMP Design Elements Which Contribute to Thermal Loading

During the course of the study it became obvious that several BMP design elements were actually increasing total Delta-T's. Among the top five contributing factors were:

- undersized infiltration treatment system capacity;
- the presence of a large wet pool;
- poorly shaded pilot and outflow channels;
- poorly shaded storage pool areas; and
- excessively long periods of extended detention control.

4. BMP Temperature Reduction Methods

A number of BMP design features and methods could be employed to help reduce stream warming. Methods include, but are not limited to, the following:

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- increasing, to the maximum practical extent possible, infiltration system treatment capacity;

- combining both infiltration water quality control and dry water quantity control within one, single facility;

- constructing BMP's as "off-line" rather than "on-line" facilities (this would help to reduce baseflow Delta-T's);

- incorporating baseflow diversion systems into "on-line" facilities;

- heavily shading pilot and outflow channels and storage pool areas with trees and shrubs;

- Incorporating narrow-width baseflow channels into BMP outflow channel design;

- limiting the maximum period of extended detention control to 6 - 12 hours;

- employing parallel pipe conveyance systems, so as to reduce the frequency and magnitude of receiving stream thermal loading;

- employing passive and/or mechanical systems to reduce baseflow/stormflow temperatures (e.g., cooling reservoirs, cooling chambers, and multiple-port releases for deep reservoirs).

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- Employing, when full infiltration controls are neither practical nor feasible, alternative BMP's such as sand filters; and

- Avoiding the use of permanent pools in thermally sensitive watershed areas that are expected to have low to moderate levels of watershed imperviousness.

Several of the preceding methods and design features are experimental in nature and may or may not work until tested under field conditions. In addition, some of these design features may actually reduce the overall level of water quality or quantity control. It is further recognized that these innovative engineering approaches cannot totally eliminate the large Delta-T increases produced by large volumes of urban runoff. Also, the ability of these innovative BMP's to function as designed is dependant upon proper construction and long-term maintenance. Last, stormwater management program research priorities should include the monitoring of parallel pipe and baseflow diversion systems, multiple-port release wet ponds, sand filters, peat-sand filters and other promising thermally sensitive conveyance systems and BMP's.

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Appendix A: BMP Monitoring Sites

1. Fairland Ridge Infiltration - Dry Pond



Background/ Features

- DA to BMP: 25.0 ac.
- Imperviousness: 18%
- Full 2-year water-quantity control
- Terraced side slopes which feature stilling basins, and 3 infiltration trenches for water quality control

View of terraced side slopes and large, dry storage pool area.



Pre-treatment of runoff via system of stilling basins and grass swales.

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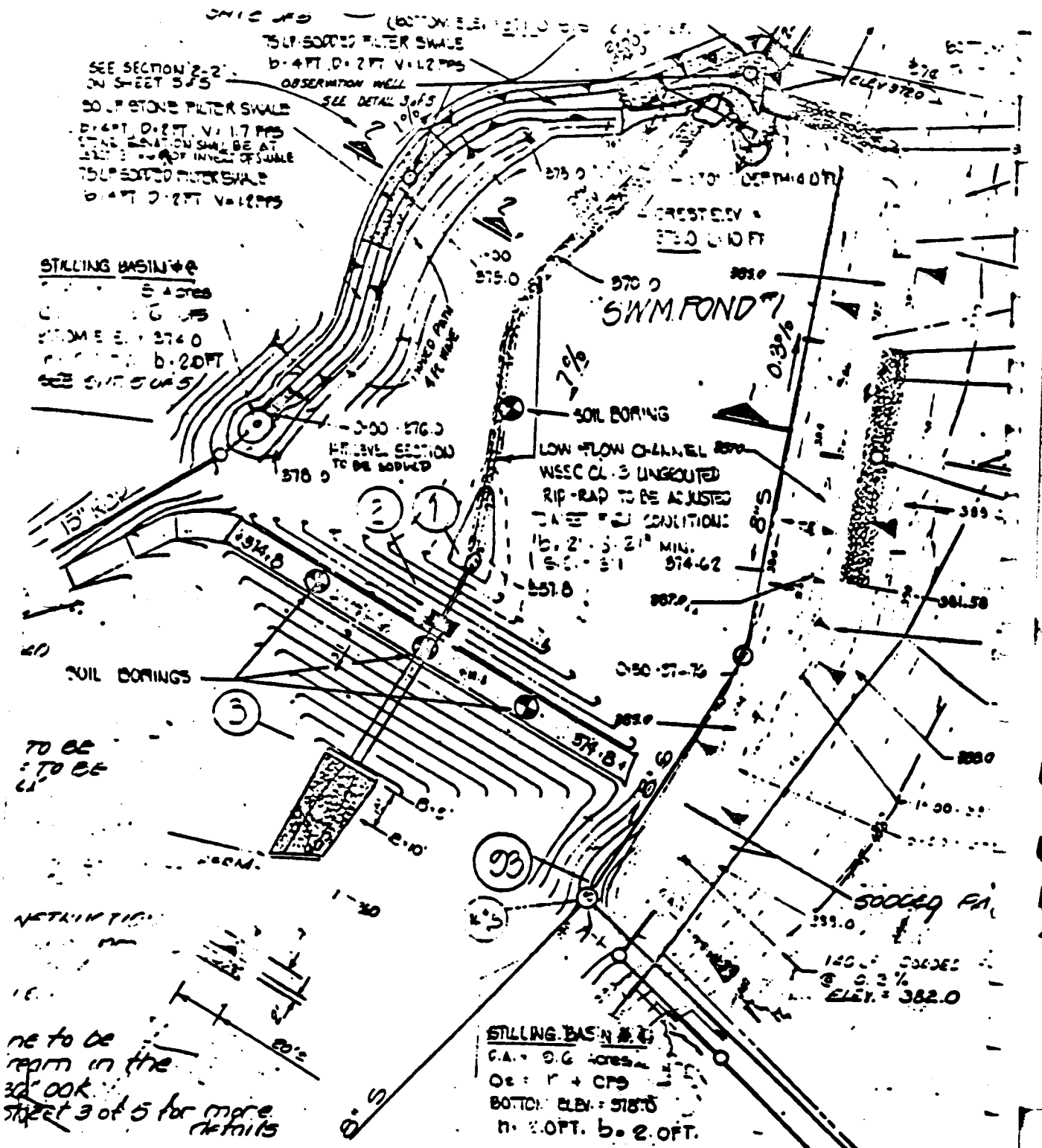

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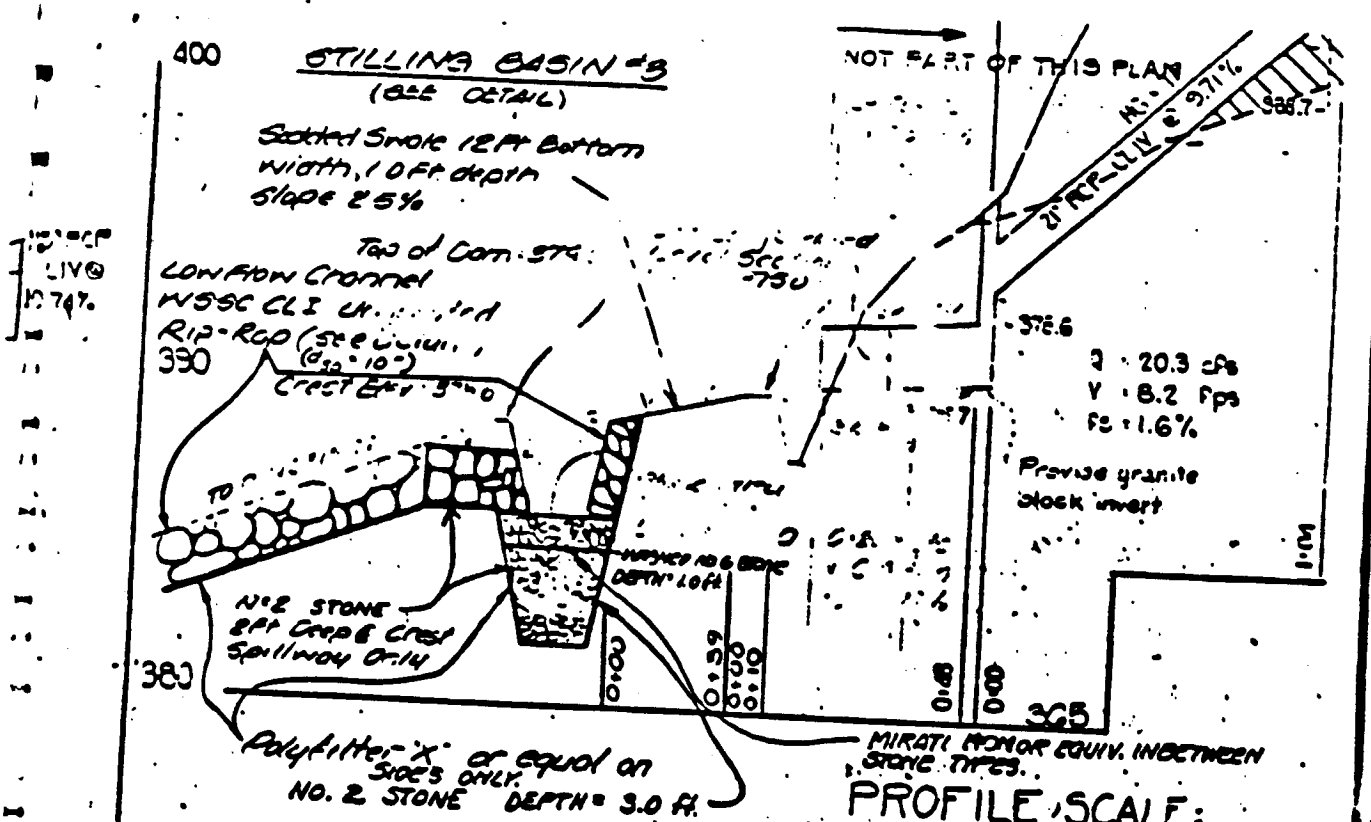
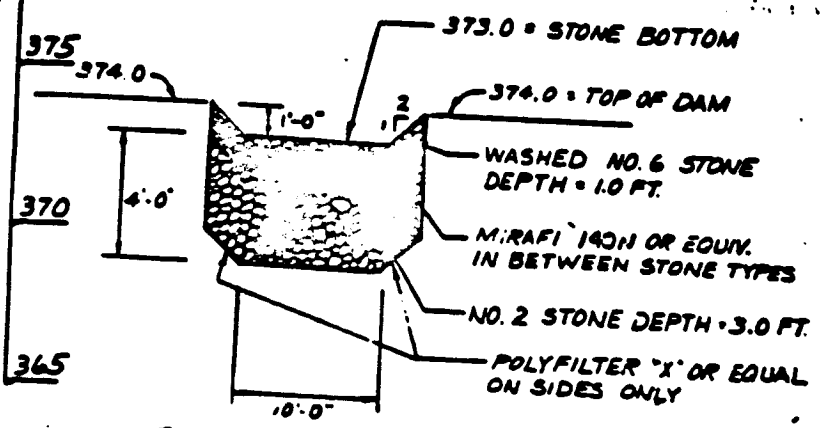
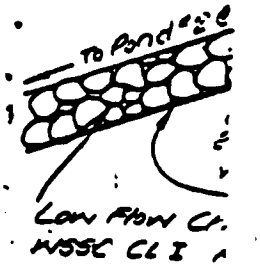




SECTION 4-4

SCALE: HORIZ. 1"=20'
VERT. 1"=5'



FAIRLAND RIDGE

JOHNSON

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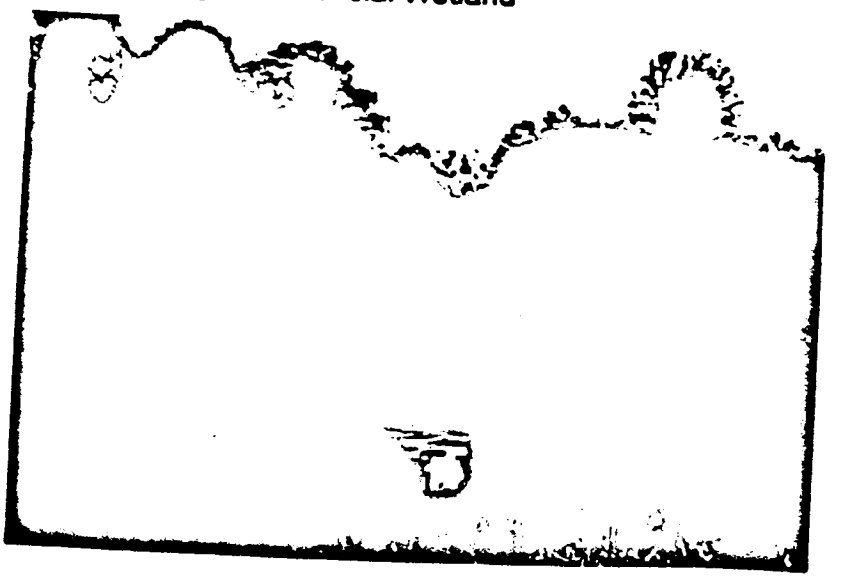
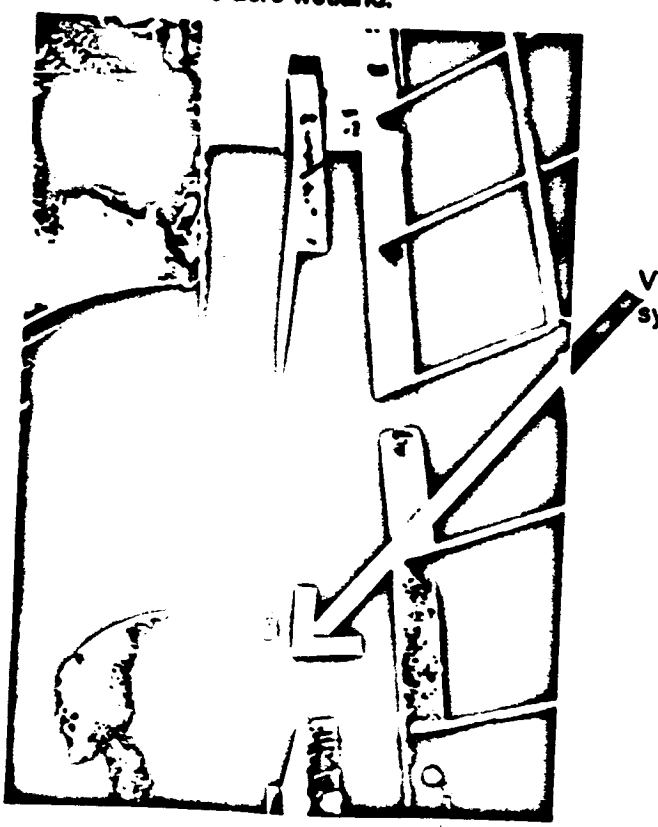
Appendix A: BMP Monitoring Sites
2. Oaksprings ED Artificial Wetland



Background Features

- DA to BMP: 140 ac.
- Imperviousness 18%
- Full 2-year water quantity control
- ED water quality control

Cattails and other emergent aquatic vegetation cover approximately 50% of this 1.0 acre wetland.



View of notched, wooden flashboard system for ED water quality control.

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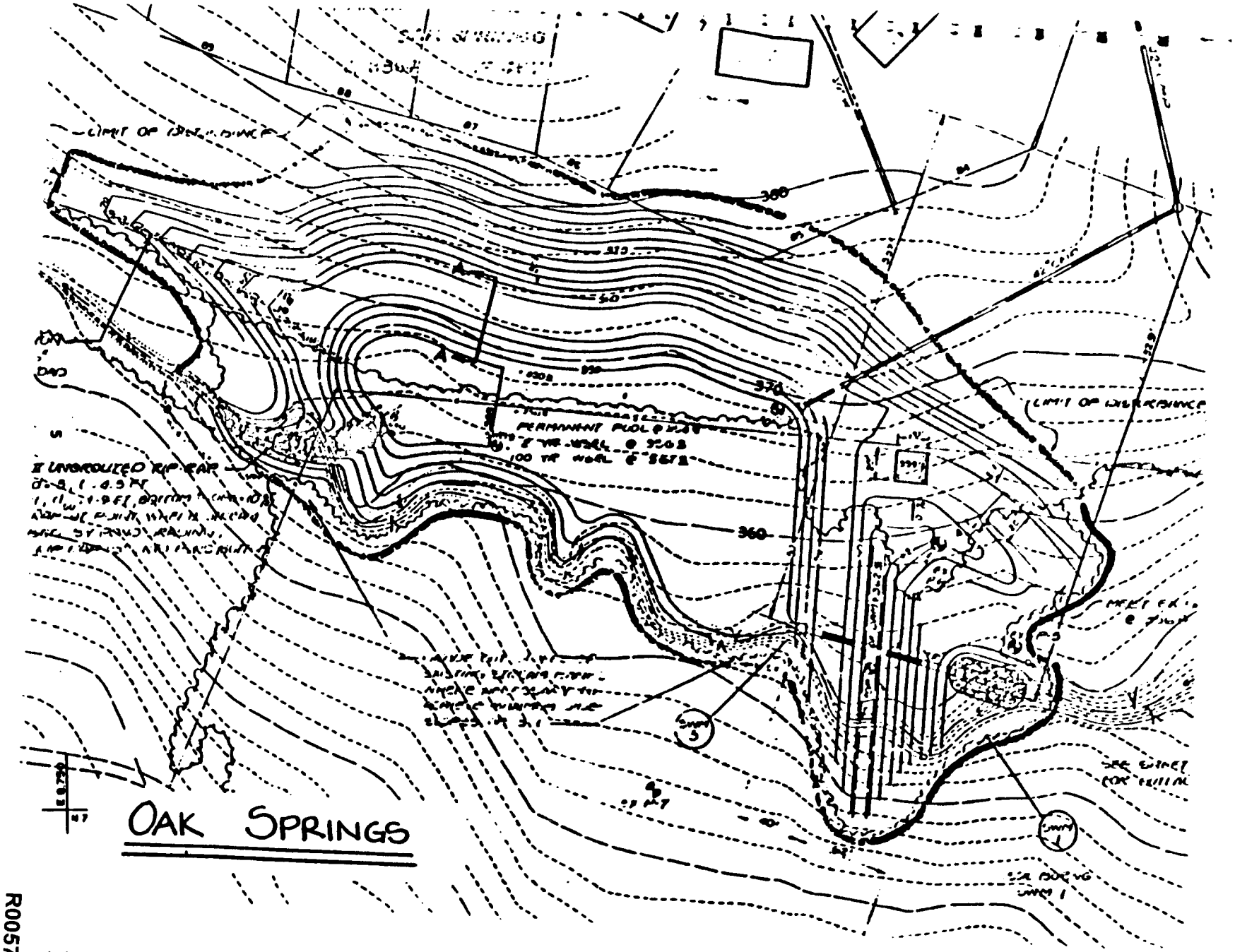

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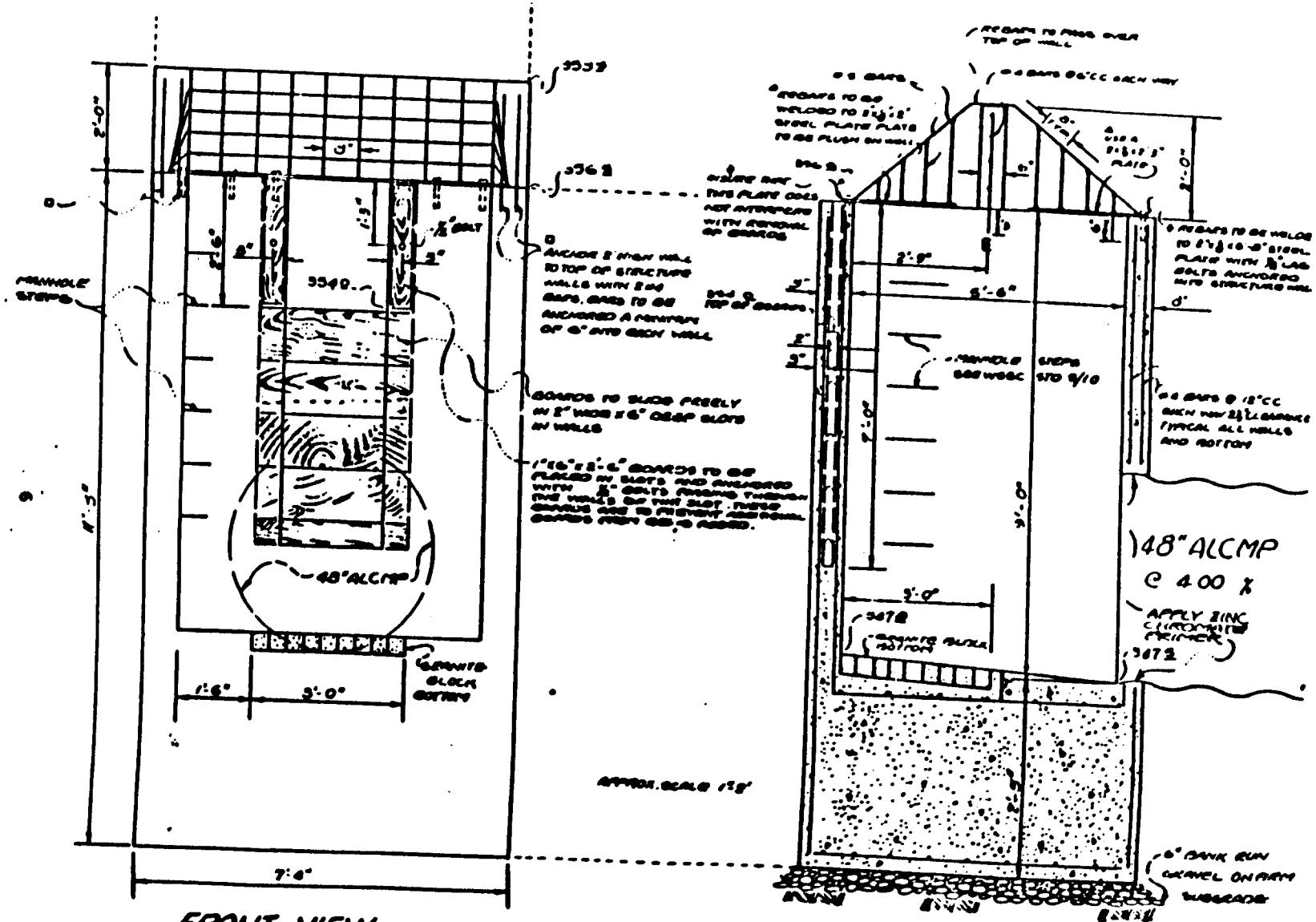

DETAIL SWM #3

OAK SPRINGS

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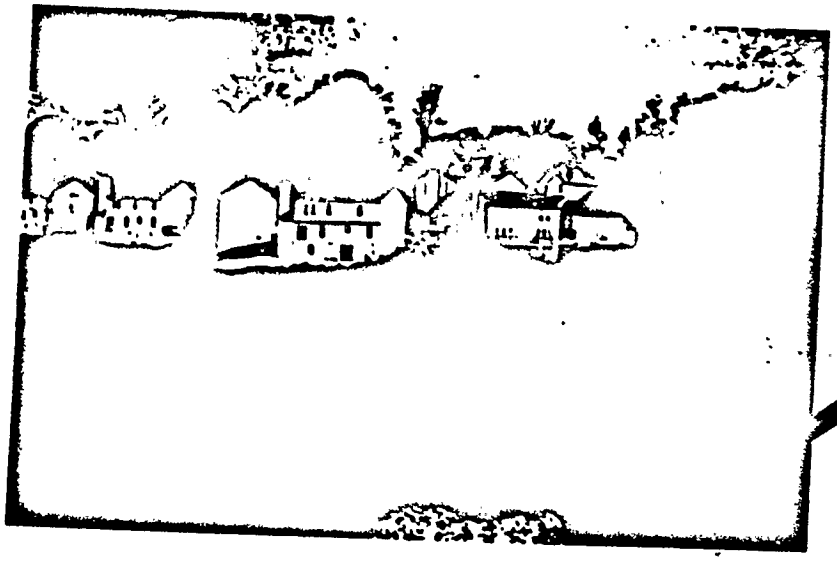
Appendix A: BMP Monitoring Sites
3. Tanglewood ED Dry Pond

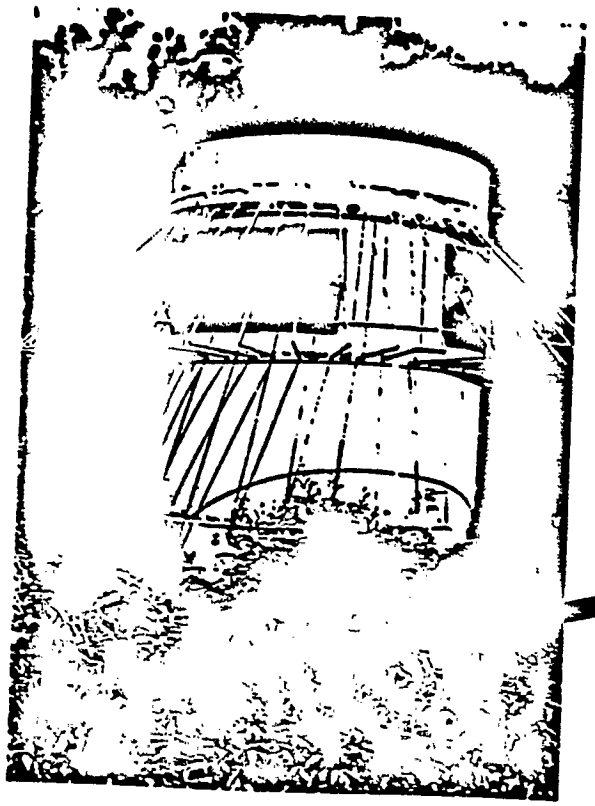


Earthen dam

Background/ Features

- DA to BMP: 195.0 ac.
- Imperviousness: 30%
- Full 2-year water quantity control
- ED water quality control

View of large,dry storage pool with partially shaded 500 ft. long pilot channel.



Low flow pipe features adjustable 18" gate valve for ED water quality control.

Low flow orifice

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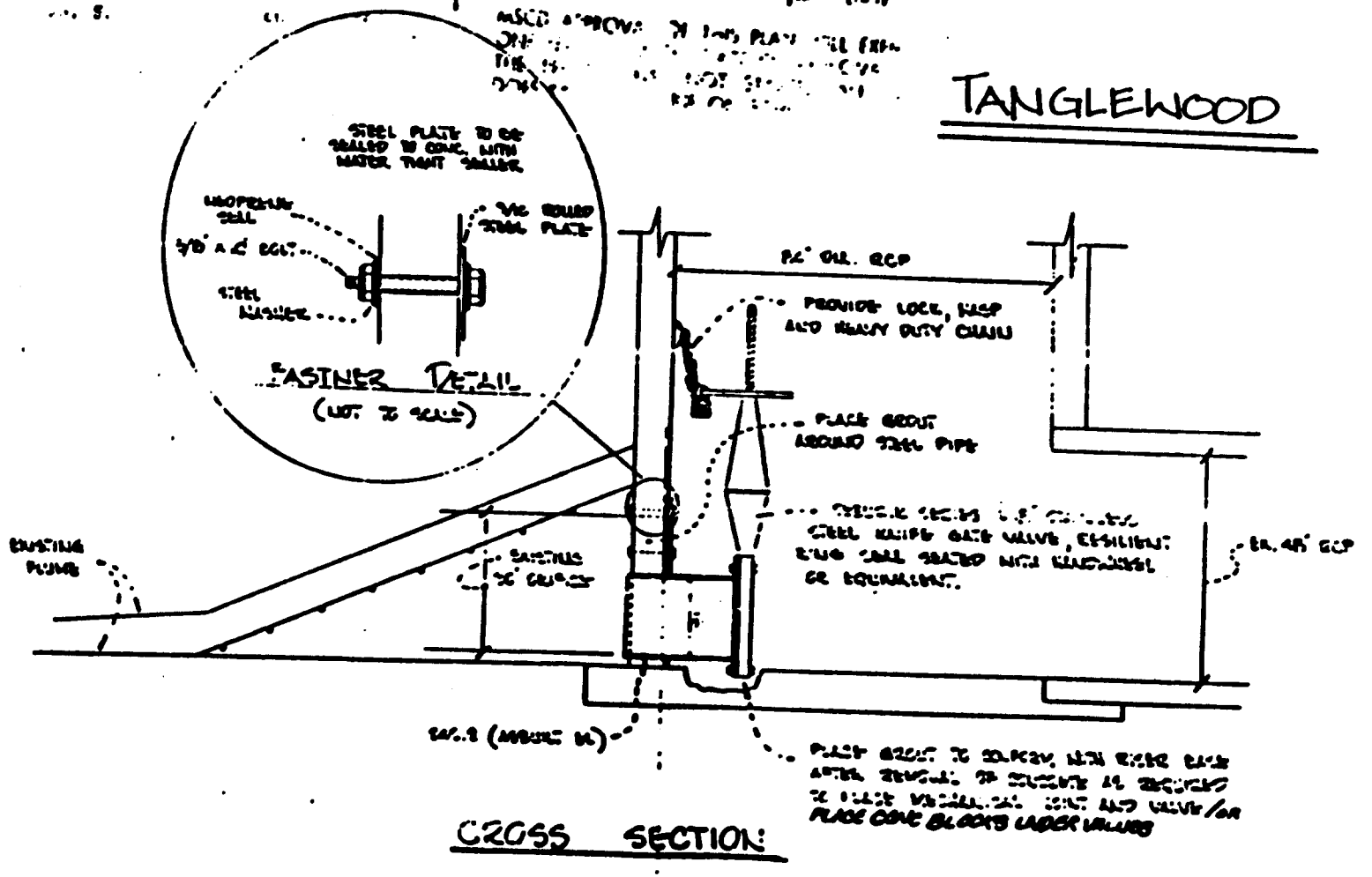

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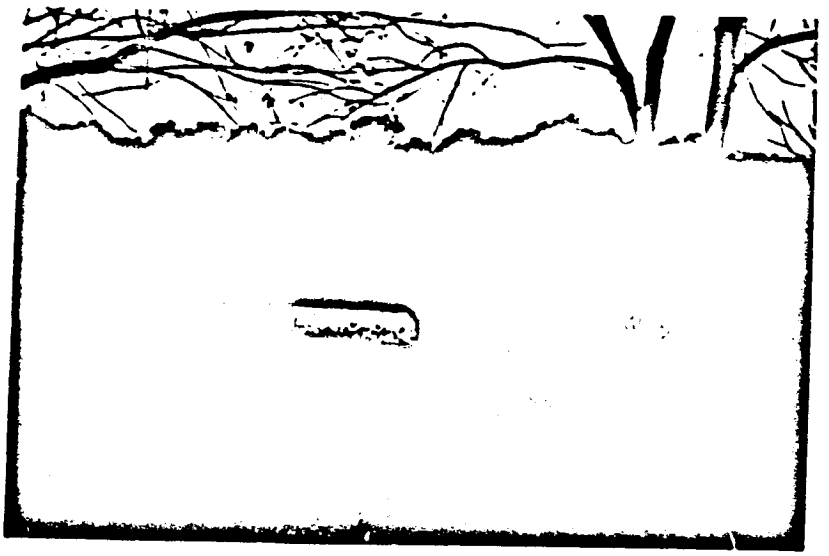
Appendix A: BMP Monitoring Sites
4. Countryside Wet Pond



Background/ Features

- DA to BMP: 165.0 ac.
- Imperviousness: 12%
- Full 2-year water quantity control
- Incidental water quality control
- Reverse sloping outlet pipe

1.5 surface acre wet pond with emergent fringe marsh.



View of 72"RCP barrel and 30 ft. wide rip-rap outfall area.

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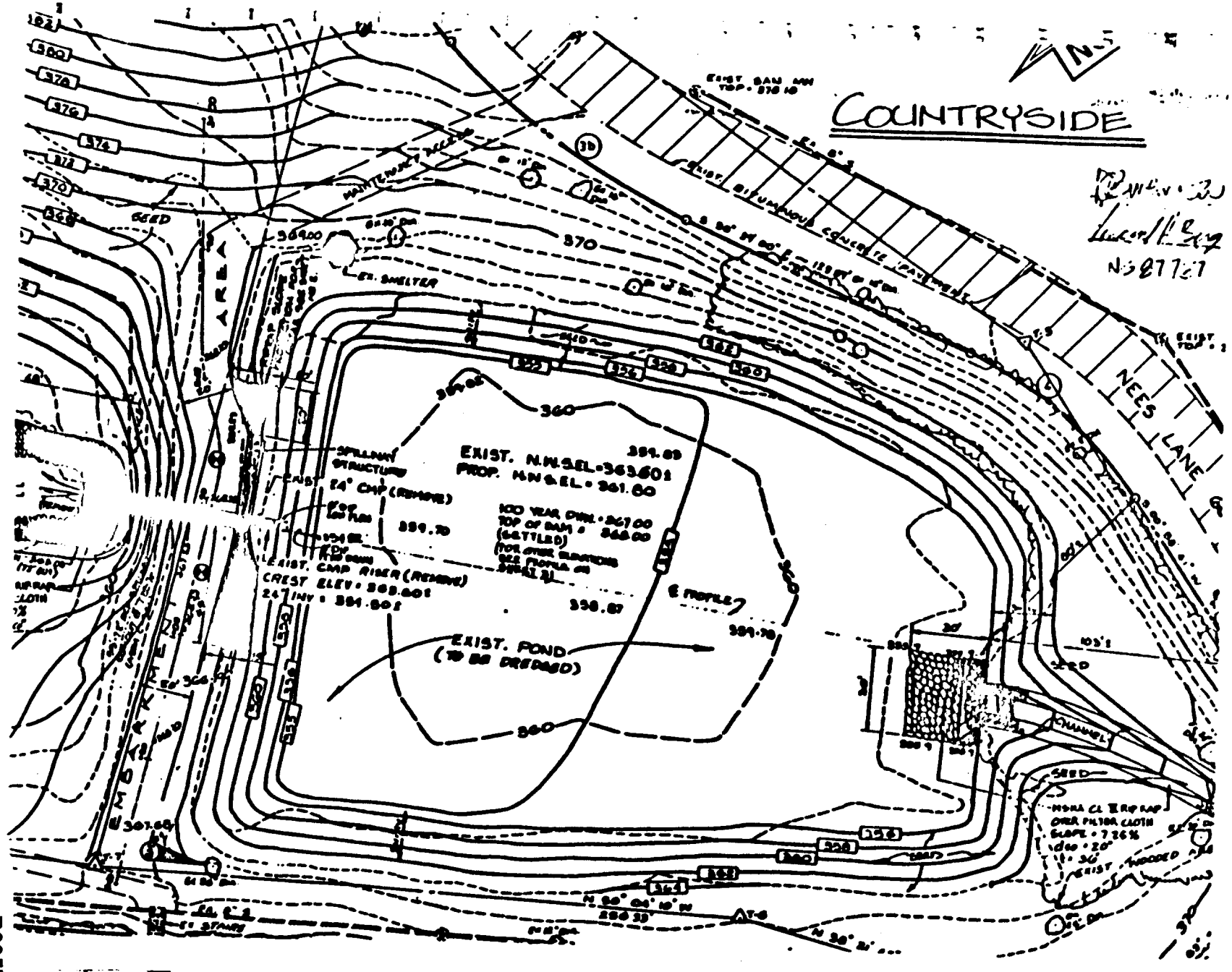

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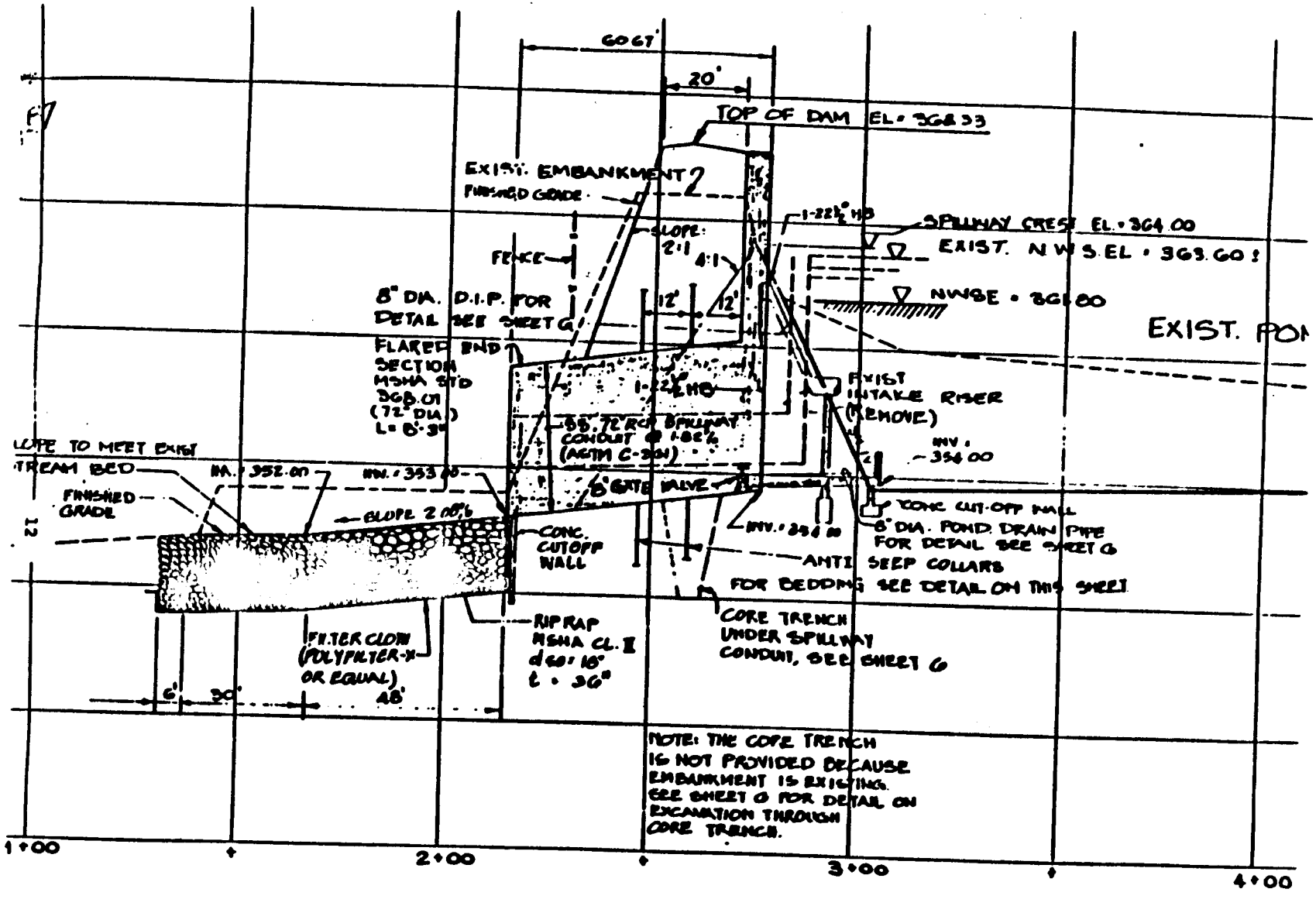

COUNTRYSIDE

PROFILE ALONG ℄ OF SPILLWAY

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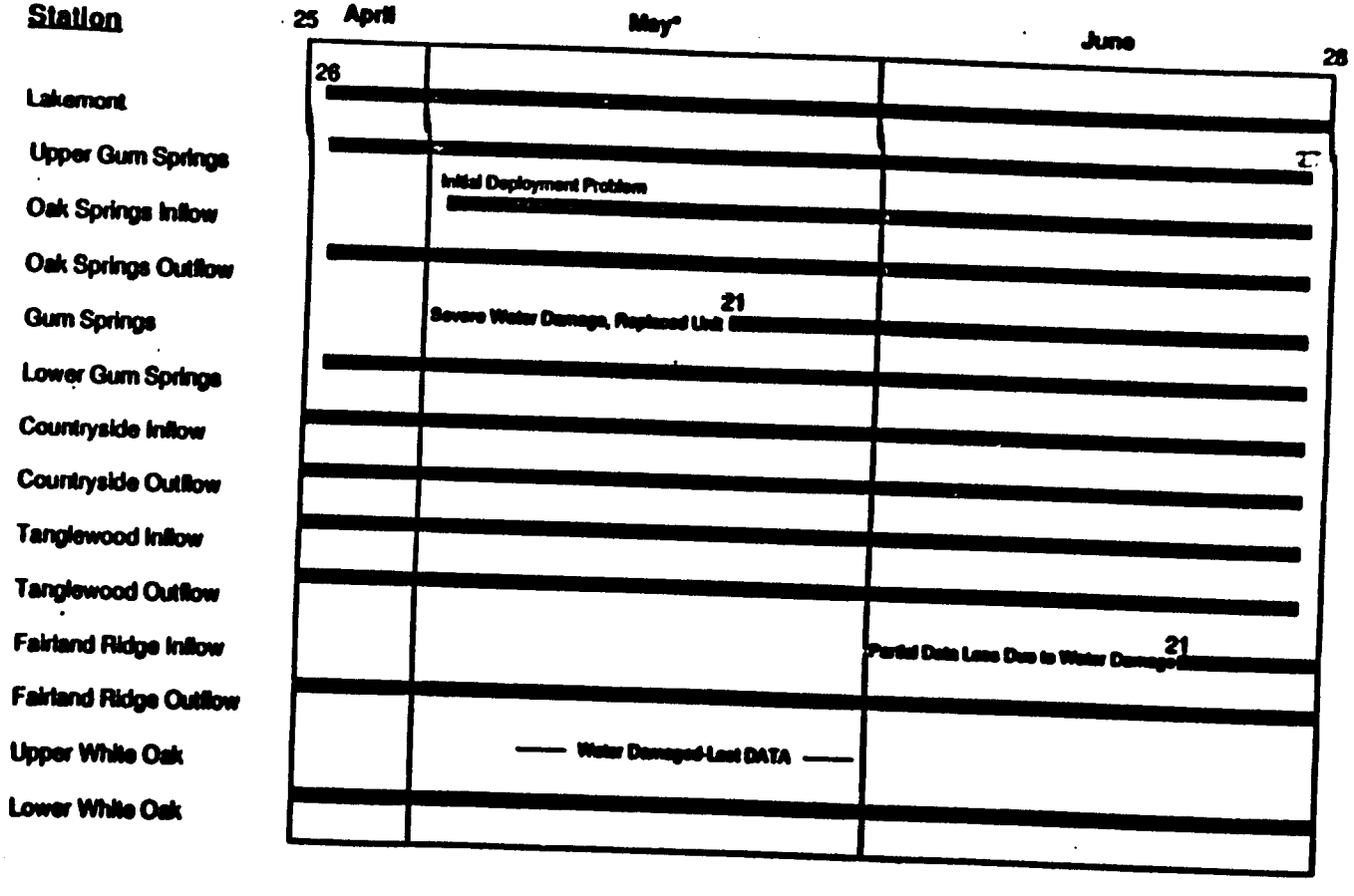
Appendix B

FIRST DEPLOYMENT PERIOD



* 10-year frequency storm event, May 6-7.

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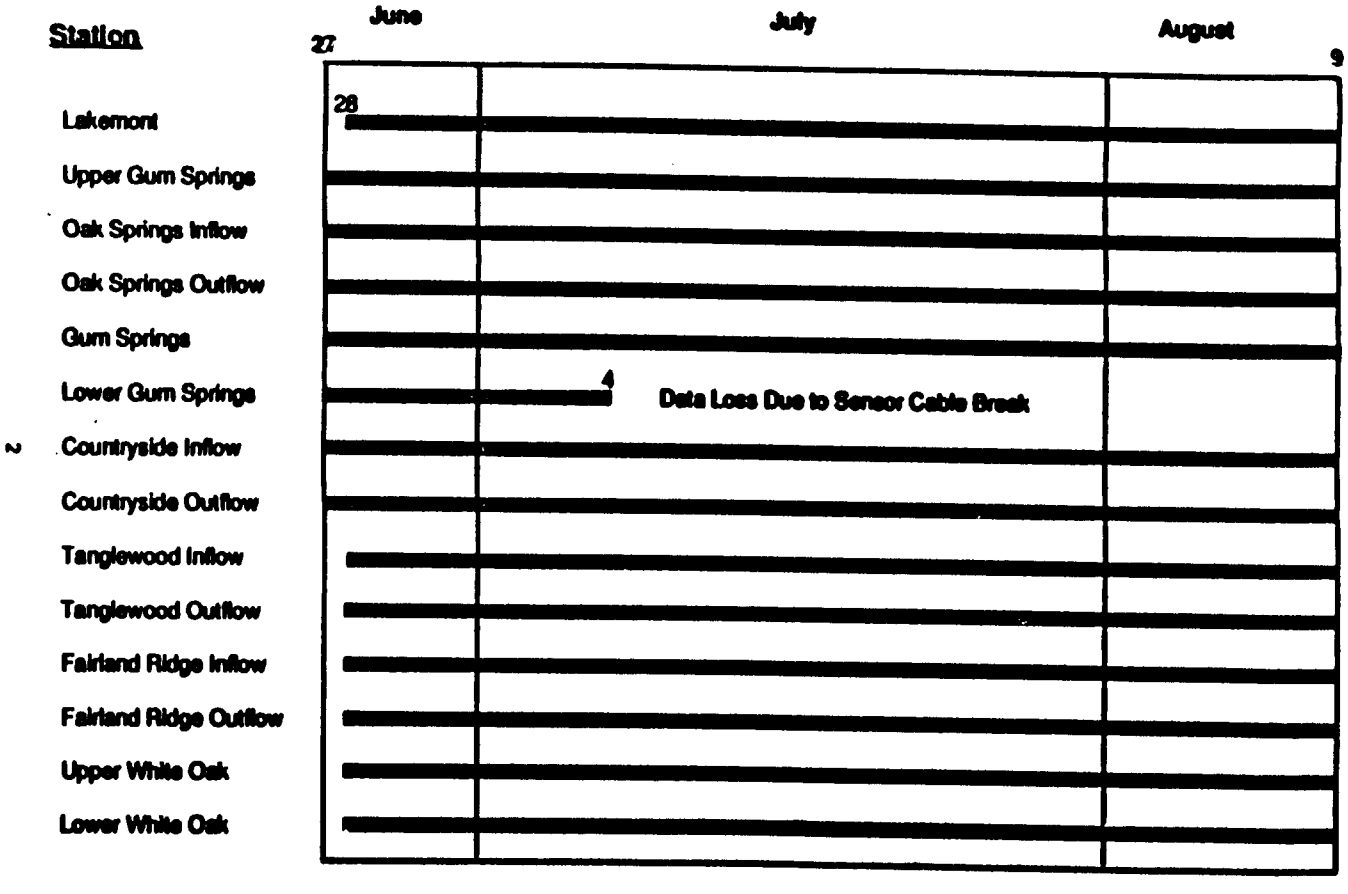
SECOND DEPLOYMENT PERIOD



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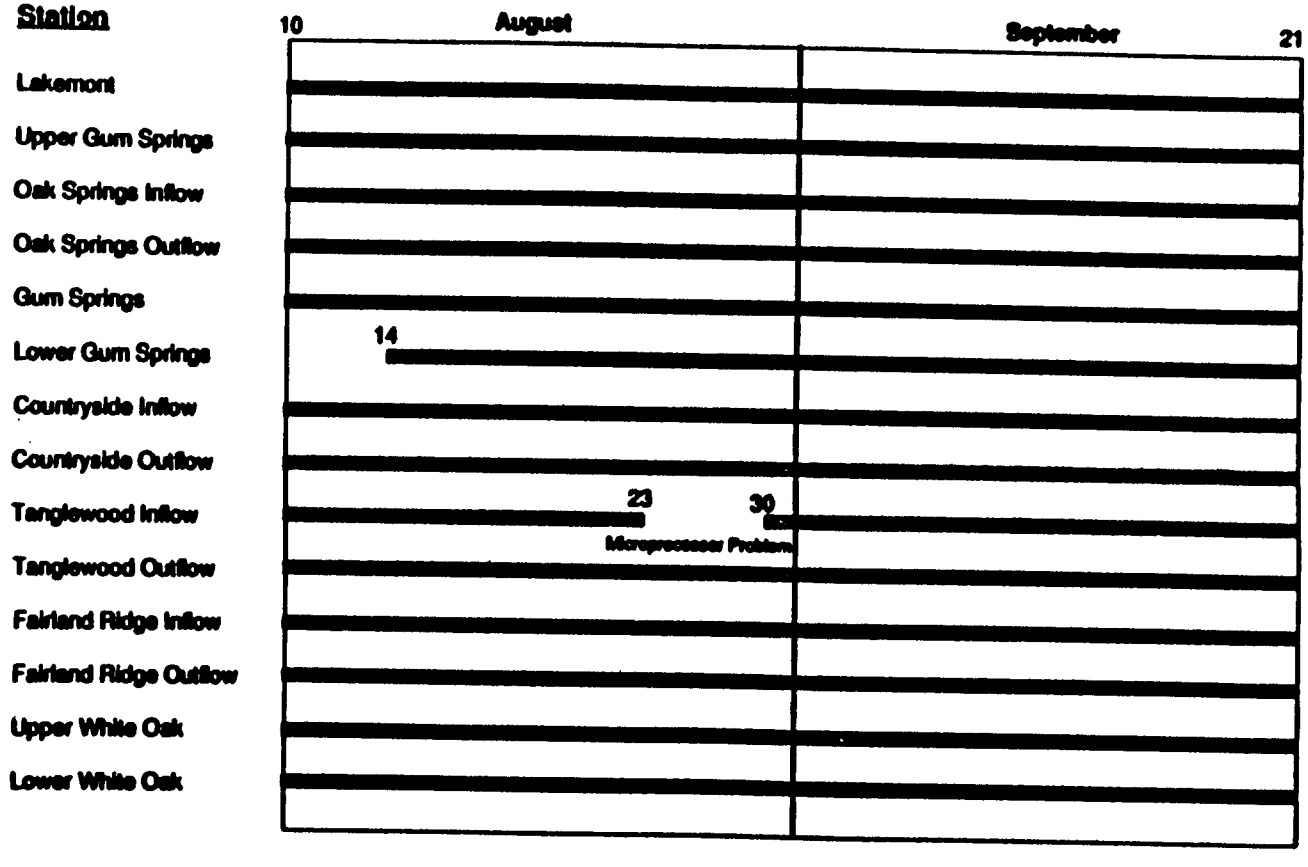
THIRD DEPLOYMENT PERIOD



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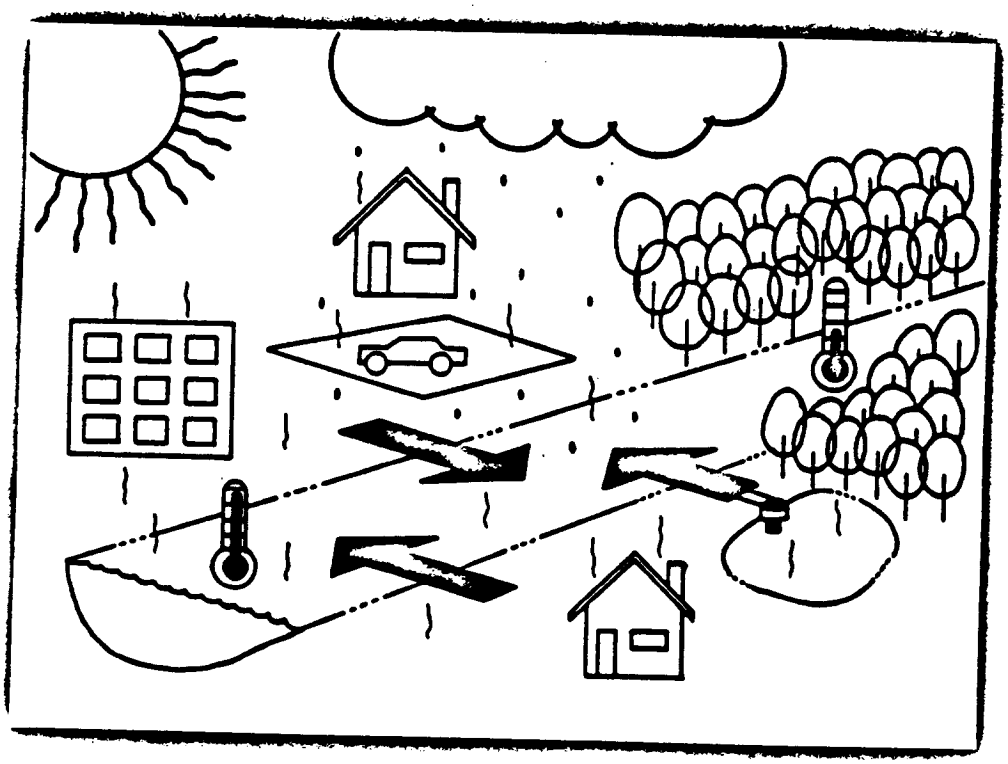
Thermal Impacts Associated With Urbanization and Stormwater Management Best Management Practices

Appendices



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For the:
Sediment and Stormwater
Administration of the
Maryland Department
of the Environment

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Appendix C.

Water Temperature and Freshwater Stream Biota: An Overview

Prepared by:

John Galli

Robert Dubose

Dept. of Environmental Programs
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A Technical Report Prepared For:

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Executive Summary

A comprehensive literature review was conducted in 1989 for the purpose of identifying the known or potential general effects of temperature regime modification on the biota of freshwater streams. The general temperature requirements for representative groups of stream biota, as well as, the principal environmental factors and human activities which influence water temperature were examined. The major findings of the study are summarized below:

- The water temperature of streams generally increases in a downstream, longitudinal fashion. Small headwater streams, which represent the largest overall group of streams, are normally cooler than larger main streams and rivers. Daily, seasonal, and annual temperature fluctuations are typically smaller in large rivers than in headwater streams.

- The volume of flow is the most important hydrologic variable influencing stream temperature. In general, thermal stability increases with increasing discharge. Groundwater inflow, via springs, etc., similarly increases the thermal stability of streams.

- Riparian vegetation has an overall moderating effect on the temperature of headwater streams. The removal of riparian vegetation can raise summer water temperatures by as much as 6-11°C and can lower winter temperatures by up to 4°C. Loss of shading can significantly alter the temperature and light regime of streams, thereby, possibly producing qualitative/quantitative changes within the resident biological community. It is further noted that all aquatic organisms are cold-blooded and therefore demonstrate little ability to acclimate or compensate for temperature changes.

- Urbanization generally alters both the flow and temperature regime of local receiving streams. Reduction of base flow, loss of riparian vegetation, and the rapid delivery of large volumes of warm or cold stormwater runoff are among the principal thermal regime modifying factors cited. Summer runoff temperatures in urban watersheds can exceed 32°C and winter runoff may be 3-4°C colder than ambient stream temperatures.

- The damming of streams and rivers also generally alters the downstream thermal regime. The degree of modification is primarily a function of the release depth of the facility, its thermal stratification characteristics, and its hydraulic residence time. In the middle-Atlantic states, surface release facilities typically shift the normal temperature cycles of the receiving stream. The general resulting pattern is one in which the stream is slower to warm in the spring, slower to cool in the fall, and warmer during the summer.

- Water temperature has considerable influence on a number of water quality parameters. This is particularly the case with regard to dissolved oxygen, which is, absolutely essential for all higher forms of aquatic

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life. The concentration of dissolved oxygen that is generally accepted as being the minimum required to maintain healthy warmwater and coldwater fish population and their support organisms, is 5.0 and 6.0 mg/L, respectively.

- Bacteria and fungi are the principal decomposers of organic materials in freshwater aquatic ecosystems. A high percentage of chromagenic bacteria present in a stream is generally indicative of non-thermally polluted conditions, whereas, the presence of thermophilic bacteria is indicative of thermal pollution. High or low temperature stress generally results in increased bacterial generation times, hence, reduced bacterial turnover rates and processing efficiency. Bacterial community diversity may be reduced at temperatures > 24.0-28.0°C and fungi are generally completely inhibited at temperatures $\geq$ 30°C.

- Based on their temperature requirements, freshwater algae are generally placed into one of the following categories: oligothermal - coldwater algae which are typically restricted to waters ranging between 0 and 15° C; mesothermal - algae which inhabit cool-warm water between 15 and 30°C; and euthermal - warmwater algae which exhibit their greatest abundance at temperatures $\geq$ 30°C. Diatoms, which are the overall dominant group of algae present in streams, are most abundant at temperatures 20-30°C. Water temperatures increases to 30°C and beyond generally causes a shift from a diatom- dominated community to one increasingly dominated by blue-green algae.

- In most freshwater ecosystems, aquatic insects are the largest group of macroinvertebrates present. Temperature greatly influences aquatic insect physiology, growth and development, reproductive success, and emergence. Water temperature regime increases of 2-3°C may be sufficient to eliminate sensitive insect species. In addition, many aquatic insects require fluctuating daily temperatures. Thermally constant conditions may therefore eliminate sensitive species.

- Water temperatures greater than 17°C have generally been considered to be above the optimum for many stoneflies, mayflies, and caddisflies, and temperatures exceeding 21°C have been shown to stress severely most coldwater organisms. As a group, stoneflies are the least temperature tolerant and are restricted to cold-cool flowing waters.

- Acclimation temperature and the period of exposure to temperatures outside the tolerance zone are the two most important factors which affect thermal tolerance and ultimately the lethal temperature of fish. Thermal stress can: negatively affect and disrupt feeding, disrupt the normal balance necessary for the initiation of spawning activities, reduce reproductive success, and predispose fish to disease and predation. Large rapid changes in water temperature (i.e., thermal shock) can be lethal when the normal escape swimming response is overwhelmed, or where no escape refugium exits. In general, juvenile

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fish are far more susceptible, because of their smaller body mass, to thermal shock than adult fish.

- Based on their temperature requirements, fish are generally placed into one of three categories:

Category	Stream Type	Physiological Optimum (°C)	Upper Lethal Temperature (°C)	Representative Species
Stenotherm	coldwater	< 20.0	< 26.0	trout & salmon
Mesotherm	coolwater	20.0 - 28.0	28.0 - 34.0	pikes, perch, darters, and most minnows
Eurytherm	warmwater	> 28.0	> 34.0	carp, goldfish, sunfish, bass, etc.

- The percentage of fish species expected to be lost from coldwater river systems is typically five percent or less at temperatures below 20°C, but increases dramatically at temperatures > 22°C. Conversely, in warmwater river systems the estimated percentage of fish species lost is less than five percent at temperatures < 30.0°C. At temperatures above 30°C a catastrophic loss of fish species is predicted to occur in these systems.

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Glossary of Terms

Acclimation Temperature - a relatively stable laboratory or field temperature, which fish and/or other organisms have physiologically adjusted to.

Anerobic - a condition in which no oxygen is present.

Coldwater Stream - cold streams which are generally capable of sustaining trout and/or their support organisms. The maximum summer water temperature in these streams seldom exceeds 21.0°C.

Coolwater Streams - streams which are too warm to support trout on a year-round basis, yet too cool to support a diverse warmwater fish community. Maximum summer water temperatures in these streams is typically less than 27°C.

Critical Thermal Maxima (CTM) - the upper zone of thermal resistance, generally characterized in fish by the loss of normal locomotary function and/or control.

Diapause - a dormant period in the life-cycle of aquatic insects brought about either by environmental factors (e.g., too hot or cold to permit normal activity) or through genetic programming.

Diurnal - having to do with a daily cycle, rhythm, or event.

Emergence - the life-cycle stage, normally the end stage, in which adult aquatic insects leave the water to mate and lay eggs.

Euthermal Algae - warmwater algae which are generally most abundant in streams when temperatures are $\geq$ 30°C.

Eurytherm - warmwater fish, which have a physiological optimum > 28.0°C. and an upper lethal temperature generally over 34°C.

Fecundity - the ability to successfully produce large numbers of healthy, viable off-spring.

Headwater Stream- typically, smaller tributary streams, whose stream order ranking is less than four (i.e., stream orders 1-3).

Lethal Temperature (LT) - temperature that is lethal to 100% of the tested specimens.

Lower Incipient Lethal Temperature (LILT) - the low temperature that is lethal to 50% of the tested specimens.

Mesotherm - coolwater fish, which have a physiological optimum in the 20-28°C range and upper lethal temperature of 28-34°C.

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Mesothermal Algae - algae which inhabit cool-warm temperature habitats between 15 and 30°C.

Molting - the process by which aquatic insects, as well as other macroinvertebrates, shed and replace their exoskelton in order to permit additional growth in body size.

Oligothermal Algae - coldwater algae, which are generally restricted to water ranging between 0 and 15°C.

Periphyton - algae which are attached to rocks, wood or other objects on the streambed.

Physiological Optimum - the temperature or temperature range in which all life processes/functions occur at their optimal level(s).

Phytoplankton - free-floating or swimming algae present in the water column.

Refugium - a protected stream or reach which provides long-term safety, for aquatic biota, from either natural or human perturbations.

Resistance - the capacity, usually measured in time, of an organism to withstand temperatures which are outside of the tolerance zone.

Stenotherm - coldwater fish, which have a physiological optimum < 20°C and an upper lethal temperature < 26°C.

Stream Order - a system for classifying streams based on morphological-tributary branching characteristics. Under this system, streams without any tributaries are deemed first-order. Second order streams are formed below the confluence of two first-order streams, third-order streams are formed downstream of the confluence of two second-order streams, and so on and so forth.

Temperature Conversion Factor - Farenheit = 1.8 x °C + 32.

Thermal Capacity - the ability of a stream to store and/or retain heat.

Thermal Constancy - a prolonged, static condition in which water temperature fluctuations are generally less than 1°C.

Thermal Shock - a large and rapid change in ambient water temperature which may negatively affect resident stream biota.

Tolerance - the ability of an organism to function indefinitely under temperature conditions which are outside of the physiological optimum.

Upper Incipient Lethal Temperature (UILT) - the high temperature that is lethal to 50% of the tested specimens.

Warmwater Stream - generally larger, low-gradient streams in which maximum summer water temperatures may exceed 30°C.

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Introduction

Life in all aquatic environments has its species composition and activity regulated by water temperature. Because all aquatic organisms are cold-blooded, or poikilothermal, the temperature of the surrounding water regulates their metabolism and ability to grow, reproduce and survive effectively. The well-known role of water temperature as a catalyst, depressant, stimulator, controller and killer of biota makes it the single most important physical parameter governing aquatic ecosystems. It is equally understood that temperature controls and directs a broad array of biological and chemical processes and activities in these systems.

Human activities such as agriculture, silviculture, industrial/power plant operations, urbanization, and the damming of rivers and streams are widely recognized as having the capacity to alter significantly both the thermal regime of the receiving body of water and the biological communities contained therein. Effects upon the receiving system can be subtle or profound, depending upon the extent of the departure from the normal temperature regime and the sensitivity of the resident biota. The growing concern over the potential thermal impacts to Maryland's freshwater streams, from both urban stormwater runoff and the various Best Management Practices (BMP's) employed for its control, provided the impetus for this study.

It is the purpose of this report to provide the reader with a broad overview of known, or potential, general effects of temperature regime modification on stream biota. In order to accomplish this objective a two-part, holistic ecosystem approach was required. Part one examined both the principal environmental factors and various human activities which influence the thermal regime of streams. Part two investigated the general thermal requirements of stream biota as well as the potential biological

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affects associated with thermal regime modification. Potential biological consequences occurring at all general levels of the aquatic food chain were researched.

Data on temperature preference, lethal temperature limits, temperature induced metabolic stress, disruption of normal life cycles, impaired growth, behavioral and other stresses to aquatic life, related to water temperature is also summarized. It should be noted that special emphasis was placed upon collecting data for fish known or expected to occur in Maryland freshwater streams.

For organizational purposes this report has been divided into eight sections. In the first section, background information on the environmental factors which shape the temperature regime of natural streams is presented. The second section examines human activities, such as urbanization, and their influence on stream temperature regime. In the third section, major temperature-dissolved oxygen relationships are briefly outlined. The fourth section provides both insight into the important role which bacteria and fungi play in aquatic systems, as well as, temperature-related findings. The general temperature and light requirements, classification and seasonal distribution of algae are identified in the fifth section. Section six outlines the physiological/temperature requirements of some of the more important groups of aquatic insects. The general physiological/temperature requirements for 63 species of fish, known or expected to occur in Maryland freshwater streams, are featured in section seven. The eighth and final section, focuses on trout and their special temperature requirements. Additional temperature-related data is also presented in the appendices.

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I. Environmental Influences on Stream Temperature

Distance From Source, Topography and Riparian Vegetation

It is well known that the temperature regime of streams under natural conditions is greatly influenced by climate, and that temperature changes with distance from the source. In general, water temperature increases in a longitudinal fashion (Figure 1). Headwater streams, stream order 1-3, are typically cooler than larger main streams and rivers (stream order 4 and above). The significance of this takes on added meaning in light of the fact that approximately 85 percent of the total stream mileage in the continental United States is comprised by headwater streams (Karr & Schlosser, 1977). Thermal changes occurring downstream from the source are largely determined by meteorological conditions, topography, riparian vegetation, and hydrological conditions.

In his study of small streams, Macan (1958) observed that these streams warmed up and reached equilibrium within very short distances from their sources. This is due to the responsiveness of the relatively small volume of water to both atmospheric variations and prevailing local conditions. Under natural conditions, headwater streams in temperate latitudes often exhibit annual temperature fluctuation ranges greater then 20°C (Ward & Stanford, 1979). Daily or diurnal fluctuations of 6°C are quite common during summer months and temperature variations as great as 14°C have been reported (Ward & Stanford, 1979).

Headwater streams are also subject to the influence of local conditions

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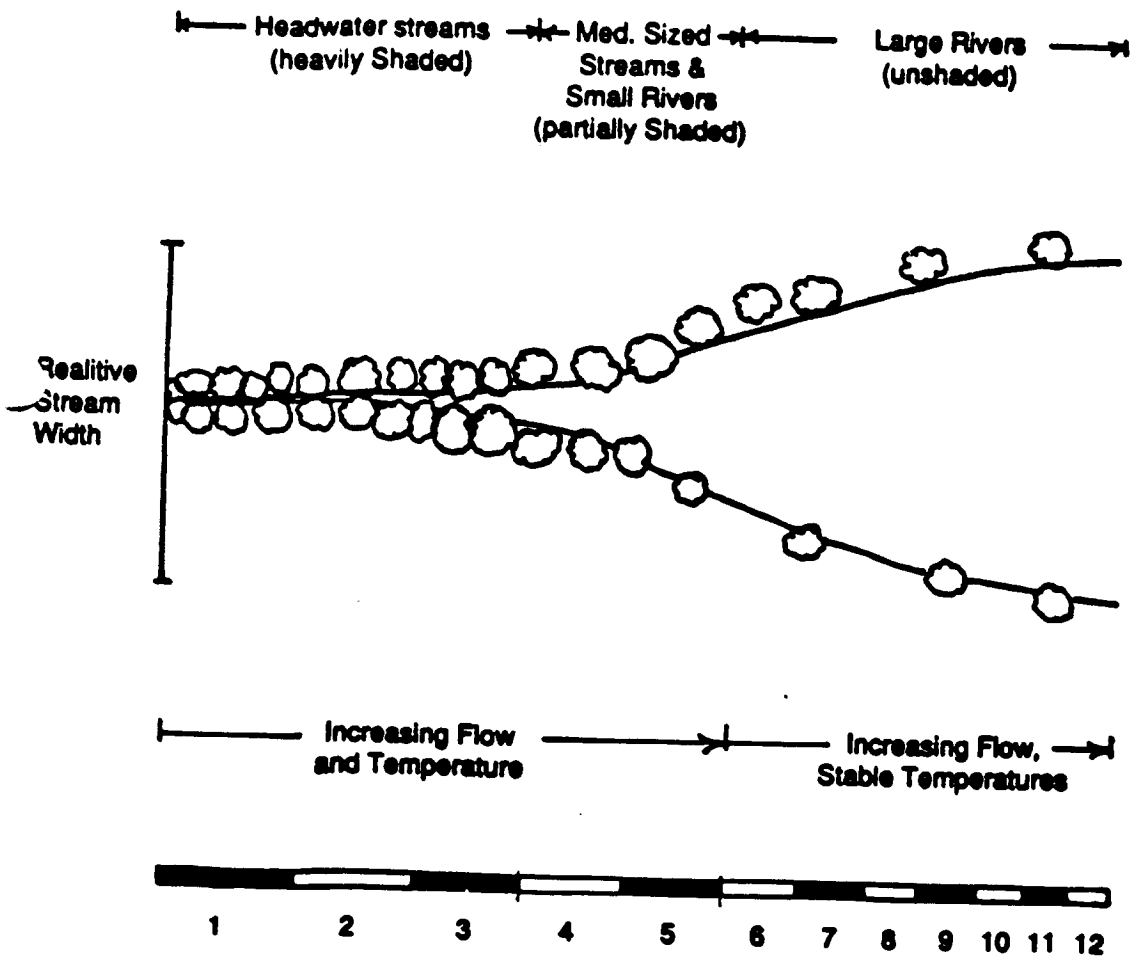
Figure 1

General Relationship Between Flow, Canopy Coverage, and Water Temperature Versus Relative Distance from Source



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such as shading by canyon walls, steep undercut banks, and riparian vegetation. The extent to which the surface of a stream is exposed or shaded from direct solar radiation and its heating effect is determined by the topographic relief and aspect, in combination with channel form and riparian vegetation (Smith & Lavis, 1975).

Stream Discharge and Air Temperature

Of the various hydrological variables influencing the thermal regime of streams, the volume of discharge is generally regarded as being the most important. Flow variations directly affect the heat or thermal capacity of a stream (i.e., its ability to store and/or retain heat).

In general, the lower the discharge, the lower the capacity for heat storage and the more responsive the stream becomes to temperature changes via heat inputs (i.e., gains or loses heat more readily). At lower levels of discharge the prevailing water temperature is heavily dependant upon air temperature and other local environmental factors (Smith & Lavis, 1975). Conversely, an increase in flow will raise the thermal capacity of the stream (i.e., more energy will be required to either raise or lower its water temperature). As discharge generally increases in a downstream direction with increasing stream order, so to does thermal stability. In addition, during periods of high discharge the thermal conditions of the headwaters extend further downstream (Ward & Stanford, 1979).

Mean, maximum and minimum stream temperatures are greatly influenced by both the volume of discharge and local air temperature. Typically, the mean

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monthly temperature of a natural stream is within a few degrees of the mean monthly air temperature when the air temperature is above freezing (Macan, 1958). In addition, the maximum water temperature in any of the warmer months is usually from 1-3°C higher than the mean monthly air temperature (Pluhowski, 1970). In much of North America, air and water temperatures both reach their respective maximums in July. During July, the maximum daily water temperature will generally average 3-4°C higher than the mean monthly water temperature for that month (Pluhowski, 1970).

Groundwater Input

Contributory aquifers which supply baseflow to streams also exert considereble influence on the water temperature regime. As a rule, groundwater has a major stabilizing effect on stream temperature. Streams which receive significant inputs of groundwater exhibit less daily and seasonal temperature variability than those receiving smaller amounts of groundwater. Spring-fed streams also tend to be cooler in summer and warmer in winter. The temperature of a spring is closely correlated to the depth of its groundwater source. Springs which have shallow groundwater sources tend to be warmer than those originating from deeper sources/strata.

In a study of the thermal characteristics of 76 springs in the Piedmont and Appalachian Provinces of Maryland, Otton and Hilleary (1985) reported maximum, minimum and median water temperatures of 19.2°C, 1.0°C, and 11.0°C, respectively. The same investigators also noted that the mean annual water temperature of these springs was within 1-2°C of the mean annual air temperature of the locality.

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II. General Impacts of Human Activities on Stream Temperature and Biota

The number and types of human activities in a watershed which may affect stream temperature and the resident biological community are many, complex, and generally interrelated. Given the limited scope of the study, major emphasis was necessarily placed upon summarizing temperature findings relevant to freshwater streams present in the Middle-Atlantic States. In an attempt to facilitate reader understanding, a simplified graphical summary of the general thermal impacts of watershed perturbations has been included as Figure 2. Specific temperature information is presented in this and the following six sections.

Loss of Vegetative Cover

The moderating influence of vegetation, particularly forest-type vegetation, on watershed micro-climate and stream temperature is widely recognized. Trees shelter both ground and stream surface from the sun's rays, reduce wind velocities near the ground, and generally lower the evaporative loss of water. In the same way, riparian vegetation functions as a thermal insulator for streams. The removal and/or addition of riparian vegetation can either raise, lower, or maintain stream temperatures.

Several studies have shown that the partial and/or complete removal of riparian vegetation along headwater streams can raise summer water temperatures by as much as 6-11°C and can lower winter temperatures by up to 4°C (Gray & Eddington, 1969; Hewlett & Forston, 1982; Lynch et al., 1980;

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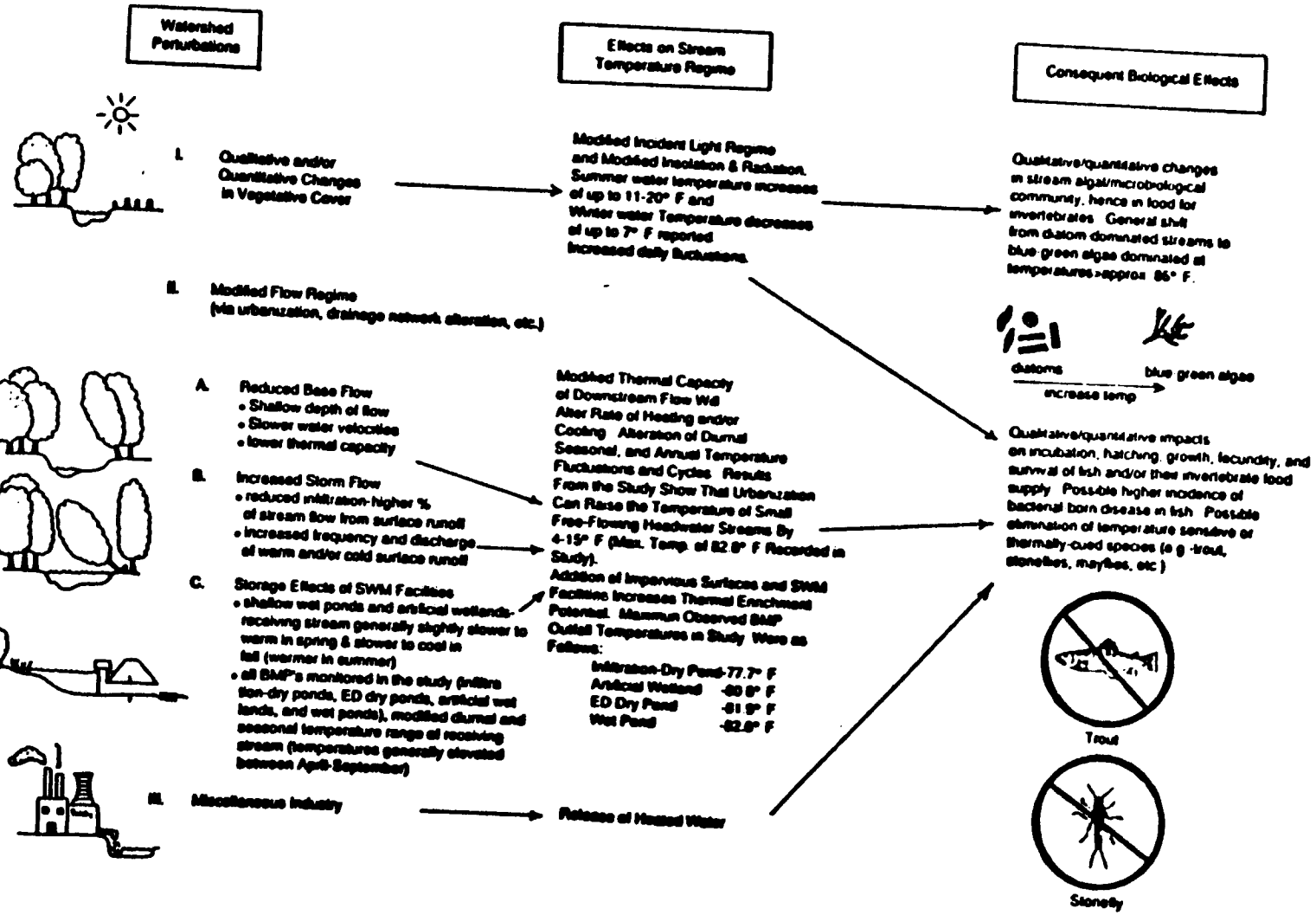
Figure 2

Summary: General Impacts of Human Activities on Stream Temperature and Biota



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Klein, 1979; Karr & Schlosser, 1977). In addition, the removal of riparian vegetation can modify the incident light regime.

As illustrated in Figure 2, the modification of a stream's light and temperature regime may, depending on the degree of change and stream sensitivity, produce qualitative and/or quantitative changes in the biological community. In addition to possible changes in the algal-microbial food base, changes may also be felt at higher levels within the food chain. If the modification of the temperature and light regimes is particularly severe, it may become energetically impossible for sensitive species to continue living in the area. Under this scenario, a shift in community structure would probably occur; with sensitive species being replaced by more tolerant and possibly less desirable ones.

Flow Regime Modification

The hydrology of a stream changes in response to the nature and level of activities within its watershed (Figure 2). This is particularly the case when a watershed experiences the effects of urbanization. In a typical, moderately developed watershed, trees and other natural vegetation are replaced with impervious surfaces such as streets, parking lots and roof tops. The replacement of natural vegetation with impervious surfaces can increase local air and ground temperatures by as much as 12°C (Pluhowski, 1970; McPherson, 1990). Rainfall, which previously percolated into the soil to replenish groundwater supplies, is increasingly converted into surface runoff. Natural drainage networks are altered or permanently destroyed through a variety of grading, channelization and stream enclosure activities

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designed to speed up the efficient removal of this runoff. Previously unregulated streams may also be dammed for water supply, stormwater management control, or a variety of other uses. The general direct and indirect effect of all these development-related changes on the flow and temperature regime of streams, exclusive of impoundments, are listed below:

- Higher peak discharges and increased volume of runoff per storm event: if storm flows are not effectively controlled, the receiving stream channel may widen by as much as two to four times over its original size (Schueler, 1987). The net effect is a reduction in both depth of flow and velocity during baseflow conditions. This, in combination with loss of bank-side vegetation, greatly increases both the amount of exposed stream surface area and length of time a unit volume of water is subject to the heating effects of solar radiation.

- Reduction in both groundwater input and associated baseflow levels resulting from the reduced level of infiltration in the watershed. This has the general double-effect of raising summer stream temperatures and lowering winter water temperatures (i.e., reduced thermal capacity). In particularly severe cases, small perennial headwater streams may become seasonally or completely dry;

- Rapid delivery of large volumes of warm or cold stormwater to the receiving stream: during certain summer storm events, runoff temperatures may exceed 32°C (Galli, 1988). Conversely, winter storm runoff may be as much as 3-4°C colder than the ambient

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temperature of the receiving stream (Pluhowski, 1970).

Storage Effects of Impoundments

The extent to which artificial lakes, ponds, and marshes modify the temperature regime of a receiving stream is primarily a function of release depth (which changes relative to the impoundments water surface elevation), the thermal stratification characteristics of the facility, and the hydraulic residence time (Wright, 1967). Changes to the receiving stream's thermal regime generally fall under six broad categories;

- Increased diurnal constancy;
- Increased seasonal constancy;
- Summer temperature depression;
- Summer temperature elevation;
- Winter temperature elevation; and
- Thermal pattern changes.

In the temperate region, surface release facilities generally shift temperature cycles (slower to warm in the spring, slower to cool in the fall) and increase the seasonal temperature range (warmer in summer), rather than producing seasonal thermal constancy in the receiving streams (Kondratieff &

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Voshell, 1980). Daily stream temperature fluctuations below surface release facilities are primarily a function of the mean depth of the facility. Very shallow ponds or marshes tend to amplify diurnal fluctuations, whereas deeper impoundments attenuate daily temperature changes. Deep hypolimnial release reservoirs typically produce seasonal thermal constancy in the receiving stream (winter-warm and summer-cool). Despite potentially great modification of the diurnal and seasonal temperature regimes, mean annual stream temperatures may not be greatly modified by impoundment.

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III. Temperature - Dissolved Oxygen Relationships

The role of water temperature in influencing various water quality parameters and regulating biological communities cannot be overemphasized. This is particularly true with regard to dissolved oxygen, which is absolutely essential for the existence of all higher aquatic life. As seen in Table 1, an inverse relationship exists between temperature and the capacity of water to hold dissolved oxygen (i.e., as water temperature increases dissolved oxygen levels decrease).

TABLE 1. RELATIONSHIP BETWEEN TEMPERATURE AND MAXIMUM DISSOLVED OXYGEN CONCENTRATION IN WATER

Temperature °C	Maximum Oxygen Concentration (ppm)
0	14.6
10	11.3
20	10.7
30	7.6

Low dissolved oxygen levels can effect negatively the metabolism, respiration, behavior, distribution, migration, feeding rate, growth and reproduction of aquatic organisms. It can further increase their susceptibility, via increased stress levels, to a wide variety of toxic substances. Ultimately, if the reduction of dissolved oxygen is sufficiently extreme, death of the organism and perhaps the entire aquatic community may

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ensue.

Anaerobic (zero oxygen) conditions at the sediment-water interface can also cause the release of nutrients, metals, and/or toxic substances, from the sediment into the overlying water column; thereby exacerbating water quality conditions. However, due to the natural turbulent flow of streams and their high reaeration potential, the preceding anaerobic scenario would only occur during periods of exceptionally low discharge and/or high organic pollutant loadings.

The concentration of dissolved oxygen which is generally accepted as being the minimum required to maintain healthy warmwater and coldwater fish populations and their support organisms, is 5.0 and 6.0 mg/L, respectively (EPA, 1976). However, the oxygen content of water cannot be used as an absolute value without taking both temperature and water velocity into consideration. Studies have shown that most species of aquatic insects and fish are able to tolerate short periods of low oxygen stress that may occur in streams if water temperatures are low and/or water velocities are relatively high. (Nebeker, 1972; Nebeker, 1973; Hoar & Randall, 1971).

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IV. Bacteria and Fungi

Often overlooked, bacteria and fungi (together with algae) are the foundation upon which the aquatic food chain rests (Figure 3). Bacteria and fungi are primarily responsible for the decomposition of both particulate and dissolved organic materials present in aquatic systems. In addition, bacteria and fungi contribute to the recycling of inorganic nutrients and, where there is organic pollution present, to self-purification. These organisms serve as an important food item for many macroinvertebrates, particularly leaf shredders and filter-feeders. The vast majority of bacteria and fungi present in aquatic systems are essential and highly beneficial. However, a very small minority are pathogenic, causing disease in fish and other life forms (including humans).

The general role which bacteria and fungi play in aquatic systems is reasonably well understood. Unfortunately, relatively little information is available concerning changes in the natural microbial community structure and function resulting from thermal stress and thermal regime alteration. The following is an attempt to list, by category, some of the temperature-related findings and, where possible, identify important ecological linkages.

Water Temperature and Bacterial Communities

- Water temperature, not dissolved oxygen, is considered to be the most

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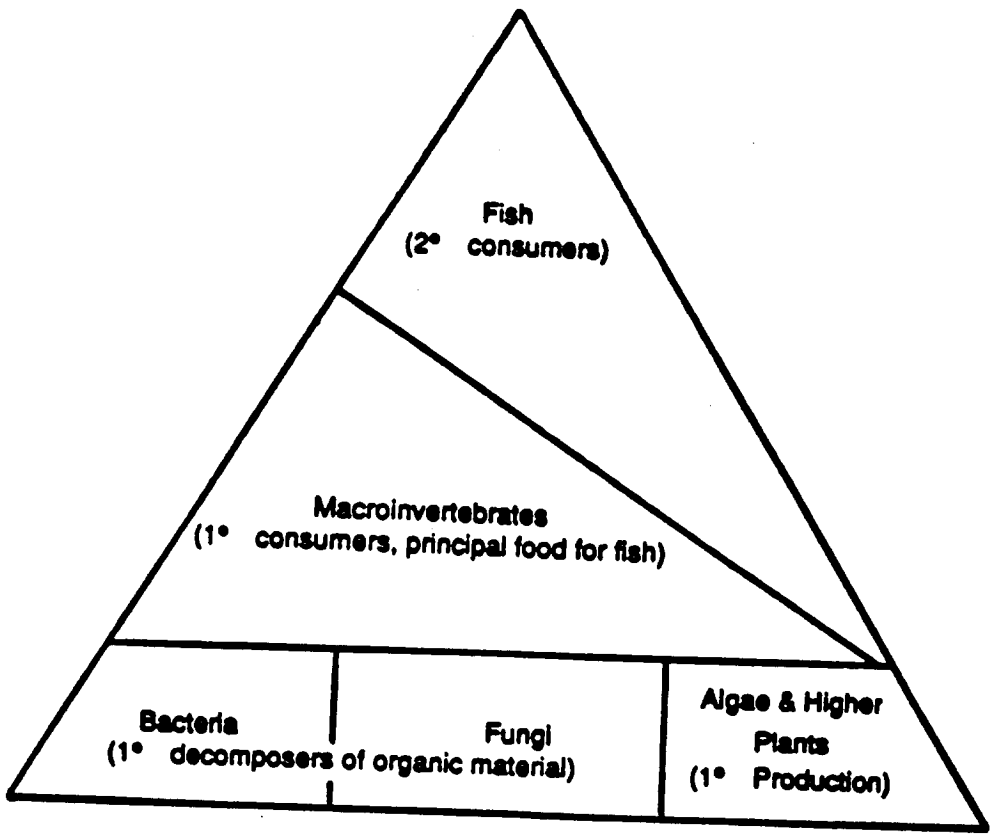
Figure 3

Conceptual Food Chain for Freshwater Ecosystems



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influential regulator of bacterial populations;

- Three groups of bacteria may be classified by their temperature requirements:

	Temperature (°C)		
	Minimum	Optimum	Maximum
Psychrophils (cold-loving)	-10 to + 5	+10 to +20	+13 to + 25
Mesophils (intermediate)	+10 to +15	+30 to +40	+30 to + 50
Thermophils (heat-loving)	+25 to +45	+50 to +75	+75 to +100

The preceding groups and boundaries are not sharply defined and the cardinal points are affected by other factors, such as nutrients, salinity, pH, and/or metabolic products;

- High or low temperature stress generally results in increased bacterial generation times, hence, reduced bacterial turnover rates and processing efficiency;

- Bacterial community diversity may be reduced at temperatures greater than 24-28°C;

- A high percentage of chromagenic bacteria, i.e., > 10 percent of total bacterial population, present in a stream is generally indicative of non-thermally polluted conditions. Conversely, the presence of Thermus aquaticus and/or other thermophilic bacteria is generally indicative of

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thermal pollution.

- Chromagenic bacteria are most abundant at temperatures between 20 and 28°C (20-22°C optimal). However, sustained temperatures in the 26-28°C range are considered inhibitory;

- The lethal temperature for bacteria is generally not far above their optimum temperature range; and

- Results of bacterial studies conducted in White Clay Creek, Pa. (Bott, 1975), suggest that some bacterial communities may be better adapted to stream temperatures which are higher than the actual ambient temperatures.

Leaf Processing

- Bacteria and fungi are important in mediating the processing and cycling of leaf material and serve as an important component in the nutrition of aquatic invertebrates;

- Leaf-shredding/consuming aquatic invertebrates are in essence, fungivores who select leaves largely on the basis of the degree of microbial colonization;

- In temperate stream systems, fungi dominate the microbial biomass during the initial phases of processing deciduous leaves. Bacteria dominate the

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latter phases of leaf processing;

- The temperature optimum for leaf processing for both fungi and bacteria appears to be 15-22°C, with bacterial optimums in the 18-22°C range;

- Many aquatic fungi exhibit poor growth at temperatures ≥ 25°C and are completely inhibited at temperatures ≥ 30°C.

Bacterial Fish Pathogens - Aeromonas sp.

- Aeromonas are a group of bacteria which cause "red sore" disease in fish and are also responsible for soft-tissue infection in scuba divers. The symptoms of red sore disease include scale erosion and sloughing, purulent lesions, and bleeding of the fins. Red sore disease is common in the southeastern United States and affects many important game fish such as largemouth bass;

- Aeromonas's survival in aquatic environments is enhanced at higher water temperatures (i.e., ≥ 30°C). It generally does not grow well at temperatures ≤ 15°C. Thus, it is present in very low numbers during seasons when the water temperature is low or in colder aquatic habitats;

- High infection levels in fish may well be related to the length of survival of Aeromonas in the water column (i.e., the longer the survival of Aeromonas the greater the potential exposure length for fish).

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V. Algae

Based on their general community type, the algae of aquatic ecosystems are placed into one of two categories: 1) periphyton (algae which are attached to rocks, wood or other bottom objects) and 2) phytoplankton (free-floating or swimming algae present in the water column). Along a stream continuum, periphyton are commonly associated with headwater streams, whereas, phytoplankton become generally more abundant as one proceeds downstream, from large streams to rivers. Typically, periphyton are more abundant in headwater streams because the relatively shallow depth of flow and lower overall turbitity of these streams allows light to penetrate all the way to the bottom. In larger turbid streams and rivers, periphyton are often restricted to shallow, margin areas.

General Temperature and Light Requirements

Light, water temperature, and flow are generally considered to be the primary factors regulating algal communities (Patrick, 1977). Most freshwater algae cannot grow at very low light intensities and appear to also be inhibited by high light intensity (Whitford & Schumacher, 1968). In addition, "every species of algae has a range of temperature tolerance, which is generally fairly wide, and a narrower range, typically near the upper end of the tolerance range in which optimum growth occurs" (Patrick, 1974).

The general temperature and light requirements and classification of the major groups of freshwater algae are summarized in Figure 4.. As seen in

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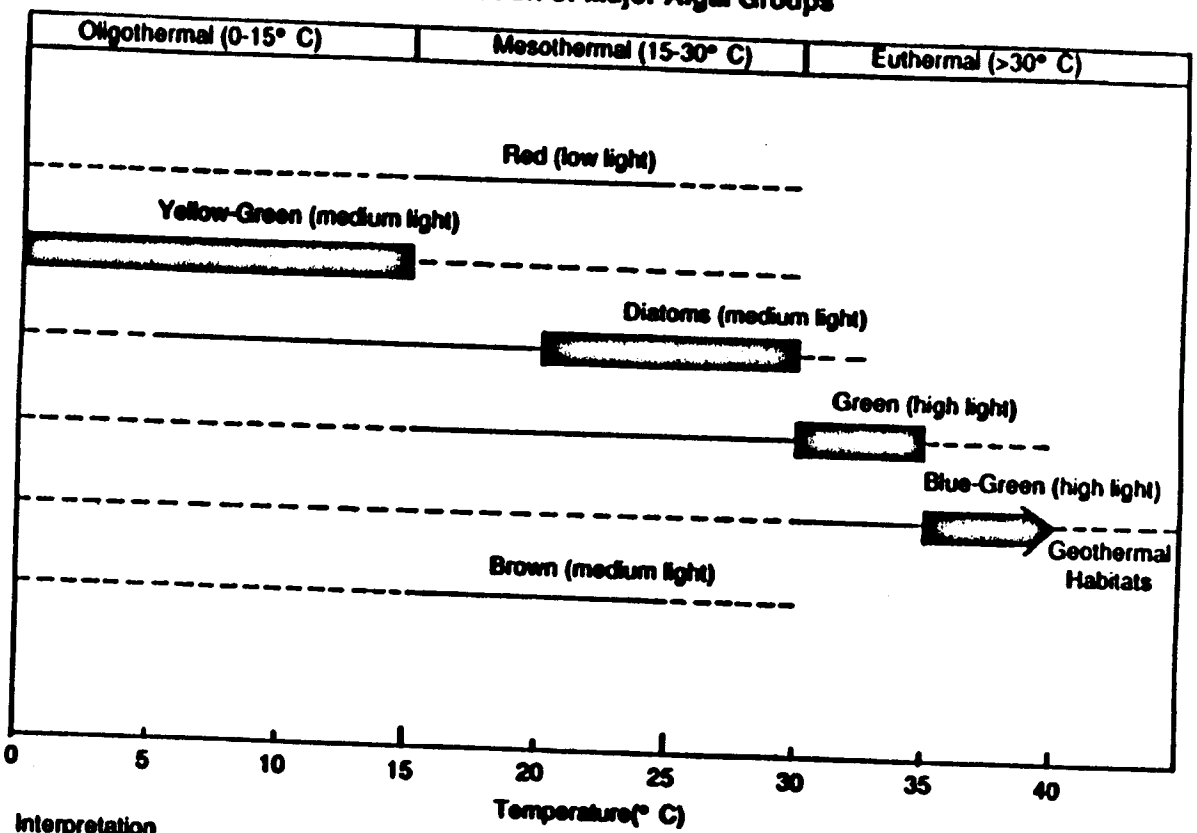
Figur

Summary: General Temperature and Light Requirements and Classification of Major Algal Groups



Interpretation

——— = Greatest number of representative species
- - - = Upper and lower temperature limits
▭ = Temperature range in which group is dominant
Oligothermal = Cold water forms, generally occuring between 0-15° C
Mesothermal = Temperate water forms, generally occuring between 15-30° C
Euthermal = Warm water forms, generally occuring at temperatures >30° C

Low Light = 200 foot candles
Medium Light = 500-1000 foot candles
High Light = >1000 foot candles

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Figure 4, oligothermal algae are coldwater forms which are generally restricted to waters ranging between 0 and 15°C. Mesothermal algae inhabit cool-warm temperature habitats between 15 and 30°C. The euthermal algae, which are characteristically warmwater forms, exhibit their greatest abundance at temperatures ≥ 30°C.

In general, diatoms dominate at temperatures between 20-30°C, green algae dominate between 30 and 35°C, and blue-green algae dominate in waters ≥ 35°C (Patrick, 1974). It is also important to note that, in most streams, diatoms are the overall dominant algal group. Red, brown and yellow-green algae typically comprise a relatively small portion of the stream algal community. Yellow-green algae are the dominant low temperature group (Whitford & Schumacher, 1968). They are normally restricted to cold streams and/or where present in warmer streams, to winter months.

The general temperature classification and seasonal distribution of 107 freshwater algae is presented in Appendix II. Other relevant temperature and ecological findings are listed as follows:

- According to Palmer (1977), the total number of algal species present in eastern rivers is generally between 70 and 140;
- Algae are an important food item for many macroinvertebrates and fish. However, both blue-green and yellow-green algae are generally considered to be a poor, unpalatable food source (largely due to the presence of exterior slime coating);

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- In most streams, temperature shifts toward the upper limit and beyond bring about a shift in species composition; generally from diatom-dominated communities to those dominated by blue-green algae;

- In a study of the algae of White Clay Creek, Pa., water temperatures averaging 30.4°C caused a shift from a diatom-dominated community to one dominated by a mixture of greens, diatoms and blue-greens. Temperature increases to 32°C and beyond resulted in the death of most diatoms.

- Moderate increases in temperature toward the optimum growth range increases algal growth. Furthermore, small temperature increases from the lower end of the tolerance range toward the optimum temperature may increase algal diversity and biomass;

- The typical seasonal algal succession pattern in temperate ponds, lakes and reservoirs is as follows: diatoms dominate in spring, green algae are abundant in early summer, followed in late summer and early autumn by blue-greens, with diatoms reappearing in great abundance in late fall;

- Turbidites > 30 ppm JTU are often high enough to cut-off sunshine almost completely, except for a shallow layer very close to the surface;

- Temperature (ΔT) experiments conducted in artificial streams suggest that sustained ΔT increases of between 5 and 7.5°C, above ambient stream temperatures, may be sufficient to cause a significant species composition shift in the algal community (Wilde and Tilley, 1981);

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- Shock exposures to high temperatures (i.e., if temperature rise is very large, if exposure continues for several hours, or if temperature is near the upper tolerance limit or beyond) can have deleterious effects and may cause death;

- Temperature increase stresses can be even more severe when accompanied by other stresses (e.g., pollution, light regime modification, and flow regime alteration).

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VI. Macroinvertebrates - Aquatic Insects

Macroinvertebrates are frequently defined as animals without backbones that are large enough to be retained on a U.S. Standard No. 30 sieve, 0.595 mm openings (Weber, 1973). In addition to serving as a major food source for fish, macroinvertebrates are an integral part of the normal energy/organic material processing system of streams. It is also noted that a relatively small group of macroinvertebrates have attained notoriety as important vectors of disease (e.g., mosquitoes, flies, and biting midges). Aquatic insects, which in most environments comprise the largest portion of this heterogeneous group shall be featured in this section.

Temperature - Physiological Relationships

As a group, aquatic insects demonstrate little ability to acclimate or compensate for temperature changes. Thus, when exposed to a new thermal regime, metabolic response is immediate and in the direction of the temperature change (Trapp & Hendricks, 1983).

Even relatively small temperature regime changes may have serious implications. For example, Sweeney and Vannote (1978) observed that changes of only 1-2°C, either warmer or cooler, from the normal temperature regime can reduce adult aquatic insect size and fecundity (the ability to produce viable off-spring), they both suggested that temperature increases of 2-3°C could eliminate sensitive species. Fecundity in aquatic insects is dependant

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upon the adult size, which is largely determined by thermal conditions during the larval period (Sweeney, in Resh and Rosenberg, 1984). Available data suggest that adult body size is inversely related to ambient stream temperatures (Vannote and Sweeney , 1980).

While many aquatic insects can successfully complete their life cycles over a broad range of temperature conditions, many have very narrow and/or specific temperature requirements. An example of the latter case is the mayfly, Ephoron album, whose life cycle is graphically depicted in Figure 5. As seen in Figure 5, three essential stages in the life cycle of this mayfly (i.e., egg development and hatching and maturation of nymphs) are temperature-dependant. Ephoron eggs will not develop unless they have been exposed to freezing temperatures, nor will nymphs hatch from eggs until the temperature rises to about 10°C, and last, nymphs do not mature unless the temperature reaches 18-20°C and remains there for several months (Lehmkul, in Gibbons & Sharitz, 1974). Thus, temperature regime modifications which either disrupt or eliminate essential temperature cues and/or conditions would, in all likelihood, eliminate this species.

In addition to influencing egg incubation period, hatching success, duration of hatching, induction and termination of diapause, emergence, and length of the larval growth period, temperature affects the ingestion and assimilation of food (Nebeker, 1971; Sweeney, in Resh and Rosenberg, 1984; Elliot, 1978). Several aquatic insects exhibit more or less constant ingestion rates at low to intermediate temperatures and then either increase or decrease these rates at higher temperatures (Sweeney, in Resh and Rosenberg, 1984).

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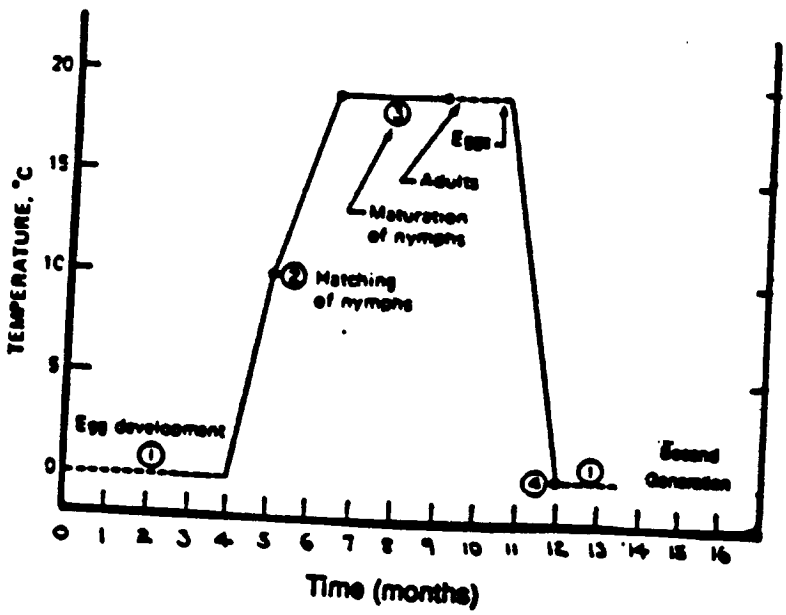
Figure 5

Thermal Requirements for the Mayfly Ephoron album (modified from Tinsman & Maurer, 1974)



Legend

①-②-③-④ = Essential stage & temperature requirement in life cycle

—— = Required temperature, flexible duration

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Although ingestion rates are usually greater at higher temperatures, assimilation rates are often lower (Heiman and Knight, 1975); hence growth rates may be impaired. Sweeney (1978) observed that metabolism in the mayfly nymph, Isonychia bicolor, doubled when temperature increased from 12.2°C to 20.5°C, and that increased respiration reduced net growth efficiency.

General Temperature Requirements

In general, water temperatures greater than 17°C have often been considered to be above the optimum for many stoneflies, mayflies, and caddisflies, and temperatures exceeding 21°C have been shown to stress severely most coldwater organisms (Gaufin and Nebeker, 1973; Ward and Stanford, 1979; Fraley, 1979). As seen in Figure 6, stoneflies are (as a group) the least temperature tolerant, and are generally restricted to cold-cool flowing waters. Conversely, dragonflies and damselflies are generally associated with warmer streams and/or lakes and ponds. Mayflies and caddisflies, as well as Diptera (flies & midges), display considerable adaptivity and have successfully invaded all three of the major aquatic habitats depicted in Figure 6.

The known or expected upper limiting water temperatures for various groups of aquatic insect larvae are listed in Appendix III. In addition, a summary of some of the findings of the known temperature requirements and effects of temperature regime alteration are presented as follows:

- Gaufin and Nebeker (1973) recommended that in order to maintain a

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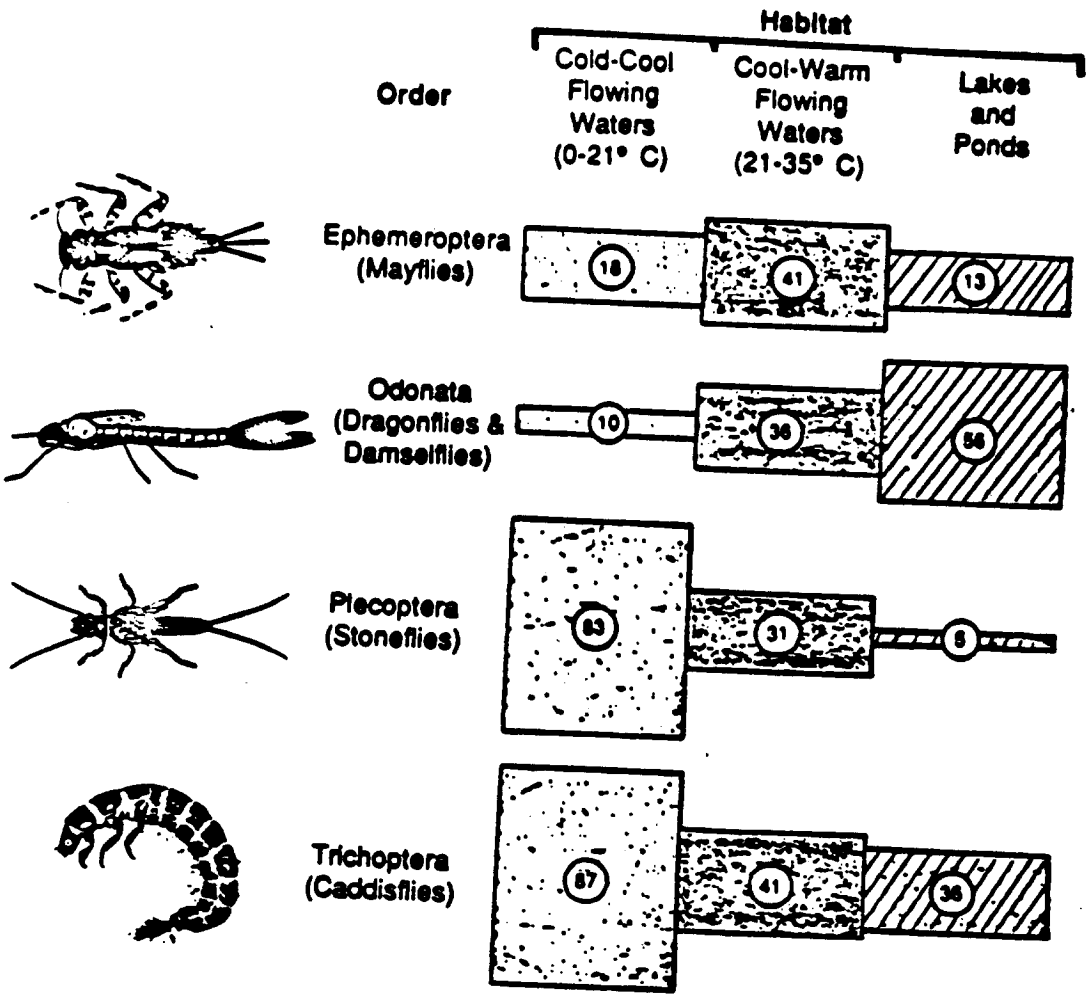
Figure 6

General Habitat of Four Orders of North American Aquatic Insects [1/] (modified from Wiggins & Mackay, 1978)



1/ Number of genera per habitat is shown within each block.

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well-rounded, diversified population of coldwater insects, maximum water temperatures should not exceed the requirements of coldwater fishes such as trout and salmon;

- As a result of temperature regime alteration, mayflies, stoneflies, and other temperature sensitive or thermally-cued invertebrates are often reduced or eliminated below impoundments (Petts, 1984; Ward and Stanford, 1979; Fraley, 1979; Kondratieff and Voshell, 1981). All too frequently, only those forms with broad tolerance levels exist. Macroinvertebrate groups without aerial adults, such as snails, oligochaetes, amphipods, isopods, and turbellarians, often increase in relative abundance in these streams (Ward and Stanford, 1979).

- Many aquatic insects, mayfly species in particular, require a fluctuating diurnal temperature regime. Constant diurnal temperatures may fail to provide the thermal range necessary to allow all body processes to operate optimally. Thermal heterogeneity may be especially important for species which undergo diapause during some portion of the life cycle;

- Seasonal thermal constancy, e.g., high winter and low summer temperatures, may directly influence aquatic insects in that it may eliminate or modify thermal stimuli essential for various life-cycle phenomena;

- The timing and duration of the emergence of aquatic insects is generally linked to water temperature, photoperiod, and/or both. An increase in

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winter water temperatures may result in the premature emergence of adult aquatic insects. In all likelihood, these early emergers will also be physically smaller in size. Insects which emerge too early in the season may be killed or inactivated by low ambient air/ground temperatures.

- Respiration in some aquatic insect larvae is highly sensitive to short-term increases and decreases in temperature. Increased respiration rates, caused by higher temperatures; reduce net growth efficiency;

- The relationship between egg production and female dry weight is generally linear for most aquatic insects. Thus, any factor which reduces adult body size affects recruitment and the competitive ability of the subpopulation; and

- At both high and low stream temperature extremes, food storage used for egg formation may not be accumulated in sufficient quantities.

Thermal Shock Effects

Limited data suggests that aquatic insects are adversely affected by exposure to high shock temperatures which approach their upper lethal limit. It also appears that thermal shocks may possibly interfere with the normal molting process and hence, may negatively affect insect growth and long-term survivability. A brief summary of the thermal shock study findings, conducted on two representative caddisflies and one mayfly species, are listed below:

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Experiments on the caddisfly, Brachycentrus americanus (Salmella and Anderson, 1978):

- No deaths occurred until water temperatures exceeded 32.9°C.
- Sharp decreases in survival occurred between 33-34°C, 100 percent mortality at 34.5°C;
- Feeding decreased with increasing temperature. Feeding during 16-day post-exposure period was affected at temperatures 3.6°C lower than those that directly affected survival (i.e., at approximately 29.3°C);
- Heat tolerance for Brachycentrus not affected by seasonal temperature change between 1-15°C.

Experiments on the mayfly, Isonychia sadleri and the caddisfly Hydropsyche (Sherberger et al., 1977):

- Isonychia - no significant mortality was observed below a shock temperature of 26.5°C. However, at shock temperatures of 26-29.0°C a significantly higher portion of shocked animals molted than the control specimens. Temperatures above 29°C reduced molting significantly. Successful molting is essential to aquatic insect growth and development;

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- No significant effects of thermal shock on rheotaxis (response to water current) or phototaxis (response to light) observed in Isonychia (i.e., no observed behavioral changes);

- In the natural environment, mortality in Isonychia would be particularly noticeable at temperatures of 30-31°C;

- For Hydropsyche, no significant effects of thermal shock were observed at temperatures less than 28°C. Significant mortality occurred at temperatures between 36-38°C;

- High mortality in both insects would occur at temperatures $\geq$ 36°C.

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VII. Fish

The ecological, recreational and commercial significance and value of fish is well known, and therefore requires no further mention. All fish are obligate poikilotherms (cold-blooded). With only one or two notable exceptions, fish lack a mechanism to maintain an internal body temperature independent of the temperature of surrounding waters. Fish are, therefore, essentially thermal conformers. Furthermore, when water temperature changes, the rate of thermal equilibration is generally rapid (Elliot, in Pickering, 1981).

General Temperature Requirements, Classification and Tolerance

Although fish may be found in waters with temperatures ranging from around zero to 44.0^{0}C, no species can survive over this entire range. Each species has a characteristic range with upper and lower lethal limits and preferred temperature optima, which changes according to the age (or life cycle stage) of the fish. Freshwater fish in temperate regions generally live within the 0-30°C temperature range. Maximum summer temperatures may exceed 30°C in shallow lakes, ponds and marshes, warmer southern streams, and/or in waters that receive a thermal discharge.

Based on their thermal requirements, fish are generally placed into one of three broad categories:

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- Stenotherm - coldwater fish, which have a physiological optimum < 20°C and an upper lethal temperature of < 26°C. Representative examples include salmon and trout.

- Mesotherm - coolwater fish, which have a physiological optimum in the 20-28°C range and upper lethal temperature of 28-34°C. Representative examples includes pikes, perch, darters, and most species of minnows.

- Eurytherm - warmwater fish, which have a physiological optimum >28°C and an upper lethal temperature generally over 34°C. Representative examples include carp, goldfish, sunfish, and bass.

The contrasting thermal requirements of the stenothermal brown trout (Salmo trutta) and eurythermal carp (Cyprinus carpio) are illustrated in Figure 7. As seen in Figure 7, the tolerance zone, feeding zone and optimum growth zones for these two representative fish are markedly different. In general, there is an inverse relationship between tolerance and resistance to thermal stress. Coldwater fish, such as the brown trout, have fairly low tolerance but high resistance (i.e., can withstand temperatures outside the tolerance zone for longer periods); whereas, warmwater fish such as the carp, typically exhibit high tolerance but low resistance.

Research has additionally shown that acclimation temperature and the period of exposure to temperatures outside the tolerance zone are the two most important factors which affect thermal tolerance and ultimately the

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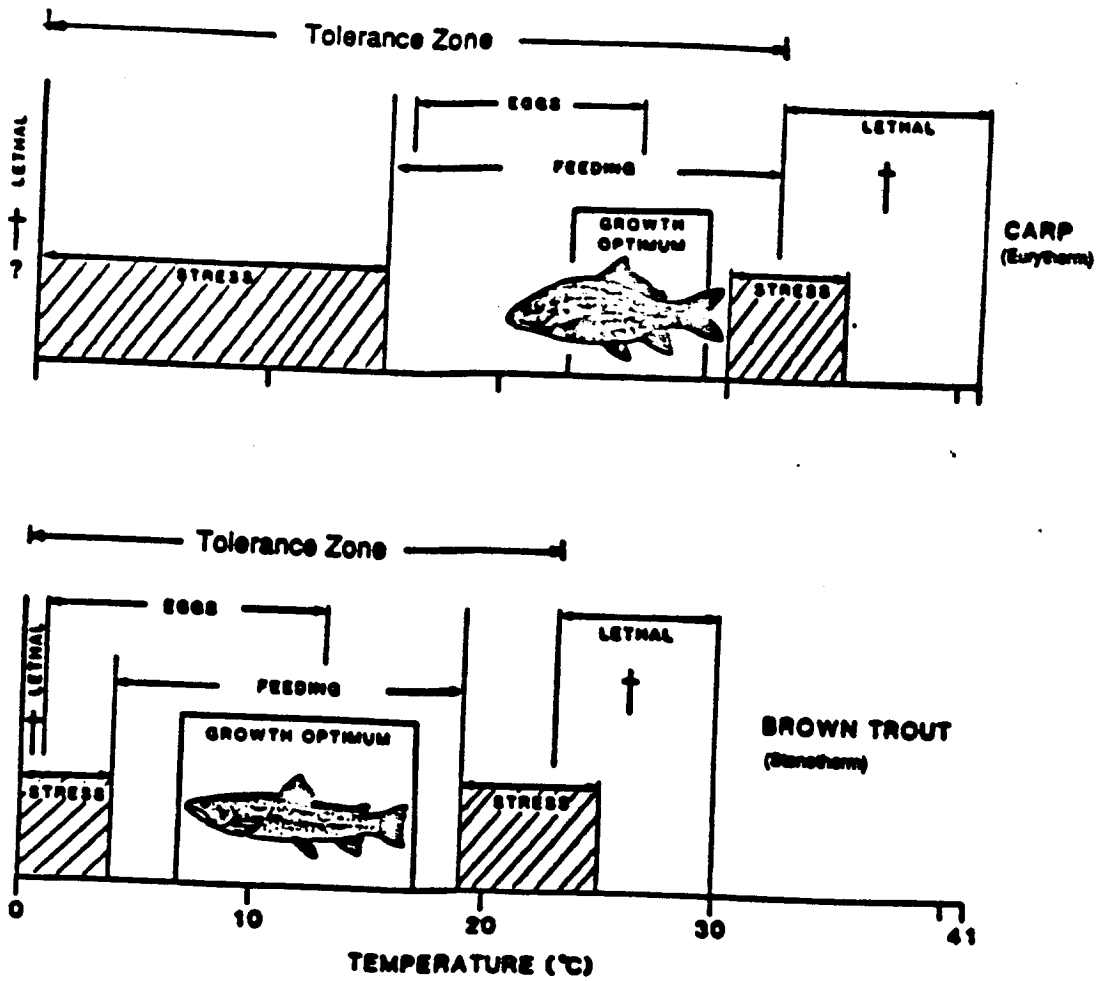
Figure 7

Thermal Requirements of the Carp, Cyprinus Carpio, and Brown Trout, Salmo trutta (modified from Elliot, 1981) 1/



1/ - Requirements based on laboratory study results.

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lethal temperature of fish. While there are several exceptions, as the age and size of a fish increases, there is typically a corresponding increase in the upper lethal temperature (Hoar & Randall, 1971). It is further noted that the egg is widely considered to be the critical stage for thermal stress (Hoar & Randall, 1971). Critical temperature limits for successful spawning and egg development are often far narrower than those for juvenile or adult fish.

Thermal Stress - Sublethal Effects

Brett (1956) divided stresses on fishes into four general categories and defined them as follows:

1. Lethal - (self-explanatory);
2. Inhibiting - a reduction in the ability of the fish to carry out its normal functions and hence a reduction in its probability for survival;
3. Loading - an undue burden on the fish with a rapid steady release of energy; and
4. Limiting - restriction of the supply of essential metabolites or interference with the chain of energy release.

Inhibiting, loading and limiting thermal stresses may all prove lethal when they continue over a long period of time.

One of the best known examples of temperature as an inhibiting-type stress is its effect on feeding activity. As illustrated by Figure 7., fish

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typically feed over a relatively well-defined temperature range or zone. Temperatures outside of this normal feeding zone generally cause the cessation of feeding. Not surprisingly, if these inhibiting temperatures are maintained beyond the fish's resistance capacity, it will ultimately starve to death. While the resistance capacity or limit is a function of the size, body composition, and vigor of the fish, it is generally shorter under an elevated temperature scenario (due to higher metabolic rate). Other examples of temperature as an inhibiting stress include its potential disruption of the normal hormonal balance necessary for the initiation of spawning activities, reduction of reproductive success, and increased predisposition to disease and predation.

Temperature can also act as a loading stress on fish growth and activity. Using the brown trout in Figure 7. as an example, the growth for this species typically occurs between 4°-$19^{o}C$. The general lack of energy for growth outside this range is due to a combination of reduced energy intake, high energy losses in waste products, high metabolic demands at temperatures above $19^{o}C$ and possibly inhibition of metabolism below $4^{o}C$ (Elliot, in Pickering, 1981).

Thermal stress can also occur within the normal growth zone of fish when there are other limiting or stress-producing factors present (e.g., reduced oxygen concentration, enzyme substrates, and nutrients or essential ions). When the food supply is reduced, both the optimum temperature and temperature range for growth are reduced (Hoar & Randall, 1971). These physiological changes are due to the combined stress effects of both reduced energy intake (food) and the loading stress of temperature. As the energy intake is

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reduced there is a significant decrease in the upper limits of the growth zone. Thus, thermal stress is not only lethal outside of the tolerance zone, but can also act subtly within the tolerance zone as an inhibiting stress, loading stress, or a loading stress in combination with other stresses (Hoar & Randall, 1971).

Temperature Detection, Avoidance and Thermal Shock

It is well known that fish possess considerable sensory powers to detect changing environmental conditions and have the response capability to select a new location. Studies have shown that fish can detect temperature changes of less than 0.5°C and are able to select a particular temperature or range of temperatures, that is, to their liking (Murray, 1971; Hoar & Randall, 1971). Moderately rapid changes of temperature normally do not elicit swimming responses in resting fish until relatively high temperatures are reached, but they do, however, affect the frequency of movement of active fish. Therefore, it is possible for fish to be caught "napping" by thermal shocks (i.e., large, rapid and potentially lethal temperature changes). In those cases where the normal escape swimming response is muted or overwhelmed, or where no escape refugium exists, the thermal shock may prove deadly.

Owing to their smaller body mass and proportionately higher surface area, juveniles are far more susceptible than adult fish to thermal shock. Thermal shock experiments conducted on trout have demonstrated that the internal body temperature of smaller fish (< 100g) changes rapidly, usually in less than 10 minutes; whereas larger adult fish may require over one hour (Elliot, in

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Pickering, 1981).

It is also noted that the rate for heat exchange is usually higher for warming than for cooling, at least in larger fish (Hoar & Randall, 1971). Most of the heat transfer in fish occurs by conduction directly through the body wall. Heat transfer through the gills accounts for only some 10-30 percent of the total heat exchange between fish and the surrounding water (Elliot, in Pickering, 1981).

Thermal Characteristics of Maryland Freshwater Fish Communities

Water temperature together with the volume of flow, water quality and physical or structural habitat are the major factors which determine the fish community characteristics of streams. While it is beyond the scope of this study to examine all of these variables, an attempt was made to identify the general temperature requirements for Maryland freshwater fish. Thermal requirement data for 63 species of fish known or expected to occur in Maryland freshwater streams is presented in Appendix IV. In addition, this information has been graphically summarized in Figure 8, so as to facilitate the comparison of temperature requirements between representative fish families.

With only one or two notable exceptions, natural coldwater stream fish communities in Maryland are generally restricted to higher altitude and/or spring-fed streams of the Appalachian and Piedmont provinces. The fish assemblage in these streams is often highly variable, but typically includes one or more species of trout (brook, brown and/or rainbow), as well as,

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Figure 8

General Temperature Requirements of Maryland Freshwater Fish

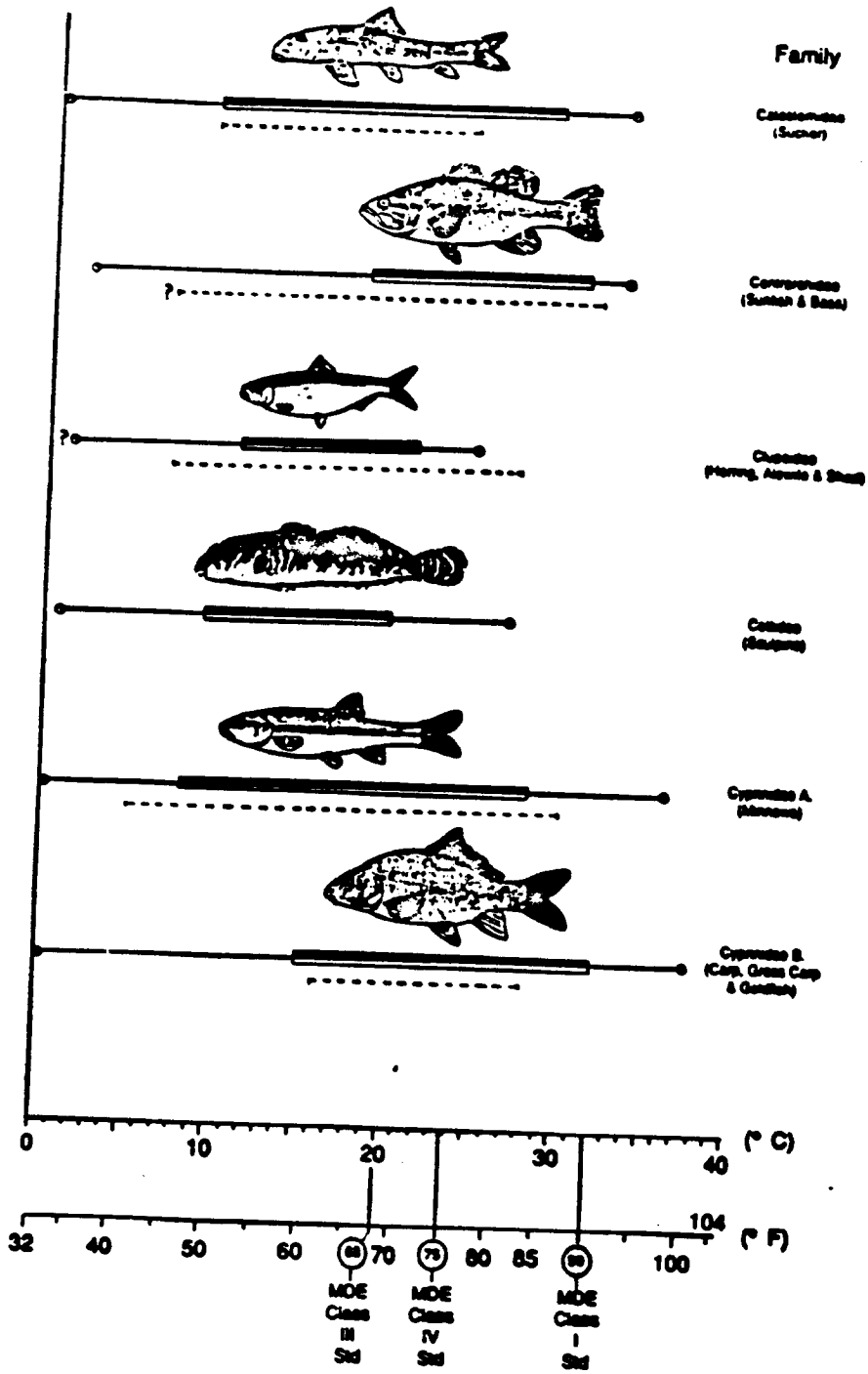

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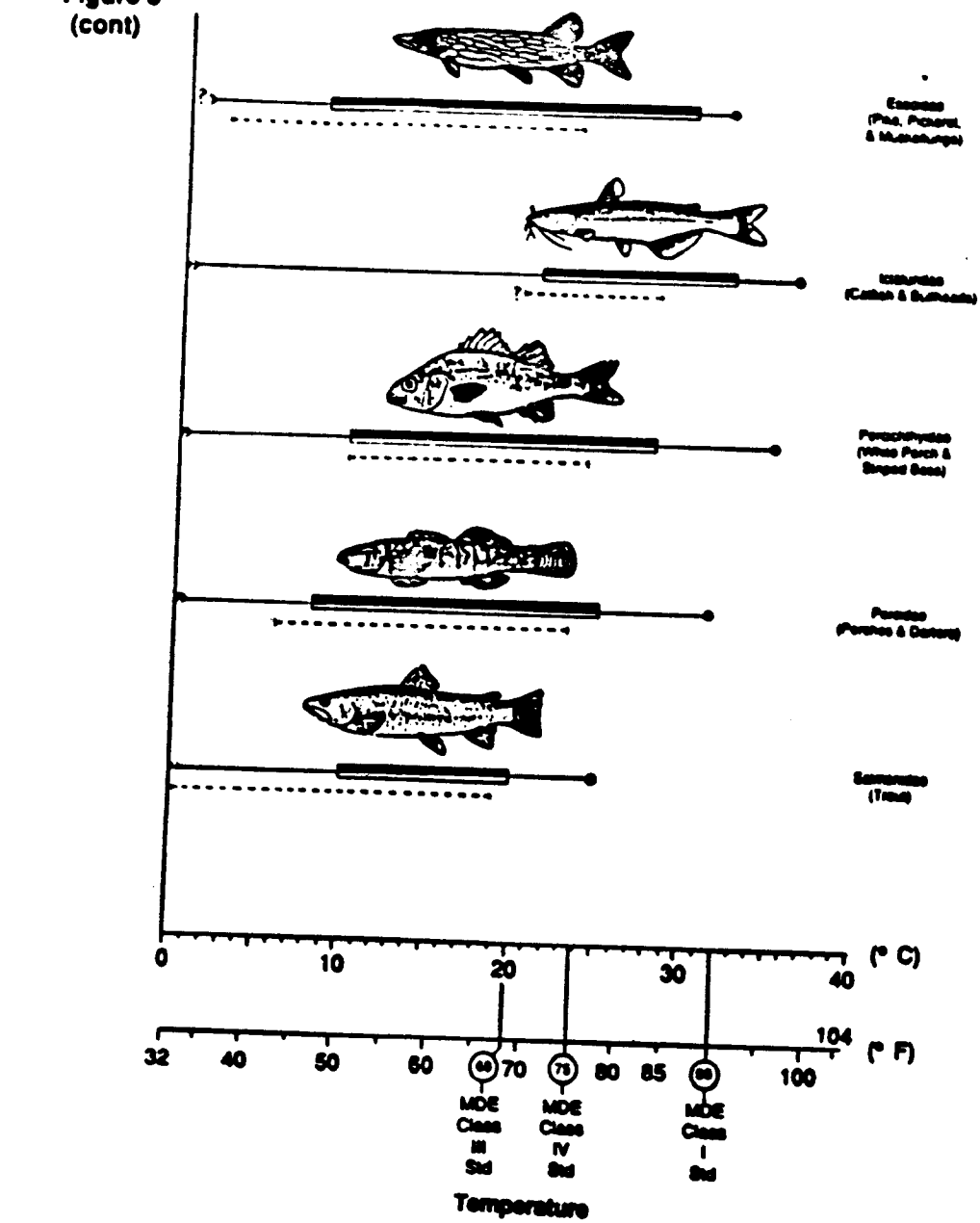
Figure 8
(cont)



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sculpins, and several minnow species. Coldwater fish generally spawn when water temperatures are less than 10°C. Maximum summer water temperatures in coldwater streams are normally less than 21°C (Winger, in Krumholz, 1981).

Coolwater streams are somewhat ambiguous in terms of general definition, fish assemblage and temperature characteristics or limits. However, for the purposes of this study, coolwater streams will be defined as those which are generally too warm to support trout on a year-round basis, yet too cool to support a diverse warmwater fish community. The fish community of coolwater streams is typically dominated by minnows and includes representative species of darters, and suckers. Larger coolwater streams often include smallmouth bass, as well as, some warmwater fish species. In general, coolwater fish spawn when water temperatures are over 10°C. Maximum summer water temperatures in coolwater streams are generally less than 27°C.

Warmwater fish communities are most commonly associated with larger, low-gradient streams which have a relatively open canopy. Vis-a-vis coldwater streams, warmwater streams generally exhibit higher species diversity and support larger, overall numbers of fish (Sheldon, 1960). The typical warmwater stream fish assemblage includes representative bass, sunfish and catfish species, as well as, minnows. Most warmwater fish spawn when water temperatures are over 15°C. Maximum summer water temperatures in most North American warmwater streams seldom exceed 33-35°C (Winger, in Krumholz, 1981).

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Thermal Enrichment

Bush et al., 1974, estimated the percentage of fish species which would be lost from six different North American coldwater and warmwater river systems under an elevated water temperature regime scenario. The estimates, which are graphically summarized in Figure 9, assumed that a fish species (adult and juvenile fish only) would be lost from a stream area either through death or emigration. Although these estimates should be viewed with a certain degree of caution, they do provide valuable insight into the potential fishery impacts stemming from thermal warming, or enrichment.

As seen in Figure 9, the percentage of fish species which would be expected to be lost from coldwater river systems is typically five percent or less at temperatures below 20°C. However, losses increase dramatically at temperatures greater than 22°C. Conversely, the estimated percentage of fish species lost from warmwater river systems is less than five percent at temperatures below 30°C. At temperatures above 30°C, a catastrophic loss of fish species is predicted to occur in these systems.

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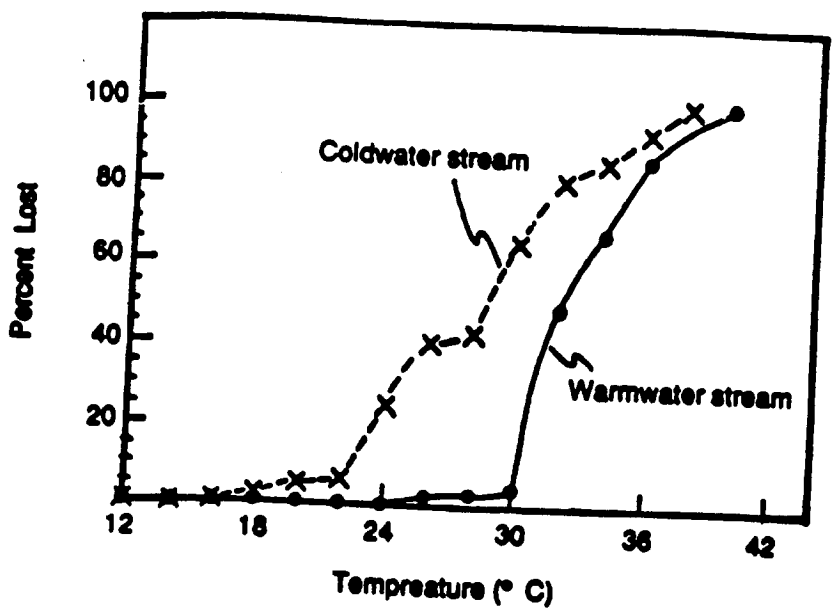
Figure 9

Predicted Percent of Fish Species Lost in Cold and Warmwater River Systems Versus Water Temperature Increases (from Bush et al., 1974)



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VIII. Trout and Thermal Stress

Detailed information on the temperature requirements for brook, brown and rainbow trout is presented in Appendix IV. Without question, these three species are the most important coldwater fish inhabiting Maryland streams. Of the three, only the brook trout is truly native to eastern North America. The brown and rainbow trout were each respectively introduced from Europe and western North America.

While the temperature requirements for these three species are quite similar, the brown trout is generally regarded as being the more temperature tolerant and the brook trout the least. It is important to note that even within a given species the difference in thermal tolerance is often surprisingly large. Much of this is due to inherent genetic or racial differences within the species and adaptation to different thermal regimes.

All trout species are extremely sensitive to thermal pollution/stress. Sustained elevated water temperatures over 20°C are generally considered to be stressful, while those at or above 25°C are usually lethal. As previously noted, a fish's ability to withstand or resist the effects of thermal stress is heavily influenced by the acclimation temperature. Trout can, depending on the acclimation temperature, survive for varying periods of time at temperatures which are ultimately lethal. As seen in Figure 10, trout acclimated at 15, 20, or 22°C survived slightly over 7 days at 25°C, 100 minutes at 28°C, and only 10 minutes at 30°C.

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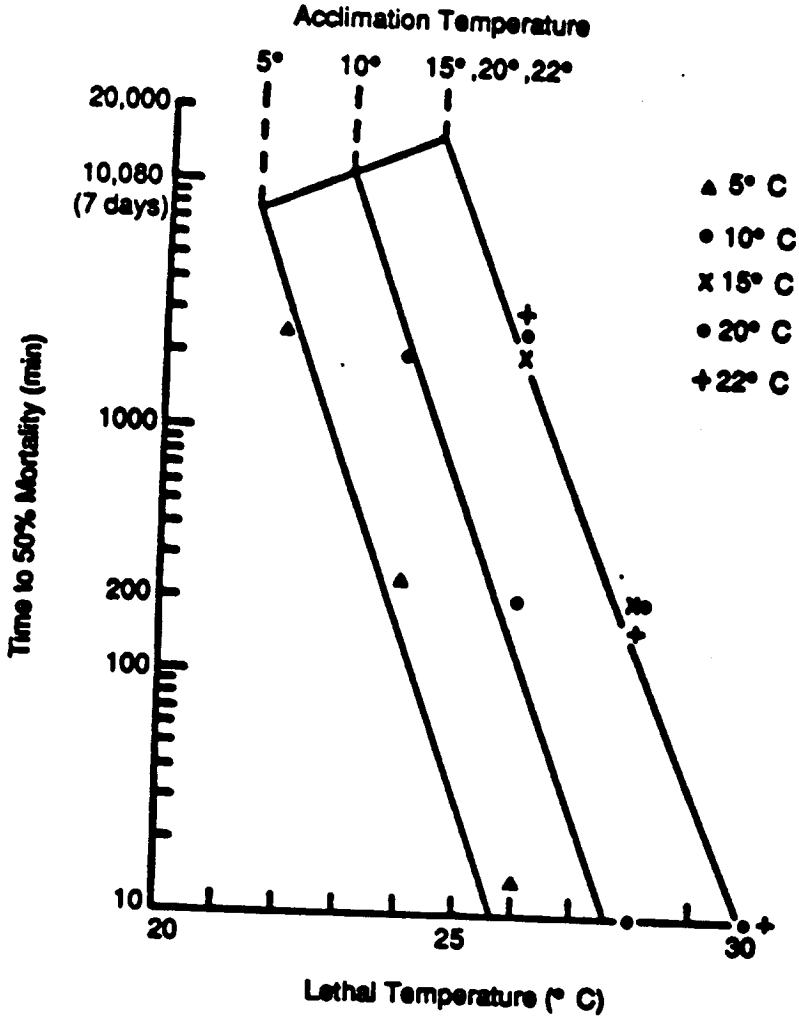
Figure 10

Relation Between Time, Acclimation Temperature and 50% Mortality of Brown Trout, Salmo trutta (from Elliot, 1981)



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Many of the sublethal effects of thermal stress have already been discussed. When thermally stressed, the blood cortisol (i.e., a hormone) levels in trout become elevated. Chronic cortisol elevation suppresses many of the endocrine processes controlling sexual maturation, resulting in reduced gonad size in both sexes (Pickering, 1989). In addition, high blood cortisol levels act as an immunosuppressant; thereby, predisposing trout to infection by common fungal and bacterial pathogens. This can lead to increased mortality from diseases such as saprolegnia infection, furunculosis, and bacterial fin-rot (Pickering, 1989).

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Appendix 1.

TEMPERATURE: FAHRENHEIT TO CELSIUS

°F	0	1	2	3	4	5	6	7	8	9
30	-1.1	-0.6	0.0	0.6	1.1	1.7	2.2	2.8	3.3	3.9
40	4.4	5.0	5.6	6.1	6.7	7.2	7.8	8.3	8.9	9.4
50	10.0	10.6	11.1	11.7	12.2	12.8	13.3	13.9	14.4	15.0
60	15.6	16.1	16.7	17.2	17.8	18.3	18.9	19.4	20.0	20.6
70	21.1	21.7	22.2	22.8	23.3	23.9	24.4	25.0	25.6	26.1
80	26.7	27.2	27.8	28.3	28.9	29.4	30.0	30.6	31.1	31.7
90	32.2	32.8	33.3	33.9	34.4	35.0	35.6	36.1	36.7	37.2
100	37.8									

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Appendix II. General Temperature Classification and Seasonal Distribution of 107 Species of Freshwater Algae

	Genus/Species	Temperature Classification	Seasonal Distribution/Max. Abundance
I.	**Diatoms (Bacillariophyceae)**		
	Achnanthes		
	exigua (coarctata)	e	
	exigua (exigua)	e	
	exigua (heterovalva)	e	
	lanceolata	O	
	linearis	O,s	
	minutissma	e	W
	Actinella punctata	O	
	Asterionella formosa	O	
	Bacillaria paradoxa	O	
	Cocconeis placentula	e	
	Cymatopleura solea	O	F
	Cymbella aspera	M,m	S
	sinuata	M,m/e	
	ventricosa	O/M,e	Su,F
	Diatoma anceps	O	F
	hiemale	O,s	
	vulgare	O/M,e	W
	Epithema zebra	M/E,e	
	Eunotia pectinalis	M	S,F
	Fragilaria capucina	O/M,e	S
	construens	O/M,e	F
	intermedia	O/M,e	
	vaucheriae	O	
	Frustulia vulgaris	O/M,e	S
	Gomphonema acuminatum	M,m	
	angustatum	O/M,m	F,W
	olivaceum	O/M,e	W,S
	parvulum	M,s	W
	Hannae arcus	O,s/m	
	Hantzchia amphioxys	O/M,e	S
	Hydrosera triquetra	M	
	Melosira distans	O,s	
	varians	O/M,e	S,Su,F
	Meridion circulare	O/M,e	W,s
	Microsiphona potamus	O/M,m	S,F
	Navicula capitata	O/M,e	F
	cryptocephla	O/M,e	S,Su,F
	mutica	M	

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Genus/Species		Temperature Classification	Seasonal Distribution/Max. Abundance
I. Diatoms cont'd			
	pseudoscutiformis	O	
	radiosa	O/M,e	
	tripunctata	O/M,e	
Nitzchia	viridula	O/M,e	
	amphiba	O/M,e	
	dissipata	O/M,e	
	filiformis	M	
	linearis	M,e	S
	microcephala	e	
	palea	M,e	S,Su,F
Pinnularia	borealis	O	
	viridis	e	S,F
Rhoicosphenia	curvata	e	
Stauroneis	phoenicentron	e	
Surirella	angustata	O/M, m/e	S,F
	ovata	O,e	W
Synedra	ulna	O	
Terpsinoe	americana	M	
II. Green Algae (Chlorophyceae)			
Chaetophora	incrassata	O	S
	pisiformis	O/M	
Draparnaldia	sp.	M	S
Helicodictyon	planktonicum	M	
Oedogonium	kurzii	M	S,F
Palmodictyon	varium	M	W
Protoderma	viride	M	
Scendesmus	obtusiuscula	M/E	
Schizogonium	murale	E	
Schizomeris	liebleinii	M	S,Su
Spirogyra	rivularis	M	S
Stigeoclonium	lubricum	M	
Tetrasopa	lubrica	M	
Volvox	aureus	M	
III. Blue-green Algae (Cyanophyceae)			
Anabaena	variabilis	O	
	sp.	M	Su
Entophysalis	lemaniea	M	
	rivularis	M	Su
Lyngbya	sp.	E	
Nostoc	commune	M	S

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Genus/Species		Temperature Classification	Seasonal Distribution/Max. Abundance
III. Blue-green Algae cont'd			
Phormidium	autumnale	M	
	angustissima	E	Su
	bijahensis	E	
	corium	E	
	subfuscum	E	
	unicatum	M	S
	valderianum	O	
Oscillatoria	chalybaea	E	
	proboscidea	E	
	sancta	E	
	tenuis	E	
Schizothrix	sp.	E	
Scytonema	varium	E	
Stigonema	mammilosum	E	
			Su
IV. Red Algae (Rhodophyceae)			
Audouinella	violacea	O	
Batrachospermum	boryanum	M	S
	macrosporum	M	
Campsopogon	coerulus	M	
Lemanea	australis	M	
	fucina	M	
V. Yellow-Green Algae (Chrysophyceae)			
Cydlonexis	annularis	O	
Phaeodermatium	rivulare	O	W
Phaeoplaca	thallosa	O	
Tetrasporopsis	perforta	O	S
Synura	caroliniana	O	W
*Vaucheria	geminata	M	
		M	
VI. Brown Algae (Xanthophyceae)			
Chloroseccus	fluidus	O	
Gloepodium	rivulare	M	
Tribonema	bombycinum	M	
Vaucheria	ornithocephala	M	
Ophiocytium	parvulum	M	

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Abbreviations/Definitions:

O - Oligothermal: coldwater forms, generally occurring between 0-15°C;

M - Mesothermal: temperate-water forms, usually occurring between 15-30°C;

E - Euthermal: warmwater forms, generally occurring at temperatures > 30°C;

s - stenothermal: occurring over a temp. range of < 5°C;

m - metathermal: occurring over a temp. range of 5-15°C;

e - eurythermal: occurring over a temp. range of > 15°C;

S - Spring

Su - Summer

F - Fall

W - Winter

*Considered by some researchers to be a Green alga.

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Appendix III. Known or Expected Upper Limiting Temperature for Various North American Aquatic Insect Larvae[1/]

	Order/Species		Upper Limiting Temperature(°C)	Reference
I.	**Plecoptera (Stoneflies)**			
1.)	Acroneuria	lycorias	18.5	Harper & Pillon, 1970
2.)	Alloperla	sweltsa	17.0	" "
3.)	Arcynopterx	parallela	19.0	Nebeker, 1973
4.)		signata	16.0	Branham et al., 1975
5.)	Isogenus	aestivalis	16.2	Nebeker, 1973
6.)		clio	13.0	Minshall & Minshall, 1966
7.)		decisus	13.0	" "
8.)	Pteronarcella	badia	24.4	Nebeker, 1973
9.)	Pteronarcys	californica	27.0	Nebeker, 1971
10.)		dorsata	20.0	" "
II.	**Ephemeroptera (Mayflies).**			
1.)	Baetis	rhodani	21.1	Nebeker, 1973
2.)		tenax	21.3	" "
3.)	Caenis	sp.	26.7	" "
4.)	Cinygmula	dipterum	11.7	Nebeker, 1971
5.)	Cloen	dipterum	29.4	Nebeker, 1973
6.)	Ecdyonurus	venosus	26.6	" "
7.)	Epeorus	pleuralis	17.0	Minshall, 1967
8.)	Ephemerella	doddsi	15.5	Nebeker, 1971
9.)		grandis	21.5	" "
10.)	Hexagenia	limbata	26.6	" "
11.)	Isonychia	sadleri	29.0	Sherberger et al., 1977
12.)	Paraletophlebia	adoptiva	15.0	Corkum, 1978
13.)		mollis	20.0	" "
14.)	Rhitrogena	semicolorata	< 23.6	Nebeker, 1973
15.)	Stenonema	femoratum	< 25.0	Lewis, 1974
16.)		integrum	< 25.0	" "
17.)		minnetonka	< 25.0	" "
18.)		modestum	< 30.0	Kondratief & Voshell, 1980
19.)		pulchellum	< 25.0	Lewis, 1974
20.)		rubrum	< 25.0	" "
21.)		smithae	< 25.0	" "
22.)		terminatum	< 25.0	" "
III.	**Trichoptera (Caddisflies)**			
1.)	Arctopsyche	grandis	20.0	Nebeker, 1973
2.)	Brachycentrus	americanus	33.3	Salmela & Anderson, 1978
3.)		occidentalis	29.7	Nebeker, 1971
4.)	Cheumatopsyche	sp.	35.0	Roback, 1967

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Order/Species			Upper Limiting Temperature(°C)	Reference
III. Trichoptera cont'd				
5.)	Chimara	sp.	30.0	Williams & Hynes, 1973
6.)	Drusinus	sp.	27.3	Nebeker, 1971
7.)	Eobrachycentrus	gelidae	5.0	Wiggins, 1965
8.)	Hydropsyche	betteni	21.0	Nebeker, 1972
9.)		sp.	30.0	Nebeker, 1971
10.)	Limnephilus	ornatus	24.8	" "
11.)	Neothermal	alicia	25.9	" "
12.)	Oligoplectrum	echo	34.4	Wiggins, 1977
13.)	Parapsyche	elis	21.7	Nebeker, 1971
IV. Diptera (Flies & Midges)				
1.)	Atherix	variegata	32.4	Nebeker, 1971
2.)	Simulium	sp.	25.1	" "

1/ The major portion of the values shown are derived from LD50 studies and should therefore be viewed as being highly conservative.

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Appendix IV.

SUMMARY: WATER TEMPERATURE REQUIREMENTS - FISH

Family: Species	General Temp. Class.	Age or Size (mm or g)	Physio. Opt. (deg. C)	Preferred Temp. (deg. C)	CTMax (deg. C)	UILT (deg. C)	Lethal Temp (deg. C)	Reference
ANGUILLIDAE:								
Anguilla rostrata (american eel)		N/A		8.0-28.0 (6.0-30.0 A) (16.7 FP)				Harila & Stauffer, 1980
CATOSTOMIDAE:								
Catostomus catostomus (longnose sucker)	Mesotherm	Juvenile (32.8 -60.8g)				26.5 (14.0 A)	28.3 (14.0 A)	Black, 1953
		N/A				27.0 (11.5 A)		
		Adult (spawning)		5.0				Fulman & Witman, 1979
Catostomus commersoni (white sucker)	Mesotherm	Eggs	15.2	9.0-24.1		28.0-29.0 (9.0-10.0 A)		McCormick, et. al., 1977
		Larvae	26.9			30.0-32.0 (15.0-21.0 A)	28.0-29.0	McCormick, et. al., 1977
		Juvenile (137mm avg)				31.2 (20.0 A)		Brett, 1944
		Adult		22.8-26.1 (23.0 A)				Reynolds & Casterlin, 1978a
				14.4-20.4				Cooper & Fuller, 1945
		Adult (spawning)		9.0-16.8°				Corbett & Powles, 1983
		N/A				26.3-29.3 (5.0-25.0 A)		Hart, 1952
		N/A			31.6 (19.0 A)			Reutter & Herderdorf, 1976
Hypentelium nigricans (northern hog sucker)	Mesotherm	YOY		15.3-28.8 (12.0-33.0 A)			33.0 (7-D UL)	Cherry, et. al., 1977
		N/A			30.8 (15.0 A)			Kowalski, et. al., 1978
		N/A		21.0-27.0				Stauffer, et. al., 1974
		N/A		27.8(FP)				Stauffer, et. al., 1975

R0058018

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SUMMARY: WATER TEMPERATURE REQUIREMENTS - FISH

Family: Species	General Temp. Class.	Age or Size (mm or g)	Physio. Opt. (deg. C)	Preferred Temp. (deg. C)	CTMax (deg. C)	Ult (deg. C)	Lethal Temp (deg. C)	Reference
(northern hog sucker cont'd)		N/A		27.9(FP) 26.6-27.7°				Stauffer, et. al., 1976
Moxostoma erythrurum (golden redhorse)		Adult (spawning)		15.6				Muyer, 1962
Moxostoma macrolepidotum (shorthead redhorse)		Adult (spawning)		10.6				Muyer, 1962
		Adult (spawning)		16.0°				Burr & Morris, 1977
		N/A					>37.2	Cross, 1967
CENTRARCHIDAE:								
Ambloplites rupestris (rock bass)	Eurythern	YOY		27.0-36.0 (18.0-36.0 A)			36.0 (7-D UL)	Cherry, et. al., 1977
		Adult & Juvenile		27.5° 27.3				Neill & Magnuson, 1974
		Adult		30.0(FP)				Reynolds & Casterlin, 1978c
		Adult (spawning)		15.6-21.1°				Scott & Crossman, 1973
		N/A		30.0° 30.2 FP)				Stauffer, et. al., 1976
		Various					>38.0°	Bailey, 1955
Lepomis cyanellus (green sunfish)	Eurythern	88-113mm		26.5-30.3 (20.0-22.0 A)				Dietinger, et. al., 1975
		YOY		16.9-30.6 (6.0-30.0 A)				
		Juvenile (55mm avg)		8.8-22.6 (5.0-30.0 A) (27.3 FP)				Jones & Irwin, 1962
		Juvenile (45-53mm)					<38.0°	Bailey, 1955

R0058019

SUMMARY: WATER TEMPERATURE REQUIREMENTS - FISH

Family: Species	Cenural Temp. Class.	Age or Size (mm or g)	Physio. Opt. (deg. C)	Preferred Temp. (deg. C)	CTMax (deg. C)	Ult. (deg. C)	Lethal Temp (deg. C)	Reference
(green sunfish cont'd)		Adult (spawning)		20.0-28.0[a]				Scott & Crossman, 1973
		N/A		30.8 (FP)	36.5			Matthews & Heins, 1987
Lepomis auritus (redbreast sunfish)	Eurythera	Adult (spawning)		21.7-25.6[a]				Davis, 1971
		Adult (spawning)		16.7-27.8[a]				Scott & Crossman, 1973
Lepomis gibbosus (pumpkinseed)	Eurythera	Various (3.6-42.7g)				30.2 (24.0 A)	31.0 (24.0 A)	Black, 1953
		Larvae	20.0-30.0					Amundrud, et. al., 1974
		Adult(reproductive development)	11.5-14.0 (male) 14.0-16.5 (female)					Burns, 1976
		Adult (102mm avg)				34.5 (20.0 A)		Brett, 1944
		Adult (90-140mm, 12-68g)			35.0-36.0 (20.0 A) 29.5-31.5 (10.0 A)			Becker & Genoway, 1979
		Adult (100-161mm)		28.0-31.0[a]				Neill & Magnuson, 1974
		Adult (30.5g avg)	25.0					Pessah & Fowles, 1974
		Adult		26.0(FP)				Reynolds & Casterlin, 1977
		Adult (spawning)		11.7-23.9[a]				Smith, 1935
		N/A				28.0-34.5 (18.0-25.0 A)		Brett, 1944
		N/A		31.5(FP)				Ferguson, 1958
		N/A			37.5			Neutter & Henderdorf, 1976
Lepomis macrochirus (bluegill)	Eurythera	Eggs				33.8		Banner & Van Arman, 1973
		Larvae		20.0-30.0[a]				

R0058020

SUMMARY: WATER TEMPERATURE REQUIREMENTS - FISH

Family: Species	General Temp. Class.	Age or Size (mm or g)	Physio. Opt. (deg. C)	Preferred Temp. (deg. C)	CTMax (deg. C)	UILT (deg. C)	Lethal Temp (deg. C)	Reference
(bluegill cont'd)		YOY		18.7-31.7 (6.0-30.0 A)				Cherry, et. al., 1975
		YOY		24.1-31.8 (12.0-36.0 A)			35.0 (7-D UL)	Cherry, et. al., 1977
		YOY(37 mm)					35.5 (21.5 A)	Hickman & Dewey, 1973
		YOY		30.3				Neill & Magnuson, 1974
		Juvenile				27.5-37.3		Banner & Van Arman, 1973
		Juvenile (86mm ML)		29.3-33.1 (25.0 A)				Baltzinger, 1974
		Juvenile	30.0					Lemke, 1977
		Adult (100-193mm)		28.5-31.0*				Neill & Magnuson, 1974
		Various (52-159mm)				23.3-35.0		Peterson & Schlesby, 1976
		Various (45-110mm)		26.7-32.8 (20.0-24.0 A)				Reynolds & Casterlin, 1976
Lepomis megalotis (longear sunfish)	Eurytherm	Adult (spawning)		21.0-26.9*				Royer & Vogle, 1969
		N/A		20.8	36.5			Matthews & Hians, 1987
Micropterus dolomieu (smallmouth bass)	Mesotherm	Fry	25.0-26.0					Coutant & De Angelis, 1983
		Fry	13.0-22.0				30.0	Shuter, et. al., 1980
		YOY		20.2-31.3 (15.0-30.0 A)				Cherry, et. al., 1975
		YOY		20.2-29.4 (15.0-33.0 A)			35.0 (7-D UL)	Cherry, et. al., 1977
		YOY (100-145mm)		29.4-30.6 (20.0-24.0 A)				Reynolds & Casterlin, 1976
		Juvenile	26.0					Horning & Pearson, 1973
		Adult		26.0-30.0* (26.0-33.0-				Wrenn, 1976

R0058021

SUMMARY: WATER TEMPERATURE REQUIREMENTS - FISH

Family: Species	General Temp. Class.	Age or Size (mm or g)	Physio. Opt. (deg. C)	Preferred Temp. (deg. C)	CTMax (deg. C)	UILT (deg. C)	Lethal Temp (deg. C)	Reference
(smallmouth bass cont'd)		Adult (spawning)	17.6-22.0					Wrenn, 1984
		Adult (spawning)		12.8-20.0*				Scott & Crossman, 1973
		N/A		30.8(FP)				Stauffer, et. al., 1976
Micropterus salmoides (largemouth bass)	Eurytherm	Eggs					32.5	Strawn, 1961
		Fry	27.0					Coutant & De Angelis, 1983
		Fry		27.5-30.0				Strawn, 1961
		YOY		29.1				Neill & Magnuson, 1974
		YOY (72-99mm)		30.0*				
		Juvenile (5.1-127g)				28.9 (20.0-21.0 A)	30.4 (21.0 A)	Black, 1953
		Juvenile	18.0					Nilmi & Beamish, 1974
		Juvenile (100-150mm)		27.8-29.4				Reynolds & Casterlin, 1976
		Adult (spawning)		20.5-22.5				Carlson & Hale, 1972
		Adult (100-408mm)		29.0-30.5*				Neill &Magnuson, 1974
		Adult (453mm)		27.0-30.0*				Wrenn, 1976
		N/A	30.0-32.0	26.6-27.7*				Scott & Crossman, 1973
Pomoxis annularis (white crappie)	Mesotherm	Adult (spawning)		16.0-20.0*				Siefert, 1968
		N/A		14.0-23.0*				Scott & Crossman, 1973
Pomoxis nigromaculatus (black crappie)	Mesotherm	Larvae	15.0-25.0					Amundrud, 1974
		YOY(>75mm)		24.0-30.0				Neill & Magnuson, 1974
		YOY(75-80)		26.5-30.5				

R0058022

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MARY: WATER TEMPERATURE REQUIREMENTS - FISH

Family: Species	General Temp. Class.	Age or Size (mm or g)	Physio. Opt. (deg. C)	Preferred Temp. (deg. C)	CTMax (deg. C)	Ult (deg. C)	Lethal Temp (deg. C)	Reference
(black crappie cont'd)		Adult		24.0(FP)				Reynolds & Casterlin, 1977
CLUPEIDAE:								
Alosa pseudoharengus (alewife)	Mesotherm	Eggs	17.8	10.0-26.7			<7.0, >30.6	Edsall, 1970
		YOY		17.0-20.0°				Brandt, 1980
		YOY		19.0-20.0° (day) 17.0-18.0° (night)				Crowder, et. al., 1981
		YOY		19.0-25.0 (1.0-25.0 A)	28.3(10.0 -12.0 A) 34.4(24.0 -26.0 A)	26.5-32.1 (10.0-25.0 A)		Otto, et. al., 1976
		Adult		11.0-14.0°				Brandt, 1980
		Adult		17.0-14.0° (day) 13.0-14.0° (night)				Crowder, et. al., 1981
		Adult		11.0-21.0 (1.0-18.0 A)	24.7 (5.0 A) 32.8 (25.0 A)	23.0-24.5 (10.0-20.0 A)		Otto, et. al., 1976
COTTIDAE:								
Cottus bairdi (mottled sculpin)	Stenotherm ?	N/A			30.9 (15.0 A)			Kovalski, et. al., 1978
		N/A		16.5				Ferguson, 1958
Cottus cognatus (slimy sculpin)	Stenotherm	Various (40-100mm)		9.0-12.0 (5.0-20.0 A) (10.0 FP)	23.5 (5.0 A) 29.4 (20.0 A)		26.5(ULT)	Otto & Rice, 1977

R0058023

MARY: WATER TEMPERATURE REQUIREMENTS - FISH

Family: Species	General Temp. Class.	Age or Size (mm or g)	Physio. Opt. (deg. C)	Preferred Temp. (deg. C)	CTMax (deg. C)	UILT (deg. C)	Lethal Temp (deg. C)	Reference
CYPRINIDAE:								
Campostoma anomalum (stoneroller)	Mesotherm	Juvenile (50-100mm)		16.5-27.4 (12.0-30.0 A) (26.2-28.8 FP)			33.0 (7-D UI)	Cherry, et. al., 1977
		YOY		13.4-28.6 (6.0-27.0 A)				Cherry, et. al., 1975
		Adult (spawning)		14.4-23.9°				Miller, 1964
		N/A		19.4-26.7°				Stauffer, et. al., 1974
		N/A		22.7-23.8				Stauffer, et. al., 1975
		N/A		26.9 (FP)				Stauffer, et. al., 1976
Carassius auratus (goldfish)	Eurytherm	Eggs					>28.0	Elliot, 1981
		Juvenile (3-8g)		33.5-36.5 (23.0-24.0 A)				Rosen & Mayer, 1969
		Juvenile (40-60mm)		27.0-32.0 (15.0-20.0 A)				Roy & Johanson, 1970
		Adult (14.2g avg)					36.3-36.9 (20 A)	Hoar, 1956
		Adult (14-23g)		23.0-26.6 (14.0 A)				Muller, 1977
Cyprinus carpio (carp)	Eurytherm	Eggs					<16.0 >26.0	Elliot, 1981
		YOY					38.0-39.0	Meuwis & Heuts, 1957
		YOY		31.8				Neill & Magnuson, 1974
		YOY		17.8-32.0				Pitt, et. al., 1956
		Juvenile (12.8g)				35.7 (26 A)	36.9 (26 A)	Black, 1953
		Adult					36.0-38.0	Meuwis & Heuts, 1957
		Adult		29.0(FP)				Reynolds & Casterlin, 1977

R0058024

SUMMARY: WATER TEMPERATURE REQUIREMENTS - FISH

Family: Species	General Temp. Class.	Age or Size (mm or g)	Physio. Opt. (deg. C)	Preferred Temp. (deg. C)	CTMax (deg. C)	Ult (deg. C)	Lethal Temp (deg. C)	Reference
(carp cont'd)		Adult (spawning)	19.0-23.0					Swee & McCrimmon, 1966
		Various (8-737)		30.6°				Neill & Magnuson, 1974
Nocomis micropogon (river chub)	Mesotherm	N/A			30.9 (15.0 A)			Kowalski, et. al., 1978
Notemigonus crysoleucas (golden shiner)	Eurytherm	Adult(70-80 mm, 2.2-3.5g)					40.0 (22.0 A)	Alpaugh, 1972
Notropis cornutus (common shiner)	Mesotherm	Adult				29.0-34.0 (13.0-23.0 A)		Brett, 1944
		Adult (spawning)		14.4-25.6°				Miller, 1964
		Adult (spawning)		19.0-21.0°				Nurnberger, 1931
		Adult (spawning)		15.6-18.3°				Scott & crossman, 1973
Notropis hudsonius (spottail shiner)	Eurytherm	YOY	27.3	25.0-32.0 (25.0 A) (29.0 FP)				Kellog & Gift, 1983
		N/A		19.0-20.0° (day) 17.0-18.0° (night)				Crowder, et. al., 1981
Notropis rubellus (rosyface shiner)	Mesotherm	N/A			31.8 (15.0 A)			Kowalski, et. al., 1978
		N/A		15.8-22.8 (6.0-27.0 A)				Cherry, et. al., 1975
		N/A					33.0 (7-D ML)	Cherry, et. al., 1977
		N/A		28.8(FP) 28.3-30.0°				Stauffer, et. al., 1976

R0058025

SUMMARY: WATER TEMPERATURE REQUIREMENTS - FISH

Family: Species	General Temp. Class.	Age or Size (mm or g)	Physio. Opt. (deg. C)	Preferred Temp. (deg. C)	CTMax (deg. C)	Ult (deg. C)	Lethal Temp (deg. C)	Reference
(rosyface shiner cont'd)		Adult (spawning)		<20.0*				Miller, 1964
		Adult (spawning)		20.0-20.2*	(25.0 A)			Mead, 1957
Notropis spilopterus (spotfin shiner)	Eurytherm	YOY	27.3	29.0				Kelling & Clift, 1983
		N/A		16.3-29.7 (6.0-30.0 A)				Cherry, et. al., 1975
		N/A		21.4-29.2 (12.0-36.0 A)			36.0	Cherry, et. al., 1977
		N/A		29.0(FP)			(7-D UL)	Stauffer, et. al., 1976
Pimephales notatus (bluntnose minnow)	Mesotherm	Adult (spawning)		>20.0				Scott & Crossman, 1973
		N/A			31.9 (15.0 A)			Kowalski, et. al., 1978
		N/A		15.7-28.9 (6.0-27.0 A)				Cherry, et. al., 1975
		N/A		19.3-29.0 (12.0-30.0 A)			32.0 (7-D UL)	Cherry, et. al., 1977
		N/A		23.0-29.0*				Stauffer, et. al., 1974
Pimephales promelas (fathead minnow)	Eurytherm	Eggs	26.1					Brungs, 1971
		Fry					34.0(ULt)	Brungs, 1971
		YOY		19.8-28.9 (12.0-27.0 A)			34.0	Cherry, et. al., 1975
		YOY		19.5-28.7 (12.0-30.0) (26.0-26.6FP)				Cherry, et. al., 1977
		Juvenile			32.4-34.0 (15.0 A)			Spieler & Roeske, 1977
		Adult (1.0g avg.)					35.1	Watenpaugh & Beitenger, 1985
		Adult (55mm avg.)		23.4(FP)				Jones & Irwin, 1962

R0058026

SUMMARY: WATER TEMPERATURE REQUIREMENTS - FISH

Family: Species	General Temp. Class.	Age or Size (mm or g)	Physio. Opt. (deg. C)	Preferred Temp. (deg. C)	CTMax (deg. C)	Ult (deg. C)	Lethal Temp (deg. C)	Reference
(fathead minnow cont'd)		Adult (spawning)		>15.6°				Scott & Crossman, 1973
		N/A			32.2-38.2 (15.0 A)			Haness & Whitchison, 1980
		N/A		26.2(FP)				Stauffer, et. al., 1976
Rhinichthys atratulus (blacknose dace)	Mesotherm	N/A			31.9 (15.0 A)			Kovalski, et. al., 1978
		Adult (spawning)		19.0				Bartnik, 1970
		Adult (spawning)		>21.1°				Scott & Crossman, 1973
		Various (21-80mm)				28.8-29.9 (20.0 A)		Terpin, et. al., 1976
Rhinichthys cataractae (longnose dace)	Mesotherm	N/A			31.8 (15.0 A)			Kovalski, et. al., 1978
		Adult (spawning)		15.0				Bartnik, 1970
		Adult (spawning)		18.0-19.0				Brazo, et. al., 1978
		Adult (spawning)		18.0-19.0				Wismer & Christie, 1987
		Adult (spawning)		15.5-19.5°				Coe & Macinisk, 1972
Semotilus atromaculatus (creek chub)	Mesotherm	N/A				32.5 (13.0 A)	34.0 (13.0 A)	McFarlane, et. al., 1976
		Adult (spawning)		>12.8°				Scott & Crossman, 1973
Semotilus margarita (pearl dace)	Mesotherm	Adult (79 mm avg)				31.1 (20.0 A)		Brett, 1944
		Adult (spawning)		>17.2°				Scott & Crossman, 1973

R0058027

SUMMARY: WATER TEMPERATURE REQUIREMENTS - FISH

Family: Species	General Temp. Class.	Age or Size (mm or g)	Physio. Opt. (deg. C)	Preferred Temp. (deg. C)	CMax (deg. C)	Util (deg. C)	Lethal Temp (deg. C)	References
Semotilus corporalis (fallfish)	Mesotherm	N/A		<28.0°				Scott & Crossman, 1973
CYPRINODONTIDAE:								
Fundulus diaphanus (banded killifish)		Juvenile				34.5 (25.0 A)		Roseborough & Carside, 1977
		YOY & Adult					>38.0°	Bailey, 1955
		Adult (39-79mm)		4.9-37.0 (6.0-36.0A) (28.6 FP)				Matisky, et. al., 1980
		N/A		19.9-27.3 (5.0-30.0 A)				Carside & Morrison, 1977
ESOCIDAE:								
Esox Lucius (northern pike)		Eggs					<2.0 >21.0	Elliot, 1981
		Adult (spawning)		6.0-7.0°				Shiklishabekov, 1978
		Adult (spawning)		<10.0°				Harrison, 1978
		Adult (spawning)		4.4-11.1°				Scott & Crossman, 1973
Esox masquinongy (muskellunge)	Mesotherm	Larvae (4 days)			29.9 (19.2 A)			Bonin & Spotila, 1978
		Larvae (37 days)			35.6 (21.5 A)			
		Juvenile	>18					Harrison & Hadley, 1979
		Juvenile (200-250mm)		25.1				Reynolds and Casterlin, 1979b
		Adult	25.6				>32.2°	Scott & Crossman, 1973
		Adult (spawning)		16.0-18.0				Harrison, 1978

R0058028

SUMMARY: WATER TEMPERATURE REQUIREMENTS - FISH

Family: Species	General Temp. Class.	Age or Size (mm or g)	Physio. Opt. (deg. C)	Preferred temp. (deg. C)	CTMax (deg. C)	UILT (deg. C)	Lethal temp (deg. C)	Reference
(muskellunge cont'd)		Adult (spawning)	12.8					Scott & Crossman, 1973
Esox niger (chain pickerel)		Adult		24.0(FP)				Reynolds & Casterlin, 1977
		N/A		21.0-30.0°			>36.7°	Scott & Crossman, 1973
ICTALURIDAE:								
Ictalurus catus (white catfish)	Eurytherm	Juvenile (194mm ML)				31.0 (20.0 A)		Kendall, et. al., 1968
		Adult (255mm ML)				29.2 (20.0 A)		
		YOY	29.6	27.0-33.0 (26 A) (30.0 FP)				Kellog & Gift, 1983
Ictalurus melas (black bullhead)	Eurytherm	Juvenile (51.9g avg)				35.0 (23.0 A)	36.7 (23.0 A)	Black, 1953
		Adult (spawning)		>21.0°				Scott & Crossman, 1973
Ictalurus natalis (yellow bullhead)	Eurytherm	Juvenile		27.6 (23.0 A)				Reynolds & Casterlin, 1978b
		Juvenile					>38.0°	Bailly, 1955
		Adult		28.8 (23.0 A)				
Ictalurus nebulosus (brown bullhead)	Eurytherm	N/A		29.0-31.0				Crawshaw, 1975
		N/A					28.6-37.5 (6.0 - 36.0 A)	Scott & Crossman, 1973
		Juvenile (110mm)					>38.0°	Bailly, 1955
		Juvenile (137mm avg)				31.0-35.7 (13.0-23.0 A)		Brett, 1944
		Adult (326mm avg)		21.0-23.0°				Kelso, 1974

R0058029

SUMMARY: WATER TEMPERATURE REQUIREMENTS - FISH

Family: Species	General Temp. Class.	Age or Size (mm or g)	Physio. Opt. (deg. C)	Preferred Temp. (deg. C)	CTMax (deg. C)	Ult. (deg. C)	Lethal Temp (deg. C)	Reference
(brown bullhead cont'd)		Adult		29.0-31.0 (3.5-28.0 A)				Richards & Ibara, 1978
		Adult (spawning)		>21.1°				Scott & Crossman, 1973
Ictalurus punctatus (channel catfish)	Eurythern	YOY (20-42mm)				36.6-37.8 (26.0-34.0 A)		Allen & Strawn, 1967; 1971
		YOY		18.9-30.5 (6.0-30.0 A)				Cherry, et. al., 1975
		Juvenile	30.0					Andrews & Stickney, 1972
		N/A		>32.0°				Stauffer, et. al., 1974
		Adult (spawning)	26.7	23.9-29.5°				Scott & Crossman, 1973
Noturus gyrinus (tadpole madtom)	Eurythern	Juvenile & Adult					>30.0°	Bailey, 1955
LEPISOSTEIDAE:								
Lepisosteus osseus (longnose gar)	Eurythern	Adult (468-815mm)		30.5°				Neill & Magnuson, 1974
OSMERIDAE:								
Osmerus mordax (rainbow smelt)	Stenothern	Larvae		5.0-6.0° (night)				Brandt, et. al., 1980
				13.0-14.0° (day) (3.0-18.0 available)				Brandt, et. al., 1980
		Larvae		10.1-16.0°				Lin & Jude, 1983

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SUMMARY: WATER TEMPERATURE REQUIREMENTS - FISH

Family: Species	General Temp. Class.	Age or Size (mm or g)	Physio. Opt. (deg. C)	Preferred Temp. (deg. C)	CTMax (deg. C)	Ult (deg. C)	Lethal Temp (deg. C)	Reference
(rainbow smelt cont'd)		Adult		7.0-8.0 (night) 11.0-16.0 (day) (3.0-18.0 available)				Brandt, et. al., 1980
PERCICHTHYIDAE:								
Morone americana (white perch)		Eggs	14.1					
		Larvae	17.6					Morgan & Rasin, 1982
		YOY	28.5	24.0-33.0 (26.0 A) (30.0 FP)				Kellog & Gift, 1983
		Juvenile (51-65mm)		11.2-34.8 (6.0-30.0 A) (23.3 FP)				Hall, et. al., 1979
		Adult (spawning)		11.0-16.0°				Scott & Crossman, 1973
		N/A		>24.0°				Scott & Crossman, 1973
Morone saxatilis (striped bass)		YOY	24.0					Cox & Coutant, 1981
		YOY	28.5	25.0-33.0 (24.0 A) (27.0 FP)				Kellog & Gift, 1983
PERCIDAE:								
Etheostoma blennioides (greenside darter)	Mesotherm	Adult			26.2-35.1 (A)			Hlohowskyj & Wissing, 1984
		Adult		21.4-23.8 (20.0 A)				Hlohowskyj & Wissing, 1987
		N/A			32.2 (15.0 A)			Rawalski, et. al., 1978
		N/A		22.2°				Stauffer, et. al., 1976

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SUMMARY: WATER TEMPERATURE REQUIREMENTS - FISH

Family: Species	General Temp. Class.	Age or Size (mm or g)	Physio. Opt. (deg. C)	Preferred Temp. (deg. C)	CTMax (deg. C)	Ult (deg. C)	Lethal Temp (deg. C)	Reference
Etheostoma fisbellare (fantail darter)	Mesotherm	Adult			30.8-36.0			Hlohowshyj & Wissing, 1985
		Adult		19.0-20.6 (20.0 A)				Hlohowshyj & Wissing, 1987
		N/A		19.3-20.3 (15.0 A)	31.1 (15.0 A)			Ingersol & Clausson, 1984
		N/A			32.1 (15.0 A)			Kowalski, et. al., 1978
		N/A		19.4-20.0				Stauffer, et. al., 1976
Etheostoma nigrum (johnny darter)	Mesotherm	N/A		22.0-22.9 (15.0 A)	30.5-30.9 (15.0 A)			Ingersoll & Clausson, 1984
Perca flavescens (yellow perch)	Mesotherm	Larvae	10.0-15.0					Amundrud, et. al., 1974
		YOY		19.2-22.4 (15.0-24.0 A)			26.0 (7-0 WL)	Cherry, et. al., 1977
		YOY		18.6-26.7 (5.0-30.0 A) (24.2 FP)				Ferguson, 1958
		YOY	28.0			32.0-34.0 (8.0-34.0 A)	34.0 (7-0 WL)	McCormick, 1976
		YOY		23.4				Neill & Magnuson, 1974
		Juvenile (2.0-50.5g)		21.5(Day) 18.5(Night)		29.2 (22.0-24.0 A)	29.1-29.8 (24.0 A)	Reynolds & Casterlin, 1979c
		Juvenile (124mm avg)				30.9 (19.0 A)		Black, 1953
		Juvenile		20.0-23.3 (24.0 A)				Brett, 1944
		Adult		11.0-27.5 (21.0 FP)				McCauley & Read, 1973
		Adult		17.6-20.1 (24.0 A)				Ferguson, 1958
								McCauley & Read, 1973

R0058032

SUMMARY: WATER TEMPERATURE REQUIREMENTS - FISH

Family: Species	General Temp. Class.	Age or Size (mm or g)	Physio. Opt. (deg. C)	Preferred Temp. (deg. C)	CTMax (deg. C)	Ult (deg. C)	Lethal Temp (deg. C)	Reference
(yellow perch cont'd)		Adult (spawning)		8.0-10.0°				Sztramko & Jalabi, 1977
		Adult (spawning)		8.9-12.2°				Scott & Crossman, 1973
		Various (46-286g)		27.1°				Neill & Magnuson, 1974
		N/A		19.0-20.0° (day) 17.0-18.0° (night)				Crowder, et. al., 1981
		N/A		21.0-24.0				Scott & Crossman, 1973
Stizostedion vitreum (walleye)	Mesotherm	Eggs(fertilization)	6.0-12.0					Smith & Koenst, 1975
		Eggs(incubation)	9.0-15.0			19.0-20.1		
		Juvenile	22.0				27.0-31.6	
		Adult (spawning)		5.6-11.1°				Scott & Crossman, 1973
		Adult		19.0-27.0				Wrenn, 1976
PERCOPSIDAE:								
Percopsis omiscomaycus (trout-perch)		N/A		15.0-18.0° (day) 7.0-8.0° (night)				Crowder, et. al., 1981
POECILIIDAE:								
Gambusia affinis (mosquitofish)	Eurytherm	Juvenile	30.0					Murtsbaugh & Cech, 1983
		Various					>38.0°	Bailey, 1955
		Adult (spawning)		25.0				Vondracek, et. al., 1988

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SUMMARY: WATER TEMPERATURE REQUIREMENTS - FISH

Family: Species	General Temp. Class.	Age or Size (mm or g)	Physio. Opt. (deg. C)	Preferred Temp. (deg. C)	CTMax (deg. C)	Ultimate (deg. C)	Lethal Temp (deg. C)	Reference
SALMONIDAE:								
Coregonus artedii (Cisco)	Stenotherm	Eggs						Colby & Brooke, 1973
		YOY					12.1	Edsall & Colby, 1970
		Adult (spawning)		3.3-5.0°		26.0		Scott & Crossman, 1973
Salmo gairdneri (rainbow trout)	Stenotherm	Eggs					<0, >20.0	Elliot, 1981
		Fry				24.0 (11.0 A)		Black, 1953
		Fry (1 mo.)		17.5				Kwain & McCauley, 1978
		YOY (6 mo.)		16.9				
		YOY(12 mo.)		11.4				
		YOY				25.0-26.0 (15.0 A).		Bidgood & Berst, 1969
		YOY		11.6-22.0 (6-24 A)				Cherry, et. al., 1975
		YOY		14.1-22.2 (12.0-24.0 A) (19.2-19.8FP)			25.0 (7-0 UL)	Cherry, et. al., 1977
		YOY (38-76mm)		15.0-21.0 (10.0-20.0 A)				Javid & Anderson, 1967
		YOY (150-200mm)			28.5 (10.0 A) 29.3 (20.0 A)			Lee & Rinne, 1980
		YOY (180-230mm)					27.0(ULT)	Charlon, et. al., 1970
		YOY (26.1g)				24.0 (11.0 A)	25.7 (11.0 A)	Black, 1953
		YOY (150-250g)		16.7 (10.0 A)				McCauley & Huggins, 1975
		YOY (<100g)		10.0-19.0°				Spingarelli & Thommes, 1979
		Juvenile	15.5-18.6			25.6 (16.0 A)		Hokanson, et. al., 1977

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SUMMARY: WATER TEMPERATURE REQUIREMENTS - FISH

Family: Species	General Temp. Class.	Age or Size (mm or g)	Physio. Opt. (deg. C)	Preferred Temp. (deg. C)	CTMax (deg. C)	Ult (deg. C)	Lethal Temp (deg. C)	Reference
(rainbow trout cont'd)		Juvenile (1-2 yr.)		11.0-16.0 (5.0-20.0 A) (13.0 FP)				Garside & Tait, 1958
		Adult (spawning)		10.0-15.5°				Scott & Crossman, 1973
		Adult		13.0-15.0°				Spingarelli & Thommes, 1979
Salmo trutta (brown trout)	Stenotherm	Eggs					0, >13.0	Elliot, 1981
		Fry					22.5 (5.0-6.0 A)	Klein, 1962
		YOY		11.7-18.5 (12.0-23.0 A) (14.3-17.8FP)			23.0 (20.0 A)	Cherry, et. al., 1977
		Juvenile			29.0-29.9		23.0 (7-D UL)	Lee & Rinne, 1980
		Adult					25.0-26.0 (14.0-26.0 A)	Klein, 1962
		Adult		9.1-14.6°				Spigarelli, et. al., 1983
		Adult (spawning)		3.0-11.0°				Witzel & MacCrimmon, 1983
		Various	4-19			25.0-30.0 (17.5-27.5 A)		Elliot, 1981
		N/A		10.0-15.0				Brown, 1946
		N/A					25.3	Everhart & Youngs, 1981
		N/A		18.9				Nihursky & Kennedy, 1967
		N/A		10.3-12.8				Reynolds and Casterlin, 1979a
		N/A	18.3-23.9					Scott & Crossman, 1973
Salvelinus fontinalis (brook trout)	Stenotherm	Eggs(viable per female)	11.7					Hokanson, et. al., 1973
		Eggs (hatch)	6.0			12.7		

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SUMMARY: WATER TEMPERATURE REQUIREMENTS - FISH

Family: Species	General Temp. Class.	Age or Size (mm or g)	Physio. Opt. (deg. C)	Preferred Temp. (deg. C)	CTMax (deg. C)	Ult (deg. C)	Lethal Temp (deg. C)	Reference
(brook trout cont'd)		Larvae				20.1		McCormick, et. al., 1972
		Fry				24.5		
		Fry		17.5 (12.7 A)				Peterson, et. al., 1979
		YOY	13.0					Baldwin, 1956
		YOY (4.0-7.0g)		16.81 (10 A)				Muller, 1977
		YOY (4.5-7.0g)		18.04 (18 A)				
		Juvenile (145mm avg)				26.1 (19.0 A)		Brett, 1944
		Juvenile	12.4-15.4					
		Juvenile (50-100mm)		13.7-19.8 (12.0-24.0 A)				McCormick, et. al., 1972
		Juvenile (150-200mm)					24.0 (7-D WL)	Cherry, et. al., 1977
					28.5 (10.0 A) 29.4 (20.0 A)			Lee & Rinne, 1980
		Adult		<19.0*				
		Adult (spawning)		4.0-13.0*				Crossar, 1930
								Witzel & MacCrimmon, 1983
		N/A					24.5-27.0 (10.0-20.0 A)	McCauly, 1958
		N/A		<20.0				Scott & Crossman, 1973

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DEFINITION OF TERMS AND ABBREVIATIONS

Temperature classification (after Hokanson, 1977):

Stenotherm - Ultimate lethal temperature <26 (deg. C)
Physiological optimum <20 (deg. C)
Mesotherm - Ultimate lethal temperature 28-34 (deg. C)
Physiological optimum 20-28 (deg. C)
Eurytherm - Ultimate lethal temperature >34 (deg. C)
Physiological optimum >28 (deg. C)

Age or Size:

mm - Length in millimeters.
g - Weight in grams
ML - Mean length
Avg - average length
Egg - Embryo inside egg envelope
Fry - Exogenous feeding, jerky swimming, and/or risen out of nesting site
Larvae - Can include fry stage, swimming is complete, and/or beginning of schooling
YOY - Young-of-year
Juvenile - older than young-of-year, but not sexually mature
Adult - Sexually mature
N/A - No age or size data reported

Temperature:

Physio. opt. - Physiological optimum for growth (unless otherwise indicated in the table).
Preferred temp. - Temperature preferred by laboratory specimens, for a given acclimation temperature; or temperature at which specimens were observed in the field.
CTMax - Critical thermal maxima: upper zone of thermal resistance; where a fish loses normal locomotary function and/or control
UILT - Upper incipient lethal temperature: temperature that is lethal to 50% of tested specimens.
Lethal Temperature- Temperature that is lethal to 100% of tested specimens.
FP - Final preferendum: temperature around which fish congregate in an infinite temperature gradient.
* - Data from field study.
A - Acclimation temperature (see Brett,1956).
7-D UL - Seven day upper lethal limit.
ULT - Upper lethal temperature: lethal temperature beyond which no acclimation is possible.

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Appendix V.

Table 1. The fishes of Maryland and Delaware and their general distributions. An = anadromous, E = endemic, N = native, Nl = regarded as native but possibly introduced, I = introduced, IP = probably introduced, Ma = euryhaline or diadromous, ? = presence suspected in Delaware, * = recorded from Delaware (appears before species name). Lower case letters = rare or restricted distributions. Letters A-C correspond to various physiographic areas (see Figure 1) [i.e., A -Coastal Plain section of Delmarva peninsula; B - Coastal Plain of southern Maryland; C - eastern division of Piedmont (Chesapeake and Delaware bay drainage); D - western division of Piedmont (Potomac drainage); E -Blue Ridge, Ridge and Valley, Great Valley; F - Atlantic Slope drainage of Appalachian Plateau; G - Ohio basin drainage of Appalachian Plateau]. Explanations of superscript numbers appear at end of table.

(Source: Lee et al., 1981)

Figure 1.

	A	B	C	D	E	F	G
PETROMYZONTIDAE							
*Lampetra appendix (DeKay)[1] American brook lamprey	nl	n	n	i			
*Lampetra aepyptera (Abbott) least brook lamprey	Nl	N					
*Petromyzon marinus Linnaeus sea lamprey	An	An	An				
ACIPENSERIDAE							
*Acipenser brevirostrum Lesueur shortnosed sturgeon	an	an	an				
*Acipenser oxyrhynchus Mitchill Atlantic sturgeon	an	an	an				
LEPISOSTEIDAE							
*Lepisosteus osseus (Linnaeus) longnose gar	Ma	Ma	Ma[2]				
AMIIDAE							
Amia calva Linnaeus bowfin	a	a	ip				
ANGUILLIDAE							
*Anguilla rostrata (Lesueur) American eel	Ma	Ma	Ma	Ma	ma	ma[2]	
CLUPEIDAE							
*Alosa aestivalis (Mitchill) blueback herring	An	An	An				
*Alosa mediocris (Mitchill) hickory shad	An	An	An				
*Alosa pseudoharengus (Wilson) alewife	An	An	An				
*Alosa sapidissima (Wilson) American shad	An	An	An				
*Dorosoma cepedianum (Lesueur) gizzard shad	Ma	Ma	ma	ma			
*Dorosoma petenense (Gunther)[3] threadfin shad	I	I		I			
SALMONIDAE							
Coregonus artedi Lesueur cisco or lake herring			p				
Salmo gairdneri Richardson rainbow trout			I	I	I	I	I
Salmo trutta (Linnaeus) brown trout			I	I	I	I	I
Salvelinus fontinalis (Mitchill) brook trout			native to upland streams widely introduced elsewhere				
OSMERIDAE							
Osmerus mordax (Mitchill) rainbow smelt		P					
UMBRIDAE							
*Umbra pygmaea (DeKay) eastern mudminnow	N	N	N	n			
ESOCIDAE							
*Esox americanus americanus Gmelin redfin pickerel	N	N	N				I
Esox lucius Linnaeus northern pike			I				Ip
Esox masquinongy Mitchill muskellunge			I				

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	A	B	C	D	E	F	G
*Esox niger Lesueur chain pickerel	N	N	I		IP		I
CYPRINIDAE							
Campostoma anomalum (Rafinesque) central stoneroller			n	N	N	N	N
†Carassius auratus (Linnaeus) goldfish	I[a]	I	I[a]	I			
Clinostomus elongatus (Kirtland) redside dace							n[a]
†Clinostomus funduloides Girard rosyside dace	n[a,b]	n	N[a]	N	n		
Ctenopharyngodon idella Valenciennes grass carp		I[a]					
*Cyprinus carpio Linnaeus common carp	I	I	I	I	I	I	I
Erycimba buccata Cope silverjaw minnow				N	N		
*Exoglossum maxillingua (Lesueur) cutlips minnow		n	N	N	N	n	
*Hybognathus regius Girard eastern silvery minnow	N	N	N	n			
Leuciscus idus (Linnaeus)[c] ide				I			
Nocomis micropogon (Cope) river chub		n	N	N	N	N	N
*Notemigonus crysoleucas (Mitchill) golden shiner	N	N	n	n	n	n	N
*Notropis amoenus (Abbott) comely shiner	n	n	N	N	N		
*Notropis analostanus (Girard) satinfin shiner	n	N	N	N	N		
*Notropis bifrenatus (Cope) bridle shiner	n	N	n				
*Notropis chalybaeus (Cope) ironcolor shiner	N	N					
*Notropis cornutus (Mitchill) common shiner		n	N	N	N	N	N
*Notropis hudsonius (Clinton) spottail shiner	N	N	n	N	N		
*Notropis procne (Cope) swallowtail shiner	n	n	N	N	N		
Notropis rubellus (Agassiz) rosyface shiner		n	N	N	n	n	
†Notropis spilopterus (Cope) spotfin shiner			n[a]	N	n		
Pimephales notatus (Rafinesque) bluntnose minnow			N	N	N	N	N
Pimephales promelas Rafinesque fathead minnow			I	I	I		
*Rhinichthys atratulus (Hermann) blacknose dace	n[a,b]	N	N	N	N	N	N
†Rhinichthys cataractae (Valenciennes) longnose dace		n	N[a]	N	N	N	N
*Semotilus atromaculatus (Mitchill) creek chub		N	N	N	N	N	N
*Semotilus corporalis (Mitchill) fallfish	n	N	N	N	N		
Semotilus margarita (Cope) pearl dace			n	n	n		n
Tinca tinca (Linnaeus)[c] tench	I	I	I	I			
CATOSTOMIDAE							
Carpiodes cyprinus (Lesueur) quillback	n	n	n	n[a]			
Catostomus catostomus (Forster) longnose sucker							n[a]
*Catostomus commersoni (Lacepede) white sucker	n	N	N	N	N	N	N
*Erimyzon oblongus (Mitchill) creek chubsucker	N	N	n	N	n		
†Hypentelium nigricans (Lesueur) northern hog sucker		n	N[a]	N	N	N	N
Moxostoma duquesnei (Lesueur) black redhorse							n
Moxostoma erythrurum (Rafinesque) golden redhorse					n[a]		

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	A	B	C	D	E	F	G
*Moxostoma macrolepidotum (Lesueur) shorthead redhorse	sp,N	R	R	R			
ICTALURIDAE							
*Ictalurus catus (Linnaeus) white catfish	N	N	R	R			
Ictalurus furcatus (Lesueur) blue catfish				I			
*Ictalurus natalis (Lesueur) yellow bullhead	N	N	N	N	N	N	N
*Ictalurus nebulosus (Lesueur) brown bullhead	N	N	N	N	N	N	N
Ictalurus punctatus (Rafinesque) channel catfish	sp	sp	sp	sp	sp	sp	sp
Noturus flavus Rafinesque stonecat							
*Noturus gyrinus (Mitchill) tadpole madtom	N	N		N	R	R	R
Noturus insignis (Richardson) margined madtom	sp	R	N				
APHREDODERIDAE							
*Aphredoderus sayanus (Gilliams) pirate perch	N	N					
PERCOPSIDAE							
Percopsis omiscomaycus (Walbaum)* trout-perch			R	R			
CYPRINODONTIDAE							
*Fundulus diaphanus (Lesueur) banded killifish	Ma	Ma	Ma	Ma			
POECILIIDAE							
*Gambusia affinis (Baird and Girard) mosquitofish	Ma	Ma					
PERCICHTHYIDAE							
*Morone americana (Gmelin) white perch	An	An	An				
*Morone saxatilis (Walbaum) striped bass	An	An	An				
CENTRARCHIDAE							
*Acantharchus pomotis (Baird) mud sunfish	N		R				
Ambloplites rupestris (Rafinesque) rock bass			I	I	I	I	
Centrarchus macropterus (Lacepede) flier		sp					N
*Enneacanthus chaetodon (Baird) blackbanded sunfish	N	R	R				
*Enneacanthus gloriosus (Holbrook) bluespotted sunfish	N	N	R				
*Enneacanthus obesus (Girard) banded sunfish	N	sp	R				
*Lepomis auritus (Linnaeus) redbreast sunfish	N	N	N	N	N	I	
Lepomis cyanellus Rafinesque green sunfish		I	I	I	I		N
*Lepomis gibbosus (Linnaeus) pumpkinseed	N	N	N	N	N	I	I
*Lepomis gulosus (Cuvier) warmouth	sp			sp	sp		
*Lepomis macrochirus Rafinesque bluegill	sp	sp	sp	sp	sp		
Lepomis megalotis (Rafinesque) longear sunfish		I		I	I		N
*Micropterus dolomieui Lacepede smallmouth bass	I	I	I	I	I	I	N
*Micropterus salmoides (Lacepede) largemouth bass	sp	sp	sp	sp		I	N
*Pomoxis annularis Rafinesque white crappie	I	I	I	I		I	N
*Pomoxis nigromaculatus (Lesueur black crappie	sp	sp	sp	sp	sp	sp	N
PERCIDAE							
Etheostoma blennioides Rafinesque greenside darter				N	N		N

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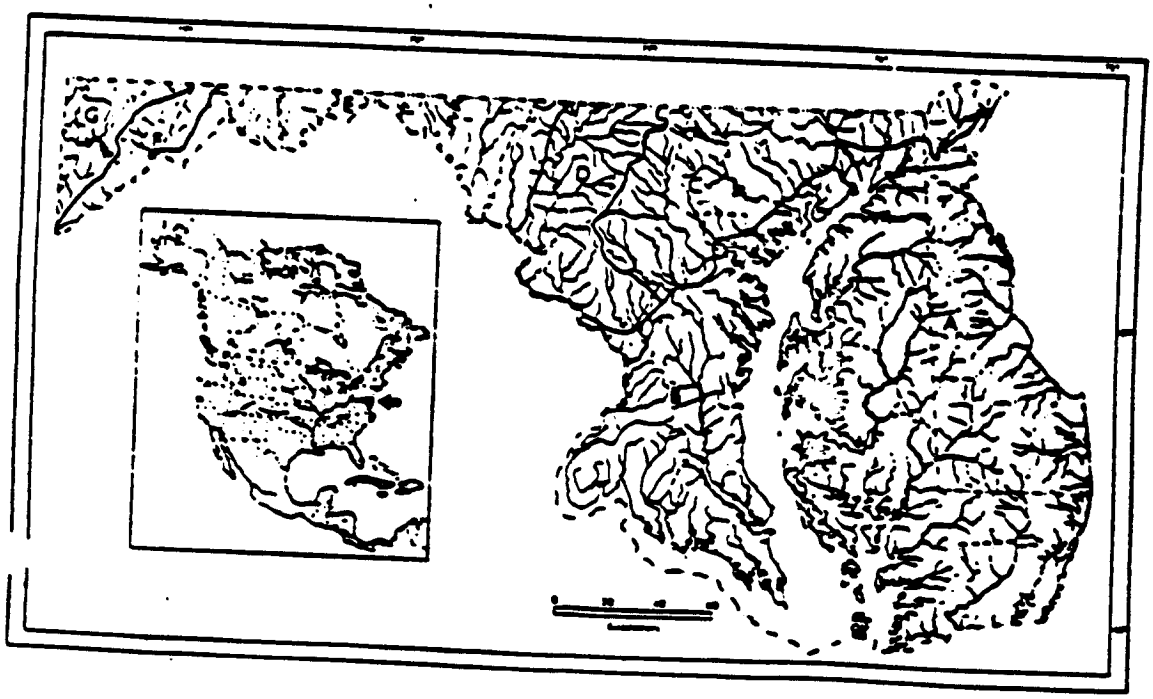
	A	B	C	D	E	F	G
Etheostoma flabellare Rafinesque fantail darter				N	N	N	
*Etheostoma fusiforme (Girard) swamp darter	N	N					
Etheostoma nigrum Rafinesque johnny darter							N
*Etheostoma olmstedi Storer tessellated darter	N	N	N	N	N		
Etheostoma sellare (Radcliffe and Welsh) Maryland darter			e				
Etheostoma vitreum (Cope) glassy darter		n	n				
Etheostoma zonale (Cope)[illegible] banded darter			i				
*Perca flavescens (Mitchill) yellow perch	N	N	N[illegible]	n	lp		i
Percina caprodes (Rafinesque) logperch		ni[illegible]	ni[illegible]				
Percina notogramma (Raney and Hubbs)[illegible] stripeback darter		n	n				
Percina peltata (Stauffer) shield darter	n	n	N	n			
Stizostedion vitreum vitreum (Mitchill) walleye		lp	lp				Nl
		COTTIDAE					
*Cottus bairdi Girard mottled sculpin	n[illegible]		N	N	N	N	N
Cottus girardi Robins[illegible] Potomac sculpin					n	N	
NATIVE	52	60	56	42	34	19	26
INTRODUCED	11	14	21	19	14	5	9
TOTAL	63	74	77	61	48	24	35



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Appendix D: 1989 Climatological Data - Glenmont, MD Weather Station

Month	Day	Air Temp. Max. (F)	Air Temp. Min. (F)	Precipitation (in.)
4	1	49	33	0.00
	2	54	30	0.00
	3	71	46	0.22
	4	77	59	0.01
	5	69	51	0.59
	6	55	42	0.02
	7	48	32	0.25
	8	49	33	0.21
	9	55	37	0.01
	10	48	37	0.00
	11	50	31	0.00
	12	57	27	0.00
	13	61	31	0.00
	14	62	51	0.00
	15	53	47	0.65
	16	62	40	0.00
	17	76	35	0.00
	18	78	59	0.48
	19	60	43	0.42
	20	64	36	0.00
	21	69	38	0.00
	22	65	40	0.00
	23	61	30	0.00
	24	66	32	0.00
	25	77	40	0.00
	26	72	47	0.00
	27	76	46	0.00
	28	69	51	0.00
	29	58	52	0.65
	30	76	55	0.00
5	1	62	58	0.79
	2	67	49	0.23
	3	62	43	0.00
	4	68	37	0.00
	5	63	57	4.65
	6	73	46	0.56
	7	55	40	0.01
	8	63	42	0.01
	9	67	43	0.50
	10	54	48	0.48
	11	54	47	0.03
	12	59	43	0.15
	13	64	41	0.07
	14	70	51	0.01
	15	62	50	0.59
	16	58	54	1.19
	17	73	56	0.05
	18	84	52	0.00

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Appendix D: 1989 Climatological Data - Glenmont, MD Weather Station

Month	Day	Air Temp. Max. (F)	Air Temp. Min. (F)	Precipitation (in.)
	19	84	53	0.00
	20	84	57	0.01
	21	80	56	0.00
	22	80	52	0.00
	23	70	60	1.04
	24	69	56	0.03
	25	84	53	0.00
	26	87	63	0.00
	27	76	59	0.52
	28	71	50	0.00
	29	78	47	0.00
	30	84	58	0.00
	31	86	65	0.01
6	1	91	69	0.00
	2	87	67	0.00
	3	85	63	0.00
	4	84	67	0.00
	5	81	64	1.03
	6	76	64	0.45
	7	69	61	1.21
	8	79	61	0.00
	9	77	66	0.62
	10	79	62	0.00
	11	74	55	0.00
	12	76	53	0.02
	13	78	68	0.01
	14	84	63	0.42
	15	84	67	0.19
	16	82	68	0.12
	17	76	64	0.11
	18	80	60	0.01
	19	83	64	0.00
	20	78	66	0.40
	21	83	68	0.23
	22	83	69	1.12
	23	80	70	0.16
	24	81	69	0.01
	25	84	66	0.00
	26	88	70	0.00
	27	90	70	0.00
	28	79	70	0.01
	29	74	58	0.00
	30	76	53	0.00
7	1	84	54	0.00
	2	86	60	0.00
	3	83	66	0.00
	4	78	70	1.50

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Appendix D: 1989 Climatological Data - Glenmont, MD Weather Station

Month	Day	Air Temp. Max. (F)	Air Temp. Min. (F)	Precipitation (in.)
	5	76	70	0.22
	6	79	71	0.38
	7	87	70	0.00
	8	80	66	0.00
	9	87	63	0.00
	10	90	69	0.00
	11	92	76	0.00
	12	82	70	0.01
	13	71	65	0.38
	14	78	64	0.00
	15	81	60	0.01
	16	70	66	0.85
	17	75	63	0.00
	18	80	61	0.00
	19	83	63	0.00
	20	84	70	1.53
	21	86	70	0.00
	22	89	74	0.00
	23	87	73	0.00
	24	89	72	0.00
	25	89	73	0.00
	26	89	72	0.07
	27	87	70	0.00
	28	84	71	0.00
	29	78	58	0.00
	30	76	59	0.54
	31	68	65	0.11
8	1	77	67	0.02
	2	79	64	0.00
	3	86	65	0.00
	4	92	70	0.00
	5	88	76	0.00
	6	89	73	0.01
	7	75	59	0.03
	8	73	52	0.00
	9	75	50	0.00
	10	71	57	0.01
	11	67	63	0.02
	12	75	63	0.08
	13	82	68	0.00
	14	80	67	0.58
	15	78	65	0.01
	16	83	68	0.00
	17	81	69	0.01
	18	71	66	0.02
	19	74	64	0.03
	20	86	65	0.00
	21	80	72	0.07

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Appendix D: 1989 Climatological Data - Glenmont, MD Weather Station

Month	Day	Air Temp. Max. (F)	Air Temp. Min. (F)	Precipitation (in.)
	22	87	68	0.01
	23	90	72	0.03
	24	77	65	0.00
	25	80	60	0.00
	26	77	63	0.00
	27	80	61	0.00
	28	85	69	0.00
	29	86	70	0.00
	30	87	64	0.01
	31	83	57	0.00
9	1	87	61	0.03
	2	82	61	0.00
	3	78	54	0.00
	4	76	53	0.00
	5	75	55	0.00
	6	78	61	0.00
	7	78	60	0.00
	8	80	58	0.00
	9	87	63	0.00
	10	90	67	0.00
	11	87	69	0.00
	12	74	65	0.22
	13	77	67	0.15
	14	80	70	0.00
	15	78	66	0.00
	16	71	65	1.06
	17	75	59	0.15
	18	70	56	0.00
	19	65	60	0.42
	20	75	63	0.75
	21	85	72	0.02
	22	84	73	0.28
	23	79	47	0.28
	24	59	41	0.00
	25	64	40	0.35
	26	68	53	0.80
	27	59	42	0.00
	28	67	38	0.00
	29	74	47	0.00
	30	67	55	0.00
10	1	65	54	0.72
	2	70	61	0.42
	3	72	50	0.00
	4	59	41	0.00
	5	67	42	0.00
	6	71	49	0.02
	7	62	41	0.01

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Appendix D: 1989 Climatological Data - Glenmont, MD Weather Station

Month	Day	Air Temp. Max. (F)	Air Temp. Min. (F)	Precipitation (in.)
	8	60	35	0.01
	9	55	38	0.00
	10	62	35	0.06
	11	66	39	0.00
	12	75	42	0.00
	13	80	50	0.00
	14	76	55	0.00
	15	82	76	0.00
	16	83	53	0.00
	17	70	61	0.98
	18	63	48	0.83
	19	56	45	0.92
	20	57	43	0.86
	21	56	37	0.00
	22	62	39	0.00
	23	65	34	0.00
	24	68	34	0.00
	25	70	35	0.00
	26	73	42	0.00
	27	74	41	0.00
	28	74	46	0.00
	29	74	47	0.00
	30	72	46	0.01
	31	66	56	0.18

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Appendix E.

Water Quality Grab Sampling Station Location Maps and Data

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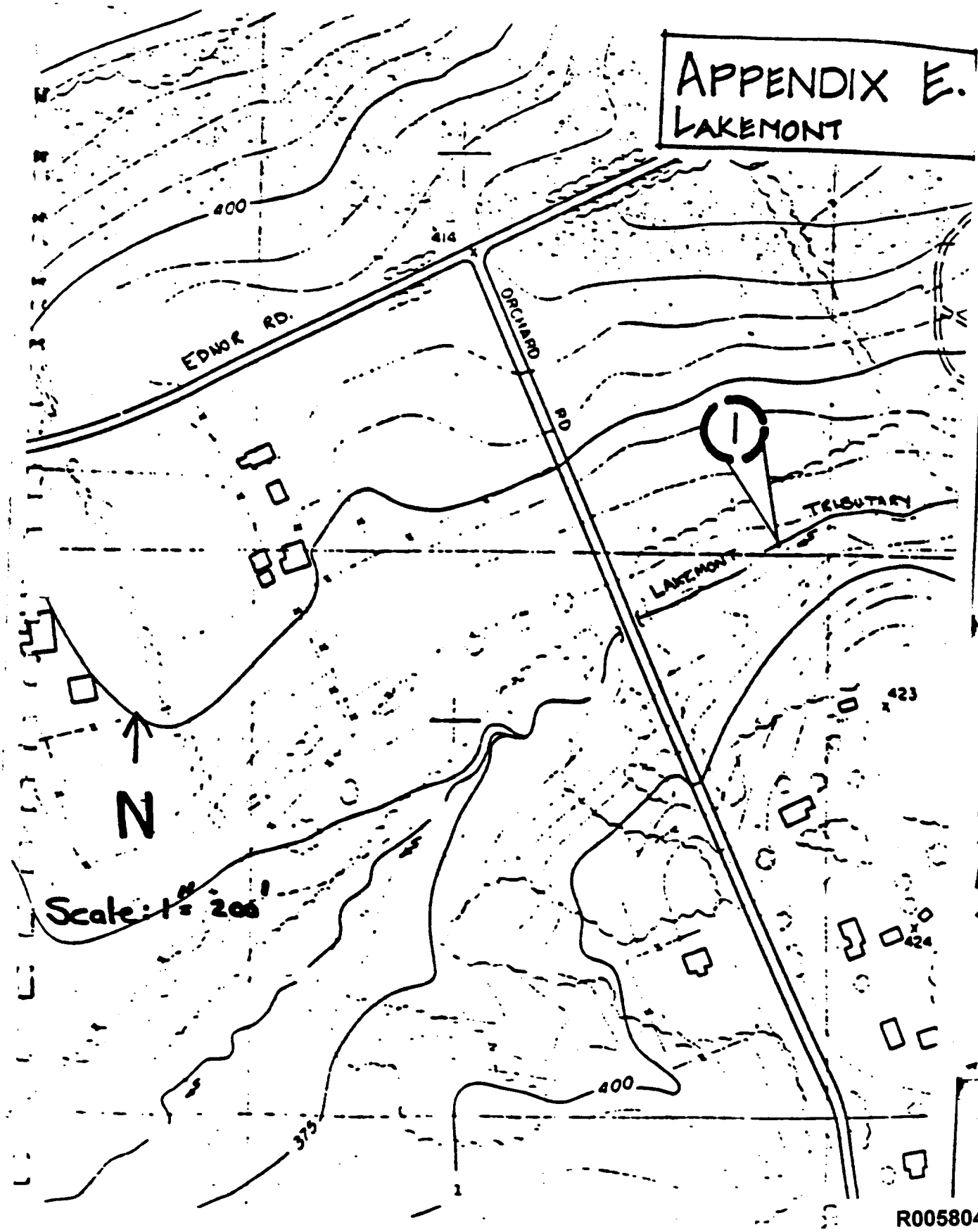
APPENDIX E.
LAKEMONT



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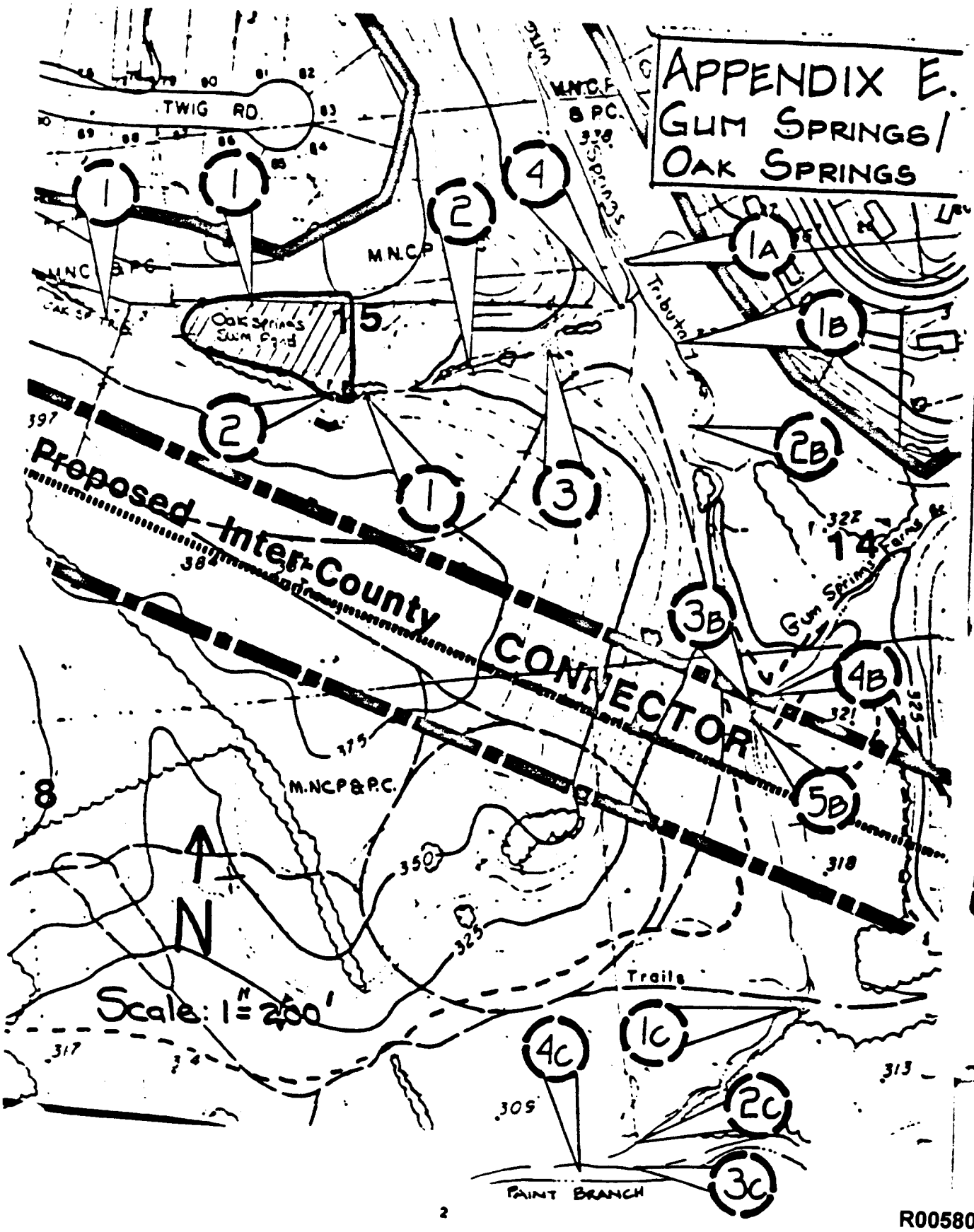

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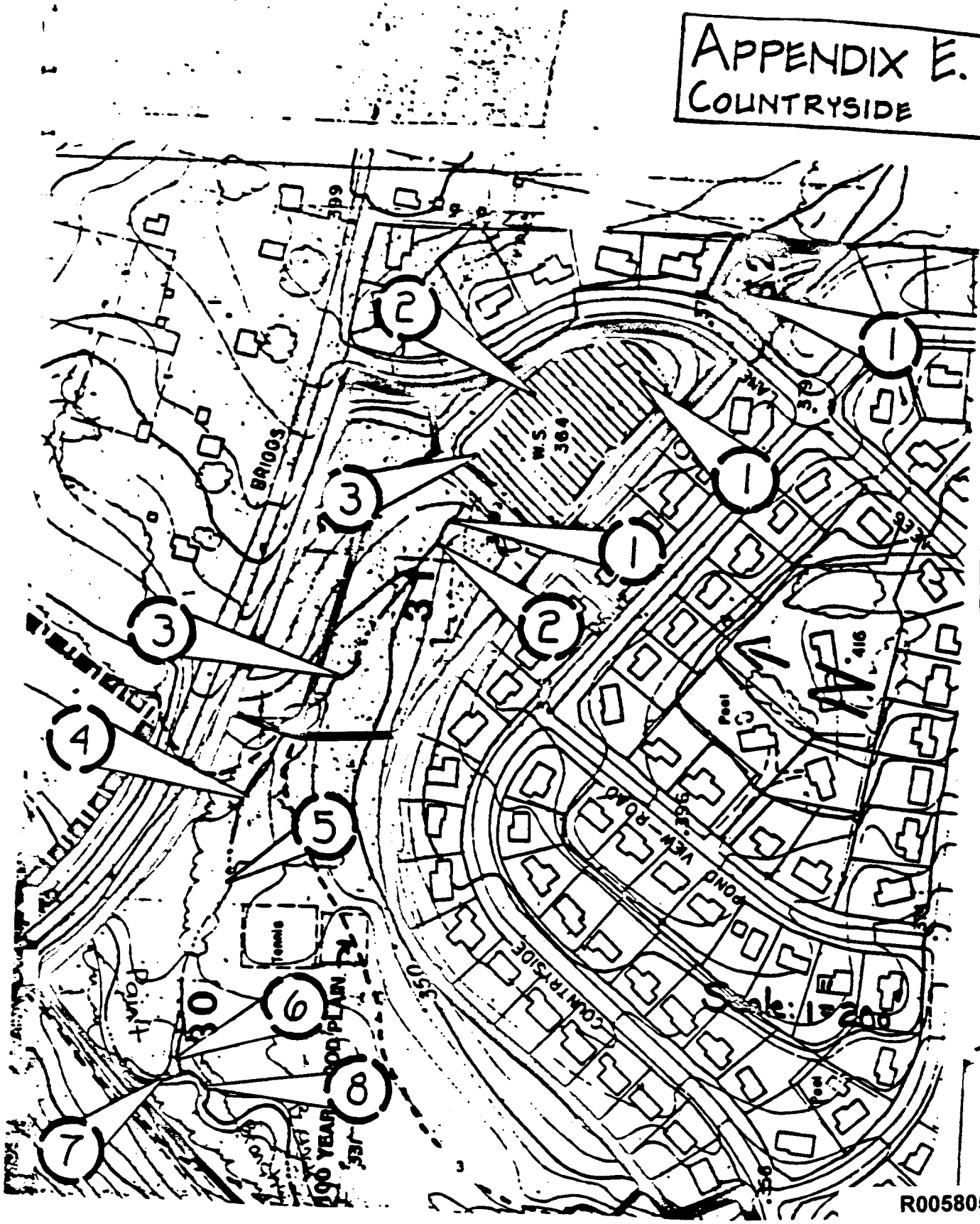
APPENDIX E.
COUNTRYSIDE



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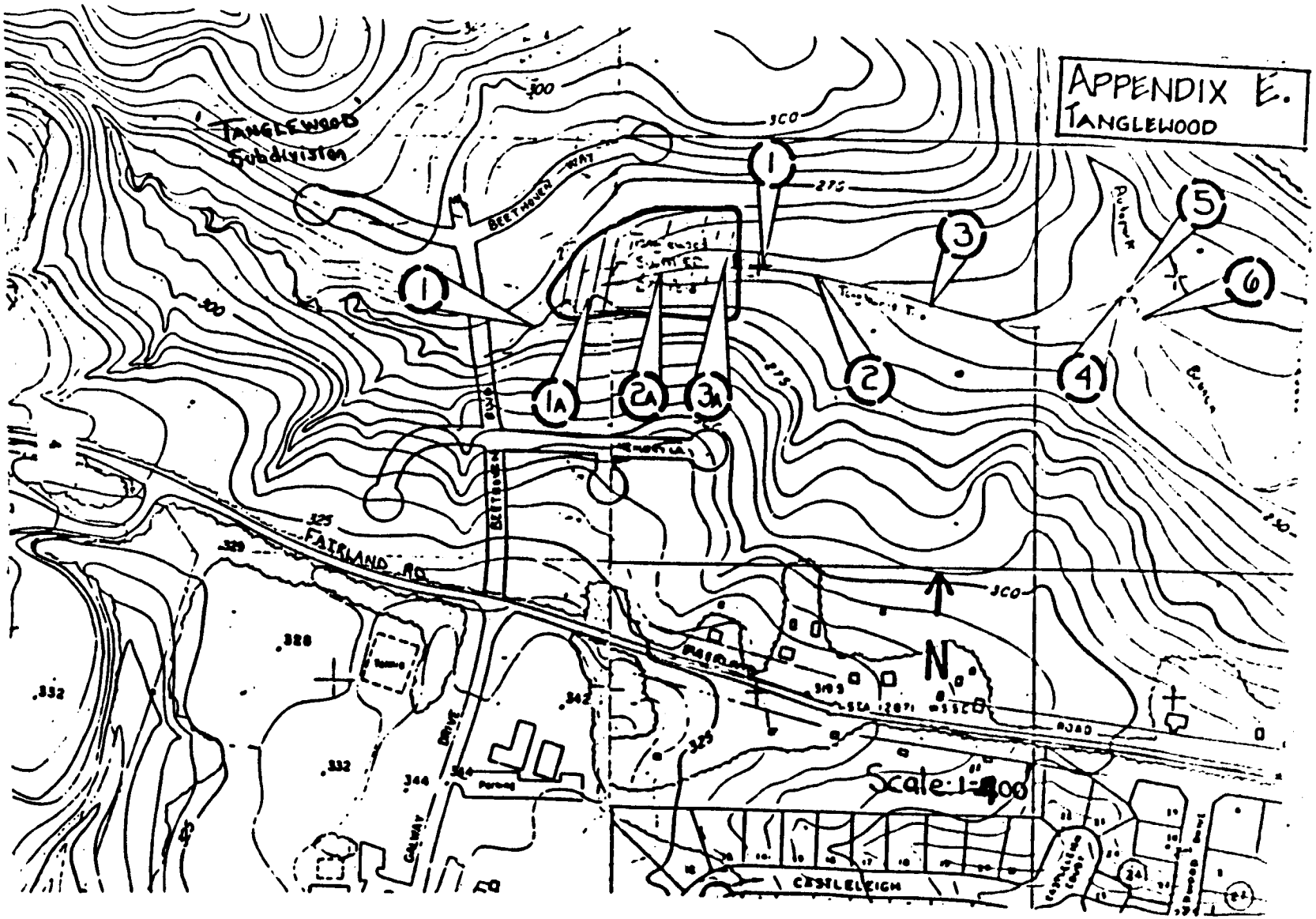

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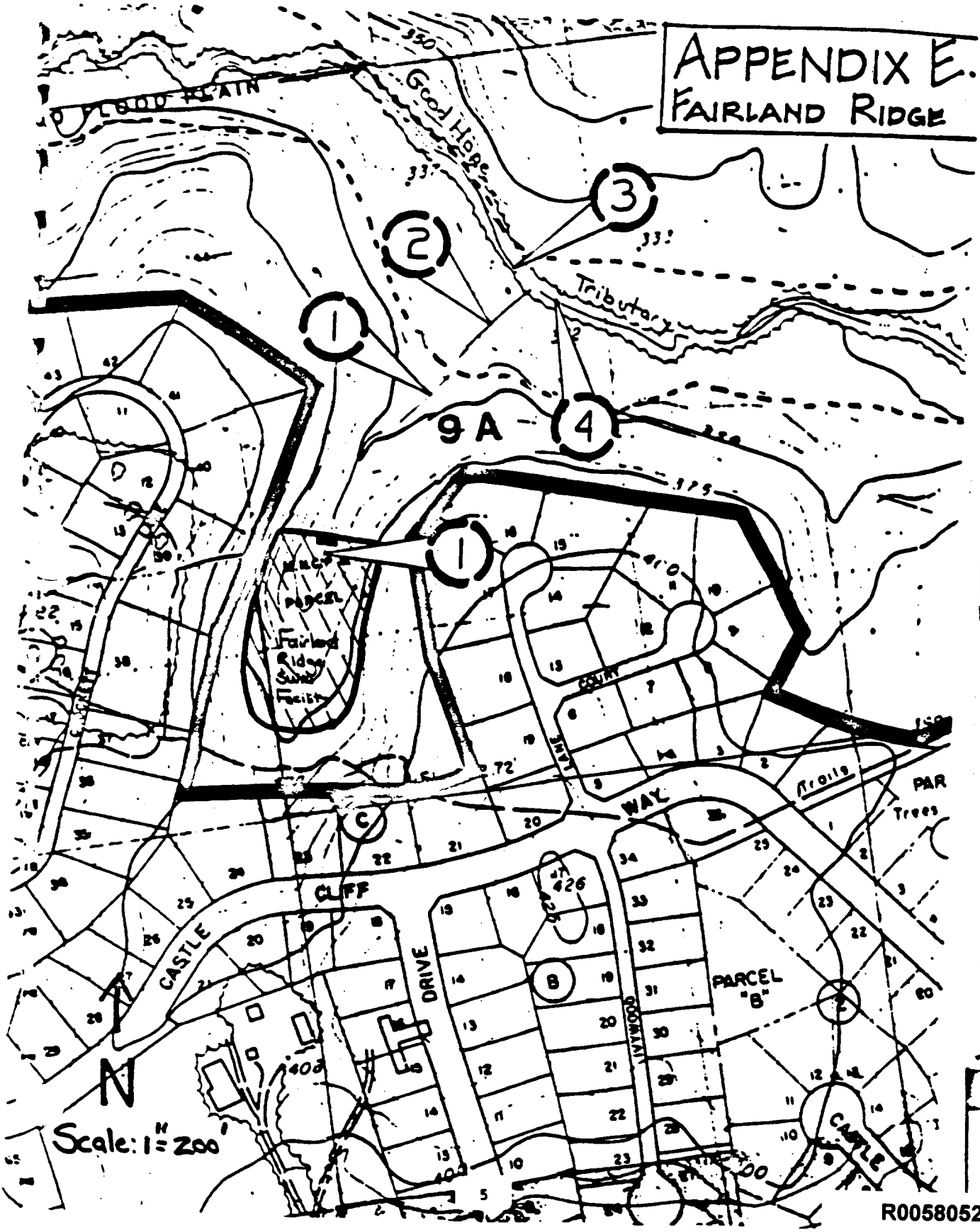
APPENDIX E.
FAIRLAND RIDGE



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APPENDIX E.
WHITE OAK
WHITE OAK TRIBUTARY
UNKNOWN CONSTRUCTION
SCALE: 1"=400'
N
1
2
3
4
5

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APPENDIX B: 1989 NWCOG WATER QUALITY GRAB SAMPLING DATA

STATION	NUMBER	MONTH	DAY	TIME HR:MIN	AIR TEMP. (F)	WATER TEMP. (C)	DO (PPM)	FLOW (CFS)
Lakecost	1	6	16	15:40	77	17.0	11.6	0.00
			21	13:45	79	16.0	11.8	1.31
			28	10:30	76	16.2	11.4	1.39
		7	6	08:15	70	16.0	11.7	2.30
			11	08:40	79	16.8	10.8	0.95
			20	09:55	74	17.5	10.8	1.02
			25	08:10	74	16.9	10.6	1.06
		8	1	12:30	71	16.2	11.2	1.00
			9	08:45	62	12.9	10.3	0.55
			17	08:14	72	16.2	11.1	0.50
			23	09:28	79	17.5	10.4	0.60
			31	16:52	75	18.4	10.1	0.60
		9	7	14:40	73	17.3	10.0	0.50
		10	20	10:20	48	12.5	9.5	3.76
Deer Gun Springs	1A	6	15	10:30	77	17.0	11.6	0.00
			20	10:25	76	15.4	10.4	1.20
			27	10:00	76	16.0	11.7	1.14
		7	5	11:05	76	17.0	10.8	1.40
			11	14:15	83	18.5	10.2	0.91
			13	11:34	69	16.5	10.4	1.51
			21	08:55	77	16.8	9.7	1.04
			25	10:30	80	17.2	11.3	0.99
		8	1	10:11	69	16.5	11.0	0.92
			9	10:31	66	14.5	10.4	0.95
			17	10:03	78	16.0	11.0	0.81
			22	10:20	78	17.0	10.0	0.94
		9	1	12:07	80	17.5	9.4	0.83
			7	12:43	71	16.4	10.0	1.07
			14	11:22	75	17.2	9.8	0.77
			20	13:20	66	18.5	9.0	1.31
			29	11:15	66	12.5	9.4	0.96
		10	6	11:28	65	13.0	9.1	0.74
			13	09:51	65	12.0	9.8	0.93
			18	15:35	59	14.0	9.4	1.02
Oakesprings inflow	1	6	15	09:10	76	20.0	9.9	0.13
			20	09:05	62	15.4	10.4	1.20
			27	08:50	77	19.7	7.9	0.07
		7	5	09:15	75	22.8	8.7	0.76
			11	13:20	83	22.0	8.3	0.04
			13	10:23	71	19.7	8.8	0.39
			21	08:15	77	22.5	9.5	0.38
			26	09:20	79	21.8	10.1	0.00
		8	1	09:15	71	19.9	8.8	0.16
			9	09:42	65	14.8	10.8	0.04
			17	09:02	73	19.0	10.0	0.05
			22	08:35	75	19.2	8.4	0.04

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APPENDIX B: 1989 HUCOG WATER QUALITY GRAB SAMPLING DATA

STATION	NUMBER	MONTH	DAY	TIME HR:MIN	AIR TEMP. (F)	WATER TEMP. (C)	DO (PPM)	FLOW (CFS)
		9	1	11:02	77	19.8	0.9	0.03
			7	11:12	73	19.3	5.9	0.01
			14	10:00	75	21.5	7.6	0.21
			20	12:07	72	19.5	9.0	1.95
			29	10:15	59	13.5	0.0	0.06
		10	6	10:25	61	12.0	7.9	0.05
			13	08:05	57	11.3	7.6	0.03
			18	14:05	61	16.0	0.4	0.57
Oakspringa Pond	1	6	15	09:30	76	21.0	6.6	-
			20	09:25	77	22.5	7.0	-
			27	09:05	77	24.5	7.9	-
		7	5	09:50	75	23.5	3.9	-
			11	13:20	86	24.0	10.4	-
			13	10:30	71	23.5	5.2	-
			21	08:27	77	23.5	6.7	-
			26	09:30	80	26.0	16.6	-
		8	1	09:20	71	20.5	6.0	-
			9	09:52	65	19.0	0.4	-
			17	09:00	75	22.0	10.0	-
			22	09:07	75	22.1	9.2	-
		9	1	11:50	80	23.0	11.5	-
			7	11:38	73	20.5	12.5	-
			14	10:25	75	21.5	9.0	-
			20	12:52	72	19.5	9.1	-
			29	10:25	65	13.0	6.5	-
		10	6	10:36	63	13.5	6.7	-
			13	08:50	58	11.5	5.5	-
			18	14:55	61	16.3	7.5	-
	2	6	15	09:35	76	22.0	7.3	-
			20	09:30	77	24.0	7.2	-
			27	09:10	77	25.9	5.2	-
		7	5	09:55	75	24.5	4.9	-
			11	13:30	86	30.0	7.1	-
			13	10:07	71	24.5	4.0	-
			21	08:30	77	24.5	6.5	-
			26	09:33	80	26.5	6.5	-
		8	1	09:25	71	21.2	4.3	-
			9	09:57	65	20.5	6.3	-
			17	09:14	75	22.0	8.7	-
			22	09:13	75	22.0	7.4	-
		9	1	11:56	80	22.5	5.5	-
			7	11:45	73	20.5	9.1	-
			14	10:34	75	22.4	5.4	-
			20	12:57	72	20.0	7.9	-
			29	10:30	65	12.5	4.9	-
		10	6	10:43	63	12.5	4.0	-

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APPENDIX B: 1989 HUCOG WATER QUALITY GRAB SAMPLING DATA

STATION	NUMBER	MONTH	DAY	TIME HR:MIN	AIR TEMP. (F)	WATER TEMP. (C)	DO (PPM)	FLOW (CFS)
			13	09:03	58	10.5	7.6	-
			18	15:00	61	16.2	5.8	-
Oakspring	1	6	20	11:40	76	23.3	8.0	-
Outflow			27	09:10	81	24.7	6.8	-
		7	5	09:55	75	23.8	6.8	-
			11	13:35	86	27.5	7.8	-
			13	10:53	71	20.0	5.3	-
			21	08:35	77	20.0	7.8	-
			26	09:37	80	26.1	9.5	-
		8	1	09:29	71	21.0	7.6	-
			9	10:00	65	19.0	7.7	-
			17	09:17	75	22.3	10.0	-
			22	09:10	75	22.0	8.2	-
		9	1	12:02	80	21.0	5.0	-
			7	11:50	73	19.5	7.2	-
			14	10:40	75	22.1	6.4	-
			20	13:02	72	19.0	8.1	-
			29	10:33	65	12.5	8.5	-
		10	6	10:06	63	12.3	8.3	-
			13	09:08	50	10.9	8.2	-
			18	15:05	61	16.2	7.0	-
2	6		20	11:35	76	21.5	6.0	-
			27	12:05	80	23.5	5.3	-
		7	5	10:05	78	23.0	7.7	-
			11	13:00	86	25.2	5.3	-
			13	10:50	71	22.0	6.1	-
			21	08:00	77	23.0	8.4	-
			26	09:02	81	24.9	7.6	-
		8	1	09:34	71	20.5	7.6	-
			9	10:03	64	17.0	7.0	-
			17	09:23	75	21.2	9.5	-
			22	09:30	76	21.0	7.0	-
		9	1	12:07	81	20.2	4.8	-
			7	11:55	73	18.0	7.0	-
			14	10:46	76	21.5	7.0	-
			20	13:06	73	19.0	8.7	-
			29	10:39	65	12.5	7.5	-
		10	6	10:50	63	12.3	7.5	-
			13	09:13	60	10.5	7.7	-
			18	15:10	60	16.0	8.3	-
3	6		15	09:50	75	21.5	8.0	0.32
			20	09:40	75	21.0	6.6	0.16
			27	09:27	80	24.5	6.4	0.11
		7	5	10:30	78	23.5	7.9	1.89
			11	14:00	86	25.5	5.5	0.10

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APPENDIX B: 1989 NWCOG WATER QUALITY GRAB SAMPLING DATA

STATION	NUMBER	MONTH	DAY	TIME HR:MIN	AIR TEMP. (F)	WATER TEMP. (C)	DO (PPM)	FLOW (CFS)
			13	11:03	71	22.5	6.0	0.27
			21	08:42	77	23.0	8.3	1.14
			26	09:55	81	24.5	6.6	0.07
		8	1	09:52	71	21.0	7.4	0.24
			9	11:00	64	17.3	6.8	0.05
			17	09:45	75	21.5	8.9	0.06
			22	10:00	76	20.9	8.1	0.05
		9	1	12:27	81	21.0	6.8	0.03
			7	12:00	73	18.3	7.7	0.04
			14	10:52	76	21.6	7.2	0.31
			20	01:14	73	19.8	8.9	2.02
			29	10:44	65	12.5	7.2	0.09
		10	6	11:12	63	13.0	6.7	0.07
			13	09:42	60	11.3	7.3	0.05
			18	15:15	60	15.5	8.8	0.78
	4	6	20	11:30	75	21.5	8.6	-
			27	12:00	80	23.5	7.7	-
		7	5	10:42	78	23.0	7.9	-
			11	14:22	86	20.0	9.8	-
			13	11:22	71	22.3	8.1	-
			21	08:50	77	23.5	8.6	-
			26	10:12	81	24.5	8.3	-
		8	1	09:59	81	21.5	8.7	-
			9	10:25	64	17.5	4.6	-
			17	09:50	75	20.0	9.6	-
			22	10:09	76	20.1	7.8	-
		9	1	12:25	81	19.5	3.8	-
			7	12:36	73	18.0	9.8	-
			14	11:14	76	21.5	8.5	-
			20	13:31	73	19.3	9.4	-
			29	11:07	65	13.5	5.8	-
		10	6	11:10	63	13.5	7.1	-
			13	09:40	60	11.9	7.0	-
			18	15:20	60	15.8	9.0	-
Gun Springs	18	6	15	11:30	76	17.0	13.0	-
			20	10:35	75	16.5	10.8	-
			27	10:40	78	18.0	11.4	-
		7	5	11:30	75	21.5	9.7	-
			11	14:25	82	20.8	10.2	-
			13	11:48	69	16.5	10.3	-
			21	08:52	77	21.0	9.5	-
			26	10:40	80	18.2	11.6	-
		8	1	10:40	72	17.2	11.0	-
			9	11:00	66	14.8	10.0	-
			17	10:27	77	17.8	11.0	-
			22	10:34	77	17.5	10.6	-

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APPENDIX E: 1989 NWCOG WATER QUALITY GRAB SAMPLING DATA

STATION	NUMBER	MONTH	DAY	TIME HR:MIN	AIR TEMP. (F)	WATER TEMP. (C)	DO (PPM)	FLOW (CFS)
		9	1	13:15	80	18.5	9.4	-
			7	12:50	71	16.4	10.2	-
			14	11:55	75	18.0	9.4	-
			20	13:36	73	18.5	9.3	-
			29	11:50	64	12.5	9.5	-
		10	6	11:40	62	13.0	8.9	-
			13	10:00	65	12.0	9.9	-
			18	15:42	59	15.0	9.4	-
	2B	7	11	14:30	82	19.8	9.0	-
			13	11:53	69	16.8	9.7	-
			21	11:07	79	20.5	8.8	-
			26	10:40	80	18.2	11.6	-
		8	1	10:48	72	17.2	10.5	-
			9	11:09	66	14.9	10.2	-
			17	10:31	77	17.5	11.1	-
			22	10:41	77	17.8	10.0	-
		9	1	13:22	80	10.0	9.6	-
			7	13:05	71	16.5	9.7	-
			14	11:58	75	18.0	8.7	-
			20	13:45	73	18.8	9.2	-
			29	11:56	64	12.5	9.4	-
		10	6	11:45	62	13.0	8.2	-
			13	10:15	65	12.0	9.7	-
	3B	6	20	10:50	76	16.0	11.3	-
			27	10:52	70	17.5	11.0	-
		7	5	11:42	75	21.0	10.0	-
			11	14:42	86	20.0	9.9	-
			13	12:02	70	16.0	10.2	-
			21	11:14	79	20.7	9.0	-
			26	11:01	81	18.5	11.8	-
		8	1	11:00	70	17.2	10.9	-
			9	11:30	66	14.9	11.0	-
			17	10:36	77	17.5	11.7	-
			22	10:47	77	17.5	9.7	-
		9	1	13:26	70	18.5	9.4	-
			7	13:12	71	16.8	10.5	-
			14	12:12	75	17.8	9.1	-
			20	13:49	76	18.8	9.6	-
			29	12:01	63	12.5	9.9	-
		10	6	11:50	62	13.0	9.3	-
			13	10:19	65	12.0	10.2	-
			18	15:50	57	14.5	10.0	-
	4B	6	20	10:55	76	15.5	10.8	-
			27	10:50	78	17.0	11.3	-
		7	5	11:40	75	17.5	9.0	-

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APPENDIX B: 1989 HWCOG WATER QUALITY GRAB SAMPLING DATA

STATION	NUMBER	MONTH	DAY	TIME HR:MIN	AIR TEMP. (F)	WATER TEMP. (C)	DO (PPM)	FLOW (CFS)
			11	14:40	86	18.5	10.0	-
			13	12:06	70	17.5	8.4	-
			21	11:18	79	17.0	10.8	-
			26	11:00	81	17.5	11.0	-
		8	1	10:56	70	16.5	10.2	-
			9	11:16	66	14.8	10.0	-
			17	10:39	77	17.0	11.2	-
			22	10:49	77	16.9	9.0	-
		9	1	13:28	70	18.0	8.1	-
			7	13:15	71	17.0	10.0	-
			14	12:15	75	16.4	9.5	-
			20	13:51	76	18.0	9.0	-
			29	12:04	63	13.0	9.3	-
		10	6	11:52	62	13.0	8.0	-
			13	10:21	65	12.0	9.5	-
			10	15:53	57	13.5	9.1	-
	5B	6	20	10:58	76	15.7	10.5	-
			27	10:55	70	17.3	11.0	-
			5	11:05	75	21.0	9.0	-
		7	11	14:30	86	20.0	10.0	-
			13	12:00	70	17.3	10.4	-
			21	11:21	79	20.4	9.9	-
			26	10:55	81	18.5	11.0	-
		8	1	11:00	70	17.2	10.9	-
			9	11:18	66	14.8	10.8	-
			17	10:41	77	17.3	11.6	-
			22	10:52	77	17.2	9.7	-
		9	1	13:33	70	18.1	8.7	-
			7	13:10	71	16.5	10.3	-
			14	12:10	75	17.6	9.5	-
			20	13:53	76	19.0	9.4	-
			29	12:06	63	12.5	9.9	-
		10	6	11:56	62	13.0	9.4	-
			13	10:23	65	11.8	10.2	-
			10	15:57	57	14.5	9.0	-
Lower Gun Springs	1C	6	15	12:10	78	17.0	12.0	1.02
			20	11:05	76	15.7	10.3	1.13
			27	11:10	77	17.3	11.0	1.14
		7	5	12:25	76	20.5	9.0	3.50
			11	15:05	86	20.2	10.2	0.99
			13	12:16	70	17.3	10.6	1.68
			21	11:32	78	20.3	9.4	3.07
			26	11:23	81	18.5	12.2	1.07
		8	1	11:25	70	17.5	11.4	1.21
			9	11:30	66	15.0	10.9	0.97
			17	10:56	77	17.5	11.0	0.91

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APPENDIX B: 1989 MWCOG WATER QUALITY GRAB SAMPLING DATA

STATION	NUMBER	MONTH	DAY	TIME HR:MIN	AIR TEMP. (F)	WATER TEMP. (C)	DO (PPM)	FLOW (CFS)
		9	22	11:14	79	17.5	10.0	0.80
			1	14:15	70	18.0	8.4	0.77
			7	13:30	71	16.6	9.9	0.80
			14	12:26	75	17.0	9.9	1.02
			20	14:09	76	19.0	9.4	3.73
			29	12:43	63	12.5	9.8	1.02
		10	6	12:18	62	12.8	9.2	1.03
			13	10:40	65	12.0	10.2	0.86
			18	16:05	57	16.0	9.8	1.97
	2C	7	13	12:37	71	17.3	10.6	-
			21	11:52	70	20.2	9.7	-
			26	11:45	81	10.5	11.0	-
		8	1	11:35	70	17.5	11.8	-
			17	11:20	77	17.0	11.8	-
			22	11:03	79	18.0	10.6	-
		9	1	14:27	70	18.5	9.6	-
			7	14:00	71	16.5	11.0	-
			14	13:12	75	18.0	9.5	-
			20	14:13	76	18.8	9.8	-
			29	12:50	63	12.5	9.8	-
		10	6	12:26	62	12.8	9.7	-
			13	10:58	65	12.0	10.5	-
Paint Branch upstream of confluence with Sun Springs	3C	7	13	12:43	71	19.7	10.2	-
			21	11:55	70	20.0	9.1	-
			26	11:51	81	21.0	11.9	-
		8	1	11:30	70	18.5	11.8	-
			17	11:33	77	19.1	11.8	-
			22	11:40	79	19.5	10.4	-
		9	1	14:29	70	20.0	9.5	-
			7	14:03	71	18.4	10.7	-
			14	13:16	75	19.0	9.7	-
			20	14:16	76	18.5	9.8	-
			29	12:51	63	12.5	10.1	-
		10	6	12:28	62	12.3	9.8	-
			13	10:59	65	11.5	10.7	-
Paint Branch downstream of confluence with Sun Springs	4C	7	13	12:43	71	18.7	9.6	-
			21	11:58	70	20.0	9.3	-
			26	11:40	81	21.5	12.0	-
		8	1	11:42	70	18.1	11.0	-
			17	11:30	77	20.0	11.8	-
			22	11:45	79	20.8	10.2	-
		9	1	14:32	70	20.0	9.0	-
			7	14:02	71	17.6	10.5	-
			14	13:19	75	19.4	9.6	-
			20	14:10	76	18.8	9.4	-

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APPENDIX E: 1989 NVCOG WATER QUALITY GRAB SAMPLING DATA

STATION	NUMBER	MONTH	DAY	TIME HR:MIN	AIR TEMP. (F)	WATER TEMP. (C)	DO (PPM)	FLOW (CFS)
		10	29	12:54	63	12.5	9.9	-
			6	12:29	62	12.0	9.7	-
			13	11:01	65	11.5	10.5	-
Countryside Inflow	1	6	15	14:30	78	17.5	9.5	0.33
			21	11:15	79	18.5	10.5	0.26
			27	12:05	81	19.0	10.2	0.23
		7	5	14:30	76	20.0	9.8	12.42
			11	09:25	82	20.0	9.7	0.24
			20	10:30	77	20.0	8.3	1.03
			25	09:05	75	19.0	9.0	0.16
		8	2	13:50	74	20.0	10.4	0.16
			9	11:30	66	15.0	10.9	0.97
			16	12:30	81	19.0	10.6	0.17
			22	12:31	80	20.1	6.8	0.17
		9	1	09:40	74	18.2	8.1	0.13
			7	08:50	71	17.5	9.0	0.12
			14	13:50	77	19.5	8.5	0.12
			20	11:25	73	18.0	9.0	0.46
			29	13:30	69	15.0	8.3	0.15
		10	6	13:00	67	14.0	8.6	0.16
			13	11:36	72	13.5	9.1	0.15
			20	10:59	49	12.0	9.4	4.96
Countryside Pond	1	6	15	15:00	78	25.5	>20.0	-
			21	12:15	79	23.0	10.0	-
			27	12:24	85	30.5	17.0	-
		7	6	09:45	74	24.0	7.8	-
			11	09:40	83	23.5	17.2	-
			20	10:45	77	24.0	6.5	-
			25	09:10	78	22.5	11.4	-
		8	2	13:39	77	26.5	12.5	-
			9	12:20	70	25.0	8.0	-
			16	12:39	81	22.0	7.9	-
			22	12:44	82	27.5	7.0	-
		9	1	09:50	76	25.0	9.1	-
			7	09:12	73	22.4	9.5	-
			14	14:04	79	26.3	10.0	-
			20	11:30	75	21.3	9.0	-
			29	13:39	73	19.0	10.7	-
		10	6	13:09	69	16.5	10.8	-
			13	11:44	77	17.0	9.6	-
			20	11:12	49	12.5	7.5	-
	2	6	21	12:18	79	26.0	12.6	-
			27	12:30	85	30.5	>20.0	-
		7	6	09:10	74	24.6	6.8	-
			11	09:45	83	23.5	17.5	-

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APPENDIX B: 1989 HMCOG WATER QUALITY GRAB SAMPLING DATA

STATION	NUMBER	MONTH	DAY	TIME HR:MIN	AIR TEMP. (F)	WATER TEMP. (C)	DO (PPM)	FLOW (CFS)
			20	10:47	77	25.0	7.7	-
			25	09:15	70	23.0	12.6	-
		8	2	13:36	77	27.5	13.4	-
			9	12:26	70	25.3	8.9	-
			16	12:42	81	26.0	10.8	-
			22	12:47	82	27.5	8.2	-
		9	1	09:55	76	25.3	9.4	-
			7	09:19	73	22.5	9.8	-
			14	14:08	79	26.1	12.0	-
			20	11:34	75	21.8	9.0	-
			29	13:42	73	19.2	11.4	-
			6	13:12	69	17.0	10.2	-
			13	11:46	77	15.5	9.8	-
			20	11:15	49	13.0	7.7	-
	3	6	15	15:12	78	26.0	19.0	-
			21	12:20	79	25.5	12.6	-
			27	12:35	85	29.5	>20.0	-
		7	6	09:15	74	23.5	7.3	-
			11	09:47	83	23.0	10.4	-
			20	10:50	77	25.0	8.3	-
			25	09:18	70	23.0	11.6	-
		8	2	13:34	77	27.0	12.5	-
			9	12:27	70	25.9	8.6	-
			16	12:45	81	26.8	10.2	-
			22	12:50	82	26.5	8.0	-
		9	1	09:57	76	25.5	9.5	-
			7	09:25	73	22.5	8.5	-
			14	14:17	79	26.3	9.9	-
			20	11:37	75	22.0	9.7	-
			29	13:44	73	18.8	9.7	-
		10	6	13:14	69	17.0	9.2	-
			13	11:48	77	15.5	9.1	-
			20	11:17	49	13.0	7.1	-
Countryside Outflow	1	6	15	15:18	70	21.0	13.5	-
			27	12:40	80	26.0	10.3	-
		7	6	10:00	74	23.0	9.3	-
			11	09:50	83	24.5	7.3	-
			20	11:05	77	23.5	9.6	-
			25	09:32	70	25.0	7.1	-
		8	2	13:32	77	26.0	12.1	-
			9	12:29	70	23.2	8.2	-
			16	12:48	81	23.5	10.3	-
			22	12:56	82	24.8	7.3	-
		9	1	10:00	76	25.0	8.8	-
			7	09:29	73	22.1	9.0	-
			14	14:20	79	24.0	9.1	-

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APPENDIX B: 1989 HWCOG WATER QUALITY GRAB SAMPLING DATA

STATION NUMBER	MONTH	DAY	TIME HR:MIN	AIR TEMP. (F)	WATER TEMP. (C)	DO (PPM)	FLOW (CFS)
		20	11:40	75	21.0	9.7	-
		29	13:07	73	16.5	9.4	-
	10	6	13:16	69	16.5	9.1	-
		13	11:51	77	16.3	9.8	-
		20	11:20	69	13.0	9.2	-
2	6	27	12:50	80	26.5	9.1	-
	7	6	10:05	74	23.5	8.9	-
		11	09:52	83	25.2	6.8	-
		20	11:15	77	22.5	9.5	-
		25	09:42	78	24.9	6.2	-
	8	3	13:15	77	24.2	9.4	-
		9	12:40	70	24.2	7.1	-
		16	13:15	81	24.9	8.3	-
		22	13:13	82	25.8	6.8	-
	9	1	10:15	76	22.8	6.5	-
		7	09:35	73	21.6	6.7	-
		14	14:25	79	24.7	7.3	-
		20	11:55	75	21.0	9.0	-
		29	14:07	73	18.0	7.6	-
	10	6	13:33	69	16.3	7.7	-
		13	12:02	77	15.5	8.3	-
		20	11:28	67	13.0	9.2	-
3	6	15	15:15	78	22.0	8.0	0.41
		21	11:55	76	23.5	9.1	-
		27	13:00	85	25.5	7.3	0.26
	7	6	10:15	74	23.0	8.3	2.09
		11	10:10	83	24.8	6.6	0.25
		20	11:30	77	22.5	9.4	0.36
		25	10:00	78	24.0	7.0	0.42
	8	3	13:07	77	23.5	10.4	0.35
		9	12:05	70	23.0	7.8	0.16
		16	13:20	80	24.0	9.4	0.17
		22	13:07	82	24.0	7.2	0.23
	9	1	10:30	76	22.1	5.5	0.18
		7	09:52	73	20.7	7.3	0.14
		14	14:38	79	24.2	6.7	0.22
		20	12:00	75	21.0	9.1	1.81
		29	14:13	73	17.0	7.9	0.32
	10	6	13:29	69	17.0	7.5	0.35
		13	12:20	77	15.3	8.4	0.21
		20	11:45	67	12.5	8.8	13.8
4	6	27	13:05	80	25.5	7.8	-
	7	11	10:25	83	24.8	7.3	-
		20	11:35	77	22.5	9.6	-
		25	10:05	78	23.5	7.8	-

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APPENDIX B: 1989 NVCOG WATER QUALITY GRAB SAMPLING DATA

STATION NUMBER	MONTH	DAY	TIME HR:MIN	AIR TEMP. (F)	WATER TEMP. (C)	DO (PPM)	FLOW (CFS)
	8	2	13:03	77	23.0	10.4	-
		16	13:23	80	23.5	9.2	-
		22	13:51	82	24.0	7.1	-
	9	1	10:37	76	21.0	6.5	-
		7	10:09	73	21.5	6.7	-
		14	14:43	79	23.5	7.6	-
		20	12:03	75	21.0	5.5	-
		29	14:15	73	17.0	7.0	-
	10	6	13:42	69	15.5	7.3	-
		13	12:22	77	14.5	8.5	-
		20	11:40	47	12.5	9.2	-
5	6	27	13:10	80	25.0	0.2	-
	7	11	10:30	83	23.0	0.0	-
		20	11:40	77	22.5	9.7	-
		25	10:10	78	23.5	0.3	-
	8	2	13:00	77	22.9	11.4	-
		16	13:26	80	23.0	9.0	-
		22	13:55	82	23.9	7.9	-
	9	1	10:41	76	21.0	7.2	-
		7	10:15	73	20.0	7.1	-
		14	14:47	79	22.5	7.1	-
		20	14:07	75	20.0	7.3	-
		29	14:19	73	16.5	7.6	-
	10	6	13:07	69	15.0	7.5	-
		13	12:25	77	15.0	7.5	-
		20	11:51	47	12.5	9.2	-
6	6	27	13:15	80	24.5	6.8	-
	7	11	10:37	83	23.0	0.0	-
		20	11:45	77	22.5	9.5	-
		25	10:15	78	23.5	7.9	-
	8	2	12:50	77	22.5	10.6	-
		16	13:31	80	23.0	10.0	-
		22	14:00	82	23.0	8.0	-
	9	1	10:40	76	20.8	7.0	-
		7	10:33	73	18.7	8.7	-
		14	14:53	79	21.0	7.0	-
		20	12:11	75	21.0	8.9	-
		29	14:24	73	16.5	8.1	-
	10	6	13:50	69	15.5	7.9	-
		13	12:28	77	14.5	9.3	-
		20	11:54	47	12.5	9.2	-
7	6	27	13:20	80	20.5	10.9	-
	7	11	10:40	83	21.0	10.2	-
		20	11:47	77	20.5	9.7	-
		25	10:20	78	20.0	9.9	-

Point Branch
ean of
Cryside
Tributary

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APPENDIX E: 1989 NVCOG WATER QUALITY GRAB SAMPLING DATA

STATION	NUMBER	MONTH	DAY	TIME HR:MIN	AIR TEMP. (F)	WATER TEMP. (C)	DO (PPM)	FLOW (CFS)
		8	2	12:58	77	19.0	12.0	-
			16	13:38	80	20.0	11.4	-
			22	14:02	82	20.5	9.6	-
		9	1	10:51	76	18.2	9.8	-
			7	10:30	73	17.0	10.0	-
			14	14:56	79	18.6	9.5	-
			20	12:13	75	18.8	9.7	-
			29	14:26	73	13.5	9.6	-
		10	6	13:52	69	13.0	9.8	-
			13	12:29	77	13.0	10.6	-
			20	11:57	47	11.5	9.9	-
Paint Branch downstream of Countryside Tributary	8	6	27	13:25	80	21.0	10.8	4.70
		7	11	10:35	83	20.8	10.2	-
			20	11:47	77	21.5	9.7	-
			25	10:26	78	20.5	10.2	-
		8	2	12:51	77	20.0	11.0	-
			16	13:41	80	20.0	11.0	-
			22	14:05	82	20.5	9.1	-
		9	1	10:55	76	18.5	9.5	-
			7	10:27	73	17.2	10.0	-
			14	15:00	79	18.7	9.3	-
			20	12:15	75	18.5	9.7	-
			29	14:30	73	13.5	9.6	-
		6	6	13:55	69	13.0	9.7	-
			13	12:31	77	13.3	10.4	-
			20	12:01	47	11.5	9.6	-
Tanglewood Inflow	1	6	18	11:30	77	17.5	10.8	-
			20	12:50	78	19.5	10.0	0.93
			27	15:00	83	21.5	9.8	0.10
		7	6	11:15	75	21.2	9.4	0.06
			12	10:20	77	21.5	8.2	0.20
			20	14:00	78	21.0	8.6	0.09
			25	12:50	83	21.9	7.9	0.20
		8	1	14:00	74	19.5	9.5	0.10
			9	14:15	70	18.0	8.3	0.10
			16	11:10	81	20.1	10.6	0.15
			23	12:17	82	21.5	8.1	0.21
			31	15:12	74	21.4	7.6	0.26
		9	8	10:06	70	17.8	7.4	0.13
		10	13	13:00	76	15.0	8.8	0.16
			20	12:57	47	12.5	8.8	2.03
Inglewood Pond	1A	6	27	15:05	83	22.5	10.8	-
		7	6	11:25	75	21.2	9.5	-
			12	10:56	86	22.5	10.3	-
		8	9	14:27	70	19.0	9.6	-

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APPENDIX B: 1989 NUCOG WATER QUALITY GRAB SAMPLING DATA

STATION	NUMBER	MONTH	DAY	TIME HH:MIN	AIR TEMP. (F)	WATER TEMP. (C)	DO (PPM)	FLOW (CFS)
			16	11:14	81	21.2	10.8	-
			23	12:55	82	23.8	10.2	-
			31	15:29	74	22.0	8.6	-
		9	8	10:24	70	18.5	9.5	-
		10	13	13:10	76	15.0	10.0	-
			20	13:08	47	12.5	9.6	-
	2A	6	27	15:10	83	23.6	9.6	-
		7	6	11:35	75	21.8	9.1	-
			12	11:07	80	22.6	9.7	-
			20	14:17	78	25.5	6.5	-
			25	12:57	83	22.5	10.2	-
		8	1	14:14	74	20.9	14.3	-
			9	14:37	70	19.0	8.7	-
			16	11:18	81	21.8	11.1	-
			23	13:04	82	25.0	7.6	-
			31	15:35	82	23.1	8.3	-
		9	8	10:20	70	18.4	8.9	-
		10	13	13:14	76	15.8	10.6	-
			20	13:12	47	12.0	8.8	-
	3A	6	27	13:10	83	23.8	4.2	-
		7	6	11:50	75	22.0	6.7	-
			12	11:15	82	23.0	9.3	-
			20	14:23	78	24.0	6.6	-
		8	1	14:19	74	20.5	9.6	-
			9	14:42	70	20.3	7.7	-
			16	11:22	81	21.5	11.2	-
			31	15:42	82	23.5	7.0	-
		9	8	10:34	70	18.4	7.0	-
		10	13	13:19	76	16.5	9.3	-
			20	13:18	47	12.8	8.6	-
Tanglewood Outflow	1	6	27	15:25	83	24.5	8.9	-
		7	6	11:55	77	22.2	7.0	-
			12	11:20	78	22.5	6.0	-
			20	14:27	82	23.0	9.5	-
			25	13:05	83	23.9	9.0	-
		8	1	14:43	75	20.5	9.8	-
			9	14:44	75	20.5	8.0	-
			16	11:25	81	20.8	10.0	-
			23	13:10	82	24.0	8.1	-
			31	15:45	73	21.5	15.3	-
		9	8	10:38	72	17.8	8.4	-
		10	13	13:22	76	14.0	8.9	-
			20	13:22	47	12.5	8.8	-
	2	6	18	11:00	77	18.5	9.6	0.56

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APPENDIX B: 1989 NMCOG WATER QUALITY GRAB SAMPLING DATA

STATION	NUMBER	MONTH	DAY	TIME HR:MIN	AIR TEMP. (F)	WATER TEMP. (C)	DO (PPM)	FLOW (CFS)
			20	13:15	76	22.0	9.0	1.01
			27	15:30	83	25.0	9.5	0.30
		7	6	12:10	77	22.5	7.8	1.81
			12	11:27	70	22.3	8.7	0.43
			20	14:35	82	22.8	8.0	7.12
			25	13:15	83	24.1	8.4	0.35
		8	1	14:40	75	21.0	9.7	0.35
			9	14:56	75	20.3	8.0	0.17
			16	11:40	81	20.5	10.4	0.26
			23	13:14	82	23.7	8.2	0.23
			31	15:50	73	22.7	6.7	0.16
		9	8	10:43	72	18.0	7.9	0.11
		10	13	13:30	76	15.0	8.8	0.22
			20	13:35	69	13.0	9.1	6.06
	3	6	27	15:00	83	24.8	7.4	-
		7	6	12:25	77	22.0	8.5	-
			12	11:40	70	22.5	8.2	-
			20	14:50	82	23.0	8.9	-
			25	13:30	83	23.7	9.9	-
		8	1	14:05	75	20.5	9.8	-
			9	14:56	75	20.3	8.0	-
			16	11:06	81	20.2	11.2	-
			23	13:33	82	23.3	8.0	-
			31	15:59	73	21.0	9.7	-
		9	8	10:56	72	18.0	9.0	-
		10	13	13:03	76	15.0	9.7	-
			20	13:44	69	13.0	9.1	-
	4	7	6	12:30	77	22.5	8.9	-
			12	11:02	81	22.5	9.6	-
			20	14:55	82	23.0	8.9	-
			25	13:35	83	23.5	10.6	-
		8	1	14:53	75	20.5	9.6	-
			16	11:57	81	21.2	11.4	-
			23	13:30	82	23.3	8.7	-
		9	8	11:01	72	18.5	9.1	-
		10	13	13:47	76	15.0	10.0	-
			20	13:48	69	13.3	9.1	-
Auto Park Branch upstream of Tanglewood Tributary	5	7	6	12:35	77	21.0	9.6	-
			12	11:50	81	22.3	9.1	-
			20	14:53	82	22.0	9.4	-
			25	13:33	83	22.2	9.5	-
		8	1	14:49	75	20.0	8.8	-
			16	11:52	81	20.5	10.8	-
			23	13:40	82	22.0	9.0	-
		9	8	11:03	72	18.5	9.5	-

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APPENDIX B: 1989 HMCOG WATER QUALITY GRAB SAMPLING DATA

STATION	NUMBER	MONTH	DAY	TIME HR:MIN	AIR TEMP. (F)	WATER TEMP. (C)	DO (PPM)	FLOW (CFS)
		10	13	13:46	76	15.5	9.0	-
			20	13:47	49	12.3	9.4	-
Auto Park Branch	6	7	6	12:40	77	21.5	9.6	-
downstream of			12	11:52	81	22.0	8.8	-
Tanglewood			20	14:54	82	22.5	9.1	-
Tributary			25	13:37	83	23.0	9.9	-
		8	1	14:51	75	20.0	9.4	-
			16	11:55	81	21.2	11.4	-
			23	13:44	82	23.3	9.0	-
		9	8	11:07	72	10.4	9.5	-
		10	13	13:49	76	15.3	9.6	-
			20	13:50	49	12.3	9.4	-
Fairland Ridge	1	6	10	09:35	77	16.5	8.6	-
Inflow			20	14:10	78	15.0	9.9	-
			28	08:45	75	16.5	9.1	-
			6	13:15	81	23.0	7.8	-
			11	11:15	69	17.0	10.8	-
			20	12:25	79	22.5	8.8	-
		7	25	10:57	84	10.8	9.1	-
		8	2	11:30	76	17.5	10.4	-
			9	15:18	77	15.9	9.4	-
			16	09:59	75	16.8	10.4	-
			23	10:42	77	16.8	7.9	-
			31	13:00	78	16.8	9.0	-
		9	8	08:45	65	15.4	9.6	-
		10	13	14:11	80	15.0	7.7	-
			18	17:02	57	16.5	8.5	-
Fairland Ridge	1	7	6	13:55	77	22.0	8.9	-
Outflow			11	11:25	85	19.2	10.8	-
			20	12:45	79	21.8	9.5	-
			25	11:20	82	20.8	9.5	-
		8	2	11:47	75	18.8	10.1	-
			9	15:37	73	15.1	9.5	-
			16	10:13	77	17.5	12.2	-
			23	10:53	80	18.3	7.5	-
			31	12:50	77	16.8	8.9	-
		9	8	09:04	67	15.5	9.6	-
		10	13	14:41	75	13.3	10.8	-
			18	17:12	56	16.5	6.5	-
	2	6	10	10:10	78	16.8	11.8	0.05
			20	14:20	73	17.5	8.6	0.00
			28	09:10	75	17.3	8.5	0.07
		7	6	14:00	77	21.5	8.8	0.29
			11	11:50	85	20.8	8.9	0.06

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APPENDIX E: 1989 HWCOG WATER QUALITY GRAB SAMPLING DATA

STATION	NUMBER	MONTH	DAY	TIME HR:MIN	AIR TEMP. (F)	WATER TEMP. (C)	DO (PPM)	FLOW (CFS)
			28	12:50	79	22.0	8.6	0.55
			25	11:25	82	19.5	9.5	0.04
		8	2	11:51	75	17.8	9.0	0.05
			9	15:43	73	16.0	9.0	0.06
			16	10:23	77	17.5	10.2	0.07
			23	11:13	80	18.5	8.6	0.05
			31	12:30	77	18.4	8.5	0.04
		9	8	09:20	67	15.0	7.8	0.05
		10	13	16:29	75	16.3	9.3	0.05
			18	17:25	56	14.0	8.4	0.00
Good Hope Tributary upstream of Fairland Ridge	3	6	18	10:30	70	16.0	11.0	-
			20	09:36	75	17.5	11.0	-
		7	6	14:10	77	19.0	10.0	-
			11	12:05	85	20.1	10.2	-
			20	13:00	79	20.0	10.6	-
			25	11:35	82	19.2	11.0	-
		8	2	12:12	75	17.5	11.4	-
			9	15:05	67	16.2	9.8	-
			16	10:31	77	17.5	11.8	-
			23	11:30	80	19.0	8.2	-
			31	12:00	77	18.4	10.0	-
		9	8	09:31	67	16.3	10.4	-
		10	13	16:35	75	16.0	10.1	-
			18	17:25	56	13.5	9.8	-
Good Hope Tributary downstream of Fairland Ridge	4	6	18	10:33	78	16.0	11.7	-
			20	09:40	75	17.5	9.8	-
		7	6	14:14	77	19.2	10.8	-
			11	12:00	85	20.0	9.0	-
			20	13:05	79	20.2	10.2	-
			25	11:30	82	18.0	9.1	-
		8	2	12:15	75	17.5	11.0	-
			9	15:00	67	16.2	9.4	-
			16	10:34	77	17.5	11.8	-
			23	11:35	80	19.5	8.4	-
			31	12:20	77	18.4	9.6	-
		9	8	09:36	67	16.0	10.3	-
		10	13	16:37	75	14.0	9.8	-
			18	17:31	56	13.5	9.6	-
Upper White Oak Tributary	1	6	16	13:55	78	20.0	10.2	-
			21	09:15	74	19.0	8.5	-
			28	16:15	77	21.5	8.7	-
		7	6	15:05	70	21.5	7.8	-
			12	08:20	75	20.3	9.2	-
			13	08:40	73	23.5	8.5	-
			20	15:35	78	21.5	9.5	-

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APPENDIX B: 1989 HWCOG WATER QUALITY GRAB SAMPLING DATA

STATION	NUMBER	MONTH	DAY	TIME HR:MIN	AIR TEMP. (F)	WATER TEMP. (C)	DO (PPM)	FLOW (CFS)
			26	13:30	84	22.5	10.2	-
		8	2	09:25	73	20.5	10.5	-
			9	16:21	71	19.2	7.8	-
			16	08:16	74	21.2	9.4	-
			23	15:00	86	22.0	6.5	-
			31	13:25	75	20.5	7.7	-
		9	8	11:34	72	20.5	8.7	-
		10	20	14:40	69	14.0	8.8	-
upstream of sediment trap	2	6	16	14:00	80	20.5	-	-
		7	6	15:20	78	22.5	8.2	-
			12	08:49	76	22.2	-	-
			13	08:50	73	23.9	-	-
			20	15:46	78	23.5	7.4	-
			26	13:37	84	25.0	9.3	-
		8	2	09:39	73	21.0	10.3	-
			9	15:29	71	21.2	8.6	-
			16	08:34	74	21.0	8.9	-
			23	15:26	84	26.7	-	-
			31	13:37	78	25.0	-	-
		9	8	11:45	73	21.7	-	-
		10	20	14:29	69	14.0	8.5	-
downstream of sediment trap	3	6	16	14:02	80	22.0	-	-
		7	6	15:23	78	23.5	7.9	-
			12	08:51	76	22.8	-	-
			13	08:55	73	23.9	-	-
			20	15:47	78	24.5	7.2	-
			26	13:40	84	25.0	9.5	-
		8	2	09:42	73	20.0	10.0	-
			9	15:32	71	21.2	7.3	-
			16	08:39	74	21.0	9.4	-
			23	15:25	88	27.2	-	-
			31	13:40	78	25.0	-	-
		9	8	11:48	73	21.7	-	-
		10	20	14:31	69	14.0	8.8	-
sediment trap inflow	4	7	12	08:42	76	25.0	-	-
			13	08:45	76	22.8	-	-
			20	15:45	78	30.0	6.7	-
			26	13:35	84	33.0	11.6	-
		8	2	09:33	73	22.0	10.0	-
			16	08:33	76	20.5	9.6	-
			23	15:17	88	35.6	-	-
			31	13:33	78	27.2	-	-
		9	8	11:40	73	22.8	-	-
sediment trap	5	7	6	15:25	78	25.0	6.5	-

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APPENDIX B: 1989 MWCOG WATER QUALITY GRAB SAMPLING DATA

STATION	NUMBER	MONTH	DAY	TIME HR:MIN	AIR TEMP. (F)	WATER TEMP. (C)	DO (PPM)	FLOW (CFS)
outflow			12	08:45	76	28.3	-	-
			13	08:47	76	26.1	-	-
		8	2	09:37	73	22.5	9.2	-
			9	16:20	71	24.0	9.6	-
			23	15:19	88	31.7	-	-
			31	13:35	78	27.2	-	-
		9	8	11:42	73	22.0	-	-
		10	20	14:27	49	12.0	8.3	-
Lower White Oak	1	7	20	15:55	79	23.5	8.5	-
			26	13:46	84	24.5	11.2	-
		8	2	09:50	72	20.0	11.6	-
			9	15:30	73	20.2	10.1	-
			16	08:46	73	20.5	10.2	-
		10	20	14:36	50	13.0	9.4	-
	2	6	16	14:20	77	21.4	10.6	0.31
			21	09:20	75	20.0	10.8	0.33
			28	16:42	77	21.6	10.0	0.40
		7	6	15:40	77	23.0	9.5	0.51
			12	09:06	73	22.5	9.3	0.33
			13	09:21	71	21.5	9.9	2.67
			26	14:13	84	24.5	10.9	0.35
		8	2	10:15	72	20.0	10.1	0.35
			9	16:55	73	18.0	7.9	0.27
			16	09:07	73	20.2	10.3	0.36
			23	15:40	83	24.0	7.0	0.27
			31	13:45	73	21.5	8.6	0.24
		9	8	12:02	72	19.5	7.0	0.29
		10	20	14:51	50	12.0	9.4	4.03
	3	7	26	14:45	84	24.0	10.0	-
		8	2	10:27	72	20.0	10.9	-
			16	09:19	74	20.0	11.5	-
		10	20	15:09	50	12.5	9.3	-
Paint Branch upstream of Lower White Oak	4	7	12	09:36	77	21.6	9.6	-
			26	14:43	84	23.5	12.0	-
		8	2	10:30	72	19.2	11.6	12.44
			16	09:21	73	19.0	12.4	-
			23	16:00	83	23.9	-	-
			31	14:03	73	21.5	10.3	-
		9	8	12:29	72	18.5	11.2	-
		10	20	15:04	50	12.0	10.0	-
Paint Branch downstream of Lower White Oak	5	7	12	09:30	77	21.6	9.9	-
			26	14:30	84	24.0	12.9	-
		8	2	10:25	72	19.2	12.6	-

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APPENDIX B: 1989 HMCOG WATER QUALITY GRAB SAMPLING DATA

STATION	NUMBER	MONTH	DAY	TIME HH:MIN	AIR TEMP. (F)	WATER TEMP. (C)	DO (PPM)	FLOW (CFS)
			16	09:27	73	19.0	12.4	-
			23	16:07	83	23.9	-	-
			31	14:03	73	21.8	10.1	-
		9	8	12:33	72	10.5	11.3	-
		10	20	15:07	50	12.0	10.0	-

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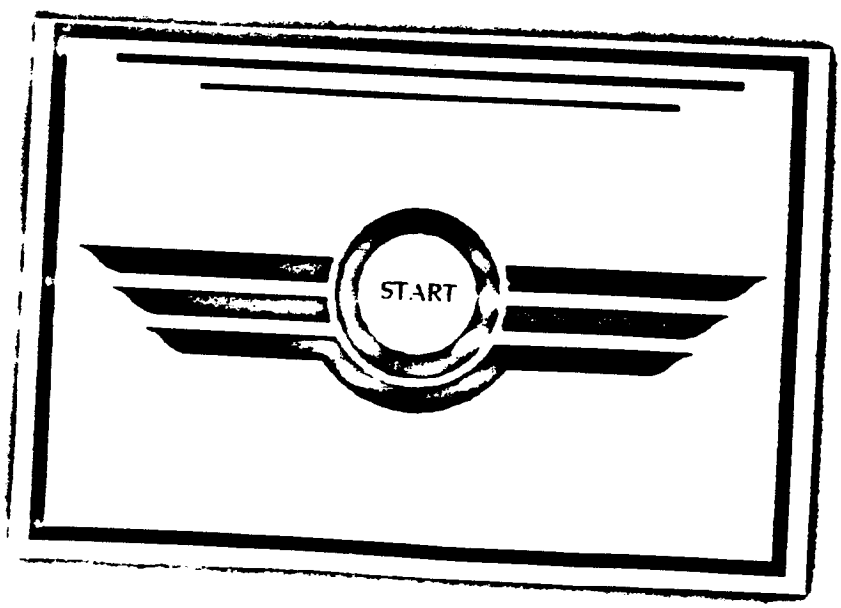
VOL 12

COMPREHENSIVE WATERSHEDS
ORDINANCE FOR CITY OF AUSTIN, TX

1986



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R0058073

CURTIS WILLIAMS & ASSOCIATES
PLANNING AND ENVIRONMENTAL CONSULTANTS

VOL 12 2 4781

CITY OF AUSTIN, TEXAS
COMPREHENSIVE WATERSHEDS ORDINANCE

Included herein is the City of Austin's Comprehensive Watersheds Ordinance, adopted May 8, 1986, which provides development standards designed to protect water quality and other environmental features throughout the City of Austin and its Extra-Territorial Jurisdiction.

The Comprehensive Watersheds Ordinance comprises the initial section of the City's environmental code, and is applicable to subdivisions and site developments. It combines five previously existing ordinances totalling 250 pages of subdivision and site development regulations into 50 pages and standardizes procedures and criteria, while approximately doubling the land area which is subject to watershed requirements as compared to the previous ordinances.

Also included are several pieces of supporting information, including a newspaper clipping, a companion set of recommendations for further water quality protection measures other than the ordinance, a summary of four "primary water quality control strategies" considered for use in the ordinance, a summary of the ordinance, and some graphics and sample calculations created to help explain concepts in the ordinance.

Mr. Curtis S. Williams, then in his capacity as Environmental Officer for the City's Office of Land Development Services, was the primary staff member responsible for drafting the ordinance and ushering it through the public review and approval process.

311-B WEST MARY STREET
AUSTIN, TEXAS 78704
(512) 441-0171

R0058074

Comprehensive Watersheds Ordinance

CITY OF AUSTIN, TEXAS

ORDINANCE NO. 860508-V

AN ORDINANCE AMENDING THE AUSTIN CITY CODE OF 1981; ESTABLISHING A COMPREHENSIVE WATERSHEDS ORDINANCE FOR AUSTIN'S WATERSHEDS; PROVIDING STANDARDS FOR DEVELOPMENT WITHIN SUCH WATERSHEDS; REQUIRING COMPLIANCE FOR SUBDIVISIONS AND SITE DEVELOPMENTS; SUPERSEDING OTHER ORDINANCES; PROVIDING FOR SEVERABILITY; AND PROVIDING AN EFFECTIVE DATE.

BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF AUSTIN:

PART 1. That the Austin City Code of 1981, hereby is amended to establish a new Chapter 13-15 (Environmental Code), Article II, (Comprehensive Watersheds Ordinance) as hereinafter stated:

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DIVISION I. GENERAL PROVISIONS

SEC. 13-15-201. FINDINGS AND OBJECTIVES

The City Council hereby makes the following findings:

(a) Many of the watersheds within the City's jurisdiction contribute significantly to Austin's drinking water supply.

(b) Waterways and their associated watersheds within the City of Austin's jurisdiction represent significant and irreplaceable recreational and aesthetic resources and contribute directly to the City's public health.

(c) The continued economic growth of the City is dependent on an adequate quality and quantity of water, a pleasing natural environment, and recreational opportunities in close proximity to the City.

(d) All watersheds within the City's jurisdiction, and especially those with abrupt topography, sparse vegetation, and thin and easily disturbed soil, are vulnerable to non-point source pollution and sedimentation resulting from development activities.

(e) All watersheds within the City's jurisdiction are undergoing development or are facing development pressure.

(f) If watersheds within the City's jurisdiction are not developed in a sensitive and innovative manner, their water resources, natural environment, and recreational characteristics will be irreparably damaged.

(g) Protection of Critical Environmental Features such as caves, sinkholes, springs, canyon rimrocks, and bluffs, is necessary to protect water quality in those areas most susceptible to pollution.

(h) The City Council is the trustee of such water supply and the natural environment of all watersheds within the City's jurisdiction for existing and future generations of citizens of the City, as well as for downstream users of the Colorado River.

(i) The City Council is desirous of adopting appropriate development rules and regulations for the purpose of protection of the watersheds within its jurisdiction as a facet of its overall program for the control and abatement of pollution resulting from generalized discharges of pollution which are not traceable to a specific source such as storm sewer and wastewater discharges and urban runoff from rainwater.

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(j) The City Council further finds that minimum standards should be adopted as an application of general principles for conservation and development to encourage innovative planning and design of urban developments to protect the water quality and recreational resources of Lake Austin, Lake Travis, Barton Creek, the Edwards Aquifer, and other watersheds within the City's jurisdiction, the purposes of which standards include:

1. To prevent or compensate for increases in soil erosion and sedimentation during and after development activities;

2. To prevent or compensate for increases in erosive velocities of runoff;

3. To prevent indiscriminate stripping of vegetation and unnecessary loss of soils;

4. To prevent or reduce increases in the pollutant concentrations and total pollutant loading of runoff drainage;

5. To prevent construction activity that may precipitate mass movement, slumping, or erosion of land surfaces;

6. To prevent unacceptable wastewater discharges from reaching Austin's creeks and lakes;

7. To prevent loss of recharge to localized aquifers supplying local seeps and springs essential to the maintenance of the ecosystem and the base flow and water quality of many of Austin's creeks; and,

8. To prevent loss of recharge to the Edwards Aquifer and to protect the quality of the recharge to the Edwards Aquifer.

SEC. 13-15-202. APPLICATION OF ARTICLE AND COORDINATION WITH OTHER ORDINANCES.

(a) This Article sets out special requirements for the development of land located in all watersheds within or partially within the City's jurisdiction. A person wishing to develop land in these watersheds must comply with the requirements and provisions of this Chapter. When the land being developed lies partially within and partially beyond the watershed boundary within the City's jurisdiction, this Article shall apply only to that portion of the land within the watershed subject to the City's jurisdiction.

(b) The requirements of this Article shall apply to all development of land proposed or undertaken by the City of Austin.

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(c) In case of conflict between the requirements of this Article and any other ordinance, the more restrictive requirements shall govern.

(d) The Director of the Office of Land Development Services shall design and administer a system, including necessary forms, that coordinates the requirements of both this Article and the other provisions of this Chapter, minimizes duplication of requirements and conflict between same and facilitates the expeditious processing of plans and permits.

(e) The Director of the Office of Land Development Services shall determine the boundaries of designated watersheds and the Edwards Aquifer Recharge and Contributing Zones from existing maps prepared by the City of Austin and other public entities, plus additional topographic and hydrologic data as necessary to determine those boundaries. All questions concerning the exact boundary of the Edwards Aquifer Recharge Zone shall be recommended by the Chief Environmental Officer, and determined by the City Council. For all property within fifteen hundred feet (1500') of the designated boundary, the applicant shall provide a certified report by a qualified geologist or hydrologist as to whether recharge is affected by drainage on or from the property, based on field verification. For purposes of illustration, the watersheds and aquifer zone boundaries are identified on a map attached as Exhibit "A". Copies of the map are available for inspection at the offices of the City Clerk, Office of Land Development Services, Public Works Department, Planning and Growth Management Department and City/County Health Department.

SEC. 13-15-203. DEFINITIONS.

The following words, terms and phrases, when used in this Article, shall have the meanings ascribed to them in this Section, except where the context clearly indicates a different meaning:

Alternative Sewage Disposal Systems: Private sewage facilities other than a standard septic tank and/or soil absorption-type drainfield. Such systems include, but are not limited to, aerobic systems, lined evapotranspiration systems, low pressure-dosing trench fields, systems utilising greywater disposal and composting toilet systems.

Applicant: A person applying for plan approval under this Article.

Bluff: An abrupt vertical change in topography of more than forty (40) feet with an average slope steeper than four (4) feet of rise for one (1) foot of horizontal travel.

Canyon Rimrock: A horizontal outcrop and vertical face of a hard limestone layer paralleling the side of a canyon or surrounding a canyon head. Rimrock is further delimited by the presence of a steep rock substrate (greater than 60% slope) which has a vertical extent of at least

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four (4) feet, and which has a recognizable horizontal continuity of at least fifty (50) feet. Around the edge of the Jollyville Plateau such features are normally encountered at the contact of the Edwards limestone and underlying strata. Elsewhere, rimrocks may occur locally in Glen Rose formations.

Catchment Area: The area, defined by topographic relief, which drains to a point recharge, or critical environmental feature.

Cave: A natural underground cavity, recess, chamber, or series of chambers generally produced by the solution of limestone by subterranean water.

Chief Environmental Officer: The Chief Environmental Officer of the City of Austin, as designated by the City Manager.

Centerline of a Waterway: The centerline of the waterway refers to existing topographically defined channels. If not readily discernible, the centerline shall be determined by (first) the low flow line, or (second) the center of the two year floodplain.

City of Austin Jurisdiction: All land located within the corporate limits of the City of Austin and including its extra-territorial jurisdiction.

Cluster Housing: Attached or detached residential housing that maximizes common open space by grouping housing units to minimize individual yards and which, for each detached unit, has a maximum lot area of fifteen thousand (15,000) square feet.

Commercial Development: All development other than recreational, open space, multi-family or other residential housing units.

Comprehensive Plan: The City of Austin's Comprehensive Plan, or an element thereof, adopted by ordinance by the City Council in accordance with the City Charter.

Contractor: Any person, other than owner, engaging in development on land located within the City of Austin's jurisdiction.

Crest of Bluff: A line on the ground parallel to and at the top of a bluff, beyond which the average slope is no steeper than one (1) foot of rise in two (2) feet of travel, for a horizontal distance of not less than forty (40) feet.

Critical Environmental Features: Features which have been determined to be of critical importance to the protection of one or more environmental resources. They include such features as bluffs, springs, canyon rimrocks, caves, sinkholes and wetlands.

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Critical Water Quality Zone: Protection zones for waterway corridors as defined in Section 13-15-232 of this Article.

Development: Buildings, roads and other structures, construction, excavation, mining, dredging, grading, filling, clearing or removing vegetation, and the deposit of refuse, waste or fill. Lawn and yard care, including mowing of tall weeds and grass, gardening, tree care and maintenance, removal of trees or other vegetation damaged by natural forces, and ranching and farming shall not constitute development. Utility, drainage, and street repair, maintenance and installation which does not require land disturbance or result in additional impervious cover shall also not constitute development.

Drainfield: (Private sewage facility disposal area): Trench or bed utilized for final wastewater disposal.

Duplex (Two-Family Residential Housing Unit): One of the two (2) separate components of a detached building, each of which components is occupied or suitable for occupancy by only one family as a residence, and having kitchen, bath and sanitary facilities and appropriate appurtenances for such occupancy. Each of such separate components shall be deemed as one unit for the purposes of density calculation and the transfer of development rights.

Edwards Aquifer: The water-bearing substrata also known as the Edwards and Associated Limestones Aquifer. It includes the stratigraphic rock units known as the Edwards Formation and Georgetown Formation.

Edwards Aquifer Recharge Zone: The interim boundaries of the recharge zone shall encompass all land over the Edwards Aquifer recharging the same, as determined by the surface exposure of the geologic units comprising the Edwards Aquifer, including such areas overlain with quaternary terrace deposits. Permanent boundaries may be determined at a later date as part of a more comprehensive delineation of the entire recharge zone.

Edwards Aquifer Contributing Zone: All land generally to the west and upstream of the Edwards Aquifer Recharge Zone that provides drainage into the Edwards Aquifer Recharge Zone.

Faults and Fractures: Significant fissures or cracks in rock which may permit infiltration of surface water to underground cavities and channels.

Impervious Cover: Roads, parking areas, buildings, swimming pools, rooftop landscapes and other impermeable construction covering the natural land surface; this shall include, but not be limited to, all streets and pavement within the development. To calculate impervious cover see Section 13-15-243.

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Individual On-Site Wastewater System (Private Sewage Facility): All systems and methods used for the disposal of sewage, other than organized sewage disposal systems. Private sewage facilities are usually composed of three units: the generating unit (the residence, institution, etc.), treatment unit (septic tank, etc.) and the disposal unit (the drainfield that may be an absorption trench or bed, or an evapotranspiration bed).

Intermediate Waterway: A channel, creek, stream, branch, or watercourse as defined in Sections 13-15-262, 13-15-272, and 13-15-282.

Legal Lot: A tract of land that existed in its present configuration prior to the effective date of the City of Austin Subdivision Ordinance.

Legally Platted Lot: A lot which is part of a subdivision approved by the City of Austin Planning Commission.

Major Waterway: A channel, creek, stream, branch or watercourse as defined in Sections 13-15-262, 13-15-272, and 13-15-282.

Minor Waterway: A channel, creek, stream, branch or watercourse as defined in Sections 13-15-262, 13-15-272, and 13-15-282.

Multi-Family Development: Any development having three (3) or more attached residential units in a single building.

Natural Drainage: A stormwater runoff conveyance system not altered by development.

Natural State: Substantially the same conditions of the land which existed prior to its development, including but not limited to the same type, quality, quantity and distribution of soils, ground cover, vegetation and topographic features.

Net Site Area: That area in the Uplands Zone, excluding land designated for wastewater irrigation, and then calculated to include all acreage on 0-15% slopes; added to forty (40) percent of the acreage on 15-25% slopes; added to twenty (20) percent of the acreage on 25-35% slopes.

One-Family Residential Housing Unit: A detached building occupied or suitable for occupancy by only one family as a residence, and having kitchen, bath and sanitary facilities and appropriate appurtenances for such occupancy.

Overland Drainage: Stormwater runoff which is not confined by any natural or man-made channel such as a creek, drainage ditch, storm sewer, or the like.

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Owner: Any person, having a freehold interest in land within the City of Austin's jurisdiction, a leasehold interest therein, or a lesser tenancy thereon.

Permit: The application for a particular development subject to the provisions of this Article, approved development plan, special notes and other attachments thereto.

Person: Any individual, association, non-profit corporation, professional association, joint stock company, corporation, proprietorship, partnership, or joint venture.

Point Recharge Feature: Any cave, sinkhole, fault, joint or other specific natural feature situated over the Edwards Aquifer Recharge Zone which may be demonstrated to transmit or has the potential to transmit a significant amount of surface water into the subsurface strata. Guidelines to identifying and evaluating such features are maintained by the Chief Environmental Officer.

Plan: Any development proposal submitted to the City of Austin for approval under this Article, which includes but is not limited to subdivision plans, final plats or site development permits and the drawings, documents and other appurtenances as required by Division 3 for the subdivision or development of land located within the City of Austin's jurisdiction.

Recharge Basin: A man-made structure specifically designed to maintain or enhance the transmission of surface water into the subsurface strata.

Retail: Any commercial land use within the City of Austin defined by Chapter 13-2A of the City Code as general retail (GR) or local retail (LR).

Sedimentation and Filtration Basins: Basins required by this Article to provide water quality benefits through the sedimentation or filtration of runoff.

Sinkhole: A circular or oblong depression formed in soluble rock by the action of subterranean water which is a potential point of significant recharge.

Site Development Permit: Permit required from the Office of Land Development Services for development of other than single-family or duplex residential uses on a lot or tract of land, in accordance with the provisions of Chapter 9-10 of the City Code.

South Edwards Aquifer Recharge Zone: That portion of the Recharge Zone located south of the Colorado River, and north of the Blanco River.

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Spoil: Excess material such as rocks, dirt, vegetation, debris, etc. generated as a result of development.

Spring: A point or zone of natural groundwater discharge having measurable flow and/or a pool, however small, and characterized by the presence of a mesic plant community adapted to the moist conditions of the site, typically including one or more of the following species:

maidenhair fern	(Adiantum capillis-veneris)
wild columbine	(Aquilegia canadensis)
southern shield fern	(Thelypteris kunthii)
Missouri violet	(Viola missouriensis)
wooly dicanthelium	(Dicanthelium lanuginosum)
spicebush	(Lindera benzoin)
nimblewill grass	(Muhlenbergia schreberi)
trillium	(Trillium spp.)
water-pimpernel	(Samolus parviflorus)
eastern sycamore	(Platanus racemosa)
green dragon	(Arisaema dracontium)
bushy bluestem	(Andropogon glomeratus)
water bentgrass	(Agrostis semiverticillata)
dwarf palmetto	(Sabal minor)

Subdivision: The division of land into one or more lots, as approved by the Planning Commission in accordance with the provisions of Chapter 13-3 of the City Code.

Suburban Watersheds: All watersheds within the City of Austin's jurisdiction which are not otherwise designated herein as "Urban", "Water Supply Suburban", or "Water Supply Rural". Such watersheds are shown on Exhibit "A", which is incorporated by reference herein and include, but are not limited to, South Boggy, Carson, Cedar, Cottonmouth, Country Club, Decker, Dry (South and East), Elm, Gilleland, Harris Branch, Maha, Marble, North Fork, Rinard, Walnut, and Wilbarger Creeks, the Colorado River (downstream of U.S. 183), and those portions of the Onion, Bear, Little Bear, Slaughter, and Williamson Creek watersheds which are not located in the Edwards Aquifer Recharge or Contributing Zones.

Two Family Residential Housing Unit: Duplex.

Uplands Zone: All land and waters that are not included within the critical water quality zone or water quality buffer zone.

Urban Watersheds: All watersheds as depicted on Exhibit "A", which is incorporated by reference herein including all land within the City's jurisdiction and draining to: Blunn, Buttermilk, East Boggy, East Bouldin, West Bouldin, Fort, Harper Branch, Little Walnut, Johnson, Shoal, Tannehill, and Waller Creeks, Town Lake/Colorado River (north side from Johnson Creek to U.S. 183), and Town Lake/Colorado River (south side from Barton Creek to U.S. 183).

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Water Quality Buffer Zone: A buffer zone established parallel to all critical water quality zones and defined in Sections 13-15-264, 13-15-274, and 13-15-284.

Water Supply Rural Watersheds: All watersheds as depicted on Exhibit "A", which is incorporated by reference herein including all land within the City of Austin's jurisdiction and draining to: Lake Austin (excluding areas on the east side of the Lake south of and including Bull Creek), Lake Travis, Little Barton Creek, Barton Creek (excluding the area east of Barton Creek and north of Loop 360), and the portions of the Onion, Bear, Little Bear, and Slaughter (upstream of FM 1826) Creek watersheds which are located in the Edwards Aquifer Recharge or Contributing Zones.

Water Supply Suburban Watersheds: All watersheds as depicted on Exhibit "A", which is incorporated by reference herein including all land within the City's jurisdiction and draining to: Barton Creek (east of Barton Creek and North of Loop 360), Bull, West Bull, Dry (North and West), Taylor Slough, Lake and Rattan Creeks, Town Lake (south side from Barton Creek to Tom Miller Dam), Town Lake (north side from Johnson Creek to Tom Miller Dam), other Lake Austin (east side from Tom Miller Dam to Bull Creek), and those portions of the Williamson, Slaughter (downstream of FM 1826) and Brushy Creek watersheds which are located in the Edwards Aquifer Recharge or Contributing Zones.

Wetlands: Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Classification of areas as wetlands shall follow the "Classification of Wetlands and Deepwater Habitats of the United States" as published by the U.S. Fish and Wildlife Service (FWS/OBS-79/31).

SEC. 13-15-204. BURDEN OF PROOF

An applicant submitting plans for approval under this Article must establish that his or her plans comply with the requirements of this Article and with the applicable requirements of the rest of this Chapter. Compliance must be certified by a professional engineer registered in the State of Texas and knowledgeable in the field of Civil Engineering.

SEC. 13-15-205. VARIANCES

(a) Variances by Planning Commission

1. The Planning Commission may grant a variance from one or more requirements of this Article if an applicant requests the variance in writing and the Commission finds that, because of special circumstances applicable to the property involved, a strict application of the provisions prevents the owner of the property from enjoying the privileges or safety associated with other

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similarly situated property with similarly timed development. Where such conditions are found, the variance permitted shall be the minimum departure from the terms of this Article and other ordinance requirements necessary to avoid such deprivation of privileges enjoyed by other property owners and to facilitate a reasonable use, which will not create significant probabilities of harmful environmental consequences. The Planning Commission may not grant a variance if it provides the applicant with any special privileges not enjoyed by other similarly situated property with similarly timed development, or if based on a special or unique condition which was created as a result of the method by which a person voluntarily subdivides or develops land.

2. The Planning Commission may grant a variance from one or more requirements of this Article, including but not limited to, Sections 13-15-232, 13-15-264, 13-15-274, and 13-15-284, if an applicant requests the variance in writing and the Commission finds that the application of such provisions leaves the property owner without any reasonable, economic use of the entire property. Where such conditions are found, the variance permitted shall be the minimum departure from the terms of this Article and other ordinance requirements necessary to establish a reasonable, economic use of the entire property.

3. The applicant has the burden of proving his or her entitlement to the variance.

4. Before acting on a variance request under the Subsection, the Planning Commission shall consider the review and recommendations of the Environmental Board.

5. The Planning Commission shall prepare written findings of fact justifying its grant or denial of the variance request.

(b) Administrative Variances

1. The Director of the Office of Land Development Services may grant a variance from the provisions of Sections 13-15-232(d), 13-15-234(d), 13-15-236(a), 13-15-248(b), and 13-15-274(d) when such variance is determined to be consistent with the standards and intent of the pertinent Section.

2. The applicant has the burden of proving his or her entitlement to the variance.

3. The Director shall make written findings justifying the grant or denial of each variance.

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(c) The Director of the Office of Land Development Services shall prepare and maintain in the Office of Land Development Services for public inspection:

1. A written summary of variances granted and denied under Subsections (a) and (b); and,

2. The contents of the files, including the appeal record if there was an appeal, for each variance acted on by the Planning Commission.

SEC. 13-15-206. APPEALS

(a) Appeal of Planning Commission Variances. Any citizen of the City of Austin or any person owning property in a watershed within which a project is located may appeal the granting or denial of a variance by the Planning Commission pursuant to Section 13-15-205(a) of this Article, by filing a written notice with the Office of Land Development Services on or before the tenth (10th) calendar day after such decision. Said notice shall point out with specificity why, in the opinion of the appellant, the decision of the Planning Commission was improper. The City Council shall set a public hearing on the appeal within forty-five (45) calendar days of the date the notice was filed. If there are multiple appeals by the same granting or denial of a variance, or if the appeal is combined with an appeal for the approval or denial of a site plan, the Council shall decide all appeals at the same hearing. The appellant has the burden of proof on appeal and the Council must decide the appeal solely on the record before the Planning Commission, the written appeal, the written response to the appeal from the applicant, and written reports or other relevant and necessary information from appropriate City departments as may be requested by the Council. After considering the appeal, the Council may affirm the decision of the Planning Commission, reverse it, or modify it to comply with the requirements of this Article.

(b) Appeal of Administrative Variances. Any citizen of the City of Austin or any person in a watershed within which a project is located may appeal the granting or denial of an administrative variance to the Planning Commission. The appeal must be delivered to the Director of the Office of Land Development Services within ten (10) calendar days after the date of the Director's decision. The Director shall transmit the appeal with the plan to the Planning Commission, which shall decide all appeals relating to a particular plan when it acts on the plan. The applicant has the burden of proof on appeal. The decision of the Planning Commission shall be final on the appeal of an administrative variance.

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(c) Appeal of Site Development Permit. Any citizen of the City of Austin or any person owning property in the watershed within which the project is located may appeal the approval or denial of a site development permit by the Director of the Office of Land Development Services to the City Council by filing a written notice with the Office of Land Development Services on or before the tenth calendar day after such decision. Appeal may not be taken, however, from disapproval of a site development permit application pending receipt of additional information. Said notice shall point out with specificity why, in the opinion of the appellant, the decision of the Director of the Office of Land Development Services was improper. The City Council shall set a public hearing on the appeal within forty-five (45) calendar days of the date the notice was filed. The appellant has the burden of proof on appeal and the Council must decide the appeal solely on the basis of the permit application file, the written appeal, the written response to the appeal from the applicant, if any, oral argument at the Council hearing, written reports or other relevant and necessary information from the appropriate City departments as may be requested by the Council. After considering the appeal, the Council may affirm the action of the Director of the Office of Land Development Services, reverse it, or modify it to comply with the requirements of this Article.

SEC. 13-15-207. EXEMPTIONS

(a) This Article shall not apply to watersheds defined as "Urban". However, development in Urban Watersheds is subject to the requirements of the Town Lake Critical Water Quality Zone, and all commercial and multi-family development within 500 feet of the 429.0-foot contour of Town Lake must provide sedimentation/filtration basins in accordance with Section 13-15-238 of this Article.

(b) Except as provided in subsections (c), (d), and (e), this Article shall not apply to any development for which a preliminary plan, final plat, site development permit, Travis County development permit, zoning site plan, planned unit development, planned development agreement, or development phasing agreement was approved by the applicable governmental authority, prior to the effective date, or a land use plan for an out-of-City MUD approved by the City Council after a public hearing which occurred prior to the effective date, or a land use plan with permanent zoning for an in-city MUD, which was approved by the City Council prior to the effective date.

(c) This Article shall apply to subdivisions and site developments that were approved before the effective date of this ordinance and that propose to withdraw water from the South Edwards Aquifer and propose residential development other than single-family residential with a maximum density of two units per acre.

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(d) Development otherwise exempt under subsection (b) loses its exemption unless, on the effective date or within five years after the effective date of this Article, the development:

1. has or obtains a site development permit or building permit;

2. has or obtains an approved final plat for at least 50 percent of the land area of the development shown on the preliminary plan;

3. has or obtains permanent zoning tied to a site plan;

4. is or becomes part of an approved site plan or land use plan for a planned unit development, municipal utility district, planned development agreement, or development phasing agreement.

(e) Even though it is exempt under this section, a commercial or multi-family development with more than 20 percent impervious cover must provide sedimentation/filtration basins in accordance with sections 13-15-238 of this Article.

(f) This Article shall not apply to the subdivision of land that proposes a residential density of not more than one, one-family housing unit for every five acres and is appropriately restricted to that residential density.

(g) This Article shall not apply to the resubdivision or reconfiguration of any tract exempted by this section which does not result in an overall increase in density or impervious cover above that on the exempted subdivision or plan. Applicants may change lot sizes and dimensions, roadway alignments, subdivide commercial and multi-family lots into smaller lots, and reallocate impervious cover or transfer density among lots so long as the overall impervious cover and density on the originally approved plan do not increase. In addition, areas reserved for wastewater irrigation and not restricted against future development may be subdivided and resubdivided when no longer needed for irrigation purposes; provided, however the subdivision or resubdivision of such irrigable area shall be required to comply with this Article.

(h) Development exempt from this Article under this section is governed by the applicable watershed ordinance, if any, in effect on the effective date of this ordinance. Development exempt under subsection (f) is not subject to any watershed ordinance.

(i) The impervious cover limits of Divisions 6, 7, and 8 of this Article shall not apply to roadway construction pursuant to a City of Austin Capital Improvements Program if the limits would require the condemnation of adjacent pervious land. Development adjacent to the roadway shall account for the roadway's impervious cover in accordance with Section 13-15-242(e) of this Article.

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(j) This Article shall not apply to a legal lot, as defined in Section 13-15-203, provided, however, that the provisions of this Article shall become applicable to such lot in the event that development of the property requires subdivision approval.

(k) This Article shall not apply to the development of any tract of land that was previously exempted from the Lake Travis Watershed Ordinance by specific action of the City Council.

(l) Notwithstanding any other provisions of this section, any final plat approved prior to the effective date of this Article for which a site development permit, building permit or site plan has not been approved within 10 years from the effective date shall be subject to its provisions.

(m) The impervious cover provisions of Division 6, 7, and 8 of this Article shall not apply to any public school district project; and provided additionally, that any public school district projects for sites acquired prior to the effective date of the ordinance shall be exempt from its provisions.

SEC. 13-15-208. WAIVERS

(a) A developer may apply in writing to the Director of Land Development Services to waive some or all of the requirements of this Article, except as provided in subsection (g), if an application for a preliminary plan, major project review, or site development permit for the development was accepted as complete for filing before the effective date of this Article. The Director must receive an application for Waiver within ninety (90) calendar days after the effective date of this Division or waiver under this Section is barred.

(b) The Director of Land Development Services shall review each application for waiver to determine whether the developer in preparing the preliminary plan or site development permit application relied in good faith on the applicable watershed ordinance then in effect and whether the reliance was reasonable and substantial. In making this determination the Director shall consider when the preliminary plan or site development permit application was filed and the time, effort, and money expended by the developer in preparation. The Director shall recommend in writing for or against the requested waiver, based on the determination of reliance. The Director shall forward the recommendation, together with a concise, written explanation of the basis for the recommendation, the waiver application, and the application for a preliminary plan or site development permit, to the Planning Commission within 30 calendar days from the date the waiver application was received.

(c) The Planning Commission shall consider the recommendation at a public hearing within 30 calendar days from the date it receives the recommendation. After the public hearing the Planning Commission may

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approve, disapprove, or modify the recommendation, in accordance with the standard described in subsection (b), and the Planning Commission shall forward its written recommendation on the waiver application to the City Council within 75 calendar days after the application was received by the Director of Land Development Services.

(d) The City Council shall hold a public hearing on the Planning Commission's recommendation within 30 calendar days after it receives the recommendation. After the hearing the City Council may approve, disapprove, or modify the recommendation in accordance with the standard described in subsection (b).

(e) A developer has the burden of proving his or her entitlement to the requested waiver before the Director of Land Development Services, the Planning Commission, and the City Council.

(f) A development for which some or all of the requirements of this Article have been waived becomes subject to the waived requirements unless, within five years from the effective date of this Division, the development:

1. has or obtains a site development or building permit;

2. has or obtains an approved final plat and site plan for at least 50 percent of the land area of the development shown on the preliminary plan;

3. has or obtains permanent zoning tied to a site plan;

4. is or becomes part of an approved site plan or land use plan for a planned unit development, municipal utility district, planned development agreement; or development phasing agreement.

(g) Notwithstanding the approval of a waiver under this section, commercial or multi-family development with more than 20 percent impervious cover must provide sedimentation/filtration basins in accordance with section 13-15-238 of this Article.

SEC. 13-15-209. HARDSHIP PROVISIONS

(a) Any person owning title to property within any of the watersheds to which this ordinance is applicable may request administrative review of the effect of this ordinance upon an individual tract if such review is requested on or before May 1, 1987.

(b) An administrative review shall consist of an analysis by the Office of Land Development Services of the effect of the application of the ordinance upon a tract held in ownership by any person on or before the date of passage of this ordinance to determine:

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1. The percentage of net development in square feet of impervious cover or residential units lost, if any, by virtue of the application of this ordinance to the tract in question as compared with the net development possible under ordinances and available utility service existing on the date of passage of this ordinance.

2. The development configuration most likely to maximize the economic value of the tract under application of the terms of this ordinance.

(c) In case any tract has its net development in square feet of impervious cover or residential units reduced by 50% or more, by application of the terms of this ordinance, the following procedures shall apply:

1. The owner of the tract may develop the tract according to the terms of this ordinance, without application of other provisions of this section.

2. The owner may request that the Office of Land Development Services develop a site specific plan to protect water quality utilizing any combination of the provisions contained in Sections 13-15-231 - 13-15-290 of this ordinance, including density controls, impervious cover limitations and structural controls, which shall, in the opinion of the Office of Land Development Services, accomplish substantial protection of water quality in the run-off of water occurring from said tract to any minor, intermediate, or major waterway in any area regulated by this ordinance. In developing such a site specific plan, the Office of Land Development Services shall balance the techniques of water quality protection with the maximization of the economic utilization of the tract in order to achieve the most cost effective plan affording substantial protection of water quality. The burden of producing all other elements of the plan other than the element prepared by the Office of Land Development Services for the property shall be distributed according to pre-existing requirements.

3. Any plan developed by the Office of Land Development Services under paragraph (2) above shall be presented to the person owning such land for approval by such person within sixty (60) days of the request for the development of such plan in order that such plan may be presented to the City Council for adoption. If the owner wishes to present the plan to the City Council for adoption, the plan shall be presented to the Council for adoption by ordinance within thirty (30) days of written acceptance of the plan by the owner.

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4. The City Council shall consider the plan and action upon the plan shall be approved or disapproved according to the requirements for consideration of ordinances within sixty (60) days following its presentation to the Council by the Office of Land Development Services, following acceptance by the owner.

(d) This section shall be a remedy available in addition to all other exemptions and remedies provided a person owning title to property under this division.

SEC. 13-15-210. RESERVED

DIVISION 2. MAINTENANCE AND ENFORCEMENT

SEC. 13-15-211. MAINTENANCE

All developments of land located within the City of Austin's City limits or extra-territorial jurisdiction shall comply with the provisions of this Section.

a) All sedimentation and filtration basins and their appurtenances required for commercial and multi-family development shall be maintained by the property owner.

(b) Maintenance of sedimentation and filtration basins for single-family or duplex residential development shall be by the City of Austin.

(c) The maintenance of all sedimentation and filtration basins and their appurtenances shall be to the standards and specifications of the City of Austin's "Design Guidelines for Water Quality Control Basins", as prepared by the Department of Public Works.

(d) Duly authorized inspectors of the City shall have the right of entry on the land or premises where property owners are required to maintain drainage facilities or detention/filtration facilities, for the purpose of inspection of the maintenance required. The Public Works Department shall inspect the premises of each such facility approved pursuant to this Article at least once per year. Where noncompliance is found, the City shall request in writing that the property owner comply. This notice shall describe the measures required to be taken. If, within one (1) month of the notice, the maintenance required is not accomplished, the City shall either:

1. Cause the necessary restoration to be accomplished and assess the property owner for the City's actual cost, or

2. Bring an action for mandatory injunction to require the property owner to accomplish the necessary maintenance.

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(e) A Dedicated Fund shall be set up by the City to maintain and monitor basins for single-family and duplex uses and to monitor basins for other residential and commercial uses. The subdivider or developer shall pay into the fund as per the adopted Fee Schedule of the City of Austin. These fees shall be paid at the time the subdivider posts fiscal requirements for his or her subdivision, or at the time of site development permit approval.

(f) An annual report shall be made by the Director of Public Works to the City Council about the status of the program and the funds.

SEC. 13-15-212. INSPECTIONS

(a) Any person or his successor and assigns who has filed a plan for approval pursuant to this Article shall agree in writing to allow entry on the land or premises which is the subject of such application for the purpose of inspection of conditions on the premises during the approval stage and during development and construction by duly authorized inspectors of the City.

(b) The City shall cause such inspections to be made of the land or premise during development and construction so as to assure full compliance with all terms, conditions, requirements, and agreements to which the person obtaining approval of a plan under this Article is bound.

(c) The applicant shall designate one person or legal entity, with a current street address, to which notice shall be given pursuant to this Article.

(d) Any permit holder shall agree to allow entry on the land or premises which is the subject of the permit for the purpose of the aforementioned inspection.

SEC. 13-15-213. PRE-CONSTRUCTION CONFERENCE

(a) A pre-construction conference shall be required for all development under this ordinance.

(b) Subsequent to installation of erosion and sedimentation controls, and prior to beginning construction, a permit holder shall request in writing and attend, along with his design engineer, contractor, and field engineer, an erosion and sedimentation control inspection coordinated and scheduled by the Director of Public Works, and attended by all relevant City departments. Said conference shall take place on the site. The permit holder should be prepared to demonstrate that the erosion and sedimentation controls are in compliance with the Erosion and Sedimentation Control Manual, and to

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present a plan including, but not limited to future erosion and sedimentation controls, tree protection measures, and drainage, utility and street layouts. The conference must be held within ten (10) days of the receipt of the request or permit holder may proceed with construction.

SEC. 13-15-214. CRIMINAL ENFORCEMENT

(a) It shall be unlawful for any person, corporation, partnership, joint venture, contractor, agent, owner, or any person having physical control of land situated in whole or in part within watersheds located within the City's jurisdiction to undertake, to engage in, perform, authorize, allow, direct, or permit development on that land unless a valid current plan has been approved by the City of Austin and the appropriate development permits obtained by the owner, design engineer, or contractor authorizing that development.

(b) An owner of land situated in whole or in part within a watershed commits a violation of Subsection (a) hereof by personally undertaking, engaging in, or performing development on that property without having first obtained a valid, current development permit from the City of Austin authorizing said development; by agreeing, allowing, permitting, authorizing, or directing another to openly and notoriously perform, engage in, or undertake development on his/her property where no valid, current permit has been obtained; by knowingly allowing another to engage in, perform, or undertake development on his property without his consent where no such valid permit has been obtained.

(c) A contractor commits a violation of Subsection (a) hereof when said contractor, with or without the owner's consent, engages in, performs, or undertakes development upon property situated in whole or in part within the watersheds located within the City's jurisdiction without having obtained or secured a current, valid development permit issued by the City of Austin to that contractor. A true copy of the permit shall be kept at the site at all times during development. The contractor shall cause the permit to be immediately available at the site for examination upon request by any authorized City inspector, as evidenced by an identification card bearing the seal of the City of Austin, naming the inspector, and signed by a person purporting to be empowered to issue said identification card. Evidence of the contractor's failure to have displayed the copy of the permit at the site upon request by an authorized City inspector shall constitute prima facie evidence that there is no valid, current City development permit for development of the site.

(d) Any person to whom a development permit has been issued by the City of Austin pursuant to this Article commits a violation thereof, punishable hereunder, if such person fails to observe and perform the terms and conditions stated in such permit.

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(e) Any person violating any of the provisions of this Article, upon conviction, shall be fined in an amount not exceeding $1,000. Each violation hereof occurring during a calendar day shall be a distinct and separate offense from such a violation occurring during the next preceding or next following calendar day.

(f) It shall not be necessary for the complaint filed in any case hereunder to negate any exception, whether exemption or variance, contained in this Article concerning any prohibited act; but, any such exception made herein may be used as a defense by any person charged by such complaint.

(g) Nothing herein shall limit the City's authority to seek injunctive or other civil relief available under the law.

SEC. 13-15-215. CEASE AND DESIST ORDER

(a) When either the Office of Environmental Resource Management (ERM), Public Works Department, Water and Wastewater Utility, Electric Utility, or Building Inspection Department determines that there has been noncompliance with any material term, condition, requirement or agreement under this Article, the person who either has or should have obtained an approved development permit shall be ordered to cease and desist from allowing further development and/or from allowing transportation of construction material to the alleged noncompliant site until such site is in compliance with this Article.

(b) Said cease and desist order ("Red Tag") shall be in writing and shall be posted on the site.

(c) The City shall bring suit in a court of competent jurisdiction to restrain and enjoin any person attempting or allowing development or construction without an approved development permit or any person failing or allowing failure to cease and desist from further development or construction under Subsection (a).

(d) No further City inspection or utility connections shall be made until such site is in compliance with this ordinance, as determined by the Chief Environmental Officer of the City.

SEC. 13-15-216. APPEAL OF CEASE AND DESIST ORDER

(a) Appeal of a cease and desist order, issued pursuant to Section 13-15-215, may be made by the person aggrieved to the Chief Environmental Officer. Such appeal shall be perfected by giving written notice containing the following information to the Chief Environmental Officer within three (3) days of the posting on the site of the cease and desist order:

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1. The name and address of the person making the appeal
2. The facts surrounding the particular ruling
3. The ruling of the issuing department
4. The technical reasons why the ruling should be set aside.

(b) Within a period of three (3) days from the filing of the appeal, the Chief Environmental Officer or his designee shall hear the appeal together with technical testimony of the person making the appeal, or his technical expert, and the department, and make a decision either affirming or reversing the department's decision within two (2) days thereafter. The person requesting the hearing shall be notified of the decision in writing. The notification shall be accompanied by a statement of the reasons for the decision.

(c) Appeal of the Chief Environmental Officer's decision may be made by the person aggrieved to the Planning Commission. Such appeal shall be perfected by giving a written notice containing the following information to the Chairman of the Planning Commission within three (3) days after the receipt of the decision of the Chief Environmental Officer:

1. The name and address of the person making the appeal.
2. The facts surrounding the particular ruling.
3. The rulings of the issuing department and Chief Environmental Officer.
4. The technical reasons why the ruling should be set aside.

(d) The Planning Commission shall hear the appeal at the next regular meeting following receipt of the notice. If the appeal is not heard by the Planning Commission within twenty (20) days from the filing of the appeal with the Commission, the appeal shall be deemed granted.

(e) Appeal under this Section shall not stay the cease and desist order.

SEC. 13-15-217. CERTIFICATE OF COMPLIANCE OR OCCUPANCY

No City utilities may be connected to a site unless a certificate of compliance is issued by the Department of Public Works when the development is completed pursuant to requirements of this Article for areas outside the City limits or until the Building Inspection Department issues a certificate of occupancy with the written concurrence of the Director of Public Works for areas within the City limits. Requests by the developer/owner for a certificate of compliance or occupancy for development other than single-family or duplex residential housing construction shall be accompanied by a certificate prepared and signed by a professional engineer registered in the State of Texas attesting to the completion of the project in substantial conformance with the development permit.

SEC. 13-15-218.-220. RESERVED

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DIVISION 3. REQUIREMENTS FOR SUBMISSION OF DEVELOPMENT PLAN

SEC. 13-15-221. APPROVAL AND PREAPPLICATION CONFERENCE

(a) Before subdividing land located in the watersheds in the City's jurisdiction, an applicant must first obtain approval from the Planning Commission of the plans and plat required by this Division and by the other provisions of this Chapter.

(b) No commercial or multi-family development shall be undertaken on any land, tract or parcel within the City's jurisdiction until the effective date of a site development permit for said development issued by the Director of the Office of Land Development Services.

(c) For developments exceeding one hundred acres in size, a prospective applicant shall request in writing, prior to submitting a plan for approval, a development preapplication conference coordinated and scheduled by the Director of the Office of Land Development Services and attended by the applicant and representatives of all relevant City departments. Applicants should be prepared to present a conceptual plan at that time, including, but not limited to conceptual drainage, land use, utility and street layout. The conference must be held within ten (10) days of the request or the applicant may proceed to submit a plan.

SEC. 13-15-222. PLAN SUBMISSION REQUIREMENTS - GENERAL

(a) An applicant seeking approval of a plan must file copies of a plan of the proposed development with the Director of the Office of Land Development Services and pay the filing fee required by ordinance.

(b) Applicants for subdivisions for uses other than single-family or duplex residential may submit information demonstrating compliance with this Article for individual lots at the time of Site Development Permit Application, provided that the applicant demonstrates that such lots have access consistent with this Article and appropriately restricts the plat to assure compliance at a later date.

(c) The plan shall meet all requirements and conditions established by the other Sections of this Article and shall meet additional requirements set forth below. The proposed plan shall be certified as complete and accurate and in compliance with the provisions of this Article by a professional engineer registered in the State of Texas and knowledgeable in the field of Civil Engineering.

(d) An applicant seeking approval of a plan under this Article must submit the following information; unless the Director of the Office of Land Development Services determines that due to the scope and nature of the proposed development, some of the information is unnecessary:

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1. A topographic map, with two foot contour intervals, at a scale of 1 inch to 100 feet for subdivision plans and 1 inch to 40 feet for site development plans, each meeting national map accuracy standards showing:

   a. All development or improvements on the site that are existing and those that are proposed.

   b. The limits of the one-hundred (100) and twenty-five (25) year floodplains, based on existing channel conditions, of all creeks and major drainage channels prior to any alteration of land assuming fully developed watershed conditions exist.

   c. The location, type, acreage, and percentage of impervious cover, including both existing and proposed for each slope category and the totals.

   d. The delineation of each Major, Intermediate, and Minor Waterway as defined herein.

   e. The delineation of the Critical Water Quality Zone, Water Quality Buffer Zone, Upland Zone, and Edwards Aquifer Recharge Zone, as applicable.

   f. The two year floodplains where needed to determine the Critical Water Quality Zone.

   g. The location of any Critical Environmental Features such as point recharge features, canyon rimrocks, bluffs, and wetlands, and required setbacks therefrom.

2. A slope map drawn at the same scale as the topographic map for those sites having greater than fifteen percent (15%) slopes, depicting slopes of 0-15%, 15-25%, 25-35%, and over 35%. Slopes may be calculated based on contour intervals not to exceed five (5) feet. The slope map shall show:

   a. All development or improvements on the site including adequate building sites for any single-family or duplex lots, exclusive of any required setbacks and easements and any slopes over 25%, and based on the assumed impervious cover defined in Section 13-15-243(c).

   b. Areas of cut and fill in excess of four (4) feet, or, for roadways, cut and fill outside the right-of-way.

   c. The location of proposed spoil disposal sites.

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d. The location of wastewater lines, drainfields, and effluent irrigation areas, effluent holding ponds, and tailwater control berms.

e. Buffer zones for commercial, multi-family, or cluster development, where applicable.

3. An engineer's report including:

a. A drainage study addressing the design criteria set forth in the Drainage Criteria Manual.

b. The land area calculated in acres for each slope class and each water quality zone within the development.

c. The net site area, as calculated herein, along with detailed calculations and the methodology used to calculate total allowed and proposed impervious cover or density for the development, as well as all transfer of development rights calculations. The total impervious area shall be separated into areas of streets, off-street parking, commercial areas, tennis courts and other recreational areas, and residential areas. All pedestrian sidewalks within street rights-of-way or parallel to private streets may be excluded from the impervious cover calculations.

d. An erosion/sedimentation control plan consistent with the requirements of Section 13-15-233.

e. Roadway and driveway preliminary profiles for those portions of all roadways and driveways crossing slopes in excess of fifteen percent (15%).

f. A vegetative description delineating ground cover types, defining the cover-types by general species composition and range of tree diameters. The vegetative description shall be accompanied by an aerial photograph at a scale of 1" = 400 ft. A mylar overlay accompanying the photograph shall show approximate locations and identities of all trees and definable groups of trees with crown diameters equal to or greater than forty (40) feet and showing the approximate locations and identities of any other significant plant material.

g. An engineer's seal, signature, and statement certifying that the plan is complete, correct, and in compliance with this Article, along with the Engineer's Summary Letter.

4. A request and justification for a variance according to Section 13-15-205.

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SEC. 13-15-223. ENVIRONMENTAL ASSESSMENT

For all developments located in watersheds designated as "Water Supply Suburban" or "Water Supply Rural", an Environmental Assessment is required which includes the following information; unless the Director of the Office of Land Development Services determines that due to the scope and nature of the proposed development some of the information is unnecessary:

(a) A hydrogeologic element which:

1. Generally describes the topography, soils, and geology of the site.

2. Identifies springs and significant point recharge features on the site.

3. Demonstrates that proposed drainage patterns will protect the quality and quantity of recharge at those points, as required by Section 13-15-239.

(b) A vegetative element which:

1. Includes either a tree survey of all trees with a diameter of eight inches (8") or more measured four and one-half (4-1/2) feet above natural grade level or, upon approval of the City Arborist, a set of nine by nine inch aerial photographs providing complete, stereo coverage of the area photographed between the months of April and November at a scale no greater than one inch equals four hundred feet.

2. Includes, for all commercial and multi-family sites, a vegetative survey which shows the approximate location of and identifies all significant plant material on the site.

3. Demonstrates that the design of the plan has been accomplished to preserve to the greatest extent reasonable any significant trees and vegetation on the site and to provide maximum erosion control and overland flow benefits from such vegetation.

(c) A wastewater element, where applicable, which:

1. Includes calculations of drainfield or wastewater irrigation areas as required by this Article.

2. Provides environmental justification for sewer line locations in Critical Water Quality Zones, where applicable, and describes construction techniques and standards for wastewater lines.

3. Describes alternative wastewater disposal systems to be used over the Edwards Aquifer Recharge Zone.

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4. Discusses any proposed on-site collection and treatment systems, their treatment levels, and impacts on receiving watercourses, including the Edwards Aquifer, as required by this Article.

(d) Identification of any Critical Environmental Features as required by this Article, and proposed means for protection of such areas.

(e) Environmental justification for spoil disposal locations or roadway alignments, as required in Sections 13-15-235, 13-15-236, and 13-15-237.

(f) Methods proposed to achieve overland flow, and justification to use enclosed storm sewers, where proposed.

(g) A description of any industrial uses proposed, as well as a program for pollution abatement as required by this Article.

SEC. 13-15-224. FINAL PLAT

In addition to satisfying other requirements of this Article, a final plat, where applicable, must:

(a) Contain on the face of the plat or place in a separate covenant the following notes, as applicable, which:

1. Incorporate by reference the terms and requirements of this Article of this Chapter, which shall be required in all cases;

2. Restricts the land in the subdivision to the impervious cover limitations of this Article;

3. Provides for the maintenance of structural water quality controls as required by Section 13-15-211;

4. Provides for separate approval of any driveway with grades in excess of fourteen (14) percent when applicable under Section 13-15-248;

5. Provides for joint-use driveways when applicable under Section 13-15-248;

6. Limits cut and fill on any lot to a maximum of four (4) feet, as required in Section 13-15-235.

7. Requires erosion controls to be installed for single-family and duplex construction.

8. Specifies the transfer of development rights used.

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(b) Contain a statement dedicating to the City of Austin those water quality basins required under Section 13-15-211 to be maintained by the City.

(c) Be accompanied by such restrictive covenants, easements or contracts as may be necessary and appropriate to ensure adequate property owner maintenance of water quality basins under Section 13-15-211 and/or to facilitate the use of joint-use driveways under Section 13-15-248.

(d) Be accompanied by a fee in the amount established by ordinance; such fee to be used for the purpose of funding a program for maintaining and monitoring water quality basins and other drainage facilities and conveyances as described in Section 13-15-238.

SEC. 13-15-225.-230. RESERVED

DIVISION 4. GENERAL STANDARDS

SEC. 13-15-231. COMPLIANCE

All plans submitted shall comply with the provisions of this Division and any other applicable provisions of this Article.

SEC. 13-15-232. CRITICAL WATER QUALITY ZONES

(a) Critical water quality zones shall be established along all intermediate, minor and major waterways with drainage basins as defined in Sections 13-15-262, 13-15-272, and 13-15-282. The zone line shall be delineated parallel to each such waterway according to the size of the drainage basin:

1. For minor waterways, the zone line shall be defined by the limits of the one hundred year floodplain; provided that it shall never extend beyond one hundred (100) feet on each side from the centerline of the waterway; provided further that the line shall never be located less than fifty (50) feet on each side from the centerline of the waterway.

2. For intermediate waterways, the zone line shall be defined by the limits of the one hundred year floodplain; provided that it shall never extend beyond two hundred (200) feet on each side from the centerline of the waterway; provided further that the line shall never be located less than one hundred (100) feet on each side from the centerline of the waterway.

3. For major waterways, the zone line shall be defined by the limits of the one hundred year floodplain; provided that it shall never be located greater than four hundred (400) feet on each side from

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the centerline of the waterway; provided further however, that the line shall never be located less than two hundred (200) feet on each side from the centerline of the waterway.

4. Notwithstanding all of the above, in no event shall the Critical Water Quality Zone extend beyond the crest of a bluff, as defined in Section 13-15-203.

(b) The floodplain delineation shall be based on a channel in its unaltered state, unless modifications are approved pursuant to regulations adopted by the City Council, and shall assume fully developed watershed conditions.

(c) Critical water quality zones shall be established along Lake Travis, Lake Austin, and Town Lake. The zone line shall be delineated parallel to the normal pool levels of Lake Travis (681.0 foot contour), Lake Austin (492.8 foot contour), and Town Lake (429.0 foot contour), and shall extend a horizontal distance of seventy-five (75) feet inland for proposed detached single-family residential development, and one hundred (100) feet for other residential or commercial development.

(d) The critical water quality zone shall remain free of all construction activity, development and alterations except that the following may be permitted:

1. Arterial, collector, and residential street crossings only as provided below:

   a. Major waterways may be crossed by arterial streets that are identified in the City of Austin Roadway Plan.

   b. Intermediate waterways may be crossed by arterial and collector streets, provided, however, that no collector street crossing shall be within two thousand five hundred (2,500) feet of any other collector or arterial street crossing on the same waterway; provided further, however, that in those watersheds designated as "Water Supply Suburban" or "Water Supply Rural", no collector street crossing shall be within one mile of any other collector or arterial street crossing on the same waterway.

   c. Minor waterways may be crossed by arterial and collector streets, provided, however, that no collector street crossing shall be within one thousand (1,000) feet of any other crossing of a collector or arterial street on the same waterway; provided further, however, that in those watersheds designated as "Water Supply Suburban" or "Water Supply Rural", no collector street crossing shall be within two thousand (2,000) feet of any other collector or arterial street crossing on the same waterway.

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d. Minor waterways may be crossed by a residential or commercial street only when necessary to provide access to property which cannot otherwise be safely accessed.

e. The Director of the Office of Land Development Services may vary these requirements prior to, or at the time of, plan approval, after receiving a report from the Urban Transportation Department.

2. Fences that do not obstruct flood flows.

3. Public and private parks, golf courses and open spaces, other than parking lots, when a program of fertilizer, pesticide and herbicide use is approved by the Office of Land Development Services, provided, however, that in watersheds designated as Water Supply Rural or where the Critical Water Quality Zone lies within the South Edwards Aquifer Recharge Zone, park development is limited to trails and facilities (other than stables and corrals for animals) for hiking, jogging, nonmotorized biking, and nature walks.

4. Boat docks, piers, wharves, or marinas, and necessary access and appurtenances, along Lake Travis, Lake Austin, and Town Lake, where otherwise permitted by the City of Austin. All treated building materials that will be submerged in water must be approved by the Office of Land Development Services prior to a waterway development permit being issued.

5. Detention basins, utilities, maintenance, and floodplain alterations as permitted by Chapter 9-10, Article IV, Division 1 and 2, and other provisions of this Article.

SEC. 13-15-233. EROSION AND SEDIMENTATION CONTROL.

(a) Erosion and sedimentation controls, as specified in the Erosion and Sedimentation Control Manual, are required for all construction and development, including but not limited to, commercial, multi-family, single-family and duplex construction. Moreover, the construction of all roads, utilities, parks, golf courses, water quality and detention basins, and all other activities utilizing clearing, trenching, grading, or other construction techniques shall comply with the Manual.

(b) Applications for waterway or site development permits shall be accompanied by a proposed construction sequence to demonstrate an acceptable plan for erosion control and tree protection during the construction period and restoration of the land after the construction period and shall be submitted to the Director of the Office of Land Development Services for review. All measures for erosion control and restoration shall be performed in accordance with the Erosion and Sedimentation Control Manual.

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(c) Projects shall not be considered complete until restoration has been made, the required vegetation established, and certified by the Public Works Department for acceptance as installed. In the event the City accepts maintenance responsibility for the streets, drainage facilities and utilities prior to completion of restoration requirements, a separate and enforceable agreement to ensure completion of restoration requirements shall be entered into by the City of Austin and the developer.

(d) After two (2) days written notice to the permit holder of the plan, modifications from the approved erosion control and construction sequencing plans may be made in the field if the City inspector deems the controls or sequencing inappropriate or inadequate and has confirmed his/her findings with the Office of Land Development Services, and has their written approval. Minor changes which result in an upgrading of erosion controls or simply reflect the progression of construction on a site, may be accomplished in the field without such written approval.

SEC. 13-15-234. CLEARING AND TEMPORARY SITE DISTURBANCES

(a) Clearing for road construction shall not be permitted before final plat approval. Work done on the ground in preparation of site development or final plat approval shall be limited to surveying and geological testing. Areas cleared for surveying and testing shall not exceed a width of fifteen (15) feet, and no trees with a diameter greater than eight inches (8") shall be removed.

(b) Clearing for the temporary storage of spoils or construction equipment shall be designated on the construction plans and shall be restored in accordance with the Erosion and Sedimentation Control Manual. The topsoil should be protected against erosion during and after the site grading operations. Where practical, the existing vegetation should be left in place.

(c) The length of time between roughcutting and final surfacing of roadways may not exceed eighteen (18) months. If an applicant does not meet this deadline, the Director of the Public Works Department shall notify him in writing that the City will complete the streets or revegetate the disturbed area at his expense unless he does so within sixty (60) days after the date of the notice.

(d) Roadway clearing width within a subdivision shall not exceed twice the roadway surface width or the width of the dedicated right-of-way, whichever is less. Right-of-way widths shall not be increased to provide additional clearing under this provision. Such roadway clearing width may be varied by the Director of the Office of Land Development Services where, in the Director's opinion, unusual topographic conditions necessitate such a variance. Clearing for

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short run road (300 feet or less) construction problem areas may be increased to two and one-half times the roadway width, right-of-way permitting. In cases where, due to slopes, clearing activities would normally result in cleared materials sliding onto areas beyond the clearing widths specified above, retaining walls or other methods shall be utilized to prevent such sliding.

SEC. 13-15-235. CUT AND FILL

(a) No fill on any lot or other land within the subdivision, except within roadway right-of-way, shall exceed a maximum of four (4) feet of depth. Fill placed under foundations with sides perpendicular to the ground, or with pier and beam construction, need not comply with this requirement, but must be placed in a manner consistent with Section 13-15-237. Backfill for utility construction or wastewater drainfields is also exempt from this provision.

(b) Except for structural excavation, no cut on any lot or other land within the subdivision, other than within roadway right-of-way, shall be greater than four (4) feet. For the purposes of this Subsection, structural excavation means excavation required for construction of building foundations consistent with Section 13-15-237, but shall not include cuts for private or public roads or driveways where structural side-slope stabilization (containment) is proposed. Cuts for utility installation or wastewater drainfield excavation are exempt from this provision, subject to restoration of such areas to natural grade.

(c) Cut and fill for roadways shall be contained within allowable roadway clearing widths.

(d) In all cases, slopes generated by cut and fill shall be stable, giving full consideration to soil characteristics and erosion potential. Techniques to be used are to be specified with the final plat. Slopes exceeding a 3 to 1 ratio, other than cuts which are determined to be stable, must be stabilized by permanent structural means (e.g., dry stack walls, terraces, exposed aggregate concrete walls, etc.), and approved by the Director of the Office of Land Development Services.

SEC. 13-15-236. SPOIL DISPOSAL

(a) Spoil disposal sites shall not be located within the one-hundred (100) year floodplain or on slopes greater than fifteen (15) percent gradient unless the Director of the Office of Land Development Services finds that a necessary public benefit is derived from the use of the spoil. Such benefits may include, but are not limited to:

1. Roadways.

2. Stormwater detention facilities, after consideration of reports from the Public Works Department and the Environmental Review Division of the Office of Land Development Services.

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3. Public or private park sites, after consideration of reports from the Environmental Review Division and the Parks and Recreation Department.

4. Building sites as per Section 13-15-235.

(b) Spoil disposal sites shall be located such that reasonable access to the site is available. Access routes shall utilize existing and approved roadways wherever possible and shall not be located within waterways except where no reasonable alternative is available, or when used to construct water quality and/or detention basins. Plans should address the restoration of such access roads and basins.

(c) Restoration and revegetation shall be carried out in conformance with the Erosion and Sedimentation Control Manual, with particular emphasis on the Section entitled "Standards for Land Grading".

SEC. 13-15-237. CONSTRUCTION ON SLOPES

(a) No roadways or driveways shall be constructed on slopes in excess of fifteen percent (15%) except where necessary to provide primary access to areas of flatter slopes, constituting a minimum of two (2) contiguous acres or building sites for at least five (5) residential units. Cuts and fills on roadways or driveways are to be restored as described herein.

(b) No building or parking areas shall be constructed on slopes in excess of fifteen percent (15%), provided, however, that buildings and parking structures may be located on slopes of 15% - 25% when the following criteria are met:

1. Impervious cover on 15-25% slopes shall not exceed ten percent (10%) of the total area of 15-25% slope.

2. Structures located upslope of slopes between 15% - 25% and not using terracing techniques shall be constructed utilizing pier and beam techniques. Fill shall be placed to blend with the natural contour. No vertical walls shall extend beyond the lowest finished floor elevation, other than necessary to screen mechanical appurtenances, and shall be stepped, if appropriate. Terraced fill and walls shall be a maximum 1 to 1 running grade limited to four (4) feet in height for each terrace. This Section shall not apply to single family and duplex construction.

3. Structures located downslope of slopes between 15-25% should be terraced and consolidated into the hillside. Structural excavation shall not exceed a maximum of eight (8) feet in depth, except by terracing. Areas of cut not hidden from view shall be effectively screened by additional landscaping.

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4. Hillside vegetation shall not be disturbed other than that necessary to locate the structure. All disturbed areas shall be restored with native vegetation.

5. If terraces are not provided, cuts and fills are to be restored to 3 to 1 slopes and revegetated. Restored slopes shall be limited to as short a length as possible.

SEC. 13-15-238. SEDIMENTATION AND FILTRATION BASINS

(a) Where required, water quality sedimentation-filtration or detention-sedimentation basins shall be situated and constructed to capture, isolate, and hold at least the first one-half (1/2) inch of runoff from all contributing areas and shall be shown on the slope map with details of construction.

(b) The basins and drainage into the basins shall be designed in accordance with the Department of Public Works' "Design Guidelines For Water Quality Control Basins" as approved by City Council after public hearing and as administratively approved from time to time.

(c) Water quality sedimentation-filtration basins shall not be required for greenbelts, open space, golf courses and other similar uses.

(d) Except as provided in Section 13-15-238(e), all basins located in the Edwards Aquifer Recharge Zone shall have impervious liners. The location of such basins and drainage to them shall avoid recharge features (faults, fractures, sinkholes, etc.) to the greatest extent possible.

(e) Basins in the Edwards Aquifer Recharge Zone which drain residential areas with up to 40% impervious cover may be designed to recharge the groundwater. Applicants shall identify any opportunities for such recharge on the plan submitted under Section 13-15-223. The recharge basins shall include sedimentation/filtration and shall be designed according to Public Works guidelines. Approval shall be by the Office of Land Development Services.

SEC. 13-15-239. CRITICAL ENVIRONMENTAL FEATURES

(a) Except as provided in Section 13-15-239(d) and (e), no construction other than for yards or hiking trails shall be undertaken within one hundred fifty (150) feet of a critical environmental feature, and the natural vegetative cover shall be retained in this buffer zone to the maximum practical extent. No clearing, alteration, or development of any kind shall be permitted within fifty (50) feet of a critical environmental feature, except hiking trails for educational purposes as designated by the Parks and Recreation Department. No residential

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lot shall encompass or be located closer than fifty (50) feet from a critical environmental feature. Wastewater disposal and irrigation areas shall never be located less than one hundred fifty (150) feet from a critical environmental feature.

(b) Drainage patterns shall be designed to protect critical environmental features from runoff from developed areas, or to maintain the catchment areas of recharge features in a natural state, (except as provided in Section 13-15-239 (d)), and special erosion controls shall be utilized where necessary to avoid impacts of erosion or sedimentation. Approved recharge basins, under Section 13-15-238(e) above, which discharge to point recharge features may be located within the setbacks required by this Section, but shall not be located less than fifty (50) feet from a critical environmental feature.

(c) Except as provided in Section 13-15-239 (e), point recharge features with topographically defined catchment basins extending beyond the setbacks required in Section 13-15-239 (a) shall have a construction setback coinciding with the limit of the upslope extent of the catchment, not to exceed a total of three hundred (300) feet.

(d) Except where prohibited or precluded by Section 13-15-239 (f), for recharge features with a catchment area of less than one and one-half (1.5) acres, the one hundred fifty (150) foot buffers required by Section 13-15-239 (a) may be reduced to the limits of the catchment, but shall not be reduced to less than fifty (50) feet from a critical environmental feature.

(e) Where buffer zones around recharge features and bluffs are proposed to be less than those required by (a) above, the burden of proof shall be on the applicant to demonstrate that : 1) the proposed measure(s) protect and preserve all characteristics of the feature which define it as a critical environmental feature; or 2) the feature is not a critical environmental feature as defined in Section 13-15-203. Provided however, that in no instance shall setbacks be less than fifty (50) feet from the critical environmental feature.

(f) No provision herein shall limit the applicant, the Chief Environmental Officer, or the Office of Land Development Services from recommending for Planning Commission approval additional or alternative measures necessary to protect characteristics of specific CEFs which may be unrelated directly to water quality protection.

SEC. 13-15-240. INNOVATIVE MANAGEMENT PRACTICES

Innovative runoff management practices designed to address the requirements of Sections 13-15-238 and 13-15-239 of this Article, enhance recharge of groundwater, and maintain the function of critical environmental features

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are encouraged. Innovative practice proposals shall be reviewed by the Department of Public Works and the Chief Environmental Officer and approved by the Director of the Office of Land Development Services.

Innovative practices shall be judged on technical merit, the degree to which they meet the intent of the ordinance in regard to water quality protection and improvement, resource protection and impact mitigation, the advantages over standard practices required by this ordinance and the anticipated maintenance requirements.

SEC. 13-15-241. WASTEWATER TREATMENT

Projects utilizing wastewater package treatment plants for sewage disposal are recommended to:

(a) In watersheds designated as "Water Supply Suburban" or "Water Supply Rural", obtain an irrigation (no-discharge) permit from the State meeting a minimum BOD/TSS treatment level of 10/15 mg/l or a minimum BOD/TSS/NH_3-N/PHOSPHORUS treatment level of 5/5/2/1 mg/l if irrigating land over the Edwards Aquifer Recharge Zone; or

(b) In watersheds not designated as per (a) above, obtain an irrigation (no-discharge) permit from the State meeting a minimum BOD/TSS treatment level of 10/15 mg/l or a minimum BOD/TSS/NH_3-N/PHOSPHORUS treatment level of 5/5/2/1 mg/l if discharging directly to a waterway other than the Colorado River or 10/15 mg/l if discharging directly to the Colorado River.

(c) If it is desired to deviate from the requirements in (b) above then the proposal must be accompanied by a comprehensive environmental assessment of the individual and cumulative impacts of the discharge on surface water and groundwater quality such that instream modeling studies performed by a professional engineer registered in the State of Texas with expertise in the water quality area indicates that baseline water quality will not be degraded below predevelopment conditions as a result of the proposed discharge.

SEC. 13-15-242. IMPERVIOUS COVER CALCULATIONS

(a) Impervious cover calculations shall include all roads, driveways, parking areas, buildings, decking, rooftop landscapes and other impermeable construction covering the natural land surface. Swimming pool surface water area for pools which discharge to the storm drainage system shall also be included. Sidewalk impervious cover is not included. Water quality and detention basins, swales, and other conveyances for drainage purposes only shall not be calculated as impervious cover.

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(b) Impervious cover credit shall not be given for permeable or interlocking pavers or for existing impervious cover; provided, however, that a maximum of twenty percent (20%) credit may be given when permeable pavers are approved by the Office of Land Development Services in accordance with Section 13-15-241 (Innovative Management Practices) for recharge enhancement purposes.

(c) For calculation purposes, impervious cover for one-family or duplex lots shall be assumed as follows:

Lot Area	Impervious Cover
1 acre or greater	5,000 sq. ft.
10,000 sq. ft. - 1 acre	3,000 sq. ft.
5,750 sq. ft. - 10,000 sq. ft.	2,500 sq. ft.
less than 5,750 sq. ft.	2,000 sq. ft.

(d) Impervious cover calculations shall include each roadway within a proposed development only up to a maximum pavement width of forty-four (44) feet. Requirements for detention, sedimentation, or filtration of runoff from such roadways are not affected by this provision.

(e) Development adjacent to roadways built as a City of Austin Capital Improvements Program project after the effective date of this ordinance shall include in its impervious cover calculations pavement width for the roadway up to a maximum of forty-four (44) feet and the associated right-of-way, or one-half the pavement width and right-of-way for roadways external to but adjacent to the development.

SEC. 13-15-243-245. RESERVED

DIVISION 5. ADDITIONAL STANDARDS FOR WATER SUPPLY WATERSHEDS

SEC. 13-15-246. COMPLIANCE

In addition to the requirements listed above, all development in watersheds designated as "Water Supply Suburban" and "Water Supply Rural" categories shall conform to the requirements in this Part.

SEC. 13-15-247. ROADWAYS

(a) In watersheds designated as Water Supply: Rural and Water Supply: Suburban Class I, street and right-of-way design for local and residential collector streets in the Critical Water Quality Zone and the Water Quality Buffer Zone must comply with the alternative urban street standards for streets without curbs and gutters set out in Division 2.1 of Article IV of the Subdivision Chapter, subject to the density limitations of that Division.

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(b) Commercial and industrial streets may be designed to maximize overland drainage through the use of frequent curb openings, roadside swales, or other means. Arterial streets shall be designed in accordance with the City of Austin's Roadway Plan.

(c) Roadways in the Upland Zone may utilize the alternative urban street standards set out in Division 2.1 of Article IV where consistent with transportation concerns, and the density limitations of Division 2.1.

(d) Street right-of-way width established under Section 13-3-83 of the Subdivision Chapter may be varied by the Planning Commission for areas located outside the City limits within the "Water Supply Rural" and "Water Supply Suburban" watersheds after the Commission has considered:

1. Reports from the Department of Urban Transportation and the Office of Land Development Services, in which the adequacy of proposed alternative widths have been assessed.

2. The applicant's written justification for the variance.

3. The applicant's preliminary plans of the streets proposed to be built under the proposed variance.

(e) The requirement for curbs and gutters in urban subdivisions may be waived by the Planning Commission after the Commission has considered reports from the Directors of the Department of Urban Transportation and the Office of Land Development Services, in which the adequacy of proposed alternatives to satisfying the needs for storm drainage, traffic safety and the general public welfare are assessed.

SEC. 13-15-248. DRIVEWAYS

(a) Every lot shall be reasonably accessible by vehicle from the roadway to the probable building site. For a minimum travel distance of twenty-five (25) feet from the right-of-way edge, the driveway grade may exceed fourteen (14) percent only with specific approval of surface and geometric design proposals by the Urban Transportation Department and the Office of Land Development Services. This required specific approval shall be so noted on the subdivision plat with approval to be obtained when specific driveway plans are submitted by the builder.

(b) A joint-use driveway may be utilized to access up to eight (8) residential units, as an alternative to a public or private street. For joint-use driveways, paving width shall be no less than twenty (20) feet. Such driveways may utilize a design speed no lower than ten (10) mph. The Director of the Office of Land Development Services

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shall consider recommendations from the Urban Transportation Department on driveway grades and length for each site prior to approving a joint-use driveway. The use of joint-use driveways does not eliminate the requirements of adequate road frontage for each lot. The joint use driveways shall be shown on the preliminary plan. A note shall be placed on the final plat indicating the lots utilizing the joint use driveways for access and prohibiting access to such lots except by way of the joint use driveways.

SEC. 13-15-249. OVERLAND FLOW

(a) Drainage patterns should be designed to prevent erosion, maintain infiltration and recharge of local seeps and springs, and attenuate the harm of contaminants collected and transported by stormwater. Overland sheet flow and natural drainage features and patterns shall be maintained whenever possible and the dispersion of runoff back to sheet flow shall be a primary objective of drainage design where possible, depending on volumes and velocities of runoff for the subdivision, as opposed to concentrating flows in storm sewers and drainage ditches.

(b) Construction of enclosed storm sewers and impervious channel linings are permitted only when the Director of the Office of Land Development Services, on the basis of competent engineering evidence, concludes that such storm sewers or impervious linings are the preferred option.

(c) If storm sewers are deemed necessary as specified in (b) above, an applicant shall design his/her drainage system to mitigate its harmful impact on water quality by using structural devices or other methods to prevent erosion and dissipate discharges from outlets wherever practicable, and by locating discharges to maximize overland flow through buffer zones or grass-lined swales.

SEC. 13-15-250. WASTEWATER RESTRICTIONS

(a) Sewer lines shall not be located in Critical Water Quality Zones other than for necessary crossings, except upon approval of a variance from this Section by the Planning Commission which shall be considered pursuant to an environmental assessment and the applicant evaluating the environmental impacts of alternative sewer alignments. At the request of the Environmental Review Division of the Office of Land Development Services, the applicant shall examine and evaluate alternative alignments prior to the Planning Commission hearing on the variance request. In the event it is concluded that the wastewater line should be in the Critical Water Quality Zone, it shall be located outside the two (2) year floodplain except as consistent with regulations adopted by the City Council.

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(b) Unsewered lots overlying the Edwards Aquifer Recharge Zone shall use alternative sewage disposal systems which utilize final effluent disposal other than conventional soil absorption drainfields, and shall be installed in accordance with this Article and Chapter 6-5 of the City Code.

(c) Residential lots utilizing on-site wastewater disposal systems shall be at least one (1) acre in size and shall have at least one half (1/2) acre of contiguous land with slope of less than fifteen (15) percent gradient or have at least three quarters (3/4) of an acre of contiguous land with less than twenty-five (25) percent gradient; provided, however, that such systems shall not be located within the Critical Water Quality Zone.

(d) All construction of sewer systems within the Edwards Aquifer Recharge Zone shall comply with the special construction standards of Section VII-B of the City of Austin manual, Standard Specifications for Water and Wastewater Utility Construction.

(e) Projects utilizing wastewater treatment by land application shall have at least eight thousand (8,000) square feet of irrigated land per living unit equivalent (L.U.E.), as defined by the City of Austin Water and Wastewater Department or at least seven thousand (7,000) square feet of irrigated land per living unit equivalent (L.U.E.) and six (6) inches of topsoil. No irrigation shall be allowed on slopes of greater than fifteen (15) percent gradient or in the Critical Water Quality Zone or one hundred (100) year floodplain. Package treatment plants shall have at least one hundred (100) days of storage capacity available in the event of wet weather conditions or plant failure. All such systems shall provide for forty-eight (48) hours of storage capacity if utilizing subsurface effluent disposal. No irrigation shall take place during wet weather conditions.

(f) Commercial development must locate all disposal areas outside of the 40% buffer zone as required in Section 13-15-285(b)(2).

SEC. 13-15-251. BLASTING

(a) Blasting on property located directly over the Edwards Aquifer Recharge Zone is limited to areas outside of the Critical Water Quality Zone and Water Quality Buffer Zone, unless the applicant demonstrates that no feasible alternative exists.

(b) Blasting is prohibited within three hundred feet (300') of any Critical Environmental Feature, as defined in Section 13-15-203, unless the applicant demonstrates that no feasible alternative exists.

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SEC. 13-15-252. INDUSTRIAL USES

(a) An applicant proposing any industrial use, as defined in the City of Austin Zoning Code (Ch. 13-2A), and which is not completely enclosed within a building or buildings, must provide a pollutant attenuation plan which:

1. Proposes methods to capture the first one-half (1/2) inch of runoff from developed areas to contain and filter pollutants generated on-site as specified in Section 13-15-238 of this Chapter.

2. Retains dust and other particulate matter on-site, to the greatest extent feasible.

(b) The design of storage facilities for hydrocarbon or hazardous substances, including leak detection systems, spill containment areas, or other control measures shall meet the requirements as set out in 9-10-530, (Hazardous Materials Ordinance).

SEC. 13-15-253.-260. RESERVED

DIVISION 6. SUBURBAN WATERSHEDS - MAXIMUM DEVELOPMENT INTENSITY

SEC. 13-15-261. COMPLIANCE

All development located in watersheds designated herein as "Suburban" must comply with the provisions of this Division, which are summarized in Table 1 (Exhibit "B", which is incorporated herein by reference).

SEC. 13-15-262. WATERWAY DEFINITIONS

Minor, intermediate, and major waterways shall be designated for any channel, creek, stream, branch or watercourse according to drainage area as follows:

Waterway	Drainage Area
Minor	320 acres - 640 acres
Intermediate	640 acres - 1280 acres
Major	over 1280 acres

SEC. 13-15-263. CRITICAL WATER QUALITY ZONE

The critical water quality zone shall remain free of all development activity, except as provided for by Section 13-15-232 of this Article.

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SEC. 13-15-264. WATER QUALITY BUFFER ZONE

(a) Water quality buffer zones shall be established parallel to all critical water quality zones, except for minor waterways and along the shoreline of Town Lake, and shall extend from the outer boundaries of the critical water quality zone for one hundred and fifty feet (150') along major waterways and one hundred feet (100') along intermediate waterways.

(b) The projected impervious cover in any development or portion thereof that lies within the water quality buffer zone shall not exceed thirty (30) percent of the land area of the zone, exclusive of land within a one hundred year floodplain.

(c) Detention/sedimentation and sedimentation/filtration basins may be located in the water quality buffer zone.

13-15-265. UPLANDS ZONE

(a) The projected impervious cover for all one-family residential development of land in the uplands zone with minimum lot sizes of 5,750 square feet or more shall not exceed fifty (50) percent of the net site area, or sixty (60) percent if transfers of development intensity are made in accordance with Section 13-15-266 herein.

(b) The projected impervious cover for all one-family and two-family residential development of land in the uplands zone, other than those subject to (a) above, shall not exceed fifty-five (55) percent of the net site area, or sixty (60) percent if transfers of development intensity are made in accordance with Section 13-15-266 herein.

(c) The projected impervious cover for multi-family residential development of land in the uplands zone shall not exceed sixty (60) percent of the net site area, or seventy (70) percent if transfers of development intensity are made in accordance with Section 13-15-266 herein.

(d) The projected impervious cover for commercial development of land in the uplands zone shall not exceed eighty (80) percent of the net site area, or ninety (90) percent if transfers of development intensity are made in accordance with Section 13-15-266 herein.

SEC. 13-15-266. TRANSFER OF DEVELOPMENT INTENSITY

(a) For every one acre of land in the critical water quality zone which is dedicated to the City in fee simple and the gift is approved by the City, the applicant is entitled to an additional twenty thousand (20,000) square feet of impervious cover on lands in the uplands zone. Dedication of land under this section may be credited toward satisfaction of the requirements of the Parkland Dedication Ordinance in accordance with regulations adopted by the City Council.

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(b) For every one acre of land in the water quality buffer zone which is left undeveloped and undisturbed and is not included in impervious cover calculations elsewhere, the applicant is entitled to an additional twenty thousand (20,000) square feet of impervious cover on lands in the uplands zone.

(c) For every one acre of land in the uplands zone which is located within a buffer of a Critical Environmental Feature and which is left natural and undisturbed, the applicant is entitled to an additional twenty thousand (20,000) square feet of impervious cover on lands elsewhere in the uplands. Such buffer area may also be included in the net site area calculations for the upland zone.

(d) Eighty-five (85) percent of the transfer credit in (b) is permitted for golf courses and other recreational uses which are restored using predominantly native plants and grasses and which provide a plan for minimizing the use and impact of pesticides, herbicides and fertilizers. Fifty (50) percent of the transfer credit is permitted for land used for wastewater disposal.

(e) For every one acre of land in the uplands zone which is utilized for wastewater irrigation; is legally restricted against any future development, and leaves the irrigation area in a natural state (other than for necessary irrigation lines and tailwater control berms), the applicant is entitled to an additional twenty thousand (20,000) square feet of impervious cover elsewhere in the uplands zone.

(f) Development intensity may not be transferred to a receiving tract whose boundary is beyond a one-mile radius from the transferring tract unless the tracts are either contiguous and under single ownership or are not separated by and owned by someone other than the applicant.

(g) Development intensity rights may not be transferred unless the transferring tract is platted concurrently with the receiving tract and all rights are transferred from the transferring tract at that time.

(h) An applicant transferring development intensity must note the transfer on the plats of both the transferring and receiving tracts, in a manner satisfactory to the Director of Land Development Services, and must file in the deed records a restrictive covenant, approved by the City Attorney, that runs with the transferring tract.

SEC. 13-15-267. STRUCTURAL CONTROLS

(a) Sedimentation/filtration basins shall be required to serve all commercial and multi-family development with impervious cover in excess of twenty (20) percent of the net site area.

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(b) Detention/sedimentation or retention/sedimentation basins shall be required for all other residential development with impervious cover in excess of twenty (20) percent of the net site area.

(c) Sedimentation/filtration [and detention/sedimentation] basins shall be designed in accordance with the provisions of Section 13-15-238.

SEC. 13-15-268.-270. RESERVED

DIVISION 7. WATER SUPPLY SUBURBAN WATERSHEDS - MAXIMUM DEVELOPMENT INTENSITY

SEC. 13-15-271. COMPLIANCE

All development located in watersheds designated herein as "Water Supply Suburban" must comply with the provisions of this Division which are summarized in Table 1 (Exhibit "B", which is incorporated herein by reference), according to the following subcategories:

(a) Class I: Bull, West Bull, Dry (North), Dry (West), Taylor Slough, other Lake Austin (east side from Tom Miller Dam to Bull Creek), Town Lake (north side from Johnson Creek to Tom Miller Dam), Town Lake (south side from Barton Creek to Tom Miller Dam), Barton Creek (east of Barton Creek and north of Loop 360), and that portion of the Slaughter Creek watershed (downstream of FM 1826) which is located in the Edwards Aquifer Recharge or Contributing Zones.

(b) Class II: That portion of the Williamson Creek watershed which is located in the Edwards Aquifer Recharge or Contributing Zones.

(c) Class III: Those portions of the Lake, Rattan, Buttercup, and Brushy Creek watersheds which are located in the Edwards Aquifer Recharge or Contributing Zones.

SEC. 13-15-272. WATERWAY DEFINITIONS

Minor, intermediate and major waterways shall be designated for any channel, creek, stream, branch, or watercourse according to Class I, II, or III designation and drainage area as follows:

	Drainage Area (acres)		
Waterway	Class I	Class II	Class III
Minor	128-320	128-320	320-640
Intermediate	320-640	320-640	640-1280
Major	over 640	over 640	over 1280

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SEC. 13-15-273. CRITICAL WATER QUALITY ZONE

The critical water quality zone shall remain free of all development activity, except as provided for by Section 13-15-232 of this Article.

SEC. 13-15-274. WATER QUALITY BUFFER ZONE

(a) Water quality buffer zones shall be established parallel to all critical water quality zones, except along the shorelines of Lake Austin and Town Lake, and shall extend from the outer boundaries of the critical water quality zone for three hundred feet (300') along major waterways, two hundred feet (200') along intermediate waterways, and one hundred feet (100') along minor waterways.

(b) No development other than that permitted in the Critical Water Quality Zone is permitted in the water quality buffer zone where such zone lies over the South Edwards Aquifer Recharge Zone.

(c) Except as restricted by (b), the projected impervious cover in any development or portion thereof that lies within the water quality buffer zone shall not exceed the following maximums within the zone, exclusive of land within a one hundred year floodplain:

	Class I	Class II	Class III
Impervious Cover:	18%	30%	30%

(d) No detention and/or sedimentation/filtration basins which serve development in the uplands zone shall be permitted in the water quality buffer zone; provided, however, that sedimentation/filtration basins to serve that portion of any development located in the buffer zone shall be permitted in the buffer zone, and that the Director of the Office of Land Development Services may administratively vary the requirement where it is determined that locating a pond in the buffer minimizes environmental impact.

SEC. 13-15-275. UPLANDS ZONE

(a) The projected impervious cover for all one-family residential development of land in the uplands zone with minimum lot sizes of 5,750 square feet or more shall not exceed the maximums specified below based on the net site area, or the maximums specified if transfers of development intensity are made in accordance with Section 13-15-276 herein:

	Class I	Class II	Class III
Impervious Cover	30%	40%	45%
With Transfer	40%	55%	50%

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(b) The projected impervious cover for all one-family and two-family residential development of land in the uplands zone, other than those subject to (a) above, shall not exceed the maximums specified below based on the net site area, or the maximums specified if transfers of development intensity are made in accordance with Section 13-15-276 herein:

	Class I	Class II	Class III
Impervious Cover	30%	40%	55%
With Transfer	40%	55%	60%

(c) The projected impervious cover for multi-family residential development of land in the uplands zone shall not exceed the maximums specified below based on the net site area, or the maximums specified if transfers are made in accordance with Section 13-15-276 herein:

	Class I	Class II	Class III
Impervious Cover	40%	60%	60%
With Transfer	55%	65%	65%

(d) Except as provided by Subsections (e) and (f) below, the projected impervious cover for commercial development of land in the uplands zone shall not exceed the maximums specified below based on the net site area, or the maximums specified if transfers are made in accordance with Section 13-15-276 herein:

	Class I	Class II	Class III
Impervious Cover	40%	60%	65%
With Transfer	55%	70%	70%

(e) Notwithstanding (d) above, the projected impervious cover for retail commercial development in Class I watersheds shall not exceed fifty (50) percent of the net site area, or sixty (60) percent if transfers of development intensity are made in accordance with Section 13-15-276 herein, for all land within one thousand feet (1000') of the right-of-way of two intersecting roadways, each designated as a Major Arterial, Parkway, Expressway, or Freeway in the Austin Metropolitan Area Roadway Plan, as in effect on January 1, 1986 where at least one of the roadways is designated a Parkway, Expressway, or Freeway, limited, however, to intersections which are located within the City limits of the City of Austin or which are annexed thereto at a later date or which request limited or full purpose annexation at the time for final plat approval.

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(f) Notwithstanding (d) above, the projected impervious cover for retail commercial development in Class I watersheds shall not exceed sixty (60) percent of the net site area, or seventy (70) percent if transfers of development intensity are made in accordance with Section 13-15-276 herein, for all land within one thousand five hundred feet (1500') of the right-of-way of two intersecting roadways maintained by the State, where such intersections are located within the City limits of the City of Austin or are annexed thereto at a later date or which request limited or full purpose annexation at the time of final plat approval.

(g) The distances specified from the above intersections are intended to create 1000 foot squares at each corner under (e) and 1500 foot squares at each corner under (f), for impervious cover calculations purposes.

(h) Impervious cover allowances for development subject to (e) and (f) above shall be pro-rated according to retail, other commercial, or residential land uses within those areas when mixed-use development is proposed.

(i) Nothing herein limits the authority of the City Council in the zoning process to limit impervious cover below the maximum specified for tracts determined by the Council to be particularly sensitive environmentally, including but not limited to, having a critical water quality zone or critical environmental feature on or near the site.

SEC. 13-15-276. TRANSFER OF DEVELOPMENT INTENSITY

(a) Except as limited in (c), for every one acre of land in the critical water quality zone which is dedicated to the City or another in fee simple and the gift is approved by the City, the applicant is entitled to additional impervious cover on lands in the uplands zone as follows:

	Class I	Class II	Class III
Impervious Cover (Sq. Ft.)	15,000	20,000	20,000

Dedication of land under this section may be credited toward satisfaction of the requirements of the Parkland Dedication Ordinance in accordance with regulations adopted by the City Council.

(b) Except as limited in (c) and (d), for every one acre of land in the water quality buffer zone which is left undeveloped and undisturbed and is not included in impervious cover calculations elsewhere, the applicant is entitled to additional impervious cover on lands in the uplands zone as follows:

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	Class I	Class II	Class III
Impervious Cover (Sq. Ft.)	15,000	20,000	20,000

(c) Only one-half of the above transfer credit is permitted for land which lies over the South Edwards Aquifer Recharge Zone.

(d) Eighty-five (85) percent of the transfer credit in (b) is permitted for golf courses and other recreational uses which are restored using predominantly native plants and grasses and which provide a plan for minimizing the use of pesticides, herbicides, and fertilizers. Fifty (50) percent of the transfer credit is permitted for land used for wastewater disposal.

(e) For every one acre of land in the uplands zone which is located within a buffer of a Critical Environmental Feature and which is left natural and undisturbed, the applicant is entitled, in addition to net site area calculations for that land, to additional impervious cover on lands elsewhere in the uplands zone as follows:

	Class I	Class II	Class III
Impervious Cover (Sq. Ft.)	15,000	20,000	20,000

(f) For every one acre of land in the uplands zone which is utilized for wastewater irrigation, is legally restricted against any future development, and leaves the area in a natural state (other than for necessary irrigation lines and tailwater control berms), the applicant is entitled to additional impervious cover elsewhere in the uplands zone as follows:

	Class I	Class II	Class III
Impervious Cover (Sq. Ft.)	15,000	20,000	20,000

(g) Development intensity may not be transferred to a receiving tract whose boundary is beyond a one-mile radius from the transferring tract unless the tracts are either contiguous and under single ownership or are not separated by and owned by someone other than the applicant.

(h) Development intensity rights may not be transferred unless the transferring tract is platted concurrently with the receiving tract and all rights are transferred from the transferring tract at that time.

(i) An applicant transferring development intensity must note the transfer on the plats of both the transferring and receiving tracts, in a manner satisfactory to the Director of Land Development Services, and must file in the deed records a restrictive covenant, approved by the City Attorney, that runs with the transferring tract.

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SEC. 13-15-277. STRUCTURAL CONTROLS

(a) Sedimentation/filtration basins shall be required to serve all development with impervious cover in excess of twenty (20) percent of the net site area.

(b) Sedimentation/filtration and detention/sedimentation basins shall be designed in accordance with the provisions of Section 13-15-238.

SEC. 13-15-278.-280. RESERVED

DIVISION 8. WATER SUPPLY RURAL WATERSHEDS - MAXIMUM DEVELOPMENT INTENSITY

SEC. 13-15-281. COMPLIANCE

All development located in watersheds designated herein as "Water Supply Rural" must comply with the provisions of this Division, which are summarized in Table 1 (Exhibit "B", which is incorporated by reference herein).

SEC. 13-15-282. WATERWAY DEFINITIONS

Minor, intermediate, and major waterways shall be designated for any channel, creek, stream, branch, or watercourse according to drainage area as follows:

Waterway	Drainage Area
Minor	64 acres - 320 acres
Intermediate	320 acres - 640 acres
Major	over 640 acres

SEC. 13-15-283. CRITICAL WATER QUALITY ZONE

The critical water quality zone shall remain free of all development activity, except as provided for by Section 13-15-232 of this Article.

SEC. 13-15-284. WATER QUALITY BUFFER ZONE

(a) Water quality buffer zones shall be established parallel to all critical water quality zones, except along Lake Austin and Lake Travis, and shall extend from the outer boundaries of the critical water quality zone for three hundred feet (300') along major waterways, two hundred feet (200') along intermediate waterways, and one hundred feet (100') along minor waterways.

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(b) No development other than that permitted in the Critical Water Quality Zone is permitted in the water quality buffer zone where such zone lies over the South Edwards Aquifer Recharge Zone.

(c) Except as restricted by (a), development in the water quality buffer zone is limited to:

1. Development authorized in the critical water quality zone;

2. Streets;

3. Drainage facilities;

4. Public and private parks and open space; and,

5. One and two-family residential housing units developed at an average density of one unit or less for every three (3) acres, exclusive of land within a one hundred year floodplain, with a minimum lot size of two (2) acres.

(d) Each lot or part of a lot located in both the water quality buffer zone and the critical water quality zone must have at least two (2) acres in the water quality buffer zone.

(e) No detention and/or sedimentation/filtration basins shall be permitted in the water quality buffer zone.

SEC. 13-15-285. UPLANDS ZONE

(a) Residential development in the uplands zone is limited to:

1. One and two-family residential housing units at an average density of one unit or less for every two (2) acres of net site area, with a minimum lot size of three-quarter acre, or up to one unit or less for every acre with a minimum lot size of one-half acre if transfers of development intensity are made in accordance with Section 13-15-286 herein.

2. Cluster housing at an average density of one (1) unit or less for each one (1) acre of net site area, or up to two (2) units per acre if transfers of development intensity are made in accordance with Section 13-15-286. Developments in watersheds other than Lake Austin or Lake Travis shall leave, or restore if necessary, at least forty percent (40%) (all in the uplands zone) of his/her proposed cluster housing site in or to its natural state and shall leave it in that state to serve as a buffer located contiguous to the development for the purpose of receiving overland drainage.

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(b) Commercial development in the uplands zone is permitted, if:

1. Except as provided by Subsections (c), (d), and (e) below, the proposed impervious cover on the commercial site does not exceed twenty (20) percent of the net site area, or up to twenty five (25) percent if transfers of development intensity are made in accordance with Section 13-15-286 herein; and

2. Upon completion of development the applicant leaves or restores if necessary, at least forty (40) percent (all in the uplands zone) of his/her proposed commercial site in or to its natural state and leaves it in that state to serve as a buffer located contiguous to the development to receive runoff from the development for the purposes of overland drainage.

(c) Where commercial or multi-family development is either zoned appropriately by the City of Austin, is designated for such use by the City's Comprehensive Plan, is designated as such by a Municipal Utility District land plan which is part of an approved consent agreement with the City, or constitutes a maximum of five (5) percent of a subdivision with the remainder restricted to other residential or open space uses, impervious cover shall not exceed forty (40) percent of the net site area in the uplands zone, or up to fifty (50) percent if transfers of development intensity are made in accordance with Section 13-15-286 herein, and subject to the forty (40) percent buffer zone requirement of (b)(2) above.

(d) Notwithstanding (b) and (c) above, the projected impervious cover for retail commercial development shall not exceed fifty (50) percent of the net site area, or sixty (60) percent if transfers of development intensity are made in accordance with Section 13-15-286 herein, for all land within one thousand feet (1000') of the right-of-way of two intersecting roadways, each designated as a Major Arterial, Parkway, Expressway, or Freeway in the Austin Metropolitan Area Roadway Plan, as in effect on January 1, 1986, where at least one of the roadways is designated a Parkway, Expressway, or Freeway, limited, however, to intersections which are located within the City limits of the City of Austin or which are annexed thereto at a later date or which request is limited or full purpose annexation at the time of final plat approval.

(e) Notwithstanding (b) and (c) above, the projected impervious cover for retail commercial development shall not exceed sixty (60) percent of the net site area, or seventy (70) percent if transfers of development intensity are made in accordance with Section 13-15-286 herein, for all land within one thousand five hundred feet (1500') of the right-of-way of two intersecting roadways, maintained by the State, where such intersections are located within the City limits of the City of Austin or are annexed thereto at a later date or which request limited or full purpose annexation at the time of final plat approval.

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(f) The distances specified from the above intersections are intended to create 1000 foot squares at each corner under (d) and 1500 foot squares at each corner under (e), for impervious cover calculation purposes.

(g) Impervious cover allowances for development subject to (d) and (e) above shall be pro-rated according to retail, other commercial, and residential land uses within those areas when mixed-use development is proposed.

(h) Nothing herein limits the authority of the City Council in the zoning process to limit impervious cover below the maximum specified for tracts determined by the Council to be particularly sensitive environmentally, including but not limited to having a critical water quality zone or critical environmental feature on or near the site.

(i) Development subject to (d) and (e) above is exempt from the forty percent buffer requirement for commercial development, but must provide filtration as per Section 13-15-287(b).

(j) Development or related activity necessitating restoration to the natural state is authorized in the forty (40) percent buffer zones above only for fences, utilities which cannot reasonably be located elsewhere, irrigation lines other than when associated with wastewater disposal, and access for these purposes and to the building site and clearing necessary for these purposes.

SEC. 13-15-286. TRANSFER OF DEVELOPMENT INTENSITY

(a) Except as limited by (c) and (d) below, for every one acre of land in the critical water quality zone or water quality buffer zone which is dedicated to the City or another in fee simple and the gift is approved by the City, the applicant is entitled to an additional one (1) one-family residential housing unit or to an additional six thousand (6,000) square feet of impervious cover for commercial or multi-family residential development in the uplands zone. Dedication of land under this section may be credited toward satisfaction of the requirements of the Parkland Dedication Ordinance in accordance with regulations adopted by the City Council.

(b) Except as limited by (c) and (d) below, for every one acre of land in the water quality buffer zone which is left undeveloped and undisturbed and is not included in density calculations elsewhere, the applicant is entitled to an additional one (1) one-family residential housing unit or to an additional six thousand (6,000) square feet of impervious cover for commercial or multi-family residential development in the uplands zone. Parkland gifts in (a) are counted separate from this provision and the transfers are cumulative.

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(c) Only one-half of the above transfer credits are permitted for water quality buffer zone land which lies over the South Edwards Aquifer Recharge Zone.

(d) Eighty-five (85) percent of the transfer credits for water quality buffer zone land is permitted for golf courses and other recreational uses which are restored using predominantly native plants and grasses and which provide a plan for minimizing the use of pesticides, herbicides, and fertilizers. Fifty (50) percent of the transfer credit is permitted for land used for wastewater disposal, if within the water quality buffer zone.

(e) For every one acre of land in the uplands zone which is located within a buffer of a Critical Environmental Feature and which is left natural and undisturbed, the applicant is entitled, in addition to net site area calculations for that land, to an additional one (1) one-family residential housing unit or to an additional six thousand (6,000) square feet of impervious cover for commercial or multi-family residential development elsewhere in the uplands zone.

(f) For every one (1) acre of land in the uplands zone which is utilized for wastewater irrigation, is legally restricted against any future development, and leaves the irrigation area in a natural state (other than for necessary irrigation lines and tailwater control berms), the applicant is entitled to an additional one (1) one-family residential housing unit or to an additional six thousand (6,000) square feet of impervious cover for commercial or multi-family residential development elsewhere in the uplands zone.

(g) Development intensity may not be transferred to a receiving tract whose boundary is beyond a one-mile radius from the transferring tract unless the tracts are either contiguous and under single ownership or are not separated by and owned by someone other than the applicant.

(h) Development intensity rights may not be transferred unless the transferring tract is platted concurrently with the receiving tract and all rights are transferred from the transferring tract at that time.

(i) An applicant transferring development intensity must note the transfer on the plats of both the transferring and receiving tracts, in a manner satisfactory to the Director of Land Development Services, and must file in the deed records a restrictive covenant, approved by the City Attorney, that runs with the transferring tract.

SEC. 13-15-287. STRUCTURAL CONTROLS

(a) Except as required by Subsection (c) for one-family and two-family residential development in the Lake Austin and Lake Travis watersheds,

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sedimentation/filtration basins shall be required to serve all residential and commercial development elsewhere in the Water Supply Rural Watersheds if the net site area contains more than 20 percent impervious cover; and either

1. There is less than 75 percent vegetative cover in the 40 percent buffer zone; or

2. More than 50 percent of the land in the 40 percent buffer zone has slopes in excess of 15 percent.

(b) Sedimentation/filtration basins shall be required to serve all commercial development if the net site area contains more than forty (40) percent impervious cover.

(c) Sedimentation/filtration basins shall be required to serve all one-family and two-family residential development in the Lake Austin and Lake Travis watersheds if the net site area contains more than 20 percent impervious cover.

(d) If structural controls are required by Subsection (a), an applicant may locate them in the 40 percent buffer zone if they are located to maximize overland flow and recharge in the undisturbed remainder of the 40 percent buffer zone.

(e) Sedimentation/filtration basins shall be designed in accordance with the provisions of Section 13-15-238.

SEC. 13-15-288.-290. RESERVED

PART 2. That Section 13-3-3 (Subdivisions) of the Austin City Code of 1981 is hereby amended to read as follows:

SEC. 13-3-3. COMPLIANCE REQUIRED.

No person shall create a subdivision of land within the City limits or within its extra-territorial jurisdiction without complying with the provisions of this Chapter. All plats and subdivisions of any such land shall conform to the rules and regulations set forth in this Chapter and to the provisions of Chapter 13-15, Article II (Comprehensive Watersheds Ordinance).

PART 3. That Division 1 of Article V (Special Requirements for Site Development and Use in Water Quality Related Environmentally Sensitive Areas) of Chapter 9-10 of the Austin City Code of 1981 is hereby amended to read as follows:

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SEC. 9-10-161. SITE DEVELOPMENT PERMIT REQUIRED

No development shall be undertaken on any land, tract, parcel, or lot within the City limits or within its extra-territorial jurisdiction until a site development permit for said development has been obtained by the owner of said property from the Director of the Office of Land Development Services. This requirement shall not apply to any single-family or duplex residential structures or appurtenances thereto where one such structure is built per legal lot. No waterway development permit is required where a site development permit has been issued within the City limits, such site development permit has become effective and where all requirements of Article IV, Division 2 of Chapter 9-10 are met.

SEC. 9-10-162. COMPLIANCE REQUIRED

All development of land governed by this Article shall conform to the rules and regulations set forth in this Chapter and to the provisions of Chapter 13-15, Article II (Comprehensive Watersheds Ordinance).

SEC. 9-10-163. APPLICATION

(a) Application for a site development permit shall be submitted to the Director of the Office of Land Development Services and shall be accompanied by a site development plan.

(b) The Director of the Office of Land Development Services shall design and administer a system, including necessary forms, that coordinates the requirements of this Article and Division and the rest of this Chapter, minimizes duplication of requirements and conflict between them, and facilitates the expeditious processing of site development applications.

SEC. 9-10-164. FEES

Applications for permits required by the provisions of this Article shall be accepted only upon payment of the appropriate fees as established by ordinance.

9-10-165. ADVERTISING APPLICATION

(a) Within two (2) days of the filing of any application for a site development permit, the City shall place signs on property under application for the purposes of advertising said permit. The signs shall meet the following requirements:

1. Each sign shall be no smaller than eighteen (18) inches by thirty (30) inches;

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2. Each sign shall include the words "Proposed Site Development Permit," plus such other information as may be determined necessary by the Director of the Office of Land Development Services.

(b) Signs placed on the property involved must be within ten (10) feet of any property line paralleling any established or proposed street and must be visible from that street.

(c) All required signs shall remain on the property until final disposition of the permit request is determined.

SEC. 9-10-166. ISSUANCE

(a) A site development permit not denied or disapproved by the Director of the Office of Land Development Services within twenty (20) days following the date of application therefore shall issue automatically to the applicant.

(b) If the Director of the Office of Land Development Services denies the permit or disapproves it pending receipt of additional information, he shall notify the applicant in writing via certified mail. His/her letter to the applicant shall be accompanied by a detailed statement of the reasons for such action, which reasons must be based on standards contained herein.

(c) The permit shall be effective ten (10) days after issuance unless an appeal is filed.

SEC. 9-10-167-170. RESERVED

PART 4. That the provisions of Chapter 9-10, Article V (Special Requirements for Site Development and Use in Water Quality Related Environmentally Sensitive Areas), Divisions 2 through 5; Chapter 13-3, Article VII (Special Requirements for Subdivisions in Environmentally Sensitive Areas); Secs. 13-3-116 through 13-3-126 (Lake Austin Watershed); Section 13-3-5.1 (Special Requirements for Lake Austin Peninsula); and Ordinance No. 840308-k (Lake Travis Watershed) are hereby superseded by this ordinance for all projects subject to its provisions.

PART 5. This ordinance shall be reviewed by the City Council no later than two (2) years after its effective date.

PART 6. If any provision, section, sentence, clause, or phrase of this ordinance, or the application of same to any person or set of circumstances, is for any reason held to be unconstitutional, void, or invalid (or is for any reason unenforceable), the validity of the remaining portions of this ordinance or its application to other

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persons or sets of circumstances shall not be affected thereby, it being the intent of the City Council of the City of Austin adopting, and of the Mayor in approving this ordinance, that no portion hereof or provision or regulation contained herein shall become inoperative or fail by reason of any unconstitutionality or invalidity of any other portion, provision, or regulation.

PART 7. This ordinance shall become effective ten (10) days following the date of its passage as provided by the City Charter of the City of Austin.

PASSED AND APPROVED

May 8, 1986

Frank C. Cooksey
Mayor

APPROVED: Paul C. Isham
City Attorney

ATTEST: Betty G. Brown
Betty G. Brown
Deputy City Clerk

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EXHIBIT B
TABLE I
MAXIMUM DEVELOPMENT INTENSITY

Watershed Category	Waterways: Minor	Waterways: Inter.	Waterways: Major	Critical Water Quality Zone	Water Quality Buffer Zone	Uplands Zone*		W/Transfer	Other
1. Suburban									
Drainage Area	320 ac	640 ac	1280 ac	No Development	30% impervious cover	Resid:	50% imp.	60%	Sedimentation
Buffer Zone	None	100 ft.	150 ft.			Dup/SL:	55% imp.	60%	Sedimentation
						MF:	60% imp.	70%	Filtration
						Comm:	80% imp.	90%	Filtration
2. Water-Supply Suburban									
a) Class I									
Drainage Area	128 ac.	320 ac.	640 ac.	No Development	18% impervious cover; no development over Recharge Zone	Resid:	30% imp.	40%	Filtration
Buffer Zone	100 ft.	200 ft.	300 ft.			MF:	40% imp.	55%	Filtration
						Comm:	40% imp.	55%	Filtration
b) Class II (Williamson)									
Drainage Area	128 ac	320 ac	640 ac	No Development	30% impervious cover; no development over Recharge Zone	Resid	40% imp.	55%	Filtration
Buffer Zone	100 ft	200 ft	300 ft			MF:	60% imp.	65%	Filtration
						Comm:	60% imp.	70%	Filtration
c) Class III (North Edwards)									
Drainage Area	320 ac	640 ac	1280 ac	No Development	30% impervious cover	SF:	45% imp.	50%	Filtration
Buffer Zone	100 ft	200 ft	300 ft			Dup/SL:	55% imp.	60%	Filtration
						MF:	60% imp.	65%	Filtration
						Comm:	65% imp.	70%	Filtration
3. Water-Supply Rural									
Drainage Area	64 ac	320 ac	640 ac	No Development	1 unit per 3 acres; no development over Recharge Zone	SF:	0.5 upa	1.0 upa	-
Buffer Zone	100 ft	200 ft	300 ft			Cluster:	1.0 upa	2.0 upa	40% Buffer**
						MF/Comm:	20% imp.	25%	40% Buffer
						Planned:	40% imp.	50%	40% Buffer
						***Retail:	50-60%	60-70%	Filtration

* Net site area

** opt in Lake Austin/Lake Travis; filtration requir

*** at major intersections

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BACKGROUND MATERIALS

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7. Alternative Street Standards - develop roadway standards which minimize environmental disruption when located on steep slopes, across waterways, or over Recharge areas.

8. Streambank Erosion Control Assessment - undertake a comprehensive assessment of existing streambank erosion problem areas, evaluate streambank erosion potential and identify needs for streambank erosion control in urban and suburban watershed.

9. Wastewater Treatment - implement program for upgrading City's treatment plants to conform with the Governor's Committee recommendations for the Colorado River and its tributaries; also evaluate methods to assure long-term reliability of sewer lines, lift stations and plants.

10. Environmental Education - develop programs to educate the public about lawn care practices, oil and grease disposal, litter control, and agricultural runoff.

11. Edwards Aquifer Fund - assess feasibility of public/private fund for purchase of key recharge sites or other environmentally sensitive lands within the Recharge Zone, or for educational purposes.

12. Impact Mitigation Fund - assess feasibility of a percentage set-aside fund for impact mitigation on C.I.P. projects.

13. Industrial Waste Management Program - continue to improve spill response capability and improve compliance for storm sewer discharges.

14. Evaluation of Budget - review, at least every two years, the budget and funding of the items in this program in order to allow completion of projects in a timely and efficient manner.

We recognize that the Comprehensive Watersheds Ordinance, while representing a significant initial step, cannot alone be considered a water quality protection program for the City of Austin and feel that these other endeavors are necessary to assure that Austin's lakes, creeks, tributaries, and groundwater are adequately protected.

Sincerely,

Pat Malone, Chairman
Comprehensive Watersheds Ordinance Task Force

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Section B
Austin American-Statesman
Monday, November 10, 1986

City & State

Lone Star Legacy, B2
Nat Henderson, B2
Obituaries, B5

Mike Kelley



Legal humor, for the record

U.S. District Judge Jerry Buchmeyer of Dallas writes a regular and wonderfully funny column for the *Texas Bar Journal*. He has thieved some material from a volume called *More Humor in the Court*. I blave it from him. These have to do with taking depositions, sworn statements. As Judge Buchmeyer notes, lawyers are taught how to take a deposition but too often, not what May Happen when they do. Herewith:

Q: Are you married?
A: No, I am divorced.
Q: What did your husband do before you divorced him?
A: A lot of things that I didn't know about.

* * *

Q: Now, at the time you married Mr. Smith in December '78, did you love him?
A: Yes.
Q: Why?

* * *

Q: What is your name?
A: Ernestine McDowell.
Q: And what is your marital status?
A: Fair.

* * *

Q: Do you know how far pregnant you are right now?
A: I will be three months Nov.
Q: Apparently, then, the date of conception was Aug. 8?
A: Yes.
Q: What were you and your husband doing at that time?

* * *

Q: Wasn't this dog your favorite dog? Weren't you the favorite of this dog?
A: He never specified that. He never related that to me.

* * *

Q: Now, officer, besides the



Staff Photo by Jay Godwin

Metal detectives

Eunice Zapata of San Antonio joins more than 60 Texans and Oklahomans at the first Capital City Open Hunt. The Austin Metal Detecting Club gave prizes Sunday for tokens found during the event.

Expanded creek rules drafted on urban runoff

Streams lacking protection targeted for pollution limits

By Robert Cullick
American-Statesman Staff

The city staff is writing ordinances that would expand pollution safeguards to creeks not protected by special development laws and is revising ordinances that already protect certain watersheds.

The move to expand coverage of city ordinances began in late summer, when an *American-Statesman* series pointed out that ordinances designed to mitigate urban runoff only protect creeks that empty into the Colorado River upstream of city water intake pipes. Eastern creeks, which join the Colorado downstream of Longhorn Dam, have no protection.

Staff for several offices, boards, and commissions began writing proposed changes to the watershed ordinances and caused confusion as to who was taking the lead role.

City Manager Jorge Carrasco announced plans in August to propose an expansion of coverage to Walnut Creek. The Environmental Board, whose role has been bolstered to include water quality protection, began writing an ordinance to cover the northern section of the Edwards Aquifer. Members of the Planning Commission began a subcommittee investigation. Mayor Frank Cooksey called for a moratorium on development in the Bear Creek and Onion Creek watersheds while an ordinance was being written for those areas.

The false starts ended in late October, when City Council member Smoot Carl-Mitchell introduced a resolution that directed the city staff to take the lead in developing ordinances.

The ordinances are to combat urban runoff — rainwater that washes chemicals, organic matter, and debris off roofs, pavements, and yards into storm sewers and city creeks, which carry the runoff into the Colorado.



Council member Smoot Carl-Mitchell helps focus the drafting process.

The pollution, directly attributed to growth, is filling the Colorado with sediment and adding pesticides, fecal coliform bacteria, and such heavy metals as lead, arsenic, and chromium. It also contains organic matter and petrochemicals that can debilitate the river as raw sewage does.

Curtis Williams, environmental coordinator for the Office of Land Development Services, is leading the effort to write ordinances to satisfy those in the environmental community calling for stricter rules and to calm the fears of developers, bankers, and business interests worried the laws will shut down growth throughout the county.

Williams was moved from the once independent Office of Environmental Resource Management when it was pruned and made part of the Planning and Growth Management Department. His move to Land Development Services was widely supported by environmental activists at City Hall.

Williams is appealing for a little time. There have been complaints that citywide water quality ordinances would be overly restrictive.

"I think they need to see what comes out," Williams said. "A lot of people's minds will be put at ease." Specifications of the intensity of development "will be high enough to do the development that is contemplated," he said. A draft of the staff proposal to the City Council will be out in early December, he said.

The Williams proposal could be considered a "measured response." Travis County and parts of Williamson County would be divided into several categories, depending on the level of pollution abatement desired.

Depending on the level of protection, the city would use one or more of four strategies. In all cases, development along creeks, including the laying of utility lines in creek bottoms, would be restricted.

Much of the area covered by the proposed ordinance is covered by watershed ordinances. Williams said he hopes to streamline the ordinances to make them more consistent and comprehensible.

Lake Travis, Lake Austin, and Barton Creek would receive the most restrictive protection. Inner city creeks — Shoal, Bouldin, Waller, and others — would receive the least protective, least restrictive controls since development of the watersheds is nearly complete.

In between would be protections for the eastern creeks that flow into the Colorado downstream of the city water intake. The protections there would allow more intensive development than in the western part of the county. Single family housing would not be affected in much of the eastern area

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Table 1

Water Quality Strategy Applications

Water Quality Strategy	Topography	Development Intensity	Maintenance/Administration
Water Quality Zones	Flat; moderate; steep	All except existing highly urbanized	Low
Density Controls	Flat; moderate; steep	Low	Low
Impervious Cover	Flat; moderate; steep	Moderate; high	Moderate
Structural Controls	Flat; moderate	Moderate; high	High

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City of Austin
Founded by Congress, Republic of Texas, 1839
Municipal Building, Eighth at Colorado, P.O. Box 1088, Austin, Texas 78767 Telephone 512/499-2000

March 5, 1986

Mayor Frank C. Cooksey
and Councilmembers
City Hall
Austin, Texas

Dear Mayor Cooksey,

The Comprehensive Watersheds Ordinance Task Force recommends for your consideration, the following fourteen point program to address water quality needs in Austin, particularly in the urban watersheds. It was the belief of the Task Force that if the already heavily impacted Urban Watersheds were exempted from this ordinance, a program of retrofit and rehabilitation was necessary. Some of these items are applicable to all watersheds in Austin and are meant as guidance on future programs that the City should consider in addition to the ordinance this Task Force is transmitting to you. We urge you to consider these suggestions in future plans for water quality protection.

1. Urban Watersheds Retrofit Feasibility Study - identify locations, in major commercial areas, parks, schools, etc., to locate water quality control retrofit structures within the "Urban" watersheds, and develop control practices (including non-traditional approaches) suitable for urban watersheds.

2. Zoning Policies - develop a set of zoning policies, particularly oriented to the "Urban" watersheds, through which additional water quality protection can be assured, e.g., setbacks from creeks lower intensity near creeks, filtration, etc.

3. Erosion and Sedimentation Control Manual - amend to incorporate "Guidelines for Water Quality Ponds," and other technical criteria from the ordinance if appropriate.

4. Floodplain Ordinance - finalize ordinance to better define "natural and traditional character" of waterways and permitted floodplain alterations.

5. Water Quality Monitoring Program - annual and periodic status reports on the monitoring program, along with specific goals to be evaluated.

6. Drainage Criteria Manual - amend to provide criteria for overland flow and alternatives to direct discharges to waterways.

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Table 3

Water Quality Strategies for Austin Watersheds

Type of Watershed	Water Quality Strategies	Justification
Exempt Watersheds: (Urban) Blunn, East Boggy, East Bouldin, Johnson, Shoal, Town Lake (MoPac - Hwy. U.S. 183) Waller, West Bouldin, Fortview, Tannehill	Structural Controls - Commercial and Multi-family exceeding 3 acres	Highly urbanized watersheds already developed in most areas. Very little land area available for Water Quality protection other than through minimal structural controls.
Urban Watersheds: (Suburban) Buttermilk, Carson, Cottonmouth, Country Club, Decker, Dry, Elm, Gilleland, Harris Branch, Maha, Marble, Onion, South Boggy, Town Lake (MoPac to Tom Miller Dam), Walnut, Little Walnut, Wilbarger, Williamson, Slaughter, Bear, Colorado River	Water Quality Zones Impervious Cover Limitations Structural Controls	Public health, recreation, and aesthetic benefits of Water Quality protection only, intense development and urban services committed or planned.
(Water Supply - Suburban) Water Supply - Moderate Intensity Aquifer-related Slaughter, Aquifer-related Williamson, Brushy, Bull Creek, Lake Creek, Rattan	Water Quality Zones (strict) Impervious Cover Limitations (strict) Structural Controls	Drinking Water Supply; Edwards Aquifer recharge; relatively flat topography; committed or planned for moderate development intensity. Likelihood of urban services in the future.
(Water Supply - Rural) Water Supply - Low Intensity Aquifer-related Onion, Barton, Aquifer- related Bear and Little Bear, Lake Austin, Lake Travis	Water Quality Zones (strict) Density Controls Very Limited Commercial Development	Drinking water supply; Edwards Aquifer recharge; steeper topography; little Committment for intense development. Lack of urban services in the future. Needs low maintenance and administrative strategies.

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PRIMARY
WATER QUALITY CONTROL STRATEGIES

WATER QUALITY ZONES - Critical Water Quality Zones and Buffer Zones around creeks to provide pollutant removal through overland flow and to minimize disturbance in close proximity to creeks.

DENSITY CONTROLS - Directly limits the amount of pollutants generated from a site by limiting the intensity of development and activity on the site.

IMPERVIOUS COVER LIMITATIONS - Indirectly limits the amount of pollutants generated from a site by limiting the impervious surfaces associated with development on a particular site.

STRUCTURAL CONTROLS - Engineering design which provides for pollutant removal through the use of sedimentation and filtration ponds.

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Exemptions continued:

- Resubdivisions of preliminary or final subdivisions approved prior to 5/19/86 when not increasing density or impervious cover.
- Subdivisions within a MUD (approved by 5/19/86) that is outside the City.
- Subdivisions within an in-City MUD approved by 5/19/86 with zoning approved by 5/19/86.

B. Waivers - All waivers must be requested through the Environmental Review Division and must go to the Planning Commission and City Council for approval. Waivers must be submitted within 90 days of 5/19/86.

- Subdivisions in the process as of 5/19/86 and not otherwise exempt.
- Site development permits in the process as of 5/19/86 and not otherwise exempt (an approved preliminary or final subdivision).

C. Hardship Provisions

- from 5/19/86 until 5/1/87 any property owner may request that OLDS staff review their project or property to determine the amount of impervious cover or residential units that are lost under this ordinance as compared to previous ordinances.
- if this loss exceeds 50% staff and the applicant may work out a compromise that the applicant can take to the City Council for approval or opt to comply with the new ordinance.

IV. Water Quality Zones

- Critical Water Quality Zones are established along creeks with drainage basins over certain sizes (depends on which category). Each waterway is classified as major, minor, or intermediate. Generally defined as the floodplain but there are minimums and maximums (e.g. Water Supply Rural: Drainage basin between 64 and 320 acres: minor waterway) - no development in the CWQZ.

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Table 2

Watershed Category Characteristics

Watersheds	Water Quality and Supply	Topography	Development Intensity	Utility Service
Exempt	Creeks highly disturbed	Relatively flat	Intense development	Committed, in place
	Drainage function		Already substantially built out	
Urban	Creeks disturbed in some areas	Flat to rolling	Intense development planned or committed	Planned or committed
	Public health, recreational, aesthetic benefits			
Water Supply - Moderate Intensity	Drinking water supply	Flat to rolling	Moderate densities committed or planned	Planned for the near future
	Edwards Aquifer recharge			
Water Supply - Low Intensity	Drinking water supply	Flat to steep	Low intensity limited commercial	Not currently planned
	Edwards aquifer recharge			

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Comprehensive Watersheds Ordinance

Summary

I. Ordinance Structure

- Combines site development and subdivision regulations in one document.
- Note that if a commercial subdivision wishes to submit the specific information on individual lots during site development, it is now automatic - no variance needed.
- Beyond the basic submittal requirements, an environmental assessment is required for all water supply watersheds.
- There are two tiers of standards: general standards for all watersheds and additional standards for water supply watersheds.
- Final three sections set out the development intensities and structural control requirements.

II. Categories

- Urban - Downtown watersheds.
- Suburban - Eastern watersheds. Non-water supply.
- Water Supply Suburban - watersheds committed to a certain development intensity and level of City services, near-western part of the City - Already had previous watershed ordinance
- Water Supply Rural - watersheds with little or no committed City services for western boundaries of City. Had previous watershed ordinances.

III. Exemptions, Waivers, Hardships
(see attachment for Exemptions and Waivers)

A. Exemptions

- "Urban" watersheds
- All final plats for subdivisions with an approved preliminary prior to 5/19/86.
- Site development permits for lots which are legal lots or part of an approved preliminary or final prior to 5/19/86.
- Site development permits for tracts with approved zoning site plans, PDA's, PUD site plans, waterway development permits, County development permits approved prior to 5/19/86.

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General Standards continued:

- Spoil Disposal - cannot be placed in 100 year floodplain or on slopes over 15% unless placed in a planned roadway area, stormwater detention facility, building site or parks site.

- Construction on Slopes - no roadway or driveways on slopes over 15% unless providing access to flatter slopes, no structures on slopes over 15% except 10% impervious cover allowed on slopes of 15-25% as long as specified containment or terracing is done.

- Sedimentation/Filtration Basins - Basins required for certain types of development over specified impervious cover. To be designed in accordance with new Design Guidelines drafted by Public Works.

- Critical Environmental Features - 50-150 foot setbacks required from springs, seeps, bluffs, canyon rimrocks, wetlands, faults or sinkholes.

- Innovative Management Practices - allows applicants to submit plans to recharge groundwater via CEF's where deemed appropriate.

- Wastewater Treatment - recommends that wastewater package treatment plants meet certain discharge or no discharge standards that were established by the Governor's Task Force on the Colorado River.

- Impervious Cover Calculations - no credit for pervious pavers, residential impervious cover assumptions for different lot sizes, sets out limits for calculating roadway impervious cover.

B. Additional: Water Supply Watersheds

- Roadways - alternative urban standards for local and residential collectors, gives Planning Commission authority to vary roadway widths when recommended by staff.

- Driveways - limits grades to 14% without UTD approval and limits joint use driveways to accessing 8 units.

- Overland Flow - preference for overland flow, use of enclosed storm sewers only with permission from CLDS.

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Water Quality Zones continued:

- Water Quality Buffer Zones are established parallel to all CWQZ's except for minor waterways in the Suburban category. Sizes of Buffer Zones differ depending on type of waterway and which category; WQBZ's allow for limited development, between 18-30% impervious cover depending on category (1 unit per 3 acres in Water Supply Rural).

V. Submittal Requirements

A. General

- topo map, floodplain limits, slope map, net site area and impervious cover calculations, location of Critical Environmental Features, areas of cut and fill in excess of four feet and a vegetative description (other minor requirements such as spoils disposal areas also).

B. Water Supply Watersheds

- Environmental Assessment - includes three elements; a hydrogeologic, wastewater and vegetative assessment.

VI. Standards

A. General

- CWQZ - no development except limited roadway crossing, utilities and certain park uses.

- Erosion and Sedimentation Control - all projects must submit a plan and comply - using the Erosion and Sedimentation Control Manual for guidance.

- Clearing and Temporary Site Disturbance - limits surveying width to 15 feet, length of time between roughcutting and surfacing cannot exceed 18 months, limits roadway clearing width to twice the surface width.

- Cut and Fill - no cut and fill over four feet except for within roadway right-of-way and for structural excavation.

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EXHIBIT B
TABLE I
MAXIMUM DEVELOPMENT INTENSITY

Watershed Category	Waterways Minor	Waterways Inter.	Waterways Major	Critical Water Quality Zone	Water Quality Buffer Zone	Uplands Zone*		W/Transfer	Other
1. Suburban									
Drainage Area	320 ac	640 ac	1200 ac	No Development	30% impervious cover	Resid:	50% imp.	60%	Sedimentation
Buffer Zone	None	100 ft.	150 ft.			Dup/SL:	55% imp.	60%	Sedimentation
						MF:	60% imp.	70%	Filtration
						Comm:	80% imp.	90%	Filtration
2. Water-Supply Suburban									
a) Class I									
Drainage Area	120 ac.	320 ac.	640 ac.	No Development	10% impervious cover; no development over Recharge Zone	Resid:	30% imp.	40%	Filtration
Buffer Zone	100 ft.	200 ft.	300 ft.			MF:	40% imp.	55%	Filtration
						Comm:	40% imp.	55%	Filtration
b) Class II (Williamson)									
Drainage Area	120 ac	320 ac	640 ac	No Development	30% impervious cover; no development over Recharge Zone	Resid	40% imp.	55%	Filtration
Buffer Zone	100 ft	200 ft	300 ft			MF:	60% imp.	65%	Filtration
						Comm:	60% imp.	70%	Filtration
c) Class III (North Edwards)									
Drainage Area	320 ac	640 ac	1200 ac	No Development	30% impervious cover	SF:	45% imp.	50%	Filtration
Buffer Zone	100 ft	200 ft	300 ft			Dup/SL:	55% imp.	60%	Filtration
						MF:	60% imp.	65%	Filtration
						Comm:	65% imp.	70%	Filtration
3. Water-Supply Rural									
Drainage Area	64 ac	320 ac	640 ac	No Development	1 unit per 3 acres; no development over Recharge Zone	SF:	0.5 upa	1.0 upa	-
Buffer Zone	100 ft	200 ft	300 ft			Cluster:	1.0 upa	2.0 upa	40% Buffer**
						MF/Comm:	20% imp.	25%	40% Buffer
						Planned:	40% imp.	50%	40% Buffer
						***Retail:	50-60%	60-70%	Filtration

* Net site area

** Except in Lake Austin/Lake Travis; filtration required.
*** [illegible] at major intersections

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Net Site Area

Assume:

Total Site:	100 acres
CWQZ:	10 acres (all 0-15% slope)
WQBZ:	10 acres (5 ac. 15-25%; 5 ac. 25-35%)
Uplands:	80 acres
0 - 15%:	50 acres
15 - 25%:	10 acres
25 - 35%:	10 acres
35% +:	10 acres

Example: Water Supply Suburban Class I (MF/Comm)

CWQZ = No development
WQBZ = 18% impervious x 10 ac. = 1.8 acres
Net Site Area =
50 ac (0-15%) x 100% = 50 ac.
10 ac (15-25%) x 40% = 4 ac.
10 ac (25-35%) x 20% = 2 ac.

Net Site Area: 56 ac.

Allowable Impervious = 40% x 56 ac. = 22.4 acres
Total = 24.2 acres

With Transfer (no development in WQBZ, dedicate CWQZ) 22.4 acres
20 acres x 15,000 sq. ft./ac. 6.9 acres
Total allowable impervious with transfer: 29.3 acres

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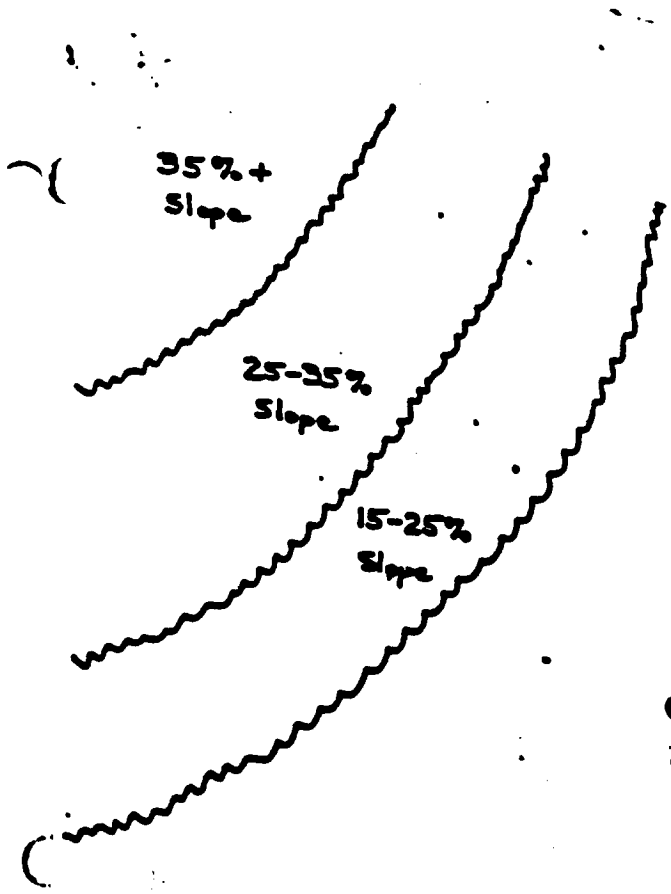

NET
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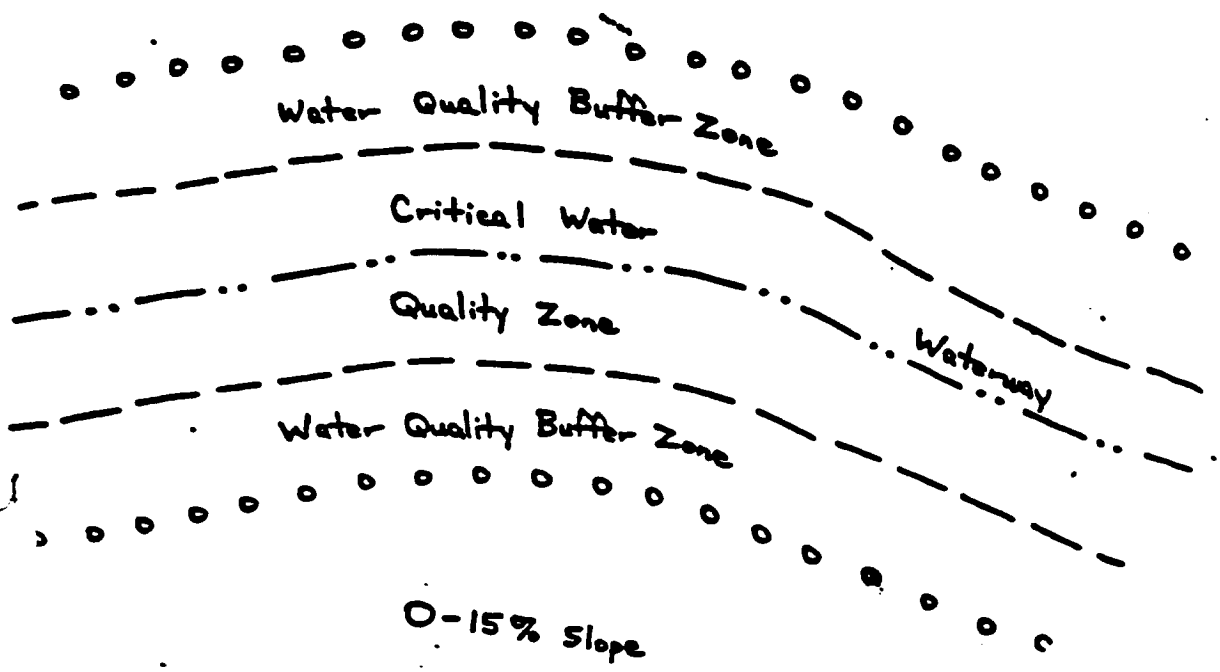
AREA



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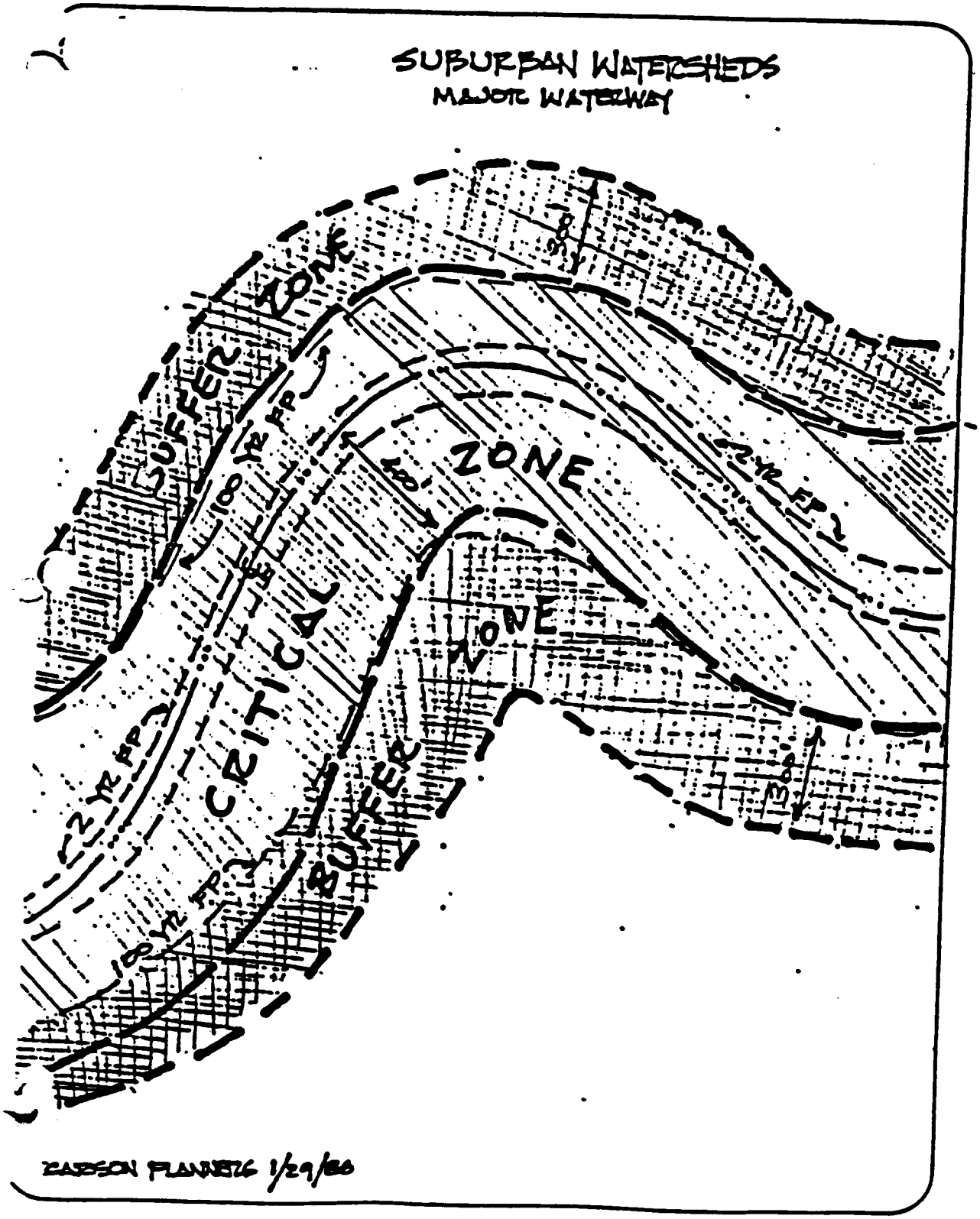

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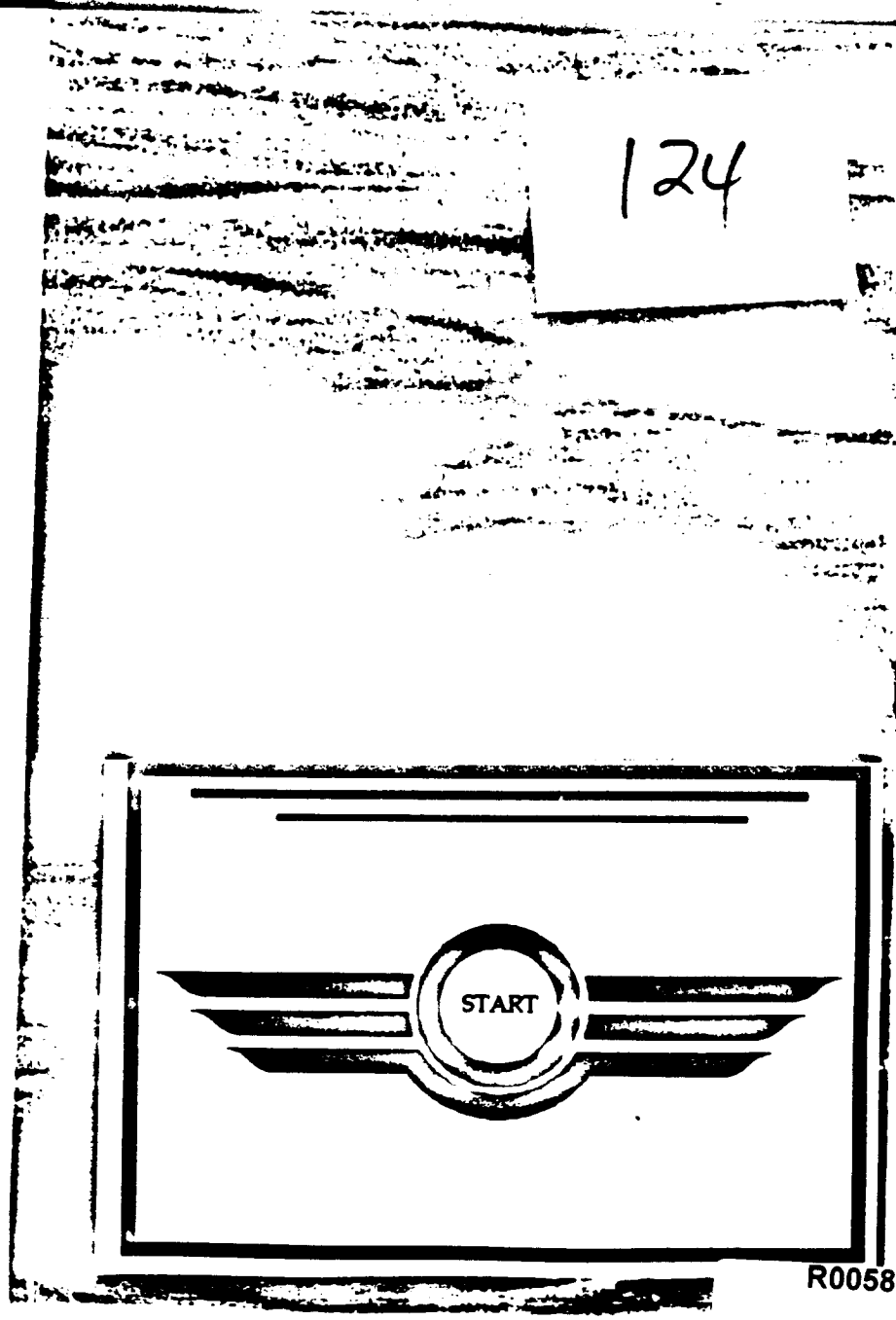
Performance Measures



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PERFORMANCE MEASURES FOR THE NATIONAL CSO CONTROL PROGRAM

EXECUTIVE SUMMARY

BACKGROUND AND PURPOSE

The National Combined Sewer Overflow (CSO) Control Policy (the CSO Policy) was signed on April 8, 1994. This signing culminated a lengthy process of policy development and negotiation among CSO communities, the U.S. Environmental Protection Agency (EPA), the states, and environmental groups. Based upon the National Pollution Discharge Elimination System (NPDES), the CSO Policy establishes a consistent national approach for controlling CSOs.

Highlights of the CSO Policy are its recognition of the site-specific nature of combined sewer systems (CSSs), and the variability of receiving water conditions and CSO impacts on receiving waters. The CSO Policy also provides flexibility to CSO communities so that control programs can be developed to fit local needs. In addition, the CSO Policy recognizes the cost burden to CSO communities, and allows for staged implementation.

Consistency within the CSO Policy is established by requirements for all CSO communities to implement Nine Minimum Controls (NMCs). Consistency is also established by requiring CSO communities to develop comprehensive long-term control plans (LTCPs) tailored to site-specific conditions.

Building upon the CSO Policy and associated guidance from EPA and the states, CSO communities are in varying stages of implementing the NMCs and developing LTCPs. Large investments in time and money are being directed toward CSO control across the nation. It is widely recognized that measuring and tracking the success of CSO control is necessary. In particular, there is a need to identify and quantify environmental benefits associated with CSO control efforts so that rate payers, elected officials and the public at large will be able to assess the investment in CSO control and its anticipated benefits.

The ***purpose of this report*** is to describe and recommend series of performance measures that are recommended for use by utilities and local government agencies to track improvements and benefits associated with CSO control. Performance measures provide a means for the quantification and documentation of the results and effectiveness of CSO control efforts. They can be used to measure and report progress toward achieving goals and objectives, and they can be instrumental in guiding management activities.

This study was sponsored by AMSA (the Association of Metropolitan Sewerage Agencies), and was partially funded under a cooperative agreement with EPA.

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STUDY METHODOLOGY

The study was designed to maximize the number of participants involved and the amount of input received from parties having a substantial interest in CSO control. A Work Group formed by AMSA consisting of representatives from the major stakeholders involved in the CSO Policy development guided the study elements, developed and applied selection criteria, and made all of the final recommendations. Separate Focus Group meetings targeted at CSO communities, environmental groups, and state and federal permitting authorities were used to obtain additional ideas and to hear concerns related to CSO control and performance measures. Field interviews with CSO communities were utilized to determine the applicability and usefulness of performance measures. Work Group discussions and deliberations resulted in the final selection of recommended performance measures and production of this document.

STUDY FINDINGS

In addition to recommending performance measures for CSO control, the Work Group developed a summary of observations regarding CSO control and the selection of performance measures. These observations and the recommended performance measures are described separately below.

Observations

Basic Principles: Urban waters are very complex. CSO discharges are one of many sources of pollution that contribute to water quality and other environmental problems. Other sources include storm water, septic systems, upstream nonpoint source pollution and agricultural runoff, municipal and industrial wastewater, atmospheric deposition, and contaminated bottom sediments. In order to place the CSO performance measures into context, several basic principles were used to guide their development:

- Performance measures in this study are primarily for local use by CSO communities.
- CSSs and the impacts of CSO discharges are very site specific. CSO control is expensive and largely dependent on local funding. Difficult choices have to be made by CSO communities. Performance measures provide a means to guide management activities and to track results.
- A menu-like framework provides CSO communities with the opportunity to select appropriate performance measures to match locally defined objectives.
- Some performance measures have value at the watershed level where multiple sources impact water quality and environmental conditions.
- Some performance measures have value for tracking the programmatic effectiveness of CSO control programs at the national or state levels.
- Data for some performance measures are more appropriately gathered by agencies other than local governments.

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Categories of Performance Measures: The potential performance measures considered by the Work Group fell into four categories. These are:

- Administrative Measures.
- End-of-Pipe Measures.
- Receiving Water Measures.
- Ecological, Human Health and Resource Use Measures.

The Work Group recognized the need to identify environmental measures that connected program activities and dollars spent on environmental infrastructure with measurable improvements in water quality, habitat and the beneficial use of receiving waters. The difficulty of isolating CSO impacts in complex urban waters receiving pollutants from many sources was also recognized. The complexity of urban waters makes it difficult to use the results of ambient or ecological monitoring to reliably establish cause and effect relationships between CSOs and environmental conditions. Therefore, the Work Group observed that the four categories encompassed a sufficiently broad range of performance measures from which CSO communities could make selections based upon local needs.

Designated Uses: It was observed that CSO discharges can contribute to nonattainment of designated uses in urban waters. However, nonattainment is often not dependent on a single source. Instead, multiple sources are usually responsible. The Work Group observed that environmental management directed at the attainment of designated uses in urban receiving waters is more likely to be successful if all pollution sources are addressed in the context of a watershed approach.

Locally Defined Objectives: The Work Group recognized the site specific nature of CSO control and potential opportunities to focus on locally defined objectives and anticipated benefits that go beyond regulatory requirements. For example, water bodies avoided by the public before CSO controls were implemented are transformed into popular greenways; water-based recreation activity increases; blighted urban waterfronts become valuable sites for residential or commercial redevelopment. In these and other examples, elimination of odors or nuisances and improvement of water quality and habitat enhance the desirability of the water and shoreline for public use and enjoyment. Regulatory requirements can help to create the conditions for increased recreational and economic activity. The quantification of performance measures for locally defined objectives is a valuable way to track benefits associated with CSO control.

Watershed Approach: Because of the broad variety of pollution sources affecting urban waters, the Work Group found that CSO control should be viewed in the context of watershed management. In particular, many of the receiving water, human health, ecological and resource use measures quantify impacts or effects that are often governed by sources beyond CSOs. Further, the importance of the watershed approach is clearly

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recognized in the CSO Policy where it is stated that:

> ***"Permitting authorities are encouraged to evaluate water pollution control needs on a watershed management basis and coordinate CSO control with other point and nonpoint source activities."*** **(Section I.B.)**

In recognition of the importance of the watershed approach, the Work Group identified performance measures that were particularly suitable for tracking environmental change on a watershed basis.

Cost Considerations: The Work Group found that cost is an important factor in the consideration of performance measures. In particular:

- The cost of obtaining data for the performance measures should be commensurate with the usefulness of the data.
- The cost of obtaining data for the performance measures should not represent an extra burden to CSO communities beyond what was stated or intended in the CSO Policy.
- The cost of CSO control is not a performance measure per se, but should be tracked to put the economic investment of CSO control into context.

Recommended Performance Measures

The Work Group identified and recommended twenty-four individual performance measures to be used to track and quantify the results of CSO control. The recommended performance measures are summarized in the attached table. All twenty-four were considered to be *Appropriate for General Use* by CSO communities. Four were additionally identified as *Appropriate for Tracking on a National Basis*. This limited group of measures would be particularly useful in tracking the overall status of the CSO Control Program, and reduction in the occurrence of CSO discharges to receiving waters.

A menu-like framework was developed for the performance measures to encourage CSO communities to select the most appropriate performance measures to meet their needs. The LTCP and local knowledge of the CSS, receiving waters, and impacts should be used to guide CSO communities in the selection of a subset of performance measures that will demonstrate the results of CSO control.

Many of the performance measures will not be appropriate for all or most CSO communities. For example, tracking beach closures is not warranted where there are no beaches. Similarly, tracking nutrient load reduction may not be warranted in CSO communities where the nutrient load associated with CSOs is not considered to be a problem. Common sense, local conditions and cost effectiveness should drive the selection of performance measures.

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Summary of Recommended Performance Measures

ADMINISTRATIVE	END-OF-PIPE	
• Documented Implementation of NMCs (1) • Status of LTCP(1) • Waste Reduction	Flow Measurement • Wet Weather Flow Budget • CSO Frequency(1) • CSO Frequency in Sensitive Areas(1) • CSO Volume • CSO Volume in Sensitive Areas • Dry Weather Overflows	Pollutant Load Reduction • BOD Load • TSS Load • Nutrient Load • Floatables
RECEIVING WATER	**ECOLOGICAL/HUMAN HEALTH/RESOURCE USE**	
• Dissolved Oxygen Trend • Fecal Coliform Trend • Floatables Trend • Sediment Oxygen Demand Trend • Trend of Metals in Bottom Sediments	• Shellfish Bed Closures • Benthic Organism Index • Biological Diversity Index • Recreational Activities • Beach Closures • Commercial Activities	

(1) Appropriate for National Tracking

A two-page description of each performance measure provides a general discussion of the expected results for each measure, the conditions that are appropriate, and why the data is important. Examples and anecdotal information have been provided where available. The description also contains a single-page Profile Sheet for each performance measure. The Profile Sheets provide a readily available visual reference for managers that will be helpful in selection of the most appropriate performance measures.

RECOMMENDATIONS FOR IMPLEMENTATION

Assessment of the effectiveness of controls and measuring improvements in receiving waters and other benefits is a major part of CSO control. Specific recommendations on the identification and selection of performance measures as well as the major elements of implementing data collection and reporting programs are outlined. Comments on state and federal use of performance measures are also provided.

RELATIONSHIP TO OTHER NATIONAL PROGRAMS

CSO performance measures can be related to other ongoing national programs including wet weather program efforts such as the urban wet weather and stormwater activities, the establishment of national environmental goals and indicators, and the interagency coordination of water quality monitoring. Most of these efforts are conducted in partnership by EPA and other federal agencies, states, tribes, local governments, and private entities. The principal national programs and relevant projects related to goals, environmental indicators, and performance measures are described.

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1.0 INTRODUCTION

1.1 BACKGROUND AND PURPOSE

The National Combined Sewer Overflow (CSO) Control Policy (the CSO Policy) was signed by Carol Browner, the Administrator of the U.S. Environmental Protection Agency (EPA), on April 8, 1994 (EPA, 1994). This signing culminated a lengthy process of policy development and negotiation among CSO communities, EPA, the states, and environmental groups. Based upon the National Pollution Discharge Elimination System (NPDES), the CSO Policy establishes a consistent national approach for controlling CSOs.

Highlights of the CSO Policy are its recognition of the site-specific nature of combined sewer systems (CSSs), and the variability of receiving water conditions and impacts. The CSO Policy also provides flexibility to CSO communities so that control programs can be developed to fit local needs. In addition, the CSO Policy also recognizes the cost burden to CSO communities, and it allows for staged implementation of controls.

Consistency within the CSO Policy is established by requirements for all CSO communities to implement Nine Minimum Controls (NMCs). The NMCs are technology-based controls that can be used to abate CSO problems without extensive engineering studies or substantial construction costs. The NMCs place emphasis on maintenance and proper operation of the CSS to ensure maximum use of the collection system and treatment capacity of the publicly owned treatment works (POTWs). Consistency is also established by requiring CSO communities to develop comprehensive long-term control plans (LTCPs) tailored to site-specific conditions. The development of LTCPs is a comprehensive effort that leads to the identification and implementation of technically feasible, effective and affordable controls.

Building upon the CSO Policy and associated guidance from EPA and the states, CSO communities are in varying stages of implementing the NMCs and developing LTCPs. Large investments in time and money are being directed toward CSO control across the nation. It is widely recognized that measuring and tracking the success of CSO control is necessary. In particular, there is a need to identify and quantify environmental benefits associated with CSO control efforts so that rate payers, elected officials and the public at large will be able to assess the investment in CSO control and anticipated benefits.

The purpose of this report is to describe a series of performance measures that are recommended for use by utilities and local government agencies to track improvements and benefits associated with CSO control.

These performance measures were developed in a study sponsored by AMSA (the Association of Metropolitan Sewerage Agencies) and supported under a cooperative agreement with EPA. A Work Group representative of the major stakeholders instrumental in developing the CSO Policy carried out the assessment of performance

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measures. The stakeholders included utilities and local government agencies responsible for operating CSSs (referred to as CSO communities), non-governmental environmental advocacy groups, and federal and state NPDES permitting authorities. The report is organized as follows:

Section 1.0: Introduction.
Section 2.0: Description of Study Methodology.
Section 3.0: Study Findings.
Section 4.0: Recommendations for Implementation.
Section 5.0: Relationship to Other National Programs.

The remainder of this section provides additional background on the CSO Policy and performance measures.

1.2 KEY PRINCIPLES AND EXPECTATIONS OF THE CSO POLICY

The CSO Policy contains four key principles intended to ensure that CSO controls are cost-effective and meet the requirements of the Clean Water Act (CWA) of 1972 and its amendments. These are:

- Provide clear levels of control that would be presumed to meet appropriate health and environmental objectives.
- Provide sufficient flexibility to CSO communities, especially those that are financially disadvantaged, to consider the site-specific nature of CSOs and to determine the most cost-effective means of reducing pollutants and meeting CWA objectives and requirements.
- Allow a phased approach for implementation of CSO controls considering a community's financial capability.
- Review and revise, as appropriate, water quality standards and their implementation procedures when developing LTCPs to reflect the site-specific wet weather impacts of CSOs.

The CSO Policy also clearly defines expectations for permittees, state water quality standards authorities, and other NPDES permitting and enforcement authorities. These expectations include:

- Permittees should implement the NMCs as soon as practical, but no later than January 1, 1997.
- Permittees should give priority to sensitive areas.
- Permittees should develop LTCPs.
- State water quality standards authorities should review and revise, as appropriate, state water quality standards during the CSO long-term planning process.

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1.2.1 Nine Minimum Controls

The NMCs that are to be implemented and documented by all CSO communities by January 1, 1997 are described briefly in Table 1-1. The selection and implementation of control measures should be based upon site-specific conditions and characteristics of the CSS. Documentation of the NMCs may include operation and maintenance plans, revised sewer use ordinances for industrial users, sewer system inspection reports, infiltration/inflow studies, pollution prevention programs, public notification plans, and facility plans.

1.2.2 Long Term Control Plans

The LTCP is a comprehensive plan that recognizes the site-specific nature of CSOs and their impacts on receiving waters. The long term planning approach consists of four major elements: system characterization; development and evaluation of alternatives; selection and implementation of controls; and compliance monitoring. A primary objective of the LTCP is to develop and evaluate a reasonable range of CSO control alternatives sufficient to meet water quality standards, including attainment and protection of designated uses on CSO-impacted receiving waters. The CSO Policy allows flexibility in allowing a CSO community to select controls that are cost-effective and tailored to meet local conditions.

Two general approaches to attainment of water quality standards are recognized in the CSO Policy. These are the "demonstration" approach and the "presumption approach." Both approaches provide CSO communities with targets for controls that achieve compliance with the CWA, particularly the protection of designated uses. Under the "demonstration" approach, water quality modeling or other tools are used to demonstrate that predicted CSO discharges resulting from the LTCP would be sufficient to attain water quality standards. The "presumption" approach is based upon the premise that a LTCP that meets certain minimum defined performance criteria in terms of expected frequency of overflow or percent capture of the CSO pollutant load would be presumed to provide an adequate level of control to meet the water quality-based requirements of the CWA.

CSO communities are encouraged to meet and coordinate frequently with state water quality standards authorities and NPDES permitting authorities, and to engage the general public in the planning process through public participation activities. In particular, the development of goals, the evaluation of alternatives, and the consideration of the local financial impacts of the LTCP should be a collaborative effort among all of the participating interests. The development of performance measures or other measures of success to quantify environmental improvements and benefits related to CSO control is also a major element of the LTCP. Because of the site-specific nature of CSSs and CSO impacts, a strong linkage between performance measures and locally defined objectives is essential.

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Table 1-1 Summary of the Nine Minimum Controls

1. **Proper operation and regular maintenance programs for the sewer system and the CSOs.** This control should consist of a program that clearly establishes operation, maintenance, and inspection procedures to ensure that a CSS and treatment facility will function in a way to maximize treatment of combined sewage and still comply with NPDES permit limitations.

2. **Maximum use of the collection system for storage.** This control consists of making relatively simple modifications to the CSS to enable the system to store wet weather flows until downstream sewers and treatment facilities can handle them.

3. **Review and modification of pretreatment requirements to ensure that CSO impacts are minimized.** The objective of this control is to minimize the impacts of discharges into CSSs from nondomestic sources during wet weather events, and to minimize CSO occurrences by modifying inspection, reporting, and oversight procedures within an approved pretreatment program.

4. **Maximization of flow to the POTW for treatment.** This control entails simple modifications to the CSS and treatment plant to enable as much wet weather flow as possible to reach the treatment plant.

5. **Elimination of CSOs during dry weather.** This control includes any measures taken to ensure that the CSS does not overflow during dry weather conditions.

6. **Control of solid and floatable materials in CSOs.** This control is intended to control, if not eliminate, visible floatables and solids using relatively simple measures including baffles, screens, racks, booms and skimmer vessels.

7. **Pollution prevention programs to reduce contaminants in CSOs.** This control is intended to keep contaminants from entering the CSS and prevent subsequent discharge to receiving waters through street cleaning, public education, solid waste collection and recycling.

8. **Public notification to ensure that the public receives adequate notification of CSO occurrences and CSO impacts.** The intent of this control is to inform the public of the location of outfalls, the actual occurrence of CSOs, the possible health and environmental effects of CSOs, and the recreational or commercial activities curtailed as a result of CSOs.

9. **Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls.** This control involves visual inspections and other simple methods to determine the occurrence and apparent impacts of CSOs.

Source: CSOs: Guidance for Nine Minimum Controls. EPA 1995b.

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1.2.3 Guidance Documents

EPA has developed a series of guidance documents to assist CSO communities and NPDES authorities with interpretation of the CSO Policy and its implementation. These guidance documents provide specific information on the NMCs, the development of LTCPs, and other technical, financial and permitting issues. A list of guidance documents is as follows:

Combined Sewer Overflows - Guidance for Long Term Control Plan (EPA, 1995a)
Combined Sewer Overflows - Guidance for Nine Minimum Controls (EPA, 1995b)
Combined Sewer Overflows - Guidance for Screening and Ranking (EPA, 1995c)
Combined Sewer Overflows - Guidance for Funding Options (EPA, 1995d)
Combined Sewer Overflows - Guidance for Permit Writers (EPA, 1995e)

Complete references are provided in Section 6.0 These documents are available from the EPA Office of Water's Document Center, or through EPA's PIPES electronic bulletin board (BBS). The modem BBS number is (703) 749-9216. The World Wide Web address is *http://www.ehsg.saic.com/pipes.*

1.3 PERFORMANCE MEASURES

EPA has established five strategic goals focused on water resources. These are the protection and enhancement of public health; the protection and enhancement of ecosystems; the attainment of uses designated by states and tribes; the improvement of ambient conditions; and the reduction in pollutant loadings. Addressing CSOs on a consistent basis across the nation is one of several programs intended to achieve these goals.

In order to assess the progress and success of individual programs such as the CSO control program, or the cumulative effect of multiple programs on a watershed basis, it is important to compare the quality of the environment and change over time with a well chosen set of performance measures. Traditionally, simple quantitative or administrative measures of program activities were used extensively for this purpose. These include measures such as the number of permits issued, the number of controls implemented, and other measures of an administrative nature. It has become increasingly clear in recent years that environmental measures are also very important as they explain more about the health and condition of the water bodies themselves, and the designated uses of water bodies that management programs are trying to protect. Toward this end, environmental measures provide a means to quantify and track the chemical, physical and biological integrity of the nation's waters.

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1.4 POTENTIAL USERS OF PERFORMANCE MEASURES

Performance measures provide a medium for the quantification and documentation of the results and effectiveness of CSO control efforts. They can be used to measure and report progress toward achieving goals and objectives, and they can be instrumental in guiding management activities. A clear understanding of the objectives of CSO control at each level of government is necessary if performance measures are to be implemented effectively.

At the local level, performance measures can be used by CSO communities to measure and report progress in achieving locally defined goals and objectives. Performance measures can also be used to guide management activities, and to communicate environmental improvement and change to rate payers, elected officials and the public at large. Return on investment is an important consideration. CSO communities are making substantial investments in CSO control. Performance measures provide a means to track environmental benefits that can be related back to the investment.

At the state level, performance measures can be used by resource and NPDES permitting authorities to track compliance and implementation, and to quantify change in environmental conditions. State objectives and the state permitting strategy will need to be consistent with recommended performance measures. Statewide coordination will improve the usefulness of performance measures in that information for select measures can be tracked and aggregated on a watershed or statewide basis.

At the regional and national levels, performance measures can be used in several ways. These are to track the overall status of programmatic requirements; to track the effectiveness of controls; and to track real improvements in the environment on regional and national levels. As noted by the Government Accounting Office (GAO), "in order to manage for environmental results, EPA needs measures both of the nature and level of its own activities, and of the effects of current levels of pollution and contamination on people and the environment" (GAO, 1988).

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2.0 STUDY METHODOLOGY

2.1 OVERVIEW

The study was designed to maximize the number of participants involved and the amount of input received from parties having a substantial interest in CSO control. A Work Group formed by AMSA consisting of representatives from the major stakeholders involved in the CSO Policy development guided the study and made all of the final recommendations. Separate Focus Group meetings targeted at CSO communities, environmental groups, and state and federal permitting authorities were used to obtain additional ideas and to hear concerns related to CSO control and performance measures. Field interviews with CSO communities were utilized during the later stages of the study to determine the applicability and usefulness of performance measures. Work Group discussions and deliberations resulted in the final selection of recommended performance measures and production of this document.

2.2 WORK GROUP

AMSA convened a Work Group with eighteen members to provide direction and guidance to the study. Each member of the Work Group had extensive experience with CSO operations, wet weather issues, and urban water quality. The Work Group held four public meetings that were professionally facilitated.

At its first meeting in March, 1995, the Work Group received briefings from EPA on the subjects of environmental indicators, wet weather programs, the CSO Policy, and the Intergovernmental Task Force on Monitoring Water Quality. The Work Group developed four categories for performance measures. These were administrative measures, end-of-pipe measures, receiving water measures, and a category encompassing ecological, human health and resource use measures. During a brainstorming session, a first-cut preliminary list of forty-eight performance measures was identified (see Appendix B). The Work Group also provided direction for the convening of regional Focus Group meetings in order to reach out to CSO communities, regulatory agencies, environmental interests and the general public to obtain additional ideas on performance measures for CSO control.

At its second meeting in June, 1995, the Work Group reviewed the results of the Focus Group meetings and initiated a process to screen the first-cut preliminary list and other suggestions received from the Focus Groups. The selection criteria used in the screening process were as follows:

- Is the measure directly linked to CSOs?
- Is the measure quantifiable and "trendable" (i.e., can change be tracked over time)?
- Is the measure reasonable regarding the cost of data collection and analysis?
- Is the measure objective?
- Is the measure flexible?

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- Is the measure an indicator of water quality conditions?
- Is the measure useful in system management?
- Is the measure meaningful at the local, state and national level and to the public?
- Is the measure consistent across related programs (e.g., storm water, etc.)?

Screening produced a shorter list of performance measures that were evaluated in field interviews with CSO communities.

At its third meeting in September, 1995, the Work Group reviewed the results of the field interviews and finalized a set of recommended performance measures and units of measurement. The Work Group also discussed the organization of the final report and its distribution and promotion.

At its fourth and last meeting in November, 1995, the Work Group reviewed a Draft Final Report and made final changes and modifications to the performance measures and other recommendations.

2.3 FOCUS GROUP MEETINGS

During May and June, 1995, AMSA convened a series of six Focus Group meetings to review and refine the list of potential performance measures for CSO control. Three Focus Group meeting were held in Boxborough, MA, for New England-based CSO communities, regulatory agency representatives, and environmental interests. An additional three Focus Group meetings were held in Fort Mitchell, KY, for Ohio River Valley representatives for the same interest groups. The meetings were attended by approximately eighty-five participants (see listing in Appendix A). Each participant brought a wealth of experience and knowledge related to CSO systems, CSO impacts and CSO controls to the discussion of performance measures. All six Focus Group meeting were professionally facilitated and followed a similar process:

- Participants developed and discussed an extensive list of potential performance measures, and related their concerns about CSO control and performance measurement.
- Participants voted to identify the most important performance measures.
- Participants ranked the first-cut list of forty-eight performance measures developed by the Work Group at its March meeting according to their relative importance: high, medium or low.

Several key performance measures were discussed at all of the Focus Group meetings and were determined to be very important across all interest groups. These were:

- The frequency and volume of overflows (normalized for precipitation).
- Documented compliance (implementation) with the NMCs.

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- Use attainment (or use impairment), as generally indicated by instream measures of fecal coliform and dissolved oxygen.
- Aesthetics, including consideration of waterfronts as an economic amenity.

Several key concepts that performance measures should incorporate were discussed at each Focus Group meeting. Because of their importance to the development and implementation of performance measures, these concepts are highlighted below:

- All four of the categories of performance measures (administrative; end-of-pipe; receiving water; and ecological/human health and resource use measures) may have a role in tracking performance and benefits.
- Use of performance measures at the local level should be linked to locally defined objectives, and to site specific control plans.
- It may be very difficult to determine CSO control benefits in urban waters affected by multiple sources including point sources, urban storm water, sanitary sewer overflows (SSOs), septic systems, and agricultural sources.
- CSO control should be viewed in the context of watershed management.
- The presence of raw waste discharges to urban waters is unsettling regardless of impacts, and there is a certain *peace of mind factor* associated with CSO control.

Focus Group rankings of the first-cut performance measures are in Appendix B.

2.4 FIELD INTERVIEWS

During August and September, 1995, field interviews were conducted in order to test the appropriateness of performance measures in CSO communities of different size, at different stages in planning and implementation, in different geographic areas, and with different receiving water impacts. In order to do this, interviews were scheduled with CSO managers, POTW operators, public works staff involved in the maintenance and operation of collection systems, laboratory staff, CSO consultants, permit writers, and environmental groups. A total of eighteen CSO communities and six regulatory and environmental organizations participated in the field interviews. All but one of the CSO communities (Atlanta, GA) were visited in-person by one or more members of the study team. The participating CSO communities (grouped by population) and were:

CSO Communities Greater than 100,000	CSO Communities 20,000 to 100,000	CSO Communities Less than 20,000
King County (Seattle), WA	Portland, ME	Mechanics Falls, ME
Monroe County, NY	Everett, WA	Rockland, ME
Middlesex County, NJ	Newark, OH	Skowhegan, ME
Atlanta, GA	Perth Amboy, NJ	Bath, ME
Akron, OH	New Brunswick, NJ	Gardiner, ME
	So. Portland, ME	Anacortes, WA
	Augusta, ME	

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Other participating agencies and organizations were:

Other Agencies and Organizations
Maine Department of Environmental Protection
Washington Department of Ecology
New Jersey Department of Environmental Protection and Energy
Casco Bay National Estuary Program, Maine
Ohio Environmental Protection Agency
EPA Region X, Seattle, WA

The individuals representing these agencies are listed in Appendix A.

The field interviews focused on a short list of twenty-six performance measures screened and identified by the Work Group at its second meeting. Two central questions were asked for each performance measure at the interviews:

Is the performance measure applicable in your system?

If applicable, what is your assessment of the measure as a useful and practical way to track environmental improvement associated with CSO control?

The results of the interviews were quantified for each measure into a composite score associated with high, medium and low applicability. Where indicated as applicable, the results were also quantified for high, medium and low usefulness. The results of the field interviews reinforced the general findings of the Focus Groups. The results also enabled the Work Group to separate those performance measures with broad applicability from those applicable on a site-specific basis. In addition, performance measures that were nearly universally judged as "not applicable" and "not useful" were eliminated from further consideration.

2.5 REPORT PREPARATION

A Draft Final Report was prepared by the study consultants and distributed to the Work Group, AMSA staff, and select staff at EPA for review. Review comments, suggestions and ideas were submitted to the study consultants at the fourth Work Group meeting and incorporated into a Revised Draft Final Report. The Final Study Report was approved for publication and distribution by AMSA following another round of review and comments by the Work Group.

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3.0 STUDY FINDINGS

3.1 INTRODUCTION

The formulation of study findings by the Work Group was based upon a broad variety of information sources and dialog. The information, advice and recommendations received at the Focus Group meetings and field interviews were extremely valuable and provided firsthand knowledge from dozens of CSO communities and receiving water situations. The Work Group also received briefings from EPA staff on the National Environmental Goals Project and the Office of Water Environmental Indicators Project. In addition, the study consultants provided advice and suggestions in the areas of water quality and the design, operation and maintenance of CSSs. Finally, the Work Group drew upon the collective experience of its members in the administration and operation of public utilities; permit writing; environmental assessment; environmental advocacy; city management; and the development of public policy. It was this experience base that enabled the Work Group to engage in technical and policy discussions and debate that led to the finalization of recommendations.

The study findings are presented in two subsections. These are:

- **Observations:** The observations are study findings that are useful for understanding CSO control and the selection of performance measures. This subsection provides information on basic principles, the categories of performance measures, designated uses, locally defined objectives, and cost considerations.

- **Recommended Performance Measures:** The recommended performance measures are described in detail in this subsection. The description indicates what the performance measure is trying to track, units of measurement, and where its use might be appropriate. Examples and anecdotal information are also included. In addition, individual Profile Sheets provide a brief overview for each performance measure. Profile Sheets cover applicability and use, advantages and disadvantages, potential data sources, probable reporting agencies, cost of data collection, and other information in a consistent manner.

3.2 OBSERVATIONS

General observations and findings developed by the Work Group are as follows:

3.2.1 Basic Principles

Urban waters are typically very complex. CSO discharges are one of many sources of pollution that contribute to impaired or poor water quality and other environmental problems in urban waters. Other sources include storm water, failed septic systems, upstream nonpoint source pollution and agricultural runoff, municipal and industrial

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wastewater, atmospheric deposition, and contaminated bottom sediments. In order to place the CSO performance measures into context, several basic principles were used to guide their development. These basic principles are as follows:

- Performance measures were developed in this study primarily for local use by CSO communities.
- CSSs and the impacts of CSO discharges are very site specific. CSO control is expensive and largely dependent on local funding. Difficult choices have to be made by CSO communities. Performance measures provide a means to guide management activities and to track results.
- A menu-like framework for performance measures provides CSO communities with a way in which to select performance measures to match local needs and objectives.
- Some performance measures have value at the watershed level where multiple sources impact water quality and environmental conditions.
- Some performance measures have value for tracking the programmatic effectiveness of CSO control programs at state or national levels.
- Data for some performance measures are more appropriately gathered by agencies other than local governments.

The Work Group believed it will be important for readers to keep these basic principles in mind as they review and consider the recommended performance measures.

3.2.2 Categories of Performance Measures

The potential performance measures considered by the Work Group fell into four categories:

- Administrative Measures.
- End-of-Pipe Measures.
- Receiving Water Measures.
- Ecological, Human Health and Resource Use Measures.

As shown in Figure 3-1, EPA recommends that preference be given to the use of data from the categories containing receiving water, ecological, human health and resource use measures (e.g., improvements in ambient water quality, increased numbers and diversity of aquatic life, fewer beach closures, etc.). These preferred environmental measures provide tangible, results-oriented data for measuring performance. In contrast, the use of data from the less preferred categories containing administrative and end-of-pipe measures (e.g., number of permits issued, dollars spent, overflow volume, etc.) provides little tangible evidence of environmental change and improvement. Measures from within these categories track the results of administrative activities and changes in loadings, but do not directly address changes in ambient or environmental conditions.

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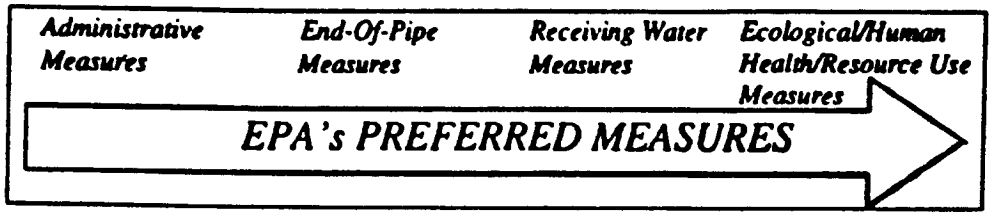
Fig. 3-1 Preferred Data for Measuring Environmental Results



From the outset of the study, the Work Group endeavored to identify "preferred" environmental measures that connected program activities and dollars spent on environmental infrastructure with measurable improvements in water quality, habitat, human health, and the beneficial use of receiving waters. However, following extensive review and discussions, the Work Group found that reliance on environmental measures alone would not be satisfactory. In complex urban waters it is often difficult to isolate CSO impacts with specific water quality and environmental measures on account of the many pollutant sources that affect these waters. The results of ambient or ecological monitoring can rarely be used to reliably establish cause and effect relationships between CSOs and environmental conditions. While the preferred environmental measures are important, they are not often definitive. Consequently, the Work Group found that a balanced approach with equal emphasis on all four categories and consideration of a broad spectrum of performance measures is warranted. Individual performance measures from within each category will be useful and appropriate for tracking CSO control.

Use of a broad spectrum of performance measures across these categories will allow local government officials, policy makers, and the public to assess the effectiveness of CSO controls, the general health of the environment, and changes in its condition. It will also provide a means to meet several program management needs articulated by the Government Accounting Office (GAO, 1988). These are:

- Assess progress in meeting program objectives.
- Help allocate scarce resources.
- Identify areas to target resources and marshal support for current programs.
- Serve as part of a performance and accountability system.

3.2.3 Designated Uses

The attainment of designated uses was discussed extensively by the Work Group as a central goal of CSO control efforts. It was recognized that CSO discharges can contribute to nonattainment of designated uses in urban waters. However, nonattainment is often not dependent on a single source. Instead, multiple sources are usually responsible. The Work Group observed that environmental management directed at the attainment of designated uses in urban receiving waters is more likely to be successful if all pollution sources are addressed in the context of a watershed approach.

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As background, designated uses are water uses identified in state water quality standards. Designated uses can vary from one water body to the next, or from one reach to another within water bodies. Examples of designated uses include cold or warm water fisheries, shellfish harvesting, public water supply, contact recreation (including swimming), agricultural water, and navigation. As required under the CWA, designated uses must be achieved and maintained.

Designated uses for water bodies are determined by states or tribes. Regulatory authorities often reference designated uses and the maintenance of designated uses in NPDES permits. As prescribed under Section 305(b) of the CWA, states, tribes, and other jurisdictions assess and report on the status of surface waters every two years in State 305(b) Water Quality Assessment Reports. These assessments report on whether or not designated uses are being supported. They are generally based upon available physical, chemical and biological information as well as direct observation and professional judgment. Varying degrees of use support are quantified on a state-wide basis in categories such as fully supporting, fully supporting but threatened, partially supporting, and not supporting. A relative assessment of the causes of nonsupport of designated uses is typically included in the 305(b) reports. Examples of causes include pesticides, metals, nutrients, organic enrichment and pathogen indicators. Sources of water quality problems that impact designated uses are also assessed on a state-wide basis. Sources can include industrial point sources, municipal point sources, CSOs, agriculture, construction, etc.

The Work Group recognized that CSO communities will benefit from coordination with state resource and regulatory agencies concerning designated uses and the reporting of use support in state 305(b) reports. The Work Group also recognized that the CSO Policy and other federal regulations provide several options if it appears that designated uses and water quality standards may not be appropriate for wet weather conditions. These include review of water quality standards and use attainability analysis. CSO communities, NPDES permitting authorities, the states, and other stakeholders may need to discuss this issue in the formulation of LTCPs and in the development of wet weather programs on a watershed basis.

3.2.4 Locally Defined Objectives

There is a natural tendency in discussions of CSO control planning and implementation to emphasize regulatory requirements. The CSO Policy states that one of its main purposes is "to expedite compliance with the requirements of the CWA" (CSO Policy, Section I.A.). Attainment of designated uses through control of CSOs and other pollution sources is related to compliance with CWA mandates as reflected in state water quality standards. In short, much of the focus in CSO control planning, and consequently many of the performance measures in this report, deal with federal or state mandates.

This regulatory focus should not cause CSO Communities to lose sight of what the Work Group called "locally defined objectives." Many potentially useful performance measures

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relate to the achievement of local objectives that are not mandated by standards or permits. The distinction between regulatory requirements and locally defined objectives may not always be clear. Nevertheless, it is a useful distinction for local officials responsible for planning and implementing water quality improvement programs.

Work Group and Focus Group participants repeatedly spoke of the site specific nature of CSO control and offered examples of the resulting benefits: water bodies avoided by the public before controls were implemented are transformed into popular greenways; water-based recreation activity increases; blighted urban waterfront areas become valuable sites for residential or commercial redevelopment. In these and other examples, elimination of odors or nuisances and improvement of water quality and habitat enhanced the desirability of the water and shoreline for public use and enjoyment. Compliance with regulatory requirements helps to create the conditions for increased recreational or economic activity.

Achievement of locally defined objectives may be measured in terms of fishing, swimming or boating person-days; increased waterfront property values; development and use of shoreline trails; or other measures of activity or economic value. Regulations and permits contain standards that define a level of water quality sufficient to support designated uses. But permits do not specify the level of an activity that should actually take place after standards are met. Objectives of this type, and performance measures to document their achievement, are a matter of local discretion.

There are two reasons for considering performance measures related to locally defined objectives before and after implementing CSO controls. First, identifying local objectives for CSO-impacted water bodies during the planning process can produce better outcomes. If project objectives are seen as broader than compliance with regulations, opportunities may be found for enhancing project benefits. For example, trails and shoreline access points can be designed in conjunction with CSO piping and control structures. Waterfront sites suitable for public or private redevelopment can be acquired as part of CSO control projects.

Second, locally defined objectives are helpful in communication with the public. People can understand and support a goal of turning an urban stream from an open sewer into a scenic greenway. By formulating a vision for the future of receiving waters and adjacent lands, and then measuring success, local officials can assure ratepayers that their money is being spent wisely in the public interest.

3.2.5 Watershed Approach

Because of the broad variety of pollution sources affecting urban waters, the Work Group found that CSO control should be viewed in the context of watershed management. In particular, many of the receiving water measures and ecological, human health and resource use measures quantify impacts or effects that are often governed by sources beyond CSOs. Attaining water quality standards and meeting designated uses in most urban waters can only be accomplished through a concerted effort to limit all sources of

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pollutants. This method of assessment and management is commonly referred to as the "Watershed Approach."

The Watershed Approach is built on three main principles. First, the target watersheds should be those where pollution poses the greatest risk to human health, ecological resources, desirable use of the water, or a combination of these. Second, all parties with a stake in the watershed should participate in the analysis of problems and the creation of solutions. Third, the actions undertaken should draw upon the full range of methods and tools available, integrating them into a coordinated, multiorganization attack on the problems. Other attributes of the Watershed Approach are that it provides a geographic focus for environmental management; it encourages the prioritization of objectives; and it fortifies partnerships and the development of integrated solutions. Because of the broad geographic areas covered, and the variety of pollution sources considered, state or regional agencies typically take an active leadership role in watershed studies. CSO communities typically participate as one of the stakeholders.

The importance of the Watershed Approach is clearly recognized in the CSO Policy where it is stated that:

> ***"Permitting authorities are encouraged to evaluate water pollution control needs on a watershed management basis and coordinate CSO control with other point and nonpoint source activities." (Section I.B.)***

The discussion of the "Demonstration Approach" in the CSO Policy also directly addresses watershed issues in discussing the need to allocate pollution among all sources:

> ***"Where water quality standards and designated uses are not met in part because of natural background conditions or pollution sources other than CSOs, a total maximum daily load (TMDL) including a wasteload allocation and a load allocation, or other means, should be employed to apportion pollution loads". (Section II.C.4.b)***

In recognition of the importance of the watershed approach, the Work Group identified performance measures that were particularly suitable for tracking environmental change on a watershed basis. However, many receiving water and ecological measures require expertise and an investment in staff and resources that go beyond the capabilities typically found in CSO communities. Therefore, it may be advantageous to share and coordinate monitoring targeted at watershed issues among involved federal, state, regional and local government agencies so that the appropriate expertise is utilized, and the cost burden to the CSO community is limited.

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3.2.6 Cost Considerations

The Work Group found that cost is an important factor in the consideration of performance measures. In particular:

- The cost of obtaining data for the performance measures should be commensurate with the usefulness of the data.
- The cost of obtaining data for the performance measures should not represent an extra burden to CSO communities beyond what was stated or intended in the CSO Policy. (*Note: CSO communities may want to voluntarily take on added costs to track important measures associated with locally defined objectives.*)
- The cost of CSO control is not a performance measure per se, but should be tracked to put the economic investment of CSO control into context. CSO communities are encouraged to identify the relative cost of management and control alternatives in order to determine whether or not program activities are cost-effective.

3.3 RECOMMENDED PERFORMANCE MEASURES

3.3.1 Overview

The Work Group identified and recommended twenty-four individual performance measures to be used to track and quantify the results of CSO control. These recommended performance measures are summarized in Table 3-1. As shown, all four categories of performance measures are represented: administrative measures; end-of-pipe measures; receiving water measures; and ecological/human health/resource use measures. The end-of-pipe category is divided into two subcategories: measures of flow; and measures of pollutant load reduction. These performance measures are considered to be the ones that will generally be most useful for CSO communities. Other performance measures not included within these recommendations may also be appropriate. A discussion of performance measures and environmental indicators from other national programs is presented in Section 5.0

All twenty-four of the performance measures were considered to be *Appropriate for General Use* by CSO communities. Four of the performance measures were identified as *Appropriate for National Tracking*. The performance measures recommended as appropriate for national tracking represent a limited group of measures that would be particularly useful in tracking the overall status of the CSO Control Program, and reduction in the occurrence of CSO discharges to receiving waters. These measures are generally well understood by CSO communities, they can be monitored and tracked in a consistent manner across the nation, and they can be aggregated on an annual basis for simple trend analysis.

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Table 3-1 SUMMARY OF RECOMMENDED PERFORMANCE MEASURES

FOR GENERAL USE AND NATIONAL TRACKING

Administrative	End-Of-Pipe
Documented Implementation of NMCs Status of LTCP	CSO Frequency CSO Frequency in Sensitive Areas

FOR GENERAL USE

Administrative	End-Of-Pipe	Receiving Water	Ecological/Human Health/ Resource Use
Waste Reduction	Flow Wet Weather Flow Budget CSO Volume CSO Volume in Sensitive Areas Dry Weather Overflows	Dissolved Oxygen Trend Fecal Coliform Trend Floatables Trend Sediment Oxygen Demand Trend Trend of Metals in Bottom Sediment	Shellfish Bed Closures Benthic Organism Index Biological Diversity Index Beach Closures Recreational Activities Commercial Activities
	Pollutant Load Reduction BOD Load TSS Load Nutrient Load Floatables		

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As shown in Table 3-1, the recommended performance measures are arrayed in a menu-like framework. This format is intended to present the performance measures in a manner that encourages CSO communities to select the most appropriate performance measures to meet their needs. The LTCP and local knowledge of the CSS, receiving waters, and impacts should be used to guide CSO communities in the selection of a subset of performance measures that will demonstrate the results of CSO control.

Many of the performance measures will not be appropriate for all CSO communities. For example, tracking beach closures is not warranted where there are no beaches. Similarly, tracking nutrient load reduction may not be warranted in CSO communities where the nutrient load associated with CSOs is not considered to be a problem. Common sense, local conditions, and cost-effectiveness should drive the selection of performance measures.

The relationship of the performance measures to the NMCs and the LTCP is presented in a generalized manner in Table 3-2. As shown, several of the NMCs are given special attention as individual performance measures. These are waste reduction, floatables, and dry weather overflows (DWOs). These measures might be useful on a case-by-case basis for CSO communities where special emphasis on these controls would be particularly valuable and consistent with the LTCP.

3.3.2 Technical Considerations

The primary purpose of collecting data on performance measures is to develop sufficient information so that meaningful yet simple trends can be developed. The time period of interest extends from baseline or pre-control conditions to full implementation of the LTCP, and beyond. Most of the performance measures require quantification on an annual or per year basis. Year-to-year differences and changes are targeted for tracking and trend analysis. Data collection should therefore be as consistent as possible from year-to-year.

The collection and examination of rainfall data is a major element of sewer system characterization. Rainfall data is also essential to the operation and management of most CSSs, and an important component in the assessment of several performance measures. With the exception of snowmelt conditions, the occurrence of CSO events is directly related to the frequency, duration, intensity and magnitude of rainfall. Changes in the performance of the CSS will also be directly related to the variability of rainfall from year-to-year. Therefore, several of the performance measures will require some "normalization" in order to make the results comparable from one year to the next. The simplest method of normalization is to divide the results (e.g., number of overflow events per year) by a normalization ratio calculated by dividing the annual rainfall received within a given year by long term average annual rainfall. The normalization ratio in this approach weights the results from one year to the next according to the annual rainfall or precipitation total for each year. Other more complex normalization methods based upon

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Table 3-2 Relationship of Performance Measures to the Nine Minimum Controls and the LTCP

PERFORMANCE MEASURES	NINE MINIMUM CONTROLS									LTCP	
	Proper O & M	Maximize Storage	Pretreat-ment	Maximize Flow to POTW	Eliminate DWOs	Control Solids & Floatables	Pollution Prevention	Public Notifi-cation	Monitor	Presump-tion Approach	Demon-stration Approach
Administrative											
Documented Implementation of NMCs	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Status of LTCP								✓			
Waste Reduction						✓	✓				
End-Of-Pipe											
Wet Weather Flow Budget		✓		✓						✓	✓
CSO Frequency									✓	✓	✓
CSO Frequency in Sensitive Areas									✓	✓	✓
CSO Volume										✓	✓
CSO Volume in Sensitive Areas										✓	✓
Dry Weather Overflows	✓		✓		✓				✓		✓
BOD Load										✓	✓
TSS Load										✓	✓
Nutrient Load										✓	✓
Floatables						✓					✓
Receiving Water											
Dissolved Oxygen Trend											✓
Fecal Coliform Trend											✓
Floatables Trend						✓					
Sediment Oxygen Demand Trend											
Trend of Metals in Bottom Sediments											
Ecological/Resource Use											
Shellfish Bed Closures									✓		✓
Benthic Organism Index											✓
Biological Diversity Index											✓
Beach Closures									✓		
Recreational Activities									✓		✓
Commercial Activities											

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rainfall intensity, rainfall duration, or correlations between other overflow and rainfall characteristics may be applied as appropriate.

3.3.3 Description of Performance Measures and Profile Sheets

A two-page summary for each performance measure is provided (see Table 3-3 for page locations). This includes:

- A **Description** for each performance measure with a general discussion about the expected results for each measure, the conditions that are appropriate for its use, and why the data is important. Examples and anecdotal information from CSO communities and federal and state programs have been provided where available.

- A single-page **Profile Sheet** for each performance measure that provides a readily available visual reference for managers that will be helpful in selection of the most appropriate performance measures. Each Profile Sheet contains a definition of the performance measure, and addresses applicability and use, advantages and disadvantages, units of measurement, probable reporting agency, potential data sources, cost of data collection, and a reference for additional information.

A qualitative assessment of each performance measure with regard to the attributes listed below is also contained in the Profile Sheets:

- Relationship to CSO discharge.
- Ability to be quantified for trend analysis.
- Usefulness relative to the cost of data collection.
- Flexibility with respect to local objectives and conditions.
- Ability to be understood by the general public.
- Relationship to environmental improvement.
- Applicability in a watershed context.

Attributes are rated as high, medium or low. The attributes are generally consistent with the selection criteria applied by the Work Group to screen potential performance measures.

The relative information provided on the cost of data collection and attributes are not provided as conclusions, but are presented as general considerations to be used in the comparison of performance measures.

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Table 3-3 Page Reference for Performance Measures

PERFORMANCE MEASURE	PAGE
Administrative	
Documented Implementation of NMCs	3-14 to 3-15
Status of LTCP	3-16 to 3-17
Waste Reduction	3-18 to 3-19
End-of-Pipe	
Wet Weather Flow Budget	3-20 to 3-21
CSO Frequency	3-22 to 3-23
CSO Frequency in Sensitive Areas	3-24 to 3-25
CSO Volume	3-26 to 3-27
CSO Volume in Sensitive Areas	3-28 to 3-29
Dry Weather Overflows	3-30 to 3-31
BOD Load	3-32 to 3-33
TSS Load	3-34 to 3-35
Nutrient Load	3-36 to 3-37
Floatables	3-38 to 3-39
Receiving Water	
Dissolved Oxygen Trend	3-40 to 3-41
Fecal Coliform Trend	3-42 to 3-43
Floatables Trend	3-44 to 3-45
Sediment Oxygen Demand Trend	3-46 to 3-47
Trend of Metals in Bottom Sediments	3-48 to 3-49
Ecological/Resource Use	
Shellfish Bed Closures	3-50 to 3-51
Benthic Organism Index	3-52 to 3-53
Biological Diversity Index	3-54 to 3-55
Beach Closures	3-56 to 3-57
Recreational Activities	3-58 to 3-59
Commercial Activities	3-60 to 3-61

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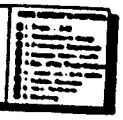
CSO Performance Measure Description
Documented Implementation of the Nine Minimum Controls



This administrative measure gauges how individual CSO communities and groups of CSO communities are progressing with implementation of the Nine Minimum Controls (see Table 1-1). As identified in the CSO Policy, the Nine Minimum Controls represent technology-based controls that can produce substantial environmental improvement at relatively low cost. At the local level, this measure is a simple yes or no, or a listing of the minimum controls implemented to date. At the state or national level, this measure represents the cumulative number of CSO communities where it has been documented that the Nine Minimum Controls are in place.

All CSO communities are expected to implement the Nine Minimum Controls by January 1, 1997. Documentation should include the alternatives considered, actions taken, scheduled actions to be taken in the future, and an assessment of the effectiveness of the controls in reducing or eliminating water quality impacts. Documentation that the Nine Minimum Controls are in place can come in many forms including facility plans, inspection and maintenance reports, public notices, and other technical studies. The Nine Minimum Controls are operating practices that are intended to be sustained over time, so documentation should be a continuing or periodic process. Specific guidance on documentation for each of the controls is discussed in EPA's *Guidance for Nine Minimum Controls* (U.S. EPA, 1995b).

While this measure does not directly measure receiving water or environmental results, it nevertheless provides a strong measure of progress in the reduction of CSOs at the source. It is therefore recommended as a performance measure that may be used for national tracking of activities and results related to CSO control.

Example

An informal survey of several dozen CSO communities in New England and the Midwest during May and June of 1995 revealed that nearly all CSO communities believed they had implemented or were in the process of implementing most of the Nine Minimum Controls. The control of solid and floatable material appears to present the largest challenge.

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NINE MINIMUM CONTROLS

1. Proper O & M
2. Maximization of Storage
3. Pretreatment Requirements
4. Maximum Flow to POTW
5. Elim. of Dry Weath Overflows
6. Control Solids & Floatables
7. Pollution Prevention
8. Public Notification
9. Monitoring

CSO Performance Measure Profile Sheet
Documented Implementation of the Nine Minimum Controls

Category: **Administrative**

Description:
The cumulative number of CSO communities with Nine Minimum Controls in place (# of CSO communities). For CSO communities, a description of progress in implementing the Nine Minimum Controls would be appropriate.

Applicability and Use:
Implementation of the Nine Minimum Controls is a requirement for all CSO communities under the CSO Policy. This performance measure is therefore appropriate for most CSO communities. Locally, it will be useful for CSO communities to demonstrate compliance with requirements established under the CSO Policy. At the state and federal level, this performance measures will be useful in tracking the implementation of the Nine Minimum Controls.

Advantages of Measure:
- Potentially includes all or most CSO communities in the nation.
- Largely based upon documentation of standard operating procedures for a CSS.
- Cost is relatively small.
- Shows progress of implementation at the state and national levels.

Disadvantages of Measure:
- Documentation may be inconsistent from community to community and state to state.
- Not a measure of environmental results.

For More Information:
U.S. EPA. 1995. *CSOs: Guidance for Nine Minimum Controls.* EPA 832-B-95-003.

Units of Measurement:
Number of CSO communities.

Probable Reporting Agency:
CSO communities and Federal/State Regulatory Agencies.

Potential Data Sources:
Documentation Reports from CSO communities.

Cost of Data Collection:
Low. Information should be available. Documentation costs should be substantially less than implementation costs.

Attributes:

* Linkage to CSO discharge	●
* Quantifiable for trend analysis	◗
* Usefulness relative to the cost of data collection	●
* Flexibility with respect to local objectives and conditions	●
* Understandable to the public	◗
* Relationship to environmental improvement	○
* Watershed Context	◗

KEY
● High ◗ Moderate ○ Low

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CSO Performance Measure Description
Status of Long-Term Control Plans (LTCPs)



This administrative measure assesses how individual CSO communities and groups of CSO communities are progressing with regard to the development and implementation of LTCPs. As described in the CSO Policy, the nine elements of the LTCP are:

1. Characterization, monitoring and modeling activities.
2. Public participation.
3. Consideration of sensitive areas.
4. Evaluation of alternatives.
5. Cost/performance considerations.
6. Operational plan revisions.
7. Maximization of treatment at the existing POTW for wet weather flows.
8. Implementation schedule.
9. Post-construction compliance monitoring program.

At the local level, this measure is a simple determination of the status of the LTCP with regard to the nine elements above covering the initiation of planning, system characterization, the evaluation of alternatives, and implementation. At the state or national level, this measure represents the cumulative number of CSO communities with LTCPs in development, being implemented, and completed.

While this measure is not a direct measure of receiving water or environmental results, it nevertheless provides a strong measure of progress in the development and implementation of LTCPs focused on reducing the frequency and volume of CSOs. It is therefore recommended as a performance measure that may be used for national tracking of activities and results related to CSO control.

Example

There are 117 CSO communities in New England. EPA Region I reports that 38 have LTCPs in development, 30 are implementing LTCPs, and 17 have completed implementation.

Source: U.S. EPA Region I, Boston, MA.

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CSO Performance Measure Profile Sheet
Status of Long-Term CSO Control Plans

Category: **Administrative**

Description:
The number of CSO communities with LTCPs in development, being implemented, and completed (# of CSO communities). For CSO communities, a description of the status of the LTCP would be appropriate.

Applicability and Use:
This performance measure is appropriate for most CSO communities. LTCPs are intended to be water quality-based control plans that are technically feasible, affordable and consistent with the CSO Policy. At the local level this measure will have some value for elected officials and the general public as an indication of the status of required planning and implementation. At the state and federal levels, the aggregate numbers provide a snapshot of compliance with programmatic requirements.

Advantages of Measure:
- Potentially includes all or most CSO communities in the nation.
- LTCPs recognize the site specific nature of CSOs and their impacts on receiving waters.
- LTCPs provide a consistent way for state and federal agencies to track programmatic requirements.
- No additional costs are required to track this measure.

Disadvantages of Measure:
- Not a measure of environmental results.

For More Information:
U.S. EPA. 1995. *CSOs: Guidance for Long-Term Control Plan.* EPA 832-B-95-002.

Units of Measurement:
Number of CSO communities.

Probable Reporting Agency:
CSO communities and Federal/State Regulatory Agencies.

Potential Data Sources:
- Long Term Control Plans.
- Implementation schedules.

Cost of Data Collection:
Low. Information should be available.

Attributes:

* Linkage to CSO discharge	●
* Quantifiable for trend analysis	○
* Usefulness relative to the cost of data collection	●
* Flexibility with respect to local objectives and conditions	●
* Understandable to the public	◗
* Relationship to environmental improvement	○
* Watershed Context	◗

KEY
● High ◗ Moderate ○ Low

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CSO Performance Measure Description
Waste Reduction



This administrative measure provides a quantification of the success of pollution prevention and other activities in reducing the amount of solids and floatables entering the CSS. Waste reduction is the volume of waste material prevented from entering the CSS from pollution prevention activities and catch basin cleaning. The units for this measure are cubic yards, pounds or tons per year.

Pollution prevention activities include street sweeping, solid waste collection, recycling, product bans, and household hazardous waste disposal. These activities control dissolved pollutants as well as solids and floatables. Modification of catch basins and routine catch basin cleaning are important elements of preventing waste material from entering the collection system. The stenciling of catch basins at the inlet to warn against dumping and disposal of motor oil, anti-freeze and other hazardous materials is an effective measure. However, the results of some activities such as stenciling and product bans are not readily quantifiable.

All CSO communities are required to implement pollution prevention programs to reduce contaminants in CSOs as part of the Nine Minimum Controls. Waste reduction is easily understood by the general public. It is considered as a separate performance measure because waste reduction is emphasized in some CSO communities, and the tracking of individual elements of waste reduction can be used as a measure of program success.

Example

The King County Department of Metropolitan Services in Seattle, Washington has implemented a comprehensive program to reduce waste from entering the CSS. This program requests businesses and households to be careful not to let pollutants enter storm drains, and to maintain catch basins. The major elements of this program are as follows:

- ***Practice Good Housekeeping*** by keeping parking lots and walkways clean, cleaning up spills, keeping dumpsters covered and secure, storing chemicals properly, covering bare ground to prevent erosion, and keeping pet waste out of storm drains.
- ***Trap Pollutants*** by using a drip pan when transferring liquids from one container to another, and using a tarp to catch paint chips and wood and metal shavings when blasting, grinding, or sanding.
- ***Watch Your Washwater*** when washing your car or cleaning shop floors and divert oil, detergents and trace metals away from storm drain.
- ***Maintain Your Catch Basins*** through regular inspection and maintenance, cleaning, proper disposal of solids, and stenciling to reduce waste dumping.

Source: King County Department of Metropolitan Services, Seattle, WA.

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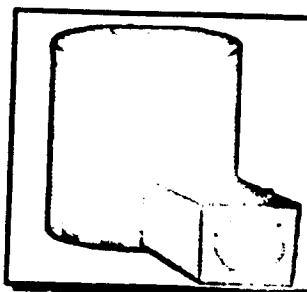

CSO Performance Measure Profile Sheet

Waste Reduction

Category: **Administrative**

Description:
Trend of the volume of waste material prevented from entering the combined sewer system from pollution prevention activities and catch basin cleaning.

Applicability and Use:
Pollution prevention is one of the Nine Minimum Controls. Waste Reduction may be particularly useful as a performance measure in CSO communities where pollution prevention is emphasized. Increases in waste reduction volumes will generally indicate improvement in a combination of pollution prevention activities.

Advantages of Measure:
- Data for catch basin cleaning, street sweeping, recycling and other pollution prevention activities are available in many CSO communities.
- Many elements of waste reduction are understood by the public.

Disadvantages of Measure:
- Many types of pollution prevention activities are difficult to measure.
- Data for the combined and separate portions of the sewer system may be difficult to break out.
- The linkage between waste reduction and environmental improvement is weak.
- Trend analysis may be highly influenced by the frequency of maintenance activities and the success of recycling and other pollution prevention activities. These activities can work in different directions and be difficult to interpret, (i.e., more recycling may mean less waste removed from catch basins).

For More Information:
U.S. EPA. 1995. *CSOs: Guidance for Nine Minimum Controls.* EPA 832-B-95-003.

Units of Measurement:
Cubic yards, pounds or tons per year.

Probable Reporting Agency:
CSO Communities.

Potential Data Sources:
- Maintenance records.
- Tipping fees.
- Recycling records.

Cost of Data Collection:
Low to Medium. Cost to gather existing data is low. The cost of initiating new data collection activities may be low to medium.

Attributes:

* Linkage to CSO discharge	◗
* Quantifiable for trend analysis	○
* Usefulness relative to the cost of data collection	◗
* Flexibility with respect to local objectives and conditions	●
* Understandable to the public	◗
* Relationship to environmental improvement	○
* Watershed Context	○

KEY
● High ◗ Moderate ○ Low

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CSO Performance Measure Description
Wet Weather Flow Budget



This measure quantifies the volume of wet weather flow within the CSS and how it is allocated. The appropriate components of the wet weather flow budget will vary from community to community depending on the design and configuration of the collection system, the capacity of the POTW, and the control alternatives selected for implementation. The wet weather flow budget may include the following components:

- Flow eliminated due to sewer separation.
- Flow diverted prior to the CSS (e.g., down spout diversion).
- Flow receiving primary or the equivalent of primary treatment.
- Flow receiving secondary or greater treatment at the POTW.
- Flow receiving no treatment.

The units for this measure are millions of gallons per year (MG/year). The use of flow meters strategically located within the CSS to measure the wet weather flow budget is ideal, but may be too costly or impractical in many CSO communities. The use of collection system models, supplemented with a continuing field validation program, will suffice in most instances. Some normalization of the components of the wet weather flow budget may be required to account for year-to-year differences in precipitation.

Example

The City of South Portland, ME combines real time flow measurements with model-based estimates to compute a wet weather flow budget. The wet weather flow budget for 1995 is illustrated in this example.

Wet Weather Flow Budget: 1995

Flow eliminated due to separation:		184 MG
Flow diverted from CSS:		
Redirection of roof drains	6 MG	
Redirection of sump pump discharges	52 MG	
Flow slipping (1)	12 MG	
Subtotal Diverted:		70 MG
Flow receiving primary or equivalent treatment		2 MG
Flow receiving secondary or greater treatment		2,018 MG
Flow receiving no treatment		32 MG

(1) Flow slipping is the placement of solid covers on select catch basins to divert flow away from the CSS.

Source: City of South Portland, ME.

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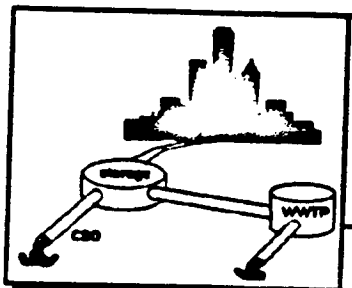

CSO Performance Measure Profile Sheet

Wet Weather Flow Budget

Category: **End-Of-Pipe**

Description:
Trend of the volume of wet weather flow:
a. Eliminated due to separation.
a. Diverted from CSS (e.g., down spout diversion).
b. Receiving primary or the equivalent of primary treatment.
c. Receiving secondary or greater treatment.
d. Receiving no treatment.

Applicability and Use:
Measuring and accounting for the volume of wet weather flow is a fundamental element of the proper operation and management of a CSS. Establishing a wet weather flow budget may be very valuable in CSO communities where reductions in wet weather flow and diversion within the CSS are important elements of the LTCP.

Advantages of Measure:
- Flow is a well understood unit of measurement, and many control practices are aimed at flow reduction or flow diversion.
- The use of flow meters and models to measure and estimate flow volumes and the flow budget is a common practice in most CSSs.

Disadvantages of Measure:
- The installation and operation of flow meters can be expensive.
- The comparison of wet vs. dry years may be difficult unless normalization procedures are applied.

For More Information:
U.S. EPA. 1995. *CSOs: Guidance for Long-Term Control Plan.* EPA 832-B-95-002.

Units of Measurement:
MG per year.

Probable Reporting Agency:
CSO Communities.

Potential Data Sources:
- Flow meters.
- Collection system modeling.

Cost of Data Collection:
Variable. Use of existing computer models is a relatively low cost. Metering of CSS is a relatively high cost.

Attributes:

* Linkage to CSO discharge	●
* Quantifiable for trend analysis	●
* Usefulness relative to the cost of data collection	●
* Flexibility with respect to local objectives and conditions	●
* Understandable to the public	◗
* Relationship to environmental improvement	○
* Watershed Context	◗

KEY
● High ◗ Moderate ○ Low

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CSO Performance Measure Description
CSO Frequency



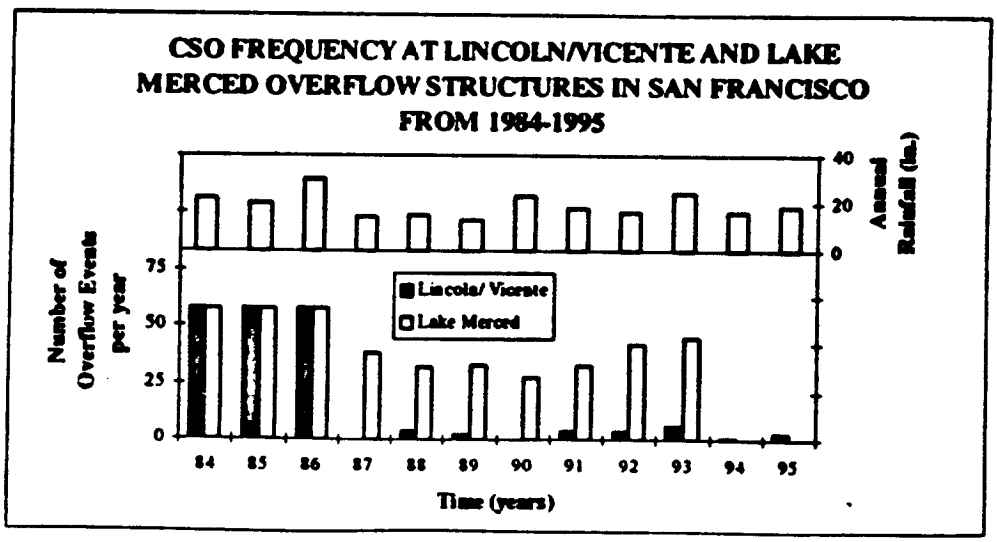
This end-of pipe measure tells us if the frequency of CSO discharge events is changing over time. CSO frequency is a quantification of the frequency of overflow events on an annual basis. The units of measurement are number of overflow events per year. Reducing the frequency of CSOs discharging to surface waters is one of the major goals of the CSO Policy. CSO frequency is therefore recommended as a performance measure that may be used for national tracking of activities and results related to CSO control.

An overflow event is defined as ***one or more overflows from a CSS as the result of a precipitation event that do not receive the minimum treatment specified.*** CSO frequency is particularly important for CSO communities interested in the "presumption" approach under which a total of no more than four overflow events per year is presumed to provide an adequate level of control.

The use of flow meters within the CSS is the ideal method of measurement, but can be very costly. Simpler methods including automatic water level recorders, block tests, and other mechanical devices may be appropriate. The use of collection system models, supplemented with a continuing field validation program, will suffice in most instances. Some normalization of annual CSO frequency values might be helpful in long term trend analysis to account for year-to-year differences in precipitation.

Example

The City of San Francisco has implemented CSO controls and reduced CSO frequency at major outfalls as illustrated in this example. Results are not normalized.



Source: San Francisco Department of Public Works, San Francisco, CA.

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CSO Performance Measure Profile Sheet

CSO Frequency

Category: **End-Of-Pipe**

Description:
Trend of the frequency of overflow events per year from the CSS (number of overflow events per year normalized for precipitation). An overflow event is defined as *one or more overflows from a CSS as the result of a precipitation event that do not receive the minimum treatment specified.*

Applicability and Use:
Quantification of the occurrence and frequency of overflows is basic to the operation and management of combined sewer systems. Reducing the occurrence of CSOs is a primary objective of CSO control. CSO frequency is particularly appropriate for CSO communities considering the Presumption Approach and the option to reduce the frequency of overflows to no more than an average of four overflow events per year. This performance measure is recommended for national tracking of activities and results related to CSO control.

Advantages of Measure:
- Consistent with the *Presumption Approach* in the CSO Policy.
- Can be measured or modeled in a variety of ways with a fairly high level of precision.
- Provides an understandable measure of control effectiveness.

Disadvantages of Measure:
- Comparison of wet and dry years may be difficult unless the data is normalized.
- The cost and effort to install and maintain meters and to develop a model of the CSS can be substantial.

For More Information:
U.S. EPA. 1995. *CSOs: Guidance for Long-Term Control Plan.* EPA 832-B-95-002.

Units of Measurement:
Number of overflow events per year.

Probable Reporting Agency:
CSO Communities.

Potential Data Sources:
- Flow meters.
- Collection system modeling.

Cost of Data Collection:
Variable. Use of existing computer models is a relatively low cost. Metering of CSS is a relatively high cost.

Attributes:

• Linkage to CSO discharge	●
• Quantifiable for trend analysis	●
• Usefulness relative to the cost of data collection	●
• Flexibility with respect to local objectives and conditions	●
• Understandable to the public	◗
• Relationship to environmental improvement	○
• Watershed Context	◗

KEY
● High ◗ Moderate ○ Low

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CSO Performance Measure Description
CSO Frequency in Sensitive Areas



This end-of-pipe measure quantifies the frequency of overflow events into sensitive areas on an annual basis. The units are number of overflows per year. Under the CSO Policy, CSO communities are expected to give the highest priority to controlling overflows to sensitive areas in the development of LTCPs. As a minimum, sensitive areas include designated Outstanding National Resource Waters, National Marine Sanctuaries, waters with threatened or endangered species and their habitat, waters with primary contact recreation (e.g., bathing beaches, etc.), public drinking water intakes or their designated protection areas, and shellfish beds. CSO frequency in sensitive areas is recommended as a performance measure that may be used for national tracking of activities and results related to CSO control.

An overflow event is defined as ***one or more overflows from a CSS as the result of a precipitation event that do not receive the minimum treatment specified.***

The use of flow meters within the CSS is the ideal method of measurement, but can be very costly. Simpler methods including automatic water level recorders, block tests, and other mechanical devices may be appropriate. The use of collection system models will suffice in most instances. Some normalization of annual totals for CSO frequency in sensitive areas might be helpful in long term trend analysis to account for year-to-year differences in precipitation.

Example

The Massachusetts Water Resources Authority's LTCP for the Boston Harbor area includes the elimination of CSO discharges to "critical use areas." Swimming and shellfishing are considered to be critical uses. As illustrated in this example, the frequency of CSO discharges to these critical use areas is expected to decrease to zero as the LTCP including sewer separation and relocation to less sensitive areas is implemented.

Critical Use		CSO Frequency for a Typical Year (#/YR)	
Areas	**Activities**	**Baseline**	**Projected in LTCP**
North Dorchester Bay	swimming, shellfishing	78	0
South Dorchester Bay(1)	swimming, shellfishing	22	0
Neponset River	shellfishing	17	0
Constitution Beach(1)	swimming, shellfishing	16	0
(1) Baseline includes partial treatment.	**Totals:**	133	0

Source: Massachusetts Water Resources Authority, Boston, MA.

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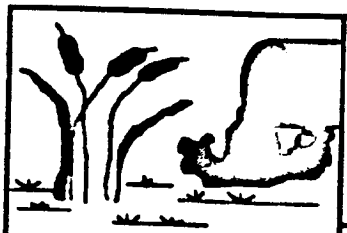
R0058192



CSO Performance Measure Profile Sheet
CSO Frequency in Sensitive Areas

Category: **End-Of-Pipe**

Description:
Trend of the frequency of overflow events per year from the CSS with discharges to sensitive areas (number of overflow events per year). An overflow event is defined as *one or more overflows from a CSS as a result of a precipitation event that do not receive the minimum treatment specified.*

Applicability and Use:
Municipalities are expected to give the highest priority to the control of CSOs discharging to sensitive areas. Sensitive areas include marine sanctuaries, water with threatened or endangered species, beaches, shellfish beds, and waters designated for water supply use. This performance measure is appropriate for all CSO communities with discharges to sensitive areas. It is also recommended for national tracking of activities and results related to CSO control.

Advantages of Measure:
- High priority within the CSO Policy.
- Can be measured or modeled in a variety of ways with a fairly high level of precision.
- Relationship to environmental improvement is not direct but could be substantial.

Disadvantages of Measure:
- Comparison of wet and dry years may be difficult unless the data is normalized.
- The cost and effort to install and maintain meters and to develop a model of the CSS can be substantial.

For More Information:
U.S. EPA. 1995. *CSOs: Guidance for Long-Term Control Plan.* EPA 832-B-95-002.

Units of Measurement:
Number of overflow events per year to sensitive areas.

Probable Reporting Agency:
CSO Communities.

Potential Data Sources:
- Flow meters.
- Mechanical devices.
- Collection system modeling.

Cost of Data Collection:
Variable. Metering of CSS is a relatively high cost. Mechanical devices are low in cost.

Attributes:

* Linkage to CSO discharge	●
* Quantifiable for trend analysis	●
* Usefulness relative to the cost of data collection	●
* Flexibility with respect to local objectives and conditions	●
* Understandable to the public	◗
* Relationship to environmental improvement	◗
* Watershed Context	◗

KEY
● High ◗ Moderate O Low

VOL 12 2 4900
R0058193

CSO Performance Measure Description
CSO Volume



This end-of-pipe measure tracks the volume of CSO discharge over time. It represents a quantification of the volume of overflows from a CSS on an annual basis. The units are millions of gallons per year (MG/year). CSO volume represents a potentially important performance measure for CSO communities interested in the "presumption" approach within their LTCP. Under the presumption approach, the elimination or capture for treatment of no less than 85% by volume of the combined sewage collected in the CSS on an annual average basis may be presumed to provide an adequate level of control.

Volume is best measured with metering systems that continuously record water level and/or velocity at outfalls within the CSS. Block tests or other simple mechanical devices that might be appropriate for measurement of the occurrence of an overflow event are not appropriate for the measurement of volume. The use of collection system models will suffice in most instances. Some normalization of the annual CSO volume might be helpful in long term trend analysis to account for year-to-year differences in precipitation.

Example

In 1992 the City of South Portland, ME installed a sophisticated yet cost-effective network of flow meters to measure real time flows within their CSS. Installation coincided with the implantation of CSO controls. The trend of CSO volume with a simple example of normalization with precipitation data is illustrated in this example.

Year	CSO Volume MG/YR	Annual Precipitation Inches	Normalization Ratio (1)	Normalized CSO Volume MG/YR
Pre Control	528	44.34(2)	1.00	528
1992	105	38.51	0.87	121
1993	289	43.81	0.99	292
1994	195	43.98	0.99	197
1995	32	41.43	0.93	34

(1) This example illustrates a simple normalization ratio calculated by dividing annual precipitation by average annual precipitation, with annual volume divided by the ratio. Other more sophisticated normalization procedures may be appropriate where uncontrolled CSO volume can be correlated with precipitation.

(2) Average Annual precipitation is 44 34 inches

Source: City of South Portland, ME.

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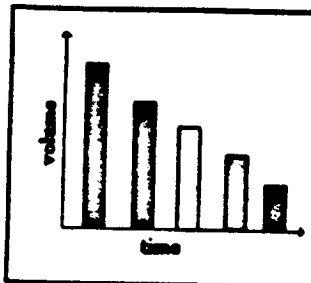
R0058194



CSO Performance Measure Profile Sheet

CSO Volume

Category: **End-Of-Pipe**

Description:
Trend of the volume of water discharged from the combined sewer system over a year.

Applicability and Use:
Measuring CSO volume is fundamental to the characterization of CSSs and to the evaluation of control alternatives. This performance measure has general applicability for most CSO communities. CSO volume is particularly appropriate for CSO communities considering the *Presumption Approach* and the option to eliminate or capture for treatment of no less than 85% by volume of the combined sewage collected in the CSS.

Advantages of Measure:
- Consistent with the *Presumption Approach* in the CSO Policy.
- Can be measured or modeled in a variety of ways with a fairly high level of precision.
- Provides an understandable measure of control effectiveness.

Disadvantages of Measure:
- Comparison of wet and dry years may be difficult unless the data is normalized.
- The cost and effort to install and maintain meters and to develop a model of the CSS can be substantial.

For More Information:
U.S. EPA. 1995. *CSOs: Guidance for Long-Term Control Plan.* EPA 832-B-95-002.

Units of Measurement:
MG per year.

Probable Reporting Agency:
CSO Communities.

Potential Data Sources:
- Flow meters.
- Collection system modeling.

Cost of Data Collection:
Variable. Use of existing computer models is a relatively low cost. Metering of CSS is a relatively high cost.

Attributes:

* Linkage to CSO discharge	●
* Quantifiable for trend analysis	●
* Usefulness relative to the cost of data collection	●
* Flexibility with respect to local objectives and conditions	●
* Understandable to the public	◗
* Relationship to environmental improvement	○
* Watershed Context	◗

KEY
● High ◗ Moderate ○ Low

VOL 12 2 4902

R0058195

CSO Performance Measure Description
CSO VOLUME IN SENSITIVE AREAS



This end-of-pipe measure tracks the CSO volume discharged in sensitive areas over time. It represents a quantification of the volume of overflows from a CSS discharged to sensitive areas on an annual basis. The units are millions of gallons per year (MG/year). Under the CSO Policy, CSO communities are expected to give the highest priority to controlling overflows to sensitive areas in the development of LTCPs. As a minimum, sensitive areas include designated Outstanding National Resource Waters, National Marine Sanctuaries, waters with threatened or endangered species and their habitat, waters with primary contact recreation (e.g., bathing beaches, etc.), public drinking water intakes or their designated protection areas, and shellfish beds. This measure may also be useful under the presumption approach, where the elimination or capture for treatment of no less than 85% by volume of the combined sewage collected in the CSS on an annual average basis might be presumed to provide an adequate level of control.

Volume is best measured with metering systems that continuously record water level and/or velocity at outfalls within the CSS. Block tests or other simple mechanical devices that might be appropriate for measurement of the occurrence of an overflow event are not appropriate for the measurement of volume. The use of collection system models will suffice in most instances. Some normalization of the annual CSO volume in sensitive areas might be helpful in long term trend analysis to account for year-to-year differences in precipitation.

Example

The City of San Francisco, CA has implemented CSO controls to reduce discharge volume in sensitive areas as illustrated in this example.

Sensitive Areas	Activities	Pre-Control Vol.(MG/YR)	Current 1995 Vol.(MG/YR)	Projected 1997(1) Vol.(MG/YR)
Sunnydale	shellfish beds windsurfing	645	10	10
Ocean Beach	swimming surfing	2,117	491	341
Baker Beach	swimming	529	123	85
Aquatic Park	swimming	570	57	57
	Totals:	**3,861**	**681**	**493**

(1) All discharges projected for 1997 will have received the minimum treatment required in the CSO Policy.

Source: San Francisco Department of PublicWorks, San Francisco, CA.

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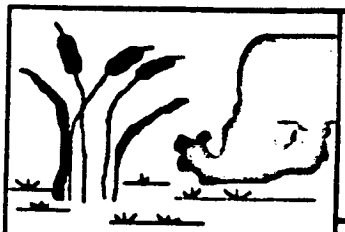
R0058196



CSO Performance Measure Profile Sheet
CSO Volume in Sensitive Areas

Category: **End-Of-Pipe**

Description:
Trend of the volume of CSO discharged to sensitive areas.

Applicability and Use:
CSO communities are expected to give the highest priority to the control of CSOs discharging to sensitive areas. Sensitive areas include marine sanctuaries, water with threatened or endangered species, beaches, shellfish beds, and waters designated for water supply use. This performance measure has general applicability for all CSO communities with discharges to sensitive areas where the quantification of CSO volume is consistent with the LTCP.

Advantages of Measure:
- High priority within the CSO Control Policy.
- Can be measured or modeled in a variety of ways with a fairly high level of precision.
- Relationship to environmental improvement is not direct but could be substantial.

Disadvantages of Measure:
- Comparison of wet and dry years may be difficult unless the data is normalized.
- The cost and effort to install and maintain meters and to develop a model of the CSS can be substantial.

For More Information:
U.S. EPA. 1995. *CSOs: Guidance for Long-Term Control Plan.* EPA 832-B-95-002.

Units of Measurement:
MG per year.

Probable Reporting Agency:
CSO Communities.

Potential Data Sources:
- Flow meters.
- Collection system modeling.

Cost of Data Collection:
Variable. Use of existing computer models is a relatively low cost. Metering of CSS is a relatively high cost.

Attributes:

* Linkage to CSO discharge	●
* Quantifiable for trend analysis	●
* Usefulness relative to the cost of data collection	●
* Flexibility with respect to local objectives and conditions	●
* Understandable to the public	◗
* Relationship to environmental improvement	◗
* Watershed Context	◗

KEY
● High ◗ Moderate ○ Low

R0058197

VOL 12 2 4904

CSO Performance Measure Description
Dry Weather Overflows



This end-of-pipe measure quantifies the number of dry weather overflows (DWOs) that have been observed or occurred over the course of a year. The elimination of DWOs during dry weather is a major objective of the CSO Policy, and one of the Nine Minimum Controls. Because dry weather overflows are prohibited under the Clean Water Act and the NPDES Program, DWOs are included as a separate performance measure.

Implementation of a performance measure for DWOs requires two elements:

- A system for detection and documentation of DWOs; and
- A method of quantification that is meaningful.

Detection methods can include operator inspection of regulators or outfalls at a set frequency, use of visual or mechanical detection devices, or continuous on-line monitoring. Inspection frequency and other technical issues are addressed in EPA's *Combined Sewer Overflows - Guidance Document for the Nine Minimum Controls* (U.S. EPA, 1995a).

Quantification should be consistent from year-to-year so that the measure can be trendable over time. Given the variety of DWO detection methods, quantification of flow volume or flow rate is not realistic for most CSO communities. However, potentially meaningful measures would be the number of DWO occurrences per year (with "occurrence" defined as a period of continuous overflow at an individual regulator or outfall), and the number of DWO-days per year (defined as the number of days of continuous overflow at a given structure per year). An alternative measure would be the number of DWO occurrences found per 100 inspections.

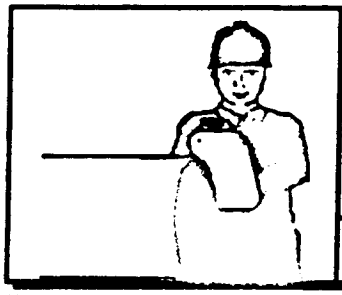
Example

An informal survey revealed that the occurrence of DWOs has not been tracked and quantified on a regular basis in most CSO communities. However, with the *elimination of CSOs during dry weather* as one of the NMCs, greater attention to detecting and documenting DWOs is anticipated. DWOs are particularly significant for the following reasons:

- Contaminants in DWOs, including pathogens, are undiluted compared with wet weather overflows.
- DWOs occur at a time when inclement weather would not discourage recreational contact with receiving waters, thus increasing public health risks.
- The presence of continuous or frequent DWOs could be indicative of more widespread operations and maintenance deficiencies.

VOL 12 2 4905

R0058198



CSO Performance Measure Profile Sheet

Dry Weather Overflows

Category: **End-Of-Pipe**

Description:
Trend of the number of dry weather overflows found per year within a combined sewer system (# per year or # days per year).

Applicability and Use:
The elimination of dry weather overflows is a major objective of the CSO Control Policy. It is also one of the Nine Minimum Controls, and subject to tracking and reporting requirements. Quantifying and tracking the number of dry weather overflows may be a useful performance measure in its own right for CSO communities where dry weather overflows are a recognized ongoing problem, and where the elimination of dry weather controls is emphasized within the LTCP. In these instances, additional effort may be required to quantify the occurrence of dry weather overflows in a meaningful, consistent and comprehensive manner.

Advantages of Measure:
- The elimination of dry weather overflows is a requirement for all CSO communities.
- Provides a measure of gross pollution and pollution abatement.
- Potentially applicable for all CSO communities.
- Overflows can be measured in several ways, including visual inspection.

Disadvantages of Measure:
- Consistency of measurement from system to system will vary greatly.

For More Information:
U.S. EPA. 1995. *CSOs: Guidance for Nine Minimum Controls.* EPA 832-B-003.

Units of Measurement:
per year or # days per year.

Probable Reporting Agency:
CSO Communities.

Potential Data Sources:
- Flow meters.
- Inspection reports.
- Block tests or mechanical devices.

Cost of Data Collection:
Low. Should be part of proper Operation & Maintenance.

Attributes:

* Linkage to CSO discharge	●
* Quantifiable for trend analysis	●
* Usefulness relative to the cost of data collection	●
* Flexibility with respect to local objectives and conditions	●
* Understandable to the public	◗
* Relationship to environmental improvement	○
* Watershed Context	◗

KEY
● High ◗ Moderate ○ Low

VOL 12 2 4906

R0058199

CSO Performance Measure Description
BOD Load



This end-of-pipe measure provides an estimate of the amount of oxygen demanding material discharged from the CSS to receiving waters over time. BOD load is the pounds of biochemical oxygen demand (BOD) in organic matter discharged from a CSS over the course of a year. The units for this measure are pounds per year of BOD. BOD_5, the amount of dissolved oxygen consumed in five days by biological processes, is commonly used as a measure of the strength or concentration of wastewater influent and effluent in mg/l. The BOD load from the CSS is the product of flow and concentration.

This measure may be important in those systems where the contribution of BOD from the CSS is a major cause of depressed dissolved oxygen, and where a reduction in the CSS contribution of BOD is an integral part of the LTCP. Tracking the trend of BOD load reductions over time in these systems should correlate with improved dissolved oxygen levels in impacted receiving waters. In general, changes in BOD load over time will typically be due to changes in CSO volume. However, the average concentration of BOD_5 in CSO discharges could be reduced over time due to the implementation of certain control technology such as swirl concentrators or other practices to reduce solids and first flush effects. Automated samplers could be used to monitor flow and BOD_5 concentrations for load calculation. The use of collection system models to estimate BOD load will suffice in most instances. Normalization of the annual BOD load might be helpful in long term trend analysis to account for year-to-year differences in precipitation.

Example

The Narragansett Bay Commission operates and maintains combined sewer interceptors and POTWs serving ten communities in north central Rhode Island including Providence, Central Falls and Pawtucket. The CSS includes 85 overflow structures that discharge to several rivers tributary to upper Narragansett Bay.

A conceptual design for the LTCP was completed in 1993 that includes recommendations for the construction of both near surface storage facilities and deep tunnels. Flows captured within these facilities will be pumped back to the interceptor system following storms, and will receive secondary treatment.

It is anticipated that implementation of the LTCP will result in an 86 percent reduction in the BOD load from the CSS. BOD loads can be tracked on an annual basis through a combination of direct measurement and model-based estimates. However, earlier studies had shown that bacterial contamination and floatables represent the two most important impacts associated with CSO discharges. A watershed-based comparison of BOD loading sources indicated that CSOs represent only 15 percent of the annual BOD load to the upper Bay. POTWs and upstream watershed sources represent 44 and 41 percent of the BOD load, respectively. BOD loads from the CSS are therefore not a major concern, and the Narragansett Bay Commission will utilize other performance measures more applicable for the upper Bay to track performance. This example is intended to illustrate the point that CSO communities should focus on those performance measures that are most applicable for their site-specific situation.

Source: Narragansett Bay Commission, Providence, RI

R0058200

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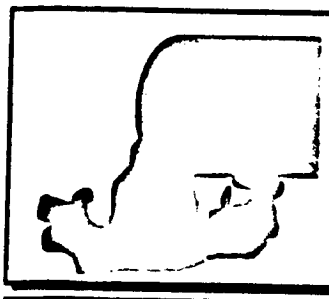

CSO Performance Measure Profile Sheet

BOD Load

Category: **End-Of-Pipe**

Description:
Trend of the pounds of BOD discharged from the combined sewer system (lbs per year normalized for precipitation).

Applicability and Use:
The BOD load in CSO discharge can be an important source of organic material in some receiving waters. BOD load potentially impacts water quality and habitat. The quantification of BOD load has general applicability where BOD is contributing to depressed dissolved oxygen conditions, or to the buildup of organic deposits in bottom sediments. It can be used by CSO communities to document reductions in BOD load where this is targeted in the LTCP. Quantifying BOD load also has significance at the watershed level where cause and effect relationships and tradeoffs among control options are examined.

Advantages of Measure:
- A variety of approaches can be used to quantify BOD load including direct measurement and application of models with varying levels of sophistication.
- BOD is a conventional pollutant that is relatively easy to measure and model.
- BOD load reduction has been a major element of waste water control at POTWs, and it is well understood by managers.

Disadvantages of Measure:
- Comparison of wet and dry years may be difficult unless the data is normalized.
- Load by itself is not a direct measure of environmental conditions.

For More Information:
U.S. EPA. 1995. *CSOs: Guidance for Long-Term Control Plan.* EPA 832-B-95-002.

Units of Measurement:
Pounds of BOD per year.

Probable Reporting Agency:
CSO Communities.

Potential Data Sources:
- Automated monitoring.
- Model-based estimates.

Cost of Data Collection:
Low to Medium. Use of existing computer models periodically validated with BOD concentrations at the outfalls is appropriate.

Attributes:

* Linkage to CSO discharge	●
* Quantifiable for trend analysis	●
* Usefulness relative to the cost of data collection	○
* Flexibility with respect to local objectives and conditions	◗
* Understandable to the public	◗
* Relationship to environmental improvement	○
* Watershed Context	●

KEY
● High ◗ Moderate ○ Low

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R0058201

CSO Performance Measure Description
TSS Load



This end-of-pipe measure provides an estimate of the amount of TSS (total suspended solids) discharged from the CSS to receiving waters over time. TSS load is the pounds of TSS discharged from a CSS over the course of a year. The units for this measure are pounds per year of TSS. TSS is commonly used as a measure of the strength or concentration of wastewater influent and effluent in mg/l. The TSS load from the CSS is the product of flow and concentration.

This measure may be important in those systems where the contribution of suspended solids from the CSS is a major cause of turbidity and associated receiving water impacts, and where a reduction in the CSS contribution of TSS is an integral part of the LTCP. In general, changes in TSS load over time will typically be due to changes in CSO volume. However, the average concentration of TSS in CSO discharges could be reduced over time due to the implementation of certain control technology such as swirl concentrators or other practices to reduce solids and first flush effects. Automated samplers could be used to monitor flow and TSS concentrations for load calculation. The use of collection system models to estimate TSS load will suffice in most instances. Normalization of the annual TSS load might be helpful in long term trend analysis to account for year-to-year differences in precipitation.

Example

The Columbus Water Works in Columbus, Georgia operates and maintains a sewer collection system and POTW with a service area of over 26,000 acres. The Long Term Control Plan (LTCP) initially identified 5,132 acres in the CSS. This initial phase of the CSO program allowed 2,520 acres to be separated from the CSS via installation of a single interceptor sewer. The remaining CSS covers 2,612 acres and includes 16 CSOs: 15 discharging to the Chattahoochee River, and one to Werecoba Creek.

Columbus initiated designs for sewer separation and for CSO conveyance and treatment in 1992. Two CSO treatment facilities were completed in late 1995 that include coarse screening, vortex separation, disinfection, degritting of vortex underflow, and secondary vortex. An EPA funded Demonstration Project testing the cost effectiveness of several treatment processes including high rate filtration and ultra violet disinfection is also underway with construction scheduled for completion in May 1996. A two year testing program will identify the applicability of these processes to CSO treatment.

It is anticipated that implementation of the LTCP will result in an 85 percent reduction in the TSS load from the CSS. TSS loads can be tracked on an annual basis through a combination of direct measurement and model-based estimates. However, earlier studies had shown that bacterial contamination and floatables represent the two most important impacts associated with CSO discharges. Columbus may elect to monitor and track annual TSS loads once the CSO demonstration project has been completed, but TSS is not a major concern. TSS and fecal coliform measurements will be made on the influent and effluent of both treatment facilities as well as up and downstream of the plant outfalls. However, other performance measures included in the NPDES permit and more applicable to site specific conditions in Columbus will probably be utilized to track performance.

Source: Columbus Water Works, Columbus, GA.

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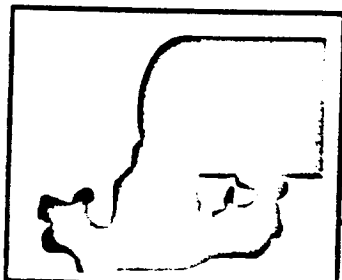
R0058202



CSO Performance Measure Profile Sheet

TSS Load

Category: **End-Of-Pipe**

Description:
Trend of the pounds of TSS discharged from the combined sewer system (lbs per year normalized for precipitation).

Applicability and Use:
The reduction of TSS loads to receiving waters is a major element in CSO control. The quantification of TSS load has general applicability where TSS is contributing to water quality problems or habitat impairment. It can be used by CSO communities to document reduction in TSS where this is targeted in the LTCP. The quantification of TSS load can be important in receiving waters where the accumulation of CSO solids in bottom sediments represents a persistent problem. It is also valuable in watershed studies where multiple sources of TSS have been identified as contributing to problems on a watershed scale.

Advantages of Measure:
- A variety of approaches can be used to quantify TSS load including direct measurement and application of models with varying levels of sophistication.
- TSS is a conventional pollutant that is relatively easy to measure and model.
- TSS load reduction has been a major element of waste water control at POTWs, and it is well understood by managers.

Disadvantages of Measure:
- Comparison of wet and dry years may be difficult unless the data is normalized.
- Load by itself is not a direct measure of environmental conditions.

For More Information:
U.S. EPA. 1995. *CSOs: Guidance for Long-Term Control Plan.* EPA 832-B-95-002.

Units of Measurement:
Pounds of TSS per year.

Probable Reporting Agency:
CSO Communities.

Potential Data Sources:
- Automated monitoring.
- Model-based estimates.

Cost of Data Collection:
Low to Medium. Use of existing computer models periodically validated with TSS concentrations at the outfalls is appropriate.

Attributes:

• Linkage to CSO discharge	●
• Quantifiable for trend analysis	●
• Usefulness relative to the cost of data collection	○
• Flexibility with respect to local objectives and conditions	◗
• Understandable to the public	◗
• Relationship to environmental improvement	○
• Watershed Context	◗

KEY
● High ◗ Moderate ○ Low

VOL 12 2 4910
R0058203

CSO Performance Measure Description
Nutrient Load



This end-of-pipe measure provides an estimate of the amount of nutrients discharged from the CSS to receiving waters over time. Nutrient load is the pounds of total nitrogen (TN) and/or the pounds of total phosphorus (TP) discharged from a CSS over the course of a year. The units for this measure are pounds per year of TN and/or TP. Nutrient load from the CSS is the product of flow and concentration.

This measure may be important in those systems where the discharge of nutrients from the CSS contributes to eutrophication and associated impacts, and where a reduction in the CSS contribution of nutrients is an integral part of the LTCP. The targeted nutrient load may be TN, TP or both, depending on which is considered to be the nutrient that is limiting the growth of algae or other nuisance aquatic plants. In general, changes in nutrient load over time will typically be due to changes in CSO volume. However, pollution prevention and other nonstructural controls can reduce the concentration of nutrients in CSOs. Automated samplers could be used to monitor flow and nutrient concentrations for load calculation. The use of collection system models to estimate nutrient load will suffice in most instances. Normalization of the annual TSS load might be helpful in long term trend analysis to account for year-to-year differences in precipitation.

Example

No specific examples of CSO communities quantifying and tracking nutrient loads on an annual basis were found. The nutrient component of CSO loads is usually small relative to other sources including agricultural runoff, urban runoff and point sources. Nevertheless, nutrient load might be an appropriate performance measure where CSOs discharge to eutrophic lakes, estuaries or coastal waters, and where nutrients removed through CSO control can be credited toward targeted nutrient load reductions on a watershed basis.

R0058204

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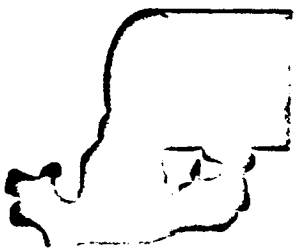


CSO Performance Measure Profile Sheet

Nutrient Load

Category: **End-Of-Pipe**

Description:
Trend of the pounds of nutrients discharged from the combined sewer system (lbs per year normalized for precipitation).

Applicability and Use:
The phosphorus and nitrogen loads in CSO discharges can be a source of nutrient enrichment in receiving waters. The quantification of nutrient load has limited applicability where the CSO contribution of nutrients to receiving waters is substantial, and where tracking nutrient load reduction is targeted in the LTCP. Evaluations of nutrient enrichment require site-specific consideration of existing and historical eutrophication conditions, water uses, and relevant standards and criteria.

Advantages of Measure:
- A variety of approaches can be used to quantify nutrient load including direct measurement and application of models with varying levels of sophistication.
- Nutrient load reduction has been a major element of waste water control at POTWs, and it is well understood by managers.
- Nutrient reduction from all sources is becoming increasingly important in some watersheds.

Disadvantages of Measure:
- The comparison of wet and dry years may be difficult unless normalization procedures are applied.
- The CSO component of nutrient loads on a watershed basis is typically small relative to point and agricultural sources.
- Load by itself is not a direct measure of environmental conditions.

For More Information:
U.S. EPA. 1995. *CSOs: Guidance for Long-Term Control Plan.* EPA 832-B-95-002.

Units of Measurement:
Pounds of nutrients per year.

Probable Reporting Agency:
CSO Communities.

Potential Data Sources:
- Automated monitoring.
- Model-based estimates.

Cost of Data Collection:
Low to Medium. Use of existing computer models periodically validated with nutrient concentrations at the outfalls is appropriate.

Attributes:

* Linkage to CSO discharge	●
* Quantifiable for trend analysis	●
* Usefulness relative to the cost of data collection	○
* Flexibility with respect to local objectives and conditions	◗
* Understandable to the public	◗
* Relationship to environmental improvement	○
* Watershed Context	●

KEY
● High ◗ Moderate ○ Low

VOL 12 2 4912

R0058205

CSO Performance Measure Description
Floatables



This end-of-pipe measure quantifies the amount of solids and floatables captured within the combined sewer system. The units for this measure are cubic yards, pounds or tons per year. The methods utilized to remove solids and floatables from combined sewage within the CSS include baffles, screens, and trash racks. End-of-pipe methods include nets and outfall booms.

All CSO communities are required to control solid and floatable materials in CSOs as part of the Nine Minimum Controls. Quantification of the volume of solids and floatables controlled on an annual basis is a measure that would be understood by the general public, and it is considered to have value as a separate performance measure on a site-specific basis. This measure may be important in those systems where the discharge of solids and floatable material produces substantial aesthetic and public health impacts, and where the control of solid and floatable materials is an integral part of the LTCP.

Example

The City of Newark, NJ has thirty CSO outfalls. The New Jersey General Permit for CSSs requires the capture of all floatables greater than one-half inch in diameter from CSO discharges. A CSO Floatable Reduction Demonstration Project was carried out in Newark with an EPA grant during 1994. The demonstration focused upon the effectiveness of rigid frame netting technology to capture floatables at two outfalls. The results of the study indicated that the Trash Trap™ system incorporating a series of nets supported by pontoon structures was very effective, capturing over 95 percent of the floatables present. Further, the technology was reliable and reasonable with regard to capital cost, operation and maintenance costs, and cost per pound of floatable captured.

The composition of CSO Floatables from two separate outfalls is as follows:

Item	% Volume	% Weight
Plastic/paper bags	12 - 26	7 - 15
Plastic bottles	10 - 19	6 - 7
Straws	0 - 2	0 - 1
Cans	< 1	0 - 1
Styrofoam	14 - 20	3 - 5
Glass bottles	3 - 4	3 - 6
Wood	3	3
Medical waste	<1	<1
Misc. solids, leaves	38 - 45	66 - 73
Other(1)	0 - 1	0 - 2

(1) Most common items are other plastics, condoms, shoes and bottle caps.

Source: Parsons Engineering Science, Inc., Final Report: CSO Floatable Control Demonstration Project, submitted to the City of Newark, NJ, October, 1995.

VOL 12 2 4913

R0058206



CSO Performance Measure Profile Sheet

Floatables

Category: **End-Of-Pipe**

Description:
Trend of the volume of floatables captured within the combined sewer system (cubic yards, pounds or tons per year normalized for precipitation).

Applicability and Use:
Floatables captured within the CSS are solids and other materials prevented from being discharged to a receiving water. This measure will be particularly useful in CSO communities where there is a heightened awareness of floatables as an aesthetic nuisance, a cause of beach closures, or a contributing factor to other environmental and health problems.

Advantages of Measure:
- Floatables are highly visible and understandable by the public.
- Floatables control is one of the Nine Minimum Controls.
- Quantification of floatables captured provides a positive measure for the general public of constructive action.
- Floatables control may be cost effective.

Disadvantages of Measure:
- End-of-Pipe technologies are relatively new and untested, and may be expensive or difficult to adapt to many CSSs.
- Results may be difficult to interpret due to initiatives in other areas such as pollution prevention, catch basin cleaning, etc.
- Involves construction, operation and maintenance costs.

For More Information :
U.S. EPA. 1995. *CSOs: Guidance for Nine Minimum Controls.* EPA 832-B-95-003.

Units of Measurement:
Cubic yards, pounds or tons per year.

Probable Reporting Agency:
CSO Communities.

Potential Data Sources:
- In system screens/racks.
- End-of-pipe nets and booms.

Cost of Data Collection:
Medium to High. Requires capital costs as well as ongoing Operation and Maintenance costs.

Attributes:

• Linkage to CSO discharge	●
• Quantifiable for trend analysis	◗
• Usefulness relative to the cost of data collection	◗
• Flexibility with respect to local objectives and conditions	●
• Understandable to the public	●
• Relationship to environmental improvement	○
• Watershed Context	◗

KEY
● High ◗ Moderate ○ Low

R0058207

VOL 12 2 4914

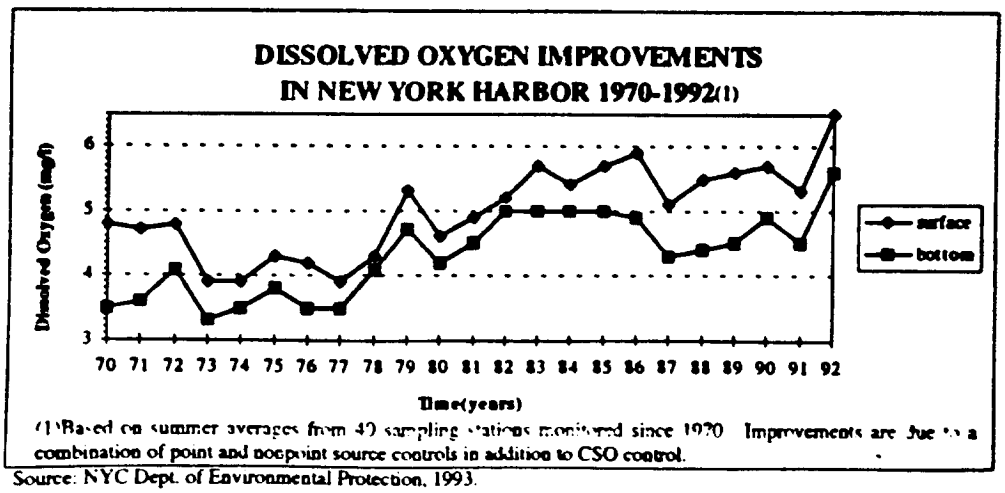
CSO Performance Measure Description
Dissolved Oxygen Trend

This receiving water measure describes the dissolved oxygen condition of impacted receiving waters over time. The dissolved oxygen trend is a time plot of the concentration of dissolved oxygen over time. The units are mg/l of dissolved oxygen.

Dissolved oxygen is vital to fish and other aquatic life, and for the prevention of odors. The level of dissolved oxygen is viewed as one of the most important indicators of a water body's ability to support desirable aquatic life. Dissolved oxygen concentration is widely applied to gauge attainment of designated uses and water quality standards. This measure may be important in those systems where the contribution of oxygen demanding material (the BOD load) from the CSS is a major cause of depressed dissolved oxygen in receiving waters, and where improvement of dissolved oxygen is a major objective of the LTCP. Tracking the trend in dissolved oxygen in impacted receiving waters may be appropriate for systems where the demonstration approach is utilized to show the adequacy of the LTCP with regard to criteria related to designated uses and water quality standards. Attainment of water quality standards is assessed by superimposing the dissolved oxygen standard on the time plot. Because of the variety of pollutant sources potentially affecting the dissolved oxygen balance in urban waters, this performance measure is well-suited for tracking improvement on a watershed scale.

The measurement of dissolved oxygen should be performed in waters that are known to be impacted by CSOs so that improvement can be tracked over time as controls are implemented. Continuous automated sampling provides the best record of wet weather impacts. Grab samples will suffice in most instances if the data reflect wet weather or impacted conditions.

Example

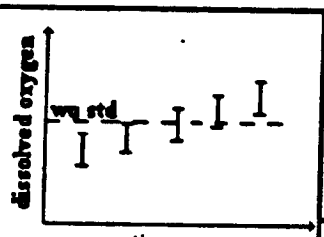


(1) Based on summer averages from 40 sampling stations monitored since 1970. Improvements are due to a combination of point and nonpoint source controls in addition to CSO control.

Source: NYC Dept. of Environmental Protection, 1993.

VOL 12 2 4915

R0058208



CSO Performance Measure Profile Sheet

Dissolved Oxygen Trend

Category: **Receiving Water**

Description:
Trend of dissolved oxygen in CSO impacted receiving water (time plot or trend analysis of dissolved oxygen in mg/l).

Applicability and Use:
The dissolved oxygen concentration of receiving waters is a widely used measure of water quality conditions. This receiving water measure has general applicability for receiving waters where it is consistent with the LTCP. It is most applicable in those situations where depressed dissolved oxygen conditions occur and are caused in part by CSO loadings and/or sediment oxygen demand originating from CSO solids.

Advantages of Measure:
- Dissolved oxygen can be monitored in the field with simple inexpensive equipment.
- Dissolved oxygen can be monitored continuously making it possible to record trends over time.
- Dissolved oxygen has value at the local and watershed levels.
- Historical records are available in many receiving waters.

Disadvantages of Measure:
- Impacts can be transferred downstream and away from CSO outfalls in some systems.
- It may be difficult to associate change over time with CSO reductions because of other watershed sources.

For More Information:
U.S. EPA. 1995. *CSOs: Guidance for Long-Term Control Plan.* EPA 832-B-95-002.

Units of Measurement:
Milligrams per liter (mg/l) of DO.

Probable Reporting Agency:
CSO Communities.
State and Federal Agencies.

Potential Data Sources:
- Water quality surveys.
- Continuous samplers.

Cost of Data Collection:
Medium to High. Requires long term commitment to consistent monitoring during wet weather events.

Attributes:

• Linkage to CSO discharge	◗
• Quantifiable for trend analysis	●
• Usefulness relative to the cost of data collection	◗
• Flexibility with respect to local objectives and conditions	◗
• Understandable to the public	◗
• Relationship to environmental improvement	●
• Watershed Context	●

KEY
● High ◗ Moderate ○ Low

VOL 12 2 4916
R0058209

CSO Performance Measure Description
Fecal Coliform Trend

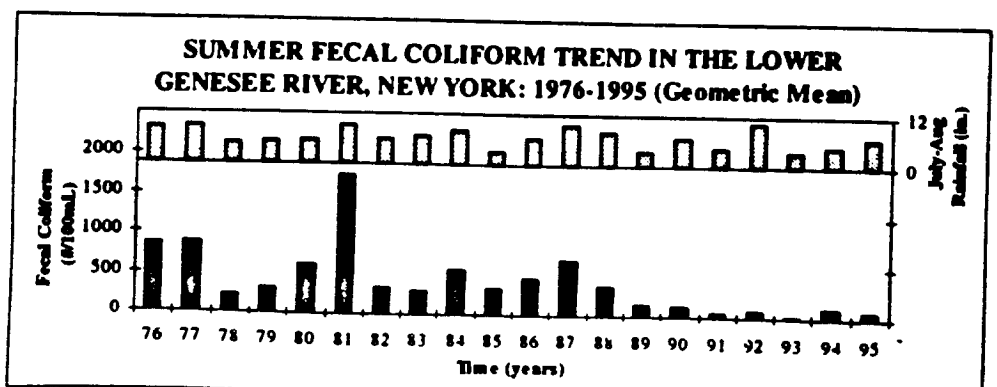
This receiving water measure describes the bacterial condition of impacted waters over time. Fecal coliform is a bacteria found in the intestinal tracts of mammals. Its presence in receiving waters indicates pollution and possible contamination by pathogens. The fecal coliform trend is a time plot of fecal coliform bacteria levels in impacted receiving waters. The units are the number of fecal coliforms per 100 ml.

Fecal coliform is the most widely used measure of the bacteriological condition of receiving waters. Urban waters typically have elevated fecal coliform levels during and following wet weather periods caused by a variety of sources including CSOs, storm water, agricultural runoff, failed septic systems, and marine discharges. This measure may be important in those systems where bacteria from the CSS contributes to elevated bacterial conditions in receiving waters, and where reducing bacterial contamination in receiving waters is a major objective of the LTCP. Tracking the trend of fecal coliform in impacted receiving waters may be appropriate for systems where the demonstration approach is utilized to show the adequacy of the LTCP with regard to criteria related to designated uses and water quality standards. Because of the variety of fecal coliform sources potentially affecting urban waters, this performance measure is well-suited for tracking improvement on a watershed scale.

Fecal coliform should be measured in waters that are known to be impacted by CSOs so that improvement can be tracked over time as controls are implemented. Grab samples will be adequate in most instances if the data reflect wet weather or impacted conditions. Use of other indicator organisms such as total coliform (*Escherichia coli*) or fecal streptococci (enterococci) may be appropriate where applicable.

Example

Monroe County, New York, which includes the city of Rochester, has implemented CSO controls including Best Management Practices and construction of expanded conveyance capacity that have substantially reduced fecal coliform levels in the lower Genesee River.



Source: Monroe County Health Department, Environmental Health Laboratory, NY.

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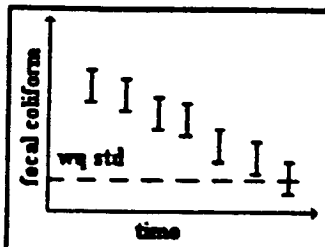
R0058210



CSO Performance Measure Profile Sheet

Fecal Coliform Trend

Category: **Receiving Water**

Description:
Trend of the wet weather concentration of fecal coliform or other bacterial indicator concentrations in CSO-impacted receiving waters (time plot or trend analysis of fecal coliform in #/100 ml in receiving water).

Applicability and Use:
The level of fecal coliform in receiving waters is a widely used measure of water quality conditions. Bacterial contamination is one of the major pollutants of concern discharged from CSOs. High bacterial levels can affect shellfishing, swimming, and other designated uses. Measuring the trend of fecal coliform can be a useful way for many CSO communities to assess the effectiveness of CSO control measures.

Advantages of Measure:
- Widely applied to gauge attainment of designated uses and water quality standards.
- Historical records are available in many receiving waters.

Disadvantages of Measure:
- Cannot be continuously monitored, making it difficult to obtain wet weather samples during and following overflow events.
- It may be difficult to associate change over time with CSO control because of other watershed sources of contaminants and management activities.

For More Information:
APHA, AWWA, WEF. 1995. *Standard Methods For the Examination of Water and Wastewater, 19th Edition.*

Units of Measurement:
per 100 ml or other appropriate units.

Probable Reporting Agency:
CSO Communities.
State Agencies.

Potential Data Sources:
- Water quality surveys.

Cost of Data Collection:
Medium to High. Requires long term commitment to consistent monitoring during wet weather events.

Attributes:

* Linkage to CSO discharge	◗
* Quantifiable for trend analysis	●
* Usefulness relative to the cost of data collection	◗
* Flexibility with respect to local objectives and conditions	◗
* Understandable to the public	◗
* Relationship to environmental improvement	●
* Watershed Context	●

KEY
● High ◗ Moderate ○ Low

R0058211

VOL 12 2 4 9 1 8

CSO Performance Measure Description
Floatables Trend



This receiving water measure quantifies the amount of floatable debris collected annually from clean up programs in CSO-impacted receiving waters including beach and shoreline surveys. The amount of floatables collected by skimmer boats in harbors could also be used to quantify a floatables trend. The units for this measure are cubic yards, pounds or tons per year. The number of items collected may also be appropriate.

Floatables in receiving waters represent an aesthetic nuisance and a potential public health problem. The wash-up of floatable sanitary and medical waste can result in beach closures. Floatables can also cause significant damage to wildlife and habitat. Floatables trend may be an important measure in CSO communities where there is a heightened awareness of floatables as a health hazard, aesthetic detraction, or environmental problem. Floatables are tangible and usually understood by the public.

The use of this performance measure presents several challenges. Street litter is a primary source of floatables. With the exception of certain personal hygiene products, it is often difficult to distinguish the origin of floatables (e.g., CSO vs. urban stormwater). Clean up programs including beach and shoreline surveys are usually dependent on volunteers, and the quantification of floatables is often not precise. Weather, the number of people involved, and other factors affect the total volume collected. Consequently, the linkage of trend analysis to CSO control is difficult to establish.

Example

Floatables control is a top priority of the New York City Department of Environmental Protection's CSO Abatement Program. Floatables have contributed to several problems in New York Harbor including beach closing, interference with navigation, and entanglement of wildlife. It is estimated that 85 percent of floatables in the Harbor originate from CSOs and separate storm sewers conveying street litter.

In addition to enhanced street sweeping, catch basin modifications, public education, and hydraulic control, New York City has aggressively studied and pursued floatables containment and removal. The principal controls include end-of-pipe nets, booms, and marine vessels that skim floatables from the water. From June 1994 through May 1995, 150,000 pounds of trash were boomed and skimmed. Since 1989, the capture of floatables from CSOs has increased from 30 to 70 percent.

Source: New York City Department of Environmental Protection, New York, NY.

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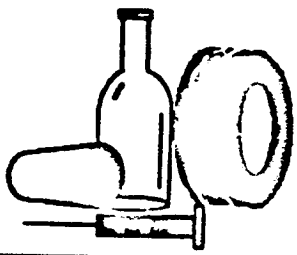
R0058212



CSO Performance Measure Profile Sheet

Floatables Trend

Category: **Receiving Water**

Description:
Trend of floatables measured or collected from receiving water cleanup programs or beach surveys (cubic yards, pounds or tons per year).

Applicability and Use:
Floatables are one of the major pollutants of concern discharged from CSOs. CSO communities are expected to control floatables as one of the Nine Minimum Controls. Tracking the trend of floatables collected in key use areas can be a useful performance measure for some CSO communities where it is consistent with the LTCP. Floatables trend represents an alternative to the end-of-pipe capture and measurement of floatables.

Advantages of Measure:
- Understandable to the public.
- Can be targeted at key problem areas to reduce cost and effort.
- Can help to determine the CSO contribution to debris problems.

Disadvantages of Measure:
- May be difficult to detect trend as volume of floatables may be highly variable.
- Non-CSO sources may still be a problem following CSO control.

For More Information:
U.S. EPA. 1995. *CSOs: Guidance for Nine Minimum Controls.* EPA 832-B-95-003.

Units of Measurement:
Cubic yards, pounds, tons per year or number of items collected.

Probable Reporting Agency:
CSO Communities.
Environmental Agencies.
Volunteers.

Potential Data Sources:
- Monthy or annual survey.
- Cleanup program records.

Cost of Data Collection:
Variable. Use of volunteers is low. Use of equipment intensive methods such as skimmer boats is high.

Attributes:

* Linkage to CSO discharge	◗
* Quantifiable for trend analysis	◗
* Usefulness relative to the cost of data collection	◗
* Flexibility with respect to local objectives and conditions	●
* Understandable to the public	●
* Relationship to environmental improvement	◗
* Watershed Context	◗

KEY
● High ◗ Moderate ○ Low

VOL 12 2 4920
R0058213

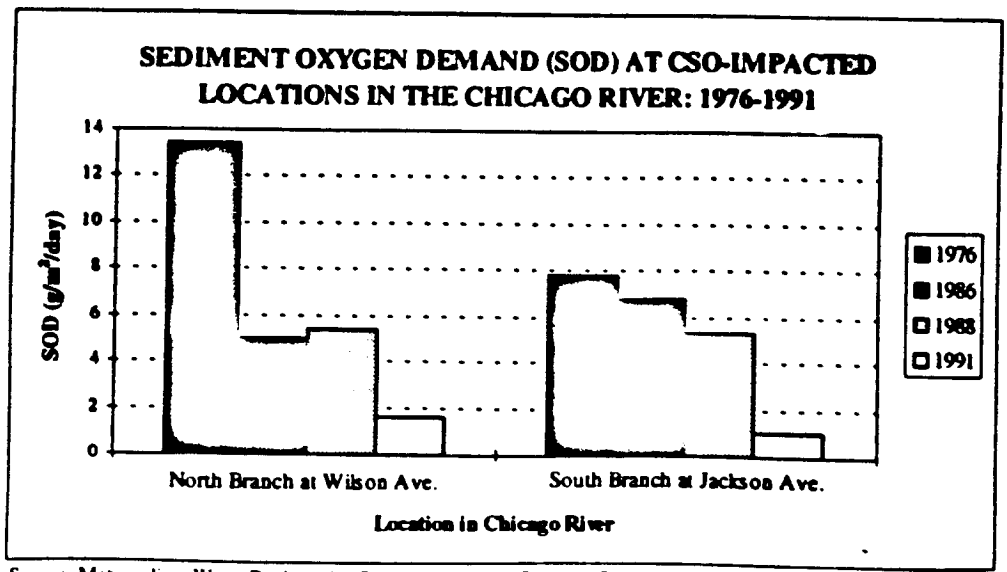
CSO Performance Measure Description
Sediment Oxygen Demand Trend

Sediment oxygen demand (SOD) is a measure of the potential of bottom deposits of organic material to decay and continuously remove oxygen from the overlying waters. SOD exerts its impact on receiving waters by reducing the dissolved oxygen concentration. The SOD trend is a time series of SOD measurements. The units of measurement are grams of oxygen (O_2) in meters squared per day.

SOD can be an important component of the dissolved oxygen balance in receiving waters that receive substantial organic loadings. It is particularly important in slow moving streams, estuaries and harbors where organic material accumulates in bottom sediments, and where scouring is minimal or infrequent. BOD and TSS loads discharged from CSSs can contribute to the accumulation of bottom deposits and to SOD. This measure may be important in those systems where dissolved oxygen impacts have been observed, and where SOD is known to be an important component of dissolved oxygen depression. Where applicable, use of this receiving water measure may provide an indication of whether or not the LTCP is having any influence on the SOD component of the dissolved oxygen balance. Because of the variety of pollutant sources potentially affecting SOD, this performance measure is well-suited for tracking improvement on a watershed scale.

Specialized skills are required for the measurement of SOD. Measurement once per year at impacted sites may be appropriate. Consistency in location and analytical technique from one year to the next is essential for the results to be meaningful.

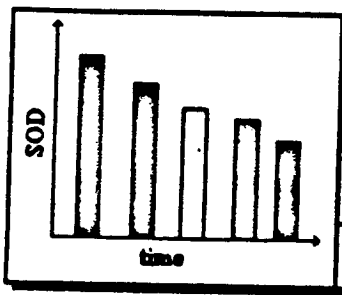
Example



Source: Metropolitan Water Reclamation District of Greater Chicago, Chicago, IL.

VOL 12 2 4921

R0058214



CSO Performance Measure Profile Sheet

Sediment Oxygen Demand Trend

Category: **Receiving Water**

Description:
Trend of sediment oxygen demand in CSO-impacted receiving waters (time plot of sediment oxygen demand).

Applicability and Use:
Sediment Oxygen Demand (SOD) is a measure of the capacity of bottom sediments to remove oxygen from overlying waters. The performance measure may be useful in receiving waters where dissolved oxygen levels are continuously depressed, and where CSOs have been identified as contributing substantially to organic loadings. Tracking SOD over time may be an effective way to quantify long-term improvements due in part to CSO control.

Advantages of Measure:
- Trend can be linked to CSO control in some CSO communities.
- Measurement once per year should be sufficient.

Disadvantages of Measure:
- Requires high skill level to measure Sediment Oxygen Demand properly.
- Sediment Oxygen Demand is not widely understood.
- Sediment Oxygen Demand is not necessarily meaningful in itself. Its importance varies with its contribution to the overall dissolved oxygen budget of receiving water.

For More Information:
APHA, AWWA, WEF. 1995. *Standard Methods For the Examination of Water and Wastewater, 19th Edition.*

Units of Measurement:
Grams of O_2 in meters squared/day.

Probable Reporting Agency:
State Agencies.
Research institutions.

Potential Data Sources:
- Annual survey.

Cost of Data Collection:
Medium to High. Measurement requires specialized field and laboratory expertise.

Attributes:

* Linkage to CSO discharge	◗
* Quantifiable for trend analysis	●
* Usefulness relative to the cost of data collection	◗
* Flexibility with respect to local objectives and conditions	◗
* Understandable to the public	○
* Relationship to environmental improvement	●
* Watershed Context	●

KEY
● High ◗ Moderate ○ Low

VOL 12 2 4922
R0058215

CSO Performance Measure Description
Trend of Metals in Bottom Sediments

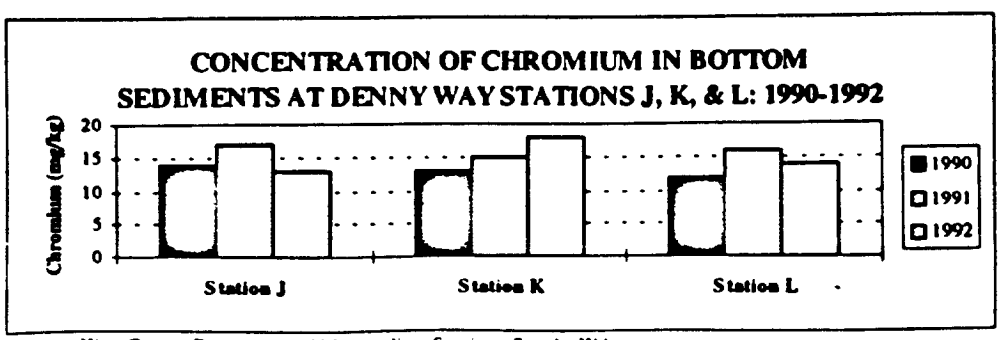
This performance measure tracks the trend of select metals in bottom sediments. The principal metals of interest are the six metals most commonly found in urban runoff as reported in the Nationwide Urban Runoff Program (U.S. EPA, 1983). These are: cadmium, chromium, copper, lead, nickel, and zinc. Other metals may be important in some CSO communities. The trend of metals in bottom sediments is a time series of the concentration of individual metals in bottom sediments. The appropriate units of measurement are mg/kg.

The potential sources of metals in urban waters include municipal and industrial wastewater, urban runoff, industrial storm water, and other nonpoint sources. CSO discharges may represent a source in some CSO communities. Elevated metals concentrations in bottom sediment may cause adverse ecological and human health effects. This measure may be important in those systems where contaminated sediments are a recognized problem, and where the reduction in metals from the CSS is an objective of the LTCP. Because of the variety of sources potentially contributing to metals in bottom sediments, this performance measure is well-suited for tracking improvement on a watershed scale.

Specialized skills are required for the measurement of metals in bottom sediments. Measurement once per year at impacted sites may be appropriate. Consistency in location and analytical technique from one year to the next is essential for the results to be meaningful.

Example

Sediment quality monitoring is an ongoing part of the CSO control program being implemented by the King County Department of Metropolitan Services in Seattle, WA. The Denny Way CSO featured in this example is the largest in the CSS. Construction of a storage/treatment tunnel and relocation of the outfall to deeper waters will eventually eliminate CSO impacts at this site. Prior to control, a clean sand cap was applied to bottom sediments. The accumulation and concentration of metals in bottom sediments within this cap prior to control is illustrated. Monitoring will continue following the implementation of controls, and it is expected that concentrations will decrease over time. However, metals can have a long residence time in bottom sediments, and commitment to long term monitoring is needed for this performance measure.



Source: King County Department of Metropolitan Services, Seattle, WA.

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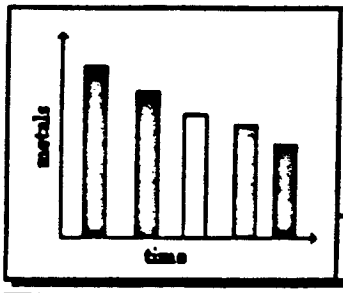
R0058216



CSO Performance Measure Profile Sheet

Trend of Metals in Bottom Sediments

Category: **Receiving Water**

Description:
Trend of the concentration of selected metals in bottom sediments (time plot of metals in mg/kg).

Applicability and Use:
Elevated metals concentration in bottom sediments may cause human health and ecological impacts. This performance measure may be useful in areas where sediment contamination is present, and where the reduction of metals load from the CSS is a goal of the LTCP.

Advantages of Measure:
- Trend can be linked to CSO control in some CSO communities.
- Measurement once per year should be sufficient.

Disadvantages of Measure:
- Requires a high skill level to measure metals in bottom sediment properly.
- Non-CSO sources of metals contamination are typically dominant in most areas.
- It may be difficult to associate change over time with CSO control because of other watershed sources of pollution.

For More Information:
APHA, AWWA, WEF. 1995. *Standard Methods For the Examination of Water and Wastewater, 19th Edition.*

Units of Measurement:
Metals concentration in mg/kg.

Probable Reporting Agency:
State Agencies.
CSO Communities.

Potential Data Sources:
- Annual survey.

Cost of Data Collection:
Medium to High. Measurement requires specialized field and laboratory expertise.

Attributes:

* Linkage to CSO discharge	○
* Quantifiable for trend analysis	●
* Usefulness relative to the cost of data collection	◗
* Flexibility with respect to local objectives and conditions	◗
* Understandable to the public	○
* Relationship to environmental improvement	●
* Watershed Context	●

KEY
● High ◗ Moderate ○ Low

VOL 12 2 4924

R0058217

CSO Performance Measure Description
Shellfish Bed Closures

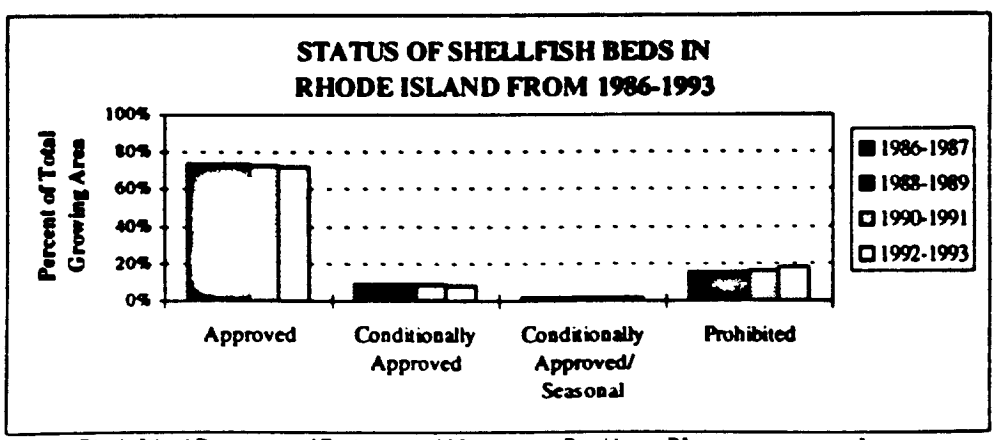


This resource use measure quantifies the extent of shellfish bed closures from year-to-year. Shellfish beds are used for both recreational and commercial harvesting. Shellfish tend to accumulate pathogens and other toxic material in their tissue. Bacteriological contamination in receiving waters is the principal reason for shellfish bed closures. The recommended unit of measurement is acre days closed per year. Insofar as it is possible, the number of shellfish bed closures attributable to CSOs provides an even better measure if cause and effect can be distinguished. Other alternative units may be appropriate where there is a history of use and they are readily understood

Shellfishing is a major commercial and recreational activity in many receiving waters. The closure of shellfish beds represents non-attainment of a designated use. Shellfish beds are closed in order to protect human health. The sources of pollution that are usually responsible for shellfish bed closures include agricultural runoff, urban runoff, failed septic systems, and CSO discharges. This measure may be important in those systems where shellfish bed closures are limiting commercial and recreational activities, and where the reduction in shellfish bed closures is consistent with the objectives of the LTCP. Because of the variety of sources potentially contributing to shellfish bed closures, this performance measure is well-suited for tracking improvement on a watershed scale.

Example

The Rhode Island Department of Environmental Management has a Shellfish Growing Area Monitoring Program. Seventeen separate growing areas are covered with from nine to thirty-nine stations in each area. The result of this monitoring aggregated to the state level as reported in biennial 305(b) reports are presented below. The units are percent of growing area in acres, not the recommended acre-days. As shown, no major changes have occurred over the past decade.



Source: Rhode Island Department of Environmental Management, Providence, RI.

VOL 12 2 4925

R0058218



CSO Performance Measure Profile Sheet

Shellfish Bed Closures

Category: **Ecological/Human Health/ Resource Use**

Description:
Extent of shellfish bed closures attributed to CSO discharges (acre/days closed per year).

Applicability and Use:
Shellfish bed closures pose a serious impact to commercial and recreational activities. Shellfish bed closures are based upon bacterial levels. Bacterial contamination is one of the major pollutants of concern discharged from CSOs. This performance measure may be appropriate for CSO communities where shellfish bed closures are a problem, and where CSO sources contribute to the problem.

Advantages of Measure:
- Widely used and understood by the public.
- Represents a direct measure of a designated use.
- Historical records are available in many receiving waters.

Disadvantages of Measure:
- It may be difficult to associate change over time with CSO control because of other watershed sources of pollution and management activities.

For More Information:
U.S. Food and Drug Administration (FDA). 1992. *National Shellfish Sanitation Program Manual of Operations, Part I: Sanitation of Shellfish Growing Areas.*

Units of Measurement:
Acre/days closed per year.

Probable Reporting Agency:
State/County Health Department.

Potential Data Sources:
- Health Department Reports.

Cost of Data Collection:
Low to Medium. Data should be available from Health Departments.

Attributes:

* Linkage to CSO discharge	◗
* Quantifiable for trend analysis	●
* Usefulness relative to the cost of data collection	●
* Flexibility with respect to local objectives and conditions	◗
* Understandable to the public	●
* Relationship to environmental improvement	●
* Watershed Context	●

KEY
● High ◗ Moderate ○ Low

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CSO Performance Measure Description
Benthic Organism Index

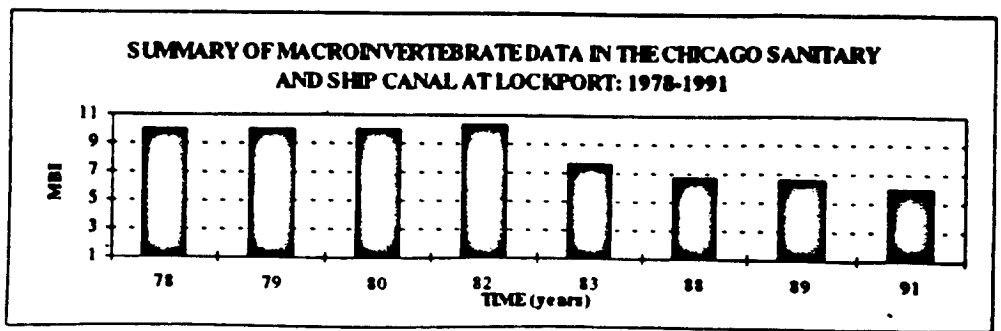
This ecological measure provides an estimate of the aquatic health of impacted waters. The benthic organism index is a measure of the diversity of macro-invertebrates within the benthic zone at the interface of bottom sediment with overlying waters. Benthic macroinvertebrates act as an in-place indicator of the quality of aquatic habitat. The abundance and diversity of species present as well as the ratio of pollution sensitive to pollution tolerant species are important indicators of current conditions.

Improvements in the aquatic health of receiving waters are anticipated as CSO controls are implemented. This measure may be important in those systems where aquatic habitat is impaired, and where improvement of the aquatic health of receiving waters is consistent with the LTCP Because of the variety of pollutant sources potentially affecting the macroinvertebrate community in urban waters, this performance measure is well-suited for tracking improvement on a watershed scale.

Specialized skills are required to conduct macroinvertebrate surveys. Many indices or protocols can be used, such as the Rapid Bioassessment Protocol, the Hilsenhoff Biotic Index, and the Invertebrate Community Index. Comparison with results from similar but relatively unimpacted reference sites is usually required. The units of measurement are typically in index-specific metrics. These indices and protocols are appropriate for most streams. Other comparable measures for deeper rivers, lakes, estuaries and coastal situations are under development by the EPA.

Example

The Macroinvertebrate Biotic Index (MBI) is used extensively in Illinois for biomonitoring. The MBI ranges from 11 to 1, with 11 representing the highest pollution tolerance, and, generally speaking, the most degraded water quality and habitat. The MBI is derived from the number of species collected and their pollution tolerance rating. In this example from the Chicago Sanitary & Ship Canal at Lockport, IL, the MBI trend over the period 1978 through 1991 is illustrated. The improvement over time at this site (decreasing MBI values) is the result of the cumulative effect of many water pollution control activities including CSO control and improved levels of municipal and industrial wastewater treatment. Note that data is not available for each year.



Source: Illinois EPA and the Metropolitan Water Reclamation District of Greater Chicago, Chicago, IL.

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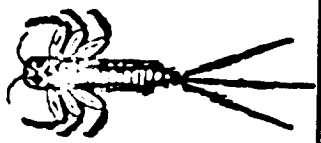

CSO Performance Measure Profile Sheet

Benthic Organism Index

Category: **Ecological/Human Health/ Resource Use**

Description:
Annual survey of macroinvertebrates in CSO receiving waters (e.g., Rapid Bioassessment Protocols (RBP), Macroinvertebrates Biotic Index (MBI), or Invertebrate Community Index (ICI)).

Applicability and Use:
The use of benthic organism indices as a measure of the health of aquatic systems in rising. Biological measures are being integrated with and in some instances replacing traditional water quality measures. This performance measure may be applicable in impaired water where CSO control and other environmental management activities are expected to improve aquatic habitat over time.

Advantages of Measure:
- Provides a direct measure of ecological results.
- Measurement once per year should be sufficient, if performed during the same season each year. Longer intervals may be acceptable.

Disadvantages of Measure:
- Requires high skill level to measure properly.
- Results are not readily understandable to the public, or even to environmental professionals other than specialized biologists.

For More Information:
U.S. EPA. 1989. *Rapid Bioassessment Protocols (RBP) for Use in Streams and Rivers - Benthic Macroinvertebrates and Fish.* EPA 440-4-89-001.

Units of Measurement:
Method specific index.

Probable Reporting Agency:
State Agencies.

Potential Data Sources:
- Annual surveys.

Cost of Data Collection:
Medium to High. Measurement requires specialized field and laboratory expertise.

Attributes:

• Linkage to CSO discharge	◗
• Quantifiable for trend analysis	●
• Usefulness relative to the cost of data collection	●
• Flexibility with respect to local objectives and conditions	●
• Understandable to the public	○
• Relationship to environmental improvement	●
• Watershed Context	●

KEY
● High ◗ Moderate ○ Low

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CSO Performance Measure Description
Biological Diversity Index



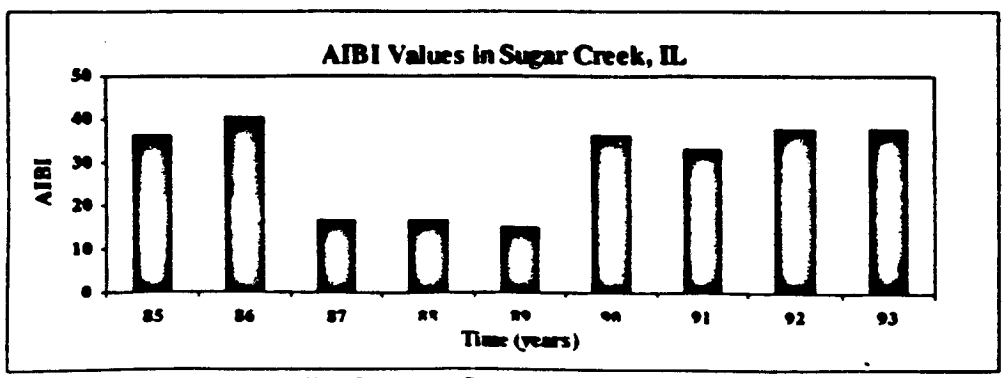
This ecological measure provides a broad assessment of the health of receiving waters by assessing habitat and the abundance and diversity of multiple organisms in receiving waters. Use of a composite biological diversity index provides a comprehensive evaluation of the aquatic community. This performance measure relates to the "Fishable" goal of the CWA. Appropriate measures include the Index of Biologic Integrity (IBI), the Rapid Bioassessment Protocol (RBP), and the Index of Well Being (I_{wb}).

Improvements in the aquatic health of receiving waters are anticipated as CSO controls are implemented. This measure may be important in those systems where aquatic habitat is impaired, and where improvement of the aquatic health of receiving waters is consistent with the LTCP. Because of the variety of pollutant sources potentially affecting the aquatic community in urban waters, this performance measure is well-suited for tracking improvement on a watershed scale.

Specialized skills are required to conduct biological surveys. Comparison with results from comparable but relatively unimpacted reference sites is usually required. The units are typically in index-specific metrics. These indices and protocols are most appropriate for shallow streams. Other comparable measures for deeper streams, lakes and coastal situations are under development by the EPA.

Example

The Bloomington and Normal Water Reclamation District in Illinois conducts annual biosurveys along Sugar Creek to evaluate the health of fish populations and potential impacts from agricultural runoff, urban runoff, CSOs, and point source discharges. An Alternate Index of Biotic Integrity (AIBI) is one of several measures used. The results at a CSO-impacted site (Biological Sampling Site No. 9) are presented below to illustrate the use of this performance measure. While some CSO control has been implemented, other factors appear to influence biological diversity. For example, 1987, 1988 and 1989 were drought years with intermittent flows. In addition, natural habitat is also limited in this channelized urban waterway. The value of the annual AIBI surveys is that they serve as a barometer of current aquatic conditions relative to the past, and as a baseline reference for the future.



Source: Bloomington and Normal Water Reclamation District, IL.

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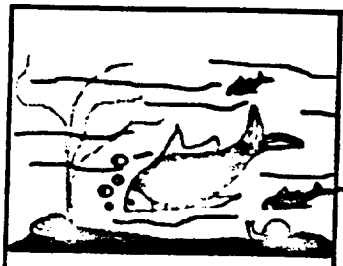

CSO Performance Measure Profile Sheet

Biological Diversity Index

Category: Ecological/Human Health/ Resource Use

Description:
Annual survey of aquatic communities in CSO receiving waters (e.g., Index of Biologic Integrity (IBI), Rapid Bioassessment Protocol (RBP) etc.).

Applicability and Use:
The use of biological diversity indices as a measure of the health of aquatic systems is rising. Biological measures are being integrated with and in some instances replacing traditional water quality measures. This performance measure may be applicable in impaired water where CSO control and other environmental management activities are expected to improve aquatic habitat over time.

Advantages of Measure:
- Provides a direct measure of ecological results.
- Measurement once per year should be sufficient, if performed during the same season each year.
- Directly related to the "fishable" goal of the CWA.

Disadvantages of Measure:
- Requires high skill level to measure properly.
- Results are not very understandable.
- Drought can affect results in some water bodies.
- Results are not readily understandable to the public, or even to environmental professionals other than specialized biologists.

For More Information:
U.S. EPA. 1989. *Rapid Bioassessment Protocols (RBP) for Use in Streams and Rivers - Benthic Macroinvertebrates and Fish.* EPA 440-4-89-001.

Units of Measurement:
Method specific index.

Probable Reporting Agency:
State Agencies.

Potential Data Sources:
- Annual surveys.

Cost of Data Collection:
Medium to High. Measurement requires specialized field and laboratory expertise.

Attributes:

* Linkage to CSO discharge	◗
* Quantifiable for trend analysis	●
* Usefulness relative to the cost of data collection	●
* Flexibility with respect to local objectives and conditions	●
* Understandable to the public	○
* Relationship to environmental improvement	●
* Watershed Context	●

KEY
● High ◗ Moderate ○ Low

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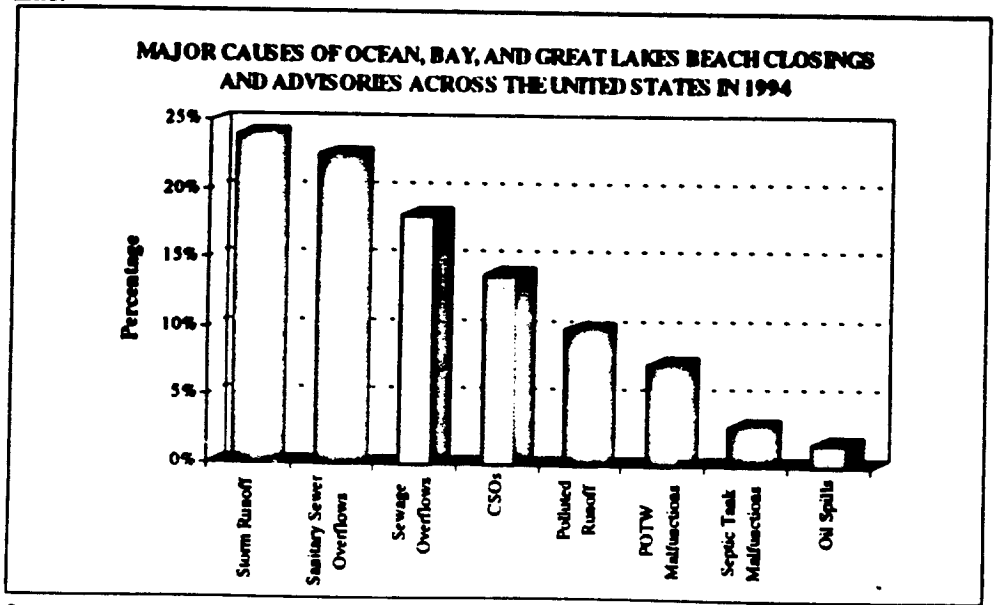
CSO Performance Measure Description
Beach Closures

Beach closures are one of the most obvious and understandable measures of the impacts of pollution. This measure of resource use represents the incidence of the closure of beaches for swimming or other contact recreation because of elevated bacterial concentrations that are indicative of potential public health problems and waterborne illness. This performance measure relates directly to the "swimable" goal of the CWA. The simplest unit of measurement is the number of beach closures per year. Insofar as it is possible, the number of beach closures attributable to CSOs provides an even better measure if cause and effect can be distinguished.

Contact recreation, including swimming, is an important designated use in many receiving waters. This measure may be important in those systems where there are beaches, and where implementation of the LTCP may be expected to contribute to a reduction in beach closures. Because of the variety of pollutant sources potentially contributing to beach closures, this performance measure is well-suited for tracking improvement on a watershed scale.

Example

The major causes of beach closures across the United States during 1994 are presented below. As shown, it is reported that CSOs were the major cause of 17 percent of beach closures and advisories. Although this example does not illustrate a trend for CSOs, follow-up surveys after the implementation of CSO controls would show change over time.



Source: *Testing the Waters V: Politics and Pollution at U.S. Beaches.* Natural Resources Defense Council, June 1995.

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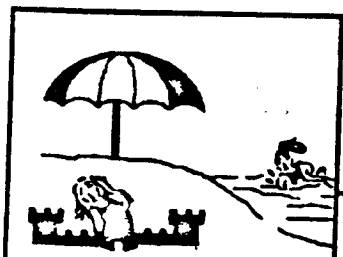

CSO Performance Measure Profile Sheet

Beach Closures

Category: Ecological/Human Health/ Resource Use

Description:
Number of beach closures attributed to CSO discharges (# per year).

Applicability and Use:
Beach closures represent a serious impairment of a designated use. Beach closures are usually based upon high bacterial levels or the presence of potential health hazards due to the wash-up of floatables. Both bacterial contamination and floatables are major pollutants of concern discharged from CSOs. This performance measure may be appropriate for CSO communities where beach closures are a problem, and where CSO sources contribute to the problem.

Advantages of Measure:
- Widely used and understood by the public.
- Directly linked to the "swimmable" goal of the Clean Water Act.

Disadvantages of Measure:
- It may be difficult to associate change over time with CSO control because of other watershed sources of pollution and management activities.

For More Information:
National Resources Defense Council. 1995. *Testing the Waters V: Politics and Pollution at U.S. Beaches.*

Units of Measurement:
Number per year.

Probable Reporting Agency:
State/County Health Department.

Potential Data Sources:
- Local records.

Cost of Data Collection:
Low to Medium. Data should be readily available from Health Departments.

Attributes:

* Linkage to CSO discharge	◗
* Quantifiable for trend analysis	●
* Usefulness relative to the cost of data collection	●
* Flexibility with respect to local objectives and conditions	◗
* Understandable to the public	●
* Relationship to environmental improvement	●
* Watershed Context	●

KEY
● High ◗ Moderate ○ Low

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CSO Performance Measure Description
Recreational Activities

This measure provides a quantitative assessment of the number of individuals participating in recreational activities on or adjacent to impacted receiving waters. It is intended to measure participation in water-oriented recreation activities. The units of measurement would have to be determined locally but could include boat rentals, fishing days, the number of swimmers, or other quantification of recreational activities on an annual basis. Any measure of recreation activities or events that bring people back to impacted receiving waters or adjacent public areas for recreational purposes would probably be acceptable.

It is anticipated that recreational activities will increase substantially in urban waters as CSO controls are implemented. This measure may be appropriate for CSO communities that have identified increased recreational use as a locally defined objective. This performance measure is well-suited for tracking improvement on a watershed scale.

Example

The Metropolitan Water Reclamation District of Greater Chicago is responsible for a CSS with a service area of 375 square miles. TARP, an ambitious Tunnel and Reservoir Plan initiated during the 1970s, is the principal CSO control. CSOs are diverted to the deep tunnels for storage during wet weather events, and later pumped to POTWs for treatment. TARP phase I is nearing completion, and the majority of CSO discharges have been or soon will be eliminated.

The Chicago River has been an important beneficiary of TARP implementation. Flowing through the heart of the city, the Chicago River is reported to be cleaner now than it has been in over a century. In spite of its industrial character, this urban river is rapidly becoming a major recreational resource within the Chicago metropolitan area. Fishing is back as the number of species present has doubled and tripled at many locations over the past twenty years. Canoeing and other recreational boating is resurging in areas where this was previously unthinkable. The river banks are approachable and frequented more than ever for a variety of diverse recreational activities. The Chicago River is healing itself, and CSO control is a major factor in this process. The quantification of new recreational activities on the river and along its banks can be an important measure of the success of CSO control and investment in TARP.

Source: Metropolitan Water Reclamation District of Greater Chicago, Chicago, IL; and the Chicago Tribune, August 1995.

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CSO Performance Measure Profile Sheet

Recreational Activities

Category: **Ecological/Human Health/ Resource Use**

Description:
Quantification of water oriented recreation on an annual basis (e.g., user days, boat rental, etc. per year).

Applicability and Use:
Recreational activities covers a wide range of passive and active water oriented activities. This performance measure attempts to quantify real use attainment that may be linked to CSO control. It takes activities and benefits into account that might otherwise be overlooked. The use of recreational activities as a performance measure may be appropriate for CSO communities where implementation of the LTCP and other environmental management activities are expected to result in increased recreational use of impacted waters.

Advantages of Measure:
- Understandable to the public.
- Directly linked to designated uses.
- Data collection can be built-in to concession and resource management activities.

Disadvantages of Measure:
- It may be difficult to associate change over time with CSO control because of other watershed sources of pollution and management activities.
- Recreational interests of the public may change for reasons totally unrelated to water quality.

For More Information:
Coast Alliance. 1995. *State of the Coast.*

Units of Measurement:
Activity measure.

Probable Reporting Agency:
Chamber of Commerce.

Potential Data Sources:
- Local records.

Cost of Data Collection:
Variable. Information for some activities such as fishing licenses, boat rentals, etc. should available. Other activities may require new surveys or new quantification techniques.

Attributes:

* Linkage to CSO discharge	◗
* Quantifiable for trend analysis	●
* Usefulness relative to the cost of data collection	●
* Flexibility with respect to local objectives and conditions	●
* Understandable to the public	●
* Relationship to environmental improvement	◗
* Watershed Context	●

KEY
● High ◗ Moderate ○ Low

R0058227

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CSO Performance Measure Description
Commercial Activities



This resource use measure provides an economic indicator of the value of commercial activities in receiving waters and waterfront areas. It is intended to measure economic activity related to CSO-impacted activities. Its use is intended to provide a barometer of business activity that is spawned by CSO control and other waterfront cleanup activities. Potential measurement units include the dock-side value of commercial fishing and shellfishing activities, revenues from waterfront concessions, real estate values, rental values, business tax revenues, tourism, and other indicators of commercial and economic activity that can be quantified and tracked.

Commercial development focused on previously polluted and underutilized urban receiving waters has been successfully implemented in many cities across the nation. This measure may be appropriate for CSO communities that have identified increased commercial activity as a locally defined objective. Because of the variety of pollutant sources potentially limiting commercial development and economic activities, this performance measure is well-suited for tracking improvement on a watershed scale.

Example

Casco Bay is an important receiving water along the south coast of Maine. CSOs form several Maine communities as well as other point and nonpoint sources affect water quality and habitat within Casco Bay. As these sources are controlled, the value of commercial activities associated with the Bay is expected to increase. Several economic indicators for Casco Bay are described to illustrate the use and importance of commercial activities as a performance measure.

As reported in the Draft Casco Bay Plan, *the species and ecosystems of Casco Bay provide a valuable economic resource for the region.*

- The value of the fisheries industry within Casco Bay is estimated to be $102 million per year. The soft-shell clam industry alone provides full or partial employment for approximately 300 people.
- The value of tourism and recreation in Casco Bay is estimated to be $250 million per year.
- Waterfront property along Casco Bay is estimated to be up to four times as valuable as similar property not located on the water.

It is often inappropriate to associate trends in commercial activity solely on the basis of CSO control as many other many other factors are involved. However, investment in CSO control is one element of environmental management and stewardship intended to improve water quality and habitat in impacted waters. The enhanced economic vitality of water bodies like Casco Bay due to this investment could be linked with measures of commercial activity.

Source: Casco Bay Estuary Project, ME

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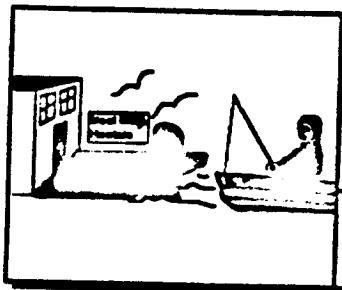

CSO Performance Measure Profile Sheet

Commercial Activities

Category: **Ecological/Human Health/ Resource Use**

Description:
The value of commercial activities in receiving waters and waterfront areas.

Applicability and Use:
Commercial activities cover a wide range of water-oriented activities. This performance attempts to quantify the amount and value of commercial activities in receiving waters and adjacent waterfront areas. The use of commercial activities as a performance measure may be appropriate for CSO communities where implementation of the LTCP and other restoration activities are expected to result in increased commercial activities.

Advantages of Measure:
- Understandable to the public.
- Data collection consists of compiling existing information in most instances.

Disadvantages of Measure:
- It may be difficult to associate change over time with CSO control because of other watershed sources of pollution and management activities, as well as economic factors wholly unrelated to water quality.

For More Information:
Coast Alliance. 1995. *State of the Coast.*

Units of Measurement:
Dollars per year.

Probable Reporting Agency:
Chamber of Commerce.
Department of Commerce.

Potential Data Sources:
- Local records.

Cost of Data Collection:
Variable. Economic indicators related to fisheries, waterfront property values, tourism, etc. may be readily available in some CSO communities.

Attributes:

* Linkage to CSO discharge	◗
* Quantifiable for trend analysis	◗
* Usefulness relative to the cost of data collection	●
* Flexibility with respect to local objectives and conditions	●
* Understandable to the public	●
* Relationship to environmental improvement	◗
* Watershed Context	●

KEY
● High ◗ Moderate ○ Low

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4.0 RECOMMENDATIONS FOR IMPLEMENTATION

4.1 INTRODUCTION

CSO control is ideally a coordinated effort among CSO communities, the federal government, states, and the public. All of these parties want CSO control to be successful, and all have a stake in the results. CSO communities, NPDES permitting authorities, and state water quality standards authorities are expected to undertake specific actions that are described in the CSO Policy. These include implementation of the NMCs, development and implementation of LTCPs, and regulatory review, support and oversight. Assessment of the effectiveness of control practices and measuring improvement in receiving waters is a major part of CSO control. The need to implement a program to track results and change over time is essential. The first step toward this end is the identification and selection of individual performance measures that are consistent with the LTCP and other locally defined objectives. The second step is the implementation of data collection and reporting for specific performance measures. These two steps are described in more detail below. In addition, potential federal and state use of performance measures is also discussed.

4.2 IDENTIFICATION AND SELECTION OF PERFORMANCE MEASURES

Identification begins with the CSO community and the local agency or department in charge of CSO control. The identification and selection of performance measures are undertaken as part of planning associated with implementation of the NMCs, and development and implementation of the LTCP. In fact, the identification of measures to meet CSO control goals and the implementation of post construction compliance monitoring are technical activities under the LTCP. CSO Communities should consider the identification and use of performance measures in relationship to the LTCP and other locally defined objectives. The major elements of identification are as follows:

- Characterize the CSS and baseline conditions.
- Identify the impact of CSOs in local receiving waters.
- Identify the CSO and water quality problems with the highest public interest through public participation.
- Identify local responsibilities under the CSO Policy, and other state policies and regulations where applicable.
- Identify what implementation of the LTCP is trying to accomplish and improve, particularly environmental results.
- Identify CSO control goals, water quality goals, and other locally defined objectives for the impacted waters and affected shorelines.
- Identify local financial capability and resources.
- Visit the menu-like framework (Table 3-1) and determine what performance measures will be most appropriate to meet local needs.
- Identify the agencies and programs that will collect data for individual performance measures.

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- Identify the agency or program that will have overall responsibility for data management, coordination and reporting.
- Coordinate and negotiate with the NPDES permitting authority regarding data collection, reporting and compliance monitoring needs.

4.3 IMPLEMENTATION OF DATA COLLECTION AND REPORTING

Data collection and reporting are carried out as part of implementation of the NMCs, and development and implementation of the LTCP. The major elements of implementation are as follows:

- Confirm data management, coordination, and data collection responsibilities.
- Enlist the public and local environmental and civic groups as participants.
- Coordinate the selection of performance measures with the state authorities and the permitting agency. Consider parallel monitoring needs for storm water, SSO and other NPDES programs.
- Coordinate activities with local watershed and estuary programs where applicable.
- Coordinate activities with the U.S. Geological Survey and other agencies and institutions to identify cooperative efforts and cost-sharing opportunities.
- Encourage citizen volunteer monitoring where it fits in with the identified performance measures.
- Develop a central data base for storing and tracking data collected on performance measures.
- Produce regular reports on results.
- Coordinate results with state 305(b) programs.
- Review the data and results on a regular basis and use the information to guide CSO management activities.
- Coordinate data collection with NPDES permit monitoring and reporting requirements.
- Share data and information with the public and other CSO communities.

4.4 FEDERAL AND STATE USE OF PERFORMANCE MEASURES

The development of performance measures that would be useful for CSO communities was emphasized within this study. However, it was recognized that federal and state agencies, including permitting authorities, have a vested interest in the successful implementation and use of performance measures. In addition, it was recognized that the performance measures would provide useful information for state and federal programs. Therefore, the potential use of performance measures by state and federal agencies is described.

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At the federal level, EPA should select a small number of performance measures that could be used to track programmatic results at the national level. Four specific performance measures considered in this study are recommended as appropriate for national tracking. These are:

- Documented Implementation of the NMCs.
- Status of LTCPs.
- CSO Frequency.
- CSO Frequency in Sensitive Areas.

The data for these measures should be collected primarily from the EPA Regional Offices and/or directly from state CSO program offices. In general, it is believed that information for these performance measures can be collected in a consistent manner, and that aggregation at the national level would produce a meaningful quantification of the results of CSO control efforts. Close coordidnation among EPA, the states and CSO communities is required.

At the state level, consideration of the following will increase the usefulness of data collection for performance measures:

- States should coordinate performance measures on a state wide basis that recognizes the site-specific nature of CSOs and their impacts.
- States should identify a small number of performance measures that can be used to track programmatic results at the state level. These measures should be carefully selected and defined so that they pose little if any additional administrative burden on CSO communities. Consideration of the performance measures recommended as appropriate for national tracking and noted above would be useful.
- States should provide assistance and field support for monitoring receiving water and ecological measures, particularly where diverse watershed sources are thought to be the cause of impacts.

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5.0 RELATIONSHIP TO OTHER NATIONAL PROGRAMS

CSO performance measures can be related to other ongoing national programs including wet weather program efforts such as the urban wet weather and stormwater activities, the establishment of national environmental goals and environmental indicators to measure them, and the revitalization of water quality monitoring. Most of these efforts are conducted in partnership by EPA and other federal agencies, states, tribes, local governments, and private entities. The purpose of this section is to describe the principal national programs and relevant projects related to goals, environmental indicators, and performance measures.

Government Performance and Results Act (GPRA)

One overall effort at the federal level is the Government Performance and Results Act of 1993. This act requires all federal agencies to have a strategic planning process by September, 1997 which identifies key stakeholder's expectations and priorities, agency missions, high-priority long-term objectives, strategies and resources needed to achieve objectives, and types of information that can be used to measure, or indicate progress toward the long-term objectives. Following the establishment of a strategic plan, agencies will need to produce annual performance plans and reports. The annual performance plan will identify program performance indicators, annual performance goals, and processes and resources needed to achieve goals. The annual performance reporting will compare actual progress with the goals, explain why any performance goals were not met, and communicate the value of effective programs.

In the environmental indicator development process, national and international organizations are using various conceptual frameworks to present the data needed and the relationships among the types of measures. One of the most widely used is the Pressure-State-Response (PSR) framework. As explained by the World Resource Institute, (WRI, 1995), pressure indicators measure the pressures on the environment caused by human activities; state indicators measure changes in the physical or biological condition of the natural world; and response indicators measure what society is doing to address environmental change and problems. As shown below, the categories of performance measures utilized in the development of CSO performance measures generally fit within the PSR framework.

Direct Pressure (P)	State (S) or Condition	Societal Response (R)
End-of Pipe Measures	Receiving Water Measures Ecological Measures Human Health Measures Resource Use Measures	Administrative Measures

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National Environmental Goals Project

EPA is in the process of establishing long-range environmental goals with ambitious but realistic milestones for measuring progress toward these goals by the year 2005. The milestones are measured by data from environmental indicators. These goals and the milestones which will mark measured improvement in or alleviation of pressures to the environment will be presented in an EPA report being prepared for review in 1996.

The proposed topics to be covered in the report include clean water and safe drinking water goals. The clean water goal states that:

> *All waters will support healthy communities of fish, plants, and other aquatic life. Surface waters will be safe for fishing and swimming and for sources of drinking water. Ground waters will be safe for intended uses. Remaining wetlands will be protected and many that have been lost will be restored.*

The safe drinking water goal states that:

> *Every public water system will consistently provide water that is safe to drink.*

Environmental Indicators

Environmental indicators are being used to support planning efforts in many programs. As reported by the Intergovernmental Task Force on Monitoring Water Quality (ITFM), "indicators are measurable features which singly or in combination provide managerially and scientifically useful evidence of environmental and ecosystem quality, or reliable evidence of trends in quality" (ITFM, 1994). EPA's Office of Water is leading an effort to develop national water environmental indicators in collaboration with other public and private partners. The development and reporting of national water environmental indicators feeds the activities of the GPRA and the National Environmental Goals Project. Within EPA, the main purposes for having national water environmental indicators include:

- Showing the condition of our nation's waters over time.
- Measuring progress towards national water goals.
- Measuring the effectiveness of national water programs.

EPA has selected and is proposing to report on 16 water environmental indicators. The relationship of the proposed EPA Office of Water indicators to the recommended CSO performance measures developed in this study is presented in Table 5-1. A more complete description of these proposed indicators is located in Appendix C.

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Table 5-1. Relationship of the Office of Water Environmental Indicators to CSO Performance Measures Developed in this Study

OFFICE OF WATER INDICATORS	CSO PERFORMANCE MEASURES
HUMAN HEALTH	
♦ Violations of drinking water standards.	
♦ Drinking water systems not meeting filtration requirements.	
♦ Lead levels in public drinking water systems.	
♦ Source water protection for ground water.	
♦ Waters meeting drinking water designated uses.	
♦ Fish consumption advisories.	
♦ Shellfish bed closures.	♦ Shellfish Bed Closures, Commercial Activities.
♦ Waters meeting fish and shellfish consumption designated uses.	
♦ Waters meeting recreation designated use.	♦ Beach Closures, Recreational Activities.
ECOSYSTEM HEALTH	
♦ Biological integrity of the water.	♦ Benthic Organism Index, Biological Diversity Index.
♦ Species at risk.	♦ CSO Frequency in Sensitive Areas, CSO Volume in Sensitive Areas, Benthic Organism Index, Biological Diversity Index.
♦ Wetland acreage.	
♦ Waters meeting aquatic life designated uses.	♦ Benthic Organism Index, Biological Diversity Index.
DESIGNATED USES	
♦ Human health and ecosystem health.	
CONSERVE OR IMPROVE AMBIENT CONDITIONS	
♦ Selected surface water quality pollutants.	♦ Dissolved Oxygen Trend, Fecal Coliform Trend, Floatables Trend.
♦ Selected ground water quality pollutants.	
♦ Contaminated sediments.	♦ Sediment Oxygen Demand Trend, Trend of Metals in Bottom Sediments.
PREVENT OR REDUCE POLLUTANT LOADINGS	
♦ Point source loadings to surface and ground water.	♦ Wet Weather Flow Budget, CSO Frequency, CSO Volume, BOD Load, TSS Load, Nutrient Load, Floatables.
♦ NPS loadings to surface and ground water.	
♦ Marine Debris.	♦ Floatables, Floatables Trend.

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Environmental indicators at the national level emphasize measurements related to the goals of the national CWA and Safe Drinking Water Act and the following objectives:

- Conserving and enhancing public health.
- Conserving and enhancing aquatic ecosystems.
- Supporting water uses designated by States.
- Conserving and improving ambient conditions.
- Preventing or reducing pollutant loadings.

These objectives support one another and are illustrated in a hierarchical order as illustrated in Figure 5-1. These overall indicators provide the framework for additional indicators and measurements made at the specific program level, such as the performance measures for the National CSO Control Program recommended in this study.

Wet Weather Programs

EPA's National Water Program Agenda for the Future, issued by the EPA's Assistant Administrator for Water on December 30, 1994, identified the improvement in wet weather flow controls as one of two programmatic priorities for EPA's Office of Water. The Agenda also discussed issues associated with improving control of wet weather flows.

EPA formed the Urban Wet Weather Flows Advisory Committee in the spring of 1995. The Committee's purpose is to address issues associated with water quality impacts from urban wet weather flows and other storm water discharges under Section 402(p)(6) of the CWA. The Committee's mission is to provide a forum to develop recommendations on wet weather discharges (including CSOs) in an innovative and cost-effective manner. The Committee formed a Watershed Work Group whose mission is to recommend to the Committee how comprehensive watershed management can best contribute to meeting human health, ecological health and water quality goals when dealing with problems caused by wet weather flows in urban areas. One of the recommendations to be developed by this workgroup will identify appropriate measures of success for documenting the effectiveness of controlling urban wet weather flows. The performance measures identified in this report should be useful to the Watershed Work Group in the identification of measures to evaluate the impacts of urban wet weather flows on receiving water bodies.

EPA's Office of Wastewater Management is also supporting a multitask project to develop and implement storm water environmental indicators. Municipalities and other storm water dischargers will use the identified indicators to assess the effectiveness of storm water control efforts, and provide data for a national storm water indicators tracking system. At the time of this writing (January, 1996), Phase I of the storm water project is nearly complete, and two documents are in draft form. The first document describes recent efforts to develop and implement environmental indicators and techniques for assessing the effectiveness of municipal storm water management programs. The

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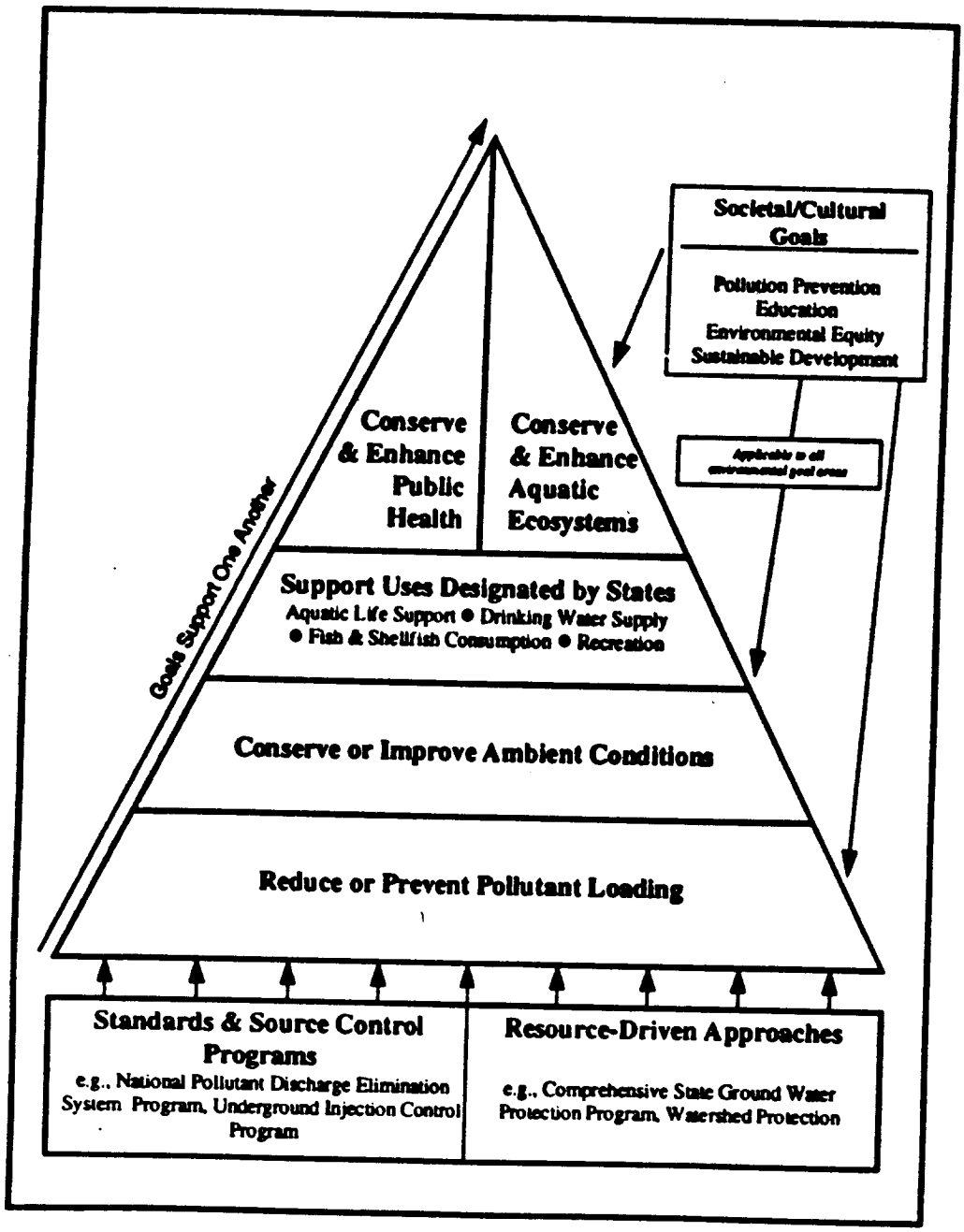
Figure 5.1 National Goals: Clean Waters and Safe Drinking Water



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identified indicators are grouped into seven broad categories: water quality indicators, physical and hydrological indicators, biological indicators, whole watershed indicators, social indicators, programmatic indicators, and site indicators. The second report contains profile sheets on the indicators that were identified in each of the seven broad categories. It also presents a framework for using the identified indicators and a methodology for establishing an indicator monitoring program. These reports should be available in 1996.

There are commonalities between the storm water indicators and the CSO performance measures. Communities with both combined and separate storm sewer systems should explore these commonalties before deciding on operating separate programs to measure the effectiveness of their control programs. An integrated program would in most cases be more cost-effective

Revitalizing Monitoring

Indicators are only as good as the data to report on them, so it is critical to support the indicators efforts with strong monitoring and data programs. Several major efforts are underway to revitalize monitoring which will, among other things, provide good data for indicators.

The Intergovernmental Task Force on Monitoring Water Quality - The ITFM was formed in early 1992 to design a nationwide water monitoring strategy for the collection of water quality data within all public and private sectors. The Task Force is a partnership that includes representatives from 20 federal, state, tribal, and interstate organizations. EPA chairs the ITFM, and the U.S. Geological Survey (USGS) has lead-agency responsibility for water information coordination. In addition to the 20 officially designated ITFM representatives, more than 150 individuals in federal and state agencies have participated in nine working groups to provide additional perspective and technical expertise on specific issues. Private sector organizations also participate in the process through the Federal Advisory Committee on Water Data for Public Use, public meetings announced in the *Federal Register*, and an initiative to promote coordination of ambient and compliance monitoring. The National Strategy is available from the USGS Office of Water Data Coordination (703 648-5023), or through the Internet at http://h2o.usgs.gov.

Pilot Programs - EPA is sponsoring pilot programs in eight states to test the implementation of the sixteen national indicators at the state and watershed level. One important objective of these pilot programs is to determine which of the indicators are best suited for use as measures of program effectiveness at the state level. A second group of pilot programs, undertaken in conjunction with the ITFM, is testing how to better integrate the use of ambient and compliance monitoring information in priority watersheds. The main objective of these pilot programs is to determine the most effective ways to integrate this information among all public and private stakeholders.

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State and Tribe Monitoring Strategies - To facilitate efficient monitoring programs, the EPA is working closely with states and tribes to help them develop multi-year monitoring strategies to comprehensively assess the waters within their boundaries on a five-year cycle using a variety of monitoring techniques according to the condition of and goals for the waters. Guidance to develop these strategies parallels that agreed to by the ITFM. These comprehensive monitoring efforts in coordination with the individual program performance measures will aid in evaluating both program effectiveness and the condition of the nation's waters.

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GLOSSARY

AMSA	The Association of Metropolitan Sewerage Agencies.
BOD	Biochemical Oxygen Demand: a measure of the amount of oxygen consumed in the biological processes that break down organic matter in water.
Catch basin	A chamber usually built at the curbline of a street, which admits surface water for discharge into a storm drain.
Combined sewer	A sewer designed to carry wastewater and stormwater runoff.
CSO	Combined Sewer Overflow: The term CSO can be used to mean either (1) the portion of flow from a combined sewer system (CSS) which discharges into a water body from an outfall located upstream of the headworks of a POTW, usually during a rainfall event; or (2) the outfall pipe which carries this discharge.
CSO Event	One or more overflows from a CSS as a result of a precipitation event that do not receive the minimum treatment specified.
CSO Policy	The Combined Sewer Overflow (CSO) Policy, April, 1994.
CSS	Combined Sewer System: a wastewater collection systems designed to carry sanitary sewage (consisting of domestic, commercial, and industrial wastewater) and storm water (surface drainage from rainfall or snowmelt) in a single pipe to a treatment facility.
CWA	The Clean Water Act of 1972 and its Amendments.
Dissolved oxygen	The oxygen freely available in water. Dissolved oxygen is vital to fish and other aquatic life and for the prevention of odors. Traditionally, the level of dissolved oxygen has been accepted as the single most important indicator of a water body's ability to support desirable aquatic life.
DWO	Dry Weather Overflow: a combined sewer overflow that occurs during dry weather flow conditions.
Fecal coliform	A bacteria found in the intestinal tracts of mammals. The presence of fecal coliform in water is an indicator of pollution and possible contamination by pathogens.

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Floatables	Solid or semi-solid materials discharged from a combined sewer that represent an aesthetic nuisance, a threat to wildlife, and a pubic health problem.
LTCP	Long Term Control Plan.
MG	Million Gallons.
NPDES	National Pollutant Discharge Elimination System: a provision of the Clean Water Act which prohibits discharge of pollutants into waters of the United States unless a special permit is issued by EPA, a state, or (where delegated) a tribal authority.
NMC	Nine Minimum Controls.
POTW	Publicly Owned Treatment Works: a waste-treatment works owned by a state, a utility, a unit of local government, or a tribe designed to treat domestic wastewaters.
PSR	Pressure - State - Response framework.
Sensitive areas	Areas of particular environmental significance or sensitivity that could be adversely affected by a CSO, including Outstanding National Resources Waters, National Marine Sanctuaries, water with threatened or endangered species, waters with primary contact recreation, public drinking water intakes, shellfish beds, and other areas identified by the permittee or NPDES permitting authority, in coordination with the appropriate State or Federal agencies.
Sewage overflow	Bypassed or inadequately treated sewage.
SOD	Sediment Oxygen Demand: a measure of the capacity of bottom sediments to remove oxygen from overlying waters.
SSO	Sanitary Sewer Overflow.
TSS	Total suspended solids: a standard measure of the concentration of particulate matter in wastewater, effluent or receiving waters.

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APPENDIX A

FOCUS GROUP, FIELD INTERVIEW PARTICIPANTS AND INDIVIDUALS WHO ASSISTED WITH ANECDOTAL INFORMATION AND EXAMPLES

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NEW ENGLAND FOCUS GROUP MEETINGS	
REGULATORY AGENCIES	
Gregg Comstock	New Hampshire Department of Environmental Services
Chris Feeney	Rhode Island Department of Environmental Management
Bill Hogan	Connecticut Department of Environmental Protection
Jeff Jordan	Casco Bay Estuary Project, City of South Portland, Maine
Angelo Liberti	Rhode Island Department of Environmental Management Division of Water Resources
Jay Manning	Rhode Island Department of Environmental Management Division of Water Resources
Mike O'Brien	Connecticut Department of Environmental Protection
John O'Hare	Greater Lawrence Sanitary District, North Andover, Maine
Steve Silva	Environmental Protection Agency Region I
Ben Viola	Maine Department of Environmental Protection
ENVIRONMENTAL INTERESTS	
Nicole Cromwell	Save the Bay, Providence, Rhode Island
John Elwood	Friends of the Muddy River
Phillip Holmes	Rhode Island Shell Fisherman's Association
Curtis Johnson	Connecticut Fund for the Environment
Jeff Jordan	Casco Bay Estuary Project, City of South Portland, Maine
Betsy McCroy	Massachusetts Bays Program
Joe Payne	The Friends of Casco Bay Baykeeper
Nancy Phillips	Nashua River Watershed Association
Steve Silva	Environmental Protection Agency Region I
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Bob Zimmerman	Charles River Watershed Association
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Roy Anderson	City of Newport, Rhode Island Utilities Department
Lynn Browne	Gloucester, Massachusetts Department of Public Works
Tom Brueckner	Narragansett Bay Commission, Rhode Island
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Steven Freedman	Whitman Howard, South Portland, Maine
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Phil Heckler	New York City Department of Environmental Protection
Denise Horan	Metropolitan District, Hartford, Connecticut
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Dave Koblak	Massachusetts Water Resource Authority, Boston, Massachusetts
Lise Marx	Massachusetts Water Resource Authority, Boston, Massachusetts
Brad Moore	City of Bangor, Maine
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KENTUCKY/MIDWEST FOCUS GROUP MEETINGS	
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Jennifer Echlin	Ohio River Valley Water Sanitation Commission, Cincinnati, Ohio
Geoff Edwards	Ohio River Valley Water Sanitation Commission, Cincinnati, Ohio
Jim Gibson	Ohio River Valley Water Sanitation Commission, Cincinnati, Ohio
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Larry James	Environmental Management Corp Jeffersonville Waste Water Treatment Plant, Indiana
Steve John	National League of Cities
George Kurz	Consoer Townsend & Association, Nashville, Tennessee
Jeff Lape	Woolpert, Alexandria, Virginia
John McManus	Ohio River Valley Water Sanitation Commission, Cincinnati, Ohio
Bob Oerther	Frankfort Sewer Division, City of Frankfort, Kentucky
Sara Qualls	Tennessee Division of Water Pollution Control
Don Reeve	Ohio Environmental Protection Agency
John Rexing	Evansville, Indiana Water & Sewer Utility
Nancy Shultz	CH2M HILL, Milwaukee, Wisconsin
Dean Studer	Illinois Environmental Protection Agency
Steve Stutler	West Virginia Department of Environmental Protection
Peter Swenson	US Environmental Protection Agency %
Peter Tennant	Ohio River Valley Water Sanitation Commission, Cincinnati, Ohio
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Steve John	National League of Cities
George Kurz	Consoer Townsend & Association, Nashville, Tennessee
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Larry Bonar	Moundsville, West Virginia
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Ted Burgess	Camp Dresser & McKee
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Gordon Garner	Louisville & Jefferson County Metropolitan Sewer District, Kentucky
Derek Guthrie	Louisville & Jefferson County Metropolitan Sewer District, Kentucky
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Greg Peugh	EV Engineering, Louisville, Kentucky
Ken Pew	Northeast Ohio Regional Sewer District
John Rexing	Evansville, Indiana Water & Sewer Utility
Frank Rothfuss	Woolpert, Cincinnati, Ohio
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Steve Merrill	Brown and Caldwell Consultants
Joe Payne	Friends of Casco Bay, Maine
Dave Pineo	City of South Portland, Maine
Don Rector	Ohio Environmental Protection Agency
Wendy Reust	City of Akron Bureau of Engineering, Ohio
Tyler Richards	City of Atlanta, Georgia
Joseph Sawyer	City of Newark, Ohio
Joe Sawyer	City of Newark, Ohio
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Gunars Sriebers	King County Department of Metropolitan Services, Seattle, Washington
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Dick Lanyon	Metropolitan Water Reclamation District of Greater Chicago, Illinois
Frank Loucar	New York City Department of Environmental Protection, New York
Dave Pineo	City of South Portland, Maine
Jim Salerno	City of San Francisco, California
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APPENDIX B

SUMMARY OF FOCUS GROUP RANKINGS OF THE FIRST-CUT PERFORMANCE MEASURES DEVELOPED BY THE WORK GROUP

A total of forty-eight potential or first-cut performance measures were identified in a brainstorming session by the Work Group. These measures were subsequently distributed at six regional Focus Group meetings in New England and Kentucky where the participants ranked the measures according to their usefulness to quantify and track change and improvement associated with CSO control. The results of this ranking are presented in the following table.

Separate rankings were developed for performance measures in four categories:

- Administrative Measures;
- End-of-Pipe Measures;
- Receiving Water measures; and
- Ecological, Human Health and Resource Use Measures.

Ranks were determined using 1 as the best performance measure, 2 as the second best measure, etc. Individual rankings and totals are presented for each Focus Group meeting, where

- Environ. Rank is the ranking of the environmental Focus Group;
- Reg. Rank is the ranking of the regulatory Focus Group; and
- CSO Rank is the ranking of the CSO communities.

A composite overall rank that includes the results of all six Focus Group meetings is provided in the rightmost column.

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SUMMARY OF FOCUS GROUP RAKING OF THE FIRST-CUT PERFORMANCE MEASURES DEVELOPED BY THE WORK GROUP

Focus Group Survey Summary							
Criteria	New Engl. Environ. Rank	New Engl. Reg. Rank	New Engl. CSO Rank	Kentucky Environ. Rank	Kentucky Reg. Rank	Kentucky CSO Rank	Overall Rank
Administrative Measures							
Wet Weather Flow	4	1	1	2	4	1	1
Nine Minimum Controls	3	5	3	7	1	2	2
Long Term CSO Control Plan (LTCCP) in Development	10	2	4	3	2	3	3
Waste Reduction	1	9	2	6	3	7	4
LTCCP Implemented	7	3	6	4	6	4	5
Outfall Inspections	6	7	5	8	7	5	6
LTCCP Completed	8	4	7	5	5	10	7
Enforcement	5	8	12	1	8	11	8
Annual Report	9	10	8	11	9	6	9
Public Outreach	2	12	9	12	10	8	10
Size of Combined Sewer System	11	11	11	9	11	9	11
Combined Sewer System Separation	12	6	10	10	12	12	12
End-of-Pipe Measures							
Dry Weather Overflows	4	8	1	1	1	2	1
Floatables	3	4	2	2	6	4	2
Volume of CSO Discharge in Sensitive Areas	5	2	5	5	5	3	3
Frequency of CSO Discharges in Sensitive Areas	6	3	6	6	3	1	4
Reduction in CSO Volume	8	6	4	4	4	7	5
Fecal Coliform Load	1	7	3	11	7	5	6
CSO Volume	14	1	9	3	9	9	7
Overflows per Outfall	11	5	14	7	2	6	8
TSS Load	2	10	8	9	10	11	9
BOD Load	12	9	11	8	8	8	10
Fecal Coliform Concentration	7	11	7	15	11	10	11
Nutrient Load	9	15	12	10	13	15	12
Grit	13	12	10	12	15	14	13
TSS Concentration	10	14	13	14	14	13	14
BOD Concentration	15	13	15	13	12	12	15
Receiving Water Measures							
Fecal Coliform	1	1	2	6	3	2	1
Dissolved Oxygen	5	4	5	1	1	1	2
Fecal Coliform Trend	3	2	1	7	2	4	3
Dissolved Oxygen Trend	6	3	4	2	4	3	4
Water Clarity Trend	4	5	3	4	7	7	5
Metals in Bottom Sediments	2	7	7	3	5	6	6
Sediment Oxygen Demand Trend	7	6	6	5	6	5	7
Ecological, Human Health, and Resource Use Measures							
Shellfish Bed Closures	2	2	2	3	8	11	1
Attainment of Designated Use	13	4	1	2	8	3	2
Recreational Use	8	6	5	8	5	1	3
Beach Closures	7	1	3	7	7	9	4
Fish Abundance and Diversity	1	11	7	8	2	5	5
Fish Kills	14	8	12	1	1	2	6
Visual Impacts	9	5	4	5	12	4	7
Benthic Organism Index	5	12	10	10	3	7	8
Fish or Shellfish Advisories	10	7	6	4	9	12	9
Biological Diversity Index	3	13	8	11	4	10	10
Relative Habitat Improvement	4	9	11	12	10	8	11
Nuisance Complaints	11	10	9	8	11	6	12
Shellfish Harvest	8	3	14	13	14	13	13
Commercial Activities	12	14	13	14	13	14	14

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APPENDIX C

LIST OF EPA WATER ENVIRONMENTAL INDICATORS

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LIST OF EPA WATER ENVIRONMENTAL INDICATORS(1)

Human Health	1. Violations of drinking water standards. Population provided drinking water by community water systems reporting one or more violations of maximum contaminant levels or treatment techniques. 2. Drinking water systems not meeting filtration requirements. Number of systems and population served by water systems that have not met the requirements of the Surface Water Treatment Rule. 3. Lead levels in public drinking water systems. This will report the population served by public drinking water systems that exceed the lead in drinking water action level (more than 10 percent of the lead samples exceed 15 parts per million, grouped to the 90th percentile). It would measure the lead in distribution systems, not ambient conditions. 4. Source water protection for ground water. Initially, number of source water protection programs for groundwater used as drinking water. 5. Waters meeting safe drinking water designated uses. Number of surveyed waterbodies that can support safe drinking water supply. 6. Fish consumption advisories. Percentage of river miles and lake acres for which States have issued fish consumption advisories for particular chemical contaminants (mercury, metals, dioxin, chlordane, PCBs, DDT, Other). 7. Shellfish bed closures. Presents the classification status of the nation's shellfish harvest areas for human consumption using NOAA survey data. 8. Waters meeting fish and shellfish consumption designated uses. Number of surveyed waterbodies that can support fish and shellfish consumption. 9. Waters meeting recreation designated uses. Number of surveyed waterbodies that can support safe recreation.
Ecosystem Health	10. Biological integrity of the water. The number of waters that meet the biological integrity objective of the Clean Water Act, as determined by States working with EPA to ascertain which waters are similar to regional reference conditions selected by States as goals for their waters. 11. Species at risk. Depicts the status of aquatic plants and animals in five categories: extinct, critically imperiled, imperiled, vulnerable, apparently secure, or demonstrably secure using criteria that includes distributional range and extent of appropriate habitat, population and range, threats, fragility or susceptibility to threats. 12. Wetland acreage. Loss of acres of wetland from 1780 to present. 13. Waters meeting aquatic life designated uses. Number of surveyed waterbodies that can support healthy aquatic life.
Designated Uses	States and tribes designated uses for their waterbodies that include safe drinking water supply (indicator 1), fish and shellfish consumption (indicator 6), recreation (indicator 9), and healthy aquatic life (indicator 13). Although this is a separate and important objective, the designated use indicators are discussed under the related objectives.
Ambient Conditions	14. Selected surface water quality parameters. The parameters that are chosen as loadings indicators will be tracked in the ambient environment 15. Selected ground water quality parameters. The parameters chosen to track contaminants in ground water will be measured in the ambient environment for ground water systems that do not violate drinking water use. 16. Contaminated sediments. Reports sediment toxicity in the sites sampled for EPA's Contaminated Sediment Inventory. Data collected on pesticides, halogens, metals, organics (C, H, O and N, S, P), PAHs, and PCBs as well as total phosphorus, total nitrogen, sediment oxygen demand, pathogens, TRI chemicals (PS; organics, metals & pesticides (NPS), total organic carbon and acid volatile sulfide.
Loadings	17. Point source loadings to surface and ground water. Reduction in loads of specific pollutants. 18. Nonpoint Source loadings to surface and ground water. NPS loadings are difficult to identify and track. The 1995 report will focus on soil loss and may add nutrients and pesticides. 19. Marine Debris. Pounds of trash collected during annual beach cleanup sponsored by Center for Marine Conservation (CMC), EPA, NOAA and others.

(1)This list of water environmental indicators will be published by the Environmental Protection Agency and its Federal, State, and Tribal Partners in the first national water indicators report in 1996.

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ACTION PLAN DEMONSTRATION PROJECT

DEMONSTRATION OF GASOLINE FUELING STATION

BEST MANAGEMENT PRACTICES

FINAL REPORT

October 1994

Submitted to

U.S. Environmental Protection Agency, Region IX
San Francisco Estuary Project

Prepared for

County of Sacramento
Water Resources Division

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Executive Summary

This report summarizes the findings of the Demonstration of Gasoline Fueling Station Best Management Practices project. The project is an "Action Plan Demonstration Project" (APDP) funded in part by a grant awarded by the U. S. Environmental Protection Agency (U.S. EPA) through the San Francisco Estuary Project to the County of Sacramento (County). The purposes of the study were to characterize storm water runoff from gasoline fueling stations, demonstrate the effectiveness of pollution prevention technologies or best management practices (BMPs) in reducing pollutant loadings from gasoline fueling station runoff, and to disseminate information on effectiveness and costs to a wide audience.

The basic project design involved a two year study in which:

- during the first wet season (1992/93), samples of sheet flow runoff from three gas stations were collected prior to BMP implementation and analyzed in the laboratory for a variety of pollutants (Phase 1);
- best management practices were developed and implemented during the following dry season (Phase 1); and
- the following wet season (1993/94), after BMP implementation, runoff samples were collected and analyzed for the purpose of comparing pre-BMP data to post-BMP data for a quantitative evaluation of BMP effectiveness (Phase 2).

The growing body of published studies and storm water monitoring data continues to indicate that vehicles are one of the most significant sources of storm water pollutants and that areas where service of vehicles is conducted may be of particular concern. Fueling station discharges may be regulated in the future, so cost-effective BMPs will be very important not only in pollution reduction, but regulatory compliance as well.

The initial work on Phase 1 included the selection of three representative gasoline fueling stations whose owners/operators were willing to participate in the BMP demonstration program. Runoff samples from six storms were collected at each of the three stations during the 1992/93 wet season. Multiple samples were collected manually from sheet flow to represent a flow-weighted composite sample of approximately the first 0.30 inch of rainfall. Climatological data were also compiled

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throughout the first wet season to aid in interpreting the storm water runoff results. The major classes of constituents analyzed in Phase 1 were:

Oil & Grease,
Total suspended solids,
Heavy metals (thirteen priority pollutant metals, aluminum, and iron),
Polycyclic aromatic hydrocarbons, and
Petroleum hydrocarbons.

After the first three storms, constituents not found in detectable concentrations or those found significantly below levels of concern were no longer included in the analyses, thereby allowing the analyses to focus on indicator pollutants. These pollutants were present in relatively high concentrations and were thought to be representative of the other pollutants on-site. The following pollutants were selected as indicators:

Oil & Grease,
Total suspended solids, and
Heavy metals (cadmium, chromium, copper, lead, and zinc)

Runoff water quality data from the first wet season of this study appeared comparable to results from recent related studies. Regressions of the pre-BMP data versus four rainfall parameters were performed: rainfall intensity during the period of sampling, cumulative precipitation to date, days since last storm of 0.10 inch or greater, and days since last storm of 0.25 inch or greater. This was done for each station individually and for the pooled data set. Overall, the regressions of pre-BMP runoff concentrations versus rainfall parameters showed the most consistent relationship to be between log concentration and days since last storm >0.25 inch, particularly for zinc. This result indicated that pollutant buildup occurs during dry periods, and runoff concentrations reflect the length of the buildup period.

The selection process for best management practices included all the potential BMPs applicable to the stations given the physical limitations of the sites. Off-site BMPs (e.g., detention pond, wetlands) were not considered because the scope and budget did not allow for these to be tested. Best management practices were selected using a semi-quantitative scoring method based on cost and perceived effectiveness in reducing pollutants. A suite of BMPs was selected to implement at each station that focuses on the areas with the greatest potential to generate pollutants (e.g., air/water supply area, fueling area, drive through area) as opposed to areas with less pollution potential (e.g., roof drains).

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The following BMPs were selected for implementation at each station:

- Mobile Cleaning,
- Litter Control,
- Public Notices,
- Storm Drain Stenciling,
- Spill Cleanup Materials, and
- Employee Training.

The selected BMPs were implemented in the summer of 1993. Post-BMP runoff samples from the 1993-94 wet season were collected and analyzed to compare pre-BMP data to post-BMP data for a quantitative evaluation of BMP effectiveness.

Based on observations by project personnel and best professional judgment about the efficacy of source controls, it is highly likely that of the six BMPs implemented at the gas stations, the one BMP with the most significant chance to affect runoff quality was mobile high pressure water cleaning. The combined effect of the other five source controls was not likely to have a significant impact on the sources of pollution at the stations, namely, high volume vehicle traffic and leaks and spills of vehicle fluids. Consequently, the study can be considered in large part a pilot test of mobile cleaning as a best management practice.

When all the data from the pre-BMP condition is combined and compared against all the post-BMP condition data, the only statistically significant difference in the pre- to post-BMP concentrations was for oil and grease, and it was higher after the BMPs were implemented. For the event mass loading comparisons, no statistically significant differences were found between the pre- and post-BMP data. This indicates that, generally speaking, gas station runoff quality was not significantly different before and after implementation of BMPs.

Although visual observations by the field crew confirmed that a significant amount of pollutants were removed with each cleaning, it is likely that the cleanings may have made more pollutants "available" for washoff in the next event, either storm or cleaning, by freeing up pollutants and allowing them to redeposit on the pavement surface. Potential reasons for this observation include:

- High pollutant deposition
- Rough surface texture
- Heavy pollutant buildup
- Incomplete washoff after cleaning

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All-in-all, it appears that this pilot test of mobile cleaning asphalt surfaces, at high sales volume gas stations, near busy intersections on major streets, was probably a worst case scenario for this potential best management practice. The cost of mobile cleaning the fueling stations used for this study was estimated to be about $600 per station washdown which is equivalent to $1,300 per acre of paved surface. Therefore, the cost of mobile cleaning a significant amount of the areas in a watershed exposed to vehicle traffic, on a regular basis, would be quite high.

Since the results were inconclusive, this study cannot recommend the implementation of the mobile cleaning BMP on a large scale. However, field observations and study results seem to indicate that, given the right conditions, mobile cleaning may have the potential to remove sources of storm water pollution. It is clear from this study and others that it is not just gas station runoff, but runoff from any area where vehicles travel, park, or are serviced that is of concern. Recommendations are made for further investigation of BMPs for impervious areas exposed to vehicle traffic.

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Action Plan Demonstration Project

Demonstration of Gasoline Fueling Station

Best Management Practices

Final Report

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1.0 Introduction

1.1 Purpose and Scope

This report summarizes the findings of the Demonstration of Gasoline Fueling Station Best Management Practices project. The project is an "Action Plan Demonstration Project" (APDP) funded in part by a grant awarded by the U. S. Environmental Protection Agency (U.S. EPA) through the San Francisco Estuary Project to the County of Sacramento (County). The purposes of the study were to characterize storm water runoff from gasoline fueling stations, demonstrate the effectiveness of pollution prevention technologies or best management practices (BMPs) in reducing pollutant loadings from gasoline fueling station runoff, and to disseminate information on effectiveness and costs to a wide audience.

The basic project design involved a two year study in which:

- during the first wet season (1992/93), samples of runoff were collected prior to BMP implementation and analyzed in the laboratory for a variety of pollutants (Phase 1);
- best management practices were developed and implemented during the following dry season (Phase 1); and
- the following wet season (1993/94), after BMP implementation, runoff samples were collected and analyzed for the purpose of comparing pre-BMP data to post-BMP data for a quantitative evaluation of BMP effectiveness (Phase 2).

The scope of study was developed after a review of previous studies of storm water runoff. Information was obtained from a literature review and from discussions with researchers at agencies and in academia. Although no study was found that focused solely on runoff from gasoline fueling stations, several studies provided guidance for sample collection methodology and described pollutants typically found at gas stations.

1.2 Project Strategy

Approach

The project was conducted in two phases. The work in Phase 1 (first wet and dry seasons) consisted of identifying the pollutant loading from three representative

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gasoline fueling stations by collecting and analyzing runoff samples. Additionally, Phase 1 included selecting and implementing BMPs at the gas stations with the intent of reducing those pollutants found in the runoff water samples.

Specific tasks in Phase 1 included a literature review, gas station selection, sampling design, water quality monitoring and analysis, BMP selection and implementation, and public participation. This phase of the work culminated with the development of a Phase 1 Report (Sacramento County, 1993a) summarizing the completed tasks and associated findings.

The work in Phase 2 (second wet season) consisted of determining the effectiveness of the implemented BMPs in reducing pollutant loading by re-sampling the selected gas stations after BMP implementation and analyzing the results. The Phase 2 work culminates with the development of this comprehensive final report summarizing all the completed tasks, associated findings, results, and cost estimates to implement the BMPs on a basinwide scale.

Applied Science

As the term "Action Plan Demonstration Project" implies, this study was conducted as an applied science project, as opposed to a basic research project. This is an important distinction to make, because it influenced the project study design. The primary goal of this project was to demonstrate the effectiveness of BMPs in reducing storm water pollutants generated at gas stations. The most critical factor in demonstrating BMP effectiveness is the need to establish a sufficient database to show statistically significant differences between the pre- and post-control measure implementation. Without this, any conclusions will be judged and received with some hesitation. Such a database is difficult to develop because of the variability among storms (quantity, duration, intensity, etc.) and the variability among sites (runoff characteristics, activities located on-site, etc.).

The ability to discern statistically significant differences between two data sets hinges not only on the variability within each of the two data sets, but also on the number of data points in each set. When data variability is likely to be high, as in this case, it is necessary to have either correspondingly large data sets or a relatively large difference in their average values to demonstrate a statistically significant difference. The project team therefore advocated an approach that emphasized maximum production of useful data.

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In practical terms, this approach meant the collection and analysis of samples from the maximum number of storms in each of the two wet seasons. To accomplish this within the available budget, it was necessary to focus the analyses on indicator pollutants. These pollutants were known or expected to be present in relatively high concentrations, and to be representative of the other pollutants on-site. By focusing on a subset of the expected pollutants, money was spent where it could produce the most useful data. As discussed more specifically in section 4, Monitoring, the selection of indicator pollutants was based on both the literature review and the sample results from the first three storms.

Another way to maximize the statistical validity of pre- and post-BMP comparisons is to maximize the difference in the pre- and post-BMP data. To effect this, the project team implemented a full suite of BMPs at each station, as opposed to implementing one BMP at each station. The presumption was that the combined effect of the suite of best management practices would increase the likelihood of reducing pollutants, thereby producing more statistically significant results.

Characterization of gas station runoff was also a goal of the project. Given the applied science emphasis and practical constraints on project funding, a detailed, comprehensive characterization of all possible constituents in gas station runoff was not feasible. The runoff characterization therefore also focused on a limited list of key constituents.

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2.0 *Background*

This section describes the scientific and regulatory background to the project.

2.1 Literature Review

The objective of the literature review was to collect, compile, and review the existing information on toxic pollutant loads associated with storm water runoff from gas stations. This information was used to support subsequent project tasks. Two independent approaches were used to conduct the review: on-line database searching on DIALOG to find published information, and telephone contacts to find any additional published information. The on-line database search showed that very little had been published on the topic of storm water runoff from service stations. The most closely related studies were conducted in Europe, but most of these efforts studied wastewater, and none focused strictly on storm water. However, valuable information was obtained through discussions with researchers (Sacramento County, 1992a).

2.2 Regulatory Impetus

As a result of published studies and monitoring data from municipalities, there is growing support for regulation of fueling station discharges, both sanitary as well as storm water. The growing body of storm water monitoring data continues to indicate that vehicles are one of the most significant sources of storm water pollutants and that areas where service of vehicles is conducted may be of particular concern. In fact, several agencies, including the City of Palo Alto Regional Water Quality Control Plant (RWQCP) and the County of Orange Environmental Management Agency, have recently passed new ordinances that regulate discharges from vehicle service facilities, including fueling stations (Palo Alto RWQCP, 1993; County of Orange, 1993). These agencies require the implementation of BMPs such as secondary containment, spill controls, and employee training, to comply with their ordinances.

At the national level, bills drafted to reauthorize the Clean Water Act are focusing on vehicle service facility discharges, particularly storm water runoff. In addition, U.S. EPA has been developing options for Phase II of the federal storm water regulations, that generally include increased regulation of vehicle service facilities, including fueling stations. The overall impression from this evidence is that fueling station discharges

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will be regulated, and so cost-effective BMPs will be very important in not just pollution reduction, but regulatory compliance as well.

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3.0 *Monitoring Plan*

This section describes issues related to the constituents that were analyzed, the quality assurance and quality control aspects of the study design, and the sampling site selection process, including gasoline fueling station selection and sampling point determination. In addition, the sampling program design is provided, including weather monitoring, storm selection, sample collection, and sample handling procedures.

3.1 Constituents

The identification of constituents to analyze focused on the constituents generally thought to be present at fueling stations. Information on the likely pollutants from vehicles and vehicle traffic were obtained from a number of sources (Shaheen, 1975; Federal Highway Administration, 1984; City of Puyallup, 1988; Pitt and Field, 1990; Sacramento County, 1992b; Washington Department of Ecology, 1992; Wisconsin Department of Natural Resources, 1992). Based on a review of these studies, the major classes of constituents analyzed in the pre-BMP phase were:

Oil & Grease,
Total suspended solids,
Heavy metals,
Polycyclic aromatic hydrocarbons, and
Petroleum hydrocarbons.

For each constituent analyzed (see Table 3.1), the EPA test method, detection limit, sample type, sample bottle, maximum holding times, and preservative are listed. Samples were not filtered before analysis.

Based on the results from the first three storms of Phase 1, constituents not found in detectable concentrations or those found significantly below levels of concern were no longer included in the analyses after the third storm, thereby allowing the analyses to focus on pollutants regularly found in significant concentrations (i.e., indicators). This action was consistent with the project's applied science approach (see section 1, Introduction).

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TABLE 3.1 - CONSTITUENTS ANALYZED

EPA Test Method	Constituent	Event[1]	Detection Limit	Sample Type[2]	Sample Bottle[3]	Maximum Hold Time	Preservative
413.2	Oil & Grease	x	0.5 mg/l	C	B	28 days	Cool, 4°C, H_2SO_4 to pH < 2
160.2	Total Suspended Solids	x	3 mg/l	C	B	7 days	Cool, 4° C
200	Priority Metals (13)			C	B	6 months	HNO_3 to pH < 2
204.2	Antimony	x	1 ug/l			28 days	
206.2	Arsenic	x	4 ug/l				
200.7	Beryllium	x	10 ug/l				
213.2	Cadmium	x	0.1 ug/l				
218.2	Chromium	x	1 ug/l				
220.2	Copper	x(D)[5]	1 ug/l				
239.2	Lead	x(D)	1 ug/l				
245.2	Mercury	x	0.2 ug/l				
249.2	Nickel	x	1 ug/l				
270.3	Selenium	x	1 ug/l				
272.2	Silver	x	1 ug/l				
279.2	Thallium	x	1 ug/l				
289.1	Zinc	x(D)	1 ug/l				
200.7	Aluminum	x(D)	50 ug/l	C	B	6 months	HNO_3 to pH < 2
200.7	Iron	x(D)	30 ug/l				
610/8310	PAHs (16)			C	B	7/40[4]	Cool, 4°C
	Acenapthene	x	1.6 ug/l				
	Acenapthylene	x	1.6 ug/l				
	Anthracene	x	0.5 ug/l				
	Benzo (a) anthracene	x	0.2 ug/l				
	Benzo (a) pyrene	x	0.3 ug/l				
	Benzo (b) fluoranthene	x	0.3 ug/l				
	Benzo (g,h,i) perylene	x	0.4 ug/l				
	Benzo (k) fluoranthene	x	0.3 ug/l				
	Chrysene	x	0.15 ug/l				
	Dibenzo (a,h)anthracene	x	0.9 ug/l				
	Fluoranthene	x	0.9 ug/l				
	Fluorene	x	0.4 ug/l				
	Indeno (1,2,3-cd) pyrene	x	0.2 ug/l				
	Naphthalene	x	1.6 ug/l				
	Phenanthrene	x	0.15 ug/l				
	Pyrene	x	0.9 ug/l				
8015 Modified	Petroleum Hydrocarbons			C	B	14 days	Cool, 4°C
	Gas	x	0.5 mg/l				
	Diesel	x	0.5 mg/l				

[1] Event = storms events sampled
[2] C = composite
[3] B = borosilicate
[4] 7/40 = 7 days for extraction and 40 days for analysis
[5] (D) = Analyzed for dissolved concentration for one storm event each season.

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The following pollutants were selected as indicators and were analyzed in samples from all twelve storms (6 pre- and 6 post-BMP):

Oil & Grease;
Total suspended solids; and
Heavy metals -
Cadmium,
Chromium,
Copper,
Lead, and
Zinc.

The same suite of parameters that were analyzed in the environmental samples were also analyzed in the Quality Control (QC) samples (field duplicate, field blank, laboratory duplicate, matrix spike and matrix spike duplicate samples).

3.2 Quality Assurance / Quality Control

A Quality Assurance Project Plan (QAPP) (Sacramento County, 1993b) was prepared for the project using guidance from the *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans*, (U.S. EPA, 1983). The QAPP presented specific information including data quality objectives, data use objectives, procedures, organization, functional activities, and specific quality assurance (QA) and quality control activities for the project.

QA/QC Sample Collection and Handling

Strict adherence to the sampling protocols described in section 3.4 is the most important QA/QC measure to be followed in the field. Documentation of consistency in sampling and analytical procedures is important for the validation of any sampling effort. As a part of field QA/QC, the chain-of-custody for each sample was strictly maintained. Sampling points for both Field QC samples and Laboratory QC samples were located at the same point that environmental sample collection took place.

Field QC Samples

Two types of field QC samples were used for Phase 1 and 2: field duplicate samples (duplicates) and field bottle blank samples (blanks). The objective of collecting duplicates was to obtain a check on sampling and analytical precision. The objective of collecting blanks was to check for cross-contamination during sample collection, shipment, and laboratory handling.

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Field duplicate samples were collected in the field using the same sample collection methodology and sampling procedures as those used for collecting environmental samples. The procedure consisted of filling two 5 liter composite sample bottles, one for the environmental sample and one for the duplicate. Each time a 1 liter aliquot was collected and poured into the first 5 liter composite bottle, a second 1 liter aliquot was collected immediately thereafter and poured into the second 5 liter composite bottle. Both composite bottles remained on ice and were covered with screw-on caps, except during sample introduction. A discussion of sampling procedures is presented in section 3.4.

Blanks were collected concurrently with the environmental samples. Contaminant free water sufficient for the specified QA/QC analyses, a separate 1 liter glass bottle, and a separate 5 liter composite bottle were brought into the field along with the environmental sample containers. Each time a runoff sample was collected at the sampling point, an aliquot of contaminant-free water was poured into the separate 1 liter bottle and then into the separate 5 liter composite bottle. Both 5 liter bottles (environmental and blank composites) remained on ice and were covered with screw-on caps, except during sample introduction.

Both duplicates and blanks were labeled, packaged and sealed in the same manner as the environmental samples. The duplicate and blank samples were submitted blind to the laboratory along with the environmental samples. Because one environmental composite sample from each gas station was collected and delivered to the laboratory for each storm event, the sample was uniquely identified by station name and date. The identity of blank and duplicate samples was disguised.

Laboratory QC Samples

Matrix spike and matrix spike duplicate analyses of field samples were conducted as a quality control check. In addition, laboratory duplicates and method blanks were analyzed as part of the laboratory's routine in-house protocols. A complete discussion of the laboratory QA/QC program is provided in the QAPP (Sacramento County, 1993b).

QA/QC Sample Collection and Analysis Frequency

Due to the unpredictable and uncontrollable nature of storms, the frequency of collecting QA/QC samples deviated from the recommended U.S. EPA (1980) collection frequency for duplicates of "one sample per week or 10% of all field samples, whichever

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is greater," and for blanks "one blank per day." The collection frequency for this particular project was driven by storm events. Thus, QA/QC samples were collected on an event basis for each storm sampled. One field duplicate and one field blank were collected and analyzed for each event. One matrix spike, one matrix spike duplicate, and one laboratory duplicate was collected and analyzed for each event. QA/QC samples were collected at each of the three gas stations on a rotating basis.

3.3 Sampling Site Selection

The selection of sampling sites was a two step, sequential process. The first step was identifying three gas stations with appropriate characteristics whose owners/operators were willing to participate in the study. After the sites were identified, the actual sampling points were selected.

Station Selection

The goal of the site selection process was to select three representative gasoline fueling stations whose owner/operators were willing to participate in the BMP demonstration program. The following general principles were followed in this process:

- Maximize statistical validity of pre- and post-BMP comparisons.
- Select stations that are representative of those in Sacramento County.
- Select similar sites; minimize variability that may confound pre-and post-BMP comparisons.

As noted above, one of the guiding principles in site selection was to select sites that enhanced the ability to distinguish between pre- and post-BMP implementation. To this end, the project team originally expected to select stations that have automotive service bays. During the course of the site selection process, however, it became apparent that the major oil companies are phasing out the traditional service stations that provide a mix of gasoline sales and automotive repair services, and replacing them with the modern self service/convenience store facility.

The site selection process also strove to identify stations that are representative of gasoline service stations in Sacramento County. Lists of existing retail gasoline operations in Sacramento County were obtained from the records of public agencies during the site selection phase of the project. The major oil companies operating retail gasoline outlets in Sacramento were contacted individually. A meeting of the Western

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States Petroleum Association's (WSPA) Environmental Management Subcommittee was attended by a member of the consultant team. From these contacts, information was obtained regarding the types of stations which represent typical gasoline stations currently in operation in Sacramento County. This information was used in the selection of gas station sites.

The typical station is now a self service gasoline retailer with a convenience market and without automobile repair service bays. Furthermore, older stations providing repair services are being renovated and converted to the self service/convenience market type of station. This type of station was therefore selected as most representative of gasoline retail stations in Sacramento County, and the selected gas stations all conform to this set of characteristics.

Given the ongoing changes in the oil industry, it was also considered important to select stations operating under companies that appear to be stable in the Sacramento market, to provide some security that the selected stations would still be in operation at the conclusion of the project. The project team selected one station from each of the three leading gasoline retailers in Sacramento County. This decision increased the representativeness of the program and added credibility to the results.

The three selected stations were located in fairly close geographical proximity to one another (2 miles) (see Figure 3.1), and all receive an average of 19 to 20 inches of annual rainfall. The stations were located in the suburban Citrus Heights / Fair Oaks area of northeastern Sacramento County. The sites are within the Arcade Creek watershed, a 25,000 acre mixed use watershed which drains to the Sacramento River via the Natomas East Main Drainage Canal, and then into the San Francisco Bay Delta/Estuary.

All three stations were high volume gasoline retailers (over 200,000 gallons per month) that emphasized self service gasoline sales. All three stations were situated at busy, signalized intersections along major arterial roadways. Station X was the parent oil company's highest volume retail station in Sacramento County. All three stations had convenience markets; none provided automotive repair services or had automobile service bays. Station Z had a car wash, but most of the runoff from this activity flowed away from the sample collection point. Figures 3.2, 3.3, and 3.4. show the facility layout for each of the three stations.

Besides the representativeness of the selected stations, the other key selection criteria involved the selection of similar stations, to minimize station-to-station variability in the

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runoff chemistry data and maximize the statistical validity of the pre- and post-BMP comparison. The selected stations had the following characteristics in common:

- Geographic location (similar precipitation and atmospheric deposition)
- Local setting (land uses, traffic patterns)
- Quantity of gasoline sold (high volume sales)
- Station layout and design
- Mix of services (e.g., convenience store)
- Existing BMPs and on-site treatment

Stations also were chosen where samples could be collected effectively, safely, and securely, and where the collected runoff would include only runoff from the gasoline station, uncomplicated by runoff from off-site. Finally, and in practical terms most importantly, stations were selected where the owner/operator has pledged their full cooperation.

Sampling Points

In essentially all cases, collection of storm water runoff that includes only service station runoff requires collection of samples on the service station property. Therefore, oil company approval was required before physical modifications could be made to the site to accommodate sample collection. The WSPA members, representing the three gasoline station retail outlets, agreed to allow these physical modifications to be made.

Statistical techniques were used to determine the number of sampling locations and storm events that should be included in the project, subject to the project's budgetary, logistic, and practical constraints. The statistical methods included an ANOVA model used in conjunction with statistical power analysis, a sampling plan design tool (Cohen, 1988). This analysis concluded that a 50% change in runoff concentrations due to BMP implementation would produce a statistically significant difference in pre- and post-BMP runoff characteristics, assuming three gas stations with one sampling point and six storms each for both the pre- and post-BMP sampling.

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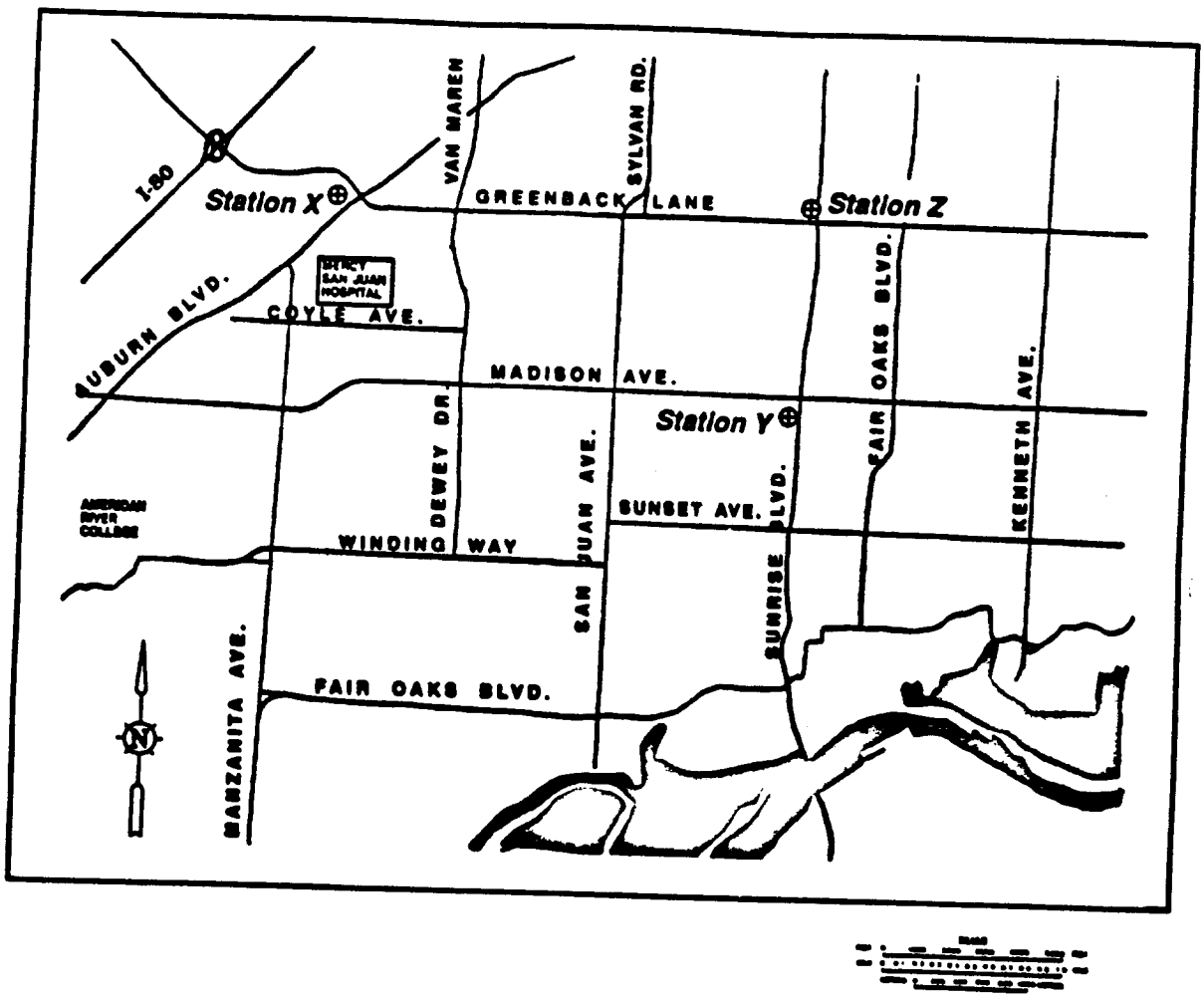

Figure 3.1

GASOLINE FUELING STATIONS

Vicinity Map

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Figure 3.2

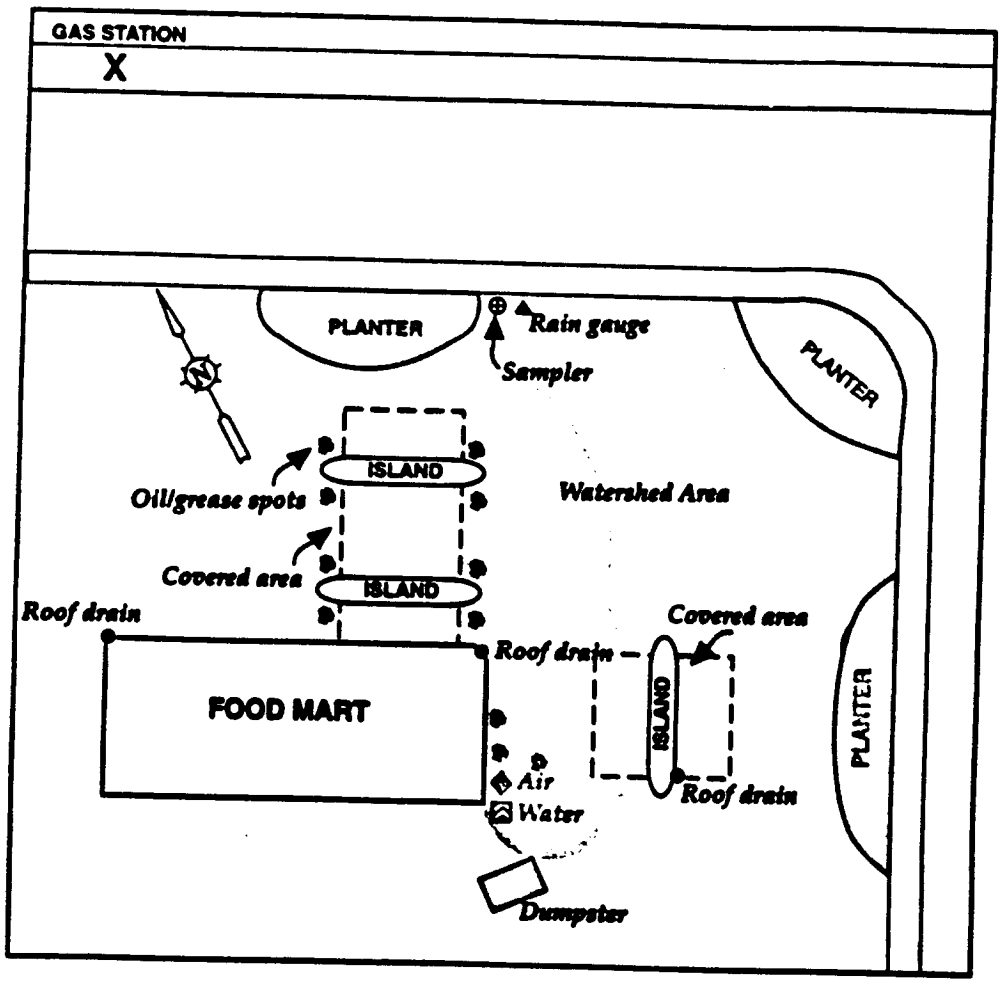

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Figure 3.3

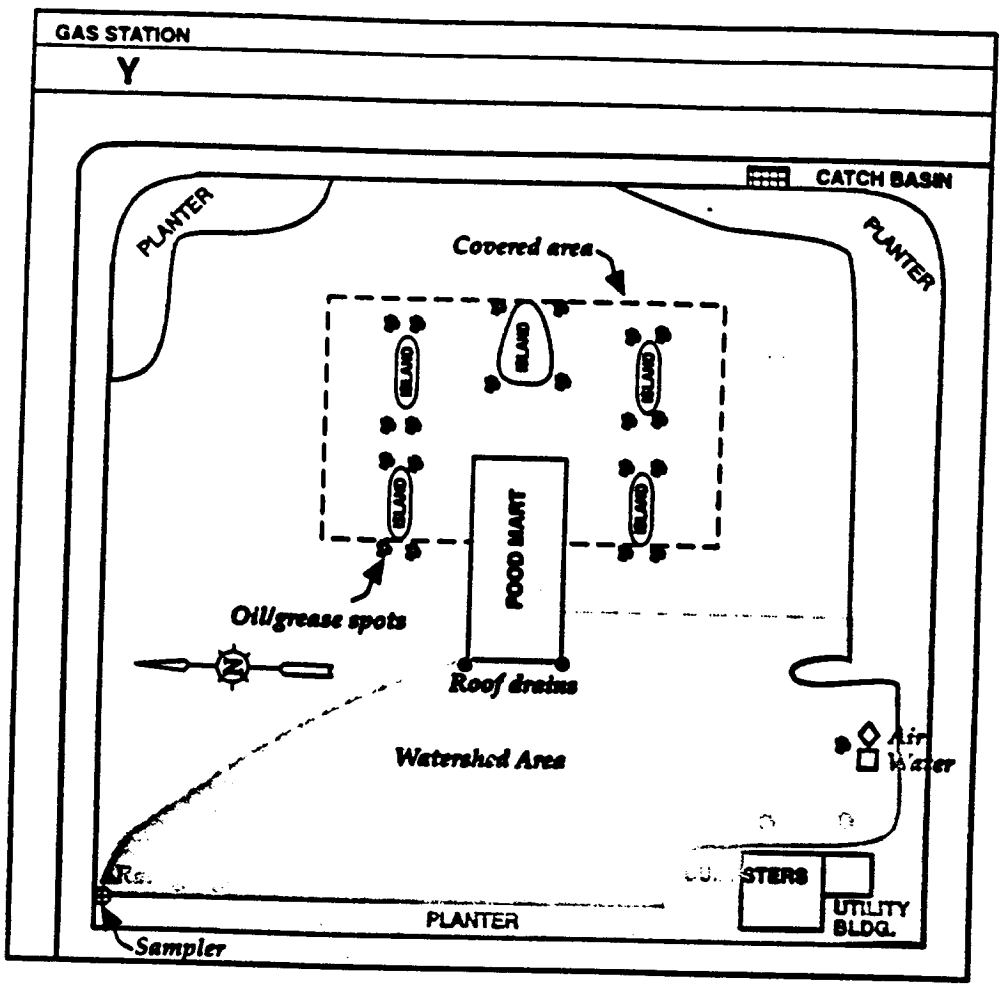

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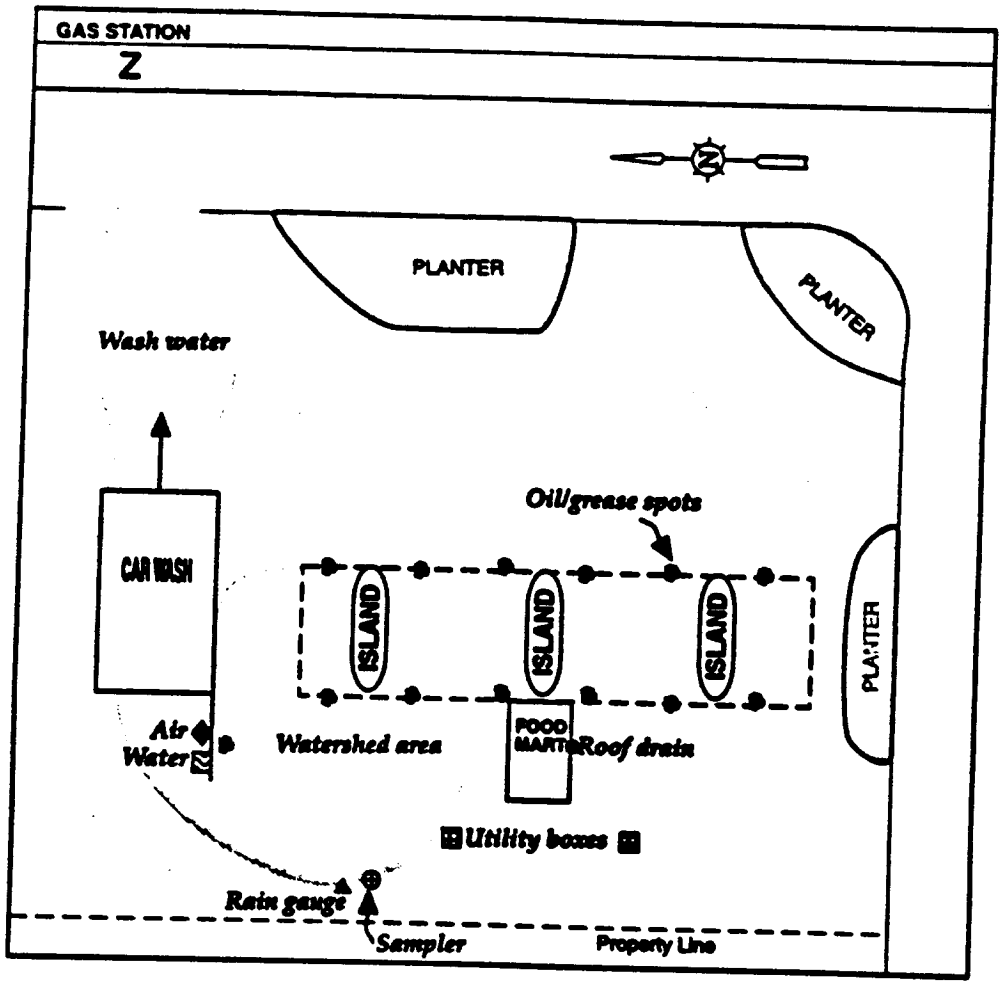
Figure 3.4



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Given the expressed wish of the participating oil companies for the project to have a minimal impact on station operations (i.e., no interference with traffic flow or services), and the project's budgetary constraints (the cost of sampling manpower and monitoring station installation); the selection of one representative sampling point at each gas station was considered adequate. Safety of field sampling personnel was also a factor in sampling point selection. Sampling points were chosen based on the following criteria:

- Minimum intrusion of off-site runoff co-mingling with the sample
- Minimum interruption of station operation
- Maximum safety for sampling crews
- Consistency among gas stations
- Locations receiving runoff representative of gasoline fueling stations, including runoff from fueling areas and air and water supply service areas

At each of the three gas stations, a sampling point was selected where station runoff left the property, where the runoff stream at the sampling point drained a significant portion of the property, and where the runoff stream at the sampling point included drainage from fueling areas and auxiliary services (especially air and water supply areas). These sampling points were selected after careful site inspection and dry weather flow testing (observation of drainage patterns by allowing water to flow from a garden hose onto the areas of interest). Subsequent storm sampling experience at the gas stations confirmed that the sampling points received runoff representative of the gas stations.

Samples were collected at each of the three selected gas stations from the sampling points indicated in Figures 3.2, 3.3, and 3.4.

3.4 Sampling Program Design

Weather Monitoring

Weather was monitored during this project to maximize the likelihood of "capturing" six storms each season, to minimize false starts, and to ensure that the sampling equipment and team was prepared in sufficient time to collect runoff samples. The incoming storms were monitored using the Weather Network on-line weather database system, as well as direct telephone contacts with Weather Network and National Weather Service forecasters. The project team accessed Weathernet's on-line database via modem through an account established for this project, thereby providing live access to Weather Network forecasters available around the clock during-impending storm events.

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Storm Selection

Using Weathernet information and a "phone tree," the Field Sampling Coordinator kept the project team informed as to the likelihood of sampling. As a storm approached, the Field Sampling Coordinator made a recommendation to the rest of the project team as to whether the storm was likely to be large enough for the purposes of this study. Only storms predicted to provide sufficient runoff to be sampled were selected.

Storm Events

Storm water monitoring programs in Sacramento County typically have restricted sampling events to storms expected to produce over 0.5 inch of rainfall within a 24-hour period, to achieve sufficient runoff to collect adequate samples. This guideline was adopted for the current project as well. In an average rainfall year, Sacramento County receives approximately 19-20 inches of precipitation in the area of the selected gas stations. In recent drought years (1986/87-1991/92), the annual rainfall has totaled significantly less. Given that some precipitation will occur during storms which do not meet the 0.5 inch / 24-hour intensity criteria, and given that it was not possible to predict the annual precipitation in advance, six was considered to be the number of storms that could reasonably be expected to be sampled within a wet season.

Sample Collection

Sheet flow samples were collected manually (without the use of sampling equipment) by placing a 1 liter glass bottle below grade at a sampling point (monitoring station). As shown in Figure 3.5, the monitoring station consisted of a 12 inch inside diameter by 18 inch deep reinforced concrete pipe (RCP) placed in the pavement at each location. A 3/8 inch aluminum plate was bolted in-place over the hole when sampling was not taking place. The plate was removed before sampling began.

At each station a 1 liter glass sample bottle was used to collect water for all the constituent analyses, and a 5 liter borosilicate glass bottle was used for compositing the 1 liter aliquots. During sampling, sheet flow runoff flowed over the lip of the RCP and was collected directly into the 1 liter sampling bottle. Continuous bailing was performed to keep the water level in the hole sufficiently below the mouth of the bottle to prevent cross-contamination of the collected sample. The individual 1 liter sample aliquots were composited immediately into the 5 liter borosilicate glass bottle.

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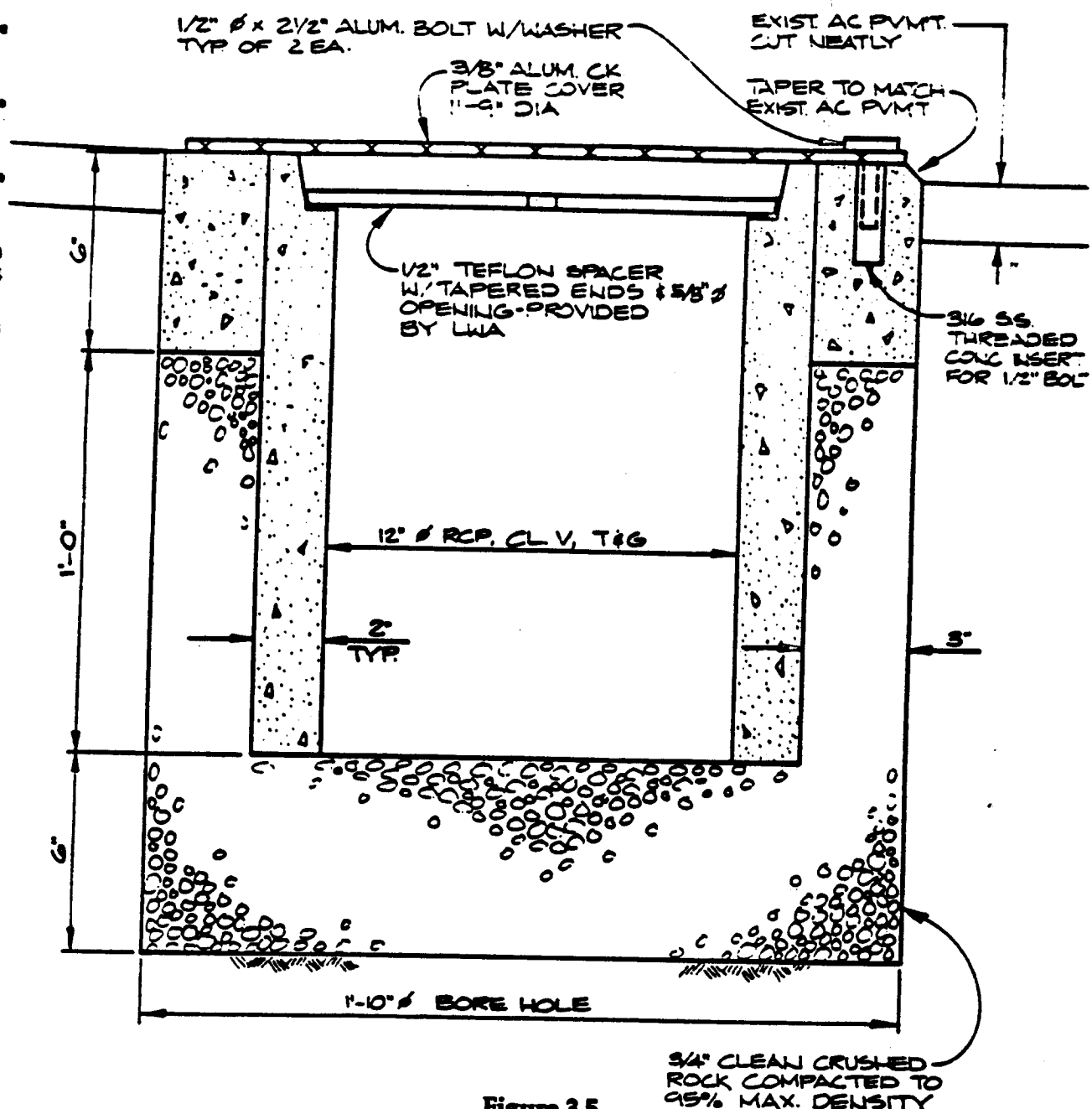

Figure 3.5

MONITORING STATION (NOT IN USE)

SCALE: 3" = 1'-0"

DRAWN BY: ENZ
DESIGNED BY: TLW
CHECKED BY: AR

LWA NO. 183.01
9/23/92

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Samples were flow weighted by collection at intervals based on a pre-determined increment of rainfall volume, equal to 0.05 inches. To accomplish this, rain gauges were used to measure rainfall volume during storm sampling. The same type of gauge was placed at each of the three stations during the sampling period to provide site-specific data. The gauges were placed in an open area on-site, away from the influence of structures or trees. The rain gauges were checked periodically, depending on the rainfall intensity, and the amount of rain in each gauge was recorded during the sampling period to yield rate information as well as total rainfall data. Upon initiation of runoff sufficient to permit sample collection, a 1 liter sample was collected every 0.05 inches of measured rainfall until the composite bottle contained 5 liters of sample.

Sample collection was initiated by the Field Sampling Coordinator. Each station had dedicated staff who covered that station for the duration of the sampling period. All field observations were recorded, including storm characteristics, runoff characteristics, activities on-site, irregularities or difficulties in the sampling procedure, the time each grab sample was taken, and unusual qualities of the runoff sample.

Sample Handling

The composite container was field preserved at approximately 4° Centigrade by storage in a cooler containing ice. The filled composite sample containers were maintained on ice until delivery to the analytical laboratory. Delivery to the lab occurred within 24 hours of the completion of sampling. The composite containers remained closed with a screw on cover containing a Teflon Seal. Upon delivery to the lab, the composite was split by laboratory personnel into aliquots for the specified analyses, and preserved accordingly (see Table 3.1). Prior to pouring off aliquots from the composite for analyses, the composite sample was thoroughly shaken to ensure that representative samples were obtained.

Rainfall Monitoring

In addition to the on-site rain gauges used to measure rainfall during the sample collections, rainfall data were accessed from the closest Sacramento County ALERT system rain gauges. Figure 3.6 shows the location of three ALERT rain gauges in the vicinity of the three gas stations. The gauges are designated by numbers and nearby street names.

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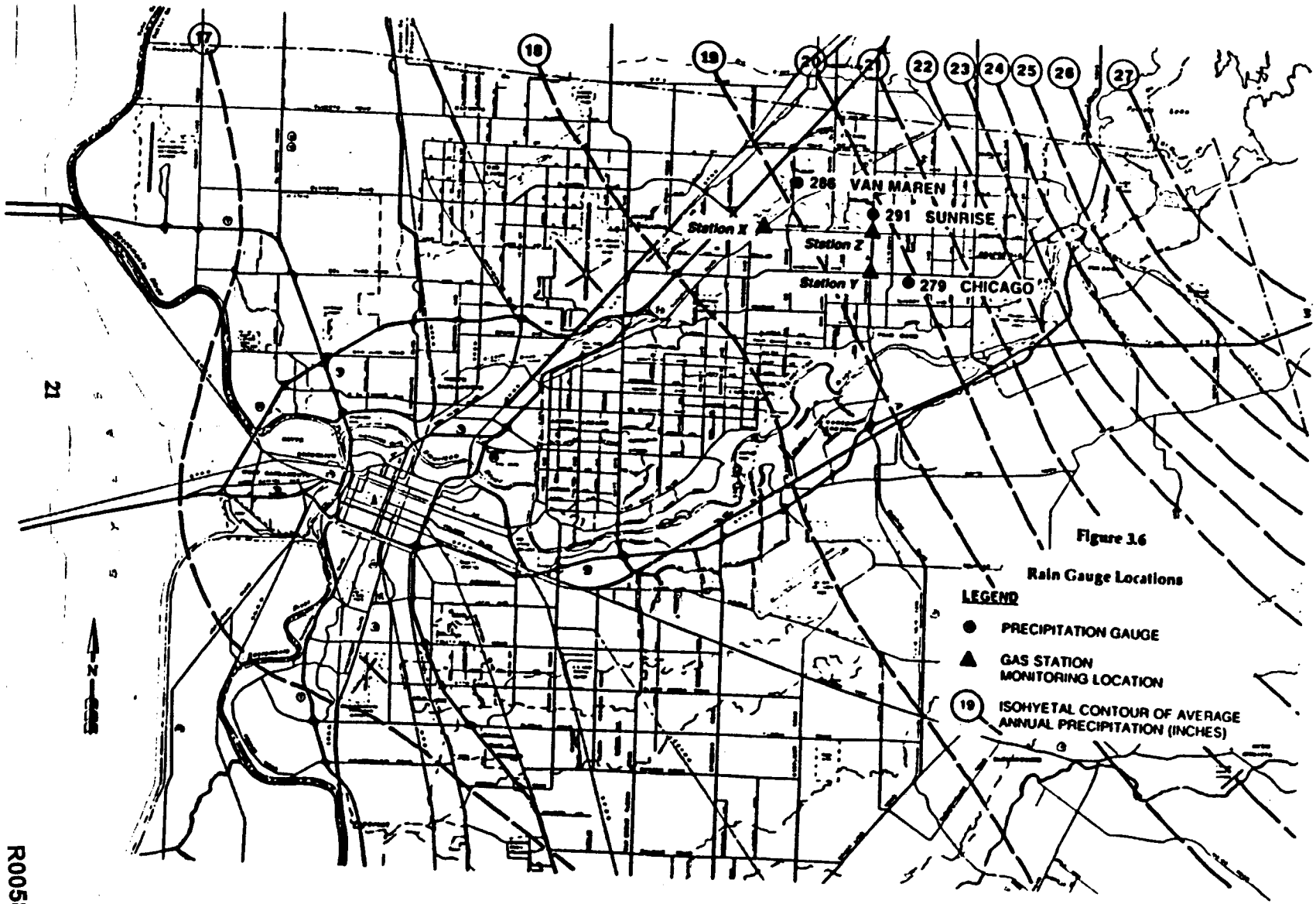

Figure 3.6

Rain Gauge Locations

R0058284

4.0 *Best Management Practices (BMPs)*

This section describes the selection and implementation of best management practices designed to reduce gas station runoff pollution.

4.1 Selection

The selection of best management practices was based on a review of appropriate BMPs described and used elsewhere for vehicle-related activities (SCVNPSPCP, 1992; U.S. EPA, 1992; Palo Alto RWQCP, 1993; California SWQTF, 1993; County of Orange, 1993). As part of Phase 1, BMPs were selected based on their effectiveness, practicality, and cost by using a semi-quantitative scoring method (Sacramento County, 1993a). The following six BMPs were selected and implemented:

- Mobile High Pressure Water Cleaning
- Public Notices
- Litter Control
- Storm Drain Stenciling
- Spill Cleanup Materials
- Employee Awareness

The above list includes all of the BMPs applicable to the stations given the physical limitations of the sites. The selected best management practices were either low in cost, and/or high in perceived effectiveness in reducing pollutants. A "potential for disruption" criterion helped guide the selection toward BMPs that were acceptable to the station owners/operators. The BMPs tended to focus on the areas of the stations with the greatest potential to generate pollutants (e.g., air/water supply area, fueling area, drive through area) as opposed to areas with less pollution potential (e.g., roof drains, landscaping). On-site treatment control BMPs were not selected because of their high relative cost and disruption to operations. Off-site BMPs (e.g., detention pond, wetlands) were not considered because the scope and budget did not allow for these to be tested. Therefore, all of the best management practices selected for implementation were source controls.

One way to maximize the statistical validity of pre- and post-BMP comparisons is to maximize the difference in the pre- and post-BMP data. To effect this, the project team implemented the full suite of BMPs at each station, as opposed to implementing one

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BMP at each station. The presumption was that the combined effect of the suite of best management practices would increase the likelihood of reducing pollutants, thereby producing more statistically significant results. The need to implement a suite of BMPs is especially important with source controls, because there are a variety of pollutant sources, each requiring a best management practice. If treatment controls had been a more viable approach, it's possible that fewer BMPs would have been necessary to produce a reduction in pollutants.

4.2 Implementation

Having selected the BMPs, the project team worked with the station owners/operators to gain their final approval and to implement the BMPs. The following discussions provide some detail on the actual implementation of each of the selected best management practices.

Mobile High Pressure Water Cleaning - The entire drainage area used in Phase 1, particularly the air/water supply, fueling, and drive through areas, was cleaned an average of about twice per month using a high pressure (3,000 psi) and high temperature (210°F) mobile cleaning unit (Figure 4.1). The wash water generated was collected using a "Vacu-boom," a portable, runoff collection system (Figures 4.2 and 4.3). The "Vacu-boom" includes a hollow, flexible snake that is connected to a high power wet vacuum unit. The apparatus enables sheet flow to be captured and conveyed to a sanitary sewer inlet.

Several concerns were identified and resolved before using the mobile cleaning system including: 1) potential asphalt erosion caused by the high temperature of the water, 2) wash water disposal, 3) safety of the cleaning operator and the equipment, and 4) disruption of normal station operations. To reduce the potential for erosion of the asphalt, the operator avoided persistent spraying in one area to avoid heating up the asphalt surface. Wash water disposal was handled by discharging into the sanitary sewer system via a cleanout or rest room connection. The safety and disruption issues were addressed by conducting cleaning operations late at night during slower business hours and by supplying the operator and assistant with safety orange cones and an orange vest for increased visibility.

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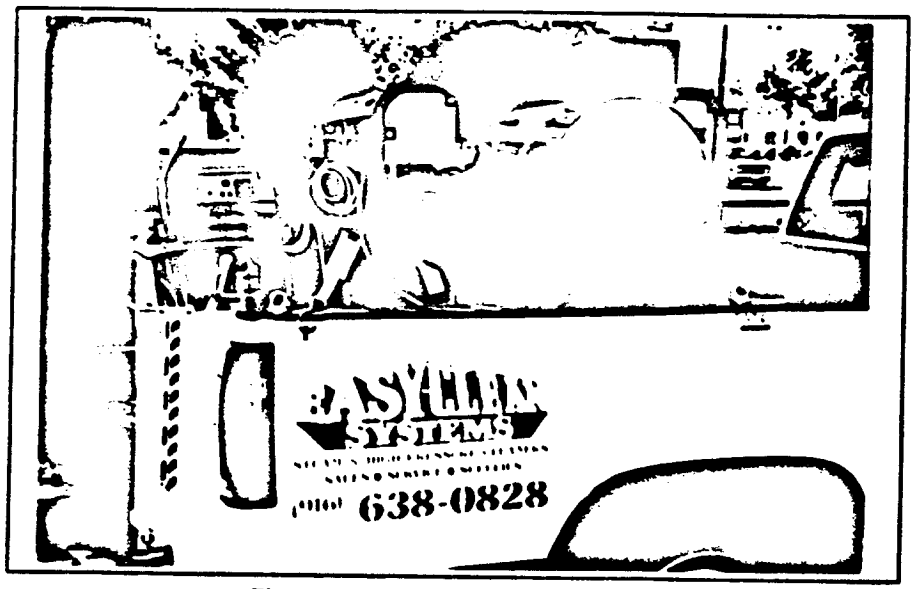

Figure 4.1 Mobile Cleaning System

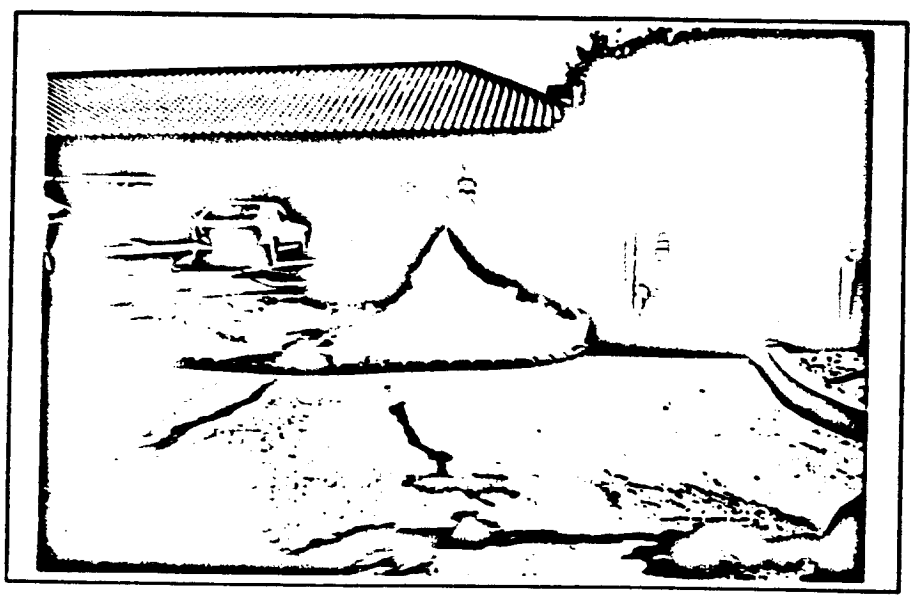

Figure 4.2 Vacu-boom

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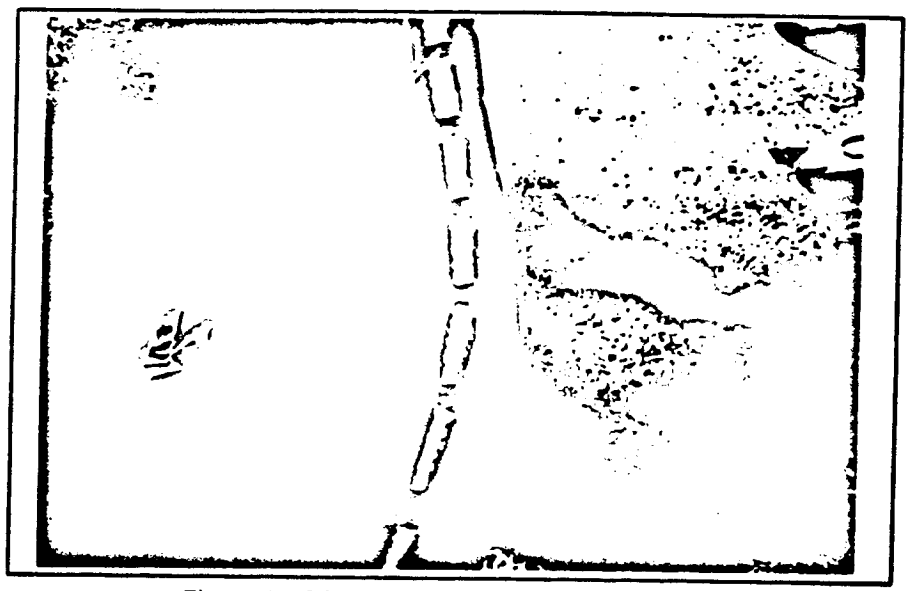

Figure 4.3 Wash water collected by Vacu-boom

The objective of the mobile cleaning BMP was to free the pollutants from the asphalt surface using high temperature and high pressure water and to transport the pollutants, in water suspension, to the Vacu-boom apparatus. The method of application that appeared to be the most effective was to initially wet the asphalt surface over the entire drainage area to the point of saturation without creating any significant runoff. The mobile cleaning took place starting from the furthest upstream point in the drainage area and working down in a back and forth line to the furthest downstream point. By initially wetting the surface, the waste stream from the mobile cleaning was able to freely travel down to the Vacu-boom without the water being "used up" in the wetting of dry asphalt. Water quality samples of the waste stream were originally going to be taken to determine the type and amount of pollutants being removed in the mobile cleaning BMP. However, since the Vacu-boom wet vacuum contained copper and brass fittings and components, project staff decided that the results would not be reliable and therefore abandoned the idea.

Table 4.1 presents data on the mobile cleanings performed during the project. The information presented in Table 4.1 relates the mobile cleaning number, dates of mobile cleaning, the stations cleaned, and the days since the previous cleaning with the storm number, the storm date, the number of days since the last cleaning, and the number of cleanings since the last storm sampled. The drainage areas at the three stations were mobile cleaned a total of ten times between late October 1993 and late March 1994.

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To further explain Table 4.1, starting with the first column, the first cleaning occurred on 10/27/93 for stations Y and Z, and on 11/4/93 for station X. The second cleaning occurred on 11/9/93 for all three stations which resulted in 5 days since the last cleaning for station X and 13 days since the last cleaning for stations Y and Z (fourth column). The first storm (fifth column) was sampled on 11/29/93 (sixth column) which was 20 days since the last cleaning (seventh column) that was done on 11/9/93. The drainage areas at all the stations were mobile cleaned twice prior to this storm (eighth column).

Table 4.1 Mobile Cleaning/Sampled Storm Information

Mobile Cleaning Data				Sampled Storm Data			
Mobile Cleaning Number	Date of Mobile Cleaning	Station(s)	Days Since Previous Cleaning	Storm Number	Storm Date	Number of Days Since Last Cleaning	Cleanings Since Last Storm Sampled
1 1	10/27/93 11/4/93	Y and Z X					
2	11/9/93	All	5 (X) 13 (Y/Z)	1	11/29/93	20	2
3	12/5/93	All	26	2	12/11/93	6	1
4	12/23/93	All	18				
5	1/10/94	All	18	3	1/24/94	14	2
6	1/26/94	All	16	4	2/6/94	11	1
7	2/9/94	All	14	5	2/17/94	8	1
8	2/23/94	All	14				
9	3/9/94	All	14				
10	3/23/94	All	14	6	4/8/94	16	3

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Public Notices - Signs educating the public about good housekeeping practices and what to do in the event of a spill were displayed in the air/water supply area. One sign requested that the gas station attendant be notified should a spill occur and the other sign requested that litter be properly disposed (Figure 4.4).

Litter Control - To supplement the litter control sign, the project team monitored the presence of trash receptacles in the air/water supply area (Figure 4.4).

Storm Drain Stenciling - The public is usually unaware that storm drains flow directly to a creek, river, or a bay. Storm drain stenciling conveys the message that the water that flows into the catch basin goes directly to the local rivers. The on-site, and nearby off-site storm drain inlets were stenciled to increase public awareness (Figure 4.5).

Spill Cleanup Materials - To ensure that spilled fluids are promptly removed, cleanup materials must be readily available. All three stations keep spill cleanup materials on-site. The station managers were also encouraged to, not only keep the spill materials readily available, but also to train employees in the proper use of the spill materials.

Employee Awareness - All three stations and their parent corporations have employee training programs that include material and waste management practices. This training was supplemented, as necessary, to assist the project team in understanding the conditions at each station. Because the team could not be at each of the stations most of the time, the employees were encouraged to use log sheets to record significant events (e.g., spills) that could help to interpret study results. However, the use of log sheets to monitor spills outside the fueling areas was difficult to implement because the limited staff found at these type of stations usually did not have the time to make observations.

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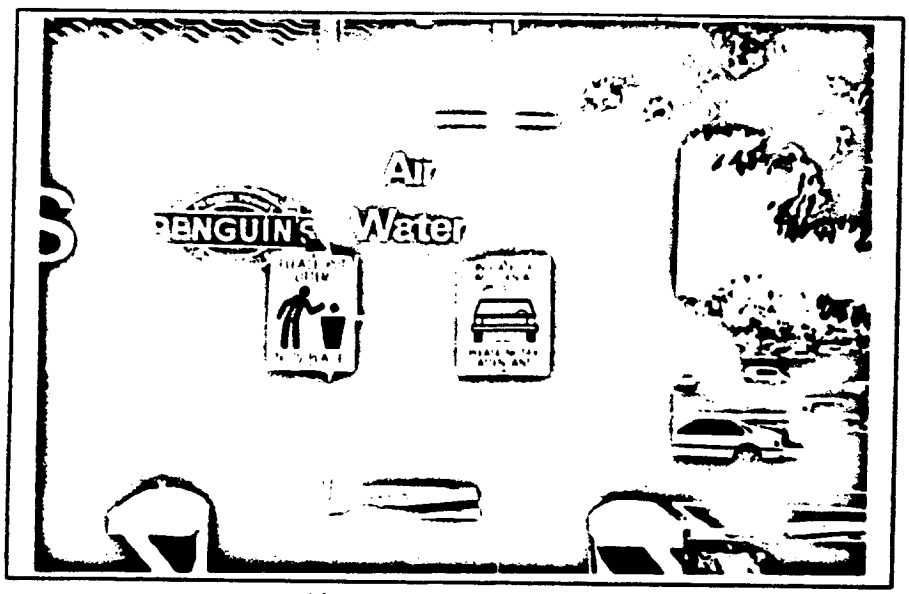

Figure 4.4 Public Notices

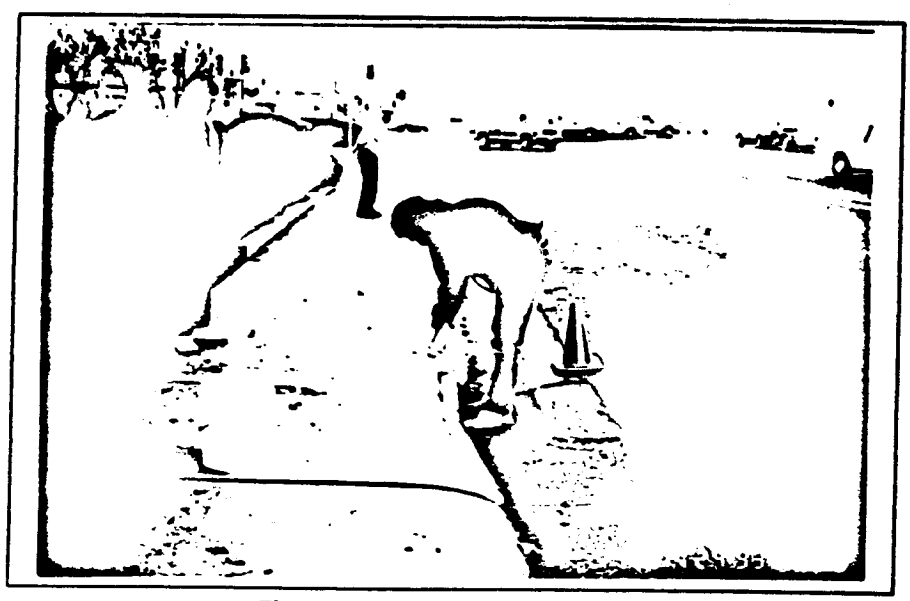

Figure 4.5 Storm Drain Stenciling

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5.0 Results

This section describes the results of the first (pre-BMP) and second (post-BMP) year's wet season's measurements, including drainage area estimates, climatological data, runoff sample analyses, and graphs.

5.1 Drainage Area Estimates

For each of the stations, the area draining to the collection point was less than the total area of the station (see Figures 4.2-4.4). Measurements of the drainage area to the sample collection point were made based on site plans provided by the County of Sacramento and field measurements, including field flow (hose) trials, made by the project team. A planimeter was used to determine the watershed areas depicted in Figure 3.2 through 3.4. The estimated dimensions of the drainage areas are provided in Table 5.1.

As shown in Table 5.1, there are several ways to calculate the area draining to the sample collection point. The project team is using the exposed paved area plus the roof drainage area (row 6 in Table 5.1) to represent the "sample area," or area draining to the collection point. This area excludes the *covered* paved drainage area because runoff normally does not flow through this area. One difference between the stations is the percent of roof area draining to the collection point, with station X having significantly more roof drainage area (29%) than either of the other two stations (Y = 4% and Z = 0%).

5.2 Sampling Results

Climatological Results

Climatological data were compiled throughout both wet seasons to aid in interpreting the storm water runoff results. These data included areawide rainfall totals from Sacramento County ALERT system rain gauges, inter-event times (time between significant storms), and rainfall intensity data recorded during sampling. Rainfall data collected at the three ALERT gauges were used to calculate the cumulative precipitation for the 1992-93 (Figure 5.1) and 1993-94 wet seasons (see Figure 5.3). Figures 5.2 and 5.4 show the daily precipitation totals for the 1992-93 and 1993-94 wet seasons, respectively.

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Table 5.1 Drainage Area Estimates

	Area		Station X (sq. ft.)	Station Y (sq. ft.)	Station Z (sq. ft.)
1	Exposed Paved Drainage Area		2,826	3,794	2,844
2	Covered Paved Drainage Area (1)	+	222	149	887
3	Total Paved Drainage Area (2)	=	3,048	3,943	3,731
4	Roof Drainage Area	+	1,150	168	0
5	Total Paved + Roof Drainage Area	=	4,198	4,111	3,731
6	Exposed Paved + Roof Drainage Area (3) = Sample Area (Row 1 + Row 4)		3,976	3,962	2,844
7	Roof Drainage as Percent of Sample Area		29%	4%	0%
8	Area of Gas Station (4)		20,809	18,358	30,423
9	Sample Area as Percent of Gas Station Area		19%	22%	9%

(1) Covered paved drainage area is a potential source of pollutants but runoff normally does not flow through this area.

(2) Total paved drainage area is the sum of the exposed drainage area and the covered drainage are (covered by an overhang).

(3) Excludes covered paved drainage area.

(4) Area of gas station includes buildings, landscaping, and other facilities but excludes adjacent streets and sidewalks.

All four plots of precipitation data show when the six pre-BMP and six post-BMP sampling events took place.

Once collected, the ALERT system rainfall data allowed for the calculation of the time between sampled storms (inter-event time). The determination of inter-event time depends on the definition of a "significant" storm. Consistent with U.S. EPA storm water regulations (40 CFR 122.26), the project team used 0.10 inches of rain as the significant storm threshold. Table 5.2 presents the inter-event data for both wet seasons.

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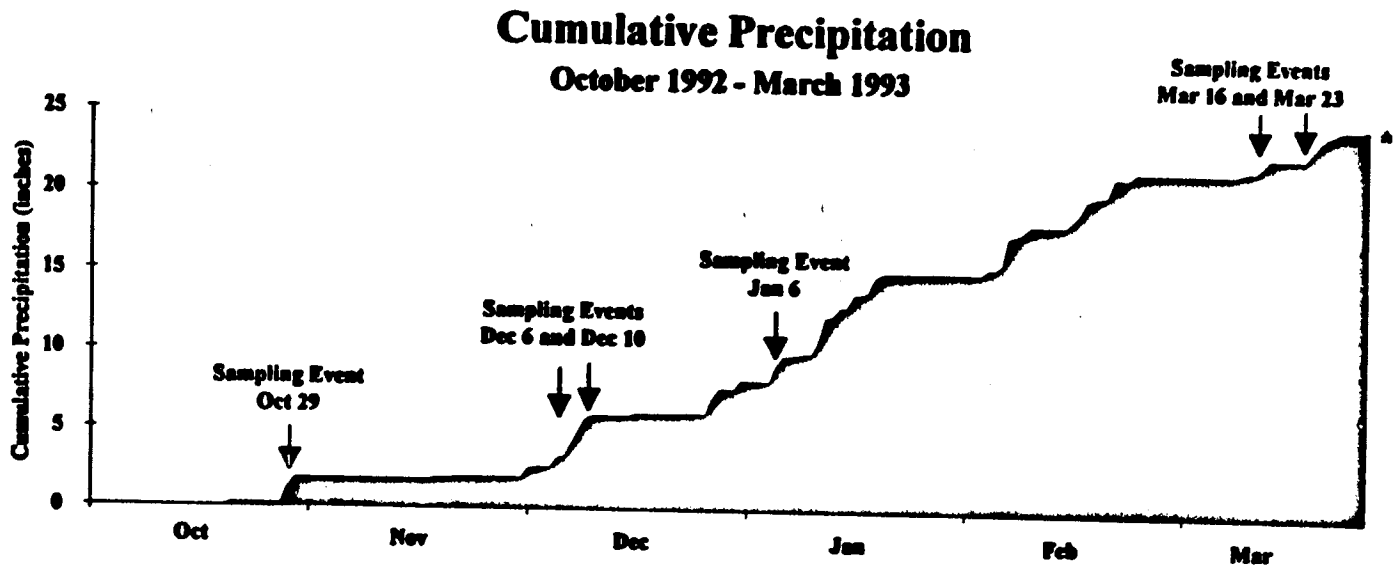
Figure 5.1



Note: Daily rainfall average is based on an unweighted average of the calculated rain gauge #291 (Sunrise) data and the recorded rainfall measurements from rain gauges #279 (Chicago) and #286 (VanMaren).

* Total Precipitation for October 1, 1992 - March 31, 1993 = 24.69 inches.

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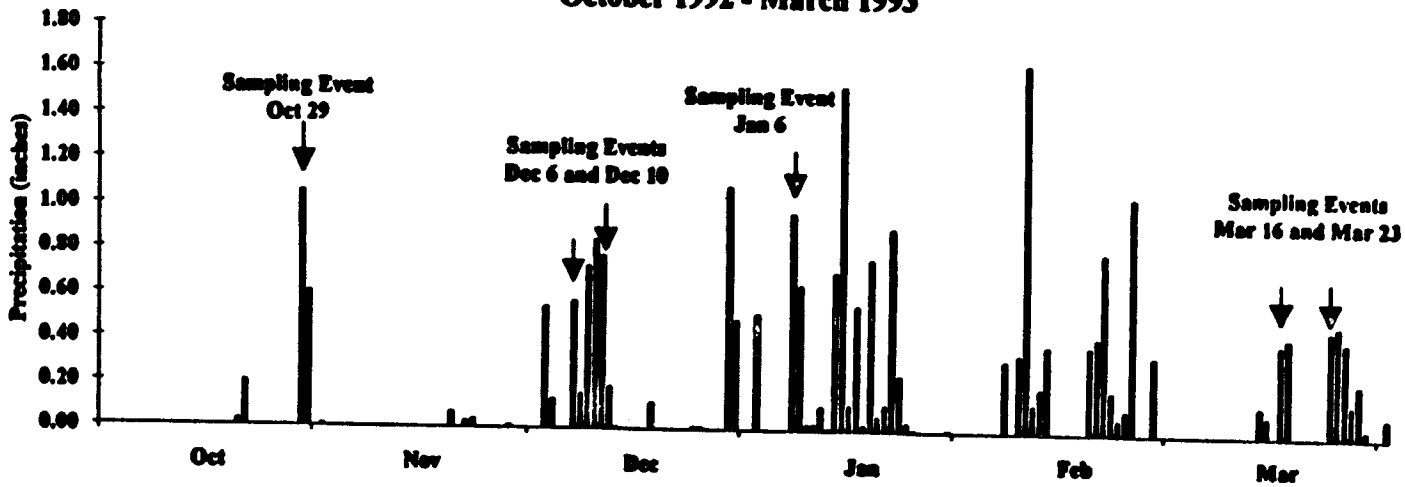
Figure 5.2

Daily Precipitation Totals

October 1992 - March 1993



Note: Daily rainfall average is based on an unweighted average of the calculated rain gauge #291 (Sunrise) data and the recorded rainfall measurements from rain gauges #279 (Chicago) and #286 (VanMaren).

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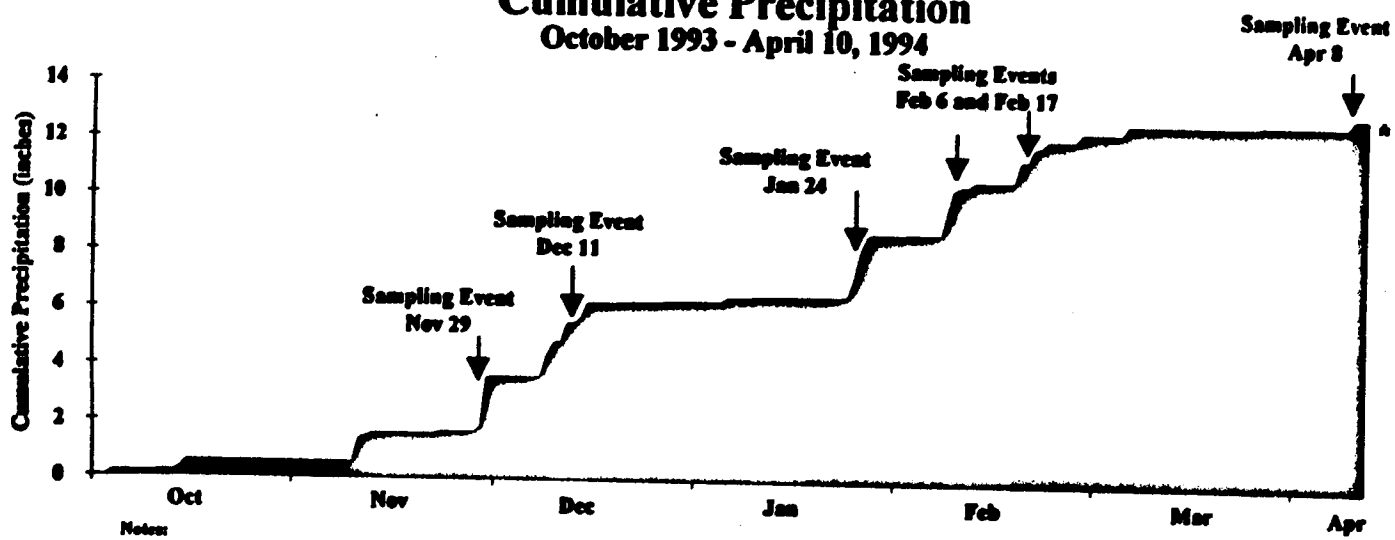
Figure 5.3



Notes:

1) Rain gauge #291 (Sunrise) data was not used based on incomplete and inconsistent data. Calculation is based on the average of recorded measurements from rain gauges #279 (Chicago) and #286 (Vandalorn).

2) Daily rainfall average is based on an unweighted average of the calculated rain gauge #291 (Sunrise) data and the recorded rainfall measurements from rain gauges #279 (Chicago) and #286 (Vandalorn).

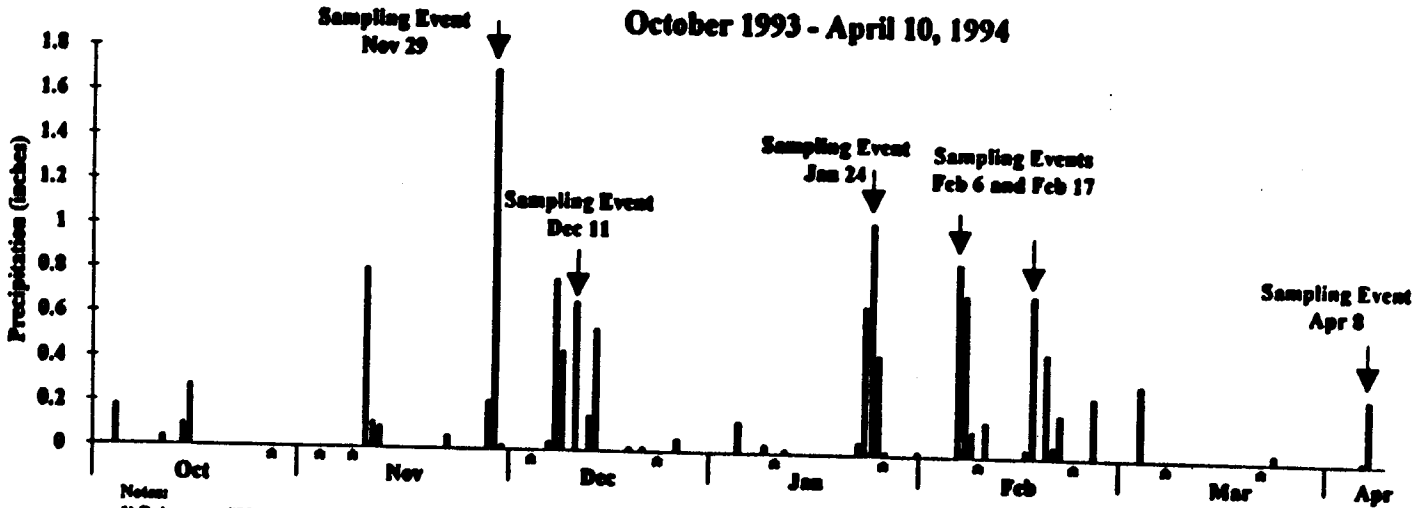
* Total Precipitation for Oct 1, 1993 - April 10, 1994 = 13.18 inches.

R0058296

Figure 5.4

Daily Precipitation Totals

October 1993 - April 10, 1994



Notes:

1) Rain gauge #291 (Sunrise) data was not used based on incomplete and inconsistent data. Calculation is based on the average of recorded measurements from rain gauges #279 (Chicago) and #286 (VanMeter).

2) Daily rainfall average is based on an unweighted average of the calculated rain gauge #291 (Sunrise) data and the recorded rainfall measurements from rain gauges #279 (Chicago) and #286 (VanMeter).

a Mobile Cleaning Dates: 10/27/93; 11/04/93; 11/09/93; 12/02/93; 12/22/93; 1/10/94; 1/25/94; 2/08/94; 2/22/94; 3/09/94; 3/23/94.

R0058297

Table 5.2 Inter-event Time Data

Pre-BMP Monitoring							
Storm #	Sampled Storm Date	Previous Storm Date (> 0.10")	Total Depth* (inches)	Inter-event Time (days)	Previous Storm Date (> 0.25")	Total Depth* (inches)	Inter-event Time (days)
1	29-Oct-92	21-Oct-92	0.21	8	29-Jun-92	0.35	122
2	6-Dec-92	3-Dec-92	0.13	3	2-Dec-92	0.54	4
3	10-Dec-92	9-Dec-92	0.78	1	9-Dec-92	0.78	1
4	6-Jan-93	1-Jan-93	0.52	5	1-Jan-93	0.52	5
5	16-Mar-93	14-Mar-93	0.11	2	26-Feb-93	0.34	18
6	23-Mar-93	17-Mar-93	0.39	6	17-Mar-93	0.39	6

Post-BMP Monitoring							
Storm #	Sampled Storm Date	Previous Storm Date (> 0.10")	Total Depth** (inches)	Inter-event Time (days)	Previous Storm Date (> 0.25")	Total Depth** (inches)	Inter-event Time (days)
1	29-Nov-93	28-Nov-93	0.22	1	11-Nov-93	0.91	18
2	11-Dec-93	9-Dec-93	1.04	2	9-Dec-93	1.04	2
3	24-Jan-94	23-Jan-94	0.74	1	23-Jan-94	0.74	1
4	6-Feb-94	26-Jan-94	0.48	11	26-Jan-94	0.48	11
5	17-Feb-94	10-Feb-94	0.16	7	8-Feb-94	0.32	9
6	8-Apr-94	5-Mar-94	0.34	34	5-Mar-94	0.34	34

* = Weighted average of three closest rain gauges
** = Average of Chicago and Van Maren Cripple rain gauges

Because 1992-93 (pre-BMP) was a relatively wet year in California, with frequent storms occurring on a regular basis throughout the winter, the inter-event times were fairly short, ranging from 2 to 9 days. In 1993-94 (post-BMP), about half as much rain fell as compared to 1992-93 (approx. 13 inches versus approx. 26 inches). The inter-event times in 1993-94 reflected the drier winter, ranging from 0 up to 33 days. Because a 0.10 inch storm does not always produce a significant volume of runoff (depending on duration and intensity), inter-event times based on the previous storm of 0.25 inches or greater were also evaluated for both years.

As discussed in section 3.4, Sampling Program Design, rain gauges were used to measure rainfall volume at the three gas stations during storm sampling. The same type of gauge was placed at each of the three stations during the sampling period to give site-specific data. The gauges were placed in an open area on-site, away from the influence of structures or trees. The rain gauges were checked periodically, depending on the rainfall intensity, and the amount of rain in each gauge was recorded during the sampling period to yield rate information as well as total rainfall data.

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Table 5.3 presents information for both wet seasons on observed rainfall and the period of observation as recorded during sample collection, and the calculated rainfall intensity. The intensity shown is simply the quotient of the measured rainfall divided by the total time of observation, which corresponds to the amount of time required to collect the composite sample. For the most part, the differences in the rainfall intensities represent the inherent variability caused by the geographic separation of the stations.

Runoff Water Quality Results

QA/QC Evaluation

On a quarterly basis, a review of the QA/QC program was conducted, fulfilling the requirement for such a review as described in the Quality Assurance Project Plan (Sacramento County, 1993b). The quality control data from the storms indicated that the data quality objectives, as measured by the project specific numerical goals (Sacramento County, 1993b), were generally met during the second wet season. Specifically, precision, expressed as relative percent difference, was within the goals of +/- 20% for oil & grease and metals, and within +/- 10% for TSS, except for one storm (February 17 = +11%). Percent spike recovery values were all within the 80-120% accuracy goal for metals, and 70-130% for oil & grease. In addition, the collection of samples from all six storms exceeded the completeness goal of four storms for the season.

The qualitative system audits performed during this period indicated that the measurement systems were used appropriately and that the sampling and analysis activities matched those presented in the QAPP. The performance audit data described above indicate that data of known and defensible quality were produced. During the second wet season, there was one analytical result from a field duplicate in the third storm that did not match well with its corresponding environmental sample. With this exception, no other significant QA problems occurred during the 1993-94 monitoring.

Runoff Water Quality Data

Table 5.4 presents the pre-BMP (1992-93) runoff data for analytes detected in at least 75% of analyzed samples (i.e., indicators, nickel, aluminum, and iron). Table 5.5 presents the post-BMP (1993-94) data for the indicator analytes. As expected for storm

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Table 5.3 Gas Station Rainfall Intensities

Pre-BMP Monitoring

Parameter	Station X	Station Y	Station Z	Mean	Std. Dev.
29-Oct					
Rainfall (inches)*					
Time (hours)*					
Intensity (inches/hr.)*					
6-Dec					
Rainfall (inches)	0.27	0.22	0.53	0.34	0.17
Time (hours)	5.68	9.18	10.00	8.29	2.29
Intensity (inches/hr.)	0.05	0.02	0.05	0.04	0.02
10-Dec					
Rainfall (inches)	0.42	0.33	0.15	0.30	0.14
Time (hours)	0.67	0.58	0.75	0.67	0.09
Intensity (inches/hr.)	0.63	0.57	0.20	0.47	0.23
6-Jan					
Rainfall (inches)	0.27	0.20	0.25	0.24	0.04
Time (hours)	3.07	2.21	2.50	2.59	0.44
Intensity (inches/hr.)	0.09	0.09	0.10	0.09	0.01
16-Mar					
Rainfall (inches)	0.27	0.15	0.15	0.19	0.07
Time (hours)	6.25	5.42	5.25	5.64	0.54
Intensity (inches/hr.)	0.04	0.03	0.03	0.03	0.01
23-Mar					
Rainfall (inches)	0.15	0.13	0.13	0.14	0.01
Time (hours)	6.08	4.18	3.75	4.67	1.24
Intensity (inches/hr.)	0.02	0.03	0.03	0.03	0.01
Average Storm Rainfall (inches) (n=15)				0.24	0.08
Average Storm Time (hours) (n=15)				4.37	0.92
Average Storm Intensity (inches/hr.) (n=15)				0.13	0.05

* = Samples collected on October 29, 1992, were grab samples; rainfall intensity was not measured.

Post-BMP Monitoring

Parameter	Station X	Station Y	Station Z*	Mean	Std. Dev.
29-Nov					
Rainfall (inches)	1.65	1.77	1.71	1.71	0.06
Time (hours)	10.78	10.23	10.3	10.44	0.30
Intensity (inches/hr.)	0.153	0.173	0.166	0.164	0.010
11-Dec					
Rainfall (inches)	0.47	0.87	0.67	0.67	0.20
Time (hours)	11.00	11.00	8.93	10.31	1.20
Intensity (inches/hr.)	0.043	0.079	0.075	0.066	0.020
24-Jan					
Rainfall (inches)	1.46	0.63	1.045	1.05	0.42
Time (hours)	12.34	11.81	20.39	14.85	4.81
Intensity (inches/hr.)	0.118	0.053	0.051	0.074	0.038
6-Feb					
Rainfall (inches)	0.87	0.87	0.87	0.87	0.00
Time (hours)	15.27	15.00	15.27	15.18	0.16
Intensity (inches/hr.)	0.057	0.058	0.057	0.057	0.001
17-Feb					
Rainfall (inches)	0.71	0.75	0.73	0.73	0.02
Time (hours)	15.88	21.25	24.65	20.59	4.42
Intensity (inches/hr.)	0.045	0.035	0.030	0.037	0.008
8-Apr					
Rainfall (inches)	0.35	0.24	0.295	0.30	0.05
Time (hours)	10.69	11.00	6.60	9.43	2.46
Intensity (inches/hr.)	0.033	0.022	0.045	0.033	0.012
Average Storm Rainfall (inches) (n=18)				0.89	0.13
Average Storm Time (hours) (n=18)				13.47	2.22
Average Storm Intensity (inches/hr.) (n=18)				0.07	0.01

* Rainfall data from the ALERT rain gauge near Station Z was incomplete and inconsistent. Therefore, rainfall data for Station Z is the average of rainfall data measured at ALERT rain gauges near Stations X and Y.

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water runoff samples, the variability was quite high in both year's data sets. Standard deviations of mean values by storm, by station, and of the pooled data were high.

Table 5.4 Fueling Station Storm Water Runoff Data
Pre-BMP Monitoring (1992/93)

Concentrations in ug/l
(Except where otherwise noted)

Constituent	Station	29-Oct	6-Dec	10-Dec	06-Jan	16-Mar	23-Mar	Station Mean	Standard Deviation	
TSS (mg/l)	X	34	110	110	130	53	38	79	42	
	Y	150	52	31	46	36	40	59	45	
	Z	26	96	9	29	36	42	40	30	
	Mean	70	86	50	68	42	40	Pooled Data Mean		59
	Std. Dev.	69	30	53	54	10	2	Std. Deviation		40
O&G (mg/l	X	2.7	15 <	0.5	5.4	12	1.9	6.3	5.9	
	Y	6.9	7.8	1.0	0.6	5.0	1.0	3.7	3.3	
	Z	1.2	14	0.8	2.0	3.9	1.2	3.9	5.1	
	Mean	3.6	12.3	0.8	2.7	7.0	1.4	Pooled Data Mean		4.6
	Std. Dev.	3.0	3.9	0.3	2.5	4.4	0.5	Std. Deviation		4.7
Cadmium	X	0.38	1.80	1.90	0.42	0.77	0.54	0.97	0.70	
	Y	1.40	0.71	0.31	0.25	0.60	0.27	0.59	0.44	
	Z	0.54	0.56	0.11	0.39	0.53	0.45	0.43	0.17	
	Mean	0.77	1.02	0.77	0.35	0.63	0.42	Pooled Data Mean		0.66
	Std. Dev.	0.55	0.68	0.98	0.09	0.12	0.14	Std. Deviation		0.50
Chromium	X	4.3	6.7	9.4 <	1.0	4.1	3.0	4.8	2.9	
	Y	11	4.1	2.6	1.8	5.5	2.6	4.6	3.4	
	Z	7.4	2.9 <	1.0 <	1.0	4.0	2.5	3.1	2.4	
	Mean	7.6	4.6	4.3	1.3	4.5	2.7	Pooled Data Mean		4.2
	Std. Dev.	3.4	1.9	4.5	0.5	0.8	0.3	Std. Deviation		2.8
Copper	X	30	26	9.7	5.2	20	13	17.3	9.7	
	Y	68	31	6.0	7.6	45	20	29.6	23.9	
	Z	9.3	26	6.0	9.2	37	85	28.8	30.1	
	Mean	35.8	27.7	7.2	7.3	34.0	39.3	Pooled Data Mean		25.2
	Std. Dev.	29.8	2.9	2.1	2.0	12.8	39.7	Std. Deviation		21.6
Lead	X	34	28	17	8.2	54	15	26.0	16.6	
	Y	150	28	17	16	63	24	49.7	52.1	
	Z	15	28	7.0	15	32	50	24.5	15.5	
	Mean	66.3	28.0	13.7	13.1	49.7	29.7	Pooled Data Mean		33.4
	Std. Dev.	73.1	0.0	5.8	4.2	15.9	18.2	Std. Deviation		32.1

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Table 5.4 Fueling Station Storm Water Runoff Data
Pre-BMP Monitoring (1992/93)

Concentrations in ug/l
(Except where otherwise noted)

Constituent	Station	29-Oct	6-Dec	10-Dec	06-Jan	16-Mar	23-Mar	Station Mean	Standard Deviation	
Nickel	X	5.2	5.1	11	NA	NA	NA	7.1	3.4	
	Y	9.4	3.1 <	5.0	NA	NA	NA	5.8	3.2	
	Z	< 5.0	3.1	3.1	NA	NA	NA	3.7	1.1	
	Mean	6.5	3.8	6.4					Pooled Data Mean	5.6
	Std. Dev.	2.5	1.2	4.1					Std. Deviation	2.8
Zinc	X	690	500	430	180	430	550	463	169	
	Y	410	190	59	82	130	91	160	131	
	Z	2400	200	53	84	150	200	515	926	
	Mean	1167	297	181	115	237	280		Pooled Data Mean	379
	Std. Dev.	1077	176	216	56	168	240		Std. Deviation	525
Aluminum	X	NA	800	2300	NA	NA	940	1347	829	
	Y	NA	810	570	NA	NA	310	563	250	
	Z	NA	910	140	NA	NA	660	577	395	
	Mean		840	1003			643		Pooled Data Mean	829
	Std. Dev.		61	1143			317		Std. Deviation	614
Iron	X	NA	1300	2700	340	NA	NA	1447	1187	
	Y	NA	1000	600	110	NA	NA	570	446	
	Z	NA	1300	190	850	NA	NA	780	558	
	Mean		1200	1163	433				Pooled Data Mean	932
	Std. Dev.		173	1346	379				Std. Deviation	798

For both data sets (1992-93 and 1993-94) and for nearly all of these analytes, the number of samples was equal to or greater than five, except for chromium at station Z (n = 4) in 1992-93, and chromium at station Y (n = 3) in 1993-94. In order to increase the statistical validity of the chromium results, a distributional method was used to establish a maximum likelihood value for the non-detect results. The method used is outlined in Appendix A.

For example, the calculated values for the 1992-93 non-detected chromium values were 1.02 ug/L and 1.67 ug/L. These values were higher than the analytical detection limit, indicating a data gap between the detected values and the non-detected values. Given that the chromium values calculated to replace the non-detected values were actually slightly greater than the detection limit, it was concluded that it would be reasonable to replace the two non-detected values with the detection limit (1.0 ug/L).

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Table 5.5 Fueling Station Storm Water Runoff Data
Post-BMP Monitoring (1993-94)

Concentrations in ug/l
(Except where otherwise noted)

Constituent	Station	29-Nov	11-Dec	24-Jan	06-Feb	17-Feb	08-Apr	Station Mean	Standard Deviation	
TSS (mg/l)	X	30	44	80	54	46	90	57	23	
	Y	24	62	120	29	37	160	72	56	
	Z	42	84	240	32	43	250	115	102	
	Mean	32	63	147	38	42	167	Pooled Data Mean		82
	Std. Dev.	9	20	83	14	5	80	Std. Deviation		67
O&G (mg/l)	X	4.5	18	8.9	6.7	5.4	21	10.8	7.0	
	Y	5.2	2.7	13	5.7	2.2	15	7.3	5.4	
	Z	6.9	6.9	4.5	6.2	4.2	29	9.6	9.6	
	Mean	5.5	9.2	8.8	6.2	3.9	21.7	Pooled Data Mean		9.2
	Std. Dev.	1.2	7.9	4.3	0.5	1.6	7.0	Std. Deviation		7.0
Cadmium	X	0.73	0.28	0.92	0.21	0.61	0.85	0.60	0.30	
	Y	0.52	0.19	1.1	0.12	0.21	1.7	0.64	0.63	
	Z	1.2	0.48	0.42	0.22	0.81	4.5	1.27	1.62	
	Mean	0.82	0.32	0.81	0.18	0.54	2.35	Pooled Data Mean		0.84
	Std. Dev.	0.35	0.15	0.35	0.06	0.31	1.91	Std. Deviation		0.98
Chromium	X	3.5	3.2	3.7	1.3	3.2	5.9	3.5	1.5	
	Y	1.8	< 1.0	5.7	< 1.0	< 1.0	9.8	3.4	3.6	
	Z	3.9	3.9	1.3	2.6	2.5	14	4.7	4.7	
	Mean	3.1	2.7	3.6	1.6	2.2	9.9	Pooled Data Mean		3.8
	Std. Dev.	1.1	1.5	2.2	0.9	1.1	4.1	Std. Deviation		3.3
Copper	X	12	10	13	5	10	23	12	6	
	Y	17	16	58	13	8.4	350	77	135	
	Z	84	22	14	16	140	460	123	173	
	Mean	38	16	28	11	53	278	Pooled Data Mean		71
	Std. Dev.	40	6	26	6	76	227	Std. Deviation		124
Lead	X	34	7.1	20	2.9	14	32	18	13	
	Y	18	13	98	11	13	93	41	42	
	Z	210	33	18	22	70	580	156	220	
	Mean	87	18	45	12	32	235	Pooled Data Mean		72
	Std. Dev.	107	14	46	10	33	300	Std. Deviation		133
Zinc	X	270	350	440	170	380	620	372	154	
	Y	150	83	300	84	41	760	236	272	
	Z	430	200	150	100	360	1400	440	487	
	Mean	283	211	297	118	260	927	Pooled Data Mean		349
	Std. Dev.	140	134	145	46	190	416	Std. Deviation		316

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Also for the 1992-93 data set, this same method was used to determine values for non-detect results on oil & grease (December 10 storm) and chromium (January 6 storm) at station X. In both cases, the values calculated to replace the non-detected values were actually slightly greater than the detection limit. So it was deemed reasonable to replace the two non-detected values with their respective detection limits (0.5 mg/L - oil & grease; 1.0 ug/L - chromium).

Appendix B presents plots of pollutant concentrations versus station for all six post-BMP storms. Where applicable, the plots include water quality objectives (SWRCB, 1991) for comparison. This comparison is very conservative because it does not consider the fate of the pollutants (e.g., adsorption) and the fact that the samples were collected upstream of the storm drain system, as well as the receiving waters for which these objectives are developed (SWRCB, 1991).

Appendix B also presents plots of post-BMP pollutant concentrations versus storm for the three stations. As in the case with the previous plots, where applicable, the plots include water quality objectives (SWRCB, 1991) for comparison. Again, this comparison is very conservative because of the reasons outlined above. As was the case with the first year's data, pooled mean concentrations of copper, lead, and zinc (Table 5.5) exceeded California Inland Surface Waters Plan water quality objectives based on a Sacramento River hardness value of 59 mg/L as $CaCo_3$.

Comparison to Related Studies

Table 5.6 presents some of the pre-BMP runoff water quality data from this study along with data from recent characterization studies. These studies have focused in whole or in part on vehicle-related sources. The studies vary in sample size (n=4 to 18), sample type (composite, grab), waste stream type (sheet flow runoff, simulated runoff, oil/grit separator water), and activity area (gas stations, fueling islands, oil/grit separators, parking, streets, vehicle service, driveways). So direct comparisons among studies is not possible. However, it does appear that the pre-BMP results from this study are comparable to results from other studies.

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Table 5.6 Data Comparison - Related Studies

Constituent (ug/l)	Sacramento County 1993 (this study)	WSPA 1993	Maryland DE 1993	Maryland DE 1993	Wisconsin DNR 1992			Pitt & Field 1990		
					Driveways	Parking	Streets	Vehicle Service	Parking	Streets
Aluminum	829	ND	ND	ND	ND	ND	ND	920	1550	4,000
Cadmium	0.7	ND	UND	15.29	0.5	1.0 & 0.6*	0.8 to 3.3**	8	0.72	0.76
Chromium	4.2	ND	5	17.63	2	12 & 5	5 to 23	19	18	3.3
Copper	25.2	200	72	112.63	17	41 & 15	24 to 76	8.3	20	15
Lead	33.4	ND	48	162.38	17	38 & 22	33 to 86	75	30	30
Nickel	4.7	ND	UND	ND	ND	ND	ND	35	40	3
Zinc	379	200 to 600#	373	554	107	304 & 178	220 to 575	67	30	58
Oil & grease (mg/l)	4.6	1 to 34	ND	95.51	ND	ND	ND	ND	ND	ND
TSS (mg/l)	59	10 to ?	ND	ND	173	312 & 58	233 to 763	ND	ND	ND
Number of samples	9 to 18	5	4	7	12	6 & 12	18	4	12 to 13	6
Sample type	Composite	Grab	Composite	Grab	Composite	Composite	Composite	Grab	Grab	Grab
Waste stream type	Sheet flow runoff	Simulated runoff	Water in chambers	Water in chambers	Sheet flow runoff	Sheet flow runoff	Sheet flow runoff	Sheet flow runoff	Sheet flow runoff	Sheet flow runoff
Activity area	Gas stations	Fueling	Oil/grit separator	Oil/grit separator	Residential driveways	Parking	Streets	Vehicle service	Parking	Streets

Studies are referenced in section 9.
UND = undetected; ND = no data.
# = range; * = means of two study areas; ** = range of street types (feeder, collector, arterial).

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6.0 *Data Analysis*

This section describes the first and second year's data analysis, including a determination of which distribution plots (normal or log-normal) best fit the data, estimation of mass loads, analysis of station-to-station and pre- to post-BMP differences, evaluation of seasonal trends, and evaluation of high pressure water cleaning.

6.1 Descriptive Statistics

Descriptive statistics (mean, median and standard deviation) for each year for each constituent, for each station individually, and for all three stations combined, are presented in Table 6.1.

Table 6.1 Descriptive Statistics

Pre- and Post-BMP Data Combined

	TSS	O&G	O&G w/ NDs	Cd	Cr	Cr w/ NDs	Cu	Pb	Zn
Median	45	5.3	5.3	0.535	3.2	3.2	16.5	23	200
Mean	70.42	6.89	6.91	0.75	3.67	3.99	47.93	52.51	364.36
Standard Deviation	56.23	6.40	6.37	0.78	3.43	3.05	91.90	98.40	433.42

Pre-BMP Data Only

	TSS	O&G	O&G w/ NDs	Cd	Cr	Cr w/ NDs	Cu	Pb	Zn
Median	41	2.35	2.35	0.535	3.5	3.5	20	26	195
Mean	59.33	4.55	4.61	0.66	3.83	4.16	25.22	33.40	379.39
Standard Deviation	39.58	4.66	4.61	0.50	3.22	2.78	21.60	32.09	524.51

Post-BMP Data Only

	TSS	O&G	O&G w/ NDs	Cd	Cr	Cr w/ NDs	Cu	Pb	Zn
Median	50	6.45	6.45	0.565	3.2	3.2	16	21	285
Mean	81.50	9.22	9.22	0.84	3.52	3.83	70.63	71.61	349.33
Standard Deviation	67.18	7.02	7.02	0.98	3.62	3.29	124.08	132.68	316.48

6.2 Determination of Best Fit Distributions

The initial data analysis step involved testing the runoff water quality data to determine whether the data better fit a normal or log-normal distribution. The data were plotted using both a normal scale and a log scale for the y-axis, in each case plotted with a normal probability distribution for the x-axis. By fitting a regression line to the data

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plot, it can be determined how well the data fit a normal or log-normal distribution. Only those constituents with four or more detected values at each station were included in this analysis. Those constituents were total suspended solids, oil & grease, cadmium, chromium, copper, lead, and zinc. The analysis was completed for each year of data separately for each gas station, and then for the data from all three stations combined.

As discussed in section 5.2, Sampling Results, non-detected data were replaced with the appropriate values before plotting so that the true number of data points could be used on each plot. In each case the curve-fitting function in Kaleidagraph™ was used to determine the equation of the line that fit the data most closely. Kaleidagraph™ reports an "R" value, which is an indication of how well the line approximates the actual data. Curves with "R" values close to 1.0 fit best.

Plots for Data Grouped by Constituent and Station

For the pre-BMP condition, the log-normal distribution fit the majority of the data best for the individual stations. In the case of cadmium and lead, the log-normal plots had higher "R" values than the normal plots for each sampling location, indicating that the log-normal curves fit best. In the case of chromium, copper, total suspended solids, and zinc, the station Y and Z curves fit best on the log-normal plot, but the curves for X fit slightly better on the normal plot. The station X and Y curves for oil and grease also fit best on the normal plot.

Plots for Data Grouped by Constituent Only (All Stations Combined)

For the pre-BMP data, for each of the seven constituents evaluated, when the data from all three stations were combined, the log-normal curves fit best. Each of the "R" values was greater than 0.93, indicating that the curves fit the data fairly well.

For the post-BMP data, log-normal distributions provided the best curve fits for the combined data sets for all constituents tested.

Assumption of Log-normal Distribution

Based upon the preceding analysis of the distributional characteristics of the data, the log-normal curves best fit the data overall for the constituents examined in this study. The regression analysis (sections 6.5 and 6.6) therefore assumes that the data are generally log-normally distributed. The distribution plots are shown in Appendix C.

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6.3 Estimation of Event Mass Loads

For each constituent and station, event mass loads (EMLs) were estimated for each storm event monitored. The EMLs were calculated from the product of the measured pollutant concentration and the estimated runoff flow volume through the gas station monitoring site drainage area. The runoff flow volume for each storm was calculated from the estimated surface area draining to the monitoring site (as described in section 5.1), and the rainfall volume measured at the ALERT system rain gauge nearest the site. The estimated mass loads for the pre-BMP and post-BMP storm events are shown in Tables 6.2 and 6.3.

6.4 Analysis of Station-to-Station Differences and Pre- to Post-BMP Differences

Statistical analyses were conducted to determine whether runoff water quality differed from station-to-station during the study, and whether post-BMP runoff quality differed from pre-BMP runoff quality.

T-tests were used to evaluate the differences in gas station runoff water quality among the stations in each of the two years of the project, and also to evaluate the differences in runoff quality between the pre-BMP and post-BMP conditions. For the station-to-station comparisons, the tests were done by pairs of stations (X:Y, Y:Z, X:Z). A robust form of the paired, two-tailed Student's t-test was used. This test compares the means of two data sets, but does not assume that the variances of the populations from which the data sets are drawn are equal. The paired sample test is appropriate for data sets where the observations are in paired sets, as in this study.

The t-test evaluates the relative difference in mean values between two data sets. The test is set up to test what is called the "null hypothesis"; that is, the hypothesis that there is no significant difference between the two data sets. Technically, the t-test determines the probability of error associated with rejecting the null hypothesis. This is essentially equivalent to the probability of error (known as the "p" value) associated with accepting the hypothesis that there is a significant difference between two data sets.

The key measure produced by the t-test is the probability (p) value. A significant difference is considered to exist between the data sets when the p-value is less than or equal to 0.05, which indicates that the probability of error associated with rejecting the null hypothesis (or with accepting the alternative hypothesis that the data sets are different) is less than five percent.

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Table 6.2 Pre-BMP Event Mass Loads

All values in grams

Event	Station	TSS	Oil & Grease	Cadmium	Chromium	Copper	Lead	Zinc
10/29/92		1,719.61	136.56	0.02	0.22	1.52	1.72	34.90
12/6/92		4,105.06	559.78	0.07	0.25	0.97	1.04	18.66
12/10/92	X	4,699.21	21.36	0.08	0.40	0.41	0.73	18.37
1/6/93		8,426.17	350.01	0.03	0.06	0.34	0.53	11.67
3/16/93		2,914.79	659.95	0.04	0.23	1.10	2.97	23.65
3/23/93		1,791.30	89.56	0.03	0.14	0.61	0.71	25.93
10/29/92		3,638.87	167.39	0.03	0.27	1.65	3.64	9.95
12/6/92		1,892.21	283.83	0.03	0.15	1.13	1.02	6.91
12/10/92	Y	913.18	29.46	0.01	0.08	0.18	0.50	1.74
1/6/93		2,789.80	36.39	0.02	0.11	0.46	0.97	4.97
3/16/93		1,247.61	173.28	0.02	0.19	1.56	2.18	4.51
3/23/93		1,802.11	45.05	0.01	0.12	0.90	1.08	4.10
10/29/92		895.94	41.35	0.02	0.25	0.32	0.52	82.70
12/6/92		3,859.43	562.83	0.02	0.12	1.05	1.13	8.04
12/10/92	Z	484.58	43.07	0.01	0.05	0.32	0.38	2.85
1/6/93		2,997.95	206.76	0.04	0.10	0.95	1.55	8.68
3/16/93		1,654.04	179.19	0.02	0.18	1.70	1.47	6.89
3/23/93		3,015.18	86.15	0.03	0.18	6.10	3.59	14.36

Table 6.3 Post-BMP Event Mass Loads

All values in grams

Event	Station	TSS	Oil & Grease	Cadmium	Chromium	Copper	Lead	Zinc
11/29/93		2,430.63	364.59	0.06	0.28	0.97	2.75	21.88
12/11/93		1,015.46	415.42	0.01	0.07	0.23	0.16	8.08
1/24/94	X	5,735.30	638.05	0.07	0.27	0.93	1.43	31.54
2/6/94		2,306.89	286.22	0.01	0.06	0.21	0.12	7.26
2/17/94		1,603.72	188.26	0.02	0.11	0.35	0.49	13.25
3/6/94		1,546.76	360.91	0.01	0.10	0.40	0.55	10.66
11/29/93		1,840.23	398.72	0.04	0.14	1.30	1.38	11.50
12/11/93		2,336.67	101.76	0.01	0.03	0.60	0.49	3.13
1/24/94	Y	3,274.98	354.79	0.03	0.16	1.58	2.67	8.19
2/6/94		1,092.96	214.82	0.00	0.03	0.49	0.41	3.17
2/17/94		1,202.13	71.48	0.01	0.03	0.27	0.42	1.33
3/6/94		1,663.48	155.95	0.02	0.10	3.64	0.97	7.90
11/29/93		5,155.96	847.05	0.15	0.48	10.31	25.78	52.79
12/11/93		4,040.34	331.89	0.02	0.19	1.06	1.59	9.62
1/24/94	Z	18,004.93	337.59	0.03	0.10	1.05	1.35	11.25
2/6/94		1,998.63	387.24	0.01	0.16	1.00	1.37	6.25
2/17/94		2,253.49	220.11	0.04	0.13	7.34	3.67	18.87
3/6/94		5,294.51	614.16	0.10	0.30	9.74	12.28	29.65

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Station-to-Station Differences - Pre-BMP Monitoring

The t-test p-values produced by the station-to-station comparisons of runoff pollutant concentrations for the pre-BMP condition (1992-93 monitoring) are shown in Table 6.4. In two instances, the p-value was small enough (<0.05) to warrant further investigation. The variances for these two instances were very large in comparison to the means, however, which indicates that the difference was likely an artifact rather than a significant difference. All of the other values indicate no statistically significant differences among the gas stations for the baseline monitoring, using the log-transformed values. These results allowed the data to be "pooled" or combined into a larger data set for evaluations of rainfall-related effects, and allowed the pooling of the data from the three stations in the pre-BMP analyses.

Table 6.4 p-Value Matrix; Paired t-tests
Pre-BMP (1992/93) Concentration Data

	Station Group		
Constituent	X/Y	Y/Z	X/Z
Total suspended solids	0.542	0.434	0.101
Oil & grease	0.232	0.936	0.112
Cadmium	0.349	0.345	0.155
Chromium	0.938	0.029	0.365
Copper	0.116	0.960	0.423
Lead	0.259	0.328	0.865
Zinc	0.002	0.329	0.884

Station-to-Station Differences - Post-BMP Monitoring

The t-test p-values produced by the station-to-station comparisons of runoff pollutant concentrations for the post-BMP condition (1993-94 monitoring) are shown in Table 6.5. As with the pre-BMP monitoring data, the t-test results indicate that no significant differences can be determined in post-BMP runoff water quality from one station to another. No p-values below 0.05 were obtained from the comparisons of the various station pairs. These results allowed the data to be "pooled" or combined into a larger data set for evaluations of rainfall-related effects, and allowed the pooling of the data from the three stations in the post-BMP analyses.

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Table 6.5 p-Values; Paired t-tests Post-BMP (1993/94) Concentration Data*			
	Station Group		
Constituent	X/Y	X/Z	Y/Z
TSS	0.357	0.143	0.085
Oil and Grease	0.265	0.684	0.468
Cadmium	0.832	0.321	0.243
Chromium (ND values replaced)	0.894	0.441	0.307
Copper	0.274	0.167	0.164
Lead	0.200	0.172	0.225
Zinc	0.102	0.677	0.129

Table 6.6 p-Values; Paired t-tests Post-BMP (1993/94) Event Mass Data*			
	Station Group		
Constituent	X/Y	X/Z	Y/Z
TSS	0.347	0.100	0.107
Oil and Grease	0.032	0.498	0.024
Cadmium	0.108	0.184	0.063
Chromium (ND values replaced)	0.032	0.226	0.042
Copper	0.169	0.054	0.074
Lead	0.708	0.126	0.157
Zinc	0.028	0.445	0.050

* These values are the two-tail p-values from the paired t-tests performed on data for each pair of stations in the study. Each value represents the probability of error in accepting the hypothesis that there is a significant difference in the samples taken at two different gas stations.

Table 6.7 p-Values; Paired t-tests Pre-BMP (1992/93) Concentrations vs. Post-BMP (1993/94) Concentrations				
	Station			
Constituent	X	Y	Z	All
TSS	0.305	0.732	0.160	0.316
Oil and Grease (ND values replaced)	0.257	0.326	0.282	0.045
Cadmium	0.278	0.895	0.254	0.541
Chromium (ND values replaced)	0.342	0.614	0.494	0.770
Copper	0.313	0.453	0.172	0.121
Lead	0.390	0.798	0.185	0.259
Zinc	0.260	0.601	0.867	0.835

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For the post-BMP monitoring, the EMLs were also tested for station-to-station differences. Significant differences were observed both between stations X and Y, and between stations Y and Z, for chromium, zinc, and oil and grease (see Table 6.6).

Pre-BMP to Post-BMP Differences

The lack of statistically significant differences in pollutant concentration data among the three stations for both years permits grouping of the data from the three stations in the pre- and post-BMP analyses, as well as use of the combined data sets in evaluations of rainfall-related effects for each year.

T-tests were again used to compare the pre-BMP monitoring results to those of the post-BMP conditions. The tests were run for each station individually and for data from the three stations combined, in each case comparing the pre-BMP data to the post-BMP data. The comparisons were done for both concentrations and mass loadings.

The results of the concentration data comparisons are shown in Table 6.7. A significance level of p=0.05 was again used to determine whether statistically significant differences exist. The only statistically significant difference in the pre- to post-BMP comparisons was found in the combined stations data sets for oil and grease. For the EML comparisons (Table 6.8), no statistically significant differences were found between the pre- and post-BMP data. This indicates that, generally speaking, gas station runoff quality was not significantly different before and after implementation of BMPs. A complete set of the paired t-test results is presented in Appendix D.

Table 6.8 p-Values; Paired t-tests
Pre-BMP (1992/93) Masses vs. Post-BMP (1993/94) Masses

Constituent	Station			
	X	Y	Z	All
TSS	0.233	0.826	0.217	0.498
Oil and Grease (ND values replaced)	0.659	0.297	0.130	0.069
Cadmium	0.324	0.778	0.178	0.531
Chromium (ND values replaced)	0.123	0.111	0.093	0.443
Copper	0.176	0.601	0.093	0.110
Lead	0.510	0.458	0.182	0.248
Zinc	0.173	0.775	0.908	0.508

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6.5 Evaluation of Seasonal Trends

Regression analysis was used to evaluate the effects of precipitation patterns on gas station runoff chemistry for each of the two study years. A regression analysis provides an evaluation of the best-fit line drawn through a data plot. The "p" value indicates the likelihood that the observed relationship is due to chance. A p-value of ≤ 0.05 is generally considered to indicate a statistically significant relationship. The "r" value indicates the relative "goodness of fit", or strength of the relationship. An r value of 1 equals a perfect positive correlation between the data points; -1 equals a perfect negative correlation.

For the pre-BMP data, regressions were performed on the runoff concentration data vs. four rainfall parameters: rainfall intensity during the period of sampling, cumulative precipitation to date, days since last storm of 0.1" or greater, and days since last storm of 0.25" or greater.

For the post-BMP runoff concentration data, additional precipitation parameters were added: sampled storm depth (volume), intensity of storm (overall intensity during the entire storm event, from the ALERT rain gauge data), and elapsed rainfall before start of sampling. For the post-BMP event mass data, regressions were run on a smaller subset of precipitation parameters: cumulative precipitation to date, and days since last storm of 0.25" or greater.

The regressions were run for each station individually and for the combined stations data set. The log-transformed pollutant concentration values were used in all cases.

Pre-BMP Concentration Data

The statistically significant regression relationships for the pre-BMP data are shown in Table 6.9. The highest number of statistically significant regression relationships ($p \leq 0.05$) was found with the "days since last storm >0.25 inch" parameter. Four different constituents at station Y (chromium, lead, zinc, and TSS) and one constituent at station Z (zinc) were significantly correlated with this parameter. For the pooled data set (all stations combined), chromium and zinc were again significantly correlated with this parameter, although the r values were relatively low.

For the "days since last storm >0.10 inch" parameter, the station X regression of cadmium concentration was statistically significant, and had a fair r value, but the slope is negative, indicating that cadmium concentration decreases as the inter-event time gets longer, which is counterintuitive. It is likely that this result was an artifact due to

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chance. The pooled zinc data set was positively correlated with days since last storm >0.10 inch, although the r value was marginal.

At station Z, cadmium, lead, and zinc showed decreasing concentrations in relation to increasing rainfall intensity, which is plausible due to the diluting effect of more intense rainfall. For the pooled data set, oil and grease showed a similar inverse relationship to intensity, but the r value was weak.

Overall, the regressions of pre-BMP runoff concentrations versus rainfall parameters indicated that zinc (and possibly other metals) appeared to exhibit a build-up effect during dry periods at the fueling stations. Zinc concentration tended to decrease as the inter-event time decreased.

Table 6.9 Significant* Regressions
Rainfall Parameters vs. Concentrations**
Pre-BMP (1992/93) Monitoring

Station	Independent Variable	Dependent Variable**	"r" value
Y	Days Since Last Storm >0.25"	Chromium	0.84
Y	Days Since Last Storm >0.25"	Lead	0.88
Y	Days Since Last Storm >0.25"	Zinc	0.84
Y	Days Since Last Storm >0.25"	TSS	0.94
Z	Days Since Last Storm >0.25"	Zinc	0.93
Pooled	Days Since Last Storm >0.25"	Chromium	0.50
Pooled	Days Since Last Storm >0.25"	Zinc	0.65
X	Days Since Last Storm >0.10"	Cadmium	-0.82
Pooled	Days Since Last Storm >0.10"	Zinc	0.49
Z	Rain Intensity	Cadmium	-0.96
Z	Rain Intensity	Lead	-0.96
Z	Rain Intensity	Zinc	-0.93
Pooled	Rain Intensity	Oil & Grease	-0.54

* = $p < 0.05$
** = log-transformed concentrations
Pooled = Combined data from all stations

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Table 6.10 Regression p-Values (Post-BMP) Concentrations

		Cumulative Precipitation to Date	Sampled Storm Depth	Days Since Last Storm > 0.1"	Days Since Last Storm > 0.25"	Intensity of Storm	Intensity During Sampling	Elapsed Rainfall Before Start of Sampling (in.)	Days Since Last Cleaning
Log(TSS)	*X*	0.1103	0.4896	0.1886	0.6909	0.4444	0.7692	0.1718	0.9969
	Y	0.2697	0.0597	0.3056	0.7321	0.2022	0.9972	**0.0174**	0.9515
	Z	0.5125	0.3946	0.4381	0.7572	0.5205	0.9441	**0.0325**	0.7092
	All	0.0649	**0.0339**	0.0663	0.5144	0.0814	0.8208	**0.0002**	0.7225
Log(O&G) w/ NDs	*X*	0.5161	0.1186	0.2646	0.6480	0.2190	0.6564	**0.0387**	0.6438
	Y	0.5560	0.4440	0.3036	0.3841	0.6970	0.7292	0.5601	0.1719
	Z	0.4010	0.3102	**0.0185**	**0.0301**	0.9382	0.0824	0.5521	0.4701
	All	0.1581	**0.0619**	**0.0065**	**0.0426**	0.3347	0.4158	0.0661	0.2716
Log(Cd)	*X*	0.8448	0.5016	0.7631	0.5149	0.4218	0.3148	0.5219	0.2005
	Y	0.6521	0.5450	0.3988	0.3354	0.8459	0.7577	0.4460	0.1565
	Z	0.5223	0.6106	0.1429	**0.0405**	0.8763	0.3971	0.6570	0.3249
	All	0.3630	0.6338	0.0747	**0.0197**	0.7761	0.7500	0.2161	**0.0199**
Log(Cr) w/ NDs	*X*	0.8021	0.8168	0.5073	0.4131	0.9546	0.7840	0.1533	0.5075
	Y	0.6004	0.3965	0.2983	0.3654	0.7170	0.8315	0.3202	0.2258
	Z	0.5153	0.3644	**0.0518**	**0.0276**	0.9081	**0.0392**	0.7521	0.6132
	All	0.3268	0.1963	**0.0264**	**0.0247**	0.8257	0.6968	0.1012	0.1122
Log(Cu)	*X*	0.6899	0.8122	0.3435	0.2766	0.9624	0.7645	0.1669	0.3769
	Y	0.3235	0.2144	0.0914	0.1959	0.4657	0.7271	0.2557	0.3623
	Z	0.3454	0.5407	0.1301	**0.0313**	0.9403	0.2945	0.9371	0.5180
	All	0.1762	0.1760	**0.0211**	**0.0171**	0.5163	0.4651	0.2725	0.1964
Log(Pb)	*X*	0.9029	0.5647	0.7351	0.3467	0.3970	0.4848	0.5808	0.1370
	Y	0.4545	0.2792	0.3979	0.5548	0.5129	0.6343	0.2344	0.3422
	Z	0.6796	0.8260	0.1639	**0.0115**	0.6139	0.3024	0.9301	0.2417
	All	0.5688	0.6648	0.1307	**0.0357**	0.7680	0.9682	0.4358	**0.0489**
Log(Zn)	*X*	0.4276	0.5366	0.3879	0.5603	0.6730	0.8652	0.0529	0.8553
	Y	0.5956	0.4430	0.2074	0.2352	0.7733	0.9900	0.4260	0.1765
	Z	0.4890	0.5753	0.1400	**0.0395**	0.9116	0.3483	0.7036	0.3931
	All	0.2344	0.2870	**0.0290**	**0.0222**	0.8112	0.8248	0.1406	0.1071

Note: p-values below 0.05 are shaded and bold.

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Post-BMP Concentration Data

The regression results for the concentration data are shown in Table 6.10. The statistically significant regression relationships are indicated by shading. Plots of the significant regressions are presented in Appendix E. There were several significant relationships but, as was the case with the pre-BMP data, the highest number of statistically significant regression relationships ($p \leq 0.05$) was found with the "days since last storm >0.25 inch" parameter. All five metal constituents and oil & grease, both at station Z and for the pooled data set (all stations combined), were significantly correlated with this parameter. Only TSS did not show any significant correlation with the "days since last storm >0.25 inch" parameter.

Concentrations of three of the five metals and oil & grease, in the pooled data set, were also significantly correlated with the "days since last storm >0.10 inch" parameter. Pooled data set concentrations of TSS showed statistically significant regression relationships with two parameters, elapsed rainfall before start of sampling and sampled storm depth. Both these parameters relate to volume of the sampled storm.

Post-BMP Event Mass Load Data

The regression results for the event mass load data are shown in Table 6.11. The statistically significant regression relationships are indicated by shading. Plots of the significant regressions are presented in Appendix F. In contrast to the post-BMP concentration data, there were no statistically significant regression relationships with the parameter "days since last storm of 0.25" or greater."

6.6 Evaluation of Effects of Mobile Cleaning

Despite the result, discussed in pre- to post-BMP Differences (section 6.4) that, overall, gas station runoff quality was not significantly different after implementation of BMPs, there were statistically significant regression relationships ($p \leq 0.05$) between both the post-BMP concentration and event mass load data, and the "days since last cleaning" parameter. The pooled concentration data set for two metals, cadmium and lead, showed a significant correlation with "days since last cleaning." The event mass load data showed a number of statistically significant regression relationships with the "days since last cleaning" parameter. The pooled data sets for three metals (cadmium, chromium, and zinc) and oil & grease showed that the event mass loads of these constituents decreased with decreasing number of days since last cleaning.

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Table 6.11 Regression p-Values (Post-BMP)

Event Mass Loadings

Constituent	Station	Cumulative Precipitation to Date	Days Since Last Storm > 0.25"	Days Since Last Cleaning
TSS	X	0.7658	0.4513	0.5112
	Y	0.5454	0.3378	0.8371
	Z	0.8233	0.5012	0.5805
	All	0.7037	0.3187	0.4481
O&G w/ NDs	X	0.5140	0.4863	0.6343
	Y	0.2371	0.9747	0.0613
	Z	0.4292	0.1619	**0.0219**
	All	0.1679	0.5502	**0.0169**
Cd	X	0.3253	0.7476	0.1647
	Y	0.2985	0.7547	**0.0301**
	Z	0.5579	0.1510	**0.0402**
	All	0.2249	0.2727	**0.0069**
Cr w/ NDs	X	0.2471	0.8642	0.1221
	Y	0.6132	0.7992	**0.0447**
	Z	0.3543	0.1961	0.0927
	All	0.1374	0.3442	**0.0087**
Cu	X	0.2864	0.9401	0.0903
	Y	0.4059	0.0854	0.2210
	Z	0.8915	0.0635	0.2028
	All	0.7823	0.0757	0.1462
Pb	X	0.1708	0.8207	0.0532
	Y	0.7035	0.7094	0.2837
	Z	0.4141	0.1994	**0.0458**
	All	0.3274	0.2335	0.0516
Zn	X	0.4824	0.5991	0.3023
	Y	0.4341	0.4368	**0.0065**
	Z	0.4766	0.2153	0.0616
	All	0.2818	0.3637	**0.0194**

Note: p-values below 0.05 are shaded and bold.

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7.0 *Discussion and Recommendations*

This section discusses the results of Phase 1 and Phase 2 and makes recommendations for further research.

7.1 Discussion

One of the goals of the project was to compare pre-BMP data to post-BMP data for a quantitative evaluation of BMP effectiveness. As discussed in section 4, Best Management Practices, the project team implemented the full suite of BMPs at each station, as opposed to implementing one BMP at each station. The presumption was that the combined effect of the suite of best management practices would increase the likelihood of reducing pollutants, thereby producing more statistically significant results.

Based on observations by project personnel and best professional judgment about the efficacy of source controls, it is highly likely that of the six BMPs implemented at the gas stations, the one BMP with the most significant chance to affect runoff quality was mobile high pressure water cleaning. The combined effect of the other five source controls:

- public notices,
- litter control,
- storm drain stenciling,
- spill cleanup materials, and
- employee awareness,

seems likely to have a much less significant impact on the primary sources of pollution at the stations, namely, high volume vehicle traffic and leaks and spills of vehicle fluids. In addition, some of the other source controls (litter control, spill cleanup, and employee training) were in place, to some extent, during the pre-BMP period. Consequently, the study can be considered in large part a pilot test of mobile cleaning as a best management practice. The discussion of BMP effectiveness therefore focuses on mobile cleaning.

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Climatological Differences

In discussing the differences between the pre-BMP and post-BMP data, it is important to note the large difference in the climatology of the two wet seasons. In 1993-94 (post-BMP), about half as much rain fell compared to the pre-BMP wet season (1992-93) (approx. 13 inches versus approx. 26 inches). Because 1992-93 (pre-BMP) was a relatively wet year in California, with frequent storms occurring on a regular basis throughout the winter, the inter-event times were fairly short, ranging from 1 to 8 days. The inter-event times in 1993-94 reflected the drier winter, ranging from 1 to 34 days. Average inter-event time for pre-BMP sampling events was four days, compared to over nine days for post-BMP samples. As discussed below, both pre-BMP and post-BMP runoff quality was significantly affected by the inter-event time period (number of days since last storm).

Research by others including Pitt (1987), indicates that rain depth and intensity significantly affect particulate residue washoff from impervious surfaces. Normal rains, up to about one inch, typically remove only about 10-20 percent of the particulate residue on a surface. So it is possible that during the post-BMP wet season, when total rainfall was one-half of the pre-BMP wet season, that relatively less particulate residue was washed off the asphalt surfaces at the gas stations by storm events.

Summary of Pre-BMP to Post-BMP Differences

When all the data from the pre-BMP condition is combined and compared against all the post-BMP condition data, the only statistically significant difference in the pre- to post-BMP concentrations was for oil and grease, and it was higher after the BMPs were implemented. For the event mass loading comparisons, no statistically significant differences were found between the pre- and post-BMP data. This indicates that, generally speaking, gas station runoff quality was not significantly different before and after implementation of BMPs.

However, these results must be interpreted in light of the sample size data variability and climatological effects, as follows:

1. Although the sample size for both years (n=18, 3 stations x 6 storms) is reasonable, given the logistical challenges of storm water monitoring; statistically, it is a relatively small sample size, particularly considering the inherently large variability in storm water data.

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2. A review of the data from both years (Tables 5.4 and 5.5) confirms the high degree of variability in the pooled data. Standard deviations were generally as large as the means.

Effects of Climatology on Pre-BMP and Post-BMP Concentration Data

Overall, the regressions of pre-BMP runoff concentrations versus rainfall parameters indicated that zinc (and possibly other metals) appeared to exhibit a buildup effect during dry periods at the fueling stations. Zinc concentration tended to decrease as the inter-event time decreased. Similarly, for post-BMP data, the highest number of statistically significant regression relationships ($p \leq 0.05$) was found with the "days since last storm >0.25 inch" parameter (all five metal constituents and oil & grease), and with the "days since last storm >0.10 inch" parameter (three of the five metals and oil & grease).

This buildup or accumulation effect has been documented in other studies (U.S. EPA, 1979; U.S. EPA, 1985; Pitt and McLean, 1986) for particulates. It appears from this study that many of the heavy metals and oil & grease exhibit a similar effect. These data also seem to indicate that the accumulation of these pollutants translates into higher concentrations in the runoff, that is, that what accumulates tends to wash off.

For the post-BMP data, the only constituent that did not show any significant correlation with either of the "days since last storm" parameters was TSS. The concentration of total suspended solids in runoff did not increase with increasing time between significant storms. The potential explanations for this result are discussed below in relation to the effects of mobile cleaning.

Effects of Mobile Cleaning on Concentration and Mass Load Data

Although overall gas station runoff quality was not significantly different after implementation of BMPs, the length of time between cleanings and sampled storm events seems to have affected runoff quality. There were statistically significant regression relationships ($p \leq 0.05$) between both the post-BMP concentration and event mass load data for some metals and oil & grease, and the "days since last cleaning" parameter. This result appears to parallel the correlations found between the post-BMP concentration data and the "days since last storm" parameters. It seems that, in general, measured runoff concentrations for some metals and oil & grease increase with increasing time since the previous "washoff" event, whether that event was natural (storm) or artificial (cleaning).

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In contrast to metals and oil & grease, the post-BMP concentrations and event mass loads of total suspended solids in runoff did not increase with increasing time between cleanings. Again, this result appears to parallel the correlations found between the post-BMP TSS concentration and load data and the "days since last storm" parameters. There are a couple of potential explanations for these results in relation to the effects of mobile cleaning.

One potential reason that post-BMP TSS concentrations and loads did not increase with increasing time between either storms or cleanings is that the cleanings were effective at removing available particulate residue and possibly even reducing the total residue lodged in the spaces of the asphalt surface. It is possible that the cleanings were much more effective at removing TSS, which did not exhibit a buildup effect, than in removing oil & grease and heavy metals, which did show an accumulation effect. It is likely that oil & grease have a strong affinity for asphalt surfaces because of the similarities in their chemical composition. This affinity would make the separation of oil & grease from asphalt difficult, even under the high pressure and temperature conditions created by the cleanings. As for the heavy metals, although they have been shown to be bound to particulates, it is likely that a significant amount of metals are also bound to oil & grease.

Another potential reason that post-BMP TSS data did not correlate with the "days since last ..." parameters may relate to the fact that the post-BMP concentrations of TSS showed statistically significant regression relationships with two completely different parameters than the other constituents: elapsed rainfall before start of sampling and sampled storm depth. Both these parameters relate to volume of the sampled storm. This result is consistent with the research of Pitt (1987), discussed previously, that indicates that rain depth and intensity significantly affect residue washoff from impervious surfaces, and that the accumulation of particulates on paved surfaces does not necessarily translate into those particulates being washed off by storm runoff. This study's results may indicate that, when total rainfall was significantly reduced during the post-BMP wet season, very little particulate residue was washed off the asphalt surfaces at the gas stations by storm events.

The point could be made that although total rainfall was significantly reduced during the post-BMP wet season, it would seem that the ten mobile cleanings that took place during this time would have, in a sense, "made up for" the lower frequency and volume of storms, and washed off much of the particulates. However, the timing of the cleanings was such that they may have had little impact on TSS buildup. Although the

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mobile cleanings occurred interspersed throughout the wet season (see Figure 5.4), only the last two mobile cleanings occurred after a significant storm (greater than 0.1 inch) and before the sampled storm (#6), and therefore, shortened the number of days, and presumably the TSS accumulation, since a significant event, either storm or cleaning.

Effectiveness of Mobile Cleaning

Although visual observations (see Figure 4.3) confirmed that a significant amount of pollutants were removed with each cleaning, it is likely that the cleanings may have made more pollutants, particularly oil & grease, "available" for washoff in the next event, either storm or cleaning, by freeing up pollutants and allowing them to redeposit on the pavement surface. There are several reasons for this observation.

1. Pollutant deposition - The asphalt at gas stations, particularly the high sales volume stations used in this study, is subject to very high pollutant deposition rates. The sources include not only the vehicles themselves traveling over the surface for routine services (e.g., fueling), but episodic sources like fluid spills in the air/water supply area, and local sources like the resuspension and deposition of airborne pollutants from vehicles stopping at the intersections and traveling on the major streets adjacent to the stations. The net effect is an essentially continuous deposition of pollutants at such locations. The cleaning effort may not have been sufficient for the level of pollutant deposition occurring at the gas stations.

2. Surface texture - Asphalt is a relatively rough and porous surface. Because of its texture, it has innumerable miniature storage spaces that receive and detain pollutants as they are deposited on its surface. These spaces act as pollutant sources when it rains or when the surface is cleaned. The ability of high pressure cleaning to efficiently remove pollutants from porous surfaces is questionable.

3. Pollutant buildup - A relatively long-term buildup of pollutants may have occurred on the outside pavement surfaces of these stations because of the significantly reduced volumes of rain that fell during the six year drought period preceding the study. In addition, because of drought restrictions, the use of water to clean asphalt surfaces at these stations was prohibited by local ordinance during much of this period. The high pressure cleanings may have loosened up the long-term buildup of pollutants which otherwise would not have been available for washoff during normal rainfall conditions.

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4. Water accumulation before runoff - Because of the innumerable miniature storage spaces in asphalt, a significant amount of water must fall, in the case of a storm, or be applied, in the case of a cleaning, before these spaces are "filled" and runoff occurs. Observations by the mobile cleaning crew confirmed that the asphalt had to be wetted first before actual cleaning could start. This phenomena means that when cleaning time is restricted, as it was at the stations because of high traffic volumes, it is difficult to tell if the spray application rate is sufficient to overcome the necessary wetting and create a constant sheet flow toward the wash water collection device.

5. Incomplete washoff after cleaning - The mobile cleaning crew reported that although visual observations indicated that the cleanings removed a significant amount of pollutants, they also probably left behind a significant amount for a couple of reasons:
   a) The asphalt seemed to contain more pollution than the crew had time to remove.
   b) The limited coverage of the cleaning wand meant that even when the crew was able to remove significant quantities of the pollutants from the asphalt and suspend them in the sheet flow, as soon as the wand was moved to another area, pollutants started settling out of the sheet flow back into the asphalt, resulting in a redistribution rather than removal of some pollutants.

   It's likely that some of the pollutants left behind or redistributed were previously not available to be washed off, but were made available by mobile cleaning to be washed off in the next significant storm.

All-in-all, it appears that this pilot test of mobile cleaning asphalt surfaces, at high sales volume gas stations, near busy intersections on major streets, was probably a worst case scenario for this potential best management practice. The cost of mobile cleaning used by the fueling stations for this study was estimated to be about $600 per station per wash down, which is equivalent to $1,300 per acre of paved surface. Therefore, the cost of mobile cleaning a significant portion of the areas in a watershed exposed to vehicle traffic, on a regular basis, would be quite high.

Because the results were inconclusive, this study cannot recommend the implementation of the mobile cleaning BMP on a large scale. However, field observations and study results seem to indicate that, given the right conditions, mobile cleaning may have the potential to remove sources of storm water pollution. The discussion below provides some ideas on the focus of future studies.

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7.2 Recommendations for Conduct of Future Studies

Monitoring results for the pre- and post-BMP study showed that constituent concentrations in runoff from the fueling stations are similar to those found in storm water monitoring data on streets, parking lots, driveways, oil/grit separators, and other areas that have significant exposure to vehicle traffic. In this study, the potential for interference with gas station activities and the resulting disruption to business constrained implementation of mobile cleaning. Because runoff from other areas significantly exposed to vehicles is likely to be representative of gas stations, it may be more appropriate to conduct future investigations of source control effectiveness on paved surfaces exposed to vehicle traffic that are not subject to the logistical constraints at high volume fueling stations. The discussion below is intended to provide insight on how to improve investigations of BMP effectiveness.

Existing Source Controls

Because existing source controls such as spill cleanup, litter control ,and employee education were being implemented at the fueling stations on a regular basis in the pre- and post-BMP study periods, their effectiveness could not be quantified. However, their ability to prevent potential sources of contamination is high and should be emphasized in all commercial and industrial areas where outdoor spills may occur.

New Construction Source Controls

Methods of source control not used in this study because of the high costs of retrofit include those that could normally be built as part of new facility construction. These BMPs include isolating runoff, redirecting runoff from areas with high pollution potential, or substituting cement for asphalt because it is easier to clean. Many of these best management practices may be cost-effective over the long-term in reducing storm water pollution.

Further Study of Mobile Cleaning

In this study, the potential for interference with gas station activities precluded extensive quantitative monitoring of the mobile cleaning method itself. Application rates varied over the drainage areas because of traffic, operator judgment, and time constraints. To reduce variability, a controlled application could be done by monitoring the amount and rate of application of high pressure/high temperature water. Other

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parameters to monitor might be use of soaps and detergents, use of different cleaning apparatus, and application on different pavement surfaces (e.g., cement concrete).

Because of the high cost of mobile cleaning, its practical use may be limited to spot cleaning specific areas with evidence of spills or staining such as behind restaurants, around vehicle service areas, and on heavily stained areas of parking lots. The important elements of mobile cleaning are that it be preventative and that the wash water be collected and disposed of properly.

Improvement in Pre- and Post-BMP Study Design

One of the advantages of this study's two-year time frame was that it allowed ample time after the pre-BMP monitoring to select and implement best management practices before the post-BMP monitoring began. The disadvantages of this time span were that climatological and site conditions changed between the pre-BMP and post-BMP monitoring. One alternative to this method is to conduct the study in the same wet season by monitoring a large number of vehicle traveled areas and service facilities of similar characteristics for the first few storms to verify that the data can be pooled, and then to implement the BMPs at some sites for the remaining storms to achieve a direct comparison on a per storm basis. This method may reduce climatological differences and differences in sites that occur from year to year. However, it would be necessary to statistically account for the effects of seasonal variation on runoff quality.

Use of Larger Watershed Treatment Controls

This study has attempted to demonstrate the effectiveness of BMPs, and source controls in particular, in reducing pollutant loadings from gasoline fueling station runoff. It is clear from this study and others that it is not just gas station runoff, but runoff from any area where vehicles travel, park, or are serviced that is of concern. Unfortunately, this description includes most of the area in urban watersheds and much of the area in suburban watersheds. The success and the practicality of implementing all but the most restrictive source controls (e.g., product reformulations - unleaded gasoline) over such a large area is questionable. In addition, measuring the effectiveness of less restrictive source controls is complicated by the inherent variability in runoff data. As a result, regional treatment such as detention basins, which have been used successfully elsewhere, may warrant a closer look in California.

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8.0 *Public Participation*

This section describes the public participation process for the project. One of the goals of the project is to disseminate the results to a wide audience. To effect this goal, three presentations were made as part of the Phase 1 effort. The first presentation was an open house hosted by Sacramento County, a second presentation was made to WSPA at the beginning of the project, and, near the end of Phase 1, a third presentation was made to the American Public Works Association (APWA) California Stormwater Quality Task Force, a consensus building group of about 100 representatives from regulatory agencies, municipalities, industry, construction, and consulting firms.

A final presentation was made after Phase 2, also to the APWA California Stormwater Quality Task Force. Members of the project team presented preliminary results from the analysis of the post-BMP data as part of a larger presentation on monitoring results from a number of projects statewide, including the WSPA study of gas stations and parking lots (WSPA, 1993).

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Appendix A

Distributional Method to Determine Non-detect Values

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Distributional Method to Determine Non-detect Values

Example: Chromium concentration at station Z, December 10, 1992 and January 6, 1993.

1. Assign ranks to each of the results in ascending order of concentration, beginning with the two non-detected values. The first non-detected value was rank one and the greatest concentration (7.4 ug/L) was assigned a rank of 6.

2. Assign probabilities to each value in the data set using the Hazen (1930) method:

   $p_i = (i - 0.5 / n) * 100\%$

   where i is the rank of the given data point, p_i is the probability assigned to the ith data point, and n is the number of data points.

3. Create a probability plot with the percent probability along the x-axis and the concentration on a log scale along the y-axis.

4. Using the curve fitting function of Kaleidagraph™, generate an exponential curve that closely matches the actual data curve:

   concentration = $2.6757e^{0.69726z}$

   where z is the standard normal deviate, or Z-statistic, corresponding to the specific cumulative probability (in percent).

5. Use the equation just derived, calculate values for the same probabilities as the original data points. The points with 8.33% and 25.00% probability correspond to the on-detected values.

6. The calculated values for the non-detects were 1.02 ug/L and 1.67 ug/L. These values were higher than the analytical detection limit, indicating a data gap between the detected values and the non-detected values.

7. Replace the non-detected values with the detection limit. (1.0 ug/L) since the values calculated to replace the non-detected values were actually slightly greater than the detection limit.

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Appendix B

Post-BMP Data Plots

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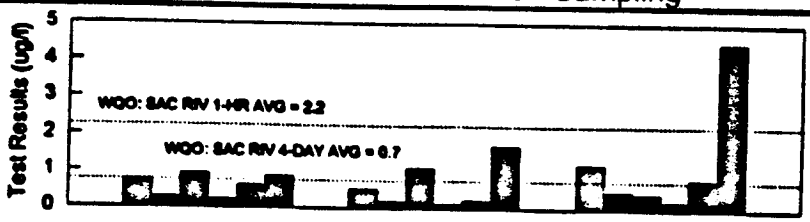
CADMIUM

Gas Station Stormwater Runoff Sampling

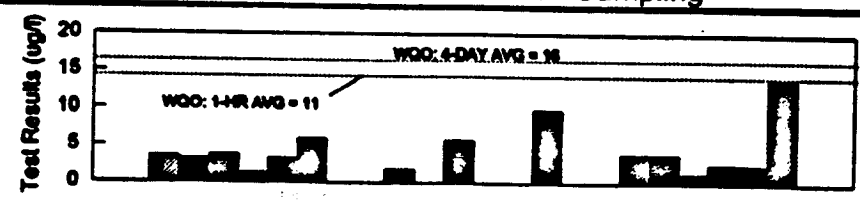


	Station X	Station Y	Station Z
29-Nov	0.73	0.52	1.2
11-Dec	0.28	0.19	0.48
24-Jan	0.92	1.1	0.42
06-Feb	0.21	0.12	0.22
17-Feb	0.61	0.21	0.81
08-Apr	0.85	1.7	4.8

Note: Method Detection Limit for Cadmium is 0.10 ug/l

CHROMUIM

Gas Station Stormwater Runoff Sampling



	Station X	Station Y	Station Z
29-Nov	3.5	1.6	3.9
11-Dec	3.2	ND	3.9
24-Jan	3.7	5.7	1.3
06-Feb	1.3	ND	2.6
17-Feb	3.2	ND	2.5
08-Apr	5.9	9.8	14

Note: Method Detection Limit for Chromium is 1.0 ug/l

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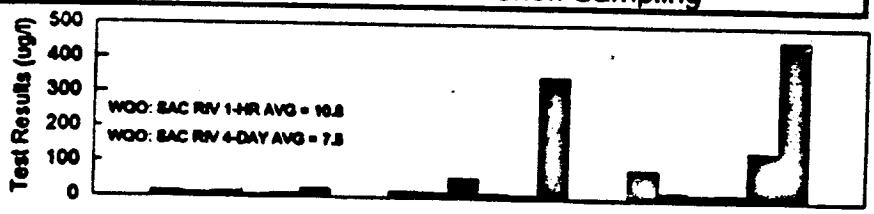
COPPER

Gas Station Stormwater Runoff Sampling

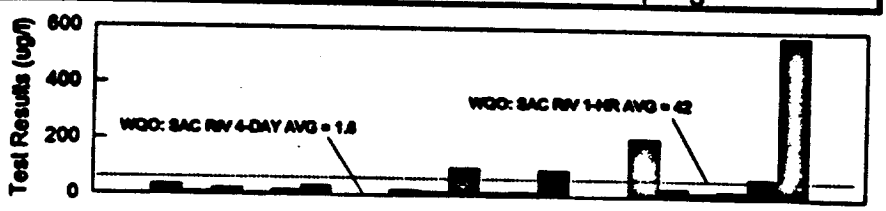


	Station X	Station Y	Station Z
29-Nov	12	17	84
11-Dec	10	16	22
24-Jan	13	58.0	14.0
06-Feb	5	13	16
17-Feb	10	8.4	140
08-Apr	23	350	460

Note: Method Detection Limit for Copper is 1.0 ug/l

LEAD

Gas Station Stormwater Runoff Sampling



	Station X	Station Y	Station Z
29-Nov	34	18	210
11-Dec	7.1	13	33
24-Jan	20	98	18.0
06-Feb	2.9	11	22
17-Feb	14	13	70
08-Apr	32	93	580

Note: Method Detection Limit for Lead is 1.0 ug/l

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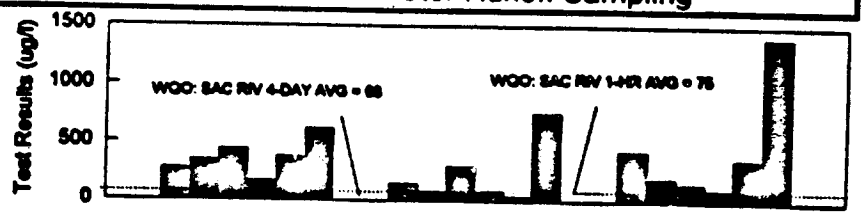
ZINC

Gas Station Stormwater Runoff Sampling



	Station X	Station Y	Station Z
29-Nov	270	150	430
11-Dec	350	83	200
24-Jan	440	300	150
06-Feb	170	84	100
17-Feb	380	41	360
08-Apr	620	760	1400

Note: Method Detection Limit for Zinc is 1.0 ug/l

TOTAL SUSPENDED SOLIDS

Gas Station Stormwater Runoff Sampling



	Station X	Station Y	Station Z
29-Nov	30	24	42
11-Dec	44	62	84
24-Jan	80	120	240
06-Feb	54	29	32
17-Feb	46	37	43
08-Apr	90	160	250

Note: Method Detection Limit for TSS is 3.0 mg/l

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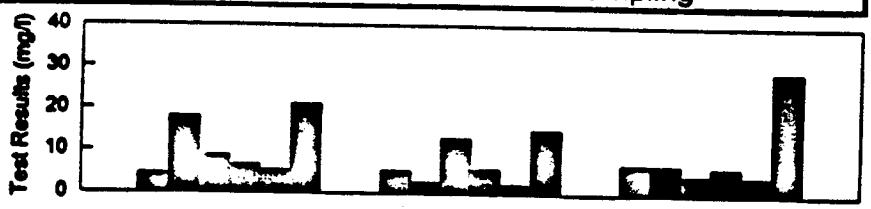
OIL & GREASE

Gas Station Stormwater Runoff Sampling



	Station X	Station Y	Station Z
29-Nov	4.5	5.2	6.9
11-Dec	18	2.7	6.9
24-Jan	8.9	13.0	4.5
06-Feb	6.7	5.7	6.2
17-Feb	5.4	2.2	4.2
08-Apr	21	15.0	20

Note: Method Detection Limit for Oil & Grease is 0.5 mg/l

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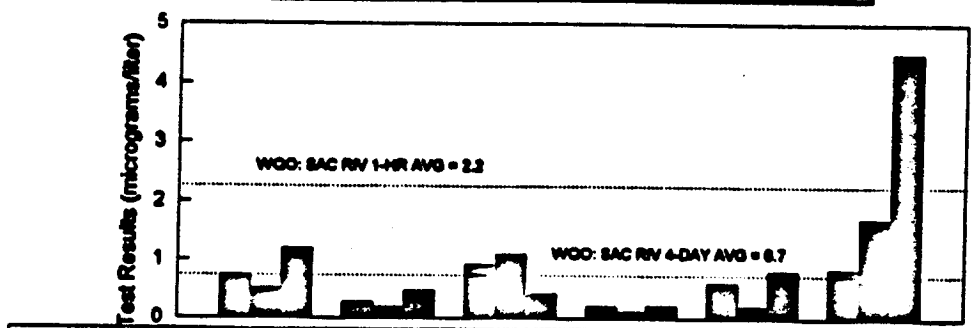
CADMIUM

Gas Station Stormwater Runoff Sampling

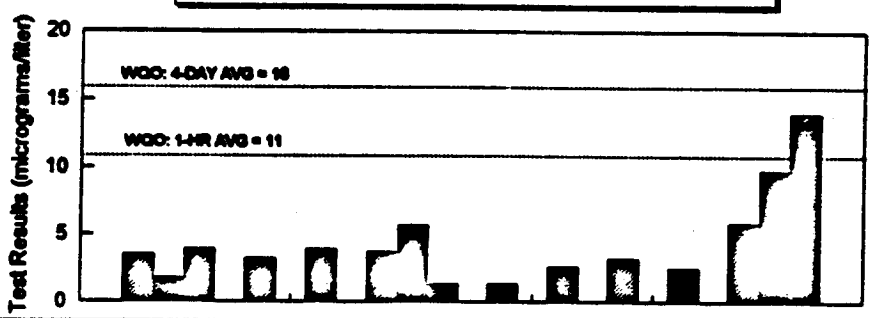


	29-Nov	11-Dec	24-Jan	06-Feb	17-Feb	08-Apr
Station X	0.73	0.28	0.92	0.21	0.61	0.85
Station Y	0.52	0.19	1.1	0.12	0.21	1.7
Station Z	1.2	0.48	0.42	0.22	0.81	4.5

Note: Method Detection Limit for Cadmium is 0.10 ug/l

CHROMIUM

Gas Station Stormwater Runoff Sampling



	29-Nov	11-Dec	24-Jan	06-Feb	17-Feb	08-Apr
Station X	3.5	3.2	3.7	1.3	3.2	5.9
Station Y	1.8	ND	5.7	ND	ND	9.8
Station Z	3.9	3.9	1.3	2.6	2.5	14

Note: Method Detection Limit for Chromium is 1.0 ug/l

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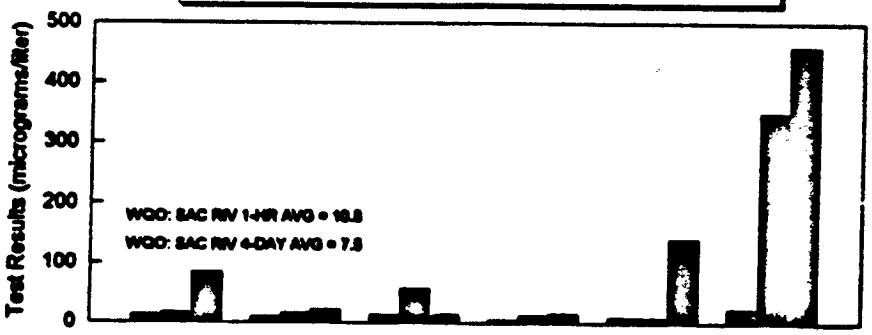
COPPER

Gas Station Stormwater Runoff Sampling

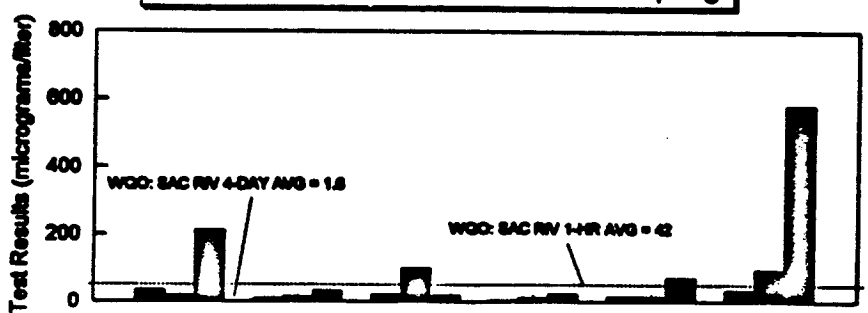


	29-Nov	11-Dec	24-Jan	06-Feb	17-Feb	08-Apr
Station X	12	10	13	5	10	23
Station Y	17	16	58.0	13	8.4	350
Station Z	84	22	14.0	16	140	460

Note: Method Detection Limit for Copper is 1.0 ug/l

LEAD

Gas Station Stormwater Runoff Sampling



	29-Nov	11-Dec	24-Jan	06-Feb	17-Feb	08-Apr
Station X	34	7.1	20	2.9	14	32
Station Y	18	13	98	11	13	93
Station Z	210	33	18.0	22	70	580

Note: Method Detection Limit for Lead is 1.0 ug/l

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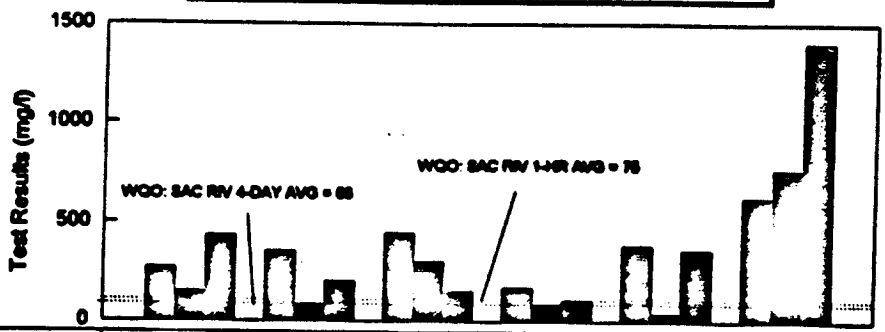
ZINC

Gas Station Stormwater Runoff Sampling

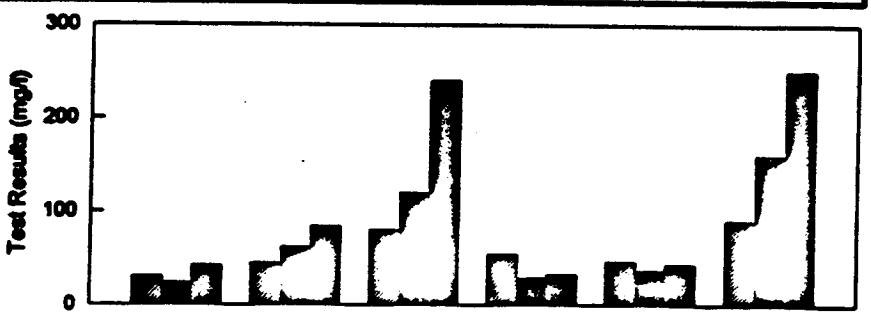


	29-Nov	11-Dec	24-Jan	06-Feb	17-Feb	08-Apr
Station X	270	350	440	170	380	620
Station Y	150	83	300	84	41	760
Station Z	430	200	150	100	380	1400

Note: Method Detection Limit for Zinc is 1.0 ug/l

TOTAL SUSPENDED SOLIDS

Gas Station Stormwater Runoff Sampling



	29-Nov	11-Dec	24-Jan	06-Feb	17-Feb	08-Apr
Station X	30	44	80	54	46	90
Station Y	24	62	120	29	37	160
Station Z	42	84	240	32	43	250

Note: Method Detection Limit for TSS is 3.0 mg/l

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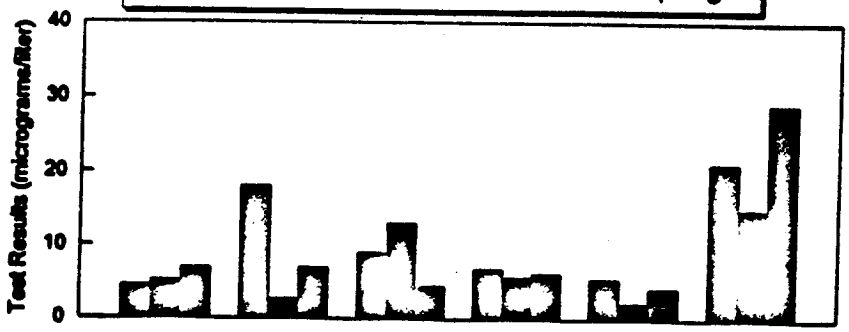
OIL & GREASE

Gas Station Stormwater Runoff Sampling



	29-Nov	11-Dec	24-Jan	06-Feb	17-Feb	06-Apr
Station X	4.5	18	8.9	6.7	5.4	21
Station Y	5.2	2.7	13.0	5.7	2.2	15.0
Station Z	6.9	6.9	4.5	6.2	4.2	29

Note: Method Detection Limit for Oil and Grease is 0.5 mg/l

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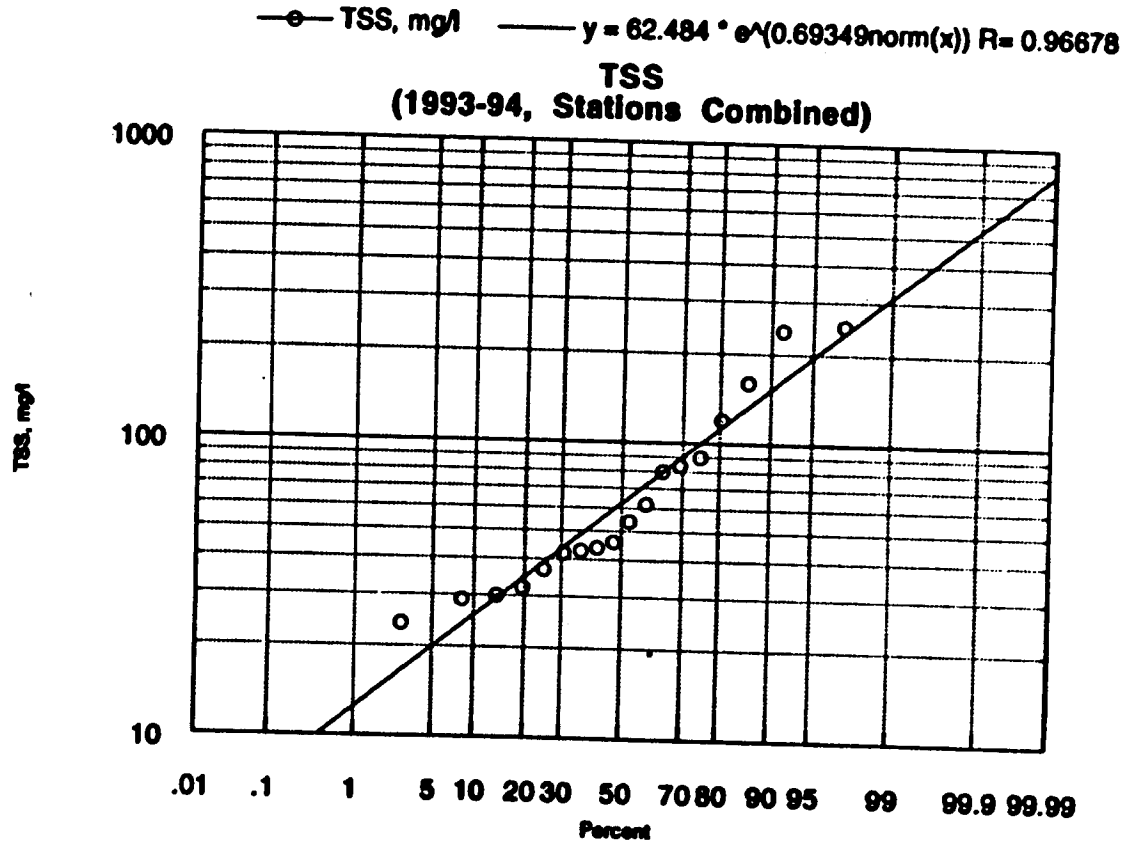
Appendix C
Distribution Plots

R0058341



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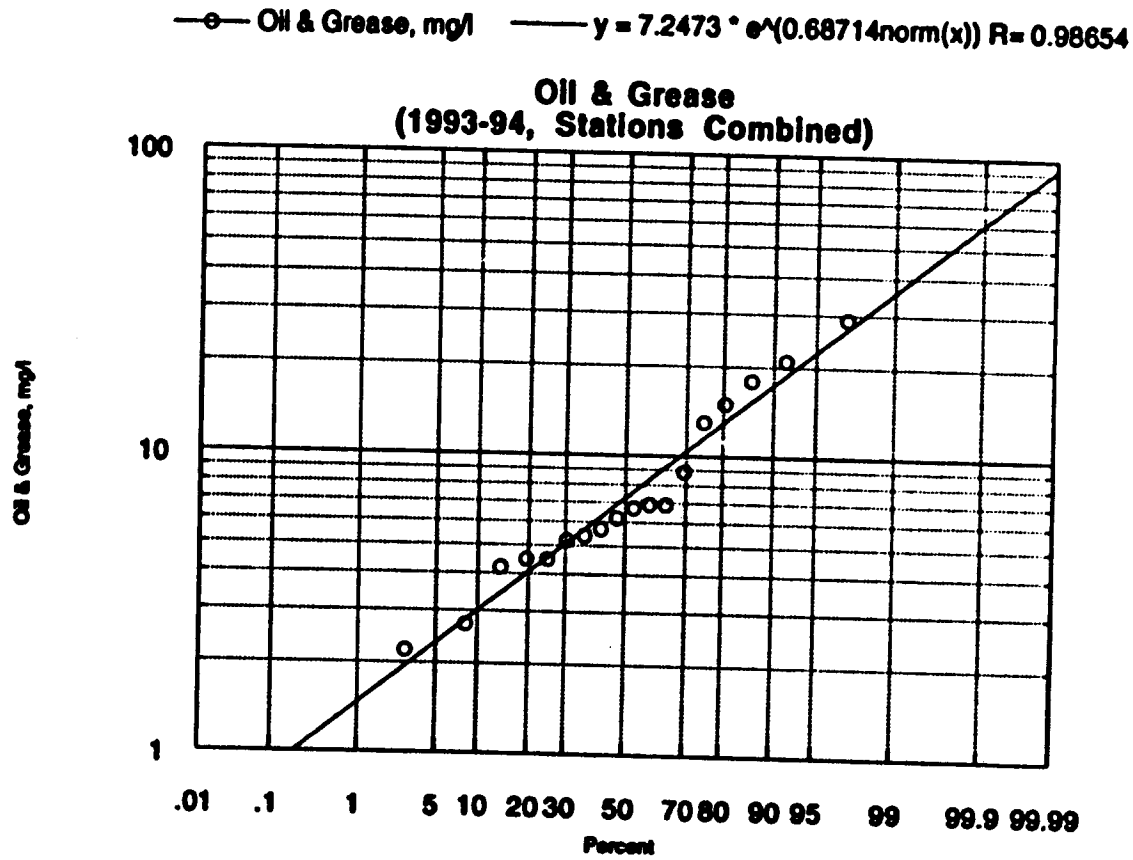
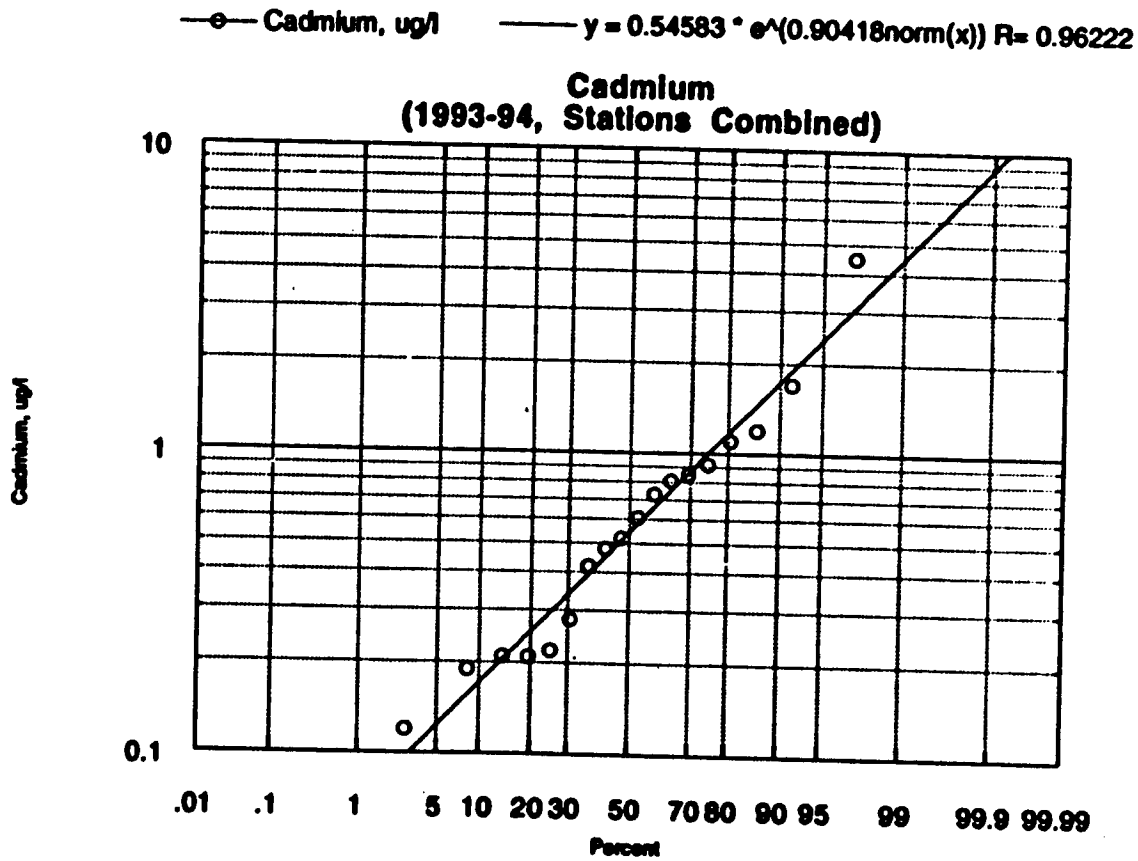

Oil & Grease, mg/l
y = 7.2473 * e^(0.68714norm(x)) R= 0.98654
Oil & Grease
(1993-94, Stations Combined)
Oil & Grease, mg/l
100
10
1
.01
.1
1
5
10
20
30
50
70
80
90
95
99
99.9
99.99
Percent

R0058343



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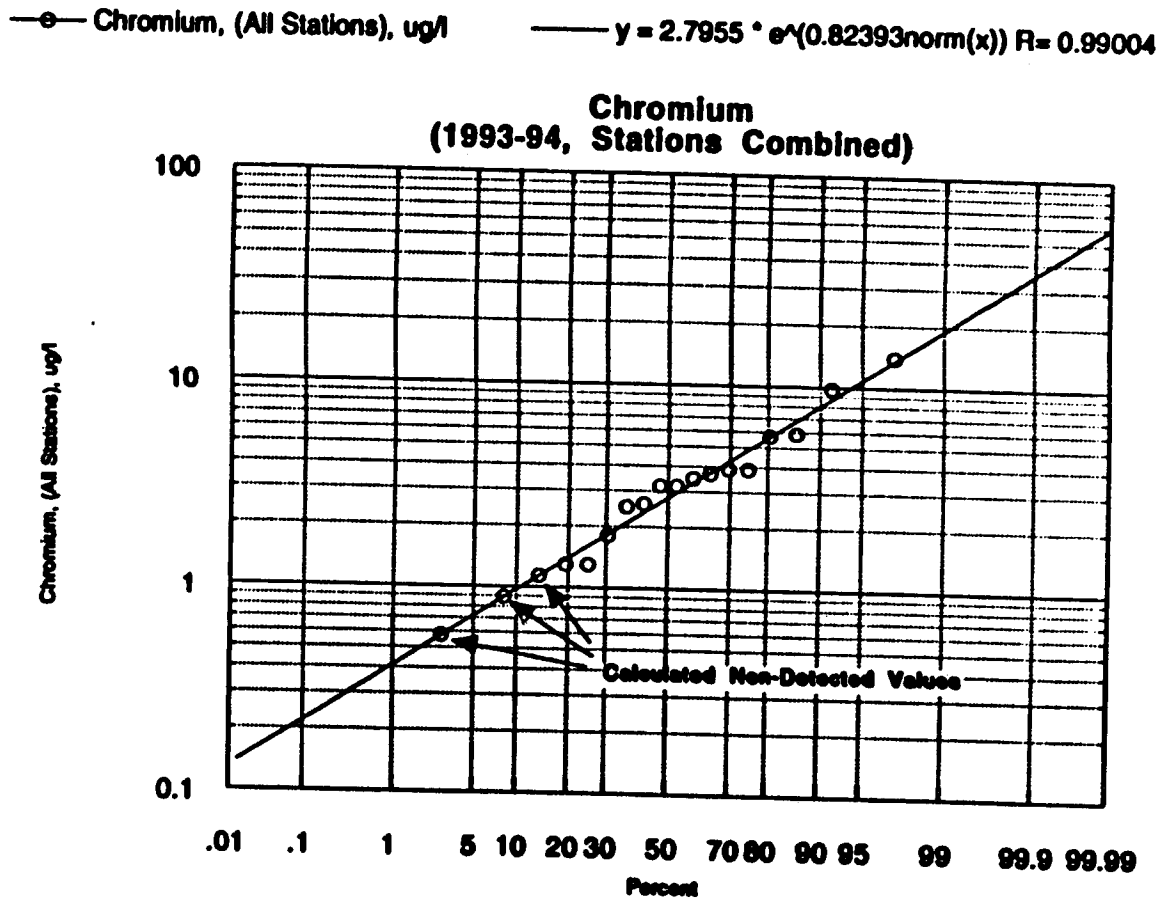
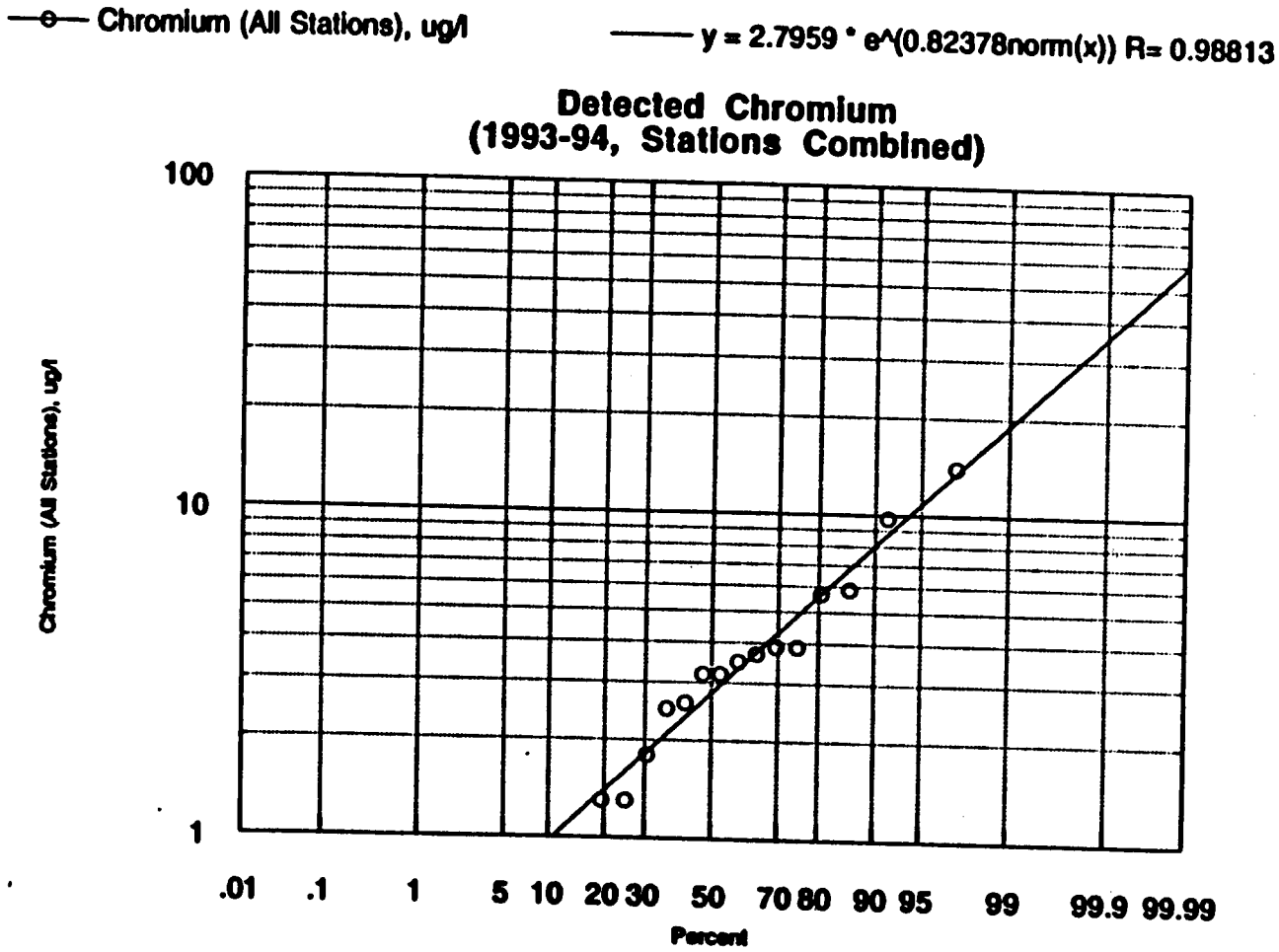


R0058345

25535 2 21 NOV



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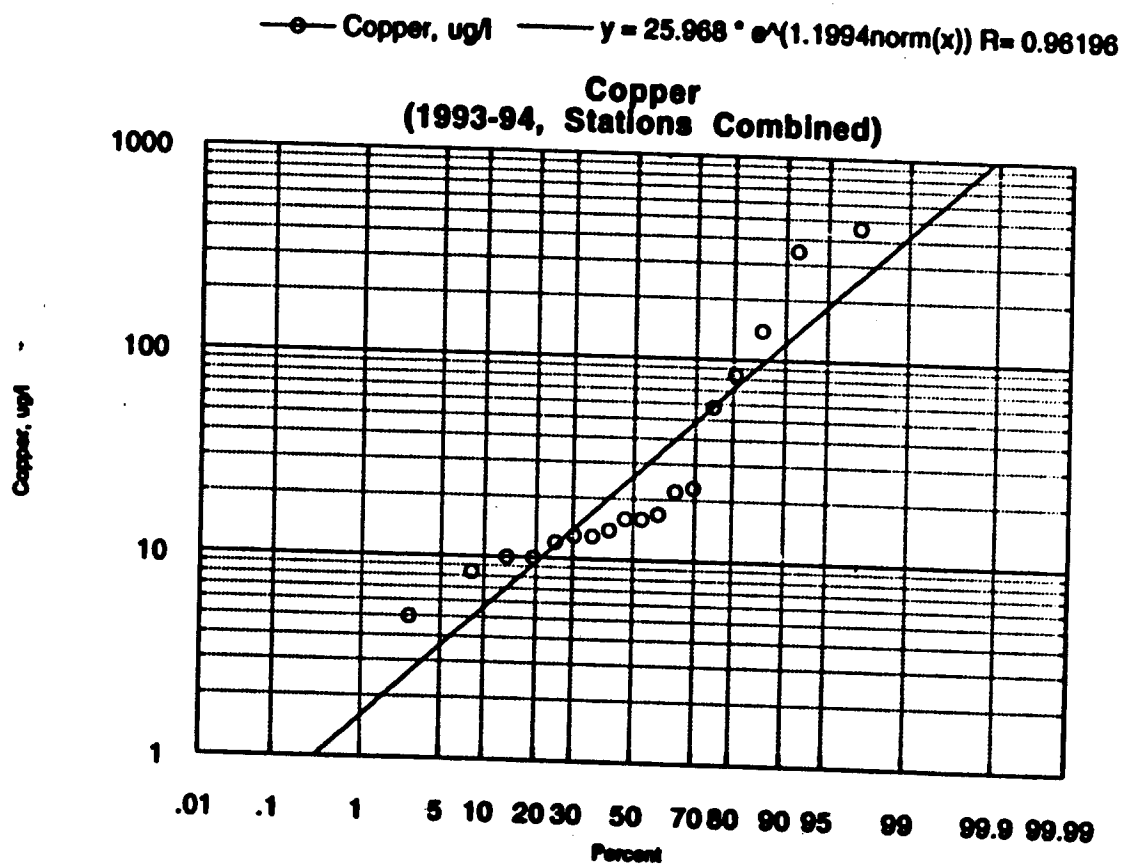
Copper, ug/l
y = 25.968 * e^(1.1994norm(x)) R= 0.96196
Copper
(1993-94, Stations Combined)
1000
100
10
1
Copper, ug/l
.01
.1
1
5
10
20
30
50
70
80
90
95
99
99.9
99.99
Percent

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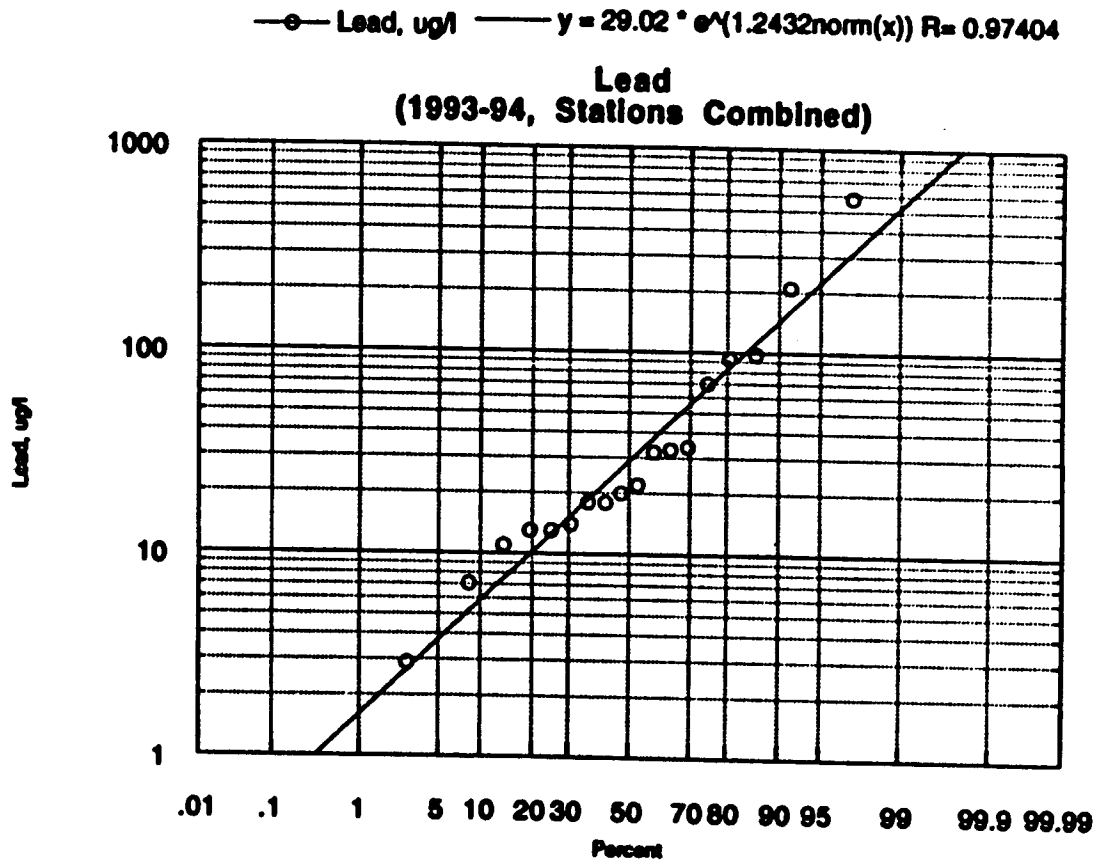
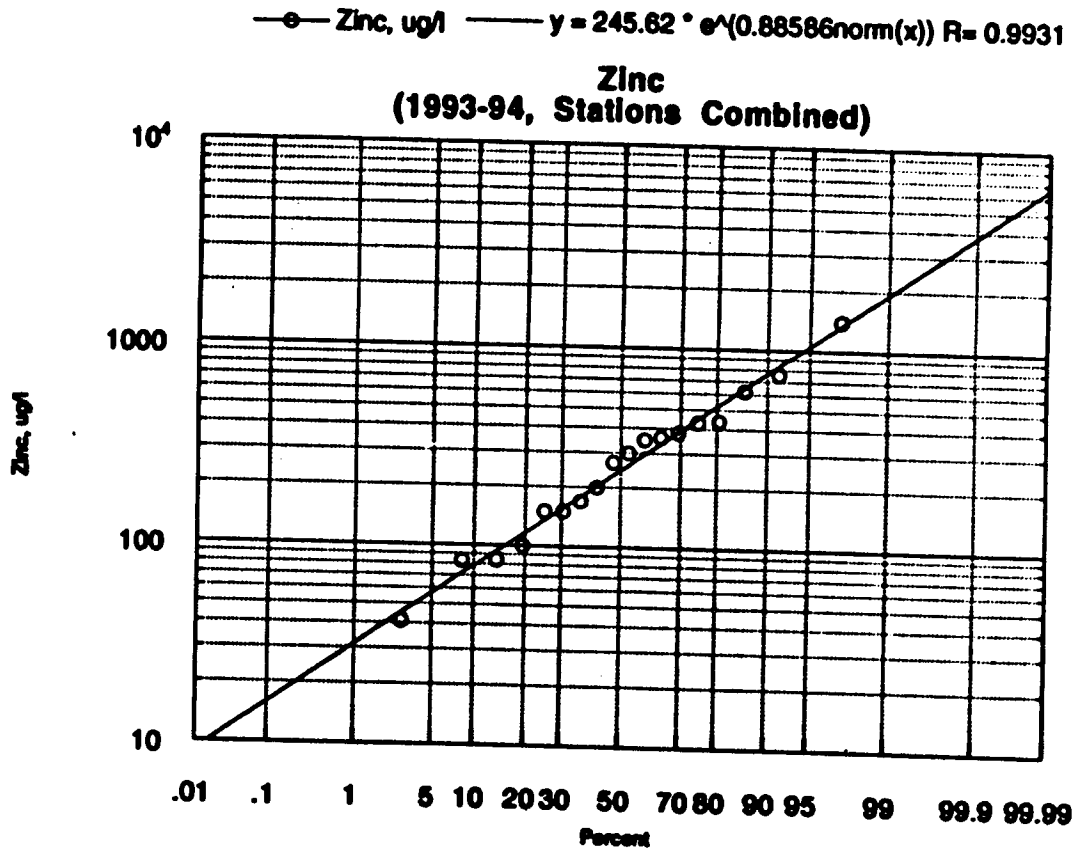

Lead, ug/l
y = 29.02 * e^(1.2432norm(x)) R= 0.97404
Lead
(1993-94, Stations Combined)
1000
100
10
1
Lead, ug/l
.01
.1
1
5
10
20
30
50
70
80
90
95
99
99.9
99.99
Percent

R005834


Zinc, ug/l
y = 245.62 * e^(0.88586norm(x)) R= 0.9931
Zinc
(1993-94, Stations Combined)
10^4
1000
100
10
Zinc, ug/l
.01 .1 1 5 10 20 30 50 70 80 90 95 99 99.9 99.99
Percent

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Appendix D

Paired t-test Results

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t-Test Results, 1993-94 Data

Cadmium

t-Test: Paired Two Sample for Means	X	Y	X	Z	Y	Z
Mean	0.6	0.64	0.6	1.271667	0.64	1.271667
Variance	0.08728	0.40148	0.08728	2.619697	0.40148	2.619697
Observations	6	6	6	6	6	6
Pearson Correlation	0.7896668		0.495263		0.807468	
Hypothesized Mean Difference	0		0		0	
df	5		5		5	
t Stat	-0.2229575		-1.10091		-1.32434	
P(T<=t) one-tail	0.4161954		0.160545		0.121347	
t Critical one-tail	2.0150492		2.015049		2.015049	
P(T<=t) two-tail	0.8323908		0.32109		0.242693	
t Critical two-tail	2.5705776		2.570578		2.570578	

Chromium with ND values replaced

t-Test: Paired Two Sample for Means	X	Y	X	Z	Y	Z
Mean	3.4666667	3.319308	3.466667	4.7	3.319308	4.7
Variance	2.1626667	13.621	2.162667	21.716	13.621	21.716
Observations	6	6	6	6	6	6
Pearson Correlation	0.8416022		0.792638		0.770473	
Hypothesized Mean Difference	0		0		0	
df	5		5		5	
t Stat	0.1399916		-0.83741		-1.13782	
P(T<=t) one-tail	0.4470656		0.22027		0.153381	
t Critical one-tail	2.0150492		2.015049		2.015049	
P(T<=t) two-tail	0.8941311		0.440539		0.306762	
t Critical two-tail	2.5705776		2.570578		2.570578	

Copper

t-Test: Paired Two Sample for Means	X	Y	X	Z	Y	Z
Mean	12.166667	77.06667	12.16667	122.6667	77.06667	122.6667
Variance	35.766667	18202.59	35.76667	29781.87	18202.59	29781.87
Observations	6	6	6	6	6	6
Pearson Correlation	0.9149217		0.874993		0.929898	
Hypothesized Mean Difference	0		0		0	
df	5		5		5	
t Stat	-1.2278878		-1.61722		-1.63231	
P(T<=t) one-tail	0.1370678		0.083377		0.081771	
t Critical one-tail	2.0150492		2.015049		2.015049	
P(T<=t) two-tail	0.2741355		0.166754		0.163543	
t Critical two-tail	2.5705776		2.570578		2.570578	

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Lead

t-Test: Paired Two Sample for Means	X	Y	X	Z	Y	Z
Mean	18.333333	41	18.33333	155.5	41	155.5
Variance	163.63067	1790	163.6307	48443.1	1790	48443.1
Observations	6	6	6	6	6	6
Pearson Correlation	0.4967467		0.726924		0.489949	
Hypothesized Mean Difference	0		0		0	
df	5		5		5	
t Stat	-1.4755		-1.5925		-1.3833	
P(T<=t) one-tail	0.1000493		0.066076		0.112576	
t Critical one-tail	2.0150492		2.015049		2.015049	
P(T<=t) two-tail	0.2000986		0.172151		0.225152	
t Critical two-tail	2.5705776		2.570578		2.570578	

Oil & Grease

t-Test: Paired Two Sample for Means	X	Y	X	Z	Y	Z
Mean	10.75	7.3	10.75	9.616667	7.3	9.616667
Variance	49.027	29.184	49.027	91.53367	29.184	91.53367
Observations	6	6	6	6	6	6
Pearson Correlation	0.4331416		0.741144		0.663174	
Hypothesized Mean Difference	0		0		0	
df	5		5		5	
t Stat	1.2536065		0.43217		-0.78568	
P(T<=t) one-tail	0.1327039		0.341811		0.233817	
t Critical one-tail	2.0150492		2.015049		2.015049	
P(T<=t) two-tail	0.2654077		0.683621		0.467634	
t Critical two-tail	2.5705776		2.570578		2.570578	

TSS

t-Test: Paired Two Sample for Means	X	Y	X	Z	Y	Z
Mean	57.333333	72	57.33333	115.1667	72	115.1667
Variance	529.06667	3105.2	529.0667	10442.57	3105.2	10442.57
Observations	6	6	6	6	6	6
Pearson Correlation	0.9281132		0.914248		0.9758	
Hypothesized Mean Difference	0		0		0	
df	5		5		5	
t Stat	-1.0140833		-1.73406		-2.14296	
P(T<=t) one-tail	0.1785367		0.071718		0.042499	
t Critical one-tail	2.0150492		2.015049		2.015049	
P(T<=t) two-tail	0.3570733		0.143436		0.084999	
t Critical two-tail	2.5705776		2.570578		2.570578	

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Zinc

t-Test: Paired Two Sample for Means	X	Y	X	Z	Y	Z
Mean	371.66667	236.3333	371.6667	440	236.3333	440
Variance	23576.667	74121.07	23576.67	237080	74121.07	237080
Observations	6	6	6	6	6	6
Pearson Correlation	0.8400584		0.783004		0.889155	
Hypothesized Mean Difference	0		0		0	
df	5		5		5	
t Stat	2.0003495		-0.44174		-1.81603	
P(T<=t) one-tail	0.050947		0.338564		0.064534	
t Critical one-tail	2.0150492		2.015049		2.015049	
P(T<=t) two-tail	0.101894		0.677128		0.129067	
t Critical two-tail	2.5705776		2.570578		2.570578	

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t-Test Results for 1992-93 Data vs. 1993-94 Data

Copper

t-Test: Paired Two Sample for Means	X		Y		Z		Combined Stations	
	Pre-BMP	Post-BMP	Pre-BMP	Post-BMP	Pre-BMP	Post-BMP	Pre-BMP	Post-BMP
Mean	17.31667	12.16667	29.6	77.06667	28.75	122.6667	25.22222	70.63333
Variance	93.38567	35.76667	569.36	18202.59	903.551	29781.87	483.8901	16300.26
Observations	6	6	6	6	6	6	18	18
Pearson Correlation	0.024166		-0.26156		0.952472		0.508859	
Hypothesized Mean Difference	0		0		0		0	
df	5		5		5		17	
t Stat	1.122225		-0.81293		-1.59498		-1.63376	
P(T<=t) one-tail	0.156374		0.226606		0.085603		0.060345	
t Critical one-tail	2.015049		2.015049		2.015049		1.739606	
P(T<=t) two-tail	0.312747		0.453212		0.171207		0.12069	
t Critical two-tail	2.570578		2.570578		2.570578		2.109819	

Lead

t-Test: Paired Two Sample for Means	X		Y		Z		Combined Stations	
	Pre-BMP	Post-BMP	Pre-BMP	Post-BMP	Pre-BMP	Post-BMP	Pre-BMP	Post-BMP
Mean	26.03333	18.33333	49.66667	41	24.5	155.5	33.4	71.61111
Variance	274.1667	163.8307	2714.667	1790	241.1	48443.1	1090.48	18838.69
Observations	6	6	6	6	6	6	16	18
Pearson Correlation	0.085846		-0.3886		0.7580		0.04736	
Hypothesized Mean Difference	0		0		0		0	
df	5		5		5		17	
t Stat	0.94137		0.288411		-1.53817		-1.16263	
P(T<=t) one-tail	0.194668		0.389163		0.09231		0.129857	
t Critical one-tail	2.015049		2.015049		2.015049		1.739606	
P(T<=t) two-tail	0.389737		0.788376		0.18462		0.259374	
t Critical two-tail	2.570578		2.570578		2.570578		2.109819	

Zinc

t-Test: Paired Two Sample for Means	X		Y		Z		Combined Stations	
	Pre-BMP	Post-BMP	Pre-BMP	Post-BMP	Pre-BMP	Post-BMP	Pre-BMP	Post-BMP
Mean	463.3333	371.6667	180.3333	236.3333	514.5	440	379.3889	349.3333
Variance	28546.67	23576.67	17089.07	74121.07	656820.7	237080	291286.5	108048.1
Observations	6	6	6	6	6	6	18	18
Pearson Correlation	0.402936		-0.28579		0.029431		0.086938	
Hypothesized Mean Difference	0		0		0		0	
df	5		5		5		17	
t Stat	1.270849		-0.55728		0.176589		0.211876	
P(T<=t) one-tail	0.129849		0.300681		0.433392		0.417381	
t Critical one-tail	2.015049		2.015049		2.015049		1.739606	
P(T<=t) two-tail	0.259698		0.601362		0.866783		0.834723	
t Critical two-tail	2.570578		2.570578		2.570578		2.109819	

Total Suspended Solids

t-Test: Paired Two Sample for Means	X		Y		Z		Combined Stations	
	Pre-BMP	Post-BMP	Pre-BMP	Post-BMP	Pre-BMP	Post-BMP	Pre-BMP	Post-BMP
Mean	79.16667	57.33333	59.16667	72	39.66667	115.1667	59.33333	81.5
Variance	1780.967	529.0667	2034.567	3105.2	886.6667	10442.57	1658.353	4778.265
Observations	6	6	6	6	6	6	18	18
Pearson Correlation	0.082773		-0.47344		-0.20492		-0.32803	
Hypothesized Mean Difference	0		0		0		0	
df	5		5		5		17	
t Stat	1.143288		-0.3825		-1.8491		-1.03402	
P(T<=t) one-tail	0.152344		0.365867		0.060021		0.157807	
t Critical one-tail	2.015049		2.015049		2.015049		1.739606	
P(T<=t) two-tail	0.304689		0.731794		0.120042		0.315615	
t Critical two-tail	2.570578		2.570578		2.570578		2.109819	

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Oil & Grease w/ ND values replaced

t-Test: Paired Two Sample for Means	X		Y		Z		Combined Stations	
	Pre-BMP	Post-BMP	Pre-BMP	Post-BMP	Pre-BMP	Post-BMP	Pre-BMP	Post-BMP
Mean	6.25	10.75	3.716667	7.3	3.85	9.616667	4.605556	9.222222
Variance	34.987	49.027	10.58567	29.184	25.959	91.53367	22.4735	52.10771
Observations	6	6	6	6	6	6	18	18
Pearson Correlation	0.117611		-0.72176		-0.2055		-0.1128	
Hypothesized Mean Difference	0		0		0		0	
df	5		5		5		17	
t Stat	-1.27901		-1.08751		-1.2045		-2.15904	
P(T<=t) one-tail	0.128517		0.163217		0.141148		0.022715	
t Critical one-tail	2.015049		2.015049		2.015049		1.739606	
P(T<=t) two-tail	0.257034		0.326433		0.282296		0.045431	
t Critical two-tail	2.570578		2.570578		2.570578		2.109819	

Cadmium

t-Test: Paired Two Sample for Means	X		Y		Z		Combined Stations	
	Pre-BMP	Post-BMP	Pre-BMP	Post-BMP	Pre-BMP	Post-BMP	Pre-BMP	Post-BMP
Mean	0.968333	0.6	0.59	0.64	0.43	1.271667	0.662778	0.837222
Variance	0.485857	0.08728	0.1934	0.40148	0.02888	2.619697	0.282162	1.014457
Observations	6	6	6	6	6	6	18	18
Pearson Correlation	0.068646		-0.32082		0.162128		-0.12772	
Hypothesized Mean Difference	0		0		0		0	
df	5		5		5		17	
t Stat	1.217654		-0.13825		-1.28636		-0.62364	
P(T<=t) one-tail	0.13884		0.447343		0.126959		0.27067	
t Critical one-tail	2.015049		2.015049		2.015049		1.739606	
P(T<=t) two-tail	0.27768		0.894687		0.253919		0.541139	
t Critical two-tail	2.570578		2.570578		2.570578		2.109819	

Chromium w/ ND values replaced

t-Test: Paired Two Sample for Means	X		Y		Z		Combined Stations	
	Pre-BMP	Post-BMP	Pre-BMP	Post-BMP	Pre-BMP	Post-BMP	Pre-BMP	Post-BMP
Mean	4.75	3.466667	4.6	3.319306	3.133333	4.7	4.161111	3.828958
Variance	8.636	2.162667	11.572	13.621	5.702667	21.716	8.183693	11.43509
Observations	6	6	6	6	6	6	18	18
Pearson Correlation	0.21243		-0.36108		0.01276		-0.18038	
Hypothesized Mean Difference	0		0		0		0	
df	5		5		5		17	
t Stat	1.050076		0.537935		-0.7367		0.297169	
P(T<=t) one-tail	0.170882		0.306847		0.247199		0.384999	
t Critical one-tail	2.015049		2.015049		2.015049		1.739606	
P(T<=t) two-tail	0.341764		0.613693		0.494398		0.769939	
t Critical two-tail	2.570578		2.570578		2.570578		2.109819	

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Event Mass Load t-Test Results, 1993-94 Data

Cadmium

t-Test: Paired Two Sample for Means	X	Y	X	Z	Y	Z
Mean	0.029402	0.017679	0.029402	0.0589	0.017679	0.0589
Variance	0.00069	0.000209	0.00069	0.002697	0.000209	0.002697
Observations	6	6	6	6	6	6
Pearson Correlation	0.89988		0.435162		0.738288	
Hypothesized Mean Difference	0		0		0	
df	5		5		5	
t Stat	1.956887		-1.54062		-2.38196	
P(T<=t) one-tail	0.053858		0.09202		0.031506	
t Critical one-tail	2.015049		2.015049		2.015049	
P(T<=t) two-tail	0.107716		0.184039		0.063012	
t Critical two-tail	2.570578		2.570578		2.570578	

Chromium (ND values replaced)

t-Test: Paired Two Sample for Means	X	Y	X	Z	Y	Z
Mean	0.14853	0.081587	0.14853	0.22563	0.081587	0.22563
Variance	0.009935	0.003331	0.009935	0.019982	0.003331	0.019982
Observations	6	6	6	6	6	6
Pearson Correlation	0.884403		0.399032		0.397664	
Hypothesized Mean Difference	0		0		0	
df	5		5		5	
t Stat	2.949519		-1.38207		-2.7202	
P(T<=t) one-tail	0.015952		0.112753		0.020882	
t Critical one-tail	2.015049		2.015049		2.015049	
P(T<=t) two-tail	0.031903		0.225506		0.041765	
t Critical two-tail	2.570578		2.570578		2.570578	

Copper

t-Test: Paired Two Sample for Means	X	Y	X	Z	Y	Z
Mean	0.515424	1.315192	0.515424	5.083091	1.315192	5.083091
Variance	0.119316	1.549172	0.119316	20.65311	1.549172	20.65311
Observations	6	6	6	6	6	6
Pearson Correlation	0.210564		0.274093		0.479863	
Hypothesized Mean Difference	0		0		0	
df	5		5		5	
t Stat	-1.60628		-2.50734		-2.25354	
P(T<=t) one-tail	0.084561		0.027002		0.036974	
t Critical one-tail	2.015049		2.015049		2.015049	
P(T<=t) two-tail	0.169122		0.054003		0.073948	
t Critical two-tail	2.570578		2.570578		2.570578	

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Lead

t-Test: Paired Two Sample for Means	X	Y	X	Z	Y	Z
Mean	0.919055	1.058088	0.919055	7.673873	1.058088	7.673873
Variance	1.031839	0.77322	1.031839	96.36701	0.77322	96.36701
Observations	6	6	6	6	6	6
Pearson Correlation	0.598228		0.794486		0.121589	
Hypothesized Mean Difference	0		0		0	
df	5		5		5	
t Stat	-0.39687		-1.83217		-1.66227	
P(T<=t) one-tail	0.353919		0.063207		0.078674	
t Critical one-tail	2.015049		2.015049		2.015049	
P(T<=t) two-tail	0.707837		0.126414		0.157347	
t Critical two-tail	2.570578		2.570578		2.570578	

Zinc

t-Test: Paired Two Sample for Means	X	Y	X	Z	Y	Z
Mean	15.44389	5.869411	15.44389	21.40359	5.869411	21.40359
Variance	89.90706	15.32678	89.90706	306.2017	15.32678	306.2017
Observations	6	6	6	6	6	6
Pearson Correlation	0.625462		0.256557		0.743803	
Hypothesized Mean Difference	0		0		0	
df	5		5		5	
t Stat	3.058509		-0.82915		-2.56761	
P(T<=t) one-tail	0.014075		0.222392		0.02509	
t Critical one-tail	2.015049		2.015049		2.015049	
P(T<=t) two-tail	0.02815		0.444784		0.05018	
t Critical two-tail	2.570578		2.570578		2.570578	

Oil and Grease

t-Test: Paired Two Sample for Means	X	Y	X	Z	Y	Z
Mean	375.5769	216.2529	375.5769	456.3391	216.2529	456.3391
Variance	22777.25	18038.49	22777.25	53546.74	18038.49	53546.74
Observations	6	6	6	6	6	6
Pearson Correlation	0.571564		0.044051		0.604081	
Hypothesized Mean Difference	0		0		0	
df	5		5		5	
t Stat	2.937986		-0.73095		-3.18764	
P(T<=t) one-tail	0.016166		0.248804		0.012165	
t Critical one-tail	2.015049		2.015049		2.015049	
P(T<=t) two-tail	0.032332		0.497608		0.024329	
t Critical two-tail	2.570578		2.570578		2.570578	

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R0058357

Total Suspended Solids

t-Test: Paired Two Sample for Means	X	Y	X	Z	Y	Z
Mean	2439.793	1901.743	2439.793	6124.645	1901.743	6124.645
Variance	2880667	655819.6	2880667	35824573	655819.6	35824573
Observations	6	6	6	6	6	6
Pearson Correlation	0.700161		0.918534		0.895821	
Hypothesized Mean Difference	0		0		0	
df	5		5		5	
t Stat	1.038118		-2.01611		-1.96198	
P(T<=t) one-tail	0.173394		0.049933		0.053508	
t Critical one-tail	2.015049		2.015049		2.015049	
P(T<=t) two-tail	0.346788		0.099865		0.107016	
t Critical two-tail	2.570578		2.570578		2.570578	

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R0058358

Pre vs. Post Mass Load t-tests

t-Test: Paired Two Sample for Means

Cadmium

	X		Y		Z		Stations Combined	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean	0.043764	0.029401587	0.019508389	0.017678846	0.024002988	0.05890011	0.02909192	0.035326847
Variance	0.000532	0.000589909	8.62242E-05	0.000209282	0.000136686	0.002696945	0.000369591	0.001376132
Observations	6	6	6	6	6	6	18	18
Pearson Correlation	0.218226		0.252249851		-0.120555762		0.024306729	
Hypothesized Mean Difference	0		0		0		0	
df	5		5		5		17	
t Stat	1.094217		0.298963471		-1.685083687		-0.63849312	
P(T<=t) one-tail	0.161875		0.389217723		0.089170462		0.265513024	
t Critical one-tail	2.015049		2.015049176		2.015049176		1.739606432	
P(T<=t) two-tail	0.323750		0.778435446		0.178340923		0.531026048	
t Critical two-tail	2.570578		2.570577635		2.570577635		2.109818524	

Chromium

	X		Y		Z		Stations Combined	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean	0.216800	0.148530145	0.151590723	0.081586926	0.1486771	0.225630003	0.172356104	0.151915862
Variance	0.012820	0.009934909	0.004684991	0.00333066	0.005112094	0.019981786	0.007699412	0.013446186
Observations	6	6	5	6	6	6	18	18
Pearson Correlation	0.647692		0.018361801		0.831298979		0.441116309	
Hypothesized Mean Difference	0		0		0		0	
df	5		5		5		17	
t Stat	1.863733		1.932820686		-2.070219808		0.786137269	
P(T<=t) one-tail	0.061479		0.055644008		0.046806801		0.221303936	
t Critical one-tail	2.015049		2.015049176		2.015049176		1.739606432	
P(T<=t) two-tail	0.122957		0.111288012		0.093213609		0.442607871	
t Critical two-tail	2.570578		2.570577635		2.570577635		2.109818524	

Copper

	X		Y		Z		Stations Combined	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean	0.825292	0.515423911	0.979318237	1.315191758	1.7403333	5.0630013	1.181647863	2.30456899
Variance	0.205539	0.118316491	0.3454077	1.549171681	4.831823583	20.65311243	1.782522982	10.7662097
Observations	6	6	6	6	6	6	18	18
Pearson Correlation	0.294726		-0.167945287		0.491388954		0.520393643	
Hypothesized Mean Difference	0		0		0		0	
df	5		5		5		17	
t Stat	1.573978		-0.558556531		-2.088887701		-1.884883485	
P(T<=t) one-tail	0.088153		0.300276328		0.046703025		0.055159082	
t Critical one-tail	2.015049		2.015049176		2.015049176		1.739606432	
P(T<=t) two-tail	0.176305		0.600552655		0.09340605		0.110316164	
t Critical two-tail	2.570578		2.570577635		2.570577635		2.109818524	

Lead

	X		Y		Z		Stations Combined	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean	1.283191	0.919055338	1.565580703	1.058066231	1.438312749	7.673872928	1.42902819	3.217005499
Variance	0.859791	1.031838764	1.34033225	0.773220436	1.342924806	96.36700661	1.056191013	39.39360736
Observations	6	6	6	6	6	6	18	18
Pearson Correlation	0.165165		-0.13916701		0.017762837		0.014328101	
Hypothesized Mean Difference	0		0		0		0	
df	5		5		5		17	
t Stat	0.709484		0.802934227		-1.548329626		-1.195458884	
P(T<=t) one-tail	0.254865		0.229231934		0.091103627		0.124159078	
t Critical one-tail	2.015049		2.015049176		2.015049176		1.739606432	
P(T<=t) two-tail	0.509729		0.458463868		0.182207065		0.248318151	
t Critical two-tail	2.570578		2.570577635		2.570577635		2.109818524	

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Zinc

	X		Y		Z		Stations Combined	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean	22.194818	15.44389429	5.362713165	5.869411439	20.58829657	21.40359172	16.04860929	14.23896582
Variance	63.074839	89.90705886	7.807071533	15.32678374	939.6433079	306.2017395	358.1214241	164.3633444
Observations	6	6	6	6	6	6	18	18
Pearson Correlation	0.295417		0.284081185		0.910169474		0.810780488	
Hypothesized Mean Difference	0		0		0		0	
df	5		5		5		17	
t Stat	1.587616		-0.301744757		-0.121667111		0.675798178	
P(T<=t) one-tail	0.086616		0.387496909		0.453950803		0.25412927	
t Critical one-tail	2.015049		2.015049176		2.015049176		1.739606432	
P(T<=t) two-tail	0.173236		0.774993816		0.907901206		0.50825854	
t Critical two-tail	2.570578		2.570577635		2.570577635		2.109818524	

Oil & Grease

	X		Y		Z		Stations Combined	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean	302.870881	375.5769152	122.5663992	216.252874	186.5582928	456.3391489	203.9985244	349.389646
Variance	69627.98147	22777.25343	10538.3198	18038.49327	38760.09752	53546.73852	40876.38627	38288.74305
Observations	6	6	6	6	6	6	18	18
Pearson Correlation	-0.651861		-0.373226942		-0.447903126		-0.279773765	
Hypothesized Mean Difference	0		0		0		0	
df	5		5		5		17	
t Stat	-0.466788		-1.164000861		-1.811211964		-1.938054309	
P(T<=t) one-tail	0.329475		0.148470771		0.064934827		0.034703861	
t Critical one-tail	2.015049		2.015049176		2.015049176		1.739606432	
P(T<=t) two-tail	0.658949		0.298941543		0.129869654		0.069407722	
t Critical two-tail	2.570578		2.570577635		2.570577635		2.109818524	

Total Suspended Solids

	X		Y		Z		Stations Combined	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean	3942.690113	2439.793209	2047.297842	1901.743023	2151.187498	6124.644622	2713.725151	3488.728951
Variance	6265498.9	2880667.445	1018859.208	655819.5721	1796392.012	35824573.38	3472312.582	15308256.1
Observations	8	6	6	6	8	6	18	18
Pearson Correlation	0.210292		-0.417280084		-0.608082071		-0.257838891	
Hypothesized Mean Difference	0		0		0		0	
df	5		5		5		17	
t Stat	1.357015		0.232240146		-1.413793011		-0.682598486	
P(T<=t) one-tail	0.116411		0.412778922		0.108276809		0.24895719	
t Critical one-tail	2.015049		2.015049176		2.015049176		1.739606432	
P(T<=t) two-tail	0.232821		0.825557845		0.216553618		0.49791438	
t Critical two-tail	2.570578		2.570577635		2.570577635		2.109818524	

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2

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R0058360

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2

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Appendix E

Significant Regression Plots - Concentration

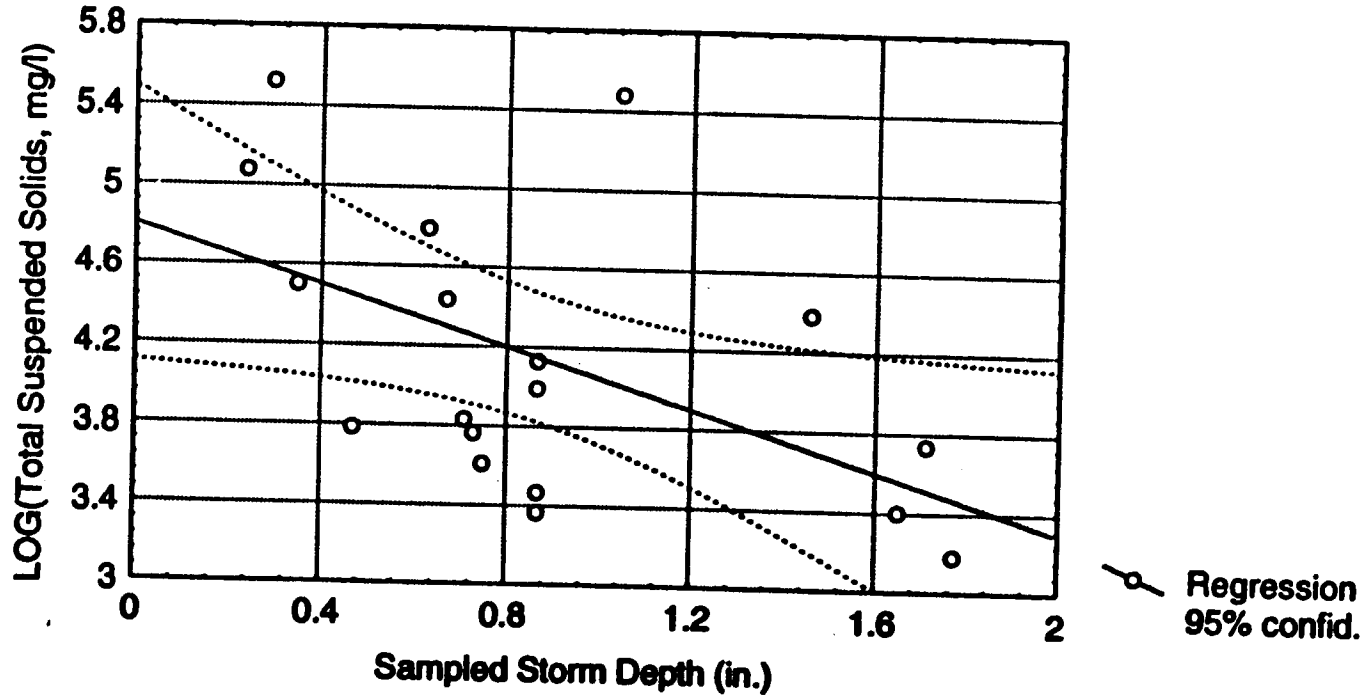
R0058361

Sampled Storm Depth vs. LOG(TSS)

LOG_TSS = 4.8038 - .7544 * DEPTH

Correlation: r = -.5016

p=0.033946



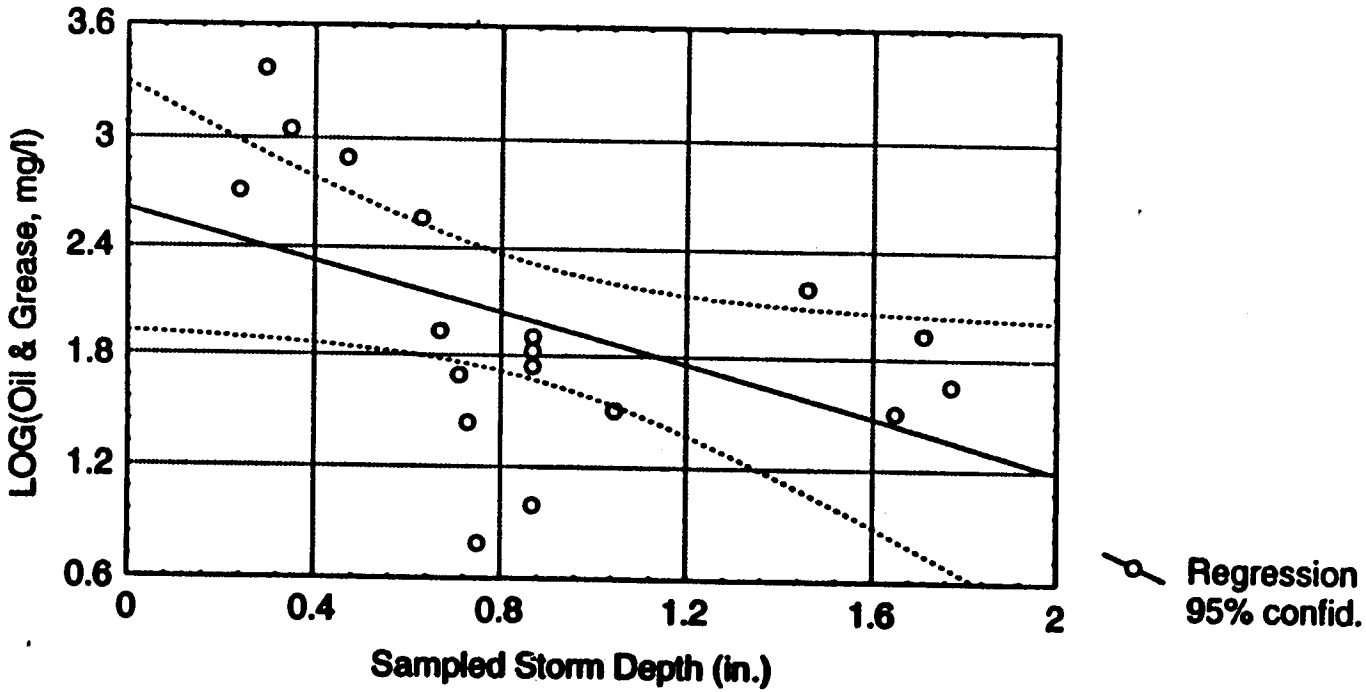
R0058362

Sampled Storm Depth vs. LOG(Oil & Grease)

LOG_O_G = 2.6110 - .7109 * DEPTH

Correlation: r = -.4838

P=0.041929



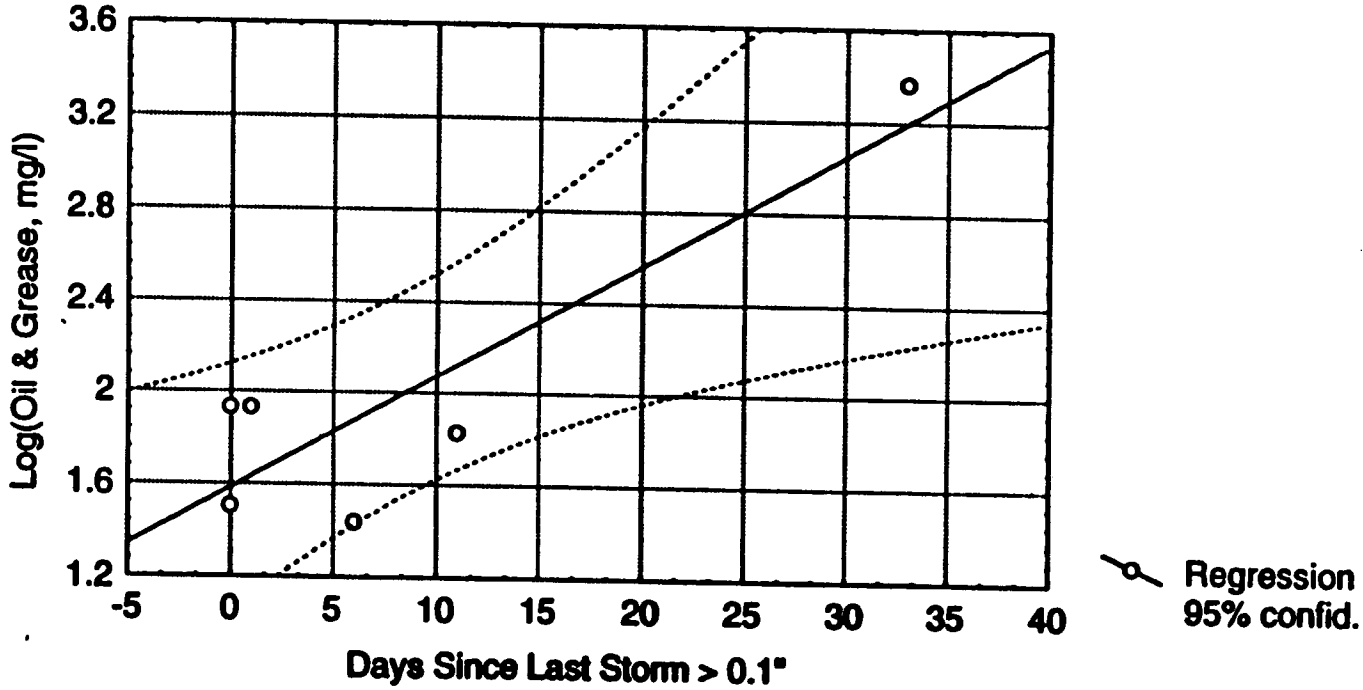
R0058363

Days Since Last Storm > 0.1" vs. Log(Oil & Grease), Station Z

LOG_O_G = 1.5833 + .04890 * DSLS_10

Correlation: r = .88667

p=0.018539



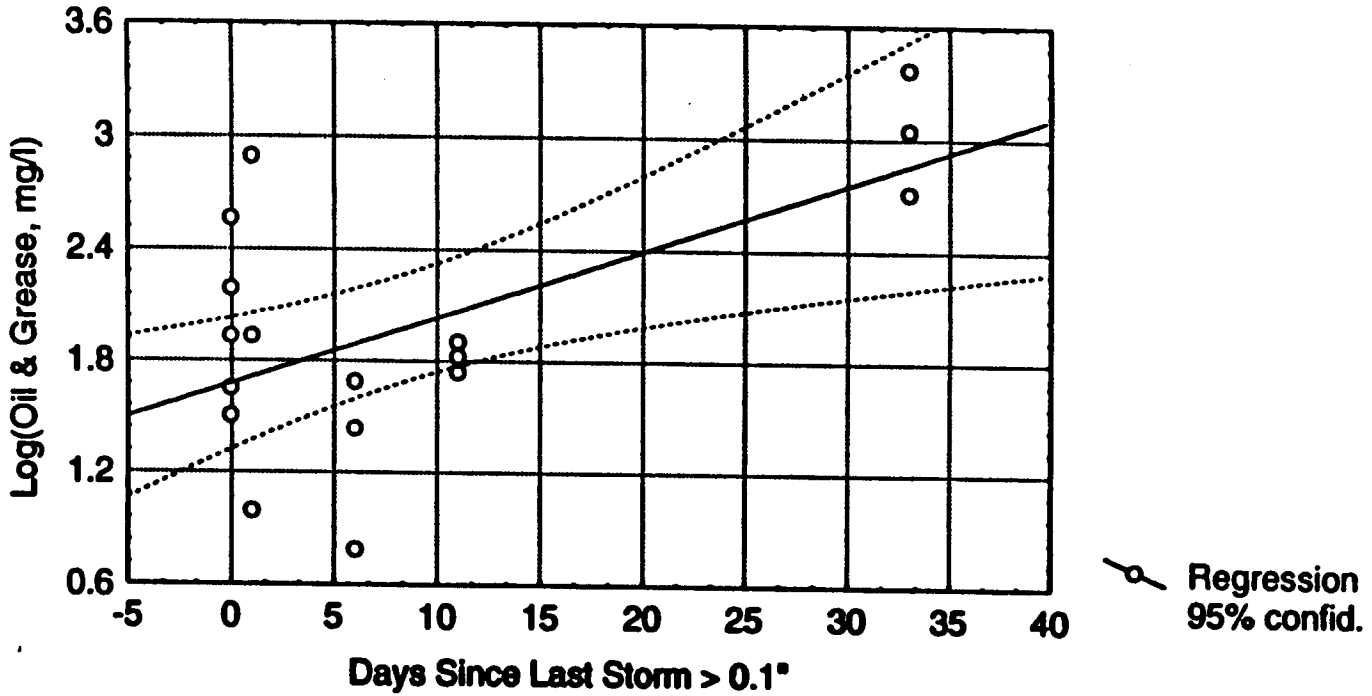
R0058364

Days Since Last Storm > 0.1" vs. Log(Oil & Grease)

LOG_O_G = 1.6765 + .03578 * DSLS_10

Correlation: r = .61611

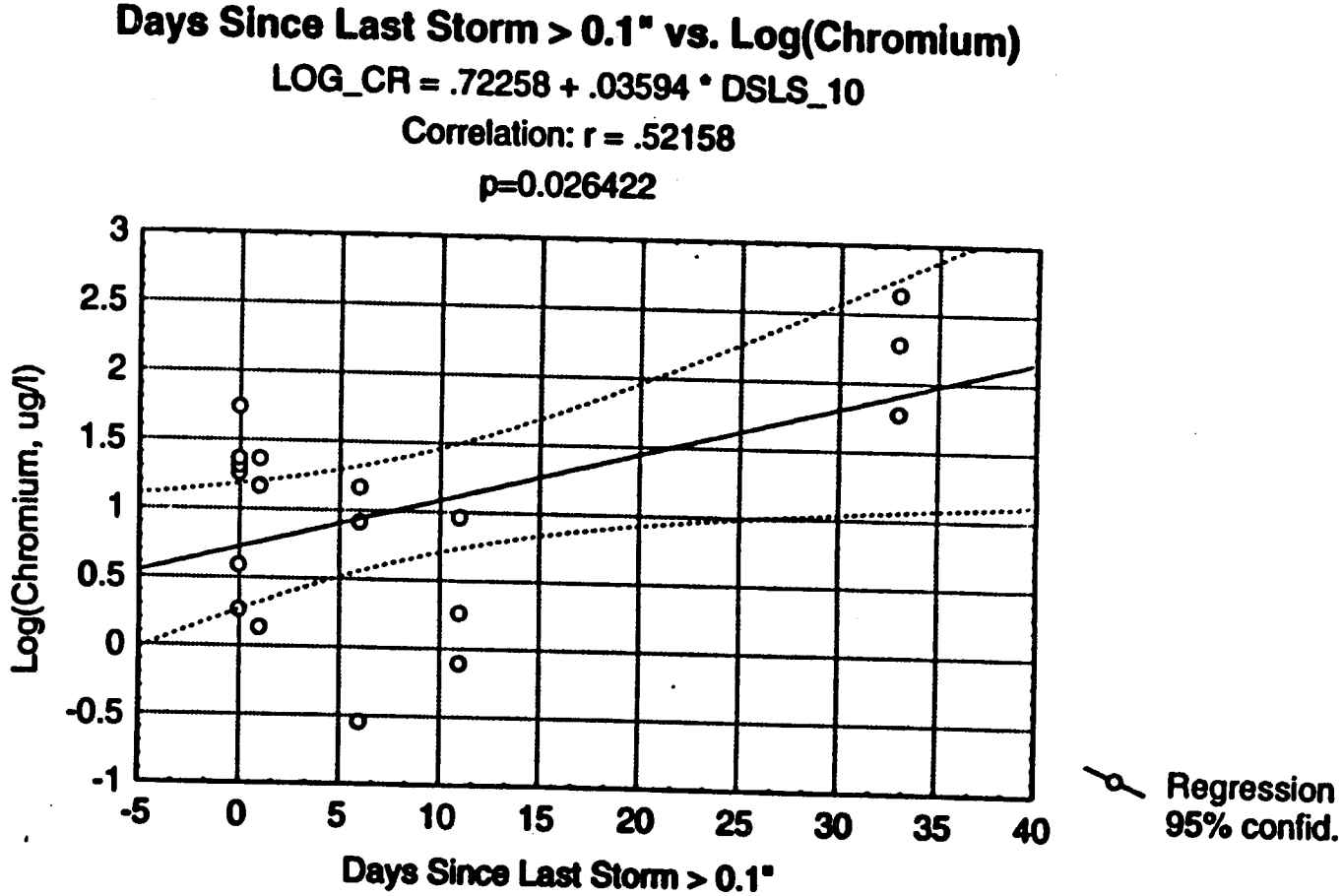
p=0.006477



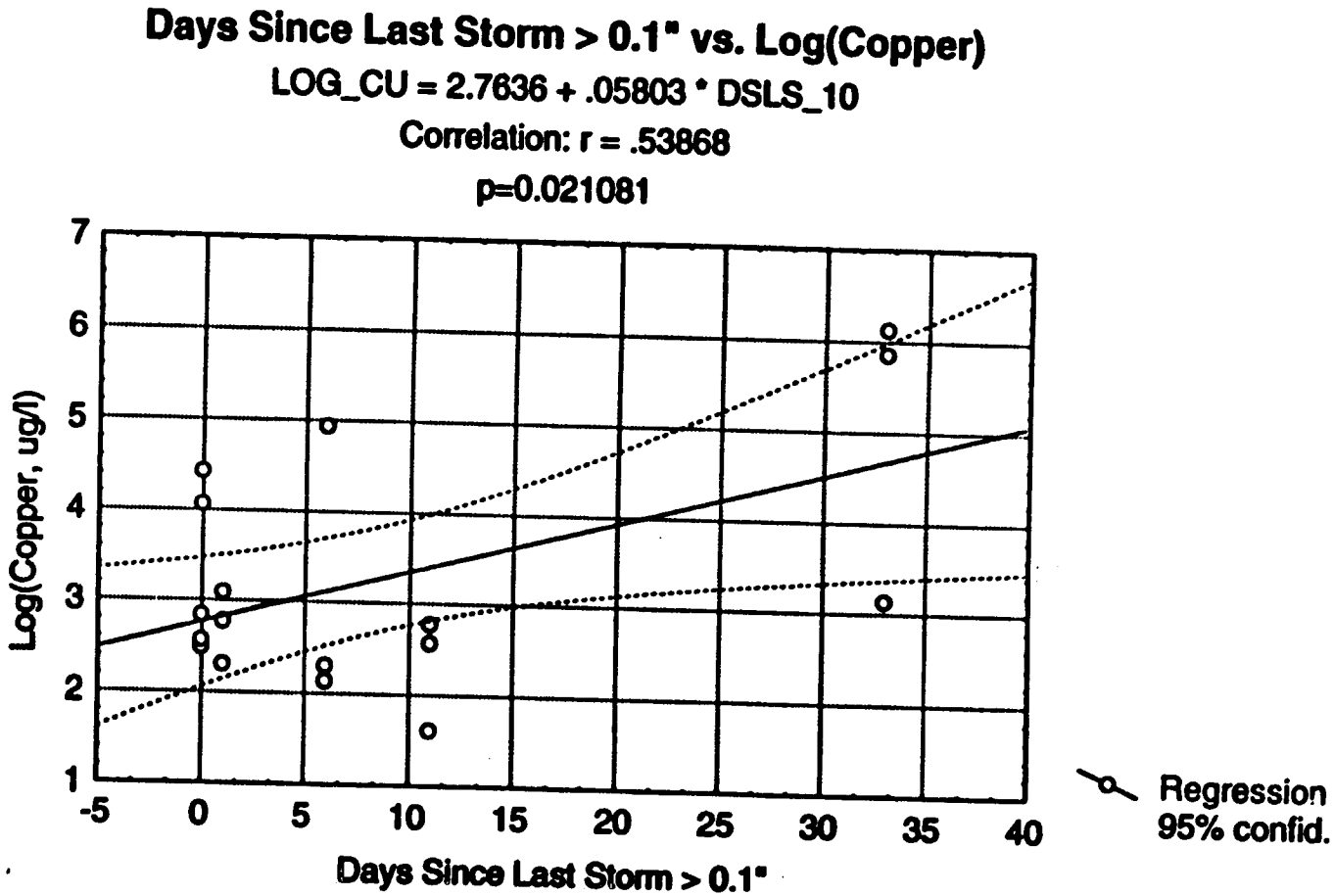
R0058365

VOL 12

2 5012


Days Since Last Storm > 0.1" vs. Log(Chromium)
LOG_CR = .72258 + .03594 * DSLS_10
Correlation: r = .52158
p=0.026422
Log(Chromium, ug/l)
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-5
0
5
10
15
20
25
30
35
40
Days Since Last Storm > 0.1"
Regression
95% confid.

R0058366


Days Since Last Storm > 0.1" vs. Log(Copper)
LOG_CU = 2.7636 + .05803 * DSLS_10
Correlation: r = .53868
p=0.021081
Log(Copper, ug/l)
7
6
5
4
3
2
1
-5
0
5
10
15
20
25
30
35
40
Days Since Last Storm > 0.1"
Regression
95% confid.

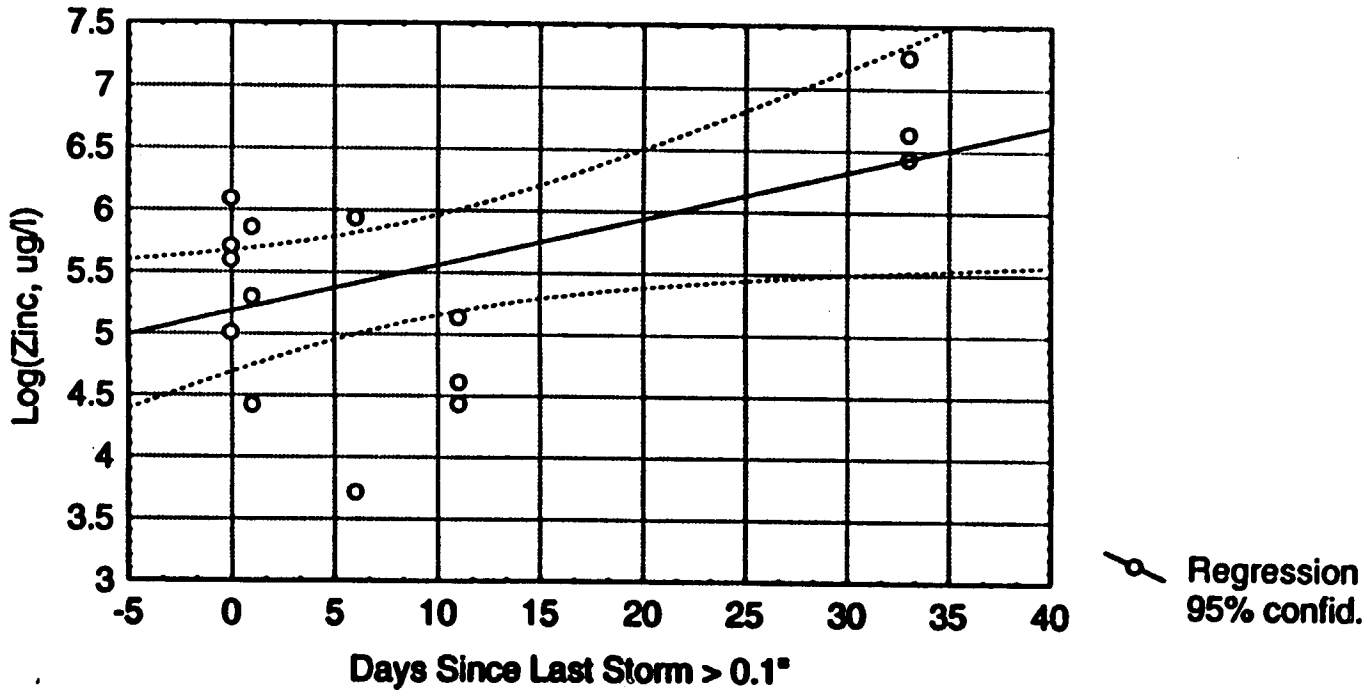
R0058367

Days Since Last Storm > 0.1" vs. Log(Zinc)

LOG_ZN = 5.1807 + .03801 * DSLS_10

Correlation: r = .51429

p=0.028995



R0058368

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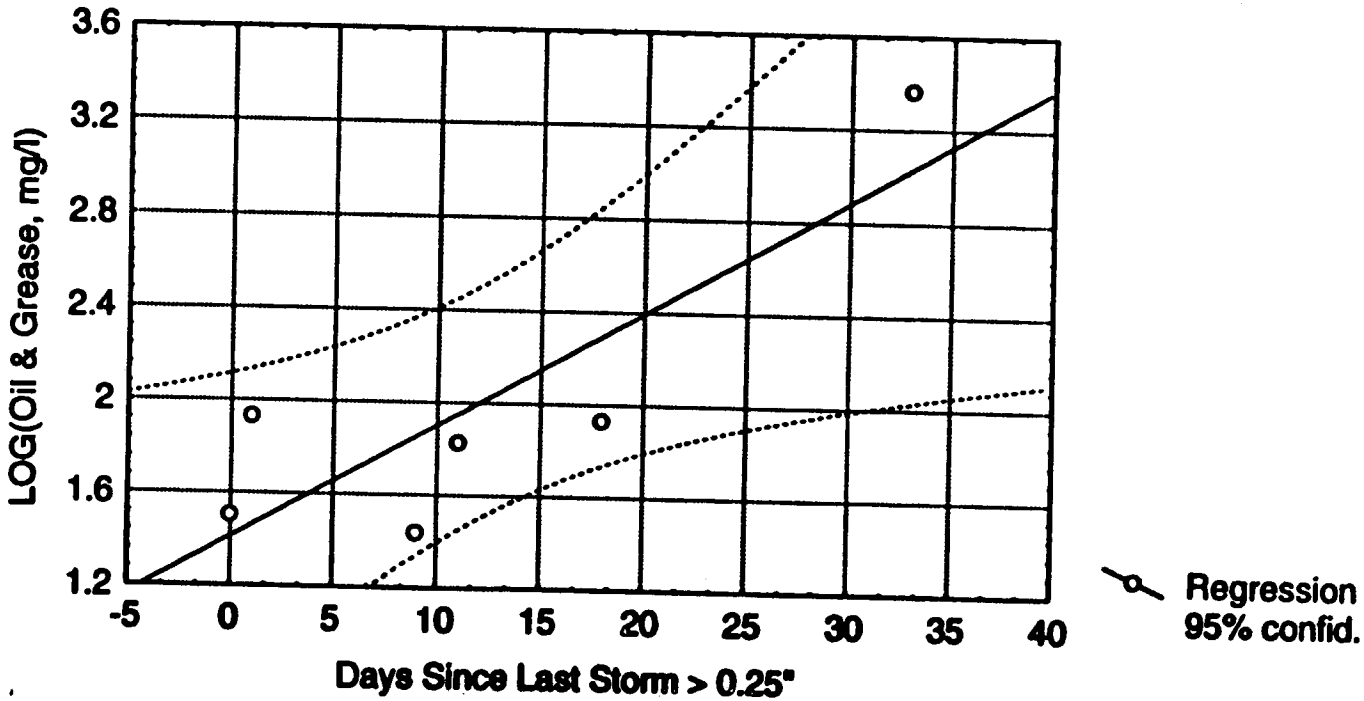
2 5075

Days Since Last Storm > 0.25" vs. LOG(Oil & Grease), Station Z

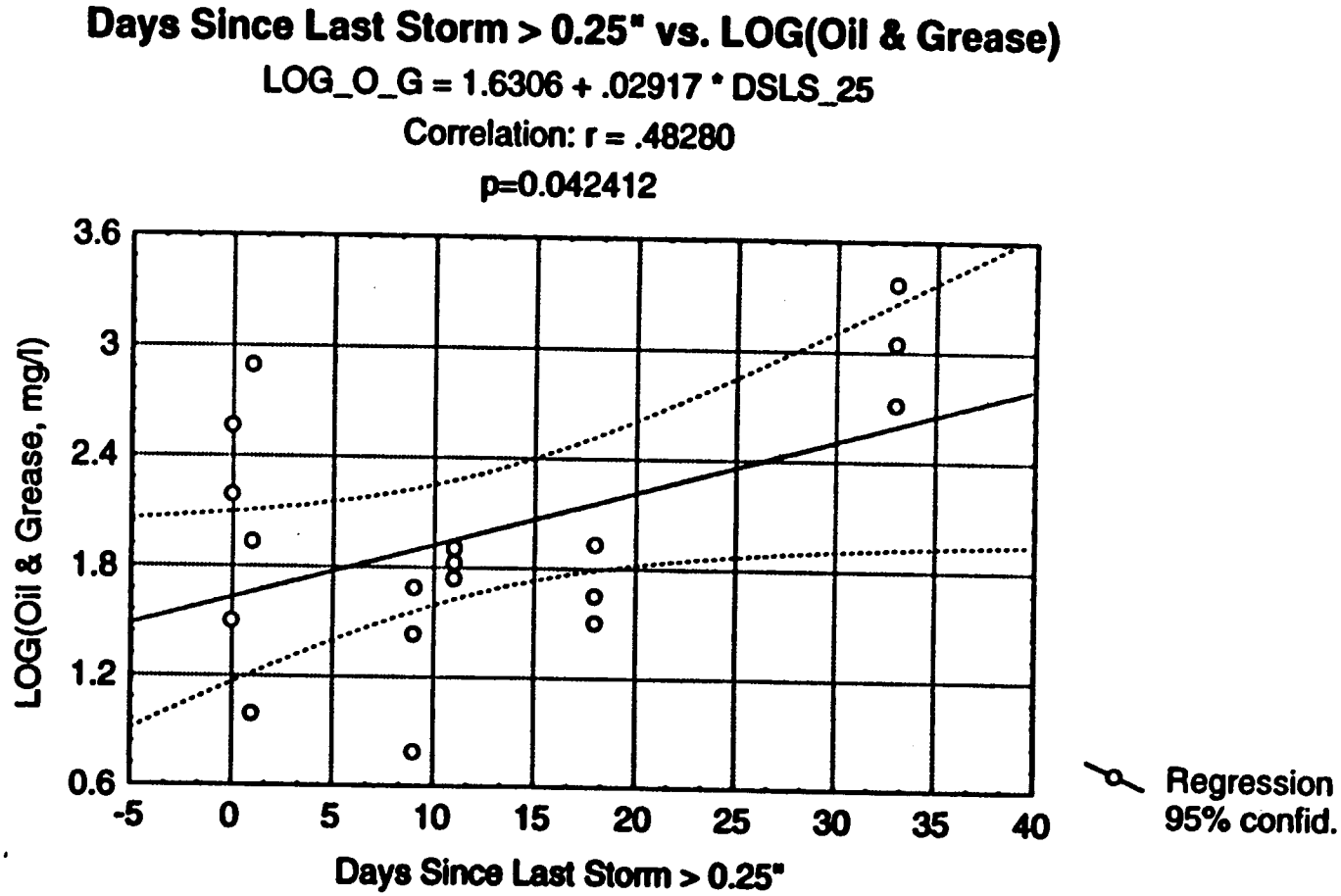
LOG_O_G = 1.4105 + .04904 * DSLS_25

Correlation: r = .85483

p=0.030080



R0058369


Days Since Last Storm > 0.25" vs. LOG(Oil & Grease)
LOG_O_G = 1.6306 + .02917 * DSLS_25
Correlation: r = .48280
p=0.042412
LOG(Oil & Grease, mg/l)
3.6
3
2.4
1.8
1.2
0.6
-5
0
5
10
15
20
25
30
35
40
Days Since Last Storm > 0.25"
Regression
95% confid.

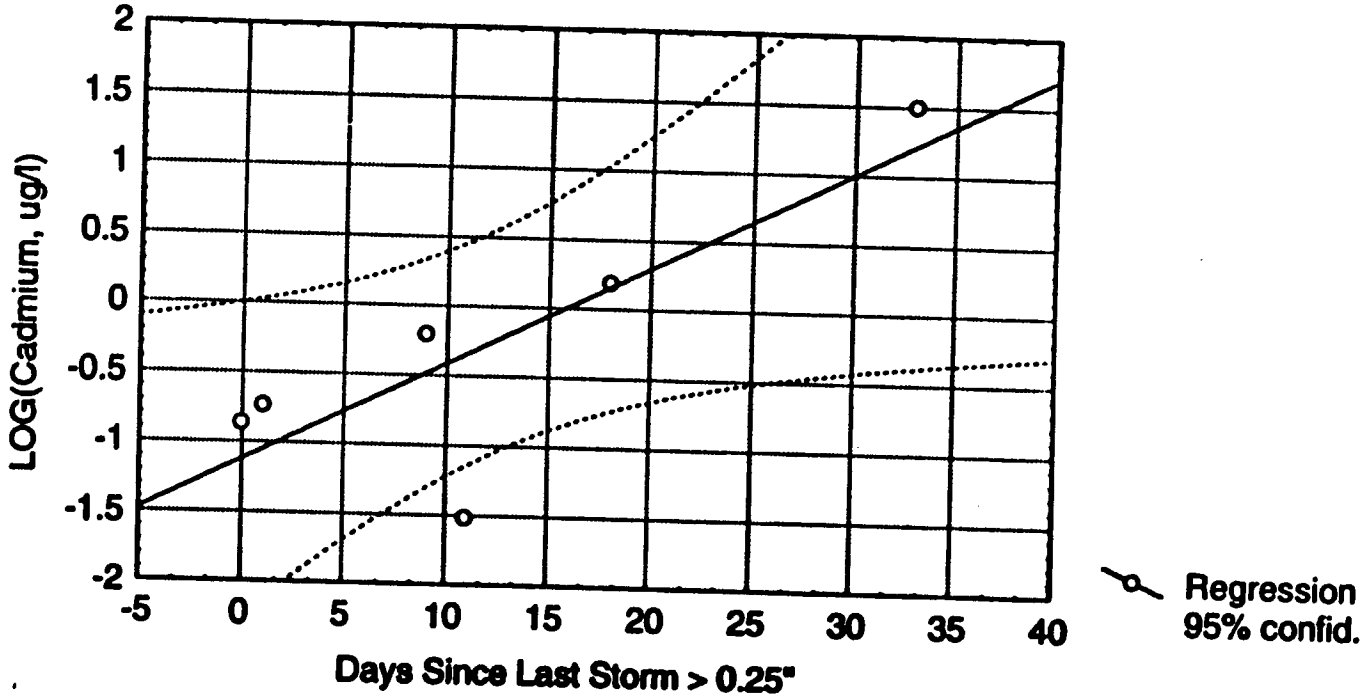
R0058370

Days Since Last Storm > 0.25" vs. LOG(Cadmium), Station Z

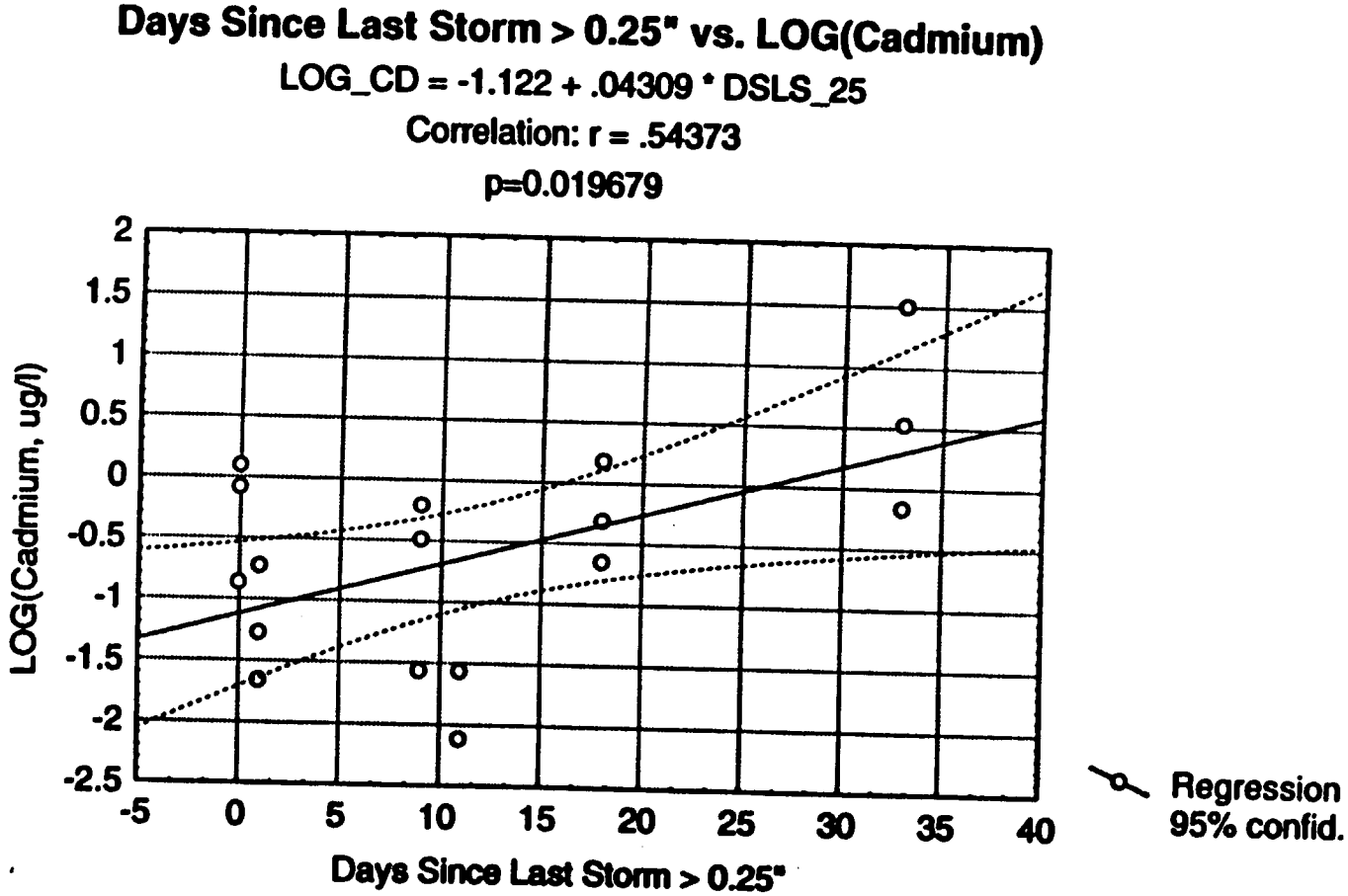
LOG_CD = -1.124 + .07089 * DSLS_25

Correlation: r = .83077

p=0.040533



R0058371


Days Since Last Storm > 0.25" vs. LOG(Cadmium)
LOG_CD = -1.122 + .04309 * DSLS_25
Correlation: r = .54373
p=0.019679
LOG(Cadmium, ug/l)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-5
0
5
10
15
20
25
30
35
40
Days Since Last Storm > 0.25"
Regression
95% confid.

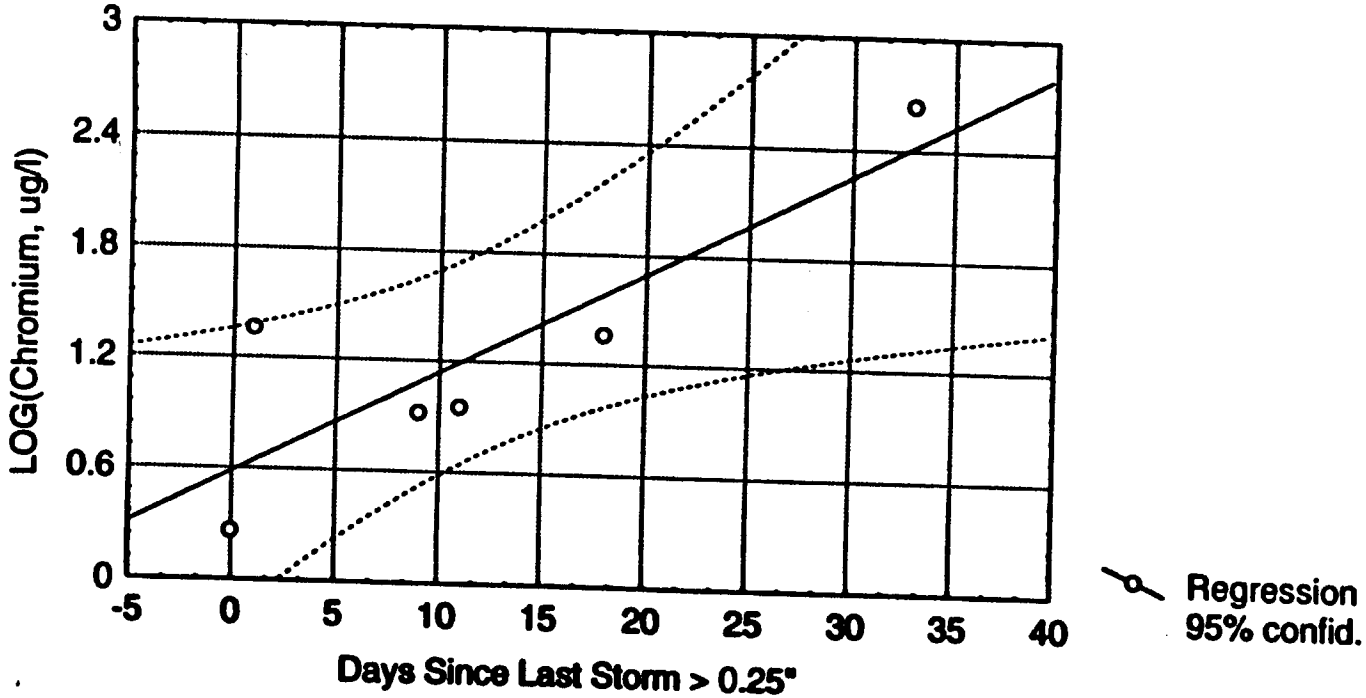
R0058372

Days Since Last Storm > 0.25" vs. LOG(Chromium), Station Z

LOG_CR = .58277 + .05554 * DSLS_25

Correlation: r = .86114

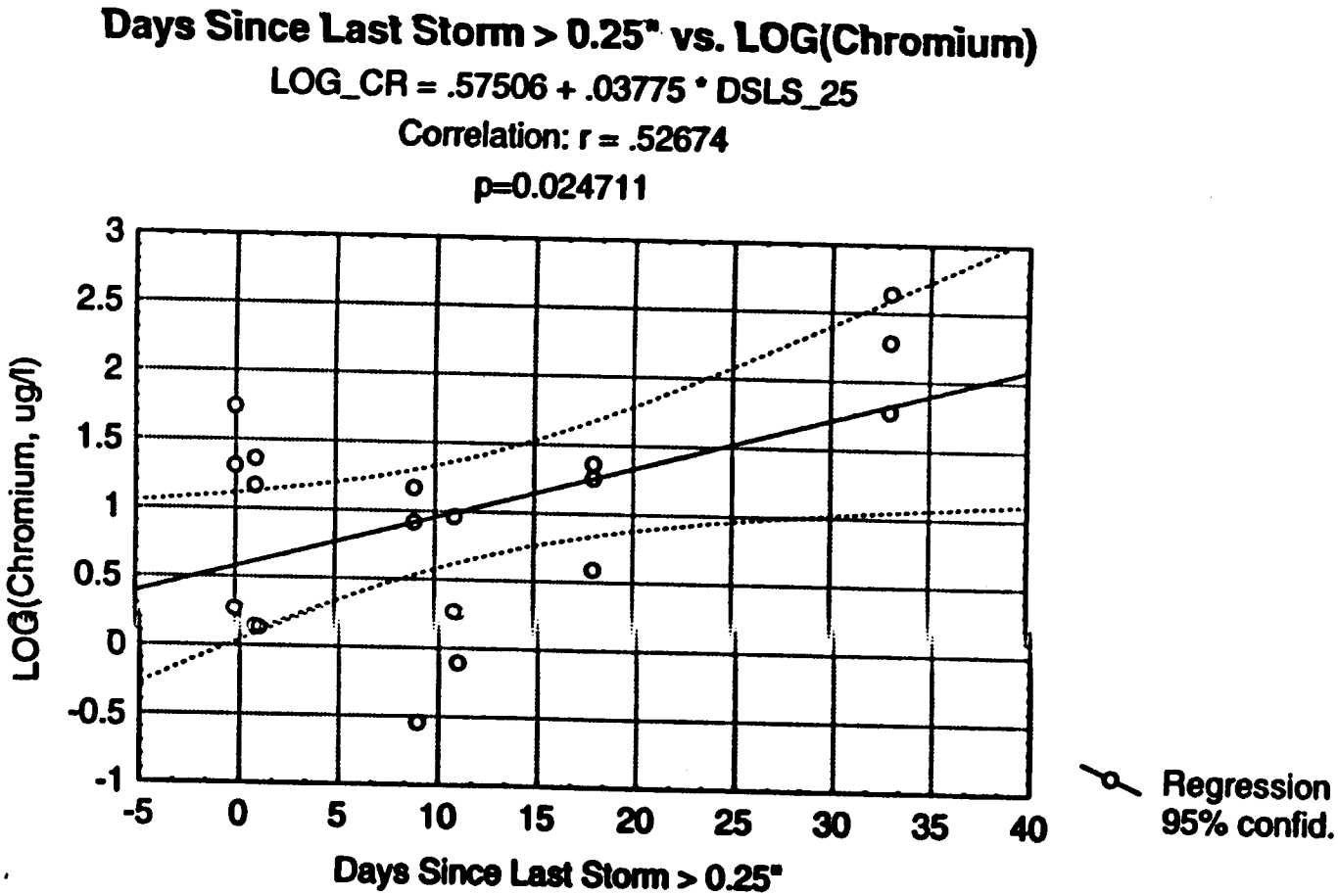
p=0.027586



R0058373

VOL 12

2 5 0 8 0



R0058374

VOL 12

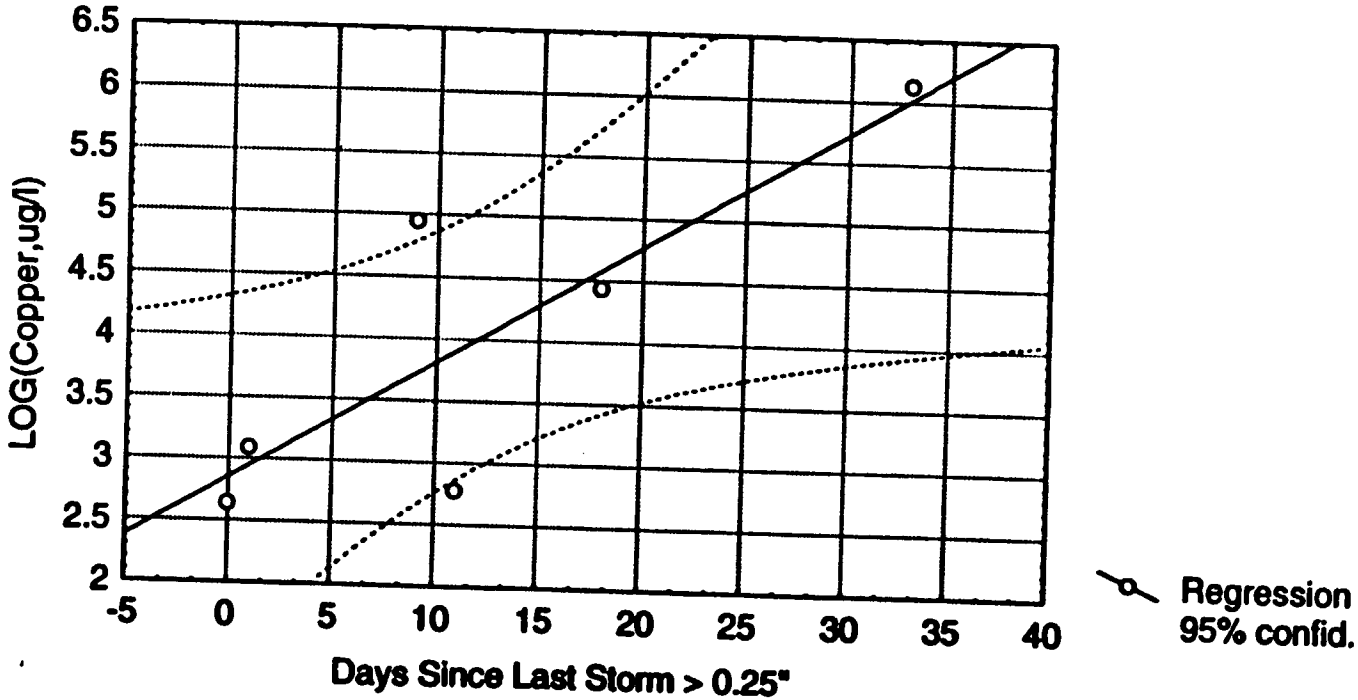
2 5 0 8 -

Days Since Last Storm > 0.25" vs. LOG(Copper), Station Z

LOG_CU = 2.8510 + .09584 * DSLS_25

Correlation: r = .83959

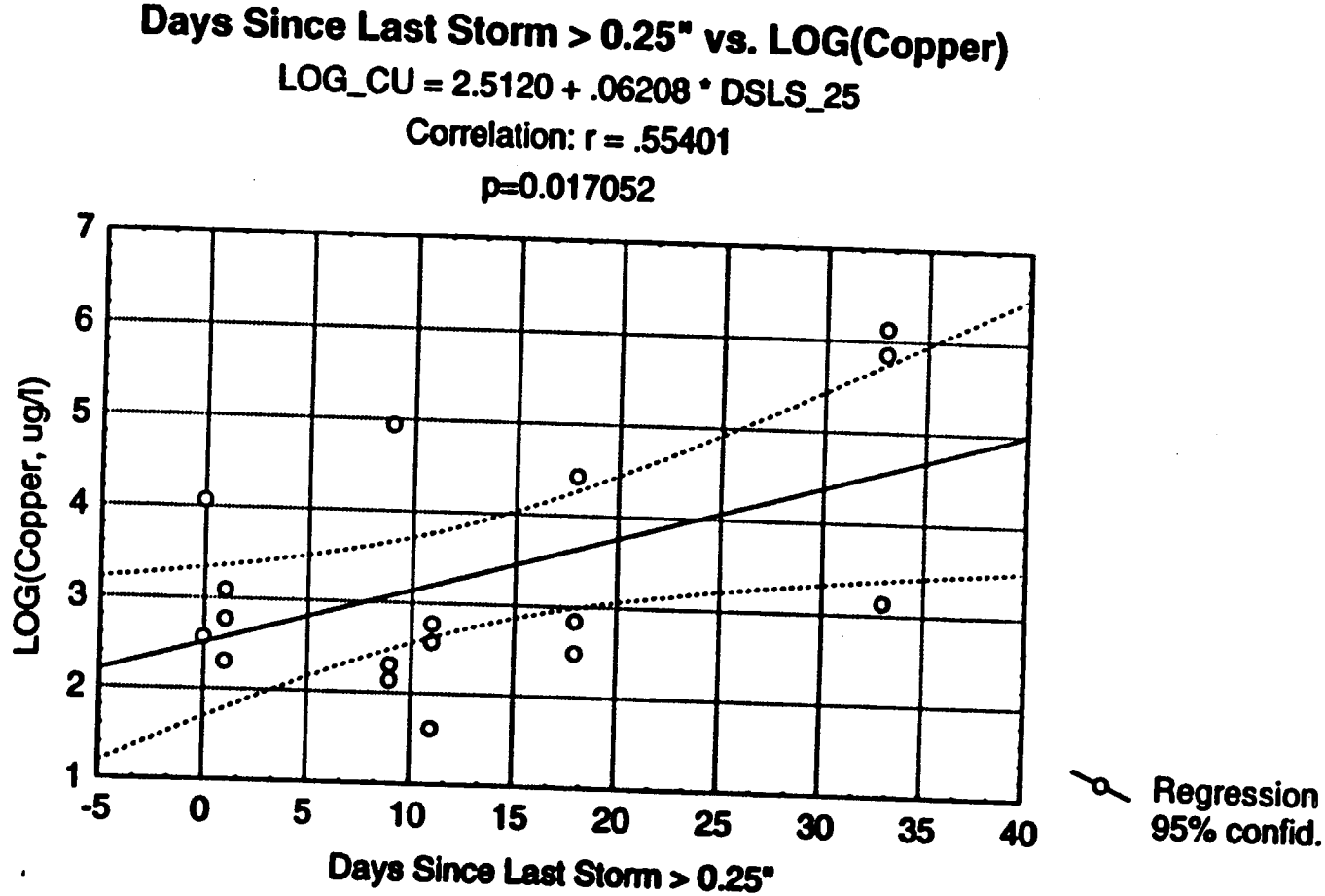
P=0.036535



R0058375

VOL 12

2 5 0 8 2


Days Since Last Storm > 0.25" vs. LOG(Copper)
LOG_CU = 2.5120 + .06208 * DSLS_25
Correlation: r = .55401
p=0.017052
LOG(Copper, ug/l)
7
6
5
4
3
2
1
-5
0
5
10
15
20
25
30
35
40
Days Since Last Storm > 0.25"
Regression
95% confid.

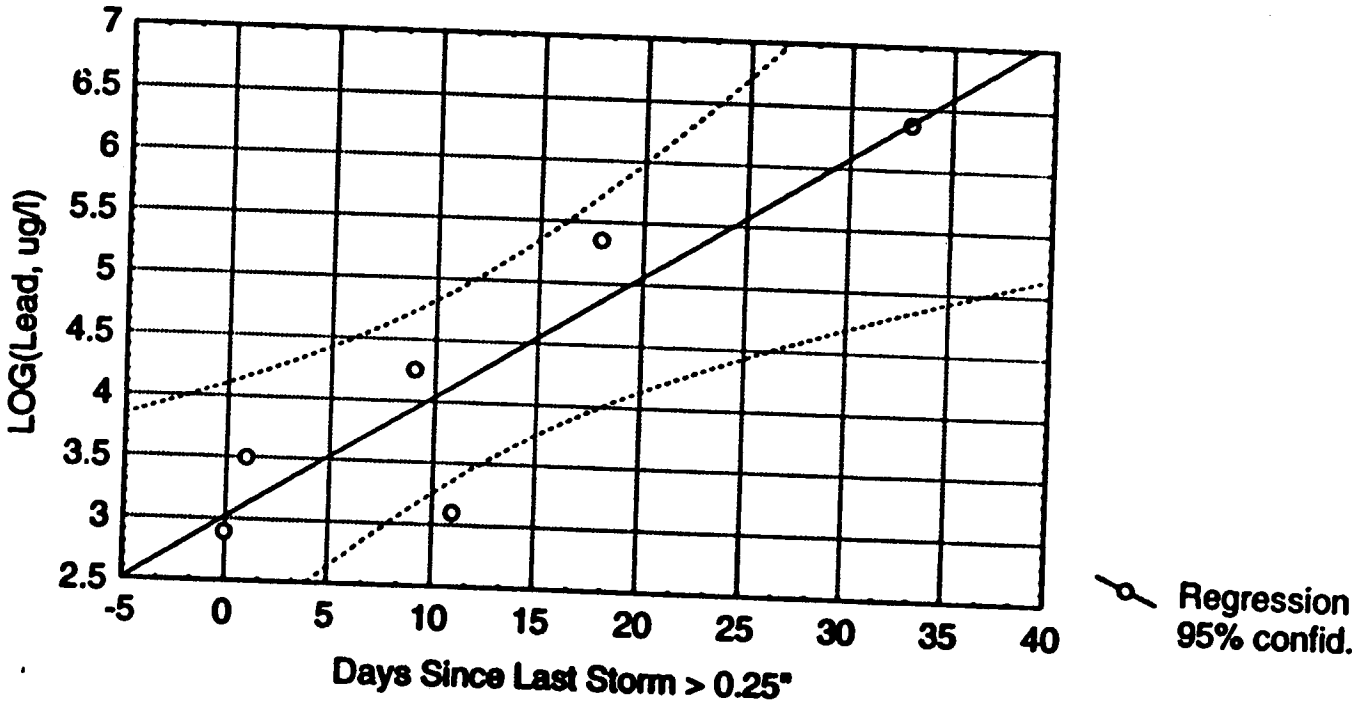
R0058376

Days Since Last Storm > 0.25" vs. LOG(Lead), Station Z

LOG_PB = 3.0151 + .10203 * DSLS_25

Correlation: r = .91122

p=0.011472



R0058377

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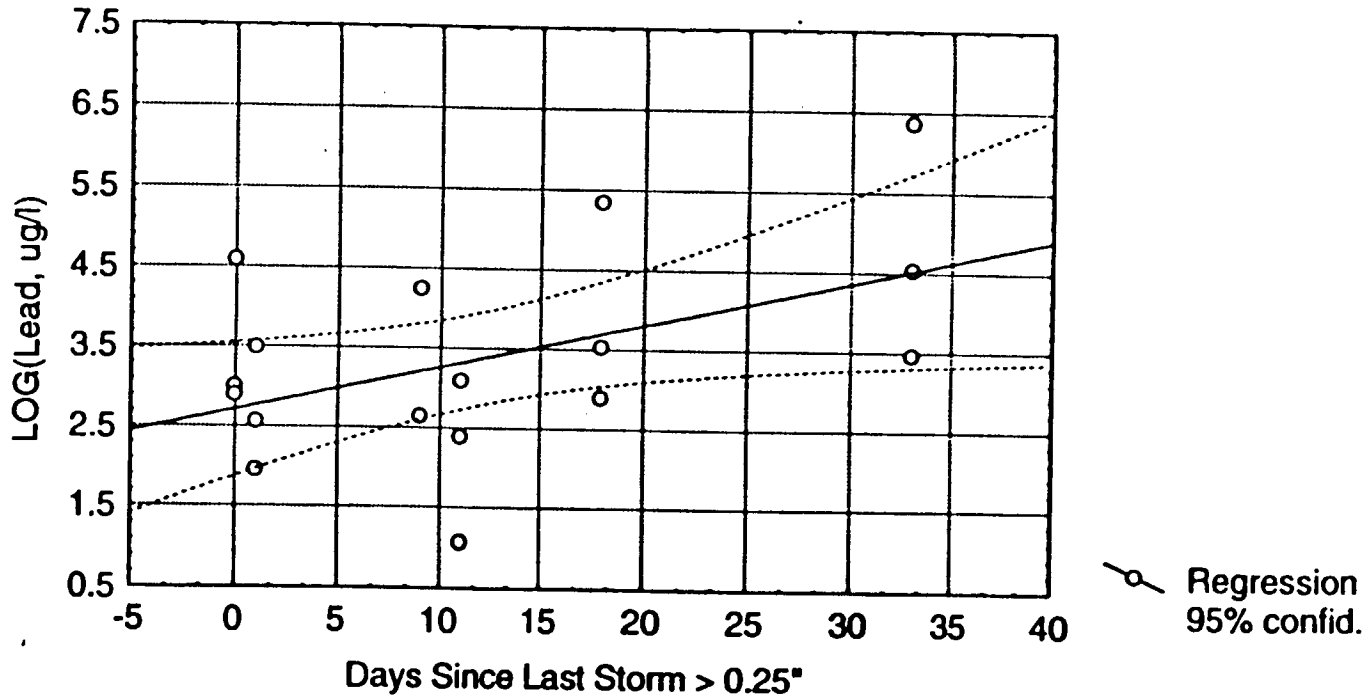
2 5084

Days Since Last Storm > 0.25" vs. LOG(Lead)

LOG_PB = 2.7118 + .05469 * DSLS_25

Correlation: r = .49738

p=0.035714



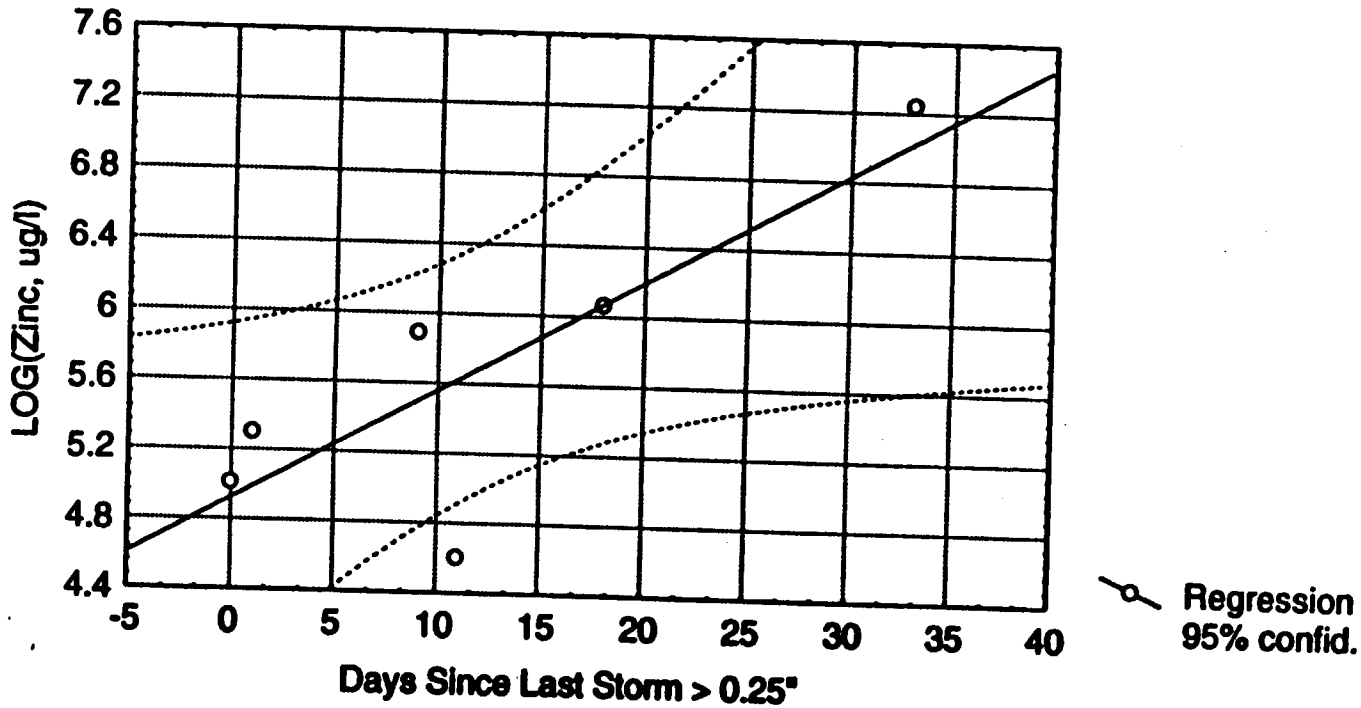
R0058378

Days Since Last Storm > 0.25" vs. LOG(Zinc), Station Z

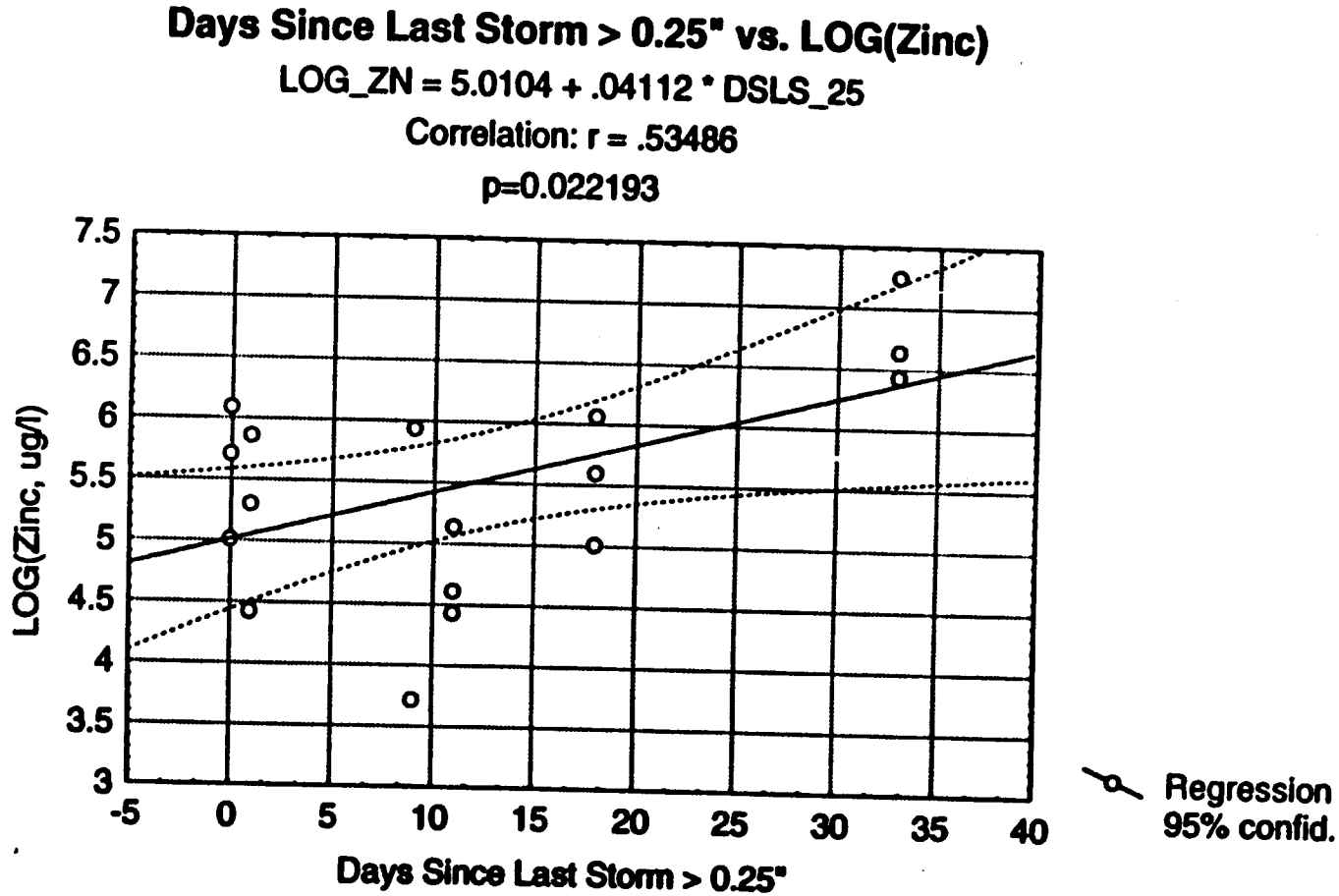
LOG_ZN = 4.9213 + .06362 * DSLS_25

Correlation: r = .83304

p=0.039486



R0058379


Days Since Last Storm > 0.25" vs. LOG(Zinc)
LOG_ZN = 5.0104 + .04112 * DSLS_25
Correlation: r = .53486
p=0.022193
LOG(Zinc, ug/l)
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
-5
0
5
10
15
20
25
30
35
40
Days Since Last Storm > 0.25"
Regression
95% confid.

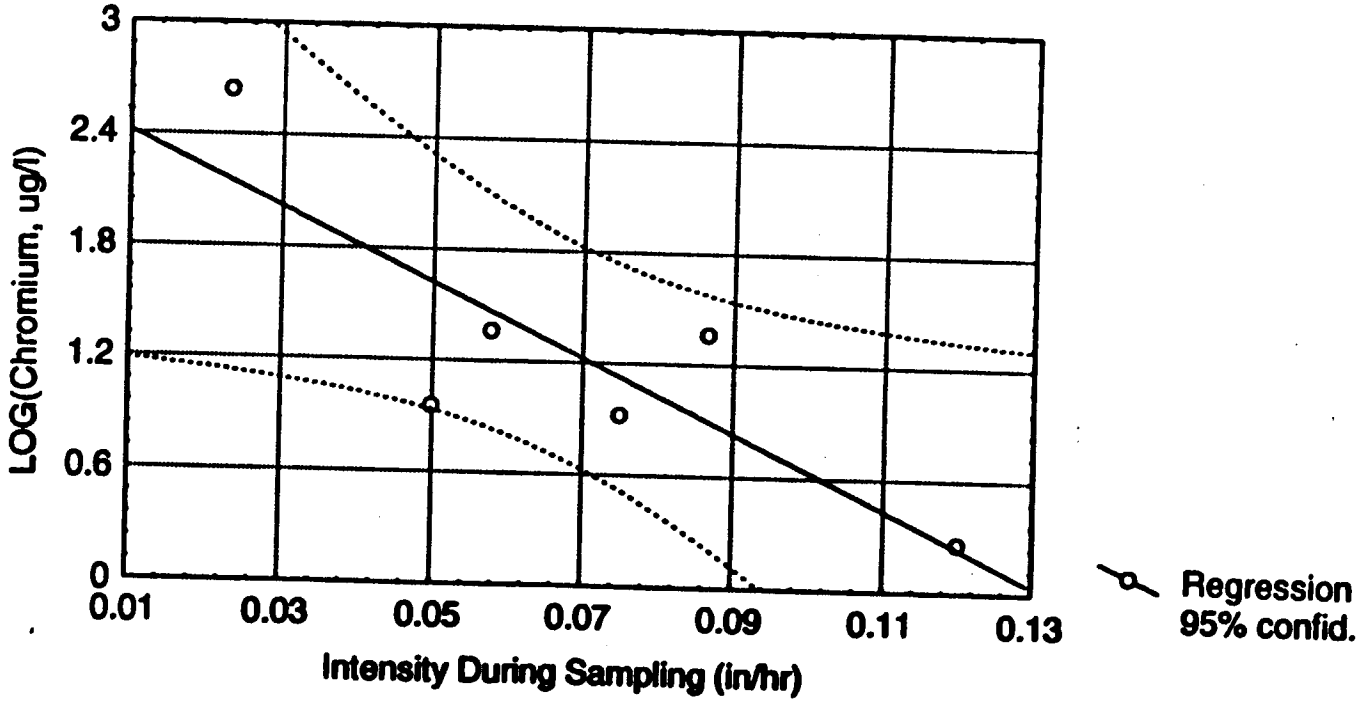
R0058380

Intensity During Sampling vs. LOG(Chromium), Station Z

LOG_CR = 2.6126 - 19.82 * INT_SAMP

Correlation: r = -.8336

p=0.039210



R0058381

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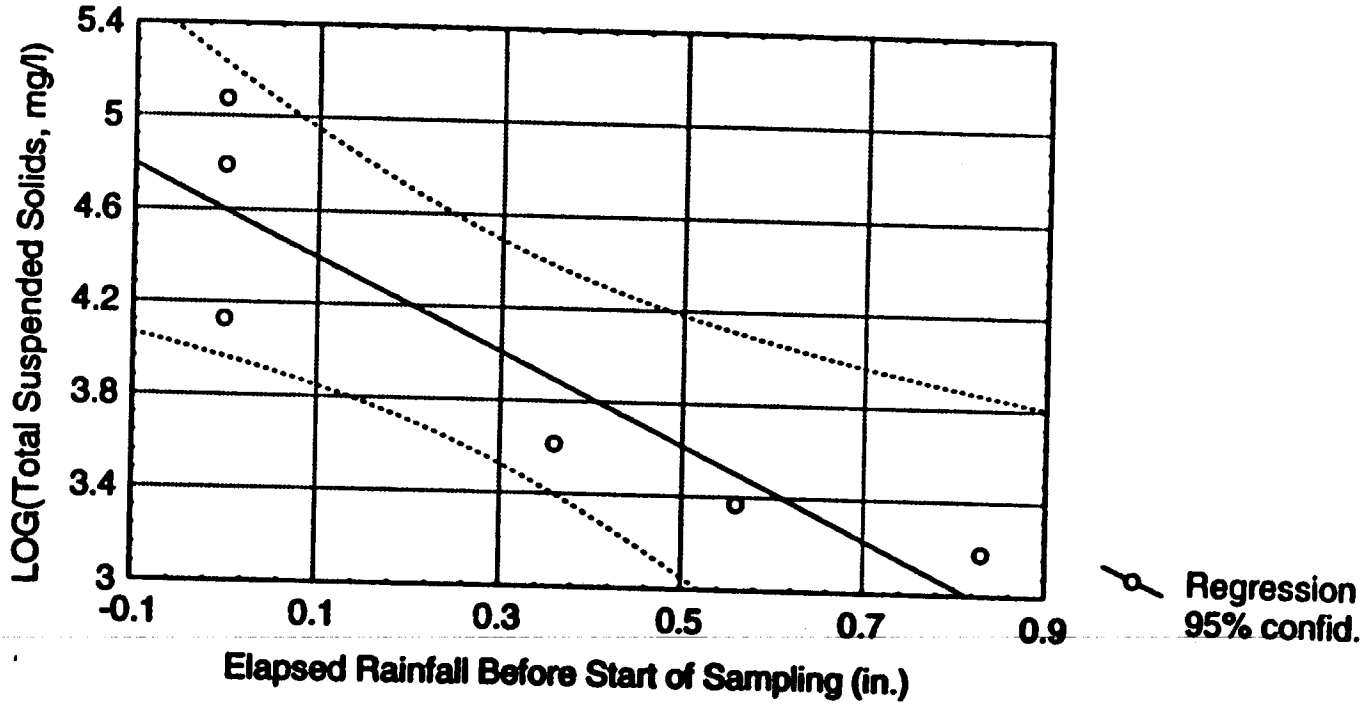
Elapsed Rainfall Before Sampling vs. LOG(TSS), Station Y

LOG_TSS = 4.5963 - 1.961 * MISSED

Correlation: r = -.8904

p=0.017368



R0058382

VOL 12

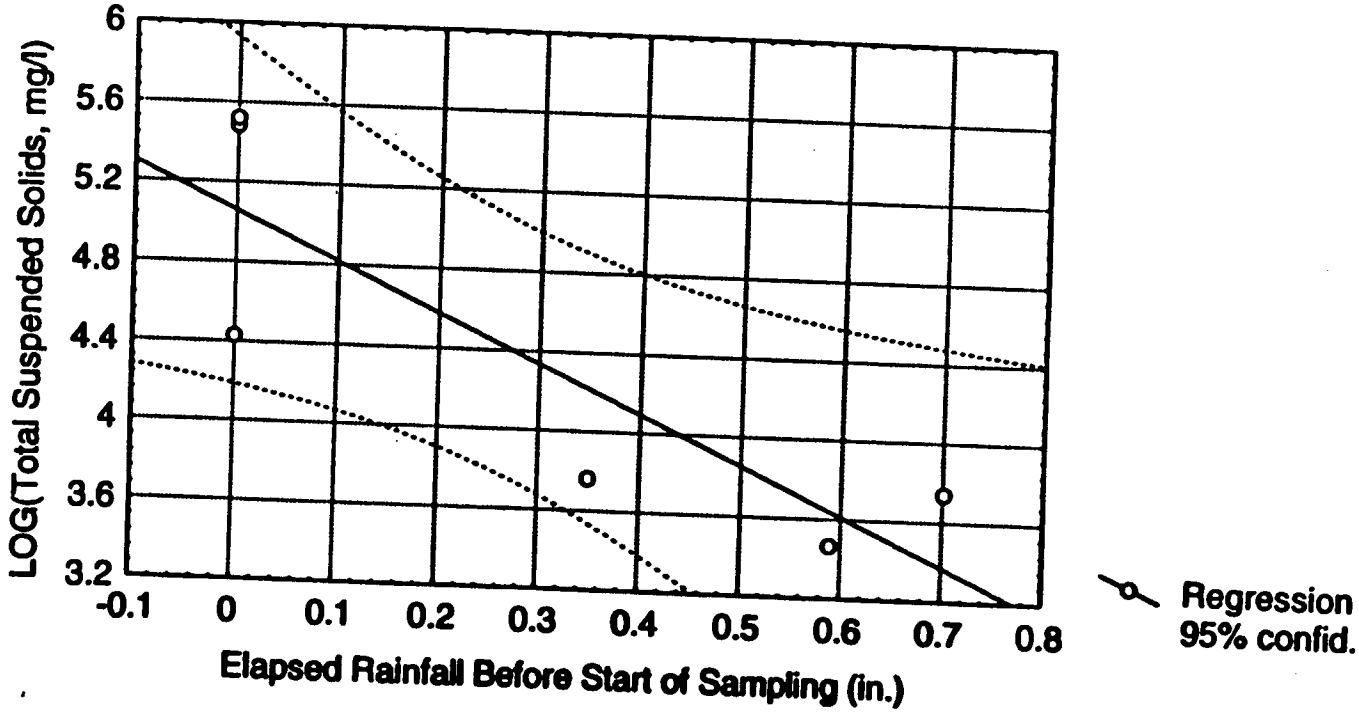
2 5089

Elapsed Rainfall Before Sampling vs. LOG(TSS), Station Z

LOG_TSS = 5.0594 - 2.412 * MISSED

Correlation: r = -.8489

p=0.032524



R0058383

VOL 12

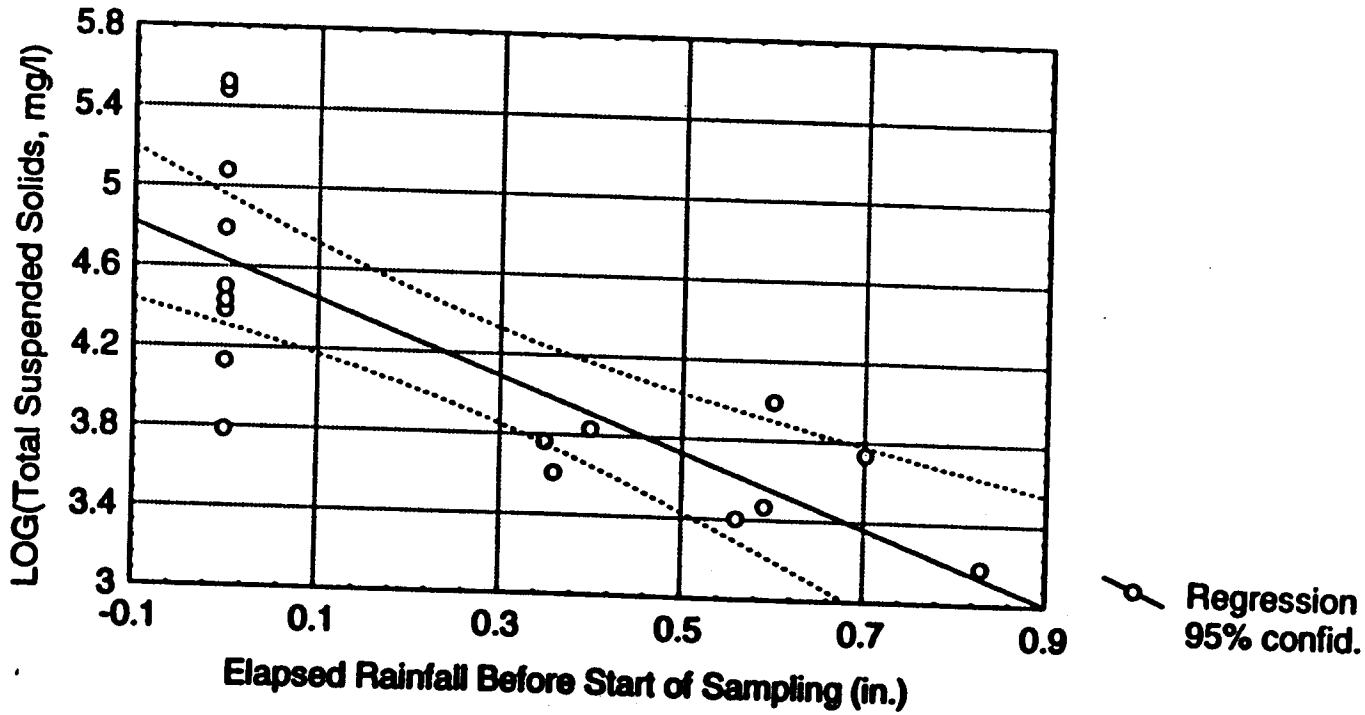
2 5090

Elapsed Rainfall Before Sampling vs. LOG(TSS)

LOG_TSS = 4.6333 - 1.812 * MISSED

Correlation: r = -.7721

p=0.000174



R0058384

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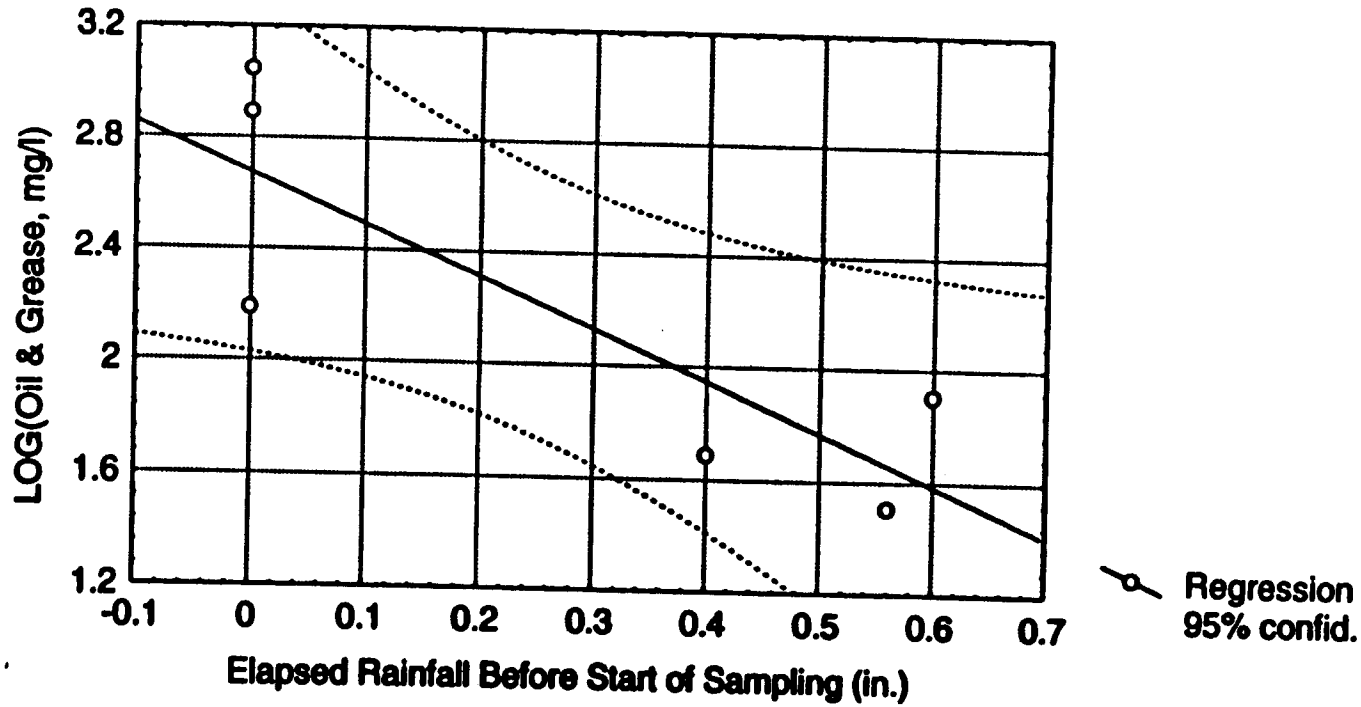
Elapsed Rainfall Before Sampling vs. LOG(O&G), Station X

LOG_O_G = 2.6745 - 1.816 * MISSED

Correlation: r = -.8347

p=0.038737



R0058385

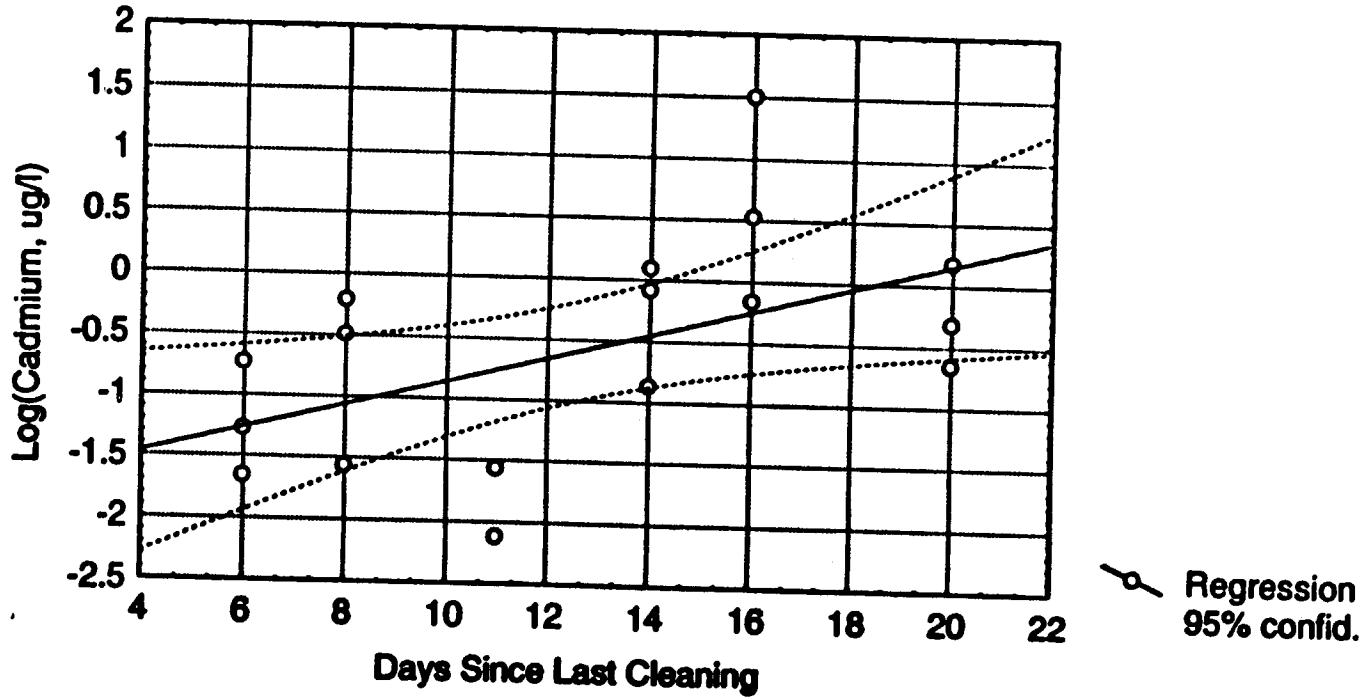
26635

Days Since Last Cleaning vs. Log(Cadmium)

LOG_CD = -1.872 + .10135 * L_CLEAN

Correlation: r = .54293

p=0.019895



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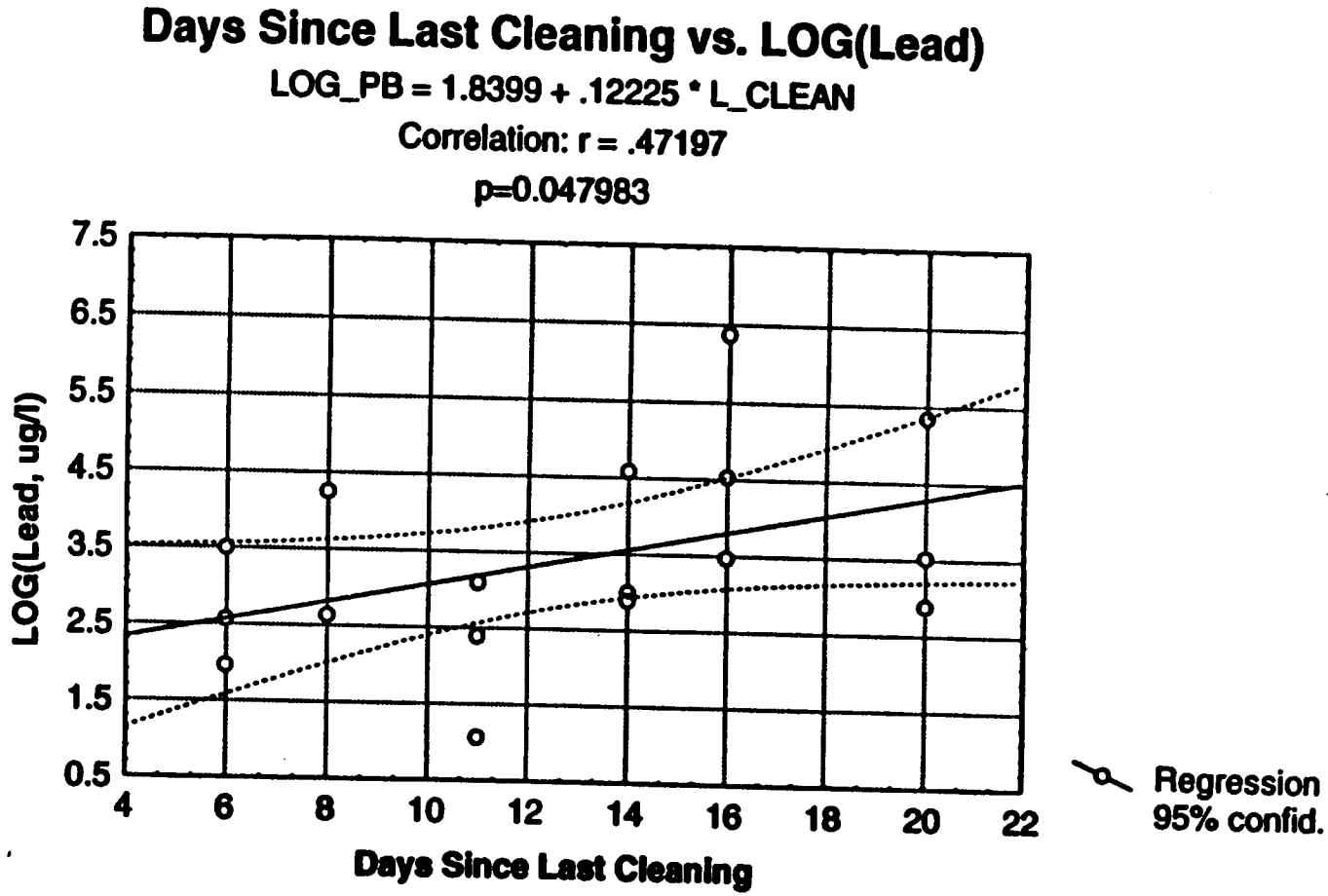
Days Since Last Cleaning vs. LOG(Lead)
LOG_PB = 1.8399 + .12225 * L_CLEAN
Correlation: r = .47197
p=0.047983
LOG(Lead, ug/l)
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
4
6
8
10
12
14
16
18
20
22
Days Since Last Cleaning
Regression
95% confid.

R0058387

Document

Appendix F

Significant Regression Plots - Event Mass Loads

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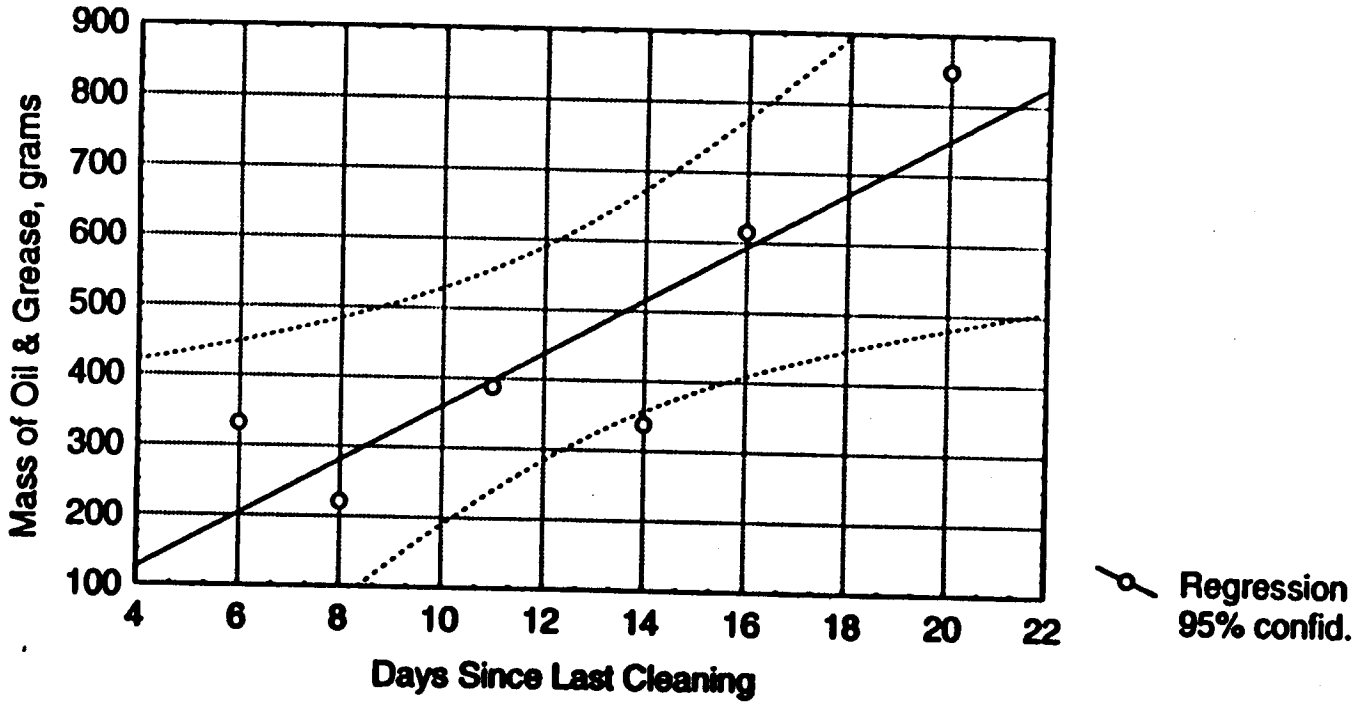
R0058388

Days Since Last Cleaning vs. Mass of Oil & Grease, Station Z

MASS_O_G = -30.77 + 38.969 * L_CLEAN

Correlation: r = .87666

p=0.021880



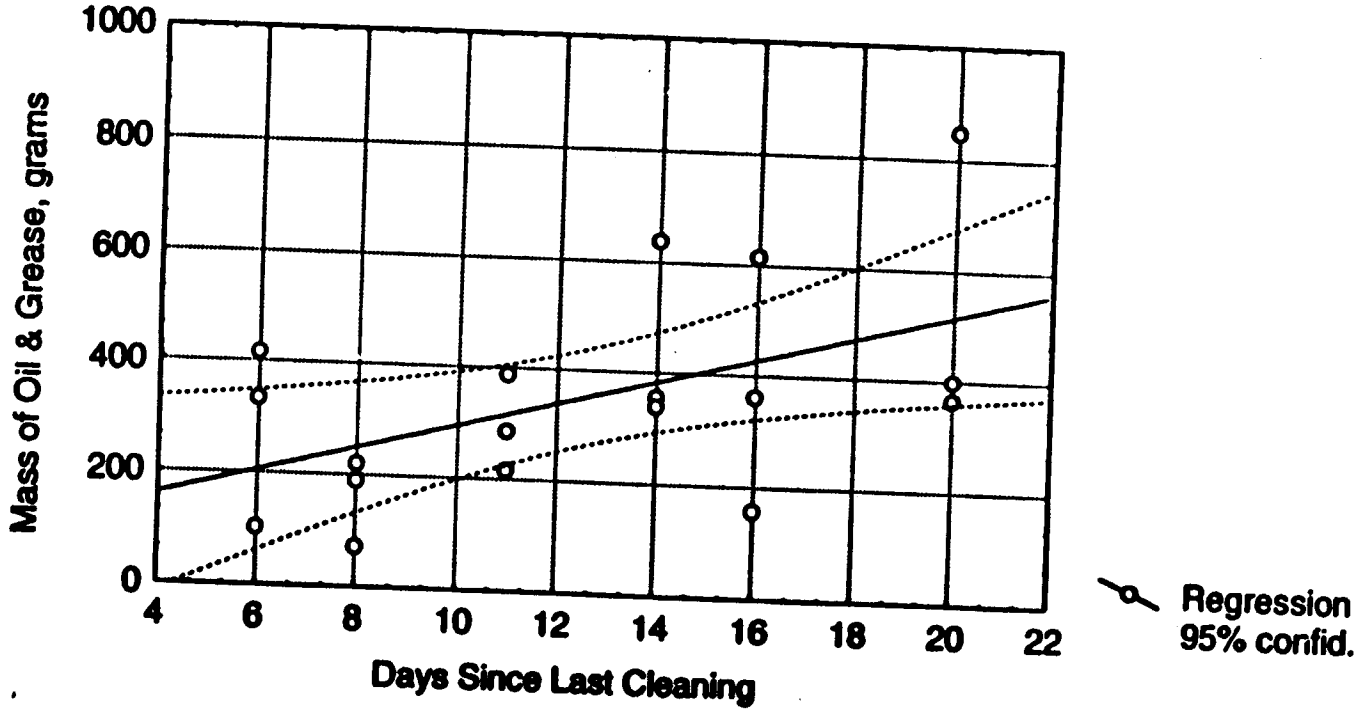
R0058389

Days Since Last Cleaning vs. Mass of Oil & Grease

MASS_O_G = 71.981 + 22.193 * L_CLEAN

Correlation: r = .55460

p=0.016909



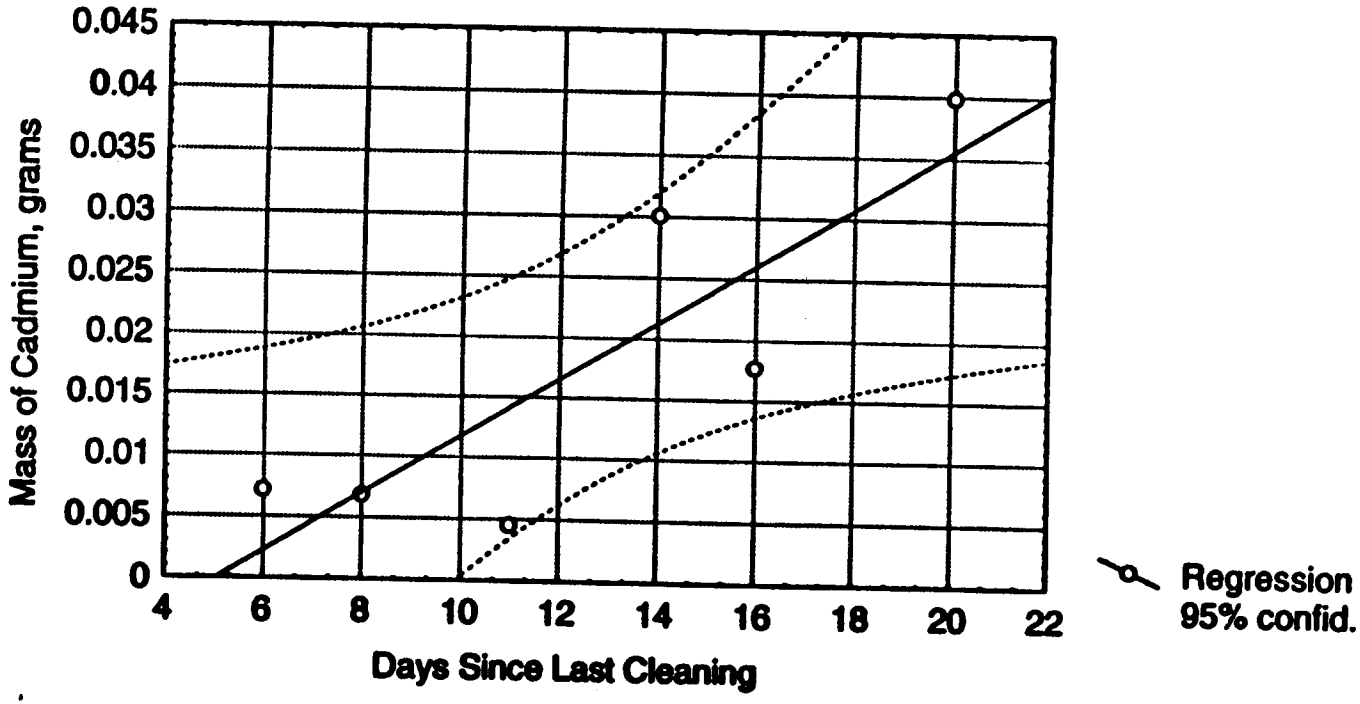
R0058390

Days Since Last Cleaning vs. Mass of Cadmium, Station Y

MASS_CD = -.0120 + .00238 * L_CLEAN

Correlation: r = .85486

p=0.030068



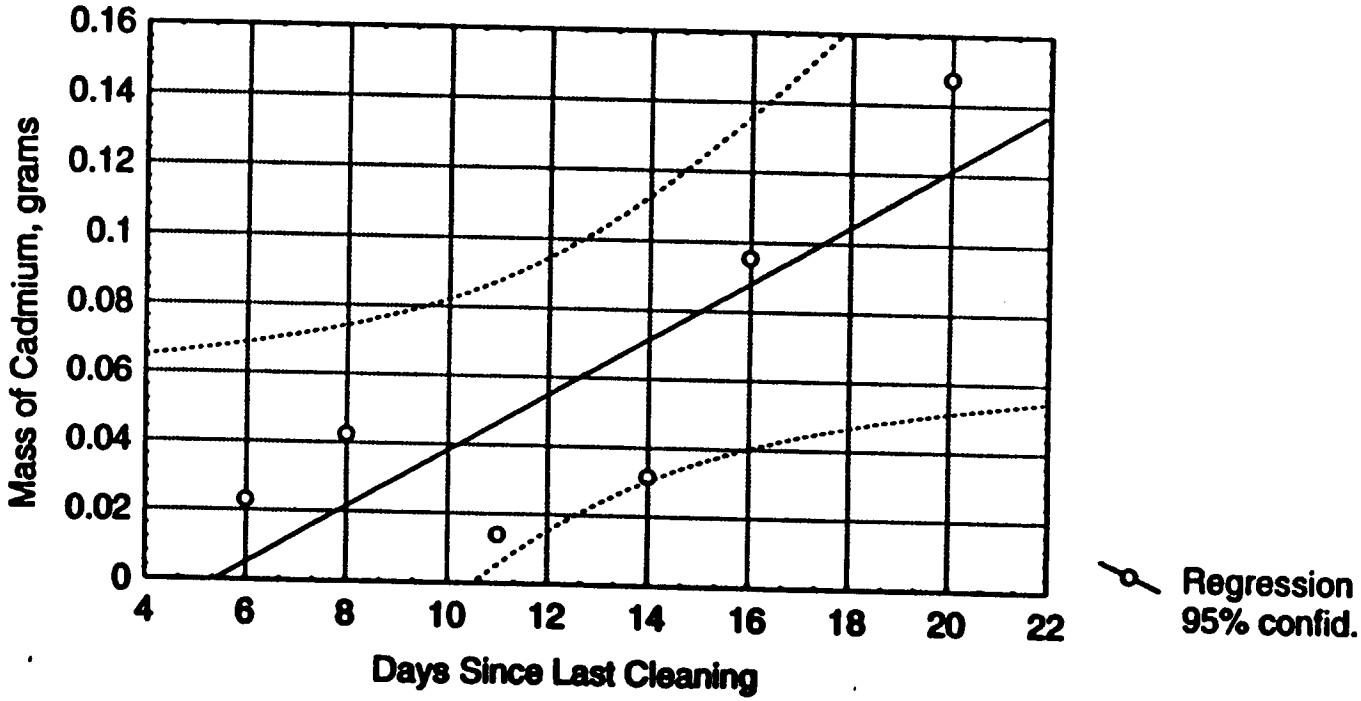
R0058391

Days Since Last Cleaning vs. Mass Load of Cadmium, Station Z

MASS_CD = -.0448 + .00829 * L_CLEAN

Correlation: r = .83150

p=0.040197



R0058392

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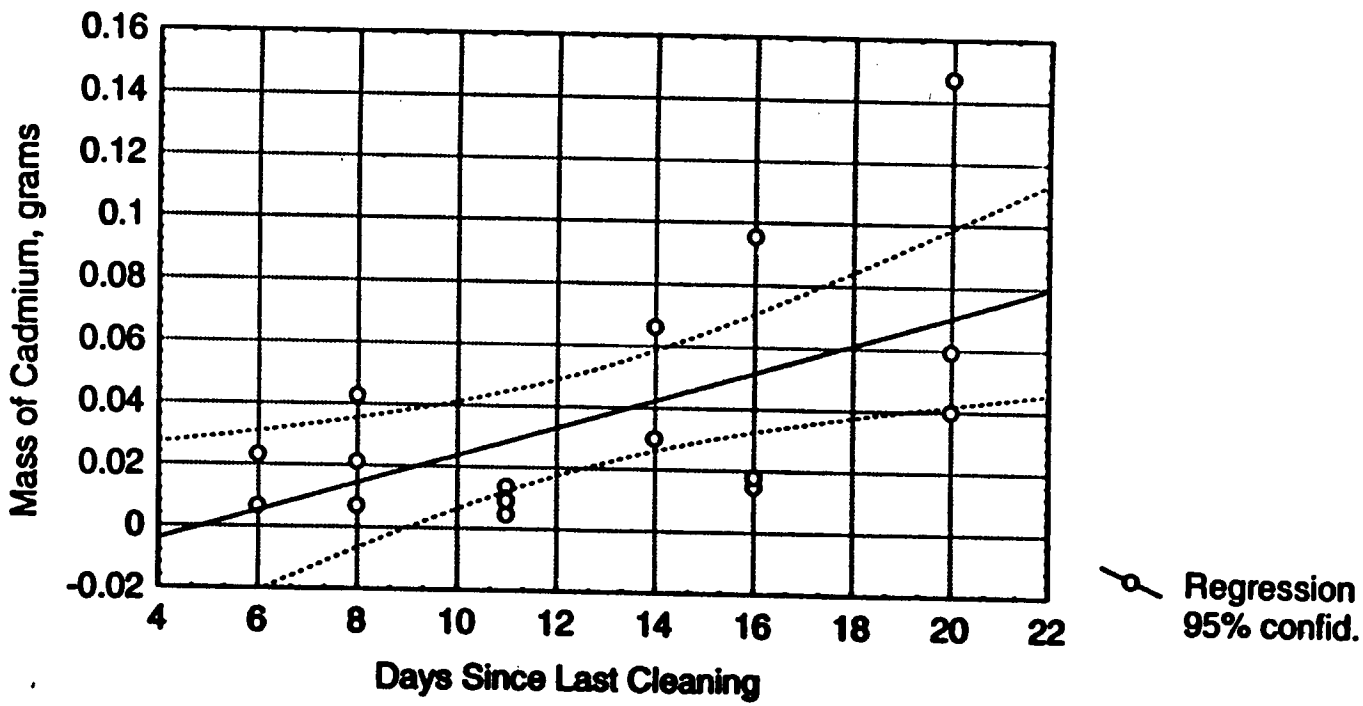
Days Since Last Cleaning vs. Mass of Cadmium

MASS_CD = -.0227 + .00465 * L_CLEAN

Correlation: r = .61235

p=0.006906



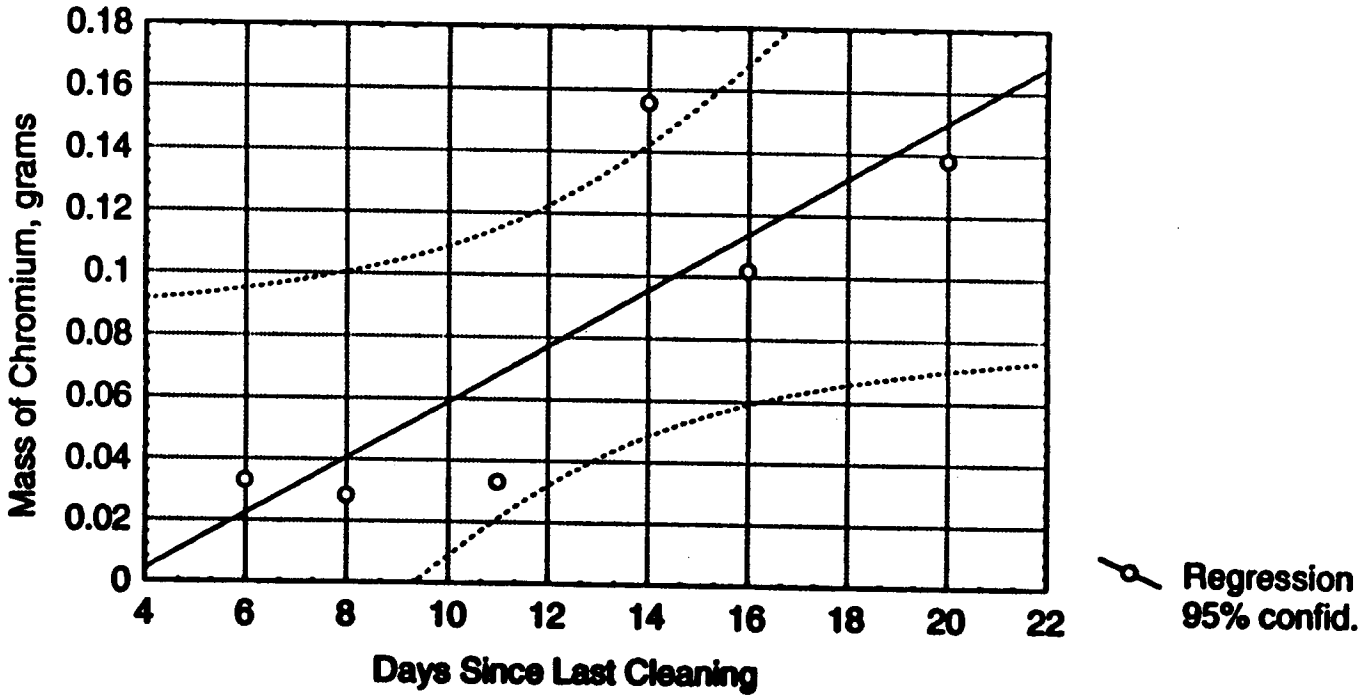
R0058393

Days Since Last Cleaning vs. Mass of Chromium, Station Y

MASS_CR = -.0323 + .00911 * L_CLEAN

Correlation: r = .82194

p=0.044734



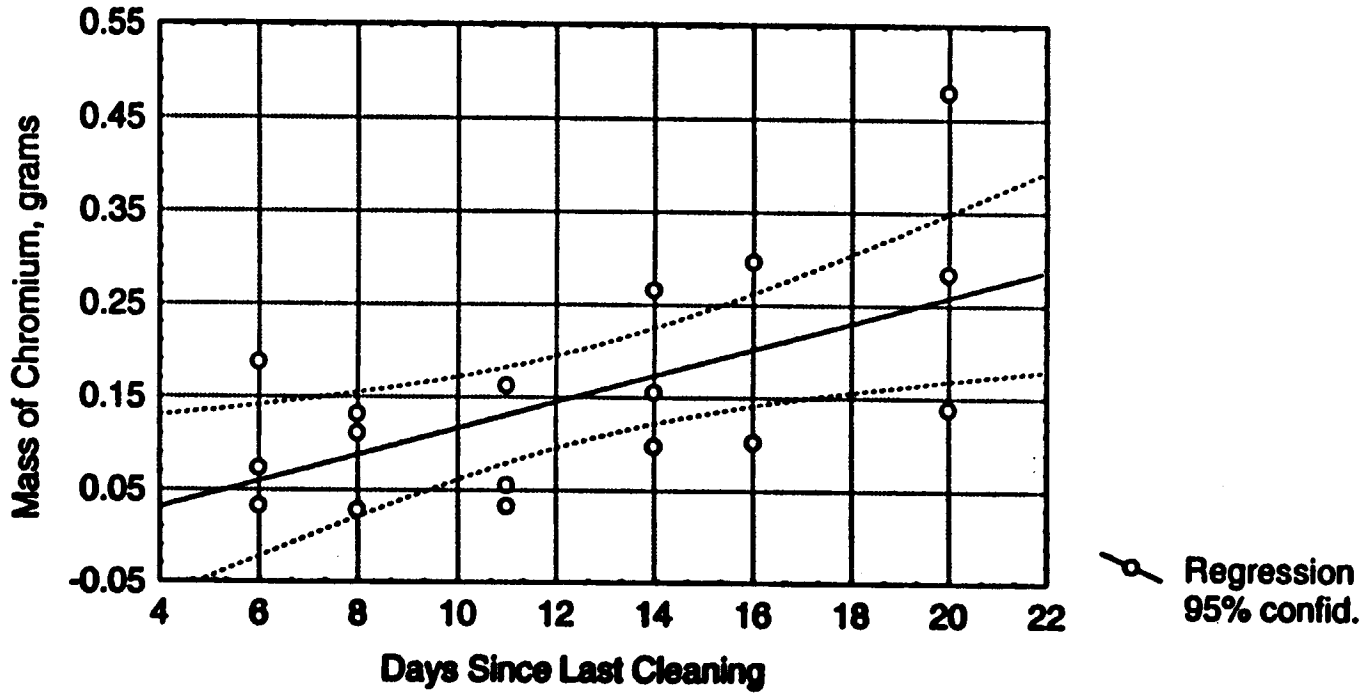
R0058394

Days Since Last Cleaning vs. Mass of Chromium

MASS_CR = -.0256 + .01420 * L_CLEAN

Correlation: r = .59870

p=0.008660



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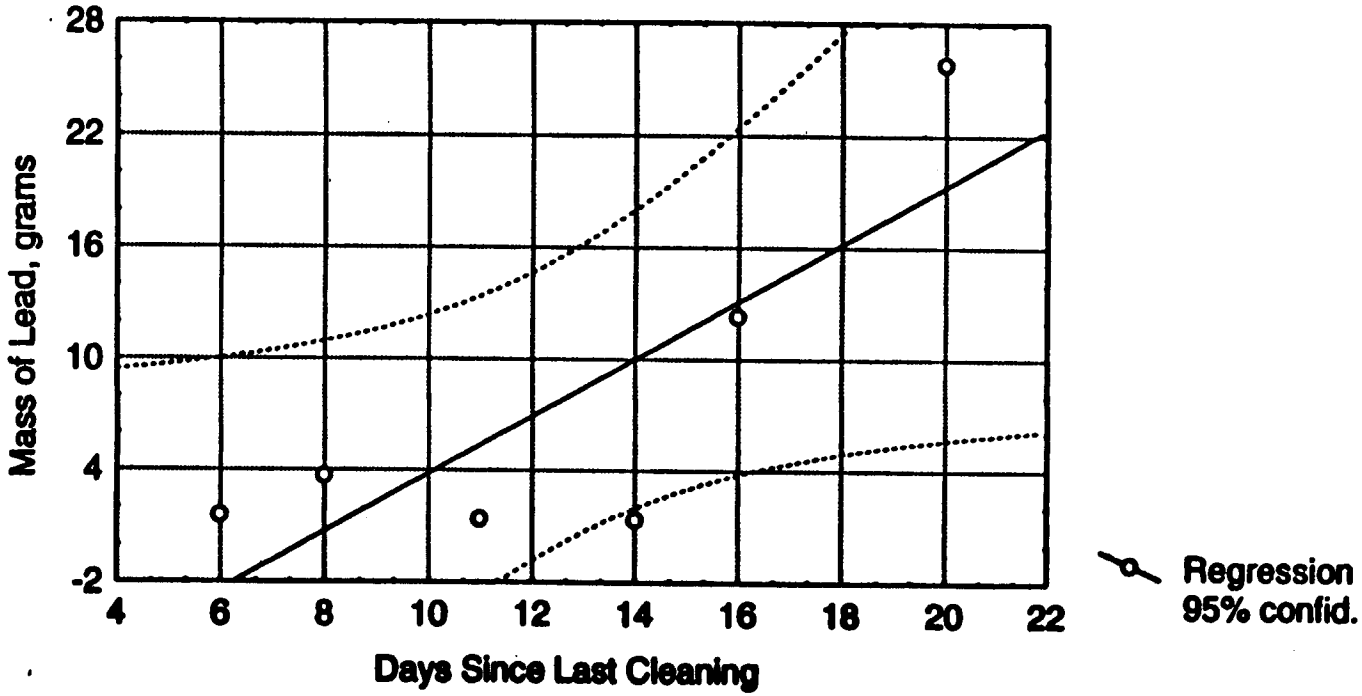
Days Since Last Cleaning vs. Mass of Lead, Station Z

MASS_PB = -11.65 + 1.5460 * L_CLEAN

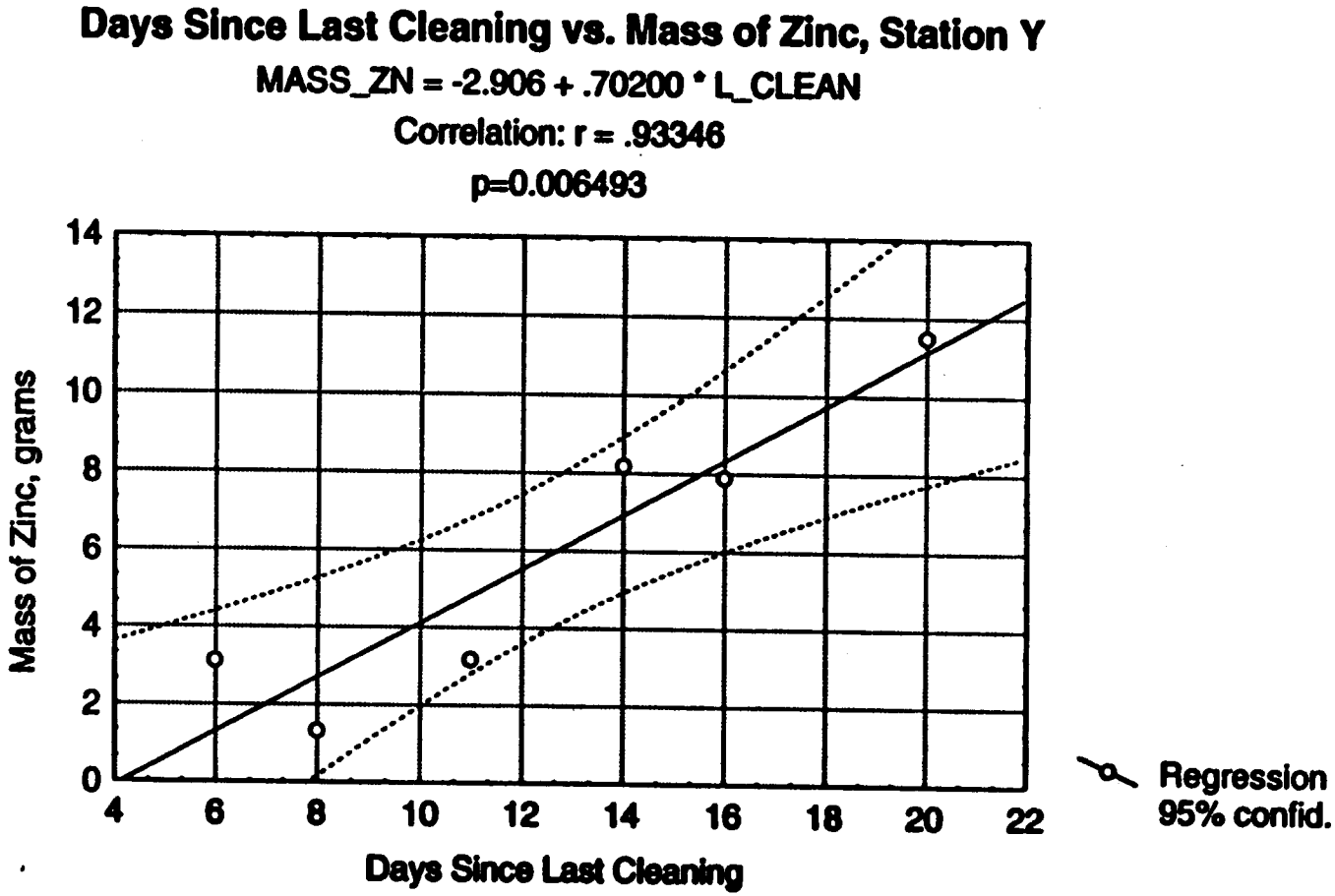
Correlation: r = .81983

P=0.045770



R0058396

EC-5 2 VOL 12



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2
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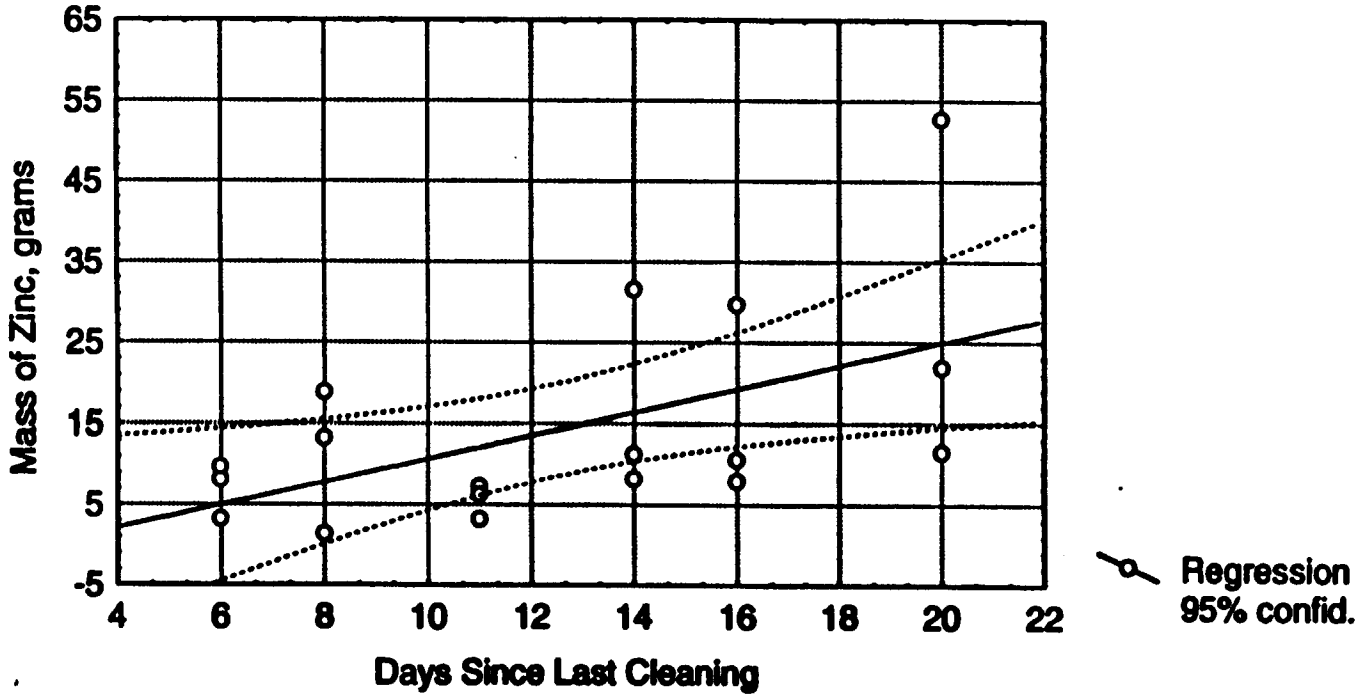
Days Since Last Cleaning vs. Mass of Zinc

MASS_ZN = -3.613 + 1.4282 * L_CLEAN

Correlation: r = .54473

p=0.019411



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Orange County

NPDES Stormwater Program

DRAINAGE AREA MANAGEMENT PLAN

April, 1993

Submitted to the
San Diego and Santa Ana Regional Water Quality Control Boards
in compliance with NPDES Stormwater and Urban Runoff Permits
CA 018740 and CA 8000180

A COOPERATIVE PROJECT
OF THE COUNTY OF ORANGE, THE CITIES OF ORANGE COUNTY
AND THE ORANGE COUNTY FLOOD CONTROL DISTRICT

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ORANGE COUNTY

NPDES Storm Water Permit Program

DRAINAGE AREA MANAGEMENT PLAN

April, 1993

Submitted to the San Diego and Santa Ana
Regional Water Quality Control Boards
in Compliance with NPDES
Storm Water and Urban Runoff Permits
CA 0108740 and CA 8000180

A COOPERATIVE PROJECT BETWEEN THE COUNTY OF ORANGE,
THE CITIES OF ORANGE COUNTY,
AND THE ORANGE COUNTY FLOOD CONTROL DISTRICT

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EXECUTIVE SUMMARY

This document details the Drainage Area Management Plan (DAMP) to be implemented by the Cities and the County of Orange and the Orange County Flood Control District. Orange County's Drainage Area Management Plan was prepared in compliance with the specific requirements of NPDES Stormwater Permits No. CA 8000180 and No. CA 0108740.

This baseline DAMP is presented as the first step of a comprehensive planning process rather than the culmination. The plan will therefore undergo revision as new information, particularly water quality data, becomes available.

The County and many of the cities have already been performing practices and procedures which protect the quality of stormwater runoff, such as monitoring to identify problems, implementing construction site and agriculture erosion and sediment control programs, implementing a watershed sediment control program on San Diego Creek and Upper Newport Bay, sweeping streets, managing solid waste, initiating residential recycling programs, maintaining storm drains and catch basins, enforcing prohibitions on illegal discharges, controlling spills, supervising industrial waste discharges through permitting, and enforcing ordinances prohibiting certain discharges. Through this DAMP, the co-permittees intend to improve existing stormwater quality management practices and, where necessary, to address identified problems and to implement new practices.

This DAMP has been formulated with the following objectives in mind:

- Meet the requirements of NPDES stormwater permits CA 0108740 and CA 8000180;
- Insure effective public participation and support;
- Focus on problems identified through monitoring;
- Utilize available resources effectively;
- Implement public education BMPs early;
- Detect and eliminate illegal discharges;
- Evaluate opportunities for retrofitting existing structures;
- Verify Best Management Practices (BMPs) designs through experience; and
- Develop plans on a watershed basis.

Private and public sector representatives participated in developing the storm water pollutant control programs described within this DAMP. Throughout the DAMP's evolution, the document will be available for public review and comment. Overall program guidance will be provided by the NPDES Co-permittees.

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1. 0 INTRODUCTION

This document outlines Orange County's Drainage Area Management Plan to be implemented by the cities of Anaheim, Brea, Buena Park, Costa Mesa, Cypress, Dana Point, Fountain Valley, Fullerton, Garden Grove, Huntington Beach, Irvine, Laguna Beach, Laguna Hills, Laguna Niguel, La Habra, Lake Forest, La Palma, Los Alamitos, Mission Viejo, Newport Beach, Orange, Placentia, San Clemente, San Juan Capistrano, Santa Ana, Seal Beach, Stanton, Tustin, Villa Park, Westminster, and Yorba Linda, the County of Orange; and the Orange County Flood Control District within the Orange County storm water drainage system. Newly incorporated cities and other agencies will be included in the implementation process if they choose to participate in the National Pollutant Discharge Elimination System (NPDES) storm water program.

The stormwater pollution control effort, of which this DAMP is a part, is the result of twenty years of legislative effort beginning with the 1972 Water Pollution Control Act, subsequently known as the Clean Water Act. The Clean Water Act established the NPDES and required the Environmental Protection Agency (EPA) to issue regulations to be effective by 1983, that include stormwater runoff from rainfall. The program was called the National Pollutant Discharge Elimination System (NPDES).

As a result of concerns that urban stormwater runoff can carry pollutants from diverse sources, Congress passed the Water Quality Act of 1987 which required EPA to bring stormwater discharges into the NPDES program. These regulations were issued on November 16, 1990.

1. 1 Objectives of the Drainage Area Management Plan

The immediate objective of this DAMP is to fulfill the commitment of the co-permittees to present a plan that satisfies NPDES requirements. In addition, however, there are a number of important public policy issues which have influenced the co-permittees in framing this plan and which consequently define the objectives of the DAMP. Resources, both public and private, are limited. Public support is essential. In implementing this program it is the intent of the co-permittees to proceed in a measured, deliberate way designed to obtain the maximum benefit for the resources expended and to secure maximum public awareness, understanding, and support.

The co-permittees intend to proceed with the public participation, education, and information program immediately to raise the level of public awareness and at the same time improve the protection of runoff water quality. It is therefore an objective to develop and implement a countywide program of educational BMPs as an early priority.

The co-permittees want a stormwater quality management program which focuses resources on water quality problems, wherever identified within the County. They also intend to have a priority system to assure that water quality problems receive the available resources and attention. It is therefore planned to analyze and evaluate the existing and future monitoring data to identify those

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watersheds exhibiting the most urgent need for attention.

The co-permittees are aware that a successful stormwater quality management program will depend on the awareness, commitment, cooperation, and support of the various segments of the public, including businesses, industry, development, utilities, environmental groups, institutions, homeowners, and the general public. Accordingly, it is an objective of this plan to assure an open planning process, with ample opportunity for public participation and meaningful consideration of the input obtained. Accomplishment of this objective will be furthered by the management structure provided herein and by public meetings, hearings, and workshops as part of the planning and decision-making process.

The co-permittees presently own and operate an extensive system of flood control, drainage, recreational, habitat, and greenbelt corridor facilities. Some of these have already been modified to yield regional water quality benefits while still safely and reliably performing their primary function. It is the intent of the co-permittees to evaluate opportunities to incorporate stormwater quality features into existing flood control structures in each Orange County watershed.

The co-permittees have considerable experience and expertise in the planning, design and operation of flood control and drainage systems. They are familiar with the regional watershed approach to drainage planning and they are aware of the economic benefit of regional flood control facilities. The co-permittees therefore intend to approach the runoff water quality management program on the same regional watershed basis, guided by the priorities identified through the monitoring program.

Research, technical, and engineering design data indicate that source term quantification and design parameters are still in a developmental phase. "This finding tends to support the need for local data before making what may be far-reaching and expensive water quality management decisions."[1] The co-permittees intend to investigate the relative cost-effectiveness of the various structural BMP designs through a program of experimental construction and observation.

It is an objective of the co-permittees to vigorously detect and eliminate illegal discharges into the storm drain system. The co-permittees are committed to the pursuit of equity in distributing the cost of implementating of this program.

Orange County's Drainage Area Management Plan was prepared in compliance with the specific requirements of NPDES Stormwater Permits (No. CA 8000180 and No. CA 0108740). The plan proposes a wide range of Best Management Practices (BMPs) and control techniques which will be implemented over the term of the current permits. For planning purposes, these Best Management Practices are organized into seven program components. The goals of these seven components are:

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[1] Stormwater Detention for Drainage, Water Quality, and CSO Management, Peter Stahre & Ben Urbonas, Prentice-Hall, 1990

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1. Public Agency Activities (Section 5.0)

Improve existing city and county pollution prevention activities and implement appropriate new practices to further reduce the amount of pollutants entering the storm drain system. Municipal government activities include housekeeping practices such as hazardous materials management in maintenance yards/facilities and community services such as street-sweeping, facility maintenance, trash removal, waste-oil disposal, and spill response and enforcement activities.

Implement the steps described in this DAMP:

- Initiate educational BMPs throughout the County;
- Detect and eliminate illegal discharges;
- Conduct stormwater monitoring program;
- Priortize watersheds based on evaluation of monitoring data;
- Evaluate the possibility of modifying existing stormwater facilities and/or stormwater maintenance programs to reduce pollutants in stormwater discharges.
- Evaluate appropriate BMP candidates; and
- Implement proven cost-effective BMPs.

2. Public Education (Section 6.0)

Educate the public about the issue of nonpoint source pollution and the practices they can adopt that will assist in pollution prevention.

3. New Development Controls (Section 7.0)

Ensure that all new development incorporates appropriate postconstruction nonstructural and structural BMPs, and equitably participates in the implementation of watershed structural BMPs as described herein.

4. Construction Site Controls (Section 8.0)

Ensure that construction sites implement pollutant-control practices that address control of construction-related pollutants including erosion control and on-site hazardous materials management.

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5. Industrial Discharger Identification (Section 9.0)

Develop identification records of industrial dischargers in Orange County.

6. Illicit Discharge/Connection Identification and Elimination (Section 10.0)

Identify and eliminate non-permitted discharges and illicit connections to the storm drain system.

7. Monitoring (Section 11.0)

Conduct water quality monitoring county-wide to identify areas with particular water-quality problems to assist in the prioritization of watersheds for analysis and planning, and to assist in the prioritization of pollutants to facilitate the development of specific controls to address these problems.

Each of the seven program components is an integral part of the Drainage Area Management Plan. The success of the overall program will therefore reflect the combined impact of all program components.

1.2 "Maximum Extent Practicable"

The federal regulations indicate that proposed management programs such as this DAMP "shall include a comprehensive planning process which involves public participation and where necessary intergovernmental coordination, to reduce the discharge of pollutants to the maximum extent practicable using management practices, control techniques and systems, design and engineering methods, and such other provisions which are appriopriate."

The Permit defines "maximum extent practicable" as follows: "Maximum extent practicable (MEP) means to the maximum extent possible, taking into account equitable considerations of synergistic, additive, and competing factors, including but not limited to, gravity of the problem, fiscal feasiblity, public health risks, societal concern, and social benefits." Its presence places upon the co-permittees the responsibility of weighing economic, societal, and equity issues as they define the policies and standards to be employed in implementing the program.

1.3 Description of Drainage Area and Climate

Orange County has an area of 500,000 acres, beginning on a coastal plain and rising to an elevation of over 5,000 feet in the Puente Hills and Santa Ana Mountains to the north and east. Before urbanization which began in the early 1950's, Orange County was drained by ephemeral streams and agricultural drainage ditches which were dry most of the year and carried measurable flow primarily during short duration flash floods and longer duration general winter storms.

As urbanization progressed, man-made agricultural drainage ditches were enlarged to flood

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control channels and the few natural streams such as Santa Ana River and San Juan Creek were constrained within levees to provide flood protection. Ephemeral flows in some of the man-made and natural channels have been replaced with continuous low flows from urban and agricultural irrigation.

Orange County's climate has hot dry summers and mild winters. Nearly all the annual precipitation falls in only a few storm events between November and May. During times of drought, it is not unusual for years to pass between major rainfalls. Precipitation results from three distinct mechanisms. The most important is the convergence mechanism associated with general winter storms originating in Alaska and picking up moisture as they travel south and east. The second major precipitation mechanism is orographic lifting where moist air masses are deflected upward by local mountains, releasing rain. Orographic rainfall is also associated with winter rainfall. The third precipitation mechanism, which can cause extremely intense local precipitation, is the convective thunderstorm. One of the most intense convective rainfall events of record in Southern California dropped 11 inches of rainfall in about 80 minutes. On occasion, unstable tropical air masses move in from the south and produce rainfall. These tropical air masses combine convergence mechanisms with convective mechanisms to produce intense thunderstorms.

It is common for successive storms of varying durations and intensities to compound their effects, with the heavy rainfall of the second or third storm creating the most severe flood conditions. Regardless of the source of precipitation, rainfall in Orange County is a rare event. The present urban and former agricultural lifestyles are made possible only by large quantities of water imported from the Colorado River and Northern California.

1. 4 Implementation of the Drainage Area Management Plan

The Co-permittees will gather information from the monitoring program and other sources to identify the source of pollutants for each identified problem. The purpose of this effort is to assist in the investigation and development of funding souces which equitably assess existing communities and areas of new development in proportion to their relative contribution to the problem. Such a policy is essential to the establishment and maintenance of a broad base of community support for the program.

Since existing developed areas are on the tax rolls, any implementation program for financing improvements and activities assessable to developed areas will consider allocating a portion of the ad valorem tax revenue and other municipal and County revenues for program support. Should program requirements exceed available revenues from these sources the co-permittees will investigate other funding mechanisms.

BMPs will be required for both existing developed areas and areas of new development. The co-permittees will consider such options and will conduct public discussions to hear the views of various members of the community. There is ample precedent for the determination of a particular development's share of public plan facilities, such as sewer capacity, roads, and parks. These

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precedents will be considered by the TAC in its development of the appropriate mechanism for implementing the program on a fair share basis in areas of new development.

The non-topographic boundary between Orange and adjoining Counties could result in certain co-permittees to the Stormwater Permit Implementation Agreement being subjected to flows originating from areas that are subject to NPDES municipal stormwater permits issued by Regional Water Quality Control Boards not a part of this DAMP. This DAMP is applicable only to stormwater permits issued by the San Diego and Santa Ana Regional Water Quality Control Boards, although Section 2.2.8 of DAMP acknowledges the fact that certain co-permittees could be impacted adversely by flows from drainage areas outside the two stormwater permit areas of the San Diego and Santa Ana Regions.

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2.0 PROGRAM MANAGEMENT

2.1 Introduction

The management activities for the municipal stormwater program include providing administrative and technical support for the NPDES Co-permittees and their Technical Advisory Committee (TAC); developing and executing inter-governmental agreements necessary for program implementation,developing reports and other materials required by NPDES permits; developing budgets and fiscal analyses; reviewing and developing policy positions and representing the Program before appropriate agencies; developing Best Management Practices (BMPs); planning activities needed to direct the program; and program coordination with all affected local government agencies.

A more detailed discussion of these management tasks is provided below.

2.2 Major Management Activities

2.2.1 Decision Making

As noted in the Executive Summary, overall program guidance (including votes where necessary) will be provided by the NPDES Co-permittees.

The advisory group for program development and implementation is the NPDES Technical Advisory Committee (TAC). The TAC comprises one City Engineer, or selected representative, from each of the County Supervisorial Districts and a representative from the County of Orange Environmental Management Agency.

Administrative support for this committee includes maintenance of mailing lists of participating and interested parties, reserving meeting venues, preparing agendas and notifying participants, that public noticing required by law, and preparation of minutes.

The County has established a Stormwater Section to coordinate countywide compliance activities and submittals to the Regional Water Quality Control Boards under policy direction of the Co-permittees.

2.2.2 Agreement for Program Implementation

The agreement (see Appendices C and D) underpinning County and city cooperation is the NPDES Storm Water Permit Implementation Agreement which establishes the responsibilities of each party (County, Flood Control District, and cities) with respect to compliance with the NPDES Storm Water Permits issued by the Regional Water Quality Control Boards (RWQCBs). This Agreement also establishes a funding mechanism for the shared costs of the Program based on each municipality's area and resident population.

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Specific program responsibilities are as follows:

The CITIES shall, to the maximum extent practicable:

- Implement a facility inspection program in accordance with the uniform criteria developed by the DISTRICT and recommended by the Co-permittees, for all municipal separate storm sewers as defined by the stormwater permit and within the jurisdictional boundaries of that city.
- Submit storm drain maps to the COUNTY.
- Prepare watershed characterizations, including:

  a. Zoning designations and

  b. Identification of areas where hazardous materials are stored, manufactured or disposed of.
- Review approve, and implement system-wide BMP's.
- Eliminate or have eliminated, illegal/illicit connections to the storm drain system.
- Identify the legal authority for control of discharges to the storm drain system.
- Provide the COUNTY with annual reports and any other information needed to satisfy NPDES permit reporting requirements.
- Evaluate existing water pollution control ordinances, which prohibit non NPDES permitted discharges to the municipal separate storm sewer system. If legal counsel determines that new or amended ordinances are needed, submit these in acccordance with each co-permitee's procedures.

The COUNTY and the DISTRICT shall be responsible for:

- Functioning as the principal permittees responsible for overall program management.
- Preparing implementation and annual operating budgets.
- Preparing compliance reports to the Regional Water Quality Control Boards (RWQCBs).
- Preparing a draft system-wide BMP Program Report.

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- o Monitoring the implementation of system-wide BMP's, to evaluate structural and procedural BMP's and preparation of an annual report detailing results for presentation to the RWQCB.

- o Performing the water quality and hydrographic monitoring for permit compliance.

- o Administering the water pollution control program.

- o Developing uniform criteria for annual inspection of drainage facilities.

In addition, the COUNTY will also undertake, in the unincorporated areas, all the activities required of the cities.

The DISTRICT will also perform inspections, at no cost to the cities or the county, on those facilities owned by the District and on municipal separate storm sewers in unincorporated County. Contracts for such inspections within the cities may be undertaken at the sole expense of the requesting city (See Appendix C and Appendix D).

2. 2. 3 NPDES Permit Reporting Requirements

The following reports will be produced under the auspices of the NPDES Technical Advisory Committee and submitted to the Boards. The report submittal dates are the dates that the compliance reports are due at the Boards.

TABLE 1

NPDES PERMIT PROGRESS REPORT SCHEDULE
PROGRAM REPORT SUBMITTAL

Water Quality Monitoring	Annually 11/30
Reconnaissance Survey	Annually 1/31
Drainage Area Management Plan Status	Annually 8/31
Fiscal Analysis	Annually 8/31
Data Analysis	Annually 1/31
Program Analysis	Annually 3/31

2.2.4 DAMP Implementation And reporting Schedule

The reports and tasks required by this DAMP are listed in Appendix A (See Appendix B for Co-Permittee Implementation Plan).

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2.2.5 Budget

The County will be responsible for preparing draft annual budgets for shared program costs, to be approved by the Co-permittees. In addition, the County will track shared program cost expenditures and prepare financial reports which will be distributed to all the co-permittees.

2.2.6 Program Representation

The County is a member of the State Water Resources Control Board Storm Water Quality Task Force which assists the SWRCB in developing the NPDES Storm Water Permit Program. The County will continue participating in the Task Force and will report activities to the co-permittees on a regular basis.

2.2.7 Planning

In accordance with the Implementation Agreement the County will administer and coordinate Program Planning and Development.

2.2.8 Co-Permittees having Watershed Boundaries Outside Those Covered By Sanat Ana And San Diego region NPDES Permits

Those co-permittees in compliance with a stormwater permit issued by either the Santa Ana or San Diego Regional Water Quality Control Boards shall be deemed in compliance with this DAMP even though portions of their drainage boundaries extend to other Regional Water Quality Control Board jurisdictions.

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3.0 PLAN DEVELOPMENT

3.1 Regulatory Requirements

Section 101-Declaration of Goals and Policy-of the Clean Water Act, as amended by the Water Quality Act of 1987 states:

"It is the national policy that programs for the control of nonpoint source pollution be developed and implemented in an expeditious manner so as to enable the goals of this Act to be met through the control of both point and nonpoint sources of pollution."

EPA regulations require that storm water quality management plans include programs that address four types of pollutant sources (1) Runoff from commercial and residential areas; (2) Runoff from industrial sites; (3) Runoff from construction sites; and (4) Non-storm water discharges.

According to the regulations, an overall drainage area management program shall include a comprehensive planning process incorporating public participation and intergovernmental cooperation. The drainage area management program shall also meet the "Maximum Extent Practicable" (MEP) standard of pollutant control. The proposed program shall also describe priorities for implementing controls on a system wide basis, a watershed basis, a jurisdiction basis, or on individual outfalls.

The regulations also identify specific elements for addressing runoff from commercial and residential areas. These elements are:

- A program for maintenance activities for structural controls.
- Planning procedures to assess stormwater quality and to implement appropriate controls to reduce pollutant discharges from areas of new development and significant redevelopment.
- Planning procedures to assess flood water management project impacts on the water quality of receiving water bodies.
- A program to evaluate the possibility of modifying existing stormwater facilities and/or stormwater maintenance programs to reduce pollutants in stormwater discharges.
- A program to monitor runoff from municipal waste treatment, storage, and disposal facilities.
- A program to monitor municipal storm drain water quality.

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- o A program to reduce pollution associated with the application of pesticides and fertilizer

The NPDES permits require development and implementation of best management practices to control the discharge of pollutants to waters of the United States. The vehicle for this BMP implementation is the Drainage Area Management Plan (DAMP) which shall include modifications to existing BMPs and other storm water system management programs to reduce pollutants in the storm water discharges from industrial, commercial, and residential areas to the maximum extent practicable. Specific requirements are:

- o Structural controls.
- o Nonstructural controls such as education programs, management practices, and regulatory approaches.
- o Enforcement programs.

In addition, an implementation plan is required in the DAMP for site specific structural and non-structural BMPs at construction sites (Commercial/Industrial construction sites disturbing one acre or more of total land area and residential construction sites disturbing 5 acres or more). An implementation plan is also required to assure that runoff from all new development or significant re-development is appropriately managed to the maximum extent practicable. NOTE: Both plans were completed early in 1993.

3.2 Plan Development

3.2.1 Approach To Plan Development

This DAMP has been developed to accomplish the objectives summarized in the Executive Summary and in Section 1.1.

The DAMP elements fall in to two general categories: prevention of pollutant introduction into the drainage system and removal of pollutants from the drainage system. The prevention-oriented elements include identification and elimination of illegal discharges, continued supervision of permitted industrial discharges, the early implementation of non-structural BMPs throughout the County in new developments and existing communities, and the continued use of structural and non-structural on-site BMPs for construction projects.

The removal-oriented element is a watershed planning program for structural BMPs. Water quality problems will be identified through the monitoring program. Watersheds will be considered using the principles of MEP. Watersheds determined to require additional BMPs will be surveyed for potential retrofitting. Existing flood control, retarding, sediment control, water conservation, recreation, habitat, and greenbelt facilities

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will be evaluated in terms of their potential for modification to provide water quality benefits. Where retrofitting opportunities are not found, new structural BMPs will be considered, using the principles of MEP.

New structural BMPs will be selected from candidate BMPs which have been field-tested and evaluated as to their pollutant removal efficiency and cost effectiveness. New structural BMPs will be planned and located to maximize their cost-effectiveness.

Structural BMP program costs will be distributed among existing developed communities and newly developing areas in proportion to their responsibility for the recognized water quality problem, as far as possible. This is not intended to preclude the use of structural BMP's within new developments to address problems identified in the watershed planning process.

3.2.2 BMP Selection

Candidate non point source (NPS) control measures will be selected from review of technical literature, review of existing NPS control programs, and input from consulting firms and municipalities already involved in NPS control program implementation.

A summary of existing BMPs within Orange County is presented in Table 2. Collectively these existing BMPs provide a significant level of control for the target NPS pollutants identified in the federal regulations and the Region 9 NPDES permit. Furthermore, these existing BMPs include the permit-required structural and non-structural controls and function as pollutant controls in industrial, commercial and residential areas. The DAMP focuses on improving these BMPs and setting out a timetable for countywide implementation (see Section 5.0). The DAMP also considers new residential and commercial/industrial sites (Section 7.0) and construction sites (Section 8.0). Recognizing the need for a coordinated effort to insure the successful implementation of structural controls for storm water quality management, Sections 7.0 and 8.0 have provided for BMP development under the guidance of steering groups that included both public and private sector representation.

3.2.3 Plan revision

The NPDES Technical Advisory Committee will review, and submit to the Co-permittees for local approval, the DAMP and amendments to the DAMP. The documents will then be submitted to the Regional Water Quality Control Boards.

3.2.4 Public Participation

Public participation in the preparation and amendment of the DAMP will be encouraged in accordance with the NPDES Stormwater Permits.

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3.3 Financing

3.3.1 Watershed Structural BMPs

Financial requirements for construction, operation and maintenance of watershed structural BMPs will be studied. Appropriate financing programs will be proposed, including consideration of means to assure appropriate participation by land developers and project proponents.

3.3.2 Operation And Maintenance

Those structural BMPs which are retrofitted onto existing structures will continue to be operated and maintained by the present owners. The planning process will include consideration and determination of maintenance responsibility for each new structure. A funding source for the operation and maintenance will be developed by the TAC with the support and discussion of the Co-permittees.

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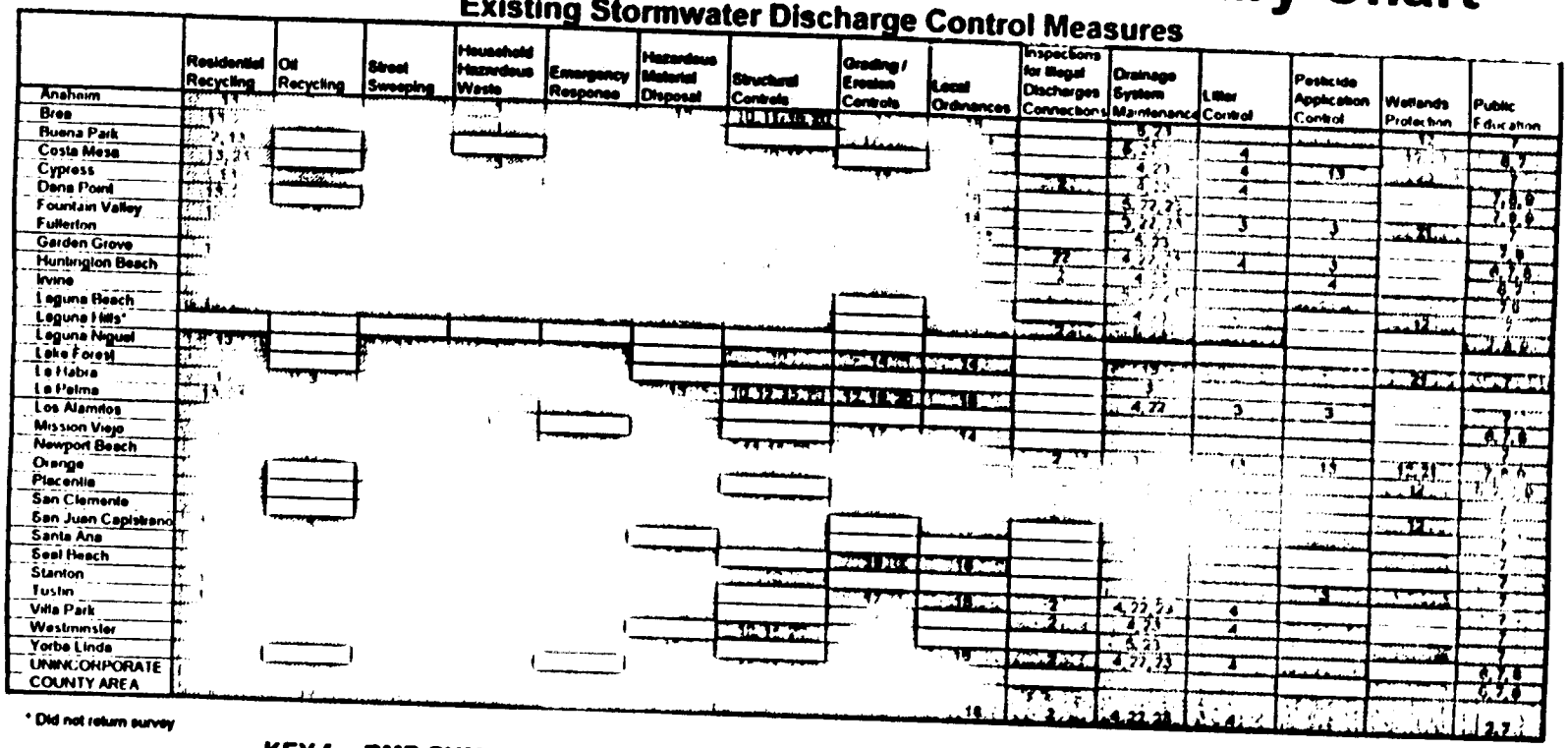
Best Management Practices Summary Chart

Existing Stormwater Discharge Control Measures



* Did not return survey

KEY for BMP SUMMARY CHART

1 Household Hazardous Waste Center established or will be established within city boundaries by the Orange County Fire Dept.
2 Program in the planning stages
3 Has contact or participates in county program
4 As needed
5 At least annually
6 Procedures for oil / hazardous material disposal
7 Information about nonpoint source pollution
8 Newspapers / Newsletters
9 Flyers / Brochures
10 Floodplain Management Controls
11 Stormwater Quality Controls
12 If required by CEQA (California Environmental Quality Act)
13 Handled by contractor
14 Operates under county codes and policies
15 As required by FEMA through Flood Insurance Program
16 Has Industrial Waste Ordinance specific to controlling hazardous material / waste dumping into surface waters
17 Not specific to hazardous material or pollutant discharge control
18 Has adopted Uniform Fire Code Articles for pollution control
19 Has adopted sections of the Uniform Building Code for grading / runoff control
20 Specific controls established on a case by case basis, especially if pertains to new development
21 As required by the US Corps of Engineers, Fish & Game or Fish & Wildlife
22 Drains / Channels
23 Inlets / Catchbasins
24 No curbside - after trash pickup, recyclables are separated at transfer station
25 Pilot program in effect
26 Handled by city Sanitation and Fire in cooperation with EMA

CONTROL MEASURE EXISTS

CONTROL MEASURE DOES NOT EXIST

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4.0 EXISTING LEGAL AUTHORITY

4.1 Introduction

The NPDES Storm Water Permits require implementation of a program to reduce pollutants in storm water discharges from commercial, industrial, and residential areas to the "maximum extent practicable." Central to this program is the establishment, by each municipality, of adequate legal authority to regulate the discharge of pollutants to the municipal separatestorm sewer.

4.2 Regulatory Requirements

Section 402(p) of the Federal Water Pollution Control Act, as amended by the Water Quality Act of 1987, requires that municipal NPDES Storm Water Permit include:

1. A requirement to effectively prohibit non-storm water discharges into the storm sewer.

2. Controls to reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques and system, design and engineering methods and such other provisions as the Administrator or the State determines appropriate for the control of such pollutants.

Regulations, promulgated by EPA on November 16, 1990 (40 CFR 122.26 (d)(2)) require municipal NPDES Storm Water Permit applicants to demonstrate that they have adequate legal authority.

4.3 Authority To Control Pollutant Discharge

The County of Orange obtains its authority to control pollutants in storm water discharges, to prohibit illegal discharges, to control spills, and carry out flood control facility inspections from the Orange County Flood Control Act and the County's Water Pollution Ordinance.

The Orange County Water Pollution Ordinance regulates discharges associated with industrial activity by prohibiting the dumping or discharge of "industrial waste" by any individual in a manner that "will or may cause or result in the pollution of any underground or surface waters..." The ordinance also establishes the requirement for an industry to obtain a permit from the County if it intends to discharge. A permit may be issued if it is found that discharges will not result in pollution of ground or surface waters if it is found necessary to dispose of wastes in such a manner.

The County has the authority to enforce and to administer the provisions contained in the ordinance, including the authority to inspect any violation. The County also has the right to revoke a permit if it sees fit. Of the County's twenty-nine constituent cities, eighteen have adopted a similar or share the same water pollution ordinance.

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In addition to the Water Pollution Ordinance, the Orange County Code establishes its authority to regulate various discharges in other ordinances.

- The County Solid Waste Management Ordinance (or comparable City ordinances) regulates where solid and liquid wastes, including hazardous and industrial wastes may and may not be deposited or discharged.
- The Harbor Sanitation Ordinance prohibits discharge of any refuse matter of any description from shore or sea into the "navigable waters of a harbor."
- The Uniform Fire Code prohibits the discharge of any waste liquid containing crude petroleum or its products "into or upon" any drainage canal or ditch, storm drain, sewer, ... or upon the ground."

4.4 Summary

Under existing codes, Orange County and twenty of the thirty-one cities have adequate legal authority to regulate (control, inspect, and enforce) discharges of pollutants to the municipal storm drains. The County's Water Pollution Ordinance, in particular, establishes authority of the County of Orange to inspect any violations. It is however intended that a Model Ordinance be developed to bring regulatory language "up to date".

4.5 Recommendations

Prepare a study for review and consideration by the NPDES TAC and Co-permittees which:

- Details existing legal authority of each co-permittee.
- Drafts amendments to existing regulations, if necessary, to adequately regulate and control pollutants in stormwater discharges as required by NPDES regulations.

After review and consideration of existing legal authority, the TAC will make recommendations to Co-permittees regarding necessary actions they must take to comply with NPDES regulations.

A committment has been made to retaining consultant services geared to developing a new Model Ordinance for water quality protection, which will be presented to all municipal Co-permittees for consideration as to adoption. The Water Pollution Enforcement Implementation Plan (See Appendix E) also provides considerably more detail on the possible scope of revised regulatory authority as an Appendix to this Drainage Area Management Plan.

4.6 Implementation Schedule

- Select consultant to complete study by July 1, 1992.

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- Submit Water Pollution Enforcement Implementation Plan by October 1, 1992.
- TAC recommendations to Co-permittees by July 1993.

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5.0 PUBLIC AGENCY ACTIVITIES

5.1 Introduction

All of the municipal NPDES Storm Water Permit co-permittees routinely conduct preventive maintenance activities that are widely recognized as effective Best Management Practices for nonpoint source pollutant control. These activities are detailed in Table 2 and include street sweeping, litter control, and catchbasin/drainage facility maintenance. One objective of this component of the Drainage Area Management Plan is to evaluate these existing public agency activities and, where necessary, implement improvements or new practices to reduce the amount of pollutants entering the storm drain system to the maximum extent practicable within financial and staffing constraints.

Initially this evaluation will require documentation of selected maintenance activities by the co-permittees. Data generated by this documentation process will be analyzed by County staff as lead agency for the program. Where differences in water quality can be directly attributed to the presence, absence, particular methodology, or frequency of a maintenance activity, the most effective strategy will be used as the basis for specific activity guidelines which will be developed by the County for consideration by the co-permittees. In addition, the County will undertake a number of site specific investigations to generate additional data for the purposes of evaluating an activity (e.g. Sec. 5.2.5).

Other objectives are set forth in Section 1 including implementing the steps described herein leading to development and implementation of priority watershed plans, and operating and maintaining the watershed plan structures.

5.2 Existing Municipal Government Activities

5.2.1. Litter Control

Litter control is an important element in the diversion of trash and other materials from the storm drain system.

1. Recommendations

   - o Evaluate the need for litter control regulation amongst co-permittees and propose draft ordinance or changes to existing ordinances if necessary (to be performed by the County as part of the legal authority review).

2. Schedule

   - o Report existing litter control regulations and describe existing municipal litter control programs by July 31, 1993.

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5.2.2 Recycling

Community programs for collection and recycling of non-hazardous solid wastes have already been initiated statewide in response to the California Integrated Waste Management Act of 1989.

Municipal programs to collect recyclable materials are currently conducted in twenty-seven of Orange County's twenty-nine cities. In addition, collection centers, as required by California Law, are operated countywide in public places such as shopping centers so that recyclables can be deposited on a daily basis.

No improvements to these programs are proposed as part of the Drainage Area Management Plan. A reporting procedure will be implemented so that the volume of potential pollutants diverted from the storm drain system can be recorded. The specific information to be recorded, will be in accordance with the existing requirements of AB 939.

1. Recommendations

   - o Identify constituent materials (Article 2, Section 41030).
     - Volume
     - % by weight or volume
     - Material type
     - Source of generation (residential, commercial, industrial etc.)
   - o Describe methods used to determine the amount and categories of solid wastes (Article 4, Section 41071).

2. Schedule

   - o Submit a copy of the information required for AB939 (and a brief description of the programs). Include any public education fliers. Submit this information by July 31, 1993 and every year thereafter for use in the annual Progress Reports.

5.2.3 Drainage Facility Maintenance

All of the Orange County co-permittees clean out the storm drain inlets, catchbasins, and lines within their jurisdictions. Generally this work is performed on an as-needed basis.

1. Recommendations

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- o Inspect facilities regularly to determine if service is required.

  - Open Channels: Inspect annually* before storm season, remove debris as necessary.
  - Underground facilities 39" and larger diameter: Inspect every two years*.
  - All facilities: Remove debris and sediment either manually or by mechanical methods, use flushing in emergency situations only.

  * Inspection frequencies will be re-evaluated after one complete system inspection.

- o Special catch basins and other storm drain inlets.

  - Refer to Section 5.2.4.

2. Schedule

- o Co-permittees are to provide sample copies of inspection and maintenance logs. Submit by July 1, 1992. Logs are to include a description of the total volume of material, and estimates of the percentage of paper, plastic material, vegetation, soil and "other" materials.

- o Submit data tables that document the number of catchbasins and drains and length of channel/pipe cleaned per year by July 31, 1993 and every year thereafter for the annual Program Report.

- o Provide specific information on any facility where evidence of chemical contaminants are found. Include the nature and extent of the contaminants, and the location.

5.2.4 Catch Basin Stenciling

The goal of the stenciling program is to label and subsequently maintain labels on stormdrain inlets throughout Orange County. Initially the label will comprise NO DUMPING - DRAINS TO OCEAN written in 3" black letters on either the top of the curb or the curb face adjacent to the inlet. Each co-permittee, however, may implement its own variation of this catchbasin stenciling program.

1. Establish stenciling program and complete by 1995.

2. Schedule

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- Complete catchbasin stenciling by the end of the permit in 1995. Submit number of catchbasins stenciled to date on July 31, 1993 and every year thereafter for the annual progress reports.

5.2.5 Street Sweeping

Currently, all the Orange County co-permittees maintain street-cleaning programs which sweep residential, commercial and industrial areas at least once a month. Most sweep on a weekly basis using rotating brush sweepers.

A method for evaluating the effectiveness of street sweeping county-wide is not currently available. It is recommended that such a procedure be developed.

1. Recommendations

- Obtain the schedule of all street sweeping operations.
- Consider vacuum sweepers when purchasing new equipment because they are more efficient at fine particle removal and can additionally be used for leaf collection and catch basin maintenance.
- Review, implement and enforce parking controls to coincide with sweeper schedule.
- Develop a system for spot testing the amount of loose debris on street surface, and the heavy metal content, as a function of time between sweepings (County as lead agency).

2. Schedule

- Submit the street sweeping schedule by July 31, 1993
- Submit sample copies of any log sheets used for internal documentation of the program.
- Develop and perform feasibility testing on a system for collecting and testing loose debris on street surfaces, and report results by July 31, 1993, for incorporation into the annual Program Report.

5.2.6 Hazardous Materials Management

The activities at various City and County facilities involve the use of hazardous materials and the generation of hazardous wastes. These materials include paints, solvents,

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pesticides, fertilizers and motor oil As a matter of policy, used motor oil and motor oil filters will be recycled or managed as hazardous waste.

All municipalities will review and where appropriate implement improvements to hazardous materials management practices. These practices may be structural, such as covering storage/transfer areas and construction of secondary containment structures, and non-structural such as improved inspection procedures.

1. Schedule

   - o Prepare a list of improvements made to public facility hazardous material storage sites (defined as sites at which there are hazardous materials stored in quantities greater than or equal to 55 gallons, 500 lbs., or 200 cu. ft.) to reduce potential discharge of pollutants to the stormdrain. Submit updated list by July 31, 1993 and every year thereafter for the annual Progress Reports.

5.2.7 Household Hazardous Waste Collection

Orange County has an effective household hazardous waste collection program administered by the Integrated Waste Management Department. Refer to Section 6.3.2 for a detailed description of this program.

1. Recommendation

   - o Provide data to demonstrate the effectiveness of the program.

2. Schedule

   - o Provide, by July 31, 1993, and every year thereafter, a summary of information on toxic roundups and materials collected, plus data generated by the Integrated Waste Management Program.

5.2.8 Emergency Spill Response

The Orange County Hazardous Materials Area Plan has been adopted by nineteen County municipalities. For these, planned responses to a hazardous materials emergency specify the:

1) Incident command during the post emergency period of hazardous materials releases into the county flood control system, spills in public facilities and releases into county tidelands and harbors.

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2) Participation in unified command during the emergency and post emergency period for incidents which threaten surface or groundwaters and releases in public facilities.

3) Direction and monitoring of clean-up activities where municipal jurisdiction and public facilities are involved.

The non-participating municipalities can be expected to develop one or more of their own programs, along similar lines. The Water Pollution Enforcement Plan, also prepared in permit compliance, will specify a schedule for city adoption of a revised ordinance, with criteria for an independent city spill response program, including clear assignment of support function responsibilities.

1. Schedule

- o Identify spill response staff and resources (physical and financial) for each Co-permittee by April, 1993
- o Undertake staff training by June, 1993.
- o Program implementation - June, 1993.

5.2.9 Fertilizer Management

Fertilizer management is the most effective means of controlling nutrient loss from landscaped areas. The development of a proper fertilizer management program (See Appendix F) is thus an important element of the Drainage Area Management Plan. Specific recommendations focus on the implementation of guidelines for public agency activities.

1. Recommendations

- o Establish guidelines for fertilizer application and landscape maintenance.

  - Specify the appropriate type and amount of fertilizer by using soil testing or other techniques.
  - Apply only what is needed or appropriate for the type of plants being grown.
  - To minimize surface runoff incorporate fertilizer into the soil and do not overwater after application
  - Use compost, peat, or mulch where applicable to increases soil porosity and thus water retention
  - Immediately clean up any fertilizer spilled on roads or sidewalks

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- To measure program effectiveness monitor usage rates by chemical category, and presence of fertilizer residues in Receiving Waters.

2. Schedule

- Submit by July 31, 1992 Fertilizer Management Guidelines which would include application frequencies, types of fertilizer used, and concentration per unit area and location of sites where fertilizer is applied (See Appendix F).

- Report by July 31, 1993 and every year thereafter, the amounts of fertilizer used each year, by chemical category.

5.2.10 Pesticide Management

A Pesticide Management Plan will be developed. This plan will address both acute toxicity concerns and chronic exposure concerns associated with all insecticides, rodenticides and herbicides.

1. Acute toxicity problems normally occur when concentrated pesticides are being improperly stored, transported or mixed. Specific management procedures that address acute toxicity concerns are:

- Secure pesticides and application equipment to prevent tipping or excess jarring. Carry these materials in a part of the vehicle totally isolated from people, food and clothing during transportation.

- Bring to the work site only the amount of pesticide needed for the days use.

- Inspect daily for leaks, equipment used to store, transport, mix, or apply pesticides.

- Do accident pre-planning. In the unlikely event of a spill, take the following immediate actions:

  - Stop the spill
  - Warn others
  - Isolate the area
  - Minimize your own and others' risk
  - Contact the designated city/county department for further management and disposal

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2. Consideration of long term chronic toxicity requires much broader program evaluation. OCEMA Public Works Operations, for example, uses new equipment and careful scheduling to maximize the Pacific Flyover habitat value of the Santa Ana River. The framework for that evaluation is detailed below and will be applied in this DAMP:

- o Maintain a list of pesticides and their specific uses. This information should already be documented through Hazardous Material Disclosure Requirements.

- o Establish proper application methods and procedures.

  - Always follow label instructions.
  - Note hazards related to the physical form of pesticide (dust, granular, spray).
  - Apply pesticides in the quantities and frequencies recommended.
  - Maintain application equipment.
  - Consider factors that may influence the type and amount of pesticide used, such as weather/soil conditions, area drainage patterns, and non-target organisms.

- o Establish controls to prevent surface and groundwater contamination.

  - Use only what is needed to prevent excess runoff.
  - Equipment and containers should be cleaned only in areas registered for use of pesticide and where accidental spills will not pollute water resources or contaminate the soil. Water used for cleaning equipment and triple-rinsing pesticide containers should be collected and used to dilute the next pesticide mixture. Triple-rinsed containers can be disposed of as trash.

- o Establish storage and disposal procedures.

- o Evaluate less toxic alternatives to pesticides (eliminate carcinogens, teratogens).

- o Consider whether broad spectrum or single specific use materials might be more appropriate in a given situation.

- o Consider pesticides that degrade more quickly, bind more strongly to soil particles, and have low water solubility.

- o Pesticide use must be supervised or performed by an individual with a California Pesticide Applicators Certificate.

- o A pest control advisor must provide a signed recommendation to an applicator describing the proper methods (e.g., - application rate) for using a specific pesticide or herbicide.

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- Each co-permittee should review State (CCR Title 26) and Federal (40 CFR 162-180) pesticide storage and labeling requirements.

3. Schedule

- Submit a model Pesticide Management Plan incorporating the BMPs by July 31, 1992.

- Report progress on plan implementation by July 31, 1993 and every year thereafter.

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6.0 PUBLIC INFORMATION

6.1 Introduction

Public education is an essential part of a BMP program Developing programs to inform and involve the public can be an effective method for controlling nonpoint source pollution. When a community has a clear idea where the pollution comes from, how it can affect them and what they can do to prevent those affects, it will be more willing to support and participate in program implementation.

6.2 Regulatory Requirements

The federal regulations specifically require, as part of the drainage area management plan, a description of educational activities, public information activities, and other appropriate activities to facilitate the proper management and disposal of used oil and toxic materials (Federal Register/Vol. 55, No. 222, p. 48071).

In addition, the regulations also specify education programs for construction site operators and a program to facilitate public reporting of illicit discharges.

The NPDES permits similarly follow federal requirements and specify as a component of the Drainage Area Management Plan education programs to educate the public on proper disposal of hazardous/toxic wastes. These may include public workshops, meetings notifications by mail, collection programs for household hazardous wastes.

6.3 Public Information And Education

The primary goal of the public education programs is to inform the community about the origins and causes of nonpoint source pollution and to constructively involve the public, municipalities, businesses, industries and development community in the Storm Water Program's objective of controlling nonpoint source pollution at its source. Achievement of this goal will require development of materials to explain the nature of nonpoint source pollution and its significant contribution to water quality impairment and to identify and promote behavioral changes that will contribute to controlling pollutants at the source.

In addition, the program will coordinate activities with other agencies running public information programs such as water districts, sanitation districts, fire departments and community and environmental groups.

6.3.1 Nonpoint Source Pollution Awareness

Raising public awareness of nonpoint source pollution and Orange County's stormwater program will entail development of informational materials aimed at local officials, public

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agency personnel and the general public.

The County of Orange will coordinate a County-wide public awareness program for the benefit of all co-permittees. This will be a regional public outreach program addressing storm water quality problems and solutions applicable to all co-permittees. Individual co-permittees, at their option and expense, may choose to enhance the regional information to address specific storm water quality problems.

The County-wide public awareness program will include placing storm water quality articles in EMA's existing Flood Awareness program newsletters, preparing and distributing a stormwater pollution brochure and poster; and incorporating a storm water pollution features into EMA's County fair booth, community fair booths, and speaking engagements.

Regional public information materials will be distributed to each of the co-permittees who will in turn make the materials available at the Orange County, community and industrial fairs, disaster preparedness fairs, community facilities, and public libraries.

6.3.2 Household Hazardous Waste Collection

Orange County has an active and effective household hazardous waste collection program. This program is administered by the Orange County Integrated Waste Management Department. The goals of the program are to educate residents about household hazardous materials, influence buying habits to decrease the amount of hazardous materials used, and offer a safe and proper method to dispose of hazardous materials.

The program consists of four fixed collection sites and a Community Awareness Program (CAP). The CAP has made numerous public presentations, by staff and trained volunteers, to schools, civic organizations, and private industries. A "Healthy Home" video and a 24-hour hotline are used to promote program awareness.

In addition, many public information strategies are used to inform the public of the availability of household hazardous materials collection centers. These strategies include fact sheets in utility bills, radio and television public service announcements, and newspaper advertisements.

The existing household hazardous materials program fulfills NPDES requirements.

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7.0 NEW DEVELOPMENT

7.1 Regulatory Requirements

The federal regulations specify that drainage area management programs include "a description of planning procedures including a comprehensive master plan to develop, implement, and enforce controls to reduce the discharge of pollutants from areas of new development and significant redevelopment."

The RWQCBs have indicated that the need for individual storm water quality management plans applies equally to private and public works projects. Transportation corridors, schools, parks, flood control projects and other public facilities will thus be subject to the same requirements as planned communities and mini-malls.

The California Government Code prevents city/county regulation of other public entities such as school, sanitation, and water districts. The NDPES permits, however, identify these entities as potential dischargers of storm water to the Orange County drainage area and the expectation is that these entities will work cooperatively with the co-permittees to manage urban Storm Water runoff. These entities include: Caltrans, Universities and Colleges, Metropolitan Water District, Department of Defense, School Districts, Sanitation Districts, Water Districts, and Railroads.

7.2 Program Development

The program will be developed using the principle of Maximum Extent Practicable, and the following application of BMPs.

Each new development will be required to implement appropriate non-structural BMPs in keeping with the size and type of development, to minimize the introduction of pollutants into the drainage system.

Each new development will also be required to implement appropriate "routine" structural BMPs in keeping with the size and type of development. "Routine" structural BMPs are economical, practicable, small scale-measures which can be feasibly applied at the smallest unit of development. Routine structural BMPs may function either to minimize the introduction of pollutants into the drainage system or to remove pollutants from the drainage system. Routine structural BMPs are intended to address drainage water quality impacts inherent in development, and need not be related to any identified water quality problem.

"Special" structural BMPs will be installed in new development to address specific water quality problems identified in the watershed planning process. This requirement may be addressed by providing an on-site "special" structural BMP, or by contributing to the implementation of a structural BMP specified in the watershed plan. "Special" structural

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BMPs are engineered facilities designed to address specific pollutant problems identified in the watershed planning process, runoff management plan, CEQA process, or similar watershed planning. However, it is not the intent of this program to restrict city or county planning commissions or their governing bodies from imposing additional stormwater management requirements as a condition of development.

Compliance with these requirements necessitated development of a program to ensure that storm water quality management is considered during a project's planning phase, implemented during construction, and ultimately maintained for the life of the project. In addition, the program must be adopted and uniformly enforced by all municipalities.

As described in Section 1.0, this DAMP is comprised of preventive and corrective (removal) measures. Applying this concept to new development, it is intended that each new development will implement an approved program of BMPs to minimize the amount of pollution entering the drainage system. The New Development Task Force has developed guidelines for approval and use by Co-permittees and developers. These guidelines include conditions of approval, ongoing land use conditions, covenants, and restrictions, and user education and information.

7.3 Program Planning

The requirement for a post construction storm water quality management plan will be specified in each co-permittee's standard conditions of approval. These conditions will require project proponents to submit for approval a proposal identifying the BMPs that will be incorporated into the project to control non-point source pollutants after construction. Standard Conditions of Approval will be developed and implemented countywide as particular areas of concern are identified. Specific conditions will also be developed, with industry involvement, for certain types of new development such as gas stations, automotive centers, and food outlets.

In order to process storm water pollutant control proposals, planning approval procedures will have to be modified to ensure that these proposals represent "maximum extent practicable" levels of implementation. This modification may include formulation of procedures and guidelines for staff review of submittals, creation of guidance documents or checklists for the reviewing staff, and development of a program to communicate municipal control plan expectations to contractors and developers requiring guidance.

The final planning phase consideration is education, specifically the need to inform developers and contractors of pollutant control requirements for construction of all new developments irrespective of size.

7.4 Program Financing

Each developer will finance and implement the construction site controls specified in this program and will institute the appropriate development BMPs. To the extent the completed area

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of new development even with non- structural BMPs in place can reasonably be expected to contribute to a watershed problem identified in the monitoring and watershed prioritization programs, the developer will also be required to contribute to the watershed program. This could be accomplished by establishing for each watershed a drainage water quality plan and funding program.

7.5 Program Implementation

- Refer to New Development Program Schedule in Figure 1.
- Establish a New Developments Task Force representing Co-Permittees and the BIA to provide program guidance in all aspects of its development and county-wide implementation.
- Develop and implement "non-structural" BMPs and submit initial report.
- Develop and implement "routine" structural BMPs and submit initial report.
- Finalize standard conditions of approval.
- Develop evaluate, and implement cost-effective "special" structural BMPs as indicated by the watershed planning process.
- Develop and adopt site specific conditions of approval for special developments such as gas stations, automotive repair facilities, food outlets, and other potentially significant sources of urban pollutants.
- Develop a guidance document to ensure the uniform processing of storm water quality control plan proposals. This could be modified by individual co-permittees to the extent needed to fit into their permit processing and issuance systems (See Appendix G).
- Develop an education program for developers and contractors. Educational materials and program may include:

  - Brochures
  - Ongoing coordination with construction and development organizations such as the BIA.
  - Providing speakers for seminars and conferences.

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8.0 CONSTRUCTION

8.1 Introduction

Concern over construction sites as a major source of sediment and other pollutants is addressed in the federal regulations, which require a description of a program to implement and maintain structural and nonstructural BMPs to reduce pollutants in storm water runoff from construction sites. Specific components of the program are to include a description of procedures for site planning that incorporate consideration of potential water-quality impacts; a description of requirements for nonstructural and structural BMPs, a description of procedures for identifying priorities for inspecting sites and enforcing control measures that consider the nature of the construction activity, topography, and the characteristics of soils and receiving water quality; and a description of appropriate educational and training measures.

In addition to sediment, construction sites may be a source of pollutants such as paints, lacquers, and primers; herbicides and pesticides; landscaping and soil stabilization residues; soaps and detergents; wood preservatives; equipment fuels, lubricants, coolants, and hydraulic fluids; and cleaning solvents.

These pollutants can leak from heavy equipment, be spilled, or can be eroded by rain from exposed stockpiles. Once released, they may adsorb onto sediment particles and can be transported into the aquatic environment, where they may become available to enter aquatic food chains, cause fish toxicity problems, contribute to algal blooms, impair recreational uses, and degrade the water as a drinking source.

Sediment controls for construction activity directly impacting a watercourse should address sediment transport issues in the watercourse so that the natural quantity of sediment is not significantly changed. Contaminated sediment must be prevented from reaching the watercourse.

8.2 Regulatory Requirements

The municipal NPDES permits state that ... "industrial/commercial construction operations that result in a disturbance of one acre or more of total land area...and residential construction sites that result in the disturbance of five acres or more...shall be required to develop and implement BMPs...to control erosion and siltation and contaminated runoff from the construction sites."

Construction activities disturbing five acres or more of land will also be required to comply with a general Construction NPDES Storm Water Permit from the State Water Resources Control Board. In an April 2, 1992 ruling by the U.S. District Ninth Circuit Court of Appeal, the Court invalidated the exemption granted by USEPA for construction activity on less than five (5) acres, and remanded to EPA for further action. This Permit may be re-opened, as necessary, to accomodate any consequent changes to the definition of construction activity.

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8.3 Existing Construction Practices

All public works construction contracts administered by the co-permittees are governed by "Standard Specifications for Public Works Construction" (the "Green Book"). Green Book Section 7 - "Responsibilities of the Contractor" imposes specific construction practices which are hereby included as Best Management Practices for public works construction. In general, the Green Book requires the Contractor to keep informed of, and at all times observe and comply with, State and National laws and County and Municipal ordinances and regulations.

The Green Book requires contractors, among other things, to: keep equipment in good condition (i.e., no fluid leaks) and insure that equipment and facilities meet requirements of ordinances and laws, keep the work site clean and free from rubbish and debris; use a street sweeper to keep paved areas clean; clear the work site of equipment and unused materials; prevent spillage on haul routes, and immediately remove spillage and clean the area; remove excavated material from catch basins or similar structures; comply with air pollution regulations; provide sanitation and control wastewater; provide water pollution, mud, and silt control to protect channels, storm drains, and bodies of water; and maintain drainage within and through the work site.

In addition, certain public works construction contracts administered by the co-permittees may include Special provisions and approved Standard Plans. Applicable Special Provisions and Standard Plans are hereby included as Best Management Practices for public works construction.

8.4 Existing Sediment Control Programs

8.4.1 Grading Codes

The co-permittees enforce strict grading codes designed to protect slopes from erosion and failure. These codes are also designed to protect watercourses and adjacent property from the effects of eroded soil or blowing dust.

8.4.2 "208" Program

The 208 Areawide Waste Treatment Management Plan, mandated by Section 208 of the Clean Water Act of 1972, was prepared by the Southern California Association of Governments (SCAG), eight participating local agencies, and the Los Angeles, Santa Ana, and San Diego Regional Water Quality Control Boards. The 208 Plan was adopted in 1979 as a management plan for nonpoint source waste and associated water quality degradation.

The Plan addressed nonpoint sources of waste associated with urban, agricultural and construction activities. Agriculture and construction activities were identified as significant sources of sediment to the Upper Newport Bay through direct rainfall and

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drainage across such lands and established drainage channels.

As part of the 208 Plan, the Water Quality Action Plan gives priority to the restoration and protection of the Newport Bay The Action Plan consists of land management practices to reduce sediment at its source and structural measures to localize sediment deposition and facilitate its removal This is proposed through channel stabilization and use of retarding basins. Sediment control activities continue in the Newport Bay Watershed, together with a sediment monitoring program.

8.4.3 Agricultural Best Management Practices

The purpose of the Agricultural Best Management Practices (AgBMP) Program is to reduce the rate of sedimentation in Upper Newport Bay using erosion control measures within the agricultural areas of the San Diego Creek Watershed.

The role of the Orange County Environmental Management Agency (OCEMA), in the AgBMP Program, is to ensure the voluntary implementation of erosion control measures, based on AgBMPs, by The Irvine Company (TIC), the major agricultural land owner, and to report to the Regional Water Quality Control Board (RWQCB).

This role is defined in a Memorandum of Agreement (MOA), of June 1983, between Orange County and the RWQCB. The MOA obliges OCEMA to request landowners in the unincorporated areas of the watershed to develop and implement Resources Conservation Plans. OCEMA is also obliged to submit tri-annual reports, to the RWQCB, detailing the status of AgBMP implementation.

Since the inception of the AgBMP Program, OCEMA has been fulfilling its obligations, under the MOA, with technical assistance from the Riverside-Corona Resource Conservation District.

8.5 Program Development

The problem of construction site erosion and sediment loss has long been recognized by the Co-permittees. Consequently City and County grading ordinances and codes, the Green Book, and Public Works construction specifications already contain adequate requirements for construction practices for erosion control.

Full compliance with NPDES permit requirements, however, will require changes in grading practices to recognize sediment balance concepts, control of regulated materials used on the job site, and control of sediments polluted by contaminants.

Control of stormwater pollution associated with construction will be handled through the existing grading, building permit, and public works contracting process.

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8.6 Program Implementation

- Refer to Construction Program Schedule in Figure 2.
- Establish a Construction Site Task Force under the direction of the NPDES Technical Advisory Committee to provide program guidance in all aspects of implementing a construction stormwater pollution program (See Appendix H).
- Verify to what extent existing codes, ordinances, and public works construction specifications can be applied to stormwater pollution problems. Refer to Section 4 0 for a detailed description of existing legal authority and actions to be taken to comply with Federal regulations.

8.7 Enforcement

Municipal grading and building inspectors will insure compliance with NPDES regulations as part of their present jobs. Inspection program elements specifically addressing stormwater pollution will include:

- Inspection at the beginning of construction to verify that required nonstructural or structural stormwater pollution control measures are in place.
- Inspection during storm events.
- Inspection shortly before notice of completion is filed.

8.8 Stormwater Pollutant Control Plan

Preparation of a stormwater pollutant control plan will be the responsibility of the project proponent. The stormwater pollutant control plan may be incorporated into the erosion control plan. The proponent may delegate the authority to prepare the plan to the contractor. The plan will include those elements specified by terms of the General State Permit, such as:

- Limits of disturbance (e.g. grading, clearing and grubbing, or pavement removal limits).
- An description of sources and nature of stormwater pollutants. On large projects, hydrologic routing of stormwater runoff may be required.
- For construction affecting a natural or unlined watercourse, a description of sediment or other controls to prevent erosion or silting of the watercourse.
- Appropriate Best Management Practices to reduce stormwater pollutants to the maximum extent practicable.

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- Describing non-storm water discharges that can be anticipated.

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FIGURE 1: NEW DEVELOPMENT TIME SCHEDULE

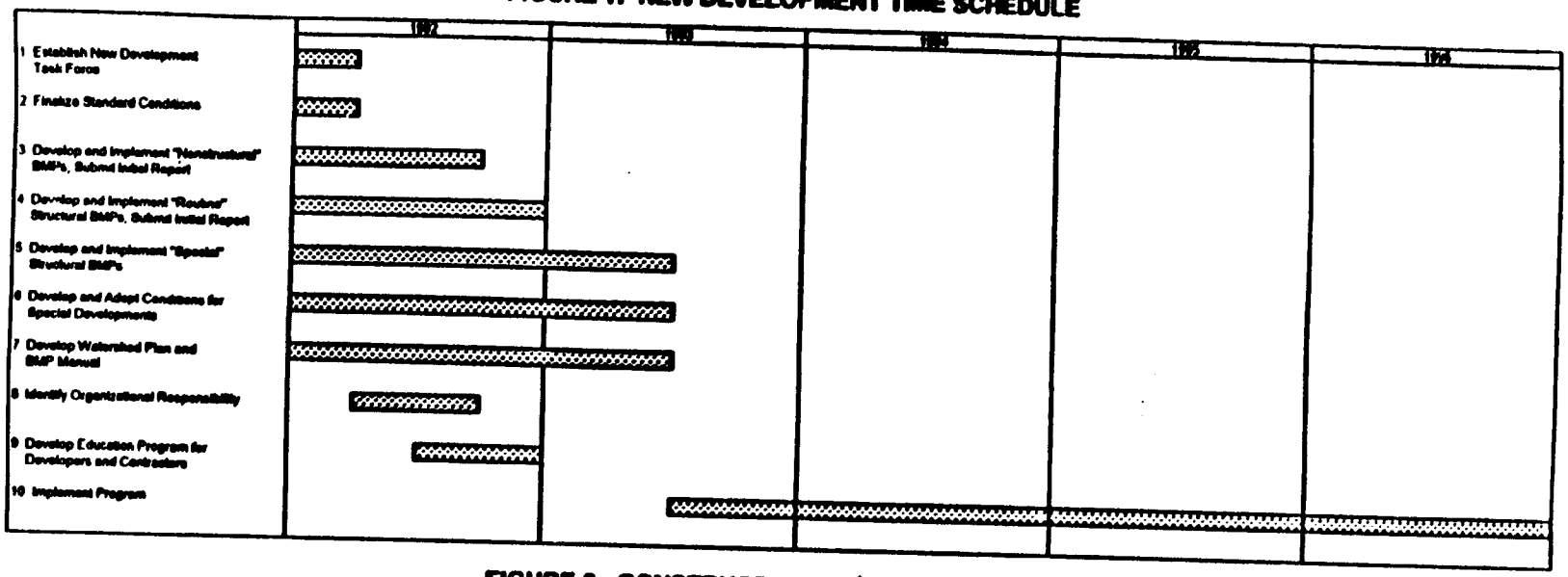
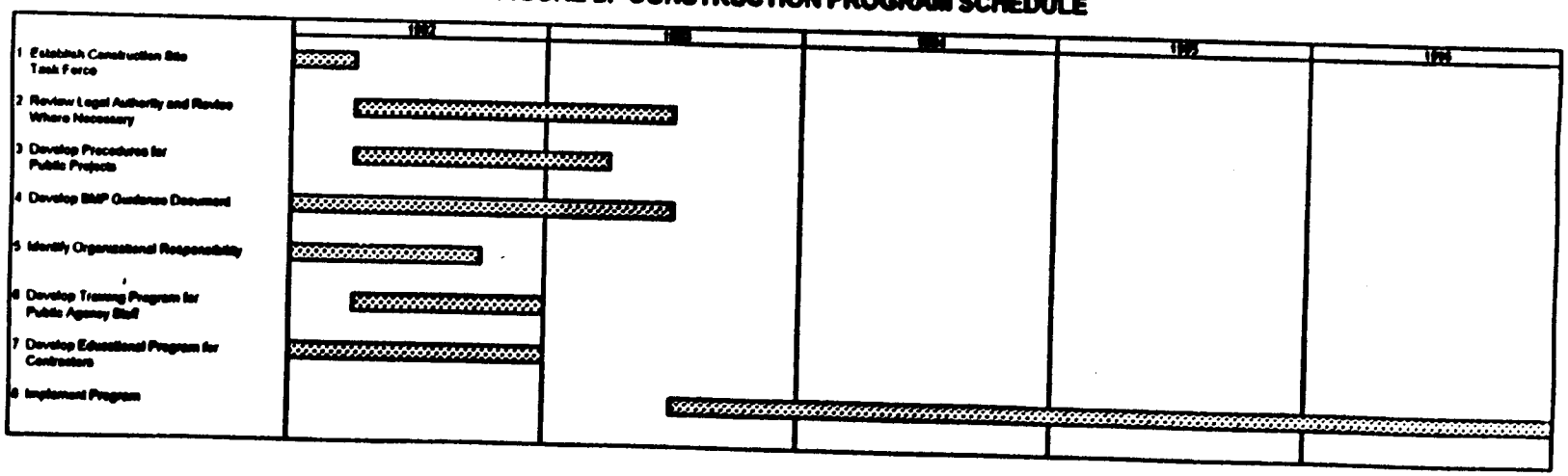


FIGURE 2: CONSTRUCTION PROGRAM SCHEDULE



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9.0 INDUSTRIAL DISCHARGER IDENTIFICATION

9.1 Introduction

The objective of the Industrial Discharger Identification Program is to identify industrial stormwater dischargers in Orange County and notify them of State industrial stormwater permitting requirements This program is designed to provide coordination between the co-permittees and industrial dischargers in order to comply with the separate requirements of municipal and industrial stormwater discharger regulations.

9.2 Regulatory Requirements

Code of Federal Regulations Part 40 Section 122.26 (a) (4) requires industrial stormwater dischargers to notify operators of municipal storm drain systems receiving industrial stormwater discharges. Industrial stormwater dischargers will notify the co-permittee owning the storm drain into which the industrial stormwater flows. Municipal storm water permits issued by the San Diego (No. CA 0108740) and Santa Ana (No. CA 8000180) Regional Water Quality Boards state that industrial dischargers are required to cooperate with the County, and are further required to obtain individual industrial stormwater discharge permits from the Regional Boards.

Regulations proposed after the municipal storm water permits were issued will require industries to apply for coverage under a general regulatory permit issued by the State Water Resources Control Board.

In either case, the regulatory intent is for the co-permittees to maintain records of notifications submitted by industrial dischargers. Regulation of industrial discharges will be a Region or State responsibility.

9.3 Program Development

A central database will be developed which will consolidate the 40 CFR 122.26 (a) (4) notifications, the current NPDES permit holders, and industries whose SIC codes are identified by the State Water Resources Control Board as requiring coverage under the State's General Industrial NPDES Storm Water Permit. The database will provide the basis for a single notification to all the identified industrial facilities informing facilities' staff of the existence of the NPDES storm water program and possible state general permit application requirements. This countywide notification will be undertaken by county staff on behalf of all the co-permittees.

9.4 Program Implementation

- Define and compile database.
- Prepare information pack for industry (See Appendix I).

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- Complete one-time distribution of information materials by July 1992.

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10.0 ILLICIT CONNECTION/DISCHARGE IDENTIFICATION AND ELIMINATION

10.1 Introduction

Major sources of contamination in urban and stormwater runoff are illicit connections and illegal discharges. An example of an illicit connection is any intentional discharge to a municipal separate storm sewer that is not composed entirely of stormwater and that is not covered by an NPDES permit. The discharge does not have to contain particular constituents to be considered illicit. Such an illicit connection becomes illegal when the discharger is notified of the illicit connection and continues the discharge without having obtained an NPDES permit.

The NPDES permits require that the permittees shall effectively eliminate all identified illegal discharges/illicit connections in the shortest time practicable, and in no case later than July 1, 1995. In order to reduce the pollutant load from these sources, a facility inspection and documentation program has been developed by the Co-permittees.

10.2 Regulatory Requirements

The Orange County NPDES Permits, as mandated by Federal regulation, require a reconnaissance survey be conducted to identify illicit connections and illegal discharges to the storm drain systems. On January 31, 1991, a proposed field manual was submitted to the Santa Ana and San Diego Regional Water Quality Control Boards outlining general procedures for inspecting the drainage facilities and detecting contamination. The permits also include requirements for:

- Ordinances prohibiting illegal drainage entries and improper disposal (see Section 4.0).
- An implementation plan for prosecuting violators and eliminating illegal discharges, to be submitted by January 31, 1992 (see Appendix E).

10.3 Program Development

Draft inspection procedures were prepared by the Orange County Environmental Management Agency/Public Works Department and presented to the co-permittees for review (See Appendix J). The proposal submitted to the Water Quality Control Boards establishes facility inspection frequencies, documentation requirements, and pollution reporting procedures.

Open storm channels, retention basins and other above ground facilities will be inspected on an annual basis. Underground storm drains with diameters of 39 inches or greater will be inspected biennually. Facility inspection frequencies will be re-evaluated in cooperation with the Cities and the RWQCB's after all co-permittees have completed the first round of inspections. Based on this review, the frequencies may be modified.

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Inspectors will be responsible for maintaining the proper program documentation Any suspected illegal discharge discovered during inspections must be recorded on a field log and reported to the appropriate water pollution response/enforcement agency for further investigation. All undocumented drainage entries will also be logged, identified on a map and forwarded to the appropriate local agency for verification of permit status. Action will be taken to approve undocumented connections into the municipal storm drain system by permitting or pursue abatement of those entries if determined to be illegal.

10.4 Program Implementation

The County and the City of Huntington Beach have implemented facility inspection programs The remaining Cities will be submitting implementation schedules to be included in the January 31, 1992 Reconnaissance Survey progress report. The progress report will also contain the following information:

- Analysis of the inspection results.
- Information used to identify illegal discharges/illicit connections (i.e., - visual observations, land use).
- A list of identified or suspected illegal dischargers.
- Identify large industrial facilities where hazardous/toxic substances are stored and/or used.
- Provide a list of local landfills, hazardous waste disposal, treatment, and recovery facilities and any known spills, leaks or other problems in the area.
- A discussion on all activities, related to the survey, conducted during the past year.

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11.0 WATER QUALITY MONITORING PROGRAM

11.1 Introduction

A water monitoring program (See Appendix K) has been developed and implemented to aid in the detection and control of illicit/illegal discharges to municipal separate storm drain systems. The Co-permittees will utilize information from the monitoring program and other sources to identify the source(s) of pollution for each identified problem. The monitoring program includes field screening, storm sampling and; dry-weather sampling to identify sources and concentrations of pollutants.

The identification of sources which contribute pollutants to storm sewers is a critical step in characterizing the nature and extent of pollutants in discharges and in developing appropriate control measures.

11.2 Regulatory Requirements

Federal regulations require operators of municipal storm sewers to develop a "proposed monitoring program for representative data collection for the term of the permit that describes the location of outfalls or field screening points to be sampled (or the location of instream stations), why the location is representative, the frequency of sampling, parameters to be sampled, and a description of sampling equipment."

The objectives of the monitoring program as stated in the Permit are:

- To define the type, magnitude (concentration and mass load) and sources of pollutants in the storm water system discharges within each permittees respective jurisdiction so that appropriate pollution prevention and correction measures can be identified;
- To evaluate the effectiveness of pollution prevention and correction measures; and
- To evaluate the compliance with water quality objectives established for the storm water system or its components.

11.3 Program Development

From 1973 to 1990, the Environmental Resources Division of the County of Orange Environmental Management Agency conducted routine water quality monitoring on drainage facilities which are tributary to water bodies identified as waters of the state by the San Diego and Santa Ana Regional Quality Control Boards. The receiving waters were also monitored routinely to assess the chronic effects on established beneficial uses.

When the storm channel monitoring program was initiated in 1973, monthly nutrient and trace

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element sampling was performed at several locations Sediment samples were collected semiannually to assess the impact of contaminant deposition and adsorption Additional constituents such as mercury, selenium, DDT, PCBs and radioactivity were also evaluated on a semiannual basis to address public concerns regarding the pollution threat from these constituents.

In order to bring the existing program in full compliance with new federal NPDES regulations, field screening to detect gross contamination was added to the program. The number of sampling sites in the channels and receiving waters were also increased in order to better assess the amount and type of contamination in storm water and urban runoff.

In addition, it is proposed that the program assess the impact of selected, permitted NPDES discharges including the runoff from nurseries in the San Diego Creek watershed. Information gathered during the life of the permit will be used in developing future monitoring programs.

11.4 Program Implementation

The monitoring program for storm channels and receiving waters consists of field screening (channels only); dry-weather, flow-composite, sampling; and storm sampling.

Field screening will be used to detect gross contamination which may be indicative of illegal disposal of pollutants. Monitoring locations were sited on channels which have drainage areas greater than one square mile or which have industrial (manufacturing) land uses in the drainage areas. Reports exhibiting elevated concentrations of field-screening constituents will be referred to the EMA Water Pollution Section for further investigation.

Data from dry-weather and storm sampling will be used to estimate the total annual volume of contaminants discharged by each monitored channel. These monitoring locations will be in channels which are identified in the permits as "Waters of the State", or will be in major tributaries to "Waters of the State".

Monitoring locations include 90 field screening stations, 34 channel sampling stations, and 20 sampling stations within the harbors and bays throughout the County.

Storm monitoring of channels will also be used to evaluate the level of contamination during and after storm events. Samples will be analyzed from the first 4 hours of the storm (first flush), the next 20 hours, and from two consecutive 36 hour periods (after the first day). These data will be used to compute four-day average, contaminant concentrations.

The receiving water monitoring program includes stations in the Huntington Harbor; Sunset, Anaheim, and Bolsa Bays; Upper and Lower Newport Bays; and Dana Point Harbor. These stations will also be monitored during and subsequent to storms for the same contaminants as in the channel monitoring program.

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In the channel and receiving water monitoring programs semiannual sampling of bed sediment will also be conducted to determine the chronic effects of storm water runoff.

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COUNTY OF ORANGE

ENVIRONMENTAL MANAGEMENT AGENCY

SANTA ANA, CALIFORNIA

REGULATION FUNCTION
Robert F. Wingard, Director

Prepared by
Chris Crompton, Manager, Environmental Resources Division
Richard Boon, Supervisor, Stormwater Section and
Ward Allebach, Environmental Resources Specialist

DRAINAGE AREA MANAGEMENT PLAN
IMPLEMENTATION PLAN

April 22, 1993

MICHAEL M. RUANE
Director

ORANGE COUNTY BOARD OF SUPERVISORS

ROGER R. STANTON
First District

HARRIETT M. WIEDER
Second District

GADDI H. VASQUEZ
Third District

WILLIAM G. STEINER
Fourth District

THOMAS F. RILEY
Fifth District

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ATTACHMENTS

Attachment 1: Reporting for the Reconnaissance Survey Progress Report
Attachment 2: Reporting for the DAMP Implementation Report
Attachment 3: Reporting for the Fertilizer/Pesticide Management Progress Report
Attachment 4: Reporting for the Fiscal Analysis Report

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ATTACHMENT 1

Reconnaissance Survey Progress Report

Annual Reporting Forms and Procedures

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RECONNAISSANCE SURVEY PROGRESS REPORT

Annual Reporting Forms and Procedures

1 0 INTRODUCTION

As detailed in the DAMP Implementation Plan, an annual report of progress made toward implementation of a drainage facilities inspection program is required of each co-permittee for inclusion in the annual Reconnaissance Survey Progress Report, due to the Regional Water Quality Control Boards annually by January 31.

2.0 PURPOSE OF THE REPORT

The Reconnaissance Survey Progress Report is intended to reflect co-permittee action toward eliminating illegal discharges into municipal storm drain systems. For the cities, this includes (1) an inventory of all above ground storm drain facilities and all below ground facilities greater than 39 inches, (2) a report of facilities inspection progress, and (3) a report of investigations of potential sources of illegal discharges (i.e. undocumented connections and updated lists of landfills and hazardous materials facilities within co-permittee jurisdiction).

3.0 PROCEDURES

Co-permittees must complete two reports -- a Reconnaissance Survey Summary Chart and a Suspected Illegal Discharges Report -- and submit them to County Stormwater Staff by December 15 of each year. A brief discussion of reconnaissance survey activities, to be completed through questionnaire, should also be included. A further explanation of how to complete these reports follows:

3.1 Reconnaissance Survey Summary

Co-permittees must report reconnaissance survey activities for all above ground drainage facilities and all below ground facilities greater than 39 inches in diameter. For these, co-permittees must report (1) the total miles of facilities in their jurisdiction, (2) the miles of facility inspections completed in the previous year, (3) the date that the current cycle of inspections began and the miles and percentage of total miles inspected in the cycle, (4) the number of suspected and/or actual illegal dischargers found in the previous year and (5) the number of undocumented connections found in the previous year.

Notes on Completing the Reconnaissance Survey Summary:

1.) According to the DAMP, co-permittees are required to complete inspection of all facilities every two years. A "cycle" (as referred to above) refers to a completion of inspections.

2.) "Total Miles of Facilities Inspected" and "Percentage of Facilities Inspected" both refer to facilities inspected since the last report, not a cumulative total.

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3) Undocumented connections are not to be considered "potential" illegal discharges

4) Under "Comments," be certain to characterize the origins or suspected origins of the undocumented connections found by facility inspection crews as being residential, commercial or industrial. For example, a statement such as "The majority of the 35 undocumented connections found originated from residential area swimming pools" would suffice

5) All suspected and actual illegal discharges reported in this summary chart must be completed on the Illegal Discharges Report.

6.) Do not report the results of routine inspections on the summary chart; if submitted, these should be included as an addendum to the report.

3.2 Suspected Illegal Discharges Report

Co-permittees must complete a list of all suspected and actual illegal discharges into city storm drain systems identified in the previous year. In keeping with the requirements of the permits, this list must include (1) the channel into which the discharge occurred, (2) the major adjacent land uses served by the channel (residential, commercial or industrial), (3) identification of suspected illegal dischargers, (4) the date of discharge, (5) visual observations of discharges (color, turbidity, etc.) and (6) the main water body receiving flow from the drainage facility. This information should have been compiled through the implementation of the Reconnaissance Survey Field Inspection and Documentation Manual, distributed to co-permittees in 1991.

Note that illegal discharges are considered "suspected" until they have been resolved through the proper authoritative channels.

3.3 Reconnaissance Survey Questionnaire

Co-permittees must include a brief discussion of the programs implemented in each calendar year related to the Reconnaissance Survey and their effectiveness in identifying and eliminating illegal discharges and illicit connections to the storm drain systems within their jurisdiction. A questionnaire has been developed and will be updated as needed for each annual report.

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SUSPECTED ILLEGAL DISCHARGES REPORT

City of _____

Channel/Drain (list by facility number)	Area Served By Channel/Drain			Suspected Discharger Identification			Date of Discharge	Description of Discharge	Receiving Waters
	Residential	Commercial	Industrial	Name	Location	Type of Facility			
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

Report Completed By _____

Title _____

Phone _____ Date _____

R0058455

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RECONNAISSANCE SURVEY SUMMARY

City of _____

Type of Facility	Total Miles of Facility	Total Miles Inspected During 1993	Percentage of Facilities Inspected During 1993	Number of Inspection Cycles Completed Since 1991*	Number of Illegal Discharges Identified (Potential & Actual)**	Number of Undocumented Connections Found
Above Ground Drainage Facilities						
Below Ground Drainage Facilities (Over 39" in Diameter)						

* a "cycle" is defined as completion of inspection of all facilities

** refers to (1) "potential" discharges which have not yet been determined to be illegal and (2) "actual" discharges which have been cited in accordance with local ordinance (list as one total, not separately)

Report Completed By _____

Title _____

Phone _____ Date _____

R0058456

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Reconnaissance Survey Questionnaire

City of _____

Your responses to the following questionnaire will assist in completion of the 1994 Reconnaissance Survey Progress Report, due to the Regional Water Boards by January 31, 1993 Please complete and return to the County Stormwater Program **no later than December 15, 1993**, to assure timely submittal of the report.

1.0 The Reconnaissance Survey Summary Chart

1. If your City has not completed one full "cycle" of facility inspections (including both above and below ground inspections), when do you expect to complete one cycle?

   Date _____

2. a. Do your facility inspectors use the standardized form included in the Reconnaissance Survey Field Manual for reporting conditions found during routine inspections?

   _____ Yes _____ No

   b. If not, do they use a form developed by the City?

   _____ Yes _____ No

   c. If so, please submit a copy of the documentation form developed by your City with this report.

   d. If no documentation of facility inspections has been undertaken, when does your City intend to begin documentation?

   Date _____

3. a. Has your city used video cameras for underground inspections?

   _____ Yes _____ No

   b. If not, what inspection method does your City use?

   c. If your City has not begun underground inspections, what method do you intend to use?

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2.0 Illegal Discharges/Illicit Connections

1 If your facility inspectors have discovered illegal discharges to the storm drain system, are steps being taken by your City to investigate and eliminate them, as specified in the NPDES permits?

____ Yes ____ No

If so, describe the steps being taken (attach a separate sheet, if necessary).

2. If any illicit connections were discovered to the storm drain system, were steps taken (or are being taken) to bring them into compliance with local requirements?

____ Yes ____ No

If so, describe the steps being taken.

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3. If any undocumented connections were discovered, please characterize the land use of the surrounding areas as residential, industrial or commercial below. If records have not been kept concerning land use surrounding the location of undocumented connections, please estimate the percentages (i.e. "about 50 percent residential, 25 percent industrial," etc.).

Undocumented Connections

Residential	Industrial	Commercial

3.0 Other Reconnaissance Survey Data

1 a. A computer database was made available to co-permittees in 1993 for documenting illegal discharges and illicit connections Was this database utilized by your City?

_____ Yes _____ No

b Does your City maintain its own computer database for documenting illegal discharges and illicit connections?

_____ Yes _____ No

c. Is your City considering such a database?

_____ Yes _____ No

2. a. Does your City conduct its own facility inspections or is the work contracted?

_____ Yes _____ No

b. If the work is contracted, who is performing the inspections?

_____

3. a. The County held a reconnaissance survey workshop for drainage facility inspectors August 1992. Have your City inspectors participated in any further training for facility inspections?

_____ Yes _____ No

b. If so, please describe this training (sponsored by, when, where, etc.).

c. Is there a need for further County-sponsored training programs?

_____ Yes _____ No

4. Other than the programs mentioned in this questionnaire, has your City initiated any other programs to identify and eliminate illegal discharges and illicit connections to the storm drain system?

_____ Yes _____ No

If so, please describe.

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ATTACHMENT 2

Drainage Area Management Plan Status Report

Annual Reporting Questionnaire

R0058460

DRAINAGE AREA MANAGEMENT PLAN

Annual Status Report

City of _____

I. DAMP Section 4, Legal Authority

1. Has the City adopted an ordinance to provide adequate legal authority to regulate discharges to municipal storm drain systems and to implement the programs of the DAMP? If so, when?

Yes _____ No _____

II. DAMP Section 5, Public Agency Activities

(If a specific section of the DAMP has not been completed or is in the process of being completed, please indicate progress toward implementation or the status of the program under "comments." Attach a separate sheet, if necessary.)

1. Attach a report or existing litter control regulations with a description of existing litter control programs (Section 5.2.1)?

Comments on litter control program effectiveness and future plans.

2. Attach a copy of the recycling information required for AB 939 (Article 2, Section 41030), a brief description of the programs and any public education material developed or distributed by the City (Section 5.2.2).

Comments on recycling program effectiveness and future plans.

3. Regarding the facility maintenance program, please attach the following (Section 5.2.3):

   A. Copies of facility inspection and maintenance logs detailing total volume of material removed from city drainage facilities since the last report and estimating the percentage of paper, plastic, vegetation, soil and "other" materials.

   B. Data tables that document the number of drains and length of channel/pipe cleaned since the last report.

   C. Any specific information on facilities where evidence of chemical contaminants have been found since the last report, including the nature, extent and location of the contamination identified.

Comments on drainage facility maintenance program effectiveness and future plans.

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4. How many catchbasins have been stenciled with the phrase "NO DUMPING -- DRAINS TO OCEAN" or with a variation on the phrase (Section 5.2.4)?

Phrase Used _____

Number of Catchbasins Stenciled _____

Comments on catchbasin stenciling program.

5. Attach copies of street sweeping schedules and sample log sheets used for internal documentation of the street sweeping program (Section 5.2.5).

Comments on street sweeping program effectiveness and future plans.

6. Attach an updated list of improvements made to public facilities for storage of hazardous materials, as defined in the DAMP Section 5.2.6.

Comments on hazardous materials management program effectiveness and future plans.

7. Submit a summary of any information or data gathered from toxic roundups and household hazardous waste collections in the last year (Section 5.2.7). Include quantities and materials collected, public education/information materials distributed and data generated by the Integrated Waste Management Program.

Comments on household hazardous waste collection effectiveness and future plans.

8. A. Have emergency spill response staff and resources been identified (Section 5.2.8)?

Yes _____ No _____

B. If so, has the staff identified undertaken training to implement the County emergency spill response program (Section 5.2.8)?

Yes _____ No _____

Comments on emergency spill response program effectiveness and future plans.

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9 Complete the attached Annual Progress Report for Fertilizer and Pesticide Management.

Comments on fertilizer/pesticide management program effectiveness and future plans.

III. DAMP Section 6, Public Education/Information

1. Describe steps taken by the City in the last year to further public education pertaining to stormwater quality, including materials developed or distributed, events/workshops/ activities attended or coordinated or any other relevant actions taken (Section 6.3). Attach a separate sheet, if necessary.

Comments on public education/information program effectiveness and future plans.

IV. DAMP Section 7, New Development

1. In its standard conditions for project approval, has the City required that developers provide post-construction stormwater management plans to control nonpoint sources of pollution (Sections 7.1 and 7.2)?

Yes _____ No _____

Comments.

2. Has the City participated in the distribution of educational materials to developers and contractors to make them more aware of stormwater quality issues and requirements (Section 7.2)?

Yes _____ No _____

Comments.

3. Has the City adopted the Best Management Practices (BMPs) developed by the County's New Development and Construction Task Force to be recommended at the planning stages for specific types of new development, such as gas stations, automotive centers and fast-food outlets (Section 7.3)?

Yes _____ No _____

Comments.

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V. DAMP Section 8, Construction

1 Has the City ensured that construction projects affecting more than five acres within its jurisdiction have obtained Statewide General Construction Permit coverage prior to issuance of grading, grubbing clearing, surface mining or paving permits (Section 8 2)?

Yes _____ No _____

Comments.

2. Do City grading and building inspectors regularly ensure compliance with NPDES regulations (Section 8.7) through:

A. Inspection at the beginning of construction to verify that required stormwater pollution control measures are in place?

Yes _____ No _____

B. Inspection during storm events?

Yes _____ No _____

C. Inspection shortly before notice of completion is filed?

Yes _____ No _____

Comments on construction inspection program.

I, _____, as a duly designated representative for the City of _____, hereby certify under penalty of perjury that the materials and information presented in this report represent a true and faithful response in accordance with the terms of the co-permittees' NPDES permit.

Signature _____

Title _____

Date _____

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ATTACHMENT 3

Fertilizer and Pesticide Management
Annual Progress Report

R0058465

FERTILIZER AND PESTICIDE MANAGEMENT

Annual Progress Report

City of _____

I. **Fertilizer Management**

1 Were any soils in your jurisdiction tested for compatibility with the fertilizers being used (Section 2.3.1)?

Yes ____ No ____

2. Were qualified fertilizer specialists consulted regarding:

A. fertilizer application rates or timing (Sections 2.3.2 and 2.3.3)?

Yes ____ No ____

B. storage of fertilizers (Section 2.5)?

Yes ____ No ____

C. handling of fertilizers (Section 2.5)?

Yes ____ No ____

3. Were organic or slow release fertilizers used to a greater extent than in previous years (Section 2.2.2)?

Yes ____ No ____

4. Was it necessary to upgrade fertilizer storage facilities to meet the recommendations of the Fertilizer Management Guidelines (Section 2.2.2)?

Yes ____ No ____

If so, how?

5. Did you have any spills of fertilizers in your jurisdiction in the last year?

Yes ____ No ____

If yes, explain the circumstances and the steps taken to mitigate the situation (attach a separate sheet, if necessary, or a copy of the incident report).

6. In the course of the last year, over how many acres of land did your jurisdiction apply fertilizers? _____ acres

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7 Attach a complete list of the fertilizers used in your jurisdiction in the last year, and note any changes in the list from the previous year.

II. Pesticide Management

1. Have all of your pest control personnel (applicators) obtained Qualified Applicators Licenses from the state?

Yes _____ No _____

If no, have they completed the County's equivalent training program (Section 3.3.2)?

Yes _____ No _____

2. Did you test any soils for compatibility with pesticides in the last year (Section 3.3.7)?

Yes _____ No _____

3. Were the recommended inspections conducted, as referenced in the Pesticide Management guidelines, for the following?

A. inspection of pesticide application equipment (Section 3.3.6)?

Yes _____ No _____

B. inspection of contracted and/or in-house pest control crew activities (Section 3.4.1)?

Yes _____ No _____

C. inspection of pesticide storage facilities (Section 3.5)?

Yes _____ No _____

If not, explain.

4. Were the appropriate measures completed for the following, as recommended in the Pesticide Management program?

A. transportation of pesticides (Section 3.5)?

Yes _____ No _____

B. disposal of pesticides (Section 3.5)?

Yes _____ No _____

If not, explain.

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5 In the course of the last year, to how many acres of land did your jurisdiction apply pesticides? _____ acres

6. Have you had any spills or other releases of pesticides in your jurisdiction in the last year?

Yes ____ No ____

If yes, explain the circumstances and the steps taken to mitigate the situation (attach a separate sheet, if necessary, or a copy of the incident report).

7. Submit a complete list of the pesticides you have used in the last year, noting any changes in the list from the previous year (indicate which pesticides contain restricted or Category One chemicals).

III. Integrated Pest Management

1. Does your jurisdiction currently implement Integrated Pest Management (IPM) techniques as recommended in the Management Guidelines for Use of Fertilizers and Pesticides?

Yes ____ No ____

2. If any, list the specific alternatives to pesticides that were employed by your pest control crews in the last year.

3. Have your work crews reduced the number of pesticides in use in your jurisdiction in the last year as a result of IPM?

If yes, quantify the reduction. Yes ____ No ____

Report Prepared by _____

Title _____

Date _____

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APPENDIX A

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DAMP IMPLEMENTATION AND REPORTING SCHEDULE
(Reference Section 2.2.4)

SCHEDULE
The tasks included in this Plan will be accomplished in accordance with the following schedule.

RECONNAISSANCE SURVEY

Progress Report	January 31, 1992
Progress Report	January 31, 1993
Progress Report	January 31, 1994

PLAN FOR PROSECUTING ILLEGAL DISCHARGES

Plan	January 31, 1992
Progress Report	January 31, 1993
Progress Report	January 31, 1994

DRAINAGE AREA MANAGEMENT PLAN

Progress Report	August 31, 1992
Progress Report	August 31, 1993
Progress Report	August 31, 1994

STORMWATER SYSTEM MONITORING PROGRAM

Progress Report	November 30, 1991
Progress Report	November 30, 1992
Progress Report	November 30, 1993
Progress Report	November 30, 1994

RECEIVING WATER MONITORING PROGRAM

Progress Report	November 30, 1991
Progress Report	November 30, 1992
Progress Report	November 30, 1993
Progress Report	November 30, 1994

ANNUAL FISCAL ANALYSIS

Fiscal Report	July 31, 1991
Fiscal Report	July 31, 1992
Fiscal Report	July 31, 1993
Fiscal Report	July 31, 1994

DATA/PROGRAM ANALYSIS

Data Report	January 31, 1991
Data Report	January 31, 1992
Data Report	January 31, 1993
Data Report	January 31, 1994

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APPENDIX B

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City of _____
19___ Fiscal Analysis Summary

MAINTENANCE COSTS

DAMP COST ELEMENT		Previous FY Cost, Dollars		Projected Current FY Cost, Dollars	
		DAMP PORTION	EXISTING PROGRAM	DAMP PORTION	EXISTING PROGRAM
Program Management (Section 2.0 of DAMP)					
Public Agency Activities (Section 5.0 of DAMP)	Litter Control				
	Recycling				
	Drainage Facility Maintenance				
	Catch Basin Stenciling				
	Street Sweeping				
	Hazardous Materials Management				
	Public Property & Street Chemical Spill Response				
	Pesticide & Fertilizer Management				
Public Information (Section 6.0 of DAMP)	Nonpoint Source Pollution Awareness				
	Household Hazardous Waste Collection				
New Development (Section 7.0 of DAMP)					
Construction (Section 8.0 of DAMP)					
Illicit Connection / Discharge Identification & Elimination (Section 10.0 of DAMP)	Facility Inspection				
	Other Efforts to Identify & Eliminate Illicit Connections				
Other Best Management Practices					
TOTALS					

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City of _____
19___ Fiscal Analysis Summary

CAPITAL COSTS

DAMP COST ELEMENT		Previous FY Cost, Dollars		Projected Current FY Cost, Dollars	
		DAMP PORTION	EXISTING PROGRAM	DAMP PORTION	EXISTING PROGRAM
Program Management (Section 2.0 of DAMP)					
Public Agency Activities (Section 5.0 of DAMP)	Litter Control				
	Recycling				
	Drainage Facility Maintenance				
	Catch Basin Stenciling				
	Street Sweeping				
	Hazardous Materials Management				
	Public Property & Street Chemical Spill Response				
	Pesticide & Fertilizer Management				
Public Information (Section 6.0 of DAMP)	Nonpoint Source Pollution Awareness				
	Household Hazardous Waste Collection				
New Development (Section 7.0 of DAMP)					
Construction (Section 8.0 of DAMP)					
Illicit Connection / Discharge Identification & Elimination (Section 10.0 of DAMP)	Facility Inspection				
	Other Efforts to Identify & Eliminate Illicit Connections				
Other Best Management Practices					
TOTALS					

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City of _____
19___ Fiscal Analysis Summary

OPERATIONS COSTS

DAMP COST ELEMENT		Previous FY Cost, Dollars		Projected Current FY Cost, Dollars	
		DAMP PORTION	EXISTING PROGRAM	DAMP PORTION	EXISTING PROGRAM
Program Management (Section 2.0 of DAMP)					
Public Agency Activities (Section 5.0 of DAMP)	Litter Control				
	Recycling				
	Drainage Facility Maintenance				
	Catch Basin Stenciling				
	Street Sweeping				
	Hazardous Materials Management				
	Public Property & Street Chemical Spill Response				
	Pesticide & Fertilizer Management				
Public Information (Section 6.0 of DAMP)	Nonpoint Source Pollution Awareness				
	Household Hazardous Waste Collection				
New Development (Section 7.0 of DAMP)					
Construction (Section 8.0 of DAMP)					
Illicit Connection / Discharge Identification & Elimination (Section 10.0 of DAMP)	Facility Inspection				
	Other Efforts to Identify & Eliminate Illicit Connections				
Other Best Management Practices					
TOTALS					

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APPENDIX C

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ORIGINAL
CLERK OF THE BOARD
ORANGE COUNTY

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National Pollutant Discharge Elimination System
Stormwater Permit Implementation Agreement
Santa Ana/San Diego Regions

- This AGREEMENT entered into as of this 18th day of December, 1990 by the County of Orange, (herein called the COUNTY), the Orange County Flood Control District (herein called the DISTRICT and the Cities of Anaheim, Brea, Buena Park, Costa Mesa, Cypress, Dana Point, Fountain Valley, Fullerton, Garden Grove, Huntington Beach, Irvine, Laguna Beach, Laguna Niguel, La Habra, La Palma, Los Alamitos, Mission Viejo, Newport Beach, Orange, Placentia, San Clemente, San Juan Capistrano, Santa Ana, Seal Beach, Stanton, Tustin, Villa Park, Westminster, and Yorba Linda (herein called the CITIES) establishes the responsibilities of each party with respect to compliance with National Pollutant Discharge Elimination System (NPDES) Stormwater regulations administered by the United States Environmental Protection Agency (EPA) under the authority granted by the Clean Water Act (CWA) and its 1987 amendments, the Water Quality Act (WQA).

RECITALS

Whereas

Congress in 1987 amended Section 402 of the Federal Clean Water Act (33 U.S.C.A. 1342(p)) to require the federal Environmental Protection Agency to promulgate regulations for applications for permits for stormwater discharges; and

Whereas

These permit regulations will require the control of pollutants from stormwater discharges by requiring a National Pollutant Discharge Elimination System permit which would allow the lawful discharge of stormwaters into waters of the United States; and

Whereas

These EPA regulations will require NPDES permits for discharges from municipal storm sewers on a system-wide or jurisdiction-wide basis; and

Whereas

The Legislature, in enacting the Orange County Flood Control Act, created the Orange County Flood Control District to provide for the control of flood and storm waters; and

Whereas

The powers granted to the DISTRICT include carrying on technical and other investigations, examinations, or tests of all kinds, making measurements, collecting data, and making analyses, studies, and inspections pertaining to water supply, control of floods, use of water, water quality, nuisance, pollution, waste, and contamination of water, both within and without the DISTRICT; and

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Whereas
The CITIES, the COUNTY and the DISTRICT desire to develop an integrated stormwater discharge management program with the objective of improving water quality in the County of Orange; and

Whereas
The California State Water Resources Control Board (CSWRCB) as designee of the EPA has delegated authority to the Regional Water Quality Control Boards-Santa Ana Region (RWQCB-SAR) and San Diego Region (RWQCB-SDR) for administration of the NPDES Storm Water permit application process within the boundaries of their Regions; and

Whereas
The COUNTY, DISTRICT and CITIES have been designated as co-permittees by the RWQCBs; and

Whereas
The COUNTY has been designated as the lead Agency on the permits; and

Whereas
Cooperation between the CITIES, the COUNTY and the DISTRICT to jointly file applications for NPDES Stormwater permits is in the best interests of the CITIES, the COUNTY and the DISTRICT; and

Whereas
The COUNTY is willing to share the expertise of its staff with the CITIES so that they can join in seeking and implementing certain requirements of the NPDES Stormwater permits; and

NOW THEREFORE: The parties hereto do mutually agree as follows:

I. Filing Status. The COUNTY, DISTRICT and CITIES will file the applications for stormwater permits as co-permittees. The COUNTY, the DISTRICT and each individual city will be a co-permittee.

II. Incorporation of Federal Guidelines. The terms of all applicable Federal and State guidelines, as presently written or as changed during the life of this agreement are hereby incorporated by reference and made a part of this AGREEMENT and take precedence over any inconsistent terms of this agreement. Inconsistencies between the terms of the permit and final federal regulations are not applicable unless mandated by court order.

III. Delegation of Responsibilities. The responsibilities of each of the parties shall be as follows:

A. The COUNTY, on a cost-shared basis, shall administer system compliance by

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1. Preparing implementation and annual operating budgets. The budget year shall coincide with the fiscal year of the COUNTY, July 1 - June 30.

   a. The participants shall be permitted to review and approve the annual operating budget for the forthcoming year. Criteria for approval shall be affirmative responses from a majority of the co-permittees which represent a majority of the percentage contribution as described in Section IV. The COUNTY and the DISTRICT will represent one voting co-permittee with their percentage contribution equal to the total of the COUNTY and the DISTRICT as described in Section IV. The review period shall be from November 1 to November 30 of each year with approval of the final budget to be completed by December 15.

   b. The annual operating budget shall not be exceeded without prior consent of the majority of the co-permittees which represent a majority of the percentage contribution.

2. Preparing compliance reports to the Regional Board and providing copies to the co-permittees.

3. Preparing a draft system-wide Best Management Practices (BMP) Program report.

4. Monitoring the implementation and ensuring the effectiveness of system-wide BMPs. This will include field reconnaissance to evaluate structural and procedural BMPs. An annual report to the RWQCB will be prepared presenting the results of these evaluations.

B. The DISTRICT shall, to the maximum extent practicable and on a cost-shared basis except in paragraph 4 below,

1. Perform the water quality and hydrographic monitoring for permit compliance.

2. Administer the water pollution control program by enforcing the Orange County Water Pollution Ordinance.

3. Develop uniform criteria for annual

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inspection of drainage facilities.

4. Perform inspections, at no cost to the CITIES or the COUNTY, on these facilities owned by the DISTRICT and on municipal separate storm sewers in unincorporated County. Contracts, for such inspections within CITIES may be undertaken at the sole expense of the requesting city.

C. The CITIES shall, to the maximum extent practicable and at no cost to COUNTY or DISTRICT,

1. Implement a facility inspection program in accordance with the uniform criteria developed by the DISTRICT, for all municipal separate storm sewers as defined by the stormwater permit and within the jurisdictional boundaries of that city.

2. Submit to the COUNTY, storm drain maps with periodic revisions which reflect the modifications that were made to the storm drain system.

3. Prepare watershed characterizations, including:

a. Zoning designations and

b. Identification of areas where hazardous materials presently are or are suspected to have been stored, manufactured or disposed of. This shall include sites at which a hazardous material spill has occurred.

4. Review, approve, and implement system-wide BMPs.

5. Eliminate or have eliminated, illegal/illicit connections to the storm drain system.

6. Identify the legal authority for control of discharges to the storm drain system.

7. Provide to the COUNTY annual reports (on forms provided by the COUNTY) and any other information needed to satisfy annual reporting requirements of the RWQCBs.

8. Adopt and enforce, or name DISTRICT as enforcer of a water pollution control ordinance, which prohibits non-NPDES permitted discharges to the municipal

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separate storm sewer system.

D. The COUNTY shall, to the maximum extent practicable and at no cost to the CITIES or the DISTRICT, undertake in the unincorporated areas of the COUNTY, all activities required above of the CITIES that are not responsibilities of the DISTRICT as outlined in Section III. B.

IV. Program Costs. The responsibilities for payment of all shared costs of equipment, services, contracted analytical services, and the cost of the Regional Board permits, shall be distributed among the DISTRICT, COUNTY and CITIES as follows:

Participant	Percentage Contribution
DISTRICT	5
CITIES + COUNTY	95

The individual percentage contributions from each city and the COUNTY shall be functions of their respective areas and populations relative to those of the entire County. Each shall be calculated as one half of the sum of the area and population fractions, multiplied by 95. Excluded are national forests, state parks, airports, landfills, oceans, harbors, tidal bays and military installations. The contribution of the COUNTY shall be calculated from unincorporated areas and their respective populations.

$$\text{Share in percent for City \# 1} = \frac{\left[\frac{x_1}{x_{tot}}\right] + \left[\frac{y_1}{y_{tot}}\right]}{2} (95)$$

x = area
y = population
tot = total population or area
95 = total percentage excluding Flood Control District contribution

The percentage shares shall be calculated by the COUNTY EMA Environmental Resources Division from population and area data. These calculations shall be completed by November 1 of each year and shall be included in the annual budget proposal. The initial percentage shares are presented in Attachment 1.

The total of shared costs shall not exceed $1,000,000 for the first year of the program. A deposit which constitutes a share percentage of the total anticipated first year costs shall be required of each city. The

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COUNTY shall send invoices for these deposits to the CITIES within 15 days of the signing of this AGREEMENT by the Board of Supervisors. Each city shall pay the deposit within 45 days of the date of the invoice.

If at any time during a given fiscal year the program costs exceed the sum of the deposits, the COUNTY shall submit invoices to the CITIES to recover the deficit. The share for each city shall be prorated according to the formula above. Each city shall pay the invoice within 45 days of the billing date.

The COUNTY shall prepare a fiscal year end accounting within 60 days of the end of the fiscal year. If the fiscal year end accounting results in costs (net of interest earnings) exceeding the sum of the deposits, the COUNTY shall invoice each city for its prorated share of the excess cost. Each city shall pay the billing within 45 days of the date of the invoice. If the fiscal year end accounting results in the sum of the deposits exceeding costs (net of interest earnings), the excess deposits will carry forward to reduce the billings for the following year.

After the initial billing for the program, the COUNTY shall invoice each city for its annual deposit at the beginning (July 1) of each fiscal year. Each city shall pay the deposit within 45 days of the date of the invoice. Each city's deposit shall be based on their prorated share of the approved annual budget, reduced for any surplus identified in the prior fiscal year end accounting.

Interest earned on the CITIES deposits will not be paid to the CITIES, but will be credited against the CITIES share of the program costs.

Upon termination of the program a final accounting shall be performed by the COUNTY. If costs (net of interest earnings) exceed the sum of the deposits, the COUNTY shall invoice each city for its prorated share of the excess. Each city shall pay the invoice within 45 days of the date of the invoice. If the sum of the deposits exceeds the costs, the COUNTY shall reimburse to each city its prorated share of the excess, within 45 days of the final accounting. Interest earnings are used to offset the CITIES share of program costs and will not be refunded to the CITIES.

Each city and the COUNTY shall bear the financial responsibility for implementing the Program, within its jurisdictional boundaries, as outlined in Section III. C. and D.

The filing fees for the Permits shall be included in

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the first year costs.

V. Life of the AGREEMENT. The life of the AGREEMENT shall be indefinite or as long as the WQA mandates compliance.

VI. Additional Parties. Any city which becomes signatory to this AGREEMENT after the applications for the initial NPDES Stormwater permits have been approved and any city which becomes incorporated shall become a co-permittee on the NPDES Stormwater permit issued by its respective RWQCB and shall comply with all of the provisions of this AGREEMENT. The date of initiation, for determining participant costs for newly incorporated CITIES shall be the date of incorporation, and for a city signing after NPDES Stormwater permit approval it shall be the date of the initial application for the NPDES Stormwater permit. The costs for adding the additional parties to the program, including additional permit and processing fees, shall be paid by the added party. Monies to be reimbursed to the existing co-permittees shall be credited to their respective annual program operating fees for the following budget year.

VII. Withdrawal from the AGREEMENT. A participant may withdraw from the AGREEMENT 60 days subsequent to written notice to the COUNTY. The COUNTY will notify the remaining co-permittees within 10 business days of receipt of the withdrawal notice. The withdrawing participant shall agree to file for a separate permit and to comply with all of the requirements established by the RWQCB(s). In addition, withdrawal shall constitute forfeiture of the withdrawing participant's deposit for the budget year of withdrawal. The withdrawing participant shall be responsible for all lawfully assessed penalties as a consequence of withdrawal. The cost allocations to the remaining members will be recalculated in the following budget year.

VIII. Non-compliance with Permit Requirements. Any participant found in non-compliance with the conditions of the permit within their jurisdictional responsibilities shall be solely liable for any lawfully assessed penalties, pursuant to Section 13385 of the Water Code. Common penalties shall be calculated according to the formula outlined in Section IV.

IX. Legal Action/Costs/Attorney Fees. Where any legal action is necessary to enforce any provision hereof for damages by reason of an alleged breach of any provisions of this AGREEMENT, the prevailing party shall be entitled to receive from the losing party all

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litigation and collection expenses, administrative costs, witness fees and court costs.

X. **Amendments to the AGREEMENT.** This AGREEMENT may be amended by consent of a majority of the co-permittees which represent a majority of the percentage contributions as described in Section IV. The COUNTY and the DISTRICT will represent one voting co-permittee with a percentage contribution equal to the sum of the individual contributions of the COUNTY and DISTRICT as described in Section IV. No amendment to this AGREEMENT shall be effective unless it is in writing and signed by the duly authorized representatives of the majority of co-permittees.

XI. **Authorized Signatories.** The County Director of Public Works and the respective City Engineers or Directors of Public Works, shall be authorized to execute the application(s) for NPDES Stormwater permit(s) and take all other procedural steps necessary to file the application(s) for NPDES Stormwater permit(s).

XII. **Notices.** All notices shall be deemed duly given if delivered by hand; or three (3) days after deposit in the U.S. Mail, postage prepaid.

XIII. **Governing Law.** This AGREEMENT will be governed and construed in accordance with laws of the State of California. If any provision or provisions of this AGREEMENT shall be held to be invalid, illegal or unenforceable, the validity, legality and enforceability of the remaining provisions shall not in any way be affected or impaired hereby.

XIV. **Consent to Breach not Waiver.** No term or provision hereof shall be deemed waived and no breach excused, unless such waiver or consent shall be in writing and signed by the co-permittee to have waived or consented. Any consent by any co-permittee to, or waiver of, a breach by the other, whether express or implied, shall not constitute a consent to, waiver of, or excuse for any other different or subsequent breach.

XV. **Applicability of Prior Agreements.** This document constitutes the entire AGREEMENT between the co-permittees with respect to the subject matter; all prior agreements, representations, statements, negotiations and undertakings are superseded hereby.

XVI. **Execution of the AGREEMENT.** This AGREEMENT may be executed in counterpart and the signed counterparts shall constitute a single instrument.

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IN WITNESS WHEREOF, this AGREEMENT has been executed as of the day and year first above written.

SIGNED AND CERTIFIED THAT A COPY OF THIS DOCUMENT HAS BEEN DELIVERED TO THE CHAIRMAN OF THE BOARD

LINDA D. RUTH 12/18/90
Clerk of the Board of Supervisors
County of Orange, California

COUNTY OF ORANGE

By _____
Chairperson, Board of Supervisors

ORANGE COUNTY FLOOD CONTROL DISTRICT

By _____
Chairperson, Board of Supervisors

SIGNED AND CERTIFIED THAT A COPY OF THIS DOCUMENT HAS BEEN DELIVERED TO THE CHAIRMAN OF THE BOARD.

LINDA D. RUTH 12-18-90
Clerk of the Board of Supervisors
County of Orange, California

APPROVED AS TO FORM:
ADRIAN KUYPER, COUNTY COUNSEL
ORANGE COUNTY, CALIFORNIA

Deputy 10-19-90
Date

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City of Anaheim

By _____
City Manager

ATTEST:

_____
City Clerk

APPROVED AS TO FORM:

_____, Deputy
City Attorney

City of Buena Park

By _____
Mayor

ATTEST:

_____
City Clerk

APPROVED AS TO FORM:

_____
City Attorney

City of Brea

By _____
Mayor

ATTEST:

_____
City Clerk 10-3-90

APPROVED AS TO FORM:

_____
City Attorney

City of Costa Mesa

By _____
Mayor

ATTEST:

_____
City Clerk
City Council approved October 1, 1990

APPROVED AS TO FORM:

_____ 9-17-90
City Attorney

R0058485

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City of Cypress

By [signature]
Mayor

ATTEST:

[signature]
City Clerk

APPROVED AS TO FORM:

[signature]
City Attorney

City of Fountain Valley

By [signature]
Mayor

ATTEST:

[signature] 4/3/90
City Clerk

APPROVED AS TO FORM:

[signature]
City Attorney

City of Fullerton

By [signature]
Mayor

ATTEST:

[signature]
City Clerk

APPROVED AS TO FORM:

[signature]
City Attorney

City of Pine Point

By [signature]
City Engineer or Designated Alternate
Gary Dycart, Deputy City Engineer

ATTEST:

[signature]
City Clerk Mary A. Carlson

APPROVED AS TO FORM:

[signature]
City Attorney Jerry M. Patterson

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City of Garden Grove
By _____
Mayor

ATTEST:
_____
City Clerk
Approved by Council 4/3/90
APPROVED AS TO FORM:
_____
City Attorney

10

REQUEST FOR CITY COUNCIL ACTION

Date: October 1, 1990

APPROVED BY CITY COUNCIL
_____ 19__
_____
City Clerk

Submitted to: Honorable Mayor and City Council

Submitted by: Michael T Uberuaga, City Administrator

Prepared by: Louis F Sandoval, Director of Public Works

Subject: ENVIRONMENTAL PROTECTION AGENCY - NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

Consistent with Council Policy? [X] Yes [ ] New Policy or Exception

Statement of Issue, Recommendation, Analysis, Funding Source, Alternative Actions, Attachments

STATEMENT OF ISSUE:

As part of the U S Clean Water Act, the EPA has initiated a program to clean up our storm waters The program is called the National Pollutant Discharge Elimination System (NPDES) To bring about a more organized and efficient approach to this program, the County of Orange (EMA and Flood Control) and all of the cities in the county have developed a unified program The county has the expertise to do much of the needed investigation and storm water testing throughout the entire county (they have already a limited program in place) and is willing to be the lead agency A committee comprised of the county and all of the cities has developed an implementation agreement to be executed by all of the agencies.

RECOMMENDATION:

Authorize the Mayor, the City Administrator, the Director of Public Works and the City Clerk to execute the National Pollutant Discharge Elimination System Storm Water Permit Implementation Agreement.

ANALYSIS:

At the meeting of May 7, 1990, the City Council authorized the City to be a co-permittee on the application for the permit. The permit was subsequently submitted to the Santa Ana Regional Water Quality Control Board and approved by that body

We have received the final draft of the implementation agreement from the county It is imperative that the agreement be executed at this time in order to begin implementation of our program prior to receipt of the final EPA rules and guidelines scheduled to come out in late October.

The county-wide committee, not knowing the exact cost for the first year of implementation has prepared a first year program budget of $1,000,000 As identified in the attached agreement, the Huntington Beach share of the program is 5 80% or $58,090 78 for that first year. The $58,090 78 is included in the current budget of $105,000.

FUNDING SOURCE:

Included in the 1990/91 budget (Flood Fund) is $105,000 for an NPDES inspector position and the first year program costs.

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NOV 12

City of Laguna Niguel
By
Mayor

ATTEST:
City Clerk

APPROVED AS TO FORM:
City Attorney

City of La Palma
By
Mayor

ATTEST:
City Clerk

APPROVED AS TO FORM:
City Attorney

City of La Habra
By
City Manager

ATTEST:
City Clerk

APPROVED AS TO FORM:
City Attorney

City of Los Angeles
By
City Engineer

ATTEST:
City Clerk

APPROVED AS TO FORM:
City Attorney

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ACTION OF THE CITY COUNCIL OF THE
CITY OF MISSION VIEJO, CALIFORNIA
NOVEMBER 13, 1990

ADDRESSED TO:	Bob Collacott Orange County EMA 10853 Douglass Road Anaheim, CA 92806
COPY TO:	Dennis Wilberg, Director of Public Works/City Engineer
MEETING DATE:	November 13, 1990
COUNCILMEMBERS PRESENT:	Craycraft, Jaffe, Keena, Murray
COUNCILMEMBERS ABSENT:	Curtis
AGENDA ITEM NO.:	6.6
SUBJECT:	National Pollutant Discharge Elimination System (NPDES) for Urban Stormwater Runoff

MOTION made by Councilman Craycraft, seconded by Councilman Murray, carried 4-0, Council referred the matter to staff for further investigation.

STATE OF CALIFORNIA)
COUNTY OF ORANGE)
CITY OF MISSION VIEJO)

I, IVY J. SOBEL, City Clerk of the City of Mission Viejo, California, do hereby certify the foregoing to be the official action taken by the City Council at the above meeting.

IN WITNESS WHEREOF, I have hereunto set my hand and seal this 20th day of November, 1990.

(SEAL)

Ivy J. Sobel
City Clerk

City of Mission Viejo
By _____
Mayor
Christian M. Keena

ATTEST:
City Clerk
Ivy J. Sobel

APPROVED AS TO FORM:
City Attorney
Scott Field

City of Newport Beach
By _____
Mayor

ATTEST:
Wanda E. Laggio
City Clerk

APPROVED AS TO FORM:
City Attorney

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City of Orange

By Frank V. Hoge
Director of Public Works

ATTEST:

City Clerk

APPROVED AS TO FORM:

Gene R. Minsker
City Attorney 10-11-90
Attachment 1 GRM 10/18/90

City of San Clemente

By Candace Haggard
Mayor 11-7-90

ATTEST:

Myrna Erway
City Clerk

APPROVED AS TO FORM:

[illegible]
City Attorney

CITY OF PLACENTIA

By [illegible]
Mayor OCT 2 1990

ATTEST:

Edmund M. Ponce
City Clerk OCT 2 1990

APPROVED AS TO FORM:

Carol B. Tanebaum
City Attorney

APPROVED AS TO CONTENT:

Robert Hoda
Director of Public Works/
City Engineer

City of San Juan Capistrano

By [illegible]
Mayor

ATTEST:

[illegible]
City Clerk

APPROVED AS TO FORM:

[illegible]
City Attorney

R0058490

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City of Santa Ana

By _____
Mayor

By _____
City Manager

ATTEST:

_____
City Clerk

APPROVED AS TO FORM:

_____
City Attorney

City of Stanton

By _____
Director of Public Works

ATTEST:

_____
City Clerk

APPROVED AS TO FORM:

_____
City Attorney

City of Tustin

By _____
Mayor

ATTEST:

_____
City Clerk

APPROVED AS TO FORM:

_____
City Attorney/Deputy

City of Seal Beach

By _____
City Manager

ATTEST:

_____
City Clerk

APPROVED AS TO FORM:

_____
City Attorney

Oct 16 1990

Stanton

R0058491

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ALTERNATIVE ACTION:

Withdraw the City of Huntington Beach from the permit and file a separate permit with the Santa Ana Water Quality Control Board.

ATTACHMENTS:

1. Request for Council Action dated May 7, 1990
2. NPDES Storm Water Permit Application Implementation Agreement

MTU:LFS:REE:lb

2556g/1 & 2

STATEMENT OF THE ACTION OF THE CITY COUNCIL

Council Chamber, Civic Center
Huntington Beach, California
Monday, October 1, 1990

A videotape recording of this meeting is on file in the City Clerk's Office

Mayor Mays called the regular meetings of the City Council and the Redevelopment Agency of the City of Huntington Beach to order at 7 p.m.

ROLL CALL

PRESENT: MacAllister, Winchell, Green, Mays, Bannister, Silva, Erskine
ABSENT: None

****

(City Council) AGREEMENT - APPROVED - ENVIRONMENTAL PROTECTION AGENCY - NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) (600 25)

A motion was made by MacAllister, seconded by Green, to approve and authorize execution of the National Pollutant Discharge Elimination System Storm Water Permit Implementation Agreement to clean up storm water (Huntington Beach share is $58,090.78 for the first year). The motion carried by the following roll call vote:

AYES: MacAllister, Winchell, Green, Mays, Bannister, Silva, Erskine
NOES: None
ABSENT: None

****

Mayor Mays adjourned the regular meeting of the City Council and the regular meeting of the Redevelopment Agency of the City of Huntington Beach to 7 p.m., Monday, October 8, 1990, to Room B-6, Civic Center

ATTEST:

Connie Brockway
City Clerk and ex-officio Clerk of the City Council of the City of Huntington Beach, California

Connie Brockway
City Clerk

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Page 2 - Council/Age. / Statement of Action - 10/10/5.

STATE OF CALIFORNIA)
County of Orange)
City of Huntington Beach)

Mays
Mayor

I, CONNIE BROCKWAY, the duly elected and qualified City Clerk of the City of Huntington Beach, California, do hereby certify that the above and foregoing is a true and correct Statement of Action of the City Council of said City at their regular meeting held on the 1st day of October 1990.

WITNESS my hand and seal of the said City of Huntington Beach this the 10th day of October 1990.

Connie Brockway
City Clerk and ex-officio Clerk of the City Council of the City of Huntington Beach, California

Deputy

City of Irvine
By
Mayor

ATTEST:
City Clerk 9/24/90

APPROVED AS TO FORM:
City Attorney

City of Huntington Beach
By
City Administrator
By
Director of Public Works
9-26-90
By
Mayor

ATTEST:
Connie Brockway
City Clerk 10/9/90

APPROVED AS TO FORM:
10-2-90
City Attorney 9-18-90

City of Laguna Beach
By
City Manager

ATTEST:
10-17-90
City Clerk

APPROVED AS TO FORM:
City Attorney

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City of Villa Park

By Jeanette E. Peck
City Engineer

ATTEST:

J. Karpene Miller
City Clerk

APPROVED AS TO FORM:

City Attorney

City of Yorba Linda

By
Mayor Pro Tem

ATTEST:

Carola Wallace
City Clerk

APPROVED AS TO FORM:

City Attorney

Dated: 9/25/90

City of Westminster

By
Mayor

ATTEST:

Mary Lou Morey
City Clerk

APPROVED AS TO FORM:

City Attorney

APPROVED AS TO CONTENT:

Acting City Manager

R0058494

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ATTACHMENT 1

1990-91 PARTICIPANT SHARE CALCULATIONS

2 52002

R0058495

GROSS DRY LAND AREA FIGURES SUPPLIED BY EMA SURVEYOR/BOUNDARY UNIT:

ANAHEIM	44.99
BREA	10.36
BUENA PARK	10.06
COSTA MESA	15.34
CYPRESS	6.93
DANA POINT	6.44
FOUNTAIN VALLEY	9.55
FULLERTON	22.30
GARDEN GROVE	17.77
HUNTINGTON BEACH	27.27
IRVINE	43.40
LAGUNA BEACH	7.50
LAGUNA NIGUEL	14.70
LA HABRA	7.70
LA PALMA	2.01
LOS ALAMITOS	4.26
MISSION VIEJO	16.39
NEWPORT BEACH	13.77
ORANGE	23.18
PLACENTIA	6.61
SAN CLEMENTE	17.09
SAN JUAN CAPISTRANO	14.05
SANTA ANA	27.34
SEAL BEACH	10.72
STANTON	3.13
TUSTIN	10.98
VILLA PARK	2.08
WESTMINSTER	10.19
YORBA LINDA	17.96
COUNTY OF ORANGE	364.80

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LAND AREA DEDUCTED FROM JURISDICTIONS:

Landfills:

	Area (Sq. Miles)	Jurisdiction
Olinda	.89	County
Santiago	.25	County
Prima Deschecha	2.34	County
Bee Canyon	1.13	County
Coyote Canyon	1.09	County

State Parks:

	Area (Sq. Miles)	Jurisdiction
Alamitos St. Beach	.002	Seal Beach
Bolsa Chica St. Beach	.27	Huntington Beach
Chino Hills St. Park	4.09	County
Corona Del Mar St. Beach	.05	Newport Beach
Crystal Cove St. Park	6.30	County
Doheny St. Beach	.40	Dana Point
Huntington St. Beach	.20	Huntington Beach
San Clemente St. Beach	.18	San Clemente

Airports:

	Area (Sq. Miles)	Jurisdiction
Fullerton	.11	Fullerton
John Wayne	.78	County

Military Facilities:

	Area (Sq. Miles)	Jurisdiction
Marine Corps Air Station El Toro	2.40	Tustin
Marine Base	6.25	County
Los Alamitos Armed Services Reserve Center	2.07	Los Alamitos
Seal Beach Weapons Station	2.17	Seal Beach

ational Forests:

	Area (Sq. Miles)	Jurisdiction
Cleveland National Forest	86.75	County

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ATTACHMENT 1

WEIGHTED AVERAGE METHOD

WEIGHTINGS: POPULATION 50%
AREA 50%

	1-1-90 *POPULATION	% OF POP.	7-31-90 **AREA (sq. miles)	% OF AREA	WEIGHTED AVERAGE SHARE	PER $1,000,000 BUDGETED
ANAHEIM	247,822	10.65%	44.99	6.70%	8.243428%	$82,434.28
BREA	33,815	1.45%	10.36	1.54%	1.423452%	$14,234.52
BUENA PARK	66,608	2.86%	10.06	1.50%	2.371843%	$23,718.43
COSTA MESA	94,706	4.07%	15.34	2.28%	3.019148%	$30,191.48
CYPRESS	43,703	1.96%	6.93	1.03%	1.423327%	$14,233.27
DANA POINT	31,189	1.34%	6.04	0.90%	1.064192%	$10,641.92
FOUNTAIN VALLEY	56,382	2.42%	9.53	1.42%	1.826951%	$18,269.51
FULLERTON	111,737	4.80%	22.19	3.31%	3.851549%	$38,515.49
GARDEN GROVE	135,286	5.82%	17.77	2.65%	4.019693%	$40,196.93
HUNTINGTON BEACH	191,630	8.24%	26.80	3.99%	5.809078%	$58,090.78
IRVINE	102,618	4.40%	43.40	6.46%	5.161863%	$51,618.63
LAGUNA BEACH	24,599	1.06%	7.50	1.12%	1.083922%	$10,839.22
LAGUNA NIGUEL	37,527	1.61%	14.78	2.19%	1.904306%	$19,043.06
LA HABRA	49,398	2.12%	7.78	1.15%	1.635345%	$16,353.45
LA PALMA	16,120	0.69%	2.01	0.30%	0.471369%	$4,713.69
LOS ALAMITOS	12,206	0.52%	2.19	0.33%	0.426182%	$4,261.82
MISSION VIEJO	73,537	3.25%	16.39	2.44%	2.702015%	$27,020.15
NEWPORT BEACH	70,202	3.02%	13.72	2.04%	2.526173%	$25,261.73
ORANGE	107,712	4.63%	23.18	3.45%	3.839402%	$38,394.02
PLACENTIA	42,060	1.81%	6.61	0.98%	1.326499%	$13,264.99
SAN CLEMENTE	40,381	1.74%	16.91	2.52%	2.020936%	$20,209.38
SAN JUAN CAPISTRANO	25,268	1.09%	14.05	2.09%	1.509994%	$15,099.94
SANTA ANA	293,961	10.14%	27.34	4.07%	6.752498%	$67,524.98
SEAL BEACH	27,347	1.18%	8.53	1.27%	1.163322%	$11,633.22
STANTON	28,427	1.22%	3.13	0.47%	0.801911%	$8,019.11
TUSTIN	49,409	2.12%	8.58	1.28%	1.615939%	$16,159.39
VILLA PARK	6,959	0.30%	2.08	0.31%	0.289259%	$2,892.59
WESTMINSTER	73,483	3.16%	10.19	1.52%	2.219791%	$22,197.91
YORBA LINDA	52,367	2.25%	17.96	2.68%	2.339973%	$23,399.73
COUNTY OF ORANGE	234,032	10.06%	253.16	38.31%	22.831329%	$228,313.29
COUNTY FLOOD CONTROL					5.000000%	$50,000.00
	2,326,211	100.00%	671.38	100.00%	100.000000%	$1,000,000.00

NUMBERS MAY NOT POST DUE TO ROUNDING

* Source: California State Department of Finance

** Source: Environmental Management Agency - Surveyor/Boundary Unit
Area has been calculated using the dry land area figures provided by EMA and subtracting areas in each jurisdiction for national forests, state parks, airports, landfills and military installations.

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ATTACHMENT 4

Fiscal Analysis Report

Annual Reporting Forms and Procedures

2

5206

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FISCAL ANALYSIS REPORT

Annual Reporting Forms and Procedures

1.0 SCHEDULE

As detailed in the DAMP Implementation Plan, financial reports are required from each co-permittee by July 15 of each year for inclusion in the annual Program Fiscal Analysis, which is prepared by the Orange County Stormwater Section and is due to the Regional Water Quality Control Boards annually by August 31.

2.0 PURPOSE OF THE REPORT

The Fiscal Analysis is intended to depict, as accurately as possible, all NPDES-related costs for each co-permittee. For the cities, this includes costs for (1) city operations, (2) contracted services and (3) functions financed by other means. Estimates should be used where accounting systems do not provide sufficient information.

Do not include NPDES permit costs or shared costs, which constitute contributions to activities performed by the County on behalf of the co-permittees rather than direct city expenditures for DAMP programs. This information is evaluated separately.

3.0 PROCEDURES

The NPDES permits specifically require separate input for Capital, Operations and Maintenance expenditures, which are defined as follows:

- "Capital Costs" refer to expenditures for capital equipment and facilities;
- "Operations Costs" refer to normal costs of operation, less maintenance costs.
- "Maintenance Costs" refer to the cost of maintaining equipment and facilities in working order.

These costs are to be reported on the three attached forms attached. The forms are set in the same format for reporting (1) *actual* expenditures for DAMP programs in the previous fiscal year and (2) *projected* expenditures for the coming fiscal year. These expenditure columns are further subdivided into costs for the programs already in place before DAMP implementation and for programs specifically implemented to comply with the DAMP. Procedures for completing the forms are as follows:

1.) Under the "Existing Program" column, list the costs of those pre-existing programs which contribute to pollution control and were generally in place prior to the advent of NPDES requirements.

2.) Under "DAMP Portion" column, list any additional cost for each program, beyond "Existing Program" costs, required to meet DAMP specifications. If no program existed

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previous to DAMP implementation, list the total cost under this column.

3.) Do not combine costs for two or more DAMP Cost Elements in a single line. For example, do not count the same cost figures for a hazardous waste contractor under both Hazardous Materials Management and Household Hazardous Waste Collection. Break up the costs appropriately (estimate if necessary, qualifying estimates under Comments.

4.) Where accounting systems do not separate Maintenance Costs from Operations Costs, estimate using a percentage factor to split the two, and so note under Comments.

5.) Show actual costs for the previous fiscal year and projected costs for the next. Where funding is expected but not approved, use your best estimate, noting so under Comments.

6.) List the costs for contracted operations under Operations Costs, and note under Comments that the item was contracted. Do not attempt to break out Capital or Maintenance cost elements from such contracted items.

7.) Tasks performed by volunteer organizations or inmates for which there is no direct charge *should be included as program costs.* Although they do not present an immediate cost to the program, these services should be listed according to their estimated dollar value under the appropriate category because they do represent a potential cost to the NPDES program in future years. A note should be placed in the Comments column stating who performed the effort and that there was no actual cost to the city.

4.0 NOTES ON TABLE HEADINGS

- **Hazardous Materials Management** -- Under "DAMP Portion," include the cost of any facilities improvements needed to meet DAMP requirements.
- **Public Property and Street Chemical Spill Response** -- This section refers to actions of the Fire Department and others in response to calls for assistance.
- **Pesticide and Fertilizer Management** -- Under "DAMP Portion," include the fiscal impact from implementing the Management Guidelines for Use of Fertilizers and Pesticides developed by the County for the cities.
- **New Development and Construction** -- Under "DAMP Portion," include the fiscal impact of implementing new programs to meet DAMP requirements.
- **Illicit Connections/Discharge Identification & Elimination** -- This element refers to Reconnaissance Survey activities. The sub-element under this titled "Other Efforts to Identify and Eliminate Illicit Connections/Discharges" refers to follow-up activities resulting from facility inspection findings. This could include the cost of an investigation or legal proceeding related to an identified illegal discharge.

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1.0 INTRODUCTION

To comply with federal regulations, the City of _____ must develop and implement various nonpoint source pollutant control programs according to the requirements of their National Pollutant Discharge Elimination System (NPDES) Stormwater Permits issued by the Santa Ana and San Diego Regional Water Quality Control Boards. The Orange County Flood Control District, the County of Orange and its incorporated cities are co-permittees in these permits.

The County of Orange, as lead agency, has developed a Drainage Area Management Plan (DAMP) that will meet permit requirements to be implemented by each city. The purpose of the DAMP is to help the cities implement Best Management Practices (BMPs) in accordance with the specific requirements of the NPDES permits. DAMP implementation involves controlling runoff from commercial, residential, industrial and construction sites and controlling pollutant sources such as illegal discharges and illicit connections to storm drain systems.

This Implementation Plan was designed to outline the actions that need to be taken by each co-permittee, a time frame to complete those actions and when specific information must be submitted to the County Stormwater Program for annual reporting to the Regional Boards.

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R0058502

Organization of Responsibilities

DAMP Section	City Department in Charge	Date Annual Progress Report Due to County
Section 2 Program Management		
Reconnaissance Survey Progress Report	_____	Dec. 15
DAMP Status Report	_____	June 15
Fiscal Analysis Report	_____	July 15
Data Analysis Report	*(information only, no action required)*	
Program Analysis Report	*(information only, no action required)*	
Water Quality Monitoring Progress Report	*(information only, no action required)*	
Section 4 Legal Authority		
Water Quality Ordinance Review	_____	July 31, 1993 *(not annual)*
Section 5 Public Agency Activities		
5.2.1 Litter Control	_____	June 15, 1993
5.2.2 Recycling	_____	June 15
5.2.3 Drainage Facility Maint.	_____	June 15
5.2.4 Catchbasin Stenciling	_____	June 15
5.2.5 Street Sweeping	_____	June 15, 1993
5.2.6 Hazardous Materials Mgmt	_____	June 15
5.2.7 Household Hazardous Waste Collection	_____	June 15
5.2.8 Emergency Spill Response	_____	June 15
5.2.9 Fertilizer Management	_____	June 15
5.2.10 Pesticide Management	_____	June 15
Section 6 Public Education/Information	_____	June 15
Section 7 New Development	_____	June 15
Section 8 Construction	_____	June 15
Section 9 Industrial Discharger Identification	*(requirements completed)*	
Section 10 Illicit Connection/Discharge Identification and Elimination	*(included in Reconnaissance Survey Report)*	
Section 11 Water Quality Monitoring	*(included in Water Quality Monitoring Report)*	

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2.0 PROGRAM MANAGEMENT – COMPLIANCE REPORTING

Under the co-permittees' NPDES Storm Water Permit Implementation Agreement, the County of Orange was designated to coordinate countywide compliance with the NPDES permits. In accordance with this responsibility, the County must prepare a number of progress reports on the status of the program for annual submittal to the Regional Boards. These reports are described as follows:

2.1 Reconnaissance Survey Progress Report

Description:
Report to show evidence of implementation of a plan to detect and eliminate illegal discharges to the stormwater conveyance systems and to show the resulting reduction in loadings of pollutants in receiving waters. All illegal/illicit discharges must be eliminated by July 16, 1995. Those identified after that date must be eliminated in the shortest time practicable.

This progress report is due to the Regional Boards annually by January 31.

Action Required:
Cities must report progress toward implementation of the Reconnaissance Survey Field Manual to County Stormwater Staff by December 15 annually, including:

- a listing of identified or suspected illegal discharges and undocumented connections discovered as a result of reconnaissance survey implementation, including names, locations and types of facilities, name of stormwater conveyance systems and the name of the waters receiving nonstormwater discharge;

- a report of the *total miles* of above ground and below ground (greater than 39 inches in diameter) stormwater conveyance system facilities under city jurisdiction and the *total miles of those facilities that were inspected* in the previous year;

- other information that could lead to the identification of illegal/illicit discharges to the storm drain system, such as visual observations or major land use activity changes, and

- any changes to the proposed implementation plan, including time schedule for prosecution of violators and elimination of illegal discharges to the storm drain systems.

Refer to Attachment 1 for the appropriate annual reporting forms, which should be completed and returned to County Stormwater Staff.

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2.2 Data Analysis Report

Description:
The results of the chemical analysis and quantitative data (such as flow, precipitation and water level) will be compiled for each sampling of the drainage area and storm event and for different times during the same storm event. Mass loadings for pollutants of concern will be calculated and the impact of stormwater discharge will be discussed starting with the most significantly impacted receiving waters.

The Data Analysis is due to the Regional Boards annually by January 31.

Action Required:
No action is required of the cities for this report.

2.3 Program Analysis Report

Description:
As lead agency for the co-permittees, the County must prepare an analysis of the effectiveness of the stormwater management program. If the water quality objectives for receiving waters are violated, the County must identify proposed programs that will result in the attainment of the objectives and a time table for implementing new programs. This analysis is to be completed by the County based on the performance of the co-permittees in meeting the requirements of their NPDES permits during the previous year.

The Program Analysis is due to the Regional Boards annually by March 31.

Action Required:
No action is required of the cities.

2.4 Drainage Area Management Plan Status Report

Description:
Co-permittees must complete an annual progress report assessing the reduction of pollutants discharged to local receiving waters and evaluating the effectiveness of BMPs developed to improve the quality of stormwater and urban runoff. The report should further recommend BMP modifications and include a schedule for implementation to achieve compliance with any water quality objectives not attained.

The report will include (1) existing BMPs accepted by the Cities, and (2) proposed changes to BMPs for reducing pollutants in stormwater and urban runoff, including proposed structural and nonstructural controls.

The Drainage Area Management Plan Status Report is due to the Regional Boards annually by July 31.

Action Required:
Cities must submit to the County annually by June 15 a report summarizing progress toward implementation of the DAMP. Because of overlapping information required for other annual

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reports, the necessary information should focus largely on DAMP Sections 5 0 through 8 0 (refer to Attachment 2).

The County, as lead agency, will assess the reduction of pollutants to local receiving waters and evaluate the effectiveness of the BMPs implemented through the DAMP, as required under the NPDES permits.

Section 3.0 details the cities responsibilities toward completing this permit requirement, and Attachment 2 details the information that must be submitted to County Stormwater Staff to complete the annual report.

2.5 Fiscal Analysis Report

Description:

Co-permittees must complete an annual report of all capital, maintenance and operations expenditures incurred in the previous fiscal year to implement the programs necessary under the NPDES permits. The County, as lead agency for the co-permittees, will compile this information and analyze the data.

The Fiscal Analysis is due to the Regional Boards annually by August 31.

Action Required:

Annually, no later than July 15, cities must complete a breakdown of costs and projected costs for the current and coming fiscal year and report any other information relative to the fiscal status of the NPDES program.

Refer to Attachment 4 for the appropriate annual reporting forms and instructions on how to complete them.

2.6 Water Quality Monitoring Progress Report

Description:

The County water quality monitoring program has been in effect since 1973. Additional sampling stations have been added to comply with the NPDES permits.

The Water Quality Monitoring Progress Report is due to the Regional Boards annually by November 30.

Action Required:

No action is required of the cities.

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3.0 DAMP IMPLEMENTATION – PROGRAM REPORTING

3.1 Legal Authority

Description:
The County obtains its authority to control pollutants in stormwater discharges, to prohibit illegal discharges, to control spills and to carry out flood control facility inspections from the Orange County Flood Control Act and the County Water Pollution Control Ordinance.

The County has the authority to enforce and administer the ordinance, including the authority to inspect any violation. The County also has the right to revoke any discharge permit granted under the ordinance if it sees fit.

Action Required:
All co-permittees must demonstrate adequate legal authority to implement the programs of the DAMP (i.e. to regulate the discharge of pollutants to municipal separate storm drain systems).

To accomplish this, in December 1992, the co-permittees initiated a process to develop a model water quality ordinance, an enforcement consistency guide and an enforcement training program. The ordinance is intended to serve as a model for each individual co-permittee to adopt in order to provide adequate legal authority (1) to regulate the discharge of pollutants to municipal separate storm drain systems in Orange County and (2) to implement pollution control programs. **Implementation is set for December 1993.**

3.2 Public Agency Activities

Cities must report their progress toward implementation of each of the Public Agency Activities detailed in this section of the DAMP to the County Stormwater Staff **no later than June 15, 1993** and annually thereafter. This information will be used in the DAMP Status Report, due to the Regional Boards annually by July 31 (refer to Attachments 2 and 3 for the annual reporting forms for each subsection).

3.2.1 Litter Control (DAMP Section 5.2.1)

Description:
Litter control is an important element in the diversion of trash and other materials from the storm drain system.

Action Required:
Cities must examine their individual municipal litter control regulations and provide the County with a description of existing programs. This report must be submitted **no later than June 15, 1993**. The need to propose a draft ordinance or changes to existing regulations will be evaluated as part of the legal authority review detailed Section 4 of the DAMP.

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3.2.2 *Recycling (DAMP Section 5.2.2)*

Description:
Community programs for collection and recycling of nonhazardous solid wastes have already been initiated in most Orange County municipalities in response to the California Integrated Waste Management Act of 1989 (AB 939). No improvements to these programs are proposed as part of the DAMP, but a reporting procedure will need to be implemented to document the volume of potential pollutants diverted from the storm drain systems.

Action Required:
Cities must submit copies of the information required for AB 939 by June 15, 1993, and every year thereafter. Specifically, this means identifying constituent materials by:

(1) volume
(2) percentage by weight
(3) material type
(4) source of generation (residential, commercial, industrial, etc.).

Cities must also submit a brief description of city recycling programs, the methods used to determine the amount and categories of solid wastes recycled and any public education material developed or distributed since the last annual report.

3.2.3 *Drainage Facility Maintenance (DAMP Section 5.2.3)*

Description:
All Orange County co-permittees clean out storm drain inlets, catchbasins and lines within their jurisdiction on an as-needed basis. Some of this information is included in the Reconnaissance Survey Progress Report, due to the Regional Boards annually by February 1.

Action Required:
As required for Reconnaissance Survey activities, Cities must complete the necessary cleaning of drainage facilities on a regular basis. Specifically, cities must:

- inspect all open channels annually before storm season and remove debris as necessary;
- inspect underground facilities of 39" in diameter and larger every two years;
- remove debris and sediment manually or by mechanical methods, using flushing only in emergency situations.

Additionally, to complete this section of the DAMP, Cities must provide the County Stormwater Staff annually, **no later than June 15** and every year thereafter, with:

- copies of facility inspection and maintenance logs that include a description of total volume of materials/debris removed from drainage facilities and estimates of the percentage of paper, plastic material, vegetation, soil and "other" materials;

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- data tables that document the number of drains and the length of channel/pipe cleaned in the previous year, and

- specific information on any facility where evidence of chemical contaminants has been found in the previous year, including the nature, extent and location of the contamination identified.

3.2.4 Catchbasin Stenciling (DAMP Section 5.2.4)

Description:
To alert the public to the issue of nonpoint source pollution and the fact that stormwater is not treated, catchbasins in Orange County are to be stenciled with the phrase "No Dumping -- Drains to Ocean," or a similar variation.

Action Required:
Cities must document the number of catchbasins stenciled by **June 15, 1993** and every year thereafter. The catchbasin stenciling program must be completed by 1995. (This program could be completed as part of a community or volunteer program.)

3.2.5 Street Sweeping (DAMP Section 5.2.5)

Description:
All cities currently have at least monthly street-cleaning programs for residential, commercial and industrial areas.

Action Required:
Cities must submit street sweeping schedules to County Stormwater Staff by **June 15, 1993.**

3.2.6 Hazardous Materials Management (DAMP Section 5.2.6)

Description:
Various city activities involve the use of hazardous materials and the generation of hazardous wastes, including paints, solvents, pesticides, fertilizers and motor oil. As a matter of policy, used motor oil and motor oil filters will be recycled or managed as hazardous waste.

Co-permittees will review and, where appropriate, implement structural or nonstructural improvements to public agency hazardous materials management practices and facilities.

Action Required:
Cities must submit a list of improvements made to public facilities for storage of hazardous materials (defined as sites at which there are aggregate quantities greater than 55 gallons, 500 lbs. or 200 cu. ft.) by **June 15, 1993** and every year thereafter.

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3.2.7 *Household Hazardous Waste Collection (DAMP Section 5.2.7)*

Description:
Orange County has an effective household hazardous waste collection program administered by the Integrated Waste Management Department.

Action Required:
Cities must submit to the County a summary of information on toxic roundups and materials collected by **June 15, 1993** and every year thereafter.

3.2.8 *Emergency Spill Response (DAMP Section 5.2.8)*

Description:
The Orange County Hazardous Materials Area Plan has been adopted by most of the cities. The plan is a set of planned responses to hazardous materials emergencies, addressing chain-of-command, public agency participation and jurisdictional authority.

Action Required:
Cities that do not adopt the countywide plan are expected to develop one of their own. Cities must identify spill response staff and resources by April 1993 and undertake staff training and program implementation by December 1993. Progress toward this implementation must be reported to County Stormwater Staff annually by **June 15.**

3.2.9 *Fertilizer and Pesticide Management (DAMP Sections 5.2.9 and 5.2.10)*

Description:
The proposed Guidelines for Use of Fertilizers and Pesticides was developed as a model for cities to follow in their vegetation management practices.

The guidelines recommend steps for the safest application, storage, transportation, handling and disposal of fertilizers and pesticides that will avoid nutrient loss into and chemical contamination of County storm drain systems. The guidelines specifically address appropriate application methods for fertilizers and pesticides, surface runoff minimization, accident mitigation and Integrated Pest Management (IPM).

Action Required:
Cities are expected to have adopted the Management Guidelines for Use of Fertilizers and Pesticides developed by the County, or a similar plan of their own, by February 1993.

Cities must report by **June 15, 1993**, and every year thereafter, on progress toward implementation of the management guidelines, including the amounts of fertilizers and pesticides used in their jurisdiction, the locations and frequencies of application and steps taken to implement IPM techniques. Refer to Attachment 3 for the details of annual reporting.

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3.3 Public Information

Description:
The co-permittees need to take an active role in educating the public about the issue of nonpoint source pollution and the practices people can adopt to assist in pollution prevention. Educational BMPs will target local officials, public agency personnel and the general public, and they will include developing brochures for distribution, organizing educational workshops and providing speakers for seminars and conferences.

The DAMP specifies education programs (BMPs) for industrial and construction site operations, and programs to facilitate public reporting of illegal discharges. Also, wherever possible, co-permittees will coordinate activities with other agencies running public information programs, such as water and sanitation districts, fire departments and environmental groups.

The County will take the lead in coordinating a countywide public awareness program for the benefit of all co-permittees and will develop regional public information materials to be distributed locally by the co-permittees.

Action Required:
Cities must make public information materials developed by the County available to their local communities. This may be done through homeowners' associations, at County, community and industrial fairs, at community facilities or at public libraries. Individual co-permittees, at their option and expense, may choose to enhance the regional information to address their own specific storm water quality problems.

Co-permittees must report to County Stormwater Staff annually by June 15 on steps taken to further public education and disseminate information pertaining to stormwater quality. Refer to the information requested in Attachment 2.

3.4 New Development

Description:
The DAMP requires that each new development be required to implement appropriate nonstructural, "routine" structural and "special" BMPs as identified by the New Development/Construction Task Force. These measures will be implemented specific to the proposed size, location and type of development in order to minimize pollutant discharge into the drainage system.

The Task Force has completed a BMP plan and Standard Conditions of Approval that, when finalized, will be available for co-permittees to distribute to developers. The plan will provide definitions of BMPs and make recommendations for those that are appropriate for different types of development.

Action Required:
Cities must require that developers complete post-construction stormwater quality management plans, including BMPs to control nonpoint sources of pollution. The County will take the lead in

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developing an educational program for developers and contractors, and cities should help in the local distribution of these materials.

Cities must report annually to the County Stormwater Staff by June 15 the steps taken toward meeting these obligations of the DAMP. Refer to Attachment 2 for the appropriate reporting information.

3.5 Construction

Description:
BMPs that address control of building site-related pollutants must be implemented for construction operations that disturb one acre or more of total land area for an industrial/commercial activity and residential construction sites that disturb five acres or more These BMPs must address erosion control, on-site hazardous materials management and contaminated runoff.

Specifically, stormwater pollution control BMPs must:

- describe site planning procedures that address water quality impact;
- describe the requirements for structural and nonstructural BMPs;
- identify the priorities for inspecting and enforcing pollution control measures; and
- incorporate appropriate educational and training measures for construction site operators.

All programs must consider the nature of the construction, site-specific topography and the characteristics of the soils and receiving waters.

Construction activities disturbing five acres or more of land are also required to comply with the Statewide General Construction Permit.

Action Required:
Prior to issuance of grading, grubbing clearing, surface mining or paving permits for all public or private projects of more than five acres, cities must assure that the project proponent (which may be themselves) has secured a Statewide General Construction Permit. For public works and commercial/industrial projects greater than five acres, cities must also assure compliance with the guidelines established by the co-permittees' New Development and Construction Task Force in Construction Activity Best Management Practices for Public Works (DAMP, Chapter 8 Addendum) before issuance of the appropriate permits to begin construction.

Also, for public works and commercial/industrial projects greater than one acre (but less than five acres), cities must assure compliance with the DAMP, Chapter 7 Addendum. Note that residential construction projects on less than five acres are not affected by this.

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City grading and building inspectors must verify that appropriate NPDES stormwater pollution control measures are in place through inspections (1) at the beginning of construction, (2) during storm events and (3) shortly before a notice of completion is filed
Cities must report annually by June 15 on progress toward implementation of these requirements, on the incorporation of BMPs recommended in the Task Force guidelines into local standard conditions for approval and on the distribution of educational materials to developers.

Refer to Attachment 2 for the annual reporting information due annually to the County Stormwater regarding this program.

3.6 Industrial Discharger Information

Description:
The objective of this section of the DAMP is to identify industrial stormwater dischargers and notify them of the requirements of the Statewide General Industrial Permit. Cities need not retain records of Notices of Intention (NOIs) submitted by industrial dischargers within their jurisdiction. Record-keeping and enforcement responsibilities will be taken by the Region or by the State.

Action Required:
No action is required of the cities for this report.

3.7 Illicit Discharge/Illegal Connection Identification And Elimination

Description:
In order to reduce illegal discharges into storm drain systems, illicit connections will be identified in conjunction with regular storm drain inspections. Also, cities are obligated to implement a facility inspection program for all municipal separate storm sewers as defined by the NPDES permits and approve ordinances to prohibit illicit connections and illegal discharges to municipal storm drain systems.

An implementation schedule was submitted as of January 31, 1992 as part of the Reconnaissance Survey Progress Report, to be updated annually and to include (1) an analysis of inspection results and (2) a list of suspected illegal discharges and illicit connections.

Action Required:
The action required under this section of the DAMP is included in the Reconnaissance Survey Progress Report. Refer to Attachment 1 for the information required.

3.8 Water Quality Monitoring Program

Description:
The County water quality monitoring program has been in effect since 1973. Additional sampling stations have been added to comply with the NPDES permits, evaluating contamination levels before and after storm events. The program will evolve as more data is accumulated and analyzed.

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The Water Quality Monitoring Progress Report, completed annually by November 30 and submitted to the Regional Water Boards for review, addresses the requirements of this section of the DAMP.

Action Required:
No action is required of the cities for this report.

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APPENDIX D

R0058515

ORIGINAL
CLERK OF THE BOARD
ORANGE COUNTY

Amendment No. 1 to
National Pollutant Discharge Elimination System
Stormwater Permit Implementation Agreement
Santa Ana/San Diego Regions

This AMENDMENT entered into as of this 26th day of October, 1993 by the County of Orange, (herein called the COUNTY), the Orange County Flood Control District (herein called the DISTRICT), and the Cities of Anaheim, Brea, Buena Park, Costa Mesa, Cypress, Dana Point, Fountain Valley, Fullerton, Garden Grove, Huntington Beach, Irvine, Laguna Beach, Laguna Hills, Laguna Niguel, Lake Forest, La Habra, La Palma, Los Alamitos, Mission Viejo, Newport Beach, Orange, Placentia, San Clemente, San Juan Capistrano, Santa Ana, Seal Beach, Stanton, Tustin, Villa Park, Westminster, and Yorba Linda (herein called the CITIES) adds two additional co-permittees, provides revised participant share calculations, and establishes the NPDES Technical Advisory Committee.

RECITALS

WHEREAS, Section X of the Stormwater Permit Implementation Agreement (hereinafter, AGREEMENT) states that the Agreement may be amended by consent of a majority of the co-permittees which represent a majority of the percentage contributions as described in Section IV of the AGREEMENT; and

WHEREAS, Section VI of the AGREEMENT states that any city which becomes signatory to this AGREEMENT after the applications for the initial NPDES Stormwater permits have been approved shall comply with all of the provisions of this AGREEMENT; and,

WHEREAS, other government bodies or public agencies may request to become a co-permittee to the AGREEMENT.

WHEREAS, program costs and participant share calculations are based on the original 31 co-permittees and do not include calculations for additional co-permittees; and,

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WHEREAS, administrative and technical tasks originally anticipated to be handled by the co-permittees are best handled by a Technical Advisory Committee; and

NOW THEREFORE: The parties hereto do mutually agree as follows:

1. Newly-incorporated co-permittees by their signatures hereon, are added as co-permittees to the AGREEMENT.

2. Participant share calculations shall be recomputed in accordance with the AGREEMENT, as amended, when additional co-permittees are added. Amended calculations and computation method are provided in Exhibit A.

3. The COUNTY as principal permittee may retain the services of professional consultants and may fund, or contribute to funding technical and/or economic studies conducted by professional organizations such as the American Public Works Association.

4. The co-permittees hereby establish a Technical Advisory Committee (herein called COMMITTEE) consisting of five members chosen by the Orange County City Engineers Association, and one member representing the County of Orange. The Committee shall prepare By-laws for Technical Advisory Committee and submit same to the co-permittees for approval. The Committee will act in an advisory role to the co-permittees and implement policy previously established by the co-permittees.

5. This AMENDMENT may be executed in counterpart and the signed counterparts shall constitute a single instrument.

6. This AMENDMENT incorporates the following Exhibits:

Exhibit A - Attachment 1 to Stormwater Permit Implementation Agreement: Revised Participant Share Calculations to account for additional co-permittees and current census data.

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R0058517

IN WITNESS WHEREOF, this AGREEMENT has been executed as of the day and year first above written.

COUNTY OF ORANGE

BY _____
Chairman of the Board of Supervisors

ORANGE COUNTY FLOOD CONTROL DISTRICT

DATE: OCT 26 1993

BY _____
Chairman of the Board of Supervisors
Orange County Flood Control District

ATTEST:

DATE: OCT 26 1993

BY _____
Phyllis A. Henderson
Clerk of the Board of Supervisors
Orange County, California

APPROVED AS TO FORM:
TERRY C. ANDRUS, County Counsel
ORANGE COUNTY, CALIFORNIA

BY _____
Deputy

05-Aug-1992

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CITY OF ANAHEIM

DATE: 9-16-93

BY _____
Mayor

ATTEST:

DATE: 9-16-93

BY _____
City Clerk

APPROVED AS TO FORM:
JACK L. WHITE, CITY ATTORNEY

DATE: 7-2-93

BY _____
Deputy

CITY OF BREA

DATE: _____

BY _____
Mayor

ATTEST:

BY _____
City Clerk

CITY OF BUENA PARK

DATE: _____

BY _____
Mayor

ATTEST:

DATE: _____

BY _____
City Clerk

CITY OF COSTA MESA

DATE: _____

BY _____
Mayor

ATTEST:

DATE: _____

BY _____
City Clerk

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R0058519

CITY OF ANAHEIM

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF BREA

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF BUENA PARK

DATE: September 23, 1992 BY _____
Mayor

ATTEST:

DATE: September 23, 1992 BY Arlene M. Cain
City Clerk

CITY OF COSTA MESA

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

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R0058520

CITY OF ANAHEIM

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF BREA

DATE: 1-19-93 BY _____
Mayor

ATTEST:

DATE: 1-19-93 BY Elaine Cappo
City Clerk

CITY OF BUENA PARK

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF COSTA MESA

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

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R0058521

CITY OF ANAHEIM

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF BREA

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF BUENA PARK

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

City Council Approved On:
November 16, 1992

CITY OF COSTA MESA

DATE: 11-17-92 BY Mary L. Hornbuckle
Mayor

APPROVED AS TO FORM:
BY: Kathe 10-15-92
CITY ATTORNEY'S OFFICE
CITY OF COSTA MESA

ATTEST:

DATE: _____ BY Eileen P. Shinney
City Clerk

16-Jul-1992

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CITY OF CYPRESS

DATE: 9-14-92

BY Richard Pashaian
Mayor

ATTEST:

DATE: 9-15-92

BY Silvia M. Hanna
(Deputy) City Clerk

CITY OF DANA POINT

DATE: _____

BY _____
Mayor

ATTEST:

DATE: _____

BY _____
City Clerk

CITY OF FOUNTAIN VALLEY

DATE: _____

BY _____
Mayor

ATTEST:

DATE: _____

BY _____
City Clerk

CITY OF FULLERTON

DATE: _____

BY _____
Mayor

ATTEST:

DATE: _____

BY _____
City Clerk

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R0058523

CITY OF CYPRESS

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF DANA POINT

DATE: _____ BY Karen Lloreda
Karen Lloreda, Mayor

APPROVED AS TO FORM:

Jerry M. Patterson
JERRY M. PATTERSON, CITY ATTORNEY
DATE: January 12, 1993

ATTEST:

BY Katherine M Hollywood
Katherine M. Hollywood, City Clerk

CITY OF FOUNTAIN VALLEY

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF FULLERTON

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

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CITY OF CYPRESS

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF DANA POINT

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF FOUNTAIN VALLEY

DATE: _____ BY James D. Patterson Jr.
Mayor

ATTEST:

DATE: _____ BY Jane Irvin
Deputy City Clerk

CITY OF FULLERTON

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

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CITY OF CYPRESS

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF DANA POINT

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF FOUNTAIN VALLEY

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF FULLERTON

DATE: 11-5-92 BY Don Bankhead
Mayor

ATTEST:

DATE: 11-5-92 BY _____
City Clerk

APPROVED AS TO FORM FULLERTON CITY ATTORNEY

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CITY OF GARDEN GROVE

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF HUNTINGTON BEACH

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF IRVINE

DATE: _____ BY [signature]
Mayor

APPROVED AS TO FORM:
[signature]
CITY ATTORNEY

ATTEST:

DATE: 11-3-92 BY [signature]
City Clerk

CITY OF LAGUNA BEACH

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

2

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4.1-23

R0058527

CITY OF GARDEN GROVE

DATE: November 17, 1992

BY _____
Mayor

ATTEST:

DATE: _____

BY _____
City Clerk

CITY OF HUNTINGTON BEACH

DATE: _____

BY _____
Mayor

ATTEST:

DATE: _____

BY _____
City Clerk

CITY OF IRVINE

DATE: _____

BY _____
Mayor

ATTEST:

DATE: _____

BY _____
City Clerk

CITY OF LAGUNA BEACH

DATE: _____

BY _____
Mayor

ATTEST:

DATE: _____

BY _____
City Clerk

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CITY OF GARDEN GROVE

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF HUNTINGTON BEACH

DATE: _____ BY [signature]
Mayor

APPROVED AS TO FORM:

[signature]
City Attorney 10-13-92
GCH 10-14-92

ATTEST:

DATE: _____ BY [signature] 10/20/92
City Clerk

CITY OF IRVINE

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF LAGUNA BEACH

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

VOL 12

2

5236

R0058529

CITY OF LAGUNA NIGUEL

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF LAKE FOREST

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF LA HABRA

DATE: 6/4/93 BY Lee Prosser
City Manager

ATTEST:

DATE: 6/4/93 BY Shawn C. Spader
City Clerk

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///

VOL 12 2 5237

R0058530

CITY OF LAGUNA HILLS

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF LAGUNA NIGUEL

DATE: 1/27/93 BY _____
Mayor

ATTEST:

DATE: 1/27/93 BY _____
City Clerk

CITY OF LAKE FOREST

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF LA HABRA

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

VOL 12 2 5238

R0058531

CITY OF LAGUNA HILLS

DATE: September 22 1992

BY _____
Mayor
MELODY CARRUTH

ATTEST:

DATE: 9/16/92

BY _____
City Clerk
MARY A. CARLSON

APPROVED AS TO FORM:

LOIS E. JEFFREY, CITY ATTORNEY

CITY OF LAGUNA NIGUEL

DATE: _____

BY _____
Mayor

ATTEST:

DATE: _____

BY _____
City Clerk

CITY OF LAKE FOREST

DATE: _____

BY _____
Mayor

ATTEST:

DATE: _____

BY _____
City Clerk

CITY OF LA HABRA

DATE: _____

BY _____
Mayor

ATTEST:

DATE: _____

BY _____
City Clerk

VOL 12 2 5239

R0058532

CITY OF LA PALMA

DATE: September 23, 1992

BY _____
Mayor

ATTEST:

DATE: September 25, 1992

BY _____
City Clerk

CITY OF LOS ALAMITOS

DATE: _____

BY _____
Mayor

ATTEST:

DATE: _____

BY _____
City Clerk

CITY OF MISSION VIEJO

DATE: _____

BY _____
Mayor

ATTEST:

DATE: _____

BY _____
City Clerk

CITY OF NEWPORT BEACH

DATE: _____

BY _____
Mayor

ATTEST:

DATE: _____

BY _____
City Clerk

VOL 12 2 5240

R0058533

CITY OF LA PALMA

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF LOS ALAMITOS

DATE: September 29, 1992 BY _____
Mayor

ATTEST:

DATE: September 29, 1992 BY _____
City Clerk

CITY OF MISSION VIEJO

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF NEWPORT BEACH

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

VOL 12 2 5241

R0058534

CITY OF LA PALMA

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF LOS ALAMITOS

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF MISSION VIEJO

DATE: Sept. 14, 1992 BY Sharon Cady
Mayor

ATTEST:

DATE: Sept. 16, 1992 BY _____
City Clerk

CITY OF NEWPORT BEACH

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

VOL 12 2 5242

R0058535

CITY OF LA PALMA

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF LOS ALAMITOS

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF MISSION VIEJO

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF NEWPORT BEACH

DATE: 12-16-92 BY _____
Mayor

ATTEST:

DATE: 12-16-92 BY Wanda E. Kaggio
City Clerk

CITY OF NEWPORT BEACH CALIFORNIA

VOL 12 2 5243

R0058536

CITY OF ORANGE

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF PLACENTIA

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF SAN CLEMENTE

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF SAN JUAN CAPISTRANO

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

VOL 12 2 5244
R0058537

CITY OF ORANGE

DATE: 11/18/92
APPROVED AS TO FORM:

by Robert O. Herrick
City Attorney (Cont.)

DATE: 11-24-92

BY Glen Blythe
Mayor

ATTEST:

BY Marilyn J. Jensen
City Clerk

CITY OF PLACENTIA

DATE: _____

BY _____
Mayor

ATTEST:

DATE: _____

BY _____
City Clerk

CITY OF SAN CLEMENTE

DATE: _____

BY _____
Mayor

ATTEST:

DATE: _____

BY _____
City Clerk

CITY OF SAN JUAN CAPISTRANO

DATE: _____

BY _____
Mayor

ATTEST:

DATE: _____

BY _____
City Clerk

VOL 12 2 5245

R0058538

CITY OF ORANGE

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF PLACENTIA

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF SAN CLEMENTE

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF SAN JUAN CAPISTRANO

DATE: May 4, 1993 BY _____
Mayor

ATTEST:

DATE: May 4, 1993 BY _____
City Clerk

VOL 12 2 5246

R0058539

CITY OF ORANGE

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF PLACENTIA

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF SAN CLEMENTE

DATE: 10-7-92 BY _____
Mayor

ATTEST:

DATE: 10-7-92 BY Myrna Erway
City Clerk

CITY OF SAN JUAN CAPISTRANO

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

VOL 12 2 5247

R0058540

CITY OF SANTA ANA

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF SEAL BEACH

DATE: August 24, 1992 BY _____
Mayor

ATTEST:

DATE: August 25, 1992 BY _____
City Clerk

CITY OF STANTON

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF TUSTIN

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

VOL 12 2 5248

R0058541

APPROVED AS TO FORM

EDWARD J. COOPER
CITY ATTORNEY

DATE: _____

Approved as to content:

City Manager

DATE: _____

CITY OF SANTA ANA

BY _____
Mayor

ATTEST:

BY _____
City Clerk

CITY OF SEAL BEACH

DATE: _____

BY _____
Mayor

ATTEST:

DATE: _____

BY _____
City Clerk

CITY OF STANTON

DATE: _____

BY _____
Mayor

ATTEST:

DATE: _____

BY _____
City Clerk

CITY OF TUSTIN

DATE: _____

BY _____
Mayor

ATTEST:

DATE: _____

BY _____
City Clerk

VOL 12 2 5249

R0058542

CITY OF SANTA ANA

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF SEAL BEACH

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF STANTON

DATE: 11/12/92 BY _____
Mayor

ATTEST:

DATE: 11-12-92 BY Denise Archambault, Deputy
City Clerk

CITY OF TUSTIN

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

VOL 12 2 5250
R0058543

CITY OF SANTA ANA

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF SEAL BEACH

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF STANTON

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF TUSTIN

DATE: _____ BY Leslie A Bontows
Mayor

ATTEST:

DATE: Sept. 8, 1992 BY _____
City Clerk

VOL 12 2 5251

R0058544

CITY OF VILLA PARK

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF WESTMINSTER

DATE: August 26, 1992 BY Charles V. Smith
Mayor

ATTEST:

DATE: August 26, 1992 BY Mary Lou Mowry
City Clerk

CITY OF YORBA LINDA

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

NJ:vm/crPVF02-113(2140)2051913295769
16-Jul-1992

VOL 12 2 5252

R0058545

CITY OF VILLA PARK

DATE: 8-25-92

BY _____
Mayor

ATTEST:

DATE: 8-25-92

BY _____
City Clerk

CITY OF WESTMINSTER

DATE: _____

BY _____
Mayor

ATTEST:

DATE: _____

BY _____
City Clerk

CITY OF YORBA LINDA

DATE: _____

BY _____
Mayor

ATTEST:

DATE: _____

BY _____
City Clerk

NJ:vm/crPVF02-113(2140)2051913295769
16-Jul-1992

VOL 12 2 5253

R0058546

CITY OF VILLA PARK

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF WESTMINSTER

DATE: _____ BY _____
Mayor

ATTEST:

DATE: _____ BY _____
City Clerk

CITY OF YORBA LINDA

DATE: _____ BY _____
Mayor

ATTEST:

DATE: Sept. 15, 1992 BY _____
City Clerk

NJ:vm/crPWF02-113(2140)2051913295769
16-Jul-1992

VOL 12 2 5254

R0058547

City of Laguna Beach

By _____
City Manager

ATTEST:

_____ 10-22-92
City Clerk of the City of Laguna Beach

APPROVED AS TO FORM:

_____
City Attorney

VOL 12 2 5255

R0058548

VOL 12 2 5256

EXHIBIT A

Revised Attachment 1
to
Stormwater Permit Implementation Agreement

FY 1992-1993 PARTICIPANT SHARE CALCULATIONS

PROJECTED SCHEDULE OF ENTITY'S SHARES
FOR FISCAL YEAR 1992/93

WEIGHTED AVERAGE METHOD

WEIGHTINGS: POPULATION 50%
AREA 50%

ENTITY	1 1-1-91 POPULATION*	2 1-1-91 AREA**	3 W.A.S.R.***	4 ADJUSTED BUDGET SHARE
ANAHEIM	273,491	44.993	8.4802348%	$77,178.62
BREA	32,950	10.404	1.4053140%	$12,789.76
BUENA PARK	69,804	10.064	2.0551462%	$18,703.89
COSTA MESA	97,437	15.343	2.9683999%	$27,015.41
CYPRESS	42,628	6.925	1.3150161%	$11,967.96
DANA POINT	32,760	6.040	1.0658804%	$9,700.58
FOUNTAIN VALLEY	53,699	9.553	1.7203975%	$15,657.34
FULLERTON	115,563	22.298	3.8362899%	$34,914.07
GARDEN GROVE	165,016	17.773	4.0281982%	$36,660.63
HUNTINGTON BEACH	182,783	26.800	5.4158657%	$49,289.79
IRVINE	111,418	43.369	5.3823417%	$48,984.69
LAGUNA BEACH	23,448	7.800	1.0305601%	$9,379.13
LAGUNA HILLS	22,666	5.195	0.8156785%	$7,423.49
LAGUNA NIGUEL	47,699	14.669	2.0041794%	$18,240.04
LAKE FOREST	56,070	10.245	1.8171597%	$16,537.97
LA HABRA	51,617	7.699	1.5396836%	$14,010.86
LA PALMA	15,437	2.014	0.6381993%	$3,988.05
LOS ALAMITOS	11,643	2.186	0.3818675%	$3,475.19
MISSION VIEJO	73,724	16.392	2.6141906%	$23,791.75
NEWPORT BEACH	67,268	13.720	2.2900742%	$20,841.96
ORANGE	112,709	23.202	3.8535310%	$35,070.99
PLACENTIA	41,375	6.606	1.2674754%	$11,535.29
SAN CLEMENTE	42,164	16.910	2.0751680%	$18,886.10
SAN JUAN CAPISTRANO	26,745	14.054	1.5724803%	$14,311.14
SANTA ANA	300,256	27.339	7.6121440%	$69,278.12
SEAL BEACH	25,095	8.488	1.1137341%	$10,136.09
STANTON	30,818	3.131	0.8063187%	$7,338.31
TUSTIN	52,145	8.582	1.6171435%	$14,717.62
VILLA PARK	6,279	2.077	0.2750657%	$2,503.37
WESTMINSTER	78,803	10.190	2.2299129%	$20,294.44
YORBA LINDA	53,878	17.965	2.3712515%	$21,580.76
ORANGE COUNTY	155,889	152.528	14.6013177%	$132,886.59
O.C.F.C.D. (TOTAL)	--	--	10.0000000%	$91,010.00
TOTALS	2,453,277	584.554	100.0000000%	$910,100.00

* SOURCE: CALIFORNIA STATE DEPARTMENT OF FINANCE (LAKE FOREST POPULATION FROM 4/1/90 CENSUS)

** SOURCE: ENVIRONMENTAL MANAGEMENT AGENCY - SURVEYOR BOUNDARY UNIT. AREA HAS BEEN CALCULATED US LAND AREA FIGURES PROVIDED BY EMA AND SUBTRACTING AREAS IN EACH JURISDICTION FOR NATIONAL FORESTS PARKS, AIRPORTS, LANDFILLS AND MILITARY INSTALLATIONS.

*** W.A.S.R. = WEIGHTED AVERAGE SHARE

TABLE BY EMA/ERD

VOL 12 2 5257

R0058550

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

TECHNICAL ADVISORY COMMITTEE

BYLAWS

A COOPERATIVE PROGRAM BETWEEN THE CO-PERMITTEES OF THE STORMWATER PERMIT IMPLEMENTATION AGREEMENT FOR THE SANTA ANA & AND SAN DIEGO REGIONS WITHIN ORANGE COUNTY

VOL 12 2 5258

3 JUL 9 2

R0058551

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1.2 Background	1
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R0058552

1.0 Introduction

1.1 Purpose

These Bylaws define the membership and authority of the National Pollutant Discharge Elimination System Technical Advisory Committee (hereinafter known as "Committee"). The purpose of the Committee is to serve the co-permittees of the Stormwater Permit Implementation Agreement between the County of Orange, the Orange County Flood Control District, and other participants (hereinafter, collectively known as "co-permittees") in an advisory capacity and help manage and implement the NPDES Permit Program.

1.2 Background

On July 13, 1990, the County of Orange and the Orange County Flood Control District (OCFCD), in cooperation with the Cities, obtained NPDES Permit Nos. CA 8000180 and CA 0108740 for areawide stormwater discharge permits under the National Pollutant Discharge Elimination System (NPDES).

The co-permittees believe the implementation of the stormwater discharge program will be implemented more efficiently and effectively through this Committee. Committee Members serving the Cities will be selected by the Orange County City Engineers Association.

1.3 Stormwater Permit Implementation Agreement

The Stormwater Permit Implementation Agreement (hereinafter known as "Agreement"), executed on December 18, 1990, governs the administration of the NPDES municipal stormwater permits. This Agreement identifies the County of Orange, the incorporated cities, other government entities and the Orange County Flood Control District collectively as co-permittees.

2.0 Technical Advisory Committee

2.1 Formation

The Stormwater Permit Implementation Agreement will be amended to create the Committee.

The Committee will be governed by these Bylaws.

2.2 General Tasks

The Committee will receive, review, recommend and take appropriate actions on all program related matters including financial reports on behalf of the co-permittees. The Committee will where appropriate seek co-permittees approval. The Committee will interpret and implement policy established by the co-permittees and advise co-permittees on matters relating to the program as required by the co-permittees.

The relationship between the Committee and other NPDES program participants is illustrated in Exhibit 1.

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2.3 Membership

The Committee will consist of six members: Five members each representing a supervisorial district and nominated by the Orange County City Engineers Association via the Orange County League of California Cities.

The sixth member will represent the Director, EMA.

Alternate representatives for appointed members will not be permitted.

2.3.1 Term of Membership

City members will serve three years on a staggered schedule as shown in Exhibit 2.

2.3.2 Committee Chairman

The Chairman will be elected annually by a majority vote of the Committee at its first meeting.

Exhibit 2 lists present and past members of the Committee.

2.4 Meeting Frequency

At least one meeting will be held each year. Additional meetings may be held as required.

2.5 Committee Support

Staff support to the Committee will be provided by EMA - Flood Program Division and Environmental Resources Division, and others as required. The Manager EMA-Flood Program Division or his designee will serve as the Secretary and keep minutes of meeting proceedings.

3.0 Delegated Authority

3.1 Annual Operating Budget

The Committee will formulate, review and recommend annual operating budgets to the co-permittees for approval in accordance with the Agreement and these Bylaws.

3.2 Submittals to Regulatory Authorities

The Committee will review all items submitted on behalf of co-permittees to the regulatory authorities as part of the Agreement.

3.2.1 Stormwater Permit Implementation Agreement

The Committee will review, and submit Stormwater Permit Implementation Agreement amendments to the co-permittees for approval.

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3.2.2 Drainage Area Management Plan

The Committee will review, and submit the Drainage Area Management Plan and amendments to this Plan to the co-permittees for approval.

3.2.3 NPDES Permits

The Committee will review, and submit new or amended NPDES Permits associated with the Municipal Stormwater discharge program to the co-permittees for approval.

3.2.4 Legislation

The Committee will review all proposed legislation relating to Stormwater Pollution (NPDES) and recommend appropriate action to co-permittees.

3.3 Consultant Selection

The Committee will review Scopes of Work, Requests for Proposals, and consultant slates for providing specialized services related to the NPDES program and make appropriate recommendations on these matters to co-permittees or the County as lead co-permittee.

3.4 Budgetary Items

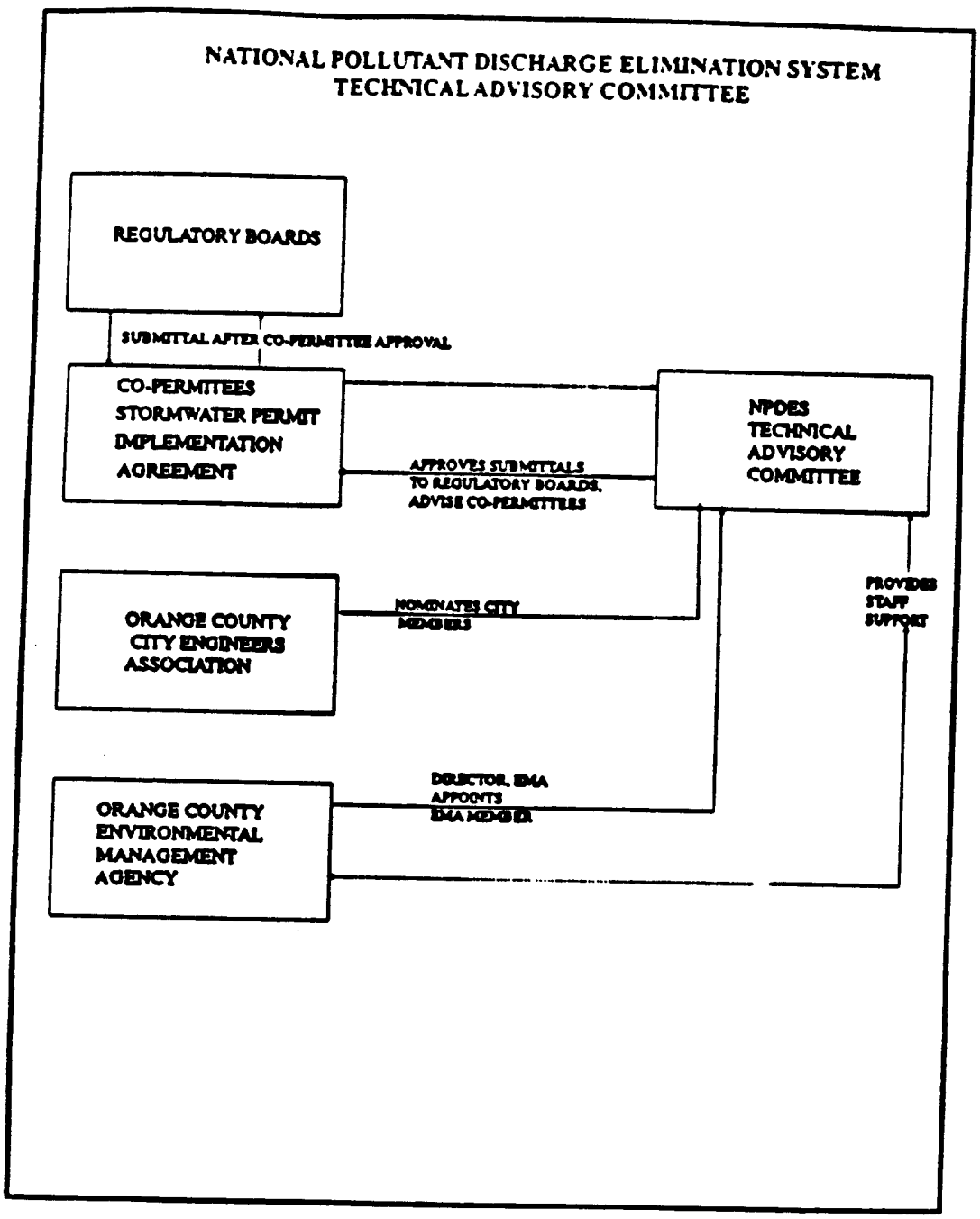
All budgetary matters will be submitted with recommendations by the Committee for approval by the co-permittees. Budgetary items with recommended action will be submitted in writing to each co-permittee.

4.0 Communication with Others

The Committee may conduct informal communications as necessary with others on behalf of the co-permittees to carry out its delegated authority in implementing program.

VOL 12 2 52662

Exhibit 1



VOL 12 2 5263

Exhibit 2

NPDES TECHNICAL ADVISORY COMMITTEE
COMMITTEE MEMBERS

YEAR	NAME	TERM EXPIRATION DATE	SUPV. DISTRICT	CITY OR AGENCY
1993		8-31-95	3	
		8-31-93	1	
		8-31-93	4	
		8-31-94	2	
		8-31-94	5	
	W. L. Zaun	N/A	N/A	EMA/PW
1992	Hugh Berry	8-31-92	3	Fullerton
	Lee Harry	8-31-93	1	Santa Ana
	Frank Page, Chairman	8-31-93	4	Orange
	Don Noble	8-31-94	2	Huntington Beach
	John Wolter	8-31-94	5	Newport Beach
	W. L. Zaun	N/A	N/A	EMA/PW
1991	Formation Committee			
	W. L. Zaun, Chairman	•	N/A	EMA/PW
	Lee Harry	•	1	Santa Ana
	Don Noble	•	2	Huntington Beach
	Hugh Berry	•	3	Fullerton
	Frank Page	•	4	Orange
	John Wolter	•	5	Newport Beach

• Term expires upon confirmation of regular members

VOL 12 2 5264

R0058557

REFERENCES

1. Orange County Flood Control Act, 1927.
2. National Pollutant Discharge Elimination System Stormwater Permit Implementation Agreement; Santa Ana/San Diego Regions.
3. Orange County NPDES Storm Water Permit Program Drainage Area Management Plan.

THE FOREGOING INSTRUMENT IS A TRUE AND CORRECT COPY OF THE ORIGINAL ON FILE IN THIS OFFICE.

ATTEST: October 28, 19 93
PHYLLIS A. HENDERSON, Clerk of the Board of Supervisors, County of Orange

BY Catherine Dinh, DEPUTY

VOL 12 2 5265

APPENDIX E

VOL 12

2

5266

R0058559

ORANGE COUNTY
NPDES STORMWATER PERMIT PROGRAM

DRAINAGE AREA MANAGEMENT PLAN

WATER POLLUTION ENFORCEMENT IMPLEMENTATION PROGRAM

May 4, 1993

Submitted to the San Diego and Santa Ana Regional Water Quality Control Boards
in compliance with NPDES Stormwater and Urban Runoff Permits
CA 0108740 and CA 8000180

A COOPERATIVE PROJECT OF
THE COUNTY OF ORANGE, THE CITIES OF ORANGE COUNTY
AND THE ORANGE COUNTY FLOOD CONTROL DISTRICT

VOL 12 2 5267

R0058560

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2.0 BACKGROUND

3.0 REGULATORY REQUIREMENTS

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- 3.2 Municipal NPDES Permit Requirements
- 3.3 Federal Requirements

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- 4.1 Introduction
- 4.2 Detection Programs
- 4.3 Enforcement

5.0 ENFORCEMENT PROGRAM ELEMENTS

- 5.1 Introduction
- 5.2 Program Elements

6.0 PROGRAM IMPLEMENTATION

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- 6.2 Information Systems
- 6.3 Field Inspections
- 6.4 Investigator Training
- 6.5 Other

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2

5268

R0058561

EXECUTIVE SUMMARY

This report details a water pollution enforcement implementation program prepared in compliance with the requirements of Orange County's National Pollutant Discharge Elimination System (NPDES) municipal stormwater permits A review of Orange County's existing water pollution enforcement program identifies two areas requiring modification First, the ordinance underpinning the program does not meet current regulatory requirements and second, there is no uniform countywide water pollution enforcement program This program addresses these two issues by proposing development of a new ordinance, increased water pollution awareness amongst local agency staff involved in routine environmental compliance inspections, and the identification and training of enforcement staff to specified criteria (or delegation of enforcement authority to an existing County water pollution enforcement section).

VOL 12 2 5269

R0058562

1.0 INTRODUCTION

Orange County's municipal NPDES Stormwater Permits require the co-permittees to control the discharge of pollutants to waters of the United States through emergency spill response, source control measures, elimination of illegal discharges/illicit connections, and legal authority and its enforcement Source control measures are fully addressed in the Drainage Area Management Plan The County of Orange's planned response to a hazardous materials emergency is comprehensively detailed in the County of Orange Hazardous Materials Area Plan, one of the most sophisticated spill response programs in the nation Many elements of an effective enforcement program, such as the cooperative Orange County Hazardous Materials Strike Force and a water pollution ordinance are also long-established Full implementation of the permit compliance program will, however, require the limited development and implementation of new or modified program elements.

With respect to legal authority and enforcement, the focus of this report, there already exists, within Orange County, an effective and long established water pollution enforcement program. This report therefore proposes modifications to ensure that this program meets current NPDES regulatory requirements The objective of the proposed program is uniform countywide legal authority and enforcement utilizing a revised ordinance and existing environmental compliance programs.

2.0 BACKGROUND

The 1987 Water Quality Act required EPA to promulgate regulations establishing NPDES permit application requirements for stormwater discharges associated with industrial activity, discharges from large municipal storm drain systems (serving a population 250,000) and discharges from medium municipal storm drain systems (serving a population of 100,000 to 250,000). On March 15, 1990, Orange County's 29 constituent cities, in cooperation with the County of Orange and the County of Orange Flood Control District submitted NPDES applications to the Regional Water Quality Control Board (RWQCB) - Santa Ana Region and San Diego Region for area wide NPDES stormwater discharge permits. These applications resulted in the issuance of municipal NPDES stormwater permits in July, 1990.

These permits include requirements for:

- Field inspection and documentation of drainage systems.
- Detection procedures for illegal discharges/illicit connections.
- Ordinances prohibiting illegal discharges/illicit connections.
- An implementation plan for prosecuting violators and eliminating illegal discharges.

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3.0 REGULATORY REQUIREMENTS

3.1 Introduction

The parameters of a water pollution control program are specified in the municipal NPDES stormwater permits and in EPA regulations (40 CFR Parts 122, 123, and 124) It is appropriate to consider the latter since these regulations and supporting preamble define the nationwide intent of the program and may provide the basis of Orange County's municipal permits upon their renewal in July, 1995

3.2 Municipal NPDES Permit Requirements

NPDES Permits CA 0108740 and CA 8000180 impose two general requirements on the co-permittees, the prohibition of illegal discharges from entering into the municipal storm drain system and the development and implementation of pollutant controls, termed best management practices (BMPs) to the maximum extent practicable More specific requirements for an enforcement program are detailed in subsequent permit sections.

Section V.1 requires submittal, for Regional Board review, of an implementation plan for prosecuting violators and eliminating illegal discharges. Under V 4 this plan is to include a description of the legal authorities for prosecuting violators and eliminating or controlling illicit disposal practices/illegal discharges to the storm drain system, and a proposed time schedule for obtaining such legal authorities.

In V.6 the co-permittees are required to effectively eliminate all identified illegal discharges (i.e., non-stormwater discharges not specifically permitted) and illicit connections in the shortest time practicable, and in no case later than July 1, 1995. Illegal discharges/illicit connections identified after that date are required to be eliminated in the shortest time practicable.

Under the required elements of the co-permittees Drainage Area Management Plan (DAMP), enforcement programs are to include response to emergency incidents, field inspections, and identification and elimination of illegal discharges/illicit connections to the storm drain systems.

3.3 Federal Requirements

Since issuance of Orange County's "early" NPDES permit, EPA rules and regulations were promulgated (Federal Register November 16, 1990 Rules and Regulations, Page 48069). These will likely be the basis of any renewal of the Orange County municipal permits in 1995. Under these regulations the municipality is required to demonstrate "adequate legal authority" to:

- Control the contribution of pollutants to the municipal storm drain system by stormwater discharges associated with industrial activity.
- Prohibit illicit discharges to the municipal storm drain system.

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- Control spills, dumping or disposal of materials other than stormwater

- Control through interagency agreements amongst co-permittees the contribution of pollutants from one municipality into the common combined flood control/stormwater conveyance system managed by the Orange County Flood Control District.

- Require compliance with conditions in ordinances.

- Carry out all inspection, surveillance and monitoring procedures necessary to determine compliance and noncompliance with permit conditions, and effectively prohibit illicit discharge to the municipal storm drain system.

These federal regulations also require description of a system wide management program, including a schedule to detect and remove (or require the discharger to the municipal storm drain to obtain a separate NPDES permit for) illicit discharges and improper disposal into the storm drain. Specifically, this program is to address:

- Implementing (including inspections and enforcement) an ordinance to prevent illicit discharges to the storm drain system.

- Effective field screening activities.

- Investigating portions of the storm drain system that, based on field screening results or other information, indicate a reasonable potential of containing illicit discharges.

- Prevention, containment, and response to spills.

- Promoting, publicizing, and facilitating public reporting of illicit discharges.

Finally, municipalities are required, to monitor and control pollutants in stormwater discharges to municipal storm drain systems from municipal landfills, hazardous waste treatment, disposal, and recovery facilities, industrial facilities that are subject to Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA) and industrial facilities that are contributing a substantial pollutant loading to the storm drain system. Except for long inactive facilities, all of these also require individual NPDES permit coverage.

4.0 EXISTING PROGRAMS

4.1 Introduction

The elimination of non-stormwater discharges to the municipal storm drain system involves concurrent detection/investigation/enforcement and public education programs. The co-permittees already have programs that facilitate detection of non-stormwater discharges including: drainage facility inspection (Reconnaissance Survey), field screening for gross contamination, industrial facility inspection, and wide distribution of public education materials that provide phone numbers

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for reporting spills and dumpings

Enforcement requires underlying statutory authority and implementation procedures A water pollution ordinance administered by County staff exists for the unincorporated area, all Flood Control District properties, and most cities Prosecution is handled by the Orange County District Attorney As noted earlier, one element of NPDES compliance will be updating the language of this ordinance

4.2 Detection Programs

4.2.1 Industrial Facility Inspection

A number of different public agencies routinely conduct inspections of industrial facilities. The Orange County Health Care Agency regulates the storage and disposal of hazardous wastes through the Health and Safety Code (H&S Code 6 95 and California Code of Regulations Title 22) Approximately 5500 businesses are inspected annually to ensure proper hazardous waste management.

The Fire Departments in Orange County regulate the storage of hazardous materials through disclosure ordinances such as OCC Sec 4-3-200 to 300) and Article 80 of the Fire Code. This regulation involves facility inspection at over 7000 businesses.

Table 1 Disclosure Program: Businesses regulated by Fire Departments

Fire Department	Number of Businesses in Disclosure Program
Orange County	3,500
Anaheim	1,000
Brea	160
Buena Park	250
Fountain Valley	200
Garden Grove	340
Huntington Beach	500 (inc. 200 oil wells)
Newport Beach	140
Santa Ana	750

Agricultural chemicals, including pesticides and herbicides, are regulated by the Agriculture Commissioner through the State Agriculture Code (California Code of Regulations Title 3, Sec. 6000 et seq.). The Commissioner's office performs facility inspections and initiates enforcement action for non-compliance.

Solid waste disposal at landfills is regulated in the unincorporated areas by the Integrated Waste Management Department of the County of Orange through the County Code (Sec. 4-3-17 to 4-3-147). Waste collection services within the incorporated areas are administered by the individual cities.

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Discharges to the sanitary sewers are regulated by the County Sanitation Districts of Orange County (CSDOC) in north Orange County and the Aliso Water Management Agency and the South East Regional Reclamation Authority (AWMA/Serra) in the south. Both organizations conduct facility inspections

Municipal code compliance is administered by city and County code enforcement staff. This responsibility includes regulation of land use and land alteration through enforcement of zoning codes included in the Codified Ordinances of each co-permittee municipality Local Code Enforcement staff perform inspections in response to complaints and initiate enforcement actions for non-compliance

4.2.2 Drainage Facility Inspection

All the co-permittees are, under a separate NPDES permit requirement, conducting inspections of their drainage facilities Under the criteria established by the Stormwater Program, surface facilities will be inspected annually and below grade facilities (39" diameter) will be inspected every two yrs.

4.2.3 Field Screening

Field screening is conducted annually at 89 locations throughout the Orange County drainage system. The specific objective of this component of the water quality monitoring program is to detect gross contamination arising from illegal discharges, through analysis for phenols, cyanide, chlorine, copper, chromium, pH and conductivity.

4.2.4 Incident Reporting

The reporting of spills and dumpings is facilitated by the listing of City/County telephone numbers in materials produced and distributed by the Stormwater Program's public education activities. In addition, Orange County "white-page" telephone directories list the County's Water Pollution Section telephone number, while the County's quarterly "Hazardous Waste News" encourages people to report spills and dumpings by dialing 9-1-1.

4.3 Enforcement

4.3.1 Statutory Authority

Local statutory authority to control discharges is embodied in the Industrial Waste Disposal Ordinance, now more widely known as the Water Pollution Ordinance (OCC Sec. 4.3.148 to 190) which has been adopted by twenty Orange County cities and the County of Orange. This ordinance prohibits unpermitted discharges of industrial waste. Specifically, "No person, firm, or corporation shall discharge... any industrial waste in a manner which or may cause pollution of any underground or surface waters." The ordinance also details permitting for dischargers and businesses regulated by its provisions. In addition, city and county staff may variously cite other code sections from the Fish and Game Code, Water Code, Fire Code, and Penal Code, for

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controlling discharges

Specific limitations associated with the existing ordinance include its definition of regulated industrial waste (" any and all liquid or solid waste substance, not sewage, from any producing, manufacturing or processing operation of whatever nature) which appears to exclude wastes from a wide variety of non-manufacturing situations such as product dispensing operations and releases from vehicles

It is also believed that the following powers will ultimately be needed, none of which are clearly provided in the current language:

a To clean-up and abate illicit discharges, which could include physical removal and consequent expense-liening against title to discharger-owned properties, or in instances of spills in transit, to invoice responsible parties for costs, and pursue cost recovery legal action.

b To control the discharge to the municipal storm drain system of spills, dumping or disposal of materials other than stormwater.

c. To eliminate illicit physical discharge connections to the public storm drain system, and prohibit future connections except by permit or standing agreement.

d. To implement policy and provisions of the Orange County Drainage Area Management Plan, which may include required structural and non-structural controls over construction and new development, and required maintenance of same.

e. To administratively determine how enforcement efforts should be targeted. For example, municipalities may variously wish to conduct enforcement efforts on a prioritized watershed basis, on an area by area schedule, in conjunction with inspections for other purposes, or in response to complaints.

f. To utilize funds generated by all financing mechanism(s) in multi-jurisdiction projects and programs.

g. To control the water quality impacts of uses or activities (i.e., brush clearance, landscaping, paving, and outdoor material storage, for example) that may require no discretionary or ministerial permits.

h. To withhold municipal building and grading permits where other agencies (including state and federal) are prosecuting water resources/pollution violations for an uncorrected condition.

i. To issue correction or fee citations for observed violations.

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j To issue administrative orders to cease and desist illicit discharges and restrict physical access to public property for activities, operations or businesses that violate orders

k To carry out all inspections, surveillance and monitoring procedures necessary to determine compliance or non-compliance with approved discharge permit conditions or to discover illicit discharges to the storm drain system.

l To pursue retroactive cases (i e , to prosecute without having to prove a spill or discharge occurred after the effective Ordinance date)

m To establish optional alternative criminal/civil approaches to enforcement, including administrative civil penalty assessments.

n To seek public property trespass damages for physical damages caused.

o To establish strict liability for violators.

p In emergency situations, to suspend public or private operations or businesses, or elements of operations or businesses, that by their nature are discharging or threaten to discharge pollutants to the public storm drain system.

4.3.2 Enforcement

Enforcement is the process of effecting legal authority. Investigations of code violations pertaining to water pollution and hazardous materials management are routinely undertaken by various co-permittee agencies including Anaheim and Orange Fire Departments, Irvine and Newport Beach Police Departments, and EMA's Water Pollution Section. Although investigations may be unilateral efforts, more typically they are coordinated with other federal, state and local agencies through the Orange County Hazardous Materials Strike Force. The Strike Force is headed by the Orange County District Attorney's Office and includes representatives of a wide variety of local, regional, and state agencies including:

OCEMA/Water Pollution and Agricultural Commissioner OCHCA/Environmental Health
County and City Fire Departments County Counsel and City Attorneys
Sheriff and City Police Departments
Sanitation Districts and Water Districts
Orange County Integrated Waste Management
California Department of Fish and Game
Regional Water Quality Control Boards (RWQCB)

The agencies coordinate closely on individual cases, with each agency responsible for its own area of expertise. In issues of water pollution, enforcement is generally lead by those authorities with the strongest powers to cite for violations, i.e., California Department of Fish and Game, RWQCB, Coast Guard and EPA.

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5.0 ENFORCEMENT PROGRAM ELEMENTS

5.1 Introduction

The purpose of this section is to define the necessary elements of an effective water pollution enforcement program Based on the regulatory review in Section 3 0 and the limitations identified in Section 4 0, notably the need for revised legal authority and enforcement expertise, the following required program elements have been identified

5.2 Program Elements

Uniform Program Content - All co-permittees will implement a uniform program to eliminate illegal discharges to the municipal storm drain system The co-permittees collectively will adopt a uniform time schedule to identify and eliminate illegal discharges to the storm drain system

A uniform program throughout Orange County is consistent with the intent of the permits, the federal regulations, the Implementation Agreement, and with direction received from Regional Board Staff.

Adequate Legal Authority
All co-permittees will enact adequate statutory authority to enable them to control stormwater pollution including a prohibition on non-NPDES permitted discharges to the municipal stormdrain system. The establishment of adequate statutory authority is clearly identified in the NPDES permits and federal regulations as the responsibility of all co-permittees.

Assignment of Enforcement Responsibilities
All co-permittees will individually pursue enforcement actions to control storm water pollution or will delegate authority for enforcement to the Flood Control District. The NPDES permits identify the County, as principal permittee, and the cities, as co-permittees, as having responsibility for pursuing enforcement actions. The Implementation Agreement between the co-permittees allows the cities to "name the District as enforcer of a water pollution control ordinance."

It should be made clear that staff other than law enforcement officers or criminal investigators may become intimately involved in enforcement of this program. This is typically the case with local nuisance ordinances, building and zoning code violations, etc., where the bulk of "leg-work", due to practical limitations on the resources of police departments and municipal prosecutors, is borne by other municipal staff.

Special Facilities
All co-permittees will inspect, monitor, and control pollutants in stormwater discharges from landfills, hazardous waste treatment, disposal, and recovery facilities, industrial facilities subject to Section 313 of Title III of SARA, and industrial facilities located in their jurisdictions and determined to be significant sources of stormwater pollutants.

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Progress Reporting
All co-permittees will submit a progress report for each calendar year that evaluates their program of detecting and eliminating illegal discharges to the storm drain system

Information Systems
Central Reporting "Hot-Line" - The co-permittees will establish and publicize one countywide central phone number for the reporting of illegal discharges.

Listing of Permitted Discharges - The County on behalf of the co-permittees will maintain the list of permitted discharges

Field Inspections
All co-permittees will conduct field investigations of illegal discharges based on reports of spill incidents, determination of illegal connections, referrals from the public and other agencies and evidence of gross contamination from field screening data These activities are specified in the NPDES permits and federal regulations.

Definition of Staff Resources
Each co-permittee will identify staff assigned to perform investigations and admininstratively support those investigations.

Investigator Training Equipment
Co-permittee "investigators" will be trained and equipped to recognize and identify suspected illegal discharges; collect, preserve, and submit samples for analysis utilizing procedures defined in 40 CFR Part 136, SW846, and Standard Methods for the Analysis of Water and Wastewater; and to implement quality assurance/quality control protocols. Co-permittee staff investigators will be trained to collect evidence, utilize chain-of-evidence procedures, carry out surveillance of suspects releasing non-permitted discharges, photo document incidents, prepare reports and compile case submittals.

Investigator Role
Investigators will be available on a 24 hour basis to perform investigations. Criminal prosecution requires a high burden of proof. According to EPA this means that the prosecutor must prove every element of a crime beyond a reasonable doubt. The evidence collected at investigations should be adequate to support a criminal prosecution.

Co-permittee staff investigators may be required to provide both factual and "expert" testimony in hearings and trials per the judicial process to enforce the elimination of illegal discharges.

Finally, investigations of illegal discharges may result in findings that an emergency condition exists threatening life and property.

Staff investigators will be trained to recognize such conditions and to initiate an emergency response using the Orange County Hazardous Materials Area Plan, or

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equivalent City Plan

Administrative Support
Co-permittee staff will be provided to support all those actions/procedures to eliminate illegal discharges Co-permittee staff will coordinate actions with other agencies and participate in interagency meetings that pertain to the elimination of illegal discharges

6.0 PROGRAM IMPLEMENTATION

This Section details a schedule for implementing the previously described enforcement program elements Based on the regulatory requirements (Section 3 0), a review of existing programs (Section 4 0), and recognition of the need for specific program elements (Section 5 0), the following main areas of program modification are identified Adequate Legal Authority, Information Systems, Field Inspections, and Investigator Training.

6.1 Adequate Legal Authority

To address the issues of "adequate legal authority" a consultant (or the County Counsel) will be retained on behalf of the co-permittees to conduct a thorough review of existing city and county ordinances and to develop a new model Water Quality Ordinance that fulfills state and federal requirements for effective control of discharge to the storm drain system. The schedule for completing this work is detailed in the Drainage Area Management Plan.

- Prepare Request for Proposals (RFP) and Scope of Work - completed October, 1992.
- Recommend consultant to complete study - February 1993.
- Consultant recommendations to co-permittees - December 1993.
- Adoption and implementation by co-permittees - December 1993.

In the interim period, cities will be encouraged to adopt the existing Water Pollution Ordinance.

6.2 Information Systems

Extensive public education efforts already facilitate public reporting of spills or improper waste disposal. During 1992/93, creation of a water pollution telephone "hot-line" will be undertaken to further promote public awareness and program involvement.

- Develop, implement, and advertise water pollution telephone "hot-line" - July 1993 completion.

Information that has been collected identifying all permitted discharges from landfills, hazardous waste treatment, disposal, and recovery facilities, and industrial facilities will be shared so that co-permittee responsibilities for inspection, monitoring, and controlling discharge pollutants may

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be carried out

- Distribute information on permitted discharges to co-permittees - May 1993 completion

6.3 Field Inspections

The industrial facility field inspection programs undertaken by co-permittee agencies other than the Environmental Resources Division of the County EMA are oriented to visual recognition of contamination rather than sources of stormwater pollution These agencies such as City Building, Business License, and Fire inspectors will be formally briefed on water quality protection concerns and provided with contacts to whom discharge information could be passed The schedule would be

- Develop handbook for use by co-permittee agencies (e g , municipal fire departments, inspectors and staff investigators, Orange County Health Care Agency, etc) - June 1993 completion
- Coordinate with other co-permittees - June 1993.
- Implement reporting of discharges - December 1993

Note: Reporting of discharges may be on an informal basis or formalized in Memoranda of Understanding between inspecting and enforcing agency(ies).

6.4 Investigator Training

It is recognized in Section 4.3 that Countywide there is neither uniform legal authority nor uniform water pollution enforcement. Currently, investigation is conducted primarily by EMA in accordance with the current Water Pollution Ordinance Co-permittees may take enforcement actions independently or may arrange for service through the County. Indeed, a number of cities do have effective independent enforcement programs Newport Beach and Irvine, for example, specifically assign police department staff to environmental crime investigations In Anaheim, Huntington Beach and Orange the fire department has primary responsibility.

Section 5.0 details the expertise necessary for staff to undertake effective enforcement. The primary rationale for the required expertise is that enforcement may in certain instances result in criminal prosecution Such prosecution requires a high burden of proof and thus a high degree of competency and technical understanding. This does not, however, preclude less highly trained staff from issuing citations for minor infractions, such an approach is envisioned as one element of the new ordinance.

In addition to designated enforcement staff with specific technical competency, effective enforcement will also require development of an enforcement response guide to ensure that Countywide, staff react in a consistent manner to similar instances of non-compliance.

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If staff follow documented enforcement procedures, dischargers will not view subsequent regulatory action as subjective, arbitrary or unreasonable. Indeed, the regulated community will recognize that certain violations will always bring a particular enforcement response. Although EPA's guidance manuals for POTW Pretreatment Program Development extensively address enforcement response plans, sanitary sewer protection programs and storm drain protection programs developed in compliance with NPDES Stormwater Permits are not directly analagous.

Consequently, a stormwater-specific enforcement response guide would be developed in conjunction with the proposed Water Quality Ordinance by the selected consultant.

The schedule for implementing an investigation program is clearly governed by the time frame over which legal authority is developed and adopted:

- Identify staff and resources (or delegate authority to EMA) - December 1993
- Develop enforcement response guide completion - December 1993
- Undertake staff training on enforcement guide - December 1993

Note: Investigators may also require training to meet Federal and State OSHA standards related to the variety of hazardous materials which may be encountered in field activities.

- Implementation - December 1993

6.5 Other (technical points)

The permits require annual reporting of progress with enforcement activities. The schedule for preparation of these reports is:

- Submittal of Co-permittee data to County - December 1992, 1993, 1994.
- Compilation of data by County into report form and submittal to Regional Boards - January 1993, 1994, 1995.

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COUNTY OF ORANGE

ENVIRONMENTAL MANAGEMENT AGENCY

SANTA ANA, CALIFORNIA

REGULATION FUNCTION
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MANAGEMENT GUIDELINES FOR USE OF FERTILIZERS AND PESTICIDES

March 12, 1993

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For Fertilizer and Pesticide Management

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EXECUTIVE SUMMARY

This document was prepared to fulfill the commitment in the Orange County Drainage Area Management Plan (DAMP), Sections 5 2 9 and 5 2 10, which requires that co-permittees establish guidelines for the management of fertilizers and pesticides

The main objective of these guidelines is to safeguard to "the maximum extent practicable" against unnecessary discharges of fertilizers and pesticides into surface and groundwater systems and to establish safe and reasonable standards for handling those materials The guidelines are based on state and federal laws, environmental policies and "best management practices" established by various public and private agencies

The County and many of the cities have already been following many of these guidelines. However, through this document, it is envisaged that these practices will be adopted by the County and all of the co-permittees to establish a set of uniform standards and procedures.

In addition to management guidelines, this document also includes a summary of the findings of the June 2 fertilizer and pesticide survey, specifically outlining and comparing different aspects of the policies and procedures of the co-permittees.

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1.0 INTRODUCTION

1.1 Status of Fertilizer and Pesticide Use

Fertilizers and pesticides are primary tools of vegetation management Used properly, fertilizers provide important nutrient supplies for vegetation and agriculture, and pesticides help to protect those resources from potential harm.

Used improperly, fertilizers and pesticides can become an impairment to surface and groundwater supplies Careless application, mixing, transportation, storage and disposal allow chemicals to enter surface and groundwater through runoff and infiltration, the same handling problems endanger human health through exposure to toxic chemicals, soil degradation often results from overuse and misuse of pesticides and fertilizers Even under ideal conditions, there is still a high level of risk, and consequently, there is a need for considerable professional planning and management.

1.2 Management Options

Because of the risk involved in using fertilizers and pesticides, the development of management guidelines for use of fertilizers and pesticides is an essential element of the Drainage Area Management Plan (DAMP). These guidelines are designed not only to comply with National Pollutant Discharge Elimination System (NPDES) permitting, but also to minimize any threat to human health and environmental resources from improper use of fertilizers and pesticides. It is envisaged that consideration of these guidelines by the co-permittees will cause public agencies to re-evaluate their approach to using fertilizers and pesticides and move toward reducing dependence on them.

The guidelines that follow are intended for the use of the co-permittees, although they may ultimately be used on a broaderscale. They are based on the laws, management guidelines and "best management practices" established by other federal, state and local agencies. They recognize that the safe management of fertilizers and pesticides is a shared responsibility between the field worker and management. These guidelines address the concern for fertilizer and pesticide use at a basic level, and if followed, they should reasonably prevent environmental damage to the highest degree possible.

1.3 Definitions

For the purpose of these guidelines, fertilizers may be referred to as "nutrients" or "soil nutrients," and the term "pesticides" will encompass all herbicides, insecticides, fungicides and rodenticides. The California Food and Agricultural Code and the California Code of Regulations Title 3 (3 CCR) constitute the laws and regulations referenced in this plan. They are referenced often and usually referred to as the "State Code." Also, co-permittees in the NPDES permits shared by the County and its incorporated cities will be referred to as "public agencies," and employees working for these public agencies who handle fertilizers and pesticides will be referred to as "workers" or "public employees."

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2.0 FERTILIZER MANAGEMENT

2.1 Definition and Scope of Guidelines

Fertilizers are nutrients applied to soil to provide a better growing environment for plants The fertilizers most commonly in use in Southern California today are nitrogen- and phosphorus-based Both leach into soils easily in the presence of water and have become a water quality concern, causing algal blooms and eutrophication and, in some cases, causing levels to exceed federal drinking water standards

However, fertilizers also play the important role of promoting vegetation growth that protects soil from erosion and enhances landscape aesthetics Because there is a necessity for soil nutrients and because there is a potential for adverse effects on local waterways due to the loss of these nutrients through runoff and infiltration, management guidelines are necessary as a means of reducing the loss of fertilizers into water supplies

2.2 General Considerations

2.2.1 State and Federal Law

Because most fertilizers are not as toxic as pesticides, state and federal lawmakers have not developed regulations for their use. Fertilizers are not usually considered an immediate danger to public health or safety. However, the California Fertilizer Association, a Sacramento-based organization, has developed complete management guidelines for fertilizer use and the State Department of Food and Agriculture has recommendations for use of nitrate-based fertilizers, both of which are available for consultation.

2.2.2 General Recommendations

1. Public agencies should periodically test soils before applying fertilizers to be certain that application is appropriate for and compatible with soil conditions. The samples should be analyzed by a qualified specialist, and workers should follow the recommendations for application.

2. Public agencies should choose to use organic fertilizers such as compost, peat and mulch wherever possible to increase soil porosity and water retention.

3. Workers should apply only the minimum amount of fertilizer needed and incorporate it directly into the soil around the plant where possible to minimize potential surface runoff.

4. Workers should not apply fertilizers in the rain or on the same day that rain is expected.

5. Workers should immediately cleanup any spill of fertilizers.

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6 Storage facilities should be covered and have impermeable foundations so that potential spills don't have the opportunity to runoff into surface water or leach into groundwater systems

7 Fertilizers that may be carried by the wind should be stored in areas away from open loading spaces and entrances of storage warehouses.

8 Fertilizers should be securely covered in the vehicle before being taken to application sites so that none can spill or fly out during transport.

9 Use slow release fertilizers -- such as water soluble nitrogen fertilizers, coated fertilizers and fertilizers of limited solubility -- wherever possible to reduce the chances of leaching.

2.3 Planning for Use of Fertilizers

2.3.1 Soil Testing

Most fertilizers travel quickly through water. Therefore, fertilizers will leach through soil and potentially contaminate groundwater more quickly after excess watering or irrigation, after heavy rains and where the water table is high. For this reason, soil testing is an important management technique to determine the safest fertilizer application rate.

The California Landscape Contractors Association (CLCA) has a complete list of organizations in Southern California that offer soil testing and analyzing for fertilizer use. To get a copy of that list, CLCA can be contacted at (916) 448-2522. If a reliable soil analyst is not already known, it is advisable for public agencies to consult CLCA and research a specialist who can make recommendations for fertilizer use.

2.3.2 Application Rates

The amount of fertilizer needed for different applications depends on a number of factors. For specific recommendations, a qualified specialist should be consulted. However, some factors to be considered include:

- the vegetation's ability to use fertilizer;

- the amount of nutrients already in the soil, including fertilizer that may still be present from a previous application;

- the amount of soil nutrients that will or can be obtained from natural processes;

- expected loss of nutrients from the soil, and

- temperature at the time of application.

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2.3 3 Timing

For vegetation with different growth patterns, fertilizers should be applied at different times and in different quantities The vegetation being managed should be researched and fertilizers applied only according to the recommended amounts and at the recommended time intervals so that waste of fertilizer and risk of water contamination are minimized This research should be incorporated in a recommendation from a qualified specialist for fertilizer applications.

2.4 Application Methods of Fertilizers

This section details the most common methods for application of fertilizers These are not the only acceptable methods of fertilizer application Every application has its own unique circumstances and variables to consider A qualified fertilizer specialist should be consulted to recommend the most appropriate application method.

2.4.1 Banding of Fertilizer

Probably the most common and safest application method, this involves physically working small amounts of fertilizer into the soil in a band beneath and around the sides of a seed. It allows new roots to efficiently use the nutrients and minimizes potential nutrient loss to surface runoff. However, given the labor involved, banding may not be practical for most public agency fertilizer applications.

2.4.2 Foliar Fertilization

This is fertilizer applied in solution form that is absorbed through leaves and stems. The method can reduce nutrient leaching into the soil when applied correctly and can be performed at the same time as pesticide applications to avoid spraying twice. In the latter case, the guidelines for pesticide use must also apply.

2.4.3 Broadcast Application

By this method, dry or liquid fertilizer is uniformly spread over the soil surface. This is often done mechanically, an example being the "drop spreader," which is usually an inverted triangle hopper. The simplest of mechanical applicators, the drop spreader is commonly mounted on wheels and pushed by hand or pulled by vehicle to drop fertilizer out the bottom of the triangle.

Other types of broadcast applicators include spray booms for liquid fertilizer or "spinning disks" mounted on a moving vehicle that throw dry fertilizer into the air. It should be noted that these latter methods do not offer much control over fertilizer drift in adverse weather conditions.

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2.4.4 Fertigation

Although not likely to be used by public agencies for fertilizer applications, this method is common among Californian farmers who incorporate fertilizers into irrigation water. The potential for nutrient leaching using this method, though, appears to be high.

2.5 Storage and Handling of Ferilizers

2.5.1 General Description

When stored and handled properly, fertilizers present no hazard to the users' health. Public employees responsible for storage and handling of fertilizers should be aware that some fertilizers have properties that can result in dangerous chemical reactions if mixed with other substances or under unusual conditions. For example, ammonium nitrate may become explosive if it becomes mixed in diesel fuel, a dehumidifier may be necessary for storage areas where sensitive fertilizers are stored. Also, because most fertilizers tend to be corrosive, concrete structures are preferred for fertilizer storage facilities.

2.5.2 Dry Fertilizer

In most cases, dry fertilizers are safe to store, transport and handle. However, because some fertilizers have unique, potentially dangerous properties, it is advisable for public agencies to consult a qualified fertilizer specialist for the safest storage and handling procedures for specific fertilizers.

2.5.3 Liquid Fertilizer

Fertilizers in liquid form are potentially more hazardous than dry fertilizer. Public employees responsible for storage and handling need to be aware of the specific properties of each liquid fertilizer in use, including corrosivity and tolerable temperature and pressure ranges. Protective equipment may be necessary for workers handling fertilizers such as sulfuric or phosphoric acid. A qualified fertilizer specialist should be consulted for recommending the safest handling and storage procedures for specific liquid fertilizers.

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3.0 PESTICIDE MANAGEMENT

3.1 Definition and Scope of Guidelines

Pesticides are designed to kill or restrict the growth of plants and organisms, and thus, are potentially dangerous chemicals Increasing scientific concern for their safe use and heightened public awareness of health concerns has led to more and more regulations in the United States at both the state and federal level Pesticide use by public agencies often involves applications to keep flood control channels and roadways clear or to minimize health and safety hazards of disease-bearing rodents and insects -- any of these applications can drain into stormwater basins if not controlled properly. Although safety concerns and the cost of complying with new regulations have encouraged some public agencies to cut back on the use of pesticides, use is still common, and their management is therefore essential

3.2 General Considerations

3.2.1 State and Federal Law

The California Department of Food and Agriculture and the federal Toxic Substances Control Act (TSCA) have set forth extensive rules and regulations that must be met by all public agencies. At an absolute minimum, public agencies must comply with these laws or be subject to the penalties described in the statutes.

3.2.2 Chemical Labels and Materials Safety Data Sheets (MSDS)

1. Without exception, chemical labels provided by the manufacturer of each pesticide are the first source of recommendations and instructions for chemical use. Whenever a chemical is to be used by a worker or a contractor of a public agency, the user needs to be intimately familiar with the label instructions and requirements.

As described in the State Code (3 CCR, Ch. 2, Subch. 1, Art. 10), the label must appear on the immediate container of the chemical and include, in prominent, bold type, the appropriate warning or caution statement according to its toxicity classification. If a chemical is transferred to another container, a copy of the label should be transferred with it.

Workers should never handle a container that doesn't have a warning label attached, and the supervisor in charge should be immediately advised of the situation. If a label is badly damaged, it shall be replaced by the supervisor.

2. Workers using pesticides shall have readily available the Materials Safety Data Sheets (MSDS) for each chemical they are using Although the MSDS is a form that may vary in appearance for different chemicals, the information is the same, as required by law. Similar to the chemical labels, these sheets contain information necessary to handle each chemical safely, and all workers shall be familiar with the information.

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MSDS sheets include chemical identifications, hazardous ingredients, physical data, fire and explosion data, health hazards, reactivity data, spill or leak cleanup procedures, special protection and special precautions.

3.2.3 General Recommendations

1. Public agencies should maintain a complete list of all chemicals and their uses.

2. Public agencies should thoroughly investigate and consider all alternatives to pesticide use.

3. Workers shall use pesticides only according to label instructions.

4. Work crews should bring to the work site only the amount of chemical to be used during the application and use only the minimum amount of the chemical that is necessary.

5. Workers should consider weather conditions that could affect application (for example, they shouldn't spray when winds are exceeding 5 mph, when raining or when rain is likely).

6. Workers should consider area drainage patterns (for example, they shouldn't apply near wetlands, streams and lakes or ponds unless it is for an approved maintenance activity).

7. Workers should consider soil conditions before applying pesticides (for example, they shouldn't apply to bare or eroded ground).

8. Workers shall triple-rinse empty pesticide containers before disposal and use the leftover wash as spray.

9. Workers should never clean or rinse pesticide equipment and containers in the vicinity of storm drains.

10. Pesticides should only be stored in areas with cement floors and in areas insulated from temperature extremes.

11. Workers shall secure chemicals and equipment during transportation to prevent tipping or excess jarring in a part of the vehicle completely isolated from people, food and clothing.

12. Workers or their supervisors should inspect pesticide equipment, storage containers and transportation vehicles daily.

13. Public agencies should adopt a plan for dealing with potential accidents before they happen.

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14 Workers should immediately clean up any chemical spill according to label instructions and notify the appropriate supervisors and agencies

3.3 Planning for the Use of Pesticides

3 3 1 Selection of Appropriate Pesticides

1 Pesticides are to be used only after recommendation from a state-licensed pest control advisor.

2. Public agencies should seek advice for appropriate pesticide use from the Orange County Agricultural Commission, from other professional pesticide handlers and/or through professional publications The County Agricultural Commission can be contacted at (714) 447-7100.

3 A special effort should be made to limit use of restricted pesticides and all other Category One pesticides.

3.3.2 Certification, Licensing and Permitting

1. Pesticides are only to be applied by or under the direct supervision of a state-licensed or certified pesticide applicator or by workers with equivalent training.

2. Chemicals listed as "restricted" in the State of California may be used only under a restricted materials permit (3 CCR Ch. 2, Subch. 4) to be issued by the Orange County Agricultural Commission. The permit must be renewed annually for continued use. For more information, contact the Commission at (714) 447-7100.

3. Other guidelines concerning permits, licensing and certification that need to be followed before pesticide application are detailed in the State Code (3 CCR, Ch. 3, Subch. 1).

3.3.3 Employee Training

1. Public agency employees must know the information on the chemical label and its MSDS before using pesticides in any capacity. In addition, they shall (a) know the immediate and long-term health hazards posed by chemicals to be used, the common symptoms of chemical poisoning and the ways poisoning could occur, and (b) know the safe work practices to be followed, including the appropriate protective clothing, equipment, mixing, transportation, storage, disposal and spill cleanup procedures that apply to the specific chemicals being used.

2. In addition to the training and annual continuing education required by State Law for licensing and certification (3 CCR, Ch. 3, Subch. 3, Art.2), public employees are

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encouraged to participate in continuing pesticide education programs whenever programs are available

3 3 4 Accident Mitigation

Public agencies using pesticides should have plans for dealing with potential accidents before they happen These plans should consider

1 Labels and MSDS Sheets -- All workers handling pesticides must be familiar with these instructions. The steps for accident mitigation are spelled out on chemical labels and MSDS sheets

2 Spill Cleanup Kits -- Any time pesticides are being handled, there should be a cleanup kit on hand in case of an accident This means there should always be a cleanup kit located in pesticide storage areas, on vehicles used to transport pesticides and on location where the chemicals are being applied Although these kits may vary in what they contain depending on the chemical type and the situation, at a minimum they should include:

- spill-control procedures;
- a five gallon drum with sealable lid;
- a dust pan and broom;
- a squeegee;
- a shovel;
- protective goggles, gloves, boots, coveralls;
- a tarp (for covering dry spills);
- detergent and water (check label or MSDS for proper use);
- barricade tape, florescent traffic safety cones or string to cordon off an area, and
- large sponges, containment booms or some other absorbent material.

3. Cleanup Procedures -- Spilled pesticides must be prevented from entering the local surface and/or groundwater supplies. Specific recommendations for spill cleanup should be available on each chemical label or MSDS. Specific recommendations for the sequence of procedures may also vary depending on the situation. However, generally, in case of a spill, the responsible worker(s) should:

EVALUATE the accident and quickly determine the most immediate concerns (medical and/or environmental).

CONTAIN OR CONTROL the spill.

NOTIFY the supervisor in charge who should, in turn, notify the proper authorities. If contact cannot be made, dial 911.

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ISOLATE the area with fluorescent traffic safety cones, ropes or some other cordoning device to be sure that no one walks, wanders or drives through the spill area.

CLEAN UP the spill as best as possible following label instructions and using the appropriate spill cleanup kit.

EVALUATE any damage that may have occurred resulting from the spill (property damage, health damage, equipment damage, etc) and make notes on all relevant details and circumstances before leaving the scene.

PREPARE A COMPLETE REPORT detailing the incident immediately after leaving the scene upon returning to the work place and submit it to the immediate supervisor.

3.3.5 Emergency Medical Care

Accident situations requiring emergency medical care are likely to involve acute exposure to potentially toxic chemicals. Instructions for handling these exposures appear on the chemical label. Workers should:

1. Be aware of the symptoms of acute exposures for each chemical being used.

2. Have a predetermined strategy for dealing with exposure scenarios, including knowing (a) the label recommendations for dealing with acute exposures and (b) the nearest medical facility where emergency care is available.

3.3.6 Equipment and Equipment Maintenance

All equipment for the handling of pesticides should be inspected and cleaned by workers before each use to ensure that there are no problems that could lead to chemical leaks, spills or accidents during the day's work (3 CCR, Ch. 3, Subch. 3, Art. 2).

3.3.7 Groundwater and Surface Water Protection

Similar to the discussion of leaching in fertilizer management, the main factors determining the rate at which pesticides enter groundwater and surface water systems are chemical mobility, solubility and persistence and the soil type. For example, potentially dangerous chemicals are likely to have a high solubility and an extremely long half-life, and they are not likely to be easily absorbed into the soil. Therefore, chemicals that decompose rapidly may be preferred. However, note that to choose a chemical that may need to be applied two or three times as often may not make sense from a transportation and application risk standpoint.

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Because of these factors, regardless of the category of chemicals being used, pesticide advisors should periodically test the soil for compatibility with specific chemicals before recommending pesticides for a specific area

Furthermore, because the effect of these uses is not always immediately apparent, public agencies should periodically test areas that could be particularly vulnerable to contamination or deterioration The results of these tests should be kept on public record

3.4 Application of Pesticides

3.4.1 Supervision

1. In cases where supervision of pesticide applications is required by the State Code, supervision must be handled by a state-licensed or certified pesticide applicator For all other pesticides applications, supervision may be handled by workers with equivalent training.

2. Public agencies that contract for pesticide applications should periodically inspect contracted work crews to be certain that contractors are following proper management guidelines. Public agencies handling their own applications should likewise inspect their own work crews on a regular basis to ensure that safety standards are being met

3.4.2 Proper Techniques

1. Read the label carefully and follow application instructions Be absolutely certain that the right chemical is being used for the right job before applying.

2. To prevent potentially harmful runoff, only the absolute minimum amount of pesticides should be used to ensure vegetation safety.

3. Recommendations for best weather conditions to prevent pesticide spray drift are outlined in the State Code, Chapter 2, Subchapter 4, Article 2.

3.4.3 User Safety and Protection

1. Public agencies shall have on hand equipment for application of pesticides including eye protection, gloves, respiratory gear and impervious full-body, chemical resistant clothing when called for by the chemical label.

2. Even when wearing respiratory gear or masks, when dealing with spray applications of pesticides, workers should avoid directly inhaling in the spray mist.

3. Workers should avoid working alone, especially at night.

4. Workers should clean equipment, clothing and self thoroughly after each application.

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5 State laws regarding re-entry into fields that have recently been treated with pesticides shall be followed (3 CCR, Ch 3, Subch 3, Art 3).

6 Public agencies are responsible for knowing and informing workers about the specific pesticides being used including how they are properly handled, the dangers involved and the proper training and safety procedures.

7 Public agencies are responsible for keeping updated records and a complete list of the pesticides being used in their jurisdiction This should include the chemicals, amount in storage, amount of applications, dates and location of applications and pests controlled with each application.

8 Public agencies shall keep all relevant label and MSDS information for each chemical updated and readily available at all times to workers handling the materials.

3.5 Storage, Disposal and Transportation

3.5.1 Proper Storage

1. Storage areas should be away from living areas and in a covered area that is well-insulated from temperature extremes; they should have a cement floor and good ventilation. Also, storage areas should be clearly marked according to state standards and be securely locked at all times when not in use.

2. Public agencies shall ensure that chemical labels on pesticides being stored or used are kept in good condition and attached to all containers holding pesticides (3 CCR, Ch. 3, Subch. 2, Art. 4).

3. Workers should ensure that storage equipment and containers are inspected daily for leaks or defects before being taken on the job. Containers should also be inspected and before storing at the end of the day.

3.5.2 Proper Disposal

1. Workers shall make certain that chemical containers are triple-rinsed before disposal (3 CCR, Ch. 3, Subch. 2, Art.

2. It is recommended that cleaned containers be sent back to the manufacturer for recycling whenever possible. However, once triple-rinsed, most haulers will take them to most landfills.

3. Workers should use left over rinse water as spray.

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4 Public agencies should ensure that surplus or out-of-date chemicals are given to a licensed hazardous waste hauler for disposal

3 5 3 Safe Transportation Methods

1. Before transporting pesticides, workers shall ensure that all pesticide containers are tightly sealed and secured from tipping or excess jarring (3 CCR, Ch. 3, Subch. 2, Art. 4)

2. Transportation compartments on vehicles shall be isolated from the compartment carrying people, food and clothing and should be securely locked (3 CCR, Ch. 3, Subch. 2, Art. 4).

3. Workers should transport only the amount of pesticide needed for the day to the site.

4. Workers should be certain that the appropriate chemical labels and MSDS sheets, a spill cleanup kit, the location of emergency medical care and a first aid kit are always brought along when transporting pesticides.

5. Public agencies should encourage all vehicles used for pesticide transportation to include radio communications for contacting help in case of a spill or some other emergency.

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4.0 INTEGRATED PEST MANAGEMENT (IPM)

4.1 Background on Pesticide Use

For most of the last 50 years, the trend in vegetation management has been toward a greater reliance on pesticides The result has been not only an enormous increase in the use of many dangerous chemicals, but also an enormous increase in the number of pests that are resistant to the pesticides being produced -- in essence, as more pesticides have been produced, more resistent strains of pests have evolved Worse, recent studies have shown that the end result of this global trend has been no net gain in vegetation survival rates.

With these realizations becoming well-known, vegetation managers are now moving away from their reliance on pesticides and toward an integrated approach that combines limited pesticides use with more environmentally-friendly pest control techniches.

4.2 Scope of Guidelines

For public agencies in Orange County, IPM practices should be preferred to the sole use of pesticides as the primary means of vegetation management. These techniques are designed to prevent overuse and to reduce reliance on them. IPM should be considered by all public agencies or their contractors before intensive use of pesticides.

The goal of IPM is not to eliminate all pests, but to keep their populations at a manageable number. Pesticides are part of IPM techniques, but they are used in small quantities and only after all other alternatives have been reviewed.

4.3 Alternatives to Pesticides

Some of the alternatives to pesticides that may be considered as part of an IPM program include:

1. Introduction of natural predators such as ladybugs, lacewings, garter snakes and toads. Also, some bacteria, viruses and insect parasites may be preferable to pesticides.
2. Selected removal or rotation of vegetation habitat to eliminate the breeding places of specific pests.
3. Weeding, hoeing and trapping manually. Pruning and thinning of trees is also an effective means of preventing epidemic tree insects and diseases.

Also, at certain times of the year and under certain environmental conditions, certain pests can be expected. Therefore, timely planting or well-timed use of small quantities of pesticides may avoid the need for some chemical use.

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GLOSSARY

TERMS, ABBREVIATIONS, ACRONYMS

RELATED TO THE MANAGEMENT GUIDELINES FOR USE OF FERTILIZERS AND PESTICIDES

Best Management Practices (BMPs)
Schedules of activity, prohibitions of practices, maintenance procedures and other management practices to prevent or reduce the pollution of "waters of the United States." BMPs also include treatment requirements, operating procedures and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

California Code of Regulations Title 3, Division 6 (3 CCR)
The State of California code regulating pesticides and pest control operations.

California Fertilizer Association (CFA)
An organization promoting progress in the fertilizer industry in the interest of an efficient and profitable agricultural community. Activities of CFA include developing and disseminating new information to its members and others; supporting production-oriented research programs to identify maximum yield systems for farmers; promoting agronomic topics at our schools, colleges and universities; and maintaining open communications among the industry, universities and other state and federal agencies.

Chemical Labels
As required by federal law, manufacturers of pesticides must provide chemical labels on the containers of all pesticides distributed. These labels include all necessary information on the chemical constituents of the pesticide, including recommendations and instructions for use, toxicity classification and the appropriate warning statements and emergency procedures in case of acute exposures. As required by state law, labels must be kept in good, readable condition and be attached to all pesticide containers at all times.

Co-permittee
A permittee to an NPDES permit that is responsible for permit conditions relating to the discharge for which it is operator. As used in the Stormwater Permit Implementation Agreement, co-permittees are the County of Orange, its incorporated cities and the Orange County Flood Control District.

Drainage Area Management Plan (DAMP)
A document required under the municipal NPDES stormwater permits granted to the co-permittees by the Santa Ana and San Diego Regional Water Quality Control Boards.

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Equivalent Training
A term referring to public agency employees dealing with the application of pesticides who have not received a qualified applicator's license (QAL) from the State of California but who has completed a training course in pesticide application offered by the County of Orange.

Eutrofication
A decrease of dissolved oxygen in a body of water to such an extreme extent that plant life is favored over animal life. For example, a lake that has been overgrown in algae on the surface is likely in a state of eutrofication.

Integrated Pest Management (IPM)
The trend in vegetation management which supports moving away from reliance on pesticides and toward an integrated approach of limited pesticide use with more environmentally-friendly pest control techniques.

Materials Safety Data Sheet (MSDS)
Similar to chemical labels and also required by federal law, these sheets contain all information necessary for the safe handling of pesticides. They include chemical identifications, hazardous ingredients, physical data, fire and explosion data, health hazards, reactivity data, spill or leak cleanup procedures, special protection and special precautions.

Maximum Extent Practicable (MEP)
MEP means taking into account equitable considerations of competing factors including, but not limited to, the gravity of the problem, fiscal feasibility, public health risks, societal concern and social benefits.

National Pollutant Discharge Elimination System (NPDES)
The national program under the Clean Water Act for controlling discharges from point source discharges directly into the waters of the U.S.

Pest Control Adviser (PCA)
Certification obtained from the State of California after demonstrating an adequate knowledge of pests, pesticides and the implications of pesticide use. A recommendation for pesticide use must be obtained from a PCA before public agencies may approve any pesticide applications.

Qualified Applicators License (QAL)
A license obtained from the State of California after demonstrating adequate knowledge of the proper techniques for handling, storing, transporting and applying pesticides. Workers must obtain a QAL before being permitted to apply or supervise application of Category One pesticides.

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Qualified Fertilizer Specialist
A person designated by the governing public agency who is knowledgeable of the proper techniques for handling, storing, transporting and applying fertilizers as defined in the Management Guidelines for Use of Fertilizers and Pesticides. This person shall be able to sample, inspect, test and make analyses of fertilizers that are in use or being considered for use in the agency's jurisdiction to such an extent that may be necessary to comply with the management guidelines.

Restricted Materials Permit
A permit that must be acquired by any public agency before application of any one of the pesticides listed as restricted by the State of California in the State Code of Regulations Title 3, Division 6. In Orange County, this permit must be obtained from the County Agricultural Commissioner.

State Code
In this report, referring to the State of California Code of Regulations Title 3, Division 6 and referenced as "3 CCR."

Storm Drain
Pipe or channel structure designed to convey only stormwater runoff for purposes of flood protection. Federal regulations use the term "storm sewer." Use of the word "sewer" for a stormwater conveyance structure should be discouraged, since the word "sewer" also includes sanitary sewers and combined sewers which carry human waste.

Toxicity Classification
Pesticides are grouped into three categories by the California Department of Food and Agriculture according to their toxicity or potential for causing injury to people. Category One pesticides are the most hazardous and their use is normally restricted, while Category Three pesticides are least toxic to people and are generally less hazardous.

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APPENDIX I

Annual Progress Report
For Fertilizer and Pesticide Management

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APPENDIX 1
Annual Progress Report for Fertilizer and Pesticide Management

Pursuant to the Drainage Area Management Plan (DAMP), a report must be completed annually by July 31 on co-permittee progress toward implementation of a fertilizer and pesticide management plan Subsequently, this information will be included in the DAMP Progress Report which is required under the co-permittees' NPDES permits and is due to the Regional Water Quality Control Boards annually by July 31 The report will also include a Fertilizer and Pesticides Use Summary Chart similar to the one found in Attachment 1.

As lead agency for the co-permittees, the County is responsible for completing the progress report on the DAMP, and, therefore, each co-permittee must submit the attached annual progress report pertaining to the implementation of the fertilizer and pesticide management guidelines by June 15, 1993 and every year thereafter.

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ANNUAL PROGRESS REPORT
FOR FERTILIZER AND PESTICIDE MANAGEMENT
City of _____

I. Fertilizer Management

1. Were any soils in your jurisdiction tested for compatibility with the fertilizers being used (Section 2.3.1)?

Yes ____ No ____

2. Was a qualified fertilizer specialist consulted regarding:

A. fertilizer application rates or timing (Sections 2.3.2 and 2.3.3)? Yes ____ No ____

B. storage of fertilizers (Section 2.5)? Yes ____ No ____

C. handling of fertilizers (Section 2.5)? Yes ____ No ____

3. Were organic or slow release fertilizers used to a greater extent than in previous years (Section 2.2.2)?

Yes ____ No ____

4. Was it necessary to upgrade fertilizer storage facilities to meet the recommendations of the Fertilizer Management Guidelines (Section 2.2.2)? Yes ____ No ____

If so, how?

5. Have you had any reported spills of fertilizers in your jurisdiction in the last year?

Yes ____ No ____

If yes, please explain the circumstances and the steps taken to mitigate the situation (attach a separate sheet, if necessary, or a copy of the incident report).

6. In the course of the last year, to how many acres of land did your jurisdiction apply fertilizers? _____ acres

7. Please attach a complete list of the fertilizers used in your jurisdiction in the last year, and note any changes in the list from the previous year.

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II. Pesticide Management

1 Have all of your pest control personnel (applicators) obtained Qualified Applicators Licenses from the state?

Yes ____ No ____

If no, have they completed the County's equivalent training program (Section 3.3.2)?

Yes ____ No ____

2 Did you test any soils for compatibility with pesticides in the last year (Section 3.3.7)?

Yes ____ No ____

3 Were the recommended inspections conducted, as referenced in the Pesticide Management guidelines, for the following:

A. inspection of pesticide application equipment (Section 3.3.6)?

Yes ____ No ____

B. inspection of contracted and/or in-house pest control crews (Section 3.4.1)?

Yes ____ No ____

C. inspection of pesticide storage facilities (Section 3.5)?

Yes ____ No ____

4. Were the appropriate measures completed for the following, as recommended in the Pesticide Management program?

A. transportation of pesticides (Section 3.5)?

Yes ____ No ____

B. disposal of pesticides (Section 3.5)?

Yes ____ No ____

5. In the course of the last year, to how many acres of land did your jurisdiction apply pesticides? _____ acres

6. Have you had any reported spills or other releases of pesticides in your jurisdiction in the last year?

Yes ____ No ____

If yes, please explain the circumstances and the steps taken to mitigate the situation (attach a separate sheet, if necessary, or a copy of the incident report).

7. Please submit a complete list of the pesticides you have used in the last year, noting any changes in the list from the previous year (indicate which pesticides contain restricted or Category One chemicals).

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III. Integrated Pest Management

1 Does your jurisdiction currently implement Integrated Pest Management (IPM) techniques as recommended in the Management Guidelines for Use of Fertilizers and Pesticides?

Yes _____ No _____

2 If any, list the specific alternatives to pesticides that were employed by your pest control crews in the last year.

3 Have your work crews reduced the number of pesticides in use in your jurisdiction in the last year as a result of IPM?

Yes _____ No _____

If yes, please quantify the reduction.

Report Prepared by _____

Title _____

Date _____

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APPENDIX G

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BEST MANAGEMENT PRACTICES FOR NEW DEVELOPMENT INCLUDING NON-RESIDENTIAL CONSTRUCTION PROJECTS (1-5 acres)

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Attachment B: Spill Containment Requirements

B-1: County Sanitation Districts of Orange County

Attachment C: Water Quality Management Plan Outline

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1.0 INTRODUCTION

This Appendix was prepared by the New Development/Construction Task Force a group comprising County, City, Building Industry Association, Association of General Contractors, and Civil Engineers & Land Surveyors of California representatives with additional input from the Food Sanitation Advisory Council, Sanitation Districts, and the Western States Petroleum Association In accordance with Sections 7 5 and 8 6 of the DAMP it was reviewed by the Technical Advisory Committee (TAC) and submitted for Co-permittee implementation. Section 1-4 of the DAMP, in discussing Best Management Practices (BMPs) for existing developed areas and areas of new development, states that "The co-permittees will consider such options and will conduct public discussions to hear the views of various members of the community." The composition of the Task Force and the review process reflects such an approach.

The objective in preparing this Appendix was to identify relatively small-scale development source pollutant prevention and treatment measures that could be incorporated into new development. The New Development/Construction Task Force was identified in the DAMP as a program guidance body to recommend which BMPs should be required as standard practice (and when), and which should be viewed as solutions applicable only to special water quality problems, on a case by case basis.

The Drainage Area Management Plan does not specify a minimum development size to be considered for BMP applications, nor does it specify which land uses should receive the most attention. In general, BMPs are required on a wide variety of land uses, both residential and non-residential. BMPs should also be required on accessory uses of concern (such as outdoor material/equipment storage, vehicle/equipment fueling and service) and certain low intensity (but potentially high polluting) uses such as golf courses and plant nurseries.

2.0 REGULATORY REQUIREMENTS

Orange County's municipal NPDES permits require:

> "All new developments and existing facilities with significant redevelopment, irrespective of size, must develop individual, comprehensive, long-term post construction storm water management plans, incorporating structural and non-structural BMPs"; and
>
> "All industrial/commercial construction operations that result in a disturbance of one acre or more of total land area (or smaller parcel of land which is part of a large common development) and residential construction sites that result in a disturbance of five acres or more of total land area (or smaller parcel of land which is part of a larger common development) shall be required to develop and implement BMPs." (Order 90-71, pages 18 and 19).

The requirement for storm water quality management applies equally to private and public projects.

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3.0 BMP SELECTION

Candidate non-point source (NPS) control measures have been selected from review of technical literature, review of existing NPS control programs, and input from consulting firms and municipalities already involved in NPS control program implementation. As required by terms of Orange County's municipal NPDES permits, consideration was given to:

Structural Controls: First flush diversion, detention/retention basins, infiltration trenches/basins, porous pavement, oil/grease separators, grass swales, swirl concentrators, and engineering and design modification of existing structures.

Non-structural Controls: Programs to educate the public on proper disposal of hazardous/toxic wastes, regulatory approaches, street sweeping and facility maintenance, and detection and elimination of illicit connections and illegal dumping.

Each new development will be required to implement appropriate non-structural BMPs in keeping with the size and type of development, to minimize the introduction of pollutants into the drainage system.

Each new development will also be required to implement appropriate "routine" structural BMPs in keeping with the size and type of development. "Routine" structural BMP's are economical, practicable, small scale-measures which can be feasibly applied at the smallest unit of development.

A wide variety of documents from other jurisdictions, including the State BMP Manuals, as well as a number of new development BMP plans approved in the unincorporated area (plus a number in Cities) have been reviewed. The measures identified in Tables 1 and 2 are to be deemed "standard practice" to be required on new developments, as specified.

Later, "special" structural BMPs may be installed to address specific water quality problems identified in the watershed planning process. "Special" structural BMPs are engineered facilities designed to address specific pollutant problems identified in the watershed planning process, runoff management plan, CEQA process, or similar watershed planning. Thus, there will be the future need to revisit these requirements at an as-yet unspecified date or frequency.

3.1 Non-structural Measures

N1. Education for Property Owners, Tenants and Occupants - For developments with no Property Owners Association (POA)[1] or with POAs of less than fifty (50) dwelling units, practical information materials will be provided to the first residents/occupants/tenants on

[1] The term "Property Owners' Association" or POA as used herein means a nonprofit corporation or unincorporated association created for the purpose of managing a common interest development [from California Civil Code Sec. 1351(a)].

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general good housekeeping practices that contribute to protection of storm water quality initially these materials will be provided by the developer Thereafter such materials will be available through the co-permittees' education program Different materials for residential, office commercial, retail commercial, vehicle-related commercial, and industrial uses will be involved

For developments with a POA and residential projects of more than fifty (50) dwelling units, project conditions of approval will require that the POA provide environmental awareness education materials, made available by the municipalities, to all members periodically Among other things, these materials will descnbe the use of chemicals (including household type) that should be limited to the property, with no discharge of specified wastes via hosing or other direct discharge to gutters, catch basins and storm drains.

N2. Activity Restrictions - If a POA is formed, conditions, covenants, and restrictions shall be prepared by the developer for the purpose of surface water quality protection. Alternatively, use restrictions may be developed by a building operator through lease terms, etc.

N3. Common Area Landscape Management - Ongoing maintenance consistent with County Water Conservation Resolution or city equivalent, plus fertilizer and pesticide usage consistent with County Management Guidelines for Use of Fertilizers and Pesticides, or city equivalent.

N4. BMP Maintenance - Identification of responsibility for implementation of each non-structural BMP and scheduled cleaning of all BMP structural facilities.

N5. Title 22 CCR Compliance - Compliance with Title 22 of the California Code of Regulations and relevant sections of the California Health & Safety Code regarding hazardous waste management, to be enforced by County Environmental Health on behalf of State.

N6. Local Industrial Permit Compliance - Provides for clean storm water discharges from fuel dispensing areas, and requires permission to discharge industrial wastes to public properties.

N7. Spill Contingency Plan - Prepared by building operator for use by specified types of building or suite occupancies (County Environmental Health has provided list to County Building Plan Check, as an example), and which mandates stockpiling of cleanup materials, notification of responsible agencies, disposal of cleanup materials, documentation, etc.

N8. Underground Storage Tank Compliance - Compliance with State regulations dealing with underground storage tanks, enforced by County Environmental Health on behalf of State.

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N9 Hazardous Materials Disclosure Compliance - Compliance with County and comparable City ordinances typically enforced by respective fire protection agency

N10 Uniform Fire Code Implementation - Compliance with Article 80 of the Uniform Fire Code enforced by fire protection agency

N11 Common Area Litter Control - For developments with POAs, the POA will be required to implement trash management and litter control procedures in the common areas aimed at reducing pollution of drainage water The Associations may contract with their landscape maintenance firms to provide this service during regularly scheduled maintenance, which should consist of litter patrol, emptying of trash receptacles in common areas, and noting trash disposal violations by homeowners or businesses and reporting the violations to the Association for investigation.

N12. Employee Training - Education program (see N1) as it would apply to future employees of individual businesses Developer either prepares manual(s) for initial purchasers of business site or for development that is constructed for an unspecified use makes commitment on behalf of POA to prepare.

N13. Housekeeping of Loading Docks - Loading docks for grocery, drug and discount stores and warehouse type commercial and industrial loading docks must be kept in a clean and orderly condition through a regular program of sweeping and litter control and immediate cleanup of spills and broken containers.

N14. Common Area Catch Basin Inspection - For developments with POAs and privately maintained drainage systems, require the Association to have privately owned catch basins inspected and, if necessary, cleaned prior to the storm season, no later than October 15th each year.

N15. Street Sweeping Private Streets and Parking Lots - For developments with POAs and privately owned streets and parking lots, require the streets and parking lots be swept prior to the storm season, no later than October 15th each year.

N16. Commercial Vehicle Washing - Vehicle exteriors may be washed with tap water or deionized water without the use of soaps or detergents and discharged to the storm drain system. Solvents/degreasers may be used on a spot basis but must be wiped off before the vehicle is rinsed.

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3.2 Routine Structural BMPs

S1. Filtration - Surface runoff shall be directed to landscaped areas wherever practicable and as recommended by the engineer of record.

S2. Common Area Efficient Irrigation - Physical implementation of landscape plan consistent with County Water Conservation Resolution or city equivalent, which may include provision of water sensors, programmable irrigation times (for short cycles), etc.

S3. Common Area Runoff-minimizing Landscape Design - Group plants with similar water requirements in order to reduce excess irrigation runoff and promote surface filtration.

S4. Community Car Wash Racks - In complexes larger than 100 units where car washing is allowed, a designated car wash area which does not drain to a storm drain system shall be provided for common usage. Wash waters from this area may be directed to the sanitary sewer (in accordance with Attachment A and with the prior approval of the sewering agency), to an engineered infiltration system, or to an equally effective alternative.

S5. Wash Water Controls for Food Preparation Areas - Food establishments (per State Health & Safety Code 27520) shall have either contained areas, sinks, each with sanitary sewer connections for disposal of wash waters containing kitchen and food wastes. If located outside, the contained areas, sinks shall also be structurally covered to prevent entry of stormwater.

S6. Trash Container (dumpster) Areas - Trash container (dumpster) areas to have drainage from adjoining roofs and pavements diverted around the area(s), and:

A. For trash container areas associated with fuel dispensing, vehicle repair/ maintenance, and industry, such areas are to be roofed over or drained to a water quality inlet (see S16), engineered infiltration/filtration system, or equally effective alternative.

B. For trash container areas associated with restaurants and warehouse/grocery operations such areas are to be screened or walled to prevent off-site transport of trash.

S7. Self-contained Areas for Washing/Steam Cleaning/Maintenance/Repair/ Material Processing - Self-contained areas are required for washing/steam cleaning, wet material processing, and maintenance activities, specifically:

A. For businesses where washing of vehicles without steam cleaning occurs, provide wash racks constructed in accordance with the guidelines in Attachment A and with the prior approval of the sewering agency (Note: Discharge monitoring may be required by the sewering agency). Alternatively, refer to N16.

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B. Where steam cleaning occurs, provide wash racks as in S7A. or structurally contain (with a cover for rain events) runoff from such areas on site for commercial waste removal.

C. Where wet material processing occurs (eg. electroplating), secondary containment structures (not double wall containers) shall be provided to hold spills resulting from accidents, leaking tanks or equipment, or any other unplanned releases (Note: If these are plumbed to the sanitary sewer, the structures and plumbing shall be in accordance with Attachment B and with the prior approval of the sewering agency). Also see N10.

D. Where vehicle repair/maintenance occurs, impermeable berms, drop inlets, trench catch basins, or overflow containment structures shall be provided around repair bays to prevent spilled materials and wash-down waters from entering the storm drain system.

S8 Outdoor Storage - Where a plan of development contemplates or building plans incorporate outdoor containers for oils, fuels, solvents, coolants, wastes, and other chemicals, these shall be protected by secondary containment structures (not double wall containers). Also see N10. For outdoor vehicle and equipment salvage yards, and outdoor recycling the entire storage area shall drain through water quality inlets (see S16.).

S9. Motor Fuel Concrete Dispensing Areas - Areas used for fuel dispensing shall be paved with concrete (no use of asphalt). Concrete surfacing to extend 6 1/2' from the corner of each fuel dispenser in any direction. This distance may be reduced to OR the maximum length that the fuel dispensing hose and nozzle assembly may be operated in any direction plus one (1) foot. In addition, the fuel dispensing area shall be graded and constructed so as to prevent drainage flow either through or from the fuel dispensing area (also see S11.).

S10. Motor Fuel Dispensing Area Canopy - All motor fuel concrete dispensing areas are to have a canopy structure for weather protection, extending over the motor fuel concrete fuel dispensing area as defined in No. 9.

S11. Motor Fuel Concrete Dispensing Area Interruptable Drainage - The concrete motor fuel dispensing area will be graded and constructed so as to drain to an underground clarifier/ sump/tank equipped with a shut-off valve that can stop the further draining of stormwater or spilled material therefrom into the street or storm drain system. Spills will be immediately cleaned up according to Spill Contingency Plan

S12. Energy Dissipaters - Energy dissipaters are to be installed at the outlets of new storm drains which enter unlined channels, in accordance with applicable agency specifications.

S13. Catch Basin Stenciling - Phrase "No Dumping - Drains to Ocean" or equally effective phrase to be stenciled on catch basins to alert the public to the destination of pollutants discharged into stormwater.

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S14 Diversion of Loading Dock Drainage - Below grade loading docks for grocery stores and warehouse/distribution centers of fresh food items will drain through water quality inlets (see S16), or to an engineered infiltration system, or an equally effective alternative.

S15 Inlet trash racks - Where appropriate to reduce intake and transport through the storm drain system of large floatable debris, trash racks shall be provided where drainage from open areas enters storm drains (County EMA Standard Plan 1305 & 1327, CalTrans Standard Plan D96 & D98-C, or City equivalent)

S16 Water Quality Inlets - Water Quality Inlets designed to remove free phase liquid petroleum compounds, grease, floatable debris, and settleable solids can be used in the following applications: S6, S8, S14

4.0 CONSTRUCTION REGULATORY REQUIREMENTS

The municipal NPDES permits state that ... "industrial/commercial construction operations that result in a disturbance of one acre or more of total land area.. and residential construction sites that result in the disturbance of five acres or more...shall be required to develop and implement BMPs...to control erosion and siltation and contaminated runoff from the construction sites."

Construction activities disturbing five acres or more of land will be required to comply with a general Construction NPDES Storm Water Permit from the State Water Resources Control Board. The following is therefore required as a result of the wording of the NPDES permits and applies only to commercial/industrial operations disturbing land areas of one to five acres.

Co-permittees shall ensure that the following requirements are defined on permit plan cover sheets as either general or special notes.

1. Construction sites shall be maintained in such a condition that an anticipated storm does not carry wastes or pollutants off the site.

   Discharges of material other than stormwater are allowed only when necessary for performance and completion of construction practices and where they do not: cause or contribute to a violation of any water quality standard; cause or threaten to cause pollution, contamination, or nuisance; or contain a hazardous substance in a quantity reportable under Federal Regulations 40 CFR Parts 117 and 302.

   Potential pollutants include but are not limited to: solid or liquid chemical spills; wastes from paints, stains, sealants, glues, limes, pesticides, herbicides, wood preservatives and solvents; asbestos fibers, paint flakes or stucco fragments; fuels, oils, lubricants, and hydraulic, radiator or battery fluids; fertilizers, vehicle/equipment wash water and concrete wash water; concrete, detergent or floatable wastes; wastes from any engine/ equipment steam cleaning or chemical degreasing; and superchlorinated potable water line flushings.

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During construction, disposal of such materials should occur in a specified and controlled temporary area on-site, physically separated from potential storm water run-off, with ultimate disposal in accordance with local, state and federal requirements

2 Dewatering of contaminated groundwater, or discharging contaminated soils via surface erosion is prohibited Dewatering of non-contaminated groundwater requires a National Pollutant Discharge Elimination System Permit from the respective State Regional Water Quality Control Board.

5.0 DEVELOPMENT PLANNING

Municipal Storm Water Permit compliance requires that storm water quality management is considered during a project's planning phase, implemented during construction, and ultimately maintained for the life of the project In addition, the program must be adopted and uniformly implemented by all municipalities.

Applying this concept to new development, it is intended that each new development will incorporate the approved program of BMPs to minimize the amount of pollution entering the drainage system.

Standard Conditions of Approval were developed to be implemented countywide to address land use areas of concern. The requirement for a post-construction storm water quality management plan will be specified in each co-permittee's standard conditions of approval. These conditions will require project proponents to submit for approval a proposal identifying the BMPs that will be incorporated into the project to control non-point source pollutants after construction.

Each municipality will require BMPs for specified new development through similar processes. The typical process is outlined as follows:

1. The present municipal procedure for approval of grading, building, and similar permits will be modified to include incorporation of the BMPs listed in Tables 1 and 2, as applicable.

2. Municipalities will make this Appendix, detailing implementation of BMPs, available to applicants through the permitting process. Applicants will be informed at the earliest possible point of processing of these requirements.

3. Applicants will be required to submit a Water Quality Management Plan (WQMP) at appropriate discretionary and ministerial permit issuance levels. The Plan shall include a description of the project and an outline of which BMPs apply to the project pursuant to this Appendix. A sample Plan outline is provided in Attachment C. The Plan shall also include a location map and a project map identifying storm drain facilities and receiving waters.

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As increasing detail concerning the nature of specific uses within the project becomes available, the WQMP shall be refined

4 Upon review of the WQMP, each municipality will require project incorporation of the identified routine structural and non-structural BMPs.

GENERAL CONDITIONS to be applied by municipalities

Upon discretionary actions that include a precise plan of development:

1. Prior to issuance of building permits, permit applicant shall submit for approval of City/EMA Official(s), a water quality management plan (WQMP) specifically identifying Best Management Practices (BMPs) that will be used on site to control predictable pollutant run-off.

   This WQMP shall identify the: structural and non-structural measures specified in this Appendix detailing implementation of BMPs whenever they are applicable to the project (when the project has a below grade loading dock, for example); the assignment of long-term maintenance responsibilities (specifying the developer, parcel owner, maintenance association, lessee, etc.), and, shall reference the location(s) of structural BMPs.

Upon Subdivisions of Land:

2. Prior to Recordation and if determined applicable by City/EMA Official(s), applicant shall submit a WQMP that identifies the application and incorporation of those routine structural and non-structural BMPs outlined in the Countywide NPDES Drainage Area Management Plan Appendix detailing implementation of BMPs not dependent on specific land uses, for approval of City/EMA Officials.

Upon projects whose discretionary or grading or surface mining or grubbing and clearing or paving approval could result in the surface disturbance of more than five (5) acres, or which is an integral part of an earlier such approval not yet fully implemented (for example, a development area, road, or channel being graded/improved in phases):

3. Prior to issuance of grading or grubbing and clearing or surface mining or paving permits, applicant shall obtain coverage under the NPDES Statewide Industrial Stormwater Permit for General Construction Activities from the State Water Resources Control Board. Evidence this has been attained shall be submitted to City/EMA Official(s).

All three conditions also functionally apply to public projects where the local jurisdiction technically chooses not to issue formal permits to themselves or hired-contractors, but nonetheless undertakes the work.

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SPECIAL CONDITIONS

To address unusual situations, particularly when an unanticipated element of land use or occupancy is proposed after a basic building has already been completed, the County itself applies and recommends application of language similar to the following condition upon permit issuance decisions that involve projects constructed for an unspecified use.

> Prior to issuance of certificates of use and occupancy or building permits for individual tenant improvements or construction permits for a tank or pipeline, uses shall be identified and, for specified uses, the applicant shall propose plans and measures for chemical management (including, but not limited to, storage, emergency response employee training, spill contingencies and disposal) to the satisfaction of the EMA Official(s).
>
> Chemical management plans shall be approved by the EMA Official(s)and other specified agencies such as County Fire, the Health Care Agency, and sewering agencies to ensure implementation of each agency's respective requirements. Further, a copy of the approved "Chemical Management Plans" shall be furnished to the EMA Building Official, prior to the issuance of any certificates of use and occupancy.
>
> Certificates or permits may be ministerially withheld if features needed to properly manage chemicals cannot be incorporated into a previously completed building, center, or complex..

For the County, the Health Care Agency Environmental Health and Fire Department have provided a list of specified uses/occupancies of concern to Building Plan Check.

6.0 EDUCATIONAL PROGRAM FOR DEVELOPERS AND CONTRACTORS

The following defines the required educational program for developers and contractors per DAMP Section 7.3.

This Appendix with its attachments will contain the legal, administrative, and technical information needed to acquaint developers and contractors with the NPDES program. Orange County developers and contractors have been implementing erosion control plans for many years and are familiar with that portion of the program. New requirements resulting from the NPDES Permit and the DAMP are contained herein.

The Building Industry Association and the Associated General Contractors have been asked to assume responsibility for alerting their members of the information contained in this Appendix. The Appendix text will be made available by the County and Cities as part of the development review process.

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ATTACHMENT A

COUNTY SANITATION DISTRICTS OF ORANGE COUNTY

Guidelines For Preventing Sewer Discharge Of Surface Runoff Through wash Pads August 1992

Purpose And Scope

These guidelines are established pursuant to Section 203 of the Districts' Wastewater Discharge Regulations (Ordinance) as amended February 7, 1992. Section 203 provides that

> No person shall discharge groundwater, surface runoff, or subsurface drainage to the Districts' sewerage facilities except as provided herein Pursuant to section 305, et seq., the Districts may approve the discharge of such water only when no alternate method of disposal is reasonably available or to mitigate an environmental risk or health hazard.

The Guidelines presented herein are intended for the implementation of this policy as it applies to preventing surface runoff from entering the Districts' sewerage system through exposed wash pads.

Application

Two sources from which surface runoff can potentially enter the Districts' sewerage system are the exposed area around the wash pad and the wash pad itself.

Exposed Area Around the Wash Pad: Appropriate measures must be taken to insure that surface runoff from the exposed area around the wash pad (e.g. parking lot, storage areas) does not enter the sewer. Surface runoff must be directed away from the sewer. Appropriate measures include grading the open area to redirect surface runoff to the storm drain; berming around the wash pad; or trenching around the wash pad with grating over the trench, and directing the collected water to a storm drain in accordance with stormwater discharge requirements.

The Wash Pad: Appropriate measures must be taken to insur that surface runoff from the wash pad itself does not enter the sewer. Provided that local regulations are satisfied, roofing will be required for all exposed wash pads which have a total area exceeding 150 square feet. If the roof structure does not include walls, then the roof's overhang must extend a minimum of 20 percent of the roof's height. All roof drains must be routed to a storm drain.

Where roofing of exposed areas is infeasible or prohibited by local regulations, the Districts may accept the use of an automated surface runoff diversion system. [Note: This diversion system will not substitute for the appropriate measures cited above for surface runoff from the exposed area around the wash pad.] In cases where a diversion

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system is installed, only the first 0 1 inch of rainwater will be allowed to enter the sewer After the first 0 1 inch of rainfall, excess rainwater must be diverted to an appropriate drainage system by use of an automated divrsion system The diversion system is subject to acceptance by the Districts Manual methods of diversion (e g manual gates, removable plugs) are not acceptable Companies are responsible for maintaining the automated diversion system in proper operating condition to ensure that no excess surface runoff from the wash pad is discharged to the sewer

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ATTACHMENT B

COUNTY SANITATION DISTRICTS OF ORANGE COUNTY

Minimum Requirements For Spill Containment

1. Elimination of all floor drains in the wet process area.

2 Installation of containment facilities to hold any drag-out process materials or spills resulting from employee accidents, leaking tanks or orher equipment, or any other accidental releases Installation of structures to seal the floor at any potential wastewater discharge points.

3. Provide direct plumbing of all overflow or final rinse tanks and concentrated waste/wastewater to the pretreatment system or holding tank. Regulated process wastewater may be plumbed to downstream of the pretreatment system, but upstream of the sample point, if it can be shown by sampling and analysis to meet permit limitations. An analysis report of these waste streams by-passing treatment must be submitted for Districts' approval.

4. Spill containment (SC) volume requirements:

   - o If the SC is inside (covered), the volume must be equal to 110% of the largest tank or 10% of the total process tank volume inside the bermed area (whichever is larger). An additional 1" of freeboard or height must be added.
   - o If SC is outside (outdoors), use the inside criteria plus capacity to hold a rainfall of 24 hours based on a 25 year storm. An additional 1" of freeboard or height must be added.
   - o Appropriate deductions to the spill containment volume shall be made for tanks and/or equipment occupying the same spill containment area.

5. Separation of incompatible chemicals with a berm or other impermeable barrier.

6. All berm penetrations or leaks must be sealed.

7. The floor and berm must be made or coated with material capable of withstanding spills of the chemicals being stored.

8. Spill containment is also required in the pretreatment system area to prevent hazardous chemicals used in the pretreatment system and untreated wastes from entering the sample point.

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ATTACHMENT C

WATER QUALITY MANAGEMENT PLAN OUTLINE

COVER PAGE

Name of Project
Name of Company
Date

NEXT PAGE

Signed Statement (with/date) certifying that the provisions of the WQMP have been accepted by the applicant and that the applicant will strive to have the plan carried out by all future successors.

REPORT TABLE OF CONTENTS

I. Tract or Discretionary permit number(s) and condition number(s). Spell out conditions verbatim.

II. Project Description

1. Type of project
2. Project size
3. Homeowners Association or Property Owner's Association Formation

III. Site Description

1. Identify the watershed the project is in.
2. Is there a pre-existing water quality problem that has been identified in the watershed planning process?

IV. Best Management Practices (BMPs)

1. List and describe applicable structural and non-structural BMPs from DAMP Appendix that are applicable to your project, depending on the proposed land use, size, and use of a property owners association.

V. Inspection/Maintenance Responsibility For BMPs

VI. Figures

1. Location Map

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2 Site Plan (reduced drainage map acceptable) identifying storm drain facilities and receiving waters.

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Table 1: Appropriate Nonstructural BMPs

Appropriate Nonstructural BMPs	Residential	Industrial	Retail/Office Center	Restaurants Warehouse/Grocery	Fuel Dispensing	Vehicle Repair / Maintenance
Homeowner/Tenant Education (N1)	X	X	X			
Activity Restrictions (N2)	X	X	X	X	X	X
Common Area Landscape Management (N3)	X	X	X			
BMP Maintenance (N4)	X	X	X	X	X	X
Title 22 CCR Compliance (N5)		X			X	X
Local Industrial Permit Compliance (N6)		X			X	
Spill Contingency Plan (N7)		X			X	X
Underground Storage Tank Compliance (N8)		X			X	
Haz-Mat Disclosure Compliance (N9)		X			X	X
Uniform Fire Code Implementation (N10)		X			X	X
Litter Control (N11)	X	X	X	X	X	X
Employee Training (N12)		X	X	X	X	X
Housekeeping of Loading Docks (N13)		X		X		
Catchbasin Inspection (N14)	X	X	X	X	X	X
Private Street/Lot Sweeping (N15)	X	X	X			
Commercial Vehicle Washing (N16)		X				X

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Table 2: Routine Structural BMPs

Routine Structural BMPs	Residential	Industrial	Retail/Office Center	Restaurants Warehouse/Grocery	Fuel Dispensing	Vehicle Repair / Maintenance
Filtration (S1)	X	X	X	X		
Common Area Efficient Irrigation (S2)	X	X	X			
Common Area Runoff-Minimizing Landscape (S3)	X	X	X			
Community Car Wash Racks (S4)	X					
Wash Water Controls For Food Preparation Areas (S5)				X		
Trash Container (Dumpster) Areas (S6)		X		X	X	X
Self-Contained Areas for Washing/ Steam Cleaning/Repair/Mat Processing (S7)		X				X
Outdoor Storage (S8)		X				
Concrete Fuel Dispensing Area (S9)					X	
Extended Fuel Dock Canopy (S10)					X	
Interr. Flow from Motor Fuel Dispensing Areas (S11)					X	
Energy Dissipators (S12)	X	X	X			
Catchbasin Stenciling (S13)	X	X	X			
Diversion of Loading Dock Drainage (S14)				X		
Inlet Trash Racks (S15)	X	X	X			
Water Quality Inlets (S16)		X		X	X	X

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APPENDIX H

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BEST MANAGEMENT PRACTICES FOR PUBLIC WORKS CONSTRUCTION

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TABLE OF CONTENTS

1.0 INTRODUCTION

2.0 REGULATORY REQUIREMENTS

3.0 BEST MANAGEMENT PRACTICES FOR PUBLIC WORKS CONSTRUCTION

3.1 General Criteria

3.2 Sediment and Erosion Control

3.3 Public Works Construction Practices

4.0 STORM WATER POLLUTION PREVENTION PLAN

5.0 MONITORING PROGRAM AND REPORTING REQUIREMENTS

5.1 Implementation

5.2 Site Inspections

5.3 Non-Compliance Reporting

5.4 Monitoring Records

6.0 TRAINING PROGRAM FOR PUBLIC AGENCY STAFFS

7.0 EDUCATION PROGRAM FOR PUBLIC WORKS CONTRACTORS

ATTACHMENTS

Exhibit A: Best management Practices and Document References

Exhibit B: Common Restrictions on BMP Appropriateness

Exhibit C: County of Orange Standard Plans

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1.0 INTRODUCTION

This Appendix fulfills requirements of Section 8 6 2 of the Drainage Area Management Plan (DAMP) for developing a public works construction storm water pollution prevention program to regulate public works construction The requirements are modeled after the State General Construction Activity Storm Water Permit Federal and State regulations and related information are incorporated by reference A storm water pollution control program will be implemented to reduce pollutants in storm water run-off from construction sites to the maximum extent practicable. This Appendix provides guidance to co-permittees for uniform implementation of NPDES requirements and individual co-permittees will continue to retain the ability to add, amend, or delete specific requirements to reflect local conditions.

2.0 REGULATORY REQUIREMENTS

This Appendix applies only to co-permittee public works construction projects Public works construction projects shall comply with the State General Construction Activity Storm Water Permit (Construction Permit) where applicable. Co-permittees awarding a public works construction contract shall submit a Notice of Intent (NOI) to the State Water Resources Control Board.

3.0 BEST MANAGEMENT PRACTICES FOR PUBLIC WORKS CONSTRUCTION

3.1 General Criteria

Public works construction activities will implement non-structural (source control) and structural Best Management Practices (BMPs) to control contaminated storm water run-off to the maximum extent practicable (MEP), where MEP is defined in the NPDES permit as "...the maximum extent possible, taking into account equitable considerations of synergistic, additive, and competing factors, including but not limited to, gravity of the problem, fiscal feasibility, public health risks, societal concern, and social benefits."

BMPs selected are to be based on rational criteria including magnitude and type of potential pollutants, water quality objectives of receiving water bodies, and the principle of MEP. As a minimum, BMP selection shall be consistent with the State General Construction Activity Storm Water Permit. A BMP list with corresponding reference documents is provided for information purposes as Exhibit A.

Figure 15 from APWA's Special Report No. 61 "Water Quality: Urban Run-off Solutions", reproduced as Exhibit B, provides guidance on restrictions to BMP use.

Other sources for BMPs are found in co-permittee's approved standard plans and BMPs listed in the State General Construction Activity Storm Water Permit and other Environmental Protection Agency documents. Another reference on storm water retention for removal of pollutants other than sediment is found in "Methodology for Analysis of Detention Basins for Control of Urban Run-off Quality", EPA440/5-87-001.

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3.2 Sediment and Erosion Control

Ordinances regulating sediment and erosion control are found with most if not all co-permittees In the absence of such ordinances, the County of Orange Grading and Excavation Code (Title 7, Division 1, Article 8 of the Codified Ordinances) and the County of Orange Grading Manual (Board of Supervisors Resolution No 81-1358) are considered as meeting the sediment and erosion control requirements Grading and excavation codes of co-permittees not inconsistent with the County codes considering local conditions, are also considered as BMPs meeting the sediment and erosion control requirements The State General Construction Activity Storm Water Permit BMPs are also considered as suitable for meeting the sediment and erosion control requirements.

Where desilting is found to be required for sediment control, appropriate BMPs such as the Orange County Environmental Management Agency Standard Plans 1326-Pipe Entrance to Earth Channel, 1327-Desilting Basin, 1328-Sandbag Velocity Reducer, 1329-Street Desilting Basin, and 1330-Temporary Drainage Inlet (attached as Exhibit C) are considered as meeting sediment control requirements. Similar or equivalent sediment control BMPs of other co-permittees, not inconsistent with the County Standard Plans, considering local conditions, are also considered as meeting the sediment control requirements.

3.3 Public Works Construction Practices

Public works construction practices from the latest edition of "Standard Specifications for Public Works Construction" (SSPWC) are considered as meeting the sediment, erosion, and pollutant control requirements in the Municipal NPDES permits.

The following specific construction practices for public works construction are found in SSPWC Section 7 - "Responsibilities of the Contractor", and will be followed by contractors working for co-permittees:

- **Cleanup and Dust Control**

  Throughout all phases of construction, including suspension of work, and until final acceptance of the project, work site shall be kept clean and free from rubbish and debris. Dust nuisance will be abated by cleaning, sweeping, and sprinkling with water, or other means as necessary. The use of water resulting in mud on public streets will not be permitted as a substitute for sweeping or other methods.

  Where appropriate and when required a self-loading motor sweeper with spray nozzles will be used at least once each working day to keep paved areas acceptably clean wherever construction, including restoration, is incomplete.

  Materials and equipment shall be removed from the site as soon as these are no longer necessary, and upon completion of the construction project, the site shall be cleared of

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equipment, unused materials, and rubbish so as to present a clean and neat appearance

Care shall be taken to prevent spillage of earth or construction materials offsite Any such spillage shall be removed immediately and the area cleaned

- Sanitation

All enclosed toilets for the use of employees at the construction site shall be maintained in a neat and sanitary condition These facilities shall comply with all applicable laws, ordinances, and regulations pertaining to the public health and sanitation of dwellings and camps.

Sanitary sewage flow shall not be interrupted. Should the Contractor disrupt existing sewer facilities, sewage shall be conveyed in closed conduits and disposed of in a sanitary sewer system Sewage shall not be permitted to flow in trenches or be covered by backfill

- Water Pollution Control

Construction activities will be conducted in a manner to protect channels, storm drains, and bodies of water from pollution. Also, the operations shall be scheduled so as to minimize or avoid muddying and silting of said channels, drains, and waters. Water pollution control work shall consist of constructing necessary facilities when required to provide prevention, control, and abatement of water pollution.

- Drainage Control

Drainage within and through the work areas will be maintained. Temporary dams of sandbags, asphaltic concrete, or other acceptable material will be used to protect the work site as appropriate. Such temporary dams shall be removed from the site as soon as their use is no longer necessary.

- Storage of Equipment and Materials in Public Streets

Construction materials shall not be stored in streets, roads, or highways for more than 5 days after unloading. All materials or equipment not installed or used in the construction within 5 days after unloading shall be stored elsewhere unless authorized additional storage time.

Excavated material, except that which is to be used as backfill in the adjacent trench, shall not be stored in public streets, roads, or highways unless otherwise permitted. After placing backfill, all excess material shall be removed immediately from the site.

- Special Hazardous Substances and Processes

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Material usage shall be accomplished with strict adherence to California Division of Industrial Safety requirements and all manufacturers' warnings and application instructions listed on the Material Safety Data Sheet and on the product container label

4.0 STORM WATER POLLUTION PREVENTION PLAN (SWPPP)

For public works construction activities that result in a disturbance of five acres or more of total land area (or a smaller construction site which is part of a larger common project), a Storm Water Pollution Prevention Plan (SWPPP) will be prepared and implemented The SWPPP shall be consistent with the State General Construction Activity Storm Water Permit and the provisions of this Chapter.

Public Works construction activities less than 5 acres are required by the DAMP to comply with appropriate pollution prevention control practices in accordance with the current edition of Standard Specifications for Public Works Construction, and the provisions of this Chapter

5.0 MONITORING PROGRAM AND REPORTING REQUIREMENTS

Public works construction activities requiring a SWPPP will also require preparation and administration of a storm water monitoring program. The monitoring program will be consistent with the State General Construction Activity Storm Water Permit.

5.1 Implementation

Each co-permittee will be responsible for implementing these requirements until construction activity is complete.

For ongoing construction activity involving a change in ownership of property covered by this Permit, each co-permittee will insure that the new owner implements the requirements of the Section concurrent with the change of ownership.

5.2 Site Inspections

The construction inspector, accompanied by the contractor will conduct inspections of the construction site prior to anticipated storm events and after actual storm events to identify areas contributing to a storm water discharge associated with construction activity and to evaluate whether measures to reduce pollutant loadings identified in the SWPPP are adequate and properly implemented in accordance with the terms of the Permit or whether additional control measures are needed. A record of the inspections will include the date of the inspection, the individual(s) who performed the inspection and the observations.

5.3 Non-compliance Reporting

Each co-permittee will notify the appropriate Regional Water Board if compliance cannot be certified and/or if there are other instances of non-compliance. The notifications will identify the

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type(s) of non-compliance, describe the actions necessary to achieve compliance, and include a time schedule, subject to the modifications by the Regional Water Board, indicating when compliance will be achieved Non-compliance notifications will be submitted within 30 days of identification of non-compliance

5.4 Monitoring Records

Each co-permittee will retain records of all inspections, compliance certifications, and non-compliance reporting for a period of at least three years With the exception of non-compliance reporting, these records need not be submitted to the State

For purposes of compliance with the Municipal NPDES permit, each Co-permittee will report instances of non-compliance in the annual reconnaissance report to the County, and will maintain the monitoring records in Co-permittee files on each public works project

6.0 TRAINING PROGRAM FOR PUBLIC AGENCY STAFFS

To insure uniform enforcement, all grading, building, and public works construction inspectors, and all other appropriate public agency staff members will be provided adequate training. A general training program will be developed by the Environmental Management Agency and be provided to all co-permittees The training objectives include but are not limited to.

- Historical background and Federal Acts
- EPA and State NPDES regulations - Construction and Industrial permits
- Municipal NPDES permits and storm water Permit Implementation Agreement
- Selection of BMPs for pollutant control
- Inspection of non-structural BMPs
- Monitoring requirements

7.0 EDUCATION PROGRAM FOR PUBLIC WORKS CONTRACTORS

Contractor training will be included as part of pre-job conferences, to address:

- Historical background, Federal, State, Municipal NPDES regulations.
- State General Construction Storm Water Permit
- Selection of BMPs for pollutant control
- Compliance with Municipal NPDES permit

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- o Monitoring requirements
- o Review of Storm Water Pollution Prevention Plan

EXHIBITS

A Best Management Practices and Document Reference

B Common BMP Restrictions

C Orange County Environmental Management Agency Standard Plans 1326, 1327, 1328, 1329, and 1330

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EXHIBIT A

BEST MANAGEMENT PRACTICES AND DOCUMENT REFERENCE

BEST MANAGEMENT PRACTICES	(See references at end of Section) 1	2	3	4
NON-STRUCTURAL BMPS				
Illicit Connection/Non-Stormwater Discharge Elimination	X	X		
Spill Prevention and Response	X			
Vehicle or Equipment Fueling	X			
Vehicle or Equipment Maintenance	X			
Vehicle or Equipment Washing	X			
Loading/Unloading Liquid Materials	X			
Container storage of Liquids, Food Wastes	X			
Outside Storage of Raw Materials, Products, By-Products	X	X		
Outside Manufacturing Activities	X			
Mineral Extraction and Processing	X		X	
Sanitation			X	X
Financial Bonding			X	
Inspection				X
STRUCTURAL BMPS - CONTRACTOR ACTIVITY				
Equipment Fueling	X			
Disposal of Construction Debris	X	X	X	

EXHIBIT A

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BEST MANAGEMENT PRACTICE	(See references at end of Section) 1	2	3	4
Vehicle Maintenance and Cleaning	X			
Storage of Construction Chemicals	X			
General Guidelines				
o Managing Hazardous Products	X	X		
o Equipment Washing	X	X		
o Spills	X	X		
o Contaminated Soils	X			
o Concrete Trucks	X			
o Sandblasting Grits	X			
o Asbestos and PCBs	X			
STRUCTURAL BMPS - EROSION & SEDIMENT CONTROL				
General Criteria				
o Minimize Disturbed Areas	X		X	
o Prevent Erosion	X	X	X	
o Remove Sediment	X	X	X	
o Grading Clearance			X	
o Grading Permit Required to Alter Watercourse			X	
Temporary Cover Practices	X		X	
Permanent Cover Practices	X		X	

EXIBIT A

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BEST MANAGEMENT PRACTICE	(See references at end of Section) 1	2	3	4
Erosion Control BMPs				
o Stabilize Construction Entrance and Tire Wash	X		X	
o Construction Road Stabilization	X	X	X	
o Dust Control	X	X	X	
o Pipe Entrance to Earth Channel			X	X
o Interceptor Drain			X	
o Re-evaluation after each Rainstorm			X	
o Velocity Dissipation Devices				
o Drainage Swales				
o Check Dams				
o Storm Drain Inlet Protection				
Sediment Removal BMPs		X	X	
o Silt Fence	X		X	
o Straw Bale Barrier	X			
o Brush Barrier	X			
o Gravel Filter Berm	X			
o Gravel Velocity Reducer				X
o Temporary Drainage Inlet				X
o Storm Drain Inlet Protection	X		X	
o Street Desilting Basin-Vehicle Access Ramp			X	X

EXHIBIT A

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BEST MANAGEMENT PRACTICE	(See references at end of Section) 1	2	3	4
o Sedimentation/Desilting Basin	X		X	X
STRUCTURAL BMPS - LONG TERM POLLUTION CONTROL				
Infiltration	X			
Constructed Wetlands	X			
Wet Pond	X			
Wet Vault	X			
Extended Detention	X			
Sand Filtration	X			
Biofilters	X			
Multiple Systems	X			
Integration with Drainage Facilities	X			
Subsurface Drains				
Pipe Slope Drains				
Level Spreaders				
OFFSET CONTROL APPROACHES				
o Enhanced Air Pollution Control	X	X		
o Enhanced Process Wastewater Treatment	X			
EMERGING TECHNOLOGIES	X			

References

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1 State of California Best Management Practices Handbook

2 Standard Specifications for Public Works Construction

3 Orange County EMA Grading and Excavation Code, and Grading Manual

4 Orange County EMA Standard Plans

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EXHIBIT C

ENVIRONMENTAL MANAGEMENT AGENCY

STANDARD PLANS

1326 - Pipe Entrance to Earth Channel

1327 - Desilting Basin

1328 - Sandbag Velocity Reducer

1329 - Street Desilting Basin - Vehicle Access Ramp

1330 - Temporary Drainage Inlet

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APPENDIX I

R0058638

Did You Know You May Need a Storm Water Permit?

(whether or not you have materials that contact storm water)

What the Clean Water Act requires

In 1972, the Federal Water Pollution Control Act (also referred to as the Clean Water Act or CWA) was amended to provide that the discharge of pollutants to waters of the United States from any point source is effectively prohibited, unless the discharge is in compliance with a NPDES permit. The 1987 amendments to the CWA established a framework for regulating municipal and industrial storm water discharges under the NPDES program. On November 16, 1990, the Federal Environmental Protection Agency (EPA) published final regulations that establish application requirements for storm water permits. The regulations require specific categories of industrial facilities to obtain an NPDES permit.

The regulations allow authorized states to issue general permits or individual permits. The State Water Resources Control Board has elected to issue a statewide general permit that will apply to all dischargers, except those performing construction activities. There is a separate general permit for construction activities.

Coverage under the general permit requires that dischargers:

- Eliminate non-storm water discharges (including illicit connections) to storm water systems;
- Develop and implement a storm water pollution prevention plan; and,
- Monitor discharges to storm water systems.

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Who must have a Permit

The permit extends to facilities described in the categories below, whether the activity is primary or auxiliary (a complete list of facilities is shown on the back page).

- Facilities subject to storm water effluent guidelines (40 CFR Subchapter N);
- Manufacturing facilities;
- Mining and oil and gas facilities;
- Hazardous waste treatment, storage, or disposal facilities;
- Landfills, land applications sites, and open dumps that receive industrial waste;
- Recycling facilities such as metal scrap yards, battery reclaimers, salvage yards, and automobile yards;
- Steam electric generating facilities;
- Transportation facilities;
- Sewage treatment plants; and,
- Any facilities where materials are exposed to storm water.

How to obtain Permit coverage

To obtain authorization for continued and future industrial storm water discharge, owners, or operators when the owners do not operate the facility, must submit a Notice of Intent Form (NOI) to be covered by the Permit. Certification of the NOI signifies that the discharger intends to comply with the provisions of the permit.

EPA's regulations exclude dischargers covered by a general permit from submitting individual permit applications. The NOI requirements are intended to establish a mechanism which can be used to obtain a clear accounting of the number of dischargers complying with the permit, their identities, the nature of operations at their facilities and the location of such facilities. A $250 annual fee is required for coverage under the general permit.

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Where to file for Permit coverage

The NOI, accompanied by the annual fee, should be sent to the following address:

State Water Resources Control Board
Division of Water Quality
PO Box 1977
Sacramento, CA 95812-1977
Attention: Storm Water Permit Section

The submittal of an NOI to the SWRCB is the initial step in the permit application process. By submitting the NOI, you are committing to several follow-up activities. These include preparation of a Stormwater Pollution Prevention Plan (SWPPP), establishment of an on-site monitoring program, implementing Best Management Practices (BMP's) and record retention/reporting activities.

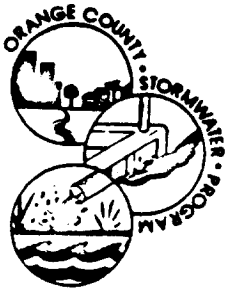
Facilities that discharge industrial storm water and do not obtain coverage under this Permit or by an individual permit will be in violation of the Clean Water Act and the California Water Code. There are substantial fines that can be pursued by the State or Regional Boards, EPA or by private citizens.

When to file for Permit coverage

A completed NOI must be filed no earlier than January 15, 1992 and no later than March 30, 1992. Facilities beginning operations after March 30 must submit an NOI 30 days prior to the beginning of operations.

Who to call for more information

The State Water Resources Control Board Water Quality Order No. 91-13-DWQ, "Waste Discharge Requirements for Discharges of Storm Water Associated with Industrial Activities Excluding Construction Activities," plus a related fact sheet and NOI, can be obtained by calling Jesse M. Diaz, 916/657-0756; Archie Mathews, 916/657-1110; Don Perrin, 916/657-1288; or Leo Cosentini, 916/657-1009. State Board staff can also answer any questions you may have regarding the Permit.



This newsletter has been prepared by the Orange County Storm Water Program, a cooperative project of the Orange County Flood Control District, the County of Orange and its incorporated cities, in compliance with its municipal NPDES Permit.

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Facilities Covered By the General Permit

Industrial facilities include Federal, State, municipally owned, and private facilities from the following categories:

Facilities subject to storm water effluent guideline limitations: Includes categories of facilities specified in 40 CFR* Subchapter N. Currently, these are cement manufacturing (40 CFR 411), feedlots (40 CFR 412), fertilizer manufacturing (40 CFR 418), petroleum refining (40 CFR 419), phosphate manufacturing (40 CFR 422), steam electric (40 CFR 423), coal mining (40 CFR 434), mineral mining and processing (40 CFR 436), ore mining and dressing (40 CFR 440) and asphalt emulsion (40 CFR 443).

Manufacturing facilities: Standard industrial classifications (SICs*) 24 (except 2411 and 2434), 26 (except 265 and 267), 28 (except 283), 29, 311, 32 (except 323), 33, 3441 and 373.

Oil and gas/mining facilities: SICs 10 through 14 including active or inactive mining operations (except for areas of coal mining operations meeting the definition of a reclamation area under 40 CFR 434.11(l) because of performance bond issued to the facility by the appropriate Surface Mining Control and Reclamation Act (SMCRA) authority has been released, or except for area of non-coal mining operations which have been released from applicable State or Federal reclamation requirements after December 17, 1990 and oil and gas exploration, production, processing or treatment operations or transmission facilities that discharge stormwater contaminated by contact with or that has come into contact with any overburden, raw material, intermediate products, finished products, by-products or waste products located on the site of such operations. Inactive mining operations are mined sites that are not being actively mined, but which have an identifiable owner/operator. Inactive mining sites do not include sites where mining claims are being maintained prior to disturbances associated with the extraction, beneficiation or processing of mined material, nor sites where minimal activities are undertaken for the sole purpose of maintaining a mining claim.

Hazardous waste treatment, storage or disposal facilities: Includes those operating under interim status or a permit under Subtitle C of the Resource Conservation and Recovery Act (RCRA).

Landfills, land application sites and open dumps: Sites that receive or have received industrial waste from any of the facilities covered by this permit, sites subject to regulation under Subtitle D of RCRAs and sites that have accepted wastes from construction activities (construction activities include any clearing, grading or excavation that results in disturbance of five acres or more).

Recycling facilities: SICs 5015 and 5093. These codes include metal scrapyards, battery reclaimers, salvage yards and automobile junkyards.

Steam electric power generating facilities: Includes coal handling sites.

Transportation facilities: SICs 40, 41, 42 (except 4221-25), 43, 44, 45 and 5171 which have vehicle maintenance shops, equipment cleaning operations or airport deicing operations. Only those portions of the facility involved in vehicle maintenance (including vehicle rehabilitation, mechanical repairs, painting, fueling and lubrication) or other operations identified herein that are associated with industrial activity.

Sewage or wastewater treatment works: Facilities used in the storage, treatment, recycling and reclamation of municipal or domestic sewage, including land dedicated to the disposal of sewage sludge that are located within the confines of the facility, with a design flow of one million gallons per day or more, or required to have an approved pretreatment program under 40 CFR Part 403. Not included are farm lands, domestic gardens or lands used for sludge management where sludge is beneficially reused and which are not physically located in the confines of the facility, or areas that are in compliance with Section 405 of the CWA.

Manufacturing facilities where materials are *exposed* to stormwater: SICs 20, 21, 22, 23, 2434, 25, 265, 267, 27, 283, 285, 30, 31 (except 311), 323, 34 (except 3441), 35, 36, 37 (except 373), 38, 39 and 4221-4225.

*CFR refers to the Code of Federal Regulations available at major libraries. SIC code descriptions are in the Standard Industrial Classification Manual prepared by the Executive Office of the President, Office of Management and Budget, available at most libraries.

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R0058642

State to Regulate Construction Discharges

Sites Greater Than Five Acres May Need a Storm Water Permit

Who Needs a Construction Permit

If your construction project involves five acres of land area or more, you probably need coverage under the State of California's new General Construction Activity Storm Water Permit. The Permit, adopted by the State Water Resources Control Board (State Water Board), is part of the federal National Pollution Discharge Elimination System (NPDES) storm water program that regulates pollutants in municipal and industrial discharges, including both private and public sector construction activity.

Under the General Construction Permit, "construction" is defined as site activity that involves any clearing, grading or excavation, or site activity subject to water quality certification for dredging and filling that is not already regulated by the Army Corps of Engineers. Construction sites that are less than five acres but are part of a larger, common development plan must also obtain coverage under the Permit.

Construction projects that are exempt from this criteria include routine maintenance activities such as maintaining original line and grade, hydraulic capacity and the original purpose of the facility, or emergency construction that is necessary to protect public health and safety. If uncertain, operators of facilities should confirm with their local Regional Water Quality Control Board (in Orange County, the Santa Ana or San Diego Regional Water Boards) whether specific maintenance activities qualify under this exemption.

What Does the Permit Require

Under the General Construction Storm Water Permit, operators of affected construction projects commit to:

- eliminating or reducing non-storm water discharge into storm water systems;
- developing and implementing a Storm Water Pollution Prevention Plan; and
- performing inspections of storm water control structures and pollution prevention measures.

To meet these goals, construction site operators will need to implement Best Management Practices (BMPs) for the control of pollutant discharges in their storm water, establish an on-site inspection program for water quality monitoring and report noncompliance to their Regional Water Board. Records need to be kept for at least three years.

When construction is complete or ownership transferred, operators must notify the State Water Board to indicate that all Permit requirements have been met.

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How to Comply with the Permit

Before construction may begin, owners or operators of affected construction sites need to submit a certified Notice of Intention (NOI) and a check for the appropriate annual fee (currently $250 for construction sites in Orange County) to the State Water Board. Completing an NOI signifies an intent to comply with the terms of the General Construction Storm Water Permit. The NOI is also meant to identify the location and scope of operations of proposed construction that could adversely affect storm water systems, as well as to clearly identify the responsible parties for construction activities.

In Orange County, the Permit is to be implemented and enforced by the Santa Ana and San Diego Regional Water Boards. Dischargers who do not submit an NOI and do not obtain Permit coverage will be in violation of the Clean Water Act and the California Water Code. There are substantial fines that can be pursued by the State for noncompliance of up to $25,000 per day for each violation.

When and Where to Apply for Coverage Under the Permit

Affected ongoing construction projects must submit an NOI by September 30, 1992. Those commencing after that date must submit before construction may begin.

The NOI (Form NOI-2) can be obtained from the State Water Board and, with the $250 fee, must be sent to:

State Water Resources Control Board
Division of Water Quality
Storm Water Permit Unit
P.O. Box 1977
Sacramento, CA 95812-1977

Realizing that the deadline for ongoing construction has come about relatively quickly, the State Water Board has indicated that it will not penalize NOIs submitted within a reasonable time frame after September 30, 1992.

For More Information

This flyer is meant to notify as many affected businesses and individuals as possible of the General Construction Storm Water Permit and to briefly explain what needs to be done to comply. Some important aspects are not fully addressed, such as the Storm Water Pollution Prevention Plan, record-keeping and monitoring procedures, and potential follow-up legislation.

Affected owners and operators who have questions regarding their obligations are urged to contact the State Water Board for a copy of the Permit, the NOI form and a related fact sheet. This information can be obtained through the State Water Board's Construction Storm Water Information Line at 916/657-1146. State Water Board staff can also answer questions regarding the Permit.



This Flyer was prepared by the Orange County Stormwater Program, a cooperative effort of the Orange County Flood Control District, the County of Orange and its incorporated cities, in compliance with its municipal NPDES Permit.

The Orange County Stormwater Program, 10852 Douglass Rd., Anaheim, CA 92806

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APPENDIX J

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R0058645

ORANGE COUNTY NPDES STORMWATER PROGRAM

RECONNAISSANCE SURVEY: FIELD INSPECTION AND DOCUMENTATION MANUAL

PROCEDURES FOR IDENTIFYING ILLEGAL DISCHARGES AND ILLICIT CONNECTIONS TO THE STORM DRAIN SYSTEM

JANUARY 31, 1991

Submitted to the San Diego and Santa Ana
Regional Water Quality Control Boards
in Compliance with NPDES Stormwater and Urban Runoff Permits
Ca 0108740 and Ca 8000180

A COOPERATIVE PROJECT BETWEEN THE COUNTY OF ORANGE, THE ORANGE COUNTY FLOOD CONTROL DISTRICT AND ITS TWENTY-NINE INCORPORATED CITIES

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2 0 INSPECTION PROCEDURES

2 1 Inspection frequencies
2 2 Documenting Facility Inspections
2.3 Illegal Discharges/Illicit Connections
2.4 Safety
2.5 Implementation
2.6 Estimated Costs

3.0 FIELD INSPECTION LOG

4.0 DRAINAGE FACILITY INVENTORY

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R0058647

1.0 INTRODUCTION

The Clean Water Act of 1987 requires municipalities to apply for NPDES (National Pollutant Discharge Elimination System) permits for controlling urban stormwater runoff. The issued permits include requirements for:

- field inspection and documentation of drainage systems
- detection procedures for illegal discharges/illicit connections
- ordinances prohibiting illegal discharges/illicit connections
- an implementation plan for prosecuting violators and eliminating illegal discharges

The facility inspection and documentation manual was prepared by the County as lead agency in cooperation with the cities.

The Porter-Cologne Water Quality Act (California State Law) authorizes the State Water Resources Control Board through its Regional Water Quality Control Boards (RWQCBs) to enforce the federal Clean Water Act and regulate stormwater discharges. The Orange County NPDES permits were issued in July 1990 by the Santa Ana and San Diego RWQCBs to the County and the twenty-nine incorporated cities. The County of Orange is the lead agency in the development and implementation of the Stormwater Permit Programs.

This Facility Inspection and Documentation Manual has been prepared in order to comply with the NPDES permit requirements. The purpose of the manual is twofold:

- to assist in the identification and elimination of illegal discharges and illicit connections
- to document the storm drain systems

This Facility Inspection and Documentation Proposal will serve as a guideline to ensure consistency between county and city programs. Each city will be responsible for inspecting and documenting their own drainage facilities.

2.0 INSPECTION PROCEDURES

All open drainage facilities and underground drainage facilities (39 inches and larger) under the jurisdiction of the Local Agency will be inspected to identify pollutant discharges and to regulate undocumented and illegal drainage entries into said facilities.

2.1 Inspection Frequencies

Open storm drains, retention basins and other above ground facilities will be inspected on an annual basis. Underground storm drains with diameters of 39 inches or greater will be inspected biannually. Facility inspection frequencies will be re-evaluated in cooperation with cities and the RWQCBs after the first round of inspections. Based on this review, the frequencies may be modified.

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2.2 Documenting Facility Inspections

A. Each facility surveyed will be documented by filling out a Field Inspection Log (refer to Section 3.0) Information will include facility, location and land use

B Inspectors will be responsible for filling out log sheets, updating maps and completing reports

C All new stormwater discharges to the municipal storm drain system not shown on current maps will be transferred onto local and Orange County drainage maps and/or submitted to EMA/Environmental Resources This information will be compiled and provided to the RWQCBs.

D. Updating drainage maps will be an ongoing task of each co-permittee. Permanent changes will be made after completion of the biannual inspections.

2.3 Illegal Discharges/Illicit Connections

A. Any suspected illegal discharge discovered during inspections must be documented on the Field Log and reported to the appropriate water pollution response/enforcement agency for further investigation.

B. All undocumented entries will be logged and forwarded to the appropriate local agency for verification of permit status.

C. Appropriate actions will be taken to approve undocumented stormwater discharge entries into the municipal storm drain system by permit procedure and/or pursue abatement of those entries that are determined to be illegal/illicit connections and not in compliance with the local agency standards.

2.4 Safety

The inspection of underground facilities will be performed in compliance with appropriate safety standards. The use of video technology is encouraged.

2.5 Implementation

Each city must provide implementation schedules for fiscal year 91/92 for submittal to the Regional Water Quality Control Boards. The RWQCBs will provide a letter establishing a date for submitting these implementation schedules.

Inspection of County drainage facilities is currently being implemented. Surveying for illegal discharges/illicit connections began on a part time basis in August 1989. To date, approximately 200 miles of above ground facilities have been inspected. Approximately 103 miles of underground inspection has been completed. Reconnaissance is due to begin on a full-time basis in

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March 1991, so it is expected that the first round of inspections will be completed by June 1991 Due to the lack of a road drainage facility inventory, a time table for inspection at these facilities has not been established An inventory is currently being prepared

2.6 Estimated Costs

County Public Works has provided a breakdown of costs for one year of inspection for a crew working full-time (10 hrs/day, 40 hrs/week):

ABOVE GROUND FACILITIES (approx. 260 miles)

	Hourly Rate	Over Head	TOTAL COST
1 Maintenance Technician	$19.36	$17.77	$38.92
1 Pickup Truck			$3.80
			$42.72/hour

UNDERGROUND FACILITIES (approx. 240 miles)

	Hourly Rate	Over Head	TOTAL COST
3 Maintenance Technicians	$60.57	$53.19	$116.76
2 Maintenance Workers	$26.92	$23.64	$ 50.56
Equipment Truck			$8.75
1-Ton Utility			$4.80
Pickup Truck			$3.80
			$181.67/hour

TOTAL PROGRAM COST/YEAR: $466,731.20

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STORMWATER PERMIT PROGRAM
FIELD INSPECTION LOG

INSPECTOR DATE
FACILITY TYPE
LOCATION REACH
CONDITION OF CHANNEL/DRAIN (include debris accumulation)

DRAINAGE AREA/LAND USE

PossibleUndocumented Entry And/Or Suspected Illegal Discharge

LOCATION OF ENTRY

DIMENSIONS/TYPE OF CONNECTION

TYPE OF FLOW/DISCHARGE

SOURCE OF CONNECTION?

RECORD ANY EVIDENCE OF ILLEGAL DISCHARGE- ODOR, COLOR, CONSISTENCY, WILDLIFE/ VEGETATION AFFECTED, STAINING, ETC.

LIST ANY NEARBY INDUSTRIES OR BUSINESSES

SOURCE OF DISCHARGE?

WATER POLLUTION RESPONSE AGENCY NOTIFIED BY PHONE? - LIST CONTACT/TIME

ACTION REQUIRED:

SUBMIT COPY TO PERMITS TO VERIFY DOCUMENTATION
SUBMIT COPY FOR MAP UPDATE
SUBMIT COPY TO EMA/ENVIRONMENTAL RESOURCES
FACILITY MAINTENANCE NEEDED

COMMENTS

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R0058651

APPENDIX K

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R0058652

COUNTY OF ORANGE

ENVIRONMENTAL MANGEMENT AGENCY

SANTA ANA, CALIFORNIA

REGULATION FUNCTION
Ronald J. Novello, Director

Prepared By
Bob Collacott, Manager, Environmental Resources Division
and Bruce Moore, Supervisor, Water Quality Section

WATER QUALITY AND RECEIVING WATER MONITORING PROGRAM

February 10, 1991

Michael M. Ruane
Director

ORANGE COUNTY BOARD OF SUPERVISORS

ROGER R. STANTON
First District

GADDI H. VASQUEZ
Third District

HARRIET M. WIEDER
Second District

DON R. ROTH
Fourth District

THOMAS RILEY
Fifth District

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Appendix 2	Location Map of Sampling Sites in Flood Control Channels of Orange County

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EXECUTIVE SUMMARY

The following report was prepared in response to the requirements contained in Stormwater and Urban Runoff Permits issued to the County of Orange and the cities of Orange County These permits, prepared by the Santa Ana and San Diego Regional Water Quality Control Boards, required that proposals for water quality monitoring programs be submitted to the Boards by November 30, 1990 The report was submitted and approved by the Regional Boards in 1991

The monitoring program for storm channels and receiving waters consists of field screening (channels only), dry-weather, flow-composite sampling, and storm sampling.

Field screening is used to detect gross contamination which may be indicative of illegal disposal of pollutants. Monitoring locations are sited on channels which have drainage areas greater than one square mile or which have industrial (manufacturing) land uses in the drainage areas. Reports exhibiting elevated concentrations of field-screened constituents are to be referred to the EMA Water Pollution Section for further investigation.

Data from dry-weather and storm sampling are used to estimate the total annual volume of contaminants discharged by each monitored channel. These monitoring locations are in channels which are identified in the permits as "Waters of the State" or are in major tributaries to "Waters of the State".

Storm monitoring of channels is performed to evaluate the level of contamination during and after storm events. Samples are analyzed from two consecutive 48 hours periods of a storm. These data are used to compute four-day average, contaminant concentrations.

The receiving water monitoring program includes stations in the Huntington Harbour; Sunset, Anaheim, and Bolsa Bays; Upper and Lower Newport Bays; and Dana Point Harbor. These stations are monitored during and subsequent to storms for the same contaminants as in the channel monitoring program.

In the channel and receiving water monitoring programs, semiannual sampling of bed sediment is conducted to determine the chronic effects of stormwater runoff.

The permits are renewable and have a term of five years. They were issued in July of 1990. The water quality monitoring programs were initiated in February of 1991.

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1.0 INTRODUCTION

To comply with Order Nos 90-71 (NPDES No CA 8000180) and 90-38 (NPDES No CA 0108740), Stormwater and Urban Runoff Management Permits issued by the Santa Ana and San Diego California Regional Water Quality Control Boards (RWQCB), the following water quality monitoring program was prepared.

The water quality monitoring is conducted by the County of Orange Environmental Management Agency (EMA) by the authority granted by California Assembly Bill No. 3664 which amended the Orange County Flood Control Act. The amended Act gives EMA (formerly the Orange County Flood Control District) the legal authority to "carry on technical and other investigations, examinations, or tests of all kinds, making measurements, collecting data, and making analyses, studies, and inspections pertaining to water supply, control of floods, use of water, water quality, nuisance, pollution, waste, and contamination of water both within and without the District."

The monitoring program is funded through a cooperative agreement (Stormwater Permit Implementation Agreement) between the County and the cities of Orange County.

This monitoring program was prepared with the following considerations:

1. Program objectives established in the permit;
2. Funding available for personnel, equipment and analytical services;
3. Present and proposed equipment and staffing;
4. Safety during storm monitoring;
5. Existing data;
6. Historical annual frequency of representative storms; and
7. Tidal influences on the collection of representative samples.

The Receiving Water and Stormwater System Monitoring Programs have been combined in this document.

2.0 OBJECTIVES

The objectives of the monitoring program as stated in the Santa Ana RWQCB Permit are:

1. To define the type, magnitude (concentration and mass load*[1]) and sources of pollutants in the stormwater system discharges within each permittees respective

[1] Terms marked with an asterisk are defined in the glossary.

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jurisdiction so that appropriate pollution prevention and correction measures can be identified.

2. To evaluate the effectiveness of pollution prevention and correction measures, and

3. To evaluate the compliance with water quality objectives established for the stormwater system or its components

In addition, the program is designed to assess the impacts of selected, permitted, NPDES discharges on the discharges of the Municipal Separate Storm Sewer System These NPDES discharges include the runoff from nurseries in the San Diego Creek watershed Information gathered during the life of the permit (FYs 90-95) will be used in developing future monitoring programs.

2.1 Discussion

Objective 1.

To define the mass load of pollutants from the stormwater system is a substantial undertaking. The degree of accuracy in determining this quantity is a function of the available equipment, manpower and funds (for analytical services). The program concentrates on the major regional* facilities which discharge directly to large receiving water bodies (Pacific Ocean; Huntington Harbour/Sunset, Anaheim and Bolsa Bays; Upper Newport Bay; Dana Point Harbor; Santa Ana and San Gabriel Rivers; and San Juan Creek).

To calculate the mass load from major regional facilities requires a representative sampling of these outfalls throughout the year. This representative sampling entails flow-weighted* automatic sample collection during storms and the dry season. Equipment required includes automatic wastewater samplers with toxics (synthetic organic compounds) sampling capabilities and continuous water discharge recorders. The proposed monitoring program reflects the current and proposed availability of this required equipment.

To assist in the development of the appropriate pollution prevention and correction measures (generally water pollution enforcement activities) a field screening program is performed. The intent of the program is to detect gross contamination by illegal/illicit* connections.

Objective 2

To assume that the water quality benefit from each Best Management Practice (BMP) could be measured by water quality monitoring is very presumptuous. The only BMPs which may result in any statistically significant change in water quality would be water quality structures such as basins where the water quality benefit would be determined by monitoring the quality of inflow and outflow; or the elimination through enforcement activities of a significant (high mass load relative to ambient) illegal/illicit connection. The San Diego Creek Sediment Monitoring Program – a cooperative project of the County of Orange, the Irvine Company and the cities of Irvine,

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Tustin and Newport Beach -- assesses the sediment trapping efficiency of in-channel basins in San Diego Creek Much of the contaminants found in stormwater discharge are adsorbed onto these sediments.

Assessing the effectiveness of some BMP programs can be conducted by monitoring the volume of collected material (recycled oil, street sweepings etc) which may have otherwise entered the storm sewer system This assessment approach will be developed in subsequent compliance program documents

The water quality monitoring program is designed to identify trends in the receiving water quality which result from the entire BMP program.

Objective 3

Both Regional Boards have adopted as a general objective, the State Water Resources Control Board Resolution No 68-16, the policy of nondegradation of the waters of the State of California. In this resolution it is stated that "it is the policy of the State that the granting of permits and licenses for unappropriated water and the disposal of wastes into the waters of the state shall be so regulated as to achieve highest water quality consistent with maximum benefit to the people of the State and shall be controlled so as to promote the peace, health, safety and welfare of the people of the State; and ..."

Water quality objectives (limiting concentrations) have been adopted by each RWQCB, in their respective Basin Plans, to protect the waters with specific beneficial uses. Most of these objectives are applicable only to waters designated as Municipal Water Supply (MUN) and would not be appropriate for channels which are primarily stormwater conveyances. Other objectives were developed to protect freshwater and marine habitats.

The monitoring program for the Stormwater Permit only evaluates the types of contamination which significantly affect the existing or intended beneficial uses of the receiving waters. The following is a list of chemical characteristics which were considered in developing the monitoring programs.

1. Biostimulatory substances (compounds of nitrogen and phosphorus) can lead to nuisance growths of plants and algae.

2. The illegal introduction of acidic or alkaline substances to the stormdrain system can alter the pH and create chronic or acute toxicity problems for the indigenous biota.

3. Discharges of waters with high temperature can be harmful or lethal to aquatic life in the receiving water.

4. Unionized ammonia* can be toxic to aquatic life. The concentration of this contaminant is a function of the pH and the temperature.

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5 Depressed dissolved oxygen levels can result from inputs of substances which impart a high biochemical (BOD) or chemical (COD) oxygen demand on the receiving waters. Stormwaters typically have elevated BODs and CODs

6 Trace elements* at high concentrations can be toxic to aquatic life. These can be introduced into the system by illegal discharges from plating or integrated circuit board companies.

7. The toxicity of trace elements is inversely proportional to the hardness*

8 PCBs, organochlorine pesticides and herbicides (PHP)* are toxic to aquatic life and have been detected in several channels and receiving waters in the the Toxic Substance Monitoring Program (TSMP) and the State Mussel Watch Program (SMW).

9. Many organic and inorganic contaminants are adsorbed onto settleable and suspended solids. Settleable solids can deposit in the receiving waters reducing circulation and impacting navigation. Contaminated settleable solids introduce toxics at the bottom of the food chain. These toxic compounds can be concentrated at higher levels of the food chain.

3.0 EQUIPMENT INVENTORY

The County's Environmental Resources Division currently maintains a large inventory of water quality and hydrographic monitoring equipment. These include automatic wastewater samplers, portable and laboratory diagnostic equipment, fluvial* and bed sediment samplers, streamgages, a fleet of vehicles, and a boat. Table 1a is a list of the laboratory and transportable field equipment. Table 1b is a list of the equipment currently in the field at streamgaging stations near the proposed sampling locations. This hydrographic monitoring equipment includes water level sensors (mechanical floats or manometers), graphic analog recorders, and transmitting dataloggers. The information is transmitted (by radio frequency) to the County's ALERT Flood Warning System. The system is capable of converting the water level information into discharge rates so that flow compositing of discrete samples can be conducted in the laboratory.

Flow-weighting* of composite samples is dependent on the availability of necessary equipment and the desired analyses. To collect samples for full-spectrum analyses (organic and inorganic), the wetted components of the automatic sampler must be composed of inert materials. Presently EMA has 18 such samplers, including two ISCO model 2700s and 16 ISCO model 3700s. The Model 3700 allows a more accurate flow compositing (when integrated with a flowmeter) because it is capable of maintaining a uniform sample volume whereas the model 2700, which operates on a timed collection cycle and sample volume is influenced by the level of water in the channel, does not.

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The current sampler inventory also includes seven older model ISCO samplers (1680) which have only inorganic sampling capabilities (nutrients and trace elements) These also can be integrated with a flowmeter to obtain a reasonable flow-weighted sample A Manning Model 4500T automatic sampler is also available This unit can collect representative samples which are high in suspended or settleable solids Its vacuum collection system (versus ISCO's peristaltic* pump) provides a higher sample transport velocity with less settling of solids in the collection line The model 4500T also can ensure uniform sample volumes but does not have toxics (organic) monitoring capability In order to collect flow-weighted composites, it requires a compatible flowmeter or must be used in channels with continuous water level recorders.

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4.0 FIELD SCREENING PROGRAM

This program is designed to detect gross contamination of regional flood control facilities by illegal/illicit discharges. Monitoring involves one dry season (two samplings at least four hours apart) and one storm sampling of the facilities listed in Table 2. A map with these locations can be found in the Appendices. The criteria for channel selection were drainage area size and/or presence of industrial land uses in the corresponding watershed. Those channels with drainage areas greater than one square mile and smaller conduits with industrialized watersheds are included. Also included are retention/detention basins with detention times greater than 24 hours.

The monitoring parameters are those listed on the attached Field Screening Information sheet (Figure 1). This information includes channel configuration, discharge rate (measured if pollution observed, otherwise estimated), instrumental determinations of physical conditions, visual and olfactory observations, and field chemical analyses and is consistent with the federal regulations. The chemical analyses are used as indicators of swimming pool (chlorine residual), illegal construction dewatering (total suspended and settleable solids), printed circuit board (copper), plating (chromium, cyanides), plastics manufacturing (phenols) and sewer line (MBAS, phenols) discharges. Although zinc is not usually a component of illegal discharges, it is found in relatively high concentrations in stormwater and numerical objectives are listed for it in the ISWP. Dissolved zinc concentrations from tire wear and corrosion of galvanized steel is measured during dry weather and storms. Samples for Chemical Oxygen Demand (COD) are collected and analyzed at the Environmental Resources Laboratory.

All of the chemical analyses from Figure 1 can all be performed in the field except for MBAS and suspended and settleable solids. Samples are collected for "laboratory" analyses if high silt-clay turbidity or foam are observed.

The in-situ chemical analyses are performed with a field uv-visible spectrophotometer* and pre-packaged, single analysis reagents. Information which indicates pollution is referred to the Water Pollution Section of the Environmental Resources Division. If the source is determined to be continuous and non-point, follow-up sampling is performed to assess the mass loading. Identified point sources will be issued a discharge permit or be eliminated through enforcement.

The stations in the field screening program are monitored each year according to the procedure outlined above. Additional channels will be added to the list if the land uses in the watersheds become industrial.

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5.0 CHANNEL MONITORING PROGRAM

The channel monitoring program includes the streamcourses also identified in the permits as receiving waters In addition to these receiving water channels, five stations in the Huntington Harbour watershed, five stations in the Upper Newport Bay watershed and two quality control stations are included in the program Table 3 is a list of the sampling locations The sites can also be found on the map in the Appendices

5.1 Monitoring Locations

The rationale for selection of these monitoring locations included the existence of prior monitoring data, the proximity of existing, continuous discharge monitoring locations, and general compliance to the lists of "Waters of the State" in the permits. The additional stations were chosen because they were tributary to "Waters of the State" and, in some instances (Lane and Barranca Channels), have exhibited (in the current monitoring program) higher than system average concentrations of heavy metals.

Two quality control stations (upper San Juan Creek and Silverado Creek) are monitored to establish "no or limited urban impact" conditions to which the urban channels can be compared. These channels have also been designated as "Waters of the State" in the Stormwater Permits.

5.2 Monitoring Parameters

The selection of monitoring parameters was based on the analyses of past data from EMA, the RWQCB-SAR Toxic Substance Monitoring Program (TSMP) for Huntington Beach Channels and the State Mussel Watch Program (SMW).

A voluminous amount of data has been collected during dry weather conditions. Both the TSMP and EMA data show that aqueous concentrations of organochlorine pesticides and trace metals (except for rare instances) have been low or below the detection limits of the laboratory. Sediment samples collected from the channel bottoms have exhibited higher relative concentrations of these contaminants. This is a logical observation since these contaminants tend to be adsorbed onto silt and clay particles which deposit onto the channel bottom when water velocities decrease after storms. Shellfish collected in the SMW have also shown bioaccumulation of these substances.

5.2.1 Dry-weather

The constituents monitored during dry weather conditions include biostimulatory substances (nutrients*) which tend to be found in the dissolved form. This nutrient sampling should be conducted in channels which have historically produced high (greater than 20 ppm as NO3) mean nitrate concentrations or are directly tributary to major waters of the state (Pacific Ocean, Sunset/Bolsa Bay, and Upper Newport Bay). These stations

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include those in the upper San Diego Creek watershed, San Juan Creek, Aliso Creek, Prima Deschecha, Segunda Deschecha, Bolsa Chica and East Garden Grove-Wintersburg Channels.

Stations which have exhibited high (relative to system average) dry-weather trace element concentrations, such as Lane and Barranca Channels in the San Diego Creek watershed, will be sampled for these contaminants.

Bed sediment sampling of channels, designated as "Waters of the State", is used to assess the magnitude of pollutant (trace elements, PHP, Polynuclear Aromatic Hydrocarbons* [PAH]) deposition PAHs include the byproducts of combustion (automotive emissions) and are washed into the system during storms. This sampling will also be conducted in Lane and Barranca Channels to evaluate the potential for pollutant discharges to San Diego Creek during high water velocities (scouring) Samples will be collected in specially prepared glass containers with Teflon caps The bed material will be sampled as close to midchannel as possible This type of sampling, however, will not be conducted in channels which are concrete-lined.

5.2.2 Storms

Storm monitoring includes collection of samples for nutrients and trace metals. The mean values (event mean concentration) of the storm data are assumed representative of all storms for that channel. These mean values are used in computing the annual mass pollutant load from those channels. During the first 48 hours of each monitored storm, samples are collected for both nutrients and trace metals. Two additional samples from the subsequent 48 hour period are analyzed.

Storm samples may be analyzed for particle size distribution to correlate the level of contamination to the concentrations of transported silts and clays. If a significant correlation can be developed between silt/clay and pollutant concentrations, the former analyses are used to supplement the chemical concentration data used in mass load calculations.

These particle size distribution analyses are much less expensive than chemical analyses. They can be performed in the Environmental Resources Laboratory. Grab samples of fluvial (transported) sediment can be collected during storm sampling with equipment currently available.

Initially this correlation analysis will be attempted for stations which are presently monitored in the San Diego Creek sediment transport study. If a significant correlation is identified, the sampling will be expanded to other stations.

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5.3 Monitoring Frequency

The frequency must be developed so that the program is cost effective and produces data which can be used to address the program objectives. An initial frequency has been be proposed and may be modified according to analysis of the collected data

For example, if after two years of representative storm sampling (5-10 storms) no (below detection limit) trace element contamination is detected, the monitoring frequency for those parameters will be reduced upon approval by the Regional Boards. If the standard deviation of the mean concentration is low the same reduction will be implemented. If however, a mean concentration of a contaminant exceeds a water quality standard but the standard deviation of that mean is high, the sampling frequency for that contaminant will be increased to more accurately assess the mass loading.

The current initial frequency is outlined in Table 3a.

5.3.1 Dry-weather

The present frequency for dry weather monitoring for nutrients and trace elements is monthly. This frequency is based on the present equipment, staffing, the analytical services budget, and the past observed seasonal variations in concentrations and water discharges. Nutrient monitoring is conducted using the entire inventory of automatic samplers. Sites without continuous water level recorders are sampled with automatic samplers and compatible flowmeters. Field determinations of dissolved oxygen, electrical conductance*, pH and temperature are made at the time of sampler collection.

Semiannual sediment sampling is conducted before the storm season to assess the magnitude of dry season, pollutant deposition and after the storm season to assess the deposition and/or removal (due to channel scouring) as a result of storms.

5.3.2 Storms

The period designated as the official storm season by EMA is October 15 to April 15 of each year. This period was established from storm frequency analysis.

The automatic sampling equipment is left in the field (on storm activation mode) during this period and will be serviced weekly (battery changes, sample line/strainer inspection and operational checks). Since the number of storm samplings is a function of the number of representative storms*, the available staff and equipment, an annual frequency can only be estimated. Three to five samplings per year will be attempted.

The data from storm sampling are used to characterize the distribution of pollutants during and after storm events. Prior to a storm, an automatic sampler is programmed to activate when the water level in the channel is indicative of a storm. The level of activation is

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above the maximum observed (from discharge hydrograph analysis) diurnal water surface elevation. Once activated, 24 discrete, bi-hourly samples are collected. The time of activation is determined from the the memory on the sampler or remotely from the ALERT water level sensor records.

Samples collected by the samplers are composited according to water level records. All samples comprising the storm are composited together. If the storm lasts more than the sampled period, the samples are composited in two groups of 12. If no water level information is available, electrical conductivities of each sample are measured. The series of samples with similar conductivities comprise the first composite. If there is a significant change in conductivity from one sample to that which was subsequently collected, the later is first sample of the second composite.

A second 48-hour sampling (24 discrete samples: one collected every two hours) is initiated within 12 hours of cessation of the first 48-hour sampling. The samples are composited in a manner similar to that used for the first 48-hour sampling. In addition to determining the degree of contamination during and after the storm, the data are used to determine four-day average concentrations of the monitored substances.

Since there are fewer automatic samplers than monitoring locations, the samplers cannot be permanently assigned to a site. During the storm season, a sampler remains at a monitoring site until at least three complete 96-hour samplings have been completed.

Operational problems at some stations in the Upper Newport Bay watershed, specifically San Diego Creek and Big Canyon Wash, and vandalism at Hicks Canyon Wash have prevented complete samplings with automatic samplers. Grab samples will be collected at these locations performing other functions in the watershed such as field screening and fluvial sediment monitoring. If more than one sample is collected at each station during the storm evaluations of water quality relative to the ISWP objectives can be made. This grab sampling method will be used until the operational problems with the sampling locations are resolved.

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6.0 RECEIVING WATER PROGRAM

6.1 Monitoring Locations

The waterbodies that are monitored in the Receiving Water Program include the Huntington Harbour/Anaheim, Sunset, Bolsa Bay complex; the Upper and Lower Newport Bay; Dana Point Harbor; the Santa Ana River; San Diego and San Juan Creeks. The last three waterbodies are included in the Channel Monitoring Program as are many of the other channels designated as "Waters of the State".

The monitoring locations were chosen on the basis of the existence of past data and the proximity of tributary inputs. The locations are listed in Table 4 and maps are in the appendices. As in the Channel Monitoring Program, quality control (assumed to be limitedly affected) stations at the Harbor entrances are also monitored.

6.2 Monitoring Parameters

6.2.1 Dry-weather

Dry season sampling includes semiannual sediment analyses for organic and trace element concentrations as well as nutrient evaluations of the water.

6.2.2 Storms

These locations are sampled during storms for the same contaminants monitored in the channel program (storms). Samples representative of the entire water column are collected with a USGS depth integrating sampler which has been coated with trace metal (epoxy) paint. The depth and velocity of the fresh water lens* are also noted. Field readings of dissolved oxygen, electrical conductivity, pH and temperature are made throughout the water column at the time of sampling. The Hydrolab with datalogger enables the operator to make these measurements quickly.

6.3 Monitoring Frequency

The proposed frequencies for Harbor/Bay monitoring are outlined in Table 4b.

6.3.1 Dry-weather

Dry weather monitoring is conducted monthly (to monitor the influences of tributary inflows and tidal flushing) in the Upper Newport Bay and semiannually (pre and post storm season) at other locations (unless designated storm only in Table 4). Monthly nutrient samplings are conducted in the Upper Newport Bay on the days subsequent to the period during which the automatic samplers were used in the watershed. The nutrient

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content of the tributary discharges are assumed to be seasonally influenced, monthly sampling allows three determinations per season.

Control stations at the Harbor entrances are sampled during storms (if safe to do so); problems with rapid currents, depth to bottom, and boat traffic make semiannual benthic sediment sampling impractical at these sites.

6.3.2 Storms

The storm monitoring frequency is dependent on the weather and is limited by the amount of equipment (one boat) and available manpower. Storms greater than 0.5 inches in magnitude are monitored. This volume of rainfall usually is great enough to generate rainfall which shows a significant impact in these receiving waters. Two followup samplings, 48 and 96 hours from the initial storm sampling, are conducted to assess the chronic and acute influences of the runoff on the receiving waters.

As in the channel monitoring program, the frequency will be modified according to the analyses of the data.

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7.0 DATABASE MANAGEMENT

The water quality monitoring data are entered into the USEPA's national water quality database, located in Triangle Park, North Carolina. This database management system is known as STORET, an acronym meaning storage/retrieval. The data storage and retrieval process is performed by PC communication, via modem, with the system mainframe.

Chemical data from the contractor laboratory and field data collected by Enviromental Resources staff are tranformed into the proper computer format and are transmitted to the National Computer Center. After the transmitted data is integrated into the STORET database, the information is rechecked and edited, if necessary.

Retrievals of information can be in various forms including raw data, statistics, graphical displays and maps. These retrievals are also performed with the PC/modem link.

8.0 QUALITY ASSURANCE

All methods of analyses employed by the contractor laboratory shall be from 40 CFR Part 136, "Guidelines for Establishing Test Procedures for the Analyses of Pollutants Under the Clean Water Act". Included are the APHA-AWWA-WPCF Standard Methods for the Examination of Water and Wastewater, 18th Edition. Field, chemical test methods shall be EPA approved (if available).

Quality assurance of chemical analyses performed by the contractor laboratory is conducted by the contractor laboratory through its internal quality control program and by a blind, check-sample submittal program conducted by the County.

With every batch of samples submitted to the contractor laboratory, at least one synthetically prepared, spiked or replicate sample for each 10 samples is included. The synthetic or spiked samples containing trace elements or organic compounds will be prepared using aliquots of commercially or EPA prepared stock solutions. Quality assurance samples containing nutrients are prepared from aliquots of stock solutions prepared in the Environmental Resources laboratory. Replicate samples are splits of well-mixed samples. Both fractions are be sent to the laboratory to evaluate the precision of analyses.

The accuracy of analyses is evaluated from the results of the synthetic and spiked sample submittals. A deviation from the contract limits of error will result in a request to reanalyze the batch of samples containing the QC sample. Only that constituent which exhibits the discrepancy is reanalyzed in each sample.

9.0 PROGRAM COSTS

The costs for the sampling programs include manpower, equipment and contracted analytical services. Manpower includes sample collection / preparation, hydrographic monitoring and

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calculations, equipment maintenance, employee training, laboratory contract administration including quality control, database management and report preparation

9.1 Labor

9.1.1 Sampling/Water Quality Monitoring

A team of two people is required to conduct the water quality field sampling. This sampling includes field screening and channel/receiving water monitoring (storm and dry-weather). The time required includes transportation, sample collection, automatic sampler deployment, sample preparation (labeling, preservation, logging, laboratory submittal) and equipment maintenance. The annual required manpower is summarized in Table 5.

9.1.2 Hydrographic Monitoring

EMA conducts hydrographic monitoring to support its Public Works/Flood Control Design and Field Operations Divisions. Hydrographic monitoring for the Stormwater Program which exceeds these requirements is charged to the Program. This monitoring includes maintenance, stage-discharge calibration and preparation of annual discharge summaries for stations on receiving water channels which presently do not have (or were not previously scheduled to have) continuous water level recorders. Each new gaging station requires 120 manhours of maintenance annually. Calculations of precipitation intensities for stations in excess of the number in the present program is charged to the program. These calculations require 40 hours annually to complete.

9.1.3 Analytical Services Contract Administration

Contract administration includes quality control sample preparation, analytical report evaluation, and invoice processing. This requires approximately 20 hours per month or 240 hours annually.

9.1.4 Database Management

Database management as described in Section 10.0 requires approximately 20 hours monthly or 240 hours annually.

9.1.5 Report Writing

Compilation of data and report writing require approximately 400 hours annually. The reports include rainfall intensities at 23 existing EMA precipitation gages, discharge summaries for streamgages near water quality stations, calculations of the annual pollutant load from each monitored channel and a summary of the impacts of those discharged pollutants on the the water and bed sediment quality of each receiving water. The results

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of the monitoring are to be used in the modification of existing BMPs or the implementation of new BMPs

The annual report is reviewed by the Copermittees before submittal to the Regional Water Quality Control Boards.

9 1 6 Training

Training must be completed by all staff throughout the life of the permit. This training includes OSHA-required hazardous material handling; equipment operation, new employee orientation, and computer software usage (STORET). Approximately 240 hours annually is devoted to training.

9 1.7 Labor Summary

The total annual manpower requirement is approximately 5424 hours (see Table 6). Most of the work is performed by Environmental Resources Specialist IIs who are presently compensated at an hourly rate (including overhead) of $23.79. The 5424 hours computes to approximately $129,000. Approximately half of the storm sampling, however, is conducted during non-working (overtime) hours. The total number of overtime hours required annually is 910. This computes to an additional $10,800 or a total of $139,900.

9.2 Analytical Services

The costs for analytical services were derived from the contract fee schedule from the current analytical services vendor, Brown and Caldwell Analytical Laboratories. The costs per analysis and the total annual costs are also outlined in Table 5.

9.3 Equipment Costs

Equipment required to supplement the existing inventory of EMA includes automatic samplers; flowmeters; field, diagnostic equipment and analytical reagents; and continuous water level recording gages.

Continuous water level recording gages will be installed at the urban channels which are identified as "Waters of the State" and currently lack this equipment. Eight stations currently fit this criteria. They are Serrano Creek; Segunda Deschecha, Prima Deschecha, Sand Canyon, and Bee Canyon Channels; and Rattlesnake Canyon, Hicks Canyon and Agua Chinon Washes. The cost of the equipment per station is approximately $7,500.

Four vehicles are used in the sampling program. Two of these were replaced FY 92/93 at a cost of $25,000 each.

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Miscellanous equipment expenditures (analytical reagents, automatic sampler, repair parts, field sampling equipment, etc) is approximately $5,000 annually

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10.0 DEFINITION OF TERMS

Beneficial Uses - Categories into which specific Waters of the State have been assigned by the Regional Water Quality Control Board A listing of the present and intended beneficial uses of each Water of the State can be found in the respective Regional Water Quality Control Board Basin Plans.

Best Management Practices (BMPs) - Programs, procedures, or structural devices intended to reduce the impact of non-point source urban runoff on the receiving waters.

Electrical Conductance - also known as specific conductance or electrical conductivity. It is the numerical expression of ability of a solution to carry an electric current It is proportional to the concentration of dissolved ionic solids

Flow-weighted Sampling - Samples are collected in proportion to the volume of water passing the sampling point The composite of all samples collected is representative of the entire period of collection.

Fluvial - That sediment which is transported when water velocity increases as during storms.

Freshwater Lens - The layer of freshwater will flows over the more dense salt water layer. This situation occurs when the magnitude of the tributary discharge into the saline receiving water is great, as in a storm.

Hardness - The amount of calcium and magnesium measured as calcium carbonate.

Illegal/illicit - When referring to discharges an illicit connection is an undocumented or unpermitted conduit. An illegal discharge is one which is in direct violation of an ordinance.

Mass Load - The annual total mass (pounds or tons) discharged from a tributary stream into a receiving water.

Nutrients - The physical or chemical characteristics from the following list.

- nitrate + nitrite
- ammonia
- Total Kjeldahl Nitrogen (TKN)
- total phosphate
- total suspended solids (TSS)
- volatile suspended solids (VSS)
- pH
- dissolved oxygen
- specific conductance
- turbidity

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Polynuclear Aromatic Hydrocarbons (PAHs) - Those organic compounds from the following list

Acenaphthene	Chrysene
Acenaphthylene	Dibenzo(a.h)anthracene
Anthracene	Fluoranthene
Benzo(a)anthracene	Fluorene
Benzo(a)pyrene	Indeno(1.2.3-cd)pyrene
Benzo(b)fluoranthene	Naphthalene
Benzo(ghi)perylene	Phenanthrene
Benzo(k)flouranthene	Pyrene

PCB - Polychlorinated biphenyls Those analyzed by EMA include:

Aroclor 1016	Aroclor 1221	Aroclor 1232
Aroclor 1242	Aroclor 1248	Aroclor 1254
Aroclor 1260	Aroclor 1262	

Peristaltic - When describing a pump, it is fluid transport in a tubing when a rotating pinch roller assembly compresses the tubing in the pump housing. The fluid moves in the direction of rotation.

PHP - Pesticides, herbicides and PCBs.

Aldrin	2,4-D
Dieldrin	2,4,5-TP Silvex
Chlordane	Malathion
Endosulfan I	Methoxychlor
Endosulfan II	Ethyl Parathion
Endosulfan sulfate	Perthane
Endrin	Simazine
Heptachlor epoxide	p,p' DDD
Heptachlor	p,p' DDE
alpha BHC	p,p' DDT
beta BHC	Toxaphene
delta BHC	PCBs from above
gamma BHC (lindane)	

Regional Facilities - Flood control channels with drainage areas greater than one square mile. Designated by a letter followed by two numeric characters (e.g. C02 - Bolsa Chica Channel).

Representative Storms - Those storm events during which at least 0.1 inch of rain falls and which were preceded by at least 96 hours of dryness.

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Spectrophotometer - An instrument used in colorometric analysis A solution containing an unknown concentration of a substance is treated with reagents to form a colorometric complex The intensity of the color of this complex is measured against that of a complexed solution of known concentration

Stormwater - as defined by the EPA means storm water runoff, snow melt runoff, surface runoff, street cleaning or maintenance, runoff from fire fighting, infiltration (other than infiltration contaminated by seepage from sanitary sewers or by other discharges) and drainage. Included is runoff from residential car washing and irrigation.

Trace Elements - Those elements from the following list:

copper lead zinc nickel chromium cadmium silver

Unionized Ammonia - Dissolved gaseous ammonia.

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LIST OF APPENDICES

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FIGURE 1
Field Screening Information

DATE:___/___/_____
CHANNEL NAME:_____ **EMA FACILITY NO.:**_____
SAMPLING LOCATION: u/s d/s _____
THOM BROS MAP PAGE:_____
DRAINAGE AREA:industrial/commercial/agricultural/other_____
CHANNEL CONFIGURATION:concrete, earthen, pipe, culvert, trapezoidal, vertical walled, rectangular box, gabion, grass lined, rip-rap,
other_____
DIMENSIONS: CH WIDTH/PIPE DIAM_____ ft/in **AVE DEPTH:**_____ft/in
WEATHER: sunny, cloudy, windy, hot, cold, rain, fog, other_____

TIME:_____ **AIR TEMP:**_____C
FLOWRATE:_____cfs est/meas
pH:_____ **EC:**_____umhos/cm
DO:_____ppm **TEMP:**_____C
FLOATABLES: yes/no
DESCRIBE:_____
OIL SHEEN: yes/no
ODOR: yes/no
DESCRIBE:_____
TURBIDITY: yes/no/organic/silt-clay
Sample # _____
FOAM: yes/no **Sample #** _____
ALGAE: yes/no
AQUATIC LIFE: yes/no/stressed

TOTALCHLORINE:_____mg/L
TOTALCOPPER:_____mg/L
TOTAL PHENOL:_____mg/L
TOTAL CHROMIUM:_____mg/L
HEXAVALENT CHROMIUM:_____mg/L
FREE CYANIDE:_____mg/L
COD SAMPLE #:_____
COD:_____mg/L

COMMENTS:_____

_____

_____

TIME:_____ **AIR TEMP:**_____C
FLOWRATE:_____cfs est/meas
pH:_____ **EC:**_____umhos/cm
DO:_____ppm **TEMP:**_____C
FLOATABLES: yes/no
DESCRIBE:_____
OIL SHEEN: yes/no
ODOR: yes/no
DESCRIBE:_____
TURBIDITY: yes/no/organic/silt-clay
Sample # _____
FOAM: yes/no **Sample #** _____
ALGAE: yes/no
AQUATIC LIFE: yes/no/stressed

TOTAL CHLORINE:_____mg/L
TOTAL COPPER:_____mg/L
TOTAL PHENOL:_____mg/L
TOTAL CHROMIUM:_____mg/l
HEX CHROMIUM:_____mg/L
FREE CYANIDE:_____mg/L
COD SAMPLE #:_____
COD:_____mg/L

COMMENTS:_____

_____

_____

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TABLE 1a - EQUIPMENT INVENTORY

Item	Quant.	Equipment	Function	Notes
1	14	Rugid Flowmeter-Transceiver	Remote control of ISCO automatic samplers, continuous water level/flow measurement	System should be in operation by October 15 1993
2	7	ISCO Model 1680 Wastewater Sampler	Automatic Sampling of Channels	No organics sampling capability
3	2	ISCO Model 2700 Wastewater Sampler	Automatic Sampling of Channels	Non-uniform sample volumes, inorganic/organic sampling
4	18	ISCO Model 3700 Wastewater Sampler	Automatic Sampling of Channels	Uniform volume capability for all samples collected; inorganic/organic sampling
5	5	ISCO 3200 Series Portable Flowmeters	Continuous water level monitoring and flow-comp.	In use
6	1	Manning Model 4500T Wastewater Sampler	Automatic sampling of water with high suspended solids	No organics capability; req. compatible flowmeter
7	2	Hydrolab Surveyor II with datalogger	Multiparameter oceanographic probe	Dissolved oxygen, pH, temperature, conductivity
8	2	Orion Model 124 Conductivity/Salinity Meter	Field monitoring	Digital readout, temperature compensating
9	3	YSI Model 51B Dissolved Oxygen Meter	Field monitoring	Analog readout, temperature compensating
10	1	YSI Model 53 Dissolved Oxygen Meter	Field monitoring	Digital readout, temperature compensating
11	3	YSI Model 33 S-C-T Conductivity Meter	Field monitoring	Non temperature compensating; Will be replaced in FY 91/92
12	1	Amber Science Conductivity Meter	Field monitoring	Temperature compensating to 25C
13	1	Horiba Water Quality Checker	Field monitoring	Multiparameter probe including DO,pH,conductivity,temperature and turbidity
14	1	Ekman Petite Ponar Sediment Sampler	Sampling of bottom material	
15	1	8" LaMotte Limnological Secchi Disk	Field turbidity measurement	New oceanographic model in use
16	1	Kemmerer 2L Depth Sampler	Subsurface water sampling	
17	1	Sierra Misco Remote Dissolved Oxygen Sensor	Continuous dissolved oxygen monitoring	

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TABLE 1a - EQUIPMENT INVENTORY

Item	Quant.	Equipment	Function	Notes
18	1	Hach Model 2000 Portable uv-visible spectrophotometer	Colorimetric analyses for field screening	
19	1	GMC Jimmy 4X4	Sampling vehicle	
20	1	Chevrolet Hi-cube Van	Sampling vehicle Mobile laboratory	Expected to be in service by January 1, 1989
21	2	GMC Utility Body Pickup	Hydrographic monitoring	
22	1	15' Boston Whaler with 35HP Outboard Engine & 10 HP Auxiliary Engine	Harbor, bay and reservoir monitoring	
23	1	Perkin Elmer Model 3030B AA Spectrophotometer	Trace element analyses	For samples req immediate analysis for enforcement
24	1	Orion Model 900 Ionanalyzer	pH and specific ion analyses	
25	1	Micromeritics Sedigraph Model 5200	Particle size distribution of fluvial sediment samples	For silt clay fractions
26	1	Visual Accumulation Tube	Particle size distribution of fluvial sediment samples	For sand less than 1 mm
27	3	Montedoro Whitney PVM-2A Velocity Flow Meter	Field discharge measurements	
28	2	Rickly Hydrological 4-wheel base cranes	Hydrographic monitoring and fluvial sediment collection	with Scientific Instruments 8-58 sounding reels
29	4	Depth integrating Sediment Samplers	Fluvial sediment sample collection	
30	1	Hach DR/700 Colorimeter	For field analysis	
31	2	Jenco model 6009 pH meter	For field analysis	

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TABLE 2 - FIELD SCREENING LOCATIONS

No.	Channel Name	EMA Fac. Number	Sampling Site Location	Cities in Drainage Area	1990 Thom. Bros. Map Page
1	Coyote Creek	A01	at Walnut Ave	Br,LH	2-A5
2	Coyote Creek	A01	u/s A03 Valley View	BP,Br,LH	4-E6
3	Brea Creek	A02	at Western Ave	Br,Ful,LH	5-B5
4	Fullerton Creek	A03	at Valley View St.	BP,Ful	9-E1
5	Brea Canyon Channel	A04	at Puente	Br	6-C1
6	Loftus Diversion Channel	A06	at Imperial Hwy	Br,Ful	7-A1
7	Imperial Channel	A07	at Imperial Hwy.	Br,Ful,LH	1-F6
8	La Mirada Creek	A08	at Macy & Whittier Blvd.	LH	1-E4
9	Tonner Canyon Channel	A09	u/s A04 Lambert	Co	3-C5
10	Carbon Creek Channel	B01	at Denni St.	Ana,BP,Cyp	9-C6
11	Carbon Creek Channel	B01	at Placentia Ave.	Ana,Pla,YL	12-A1
12	Carbon Creek Channel	B01	at Kenwood & Raymond	Ana,Ful,Pla,YL	11-D2
13	Carbon Creek Channel	B01	at Valley View & Ball	Ana,Ful,Pla,YL	9-F6
14	Placentia Storm Channel	B01S03	at Orangethorpe Ave.	Ful,Pla	12-A1
15	Moody Creek Channel	B02	u/s A01 at Crescent	BP,Cyp,LP	9-C4
16	Los Alamitos Channel	C01	at Westminster Ave.	LA,SB	19-C6
17	Los Alamitos Basin	C01B02	at Westminster Ave.	LA Co,SB	19-E1
18	Bolsa Chica Channel	C02	at Westminster Blvd.	LA,SB,Wes	14-D6
19	Stanton Storm Channel	C02S01	at Valley View St.	Cyp,Stn	14-F2
20	Jonathan Storm Channel	C02S03	at Valley View St.	Cyp	14-F1
21	Anaheim-Barber City Channel	C03	at Rancho Rd.	Ana,GG,HB,Wes	20-E1
22	Humbolt Storm Channel	C03S02	at Springdale St.	Wes	14-F6
23	Westminster Channel	C04	at McFadden Ave.	GG,HB,Wes	20-F3
24	E. Garden Grove Wintersburg	C05	at Goldenwest Ave.	Ana,GG,HB,Wes	21-B5
25	West Street Basin	C05B01	at West & Chapman	GG	16-C3
26	Haster Basin	C05B02	at Haster & Lampson	Ana,GG,Or	16-D4
27	Ocean View Channel	C06	at Beach Blvd.	FV	21-C5
28	Greenville Banning Channel	D03	at Sunflower	SA	27-D2
29	Greenville Banning Channel	D03	at Hamilton ave.	SA,CM	30-F1
30	Fairview Channel	D04	u/s D03 Confluence	CM	27-A4
31	Fountain Valley Channel	D05	at Bushard Ave.	FV,HB	26-E3
32	Carbon Canyon Diversion Ch.	E02	at SA River	Ana	12-C3
33	Miller Basin	E02B01	at Miller & Orangethorpe	Ana,YL	7-C6
34	Carbon Creek Channel	E03	at Chapman Ave.	Pla	7-C5
35	Richfield Channel	E05	u/s E04 Orangethorpe ave.	Pla,YL	7-D6
36	Esperanza Channel	E06	at Dominguez Ranch Rd.	YL	6-E5
37	Collins Channel	E07	at SA River At Main	Or	17-B1
38	Santiago Creek Channel	E08	at Bristol St.	Or,SA,VP	16-F5
39	Villa Park Dam	E08D01	at Lolita St.	Co	13-E6
40	Gypsum Creek Channel	E09	u/s Owl Rock Concrete	Co	43-C2
41	Bitterbush Channel	E11	at SA River	Or	17-A3
42	Southeast Anaheim Channel	E12	at SA River	Ana,Or	17-A3
43	Santa Ana-Delhi Channel	F01	at So. of Baker	SA	22-D2
44	Santa Ana-Delhi Channel	F01	u/s F03 confluence	CM,SA	27-F3
45	Santa Ana-Delhi Channel	F01	at Irvine ave.	CM,NB,SA	28-A6
46	Santa Ana Gardens Channel	F02	at Sunflower Ave.	SA	28-A2
47	Paularino Channel	F03	at Bristol St.	CM	27-F4
48	Bonita Canyon Channel	F04	u/s F05 confluence	Irv	32-C1

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TABLE 2 - FIELD SCREENING LOCATIONS

No.	Channel Name	EMA Fac. Number	Sampling Site Location	Cities in Drainage Area	1990 Thom. Bros. Map Page
49	San Diego Creek	F05	at Campus Dr	Irv	28-D6
50	Peters Canyon Channel	F06	at Barranca Pkwy	Irv Tus	28-F2
51	El Modena-Irvine Channel	F07	at Michelle Dr	Tus	24-B5
52	Lane Channel	F08	at Jamboree Rd	Irv,SA	28-D4
53	Armstrong Storm Channel	F08S01	at Lane Channel	Irv	28-D2
54	Barranca Channel	F09	at Main St.	Irv,Tus	28-E3
55	Santa Ana-Santa Fe Channel	F10	u/s F06 confluence	SA,Tus	29-B1
56	South West Tustin Channel	F11	at McFadden Ave.	SA	23-D4
57	North Tustin Channel	F12	at Holt Ave.	Co,Tus	24-A1
58	Rechill Channel	F13	at Irvine Blvd.	Co	24-B2
59	San Joaquin Channel	F14	u/s F06 confluence /Culver	Irv	28-F4
60	Sand Canyon Channel	F15	u/s F06 Culver/Univ.	Irv	28-F6
61	Bee Canyon Channel	F17	at Alton/Pacifica	Co,Irv	29-F6
62	Agua Chinon Channel	F16	at Irvine Center Dr.	Irv	51-A6
63	Serrano Creek Channel	F19	at Muirlands Ave.	Irv	29A-C1
64	Borrego Canyon Channel	F20	at Alton Pkwy.	Co,Fed	51-B6
65	Canada Channel	F23	at Lake Forrest Rd.	Irv	29A-B3
66	Central Irvine Channel	F25	u/s F06 Trabuco Ave.	Co,Irv	24-D6
67	Rattlesnake Canyon Wash	F26	at Bryan Ave.	Co	24-D5
68	Hicks Canyon Wash	F27	at Culver Dr.	Co,Irv	24-E4
69	E. Costa Mesa Channel	G02	at Highland Ave.	CM,NB	31-E4
70	Santa Isabella Channel	G03	at Irvine Ave.	CM	31-F2
71	Big Canyon Wash	G04	at Jamboree Blvd.	NB	31-F4
72	Laguna Canyon Channel	I02	at Woodland Ave.	Co,LB	34-E1
73	Aliso Creek Channel	J01	at Aliso Creek Rd.	Co	29C-D6
74	Aliso Creek Channel	J01	at PCH	Co	35-A5
75	Sulphur Creek Channel	J03	at Laguna Niguel Reg. Park	Co	35-E2
76	Narco Channel	J04	at Laguna Niguel Reg. Park	Co	35-E2
77	English Canyon Channel	J07	at Los Alisos Blvd.	MV	29B-A4
78	Salt Creek Channel	K01	at PCH	DP	37-C3
79	San Juan Creek Channel	L01	at PCH	SJC	38-F4
80	San Juan Creek Channel	L01	at Hot Springs Canyon Rd.	Co	83-B1
81	Trabuco Creek Channel	L02	at Camino Capistrano	Co,SJC	38-B3
82	Trabuco Creek Channel	L02	at Trabuco Creek Rd.	Co	58-59-E5
83	Oso Creek Channel	L03	at Crown Valley Pkwy.	MV	29D-B6
84	Oso Creek Channel	L03	at Alicia Pkwy.	MV	29B-D4
85	La Paz Channel	L04	u/s L03 confluence	MV	29D-B3
86	Cascadita Canyon Storm Channel	M01S01	at Camino Capistrano	SC	38-B1
87	Marguita Storm Channel	M00S07	at Pacific Ocean	SC	39-C4
88	Prima Deschecha Channel	M01	at Calle Grande Vista	SC	39-B1
89	Segunda Deschecha Channel	M02	at El Camino Real	SC	39-C3

Changes from 90/91

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Table 1b Continuous Water Level Recording Stations

	Channel Name	Streamgage Location	Present Equipment Status	Notes
1	Bolsa Chica Channel	at Westminster Avenue	FS / A-71 / ATB / ATDL	
2	Anaheim Barber City Channel	at Rancho Road	HgM / A-71 / ATB / ATDL	
3	Westminster Channel	d/s Beach Boulevard	FS / A-71 / ATB / ATDL	Sampled at McFadden Ave.
4	East Garden Grove Wintersburg Channel	at Gothard Street	FS / A-35 / ATB / ATDL	Sampled at Goldenwest St.
5	Santa Ana River	at Imperial Highway	HgM / A-35 / ATB / AT	
6	Santa Ana River	at Fifth Street	HgM / A-71	operated by USGS
7	Santiago Creek	at Bristol Street	HgM / A-71 / ATB / ATDL	operated by USGS
8	Santa Ana Delhi Channel	at Irvine Avenue	FDWG / A-71 / ATB / ATDL	
9	San Diego Creek	at Culver Drive	FDWG / A-71 / ATB / ATDL	
10	San Diego Creek	at Campus Drive	FDWG / A-71 / ATB / ATDL	
11	Peters Canyon Wash	at Barranca Parkway	FS / A-71 / ATB / ATDL	
12	Laguna Canyon Channel	at Woodland Avenue	FS / A-71 / ATB / ATDL	Infrared transmitter/repeater
13	Aliso Creek	u/s PCH	HgM / A-71	impacted by shifting sand
14	San Juan Creek	at La Novia	HgM / A-71 / ATB / AT	
15	Trabuco Creek	at Camino Capistrano	FS / 2A-35 / AT	
16	Oso Creek	at Crown Valley Parkway	FS / A-71 / ATB / ATDL	will be impacted by const.

FS - Float level sensor
HgM - Leopold Stevens or Scientific Instruments Mercury manometer
FDWG - Fluid Data Watergage
A-35 - Leopold Stevens A-35 continuous water level stripchart recorder
A-71 - Leopold Stevens A-71 continuous water level stripchart recorder
2A-35 - Leopold Stevens dual pen, continuous water level stripchart recorder
ATB - ALERT tipping bucket raingage
AT - ALERT transmitter
ATDL - ALERT transmitter with datalogger

TABLE 3 CHANNELS MONITORED WITH AUTOMATIC SAMPLERS

Huntington Harbour Anaheim, Sunset, Bolsa Bay Watershed

Station	STORET Code	Location
Bolsa Chica Channel *	BCC02	at Westminster Avenue
Anaheim Barber City Channel *	ABCC03	at Rancho Road
Westminster Channel *	WMCC04	at McFadden Avenue
E. Garden Grove-Wintersburg Channel *	EGWC05	at Gothard Street
Sunset Channel	SUNC07	at Saybrook Drive

* Continously recording streamgage located nearby

Upper Newport Bay Watershed

Station	STORET Code	Location
Santa Ana-Delhi Channel *	SADF01	at Irvine Avenue
Bonita Canyon Channel ●	BCF04	at San Diego Creek Conf
San Diego Creek ●*	WYLSED	at Culver Drive
San Diego Creek ●*	SDMF05	at Campus Drive
Peters Canyon Wash ●*	BARSED	at Barranca Parkway
Lane Channel	LANF06	at Jamboree Road
Barranca Channel	BC2F09	at Main Street
Sand Canyon Channel ●	SCCF15	at Culver Drive
Bee Canyon Channel ●	BEEF17	at Irvine Center Drive
Agua Chinon Wash ●	ACWF18	at Irvine Center Drive
Serrano Creek ●	SERF19	at Alton Parkway
Rattlesnake Canyon Wash ●	RCWF26	at Alton Parkway
Hicks Canyon Wash ●	HCWF27	at Bryan Avenue
Costa Mesa Channel	CMCC02	at Highland Avenue
Santa Isabella Channel	SICC03	at Irvine Avenue
Big Canyon Wash	BCWC04	at Back Bay Drive

● Identified as a water of the State in the Stormwater Permits

South County Watershed

Station	STORET Code	Location
Laguna Canyon Channel ●*	LCWI02	at Woodland Avenue
Aliso Creek Channel ●*	ACJ01	u/s PCH
Sulphur Creek Channel ●*	SCDAM	d/s Sulphur Creek Dam
San Juan Creek ●*	SJNL01	at La Novia Avenue
San Juan Creek ●	SJCHSC	at Hot Springs Canyon Rd.
Trabuco Creek ●*	TCOL02	at Camino Capistrano
Oso Creek ●*	OSOL03	at Crown Valley Parkway
Prima Deschecha Channel ●	PDCMO1	at Calle Vista Grande
Segunda Deschecha Channel ●	SDCMO2	at El Camino Real

Santa Ana River Watershed

Station	STORET Code	Location
Santa Ana River ●*	SARIMP	at Imperial Highway
Santa Ana River ●*	SARADM	at Adams Ave.
Santiago Creek ●*	SANE06	at Bristol Street
Silverado Creek ●	SILE17	at Silverado Canyon Road

Changes from 90/91

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TABLE 3a - CHANNEL MONITORING FREQUENCIES

Huntington Harbour Watershed

STORET Code	Nutrients	Trace(aq)	Trace(s)	PHP(s)	PAH(s)
BCC02	m/st	st			
ABCC03	st	st			
WMCC04	st	st			
EGWC05	m/st	st			
SUNC07	st	st			

Newport Bay Watershed

STORET Code	Nutrients	Trace(aq)	Trace(s)	PHP(s)	PAH(s)
SADF01	st	st			
BCF04	st	st	semi	semi	semi
SDMF05	m/st	st	semi	semi	semi
WYLSED	m/st	st	semi	semi	semi
BARSED	m/st	st	semi	semi	semi
LANF08	st	m/st	semi	semi	semi
BC2F09	st	m/st	semi	semi	semi
SCCF15	m/st	st	semi	semi	semi
BEEF17	m/st	st	semi	semi	semi
AGWF18	m/st	st	semi	semi	semi
SERF19	m/st	st	semi	semi	semi
RCWF26	m/st	st	semi	semi	semi
HCWF27	m/st	st	semi	semi	semi
CMCG02	st	st			
SICG03	st	st			
BCWG04	st	st			

South County Watershed

STORET Code	Nutrients	Trace(aq)	Trace(s)	PHP(s)	PAH(s)
LCWI02	st	st			
ACJ01	m/st	st	semi	semi	semi
SCBJ03	st	st	semi	semi	semi
SJCL01	m/st	st	semi	semi	semi
TCOL02	st	st	semi	semi	semi
OSOL03	st	st	semi	semi	semi
PDCM01	m/st	st	semi	semi	semi
SDCM02	m/st	st			
OHBL01	m/st	st	semi	semi	semi

Santa Ana River Watershed

STORET Code	Nutrients	Trace(aq)	Trace(s)	PHP(s)	PAH(s)
SARIMP	st	st	semi	semi	semi
SARE01	st	st	semi	semi	semi
SANE08	st	st	semi	semi	semi
SILE17	m/st	st	semi	semi	semi

m - monthly; semi - semiannual; st - storm

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TABLE 4 - HARBOR/BAY MONITORING LOCATIONS

Huntington Harbour/Anaheim, Sunset, Bolsa Bay

Station	STORET Code	Location
Sunset Aquatic Park	HUNSUN	near U S Navy bouys
Huntington Harbour	HUNBCC	near Bolsa Chica Channel mouth
Huntington Harbour	HUNWAR	at Warner Avenue
Chrisbana Bay	HUNCRS	near Sunset Channel outlet
Anaheim Bay	HUNHAR	between ends of jetties
Bolsa Bay	BBOLR	at old launch ramp

Newport Bay

Station	STORET Code	Location
Upper Newport Bay	UNBJAM	d/s Jamboree Rd. near the old salt works
Upper Newport Bay	UNBSDC	in the slu zone
Upper Newport Bay	UNBBCW	SE/North Island, d/s Big Canyon Wash
Upper Newport Bay	UNBNSB	W/Shellmaker Island, E/North Star Beach
Upper Newport Bay	UNBNDS	near entrance to Newport Dunes
Upper Newport Bay	UNBCHB	at PCH
Lower Newport Bay	UNBHAR	in Harbor Island Reach near Collins Isle
Lower Newport Bay	UNBTUB	in the Turning Basin
Lower Newport Bay	UNBRIN	in the Rhine Channel
Lower Newport Bay	UNBHAR	at the Harbor entrance

Dana Point Harbor

Station	STORET Code	Location
East Basin	DAPTEB	near stormdrain outlet
West Basin	DAPTWB	near stormdrain outlet
Launch ramp	DAPTLR	near stormdrain in launch ramp bulkhead
Boatyard	DAPTLR	near boatyard dock
Harbor Entrance	DAPTHE	between ends of jetties

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TABLE 4a - HARBOR/BAY MONITORING FREQUENCIES

Huntington Harbour/Sunset, Anaheim, Bolsa Bays

STORET Code	Nutrients	Trace(aq)	Trace(s)	PHP(s)	PAH(s)
HUNSUN	semi/st/f	st/f			
HUNBCC	semi/st/f	st/f	semi	semi	semi
HUNWAR	semi/st/f	st/f	semi	semi	semi
HUNCRB	semi/st/f	st/f	semi	semi	semi
HUNHAR	st	st			
BBOLR	semi/st/f	st/f	semi	semi	semi

Newport Bay

STORET Code	Nutrients	Trace(aq)	Trace(s)	PHP(s)	PAH(s)
UNBJAM	m/st/f	st/f	semi	semi	semi
UNBSDC	m/st/f	st/f	semi	semi	semi
UNBBCW	m/st/f	st/f	semi	semi	semi
UNBNSB	m/st/f	st/f			
UNBNDB	m/st/f	st	semi	semi	semi
UNBCHB	st	st			
LNBHIR	semi/st/f	st/f	semi	semi	semi
LNBTUB	st	st			
LNBRIN	st	st	semi	semi	semi
LNBHAR	st	st			

Dana Point Harbor

STORET Code	Nutrients	Trace(aq)	Trace(s)	PHP(s)	PAH(s)
DAPTEB	semi/st/f	st/f	semi	semi	semi
DAPTWB	semi/st/f	st/f	semi	semi	semi
DAPTLB	semi/st/f	st/f	semi	semi	semi
DAPTLR	st/f	st/f	semi	semi	semi
DAPTHE	st	st			

m - monthly; semi - semiannual; st - storm; f - 48/96 hr followup

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Table 5 - Analytical Cost and Labor Estimates

Activity	Type of Analyses	Annual Freq	No of Stations	Samples per/Stn	Cost per Analysis	Total Cost	Labor (hrs)
Field Screening	Varied	2	90		EMA		1080
Channel Monitoring (monthly)	Nutrients	12	17	1	$105	$21,420	480
	Trace(aq)	12	2	1	$80	$1,920	
Channel Monitoring (semiannual)	Trace(sed)	2	23	1	$95	$4,370	160
	PHP(sed)	2	23	1	$600	$27,600	
	PAH(sed)	2	23	1	$175	$8,050	
Channel Monitoring (3-5 storms, 48 hrs)	Nutrients	4	34	2	$105	$28,560	544
	Trace(aq)	4	34	2	$80	$21,760	
Channel Monitoring (48 hr storm followup)	Nutrients	4	8	2	$105	$6,720	336
	Trace(aq)	4	21	2	$80	$13,440	
Upper Newport Bay Monitoring (monthly)	Nutrients	12	4	1	$105	$5,040	144
Harbor/Bay Monitoring (semiannual)	Nutrients	2	9	1	$105	$1,890	120
	Trace(sed)	2	13	1	$95	$2,470	
	PHP(sed)	2	13	1	$600	$15,600	
	PAH(sed)	2	13	1	$175	$4,550	
Harbor/Bay Monitoring (storm)	Nutrients	2	20	1	$105	$4,200	120
	Trace(aq)	2	20	1	$80	$3,200	
Harbor/Bay Monitoring (48/96 hr storm followup)	Nutrients	2	13	2	$105	$5,460	240
	Trace(aq)	2	13	2	$80	$4,160	
QA/QC Samples	Nutrients	50	1	1	$105	$5,250	
	Trace(aq)	30	1	1	$80	$2,400	
	Trace(sed)	10	1	1	$95	$950	
	PHP(sed)	10	1	1	$600	$6,000	
	PAH(sed)	10	1	1	$175	$1,750	
Hydrographic Monitoring							1000
In-house Analyses							80
Contract Administration							240
Database Management							240
Report Writing							400
Training							240
Totals						$196,760	5424

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Table 6 - Annual Labor Summary

Activity	Hours	
	RH	OT
Field Screening	810	270
Channel Monitoring (monthly)	480	
Channel Monitoring (semiannual)	160	
Channel Monitoring (storm)	272	272
Channel Monitoring (48 hr followup)	168	168
Upper Newport Bay Monitoring (monthly)	144	
Harbor/Bay Monitoring (semiannual)	120	
Harbor/Bay Monitoring (storm)	120	
Harbor/Bay Monitoring (storm followup)	120	120
Hydrographic Monitoring	920	80
In-House Analyses	80	
Lab Contract Administration	240	
Database Management	240	
Report Writing	400	
Training	240	
Totals	4514	910

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Table 7 - Annual Equipment Costs

Equipment	cost/item *	FY 90/91	FY 91/92	FY 92/93	FY 93/94	FY 94/95
Automatic Sampler	$3,500	3	10	5		
Flowmeter	$3,000	5	10	5		
Spectrophotometer	$1,500	1	1			
Field Screening Reagents	$1,000	1	1	1	1	1
Streamgages	$7,500		8			
Vehicles	$20,000			2		
Conductivity Meters	$1,300		2			
Miscellaneous Supplies	$5,000	1	1	1	1	1
TOTAL *		$33,000	$135,100	$76,500	$6,000	$6,000
TOTAL (adj. for cost of living)			$148,600	$95,000	$8,000	$8,800

* 1990 dollars

Table 8 - Total Annual Costs with 100% Program Completion

Item	FY 90/91	FY 91/92	FY 92/93	FY 93/94	FY 94/95
Labor @ #	$88,200	$146,900	$154,200	$161,900	$170,000
Equipment *	$33,000	$148,600	$95,000	$8,000	$8,800
Analytical Services *	$98,380	$196,760	$196,760	$216,436	$238,080
TOTALS	$219,580	$492,260	$445,960	$386,336	$416,880

@ Environmental Resources Specialist II hourly rate of $23.79 (w/benefits)
# with 5% annual cost of living adjustments
* with 10% annual cost of living adjustments in 93/94 and 94/95

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9.0 SWMP IMPLEMENTATION PLAN

The Storm Water Management Plan (SWMP) Implementation Plan summarizes major activities to be accomplished during the period June of 1995 through June of 2000. The approach emphasized by the Program is to establish greater clarity of Program mission, goals, and objectives while encouraging continuous improvement through an adaptive management implementation strategy. This SWMP seeks to focus on shared co-permittee commitment, implementation consistency and effectiveness, greater regional coordination through the Bay Area Stormwater Management Agencies Association (BASMAA), improved integration of the various Program elements, simplification of annual reporting for routine activities and linkage of the SWMP to the Program's annual reporting, work plan preparation, and budgeting processes.

To implement the continuous improvement strategy, the Program is committed to maintaining the SWMP as an up-to-date and living document by linking it to the Program's annual reporting process. In contrast to the Program's first SWMP, this plan includes less specific detail but a greater emphasis on commitment to the accomplishment of overall Program goals. Some Program elements include three alternative implementation strategies which have been designed to reflect co-permittee characteristics summarized in Appendix A. This approach is reflected in the Program's Mission Statement, which is presented in the SWMP Preface. The goals of the overall Program are presented in Chapter 3 while the particular goals and objectives of the SWMP are presented in Chapter 1.

9.1 Program Commitment to SWMP Implementation

The Program's Mission Statement states, in part: *The 15 co-permittees of the Santa Clara Valley Nonpoint Source Pollution Control Program are committed to a cooperative program of pollution prevention and control measure activities which reduce or eliminate pollutants in storm water to the maximum extent practicable.* All co-permittees have committed to follow the general approach and activities of the implementation plan presented in this chapter. The specific details of year to year implementation of tasks, the evaluation of those tasks, and any deviation from the tasks or time schedule contained in the SWMP Implementation Plan will be reported in the detailed annual work plans and the Annual Report.

9.2 Ongoing Coordination with Regional Board and Interested Citizens

The Program invites and encourages Regional Board staff, interested citizens, and representatives of public interest groups to attend its monthly Management Committee meetings and other Program Subcommittee meetings in order to directly participate in key Program discussions and decisions. In addition, Program staff at SCVWD are committed to periodic meetings with Regional Board staff to ensure effective communication and cooperation.

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9.3 Program Management, Roles, and Responsibilities

The Program's organization, administration, management, internal and external coordination, co-permittee and committee roles and responsibilities, and institutional arrangements are presented in Chapter 6. Key documents which define roles and responsibilities include the Program's Memorandum of Agreement, Bylaws, and NPDES permit, and the March 1994 South Bay Copper Reduction Memorandum of Understanding. The SWMP is intended to serve as a Program policy document and five year plan rather than a detailed description of Program management. Thus, Program Management activities include only those new tasks aimed at improving the effectiveness of the existing Program management.

9.4 Annual Reporting, Evaluation, and SWMP Update

The Program's purposes and the process of annual reporting and evaluation, the roles and responsibilities of the Program and its co-permittees, and the linkage of this process to the update of the SWMP are described in Chapter 7. Emphasis is placed on continuous improvement of control measure effectiveness and cost effectiveness, streamlining and simplifying annual reporting of routine ongoing activities, and the use of new information from monitoring, special studies, pilot projects, or other sources as it becomes available. If necessary, the SWMP will be updated each year following submittal of the Annual Report. Program and co-permittee work plan and budget planning processes will be initiated annually following the update of the SWMP and will use current information for budget planning and decision making. The annual reporting process also serves as the mechanism for accountability for regulatory compliance.

9.5 Implementation Plan Elements and Time Schedules

Because this is the Program's second Storm Water Management Plan, it includes significant changes to the document's organization, format, and update process based upon experience gained during implementation the first SWMP. In addition, details on the development of the SWMP and its elements have not been included because the Program's co-permittees and Regional Board staff are familiar with the Program. Additional Program elements such as Program Management, Metals Control Measures, and Watershed Management have been added to the Implementation Plan for purposes of defining Program policy and strategy, and to provide a-sufficient statement of commitment for purposes of regulatory compliance. A summary of Program elements of the implementation plan is presented below.

PM - Program Management
RPT - Annual Reporting and Evaluation
MON - Monitoring
PAA - Public Agency Activities
PIP - Public Information and Participation
MET - Metals Control Measures

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WMM - Watershed Management Measures
ICID - Illicit Connection/Illegal Dumping
IND - Industrial and Commercial Dischargers
NDC - New Development and Construction

9.6 Demonstration/Pilot Projects and Control Measure Activities

The Demonstration and Pilot Projects currently underway or planned listed in Table 5.2-2 are intended to facilitate the development of BMPs for control measures, improve the efficiency and/or effectiveness of existing control measures, or to evaluate the effectiveness (and quantify pollutant reduction) of control measures. Each of the projects will potentially affect one or more of the control measure activities in the implementation plan. The control measure activities which could be affected by each project are presented in Table 9.6-1.

Table 9.6-2 lists the demonstration/pilot projects, any currently scheduled project or study completion date, and the anticipated usefulness or product expected from the project. For example, the Parking Lot BMP Development project is scheduled for completion in December 1995. The product of this study will be a manual of low cost new and retrofit BMPs for urban parking lots, such as malls, convenience stores, and municipal lots. The reproduction of the manual for co-permittees use and distribution is anticipated to take until March 1996, at which time the manual will be ready for widespread distribution. It is expected that the co-permittees can implement appropriate BMPs at municipally-owned lots fairly rapidly. However, referring to control measure IND-2.8, a strategy which includes inventory, outreach, and enforcement is needed for application of the manual to commercial and industrial facilities.

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TABLE 9.6-1
Relationship Between Demonstration/Pilot Projects and Control Measure Activities

Demonstration/ Pilot Project	Public Agency Activities (PAA)	Public Information/ Participation (PIP)	Metals (MET)	Watershed Management Measures (WMM)	Illicit Connection/ Illegal Dumping Elimination (ICID)	Industrial Dischargers Control Program (IND)	New Development and Construction Activities (NDC
Parking Lot BMP Development	PAA-1,2,4,7	PIP-3	MET-1,2	WMM-4		IND-1,2,3	NDC-1,2,3,5
Food Handling Facility BMP Development	PAA-2,7	PIP-3		WMM-4	ICID-2,3	IND-1,2,3	
Brake Pad Study (Phase I and II)	PAA-2,3,4,7	PIP-2,3	MET-1,2	WMM-1			NDC-1,5
Sediment Study (Phase I and II)	PAA-2,3,4,5,6,7	PIP-3	MET-1,2	WMM-2,3,4	ICID-1,2,3	IND-1,2,3	NDC-1,2,3,4,5
Quantification Studies		PIP-2,3	MET-1,2	WMM-2,3,4			
Transportation	PAA-2,4,7	PIP-2,3	MET-1,2	WMM-1,2,4			NDC-1,2,3,5
Watershed Protection and Restoration	PAA -1,2,3,4,5,6,7,8	PIP-2,3	MET-1,2	WMM-1,2,3,4	ICID-1,2,3	IND-1,2,3	NDC-1,2,3,4,5
Identify New Copper Sources		PIP-2,3	MET-1,2				
Corrosion Control	PAA-2,3,6	PIP-2,3	MET-1,2	WMM-1	ICID-1,2,3	IND-1,2,3	NDC-2,3,5
Pesticide Application	PAA -1,2,3,4,5,6,7,8	PIP-2,3	MET-1	WMM-1,2	ICID-1,2,3		NDC-1,2,3,4,5
Improved Street Sweeping	PAA-1,2,4,7	PIP-3	MET-1,2	WMM-1,2,4			NDC-4
Improve Public Facilities or Storm Water Facilities Design, Operation, and Maintenance Practices	PAA -1,2,3,4,5,6,7,8	PIP-3	MET-1,2	WMM-1,2,4			NDC-5
Watershed Classification	PAA-2,3,5,6,7,8	PIP-2,3	MET-1,2	WMM-3	ICID-1,2,3	IND-1,2,3	NDC-1,2,3,4,5

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TABLE 9.6-2
Scheduled/Planned Completion Dates for and Utility/Product to be Derived from Demonstration/Pilot Projects and Control Measure Activities

Demonstration/ Pilot Project	Study Completion Date	Utility/Product
Parking Lot BMP Development	December 1995	Manual of new and retrofit BMPs available area-wide March 1996
Food Handling Facility BMP Development	June 1994	Manual, poster, training aids available area-wide September 1994
Brake Pad Study (Phase I and II)	Phase I completed September 1994 Phase II dependent on USEPA grant	Influence state/national legislative strategy to address product reformulation
Sediment Study (Phase I and II)	Phase I - February 1995 Phase II not started	Identify sources and define control measure strategies
Quantification Studies	Baseline quantifications from co-permittees due FY 1994-95	Establish Copper and heavy metals reductions to date, and additional reductions to meet wasteload allocation(s)
Transportation	None scheduled	Identify potential control measures
Watershed Protection and Restoration	District CRWMP - October 1994 District pilot scope - October 1995	Results from District pilot scope - FY 1997-98
Identify New Copper Sources	Request funding for pilot studies - April 1995	Identify sources and define control measure strategies
Corrosion Control	District study - April 1995	Corrosion control strategy - January 1996
Pesticide Application	Request national studies be conducted - July 1995	Influence state/national legislative strategy to address problem
Improved Street Sweeping	Equipment effectiveness comparison - October 1994	Equipment selection recommendations November 1994
Improve Public Facilities or Storm Water Facilities Design, Operation, and Maintenance Practices	None scheduled	Develop and implement improved designs and procedures to maximize pollutant reduction
Watershed Management	June 1997 (Coyote Creek) June 1998 (strategy for other watersheds)	Planning Tool for Watershed Protection

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9.7 Format of Implementation Plan

This section describes, in summary form, each of the Program's elements, activities, and tasks, the relevant roles and responsibilities of the Program and its co-permittees, and the corresponding implementation time schedules. The tasks and time schedules will be updated as necessary in conjunction with the annual reporting process.

Each Program element is designated by a character abbreviation as summarized in Section 9.5. Activities within a Program element are designated by the addition of a number to the character abbreviation. Thus, the Public Information and Participation element is designated as PIP and the first activity within this element (General Outreach) is designated as PIP-1.

The approach used in the Implementation Plan consists of providing a uniform plan, with some Program elements having a single strategy. Other elements have alternative implementation strategies, which will apply to all 15 co-permittees except as specifically noted and explained by the co-permittees in the individual work plans to be submitted as an appendix to the SWMP and the application for NPDES permit renewal. This approach is being proposed to achieve the SWMP goals of Chapter 1. The focus is placed on defining the goals to be achieved, facilitating consistent implementation, and making the SWMP a true policy and planning document rather than a detailed list of specific activities which quickly become outdated.

Tables 9-7.1 through 9-7.10 provide information on the roles and responsibilities of the Program, its subcommittees, each co-permittee and other involved parties related to performing activities with Program elements. An organization taking a lead role with respect to a task or activity is designated with an "L." A lead role is defined as actual performance of or full financial support for all or part of an activity. It is possible to have more than one lead organization per activity. A supporting role with respect to a task or activity is designated with an "S." Supporting organizations provide financial or technical assistance to lead organizations. If the Program is noted as a lead or supporting entity, all co-permittees are considered to support this activity by definition, however this support is not additionally noted. If an individual co-permittee also provides financial or technical assistance to the Program for an activity, a support role is noted. For example, the SCVWD supports the Program's watershed management activities by providing technical assistance through its Coyote Creek Watershed Planning effort.

General scheduling information is also provided in Tables 9-7.1 through 9-7.10. Estimated project completion dates (by fiscal year) are noted for new tasks. Projected implementation dates are noted for new activities. Completed tasks are denoted by the word "Done," followed by the fiscal year of completion. On-going activities or tasks are designated "OG." The status of new tasks or activities which are dependent on on-going or future analysis or studies and cannot yet be accurately scheduled are denoted "TBC," (to be considered).

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More detailed information on strategy and role selection and scheduling is included in the individual agency work plans.

PM—Program Management

PM GOALS AND OBJECTIVES

The goal of Program Management (PM) is to effectively and efficiently plan and implement the various activities of the Program elements, leading to cost effective achievement of the Program's stated goals and compliance with the NPDES permit and other regulatory requirements.

PM IMPLEMENTATION

Program Management is carried out through a combination of Program staff, provided by the Santa Clara Valley Water District, and by the Management Committee, Steering Committee, and the subcommittees. The Program Manager has overall responsibility for implementation of the area-wide activities of the Program and receives general policy direction from the Management Committee. Additional discussion of Program Management, including roles and responsibilities of co-permittees and committees, is provided in Chapter 6.

COORDINATION AND INTEGRATION WITH OTHER ACTIVITIES

Program Management embraces and is integrated with all Program elements because of the budget and regulatory compliance issues and objectives. In accordance with the Memorandum of Agreement, the Program Manager, in consultation with the Budget Subcommittee, prepares the proposed Program budget for review and approval by the Management Committee and reports at least quarterly on the status of budget execution. Program compliance issues are discussed within the NPDES Permit Subcommittee and general policy direction is provided by the Management Committee.

EFFECTIVENESS EVALUATION

Program Management is evaluated by the Management Committee through ongoing discussion and through the annual reporting process.

PM ACTIVITIES

PM-1 Program Policy, Administration, and Management

The purpose of this activity is to clarify the missions, roles, and responsibilities of the Management Committee, subcommittees, their chairs and members and to improve integration and coordination of Program policies and activities by establishing a Steering Committee.

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Task 1: Develop Management Committee/Subcommittee mission statements.
Task 2: Establish a Steering Committee to address policy, administrative, and strategic issues.
Task 3: Amend Program Bylaws to enact recommendations from the Steering Committee.

PM-2 Improve Institutional Arrangements to Meet Program Goals

The objective of this activity is to identify opportunities to improve the Program's internal (area-wide) and external (regional, state, and national) institutional arrangements in order to more effectively and efficiently meet the Program's overall goals. These activities are discussed in detail in Chapter 6. Institutional arrangements to facilitate effective watershed management are included in WMM-1.

Task 1: Increase the Program-level staffing at the District to improve effectiveness.
Task 2: Review and assess the strengths and weaknesses of the Program's MOA.
Task 3: Amend the Program's MOA if recommended in Task 2.
Task 4: Identification of new internal Program arrangements to facilitate or improve PM, WMM, MET, PAA, PIP, IND, ICID and NDC elements.
Task 5: Identification of new external arrangements to encourage or support regional, state, or national coordination and collaboration (CalTrans).
Task 6: Implement recommendations in Tasks 4 and 5.

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TABLE 9.7-1
PM Roles and Responsibilities and Schedule

Activities & Tasks	Reg Brd	BASMAA	Program	Mgmt Comm	Steering Committee	Co-P
PM-1 Program Policy, Administration, and Management						
1. Develop Management Committee/Subcommittee mission statements			S	L 94-95	S	
2. Establish a Steering Committee to address policy and administrative issues			S	L 94-95		
3. Amend Program Bylaws to enact recommendations from Task 2				L 94-95		
PM-2 Improve Institutional Arrangements to Meet Program Goals						
1. Increase Program-level staffing at the District to improve effectiveness						L SCVWD 94-95
2. Review and assess the strengths and weaknesses of the Program's MOA			S		L 94-95	S
3. Amend the Program's MOA if recommended in Task 2			S	S	S	L 95-96
4. Identification of new internal Program arrangements to facilitate or improve PM, WMM, MET, PAA, PIP, IND, ICID and NDC elements			S		L 95-96	S
5. Identification of new external arrangements to encourage or support regional, state, or national coordination and collaboration			L 95-96		S	S
6. Implement recommendations of Tasks 4 & 5.				S		L

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RPT—ANNUAL REPORTING AND EVALUATION

RPT GOALS AND OBJECTIVES

The goals and historical evolution of annual reporting are discussed in detail in Chapter 7. The principal goal of annual reporting and evaluation is to demonstrate to the Regional Board the co-permittees compliance with their NPDES permit. The secondary goal, which is of greatest value to the Program, is to: (1) annually assess the progress and effectiveness to date, (2) serve as a forum for co-permittee sharing of information and results in order to continuously improve effectiveness and efficiency, and (3) serve as a mechanism to update the Storm Water Management Plan. An important objective of the Program in this SWMP is to reduce the administrative burden of annual reporting by streamlining and simplifying the reporting requirements of routine ongoing activities.

RPT IMPLEMENTATION

There is a single implementation approach for this element which all co-permittees must follow. Program staff take the lead on providing guidance in annual reporting based upon discussion and recommendations by the Program's Subcommittees and Management Committee and in compiling, filing, and distributing the Annual Report.

INTEGRATION AND COORDINATION WITH OTHER PROGRAM ELEMENTS

The Annual Report integrates all Program elements by providing a status report and proposing changes to the Program's Storm Water Management Plan subject to review and approval by the Regional Board.

RPT EFFECTIVENESS EVALUATION

Program participants continuously evaluate both the effectiveness of the various Program elements as well as the annual reporting and evaluation process itself. An important objective stated above is to streamline and simplify the reporting requirements for routine or ongoing activities. This is proposed in order to improve Program and co-permittee efficiency and to focus on new management measures, activities, and special study results.

RPT ACTIVITIES

RPT-1 Continuously Improve Annual Reporting and Evaluation

The purpose of this ongoing activity is to continuously improve the quality, value, and efficiency of the Program's Annual Reporting and Evaluation process.

Task 1: Evaluate the recent reporting process and identify areas needing improvement.

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Task 2: Identify and develop minimum performance standards for activities which can be reported in a check list format.
Task 3: Submit proposed changes to Regional Board for review and approval.
Task 4: Develop and implement annual co-permittee performance evaluation plan.

TABLE 9.7-2
RPT Roles and Responsibilities and Schedule

Activities & Tasks	Reg Brd	BASMAA	Program	Mgmt Comm	Subcomm	Co-P
RPT-1 Continuously Improve Annual Reporting and Evaluation						
1. Evaluate the recent reporting process and identify areas needing improvement.			S	S	L OG	
2. Identify and develop minimum performance standards for activities which can be reported in a check list format.			S	S	L OG	
3. Submit proposed changes to Regional Board for review and approval.			S	L OG	S	
4. Develop and implement annual evaluation plan.			L OG	S	S	S

MON—MONITORING PROGRAM

MON GOALS AND OBJECTIVES

The overall goal of monitoring is to obtain adequate information to characterize and define problems, and in turn implement and assess the effectiveness of management measures which are designed to provide reasonable protection of resources and beneficial uses. The monitoring program's specific objectives, major findings, and plan summary are discussed in detail in Chapter 8.

MON IMPLEMENTATION

Monitoring activities are implemented at the regional, area-wide, and community-specific (co-permittee) levels. Regional monitoring of the San Francisco Bay Delta Estuary is implemented by the San Francisco Estuary Institute for the Regional Board. Regional research and monitoring is a program area identified in the San Francisco Estuary Project's June 1993 Comprehensive Conservation and Management Plan. The Program annually funds

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a proportionate share of the cost of the Regional Monitoring Plan and uses information reported by this activity to adjust control measure activities.

Area-wide monitoring activities are implemented by Program staff on behalf of all co-permittees in order to comply with the Program's NPDES permit, identify sources, and assess the effectiveness of control measures. Key objectives of Program monitoring include comparison of storm water discharges with water quality criteria, identifying sources of pollutants and toxicity, evaluating effectiveness of control measures, and providing direction to the overall Program based upon an ongoing definition and characterization of problems.

Community-specific or targeted monitoring may be implemented by co-permittees as a tool to assist in identifying special problems, illicit connections, or illegal dumping problems. At the co-permittee level, monitoring is one of many tools that may be used to assist in local activities.

INTEGRATION AND COORDINATION WITH OTHER ACTIVITIES

Monitoring activities are coordinated and integrated with many other activities of the Program. Information obtained from the Regional Monitoring Plan and the Program's monitoring activities is used to direct future Program activities and make decisions regarding problem characterization, source identification, effectiveness of control measures, and Program priorities. Thus the knowledge gained through this Program element is used as input to the overall Program direction as well as other Program elements.

MON EFFECTIVENESS EVALUATION

One of the objectives of the Program's monitoring activities is to assess effectiveness of control measures of other Program elements. The best measure of effectiveness evaluation of the monitoring program itself is an ongoing assessment of whether it is providing useful information to help direct and prioritize future Program activities. The Program's objective is to propose modifications to the monitoring plan as needed to provide information necessary to address evolving issues and questions.

MON ACTIVITIES

MON-1 Participate in the Regional Monitoring Plan

The objective of this activity is to support and participate in the Regional Monitoring Plan (RMP) in order to obtain the greatest value of resulting information at the most reasonable public cost.

Task 1: Fund the Program's appropriate share of the RMP.
Task 2: Participate in the policy and technical committees of the RMP.
Task 3: Use RMP findings to assist in setting future direction of the Program.

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MON-2 Implement and Evaluate the Program's Monitoring Plan

Five specific objectives of this activity are described in Chapter 8. Increased emphasis will be placed on integrated watershed based monitoring of water quality, sediment, soil, and biological resources.

- Task 1: Report and describe findings through the Program's annual reporting process.
- Task 2: Identify and propose changes to the Plan to improve its effectiveness.
- Task 3: Develop and implement annual control measure effectiveness evaluation plan.
- Task 4: Coordinate regionally through BASMAA in order to share information.
- Task 5: Develop and implement additional monitoring activities designed to meet the goals of the Watershed Management Measures (WMM).
- Task 6: Conduct a pilot project to evaluate the use of a watershed monitoring approach.

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TABLE 9.7-3
MON Roles and Responsibilities and Schedule

Activities & Tasks	Reg Brd	BASMAA	Program	Mgmt Comm	Subcomm	Co-P
MON-1 Participate in the Regional Monitoring Plan						
1. Fund the Program's appropriate share of the RMP.			S	L		
2. Participate in the policy and technical committees of the RMP		S	L	S		
3. Use RMP findings to assist in setting future direction of the Program	S		S	L	S	
MON-2 Implement and Evaluate the Program's Monitoring Plan						
1. Report and describe findings through the Program's annual reporting process.			L			
2. Identify and propose changes to the Plan to improve its effectiveness.			S	L		
3. Develop and implement annual control measure effectiveness evaluation plan.	S	S	L	S	S	
4. Coordinate regionally through BASMAA in order to share information.	S	L	S			
5. Develop and implement additional monitoring activities designed to meet the goals of the Watershed Management Measures (WMM).	S	S	L	S	S	S
6. Conduct a pilot project to evaluate the use of a watershed monitoring approach.			L	S		S

L (Lead Agency)
S (Support Agency)

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PAA—PUBLIC AGENCY ACTIVITIES

PAA GOALS AND OBJECTIVES

Control measures under the Public Agency Activities (PAA) element have the goal of reducing or eliminating adverse water quality impacts due to construction, operations, and maintenance actions by municipalities of the Program. Successful implementation of PAA activities is particularly important since agencies in the Program should serve as good examples to the community.

PAA IMPLEMENTATION

With the exception of effectiveness evaluation development or special studies, the PAA element is implemented at the agency-specific level; there are no Program-wide or regional level implementation activities. Related elements such as PIP and New Development and Construction may consist of Program level activities in response to PAA needs or outputs. There is a single implementation strategy for this element which all co-permittees must follow, if the specific activity or issue area is applicable. Detailed information regarding implementation of these activities is included in the individual co-permittee work plans.

INTEGRATION AND COORDINATION WITH OTHER PROGRAM ELEMENTS

Public Agency Activities should be closely coordinated with the PIP element (with municipal employees as the target audience) and with the NDC element. Municipal staff education and training needs should be outputs of the PAA element which serve as inputs to the PIP element. Those municipal activities such as planning, design, and construction of public agency projects should be closely coordinated and integrated with the NDC element to assure implementation of public projects is consistent with those of the private sector.

PAA EFFECTIVENESS EVALUATION

Intrinsic to implementation of PAA element activities is an iterative process of effectiveness evaluation leading to BMP refinement. This process includes six components:

1. Inventory public agency operations and maintenance (O&M) activities
2. Assess and prioritize the pollution potential of O & M activities
3. Evaluate potential BMPs
4. Select and implement BMPs
5. Evaluate the effectiveness of the BMPs selected and report results
6. Refine/revise BMP implementation

Eventually, as PAA BMPs are selected and refined, co-permittees will concentrate on steps 5 and 6.

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Mechanisms to determine and track effectiveness of the PAA activities will be developed and implemented, where feasible, as part of this element.

PAA ACTIVITIES

The following is an outline of PAA activities and tasks.

PAA-1 Municipal Corporation Yards

Task 1: Prepare Storm Water Pollution Prevention Plans (SWPPPs).
Task 2: Implement SWPPPs.

PAA-2 Parks and Recreation

Task 1: BMPs for storage and application of fertilizers and pesticides.
Task 2: Implement equipment wash water BMPs.
Task 3: Implement maintenance activities BMPs.
Task 4: Implement swimming pool BMPs.

PAA-3 Storm Drain System Operation & Maintenance

Task 1: Perform inlet maintenance.
Task 2: Perform line maintenance.
Task 3: Perform solid waste management.
Task 4: Perform debris basin maintenance.
Task 5: Research and incorporate structural retrofits.

PAA-4 Streets and Roads

Task 1: Perform street sweeping/cleaning.
Task 2. Implement practices to improve street sweeping effectiveness.
Task 3: Implement pavement washing BMP (sidewalks, plazas, parking lots, etc.).
Task 4: Implement saw cut slurry management BMPs.
Task 5: Implement paving BMPs.
Task 6: Inventory median irrigation and pesticide use practices and implement appropriate BMPs.

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PAA-5 Flood Control

Task 1: Coordinate project planning with NDC element activities.
Task 2: Conduct an inventory of all key operations and maintenance activities.
Task 3: Evaluate and implement opportunities to reduce the use of pesticides.
Task 4: Evaluate and implement opportunities for sediment management.
Task 5: Evaluate and implement opportunities for vegetation protection and restoration.
Task 6: Evaluate and implement opportunities for improved fisheries management.

PAA-6 Water Utility Operations

Task 1: Coordinate project planning with NDC element activities.
Task 2: Conduct an inventory of all key operations and maintenance activities.
Task 3: Identify all routine & unplanned non-stormwater discharges.
Task 4: Identify discharges to receiving waters of all chemical additives.
Task 5: Develop management plan to reduce/eliminate discharges of concern.
Task 6: Implement the discharge management plan.
Task 7: Evaluate impacts of ongoing O&M activities from Task 2.
Task 8: Develop a plan to reduce/eliminate O&M impacts of concern.
Task 9: Implement the O&M impacts management plan.

PAA-7 Public Facilities

Task 1: Implement parking lot BMPs.
Task 2: Implement BMPs to reduce pollutant loading from golf courses.
Task 3: Implement BMPs to reduce pollutant loading from hospital sites.
Task 4: Implement BMPs to reduce pollutant loading from public buildings, plazas, landscaping, etc.

PAA-8 Ponds, Fountains, & other Public Water Bodies

Task 1: Implement BMPs to control algae.
Task 2: Implement BMPs to control chlorine/pollutant discharges.

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TABL
PAA Roles, Respon
(Public Age

Activities & Tasks	Reg Brd	BASMAA	Program	Subcomm	Cbl	Cpt	LA	
PAA-1 Municipal Corporation Yards								
1. Prepare Storm Water Pollution Prevention Plans (SWPPPs)				S-Maint	L 95-96	L Done (94-95)	L Done (94-95)	9
2. Implement SWPPPs					L 95-96	L 95-96	L 95-96	9
PAA-2 Parks and Recreation								
1. Implement BMPs for storage and application of fertilizers and pesticides					L OG	L OG	L OG	
2. Implement equipment wash water BMPs					L 95-96	L OG	L OG	
3. Implement maintenance activities BMPs					L OG	L 95-96	L OG	
4. Implement swimming pools BMPs					L OG	L OG	L OG	
PAA-3 Storm Drain System Operation & Maintenance								
1. Perform inlet maintenance					L OG	L OG	L OG	(
2. Perform line maintenance					L OG	L OG	L OG	(
3. Perform solid waste management					--	L OG	L OG	(
4. Perform debris basin management					--	--	--	
5. Research and incorporate structural retrofit opportunities			S	S-Maint	L TBC	L TBC	L TBC	T

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L = Lead Agency, S = Support Agency, OG = Ongoing, FY = Fiscal Year, "--" = Not Applicable, TBC = To Be Considered

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TABLE 9.7-4
, Responsibilities, and Schedule
ıblic Agency Activities)

	LAH	LG	Mlp	MS	MV	PA	SJ	SC	SCC	Stga	SV	SCVWD
ıe)5)	L 95-96	L 95-96	L Done (94-95)	–	L 95-96	L 94-95	L 94-95	L 94-95	L 95-96	L 95-96	L 94-95	L 94-95
)6	L 96-97	L 95-96	L 95-96	–	L 96-97	L OG	L 96-97	L 95-96	L 96-97	L 95-96	L 95-96	L 95-96
	–	L OG	L OG	–	L OG	L OG	L OG	L OG	L OG	L OG	L OG	–
–	–	L OG	L OG	–	L OG	L OG	L 96-97	L OG	L OG	L OG	L OG	–
	–	L OG	L OG	–	L OG	L OG	L OG	L OG	L OG	L OG	L OG	–
	–	–	L OG	–	L OG	L 95-96	L OG	L OG	L OG	–	L OG	–
	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L 95-96	L OG	–
	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L 95-96	L OG	–
	L OG	–	L OG	–	L OG	L OG	L OG	L OG	L OG	L OG	L OG	–
	–	–	–	–	–	–	L OG	–	–	–	–	–
	L TBC	L TBC	L TBC	L TBC	L TBC	L TBC	L TBC	L TBC	L TBC	L TBC	L OG	–

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TABLE
PAA Roles, Responsi
(Public Agenc
(contir

Activities & Tasks	Reg Brd	BASMAA	Program	Subcomm	Cbl	Cpt	LA	LA
PAA-4 Streets and Roads								
1. Perform street sweeping/cleaning					L OG	L OG	L OG	L 96-9
2. Implement practices to improve street sweeping effectiveness			S	S-Maint	L TBC	L TBC	L TBC	–
3. Implement pavement washing BMPs (sidewalks, plazas, parking lots, etc.)				S-Maint	L OG	L 95-96	L OG	–
4. Implement saw cut slurry BMPs				S-Maint	L OG	L OG	L OG	–
5. Implement paving BMPs					L OG	L OG	L OG	L OG
6. Implement median irrigation and pesticide use BMPs					L OG	L 95-96	L OG	–
PAA-5 Flood Control								
1. Coordinate project planning with activities in NDC element				S-Maint, New Dev	–	–	–	–
2. Conduct an inventory of all key operations and maintenance activities					–	–	–	–
3. Evaluate & implement opportunities to reduce the use of pesticides					–	–	–	–
4. Evaluate & implement opportunities for sediment management					–	–	–	–
5. Evaluate & implement opportunities for vegetation protection & restoration					–	–	–	–

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= Lead Agency, S = Support Agency, OG = Ongoing, FY = Fiscal Year, "--" = Not Applicable, TBC = To Be Considered

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TABLE 9.7-4
sponsibilities, and Schedule
: Agency Activities)
(continued)

LAH	LG	Mlp	MS	MV	PA	SJ	SC	SCC	Stga	SV	SCVWD
L 96-97	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	–
–	L TBC	L OG	L TBC	L TBC	L TBC	L OG	L TBC	L TBC	L TBC	L TBC	–
–	L OG	L OG	–	L OG	L OG	L 95-96	L OG	L OG	L OG	L OG	–
–	L OG	L 95-96	–	L OG	L OG	L 95-96	L 95-96	L OG	L OG	L TBC	–
L	L OG	L OG	–	L OG	L OG	L 95-96	L OG	OG	L OG	L OG	–
	L OG	L OG	–	L OG	L 95-96	L OG	L OG	OG	L OG	L OG	–
–	–	–	–	–	–	L 95-96	L OG	–	–	–	L OG
–	–	–	–	–	–	–	L OG	–	–	NA	L 95-96
–	–	–	–	–	–	–	L OG	–	–	–	L OG
–	–	–	–	–	–	–	L OG	–	–	L TBC	L OG
–	–	–	–	–	–	–	L OG	–	–	–	L OG

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TABLE
PAA Roles, Responsi
(Public Agenc
(conti

Activities & Tasks	Reg Brd	BASMAA	Program	Subcomm	Cbl	Cpt	LA	LA
6. Evaluate & implement opportunities for improved fisheries management					–	–	–	–
PAA-6 Water Utility Operations								
1. Coordinate project planning with activities in NDC element					–	L TBC	–	–
2. Inventory all key operations and maintenance activities					–	L 96-97	–	–
3. Identify all routine & unplanned non-stormwater discharges					–	L 96-97	–	–
4. Identify discharges to receiving waters of all chemical additives					–	L 96-97	–	–
5. Develop management plan to reduce/eliminate discharges of concern					–	L 97-98	–	–
6. Implement the discharge management plan					–	L 97-98	–	–
7. Evaluate impacts of ongoing O&M activities from Task 2					–	L 97-98	–	–
8. Develop a plan to reduce/eliminate O&M impacts of concern					–	L 97-98	–	–
9. Implement the O&M impacts management plan					–	L 97-98	–	–

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= Lead Agency, S = Support Agency, OG = Ongoing, FY = Fiscal Year, "–" = Not Applicable, TBC = To Be Considered

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TABLE 9.7-4
esponsibilities, and Schedule
c Agency Activities)
(continued)

LAH	LG	Mlp	MS	MV	PA	SJ	SC	SCC	Stga	SV	SCVWD
–	–	–	–	–	–	–	–	–	–	–	L OG
–	–	L OG	–	L OG	L OG	L OG	L OG	–	–	L OG	L OG
–	–	L 95-96	–	L 94-95	L Done (93-94)	L 95-96	L 95-96	–	–	L Done (90-91)	L 95-96
–	–	L 95-96	–	L Done (94-95)	L Done (93-94)	L 95-96	L 95-96	–	–	L Done (90-91)	L Done (94-95)
	–	L 96-97	–	L Done (94-95)	L Done (94-95)	L 95-96	L 95-96	–	–	–	L Done (94-95)
–	–	L 96-97	–	–	L Done (94-95)	L 95-96	L 95-96	–	–	NA	L 95-96
–	--	L 96-97	–	–	L 94-95	L 95-96	L 96-97	–	–	NA	L 96-97
–	--	L 96-97	–	L OG	L Done (93-94)	L 95-96	L 95-96	--	–	L Done (90-91)	L 96-97
–	--	L 96-97	–	–	L Done (93-94)	L 95-96	L 95-96	--	–	L Done (94-95)	L 97-98
–	–	L 96-97	–	–	L OG	L 95-96	L 96-97	--	--	L OG	L 98-99

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TABLE
PAA Roles, Responsib
(Public Agenc
(contir

Activities & Tasks	Reg Brd	BASMAA	Program	Subcomm	Cbl	Cpt	LA	LA
PAA-7 Public Facilities								
1. Implement parking lot BMPs					TBC	L OG	L OG	L OG
2. Manage golf course discharges					--	L 95-96	--	--
3. Manage hospital site discharges					--	--	--	--
4. Manage discharges from other public buildings, plazas, landscaping, etc.					L TBC	L OG	L OG	L OG
PAA-8 Ponds, Fountains, & Other Public Water Bodies								
1. Implement BMPs to control algae					--	L OG	--	--
2. Implement BMPs to control chlorine/pollutant discharges					--	L OG	OG	--

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L = Lead Agency, S = Support Agency, OG = Ongoing, FY = Fiscal Year, "--" = Not Applicable, TBC = To Be Considered

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TABLE 9.7-4
esponsibilities, and Schedule
c Agency Activities)
(continued)

LAH	LG	Mlp	MS	MV	PA	SJ	SC	SCC	Stga	SV	SCVWD
L OG	L TBC	L OG	L TBC	L OG	L TBC	L OG	L OG	L OG	L TBC	L OG	L 95-96
–	–	–	–	–	L 95-96	L 95-96	L OG	L OG	–	L OG	–
–	–	–	–	–	–	–	–	OG	–	–	–
L OG	L TBC	L OG	L TBC	L OG	L OG	L OG	L OG	L OG	L TBC	L OG	L 95-96
–	L OG	L OG	–	L OG	–	L OG	L OG	L OG	L OG	L OG	–
	L OG	L OG	–	L OG	–	L OG	L OG	L OG	L OG	L OG	–

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PIP- PUBLIC INFORMATION AND PARTICIPATION

PIP GOALS AND OBJECTIVES

Public Information and Participation (PIP) has the dual goals of (1) changing specific behaviors that adversely impact the water quality of streams and the Bay and (2) increasing the understanding and appreciation of streams and the Bay. The second PIP goal may eventually lead to a change in values by individuals and society as a whole. These two PIP goals can be achieved through the implementation of the following PIP programmatic activities: (1) general outreach, (2) targeted outreach, (3) educational programs, and (4) citizen participation.

PIP IMPLEMENTATION

PIP activities are implemented at the regional, Program-wide, and community-specific (co-permittee) levels. Regional activities and tasks are implemented in cooperation with or through the Bay Area Stormwater Management Agencies Association (BASMAA). Program-wide activities are implemented uniformly throughout the Santa Clara Valley by the Program staff or contractors. Community-specific activities are implemented by each co-permittee and are reflective of the characteristics of the co-permittee's jurisdiction.

There are three implementation strategies presented for the PIP Targeted Outreach activity in order to accommodate the variation in co-permittee characteristics. All co-permittees must select one of the Targeted Outreach strategies. Each co-permittee must provide an explanation of the qualifying conditions or criteria on which their strategy selection is based in their individual work plans.

Each of the PIP Targeted Outreach activities defines a list of required tasks and the bases and standards for evaluation. All co-permittees must provide an explanation for any of the tasks within applicable activities that are proposed to be eliminated or modified, and the co-permittees must also prepare a time schedule indicating the target completion date for each activity. Detailed information on the progress and success of each individual task within a PIP activity will be reported by each co-permittee in their detailed work plans and/or the Program's Annual Report. Regional and Program level activities will be reported by the Program.

COORDINATION AND INTEGRATION WITH OTHER ACTIVITIES

Because some PIP goals and objectives are directly related to and driven by other Program elements, many specific needs and tasks will be identified within those other Program elements. The PIP Targeted Outreach needs will be defined through other Program elements, such as the IND, ICID or PAA elements. Specific products, outreach strategies, distribution methods, and evaluation techniques will be defined to meet those identified needs and developed at the Program level in close cooperation with the PIP Subcommittee and

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members of the originating Subcommittee(s). Upon completion of products or materials, actual implementation may be at the co-permittee level, Program-wide, or regional depending on the outreach strategy. Other PIP activities, such as General Outreach and Education, will be implemented at the Program and regional levels and will be considered a voluntary activity for co-permittees' community specific actions.

PIP EFFECTIVENESS EVALUATION

Perhaps one of the most difficult aspects of the PIP element is assessing its effectiveness. The Program's strategy to determine effectiveness will be to evaluate specific PIP activities which are most suitable for evaluation, rather than to attempt to evaluate PIP as a whole. To the extent feasible, effectiveness measures will be defined at the time of initial product development and outreach strategy definition. The focus will be on measuring actual behavior and attitude changes rather than measuring the quantity of the outreach messages or materials.

PIP-1 Develop a Program PIP Strategy and Plan for the Years 1995-2000

This activity will be conducted by the Program in close cooperation with the PIP Subcommittee, co-permittees, and BASMAA. Target completion date is July 1, 1995. The objectives of the PIP strategy are to clearly state PIP goals based upon and consistent with overall Program goals and objectives, distinguish and coordinate activities to be implemented at the regional versus Program-wide and co-permittee level, develop and implement a PIP effectiveness assessment strategy, establish well-defined criteria for PIP priorities, establish criteria which define the best level of PIP outreach method (region, Program, or local), coordinate and integrate PIP with all other Program elements, identify marketing or market research needs, and develop sound evaluation techniques.

Task 1: Develop/Refine Program-wide PIP goals and objectives.
Task 2: Determine and prioritize Targeted Outreach needs based on PIP goals.
Task 3: Develop a three level outreach strategy: regional, Program ,city.
Task 4: Develop PIP coordination and support plan.
Task 5: Define near term tasks within PIP activities and budget estimates.
Task 6: Develop a standard process for product development, outreach strategy, and effectiveness measurement.

PIP-2 General Outreach

This activity will be conducted at the regional and Program levels. Co-permittees may add general outreach to their community-specific activities on a voluntary basis. The objective of this activity is to increase the general public awareness and appreciation of water quality issues in streams and the Bay and the importance of protecting beneficial uses. Other goals include establishing consistency with the Public Involvement and Education objectives of the San Francisco Estuary Project.

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Task 1: Distribute existing materials.
Task 2: Participate in a BASMAA regional advertising campaign.
Task 3: Develop and distribute general information written materials.
Task 4: Develop and broadcast general information audio materials.
Task 5: Develop and broadcast general information video materials.
Task 6: Develop material and an outreach strategy to support the WMM element.

PIP-3 Targeted Outreach

This activity will be conducted primarily at the Co-permittee level, but will also be conducted at the Program and regional levels, as appropriate, based upon overall Program and PIP goals and outreach strategies. The objective of this activity is to change those specific behaviors which are known to adversely impact water quality in streams and the Bay or impact beneficial uses. This activity consists of three Co-permittee level implementation strategies. All co-permittees must select one of the strategies and provide an explanation of the qualifying conditions in their work plans and/or the Annual Report.

STRATEGY 1

Qualifying Conditions:

Primarily residential communities-limited commercial activity.

Activities/Tasks:

Task 1: Develop outreach materials for residential education.
Task 2: Implement residential outreach.
Task 3: Implement commercial outreach, as determined by PAA, IND and ICID element activities.
Task 4: Implement outreach to the development community, as determined by NDC element activities.
Task 5: Educate/train public employees.
Task 6: Modify outreach and educational efforts as new materials/information become available.

Reporting and Evaluation Criteria:

Written outreach strategy and distribution plans. Annual summary of products developed/distributed and training activities. Annual revision of outreach plans. Evaluation of response to identified needs by appropriate co-permittee departments or subcommittee.

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STRATEGY 2

Qualifying Conditions:

Moderate amount of commercial areas and some light industrial development in the form of modern industrial parks.

Activities/Tasks:

Task 1: Develop outreach materials for residential education.
Task 2: Implement residential outreach.
Task 3: Implement commercial/light industrial outreach, as determined by PAA, IND, ICID and MET element activities.
Task 4: Implement outreach to the development community, as determined by NDC element activities.
Task 5: Educate/train public employees.
Task 6: Modify outreach and educational efforts as new materials/information become available.

Reporting and Evaluation Criteria:

Written outreach strategy and distribution plans. Annual summary of products developed/distributed and training activities. Annual revision of outreach plans. Evaluation of response to identified needs by appropriate co-permittee department or subcommittee. Analysis of trends in observed pollution problems.

STRATEGY 3

Qualifying Conditions:

Older business districts and/or some relatively heavy industrial areas.

Activities/Tasks:

Task 1: Develop outreach materials for residential education.
Task 2: Implement residential outreach.
Task 3: Implement outreach commercial/industrial outreach, as determined by PAA, IND, ICID and MET element activities.
Task 4: Implement outreach to facilities regulated by the State NPDES General Industrial permit.

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Task 5: Implement outreach to the development community, as determined by NDC element activities.
Task 6: Incorporate and coordinate educational outreach into ongoing inspection activities.
Task 7: Develop and implement outreach to meet goals of the WMM element.
Task 8: Educate/train public employees.
Task 9: Modify outreach and educational efforts as new materials/information become available.

Reporting and Evaluation Criteria:

Written outreach strategy and distribution plans. Annual summary of products developed/distributed and training activities. Annual revision of outreach plans. Evaluation of response to identified needs by appropriate co-permittee department or subcommittee. Analysis of trends in observed pollution problems. Analysis of inspections and use of educational materials by facilities to comply with nonpoint source reductions.

PIP-4 Education Programs

This activity will be conducted primarily at the Program level. It will be implemented at the co-permittee level as a voluntary measure. The objective of this activity is to change peoples' values through education and understanding of the importance of water quality and beneficial uses in streams and the Bay. Because values change very slowly and over the long term, it is important to incorporate the needed education into the curriculum at various points (e.g. K-12, college, post educational). Educational programs directed at public employees or other specifically targeted groups will be implemented through the PIP Targeted Outreach activity and closely coordinated with the appropriate Program element and subcommittee.

Task 1: Develop and implement school education programs.
Task 2: Develop and implement general public programs.

PIP-5 Citizen Participation

This activity will be conducted primarily at the co-permittee level since individual co-permittees are best suited to enlist and engage their local citizens and organized citizen groups. Some tasks within this activity, such as Streamkeepers Pilot Implementation and Watershed Monitoring Strategy development, will be conducted at the Program level. The objective of this activity builds upon the objectives of (1) general outreach, (2) targeted outreach, and (3) education programs, in that it seeks to inform and engage citizens through direct participation and in such a way as to (1) increase their awareness and appreciation of the functions and values of streams and the Bay, (2) modify behaviors which they may have exhibited which adversely affected water quality or compromised beneficial uses,

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(3) influence a positive change in their values toward a deeper appreciation of streams and the Bay, and (4) motivate them to become participants of a community creek watch.

Task 1: Complete Pilot Streamkeepers Program.
Task 2: Support Citizen Monitoring through implementation of Streamkeepers.
Task 3: Coordinate with Streamkeepers to respond to citizen reports of pollution problems.
Task 4: Identify other opportunities for citizen participation.

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TABL
PIP Roles, Respons
(Public Informatio

Activities & Tasks	Reg Brd	BASMAA	Program	Subcomm	Cbl	Cpt	LA
PIP-1 Develop a Program PIP Strategy and Plan for the Years 1995-2000							
1. Develop/refine Program-wide PIP goals and objectives			S	L Done (94-95)	–	–	–
2. Determine and prioritize Targeted Outreach needs based on PIP goals			S	L-PI/P 95-96	–	–	–
3. Develop a three-level outreach strategy: regional, program, city		S	S	L-PI/P OG	–	–	–
4. Develop PIP coordination and support plan			S	L-PI/P OG S-Other sub.	–	–	–
5. Define near-term tasks within PIP activities and budget estimates			S	L-PI/P OG	–	–	–
6. Develop standard process for product development, outreach strategy and effectiveness measurement				L-PI/P	–	–	–
PIP-2 General Outreach							
1. Distribute existing materials			L OG	S-PI/P	L OG	L OG	L OG
2. Participate in a BASMAA regional advertising campaign		L OG	S		–	–	–
3. Develop and distribute general information written materials		L development OG	L distrib. OG	L-PI/P development OG	L OG	L OG	L distrib. OG
4. Develop and broadcast general information audio materials		L development OG	S	S-PI/P	–	–	–

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= Lead Agency, S = Support Agency, OG = Ongoing, FY = Fiscal Year, "–" = Not Applicable, TBC = To Be Considered

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TABLE 9.7-5
esponsibilities, and Schedule
rmation and Participation)

LA	LAH	LG	Mlp	MS	MV	PA	SJ	SC	SCC	Stga	SV	SCV WD
–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–
L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG
–	–	–	–	–	–	–	–	–	–	–	–	–
L listrib. OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG
–	–	–	–	–	–	S TBC	–	–	–	–	L OG	–

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TABLE 9.7-5
Responsibilities, and Schedule
ormation and Participation)

LA	LAH	LG	Mlp	MS	MV	PA	SJ	SC	SCC	Stga	SV	SCV WD
–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–
—	–	–	–	–	–	–	–	–	–	–	–	–
—	–	–	–	–	–	–	–	–	–	–	–	–
L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG
–	–	–	–	–	–	–	–	–	–	–	–	–
L distrib. OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG
–	–	–	–	–	–	S TBC	–	–	–	–	L OG	–

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TABL
PIP Roles, Responsi
(Public Informatio
(conti

Activities & Tasks	Reg Brd	BASMAA	Program	Subcomm	Cbl	Cpt	LA
5. Develop and broadcast general information video materials		L development OG	S	S-PI/P	–	L OG	L OG
6. Develop material and outreach strategy to support WMM element			L	L-PI/P	–	–	–
PIP-3 Targeted Outreach, Strategy 1							
1. Develop outreach materials for residential education				L-PI/P OG	L OG	–	L OG
2. Implement residential outreach				S-PI/P	L OG	–	L OG
3. Implement commercial outreach, as determined by PAA, IND and ICID element activities				S-PI/P,Maint, Ind/Comm	L OG	–	L OG
4. Implement outreach to the development community, as determined by NDC element activities				S-PI/P, New Dev	L OG	–	L OG
5. Educate/train public employees			S	S-PI/P	L OG	–	L OG
6. Modify outreach and educational efforts as new materials/ information become available				S-All OG	L OG	–	L OG
PIP-3 Targeted Outreach, Strategy 2							
1. Develop outreach materials for residential education				L-PI/P OG	–	L OG	–
2. Implement residential outreach				S-PI/P	–	L OG	–

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Lead Agency, S = Support Agency, OG = Ongoing, FY = Fiscal Year, "–" = Not Applicable, TBC = To Be Considered

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TABLE 9.7-5
esponsibilities, and Schedule
rmation and Participation)
(continued)

LA	LAII	LG	Mlp	MS	MV	PA	SJ	SC	SCC	Stga	SV	SCV WD
L OG	–	L OG	L OG	–	L OG	L OG	–	L OG	–	L OG	L OG	–
–	–	–	–	–	–	–	–	–	–	–	–	S
L OG	–	L OG	–	L OG	–	–	–	–	OG	L OG	–	–
L OG	–	L OG	–	L OG	–	–	–	–	OG	L OG	–	–
L O –	–	L OG	–	OG (PAA only)	–	–	–	–	OG	L OG	–	–
L OG	L OG	L OG	–	L OG	–	–	–	–	OG	L OG	–	–
L OG	L OG	L OG	–	L OG	–	–	–	–	OG	L OG	–	–
L OG	L OG	L OG	–	L OG	–	–	–	–	OG	L OG	–	–
–	–	–	–	–	–	L OG	–	–	–	L OG	–	–
–	–	–	–	–	–	L OG	–	–	–	L OG	–	–

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TABLE
PIP Roles, Responsibi
(Public Information
(contin

Activities & Tasks	Reg Brd	BASMAA	Program	Subcomm	Cbl	Cpt	LA
3. Implement commercial/light industrial outreach, as determined by PAA, IND, ICID, and MET element activities				S-PI/P,Maint, Ind/Comm	–	L OG	–
4. Implement outreach to the development community, as determined by NDC element activities				S-PI/P, New Dev	–	L OG	–
5. Educate/train public employees			S	S-PI/P	–	L OG	–
6. Modify outreach and educational efforts as new material/ information becomes available				S-All OG	–	L OG	–
PIP-3 Targeted Outreach, Strategy 3							
1. Develop outreach materials for residential education				L-PI/P OG	–	–	–
2. Implement residential outreach				S-PI/P	–	–	–
3. Implement commercial/industrial outreach, as determined by PAA, IND, ICID, and MET element activities				S-PI/P, Maint, Ind/Comm	–	–	–
4. Implement outreach to facilities regulated by the State NPDES General Industrial permit				S-PI/P, Ind/Comm	–	–	–
5. Implement outreach to the development community, as determined by NDC element activities				S-PI/P, New Dev	–	–	–

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= Lead Agency, S = Support Agency, OG = Ongoing, FY = Fiscal Year, "–" = Not Applicable, TBC = To Be Considered

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TABLE 9.7-5
sponsibilities, and Schedule
mation and Participation)
(continued)

LA	LAH	LG	Mlp	MS	MV	PA	SJ	SC	SCC	Stga	SV	SCV WD
–	–	–	–	–	–	L OG	–	–	–	–	–	–
–	–	–	–	–	–	L OG	–	–	–	–	–	–
–	–	–	–	–	–	L OG	–	–	–	–	–	–
–	–	–	–	–	–	L OG	–	–	–	–	–	–
–	–	–	L OG	–	L OG	–	L OG	L OG	–	–	L OG	–
–	–	–	L OG	–	L OG	–	L OG	L OG	–	–	L OG	–
–	–	–	L TBC	–	L OG	–	L OG	L TBC	–	–	L OG	–
–	–	–	L 94-95	–	L 94-95	–	L 95-96	L 95-96	–	–	L OG	–
–	–	–	L OG	–	L OG	–	L 95-96	L OG	–	–	L OG	–

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TABL
PIP Roles, Responsi
(Public Informatio
(conti

Activities & Tasks	Reg Brd	BASMAA	Program	Subcomm	Cbl	Cpt	LA
6. Incorporate educational outreach into ongoing inspection activities					–	–	–
7. Implement outreach to meet goals of WMM element			L	L-PI/P	–	–	–
8. Educate/train public employees			S	S-PI/P	–	–	–
9. Modify outreach and educational efforts as new material/ information becomes available				S-All OG	–	–	–
PIP-4 Education Programs							
1. Develop and implement school education programs				L-PI/P 96-97	L TBC	L OG	L OG
2. Develop and implement general public programs			L OG	L-PI/P OG	L TBC	L OG	–
PIP-5 Citizen Participation							
1. Complete pilot Streamkeepers Program			L Done (94-95)		–	–	–
2. Support citizen monitoring through implementation of Streamkeepers			L OG		–	–	–
3. Coordinate with Streamkeepers to respond to citizen reports of pollution problems			L OG		S TBC	–	–
4. Identify other opportunities for citizen participation				L-PI/P OG	TBC		L OG

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L = Lead Agency, S = Support Agency, OG = Ongoing, FY = Fiscal Year, "--" = Not Applicable, TBC = To Be Considered

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TABLE 9.7-5
esponsibilities, and Schedule
rmatioa and Participation)
(continued)

LA	LAH	LG	Mlp	MS	MV	PA	SJ	SC	SCC	Stga	SV	SCV WD
–	–	–	L OG	–	L OG	–	L OG	L OG	–	–	L OG	–
–	–	–	–	–	–	–	S	S	–	–	S	–
–	–	–	L OG	–	L OG	–	L OG	L OG	–	–	L OG	–
–	–	–	L OG	–	L OG	–	L 95-96	L OG	–	–	L OG	–
L G	–	L TBC	L OG	TBC	L OG	L OG	L 95-96	–	–	TBC	L OG	L OG
	–	L TBC	L OG	TBC	L OG	L OG	L OG	L OG	95-96	TBC	L OG	L OG
–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	OG	–	–	S OG	S	–	–	–	–	L OG
–	–	S TBC	L OG	S TBC	L OG	L OG	L OG	–	–	S TBC	–	L OG
L OG	–	TBC	L OG	TBC	L OG	L OG				L OG	L OG	

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MET—METALS CONTROL MEASURES

MET GOALS AND OBJECTIVES

The goal of the Program's Metals Control Measures (MET) is to reduce metals concentrations in Santa Clara Valley streams and loads to the South Bay for those metals which have been found to be regularly present in detectable quantities in storm water and are of environmental concern. A process for assigning priority to metals reduction is provided in Chapter 4. Priority is given to reducing copper loads in order to implement the March 1994 Copper Reduction MOU, meet the requirements of the December 1993 Cease and Desist Order, and attain the goals of the CCMP mass emissions strategy.

MET IMPLEMENTATION

This Program element is implemented at the Program level in terms of coordinating, tracking and reporting the progress, and at the co-permittee level in terms of implementing specific control measure activities. Control measures for metals reduction generally fall into other Program elements and take a watershed approach to implementation. Emphasis will be given to those metals for which a waste load allocation is pending or has been adopted (e.g., copper), and those metals known to be of urban origin and present in storm water (copper, cadmium, lead).

COORDINATION AND INTEGRATION WITH OTHER ACTIVITIES

Metals control measure activities fall into other Program elements but are grouped together in this element for purposes of regulatory compliance, quantification of load reduction, annual reporting, accountability, and logical organization of a group of targeted control measures. Each control measure action within a particular task will be cross referenced to the Program element and activity in which it is located as part of the annual reporting process.

MET EFFECTIVENESS EVALUATION

The regulatory mandates for the heavy metals, and copper in particular, are such that source identification and quantification of control measure effectiveness is probably the most advanced of any activities of the Program. Effectiveness is measured through special studies, pilot projects, and ongoing evaluation and reporting.

MET ACTIVITIES

MET-1 Copper Load Reduction

The principal purpose of this activity is to meet the commitments of the March 1994 Copper Reduction MOU and the regulatory requirements in Provision B of the December 1993 Cease

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and Desist Order. Other objectives include consolidation of the efforts contained in other Program elements into a single area in the annual reporting process.

Task 1: Estimate and assign Caltrans metal load reduction responsibilities.
Task 2: Define and implement short term copper reduction measures and quantify their credits.
Task 3: Develop implementation plan for long term copper reduction measures and strategies per MOU.
Task 4: Quantification & evaluation per MOU through annual reporting process.
Task 5: Report on effectiveness of various pilot projects.
Task 6: Assess progress and potential need for additional measures.

MET-2 Other Heavy Metals Reduction

The purpose of this activity is to meet the requirements of Provision A in the December 1993 Cease and Desist Order which requires identification and implementation of control measures for heavy metals. Chapter 4 contains a method for determining the priorities of heavy metals reduction.

Task 1: Determine reductions of other metals associated with copper control measures.
Task 2: Develop and implement control measures for priority metals.
Task 3: Quantify reduction estimates.

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TABL
MET Roles, Responsibilities
(Metals Co

Activities & Tasks	Reg Brd	BASMAA	Program	Subcomm	Cbl	Cpt	LA
MET-1 Copper Load Reduction							
1. Estimate and assign Caltrans metals load reduction responsibilities	S		L 95-96	S Copper Reduction Task Force	–		
2. Define and implement short-term copper reduction measures and quantify their credits	S		L	L Copper Reduction Task Force	–		
3. Develop an implementation plan for long-term copper reduction measures and strategies per MOU	S		L	S	–		
4. Quantification and evaluation per MOU through annual reporting process			L	S	S TBC	S TBC	S TBC
5. Report on effectiveness of various pilot projects			L 96-97		–		
6. Assess progress and potential need for additional measures	S		L 96-97		–		
MET-2 Other Heavy Metals Reduction							
1. Determine reductions of other metals associated with copper control measures	S		L	S Copper Reduction Task Froce	–		
2. Develop and implement control measures for priority metals	S		L	S	L TBC	L TBC	L TBC
3. Quantify reduction estimates	S		L	S	–		

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L = Lead Agency, S = Support Agency, OG = Ongoing, FY = Fiscal Year, "–" = Not Applicable, TBC = To Be Considered

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TABLE 9.7-6
ibilities, and Implementation Schedule
als Control Measures)

LA	LAH	LG	Mlp	MS	MV	PA	SJ	SC	SCC	Stga	SV	SCV WD
		–	–	–						–		
		–	–	–						–		
		–	–	–						–		
S T'	S TBC	S TBC	S TBC	S TBC	S TBC	S TBC	S TBC	S TBC	S TBC	S TBC	S TBC	S TBC
		–		–		S	S			–	S	
		–		–						–		
		–	–	–						–		
L TBC	L TBC	L TBC	–	L TBC	–	L TBC	L TBC	L TBC	L TBC	L TBC	L TBC	L TBC
		–	–	–						–		

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WMM—WATERSHED MANAGEMENT MEASURES

WMM GOALS AND OBJECTIVES

In the broadest sense, the principal goal of watershed management is to protect the beneficial uses of Santa Clara Valley streams and the South Bay. The key SWMP purpose is to facilitate this goal. Secondary goals include protecting surface and groundwater drinking water supplies, increasing community awareness and appreciation of the importance of watersheds and water resources, and engaging the community in watershed protection. This element also meets the requirements of Provision D of the December 1993 Cease and Desist Order, the watershed planning and classification measures of the March 1994 Copper Reduction MOU, and the spirit of the San Francisco Estuary Project CCMP and the Coastal Zone Act and Reauthorization Amendments. Watershed Management recognizes the watershed specific goals, values, problems, and solutions.

WMM IMPLEMENTATION

This Program element is coordinated and managed at the Program level but specific activities are implemented at the co-permittee level. A phased approach to implementation is proposed. Certain activities such as the development of watershed monitoring goals and protocols are proposed to be implemented at the regional level through BASMAA and with assistance from the San Francisco Estuary Institute. Other activities such as the development of a pilot watershed management Plan will be initiated by the Program with SCVWD as the lead agency, and expanded to a Program-wide effort as it matures. Cities and the county play the key role in land use planning and implementation of New Development control measures.

INTEGRATION AND COORDINATION WITH OTHER PROGRAM ELEMENTS

Watershed Management is an approach to comprehensive pollutant reduction and natural resource management which seeks to coordinate and integrate many goals, objectives, and activities in such a way as to provide maximum overall benefits at the minimum overall cost to the community. Watershed Management embraces many specific activities of other Program elements, especially those within the NDC element, and includes a Program and regional level approach to coordination and integration. The Watershed Management Measures also seek to meet the intent of the San Francisco Estuary Project, the Coastal Zone Act and Reauthorization Amendments, and Regional Board staff guidance for new development (see Chapter 5).

WMM EFFECTIVENESS EVALUATION

Watershed management involves the effective coordination of many different activities in order to achieve watershed specific goals and priorities. Thus, watershed management effectiveness can be measured indirectly through an evaluation of the success in coordination

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of Program and related activities. Other success criteria will need to be defined as a clearer purpose is established and watershed specific goals, problems, and solutions are defined.

WMM ACTIVITIES

WMM-1 Improve Institutional Arrangements

This activity emphasizes first establishing the specific goals and objectives for the overall Program to undertake in a watershed management approach and then identify opportunities to achieve these objectives through impro ement of existing or new institutional arrangements. In contrast to activity PM-2, the objectives of WMM-1 are specific to watershed protection.

Task 1: Define the Program's goals and objectives of watershed management.
Task 2: Review CONCUR/PERC paper and identify opportunities.
Task 3: Develop new institutional arrangements (including goals).

WMM-2 Develop Watershed Monitoring Plan and Protocols

The purpose of this activity is to define a uniform watershed monitoring framework for the Bay Area. This activity will be carried out in coordination with BASMAA, the San Francisco Estuary Institute, and the Regional Board.

Task 1: Define Goals and Objectives of watershed monitoring.
Task 2: Establish monitoring sampling design, protocols, and data management plan.
Task 3: Define linkage to WMM-3, Watershed Classification.
Task 4: Initiate pilot watershed monitoring (see WMM-4).

WMM-3 Implement Watershed Classification

The purpose of this activity is to meet commitments of the March 1994 Copper Reduction MOU and develop an approach to watershed classification that maximizes cost effectiveness of pollutant reduction measures and protection of natural resources and beneficial uses.

Task 1: Review CONCUR Watershed Classification paper.
Task 2: Identify opportunities to use CONCUR paper concepts.
Task 3; Define linkage to watershed monitoring (WMM-2).
Task 4: Classify and prioritize watersheds.

WMM-4 Develop a Pilot Watershed Plan

The objective of this activity is to initiate watershed management through the development of a pilot watershed plan. The results of the pilot effort will be used to direct other watershed planning activities to be implemented under WMM-5. While SCVWD will take the lead on

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many PAA efforts in the pilot, cities and counties will play key roles in land use management.

Task 1: Coordinate with SCVWD Coyote Watershed Planning effort.
Task 2: Evaluate the Pilot project process and results.
Task 3: Recommendations for future plans.
Task 4: Develop model watershed plan.

WMM-5 Implement Area-Wide Watershed Management

This is the final activity under the Watershed Management Measures and represents full implementation of the WMM element. The objective is phased implementation of institutional arrangements (WMM-1), watershed monitoring (WMM-2), watershed classification (WMM-3), and a pilot watershed planning effort (WMM-4), leading to full implementation.

Task 1: Develop an area-wide watershed management strategy and plan.
Task 2: Implement the watershed management strategy.

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TABL
WMM Roles, Respo
(Watershed Man

Activities & Tasks	Reg Brd	BASMAA	Program	Subcomm	Cbl	Cpt	LA
WMM-1 Improve Institutional Arrangements							
1. Define the Program's goals and objectives of watershed management			L 95-96				
2. Review CONCUR/PERC paper and identify opportunities			L 95-96				
3. Develop institutional arrangements (including goals)			L 96-97				
WMM-2 Develop Watershed Monitoring Plan and Protocols							
1. Define goals and objectives of watershed monitoring		L 95-96	S				
2. Establish monitoring sampling design, protocols, and data management plan		L 95-96	S				
3. Define linkage to WMM-3, Watershed Classification			L 96-97				
4. Initiate pilot watershed monitoring (see WMM-4)		L 96-97	S				
WMM-3 Watershed Classification							
1. Review CONCUR Watershed Classification paper			L 95-96				
2. Identify opportunities to use CONCUR paper concepts			L 95-96				
3. Define linkage to watershed monitoring (WMM-2)			L 96-97				
4. Classify and prioritize watersheds			L 98-99				

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L = Lead Agency, S = Support Agency, OG = Ongoing, FY = Fiscal Year, "–" = Not Applicable, TBC = To Be Considered

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TABLE 9.7-7
Responsibilities, and Schedule
l Management Measures)

A	LAH	LG	Mlp	MS	MV	PA	SJ	SC	SCC	Stga	SV	SCV WD

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TABL
WMM Roles, Respo
(con

Activities & Tasks	Reg Brd	BASMAA	Program	Subcomm	Cbl	Cpt	LA
WMM-4 Develop a Pilot Watershed Plan							
1. Coordinate with SCVWD Coyote Watershed Planning effort			S				
2. Evaluate pilot process and results	S		L				
3. Provide recommendations for future plans	S	S	L				
4. Develop model watershed plan			S				
WMM-5 Implement Area-Wide Watershed Management							
1. Develop area-wide watershed management strategy and plan			L 98-99				
2. Implement watershed management strategy			L 99-00				

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TABLE 9.7-7
es, Responsibilities, and Schedule
(continued)

LA	LAH	LG	Mlp	MS	MV	PA	SJ	SC	SCC	Stga	SV	SCV WD
												L
												S
												S
									TBC			

=

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ICID—ILLICIT CONNECTION AND ILLEGAL DUMPING IDENTIFICATION AND ELIMINATION ACTIVITIES

ICID GOALS AND OBJECTIVES

Control measures under the ICID element have the goal of identifying and eliminating non-permissible non-storm water discharges associated with either illegal dumping or illicit connections between sanitary/process water lines and storm drains.

ICID IMPLEMENTATION

This program element is implemented at the co-permittee level with Program support provided in developing guidance and policies for permissible and non-permissible non-storm water discharges and alternative disposal methods. These control measures include inspections. Co-permittees may enter into cooperative agreements with other co-permittees or agencies (e.g., sanitation districts) to assist in inspections. There are three strategies designed to accommodate differences in the co-permittee community characteristics: co-permittees which are primarily residential Strategy 1), co-permittees that have moderate amounts of commercial and light industry and reasonably new storm drain systems (Strategy 2), and co-permittees which have a moderate amount of heavy industry or business districts served by older storm drain systems. The strategies are intended to build on each other, and therefore co-permittees which qualify for Strategy 2 are required to implement activities under Strategy 1. Implementation will take into account and build on past accomplishments of the first permit period.

COORDINATION WITH OTHER PROGRAM ELEMENTS

PIP Element: For successful implementation of the illegal dumping/illicit connection identification and elimination program element, coordination will be required with the PIP program element which will provide focused outreach materials for educating target audiences about specific non-permissible non-storm water discharges (e.g, pool/spa discharges, restaurant practices).

IND Element: The illicit connection/illegal dumping program element will be integrated into the industrial control program as inspection for storm water discharges as well as non-storm water discharges can be conducted simultaneously.

Regional Board: This element should be coordinated with the Regional Board who issues NPDES waste discharge permits for cleanup operations that often discharge into storm channels or storm drain systems.

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EFFECTIVENESS EVALUATION

Measures of effectiveness will be tailored to reflect the conditions and community characteristics of each co-permittee and will differ as described under each strategy. Overall, the evaluation of effectiveness will focus on the number of connections and dumping incidents identified and eliminated each year for a given level of effort (e.g., problems identified per 100 inspections). Ideally, the success of the program would be reflected in a reduction of problems for a given level of effort with each succeeding year.

STRATEGY 1

Qualifying Conditions:

Primarily Residential Communities

Activities:

The primary causes of illegal discharges in residential communities stems from homeowner misunderstanding of what materials are permitted to enter the storm drain system; therefore key elements in the strategy are coordinating with PIP element activities to conduct homeowner education through public outreach and responding to citizen complaints. The technical basis for residential outreach is primarily the Program's list of permissible and non-permissible non-storm water discharges. Co-permittees will review this list in the context of their jurisdiction and develop a list of homeowner activities (e.g., illicit pool and spa connections, dumping of used motor oil, mobile cleaner discharges) which are potentially the primary causes of non-permissible non-storm water discharges. Based on this list, the co-permittee will develop and implement a focused outreach program coordinating with other agencies (e.g., County Health) as appropriate. In addition to these activities, illicit connection identification activities are coordinated with public agency element activities.

Specific tasks to be accomplished will vary depending on the jurisdiction and previous related efforts of the first SWMP. The following are recommended tasks that may be tailored and modified for each co-permittee:

ICID-1 Residential Illegal Discharge Elimination

- Task 1: Prioritize non-storm water discharges of concern (target audience identification).
- Task 2: Coordinate with PIP element activities to develop residential outreach materials.
- Task 3: Implement incident response plan and update as necessary.
- Task 4: Conduct illegal dumping/illicit connection inspections/surveys in response to citizen complaints and in coordination with PAA element activities.

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Reporting and Evaluation Criteria:

The co-permittees will annually document the number and type of incidents identified, addressed, and resolved or non-resolved; coordination with other co-permittees or agencies including MOUs and agreements; and the number of complaints received. It is anticipated that the number of complaints will increase in the early years of implementation as citizens become more aware of problems, and gradually decrease as education efforts begin to create a permanently aware population.

STRATEGY 2

Qualifying Condition:

Jurisdiction contains moderate amount of commercial areas (e.g., malls, commercial strip development) and/or light industrial development most of which is in the form of relatively modern industrial parks.

Activities:

Commercial and light industrial areas constitute an additional source of illegal dumping and illicit connections and warrant additional activities beyond those specified in Strategy 1. The public outreach target audience should be expanded to address commercial and light industrial activities. A sustained illegal dumping identification and illicit connection elimination program consisting of education, coordinated inspections, spill response, complaint response, alternative disposal guidance, enforcement, and reporting should be developed and implemented. Implementation should be conducted through the most cost-effective means and, in most municipalities, will be integrated with IND and PAA element activities. Inspection and enforcement coordination will likely be required with maintenance staff, HAZMAT and pretreatment industrial inspectors, and health inspectors, among others.

Specific, *in addition to those under Strategy 1*, are:

ICID-2 Illegal Discharge Elimination for Commercial and Light Industrial Facilities

Task 1: Prioritize inventory of facilities developed in the IND element.
Task 2: Coordinate with PIP element activities to develop appropriate outreach materials and strategy.
Task 3: Establish system of receiving, responding, and tracking response to citizen complaints.
Task 4: Coordinate with other agencies to develop agreements for alternative disposal options.
Task 5: Evaluate and obtain enforcement authority and develop enforcement procedures.

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Task 6: Develop illicit connection survey plan.
Task 7: Perform illegal dumping/illicit connection inspections in conjunction with IND element activities.

Reporting and Evaluation Criteria:

Written illegal dumping identification and elimination strategy that includes criteria for selection of high priority activities and areas, inventory of commercial/industrial businesses in high priority activities and areas, inspection methods, enforcement authority, and coordination of implementation with other agencies. Annual reporting will include type and extent of inspections, the number and type of problems encountered, actions taken, and status of resolution. The primary evaluation criteria for effectiveness will be number and type of incidents identified and eliminated and the type and extent of inspections.

STRATEGY 3

Qualifying Conditions:

Jurisdiction that contains older business districts and/or some relatively heavy industrial areas.

Activities:

Older business districts and/or older industries are often served by older storm drain and sanitary sewer systems that may potentially contain more cross connections than is found with more recent construction. *In addition to implementing activities identified under Strategies 1 and 2,* jurisdictions containing such areas should develop and implement an outreach strategy for older non-residential areas and develop and implement a plan for routine surveillance for illicit connections. The surveillance plan should build on relevant information obtained from activities conducted during implementation of the first SWMP.

Specific tasks are:

ICID-3 Illegal Discharge Elimination for Older Business and Heavy Industrial Areas

Task 1: Coordinate with PIP element activities to develop appropriate outreach materials and strategy for older business districts and heavy industrial facilities, as appropriate.
Task 2: Develop system surveillance plan which includes prioritization of non-residential areas to be inspected.
Task 3: Conduct routine system surveillance of storm drains.

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Reporting and Evaluation Criteria:

Written outreach strategy and surveillance plan. Annual report to include the type and extent of surveys conducted, survey methods and schedule, training and staffing information, problems encountered, actions taken, and status of resolution of problems.

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TABLE
ICID Roles, Responsibilities,
(Illicit Connection

Activities & Tasks	Reg Brd	BASMAA	Program	Subcomm	Cbl	Cpt	LA	L
ICID-1 Residential Illegal Discharge Elimination (Strategy I)								
1. Prioritize nonstorm water discharges of concern (target audience identification)				L-Ind/Comm 95-96	L OG	L 95-96	L OG	D (92
2. Coordinate with PIP element to develop residential outreach materials				L-PI/P, Ind/Comm OG	L OG	L OG	L OG	
3. Implement incident response plan					L OG	L OG	L OG	
4. Conduct illegal dumping/illicit connection inspections/surveys in response to citizen complaints and in coordination with PAA element.					L OG	L OG	L OG	
ICID-2 Illegal Discharge Elimination for Commercial and Light Industrial Facilities (add for Strategies 2 and 3								
1. Prioritize inventory of facilities developed in IND element					L Done	L Done (94-95)	L Done (93-94)	
2. Coordinate with PIP element to develop commercial/light industrial outreach materials and strategy				L-PI/P, Ind/Comm OG	L OG	L OG	L OG	
3. Establish system of receiving, responding, and tracking response to citizen complaints					L 95-96	L OG		
4. Coordinate with other agencies to develop agreements for alternative disposal options				L-Ind/Comm 95-96	L TBC	L OG	L Done (93-94)	

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= Lead Agency, S = Support Agency, OG = Ongoing, FY = Fiscal Year, "--" = Not Applicable, TBC = To Be Considered

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TABLE 9.7-8
ıilities, and Implementation Schedule
ınection/Illegal Dumping)

	LAH	LG	Mlp	MS	MV	PA	SJ	SC	SCC	Stg	SV	SCV WD
	L Done (92-93)	L OG	L OG	L OG	L Done (93-94)	L Done (91-92)	L OG	L Done (94-95)	L 95-96	L OG	L Done (90-91)	--
	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	S
	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG
	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG
and 3)												
	--	L Done	L Done (94-95)	--	L Done (93-94)	L Done (92-93)	L OG	L Done (94-95)	--	L Done	L Done (90-91)	--
	--	L OG	L Done (94-95)	--	L OG	L OG	L OG	L OG	--	L OG	L OG	S OG
	--	L 95-96	L Done (92-93)	--	L Done 93-94	L Done (92-93)	L Done (90-91)	L Done (94-95)	--	L 95-96	L Done (90-91)	L OG
	--	L TBC	L OG	--	L OG	--	L OG	L OG	--	L TBC	L OG	--

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TABL
ICID Roles, Responsibilities,
(Illicit Connectio
(con

Activities & Tasks	Reg Brd	BASMAA	Program	Subcomm	Cbl	Cpt	LA	L
5. Evaluate and obtain enforcement authority and develop enforcement procedures					L TBC	L Done 91-92		
6. Develop illicit connection survey plan					L OG	L Done (91-92)	L Done (92-93)	
7. Perform illegal dumping/illicit connection inspections in conjunction with IND activities					L OG	L OG	L OG	
ICID-3 Illegal Discharge Elimination for Older Business and Heavy Industrial Areas (Add for Strategy 3)								
1. Coordinate with PIP element to develop outreach materials and strategy for older business and heavy industrial areas				L-PI/P, Ind/Comm	–	–	–	
2. Develop system surveillance plan which includes prioritization of non-residential areas to be inspected					–	–	–	
3. Conduct routine system surveillance of storm drains					–	–	–	

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L = Lead Agency, S = Support Agency, OG = Ongoing, FY = Fiscal Year, "–" = Not Applicable, TBC = To Be Considered

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TABLE 9.7-8
ibilities, and Implementation Schedule
anection/Illegal Dumping)
(continued)

	LAH	LG	Mlp	MS	MV	PA	SJ	SC	SCC	Stg	SV	SCV WD
	–	L TBC	L OG	–	L Done 94-95	L Done (94-95)	L Done (93-94)	L Done (94-95)	–	L TBC	L Done (90-91)	–
)	–	L OG	L OG	–	L Done 93-94	L Done (91-92)	L Done	L Done (92-93)	–	L OG	L Done (92-93)	–
	–	L OG	–	–	L OG	L OG	L Done	L 95-96	–	L OG	L OG	–
)												
		–	L OG	–	L OG	–	L OG	L	–	–	–	S
	–	–	L Done (94-95)	–	L Done 93-94	–	L Done (94-95)	L 95-96	–	–	–	–
	–	–	L OG	–	L OG	–	L OG	L 95-96	–	–	–	–

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IND—INDUSTRIAL AND COMMERCIAL DISCHARGERS CONTROL PROGRAM ELEMENT

IND GOALS AND OBJECTIVES

The goals and objectives of the industrial and commercial discharger's program element is to control storm water discharges associated with industrial and commercial activities into municipal storm drain systems.

IND IMPLEMENTATION

This program element is implemented at the co-permittee level with Program support in developing BMP guidance and PIP materials that may be useful in educating target audiences. Implementation strategies are developed for three land use conditions so that co-permittees can select the most appropriate strategy for their community characteristics.

INTEGRATION AND COORDINATION WITH OTHER PROGRAM ELEMENTS

PIP Element: Various activities will require targeted commercial and industrial educational materials (eg, BMP guidance) to be developed through the PIP program element.

ICID Element: Many activities in the IND program element can be cost-effectively coordinated with the illicit connection and illegal dumping identification and elimination program element. The Program has facilitated this coordination by creating a joint subcommittee responsible for assisting in the implementation of both elements.

Regional Board: This element should be coordinated with the Regional Board which regulates certain industries that are covered by the State General Industrial Permit.

Other Inspection Agencies: This element should be coordinated with HAZMAT, POTW pretreatment, County Department of Health, and other agencies with inspection responsibilities to minimize the number of inspections at a given facility and to provide more cost effective programs.

IND EFFECTIVENESS EVALUATION

Effectiveness evaluation criteria will be tailored to co-permittee community characteristics. Recommended criteria include the number of problems identified and resolved relative to a given level of effort (e.g., number of inspections) and the percentage of significant sources inspected per year. Yearly progress would show a decrease in problems for a given level of implementation.

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STRATEGY 1

Qualifying Conditions:

Primarily residential communities with limited commercial or industrial uses.

Activities:

For jurisdictions in this category there are very few commercial areas and likely to be no industrial facilities. In this case, co-permittees will identify and inspect all commercial facilities that handle pollutants of concern and may have exposure to storm water, follow up with educational assistance and, if necessary, take enforcement action. Co-permittees will also assist facilities to comply with General Industrial permit, as appropriate.

Recommended Tasks are:

IND-1 Commercial/Industrial Inspection and Outreach (Few Facilities)

Task 1: List all commercial/industrial facilities.
Task 2: Identify which facilities have exposure and are potential sources of pollutants of concern.
Task 3: Conduct inspections and provide outreach.

Reporting and Evaluation Criteria:

Report on number of facilities inspected, any problems or enforcement actions taken and their resolution.

STRATEGY 2

Qualifying Conditions:

Jurisdictions which contain moderate amount of commercial land use and/or light industrial development.

Activities:

Jurisdictions in this category will focus source control efforts on specific commercial facilities that are potential storm water pollutant sources (e.g., restaurants, gas stations, automotive repair shops). A secondary focus will be to address treatment options for sources common to various facilities (e.g., parking lots). Activities shall include targeted outreach to these facilities using BMP guidance and PIP materials developed by the Program and/or the local co-permittee. If the jurisdiction contains a sufficient

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number of facilities, a commercial/industrial data base will be developed in order to support inspection, enforcement, and reporting functions. Facilities may be ranked in terms of potential for exposure and materials handled using guidance contained in the Program's Source Identification Report or other information. An inspection program will be implemented using co-permittee resources, Program resources, and/or other agencies resources such as the sanitary district, HAZMAT, or County Environmental Health. The inspection program results will be used to update the data base and refine the scope and necessity of continued inspections. The co-permittee will consider the feasibility of developing a commercial awards program to recognize cooperating facilities.

Specific tasks that the local agencies may tailor or modify for their community characteristics are:

IND-2 Commercial/Light Industrial Inspections

Task 1: Identify and prioritize commercial and industrial sources.
Task 2: Develop a commercial/industrial data base for tracking progress, reporting.
Task 3: Coordinate with PIP element activities to develop commercial/industrial BMP guidance materials.
Task 4: Develop and implement inspector training program.
Task 5: Conduct inspections in cooperation with other agencies.
Task 6: Develop cooperative agreements with other agencies to coordinate inspections.
Task 7: Evaluate feasibility of commercial awards program.
Task 8: Develop parking lot BMPs and a control strategy based on Program/USEPA pilot project.
Task 9: Implement parking lot control strategy.

Reporting and Evaluation Criteria:

Number and comprehensiveness of inspections conducted and percentage of important sources inspected per year. Number of problems resolved. Year to year progress in reducing problems and the number of facilities which require inspections due to compliance.

STRATEGY 3

Qualifying Conditions:

Jurisdictions which contain older business districts and/or heavy industries.

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Activities:

Monitoring data indicate that the quality of storm water runoff is poorer from catchments which have significant industrial sources. For jurisdictions in this category, there is the need to assist industries to comply with the State's General Industrial Permit and to assist other industries (who are not covered by the permit but constitute an important source of pollutants, e.g., auto repair) to comply with local requirements. If useful, enter into agreement with Regional Board on coordinating inspections, reporting, and referrals of problems. Outreach should be conducted utilizing existing BMP and PIP materials developed (or in the process of being developed) by the Program and by co-permittees. An inspection program similar to that outlined in the above strategy should be developed and implemented with additional consideration for assisting industries with General Permit compliance. Jurisdictions in this category may also have industrial clean-up operations ongoing where treated groundwater is discharged (under permit from the Regional Board) to the jurisdiction's storm drain system or local streams. In this case, the co-permittee should work with the Regional Board and these businesses to ensure that storm water and non-storm water discharge issues are addressed.

Additional specific tasks beyond those identified in Strategy 2 are:

IND-3 Older Business Districts and Heavy Industrial Area Inspections

Task 1: Identify industries regulated by the State NPDES General Industrial permit.
Task 2: Develop and implement outreach strategy and inspection plan to assist regulated industries in complying with NPDES General Industrial permit (non-compliance problems to be reported to the Regional Board).
Task 3: Coordinate with PIP element activities to develop outreach materials to assist permitted and non-permitted industries to comply with State and local requirements, as applicable, and enforce compliance where necessary.
Task 4: Develop MOU with Regional Board to coordinate inspection and enforcement activities for permitted facilities.

Reporting and Evaluation Criteria:

Similar to Strategy 2 but with additional focus on industrial facilities and coordination with the Regional Board.

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TABL
IND Roles, Responsibilities,
(Industrial and Con

Activities & Tasks	Reg Brd	BASMAA	Program	Subcomm	Cbl	Cpt	LA	
IND-1 Commercial/Industrial Inspections and Outreach Activities (Where There are Few Facilities)—Strateg								
1. List all commercial/industrial facilities					--	--	L Done (92-93 & 93-94)	
2. Identify which facilities have exposure and are potential sources of pollutants of concern					--	--	L Done (92-93 & 94-95)	
3. Conduct inspections and provide outreach					--	--	L OG	
IND-2 Commercial/Light Industrial Inspections and Outreach Activities (Strategies 2 and 3)								
1. Identify and rank commercial/industrial sources					L Done	L Done (94-95)	--	
2. Develop a commercial/industrial database for tracking progress, and reporting					L TBC	L Done (94-95)	--	
3. Coordinate with PIP element to develop commercial/industrial BMP guidance materials					L OG	L OG	--	
4. Develop and implement inspector training program				S-Ind/Comm	--	L Done (94-95)	--	
5. Conduct inspections in cooperation with other agencies					--	L OG	--	
6. Develop cooperative agreements with other agencies to coordinate inspections					L 95-96	--	--	L (9

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L = Lead Agency. S = Support Agency, OG = Ongoing. FY = Fiscal Year. "--" = Not Applicable, TBC = To Be Considered

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...LE 9.7-9
...ibilities, and Implementation Schedule
...and Commercial Dischargers)

A	LAH	LG	Mlp	MS	MV	PA	SJ	SC	SCC	Stga	SV	SCV WD
Strategy 1												
...ne ...3 & ...94)	L Done (92-93)	–	–	–	–	–	–	–	94-95	–	–	–
L ...one ...93 & ...95)	L Done (92-93)	–	–	–	–	–	–	–	94-95	–	–	–
... ...5	S	–	–	–	–	–	–	–	OG	–	–	–
	–	L Done	L 95-96	–	L Done 93-94	L Done (91-92)	L OG	L Done (94-95)	–	L Done	L Done (90-91)	–
	–	L TBC	L Done (94-95)	–	L Done 93-94	L Done (91-92)	L Done (94-95)	L 95-96	–	L TBC	L Done (90-91)	–
	–	L OG	L OG	–	L OG	L OG	L OG	L OG	–	L OG	L OG	S
	–	–	L Done (94-95)	–	L Done 94-95	L Done (91-92)	L Done (94-95)	L 95-96	–	L 94-95	L Done (90-91)	–
	–	–	L OG	–	L Done (93-94)	L OG	L OG	L 95-96	–	–	L OG	–
	Done (92-93)	L 95-96	–	–	–	L Done (90-91)	L Done (94-95)	L Done (94-95)	–	L TBC	–	–

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TABL
IND Roles, Responsibilities,
(Industrial and Co
(con

Activities & Tasks	Reg Brd	BASMAA	Program	Subcomm	Cbl	Cpt	LA
7. Evaluate feasibility of commercial awards program and develop, if appropriate				L-Ind/Comm 95-96	L TBC	L TBC	–
8. Develop parking lot BMPs and control strategy based on current EPA/Program pilot project			L 95-96	S-Ind Maint	–		
9. Implement parking lot control strategy					L TBC	L TBC	L TBC
IND-3 Older Business District and Heavy Industrial Area Inspections (Add for Strategy 3)							
1. Identify industries regulated by State NPDES General Industrial Permit					–	–	–
2. Develop and implement outreach strategy and inspection plan to assist regulated industries in complying with NPDES industrial permits: report (noncompliance problems to be reported to Regional Board)					–	–	–
3. Coordinate with PIP element to develop materials to assist permitted and nonpermitted industries in complying with state and local requirements, as applicable, and enforce compliance where necessary					–	–	–
4. Develop MOU with Regional Board to coordinate inspection/enforcement activities for permitted facilities	L TBC			S-Ind/Comm	–	–	–

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L = Lead Agency, S = Support Agency, OG = Ongoing, FY = Fiscal Year, "--" = Not Applicable, TBC = To Be Considered

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LAH	LG	Mlp	MS	MV	PA	SJ	SC	SCC	Stga	SV	SCV WD
–	L TBC	L TBC	–	L Done (91-92)	L Done (91-92)	L TBC	S TBC	–	L TBC	L Done (91-92)	–
	–	–	–	L TBC	S TBC				–		
L TBC	L TBC	L TBC	L TBC	L TBC	L TBC	L TBC	L TBC	–	L TBC	L TBC	–
–	–	L OG	–	L Done 94-95	–	L	L	–	–	–	–
–	–	L Done (94-95)	–	L Done 94-95	–	L Done (94-95)	L Outreach Done (94-95)	–	–	–	–
–	–	L OG	–	L OG	–	L OG	L OG	–	–	–	–
–	–	L TBC	–	L TBC	–	L TBC	S TBC	–	–	–	–

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NDC—NEW DEVELOPMENT AND CONSTRUCTION ACTIVITIES CONTROL MEASURES

NDC GOALS AND OBJECTIVES

The goal of new development and construction activities control measures is to minimize the adverse effects on urban runoff from new and redevelopment both during and after construction. Activities contained within this element apply to private development and to public agency construction projects.

NDC IMPLEMENTATION

This program element is implemented primarily at the co-permittee level. Significant effort will be put toward integrating Program, CZARA and CCMP goals into project planning and design, strengthening current project approval and inspection procedures, and evaluating BMPs. Program support is provided in developing BMP selection guidance and modifications to CEQA language to incorporate storm water quality issues. Regional level coordination is provided through the Program's participation in the BASMAA New Development Subcommittee.

INTEGRATION AND COORDINATION WITH OTHER PROGRAM ELEMENTS

PAA element: Planning, design and construction of public agency projects shall be conducted to comply with the NDC element. In addition, for consistency of approach, long-term maintenance issues related to the selection of post-construction storm water BMPs for private developments need to be coordinated with the PAA element.

PIP Element: The new development and construction activities control element coordinates with the PIP element to develop and up date focused outreach materials for contractors, developers, engineers and municipal staff. These materials include general construction-related manuals and BMP brochures for specific construction trades.

MET element: The erosion control activities of the new development and construction activities control element may be effective metal control measures. Erosion control activities will be analyzed for load reduction potential as part of the Program's pilot sedimentation study.

WMM element: An outcome of the Coyote Creek pilot watershed management plan will be development of model watershed protection policies and ordinances. These model policies will incorporate the provisions of the Regional Board's *Staff Recommendations for New and Redevelopment Controls for Storm Water Programs* related to the siting, design, and construction of new development. Area-wide watershed management implementation will follow recommendations of the pilot watershed plan (see WMM-4 and WMM-5).

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IND element: New and redevelopment proposals for regulated industries are to be advised of the need to comply with the Regional Board's NPDES General Industrial Storm Water Discharge Permit as part of the project approval process.

Regional Board: This element should be coordinated with the Regional Board who regulate construction projects disturbing five or more acres of land area through NPDES General Construction Activities Storm Water Discharge permits.

Local Flood Control Agencies: Aspects of this element related to post-construction structural water quality controls should be coordinated with the Santa Clara Valley Water District Flood Control Department and/or the local agency having flood control design and maintenance responsibilities.

NDC EFFECTIVENESS EVALUATION

Effectiveness evaluation criteria will be based on implementation of the Regional Board *Staff Recommendations for New and Redevelopment Controls for Storm Water Programs* as applicable to each co-permittee's physical, economic and demographic conditions. Progress would be indicated by improvements in project approval and inspection procedures, incorporation of permanent storm water BMPs into project designs, and by implementation of watershed protection policies and storm water master planning related to controlling storm water quality from development sites.

NDC ACTIVITIES

NDC-1 Planning Procedures

Task 1:	Integrate Program, CZARA and CCMP goals into private and public project planning and design.
Task 2:	Revise project approval procedures to incorporate review for storm water quality issues.
Task 3:	Prepare and analyze development potential (available sites, development potential, General Plan projections).
Task 4:	Incorporate storm water quality issues into General Plan policies, goals and objectives.
Task 5:	Incorporate storm water quality issues into environmental review processes (CEQA, NEPA).
Task 6:	Utilize model watershed management plan prepared in WMM element to develop and/or revise policies, ordinances and design criteria.
Task 7:	Investigate the use of new BMPs for public agency projects.

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NDC-2 Permitting/Design

Task 1: Establish minimum standards and BMPs for both construction and post-construction storm water quality controls, including erosion and sediment controls.

Task 2: Review and revise existing permit requirements to require incorporation of storm water BMPs and related information into project plans, specifications and permits.

Task 3: Require all projects regulated by the State NPDES General Construction Activities Storm Water Discharge permit to file for coverage under this permit as a condition of local agency construction permit approval.

Task 4: Coordinate storm water BMP requirements with other agency permitting requirements (e.g. zoning, design criteria, Hazmat, fire safety).

NDC-3 Education and Outreach

Task 1: Coordinate with PIP element activities to provide public agency training (Planning, Building, Public Works staff).

Task 2: Develop outreach materials for contractors, developers and designers on construction and new development BMPs and compliance with State NPDES General Construction permit.

NDC-4 Construction Control Activities

Task 1: Adopt inspection procedures (checklists, enforcement, reporting) consistent with the State NPDES General Construction Activities Storm Water Discharge permit and existing inspection programs.

Task 2: Require the use and/or construction of BMPs through inspection and enforcement.

NDC-5 Post-Construction Control Activities

Task 1: Develop and implement procedures for coordinating with the local flood control agency on issues related to applicable post-construction BMPs.

Task 2: Develop an operations and maintenance program to guarantee on-going responsibility of post-construction BMPs.

Task 3: Implement program for operation and maintenance of post-construction BMPs.

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Activities & Tasks	Reg Brd	BASMAA	Program	Subcomm	Cbl	Cpt	LA	L
NDC-1 Planning Procedures								
1. Integrate Program, CZARA, and CCMP goals into private and public project planning and design					TBC	L 94-95		L O
2. Revise project approval procedures to incorporate review for storm water quality issues					L TBC	L Done (94-95)	L 95-96	L Do (93-
3. Prepare and analyze development potential (available sites, development potential, General Plan projections)					L Done (93-94)	L Done (93-94)	L Done (93-94)	L Do (93-
4. Incorporate storm water quality issues into General Plan policies, goals, and objectives					L 96-97	L Done (92-93)	L Done (93-94)	L 95-9
5. Incorporate storm water quality issues into environmental review processes (CEQA, NEPA)					L TBC	L Done (94-95)	L Done	L Don (91-9
6. Utilize model watershed plan prepared in WMM element to develop and/or revise policies, ordinances, and design criteria					L TBC	L TBC	L TBC	L TBC
NDC-2 Permitting/Design								
1. Establish minimum standards and BMPs for both construction and postconstruction storm water quality controls, including erosion and sediment controls		S		S-New Dev	L TBC	L 95-96	L OG	L OG

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L = Lead Agency. S = Support Agency, OG = Ongoing, FY = Fiscal Year. "--" = Not Applicable, TBC = To Be Considered

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LAH	LG	Mp	MS	MV	PA	SJ	SC	SCC	Stga	SV	SCV WD
L OG	TBC	L OG	TBC	OG	L OG	L OG	L OG	OG	TBC	L TBC	L TBC
L Done (93-94)	L TBC	L Done (94-95)	L TBC	L Done (94-95)	L Done (93-94)	L Done (94-95)	L Done (94-95)	L Done (94-95)	L TBC	L Done (93-94)	–
L Done (93-94)	L Done (93-94)	L 95-96	L Done (93-94)	L Done (93-94)	L Done (93-94)	L OG	L Done (93-94)	L Done (93-94)	L Done (93-94)	L Done (93-94)	–
L 95-96	L TBC	L Done (91-92)	L 95-96	L Done 93-94	L 95-96	L Done (94-95)	L Done (92-93)	L Done (92-93)	L TBC	L Done (92-93)	–
L Done (91-92)	L TBC	L Done (77-78)	L TBC	L Done 93-94	L 95-96	L Done (94-95)	L Done (94-95)	L Done (94-95)	L TBC	L Done (90-91)	L OG
L TBC	L TBC	L Done (94-95)	L TBC	L TBC	L TBC	L TBC	L TBC	L TBC	L TBC	L TBC	L TBC
L OG	L TBC	L 95-96	L TBC	L Done (94-95)	L 95-96	L Done (94-95)	L 95-96	L 95-96	L TBC	L Done (93-94)	L Done (93-94)

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TABL
NDC Roles, Respon
(New Developme
(co

Activities & Tasks	Reg Brd	BASMAA	Program	Subcomm	Cbl	Cpt	LA	L
2. Review and revise existing permit requirements to require incorporation of storm water BMPs and related information into project plans, specifications, and permits				S-New Dev	L Done (94-95)	L Done (94-95)	L OG	D (93
3. Require all projects regulated by the State NPDES General Construction Permit to file for coverage under this permit as a condition of local agency construction permit approval					L TBC	L OG	L OG	O
4. Coordinate storm water BMP requirements with other agency permitting requirements (e.g., zoning, design criteria, Hazmat, fire safety)					L OG	L 95-96	L OG	L O
NDC-3 Education and Outreach								
1. Coordinate with PIP element to provide public agency training (Planning, Building, Public Works staff) in coordination with PIP element	S		L OG	S-PI/P	L OG	L OG	L OG	L O
2. Develop outreach materials for contractors, developers, and designers on construction and new development BMPs and NPDES permit compliance		S		S-New Dev, PI/P	L OG	L OG	L OG	–

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espuasibilities, and Schedule
opment and Construction)
(continued)

LAH	LG	Mlp	MS	MV	PA	SJ	SC	SCC	Stga	SV	SCV WD
L Done (93-94)	L Done	L Done (94-95)	L 95-96	L Done (94-95)	L Done (94-95)	L 95-96	L 95-96	L 95-96	L 95-96	L Done (93-94)	–
L OG	L TBC	L OG	L TBC	L OG	L OG	L OG	L OG	L OG	L TBC	L TBC	–
L OG	L OG	L OG	L OG	L Done (94-95)	L OG	L OG	L 95-96	L 95-96	L OG	L OG	–
L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG
–	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	L OG	–	L OG

December 20, 1994
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TABLE
NDC Roles, Responsi
(New Development
(conti

Activities & Tasks	Reg Brd	BASMAA	Program	Subcomm	Cbl	Cpt	LA	LA
NDC-4 Construction Control Activities								
1. Adopt and implement inspection procedures (checklists, enforcement, reporting) consistent with the State NPDES General Construction Activities Storm Water Discharge permit and existing inspection programs		S		S-New Dev	L TBC	L 94-95	L 95-96	L 96-9
2. Require the use and/or construction of BMPs through inspection and enforcement	S				L OG	L OG	L OG	L OG
NDC-5 Postconstruction Control Activities								
1. Develop and implement procedures for coordinating with the local flood control agency on issues related to applicable postconstruction BMPs		S		S-New Dev, Maint	--	--	--	--
2. Develop and implement an operations and maintenance program to guarantee ongoing responsibility of postconstruction storm water BMPs		S		S-New Dev, Maint	--	L 96-97	L 96-97	--

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LAH	LG	Mlp	MS	MV	PA	SJ	SC	SCC	Stga	SV	SCV WD
L 96-97	L TBC	L OG	L TBC	L Done (94-95)	L 94-95	L Done (94-95)	L Done (94-95)	L Done (94-95)	L TBC	L Done (93-94)	–
L OG	L OG	L OG	L OG	L OG	L 94-95	L OG	L OG	L OG	L OG	L OG	–
	–	L OG	–	L Done (94-95)	L OG	L OG	L TBC	L OG	–	L TBC	L OG
–	–	L OG	–	L Done (94-95)	L TBC	L 95-96	L TBC	–	–	–	S

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HARTCROWSER

Earth and Environmental Technologies

SERVICE STATION
STORM WATER RUNOFF STUDY
CONTRACT NO. DT 308-02

Prepared for

Western States Petroleum Association

October 5, 1993
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Seattle • Tacoma • Richland • Anchorage • Portland • San Francisco • Long Beach

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SERVICE STATION STORM WATER RUNOFF STUDY

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LOS ANGELES REGION

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1.0 SUMMARY OF FINDINGS

This Retail Gasoline Outlet Storm Water Runoff Study identifies and quantifies chemical constituents detected in simulated storm water runoff from concrete and asphalt pavement at five preselected retail gasoline outlets (RGOs). The RGOs were selected to represent geographical areas, varying population densities, and different types of RGOs operating in California. Rainfall typical for California was simulated at each of the five RGOs. Runoff generated during the tests was collected and analyzed to identify and quantify chemical constituents that may have been present.

Metals.

The study analyzed metals in the first 15-minute sample (first flush) of runoff from the RGO pump island area. The concentrations reported in the data are below minimum analytical detection limits with the exceptions of barium, copper, and zinc. The GTEL Environmental Laboratory, Inc. (GTEL) analytical data sheets indicate that the maximum detection limit was increased for some samples due to a foaming effect noted in these samples.

The analytical results for metals demonstrate that the maximum concentrations of most constituents detected in the runoff water samples are lower than current United States Environmental Protection Agency (EPA) primary and secondary drinking water maximum contaminant levels (MCLs). The exceptions are antimony, arsenic, beryllium, cadmium, and lead, where the concentration cannot be compared to the drinking water MCLs because the minimum analytical detection limits are higher than the drinking water MCLs.

Volatile Organic Compounds.

The data collected during this study indicate that all VOC concentrations found in the storm water runoff from the pavement at RGOs are below the EPA MCLs. The concentrations of metals and VOCs detected during this study represent normal conditions at RGOs where the RGOs maintain effective housekeeping practices and cleanup of incidental spills.

At each RGO, nine samples of runoff water were obtained to be analyzed for the volatile organic compounds benzene, toluene, ethylbenzene and total xylenes (BTEX). Forty-five samples were collected from the five RGOs for analysis of volatile organic compound (VOC) content. Of 45 samples, 27 of the samples were below analytical detection limits (reported as ND, not detected). In the remaining 18 samples, VOCs were detected in the

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runoff water at concentrations below the respective EPA MCLs. Out of the 45 samples, all were below the EPA MCLs.

2.0 PROJECT PROCEDURES

The simulated storm water runoff tests were conducted to identify and quantify chemical constituents in runoff at the five selected RGOs. The findings presented in this report identify the levels of chemicals commonly present in the runoff from typical RGOs in California. The data are presented as a comparison between each RGO and EPA primary and secondary drinking water MCLs.

Representatives of the Western States Petroleum Association (WSPA) selected RGO categories to represent the various geographical areas, varying population densities and types of RGOs located in California. The storm water runoff sampling was conducted at the five Southern California RGOs selected by the WSPA representatives.

Rainfall was simulated in the same manner at both the pump island (automotive refueling areas) and the driveway approach areas at each RGO (See Figure 1); samples were collected in the same manner at each RGO; sampling equipment was properly cleaned between each round of sampling. The only notable difference in the testing methodologies at the five RGOs occurred at the Category 5 RGO. One quart of gasoline was "spilled" at the pump island of the Category 5 RGO and cleaned up with absorbent material prior to the rainfall simulation. The "spill" was simulated at the pump island area only.

Tables 1 through 5 identify the sample source, collection time, date, weather conditions, and the specified analyses for each of the samples collected at the five RGOs.

The rainfall simulation was designed to represent the light, medium, and heavy rainfall regions of California. This report compares and documents the analytical data obtained from these tests. The test data quantify the concentrations of storm water constituents in runoff at the RGO pump islands and in driveway approaches to the RGO and pump islands. The analytical data for the samples collected at the five selected RGOs are summarized in Tables 6 through 9. The GTEL analytical data sheets are presented in Appendix A.

A comparison of average RGO runoff concentrations with water quality criteria and typical urban runoff are presented in Tables 10 through 14.

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3.0 LITERATURE SEARCH

Initially a computerized literature file search was conducted to assess whether other similar studies had been performed which contained scientific information that may contribute to this storm water runoff project. The computerized literature file search did not disclose a previous RGO storm water study. Key literature abstracts relating to storm water runoff or other related information is included in Appendix B.

The computerized literature file search was conducted using the Dialog Information Database. The search was conducted of the following files:

NTIS (National Technical Information) - File 6;
COMPENDEX (Engineering Information Inc., NY, NY) - File 8;
APILIT (American Petroleum Institute) - File 354;
Pollution Abstracts/Cambridge Scientific Abstracts - File 41;
Water Resources Abstracts - File 117;
WATERNET (American Water Works Association,) - File 245; and
CA SEARCH (Chemical Abstracts , Columbus, OH) - File 399.

4.0 TECHNICAL APPROACH

The technical approach for this project included:

Developing site selection criteria and selecting representative RGOs;
Conducting preliminary field testing to establish test procedures; and
Determining sampling and analytical procedures.

These topics are described in detail in the following sections.

4.1 Selection of Retail Gasoline Outlets

The selection of the RGOs for this study was based on a cross section of the various populated and geographic areas in California and used the following criteria:

Anticipated refueling frequencies and anticipated ages of vehicles expected to frequent the RGOs.

Anticipated commercial use, based on the RGO's location.

The RGO's age and general appearance.

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The construction class of the RGO including fuel islands, mechanics' bays, car washes and convenience stores.

The topography around the RGO including the drainage pattern and adjacent property use.

The WSPA members provided RGOs to represent differing examples of the above-listed categories. The RGOs selected for each category are located in the following cities in California:

Trabuco Canyon
Apple Valley
San Diego
Rancho Cucamonga
Los Angeles

Using the criteria previously mentioned, the RGOs which were selected had the following characteristics:

Category 1

Throughput greater than 250,000 gallons per month
Urban location, little or no commercial use
New facility, clean appearance
Covered fuel islands; carwash; no mechanics' bays
Hilly area, runoff to the east and west; facility is bermed[1]; shopping center adjacent to RGO

The Category One RGO was observed to have minimal staining on the ground surface around the pump islands. The pump island and driveway approach areas are concrete. The driveway approach area was observed to be relatively clean and free of oil and grease stains.

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Category 2

Throughput greater than 250,000 gallons per month
Urban location, little or no commercial use
New facility, clean appearance
Covered fuel islands; carwash; convenience store; no mechanic's bays
Flat area, runoff to the west; facility is bermed; fast food adjacent to RGO

The Category Two RGO was observed to have minimal staining on the ground surface around the pump islands. The pump island and driveway approach areas are concrete. The driveway approach area is concrete and was observed to have oil and grease stains.

(1) - refers to concrete curbs (present at the category 1 and 2 RGOs) which direct the flow of storm water to on-site surface storm drains. At the RGOs without berming, rainfall on the RGO lot flows into surface storm drains on-site or off of the RGO into the street adjacent the RGO.

Category 3

Throughput of 150,000 to 250,000 gallons per month
Inner city, light commercial use
Older facility, stained and degraded concrete and asphalt
Covered fuel islands; mechanic's bays
Flat area, runoff to the south; facility is not bermed; residential and retail adjacent to RGO

The Category Three RGO was observed to have dark oil and grease stains on the ground surface around the pump islands and in the driveway approach areas. The pump island areas are concrete. The asphalt in the driveway approach areas was observed to be in poor condition, or degraded.

Category 4

Throughput of 150,000 to 250,000 gallons per month
Urban location, light commercial use
Older facility, stained and degraded concrete and asphalt
Covered fuel islands; mechanic's bays
Area sloped to the south; runoff to the south; facility is not bermed; shopping center adjacent to RGO

The Category Four RGO was observed to have oil and grease stains on the ground surface around the pump islands. The pump island areas are concrete. The asphalt in the driveway approach areas was observed to be in good condition.

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Category 5

Throughput less than 150,000 gallons per month
Inner city, high commercial use
Older facility, stained and degraded concrete and asphalt
Covered fuel islands with mechanic's bays
Flat area, runoff to the north and south; facility is not bermed; industrial and retail adjacent to RGO

The Category Five RGO was observed to have oil and grease stains on the ground surface around the pump islands. The pump island areas are concrete. The asphalt in the driveway approach areas was observed to be degraded.

4.2 Preliminary Field Testing

Two days of preliminary field testing were conducted prior to initiating the on-site RGO storm water evaluation (discussed in further detail in Appendix C - Preliminary Field Testing). The preliminary field testing was performed at an abandoned RGO in Westminster, California.

The preliminary field testing was conducted to achieve the following objectives:

Develop the simulated rainfall distribution system;

Determine the minimum rainfall rate necessary to create sheet flow;

Test the containment berms and collection apparatus for performance and effectiveness;

Determine a method to contain water generated during rainfall simulation; and

Develop safety protocol to ensure that RGO personnel and customers were not exposed to hazards during the testing period.

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4.3 Water Application

The test was designed to simulate a significant storm as defined by the National Oceanic and Atmospheric Administration (NOAA). A significant storm is defined as a continuous discharge of storm water for a minimum of one hour, or intermittent discharges of storm water for a minimum of three hours, in a 12-hour period.

During the test, potable water was distributed over the pump island and the driveway approach areas at a rate sufficient to provide adequate coverage of the test zone and develop sheet flow.

The test area evaluated at each RGO was approximately 400 square feet. The volume of water required to attain adequate sheet flow across each test area was determined to occur at a flow rate of about 2.0 gallons per minute (gpm). Based on this flow rate, the test was designed to run for a duration of 45 minutes. The 45-minute test was divided into three, 15-minute periods.

A flow rate of 2.0 gpm was dispensed over the 400 square-foot test area (See Figure 1) for a total of 45 minutes. This flow rate was determined to be appropriate for the test area size and functional operation of the water dispensing equipment. The flow rate of 2.0 gpm was sufficient to generate sheetflow within the test area.

Water distributed at the constant flow rate of 2.0 gpm distributed approximately 0.125 inches of "rain" over the test area in the first 15-minute period (33 gallons over 400 square feet). After 30 minutes, 0.250 inches of "rain" was distributed over the test area (66 gallons over 400 square feet). After 45 minutes, 0.375 inches of "rain" was distributed over the test area (100 gallons over 400 square feet).

4.4 Water Dispensing System

The water dispensing system was comprised of a supply line (a flexible hose), a flow meter with an on/off valve and 1 inch diameter, schedule 80 polyvinyl chloride (PVC) pipe. One end of the supply line was attached to the source water (the RGO hose bib). The other end of the supply line was attached to the flow meter. The flow meter was attached to the network of PVC pipes. The PVC pipes were perforated at 8 to 12 inch intervals with 3/64 inch holes (See Figure 2).

At each RGO, the network of pipes was set up so that the water would cover an area approximately 20 feet x 20 feet. The location of the water

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dispensing equipment was positioned at each RGO depending on the physical layout and the slope of the RGO. The volume of water was regulated by a shut-off valve and monitored by the flow meter. The water was dispensed through the network of PVC pipe.

4.5 Water Collection Apparatus

The containment berms consisted of sand-filled polyethylene tubing. The berms were constructed of 5-foot-long tubes and placed into position around the test area. The containment berms were used to channel the runoff water to the collection point. A stainless steel collection trough was placed at the lowest point of the test area and incorporated into the containment berms (See Figures 2 and 3).

At the end of each 15 minute period, an electric pump was used to pump the collected water into a 55-gallon steel drum. The 55-gallon drum was lined with a polypropylene liner. A new liner was used for each test to ensure the composite samples were representative of the test area being sampled. The electric water pump and sampling scoop were properly cleaned between sampling rounds using a solution of deionized water and alconox and then rinsed with deionized water.

4.6 Staged Spill and Cleanup Sampling Event

A staged spill was conducted at the Category 5 RGO. The RGO was randomly picked from the five categories. The spill was conducted to simulate the type of spill that would occur at the pump island if a motorist were to drop the pump nozzle while in the process of fueling an automobile. No cleanup or sweeping was performed prior to conducting the spill.

To simulate the spill the pump nozzle was used to dispense one quart of regular unleaded gasoline onto the ground. The gasoline was allowed to spread out naturally. After one minute, absorbent material was applied to the spill area and allowed to soak up the gasoline. When the absorbent material appeared saturated and the gasoline appeared to be completely soaked up, the absorbent was swept up.

After sweeping up the absorbent, the water dispensing equipment was set up and the storm water runoff test begun. The spill was conducted at the pump island area only.

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5.0 SAMPLE COLLECTION

A total of 28 samples were collected at each RGO. Tables 1 through 5 identify the site-specific conditions for each round of samples collected at the five RGOs. The sample source, collection time, date, weather conditions, and the specified analyses for the samples are listed in the tables.

Appendix E lists rainfall dates and amounts prior to the simulated rainfall runoff testing. Appendix F contains volume calculations of the simulated runoff at each RGO.

5.1 Sampling Procedures

Sampling procedures followed strict sampling protocol established by SW846, "Test Methods for Evaluating Solid Waste" (including surface and groundwater). Samples were obtained using cleaned sampling equipment and placed into laboratory supplied and certified "clean" sample containers. The samples were kept at or below 4 degrees Celsius.

Prior to starting each test, a background sample was collected from the RGO's potable water at the end of the supply line used to deliver water to the network of PVC pipes, this sample was the Round 1 sample. After the simulation started, the predetermined flow rate was adjusted and three successive samples were collected from the collection trough at 15-minute intervals.

Trip blanks are sent along with field samples as a measure of quality assurance. Trip blanks are used to ensure that the field samples represent the material sampled and not material or chemicals introduced during transport. The trip blanks were analyzed to verify that contamination was not introduced to the samples while they are in transit between point of collection and the laboratory.

For the RGO runoff sampling the same type of vials were used for the trip blanks as were used to collect the water samples at the RGOs. The vials were filled with purified water and handled in the same manner as the other samples, which were analyzed for VOCs and TPH. One trip blank was stored in each cooler together with the field samples. See Appendix D - Sampling Procedures for detailed sampling procedures followed for this study.

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5.2 *Sample Time and Location*

At each RGO the following samples were obtained:

One background sample from the RGO potable water source;

Three discrete grab samples of runoff from the pump island area collected at 15-minute intervals;

One composite sample of total runoff from the 55-gallon drum collected from the pump island area over the 45-minute test duration;

Three discrete grab samples of runoff from the driveway approach area collected at 15-minute intervals;

One composite sample of total runoff from the 55-gallon drum collected from the driveway approach area over the 45-minute test duration; and

One trip blank sample for quality assurance was filled with deionized water prior to arriving at the RGO for the sampling event.

See Figure 2 for sample time, location and sample round numbers.

5.3 *Sample Analytical Methods*

The samples were analyzed by the methods listed below.

Volatile Organic Compounds -	EPA method 8020
Total Petroleum Hydrocarbons -	EPA method 8015
Total Suspended Solids -	EPA method 160.2
Total Recoverable Oil and Grease -	EPA method 413.2
Title 26 Metals -	EPA method 6010 and EPA method 7470

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6.0 RESULTS AND DISCUSSION

6.1 Physical Condition of Retail Gasoline Outlets

The laboratory test results indicate that the physical condition of the RGO did not influence the concentrations of chemicals detected in the storm water at the pump island areas and the driveway approach areas. This was for both asphalt and concrete ground surfaces.

The analytical data for the samples collected at the five selected RGOs are summarized in Tables 6 through 9. The GTEL analytical data sheets are presented in Appendix A.

6.2 Volatile Organic Compounds and Total Petroleum Hydrocarbons

All samples were determined to be below the EPA MCLs for the VOCs (benzene, toluene, ethylbenzene and total xylenes). Data presented in Table 6 indicates that most concentrations of VOCs in the runoff samples are below analytical detection limits. Some samples had detectable concentrations of VOCs, but the concentrations were below the EPA MCLs. The only clear pattern emerging from the data is that total xylenes are the most prevalent VOC to be detected; this pattern is logical due to total xylenes having a lower vapor pressure (i.e., lesser tendency to volatilize) compared to benzene, toluene, and ethylbenzene.

The EPA MCLs for the BTEX compounds are as follows:

Compound	EPA MCLs
benzene	5 μg/L
toluene	1,000 μg/L
ethylbenzene	700 μg/L
total xylenes	10,000 μg/L

At the Category 1 RGO, concentrations of VOCs were detected in each sample of runoff from the pump island area. Toluene was detected at a maximum of 0.8 micrograms per liter (μg/L) and total xylenes were detected at a maximum of 1.4 μg/L. The VOCs were not detected in the runoff samples from the driveway approach area.

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At the Category 2 RGO, VOCs were not detected in the samples from the pump island area. VOCs were detected in the samples from the driveway approach area. Benzene was detected at 1.5 µg/L in the 15-minute sample (the first flush) from the driveway approach area and at 0.4 µg/L in the composite sample from the driveway approach area. Toluene was detected in the trip blank that was sent along with the samples from this RGO at 0.5 µg/L. (See Trip Blank section)

At the Category 3 RGO, the highest concentrations of VOCs were detected in the 15-minute sample from the pump island area and the 45-minute runoff sample from the driveway approach area. Toluene was detected at 7.9 µg/L and total xylenes were detected at 20 µg/L in runoff from the pump island area. Benzene was detected at 0.5 µg/L, toluene at 4.5 µg/L, ethylbenzene at 1.1 µg/L and total xylenes at 12 µg/L in the runoff from the driveway approach area.

At the Category 4 RGO, the highest concentrations of VOCs were detected in the source water and in the last runoff sample from the pump island. The application water was determined to have toluene at 0.3 µg/L and total xylenes at 7.1 µg/L. Toluene was detected at 0.4 µg/L and total xylenes were detected at 1.5 µg/L in the last runoff sample. Toluene was detected in the trip blank that was sent along with the samples from this RGO at 0.7 µg/L. (See Trip Blank section)

At the Category 5 RGO, VOCs were detected in the runoff from the pump island following the spill and cleanup of one quart of gasoline. The highest concentrations of VOCs detected at this RGO were benzene at 1.0 µg/L, toluene at 14 µg/L, ethylbenzene at 6.3 µg/L and total xylenes at 41 µg/L. VOC concentrations were below detection limits in the runoff samples from the driveway approach area.

6.3 Suspended Solids

The analytical results for total suspended solids are presented in Table 7. Most of the results are below analytical detection limits. Total Suspended Solids were not detected at the Category 1 and 2 RGOs. Total Suspended Solids were detected in the application water at the Category 3 and 4 RGOs at 11 and 14 mg/L, respectively. These results were slightly above the detection limit of 10 mg/L. These levels were reflected in the runoff data. At the Category 5 RGO, the 45-minute sample from the driveway approach

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area had 13 milligrams per liter of total suspended solids, slightly above the detection limit of 10 mg/L.

6.4 Metals

The analytical results for the metals are presented in Table 8. The data represent the metal concentrations in the 15-minute sample from the pump island area at each of the RGOs. Subsequent samples were not analyzed for metals. All of the concentrations reported in the data are below analytical detection limits with the exceptions of barium, copper and zinc.

The EPA MCLs and detection limits for barium, copper and zinc are listed below:

element	EPA MCL	Detection Limit
barium	1,000 µg/L	20 µg/L
copper	1,000 µg/L	200 µg/L
zinc	5,000 µg/L	100 µg/L

At the Category 1 RGO, barium was detected at 130 µg/L.

At the Category 2 RGO, all metals analyzed for were ND, not detected.

At the Category 3 RGO, barium was detected at 60 µg/L and zinc at 200 µg/L.

At the Category 4 RGO, barium was detected at 60 µg/L and zinc at 200 µg/L.

At the Category 5 RGO, barium was detected at 80 µg/L, copper at 200 µg/L and zinc at 600 µg/L.

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6.5 Recoverable Oil and Grease

The analytical results for total recoverable oil and grease are listed in Table 9. The detection limit for the oil and grease test was 1 mg/L. The highest detected concentration of oil and grease was 34 mg/L.

At the Category 1 RGO, total recoverable oil and grease was at the detection limit in the 15-minute sample and the 45-minute sample from the pump island area. In the driveway approach area, the 15-minute sample and the 45-minute sample had oil and grease concentrations of 2 mg/L.

At the Category 2 RGO, total recoverable oil and grease was at the detection limit in the 15-minute sample from the driveway approach area and composite sample from the driveway approach area.

At the Category 3 RGO, the highest total recoverable oil and grease was detected at 8 mg/L in the 15-minute sample from the pump island area. The subsequent samples in the pump island area for the 30, 45-minute and composite samples were 3, 2 and 3 mg/L, respectively.

At the Category 4 RGO, an unexpected result in the analytical data is reported. A 15 mg/L concentration of total recoverable oil and grease is reported in the source water. The 15 mg/L concentration in the background sample is higher than the 4, 2, and 8 mg/L concentrations reported in the 15, 30, and 45-minute runoff water samples collected.
At the Category 5 RGO, the total recoverable oil and grease concentrations detected were the highest among the RGOs. The composite sample at the pump island area had a concentration of 34 mg/L. The composite sample at the driveway approach area had a concentration of 29 mg/L.

6.6 Trip Blanks

Toluene was detected in the quality control trip blanks that were sent with the runoff samples from the Category 2 and 4 RGOs at concentrations of 0.5 µg/L and 0.7 µg/L, respectively. These concentrations are slightly above the analytical detection limit of 0.3 µg/L. The laboratory did not provide the trip blanks used for this test. The trip blanks were filled with bottled water prior to arriving at each RGO from different bottles of purified water. In the two trip blanks with detectable levels of toluene, the concentrations of toluene were higher than the levels detected in the runoff

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water. Contamination was not introduced through sample handling or transportation because toluene was not detected in the other samples from this site.

The GTEL laboratory director, Ms. Joan Greenwood, indicated that GTEL has detected toluene in batches of purified bottled water. At our request, Ms. Greenwood prepared a letter to explain their findings. The letter is included in Appendix H. The letter states that GTEL has detected toluene in bottles of "pure" water from commercial bottled water companies. Water in glass containers has frequently contained toluene in concentrations up to 2 μg/L. GTEL found plastic containers to contain toluene in even higher concentrations.

7.0 WATER QUALITY COMPARISON

The average concentrations for the chemical compounds studied during the runoff test are compared to water quality criteria and typical urban runoff in Tables 10 through 14.

7.1 EPA MCLs

The data indicate that the average concentrations observed at the five RGOs are lower than the current EPA primary and secondary drinking water MCLs with a few exceptions. The exceptions are antimony, arsenic, beryllium, cadmium, and lead. These exceptions exist because laboratory analytical detection limits are higher than the drinking water MCLs.

We note here that this study illustrates a problem typical of many water quality studies; the analyses employed in the study were performed using standard methods approved by regulatory agencies. However, the detection limits inherent to the standard methods are higher than current and proposed water quality criteria identified in the CA Draft Freshwater and Saltwater Aquatic Life Water Quality Objectives. Achieving lower detection limits requires specialized and expensive analytical techniques sometimes by non-standard research-oriented methods.

7.2 Federal Freshwater and Marine Aquatic Life

The EPA has published chronic exposure water quality criteria for freshwater and marine aquatic life. Concentrations from the RGO runoff which exceed these criteria are copper and zinc. Many of the EPA freshwater and marine aquatic life criteria are below the analytical detection

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limits attainable by laboratory methods employed for sample analysis in this study.

7.3 Draft California Freshwater/Saltwater Aquatic Life Water Quality

The State of California is proposing water quality objectives for freshwater and saltwater aquatic life. Comparisons of the RGO runoff with the proposed four-day exposure freshwater aquatic life objectives are difficult because many of the objectives must be calculated by use of the hardness concentrations in the aquatic environment. With respect to the proposed four-day exposure marine chronic objectives, the standards are set below the analytical detection limits attainable by the laboratory methods employed for this study except for chromium and selenium; neither of which were detected in the runoff in concentrations above the proposed objectives.

7.4 Range of Concentrations Typical in Urban Runoff

Tables 10 through 14 also list ranges of chemical concentrations typical of urban runoff as reported in the EPA's Nationwide Urban Runoff Program (NURP). Comparison of the analytical data obtained from the runoff at the five RGOs represented by this study show the chemical concentrations from runoff water are similar to the ranges reported by NURP. The data from this study showed slightly higher concentrations of toluene and copper. The data produced by this study are in the lower ranges of many of the concentrations reported in the NURP, for example, benzene and total suspended solids.

8.0 CONCLUSION

All volatile organic compound concentrations detected in the samples of runoff water were below EPA MCLs. More testing will be necessary to determine the levels of gasoline constituents present in stormwater.

The results of the incidental spill performed at the Category 5 RGO indicate that good housekeeping practices minimize the amount of gasoline constituents present on the RGO ground surface. By minimizing the gasoline constituents present on the ground surface, minimal gasoline constituents will be available to be washed away with the runoff water from the RGO surface during a storm event.

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TABLES

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Station Category 1
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Table 1

Sample ID	Time	Location	Analysis	Weather
101-1	Water Sample 9:25	Background (Service Station Source Water)	EPA 8015M EPA 8020	Clear and sunny Temp. 72°F Rel. Hum. 63%
101-2	Water Sample 9:25	Background (Service Station Source Water)	EPA 160.2	Temp. 72°F Rel. Hum. 63%
101-3	Water Sample 9:25	Background (Service Station Source Water)	EPA 413.2	Temp. 72°F Rel. Hum. 63%
102-1	15-minute sample 9:33	Pump Island	EPA 8015M EPA 8020	Temp. 72°F Rel. Hum. 63%
102-2	15-minute sample 9:33	Pump Island	EPA 160.2	Temp. 72°F Rel. Hum. 63%
102-3	15-minute sample 9:33	Pump Island	EPA 413.2	Temp. 72°F Rel. Hum. 63%
102-4	15-minute sample 9:33	Pump Island	CAM 22 Metals	Temp. 72°F Rel. Hum. 63%
103-1	30-minute sample 9:48	Pump Island	EPA 8015M EPA 8020	Temp. 73°F Rel. Hum. 61%
103-2	30-minute sample 9:48	Pump Island	EPA 160.2	Temp. 73°F Rel. Hum. 61%
103-3	30-minute sample 9:48	Pump Island	EPA 413.2	Temp. 73°F Rel. Hum. 61%
104-1	45-minute sample 10:04	Pump Island	EPA 8015M EPA 8020	Temp. 72°F Rel. Hum. 62%
104-2	45-minute sample 10:04	Pump Island	EPA 160.2	Temp. 72°F Rel. Hum. 62%
104-3	45-minute sample 10:04	Pump Island	EPA 413.2	Temp. 72°F Rel. Hum. 62%
105-1	Composite Sample 10:10	Pump Island	EPA 8015M EPA 8020	Temp. 72°F Rel. Hum. 62%
105-2	Composite Sample 10:10	Pump Island	EPA 160.2	Temp. 72°F Rel. Hum. 62%
105-3	Composite Sample 10:10	Pump Island	EPA 413.2	Temp. 72°F Rel. Hum. 62%
106-1	15-minute sample 12:04	Driveway Approach	EPA 8015M EPA 8020	Temp. 80°F Rel. Hum. 49%
106-2	15-minute sample 12:04	Driveway Approach	EPA 160.2	Temp. 80°F Rel. Hum. 49%
106-3	15-minute sample 12:04	Driveway Approach	EPA 413.2	Temp. 80°F Rel. Hum. 49%
107-1	30-minute sample 12:19	Driveway Approach	EPA 8015M EPA 8020	Temp. 81°F Rel. Hum. 49%
107-2	30-minute sample 12:19	Driveway Approach	EPA 160.2	Temp. 81°F Rel. Hum. 49%
107-3	30-minute sample 12:19	Driveway Approach	EPA 413.2	Temp. 81°F Rel. Hum. 49%
108-1	45-minute sample 12:33	Driveway Approach	EPA 8015M EPA 8020	Temp. 80°F Rel. Hum. 46%
108-2	45-minute sample 12:33	Driveway Approach	EPA 160.2	Temp. 80°F Rel. Hum. 46%
108-3	45-minute sample 12:33	Driveway Approach	EPA 413.2	Temp. 80°F Rel. Hum. 46%
109-1	Composite Sample 12:45	Driveway Approach	EPA 8015M EPA 8020	Temp. 80°F Rel. Hum. 46%
109-2	Composite Sample 12:45	Driveway Approach	EPA 160.2	Temp. 80°F Rel. Hum. 46%
109-3	Composite Sample 12:45	DrivewayApproach	EPA 413.2	Temp. 80°F Rel. Hum. 46%

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Category 2
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Table 2

Sample ID	Time	Location	Analysis	Weather
301-1	Water Sample 7:30	Background (Service Station Source Water)	EPA 8015M EPA 8020	Temp. 62°F Rel. Hum. 47%
301-2	Water Sample 7:30	Background (Service Station Source Water)	EPA 160.2	Temp. 62°F Rel. Hum. 47%
301-3	Water Sample 7:30	Background (Service Station Source Water)	EPA 413.2	Temp. 62°F Rel. Hum. 47%
302-1	15-minute sample 7:56	Pump Island	EPA 8015M EPA 8020	Temp. 65°F Rel. Hum. 44%
302-2	15-minute sample 7:56	Pump Island	EPA 160.2	Temp. 65°F Rel. Hum. 44%
302-3	15-minute sample 7:56	Pump Island	EPA 413.2	Temp. 65°F Rel. Hum. 44%
302-4	15-minute sample 7:56	Pump Island	CAM 22 Metals	Temp. 65°F Rel. Hum. 44%
303-1	30-minute sample 8:11	Pump Island	EPA 8015M EPA 8020	Temp. 66°F Rel. Hum. 43%
303-2	30-minute sample 8:11	Pump Island	EPA 160.2	Temp. 66°F Rel. Hum. 43%
303-3	30-minute sample 8:11	Pump Island	EPA 413.2	Temp. 66°F Rel. Hum. 43%
304-1	45-minute sample 8:26	Pump Island	EPA 8015M EPA 8020	Temp. 69°F Rel. Hum. 37%
304-2	45-minute sample 8:26	Pump Island	EPA 160.2	Temp. 69°F Rel. Hum. 37%
304-3	45-minute sample 8:26	Pump Island	EPA 413.2	Temp. 69°F Rel. Hum. 37%
305-1	Composite Sample 8:30	Pump Island	EPA 8015M EPA 8020	Temp. 69°F Rel. Hum. 37%
305-2	Composite Sample 8:30	Pump Island	EPA 160.2	Temp. 69°F Rel. Hum. 37%
305-3	Composite Sample 8:30	Pump Island	EPA 413.2	Temp. 69°F Rel. Hum. 37%
306-1	15-minute sample 9:40	Driveway Approach	EPA 8015M EPA 8020	Temp. 85°F Rel. Hum. 25%
306-2	15-minute sample 9:40	Driveway Approach	EPA 160.2	Temp. 85°F Rel. Hum. 25%
306-3	15-minute sample 9:40	Driveway Approach	EPA 413.2	Temp. 85°F Rel. Hum. 25%
307-1	30-minute sample 10:35	Driveway Approach	EPA 8015M EPA 8020	Temp. 88°F Rel. Hum. 21%
307-2	30-minute sample 10:35	Driveway Approach	EPA 160.2	Temp. 88°F Rel. Hum. 21%
307-3	30-minute sample 10:35	Driveway Approach	EPA 413.2	Temp. 88°F Rel. Hum. 21%
308-1	45-minute sample 10:50	Driveway Approach	EPA 8015M EPA 8020	Temp. 89°F Rel. Hum. 20%
308-2	45-minute sample 10:50	Driveway Approach	EPA 160.2	Temp. 89°F Rel. Hum. 20%
308-3	45-minute sample 10:50	Driveway Approach	EPA 413.2	Temp. 89°F Rel. Hum. 20%
309-1	Composite Sample 10:55	Driveway Approach	EPA 8015M EPA 8020	Temp. 89°F Rel. Hum. 20%
309-2	Composite Sample 10:55	Driveway Approach	EPA 160.2	Temp. 89°F Rel. Hum. 20%
309-3	Composite Sample 10:55	Driveway Approach	EPA 413.2	Temp. 89°F Rel. Hum. 20%

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Category 3
9/3/92

Table 3

Sample ID	Time	Location	Analyses	Weather
1-1	Water Sample 11:30	Background (Service Station Source Water)	EPA 8015M EPA 8020	Cloudy & cool Temp. 82°F Rel. Hum. 63%
1-2	Water Sample 11:30	Background (Service Station Source Water)	EPA 160.2	Temp. 82°F Rel. Hum. 63%
1-3	Water Sample 11:30	Background (Service Station Source Water)	EPA 413.2	Temp. 82°F Rel. Hum. 63%
2-1	15-minute sample 12:06	Pump Island	EPA 8015M EPA 8020	Temp. 83°F Rel. Hum. 60%
2-2	15-minute sample 12:06	Pump Island	EPA 160.2	Temp. 83°F Rel. Hum. 60%
2-3	15-minute sample 12:06	Pump Island	EPA 413.2	Temp. 83°F Rel. Hum. 60%
2-4	15-minute sample 12:06	Pump Island	CAM 22 Metals	Temp. 83°F Rel. Hum. 60%
3-1	30-minute sample 12:22	Pump Island	EPA 8015M EPA 8020	Temp. 84°F Rel. Hum. 59%
3-2	30-minute sample 12:22	Pump Island	EPA 160.2	Temp. 84°F Rel. Hum. 59%
3-3	30-minute sample 12:22	Pump Island	EPA 413.2	Temp. 84°F Rel. Hum. 59%
4-1	45-minute sample 12:38	Pump Island	EPA 8015M EPA 8020	Temp. 83°F Rel. Hum. 60%
4-2	45-minute sample 12:38	Pump Island	EPA 160.2	Temp. 83°F Rel. Hum. 60%
4-3	45-minute sample 12:38	Pump Island	EPA 413.2	Temp. 83°F Rel. Hum. 60%
5-1	Composite Sample 12:44	Pump Island	EPA 8015M EPA 8020	Temp. 83°F Rel. Hum. 60%
5-2	Composite Sample 12:44	Pump Island	EPA 160.2	Temp. 83°F Rel. Hum. 60%
5-3	Composite Sample 12:44	Pump Island	EPA 413.2	Temp. 83°F Rel. Hum. 60%
6-1	15-minute sample 14:55	Driveway Approach	EPA 8015M EPA 8020	Temp. 78°F Rel. Hum. 67%
6-2	15-minute sample 14:55	Driveway Approach	EPA 160.2	Temp. 78°F Rel. Hum. 67%
6-3	15-minute sample 14:55	Driveway Approach	EPA 413.2	Temp. 78°F Rel. Hum. 67%
7-1	30-minute sample 15:11	Driveway Approach	EPA 8015M EPA 8020	Temp. 80°F Rel. Hum. 63%
7-2	30-minute sample 15:11	Driveway Approach	EPA 160.2	Temp. 80°F Rel. Hum. 63%
7-3	30-minute sample 15:11	Driveway Approach	EPA 413.2	Temp. 80°F Rel. Hum. 63%
8-1	45-minute sample 15:25	Driveway Approach	EPA 8015M EPA 8020	Temp. 80°F Rel. Hum. 63%
8-2	45-minute sample 15:25	Driveway Approach	EPA 160.2	Temp. 80°F Rel. Hum. 63%
8-3	45-minute sample 15:25	Driveway Approach	EPA 413.2	Temp. 80°F Rel. Hum. 63%
9-1	Composite Sample 15:42	Driveway Approach	EPA 8015M EPA 8020	Temp. 80°F Rel. Hum. 63%
9-2	Composite Sample 15:42	Driveway Approach	EPA 160.2	Temp. 80°F Rel. Hum. 63%
9-3	Composite Sample 15:42	Driveway Approach	EPA 413.2	Temp. 80°F Rel. Hum. 63%

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Category 4
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Table 4

Sample ID	Time	Location	Analysis	Weather
201-1	Source Water Sample 9:30	Background (Service eStation Source Water)	EPA 8015M EPA 8020	Clear Temp. 72°F Rel. Hum. 67%
201-2	Source Water Sample 9:30	Background (Service eStation Source Water)	EPA 160.2	Temp. 72°F Rel. Hum. 67%
201-3	Source Water Sample 9:30	Background (Service eStation Source Water)	EPA 413.2	Temp. 72°F Rel. Hum. 67%
202-1	15-minute sample 9:55	Pump Island	EPA 8015M EPA 8020	Temp. 75°F Rel. Hum. 66%
202-2	15-minute sample 9:55	Pump Island	EPA 160.2	Temp. 75°F Rel. Hum. 66%
202-3	15-minute sample 9:55	Pump Island	EPA 413.2	Temp. 75°F Rel. Hum. 66%
202-4	15-minute sample 9:55	Pump Island	CAM 22 Metals	Temp. 75°F Rel. Hum. 66%
203-1	30-minute sample 10:10	Pump Island	EPA 8015M EPA 8020	Temp. 75°F Rel. Hum. 65%
203-2	30-minute sample 10:10	Pump Island	EPA 160.2	Temp. 75°F Rel. Hum. 65%
203-3	30-minute sample 10:10	Pump Island	EPA 413.2	Temp. 75°F Rel. Hum. 65%
204-1	45-minute sample 10:25	Pump Island	EPA 8015M EPA 8020	Temp. 77°F Rel. Hum. 64%
204-2	45-minute sample 10:25	Pump Island	EPA 160.2	Temp. 77°F Rel. Hum. 64%
204-3	45-minute sample 10:25	Pump Island	EPA 413.2	Temp. 77°F Rel. Hum. 64%
205-1	Composite Sample 10:30	Pump Island	EPA 8015M EPA 8020	Temp. 77°F Rel. Hum. 64%
205-2	Composite Sample 10:30	Pump Island	EPA 160.2	Temp. 77°F Rel. Hum. 64%
205-3	Composite Sample 10:30	Pump Island	EPA 413.2	Temp. 77°F Rel. Hum. 64%
206-1	15-minute sample 13:25	Driveway Approach	EPA 8015M EPA 8020	Temp. 84°F Rel. Hum. 48%
206-2	15-minute sample 13:25	Driveway Approach	EPA 160.2	Temp. 84°F Rel. Hum. 48%
206-3	15-minute sample 13:25	Driveway Approach	EPA 413.2	Temp. 84°F Rel. Hum. 48%
207-1	30-minute sample 13:40	Driveway Approach	EPA 8015M EPA 8020	Temp. 83°F Rel. Hum. 48%
207-2	30-minute sample 13:40	Driveway Approach	EPA 160.2	Temp. 83°F Rel. Hum. 48%
207-3	30-minute sample 13:40	Driveway Approach	EPA 413.2	Temp. 83°F Rel. Hum. 48%
208-1	45-minute sample 13:55	Driveway Approach	EPA 8015M EPA 8020	Temp. 83°F Rel. Hum. 48%
208-2	45-minute sample 13:55	Driveway Approach	EPA 160.2	Temp. 83°F Rel. Hum. 48%
208-3	45-minute sample 13:55	Driveway Approach	EPA 413.2	Temp. 83°F Rel. Hum. 48%
209-1	Composite Sample 13:55	Driveway Approach	EPA 8015M EPA 8020	Temp. 83°F Rel. Hum. 48%
209-2	Composite Sample 13:55	Driveway Approach	EPA 160.2	Temp. 83°F Rel. Hum. 48%
209-3	Composite Sample 13:55	Driveway Approach	EPA 413.2	Temp. 83°F Rel. Hum. 48%

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Category 5
9/17/92

Table 5

Sample ID	Time	Location	Analysis	Weather
401-1	Source Water Sample 5:25	Background (Service Station Water Source)	EPA 8015M EPA 8020	Cloudy & sprinkling Temp. 84°F Rel. Hum. 36%
401-2	Water Sample 5:25	Background (Source)	EPA 160.2	Temp. 84°F Rel. Hum. 36%
401-3	Water Sample 5:25	Background (Service Station Water Source)	EPA 413.2	Temp. 84°F Rel. Hum. 36%
402-1	15-minute sample 5:56	Pump Island	EPA 8015M EPA 8020	Temp. 84°F Rel. Hum. 36%
402-2	15-minute sample 5:56	Pump Island	EPA 160.2	Temp. 84°F Rel. Hum. 36%
402-3	15-minute sample 5:56	Pump Island	EPA 413.2	Temp. 84°F Rel. Hum. 35%
402-4	15-minute sample 5:56	Pump Island	CAM 22 Metals	Temp. 84°F Rel. Hum. 36%
403-1	30-minute sample 6:11	Pump Island	EPA 8015M EPA 8020	Temp. 83°F Rel. Hum. 36%
403-2	30-minute sample 6:11	Pump Island	EPA 160.2	Temp. 83°F Rel. Hum. 36%
403-3	30-minute sample 6:11	Pump Island	EPA 413.2	Temp. 83°F Rel. Hum. 36%
404-1	45-minute sample 6:26	Pump Island	EPA 8015M EPA 8020	Temp. 83°F Rel. Hum. 35%
404-2	45-minute sample 6:26	Pump Island	EPA 160.2	Temp. 83°F Rel. Hum. 35%
404-3	45-minute sample 6:26	Pump Island	EPA 413.2	Temp. 83°F Rel. Hum. 35%
405-1	Composite Sample 6:30	Pump Island	EPA 8015M EPA 8020	Temp. 83°F Rel. Hum. 35%
405-2	Composite Sample 6:30	Pump Island	EPA 160.2	Temp. 83°F Rel. Hum. 35%
405-3	Composite Sample 6:30	Pump Island	EPA 413.2	Temp. 83°F Rel. Hum. 35%
406-1	15-minute sample 7:45	Driveway Approach	EPA 8015M EPA 8020	Temp. 80°F Rel. Hum. 45%
406-2	15-minute sample 7:45	Driveway Approach	EPA 160.2	Temp. 80°F Rel. Hum. 45%
406-3	15-minute sample 7:45	Driveway Approach	EPA 413.2	Temp. 80°F Rel. Hum. 45%
407-1	30-minute sample 8:00	Driveway Approach	EPA 8015M EPA 8020	Temp. 78°F Rel. Hum. 58%
407-2	30-minute sample 8:00	Driveway Approach	EPA 160.2	Temp. 78°F Rel. Hum. 58%
407-3	30-minute sample 8:00	Driveway Approach	EPA 413.2	Temp. 78°F Rel. Hum. 58%
408-1	45-minute sample 8:15	Driveway Approach	EPA 8015M EPA 8020	Temp. 78°F Rel. Hum. 58%
408-2	45-minute sample 8:15	Driveway Approach	EPA 160.2	Temp. 78°F Rel. Hum. 58%
408-3	45-minute sample 8:15	Driveway Approach	EPA 413.2	Temp. 78°F Rel. Hum. 58%
409-1	Composite Sample 8:20	Driveway Approach	EPA 8015M EPA 8020	Temp. 78°F Rel. Hum. 58%
409-2	Composite Sample 8:20	Driveway Approach	EPA 160.2	Temp. 78°F Rel. Hum. 58%
409-3	Composite Sample 8:20	Driveway Approach	EPA 413.2	Temp. 78°F Rel. Hum. 58%

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Table 6
AROMATIC VOLATILES AND TPH RESULTS

WSPA Category	Sample ID	Date Sampled	Benzene in µg/L (ppb) 0.3 µg/L [1]	Toluene in µg/L (ppb) 0.3 µg/L [1]	Ethylbenzene in µg/L (ppb) 0.3 µg/L [1]	Total Xylenes in µg/L (ppb) 0.6 µg/L [1]	TPH as Gasoline in µg/L (ppb) 100 µg/L [1]
1	101-1	9/4/92	<0.3	<0.3	<0.3	<0.6	<100
1	102-1	9/4/92	<0.3	0.5	<0.3	0.7	<100
1	103-1	9/4/92	<0.3	0.6	<0.3	0.8	<100
1	104-1	9/4/92	<0.3	0.8	<0.3	1.4	<100
1	105-1	9/4/92	<0.3	0.8	<0.3	1.3	<100
1	106-1	9/4/92	<0.3	<0.3	<0.3	<0.6	<100
1	107-1	9/4/92	<0.3	<0.3	<0.3	<0.6	<100
1	108-1	9/4/92	<0.3	<0.3	<0.3	<0.6	<100
1	109-1	9/4/92	<0.3	<0.3	<0.3	<0.6	<100
1	TB	9/4/92	<0.3	<0.3	<0.3	<0.6	<100
2	301-1	9/10/92	<0.3	<0.3	<0.3	<0.6	<100
2	302-1	9/10/92	<0.3	<0.3	<0.3	<0.6	<100
2	303-1	9/10/92	<0.3	<0.3	<0.3	<0.6	<100
2	304-1	9/10/92	<0.3	<0.3	<0.3	<0.6	<100
2	305-1	9/10/92	<0.3	<0.3	<0.3	<0.6	<100
2	306-1	9/10/92	1.3	<0.3	<0.3	<0.6	<100
2	307-1	9/10/92	<0.3	<0.3	<0.3	<0.6	<100
2	308-1	9/10/92	<0.3	<0.3	<0.3	<0.6	<100
2	309-1	9/10/92	0.4	<0.3	<0.3	<0.6	<100
2	TB	9/10/92	<0.3	0.5	<0.3	<0.6	<100
3	1-1	9/3/92	<0.3	<0.3	<0.3	1.5	<100
3	2-1	9/3/92	<3.0	7.9	<3.0	20	<1000
3	3-1	9/3/92	<0.3	<0.3	<0.3	<0.6	<100
3	4-1	9/3/92	<0.3	0.4	<0.3	1.1	<100
3	5-1	9/3/92	<0.3	0.3	<0.3	1.1	<100
3	6-1	9/3/92	<3.0	<3.0	<3.0	<6.0	<1000
3	7-1	9/3/92	<3.0	<3.0	<3.0	<6.0	<1000
3	8-1	9/3/92	0.5	4.5	1.1	12	<100
3	9-1	9/3/92	<0.3	0.8	<0.3	3.4	<100
3	TB	9/3/92	<0.3	<0.3	<0.3	<0.6	<100
4	201-1	9/9/92	<0.3	0.3	<0.3	7.1	<100
4	202-1	9/9/92	<0.3	<0.3	<0.3	<0.6	<100
4	203-1	9/9/92	<0.3	<0.3	<0.3	<0.6	<100
4	204-1	9/9/92	<0.3	0.4	<0.3	1.5	<100
4	205-1	9/9/92	<0.3	<0.3	<0.3	1.4	<100
4	206-1*	9/9/92	<3.0	<3.0	<3.0	<6.0	<1000
4	207-1	9/9/92	<0.3	<0.3	<0.3	<0.6	<100
4	208-1	9/9/92	<0.3	<0.3	<0.3	<0.6	<100
4	209-1	9/9/92	<0.3	<0.3	<0.3	<0.6	130
4	TB	9/9/92	<0.3	0.7	<0.3	<0.6	<100
5	401-1	9/17/92	<0.3	<0.3	<0.3	<0.6	<100
5	402-1*	9/17/92	<3.0	9.5	<3.0	19	<1000
5	403-1*	9/17/92	<3.0	14	5.0	37	<1000
5	404-1	9/17/92	1.0	13	6.3	41	180
5	405-1*	9/17/92	<3.0	9.5	3.4	22	<1000
5	406-1*	9/17/92	<7.5	<7.5	<7.5	<15	<2500
5	407-1*	9/17/92	<3.0	<3.0	<3.0	<6.0	<1000
5	408-1*	9/17/92	<7.5	<7.5	<7.5	<15	<2500
5	409-1*	9/17/92	<7.5	<7.5	<7.5	<15	<2500
5	TB	9/17/92	<0.3	<0.3	<0.3	<0.6	<100

1 - Detection Limit

* - Detection limit increased due to matrix effect (foaming)

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Table 7
TOTAL SUSPENDED SOLIDS RESULTS

WSPA Category No.	Sample ID	Date Sampled	Total Suspended Solids in mg/L (ppm)
1	101-2	9/4/92	<10
1	102-2	9/4/92	<10
1	103-2	9/4/92	<10
1	104-2	9/4/92	<10
1	105-2	9/4/92	<10
1	106-2	9/4/92	<10
1	107-2	9/4/92	<10
1	108-2	9/4/92	<10
1	109-2	9/4/92	<10
2	301-2	9/10/92	<10
2	302-2	9/10/92	<10
2	303-2	9/10/92	<10
2	304-2	9/10/92	<10
2	305-2	9/10/92	<10
2	306-2	9/10/92	<10
2	307-2	9/10/92	<10
2	308-2	9/10/92	<10
2	309-2	9/10/92	<10
3	1-2	9/3/92	11
3	2-2	9/3/92	13
3	3-2	9/3/92	<10
3	4-2	9/3/92	<10
3	5-2	9/3/92	<10
3	6-2	9/3/92	<10
3	7-2	9/3/92	<10
3	8-2	9/3/92	<10
3	9-2	9/3/92	<10
4	201-2	9/9/92	14
4	202-2	9/9/92	<10
4	203-2	9/9/92	<10
4	204-2	9/9/92	<10
4	205-2	9/9/92	13
4	206-2	9/9/92	11
4	207-2	9/9/92	10
4	208-2	9/9/92	12
4	209-2	9/9/92	<10
5	401-2	9/17/92	<10
5	402-2	9/17/92	<10
5	403-2	9/17/92	<10
5	404-2	9/17/92	<10
5	405-2	9/17/92	<10
5	406-2	9/17/92	<10
5	407-2	9/17/92	<10
5	408-2	9/17/92	13
5	409-2	9/17/92	<10

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Table 8
METALS RESULTS

WSPA Category No:	1	2	3	4	5
Sample ID:	102-4	302-4	2-4	202-4	402-4
Date Sampled:	9/4/92	9/10/92	9/3/92	9/9/92	9/17/92
Metals in µg/L (ppb)					
Antimony	<40	<40	<40	<40	<40
Arsenic	<100	<100	<100	<100	<100
Barium	130	<20	60	60	80
Beryllium	<10	<10	<10	<10	<10
Cadmium	<30	<30	<30	<30	<30
Chromium	<40	<40	<40	<40	<40
Cobalt	<20	<20	<20	<20	<20
Copper	<200	<200	<200	<200	200
Lead	<100	<100	<100	<100	<100
Mercury	<1	<1	<1	<1	<1
Molybdenum	<20	<20	<20	<20	<20
Nickel	<100	<100	<100	<100	<100
Selenium	<40	<40	<40	<40	<40
Silver	<50	<50	<50	<50	<50
Thalium	<400	<400	<400	<400	<400
Vanadium	<200	<200	<200	<200	<200
Zinc	<100	<100	200	200	600

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5502

Table 9
TOTAL RECOVERABLE OIL AND GREASE RESULTS

WSPA Category No.	Sample ID	Date Sampled	Total Oil and Grease in mg/L (ppm)
1	101-3	9/4/92	<1
1	102-3	9/4/92	1
1	103-3	9/4/92	<1
1	104-3	9/4/92	1
1	105-3	9/4/92	<1
1	106-3	9/4/92	2
1	107-3	9/4/92	1
1	108-3	9/4/92	2
1	109-3	9/4/92	1
2	301-3	9/10/92	<1
2	302-3	9/10/92	<1
2	303-3	9/10/92	<1
2	304-3	9/10/92	<1
2	305-3	9/10/92	<1
2	306-3	9/10/92	1
2	307-3	9/10/92	<1
2	308-3	9/10/92	<1
2	309-3	9/10/92	1
3	1-3	9/3/92	<1
3	2-3	9/3/92	8
3	3-3	9/3/92	3
3	4-3	9/3/92	2
3	5-3	9/3/92	3
3	6-3	9/3/92	1
3	7-3	9/3/92	<1
3	8-3	9/3/92	1
3	9-3	9/3/92	<1
4	201-3	9/9/92	15
4	202-3	9/9/92	4
4	203-3	9/9/92	2
4	204-3	9/9/92	8
4	205-3	9/9/92	1
4	206-3	9/9/92	2
4	207-3	9/9/92	1
4	208-3	9/9/92	<1
4	209-3	9/9/92	<1
5	401-3	9/17/92	<1
5	402-3	9/17/92	9
5	403-3	9/17/92	7
5	404-3	9/17/92	9
5	405-3	9/17/92	34
5	406-3	9/17/92	9
5	407-3	9/17/92	11
5	408-3	9/17/92	6
5	409-3	9/17/92	29

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Table 10
COMPARISON OF ANALYTICAL RESULTS FOR THE CATEGORY I STATION VERSUS WATER QUALITY CRITERIA AND TYPICAL CONCENTRATIONS IN URBAN RUNOFF

	Average Concentration Observed in Runoff	USEPA Drinking Water MCL (a)	CA Drinking Water Objective (b)	USEPA Freshwater Aquatic Life Chronic (c)	USEPA Marine Aquatic Life Chronic (c)	CA Draft Freshwater Aquatic Life Water Quality Objectives (d)	CA Draft Saltwater Aquatic Life Water Quality Objectives (e)	Range of Concentrations Typical in Urban Runoff (f)
Aromatic Volatiles in µg/L (ppb)								
Benzene	<0.3	5	0.34	--	700	--	--	1-13
Toulene	<0.47	1,000	--	--	5,000	--	--	3.9
Ethylbenzene	<0.3	700	--	--	--	--	--	--
Total Xylenes	<0.8	10,000	--	--	--	--	--	--
Total suspended solids in mg/L (ppm)	<10							17-2,900
Metals in µg/L (ppb)								
Antimony	<40	5	14	1,600	--	--	--	2.6 - 23
Arsenic	<100	50	5	--	--	190	36	1 - 50.5
Barium	130	1,000	--	--	--	--	--	--
Beryllium	<10	1	0.008	5.3	--	--	--	1 - 49
Cadmium	<30	5	10	1.1	9.3	(g)	9.3	0.1 - 14
Chromium (Hexavalent)	<40	100	50	11	50	11	50	1 - 190
Cobalt	<20	--	--	--	--	--	--	--
Copper	<200	1,000	1,000	12	2.9	(g)	--	10 - 100
Lead	<100	50	50	3.2	5.6	(g)	5.6	6 - 460
Mercury	<1	2	12	0.012	0.025	--	--	0.6 - 1.2
Molybdenum	<20	--	--	--	--	--	--	--
Nickel	<100	100	600	160	8.3	(g)	8.3	1 - 182
Selenium	<40	50	10	35	54	5	71	2 - 77
Silver	<50	50	500	0.12	--	--	--	0.2 - 0.8
Thallium	<400	1	1.7	40	--	--	--	1 - 14
Vanadium	<200	--	--	--	--	--	--	--
Zinc	<100	5,000	5,000	110	58	(g)	86	10 - 2,400

R0058797

Table 11

COMPARISON OF ANALYTICAL RESULTS FOR THE CATEGORY 2 STATION VERSUS WATER QUALITY CRITERIA AND TYPICAL CONCENTRATIONS URBAN RUNOFF

	Average Concentration Observed in Runoff	USEPA Drinking Water MCL (a)	CA Drinking Water Objective (b)	USEPA Freshwater Aquatic Life Chronic (c)	USEPA Marine Aquatic Life Chronic (c)	CA Draft Freshwater Aquatic Life Water Quality Objectives (d)	CA Draft Saltwater Aquatic Life Water Quality Objectives (e)	Range of Concentrations Typical in Urban Runoff (f)
Aromatic Volatiles in µg/L (ppb)								
Benzene	<0.44	5	0.34	--	700	--	--	1-13
Toulene	<0.3	1,000	--	--	5,000	--	--	3-9
Ethylbenzene	<0.3	700	--	--	--	--	--	--
Total Xylenes	<0.6	10,000	--	--	--	--	--	--
Total suspended solids in mg/l (ppm)	<10							17-2,900
Metals in µg/L (ppb)								
Antimony	<40	5	14	1,600	--	--	--	2.6 - 23
Arsenic	<100	50	5	--	--	190	36	1 - 50.5
Barium	<20	1,000	--	--	--	--	--	--
Beryllium	<10	1	0.008	5.3	--	--	--	1 - 49
Cadmium	<30	5	10	1.1	9.3	(g)	9.3	0.1 - 14
Chromium (Hexavalent)	<40	100	50	11	50	11	50	1 - 190
Cobalt	<20	--	--	--	--	--	--	--
Copper	<200	1,000	1,000	12	2.9	(g)	--	10 - 100
Lead	<100	50	50	3.2	5.6	(g)	5.6	6 - 460
Mercury	<1	2	12	0.012	0.025	--	--	0.6 - 1.2
Molybdenum	<20	--	--	--	--	--	--	--
Nickel	<100	100	600	160	8.3	(g)	8.3	1 - 182
Selenium	<40	50	10	35	54	5	71	2 - 77
Silver	<40	50	500	0.12	--	--	--	0.2 - 0.8
Thallium	<400	1	1.7	40	--	--	--	1 - 14
Vanadium	<200	--	--	--	--	--	--	--
Zinc	<100	5,000	5,000	110	58	(g)	86	10 - 2,400

R0058798

VOL 12 2 55505

Table 12
COMPARISON OF ANALYTICAL RESULTS FOR THE CATEGORY 3 STATION VERSUS WATER QUALITY CRITERIA AND TYPICAL CONCENTRATIONS URBAN RUNOFF

	Average Concentration Observed in Runoff	USEPA Drinking Water MCL (a)	CA Drinking Water Objective (b)	EPA Freshwater Aquatic Life Chronic (c)	EPA Marine Aquatic Life Chronic (c)	CA Draft Freshwater Aquatic Life Water Quality Objectives (d)	CA Draft Saltwater Aquatic Life Water Quality Objectives (e)	Range of Concentrations Typical in Urban Runoff (f)
Aromatic Volatiles in µg/L (ppb)								
Benzene	<0.32	5	0.34	--	700	--	--	1-13
Toulene	<1.68	1,000	--	--	5,000	--	--	3-9
Ethylbenzene	<1.17	700	--	--	--	--	--	--
Total Xylenes	<5.81	10,000	--	--	--	--	--	--
Total suspended solids in mg/l (ppm)	<10.4							17-2,900
Metals in µg/L (ppb)								
Antimony	<40	5	14	1,600	--	--	--	2.6 - 23
Arsenic	<100	50	5	--	--	190	36	1 - 50.5
Barium	60	1,000	--	--	--	--	--	--
Beryllium	<10	1	0.008	5.3	--	--	--	1 - 49
Cadmium	<30	5	10	1.1	9.3	(g)	9.3	0.1 - 14
Chromium (Hexavalent)	<40	100	50	11	50	11	50	1 - 190
Cobalt	<20	--	--	--	--	--	--	--
Copper	<200	1,000	1,000	12	2.9	(g)	--	10 - 100
Lead	<100	50	50	3.2	5.6	(g)	5.6	6 - 460
Mercury	<1	2	12	0.012	0.025	--	--	0.6 - 1.2
Molybdenum	<20	--	--	--	--	--	--	--
Nickel	<100	100	600	160	8.3	(g)	8.3	1 - 182
Selenium	<40	50	10	35	54	5	71	2 - 77
Silver	<50	50	500	0.12	--	--	--	0.2 - 0.8
Thallium	<400	1	1.7	40	--	--	--	1 - 14
Vanadium	<200	--	--	--	--	--	--	--
Zinc	200	5,000	5,000	110	58	(g)	86	10 - 2,400

R0058799

Table 13
COMPARISON OF ANALYTICAL RESULTS FOR THE CATEGORY 4 STATION VERSUS WATER QUALITY CRITERIA AND TYPICAL CONCENTRATIONS URBAN RUNOFF

	Average Concentration Observed in Runoff	USEPA Drinking Water MCL (a)	CA Drinking Water Objective (b)	USEPA Freshwater Aquatic Life Chronic (c)	USEPA Marine Aquatic Life Chronic (c)	CA Draft Freshwater Aquatic Life Water Quality Objectives (d)	CA Draft Saltwater Aquatic Life Water Quality Objectives (e)	Range of Concentrations Typical in Urban Runoff (f)
Aromatic Volatiles in µg/L (ppb)								
Benzene	<0.3	5	0.34	--	700	--	--	1-13
Toulene	<6.1	1,000	--	--	5,000	--	--	3.9
Ethylbenzene	<0.6	700	--	--	--	--	--	--
Total Xylenes	<2.1	10,000	--	--	--	--	--	--
Total suspended solids in mg/l (ppm)	<11.1							17-2,900
Metals in µg/L (ppb)								
Antimony	<40	5	14	1,600	--	--	--	2.6 - 23
Arsenic	<100	50	5	--	--	190	36	1 - 50.5
Barium	60	1,000	--	--	--	--	--	--
Beryllium	<10	1	0.008	5.3	--	--	--	1 - 49
Cadmium	<30	5	10	1.1	9.3	(g)	9.3	0.1 - 14
Chromium (Hexavalent)	<40	100	50	11	50	11	50	1 - 190
Cobalt	<20	--	--	--	--	--	--	--
Copper	<200	1,000	1,000	12	2.9	(g)	--	10 - 100
Lead	<100	50	50	3.2	5.6	(g)	5.6	6 - 460
Mercury	<1	2	12	0.012	0.025	--	--	0.6 - 1.2
Molybdenum	<20	--	--	--	--	--	--	--
Nickel	<100	100	600	160	8.3	(g)	8.3	1 - 182
Selenium	<40	50	10	35	54	5	71	2 - 77
Silver	<50	50	500	0.12	--	--	--	0.2 - 0.8
Thallium	<400	1	1.7	40	--	--	--	1 - 14
Vanadium	<200	--	--	--	--	--	--	--
Zinc	200	5,000	5,000	110	58	(g)	86	10 - 2,400

R0058800

Table 14

COMPARISON OF ANALYTICAL RESULTS FOR THE CATEGORY 5 STATION VERSUS WATER QUALITY CRITERIA AND TYPICAL CONCENTRATIONS URBAN RUNOFF

	Average Concentration Observed in Runoff	USEPA Drinking Water MCL (a)	CA Drinking Water Objective (b)	USEPA Freshwater Aquatic Life Chronic (c)	USEPA Marine Aquatic Life Chronic (c)	CA Draft Freshwater Aquatic Life Water Quality Objectives (d)	CA Draft Saltwater Aquatic Life Water Quality Objectives (e)	Range of Concentrations Typical in Urban Runoff (f)
Aromatic Volatiles in µg/L (ppb)								
Benzene	<3.98	5	0.34	--	700	--	--	1-13
Toulene	<7.98	1,000	--	--	5,000	--	--	3-9
Ethylbenzene	<4.83	700	--	--	--	--	--	--
Total Xylenes	<18.96	10,000	--	--	--	--	--	--
Total suspended solids in mg/l (ppm)	<10.3							17-2,900
Metals in µg/L (ppb)								
Antimony	<40	5	14	1,600	--	--	--	2.6 - 23
Arsenic	<100	50	5	--	--	190	36	1 - 50.5
Barium	80	1,000	--	--	--	--	--	--
Beryllium	<10	1	0.008	5.3	--	--	--	1 - 49
Cadmium	<30	5	10	1.1	9.3	(g)	9.3	0.1 - 14
Chromium (Hexavalent)	<40	100	50	11	50	11	50	1 - 190
Cobalt	<20	--	--	--	--	--	--	--
Copper	200	1,000	1,000	12	2.9	(g)	--	10 - 100
Lead	<100	50	50	3.2	5.6	(g)	5.6	6 - 460
Mercury	<1	2	12	0.012	0.025	--	--	0.6 - 1.2
Molybdenum	<20	--	--	--	--	--	--	--
Nickel	<100	100	600	160	8.3	(g)	8.3	1 - 182
Selenium	<40	50	10	35	54	5	71	2 - 77
Silver	<50	50	500	0.12	--	--	--	0.2 - 0.8
Thallium	<400	1	1.7	40	--	--	--	1 - 14
Vanadium	<200	--	--	--	--	--	--	--
Zinc	600	5,000	5,000	110	58	(g)	86	10 - 2,400

R0058801

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FIGURE

2

5509

R0058802

Process Flow Diagram - Water Distribution and Runoff Collection Set-Up

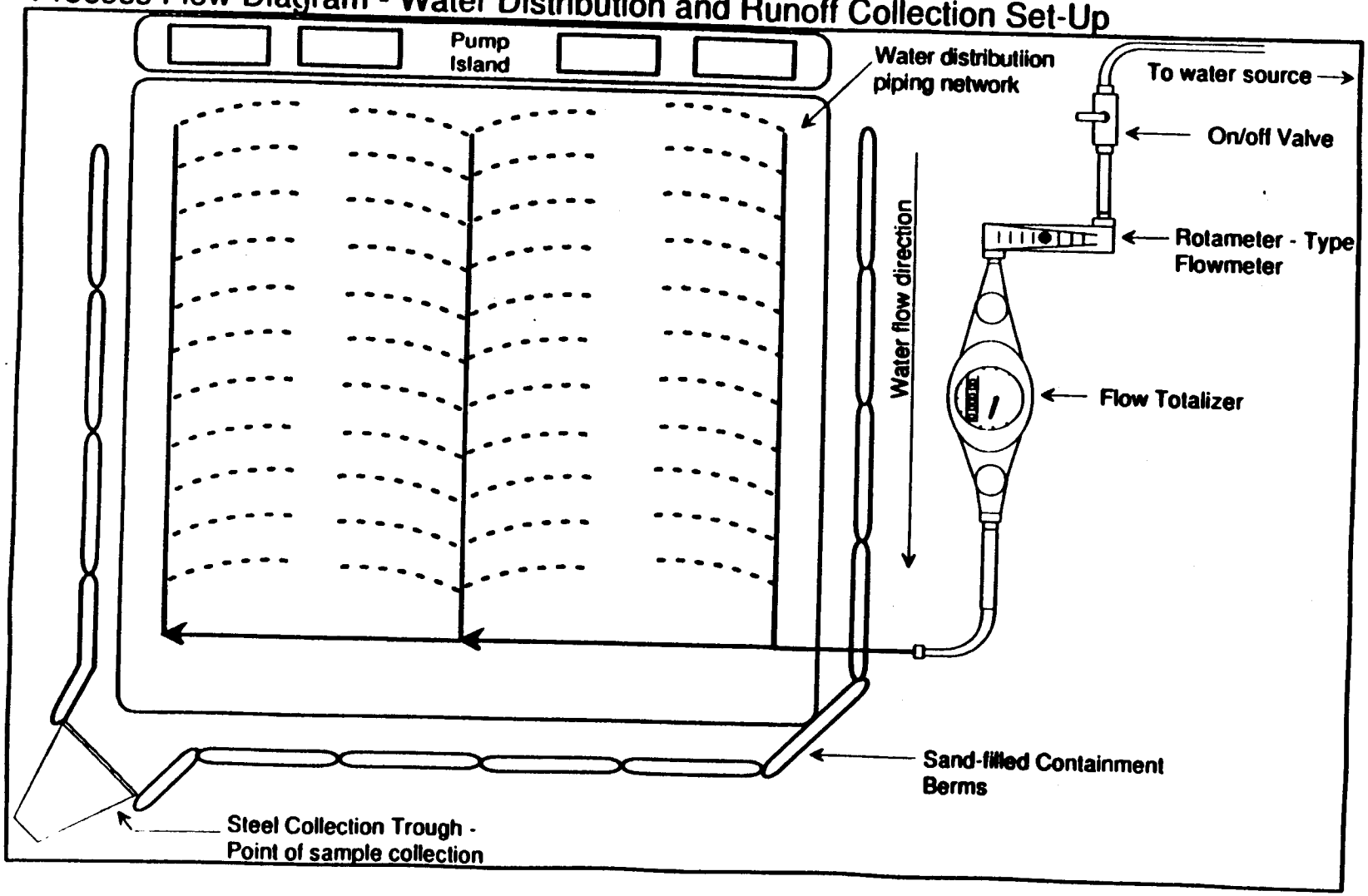


Figure 1

R0058803

C3-555 2 VOL 12

Typical RGO Runoff Sampling Set-Up

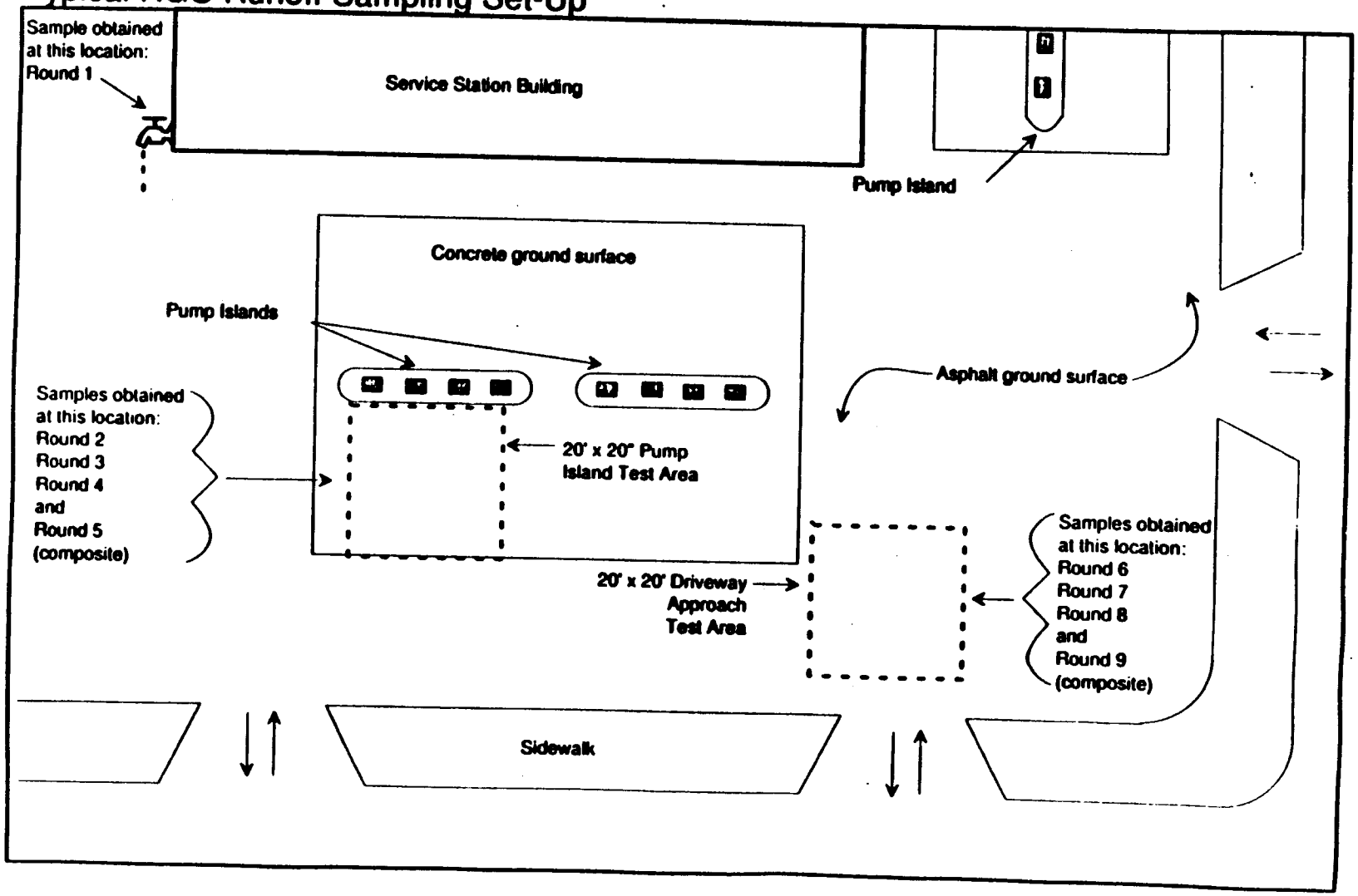
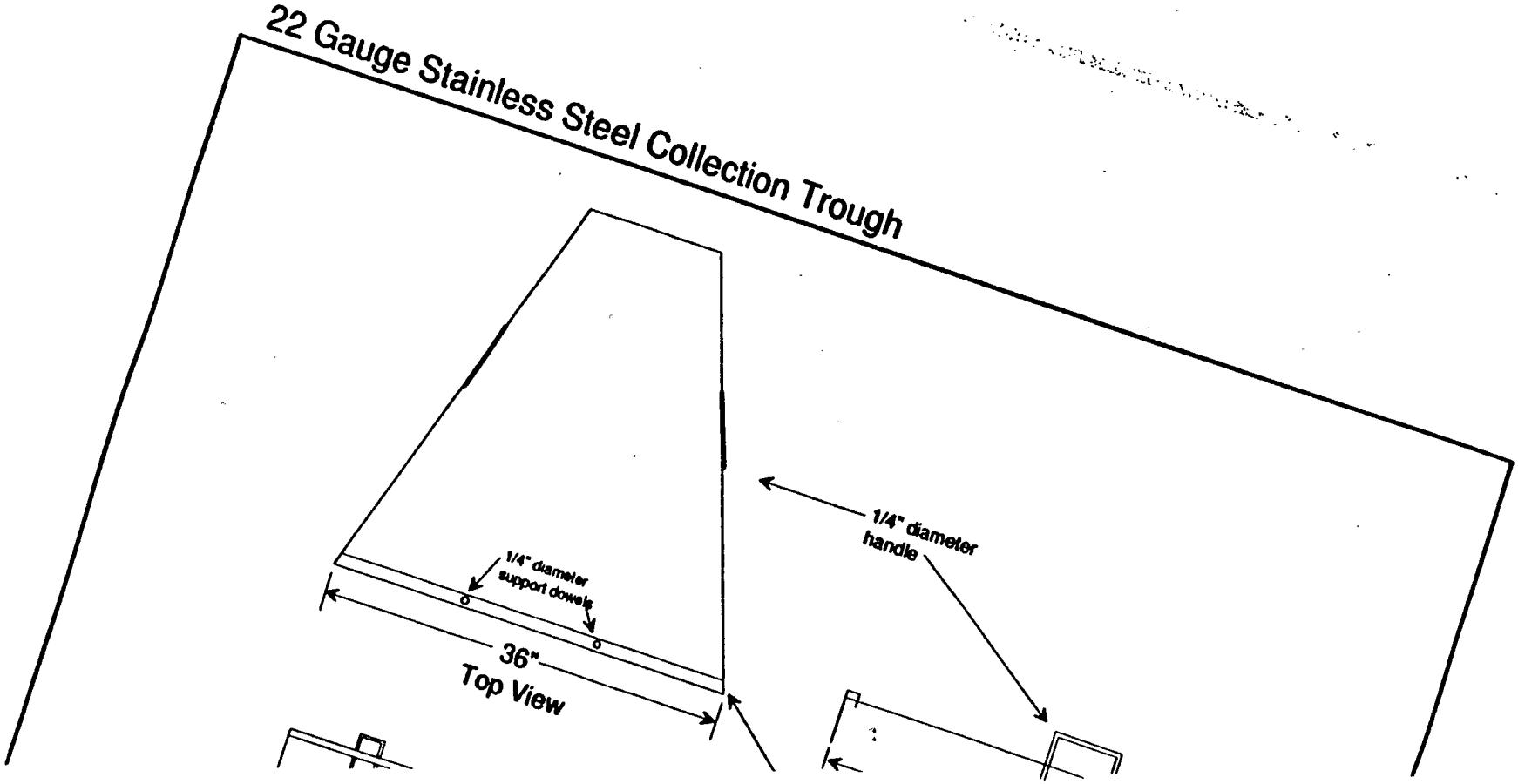


Figure 2

R0058804

[redacted]



R0058805

VOL 12

APPENDIX A
GTEL LABORATORY ANALYTICAL DATA SHEETS

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R0058806

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VOL 12

CATEGORY 1

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R0058807

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GTEL
ENVIRONMENTAL
LABORATORIES, INC.

Southwest Region
20000 / 300 Mariner Drive
Torrance, CA 90503
(310) 371-1044
(800) 727-GTEL
Fax (310) 371-8720

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: 5-6565
Work Order Number: T209038
Report Issue Date: July 1, 1993

VOL 12 2 5 5 1 5

Mr. John Netherwood
Hart Crowser
1 World Trade Center
Long Beach, CA 90831

Dear Mr. Netherwood,

This report replaces the original report, dated September 22, 1992, which is being reissued due to GTEL's inadvertant ommission of information pertaining to this project. Enclosed please find the analytical results for the samples received by GTEL Environmental Laboratories, Inc. on 9/4/92.

A formal Quality Assurance/Quality Control (QA/QC) program is maintained by GTEL, which is designed to meet or exceed the EPA requirements. Analytical work for this project met QA/QC criteria unless otherwise stated in the footnotes.

GTEL is certified by the state of California under Certification #1123.

If you have any questions concerning this analysis or if we can be of further assistance, please call our Customer Service Representative.

Sincerely,

GTEL Environmental Laboratories, Inc.

for JG

Joan Greenwood
Laboratory Director

R0058808

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: 5-6565
Work Order Number: T209038
Report Issue Date: July 1, 1993

ANALYTICAL RESULTS

Volatile Organics in Water
EPA Methods Modified 8020 and Modified 8015[a]

GTEL Sample Number		Lab Blank	09038-1A	09038-4A	09038-6A
Client Identification		-	101-1	102-1	103-1
Date Sampled		-	9/4/92	9/4/92	9/4/92
Date Analyzed		9/14/92	9/14/92	9/14/92	9/14/92
Analyte	Reporting Limit, ug/L	Concentration, ug/L			
Benzene	0.3	<0.3	<0.3	<0.3	<0.3
Toluene	0.3	<0.3	<0.3	0.5	0.6
Ethylbenzene	0.3	<0.3	<0.3	<0.3	<0.3
Xylene, total	0.6	<0.6	<0.6	0.7	0.8
BTEX, total	-	-	-	1.2	1.4
TPH as Gasoline	100	<100	<100	<100	<100
Dilution Multiplier[b]		1	1	1	1
TFT surrogate[c], % recovery		100	94.0	97.0	95.0

a. Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Revision 0, US EPA November 1986. Modification for TPH as gasoline as per California State Water Resources Board LUFT Manual procedures.

b. Indicates the adjustments made for sample dilution.

c. TFT surrogate recovery acceptability limits of 72.8-123% are derived from the 99% confidence interval of all samples during the previous quarter. Expected surrogate value is 100 ug/L.

GTEL ENVIRONMENTAL LABORATORIES, INC

R0058809

VOL 12 2 5516

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: 5-6565
Work Order Number: T209038
Report Issue Date: July 1, 1993

ANALYTICAL RESULTS

Volatile Organics in Water
EPA Methods Modified 8020 and Modified 8015[a]

GTEL Sample Number		09038-11A	09038-14A	09038-17A	09038-20A
Client Identification		104-1	105-1	106-1	107-1
Date Sampled		9/4/92	9/4/92	9/4/92	9/4/92
Date Analyzed		9/15/92	9/15/92	9/15/92	9/15/92
Analyte	Reporting Limit, ug/L	Concentration, ug/L			
Benzene	0.3	<0.3	<0.3	<0.3	<0.3
Toluene	0.3	0.8	0.8	<0.3	<0.3
Ethylbenzene	0.3	<0.3	<0.3	<0.3	<0.3
Xylene, total	0.6	1.4	1.3	<0.6	<0.6
BTEX, total	-	2.2	2.1	-	-
TPH as Gasoline	100	<100	<100	<100	<100
Dilution Multiplier[b]		1	1	1	1
TFT surrogate[c] % recovery		106	86.1	96.9	94.0

a. Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Revision 0, US EPA November 1986. Modification for TPH as gasoline as per California State Water Resources Board LUFT Manual procedures.

b. Indicates the adjustments made for sample dilution.

c. TFT surrogate recovery acceptability limits of 72.8-123% are derived from the 99% confidence interval of all samples during the previous quarter. Expected surrogate value is 100 ug/L.

VOL 12 2 5 5 1 7

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: 5-6565
Work Order Number: T209038
Report Issue Date: July 1, 1993

ANALYTICAL RESULTS

Volatile Organics in Water
EPA Methods Modified 8020 and Modified 8015[a]

GTEL Sample Number		09038-23A	09038-26A	09038-29A	
Client Identification		108-1	109-1	TRIP BLANK	
Date Sampled		9/4/92	9/4/92	9/4/92	
Date Analyzed		9/15/92	9/15/92	9/15/92	
Analyte	Reporting Limit, ug/L	Concentration, ug/L			
Benzene	0.3	<0.3	<0.3	<0.3	
Toluene	0.3	<0.3	<0.3	<0.3	
Ethylbenzene	0.3	<0.3	<0.3	<0.3	
Xylene, total	0.6	<0.6	<0.6	<0.6	
BTEX, total	-	-	-	-	
TPH as Gasoline	100	<100	<100	<100	
Dilution Multiplier[b]		1	1	1	
TFT surrogate[c], % recovery		93.4	96.8	98.2	

a. Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Revision 0, US EPA November 1986. Modification for TPH as gasoline as per California State Water Resources Board LUFT Manual procedures.

b. Indicates the adjustments made for sample dilution.

c. TFT surrogate recovery acceptability limits of 72.8-123% are derived from the 99% confidence interval of all samples during the previous quarter. Expected surrogate value is 100 ug/L.

GTEL ENVIRONMENTAL LABORATORIES INC

R0058811

VOL 12 2 5 5 1 8

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: 5-6565
Work Order Number: T209038
Report Issue Date: July 1, 1993

ANALYTICAL RESULTS

Total Suspended Solid in Water
Standard Method 209 C[a]

Sample Identification		Date Sampled	Date Analyzed	Reporting Limit, mg/L	Concentration, mg/L
GTEL No.	Client ID				
Blank		9/4/92	9/15/92	10	<10
09038-2	101-2	9/4/92	9/15/92	10	<10
09038-5	102-2	9/4/92	9/15/92	10	<10
09038-9	103-2	9/4/92	9/15/92	10	<10
09038-12	104-2	9/4/92	9/15/92	10	<10
09038-15	105-2	9/4/92	9/15/92	10	<10
09038-18	106-2	9/4/92	9/15/92	10	<10
09038-21	107-2	9/4/92	9/15/92	10	<10
09038-24	108-2	9/4/92	9/15/92	10	<10
09038-27	109-2	9/4/92	9/15/92	10	<10

a. Standard Methods for the Examination of Water and Wastewater, 18th Edition, 1992.

VOL 12 2 5519

R0058812

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: 5-6565
Work Order Number: T209038
Report Issue Date: July 1, 1993

ANALYTICAL RESULTS

Total Recoverable Oil and Grease in Water by Infrared Spectrometry EPA 413.2[a]

Sample Identification		Date Sampled	Date Extracted	Date Analyzed	Reporting Limit, mg/L	Concentration, mg/L
GTEL No.	Client ID					
Blank	–	–	9/16/92	9/17/92	1	<1
09038-3	101-3	9/4/92	9/16/92	9/17/92	1	<1
09038-6	102-3	9/4/92	9/16/92	9/17/92	1	1
09038-10	103-3	9/4/92	9/16/92	9/17/92	1	<1
09038-13	104-3	9/4/92	9/16/92	9/17/92	1	1
09038-16	105-3	9/4/92	9/16/92	9/17/92	1	<1
09038-19	106-3	9/4/92	9/16/92	9/17/92	1	2
09038-22	107-3	9/4/92	9/16/92	9/17/92	1	1
09038-25	108-3	9/4/92	9/16/92	9/17/92	1	2
09038-28	109-3	9/4/92	9/16/92	9/17/92	1	1

a. EPA 600/4-79-020, March 1983 revision.

VOL 12 2 5520

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: 5-6565
Work Order Number: T209038
Report Issue Date: July 1, 1993

ANALYTICAL RESULTS

Metals in Water
Total Threshold Limit Concentration
California Title 22 (C.A.M.)

GTEL Sample Number			Blank	09038-7		
Client Identification			-	102-4		
Date Sampled			-	9/14/92		
Date Analyzed (Method 6010)			9/14/92	9/14/92		
Date Analyzed (Method 7470)			9/17/92	9/17/92		
Analyte	Method[a]	Reporting Limit, mg/L	Concentration, mg/L			
Antimony	EPA 6010	0.04	<0.04	<0.04		
Arsenic	EPA 6010	0.1	<0.1	<0.1		
Barium	EPA 6010	0.02	<0.02	0.13		
Beryllium	EPA 6010	0.01	<0.01	<0.01		
Cadmium	EPA 6010	0.03	<0.03	<0.03		
Chromium	EPA 6010	0.04	<0.04	<0.04		
Cobalt	EPA 6010	0.02	<0.02	<0.02		
Copper	EPA 6010	0.2	<0.2	<0.2		
Lead	EPA 6010	0.1	<0.1	<0.1		
Mercury	EPA 7470	0.001	<0.001	<0.001		
Molybdenum	EPA 6010	0.02	<0.02	<0.02		
Nickel	EPA 6010	0.1	<0.1	<0.1		
Selenium	EPA 6010	0.04	<0.04	<0.04		
Silver	EPA 6010	0.05	<0.05	<0.05		
Thallium	EPA 6010	0.4	<0.4	<0.4		
Vanadium	EPA 6010	0.2	<0.2	<0.2		
Zinc	EPA 6010	0.1	<0.1	<0.1		
EPA 6010: Dilution Multiplier[b]			1	1		
EPA 7470: Dilution Multiplier[b]			1	1		

a. Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Revision 0, US EPA November 1986. Digestion by EPA Method, 3010 (ICP).

b. Indicates the adjustments made for sample dilutions.

GTEL ENVIRONMENTAL LABORATORIES, INC.

R0058814

VOL 12 2 5521

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: 5-6565
Work Order Number: T209038
Report Issue Date: July 1, 1993

CONFORMANCE/NONCONFORMANCE SUMMARY

Abbreviations:

X = Requirements Met
VOA = Volatiles
* = See Comments
SV = Semi Volatiles
NA = Not Applicable
ND = Not Detected
- = Test Not Required

#	Conformance Item	VOA GC	VOA GC/MS	SV GC	SV GC/MS	Metals	Wet Chem
1	Holding Time	X				X	X
2	Method Accuracy	X				X	X
3	Method Precision	X				X	X
4	Surrogate Recovery	X				NA	NA
5	Blank	ND				X	X

Comments:

VOL 12

2

5522

GTEL ENVIRONMENTAL LABORATORIES INC

R0058815

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: 5-6565
Work Order Number: T209038
Report Issue Date: July 1, 1993

QC Check Sample Results

Matrix: Water

Analyte	Source	Date of Analysis	Expected Value	Units	Recovery[a], %
GC:					
Benzene	Ultra Scientific	9/14/92	150	ug/L	92.0 (81.1-118)
Toluene	Ultra Scientific	9/14/92	150	ug/L	94.0 (79.9-123)
Ethylbenzene	Ultra Scientific	9/14/92	150	ug/L	97.3 (81.1-123)
Xylene, total	Ultra Scientific	9/14/92	450	ug/L	95.8 (82.9-123)
Metals:					
Arsenic	Spex	9/14/92	1.00	mg/L	105 (80-120)
Barium	Spex	9/14/92	1.00	mg/L	101 (80-120)
Cadmium	Spex	9/14/92	1.00	mg/L	104 (80-120)
Chromium	Spex	9/14/92	1.00	mg/L	106 (80-120)
Lead	Spex	9/14/92	1.00	mg/L	107 (80-120)
Mercury	Perkin-Elmer	9/17/92	0.002	mg/L	101 (80-120)
Selenium	Spex	9/14/92	1.00	mg/L	105 (80-120)
Silver	Spex	9/14/92	1.00	mg/L	97.0 (80-120)
Inorganic Chemistry:					
Oil and Grease/IR	J.T. Baker	9/16/92	25.2	mg/L	87.7 (80-120)

a. Acceptability limits are in parentheses.
NA = Not Applicable.

VOL 12 2 5523

GTEL ENVIRONMENTAL LABORATORIES, INC.

R0058816

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: 5-6565
Work Order Number: T209038
Report Issue Date: July 1, 1993

Matrix Spike and Duplicate Spike Results

Matrix: Water

Analyte	Sample ID	Date of Analysis	Sample Amount	Spike Amount	Units	Recovery, %	Duplicate Recovery[a] %	RPD[a], %
GC:								
Benzene	T209038	9/15/92	<0.3	150	ug/L	92.0	86.7 (78.3-110)	5.93 (30)
Toluene	T209038	9/15/92	<0.3	150	ug/L	94.0	88.7 (73-112)	5.80 (30)
Ethylbenzene	T209038	9/15/92	<0.3	150	ug/L	97.3	90.0 (75.1-109)	7.79 (30)
Xylene, total	T209038	9/15/92	<0.6	450	ug/L	95.8	90.7 (78.1-109)	5.47 (30)
Metals:								
Arsenic	T209038	9/14/92	<0.1	2.00	mg/L	102	NA (68.6-112)	NA
Barium	T209038	9/14/92	0.0982	2.00	mg/L	95.6	NA (67.5-110)	NA
Cadmium	T209038	9/14/92	<0.03	2.00	mg/L	99.0	NA (67.2-111)	NA
Chromium	T209038	9/14/92	<0.04	2.00	mg/L	101	NA (66.8-115)	NA
Lead	T209038	9/14/92	<0.1	2.00	mg/L	101	NA (67.1-110)	NA
Mercury	T209038	9/17/92	<0.001	0.002	mg/L	101	NA (64.8-110)	NA
Selenium	T209038	9/14/92	<0.04	2.00	mg/L	101	NA (69.5-111)	NA
Silver	T209038	9/14/92	<0.05	2.00	mg/L	92.0	NA (45.2-110)	NA
Inorganic Chemistry:								
Oil and Grease/IR	T209038	9/16/92	1.92	5.66	mg/L	74.8	NA (64-127)	NA

a. Acceptability limits are in parentheses.
NA Not Applicable.

VOL 12 2 5524

GTEL ENVIRONMENTAL LABORATORIES INC

R0058817

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: 5-6565
Work Order Number: T209038
Report Issue Date: July 1, 1993

Sample and Sample Duplicate Results

Matrix: Water

Analyte	Sample ID	Date of Analysis	Sample Results	Sample Duplicate Results	Units	RPD[a], %
Metals:						
Arsenic	T209038-7	9-14-92	<0.1	<0.1	mg/L	NA
Barium	T209038-7	9-14-92	0.129	0.0673	mg/L	NA
Cadmium	T209038-7	9-14-92	<0.03	<0.03	mg/L	NA
Chromium	T209038-7	9-14-92	<0.04	<0.04	mg/L	NA
Lead	T209038-7	9-14-92	<0.1	<0.1	mg/L	NA
Mercury	T209038-7	9-17-93	<0.001	<0.001	mg/L	NA
Selenium	T209038-7	9-14-93	<0.04	<0.04	mg/L	NA
Silver	T209038-7	9-14-93	<0.05	<0.05	mg/L	NA
Inorganic Chemistry:						
Oil and Grease/IR	T209038-22	9-16-93	1.13	1.39	mg/L	NA
Total Suspended Solid	T309038-27	9-15-93	<10	<10	mg/L	NA

a. Acceptability limits are in parentheses.
NA Not Applicable.

VOL 12 2 5525

GTEL ENVIRONMENTAL LABORATORIES, INC

R0058818

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: S-6565
Work Order Number: T209038
Report Issue Date: July 1, 1993

Reagent Water Spike Results for Organic Analyses and LCS for Inorganic Analyses[a]

Matrix: Water

Analyte	Source	Date of Analysis	Expected Value	Units	Recovery[b], %
Metals:					
Arsenic	Spex	9/14/92	1.00	mg/L	104 (70-130)
Barium	Spex	9/14/92	1.00	mg/L	97.8 (70-130)
Cadmium	Spex	9/14/92	1.00	mg/L	102 (70-130)
Chromium	Spex	9/14/92	1.00	mg/L	104 (70-130)
Lead	Spex	9/14/92	1.00	mg/L	106 (70-130)
Mercury	Perkin-Elmer	9/17/92	0.002	mg/L	101 (70-130)
Selenium	Spex	9/14/92	1.00	mg/L	103 (70-130)
Silver	Spex	9/14/92	1.00	mg/L	93.4 (70-130)
Inorganic Chemistry:					
Oil and Grease/IR	E.M. Science, J.T. Baker	9/16/92	5.0	mg/L	74.8 (70-130)

a. As required to support method accuracy or precision when matrix spike or RPD are out of control limits.
b. Acceptability limits are in parentheses.
NA Not applicable

VOL 12 2 5526

GTEL ENVIRONMENTAL LABORATORIES, INC

R0058819

CHEVRON USA Inc.
P.O. BOX 2833
LA HABRA, CA
90632-2833

Do not bill Chevron
Amani Jacks

PROJECT NAME WSPA- STORMWATER Runoff
PROJECT I.D. No.
CONSULTANT NAME HART CROWSER
ADDRESS 1 WORLD TRADE CENTER LONG BEACH 90831
PROJECT CONTACT (NAME) JOAN NETHERWOOD
(PHONE) 310 495 6360
CHEVRON FACILITY No. J-6565
CHEVRON CONTACT (NAME) Allison Fong
(PHONE) 818 543-5333

LABORATORY NAME GTEL ENVIRON. LABS
CONTRACT NUMBER T-320
COLLECTED BY (NAME) DAVID C. DARROW
(SIGNATURE) [signature]
COLLECTION DATE 9.4.92

CHAIN-OF-CUSTODY RECORD

T2-09-038
6°C

ANALYSES TO BE PERFORMED

SAMPLE No	LAB No	NUMBER OF CONTAINERS	MATRIX SOIL	MATRIX WATER	GRAB	COMPOSITE	DATE	TIME	ACIDIFIED	ICED		MODIFIED EPA 8015 TOTAL PETRO. HYDROCARB.	EPA 418.1 TOTAL RECOVERABLE PETROLEUM HYDROCARB.	EPA 8020 AROMATIC VOLATILES-BTXE	EPA 602 AROMATIC VOLATILES-BTXE	METALS ( )	OTHER EPA 413.2 OIL + GREASE	EPA 160.2 TOTAL SUSPENDED SOLIDS		DETECTION LIMIT	REMARKS
105.1		2		X	X		9.4		X	X		X		X							
105.2		1			X		9.4											X			
105.3		1			X		9.4										X				
106.1		2			X		9.4	12:02	X			X		X							
106.2		1			X		9.4	12:02										X			
106.3		1			X		9.4	12:02									X				
107.1		2			X		9.4	12:24	X			X		X							
107.2		1			X		9.4	12:24										X			
107.3		1			X		9.4	12:24									X				
108.1		2			X		9.4	12:33	X			X		X							
108.2		1			X		9.4	12:33										X			
108.3		1			X		9.4	12:33									X				
109.1		2				X	9.4	12:45	X			X		X							

RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME	TURN AROUND TIME (CIRCLE CHOICE)
[signature]	HART CROWSER	9.4.92 6:38 pm				24 HRS 5 DAYS
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME	48 HRS 10 DAYS
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED FOR LABORATORY BY (Signature)		DATE/TIME	

R0058820

VOL 12

Don't bill Chev. Amani Tony

CHEVRON USA Inc.
P.O. BOX 2833
LA HABRA, CA
90632-2833

PROJECT NAME WSPA STORMWATER Runoff
PROJECT I.D. No.
CONSULTANT NAME HART CROWSER
ADDRESS 1 WORLD TRADE CENTER LONG BEACH 90831
PROJECT CONTACT (NAME) JOHN NETHERWOOD
(PHONE) 310 495 6360
CHEVRON FACILITY No. J-6565
CHEVRON CONTACT (NAME) Allison Fong
(PHONE) 818 543-5333

LABORATORY NAME GTEL ENVIRON. LABS
CONTRACT NUMBER T-320
COLLECTED BY (NAME) DAVID G. DARROW
(SIGNATURE) [signature]
COLLECTION DATE 9.4.92

CHAIN-OF-CUSTODY RECORD

T2-09-038
6°C

ANALYSES TO BE PERFORMED

SAMPLE No	LAB No.	NUMBER OF CONTAINERS	MATRIX: SOIL	MATRIX: WATER	GRAB	COMPOSITE	DATE	TIME	ACIDIFIED	ICED		MODIFIED EPA 8015 TOTAL PETRO. HYDROCARB.	EPA 418.1 TOTAL RECOVERABLE PETROLEUM HYDROCARB.	EPA 8020 AROMATIC VOLATILES-BTXE	EPA 8021 AROMATIC VOLATILES-BTXE	METALS ( )	OTHER EPA 413.2 OIL + GREASE	EPA 160.2 TOTAL SUSPENDED SOLIDS		DETECTION LIMIT	REMARKS
109-2		1		X		X	9.4	12:45		X								X			
109-3		1		X		X	9.4	12:45		X							X				
TRIP BLANK		2		X			9.4			X		X		X							

RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME
[signature]	HART CROWSER	9.4.92 6:30 pm			
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED FOR LABORATORY BY (Signature)		DATE/TIME
			[signature]		

TURN AROUND TIME (CIRCLE CHOICE)
24 HRS 6 DAYS
48 HRS 10 DAYS

R0058821

VOL 12

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R0058822

GTEL
ENVIRONMENTAL
LABORATORIES, INC.
Southwest Region
20000 / 300 Mariner Drive
Torrance, CA 90503
(310) 371-1044
(800) 727-GTEL
Fax (310) 371-8720

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209059
Report Issue Date: September 23, 1992

Mr. John Netherwood
Hart Crowser
1 World Trade Center
Long Beach, CA 90831

Dear Mr. Netherwood,

Enclosed please find the analytical results for the samples received by GTEL Environmental Laboratories, Inc. on 9-11-92

A formal Quality Assurance/Quality Control (QA/QC) program is maintained by GTEL, which is designed to meet or exceed the EPA requirements. Analytical work for this project met QA/QC criteria unless otherwise stated in the footnotes.

GTEL is certified by the state of California under Certification #E721.

If you have any questions concerning this analysis or if we can be of further assistance, please call our Customer Service Representative.

Sincerely,

GTEL Environmental Laboratories, Inc.

Minsoon Song
Laboratory Director

cc: Allison Fong

VOL 12 2 5530

R0058823

ANA

Volatile

EPA Methods Modi

	GTEL Sample Number	
	Client Identification	
	Date Sampled	
	Date Analyzed	9-
Analyte	Reporting Limit, ug/L	
Benzene	0.3	<0.3
Toluene	0.3	<0.3
Ethylbenzene	0.3	<0.3
Xylene, total	0.6	<0.6
BTEX, total	–	–
TPH as Gasoline	100	<100
Dilution Multiplier[b]	–	–
TFT surrogate[c] % recovery	107	

a. Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Revision 0, US EPA Nov as per California State Water Resources Board LUFT Manual procedures.

b. Indicates the adjustments made for sample dilution.

c. TFT surrogate recovery acceptability limits of 72.8-123% are derived from the 99% confidence quarter. Expected surrogate value is 100 ug/L.

GTEL Torrance, CA
T209059.DOC

R0058824

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209059
Report Issue Date: September 23, 1992

ANALYTICAL RESULTS

Volatile Organics in Water
EPA Methods Modified 8020 and Modified 8015[a]

GTEL Sample Number		09059-11	09059-14	09059-17	09059-20
Client Identification		304-1	305-1	306-1	307-1
Date Sampled		9-10-92	9-10-92	9-10-92	9-10-92
Date Analyzed		9-19-92	9-19-92	9-19-92	9-19-92
Analyte	Reporting Limit, ug/L	Concentration, ug/L			
Benzene	0.3	<0.3	<0.3	1.5	<0.3
Toluene	0.3	<0.3	<0.3	<0.3	<0.3
Ethylbenzene	0.3	<0.3	<0.3	<0.3	<0.3
Xylene, total	0.6	<0.6	<0.6	<0.6	<0.6
BTEX, total	-	-	-	1.5	-
TPH as Gasoline	100	<100	<100	<100	<100
Dilution Multiplier[b]		1	1	1	1
TFT surrogate[c] % recovery		89.5	97.4	95.0	90.6

a. Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Revision 0, US EPA November 1986. Modification for TPH as gasoline as per California State Water Resources Board LUFT Manual procedures.

b. Indicates the adjustments made for sample dilution.

c. TFT surrogate recovery acceptability limits of 72.8-123% are derived from the 99% confidence interval of all samples during the previous quarter. Expected surrogate value is 100 ug/L.

VOL 12 2 5532

GTEL ENVIRONMENTAL LABORATORIES, INC.

R0058825

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209059
Report Issue Date: September 23, 1992

ANALYTICAL RESULTS

Volatile Organics in Water
EPA Methods Modified 8020 and Modified 8015[a]

GTEL Sample Number		09059-23	09059-26	09059-29	
Client Identification		308-1	309-1	TRIP BLANK	
Date Sampled		9-10-92	9-10-92	9-10-92	
Date Analyzed		9-19-92	9-19-92	9-21-92	
Analyte	Reporting Limit, ug/L	Concentration, ug/L			
Benzene	0.3	<0.3	0.4	<0.3	
Toluene	0.3	<0.3	<0.3	0.5	
Ethylbenzene	0.3	<0.3	<0.3	<0.3	
Xylene, total	0.6	<0.5	<0.6	<0.6	
BTEX, total	–	–	0.4	0.5	
TPH as Gasoline	100	<100	<100	<100	
Dilution Multiplier[b]		1	1	1	
TFT surrogate[c] % recovery		87.2	96.6	93.6	

a. Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Revision 0, US EPA November 1986. Modification for TPH as gasoline as per California State Water Resources Board LUFT Manual procedures.

b. Indicates the adjustments made for sample dilution.

c. TFT surrogate recovery acceptability limits of 72.8-123% are derived from the 99% confidence interval of all samples during the previous quarter. Expected surrogate value is 100 ug/L.

GTEL ENVIRONMENTAL LABORATORIES, INC

R0058826

VOL 12 2 5533

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209059
Report Issue Date: September 23, 1992

ANALYTICAL RESULTS

Total Suspended Solid in Water
Standard Method 209 C[a]

Sample Identification		Date Sampled	Date Analyzed	Reporting Limit, mg/L	Concentration, mg/L
GTEL No.	Client ID				
Blank	-	9-10-92	9-21-92	10	<10
09059-2	301-2	9-10-92	9-21-92	10	<10
09059-5	302-2	9-10-92	9-21-92	10	<10
09059-9	303-2	9-10-92	9-21-92	10	<10
09059-12	304-2	9-10-92	9-21-92	10	<10
09059-15	305-3	9-10-92	9-21-92	10	<10
09059-18	306-3	9-10-92	9-21-92	10	<10
09059-21	307-3	9-10-92	9-21-92	10	<10
09059-24	308-3	9-10-92	9-21-92	10	<10
09059-27	309-2	9-10-92	9-21-92	10	<10

a. Standard Methods for the Examination of Water and Wastewater, 18th Edition, 1992.

VOL 12 2 5534

R0058827

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209059
Report Issue Date: September 23, 1992

ANALYTICAL RESULTS

Metals in Water
Total Threshold Limit Concentration
California Title 22 (C.A.M.)

GTEL Sample Number			Blank	09059-7		
Client Identification			-	302-4		
Date Sampled			-	9-10-92		
Date Analyzed (Method 6010)			9-14-92	9-14-92		
Date Analyzed (Method 7470)			9-17-92	9-17-92		
Analyte	Method[a]	Reporting Limit, mg/L	Concentration, mg/L			
Antimony	EPA 6010	0.04	<0.04	<0.04		
Arsenic	EPA 6010	0.1	<0.1	<0.1		
Barium	EPA 6010	0.02	<0.02	<0.02		
Beryllium	EPA 6010	0.01	<0.01	<0.01		
Cadmium	EPA 6010	0.03	<0.03	<0.03		
Chromium	EPA 6010	0.04	<0.04	<0.04		
Cobalt	EPA 6010	0.02	<0.02	<0.02		
Copper	EPA 6010	0.2	<0.2	<0.2		
Lead	EPA 6010	0.1	<0.1	<0.1		
Mercury	EPA 7470	0.001	<0.001	<0.001		
Molybdenum	EPA 6010	0.02	<0.02	<0.02		
Nickel	EPA 6010	0.1	<0.1	<0.1		
Selenium	EPA 6010	0.04	<0.04	<0.04		
Silver	EPA 6010	0.05	<0.05	<0.05		
Thallium	EPA 6010	0.4	<0.4	<0.4		
Vanadium	EPA 6010	0.2	<0.2	<0.2		
Zinc	EPA 6010	0.1	<0.1	<0.1		
EPA 6010: Dilution Multiplier[b]			1	1		
EPA 7470: Dilution Multiplier[b]			1	1		

a. Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Revision 0, US EPA November 1986. Digestion by EPA Method 3005 (flame), 3010 (ICP) and 3020 (furnace).

b. Indicates the adjustments made for sample dilutions.

GTEL ENVIRONMENTAL LABORATORIES INC

R0058828

VOL 12 2 5535

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209059
Report Issue Date: September 23, 1992

ANALYTICAL RESULTS

Total Recoverable Oil and Grease in Water by Infrared Spectrometry EPA 413.2[a]

Sample Identification		Date Sampled	Date Extracted	Date Analyzed	Reporting Limit, mg/L	Concentration, mg/L
GTEL No.	Client ID					
Blank	-	-	9-18-92	9-21-92	1	<1
09059-3	301-3	9-10-92	9-18-92	9-21-92	1	<1
09059-6	302-3	9-10-92	9-18-92	9-21-92	1	<1
09059-10	303-3	9-10-92	9-18-92	9-21-92	1	<1
09059-13	304-3	9-10-92	9-18-92	9-21-92	1	<1
09059-16	305-2	9-10-92	9-18-92	9-21-92	1	<1
09059-19	306-2	9-10-92	9-18-92	9-21-92	1	1
09059-22	307-2	9-10-92	9-18-92	9-21-92	1	<1
09059-25	308-2	9-10-92	9-18-92	9-21-92	1	<1
09059-28	309-3	9-10-92	9-18-92	9-21-92	1	1

a. EPA 600/4-79-020, March 1983 revision.

VOL 12 2 5536

GTEL Client Number: WSP01.WSP01
Contract Number: 6C3W2323IX
Facility Number: J-6565
Work Order Number: T209059
Report Issue Date: September 23, 1992

CONFORMANCE/NONCONFORMANCE SUMMARY

Abbreviations:

X = Requirements Met
VOA = Volatiles
* = See Comments
SV = Semi Volatiles
NA = Not Applicable
ND = Not Detected
- = Test Not Required

#	Conformance Item	VOA GC	VOA GC/MS	SV GC	SV GC/MS	Metals	Wet Chem
1	Holding Time	X				X	X
2	Method Accuracy	X				X	X
3	Method Precision	X				X	X
4	Surrogate Recovery	X				NA	NA
5	Blank	ND				X	X

Comments:

VOL 12 2 5537

GTEL ENVIRONMENTAL LABORATORIES, INC

R0058830

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209059
Report Issue Date: September 23, 1992

QC Check Sample Results

Matrix: Water

Analyte	Source	Date of Analysis	Expected Value	Units	Recovery[a], %
GC:					
Benzene	Ultra Scientific	9-18-92	150	ug/L	117 (81.1-118)
Toluene	Ultra Scientific	9-18-92	150	ug/L	119 (79.9-123)
Ethylbenzene	Ultra Scientific	9-18-92	150	ug/L	115 (81.1-123)
Xylene, total	Ultra Scientific	9-18-92	450	ug/L	121 (82.9-123)
Metals:					
Arsenic	Spex	9-14-92	1.00	mg/L	105 (80-120)
Barium	Spex	9-14-92	1.00	mg/L	101 (80-120)
Cadmium	Spex	9-14-92	1.00	mg/L	104 (80-120)
Chromium	Spex	9-14-92	1.00	mg/L	106 (80-120)
Lead	Spex	9-14-92	1.00	mg/L	107 (80-120)
Mercury	Perkin-Elmer	9-17-92	0.002	mg/L	101 (80-120)
Selenium	Spex	9-14-92	1.00	mg/L	105 (80-120)
Silver	Spex	9-14-92	1.00	mg/L	97.0 (80-120)
Inorganic Chemistry:					
Oil and Grease/IR	J.T. Baker	9-21-92	25.2	mg/L	103 (80-120)

a. Acceptability limits are in parentheses.

VOL 12 2 5538

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209059
Report Issue Date: September 23, 1992

Matrix Spike and Duplicate Spike Results

Matrix: Water

Analyte	Sample ID	Date of Analysis	Sample Amount	Spike Amount	Units	Recovery, %	Duplicate Recovery[a] %	RPD[a], %
GC:								
Benzene	T209059	9-19-92	<0.3	150	ug/L	104	102 (76.3-110)	1.94 (30)
Toluene	T209059	9-19-92	<0.3	150	ug/L	106	107 (73-112)	0.935 (30)
Ethylbenzene	T209059	9-19-92	<0.3	150	ug/L	103	104 (75.1-109)	0.962 (30)
Xylene, total	T209059	9-19-92	<0.6	450	ug/L	108	109 (78.1-109)	0.917 (30)
Metals:								
Arsenic	T209038-7	9-14-92	<0.1	2.00	mg/L	102	NA (68.6-112)	NA
Barium	T209038-7	9-14-92	0.0982	2.00	mg/L	95.6	NA (67.5-110)	NA
Cadmium	T209038-7	9-14-92	<0.03	2.00	mg/L	99.0	NA (67.2-111)	NA
Chromium	T209038-7	9-14-92	<0.04	2.00	mg/L	101	NA (66.8-115)	NA
Lead	T209038-7	9-14-92	<0.1	2.00	mg/L	101	NA (67.1-110)	NA
Mercury	T209038-7	9-17-92	<0.001	0.002	mg/L	101	NA (64.8-110)	NA
Selenium	T209038-7	9-14-92	<0.04	2.00	mg/L	101	NA (69.5-111)	NA
Silver	T209038-7	9-14-92	<0.05	2.00	mg/L	92.0	NA (45.2-110)	NA
Inorganic Chemistry:								
Oil and Grease/IR	T209059-3	9-21-92	<1	4.02	mg/L	74.7	NA (64-127)	NA

a. Acceptability limits are in parentheses.
NA Not Applicable.

VOL 12 2 5539

R0058832

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209059
Report Issue Date: September 23, 1992

Sample and Sample Duplicate Results

Matrix: Water

Analyte	Sample ID	Date of Analysis	Sample Results	Sample Duplicate Results	Units	RPD[a], %
Metals:						
Arsenic	T209038-7	9-14-92	<0.1	<0.1	mg/L	NA
Barium	T209038-7	9-14-92	0.129	0.0673	mg/L	NA
Cadmium	T209038-7	9-14-92	<0.03	<0.03	mg/L	NA
Chromium	T209038-7	9-14-92	<0.04	<0.04	mg/L	NA
Lead	T209038-7	9-14-92	<0.1	<0.1	mg/L	NA
Mercury	T209038-7	9-17-92	<0.001	<0.001	mg/L	NA
Selenium	T209038-7	9-14-92	<0.04	<0.04	mg/L	NA
Silver	T209038-7	9-14-92	<0.05	<0.05	mg/L	NA
Inorganic Chemistry:						
Oil and Grease/IR	T209059-6	9-21-92	<1	<1	mg/L	NA
Total Suspended Solid	T209059-2	9-21-92	<10	<10	mg/L	NA

a. Acceptability limits are in parentheses.
NA Not Applicable.

VOL 12 2 5540

R0058833

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209059
Report Issue Date: September 23, 1992

Reagent Water Spike Results for Organic Analyses and LCS for Inorganic Analyses[a]

Matrix: Water

Analyte	Source	Date of Analysis	Expected Value	Units	Recovery[b], %
Metals:					
Arsenic	Spex	9-14-92	1.00	mg/L	104 (70-130)
Barium	Spex	9-14-92	1.00	mg/L	97.8 (70-130)
Cadmium	Spex	9-14-92	1.00	mg/L	102 (70-130)
Chromium	Spex	9-14-92	1.00	mg/L	104 (70-130)
Lead	Spex	9-14-92	1.00	mg/L	106 (70-130)
Mercury	Perkin-Elmer	9-17-92	0.002	mg/L	101 (70-130)
Selenium	Spex	9-14-92	1.00	mg/L	103 (70-130)
Silver	Spex	9-14-92	1.00	mg/L	93.4 (70-130)
Organic Lead				mg/L	(70-130)
Inorganic Chemistry:					
Oil and Grease (gravimetric)	E.M. Science, J.T. Baker	9-21-92	5.38	mg/L	87.9 (70-130)

a. As required to support method accuracy or precision when matrix spike or RPD are out of control limits.
b. Acceptability limits are in parentheses.

VOL 12 2 5541

R0058834

CHEVRON USA Inc.
P.O. BOX 2833
LA HABRA, CA
90632-2833

PROJECT NAME WEFASTORMWATER RUNOFF
PROJECT I.D. No
CONSULTANT NAME HART CROWSER
ADDRESS 1 WORLD TRADE CENTER
PROJECT CONTACT (NAME) JOHN NETHERWOOD
(PHONE) 310 9456210
CHEVRON FACILITY No. 26565
CHEVRON CONTACT (NAME) NELSON FONG
(PHONE) 818 543-5333

LABORATORY NAME GTEL
CONTRACT NUMBER T320
COLLECTED BY (NAME) DAVID & DARROW
(SIGNATURE) [signature]
COLLECTION DATE 10-07-92

CHAIN-OF-CUSTODY RECORD

T2-09-059

ANALYSES TO BE PERFORMED

SAMPLE No	LAB No	NUMBER OF CONTAINERS	MATRIX: SOIL	MATRIX: WATER	GRAB	COMPOSITE	DATE	TIME	ACIDIFIED	ICED		MODIFIED EPA 8015 TOTAL PETRO. HYDROCARB.	EPA 418.1 TOTAL RECOVERABLE PETROLEUM HYDROCARB.	EPA 8020 AROMATIC VOLATILES - BTXE	EPA 602 AROMATIC VOLATILES - BTXE	CCR 22 METALS CONV.	160.2 TOTAL OTHER SUSPENDED SOLID	415.2 OIL + GREASE		DETECTION LIMIT	REMARKS
301-1		2		X	X		9-09	7:30	X	X		X		X							
301-2		1						7:30									X				
301-3		1						7:30										X			
302-1		2						7:56	X			X		X							
302-2		1						7:56									X				
302-3		2						7:56										X			
302-4		1						7:56	X							X					
303-1		2						8:11	X			X		X							
303-2		1						8:11									X				
303-3		1						8:11										X			
304-1		2						8:26	X			X		X							
304-2		1						8:26									X				
304-3		1						8:26										X			

RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME
[signature]	HART CROWSER	9-10-92 15:00	[signature]	GTEL-Labs	9/10/92 15:00
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED FOR LABORATORY BY (Signature)		DATE/TIME

TURN AROUND TIME (CIRCLE CHOICE)
24 HRS 5 DAYS
48 HRS 10 DAYS

R0058835

VOL 12

CHEVRON USA INC.
P.O. BOX 2833
LA HABRA, CA
90632-2833

PROJECT NAME WSPA STORMWATER RUNOFF
PROJECT I.D. NO.
CONSULTANT NAME HART CROWSER
ADDRESS 1 WORLD TRADE CTR
PROJECT CONTACT (NAME) JOHN HETHERWOOD
(PHONE) 310 495 1360
CHEVRON FACILITY NO. J6515
CHEVRON CONTACT (NAME) ALISON TONG
(PHONE) 818-543-5333

LABORATORY NAME GTEL
CONTRACT NUMBER T320
COLLECTED BY (NAME) DAVID C. DARROW
(SIGNATURE) [signature]
COLLECTION DATE 10 SEPTEMBER 1992

CHAIN-OF-CUSTODY RECORD

T209059

ANALYSES TO BE PERFORMED

SAMPLE No.	LAB No.	NUMBER OF CONTAINERS	MATRIX: SOIL	MATRIX: WATER	GRAB	COMPOSITE	DATE	TIME	ACIDIFIED	ICED	MODIFIED EPA 8015 TOTAL PETRO. HYDROCARB.	EPA 418.1 TOTAL RECOVERABLE PETROLEUM HYDROCARB.	EPA 8020 AROMATIC VOLATILES - BTXE	EPA 602 AROMATIC VOLATILES - BTXE	CCR 22 METALS CA-4	413.2 OTHER OIL & GREASES	160.2 TOTAL SUSPENDED SOLIDS		DETECTION LIMIT	REMARKS
305-1	1	2		X		X	9-10-92	8:30	X	X	X		X							
305-2	1	1				X		8:30								X				
305-3	1	1				X		8:50									X			
306-1	1	2			X			10:20	X		X		X							
306-2	1	1						10:20								X				
306-3	1	1						10:20									X			
307-1	1	2						10:35	X		X		X							
307-2	1	1						10:35								X				
307-3	1	1						10:35									X			
308-1	1	2						10:50	X		X		X							
308-2	1	1						10:50								X				
308-3	1	1			X			10:50									X			
309-1	1	2				X		10:55	X		X		X							

RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME	TURN AROUND TIME (CIRCLE ONE)
[signature]	HART CROWSER	9.10.92 1550	[signature]	GTEL-Labs	9/10/92 1550	24 HRS 6 DAYS
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME	48 HRS 10 DAYS
			RECEIVED FOR LABORATORY BY (Signature)		DATE/TIME	

R0058836

VOL 12

2 55 43

CHEVRON USA Inc.
P.O. BOX 2833
LA HABRA, CA
90632-2833

PROJECT NAME WSPA STORMWATER RUNOFF
PROJECT I.D. No.
CONSULTANT NAME HART CROWSER
ADDRESS 1 WORLD TRADE CTR.
PROJECT CONTACT (NAME) JOHN NETHERWOOD
(PHONE) 310 495 6360
CHEVRON FACILITY No. 76565
CHEVRON CONTACT (NAME) [illegible]
(PHONE) 818 543-5733

LABORATORY NAME GTEL
CONTRACT NUMBER T320
COLLECTED BY (NAME) DAVID E. DARROW
(SIGNATURE) [signature]
COLLECTION DATE 10 SEPTEMBER 1992

CHAIN-OF-CUSTODY RECORD

T209059

ANALYSES TO BE PERFORMED

SAMPLE No	LAB No	NUMBER OF CONTAINERS	MATRIX: SOIL	MATRIX: WATER	GRAB	COMPOSITE	DATE	TIME	ACIDIFIED	ICED	MODIFIED EPA 8015 TOTAL PETRO. HYDROCARB.	EPA 418.1 TOTAL RECOVERABLE PETROLEUM HYDROCARB.	EPA 8020 AROMATIC VOLATILES - BTXE	EPA 602 AROMATIC VOLATILES - BTXE	METALS ( )	OTHER 413.2 OIL & GREASE	160.2 TOTAL SUSPENDED SOLIDS		DETECTION LIMIT	REMARKS
309-2		1		X		X	9-10-92	10:55		X										
309-3		1		X		X	X	10:55		X						DP	X			
TRIP BLANK		2		X			9-10-92			X	X		X			X	X	DP		

RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME
[signature]	HART CROWSER	9-10-92 15:00	[signature]	GTEL - Labs	9/10/92 15:00
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED FOR LABORATORY BY (Signature) [signature]		DATE/TIME 9/11 1:50

TURN AROUND TIME (CIRCLE CHOICE)
24 HRS 5 DAYS
48 HRS 10 DAYS

R0058837

VOL 12

2 5544

VOL 12

CATEGORY 3

2 5545

R0058838

GTEL
ENVIRONMENTAL
LABORATORIES, INC.

Southwest Region
20000 / 300 Mariner Drive
Torrance, CA 90503
(310) 371-1044
(800) 727-GTEL
Fax (310) 371-8720

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209037
Report Issue Date: September 22, 1992

VOL 12 2 5546

Mr. John Netherwood
Hart Crowser
1 World Trade Center
Long Beach, CA 90831

Dear Mr. Netherwood,

Enclosed please find the analytical results for the samples received by GTEL Environmental Laboratories, Inc. on 9/4/92.

A formal Quality Assurance/Quality Control (QA/QC) program is maintained by GTEL, which is designed to meet or exceed the EPA requirements. Analytical work for this project met QA/QC criteria unless otherwise stated in the footnotes.

GTEL is certified by the state of California under Certification #1723.

If you have any questions concerning this analysis or if we can be of further assistance, please call our Customer Service Representative.

Sincerely,

GTEL Environmental Laboratories, Inc.

Minsoon Song
Laboratory Director

cc: Allison Fong

R0058839

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209037
Report Issue Date: September 22, 1992

ANALYTICAL RESULTS

Total Suspended Solid in Water
Standard Method 209 C[a]

Sample Identification		Date Sampled	Date Analyzed	Reporting Limit, mg/L	Concentration, mg/L
GTEL No.	Client ID				
Blank	-	9/3/92	9/15/92	10	<10
09037-2	1-2	9/3/92	9/15/92	10	11
09037-5	2-2	9/3/92	9/15/92	10	13
09037-9	3-2	9/3/92	9/15/92	10	<10
09037-12	4-2	9/3/92	9/15/92	10	<10
09037-15	5-2	9/3/92	9/15/92	10	<10
09037-18	6-2	9/3/92	9/15/92	10	<10
09037-21	7-2	9/3/92	9/15/92	10	<10
09037-24	8-2	9/3/92	9/15/92	10	<10
09037-27	9-2	9/3/92	9/15/92	10	<10

a. Standard Methods for the Examination of Water and Wastewater, 18th Edition, 1992.

VOL 12 2 5541

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209037
Report Issue Date: September 22, 1992

ANALYTICAL RESULTS

Metals in Water
Total Threshold Limit Concentration
California Title 22 (C.A.M.)

GTEL Sample Number			Blank	09037-07		
Client Identification			-	2-4		
Date Sampled			-	9/3/92		
Date Analyzed (Method 6010)			9/14/92	9/14/92		
Date Analyzed (Method 7470)			9/17/92	9/17/92		
Analyte	Method[a]	Reporting Limit, mg/L	Concentration, mg/L			
Antimony	EPA 6010	0.04	<0.04	<0.04		
Arsenic	EPA 6010	0.1	<0.1	<0.1		
Barium	EPA 6010	0.02	<0.02	0.06		
Beryllium	EPA 6010	0.01	<0.01	<0.01		
Cadmium	EPA 6010	0.03	<0.03	<0.03		
Chromium	EPA 6010	0.04	<0.04	<0.04		
Cobalt	EPA 6010	0.02	<0.02	<0.02		
Copper	EPA 6010	0.2	<0.2	<0.2		
Lead	EPA 6010	0.1	<0.1	<0.1		
Mercury	EPA 7470	0.001	<0.001	<0.001		
Molybdenum	EPA 6010	0.02	<0.02	<0.02		
Nickel	EPA 6010	0.1	<0.1	<0.1		
Selenium	EPA 6010	0.04	<0.04	<0.04		
Silver	EPA 6010	0.05	<0.05	<0.05		
Thallium	EPA 6010	0.4	<0.4	<0.4		
Vanadium	EPA 6010	0.2	<0.2	<0.2		
Zinc	EPA 6010	0.1	<0.1	0.2		
EPA 6010: Dilution Multiplier[b]			1	1		
EPA 7470: Dilution Multiplier[b]			1	1		

a. Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Revision 0, US EPA November 1986. Digestion by EPA Method, 3010 (ICP).

b. Indicates the adjustments made for sample dilutions.

VOL 12 2 5548

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6585
Work Order Number: T209037
Report Issue Date: September 22, 1992

ANALYTICAL RESULTS

Total Recoverable Oil and Grease in Water by Infrared Spectrometry EPA 413.2[a]

Sample Identification		Date Sampled	Date Extracted	Date Analyzed	Reporting Limit, mg/L	Concentration, mg/L
GTEL No.	Client ID					
Blank	–	9/10/92	9/10/92	9/10/92	1	<1
09037-3	1-3	9/3/92	9/10/92	9/10/92	1	<1
09037-6	2-3	9/3/92	9/10/92	9/10/92	1	8
09037-10	3-3	9/3/92	9/10/92	9/10/92	1	3
09037-13	4-3	9/3/92	9/10/92	9/10/92	1	2
09037-16	5-3	9/3/92	9/10/92	9/10/92	1	3
09037-19	6-3	9/3/92	9/10/92	9/10/92	1	1
09037-22	7-3	9/3/92	9/10/92	9/10/92	1	<1
09037-25	8-3	9/3/92	9/10/92	9/10/92	1	1
09037-28	9-3	9/3/92	9/10/92	9/10/92	1	<1

a. EPA 600/4-79-020, March 1983 revision

VOL 12 2 5549

R0058842

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209037
Report Issue Date: September 22, 1992

ANALYTICAL RESULTS

Volatile Organics in Water
EPA Methods Modified 8020 and Modified 8015[a]

GTEL Sample Number		Lab Blank	09037-1A	09037-4A*	09037-8A
Client Identification		-	1-1	2-1	3-1
Date Sampled		-	9/3/92	9/3/92	9/3/92
Date Analyzed		9/11/92	9/11/92	9/12/92	9/11/92
Analyte	Reporting Limit, ug/L	Concentration, ug/L			
Benzene	0.3	<0.3	<0.3	<3.0	<0.3
Toluene	0.3	<0.3	<0.3	7.9	<0.3
Ethylbenzene	0.3	<0.3	<0.3	<3.0	<0.3
Xylene, total	0.6	<0.6	1.5	20	<0.6
BTEX, total	-	-	1.5	28	-
TPH as Gasoline	100	<100	<100	<1000	<100
Dilution Multiplier[b]		1	1	10	1
TFT surrogate[c] % recovery		100	89.5	78.8	90.6

a. Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Revision 0, US EPA November 1986. Modification for TPH as gasoline as per California State Water Resources Board LUFT Manual procedures.

b. Indicates the adjustments made for sample dilution.

c. TFT surrogate recovery acceptability limits of 72.8-123% are derived from the 99% confidence interval of all samples during the previous quarter. Expected surrogate value is 100 ug/L.

* Detection limit increased due to matrix effect (foaming).

VOL 12 2 5550

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209037
Report Issue Date: September 22, 1992

ANALYTICAL RESULTS

Volatile Organics in Water
EPA Methods Modified 8020 and Modified 8015[a]

GTEL Sample Number		09037-11A	09037-14A	09037-17A*	09037-20A*
Client Identification		4-1	5-1	6-1	7-1
Date Sampled		9/3/92	9/3/92	9/3/92	9/3/92
Date Analyzed		9/11/92	9/11/92	9/15/92	9/15/92
Analyte	Reporting Limit, ug/L	Concentration, ug/L			
Benzene	0.3	<0.3	<0.3	<3.0	<3.0
Toluene	0.3	0.4	0.3	<3.0	<3.0
Ethylbenzene	0.3	<0.3	<0.3	<3.0	<3.0
Xylene, total	0.6	1.1	1.1	<6.0	<6.0
BTEX, total	-	1.5	1.4	-	-
TPH as Gasoline	100	<100	<100	<1000	<1000
Dilution Multiplier[b]		1	1	10	10
TFT surrogate[c] % recovery		76.2	97.3	100	77.1

a. Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Revision 0, US EPA November 1986. Modification for TPH as gasoline as per California State Water Resources Board LUFT Manual procedures.

b. Indicates the adjustments made for sample dilution.

c. TFT surrogate recovery acceptability limits of 72.8-123% are derived from the 99% confidence interval of all samples during the previous quarter. Expected surrogate value is 100 ug/L.

* Detection limit increased due to matrix effect (foaming).

VOL 12 2 5551

R0058844

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209037
Report Issue Date: September 22, 1992

ANALYTICAL RESULTS

Volatile Organics in Water
EPA Methods Modified 8020 and Modified 8015[a]

GTEL Sample Number		09037-23A	09037-26A	09037-29A	
Client Identification		8-1	9-1	TRIP BLANK	
Date Sampled		9/3/92	9/3/92	9/3/92	
Date Analyzed		9/12/92	9/12/92	9/11/92	
Analyte	Reporting Limit, ug/L	Concentration, ug/L			
Benzene	0.3	0.5	<0.3	<0.3	
Toluene	0.3	4.5	0.8	<0.3	
Ethylbenzene	0.3	1.1	<0.3	<0.3	
Xylene, total	0.6	12	3.4	<0.6	
BTEX, total	-	18	4.2	-	
TPH as Gasoline	100	<100	<100	<100	
Dilution Multiplier[b]		1	1	1	
TFT surrogate[c] % recovery		84.4	93.4	85.4	

a. Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Revision 0, US EPA November 1986. Modification for TPH as gasoline as per California State Water Resources Board LUFT Manual procedures.

b. Indicates the adjustments made for sample dilution.

c. TFT surrogate recovery acceptability limits of 72.8-123% are derived from the 99% confidence interval of all samples during the previous quarter. Expected surrogate value is 100 ug/L.

VOL 12 2 5552

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209037
Report Issue Date: September 22, 1992

CONFORMANCE/NONCONFORMANCE SUMMARY

Abbreviations:

X = Requirements Met
VOA = Volatiles
* = See Comments
SV = Semi Volatiles
NA = Not Applicable
ND = Not Detected
- = Test Not Required

#	Conformance Item	VOA GC	VOA GC/MS	SV GC	SV GC/MS	Metals	Wet Chem
1	Holding Time	X				X	X
2	Method Accuracy	X				X	X
3	Method Precision	X				X	X
4	Surrogate Recovery	X				NA	NA
5	Blank	ND				X	X

Comments:

VOL 12 2 5553

GTEL ENVIRONMENTAL LABORATORIES, INC

R0058846

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209037
Report Issue Date: September 22, 1992

QC Check Sample Results

Matrix: Water

Analyte	Source	Date of Analysis	Expected Value	Units	Recovery[a], %
GC:					
Benzene	Ultra Scientific	9/11/92	150	ug/L	99.3 (81.1-118)
Toluene	Ultra Scientific	9/11/92	150	ug/L	111 (79.9-123)
Ethylbenzene	Ultra Scientific	9/11/92	150	ug/L	107 (81.1-123)
Xylene, total	Ultra Scientific	9/11/92	450	ug/L	119 (82.9-123)
Metals:					
Arsenic	Spex	9/14/92	1.00	mg/L	105 (80-120)
Barium	Spex	9/14/92	1.00	mg/L	101 (80-120)
Cadmium	Spex	9/14/92	1.00	mg/L	104 (80-120)
Chromium	Spex	9/14/92	1.00	mg/L	106 (80-120)
Lead	Spex	9/14/92	1.00	mg/L	107 (80-120)
Mercury	Perkin-Elmer	9/17/92	0.002	mg/L	101 (80-120)
Selenium	Spex	9/14/92	1.00	mg/L	105 (80-120)
Silver	Spex	9/14/92	1.00	mg/L	97.0 (80-120)
Inorganic Chemistry:					
Oil and Grease/IR	J.T. Baker	9/10/92	25.5	mg/L	102 (80-120)

a. Acceptability limits are in parentheses.
NA = Not Applicable.
* Indicates absolute difference.

VOL 12 2 5554

R0058847

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209037
Report Issue Date: September 22, 1992

Matrix Spike and Duplicate Spike Results

Matrix: Water

Analyte	Sample ID	Date of Analysis	Sample Amount	Spike Amount	Units	Recovery, %	Duplicate Recovery[a] %	RPD[a], %
GC:								
Benzene	T209037	9/11/92	<0.3	150	ug/L	99.3	82.7 (76.3-110)	18.2 (30)
Toluene	T209037	9/11/92	<0.3	150	ug/L	111	88.0 (73-112)	23.1 (30)
Ethylbenzene	T209037	9/11/92	<0.3	150	ug/L	107	86.7 (75.1-109)	21.0 (30)
Xylene, total	T209037	9/11/92	<0.3	450	ug/L	119	93.8 (78.1-109)	23.7 (30)
Metals:								
Arsenic	T209038	9/14/92	<0.1	2.00	mg/L	102	NA (68.6-112)	NA
Barium	T209038	9/14/92	0.0982	2.00	mg/L	95.6	NA (67.5-110)	NA
Cadmium	T209038	9/14/92	<0.03	2.00	mg/L	99.0	NA (67.2-111)	NA
Chromium	T209038	9/14/92	<0.04	2.00	mg/L	101	NA (66.8-115)	NA
Lead	T209038	9/14/92	<0.1	2.00	mg/L	101	NA (67.1-110)	NA
Mercury	T209038	9/17/92	<0.001	0.002	mg/L	101	NA (64.8-110)	NA
Selenium	T209038	9/14/92	<0.04	2.00	mg/L	101	NA (69.5-111)	NA
Silver	T209038	9/14/92	<0.05	2.00	mg/L	92.0	NA (45.2-110)	NA
Inorganic Chemistry:								
Oil and Grease/IR	09037-3	9/10/92	<1	4.78	mg/L	124	NA (64-127)	NA

a. Acceptability limits are in parentheses.
NA Not Applicable.

GTEL ENVIRONMENTAL LABORATORIES, INC.

VOL 12 2 5555

R0058848

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209037
Report Issue Date: September 22, 1992

Sample and Sample Duplicate Results

Matrix: Water

Analyte	Sample ID	Date of Analysis	Sample Results	Sample Duplicate Results	Units	RPD[a], %
Metals:						
Arsenic	T209038	9/14/92	<0.1	<0.1	mg/L	NA
Barium	T209038	9/14/92	0.129	0.0673	mg/L	NA
Cadmium	T209038	9/14/92	<0.03	<0.03	mg/L	NA
Chromium	T209038	9/14/92	<0.04	<0.04	mg/L	NA
Lead	T209038	9/14/92	<0.1	<0.1	mg/L	NA
Mercury	T209038	9/17/92	<0.001	<0.001	mg/L	NA
Selenium	T209038	9/14/92	<0.04	<0.04	mg/L	NA
Silver	T209038	9/14/92	<0.05	<0.05	mg/L	NA
Inorganic Chemistry:						
Oil and Grease/IR	T209037	9/10/92	<1	1.3	mg/L	NA
Total Suspended Solid	T209037	9/15/92	<10	<10	mg/L	NA

a. Acceptability limits are in parentheses.
NA Not Applicable.

VOL 12 2 5556

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209037
Report Issue Date: September 22, 1992

Reagent Water Spike Results for Organic Analyses and LCS for Inorganic Analyses[a]

Matrix: Water

Analyte	Source	Date of Analysis	Expected Value	Units	Recovery[b], %
Metals:					
Arsenic	Spex	9/14/92	1.00	mg/L	104 (70-130)
Barium	Spex	9/14/92	1.00	mg/L	97.8 (70-130)
Cadmium	Spex	9/14/92	1.00	mg/L	102 (70-130)
Chromium	Spex	9/14/92	1.00	mg/L	104 (70-130)
Lead	Spex	9/14/92	1.00	mg/L	106 (70-130)
Mercury	Perkin-Elmer	9/17/92	0.002	mg/L	101 (70-130)
Selenium	Spex	9/17/92	1.00	mg/L	103 (70-130)
Silver	Spex	9/17/92	1.00	mg/L	93.4 (70-130)
Inorganic Chemistry:					
Oil and Grease/IR	E.M. Science, J.T. Baker	9/10/92	4.78	mg/L	83.3 (70-130)

a. As required to support method accuracy or precision when matrix spike or RPD are out of control limits.
b. Acceptability limits are in parentheses.
NA Not applicable

GTEL ENVIRONMENTAL LABORATORIES INC

R0058850

VOL 12 2 5551

CHEVRON USA Inc.
P.O. BOX 2833
LA HABRA, CA
90632-2833

Do not be [illegible] Americas

PROJECT NAME WSPA STORMWATER RUNOFF
PROJECT I.D. No.
CONSULTANT NAME HART CROWSER
ADDRESS 1 WORLD TRADE CENTER, Long Beach 90831 Ca.
PROJECT CONTACT (NAME) JOHN NETHERWOOD
(PHONE) (310) 495 6860
CHEVRON FACILITY No. J-6565
CHEVRON CONTACT (NAME) Allison Fong
(PHONE) 818 543 5333

LABORATORY NAME GTEL Environ. Labs
CONTRACT NUMBER T320
COLLECTED BY (NAME) David C. DABROU
(SIGNATURE) [signature]
COLLECTION DATE 9.3.92

Fax 495 6361

CHAIN-OF-CUSTODY RECORD

T2-09-037
7°C

Quote T320

ANALYSES TO BE PERFORMED

SAMPLE No	LAB No	NUMBER OF CONTAINERS	MATRIX: SOIL	MATRIX: WATER	GRAB	COMPOSITE	DATE	TIME	ACIDIFIED	ICED		MODIFIED EPA 8015 TOTAL PETRO. HYDROCARB.	EPA 418.1 TOTAL RECOVERABLE PETROLEUM HYDROCARB.	EPA 8020 AROMATIC VOLATILES - BTXE	EPA 602 AROMATIC VOLATILES - BTXE	METALS	OTHER EPA 413.2 OIL+GREASE	EPA 160.2 TOTAL SUSPENDED SOLIDS	CCR TITLE 22 Cam 22	DETECTION LIMIT	REMARKS
1-1		1		X	X		9.3.92	11:30	X	X		X		X							
1-2		1		X	X		9.3.92	11:30		X								X			
1-3		1		X	X		9.3.92	11:30		X							X				
2-1		1		X	X		9.3.92	12:06	X	X		X		X							
2-2		1		X	X		9.3.92	12:06		X		DCD		DCD				X			
2-3		1		X	X		9.3.92	12:06		X							X				
2-4		1		X	X		9.3.92	12:06	X	X									X		
3-1		1		X	X		9.3.92	12:22	X	X		X		X							
3-2		1		X	X		9.3.92	12:22		X								X			
3-3		1		X	X		9.3.92	12:22		X							X				
4-1		1		X	X		9.3.92	12:38	X	X		X		X							
4-2		1		X	X		9.3.92	12:38		X								X			
4-3		1		X	X		9.3.92	12:38		X							X				

RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME
[signature]	HART CROWSER	9.4.92 6:00a			
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED FOR LABORATORY BY (Signature)		DATE/TIME

TURN AROUND TIME (CIRCLE CHOICE)
24 HRS 6 DAYS
48 HRS 10 DAYS

R0058851

0 5 5 5 2

VOL 12

CHAIN-OF-CUSTODY RECORD

T2-09-031

CHEVRON USA Inc.
P.O. BOX 2833
LA HABRA, CA 90632-2833

PROJECT NAME: USPA STORMWATER RUNOFF
PROJECT I.D. No.:
CONSULTANT NAME: HART CROWSER
ADDRESS: 1 WORLD TRADE CENTER
PROJECT CONTACT (NAME): JOHN WETHERWOOD
(PHONE): 310 495 6360
CHEVRON FACILITY No.: S-6585
CHEVRON CONTACT (NAME): Alice Fong
(PHONE): 818 543 5333

LABORATORY NAME: GTEL ENVIRON. LABS
CONTRACT NUMBER: T-320
COLLECTED BY (NAME): DAVID C. DARROW
(SIGNATURE):
COLLECTION DATE: 9.3.92

ANALYSES TO BE PERFORMED

SAMPLE No	LAB No.	NUMBER OF CONTAINERS	MATRIX: SOIL	MATRIX: WATER	GRAB	COMPOSITE	DATE	TIME	ACIDIFIED	ICED	MODIFIED EPA 8015 TOTAL PETRO. HYDROCARB.	EPA 418.1 TOTAL RECOVERABLE PETROLEUM HYDROCARB.	EPA 8020 AROMATIC VOLATILES - BTXE	EPA 602 AROMATIC VOLATILES - BTXE	METALS	OTHER EPA 413.2 OIL & GREASE	EPA 160.2 TOTAL SUSPENDED SOLIDS			DETECTION LIMIT	REMARKS
S-1		1		X		X	9.3.92	12:44		X	X		X								
S-2		1				X	9.3.92	12:44		X							X				
S-3		1				X	9.3.92	12:44		X						X					
6-1		1			X		9.3.92	2:55	X	X	X		X								
6-2		1			X		9.3.92	2:55		X							X				
6-3		1			X		9.3.92	2:55		X											
7-1		1			X		9.3.92	3:11	X	X	X		X			X					
7-2		1			X		9.3.92	3:11		X							X				
7-3		1			X		9.3.92	3:11		X											
8-1		1			X		9.3.92	3:25	X	X	X		X			X					
8-2		1			X		9.3.92	3:25		X							X				
8-3		1			X		9.3.92	3:25		X											
9-1		1				X	9.3.92	3:42	X	X	X		X			X					

RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME
	HART CROWSER	9.4.92 1:00p			
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED FOR LABORATORY BY (Signature)		DATE/TIME 9-4-92

TURN AROUND TIME (CIRCLE CHOICE)
24 HRS 5 DAYS
48 HRS (10 DAYS)

7°C

R0058852

CHEVRON USA Inc.
P.O. BOX 2833
LA HABRA, CA
90632-2833

Do... bill Ch... Arnold...

PROJECT NAME WSPA STORMWATER RUNOFF
PROJECT I.D. No.
CONSULTANT NAME HART CROWSER
ADDRESS 1 WORLD TRADE CENTER
PROJECT CONTACT (NAME) JOHN NETHERWOOD
(PHONE) 310 495 6360
CHEVRON FACILITY No. J-6565
CHEVRON CONTACT (NAME) Allison Fong
(PHONE) 818 543 5333

LABORATORY NAME GTEL ENVIRON. LABS
CONTRACT NUMBER T-320
COLLECTED BY (NAME) DAVID C. DARROW
(SIGNATURE) [signature]
COLLECTION DATE 9.3.92

CHAIN-OF-CUSTODY RECORD

72-09-037

7°C

ANALYSES TO BE PERFORMED

SAMPLE No	LAB No.	NUMBER OF CONTAINERS	MATRIX SOIL	MATRIX WATER	GRAB	COMPOSITE	DATE	TIME	ACIDIFIED	ICED		MODIFIED EPA 8015 TOTAL PETRO. HYDROCARB.	EPA 418.1 TOTAL RECOVERABLE PETROLEUM HYDROCARB.	EPA 8020 AROMATIC VOLATILES - BTXE	EPA 602 AROMATIC VOLATILES - BTXE	METALS ( )	OTHER EPA 413.2 OIL + GREASE	EPA 160.2 TOTAL SUSPENDED SOLIDS		DETECTION LIMIT	REMARKS
9.2		1		X		X	9.3.92	3:42		X								X			
9.3		1		X		X	9.3.92	3:42		X							X				
TRIP	BLANK	2		X			9.3.92			X		X		X							

RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME
[signature]	HART CROWSER	9.4.92 6:00pm			
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED FOR LABORATORY BY (Signature)		DATE/TIME

TURN AROUND TIME (CIRCLE CHOICE)
24 HRS 5 DAYS
48 HRS 10 DAYS

R0058853

VOL 12

2 55560

VOL 12

CATEGORY 4

2 5561

R0058854

GTEL
ENVIRONMENTAL
LABORATORIES, INC.

Southwest Region
20000 / 300 Mariner Drive
Torrance, CA 90503
(310) 371-1044
(800) 727-GTEL
Fax (310) 371-8720

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209058
Report Issue Date: September 25, 1992

VOL 12 2 5562

Mr. John Netherwood
Hart Crowser
1 World Trade Center
Long Beach, CA 90831

Dear Mr. Netherwood,

Enclosed please find the analytical results for the samples received by GTEL Environmental Laboratories, Inc. on 9-10-92.

A formal Quality Assurance/Quality Control (QA/QC) program is maintained by GTEL, which is designed to meet or exceed the EPA requirements. Analytical work for this project met QA/QC criteria unless otherwise stated in the footnotes.

GTEL is certified by the state of California under Certification #E723.

If you have any questions concerning this analysis or if we can be of further assistance, please call our Customer Service Representative.

Sincerely,

GTEL Environmental Laboratories, Inc.

Minsoon Song
Laboratory Director

cc: Allison Fong

R0058855

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209058
Report Issue Date: September 25, 1992

ANALYTICAL RESULTS

Volatile Organics in Water
EPA Methods Modified 8020 and Modified 8015[a]

GTEL Sample Number		Lab Blank	09058-1	09058-4	09058-6
Client Identification		–	201-1	202-1	203-1
Date Sampled		–	9-9-92	9-9-92	9-9-92
Date Analyzed		9-18-92	9-19-92	9-19-92	9-19-92
Analyte	Reporting Limit, ug/L	Concentration, ug/L			
Benzene	0.3	<0.3	<0.3	<0.3	<0.3
Toluene	0.3	<0.3	0.3	<0.3	<0.3
Ethylbenzene	0.3	<0.3	<0.3	<0.3	<0.3
Xylene, total	0.6	<0.6	7.1	<0.6	<0.6
BTEX, total	–	–	7.4	–	–
TPH as Gasoline	100	<100	<100	<100	<100
Dilution Multiplier[b]		–	1	1	1
TFT surrogate[c], % recovery		107	94.6	85.6	90.4

a. Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Revision 0, US EPA November 1986. Modification for TPH as gasoline as per California State Water Resources Board LUFT Manual procedures.

b. Indicates the adjustments made for sample dilution.

c. TFT surrogate recovery acceptability limits of 72.8-123% are derived from the 99% confidence interval of all samples during the previous quarter. Expected surrogate value is 100 ug/L.

GTEL ENVIRONMENTAL LABORATORIES, INC

VOL 12 2 5563

R0058856

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209058
Report Issue Date: September 25, 1992

ANALYTICAL RESULTS

Volatile Organics in Water
EPA Methods Modified 8020 and Modified 8015[a]

GTEL Sample Number		09058-11	09058-14	09058-17*	09058-20
Client Identification		204-1	205-1	206-1	207-1
Date Sampled		9-9-92	9-9-92	9-9-92	9-9-92
Date Analyzed		9-19-92	9-19-92	9-21-92	9-18-92
Analyte	Reporting Limit, ug/L	Concentration, ug/L			
Benzene	0.3	<0.3	<0.3	<3.0	<0.3
Toluene	0.3	0.4	<0.3	<3.0	<0.3
Ethylbenzene	0.3	<0.3	<0.3	<3.0	<0.3
Xylene, total	0.6	1.5	1.4	<6.0	<0.6
BTEX, total	–	1.9	1.4	–	–
TPH as Gasoline	100	<100	<100	<1000	<100
Dilution Multiplier[b]		1	1	10	1
TFT surrogate[c] % recovery		90.9	91.8	85.5	100

a. Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Revision 0, US EPA November 1986. Modification for TPH as gasoline as per California State Water Resources Board LUFT Manual procedures.

b. Indicates the adjustments made for sample dilution.

c. TFT surrogate recovery acceptability limits of 72.8-123% are derived from the 99% confidence interval of all samples during the previous quarter. Expected surrogate value is 100 ug/L.

*. Detection limit was increased due to matrix effect (foaming).

VOL 12 2 5564

R0058857

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209058
Report Issue Date: September 25, 1992

ANALYTICAL RESULTS

Volatile Organics in Water
EPA Methods Modified 8020 and Modified 8015[a]

GTEL Sample Number		09058-23	09058-26	09058-29	
Client Identification		208-1	209-1	TRIP BLANK	
Date Sampled		9-9-92	9-9-92	9-10-92	
Date Analyzed		9-18-92	9-18-92	9-23-92	
Analyte	Reporting Limit, ug/L	Concentration, ug/L			
Benzene	0.3	<0.3	<0.3	<0.3	
Toluene	0.3	<0.3	<0.3	0.7	
Ethylbenzene	0.3	<0.3	<0.3	<0.3	
Xylene, total	0.6	<0.6	<0.6	<0.6	
BTEX, total	-	-	-	0.7	
TPH as Gasoline	100	<100	130	<100	
Dilution Multiplier[b]		1	1	1	
TFT surrogate[c], % recovery		95.0	90.7	99.8	

a. Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Revision 0, US EPA November 1986. Modification for TPH as gasoline as per California State Water Resources Board LUFT Manual procedures.

b. Indicates the adjustments made for sample dilution.

c. TFT surrogate recovery acceptability limits of 72.8-123% are derived from the 99% confidence interval of all samples during the previous quarter. Expected surrogate value is 100 ug/L.

GTEL ENVIRONMENTAL LABORATORIES INC

R0058858

VOL 12 2 5565

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209058
Report Issue Date: September 25, 1992

ANALYTICAL RESULTS

Metals in Water
Total Threshold Limit Concentration
California Title 22 (C.A.M.)

GTEL Sample Number			Blank	09058-7		
Client Identification			-	202-4		
Date Sampled			-	9-9-92		
Date Analyzed (Method 6010)			9-14-92	9-14-92		
Date Analyzed (Method 7470)			9-17-92	9-17-92		
Analyte	Method[a]	Reporting Limit, mg/L	Concentration, mg/L			
Antimony	EPA 6010	0.04	<0.04	<0.04		
Arsenic	EPA 6010	0.1	<0.1	<0.1		
Barium	EPA 6010	0.02	<0.02	0.06		
Beryllium	EPA 6010	0.01	<0.01	<0.01		
Cadmium	EPA 6010	0.03	<0.03	<0.03		
Chromium	EPA 6010	0.04	<0.04	<0.04		
Cobalt	EPA 6010	0.02	<0.02	<0.02		
Copper	EPA 6010	0.2	<0.2	<0.2		
Lead	EPA 6010	0.1	<0.1	<0.1		
Mercury	EPA 7470	0.001	<0.001	<0.001		
Molybdenum	EPA 6010	0.02	<0.02	<0.02		
Nickel	EPA 6010	0.1	<0.1	<0.1		
Selenium	EPA 6010	0.04	<0.04	<0.04		
Silver	EPA 6010	0.05	<0.05	<0.05		
Thallium	EPA 6010	0.4	<0.4	<0.4		
Vanadium	EPA 6010	0.2	<0.2	<0.2		
Zinc	EPA 6010	0.1	<0.1	0.2		
EPA 6010: Dilution Multiplier[b]			1	1		
EPA 7470: Dilution Multiplier[b]			1	1		

a. Test Methods for Evaluating Solid Waste. SW-846. Third Edition. Revision 0. US EPA November 1986. Digestion by EPA Method 3010 (ICP).

b. Indicates the adjustments made for sample dilutions.

VOL 12 2 5566

R0058859

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209058
Report Issue Date: September 25, 1992

ANALYTICAL RESULTS

Total Recoverable Oil and Grease in Water by Infrared Spectrometry EPA 413.2[a]

Sample Identification		Date Sampled	Date Extracted	Date Analyzed	Reporting Limit, mg/L	Concentration, mg/L
GTEL No.	Client ID					
Blank	-	9-9-92	9-18-92	9-18-92	1	1
09058-3	201-3	9-9-92	9-18-92	9-18-92	1	15
09058-6	202-3	9-9-92	9-18-92	9-18-92	1	4
09058-10	203-3	9-9-92	9-18-92	9-18-92	1	2
09058-13	204-3	9-9-92	9-18-92	9-18-92	1	8
09058-16	205-3	9-9-92	9-18-92	9-18-92	1	1
09058-19	206-3	9-9-92	9-18-92	9-18-92	1	2
09058-22	207-3	9-9-92	9-18-92	9-18-92	1	1
09058-25	208-3	9-9-92	9-18-92	9-18-92	1	<1
09058-27	209-2	9-10-92	9-18-92	9-18-92	1	<1

a. EPA 600/4-79-020, March 1983 revision.

VOL 12 2 5567

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209058
Report Issue Date: September 25, 1992

ANALYTICAL RESULTS

Total Suspended Solid in Water
Standard Method 209 C[a]

Sample Identification		Date Sampled	Date Analyzed	Reporting Limit, mg/L	Concentration, mg/L
GTEL No.	Client ID				
Blank	-	9-9-92	9-21-92	10	<10
09058-2	201-2	9-9-92	9-21-92	10	14
09058-5	202-2	9-9-92	9-21-92	10	<10
09058-9	203-2	9-9-92	9-21-92	10	<10
09058-12	204-2	9-9-92	9-21-92	10	<10
09058-15	205-2	9-9-92	9-21-92	10	13
09058-18	206-2	9-9-92	9-21-92	10	11
09058-21	207-2	9-9-92	9-21-92	10	10
09058-24	208-2	9-9-92	9-21-92	10	12
09058-28	209-3	9-10-92	9-21-92	10	<10

a. Standard Methods for the Examination of Water and Wastewater, 16th Edition, 1985.

VOL 12 2 5568

R0058861

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209058
Report Issue Date: September 25, 1992

CONFORMANCE/NONCONFORMANCE SUMMARY

Abbreviations:

X = Requirements Met
VOA = Volatiles
* = See Comments
SV = Semi Volatiles
NA = Not Applicable
ND = Not Detected
- = Test Not Required

#	Conformance Item	VOA GC	VOA GC/MS	SV GC	SV GC/MS	Metals	Wet Chem
1	Holding Time	X				X	X
2	Method Accuracy	X				X	X
3	Method Precision	X				X	X
4	Surrogate Recovery	X				NA	NA
5	Blank	ND				X	X

Comments:

VOL 12 2 5569

GTEL ENVIRONMENTAL LABORATORIES, INC

R0058862

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209058
Report Issue Date: September 25, 1992

QC Check Sample Results

Matrix: Water

Analyte	Source	Date of Analysis	Expected Value	Units	Recovery[a], %
GC:					
Benzene	Ultra Scientific	9-18-92	150	ug/L	117 (81.1-118)
Toluene	Ultra Scientific	9-18-92	150	ug/L	119 (79.9-123)
Ethylbenzene	Ultra Scientific	9-18-92	150	ug/L	115 (81.1-123)
Xylene, total	Ultra Scientific	9-18-92	450	ug/L	121 (82.9-123)
Metals:					
Arsenic	Spex	9-14-92	1.00	mg/L	105 (80-120)
Barium	Spex	9-14-92	1.00	mg/L	101 (80-120)
Cadmium	Spex	9-14-92	1.00	mg/L	104 (80-120)
Chromium	Spex	9-14-92	1.00	mg/L	106 (80-120)
Lead	Spex	9-14-92	1.00	mg/L	107 (80-120)
Mercury	Perkin-Elmer	9-17-92	0.002	mg/L	101 (80-120)
Selenium	Spex	9-14-92	1.00	mg/L	105 (80-120)
Silver	Spex	9-14-92	1.00	mg/L	97.0 (80-120)
Inorganic Chemistry:					
Oil and Grease/IR	J.T. Baker	9-18-92	25.2	mg/L	88.9 (80-120)

a. Acceptability limits are in parentheses.

VOL 12 2 5510

R0058863

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209058
Report Issue Date: September 25, 1992

Matrix Spike and Duplicate Spike Results

Matrix: Water

Analyte	Sample ID	Date of Analysis	Sample Amount	Spike Amount	Units	Recovery, %	Duplicate Recovery[a] %	RPD[a], %
GC:								
Benzene	T209119	9-19-92	<0.3	150	ug/L	104	102 (76.3-110)	1.94 (30)
Toluene	T209119	9-19-92	<0.3	150	ug/L	106	107 (73-112)	0.935 (30)
Ethylbenzene	T209119	9-19-92	<0.3	150	ug/L	103	104 (75.1-109)	0.962 (30)
Xylene, total	T209119	9-19-92	<0.6	450	ug/L	108	109 (78.1-109)	0.917 (30)
Metals:								
Arsenic	T209038-7	9-14-92	<0.1	2.00	mg/L	102	NA (68.6-112)	NA
Barium	T209038-7	9-14-92	0.0982	2.00	mg/L	95.6	NA (67.5-110)	NA
Cadmium	T209038-7	9-14-92	<0.03	2.00	mg/L	99.0	NA (67.2-111)	NA
Chromium	T209038-7	9-14-92	<0.04	2.00	mg/L	101	NA (66.8-115)	NA
Lead	T209038-7	9-14-92	<0.1	2.00	mg/L	101	NA (67.1-110)	NA
Mercury	T209038-7	9-17-92	<0.001	0.002	mg/L	101	NA (64.8-110)	NA
Selenium	T209038-7	9-14-92	<0.04	2.00	mg/L	101	NA (69.5-111)	NA
Silver	T209038-7	9-14-92	<0.05	2.00	mg/L	92.0	NA (45.2-110)	NA
Inorganic Chemistry:								
Oil and Grease/IR	T209058-25	9-18-92	1.27	4.42	mg/L	87.1	NA (64-127)	NA

a. Acceptability limits are in parentheses.
NA Not Applicable.

VOL 12 2 5511

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209058
Report Issue Date: September 25, 1992

Sample and Sample Duplicate Results

Matrix: Water

Analyte	Sample ID	Date of Analysis	Sample Results	Sample Duplicate Results	Units	RPD[a], %
Metals:						
Arsenic	T209038-7	9-14-92	<0.1	<0.1	mg/L	NA
Barium	T209038-7	9-14-92	0.129	0.0673	mg/L	NA
Cadmium	T209038-7	9-14-92	<0.03	<0.03	mg/L	NA
Chromium	T209038-7	9-14-92	<0.04	<0.04	mg/L	NA
Lead	T209038-7	9-14-92	<0.1	<0.1	mg/L	NA
Mercury	T209038-7	9-17-92	<0.001	<0.001	mg/L	NA
Selenium	T209038-7	9-14-92	<0.04	<0.04	mg/L	NA
Silver	T209038-7	9-14-92	<0.05	<0.05	mg/L	NA
Inorganic Chemistry:						
Oil and Grease/IR	T209058-22	9-18-92	1.52	1.84	mg/L	NA
Total Suspended Solid	T209058-2	9-21-92	<10	<10	mg/L	NA

a. Acceptability limits are in parentheses.
NA Not Applicable.

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5512

GTEL Client Number: WSP01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209058
Report Issue Date: September 25, 1992

Reagent Water Spike Results for Organic Analyses and LCS for Inorganic Analyses[a]

Matrix: Water

Analyte	Source	Date of Analysis	Expected Value	Units	Recovery[b], %
Metals:					
Arsenic	Spex	9-14-92	1.00	mg/L	104 (70-130)
Barium	Spex	9-14-92	1.00	mg/L	97.8 (70-130)
Cadmium	Spex	9-14-92	1.00	mg/L	102 (70-130)
Chromium	Spex	9-14-92	1.00	mg/L	104 (70-130)
Lead	Spex	9-14-92	1.00	mg/L	106 (70-130)
Mercury	Perkin Elmer	9-17-92	0.002	mg/L	101 (70-130)
Selenium	Spex	9-14-92	1.00	mg/L	103 (70-130)
Silver	Spex	9-14-92	1.00	mg/L	93.4 (70-130)
Inorganic Chemistry:					
Oil and Grease/IR	E.M. Science, J.T. Baker	9-18-92	4.42	mg/L	95.5 (70-130)

a. As required to support method accuracy or precision when matrix spike or RPD are out of control limits.
b. Acceptability limits are in parentheses.
NA Not applicable.

VOL 12 2 5513

GTEL ENVIRONMENTAL LABORATORIES INC

R0058866

CHEVRON USA Inc.
P.O. BOX 2833
LA HABRA, CA
90632-2833

bill Chev

PROJECT NAME WSPA STORMWATER RUNOFF
PROJECT I.D. NO.
CONSULTANT NAME HART CROWSER
ADDRESS 1 WORLD TRADE CENTER
PROJECT CONTACT (NAME) JOHN NETHERWOOD
(PHONE) 310 495 6300
CHEVRON FACILITY NO. J-6565
CHEVRON CONTACT (NAME) Allison Fong
(PHONE) 818 543 5333

LABORATORY NAME GTEL ENVIRONMENTAL LABORATORIES
CONTRACT NUMBER T320
COLLECTED BY (NAME) DAVID C. DARROW
(SIGNATURE) [signature]
COLLECTION DATE 9 SEPTEMBER 1992

CHAIN-OF-CUSTODY RECORD

T2-09-058

Quote T320

ANALYSES TO BE PERFORMED

SAMPLE No	LAB No	NUMBER OF CONTAINERS	MATRIX: SOIL	MATRIX: WATER	GRAB	COMPOSITE	DATE	TIME	ACIDIFIED	ICED		MODIFIED EPA 8015 TOTAL PETRO. HYDROCARB.	EPA 418.1 TOTAL RECOVERABLE PETROLEUM HYDROCARB.	EPA 8020 AROMATIC VOLATILES + BTXE	EPA 602 AROMATIC VOLATILES + BTXE	METALS (Cam) CCR 22	OTHER 413.2 OIL + GREASE	160.2 TOTAL SUSPENDED SOLIDS		DETECTION LIMIT	REMARKS
201-1	1	2		X	X		9.9.92	9:30	X	X		X		X							
201-2	2	1						9:30										X			
201-3	3	1						9:30									X				
202-1	4	2						9:55	X			X		X							
202-2	5	1						9:55										X			
202-3	6	2						9:55									X				
202-4	7	1						10:05	X							X					
203-1	8	2						10:10	X			X		X							
203-2	9	1						10:10										X			
203-3	10	1						10:10									X				
204-1	11	2						10:25	X			X		X							
204-2	12	1						10:25										X			
204-3	13	1						10:25									X				

RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME
[signature]	HART CROWSER	9.10.92 15:00	[signature]	GTEL-Labs	9/10/92 15:00
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED FOR LABORATORY BY (Signature)		DATE/TIME 9/10/92 15:30

TURN AROUND TIME (CIRCLE ONE)
24 HRS 5 DAYS
48 HRS 10 DAYS

R0058867

VOL 12

2 557 4

CHEVRON USA Inc.
P.O. BOX 2833
LA HABRA, CA
90632-2833

Do not bill Chev

PROJECT NAME WSPA STORMWATER RUNOFF
PROJECT I.D. NO.
CONSULTANT NAME HART CROWSER
ADDRESS 1 WORLD TRADE CENTER
PROJECT CONTACT (NAME) JOHN NETHERWOOD
(PHONE) 310 495 6360
CHEVRON FACILITY NO. J-6565
CHEVRON CONTACT (NAME) Allison Fong
(PHONE) 818 543 5333

LABORATORY NAME GTEL ENVIRON. LABS
CONTRACT NUMBER T320
COLLECTED BY (NAME) DAVID C. DARROW
(SIGNATURE) David C Darrow
COLLECTION DATE 9 SEPTEMBER 1992

CHAIN-OF-CUSTODY RECORD

Quick T320

ANALYSES TO BE PERFORMED

SAMPLE No	LAB No	NUMBER OF CONTAINERS	MATRIX: SOIL	MATRIX: WATER	GRAB	COMPOSITE	DATE	TIME	ACIDIFIED	ICED		MODIFIED EPA 8015 TOTAL PETRO. HYDROCARB.	EPA 418.1 TOTAL RECOVERABLE PETROLEUM HYDROCARB.	EPA 8020 AROMATIC VOLATILES + BTXE	EPA 602 AROMATIC VOLATILES + BTXE	METALS (CAM) CCR 22	OTHER 413.2 OIL & GREASE	160.2 TOTAL SUSPENDED SOLIDS		DETECTION LIMIT	REMARKS
205-1	14	2		X		X	9992	10:30	X	X		X		X							
205-2	15	1				X		10:30										X			
205-3	16	1				X		10:30									X				
206-1	17	2			X			10:28	X			X		X							
206-2	18	1						10:28										X			
206-3	19	1						10:28									X				
207-1	20	2						10:40	X			X		X							
207-2	21	1						10:40										X			
207-3	22	1						10:40									X				
208-1	23	2						10:50	X			X		X							
208-2	24	1						10:50										X			
208-3	25	1			X			10:55									X				
209-1	26	2				X		10:55	X			X		X							

RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME
David C. Darrow	HART CROWSER	9/10/92 15:10	[signature]	GTEL-Tor	9/10/92 15:10
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED FOR LABORATORY BY (Signature)		DATE/TIME
			[signature]		9/10/92 15:5

TURN AROUND TIME (CIRCLE ONE)
24 HRS 5 DAYS
48 HRS 10 DAYS

R0058868

VOL 12

CHEVRON USA Inc.
P.O. BOX 2833
LA HABRA, CA
90632-2833

Chevron

PROJECT NAME WSPA STORMWATER RUNOFF
PROJECT I.D. NO.
CONSULTANT NAME HART CROWSER
ADDRESS 1 WORLD TRADE CENTER
PROJECT CONTACT (NAME) JOHN NETHERWOOD
(PHONE) (301) 495-6360
CHEVRON FACILITY NO. J-6525
CHEVRON CONTACT (NAME) ALLISON FONG
(PHONE) 818-543-5333

LABORATORY NAME GTEL
CONTRACT NUMBER T320
COLLECTED BY (NAME) DAVID C. DARROW
(SIGNATURE)
COLLECTION DATE 9 SEPTEMBER 1992

CHAIN-OF-CUSTODY RECORD

Quote T320

ANALYSES TO BE PERFORMED

SAMPLE No.	LAB No.	NUMBER OF CONTAINERS	MATRIX SOIL	MATRIX WATER	GRAB	COMPOSITE	DATE	TIME	ACIDIFIED	ICED		MODIFIED EPA 8015 TOTAL PETRO. HYDROCARB.	EPA 418.1 TOTAL RECOVERABLE PETROLEUM HYDROCARB.	EPA 8020 AROMATIC VOLATILES + BTXE	EPA 602 AROMATIC VOLATILES + BTXE	METALS ( )	OTHER 413.2 OIL & GREASE	TOTAL SUSP. SOLID 160.2		DETECTION LIMIT	REMARKS
209-2	27	1		X		X	9-10-91	13:55		X							X				
209-3	28	1		X		X	9-10-91	13:55		X								X			
TRIP	29	2		X			9/10/92			X		X		X							

RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME	TURN AROUND TIME (CIRCLE ONE)
[signature]	HART CROWSER	9-10-92 15:10	[signature]	GTEL-Labs	9/10/92 15:00	24 HRS 5 DAYS
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME	48 HRS 10 DAYS
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED FOR LABORATORY BY (Signature)		DATE/TIME 15:30	

R0058869

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VOL 12

CATEGORY 5

2

5571

R0058870

GTEL
ENVIRONMENTAL
LABORATORIES, INC.

Southwest Region
20000 / 300 Manner Drive
Torrance, CA 90503
(213) 371-1044
(800) 727-GTEL
Fax (213) 371-8720

GTEL Client Number: HCR01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209137
Report Issue Date: October 2, 1992

Mr. John Netherwood
Hart Crowser
1 World Trade Center
Long Beach, CA 90831-2300

Dear Mr. Netherwood,

This report replaces the previous report issued on 10-2-92 due to a typographical error in the dilution multiplier on page 2. Enclosed please find the analytical results for the samples received by GTEL Environmental Laboratories, Inc. on 9-18-92.

A formal Quality Assurance/Quality Control (QA/QC) program is maintained by GTEL, which is designed to meet or exceed the EPA requirements. Analytical work for this project met QA/QC criteria unless otherwise stated in the footnotes.

GTEL is certified by the state of California under Certification #E723.

If you have any questions concerning this analysis or if we can be of further assistance, please call our Customer Service Representative.

Sincerely,

GTEL Environmental Laboratories, Inc.

Minsoon Song
Laboratory Director

cc: Allison Fong

VOL 12 2 5578

R0058871

GTEL Client Number: HCR01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209137
Report Issue Date: October 2, 1992

ANALYTICAL RESULTS

Volatile Organics in Water
EPA Methods Modified 8020 and Modified 8015[a]

GTEL Sample Number		Lab Blank	09137-1	09137-4*	09137-8*
Client Identification		-	401-1	402-1	403-1
Date Sampled		-	9-17-92	9-17-92	9-17-92
Date Analyzed		9-24-92	9-24-92	9-24-92	9-24-92
Analyte	Reporting Limit, ug/L	Concentration, ug/L			
Benzene	0.3	<0.3	<0.3	<3.0	<3.0
Toluene	0.3	<0.3	<0.3	9.5	14
Ethylbenzene	0.3	<0.3	<0.3	<3.0	5.0
Xylene, total	0.6	<0.6	<0.6	19	37
BTEX, total	-	-	-	29	56
TPH as Gasoline	100	<100	<100	<1000	<1000
Dilution Multiplier[b]		1	1	10	10
TFT surrogate[c] % recovery		100	99.6	94.7	97.1

a. Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Revision 0, US EPA November 1986. Modification for TPH as gasoline as per California State Water Resources Board LUFT Manual procedures.

b. Indicates the adjustments made for sample dilution.

c. TFT surrogate recovery acceptability limits of 72.8-123% are derived from the 99% confidence interval of all samples during the previous quarter. Expected surrogate value is 100 ug/L.

* Detection limit increased due to matrix effect (foaming)

GTEL ENVIRONMENTAL LABORATORIES, INC

R0058872

VOL 12 2 5519

GTEL Client Number: HCR01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209137
Report Issue Date: October 2, 1992

ANALYTICAL RESULTS

Volatile Organics in Water
EPA Methods Modified 8020 and Modified 8015[a]

GTEL Sample Number		09137-11	09137-14*	09137-17*	09137-20*
Client Identification		404-1	405-1	406-1	407-1
Date Sampled		9-17-92	9-17-92	9-17-92	9-17-92
Date Analyzed		9-24-92	9-24-92	9-24-92	9-24-92
Analyte	Reporting Limit, ug/L	Concentration, ug/L			
Benzene	0.3	1.0	<3.0	<7.5	<3.0
Toluene	0.3	13	9.5	<7.5	<3.0
Ethylbenzene	0.3	6.3	3.4	<7.5	<3.0
Xylene, total	0.6	41	22	<15	<6.0
BTEX, total	-	61	35	-	-
TPH as Gasoline	100	180	<1000	<2500	<1000
Dilution Multiplier[b]		1	10	25	10
TFT surrogate[c], % recovery		83.7	97.4	89.6	95.9

a. Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Revision 0, US EPA November 1986. Modification for TPH as gasoline as per California State Water Resources Board LUFT Manual procedures.

b. Indicates the adjustments made for sample dilution.

c. TFT surrogate recovery acceptability limits of 72.8-123% are derived from the 99% confidence interval of all samples during the previous quarter. Expected surrogate value is 100 ug/L.

* Detection limit increased due to matrix effect (foaming)

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GTEL ENVIRONMENTAL LABORATORIES, INC

R0058873

GTEL Client Number: HCR01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209137
Report Issue Date: October 2, 1992

ANALYTICAL RESULTS

Volatile Organics in Water
EPA Methods Modified 8020 and Modified 8015[a]

GTEL Sample Number		09137-23*	09137-26*	09137-29	
Client Identification		408-1	409-1	Trip Blank	
Date Sampled		9-17-92	9-17-92	9-17-92	
Date Analyzed		9-24-92	9-24-92	9-24-92	
Analyte	Reporting Limit, ug/L	Concentration, ug/L			
Benzene	0.3	<7.5	<7.5	<0.3	
Toluene	0.3	<7.5	<7.5	<0.3	
Ethylbenzene	0.3	<7.5	<7.5	<0.3	
Xylene, total	0.6	<15	<15	<0.6	
BTEX, total	-	-	-	-	
TPH as Gasoline	100	<2500	<2500	<100	
Dilution Multiplier[b]		25	25	1	
TFT surrogate[c], % recovery		97.7	97.8	99.8	

a. Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Revision 0, US EPA November 1986. Modification for TPH as gasoline as per California State Water Resources Board LUFT Manual procedures.

b. Indicates the adjustments made for sample dilution.

c. TFT surrogate recovery acceptability limits of 72.8-123% are derived from the 99% confidence interval of all samples during the previous quarter. Expected surrogate value is 100 ug/L.

* Detection limit increased due to matrix effect (foaming)

GTEL ENVIRONMENTAL LABORATORIES, INC

VOL 12 2 5581

R0058874

GTEL Client Number: HCR01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209137
Report Issue Date: October 2, 1992

ANALYTICAL RESULTS

Total Recoverable Oil and Grease in Water by Infrared Spectrometry EPA 413.2[a]

Sample Identification		Date Sampled	Date Extracted	Date Analyzed	Reporting Limit, mg/L	Concentration, mg/L
GTEL No.	Client ID					
Blank	–	–	9-30-92	10-1-92	1	<1
09137-3	401-3	9-17-92	9-30-92	10-1-92	1	<1
09137-6	402-3	9-17-92	9-30-92	10-1-92	1	9
09137-10	403-3	9-17-92	9-30-92	10-1-92	1	7
09137-13	404-3	9-17-92	9-30-92	10-1-92	1	9
09137-16	405-3	9-17-92	9-30-92	10-1-92	1	34
09137-19	406-3	9-17-92	9-30-92	10-1-92	1	9
09137-22	407-3	9-17-92	9-30-92	10-1-92	1	11
09137-25	408-3	9-17-92	9-30-92	10-1-92	1	6
09137-28	409-3	9-17-92	9-30-92	10-1-92	1	29

a. EPA 600/4-79-020, March 1983 revision.

VOL 12 2 5582

R0058875

GTEL Client Number: HCR01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209137
Report Issue Date: October 2, 1992

ANALYTICAL RESULTS

Total Suspended Solid in Water
Standard Method 209 C[a]

Sample Identification		Date Sampled	Date Analyzed	Reporting Limit, mg/L	Concentration, mg/L
GTEL No.	Client ID				
09137-2	401-2	9-17-92	9-25-92	10	<10
09137-5	402-2	9-17-92	9-25-92	10	<10
09137-9	403-2	9-17-92	9-25-92	10	<10
09137-12	404-2	9-17-92	9-25-92	10	<10
09137-15	405-2	9-17-92	9-25-92	10	<10
09137-18	406-2	9-17-92	9-25-92	10	<10
09137-21	407-2	9-17-92	9-25-92	10	<10
09137-24	408-2	9-17-92	9-25-92	10	<10
09137-27	409-2	9-17-92	9-25-92	10	13
				10	<10

a. Standard Methods for the Examination of Water and Wastewater, 18th Edition, 1992.

VOL 12 2 5583

R0058876

GTEL Client Number: HCR01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209137
Report Issue Date: October 2, 1992

ANALYTICAL RESULTS

Metals in Water
Total Threshold Limit Concentration
California Title 22 (C.A.M.)

GTEL Sample Number			Blank	09137-7		
Client Identification			-	402-4		
Date Sampled			-	9-17-92		
Date Analyzed (Method 6010)			9-28-92	9-28-92		
Date Analyzed (Method 7470)			9-29-92	9-29-92		
Analyte	Method[a]	Reporting Limit, mg/L	Concentration, mg/L			
Antimony	EPA 6010	0.04	<0.04	<0.04		
Arsenic	EPA 6010	0.1	<0.1	<0.1		
Barium	EPA 6010	0.02	<0.02	0.08		
Beryllium	EPA 6010	0.01	<0.01	<0.01		
Cadmium	EPA 6010	0.03	<0.03	<0.03		
Chromium	EPA 6010	0.04	<0.04	<0.04		
Cobalt	EPA 6010	0.02	<0.02	<0.02		
Copper	EPA 6010	0.2	<0.2	0.2		
Lead	EPA 6010	0.1	<0.1	<0.1		
Mercury	EPA 7470	0.001	<0.001	<0.001		
Molybdenum	EPA 6010	0.02	<0.02	<0.02		
Nickel	EPA 6010	0.1	<0.1	<0.1		
Selenium	EPA 6010	0.04	<0.04	<0.04		
Silver	EPA 6010	0.05	<0.05	<0.05		
Thallium	EPA 6010	0.4	<0.4	<0.4		
Vanadium	EPA 6010	0.2	<0.2	<0.2		
Zinc	EPA 6010	0.1	<0.1	0.6		
EPA 6010: Dilution Multiplier[b]			1	1		
EPA 7470: Dilution Multiplier[b]			1	1		

a. Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Revision 0, US EPA November 1986. Digestion by EPA Method 3010 (ICP).

b. Indicates the adjustments made for sample dilutions.

GTEL ENVIRONMENTAL LABORATORIES INC

R0058877

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GTEL Client Number: HCR01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209137
Report Issue Date: October 2, 1992

CONFORMANCE/NONCONFORMANCE SUMMARY

Abbreviations:

X = Requirements Met * = See Comments NA = Not Applicable - = Test Not Required
VOA = Volatiles SV = Semi Volatiles ND = Not Detected

#	Conformance Item	VOA GC	VOA GC/MS	SV GC	SV GC/MS	Metals	Wet Chem
1	Holding Time	X				X	X
2	Method Accuracy	X				X	X
3	Method Precision	X				X	X
4	Surrogate Recovery	X				NA	NA
5	Blank	ND				X	X

Comments:

GTEL ENVIRONMENTAL LABORATORIES INC

VOL 12 2 5585

R0058878

GTEL Client Number: HCR01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209137
Report Issue Date: October 2, 1992

QC Check Sample Results

Matrix: Water

Analyte	Source	Date of Analysis	Expected Value	Units	Recovery[a], %
GC:					
Benzene	Ultra Scientific	9-23-92	150	ug/L	110 (81.1-118)
Toluene	Ultra Scientific	9-23-92	150	ug/L	109 (79.9-123)
Ethylbenzene	Ultra Scientific	9-23-92	150	ug/L	102 (81.1-123)
Xylene, total	Ultra Scientific	9-23-92	450	ug/L	112 (82.9-123)
Metals:					
Arsenic	Spex	9-28-92	1.00	mg/L	107 (80-120)
Barium	Spex	9-28-92	1.00	mg/L	100 (80-120)
Cadmium	Spex	9-28-92	1.00	mg/L	106 (80-120)
Chromium	Spex	9-28-92	1.00	mg/L	110 (80-120)
Lead	Spex	9-28-92	1.00	mg/L	109 (80-120)
Mercury	Perkin-Elmer	9-29-92	0.002	mg/L	102 (80-120)
Selenium	Spex	9-28-92	1.00	mg/L	106 (80-120)
Silver	Spex	9-28-92	1.00	mg/L	96.0 (80-120)
Inorganic Chemistry:					
Oil and Grease/IR	J.T. Baker	10-1-92	25.2	mg/L	101 (80-120)

a. Acceptability limits are in parentheses.

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R0058879

GTEL Client Number: HCR01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209137
Report Issue Date: October 2, 1992

Matrix Spike and Duplicate Spike Results

Matrix: Water

Analyte	Sample ID	Date of Analysis	Sample Amount	Spike Amount	Units	Recovery, %	Duplicate Recovery[a] %	RPD[a], %
GC:								
Benzene	T209137	9-23-92	<0.3	150	ug/L	110	117 (76.3-110)	6.17 (30)
Toluene	T209137	9-23-92	<0.3	150	ug/L	109	115 (73-112)	5.36 (30)
Ethylbenzene	T209137	9-23-92	<0.3	150	ug/L	102	112 (75.1-109)	9.35 (30)
Xylene, total	T209137	9-23-92	<0.6	450	ug/L	112	121 (78.1-109)	7.73 (30)
Metals:								
Arsenic	T209137-7	9-28-92	<0.1	2.00	mg/L	101	NA (68.6-112)	NA
Barium	T209137-7	9-28-92	0.0794	2.00	mg/L	99.0	NA (67.5-110)	NA
Cadmium	T209137-7	9-28-92	<0.03	2.00	mg/L	98.0	NA (67.2-111)	NA
Chromium	T209137-7	9-28-92	<0.04	2.00	mg/L	104	NA (66.8-115)	NA
Lead	T209137-7	9-28-92	<0.1	2.00	mg/L	101	NA (67.1-110)	NA
Mercury	T209137-7	9-29-92	<0.001	0.002	mg/L	102	NA (64.8-110)	NA
Selenium	T209137-7	9-28-92	<0.04	2.00	mg/L	102	NA (69.5-111)	NA
Silver	T209137-7	9-28-92	<0.05	2.00	mg/L	87.0	NA (45.2-110)	NA
Inorganic Chemistry:								
Oil and Grease/IR	T209137-3	10-1-92	<1	4.93	mg/L	87.0	NA (64-127)	NA

a. Acceptability limits are in parentheses.
NA Not Applicable.

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GTEL ENVIRONMENTAL LABORATORIES, INC

R0058880

GTEL Client Number: HCR01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209137
Report Issue Date: October 2, 1992

Sample and Sample Duplicate Results

Matrix: Water

Analyte	Sample ID	Date of Analysis	Sample Results	Sample Duplicate Results	Units	RPD*, %
Metals:						
Arsenic	T209137-7	9-28-92	<0.1	<0.1	mg/L	NA
Barium	T209137-7	9-28-92	0.0794	0.0803	mg/L	NA
Cadmium	T209137-7	9-28-92	<0.03	<0.03	mg/L	NA
Chromium	T209137-7	9-28-92	<0.04	<0.04	mg/L	NA
Lead	T209137-7	9-28-92	<0.1	<0.1	mg/L	NA
Mercury	T209137-7	9-29-92	<0.001	<0.001	mg/L	NA
Selenium	T209137-7	9-28-92	<0.04	<0.04	mg/L	NA
Silver	T209137-7	9-28-92	<0.05	<0.05	mg/L	NA
Inorganic Chemistry:						
Oil and Grease/IR	T209137-28	10-1-92	28.8	24.4	mg/L	16.5
Total Suspended Solid	T209137-2	9-25-92	<10	<10	mg/L	NA

*. Acceptability limits are in parentheses.
NA Not Applicable.

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R0058881

GTEL Client Number: HCR01.WSP01
Contract Number: 6CSW23231X
Facility Number: J-6565
Work Order Number: T209137
Report Issue Date: October 2, 1992

Reagent Water Spike Results for Organic Analyses and LCS for Inorganic Analyses[a]

Matrix: Water

Analyte	Source	Date of Analysis	Expected Value	Units	Recovery[b], %
Metals:					
Arsenic	Spex	9-28-92	1.00	mg/L	108 (70-130)
Barium	Spex	9-28-92	1.00	mg/L	103 (70-130)
Cadmium	Spex	9-28-92	1.00	mg/L	106 (70-130)
Chromium	Spex	9-28-92	1.00	mg/L	110 (70-130)
Lead	Spex	9-28-92	1.00	mg/L	107 (70-130)
Mercury		9-29-92	0.002	mg/L	102 (70-130)
Selenium	Spex	9-28-92	1.00	mg/L	107 (70-130)
Silver	Spex	9-28-92	1.00	mg/L	96.6 (70-130)
Inorganic Chemistry:					
Oil and Grease/IR	E.M. Science, J.T. Baker	10-1-92	4.93	mg/L	98.0 (70-130)

a. As required to support method accuracy or precision when matrix spike or RPD are out of control limits.
b. Acceptability limits are in parentheses.

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GTEL ENVIRONMENTAL LABORATORIES, INC

R0058882

CONSULTANT NAME HART ... CONTRACT NUMBER

LD 1501 CHEVRON

BILL

CHEVRON USA INC
P.O. BOX 2833
LA HABRA, CA
90632-2833

PROJECT NAME WSPA STORMWATER RUNOFF
PROJECT I.D. NO
CONSULTANT NAME HART CROWSER
ADDRESS 1 WORLD TRADE CENTER LONG BEACH
PROJECT CONTACT (NAME) JOHN NETHERWOOD
(PHONE) (310) 485 6360
CHEVRON FACILITY NO. J 6565
CHEVRON CONTACT (NAME) Allison Fong
(PHONE) 818 543 5333

LABORATORY NAME CETER ENVIRONMENTAL LABS
CONTRACT NUMBER T320
COLLECTED BY (NAME) DAVID DARROW
(SIGNATURE)
COLLECTION DATE 9.17.92

CHAIN-OF-CUSTODY RECORD

SAMPLE NO	LAB NO	NUMBER OF CONTAINERS	MATRIX: SOIL	MATRIX: WATER	GRAB	COMPOSITE	DATE	TIME (PM)	ACIDIFIED	ICED
101-1		2		X	X		9.17.92	5:50	X	X
101-2		1						5:50		
101-3		1						5:50		
102-1		2						5:56	X	
102-2		1						5:56		
102-3		1						5:56		
102-4		1						5:56	X	
103-1		2						6:11	X	
103-2		1						6:11		
103-3		2						6:11		
104-1		2						6:26	X	
104-2		1						6:26		
104-3		1						6:26		

ANALYSES TO BE PERFORMED

	MODIFIED EPA 8015 TOTAL PETRO. HYDROCARB.	EPA 418.1 TOTAL RECOVERABLE PETROLEUM HYDROCARB.	EPA 8020 AROMATIC VOLATILES - BTXE	EPA 602 AROMATIC VOLATILES - BTXE	CAM 22 METALS	EPA 413.2 OTHER OIL & GREASE	EPA 160.2 TOTAL SUSPENDED SOLIDS		DETECTION LIMIT
101-1	X		X						
101-2							X		
101-3						X			
102-1	X		X						
102-2							X		
102-3						X			
102-4					X				
103-1	X		X						
103-2							X		
103-3						X			
104-1	X		X						
104-2							X		
104-3						X			

4°C

REMARKS

RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME
	HART CROWSER	9.18.92 16:00			
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED FOR LABORATORY BY (Signature)		DATE/TIME

TURN AROUND TIME (CIRCLE ONE)
24 HRS 5 DAYS
48 HRS 10 DAYS

R0058883

C0055 2 of 12

CHEVRON USA Inc
P.O. BOX 2833
LA HABRA, CA 90632-2833

CONSULTANT NAME LIAR CROWSER
ADDRESS 1 WORLD TRADE CENTER LONG BEACH
PROJECT CONTACT (NAME) JOHN NETHERWOOD
(PHONE) (310) 415-6360
CHEVRON FACILITY NO. 5-6565
CHEVRON CONTACT (NAME) Alison Fong
(PHONE) 818 543 6333

COLLECTED BY (NAME) DAVID DARROW
(SIGNATURE)
COLLECTION DATE 9.17.92

ANALYSES TO BE PERFORMED

SAMPLE No	LAB No	NUMBER OF CONTAINERS	MATRIX: SOIL	MATRIX: WATER	GRAB	COMPOSITE	DATE	TIME (AM)	ACIDIFIED	ICED	MODIFIED EPA 8015 TOTAL PETRO. HYDROCARB	EPA 418.1 TOTAL RECOVERABLE PETROLEUM HYDROCARB	EPA 8020 AROMATIC VOLATILES - BTXE	EPA 602 AROMATIC VOLATILES - BTXE	METALS ( )	OTHER 8240 42.2 OIL + GREASE EPA 160.2 TDXIM 413 SUSPENDED SOLIDS		DETECTION LIMIT	REMARKS
105-1		2		X	X		9.17	6:30	X	X	X		X				X		4°C
105-2		1						6:30											
105-3		1						6:30											
106-1		2						7:45	X							X			
106-2		1						7:45			X		X						
106-3		1						7:45									X		
107-1		2						8:00	X		X					X			
107-2		1						8:00					X						
107-3		1						8:00									X		
108-1		2						8:15	X		X					X			
108-2		1						8:15					X						
108-3		1			X			8:15									X		
109-1		2				X		8:20	X		X					X			

RELINQUISHED BY (Signature)
ORGANIZATION: HART CROWSER
DATE/TIME: 9.18.92 16:00

RELINQUISHED BY (Signature)
ORGANIZATION
DATE/TIME

RELINQUISHED BY (Signature)
ORGANIZATION
DATE/TIME

RECEIVED BY (Signature)
ORGANIZATION
DATE/TIME

RECEIVED BY (Signature)
ORGANIZATION
DATE/TIME

RECEIVED FOR LABORATORY BY (Signature)
DATE/TIME: 9/18/92 16:00

TURN AROUND TIME (CIRCLE ONE)
24 HRS 5 DAYS
48 HRS 10 DAYS

R0058884

-6565 2 VOA

CHAIN-OF-CUSTODY RECORD

CHEVRON USA
P.O. BOX 2833
LA HABRA, CA 90632-2833

PROJECT NAME WSPA STORMWATER RUNOFF
PROJECT I.D. NO. [redacted]
CONSULTANT NAME HART CROWSER
ADDRESS 1 WORLD TRADE CENTER LONG BEACH
PROJECT CONTACT (NAME) JOHN NETTERWOOD
(PHONE) (310) 495 6360
CHEVRON FACILITY NO. J 6565
CHEVRON CONTACT (NAME) Allison Fong
(PHONE) 818 543 5333

LABORATORY NAME CITEL ENVIRONMENTAL LABS
CONTRACT NUMBER 7320
COLLECTED BY (NAME) DAVID DARRAH
(SIGNATURE) [signature]
COLLECTION DATE 9.17.92

SAMPLE No	LAB No.	NUMBER OF CONTAINERS	MATRIX: SOIL	MATRIX: WATER	GRAB	COMPOSITE	DATE	TIME (hrs)	ACIDIFIED	ICED
409-2		1		X		X	9.17	8:10		X
409-3		1		X		X	9.17	8:20		X
TRIP BLANK 2				X	X		9.17	—		X

ANALYSES TO BE PERFORMED

MODIFIED EPA 8015 TOTAL PETRO. HYDROCARB.	EPA 418.1 TOTAL RECOVERABLE PETROLEUM HYDROCARB.	EPA 8020 AROMATIC VOLATILES + BTXE	EPA 602 AROMATIC VOLATILES + BTXE	METALS	OTHER			DETECTION LIMIT
					EPA 413.2 OIL & GREASE	EPA 160.2 TOTAL SUSPENDED SOLIDS		
X		X			X			

4°C

REMARKS

RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME
[signature]	HART CROWSER	9.18.92 16:00			
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED BY (Signature)	ORGANIZATION	DATE/TIME
RELINQUISHED BY (Signature)	ORGANIZATION	DATE/TIME	RECEIVED FOR LABORATORY BY (Signature)		DATE/TIME

TURN AROUND TIME (CIRCLE ONE)
24 HRS 5 DAYS
48 HRS 10 DAYS

J6565 2 of 12

R0058885

VOL 12

APPENDIX B
KEY LITERATURE SEARCH ABSTRACTS

2

5593

R0058886

Item 62

Accession Number	100143
Main Title	Contributions of Urban Roadway Usage to Water Pollution
Personal Author	Shaheen., Donald G.;
Corporate Author	Biospherics, Inc., Rockville, Md.;Environmental Protection Agency. Washington, D.C. Office of Research an Development.
Year Published	1975
Call Number	PB-245 854
Report Number	EPA-68-01-0197; EPA-ROAP-21ASY-005; EPA/600/2-75-004;
Abstract	Street surface contaminants are deposited on roadways from many sources within an urban area. Industrial operations, land use activities, fallout of air pollutants, roadway usage and other activities contribute to the loading of particulates on urban roadways. These materials are then carried into receiving waters by storm runoff where they constitute a substantial portion of the overall water pollution problems of cities. Metropolitan Washington, D.C., with its low background of industrial emissions, was the area chosen for study of contributions of motor vehicle usage to urban roadway loading factors. Specific roadway study sites within this area were selected so as to provide minimal interference from nontraffic-related land use activities and thus isolate, as much as possible, the traffic-related depositions.

VOL 12 2 5594

Item 108

Accession Number	116665
Main Title	Toxicants in Urban Runoff: Metro Toxicant Program Report Number 2.
Personal Author	Galvin, D.V.; Moore, R.K.;
Corporate Author	Municipality of Metropolitan Seattle-METRO,WA. Water Quality Div.
Year Published	1982
Call Number	PB84-104124
Report Number	MMS/WOR-8210; EPA-P-000161-01:
Abstract	As part of the U.S. Environmental Protection Agency's Nationwide Urban Runoff Program, the Municipality of Metropolitan Seattle (METRO) studied the sources and presence of toxic substances in urban stormwater runoff, as well as their potential adverse effects on local freshwater receiving environments. Sampling and analysis were designed to provide concentration data for the Clean Water Act's priority pollutant metals and organics. Sampling of potential sources to stormwater runoff included airborne particles, street dust, and catchbasin sediments. Both urban control environmental samples were taken from interstitial streamwaters, stream sediments, and Lake Washington bottom sediments. Evaluations of toxicant control measures focuses on currently available removal techniques, such as street sweeping, detention basins, and oil separators. The report incorporates a thorough literature review and includes an extensive bibliography.

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R0058888

Item 119

Accession Number	118337
Main Title	Nationwide Urban Runoff Program, Bellevue Urban Runoff Program, Washington: Summary Report.
Personal Author	Pitt, R.; Bissonnette, P.;
Corporate Author	Bellevue Storm and Surface Utility, WA.; Environmental Protection Agency, Washington, D.C. Office of Water Program Operations.
Year Published	1984
Call Number	PB84-237213
Report Number	EPA-R-805929;
Abstract	This summary report consolidates the major findings and conclusions of several individual studies, which included: Tests conducted to contrast the biological and chemical conditions in an urban creek with a rural creek; Monitoring urban runoff quality and quantity from 3 urban areas; Analysis of many source area, urban runoff, and creek samples for metallic and organic priority pollutants; Sampling of urban stormwater and base flows rom 2 residential areas. Collection of street dirt samples and evaluation of effects of street cleaning and catchbasin cleaning on improvement of urban runoff quality.

VOL 12

2

5596

R0058889

50/5/2
03033048 E.I. Monthly No: EI9103035695

Title:	Sources of petroleum hydrocarbons in urban runoff.
Author:	Latimer, James S.; Hoffman, Eva J.; Hoffman, Gerald; Fasching, James L.; Quinn, James G.
Corporate Source:	Univ of Rhode Island, Narragansett, RI, USA
Source:	Water, Air and Soil Pollution v 52 n 1-2 Jul 1990 p 1-21
Publication Year:	1990
CODEN:	WAPLAC
ISSN:	0049-6979
Language:	English
Document Type:	JA; (Journal Article) Treatment: X; (Experimental); G; (General Review)
Journal Announcement:	9103
Abstract:	In an effort to provide a better understanding of the sources of petroleum hydrocarbons in urban runoff, petroleum products as well as probable source materials were analyzed for hydrocarbons and trace metals and then compared to urban runoff samples from four different land use areas. The petroleum products considered were No.2 and No.6 fuel oil, used and virgin crankcase oils, and gasoline. Source materials included street dust, roadside soil, roadside vegetation, and atmospheric fallout; and the land use categories were commercial, residential, interstate highway, and industrial areas. The samples were compared on the basis of hydrocarbon (saturated and aromatic) and trace metal (Cd, Pb, Mn, Cu, Fe, Zn) loadings and distributions. Results indicated that the hydrocarbon content in runoff at all four land use sites originated primarily from used crankcase oil, with a small amount of No. 2 fuel oil detected at the industrial site. Only a small portion of the crankcase oil component came from the sources surveyed, and the majority of this oil probably came from: (1) oil drops within the driving lanes on the road surfaces or deposits in parking areas, and/or (2) direct dumping of waste crankcase oil down storm drains. (Author abstract) 30 Refs.
Descriptors:	*WATER POLLUTION; RUNOFF; HYDROCARBONS; PETROLEUM PRODUCTS; OIL FUEL; LUBRICATING OILS
Identifiers:	PETROLEUM HYDROCARBONS; URBAN RUNOFF; GASOLINE; STREET DUST; ROADSIDE SOIL; ROADSIDE VEGETATION
Classification Codes:	453 (Water Pollution); 442 (Flood Control & Land Reclamation); 804 (Chemical Products); 444 (Water Resources); 523 (Liquid Fuels); 607 (Lubricants & Lubrication); 45 (POLLUTION & SANITARY ENGINEERING); 44 (WATER & WATERWORKS ENGINEERING); 80 (CHEMICAL ENGINEERING); 52 (FUEL TECHNOLOGY); 60 (MECHANICAL ENGINEERING)

VOL 12 2 5597

R0058890

50/5/13
02715323 E.I. Monthly No: EI8903022181

Title:	Site design for resource recovery facilities.
Author:	Vir, Jayant; Patel, Manu; Cividini, Bruno
Corporate Source:	Burns & Roe Enterprises Inc., Oradell, N, USA
Source:	Journal of Energy Engineering v 114 n 3 Dec 1988 p 93-98
Publication Year:	1988
CODEN:	JLEED9
ISSN:	0733-9402
Language:	English
Document Type:	JA; (Journal Article) Treatment: E: (Economic/Cost Data/Market Survey); T; (Theoretical)
Journal Announcement:	8903

Abstract: Waste-to-energy resource recovery facilities fall into two major categories: mass burn and RDF (refuse-derived fuel). Site design considerations presented here are applicable to both categories; however, layout and system description used is for mass-burn facilities. The project site is identified through a complex screening process that includes issues such as environmental compatibility and public sentiment. This paper considers the design within the selected site. Site layout and aesthetics of the facility are of utmost importance to win public support. Traffic congestion is an issue which may be of particular concern to residents in the area of the project; therefore, it is essential that sufficient on-site truck queuing space is provided to avoid traffic spillover onto public streets. Storm-water drainage system must be designed to prevent water pollution during the construction, and in many instances it must be designed to maintain predevelopment runoff rate from the site. Last is the economic consideration: Site must be designed to minimize the capital cost and cost of maintenance. (Edited author abstract)

Descriptors:	*ENERGY RESOURCES --*Waste Utilization; WATER POLLUTION --Control; INDUSTRIAL PLANTS --Site Selection; ECONOMICS; FUELS--Refuse Derived Fuels
Identifiers:	ENVIRONMENTAL COMPATIBILITY; TRAFFIC SPILLOVER
Classification Codes:	913 (Production Planning & Control); 453 (Water Pollution); 525 (Energy Management); 402 (Buildings & Towers); 911 (Industrial Economics); 521 (Combustion & Fuels); 91 (ENGINEERING MANAGEMENT); 45 (POLLUTION & SANITARY ENGINEERING); 52 (FUEL TECHNOLOGY); 40 (CIVIL ENGINEERING)

VOL 12 2 5598

R0058891

50/5/18
0197188 API Document No.: 2933131
PETROLEUM HYDROCARBONS ((HC) CONCENTRATION) IN URBAN RUNOFF FROM A COMMERCIAL LAND-USE AREA

Author: HOFFMAN E J; LATIMER J S; MILLS G L; QUINN J G
Corporate Source: UNIV. R.I.
Source: J. WATER POLLUT. CONTROL FED. V54 N.11 1517-25 (NOV. 1982
Language: English
Publication Date: 821100
API Bulletin Headings: AIR AND WATER CONSERVATION; PHYSICAL/CHEM. PROP. OF WATERS; WATER POLLUTION SOURCES
Index Terms: ASPHALT; COMMERCIAL; COMPOSITION; COMPOUNDS; CONCENTRATION; DISTRICT 1; DRAINING; ECONOMIC FACTOR; FLOW RATE; HYDROCARBON; LAND USE; LEAK; LUBRICANT/INDUSTRIAL OIL; MAP; *METEOROLOGICAL PHENOMENON; MONITORING; MOTOR OIL; NORTH AMERICA; OIL WASTE; OPERATING CONDITION; PARKING FACILITY; PARTICULATES; PAVING MATERIAL; POLLUTION SOURCE; PRIMARY; *RAINFALL; RHODE ISLAND; ROAD ASPHALT; SAND; SECONDARY; SOLID; STREAM; SURFACE; *SURFACE WATER; SUSPENSION; URBAN; USA; WASTE MATERIAL; *WATER; *WATER POLLUTANT; WATER POLLUTION
Supplementary Terms: RUNOFF
Sets of Linked Terms: 0006
Linked Terms: COMPOUNDS; HYDROCARBON; WATER POLLUTANT
LUBRICANT/INDUSTRIAL OIL; MOTOR OIL; OIL WASTE; WASTE MATERIAL; WATER POLLUTANT
PARKING FACILITY; SURFACE
PARTICULATES; WATER POLLUTANT
PAVING MATERIAL; SAND
PRIMARY; SECONDARY; WATER POLLUTION

VOL 12 2 5599

50/5/16
625319 W91-01994
Pollution of Street Run-off by Traffic and Local Conditions
Muschack, W.
Umweltbundesamt, Berlin (Germany, F.R.).
The Science of the Total Environment STENDL, Vol. 93, p 419-431, April 1990. 6 tab, 12 ref.,
Journal Announcement: SWRA2402
Investigations were performed in the Federal Republic of Germany to determine pollutant concentrations in rainwater in order to obtain a comprehensive picture of the pollution caused by precipitation runoff. Influencing parameters included: exhaust gases, tire abrasion particles, brake lining abrasion dust, leakage of hydrocarbons, and winter street cleaning activities. The analysis of these factors was complemented by the determination of detection limits. After an assessment of all possibilities, 30 substances remained, and 22 were analyzed. Lead, chromium, copper, nickel, and zinc are the elements commonly found in the emissions/particles of the aforementioned parameters. (Stoehr-PTT)
Descriptors: *Highway effects; *Pollutant identification; *Urban runoff; *Water pollution sources; Chromium; Copper; Drinking water; Heavy metals; Hydrocarbons; Lead; Nickel; Path of pollutants; Precipitation; Rainwater; Runoff; Zinc

Section Heading Codes: 5B (Water Quality Management and Protection--Sources of Pollution); 5A (Water Quality Management and Protection--Identification of Pollutants)

VOL 12 2 5600

R0058893

50/5/45
601978 W89-04065
Rainfall and Runoff Quantity and Quality Data Collected at Four Urban Land-Use Catchments in Fresno, California: October 1981 - April 1983
Oltmann, R.N.; Guay, R.; Shay, J.M.
Geological Survey, Sacramento, CA. Water Resources Div.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225.
USGS Open-File Report 84-718, 1987. 139 p., 8 fig., 16 tab, 8 ref.,
Journal Announcement: SWRA2204
Data were collected as part of the National Urban Runoff Program to characterize urban runoff in Fresno, California. Rainfall-runoff quantity and quality data are included along with atmospheric dry-deposition and street-surface particulate quality data. The data are presented in figures, and tables that reflect four land uses: industrial, single-dwelling residential, multiple-dwelling residential, and commercial. A Total of 255 storms were monitored for rainfall and runoff quantity. Runoff samples from 112 of these storms were analyzed for physical, organic, inorganic, and biological constituents. The majority of the remaining storms have pH and specific conductance data only. Ninety-two composite rain samples were collected. Of these, 63 were analyzed for physical, inorganic and (or) organic constituents. The remaining rainfall samples have pH and specific conductance data only. Nineteen atmospheric deposition and 21 street-particulate samples were collected and analyzed for inorganic and organic constituents. The report also details equipment utilization and operation, and discusses data collection methods. (USGS)
Descriptors: *Rainfall; *Pesticides; *Path of pollutants; *California; Runoff; Nutrients; Sediments; Water pollution sources; Fresno; Central Valley; San Joaquin Valley; Metals
Section Heading Codes: 5B (Water Quality Management and Protection--Sources of Pollution); 4C (Water Quantity Management and Control--Effects on Water of Man's Nonwater Activities); 7B (Resources Data--Data Acquisition)

VOL 12 2 5601

R0058894

50/5/87
159679 W82-05557
Oil and Grease in Stormwater Runoff
Stenstrom, M. K.; Silverman, G.; Bursztynsky, T.A.; Zarzana, A.L.; Salarz, S.E.
California Univ., Los Angeles, Dept. of Engineering Systems Report, February 1982. Association of Bay Area Governments, Berkeley, California. 241 p., 41 Fig., 44 Tab., 158 Ref., 3 Append.,
Journal Announcement: SWRA1511
The objective of this project was to determine the environmental effects of oil and grease in urban stormwater on marine environments in San Francisco Bay and to recommend suitable control measures. Studies show that there are significant effects of low level oil/grease pollution and that continuous pollution from urban stormwater can change the ecology of a marine environment. Five field sampling stations were selected in a stormwater basis in Richmond, CA to determine oil/grease pollution by land-use type. Samples were taken from the mouth of the watershed, a parking lot, a commercial street, a residential area, and from a light industrial facility. Land-use strongly affects oil/grease in stormwater. The major contributing factor is motor vehicles. Areas with the most auto traffic had the highest concentration of oil/grease in stormwater and the highest hydrocarbon load factor. Mean oil/grease concentration in runoff flow ranged from 4.13 mg/l in an upstream residential area to 15.25 mg/l in a parking lot. A strong correlation exists between total rainfall and total mass of oil/grease pollution--contamination is higher at the beginning of a storm than at the end. Nine control techniques showed promise. Three non-structural techniques were to recycle used crankcase oil, reduce auto emissions through better inspections, and improve standards. Six structural techniques were to improve street/parking lot cleaning, sorption systems for manhole and gutter intakes, porous pavement, greenbelts around parking lots, dispersion devices, and wetlands or marshes to trap pollutants. These are site-specific techniques but it was recommended they be developed further. (Atkins-Omniplan)
Descriptors: *Storm runoff; *Urban runoff; *Oily water; *Grease; *San Francisco Bay; Storm water; Sampling; Land use; Hydrocarbons; Chromatography; Wastewater; Oil pollution; Runoff rates; Adsorption; Rainfall-runoff relationships; Environmental effects; Path of pollutants; Ecological effects

Section Heading Codes: 5C (Water Quality Management and Protection--Effects of Pollution); 5B (Water Quality Management and Protection--Sources of Pollution)

VOL 12 2 5602

R0058895

50/5/89
158640 W82-04627

Constituents of Highway Runoff: Volume I, State-of-the-Art Report
Gupta, M.K.; Agnew, R.W.; Kobriger, N.P.
Envirex Inc., Milwaukee, WI.
Available from the National Technical Information Service, Springfield, VA 22161 as PB881-241895, Price codes: A06 in paper copy, A01 in microfiche. Federal Highway Administration Report No. FHWA/RD-81/042, February, 1981. 121 p., 16 Fig., 37 Tab., 169 Ref., DOT-FH-11-8600.
Journal Announcement: SWRA1510
The factors which most affect quantity and quality of highway runoff are traffic volume, rainfall intensity and pattern, highway drainage characteristics, operation and maintenance characteristics and degree of imperviousness of the drainage area. Maintenance of adequate drainage is one of the most important aspects of highway design. Highway runoff characteristics are similar to those of urban runoff and may exert significant shock pollutional loads on receiving waters. The weighted average of total solids accumulations between successive street cleanings, a period of 2 to 12 days, for eight cities was found to be 1400 lb/curb mile. A high percentage of street surface pollutants are associated with very fine dust and dirt particles. Substantial quantities of toxic materials, such as heavy metals and pesticides, are present in street surface contaminants with the amounts varying considerably from site to site. Because of the consistent presence of heavy metals in amounts large enough to interfere with BOD5 measurements, COD is considered to be a better parameter for measuring the oxygen demand potential of highway runoff. Highway salting rates usually range from 400 to 1200 lbs per two-lane mile. Over the winter season, a typical multiple lane highway may use 100 tons or more of salt per mile. Significant amounts of vehicle released airborne matter are settled out and washed off the road surface during rainstorms. (Moore-SRC)
Descriptors: *Highways; *Roads; *Water pollution sources; *Storm runoff; *Urban runoff; *Highway effects; Drainage effects; Particulate matter; Deicers; Environmental effects; Heavy metals; Pesticides; Oxygen demand; Salt
Section Heading Codes: 4C (Water Quantity Management and Control--Effects on Water of Man's Nonwater Activities); 5B (Water Quality Management and Protection--Sources of Pollution)

VOL 12 2 5603

R0058896

50/5/91
158289 W83-04252
Water Quality Patterns During A Storm On a Mall Parking Lot
Black, P.E.
State Univ. of New York at Syracuse, Coll. of Environmental Science and Forestry.
Water Resources Bulletin, Vol 16, No. 4, p. 615-620, August, 1980, 6 Fig. 2 Tab., 13 Ref.
Journal Announcement: SWRA1510
Rainfall, surface runoff, and subsurface drainage plus streamflow upstream and downstream of a suburban New York mall parking lot were intensively sampled during and after a thunderstorm on June 18, 1978. Prior to the 11.4mm which fell within less than 1.5 hours, no rain had fallen for 4 days. Ammonia-N concentrations were high (up to 2.5mg per liter) in parking lot runoff, a result of precipitation which contained up to 2.0mg per liter ammonia-N. Surface runoff had a peak in conductivity during the rainfall and returned to prestorm levels by the end of the study period. Initial runoff appeared gray and nearly opaque. Nine constituents (K, Mn, Fe, P, Pb, Zn, Mg, Ca, and Na) showed a peak in surface runoff between 45 and 60 min after the rain started, declined to a low at 75 min, and returned to prestorm values by 105 min. Drainage from subsurface drains was brown in color and had a strong odor. In the receiving stream, water temperature increased and conductivity decreased during the beginning of the storm and returned to prestorm levels after 5 hours. (Cassar-FRC)
Descriptors: *Urban runoff; *Nonpoint pollution sources; *Runoff; Fate of pollutants; Parking lots; Water pollution sources; Paving; Water quality; Rainfall-runoff relationships; Ammonium; Metals; Subsurface runoff; Streams; Conductivity; Water temperature; Suburban malls; New York
Section Heading Codes: 5B (Water Quality Management and Protection--Sources of Pollution)

VOL 12 2 5604

R0058897

50/5/92
158226 W82-04216
The Distribution of Heavy Metals and Petroleum Residues in the Soil from Urban Surface Runoff
Owe, M.
State Univ. of New York at Syracuse. Coll. of Environmental Science and Forestry.
PhD Thesis, January, 1981, 197 p., 56 Fig., 22 Tab., 100 Ref., University Microfilms International, Ann Arbor, MI; Order No. GAX81-18121.,
Journal Announcement: SWRA1509

The soil is thought to possess an enormous capacity for immobilizing environmental contaminants, especially those typically contained in urban surface runoff. The profiles of two common area soil, a sandy, porous Arkport and a dense clayey Dunkirk, were reconstructed in 14 cm by 80cm columns in the laboratory. The design was intended to simulate a collection basin, one fourth the surface area of the test basin. Surface runoff was sampled and collected from a heavy used shopping center parking lot. Treatments simulated actual precipitation-runoff event frequency and volume occurring during the study period. The profiles were subsequently analyzed at predetermined increments for zinc, lead, cadmium, copper and petroleum residues. An overall increase in total cation and petroleum concentration was noticed with an increase in treatment concentration. A positive relationship between contaminant concentration in the soil and treatment level, exchange capacity, final soil pH and percent organic matter was realized. A negative correlation was noticed between contaminant concentration and bulk density. Treatment level and final soil pH recovered totals far below the input amounts, consistently lower hydrocarbon totals were recovered from the Arkport. This indicates the possibility of a higher rate of petroleum residue decomposition in the more porous, better aerated Arkport soil. (Sinha-OEIS)

Descriptors: *Urban runoff; *Surface runoff; *Soil properties; *Heavy metals; Oily water; Water pollution; Water pollution sources; New York
Section Heading Codes: 5B (Water Quality Management and Protection--Sources of Pollution)

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APPENDIX C
PRELIMINARY FIELD TESTING PROCEDURES AND FINDINGS

2

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R0058899

Preliminary Field Testing Procedures and Findings

The preliminary field testing was successful in determining that a constant flow rate was needed to achieve uniform distribution of the application water over the selected area. The preliminary field testing of various distribution systems identified that a cascading flow of potable water dispersed through perforated Polyvinyl Chloride (PVC) pipe and measured by an accumulating water meter achieved the desired results. The flow rate was measured by a Rotameter with a scale of 0 through 10 gallons per minute. A stainless steel water collection trough was designed and constructed (Figure C-1) to function as a sampling point and accumulation sump to capture the applied water. It was determined that the leading edge of the stainless steel trough needed a flexible edge to conform to the irregular surface of the concrete and asphalt. A length of polypropylene tubing was cut and slipped over the leading edge of the trough for this purpose.

The captured water was pumped from the collection sump into a plastic-lined metal 55-gallon drum. Four-foot-long containment berms were used to contain the water flow. The berms were constructed from 6 millimeter clear polypropylene tubing, 4 inches in diameter, and filled with clean sand. The non-porous polypropylene and sand filled berms contained the water flow and diverted it to a preselected collection point at the lowest area of the sampling site.

Safety precautions included placing cones around the active test area and meeting with the station attendant to discuss the activities that were going to be conducted.

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APPENDIX D
SAMPLING PROCEDURES

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I

SAMPLING PROCEDURES

The water dispensing equipment was set up at each location using the PVC pipe apparatus to cover an area approximately 20 feet x 20 feet. The location of the equipment was determined at each station depending on the physical layout and the slope of the station island. The containment equipment was then placed into position around the area. The containment berms were used to channel the runoff water to the collection point. A stainless steel collection trough was placed at the lowest point of the test area and incorporated into the network berms.

Tables 1 through 5 list each sample round, the sample point or time and the analyses run on the samples collected during that round:

The first round of samples was collected from the source water. The source water sample was submitted for testing with the site samples. The predetermined flow rate was adjusted when the water flow was started. The second round of samples was taken 15 minutes into the water dispensing. A plastic scoop was used to fill the sample bottles from water in the collection trough.

After the second round of samples the water in the collection basin was pumped into a 55-gallon drum using an electric pump. The 55-gallon drum was lined with polypropylene that was changed between the pump island test location and the driveway approach test location at each station. The electric water pump and scoop were decontaminated between sample rounds using a solution of deionized water and alconox, followed by two rinses with deionized water.

For quality control one trip blank was filled with deionized water and stored in each cooler together with the field samples. The trip blank insures that the data obtained from the site testing represents the pollutants collected from the site surface and does not represent contaminates introduced during transport.

A background sample was collected from the service station's potable water at the end of the supply line that was used to produce the simulated rain. The sampling and analysis keys used for this project list the sample identification, station category, location, time interval and weather for each sampling event. The keys are presented in Tables 1 through 5.

At the Category 5 station an incidental spill evaluation was conducted at the pump island prior to conducting the runoff test. The incidental spill test was conducted using one-quart of gasoline. The staged spill of fuel was collected in absorbent that was applied to the spill and picked up prior to the application of the test water.

Grab samples were drawn from the collected water and caution was used to insure that the 40 ml vials for BTEX did not contain any head space. The samples were transported to GTEL Environmental Laboratories, Inc. in an ice chest maintained at 4 degrees Celcius where the samples were analyzed for the specified chemical compounds in the sampling protocol. The analytical data are intended to represent an estimate of the water quality from a storm event equivalent to the flow represented.

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SAMPLING PROCEDURES (Continued)

(Round 2 at 15 minutes, Round 3 at 30 minutes, and Round 4 at 45 minutes in the pump island area and Round 6 at 15 minutes, Round 7 at 30 minutes, and Round 8 at 45 minutes in the driveway approach area). At the end of each 15-minute interval, the water in the collection trough was pumped into a 55-gallon drum using an electric pump. Upon completion of the simulation, a composite sample was collected from the 55-gallon drum (Round 5 for the pump island area and Round 9 for the driveway approach area).

Trip blanks were used to ensure that the sample obtained from a site represented the material sampled and its constituents not material or chemicals introduced during transport. Trip blanks are sent along with field samples as a measure of quality assurance. The trip blanks are analyzed to verify that contamination is not introduced to the samples while they are in transit between the point of collection and the laboratory.

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APPENDIX E
ACCEPTABILITY LIMITS AND STATISTICAL ACCURACY OF LABORATORY ANALYTICAL METHODS

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R0058904

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The Acceptability Limits for the Analytical Methods

Compound	Acceptability Limit
Benzene	81.1 to 118.0 percent of actual concentration
Toluene	79.9 to 123.0 percent of actual concentration
Ethylbenzene	81.1 to 123.0 percent of actual concentration
Total Xylenes	82.9 to 123.0 percent of actual concentration
Oil and Grease	80.0 to 120.0 percent of actual concentration
Metals	80.0 to 120.0 percent of actual concentration

The Statistical Accuracy of the Analyitcal Methods

Compound	Category One	Category Two	Category Three	Category Four	Category Five
Benzene	92.0 percent	117.0 percent	99.3 percent	117.0 percent	110.0 percent
Toluene	94.0 percent	119.0 percent	111.0 percent	119.0 percent	109.0 percent
Ethylbenzene	97.3	115.0 percent	107.0 percent	115.0 percent	102.0 percnet
Total Xylenes	95.8 percent	121. 0 percent	119.0 percent	121.0 percent	112.0 percent
Oil and Grease	87.7 percent	103.0 percent	102.0 percent	88.9 percent	101.0 percent
Metals	97.0 to 107.0 percent	97.0 to 107.0 percent	97.0 to 107.0 percent	97.0 to 107.0 percent	96.0 to 109 percent

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APPENDIX F
RAINFALL DATES AND
AMOUNTS PRIOR TO SAMPLING EVENT

2

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R0058906

Rainfall Dates and Amounts Prior to Sampling Event

The following charts display the five dates prior to the sampling event during which a measurable amount of rain fell at the weather monitoring station in the vicinity of the test station. The date, days prior to testing and amount of precipitation is listed in the following tables:

Category One

Date	Days Prior to Test	Rainfall in Inches
July 12, 1992	54	0.06
July 8, 1992	58	0.06
July 7, 1992	59	0.03
May 22, 1992	105	0.01
April 1, 1992	156	0.13

Distance of weather monitoring station from Category One station, approximately 24 miles.

Category Two

Date	Days Prior to Test	Rainfall in Inches
July 9, 1992	63	0.10
July 8, 1992	64	0.10
May 9, 1992	124	0.02
April 2, 1992	161	0.07
April 1 , 1992	162	0.10

Distance of weather monitoring station from Category Two station, approximately 10 miles.

Climatological Data obtained from the National Climatic Center in Asheville, North Carolina

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Rainfall Dates and Amounts Prior to Sampling Event (Continued)

The following charts display the five dates prior to the sampling event during which a measurable amount of rain fell at the weather monitoring station in the vicinity of the test station. The date, days prior to testing and amount of precipitation is listed in the following tables:

Category Three

Date	Days Prior to Test	Rainfall in Inches
August 13, 1992	21	0.05
July 11, 1992	54	0.01
July 7, 1992	58	0.02
June 22, 1992	73	0.04
May 22, 1992	104	0.06

Distance of weather monitoring station from Category Three station, approximately 12 miles.

Category Four

Date	Days Prior to Test	Rainfall in Inches
July 12, 1992	59	0.12
July 8, 1992	63	0.06
July 7, 1992	64	0.05
May 6, 1992	98	0.05
April 1, 1992	161	0.19

Distance of weather monitoring station from Category Four station, approximately 18 miles.

Climatological Data obtained from the National Climatic Center in Asheville, North Carolina

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Rainfall Dates and Amounts Prior to Sampling Event (Continued)

The following charts display the five dates prior to the sampling event during which a measurable amount of rain fell at the weather monitoring station in the vicinity of the test station. The date, days prior to testing and amount of precipitation is listed in the following table:

Category Five

Date	Days Prior to Test	Rainfall in Inches
July 13, 1992	66	0 .05
July 9, 1992	70	0.01
July 8, 1992	71	0.02
May 5, 1992	135	0.04
April 1, 1992	169	0.33

Distance of weather monitoring station from Category Five station, approximately 2 miles.

Climatological Data obtained from the National Climatic Center in Asheville, North Carolina

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APPENDIX G
SIMULATED RAINFALL RUNOFF VOLUME CALCULATIONS

2

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R0058910

SIMULATED RAINFALL RUNOFF VOLUME CALCULATIONS

Category 1 Station

Pump Island Area:

Water flow rate approximately 1.8 gallons per minute:

86.4 gallons were dispensed in this test

Approximately 30 gallons were collected

Driveway Approach Area:

Water flow rate approximately 1.8 gallons per minute:

79.6 gallons were dispensed in this test

Approximately 30 gallons were collected

Category 2 Station

Pump Island Area:

Water flow rate approximately 1.8 gallons per minute:

86.6 gallons were dispensed in this test

Approximately 5 gallons were collected

Driveway Approach Area:

Water flow rate approximately 1.8 gallons per minute:

99.2 gallons were dispensed in this test

Approximately 53 gallons were collected

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SIMULATED RAINFALL RUNOFF VOLUME CALCULATIONS

Category 3 Station

Pump Island Area:

Water flow rate approximately 2.0 gallons per minute:

100.5 gallons were dispensed in this test

Approximately 50 gallons were collected

Driveway Approach Area:

Water flow rate approximately 2.0 gallons per minute:

99.6 gallons were dispensed in this test

Approximately 25 gallons were collected

Category 4 Station

Pump Island Area:

Water flow rate approximately 1.8 gallons per minute:

86.4 gallons were dispensed in this test

Approximately 7 gallons were collected

Driveway Approach Area:

Water flow rate approximately 1.8 gallons per minute:

74.5 gallons were dispensed in this test

Approximately 50 gallons were collected

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SIMULATED RAINFALL RUNOFF VOLUME CALCULATIONS

Category 5 Station

Pump Island Area:	Water flow rate approximately 1.7 gallons per minute:
	76.5 gallons were dispensed in this test
	Approximately 52 gallons were collected
Driveway Approach Area:	Water flow rate approximately 1.7 gallons per minute:
	83.4 gallons were dispensed in this test
	Approximately 45 gallons were collected

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APPENDIX H
LETTER FROM GTEL LABORATORY DIRECTOR

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R0058914

GTEL
ENVIRONMENTAL
LABORATORIES, INC.

Southwest Region
20000 / 300 Mariner Avenue
Torrance, CA 90503
(310) 371-1044
(800) 727-GTEL
Fax (310) 371-8720

VOL 12

July 6, 1993

Mr. David Darrow
Hart Crowser
1 World Trade Center
Long Beach, Ca. 90831

RE: Toluene in Trip Blank

Dear Mr. Darrow:

Recently, GTEL's Torrance Laboratory investigated several commercial sources of "pure" water for use as trip blanks. It was our experiance that water sold in glass containers frequently contained up to 2 parts per billion (ppb) Toluene. Water from plastic containers tended to have even higher concentrations of Toluene due to leaching. As a result of our study, we now verify purity of every trip blank prior to sending it out to Clients.

Another source of Toluene contamination in Trip Blanks is the sample container. As part of GTEL's Total Quality Management Program, evaluation of several vendors' products were conducted. One supplier's glass VOA vials consistently showed several ppb Toluene. GTEL's now purchases sample containers from a single source and receives a Certificate of Analysis with each shipment to ensure that the containers meet our specifications.

I strongly recommend that in the future, Trip Blanks be ordered directly from the Laboratory at the time the project is scheduled. It is very difficult for a consultant to make his/her own Toluene-free Trip Blanks.

If I can be of further assistance, please do not hesitate to contact me.

Very truly yours,
GTEL Environmental Laboratories, Inc.

Joan V. Greenwood
Laboratory Director

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VOL 12

APPENDIX I
MAXIMUM CONCENTRATION GRAPHS

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R0058916

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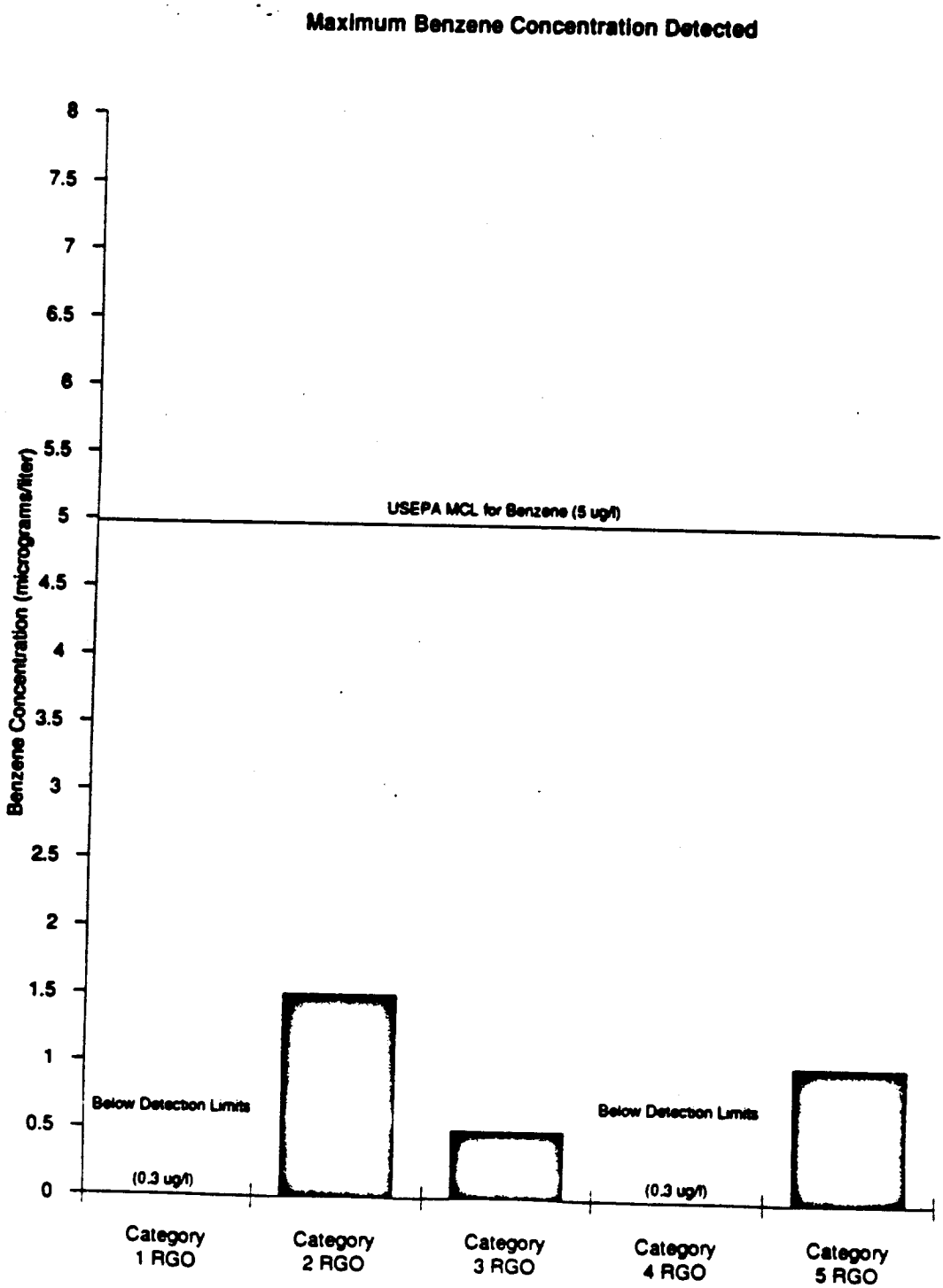
Maximum Benzene Concentration Detected
Benzene Concentration (micrograms/liter)
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
USEPA MCL for Benzene (5 ug/l)
Below Detection Limits
(0.3 ug/l)
Below Detection Limits
(0.3 ug/l)
Category 1 RGO
Category 2 RGO
Category 3 RGO
Category 4 RGO
Category 5 RGO

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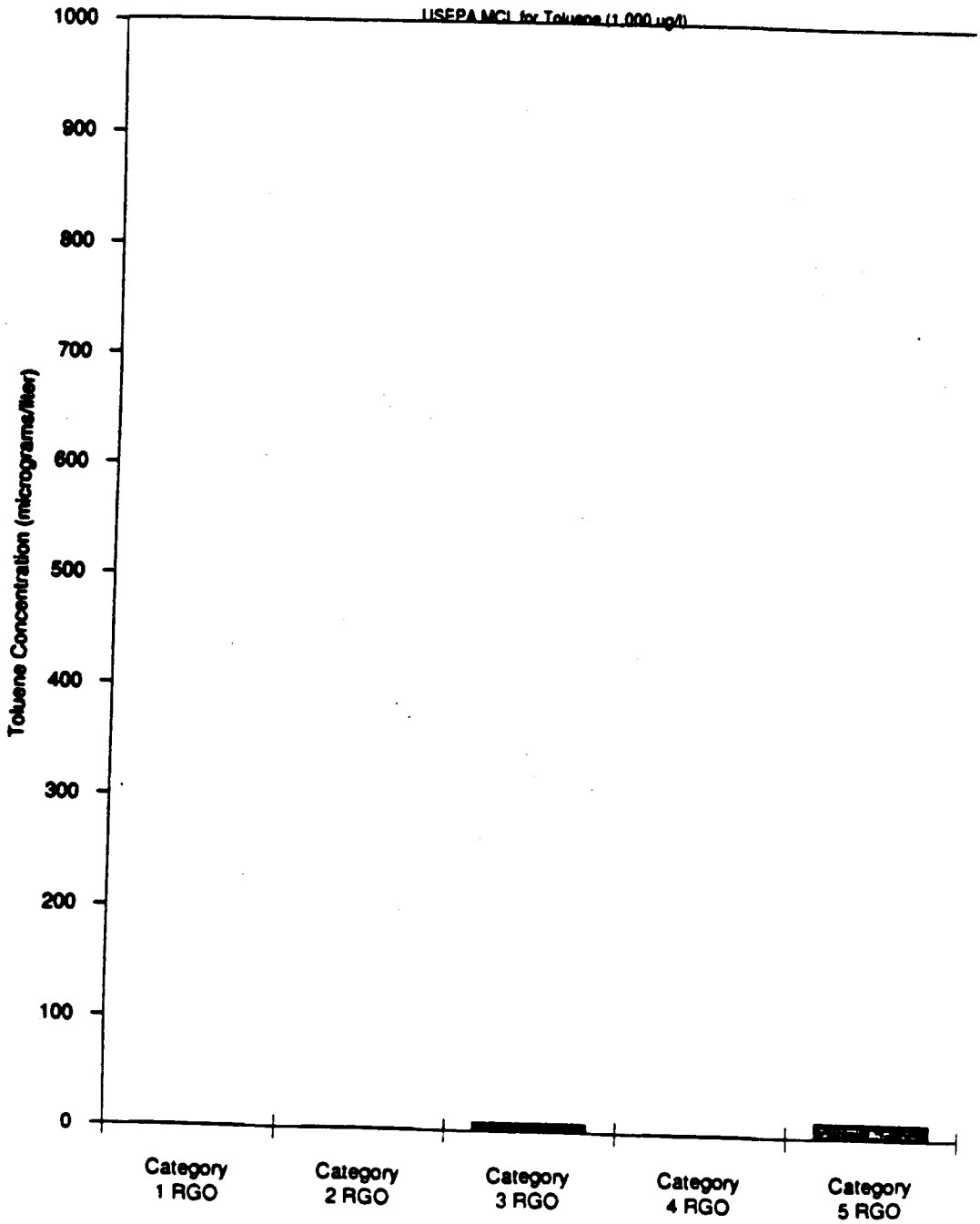
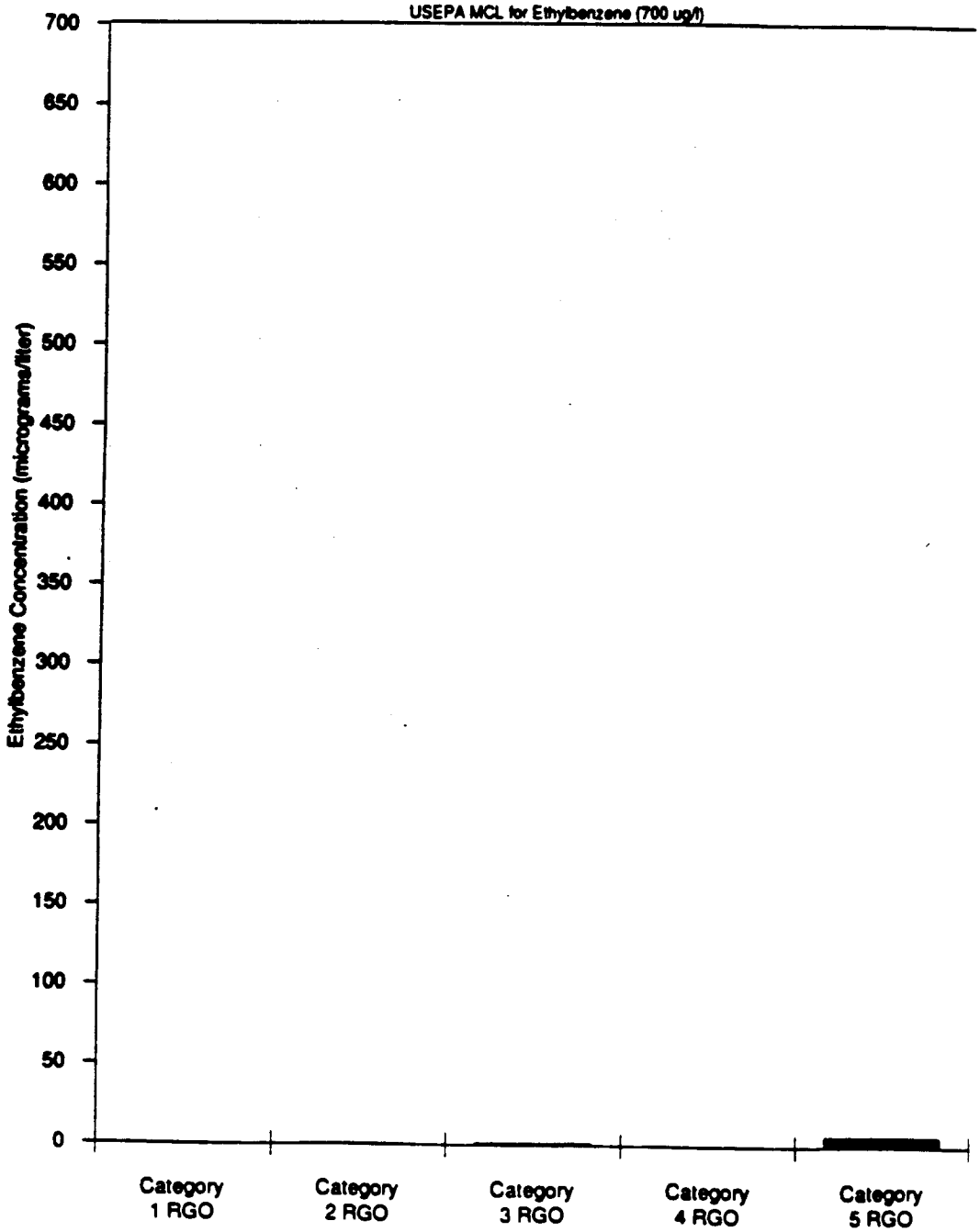
Maximum Toluene Concentration Detected



Maximum Ethylbenzene Concentration Detected



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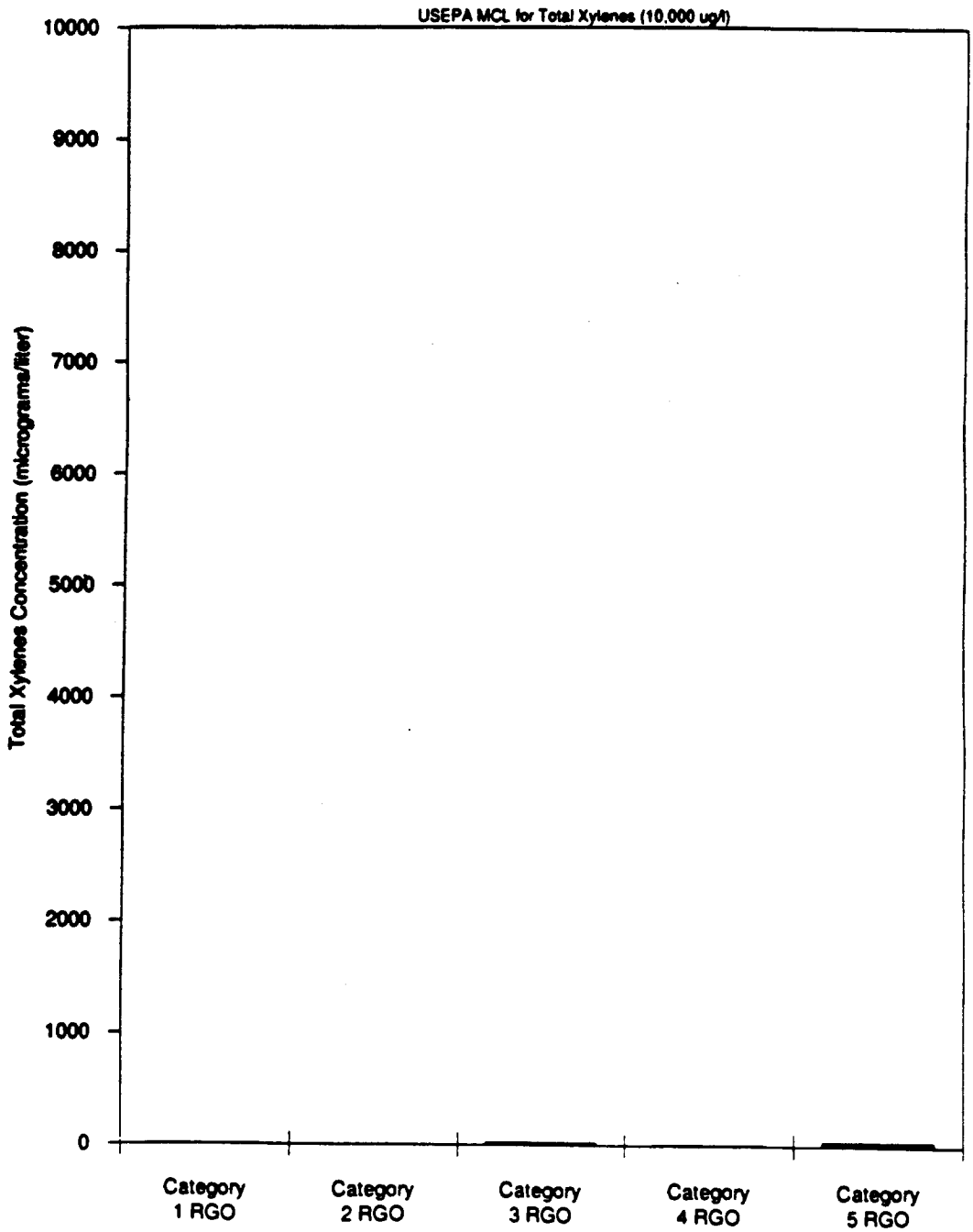
Maximum Total Xylenes Concentration Detected



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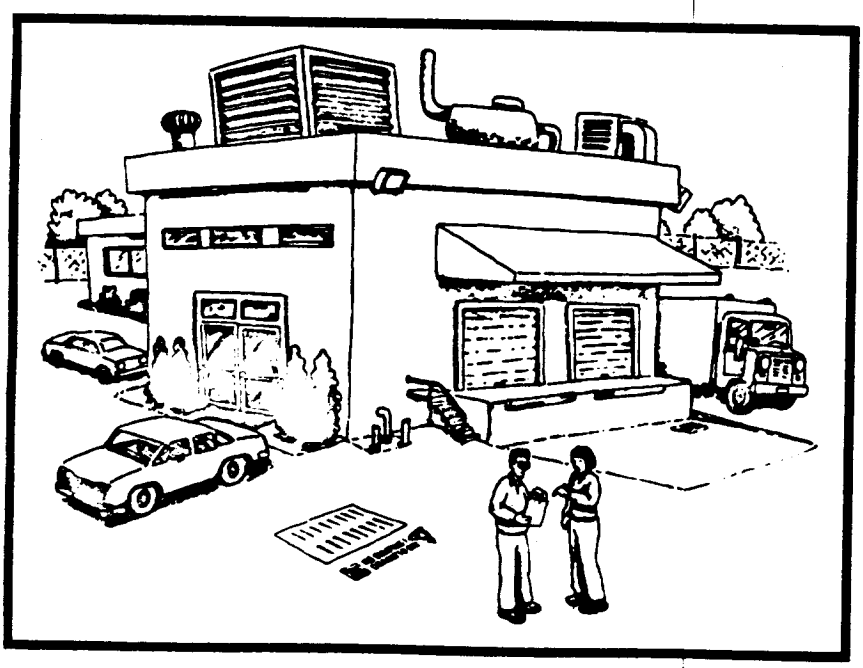
Best Management Practices for Industrial Storm Water Pollution Control



Alameda County
Urban Runoff
Clean Water Program
A Consortium of Local Agencies

R0058922

VOL 12 2 5629 F

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R0058923

INTRODUCTION:

Storm Water Pollution Control for Industrial Facilities

Storm water pollution is the major source of contamination affecting local creeks and the San Francisco Bay. Storm drains carry excess water from streets, urban centers, industrial sites, and open spaces. In Alameda County, contamination of storm water is largely due to urban runoff pollution, which occurs when contaminants from industrial, commercial, and residental areas are picked up by runoff water and carried into the storm drain. In Alameda County alone, more than 85 billion gallons of untreated water and debris pass through the storm drain systems each year and flow into the bay.

Industrial operations constitute only partly responsible for urban runoff pollution, but they are known to be a source of heavy metals, oily wastes, and other contaminants. Manufacturing, shipping, and storage operations that are exposed to storm water runoff are common contributors to storm water pollution.

Federal and state storm water regulations now require most industrial facilities to take steps to prevent such contamination. Your facility might need to be covered by the Regional Board's October 1992 Industrial Storm Water General Permit. If so, you must prepare a Storm Water Pollution Prevention Plan (SWPP) that incorporates a variety of Best Management Practices (BMPs) like the ones described in this manual. If your facility is not covered by the General Permit, you might still need to implement BMPs to comply with local pollution prevention requirements.

Unlike some pollution problems, storm water pollution cannot be covered by a single set of rules that applies to all industrial facilities. Regulated industrial facilities in Alameda County range from manufacturing facilities that occupy several square miles to storefront distributors. As a result, plants can have very different storm water quantities, flow patterns, and potential pollutants. Even different facilities within the same general industry might have to adopt different approaches to the prevention of storm water pollution.

The BMPs in this manual are recommended by the Alameda County Urban Runoff Clean Water Program to help you:

- *Prevent storm water pollution;*
- *Protect water quality in local creeks, groundwater basin and the bay; and*
- *Comply with storm water regulations.*

This manual is intended to help you identify and implement the BMPs that are necessary and economically feasible for your facility to prevent storm water pollution. The BMPs include both operating practices and structural controls designed to reduce the amount of pollutants entering the storm drain system. You will need to evaluate which apply to your facility and implement them as necessary. Specific regulations can vary from one municipality to another, so you should become familiar with local storm water ordinances in the communities in which you do business.

This manual consists of two parts. The recommended BMPs in Part 1 are basic everyday operational practices that can be very effective in preventing pollution and reducing potential pollutants at the source, with relatively minimal structural or equipment requirements.

In many industrial facilities, storm water pollution can be prevented with common-sense precautions and modest changes in routine operations or maintenance practices. The numbered sections are keyed to industrial operations that are common to many kinds of facility. For some industrial facilities, these practices alone might be sufficient to control storm water pollution.

In other cases, it will be necessary to establish new practices or build physical controls to prevent storm water pollution. Part 2 of this manual consists of "advanced management practices." The advanced BMPs require more costly or more intensive efforts to address pollutants that are not adequately controlled by the simpler operational BMPs.

R0058924

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PART 1

Recommended BMPs for Storm Water Pollution Prevention

Part 1 of this manual contains BMPs that are recommended to control storm water pollution from particular industrial activities. It is divided into numbered sections, describing activities common to many kinds of industrial facilities, and it contains BMPs tailored to each kind of industrial activity or operation.

The recommended BMPs are to be implemented on an ongoing basis for the indefinite future. Operators of commercial and industrial facilities in Alameda County should implement these BMPs or similar controls wherever they would be effective in preventing pollutants at the site from entering storm water runoff.

PREVENT WATER FROM CONTACTING WORKING AREAS.

Shipping areas, outdoor equipment, material storage areas, vehicle maintenance spaces, and working areas of all sorts are subject to contamination by raw material, process liquids, grease, oily wastes, heavy metals, and miscellaneous potential pollutants. If you prevent storm water, wash water, or water from other sources from contacting areas exposed to pollutants, you won't discharge pollutants into your storm drains. Following are measures you should take to prevent water from contacting exposed areas:

- Keep rainfall from directly contacting working areas by installing roofs or moving industrial operations indoors where possible.
- Prevent storm water *runoff* from flowing across industrial areas by using properly designed berms or grading.
- Avoid practices in which you use water that later enters the storm drains — for instance, washing in outdoor areas. Most of those practices, including many that were acceptable in the past, are now considered to be "illicit discharges" of nonstorm water to the storm drain.

KEEP POLLUTANTS OFF SURFACES THAT COME INTO CONTACT WITH WATER.

Evaluate your site carefully to identify all areas that are contacted by storm water, wash water, or other water that is discharged into the storm drain. Then take special care to keep pollutants off those surfaces. That means controlling minor leaks and spills you might otherwise overlook, and taking a close look at your operating routines and equipment to determine whether any substances are unnecessarily exposed to storm water.

MANAGE STORM WATER BEFORE IT IS DISCHARGED INTO THE STORM DRAIN.

If you cannot avoid adding pollutants to storm water, you might have to remove them before they are discharged. Storm water control regulations, and this manual, consider treatment to be a last resort and emphasize source control options, because they are usually less costly, and more effective in the long run. In this manual, treatment measures appear only under Advanced Management Practices.

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1 TRAINING AND EDUCATION FOR EMPLOYEES AND CUSTOMERS

Successful storm water pollution control relies mostly on the proper training and education of employees. Many of the recommended BMPs in this part of the manual identify specific training needs for employees who conduct the activities.

Train employees in the BMPs, because an employee's mistake can lead to a costly pollution incident. Assign experienced workers to train new employees. Review procedures as a group at least once a year.

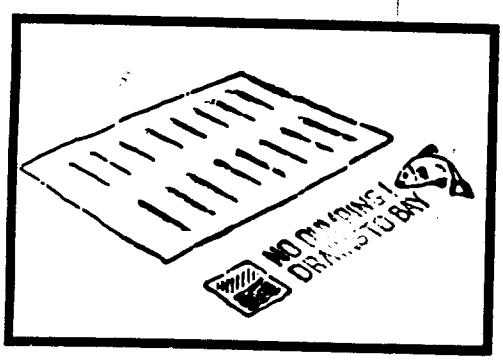
Periodically check employees' work practices to be sure the BMPs are implemented properly. Post informational signs, such as proper equipment washing procedures, at designated washing areas, and "Close the cover" signs at dumpsters and other storage areas. Stencil "NO DUMPING! — DRAINS TO BAY" messages at storm drains. (Stencils might be available from the Clean Water Program.)

Provide general information as well, because employees often respond best if they understand *why* they are being asked to conduct a new procedure. Employees' suggestions in return can help identify cost-effective storm water controls for your facility.

If you subcontract for small construction jobs or other work on your premises, include BMPs as conditions when writing contracts. Provide contractors with proper disposal options for wastes. Monitor contractors to be sure they comply with your BMPs.

If you serve customers at your facility, be aware of customer activities on-site. If they dispose of material improperly, *you* will be responsible for the violation. Ask your customers not to discard liquids into your trash cans or storm drains. If you have persistent problems, you might need to monitor your customers more carefully at trash cans, storm drains, and other potential disposal areas, on your property.

Let your customers know how you are minimizing wastes and recycling fluids to show that you are a "good neighbor," and encourage your customers to do the same. Showing clients what you are doing to protect the Bay is good public relations. Some businesses make the customer aware of their environmental requirements by including a modest environmental compliance fee, itemized on customers' billing statements, to cover handling and disposal costs for hazardous material.



Label storm drain inlets, so that employees do not dispose of waste there.

2 ELIMINATING IMPROPER DISCHARGES INTO STORM DRAINS

Local ordinances generally prohibit discharging *anything but storm water* into the storm drains. There are many ways in which nonstorm water from industrial plants can enter the storm drainage system. In most cases, those discharges are now illegal, even though they might have been permissible in the past. Industrial process water, building wastewater, and water from other sources are prohibited, with a few exceptions described in Table 1. Inspect your facility and yard to be sure no unauthorized discharges enter your storm drains.

Unauthorized discharges take two forms:

Illicit connections are improper permanent connections that allow wastewater to enter storm drains. Connections that allow sanitary or process wastewater to enter the storm drain are prohibited, including all storm drain connections from indoor drains or sinks. More information on identifying and removing illicit connections is available from your sanitary sewer district or municipality.

An **illicit discharge** is any nonstorm water discharged into the storm drainage system. Pollutants can be introduced into storm drains inadvertently by routine practices that discharge water outdoors or by routinely discharging wastes, wash water, and other material into storm drains, catch basins, and other conveyance facilities either on your property or in the street. A large part of this improper discharge results from employees' lack of understanding, coupled with a lack of readily available proper routes for the discharge.

You need to make a long-term ongoing effort to assure that no illegal discharges will occur. That requires continuing observation to identify potential sources of intentional or

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TABLE [redacted] PREFERRED DISPOSAL OPTIONS FOR WATER DISCHARGES [redacted]

WATER SOURCE	PREFERRED DISPOSAL OPTION	RESTRICTIONS OR PERMIT NEEDED	POSSIBLE OPTIONS FOR REUSE OR RECYCLING
Industrial process	**Sanitary sewer whenever possible**	**POTW permit**	**Reuse in-plant wastewater**
Noncontact cooling water	**On-site reuse**		**Reuse in closed-loop cooling system** *(cooling tower)*
• Uncontaminated*	• Storm drain if reuse is impossible	• Storm water NPDES permit	
• Contaminated	• Sanitary sewer	• POTW permit	• Treat and reuse
Industrial cooling equipment condensation		**Storm water NPDES permit**	**Hold and apply to landscape**
• Uncontaminated*	• Storm drain	• Must be tested and shown to be uncontaminated.	
• Contaminated	• Sanitary sewer	• POTW permit	
Building air conditioner condensation	**Storm drain (if city allows)**	**Some localities require discharge to POTW with permit**	
Building air conditioner coolant			**Reuse in-plant whenever possible**
• Uncontaminated*	• Storm drain	• Storm water NPDES permit	
• Contaminated	• Sanitary sewer	• POTW permit	
Storm water in outdoor secondary containment			
• Uncontaminated*	• Storm drain	• Test to determine contamination.	• Pump and apply to landscaping. (See Section 5)
• Contaminated	• Sanitary sewer	• POTW permit	
Storm water from outdoor material storage			
• Covered	• No discharge	• Zero contact with storm water.	
• Open	• Storm drain	• Water quality inlet or similar treatment. (See Section 20) Storm water NPDES permit	
Roof drain water	**Storm drain if no pollutants**	**Roof vents may be source of pollutants. See BAAQMD air emissions regulations and Section 4.**	
Industrial equipment wash water	**Sanitary sewer**	**POTW permit**	**Reuse in-plant whenever possible**
Vehicle maintenance wash water	**Sanitary sewer**	**POTW permit**	**Capture and reuse for washing**
Vehicle one-time wash water	**Storm drain (See Section 7)**	**Water only (no soap or solvents)**	**Minimize water; prevent flow across paved area**
Wash water from paved walkways in commercial and business districts	**Storm drain**	**Sweep sidewalks before washing. No cleaning chemicals may be used.**	**Minimize water use and direct to landscape.****
Commercial building exterior wash water	**Storm drain**	**Filter before it enters catch basin**	**Minimize water use and direct to landscape****
Landscape irrigation	**Storm drain**		**Minimize water so none runs off****
Potable water and potable line flushing	**Storm drain**	**Must be dechlorinated*****	
Fire-fighting flows	**Storm drain**	**Block downstream channels to detain for testing as hazardous waste**	

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inadvertent improper discharges. Discontinue or reroute the water from those activities. Measures to help prevent illegal discharges include:

- Providing well-marked proper disposal or collection methods for wastewater wherever you frequently use wash water, discharge cooling water, or produce a liquid waste that might otherwise reach the storm drain.
- Employee training that especially emphasizes proper disposal of nonstorm water (see Section 1). Educate employees to understand that storm drains connect directly to streams and the bay without treatment.
- Labeling all storm drain inlets and catch basins "NO DUMPING! — DRAINS TO BAY," so that employees will know which inlets are part of the storm drain system.
- Periodically inspecting and maintaining storm drain inlets. Clean out catch basins so that accumulated pollutants do not wash down the storm drains.

Table 1 identifies some common sources in industrial plants of water that can enter storm drains. For each source, the table lists the preferred disposal option. For water that is allowable for discharge into the storm drain, Table 1 lists conditions or restrictions placed on the discharge.

Following are conditions or restrictions placed on a few categories of special interest:

- **Cooling tower condensate** for industrial process water must be discharged into the sanitary sewer. Permits are required.
- **Internal coolant** for refrigeration or building air conditioning must not be discharged into storm drains.
- **Building air conditioner condensate** may be discharged into the storm drain *only* if it is not treated with algae inhibitors, corrosion, control chemicals, or other additives.



Wipe up spills immediately with shop rags.

Source: Storm Water Industrial General Permit for the Santa Clara Valley, Regional Water Quality Control Board/S.F. Bay Region, January 1992.
POTW (Publicly Owned Treatment Works) permit: Permit to pretreat and discharge is required from your wastewater authority.
BAAQMD: Bay Area Air Quality Management District.
* Biocides, corrosion inhibitors, or other additives are contaminants from a storm water point of view.
** Must comply with local water use restrictions during drought conditions.
*** Potable water, swimming pool water, and other chlorinated sources must be dechlorinated by aeration, retention, or chemical additives to a "no measurable chlorine" standard before reaching receiving water. If the water is not dechlorinated, it must be discharged to the sanitary sewer under a POTW permit.

3 SPILL PREVENTION, CONTROL, AND CLEANUP

Small spills can have cumulative effects that add up to a significant source of potential pollutants in your storm water discharge. The best approach by far is to prevent spills and leaks. Maintain a regular inspection and repair schedule, and correct potential spill situations. Some prevention techniques are described in Sections 4, 5, and 6.

When a spill does occur, quick and effective response is the best way to prevent pollutants from reaching storm water. Prepare a set of well-defined procedures for responding to a spill of any liquids in an area that might be exposed to storm water. The procedures can be specific for your facility. They should take into consideration all circumstances, from small and minor releases that can be easily handled to a large emergency spill, and they should identify whom to call to respond to the situation before it gets out of hand. Train employees in the procedures (Section 1).

The basic procedures should emphasize that spills be cleaned up promptly and not allowed to evaporate. Otherwise, pollutants remain on the pavement and might be washed to the storm drains with the next rain, or they remain in the soil and become a possible groundwater pollutant. If the spill is on an unpaved surface, determine whether you need to remove the contaminated soil to prevent it from becoming a source of future storm water pollutants.

Also the standard procedures should specify cleaning up leaks, drips and other spills without water whenever possible. Do not use a hose or wet mop to clean up a spill area. Hosing might remove the spill from the immediate area, but does not keep the pollutant out of the environment. On the contrary, it

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adds to the volume of the spill and spreads the spilled material around a larger area.

If you handle hazardous material, spill prevention and response procedures are described in your hazardous material management plan filed with your fire department or other hazardous material ("HazMat") authority (see Section 6). If a spill occurs, notify the authorities as required in your emergency response plan. Contain and collect the spilled substance, then dispose of the substances and any contaminated soil in compliance with hazardous materials regulations.

Small spills are those which can be wiped up with a shop rag. Do not put wet rags in the dumpster with the shop trash. Store them in a covered rag bin of the kind used at auto service stations. Avoid paper towels. You can avoid making this a waste stream by sending used rags to a professional cleaning service. (You must inform your cleaning service of what the shop rags have been used for.) Do not saturate rags with gasoline, solvents, or other volatile liquids.

Medium sized spills are too large to wipe up with a rag and require more attention. Contain and soak up the liquid, using dry absorbent material, such as vermiculite, specially prepared sawdust, or cat litter. Absorbent "snakes" may be used as temporary booms to contain and soak up the liquid. Sweep up the used absorbent material and snakes, and dispose of them appropriately, with the shop trash if nonhazardous, with the hazardous wastes if necessary. Another convenient option is to use a wet/dry shop vacuum cleaner to collect spills and dispose of the liquid with your liquid or hazardous wastes. *Do not* use vacuums for gasoline, solvents, or other volatile fluids because the enclosed vacuum could become an explosion hazard.

Larger spills must be contained then cleaned up. For spills of food waste or other nonhazardous liquid, take steps to contain and clean up the liquid and minimize the wash water used in cleanup. Shut off or plug storm drain inlets or sewer inlets where the spill can enter. If necessary, keep temporary plugs on hand to fit your inlets and train employees regarding when and how to use them. For hazardous material spills, implement your emergency procedures and alert your HazMat authority.

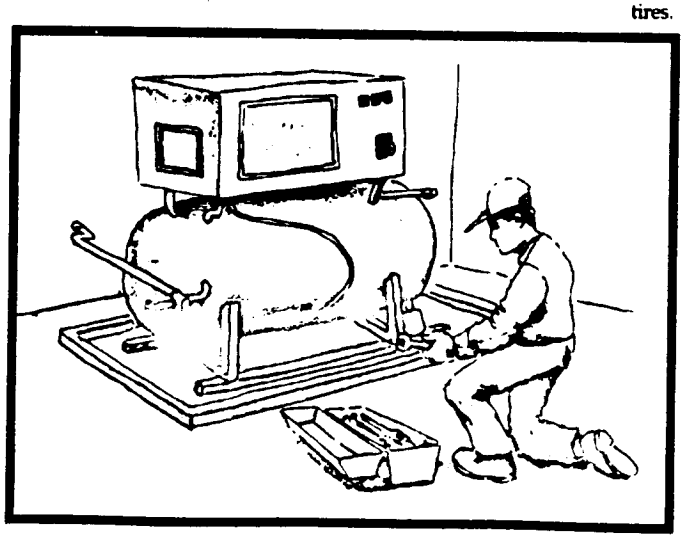
4 OUTDOOR EQUIPMENT OPERATIONS AND MAINTENANCE

Storm water from your site can accumulate pollutants by exposure to numerous small leaks, spills, and other discharges from outdoor equipment. Large equipment might require specially designed structural or advanced BMPs to reduce the potential for storm water to contact pollutants. Ordinary precautions, such as those described below, might suffice for smaller equipment.

As a first step, identify all equipment at your site that might be exposed to storm water or could discharge potential pollutants that could be exposed to storm water. Identify the kinds of pollutants each piece of equipment might generate—lubricants, coolants, and other leaks or discharges.

Be creative and thorough in developing your list. The inventory should include rooftop cooling towers or air conditioners; rooftop air vents for industrial equipment; outdoor air compressors and other service equipment; indoor wet processes where leaks or discharges might reach outdoor areas; and material transfer areas, such as loading areas where forklifts or trucks can carry pollutants outdoors on their tires.

Using the equipment inventory, assign an employee to inspect each piece of equipment on a regular basis to see that it is functioning properly. The employee might be the person responsible for operating the equipment if it is used regularly, or a maintenance staff member for equipment on the roof or in seldom-seen places. Inspect for leaks, malfunctions, and staining on and around the equipment and other evidence of leaks and discharges. Assign to the inspecting person responsibility for reporting a spill.



Keep drip pans under outdoor equipment to contain drips and leaks, especially during maintenance.

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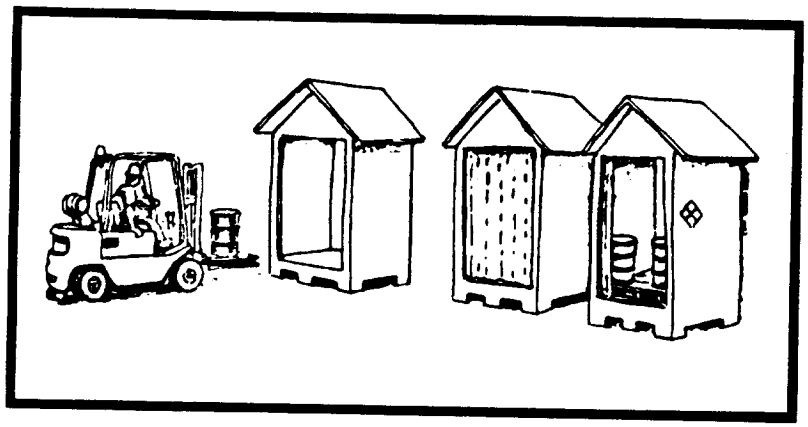

A "Doghouse" shed is one way to keep storm water away from barrels and materials kept outdoors, and at the same time it provides spill control.

Develop a routine for taking actions on the report—cleaning up the spill and repairing the leak to prevent future spills.

Where possible, take the next step toward full pollution prevention and make modifications to prevent storm water from contacting the equipment or its discharges. Place equipment on an impermeable surface, or install a drip pan beneath potential leak points. To minimize the amount of rainwater that contacts the equipment, you might construct a simple roof and install a berm to prevent run-on and runoff. If the equipment requires a "wet" process—that is, if operation inevitably releases wash water or process liquids—place it on a paved surface and install a connection to the sanitary sewer. Check with your municipality or wastewater authority to identify appropriate permits.

Air compressors and other equipment sometimes produce small quantities of automatic blowdown water, which usually contains lubricating oil or other potential pollutants. The water may not be discharged into the storm drain. Connect the blowdown to the sanitary sewer with proper approval. Or if the compressor has a frequent small bleed, place a drip pan or catchment to collect the water—do not let it soak into unpaved surfaces or run off paved surfaces.

Condensate on exterior surfaces of compressors, building cooling equipment, and other machinery may be directed to the storm drain system or, preferably, to a landscaped area.

5 OUTDOOR MATERIALS STORAGE AND HANDLING

If you handle **bulk solid material** outdoors, keep them covered in appropriate containments and protected from storm water. Apply this policy to raw material, products, by-products, and construction materials or supplies.

Store the material in one of these ways:

- The preferred method is storage on a paved surface, with a roof or covering, so that no direct rainfall contacts them, and with appropriate berms or mounding to prevent run-on of storm water. Roofs are recommended by most municipalities for new facilities.
- Where a roof is not feasible, place the material on a paved surface and cover it with plastic sheeting or tarp secured with weighted tires or sand bags. If possible, choose a mounded or bermed area that will prevent run-on of storm water through the material.

Parking lots or other surfaces near bulk material storage facilities should be swept periodically to remove fines that wash out of the material and would otherwise wash away with storm water. Larger bulk material storage facilities need more extensive structural controls for the specific facility and material.

Hazardous material must be stored in accordance with federal, state, and local HazMat requirements. The requirements are generally more than adequate to prevent storm water pollution—for instance, a HazMat secondary containment might have no drain.

If you store **liquid containers**, implement a plan and a design to control unexpected leaks and spills so that the liquid does not reach storm drains or surfaces that will be exposed to storm water. If you store hazardous material, the spill prevention plans required by your HazMat authority are adequate to ensure storm water protection. Nonhazardous material storage should also incorporate spill control designs and procedures.

Select a storage method appropriate for the type of material. Keep liquid tanks in a designated area on a paved impermeable surface and within a berm or other secondary containment. Inspect containers regularly for damage or leaks, as described in Section 4. Clean up any leaks or spills immediately (using dry methods described in Section 3), and repair the leaks promptly.

For smaller storage tanks, storage in roofed areas can prevent all contact with storm water (in combination with well-designed spill control procedures). A possible option is the "doghouse" design used by some firms (see illustration). The roof and flooring prevent contact with direct rain or run-on storm water. Contact your local HazMat and fire authorities for specific requirements.

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Storm water often accumulates in **secondary containment** areas. If this water is contaminated, it may not be discharged into the storm drain system.

You might wish to roof the containment to avoid this problem. If that is not possible, the liquids that accumulate in the containment *might*, with approval, be acceptable for discharge into the sanitary sewer. However, the area itself should have no direct connection, in case of spills. One common solution is a portable pumping system that can be moved to accommodate separate containment structures on your site. The equipment can pump water into a truck or portable temporary holding tank. The water then can be tested and disposed of according to whether any pollutants are present. Following are some disposal options:

- If the water meets criteria for hazardous waste, employ a certified hazardous waste hauler for disposal at a permitted hazardous waste facility.
- If it has constituents similar to process wastewater for which your on-site wastewater pretreatment facilities are designed, pretreat the water and discharge into the sanitary sewer.
- If it meets standards for your industrial discharge permit, discharge it into the sanitary sewer without pretreatment (if permitted by your wastewater authority).
- Reuse it on your site in an appropriate manner as industrial process water, equipment wash water, steam cleaning makeup, or another use where the water will eventually be discharged as industrial or sanitary wastewater. You might have to invest in a truck or plumbing to convey the water to its reuse location.
- If it is free of hazardous constituents, use it on your facility grounds for landscape watering. Do not apply the water to landscaping if hazardous pollutants are present—even if not concentrated enough to be hazardous waste—because the pollutants might accumulate in the soil or vegetation and eventually create a health hazard.

6 WASTE HANDLING AND DISPOSAL

Table 2 summarizes the preferred storage and disposal practices for some common industrial facility wastes. For many wastes, reusing or recycling is the most cost effective means to prevent potential pollution. Fluids that you hold for recycling are special categories of hazardous waste. You may store them on your site only for short periods in accordance with hazardous waste requirements, but they may be transported under somewhat less stringent requirements than other hazardous wastes. Many recycling services have special variances or permits, which reduce your paperwork requirements and allow shipping at reduced cost.

Keep general shop trash in a dumpster with the lid closed. Put the dumpster in a paved area, not on unpaved soil or your lawn. Keep the area clean by picking up dropped trash and sweeping the area regularly (perhaps once a week), but do not use a hose to clean up—keep water off the area. Nearly all dumpsters and trash compactors leak; keep liquid wastes out of them, and keep them closed to keep out storm water.

If you cannot prevent leakage from trash containers, install a roof or lean-to that keeps direct rainfall off them, and place asphalt curbing or berms around the dumpster to contain the leaks. (Check with your local agencies, and comply with fire codes and building permits.)

If you store **scrap metal** or other such material outdoors, keep it under a roof, cover, or tarpaulin. Keep scrap, parts or other used metals indoors. Oils and other potential pollutants can wash off long after you think the parts have been washed clean. Collect waste metal, such as used parts and metal lathe filings, for delivery to a scrap metal dealer.

If you store **empty drums** outdoors, do not hold them longer than necessary. Ship them to a drum reconditioner or another facility. Before shipping:

- Drain them completely to avoid spills.
- Seal them properly so that they are watertight, to keep storm water from entering; otherwise the water would become a process wastewater, and could not be dumped into the storm drain.

Store and handle **hazardous wastes** properly. Hazardous material or waste is not a storm water problem if they are handled in accord with state and federal regulations, and the requirements of your local HazMat control authority.

Keep hazardous waste and material indoors or under cover in a locked area, to keep nighttime trespassers away from them. Store them before disposal in special hazardous waste containers or in closed drums within a secondary containment that is approved by your HazMat authority.

In some cities of Alameda County, the municipal fire department is the HazMat authority that controls hazardous material storage, handling, and response. Other locales contract with the County Health Department. For information about handling solid wastes that might be controlled under hazardous waste regulations, contact the County's Environmental Health Department or Cal-EPA's Toxic Substances Control Division. (See the back cover for a list of regulatory agencies.)

Empty containers, such as storage barrels, oil cans, paint buckets, and aerosol cans are hazardous wastes if they once held hazardous material. You may not discard these with the regular trash. They must be stored properly so that they do not leak outdoors. Some drum suppliers accept empty drums for reuse under less stringent hazardous material recycling regulations.

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TABLE 2 PREFERRED WASTE HANDLING & DISPOSAL METHODS

		RECOMMENDED STORAGE	PREFERRED DISPOSAL	HAZARDOUS WASTE?
General Plant Wastes	• Used parts—clean metal scrap	• Bin (covered or indoors)	• Scrap collector	No
	• Used oily parts—contaminated	• Drum	• Hazardous waste hauler	Yes
	• Metal shavings	• Bin (covered or indoors)	• Scrap collector	No
	• Used rags	• Rag bin with lid	• Rag laundry	*Possibly*
	• Soiled cleanup absorbent	• Drum	• Hazardous waste hauler	Yes
	• Coolant from air conditioner or refrigeration equipment	• Recycling machine	• Reuse in-house (HVAC service company)	No
Liquid Wastes	• Paints*	• Original container, with lid	• Hazardous waste hauler	Yes
	• Waste lubricating oil	• Drum (segregated)	• Oil recycler	*Special***
	• Solvents, thinners, and miscellaneous fluids*	• Tank ("hot" waste) *Segregate different fluids to make recycling possible*	• Solvent recycler (where possible) or waste hauler	*Possibly*
Liquid Containers	• Empty drums	• Indoors or under cover	• Drum reconditioner	
	• Empty cans, bottles, aerosol cans, etc.	• Drum	• Municipal trash or hazardous waste hauler	*Possibly*
Vehicle Wastes	• Waste motor oil	• Drum (segregated)	• Recycler	*Special***
	• Brake fluid, gear oil, hydraulic fluids, etc.*	• Bottle or tank ("hot" waste)		Yes
	• Antifreeze	• Tank (segregated)		*Special***
	• Batteries	• Open rack	• Battery supplier	*Special***
	• Tires	• Covered or indoors	• Tire hauler	No
	• Oil filters	• Drum (drain first)	• Oil recycler	*Special**

*Unused pure product may sometimes be returned to the vendor rather than disposed of as waste.

**Recyclable under special hazardous-materials restrictions.

Vehicle maintenance waste material often deserves special attention. Waste oil, antifreeze, spent solvents, and some other liquids can be recycled. Spent batteries may not be discarded with trash, but must be either disposed of as hazardous waste or returned for reclamation and reuse to the dealer from whom you purchased them. Guidance on handling vehicle wastes can be found in the Automotive Industries BMP manual which is available from your municipality.

7

EQUIPMENT WASHING AND STEAM CLEANING

Wash water for industrial equipment in most cases must be discharged as process wastewater into the sanitary sewer, and it is not allowed in storm drains. To clean dirty and/or greasy field equipment or trucks, you must install equipment to capture and pretreat the wash water for discharge into the sanitary sewer as industrial process waste. It may be less costly in the long run to locate a commercial car wash that has all the appropriate equipment and municipal permits, and to contract with them for washing services offsite.

If you wash vehicles or equipment on your site, you may do so only in a designated area, which must be designed and equipped as follows:

- Pave the area.
- Mark the area clearly as a wash area, and be sure all employees know that they may wash in this area only. Post instructional signs that prohibit changing vehicle oil, washing with solvents, and other such activities.
- Install sumps or drain lines to collect wash water for treatment and discharge into the sanitary sewer; reuse (for repeated washings); or recycle (for use elsewhere on-site).

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- If the equipment is a continuing source of grease or heavy dirt, cover the area to prevent contact with rain water when not in use.
- Grade or berm the area to prevent storm water from running onto it.
- Wash inside a building designed for maintenance or equipment storage if possible. Ensure that all drains connect to the sanitary sewers.

Steam cleaning should be done on your site *only* if you are equipped to capture all the water and other wastes. All the washing requirements above apply to steam cleaning as well. Steam cleaning wash water is not allowed in storm drains unless you have a permit from your wastewater authority. Permit requirements include pretreatment with equipment such as an oil/water separator, which might have to be a hazardous waste unit. If you steam clean, do it indoors or in a specially prepared outdoor working area where you collect the wash water and treat it for discharge.

Storm water runoff from industrial roofs, trucks, parking lots, and yards flows into storm drains and directly into streams and the Bay. It never receives treatment that would remove pollutants.

8

TRUCKING AND SHIPPING/ RECEIVING

Truck loading and unloading are potential sources of pollutants when rainfall and run-on contact spilled raw material, dust, and motor fluids that accumulate in this heavy traffic area.

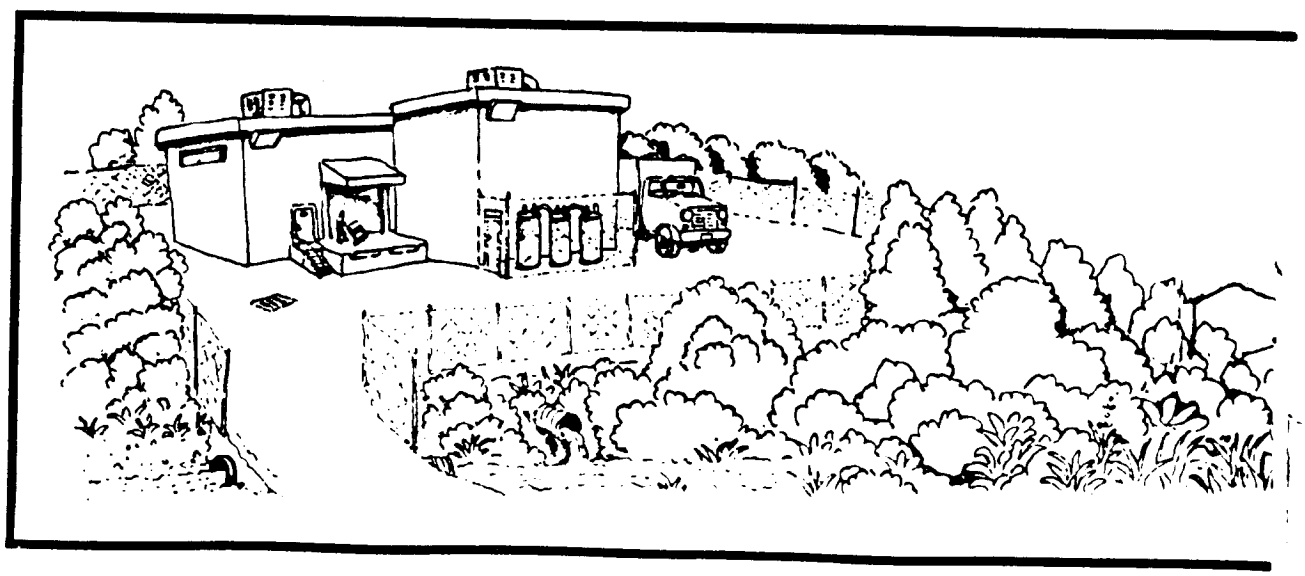
Load and unload raw material, products, and other material only at designated loading areas. In that way, you can isolate the potential source in areas that you can control, instead of in unspecified areas throughout your site. The best areas from a storm water point of view are indoor bays. For facilities that must use an outdoor loading dock, some operational BMPs and simple design features can control storm water pollution:

- Cover the loading dock area with a roof overhang, or use a door skirt that snugly fits both the building door and the truck door.
- Install curbs or berms around the loading area to prevent storm water from running onto it and any spilled material from running off it.
- Instruct the person who accepts the shipment, the truck driver, or someone else to check under the truck for leaked motor fluids, spilled matter, debris, and other foreign material.
- Develop a procedure requiring a maintenance crew to clean up spilled material promptly.

If you load or unload liquids, you need further operational precautions, and the loading dock should have additional design features. If you handle hazardous material, all the features you need are probably in place as part of a spill control and response plan. If they are not, you should select structural BMPs like those described in Section 13.

Parking lots and access roads are sources of potential pollutants from the trucks themselves and from possible spills or leaks of the material being transported. If you are regrading roads and parking lots, or if you transport materials that you expect to be significant sources of potential storm water pollutants, follow the structural BMPs recommended in Section 16. For existing facilities, especially smaller parking lots and short driveways where no hazardous material are transported, you can effectively prevent storm water pollution by implementing routine maintenance activities, such as:

- Regular visual inspection of your access roads and parking lots to identify and clean up spills.
- Removal of debris as soon as operations permit.



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Conduct street sweeping style cleanups periodically to remove loose debris, small amounts of spilled raw material, road dust, and other potential pollutants:

- Smaller spaces can easily be swept by hand.
- Do not hose off paved surfaces.
- For larger spaces, use a vacuum truck or mechanical sweeper (one that collects solids, not just brushes them aside). Whenever possible, do not use a wet washing street sweeper unless you can collect the polluted wash water.
- Private companies can perform the work on a contract basis so that you need not purchase the truck.

During the dry weather season, the appropriate frequency of sweeping for your facility depends on how heavily the road is used and the kinds of material you transport. Following are signs that you need to sweep more frequently:

- Your trucks commonly spill or drip bulk material.
- Debris or other material accumulates on the access roads. The correct frequency is one that prevents unwanted material from accumulating.

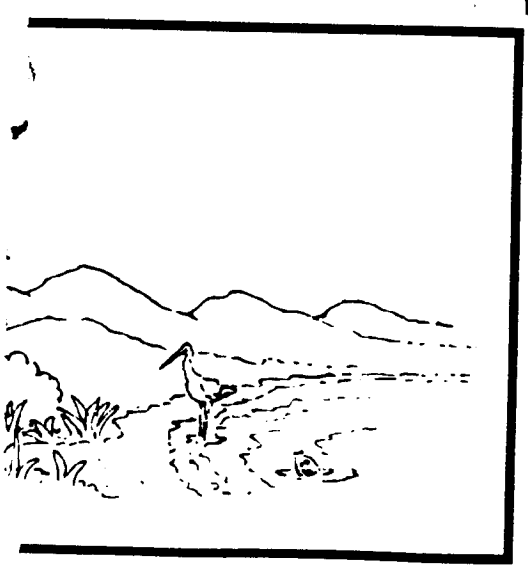
During the wet weather season, emphasize sweeping at times that will best prevent storm water from contacting potential pollutants:

- Clean the area once thoroughly before the wet weather season begins.
- After that, you may stay close to your dry season needs for debris removal, but add an additional thorough cleaning before a major rainfall (when half an inch or more is forecast).

Dispose of the cleaned-up material with your regular facility trash if there is no hazardous material. If you suspect it is hazardous — if you handle hazardous material, or if you know of a significant motor oil leak, for example — you should test the material or dispose of it with your facility's hazardous waste. You could face substantial penalties if you improperly dispose of hazardous waste.

If you **park trucks or heavy equipment** on-site, inspect the parking area for leaks of oil and motor fluids and design a procedure to report them, clean them up, and repair the leaking vehicle. Following are some practical techniques:

- Design consistent parking spots for each vehicle, so that if a leak is indicated on the ground the truck can be identified and repaired.
- Designate a person to be responsible for checking under a vehicle for leaks or spills. If you employ drivers, the driver could have the responsibility as part of a vehicle check conducted before driving.
- Clean up spills promptly, using dry cleanup procedures described in Section 3. Conduct the preferred cleanup procedures for unpaved, as well as paved, areas.
- Develop a reasonable procedure for identifying, reporting, repairing, and cleaning up leaking motor fluids and spilled material. Make sure employees are fully trained in the procedures and know who is responsible for checking each truck, who should be notified if there is a problem, and who should respond.



9 MAINTENANCE OF FLEET VEHICLES

The Automotive BMP manual prepared by the Alameda County Urban Runoff Clean Water Program addresses automotive and vehicle repair facilities. You should implement the BMPs in that manual if vehicle maintenance is a potentially significant source of pollutants on your site. Sections 9 and 10 of this manual summarize some of the appropriate BMPs for fleet maintenance at an industrial facility.

Whenever possible, perform vehicle maintenance in an indoor garage, not in outdoor parking areas. If you change oil and do other routine engine work outdoors, you should create a designated area for vehicle maintenance. Keep the area clean, as if it were part of your shop floor, and use dry cleanup practices. The area should incorporate some specific design features, such as those described in Sections 14 and 15. Some operational methods also can be successful in preventing storm water pollution at vehicle maintenance areas. A few suggestions:

- Keep equipment clean; do not allow buildup of grease and oil, which will wash away when the equipment is exposed to rain.
- If you work on vehicles outdoors, keep drip pans or containers under the vehicles at all times while you work on them — leaks and spills can occur unexpectedly. Place drip pans under vehicles as soon as you detect a leak.
- Drain fluids from any retired vehicles kept on-site for scrap or parts. Out-of-service vehicles you intend to restore and vehicles being held for resale should be checked periodically for leakage.

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- Do not change motor oil or perform vehicle or equipment maintenance in the parking lot or storage yard; use the vehicle maintenance area. Do not allow customers or employees to change their personal vehicles' oil in your vehicle service areas.

Vehicle **parking or storage yards** need to be operated with similar precautions:

- Inspect equipment in the yard for fluid leaks regularly — perhaps with a walk-by inspection for ground staining every day, and a closer visual inspection once a week.
- Keep the equipment yard clean and clear of debris, using dry sweeping methods described in Section 8. Do not hose off the area or wash with water, because any runoff becomes an illegal discharge into the storm drain.
- Maintain the yard's storm drain inlet(s) with special care. Clean them on a regular schedule and also after large storms. Pay attention to the kinds of potential pollutants that accumulate, so that you can identify the sources and take measures to control the sources.

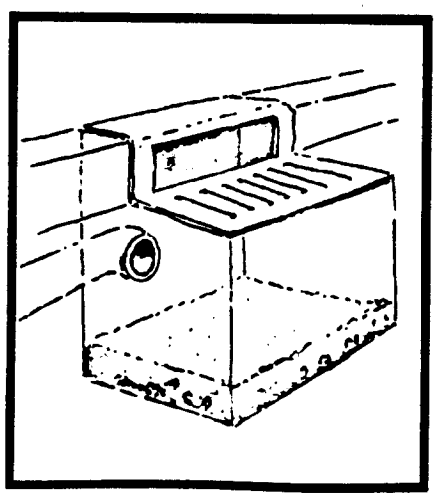
10 FUELING FLEET VEHICLES AND EQUIPMENT

If you have a vehicle fueling area, it should be designed and operated to minimize the contact of spilled fuel and leaked fluids with rain water. This section describes general principles, but simple operational controls might not be adequate for an industrial fueling facility. You might have to redesign your fueling area or install structural controls. Section 14 describes some general design approaches that can be useful in your eventual complete Storm Water Pollution Prevention Plan. Following are steps you can take for proper operation of a fueling area:

- Use a paved area or provide a concrete slab for the fueling area — never locate the area on open ground. Concrete is preferred because fuel and oils cause asphalt to deteriorate.
- Clean up gasoline overflows and spills, using dry methods described in Section 3. Do not allow spills to run off or evaporate, and do not flush the spill away with a hose. Spread absorbent material, sweep it up with a broom, and dispose of it as hazardous waste.
- Post signs that instruct pump operators not to "top off" or overfill gas tanks. Keep dry cleanup material in the fueling area, and instruct employees in the dry cleanup methods described in Section 3. Assign someone the responsibility of checking the area every day for gasoline, motor oil, or other fluids that have leaked.
- When you do routine cleaning, use a damp cloth on the pumps and a damp mop on the pavement, instead of spraying with a hose, to minimize the flow of cleaning water to the sump.

The main concept is to respond properly to fluid leaks in this spill-prone area. Even very small spills, when they happen every day, add up to a lot of fuel in the drainage system. This is an improper discharge that is illegal under the General Permit. Small spills do not present a problem if the fueling area is designed to handle spills — that is, if no storm water contacts it, and if it drains to a sump. But if the area drains to a valved-off storm drain or sewer connection, it must be pumped out before the valve may be opened during a rainfall.

A permit from the HazMat Authority is required for fuel tanks, including temporary ones. The authority will specify design features, such as the size of containments. Keep temporary fuel tanks in a bermed area that has an impervious lining, such as concrete or heavy-gauge plastic.



A catch basin helps keep debris and sediments out of the storm drain, but must be cleaned out periodically.

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11 BUILDING AND GROUNDS MAINTENANCE

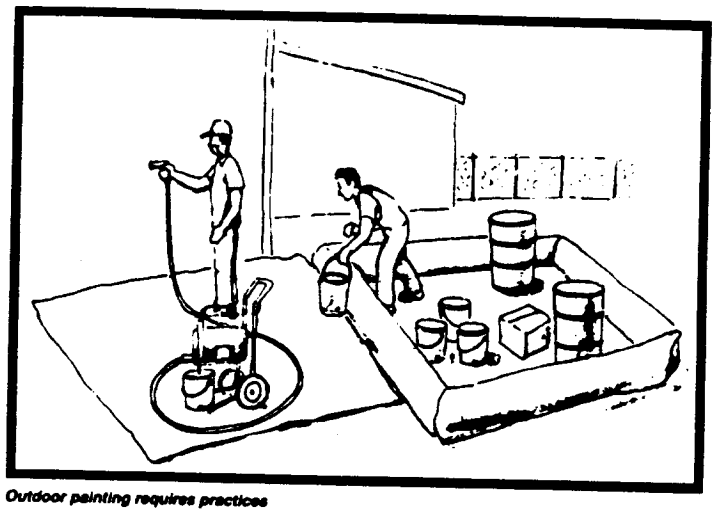
Building maintenance and general outdoor cleanup should be based on the same principles as parking lot cleanup and spill prevention: clean up without water, whenever possible, by sweeping or wiping; wash with as little water as possible; prevent and clean up spills; and clean up debris and solids, so that they do not reach the storm drains.

Maintain the **storm water conveyance system** on your property. The "conveyance system" might be as simple as roof downspouts and a gutter in your driveway or might be an extensive system of inlets, ditches, drainage channels, and underground lines. Keep all parts of the system clear of debris to avoid blockage that can cause storm water to back up. Remove from the system any spilled or leaked material that can be transported by storm water.

Clean the storm drain inlets to remove sediment and debris at least twice a year — late in the dry weather season before the first storm, and after the first major storm of the wet weather season. After each large storm, inspect the inlet; remove debris; and determine whether you need to remove sediment or do other maintenance.

The storm drain inlet might have a **catch basin**—a below-grade chamber where the storm drain pipe connects. Catch basins are intended to collect debris and sediment to prevent clogging the lines. Therefore the catch basins themselves must be cleaned out periodically to prevent flooding. If you clean catch basins annually, shortly before the wet weather season, you can keep them flowing freely and remove leaves, sediment, and other material that would otherwise be washed down the storm drain. Do not flush the catch basin with water; use a shovel or vacuum device to remove the material.

Other useful design features, such as vegetated ditches and water quality improvement inlets, are described in Sections 19, 20, and 21 as advanced BMPs.



Outdoor painting requires practices to prevent paint and dust from becoming storm water pollutants.

12 BUILDING REPAIR, REMODELING, AND CONSTRUCTION

This section describes some relatively simple BMPs that apply to minor building repairs, remodeling, and minor construction projects that involve "industrial activity exposed to storm water."

Large-scale projects, such as construction of new facilities, are covered under a separate General Permit for construction. They require more extensive storm water pollution prevention measures than described here. A manual developed by the state is available through the Clean Water Program. (See the back cover of this manual.)

The same practices are *recommended* for construction activities on industrial sites. Before you begin a construction or repair project, review the Construction BMP Manual to identify and implement the appropriate practices. If those BMPs do not apply, or are unduly elaborate for a simple construction activity that will be completed in a short time, consider the BMPs described in this section.

Store building materials under cover or in contained areas, using BMPs discussed in Section 5. For outdoor storage at a construction site, select a pollution prevention method such as:

- Putting an impermeable tarp over piles of wood, gravel or other material. Do not wait for forecasts of rain — do this every day, to avoid being caught unawares. Also it will keep material from blowing off the pile and contributing pollutants to runoff later.
- Keeping the working area clean every day for the same reason. Sweep up wood splinters, paint chips, and other residue every day, as well as thoroughly cleaning up at the end of the project.

Painting requires some basic procedures:

- Before you scrape to remove old paint, spread a ground cloth or tarpaulin to collect dust and paint chips. If the paint contains lead or tributyl tin, dispose of the paint chips as hazardous waste.
- Use impermeable ground cloths, such as plastic sheeting, while you paint. Place in-use paint buckets in a pan or on plastic sheets.

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- At the end of the work day, store paint buckets and barrels of material away from contact with storm water.
- Treat a paint spill as a chemical spill. Capture it before it flows to the storm drain, and clean it up promptly using dry methods.

During **painting cleanup**, the following are important procedures:

- If you use water-based paint, clean brushes and equipment in a sink connected to the sanitary sewer.
- Clean up oil-based paint where you can collect the waste paint and solvents for handling as small-quantity hazardous waste — do not pour it into the sink or a storm drain.
- Keep leftover paint, solvents, and other supplies for a later use, or deliver them to a solvent recycler with other plant wastes when you ship a batch.
- Handle empty paint cans and other containers as described in Section 6. Containers might be small-quantity hazardous waste. Latex paint cans are not hazardous waste if the paint is dry.

Do not fall back on old cleanup practices from days when storm water pollution was not known to be a problem. Do not pour leftover paint down the storm drain or onto the ground. Do not clean brushes into the storm drain or pour buckets of cleanup water into the drain, or wash spilled paint down the storm drain with a hose. Those practices are now categorized as "illegal dumping." Do not wipe brushes onto old newspapers or pour leftover paint supplies into newspapers and discard the paper in the trash.

Spray painting requires a few extra precautions:

- Use temporary scaffolding to hang drop cloths or draperies to shield you from the wind and to collect overspray.
- Arrange the draperies to minimize the spreading of windblown materials.
- Be aware of air-quality restrictions on spray paints that use volatile chemicals. Consider a water-based spray paint for better air quality compliance.

Sand blasting can be controlled to keep particles off paved surfaces and out of storm drains. Ask your municipality whether building and construction codes place requirements on the size and type of blasting medium that is allowed. More complete instructions are available in the Construction BMP manual for full-sized jobs, but some basics should be applied for smaller projects as well:

- Place a tarpaulin or ground cloth beneath your work to capture the blasting medium and particles from the surface being cleaned.
- Hang tarps or drop cloths to enclose the area, using temporary scaffolding if necessary. Arrange the drop cloths to protect the work area from wind and to capture airborne particles.
- Curtail operations on a windy day.
- Clean up frequently; collect dust and particles from the drop cloths before you produce a pile that is too large to handle easily.

Wood preservatives, pavement seal coating, and other outdoor surface treatments commonly contain metals, pesticides, solvents, or polymers that are hazardous materials. Handle and dispose of them properly in the following ways:

- Apply only as much of the chemical as the wood can absorb or as needed to cover the paved area.
- Soak up excess chemicals with absorbent material or rags, instead of allowing them to flow to the storm drains or soak into the soil.
- If the chemicals spill, clean them up promptly using dry techniques (See Section 3).
- When sealing a sidewalk, prevent the sealant from reaching the gutters or drains.
- When treating a roof with wood preservative or sealant, line the gutters with rags. Dispose of the rags properly—with your hazardous waste if the substances you are using are hazardous.
- If you clean a roof or sidewalk before applying preservative, sweep thoroughly to remove loose particles, then wash with water if necessary.
- Collect wash water from down spouts or drains where possible, and remove particles.
- Avoid applying surface treatment chemicals during the wet weather season.

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PART 2

Advanced BMPs and Structural Controls

Some industrial operations and plant situations require more extensive measures to control storm water pollution. Depending on your facility, and your success at eliminating potential sources of storm water pollution, your long-term implementation plan might need to contain some advanced BMPs. The BMPs include structural controls — storm water management measures that require the construction of new facilities or installation of new equipment.

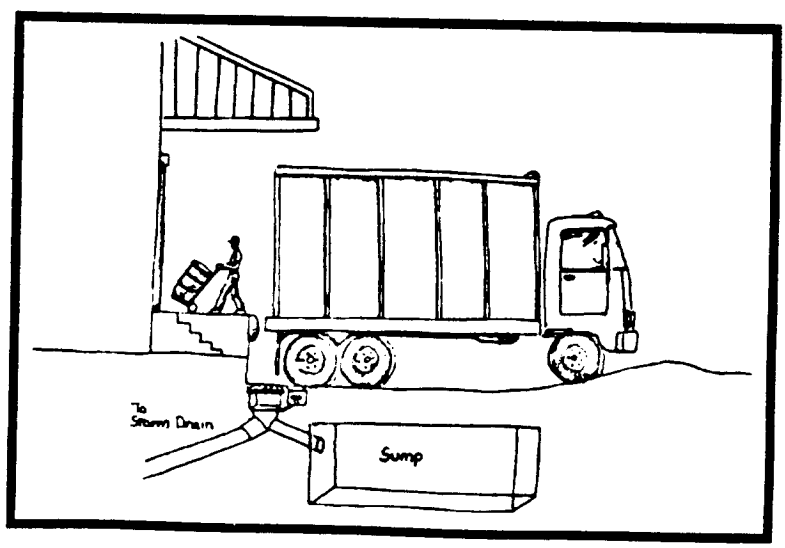
You will need to evaluate your own plant to determine which BMPs are applicable to your operations and which combination will be most effective at controlling the storm water pollutants that might run off from your site. You could find that you have a choice in selecting structural BMPs. Evaluate and select controls that are adequate and most cost-effective for your site.

The BMP descriptions in this section are not complete design standards, but describe the principles you need to consider in identifying and controlling storm water pollution. Design standards, performance specifications, and further discussion of the design and application of structural and treatment BMPs are contained in the State BMP Manual (available from the Clean Water Program).

Advanced pollution control practices take a number of forms, and might include solutions that are not listed here. If you conduct activities that are unavoidably exposed to storm water, you will need to develop more intensive source control and storm water management BMPs.

If you are renovating your shop or building a new facility, you should consider installing some of these structural controls. For example, if you regrade an equipment parking area, you should consider storm water design criteria. If you put off implementing the measures, more stringent requirements in the future could oblige you to retrofit the new or upgraded facility, which could be more costly than if you include the work in the construction or renovation.

A dead-end sump provides secure spill control, but any accumulated liquids need to be pumped out, tested, and properly disposed. Use berms or slopes to prevent run-on so storm water is not added to waste in the sump.



13 LOADING DOCK DESIGN FEATURES

Loading docks sometimes require more intensive pollution controls than the operational BMPs described in Section 8. That is especially true of areas where you load or unload liquids in containers. Bulk liquid transfers are a more intensive industrial operation that require specific control designs, and are not addressed in this manual.

Additional features of a properly designed loading dock including grading the loading area so that it is sloped or recessed to direct flow toward an inlet with a shutoff valve or toward a dead-end sump. Make sure the inlet includes a sump with enough capacity to hold a spill while the valve is closed. Keep the valve closed at all times, except when you need to release storm water or other liquids that are acceptable for discharge.

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Preferably, the inlet should connect to a sanitary sewer instead of a storm drain. Check with your wastewater treatment authority for permit requirements. Consider completely preventing contact with storm water by using a roof and berms, as described in Section 8. This will avoid both washing potential pollutants into the drain and discharging clean storm water into the sanitary sewer.

If the inlet connects to a *storm drain*, accumulated liquid must be tested and found to contain no pollutants before the valve may be opened for discharge. If the liquid does contain pollutants, you must pump it from the sump and discharge it into your sanitary sewer, providing that the wastewater treatment authority agrees to accept it. (See the recommendation below.)

If the inlet connects to a *sanitary sewer*, accumulated liquid must be tested and found to be within the parameters specified in your wastewater discharge permit before the valve may be opened for discharge. If you cannot discharge into the sanitary sewer, you need to convey the liquid to a hazardous waste disposal facility.

14 EQUIPMENT YARD DESIGN FEATURES

Parking and storage yards for large vehicles and heavy equipment generally require site-specific structural and operational controls. Follow the operational BMPs for vehicles recommended in Sections 7, 8, 9, and 10. Also assess your equipment yard to determine if there are possible sources of pollutants, and install appropriate controls to keep potential pollutants out of the storm water. Following are some measures that might be included in the design:

- Grade the area to slope toward a longitudinal drain, or install curbs to direct all storm water to a storm drain in the yard. If your yard is not too large and is properly designed, it should drain to a single storm drain. Even a small yard should include a storm drain on your property and not rely on a city-operating drain in the street.
- If you determine that the equipment yard is a significant source of oily material in your storm water, consider fitting the inlet(s) with a sand filter (see Section 20) or removing oily pollutants (see Section 21).

Segregate the area where you service vehicles, and install special structural controls:

- If possible, perform all work indoors, or construct a roof over the specified area. That will require a building permit and compliance with appropriate fire codes.
- Pave the surface with concrete, not asphalt. Vehicle fluids can dissolve asphalt or be absorbed into the blacktop and released later.
- Drain the surface to a single drain, preferably one connected to a sanitary sewer. The drain will require an oil/water separator or oil/grease trap, and must be approved by your wastewater treatment authority.
- Grade the working area to be higher than the parking lot, or surround it with a berm, to prevent storm water run-on.
- Construct a special area in which to segregate your "dirtiest" equipment (roof tar equipment, asphalt paving equipment, etc.) Handle its discharges, leaks, and runoff separately. This approach could save you from the need to treat all the runoff from the equipment yard.

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15 FLEET OR EQUIPMENT FUELING AREA DESIGN FEATURES

If your facility's vehicle fueling area is one of the significant sources you identify in your SWPP Plan, you might need more intensive BMPs than the operational efforts described in Section 10. Following are some design features to consider:

- Cover the fueling area to prevent rain from falling directly on the area. Install a roof over the fueling island, the area where vehicles park while fueling, and as much of the approach as practical. Leaked engine fluids and spilled fuel inevitably accumulate on the pavement in those heavy traffic areas.
- Storm drain and sewer inlets that drain the fueling area must be equipped with shutoff valves to keep fuel out of the drain in the event of a spill from the pumps. The valves should be kept closed at all times except during a rainfall.
- Curtail fueling activities when the valves must be open, or use extra precautions to capture any spilled fuel, such as a large drip pan under the vehicle.

A number of different approaches can serve as effective drainage design. The fueling area must be separated from the rest of the yard, both to contain any fuel spill and to prevent storm water from running onto the area. Select or adapt one of the following schemes:

- Grade the fueling area to be "mounded" or elevated. The Automotive Industries BMP manual includes a suggested mounded grading scheme.
- Install around the area berms that are high enough to redirect water from a large storm.
- Grade the entire fueling area to drain to a single inlet. You can accomplish this with longitudinal drains at the perimeter along the "downhill" side of the fueling area, or with a depression in the middle of the fueling area. Either way, be sure to design the grading to avoid run-on.
- Install at the inlet a sump from which you will pump any accumulated liquids. The sump or connection should be operated as suggested for a loading dock area in Section 13.

16 ACCESS ROADS AND RAIL CORRIDORS

Access roads and rail corridors can be significant sources of pollutants. In the General Permit, access roads and rail corridors are defined as "industrial activities exposed to storm water," which you must include when identifying potential sources and selecting BMPs for your SWPP Plan.

Maintenance and operational BMPs for access roads are the same as those described for vehicle access and parking areas under Section 9. Some structural BMPs are described below.

Proper drainage design is a good place to start. Generally, this means that the roads should be crowned and sloped outward and that storm water should not be allowed to drain across the road but be carried in ditches or culverts alongside the road. Grass lining the roadside ditches, can be an effective way to remove storm water pollutants — see Section 20. Maintain the ditch to make sure it does not clog or fill with sediments and cause storm water to overflow. Plant vegetation by the roadside to control erosion and promote rainwater infiltration.

If your site includes railroad access, preservatives on wooden railroad ties can become important pollutants. Use a less-toxic preservative. Avoid organic toxics, such as creosote and pentachlorophenol. Or use concrete ties or other nonwood ties.

Control spills and dust from railroad unloading. If your rail line delivers or picks up liquids in bulk or in containers, you might have to add spill control loading docks with shutoff valves. (See Section 3 for spill controls, and Section 13 for loading dock design features.) If parked railroad cars drip, install a drip pan at the loading dock between the rails.

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17 ON-SITE STORM WATER MANAGEMENT

Some industrial facilities will have potential pollutants exposed to storm water even after implementing source control measures like the operational BMPs described in the first part of the manual and the structural source controls discussed in this part. Further structural controls can be used to manage the storm water itself, either to control the flow of the runoff (described in Section 19), to remove some of the pollutants in passive devices (Section 20), or to remove pollutants using specially designed equipment (Section 21).

The best way to avoid the need for storm water management or treatment is to use source controls, most likely in combination. The right combination for your facility will probably include conscientious implementation of BMPs such as those recommended in Sections 1 through 12 of this manual, attention to the sources of waste at your facility, and careful reduction of process wastes.

If you need to manage storm water on-site, the most important consideration is to minimize the quantity of storm water that contacts potential pollutants. For example, keep the area of industrial activities as small as possible, separate the area from parking lots to prevent run-on, and roof or enclose the area if possible.

Design your storm water conveyance system to *isolate* the areas where storm water contacts potential pollutants, and convey water from those areas separately from water that runs off of "clean" and nonindustrial parts of the site. That will allow you to control storm water with smaller and less costly hydraulic or water quality controls. Or, if you plan to discharge to your wastewater treatment authority (see Section 18), reducing the volume will reduce the discharge cost and increase the willingness of your wastewater authority to accept the discharge.

18 REDIRECT STORM WATER DISCHARGE FROM STORM DRAIN INTO SANITARY SEWER

If source control BMPs are not adequate to prevent discharging pollutants in storm water from your facility, you might have to cease discharging storm water that contacts those pollutants. One way to avoid discharging potential pollutants with storm water is to isolate runoff from that part of your facility where the pollutants are contacted and discharge the storm water into the sanitary sewer instead of a storm drain.

Installation of new connections and new piping can be quite costly, and the necessary permits could be a barrier. Also, a permit from your local wastewater authority will be required. The permit will specify the volume of water you may discharge, the kind of pretreatment equipment you might need to install and operate, and requirements for monitoring your discharge.

Redirecting discharge to the sanitary sewer might not be allowed in all localities — some wastewater authorities have sections in their local ordinances that prohibit the discharge of storm water into the sanitary sewer. Requirements might differ from one municipality to another, so contact the authority that serves your area for information. (See the list on the back cover.)

As a rule, your wastewater treatment authority would prefer to minimize the volume of storm water that passes through the treatment system. You should reduce the quantity of storm water you redirect, using techniques like those described in Section 17.

The wastewater authority might require temporary storage of your storm water on-site, to avoid overloading its facilities during a storm. Your authority is more likely to accept discharge of storm water that has contacted pollutants if you can store it temporarily and deliver it *after* the high flows from a storm.

19 STORM WATER MANAGEMENT: HYDRAULIC CONTROLS

Hydraulic controls are intended to control the *quantity* of storm water discharge, but can be useful for water *quality* as well by removing potential pollutants from storm water. BMPs of this type are widely used to control erosion of hillsides and to remove sediments from storm water runoff. Also hydraulic control BMPs can help to remove oils and heavy metals that adsorb to sediment particles in storm water.

Design standards and operating information for hydraulic controls are available in a number of reference works. Design specifications for hydraulic controls are addressed in the State Industrial BMP manual. Many local and regional regulations that target erosion control provide specifications for hydraulic BMPs.

Hydraulic controls are designed for one of two purposes. One category controls the rate of peak flow, slowing the flow of water at the height of the storm to reduce its potential for carrying away soils and other contaminants. The other type reduces volume of runoff, generally by causing some storm water to *infiltrate* (or soak into the soil) instead of running off into storm drains, streets, or streams. Some approaches control both peak rate and volume.

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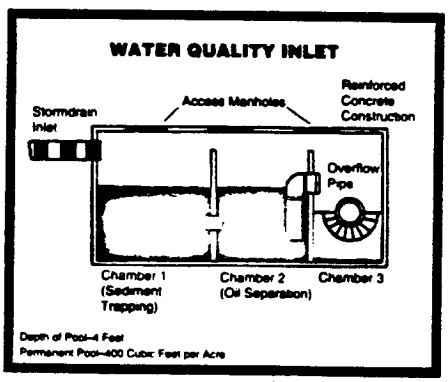
Hydraulic controls for a site are most effective if the overall site design is considered. The first step generally is to modify the site layout to increase the water-permeable surface, thereby increasing infiltration and reducing runoff volume. If greater flow control is needed, the second step might be to strategically place *infiltration trenches* to intercept runoff and promote infiltration. (Infiltration is not permitted in some areas — see Section 20.) For large quantities of flow, on-site ponds can be designed either to slow the peak flow of storm water or to hold water on-site until it infiltrates or evaporates. They are known as *detention ponds* or *retention ponds*. A variation is the *storm water wetland*, which similarly controls flow while wetland vegetation helps remove pollutants.



An API separator is only partly effective in removing oily wastes, but is more effective than an ordinary catch basin in removing sediments.

20 STORM WATER MANAGEMENT: WATER QUALITY CONTROLS

A number of specific storm water management controls are better suited to water-quality control than hydraulic control. These features might be added to various parts of the storm water conveyance system on an industrial site to help control potential pollutants in the storm water before it leaves the site. They are, for the most part, passive design features instead of treatment devices in the usual sense. Information in existing references gives design parameters for those water-quality controls, so this section merely summarizes a few types of controls.

A simple technique is a **vegetated swale** or **channel**, a ditch that carries storm water in which plants are permitted to grow. The plants provide some peak flow control by slowing the water. They also remove some pollutants by encouraging the deposit of sediments and minor oily wastes. This control can be retrofitted to some existing storm water conveyance ditches simply by allowing grasses to grow, if it does not interfere with storm water drainage and cause water to back up onto the site.

A **water quality inlet** is a simple multi-purpose device. A storm drain inlet is fitted with an enlarged catch basin or grit chamber where solids and sediments settle out of the water. A baffle restricts the flow of surface-floating oil, which can be removed by hand later. Floatable debris also collects at the baffle. This type of inlet has, in the past, been used to help remove oily wastes, but is of limited effectiveness. Section 21 describes the inlet further, including maintenance requirements.

A **sand filter inlet** is a storm drain inlet that contains sand or another filter medium. The sand removes particulates and oily wastes from storm water as it enters the storm drain. An extension of the same concept is a **sand filter**, where storm water quality can be improved before discharge. Sand filters appear to be particularly effective if used in combination with detention or retention ponds because they divert the first-flush of runoff (often carrying the most pollutants) to the filter and route the remainder of the water to the pond.

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21 STORM WATER MANAGEMENT: REMOVING OILY POLLUTANTS

A simple technique for removing oils and grease from storm water uses **oil-absorbent materials** (or oleophilic materials), such as the booms used to contain oil spills. The absorbent material preferentially absorbs oil and does not fill with water, so it can be used on storm water with small concentrations of oily materials.

Some facilities that have a storm water conveyance ditch where water flows throughout the rainy season have found it convenient to install a permanent floating boom to control an occasional light surface sheen. When the boom is spent, it is full of oil and is visibly heavier, floating lower in the water. The booms are inexpensive enough to be easily replaced whenever the absorbent is saturated. Disposal is more costly, since they might be hazardous waste, unless an oil recycler can accept the material.

Oil/water separators comprise a broad category of devices that are intended to remove oily constituents. There are many varieties of oil/water separators, and the term is not used in the same way by all equipment vendors or design specifications.

For most applications, oil/water separators are *not recommended* as a storm water management strategy. Source control BMPs are strongly preferred. Oil/water separators are fairly costly, and most designs do not operate well at the low concentrations commonly present in storm water. A sand filter inlet is typically more effective, and less costly, for the small quantities and low concentrations of oils in routine storm water runoff — that is, runoff that has not directly contacted oily industrial activities.

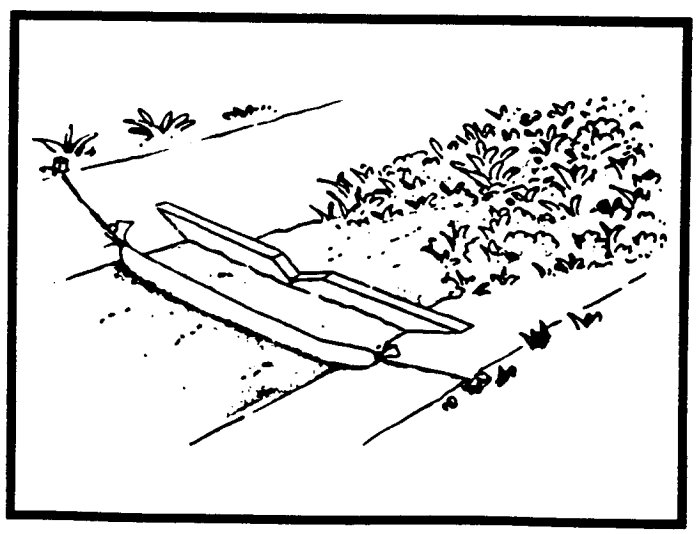
Separators can be useful in limited applications, such as for retrofitting to temporarily help a facility comply while it installs more effective source control BMPs. Another use is in spill control sumps, upstream of a treatment process. The advanced designs are sometimes used as treatment devices, discharging into a sanitary sewer storm water that contacts industrial activities in isolated areas where contact cannot be avoided.

The **API (American Petroleum Institute) oil/water separator** is a simple design. It is sometimes called an "oil and grease trap," to distinguish it from a true oil/water separator used for industrial wastewater. An API separator usually is a long basin with multiple chambers or vaults, typically installed below grade. It can be fitted to storm drains or storm water inlets in a variety of configurations — the water-quality inlet described in Section 20 is one form. The intent is to slow water and stratify the flow so that oil rises. The floating oil is then retained by one or more baffles in the chambers.

An API separator removes the bulk of floating oily wastes, especially if the oil is not well mixed but floats on top of the water. However, it is not very efficient, so storm water can still be polluted unacceptably even after it flows through the inlet. The separator works by concentrating oily wastes within the chamber, so some of the collected wastes are inevitably carried away during heavy storms. It can be made somewhat more effective at oil removal if it includes pads or pillows of oleophilic material at the water surface level.

If you install an **API separator**, *it must be maintained* regularly. It requires a standing pool of water, which should be pumped out periodically and replaced with clean water. To clean, remove oil floating on the standing pool and greasy matter collected at the baffle. Some commercial oil recyclers accept this material for recycling; otherwise, it must be handled as hazardous waste. If you install oil-absorbent pillows, they must be closely monitored and replaced when they are saturated, and must be disposed of either as hazardous waste or sent to a recycler. If the inlet includes a sediment trap, as in the water-quality inlet shown in Section 20, remove solids with a shovel between storms.

Develop a regular cleaning schedule. For inlets that don't carry much flow, three cleanings a year are sufficient— once before the rainy reason (mid-September) to remove materials that have accumulated; once after the first major storm; and then at the end of the rainy season to prevent slow loss or



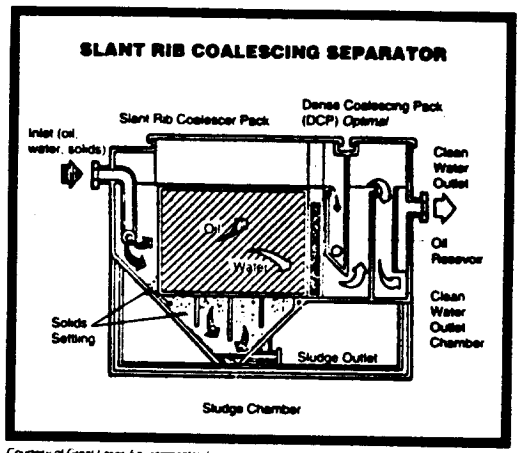
Oil-absorbent berms can remove oily sheen from storm water. Vegetation in an open ditch can slow the flow, helping sediments settle.

R0058943

evaporation of the collected oily wastes. If storm water flow is greater, the API separator might have to be cleaned monthly or periodically between storms. As another guideline, clean the separator before three inches of oil accumulate in the entry chamber.

The **CPI, or coalescing plate interceptor** oil/water separator, is a more advanced design. It is commonly used for treatment of oil-bearing industrial wastewater, but is less often cost-effective for storm water. The CPI separator generally achieves greater removal efficiency than an API type, but is more costly to purchase and operate. A CPI separator can attain a high removal efficiency and accommodate a fairly high flow rate, but at ever-increasing capital costs for the equipment because of the addition of more separator plates. Cost-effectiveness is generally optimal for relatively high concentrations of oil at low and constant flow rates.

A few design features can improve the effectiveness of an oil/water separator. Pollution removal is most effective if the concentration is high when the storm water enters the unit. Avoid diluting the water to be treated with water from other parts of the site where it does not contact the potential pollutants, both to save on the capital investment and to increase treatment effectiveness. For industrial process applications, an evaporator can be used to reduce the volume of water treated.



Courtesy of Great Lakes Environmental, Inc.

A CPI separator can be very effective in removing oil, but requires upstream sediment control and can be costly to maintain.

An oil/water separator works best if sediment is not present in the water — limit the water to be treated to isolated areas free of mud and soils if possible. Efficiency is highest with a fairly steady flow, so you might require upstream detention. Also, do not site the separator downstream of a pump, because the pump mixes the oil and water and partially emulsifies the oil, with the result that separators are less effective.

Storm water treatment generally is *not recommended* as a BMP. The State or your local wastewater authority might consider as treatment some of the devices described in Section 21, but that could open the door to some burdensome regulatory restrictions and permit requirements.

For most industrial facilities, the best advice about on-site storm water treatment is to avoid it, for a number of reasons. Most of the available treatment equipment is costly to purchase and to obtain permits for. Operational costs can also be significant — you must monitor the equipment to ensure continued effectiveness, and you might need to prepare and submit chemical analyses to demonstrate compliance.

The most troublesome permit procedures are for hazardous materials. Before installing any treatment equipment, determine whether your wastewater is hazardous. Cal-EPA/Toxics or the County Environmental Health Department will describe the necessary testing and approval procedures. If the wastewater that would enter the pretreatment equipment is considered to be hazardous you must obtain a permit from Cal-EPA/Toxics to operate a hazardous waste treatment facility. At present this might be true even for a simple water-quality inlet. If you determine that the waste stream is not hazardous, and do not apply for a hazardous waste treatment permit, keep your testing documentation on hand to show regulators.

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Pollution Control Agencies and Sources of Information

STATE OF CALIFORNIA

For information on the State's General Industrial Storm Water Permit contact:

Regional Water Quality Control Board
(510) 286-1255

State Water Resources Control Board
(916) 657-1110

For information on waste minimization and hazardous waste management technology contact:

Alternative Technology Division
(916) 324-1807

744 P Street
P.O. Box 942732
Sacramento, CA 94234-7320

Documents available from Alternative Technology:

- California Waste Exchange: A Newsletter/Catalog
- Fact Sheet: Waste Reduction for Automotive Repair Shops
- Hazardous Waste Reduction for Automotive Repair Shops:
  - Part 1: Checklist
  - Part 2: Assessment Manual
- List of CA Licensed Hazardous Waste Haulers

COUNTY OF ALAMEDA

For information on hazardous waste compliance, waste minimization, and disposal contact:

Alameda County
Environmental Services
Hazardous Materials Division
(510) 271-4320

ASSOCIATION OF BAY AREA GOVERNMENTS

P.O. Box 2050
Oakland, CA 94604-2050
(510) 464-7900

Documents available from ABAG:

- Manual of Standards for Erosion & Sediment Control Measures

SANITARY WASTEWATER AUTHORITIES

Dublin San Ramon Services District
Industrial Waste Inspector
(510) 846-4565

East Bay Municipal Utility District
(510) 287-1627

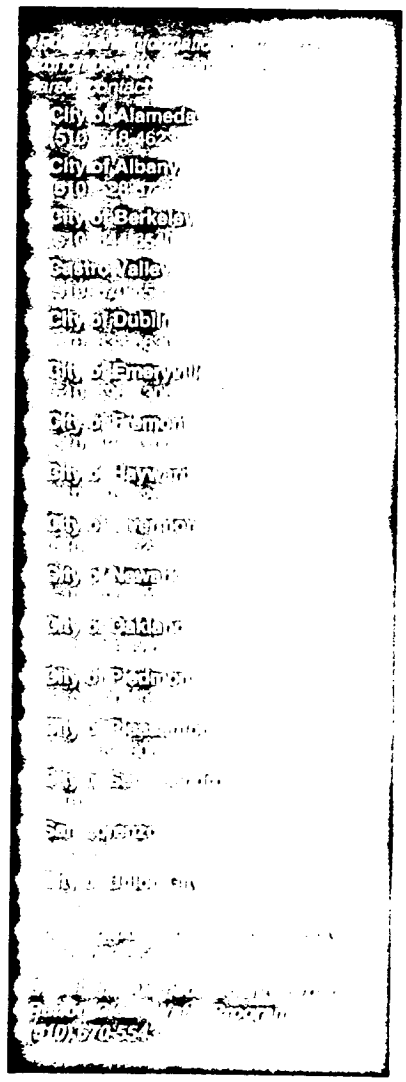
City of Hayward Water Pollution Source Control
(510) 293-5269

City of Livermore Source Control Program
(510) 373-5230

Oro Loma Sanitary District
(510) 276-4700 ext. 149

City of San Leandro
Environmental Compliance Divsion
(510) 577-3436

Union Sanitary District
Environment Compliance Section
(510) 790-0100



Alameda County
Urban Runoff
Clean Water Program
A Consortium of Local Agencies

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R0058945

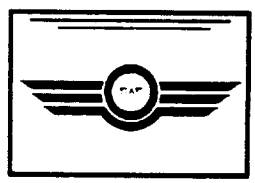
GOOD PRACTICES
TO PROTECT OUR CREEKS AND BAY

GUIDELINES FOR

- RESTAURANTS
- GROCERY STORES
- CAFETERIAS
- BAKERIES
- DELICATESSENS



130



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R0058946

GUIDELINES FOR
FOOD HANDLING FACILITIES
2

TYPES OF POLLUTION
AND
SEWER OR STORM DRAIN?
3

CLEANING EQUIPMENT
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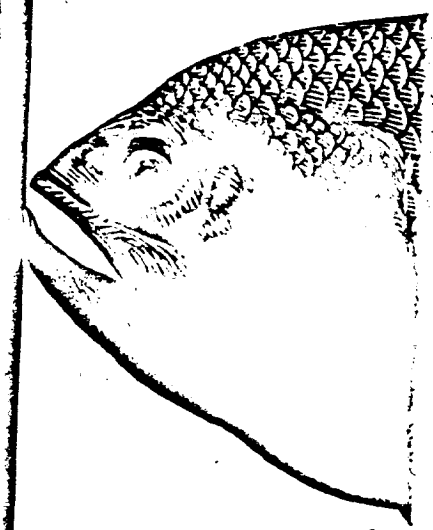

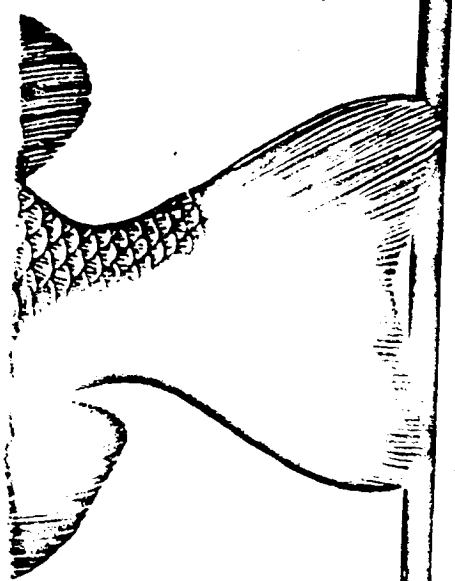

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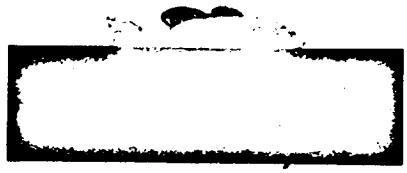
R0058947



In the Santa Clara Valley, all storm drains flow directly to local creeks and the San Francisco Bay, with no treatment. Stormwater pollution is a serious problem for wildlife dependent on our waterways, and for the people who live near polluted streams or baylands.

Food handling facilities such as restaurants, institutional cafeterias, grocery stores, bakeries, and delis, contribute to this stormwater pollution mainly through improper cleanup practices that allow food particles, oil, grease, and cleaning products to flow into a street, gutter, or storm drain.

All of the cities in the Valley are required by the Regional Water Quality Control Board to enforce local ordinances prohibiting the discharge of pollutants to storm drains or local creeks. Also, the California Department of Fish and Game forbids any discharge of materials that could pass into creeks, rivers, or the Bay that would be "deleterious to fish, plant life, or bird life."

In addition, the Santa Clara County Department of Environmental Health and local wastewater treatment plants require that all grease traps and other grease removal devices be cleaned as often as necessary to prevent overflow and to meet local grease and oil limits in wastewater. Check with these agencies to find out about other requirements — see phone numbers on page 12.

Following the practices in this manual will ensure compliance with ordinance requirements with respect to both the sanitary sewer and the storm drains, and will help contribute to a cleaner Bay. Please share this information with any contractors that you hire.

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R0058948



Food handling facilities sometimes discharge food waste, oil and grease, as well as toxic chemicals, such as cleaning products, disinfectants and pesticides, into the environment.

When cooking oil and grease is improperly disposed of into the sanitary sewer lines (indoor plumbing), the lines become plugged and back up. A sewer backup, especially in a food preparation area, presents a severe risk to the public health. Serious, even fatal diseases, can be caused by contact with raw sewage.

If cooking oil, grease, food wastes and washwater are dumped onto the street, gutter, parking lot, alley, or into a storm drain, they end up in local creeks and the San Francisco Bay, without being treated at a wastewater treatment plant. Even detergents labeled "biodegradable" contain harmful ingredients that are toxic to aquatic life. Soapy washwater that is dumped onto pavement finds its way to storm drains and into nearby creeks.

In addition to drawing flies, vermin, and creating odor and public health problems, decaying organic waste materials (primarily food and oil waste) use up the dissolved oxygen in streams and the Bay, stressing or killing aquatic animals.

Sanitary Sewer or Storm Drain?
How to Tell the Difference.

If you are not certain whether a drain leads to the storm drain or sanitary sewer, call your city's sewer department so that they can help you resolve the question. In general, drains inside the building are connected to the sanitary sewer, and outside drains (except for capped sanitary sewer "cleanouts") are connected to the storm drain system. Sanitary sewer cleanouts are usually 6 inches in diameter or smaller, storm drain inlets are larger – but there are exceptions. You need to know for sure!

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R0058949

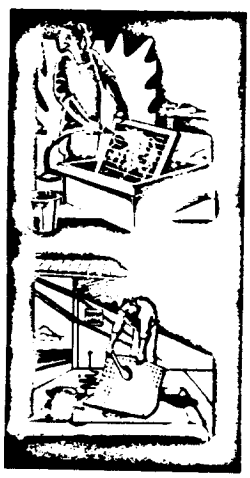
[redacted]

When cleaning floor mats, exhaust filters, garbage cans, carts, and tray racks — in order of preference:

1. Clean equipment in a designated indoor area, such as a mop sink, pot sink, or floor area with a drain connected to the sanitary sewer (indoor plumbing).

2. Clean equipment in a designated covered, bermed outdoor area with a drain connected to the sanitary sewer (indoor plumbing). This area should be isolated from the storm drain with a berm or other barrier. Don't allow food wastes to accumulate in this area. (Option 2 may not be permitted in certain cities. Check with your local planning department before installing an outside drain.)

[redacted]



- Consider installing anti-slip floors when you remodel.

- If possible, use floor mats that are small enough to be cleaned inside in a mop sink or near a floor drain.

- For hood filter cleaning companies, see "Restaurant Equipment Repairing and Servicing" in the yellow pages.

- Consider cleaning your filters in the dishwasher. Contact your local wastewater treatment plant or the County Department of Environmental Health for guidance and other cleaning options (see page 12).

- Remember that your facility is liable for the behavior of contractors that you hire. Be sure that you know how any contractor will be cleaning your equipment and disposing of washwater. No storm drain disposal is allowed!

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R0058950

When cleaning frying equipment, or when storing fat or grease for removal to a grease recycler or for waste grease disposal, follow these guidelines:



- Recycle used cooking oil, grease, and meat fat, whenever possible. See "Tallow" in the yellow pages for a list of recyclers.
- Do not contaminate the recyclable oils and grease in your tallow bin with the waste grease from your grease trap or grease interceptor.
- Inspect and clean all waste grease removal devices (grease traps and grease interceptors) regularly. For under-the-sink grease traps, we recommend skimming of the surface weekly and a more thorough cleaning quarterly. For the larger grease interceptors, we recommend pumping every 3 months (or more frequently as required to meet your local oil, fats, and grease limit). Check with your local wastewater treatment plant for guidelines.
- For disposal of waste grease from grease interceptors and traps, see "Grease Traps" and "Septic Tanks" in the yellow pages. Most landfills will not accept grease or other liquid waste from businesses. It is in your best interest to ensure that your waste grease is disposed of properly. Ask your waste grease hauler where your waste grease is disposed of.

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R0058951

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Whenever a spill occurs, and when cleaning dumpster areas, loading docks, and other paved surfaces:

Don't hose down the area!

- First, stop any spill at its source.
- If the spill could enter a storm drain, block the flow with sandbags, absorbent, rags, or a pile of dirt. You can temporarily seal the storm drain with plastic sheeting.
- Dry sweep, as much as possible, using rags and granular absorbents (e.g. cat litter) to absorb the spill. Sweep and dispose of used absorbent in the garbage (if hazardous materials are not involved).



- If wet cleaning (including high-temperature or high-pressure washing) is required, dry clean first and then mop (or if it is absolutely necessary, wash) and collect water. Dispose of water in sink or other indoor drain, not the storm drain.
- If a final rinse is necessary for health reasons, collect the rinse-water and dispose to sink or indoor floor drain. If outdoors, block storm drain before applying water. Mop up or wet-vacuum water, and dispose to sink or indoor drain.
- Do not use bleach or disinfectants if there is a possibility that the rinsewater could flow to a street, gutter, or storm drain.

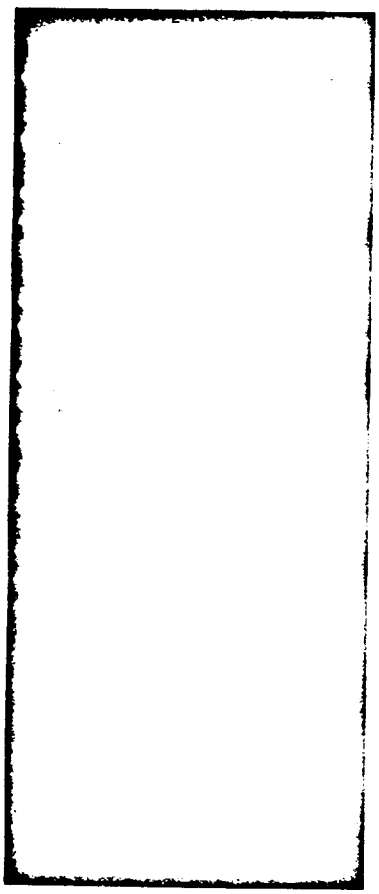
R0058952



- Keep dumpster lids closed to keep out rainwater.



- Keep dumpsters or the dumpster enclosure locked to prevent illegal dumping.



- Never place liquid waste or leaky garbage bags into a dumpster.

- Don't hose out dumpster interior. Apply absorbent over any fluids spilled in the dumpster. Absorbent and fluid will usually be knocked out when the dumpster is emptied.

- Leaking dumpsters and compactors, and dumpsters that need to be cleaned out, should be replaced by the dumpster leasing company.

- Make sure tallow bins (cooking oil/meat fat recycling bin), and any containers of waste grease are always tightly covered to prevent contamination of the grease and to prevent problems with rats and insects.

- Keep litter from accumulating around the loading docks by providing trash receptacles and encouraging employees to use them.

- Have spill cleanup materials handy near the dumpster and loading dock areas.

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R0058953



Please post the enclosed poster in the food handling area.

Copy and distribute the enclosed brochure to employees at your regular training meetings and to all new employees when they are first trained. Be sure all new employees are informed about these practices. Discuss good pollution control practices with all employees at least quarterly. The enclosed brochures have been translated into Spanish, Vietnamese, and Chinese. Call 800-794-2482 if additional originals are needed.

Stencil the storm drains in your parking lot with "No Dumping! Flows to Bay" to remind your employees that these drains flow directly to creeks and the Bay. Call 800-794-2482 for free stencils.

Post spill cleanup guidelines and the name of each shift's designated spill cleanup monitor in a visible location.

Complete the worksheet, located on pages 10-11, and share it with employees.

VOL 12 2 5661 1

R0058954



Cleaning Equipment

Clean floor mats, filters, and garbage cans...

- Indoors, in a mop sink or near a floor drain. OR...
- Outside, within your designated cleaning area, where cleaning water will not flow to the street, the gutter, a storm drain or a creek.
- Pour washwater into the mop sink... Never out the back door, or into a gutter, storm drain, or creek.

Spills

Use dry methods for spill cleanup.

- Don't hose down outside spills.
- Use rags or absorbents.
- Sweep up and dispose of absorbent to the trash.
- If necessary, mop the area with a minimum amount of water.

Dumpsters

Keep dumpster and loading dock areas clean.

- Control litter. Sweep up. Don't hose out dumpsters.
- Keep dumpster lids closed to keep out rainwater.
- Keep dumpsters or dumpster enclosure locked to prevent illegal dumping.
- Never place liquid waste or leaky garbage bags into a dumpster.
- Apply absorbent over any fluids spilled in the dumpster.
- Leaking dumpsters and compactors, and dumpsters that need to be cleaned out, should be reported to management and replaced by the dumpster leasing company.

Grease and Oil

Handle and dispose of grease properly.

- Save used grease and oil for recycling in tallow bins or sealed containers.
- Never pour grease into a sink, floor drain, storm drain, or dumpster.
- Watch out for, and report to management, overflowing grease interceptors.

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R0058955

I. GENERAL INFORMATION

1. All management personnel have reviewed this manual. YES ☐ NO ☐
2. All employees have been advised of the Cleaning Practices. YES ☐ NO ☐
3. Storm drains are stenciled "No Dumping! Flows to Bay." YES ☐ NO ☐

   For free stencils, call 800-794-2482.

GREASE TRAPS/INTERCEPTORS

1. A grease trap is located inside the facility. YES ☐ NO ☐
2. A grease interceptor is located outside the facility. YES ☐ NO ☐
3. Frequency of pumping/removing waste grease:

   every _____ weeks, _____ months, _____ years
4. Records of grease pumping are kept if required by ordinance. YES ☐ NO ☐

EQUIPMENT CLEANING

1. The following items are cleaned in such a manner that all washwater goes to the sanitary sewer or is hauled off site.

   a. Grease filters YES ☐ NO ☐
   b. Floor mats YES ☐ NO ☐
   c. Floors (mop water and rinse water) YES ☐ NO ☐
   d. Grills YES ☐ NO ☐
   e. Other_____

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R0058956

Worksheet for Water Quality Protection

Dumpsters, Recycling Containers, Trash Compactors

1. Dumpsters and recycling containers are always covered. Yes ☐ No ☐
2. There are no signs of leaks or missing drain plugs. Yes ☐ No ☐
3. Spilled materials around garbage containers are picked up regularly. Yes ☐ No ☐
4. If water is used to clean the area, washwater is collected and discharged to the sanitary sewer. Yes ☐ No ☐
5. Are trash compactors: _____ sealed or _____ unsealed
   If unsealed, are they plumbed to sanitary sewer? Yes ☐ No ☐

Spill Response

1. In case of a spill (e.g. grease), rags and absorbents such as cat litter are readily available. Yes ☐ No ☐
2. Employees are trained:
   a. To control and clean up spills. Yes ☐ No ☐
   b. To call for assistance in case of emergencies. Yes ☐ No ☐
   c. To contact the appropriate agency if the spill enters the storm drain. Yes ☐ No ☐

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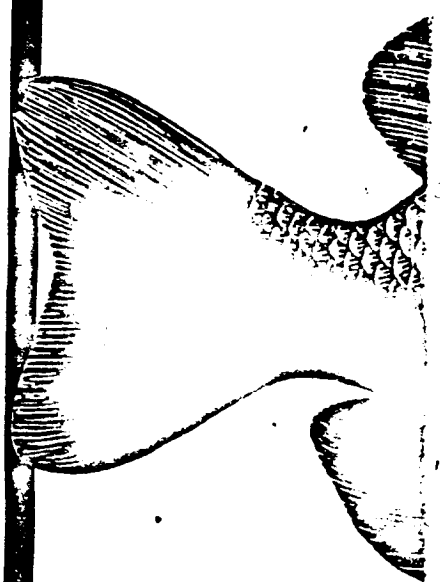
R0058957



WASTEWATER TREATMENT PLANTS:

(24 HOUR NUMBERS)

PALO ALTO REGIONAL WATER QUALITY CONTROL PLANT

415/329-2598

SERVES PALO ALTO, EAST PALO ALTO, LOS ALTOS, LOS ALTOS HILLS, MOUNTAIN VIEW, STANFORD UNIVERSITY IN MOUNTAIN VIEW. ALSO CALL ENVIRONMENTAL SAFETY DIVISION

415/903-6378

SUNNYVALE WATER POLLUTION CONTROL PLANT

408/730-7270

SAN JOSE/SANTA CLARA WATER POLLUTION CONTROL PLANT

408/945-5307

SERVES SAN JOSE, CUPERTINO, SANTA CLARA, MILPITAS, CAMPBELL, SARATOGA, LOS GATOS, MONTE SERENO, AND SURROUNDING UNINCORPORATED AREAS.

SANTA CLARA VALLEY WATER DISTRICT

FOR INFORMATION ABOUT CREEKS AND CREEK POLLUTION:

408/265-2600

(BUSINESS HOURS)

408/395-8121

(EVENINGS, WEEKENDS)

SANTA CLARA COUNTY DEPARTMENT OF ENVIRONMENTAL HEALTH

408/299-6060

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R0058958

SANTA CLARA VALLEY
NONPOINT SOURCE
POLLUTION CONTROL PROGRAM

NO DUMPING!
FLOWS TO BAY

R0058959

R0058960



Cleaning Equipment

Clean floor mats, filters, and garbage cans...

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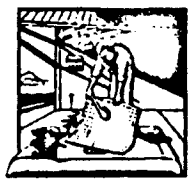
OR

- Outside, within your designated cleaning area, where cleaning water will not flow to the street, the gutter, a storm drain or a creek.



- Pour washwater into the mop sink... never out the back door, or into a gutter, storm drain, or creek.





Spills

Use dry methods for spill cleanup.

- Don't hose down outside spills.
- Use rags or absorbents.
- Sweep up and dispose of absorbent to the trash.
- If necessary, mop the area with a minimum amount of water.

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Handle and dispose of grease properly.

- Save used grease and oil for recycling in tallow bins or sealed containers.
- Never pour grease into a sink, floor drain, storm drain, or dumpster.
- Watch out for, and report to management, overflowing grease interceptors.





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- Keep dumpster lids closed to keep out rainwater.
- Keep dumpsters or the dumpster enclosure locked to prevent illegal dumping.
- Never place liquid waste or leaky garbage bags into a dumpster.
- Apply absorbent over any fluids spilled in the dumpster.
- Don't hose out dumpsters.
- Leaking dumpsters and compactors, and dumpsters that need to be cleaned out, should be reported to management and replaced by the dumpster leasing company.

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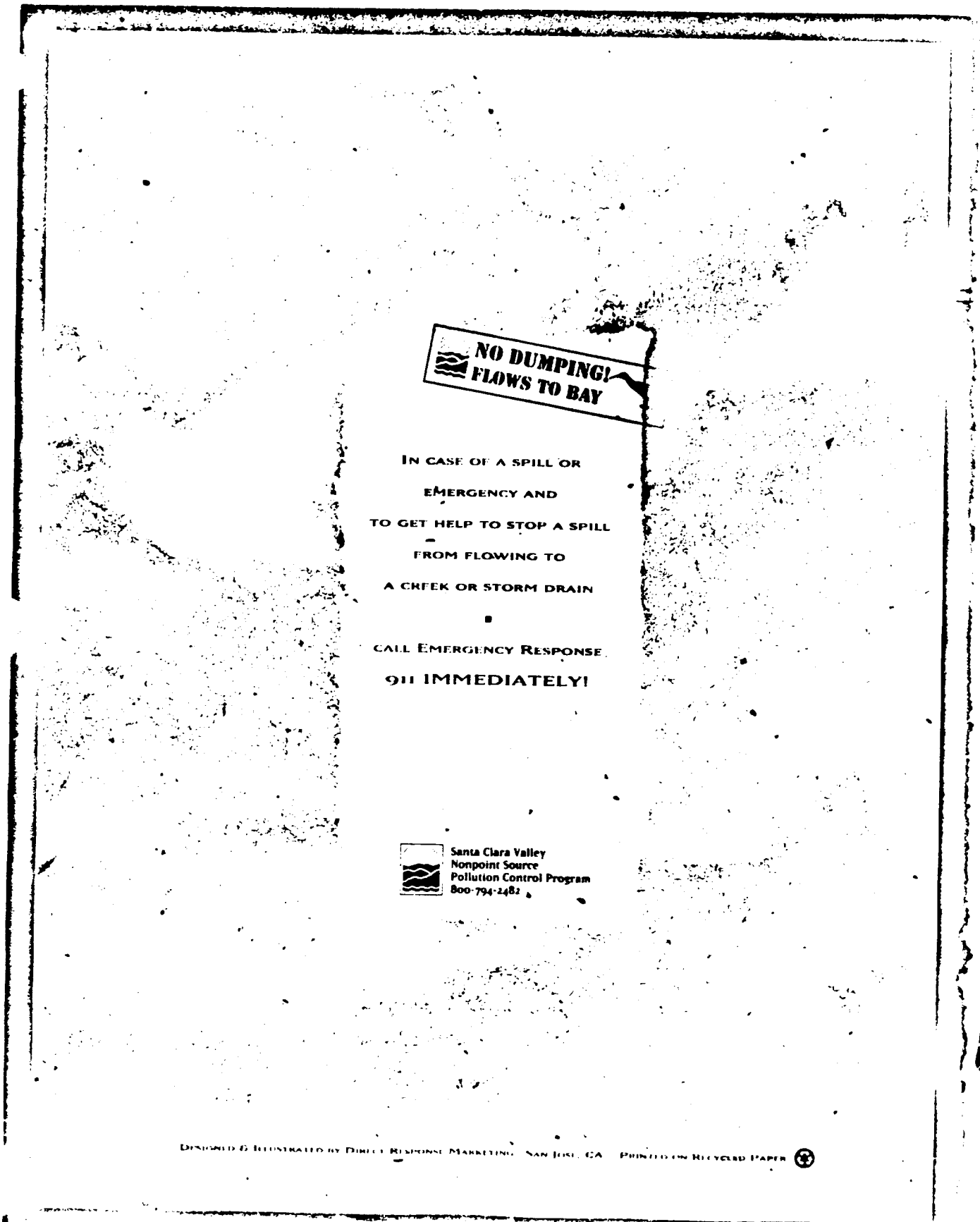
To aid in the training of your employees, you may wish to photocopy the enclosed brochures.

For additional copies of the poster or this manual call the Santa Clara Valley Nonpoint Source Pollution Control Program at 800-794-2482



VOL 12 2 5669 L

R0058962

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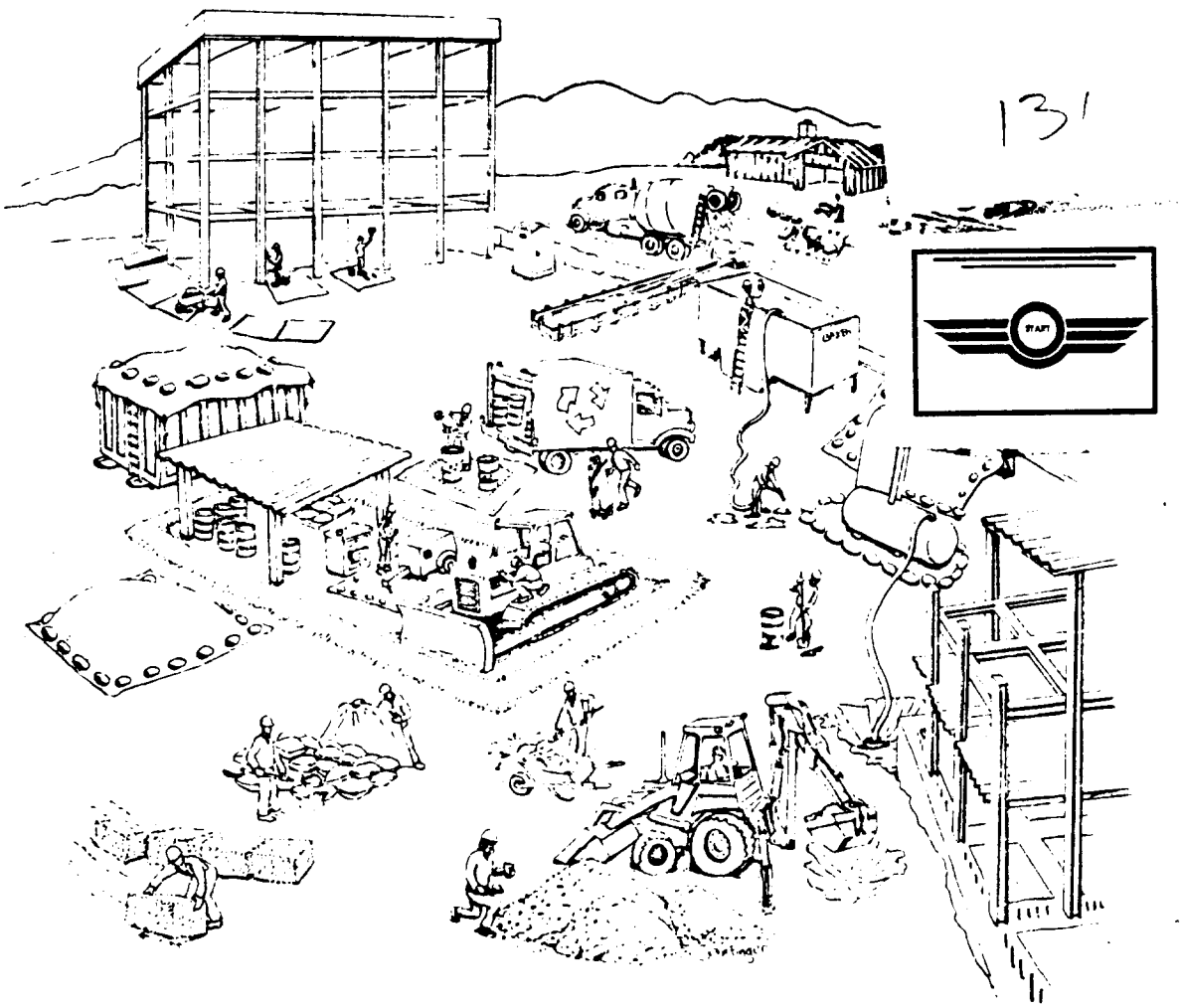
Blueprint for a Clean Bay

Best Management Practices to Prevent Stormwater Pollution from Construction-Related Activities



B A S M A A

From The Library Of
Carlos Miguel Urrunaga

The Bay Area Stormwater Management Agencies Association (BASMAA), a consortium of Bay Area municipalities from Alameda, Contra Costa, Santa Clara, San Mateo, Marin, and Solano Counties, has developed this booklet as a resource for all general contractors, home builders, and subcontractors working on construction sites.

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  - Prevent erosion
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  - Clean up spills immediately after they happen
  - Store materials under cover
  - Cover and maintain dumpsters
  - Collect and properly dispose of paint removal wastes
  - Clean up paints, solvents, adhesives, and cleaning solutions properly
  - Keep fresh concrete and cement mortars out of gutters, storm drains, and creeks
  - Service and maintain portable toilets
  - Dispose of cleared vegetation properly

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Make sure all demolition waste is properly disposed of

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Introduction

Stormwater pollution is rapidly growing in importance as a national environmental issue. In California, stormwater pollution is a major source of water pollution. To help combat the problems of stormwater pollution, federal and state governments have developed a program for monitoring and permitting discharges to municipal storm drain systems, creeks, and water bodies such as San Francisco Bay.

Municipalities in the Bay Area are required by the Clean Water Act to develop stormwater management programs that include requirements for construction activities. Your construction project will need to comply with local municipal requirements. If your construction activity will disturb five acres or more, you must also obtain coverage under the General Construction Activity Permit (see Requirements for Dischargers).

Blueprint for a Clean Bay is an introductory guide to stormwater quality control on construction sites. It contains several principles and techniques that you can use to help prevent stormwater pollution. BASMAA has developed this booklet as a resource for all general contractors, home builders, and subcontractors working on construction sites.

Blueprint for a Clean Bay is not a design manual or a Stormwater Pollution Prevention Plan (SWPPP) (see Requirements for Dischargers). For more information on the General Permit, designing stormwater quality controls, or producing a Stormwater Pollution Prevention Plan, please refer to the California Storm Water Best Management Practice Handbook for Construction Activity, or consult your local program or the SWRCB (see below). Please note that this booklet is concerned only with the management of construction sites and activities during construction.

Stormwater Pollution

Storm Drain System

Stormwater or runoff from sources like sprinklers and hoses flows over the ground into the storm drain system. In the San Francisco Bay Area, storm drain systems consist of gutters, storm drains, underground pipes, open channels, culverts, and creeks. Storm drain systems are designed to drain directly to the Bay, Delta, or Pacific Ocean with no treatment.

Pollution From Construction Sites

Stormwater runoff is part of a natural hydrologic process. However, land development and construction activities can significantly alter natural drainage patterns and pollute stormwater runoff. Runoff picks up pollutants as it flows stormwater runoff. Runoff picks up pollutants as it flows over the ground or paved areas and carries these pollutants into the storm drain system. Common sources of pollutants from construction sites include: sediments from soil erosion; construction materials and waste (e.g., paint, solvents, concrete, drywall); landscaping runoff containing fertilizers and pesticides; and spilled oil, fuel, and other fluids from construction vehicles and heavy equipment.

Adverse Effects from Stormwater Pollution

Stormwater pollution is a major source of water pollution in California. It can cause declines in fisheries, disrupt habitats, and limit water recreation activities. Even more importantly, stormwater pollution poses a serious threat to the overall health of the ecosystem.

For more information on stormwater requirements, call the State Water Resources Control Board's Stormwater Information Line at (916) 657-1146 or your local program.

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Requirements for Dischargers

Municipal Stormwater Program

Municipalities in the Bay Area are required by federal regulations to develop programs to control the discharge of pollutants to the storm drain system, including the discharge of pollutants from construction sites and areas of new development or significant redevelopment. As a result, your development and construction projects may be subject to new requirements designed to improve stormwater quality such as, expanded plan check and review, new contract specifications, and increased site inspection. For more information on municipal requirements, please contact the municipal representative listed on the back cover of this booklet.

Projects Equal To Or Greater Than 5 Acres

If your construction activity will disturb five acres or more, you must obtain coverage under the General Construction Activity Storm Water Permit (General Construction Permit) issued by the State Water Resources Control Board (SWRCB) for stormwater discharges associated with construction activity. To obtain coverage under the General Permit, a Notice of Intent (NOI) must be filed with the SWRCB. The General Construction Permit requires you to prepare and carry out a "Stormwater Pollution Prevention Plan" or SWPPP. Your SWPPP must identify appropriate stormwater pollution prevention measures or best management practices (BMPs), like the ones described in this booklet, to reduce pollutants in stormwater discharges from the construction site both during and after construction is completed. A best management practice or BMP is defined as any program, technology, process, practice, operating method, measure, or device which controls, prevents, removes, or reduces pollution.

Projects Less Than 5 Acres

If your project is less than five acres, you may still need to use BMPs to comply with local municipal requirements. Check with the local planning or engineering department for details.

Best Management Practices

General Practices

The following are some general principles that can significantly reduce pollution from construction activity and help make compliance with stormwater regulations easy:

- Identify all storm drains, drainage swales and creeks located near the construction site and make sure all subcontractors are aware of their locations to prevent pollutants from entering them.
- Clean up leaks, drips, and other spills immediately so they do not contact stormwater.
- Refuel vehicles and heavy equipment in one designated location on the site and take care to clean up spills immediately.
- Wash vehicles at an appropriate off-site facility. If equipment must be washed on-site, do not use soaps, solvents, degreasers, or steam cleaning equipment, and prevent wash water from entering the storm drain. If possible, direct wash water to a low point where it can evaporate and/or infiltrate.
- Never wash down pavement or surfaces where materials have spilled. Use dry cleanup methods whenever possible.
- Avoid contaminating clean runoff from areas adjacent to your site by using berms and/or temporary or permanent drainage ditches to divert water flow around the site. Reduce stormwater runoff velocities by constructing temporary check dams and/or berms where appropriate.
- Protect all storm drain inlets using filter fabric cloth or other best management practices to prevent sediments from entering the storm drainage system during construction activities.
- Keep materials out of the rain — prevent runoff pollution at the source. Schedule clearing or heavy earth moving activities for periods of dry weather. Cover exposed piles of soil, construction materials and wastes with plastic sheeting or temporary roofs. Before it rains, sweep and remove materials from surfaces that drain to storm drains, creeks, or channels.

For more information on the General Permits, call the State Water Resources Control Board's Stormwater Information Line at (916) 657-1146 or your local program.

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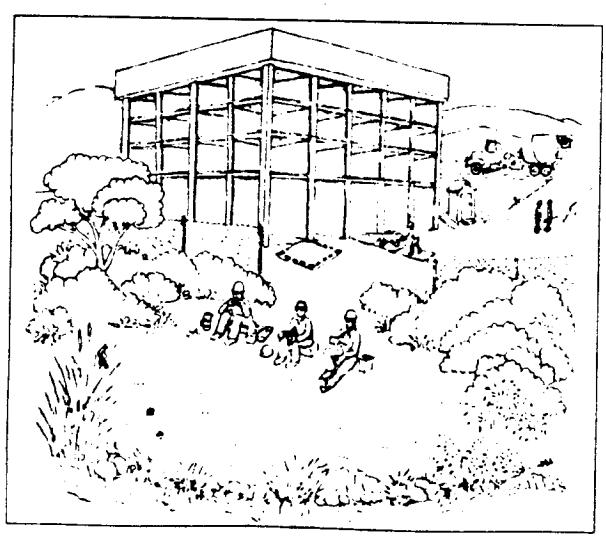
Best Management Practices

- ❑ Keep pollutants off exposed surfaces. Place trash cans around the site to reduce litter. Dispose of non-hazardous construction wastes in covered dumpsters or recycling receptacles.
- ❑ Practice source reduction — reduce waste by ordering only the amount you need to finish the job.
- ❑ Do not over-apply pesticides or fertilizers and follow manufacturers instructions for mixing and applying materials.
- ❑ Recycle leftover materials whenever possible. Materials such as concrete, asphalt, scrap metal, solvents, degreasers, cleared vegetation, paper, rock, and vehicle maintenance materials such as used oil, antifreeze, batteries, and tires are recyclable (See separate list of "Recyclers and Disposal Services" for more information).
- ❑ Dispose of all wastes properly. Materials that cannot be reused or recycled must be taken to an appropriate landfill or disposed of as hazardous waste. Never throw debris into channels, creeks or into wetland areas. Never store or leave debris in the street or near a creek where it may contact runoff.
- ❑ Illegal dumping is a violation subject to a fine and/or time in jail. Be sure that trailers carrying your materials are covered during transit. If not, the hauler may be cited and fined.
- ❑ Train your employees and inform subcontractors about the stormwater requirements and their own responsibilities.



Specific Practices

Following is a summary of specific best management practices for erosion and sediment control and contractor activities. For more information on erosion and sediment control BMPs and their design, please refer to the California Storm Water Best Management Practice Handbook for Construction Activity (March 1993) and the Association of Bay Area Governments (ABAG) Manual of Standards for Erosion & Sediment Control Measures (May 1995).

Erosion Prevention and Sediment Control

Prevent erosion

Soil erosion is the process by which soil particles are removed from the land surface, by wind, water and/or gravity. Soil particles removed by stormwater runoff are pollutants that when deposited in local creeks, lakes, Bay or Delta, can have negative impacts on aquatic habitat. Exposed soil after clearing, grading, or excavation is easily eroded by wind or water. The following practices will help prevent erosion from occurring on the construction site:

- ❑ Plan the development to fit the topography, soils, drainage pattern and natural vegetation of the site.
- ❑ Delineate clearing limits, easements, setbacks, sensitive or critical areas, trees, drainage courses, and buffer zones to prevent excessive or unnecessary disturbances and exposure.
- ❑ Phase grading operations to reduce disturbed areas and time of exposure.
- ❑ Avoid excavation and grading during wet weather.
- ❑ Limit on-site construction routes and stabilize construction entrance(s).
- ❑ Remove existing vegetation only when absolutely necessary.
- ❑ Construct diversion dikes and drainage swales to channel runoff around the site.
- ❑ Use berms and drainage ditches to divert runoff around exposed areas. Place diversion ditches across the top of cut slopes.

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Best Management Practices

- ❑ Plant vegetation on exposed slopes. Where replanting is not feasible, use erosion control blankets (e.g., jute or straw matting, glass fiber or excelsior matting, mulch netting).
- ❑ Consider slope terracing with cross drains to increase soil stability.
- ❑ Cover stockpiled soil and landscaping materials with secured plastic sheeting and divert runoff around them.
- ❑ As a back-up measure, protect drainage courses, creeks, or catch basins with straw bales, silt fences and/or temporary drainage swales.
- ❑ Once grading is completed, stabilize the disturbed areas using permanent vegetation as soon as possible.
- ❑ Conduct routine inspections of erosion control measures especially before and immediately after rainstorms, and repair if necessary.

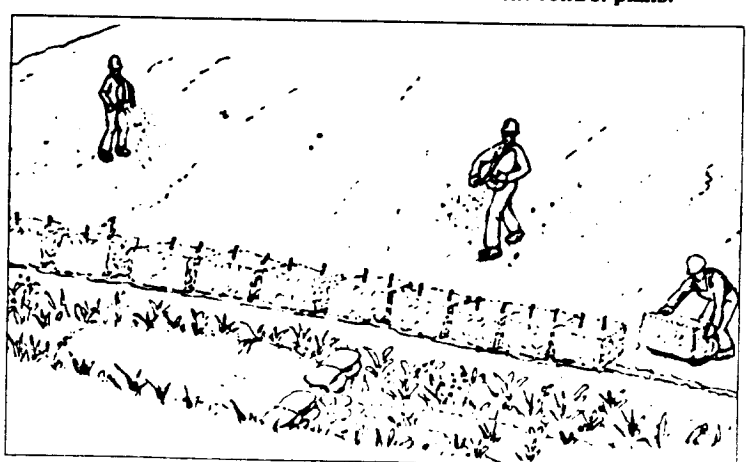
Control sediment

Sedimentation is defined as the process of depositing sediments picked up by runoff. Sediments consist of soil particles, clays, sands, and other minerals. The purpose of sediment control practices is to remove sediments from stormwater before they are transported off-site or reach a storm drain inlet or nearby creek. The most effective sediment control practices reduce runoff velocity and trap or detain runoff allowing sediments to settle out.

- ❑ Use terracing, rip rap, sand bags, rocks, straw bales, and/or temporary vegetation on slopes to reduce runoff velocity and trap sediments. Do not use asphalt rubble or other demolition debris for this purpose.
- ❑ Use check dams in temporary drains and swales to reduce runoff velocity and promote sedimentation.
- ❑ Protect storm drain inlets from sediment-laden runoff. Storm drain inlet protection devices include sand bag barriers, filter fabric fences, block and gravel filters, and excavated drop inlet sediment traps.
- ❑ Collect and detain sediment-laden runoff in sediment traps (an excavated or bermed area or constructed device) to allow sediments to settle out prior to discharge.
- ❑ Use sediment controls and filtration to remove sediments from water generated by dewatering.
- ❑ Prevent construction vehicle tires from tracking soil onto adjacent streets by constructing a temporary stone pad with a filter fabric underliner near the site exit where dirt and mud can be removed.
- ❑ When cleaning sediments from streets, driveways and paved areas on construction sites, use dry sweeping methods where possible. If water must be used to flush pavement, collect runoff to settle out sediments and protect storm drain inlets.

Note: Performance of erosion and sediment controls is dependent on proper installation, routine inspections and maintenance of the controls. Most of the BMPs described above are temporary and if left alone can quickly fall into disrepair and/or become ineffective. Routine inspections and maintenance, particularly before and after a storm event, must be part of any erosion and sediment control plan.

The California Storm Water Best Management Practices Handbook for Construction Activity and the Association of Bay Area Governments Manual of Standards for Erosion and Sediment Control provide specific details and design criteria for erosion and sediment control plans.



Drainage swales channel runoff around a construction site. Planting temporary vegetation on freshly graded areas, and trenching and staking straw bales and/or silt fences downslope are common techniques for preventing erosion and controlling sediment.

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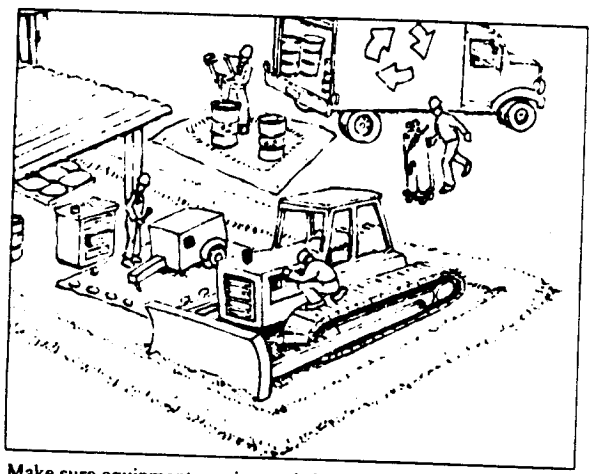

Make sure equipment repair area is bermed or well away from creeks and storm drains.

General Site Maintenance

Prevent spills and leaks

Poorly maintained vehicles and heavy equipment leaking fuel, oil, antifreeze, or other fluids on the construction site are common sources of stormwater pollution and soil contamination. Construction material spills can also cause serious problems. Careful site planning, preventive maintenance, and good materials handling practices can eliminate most spills and leaks.

- ❑ Maintain all vehicles and heavy equipment. Inspect frequently for and repair leaks.
- ❑ Designate specific areas of the construction site, well away from creeks or storm drain inlets, for auto and equipment parking and routine vehicle and equipment maintenance.
- ❑ Perform major maintenance, repair jobs and vehicle and equipment washing off-site when feasible, or in designated and controlled areas on-site.
- ❑ If you must drain and replace motor oil, radiator coolant, or other fluids on-site, use drip pans or drop cloths to catch drips and spills. Collect all spent fluids, store in labeled separate containers, and recycle whenever possible. Note that in order to be recyclable, such liquids must not be mixed with other fluids. Non-recycled fluids generally must be disposed of as hazardous wastes.

Clean up spills immediately after they happen

When vehicle fluids or materials such as paints or solvents are spilled, cleanup should be immediate, automatic, and routine.

- ❑ Sweep up spilled dry materials (e.g., cement, mortar, or fertilizer) immediately. Never attempt to "wash them away" with water, or bury them. Use only minimal water for dust control.
- ❑ Clean up liquid spills on paved or impermeable surfaces using "dry" cleanup methods (e.g., absorbent materials like cat litter, sand or rags).
- ❑ Clean up spills on dirt areas by digging up and properly disposing of the contaminated soil.



Clean up spills on dirt areas by removing contaminated soil.

- ❑ Report significant spills to the appropriate spill response agencies immediately (See reference list on the back cover of this booklet for more information).

Note: Used cleanup rags that have absorbed hazardous materials must either be sent to a certified industrial laundry or dry cleaner, or disposed of through a licensed hazardous waste disposal compay.

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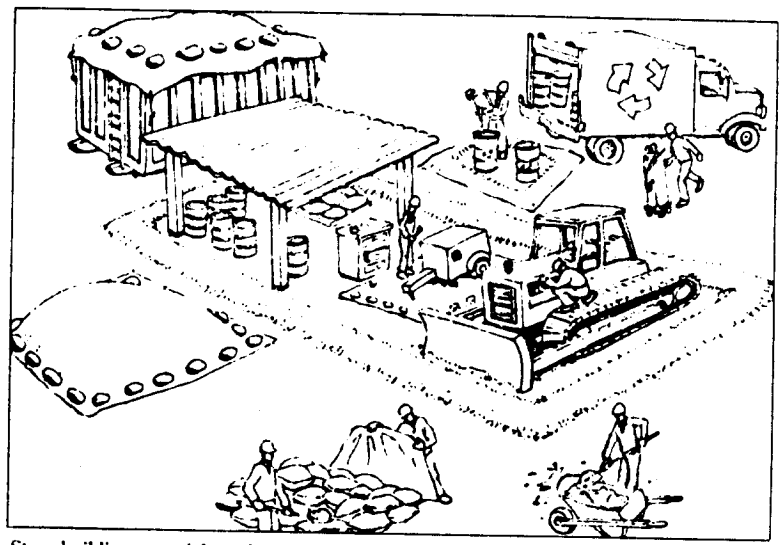
Best Management Practices

Store materials under cover

Wet and dry building materials with the potential to pollute runoff should be stored under cover and/or surrounded by berms when rain is forecast or during wet weather.

- ❑ Store stockpiled materials and wastes under a temporary roof or secured plastic sheeting or tarp.
- ❑ Berm around storage areas to prevent contact with runoff.
- ❑ Plaster or other powders can create large quantities of suspended solids in runoff, which may be toxic to aquatic life and cause serious environmental harm even if the materials are inert. Store all such potentially polluting dry materials —especially open bags— under a temporary roof or inside a building, or cover securely with an impermeable tarp. By storing dry materials under a roof, you may also help protect air quality, as well as water quality.
- ❑ Store containers of paints, chemicals, solvents, and other hazardous materials in accordance with secondary containment regulations and under cover during rainy periods.



Store building materials under cover. Make sure dumpsters are properly covered to keep out rain.

Cover and maintain dumpsters

Open or leaking dumpsters can be a source of stormwater pollution.

- ❑ Cover open dumpsters with plastic sheeting or a tarp during rainy weather. Secure the sheeting or tarp around the outside of the dumpster. If your dumpster has a cover, close it.
- ❑ If a dumpster is leaking, contain and collect leaking material. Return the dumpster to the leasing company for repair/exchange.
- ❑ Do not clean dumpsters on-site. Return to leasing company for periodic cleaning, if necessary.

Collect and properly dispose of paint removal wastes

Paint removal wastes include chemical paint stripping residues, paint chips and dust, sand blasting material and wash water. These wastes contain chemicals that are harmful to the wildlife in our creeks and the water bodies they flow to. Keep all paint wastes away from the gutter, street, and storm drains.

- ❑ Non-hazardous paint chips and dust from dry stripping and sand blasting may be swept up or collected in plastic drop cloths and disposed of as trash. Chemical paint stripping residue and chips and dust from marine paints or paints containing lead or tributyl tin must be disposed of as a hazardous waste.
- ❑ When stripping or cleaning building exteriors with high-pressure water, cover or berm storm drain inlets. If possible (and allowed by your local wastewater treatment plant), collect (mop or vacuum) building cleaning water and discharge to the sanitary sewer. Alternatively, discharge non-contaminated wash water onto a dirt area and spade into the soil. Be sure to shovel or sweep up any debris that remains in the gutter and dispose of as garbage.

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Clean up paints, solvents, adhesives, and cleaning solutions properly

Although many paint materials can and should be recycled, liquid residues from paints, thinners, solvents, glues, and cleaning fluids are hazardous wastes. When they are thoroughly dry, empty paint cans, used brushes, rags, absorbent materials, and drop cloths are no longer hazardous and may be disposed of as garbage.

- ❑ Never clean brushes or rinse paint containers into a street, gutter, storm drain, or creek.
- ❑ For water-based paints, paint out brushes to the extent possible and rinse to a drain leading to the sanitary sewer (i.e., indoor plumbing).
- ❑ For oil-based paints, paint out brushes to the extent possible, and filter and reuse thinners and solvents. Dispose of unusable thinners and residue as hazardous waste.
- ❑ Recycle, return to supplier or donate unwanted water-based (latex) paint. You may be able to recycle clean empty dry paint cans as metal (See separate list of "Recyclers and Disposal Services" for more information).
- ❑ Dried latex paint may be disposed of in the garbage.
- ❑ Unwanted paint (that is not recycled), thinners, and sludges must be disposed of as hazardous waste.
- ❑ More and more paint companies are recycling excess latex paint (See separate list of "Recyclers and Disposal Services" for more information).

Keep fresh concrete and cement mortars out of gutters, storm drains, and creeks

Concrete and cement-related mortars that wash into gutters and storm drains are toxic to fish and the aquatic environment.

- ❑ Avoid mixing excess amounts of fresh concrete or cement mortar on-site.
- ❑ Store dry and wet materials under cover, protected from rainfall and runoff.
- ❑ Wash out concrete transit mixers only in designated wash-out areas where the water will flow into settling ponds or onto dirt or stockpiles of aggregate base or sand. Pump water from settling ponds to the sanitary sewer, where allowed. Whenever possible, recycle washout by pumping back into mixers for reuse. Never dispose of washout into the street, storm drains, drainage ditches, or creeks.
- ❑ Whenever possible, return contents of mixer barrel to the yard for recycling. Dispose of small amounts of excess concrete, grout, and mortar in the trash.

Service and maintain portable toilets

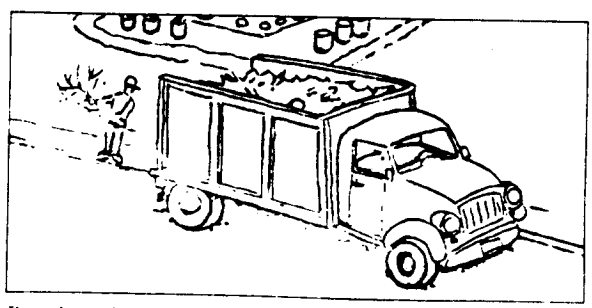
Leaking portable toilets are a potential health and environmental hazard.

- ❑ Inspect portable toilets for leaks.
- ❑ Be sure the leasing company adequately maintains, promptly repairs, and replaces units as needed.
- ❑ The leasing company must have a permit to dispose of waste to the sanitary sewer.

Dispose of cleared vegetation properly

Cleared vegetation, tree trimmings, and other plant material can cause environmental damage if it gets into creeks. Such "organic" material requires large quantities of oxygen to decompose, which reduces the oxygen available to fishes and other aquatic life.

- ❑ Do not dispose of plant material in a creek or drainage facility or leave it in a roadway where it can clog storm drain inlets.
- ❑ Avoid disposal of plant material in trash dumpsters or mixing it with other wastes. Compost plant material or take it to a landfill or other facility that composts yard waste (See separate list of "Recyclers and Disposal Services" for more information).



Recycle yard waste and tree prunings at a landfill that chips and composts plant material.

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Demolition Waste Management

Make sure all demolition waste is properly disposed of

Demolition debris that is left in the street or pushed over a bank into a creek bed or drainage facility causes serious problems for flood control, storm drain maintenance, and the health of our environment. Different types of materials have different disposal requirements or recycling options.

- ❑ Materials that can be recycled from demolition projects include: metal framing, wood, concrete, asphalt, and plate glass.
- ❑ Materials that can be salvaged for reuse from old structures include: doors, banisters, floorboards, windows, 2x4s, and other old, dense lumber.
- ❑ Unusable, unrecycleable debris should be confined to dumpsters, covered at night and during wet weather, and taken to a landfill for disposal.
- ❑ Hazardous debris such as asbestos must be handled in accordance with specific laws and regulations and disposed of as a hazardous waste. For more information of asbestos handling and disposal regulations, contact the Bay Area Air Quality Management District.
- ❑ Arrange for an adequate debris disposal schedule to insure that dumpsters do not overflow.

Roadwork and Pavement Construction

Plan roadwork and pavement construction to avoid stormwater pollution

Road paving, surfacing, and asphalt removal happen right in the street, with numerous opportunities for stormwater pollution from the asphalt mix, saw-cut slurry, or excavated material. Properly proportioned asphalt mix and well-compacted pavement avoid a host of water pollution problems.

- ❑ Apply concrete, asphalt, and seal coat during dry weather to prevent contaminants from contacting stormwater runoff.
- ❑ Cover storm drain inlets and manholes when paving or applying seal coat, slurry seal, fog seal, etc.
- ❑ Always park paving machines over drip pans or absorbent materials, since they tend to drip continuously.
- ❑ When making saw-cuts in pavement, use as little water as possible. Cover each catch basin completely with filter fabric during the sawing operation and contain the slurry by placing straw bales, sand bags, or gravel dams around the catch basin. After the liquid drains or evaporates, shovel or vacuum the slurry residue from the pavement or gutter and remove from site.
- ❑ Wash down exposed aggregate concrete only when the wash water can: (1) flow onto a dirt area; (2) drain onto a bermed surface from which it can be pumped and disposed of properly; or (3) be vacuumed from a catchment created by blocking a storm drain inlet. If necessary, place straw bales downslope, or divert runoff with temporary berms. Make sure runoff does not reach gutters or storm drains.
- ❑ Allow aggregate rinse to settle, and pump the water to the sanitary sewer if allowed by your local wastewater authority.
- ❑ Never wash sweepings from exposed aggregate concrete into a street or storm drain. Collect and return to aggregate base stockpile, or dispose with trash.
- ❑ Recycle broken concrete and asphalt (See separate list of "Recyclers and Disposal Services" for more information).

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Contaminated Ponded Stormwater, Groundwater, and Soil Guidance

Look for ponded stormwater, groundwater, and/or soil contamination

Ponded stormwater, groundwater and soil may become contaminated if exposed to hazardous materials. If any of the following conditions apply, contaminated ponded stormwater, groundwater, and/or soil may be present and pose a potential health and environmental hazard:

- ❑ The project site is in an area of previous commercial/industrial activity;
- ❑ There is a history of illegal dumping on the site or adjacent properties;
- ❑ The construction site is subject to a Superfund, state, or local cleanup order;
- ❑ Ponded stormwater, groundwater and/or water generated by dewatering exhibits an oily-sheen and/or smells of petroleum;
- ❑ Soil appears discolored, smells of petroleum and/or exhibits other unusual properties;
- ❑ Abandoned underground storage tanks, drums, or other buried debris are encountered during construction activities; or
- ❑ Spills have occurred on the site or adjacent properties involving pesticides and herbicides; fertilizers; detergents; plaster and other products; petroleum products such as fuel, oil, and grease; or other hazardous chemicals such as acids, lime, glues, paints, solvents, and curing compounds.

Take appropriate action

Ponded stormwater, groundwater, or water generated by dewatering that is contaminated cannot be discharged to a street, gutter, or storm drain. If contamination is suspected, the water should be contained and held for testing. Call the appropriate local agency and/or the Regional Water Quality Control Board for further guidance (See reference list on the back cover of this booklet for more information).

Remember: The property owner and the contractor share ultimate responsibility for the activities that occur on a construction site. You may be held responsible for any environmental damage caused by your subcontractors or employees.

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Pollution Control Agencies and Sources of Information

Storm water quality management programs

Santa Clara Valley Nonpoint Source Pollution Control Program
5750 Almaden Expressway
San Jose, CA 95118-3686
(800) 794-2482

Alameda Countywide Clean Water Program
951 Turner Court, Hayward, CA 94545 (510) 670-5543

Contra Costa Clean Water Program
255 Glacier Drive, Martinez, CA 94553-4897 (510) 313-2392
(800) NO DUMPING

San Mateo Countywide Stormwater Pollution Prevention Program
10 Twin Dolphin Drive, Suite C-200, Redwood City, CA 94065 (415) 599-1420, (800) 94-REUSE

Marin County Stormwater Pollution Prevention Program
1400 Fifth Avenue, P.O. Box 151560, San Rafael, CA 94915-1560
(415) 485-3363

Fairfield-Suisun Urban Runoff Management Program
1010 Chadbourne Road, Fairfield, CA 94585 (707) 429-8930

Vallejo Sanitation and Flood Control District
450 Ryder Street, Vallejo, CA 94590 (707) 644-8949

Bay Area Stormwater Management Agencies Association (BASMAA)
2101 Webster Street, Suite 500
Oakland, CA 94612 (510) 286-0615

Agencies to call in the event of a spill

You are required by law to report all significant releases or suspected significant releases of hazardous materials, including oil.

To report a spill, call the following agencies:

1. Dial 911 or your local emergency response number.
2. Call the Governor's Office of Emergency Services Warning Center, (800) 852-7550 (24 hours).

For spills of "Federal Reportable Quantities" of oil, chemicals, or other hazardous materials to land, air, or water, notify the National Response Center (800-424-8802). If you are not sure whether the spill is of a "reportable quantity," call the federal Environmental Protection Agency (800) 424-9346 for clarification.

For further information, see *California Hazardous Material Spill/ Release Notification Guidance* (State Office of Emergency Services, Hazardous Materials Division).

Agencies to call if you find or suspect contaminated soil or groundwater

Regional Water Quality Control Board:

San Francisco Bay Region
(510) 286-1255

Central Valley Region
(916) 255-3000

California Environmental Protection Agency (Cal EPA), Department of Toxic Substances Control (DTSC) (510) 540-3732

Documents and available resources

From State Water Resources Control Board (SWRCB)
(916) 657-1146:

General Construction Activity Storm Water Permit

California Storm Water Best Management Practice Handbook - Construction Activity

From Association of Bay Area Governments (ABAG)
(510) 464-7900:

Manual of Standards for Erosion and Sediment Control Measures

From Cal EPA, DTSC
(916) 322-3670:

Waste Minimization for the Building Construction Industry - Fact Sheet

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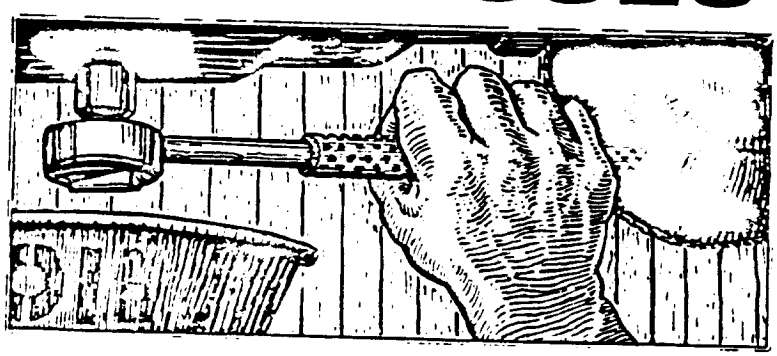
BUSINESS PARTNERS FOR Clean Water

Water Quality Protection for AUTOMOTIVE BUSINESSES



City of Bellevue
Storm and Surface Water Utility
P.O. Box 90012, Bellevue, Washington 98009-9012
(206) 451-4476

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Water Quality Protection for AUTOMOTIVE BUSINESSES



City of Bellevue Storm and Surface Water Utility
P.O. Box 90012, Bellevue, WA 98009-9012
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This manual was prepared under the direction of the City of Bellevue Storm and Surface Water Utility by the following consultants:

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November 1990

First Edition

BUSINESS PARTNERS FOR Clean Water

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How to Use This Manual

This manual will be used as a training tool at the Business Partners for Clean Water workshops for automotive-related services that are located or do work in the City of Bellevue. (The workshops are scheduled for 1990 and 1991.) It is also intended as a reference for owners and employees of automotive-related businesses and ideally will be part of any new-employee orientation.

This manual is divided into sections for easy use as follows:

SECTION 1 (Business Partners for Clean Water) is an introduction explaining the Business Partners for Clean Water Program.

SECTION 2 (Streams Are Our Business) is an overview of the surface water system, how it can be harmed, and why we should protect it.

SECTION 3 (Potential Pollutants) summarizes the major pollutants associated with automotive-related businesses and lists steps to keep those pollutants out of water.

SECTION 4 (Best Management Practices) describes in more detail the steps (called *best management practices* or BMPs) that owners and employees of automotive-related businesses can take to reduce pollution. You can go straight to Section 4's coverage of the best management practices associated with your business activities by using the following chart.

Activity	BMP #
Washing vehicles or mechanical systems by any method of cleaning with water	1,11
Fueling vehicles	2,11
Using parking lots or other outdoor areas for parking, repair work, or storage	3, 4, 5, 11
Sanding, blasting, and grinding materials	4, 11
Using liquids which can spill, including paints, solvents, oils, gasoline, detergent	6, 11
Producing or handling wastes such as paints, solvents, used oil, used gasoline or rags saturated with the above	7, 8, 9, 11
Being located by a stream	10

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SECTION 5 (Water Quality Self-Assessment and Action Program) includes a self-assessment checklist so that business owners and employees can judge how well they currently keep pollutants from the water. It also shows businesses how to create an action program identifying steps to take to protect water quality.

APPENDIX A (Resources) provides directions for reporting problems, contacting agencies for help, and locating reference materials.

APPENDIX B (Regulatory Requirements) contains summaries of and excerpts from many environmental regulations.

APPENDIX C (Glossary) lists definitions for quick reference.

Note: This manual is not a substitute for keeping abreast of applicable regulations; regulations summarized in this manual are subject to change over time, and summaries can omit detail important to a given situation. This manual does not attempt to address each individual activity for every business, but it does provide sources of additional information.

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Section 1
Business Partners for Clean Water

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1 Business Partners for Clean Water

This Business Partners for Clean Water manual discusses why automotive businesses should keep pollutants out of our streams and lakes, and how this can be done. It is geared for owners and employees of gas stations, auto repair shops, auto body shops, dealerships, detailers, and mobile fleet washing businesses. Those in other auto-related businesses will also find this manual useful. The manual is geared for businesses working in the City of Bellevue, but much of the information applies to automotive services wherever they are located.

What is "Business Partners for Clean Water"?

Business Partners for Clean Water is a cooperative effort between the City of Bellevue Storm and Surface Water Utility (SSWU) and local businesses. The goal is to reduce pollution and stream corridor degradation by local businesses and to recognize businesses which take steps to protect the water.

The program was developed with the help of a business advisory group and is partially funded by a Centennial Clean Water Fund grant from the Washington State Department of Ecology.

Five different business categories are targeted:

- automotive businesses
- construction-related businesses
- building maintenance services
- landscaping, yard maintenance, and nursery businesses
- food-related industries

Businesses in each category can learn how to protect water quality by reviewing this manual and attending a workshop targeted for that category.

The workshops will occur in 1990 and 1991. (Additional workshops may occur in the future if funding is obtained.)

Each business that attends a program workshop and prepares a water quality protection action program (meeting minimum standards) will be publicly recognized as a Business Partner for Clean Water.

For more information about the program, call the Storm and Surface Water Utility at 451-4476.

What is the Storm and Surface Water Utility?

The Storm and Surface Water Utility is a City of Bellevue department; its mission is to prevent flooding and protect water quality and aquatic wildlife habitat for the enjoyment of all citizens.

One of the first storm water utilities in the country, the SSWU is still recognized as a leader in surface water management. Initially, the SSWU focused on controlling flooding. That is still important; the SSWU protects streams and property by controlling storm water runoff and operating a number of City flood control facilities. Its water quality efforts include monitoring, inspecting the private and public drainage system, responding to water quality problems, and conducting public education.

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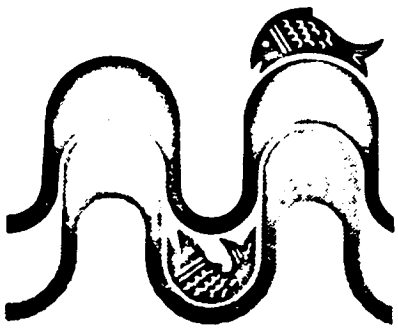

Why a water quality program for businesses?

It is against state and local law to allow pollutants to enter streams and lakes. But businesses and residents don't always realize when they're polluting. For example, a business is polluting if it lets dirty wash water enter a storm drain or if it allows the rain to wash away spilled oil.

Pollution harms our environment. It also costs money, such as the costs of responding to and cleaning up problems and the increased maintenance costs that arise when pollutants such as sediment and grease are washed into the drainage system.

The Storm and Surface Water Utility believes education is important to protecting water quality and has been a leader in public education and outreach. Business Partners for Clean Water is SSWU's first program to focus entirely on the needs of businesses. The program exists because protecting water quality depends on everyone — including business owners and employees.

In addition, the program was prompted in part by changes in state and federal law. In 1987, a section was added to the federal Water Quality Act (formerly the Clean Water Act) that requires local jurisdictions such as Bellevue to obtain permits for discharging storm water into water bodies. These permits, called National Pollutant Discharge Elimination System (NPDES) permits, require the permittee to develop and implement storm water pollution control plans.

More than ever, the City of Bellevue will be responsible for the quality of its surface waters. To meet this obligation, the City will need to better enforce its existing water quality laws and may adopt additional controls on businesses. However, the SSWU prefers voluntary cooperation over enforcement actions and is therefore pursuing education programs such as this one as a first step.

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Section 2
Streams Are Our Business

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2 Streams Are Our Business

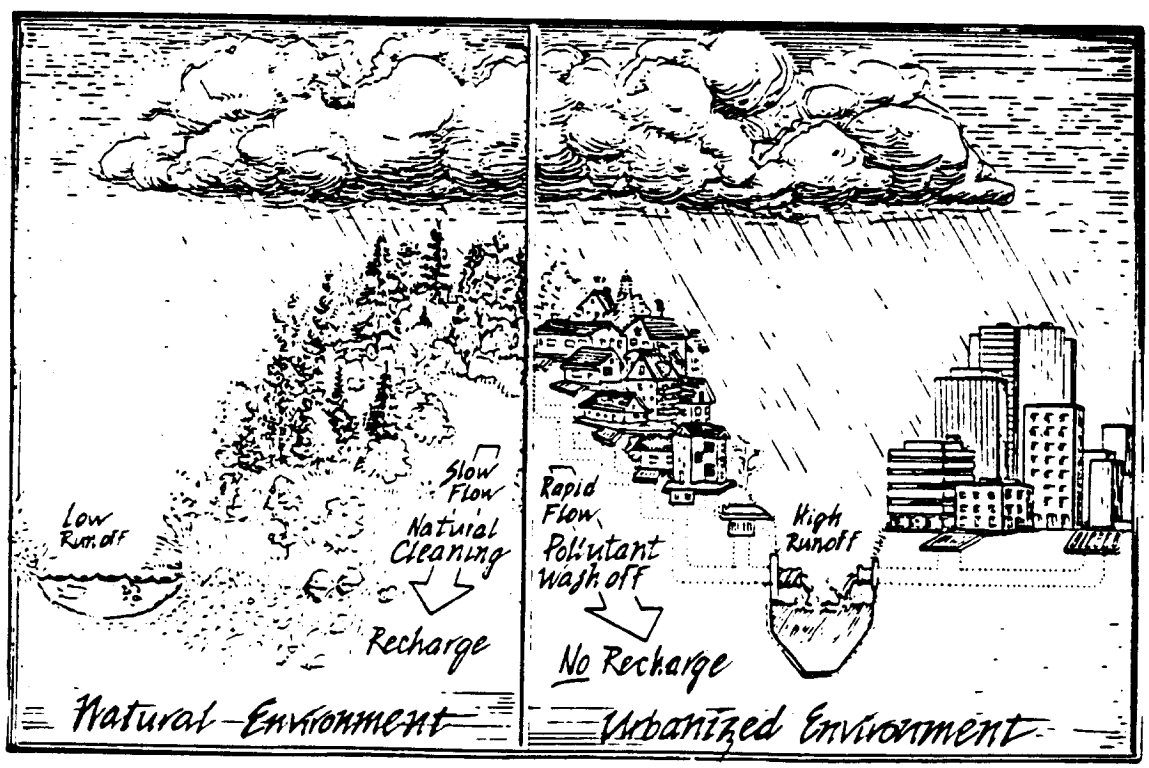
WATER
A Vital Resource

The quality of our water directly affects the quality of our lives. In the Puget Sound area, we depend on clean water for drinking, food sources, recreation, industry, aesthetics, and fish and wildlife habitat. Preserving the character of our region depends on preserving our streams, our lakes, and Puget Sound (into which our streams and rivers flow).

THE FLOW OF WATER
In a Forest Versus a City

The supply of water on earth is constant; water cycles endlessly between the sky and land, evaporating into the air and falling back to the land as rain or snow. When rain falls on undeveloped land, trees and shrubs intercept much of the water. What reaches the ground is taken up by the vegetation, collects in streams, or is absorbed into the ground where it replenishes the ground water.

In an urban area such as Bellevue, there are fewer trees and shrubs to intercept the rain. Water hits the hard surfaces of roofs, parking lots, and streets and is not absorbed into the ground. Instead, the water flows downhill until it enters a stream, wetland, lake or, more commonly, a pipe (a storm drain) which leads to a stream, wetland, or lake.



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STORM WATER RUNOFF
Carrying Pollutants In Its Path

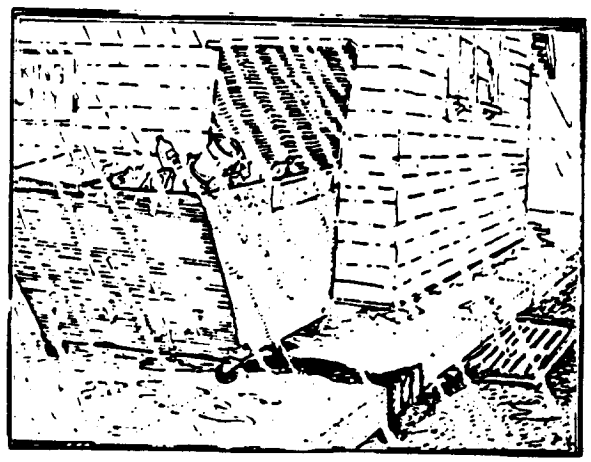
The water that flows across the land, called storm water runoff or urban runoff, collects pollutants as it travels. For example, runoff from streets and parking lots picks up oil and grease dripped from cars, asbestos worn from brake linings, and zinc from tires. Pesticides, herbicides, and fertilizers are collected from landscaped areas, and soil is washed from cleared land.

Any substance found on the ground can wind up in storm water runoff, including pollutants that settle out from the air, litter, and chemicals deliberately or inadvertently applied to the ground. Some pollutants result from everyday actions such as driving cars. Others result from harmful practices such as draining antifreeze onto streets, dumping used motor oil into storm drains, leaving soils exposed on construction sites, and applying too much fertilizer or pesticides. Because most of the pollution comes from dispersed or poorly defined sources rather than a single point such as an industrial outfall pipe, it is often called nonpoint source pollution.

POLLUTANTS
Many Different Kinds

Pollutants are substances that can render water harmful to people, fish, or wildlife or impair recreation or other beneficial uses of water.

Pollutants include *toxic* substances which are poisonous, carcinogenic (cancer causing), or otherwise harmful to people or other organisms during brief or prolonged exposure; example toxics include pesticides, solvents, preservatives, and cleaners, to name a few. *Metals* such as lead and mercury are a special category of toxic pollutants. *Oil and grease* can be toxic and can also coat fish gills (which suffocates the fish) and can block oxygen from entering water by forming a surface film or sheen.



Pollutants from leaky dumpsters can reach streams through nearby storm drains.

Other categories of pollutants include *nutrients* which are beneficial in small amounts but can be harmful in large quantities, and *oxygen demanding substances* (such as decaying plants) which use up dissolved oxygen through biological or chemical processes. (Aquatic organisms need minimum levels of dissolved oxygen to live.) Finally, *sediments* (such as soil particles) turn water cloudy, harm the aquatic habitat, and increase the cost of maintaining storm drainage facilities.

WATERSHEDS
Land Draining to Streams

Storm water runoff carries pollutants into streams and lakes and, as a result, water bodies are affected by activities far from their shores. Each stream and lake is affected by the activities within its watershed. A watershed is the geographic area from which all surface water flows to a given body of water. Because water flows downhill, watershed boundaries are ridges or high points.

The City of Bellevue includes all or parts of twelve watersheds which drain directly to Lake

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Sammamish or Lake Washington or indirectly to one of these lakes via a stream.

THE DRAINAGE SYSTEM
Streams and Built Structures

Bellevue's streams carry storm water runoff and are the backbone of the City's drainage system. The drainage system also includes built structures such as storm drain inlets and pipes which lead to streams and to detention facilities.



Every activity in a watershed affects water quality.

Detention ponds and vaults are needed to control the increased runoff volume that results when vegetation is replaced by hard surfaces. Detention vaults store runoff and release it slowly so that it does not quickly enter streams and cause erosion and flooding. The City requires most developments to construct on-site detention ponds or vaults. The City has also constructed numerous neighborhood and regional detention ponds, some of which are part of the stream system.

Detention structures can be designed to help catch or filter out pollutants which would otherwise reach the streams. Other built drainage features such as grassy ditches (swales) or created wetlands can also help to filter or remove pollutants from urban storm water. The best way to keep Bellevue's water clean is to keep pollutants from entering runoff.

INDOOR DRAINS
Another Way to Puget Sound

Indoor drains aren't usually part of the storm drainage system (although buildings from the mid 1970s and before often had floor drains leading to the storm drainage system). But indoor drains are part of another system — the sanitary sewer system — that eventually leads to Puget Sound. Sanitary sewage is treated before it reaches the Sound, but the treatment process doesn't remove all pollutants. Therefore, the City of Bellevue and Metro (which operates the regional sewer system and treatment plants) regulate what can be discharged to the sanitary sewer. (See Appendix B2.)

BELLEVUE'S STREAMS
Sensitive Urban Oases

Bellevue's streams and the stream-side or riparian areas support fish and wildlife, provide open space, and serve as outdoor classrooms and wading areas for our children. Streams and wetlands also help

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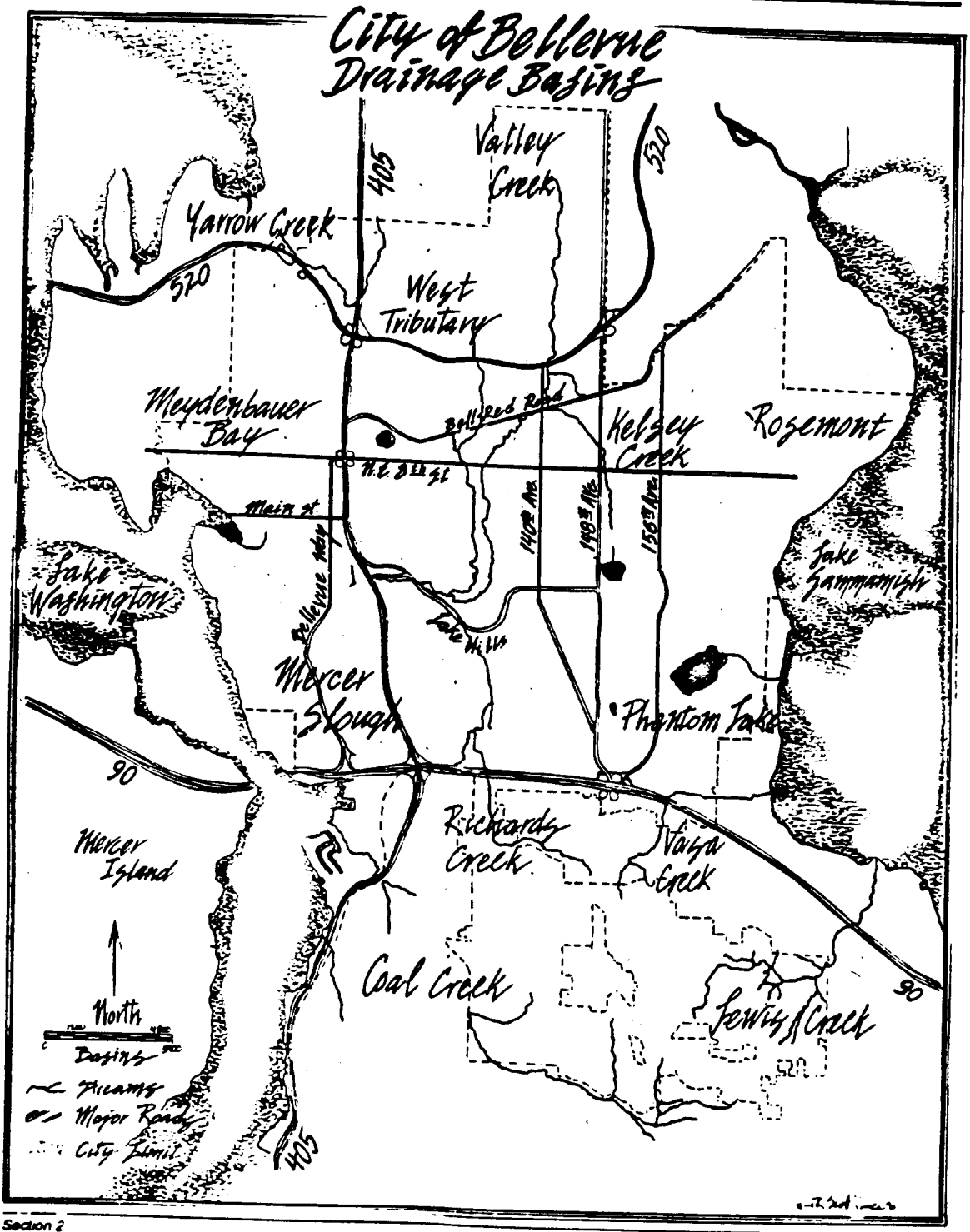

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reduce flooding by "absorbing" or slowing runoff in their meandering channels, soils, and vegetation.

A number of Bellevue streams are healthy enough to support salmonid fish — primarily chinook and coho salmon and cutthroat trout. Salmonids need specific environmental conditions in order to reach their destinations as migratory fish and to have young that survive. For example, they need a specific temperature and oxygen range. Good water quality is vital because salmon eggs and young are especially vulnerable to pollutants.

Where water quality is degraded, more sensitive species such as salmon and some of the aquatic insects they feed on are replaced by more tolerant species. What remains is a less complex ecosystem with fewer species.

BELLEVUE'S WATER QUALITY
How Clean?

In general, Bellevue streams show signs of degradation; they have higher temperatures, greater nutrient concentrations, and more bacteria and sediment than streams from less developed watersheds.

Storm water runoff, which flows into the streams, can be quite polluted. For example:

- Toxic pollutants have been found in significant concentrations; a recent Metro study found 19 of the U.S. Environmental Protection Agency's 121 priority pollutants present in street runoff.
- A study by the Nationwide Urban Runoff Program (NURP) consistently found cadmium, chromium, copper, lead, and zinc in runoff from Bellevue's Lake Hills and Surrey Downs watersheds. Nickel was found in more than half the samples. Seven other metals were found in less than half the samples.
- Oil and grease concentrations in storm water from commercial and industrial areas often exceed the Washington Department of Ecology (WDOE) standard of 10 mg/L.

Sometimes neither the source of the pollution nor its effect in the water is readily apparent, but some problems are obvious. In 1989, the SSWU received 175 calls about observed water quality problems.

Some callers report problems in the water — such as discolored water, oil on the surface, or a fish kill — but don't know the source. Others report a source of pollution, such as a fuel spill, someone dumping waste down a storm drain, or a business which routinely allows pollutants to enter storm water runoff.

POLLUTING
Against the Law

Keeping pollutants out of the water isn't just a good idea; it's the law for business owners and employees. The *Washington State Water Pollution Control Law* (RCW 90.48) and the *Bellevue City Drainage Code* (BCC 24.06) prohibit people from allowing pollutants to enter the storm drainage system or surface waters (see Appendix B5). Violating Bellevue's code is a civil offense for which monetary penalties may be imposed. Violations of the State Water Pollution Control Law, such as discharging without a required permit, can lead to violation notices, injunctive actions, civil penalties with fines up to $5,000, or criminal proceedings.

Not only is it important to avoid dumping pollutants in the water, it is also important to properly dispose of hazardous and solid wastes. If solid waste is dumped without proper permits, the person and business can be guilty of a misdemeanor. Penalties for improperly disposing of hazardous waste can be more severe. They include a fine between $100 and $10,000 and/or imprisonment for not more than one year for each violation.

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It is easier *not* to pollute than to be faced with an enforcement action. This is true for employees, not just business owners; both are liable for pollution they cause.

As stated in the Bellevue code, water pollution includes, but is not limited to, petroleum products, trash or debris, pet wastes, chemicals, paints, stream cleaning wastes, washing of fresh concrete for cleaning and/or finishing purposes or to expose aggregates, laundry wastes, soaps, pesticides, herbicides or fertilizers, sanitary sewage, heated water, chlorinated water or chlorine, degreasers and/or solvents, bark and other fibrous material, antifreeze or other automotive products, lawn clippings, leaves or branches, animal carcasses, silts, acids or alkalis, recreational vehicle wastes, dyes (without prior permission), and construction materials.

Polluting is against the law, regardless of the amount, because small amounts from lots of places add up to create a problem. (And small amounts of highly toxic pollutants are a problem in and of themselves.) In fact, the Environment 2010 report (sponsored by the State of Washington and the U.S. Environmental Protection Agency) ranked nonpoint source discharges to water — water pollution from dispersed sources — as a "priority level 1" environmental threat. (Only three of the 23 listed environmental threats were ranked as priority level 1.)

Business Partners for Clean Water is intended to make sure business owners and employees know how and why not to pollute and take steps to help keep our water clean.

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Section 3
Potential Pollutants

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3 Potential Pollutants

With proper precautions, automotive businesses can minimize harm to water quality and the natural environment. However, automotive activities such as repairing engines, washing cars, or fueling vehicles are not always done in an environmentally sensitive manner.

This section describes pollutants that can result from automotive activities and why they are a problem. It also summarizes ways to prevent or reduce pollution. These steps, referred to as *best management practices*, are described more completely in Section 4 and may involve either changing or modifying practices, structural solutions, or both.

The most common pollutants from automotive businesses are oil and grease (hydraulic, gear, and engine), toxics (in brake fluid, antifreeze, battery acids, degreasers, and solvents), and metals (from sanding debris, brakes, oils, machining shavings, paints, tires, and fuels). Some automotive businesses also may generate nutrients (from detergents), oxygen-demanding substances (such as food scraps from an associated convenience store), and sediment (dust and debris from operations).

The following table shows pollutants associated with automotive activities and how to keep them from the water.

Automotive Services:
Potential Pollution Problems and How to Prevent Them

The Problem	The Solution
Oil and grease such as from steam cleaning, repairing engines, or storing a leaky engine	• Wash vehicles and engines in a designated area. • Keep oily parts, rags, and containers covered. • Properly dispose of or recycle wastes. • Cover and drain the fueling area to the sanitary sewer. • Install and maintain an oil/water separator.
Toxics such as found in antifreeze, brake fluid, battery acid, solvents, and paints	• Maintain a clean, organized work area. • Wash vehicles and parts in a designated area. • Properly store all materials and have a spill control plan. • Properly dispose of or recycle all materials.
Metals such as from repairing brakes and engines, rebuilding and painting auto bodies, and from fuel and waste oil	• Do not sand or grind outside, unless a tarp is placed on the ground. • Clean up metal shavings and dust from sanding and grinding. • Cover containers and materials. • Properly dispose of used oils and scraps. • Recycle metal shavings and large scraps.
Nutrients such as from vehicle washing detergents and exposed soils of unpaved lots	• Wash only in a designated area. • Plant vegetation on exposed soils.

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OIL AND GREASE
A Harmful Film

Problem: Oil and grease contain a wide array of hydrocarbon compounds (compounds containing hydrogen and carbon), many of which can injure or kill aquatic life at low concentrations. Oil and grease coat fish gills and can block oxygen from entering the water.

Car lubricating agents are the major source of oil and grease found in urban runoff. Every car and car owner are potential contributors; oils and greases drip from leaks, are spilled from leaky containers or during transfer, and are dumped down storm drains.

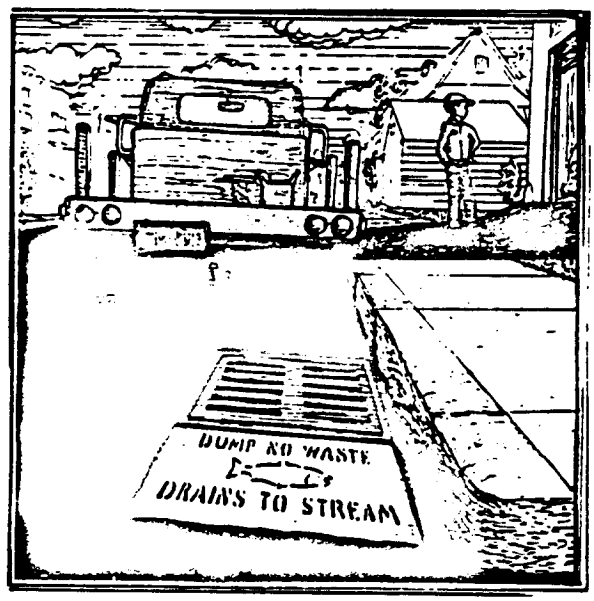
Because most automotive businesses handle oil and grease (for example, by steam cleaning or repairing engines, or simply by storing a leaky car or engine) they are potential sources of oil and grease in our streams.

Oil and grease on surfaces exposed to rain or vehicle wash water can be washed to the storm drain and ultimately the stream. This includes oil from wastes such as oil filters and soiled rags stored in uncovered or inadequate dumpsters.

At times, used oil has been deliberately poured down the storm drain. Even if the storm drain has an oil/water separator (which traps oils), it will not keep all oil out of the water, especially if pollutant concentrations are high or if the separator has not been maintained.

Solution: To minimize the amount of oil and grease that enters the stream system:

- Wash vehicles and engine parts only in a designated wash area properly connected to the sanitary sewer system with an appropriate oil/water separator.
- Keep oily parts, rags, and containers indoors or otherwise covered to prevent rain from washing the oil into the drainage system.
- Dispose of oil and grease wastes properly and recycle whenever possible; never dump them down storm drains or on the ground.
- Install and maintain an oil/water separator.



Many small releases of oil and grease from vehicles can add up to big problems in streams.

TOXICS
Poisonous to Life

Problem: Automotive businesses use or encounter a wide variety of materials toxic to the environment and sometimes also provide an avenue for such pollutants to enter the stream system. Selling gasoline; servicing engines, tires, mufflers, radiators, and batteries; and repairing and painting body chassis are among the automotive activities which generate toxic liquid and solid wastes.

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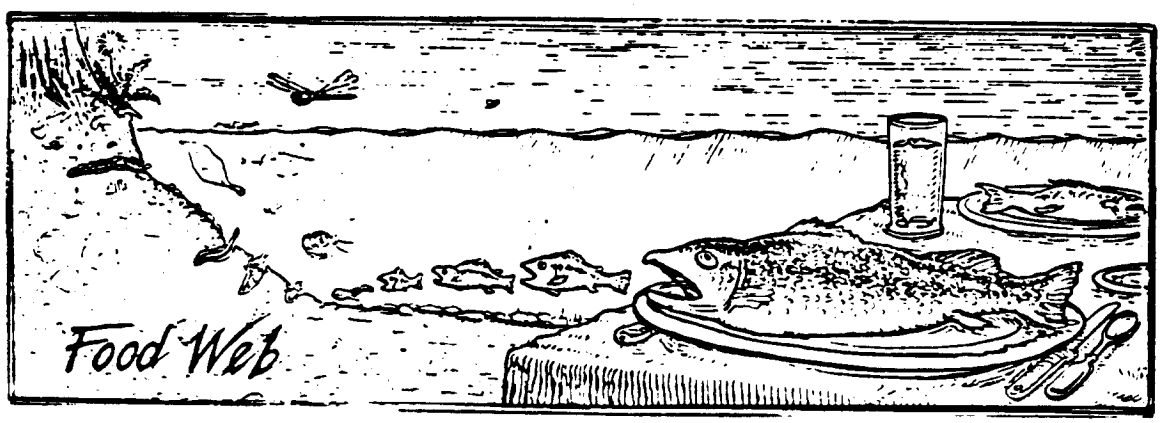
Toxic liquid wastes include used automotive products (such as antifreeze, brake fluid, radiator flush, and battery acid sludges), contaminated cleaners (such as solvents, mineral spirits, carburetor cleaners, paint thinner, and detergent wash water) and other chemicals (such as hydrochloric acid, hydrofluoric acid, hot-dip tank caustics, and naval jelly). Toxic liquid products become toxic pollutants when they leak from inadequate containers, spill during use or transfer, or are collected in wash water. Toxic liquid products also become toxic pollutants if they are deliberately poured down the storm drain or drained onto paved surfaces.

Solid waste materials (such as used batteries, empty contaminated containers, machining chips, and soiled rags) can also be a source of toxics entering lakes, wetlands, and streams. When solid wastes are stored, toxic pollutants can sometimes leak or be washed from the containers if the containers are not covered from the rain. Storm water and wind can also sweep away chips and dust created from sanding and machining automotive parts.

By definition, toxic pollutants are harmful to wildlife, people, or both. High concentrations of toxic materials can cause fish kills. In addition, some toxic pollutants accumulate in the environment; others concentrate in the food chain as one organism eats others which have been contaminated.

Solution: To minimize the release of toxic pollutants:

- Maintain a clean, organized work area.
- When washing vehicles and parts with water, only do so in a designated wash area connected to the sanitary sewer system.
- Properly store all materials and have a spill control plan.
- Dispose of all toxic materials properly and recycle whenever possible; never dump them down storm drains or on the ground.
- Cover the fueling area to keep rain from washing away leaked or spilled fuel, and drain it to the sanitary sewer.



Harmful pollutants can work their way up the food chain.

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METALS
Toxic Pollutants

Problem: Many metals are toxic pollutants and are regulated. The Environmental Protection Agency (EPA) regulates the disposal of eight hazardous metals: arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. They are commonly referred to as heavy metals and can cause injury, death, or damage, and can pollute land and water. The Washington State Department of Ecology regulates the levels of metals found in surface waters. These state regulations, called the Surface Water Quality Standards, cover the metals cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc.

Such metals are present in various auto parts and can be released to the environment in activities such as repairing and maintaining brakes, transmissions, differentials, and engines as well as rebuilding and painting auto bodies. Leaded fuels, lead additives, and wastes such as used oil, fragments from machined metal parts, and dust from sanding or grinding painted surfaces are all sources of metals. Some metals are released to the environment slowly as they corrode or leach out of the source.

A large fraction (often over half) of the metals in urban runoff are attached to sediment and settle out of the water column, accumulating at the bottom where they can remain for a long time, potentially harming bottom-dwelling organisms. Metals that are more soluble, such as copper and zinc, remain in the water and may create toxic conditions for fish and other aquatic life.

Solution: The best management practices for metals are similar to those for toxics in general:

- Do not sand or grind painted surfaces or machine parts outside, unless a tarp is placed on the ground.
- Clean up metal shavings and dust from sanding and grinding.
- Cover containers and materials including batteries and waste parts.
- Properly dispose of used oils and paints.
- Recycle metal shavings and large scraps.

NUTRIENTS
Too Much Can Be a Problem

Problem: Nutrients are substances such as phosphorus and nitrogen that stimulate plant growth. Sources of nutrients from automotive activities include vehicle washing detergents and exposed soils of unpaved parking lots.

Nutrients such as phosphorus and nitrogen are needed by plants to grow, but high levels can harm water quality. Excess levels over-stimulate the growth of algae and other aquatic plants, potentially causing unpleasant tastes, odors, unsightly conditions, and lowered dissolved oxygen levels from plant decay. Nutrients are most likely to pose a problem in slow-moving water such as lakes or sluggish streams.

Solution: Management practices that minimize nutrient losses from automotive activities:

- Wash only in a designated wash area which drains to the sanitary sewer system.
- Plant vegetation on or pave exposed soils (depending on the use of the area).

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Section 4
Best Management Practices

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4 Best Management Practices

By using *best management practices* (BMPs), you can help keep pollutants out of Bellevue's streams. Best management practices, devices or methods for reducing pollution, were introduced in Section 3 and are described more completely in this section. Some of these practices are operational whereas others are structural controls that are installed and maintained.

The following BMP categories are discussed here (they have been numbered for easy reference, not to indicate relative importance):

Best Management Practice Categories

BMP #1 *Designate Vehicle Wash Area*
BMP #2 *Cover and Drain Fueling Area*
BMP #3 *Treat Runoff with Oil/Water Separator*
BMP #4 *Keep Workplace Clean and Maintain Catch Basins*
BMP #5 *Cover Containers and Materials*
BMP #6 *Prepare for and Clean up Spills*
BMP #7 *Dispose of Wastes Properly*
BMP #8 *Minimize Wastes*
BMP #9 *Recycle Wastes*
BMP #10 *Preserve/Enhance Streams and Adjacent Vegetation*
BMP #11 *Educate Employees and Customers*

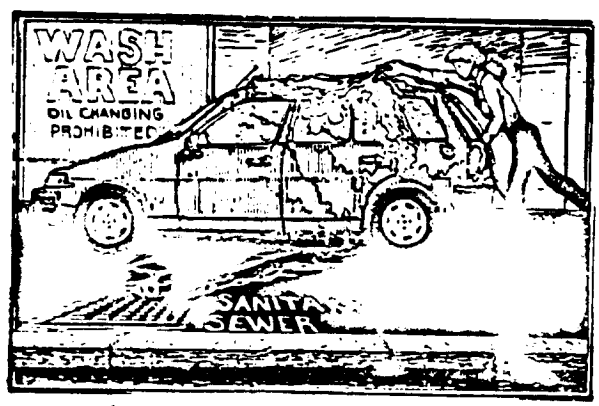
To identify best management practices appropriate for your job or business, locate the activities and corresponding BMP categories in the diagram on the following page. Then read the appropriate best management practice categories in this section.

BMP #1
Designate Vehicle Wash Area

Who: Any business that washes vehicles or mechanical systems by any method of cleaning with water — including low-pressure, high-pressure, and steam cleaning — should do so only in a designated area. This covers mobile washing services as well as business that wash on-site. Designating a wash area can involve facility changes which need to be approved by the business owner/manager. Employees who wash vehicles with water need to know the designated wash area and use it.

Why: If vehicles or mechanical equipment are washed outside a properly designed area, then oil and grease, suspended solids, heavy metals, and toxics can be washed into the drainage system in violation of state and local laws.

How: The designated wash area needs to have specific features including drainage to a sanitary sewer. Check the Bellevue Permit Center (462-2034) for permit requirements involved with any construction.



Send wash water to the sewer, not the storm drain — they're not the same thing.

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Automotive Service Activities and BMPs

Activity	Best Management Practice	BMP Reference #	Pollutants Addressed
Washing vehicles or mechanical systems by any method of cleaning with water	• Designate a properly designed vehicle wash area. Make sure all employees know they should use the designated area.	BMP 1, 11	oil, grease, toxics, nutrients, metals
Fueling vehicles	• Pave fuel area with cement, cover it, drain it to the sanitary sewer, and keep cleanup materials for spills. • Make sure all employees know how to clean up spills.	BMP 2, 11	toxics, oil, grease, metals
Using parking lots or other outdoor areas for parking, engine storage, repair work, dumpster or material storage	• Install a new or locate an existing oil/water separator. Maintain it. • Sweep parking lot and dispose of sweepings. • Pick up litter and other wastes. • Drain fluids from old vehicles kept for parts. • Clean catch basins and other drainage facilities. • Cover waste containers, including dumpsters. • Cover used batteries. • Train all employees in the proper procedures.	BMP 3, 4, 5, 11	oil, grease, toxics, metals, potentially others
Sanding, blasting, grinding	• Use a tarp to cover the ground and dispose of the collected material in the garbage. • Clean all wastes such as remaining paint chips and sandings. • See that all workers follow proper practices.	BMP 4, 11	toxics, metals
Using liquids which can spill, including paints, solvents, oils, gasoline, detergents	• Handle materials carefully to avoid spills. • Prepare a cleanup plan and know how to follow it. • Immediately clean up any spills. • Ensure all workers know what to do in the event of spills.	BMP 6,11	toxics, metals, oils, nutrients
All activities producing or handling wastes such as paints, solvents, used oil, used gasoline, or rags saturated with the above	• Minimize wastes and properly dispose of or recycle all wastes. • Ensure all workers manage waste properly.	BMP 7, 8, 9, 11	toxics, metals, oil, grease
Being located by a stream	• Preserve the stream corridor and take steps to enhance it.	BMP 10	sediment

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First, select a location for washing. To ensure proper wash water routing, washing can occur in the following areas:

- inside the business owner's building
- at a commercial washing business in which the washing occurs in an enclosure
- in a separate vehicle or equipment washing building, similar to a commercial car or truck washing business, in which all internal drains discharge to the sanitary sewer
- in an unenclosed wash area that is no bigger than 200 square feet and is designed to prevent storm water from running onto it.

Properly design and mark the wash area. Specifically, it must be:

- well marked as a wash area
- paved
- posted with signs (one that forbids the changing of oil and indicates the nearest oil recycling facility and another that forbids washing with solvents)
- drained by a system which leads to an oil/water separator and then is connected to the sanitary sewer (as described below)

Connecting a wash area's drain to the sanitary sewer requires a side sewer permit from the City Water and Sewer Utility. Refer to Appendix B2 for City regulations listing wastes prohibited from the sewer system and oil/water separator requirements.

If it is not possible to have the designated area discharge to a sanitary sewer, do one of the following:

- Place a temporary plug in the storm drain and pump the accumulated water to the nearest sanitary sewer.

- Wash vehicles with water only; do not use soaps, detergents, and cleaners. (If vehicle surfaces are greasy or oily, this method is not appropriate.)

BMP #2
Cover and Drain Fueling Area

Who: Any business that pumps gas or diesel fuel should cover and drain the fueling area. This can involve facility changes which need to be approved by the owner/manager. All employees who fuel vehicles need to know how to stop spills and clean them up.

Why: Gas and diesel spills are common when vehicles are fueled, and the cars being fueled can also drip oil. If the fueling area is improperly designed, oil and grease, metals, and toxics are washed to the drainage system in violation of state and local law.

How: The main steps are to cover the fueling area and to drain it to the sanitary sewer.

Specifically:

Cover the fuel island. This keeps rain from hitting the ground and washing away any spilled materials.

Drain the fuel area to the sanitary sewer. To do so, locate longitudinal drains at the perimeter along the "downhill" side of the island and connect them to the sanitary sewer. To comply with Metro requirements (summarized in Appendix B2) the drain should have a valve to allow shutoff in the event of a large fuel spill. Connecting to the sanitary sewer requires a side sewer permit from the City Water and Sewer Utility.

Pave the island using Portland cement concrete, not asphalt; fuel deteriorates asphalt.

Keep suitable cleanup materials on-site to allow prompt cleanup of any spill.

Post signs that instruct fuel pump operators not to overfill gas tanks; that causes spillage and vents gas fumes to the air.

Place any temporary fuel tank in a bermed, impervious area. The area should be large enough to contain 110 percent of the tank's total volume.

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Impervious liners such as heavy mil plastic or Portland cement will work.

BMP #3
Treat Runoff with Oil/Water Separator

Who: All businesses with a parking lot for more than 20 vehicles should have an oil/water separator and maintain it.

Why: Parking lots are major sources of oil and grease to the drainage system.

For new construction, the City of Bellevue Development Standards require oil/water separation devices to be installed whenever parking space is provided for more than 20 vehicles or whenever paved parking or an access road is within one-quarter mile of any open waterway or stream.

Nearly all automotive businesses in Bellevue fall into one of these two categories; the City is considering requiring existing businesses in these two categories to install an oil/water separator if they don't already have one.

How: To treat the runoff from your site, be sure that an oil/water separator is installed and maintained.

Install a new or locate an existing oil/water separator.

Chances are you already have an oil/water separator, if your business is in the City and was built or substantially remodeled in the past ten years. To locate your separator, check the manholes on or near your business site or check the "as-built" building plans. The City of Bellevue has "as-built" plans for commercial facilities built in the last 10 years; you can call the City of Bellevue Permit Center at 462-2034 and ask the Storm and Surface Water Utility representative to locate the plans for your site.

If you have an oil/water separator or if you are going to install one, it is most likely an American Petroleum Institute (API) separator. The API separator, also known as a baffle-type separator is a long vault or basin with baffles to slow the water so that dispersed oil can be removed. The City of Bellevue has design plans for numerous oil/water separators in the City *Development Standards*.

Oil/water separators are installed by a private sewer contractor between an inlet and either a storm drain or a sewer pipe. If the separator is used to treat contaminated storm water from large parking lots, businesses, and streets, it will most likely be connected to a storm drain. The Department of Ecology (867-7000) must approve the installation of oil/water separators connected to storm drains. To protect the water, the Department of Ecology encourages all businesses to connect wash areas to the sewer system. Oil/water separators connected to the sewer system must be approved by Metro (684-2300) and the Bellevue Sewer Utility (462-2034) and must drain an area less than 200 square feet.

If the oil/water separator is connected to the storm drainage system, improve the effectiveness of the separator and allow the use of a smaller separator by not routing all drainage through it. Drainage from an impervious area that is not likely to be contaminated by oil, such as rooftops, can be diverted to the storm drains at a location "downstream" of the oil/water separator.

Maintain the oil/water separator.

An oil/water separator should be cleaned before three inches of oil accumulate in the entry chamber. Generally, oil/water separators need to be cleaned at least twice a year to keep accumulated oil from escaping during an extreme storm. The most appropriate times to clean an oil/water separator are by October 15th to remove material that has accumulated during the dry season and again after the first significant storm.

Separators must be cleaned by approved and environmentally safe methods, such as those used

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by commercial tank-cleaning companies. You can find tank-cleaning services listed in the yellow pages of your telephone directory. These services will pump out the oil/water mixture and take it to a treatment facility, where the oil will be further separated for recycling. Do not use septic tank-cleaning services to clean your oil/water separator; there is no legal, environmentally safe way for them to dispose of oily wastes.

During the maintenance:

- Close the effluent shutoff valve.
- Replace oil absorbent pads.
- Test and dispose of waste oil and sludge in accordance with current Seattle-King County Health Department requirements. Call the Health Department at 296-4633 to determine which chemicals must be tested for. At a minimum they will require total petroleum testing, but they could also require a scan for solvents. Most businesses generate only a small amount of minimally contaminated sludge (residue that collects in the system); in that case, the sludge can be sealed in a container and disposed in the dumpster. If you generate a high volume (some separators can hold 20 cubic yards of dirt) of minimally contaminated sludge then you will have to arrange to have it hauled to the landfill. If the contaminants are unusually high and are above permitted levels, the sludge should be taken to a treatment, storage, and disposal facility. (See BMP #7.)
- Any standing water removed during the maintenance operation can be disposed to a sanitary sewer at an approved discharge location. This dirty standing water should be replaced with clean water to prevent oil from being washed out of the separator.

Eliminate oil sources to the maximum extent possible. Oil/water separators do not remove all oil and are not a substitute for keeping oil off the parking lot to the maximum extent possible. For example, do not store uncovered oily parts outdoors and keep business vehicles in tune.

BMP #4
Keep the Work Place Clean and Maintain Catch Basins

Who: It's up to all employees to help keep the workplace clean.

Why: Any residue (such as paint chips, metal shavings, and grease) on a surface that drains to a storm drain can be washed or blown to the City's streams and lakes, in violation of state and local laws (see Appendix B1). Messy work places increase the chance of spills.

How: Keep the work place organized and keep surfaces which drain to the City's drainage system clean. Maintain storm water facilities such as catch basins so that they serve their intended function. More specifically:

Pick up litter.

Sweep the parking lot. Dispose of the sweepings in the garbage.

Keep paint chips and metal shavings off the ground. Use a tarp to cover the ground when blasting, sanding, or grinding to catch chips and metal shavings, or do those activities inside. Call the Seattle-King County Health Department at 296-4633 to see if chips can be disposed of at a landfill.

Clean up all wastes at the work site. For instance, clean up remaining paint chips, dust, and sandings. If the wastes are wet, dry them before disposal.

Drain fluids from old vehicles kept for parts. This includes unused gas, transmission and hydraulic oil, and radiator coolant.

Cover exposed soils. Pave exposed soils on unpaved parking areas and plant vegetation on exposed soils not used for parking.

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Clean the catch basin. A catch basin needs to be cleaned when deposits fill 60 percent of the catchment area. Generally, this will be every six months, but if woody debris accumulates it should be cleaned weekly.

Clean storm water basins. Regularly remove debris from basins used for either peak-rate control or storm water treatment. Clean the control structure if the distance between the sediment and the orifice plate is less than one-third the depth.

BMP #5
Cover Containers and Materials

Who: All employees should properly store materials so they don't become sources of pollution.

Why: Rain can wash pollutants from improperly stored materials into the drainage system, in violation of state and local laws. For example, a used engine stored outside may drip oil which is then washed to the stream system.

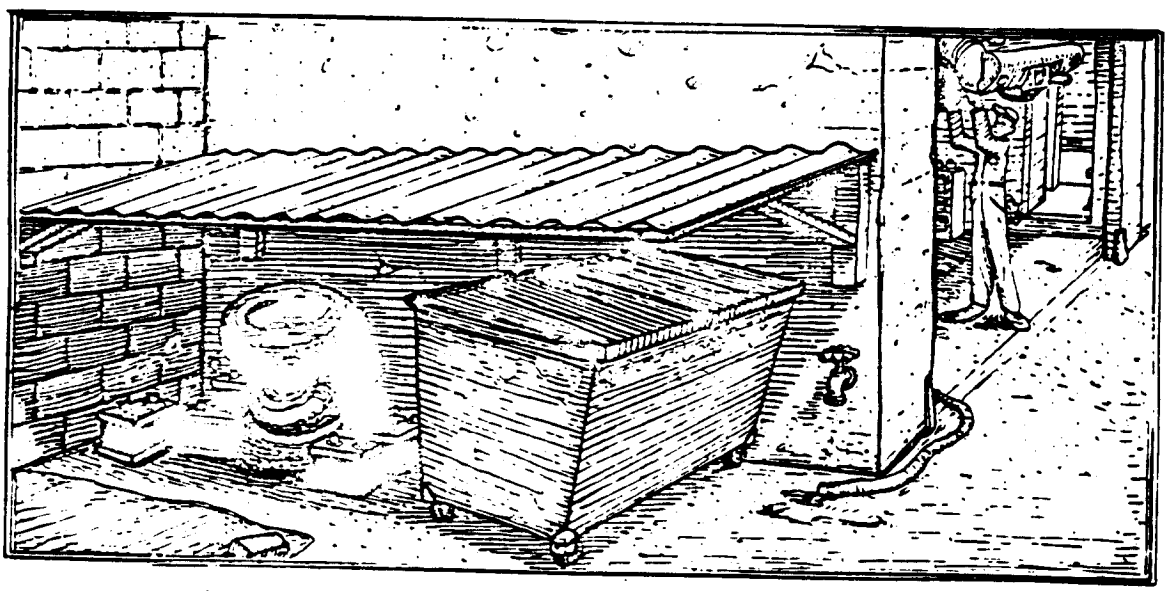
How: Raw materials, by-products, products, and their containers should be covered to keep rainfall from reaching them and washing out pollutants.

Cover all potentially polluting materials. This includes:

- dumpsters that store items awaiting final disposal such as used oil filters, cleaning rags, and food scraps
- waste-container drums, tanks, or boxes
- used batteries

Cover adequately. Several methods of covering are adequate; select one of the following methods most appropriate for the type of material. Be sure to meet the City of Bellevue *Fire Code* requirements summarized in Appendix B6.

- Store wastes inside a building.



A good storage area keeps materials covered so pollutants can't wash away.

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- Store materials or containers inside the service bay.
- Place materials or container inside another container that has a tightly fitting cover.
- Build a covered area such as a lean-to, pave the surface area beneath, and prevent runoff from entering the area.
- Place temporary plastic sheeting over the material or containers and secure the cover with ties and weighted objects.
- For liquid products or wastes, surround the storage area with a curb or dike to provide volume to contain 10 percent of the volume of all the containers or 110 percent of the volume of the largest container, whichever, is greater. If the storage area is permanent, install a drain. For used oil or liquids controlled by the fire code the liquid should drain to a dead-end sump; otherwise connect it to the sanitary sewer. (Connecting to the sanitary sewer requires a side sewer permit from the City of Bellevue.)

BMP #6
Prepare for and Clean up Spills

Who: All automotive businesses that use paints, solvents, oils, gasoline or other materials which can spill should have a spill control plan. All employees should know what to do in the case of a spill.

Why: Spills can result in toxic pollutants reaching the drainage system and can cause acute problems such as fish kills.

State law requires owners of businesses that produce hazardous waste to have a spill cleanup plan. Federal law requires the owners of facilities which store, process, or refine oil and oil products to have a spill prevention and control plan. (See Appendix B3.)

How: There are three overall practices to minimize pollution from spills: handle materials carefully to avoid spills and leaks, prepare a cleanup plan, and immediately clean up any spills. The latter two are discussed below.

Prepare a cleanup plan. Generally, a cleanup plan includes the following steps:

- Establish who to notify in the event of a spill, such as the City of Bellevue, the Department of Ecology, and Metro for large spills. (See Appendix A1.)
- Provide specific cleanup instructions. General cleanup options are discussed later in the description of this best management practice.
- Assign a person to be in charge of cleanup.
- Prepare spill containment and cleanup kits which are easy to reach and use. Firms such as the following can provide cleanup materials:

Envirosorb Co. 8128 — 187th SW Edmonds, WA 98020 778-7485	CHEMPRO 2203 Airport Way S Seattle, WA 98134 1-800-228-7872

- Post a summary of the cleanup plan at appropriate locations.

Clean up spills immediately. If a liquid spill occurs, clean it up right away following the cleanup plan and safety requirements. If there is not a plan, take the following steps:

- Stop the source of the spill.
- Contain the liquid. If there is a chance the spill could enter the storm drain or sewer, close the storm drain inlet and turn off or divert any incoming water.
- Cover the spill with absorbent material. Use materials that can be swept or picked up such as kitty litter, sawdust, or vermiculite. Do not use straw, emulsifiers, or dispersants. If the spill is small and the listed absorbent materials

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Kitty litter can be used to soak up small spills.

are not available, use rags or paper. If the spill involves battery acid, neutralize the acid with cement, lime, or bicarbonate (baking soda).

- Call the appropriate government agencies. In Bellevue, first call the City of Bellevue Storm and Surface Water Utility (455-7846, 24 hours). For large spills, call the Department of Ecology Regional Office (867-7000, 24 hours). If the spill could reach the sanitary sewer call Metro (684-2325).

- For larger spills, use the services of a private cleanup firm such as:

CHEMPRO
2203 Airport Way S
Seattle, WA 98134
1-800-228-7872

Global Diving and Salvage
2763 — 13th Ave. SW
Harbor Island
Seattle, WA 98134
623-0621

North American Environmental, Inc.
2432 E 11th St.
Tacoma, WA 98421
272-9988 (primarily PCB's)

Sol-Pro, Inc.
3401 Lincoln Rd.
Tacoma, WA 98421
627-4822

- Dispose of cleanup materials. Cleaning products used to absorb a hazardous waste (such as vermiculite used to soak up spilled degreasers) must be treated as hazardous waste. These hazardous-waste-soaked materials can not be put in the garbage. Instead, bag them or place them in a drum, label the container, and have them transported to a site authorized by the federal government.

- Oil is not generally considered hazardous unless it contains a high concentration of metals. For small oil spills, the absorber can be placed inside a sealed container — sealed plastic bags are fine — and put into the garbage can or dumpster.

BMP #7
Dispose of Wastes Properly

Who: All businesses and employees need to know how to properly dispose of waste.

Why: Proper disposal of wastes is extremely important to avoid both environmental and legal problems.

Businesses are financially and legally responsible for their waste disposal even if the waste is handled by a waste contractor. Improper disposal practices can lead to environmental contamination and the business risks losing the ability to get bank loans, to obtain or keep business insurance, and to sell the business or property; for some it can lead to a jail sentence. Recently, in Tacoma, the Hidden Valley Landfill was identified as a Superfund site;

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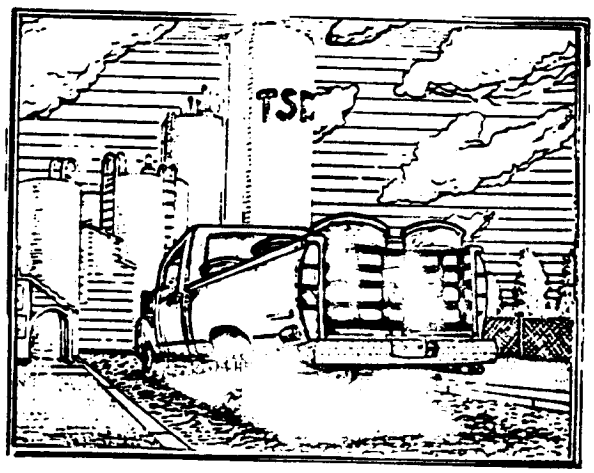
businesses who disposed of wastes there may have to pay a portion of the $24 million for cleanup.

According to Washington State law, "The owner, operator, or occupant of any premise, business establishment, or industry shall be responsible for the satisfactory and legal arrangement for the solid waste handling of all solid waste accumulated by them on the property" (WAC 173-302-190). Though the business owner has ultimate responsibility for the proper disposal of hazardous and solid waste, the employee is also legally liable. In fact, any person who violates the law by improperly disposing of hazardous waste or any person who knowingly aids another is guilty and could be fined or jailed for each separate violation. In case of a continuing violation, every day's violation is considered a separate and distinct offense (RCW 70.105.080-090).



Hazardous wastes need to be delivered to an approved TSD facility.

How: Proper waste disposal depends on both the properties and the amount of the waste. To dispose of waste, identify if it is hazardous, estimate the amount in pounds, determine the disposal method, and if necessary, contact a hazardous waste service. These steps are further explained below:

Identify whether your waste is considered hazardous. A hazardous waste is a solid or liquid material with certain properties that could pose dangers to human health, property, or the environment (see Appendix B4). Possible hazardous wastes often associated with automobile-related businesses include:

- paints, thinners, solvents, cleaning fluids, or coolants
- petroleum products or used oil contaminated with heavy metals
- used gasoline or other flammable materials
- rags saturated with gasoline or other hazardous materials

Other materials that burn or itch on contact with skin, that dissolve metals, wood, paper, or clothing, or that bubble or fume upon contact with water are also probably hazardous. Check shipping papers, labels, or material safety data sheets (MSDSs) which indicate if a product is hazardous. If you do not know whether a product or waste is hazardous, assume it is until you find out otherwise.

If wastes are hazardous, estimate the amount. Determine whether there is less than 220 pounds generated per month and whether there is less than 220 pounds accumulated at any time. This is approximately half of a 55-gallon drum. Businesses that generate more than this have different disposal requirements than those who generate less.

Stay under 220 pounds of hazardous waste produced per month and collected at your business site at any one time, and you will be considered a small-quantity generator (SQG). By state law, if you are a small-quantity generator you must identify your hazardous wastes and understand the required precautions necessary for handling and disposing of them. You must also dispose or recycle your wastes through a recycling firm, an approved landfill (the closest are in Idaho and Oregon), or send it to a treatment, storage, and disposal facility (TSD). King County Solid Waste Division is planning to operate a mobile hazardous

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waste collection facility for small quantity generators starting sometime in 1991.

Accumulate 220 pounds — or more — of hazardous waste and you lose your small-quantity generator status. You must have the waste removed by a reliable hazardous waste service within 180 days. In addition, you must get a U.S. Environmental Protection Agency identification number from the Washington State Department of Ecology and follow additional reporting requirements. Refer to Appendix B4 for more information on the Department of Ecology regulations or call the Department at 867-7000.

Determine the best disposal method. Recycling or finding someone who can use the waste are preferred to disposal. Here are some suggested disposal methods for a variety of materials:

- **Oil Paints** (may be flammable and poisonous): Excess paint should be left with the property owner for touch-ups. Small amounts of excess paints (less than a quart) can be painted onto boards or left in cans, allowed to dry, and then thrown into covered dumpsters. Allow paint thinners to settle, then strain and re-use the liquid. Leftover paint thinner must go to a treatment, storage, and disposal facility.

- **Used Oils** such as hydraulic, gear, and engine (flammable and poisonous): Recycle oils. Do not dispose or spill on the ground (including as a dust suppressant); this is against the law. Never place used oil in a dumpster or pour down a storm drain.

- **Brake Fluid** (poisonous): Brake fluid must be disposed of through a TSD.

- **Tires** (produce poisonous leachate): King County landfills will accept four tires per load. Recycling is the best option. Check the recycling section.

- **Petroleum Products** such as gasoline, diesel, or kerosene (flammable): Petroleum products must be disposed of through a TSD.

- **Degreasers** such as solvents, mineral spirits, and paint thinners (may be flammable): Small parts can be cleaned with solvents which are distilled, re-used, or recycled. Allow paint thinners to settle, then strain and re-use the liquid. When the solvent can no longer be re-used, dispose of it through a TSD.

- **Batteries** (corrosive and poisonous): Recycle, do not dispose of. Within Washington State, no person may knowingly dispose of a vehicle battery except by delivery to: a person or entity selling lead acid batteries, a person or entity authorized by the Department of Ecology to accept the battery, or to a secondary lead smelter.

If necessary, use a reliable treatment, storage, and disposal facility. To do so, locate several, check up on them, interview them, and arrange for your wastes to be transported to the one you select. Keep copies of all your transactions. These steps are further explained below:

- Locate a TSD. There are a number of private treatment, storage, and disposal companies that operate in this area. The following is a partial list to help you get started; listing does not constitute a recommendation.

CHEMPRO
2203 Airport Way S
Suite 400
Seattle, WA 98155
1-800-228-7872

Northwest EnviroService, Inc.
1500 Airport Way S
Seattle, WA 98134
622-1090

Chem-Security
10602 NE 38th Place
Kirkland, WA 98033
827-0711

- Check up on the TSD. All waste should be delivered to a site authorized by the federal or state government. Call the Hazardous Substances Information Hotline, 1-800-633-7585, to find out if a TSD has an EPA identification number or has been cited for past violations. They can also give you a list of vendors who can transport your waste.

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- Interview the TSD. Your business is responsible for what a TSD does with your waste. Ask the company for references and check them. Also ask if the company is properly insured, how it disposes of the wastes, how employees are trained, and if the company will reduce or recycle your waste before disposal. Depending on the waste, a TSD may treat it to make it less hazardous, incinerate it, or dispose of it at an authorized site.

- Arrange to transport your wastes. Large-quantity generators must have an authorized TSD transport their wastes, but small-quantity generators can choose to transport wastes themselves. The TSDs in the area operate differently in terms of services and costs. For example, as of June 1990, Chemical Processors (CHEMPRO) will only accept hazardous wastes from SQGs the last Tuesday of every month and requires little paperwork. Northwest Enviroservice, Inc. will accept it daily, but requires more paperwork. Both companies will come and pick up your wastes for $55-$77 per hour. They are willing to coordinate and combine loads, so businesses who generate small amounts of waste can develop a neighborhood "milk-run" route and share the transportation costs. This is a money-saving option for companies that generate small amounts of hazardous waste.

Get help if necessary. There are a number of organizations that can help you to determine if a substance is hazardous or how you should dispose of a material. Some of these numbers are:

Metro's Hazardous Waste Section 684-2300
Department of Ecology Hotline.....1-800-633-7585
King County Hazards Information 296-4692

If it is after business hours place the substance in a sealed container, label it, and store it in a safe place where no one can touch it.

BMP #8
Minimize Wastes

Who: All businesses and employees should look for ways to reduce waste.

Why: Like proper disposal, minimizing waste reduces the chance of associated pollutants entering the City's drainage system. Minimizing waste results in the greatest environmental benefits and is Washington State's top solid waste management priority. By reducing waste you can save the costs and regulatory process associated with proper disposal.

How: Wastes can be minimized through good housekeeping (for example, keeping products labeled and free of contaminants), separating different wastes, substituting non-hazardous materials for hazardous ones, and maintaining products. Reducing waste reduces potential sources of pollutants to the drainage system and also preserves natural resources.

Automotive businesses and employees can reduce waste in a number of ways. For example:

Use solvents more than once. Solvents such as MEK, methylene chloride, and trichloroethylene can be used more than once. Filter out the solids or let them settle before re-use. When solvents become too dirty to be used again, contact a hazardous waste treatment storage and disposal facility.

Buy the least toxic products available. Look for "non-toxic" on the label. Do not let the term "biodegradable" mislead you. Products labeled with these terms are not necessarily safe for the environment, particularly after they are used. For example, a "biodegradable" degreaser can become a hazardous waste after it is mixed with oil and solvent.

To substitute less hazardous materials and activities for more hazardous ones:

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- Rather than detergents, use hot water/steam-cleaning methods for washing oil off metal parts such as engines, tools, and equipment.
- Use non-solvent cleaners.
- Use water-based materials rather than petroleum-based.
- Use non-chlorinated compounds, instead of chlorinated compounds; non-chlorinated compounds are less toxic and less expensive to dispose of.
- Use waterless hand cleaners.

Buy only what you need. Purchase products in amounts that can be used completely and maintain a good inventory control system to prevent unnecessary purchases. Consider waste management costs before buying new materials and equipment.

Use only what is needed. Twice as much does not mean twice the results. Follow the directions.

Purchase products that last longer (for example, good quality rather than poor quality tires) and recommend them for your customers.

See if others can use your waste. Use the services of the Industrial Materials Exchange (see the recycling section).

BMP #9
Recycle Wastes

Who: Any business or employee producing or handling waste — such as oil, tires, and batteries — should recycle whenever possible.

Why: Both recycling and proper disposal reduce the risk of wastes entering the City's drainage system. But recycling is preferred to disposal because of the overall environmental benefits. For example, recycling produces one gallon of oil for each gallon of used oil. On the other hand, to produce 2.5 quarts of new motor oil, 42 gallons of high quality crude oil must be "cracked."

Recycling is second to minimizing waste in the State of Washington's priorities for solid waste management. The State has a goal to achieve a fifty percent recycling rate by 1995. Bellevue's goal is a 65 percent reduction in the waste stream by 2000.

How: Ways to make recycling work are outlined below:

Purchase recycled products. By doing so, you help ensure a use for the recyclable materials that people collect and turn in.

Separate wastes. Keep your wastes in separate containers according to the type of product and keep records of container contents (keep materials in the original container if possible). Do not mix oil, degreasers, solvents, antifreeze, or brake fluid. Combining different types of waste can prevent recycling and greatly increase disposal costs. For example, uncontaminated waste oil can be recycled, whereas waste oil mixed with solvents requires a much more complicated and expensive disposal process.

Avoid phenol. Avoid using products containing phenol compounds because they are more costly to recycle. You can find out which products you use that contain phenol compounds by asking your vendors.

Keep receipts. For documentation purposes, always keep receipts from the recycler showing the amount and specific types of wastes recycled.

Recycle what you can. Many materials are recyclable, and some private firms will pay you to let them pick up and recycle your wastes. Call recycling companies for details. Information on recycling specific items is included below (the list of private recycling agencies may not be complete and does not constitute a recommendation):

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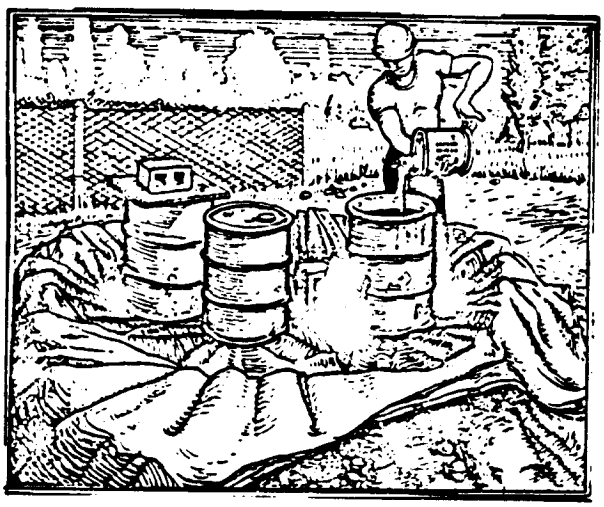

Recycle used oil; don't throw it away.

- **Used Antifreeze:**

CHEMPRO
2203 Airport Way S.
Seattle, WA 98134
223-0500
or, 1-800-228-7872

Spencer Environmental Svcs.
P.O. Box 84062
Seattle, WA 98124
467-7988

Lilyblad Petroleum Inc.
P.O. Box 1381
Tacoma, WA 98401
467-7988

Antifreeze Environmental Service
4500 A 15th St. SE
Tacoma, WA 98424
483-9197 (pickup only)

American Antifreeze
2100 146th St.
Lynnwood, WA 98036
775-9755

- **Concrete and Asphalt:**

Pacific Topsoil
14002 35th Ave. SE
Bothell, WA
486-3201

Renton Concrete Recycling
14001 68th Ave. S
Renton, WA
772-2278

Stoneway Rock and Recycling
6808 S 140th
Renton, WA 98055
226-1000

Maltby Sand and Gravel
1627 Filbert Rd. SE
Bothell, WA 98012
481-9101

- **Used Tires:**

First Tire & Wheel
10419 NE 4th
Bellevue, WA
454-9552

Rubber Granulators
12701 Mukilteo Speedway
Everett, WA
353-8040

KACA Corporation
17003 Veil Loop Rd.
Rainier, WA 98576
446-2343

PC Casing
21838 84th Ave. S
Kent, WA 98032
872-2255

Schuyler Rubber Company
1690 Woodinville-Redmond Rd.
Woodinville, WA 98072
488-2255

- **Batteries:** Washington State law requires that sellers (both wholesalers and retailers) of batteries to accept used batteries, if offered by the purchaser. Battery recyclers include the following:

Eastside Disposal
969 118th SE
Bellevue, WA
682-9730

Allied Batteries
1031 — 6th Ave. S
Seattle, WA 98409
624-4141

Standard Battery
5200 — 4th Ave. S
Seattle, WA 98108
763-1225
(or phone 841-3664 for other locations)

Western Batteries
1127 NW 54th St.
Seattle, WA 98107
784-8111

Mercer Is. Recycling
7677 SE 32nd
Mercer Is., WA 98040
236-3334

- **Metal:** Metal chips and scraps can be recycled even if they are mixed with oil. To recycle, separate cutting oils from the metal as much as possible. Store the scraps in sealed, covered containers. Maintain current material safety data sheets for the oils, since the recycler may need to know the type of oil.

CHEMPRO
2203 Airport Way S
Seattle, WA 98134
223-0500
or, 1-800-228-7872

Arrow Metals Corp.
6014 237th Place SE
Woodinville, WA 98072
481-1828

Kirkland Recycling
514 R Central Way
Kirkland, WA 98033
828-7592

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- Oil: Whenever possible, recycle hydraulic, gear, and engine oils. Oil can be re-refined because it never loses its lubricating properties; it merely becomes contaminated and the contaminants can be removed in the refining process.

  Recycle small amounts of motor oil at one of the collection centers in the City of Bellevue. To find the one nearest you, call the City of Bellevue (637-5217) or call 1-800-RECYCLE.

  For larger amounts of oil, contact one of these waste oil recyclers:

  Spencer Environmental Svcs.
  P.O. Box 84062
  Seattle, WA 98124
  467-7988

  Petro Pacific Corp.
  17223 — 8th Ave. N
  Seattle, WA 98109
  282-2823

  Amalgamated Services, Inc.
  21318 — 103rd Place SE
  Kent, WA 98031
  854-6643

  CHEMPRO
  2203 Airport Way S
  Seattle, WA 98134
  223-0500
  or, 1-800-228-7872

  Safety Kleen
  6303 212th SW
  Lynnwood, WA 98036
  775-7030

  Northwest EnviroService, Inc.
  1500 Airport Way S
  Seattle, WA 98134
  622-1090

  Petroleum Reclaiming Bus.
  3003 Taylor Way
  Tacoma, WA 98421
  383-4474

  Fuel Processors
  744 S Marsh Pt. Rd
  Anacortes, WA 98221
  225-6571

- Solvents: Solvents can be recycled on- or off-site. You can contract with a solvent tank maintenance service who will remove and replace your solvent regularly. Or your solvents can be sent off-site to be recycled and 70-80 percent returned. You can also purchase a commercial solvent recovery unit; the smallest unit available handles five gallons. Most recovery systems pay for themselves in less than two years.

  The following recyclers accept either degreasing agents or paint solvents:

  CHEMPRO
  2203 Airport Way S
  Seattle, WA 98134
  1-800-228-7872

  Northwest EnviroService
  1500 Airport Way S
  Seattle, WA 98134
  622-1090

  Sol-Pro, Inc.
  3401 Lincoln
  Tacoma, WA 98421
  627-4822

- **Paper:**

  Data Destruction
  P.O. Box 2265
  Kirkland, WA 98083
  828-4769

  Kirkland Recycling
  514 Central Way
  Kirkland, WA 98033
  828-2592

  Fibres International, Inc.
  1533 120th Ave. NE
  Bellevue, WA
  455-9811

- **Pallets:**

  Rainier Pallet
  4402 "B" Street NW
  Auburn, WA 98002
  872-8453

  Pete Edgar
  2932 224th Pl. SE
  Issaquah, WA
  392-5280

  Redmoor Resource Recovery
  6200 E Lake Sammamish Parkway SE
  Issaquah
  885-9416

- Other Materials: To recycle materials not listed here, call the Industrial Materials Exchange (IMEX) at 296-4899. IMEX, sponsored by the Seattle-King County Department of Public Health, is an information network that helps businesses find inexpensive sources or markets for hazardous or non-hazardous materials. IMEX publishes a directory six times a year listing available and wanted materials. It is distributed in the western United States, Alaska, Canada, and Pacific Rim Countries. Companies that supply materials save disposal costs, and the companies that use the wastes get the product free or at a reduced rate.

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BMP #10
Preserve/Enhance Streams and Adjacent Vegetation

Who: Any business located by a stream should be aware of City of Bellevue codes requiring stream protection. In addition, stream-side businesses can take steps to improve or restore the stream if it is now degraded.

Why: Preserving and enhancing stream corridors helps aquatic and terrestrial wildlife, helps buffer the stream from the effects of development, and preserves important natural resources for our children. Preserving stream corridors is also required by City of Bellevue codes.

How: Protecting and improving the stream corridor are discussed separately below:

Protect streams. Stream protection is required by City of Bellevue codes. In addition, many properties developed since 1984 have native growth protection easements along the stream. Bellevue codes define streams and the adjacent land — called riparian corridors — as Type A, B, or C depending on their significance. To find out if a stream or drainage ditch near your property is considered a Type A, B, or C riparian corridor call the City of Bellevue Permit Center at 462-2034 and ask for the Storm and Surface Water Utility representative.

New development or vegetation clearing is generally prohibited within Type A and B riparian corridors, which extend 50 and 25 feet respectively from each stream bank. No clearing is allowed within the corridor boundaries unless permitted by a clearing and grading permit. New structures must



Vegetation planted along streams helps protect water quality and prevent erosion.

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be set back an additional distance from the corridor boundaries. (Some Type A riparian corridors have a floodplain which extends beyond the riparian corridor and must also be protected.)

Type C riparian corridors are less protected and extend just to the top of the bank if the channel is open and to the sides of the pipe if its piped. (See Section 20.25H of the Bellevue *Land Use Code* and the *Clearing and Grading Code* for more information on riparian corridor regulations.)

Consider improving the stream corridor. First, you must first determine if the stream corridor is degraded. The stream is considered degraded if it does not provide optimum water quality or habitat — for example, if:

- the banks are eroding
- the banks have grass only or one or a very few native plants
- the banks have been artificially channeled
- the stream has been piped in places

You can help solve the first two problems listed above by planting native vegetation. Consult the *Streamside Revegetation Enhancement Criteria*, prepared by the Storm and Surface Water Utility in March, 1989. (Call 451-4476 or stop at the Permit Center for a copy). If you follow those criteria the City will waive the fee for the clearing and grading permit which is required for any work near streams, including enhancement. (If you work below the high water line, plan to fill or excavate, or are located in the City's shoreline district, you need additional permits; call the Permit Center at 462-2034 for more information.)

You can minimize costs of revegetation by planting with cuttings. For more information on the use of cuttings, call the Storm and Surface Water Utility at 451-4476 and ask for a copy of their *Bioengineering Construction Techniques*, March 1989.

If you want to do more than plant vegetation — for example, turn a straight channel into a natural meandering one — then it's best to hire a firm specializing in stream rehabilitation.

BMP #11
Educate Employees and Customers

Who: All employees need to know how and why to keep pollutants out of the water. Businesses can also raise customers' awareness of what the business is doing to preserve water quality and how they can help (for example, by fixing their car oil leaks).

Why: Many of the steps to prevent pollution are operational and need to be followed on a daily basis. Therefore, employee education is key. Showing customers what is being done to protect the water is good public relations; getting customers to take action (such as fixing an oil leak) can be good for business as well as the environment. Finally, preventing pollution is much cheaper than pollution cleanup.

How: Educational opportunities for automotive businesses include:

Participate in workshops, courses, and knowledge transfer. For example:

- Attend the Business Partners for Clean Water workshops (scheduled for 1990 and 1991).
- Conduct annual water quality training sessions for all employees.
- Include water quality training in new-employee orientations and in written procedures.
- Provide educational materials to customers, for example listing motor oil collection centers and stressing the importance of fixing car oil leaks.
- Explain BMPs to peer businesses.

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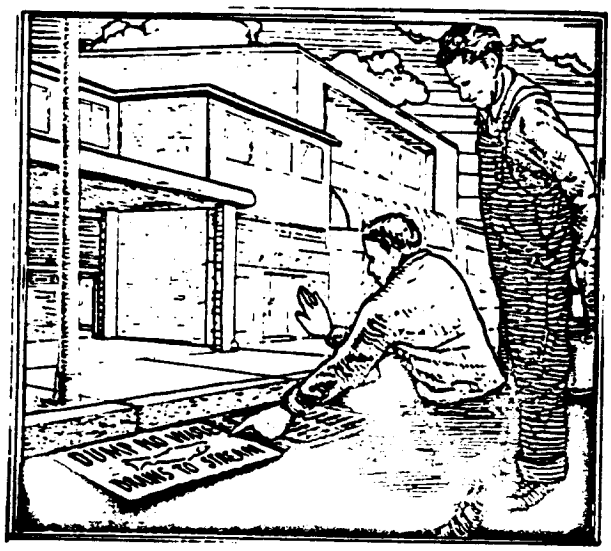

Employees can educate each other to help protect water quality.

Post signs and posters. For example:

- Stencil storm drains at workplace and construction sites. (The City of Bellevue provides stencils which say "Dump No Waste, Drains to Stream.")
- Post BMPs for employees and customers.
- Post the spill control plan.

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Section 5
Water Quality Self-Assessment and Action Program

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5 Water Quality Self-Assessment and Action Program

STEPS:
1. Complete the following assessment to evaluate current work practices that affect water quality and identify areas of needed improvement.
2. Use the results of this assessment to develop a business action program for using water quality best management practices at your business/work place.
3. Submit your action program to the City of Bellevue Storm and Surface Water Utility to qualify as a recognized Business Partner for Clean Water.

The assessment is designed to be completed by either business owners or employees. However, the action program will require the agreement of the owner/manager.

WATER QUALITY SELF-ASSESSMENT

A. Background Information

Name of Business: _____

Type of Business: _____

Name and job title of person completing this checklist:

_____

Date: _____

Number of employees: _____

Watershed in which the business is located (see the map of Bellevue watersheds in Section 2):

_____

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B. Drainage Patterns (BMP # 1, 2, 3)

Identify the locations of the storm drains which receive runoff from your property: _____

_____

_____

1. Is runoff from the site treated with an oil/water separator? (BMP #3)
   Yes_____ No_____

2. Is the fueling area covered and designed to drain to the sanitary sewer? (BMP #2)
   Yes_____ No_____ Not applicable_____

	always	sometimes	seldom/never	not applicable
3. The oil/water separator is cleaned as necessary. (BMP #3)	☐	☐	☐	☐
4. Washing vehicles or parts by any method with water is done in a properly designed designated area. (BMP #1)	☐	☐	☐	☐

If you answered yes to questions 1 and 2 (if #2 applies) and "always" to questions 3 and 4, that's great. If not, what changes are needed?

_____

_____

_____

_____

_____

C. General Housekeeping (BMP #4, 5, 6)

1. Surfaces which drain to the storm drainage system are swept clean and sweepings properly disposed. (BMP #4)	☐	☐	☐	☐
2. When sanding, grinding, or blasting, a tarp is used to cover the ground and catch chips and metal shavings. (BMP #4)	☐	☐	☐	☐
3. All wastes are cleaned up, such as remaining paint chips, dust, and sandings. (BMP #4)	☐	☐	☐	☐
4. When used cars or engines are saved for parts, they are drained of fluids and the fluids properly disposed. (BMP #4)	☐	☐	☐	☐
5. The catch basin is routinely inspected and cleaned when needed. (BMP #4)	☐	☐	☐	☐

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	always	sometimes	seldom/never	not applicable
6. Dumpsters, waste materials, and other containers and products from which pollutants can leak or be washed out are kept covered. (BMP #5)	☐	☐	☐	☐
7. The workplace is organized and materials are handled carefully to prevent spills. (BMP #6)	☐	☐	☐	☐
8. For each potentially harmful liquid which could spill (such as gasoline and oil) there is a spill control plan. (BMP #6)	☐	☐	☐	☐

If you answered "always" to all the preceding questions which apply, keep up a great job. If not, what changes are needed?

_____

_____

_____

D. Waste Management (BMP #7, 8 AND 9)

List the kinds of waste that your business produces (such as used antifreeze, used oil, solvents, and paint) and indicate whether or not it is hazardous and whether or not you recycle it. (See BMP #7 regarding hazardous waste.)

Waste	Check If Hazardous	Check If Recycled
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

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1. Does your business produce more than 220 pounds of hazardous waste per month or at any one time?

   No_____

   Yes_____ If yes, the business is considered a large quantity generator and must have an ID. number from the Washington State Department of Ecology. (BMP #7)

	always	sometimes	seldom/never	not applicable
2. Hazardous wastes that are not recycled are disposed through a treatment, storage, or disposal facility. (BMP #7)	☐	☐	☐	☐
3. Non-hazardous wastes that are not recycled are properly disposed. (BMP #7)	☐	☐	☐	☐

If you did not answer "always" to the preceding questions (if they apply), then what do you need to do to correct the situation?

_____

_____

_____

You can do more to protect the environment by recycling and cutting back on waste whenever possible. Consider the following:

What additional wastes could be recycled? Recyclable materials include used antifreeze, tires, batteries, metals, oils, solvents, paper, pallets, and more. (See BMP #9.)

_____

_____

_____

How could you reduce the amount of your waste? (See BMP #8 for ideas.)

_____

_____

_____

Could you reduce the toxicity of any of your waste by using less toxic materials? If yes, what materials could be substituted?

_____

_____

_____

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If you don't already, could you collect used oil or other automotive wastes from customers for recycling? _____

_____

_____

_____

E. Being Located near a Stream (BMP #10)

Complete this section if your business office/storage yard is within 70 feet of a stream.

What is the name of the stream?

_____

Assuming the stream is in Bellevue, check whether it is a Type A, B, or C (see BMP #10).

Type A_____ Type B_____ Type C_____

(Most of Bellevue's major streams — such as Kelsey Creek, Richards Creek, and Coal Creek — are Type A. To find out the stream type, call the City of Bellevue Permit Center at 462-2034 and ask for the Storm Surface Water Utility representative.)

	always	sometimes	seldom/never	not applicable
The applicable City of Bellevue regulations governing new development and clearing in riparian corridors are followed.	☐	☐	☐	☐

Is the stream corridor now degraded? Yes_____ No_____

For example:

- Are the banks eroding? Yes_____ No_____
- Is the adjacent vegetation just grass or limited to one or two species? Yes_____ No_____

If the stream corridor is on the business property and is now degraded, how could it be enhanced? (See BMP #11.)

_____

_____

_____

_____

_____

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F. Education (BMP #11)

	always	sometimes	seldom/never	not applicable
1. New employees are trained in how their jobs can affect water quality and in the best management practices.	☐	☐	☐	☐
2. Employees attend workshops or have other continuing training in water quality.	☐	☐	☐	☐
3. Nearby storm drains are stenciled "Dump No Waste, Drains to Stream."	☐	☐	☐	☐
4. The spill control plan or other BMP's are posted.	☐	☐	☐	☐
5. The business publicizes its best management practices or suggests ways that customers can help protect water quality.	☐	☐	☐	☐

If you answered "never" or "seldom" to any of the above questions, then there are more ways the business can help raise employee and community understanding about protecting water quality. What else might you do?

_____

_____

_____

G. Other

Identify any of your business activities which could pollute the water even if all applicable practices outlined in this assessment were followed:

_____

_____

_____

What steps would prevent pollution from those activities? (If unsure, ask for help at the workshop, or call 451-4476.)

_____

_____

_____

_____

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H. For Employees Only

What water quality best management practices apply to your job?_____

- ☐ BMP #1 *Designate Vehicle Wash Area*
- ☐ BMP #2 *Cover and Drain Fueling Area*
- ☐ BMP #3 *Treat Runoff with Oil/Water Separator*
- ☐ BMP #4 *Keep Workplace Clean and Maintain Catch Basins*
- ☐ BMP #5 *Cover Containers and Materials*
- ☐ BMP #6 *Prepare for and Clean up Spills*
- ☐ BMP #7 *Dispose of Wastes Properly*
- ☐ BMP #8 *Minimize Wastes*
- ☐ BMP #9 *Recycle Wastes*
- ☐ BMP #10 *Preserve/Enhance Streams and Adjacent Vegetation*
- ☐ BMP #11 *Educate Employees and Customers*

Based on this assessment, what changes can you make in carrying out your job to better protect water quality?

_____

_____

_____

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I. Scoring the Assessment

If you'd like to score the assessment:

1. a. Add up all the questions to which you answered either "always," "sometimes," or "seldom/never." (Maximum possible: 18 if all the questions apply to your business).
   Total _____

   b. Multiply that by 5:
   (total answered) x 5 = _____

2. a. Add up all the questions which you answered "always."
   Total number of "always": _____

   b. Multiply that by 5:
   total number of "always" x 5 = _____

3. a. Add up all the questions which you answered "sometimes."
   Total number of "sometimes": _____

   b. Multiply that by 3:
   total number of "sometimes" x 3 = _____

4. You don't need to add up the number of "seldom or never." You don't get any points for those.

5. Add your answer to 2b and 3b and divide by your answer to 1b.

If your answer is 0.8 or greater, then good for you. You're definitely taking steps to protect the water. Spread the word to your peers.

If your answer is between 0.5 and 0.8, then you're doing some things right but there's more to be done. Emphasize the areas of needed improvement in your action program.

If your answer is below 0.5, then congratulations on taking this first step and evaluating your current practices. But you need to change those practices to better protect our water.

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WATER QUALITY ACTION PROGRAM

Provide a brief description of the activities conducted by your business that could affect water quality (for example fueling, automotive repair, vehicle washing).

For each of the headings below, review the corresponding section in the self assessment and list the best management practices that apply to your business but are not currently followed. Identify when and by whom they will be started and how they will be maintained.

Example

Existing BMPs			How Maintained
Keep dumpster lid closed and check for leaks.			Posted at dumpster and reminded at meetings.
BMP to Be Implemented	**When to Initiate**	**By Whom**	**How Maintained**
Install an oil/water separator.	By 1993	Shop manager to oversee	Company hired to clean at least twice a year.

Drainage Patterns

Existing BMPs			How Maintained
BMP to Be Implemented	**When to Initiate**	**By Whom**	**How Maintained**

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General Housekeeping

Existing BMPs			How Maintained
BMP to Be Implemented	**When to Initiate**	**By Whom**	**How Maintained**

Waste Management

Existing BMPs			How Maintained
BMP to Be Implemented	**When to Initiate**	**By Whom**	**How Maintained**

Being Located near a Stream

Existing BMPs			How Maintained
BMP to Be Implemented	**When to Initiate**	**By Whom**	**How Maintained**

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Education

Existing BMPs			How Maintained
BMP to Be Implemented	**When to Initiate**	**By Whom**	**How Maintained**

Other

Existing BMPs			How Maintained
BMP to Be Implemented	**When to Initiate**	**By Whom**	**How Maintained**

If the business would like to be recognized as a Business Partner for Clean Water, complete the following information and send the action program to the City of Bellevue. In addition, a copy of your completed self-assessment would be helpful but is not required.

Business Name _____
Address _____
_____
Telephone _____
Name and Title of person preparing the action program _____
Business Owner or Owner Representative _____
Date _____
Mail to:

City of Bellevue
Storm and Surface Water Utility
Business Partners for Clean Water
P.O. Box 90012
Bellevue, Washington 98009-9012

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Appendix A
Resources

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A Resources

This appendix contains resources for the following:

A1 — Reporting Problems A-1
A2 — Contacting Agencies for Help A-3
A3 — Helpful Reference Materials A-6

A1 — REPORTING PROBLEMS

When you detect a problem in the stream or stream corridor, note the location, time of day, and other pertinent information and call the appropriate agency immediately. Please call the SSWU first at 455-7846 (24 hrs.) if the problem is in Bellevue, and the situation will be handled or referred to the appropriate agency. Inform the agency whether you have a crisis or non-crisis situation, and leave your name and phone number in case information needs to be verified.

Water quality trouble calls are divided into two categories: crisis and non-crisis. Examples of these calls are:

Crisis	Non-Crisis
fish and wildlife kills	dirty or turbid water
oil spills	minor erosion/sedimentation
hazardous chemical spills	algae blooms
sewage overflows	debris/litter problems
extreme erosion/sedimentation or flooding	animal waste
	request for information

The following is a list of potential types of crisis trouble calls and the appropriate agencies to notify. The agency contacts are listed in the order of importance for Bellevue problems.

Fish and Wildlife Kills

Contact: City of Bellevue Storm & Surface Water Utility ..... (24-hour number) 455-7846
Washington State Department of Ecology ..... (24-hour number) 867-7000

Information to give to agencies:
- location
- time of day observed
- duration
- number of fish or wildlife involved in kill
- any obvious cause of the kill

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Oil Spills

Contact:
City of Bellevue Storm & Surface Water Utility ..... (24-hour number) 455-7846
Washington State Department of Ecology (freshwater or saltwater) . (24-hour number) 867-7000
U.S. Coast Guard (saltwater only) ..... (24-hour number) 1-800-424-8802

Information to give agencies:
- specific location: address, cross streets, or noticeable landmarks; if body of water involved, which one
- description of spill (heavy tar, colored sheen, etc.)
- approximate size or volume of spill
- vehicle, vessel(s), or probable sources
- time and frequency of spill

Hazardous Chemical Spills

Contact:
911 911
City of Bellevue Storm & Surface Water Utility ..... (24-hour number) 455-7846
Washington State Department of Ecology ..... (24-hour number) 867-7000
Metro — Water Quality Lab ..... (days) 684-2346
— Treatment Plant ..... (nights) 684-1801
*Stay clear of area — area should be blocked off from public. If possible, another person should stay nearby to make sure area stays clear.

Information to give to agencies:
- the body of water, if appropriate
- description including odor
- specific location
- probable source

Sewage Overflows

Contact:
*If risk to human health, immediately notify Seattle-King County Health Department . 587-4632
City of Bellevue — Public Works Maintenance Division ..... (days) 455-7840
— Storm & Surface Water Utility ..... (nights; 24-hour number) 455-7846
Metro Renton Treatment Plant ..... (24-hour number) 226-3680
Washington State Department of Ecology ..... (24-hour number) 867-7000

Information to give to agencies:
- location

Erosion or Flooding

Contact:
City of Bellevue Storm & Surface Water Utility ..... (24-hour number) 455-7846
For erosion — Washington Conservation District 226-4867
For flooding — King County Public Works (if in unincorporated King County) 1-800-527-6237
or 296-8100
Washington State Department of Ecology ..... (24-hour number) 867-7000

Information to give to agencies:
- location and/or landmarks near problem area

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A2 — CONTACTING AGENCIES FOR HELP

Flammable Materials

City of Bellevue, Fire Protection Bureau, Fire Education Coordinator 587-3292
The Fire Protection Bureau enforces and provides information on the storage and handling of flammable, ignitable, and reactive materials.

Hazardous Products and Hazardous Waste

Seattle-King County, Department of Public Health 296-4692
The Hazard line provides information on the disposal of hazardous wastes and alternatives to hazardous products.

State of Washington, Department of Community Development 753-5255
or 1-800-526-6108
SARA: Emergency Planning and Community Right-to-Know Hotline 1-800-535-0202
RCRA and CERCLA 1-800-424-9346
These sources have information on RCRA, CERCLA (Superfund), and SARA regulations.

State of Washington, Department of Ecology, Hazardous Waste Program 1-800-633-7585
This hotline provides access to hazardous substance information.

State of Washington, Department of Labor and Industry — General 281-5447
— Safety and Health 1-800-423-7233
Call for information on the Hazard Communication Standard, Worker Right-To-Know law.

State of Washington, Department of Ecology, Northwest Regional Office 867-7000
This office enforces state regulations concerning hazardous waste.

U.S. Environmental Protection Agency, Chemical Emergency Preparedness Program 1-800-423-7233
Call for information regarding Title III, Emergency Planning, and Community Right-To-Know laws.

U.S. Environmental Protection Agency, Waste Management Branch 442-2777
or 1-800-368-5888
Call for technical information about federal environmental regulations that affect small businesses.

RCRA/Superfund Hotline 1-800-424-9346
This hotline answers general questions regarding the regulation of hazardous wastes under RCRA, CERCLA, and SARA. Answers are not legally binding and cannot be considered "official— agency policy; they are helpful in interpreting the regulations.

Other Wastes

Seattle-King County, Department of Public Health 296-4692
This agency provides specifications to ensure the integrity of containers.

King County, Solid Waste Division, Department of Public Works 296-6542
Call for information on what can be disposed at area landfills.

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Washington Toxics Coalition **632-1545**
The Washington Toxics Coalition provides information on alternative products and proper use.

Sanitary Sewer System

City of Bellevue, Water and Sewer Utilities **453-2977**
or Permit Center **462-2034**
The Sewer Utility regulates discharges into the sewer system.

Municipality of Metropolitan Seattle (Metro), Industrial Waste Section **684-2325**
Metro regulates industrial discharge into the Metro sewer system.

State of Washington, Department of Ecology **867-7000**
Call for information regarding National Pollutant Discharge Elimination System (NPDES) permits.

State of Washington, Department of Health **464-7672**
This agency disperses information on public sewage related health issues and performs inspections of wells and surface water.

Storm Water Management

City of Bellevue, Storm and Surface Water Utility (SSWU) **451-4476**
or ..... **(24-hour number) 455-7846**
or Permit Center **462-2034**
The SSWU manages the storm and surface water system in Bellevue to maintain a hydrologic balance, prevent property damage, and protect water quality and aquatic wildlife habitat.

King County Public Works, Surface Water Management **296-6519**
This department manages and regulates surface water runoff (flooding, drainage, and erosion) in unincorporated King County.

King County Conservation District **226-4867**
Throughout the County the Conservation District advises on erosion control, construction-related water quality concepts, and agricultural runoff management. They have information on soils, standard erosion control practices, and seeding rates or varieties.

Waste Reduction and Recycling

City of Bellevue, Solid Waste Program **637-5217**
This is a local resource for waste reduction and recycling information.

King County Recycling Information Line **296-4466**
Call for county-wide information.

State of Washington, Department of Ecology **1-800-633-7585**
Call for information on waste reduction.

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State of Washington, Department of Ecology 1-800-RECYCLE
Call for general recycling information such as where to recycle waste oil.

Industrial Materials Exchange 296-4899
IMEX is an information network that helps businesses find inexpensive sources or markets for materials.

Water Quality

City of Bellevue, Storm and Surface Water Utility (SSWU) 451-4476
or ..... (24-hour number) 455-7846
Among other tasks, the SSWU manages and regulates water quality.

Municipality of Metropolitan Seattle (Metro), Water Pollution Control Department, Water Resources Section 684-1233
Metro monitors water quality in area lakes, streams, and portions of Puget Sound; they also provide advice and assistance on the protection of water bodies.

Puget Sound Water Quality Authority (PSWQA) 464-7320
PSWQA provides general information about Puget Sound water quality and prepares the Puget Sound Water Quality Management Plan.

State of Washington, Department of Ecology, Northwest Regional Office 867-7000
Enforces state water quality standards and groundwater protection regulations.

U.S. Environmental Protection Agency (EPA), Region 10 Headquarters Water Division 442-1014
Public Information 442-1200
Publications 442-1519
Drinking Water Programs 442-1893
Office of Water Plan 442-2116
This division provides guidance and oversight of Nonpoint Source, State Water Quality Management, and Clean Lakes Programs, and water quality standards.

Wildlife and Habitat Protection

City of Bellevue, Parks and Recreation Department 455-6885
This department provides information on wildlife enhancement, coordinates volunteers for the wildlife volunteer program, and manages parks, open spaces, and recreational areas.

City of Bellevue, Storm and Surface Water Utility, Stream Team Program 451-4476
The Stream Team program is designed to increase awareness and involve citizens in the protection and enhancement of Bellevue's streams, fish, and wildlife.

Seattle Fisheries Patrol 464-7916
or ..... (24-hour number) 455-7700
This patrol enforces fish regulations.

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State of Washington, Department of Fisheries, Habitat Management Division, Regional Office 545-6582
The Department of Fisheries manages fish (commercial fish, food fish, and shellfish) and protects stream habitat in salmon streams.

State of Washington, Department of Fisheries, Habitat Management Division, Volunteer Fisheries Resource Program 753-4490
This program coordinates volunteer efforts in fisheries enhancement projects statewide.

State of Washington, Department of Wildlife, Region Four Office 775-1311
The Department of Wildlife manages game fish and wildlife in all inland waters, and protects their habitat.

A3 — HELPFUL REFERENCE MATERIALS

Auto Repair and Body Shops (1989). Pamphlet provided by Municipality of Metropolitan Seattle (Metro).

Bellevue City Code. Chapters 23.11 (Construction Codes, Fire Code), 24.04.105 (Unauthorized Wastes), and 24.06 (Utilities Code). Available from the City of Bellevue.

Biofiltration Systems for Storm Runoff Water Quality Control (1988). Written by R. Horner for the Municipality of Metropolitan Seattle (Metro).

City of Bellevue Development Standards. Chapter Four, Storm Drainage and Streams, is especially pertinent. The standards are enforced by City of Bellevue, Storm and Surface Water Utility.

Controlling Urban Runoff — A Practical Manual for Planning and Designing Urban BMPs (1987). Written by T. R. Schuler for the Metropolitan Washington, D.C. Council of Governments.

Guide for Hazardous Waste Generators, first edition. Developed and distributed by Washington State Department of Ecology.

Hazardous Waste Disposal: A Guide for Businesses (1988). For copies contact Municipality of Metropolitan Seattle (Metro).

Local Hazardous Waste Management Plan for Seattle-King County: Final Plan and Environmental Impact Statement for the Management of Small Quantities of Hazardous Waste in the Seattle-King County Region (August, 1989). Available from King County, Solid Waste Division.

Machine Shop Facts (1989). Pamphlet available from Metro.

Metal Shop News (1989). Pamphlet available from Metro.

Oil/Water Separator Facts (1989). Pamphlet available from Metro.

Reducing Hazardous Waste: Washington Dangerous Waste Regulation and the Vehicle Maintenance Industry. Presented by ERM — Northwest, Inc. for the Washington State Department of Ecology, Office of Waste Reduction and Recycling.

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Revised Code of Washington (RCW), Chapters 70.105 (Hazardous Waste Disposal) and 70.95 (Solid Waste Management — Recovery and Recycling). Copies available from the Washington State Department of Ecology.

Stormwater Management Manual for the Puget Sound Basin, Technical Review Draft (June, 1990). Written for the Stormwater Unit of the Department of Ecology.

Stream Team Guidebook: How residential and business volunteers can protect and enhance our water quality, fish, and wildlife, Second Edition (June 1989). Prepared by City of Bellevue, Storm and Surface Water Utility.

Washington Administrative Code (WAC), Chapters 173-304 (Minimum Functional Standards for Solid Waste Handling), 173-303 (Dangerous Waste Regulations) and 173-201 (Water Quality Standards for Surface Waters of the State of Washington). Copies provided by the Department of Ecology.

Waste Reduction in Your Business, Doc. #89-56 (1990). Provided by Washington State Department of Ecology, Waste Reduction, Recycling and Litter Control Program.

Water Quality Best Management Practices Manual for Commercial and Industrial Businesses (1989). Prepared by Resource Planning Associates for the City of Seattle. As of September 1990 this document has not been adopted as regulation, but it is available from the City of Seattle Office for Long-Range Planning.

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Appendix B
Regulatory Requirements

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B Regulatory Requirements

Many of the regulatory requirements in this appendix are excerpted from the *Stormwater Management Manual for the Puget Sound Basin*, Technical Review Draft (June 1990). Because that manual is still in draft form, it is subject to revision.

This appendix contains regulatory requirements for the following:

B1 — Air Quality
(Puget Sound Air Pollution Control Agency) B-1
B2 — Discharge to Sanitary Sewers
(Metro, City of Bellevue, and Department of Ecology Regulations) B-2
B3 — Spill Cleanup
(United States Environmental Protection Agency and State Department of Ecology) B-4
B4 — Hazardous Waste
(Department of Ecology) B-4
B5 — Polluting Surface Waters
(City of Bellevue and Washington State Code) B-7
B6 — Storage of Materials
(City of Bellevue Fire Code and Seattle-King County Health Department) B-8

B1 — AIR QUALITY (PUGET SOUND AIR POLLUTION CONTROL AGENCY)

The Puget Sound region is under the jurisdiction of regional air quality authorities who in turn must function under Washington State and federal air quality regulations. The Puget Sound Air Pollution Control Agency (PSAPCA) covers Snohomish, King, and Pierce Counties. Two other regional air quality authorities cover the remaining Puget Sound counties.

Of direct interest to persons using this manual are air authority policies on fugitive dust and outside painting. All three air authorities in the Puget Sound region require that reasonable precautions be taken to prevent fugitive particulate material from becoming airborne when handling, loading, transporting, or storing particulate material. The Puget Sound Air Pollution Control Authority specifies that reasonable precautions include: the paving of parking lots and storage areas; housekeeping measures (for example, sweeping); minimization of the accumulation of mud and dust and preventing its tracking onto public roads; and stabilization of storage piles with water spray, chemical stabilizers, tarps, or enclosures.

PSAPCA requires abrasive blasting and spray painting operations to be performed inside a booth designed to capture the blast grit and overspray. Outdoor blasting or painting of structures or items too large to be handled indoors are to be enclosed with tarps.

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PSAPCA requires reasonable precautions to prevent the tracking of material onto public roads. One precaution is wheel-washing of trucks.

Source: Adapted from *Stormwater Management Manual for the Puget Sound Basin*, Technical Review Draft (June 1990), Washington State Department of Ecology.

B2 — DISCHARGE TO SANITARY SEWERS (METRO, CITY OF BELLEVUE, AND DEPARTMENT OF ECOLOGY REGULATIONS)

To discharge storm water to a public sanitary sewer one must receive the approval of the local sewer authority, such as Metro and the City of Bellevue. If the site has not yet been assigned a sewer authority, the business or public agency wishing to discharge storm water to the sanitary sewer must obtain the approval of the Pretreatment Program administrator at the regional office of the Washington State Department of Ecology (Ecology).

Metro Requirements for Discharge to Sanitary Sewer

Storm water can not be discharged into a sanitary sewer unless specific conditions are met. For detailed information you should refer to Metro literature; Metro's telephone number is listed in Appendix A2 (the sanitary sewer system subsection). Generally, Metro's discharge requirements are as follows:

- If the discharge does not meet Ecology standards for receiving waters, it must be treated by all known and available technology, unless Ecology determines this will cause an unreasonable financial burden.
- The discharge must not exceed the hydraulic capacity of the collection system or the Metro treatment plant.
- The contaminants must not damage the collection system or the Metro treatment plant, impact the health and safety of Metro plant workers, pass through the treatment process, or limit use of Metro's sludge for land application.
- The storm water shall not have a pH less than 5.5 or contain any gas or substance which by itself or by interaction with other waste may cause corrosive damage to sewer works or treatment facilities.
- The storm water shall not contain heat in amounts that interfere with the treatment plant.
- The concentration of fats, oils and greases of animal or vegetable origin, petroleum oil, nonbiodegradable cutting oil or mineral oils shall not exceed 100 mg/l.
- Prohibited from discharge to the sanitary sewers are flammable or explosive materials including gasoline, kerosene, naphtha, benzene, toluene, xylene, ethers, alcohols, ketones, aldehydes, peroxides, chlorates, perchlorates, bromates, carbides, hydrides and sulfides, and any other substance which the City, State or EPA has indicated is a fire hazard.
- The following parameters shall not exceed the concentrations indicated: arsenic, 1 mg/l; cadmium, 3 mg/l; chromium, 6 mg/l; copper, 3 mg/l; lead, 3 mg/l; mercury, 0.1 mg/l; nickel, 6 mg/l; silver, 1 mg/l; zinc, 5 mg/l; and cyanide, 2 mg/l.

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City of Bellevue Sewer Utility Requirements for Discharge to Sanitary Sewer

City of Bellevue Sewer Utility regulations specify a number of unauthorized wastes and substances which may not be discharged into any sewer within the Utility's service area:

- any wastes or substances prohibited by Metro regulations
- surface or underground waters from any source
- any liquid or vapor having a temperature higher than 150° F
- any garbage that has not been properly shredded
- any ashes, cinders, sand, mud, straw, hair, shavings, metal, glass, rags, feathers, tar, plastics, wood, paunch manure, hay, or other solid or substance capable of causing obstruction to the flow in sewers or improper operation of the sewage works
- any waste having a pH lower than 5.5 and higher than 8.5 or having any other corrosive property capable of causing damage or hazard to the structures, equipment, or personnel of the city
- any waste containing a toxic or poisonous substance in sufficient quantity to injure or interfere with any sewage treatment process
- any waste containing suspended solids of such character and quantity that unusual attention or expense is required to handle such materials in the public sewer system or at the sewage treatment plant

Department of Ecology Requirements for Discharge to Sanitary Sewer

In setting pretreatment requirements, the local sewer authority or the Washington State Department of Ecology must operate within State Regulations WAC 173-216 (State Waste Discharge Permit Program) which in turn must comply with Federal Regulations 40 CFR 403.5 (National Pretreatment). Specific prohibitions include:

- materials which pass through the municipal treatment plant untreated or interfere with its operation
- materials which create a fire or explosion hazard, create a public nuisance or hazard to life, prevent entry into the sewer for maintenance and repair or is injurious in any other way to the operation of the system or the operating personnel
- materials which have a pH less than 5.0 or greater than 11.0 or have any corrosive property capable of causing damage or hazard to the system, equipment, or personnel
- materials which will cause obstruction to flows
- materials which will cause the sewage temperature to exceed 40° C or will in any case interfere with the biological activity in the municipal treatment plant

Sources: Summary of *Bellevue City Code* and excerpts from the *Water Quality Best Management Practices Manual for Commercial and Industrial Businesses* (1989), City of Seattle.

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B3 — SPILL CLEANUP (UNITED STATES ENVIRONMENTAL PROTECTION AGENCY AND STATE DEPARTMENT OF ECOLOGY)

USEPA — SPCC Plans (40 CFR 112)

Federal regulations require that owners or operators of facilities engaged in drilling, producing, gathering, storing, processing, refining, transferring, or consuming oil and oil products are required to have a *spill prevention and control plan* (SPCC), provided that the facility is nontransportation related; and, that the above-ground storage of a single container is in excess of 660 gallons, or an aggregate capacity greater than 1,320 gallons, or a total below-ground capacity in excess of 42,000 gallons. Examples of oil products are petroleum, fuel oil, sludge, oil refuse, and oil mixed with wastes.

The Plan must:

- be well thought out in accordance with good engineering
- achieve three objectives: prevent spills, contain a spill that occurs, and clean up the spill
- identify the name, location, owner, and type of facility
- include the date of initial operation and oil spill history
- name the designated person responsible
- show evidence of approval and certification by the person in authority
- contain a facility analysis

Ecology — Dangerous Wastes (WAC 173-303-350)

Businesses classified as hazardous (dangerous) waste generators must have a *contingency plan* which includes:

- actions to be taken in the event of spill
- descriptions of arrangements with local agencies
- the name of the owner's Emergency Coordinator
- a list of emergency equipment available
- an evaluation plan for business personnel

Source: Excerpts from the *Stormwater Management Manual for the Puget Sound Basin*, Technical Review Draft (June 1990), Washington State Department of Ecology.

B4 — HAZARDOUS WASTE (DEPARTMENT OF ECOLOGY)

The State's *Dangerous Waste Regulations* (Chapter 173-303 WAC) cover accumulation, storage, transportation, treatment, and disposal of hazardous wastes. A hazardous waste is a solid or liquid material with certain properties that could pose dangers to human health, property, or the environment.

A dangerous waste is a hazardous waste that is regulated by state law. A waste is considered dangerous if it is on a list generated by the Environmental Protection Agency or if it has certain characteristics (such as whether the material is ignitable, corrosive, reactive, EP toxic, carcinogenic, persistent, or toxic as defined by the state). State

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publications identify the 400 listed wastes and explain in detail the characteristics of dangerous waste. (See Appendices A2 and A3.) Under state law, the worst dangerous waste is referred to as extremely hazardous waste.

Following is a summary of the dangerous waste regulations pertinent for businesses or public agencies that periodically accumulate waste at their buildings. It includes aspects of the regulations that apply to waste generators and accumulation.

State regulations require generators of dangerous wastes to obtain a Washington State Department of Ecology (Ecology) identification number if they generate more than 220 pounds per month (2.2 pounds if the waste is defined as extremely hazardous).

In addition, under certain circumstances, as described below, the generator must obtain a permit to store dangerous wastes. Where storage permits are required, Ecology has the responsibility of ensuring that technical requirements are met.

Local governments must be concerned about situations where an Ecology storage permit is not required (less than 220 pounds per month). Although these generators still fall under Ecology regulations, the technical requirements are general. The first opportunity for local government to enforce the regulations is when a generator requests a building permit.

A storage permit is not required by Ecology under the following circumstances:

- if the business generates more than 2,200 pounds per month of dangerous waste but intends to store the accumulated material less than 90 days
- if the business generates between 220 and 2,200 pounds per month of dangerous waste but intends to store less than 180 days
- if the business produces less than 220 pounds per month regardless of the length of storage.

Generators that produce more than 220 pounds per month (see 1 and 2 above) and avoid the need for a permit must still fulfill these general regulations with regard to temporary storage:

<u>If Placed in Containers</u>:

- If the container is not in good condition (e.g., severe rusting, apparent structural defects) or if it begins to leak, the owner must replace the container.
- The container must be labeled as to its contents.
- The container must be lined with a material that does not react with the waste.
- The container must always be closed except when adding or removing waste.
- The container must not be opened, handled, or stored in a manner which may cause a rupture or leak.
- The containers must be examined for leakage at least weekly.
- Containers storing reactive or ignitable waste must meet requirements of the *Uniform Fire Code*.
- Incompatible wastes must be stored separately.

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- Ecology may require secondary containment of the storage area. Specifically, the storage area must:
  - be capable of collecting and holding spills and leaks
  - if uncovered, be capable of handling a 25-year storm
  - have a base which is free of cracks or gaps and is sufficiently impervious to leaks, spills and rainfall
  - be sloped or designed such that liquids can drain to a point for removal
  - have positive drainage control (e.g., a valve) to insure containment until any liquid is removed. Removal must occur in a timely manner
  - have a holding capacity equal to 10 percent of the volume of all containers or 100 percent of the volume of the largest container whichever is greater
  - not allow runoff of rainfall from areas adjacent to the storage area

If the waste does not contain free liquids the above requirements need not be met provided that the area is sloped or the containers are elevated.

If Placed in Tanks:

- The tank must be lined with a material that does not react with the waste.
- The tank, tank area, and its ancillary equipment must be inspected regularly according to a posted schedule.
- If retired, the tank is to be cleaned of all contents. Any wash waters should be disposed of in a manner similar to the disposal of the actual wastes.
- Tanks storing reactive or ignitable waste must meet the *Uniform Fire Code* requirements.
- Incompatible wastes must be stored separately.

The above generators must also have a designated employee on site or on call with the responsibility for coordinating all emergency response measures. Any spills are to be contained and cleaned up as soon as practicable.

If the business produces less than 220 pounds per month (2.2 pounds, if the waste is defined as "extremely hazardous"), it need not comply with the above regulations. It need only dispose of the waste using one of the methods acceptable to the local health department, which are as follows:

- Dispose of the waste to a facility that is permitted to accept hazardous waste.
- Dispose of the material to a recycling facility.
- Dispose of the waste to a municipal or industrial landfill that is permitted to accept hazardous waste.
- Put the waste to a beneficial use, such as the use of sludge as fertilizer. This should be cleared with the local health department.

Source: Excerpts from the *Storm water Management Manual for the Puget Sound*, Technical Review Draft (June 1990), Washington State Department of Ecology.

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B5 — POLLUTING SURFACE WATERS (CITY OF BELLEVUE AND WASHINGTON STATE CODE)

City of Bellevue Code

Chapter 24.06 of the *Bellevue City Code*, known as the *Storm and Surface Water Utility Code*, provides for the regulation and management of the City's storm and surface water system. The code prohibits the discharge, by any manner, of any organic or inorganic matter that causes pollution in the City's natural waters. The code prohibits the disposal or spilling of these pollutants on virtually any land that potentially drains to a water body. Therefore, it is extremely important that potential pollutants be handled with care.

Pollutants include, but are not limited to the following:

- petroleum products, including but not limited to oil
- gasoline, grease, fuel oil, heating oil
- chemicals, acids or alkalis
- pesticides, herbicides or chlorine
- degreasers and/or solvents
- antifreeze and/or other automotive products
- dyes (without prior permission of the SSWU)
- paints
- pet wastes or animal carcasses
- recreational vehicle wastes
- steam cleaning wastes
- washing of fresh concrete for cleaning and/or finishing purposes or to expose aggregates
- laundry wastes or soaps
- trash or debris
- bark and other fibrous material
- lawn clippings, leaves, branches, or silt
- construction materials

Under Chapter 24.06.187 any person responsible for pollutant discharge into natural waters who fails to take remedial action at the SSWU director's request is responsible for the necessary expenses incurred by the City in pollutant abatement.

Revised Code of Washington

The *Revised Code of Washington* (RCW) has provisions regarding polluting matter in general and oil in particular. Oil is defined as oils, including gasoline, crude oil, fuel oil, diesel oil, lubricating oil, sludge, oil refuse, liquid natural gas, propane, butane, oils distilled for coal, and other liquid hydrocarbons regardless of specific gravity, or any other petroleum related product. Following are excerpts from the code that pertain to polluting matter and oil.

RCW 90.48.080: *Discharge of polluting matter in waters is prohibited. It shall be unlawful for any person to throw, drain, run, or otherwise discharge into any of the waters of this state, or to cause, permit or suffer to be thrown, run, drained, allowed to seep or otherwise discharged into such waters any organic or inorganic matter that shall cause or tend to cause pollution of such waters according to the determination of the Department of Ecology, as provided for in this chapter.*

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RCW 90.48.320: *It shall be unlawful, except under the circumstances here after described in this section, for oil to enter the waters of the state from any ship or any fixed or mobile facility or installation located offshore or onshore whether publicly or privately operated, regardless of the cause of the entry or fault of the person having control over the oil, or regardless of whether it be the result of intentional or negligent conduct, accident or other cause. This section shall not apply to discharges of oil in the following circumstances:*

1. *The person discharging was expressly authorized to do so by the Department of Ecology prior to the entry of the oil into state waters.*

2. *The person discharging was authorized to do so by operation of law as provided in RCW 90.48.200.*

3. *The person having control over the oil can prove that a discharge was caused by:*
   a. *an act of war or sabotage*
   b. *negligence on the part of the United States government or the State of Washington.*

Sources: Summary of *Bellevue City Code* and excerpts from the *Revised Code of Washington.*

B6 — STORAGE OF MATERIALS (CITY OF BELLEVUE FIRE CODE AND SEATTLE-KING COUNTY HEALTH DEPARTMENT)

Generally, the storage of flammable materials is regulated by the *City of Bellevue Fire Code* and containers used for holding solid waste are regulated by the Seattle-King County Health Department.

City of Bellevue Code

Storage of flammable, ignitive, and reactive chemicals and materials must comply with the *City of Bellevue Fire Code*: Article 50, Storage of Raw Materials and Finished Products; Article 79, Storage of Flammable and Combustible Liquids; and Article 80, Storage Cabinets for Hazardous Materials.

- Storage of hazardous materials requires a permit from the fire department. In Bellevue, a fee of fifty dollars is charged for each item and each classification of hazardous materials. Any hazardous material with multiple classifications is charged only once.

- Flammable finished products and combustible liquids may be stored inside the manufacturing building as long as they are stored in a room separated from the processing area by a two-hour occupancy separation (the wall must be able to burn for two hours before a hole burns through the wall).

- Container and tank storage areas are to be protected against trespassers by fencing or other control measures. The area is to be kept free of weeds, debris, and other combustible materials.

- The storage area is to be graded to divert spills away from buildings or it shall be surrounded by a 6-inch curb. If a curb is used, a drain with a positive control valve shall be provided for draining of accumulations of rain water or spills.

- Combustible merchandise outside of buildings shall not be stored or displayed under sprinklered eaves, canopies, or other projections or overhangs of buildings which are protected by automatic sprinklers. Such

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merchandise shall not be stored or displayed within ten feet of an exit doorway.

- The storage of Class I and Class II liquids in aboveground tanks outside of buildings is prohibited within the limits established by law as the limits of districts in which such storage is prohibited. Districts for which the prohibition applies includes areas zoned as other than LI (Light Industrial) and GC (General Commercial) as defined in the *City of Bellevue Land Use Code* and designated on the City's official zoning map.

- An operator or other trained personnel shall be in attendance at all times while a tank vehicle or tank car is discharging.

- The area surrounding a tank or group of tanks shall be provided with drainage or shall be diked to prevent an accidental discharge of liquid from endangering adjacent tanks, adjoining property or reaching waterways.

- The area within the dikes shall be sloped not less than 1 percent towards an impounding basin or an approved means of disposal.

- The volume of the diked area shall not be less than 100 percent of the volume of the largest tank.

- Drains shall be installed to remove excess water from the diked area. The drains shall not discharge to natural watercourses, public sewers or drainage channels unless a valve, operable from outside the dike, prevents the release of flammable or combustible liquids.

- Provision shall be made during loading and unloading to prevent liquids from entering drainage systems, public sewers, or natural waterways. Connections to such systems by which liquids might enter shall have separator boxes.

Seattle-King County Health Department Container Requirements

Rules and Regulations No. 8 of the *Minimum Functional Standards for Solid Waste Handling* specify the characteristics of containers to insure their integrity. The rule states:

> *Reusable containers, except for detachable containers, shall be: rigid and durable; corrosion resistant; nonabsorbent and water tight; rodent-proof and easily cleanable; equipped with a close fitting cover; suitable for handling with no sharp edges or other hazardous conditions...* (Part IV, Section 1.B)

Detachable containers are reusable containers that are mechanically loaded or handled such as a dumpster or drop box.

> *Detachable containers shall be durable, corrosion-resistant, nonabsorbent, nonleaking and having either a solid cover or screen cover to prevent littering.* (Part IV, Section 1.B)
>
> *All wastewater from container cleaning shall be disposed to a sanitary sewer unless otherwise authorized by the health officer.* (Part IV, Section 1.B)
>
> *All persons collecting or transporting solid wastes shall avoid littering, or the creation of other nuisances at the loading point...* (Part IV, Section 1.C)
>
> *...solid waste shall be moved in such a manner that the contents will not fall, leak in quantities to cause a*

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nuisance, or spill therefrom. Where such spillage or leakage does occur, the waste shall be picked up immediately... (Part IV, Section 1.C)

Sources: Summary of *Bellevue City Code* and excerpts from *Water Quality Best Management Practices Manual for Commercial and Industrial Businesses* (1989), City of Seattle.

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BUSINESS PARTNERS FOR Clean Water



Appendix C
Glossary

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C Glossary

Aquatic Habitat — A place in, on, or near water where organisms are normally found.

BMP (Best Management Practices) — A general name given to a variety of methods for controlling nonpoint source pollution.

Carcinogenic — A cancer-causing substance.

CERCLA (Comprehensive Environmental Response Compensation and Liability Act) — A federal regulation, commonly called Superfund, created to remedy hazardous waste problems.

Constructed Wetland — A wetland constructed by creating ponded areas and either planting aquatic plants or allowing them to colonize naturally, usually to perform water treatment and flood control.

Contaminant — A substance that is not naturally present in the environment or is present in amounts that can, in sufficient concentration, affect the environment.

Degradation — Being lowered in value, quality, etc.

Detention Pond (Vault) — A constructed pond (or vault) that temporarily stores storm water runoff and releases it at controlled rates.

Dissolved Oxygen — Oxygen which is present (dissolved) in water and available for use by fish and other aquatic animals. If the amount of dissolved oxygen in the water is too low, the aquatic animals will suffocate.

Diversion Channels — Waterways that collect storm water runoff and divert it away from an area of concern. For example, channels can divert storm water around exposed soils which would erode or around a source of pollution which would otherwise be washed into the drainage system.

Drainage Basin — See Watershed.

Drainage System — See Storm Drainage System.

Ecosystem (Ecological System) — A community of living things interacting with one another and with their physical environment, such as a rain forest, pond, or estuary. Damage to any part may affect the whole.

EPA (Environmental Protection Agency) — A federal agency with authority for enacting and enforcing many environmental laws.

Erosion — The wearing away of the land surface by running water, wind, ice, or other geological processes.

Filter Fabric Fence — A fence constructed of a small-mesh textile that allows storm water runoff to pass through while trapping sediments.

Ground Water — Underground water supplies, also called aquifers.

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Hazardous Waste — Any solid, liquid, or gaseous substance which, because of its source or measurable characteristics, is classified under state law as dangerous or federal law as hazardous and subject to special handling, shipping, storage, and disposal requirements. Washington State businesses are regulated for two categories of hazardous waste: Dangerous and Extremely Hazardous.

Herbicide — A chemical substance used for killing plants, especially weeds.

IMEX (Industrial Materials Exchange) — This agency is an information network sponsored by the Seattle-King County Department of Health that helps businesses find inexpensive sources or markets for materials.

Impermeable — Not permitting the passage of liquids or gasses.

Impervious Surface — Material which resists or blocks the passage of water.

Infiltration — The movement of water from the surface downward through the soil.

Leaching — To extract from some material, such as the washing of pollutants from a dumpster by storm water.

Metals (Heavy Metals) — Elements such as mercury, lead, nickel, zinc, and cadmium that are of environmental concern because they can accumulate in the food chain and, in high enough concentrations, can be toxic to life. Many are also necessary nutrients but in very low concentrations.

Metro (Municipality of Metropolitan Seattle) — A Puget Sound area agency that is responsible for waste water treatment and mass transit.

MSDS (Material Safety Data Sheets) — Information supplied by the manufacturer on the chemical properties, hazards, and special handling of a product.

NPDES (National Pollutant Discharge Elimination System) — A permitting process established by the Clean Water Act that regulates the release of pollutants to waters of the United States.

Nonpoint Source (NPS) Pollution — Pollution that comes from dispersed or poorly defined sources rather than a single point such as an industrial pipe.

Nutrients — Elements or substances, such as nitrogen or phosphorus, that are necessary for plant growth. Large amounts of these substances reaching water bodies can lead to reduced water quality and eutrophication by promoting excessive aquatic algae growth. Some nutrients can be toxic at high concentrations.

Pesticide — Any chemical agent used for control of specific organisms such as insecticides, herbicides, fungicides, etc.

Pollutants — See Water Pollutants.

RCRA (Resource Conservation and Recovery Act) — A federal regulation that addresses waste handling and disposal.

Retention — The process of storing runoff on a surface area or in a storage basin so it does not enter the drainage system at a destructive rate.

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Riparian Corridor — A stream (either intermittent or year-round) and the lower and upper banks including associated vegetation which stabilizes the banks and maintains habitat.

Riprap — A facing layer or protective mound of stones placed to prevent erosion or sloughing of a stream bank or embankment.

Salmonid — Any species of fish in the salmon or trout family.

Sanitary Sewer System — A network of pipes for carrying sewage to a treatment facility.

SARA (Superfund Amendment and Reauthorization Act) — A reenactment of CERCLA with additional provisions.

Sediment — Particles from rocks, soil, or biological materials.

SSWU (Storm and Surface Water Utility) — A Bellevue utility that manages the City's storm and surface water system to maintain a hydrologic balance, prevent property damage, and protect water quality.

Storm Sewer — See Storm Drainage System.

Storm Drainage System — A network of pipes and channels for carrying storm and surface waters (not domestic, industrial, and commercial waste waters) to surface water bodies such as streams and lakes.

Storm Water Runoff — Precipitation excess that is not retained on the vegetation or surface depressions and is not lost by infiltration, and thereby is collected on the surface and runs off.

Stream Corridor — See Riparian Corridor.

Surface Roughening — Any practice that provides for rougher, more permeable surfaces that will slow runoff velocity and reduce erosion potential. Porous pavements, grassed, and gravel driveways are examples.

Surface Runoff — See Storm Water Runoff.

Swales — A grass lined ditch. More specifically, a natural or constructed waterway (usually broad and shallow covered with erosion resistant grasses) used to convey surface runoff.

TSD (Treatment, Storage and Disposal Facility) — A facility permitted by the Department of Ecology or the EPA to store, treat, or dispose of hazardous waste.

Urban Runoff — Storm water that passes through and out of developed area to a stream or other body of water. (See Storm Water Runoff.)

Water Pollutants — Substances which can render water harmful to people, fish, or wildlife or impair recreation or other beneficial uses of water.

Watershed — A geographic area within which all surface water drains into a particular body of water.

WDOE (Washington State Department of Ecology, also referred to as Ecology) — A state agency that enacts and enforces environmental laws.

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Wetland — Lands where groundwater is usually at or near the surface, or where the land is covered by shallow water for all or part of the year. Wetlands are further defined as lands where the saturation with water is the dominant factor for determining the soil development and the types of plant and animal communities living in the soil or on its surface.

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Storm Water Best Management Practices for Retail Gasoline Outlets

Prepared for:

WSPA
Western States Petroleum Association

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Project No. S2498
January 12, 1996

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EXECUTIVE SUMMARY

This report summarizes and evaluates Best Management Practices (BMPs) that are potentially appropriate for Retail Gasoline Outlets (RGOs). This report also summarizes and evaluates several studies that characterized the chemical quality of storm water runoff from RGOs. These prior studies are important because they provide a basis for evaluating and recommending appropriate BMPs for RGO applications.

Based on the results of several storm water studies, it does not appear that the water quality of storm water runoff from properly operated and maintained RGOs is appreciably different than water quality from a number of other sources, including parking lots and roads. Additionally, in most cases, the mean concentrations of oil and grease, total suspended solids, and chemical oxygen demand are below the NPDES storm water permit limitations established by several states for vehicle-related activities.

Properly operated and maintained RGOs may currently be implementing a variety of BMPs to reduce storm water contaminant concentrations. Two basic categories of BMPs are presented in this paper. The first category consists of practical pollution prevention measures. These are the basic, common operational practices and relatively simple facility modifications that are effective in preventing storm water pollution. The second category consists of storm water treatment BMPs. These include structural controls that involve installation of equipment to reduce contaminant concentrations in storm water runoff.

Practical pollution prevention measures are appropriate for RGOs because they are simple, cost effective, and protective of storm water quality. In contrast, the storm water treatment BMPs are less appropriate for RGOs because they are ineffective or unproven for treatment of low contaminant concentrations and are relatively expensive to install and maintain.

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STORM WATER BEST MANAGEMENT PRACTICES FOR RETAIL GASOLINE OUTLETS

SECTION 1.0 – INTRODUCTION

1.1 General

Storm water Best Management Practices (BMPs) are practices used to prevent or reduce the pollution of surface waters caused by storm water runoff. This report summarizes and evaluates BMPs that are potentially appropriate for Retail Gasoline Outlets (RGOs). This report also summarizes and evaluates several studies that characterized the chemical quality of storm water runoff from RGOs. These prior studies are important because they provide a basis for evaluating and recommending appropriate BMPs for RGO applications.

The Western States Petroleum Association (WSPA) commissioned this study in response to existing and anticipated regulation of storm water discharges from RGOs. In some cases, municipal ordinances require owners and operators of RGOs to implement BMPs that may not have beneficial effects on storm water quality. Additionally, the required BMPs may not be consistent between municipalities, causing compliance difficulties for RGO owners and operators. The information in this report is based on a variety of sources, including an extensive literature search and review; discussions with numerous researchers regarding on-going and unpublished studies; a review of local, state, and federal regulations; and a review of storm water BMPs currently utilized by WSPA members.

1.2 Background

In 1972, the Federal Water Pollution Control Act (also known as the Clean Water Act, or CWA) was amended to provide that any discharge of pollutants from a point source to waters of the United States is effectively prohibited unless it is in compliance with a National Pollutant Discharge Elimination System (NPDES) permit. Although this technically prohibits discharge of pollutants in storm water, the focus at that time was on the bigger problems of industrial waste and sewage treatment.

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As more significant sources of water pollution were brought under control, the impact of pollutants in storm water began to receive greater attention. Water quality studies conducted in the 1970s and 1980s identified urban runoff as a diffuse, or nonpoint, source of pollution. In response to these studies, the 1987 amendments to the Water Quality Act added Section 402(p). This section established a comprehensive, two-phased approach for the U.S. Environmental Protection Agency (EPA) to follow in addressing storm water discharges. Five types of storm water discharges are covered under the Phase I program. Dischargers within these five categories, listed below, were required to obtain permit coverage before October 1, 1992:

a. A discharge for which a permit has been issued prior to February 4, 1987.
b. A discharge associated with industrial activities.
c. A discharge from a municipal separate storm sewer system serving a population of 250,000 or more.
d. A discharge from a municipal separate storm sewer system serving a population of 100,000 or more, but less than 250,000.
e. A storm water discharge determined by the EPA Administrator or the State to contribute to a violation of a water quality standard or to be a significant contributor of pollutants to the Waters of the United States.

Storm water discharges from commercial facilities, such as RGOs and parking lots associated with other commercial operations, are not included under the Phase I regulations. However, Phase II regulations now being promulgated are expected to increase the number and type of dischargers required to obtain NPDES permit coverage for storm water discharges. EPA, in a draft Phase II report to Congress (EPA, 1993), identified several business categories that are not currently regulated by NPDES permits but are proposed for regulation in Phase II. Automotive service facilities, including RGOs, are included on EPA's list of potential Phase II permittees.

In addition to potential regulation under state and federal programs, RGOs are likely to be regulated by local municipalities. Municipalities, as part of their mandated storm water management programs, are required to monitor and control pollutants in storm water discharges from their municipal storm drainage systems. Methods of control may include regulating storm water discharges from facilities, including RGOs, that are identified by municipalities as contributors of pollutants to the municipal storm drain system.

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1.3 Water Quality of Storm Water Discharges from RGOs

To evaluate the BMPs appropriate for use at RGOs, it is necessary to develop an understanding of the types and concentrations of chemicals typically found in storm water runoff from RGOs. For this reason, summaries of three recent studies that characterized the water quality of storm water discharges from RGOs are included in this report. These studies are described in the following subsections.

1.3.1 WSPA/API RGO AND COMMERCIAL PARKING LOT STUDY

A WSPA/API storm water runoff study (WSPA/API, 1994) was conducted on six retail gasoline outlets (RGOs) and four commercial parking lots. The objective of the study was to characterize simulated storm water runoff from RGOs and compare the results with simulated runoff from commercial parking lots and published urban "background" values. The analytical results from this study are presented in Table 1.

The WSPA/API study was conducted on RGOs that were "normally operated and maintained." For the purposes of that study, "normally operated and maintained" signifies that the RGOs utilize Best Management Practices (BMPs) to minimize the buildup of potential storm water contaminants on exposed areas. These BMPs include regular sweeping of exposed areas, regular site inspections, and standardized spill response procedures. All of the RGOs were high-volume retailers, and three conducted on-site vehicle maintenance or repair services.

The study demonstrates that for the constituents analyzed, median event mean concentrations (EMCs) of chemicals in storm water runoff from normally operated and maintained RGOs are no higher than those in runoff from commercial parking lots. Additionally, median EMCs of total suspended solids, copper, lead, and zinc in runoff from RGOs and parking lots are no higher than background levels present in urban runoff as established by the National Urban Runoff Program (NURP). Furthermore, for the constituents analyzed, no significant differences were found between median EMCs of runoff from RGO pump islands and driveways. These results indicate that fueling activities at normally operated and maintained RGOs do not contribute significant additional concentrations of chemical constituents to storm water runoff.

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1.3.2 DISCRETE LAND USE TYPES STUDY

Another recent study (Shepp, 1995) investigated the petroleum hydrocarbons and general water quality characteristics associated with four discrete land uses in the Washington D.C. Metropolitan Area. The monitored sites included a parking lot where cars typically are parked for relatively long periods; a parking lot for a commercial convenience store, where short-term parking occurs; a street; and an RGO. Details were not provided regarding the throughput or BMPs used at the RGO monitored for the study, however; the station is described as a "gas and go" style facility, providing no automotive service or maintenance. Samples were collected from 26 storm events for the longer-term parking lot, 14 storm events for the short-term parking lot, 9 storm events for the street, and 13 storm events for the RGO. The mean results, which are summarized in Table 2, indicate that the mean hydrocarbon concentration in runoff from the convenience commercial store is substantially higher than the closely grouped mean values for the RGO, longer term parking lot, and street. Similar results were reported for the majority of the other parameters measured.

1.3.3 ACTION PLAN DEMONSTRATION PROJECT

Sacramento County's Action Plan Demonstration Project (Uribe and Associates, 1994) characterized storm water runoff from RGOs and evaluated the use of mobile high-pressure washing as a BMP. The report presents the analytical results of storm water samples collected over two consecutive wet seasons from three RGOs in Sacramento County.

The Sacramento County project selected high-volume (more than 200,000 gallons per month), self-service RGOs with convenience markets and without automobile repair service bays for the study.

The initial analytical program for the collected samples included analyses for oil and grease, total suspended solids, metals (13 EPA priority pollutant metals plus aluminum and iron), polycyclic aromatic hydrocarbons (PAHs), and petroleum hydrocarbons. However, some of the metals, petroleum hydrocarbons, and PAHs were consistently not detected in samples collected from the first three storm events. On the basis of these results, the following parameters were selected for the remainder of the study:

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- oil and grease
- total suspended solids
- heavy metals (cadmium, chromium, copper, lead, and zinc)

The analytical results from the study are presented in Table 3. The results of the study indicated that regular high-pressure washing of pavement surfaces at RGOs actually caused an increase in the concentrations of certain pollutants in storm water discharges.

1.4 Evaluation of RGO Storm Water Runoff Studies

The results of the three RGO storm water runoff studies described in the preceding subsections are summarized in Table 4. For comparison, Table 4 also presents the effluent limitations contained within draft or final NPDES storm water permits from several states that have promulgated effluent limitations for industrial facilities engaged in vehicle-related activities. Also presented are the mean concentrations for residential and commercial land uses from NURP (1983), a comprehensive study conducted from 1978 through 1983 with funding and guidance provided by EPA. The results of NURP provide insight on what can be considered background levels for urban runoff.

As summarized in Table 4, the mean concentrations of total suspended solids, lead, copper, and zinc in runoff from RGOs are generally below the background levels established by the results of NURP. Additionally, in most cases, the mean concentrations of oil and grease, total suspended solids, and chemical oxygen demand are below the limitations established for a number of NPDES permits, including storm water discharge limitations established for transportation-related industrial facilities located in Missouri, Alabama, Oregon, and Louisiana. On this basis, it appears that the concentrations of chemical constituents in storm water discharges from properly operated and maintained RGOs are below background concentrations and are generally below levels that require additional controls or treatment, as established by the effluent limitations developed for storm water discharges from sites where vehicle fueling, maintenance, and repair occur.

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However, it should be noted that the preceding conclusions are based on the mean concentrations from samples collected from a total of ten RGOs. The analytical results for individual RGOs and storm events are variable, as would be expected based on typical variability in RGO age, construction, throughput, and management practices. The variability in analytical results for oil and grease and total suspended solids is illustrated on the histograms presented as Figure 1. In some cases, the results exceed the background concentrations established by NURP and/or the effluent limitations developed for vehicle-related sites. The variability in analytical results shown on this figure suggests that there may be cases where concentrations of specific chemical constituents in storm water discharges from RGOs are above levels where additional controls may be required. However, the histograms also indicate that the majority of the results are below concentrations where additional controls may be required, suggesting that, in most cases, the BMPs implemented at properly operated and maintained RGOs are effective and sufficient for preventing storm water pollution.

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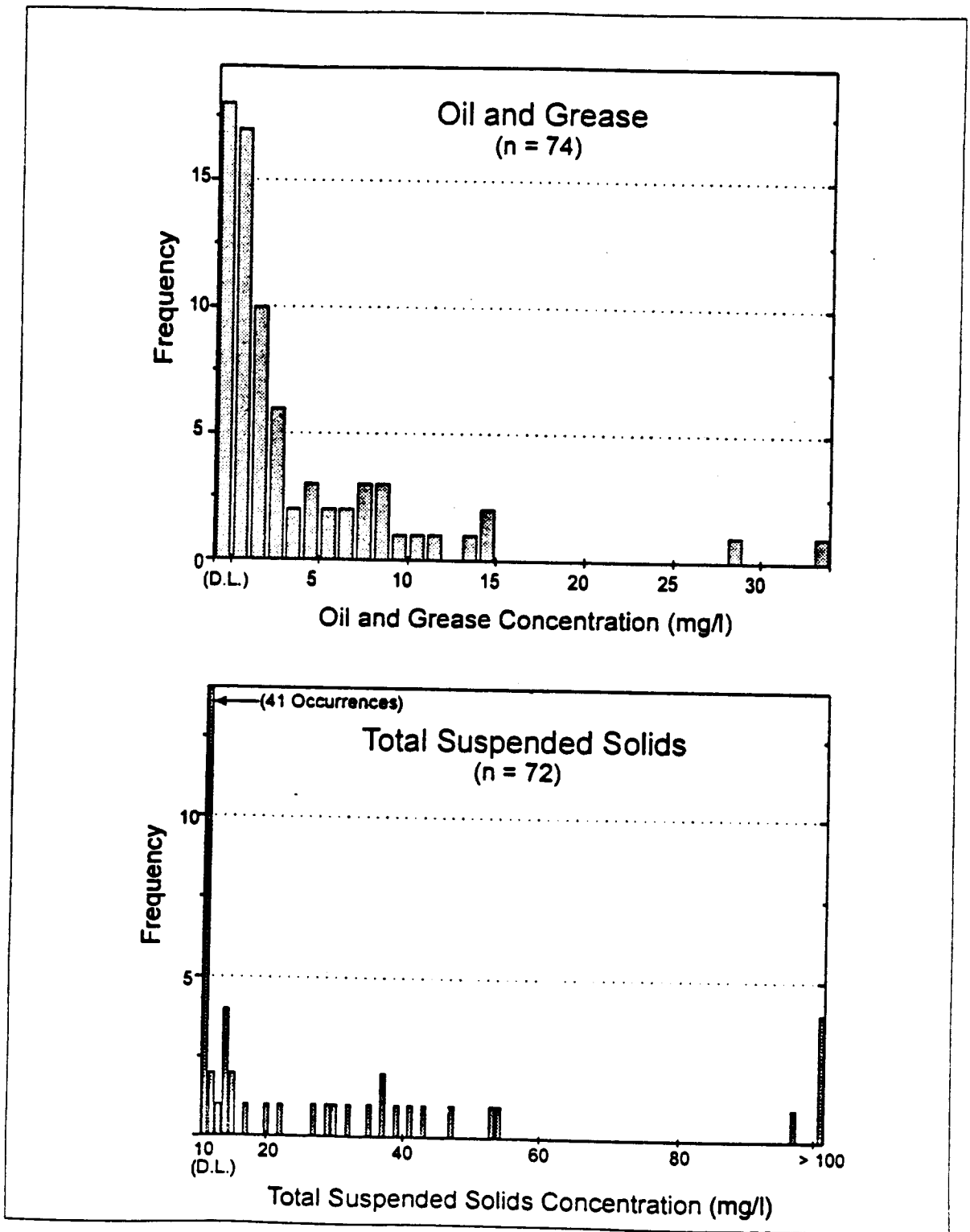

Figure 1 - Histograms of Mean Results for Oil & Grease and Total Suspended Solids from Three Recent Studies Characterizing Storm Water Runoff from RGOs

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SECTION 2.0 -- BEST MANAGEMENT PRACTICES FOR RGOs

2.1 General

As described in Section 1.4 of this report, storm water discharges from RGOs contain concentrations of oil and grease, total suspended solids, heavy metals, and other constituents. Although the concentrations of these constituents from properly operated and maintained RGOs are often no higher than from other land uses, such as parking lots and streets, there may be a requirement to minimize pollutant loading of storm water through implementation of BMPs.

Two basic categories of BMPs are described in this report. The first category consists of practical pollution prevention measures. These are the basic, everyday operational practices and relatively simple facility modifications that are effective in preventing storm water pollution. The second category consists of storm water treatment BMPs. These include structural controls that usually involve installation of equipment to treat storm water. The storm water treatment BMPs described in this report are limited to on-site treatment devices applicable to relatively small sites that lack the room necessary for traditional urban BMPs such as extended dry detention basins or wet ponds.

The first category of BMPs, pollution prevention measures, are preferred over storm water treatment BMPs because they are relatively simple and cost effective. The results of a recent survey of several WSPA/API member companies, representing several thousand RGOs across the western United States, indicated that the types of pollution prevention and source control practices that are described in this report are already being used at many RGOs. This approach for preventing pollution is endorsed by EPA as one of the best means of pollution control. In fact, the Pollution Prevention Act of 1990 set forth a national policy that:

> "...pollution should be prevented or reduced at the source whenever feasible; pollution that cannot be prevented should be recycled in an environmentally safe manner, whenever feasible; pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible; and disposal or other release into the environment should employed only as a last resort and should be conducted in an environmentally safe manner."

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The second category of BMPs are storm water treatment measures. Storm water treatment may require a fairly significant capital outlay, along with operational and maintenance expenses, and may not result in an appreciable improvement in storm water quality. Treatment of storm water discharges from RGOs is problematic for two reasons. First, as characterized in Section 1.4 of this report, storm water discharges from RGOs typically carry relatively low concentrations of contaminants. The efficiency and removal rates for many structural BMPs at such low influent concentrations are questionable. Second, storms are often short-duration events with relatively high intensities. It is often difficult to effectively treat the necessary amount of rainfall that discharges from a 100 percent impervious RGO without storing a large volume of water. Creating on-site storage for the necessary volume of storm water runoff often is the most costly item in the overall BMP system (Bell & Nguyen, 1995). Nevertheless, structural BMPs may be required for sites where it has been demonstrated that operational practices are not sufficient to control pollutants. In addition, some municipalities require the installation of structural BMPs for new developments or significant remodels. The specific requirements vary greatly between jurisdictions, and it is recommended that owners and operators contact individual municipalities for specific requirements.

A description of practical pollution prevention measures and storm water treatment BMPs are described in the following sections.

2.2 Practical Pollution Prevention Measures Suitable for RGOs

The following are proactive practical pollution prevention measures that can be effective for all RGOs. The intent of these pollution prevention measures is to control pollutants to the extent that the treatment of storm water is unnecessary. A summary of these practical pollution prevention measures is presented in Table 5.

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2.2.1 USING SPILL CONTAINMENT & OVERFILL PREVENTION EQUIPMENT

Using spill and overfill equipment for Underground Storage Tanks (USTs) can effectively reduce fuel spills during UST filling activities. Federal regulations have made installation of spill and overfill equipment mandatory for all RGO USTs installed after December 1988. For RGO USTs installed prior to December 1988, federal regulations will not require spill and overfill equipment until 1998; however, local and/or state regulations may require earlier installation. In addition, fuel pump shut-offs, including automatic shut-offs at each pump and a manual shut-off inside the building, are effective for preventing or minimizing the size of spills.

Proper maintenance of the spill containment equipment is required to ensure proper product delivery. The required maintenance includes regular removal of accumulated debris, water, and product.

2.2.2 POSTING SIGNS WARNING AGAINST "TOPPING OFF"

"Topping off" fuel tanks during fueling can lead to spills, which can potentially contribute hydrocarbon pollutants to storm water runoff. Posting high visibility signs, warning against "topping off" can be effective for minimizing these types of spills.

2.2.3 USING "HOLD OPEN" LATCHES ON DISPENSER NOZZLES

Proper use of "hold open" latches on dispenser nozzles can facilitate automated gasoline fueling and can minimize spills caused by improper fueling methods, including use of fixed objects such as gas caps, wallets, pieces of wood, etc., to keep dispenser latches open. It should be noted that "hold open" latches may not be allowed by local fire departments and may increase the potential for spills caused by customer drive-offs unless used in conjunction with break-away hoses.

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2.2.4 PROVIDING CANOPIES AND USE OF CONCRETE FOR FUELING AREAS

Providing canopies over fueling areas can reduce storm water pollution caused by direct precipitation onto fueling areas. However, canopies may not be necessary for RGOs with effective good housekeeping and spill response procedures.

Portland Cement Concrete (PCC) can be used instead of asphaltic concrete in fuel areas. This is advantageous because asphalt soaks up fuel, or can be slowly dissolved by fuel, engine fluids, and other organic liquids. Over time, the asphalt itself can become a source of storm water pollutants.

2.2.5 AVOIDING STORM WATER RUNON

RGOs should be graded to prevent storm water runon to fuel islands and outdoor maintenance areas. Runon can also be prevented by installing berms, curbs, or valley gutters to redirect the runoff. It is also possible to redirect roof gutter downspouts so that they drain away from the fueling and maintenance areas.

2.2.6 MAINTENANCE PROCEDURES FOR EXISTING OIL & GREASE SEPARATORS AND OTHER TREATMENT BMPS

Any structural BMP, including oil and grease separators, drainage sumps, and catch basins, should be maintained regularly. This reduces the potential for re-suspension and transport of settled particulates, which can be a source of storm water pollutants. Proper maintenance of oil/grit separators includes periodic sediment clean out.

2.2.7 AVOIDING RGO WASH DOWNS

As described in Section 1.3.3 of this report, a study to evaluate the use of high-pressure washing as a storm water BMP was conducted for Sacramento County (Uribe and Associates, 1994). The results of the study indicated that regular high-pressure and high-temperature washing of pavement surfaces at RGOs can actually cause an increase in the concentrations of

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certain pollutants in storm water discharges. In addition, discharges to the street or storm drain system that result from RGO washdowns is prohibited by many municipalities. As an alternative, fuel dispensers should be regularly cleaned using a damp cloth or mop. Mop water should be discharged to a mop sink connected to the sanitary sewer. However, check with your local sewer authority regarding permitting or other requirements for mop water discharges to the sewer system.

2.2.8 SWEEPING EXPOSED AREAS

Regular sweeping of exposed areas, using hand brooms and/or vacuums, can be an effective storm water BMP. Sweeping may be most effective when conducted immediately prior to the wet season and forecasted rain events. Studies show that routine sweeping is effective in reducing concentrations of total suspended solids, particulate heavy metals, and hydrocarbons bound to particulates. In addition, pollutant removal rates are shown to vary directly with the frequency of sweeping. A street sweeping study in San Jose revealed approximate removal rates of 50 percent for heavy metals and total suspended solids when streets were swept once or twice a day (NVPDC, 1992). However, a significant reduction to less than 5 percent removal was observed when the frequency of sweeping dropped to once or twice a month (Pitt, 1979).

2.2.9 ELIMINATING NON-STORM WATER DISCHARGES AND ILLICIT CONNECTIONS

Non-storm water discharges and illicit connections are potentially significant sources of storm water pollution. An example of a non-storm water discharge is the wash water from vehicle or pavement washing that is discharged to the street or storm drain system. This type of discharge is prohibited by many municipalities. Examples of illicit connections are indoor drains or sinks that discharge to the storm drain instead of the sewer system. These illicit connections are also prohibited by most municipalities, and it is recommended that all RGOs be inspected to confirm that all illicit connections are eliminated.

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2.2.10 STANDARDIZING SPILL RESPONSE PLAN

A standardized spill response plan ensures that spills are promptly detected, contained as necessary, and properly cleaned up. An effective plan provides a well-defined set of spill response procedures and establishes a training program to educate all employees about the procedures. Typical spill response techniques at RGOs include using shop rags for small spills and using absorbent materials such as vermiculite, sawdust, or cat litter for larger spills. In addition, there are commercially available adsorbent materials that can be recycled. Used shop rags should be stored in a closed bin for recycling by a cleaning service. Separate wet/dry vacuums also can be used for larger motor oil and antifreeze spills. Due to their potential flammability, spilled gasoline, solvents, or other volatile liquids should be removed using absorbent materials. Depending on the type of spill, the used absorbent materials may have to be disposed of as a hazardous waste.

2.2.11 TRAINING EMPLOYEES

Employee training is a key component of pollution prevention. Routine employee training can take the form of distinct BMP training programs or incorporating BMP training into existing employee safety or other general training sessions. An effective training program emphasizes routine employee observations of product deliveries to USTs and frequent inspections of self-serve fueling areas and other customer-related operations. RGOs with maintenance and/or repair facilities should also emphasize routine employee shop inspection to ensure that operations do not adversely impact storm water.

2.2.12 PROVIDING OVERHEAD COVERAGE OF VEHICLE MAINTENANCE AND REPAIR AREAS

Conducting vehicle maintenance and repair activities under canopies or inside buildings is an effective pollution prevention measure. Overhead coverage includes use of temporary roofs, permanent roofs, sheds, or indoor facilities. Overhead coverage prevents direct storm water

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contact with the maintenance area, which can potentially contribute automotive waste fluids to the storm water runoff.

2.2.13 PREVENTING DISCHARGES WHEN CHANGING FLUIDS

Preventing spills and other discharges in exposed maintenance and repair areas is an effective storm water BMP. A drip pan can be placed under a vehicle while disconnecting hoses, unscrewing filters, or removing other parts to capture the automotive fluids. However, if fluids are leaked onto exposed surfaces, proper spill response procedures should be performed, as described in Section 2.2.9 of this report.

2.2.14 USING PARTS CLEANING STATIONS

Using a self-contained parts cleaning station can prevent parts cleaning wash-off from contacting storm water. Parts cleaning wash-off can contain cleaning solvents, along with oil residues from the parts. Drip pans, drain boards, and drying racks can be installed as part of the cleaning station for drainage of parts cleaning wash-off into appropriate recycling or disposal equipment.

2.2.15 COLLECTING AND STORING FILTERS, WASTE OIL, AND OTHER FLUIDS

Proper collection and storage of oil filters, waste oil, and other fluids such as transmission fluid, degreasers, antifreeze, hydraulic fluid, and various cleaning solvents is an effective BMP. In addition, recycling these materials can significantly reduce the disposal costs associated with hazardous wastes. Many commercial recycling facilities pick up the wastes on site, but typically accept only separated wastes. Unseparated wastes are harder to recycle, and therefore, increase overall treatment costs. Used oil filters and fluids should be stored in covered drums. If the drums are stored in exposed areas, the drum exterior should be routinely checked for contaminants and wiped clean, if necessary.

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2.3 Storm Water Treatment BMPs

In the event that the practical pollution prevention measures described above are determined to be insufficient, or in areas where additional controls are mandated, it may be necessary to install storm water treatment devices. Descriptions of the available treatment methods for RGO storm water runoff are provided in the following subsections. A summary of these treatment BMPs are included in Table 5. The BMPs described below are limited to those that can be used in urban areas where almost 100 percent of the surface is covered with structures or pavements, and where there is insufficient space available for relatively large structural storm water quality management facilities such as extended dry detention or wet ponds. The information presented is based on a review of published and unpublished studies, discussions with researchers with studies in progress, review of literature provided by manufacturers, and discussions with personnel from numerous regulatory agencies. The descriptions provide the approximate initial installation and yearly maintenance costs. Specific design information is not included in this report; however, references that provide sufficient design level information are cited and a list of useful references is attached to this report.

2.3.1 VEGETATIVE BUFFER AREAS

2.3.1.1 BMP Description

A vegetative buffer area (VBA), also referred to as a biofilter, is a nonstructural BMP designed to remove particulate pollutants by filtration through grass and infiltration through soil. According to U.S. EPA (1991), a VBA is designed as a permanent, maintained strip of planted or indigenous vegetation located between non-point sources of pollution and receiving water bodies to remove or mitigate the effects of non-point source pollutants such as nutrients, pesticides, sediments, and suspended solids. VBAs that are used as storm water conveyance systems usually are called grass swales. A schematic of a typical grass swale is presented as Figure 2.

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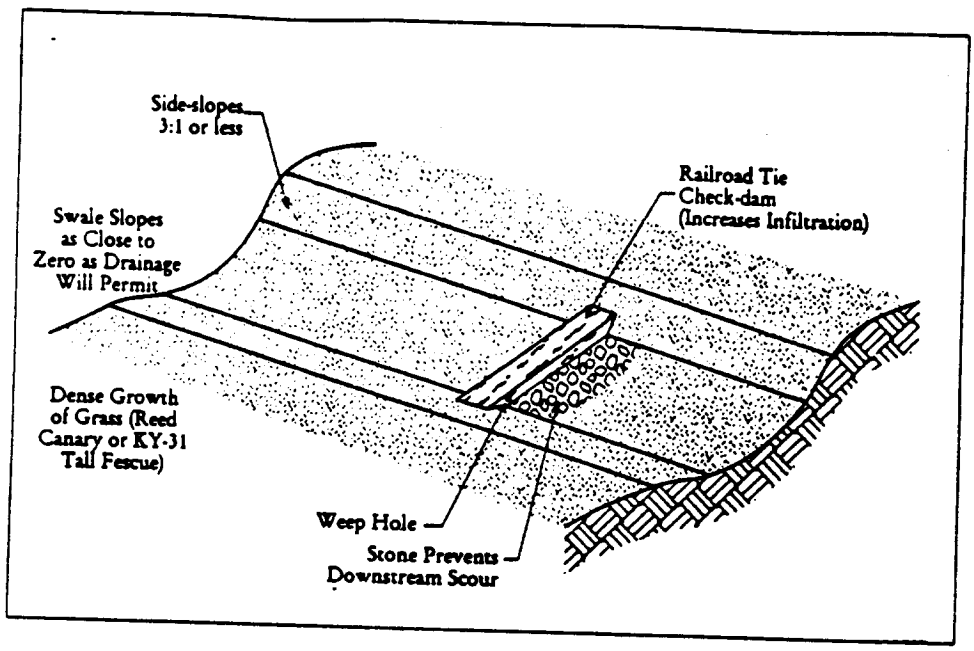

Figure 2 - Schematic of a Typical Grass Swale (MWCOG, 1987)

2.3.1.2 BMP Discussion

The vegetation in a VBA acts to filter and settle out particulate sediment and attached pollutants. The reduction in runoff velocity within the vegetated areas enhances the amount of settling and infiltration that occurs. Nutrient uptake, adsorption, and infiltration mechanisms may decrease the pollutant load entering the natural waterways. The reduced runoff velocity also lessens the potential for resuspension of particles as the flow travels toward the waterway (NVPDC, 1992). Results of modeling studies indicate that VBAs are somewhat effective in removing particulates, although settling is not optimized. VBAs are less effective in removing soluble nutrients (MWCOG, 1987).

Several methods have been proposed to size VBAs (Horner, 1988; FHWA, 1989; IEP, 1991; Tollner, et al., 1976). Using the method of Horner (1988) and assuming a 2-year event, a 3% slope, and a 4-inch grass height, the VBA area required to treat a 1/2 acre impervious site ranges between 400 and 650 square feet (Camp Dresser & McKee et. al., 1993). Typical design lengths for grass swales range from 100 to 200 feet (Horner, 1988). Studies have shown that

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swales are most effectively used on sites with a minimal amount of impervious cover, where peak discharge is less than 5 cubic feet per second (cfs) and velocities are less than 5 feet per second (fps). For these reasons, VBAs may not be a practical on-site BMP for RGOs.

Because VBAs rely on infiltration, fuel leaks or spills may potentially contaminate subsurface soils and, in some cases, groundwater. Even if discharges from leaks and spills can be avoided, metals and other contaminants may accumulate in the subsoils. As with the other infiltration BMPs, there may be waste discharge permitting requirements for VBAs (Camp Dresser & McKee et. al., 1993).

2.3.1.3 Range of Costs

According to MWCOG (1992), construction costs for a typical grass swale may range from $5 to $15 per linear foot, depending on the swale dimensions, grass type, and other possible characteristics. Maintenance costs for swales are estimated to be fairly low. Typical maintenance includes replacement of non-vegetated areas, periodic sediment removal, routine inspections, mowing, watering, and chemical applications.

2.3.2 POROUS PAVEMENT

2.3.2.1 BMP Description

Porous pavements use infiltration to control storm water runoff. This BMP is applicable as a substitute for conventional asphalt pavement on parking areas and low-traffic-volume roads, provided that the grades, subsoil characteristics, and groundwater table conditions are suitable for such use. In general, the grades should be very gentle to flat, the subsoil should have at least moderate permeability ($f \geq 0.27$ in/hr), and the depth to groundwater should be 2 to 4 feet (State of Maryland Department of the Environment). As indicated on Figure 3, porous pavements usually are layered systems, consisting of a porous asphalt surface overlying two layers of aggregate base course. The upper base course layer is designed as a filter layer, and the lower layer serves as a reservoir. A typical porous pavement asphaltic concrete mixture has approximately 16 percent voids, as opposed to conventional asphaltic concrete, which has 3 to 5 percent voids (NVPDC, 1992). The design of the actual porous pavement system is a function of several factors, including the load-bearing capacity of the subgrade, the expected traffic

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volume, and the storage capacity of the reservoir course layer. In turn, the storage capacity of the reservoir course layer is designed with respect to the depth to bedrock and the high water table, design storm, design method, allowable detention time, and existing subsurface soil infiltration rates. For sites with relatively pervious subgrade conditions, a porous pavement may allow infiltration of approximately 60 to 90 percent of the storm water runoff, depending on the rainfall intensity, existing subsurface conditions, and the actual design method used (MWCOG, 1987).

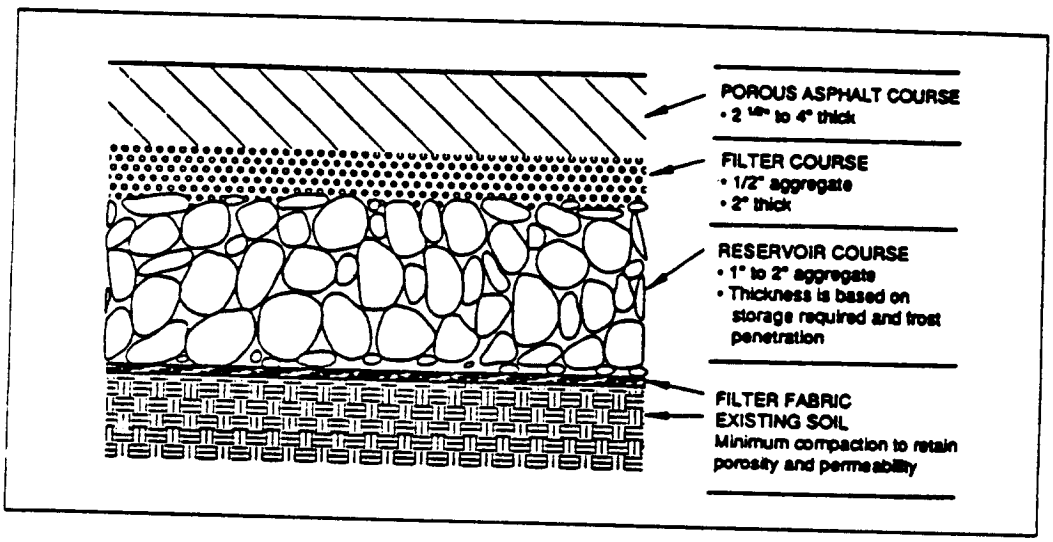

Figure 3 - Schematic of a Typical Porous Pavement (NVPDC, 1992)

2.3.2.2 BMP Discussion

Porous pavements may be an effective storm water BMP for some applications, however, because porous pavements are designed to allow rapid infiltration of storm water into subsurface soils, there is a significant potential for fuel leaks or spills to contaminate subsurface soils and, in some cases, groundwater. Also, depending on the types and concentrations of contaminants in the storm water discharge, metals and other contaminants may potentially accumulate in the subsoils. For these reasons, the use of porous pavements at RGOs is discouraged. Other problems associated with porous pavements are the high probability of pavement pore clogging from larger sized particulates and the absence of effective techniques to mitigate significant clogging that may occur. According to MWCOG (1992), 75 percent of all porous pavement

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systems surveyed in Maryland have partially or totally clogged within five years. For this reason, pretreatment of storm water to remove particulates often is recommended. Other disadvantages of porous pavements include the high level of required construction workmanship, the reduced strength of the pavement system, and the necessity of frequent inspections and maintenance after construction. Also, waste discharge permits may be required for infiltration BMPs, including porous pavements (Camp Dresser & McKee et. al., 1993).

2.3.2.3 Range of Costs

In general, a porous asphalt system may cost as much as 50 percent more than a conventional asphalt section and the necessary materials may be difficult to obtain in some regions of the country. An average additional construction cost over conventional asphaltic pavement was calculated by MWCOG (1987) for a 1-acre porous pavement BMP parking lot, using an 18-inch-thick reservoir course. The calculated construction cost was $75,054 greater than the cost of a conventional pavement section. This estimate did not include costs for initial site testing or pretreatment structures. Routine maintenance of porous pavements may constitute one to two percent of the initial construction costs (MWCOG, 1992).

2.3.3 INFILTRATION TRENCHES

2.3.3.1 BMP Description

An infiltration trench is a shallow excavation filled with a coarse stone medium to create an underground reservoir. The infiltration trench is designed to collect, store, and slowly exfiltrate storm runoff, relying on native subsurface biological, chemical, and physical pollutant removal mechanisms for treatment. A schematic of a typical infiltration trench is presented as Figure 4. The depth of the trench typically ranges from 2 to 10 feet, and the stone medium typically consists of washed aggregate with diameters of 1.5 to 3 inches (State of Maryland Department of the Environment). Infiltration trenches are only suitable for sites with relatively permeable subsurface conditions. It usually is recommended that an infiltration trench be installed at sites in conjunction with a pretreatment device (such as a filter strip, sump basin, or oil/grit separator) to remove particulate matter.

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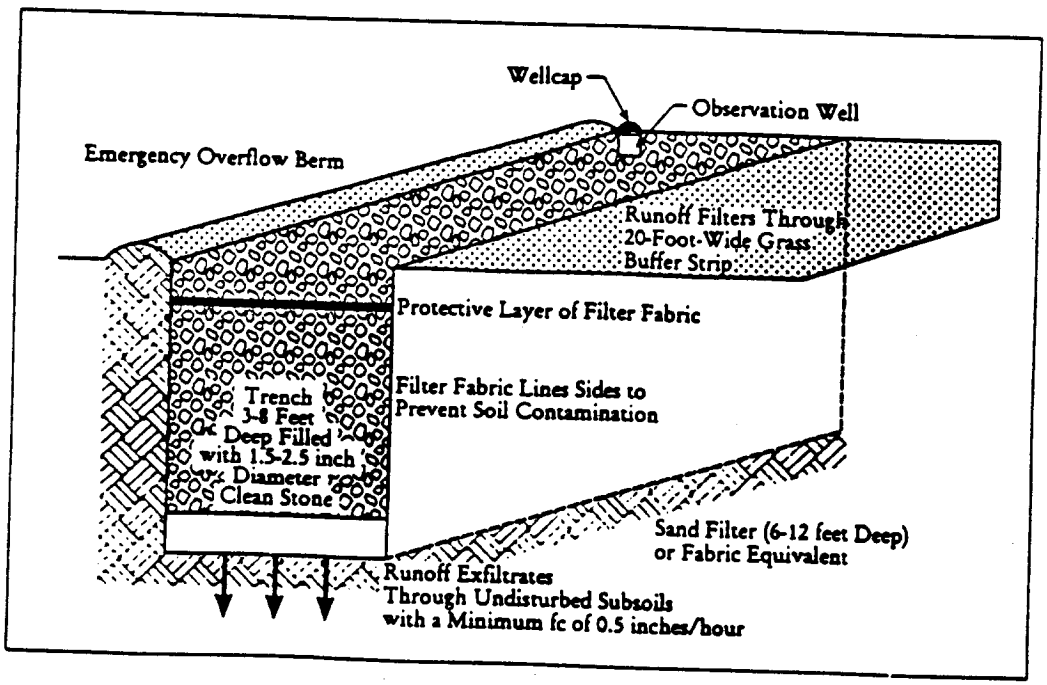

Figure 4 - Schematic of a Typical Infiltration Trench (MWCOG, 1987)

2.3.3.2 BMP Discussion

Where conditions are suitable, an infiltration trench is an adaptable BMP that effectively eliminates discharges containing soluble and particulate pollutants. However, as with other infiltration systems, trenches are not intended to trap coarse sediments and pretreatment is often necessary.

As with porous pavements, infiltration trenches are designed to allow rapid infiltration of storm water into subsurface soils. For this reason, there is a potential for fuel leaks or spills to contaminate subsurface soils and, in some cases, groundwater. RGOs that use infiltration trenches should be provided with a drainage sump equipped with a shut-off valve that can contain spills prior to discharge into the infiltration trench. In addition, depending on the types and concentrations of contaminants in the storm water discharge, metals and other contaminants may accumulate in the subsoils. There may also be waste discharge permitting requirements associated with use of infiltration trenches (Camp Dresser & McKee et. al., 1993).

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Several studies of existing infiltration trenches have revealed high failure rates. A study by Galli (1992) indicated that less than half of the nearly 50 infiltration trenches surveyed were working as designed. Another study indicated that less than one-third still functioned after five years (Schueler, 1994). Failure of infiltration trenches usually is the result of clogging, which can be caused by a variety of factors, including inadequate pretreatment devices and/or an unsatisfactory subsurface location (including poor soil infiltration rates and close proximities to bedrock and/or water table).

2.3.3.3 Range of Costs

The construction cost of infiltration trenches is dependent on the excavation, stone fill, filter cloth, and inlet and outlet pipe costs. Construction costs of trenches with storage volumes ranging from 100 to 10,000 cubic feet range from $1,000 to $10,000 (Wiegand et. al., 1986). Operation and maintenance costs for infiltration trenches range from 5 to 15 percent of the capital cost of the facility, with an average cost of 9 percent (NVPDC, 1992). Also, possible replacement or rehabilitation of infiltration trenches may be required every ten years, and the cost of this may be equal to the initial construction cost (MWCOG, 1992).

2.3.4 SEPARATORS

2.3.4.1 BMP Description

The terms oil/grit separator, oil/water separator, oil and grease trap, and water quality inlet are often used interchangeably to describe treatment devices commonly installed to remove separate-phase hydrocarbons and, in some cases, sediment from storm water runoff. These devices are adaptations of the American Petroleum Institute (API) separator. A schematic of a separator is presented as Figure 5. The separator usually is a long basin with multiple chambers or vaults, typically installed below grade. The devices can be fairly easily fitted into an existing drainage system. The separator is designed to slow water flow which promotes settling of particulates and stratifies the flow to enhance phase separation. In this manner, the heavier particulates settle out, and the oil and grease rise for removal and disposal.

Another type of separator, called the coalescing plate interceptor (CPI) separator has a more advanced design. The CPI separator contains closely spaced plates, which enhance

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removal efficiencies. These are common for treating oil-bearing industrial wastewater, but, because they are typically designed to treat low flow rates with relatively high concentrations of oil, they are not typically used for treating storm water. A CPI separator generally achieves a greater removal efficiency than an API-type separator, but is more costly to purchase and operate.

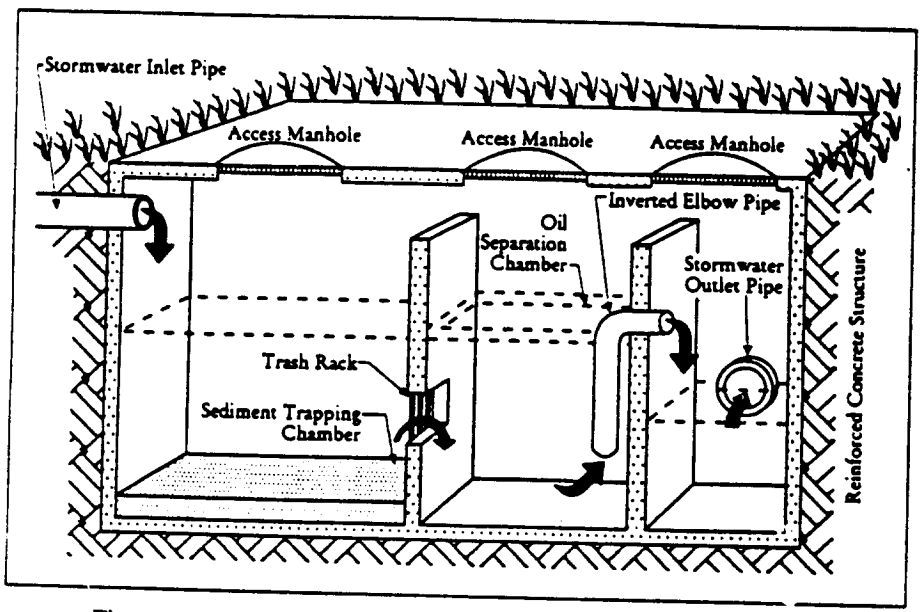

Figure 5 - Schematic of a Typical Oil/Grit Separator (NVPDC, 1992)

2.3.4.2 BMP Discussion

Although separators are commonly used, and are required in certain municipalities, recent research suggests that they are not appropriate as a storm water BMP. Separators are fairly costly to install and maintain, and most designs do not operate effectively with the low oil and grease concentrations typically found in properly operated and maintained RGOs. These devices are moderately effective for removing coarse-grained particulates along with hydrocarbons adsorbed onto particulates, but are typically not effective for removing fine-grained particulates or dissolved contaminants (NVPDC, 1992; MWCOG, 1987).

One significant problem with the use of separators as a storm water BMP is that the devices are typically designed as on-line systems with limited storage capabilities. This results in short detention times, which can cause significant re-suspension and discharge of pollutants. The

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Northern Virginia BMP Handbook (1992) states that the average detention time of a conventional oil/grease separator system is barely more than one hour. Galli (1992) also demonstrated that the detention time within separators frequently is less than 30 minutes during storms. According to the California BMP Manual (Camp Dresser & McKee et. al., 1993), to provide the detention times necessary to effectively treat the majority of runoff resulting from a moderate storm event at a 1/2 acre paved site, a separator 57 feet long is required.

Alternative system designs treat the runoff only from the first approximate 0.06 to 0.12 inch of runoff and bypass the remainder for direct discharge. Although this methodology is somewhat effective in reducing the re-suspension of pollutants, it is ineffective for treating the volume of storm water customarily recommended or required. In Virginia, the Water Quality Volume (WQV), which is the minimum quantity of storm water that must be treated, is 0.5 inch. To store and effectively treat the volume of storm water that would result from this amount of rainfall, the separators would have to be significantly larger than those currently used at most sites.

In addition to alternative designs that bypass peak storm water discharges, several vendors currently offer innovative alternate designs that appear to significantly reduce the potential for re-suspension. However, these devices still rely on phase separation for removal of oil and grease, and have not been demonstrated effective for reducing the relatively low oil and grease concentrations typical of RGOs.

Maintenance is another factor that should be considered when evaluating separators. To function as designed, these devices require regular and frequent clean-out of trapped sediments to minimize re-suspension. The standing pool of water contained within the first chamber, along with the floating oil, must be periodically pumped out and replaced with clean water. Some commercial oil recyclers may accept this material for recycling; otherwise, it must be handled as hazardous waste. The maintenance requirements for separators have been termed the "Achilles heel" of existing separator technology. One study conducted in Maryland (Schueler, 1993) found not a single separator system out of more than 100 inspected that had ever been maintained. According to Schueler (1994), this poor track record is the result of several factors, including: a lack of outside companies that perform the required maintenance; a lack of enforcement by regulators; the expense associated with maintenance; and the actual or perceived

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toxicity of the trapped sediments, resulting in limited options for safe and economical sediment disposal.

2.3.4.3 Range of Costs

The purchase and installation costs for a standard API-type system ranges from approximately $5,000 to $15,000 depending on the size and location of the facility (NVPDC, 1992). In general, separator systems are costly on a runoff volume treated basis, averaging three to four times the unit cost of other BMPs such as trenches or sand filters (MWCOG, 1992). Maintenance costs are estimated to range from $1,000 to $2,000 per site each year (Schueler, 1994).

2.3.5 SAND FILTERS

2.3.5.1 BMP Description

Sand filters are a type of structural BMP that relies on sedimentation and sand filtration to remove total suspended solids, hydrocarbons, and heavy metals. Sand filter technology is rapidly advancing, and a number of sand filter designs are currently available. A schematic of one design, the D.C. Sand Filter, is presented as Figure 6. The D.C. Sand Filter is a three-chamber gravity-flow system. The first chamber and a portion of the second chamber contain a permanent pool, which traps grit and floating material, including oil and grease. The remaining portion of the second chamber contains a 24-inch-thick sand filter underlain by a layer of filter fabric, gravel, and collector pipes. Storm water entering the structure causes the pool to rise and overflow onto the filter. The water percolates through the sand and into the underdrain system. The water then enters a clearwell and is discharged through a connector pipe. Depending on the depth of the sand filter installation and the elevation of the street, storm drain, or other conveyance, it may be necessary to use a sump pump to discharge the treated storm water.

The D.C. Sand Filter is designed as an off-line system that treats only the initial discharge or water quality volume (WQV) from a storm event. The WQV typically used is the volume of runoff from the first 0.5 inch of rainfall. For a 1/2-acre, entirely impervious RGO, the WQV is approximately 900 cubic feet of water. A flow splitter is normally used to divert the remainder of the discharge for direct discharge. The WQV must be stored until it can be processed through

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the sand filter. To store and treat this volume of storm water, the underground vault needs to be 10 feet deep, 10 feet wide, and 23.5 feet long (City of Alexandria).

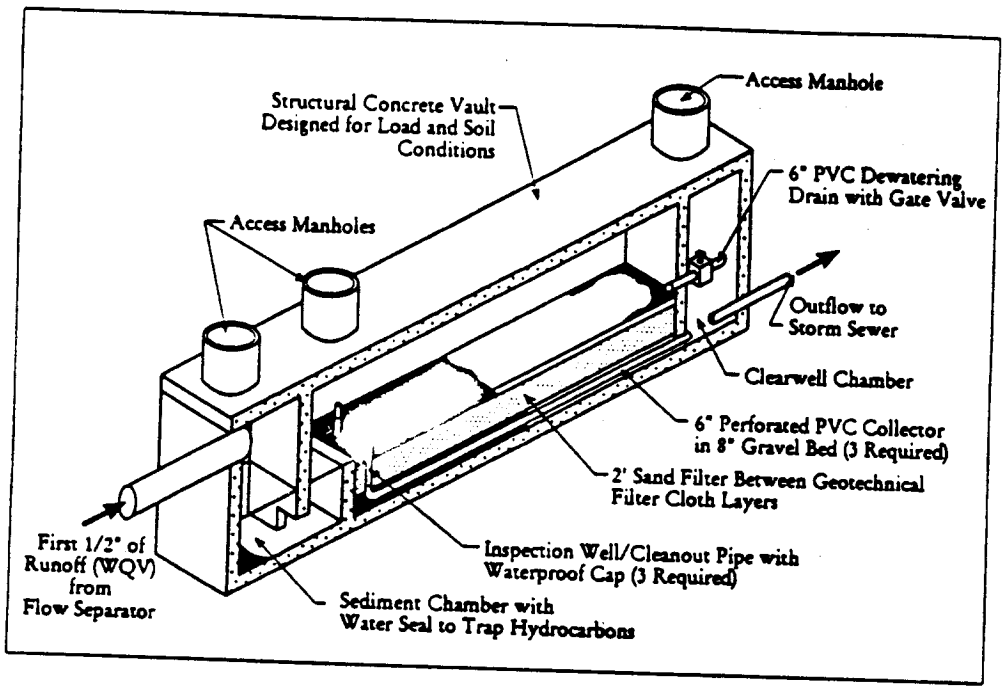

Figure 6 - Schematic of a D.C. Sand Filter (City of Alexandria, 1995)

A schematic of another type of sand filter, the Delaware Sand Filter, is presented as Figure 7. This filter consists of two parallel chambers connected by closely spaced notches in the top of the connecting wall. The filter is normally installed in-line. The first chamber is a sedimentation chamber with a permanent pool. Storm water flows into the first chamber through steel grates that cover the top of the chamber. As storm water enters the system, the permanent pool overflows through the weir notches into the second chamber, which contains an 18-inch-thick sand filter. The storm water percolates through the filter and is discharged through a filter fabric-covered grate located at the downhill end of the filter chamber. In some cases, a gravel bed and collector pipe are placed below the sand filter. The Delaware Sand Filter is designed to accept discharge until it has reached the capacity of the sedimentation chamber. The remaining storm water volume overflows and is discharged without treatment.

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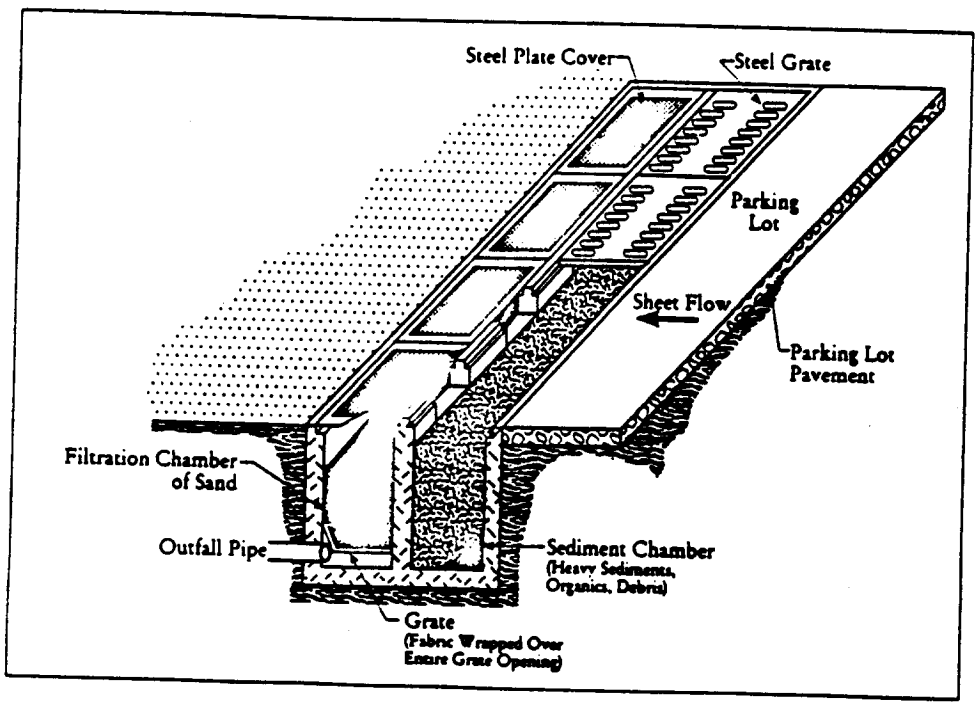

Figure 7 - Schematic of a Delaware Sand Filter (Bell & Nguyen, 1995)

2.3.5.2 BMP Discussion

Several studies have evaluated the performance of sand filters for treating storm water (City of Austin, 1991; Bell & Nguyen, 1995; Horner, 1994). The results of these studies indicate that sand filters are effective in removing particulate pollutants such as total suspended solids, lead, zinc, organic carbon, and organic nitrogen, with removal efficiencies generally exceeding 75 percent. These studies have not provided information regarding capabilities for removing dissolved metals. In some cases this could be significant, because dissolved metals are more mobile and toxic than particulate metals. The studies do indicate that sand filters can discharge nitrate and total dissolved solids, resulting in effluent concentrations of these constituents that are actually higher than influent concentrations. The net increase in nitrate concentrations suggests that nitrification may be occurring in the filter media. The net increase in total dissolved solids concentrations has been attributed to preferential leaching of cations from organic matter trapped on the surface of the sand (Schueler, 1994).

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Sand filters appear to be prone to clogging, particularly in areas where high concentrations of suspended solids are present in storm water. Clogging problems are greatly reduced in areas that are completely impervious. The sedimentation chambers are also prone to freezing when used in colder climates. One significant concern with vault filters, such as the D.C. Sand Filter, is the buildup of potentially explosive gases within the vault and the determination that the vault is considered a "confined space," requiring special health and safety procedures for entry.

Routine maintenance is a fundamental requirement for the proper functioning of sand filters. In general, maintenance operations for sand filters include periodic excavation and replacement of the top layer filter media, regular removal of trash and other larger-sized debris, and routine visual inspections of the overall filter unit, particularly after storm events. Specific recommended maintenance for D.C. Sand Filter units include semi-annual pumping and refilling of the first chamber permanent pool, and replacement of the top two to three inches of sand or overlaying layers of geotechnical cloth every three to five years (Bell & Nguyen, 1995). The disposal of used sand filter media can be an additional maintenance burden if it is classified as a hazardous waste material.

2.3.5.3 Range of Costs

Construction costs for sand filters range from approximately $10,000 to $20,000 per impervious acre treated (Schueler, 1994). Maintenance costs for sand filters have been estimated to be approximately 5 percent of the construction cost per year (MWCOG, 1992), with the required maintenance operations including raking, disposal of contaminated sand, and trash and debris removal.

2.3.6 COMPOST FILTERS

2.3.6.1 BMP Description

Compost filters are similar to sand filters, except they use compost instead of sand for the filter media. Filtration through compost provides filtration, ion exchange, molecular adsorption, and biodegradation for pollutant removal. Currently, leaf compost is the most widely used compost media in storm water compost filters. A suitable compost has maturity, low

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contaminant levels, and high humic acid content and permeability (Schueler, 1994). Filtration through compost is a patented process. The patent holder, CSF Treatment Systems, has developed a drop-in compost storm water filter unit that is sized for small impervious sites such as RGOs. A schematic of a drop-in unit is presented in Figure 8. The drop-in unit is a three-chamber system. The first chamber collects and disperses the flow over the filter media. The second chamber contains an energy dissipator, a scum baffle, the compost filter media, and an overflow route. As storm water enters the second chamber, the design flow is filtered through the media, collected by a perforated underdrain system, and then discharged through a connector pipe. If the design storm is exceeded, overflow into the third chamber will occur and storm water will be discharged without treatment. Depending on the depth of the compost filter installation and the elevation of the street, storm drain or other conveyance, it may be necessary to use a sump pump to discharge the treated or bypassed storm water.

The drop-in unit is an in-line storm water treatment structure. It is typically installed below grade and its pre-cast concrete vaults range from a 6-foot by 12-foot to an 8-foot by 18-foot configuration. These vaults can be connected in series or parallel, depending on the design flow rate. Single drop-in units are rated to treat storm water discharges between 0.28 and 0.64 cubic feet per second. The drop-in filter is sized to handle a maximum of 2.5 gallons per minute per square foot of filter surface area (CSF, 1995).

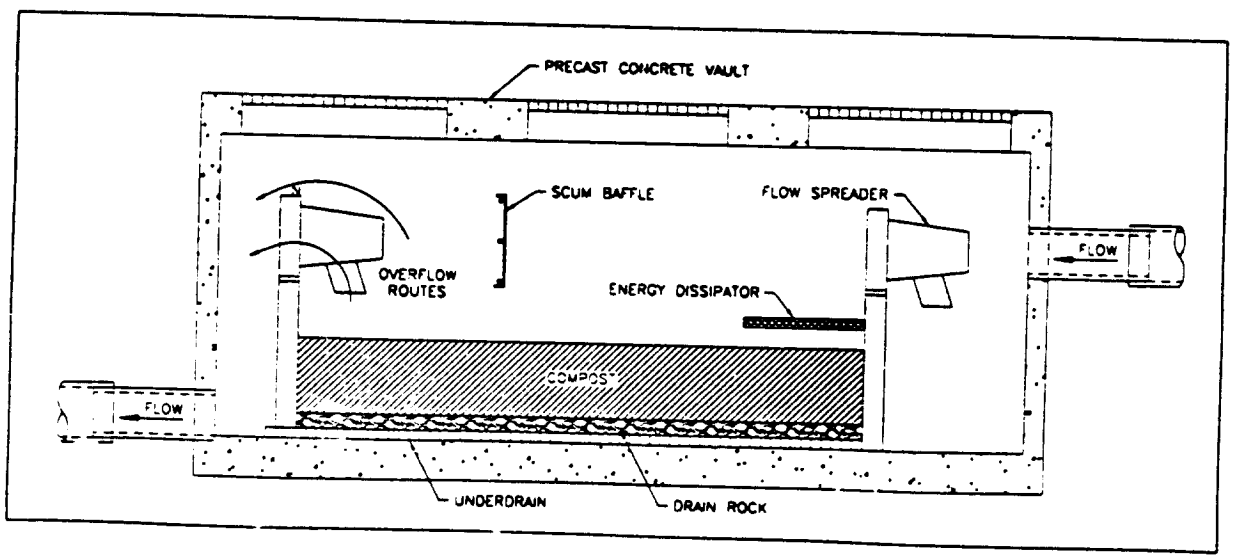

Figure 8 - Schematic of a Drop-In Compost Filter Unit (CSF, 1995)

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2.3.6.2 BMP Discussion

A limited number of compost filters have been installed to date, and there is limited independent data regarding the actual performance. Based on results provided by the manufacturer, the drop-in CSF unit averages approximately 90 percent removal for total suspended solids, and ranges from 85 to 95 percent metals removal. The drop-in unit has also shown high efficiencies in removal of hydrocarbons and oil and grease at the low concentrations (5 to 10 ppm) typical of RGO operations. Average removal rates for hydrocarbons and oil and grease at these concentrations are approximately 80 percent. The Snohomish County (Washington) Surface Water Management Agency, which considers the compost filter to be an experimental BMP, has recently installed two compost filters. The performance of these filters will be monitored over the next wet season.

Some deficiencies of the compost filter system include the potential for a net increase in the concentrations of certain pollutants, including orthophosphorous, organic nitrogen, and total dissolved solids, in the compost filter discharge. The increase in orthophosphorous concentrations may be due to the inability of compost to perform anion exchange of soluble phosphorous, and the increase in organic nitrogen may suggest the occurrence of nitrification within the filter media. The increase in total dissolved solids may be explained through possible cation leaching processes within the compost filter media.

2.3.6.3 Range of Costs

In the northwest, initial costs for drop-in units designed for small sites such as RGOs range between $17,000 and $25,000 (CFS, 1995). For drop-in units, the manufacturer recommends that the compost media be replaced annually. The cost of this maintenance procedure should range from $800 to $1,200 per year (CFS, 1995). According to information provided by the manufacturer, the used compost can be directly landfilled as a non-hazardous waste.

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2.3.7 CATCH BASIN INSERTS

2.3.7.1 BMP Description

Catch basin inserts are filtering devices that can be inserted into existing catch basins. Catch basin insert types include felt bags, tray(s), or "lobster trap" filters. A tray configuration is presented as Figure 9. Catch basin inserts are designed to remove suspended solids, trace metals, and hydrocarbons through mechanical straining, particle settling, and physical adsorption processes.

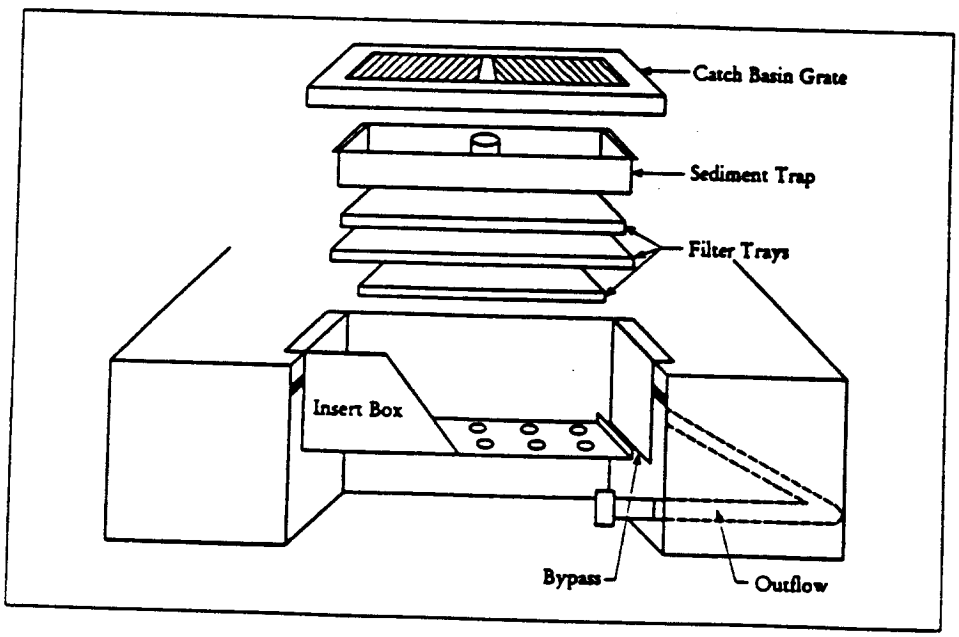

Figure 9 - Schematic of a Catch Basin Insert Tray (McPherson, 1992)

2.3.7.2 BMP Discussion

Results of one study on filter inserts indicates that filter inserts are nominally effective in removing fine sediment and associated pollutants and somewhat more effective in removing coarse material and debris (Interagency Catch Basin Insert Committee, 1995). There is little information regarding the effectiveness for hydrocarbons at the low inflow concentrations typical of properly operated and maintained RGOs. The available data does suggest, however, that removal efficiencies for hydrocarbons are low at low inflow concentrations and somewhat higher

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for high inflow concentrations. Clogging appears to be a potential problem with filter inserts, even on sites that are completely paved. In addition, preliminary indications are that the filters may require frequent replacement or cleaning.

2.3.7.3 Range of Costs

One vendor listed initial costs ranging from $1,600 to $3,200 for a three-tray filter with a flow rate capacity of 180 gpm. Annual maintenance costs for this three-tray system ranged from $6 to $520, depending on the frequency of maintenance and the respective filter media used. Disposal costs also need to be considered, and can vary considerably depending upon the classification of the used filter material waste.

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SECTION 3.0 -- CONCLUSIONS

Based on the results of several storm water studies, it appears that the contaminant levels in storm water runoff from properly operated and maintained RGOs are not appreciably different from those of many other similar sources, such as parking lots and streets. In most cases, the mean concentrations of oil and grease, total suspended solids, and chemical oxygen demand in storm water runoff from RGOs are below the NPDES storm water permit limitations set by several states for vehicle-related activities.

Properly operated and maintained RGOs may currently be implementing a variety of BMPs to reduce storm water contaminant concentrations. Two basic categories of BMPs are presented in this paper. The first category consists of practical pollution prevention measures. These are the basic, common operational practices and relatively simple facility modifications that are effective in preventing storm water pollution. The second category consists of storm water treatment BMPs. These include structural controls that involve installation of equipment to reduce contaminant concentrations in storm water runoff.

Practical pollution prevention measures are appropriate for RGOs because they are simple, cost effective, and protective of storm water quality. In contrast, the storm water treatment BMPs are less appropriate for RGOs because they are ineffective or unproven for treatment of low contaminant concentrations and are relatively expensive to install and maintain.

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Table 1
Summary of Results from WSPA/API Study
(WSPA/API, 1994)

Constituent (units)	RGOs (Pump Islands and Driveways Combined)			Parking Lots (All Use Areas Combined)		
	Number of Samples	Mean	Median	Number of Samples	Mean	Median
Oil & Grease (mg/l)	12	7.1	1	8	5.2	4.6
Total Suspended Solids (mg/l)	12	11.5	10	8	61.7	69.5
Copper (µg/l)	2	20	20	8	20.3	21
Lead (µg/l)	2	7.5	7.5	8	9.75	9.5
Zinc (µg/l)	2	170	170	8	192	190
Cadmium (µg/l)	2	ND	ND	8	ND	ND

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Table 2
Summary of Mean Concentrations from Discrete Land Use Type Study
(Shepp, 1995)

Constituent (units)	Parking Lot (All Day Parking)	RGO	Street	Commercial Parking Lot (Short-Term Parking)
Oil and Grease (mg/l)	0.9	3.7	2.2	12.4
Total Suspended Solids (mg/l)	26.8	41.3	93.3	42.9
Chemical Oxygen Demand (mg/l)	22.1	57.1	60.8	69.1
Total Organic Carbon (mg/l)	13.1	12.2	17.1	41.3
Copper (µg/l)	7.5	9	18.2	21.2
Lead (µg/l)	5.3	17.8	59.1	10.9
Zinc (µg/l)	107.8	204.3	199.6	451.6

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Table 3
Summary of Results from Action Plan Demonstration Project
(Uribe, 1994)

Constituent (units)	Pre-BMP Monitoring (18 Storm Events)		Post-BMP Monitoring (18 Storm Events)	
	Mean	Median	Mean	Median
Oil & Grease (mg/l)	4.61	2.35	9.22	6.45
Total Suspended Solids (mg/l)	59.33	41	81.5	50
Copper (µg/l)	25.22	20	70.63	16
Lead (µg/l)	33.4	26	71.61	21
Zinc (µg/l)	379.4	195	349.33	285
Cadmium (µg/l)	0.66	0.54	0.84	0.57
Chromium (µg/l)	4.16	3.5	3.52	3.2

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Table 4
Comparison of RGO Results with Typical Permit Limitations and NURP

Constituent (units)	Results from RGO Studies			Typical Permit Limitations and Results from NURP				
	WSPA/API Study (mean of all results)	Discrete Land Use Study (mean of all results)	Action Plan Demonstration Project (mean of pre-BMP results)	MO NPDES Permit[1] (daily max/ monthly avg)	AL NPDES Permit[2] (daily max/ monthly avg)	OR NPDES Permit[3] (daily max)	Louisiana Storm Water Quality Standard (daily max)	NURP - Residential/ Commercial Land Use[4]
Oil and Grease (mg/l)	7.1	3.7	4.61	15/10	15/10	10	15[5]	--
Total Suspended Solids (mg/l)	11.5	41.3	59.33	100/50	50/30	--	--	239
COD (mg/l)	--	57.1	--	--	--	--	100[6]	94
Lead (µg/l)	7.5	17.8	26	--	--	--	--	238
Copper (µg/l)	20	9	20	--	--	--	--	53
Zinc (µg/l)	170	204.3	195	--	--	--	--	353

Notes:

1. Draft NPDES permit by the State of Missouri Department of Natural Resources for firms engaged in motor freight transportation and warehousing (permit no. MO-S240000).
2. Draft NPDES permits by Alabama Department of Environmental Management for storm water discharges associated with vehicle and equipment storage, maintenance, repair, and washing (permit no. ALG140000).
3. Final NPDES permit issued by the State of Oregon, Department of Environmental Quality for transportation facilities classified as SIC codes 40, 41, 42 (except 4221-4225), 43, 44, 45, and 5171 (permit no. 1200-T).
4. Results of the National Urban Runoff Program, US EPA, 1983.
5. Standard applies to all storm water discharges (LAC 33:IV.708).
6. Ore Mining and dressing (40 CFR Part 440, Subpart C).

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Table 5
Summary of Storm Water BMPs

BMP	Description	BMP Considerations	Approximate Range of Costs[1]	Suitability for RGOs[2]
Using Spill Containment & Overfill Prevention Equipment	Prevents spills caused by overfilling USTs.	Federally required by 1998, already required in some areas.	Initial costs - high O&M costs - moderate	Suitable for RGOs.
Posting Signs Warning Against "Topping Off"	Minimizes spill occurrences by reminding employees and customers not to top off tanks.	None	Initial costs - low O&M costs - low	Suitable for RGOs.
Installing dispenser "hold open" latches	Minimizes spill occurrences by automating fuel dispensing.	Prevents use of fixed objects such as gas caps, wallets, pieces of wood, etc. to keep dispenser latches open. Can increase potential for spills caused by customer drive-offs unless used in conjunction with break away hoses. May not be allowed by local fire departments.	Initial costs - low to moderate O&M costs - low	Suitable of RGOs.
Providing Canopies and Use of Concrete for Fueling Areas	Canopies over fueling areas can minimize contact of storm water with potential pollutants. Portland Cement Concrete pavements are less prone to soak up fuel than asphaltic concrete.	Canopies also shield customers from sun and rain.	Initial costs - high O&M costs - low to moderate	Suitable for RGOs.
Avoiding Storm Water Runon	Reduces contact of storm water with fueling and maintenance areas.	Should be considered in the initial design of an RGO. Difficult to retrofit in most cases.	Initial costs - low (Initial costs for retrofit can be high) O&M costs - low	Suitable for RGOs.
Maintaining Existing Oil & Grease Separators and other treatment BMPs	The pollutant removal capabilities of oil & grease separators and other treatment BMPs can be maximized by conducting regular sediment cleanout.	Disposal of sediments removed must be properly managed.	Initial costs - N/A O&M costs - low to moderate	Suitable for RGOs with existing structural BMPs.

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Table 5 (Continued)
Summary of Storm Water BMPs

BMP	Description	BMP Considerations	Approximate Range of Costs[1]	Suitability for RGOs[2]
Avoiding RGO Wash Downs	Discharges from RGO wash downs may violate local municipal ordinances and may introduce pollutants to the storm drain system.	Discharges to the sanitary sewer from RGO wash downs may require permits.	Initial costs - low O&M costs - low	Suitable for RGOs.
Sweeping Exposed Areas	Removes particulates thereby reducing the concentrations in storm water runoff.	BMP also enhances RGO appearance.	Initial costs - low O&M costs - low to moderate	Suitable for RGOs.
Eliminating Non-Storm Water Discharges and Illicit Connections	Can eliminate potentially significant sources of storm water pollution.	Discharges from floor drains or other sources to the sanitary sewer may require permits.	Initial costs - low to moderate O&M costs - low	Suitable for RGOs.
Standardizing Spill Response Plans	Eliminates a potential source of storm water pollution by ensuring that spills are promptly detected, contained as necessary, and properly cleaned up.	Employees should be trained to properly implement the spill response plan.	Initial costs - low O&M costs - low	Suitable for RGOs.
Training Employees	Ensures that inspections and spill response procedures are properly conducted by employees.	Training program should emphasize routine inspections and standardized spill response procedures.	Initial costs - low O&M costs - low	Suitable for RGOs.
Providing Overhead Coverage of Vehicle Maintenance and Repair Areas	Prevents direct storm water contact with potential storm water pollution sources.	None	Initial costs - low to high O&M costs - low to moderate	Suitable for RGOs.
Preventing Discharges When Changing Fluids	Eliminates a potential source of storm water pollution.	Recycling fluids when possible can reduce disposal costs.	Initial costs - low O&M costs - low	Suitable for RGOs.

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Table 5 (Continued)
Summary of Storm Water BMPs

BMP	Description	BMP Considerations	Approximate Range of Costs[1]	Suitability for RGOs[2]
Using Parts Cleaning Stations	Prevents parts cleaning wash-off from contacting storm water.	Recycling fluids when possible can reduce disposal costs.	Initial costs - low to moderate O&M costs - moderate	Suitable for RGOs.
Collection and Storage of Oil Filters, Waste Oil, and Other Fluids	Minimizes contact of storm water with potential pollutants.	Used oil filters and automotive fluids should be stored in covered drums. The exterior of drums stored in exposed areas should be wiped clean on a routine basis.	Initial costs - low O&M costs - low	Suitable for RGOs.
Catch Basin Inserts	Filters storm water using devices that are inserted into existing catch basins.	Filter inserts appear to be nominally effective in removing fine sediment and associated pollutants and somewhat more effective in removing coarse material and debris. There is little information regarding the effectiveness for hydrocarbons at the low inflow concentrations typical of properly operated and maintained RGOs. The available data does suggest, however, that removal efficiencies for hydrocarbons are low at low inflow concentrations and somewhat higher for high inflow concentrations. Clogging appears to be a potential problem and frequent replacement may be necessary.	Initial costs - low to high O&M costs - low to high	May prove to be suitable for RGOs, but additional study is necessary to confirm effectiveness with low hydrocarbon inflow concentrations. Use may not be warranted where practical pollution prevention measures effectively control pollutants.
Sand Filters	Relies on sedimentation and filtration through sand to remove total suspended solids, hydrocarbons, and heavy metals.	Effective for removing particulate pollutants. Limited data regarding effectiveness for removing dissolved pollutants. May cause an increase in concentrations of nitrates and total dissolved solids.	Initial costs - high O&M costs - moderate	May be suitable for RGOs but may not be warranted where practical pollution prevention measures effectively control pollutants.

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Table 5 (Continued)
Summary of Storm Water BMPs

BMP	Description	BMP Considerations	Approximate Range of Costs[1]	Suitability for RGOs[2]
Compost Filters	Relies on sedimentation and filtration through compost to remove total suspended solids, hydrocarbons, and heavy metals.	Still considered to be an experimental BMP by many regulators and there is limited independent data regarding pollutant removal capabilities. Results provided by the manufacturer indicate a 90 percent removal for total suspended solids, 80 percent removal for hydrocarbons, and 85 to 95 percent removal for metals. The net export of orthophorous, organic nitrogen, and total dissolved solids may be problematic.	Initial costs - high O&M costs - moderate to high	May prove to be suitable for RGOs but additional independent study is necessary to confirm effectiveness. Use may not be warranted where practical pollution prevention measures effectively control pollutants.
Vegetative Buffer Areas	Removes particulate pollutants by filtration through grass and infiltration through soil.	Requires a fairly large surface area which may be problematic for highly urbanized areas and retrofits. Studies have indicated that vegetative buffer areas are somewhat effective for removing particulates and less effective in removing soluble nutrients. Because vegetative buffer areas rely on infiltration, there is a potential to contaminate subsurface soil and, in some cases, groundwater.	Initial costs - moderate to high O&M costs - low to moderate	Not suitable for most RGOs as detailed in BMP considerations.
Infiltration Trenches	Collects, stores, and slowly exfiltrates storm water runoff into subsoils.	For sites with permeable subsoils, an infiltration trench can effectively eliminate storm water discharges containing soluble and particulate pollutants. However, use at RGOs is problematic because of the significant potential for fuel leaks or spills to contaminate subsurface soils and, in some cases, groundwater. Studies have indicated high failure rates caused by clogging.	Initial costs - moderate to high O&M costs - moderate to high	Not suitable for most RGOs as detailed in BMP considerations.

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Table 5 (Continued)
Summary of Storm Water BMPs

BMP	Description	BMP Considerations	Approximate Range of Costs[1]	Suitability for RGOs[2]
Porous Pavement	Specially designed pavements allow infiltration of approximately 60 to 90 percent of the storm water runoff.	Use is limited to sites with relatively pervious subgrade conditions. Use at RGOs is problematic because of the significant potential for fuel leaks or spills to contaminate subsurface soils and groundwater. Studies also indicate a significant problem with clogging.	Initial costs - high O&M costs - moderate to high	Not Suitable for RGOs.
Separators	Designed to slow water flow which promotes settling of particulates and stratifies flow to enhance phase separation.	Most designs do not operate effectively with the low oil and grease concentrations typical of properly operated and maintained RGOs. Limited ability to remove fine-grained particulates and trace metals. On-line systems with insufficient detention times may cause re-suspension of pollutants.	Initial costs - high O&M - moderate	Not suitable for RGOs.

[1] Basis for cost estimates: Initial costs, Low: < $999, Moderate: $1000 to $5,000, High: $5000+; Operation and maintenance costs; Low: < $499 per year, Moderate: $500 to $999 per year, High: $1000+ per year

[2] Suitability determination based ability of BMP to effectively reduce concentrations of contaminants in storm water discharges from properly operated and maintained RGOs.

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Automotive-Related Industries

Best Management Practices for Storm Water and Industrial Sanitary Sewer Pollution Control



Storm drains and sanitary sewers are the two principal routes by which pollutants reach Santa Monica Bay. Storm drains carry runoff from streets, urban centers, industrial sites, and open spaces into local streams, creeks, marshes, and beaches. Sanitary sewers carry wastes to wastewater treatment plants, but small amounts of some pollutants reach the Bay in the treated water. This manual explains how you can operate your shop to reduce the amounts of antifreeze, heavy metals, oily wastes, and other substances you discharge into storm drains and sanitary sewers. Understanding and using this manual will help you keep your shop in tune, protect the Bay, and comply with local storm water pollution requirements and wastewater discharge restrictions.

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The City of Manhattan Beach gratefully acknowledges
the Santa Clara County Non-Point Source Pollution Control Program
for permission to use this brochure.

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Keep Your Shop in Tune

If your shop is tuned up and running smoothly, you will generate fewer wastes. Following the practices described in this manual will help keep heavy metals, oils, grease, and other pollutants out of the Bay.

This manual describes specific Best Management Practices (BMPs), and is intended as guidance on pollutant control for automotive shops and other automotive-related industries. Many formerly non-regulated activities are now coming under increasing scrutiny and some once acceptable practices are no longer allowed. BMPs are recommended procedures that will assist you in complying with environmental requirements of your municipality, California state agencies, and federal agencies. Specific regulations may vary from one municipality to another, so you should use this manual in conjunction with the ordinances in your community.

This section summarizes the principles behind the BMPs and describes the general guidelines you can use to keep your shop in tune. Specific BMPs are described in the following section.

Run a dry shop.

You can comply more easily with storm water and sanitary sewer requirements by cutting down on the liquids you discharge. If you are successful, your discharge will be limited to wastewater from your lavatories and rain water from your roof and parking lot. Any drains that carry wastewater from your shop must be connected to the sanitary sewer, never the storm drain. Check with your sanitary wastewater authority before connecting any drains to the sanitary sewers; sanitary sewer connections require the approval of the wastewater authority. The floor drainage may also need to be treated before discharge.

Clean up leaks, drips, and other spills without water whenever possible. Use rags for small spills, a damp mop for general clean up, and dry absorbent material for larger spills. Clean up spills immediately. Avoid hosing or wet-mopping your work areas.

Train employees and keep customers informed.

Employee misunderstanding about how to handle waste might lead to a costly pollution incident. Make sure that *all* your employees understand and implement the practices in this manual. Educate your customers, as well, and prevent them from disposing improperly on your site.

Be a zero discharger.

If you succeed in making your shop a dry operation, you can seal off your floor drains and attain zero discharge of cleanup and process wastewater. (Before sealing off any floor drains, be sure to check with your local building and fire departments to ensure the drain is not required to meet their requirements.) Prevent leaks and spills to avoid wet cleanup. Where possible, use shop equipment that does not produce wastewater, such as enclosed parts cleaners. Reduce or eliminate the hazardous materials you use to reduce the quantity of hazardous or "hot" waste you need to dispose. If you are a zero discharger, you may not need to permit, monitor, and maintain a sewer connection and will not need to install costly pretreatment equipment. Contact your sanitary wastewater authority to determine whether you need a permit if you are a zero discharger.

"Close the loop"

A closed-loop system is an easy path to pollution prevention. If you reuse or recycle fluids and other products, they never become a waste to dispose. Close the loop by purchasing reusable or recyclable materials whenever you can. By sending used liquids to a recycler, you can take advantage of special hazardous waste exemptions and cut down on the expense and paper work of handling waste liquids. A solvent service can supply solvent and parts cleaning equipment, and collect the spent solvent. Use other closed-loop services for batteries, metal scrap, and shop rags. To help avoid disposal problems, check with vendors or suppliers that any samples they give you can be returned before accepting them.

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Specific Practices to Control Waste from Auto Shop Activities

This section contains BMPs keyed to specific shop activities, and describes recommended management practices to control waste from that activity.

As a rule, the BMPs are intended to describe "state of the practice," to be implemented every day for the indefinite future, except where the practice is not reasonable or economically feasible. Many of these practices are straightforward, common sense housekeeping activities, and many may already be in place in your shop.

These recommended practices are intended to help you comply with the storm water and sanitary sewer requirements. Local requirements may vary, and you should always check with your municipal agencies for their pollution control requirements. But in general, municipal and state agencies have reviewed these practices and agree that they will help you avoid causing pollution incidents and being subject to enforcement actions.

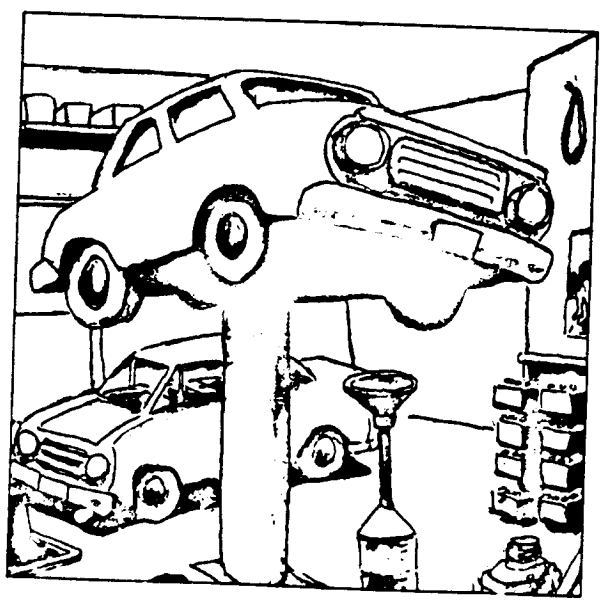
1. Changing Automotive Fluids

Drain and replace motor oil, coolant, and other fluids in a designated special area where there are no connections to the storm drain or the sanitary sewer. Minor spills can be cleaned up before the spill reaches the drains. Collect all spent fluids, store them separately, and take them to a recycler. Store waste liquids as hazardous materials. (Check with your fire department about storage requirements for hazardous materials.) If you do not recycle, the fluids must also be disposed as hazardous materials—with the associated high costs, legal liabilities, and heavy paperwork.

Brake fluid, transmission fluid, gear oil, and similar fluids pose a special problem. These may or may not be recyclable. Check with your recycler and the liquid's supplier. Some may be acceptable to mix with your recyclable motor oil. For the most part, liquids that don't contain chlorinated hydrocarbons are the least costly to recycle and the most widely accepted.

Radiator fluids usually can be accepted by an antifreeze recycler. Collect radiator **flushing fluid** rather than pouring it into your shop drain. Reuse the flushing fluid for as many radiators as possible to minimize waste discharges. If your recycler won't accept the spent flushing fluids, consider changing to another brand of fluid that can be recycled.

If your shop services **air conditioners,** you must use special equipment to collect the freon or other refrigerant. One option is a recycling machine sealed off from the atmosphere that collects the refrigerant as a liquid. Re-using the refrigerant on-site is much less costly than sending it to an off-site recycler (the only other allowable option). In many locations, it is not permissible to vent the refrigerant to the atmosphere. Check with the Air Board and your municipality to find the rules that apply to you.



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2. Working on Engines, Transmissions, and Miscellaneous Repairs

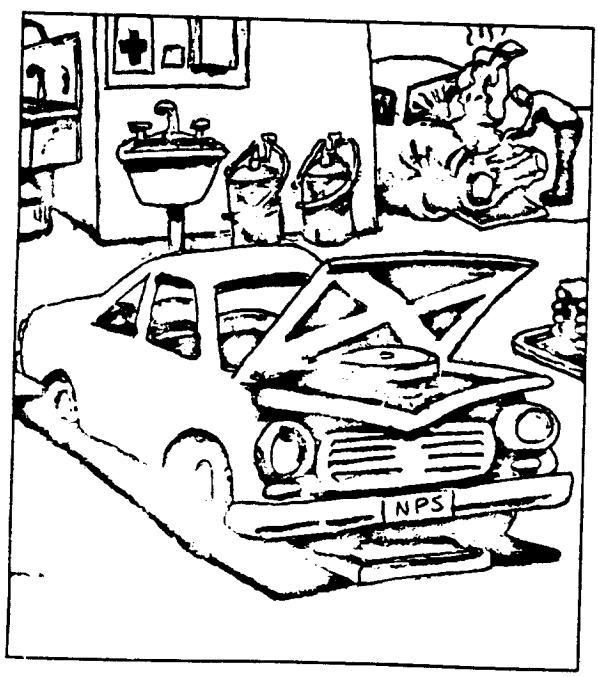
Use the "dry shop" principle whenever you work on a vehicle. When you spill or drip fluids onto the floor, clean them with a rag, instead of letting them evaporate. To reduce spills, use the following practices:

- Collect leaking or dripping fluids in drip pans or containers. If the fluids are kept separate, usually they may be recycled.

- Keep a drip pan under the car while you unclip hoses, unscrew filters, or remove other parts. Use a drip pan under any vehicle that *might* leak while you work on it to keep splatters or drips off the shop floor.

- Use larger, flat, low-brimmed pans under cars where mechanics are working, where ordinary drip pans are too cumbersome

- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave drip pans or other open containers unattended.



3. Preventing Leaks and Spills

Minimize wastes and discharges by practicing careful housekeeping to prevent leaks from vehicles and from equipment on to the shop floor. Put drip pans under leaking autos while you await permission to repair them, then make the repairs as soon as possible. Empty and wipe the drip pans when you move them to another vehicle, or when they are about half-full, to avoid spills.

Maintain your shop floor equipment to identify and repair small leaks. Check all equipment at the end of the working day to find and wipe up leaks and spills.

Be especially careful with ***wrecked vehicles*** as well as cars you keep for parts and vehicles kept on site for scrap or salvage, whether you keep them indoors or out.

- Place drip pans under vehicles as they arrive even if you believe that all fluids have leaked out before the car reaches your shop. Wrecked vehicles can continue to drip for days.

- If you need it, keep a portable inflatable berm on hand for immediate response. An inflatable berm can be quickly deployed to cover an auto-sized area conveniently. Empty the mixed fluids that leak into the berm to a "hot" waste drum.

- Drain all fluids, including air conditioner coolant, from wrecked vehicles and "parts" of cars upon arrival. Some locales require that wrecked cars be drained within 24 hours of arrival. Also drain engines, transmissions, and other used parts you keep for rebuilding.

- If you wish to park wrecked vehicles outdoors, you may need to construct a roofed and drained area for them. Visually monitoring storm water runoff from an area used to store wrecked vehicles may help you determine if roofing and draining is necessary to prevent pollutants from entering the storm drain system. Check with your local fire department before adding or making structural changes to your building.

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4. Cleaning Up Spills

To clean up after a job or at the end of the week, use dry cleanup practices whenever possible. Use a damp mop for routine cleanup, and wet-mop the floor only in the areas that need it. As a regular practice, avoid cleaning up spills and splatters by wet-mopping the whole floor. This could make your mop water a hazardous waste.

Train your employees in how to respond to a spill.

Small spills can be cleaned up with rags. Avoid paper towels. You can "close the loop" on this waste stream by sending used rags to a laundry service. Do not saturate rags with gasoline, solvents, or other hazardous liquids. Inform your laundry of what the shop rags have been used for; when rags are washed, the solvents, oils and metals are transferred to the wastewater discharged from the laundry. Some laundries will not accept heavily soiled rags.

For ***medium-sized spills***, use dry absorbent material (known as "kitty litter") to soak up the liquids. Use absorbent "snakes" as temporary booms to contain a liquid while you clean it up. (These are sold by waste control equipment manufacturers.) Sweep up the used absorbent and snakes and dispose of them with the "hot" wastes. If you keep several vacuums on hand, you can designate one for each waste (motor oil, antifreeze, etc.) and recycle the fluid. *Do not* use vacuums for gasoline, solvents or other volatile fluids because of the explosive hazards. A squeegee can also be used to help contain spills.

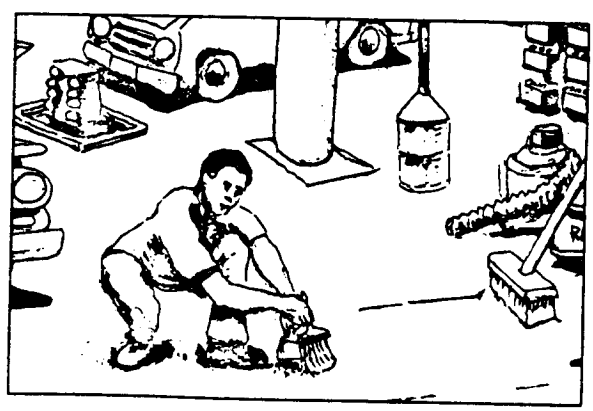
Larger spills in the shop or outdoors must be contained, then cleaned up. Your hazardous materials response plan, filed with your fire department or other hazardous materials "HazMat" authority, describes how to prepare for and respond to larger spills. If you have a floor drain, it must have an emergency shutoff. Temporary plugs can be used to prevent the spill from entering the storm drain and/or sanitary sewer. (Be sure to check with your local building and fire departments before permanently sealing off floor drains.) In the case of a spill, notify the authorities as required in your emergency response plan.

5. Identifying and Controlling Wastewater Discharges

Inspect your shop to be sure you have no unauthorized connections to the sanitary sewer or storm drain system. Sanitary sewer connections require the approval of your wastewater authority, who increasingly contends that any discharge requires costly pretreatment. Storm drain connections from indoor drains or sinks are prohibited.

Make sure employees do not pour waste liquids into floor drains, sinks, outdoor storm drain inlets, or other connections. Spent or leftover cleaning solutions, solvents, and automotive fluids are often toxic and are not acceptable for the sanitary sewer. Post signs at sinks to remind employees, and paint stencils at outdoor drains to inform customers and others. Some sanitary wastewater authorities do not allow the discharge of any material other than sanitary sewage and vehicle wash water to the sanitary sewer.

If your dry cleanup practices are successful, you can seal off your floor drains and become a zero discharger. Permanently seal the drain when you can, or use a temporary inflatable plug for an immediate response. (Check with your local fire and building departments before sealing off any floor drains to ensure the drain is not required to meet their requirements.) You may wish to use the plugged drain as a sump to collect cleanup water or spilled liquids. Pump the liquid into a drum when you need to empty the sump. Check with your HazMat authority or fire department for requirements they may have for this use of a sump.



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6. Fueling Vehicles

In general, your fueling area should be designed and operated to minimize spilled fuel and leaked fluids coming into contact with rainwater. Steps you can take include:

- Clean up spills with the "dry shop" principle. Spread absorbent material and sweep it up with a broom; dispose of it with your "hot" wastes.

- When you clean the area, use a damp cloth on the pumps and a damp mop on the pavement rather than using a hose. If you spray water from a hose here, the water becomes an illegal discharge to the storm drain.

- Install fuel pump shut-offs as directed by your fire department or HazMat authority. Usually this means an automatic shut-off at each pump, and a manual shut-off inside the building.

Fuel tanks, including temporary tanks, need to be permitted by your local fire department and HazMat authority. They will specify design features, such as size of containments. Storm drain and sewer inlets that drain the fueling area must be equipped with a shut-off valve to keep fuel out of the drains in the event of a spill from the pumps.

The *parking and approach areas* outside the immediate fueling area are also of concern. This area will receive rain, so you can't avoid discharging storm water. The storm water will carry off pollutants from spills and leaks from parked or waiting vehicles.

- Don't allow customers to wash their vehicles, change oil, or work on cars in these areas.

- Clean up spills or leaks right away, using the dry shop approach, so they don't contaminate rain water.

7. Removing and Storing Batteries

Return used batteries to your battery supplier, who will recycle them with a battery reclaimer. Batteries sent for reclamation are controlled as a modified category of hazardous wastes. You do not need to file a manifest or pay disposal taxes, but you do need to keep a shipping receipt.

Be careful with cracked or leaking batteries. Store batteries, new and used, either on an open rack (so that you can tell immediately if any are cracked and leaking) or in a double containment (as required by some locales). If you handle a large volume of batteries, or if you work on wrecked vehicles so that you commonly handle cracked batteries, take the following precautions.

- Store cracked batteries in a watertight secondary containment, such as a concrete bin with sealer on the floor and walls. Do this with all cracked batteries, even if you think all the acid has drained out, because they may not be completely dry.

- If you drop a battery, treat it as if it's cracked. Put it into the containment until you're sure it's sound.

- Cracked batteries may be shipped for recycling under the special hazardous waste category if they are carried in proper containers.

- Handle spilled acid from broken batteries with care. If you use baking soda to neutralize spilled acid during cleanup, remember that the residue is still dangerous to handle, and must be disposed of as hazardous waste because it may contain lead and other contaminants.

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8. Cleaning Parts

Clean parts without liquid cleaners whenever possible. Scrape parts with a wire brush, or use a bake oven if one is available.

Prevent spills and drips of solvents and cleansers onto the shop floor. Perform all liquid parts cleaning at a centralized station so the solvents and residues stay in one area. If you immerse parts in liquid, remove them slowly to avoid spillage. Install drip pans, drain boards, and drying racks in a way that directs drips back into the sink or the fluid holding tank. The preferred methods for liquid parts cleaning use zero-discharge equipment, such as:

- Self-contained solvent sinks cycle the liquid directly back into a storage drum. A number of good "closed-loop" services will pick up spent solvent and supply fresh solvent. You must file hazardous waste manifests for transporting the recycled solvents.

- Enclosed parts washers that use filters to remove contaminants can re-use the washing fluid almost indefinitely. Many of these use only hot water and detergents, no hazardous fluids. You need to remove a small amount of oily residue from the machine periodically, which might be a hazardous waste. Check with your oil recycler to see if this residue can be taken with the used oil. Do not put the residue in the sanitary sewer.

- Solvent recycling equipment can purify solvents for re-use on-site.

If you prefer to dispose your own solvent:

- Spent solvent must be disposed of as hazardous waste.

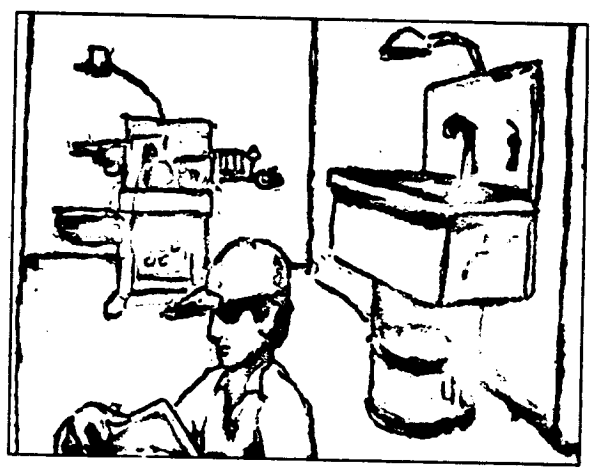
- Don't pour spent solvents, even biodegradable solvents, into your sewer drain.

- Don't dispose of the solvents by storing them in open buckets for evaporation. This leads to air emissions that are not allowed, and produces a residue that is a hazardous waste.

9. Metal Grinding and Finishing

Capture metal filings produced by grinding or machining metal parts. Enclose the unit as much as possible, and keep a bin under the lathe or grinder to hold the filings. Vacuum loose chips and metal filings to keep them out of the storm drains and sanitary sewers. Avoid wet mopping the machine shop floor. Consider spreading a tarpaulin or plastic liner on the floor to collect metal filings, and then carefully empty the tarp into a storage bin.

Capture filings from asbestos brake shoes in a separate container. Asbestos dust must be handled as hazardous waste, stored in an enclosed container and disposed to a hazardous waste hauler. If you contaminate other metal filings with asbestos, none of the mixture may be sent to ordinary scrap dealers.



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10. Storing and Disposing of Waste

The table on the opposite page summarizes the preferred storage and disposal practices for some common solid, liquid, and gaseous wastes. The overriding principle is to keep different kinds of wastes *separate*. If you recycle used oil, antifreeze, or solvents, you know how important it is to keep them separate so the recycler will accept them. Keep your non-recyclables separate, too.

Store and handle *hazardous wastes* in special hazardous waste containers, or closed drums within a secondary containment that is approved by your fire department and HazMat authority. Select a hazardous waste hauler with care; ask for customer recommendations, and review the firm's permits and authorizations. Empty containers,such as oil containers, paint buckets, aerosol cans, antifreeze bottles, and carburetor cleaner solvent cans, are hazardous wastes if they once held hazardous materials. You cannot discard these with the regular trash. Containers should be returned to the vendor or sent to a reclaimer/ refinisher whenever possible.

You might save money if you use more than one drum to hold different "hot" wastes. Keeping brake fluids, transmission fluids, and solvents containing chlorinated hydrocarbons separate from other hazardous wastes may reduce the cost of shipping and disposing of them. To be sure you aren't violating hazardous waste requirements, don't contaminate sewer discharges and clean trash with small amounts of "hot" wastes. Also, be sure to check with your local fire department about storage quantity requirements before separating hazardous materials.

In Manhattan Beach the municipal fire department is the HazMat authority that controls hazardous materials storage, handling, and response. For information about hazardous waste regulations, call the City's Fire Department, or Cal-EPA's Toxic Division.

Waste oil, antifreeze, spent solvents, and other liquids that you hold for *recycling* are special categories of hazardous waste. They must be stored on your site in accordance with hazardous waste requirements, but can be transported under somewhat less stringent requirements. Many recycling services have special variances or permits that reduce your paperwork requirements and allow shipping at reduced cost.

If you store materials *outdoors*, keep them under a roof, cover, or tarpaulin. (Be sure to check with your local fire department before adding or making structural changes to your building.) Keep solid wastes in a covered dumpster to be picked up by municipal trash services. Do not let rain water contact old parts, tires, or dumpsters. Keep scrap parts or other metals in a shed or under a roof, out of the rain. Oily contaminants can wash off long after you think all the oil has drained from parts.

If you keep *liquid containers* outdoors, keep them on a paved impermeable surface and within a berm or other secondary containment to prevent spills from running off into the yard. This is a good idea even if the liquids are not a hazardous waste (and mandatory if they are). Put a lid or cover on buckets or barrels, because any rain that enters becomes an oily waste. Consider keeping all your waste oil and other hazardous liquids indoors or in a locked area, to keep nighttime trespassers away.

Collect *waste metal*, such as used parts, for delivery to a scrap metal dealer. Deliver metal lathe filings to a scrap dealer also.

Used *oil filters* need not be handled as hazardous waste if you meet special handling requirements. Oil filters should be drained into your waste oil bin, stored in leak-proof containers, and delivered to a recycling facility. Some waste oil and fluid recyclers in Los Angeles County will pick up oil filters and help you meet the state regulatory requirements.

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Preferred Storage and Disposal Practices

		Recommended storage	Preferred disposal	Hazardous waste?
Liquids	Waste oil	Drum (segregate)	Oil recycler	Special*
	Transmission fluid	Drum (segregate)	Oil recycler	Special*
	Gear oil	Drum (segregate)	Oil recycler	Special*
	Solvents (solvent sink)	Solvent sink	Solvent Recycler	Special*
	Solvents, thinners, and miscellaneous fluids	Tank ("hot waste") (segregate)	Fluid recycler (where possible or waste hauler)	Possibly
	Brake fluid	Bottle or tank ("hot" waste)	Hazardous waste hauler	Yes
	Antifreeze	Tank (segregate)	Recycler	Special*
	Paints	Original container, with lid	Hazardous waste hauler	Yes
Solids	Used parts: clean metal scrap	Bin (covered or indoors)	Scrap collector	No
	Used oily parts, fuel filters, etc.	Drum	Hazardous waste hauler	Yes
	Metal shavings	Bin (covered or indoors)	Scrap collector	No
	Asbestos filings	Sealed bin	Hazardous waste hauler	Yes
	Tires	Covered or indoors	Tire hauler	No
	Batteries	Open rack	Battery supplier	Special*
	Oil filters	Drum (drain first)	Oil recycler	Special*
	Used rags	Rag bin with lid	Rag laundry	Possibly
	Empty cans, bottles, aerosol cans, etc.	Drum	Municipal trash or hazardous waste hauler	Possibly
	Soiled cleanup absorbent	Drum	Hazardous waste hauler	Yes
Gases	Air conditioner refrigerant	Recycling machine	Reuse in-house	No

**Recyclable under special hazardous waste restrictions.*

11. Selecting and Controlling Inventory

Careful selection and management of the materials you use can make a big difference in your waste handling and disposal and can save you money.

Choose materials that can be recycled. For example, avoid transmission and brake fluids that contain chlorinated hydrocarbons if another type is satisfactory.

Whenever possible, choose parts, cleaning solutions and other materials that are non-toxic. Water-based cleansers can provide acceptable cleaning; experiment with concentrations to find one that works. Avoid halogenated compounds, petroleum-based cleansers, and cleansers with phenol. These are highly toxic, cause difficult problems if spilled to a sewer connection, and are often costly to recycle or dispose. Control your inventory to reduce the wastes you generate. For example:

- Purchase supplies in bulk and keep them in bulk dispensers. This eliminates empty waste containers that, depending on the original contents, may need to be disposed of as hazardous waste.

- Keep on hand only the quantities of materials that you need and use them on a "first-in, first out" scheme, to avoid the need to discard unopened cans when the materials' shelf lives expire.

- Consider reducing the number of different brands or grades of materials that you need to reduce the number of containers.

- Where possible, select suppliers who provide fresh materials and accept the used materials for recycling in order to "close the loop."

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12. Outdoor Parking and Auto Maintenance

If you park vehicles outdoors while they await repair, watch them closely for leaks.

Surround the parking area with a berm to prevent storm water from flowing into dirt lots, grassy areas, or storm drains. If possible, park the cars indoors or under cover of a roof or shed so storm water does not contact the area.

As a rule, avoid using ***outdoor working areas***. If you do use any areas in this way, roof them if possible, and treat them as an extension of your service bays. Keep them clean and use dry cleanup practices. The areas need specific design features, such as:

- Pave the surface with concrete, not asphalt. The automotive fluids may dissolve asphalt, or may be absorbed into the blacktop and released later.
- Drain the surface to a single drain connected to a sanitary sewer. The drain may require an oil/water separator or oil/grease trap. The drain must be approved by your wastewater treatment authority.
- Grade the working area to be higher than the parking lot, or surround it with a berm, to prevent storm water ***run-on***.
- Constructing a roofed space will require a building permit, so consider in advance whether you need to work outdoors. Do not plan to build a new temporary roof when a wrecked vehicle arrives.

Be sure to check with your local fire department before bringing an operation indoors.

If you park wrecked cars outdoors, or store vehicles outdoors, for salvage or for parts, you may need to create a special area to accommodate them. The area should be roofed, paved, mounded or bermed, and kept clean in the same fashion as an outdoor working area.

13. Vehicle Washing, Engine Cleaning, and Automotive Steam Cleaning

If you ***occasionally wash vehicle exteriors*** with water only (no soap), you need to take only simple precautions with the discharge. Check with your wastewater authority because city requirements differ. Generally you may discharge wash water to the storm drain *directly*. Wash cars next to the drain, and don't allow wash water to flow across a parking lot or working area. Or, if you have a landscaped area, wash cars there to avoid any discharge, but be sure *all* wash water soaks into the soil.

You need to make special efforts if ***car washing is a main activity***, such as commercial car wash, or if you regularly clean trucks or dirty, greasy field equipment.

- Wash the vehicles in a covered, contained bay where the water can be collected and recycled as part of a water conservation program.
- Do not discharge vehicle wash water to a storm drain; *this is prohibited.*
- You may need a discharge permit from the sanitary wastewater authority. The discharge usually requires treatment, such as oil and grease removal, and perhaps metals removal. The treatment unit may also need a hazardous waste permit.
- Check into a closed-loop water reuse/recycling system for vehicle washing. This may be more cost effective than burdensome permit fees and analytical costs associated with a discharge permit fee from the sanitary wastewater authority.

Engine cleaning and *steam cleaning* should be done on your site *only* if you are equipped to capture all the water and other wastes. You will need to remove oils and grease in an oil/water separator or a small treatment unit before discharge. This discharge is prohibited from storm drains, requires a permit from your wastewater authority, and may require you to determine whether it is hazardous waste. If you steam clean, use an enclosed bay where the condensed steam can be collected in a sump and treated for discharge.

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14. Training and Educating Employees and Customers

Train your employees to use the practices in this manual. When you first implement them, review your current practices to see how they compare and change practices where it is appropriate. Thereafter, assign experienced workers to train new employees. Review procedures as a group at least once a year.

Check employees' work practices to be sure the BMPs are implemented properly. Post signs as reminders, such as notices not to pour liquid wastes into sinks and floor drains. Develop a routine to inspect shop equipment and procedures regularly. A once-a-week walk-through can help identify potential difficulties before they become major problems.

To keep abreast of new developments, participate in workshops, trade association meetings, and seminars. Trade association publications can be valuable sources of information. Modify your practices whenever you find a new idea that serves your shop better.

Encourage your customers to be waste-conscious. Post "don't top off" signs at gas pumps, and stencil "No dumping! Drains to Ocean" signs at storm drains.

Be aware of customer activities on your site. If they dispose of materials improperly, *you* will be responsible for the violation. Ask your customers not to discard liquids into your trash cans or storm drains. If you have persistent problems, you may need to monitor your customers more carefully at the fuel pumps, storm drains, and other potential disposal areas on your property.

You can help encourage customers to dispose properly if you can accept their waste motor oil and other fluids, either for recycling or for your "hot waste" barrels. Let your customers know how you are minimizing wastes and recycling fluids to show that you are a "good neighbor," and encourage your customers to be the same.



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15. Re-Grade or Re-Pave Outdoor Areas

Strategic grading of parking lots and outdoor spaces can be used to prevent *run-on* storm water from contacting potentially contaminated areas. Run-on is water that flows from elsewhere across the problem area, and can then carry contaminants to the storm drains. Examine your site to identify areas of concern that might contribute pollutants to storm water such as the area around fuel pumps; areas where wrecked vehicles have been parked; areas that were once used for outdoor service; and others.

Grade a parking lot or an approach to fuel pumps to "mound" the fueling area and prevent run-on. Long-term parking areas and places where wrecked vehicles are parked can also be mounded, or can be surrounded by a berm or speed-bump-sized barriers. The diagram below shows a possible grading scheme.

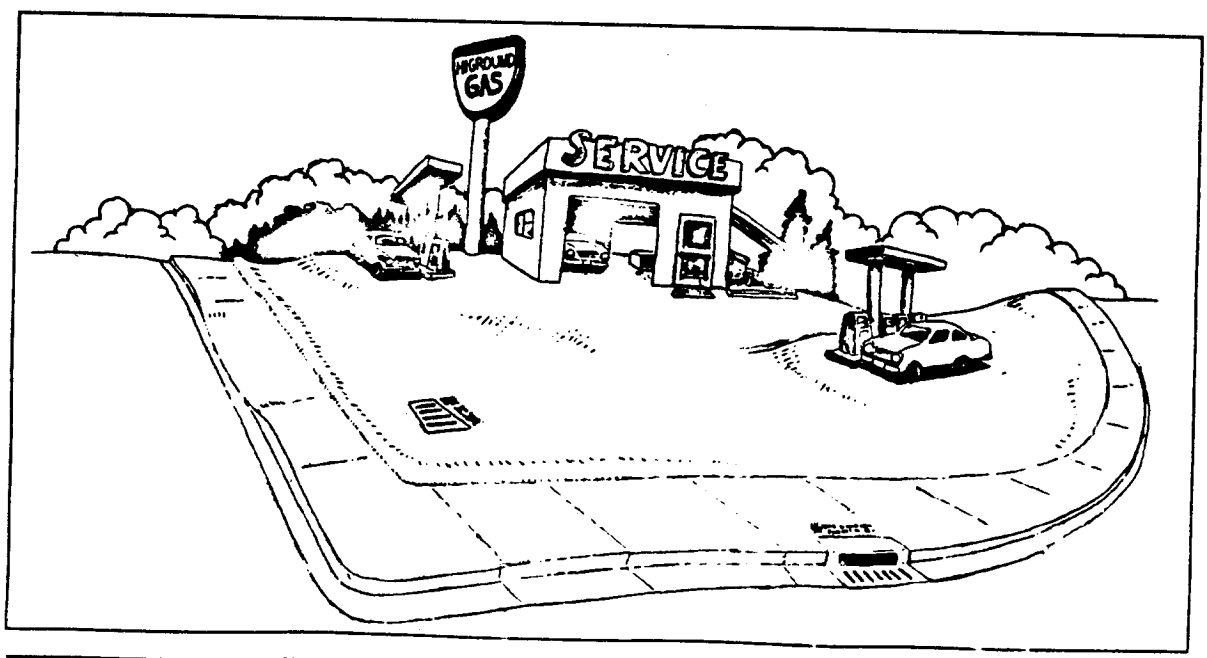
Use concrete paving instead of asphalt in areas where autos may leak fluids such as fueling islands, former or current outdoor work spaces, and heavily-used parking areas. Asphalt absorbs organic contaminants and can be slowly dissolved by some fluids. Over time, these two effects can cause the asphalt to become a source of storm water contaminants. You may need to remove asphalt paving that has been in place for a long time in heavily-used areas. Replace it with concrete if you intend to continue using it as a working space. To determine whether you need to remove the asphalt, you can sample the runoff and have it chemically tested.

16. Recycle Spent Fluids On-Site

On-site equipment to purify and recycle spent automotive fluids can fully "close the loop" and avoid generating a hazardous waste. The residue from the process generally is a hazardous waste, but the equipment itself does not need a hazardous waste treatment permit *if* you reuse any of the materials that come out of the process.

Solvent recycling distillation equipment can distill solvents to almost as high a level of purity as that produced by large hazardous waste treatment facilities. Stills can extend a solvent's lifetime almost indefinitely.

Antifreeze reclamation equipment is made in a wide range of designs, with varying equipment costs and varying quality of results. Simple units merely filter out impurities, and can extend the life of the antifreeze only a short time. More costly equipment can distill antifreeze to nearly-new quality so you can reuse it in another vehicle.



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Automotive Fluid Recyclers

Redondo Recycling
Redondo Beach
(310) 374-4006

Used Battery Collectors

Redondo Recycling
Redondo Beach
(310) 374-4006

Solvent Supply Service Companies

Safety-Kleen Corporation

Many equipment manufacturers and vendors provide on-site treatment units, recycling units, oil/water separators, and other equipment. They are not listed here. This is a partial list of commercial operations. Listing does not constitute a recommendation.

Check the yellow pages for the number of your local fire department.

For information on the urban runoff pollution control program in your area, contact:

City of Manhattan Beach
(310) 545-5621, Ext. 424

Manhattan Beach Fire Department
(310) 545-5621, Ext. 256

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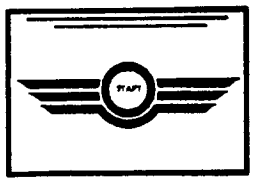

GEOMATRIX

VOL 12

RESULTS OF A RETAIL GASOLINE OUTLET AND COMMERCIAL PARKING LOT STORM WATER RUNOFF STUDY

Prepared For:
Western States Petroleum Association
and
American Petroleum Institute

Prepared By:
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Project No. S2498
September 26, 1994

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EXECUTIVE SUMMARY

This report presents the results of a two-part study of constituents present in simulated storm water runoff from six retail gasoline outlets (RGOs) and four commercial parking lots. The objective of the study is to characterize storm water runoff from RGOs and to compare the results with runoff from commercial parking lots and published urban "background" values. The study was funded by the Western States Petroleum Association (WSPA) and the American Petroleum Institute (API).

The study demonstrates that for the constituents analyzed, median event mean concentrations (EMCs) in storm water runoff from normally operated and maintained RGOs are no higher than those in runoff from commercial parking lots. Additionally, median EMCs of total suspended solids, copper, lead, and zinc in runoff from RGOs and parking lots are no higher than background levels present in urban runoff as established by the National Urban Runoff Program. Furthermore, there are no significant differences in median EMCs in runoff from RGO pump islands and driveways for the constituents analyzed. These results indicate that fueling activities at normally operated and maintained RGOs do not contribute additional significant concentrations of measured constituents in storm water runoff.

In 1987, Section 402(p) was added to the Clean Water Act to establish a framework for addressing storm water discharges under the National Pollutant Discharge Elimination System (NPDES) program. Storm water discharges from commercial facilities, such as RGOs and parking lots, are not included under the initial regulations. However, regulations are now being promulgated that are expected to increase the number and types of dischargers required to obtain NPDES permit coverage for storm water discharges. EPA, in a report to Congress (EPA, 1993), identified several business categories that are not currently regulated by NPDES permits. Automotive service facilities, including RGOs, are included on EPA's list of potential Phase II permittees.

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This study used a simulated rainfall method to induce runoff from representative RGO and parking lot test sites. The RGO and commercial parking lots used as test sites provide a variety of site and operational conditions. Simulated runoff was collected at two areas within each test site. These areas include pump islands and driveways at RGOs and high-use and moderate-use areas within commercial parking lots. Both discrete and composite runoff samples were collected during the 45-minute test. The collected samples were analyzed in accordance with appropriate EPA methods for a variety of constituents including California Code of Regulations Title 26 Metals, total suspended solids, oil and grease, total petroleum hydrocarbons as gasoline (TPHg), and benzene, toluene, ethyl benzene, and total xylenes (BTEX).

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RESULTS OF A RETAIL GASOLINE OUTLET AND COMMERCIAL PARKING LOT STORM WATER RUNOFF STUDY

1.0 INTRODUCTION

This report presents the results of a two-part study of simulated storm water runoff from six retail gasoline outlets (RGOs) and four commercial parking lots. Part I was conducted by Hart Crowser and characterized simulated storm water runoff from five RGOs. Part II was conducted by Geomatrix Consultants, Inc. (Geomatrix) and characterized simulated storm water runoff from four commercial parking lots and one RGO. The study was funded by the Western States Petroleum Association (WSPA) and the American Petroleum Institute (API).

1.1 Objective

The objective of this study is to characterize storm water runoff from RGOs and to compare the results with runoff from commercial parking lots and published urban "background" values.

1.2 Background

In 1972, the Federal Water Pollution Control Act (also known as the Clean Water Act or CWA) was amended to provide that any discharge of pollutants from a point source to Waters of the United States is effectively prohibited unless it is in compliance with a National Pollutant Discharge Elimination System (NPDES) permit. Although this technically prohibits the discharge of pollutants in storm water, the focus at that time was on the bigger problems of industrial waste and sewage treatment.

As more significant sources of water pollution were brought under control, the impact of pollutants in storm water became more noticeable. Water quality studies conducted in the 1970s and 1980s identified urban runoff as a diffuse, or nonpoint source of pollution. In response to these studies, the

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1987 amendments to the Water Quality Act added Section 402(p). This section established a comprehensive two-phased approach for the U.S. Environmental Protection Agency (EPA) to follow in addressing storm water discharges. Five types of storm water discharges are covered under the Phase I program. Dischargers within these five categories, listed below, were required to obtain permit coverage before October 1, 1992:

A) A discharge for which a permit has been issued prior to February 4, 1987;

B) A discharge associated with industrial activities;

C) A discharge from a municipal separate storm sewer system serving a population of 250,000 or more;

D) A discharge from a municipal separate storm sewer system serving a population of 100,000 or more, but less than 250,000; or

E) A storm water discharge determined by the EPA Administrator or the State to contribute to a violation of a water quality standard or to be a significant contributor of pollutants to the waters of the United States.

Discharges from commercial facilities, such as RGOs and parking lots, are not included under the Phase I regulations. However, Phase II regulations now being promulgated are expected to increase the numbers and types of dischargers that are required to obtain NPDES permit coverage for storm water discharges. EPA, in a draft Phase II report to Congress (EPA, 1993), identified several business categories that are not currently regulated by NPDES permits. Automotive service facilities, including RGOs, are included on EPA's list of potential Phase II permittees. It should be noted that, according to the EPA draft Phase II report, the list of potential permittees was created using limited reliable data on storm water problems associated with Phase II sources nationwide. In order to provide data regarding storm water runoff from potential Phase II facilities, WSPA and API commissioned this study.

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1.3 Other Studies

This study utilized the results from a recently published RGO runoff study titled *Action Plan Demonstration Project, Demonstration of Gasoline Fueling Station Best Management Practices, Phase I Report* (September, 1993), prepared by Uribe & Associates and Larry Walker Associates for the County of Sacramento, Water Resources Division. Another storm water runoff study used for the WSPA/API study described herein is the *Final Report of the Nationwide Urban Runoff Program* (December 30, 1983) prepared by the Water Planning Division of EPA. These storm water studies are described in the following sections.

1.3.1 Sacramento County's Action Plan Demonstration Project

Sacramento County's Action Plan Demonstration Project characterized storm water runoff from RGOs and identified potential best management practices (BMPs) to reduce storm water runoff pollution. EPA provided funding of the study by a grant through the San Francisco Estuary Project and the Sacramento County Water Resources Division. The report presents the analytical results of samples collected from storm water runoff from three RGOs in Sacramento County.

The Sacramento County project selected high-volume (over 200,000 gallons per month), self-service RGOs with convenience markets and without automobile repair service bays for the study. The selected RGOs are located less than 2 miles apart.

Within each RGO, a single representative sampling point was selected where station runoff leaves the property and includes drainage from the fueling and auxiliary services areas. Uribe collected samples during six storm events during the 1992/93 wet season. For five of the storms, the sample collection procedure consisted of placing a 1 liter sampling bottle into a below-grade concrete sump. A portion of the storm water discharge flowed over the lip of the sump directly into a sampling bottle. Samples were collected in this manner for each 0.05 inch increment of measured rainfall. The samples were composited immediately into a 5-liter borosilicate bottle until the 5-liter bottle was filled. The one exception to this sample collection method occurred during the first storm event, when only grab samples were collected.

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The initial analytical program for the collected samples included analyses for oil and grease, total suspended solids, metals (13 EPA priority pollutant metals plus aluminum and iron), polycyclic aromatic hydrocarbons (PAHs), and petroleum hydrocarbons. However, some of the metals, petroleum hydrocarbons, and PAHs were consistently not detected in samples collected from the first three storm events. On the basis of these results, the following parameters were selected for the final three sampling events:

- oil and grease
- total suspended solids
- heavy metals (cadmium, chromium, copper, lead, and zinc)

Pertinent results of Sacramento County's Action Plan Demonstration Project are discussed in Sections 3 and 4 of this report.

1.3.2 National Urban Runoff Program

The National Urban Runoff Program (NURP) was conducted from 1978 through 1983 with funding and guidance provided by EPA. NURP characterized the chemicals present in discharges from separate storm sewers that drain residential, commercial, and light industrial areas. NURP included 28 projects across the nation, conducted separately at the local level, but centrally reviewed, coordinated, and guided. The overall objective of the program was to collect information from a national perspective that could be used to characterize urban runoff, assess the impact of non-point source urban runoff on the quality of the receiving waters, and assist decision makers in developing control measures to limit its impact. The results of NURP provide insight on what can be considered background levels for urban runoff.

The resultant NURP data represent a cross section of regional climates, land use types, and ground surface conditions. The sites sampled during NURP included 81 sites that were unaffected by hydraulic devices, such as detention basins, that would modify runoff. A total of more than 2300 separate storm events were sampled from these sites during the project. Samples collected from these sites were tested for the following standard pollutants:

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- total suspended solids
- biochemical oxygen demand
- chemical oxygen demand
- total phosphorus
- soluble phosphorus
- total Kjeldahl nitrogen
- nitrite and nitrate as N
- heavy metals (copper, lead, and zinc)

Pertinent results of NURP are discussed in Sections 3 and 4 of this report.

2.0 WSPA/API PART I AND PART II STORM WATER RUNOFF STUDIES

This section describes both parts of the WSPA/API runoff study. Part I, conducted by Hart Crowser, characterized simulated storm water runoff from five RGOs. Part II, conducted by Geomatrix, characterized simulated storm water runoff from four commercial parking lots and one RGO.

2.1 Literature Search

As part of this WSPA/API study, Hart Crowser conducted a literature search to assess whether analytical results from prior RGO runoff studies were available for this study. The search was conducted using the Dialog Information Database and included a search of the following databases:

NTIS (National Technical Information Service)
COMPENDEX (Engineering Information Inc.)
APILIT (American Petroleum Institute)
Pollution Abstracts/Cambridge Scientific Abstracts
Water Resources Abstracts
WATERNET (American Water Works Association)
CA SEARCH (Chemical Abstracts)

The database search did not disclose prior RGO storm water runoff studies.

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2.2 Selection of RGOs and Test Sites

In selecting the RGOs to be used for the study, the following characteristics were evaluated for a number of potential RGO sites:

- monthly throughput
- site location
- anticipated level of use by commercial vehicles
- age and general appearance
- types of ancillary services provided including on-site vehicle service, car washes, or convenience stores
- on-site drainage patterns and adjacent property usage.

On the basis of this evaluation, six RGOs, all located in Southern California, were selected for the study. The six RGOs provide a representative cross section of typical RGOs in Southern California. Site characteristics for each RGO are summarized in Table 1. Each of the selected RGOs was considered "normally operated and maintained". For the purposes of this study, "normally operated and maintained" signifies that the RGOs utilize Best Management Practices (BMPs) to minimize the buildup of potential storm water contaminants on exposed areas. These BMPs include regular sweeping of exposed areas, regular site inspections, and standardized spill response procedures.

Hart Crowser and Geomatrix conducted the simulated rainfall application and sample collection at a pump island and driveway approach area within each RGO. These areas were selected to provide results that are representative of discharge from the entire RGO. A summary of pavement types and conditions of each test site location is presented in Table 2.

A simulated gasoline spill was performed at RGO 5 to provide data regarding the effectiveness of standardized spill response procedures. One quart of regular unleaded gasoline from a pump nozzle was discharged onto the pump island pavement. Absorbent material was applied to the spill after one

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minute. The absorbent material was then swept up after it appeared to have absorbed the spilled liquid, and the simulated runoff test was conducted.

2.3 Selection of Parking Lots and Test Sites

Commercial parking lots for the second part of the study were evaluated using the following criteria:

- site use
- relative parking duration
- traffic and parking volume
- pavement type, condition, and visual appearance
- cleaning methods and frequency
- on-site drainage patterns.

On the basis of this evaluation, Geomatrix and WSPA selected four commercial parking lots, all located in Southern California, for the study. The selected parking lots were associated with a grocery store, bank, office complex, and restaurant.

Simulated rainfall was applied and samples were collected at two locations at each of the four parking lots for a total of eight test sites. The test locations included one high-use and one moderate-use parking area. The high-use area was generally closer to the commercial facility entrance, and was occupied more frequently than the moderate-use area. Each of the parking lots used scheduled sweeping as a good housekeeping BMP. Parking lot test locations, conditions, and BMPs are summarized in Table 3.

2.4 Testing Methodology

To minimize test variability caused by differing rainfall intensities and durations, both parts of the WSPA/API runoff study used a simulated rainfall method to induce runoff from the study sites. The water-dispensing system and sampling procedures were identical for both the RGO and commercial

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parking lot sites. The water-dispensing system was designed to apply water uniformly over the test area and create sheet flow.

During the test, potable water was distributed uniformly over an approximate 400-square-foot area using a network of perforated 1-inch-diameter, schedule 80 polyvinyl chloride (PVC) pipes elevated approximately 4 feet above the pavement surface. A schematic of the simulated rainfall system is shown on Figure 1.

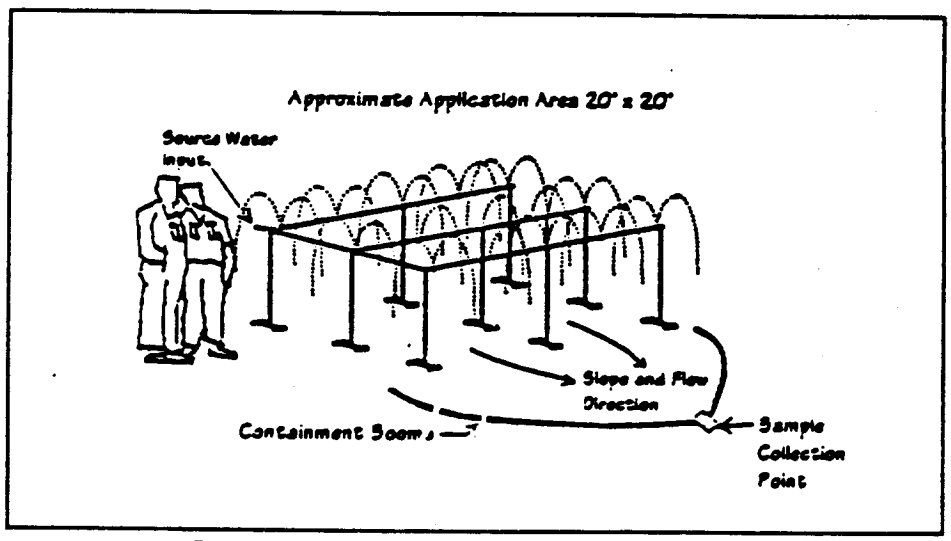

Figure 2. Schematic of Simulated Rainfall System

The water was applied at a rate of approximately 2.0 gallons per minute (gpm) for the duration of the 45-minute test. This rate represents a rainfall rate of approximately 0.008 inch per minute or 0.12 inch every 15 minutes over the test application area.

The runoff from the simulated rainfall application was channeled by gravity and sand-filled polyethylene tubing containment berms to a collection point. The runoff was diverted into a stainless steel collection trough and was pumped into a poly-lined 55-gallon steel drum.

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2.5 Sampling Procedures

Sampling procedures for both Part I and II studies follow the sampling protocol established by SW-846, "Test Methods for Evaluating Solid Waste" (including surface and groundwater).

The following samples were collected at each test site.

- A discrete grab sample from the collection trough every 15 minutes during the 45 minute test
- One composite sample from the runoff pumped into the 55-gallon drum.

In addition to these samples, a background sample of the on-site water supply was collected at the point of discharge from the simulated rainfall application apparatus, and a duplicate oil and grease sample was collected at each test site. Samples were obtained using cleaned sampling equipment and were placed into laboratory-supplied and certified "clean" sampling containers. Collected samples were labeled, placed on ice in a cooler, and maintained under proper chain-of-custody procedures. A trip blank sample was included in each of the sample coolers used for this study.

2.6 Analytical Testing

GTEL Environmental Laboratories, a state-certified analytical laboratory located in Torrance, California analyzed samples from RGOs 1 through 5. Del Mar Analytical, a state-certified laboratory located in Irvine, California analyzed samples from RGO 6 and all four parking lots.

Laboratory analyses were conducted in accordance with appropriate EPA methods. The constituents, analytical test methods, and detection limits used for the WSPA/API study are listed in Table 4.

2.7 Quality Assurance and Quality Control

Both parts of the WSPA/API study described herein developed and implemented field and laboratory quality assurance/quality control (QA/QC) procedures. Field QA/QC includes following strict sampling protocols as specified in the project work plans and standard operating procedures. These

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procedures include an evaluation of cross-contamination through the analysis of trip blanks. Laboratory QA/QC addressed the following:

- Accuracy (analysis of matrix spike recoveries on each batch of samples and regular analysis of certified samples)
- Precision (analysis of matrix spike duplicates)
- Contamination (analysis of method and filter blanks)
- Holding Time (specified holding times associated with each chemical method)
- Certified Methods of Analysis (EPA or State certified methods of analysis).

3.0 RESULTS AND DISCUSSION

The following sections present the results of the WSPA/API simulated runoff study and provide summaries of analytical data from Sacramento County's Action Plan Demonstration Project and NURP. Also presented are data plots that provide comparisons between the pump islands and driveway RGO results and between RGOs, parking lots, and NURP.

3.1 Analytical Results

The analytical results of simulated runoff samples collected from RGOs as part of this study are summarized in Tables 5a and 5b. These tables present the results of both the Part I study conducted by Hart Crowser (RGOs 1 through 5) and the Part II study conducted by Geomatrix (RGO 6). Tables 6a and 6b summarize the results of laboratory analyses of simulated runoff samples from commercial parking lots. Tables 7 and 8, respectively, summarize the results from Sacramento County's Action Plan Demonstration Project and median concentrations reported in NURP.

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3.2 Data Comparisons

This report compares analytical data from the WSPA/API RGOs and parking lots, the Action Plan Demonstration Project, and NURP using a series of box plots, Figures 3 through 24. Box plots are a simple and useful method of data comparison because they effectively describe the characteristics of single groups of data and reveal differences between groups. The components of a typical box plot are presented on Figure 2. Shown on this figure are the 25th and 75th percentiles of the data, which form the top and bottom of the box. Therefore, by definition, 25 percent of the data have a value equal to or less than the bottom line of the box, and 75 percent have a value equal to or less than the top of the box. The middle horizontal line within the box is the median, or 50th percentile (one-half of the data values are equal to or less than the median, and one-half are equal to or greater). Lines (called whiskers) extend vertically from the top and bottom of each box to the maximum and minimum data values.

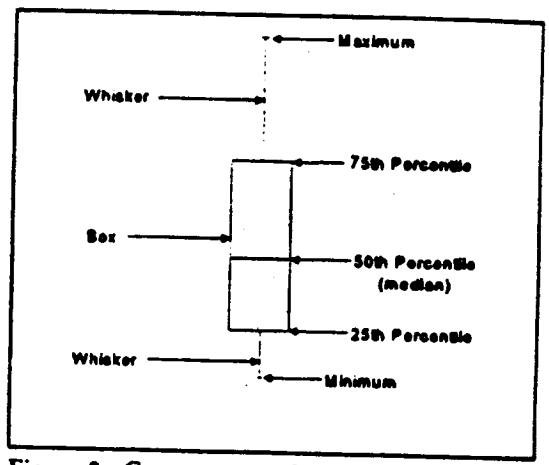

Figure 2. Components of a Typical Box Plot

In many cases, the boxes shown on Figures 3 through 24 are collapsed into a single horizontal line without a whisker extending to the minimum value. The principal reason for the shape of these plots is the presence of a large number of non-detect values in the data set. When this occurs, a single horizontal line is drawn at the detection limit, and the whisker and box segments below the reporting limit are masked.

Although Hart Crowser and Geomatrix collected and analyzed both discrete and composite samples for this study, only the composite results are used for comparison purposes in this report. Composite results are normally considered more meaningful than individual discrete results when evaluating pollutant loading in storm water discharges. It should be noted that the composite sampling

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methodology used for the WSPA/API study is equivalent to the event mean concentration (EMC) reported in NURP (EPA, 1983), which is defined as the total constituent mass discharged divided by the total runoff volume. In addition, the flow weighted sampling method used for the Action Plan Demonstration Project (Uribe, 1993) provides an estimate of EMC. To provide consistency in comparisons between these studies, the EMC will be used when describing composite discharge concentrations for the remainder of this report.

The following sections discuss comparisons between the pump island and driveway results from the WSPA/API RGOs, and between the RGOs, parking lots, and NURP.

3.2.1 Comparison of Results from RGO Pump Islands and Driveways

Figures 3 through 9 present box plots that compare EMC results between the pump islands and driveways from the WSPA/API RGOs for total suspended solids, oil and grease, total petroleum hydrocarbons as gasoline (TPHg) and benzene, toluene, ethyl benzene, and total xylenes (BTEX). On the basis of these box plots, there is no significant difference in median EMCs in runoff from pump islands and driveways for these constituents. In each case, the median EMCs from pump islands and driveways are either at or very near the detection limit. Toluene, ethyl benzene, and total xylenes were detected more frequently in samples from pump islands, primarily the result of the simulated spill on the RGO 5 pump island. However, the EMCs of these chemicals were significantly below the Maximum Contaminant Levels (MCLs) for drinking water established by EPA and California Department of Health Services (Marshack, 1993).

3.2.2 Comparison of Results from RGOs, Parking Lots, and NURP

Figures 10 through 24 present box plots that compare the EMC results for RGOs and parking lots. The median EMC results from NURP are also presented on the data plots for total suspended solids, copper, lead, and zinc (Figures 10, 20, 22, and 24, respectively). On the basis of these box plots, there is no significant difference in median EMCs between RGOs and parking lots for these constituents. In addition, the box plots for total suspended solids, copper, and zinc indicate that for these constituents, there is no significant difference in median EMCs between RGOs, parking lots,

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5.0 REFERENCES

U.S. Environmental Protection Agency, 1993. Storm Water Discharges Potentially Addressed by Phase II of the National Pollutant Discharge Elimination System Storm Water Program, Report to Congress, dated October, 1993.

Uribe & Associates and Larry Walker Associates, 1993. Action Plan Demonstration Project Demonstration of Gasoline Fueling Station Best Management Practices, Phase 1 Report, dated September 1993.

U.S. Environmental Protection Agency, Water Planning Division, 1983. Final Report of the Nationwide Urban Runoff Program, dated December 30, 1983.

Marshack, 1993. A Compilation of Water Quality Goals, Staff Report of the California Regional Water Quality Control Board Central Valley Region, dated May, 1993.

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TABLES

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and background runoff levels established by NURP. The box plots for lead, Figure 22 indicate that the median and range of EMCs from RGOs and parking lots are significantly less than the background values reported in NURP.

4.0 CONCLUSIONS

The results of this study demonstrate that for the constituents analyzed in this report, median EMCs in storm water runoff from normally operated and maintained RGOs are no higher than those in runoff from commercial parking lots. Additionally, median EMCs of total suspended solids, copper, lead, and zinc in runoff from RGOs and parking lots are no higher than background levels present in urban runoff as established by NURP. Furthermore, there are no significant differences in median EMCs in runoff from RGO pump islands and driveways for the constituents analyzed. In all cases, the fueling related constituents (TPHg and BTEX) from pump islands were either not detected or below applicable Maximum Contaminant Levels (MCLs). These results indicate that fueling activities at normally operated and maintained RGOs do not contribute additional significant concentrations of measured constituents in storm water runoff.

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TABLE 2
SUMMARY OF RETAIL GASOLINE OUTLET TEST LOCATIONS AND SURFACE CONDITIONS
WSPA/API STORM WATER RUNOFF STUDY

Test Site	Location	Pavement Type	Pavement Condition	Surface Condition
RGO 1	Pump Island	Portland Cement Concrete	Good	Minor Staining
RGO 1	Driveway Approach	Portland Cement Concrete	Good	No Staining
RGO 2	Pump Island	Portland Cement Concrete	Good	Minor Staining
RGO 2	Driveway Approach	Portland Cement Concrete	Good	Moderate Staining
RGO 3	Pump Island	Portland Cement Concrete	Degraded	Heavy Staining
RGO 3	Driveway Approach	Asphaltic Concrete	Degraded	Heavy Staining
RGO 4	Pump Island	Portland Cement Concrete	Degraded	Moderate Staining
RGO 4	Driveway Approach	Asphaltic Concrete	Good	Moderate Staining
RGO 5	Pump Island	Portland Cement Concrete	Degraded	Moderate Staining
RGO 5	Driveway Approach	Asphaltic Concrete	Degraded	Moderate Staining
RGO 6	Pump Island	Portland Cement Concrete	Good	Moderate Staining
RGO 6	Driveway Approach	Asphaltic Concrete	Good	Moderate Staining

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TABLE 3
SUMMARY OF PARKING LOT TEST LOCATIONS, CONDITIONS, AND BEST MANAGEMENT PRACTICES
WSPA/API STORM WATER RUNOFF STUDY

Test Site	Site Use	Location and Traffic/Parking Condition	Traffic/Parking Frequency	Pavement Type and Condition	Best Management Practices
TS-1	Grocery Store Parking Lot	Near Store Entrance	High Volume of Traffic/Parking Spaces Normally Occupied During Business Hours	Asphaltic Concrete, Good Condition	Daily Sweeping
TS-2	Grocery Store Parking Lot	Located in Perimeter Parking Area	Moderate Traffic Volume/Area Used For Overflow Parking, Spaces Only Used During Peak Periods	Asphaltic Concrete, Good Condition	Daily Sweeping
TS-3	Bank Parking Lot	Near Bank Entrance/Parking	High Volume of Traffic/Parking Spaces Normally Occupied	Asphaltic Concrete, Good Condition	Daily Sweeping
TS-4	Bank Parking Lot	Located in Perimeter Parking Area	Moderate Traffic Volume/Spaces Only Used During Peak Periods	Asphaltic Concrete, Good Condition	Daily Sweeping
TS-5	Office Complex Parking Lot	Near Office Entrance	High Volume of Traffic/Parking Spaces Normally Occupied	Asphaltic Concrete, Good Condition	Daily Sweeping
TS-6	Office Complex Parking Lot	Located in Perimeter Parking Area	Moderate to High Traffic Volume/Spaces Normally Filled During Business Hours	Asphaltic Concrete, Slightly Degraded Condition	Daily Sweeping
TS-7	Restaurant Parking Lot	Near Restaurant Entrance	High Traffic Volume/Parking Spaces Normally Occupied During Business Hours	Asphaltic Concrete, Moderately Degraded Condition	Sweeping Every Other Day, Occasional Washdown
TS-8	Restaurant Parking Lot	Located in Perimeter Parking Area	Moderate to High Traffic Volume	Asphaltic Concrete, Moderately Degraded Condition	Sweeping Every Other Day, Occasional Washdown

TABLE 5a

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Summary of Analytical Results for Non-metal Constituents of Simulated Runoff from Retail Gasoline Outlets
WSPA/API Storm Water Runoff Study

RGO Designation	Location	Sample Type	Sampling Date	pH	Conductance (umhos/cm)	Total Suspended Solids (mg/l)	Oil and Grease (mg/l)	TPH (ug/l)	Benzene (ug/l)	Toluene (ug/l)	Ethyl Benzene (ug/l)	Total Xylenes (ug/l)
RGO 1	Source	Background	09/04/92	NA	NA	ND(10)	ND(1)	ND(100)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
RGO 1	Pump Island	15 minute	09/04/92	NA	NA	ND(10)	1	ND(100)	ND(0.3)	0.5	ND(0.3)	0.7
RGO 1	Pump Island	30 Minute	09/04/92	NA	NA	ND(10)	ND(1)	ND(100)	ND(0.3)	0.6	ND(0.3)	0.6
RGO 1	Pump Island	45 Minute	09/04/92	NA	NA	ND(10)	1	ND(100)	ND(0.3)	0.6	ND(0.3)	1.4
RGO 1	Pump Island	Composite	09/04/92	NA	NA	ND(10)	ND(1)	ND(100)	ND(0.3)	0.6	ND(0.3)	1.3
RGO 1	Driveway	15 minute	09/04/92	NA	NA	ND(10)	2	ND(100)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
RGO 1	Driveway	30 Minute	09/04/92	NA	NA	ND(10)	1	ND(100)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
RGO 1	Driveway	45 Minute	09/04/92	NA	NA	ND(10)	2	ND(100)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
RGO 1	Driveway	Composite	09/04/92	NA	NA	ND(10)	1	ND(100)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
RGO 2	Source	Background	09/10/92	NA	NA	ND(10)	ND(1)	ND(100)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
RGO 2	Pump Island	15 minute	09/10/92	NA	NA	ND(10)	ND(1)	ND(100)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
RGO 2	Pump Island	30 Minute	09/10/92	NA	NA	ND(10)	ND(1)	ND(100)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
RGO 2	Pump Island	45 Minute	09/10/92	NA	NA	ND(10)	ND(1)	ND(100)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
RGO 2	Pump Island	Composite	09/10/92	NA	NA	ND(10)	ND(1)	ND(100)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
RGO 2	Driveway	15 minute	09/10/92	NA	NA	ND(10)	1	ND(100)	1.5	ND(0.3)	ND(0.3)	ND(0.6)
RGO 2	Driveway	30 Minute	09/10/92	NA	NA	ND(10)	ND(1)	ND(100)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
RGO 2	Driveway	45 Minute	09/10/92	NA	NA	ND(10)	ND(1)	ND(100)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
RGO 2	Driveway	Composite	09/10/92	NA	NA	ND(10)	1	ND(100)	0.4	ND(0.3)	ND(0.3)	ND(0.6)
RGO 3	Source	Background	09/03/92	NA	NA	11	ND(1)	ND(100)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
RGO 3	Pump Island	15 minute	09/03/92	NA	NA	13	8	ND(1000)	ND(3)	7.9	ND(3)	20
RGO 3	Pump Island	30 Minute	09/03/92	NA	NA	ND(10)	3	ND(100)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
RGO 3	Pump Island	45 Minute	09/03/92	NA	NA	ND(10)	2	ND(100)	ND(0.3)	0.4	ND(0.3)	1.1
RGO 3	Pump Island	Composite	09/03/92	NA	NA	ND(10)	3	ND(100)	ND(0.3)	0.3	ND(0.3)	1.1
RGO 3	Driveway	15 minute	09/03/92	NA	NA	ND(10)	1	ND(1000)	ND(3)	ND(3)	ND(3)	ND(6)
RGO 3	Driveway	30 Minute	09/03/92	NA	NA	ND(10)	ND(1)	ND(1000)	ND(3)	ND(3)	ND(3)	ND(6)
RGO 3	Driveway	45 Minute	09/03/92	NA	NA	ND(10)	1	ND(100)	0.5	4.5	1.1	12
RGO 3	Driveway	Composite	09/03/92	NA	NA	ND(10)	ND(1)	ND(100)	ND(0.3)	0.6	ND(0.3)	3.4
RGO 4	Source	Background	09/09/92	NA	NA	14	15	ND(100)	ND(0.3)	0.3	ND(0.3)	7.1
RGO 4	Pump Island	15 minute	09/09/92	NA	NA	ND(10)	4	ND(100)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
RGO 4	Pump Island	30 Minute	09/09/92	NA	NA	ND(10)	2	ND(100)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
RGO 4	Pump Island	45 Minute	09/09/92	NA	NA	ND(10)	8	ND(100)	ND(0.3)	0.4	ND(0.3)	1.5
RGO 4	Pump Island	Composite	09/09/92	NA	NA	13	1	ND(100)	ND(0.3)	ND(0.3)	ND(0.3)	1.4
RGO 4	Driveway	15 minute	09/09/92	NA	NA	11	2	ND(1000)	ND(3)	ND(3)	ND(3)	ND(6)
RGO 4	Driveway	30 Minute	09/09/92	NA	NA	10	1	ND(100)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
RGO 4	Driveway	45 Minute	09/09/92	NA	NA	12	ND(1)	ND(100)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
RGO 4	Driveway	Composite	09/09/92	NA	NA	ND(10)	ND(1)	130	ND(0.3)	ND(0.3)	ND(0.3)	ND(.6)
RGO 5	Source	Background	09/17/92	NA	NA	ND(10)	ND(1)	ND(100)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
RGO 5	Pump Island	15 minute	09/17/92	NA	NA	ND(10)	9	ND(1000)	ND(3)	9.5	ND(3)	19
RGO 5	Pump Island	30 Minute	09/17/92	NA	NA	ND(10)	7	ND(1000)	ND(3)	14	5	37
RGO 5	Pump Island	45 Minute	09/17/92	NA	NA	ND(10)	9	180	1	13	6.3	41
RGO 5	Pump Island	Composite	09/17/92	NA	NA	ND(10)	34	ND(1000)	ND(3)	9.5	3.4	22
RGO 5	Driveway	15 minute	09/17/92	NA	NA	ND(10)	9	ND(2500)	ND(7.5)	ND(7.5)	ND(7.5)	ND(15)
RGO 5	Driveway	30 Minute	09/17/92	NA	NA	ND(10)	11	ND(1000)	ND(3)	ND(3)	ND(3)	ND(6)
RGO 5	Driveway	45 Minute	09/17/92	NA	NA	13	6	ND(2500)	ND(7.5)	ND(7.5)	ND(7.5)	ND(15)
RGO 5	Driveway	Composite	09/17/92	NA	NA	ND(10)	29	ND(2500)	ND(7.5)	ND(7.5)	ND(7.5)	ND(15)
RGO 6	Driveway	Source	05/04/94	7.6	980	ND(5)	ND(1)	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.5)
RGO 6	Driveway	15 minute	05/04/94	7.6	1000	28	2.1	NA	NA	NA	NA	NA
RGO 6	Driveway	30 Minute	05/04/94	7.6	980	14	1.7	NA	NA	NA	NA	NA
RGO 6	Driveway	45 Minute	05/04/94	7.9	1000	13	ND(1)	NA	NA	NA	NA	NA
RGO 6	Driveway	Composite	05/04/94	7.9	1000	19	2.6	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.5)
RGO 6	Driveway	Duplicate	05/04/94	NA	NA	NA	6	NA	NA	NA	NA	NA
RGO 6	Driveway	Trip Blank	05/04/94	NA	NA	NA	NA	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.5)
RGO 6	Pump Island	15 minute	05/04/94	8.0	1000	21	3	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.5)
RGO 6	Pump Island	30 Minute	05/04/94	8.1	1000	ND(5)	3	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.5)
RGO 6	Pump Island	45 Minute	05/04/94	8.1	980	ND(5)	7	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.5)
RGO 6	Pump Island	Composite	05/04/94	8.1	1000	16	9.6	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.5)
RGO 6	Pump Island	Duplicate	05/04/94	NA	NA	NA	4.8	NA	NA	NA	NA	NA
RGO 6	Pump Island	Trip Blank	05/04/94	NA	NA	NA	NA	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.5)

NA — Not analyzed.
ND(10) — Not detected at specified detection limit.
[illegible] — Increased analytical method detection limit was caused by matrix effect (flooding).

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TABLE 5b
Summary of Analytical Results for Metal Constituents of Simulated Runoff from Retail Gasoline Outlets
WSPA/API Storm Water Runoff Study

RGO Designation	Location	Sample Type	Sampling Date	Aluminum (mg/l)	Antimony (mg/l)	Arsenic (mg/l)	Barium (mg/l)	Beryllium (mg/l)	Cadmium (mg/l)	Chromium (VI) (mg/l)	Chromium (mg/l)	Cobalt (mg/l)	Copper (mg/l)	Iron (mg/l)	Lead (mg/l)	Mercury (mg/l)	Molybdenum (mg/l)	Nickel (mg/l)	Selenium (mg/l)	Silver (mg/l)	Thallium (mg/l)	Vanadium (mg/l)	Zinc (mg/l)
RGO 1	Pump Island	15 minute	08/04/92	NA	ND(04)	ND(1)	0 13	ND(01)	ND(03)	NA	ND(04)	ND(02)	ND(2)	NA	ND(1)	ND(001)	ND(02)	ND(1)	ND(04)	ND(05)	ND(4)	ND(2)	ND(1)
RGO 2	Pump Island	15 minute	08/10/92	NA	ND(04)	ND(1)	ND(02)	ND(01)	ND(03)	NA	ND(04)	ND(02)	ND(2)	NA	ND(1)	ND(001)	ND(02)	ND(1)	ND(04)	ND(05)	ND(4)	ND(2)	ND(1)
RGO 3	Pump Island	15 minute	08/03/92	NA	ND(04)	ND(1)	0 09	ND(01)	ND(03)	NA	ND(04)	ND(02)	ND(2)	NA	ND(1)	ND(001)	ND(02)	ND(1)	ND(04)	ND(05)	ND(4)	ND(2)	0 2
RGO 4	Pump Island	15 minute	08/08/92	NA	ND(04)	ND(1)	0 09	ND(01)	ND(03)	NA	ND(04)	ND(02)	ND(2)	NA	ND(1)	ND(001)	ND(02)	ND(1)	ND(04)	ND(05)	ND(4)	ND(2)	0 2
RGO 5	Pump Island	15 minute	08/17/92	NA	ND(04)	ND(1)	0 08	ND(01)	ND(03)	NA	ND(04)	ND(02)	0 2	NA	ND(1)	ND(001)	ND(02)	ND(1)	ND(04)	ND(05)	ND(4)	ND(2)	0 2
RGO 6	Driveway	Source	08/04/94	ND(5)	ND(005)	ND(01)	0 11	ND(001)	ND(005)	ND(026)	ND(005)	ND(05)	0 009	ND(05)	0 004	ND(0002)	ND(1)	ND(05)	ND(01)	ND(05)	ND(001)	ND(05)	0 027
RGO 6	Driveway	15 minute	08/04/94	ND(5)	NA	NA	NA	NA	ND(005)	NA	ND(005)	NA	0 017	0 41	0 008	NA	NA	ND(05)	NA	NA	NA	NA	0 2
RGO 6	Driveway	30 minute	08/04/94	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
RGO 6	Driveway	45 minute	08/04/94	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
RGO 6	Driveway	Composite	08/04/94	ND(5)	NA	NA	NA	NA	ND(005)	NA	ND(005)	NA	0 026	0 5	0 002	NA	NA	ND(05)	NA	NA	NA	NA	0 16
RGO 6	Driveway	Duplicate	08/04/94	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
RGO 6	Driveway	Test Blank	08/04/94	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
RGO 6	Pump Island	15 minute	08/04/94	ND(5)	ND(005)	ND(01)	0 059	ND(001)	ND(005)	ND(026)	ND(005)	ND(05)	0 014	0 21	0 004	ND(0002)	ND(1)	ND(05)	ND(01)	ND(05)	ND(001)	ND(05)	0 16
RGO 6	Pump Island	30 minute	08/04/94	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
RGO 6	Pump Island	45 minute	08/04/94	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
RGO 6	Pump Island	Composite	08/04/94	ND(5)	ND(005)	ND(01)	0 1	ND(001)	ND(005)	ND(026)	ND(005)	ND(05)	0 013	0 27	0 008	ND(0002)	ND(1)	ND(05)	ND(01)	ND(05)	ND(001)	ND(05)	0 16
RGO 6	Pump Island	Duplicate	08/04/94	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
RGO 6	Pump Island	Test Blank	08/04/94	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NA — Not analyzed
ND( ) — Not detected at specified detection limit
Italics — Elevated analytical method detection limit was caused by matrix effect (dashing)

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TABLE 6a
Summary of Analytical Results for Non-metal Constituents of Simulated Runoff from Parking Lots
WSPA/API Storm Water Runoff Study

Test Site	Sample Type	Sampling Date	pH	Total Suspended Solids (mg/l)	Conductance (umhos/cm)	Oil and Grease (mg/l)	TPH (8015-G) (ug/l)	Benzene (ug/l)	Toluene (ug/l)	Ethyl benzene (ug/l)	Total Xylenes (ug/l)
TS-1	Source	01/12/94	7.8	ND (5)	1100	ND(1)	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
TS-1	15	01/12/94	7.8	250	1200	820	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
TS-1	30	01/12/94	7.8	10	1100	23	ND(50)	ND(0.3)	NC(0.3)	ND(0.3)	ND(0.6)
TS-1	45	01/12/94	7.8	10	1100	24	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
TS-1	Composite	01/12/94	7.7	6	1200	11	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
TS-1	Duplicate (20)	01/12/94	NA	NA	NA	230	NA	NA	NA	NA	NA
TS-1	Trip Blank (20)	01/12/94	NA	NA	NA	NA	ND(50)	ND(0.3)	ND(0.3)	ND(0.5)	ND(0.5)
TS-2	15	01/12/94	7.7	170	1200	13	NA	NA	NA	NA	NA
TS-2	30	01/12/94	7.4	46	1200	7.4	NA	NA	NA	NA	NA
TS-2	45	01/12/94	7.8	25	1100	3.5	NA	NA	NA	NA	NA
TS-2	Composite	01/12/94	7.7	77	1200	7	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
TS-2	Duplicate (20)	01/12/94	NA	NA	NA	24	NA	NA	NA	NA	NA
TS-2	Trip Blank (20)	01/12/94	NA	NA	NA	NA	ND(50)	ND(0.3)	ND(0.3)	ND(0.5)	ND(0.5)
TS-3	15	01/12/94	7.7	110	1100	24	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	0.74
TS-3	30	01/12/94	7.9	13	1100	6.2	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
TS-3	45	01/12/94	7.8	ND (5)	1100	5.3	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
TS-3	Composite	01/12/94	7.9	14	1100	4.1	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
TS-3	Duplicate (20)	01/12/94	NA	NA	NA	25	NA	NA	NA	NA	NA
TS-3	Trip Blank (20)	01/12/94	NA	NA	NA	NA	ND(50)	ND(0.3)	ND(0.3)	ND(0.5)	ND(0.5)
TS-4	Source	01/12/94	7.8	ND (5)	1100	ND(1)	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
TS-4	15	01/12/94	7.7	280	1200	3.7	NA	NA	NA	NA	NA
TS-4	30	01/12/94	7.8	53	1100	2.5	NA	NA	NA	NA	NA
TS-4	45	01/12/94	7.8	55	1100	2.9	NA	NA	NA	NA	NA
TS-4	Composite	01/12/94	7.7	90	1200	2.2	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
TS-4	Duplicate (20)	01/12/94	NA	NA	NA	7.1	NA	NA	NA	NA	NA
TS-4	Trip Blank (20)	01/12/94	NA	NA	NA	NA	ND(50)	ND(0.3)	ND(0.3)	ND(0.5)	ND(0.5)
TS-5	Source	01/13/94	7.9	ND (5)	1100	ND(1)	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
TS-5	15	01/13/94	7.8	140	1100	3.8	ND(50)	ND(0.3)	0.46	ND(0.3)	0.63
TS-5	30	01/13/94	7.8	160	1100	11	ND(50)	ND(0.3)	0.36	ND(0.3)	ND(0.6)
TS-5	45	01/13/94	7.8	52	1100	5.1	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
TS-5	Composite	01/13/94	7.8	62	1100	4.1	ND(50)	ND(0.3)	0.4	ND(0.3)	ND(0.6)
TS-5	Duplicate (20)	01/13/94	NA	NA	NA	3.5	NA	NA	NA	NA	NA
TS-5	Trip Blank (20)	01/13/94	NA	NA	NA	NA	ND(50)	ND(0.3)	ND(0.3)	ND(0.5)	ND(0.5)
TS-6	15	01/13/94	7.7	63	1200	3.2	NA	NA	NA	NA	NA
TS-6	30	01/13/94	7.7	17	1100	1.8	NA	NA	NA	NA	NA
TS-6	45	01/13/94	7.8	13	1100	1.8	NA	NA	NA	NA	NA
TS-6	Composite	01/13/94	7.8	39	1100	1.9	ND(50)	ND(0.3)	0.33	ND(0.3)	ND(0.6)
TS-6	Duplicate (20)	01/13/94	NA	NA	NA	3.5	NA	NA	NA	NA	NA
TS-6	Trip Blank (20)	01/12/94	NA	NA	NA	NA	ND(50)	ND(0.3)	ND(0.3)	ND(0.5)	ND(0.5)
TS-7	Source	01/17/94	7.7	ND (5)	780	ND(1)	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
TS-7	15	01/17/94	7.9	27	830	4.3	NA	NA	NA	NA	NA
TS-7	30	01/17/94	7.9	23	810	NA	NA	NA	NA	NA	NA
TS-7	45	01/17/94	7.9	25	800	4	NA	NA	NA	NA	NA
TS-7	Composite	01/17/94	7.9	88	830	6.3	ND(50)	ND(0.3)	0.46	ND(0.3)	ND(0.6)
TS-7	Duplicate (20)	01/17/94	NA	NA	NA	4.5	NA	NA	NA	NA	NA
TS-8	15	01/17/94	7.9	120	740	7.9	ND(50)	ND(0.3)	0.31	ND(0.3)	ND(0.6)
TS-8	30	01/17/94	7.9	79	700	9.4	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
TS-8	45	01/17/94	8.0	62	680	12	ND(50)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.6)
TS-8	Composite	01/17/94	8.0	120	720	5.1	ND(50)	ND(0.3)	0.31	ND(0.3)	ND(0.6)
TS-8	Duplicate (20)	01/17/94	NA	NA	NA	6.8	NA	NA	NA	NA	NA

ND(001) Not detected at specified detection limit.
NA Not analyzed.

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TABLE 6b
Summary of Analytical Results for Metal Constituents of Simulated Runoff from Parking Lots
WSPA/API Storm Water Runoff Study

Test Site	Sample Type	Sampling Date	Aluminum (mg/l)	Antimony (mg/l)	Arsenic (mg/l)	Barium (mg/l)	Beryllium (mg/l)	Cadmium (mg/l)	Chromium (VI) (mg/l)	Chromium (mg/l)	Cobalt (mg/l)	Copper (mg/l)	Iron (mg/l)	Lead (mg/l)	Mercury (mg/l)	Molybdenum (mg/l)	Nickel (mg/l)	Selenium (mg/l)	Silver (mg/l)	Thallium (mg/l)	Vanadium (mg/l)	Zinc (mg/l)
TS-1	Source	01/12/04	ND(0.5)	ND(0.005)	ND(0.01)	0.14	ND(0.001)	ND(0.005)	ND(0.025)	ND(0.005)	ND(0.05)	0.011	ND(0.05)	ND(0.001)	ND(0.002)	ND(0.1)	ND(0.1)	ND(0.01)	ND(0.05)	ND(0.001)	ND(0.05)	ND(0.001)
TS-1	15	01/12/04	2	ND(0.005)	ND(0.01)	0.13	ND(0.001)	0.0b2	ND(0.025)	0.011	ND(0.05)	0.032	2.3	0.026	ND(0.002)	ND(0.1)	ND(0.1)	ND(0.02)	ND(0.05)	ND(0.001)	ND(0.05)	0.06
TS-1	30	01/12/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-1	45	01/12/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-1	Composite	01/12/04	0.63	ND(0.005)	ND(0.01)	0.13	ND(0.001)	ND(0.005)	ND(0.025)	0.005	ND(0.05)	0.021	0.30	0.004	ND(0.002)	ND(0.1)	ND(0.1)	ND(0.01)	ND(0.05)	ND(0.001)	ND(0.05)	0.35
TS-1	Duplicate (20)	01/12/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-1	Trip Blank (20)	01/12/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-2	15	01/12/04	2.6	NA	NA	NA	NA	ND(0.005)	NA	0.007	NA	0.026	2.1	0.02	NA	NA	ND(0.1)	NA	NA	NA	NA	0.29
TS-2	30	01/12/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-2	45	01/12/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-2	Composite	01/12/04	1.7	NA	NA	NA	NA	ND(0.005)	NA	0.005	NA	0.026	1.9	0.015	NA	NA	ND(0.1)	NA	NA	NA	NA	0.17
TS-2	Duplicate (20)	01/12/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-2	Trip Blank (20)	01/12/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-3	15	01/12/04	2.3	ND(0.005)	ND(0.01)	0.16	ND(0.001)	ND(0.005)	ND(0.025)	0.008	ND(0.05)	0.025	2.6	0.026	ND(0.002)	ND(0.1)	ND(0.1)	ND(0.01)	ND(0.05)	ND(0.001)	ND(0.05)	0.45
TS-3	30	01/12/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-3	45	01/12/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-3	Composite	01/12/04	0.63	ND(0.005)	ND(0.01)	0.12	ND(0.001)	ND(0.005)	ND(0.025)	ND(0.005)	ND(0.05)	0.021	0.61	0.005	ND(0.002)	ND(0.1)	ND(0.1)	ND(0.01)	ND(0.05)	ND(0.001)	ND(0.05)	0.1
TS-3	Duplicate (20)	01/12/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-3	Trip Blank (20)	01/12/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-4	Source	01/12/04	ND(0.5)	ND(0.005)	ND(0.01)	0.12	ND(0.001)	ND(0.005)	ND(0.025)	ND(0.005)	ND(0.05)	0.02	ND(0.05)	0.002	ND(0.002)	ND(0.1)	ND(0.1)	ND(0.01)	ND(0.05)	ND(0.001)	ND(0.05)	ND(0.001)
TS-4	15	01/12/04	2.5	NA	NA	NA	NA	ND(0.005)	NA	0.009	NA	0.021	3.5	0.026	NA	NA	ND(0.1)	NA	NA	NA	NA	0.29
TS-4	30	01/12/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-4	45	01/12/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-4	Composite	01/12/04	2.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-4	Duplicate (20)	01/12/04	NA	NA	NA	NA	NA	ND(0.005)	NA	0.6.6	NA	0.021	ND(0.05)	0.015	NA	NA	NA	NA	NA	NA	NA	0.21
TS-4	Trip Blank (20)	01/12/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-5	Source	01/13/04	ND(0.5)	ND(0.005)	ND(0.01)	0.14	ND(0.001)	ND(0.005)	ND(0.025)	ND(0.005)	ND(0.05)	0.021	ND(0.05)	0.002	ND(0.002)	ND(0.1)	ND(0.1)	ND(0.01)	ND(0.05)	ND(0.001)	ND(0.05)	ND(0.001)
TS-5	15	01/13/04	2.4	ND(0.005)	ND(0.01)	0.15	ND(0.001)	ND(0.005)	ND(0.025)	0.005	ND(0.05)	0.024	3	0.017	ND(0.002)	ND(0.1)	ND(0.1)	ND(0.01)	ND(0.05)	ND(0.001)	ND(0.05)	0.7
TS-5	30	01/13/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-5	45	01/13/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-5	Composite	01/13/04	1.7	ND(0.005)	ND(0.01)	0.14	ND(0.001)	ND(0.005)	ND(0.025)	ND(0.005)	ND(0.05)	0.026	2.3	0.011	ND(0.002)	ND(0.1)	ND(0.1)	ND(0.01)	ND(0.05)	ND(0.001)	ND(0.05)	0.17
TS-5	Duplicate (20)	01/13/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-5	Trip Blank (20)	01/13/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-6	15	01/13/04	1.5	NA	NA	NA	NA	ND(0.005)	NA	ND(0.005)	NA	0.024	1.6	0.011	NA	NA	ND(0.1)	NA	NA	NA	NA	0.12
TS-6	30	01/13/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-6	45	01/13/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-6	Composite	01/13/04	1.3	NA	NA	NA	NA	ND(0.005)	NA	ND(0.005)	NA	0.018	1.2	0.007	NA	NA	ND(0.1)	NA	NA	NA	NA	0.072
TS-6	Duplicate (20)	01/13/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-6	Trip Blank (20)	01/12/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-7	Source	01/17/04	ND(0.5)	ND(0.005)	ND(0.01)	0.11	ND(0.001)	ND(0.005)	ND(0.025)	ND(0.005)	ND(0.05)	0.010	ND(0.05)	ND(0.001)	ND(0.002)	ND(0.1)	ND(0.1)	ND(0.01)	ND(0.05)	ND(0.001)	ND(0.05)	ND(0.001)
TS-7	15	01/17/04	0.51	NA	NA	NA	NA	ND(0.005)	NA	ND(0.005)	NA	0.015	1.1	0.0054	NA	NA	ND(0.1)	NA	NA	NA	NA	0.21
TS-7	30	01/17/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-7	45	01/17/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-7	Composite	01/17/04	1.4	NA	NA	NA	NA	NA	NA	NA	NA	0.012	1.5	0.006	NA	NA	ND(0.1)	NA	NA	NA	NA	0.24
TS-8	15	01/17/04	3.7	ND(0.005)	ND(0.01)	0.15	ND(0.001)	ND(0.005)	ND(0.025)	0.005	ND(0.05)	0.034	5.5	0.033	ND(0.002)	ND(0.1)	ND(0.1)	ND(0.01)	ND(0.05)	ND(0.001)	ND(0.05)	0.46
TS-8	30	01/17/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-8	45	01/17/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TS-8	Composite	01/17/04	1.7	ND(0.005)	ND(0.01)	0.012	ND(0.001)	ND(0.005)	ND(0.025)	ND(0.005)	ND(0.05)	0.017	2.1	0.012	ND(0.002)	ND(0.1)	ND(0.1)	ND(0.01)	ND(0.05)	ND(0.001)	ND(0.05)	0.24

ND(0.5) = Not detected at specified detection limit.
NA = Not analyzed

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Table 7

Analytical Results reported in "Action Plan Demonstration Project, Phase 1 Report"

Station	Date Sampled	Oil and Grease (mg/l)	Aluminum (mg/l)	Cadmium (mg/l)	Chromium (mg/l)	Copper (mg/l)	Iron (mg/l)	Lead (mg/l)	Nickel (mg/l)	Zinc (mg/l)
X	10/29/92	2.7	NA	0.00038	0.0043	0.03	NA	0.034	0.0052	0.69
Y	10/29/92	6.9	NA	0.0014	0.011	0.068	NA	0.15	0.0094	0.41
Z	10/29/92	1.2	NA	0.00054	0.0074	0.0093	NA	0.015	ND(.001)	2.4
X	12/06/92	15	0.8	0.0018	0.0067	0.026	1.3	0.028	0.0051	0.5
Y	12/06/92	7.8	0.81	0.00071	0.0041	0.031	1	0.028	0.0031	0.19
Z	12/06/92	14	0.91	0.00056	0.0029	0.026	1.3	0.028	0.0031	0.2
X	12/10/92	ND(.5)	2.3	0.0019	0.0094	0.0097	2.7	0.017	0.011	0.43
Y	12/10/92	1	0.57	0.00031	0.0026	0.006	0.6	0.017	ND(.001)	0.059
Z	12/10/92	0.8	0.14	0.00011	ND(.001)	0.006	0.19	0.007	0.0031	0.053
X	01/06/93	5.4	NA	0.00042	ND(.001)	0.0052	0.34	0.0082	NA	0.18
Y	01/06/93	0.6	NA	0.00025	0.0018	0.0076	0.11	0.016	NA	0.082
Z	01/06/93	2	NA	0.00039	ND(.001)	0.0092	0.85	0.015	NA	0.084
X	03/16/93	12	NA	0.00077	0.0041	0.02	NA	0.054	NA	0.43
Y	03/16/93	5	NA	0.0006	0.0055	0.045	NA	0.063	NA	0.13
Z	03/16/93	3.9	NA	0.00053	0.004	0.037	NA	0.032	NA	0.15
X	03/23/93	1.9	0.94	0.00054	0.003	0.013	NA	0.015	NA	0.55
Y	03/23/93	1	0.31	0.00027	0.0026	0.02	NA	0.024	NA	0.091
Z	03/23/93	1.2	0.68	0.00045	0.0025	0.085	NA	0.05	NA	0.2

ND(.001) Not detected at specified detection limit.
NA Not analyzed.

Source: Uribe & Associates, Larry Walker Associates (1993), Action Plan Demonstration Project Demonstration of Gasoline Fueling Stat Best Management Practices, September, Table 5.5 and 3.1.

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TABLE 8

Analytical Results Reported in NURP
Event Mean Concentrations (Median Results)

Category	Site	Suspended Solids (mg/l)	Copper (ug/l)	Lead (ug/l)	Zinc (ug/l)
Residential	1	288	33	137	191
	2	228	33	216	166
	3	228	33	200	166
	4	228	33	200	166
	5	228	33	200	166
	6	228	33	200	166
	7	228	33	200	166
	8	228	33	200	166
	9	228	33	200	166
	10	228	33	200	166
	11	228	33	200	166
	12	228	33	200	166
	13	228	33	200	166
	14	228	33	200	166
	15	228	33	200	166
	16	228	33	200	166
	17	228	33	200	166
	18	228	33	200	166
	19	228	33	200	166
	20	228	33	200	166
	21	228	33	200	166
	22	228	33	200	166
	23	228	33	200	166
	24	228	33	200	166
	25	228	33	200	166
	26	228	33	200	166
	27	228	33	200	166
	28	228	33	200	166
	29	228	33	200	166
	30	228	33	200	166
	31	228	33	200	166
	32	228	33	200	166
	33	228	33	200	166
	34	228	33	200	166
	35	228	33	200	166
	36	228	33	200	166
	37	228	33	200	166
	38	228	33	200	166
	39	228	33	200	166
	40	228	33	200	166
	41	228	33	200	166
	42	228	33	200	166
	43	228	33	200	166
	44	228	33	200	166
	45	228	33	200	166
	46	228	33	200	166
	47	228	33	200	166
	48	228	33	200	166
	49	228	33	200	166
	50	228	33	200	166
	51	228	33	200	166
	52	228	33	200	166
	53	228	33	200	166
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	64	228	33	200	166
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	82	228	33	200	166
	83	228	33	200	166
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	85	228	33	200	166
	86	228	33	200	166
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	90	228	33	200	166
	91	228	33	200	166
	92	228	33	200	166
	93	228	33	200	166
	94	228	33	200	166
	95	228	33	200	166
	96	228	33	200	166
	97	228	33	200	166
	98	228	33	200	166
	99	228	33	200	166
	100	228	33	200	166
Urban Open and Nonurban	1	228	33	200	166
	2	228	33	200	166
	3	228	33	200	166
	4	228	33	200	166
	5	228	33	200	166
	6	228	33	200	166
	7	228	33	200	166
	8	228	33	200	166
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	14	228	33	200	166
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	28	228	33	200	166
	29	228	33	200	166
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	36	228	33	200	166
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	38	228	33	200	166
	39	228	33	200	166
	40	228	33	200	166
	41	228	33	200	166
	42	228	33	200	166
	43	228	33	200	166
	44	228	33	200	166
	45	228	33	200	166
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	47	228	33	200	166
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	49	228	33	200	166
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	58	228	33	200	166
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	62	228	33	200	166
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	68	228	33	200	166
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	70	228	33	200	166
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	73	228	33	200	166
	74	228	33	200	166
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	82	228	33	200	166
	83	228	33	200	166
	84	228	33	200	166
	85	228	33	200	166
	86	228	33	200	166
	87	228	33	200	166
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	91	228	33	200	166
	92	228	33	200	166
	93	228	33	200	166
	94	228	33	200	166
	95	228	33	200	166
	96	228	33	200	166
	97	228	33	200	166
	98	228	33	200	166
	99	228	33	200	166
	100	228	33	200	166
Mixed	1	228	33	200	166
	2	228	33	200	166
	3	228	33	200	166
	4	228	33	200	166
	5	228	33	200	166
	6	228	33	200	166
	7	228	33	200	166
	8	228	33	200	166
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	10	228	33	200	166
	11	228	33	200	166
	12	228	33	200	166
	13	228	33	200	166
	14	228	33	200	166
	15	228	33	200	166
	16	228	33	200	166
	17	228	33	200	166
	18	228	33	200	166
	19	228	33	200	166
	20	228	33	200	166
Commercial	1	228	33	200	166
	2	228	33	200	166
	3	228	33	200	166
	4	228	33	200	166
	5	228	33	200	166
	6	228	33	200	166
	7	228	33	200	166
	8	228	33	200	166
	9	228	33	200	166
	10	228	33	200	166

Source: US Environmental Protection Agency (1983) Final Report of the Nationwide Urban Runoff Program. Table 6-1, 6-8, 6-9, and 6-10.

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FIGURES
(Figures 1 and 2 Presented in Text)

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GEOMATRIX

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5851

TOTAL SUSPENDED SOLIDS
(Event Mean Concentrations)

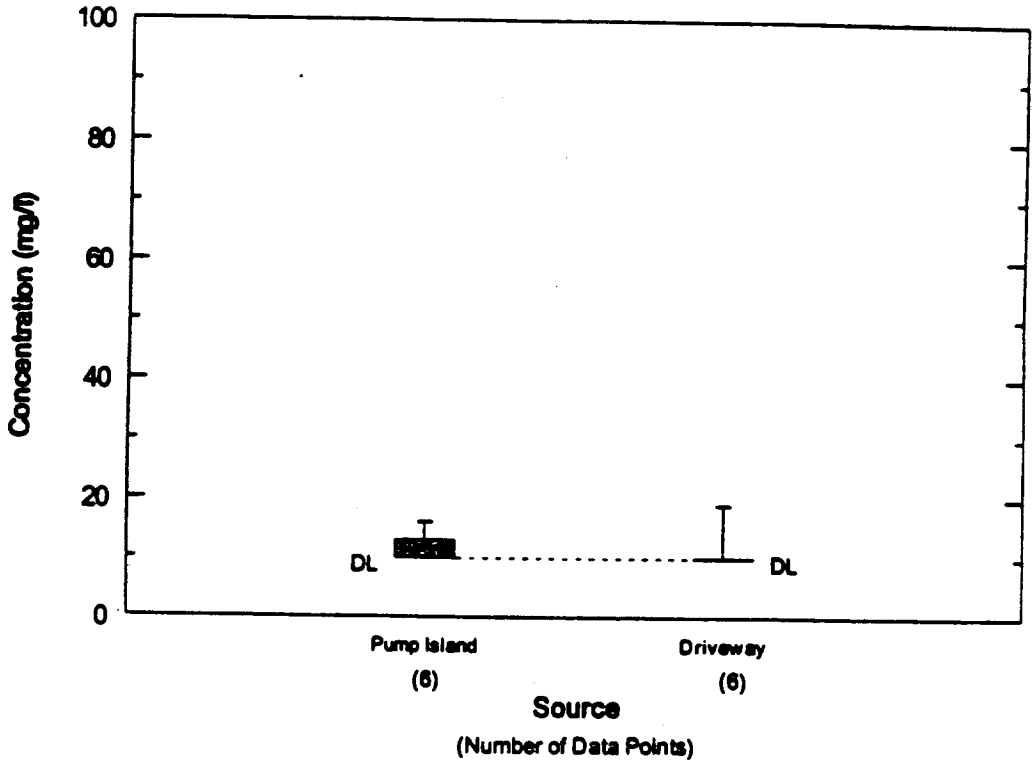

FIGURE 3

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GEOMATRIX

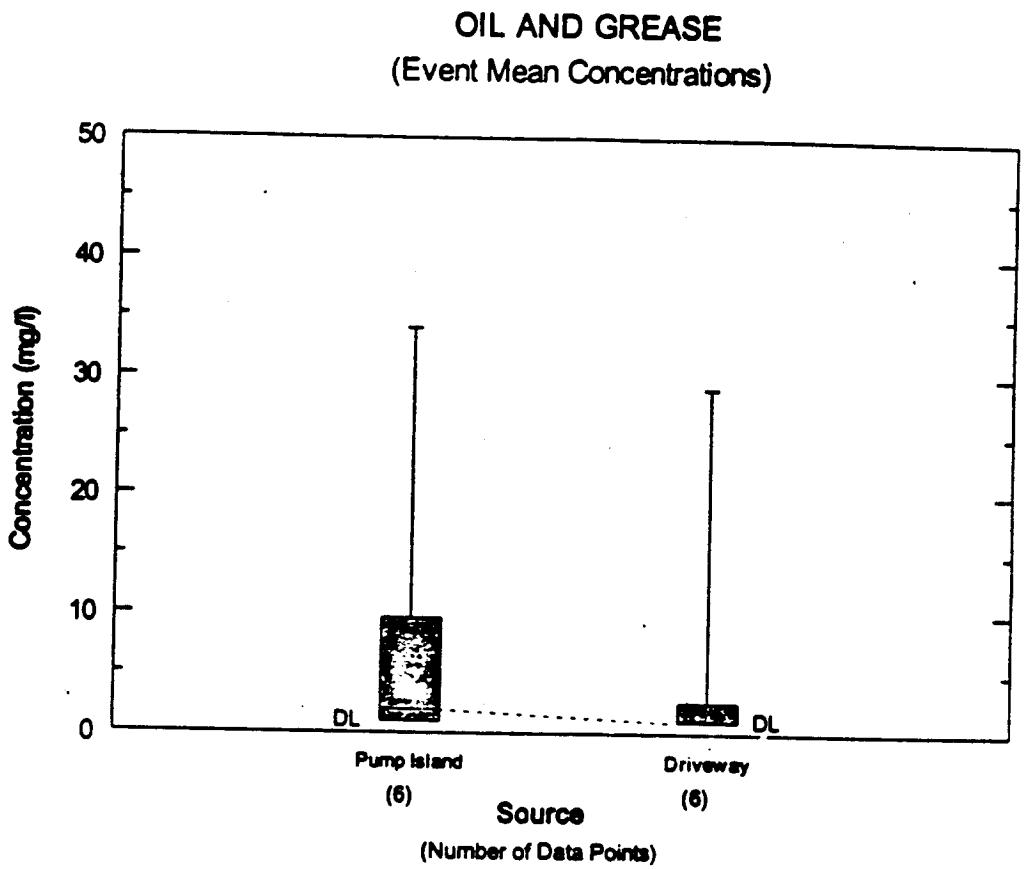

FIGURE 4

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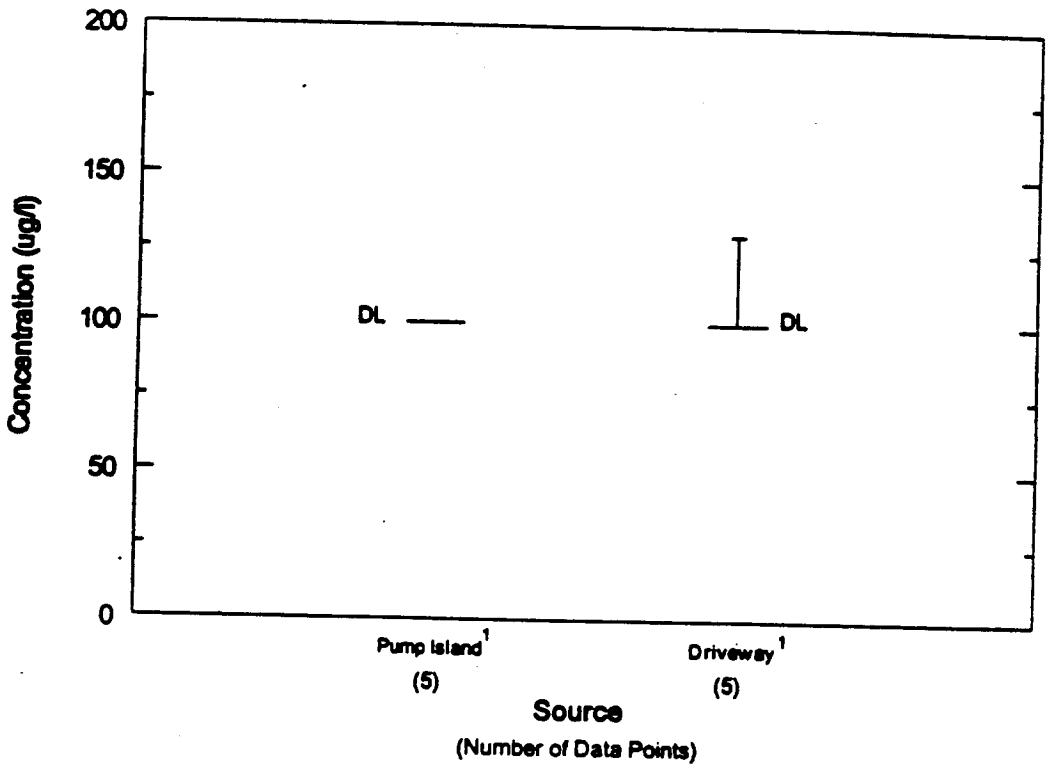
GEOMATRIX

TOTAL PETROLEUM HYDROCARBONS
(Event Mean Concentrations)



[1]Excludes data from simulated spill sample at RGO 5 because of elevated limit of detection.

FIGURE 5

GEOMATRIX

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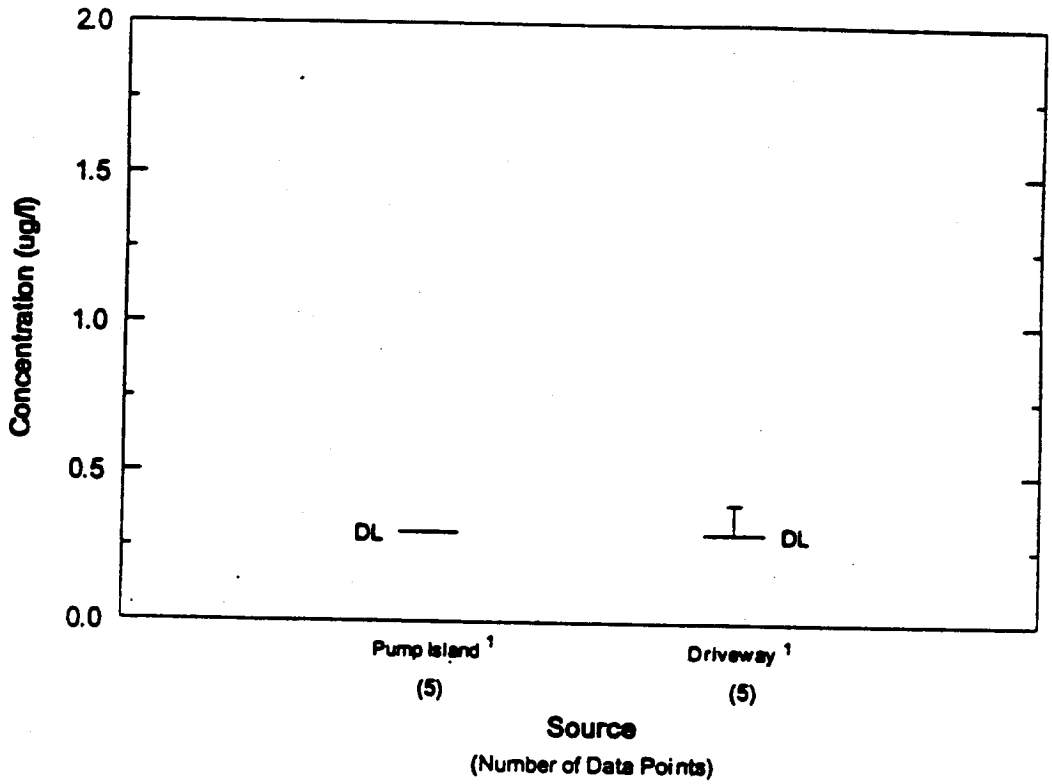
BENZENE
(Event Mean Concentrations)



[1] Excludes data from simulated spill sample at RGO 5 because of elevated limit of detection.

FIGURE 6

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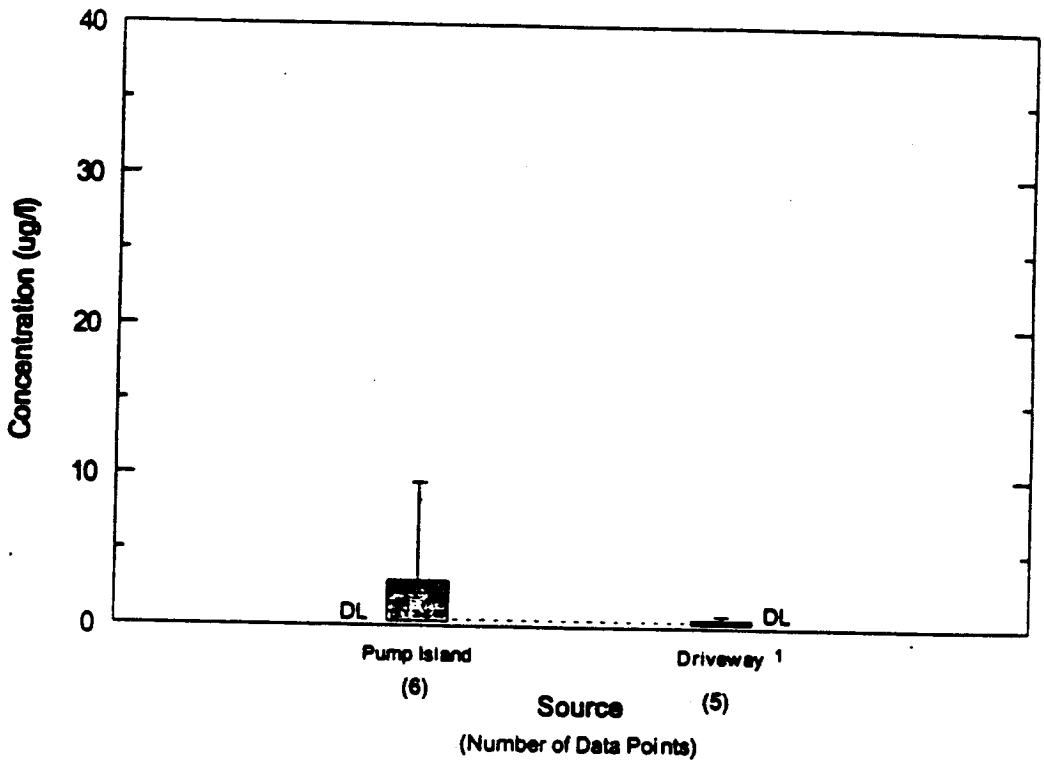
GEOMATRIX

TOLUENE
(Event Mean Concentrations)



[1]Excludes data from simulated spill sample at RGO 5 because of elevated limit of detection.

FIGURE 7

GEOMATRIX

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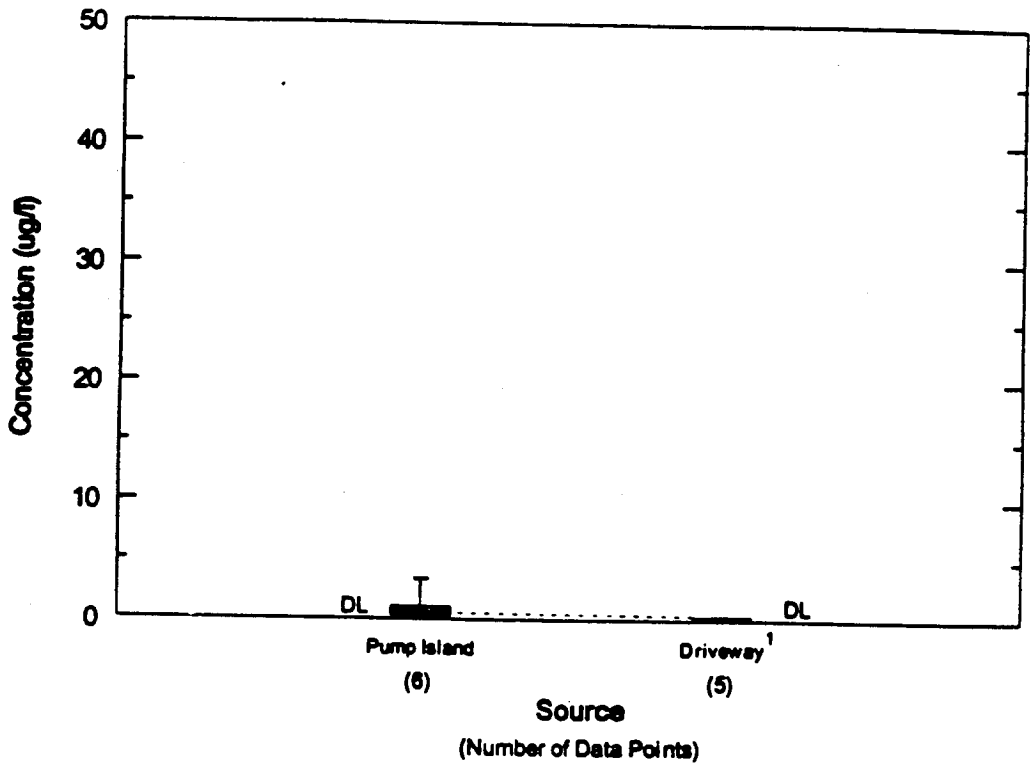
ETHYL BENZENE
(Event Mean Concentrations)



[1]Excludes data from simulated spill sample at RGO 5 because of elevated limit of detection.

FIGURE 8

R0059149

GEOMATRIX

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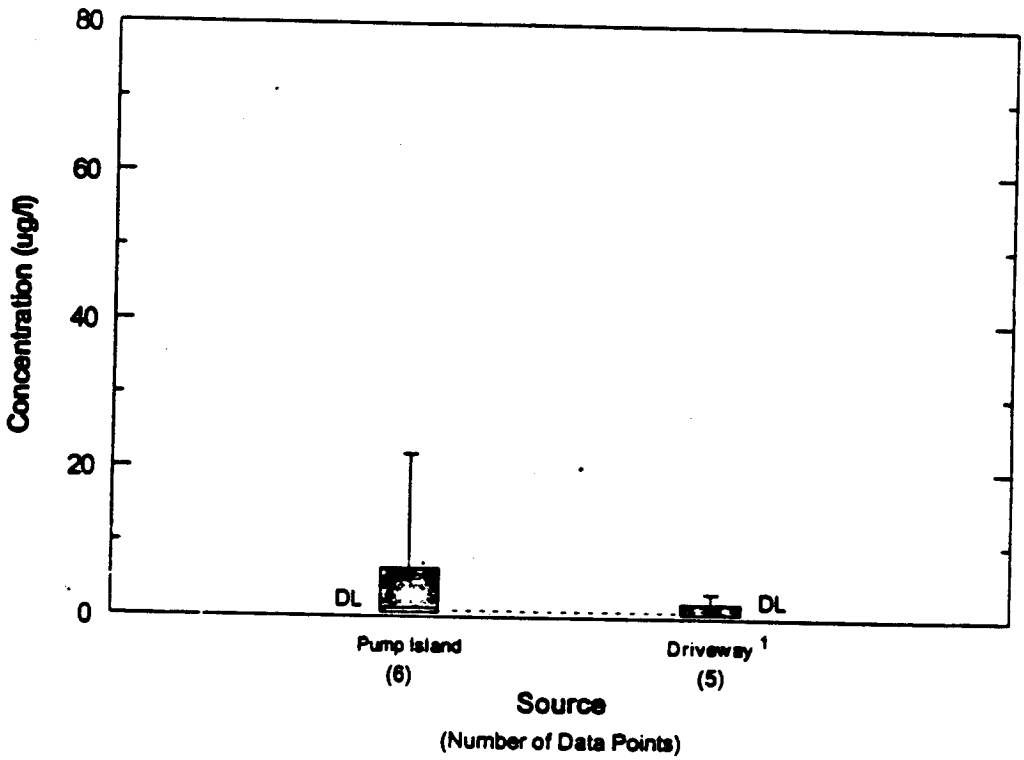
TOTAL XYLENES
(Event Mean Concentrations)



[1] Excludes data from simulated spill sample at RGO 5 because of elevated limit of detection.

FIGURE 9

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GEOMATRIX

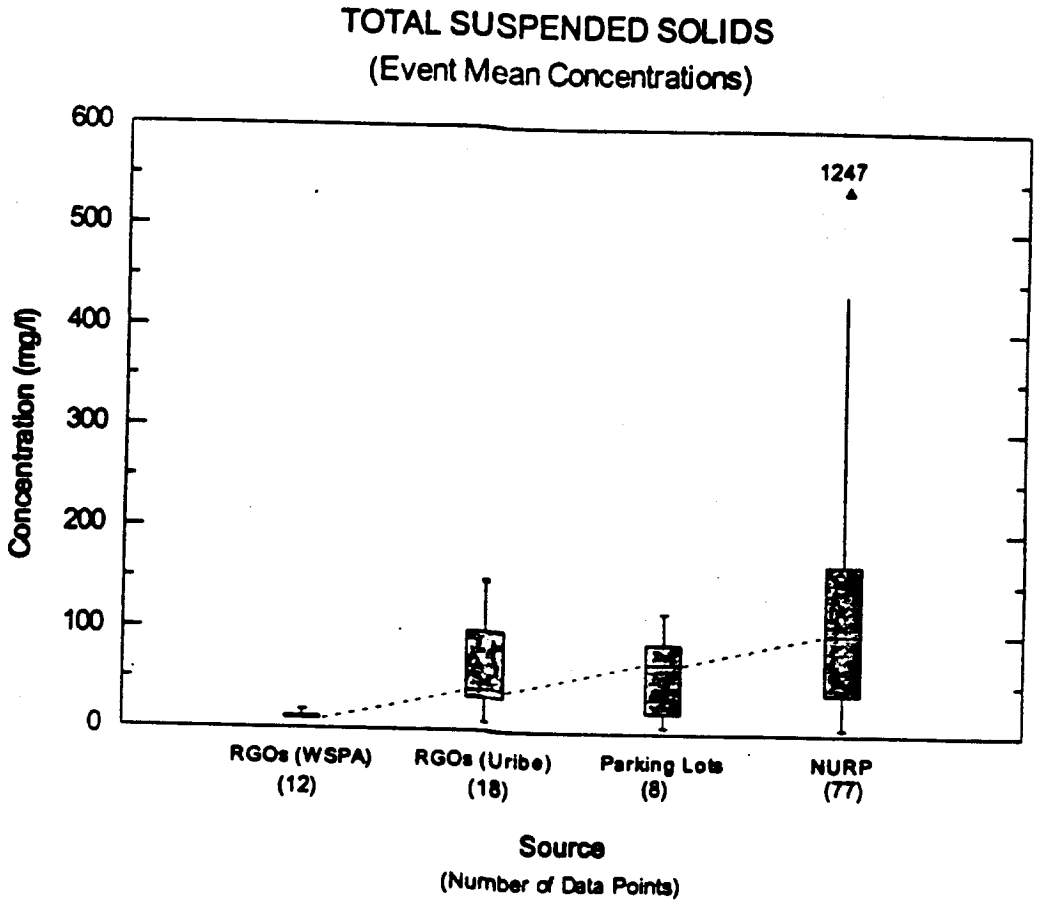

FIGURE 10

GEOMATRIX

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OIL AND GREASE
(Event Mean Concentrations)

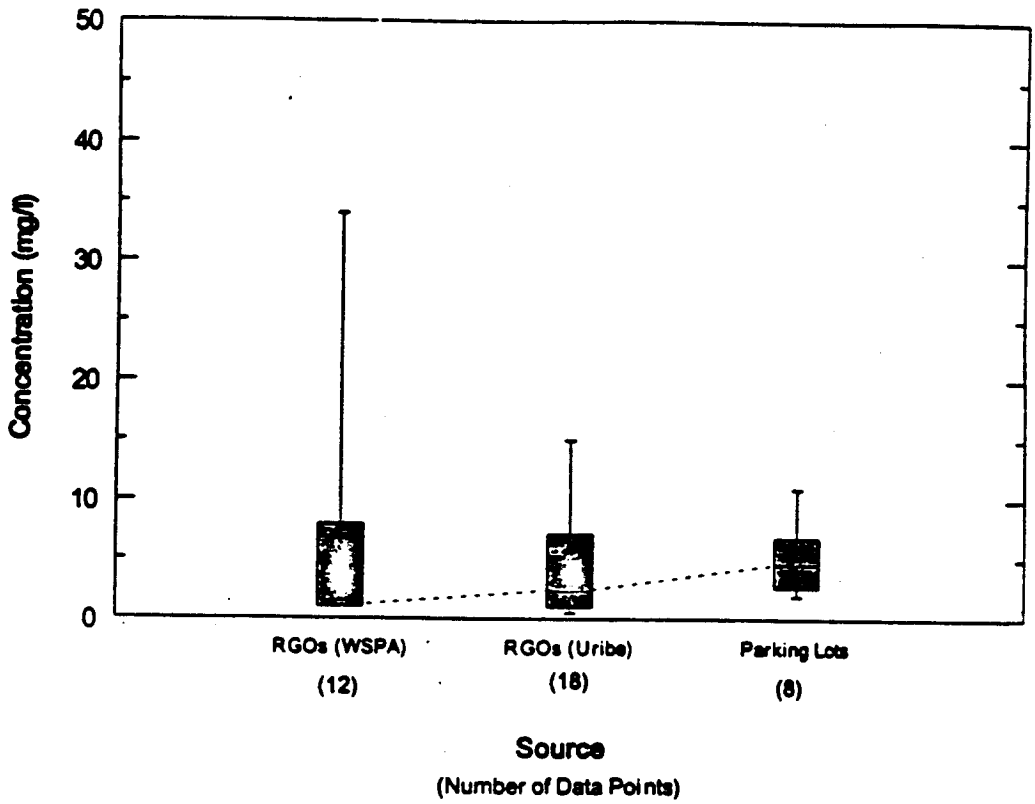

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FIGURE 11

R0059152

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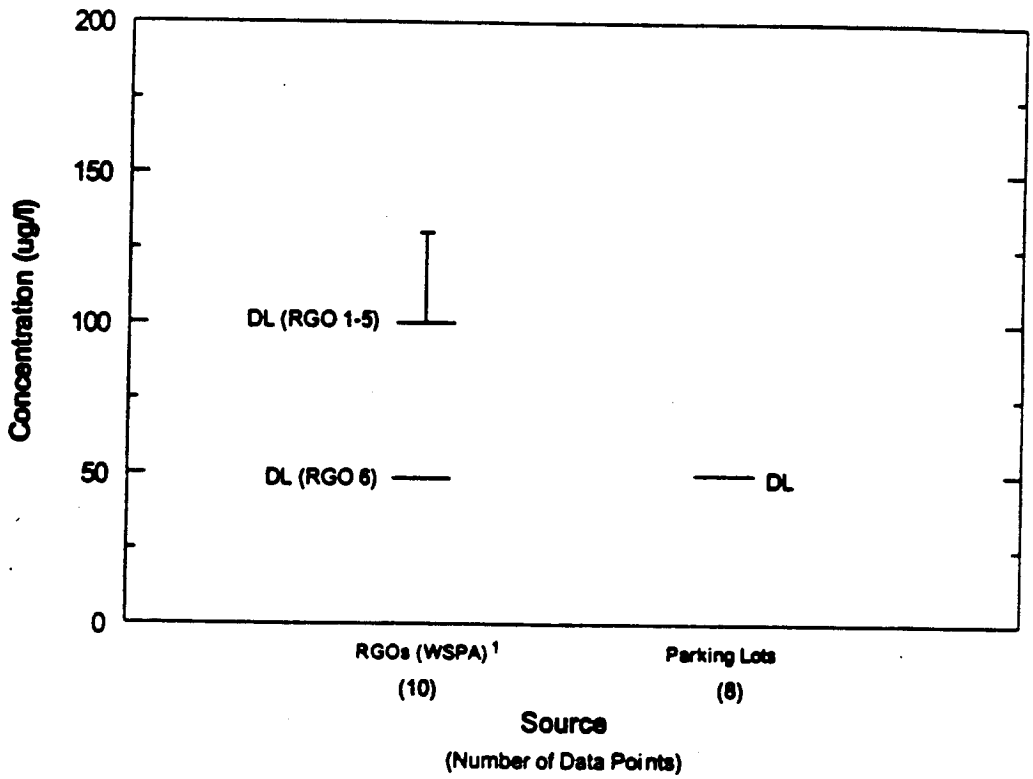
GEOMATRIX

TOTAL PETROLEUM HYDROCARBONS
(Event Mean Concentrations)



[1] Excludes data from simulated spill sample at RGO 5 because of elevated limit of detection.

FIGURE 12

GEOMATRIX

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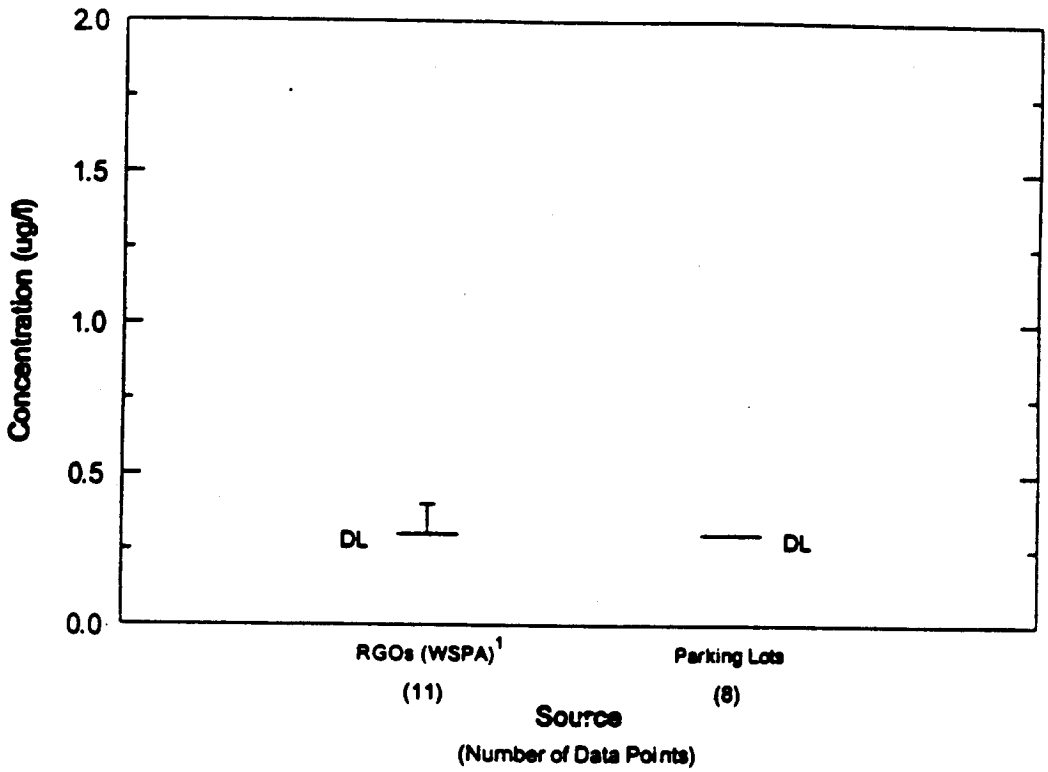
BENZENE
(Event Mean Concentrations)



[1] Excludes data from simulated spill sample at RGO 5 because of elevated limit of detection.

FIGURE 13

R0059154

GEOMATRIX

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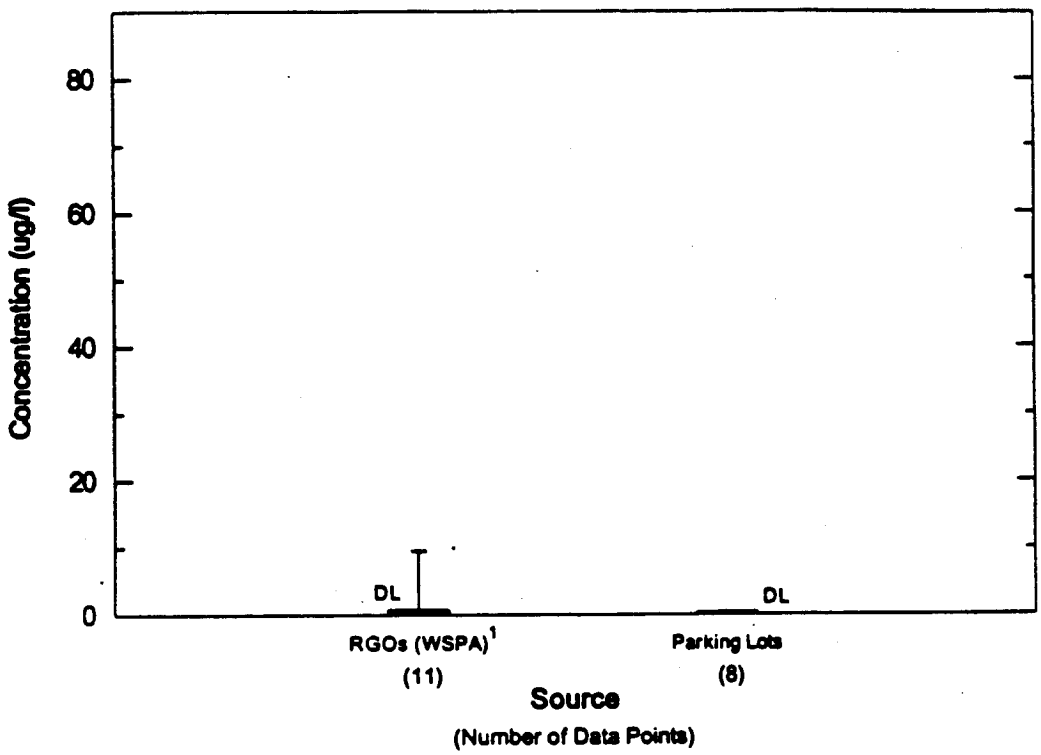
5862

TOLUENE
(Event Mean Concentrations)



[1] Excludes data from simulated spill sample at RGO 5 because of elevated limit of detection.

FIGURE 14

R0059155

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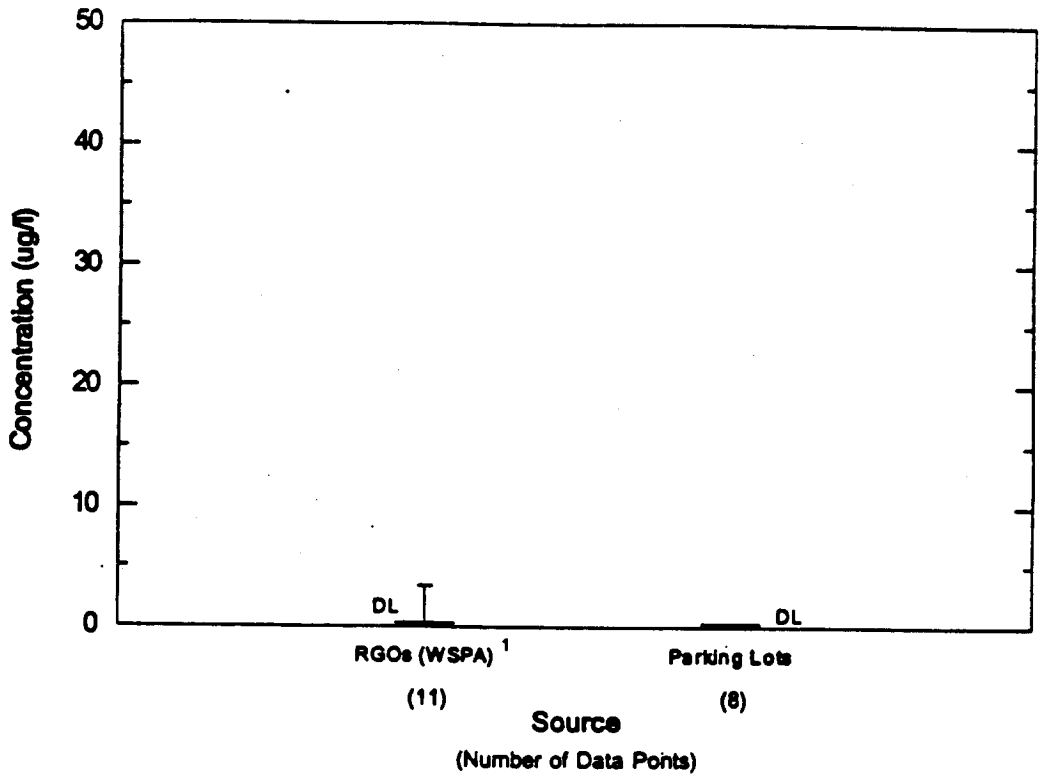
GEOMATRIX

ETHYL BENZENE
(Event Mean Concentrations)



[1]Excludes data from simulated spill sample at RGO 5 because of elevated limit of detection.

FIGURE 15

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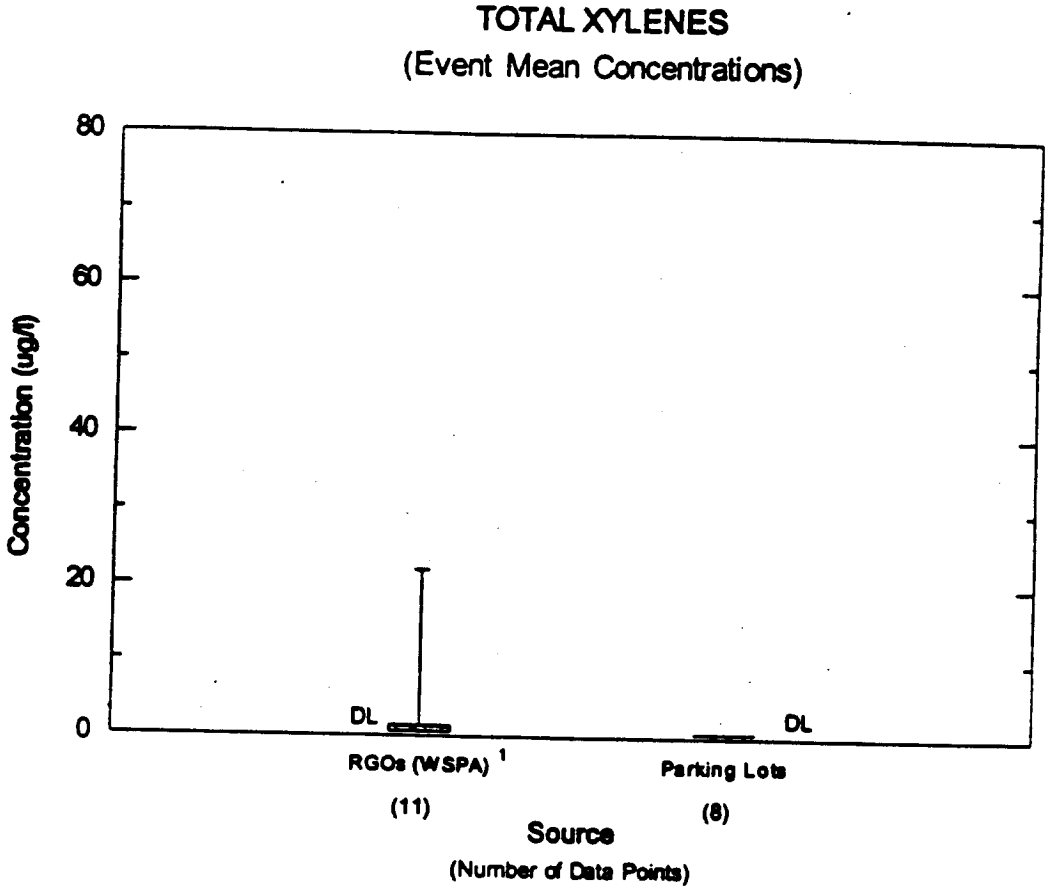
GEOMATRIX



[1]Excludes data from simulated spill sample at RGO 5 because of elevated limit of detection.

FIGURE 16

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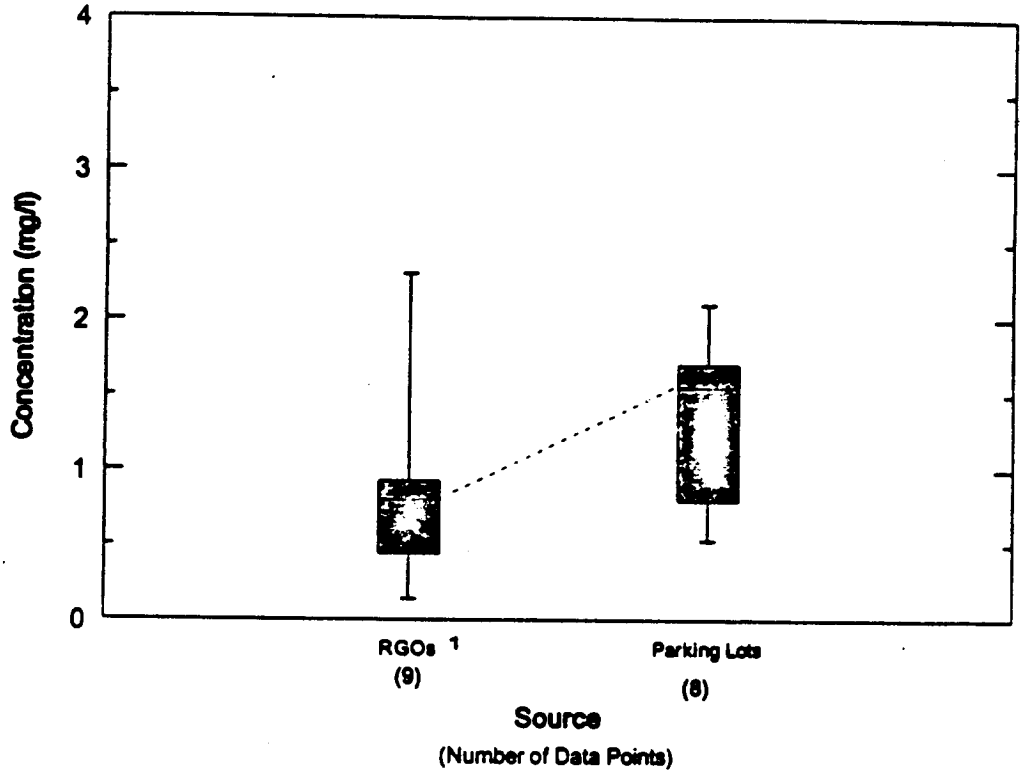
GEOMATRIX

ALUMINUM
(Event Mean Concentrations)



[1] Results from Uribe (1993) only.

FIGURE 17

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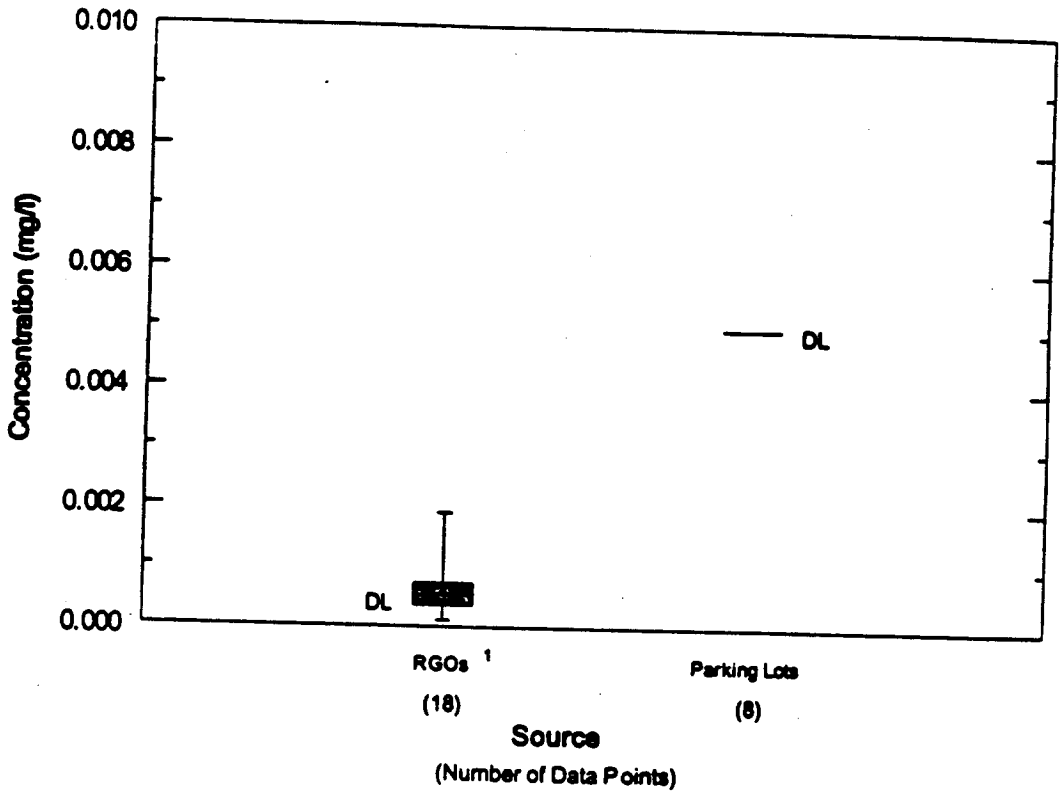
GEOMATRIX

CADMIUM
(Event Mean Concentrations)



[1] Results from Uribe (1993) only.

FIGURE 18

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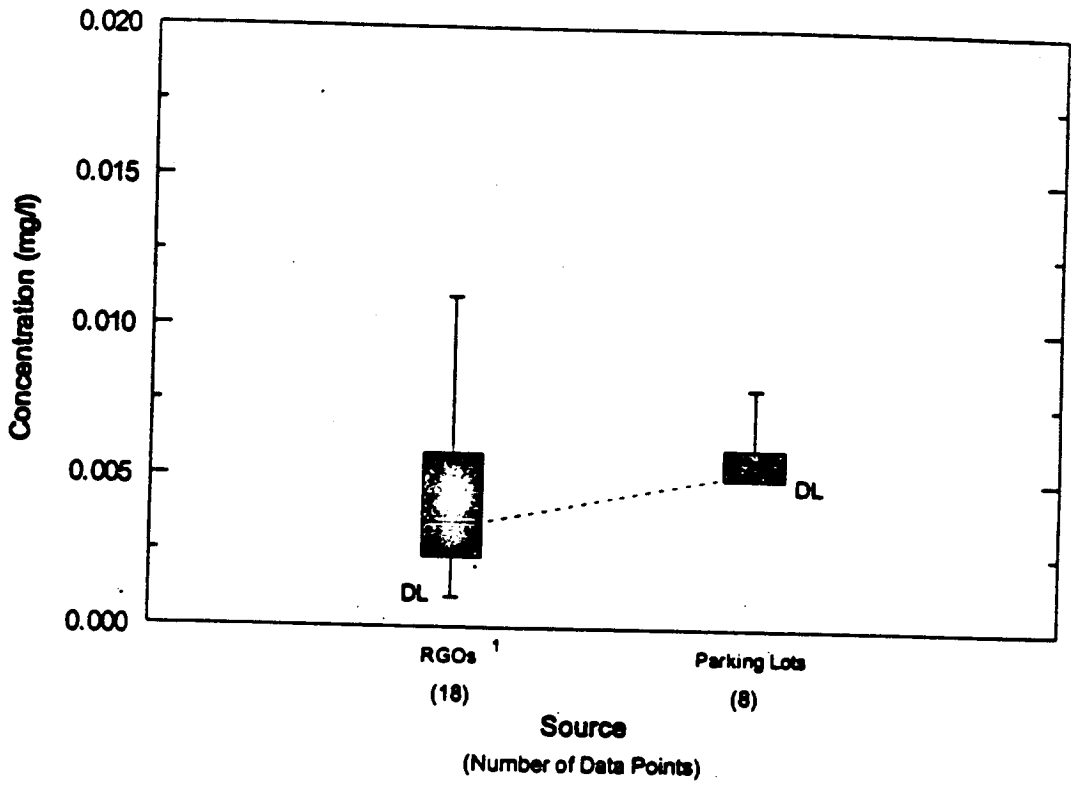
GEOMATRIX

CHROMIUM
(Event Mean Concentrations)



[1] Results from Uribe (1993) only.

FIGURE 19

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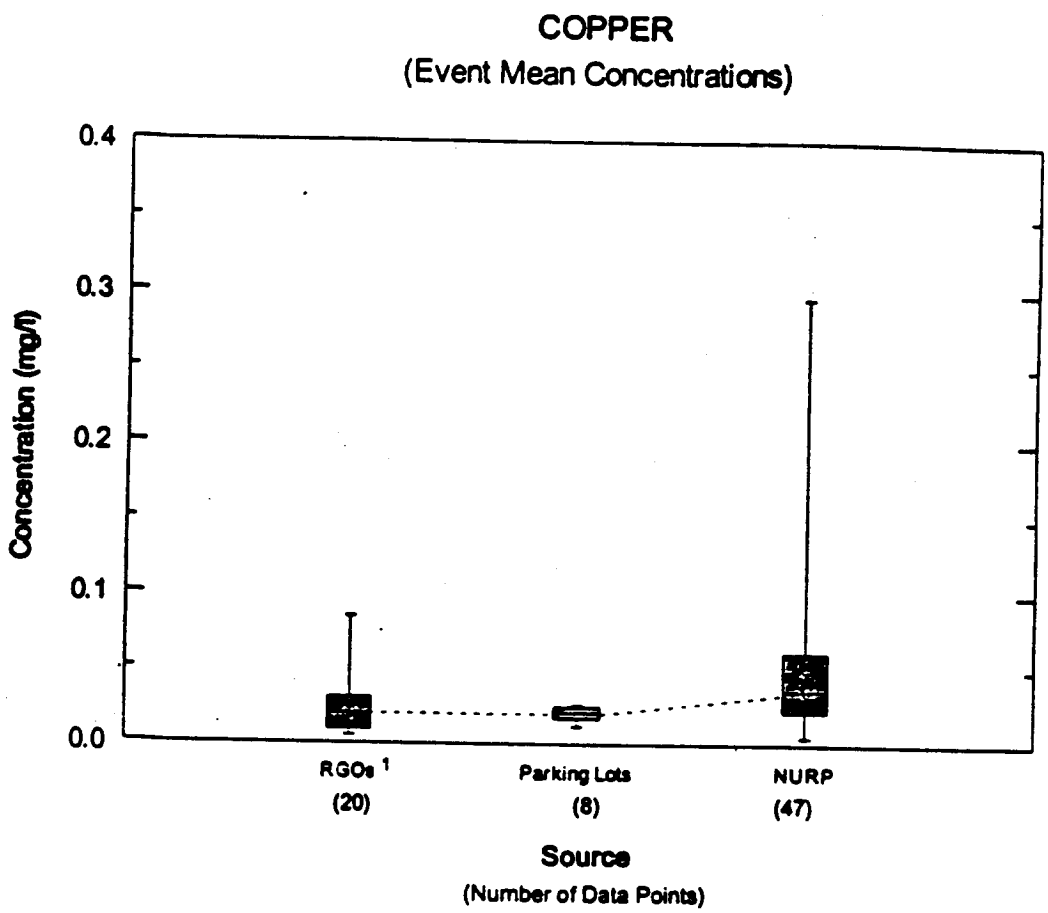
GEOMATRIX



[1] Includes WSPA and Uribe (1993) results.

FIGURE 20

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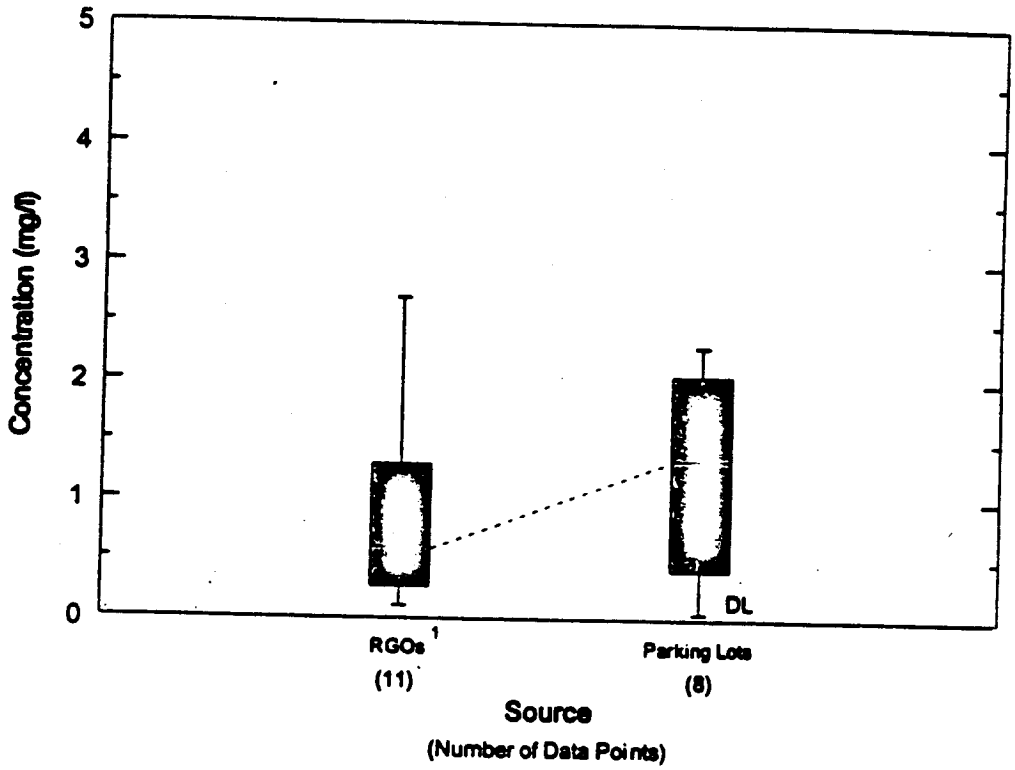
GEOMATRIX

IRON
(Event Mean Concentrations)



[1] Includes WSPA and Uribe (1993) results.

FIGURE 21

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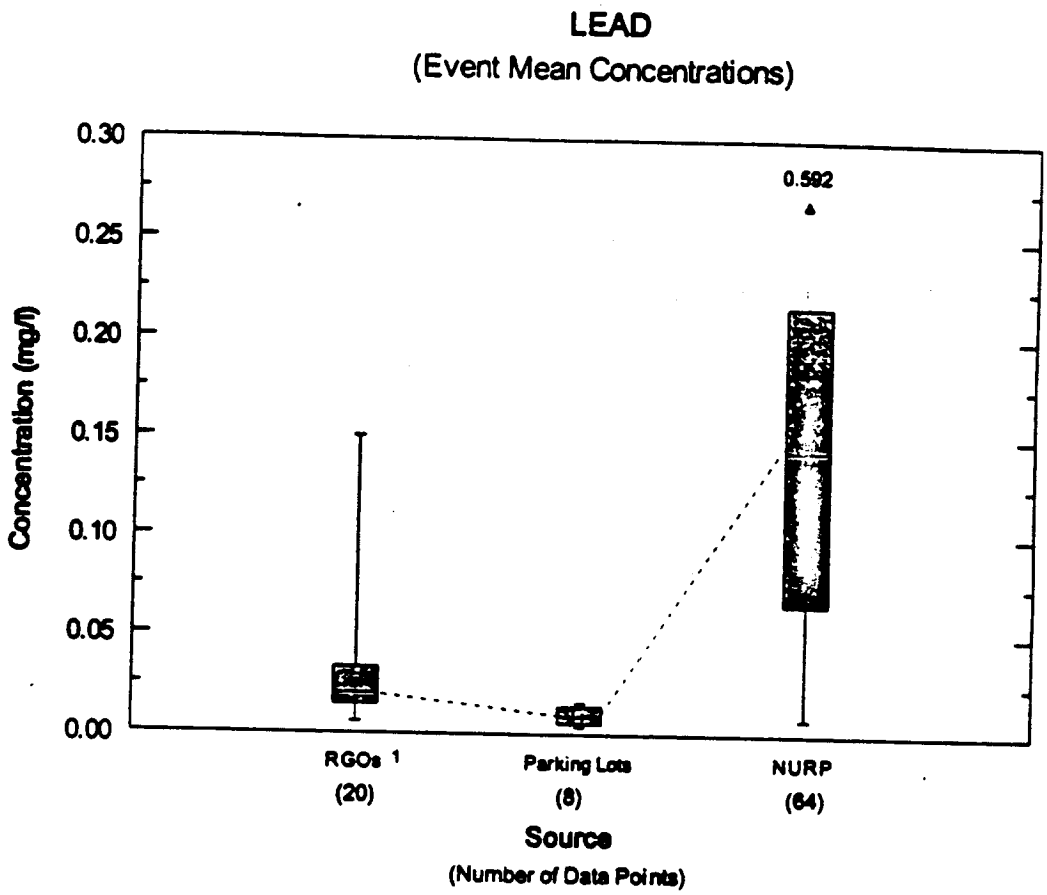
GEOMATRIX



[1] Includes WSPA and Uribe (1993) results.

FIGURE 22

GEOMATRIX

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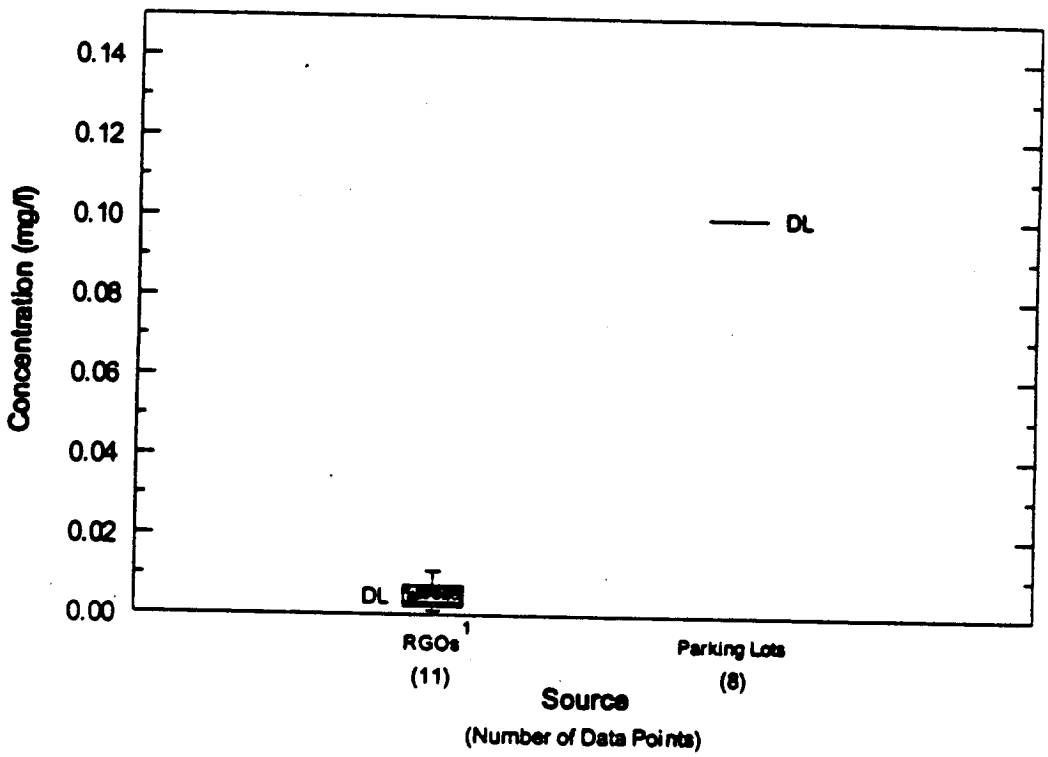
NICKEL
(Event Mean Concentrations)



[1] Results from Uribe (1993) only.

FIGURE 23

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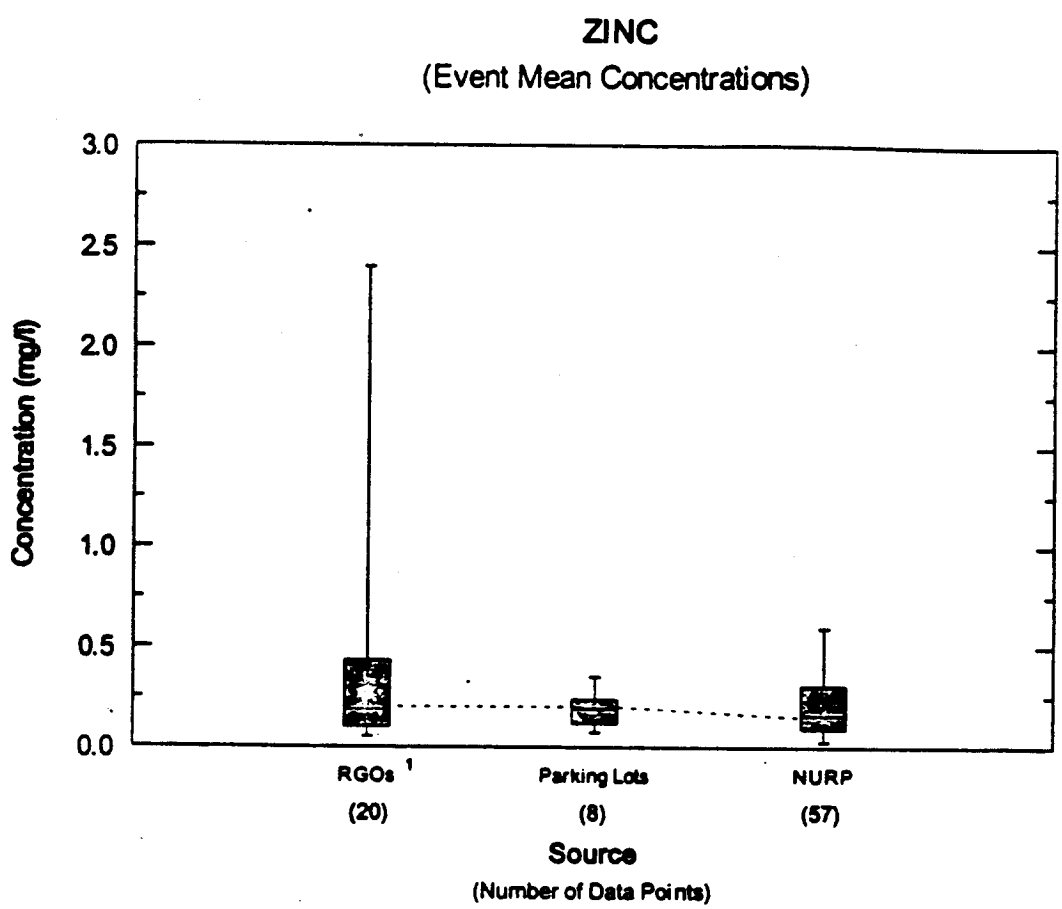
GEOMATRIX



[1] Includes WSPA and Uribe (1993) results.

FIGURE 24

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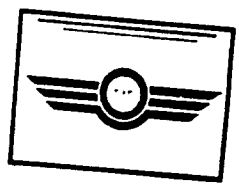

VOL 12

INDUSTRIAL STORM WATER POLLUTION CONTROL COMPLIANCE

A COMPREHENSIVE SOURCE BOOK
FOR FEDERAL, STATE, AND REGIONAL
REGULATORY REQUIREMENTS AND INFORMATION RESOURCES

2 5873 F

PREPARED BY



Santa Clara Valley
Nonpoint Source
Pollution Control Program

PROGRAM PARTICIPANTS
Campbell, Cupertino, Los Altos, Los Altos Hills, Los Gatos, Milpitas, Monte Sereno, Mountain View, Palo Alto, San Jose, Santa Clara, Saratoga, Sunnyvale, County of Santa Clara, and the Santa Clara Valley Water District

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Santa Clara Valley
Nonpoint Source
Pollution Control Program

5750 Almaden Expressway, San Jose CA 95118
(408) 265-2600 FAX (408) 266-0271

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QUALITY CONTROL BRANCH
LOS ANGELES REGION

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January 4, 1993

Dear Industrial Compliance Manual Owner:

Subject: Santa Clara Valley NPDES Industrial General Permit and Compliance Binder Update

The Santa Clara Valley Nonpoint Source Pollution Control Program (Program) is sending you the enclosed Best Management Practices (BMP) Manual, a copy of the amended portion of the Santa Clara Valley NPDES Industrial General Permit, updates of Sections 4 and 5 of the Handbook portion of the binder, a new outline for the Storm Water Pollution Prevention Plan (SWPPP), and a list of information materials available from the Program. We also describe below how, in the future, industries may be exempted from the sampling and analysis requirements of the Permit. We are sending you this information because you have purchased a Santa Clara Valley NPDES Industrial General Permit Compliance Binder from us.

If you are an industry which has filed an NOI, we are also enclosing a letter and questionnaire regarding exemptions from storm water sampling and analysis, which we request that you complete and return.

Please note that there are three NPDES Industrial General Permits. One was published by the EPA in the Federal Register on September 25, 1992. The EPA Industrial General Permit does not apply in California because it is an NPDES authorized state and the State Water Resources Control Board (State Board) has adopted a NPDES Industrial General Permit. The San Francisco Bay Regional Water Quality Control Board (Regional Board) adopted a NPDES Industrial General Permit specifically for Santa Clara Valley. If your industrial activity is located in Santa Clara Valley, only the Regional Board Industrial General Permit applies to you.

On September 16, 1992 the Regional Board amended the Santa Clara Valley Industrial General Permit to incorporate changes in the monitoring requirements under EPA's April 2, 1992 Final Rule. The State Board similarly amended the state-wide Industrial General Permit on September 17, 1992. Both permits became effective October 1, 1992, and NOI forms are still being accepted at this time without penalty. The attached permit amendment should be inserted into the Compliance Binder in the section with the Santa Clara Valley permit. The draft BMP Manual in your binder should be removed and replaced with the enclosed final manual.

PROGRAM PARTICIPANTS:
Campbell, Cupertino, Los Altos, Los Altos Hills, Los Gatos, Milpitas, Monte Sereno, Mountain View, Palo Alto, San Jose, Santa Clara, Saratoga, Sunnyvale, County of Santa Clara, and the Santa Clara Valley Water District

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The amendments to the Santa Clara Valley Industrial General Permit require a monitoring program be implemented by January 1, 1993, annual inspection and certification, and annual reporting. The minimum monitoring program requirements include monthly visual observations of storm water discharge during the wet season, observation or testing for non-storm water discharge two times during the dry season, sampling of one storm event in the 1992-93 wet season and two storm events in subsequent wet seasons. Samples must be analyzed for pH, specific conductivity, Total Suspended Solids (TSS), Total Organic Carbon (TOC) (Oil and Grease (O&G) may be substituted for TOC), and for other pollutants believed present. Industries wishing to monitor in groups were required to submit a Group Monitoring Plan to the Regional Board for approval by December 1, 1992. The amendments to the Santa Clara Valley Industrial General Permit also provided three mechanisms for exemption from the storm water sampling and analysis requirements.

Exemptions from Sampling and Analysis of Storm Water:

A discharger is not required to collect and analyze storm water samples if the discharger can certify one of the following and submits the certification to the Regional Board by December 1, 1992 for the 1992-93 wet season, and by August 1 for subsequent years:

1. A discharger certifies, in accordance with the permit provisions, that there is no exposure, or possibility of exposure, of industrial processes or materials to stormwater. The following conditions must be met:

   a. All illicit connections have been eliminated.

   b. All materials must be completely contained at all times so, if spilled, they will not directly or indirectly contact storm water.

   c. All emissions from stacks or air exhaust systems, unhoused manufacturing and heavy industrial equipment, and emissions of dust or particulate matter must not be exposed to storm water.

Or,

2. The Program has certified in writing that the discharger has an acceptable Storm Water Pollution Prevention Plan and should not be required to collect and analyze storm water samples for pollutants.

Or,

3. The discharger requests in writing that the Regional Board waive the sampling and analysis requirements (for a very good reason) and the Regional Board grants the waiver.

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Revisions to Monitoring Requirements:

The revisions to the monitoring requirements included the following four changes:

1. Eliminating the requirement to monitor the first storm event of the wet season.

2. Requiring sampling and analysis of only one storm event during the 1992-93 season.

3. Requiring either grab sampling or a combination of grab and composite sampling for analysis.

4. Allowing analysis for Oil and Grease as a substitution for Total Organic Carbon.

Certification of Elimination of Illicit Connections:

All illicit (un-permitted) connections to the storm drain system are prohibited as of October 1, 1992, and industries were required to submit certification of elimination of all illicit connections to the Regional Board by that date. Industries may have until July 1, 1993 to remove all illicit connections if a written request to the Regional Board is made which justifies the need for extension and provides a schedule for completing the work.

We hope this information has been of assistance to your compliance with the Santa Clara Valley NPDES Industrial General Permit. If you have any questions or comments or would like to obtain additional BMP manuals, please call Marcia Guzzetta at our Nonpoint Source Hotline at (800) 794-2482.

Sincerely,

Keith Whitman

Keith Whitman
Program Manager
Santa Clara Valley Nonpoint Source
Pollution Control Program

Enclosures

cc: T.Mumley, D.Hopkins - RWQCB
D.Chesterman, M.Klemencic, B.Goldie - SCVWD

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The attached pages are updates to the March 1992 binder entitled "Industrial Storm Water Pollution Control Compliance: A Comprehensive Source Book." Three items are enclosed:

1. A new Section 4 of the Industrial Storm Water Handbook (the fourth division in the binder). Please discard the entire March 1992 draft Section 4 and replace it with this one.

2. A new Section 5 of the Industrial Storm Water Handbook. Please discard the entire March 1992 draft Section 5 and replace it with this one.

3. A new outline of the Sample SWPP Plan, contained in the fifth division of the binder. Please discard the Outline pages of the March 1992 draft and replace them with these pages.

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4. SWPP PLAN PART 1: SOURCE IDENTIFICATION

The first part of the SWPP Plan is a detailed description of potential sources of contaminants that may be exposed to storm water at your facility. The intent of identifying these sources for your site can be seen as two-fold.

The primary purpose is to encourage you to identify the important potential storm water pollution sources at your facility. This will assist you in more directly addressing your SWPP Plan and monitoring program regarding pollutants from these sources at your facility. Effective source identification is important to your compliance process. This will help you to eliminate potential sources or, if this is not possible, to design effective Best Management Practices (BMPs) to prevent storm water pollution.

The second purpose of the SWPP Plan is to direct future inspectors toward locations on your site that they should be aware of, in order to determine whether your BMPs are satisfactory in preventing storm water pollution.

If your facility is designed and operated to effectively prevent storm water pollution, you may be able to complete this section with a minimal description. You may have *no* areas where contaminants could be exposed to storm water. However, this may be an unattainable ideal for the typical industrial facility, since many manufacturing processes are "dirty" by nature. The intent of the permit is not to cause you to cease operations, just to conduct them in a way that is effective at preventing storm water pollution. Still, a clear (if unstated) purpose of this section of the SWPP Plan is to encourage you to look at the areas on your site that may lead to storm water contamination, and to alter or eliminate them, even *before* your SWPP Plan goes into effect. If you eliminate the potential of a particular activity or location to contribute polluants to storm water, then you do not need to list the activity or certify that you will take continuing actions to minimize pollutants that enter storm water.

ORGANIZATION OF THIS SECTION

This section of the Guidance Handbook describes how to conduct a source identification for your facility and how to complete Part 1 of the SWPP Plan. Section 4 consists of the following parts:

- Identifying Potential Sources: Guidance on how to evaluate your facility to locate potential sources of storm water pollutants associated with industrial activities.
- Line-by-Line Guidance: One possible approach to completing Part 1 of the SWPP Plan for your facility. These steps are not part of the General Permit, but are suggested by the Santa Clara Valley NPS Program.
- Table 4-1: A suggested format for a source identification, with a list of potential sources that are common to typical industrial facilities.
- Figure 4-2: Guidance regarding the kinds of industrial activities that are likely to be potential sources; the materials which most commonly are potential pollutants from these activities; and some suggestions about the kinds of evidence commonly found at an industrial facility if a potential source is present.

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IDENTIFYING POTENTIAL SOURCES OF STORM WATER POLLUTION AT AN INDUSTRIAL FACILITY

The Source Identification part of the SWPP Plan is the record of a process that you conduct at your facility. You, the facility operator, carry the burden of identifying sources and potential sources of storm water pollution at your facility. The General Permit does not specify a list of areas that you must check, allowing you to acknowledge that once you have looked at them you've completed the job. The General Permit language instead requires you to identify *all* potential sources *specific to your facility*, and then to address these in the other parts of your SWPP Plan.

Your source identification must be a list specialized for your own facility. The Regional Board's definition of "storm water associated with industrial activities" *includes but is not limited to* some activities and materials listed in the EPA's 1990 regulations. The activities that are definitely included appear in the box on this page. The intent is to lead you to identify activities that are potential sources of storm water pollution, whether or not they are specifically listed. Activities that are not considered industrial activities are *not* included in the SWPP Plan.

The General Permit instructions state that you may *leave off the list* activities and locations that are clearly and demonstrably *not* related to industrial activities, even though they are on an industrial site and may be sources of contaminants. A prime example is employee parking lots, where motor oil leaks. Another is office buildings or commercial facilities on the industrial site, where loading docks or air conditioning equipment could drip contaminants. If these turn out to be significant sources of storm water pollutants, you may need to work with your local municipality to identify means to control the pollutants. However, they are not covered by the General Permit and need not be included in your SWPP Plan.

Storm Water Associated with Industrial Activity includes but is not limited to items on this list, developed as part of U.S. EPA regulations.

Storm water is associated with industrial activity if any of these are exposed to storm water:

- **Material handling equipment or activities**
- **Raw materials**
- **Intermediate products**
- **Final products**
- **By-products**
- **Waste products**
- **Industrial machinery**

which are located in one of these areas of your facility:

- Industrial plant yards
- Material handling sites
- Refuse sites
- Sites used for the application and disposal of process waste waters
- Sites used for residual treatment, storage or disposal
- Shipping and receiving areas
- Manufacturing buildings
- Storage areas (including tank farms) for raw materials, intermediate and final products
- Areas where industrial activity has taken place in the past and significant materials remain and are exposed to storm water

Some activities are definitely included, and some are definitely excluded. Many other activities fall into a grey area between the two. You will need to evaluate how and where they are conducted at your facility to determine whether they are potential sources. You should include in your

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source identification any locations on your site where you conduct industrial activities that may be exposed to storm water, whether or not they appear on the General Permit's list.

Because the source identification is a process, and every site is different, this guidance document does not provide a complete checklist for your facility. This section provides general guidance about the kinds of operations that could be sources of storm water pollution on your site.

The regulations are intended to address "industrial activities exposed to storm water." Exposure to storm water is not always obvious. The Regional Board's General Permit and the U.S. EPA's storm water regulations both make clear that they are *not* restricted to outdoor activities. Direct rainfall onto an outdoor activity is one obvious exposure to storm water. Another is storm water that flows across the site and contacts the activity or residues left by the activity.

Equipment used in an indoor manufacturing operation and then moved to a location where storm water contacts it is an industrial activity exposed to storm water. A less obvious circumstance is storm water that contacts particles, dust, liquid spills, or other residues that are created by an activity *inside a building*. Contaminants may be carried outdoors, for example on the tires of a forklift or through a roof vent, and build up on outdoor surfaces. These contaminants are the results of industrial activities which are exposed to storm water, and may need to be identified as potential sources.

LINE-BY-LINE GUIDANCE ON COMPLETING THE SWPP PLAN PART 1

This section contains guidance on preparing Part 1 of the SWPP Plan to conform to the "letter of the law" as put forth in the General Permit. The headings of this section correspond to specific items in the provisions of the General Permit. They also correspond to sections of the sample SWPP Plan prepared by the NPS Program for a fictitious industrial facility. The sample SWPP plan is included as an appendix to this handbook. (If you received this handbook as part of a binder distributed at the NPS Program Workshops, the sample SWPP Plan is included in Section V of the binder.)

1.0 INTRODUCTION AND BACKGROUND

Provide a brief description of your facility. Describe in a few sentences where the facility is and what work happens on the site.

2.0 SITE LOCATION AND REGIONAL INFORMATION

This section addresses permit section 5.a. which requires inclusion of a topographic or other map. The map should extend 1/4 mile beyond the facility boundary, and should show the facility, surface water bodies (including springs and wells), and the point(s) where the facility discharges storm water to a municipal storm drain system or other body of water. The requirements here may be included on the site map for Section 3.0.

2.1 Location

Briefly describe the facility location. Include descriptions of roads or railroads that serve as site boundaries. Describe the uses of the land bordering each side of the facility (e.g. other industrial uses, undeveloped, residential, agricultural).

2.2 Topography, Surface Water Bodies, and Wells

Reference your attached topographic map. If you are using the site map in section 3.0 as your topographic map, state this fact.

Describe any surface water bodies within 1/4 mile of your facility, including springs and wetlands. This should include *former* surface water bodies as well. Include creeks or intermittent streams that

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are dry due to drought, and/or creeks that are dry during summer months but are flowing during the rainy season. Also, identify any drinking water wells, water supply wells, and injection wells within 1/4 mile of your facility.

2.3 Regional Rainfall

Estimate the mean annual precipitation, in inches, for your site. This information is available from the National Weather Service, or from a local weather station with a rain gauge--for example, a central station in San Jose. For convenience, you may wish to estimate the mean annual precipitation at your site using the map in Figure 4-1. The map shows lines of equal rainfall (isohyetal lines) for the Santa Clara Valley. You can locate the approximate area of your facility and read the mean annual precipitation from the nearest isohyetal line. A rough approximation is generally adequate.

3.0 SOURCE IDENTIFICATION: SITE DESCRIPTION

Your introductory text will meet requirements in permit section 5.b. Briefly describe the facility, including the overall size in acres or square feet, the number of buildings on the site, and major activities at the site. Provide a site map that identifies the following:

- Storm water conveyance, drainage, and discharge structures
- An outline of the storm water drainage areas for each storm water discharge point
- Paved areas and buildings
- Areas of pollutant contact with storm water or release to storm water. Include potential areas as well as known areas. Examples of areas include outdoor storage or process areas; loading and unloading areas; and waste treatment, storage or disposal areas
- Location of existing storm water structural control measures (e.g., berms, etc.)
- Surface water locations, including springs and wetlands
- Vehicle service areas
- Location of each well where fluids from the facility are injected underground
- Location of each dry well or infiltration device, where fluids from the facility are allowed to drain underground. (Note that regulations now prohibit many forms of this kind of device.)

It may be more convenient to provide the required information on several maps or map layers rather than on a single map. The provided map(s) may be hand sketched, but the detail and scale must be sufficiently accurate to provide a clear illustration of storm water movement, control, and potential points of pollutant contact.

3.1 Buildings

Provide a brief description of the buildings located on your site. This section should include a description of the activities performed in the buildings, the materials utilized in the buildings, and (briefly) the management structures and procedures used in the buildings to minimize potential for contact of raw materials and wastes with storm water (e.g., berms or other secondary containment structures, oil/water separators, spill response procedures, etc.). You should reference any documents that you already have that contain this information. Examples include best management practice (BMP) manuals or spill prevention and control documents. It may be possible for you to satisfy this requirement entirely using information from existing documents.

3.2 Outdoor Storage, Manufacturing, and/or Processing Areas

Describe areas of outdoor activities at your site. Include all storage, maintenance equipment parking, and manufacturing/processing areas. Describe the activities for each area, the materials handled, and management structures and procedures used to minimize potential for contact of raw materials and wastes with storm water. Identify any processes or activities that generate significant quantities of dust or particulate matter.

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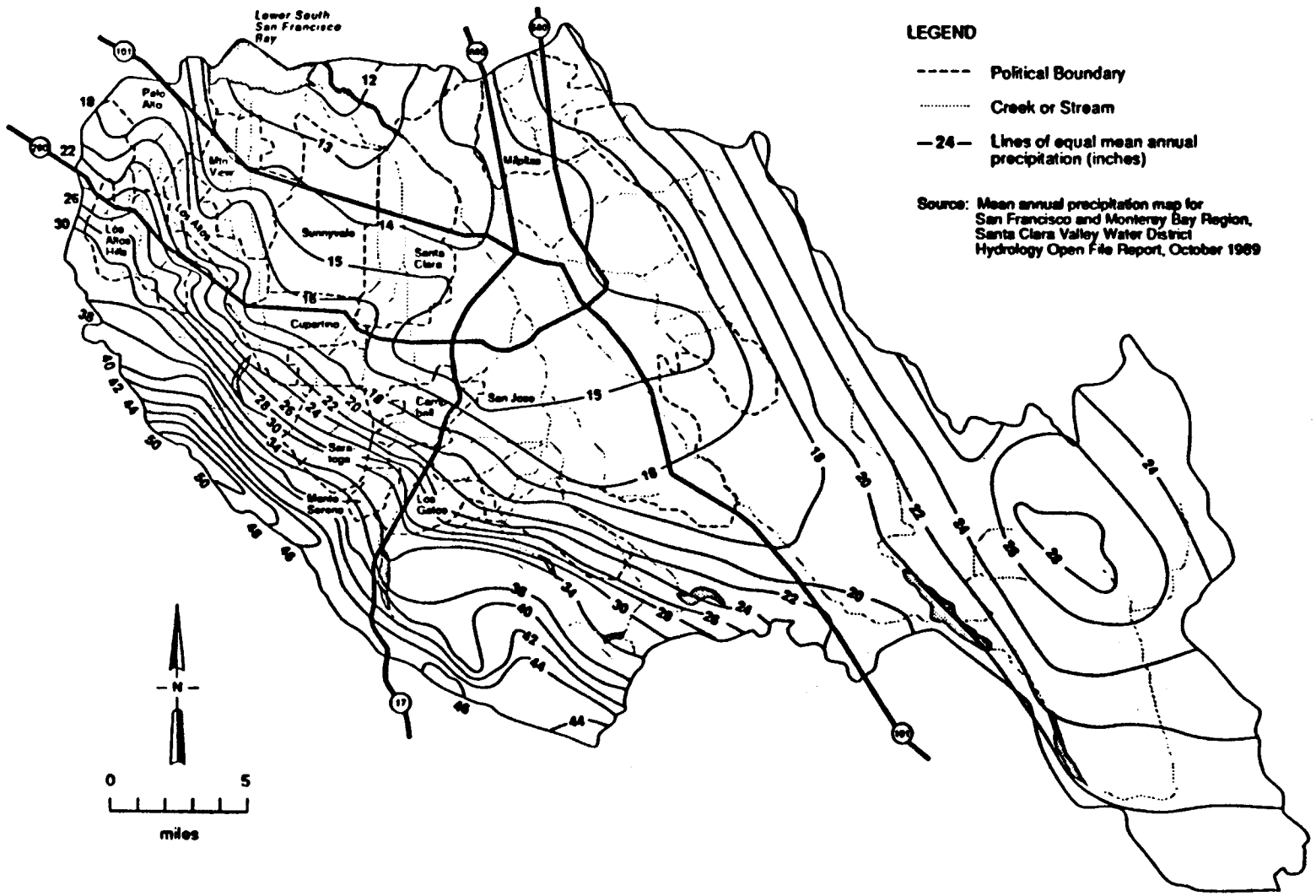
Figure 4-1. MEAN ANNUAL PRECIPITATION IN THE SANTA CLARA VALLEY



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Again, you may use references to applicable existing documents to satisfy this requirement.

3.3 Loading/Unloading Areas

Describe all loading/unloading areas. Describe the materials that are handled in each area and any management structures or procedures used to minimize potential for spills. Again, you may use references to applicable existing documents to satisfy this requirement.

3.4 Site Paving

Using best available estimates, describe the site paving and drainage. Estimate the percent of the facility that has impervious covering, that is, the percent that is paved or covered by buildings. Describe all paving (e.g., concrete or asphalt). Identify those areas that are not impervious.

Describe the drainage structures for the site, including trenches, storm drain lines, and holding ponds or tanks. Include a discussion of drainage areas that describes what areas drain to each drainage structure. Note that a small site may consist of a single drainage area.

3.5 Storm Drain System

Describe the storm drain system to which runoff from the site will drain. Identify the owner/operator of the system (typically, the city or municipality in which your facility is located) and the nearest receiving water (body of water into which runoff is discharged from the storm sewer). (See Section 3 of this handbook, describing the NOI, for advice on locating your receiving water.)

Identify all connections to the storm drain, and certify that no non-storm water discharges to the system are permitted. The certification should include a description of any tests for the presence of non-storm water discharges, the test methods used, dates of testing, and any on-site drainage points identified during testing. (Section 6 of this handbook describes the process in more detail.)

If this certification is not immediately possible because (a) this requirement necessitates significant structural changes or (b) you have applied for but not yet received an NPDES permit for non-storm water discharges, you must notify the Regional Board, the Program, and local agencies that a non-storm water discharge cannot be eliminated. The notification must include justification for a time extension, and a schedule (subject to modification by the Regional Board) indicating when non-storm water discharges will be eliminated. Note that the elimination of all non-storm water discharges must be completed prior to July 1, 1993.

3.6 Process Wastewater Sanitary Sewer System

Describe the sanitary sewer system for the facility. You must certify that there are no connections between the sanitary sewer and the storm water sewer. This certification may be incorporated into the above certification for the storm drain system.

3.7 Underground and Above Ground Storage Tanks

Describe all underground and above ground storage tanks at your site. Describe the materials that are handled in each tank and any management structures or procedures used to minimize potential for spills or leaks. This is another place where your SWPP Plan should make references to any applicable existing documents to satisfy this requirement partially or completely.

4.0 SOURCE IDENTIFICATION: DESCRIPTION OF POTENTIAL SOURCES OF POLLUTANTS IN STORM WATER DISCHARGES

4.1 Potential Pollutants

This section should discuss any materials or wastes that may be potential pollutants to storm water. These will include raw materials used in your process or maintenance activities and prod-

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ucts and wastes generated by your process or maintenance activities.

4.1.1 List of potential pollutants to storm water

Identify potential pollutants that have a reasonable potential to be present in storm water. Developing this list is a large part of your SWPP Plan. One means to complete this task is to complete Table 4-1 in the following section, using the method suggested there.

4.1.2 Estimate of annual quantities of potential pollutants in storm water runoff

Identify those potential pollutants that may be present in storm water in significant quantities. Include any materials or wastes that are stored outside or in uncovered areas for any length of time. Include materials that are delivered or picked up on a regular basis and/or that have been leaked or spilled in the past (for example, bags of powdered raw materials that have been dropped and/or ripped, fuels, oils, or liquid raw materials or product that have been spilled or dripped).

Estimate the annual quantities of each of these identified potential pollutants that may be present in runoff. Utilize any existing sampling data describing pollutants in storm water discharge. If you have no sampling data, you may have to give rough initial guesses that will be verified by later sampling and analysis activities.

You may feel that your pollutant containment structures, coupled with your management practices (e.g., spill prevention and response, erosion control, employee training, storm water treatment procedures, etc.) are effective and that the annual quantities of the identified potential pollutants in storm water are likely not significant. If this is the case, you may state this in this section. Be sure to document your containment and management practices thoroughly in Part 2 of the SWPP Plan, the part where you describe storm water management controls for your facility.

If you have identified potential pollutants that may be present in significant quantities in runoff, but you have also developed management or containment practices that are to be initiated soon to eliminate or minimize the pollutants, summarize the practices here. Upon implementation, you may establish that the pollutants are no longer likely to be present in significant quantities in runoff. This will probably require some sampling and analysis activity, but it may then also minimize your storm water monitoring requirements.

4.1.3 Existing sampling data describing pollutants in storm water discharge

Provide any existing storm water analytical data. Data summaries may be provided in tabular or text form. Graphs or other pictorial data representations may also be included.

4.2 Isolation of Storm Drain from Sanitary Sewer

Summarize inspection, testing and other information that documents that your sanitary sewer lines do not discharge to the storm drain at any point. This information may be brief if provided in more

TABLE 4-1: IDENTIFYING POTENTIAL SOURCES FOR YOUR FACILITY

Table 4-1, following page 4-8, can be used to help you through the process of identifying potential sources of storm water pollutants at your facility. The table, "Identification of Potential Storm Water Pollutants," and the accompanying description in this section are only one means of completing this process, and are not specified by the Regional Board as a compliance process. However, the Santa Clara Valley NPS Program suggests that it is likely that you can comply effectively with the General Permit's SWPP Plan requirements if you use this process to locate and fully consider the possible sources of storm water pollutants on your site.

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SOME COMMON POTENTIAL SOURCES AT A TYPICAL FACILITY

Manufacturing:
- Painting operations
- Washing operations
- Woodworking operations (sawdust)
- Primary metals operations (metal dust, coal dust)

Vehicles and Equipment:
- Outdoor or exposed maintenance areas
- Fueling areas
- Heavy equipment yards

Materials Handling Areas:
- Loading docks
- Bulk storage piles, dry materials
- Liquid storage tanks
- Liquid transfer stations
- Hazardous materials handling areas (refer to HazMat plans, SARA Title III requirements, and other requirements)
- Access roads
- Rail spurs
- Waste storage and handling areas

Rooftop and Outdoor Equipment:
- Cooling towers
- Air pollution control devices
- Roof vents from heavy manufacturing buildings
- Compressors
- Pumps
- Generators
- Transformers

SOME EVIDENCE OF PRESENCE OF POTENTIAL STORM WATER POLLUTANTS

- Stains on soil or pavement near outdoor equipment
- Small pools of standing liquid in periods long after a rain
- Equipment in poor repair or corroded
- Storage tanks corroded, stained, leaky, or in poor repair
- Particulates, soot, or oily film near roof or wall exhaust vents
- Open ports or hoses on equipment
- Metal dust, sawdust, other particles near doors to manufacturing buildings
- Uncovered storage of dry materials—large or small piles

You may wish to photocopy the blank pages of Table 4-1 and fill them in with information from your facility. You may then use the table itself to form the largest part of your "List of potential pollutants to storm water," described in paragraph 4.1.1 above, and the General Permit's Section A, provision 5.d. Or, you may prefer to use the table columns and the following steps as guidance in preparing your own tables and text to describe sources of potential storm water pollutants among your facility's industrial activities. To use the table, follow these steps.

Step 1. Identify industrial activities and materials handling areas. When you complete the table for your facility, include processes and areas at your site that are exposed to storm water. Any materials that are handled or stored outdoors (even for short time periods such as during delivery) should be listed in column 1. Potential sources may include handling of raw materials, products, or wastes, as well as process or maintenance activities.

Identifying industrial activities or materials handling areas that are sources of potential pollutants requires a thorough review by operating personnel who are familiar with the specific site and experienced in its industrial operations.

Note that in a few cases, you may need to include storm water from non-industrial activities in your source identification. Table 4-2 provides a list of potential sources to consider in a partially com-

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pleted Column 1, and a revised Column A that will help determine whether you must list them as a potential source.

Step 2. Identify materials and wastes associated with each of the activities. The General Permit requires that you identify specific *substances* that are associated with each of the potential sources of storm water pollutants. The second step is to list the materials that you use in each of your process lines, industrial activities, and materials handling areas to be sure that you can identify the source of any substances that *might* later be detected in your storm water by your required monitoring program.

Your list should include potential pollutants directly related to your processes, as well as those not so directly related (for example, materials associated with vehicle maintenance). Dust or other particulate matter generated by your site activities should be included. If your facility includes unpaved areas that are bare (no vegetation), eroded soil should be included as a potential pollutant.

Step 3. Evaluate whether each substance may be present in storm water. The six columns under the heading of Column 3 may be used to determine, for each substance noted as being present in each industrial activity or materials handling operation, whether storm water may contact the industrial activity and, thus, whether the substance may be present in storm water discharge. Table 4-1 guides you in this effort using Columns A through F. Each of these columns asks a question about some typical ways in which storm water may contact an industrial activity or materials handling operation.

These categories may not be all-inclusive, but for the most part encompass those means by which storm water typically becomes associated with an industrial activity, as described by the General Permit. Consider carefully whether there are any other possible routes by which storm water may contact industrial equipment, its effluents and wastes, or materials that are to be used in its production processes. Refer again to the section beginning on page 4-2 for more suggestions on how to determine whether an industrial activity or material handling operation might produce substances that have a potential to contact storm water.

Step 4. Identify whether each activity is a source of potential storm water pollutants. In Column 4, simply mark "yes" for any substances for which you marked "yes" in *any* of the columns A through F in Step 3. This column becomes your list of potential storm water pollutants, or "pollutants that have a reasonable potential to be present in storm water discharge in significant quantities," as required in the General Permit (page 5, section A, provision 5.d).

Step 5. Select storm water management controls. Finally, in Column 5, for each of the substances identified as a potential pollutant in Column 4, describe the storm water management controls (or best management practices, BMPs) that you will implement at the facility to control the pollutants. This is merely a list of controls you will implement, as selected and described in Part 2 or your SWPP Plan.

Column 5 on Table 4-1 may be a short reference or the name and location of the BMP, since the column has very little space for a description. You will need to describe the controls in more detail in Part 2 of your SWPP Plan. Column 5 should include a reference to the page number or section number of the full description in the SWPP Plan.

The controls should include practices or structural BMPs that you currently have in place, those that are to be implemented as soon as the SWPP Plan takes effect, and those you intend to implement in the future. For example, if one of the industrial activities listed in Column 1 is loading and unloading of solvents at a railroad spur, the solvents are probably potential storm water pollutants (because spills can be prevented as best

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TABLE 4-1. IDENTIFICATION OF POTENTIAL POLLUTANTS

1. Industrial Activity or Material Handling Area	2. Materials used and wastes generated	3. Evaluation of Potential for Pollutants to be Present in Storm Water: Enter Y or N						4. Is this a Potential Pollutant? (Enter Y if you entered Y on A, B, C, D, E, or F)	5. Storm Water Management Controls (BMPs) Enter a brief description including reference to full description and site map in SWPP Plan.
		A. Equipment or material outdoors or otherwise contacted by storm water?	B. Transfer, handling, production, or other activities that might carry materials outdoors?	C. Evidence of spills or releases of products, materials, or wastes?	D. Secondary containment insufficient capacity, cracked, or with any openings?	E. Storm drains or storm drain connections in areas contacting material or waste?	F. Other possible points where storm water contacts equipment, materials, or waste?		

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TABLE 4-1. IDENTIFICATION OF POTENTIAL POLLUTANTS: NON-INDUSTRIAL ACTIVITIES

1. Industrial Activity or Material Handling Area	2. Materials used and wastes generated	3. Evaluation of Potential for Pollutants to be Present in Storm Water: Enter Y or N						4. Is this a Potential Pollutant? (Enter Y if you entered Y on A, B, C, D, E, or F)	5. Storm Water Management Controls (BMPs) Enter a brief description including reference to full description and site map in SWPP Plan.
		A. Does runoff commingle with storm water from industrial activities?	B. Transfer, handling, production, or other activities that might carry materials outdoors?	C. Evidence of spills or releases of products, materials, or wastes?	D. Secondary containment insufficient capacity, cracked, or with any openings?	E. Storm drains or storm drain connections in areas contacting material or waste?	F. Other possible points where storm water contacts equipment, materials, or waste?		
Non-Industrial Areas									
Open spaces within facility boundary	Soil (erosion)								
	Others								
Landscaped areas	Pesticides Herbicides Clippings Soil (erosion)								
	Others								
Employee parking lots	Oils, grease from leaking motors								
	Others								

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as humanly possible but might never be reduced to zero probability). In this case, the facility probably has in place a hazardous materials management plan or spill control and response plan which is fully described in some other document in order to comply with other environmental regulations. The facility should reference that BMP in Column 5, and Part 2 of your SWPP Plan should refer to the exact title of the other document and the page on which the description of the practice may be found.

If the BMP is a structure that is not yet in place or a practice that has not been initiated, the description in the SWPP Plan should include a schedule for implementation and a sufficiently detailed description. The SWPP Plan should include enough text so that a regulator may evaluate whether it will sufficiently control the potential pollutant from the specific industrial activity that is its source.

Also in Column 5, for each of the substances identified as potential pollutants in Column 4, you should include the identifying number that you use on the SWPP Plan's site map that shows the location of the industrial activity or material handling area that is the source of the potential pollutant. Since the SWPP Plan is expected to be reviewed by a regulator who is visiting your site, the SWPP Plan should include enough information that the inspector may locate the storm water management controls at your facility.

The completed Table 4-1 can work in combination with the completed site map to summarize all the information required in the General Permit's provision requiring identification of potential pollutants, and the two can provide a reliable "road map" to any further text or documentation that plant employees need to continue implementing the correct practices.

FIGURE 4-2: SOME GUIDANCE ON POTENTIAL SOURCES OF POLLUTANTS

Figure 4-2 includes, in the left-hand column (Column 1), a number of suggested potential sources of pollutants that are common to industrial facilities of many kinds. Identify which of the listed activities or areas apply to your facility, and add them to your Table 4-1, along with others that are specific to your plant. This generic table can provide some guidance, but you can be sure that others exist on your site that do not fit these simple descriptions.

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FIGURE 4-2.
SOME COMMON POTENTIAL SOURCES, POTENTIAL POLLUTANTS, AND EVIDENCE FOR PRESENCE OF POTENTIAL POLLUTANTS. EXAMPLE PARTIALLY COMPLETED TABLE 4-1.

1. Industrial Activity or Material Handling Area	3. Evaluation of Potential for Pollutants to be Present in Storm Water							4. ...	5. ...
	2. Materials used, wastes generated	A. ...	B. ...	C. Evidence of spills or releases of products, materials, or wastes	D. ...	E. ...	F. Other possible points where storm water contacts equipment, materials, or waste		
Manufacturing Operations									
Primary metal manufacturing	Metal dust Oils, grease			Particulates or oily film at roof vents, wall vents, doors, etc.					
Wood products manufacturing	Wood chips, sawdust Paint or preservatives			Particulates carried outdoors with products, on fork trucks, etc. Stains near access doors, loading areas					
Outdoor manufacturing operations	Paint Equipment lubricants								
Area where industrial activities have taken place in the past	Metals Solvents Oils, grease			Soil or pavement contamination			Knowledge about kinds of activities and materials used		
Outdoor machinery or equipment									
Air compressors	Bleed or blowdown Lubricant			Stains near compressor			Blowdown discharge to paved area		
Pumps	Liquid being pumped Lubricant			Stains near pump; small standing puddles					
Generators	Fuel Lubricants			Stains near generator					
Equipment in general	Lubricants Hydraulic fluid Metal particles, corrosion products			Equipment rusty or in generally poor repair					
Cooling towers	Bleed or blowdown Once-through cooling water						Improper discharge; not permitted in storm drain		
Pollution control equipment									
Air scrubbers, roof vents	Blowdown or discharge; leaks Lubricants Materials from indoor manufacturing			Stains or standing liquids Particulate buildup near vents and on roof			Roof downspouts can become sources of potential pollutants if not controlled at the equipment		
Water pollution control plants	Wastewater overflow during rain Solids from treatment residuals			Standing liquids (Observe during rain)			Improper discharge--must be eliminated Treatment solids outdoors and uncovered		

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FIGURE 4-2.
SOME COMMON POTENTIAL SOURCES, POTENTIAL POLLUTANTS, AND EVIDENCE FOR PRESENCE OF POTENTIAL POLLUTANTS. EXAMPLE PARTIALLY COMPLETED TABLE 4-1.

1. Industrial Activity or Material Handling Area	3. Evaluation of Potential for Pollutants to be Present in Storm Water							4. ...	5. ...
	2. Materials used, wastes generated	A. ...	B. ...	C. Evidence of spills or releases of products, materials, or wastes	D. ...	E. ...	F. Other possible points where storm water contacts equipment, materials, or waste		
Materials handling areas									
Outdoor product handling areas	Residue from fresh paint, particles, etc.			Particles or staining on pavement or ground					
Loading docks	Materials being loaded--liquids, dry bulk solids			Particulates, stains, buildup at storm drain					
	Truck motor fluids			Pavement stains					
Storage tanks	Liquids stored			Stains near pumps, valves, connections			Connections or pumps in poor repair; tanks corroded		
	Pump lubricants			Standing liquids in small quantities					
	Metal--corrosion by-products								
Underground tanks	Liquids stored			Stains near pumps, valves, connections			Spills during tank filling, emptying		
Bulk dry material storage	Material stored			Particulates generally around site			Storage piles not covered		
Areas of residual or waste treatment or storage	Waste substances								
Scrap metal storage areas (indoors or out)	Oils, grease			Staining on scrap and on pavement, ground outside doors			Knowledge of origin of scrap		
	Metal particles, corrosion products			Scrap visually rusted, particulates visible outside doors					
Access roads and rail spurs	Materials being shipped, handled			Particulates on paving or roadbed					
	Leaked fuel, motor fluids			Staining on paving or roadbed					
Vehicle operating areas									
Vehicle fueling areas	Fuel			Stains on pavement			Area not paved		
	Leaked motor fluids, antifreeze, etc.								
Vehicle maintenance areas, heavy equipment maintenance areas, equipment yards	Leaked fuel			Stains on pavement			Area not paved		
	Spilled motor fluids, antifreeze, etc.			Stains on pavement					
	Metal particles, corrosion byproducts			Particulates generally around area			Metals open to rain water		
	Paint						Painting operations exposed to storm water		
Equipment washing areas	Wash water			Wash water flowing away from area--drainage allowing flow to storm drains			Discharge of wash water to storm drain is not permitted		
	Oils, grease								
	Other residues								

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5. SWPP PLAN PART 2: STORM WATER MANAGEMENT CONTROLS

Part 2 of the SWPP Plan is a description of storm water management controls that you commit to implementing at your facility. The intention is for you to develop an integrated approach to controlling storm water pollutants from industrial activities at your facility. The SWPP Plan should show how you will prevent pollutants that originate in industrial activities at your facility from contaminating storm water.

Part 2 of the Plan is centered on a list of your facility's storm water management controls. You are expected to develop your own list of controls, and to address effectively all of the sources identified in Part 1 of your SWPP Plan.

This is another part of the General Permit where you must develop your own site-specific plan. Neither the Regional Board nor any other agency is prepared to develop a specific list of requirements for you. The Regional Board presumes that the facility operator knows the facility best, and is best qualified to develop controls that will control storm water pollution at that facility. If you find a particular source of pollutants to be difficult (or costly) to control, it may be to your advantage to take steps to eliminate it instead.

Storm water management controls to consider for this part of your SWPP Plan may include a number of approaches:

- Operating changes that will not interfere with industrial activities, but may prevent pollutants from contacting storm water
- Improved maintenance activities to prevent inadvertent leaks and spills that may reach storm water
- Structural changes to the facility
- Equipment installed to remove pollutants from storm water before discharge.

The General Permit directs you to consider certain kinds of controls, as shown in the box below. The Regional Board has indicated that it will require Part 2 of your SWPP Plan to include controls from each of these categories, or, if no controls from a particular category apply to you, to demonstrate that you have considered the category and to demonstrate why no controls apply. Further, the General Permit specifies that every facility's operators implement some particular aspects of storm water pollution prevention. For example, every facility is expected to conduct employee training, perform periodic inspections, and keep records on the premises. These, too, are shown in the box.

Storm Water Management Controls: The General Permit's Categories

Storm water pollution prevention personnel
Preventive maintenance
Good housekeeping
Spill prevention and response
Source control
including use of alternative raw materials that have less environmental impact
Storm water management practices
(i.e., treatment devices or practices)
Sediment and erosion prevention
Employee training
Inspections
Records

Source: NPDES Storm Water General Permit for Santa Clara Valley, order no. 92-011, January 1992; Part A, no. 6, sections a - j.

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A number of guidance documents are available to provide assistance in identifying, developing, and selecting storm water management controls. A term that is commonly used for these controls is the term used in Section 4 above: best management practices, or BMPs.

The NPS Program is developing a BMP manual that concentrates on operational procedures for manufacturing facilities. It is expected to be available in the summer of 1992. (For readers who receive this handbook as part of the NPS Program's Industrial Compliance Binder, a draft of the NPS Program's BMP Manual is included in Part VI of the Binder.) The State of California is developing a BMP manual that is expected to include design specifications for equipment and structural BMPs. It is expected to be available during the autumn of 1992.

As stated in Section 4 of this handbook, the General Permit requires that you prepare the SWPP Plan by October 1, 1992. The controls that you identify in the SWPP Plan do not all need to be implemented immediately. The General Permit specifies that you implement maintenance practices and other low-cost practices by October 1, the date your SWPP Plan takes effect. All other controls that you identify in your Plan are to be implemented no later than July 1, 1993. This allows you an additional period to implement measures such as structural changes, equipment installation, other costly measures, and measures that require a lead time to obtain approval from public agencies (such as a construction permit or a sanitary sewer discharge permit).

The deferment period also allows you several months' lead time to implement some lower-cost, operational controls before implementing the higher-cost measures that you commit to in your SWPP Plan. If monitoring results from the 1992-1993 wet weather season demonstrate (to your satisfaction, and the Regional Board's) that the low-cost controls are adequate by themselves, you may not have to install the more costly measures. This is a powerful incentive to find the most effective operational controls possible, and to implement them to the utmost at your facility. It is also another incentive to eliminate industrial activities exposed to storm water, thus eliminating potential sources and avoiding the need to control them.

ORGANIZATION OF THIS SECTION

This section provides guidance on how to evaluate your facility and select storm water management controls that meet your facility's characteristics and are both cost-effective and effective at preventing pollution. This section also includes line-by-line guidance for completing the Storm Water Management Controls portion of the SWPP Plan as called for in the General Permit. As in Section 4, the numbered paragraphs describe one method of completing a SWPP Plan that may comply with the Permit, but are not specifically laid out in this fashion in the Permit.

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ORDER OF PREFERENCE IN SELECTING BMPs

As you can see, there is a wide array of possible BMPs that can provide some storm water pollution prevention. For each facility, some BMPs are more effective than others. But in most cases, a number of different BMPs or combinations of BMPs could be effective, perhaps equally well as another approach. As a general rule, the NPS Program recommends selecting BMPs from the following hierarchy. This order of preference is generally most effective at minimizing pollutants in your storm water discharge, and often most cost-effective in the long run.

1. **Alter the activity** to avoid contaminating storm water, either by avoiding creating a pollutant or by making sure the pollutant never reaches the environment.

2. **Enclose the activity** in a building or a fully-bermed and roofed area, or take other steps so that no potential pollutants reach the storm drain. This includes keeping potential pollutants off of paved surfaces where they easily wash into the storm drains, and unpaved surfaces where they sorb to soil particles that may wash into the storm drains.

3. **Cover the activity** to keep storm water off, perhaps using tarpaulins or temporary covering that is watertight for the duration of a storm. This is not as effective as fully enclosing the activity, but may be used quickly to prevent pollutants from contacting runoff from a particular storm.

4. **Segregate the activity** so that contaminants reach only a small portion of the storm water that runs off your site. This includes preventing runoff from the activity from reaching other storm water, and preventing rainfall from other parts of the site from running across the activity and becoming contaminated. The volume of contaminated water from the activity can then be kept to a minimum and handled by one of the following two methods. Remember that runoff from parking lots, commercial activities and other non-industrial activities at the facility does not need to be covered under the General Permit if it is segregated from water that contacts industrial activities.

5. **Reroute the activity's wastewater** to the sanitary sewer or to your on-site pretreatment facilities. If you cannot prevent pollutants from entering the water, you may need to handle it as wastewater rather than storm water and meet a number of discharge requirements. This generally requires, as a first step, that you minimize or eliminate storm water from the discharge--for instance, with a roof and berms. Most sanitary authorities prefer to avoid adding storm water to their system due to limited treatment capacity. You must obtain a sanitary sewer discharge permit and, in most municipalities, a city approval. Also, the wastewater authorities will require a pretreatment device on any discharge before they will accept it. Depending on the nature and volume of your wastewater, they may have other requirements.

6. **Treat storm water that contacts the activity** before discharging it to the storm drains. This often is the most costly approach, but may occasionally be necessary if other options fail. It is often also the least effective at minimizing pollutants. The order of preference suggests that you implement all applicable pollution prevention BMPs first, but if storm water still contacts potential pollutants, and it cannot be accepted by the wastewater authority, then treatment BMPs may be called for.

The Program thanks the Washington State Dept. of Ecology, which developed the Storm Water Management Manual for the Puget Sound Basin, from which this list is borrowed and adapted.

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LINE-BY-LINE GUIDANCE FOR COMPLETING THE SWPP PLAN PART 2

This section contains guidance on preparing Part 2 of your SWPP Plan in a way that conforms to the specific items called for in the General Permit (Part A, Provision 6). The headings are numbered to correspond to sections of the sample SWPP Plan prepared by the NPS Program that appears in the appendices.

5.0 STORM WATER MANAGEMENT CONTROLS

This section of your SWPP Plan consists of information regarding operations and management practices and controls used at your site to minimize potential discharge of pollutants to storm water. Many of the items required in the section may be partially or completely covered in other documents you may have prepared for your facility, such as a Spill Prevention, Control, and Countermeasures plan (SPCC) that is required for some petroleum-handling facilities or a hazardous materials management plan. You may use references to these documents; however, note that the requirements here refer particularly to storm water pollution prevention. If practices described in existing documents do not address storm water considerations, you should address those considerations here.

The controls and practices described in this section will be critical to the level of effort necessary for you to meet the requirements of this permit. If you demonstrate that your controls (e.g., containment, isolation and separation of wastes and materials) effectively minimize potential for pollutant contact with storm water and that your management practices (e.g., maintenance, spill prevention and response, erosion controls, training) are sufficiently well-designed to minimize accidental discharges and their impacts, you will significantly reduce the list of potential pollutants at your site. This will result in a lower level of effort required for permit completion and for monitoring.

5.1 Structural Source Controls

Structural source controls refer to the permanent structures at your site that are used for potential pollutant containment and isolation. All such structures, including those that are planned or under construction, should be described in this section. The form of the control and the scheduled completion date for construction should be provided.

5.1.1 Secondary containment and roofing of potential pollutants

Identify secondary containment structures for all potential pollutants. Such structures may include berms, dikes, or roofed enclosures. You may include drawings or sketches of the containment and you should identify the volume of the containment. However, note that such secondary containment, even complete enclosure in a building, does not necessarily eliminate a material as a potential pollutant. Activities such as washdown of associated equipment or transport of materials between areas may result in potential pollutant discharge. These possibilities should be carefully considered when designing containment structures and associated management practices.

5.1.2 Separation and structural isolation of wastes

Identify structures used to separate and isolate wastes in each area of your site. Such structures may include dumpsters, sumps, or tanks used to collect or store wastes prior to recycling or disposal.

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5.2 Non-structural Source Controls and Management Practices

This section should describe management practices you use to reduce contact between storm water and potential pollutants. As discussed above, these practices, in conjunction with effective control structures, can greatly reduce the effort required to comply with permit requirements. All pertinent management practices should be thoroughly explained in this section. Further, any management practices scheduled for implementation should be identified (along with scheduled implementation date).

Management practices described in existing documents may be included in your SWPP Plan by reference. However, you should be sure that the referenced practices are appropriate for storm water pollution prevention.

5.2.1 Spill prevention and response procedures

Describe the spill prevention and response procedures used at your site. Note that such procedures may vary according to the various kinds of potential pollutants. Effective procedures should be described for all potential pollutants. Identify areas where significant materials can spill into or otherwise enter the storm water conveyance systems. Describe specific material handling procedures, storage requirements and equipment cleanup procedures. Identify equipment that is kept on site ready for spill control and emergency response. Describe training for all personnel in use of the equipment and in spill response in general. Identify the internal spill reporting procedures used at the site.

If you have an existing document that describes procedures for controlling hazardous materials on your site, you may incorporate it by reference into your SWPP Plan and do not need to described those controls here.

5.2.2 List of significant spills

Tabulate all significant spills of potential pollutants that have occurred since November 19, 1988. (This is the date specified in the General Permit.)

5.2.3 Maintenance procedures and schedules

This section requires you to develop inspection and maintenance procedures for all structures and equipment at your site that are identified in Part 1 of your SWPP Plan as potential sources of storm water pollutants at your facility. Provide maintenance schedules and describe maintenance log books or other records kept at your site. Preventive maintenance involves inspection and maintenance of storm water conveyance systems, and inspection and testing of site equipment and systems that could fail and result in discharges of pollutants to storm water. Again, information in your SPCC plan (if you have one) need not be repeated.

Describe equipment maintenance and cleaning procedures that are used to:

- Ensure that equipment is operating properly
- Minimize potential contact between storm water runoff and materials and wastes associated with maintenance/cleaning activities.

5.2.4 Erosion control measures

Describe measures to limit erosion from your site. These may include paving, riprap, revegetation, and slope stabilization. Provide a description of how these measures are maintained, including methods and frequency of maintenance activities.

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5.2.5 Personnel responsible for storm water pollution prevention

Identify specific individuals (by name and job title) who are responsible for developing, implementing and revising the SWPP Plan. Update this section each year when you conduct the annual evaluation and revision of the SWPP Plan.

5.2.6 Employee training

Describe your employee training program. The program should be used to educate all personnel responsible for implementing the SWPP Plan. Training should address spill response, good housekeeping, and material management practices. Identify the dates for training of all personnel. Some further suggestions are described in the Employee Training Procedures section on the next page.

5.2.7 Industrial storm water discharge treatment procedures (if any)

Describe any existing or planned storm water discharge treatment procedures.

5.2.8 Waste collection, recycling, and disposal practices

Describe waste handling practices used to minimize potential contact between wastes and storm water run off. Be sure to discuss methods of waste storage prior to final disposal or removal from your site. Identify any areas where wastes may be directly exposed to storm water (e.g., scrap metal yards, open waste bins or burial areas). Discuss any proposed improved management practices that will eliminate these potential exposures.

5.3 Inspection Program

Develop inspection procedures to identify evidence of, or the potential for, pollutants entering storm water runoff. Inspection should be performed by trained personnel. Provide inspection schedules and describe inspection log books or other records. Records of inspections should be maintained for at least five years and include details of tracking or follow-up procedures. Inspections must include:

- Inspection of buildings
- Inspection of loading docks and outside areas
- Inspection of storm water control system
- Facility inspection for verification of SWPP Plan accuracy

5.4 Record Keeping and Reporting Procedures

Describe your record-keeping and follow-up procedures to ensure that corrective actions have been taken in response to results of inspections and/or spill response. Provide documentation procedures for reporting to appropriate agencies.

5.5 New and Proposed Storm Water Management Controls and Implementation Schedule

If you have designed or developed new structures or management procedures to improve storm water pollution prevention, describe them here. Include drawings or sketches of proposed structures. Provide documentation procedures (e.g., log books or other records) for newly developed management practices. Finally, provide the proposed schedule for implementation.

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Employee Training Procedures

When you hold training sessions, keep records of personnel who are trained in storm water pollution control and how many hours they spend training. Training in storm water management may be added to existing training for safety procedures, operating practices, or other sessions you routinely conduct.

The training should include familiarizing plant personnel with the contents of your SWPP Plan. Employees who operate any equipment you have identified as potential sources of storm water pollution need to be informed of Best Management Practices and operational controls that you have designed to control storm water pollutants. Also, provide training on the contents of your SWPP Plan to employees identified as key individuals in the Plan and employees who conduct inspections and maintenance programs called for in the Plan.

Keep records of training completed by plant employees, and attach the records to your SWPP Plan to keep it up to date. Figure 5-1, on the following page, is a sample training documentation form that you may photocopy and use.

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Figure 5 - 1 Sample Training Documentation form

Storm Water Pollution Prevention Training Sessions

	Person Trained; Position or Job Title	*Date*	*Hours*
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
12.			

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OUTLINE OF THE SAMPLE SWPP PLAN FICTITIOUS FACILITY IN SANTA CLARA COUNTY

		GENERAL PERMIT Section A: Provision Addressed
1.0	INTRODUCTION AND BACKGROUND	
2.0	SITE LOCATION AND REGIONAL INFORMATION	5.a.
	2.1 Location	
	2.2 Topography, Surface Water Bodies, and Wells	
	2.3 Regional Rainfall	
3.0	SOURCE IDENTIFICATION: SITE DESCRIPTION	
	3.1 Buildings	6.f.
	3.2 Outdoor Storage, Manufacturing, and/or Processing Areas	5.c.vii.
	3.3 Loading/Unloading Areas	5.c.iii.
	3.4 Site Paving	5.e.
	3.5 Storm Drain System	6.f.
	3.6 Process Wastewater and Sanitary Sewer System	7.
	3.7 Underground and Above Ground Storage Tanks	5.c.vi.
4.0	SOURCE IDENTIFICATION: DESCRIPTION OF POTENTIAL SOURCES OF POLLUTANTS IN STORM WATER DISCHARGES	
	4.1 Potential Pollutants	5.d.
	4.1.1 List of potential pollutants to storm water	
	4.1.2 Estimate of annual quantities of potential pollutants in storm water runoff	
	4.1.3 Existing sampling data describing pollutants in storm water discharge (if any)	5.g.
	4.2 Isolation of Storm Drain from Sanitary Sewer	7.

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5.0	STORM WATER MANAGEMENT CONTROLS	5.c.ii.; 6.
	5.1 Structural Source Controls	5.c.1.; 6.e.
	5.1.1 Secondary containment and roofing of potential pollutants	
	5.1.2 Separation and structural isolation of wastes	
	5.2 Non-Structural Source Controls and Management Practices	5.c.iv.
	5.2.1 Spill prevention and response procedures	5.c.vi.; 6.d.
	5.2.2 List of significant spills since November 19, 1988	5.c.i.; 5.f.
	5.2.3 Maintenance	5.c.ii.; 6.b.
	5.2.4 Erosion control	6.g.
	5.2.5 Personnel responsible for storm water pollution prevention	6.a.
	5.2.6 Employee training	6.h.
	5.2.7 Industrial storm water discharge treatment procedures (if any)	5.c.v.
	5.2.8 Waste collection, recycling, and disposal practices	5.c.vi.
	5.3 Inspection Program	6.c.; 6.i.
	5.4 Record Keeping and Reporting Procedures	6.j.
	5.5 New and Proposed Storm Water Management Controls and Implementation Schedule	6.a. through 6.j.
	5.5.1 Stencil storm drains	
	5.5.2 Roof truck fueling area and eliminate discharge to storm drain	
	5.5.3 Revegetate former scrap metal disposal area	
6.0	CERTIFICATION OF ELIMINATION OF NON-STORM WATER DISCHARGES TO THE STORM DRAIN SYSTEM	7.
7.0	COPY OF NOTICE OF INTENT FILED WITH SWRCB ON APRIL 1, 1992	

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5750 Almaden Expressway
San Jose, CA 95118
FAX (408) 268-7687

NPS MATERIALS ORDER

NPS 001 (12-29-92)

Please complete the following information to order Nonpoint Source Materials. Description of materials are on the back of the order form. Forms may be mailed or faxed. If you have any questions, please call the toll free number (800) 794-2482. If outside Santa Clara County, call (408) 927-0710, extension 2724.

Name: | Date:

Company: | Phone Number:

Address:

City: | State: | Zip:

Do you want to be on the mailing list for the NPS Newsletter, "The Outfall"? ☐ Yes ☐ No

Check box for each item and fill in the appropriate amounts required. Quantities for amounts other than English may be included in the box in front of the listed language. Payment for items 6 and 10 should be included with the order form. Checks should be made payable to SCVWD–NPS.

Item #	✔	Quantity	Cost	Description
1.				"The Bay Begins at Your Front Door" ☐ English ☐ Spanish ☐ Vietnamese
2.				"Help Protect Your Neighbors"
3.				"Take Me Shopping"
4.				"Pests Bugging You?" ☐ English ☐ Spanish
5.				"estuarywise"
6.				"Industrial Storm Water Pollution Control Compliance" (Binder) Cost $25 per copy.
7.				"Best Management Practices for Industrial Storm Water Pollution Control"
8.				"Best Management Practices for Automotive-Related Industries"
9.				"No Dumping! Flows to Bay" Stencil ☐ English ☐ Spanish ☐ Vietnamese
10.				"Construction Storm Water Pollution Control Compliance" (Binder) Cost $15 per copy.
11.				"Blueprint for a Clean Bay"
12a.				"General Construction and Site Supervision"
12b.				"Earth-Moving Activities"
12c.				"Roadwork and Paving"
12d.				"Heavy Equipment Operation"
12e.				"Fresh Concrete and Mortar Application"
12f.				"Landscaping, Gardening and Pool Maintenance"
12g.				"Painting and Application of Solvents and Adhesives"

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NPS MATERIALS ORDER

NPS 001 (12-29-92)

AVAILABLE MATERIALS.

1. **"The Bay Begins at Your Front Door"**

   Explains the issues and origins of nonpoint source pollution, specifically the anatomy of a storm drain system and activities that contribute to nonpoint source pollution. Available in English, Spanish and Vietnamese

2. **"Help Protect Your Neighbors"**

   Takes the concepts in "The Bay Begins..." one step further by offering examples of consumer products that are healthier in that they do not contribute significant heavy metals to the Bay, either through storm drains or through the treatment plants. Produced by the City of San Jose.

3. **"Take Me Shopping"**

   A comprehensive guide to safer alternatives to hazardous household products, including cleaning products, paints, pesticides and fertilizers, pet care products and others.

4. **"Pests Bugging You?"**

   Builds on the integrated pest management information presented in "Take Me Shopping". Addresses specific unwanted guests, such as ants, cockroaches, fleas, with suggestions for choosing and caring for plants and pets. Available in English and Spanish.

5. **"estuarywise"**

   A handbook for the San Francisco Bay-Delta Estuary, produced by the San Francisco Estuary Project. Includes tips on how to stop pollution; recipes for household cleaners and pest controls; product toxicity ratings; listings of household hazardous waste collection programs; and ways to get involved in community-wide restoration efforts. A great book for families.

6. **"Industrial Storm Water Pollution Control Compliance"**
   (Binder)

   A comprehensive source book for federal, state, and regional regulatory requirements and information resources; contains sample SWPP, EPA regulations and booklet described below.
   Cost $25

7. **"Best Management Practices for Industrial Storm Water Pollution Control"**

   A booklet of recommended BMPs for industry.

8. **"Best Management Practices for Automotive-Related Industries"**

   Best Management Practices for sanitary sewer discharges and storm water pollution control for automotive industry.

9. **"No Dumping! Flows to Bay"**

   Plastic stencil with cover letter and instruction sheet; for business, industry, or county residents, and volunteer groups; the stenciling of storm drain inlets brings nonpoint source pollution to the attention of the public and is a Best Management Practice for Business and Industry. Available in English, Spanish and Vietnamese.

10. **"Construction Storm Water Pollution Control Compliance"**
    (Binder)

    A source book for state and regional regulatory requirements and information resources; contains sample SWPPP, booklet described below and permit.
    Cost $15

11. **"Blueprint for a Clean Bay"**

    Best Management Practices for storm water pollution prevention for construction activities.

12. The following seven tri-fold pamphlets (BMPs for Construction):

    a. **"General Construction and Site Supervision"**

    b. **"Earth-Moving Activities"**

    c. **"Roadwork and Paving"**

    d. **"Heavy Equipment Operation"**

    e. **"Fresh Concrete and Mortar Application"**

    f. **"Landscaping, Gardening and Pool Maintenance"**

    g. **"Painting and Application of Solvents and Adhesives"**

PIO Instructions: Check items needed. Route items from PIO to NPS, along with this form and a typed mailing label. Retain copy of this form for our records. NPS: Route appropriate items, form and label to PIO.

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STATE OF CALIFORNIA

PETE WILSON, Governor

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION
2101 WEBSTER STREET, SUITE 500
OAKLAND, CA 94612

Phone: (510) 286-1255
FAX: (510) 286-1380



September 28, 1992

TO: INTERESTED PARTIES

SUBJECT: MONITORING PROGRAM MODIFICATIONS TO NPDES GENERAL PERMIT FOR DISCHARGES OF STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITY IN SANTA CLARA COUNTY TO SOUTH SAN FRANCISCO BAY OR ITS TRIBUTARIES

Enclosed is a copy of the NPDES General Permit Amendment, issued by the Regional Water Quality Control Board (Regional Board) on September 16, 1992, which modifies the monitoring program requirements of the subject permit. The modifications were issued in response to revised federal regulations issued by the US Environmental Protection agency in April 1992.

The modifications will:

- Add the new minimum federal requirements for an annual site inspection and certification.
- Simplify sampling requirements by eliminating the first storm sampling provision and eliminating the composite sample provision.
- Allow sample collection only during a period extending two hours around the facility's normal working hours.
- Simplify annual reporting requirements.

The Monitoring Program must be implemented by January 1, 1993. Monthly visual observations of storm water discharge are required. However, only one storm event in the 1992-93 wet season and two storm events in subsequent wet seasons must be sampled and analyzed for pollutants.

The modifications also establish a sampling exemption process for dischargers who can self-certify that areas of industrial activity are not exposed to storm water or for dischargers that have received a certification from the Santa Clara Valley Nonpoint Source Pollution Control Program.

All dischargers are still required to implement an effective Storm water Pollution Prevention Plan as of October 1, 1992. Dischargers who receive a sampling exemption are still required to conduct regular site inspections and visual observations.

If you have any questions please contact Dale Hopkins at 510-286-4398, Wil Bruhns at 510-286-0838, or Tom Mumley at 510-286-0962. The Santa Clara Valley Nonpoint Source Pollution Control Program can be reached at 800-794-2482.

Attachment

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CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

ORDER NO. 92-116, AMENDING WASTE DISCHARGE REQUIREMENTS FOR

DISCHARGES OF STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITIES IN SANTA CLARA COUNTY TO SOUTH SAN FRANCISCO BAY OR ITS TRIBUTARIES EITHER DIRECTLY OR THROUGH MUNICIPAL STORM WATER SYSTEMS

Section B: Monitoring Program and Reporting Requirements of ORDER NO. 92-011 (NPDES General Permit No. CAG612001) are to be replaced with the following:

Section B: MONITORING PROGRAM AND REPORTING REQUIREMENTS

1. Implementation

A monitoring program shall be developed and implemented for each facility covered by this General Permit. It shall be certified in accordance with the signatory requirements contained in Standard Provision C.9. A description of the monitoring program shall be retained on site and made available upon request of a representative of the Regional Board and/or the Santa Clara Valley Nonpoint Source Pollution Control Program (Program).

2. Schedule

For existing facilities (and new facilities beginning operations before January 1, 1993), a monitoring program must be developed and implemented no later than January 1, 1993. For facilities beginning operations after January 1, 1993, a monitoring program shall be developed and implemented concurrent with commencement of industrial activities.

3. Objectives

The monitoring program shall be developed and amended, when necessary, to meet the following objectives:

a. Ensure that storm water discharges are in compliance with the Discharge Prohibitions, Effluent Limitations, and Receiving Water Limitations specified in this General Permit.

b. Ensure practices at the facility to control pollutants in storm water discharges are evaluated of and revised to meet changing conditions.

c. Aid in the implementation of the Storm Water Pollution Prevention (SWPP) Plan required by this General Permit.

d. Measure the effectiveness of best management practices (BMPs) in removing pollutants in storm water discharge.

4. General Requirements for Monitoring Programs

The monitoring program shall contain:

a. Rationale for selection of monitoring methods.

b. Identification of the analytical methods to detect pollutants in storm water discharge.

c. Description of the sampling methods, sampling locations, and frequency of monitoring.

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d. A quality assurance/quality control program to assure that:

i. All elements of the monitoring program are conducted; and
ii. All monitoring is conducted by trained personnel.

e. Procedures and schedules by which the effectiveness of the monitoring program in achieving the objectives above can be evaluated.

5. Specific Requirements for Monitoring Programs

The monitoring program shall document the elimination or reduction of specific pollutants, resulting from the implementation of the SWPP Plan required by this General Permit.

a. Annual Site Inspection

All dischargers shall:

i. Conduct a minimum annual inspection of the facility site to identify areas contributing to a storm water discharge associated with industrial activity and to evaluate whether measures to reduce pollutant loadings identified in the SWPP Plan are adequate and properly implemented in accordance with the terms of the General Permit or whether additional control measures are needed. A record of the annual inspection must include the date of the inspection, the individual(s) who performed the inspection, and the observations.

ii. Certify, based on the annual site inspection, that the facility is in compliance with the requirements of this General Permit and its SWPP Plan. The certification and inspection records must be signed and certified in accordance with Standard Provisions 9 and 10 of Section C of this General Permit. Any noncompliance shall be reported in accordance with Provision 11.d. of Section C of this General Permit.

b. Non-Storm Water Discharges Observations

No less than twice during the dry season (May through September), all dischargers shall observe and/or test for the presence of non-storm water discharges at all storm water discharge locations. At minimum, tests will include visual observations of flows to determine the presence of stains, sludges, odors, and other abnormal conditions. Dye tests, TV line surveys, and/or analysis and validation of accurate piping schematics may be conducted if appropriate. Records shall be maintained of the description of the method used, date of testing, locations observed, and test results.

c. Wet Season Visual Observations

During the wet season (October through April), all dischargers shall conduct visual observations of all storm water discharge locations during the first hour of one storm event per month that produces significant storm water discharge[1] to observe the presence of floating and suspended materials, oil and grease, discolorations, turbidity, and odor, etc. Feedlots (subject to federal effluent limitation guidelines in 40 CFR Part 412) that are in compliance with Sections 2560 to 2565, Article 6, Chapter 15, Title 23, California Code of Regulations, shall, instead, conduct

[1] "Significant storm water discharge" is a continuous discharge of storm water for a minimum of approximately one hour or more.

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monthly inspections of their containment facilities to detect leaks and ensure maintenance of adequate freeboard.

d. Sampling and Analysis

During the wet season (October through April), dischargers (unless exempted per Section B.9 below) shall estimate or calculate the volume of storm water discharge from each outfall and collect and analyze samples of storm water discharge from at least one storm event during the 1992/93 wet season and two storm events during each subsequent wet season which produce significant storm water discharge. The samples should be analyzed for:

i. pH, total suspended solids (TSS), specific conductance, and total organic carbon (TOC); oil and grease (O&G) may be substituted for TOC;

ii. Toxic chemicals and other pollutants that are likely to be present in storm water discharge in significant quantities; and

iii. For facilities subject to storm water limitation guidelines in 40 CFR Subchapter N, any pollutant listed in the applicable storm water effluent limitation guideline.

6. Toxic Pollutant Analysis Reduction

Samples shall be analyzed for toxic chemicals and other pollutants as identified in Sections B.5.d.ii. for at least two consecutive sampling events. A discharger may substitute whole effluent toxicity monitoring for chemical-specific monitoring. If toxic chemicals or other pollutants are not detected in significant quantities after two consecutive sampling events, or two consecutive sampling events with no whole effluent toxicity, the facility may eliminate that toxic chemical or pollutant from future sampling events. A discharger may analyze for alternative representative parameters as a substitute for the toxic chemicals and other pollutants identified in Section B.5.d.ii as long as the discharger submits the alternative monitoring procedures with justification to the Regional Board prior to use. Unless otherwise instructed by the Regional Board, dischargers who have made such submittals may use alternative monitoring procedures.

7. (Reserved)

8. (Reserved)

9. Sampling and Analysis Exemptions

A discharger is not required to collect and analyze samples in accordance with Section B.5.d.i and ii if the discharger certifies that the facility meets all of the conditions set forth below in Section B.9.a, if the discharger obtains the Program certification described in B.9.b, or if the discharger obtains a Regional Board exemption as described in B.9.d.. A discharger which is exempt to Section B.5.d monitoring requirements is still required to comply with all other monitoring program and reporting requirements.

a. Self-Certification

The certification must state that areas of industrial activity are not exposed to storm water, including manufacturing, processing, and material handling areas and areas where material handling equipment, raw materials, intermediate products, final products, waste materials,

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byproducts, and industrial machinery are stored. Exposure includes both direct contact with storm water and the possible release of industrial pollutants into storm water (e.g., spills or leaks). In order to demonstrate that these areas are not exposed to storm water, the following conditions must be met:

i. All illicit (unpermitted) connections to the storm drainage system are eliminated;

ii. All materials must be completely contained at all times so, if spilled, they will not directly or indirectly contact storm water;

iii. All unhoused equipment associated with industrial activity is not exposed to storm water; and

iv. All emissions from stacks or air exhaust systems and emission of dust or particulates do not result in exposure to storm water.

b. Certification by the Program

The Program has certified in writing that the discharger has developed and implemented an effective Storm Water Pollution Prevention Plan and should not be required to collect and analyze storm water samples for pollutants.

c. Submittal of Sampling Exemption Certifications

Dischargers must submit sampling exemption certifications to the Regional Board by December 1, 1992 for the 1992-93 wet season and by August 1 for subsequent years. Unless otherwise instructed by the Regional Board, dischargers who file a sampling exemption certification are exempt from Section B.5.d. requirements to collect and analyze samples.

d. Exemptions by the Regional Board

The Regional Board may allow exemptions to the Section B.5.d. i and ii monitoring requirements on a case-by-case basis depending on the nature and effect of the discharge.

10. Group Monitoring

Group monitoring may be done in accordance with the following requirements:

a. A group monitoring plan may be designed and implemented by an entity representing a similar group of dischargers regulated by this General Permit (entity) or the Program.

b. At least 20 percent of the dischargers who are members of a group (and at least 4 dischargers in a group of less than 20 dischargers) must collect and analyze samples in accordance with Section B.5.d. The entity or Program may request that fewer member dischargers be allowed to collect and analyze, but reasons for this exception must be stated in the group monitoring plan (Section B.10.e.v.). The entity or Program shall select facilities from which samples are collected and analyzed which best represent the overall quality of the group members' storm water discharges.

c. The entity or Program must have the authority to levy fees against the participating dischargers in the group or be able to otherwise pay for the implementation of the group monitoring plan

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d. The entity or Program is responsible for:

i. Developing and implementing the group monitoring plan;

ii. Evaluating and reporting of group monitoring data;

iii. Recommending appropriate BMPs to reduce pollutants in storm water discharges;

iv. Submitting a group monitoring plan to the Regional Board no later than December 1, 1992 and August 1 in subsequent years; and

v. Revising the group monitoring plan as instructed by the Regional Board.

e. The group monitoring plan shall:

i. Identify the participants of the group by name and location;

ii. Include a narrative description summarizing the industrial activities of participants of the group and explain why the participants, as a whole, are sufficiently similar to be covered by a group monitoring plan;

iii. Include a list of significant materials stored or exposed to storm water and material management practices currently employed to diminish contact by these materials with storm water discharge;

iv. Identify and describe why the facilities selected to perform sampling and analysis are representative of the group as a whole in terms of processes used or materials managed. To the extent possible, representative facilities with the most extended scheduled facility operating hours should be selected;

v. If an exception to the requirement that at least 20 percent of the dischargers in a group (and at least 4 dischargers in a group of less than 20 dischargers) is requested, explain why such an exception is necessary, and how the proposed monitoring will be representative of the entire group; and

vi. Contain all items specified in Section B.4 above.

f. Sampling and analysis must comply with the applicable requirements, including Sections B.5.d, B.6, and B.11 through 17.

g. Unless otherwise instructed by the Regional Board, the group monitoring plan shall be implemented by January 1, 1993 and, in subsequent years, at the beginning of the wet season.

h. All dischargers participating in an approved group monitoring plan are required to comply with all other monitoring program and reporting requirements in Sections B.5.a, b, and c.

i. If any group includes dischargers which are subject to federal storm water effluent limitation guidelines, each of those dischargers must perform the monitoring described in Section B.5.d.iii. and submit the results of the monitoring to the Regional Board in the discharger's annual monitoring report.

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j. Dischargers regulated by this General Permit may participate in a group monitoring program that includes dischargers not regulated by this General Permit, as long as the dischargers covered by this General Permit comply with the monitoring program and reporting requirements of this General Permit.

11. Sample Locations

Samples shall be collected from all locations where storm water is discharged. Samples must represent the quality and quantity of storm water discharged from the facility. If a facility discharges storm water at multiple locations, the discharger may sample a reduced number of locations if it is established and documented in the monitoring program that storm water discharges from different locations are substantially identical and the reduced number of locations are noted in the annual monitoring report.

12. Sampling Procedures

Sampling shall consist of a grab sample from a storm event that produces significant storm water discharge that is preceded by at least three days of dry weather when industrial activity has occurred. The grab sample shall be taken during the first thirty minutes of the discharge. If the collection of the grab sample during the first 30 minutes is impracticable, the grab sample can be taken as soon as practicable during the storm event , and the discharger shall explain in the annual monitoring report why the grab sample could not be taken in the first 30 minutes. A discharger may select alternative monitoring procedures (e.g., composite sampling) as long as the discharger has submitted the proposed procedure with justification to the Regional Board prior to use. Unless otherwise instructed by the Regional Board, dischargers who have made such submittals may use other monitoring procedures.

13. Visual Observation and Sample Collection Exceptions

a. When a discharger is unable to collect any of the required samples or perform visual observations due to adverse climatic conditions (drought, extended freeze, dangerous weather conditions, etc.), a description of why the sampling or visual observations could not be conducted, including documentation of all significant storm water discharge events, must be submitted along with the annual monitoring report.

b. Dischargers are required to collect samples and perform visual observations only if significant storm water discharges commence during scheduled facility operating hours[2], or within two hours prior to or following scheduled facility operating hours. Dischargers are required to perform visual observations only within daylight hours. If dischargers do not collect samples or perform visual observations during a significant storm water discharge due to this exception, the discharger shall include documentation in the annual monitoring report.

14. Standard Methods

All sampling and sample preservation shall be in accordance with the current edition of "Standard Methods for the Examination of Water and Wastewater" (American Public Health Association). All

[2] "Scheduled facility operating hours" are the time periods when the facility is staffed to conduct any function related to industrial activity, including routine maintenance, but excluding time periods where only emergency response, security, and/or janitorial services are performed.

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monitoring instruments and equipment shall be calibrated and maintained in accordance with manufacturers' specifications to ensure accurate measurements. All analyses must be conducted according to test procedures under 40 CFR Part 136, unless other test procedures have been specified in this General Permit or by the Regional Board. All metals shall be reported as total metals. Toxicity tests shall be conducted in accordance with the latest revisions of Methods for Measuring the Acute Toxicity of Effluent to Freshwater and Marine Organisms, EPA-600/4-85-013 (March 1985). All analyses shall be conducted at a laboratory certified for such analyses by the State Department of Health Services. Dischargers may conduct their own laboratory analysis only if the discharger has sufficient capability (qualified employees, laboratory equipment, etc.) to adequately perform the test procedures.

15. Records

Records of all storm water monitoring information and copies of all reports required by this Permit shall be retained for a period of at least five years from the date of the sample, observation, measurement, or report.

These records shall include:

a. The date, place, and time of site inspections, sampling, observations, and/or measurements;

b. The individual(s) who performed the site inspections, sampling, observations, and/or measurements;

c. Flow measurements or estimates and all standard observations;

d. The date(s) analyses were performed and the time(s) analyses were initiated;

e. The individual(s) who performed the analyses;

f. The analytical techniques or methods used and the results of such analyses;

g. Quality assurance/quality control results;

h. Non-storm water discharge records (see Section B.5.b);

i. Visual observation and sample collection exception records (see Section B.13);

j. All calibration and maintenance records of instruments used; and

k. All original strip chart recordings for continuous monitoring instrumentation.

16. Annual Report

All dischargers shall submit an annual report by July 1 of each year to the Executive Officer of the Regional Board and to the Program. The report shall include a summary of monitoring observations and results, a certification that a Storm Water Pollution Prevention Plan is being implemented and is in compliance with the requirements of this General Permit, and information as required in Section B.13. The report shall be signed and certified in accordance with Standard Provisions 9 and 10 of Section C of this General Permit. The first report will be due July 1, 1993.

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Woodward-Clyde Consultants

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VOL 12

INDUSTRIAL STORM WATER POLLUTION CONTROL COMPLIANCE

A COMPREHENSIVE SOURCE BOOK
FOR FEDERAL, STATE, AND REGIONAL
REGULATORY REQUIREMENTS AND INFORMATION RESOURCES

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QUALITY CONTROL BOARD
LOS ANGELES REGION

PREPARED BY



Santa Clara Valley
Nonpoint Source
Pollution Control Program

PROGRAM PARTICIPANTS:
Campbell, Cupertino, Los Altos, Los Altos Hills, Los Gatos, Milpitas, Monte Sereno, Mountain View, Palo Alto, San Jose, Santa Clara, Saratoga, Sunnyvale, County of Santa Clara, and the Santa Clara Valley Water District

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What is the Santa Clara Valley NPS Program? How to reach us

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Storm water rules from the U.S. Environmental Protection Agency;
The Regional Board's Industrial Storm Water General Permit for Santa Clara Valley;
A list of Standard Industrial Classifications (SICs)

IV. INDUSTRIAL STORM WATER HANDBOOK: COMPLIANCE SUGGESTIONS FROM THE SANTA CLARA VALLEY NPS PROGRAM
The Santa Clara Valley Nonpoint Source Pollution Control Program's
Guide to Compliance with the Regional Board's Permit:
Filing the NOI, preparing the SWPP Plan, and preparing the Monitoring Program

V. SAMPLE COMPLIANCE DOCUMENTS: SUGGESTIONS FROM THE SANTA CLARA VALLEY NPS PROGRAM
Example plans for a "typical" facility: NOI, SWPP Plan, and Monitoring Program

VI. THE SANTA CLARA VALLEY NPS PROGRAM'S BEST MANAGEMENT PRACTICES MANUAL
Recommended maintenance and operational BMPs; suggested structural BMPs

VII. STORM WATER POLLUTION PREVENTION PLAN
Insert here your SWPP Plan.
Add future records such as annual reviews, plan revisions, and training records

VIII. CERTIFICATION OF ELIMINATION OF NON-STORM WATER DISCHARGES TO STORM DRAIN SYSTEMS
Insert here your Illicit Connection Elimination Certification.
Add records such as results of field investigations and Certification of Accuracy

IX. STORM WATER MONITORING PROGRAM
Insert here your Monitoring Program. Add records such as field sampling records, results of analyses, and documentation of participation in a Group Monitoring Plan

X. OTHER REFERENCE MATERIALS
Insert here any other materials that are useful for your facility

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INTRODUCTION

VOL 12

This binder was prepared as guidance for operators of industrial facilities in the Santa Clara Valley. The binder is designed to assist you to understand storm water pollution and the regulations that control it, and to guide you through the compliance process.

New federal, state, and regional regulations for storm water discharge and pollution control apply to industrial facilities which discharge *storm water associated with industrial activity.*

WHAT IS STORM WATER POLLUTION?

Storm water pollution is a growing concern for Santa Clara Valley cities, businesses, and environmental groups who are increasingly aware of the water quality and biological health of the South San Francisco Bay. Storm water pollution results when pollutants such as oil and grease, fertilizers, pesticides, bacteria associated with litter and animal wastes, and solvents and household chemicals flow through the storm drain system into our creeks and ultimately into the Bay. It is often referred to as "nonpoint source pollution" because it originates from a wide area rather than a single, identifiable "point source," such as an outfall pipe. Unlike industrial waste and sanitary wastewater, storm water is not treated so it carries any pollutants with it directly into the Bay. Studies have shown that these non-point sources are a significant contributor of pollutants that appear in the Bay. Pollutants released during wet weather and dry weather alike find their way to the Bay, when they are carried by the next rain after being deposited on paved surfaces or spilled into gutters and flow through the storm drain system.

WHAT ARE THE NEW REGULATIONS?

The regulations are intended to control pollution in *storm water associated with industrial activity*. The regulations are required by U.S. law under the Clean Water Act. In November 1990 the U.S. Environmental Protection Agency (EPA) published its final rule for storm water discharge regulation under the National Pollutant Discharge Elimination System (NPDES), part of the Clean Water Act rules. This rule requires many industrial facilities to obtain NPDES permits for their storm water discharges. In addition, the rule states that facilities that discharge storm water to a municipal separate system must comply with any additional storm water requirements established by the municipality where the facility is located.

In California NPDES permits are issued by the State Water Resources Control Board and its associated agencies, the Regional Water Quality Control Boards. The San Francisco Bay Regional Board is the regulating agency for storm water controls in the Santa Clara Valley. In January 1992 the Regional Board adopted an NPDES General Permit for discharges of storm water associated with industrial activity in Santa Clara Valley. You do not need to write a specific permit to request coverage for your site. The form of the General Permit is such that if you operate a facility that is defined in the U.S. and state regulations, *you must apply* for coverage and then *comply* with the same provisions as all other covered facilities.

The State Water Resources Control Board has issued a series of general permits which vary according to industrial categories and activities. These general permits include:

- General Permit for industries other than construction in Santa Clara Valley
- General Permit for construction activities in Santa Clara Valley
- General Permit for industries located in California (other than in Santa Clara Valley)
- General Permit for construction activities in California (other than in Santa Clara Valley)

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This document was written specifically to assist industries in complying with the *Santa Clara Valley industrial general permit*. The other permits may have somewhat different requirements than those addressed in this document. Materials included in this guidance binder will assist you in successfully completing the permit process to ensure full compliance with the permit requirements.

HOW DO I COMPLY?

In general, to comply with the regulations you are expected to implement reasonable controls to prevent contaminants from contacting storm water, and to perform some minimal monitoring to verify that your storm water is not contaminated. The Regional Board's Industrial Storm Water General Permit for the Santa Clara Valley requires that you complete a number of documents to demonstrate that you are complying.

This binder can help you through the steps that will bring you into compliance with the General Permit. It includes background information, step-by-step instructions on preparing compliance documents, and advice on how to get the most out of the analyses you are required to conduct. Since most of the compliance documents are not submitted but kept on your site, the binder also provides space for you to insert your compliance documents as you prepare them and to keep them as you update them over the years.

Included in this binder are:

Section I provides an introduction to storm water pollution and associated new regulations, and describes the contents of this binder.

Section II describes the Santa Clara Valley Nonpoint Source Pollution Control Program (NPS Program) and its response to the challenge of protecting water quality in the Lower South San Francisco Bay.

Section III includes copies of the following:

- U.S. EPA's Storm Water Regulations
- San Francisco Bay Regional Board's Industrial Storm Water General Permit for the Santa Clara Valley
- U.S. Office of Management and Budget's list of Standard Industrial Classifications (SICs)

Section IV is a copy of the Industrial Storm Water Handbook, which offers compliance suggestions from the NPS Program for meeting the requirements of the industrial storm water general permit. This handbook provides step-by-step advice on analyzing your facility and complying with the permit.

Section V includes sample compliance documents, including plans for storm water pollution prevention, eliminating non-storm water discharges, and monitoring. These examples are designed to provide suggested means of responding to permit requirements.

Section VI is a copy of the NPS Program's Industrial Storm Water Best Management Practices (BMP) Manual, which identifies recommended maintenance and operational BMPs and suggested structural BMPs.

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Section VII provides space for your facility's current Storm Water Pollution Prevention Plan, upon its completion. This plan will include documentation of annual review, periodic revisions, and copies of training records.

Section VIII provides a place for you to put your current Certification of Elimination of Non-Storm Water Discharges to Storm Drain Systems, including records and results of field investigations and certification of accuracy.

Section IX provides space for your facility's current Storm Water Monitoring Plan, including field sampling records, results of analysis, and annual revision, as well as documentation of participation in a group monitoring plan.

Section X allows space for you to file other materials at a later date that you find to be helpful in complying with industrial storm water regulations.

The Santa Clara Valley Nonpoint Source Pollution Control Program, or NPS Program, has prepared this binder. The NPS Program will revise and update this information periodically, as the Regional Board revises its requirements and new information becomes available. When you purchased this binder, the NPS Program asked for your name and address. New or revised pages for this binder will be made available to you in stages. Some portions that have not been completed will be available by Summer 1992. Other portions may be revised over the next few years as the General Permit compliance requirements continue to evolve.

This binder describes requirements that are in place as of Spring 1992. Additional requirements may be imposed at a later date if necessary to comply with Federal and State water quality standards and future additional regulations.

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SANTA CLARA VALLEY
NPS PROGRAM

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WHAT IS THE SANTA CLARA VALLEY NPS PROGRAM?

The Santa Clara Valley Water District, the County of Santa Clara, and thirteen cities in the Santa Clara Valley have formed the Santa Clara Valley Nonpoint Source Pollution Control Program, or NPS Program, to address storm water pollution requirements. In June 1990, the NPS Program obtained a storm water NPDES Permit from the Regional Board to regulate discharges of storm water into South San Francisco Bay. Under that permit, the NPS Program has developed a cooperative approach to assist industrial facilities in complying with the EPA and Regional Board requirements.

HOW TO REACH PROGRAM PARTICIPANTS

For more information about storm water pollution or how the industrial permit regulations apply to your facility, please contact:

NPS Program	(800) 794-2482

Many storm water pollution control activities of the NPS Program are conducted by various agencies of the individual municipalities that together make up the NPS Program. For information on municipal agencies' requirements and how they can help you, you may contact the NPS Program representative in the municipality where your facility is located at the appropriate number listed below.

City of Campbell	(408) 866-2150
City of Cupertino	(408) 252-4505
City of Los Altos	(415) 948-1491
Town of Los Altos Hills	(415) 941-7222
Town of Los Gatos	(408) 354-6864
City of Milpitas	(408) 942-2360
City of Monte Sereno	(408) 354-7635
City of Mountain View	(415) 903-6329
City of Palo Alto	(415) 329-2129
City of San Jose	(408) 277-5533
City of Santa Clara	(408) 984-3151
City of Saratoga	(408) 867-3438
City of Sunnyvale	(408) 730-7270
Santa Clara County	(408) 441-1195
Santa Clara Valley Water District (operates creeks and flood control channels)	(408) 265-2600

Included on the following pages is a fact sheet developed by the Program which describes water quality and storm runoff in the South San Francisco Bay. It provides a detailed definition of nonpoint source pollution, its causes and origins, the pollutants associated with it, its impacts on the water quality of the South Bay, and the regulations aimed to reduce its effect on water quality. The fact sheet was designed as information for *residential* customers, so some of the language is not adapted for your situation, but it includes background that is useful to industrial businesses as well.

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Santa Clara Valley
Nonpoint Source
Pollution Control Program

5750 Almaden Expressway, San Jose CA 95118
(408) 265-2600 FAX (408) 266-0271

FACT SHEET

Nonpoint Source Pollution: Water Quality and Storm Runoff in the South San Francisco Bay

February 1991

Nonpoint Source Pollution

Nonpoint source pollution is a little-understood water quality problem that is a growing concern for Santa Clara Valley municipalities.

Nonpoint source pollution is a growing concern for Santa Clara Valley cities, industries, and environmental groups who are concerned with the water quality and biological health of the South San Francisco Bay. Urban residents and informed community members have little understanding of nonpoint source pollution and how to reduce it in Santa Clara Valley.

This fact sheet explains nonpoint source (NPS) pollution and what the Santa Clara Valley cities are doing about it. The cities have developed the Santa Clara Valley Nonpoint Source Pollution Control Program to respond to this problem and comply with state and federal regulations.

What is Nonpoint Source Pollution?

The term "nonpoint source pollution" represents a process whereby pollutants, debris, and chemicals which accumulate on streets and pavement are washed off by rainfall and carried away by stormwater runoff into South San Francisco Bay. Unlike pollutants that come from a "point source" such as a sewer pipe or industrial outfall, NPS pollutants are washed from streets, neighborhoods, construction sites, parking lots, and other exposed surfaces throughout the region.

Because NPS pollutants come from a variety of sources, the pollutants contained in storm water runoff are diverse. These include motor oil, car exhaust, chemicals, eroded soil, detergents, paints, and any other discarded material carried through the storm drain system.

In Santa Clara Valley, storm water is carried to the South San Francisco Bay from storm drain outfalls and natural stream channels. Because these drains are separate from household sewer systems, NPS pollutants flow directly into the Bay without treatment.

PROGRAM PARTICIPANTS

Campbell Cupertino Los Altos Los Altos Hills Los Gatos Milpitas Monte Sereno Mountain View Palo Alto San Jose Santa Clara Saratoga Sunnyvale County of Santa Clara and the Santa Clara Valley Water District

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Nonpoint Source Pollution - A New Focus

The impact of NPS pollutants on stream or bay water quality has only recently received focused attention.

In the past, municipal public works personnel, regulators, and concerned citizens paid scant attention to storm water runoff on the assumption that these waters were relatively "clean." Waste water treatment plants were seen as the primary source of water pollutants. Nationwide studies over the last 15 years, however, have revealed that runoff from urban areas contains the same pollutants found in discharges from sewage treatment plants. In addition, water pollution from nonpoint sources has increased relative to point sources as a result of improved equipment and substantial investment into water treatment plant operations.

On the basis of these findings, municipalities and regulators have recently focused on controlling NPS pollutants. Their actions are currently aimed at identifying the source of urban runoff pollutants and reducing the quantity of pollutants entering streams, creeks and other receiving water bodies.

Nonpoint Source Pollution and Water Quality in the South Bay.

Few people realize how the South San Francisco Bay is contaminated by nonpoint source runoff.

In a year with typical rainfall, the South Bay receives approximately 23.6 billion gallons of water from the storm drain system. This flow enters the Bay from flood control channels directly, or from Coyote Creek, Guadalupe River, and other tributaries that receive flow from storm water outfalls. Once in the Bay, stormwater-borne pollutants build up due to the limited circulation of the South Bay.

The water and pollutants flowing from storm drain outfalls come from a network of storm drains within a 720-square-mile drainage area of Santa Clara Valley. Storm drains collect water runoff from rainfall, car washing, and lawn watering. Runoff picks up and carries materials leaked onto streets or spilled directly into storm drains. With 1.4 million Santa Clara Valley residents, the multitude of sources contributing pollutants rapidly adds ups to a large water pollution problem for the South Bay.

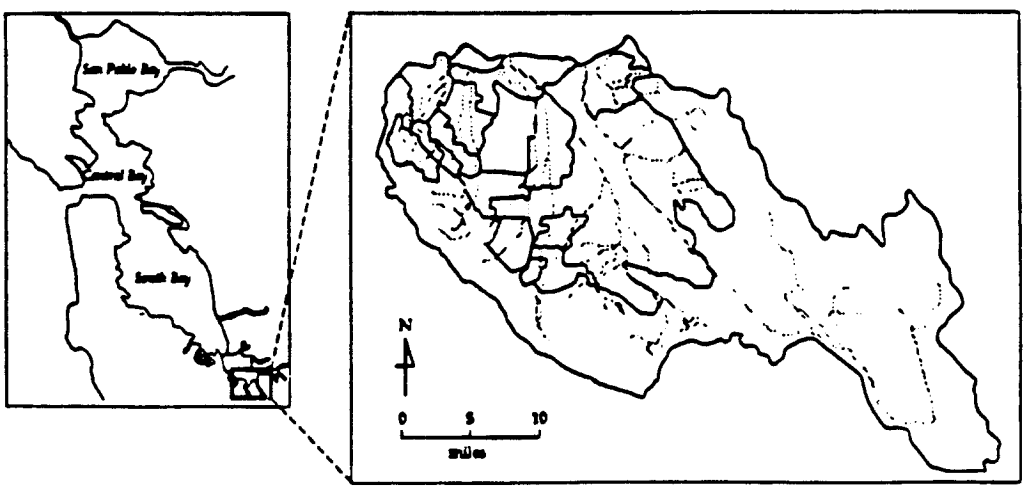

Figure 1. Santa Clara Valley Tributaries and Communities

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Pollutants

The type and quantity of contaminants entering the South Bay vary with the location of the drainage area, type of land use, and time of year. Although water flows off land surfaces during both dry and wet weather, runoff from the first major rainstorm of the season is the most polluted.

Urban runoff from the Santa Clara Valley contains a number of different pollutants including the following:

Heavy Metals: Metals and toxic contaminants from vehicle exhaust, tire compounds, motor oil, and weathered paint. Specific metals include chromium, cadmium, copper, lead, mercury, nickel, silver and zinc.

Oils and Grease: Fuels and lubricants enter storm drains from leaks and spills of automobile engines, transmissions, radiators, or improper dumping of oil into gutters and drains.

Pesticides, Herbicides & Fertilizers: Chemicals over-applied during yard care enter gutters from watering landscaped areas.

Solvents and Household Chemicals: Paint thinners, oil and water based paints, degreasers, detergents, bleach, drain cleaners, or other household products enter the Bay if dumped into storm drains or onto streets.

Bacteria and Plant Nutrients: Bacteria from sewage, animal wastes, litter, decomposing vegetation, and septic leaks or overflows enter gutters and storm drains.

These pollutants are hazardous to aquatic and human life when toxins enter the food chain and are consumed by wildlife or humans. In addition, physical contact with waters from storm drain outfalls may result in skin infections or irritations.

Water Quality Impacts in the South Bay

Limited circulation in the South Bay leads to pollutant build up and increasingly degrades the Bay's water quality.

Contaminants in nonpoint and point source runoff have a significant impact on South Bay water quality. The specific effect of concentrations of NPS pollutants on aquatic and human life has not clearly been determined, however. Figure 2 illustrates the average annual contribution of chemicals from nonpoint and point sources on the basis of total weight (determined for the period 1977 - 1988). These estimates indicate that nonpoint sources are a significant contributor of chromium, copper, lead, nickel, and zinc. Generally, nonpoint sources are the main contributor of sediment to the Bay while point sources contribute nutrients (compounds containing nitrogen and phosphorus). Due to limited circulation in the South Bay, these sediments and nutrients build up and increasingly degrade the Bay's water quality and biological health.

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The actual impacts of NPS pollutants on aquatic life at any given time, however, are difficult to discern. This is due to the variability and volume of rainfall, and the episodic nature of storm water discharges into the Bay. Further monitoring and studies will provide insight into the effects and relative importance of nonpoint sources on wildlife in the South Bay.

Nonpoint Source Regulations

The 1986 Basin Plan and recent federal regulations define Santa Clara Valley cities' actions to control nonpoint source pollutants.

In recent years, a number of federal, state, and local regulations have been created to control NPS pollution. A 1990 regulation by the U.S. Environmental Protection Agency (EPA) required cities with populations exceeding 100,000 to apply for a special permit regulating storm water flows into natural water bodies. Each permit requires cities to develop a Storm water Management Plan identifying specific measures and activities to eliminate or control pollutants in rainwater or runoff.

In the Bay Area, steps to control stormwater pollution began prior to EPA permit regulations and have been the particular concern of the San Francisco Regional Water Quality Control Board (RWQCB). At the initiative of South Bay cities, the RWQCB designated the South Bay as a water body warranting specific attention in the1986 Water Quality Control Plan for the San Francisco Bay Basin. This Plan required cities to take steps to improve Bay water quality by controlling pollutants from nonpoint sources.

To address Regional Board requirements, fifteen jurisdictions in Santa Clara County joined in 1987 to develop a proactive strategy to design and implement a Storm water Management Plan and to apply for a NPDES permit. This permit, enforced by the RWQCB and approved by the EPA, was adopted by the Board on June 20, 1990.

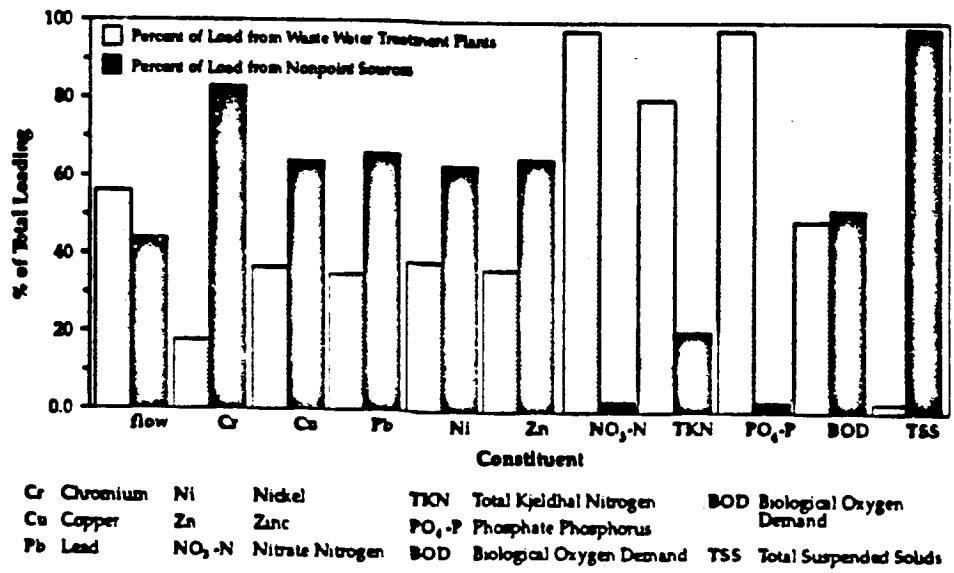

Figure 2. Nonpoint Versus Point Source Loads

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Santa Clara Valley Nonpoint Source Pollution Control Program.

15 jurisdictions in the Santa Clara Valley are taking steps to reduce nonpoint source pollutants at their source.

The Santa Clara Valley Nonpoint Source Pollution Control Program represents 15 jurisdictions in Santa Clara Valley whose rainfall runoff flows into the South Bay. Its mission is to develop and administer a Storm water Management Plan to reduce storm water-borne pollutants at their source. Specific actions include:

-Monitor wet and dry weather flows to identify the origins, types, and concentrations of nonpoint source pollutants.

-Identify and prevent industrial or sanitary wastes from discharging into the storm drain system.

-Identify and eliminate any solid and liquid waste disposal into storm drains, channels, or waterways.

-Increase existing municipal efforts to clean streets, collect solid waste, and prevent used oil and other hazardous wastes from entering storm drains.

-Promote the development and enforcement of local rules and regulations to control and eliminate pollutants from buildings under construction, industrial activities, or transport services.

-Increase public awareness about the problem of NPS , educate residents regarding proper waste management and disposal techniques, and promote public cooperation to prevent pollutants from entering storm drains.

Implementation of the Santa Clara Valley Nonpoint Source Pollution Control Program program is currently underway and will be continually evaluated and improved to meet the needs and concerns of local governments, community residents and environmental interest groups.

Glossary

Catch basins Box-like underground concrete structures with openings in curbs and gutters designed to collect water from streets and pavements.

Outfalls The end point where storm drains discharge water into a stream or the Bay.

Point Source Pollution A confined and discrete conveyance from which pollutants are or may be discharged.

Runoff Water from rain, lawn watering, melting show, or irrigation that flows over the surface of the ground.

Source Control– Actions to prevent pollution at the source.

Storm drains Above and below ground structure for transporting storm water to streams or outfalls for flood control purposes.

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REGULATIONS

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GENERAL PERMIT

Following is a copy of the Regional Board's Industrial Storm Water General Permit for Santa Clara County.

STATE OF CALIFORNIA
PETE WILSON, Governor

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION
1 WEBSTER STREET, SUITE 800
OAKLAND, CA 94612
(510) 464-1255

January 21, 1992

TO: INTERESTED PARTIES

SUBJECT: NPDES GENERAL PERMIT FOR DISCHARGES OF STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITY IN SANTA CLARA COUNTY TO SOUTH SAN FRANCISCO BAY OR ITS TRIBUTARIES

Enclosed is a copy of the NPDES General Permit, including the Fact Sheet, for Discharges of Storm Water Associated with Industrial Activity in Santa Clara County to South San Francisco Bay or its tributaries which was adopted by the Regional Board on January 15, 1992 (Order No. 92-011). Dischargers who wish to be covered by the General Permit are required to submit the Notice of Intent (NOI), Attachment 1 to the General Permit, to the State Water Resources Control Board (State Board) no later than April 30, 1992. The NOI must be sent to the following address:

State Water Resources Control Board
Division of Water Quality
Attention: Storm Water Permit Unit
P.O. Box 11977
Sacramento, CA 95812-1977

The NOI must be accompanied by an annual fee of $250 payable to the State Water Resources Control Board. The NOI will not be processed if not accompanied by the annual fee.

Note that this General Permit applies only to industrial storm water discharges in Santa Clara County that flow to South San Francisco Bay or its tributaries either directly or through municipal storm drain systems. Other industrial discharges may be covered by the General Permit for Discharges of Storm Water Associated with Industrial Activities adopted by the State Water Board on November 19, 1991 (Water Quality Order No. 91-13-DWQ). Also note that storm water discharges from construction activities are not eligible for coverage under these general permits. The State Board and/or Regional Board intent to issue one or more general permits prior to October 1992 which will apply to construction activities.

Dischargers that submit a NOI for coverage under this General Permit must also submit a copy of the NOI to the Santa Clara Valley Nonpoint Source Pollution Control Program (Program) at the following address:

Santa Clara Valley Nonpoint Source Pollution Control Program
5750 Almaden Expressway
San Jose, CA 95118

The Program was issued a NPDES Permit in June 1990 for implementation of an area-wide storm water management program, which includes an industrial storm water control element. The Program intends to assist industries in Santa Clara County in responding to this General Permit and is preparing a manual describing Best Management Practices (BMPs) to be implemented by industrial storm water dischargers. It is intended that dischargers covered by this General Permit will implement the BMPs developed by the Program or equivalent practices or control measures. If you have any questions regarding the Program please call 1-800-794-2482.

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The following is intended to clarify group monitoring requirements described in Section B(14) of the General Permit.

1. Group monitoring plans must be submitted to the Regional Board no later than August 1, 1992 (60 days prior to the wet season which begins October 1). Groups are encouraged to submit their plans as early as possible to allow adequate time for Regional Board review and possible revision of the plan prior to the beginning of the wet season. If the Regional Board rejects a group monitoring plan, each member of the group is responsible for performing individual monitoring, as described in Section B(7)(a) of the General Permit. Groups may be formed or they may add or delete participants to the group on an annual basis by submitting a revised group monitoring plan prior to August 1 of each year.

2. Dischargers participating in a group must be sufficiently similar, with the exception of dischargers represented by the Program. There are several factors that will be considered when determining whether or not a group of dischargers is sufficiently similar. The dischargers should have similar types of operations, handle or process similar types of materials, discharge similar types of waste, and/or employ similar management practices to prevent or control pollution of storm water.

3. All participants in a group monitoring plan are responsible for complying with all applicable Section B: Monitoring Program and Reporting Requirements. These include documenting implementation of control measures and management practices, performing visual inspections, making flow measurements or estimates, and submitting annual monitoring reports.

4. All participants in a group monitoring plan must discharge within the effective area of the General Permit. Dischargers may participate in groups with participants which discharge outside the effective area of the General Permit as long as the dischargers in the effective area of the General Permit are included in the minimum number of group participants which perform sampling and analyses and the individual monitoring requirements, Section B(7)(a) of the General Permit, are met.

5. The Regional Board has the authority to require monitoring beyond the minimum requirements of the General Permit (California Water Code, Section 13267(b). After a group monitoring plan is approved, the Regional Board may require revisions to the plan. Revisions may include requiring additional sampling and analyses to be performed or requiring that more of the participating dischargers perform monitoring.

Lastly, we would appreciate if you would inform other industries similar to your own of the need to obtain a storm water permit. We encourage groups of similar industries to work together in developing storm water pollution prevention plans.

If you have any questions regarding this General Permit please call our offices at 510-464-1255.

Sincerely,

Steven R. Ritchie
Executive Officer

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CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

FACT SHEET
FOR
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
GENERAL PERMIT FOR
DISCHARGES OF STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITY
IN SANTA CLARA COUNTY TO SOUTH SAN FRANCISCO BAY OR ITS TRIBUTARIES

BACKGROUND

In 1972, the Federal Water Pollution Control Act (also referred to as the Clean Water Act (CWA)) was amended to provide that the discharge of pollutants to waters of the United States from any point source is effectively prohibited, unless the discharge is in compliance with a NPDES permit. The 1987 amendments to the CWA added Section 402(p) which establishes a framework for regulating municipal and industrial storm water discharges under the NPDES program. On November 16, 1990, EPA published final regulations that establish application requirements for storm water permits. The regulations require owners or operators of specific categories of industrial facilities (dischargers), which discharge storm water associated with industrial activity (industrial storm water), to obtain an NPDES permit. Discharge of industrial storm water either directly to surface waters or indirectly, through municipal separate storm sewers, must be covered by a permit. This includes the discharge of "sheet flow" through a drainage system or other conveyance.

The regulations allow authorized states to issue general permits or individual permits to regulate industrial storm water discharges. The State Water Resources Control Board (State Board) has elected to issue a statewide general permit that will apply to all discharges requiring a permit except all construction activity discharges and industrial storm water discharges in Santa Clara County to South San Francisco Bay or its tributaries. Separate general permit(s) will be issued for construction activity discharges. The Regional Board has elected to issue a separate general permit (General Permit) that will apply to the industrial storm water discharges in Santa Clara County to South San Francisco Bay or its tributaries. The purpose of the separate Santa Clara County general permit is in part to facilitate communication between industrial storm water dischargers and the Santa Clara Valley Nonpoint Source Pollution Control Program (Program). The Program was issued NPDES Permit No. CA0029718 in June 1990 for implementation of an area-wide storm water management program, which includes an industrial storm water control element.

The General Permit accompanying this fact sheet is intended to regulate industrial storm water discharges. The consolidation of many discharges under one permit will greatly reduce the otherwise overwhelming administrative burden associated with start up of a new program to regulate industrial storm water discharges. It is also the least costly way for a discharger to obtain a permit and comply with the Federal regulations. It is expected that as the storm water program develops, the Regional Board will issue individual and general permits which regulate discharges specific to industrial categories. As new permits are adopted, discharges subject to those permits will no longer be regulated by this general permit. As permits are reissued for discharges of treated wastewater that are currently regulated by a NPDES permit, the Regional Board may include storm water provisions in the revised permit.

This General Permit generally requires dischargers to:

1. Eliminate non-storm water discharges (including illicit connections) to storm water systems;
2. Develop and implement a storm water pollution prevention plan, and;
3. Perform monitoring of discharges to storm water systems.

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TYPES OF STORM WATER DISCHARGES COVERED BY THIS PERMIT

This General Permit is intended to cover all new or existing discharges of industrial storm water from facilities required by Federal regulation to obtain a permit. This includes all facilities which are described in the categories below, whether the activity is primarily or auxiliary to the owner or operator of the facility. For example, even though a school district's primary function is education, a facility which it operates for vehicle maintenance of school buses is a transportation facility which is covered by this General Permit. Discharges from facilities and commercial enterprises which are not required by Federal regulation to obtain a permit may be covered by this General Permit if designated by the Regional Board.

Discharges requiring a permit are listed by category in 40 Code of Federal Regulations (CFR) Section 122.26(b)(14). A general description of these categories are:

1. Facilities subject to storm water effluent guidelines (40 CFR Subchapter N);
2. Manufacturing facilities;
3. Mining and Oil and Gas facilities;
4. Hazardous waste treatment, storage, or disposal facilities;
5. Landfills, land application sites, and open dumps that receive industrial waste;
6. Recycling facilities such as battery reclaimers, metal scrap, salvage, or automobile yards;
7. Steam electric generating facilities;
8. Transportation facilities;
9. Sewage treatment plants; and
10. Certain facilities if materials are exposed to storm water.

These facilities are identified more precisely in the Federal regulations by Standard Industrial Classification

The following are facilities subject to storm water effluent limitation guidelines (Category 1 above). These dischargers must comply with the provisions of this General Permit and with the promulgated Federal effluent guidelines for storm water discharges.

Cement Manufacturing (40 CFR 411)
Feedlots (40 CFR 412)
Fertilizer Manufacturing (40 CFR 418)
Petroleum Refining (40 CFR 419)
Phosphate Manufacturing (40 CFR 422)
Steam Electric (40 CFR 423)
Coal Mining (40 CFR 434)
Mineral Mining and Processing (40 CFR 436)
Ore Mining and Dressing (40 CFR 440)
Asphalt Emulsion (40 CFR 443)

The Superfund Amendments and Reauthorization Act (SARA) of 1986 resulted in the enactment of Title III of SARA, the Emergency Planning and Community Right to Know Act. Section 313 of Title III requires facilities that manufacture, import, process or otherwise use listed chemicals to report annually their release of those chemicals to any environmental media. The toxic chemicals that must be reported if released are listed in Federal Regulations at 40 CFR Part 372. This General Permit contains additional monitoring requirements for those SARA Title III facilities which are required to have a storm water permit and which have reported a release of a listed chemical to storm water on EPA Form R, Toxic Chemical Release Inventory Reporting Form.

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The State Board and Regional Board have elected not to accept EPA's group application approach or to adopt general permits for industrial groups at this time. All dischargers participating in group applications must either obtain coverage under this General Permit or apply for an individual permit by October 1, 1992. The State Board and Regional Board base this decision on the following factors:

1. EPA does not allow the states to review and approve the group applications.

2. Review of hundreds of EPA model permits and preparation of hundreds of group specific general permits is administratively burdensome and is inconsistent with the State Board's long-term permitting strategy.

3. Allowing the group application action in California would result in an inequitable and ineffective storm water permitting program. While group applicants would not be required to implement control measures to reduce pollutants in storm water discharge until they ultimately receive a permit (probably several years), dischargers under the Regional Board's general permit will be required to implement control measures beginning October 1, 1992.

4. The Regional Board is providing a group monitoring alternative, somewhat similar to the group application monitoring requirements, that should provide reduced monitoring costs to the dischargers.

When EPA issues model permits for any groups, the Regional Board may consider, as appropriate, adopting group permits based upon the EPA model permits.

TYPES OF DISCHARGES NOT COVERED BY THIS GENERAL PERMIT

- CONSTRUCTION ACTIVITIES: Discharges from construction activities of five acres or more will be covered by a separate general permit.

- FACILITIES WHICH HAVE NPDES PERMITS CONTAINING STORM WATER PROVISIONS: The NPDES permits for some industrial waste water discharges already contain requirements regulating industrial storm water. These discharges do not need coverage by this General Permit at this time as long as all industrial storm water is covered by the existing permit. When the existing permit for such discharges expires, the reissued permits will be made consistent with the new Federal and State storm water requirements, if necessary, or the Regional Board may authorize coverage under this General Permit, if appropriate.

- FACILITIES DETERMINED INELIGIBLE BY THE REGIONAL BOARD: The Regional Board may determine that discharges from a facility or groups of facilities, otherwise eligible for coverage under this General Permit, have potential water quality impacts that may not be addressed by this General Permit. In such cases, the Regional Board may require such dischargers to apply for and obtain an individual permit or a different general permit. Interested persons may petition the Regional Board to issue individual permits. The applicability of this General Permit to such facilities will be terminated upon adoption of a permit with more specific requirements.

- FACILITIES WHICH DO NOT DISCHARGE INDUSTRIAL STORM WATER TO SURFACE WATERS OR STORM SEWERS: Dischargers that capture all industrial storm water runoff from their facility and treat and/or dispose of it with their process waste water, and dischargers that retain their industrial storm water on site are not required to obtain a NPDES storm water permit. To avoid liability, the discharger should be certain that a discharge of industrial storm water to surface waters or storm sewer will not occur under any circumstances.

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NOTIFICATION REQUIREMENTS

Dischargers must submit a Notice of Intent (NOI) to obtain coverage under this General Permit. A NOI must be submitted for each individual facility to obtain coverage. Submittal of the NOI signifies that the discharger intends to comply with the conditions of the General Permit.

EPA's regulations at 40 CFR 122.21(a) exclude persons covered by general permits from requirements to submit individual or group permit applications. The NOI requirements of the General Permit are intended to establish a mechanism which can be used to establish a clear accounting of the number of dischargers covered by the General Permit, their identities, the nature of operations at the facilities, and location.

DESCRIPTION OF GENERAL PERMIT CONDITIONS

Discharge Prohibitions

This General Permit authorizes the discharge of industrial storm water. It prohibits non-storm water discharges unless authorized by a NPDES permit, except for certain permissible discharges; discharges that cause or contribute to a violation of the Program's NPDES permit; and discharges that contain a hazardous substance in excess of reporting quantities established at 40 CFR 117.3 or 40 CFR 302.4.

Receiving Water Limitations

Dischargers are required to comply with applicable water quality objectives as receiving water limitations. Compliance must be demonstrated through implementation of control measures and best management practices required by the Provisions of the General Permit. To the extent that a discharger causes violations of receiving water limitations after implementing the minimum requirements of the General Permit, the Regional Board may impose more stringent requirements on or consider issuing an individual permit to the discharger.

Provisions

Permits for industrial storm water discharges must meet all applicable provisions of Sections 301 and 402 of the Clean Water Act. These provisions require control of pollutant discharges that utilize best available technology economically achievable (BAT) and best conventional pollutant control technology (BCT) to reduce pollutants, and any more stringent controls necessary to meet water quality standards. It is not feasible at this time to establish numeric effluent limitations that apply to all discharges that may be covered by this General Permit. Therefore, the effluent limitations contained in this General Permit are narrative and include best management practices. These effluent limitations constitute compliance with the requirements of the Clean Water Act.

The narrative effluent limitations contained in this General Permit include prohibition against discharges of non-storm water. They require dischargers to control and eliminate the sources of pollutants in storm water through development and implementation of storm water pollution prevention plans. The plans must include control measures and best management practices, which may include treatment of the discharges along with source reduction, which will constitute BAT and BCT and will achieve compliance with water quality objectives.

Dischargers are also required to comply with all applicable requirements of the Program. The Program intends to assist dischargers in identifying appropriate control measures and BMPs.

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Storm Water Pollution Prevention (SWPP) Plans

The General Permit requires development and implementation of SWPP Plans emphasizing storm water best management practices (BMPs). This approach provides the flexibility necessary to establish controls which can appropriately address different sources of pollutants at different facilities.

All dischargers must prepare, retain on-site, and implement a SWPP Plan. The SWPP Plan has two major objectives: (1) to help identify the sources of pollution that affect the quality of industrial storm water discharges; and (2) to describe and ensure the implementation of practices to reduce pollutants in industrial storm water discharges. The SWPP Plans are considered reports available to the public under Section 308(b) of the CWA.

Required elements of the SWPP Plans are: (1) identification and assessment of potential pollution sources and materials inventory, (2) preventive maintenance and good housekeeping, (3) spill prevention and response procedures, (4) source controls, (5) general storm water management practices, (6) employee training, (7) inspections and record keeping, and (8) elimination and prevention of non-storm water discharges.

Monitoring Program

The General Permit requires the development and implementation of a monitoring program. Existing dischargers are given until October 1, 1992 to implement the monitoring program. New dischargers are required to implement a monitoring program when the facility begins operation. The objectives of the monitoring program are to (1) demonstrate compliance with permit conditions; (2) to aid in the development of SWPP Plans; and (3) to measure the effectiveness of BMPs in removing pollutants in industrial storm water discharges.

All dischargers are required to:

1. Perform visual observations during the dry and wet seasons. Dry weather observations are required to verify that non-storm water discharges have been eliminated. Wet season observations are required to identify sources and aid dischargers in evaluating effectiveness of the SWPP Plan.

2. Measure (or estimate) the volume of industrial storm water discharge from two significant storm events during the wet season.

3. Monitor for any parameter required in 40 CFR Subchapter N for the discharge or any hazardous chemical released to storm water as reported on U.S. EPA Form R.

4. Perform sampling and analyses on its industrial storm water discharge or participate in a group monitoring program.

5. Submit an annual report to the Regional Board.

Individual monitoring must include sampling and analyses for pH, total suspended solids, total organic carbon, specific conductance, and toxic substances which are expected to be present in storm water discharges in significant quantities. A group monitoring plan may be designed and implemented by an entity representing a group of similar dischargers regulated by this General Permit or by the Program. All participants in a group monitoring plan must discharge storm water within the boundaries of the Regional Board. A minimum of twenty percent of the dischargers participating in a group (minimum of four dischargers for groups of 20 dischargers or less) which best represent the quality of all the group

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participant's industrial storm water discharges must be monitored. Group monitoring programs must include sampling and analyses for more parameters than are required for individual monitoring programs to provide more detailed information.

All group monitoring plans are subject to Regional Board review. As appropriate, the Regional Board may terminate or require substantial amendment to the group monitoring plans, dependent, in part, on the group's overall success in meeting the General Permit monitoring program objectives.

Group monitoring is intended to alleviate the administrative burden of reviewing quantitative monitoring data from all dischargers while providing for more accurate and meaningful data representative of group participants.

Retention of Records

Dischargers are required to retain records of all monitoring information, copies of all reports required by this General Permit, and records of all data used to complete the NOI, for a period of at least three years from the date of the measurement, report, or application. This period may be extended by request of the Regional Boards.

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CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

ORDER NO. 92-011

NPDES GENERAL PERMIT NO. CAG612001

WASTE DISCHARGE REQUIREMENTS FOR:

DISCHARGES OF STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITIES IN SANTA CLARA COUNTY TO SOUTH SAN FRANCISCO BAY OR ITS TRIBUTARIES EITHER DIRECTLY OR THROUGH MUNICIPAL STORM WATER SYSTEMS

The California Regional Water Quality Control Board, San Francisco Bay Region (hereinafter called the Regional Board), finds that:

1. Federal Regulations for stormwater discharges were promulgated by the US Environmental Protection Agency on November 19, 1990. The regulations [40 Code of Federal Regulations (CFR) Parts 122, 123, and 124] require specific categories of industrial activities which discharge storm water associated with industrial activity (industrial storm water) to obtain a NPDES permit and to implement Best Available Technology Economically Achievable (BAT) and Best Conventional Pollutant Control Technology (BCT) to control pollutants in industrial storm water discharges.

2. This General Permit shall regulate industrial storm water discharges from industrial facilities in Santa Clara County to South San Francisco Bay or its tributaries either directly or through municipal storm water systems except existing discharges which have been issued NPDES permits including provisions regulating discharges of storm water, discharges of storm water from construction activities, or storm water discharges from industrial facilities determined ineligible by the Regional Board.

3. All dischargers participating in group applications must either obtain coverage under this General Permit or apply for an individual permit by October 1, 1992. The Regional Board has elected not to accept EPA's group application approach or to issue general permits for industrial groups at this time.

4. To obtain authorization for continued and future industrial storm water discharges pursuant to this General Permit, owners or operators of industrial facilities (dischargers) must submit a Notice of Intent (NOI) and appropriate annual fee in accordance with Attachment 1. Unless notified by the Regioal Board, dischargers who submit the NOI are authorized to discharge storm water from industrial activities under the terms and conditions of this permit.

5. If an individual NPDES permit is issued to a discharger otherwise subject to this General Permit, or another general permit that regulates storm water discharges is subsequently issued which covers dischargers regulated by this General Permit, the applicability of this General Permit to such dischargers is automatically terminated on the effective date of the individual permit or the date of approval for coverage under the subsequent general permit.

6. This General Permit does not pre-empt or supersede the authority of local agencies to prohibit, restrict, or control discharges of storm water or other materials to storm drain systems or other watercourses within their jurisdiction.

7. The Santa Clara Valley Nonpoint Source Pollution Control Program (hereinafter called the Program) was issued NPDES Permit No. CA0029718 on June 20, 1990. The Program, on November 25, 1991,

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adopted a "Strategy For Program Coordination Of Industrial Storm Water General Permitting Requirements" to assist industries in Santa Clara County in responding to this General Permit and which will include a manual describing Best Management Practices (BMPs) to be implemented by industrial storm water dischargers. It is intended that dischargers covered by this General Permit will implement the BMPs developed by the Program or equivalent practices or control measures.

8. The State Water Resources Control Board (State Board) adopted the California Inland Surface Waters Plan and Enclosed Bays and Estuaries Plan on April 11, 1991. In addition, the Regional Board amended its Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan) on December 17, 1986, and the State Board approved it on May 21, 1987. The Regional Board also amended its Basin Plan on December 11, 1991. These plans establish water quality objectives which apply to South San Francisco Bay and its tributaries.

9. Effluent limitations, and toxic and effluent standards established in Sections 208(b), 301, 302, 303(d), 304, 306, 307, and 403 of the Federal Clean Water Act (CWA), as amended, are applicable to storm water discharges regulated by this General Permit.

10. The action to adopt a NPDES permit is exempt from the provisions of the California Environmental Quality Act (Public Resources Code Section 21000, et seq.), in accordance with Section 13389 of the California Water Code.

11. The Regional Board has notified dischargers and interested agencies and persons of its intent to prescribe waste discharge requirements for these discharges, has provided them with an opportunity for a public hearing and an opportunity to submit written comments and recommendations, and in a public meeting, heard and considered all comments pertaining to this General Permit.

12. This Order is a NPDES permit in compliance with Section 402 of the Clean Water Act, as amended, and shall take effect upon adoption.

IT IS HEREBY ORDERED that all industrial storm water dischargers that file a NOI indicating their intent to be regulated under the terms and conditions of this General Permit shall comply with the following:

A. DISCHARGE PROHIBITIONS:

1. Discharges of water, materials, or wastes other than storm water, which are not otherwise authorized by a NPDES permit, to a storm drain system or waters of the state are prohibited, with the exception of discharges stated to be permissible in the attached Table 1.

2. All discharges of storm water from any facility covered by this General Permit which cause or contribute to a violation of NPDES Permit No. CA0029718 issued to the Program are prohibited, unless specifically authorized by the Program.

3. Industrial storm water discharges shall not cause or threaten to cause pollution, contamination, or nuisance.

4. Industrial storm water discharges shall not contain reportable quantities of a hazardous substance listed in 40 CFR 117 and/or 40 CFR 302.

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B. RECEIVING WATER LIMITATIONS:

1. Industrial storm water discharges shall not adversely impact human health or the environment.

2. Industrial storm water discharges shall not cause or contribute to a violation of any applicable water quality objective for receiving waters contained in the California Inland Surface Waters Plan or Enclosed Bays and Estuaries Plan or the Water Quality Control Plan for the San Francisco Bay Region.

C. PROVISIONS:

1. All dischargers must submit a Notice of Intent (NOI) and appropriate annual fee for each facility covered by this General Permit in accordance with Attachment 1: Notice of Intent-General Instructions.

2. All dischargers shall prepare a Storm Water Pollution Prevention Plan in accordance with Section A: Storm Water Pollution Prevention Plan Requirements for each facility covered by this General Permit. Full compliance with the provisions of the plan shall be an enforceable requirement of this permit.

3. All dischargers shall develop and implement a Monitoring and Reporting Program Plan in accordance with Section B: Monitoring and Reporting Program Plan Requirements for each facility covered by this General Permit.

4. All non-storm water discharges to storm water systems shall be eliminated by July 1, 1992, unless otherwise authorized, in accordance with Provision 7., Section A: Storm Water Pollution Prevention Plan Requirements. For the purposes of this General Permit, non-storm water discharges are defined to not include discharges stated to be permissible in the attached Table 1.

5. All dischargers shall comply with the lawful requirements of municipalities, drainage districts, and other local agencies regarding discharges to storm water systems or other water courses under such local agencies' jurisdiction. These include all applicable requirements developed by the Program under NPDES Permit No. CA0029718 for the Program, including implementing such Best Management Practices as are identified by the Program as appropriate for the facility in question, or equivalent practices or control measures. Best Management Practices will be identified in a manual currently under preparation by the Program. Such management practices, and a schedule for implementation of the practices, shall be addressed in the Storm Water Pollution Prevention Plan.

6. All discharges shall comply with the provisions contained in Section C: Standard Provisions for each facility covered by this General Permit.

7. This General Permit will expire on January 15, 1997. Upon reissuance by the Regional Board, dischargers subject to the reissued permit must file a revised Notice of Intent in accordance with the reissued general permit.

I, Steven R. Ritchie, Executive Officer, do hereby certify that the foregoing is a full, true, and correct copy of an Order adopted by the California Regional Water Quality Control Board, San Francisco Bay Region, on January 15, 1992.

Steven R. Ritchie
Executive Officer

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Section A: STORM WATER POLLUTION PREVENTION PLAN

1. A Storm Water Pollution Prevention Plan (SWPP Plan) shall be developed for each facility covered by this General Permit. The SWPP Plan shall be designed in accordance with good engineering practices to comply with BAT/BCT and shall address the following objectives:

   a. to identify pollutant sources that may affect the quality of industrial storm water discharges; and

   b. to identify, assign, and implement control measures and management practices to reduce pollutants in industrial storm water discharges.

2. Schedule. For existing facilities (and new facilities beginning operations before October 1, 1992), a SWPP Plan shall be developed and implemented no later than October 1, 1992. For facilities beginning operations after October 1, 1992, a SWPP Plan shall be developed prior to submitting a NOI and implemented when the facility begins operations.

3. Approval. The SWPP Plan shall be retained on site, certified and signed in accordance with Provisions 9. and 10. of Section C: Standard Provisions of this General Permit, and made available upon request of a representative of the Regional Board, the Program, and/or local agencies having jurisdiction over storm water systems or water courses which receive the industrial storm water discharge. The Regional Board, the Program, and/or local agency may notify the discharger if the SWPP Plan does not meet one or more of the minimum requirements of this Section. Upon notice, the discharger shall submit a time schedule to make the requested changes to the Regional Board, the Program, and/or local agency. After making the required changes, the discharger shall provide written certification that the changes have been made.

4. Changes. The discharger shall amend the SWPP Plan whenever there is a change in design, construction, operation, or maintenance which has a significant effect on the potential for the discharge of pollutants to surface waters, groundwaters, or a local agency's storm water system. The SWPP Plan should also be amended if it is in violation of any conditions of this General Permit, or in achieving the general objectives of controlling pollutants in industrial storm water discharges.

5. Source Identification. The SWPP Plan shall provide a description of potential sources which may be expected to add significant quantitities of pollutants to storm water discharges, or which may result in non-storm water discharges from the facility. The SWPP Plan shall include, at a minimum, the following items:

   a. A topographic map (or other acceptable map if a topographic map is unavailable), extending one-quarter mile beyond the property boundaries of the facility, showing: the facility, surface water bodies (including springs and wells), and the discharge point where the facility's storm water discharges to a municipal storm drain system or other water body. The requirements of this paragraph may be included in the site map required under the following paragraph if appropriate.

   b. A site map showing:

      i. Storm water conveyance, drainage, and discharge structures;

      ii. An outline of the storm water drainage areas for each storm water discharge point;

      iii. Paved areas and buildings;

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iv. Areas of pollutant contact with storm water or release to storm water, actual or potential, including but not limited to outdoor storage, manufacturing, and process areas, material loading, unloading, storage,and access areas, and waste treatment, storage, and disposal areas;

v. Location of existing storm water structural control measures (i.e., berms, coverings, etc.);

vi. Surface water locations, including springs and wetlands;

vii. Areas of existing and potential soil erosion;

viii. Vehicle service areas;

ix. Location of each well where fluids from the facility are injected underground.

c. A narrative description of the following:

i. Significant materials that have been treated, stored, disposed, spilled, or leaked in significant quantities in storm water discharge after November 19, 1988;

ii. Materials, equipment, and vehicle management practices employed to minimize contact of significant materials with storm water discharge;

iii. Material loading, unloading, and access areas;

iv. Existing structural and non-structural control measures (if any) to reduce pollutants in storm water discharge;

v. Industrial storm water discharge treatment facilities (if any);

vi. Methods of onsite storage and disposal of significant materials;

vii. Outdoor storage, manufacturing, and processing activities including activities that generate significant quantities of dust or particulates.

d. A list of pollutants that have a reasonable potential to be present in storm water discharge in significant quantities, and an estimate of the annual quantities of these pollutants in industrial storm water discharge.

e. An estimate of the size of the facility (in acres or square feet), and the percent of the facility that has impervious areas (i.e., pavement, buildings, etc.).

f. A list of significant spills or leaks of toxic or hazardous pollutants to storm water that have occurred after November 19, 1988. This shall include:

i. Toxic chemicals (listed in 40 CFR 372) that have been discharged to storm water as reported on EPA Form R;

ii. Oil or hazardous substances in excess of reportable quantities (see 40 CFR 110, 117 or 302).

g. A summary of existing sampling data (if any) describing pollutants in industrial storm water discharges.

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6. Storm Water Management Controls. The SWPP Plan shall describe the storm water management controls appropriate for the facility and a time schedule for fully implementing such controls. The schedule shall provide for implementation of maintenance practices and other low-cost practices by October 1, 1992 and full compliance with all other terms of the SWPP Plan (such as implementing practices that require structural changes) by July 1, 1993. Best Management Practices identified in a manual to be provided by the Program as appropriate for facilities of the kind in question, or equivalent practices, must be included in the description. The appropriateness and priorities of controls in the SWPP plan shall reflect identified potential sources of pollutants. The description of storm water management controls shall include, as appropriate:

   a. Storm Water Pollution Prevention Personnel. Identify specific individuals (and job titles) who are responsible for developing, implementing, and revising the Plan.

   b. Preventive Maintenance. Preventive maintenance involves inspection and maintenance of storm water conveyance system devices (i.e., oil/water separators, catch basins, etc.) and inspection and testing of plant equipment and systems that could fail and result in discharges of pollutants to storm water. Maintenance schedules including inspection and testing for failure shall be established;

   c. Good Housekeeping. Good housekeeping requires the maintenance of clean, orderly facility areas that discharge storm water. Material handling areas shall be inspected and cleaned to reduce the potential for pollutants to enter the storm water conveyance system.

   d. Spill Prevention and Response. Identification of areas where significant materials can spill into or otherwise enter the storm water conveyance systems and their accompanying drainage points. Specific material handling procedures, storage requirements, clean up equipment and procedures should be identified, as appropriate. The necessary equipment to implement a clean-up shall be available and personnel trained in proper response, containment and cleanup of spills. Internal reporting procedures for spills of significant materials shall be established.

   e. Source Control. Source controls, such as elimination or reduction of the use of toxic pollutants, covering of pollutant areas, sweeping of paved areas, containment of potential pollutants, labelling all storm drain inlets with "No Dumping" signs, isolation/separation of industrial from non-industrial pollutant sources so that runoff from these areas does not mix, etc.;

   f. Storm Water Management Practices. Storm water management practices are practices other than those which control the source of pollutants. They include treatment/conveyance structures such as drop inlets, channels, retention/detention basins, treatment vaults, infiltration galleries, filters, oil/water separators etc. Based on assessment of the potential of various sources to contribute pollutants to storm water discharges in significant quantities, additional storm water management practices to remove pollutants from storm water discharge shall be implemented and design criteria shall be described.

   g. Sediment and Erosion Prevention. Measures to limit erosion around the storm water drainage and discharge points such as riprap, revegetation, slope stabilization, etc. shall be described and implemented;

   h. Employee Training. Employee training programs shall inform all personnel responsible for implementing the SWPP Plan. Training should address spill response, good housekeeping, and material management practices. Periodic dates for training shall be identified.

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i. Inspections. All inspections shall be done by trained personnel. Material handling areas shall be inspected for evidence of, or the potential for, pollutants entering storm water discharges. A tracking or follow-up procedure shall be used to ensure appropriate response has been taken in response to an inspection. Inspections and maintenance activities shall be documented and recorded. Inspection records shall be retained for five years.

j. Records A tracking and followup procedure shall be described to ensure that adequate response and corrective actions have been taken in response to inspections. Records of inspections shall be maintained. Establishment of internal record keeping and internal reporting procedures of inspections and spill incidents.

7. Non-Storm Water Discharges. All non-storm water discharges, except those identified in Table 1, to storm water conveyance systems shall be eliminated prior to implementation of this SWPP Plan. The SWPP Plan shall include a certification that non-storm water discharges have been eliminated and a description of any tests for the presence of non-storm water discharges, the methods used, the dates of the testing, and any onsite drainage points that were observed during the testing. Such certification may not always be feasible if the discharger a) must make significant structural changes to eliminate the discharge of non-storm water discharges to the industrial storm water conveyance system, or b) has applied for, but not yet received, an NPDES permit for the non-storm water discharges. In such cases, the discharger must notify the Regional Board, the Program, and local agencies having jurisdiction over storm water systems or water courses which receive the non-storm water discharge prior to implementation of the SWPP Plan that non-storm water discharges cannot be eliminated. The notification shall include justification for a time extension and a schedule, subject to modification by the Regional Board, indicating when non-storm water discharges will be eliminated. In no case shall the elimination of non-storm water discharges exceed July 1, 1993.

8. An annual facility inspection shall be conducted to verify that all elements of the SWPP Plan (i.e., site map, potential pollutant sources, structural and non-structural controls to reduce pollutants in industrial storm water discharge, etc.) are accurate. A report of the annual inspection and observations that require a response (and the appropriate response to the observation) shall be retained as part of the SWPP Plan.

9. This SWPP Plan may incorporate, by reference, the appropriate elements of other program requirements (i.e., Spill Prevention Control and Countermeasures (SPCC) plans under Section 311 of the CWA, Best Management Programs under 40 CFR 125.100, etc.).

10. The SWPP Plan is considered a report that shall be available to the public under Section 308(b) of the CWA.

11. The SWPP Plan shall include the signature and title of the person responsible for preparation of the SWPP Plan and include the date of initial preparation and each amendment, thereto.

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Section B: MONITORING PROGRAM AND REPORTING REQUIREMENTS

1. A monitoring program shall be developed and implemented for each facility covered by this Permit. It shall be certified in accordance with the signatory requirements contained in Standard Provision C.9. For existing facilities (and new facilities beginning operations before October 1, 1992), a monitoring program must be developed and implemented no later than October 1, 1992. For facilities beginning operations after October 1, 1992, a monitoring program shall be developed prior to submittal of the NOI, and implemented when the facility begins operations. A description of the monitoring program shall be retained onsite and made available upon request of a representative of the Regional Board, the Program, and/or local agency which receives the storm water discharge.

   The monitoring program shall be developed and amended, when necessary, to meet the following objectives:

   a. To monitor the quality of storm water discharges relative to Discharge Prohibitions, Effluent Limitations, and Receiving Water Limitations.

   b. To aid in the implementation of the Storm Water Pollution Prevention Plan.

   c. To measure the effectiveness of best management practices (BMPs) in removing pollutants in storm water discharge.

2. The Regional Board, the Program, and/or local agency may notify the discharger when the monitoring program does not meet one or more of the minimum requirements of this Section. Within 30 days of notice, the discharger shall submit a time schedule to the Regional Board, the Program, and/or local agency for amending the monitoring program to meet the minimum requirements. After making the required changes, the discharger shall provide written certification to the Regional Board, the Program, and/or local agency that the changes have been made.

3. The monitoring program shall contain:

   a. Rationale for selection of monitoring methods.

   b. Analytical methods to detect pollutants in storm water discharges.

   c. Sampling methods, sampling locations, and frequency of monitoring.

   d. A quality assurance/quality control program to assure that

      i. All elements of the monitoring program are conducted; and
      ii. All monitoring is conducted by trained personnel.

   e. Procedures and schedules by which the effectiveness of the monitoring program in achieving the objectives above can be evaluated.

4. The monitoring program shall document the elimination or reduction of specific pollutants, resulting from the implementation of BMPs. During the wet season (October 1 to April 30), all dischargers shall:

   a. Conduct visual observations of the storm water discharge locations on at least one storm event

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per month that produces significant storm water discharge[1] to observe the presence of floating and suspended materials, oil and grease, discolorations, turbidity, and odor, etc. Feedlot dischargers that are in compliance with Section 2560 to Section 2565, Title 23, California Code of Regulations shall conduct monthly inspections of their containment facilities to detect leaks and ensure maintenance of adequate freeboard.

b. Measure (or estimate) the total volume of storm water discharge from at least two storm events that produce significant storm water discharge, including the first such storm event of the wet season.

c. Collect and analyze samples of storm water discharge from at least two storm events that produce significant storm water discharge, including the first such storm event of the wet season for:

i. Any pollutant described in 40 CFR Subchapter N for which the discharger is required to monitor;

ii. For those facilities subject to SARA, Title III, Section 313 water priority toxic chemicals that have been released into storm water as reported on U.S. EPA Form R (40 CFR 372) after November 19, 1988;

iii. Monitoring parameters in accordance with Section B(7) below.

5. Testing for the presence of non-storm water discharges shall be conducted no less than twice during the dry season (May to September) at all storm water discharge locations. Tests may include visual observations of flows, stains, sludges, odors, and other abnormal conditions; dye tests; TV line surveys; and/or analysis and validation of accurate piping schematics. Records shall be maintained of the description of the method used, date of testing, locations observed, and test results.

6. Samples shall be collected from all locations where storm water is discharged. Samples must represent the quality and quantity of storm water discharged from the facility. If a facility discharges storm water at multiple locations, the discharger may sample a reduced number of locations if it is established and documented in the monitoring program that storm water discharges from different locations are substantially identical.

7. The monitoring program shall include analysis of parameters according to the following two alternatives:

a. Individual Monitoring

Dischargers not participating in group monitoring must collect and analyze samples for:

i. pH, total suspended solids (TSS), specific conductance, and total organic carbon (TOC);

ii. Toxic chemicals and other pollutants that have a reasonable potential to be present in storm water discharge in significant quantities.

[1] "Significant storm water discharge" is a continuous discharge of storm water for a minimum of one hour, or intermittent discharge of storm water for a minimum of three hours in a 12-hour period.

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b. Group Monitoring

Under the group monitoring alternative (see B(14)), only selected dischargers are chosen to represent the group. The parameters at these facilities shall be:

i. Oil and grease, pH, specific conductance, TOC, five-day biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), TSS, total phosphorus, total kjeldahl nitrogen, and nitrate plus nitrite nitrogen.

ii. Toxic chemicals and other pollutants that have a reasonable potential to be present in storm water discharge in significant quantities.

8. Samples shall be analyzed for toxic chemicals and other pollutants as identified in 4(c)(ii) and 7(a)(ii) or 7(b)(ii) for at least two consecutive sampling events. As an alternative to analyzing for these toxic chemicals and other pollutants, analysis for acute toxicity may be conducted. Acute toxicity 96-hour static renewal tests shall be conducted with fathead minnows in 100 percent storm water (no dilution). If toxic chemicals or other pollutants are not detected in significant quantities in the grab and composite sample after two consecutive sampling events, or two consecutive sampling events with no acute toxicity[2], the facility may eliminate that toxic chemical or pollutant from future sampling events.

9. Sampling shall be a combination of a grab sample (to measure first-flush water quality) and a composite sample (to provide an estimate of the average runoff water quality) from a storm event that produces significant storm water discharge that is preceded by at least 72 hours of dry weather and in accordance with the following guidelines:

a. The grab sample(s) shall be taken during the first thirty minutes of the discharge. If the collection of the grab sample(s) during the first 30 minutes is impracticable, grab sample(s) can be taken during the first hour of the discharge, and the discharger shall explain in the annual monitoring report why the grab sample(s) could not be taken in the first 30 minutes.

b. The composite sample shall be either flow-weighted[3] or time-weighted[4]. Composite samples may be taken with a continuous sampler or a combination of a minimum of three grab samples taken in each hour of discharge or for the first three hours of the discharge, with each grab sample being separated by a minimum period of 15 minutes.

c. Only grab samples may be used for the determination of pH and oil and grease.

d. Composite sampling is not required for discharges from holding ponds or other impoundments with a retention period greater than 24 hours.

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[2]"no acute toxicity" means no significant difference between the control mortality and sample mortality at 95 percent confidence interval using the "t-test" statistical method described in Appendix H of Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms (EPA-600/4-89/001 March 1989 and subsequent editions).

[3]"Flow-weighted composite sample" means a composite sample consisting of a mixture of aliquots collected at a constant time interval, where the volume of each aliquot is proportional to the flow rate of the discharge.

[4]"Time-weighted composite" means a composite sample consisting of a mixture of equal volume aliquots collected at a constant time.

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10. When a discharger is unable to collect any of the required samples due to adverse climatic conditions (drought, extended freeze, dangerous weather conditions, etc.), a description of why the samples could not be collected, including documentation of the event, must be submitted along with the annual monitoring report.

11. All sampling and sample preservation shall be in accordance with the current edition of "Standard Methods for the Examination of Water and Wastewater" (American Public Health Association). All monitoring instruments and equipment shall be calibrated and maintained in accordance with manufacturers' specifications to ensure accurate measurements. All analyses must be conducted according to test procedures under 40 CFR Part 136, unless other test procedures have been specified in this permit or by the Regional Board. All metals shall be reported as total metals. Toxicity tests shall be conducted in accordance with the latest revisions of Methods for Measuring the Acute Toxicity of Effluent to Freshwater and Marine Organisms, EPA-600/4-85-013 (March 1985). All analyses shall be conducted at a laboratory certified for such analyses by the State Department of Health Services. Dischargers may conduct their own laboratory analysis only if the discharger has sufficient capability (qualified employees, laboratory equipment, etc.) to adequately perform the test procedures.

12. Records of all storm water monitoring information and copies of all reports required by this Permit shall be retained for a period of at least five years from the date of the sample, observation, measurement, or report.

    These records shall include:

    a. The date, exact place, and time of sampling, observations, and/or measurements;

    b. The individual(s) who performed the sampling, observations, and/or measurements;

    c. Flow measurements or estimates and all standard observations;

    d. The date(s) analyses were performed and the time(s) analyses were initiated;

    e. The individual(s) who performed the analyses;

    f. The analytical techniques or methods used and the results of such analyses;

    g. Quality assurance/quality control results;

    h. Non-storm water discharge records (see Section B-5);

    i. All calibration and maintenance records of instruments used; and

    j. All original strip chart recordings for continuous monitoring instrumentation.

13. All storm water monitoring results shall be reported by July 1 of each year to the Executive Officer and to the Program. The report shall include copies or summaries of the Monitoring Record of 12.a. through h. listed above. The report shall be signed and certified in accordance with Standard Provisions 9 and 10 of Section C of this Permit. The first report will be due July 1, 1993.

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14. Group Monitoring: Group monitoring may be done in accordance with the following requirements:

a. A group monitoring plan may be designed and implemented by an entity representing a similar group of dischargers regulated by this General Permit or by the Program. All participants in a group monitoring plan must discharge storm water within the boundaries of the Regional Board.

b. A minimum of twenty percent of the dischargers participating in a group (minimum of four dischargers for groups of 20 dischargers or less) must be monitored. The entity or the local agency shall select the facilities that best represent the quality of the group's storm water discharge.

c. The entity or the Program must have the authority to levy fees against the participating dischargers in the group or be able to otherwise pay for the implementation of the group monitoring plan.

d. The entity or the Program is responsible for:

i. Development and implementation of the group monitoring plan;
ii. Evaluation and reporting of group monitoring data;
iii. Recommending appropriate BMPs to reduce pollutants in storm water discharges;
iv. Submitting a group monitoring plan to the appropriate Regional Board and local agency no later than 60 days prior to the beginning of the wet season, and revising the group monitoring plan as instructed by the Regional Board or local agency.

e. The group monitoring plan shall:

i. Identify the participants of the group by name and location;

ii. Include a narrative description summarizing the industrial activities of participants of the group and explain why the participants, as a whole, are sufficiently similar to be covered by a group monitoring plan;

iii. Include a list of significant materials stored or exposed to storm water and material management practices currently employed to diminish contact by these materials with storm water discharge;

iv. Identify a minimum of twenty percent of the dischargers (minimum of four dischargers for groups of 20 dischargers or less) participating in the group, and describe why the facilities selected to perform sampling and analysis are representative of the group as a whole in terms of processes used or materials managed;

v. Contain all items specified in Section B(3) above.

f. All group monitoring must comply with the applicable requirements of Section B(6), B(7)(b), and B(8-13) above.

h. Unless otherwise instructed by the Regional Board, the group monitoring plan shall be implemented at the beginning of the wet season.

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Section C: STANDARD PROVISIONS

1. Duty to Comply

The discharger must comply with all of the conditions of this General Permit. Any permit noncompliance constitutes a violation of the Clean Water Act and the Porter-Cologne Water Quality Control Act and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or denial of a permit renewal application.

The discharger shall comply with effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants within the time provided in the regulations that establish these standards or prohibitions, even if this General Permit has not yet been modified to incorporate the requirement.

2. General Permit Actions

This General Permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the discharger for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any permit condition.

If any toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is promulgated under Section 307(a) of the Clean Water Act for a toxic pollutant which is present in the discharge and that standard or prohibition is more stringent than any limitation on the pollutant in this General Permit, this General Permit shall be modified, or revoked and reissued to conform to the toxic effluent standard or prohibition, and the discharger so notified.

3. Need to Halt or Reduce Activity Not a Defense

It shall not be a defense for a discharger in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this General Permit.

4. Duty to Mitigate

The discharger shall take all responsible steps to minimize or prevent any discharge in violation of this General Permit which has a reasonable likelihood of adversely affecting human health or the environment.

5. Proper Operation and Maintenance

The discharger shall at all times properly operate and maintain any facilities and systems of treatment and control (and related appurtenances) which are installed or used by the discharger to achieve compliance with the conditions of this General Permit and with the requirements of storm water pollution prevention plans. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. Proper operation and maintenance may require the operation of backup or auxiliary facilities or similar systems, installed by a discharger when necessary to achieve compliance with the conditions of this General Permit.

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6. Property Rights

This General Permit does not convey any property rights of any sort, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State, or local laws or regulations.

7. Duty to Provide Information

The discharger shall furnish the Regional Board, State Board, EPA, Program, or local storm water management agency within a reasonable time specified by the agencies, any requested information to determine compliance with this General Permit. The discharger shall also furnish, upon request, copies of records required to be kept by this General Permit.

8. Inspection and Entry

The discharger shall allow the Regional Board, State Board, EPA, Program, and local storm water management agency upon the presentation of credentials and other documents as may be required by law, to:

a. Enter upon the discharger's premises where a regulated facility or activity is located or conducted or where records must be kept under the conditions of this General Permit;

b. Have access to and copy at reasonable times, any records that must be kept under the conditions of this General Permit; and

c. Inspect at reasonable times any facilities or equipment (including monitoring and control equipment) that are related to or may impact storm water discharge.

d. Sample or monitor at reasonable times for the purpose of ensuring permit compliance.

9. Signatory Requirements

a. All Notices of Intent submitted to the State Board shall be signed as follows:

(1) For a corporation: by a responsible corporate officer. For the purpose of this section, a responsible corporate officer means: (1) a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation; or (2) the manager of the facility if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures;

(2) For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or

(3) For a municipality, State, Federal, or other public agency: by either a principal executive officer or ranking elected official. The principal executive officer of a Federal agency includes the chief executive officer of the agency, or the senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g. Regional Administrators of EPA).

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b. All reports, certification, or other information required by the General Permit or requested by the Regional Board, State Board, EPA, Program, or local storm water management agency shall be signed by a person described above or by a duly authorized representative. A person is a duly authorized representative only if:

(1) The authorization is made in writing by a person described above and retained as part of the Storm Water Pollution Prevention Plan.

(2) The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of manager, operator, superintendent, or position of equivalent responsibility or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.

(3) If an authorization is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization must be attached to the Storm Water Pollution Prevention Plan prior to submittal of any reports, certifications, or information signed by the authorized representative.

10. Certification

Any person signing documents under Provision 9 shall make the following certification:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted, is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

11. Reporting Requirements

a. Planned changes: The discharger shall give written notice to the Regional Board, the Program, and local storm water management agency as soon as possible of any planned physical alteration or additions to the permitted facility. Notice is required under this provision only when the alteration or addition could significantly change the nature or increase the quantity of pollutants discharged.

b. Anticipated noncompliance: The discharger will give advance notice to the Regional Board, the Program, and local storm water management agency of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

c. Compliance schedules: Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this General Permit shall be submitted no later than 14 days following each schedule date.

d. Noncompliance reporting: The discharger shall report any noncompliance at the time monitoring reports are submitted. The written submission shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times and, if the

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noncompliance has not been correct, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance.

12. Oil and Hazardous Substance Liability

Nothing in this General Permit shall be construed to preclude the institution of any legal action or relieve the discharger from any responsibilities, liabilities, or penalties to which the discharger is or may be subject under Section 311 of the CWA.

13. Severability

The provisions of this General Permit are severable, and if any provision of this General Permit, or the application of any provision of this General Permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this General Permit shall not be affected thereby.

14. Reopener Clause

If there is evidence indicating potential or actual impacts on water quality due to any storm water discharge associated with industrial activity covered by this General Permit, the owner or operator of such discharge may be required to obtain an individual permit or an alternative general permit, or this General Permit may be modified to include different limitations and/or requirements.

15. Penalties for Violations of General Permit Conditions.

a. Section 309 of the CWA provides significant penalties for any person who violates a permit condition implementing Sections 301, 302, 306, 307 308, 318, or 405 of the CWA, or any permit condition or limitation implementing any such section in a permit issued under Section 402. Any person who violates any permit condition of this permit is subject to a civil penalty not to exceed $25,000 per day of such violation, as well as any other appropriate sanction provided by Section 309 of the CWA.

b. The Porter-Cologne Water Quality Control Act also provides for civil and criminal penalties, in some cases greater than those under the CWA.

16. Availability

A copy of this General Permit shall be maintained at the discharge facility and be available at all times to operating personnel.

17. Transfers

This General Permit is not transferable to any person. A new owner or operator of an existing facility must submit a NOI in accordance with the requirements of this General Permit to be authorized to discharge under this General Permit.

18. Continuation of Expired General Permit

This General Permit continues in force and effect until a new general permit is issued or the State Board rescinds the General Permit. Only those dischargers authorized to discharge under the expiring General Permit are covered by the continued General Permit.

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ATTACHMENT 1

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

NOTICE OF INTENT (NOI) - GENERAL INSTRUCTIONS

FOR COVERAGE UNDER NPDES GENERAL PERMIT NO. CAG612001 (ORDER NO. 91-011)

Who Must Apply

Facilities which have been defined by the U.S. Environmental Protection Agency as having "storm water discharges associated with industrial activity" must obtain coverage under an NPDES permit for their storm water discharges. Facilities requiring coverage are defined in 40 CFR Section 122.26 (b)(14). All facilities in Santa Clara County which discharge to South San Francisco Bay or its tributaries either directly or through municipal storm water systems may seek coverage under this General Permit, except existing discharges which have been issued NPDES permits including provisions regulating discharges of storm water, discharges of storm water from construction activities, or storm water discharges from industrial facilities determined ineligible by the Regional Board.

Where to Apply

The NOI should be mailed to the State Water Resources Control Board at the following address:

State Water Resources Control Board
Division of Water Quality
P.O. Box 944213
Sacramento, CA 94244-2130
Attn: Storm Water Permitting Section

A copy of the NOI shall be mailed to the Santa Clara Valley Nonpoint Source Pollution Control Program at the following address:

Santa Clara Valley Nonpoint Source Pollution Control Program
5750 Almaden Expressway
San Jose, CA 95118

When to Apply

Owners/operators of existing facilities must file a NOI, along with the appropriate annual fee, no later than April 30, 1992. Owners/operators of new facilities (those beginning operations after April 30, 1992) must file a NOI at least 30 days prior to the beginning of operations.

Fees

The annual fee is $250.00 for each facility. Checks should be made payable to the State Water Resources Control Board.

Completing the NOI

Completion and submittal of the attached NOI (Form NOI-1) is required to gain coverage under the General Permit. It must be completely and accurately filled out. A facility will be considered to be covered by the General Permit upon filing a complete and accurate NOI and submitting the appropriate annual fee. A copy of the General Permit with a distinct identification number (this number will appear at the top of the permit as the WDID No.) will be sent to the owner/operator upon receipt of the NOI and fee.

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NOI–LINE BY LINE INSTRUCTIONS

The NOI consists of two parts–an NOI Form (Form NOI-1) and a site map. Please type or print when completing the NOI Form and site map.

Mark one of the three boxes at the top portion of the NOI. Check box 1 if the NOI is being completed for an existing facility, box 2 if the facility is new (has not started business), and box 3 if the NOI is being submitted to report changes to a facility already covered by the General Permit. An example of a change that warrants a resubmittal of the NOI would be a change of owner/operator of a facility. Complete only those portions of the NOI that apply to the changes (the NOI must always be signed). If box 3 is checked, the WDID No. must be included. The WDID No. is found at the top of the General Permit issued to the facility.

SECTION I–OWNER/OPERATOR

Give the name, as it is legally referred to, of the person, company, firm, public organization, or any other entity which owns the facility (or operates the facility when the owner does not operate the facility) and check the box corresponding to the appropriate ownership status of the facility. The owner/operator information may or may not be the same as the facility information requested in Section II.

SECTION II–FACILITY/SITE INFORMATION

Enter the facility's official or legal name and provide the address, county, and contact person information for the facility. Facilities that do not have a street address must provide parcel number(s) information. The contact person should be the plant or site manager completely familiar with the facility and charged with compliance and oversight of the General Permit.

SECTION III–BILLING ADDRESS

Use this section to indicate where annual fee invoices and other correspondences should be sent.

SECTION IV–RECEIVING WATER INFORMATION

In Part A of this section, the owner/operator is required to indicate whether the facilities' storm water runoff discharges to a separate storm drain system, directly to a water of the United States, or indirectly to waters of the U.S.

Discharges to separate storm drain systems are those that discharge to a collection system operated by municipalities, flood control districts, utilities, or similar entities. Storm water discharges directly to waters of the U.S. will typically have an outfall structure directly from the facility to a river, creek, lake, ocean, etc. Indirect discharges are those that may flow over adjacent properties or right-of-ways prior to discharging to waters of the U.S.

Regardless of point of discharge, the applicant must determine the closest receiving water for its storm water discharge. If discharge is to a separate storm drain system, the purveyor of that system should know the receiving water. The name of the receiving water of a direct discharge should be easily available while the receiving water of an indirect discharge may require some effort to identify.

SECTION V–INDUSTRIAL INFORMATION

Part A of this section requests the owner/operator to provide the standard industrial classification (SIC) code(s) which best describes the industrial activity taking place at your facility. Briefly describe the nature of business in Part B. In Part C, check the general industrial activities that take place at the facility.

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SECTION VI–MATERIAL HANDLING

Part A of this section requires identification of the type(s) of materials stored and handled outdoors. If other types of materials other than those listed are maintained on-site, please check other and describe the type of material.

Part B of this section requests information on any existing management practices employed at the facility. Check the appropriate categories or list other control measures you use at your facility. If none are used, leave this part blank.

SECTION VII–FACILITY INFORMATION

List the size, in acres or square feet, of the facility and the percentage of the site that is impervious.

SECTION VIII–REGULATORY STATUS

Check the appropriate box(es) and indicate the identification number of any permits currently in affect at the facility.

SECTION IX–COMMENTS

This section is provided to allow for additional parcel numbers and billing information, if needed.

SECTION X–CERTIFICATION

This section should be read by the owner/operator. The certification provides for assurances that the NOI and site map were completed in an accurate and complete fashion and with the knowledge that penalties exist for providing false information. It also requires the owner/operator to certify that the provisions in the General Permit will be complied with.

The NOI must be signed by:

For a Corporation: a responsible corporate officer.

For a Partnership or Sole Proprietorship: a general partner or the proprietor, respectively.

For a Municipality, State, or other Non-Federal Public Agency: either a principal executive officer or ranking elected official.

For a Federal Agency: either the chief or senior executive officer of the agency.

SITE MAP

Provide a "to scale" drawing of the site and its immediate surroundings. Include as much detail about the site as possible. At a minimum show buildings, material handling areas, roadways, storm water collection and discharge points, a north arrow, and the names of adjacent streets. The attached site map may be used, if convenient. The township, section, and range of each facility must be provided on the site map.

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State of California
State Water Resources Control Board

NOTICE OF INTENT

FOR GENERAL PERMIT TO DISCHARGE STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITY IN SANTA CLARA COUNTY TO SOUTH SAN FRANCISCO BAY OR ITS TRIBUTARIES

San Francisco Bay Regional Water Quality Control Board Order No. 92-011

MARK ONLY ONE ITEM: 1. ☐ Existing Facility 2. ☐ New Facility 3. ☐ Change of Information WDID # _____

I. OWNER/OPERATOR

Name:	A. Owner/Operator Type: (Check one) 1. ☐ City 2. ☐ County 3. ☐ State 4. ☐ Federal 5. ☐ Special District 6. ☐ Government Combo 7. ☐ Private
Mailing Address:	
City:	State: ☐☐ Zip: ☐☐☐☐☐–☐☐☐☐ Phone: ( ) -
Contact Person:	B 1. ☐ Owner 2. ☐ Operator 3. ☐ Owner/Operator

II. FACILITY/SITE INFORMATION

Facility Name:	County:
Street Address:	Contact Person:
City:	State: C A Zip: ☐☐☐☐☐–☐☐☐☐ Phone: ( ) -

Parcel Number(s) (If more than 4 apply to facility, enter additional numbers in SECTION IX. A):

A _____ B _____ C _____ D _____

III. BILLING ADDRESS

Send Billing Statements To: A ☐ Owner/Operator B ☐ Facility C ☐ Other (Specify in SECTION IX. B)

IV. RECEIVING WATER INFORMATION

A. Does your facility's storm water discharge directly to: (Check one)

1. ☐ Storm drain system

Owner of storm drain system: (Name) _____

2. ☐ Directly to waters of U.S. (e.g., river, lake, creek, ocean)
3. ☐ Indirectly to waters of U.S.

B. Name of closest receiving water:

_____

V. INDUSTRIAL INFORMATION

A. SIC Code(s): 1. ☐☐☐☐ 2. ☐☐☐☐ 3. ☐☐☐☐ 4. ☐☐☐☐	B. Type of Business: _____

C. Industrial activities at facility: (Check all that apply)

1. ☐ Manufacturing 2. ☐ Vehicle Maintenance 3. ☐ Hazardous Waste Treatment, Storage, or Disposal Facility (RCRA Subtitle C)
4. ☐ Material Storage 5. ☐ Vehicle Storage 6. ☐ Material Handling 7. ☐ Wastewater Treatment
8. ☐ Power Generation 9. ☐ Recycling 10. ☐ Landfill 99. ☐ Other _____

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VI. MATERIAL HANDLING/MANAGEMENT PRACTICES

A. Types of materials handled and/or stored outdoors: (Check all that apply)

1. ☐ Solvents 2. ☐ Scrap Metal 3. ☐ Petroleum Products 4. ☐ Plating Products
5. ☐ Pesticides 6. ☐ Hazardous Wastes 7. ☐ Paints 8. ☐ Wood Treating Products
99. ☐ Other (Please list)

_____

B. Identify existing management practices employed to reduce pollutants in industrial storm water discharges: (Check all that apply)

1. ☐ Oil/Water Separator 2. ☐ Containment 3. ☐ Berms 4. ☐ Leachate Collection
5. ☐ Overhead Coverage 6. ☐ Recycling 7. ☐ Retention Facilities 8. ☐ Chemical Treatment
99. ☐ Other (Please list)

_____

VII. FACILITY INFORMATION

A. Total size of site: (Check one)	B. Percent of site impervious: (Including rooftops)
_____ ☐ Acres ☐ Sq. Ft.	_____ %

VIII. REGULATORY STATUS (Check all that apply)

A. ☐ Regulated by Storm water Effluent Guidelines (40 CFR Subchapter N)	B. ☐ Waste Discharge Requirements (Order Number) _____	C. ☐ NPDES Permit CA _____
D. ☐ RCRA Permit Number _____	E. ☐ Regulated by California Code of Regulations Article 6, Chapter 15 (Footlists).	

IX. COMMENTS (Enter additional information for SECTIONS II AND III)

A. Additional Parcel Numbers:

B. Billing Information: (Enter Name and Address)

X. CERTIFICATION

"I certify under penalty of law that this document and all attachments were prepared under my direction and supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment." In addition, I certify that the provisions of the permit, including the development and implementation of a Storm Water Pollution Prevention Plan and a Monitoring Program Plan, will be complied with.

Printed Name: _____

Signature: _____ Date: _____

Title _____

STATE USE ONLY

WDID:	Regional Board Office:	Date Permit Issued:
☐☐☐☐☐☐☐☐☐☐☐	☐☐	_____

NPDES Permit Number:	Order Number:	Fee Amount Received:	Date NOI Received:
CA_____	_____	$ _____	_____

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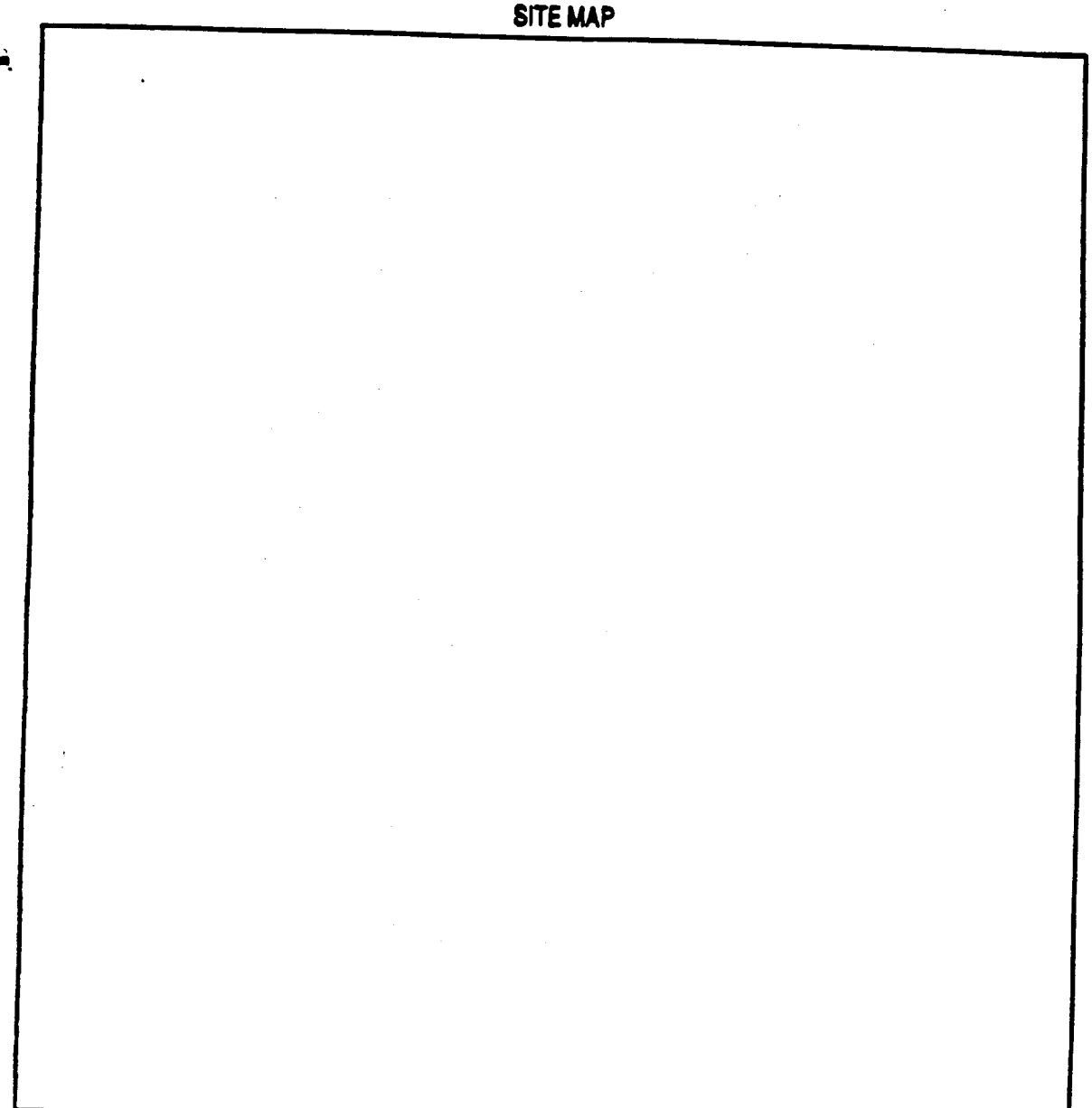
NOTICE OF INTENT
SITE MAP



MAP INFORMATION

TYPE _____

NUMBER _____

SCALE _____

STATE OF CALIFORNIA
STATE WATER RESOURCES CONTROL BOARD

FACILITY

COUNTY

DATE | DRAWN | CHECKED

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REGULATIONS

Following are the storm water rules from the U.S. Environmental Protection Agency, reprinted from the *Federal Register.*

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Federal Register

Friday
November 16, 1990

Part II

Environmental Protection Agency

40 CFR Parts 122, 123, and 124
National Pollutant Discharge Elimination System Permit Application Regulations for Storm Water Discharges; Final Rule

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Printed on Recycled Paper

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ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 122, 123, and 124

[FRL-3834-7]

RIN 2040-AA79

National Pollutant Discharge Elimination System Permit Application Regulations for Storm Water Discharges

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final rule.

SUMMARY: Today's final rule begins to implement section 402(p) of the Clean Water Act (CWA) (added by section 405 of the Water Quality Act of 1987 (WQA)), which requires the Environmental Protection Agency (EPA) to establish regulations setting forth National Pollutant Discharge Elimination System (NPDES) permit application requirements for: storm water discharges associated with industrial activity; discharges from a municipal separate storm sewer system serving a population of 250,000 or more; and discharges from municipal separate storm sewer systems serving a population of 100,000 or more, but less than 250,000.

Today's rule also clarifies the requirements of section 401 of the WQA, which amended CWA section 402(1)(2) to provide that NPDES permits shall not be required for discharges of storm water runoff from mining operations or oil and gas exploration, production, processing, or treatment operations or transmission facilities, composed entirely of flows which are from conveyances (including but not limited to pipes, conduits, ditches, and channels) used for collecting and conveying precipitation runoff and which are not contaminated by contact with, or do not come into contact with, any overburden, raw material, intermediate product, finished product, byproduct, or waste product located on the site of such operations. This rule sets forth NPDES permit application requirements addressing storm water discharges associated with industrial activity and storm water discharges from large and medium municipal separate storm sewer systems.

DATES: This final rule becomes effective December 17, 1990. In accordance with 40 CFR 23.2, this rule shall be considered final for purposes of judicial review on November 30, 1990, at 1 p.m. eastern daylight time. The public record is located at EPA Headquarters, EPA Public Information Reference Unit, room 2402, 401 M Street SW., Washington DC 20460. A reasonable fee may be charged for copying.

FOR FURTHER INFORMATION CONTACT: For further information on the rule contact: Thomas J. Seaton, Kevin Weiss, or Michael Mitchell Office of Water Enforcement and Permits (EN-336), United States Environmental Protection Agency, 401 M Street SW., Washington, DC 20460, (202) 475-9518.

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SUPPLEMENTARY INFORMATION:

I. Background and Water Quality Concerns

The 1972 amendments to the Federal Water Pollution Control Act (referred to as the Clean Water Act or CWA) prohibit the discharge of any pollutant to navigable waters from a point source unless the discharge is authorized by an NPDES permit. Efforts to improve water quality under the NPDES program traditionally and primarily focused on reducing pollutants in discharges of industrial process wastewater and municipal sewage. This program emphasis developed for a number of reasons. At the onset of the program in 1972, many sources of industrial process wastewater and municipal sewage were not adequately controlled and represented pressing environmental problems. In addition, sewage outfalls and industrial process discharges were easily identified as responsible for poor, often drastically degraded, water quality conditions. However, as pollution control measures were initially

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developed for these discharges. It became evident that more diffuse sources (occurring over a wide area) of water pollution, such as agricultural and urban runoff were also major causes of water quality problems. Some diffuse sources of water pollution, such as agricultural storm water discharges and irrigation return flows, are statutorily exempted from the NPDES program.

Since enactment of the 1972 amendments to the CWA, considering the rise of economic activity and population, significant progress in controlling water pollution has been made, particularly with regard to industrial process wastewater and municipal sewage. Expenditures by EPA, the States, and local governments to construct and upgrade sewage treatment facilities have substantially increased the population served by higher levels of treatment. Backlogs of expired permits for industrial process wastewater discharges have been reduced. Continued improvements are expected for these discharges as the NPDES program continues to place increasing emphasis on water quality-based pollution controls, especially for toxic pollutants.

Although assessments of water quality are difficult to perform and verify, several national assessments of water quality are available. For the purpose of these assessments, urban runoff was considered to be a diffuse source or nonpoint source pollution. From a legal standpoint, however, most urban runoff is discharged through conveyances such as separate storm sewers or other conveyances which are point sources under the CWA. These discharges are subject to the NPDES program. The "National Water Quality Inventory, 1988 Report to Congress" provides a general assessment of water quality based on biennial reports submitted by the States under section 305(b) of the CWA. In preparing the section 305(b) Reports, the States were asked to indicate the fraction of the States' waters that were assessed, as well as the fraction of the States' waters that were fully supporting, partly supporting, or not supporting designated uses. The Report indicates that of the rivers, lakes, and estuaries that were assessed by States (approximately one-fifth of stream miles, one-third of lake acres and one-half of estuarine waters), roughly 70% to 75% are supporting the uses for which they are designated. For waters with use impairments, States were asked to determine impacts due to diffuse sources (agricultural and urban runoff and other sources), municipal sewage, industrial process wastewaters, combined sewer overflows, and natural and other sources, then combine impacts to arrive at estimates of the relative percentage of State waters affected by each source. In this manner, the relative importance of the various sources of pollution that are causing use impairments was assessed and weighted national averages were calculated. Based on 37 States that provided information on sources of pollution, industrial process wastewaters were cited as the cause of nonsupport for 7.5% of rivers and streams, 10% of lakes, and 6% of estuaries. Municipal sewage was the cause of nonsupport for 13% of rivers and streams, 5% lakes, 48% estuaries, 41% of the Great Lake shoreline, and 11% of coastal waters. The Assessment concluded that pollution from diffuse sources, such as runoff from agricultural, urban areas, construction sites, land disposal and resource extraction, is cited by the States as the leading cause of water quality impairment. These sources appear to be increasingly important contributors of use impairment as discharges of industrial process wastewaters and municipal sewage plants come under increased control and as intensified data collection efforts provide additional information. Some examples of diffuse sources cited as causing use impairment are: for rivers and streams, 9% from separate storm sewers, 6% from construction and 13% from resource extraction; for lakes, 28% from separate storm sewers and 26% from land disposal; for the Great Lakes shoreline, 10% from separate storm sewers, 34% from resource extraction, and 82% from land disposal; for estuaries, 28% from separate storm sewers and 27% from land disposal; and for coastal areas, 20% from separate storm sewers and 29% from land disposal.

The States conducted a more comprehensive study of diffuse pollution sources under the sponsorship of the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA) and EPA. The study resulted in the report "America's Clean Water—The States' Nonpoint Source Assessment, 1985" which indicated that 38 States reported urban runoff as a major cause of beneficial use impairment. In addition, 21 States reported construction site runoff as a major cause of use impairment.

To provide a better understanding of the nature of urban runoff from commercial and residential areas, from 1978 through 1983, EPA provided funding and guidance to the Nationwide Urban Runoff Program (NURP). The NURP included 28 projects across the Nation, conducted separately at the local level but centrally reviewed, coordinated, and guided.

One focus of the NURP was to characterize the water quality of discharges from separate storm sewers which drain residential, commercial, and light industrial (industrial parks) sites. The majority of samples collected in the study were analyzed for eight conventional pollutants and three metals. Data collected under the NURP indicated that on an annual loading basis, suspended solids in discharges from separate storm sewers draining runoff from residential, commercial and light industrial areas are around an order of magnitude greater than solids in discharges from municipal secondary sewage treatment plants. In addition, the study indicated that annual loadings of chemical oxygen demand (COD) are comparable in magnitude to effluent from secondary sewage treatment plants. When analyzing annual loadings associated with urban runoff, it is important to recognize that discharges of urban runoff are highly intermittent, and that the short-term loadings associated with individual events will be high and may have shockloading effects on receiving water, such as low dissolved oxygen levels. NURP data also showed that fecal coliform counts in urban runoff are typically in the tens to hundreds of thousands per 100 ml of runoff during warm weather conditions, although the study suggested that fecal coliform may not be the most appropriate indicator organism for identifying potential health risks in storm water runoff. Although NURP did not evaluate oil and grease, other studies have demonstrated that urban runoff is an extremely important source of oil pollution to receiving waters, with hydrocarbon levels in urban runoff typically being reported at a range of 2 to 15 mg/l. These hydrocarbons tend to accumulate in bottom sediments where they may persist for long periods of time and exert adverse impacts on benthic organisms.

A portion of the NURP study involved monitoring 120 priority pollutants in storm water discharges from lands used for residential, commercial and light industrial activities. Seventy-seven priority pollutants were detected in samples of storm water discharges from residential, commercial and light industrial lands taken during the NURP study, including 14 inorganic and 63 organic pollutants. Table A-1 shows the priority pollutants which were detected in at least ten percent of the discharge samples which were sampled for priority pollutants.

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TABLE A-1.— PRIORITY POLLUTANTS DETECTED IN AT LEAST 10% OF NURP SAMPLES

(In percent)

	Frequency of detection
Metals and inorganics:	
Antimony	13
Arsenic	52
Beryllium	12
Cadmium	46
Chromium	80
Copper	91
Cyanides	23
Lead	94
Nickel	43
Selenium	11
Zinc	94
Pesticides:	
Alpha-hexachlorocyclohexane	20
Alpha-endosulfan	10
Chlordane	17
Lindane	16
Halogenated aliphatics:	
Methane, dichloro-	11
Phenols and cresols:	
Phenol	14
Phenol, pentachloro-	19
Phenol, 4-nitro	10
Phthalate esters:	
Phthalate, bis(2-ethylhexyl)	22
Polycyclic aromatic hydrocarbons:	
Chrysene	10
Fluoranthene	16
Phenanthrene	12
Pyrene	15

The NURP data also showed a significant number of these samples exceeded various EPA freshwater water quality criteria.

The NURP study provides insight on what can be considered background levels of pollutants for urban runoff, as the study focused primarily on monitoring runoff from residential, commercial and light industrial areas. However, NURP concluded that the quality of urban runoff can be adversely impacted by several sources of pollutants that were not directly evaluated in the study and are generally not reflected in the NURP data, including illicit connections, construction site runoff, industrial site runoff and illegal dumping.

Other studies have shown that many storm sewers contain illicit discharges of non-storm water and that large amounts of wastes, particularly used oils, are improperly disposed in storm sewers. Removal of these discharges present opportunities for dramatic improvements in the quality of storm water discharges. Storm water discharges from industrial facilities may contain toxics and conventional pollutants when material management practices allow exposure to storm water, in addition to wastes from illicit connections and improperly disposed wastes

In some municipalities, illicit connections of sanitary, commercial and industrial discharges to storm sewer systems have had a significant impact on the water quality of receiving waters. Although the NURP study did not emphasize the identification of illicit connections to storm sewers (other than to assure that monitoring sites used in the study were free from sanitary sewage contamination), the study concluded that illicit connections can result in high bacterial counts and dangers to public health. The study also noted that removing such discharges presented opportunities for dramatic improvements in the quality of urban storm water discharges.

Studies have shown that illicit connections to storm sewers can create severe, wide-spread contamination problems. For example, the Huron River Pollution Abatement Program inspected 880 businesses, homes and other buildings located in Washtenaw County, Michigan and identified 14% of the buildings as having improper storm drain connections. Illicit discharges were detected at a higher rate of 80% for automobile related businesses, including service stations, automobile dealerships, car washes, body shops and light industrial facilities. While some of the problems discovered in this study were the result of improper plumbing or illegal connections, a majority were approved connections at the time they were built.

Intensive construction activities may result in severe localized impacts on water quality because of high unit loads of pollutants, primarily sediments. Construction sites can also generate other pollutants such as phosphorus and nitrogen from fertilizer, pesticides, petroleum products, construction chemicals and solid wastes. These materials can be toxic to aquatic organisms and degrade water for drinking and water-contact recreation. Sediment loadings rates from construction sites are typically 10 to 20 times that of agricultural lands, with runoff rates as high as 100 times that of agricultural lands, and typically 1,000 to 2,000 times that of forest lands. Even a small amount of construction may have a significant negative impact on water quality in localized areas. Over a short period of time, construction sites can contribute more sediment to streams than was previously deposited over several decades.

II. Water Quality Act of 1987

The WQA contains three provisions which specifically address storm water discharges. The central WQA provision governing storm water discharges is section 405, which adds section 402(p) to the CWA. Section 402(p)(1) provides that EPA or NPDES States cannot require a permit for certain storm water discharges until October 1, 1992, except: for storm water discharges listed under section 402(p)(2). Section 402(p)(2) lists five types of storm water discharges which are required to obtain a permit prior to October 1, 1992:

(A) A discharge with respect to which a permit has been issued prior to February 4, 1987;

(B) A discharge associated with industrial activity;

(C) A discharge from a municipal separate storm sewer system serving a population of 250,000 or more;

(D) A discharge from a municipal separate storm sewer system serving a population of 100,000 or more, but less than 250,000; or

(E) A discharge for which the Administrator or the State, as the case may be, determines that the storm water discharge contributes to a violation of a water quality standard or is a significant contributor of pollutants to the waters of the United States.

Section 402(p)(4)(A) requires EPA to promulgate final regulations governing storm water permit application requirements for storm water discharges associated with industrial activity and discharges from large municipal separate storm sewer systems (systems serving a population of 250,000 or more) "no later than two years" after the date of enactment (*i.e.*, no later than February 4, 1989). Section 402(p)(4)(B) also requires EPA to promulgate final regulations governing storm water permit application requirements for discharges from medium municipal separate storm sewer systems (systems serving a population of 100,000 or more but less than 250,000) "no later than four years" after enactment (*i.e.*, no later than February 4, 1991).

In addition, section 402(p)(4) provides that permit applications for storm water discharges associated with industrial activity and discharges from large municipal separate storm sewer systems "shall be filed no later than three years" after the date of enactment of the WQA (*i.e.*, no later than February 4, 1990). Permit applications for discharges from medium municipal systems must be filed "no later than five years" after enactment (*i.e.*, no later than February 4, 1992).

The WQA clarified and amended the requirements for permits for storm water discharges in the new CWA section 402(p)(3). The Act clarified that permits for discharges associated with industrial activity must meet all of the applicable provisions of section 402 and section 301

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including technology and water quality based standards. However, the new Act makes significant changes to the permit standards for discharges from municipal storm sewers. Section 402(p)(3)(B) provides that permits for such discharges:

(i) May be issued on a system- or jurisdiction-wide basis;

(ii) Shall include a requirement to effectively prohibit non-storm water discharges into the storm sewers; and

(iii) Shall require controls to reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques and system, design and engineering methods, and such other provisions as the Administrator or the State determines appropriate for the control of such pollutants.

These changes are discussed in more detail later in today's rule.

The EPA, in consultation with the States, is required to conduct two studies on storm water discharges that are in the class of discharges for which EPA and NPDES States cannot require permits prior to October 1, 1992. The first study will identify those storm water discharges or classes of storm water discharges for which permits are not required prior to October 1, 1992, and determine, to the maximum extent practicable, the nature and extent of pollutants in such discharges. The second study is for the purpose of establishing procedures and methods to control storm water discharges to the extent necessary to mitigate impacts on water quality. Based on the two studies the EPA, in consultation with State and local officials, is required to issue regulations no later than October 1, 1992, which designate additional storm water discharges to be regulated to protect water quality and establish a comprehensive program to regulate such designated sources. This program must, at a minimum, (A) Establish priorities, (B) establish requirements for State storm water management programs, and (C) establish expeditious deadlines. The program may include performance standards, guidelines, guidance, and management practices and treatment requirements, as appropriate.

Section 401 of the WQA amends section 402(1)(2) of the CWA to provide that the EPA shall not require a permit for discharges of storm water runoff from mining operations or oil and gas exploration, production, processing, or treatment operations or transmission facilities if the storm water discharge is not contaminated by contact with, or does not come into contact with, any overburden, raw material, intermediate product, finished product, byproduct, or waste product located on the site of such operations.

Section 503 of the WQA amends section 502(14) of the CWA to exclude agricultural storm water discharges from the definition of point source.

III. Remand of 1984 Regulations

On December 4, 1987, the United States Court of Appeals for the District of Columbia Circuit vacated 40 CFR 122.26, (as promulgated on September 26, 1984, 49 FR 37998, September 26, 1984), and remanded the regulations to EPA for further rulemaking (*NRDC* v. *EPA*, No. 80-1607). EPA had requested the remand because of significant changes made by the storm water provisions of the WQA. The effect of the decision was to invalidate the storm water discharge regulations then found at § 122.26.

Storm water discharges which had been issued an NPDES permit prior to February 4, 1987, were not affected by the Court remand or the February 12, 1988, rule implementing the court order (53 FR 4157). (*See* section 402(p)(2)(A) of the CWA.) Similarly, the remand did not affect the authority of EPA or an NPDES State to require a permit for any storm water discharge (except an agricultural storm water discharge) designated under section 402(p)(2)(E) of the CWA. The notice of the remand clarified that such designated discharges meet the regulatory definition of point source found at 40 CFR 122.2 and that EPA or an NPDES State can rely on the statutory authority and require the filing of an application (Form 1 and Form 2C) for an NPDES permit with respect to such discharges on a case-by-case basis.

IV. Codification Rule and Case-by-Case Designations

Codification Rule

On January 4, 1989, (54 FR 255), EPA published a final rule which codified numerous provisions of the WQA into EPA regulations. The codification rule included several provisions dealing with storm water discharges. The codification rule promulgated the language found at section 402(p) (1) and (2) of the amended Clean Water Act at 40 CFR 122.26(a)(1). In addition, the codification rule promulgated the language of Section 503 of the WQA which exempted agricultural storm water discharges from the definition of point source at 40 CFR 122.2, and section 401 of the WQA addressing uncontaminated storm water discharges from mining or oil and gas operations at 40 CFR 122.26(a)(2).

EPA also codified the statutory authority of section 402(p)(2)(E) of the CWA for the Administrator or the State Director, as the case may be, to designate storm water discharges for a permit on a case-by-case basis at 40 CFR 122.26(a)(1)(v).

Case by Case Designations

Section 402(p)(2)(E) of the CWA authorizes case-by-case designations of storm water discharges for immediate permitting if the Administrator or the State Director determines that the storm water discharge contributes to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States.

In determining that a storm water discharge contributes to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States for the purpose of a designation under section 402(p)(2)(E), the legislative history for the provision provides that "EPA or the State should use any available water quality or sampling data to determine whether the latter two criteria (contributes to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States) are met, and should require additional sampling as necessary to determine whether or not these criteria are met." Conference Report, *Cong. Rec.* S18443 (daily ed. October 16, 1986). In accordance with this legislative history, today's rule promulgates permit application requirements for certain storm water discharges, including discharges designated on a case-by-case basis. EPA will consider a number of factors when determining whether a storm water discharge is a significant contributor of pollution to the waters of the United States. These factors include: the location of the discharge with respect to waters of the United States; the size of the discharge; the quantity and nature of the pollutants reaching waters of the United States; and any other relevant factors. Today's rule incorporates these factors at 40 CFR 122.26(a)(1)(v).

Under today's rule, case-by-case designations are made under regulatory procedures found at 40 CFR 124.52. The procedures at 40 CFR 124.52 require that whenever the Director decides that an individual permit is required, the Director shall notify the discharger in writing that the discharge requires a permit and the reasons for the decision. In addition, an application form is sent with the notice. Section 124.52 provides a 60 day period from the date of notice for submitting a permit application. Although this 60 day period may be appropriate for many designated storm water discharges, site specific factors may dictate that the Director provide

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additional time for submitting a permit application. For example, due to the complexities associated with designation of a municipal separate storm sewer system for a system- or jurisdiction-wide permit, the Director may provide the applicant with additional time to submit relevant information or may require that information be submitted in several phases.

V. Consent Decree of October 20, 1989

On April 20, 1989, EPA was served notice of intent to sue by Kathy Williams *et al.* because of the Agency's failure to promulgate final storm regulations on February 4, 1989, pursuant to Section 402(p)(4) of the CWA. A suit was filed by the same party on July 20, 1989, alleging the same cause of action, to wit: the Agency's failure to promulgate regulations under section 402(p)(4) of the CWA. On October 20, 1989, EPA entered into a consent decree with Kathy Williams *et al.* wherein the Federal District Court, District of Oregon, Southern Division, decreed that the Agency promulgate final regulations for storm water discharges identified in sections 402(p)(2) (B) and (C) of the CWA no later than July 20, 1990. *Kathy Williams et al.*, v. *William K. Reilly, Administrator, et al.*, No. 89-6265-E (D-Ore.) In July 1990, the consent degree was amended to provide for a promulgation date of October 31. Today's rule is promulgated in compliance with the terms of the consent decree as amended.

VI. Today's Final Rule and Response to Comments

A. Overview

Section 405 of the WQA alters the regulatory approach to control pollutants in storm water discharges by adopting a phased and tiered approach. The new provision phases in permit application requirements, permit issuance deadlines and compliance with permit conditions for different categories of storm water discharges. The approach is tiered in that storm water discharges associated with industrial activity must comply with sections 301 and 402 of the CWA (requiring control of the discharge of pollutants that utilize the Best Available Technology (BAT) and the Best Conventional Pollutant Control Technology (BCT) and where necessary, water quality-based controls), but permits for discharges from municipal separate storm sewer systems must require controls to reduce the discharge of pollutants to the maximum extent practicable, and where necessary water quality-based controls, and must include a requirement to effectively prohibit non-storm water discharges into the storm sewers. Furthermore, EPA in consultation with State and local officials must develop a comprehensive program to designate and regulate other storm water discharges to protect water quality.

This final regulation establishes requirements for the storm water permit application process. It also sets forth the required components of municipal storm water quality management plans, as well as a preliminary permitting strategy for industrial activities. In implementing these regulations, EPA and the States will strive to achieve environmental results in a cost effective manner by placing high priority on pollution prevention activities, and by targeting activities based on reducing risk from particularly harmful pollutants and/or from discharges to high value waters. EPA and the States will also work with applicants to avoid cross media transfers of storm water contaminants, especially through injection to shallow wells in the Class V Underground Injection Control Program.

In addition, EPA recognizes that problems associated with storm water, combined sewer overflows (CSOs) and infiltration and inflow (I&I) are all inter-related even though they are treated somewhat differently under the law. EPA believes that it is important to begin linking these programs and activities and, because of the potential cost to local governments, to investigate the use of innovative, non-traditional approaches to reducing or preventing contamination of storm water.

The application process for developing municipal storm water management plans provides an ideal opportunity between steps 1 and 2 for considering the full range of nontraditional, preventive approaches, including municipalities, public awareness/education programs, use of vegetation and/or land conservancy practices, alternative paving materials, creative ways to eliminate I&I and illegal hook-ups, and potentials for water reuse. EPA has already announced its plans to present an award for the best creative, cost effective approaches to storm water and CSOs beginning in 1991.

This rulemaking establishes permit application requirements for classes of storm water discharges that were specifically identified in section 402(p)(2). These priority storm water discharges include storm water discharges associated with industrial activity and discharges from a municipal separate storm sewer serving a population of 100,000 or more.

This rulemaking was developed after careful consideration of 450 sets of comments, comprising over 3200 pages, that were received from a variety of industries, trade associations, municipalities, State and Federal Agencies, environmental groups, and private citizens. These comments were received during a 90-day comment period which extended from December 7, 1988, to March 7, 1989. EPA received several requests for an extension of the comment period from 30-days up to 90-days. Many arguments were advanced for an extension including: the extent and complexity of the proposal, the existence of other concurrent EPA proposals, and the need for technical evaluations of the proposal. EPA considered these comments as they were received, but declined to extend the comment period beyond 90 days. The standard comment period on proposals normally range from 30 to 60 days. In light of the statutory deadline of February 4, 1989, additional time for the comment period beyond what was already a substantially lengthened comment period would have been inappropriate. The number and extent of the comments received on this proposal indicated that interested parties had substantially adequate time to review and comment on the regulation. Furthermore, the public was invited to attend six public meetings in Washington DC, Chicago, Dallas, Oakland, Jacksonville, and Boston to present questions and comments. EPA is convinced that substantial and adequate public participation was sought and received by the Agency.

Numerous commenters have also requested that the rule be reproposed due to the extent of the proposal and the number of options and issues upon which the Agency requested comments. EPA has decided against a reproposal. The December 7, 1988, notice of proposed rulemaking was extremely detailed and thoroughly identified major issues in such a manner as to allow the public clear opportunities to comment. The comments that were received were extensive, and many provided valuable information and ideas that have been incorporated into the regulation. Accordingly, the Agency is confident it has produced a workable and rational approach to the initial regulation of storm water discharges and a regulation that reflects the experience and knowledge of the public as provided in the comments, and which was developed in accordance with the

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procedural requirements of the Administrative Procedures Act (APA). EPA believes that while the number of issues raised by the proposal was extensive, the number of detailed comments indicates that the public was able to understand the issues in order to comment adequately. Thus, a reproposal is unnecessary.

B. Definition of Storm Water

The December 7, 1988, notice requested comment on defining storm water as storm water runoff, surface runoff, street wash waters related to street cleaning or maintenance, infiltration (other than infiltration contaminated by seepage from sanitary sewers or by other discharges) and drainage related to storm events or snow melt. This definition is consistent with the regulatory definition of "storm sewer" at 40 CFR 35.2005(b)(47) which is used in the context of grants for construction of treatment works. This definition aids in distinguishing separate storm water sewers from sanitary sewers, combined sewers, process discharge outfalls and non-storm water, non-process discharge outfalls.

The definition of "storm water" has an important bearing on the NPDES permitting scheme under the CWA. The following discusses the interrelationship of NPDES permitting requirements for storm water discharges addressed by this rule and NPDES permitting requirements for other non-storm water discharges which may be discharged via the storm sewer as a storm water discharge. Today's rule addresses permit application requirements for storm water discharges associated with industrial activity and for discharges from municipal separate storm sewer systems serving a population of 100,000 or more. Storm water discharges associated with industrial activity are to be covered by permits which contain technology-based controls based on BAT/BCT considerations or water quality-based controls, if necessary. A permit for storm water discharges from an industrial facility may also cover other non-storm water discharges from the facility. Today's rule establishes individual (Form 1 and Form 2F) and group application requirements for storm water discharges associated with industrial activity. In addition, EPA or authorized NPDES States with authorized general permit programs may issue general permits which establish alternative application or notification requirements for storm water discharges covered by the general permit(s). Where a storm water discharge associated with industrial activity is mixed with a non-storm water discharge, both discharges must be covered by an NPDES permit (this can be in the same permit or with multiple permits). Permit application requirements for these "combination" discharges are discussed later in today's notice.

Today's rule also addresses permit application requirements for discharges from municipal separate storm sewer systems serving a population of 100,000 or more. Under today's rule, appropriate municipal owners or operators of these systems must obtain NPDES permits for discharges from these systems. These permits are to establish controls to the maximum extent practicable (MEP), effectively prohibit non-storm water discharges to the municipal separate storm sewer system and, where necessary, contain applicable water quality-based controls. Where non-storm water discharges or storm water discharges associated with industrial activity discharge through a municipal separate storm sewer system (including systems serving a population of 100,000 or more as well as other systems), which ultimately discharges to a waters of the United States, such discharges through a municipal storm sewer need to be covered by an NPDES permit that is independent of the permit issued for discharges from the municipal separate storm sewer system. Today's rule defines the term "illicit discharge" to describe any discharge through a municipal separate storm sewer that is not composed entirely of storm water and that is not covered by an NPDES permit. Such illicit discharges are not authorized under the CWA. Section 402(p)(3)(B) of the CWA requires that permits for discharges from municipal separate storm sewers require the municipality to "effectively prohibit" non-storm water discharges from the municipal separate storm sewer. As discussed in more detail below, today's rule begins to implement the "effective prohibition" by requiring municipal operators of municipal separate storm sewer systems serving a population of 100,000 or more to submit a description of a program to detect and control certain non-storm water discharges to their municipal system. Ultimately, such non-storm water discharges through a municipal separate storm sewer must either be removed from the system or become subject to an NPDES permit (other than the permit for the discharge from the municipal separate storm sewer). For reasons discussed in more detail below, in general, municipalities will not be held responsible for prohibiting some specific components of discharges or flows listed below through their municipal separate storm sewer system, even though such components may be considered non-storm water discharges, unless such discharges are specifically identified on a case-by-case basis as needing to be addressed. However, operators of such non-storm water discharges need to obtain NPDES permits for these discharges under the present framework of the CWA (rather than the municipal operator of the municipal separate storm sewer system). (Note that section 316 of the Water Quality Act of 1987 requires EPA to conduct a study of de minimis discharges of pollutants to waters of the United States and to determine the most effective and appropriate methods of regulating any such discharges.)

EPA received numerous comments on the proposed regulatory definition of storm water, many of which proposed exclusions or additions to the definition. Several commenters suggested that the definition should include or not include detention and retention reservoir releases, water line flushing, fire hydrant flushing, runoff from fire fighting, swimming pool drainage and discharge, landscape irrigation, diverted stream flows, uncontaminated pumped ground water, rising ground waters, discharges from potable water sources, uncontaminated waters from cooling towers, foundation drains, non-contact cooling water (such as HVAC or heating ventilation and air conditioning condensation water that POTWs require to be discharged to separate storm sewers rather than sanitary sewers), irrigation water, springs, roof drains, water from crawl space pumps, footing drains, lawn watering, individual car washing, flows from riparian habitats and wetlands. Most of these comments were made with regard to the concern that these were commonly occurring discharges which did not pose significant environmental problems. It was also noted that, unless these flows are classified as storm water, permits would be required for these discharges.

In response to the comments which requested EPA to define the term "storm water" broadly to include a number of classes of discharges which are not in any way related to precipitation events, EPA believes that this rulemaking is not an appropriate forum for addressing the appropriate regulation under the NPDES program of such non-storm water discharges, even though some classes of non-storm water discharges may typically contain only minimal amounts of pollutants. Congress did not intend that the term storm water be used to describe any discharge that has a de minimis amount of pollutants, nor did it intend for section 402(p) to be used to

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provide a moratorium from permitting other non-storm water discharges. Consequently, the final definition of storm water has not been expanded from what was proposed. However, as discussed in more detail later in today's notice, municipal operators of municipal separate storm sewer systems will generally not be held responsible for "effectively prohibiting" limited classes of these discharges through their municipal separate storm sewer systems.

The proposed rule included infiltration in the definition of storm water. In this context one commenter suggested that the term infiltration be defined. Infiltration is defined at 40 CFR 35.2005(b)(20) as water other then wastewater that enters a sewer system (including sewer service connections and foundation drains) from the ground through such means as defective pipes, pipe joints, connections or manholes. Infiltration does not include, and is distinguished from, inflow. Another commenter urged that ground water infiltration not be classified as storm water because the chemical characteristics and contaminants of ground water will differ from surface storm water because of a longer contact period with materials in the soil and because ground water quality will not reflect current practices at the site. In today's rule, the definition of storm water excludes infiltration since pollutants in these flows will depend on a large number of factors, including interactions with soil and past land use practices at a given site. Further infiltration flows can be contaminated by sources that are not related to precipitation events, such as seepage from sanitary sewers. Accordingly the final regulatory language does not include infiltration in the definition of storm water. Such flows may be subject to appropriate permit conditions in industrial permits. As discussed in more detail below, municipal management programs must address infiltration where identified as a source of pollutants to waters of the United States.

One commenter questioned the status of discharges from detention and retention basins used to collect storm water. This regulation covers discharges of storm water associated with industrial activity and discharges from municipal separate storm sewer systems serving a population of 100,000 or more into waters of the United States. Therefore, discharges from basins that are part of a conveyance system for a storm water discharge associated with industrial activity or part of a municipal separate storm sewer system serving a population of 100,000 or more are covered by this regulation. Flows which are channeled into basins and which do not discharge into waters of the United States are not addressed by today's rule.

Several commenters requested that the term illicit connection be replaced with a term that does not connote illegal discharges or activity, because many discharges of non-storm water to municipal separate storm sewer systems occurred prior to the establishment of the NPDES program and in accordance with local or State requirements at the time of the connection. EPA disagrees that there should be a change in this terminology. The fact that these connections were at one time legal does not confer such status now. The CWA prohibits the point source discharge of non-storm water not subject to an NPDES permit through municipal separate storm sewers to waters of the United States. Thus, classifying such discharges as illicit properly identifies such discharges as being illegal.

A commenter wanted clarification of the terms "other discharges" and "drainage" that are used in the definition of "storm water." As noted above, today's rule clarifies that infiltration is not considered storm water. Thus the portion of the definition of storm water that refers to "other discharges" has also been removed. However, the term drainage has been retained. "Drainage" does not take on any meaning other than the flow of runoff into a conveyance, as the word is commonly understood.

One commenter stated that irrigation flows combined with storm water discharges should be excluded from consideration in the storm water program. The Agency would note that irrigation return flows are excluded from regulation under the NPDES program. Section 402(l)(1) states that the Administrator or the State shall not require permits for discharges composed entirely of return flows from irrigated agriculture. The legislative history of the 1977 Clean Water Act, which enacted this language, states that the word "entirely" was intended to limit the exception to only those flows which do not contain additional discharges from activities unrelated to crop production. Congressional Record Vol. 123 (1977), pg. 4360, Senate Report No. 95-370. Accordingly, a storm water discharge component, from an industrial facility for example, included in such "joint" discharges may be regulated pursuant to an NPDES permit either at the point at which the storm water flow enters or joins the irrigation flow, or where the combined flow enters waters of the United States or a municipal separate storm sewer.

Some commenters expressed concern about including street wash waters as storm water. One commenter argued including street wash waters in the definition of storm water should not be construed to eliminate the need for management practices relating to construction activities where sediment may simply wash into storm drains. EPA agrees with these points and the concerns that storm sewers may receive material that pose environmental problems if street wash waters are included in the definition. Accordingly, such discharges are no longer in the definition as proposed, and must be addressed by municipal management programs as part of the prohibition on non-storm water discharges through municipal separate storm sewer systems.

Several commenters requested that the terms discharge and point source, in the context of permits for storm water discharge, be clarified. Several commenters stated that the EPA should clarify that storm water discharge does not include "sheet flow" off of an industrial facility. EPA interprets this as request for clarification on the status of the terms "point source" and "discharge" under these regulations. In response, this rulemaking only covers storm water discharges from point sources. A point source is defined at 40 CFR 122.2 as "any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture or agricultural storm water runoff." EPA agrees with one commenter that this definition is adequate for defining what discharges of storm water are covered by this rulemaking. EPA notes that this definition would encompass municipal separate storm sewers. In view of this comprehensive definition of point source, EPA need clarify in this rulemaking only that a storm water discharge subject to NPDES regulation does not include storm water that enters the waters of the United States via means other than a "point source." As further discussed below, storm water from an industrial facility which enters and is subsequently discharged through a municipal separate storm sewer is a "discharge associated with industrial

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activity" which must be covered by an individual or general permit pursuant to today's rule.

EPA would also note that individual facilities have the burden of determining whether a permit application should be submitted to address a point source discharge. Those unsure of the classification of storm water flow from a facility, should file permit applications addressing the flow, or prior to submitting the application consult permitting authorities for clarification.

One commenter stated that "point source" for this rulemaking should be defined, for the purposes of achieving better water quality, as those areas where "discharges leave the municipal [separate storm sewer] system." EPA notes in response that "point source" as currently defined will address such discharges, while keeping the definition of discharge and point source within the framework of the NPDES program, and without adding potentially confusing and ambiguous additional definitions to the regulation. If this comment is asserting that the term point source should not include discharges from sources through the municipal system, EPA disagrees. As discussed in detail below, discharges through municipal separate storm sewer systems which are not connected to an operable treatment works are discharges subject to NPDES permit requirements at (40 CFR 122.3(c)), and may properly be deemed point sources.

One industry argued that the definition of "point source" should be modified for storm water discharges so as to exclude discharges from land that is not artificially graded and which has a propensity to form channels where precipitation runs off. EPA intends to embrace the broadest possible definition of point source consistent with the legislative intent of the CWA and court interpretations to include any identifiable conveyance from which pollutants might enter the waters of the United States. In most court cases interpreting the term "point source", the term has been interpreted broadly. For example, the holding in *Sierra Club* v. *Abston Construction Co., Inc.*, 620 F.2d 41 (5th Cir. 1980) indicates that changing the surface of land or establishing grading patterns on land will result in a point source where the runoff from the site is ultimately discharged to waters of the United States:

> Simple erosion over the natural surface, resulting in the discharge of water and other materials into navigable waters, does not constitute a point source discharge, absent some effort to *change the surface*, to *direct* the water flow or otherwise impede its progress * * * Gravity flow, resulting in a discharge into a navigable body of water, may be part of a point source discharge if the (discharger) at least initially collected or channeled the water and other materials. A point source of pollution may also be present where (dischargers) design spoil piles from discarded overburden such that, during periods of precipitation, erosion of spoil pile walls results in discharges into a navigable body of water by means of ditches, gullies and similar conveyances, even if the (dischargers) have done nothing beyond the mere collection of such and other materials * * * Nothing in the Act relieves (dischargers) from liability simply because the operators did not actually construct these conveyances, so long as they are reasonably likely to be the means by which pollutants are ultimately deposited into a navigable body of water. Conveyances of pollution formed either as a result of natural erosion or by material means, and which constitute a component of a * * * drainage system, may fit the statutory definition and thereby subject the operators to liability under the Act." 620 F.2d at 45 (emphasis added).

Under this approach, point source discharges of storm water result from structures which increase the imperviousness of the ground which acts to collect runoff, with runoff being conveyed along the resulting drainage or grading patterns.

The entire thrust of today's regulation is to control pollutants that enter receiving water from storm water conveyances. It is these conveyances that will carry the largest volume of water and higher levels of pollutants. The storm water permit application process and permit conditions will address circumstances and discharges peculiar to individual facilities.

One industry commented that the definition of waters of the State under some State NPDES programs included municipal storm sewer systems. The commenter was concerned that certain industrial facilities discharging through municipal storm sewers in these states would be required to obtain an NPDES permit, despite EPA's proposal not to require permits from such facilities generally. In response, EPA notes that section 510 of the CWA, approved States are able to have stricter requirements in their NPDES program. In approved NPDES States, the definition of waters of the State controls with regard to what constitutes a discharge to a water body. However, EPA believes that this will have little impact, since, as discussed below, all industrial dischargers, including those discharging through municipal separate storm sewer systems, will be subject to general or individual NPDES permits, regardless of any additional State requirements.

One municipality commented that neither the term "point source" nor "discharge" should be used in conjunction with industrial releases into urban storm water systems because that gives the impression that such systems are navigable waters. EPA disagrees that any confusion should result from the use of these terms in this context. In this rulemaking, EPA always addresses such discharges as "discharges through municipal separate storm sewer systems" as opposed to "discharges to waters of the United States." Nonetheless, such industrial discharges through municipal storm sewer systems are subject to the requirements of today's rule, as discussed elsewhere.

One commenter desired clarification with regard to what constituted an outfall, and if an outfall could be a pipe that connected two storm water conveyances. This rulemaking defines outfall as a point of discharge into the waters of the United States, and not a conveyance which connects to Sections of municipal separate storm sewer. In response to another comment, this rulemaking only addresses discharges to waters of United States, consequently discharges to ground waters are not covered by this rulemaking (unless there is a hydrological connection between the ground water and a nearby surface water body. *See, e.g., Exxon Corp.* v. *Train*, 554 F.2d 1310, 1312 n.1 (5th Cir. 1977), *McClellan Ecological Seepage Situation* v. *Weinberger*, 707 F.Supp. 1182, 1195–96 (E.D. Cal. 1988)).

In the WQA and other places, the term "storm water" is presented as a single word. Numerous comments were received by EPA as to the appropriate spelling. Many of these comments recommended that two words for storm water is appropriate. EPA has decided to use an approach consistent with the Government Printing Office's approved form where storm water appears as two words.

C. Responsibility for Storm Water Discharges Associated With Industrial Activity Through Municipal Separate Storm Sewers

The December 7, 1988, notice of proposed rulemaking requested comments on the appropriate permitting scheme for storm water discharges associated with industrial activity through municipal separate storm sewers. EPA proposed a permitting scheme that would define the requirement to obtain coverage under an NPDES permit for a storm water discharge associated with industrial activity through a municipal separate storm sewer in terms of the classification of the municipal separate storm sewer. EPA proposed holding municipal operators of large or medium

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municipal separate storm sewer systems primarily responsible for applying for and obtaining an NPDES permit covering system discharges as well as storm water discharges (including storm water discharges associated with industrial activity) through the system. Under the proposed approach, operators of storm water discharges associated with industrial activity which discharge through a large or medium municipal separate storm sewer system would generally not be required to obtain permit coverage for their discharge (unless designated as a significant contributor of pollution pursuant to section 402(p)(2)(E)) provided the municipality was notified of: The name, location and type of facility and a certification that the discharge has been tested (if feasible) for non-storm water (including the results of any testing). The notification procedure also required the operator of the storm water discharge associated with industrial activity to determine that: The discharge is composed entirely of storm water; the discharge does not contain hazardous substances in excess of reporting quantities; and the facility is in compliance with applicable provisions of the NPDES permit issued to the municipality for storm water.

In the proposal, EPA also requested comments on whether a decision on regulatory requirements for storm water discharges associated with industrial activity through other municipal separate storm sewer systems (generally those serving a population of less than 100,000) should be postponed until completion of two studies of storm water discharges required under section 402(p)(5) of the CWA.

EPA favored these approaches because they appeared to reduce the potential administrative burden associated with preparing and processing the thousands of permit applications associated with the rulemaking and provide EPA additional flexibility in developing permitting requirements for storm water discharges associated with industrial activity. EPA also expressed its belief, based upon an analysis of ordinances controlling construction site runoff in place in certain cities, that municipalities generally possessed legal authority sufficient to control contributions of industrial storm water pollutants to their separate storm sewers to the degree necessary to implement the proposed rule. EPA commented that municipal controls on industrial sources implemented to comply with an NPDES permit issued to the municipality would likely result in a level of storm water pollution control very similar to that put directly on the industrial source through its own NPDES permit. This was to be accomplished by requiring municipal permittees, to the maximum extent practicable, to require industrial facilities in the municipality to develop and implement storm water controls based on a consideration of the same or similar factors as those used to make BAT/BCT determinations. (*See* 40 CFR 125.3 (d)(2) and (d)(3)).

The great majority of commenters on the December 7, 1988, notice addressed this aspect of the proposal. Based on consideration of the comments received on the notice, EPA has decided that it is appropriate to revise the approach in its proposed rule to require direct permit coverage for all storm water discharges associated with industrial activity, including those that discharge through municipal separate storm sewers. In response to this decision, EPA has continued to analyze the appropriate manner to respond to the large number of storm water discharges subject to this rulemaking. The development of EPA's policy regarding permitting these discharges is discussed in more detail in the section VI.D of today's preamble.

EPA notes that the status of discharges associated with industrial activity which pass through a municipal separate storm sewer system under section 402(p) raises difficult legal and policy questions. EPA believes that treating these discharges under permits separate from those issued to the municipality will most fully address both the legal and policy concerns raised in public comment.

Certain commenters supported EPA's proposal. Some commenters claimed that EPA lacked any authority to permit industrial discharges which were not discharged immediately to waters of the U.S. Other commenters agreed with EPA's statements in the proposal that its approach would result in a more manageable administrative burden for EPA and the NPDES states. However, numerous comments also were received which provided various arguments in support of revising the proposed approach. These comments addressed several areas including the definition of discharge under the CWA, the requirements and associated statutory time frames of section 402(p), as well as the resource and enforcement constraints of municipalities. EPA is persuaded by these comments and has modified its approach accordingly. The key comments on this issue are discussed below.

EPA disagrees with commenters who suggested that EPA lacks authority to permit separately industrial discharges through municipal sewers. The CWA prohibits the discharge of a pollutant except pursuant to an NPDES permit. Section 502(12)(A) of the CWA defines the "discharge of a pollutant" as "any addition of any pollutant to navigable waters from any point source." [1] There is no qualification in the statutory language regarding the source of the pollutants being discharged. Thus, pollutants from a remote location which are discharged through a point source conveyance controlled by a different entity (such as a municipal storm sewer) are nonetheless discharges for which a permit is required.

EPA's regulatory definition of the term "discharge" reflects this broad construction. EPA defines the term to include

> additions of pollutants into waters of the United States from: surface runoff which is collected or channelled by man; *discharges through pipes, sewers, or other conveyances owned by a State, municipality, or other person which does not lead to a treatment works;* and discharges through pipes, sewers, or other conveyances, leading into privately owned treatment works.

40 CFR § 122.2 (1989) (emphasis added). The only exception to this general rule is the one contemplated by section 307(b) of the CWA, *i.e.*, the introduction of pollutants into publicly-owned treatment works. EPA treats these as "indirect discharges," subject not to NPDES requirements, but to pretreatment standards under section 307(b).

In light of its construction of the term discharge, EPA has consistently maintained that a person who sends pollutants from a remote location through a point source into a water of the U.S. may be held liable for the unpermitted discharge of that pollutant. Thus, EPA asserts the authority to require a permit either from the operator of the point source conveyance, (such as a municipal storm sewer or a privately-owned treatment works), or from any person causing pollutants to be present in that conveyance and discharged through the point source, or both. *See Decision of the General Counsel (of EPA) No. 43* ("In re Friendswood Development Co.") (June 11, 1978) (operator of privately owned treatment work and dischargers to it are both subject to NPDES permit requirements). *See also*, 40 CFR 122.3(g), 122.44(m)

[1] Indeed, the DC Circuit has held, in the storm water context that EPA may not exempt any point source discharges of pollutants from the requirement to obtain an NPDES permit. *NRDC v. Costle*, 568 F.2d 1369, 1377 (DC Cir. 1977).

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(NPDES permit writer has discretion to permit contributors to a privately owned treatment works as direct dischargers). In other words, where pollutants are added by one person to a conveyance owned/operated by another person, and that conveyance discharges those pollutants through a point source, EPA may permit either person or both to ensure that the discharge is properly controlled. Pollutants from industrial sites discharged through a storm sewer to a point source are appropriately treated in this fashion.

Furthermore, EPA believes that storm water from an industrial plant which is discharged through a municipal storm sewer is a "discharge associated with industrial activity." Today's rule, as in the proposal, defines discharges associated with industrial activity solely in terms of the origin of the storm water runoff. There is no distinction for how the storm water reaches the waters of the U.S. In other words, pollutants in storm water from an industrial plant which are discharged are "associated with industrial activity," regardless of whether the industrial facility operates the conveyance discharging the storm water (or whether the storm water is ultimately discharged through a municipal storm sewer). Indeed, there is no distinction in the "industrial" nature of these two types of discharges. The pollutants of concern in an industrial storm water discharge are present when the storm water leaves the facility, either through an industrial or municipal storm water conveyance. EPA has no data to suggest that the pollutants in industrial storm water entering a municipal storm sewer are any different than those in storm water discharged immediately to a water of the U.S. Thus, industrial storm water in a municipal sewer is properly classified as "associated with industrial activity." Although EPA proposed not to cover these discharges by separate permit, the Agency believes that it is clearly not precluded from doing so.

Many comments also supported the proposed approach, noting that holding municipalities primarily responsible for obtaining a permit which covers industrial storm water discharges through municipal systems would reduce the administrative burden associated with preparing and processing thousands of permit applications—permit applications that would be submitted if each industrial discharger through a large or medium municipal separate storm sewer system had to apply individually (or as part of a group application).

EPA appreciates these concerns. Yet EPA also recognizes that there are also significant problems with putting the burden of controlling these sources on the municipalities (except for designated discharges) which must be balanced with the concerns about the permit application burden on industries. The industrial permitting strategy discussed in section VI.D below attempts to achieve this balance.

EPA also does not believe that the administrative burden will be nearly as significant as originally thought, for several reasons. First, as discussed in section VI.F.2 below and in response to significant public comment, EPA has significantly narrowed the scope of the definition of "associated with industrial activity" to focus in on those facilities which are most commonly considered "industrial" and thought to have the potential for the highest levels of pollutants in their storm water discharges. EPA believes this is a more appropriate way to ensure a manageable scope for the industrial storm water program in light of the statutory language of section 402(p), since it does not attempt to arbitrarily distinguish industrial facilities on the basis of the ownership of the conveyance through which a facility discharges its storm water. Second, EPA's industrial permitting strategy discussed in section VI.D is designed around aggressive use of general permits to cover the vast majority of industrial sources. These general permits will require industrial facilities to develop storm water control plans and practices similar to those that would have been required by the municipality. Yet, general permits will eliminate the need for thousands of individual or group permit applications, greatly reducing the burden on both industry EPA/States. Finally, even under the proposal, EPA believes that a large number of industrial dischargers would have been appropriate for designation for individual permitting under section 402(p)(2)(E), with the attendant individual application requirements. Today's approach will actually decrease the overall burden on these facilities: rather than filing an individual permit application upon designation, these facilities will generally be covered by a general permit.

By contrast, several commenters asserted that not only does EPA have the authority to cover these discharges by separate permit, it is required to by the language of section 402(p). As discussed above, storm water from an industrial plant which passes through a municipal storm sewer to a point source and is discharged to waters of the U.S. is a "discharge associated with industrial activity." Therefore, it is subject to the appropriate requirements of section 402(p). The operator of the discharge (or the industrial facility where the storm water originates) must apply for a permit within three years of the 1987 amendments (*i.e.*, Feb. 4, 1988);[8] EPA must issue a permit by one year later (Feb. 4, 1991); and the permit must require compliance within three years of permit issuance. That permit must ensure that the discharge is in compliance with all appropriate provisions of sections 301 and 402. Commenters asserted that EPA's proposal would violate these two requirements of the law. First, the statute requires all industrial storm water discharges to obtain a permit in the first round of permitting (*i.e.*, February 4, 1990). However, Congress established a different framework to address discharges from small municipal separate storm sewer systems. Section 402(p) requires EPA to complete two studies of storm water discharges, and based on those studies, promulgate additional regulations, including requirements for state storm water management programs by October 1, 1992. EPA is prohibited from issuing permits for storm water discharges from small municipal systems until October 1, 1992 unless the discharge is designated under section 402(p)(2)(E). Thus, industrial storm water discharges from these systems would not be covered by a permit until later than contemplated by statute. Second, permits for municipal storm sewer systems require controls on storm water discharges "to the maximum extent practicable," as opposed to the BAT/BCT requirements of section 301(b)(2). Yet, all industrial storm water discharges must comply with section 301(b)(2). Thus, covering industrial storm water under a municipal storm water permit will not ensure the legally-required level of control of industrial storm water discharges.

In addition to comments on the requirements of section 402(p), EPA received several comments questioning whether EPA's proposal to cover industrial pollutants in municipal separate storm sewers solely in the permit issued to the municipality would ensure adequate control of these pollutants due to both inadequate

[8] It should be noted that EPA did not promulgate the required storm water regulations by February, 1988 as contemplated by section 402(p)(4)(A). As discussed below, today's rule requires by requires industrial storm water dischargers to file a permit application in one year.

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resources and enforcement. Some municipalities stated that the burdens of this responsibility would be too great with regard to source identification and general administration of the program. These commenters claimed they lacked the necessary technical and regulatory expertise to regulate such sources. Commenters also noted that additional resources to control these sources would be difficult to obtain given the restrictions on local taxation in many states and the fact that EPA will not be providing funding to local governments to implement their storm water programs.

Municipalities also expressed concerns regarding enforcement of EPA's proposed approach. Some municipalities remarked that they did not have appropriate legal authority to address these discharges. Several commenters also stated that requiring municipalities to be responsible for addressing storm water discharges associated with industrial activity through their municipal system would result in unequal treatment of industries nationwide because of different municipal requirements and enforcement procedures. Several municipal entities expressed concern with regard to their responsibility and liability for pollutants discharged to their municipal storm sewer system, and further asserted that it was unfair to require municipalities to bear the full cost of controlling such pollutants. Other municipalities suggested that overall municipal storm water control would be impaired, since municipalities would spend a disproportionate amount of resources trying to control industrial discharges through their sewers, rather than addressing other storm water problems. In a related vein, certain commenters suggested that, where industrial storm water was a significant problem in a municipal sewer, EPA's proposed approach would hamper enforcement at the federal/state level, since all enforcement measures could be directed only at the municipality, rather than at the most direct source of that problem.

In response to all of these concerns, EPA has decided to require storm water discharges associated with industrial activity which discharge through municipal separate storm sewers to obtain separate individual or general NPDES permits. EPA believes that this change will adequately address all of the key concerns raised by commenters.

The Agency was particularly influenced by concerns that many municipalities lacked the authority under state law to address industrial storm water practices. EPA had assumed that since several cities regulate construction site activities, that they could regulate other industrial operations in a similar manner. Several commenters suggested otherwise. In light of these concerns, EPA agrees with certain commenters that municipal controls on industrial facilities, in lieu of federal control, might not comply with section 402(p)(3)(A) for those facilities.[8] This calls into question whether EPA's proposed approach would have reasonably implemented Congressional intent to address industrial storm water early and stringently in the permitting process.

EPA also agrees with those commenters who argued that municipal controls on industrial storm water sources were not directly analogous to the pretreatment program under section 307(b), as EPA suggested in the preamble to the proposal. The authority of cities to control the type and volume of industrial pollutants into a POTW is generally unquestioned under the laws of most states, since sewage and industrial waste treatment is a service provided by the municipality. Thus, EPA has greater confidence that cities can and will adopt effective pretreatment programs. By contrast, many cities are limited in the types of controls they can impose on flows into storm sewers; cities are more often limited to regulations on quantity of industrial flows to prevent flooding the system. So too, the pretreatment program allows for federal enforcement of local pretreatment requirements. Enforcement against direct dischargers (including dischargers through municipal storm sewers) is possible only when the municipal requirements are contained in an NPDES permit.

Although today's rule will require industrial discharges through municipal storm sewers to be covered by separate permit, EPA still believes that municipal operators of large and medium municipal systems have an important role in source identification and the development of pollutant controls for industries that discharge storm water through municipal separate storm sewer systems is appropriate. Under the CWA, large and medium municipalities are responsible for reducing pollutants in discharges from municipal separate storm sewers to the maximum extent practicable. Because storm water from industrial facilities may be a major contributor of pollutants to municipal separate storm sewer systems, municipalities are obligated to develop controls for storm water discharges associated with industrial activity through their system in their storm water management program. (*See* section VI.H.7. of today's preamble.) The CWA provides that permits for municipal separate storm sewers shall require municipalities to reduce pollutants to the maximum extent practicable. Permits issued to municipalities for discharges from municipal separate storm sewers will reflect terms, specified controls, and programs that achieve that goal. As with all NPDES permits, responsibility and liability is determined by the discharger's compliance with the terms of the permit. A municipality's responsibility for industrial storm water discharged through their system is governed by the terms of the permit issued. If an industrial source discharges storm water through a municipal separate storm sewer in violation of requirements incorporated into a permit for the industrial facility's discharge, that industrial operator of the discharge may be subject to an enforcement action instituted by the Director of the NPDES program.

Today's rule also requires operators of storm water discharges associated with industrial activity through large and medium municipal systems to provide municipal entities of the name, location, and type of facility that is discharging to the municipal system. This information will provide municipalities with a base of information from which management plans can be devised and implemented. This requirement is in addition to any requirements contained in the industrial facility's permit. As in the proposal, the notification process will assist cities in development of their industrial control programs.

EPA intends for the NPDES program, through requirements in permits for storm water discharges associated with industrial activity, to work in concert with municipalities in the industrial component of their storm water management program efforts. EPA believes that permitting of municipal storm sewer systems and the industrial discharges through them will act in a complementary manner to fully control the pollutants in those sewer systems. This will fully implement the intent of

[8] EPA notes that the legal issue raised by commenters regarding whether industrial storm water would be controlled to BAT if covered by a municipal permit at the MEP level is primarily a theoretical issue. As explained above, the proposal assumed that cities would establish controls on industry very similar to those established in an NPDES permit using best professional judgment. EPA's key concern, rather, is whether cities can, in fact, establish such controls. Thus, today's final rule should not appreciably change the requirements to be imposed on industrial sources, only how those requirements are enforced.

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Congress to control industrial as well as large and medium municipal storm water discharges as expeditiously and effectively as possible. This approach will also address the concerns of municipalities that they lack sufficient authority and resources to control all industrial contributions to their storm sewers and will be liable for discharges outside of their control.

The permit application requirements for large and medium municipal separate storm sewer systems, discussed in more detail later in today's preamble, address the responsibilities of the municipal operators of these systems to identify and control pollutants in storm water discharges associated with industrial activity. Permit applications for large and medium municipal separate storm sewer systems are to identify the location of facilities which discharge storm water associated with industrial activity to the municipal system (*see* section VI.H.7. of the preamble). In addition, municipal applicants will provide a description of a proposed management program to reduce, to the maximum extent practicable, pollutants from storm water discharges associated with industrial activity which discharge to the municipal system (*see* section VI.H.7.c of this preamble). EPA notes that each municipal program will be tailored to the conditions in that city. Differences in regional weather patterns, hydrology, water quality standards, and storm sewer systems themselves dictate that storm water management practices will vary to some degree in each municipality. Accordingly, similar industrial storm water discharges may be treated differently in terms of the requirements imposed by the municipality, depending on the municipal program. Nonetheless, any individual or general permit issued to the industrial facility must comply with section 402(p)(3)(A) of the CWA.

EPA intends to provide assistance and guidance to municipalities and permitting authorities for developing storm water management programs that achieve permit requirements. EPA intends to issue a guidance document addressing municipal permit applications in the near term.

Controls developed in management plans for municipal system permits may take a variety of forms. Where necessary, municipal permittees can pursue local remedies to develop measures to reduce pollutants or halt storm water discharges with high levels of pollutants through municipal storm sewer systems. Some local entities have already implemented ordinances or laws that are designed to reduce the discharge of pollutants to municipal separate storm sewers, while other municipalities have developed a variety of techniques to control pollutants in storm water. Alternatively, where appropriate, municipal permittees may develop end-of-pipe controls to control pollutants in these discharges such as regional wet detention ponds or diverting flow to publicly owned treatment works. Finally, municipal applicants may bring individual storm water discharges, which cannot be adequately controlled by the municipal permittees or general permit coverage, to the attention of the permitting authority. Then, at the Director's discretion, appropriate additional controls can be required in the permit for the facility generating the targeted storm water discharge.

One commenter suggested that municipal operators of municipal separate storm sewers should have control over all storm water discharges from a facility that discharges both through the municipal system and to waters of the United States. In response, under this regulatory and statutory scheme, industries that discharge storm water directly into the waters of the United States, through municipal separate storm sewer systems, or both are required to obtain permit coverage for their discharges. However, municipalities are not precluded from exercising control over such facilities through their own municipal authorities.

It is important to note that EPA has established effluent guideline limitations for storm water discharges for nine subcategories of industrial dischargers (Cement Manufacturing (40 CFR part 411), Feedlots (40 CFR part 412), Fertilizer Manufacturing (40 CFR part 418), Petroleum Refining (40 CFR part 419), Phosphate Manufacturing (40 CFR part 422), Steam Electric (40 CFR part 423), Coal Mining (40 CFR part 434), Ore Mining and Dressing (40 CFR part 440) and Asphalt (40 CFR part 443)). Most of the existing facilities in these subcategories already have individual permits for their storm water discharges. Under today's rule, facilities with existing NPDES permits for storm water discharges through a municipal storm sewer will be required to maintain these permits and apply for an individual permit, under § 122.20(c), when existing permits expire. EPA received numerous comments supporting this decision because requiring facilities that have existing permits to comply with today's requirements immediately would be inefficient and not serve improved water quality.

Sections 402(p) (1) and (2) of the CWA provide that discharges from municipal separate storm sewer systems serving a population of less than 100,000 are not required to obtain a permit prior to October 1, 1992, unless designated on a case-by-case basis under section 402(p)(2)(E). However, as discussed above, storm water discharges associated with industrial activity through such municipal systems are not excluded. Thus, under today's rule, all storm water discharges associated with industrial activity that discharge through municipal separate storm sewer systems are required to obtain NPDES permit coverage, including those which discharge through systems serving populations less than 100,000. EPA believes requiring permits will address the legal concerns raised by commenters regarding these sources. In addition, it will allow for control of these significant sources of pollution while EPA continues to study under section 402(p)(6) whether to require the development of municipal storm water management plans in these municipalities. If these municipalities do ultimately obtain NPDES permits for their municipal separate storm sewer systems, early permitting of the industrial contributions may aid those cities in their storm water management efforts.

In the December 7, 1988, proposal, EPA recognized that storm water discharges associated with industrial activity from Federal facilities through municipal separate storm sewer systems may pose unique legal and administrative situations. EPA received numerous comments on this issue, with most of these comments coming from cities and counties. The comments reflected a general concern with respect to a municipality's ability to control Federal storm water discharges through municipal separate storm sewer systems. Most municipalities stated that they do not have the legal authority to adequately enforce against problem storm water discharges from Federal facilities and that these facilities should be required to obtain separate storm water permits. Some commenters stated that they have no Constitutional authority to regulate Federal facilities or establish regulation for such facilities. Some commenters indicated that Federal facilities could not be inspected, monitored, or subjected to enforcement for national security and other jurisdictional reasons. Some commenters argued that without clearly stated legal authority for the municipality, such dischargers should be required to obtain permits. One

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municipality pointed out that Federal facilities within city limits are exempted from their Erosion and Sediment Control Act and that permits for these facilities should be required.

Under today's rule, Federal facilities which discharge storm water associated with industrial activity through municipal separate storm sewer systems will be required to obtain NPDES permit coverage under Federal or State law. EPA believes this will cure the legal authority problems at the local level raised by the commenters. EPA notes that this requirement is consistent with section 313(a) of the CWA.

D. Preliminary Permitting Strategy for Storm Water Discharges Associated With Industrial Activity

Many of the comments received on the December 7, 1988, proposal focused on the difficulties that EPA Regions and authorized NPDES States, with their finite resources, will have in implementing an effective permitting program for the large number of storm water discharges associated with industrial activity. Many commenters noted that problems with implementing permit programs are caused not only by the large number of industrial facilities subject to the program, but by the difficulties associated with identifying appropriate technologies for controlling storm water at various sites and the differences in the nature and extent of storm water discharges from different types of industrial facilities.

EPA recognizes these concerns; and based on a consideration of comments from authorized NPDES States, municipalities, industrial facilities and environmental groups on the permitting framework and permit application requirements for storm water discharges associated with industrial activity, EPA is in the process of developing a preliminary strategy for permitting storm water discharges associated with industrial activity. In developing this strategy, EPA recognizes that the CWA provides flexibility in the manner in which NPDES permits are issued.[4] EPA intends to use this flexibility in designing a workable and reasonable permitting system. In accordance with these considerations, EPA intends to publish in the near future a discussion of its preliminary permitting strategy for implementing the NPDES storm water program.

The preliminary strategy is intended to establish a framework for developing permitting priorities, and includes a four tier set of priorities for issuing permits to be implemented over time:

- *Tier I—baseline permitting:* One or more general permits will be developed to initially cover the majority of storm water discharges associated with industrial activity;
- *Tier II—watershed permitting:* Facilities within watersheds shown to be adversely impacted by storm water discharges associated with industrial activity will be targeted for permitting.
- *Tier III—industry specific permitting:* Specific industry categories will be targeted for individual or industry-specific permits; and
- *Tier IV—facility specific permitting:* A variety of factors will be used to target specific facilities for individual permits.

Tier I—Baseline Permitting

EPA intends to issue general permits that initially cover the majority of storm water discharges associated with industrial activity in States without authorized NPDES programs. These permits will also serve as models for States with authorized NPDES programs.

The consolidation of many sources under one permit will greatly reduce the otherwise overwhelming administrative burden associated with permitting storm water discharges associated with industrial activity. This approach has a number of additional advantages, including:

- Requirements will be established for discharges covered by the permit;
- Facilities whose discharges are covered by the permit will have an opportunity for substantial compliance with the CWA;
- The public, including municipal operators of municipal separate storm sewers which may receive storm water discharges associated with industrial activity, will have access under section 308(b) of the CWA to monitoring data and certain other information developed by the permittee;
- EPA will have the opportunity to begin to collect and review data on storm water discharges from priority industries, thereby supporting the development of subsequent permitting activities;
- Applicable requirements of municipal storm water management programs established in permits for discharges from municipal separate storm sewer systems will be enforceable directly against non-complying industrial facilities that generate the discharges;
- The public will be given an opportunity to comment on permitting activities;
- The baseline permits will provide a basis for bringing selected enforcement actions by eliminating many issues which might otherwise arise in an enforcement proceeding; and
- Finally, the baseline permits will provide a focus for public comment on the development of subsequent phases of the permitting strategy for storm water discharges, including the development of priorities for State storm water management programs developed under section 402(p)(6) of the CWA.

Initially, the coverage of the baseline permits will be broad, but the coverage is intended to shrink as other permits are issued for storm water dischargers associated with industrial activities pursuant to Tier II through IV activities.

2. Tier II—Watershed Permitting

Facilities within watersheds shown to be adversely impacted by storm water discharges associated with industrial activity will be targeted for individual and general permitting. This process can be initiated by identifying receiving waters (or segments of receiving waters) where storm water discharges associated with industrial activity have been identified as a source of use impairment or are suspected to be contributing to use impairment.

3. Tier III—Industry Specific Permitting

Specific industry categories will be targeted for individual or industry-specific general permits. These permits will allow permitting authorities to focus attention and resources on industry categories of particular concern and/or industry categories where tailored requirements are appropriate. EPA will work with the States to coordinate the development of model permits for selected classes of industrial storm water discharges. EPA is also working to identify priority industrial categories in the two reports to Congress required under section 402(p)(5) of the CWA. In addition, group applications that are received can be used to develop model permits for the appropriate industries

[4] The courts in *NRDC v. Train*, 396 F.Supp. 1393 (D.D.C. 1975) *aff'd. NRDC v. Costle*, 568 F.2d 1369 (DC Cir. 1977), have acknowledged the administrative burden placed on the Agency by requiring individual permits for a large number of storm water discharges. These courts have recognized EPA's discretion to use certain administrative devices, such as area permits or general permits to help manage its workload. In addition, the courts have recognized flexibility in the type of permit conditions that are established, including requirements for best management practices.

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4. Tier IV—Facility Specific Permitting

Individual permits will be appropriate for some storm water discharges in addition to those identified under Tier II and III activities. Individual permits should be issued where warranted by: the pollution potential of the discharge, the need for individual control mechanisms; and in cases where reduced administrative burdens exist. For example, individual NPDES permits for facilities with process discharges should be expanded during the normal process of permit reissuance to cover storm water discharges from the facility.

5. Relationship of Strategy to Permit Applications Requirements

The preliminary long-term permitting strategy described above identifies several permit schemes that EPA anticipates will be used in addressing storm water discharges associated with industrial activity. One issue that arises with this strategy is determining the appropriate information needed to develop and issue permits for these discharges. The NPDES regulatory scheme provides three major options for obtaining permit coverage for storm water discharges associated with industrial activity: (1) individual permit applications; (2) group applications; and (3) case-by-case requirements developed for general permit coverage.

a. *Individual permit application requirements.* Today's notice establishes requirements for individual permit applications for storm water discharges associated with industrial activity. These application requirements are applicable for all storm water discharges associated with industrial activity, except where the operator of the discharge is participating in a group application or a general permit is issued to cover the discharge and the general permit provides alternative means to obtain permit coverage. Information in individual applications is intended to be used in developing the site-specific conditions generally associated with individual permits.

Individual permit applications are expected to play an important role in all tiers of the Strategy, even where general permits are used. Although general permits may provide for notification requirements that operate in lieu of the requirement to submit individual permit applications, the individual permit applications may be needed under several circumstances. Examples include: where a general permit requires the submission of a permit application as the notice of intent to be covered by the permit; where the owner or operator authorized by a general permit requests to be excluded from the coverage of the general permit by applying for a permit (*see* 40 CFR 122.28(b)(2)(iii) for EPA issued general permits); and where the Director requires an owner or operator authorized by a general permit to apply for an individual permit (*see* 40 CFR 122.28(b)(2)(ii) for EPA issued general permits).

b. *Group applications.* Today's rule also promulgates requirements for group applications for storm water discharges associated with industrial activity. These applications provide participants of groups with sufficiently similar storm water discharges an alternative mechanism for applying for permit coverage.

The group application requirements are primarily intended to provide information for developing industry specific general permits. (Group applications can also be used to issue individual permits in authorized NPDES States without general permit authority or where otherwise appropriate). As such, group application requirements correlate well with the Tier III permitting activities identified in the long-term permitting Strategy.

c. *Case-by-case requirements.* 40 CFR 122.21(a) excludes persons covered by general permits from requirements to submit individual permit applications. Further, the general permit regulations at 40 CFR 122.28 do not address the issue of how a potential permittee is to apply to be covered under a general permit. Rather, conditions for notification of intent (NOI) to be covered by the general permit are established in the permits on a case-by-case basis, and operate in lieu of permit application requirements. Requirements for submitting NOIs to be covered by a general permit can range from full applications (this would be Form 1 and Form 2F for most discharges composed entirely of storm water discharges associated with industrial activity), to no notice. EPA recommends that the NOI requirements established in a general permit for storm water discharges associated with industrial activity be commensurate with the needs of the permit writer in establishing the permit and the permit program. The baseline general permit described in Tier I is intended to support the development of controls for storm water discharges associated with industrial activity that can be supported by the limited resources of the permitting Agency. In this regard, the burdens of receiving and reviewing NOI's from the large number of facilities covered by the permit should also be considered when developing NOI requirements. In addition, NOI requirements should be developed in conjunction with permit conditions establishing reporting requirements during the term of the permit.

NOI requirements in general permits can establish a mechanism which can be used to establish a clear accounting of the number of permittees covered by the general permit, the nature of operations at the facility generating the discharge, their identity and location. The NOI can be used as an initial screening tool to determine discharges where individual permits are appropriate. Also, the NOI can be used to identify classes of discharges appropriate for more specific general permits, as well as provide information needed to notify such dischargers of the issuance of a more specific general permit. In addition, the NOI can provide for the identification of the permittee to provide a basis for enforcement and compliance monitoring strategies. EPA will further address this issue in the context of specific general permits it plans to issue in the near future.

Today's rule requires that individual permit applications for storm water discharges associated with industrial activity be submitted within one year from the date of publication of this notice. EPA is considering issuing general permits for the majority of storm water discharges associated with industrial activity in those States and territories that do not have authorized State NPDES programs (MA, ME, NH, FL, LA, TX, OK, NM, SD, AZ, AK, ID, District of Columbia, the Commonwealth of Puerto Rico, Guam, American Samoa, the Commonwealth of the Northern Mariana Islands, and the Trust Territory of the Pacific Islands) before that date to enable industrial dischargers of storm water to ascertain whether they are eligible for coverage under a general permit (and subject to any alternative notification requirements established by the general permit in lieu of the individual permit application requirements of today's rule) or whether they must submit an individual permit application (or participate in a group application) before the regulatory deadlines for submitting these applications passes. Storm water application deadlines are discussed in further detail below.

E. Storm Water Discharge Sampling

Storm water discharges are intermittent by their nature, and pollutant concentrations in storm water discharges will be highly variable. Not only will variability arise between given events, but the flow and pollutant

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concentrations of such discharges will vary with time during an event. This variability raises two technical problems: how best to characterize the discharge associated with a single storm event; and how best to characterize the variability between discharges of different events that may be caused by seasonal changes and changes in material management practices, for example.

Prior to today's rulemaking, 40 CFR 122.21(g)(7) required that applicants for NPDES permits submit quantitative data based on one grab sample taken every hour of the discharge for the first four hours of discharge. EPA has modified this requirement such that, instead of collecting and analyzing four grab samples individually, applicants for permits addressing storm water discharges associated with industrial activity will provide data as indicators of two sets of conditions: data collected during the first 30 minutes of discharge and flow-weighted average storm event concentrations. Large and medium municipalities will provide data on flow-weighted average storm event concentrations only.

Data describing pollutants in a grab sample taken during the first few minutes of the discharge can often be used as a screen for non-storm water discharges to separate storm sewers because such pollutants may be flushed out of the system during the initial portion of the discharge. In addition, data from the first few minutes of a discharge are useful because much of the traditional structural technology used to control storm water discharges, including detention and retention devices, may only provide controls for the first portion of the discharge, with relatively little or no control for the remainder of the discharge. Data from the first portion of the discharge will give an indication of the potential usefulness of these techniques to reduce pollutants in storm water discharges. Also, such discharges may be primarily responsible for pollutant shocks to the ecosystem in receiving waters.

Studies such as NURP have shown that flow-weighted average concentrations of storm water discharges are useful for estimating pollutant loads and for evaluating certain concentration-based water quality impacts. The use of flow-weighted composite samples are also consistent with comments raised by various industry representatives during previous Agency rulemakings that continuous monitoring of discharges from storm events is necessary to adequately characterize such discharges.

EPA requested comment on the feasibility of the proposed modification of sampling procedures at § 122.21(g)(7) and the ability to characterize pollutants in storm water discharges with an average concentration from the first portion of the discharge compared to collecting and separately analyzing four grab samples. It was proposed that an event composite sample be collected, as well as a grab sample collected during the first 20 minutes of runoff. Comments were solicited as to whether or not this sampling method would provide better definition of the storm load for runoff characterization than would the requirement to collect and separately analyze four grab samples.

Many commenters questioned the ability to obtain a 20 minute sample in the absence of automatic samplers. Some believed that pollutants measured by such a sample can be accounted for in the event composite sample. Others argued that this is an unwarranted sampling effort if municipal storm water management plans are to be geared to achieving annual pollutant load reductions. Many commenters advised that problems accessing sampling stations and mobilizing sampling crews, particularly after working hours, made sampling during the first 20 minutes impractical. These comments were made particularly with respect to municipalities, where the geographical areas could encompass several hundred square miles. Several alternatives were suggested including: the collection of a sample in the first hour, and representative grab sampling in the next three hours, one per hour; or perform time proportioned sampling for up to four hours.

Because of the logistical problems associated with collecting samples during the first few minutes of discharge from municipal systems, EPA will only require such sampling from industrial facilities. Municipal systems will be spread out over many square miles with sampling locations potentially several miles from public works departments or other responsible government agencies. Reaching such locations in order to obtain samples during the first few minutes of a storm event may prove impossible. For essentially the same reasons, the requirement has been modified to encompass the first 30 minutes of the discharge, instead of 20 minutes, for industrial discharges. The rule also clarifies that the sample should be taken during the first 30 minutes or as soon thereafter as practicable. Where appropriate, characterization of this portion of the discharge from selected outfalls or sampling points may be a condition to permits issued to municipalities. With regard to protocols for the collection of sample aliquots for flow-weighted composite samples, § 122.21(g)(7) provides that municipal applicants may collect flow-weighted composite samples using different protocols with respect to the time duration between the collection of sample aliquots, subject to the approval of the Director or Regional Administrator. In other words, the period may be extended from 15 minutes to 20 or 25 minutes between sample aliquots, or decreased from 15 to 10 or 5 minutes.

Other comments raised issues that apply both to the impact of runoff characterization and the first discharge representation. These primarily pertained to regions that have well defined wet and dry seasons. Comments questioned whether or not it is fair to assume that the initial storm or two of a wet season, which will have very high pollutant concentrations, are actually representative of the runoff concentrations for the area.

In response, EPA believes that it is important to represent the first part of the discharge either separately or as a part of the event composite samples. This loading is made up primarily of the mass of unattached fine particulates and readily soluble surface load that accumulates between storms. This load washes off of the basin's directly connected paved surfaces when the runoff velocities reach the level required for entrainment of the particulate load into the surface flow. It should be noted that for very fine particulates and solubles, this can occur very soon after the storm begins and much sooner than the peak flow. The first few minutes of discharge represents a shock load to the receiving water, in terms of concentration of pollutants, because for many constituents the highest concentrations of the event will occur during this initial period. Due to the need to properly quantify this load, it is not necessary to represent the first discharge from the upper reaches of the outfall's tributary area. In runoff characterization basins, the assumption is that the land use in the basin is homogeneous, or nearly so, and that the first discharge from the lower reaches for all intents and purposes is representative of the entire basin. If a sample is taken during the first 30 minutes of the runoff, it will be composed primarily of first discharge. If the sample is taken at the outfall an hour into the event, it may contain

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discharge from the remote portions of the basin. It will not be representative of the discharge because it will also contain later washoff from the lower reaches of the basin, resulting in a low estimation of the first discharge load of most constituents. Conversely, larger suspended particulates that normally are not present in first discharge due to inadequate velocities will appear in this later sampling scenario because of the influence of higher runoff rates in the lower basin. Many commonly used management practices are designed based on their ability to treat a volume of water defined by the first discharge phenomenon. It is important to characterize the first discharge load because most management practices effectively treat only, or primarily, this load.

It should be noted that first discharge runoff is sometimes contaminated by non-storm water related pollutants. In many urban catchments, contaminants that result from illicit connections and illegal dumping may be stored in the system until "flushed" during the initial storm period. This does not negate the need for information on the characteristic first discharge load, but does indicate that the first phase field screen results for illicit connections should be used to help define those outfalls where this problem might exist.

Several methods can be used to develop an event average concentration. Either automatic or manual sampling techniques can be used that sample the entire hydrograph, or at least the first four hours of it, that will result in several discrete samples and associated flow rates that represent the various flow regimes of an event. These procedures have the potential for providing either an event average concentration, an event mean concentration, or discrete definition of the washoff process. Automatic sampling procedures are also available that collect a single composite sample, either on a time-proportioned or flow proportioned basis.

When discrete samples are collected, an event average composite sample can be produced by the manual composite of the discrete samples in equal volumes. Laboratory analysis of time proportioned composite samples will directly yield the event average concentration. Mathematical averaging of discrete sample analysis results will yield an event average concentration.

When discrete samples are collected, a flow-weighted composite sample can be produced based on the discharge record. This is done by manually flow proportioning the volumes of the individual samples. Laboratory analysis of flow weighted composite samples will directly yield an event mean concentration. Mathematical integration of the change in concentrations and mass flux of the discharge for discrete sample data can produce an event mean concentration. This procedure was used during the NURP program.

EPA wishes to emphasize that the reason for sampling the type of storm event identified in § 122.21(g)(7) is to provide information that represents local conditions that will be used to create sound storm water management plans. Based on the method to be used to generate system-wide estimates of pollutant loads, either method, discrete or event average concentrations, may be preferable to the other. If simulation models will be used to generate loading estimates, analysis of discrete samples will be more valuable so that calibration of water quality and hydrology may be performed. On the other hand, simple estimation methods based on event average or event mean concentrations may not justify the additional cost of discrete sample analysis.

EPA believes that the first discharge loading should be represented in the permit application from industrial facilities and, if appropriate, permitting authorities may require the same in the discharge characterization component of permits issued to municipalities. The first discharge load should also be represented as part of an event composite sample. This requirement will assist industries in the development of effective storm water management plans.

EPA requested comments on the appropriateness of the proposed rules and of proposed amendments to the rules regarding discharge sampling. Comments were received which addressed the appropriateness of imposing uniform national guidelines. Several commenters are concerned that uniform national guidelines may not be appropriate due to the geographic variations in meteorology, topography, and pollutant sources. While some assert that a uniform guideline will provide consistency of the sample results, others prefer a program based on regional or State guidelines that more specifically address their situation.

Several commenters, addressing industrial permit application requirements, preferred that the owner/operator be allowed to set an individual sampling protocol with approval of the permit writer. Some commenters were concerned that one event may not be sufficient to characterize runoff from a basin as this may result in gross over-estimation or underestimation of the pollutant loads. Others indicated confusion with regard to sampling procedures, lab analysis procedures, and the purpose of the program.

In response, today's regulations establish certain minimum requirements. Municipalities and industries may vary from these requirements to the extent that their implementation is at least as stringent as outlined in today's rule. EPA views today's rule as a means to provide assurance as to the quality of the data collected; and to this end, it is important that the minimum level of sampling required be well defined.

In response to EPA's proposal that the first discharge be included in "representative" storm sampling, several commenters made their concerns known about the possible equipment necessary to meet this requirement. Several commenters are concerned that in order to get a first discharge sample, automatic sampling equipment will be required. Concerns related to the need for this equipment surfaced in the comments frequently; most advised that the equipment is expensive and that the demand on sampling equipment will be too large for suppliers and manufacturers to meet. Although equipment can be leased, some commenters maintained that not enough rental equipment is available to make this a viable option in many instances.

EPA is not promoting or requiring the use of automated equipment to satisfy the sampling requirements. A community may find that in the long run it would be more convenient to have such equipment since sampling is required not only during preparation of the application, but also may be required during the term of the permit to assure that the program goals are being met. Discharge measurement is necessary in order for the sample data to have any meaning. If unattended automatic sampling is to be performed, then unattended flow measurement will be required too.

EPA realizes that equipment availability is a legitimate concern. However, there is no practical recommendation that can be made relative to the availability of equipment. If automatic sampling equipment is not available, manual sampling is an appropriate alternative.

F. Storm Water Discharges Associated With Industrial Activity

1. Permit Applicability

a. *Storm water discharges associated with industrial activity to waters of the United States.* Under today's rule dischargers of storm water associated

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with industrial activity are required to apply for an NPDES permit. Permits are to be applied for in one of three ways depending on the type of facility: Through the individual permit application process; through the group application process; or through a notice of intent to be covered by general permit.

Storm water discharges associated with the industrial activities identified under § 122.26(b)(14) of today's rule may avail themselves of general permits that EPA intends to propose and promulgate in the near future. The general permit will be available to be promulgated in each non-NPDES State, following State certification, and as a model for use by NPDES States with general permit authority. It is envisioned that these general permits will provide baseline storm water management practices. For certain categories of industries, specific management practices will be prescribed in addition to the baseline management practices. As information on specific types of industrial activities is developed, other, more industry-specific general permits will be developed.

Today's rule requires facilities with existing NPDES permits for storm water discharges to apply for individual permits under the individual permit application requirements found at 122.26(c) 180 days before their current permit expires. Facilities not eligible for coverage under a general permit are required to file an individual or group permit application in accordance with today's rule. The general permits to be proposed and promulgated will indicate what facilities are eligible for coverage by the general permit.

b. *Storm water discharges through municipal storm sewers.* As discussed above, many operators of storm water discharges associated with industrial activity are not required to apply for an individual permit or participate in a group application under § 122.26(c) of today's rule if covered by a general permit. Under the December 7, 1988, proposal, dischargers through large and medium municipal separate storm sewer systems were not required, as a general rule, to apply for an individual permit or as a group applicant. Today's rule is a departure from that proposal. Today's rule requires all dischargers through municipal separate storm sewer systems to apply for an individual permit, apply as part of a group application, or seek coverage under a promulgated general permit for storm water discharges associated with industrial activity.

Municipal operators of large and medium municipal separate storm sewer systems are responsible for obtaining system-wide or area permits for their system's discharges. These permits are expected to require that controls be placed on storm water discharges associated with industrial activity which discharge through the municipal system. It is anticipated that general or individual permits covering industrial storm water dischargers to these municipal separate storm sewer systems will require industries to comply with the terms of the permit issued to the municipality, as well other terms specific to the permittee.

c. *Storm water discharges through non-municipal storm sewers.* Under today's rulemaking all operators of storm water discharges associated with industrial activity that discharge into a privately or Federally owned storm water conveyance (a storm water conveyance that is not a municipal separate storm sewer) will be required to be covered by an NPDES permit (*e.g.* an individual permit, general permit, or as a co-permittee to a permit issued to the operator of the portion of the system that directly discharges to waters of the United States). This is a departure from the "either/or" approach that EPA requested comments on in the December 7, 1988, notice. The "either/or" approach would have allowed either the system discharges to be covered by a permit issued to the owner/operator of the system segment that discharged to waters of the United States, or by an individual permit issued to each contributor to the non-municipal conveyance.

EPA requested comments on the advantages and disadvantages of retaining the "either/or" approach for non-municipal storm sewers. An abundance of comment was received by EPA on this particular part of the program. A number of industrial commenters and a smaller number of municipalities favored retaining the "either/or" approach as proposed, while most municipal entities, one industry, and one trade association favored requiring permits for each discharger.

Two commenters stated that private owners of conveyances may not have the legal authority to implement controls on discharges through their system and would not want to be held responsible for such controls. EPA agrees that this is a potential problem. Therefore, today's rule will require permit coverage for each storm water discharge associated with industrial activity.

One commenter supported the concept of requiring all the facilities that discharge to a non-municipal conveyance to be co-permittees. EPA agrees that this type of permitting scheme, along with other permit schemes such as area or general permits, is appropriate for discharges from non-municipal sewers, as long as each storm water discharge through the system is associated with industrial activity and thus currently subject to NPDES permit coverage.

One State agency commented that in the interest of uniformity, all industries that discharge to non-municipal conveyances should be required to conform to the application requirements. One industry stated that the rules must provide a way for the last discharger before the waters of the U.S. to require permits for facilities discharging into the upper portions of the system. EPA agrees with these comments. Today's rule provides that each discharger may be covered under individual permits, as co-permittees to a single permit, or by general permit rather than holding the last discharger to the waters of the United States solely responsible.

In response to one commenter, the term "non-municipal" has been clarified to explain that the term refers to non-publicly owned or Federally-owned storm sewer systems.

Some commenters supporting the approach as proposed, noted that industrial storm water dischargers into such systems can take advantage of the group application process. EPA agrees that in appropriate circumstances, such as when industrial facilities discharging storm water to the same system are sufficiently similar, group applications can be used for discharges to non-municipal conveyances. However, EPA believes that it would be inappropriate to approve group applications for those facilities whose only similarity is that they discharge storm water into the same private conveyance system. The efficacy of the group application procedures is predicated on the similarity of operations and other factors. The fact that several industries discharge storm water to the same non-municipal sewer system alone may not make these discharges sufficiently similar for group application approval.

One commenter suggested that EPA has not established any deadlines for submission of permit applications for storm water discharges associated with industrial activity through non-municipal separate storm sewer systems. EPA wants to clarify that industrial storm water dischargers into privately owned or Federally owned storm water conveyances are required to apply for permits in the same time frame as individual or group applicants (or as otherwise provided for in a general permit).

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One commenter stated that the operator of the conveyance that accepts discharges into its system has control and police power over those that discharge into the system by virtue of the ability to restrict discharges into the system. This commenter stated that these facilities should be the entity required to obtain the permit in all cases. Assuming that this statement is true in all respects, the larger problem is that one's theoretical ability to restrict discharges is not necessarily tied to the reality of enforcing those restrictions or even detecting problem discharges when they exist. In a similar vein one commenter urged that a private operator will not be in any worse a position than a municipal entity to determine who is the source of pollution up-stream. EPA agrees that from a hydrological standpoint this may be true. However, from the standpoint of detection resources, police powers, enforcement remedies, and other facets of municipal power that may be brought to bear upon problem dischargers, private systems are in a far more precarious position with respect to controlling discharges from other private sources.

In light of the comments received, EPA has decided that the either/or approach as proposed is inappropriate. Operators of non-municipal systems will generally be in a poorer position to gain knowledge of pollutants in storm water discharges and to impose controls on storm water discharges from other facilities than will municipal system operators. In addition, best management practices and other site-specific controls are often most appropriate for reducing pollutants in storm water discharges associated with industrial activity and can often only be effectively addressed in a regulatory scheme that holds each industrial facility operator directly responsible. The either/or approach as proposed is not conducive to establishing these types of practices unless each discharger is discharging under a permit. Also, some non-municipal operators of storm water conveyances, which receive storm water runoff from industrial facilities, may not be generating storm water discharges associated with industrial activity themselves and, therefore, they would otherwise not need to obtain a permit prior to October 1, 1992, unless specifically designated under section 402(p)(2)(E). Accordingly, EPA disagrees with comments that dischargers to non-municipal conveyances should have the flexibility to be covered by their permit or covered by the permit issued to the operator of the outfall to waters to the United States.

2. Scope of "Associated with Industrial Activity"

The September 26, 1984, final regulation divided those discharges that met the regulatory definition of storm water point source into two groups. The term Group I storm water discharges was defined in an attempt to identify those storm water discharges which had a higher potential to contribute significantly to environmental impacts. Group I included those discharges that contained storm water drained from an industrial plant or plant associated areas. Other storm water discharges (such as those from parking lots and administrative buildings) located on lands used for industrial activity were classified as Group II discharges. The regulations defined the term "plant associated areas" by listing several examples of areas that would be associated with industrial activities. However, the resulting definition led to confusion among the regulated community regarding the distinctions between the Group I and Group II classifications.

In amending the CWA in 1987, Congress did not explicitly adopt EPA's regulatory classification of Group I and Group II discharges. Rather, Congress required EPA to address "storm water discharges associated with industrial activity" in the first round of storm water permitting. In light of the adoption of the term "associated with industrial activity" in the CWA, and the ongoing confusion surrounding the previous regulatory definition, EPA has eliminated the regulatory terms "Group I storm water discharge" and "Group II storm water discharge" pursuant to the December 7, 1987, Court remand and has not revived it. In addition, today's notice promulgates a definition of the term "storm water discharge associated with industrial activity" at § 122.26(b)(14) and clarified the scope of the term.

In describing the scope of the term "associated with industrial activity", several members of Congress explained in the legislative history that the term applied if a discharge was "directly related to manufacturing, processing or raw materials storage areas at an industrial plant." (Vol. 132 Cong. Rec. H10832, H10836 (daily ed. October 16, 1986); Vol. 133 Cong. Rec. H176 (daily ed. January 8, 1987)). Several commenters cited this language in arguing for a more expansive or less expansive definition of "associated with industrial activity." EPA believes that the legislative history supports the decision to exclude from the definition of industrial activity, at § 122.26(b)(14) of today's rule, those facilities that are generally classified under the Office of Management and Budget Standard Industrial Classifications (SIC) as wholesale, retail, service, or commercial activities.

Two commenters recommended that all commercial enterprises should be required to obtain a permit under this regulation. Another commenter recommended that all the facilities listed in the December 7, 1988, proposal, including those listed in paragraphs (xi) through (xvi) on page 48432 of the December 7, 1988, proposal, should be included. EPA disagrees since the intent of Congress was to establish a phased and tiered approach to storm water permits, and that only those facilities having discharges associated with industrial activity should be included initially. The studies to be conducted pursuant to section 402(p)(5) will examine sources of pollutants associated with commercial, retail, and other light business activity. If appropriate, additional regulations addressing these sources can be developed under section 402(p)(6) of the CWA. As further discussed below, EPA believes that the facilities identified in paragraphs (xi) through (xvi) are more properly characterized as commercial or retail facilities, rather than industrial facilities.

Today's rule clarifies the regulatory definition of "associated with industrial activity" by adopting the language used in the legislative history and supplementing it with a description of various types of areas that are directly related to an industrial process (e.g., industrial plant yards, immediate access roads and rail lines, drainage ponds, material handling sites, sites used for the application or disposal of process waters, sites used for the storage and maintenance of material handling equipment, and known sites that are presently or have been used in the past for residual treatment, storage or disposal). The agency has also incorporated some of the suggestions offered by the public in comments.

Three commenters suggested that the permit application should focus only on storm water with the potential to come into contact with industrial-related pollutant sources, rather than focusing on how plant areas are utilized. These commenters suggested that facilities that are wholly enclosed or have their operations entirely protected from the elements should not be subject to permit requirements under today's rule. EPA agrees that these comments have merit with regard to certain types of facilities. Today's rule defines the term "storm water discharge associated with

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industrial activity" to include storm water discharges from facilities identified in today's rule at 40 CFR 122.21(b)(14)(xi) (facilities classified as Standard Industrial Classifications 20, 21, 22, 23, 2434, 25, 265, 267, 27, 283, 285, 30, 31 (except 311), 323, 34 (except 3441), 35, 36, 37 (except 373), 38, 39, 4221-25) only if:

areas where material handling equipment or activities, raw materials, intermediate products, final products, waste materials, by-products, or industrial machinery at those facilities are exposed to storm water. Such areas include: material handling sites; refuse sites; sites used for the application or disposal of process waste waters (as defined at 40 CFR 401); sites used for the storage and maintenance of material handling equipment; sites used for residual treatment, storage or disposal; shipping and receiving areas; manufacturing buildings; material storage areas for raw materials, and intermediate and finished products; and areas where industrial activity has taken place in the past and significant materials remain and are exposed to storm water.

The critical distinction between the facilities identified at 40 CFR 122.26(b)(14)(xi) and the facilities identified at 40 CFR 122.26(b)(14)(i)-(x) is that the former are not classified as having "storm water discharges associated with industrial activity" unless certain materials or activities are exposed to storm water. Storm water discharges from the latter set of facilities are considered to be "associated with industrial activity" regardless of the actual exposure of these same materials or activities to storm water.

EPA believes this distinction is appropriate because, when considered as a class, most of the activity at the facilities in § 122.26(b)(14)(xi) is undertaken in buildings; emissions from stacks will be minimal or non-existent; the use of unhoused manufacturing and heavy industrial equipment will be minimal; outside material storage, disposal or handling generally will not be a part of the manufacturing process; and generating significant dust or particulates would be atypical. As such, these industries are more akin or comparable to businesses, such as retail, commercial, or service industries, which Congress did not contemplate regulating before October 1, 1992, and storm water discharges from these facilities are not "associated with industrial activity." Thus, these industries will be required to obtain a permit under today's rule only when the manufacturing processes undertaken at such facilities would result in storm water contact with industrial materials associated with the facility.

Industrial categories in § 122.26(b)(14)(xi) all tend to engage in production activities in the manner described in the paragraph above. Facilities under SIC 20 process foods including meats, dairy food, fruit, and flour. Facilities classified under SIC 21 make cigarettes, cigars, chewing tobacco and related products. Under SIC 22, facilities produce yarn, etc., and/or dye and finish fabrics. Facilities under SIC 23 are in the business of producing clothing by cutting and sewing purchased woven or knitted textile products. Facilities under SIC 2434 and 25 are establishments engaged in furniture making. SIC 265 and 267 address facilities that manufacture paper board products. Facilities under SIC 27 perform services such as bookbinding, plate making, and printing. Facilities under SIC 283 manufacture pharmaceuticals and facilities under 285 manufacture paints, varnishes, lacquers, enamels, and allied products. Under SIC 30 establishments manufacture products from plastics and rubber. Those facilities under SIC 31 (except 311), 323, 34 (except 3441), 35, 36, and 37 (except 373) manufacture industrial and commercial metal products, machinery, equipment, computers, electrical equipment, and transportation equipment, and glass products made of purchased glass. Facilities under SIC 38 manufacture scientific and electrical instruments and optical equipment. Those under SIC 39 manufacture a variety of items such as jewelry, silverware, musical instruments, dolls, toys, and athletic goods. SIC 4221-25 are warehousing and storage activities.

In contrast, the facilities identified by SIC 24 (except and 2434), 26 (except 265 and 267), 28 (except 283 and 285), 29, 311, 32 (except 323), 33, 3441, 373 when taken as a group, are expected to have one or many of the following activities, processes occurring on-site: storing raw materials, intermediate products, final products, by-products, waste products, or chemicals outside; smelting; refining; producing significant emissions from stacks or air exhaust systems; loading or unloading chemical or hazardous substances; the use of unhoused manufacturing and heavy industrial equipment; and generating significant dust or particulates. Accordingly, these are classes of facilities which can be viewed as generating storm water discharges associated with industrial activity requiring a permit. Establishments identified under SIC 24 (except 2434) are engaged in operating sawmills, planing mills and other mills engaged in producing lumber and wood basic materials. SIC 26 facilities are paper mills. Under SIC 28, facilities produce basic chemical products by predominantly chemical processes. SIC 29 describes facilities that are engaged in the petroleum industry. Under SIC 311, facilities are engaged in tanning, currying, and finishing hides and skins. Such processes use chemicals such as sulfuric acid and sodium dichromate, and detergents, and a variety of raw and intermediate materials. SIC 32 manufacture glass, clay, stone and concrete products form raw materials in the form quarried and mined stone, clay, and sand. SIC 33 identifies facilities that smelt, refine ferrous and nonferrous metals from ore, pig or scrap, and manufacturing related products. SIC 3441 identifies facilities manufacturing fabricated structural metal. Facilities under SIC 373 engage in ship building and repairing. The permit application requirements for storm water discharges from facilities in these categories are unchanged from the proposal.

Today's rule clarifies that the requirement to apply for a permit applies to storm water discharges from plant areas that are no longer used for industrial activities (if significant materials remain and are exposed to storm water) as well as areas that are currently being used for industrial activities. EPA would also clarify that all discharges from these areas including those that discharge through municipal separate storm sewers are addressed by this rulemaking.

One commenter questioned the use of the word "or" instead of the word "and" to describe storm water "which is located at an industrial plant 'or' directly related to manufacturing, processing, or raw material storage areas at an industrial plant." The comment expressed the concern that discharges from areas not located at an industrial plant would be subject to permitting by this language and questioned whether this was EPA's intent. EPA agrees that this is a potential source of confusion and has modified this language to reflect the conjunctive instead of the alternative. This change has been made to provide consistency in the rule whereby some areas at industrial plants, such as administrative parking lots which do not have storm water discharges commingled with discharges from manufacturing areas, are not included under this rulemaking.

Two commenters wanted clarification of the term "or process water," in the definition of discharge associated with industrial activity at § 122.26(b)(14). This rulemaking replaces this term with the term "process waste water" which is defined at 40 CFR part 401.

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One commenter took issue with the decision to include drainage ponds, refuse sites, sites for residual treatment, storage, or disposal, as areas associated with industrial activity, because it was the commenter's view that such areas are unconnected with industrial activity. EPA disagrees with this comment. If refuse and other sites are used in conjunction with manufacturing or the by-products of manufacturing they are clearly associated with industrial activity. As noted above, Congress intended to include discharges directly related to manufacturing and processing at industrial plants. EPA is convinced that wastes, refuse, and residuals are the direct result or consequence of manufacturing and processing and, when located or stored at the plant that produces them, are directly related to manufacturing and processing at that plant. Storm water drainage from such areas, especially those areas exposed to the elements (*e.g.* rainfall) has a high potential for containing pollutants from materials that were used in the manufacturing process at that facility. One commenter supported the inclusion of these areas since many toxins degrade very slowly and the mere passage of time will not eliminate their effects. EPA agrees and finalizes this part of the definition as proposed. One commenter requested clarification of the term "residual" as used in this context. Residual can generally be defined to include material that is remaining subsequent to completion of an industrial process. One commenter noted that the current owner of a facility may not know what areas or sites at a facility were used in this manner in the past. EPA has clarified the definition of discharge associated with industrial activity to include areas where industrial activity has taken place in the past and significant materials remain and are exposed to storm water. The Agency believes that the current owner will be in a position to establish these facts.

One commenter suggested including material shipping and receiving areas, waste storage and processing areas, manufacturing buildings, storage areas for raw materials, supplies, intermediates, and finished products, and material handling facilities as additional areas "associated with industrial activity." EPA agrees that this would add clarification to the definition, and has incorporated these areas into the definition at § 122.26(b)(14).

One commenter stated that the language "point source located at an industrial plant" would include outfalls located at the facility that are not owned or operated by the facility, but which are municipal storm sewers on easements granted to a municipality for the conveyance of storm water. EPA agrees that if the industry does not operate the point source then that facility is not required to obtain a permit for that discharge. A point source is a conveyance that discharges pollutants into the waters of the United States. If a facility does not operate that point source, then it would be the responsibility of the municipality to cover it under a permit issued to them. However, if contaminated storm water associated with industrial activity were introduced into that conveyance by that facility, the facility would be subject to permit application requirements as is all industrial storm water discharged through municipal sewers.

EPA disagrees with several comments that road drainage or railroad drainage within a facility should not be covered by the definition. Access roads and rail lines (even those not used for loading and unloading) are areas that are likely to accumulate extraneous material from raw materials, intermediate products and finished products that are used or transported within, or to and from, the facility. These areas will also be repositories for pollutants such as oil and grease from machinery or vehicles using these areas. As such they are related to the industrial activity at facilities. However, the language describing these areas of industrial activity has been clarified to include those access roads and rail lines that are "used or traveled by carriers of raw materials, manufactured products, waste material, or by-products used or created by the facility." For the same reasons haul roads (roads dedicated to transportation of industrial products at facilities) and similar extensions are required to be addressed in permit applications. Two industries stated that haul roads and similar extensions should be covered by permits by rule. EPA is not considering the use of a permit by rule mechanism under this regulation, however this issue will be addressed in the section 402(p)(5) reports to Congress and in general permits to be proposed and promulgated in the near future. EPA would note however that facilities with similar operations and storm water concerns that desire to limit administrative burdens associated with permit applications and obtaining permits may want to avail themselves of the group application and/or general permits.

In response to comments, EPA would also like to clarify that it intends the language "immediate access roads" (including haul roads) to refer to roads which are exclusively or primarily dedicated for use by the industrial facility. EPA does not expect facilities to submit permit applications for discharges from public access roads such as state, county, or federal roads such as highways or BLM roads which happen to be used by the facility. Also, some access roads are used to transport bulk samples of raw materials or products (such as prospecting samples from potential mines) in small-scale prior to industrial production. EPA does not intend to require permit applications for access roads to operations which are not yet industrial activities.

EPA does agree with comments made by several industries that undeveloped areas, or areas that do not encompass those described above, should generally not be addressed in the permit application, or a storm water permit, as long as the storm water discharge from these areas is segregated from the storm water discharge associated with the industrial activity at the facility.

Numerous commenters stated that maintenance facilities, if covered, should not be included in the definition. EPA disagrees with this comment. Maintenance facilities will invariably have points of access and egress, and frequently will have outside areas where parts are stored or disposed of. Such areas are locations where oil, grease, solvents and other materials associated with maintenance activities will accumulate. In response to one commenter, such areas are only regulated in the context of those facilities enumerated in the definition at § 122.26(b)(14), and not similar areas of retail or commercial facilities.

Another commenter requested that "storage areas" be more clearly defined. EPA disagrees that this term needs further clarification in the context of this section of the rule. However, in response to one comment, tank farms at industrial facilities are included. Tank farms are in existence to store products and materials created or used by the facility. Accordingly they are directly related to manufacturing processes.

Regarding storage areas, one commenter stated that the regulations should emphasize that only facilities that are not totally enclosed are required to submit permit applications. EPA does not agree with this interpretation since use of the generic term storage area indicates no exceptions for certain physical characteristics. Thus discharges from enclosed storage areas are also covere by today's rule (except as discussed above). EPA also disagrees with one

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comment asserting that small outside storage areas of finished products at industrial facilities should be excluded under the definition of associated with industrial activity. EPA believes that such areas are areas associated with industrial activity which Congress intended to be regulated under the CWA. As noted above, the legislative history refers to storage areas, without reference to whether they are covered or uncovered, or of a certain size.

The same language, in the legislative history cited above, was careful to state that the term "associated with industrial activity" does not include storm water "discharges associated with parking lots and administrative and employee buildings." To accommodate legislative intent, segregated storm water discharges from these areas will not be required to obtain a permit prior to October 1, 1992. Many commenters stated that this was an appropriate method in which to limit the scope of "associated with industrial activity." However, if a storm water discharge from a parking lot at an industrial facility is mixed with a storm water discharge "associated with industrial activity," the combined discharge is subject to permit application requirements for storm water discharges associated with industrial activity. EPA disagrees with some commenters who urged that office buildings and administrative parking lots should be covered if they are located at the plant site. EPA agrees with one commenter that inclusion of storm water discharge from these areas would be overstepping Congressional intent unless such are commingled with storm water discharges from the plant site. Several commenters requested that language be incorporated into the rule which establishes that storm water discharges from parking lots and administrative areas not be included in the definition of associated with industrial activity. EPA agrees and has retained language used in the proposal which addresses this distinction.

Storm water discharges from parking lots and administrative buildings along with other discharges from industrial lands that do not meet the regulatory definition of "associated with industrial activity" and that are segregated from such discharges may be required to obtain an NPDES permit prior to October 1, 1992, under certain conditions. For example, large parking facilities, due to their impervious nature may generate large amounts of runoff which may contain significant amounts of oil and grease and heavy metals which may have adverse impacts on receiving waters. The Administrator or NPDES State has the authority under section 402(p)(2)(E) of the amended CWA to require a permit prior to October 1, 1992, by designating storm water discharges such as those from parking lots that are significant contributors of pollutants or contribute to a water quality standard violation. EPA will address storm water discharges from lands used for industrial activity which do not meet the regulatory definition of "associated with industrial activity" in the section 402(p)(5) study to determine the appropriate manner to regulate such discharges.

Several commenters requested clarification that the definition does not include sheet flow or discharged storm water from upstream adjacent facilities that enters the land or comingles with discharge from a facility submitting a permit application. EPA wishes to clarify that operators of facilities are generally responsible for its discharge in its entirety regardless of the initial source of discharge. However, where an upstream source can be identified and permitted, the liability of a downstream facility for other storm water entering that facility may be minimized. Facilities in such circumstances may be required to develop management practices or other run-on/run-off controls, which segregates or otherwise prevents outside runoff from comingling with its storm water discharge. Some commenters expressed concern about other pollutants which may arrive on a facility's premises from rainfall. This comment was made in reference to runoff with a high or low pH. If an applicant has reason to believe that pollutants in its storm water discharge are from such sources, then that needs to be addressed in the permit application and brought to the attention of the permitting authority, which can draft appropriate permit conditions to reflect these circumstances.

EPA requested comments on clarifying the types of facilities that involve industrial activities and generate storm water. EPA preferred basing the clarification, in part, on the use of Standard Industrial Classification (SIC) codes, which have been suggested in comments to prior storm water rulemakings because they are commonly used and accepted and would provide definitions of facilities involved in industrial activity. Several commenters supported the use by EPA of Standard Industrial Classifications for the same reasons identified by EPA as a generally used and understood form of classification. It was also noted that using such a classification would allow targeting for special notification and educational mailings. Three municipalities and three State authorities commented that SICs were appropriate and endorsed their use as a sound basis for determining which industries are covered.

One municipality questioned how SIC classifications will be assigned to particular industries. SICs have descriptions of the type of industrial activity that is engaged in by facilities. Industries will need to assess for themselves whether they are covered by a listed SIC and submit an application accordingly. Another commenter questioned if Federal facilities that do not have an SIC code identification are required to file a permit application. Federal facilities will be required to submit a permit application if they are engaged in an industrial activity that is described under § 122.26(b)(14). The definition of industrial activity incorporates language that requires Federal facilities to submit permit applications in such circumstances. The language has been further clarified to include State and municipal facilities.

EPA requested comments on the scope of the definition (types of facilities addressed) as well as the clarity of regulation. EPA identified the following types of facilities in the proposed regulation as those facilities that would be required to obtain permits for storm water discharges associated with industrial activity:

(i) Facilities subject to storm water effluent limitations guidelines, new source performance standards, or toxic pollutant effluent standards under 40 CFR subchapter N (except facilities with toxic pollutant effluent standards which are also identified under category (xi) of this paragraph). One commenter (a municipality) agreed with EPA that these industries should be addressed in this rulemaking. No other comments were received on this category. EPA agrees with this comment since these facilities are those that Congress has required EPA to examine and regulate under the CWA with respect to process water discharges. The industries in these categories have generally been identified by EPA as the most significant dischargers of process wastewaters in the country. As such, these facilities are likely to have storm water discharges associated with industrial activity for which permit applications should be required.

One commenter stated that because oil and gas producers are subject to effluent guidelines, EPA is disregarding the intent of Congress to exclude

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facilities pursuant to section 402(1). EPA disagrees with this comment. EPA is not prohibited from requiring permit applications from industries with storm water discharge associated with industrial activity. EPA is prohibited only from requiring a permit for oil and gas exploration, production, processing, or treatment operations, or transmission facilities that discharge storm water that is not contaminated by contact with or has not come into contact with, any overburden, raw material, intermediate products, finished products, byproducts or waste products located on the site of such operations such discharges. In keeping with this requirement, EPA is requiring permit applications from oil and gas exploration, production, processing, or treatment operations, or transmission facilities that fall into a class of dischargers as described in § 122.26(c)(iii).

(iii) Facilities classified as Standard Industrial Classifications 24 (except 2434), 26 (except 265 and 267), 28 (except 283 and 285), 29, 311, 32 (except 323), 33, 3411, 373 and *(xi). Facilities classified as Standard Industrial Classifications 20, 21, 22, 23, 2434, 25, 265, 267, 27, 283, 285, 30, 31 (except 311), 323, 34 (except 3441), 35, 36, 37 (except 373), 38, 39, 4221–25.* One large municipality and one industry agreed with EPA that facilities covered by these SICs should be covered by this rulemaking. Many commenters, however, took exception to including all or some of these industries. However as noted elsewhere these facilities are appropriate for permit applications.

One commenter stated that within certain SICs industries, such as textile manufacturers use few chemicals and that there is little chance of pollutants in their storm water discharge. EPA agrees that some industries in this category are less likely than others to have storm water discharges that pose significant risks to receiving water quality. However, there are many other activities that are undertaken at these facilities that may result in polluted storm water. Further, the CWA is clear in its mandate to require permit applications for discharges associated with industrial activity. Excluding any of the facilities under these categories, except where the facility manufacturing plant more closely resembles a commercial or retail outlet would be contrary to Congressional intent.

One State questioned the inclusion of facilities identified in SIC codes 20–39 because of their temporary and transient nature or ownership. Agency disagrees that simply because a facility may transfer ownership that storm water quality concerns should be ignored. If constant ownership was a condition precedent to applying for and obtaining a permit, few if any facilities would be subject to this rulemaking.

One State estimated that the proposed definition would lead to permits for 18,000 facilities in its State. Consequently this commenter recommended that the facilities under SIC 20–39 should be limited to those facilities that have to report under section 313 of title III, Superfund Amendments and Reauthorization Act. However, as noted by another commenter, limiting permit requirements to these facilities would be contrary to Congressional intent. While use of chemicals at a facility may be a source of pollution in storm water discharges other every day activities at an industrial site and associated pollutants such as oil and grease, also contribute to the discharge of pollutants that are to be addressed by the CWA and these regulations. While the number of permit applications may number in the thousands, EPA intends for group applications and general permits to be employed to reduce the administrative burdens as greatly as possible.

Two commenters felt the permit applications should be limited to all entities under SIC 20–39. EPA disagrees that all the industrial activities that need to be addressed fall within these SICs. Discharges from facilities under paragraphs (i) through (xi) such as POTWs, transportation facilities, and hazardous waste facilities, are of an industrial nature and clearly were intended to be addressed before October 1, 1992.

Two commenters stated that SIC 241 should be excluded in that logging is a transitory operation which may occur on a site for only 2–3 weeks once in a 20–30 year period. It was perceived that delays in obtaining permits for such operations could create problems in harvest schedule and mill demand. This commenter stated that runoff from such operations should be controlled by BMPs in effect for such industries and that such a permit would not be practical and would be cost prohibitive.

EPA agrees with the commenter that this provision needs clarification. The existing regulations at 40 CFR 122.27 currently define the scope of the NPDES program with regard to silvicultural activities. 40 CFR 122.27(b)(1) defines the term "silvicultural point source" to mean any discrete conveyance related to rock crushing, gravel washing, log sorting, or log storage facilities which are operated in connection with silvicultural activities and from which pollutants are discharged into waters of the United States. Section 122.27(b)(1) also excludes certain sources. The definition of discharge associated with industrial activity does not include activities or facilities that are currently exempt from permitting under NPDES. EPA does not intend to change the scope of 40 CFR 122.27 in this rulemaking. Accordingly, the definition of "storm water discharge associated with industrial activity" does not include sources that may be included under SIC 24, but which are excluded under 40 CFR 122.27. Further, EPA intends to examine the scope of the NPDES silvicultural regulations at 40 CFR 122.27 as it relates to storm water discharges in the course of two studies of storm water discharges required under section 402(p)(5) of the CWA.

In response to one comment, EPA intends that the list of applicable SICs will define and identify what industrial facilities are required to apply. Facilities that warehouse finished products under the same code at a different facility from the site of manufacturing are not required to file a permit application, unless otherwise covered by this rulemaking.

(iii) Facilities classified as Standard Industrial Classifications 10 through 14 (mineral industry) including active or inactive mining operations (except for areas of coal mining operations no longer meeting the definition of a reclamation area under 40 CFR 434.11(l) because the performance bond issued to the facility by the appropriate SMCRA authority has been released, or except for areas of non-coal mining operations which have been released from applicable State or Federal reclamation requirements after December 17, 1990 and oil and gas exploration, production, processing, or treatment operations, or transmission facilities that discharge storm water contaminated by contact with or that has come into contact with, any overburden, raw material, intermediate products, finished products, byproducts or waste products located on the site of such operations. Several commenters urged that Congress intended to require permits or permit applications only for the manufacturing sector of the oil and gas industry (or those activities that designated in SIC 20 through 39). EPA disagrees with this argument. The fact that Congress used the language cited above and not the appropriate the SIC definition explicitly does not indicate that a broader definition or less exclusive definition was contemplated. According to these comments, all storm water discharges from oil and gas

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exploration and production facilities would be exempt from regulation. However, EPA is convinced that a facility that is engaged in finding and extracting crude oil and natural gas from subsurface formations, separating the oil and gas from formation water, and preparing that crude oil for transportation to a refinery for manufacturing and processing into refined products, will have discharges directly relating to the processing or raw material storage at an industrial plant and are therefore discharges associated with industrial activity.

For further clarification EPA is intending to focus only on those facilities that are in SIC 10-14. Furthermore, in response to several comments, this rulemaking will require permit applications for storm water discharges from currently inactive petroleum related facilities within SIC codes 10-14, if discharges from such facilities meet the requirements as described in section VI.F.7.a. and § 122.26(c)(1)(iii). Inactive facilities will have storm water associated with industrial activity irrespective of whether the activity is ongoing. Congress drew no distinction between active and inactive facilities in the statute or in the legislative history.

(iv) Hazardous waste treatment, storage, or disposal facilities that are operating under interim status or a permit under Subtitle C of the Resource, Conservation and Recovery Act. One commenter believed that all RCRA and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) facilities should be specifically identified using SIC codes for further clarification. EPA considers this to be unnecessarily redundant, since the RCRA/CERCLA identification is sufficient.

Several industries asserted that storm water discharge from landfills, dumps, and land application sites, properly closed or otherwise subject to corrective or remedial actions under RCRA, should not be included in the definition. One commenter noted that the runoff from these areas is like runoff from undeveloped areas. One commenter also concluded that landfills, dumps, and land application sites should also be excluded if they are properly maintained under RCRA.

One commenter also rejected the idea of requiring permits from all active and inactive landfills and open dumps that have received any industrial wastes, and subtitle C facilities. This commenter felt that these facilities were already adequately covered under RCRA.

Two industry commenters felt that it would be redundant to have hazardous waste facilities regulated by RCRA and the NPDES storm water program. One felt this was especially so if there are current pretreatment standards.

The Agency disagrees that all activities that may contribute to storm water discharges at RCRA subtitle C facilities are being fully controlled and that requiring NPDES permits for storm water discharges at RCRA subtitle C facilities is redundant. First, the vast majority of permitted hazardous waste management facilities are industrial facilities involved in the manufacture or processing of products for distribution in commerce. Their hazardous waste management activities are incidental to the production-related activities. While RCRA subtitle C regulations impose controls in storm water runoff from hazardous waste management units and require cleanup of releases of hazardous wastes, they generally do not control non-systematic spills or process. These releases, from the process itself or the storage of raw materials or finished products are a potential source of storm water contamination. In addition, RCRA subtitle C (except via corrective action authority) does not address management of "non hazardous" industrial wastes, which nevertheless could also potentially contaminate storm water runoff.

Second, at commercial hazardous waste management facilities, the RCRA subtitle C permitting requirements and management standards do not control all releases of potentially toxic materials. For example, some permitted commercial treatment facilities may store and use chemicals in the treatment of RCRA hazardous wastes. Releases of these treatment chemicals from storage areas are a potential source of storm water contamination.

Finally, many RCRA subtitle C facilities have inactive Solid Waste Management Units (SWMU's) on the facility property. These SWMU's may contain areas on the land surface that are contaminated with hazardous constituents. RCRA requires that hazardous waste management facilities must investigate these areas of potential contamination, and then perform corrective action to remediate any SWMU's that are of concern. However, the corrective action process at these facilities will not be completed for a number of years due to the complexity of the cleanup decisions, and due to the fact that many hazardous waste management facilities do not yet have RCRA permits. Until corrective action has been completed at all such subtitle C facilities, SWMU's are a potential source of storm water contamination that should be addressed under the NPDES program. Finally, under section 1004(27) of RCRA, all point source discharges, including those at RCRA regulated facilities, are to be regulated by the NPDES program. Thus, there is no concern of regulatory overlap, and to the extent that the storm water regulations are effectively implemented, it will help address these units in a way that alleviates the need for expensive corrective action in the future.

(v) Landfills, land application sites, and open dumps that receive or have received industrial wastes and that are subject to regulation under subtitle D of RCRA. EPA received numerous comments supporting the regulation of municipal landfills which receive industrial waste and are subject to regulation under subtitle D of RCRA. EPA agrees with these comments. These industries have significant potential for storm water discharges that can adversely affect receiving water.

Two States argued that landfills should be addressed under the non-point source program. EPA disagrees that the non-point source program is sufficient for addressing these facilities. Further, addressing a class of facilities under the non-point source program does not exempt storm water discharges from these facilities from regulation under NPDES. The CWA requires EPA to promulgate regulations for controlling point source discharges of storm water from industrial facilities. Point sources from landfills consisting of storm water are such discharges requiring an NPDES permit. Several commenters argued that these discharges are adequately addressed by RCRA and that regulating them under this storm water rule would be redundant. However, as discussed above, RCRA expressly does not regulate point source discharges subject to NPDES permits. Given the nature of these facilities and of the material stored or disposed, EPA believes storm water permits are necessary. Similarly EPA rejects the comment that storm water discharges from these facilities are already adequately regulated by State authority. Congress has mandated that storm water discharges associated with industrial activity have an NPDES permit.

One commenter wanted EPA to define by size what landfills are covered. In response, it is the intent of these regulations to require permit applications from all landfills that receive industrial waste. Storm water discharges from such facilities are addressed because of the nature of the material with which the storm water comes in contact. The size of facility

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will not dictate what type of waste is exposed to the elements.

One commenter requested that the definition of industrial wastes be clarified. For the purpose of this rule, industrial waste consists of materials delivered to the landfill for disposal and whose origin is any of the facilities described under § 122.26(b)(14) of this regulation.

(vi) Facilities involved in the recycling of materials, including metal scrapyards, battery reclaimers, salvage yards, and automobile junkyards, including but limited to those classified as Standard Industrial Classification 5015 and 5093. One commenter suggested that the recycling of materials such as paper, glass, plastics, etc., should not be classified as an industrial activity. EPA disagrees that such facilities should be excluded on that basis. These facilities may be considered industrial, as are facilities that manufacture such products absent recycling.

Other facilities exhibit traits that indicate industrial activity. In junkyards, the condition of materials and junked vehicles and the activities occurring on the yard frequently result in significant losses of fluids, which are sources of toxic metals, oil and grease and polychlorinated aromatic hydrocarbons. Weathering of plated and non-plated metal surfaces may result in contributions of toxic metals to storm water. Clearly such facilities cannot be classified as commercial or retail.

One municipality felt that "significant recycling" should be defined or clarified. EPA agrees that the proposed language is ambiguous. It has been clarified to require permit applications from facilities involved in the recycling of materials, including metal scrapyards, battery reclaimers, salvage yards, and automobile junkyards, including but limited to those classified as Standard Industrial Classification 5015 and 5093. These SIC codes describe facilities engaged in dismantling, breaking up, sorting, and wholesale distribution of motor vehicles and parts and a variety of other materials. The Agency believes these SIC codes clarify the term significant recycling.

One municipality stated that regulation of these facilities under NPDES would be duplicative if they are publicly owned facilities. One State expressed the view that automobile junkyards, salvage yards could not legitimately be considered industrial activity. As noted above, EPA disagrees with these comments. Facilities that are actively engaged in the storage and recycling of products including metals, oil, rubber, and synthetics are in the business of storing and recycling materials associated with or once used in industrial activity. These activities are not commercial or retail because they are engaged in the dismantling of motors for distribution in wholesale or retail, and the assembling, breaking up, sorting, and wholesale distribution of scrap and waste materials, which EPA views as industrial activity. Further, being a publicly owned facility does not confer non-industrial status.

(vii) Steam electric power generating facilities, including coal handling sites, and onsite and offsite ancillary transformer storage areas. Most of the comments were against requiring permit applications for onsite and offsite ancillary transformer facilities. One commenter stated that these transformers did not leak in storage and if there were leakage problems in handling transformers, such leaks were subject to Federal and State spill clean-up procedures. The same commenter suggested that if EPA required applications from such facilities that it exclude those that have regular inspections, management practices in place, or those that store 50 transformers at any one time.

EPA agrees that such facilities should not be covered by today's rule. As one commenter noted, the Toxic Substances Control Act (TSCA) addresses pollutants associated with transformers that may enter receiving water through storm water discharges. EPA has examined regulations under TSCA and agrees that regulation of storm water discharges from these facilities should be the subject of the studies being performed under section 402(p)(5), rather than regulations established by today's rule. Under TSCA, transformers are required to be stored in a manner that prevents rain water from reaching the stored PCBs or PCB items. 40 CFR 761.65(b)(1)(i). EPA considers transformer storage to be more akin to retail or other light commercial activities, where items are inventoried in buildings for prolonged periods for use or sale at some point in the future, and where there is no ongoing manufacturing or other industrial activity within the structure.

One commenter stated that this category of industries should be loosened so that all steam electric facilities are addressed—oil fired and nuclear. EPA believes that the language as proposed broadly defines the type of industrial activity addressed without specifying each mode of steam electric production. One commenter noted that the EPA has no authority under the CWA (*Train v. CPIR, Inc.*, 426 U.S. 1 (1976)) to regulate the discharge of source, special nuclear and by-product materials which are regulated under the Atomic Energy Act. EPA agrees permit applications may not address these aspects of such facilities, however the facility in its entirety may not necessarily be exempt. A permit application will be appropriate for discharges from non-exempt categories.

(viii) Transportation facilities classified as Standard Industrial Classifications 40, 41, 42 (except 4221-25), 43, 44, 45, and 5171 which have vehicle maintenance shops, material handling facilities, equipment cleaning operations or airport deicing operations. Only those portions of the facility that are either involved in vehicle maintenance (including vehicle rehabilitation, mechanical repairs, painting, fueling, and lubrication), equipment cleaning operations, or which are identified in another subcategory of facilities under EPA's definition of storm water discharges associated with industrial activity. One commenter requested clarification of the terms "vehicle maintenance." Vehicle maintenance refers to the rehabilitation, mechanical repairing, painting, fueling, and lubricating of instrumentalities of transportation located at the described facilities. EPA is declining to write this definition into the regulation however since "vehicle maintenance" should not cause confusion as a descriptive term. One commenter wanted railroad tracks where rail cars are set aside for minor repairs excluded from regulation. In response, if the activity involves any of the above activities then a permit application is required. Train yards where repairs are undertaken are associated with industrial activity. Train yards generally have trains which, in and of themselves, can be classified as heavy industrial equipment. Trains, concentrated in train yards, are diesel fueled, lubricated, and repaired in volumes that connote industrial activity, rather than retail or commercial activity.

One commenter argued that if gasoline stations are not considered for permitting, then all transportation facilities should be exempt. EPA disagrees with the thrust of this comment. Transportation facilities such as bus depots, train yards, taxi stations, and airports are generally larger than individual repair shops, and generally engage in heavier more expansive forms of industrial activity. In keeping with Congressional intent to cover all industrial facilities, permit applications from such facilities are appropriate. In contrast, EPA views gas stations as retail commercial facilities not covered

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by this regulation. It should be noted that SIC classifies gas stations as retail.

(ix) POTW lands used for land application treatment technology/ sludge disposal, handling or processing areas, and chemical handling and storage areas. One commenter wanted more clarification of the term POTW lands. Another commenter requested clarification of the terms sludge disposal, sludge handling areas, and sludge processing areas. One State recommended that a broader term than POTW should be used. EPA notes that on May 2, 1989, it promulgated NPDES Sewage Sludge Permit Regulations: State Sludge Management Program Requirements at 40 CFR part 501. This regulation identified those facilities that are subject to section 405(f) of the CWA as "treatment works treating domestic sewage."

In response to the above comments, EPA has decided to use this language to define what facilities are required to apply for a storm water permit. Under this rulemaking "treatment works treating domestic sewage," or any other sewage sludge or wastewater treatment device or system used in the storage treatment, recycling, and reclamation of municipal or domestic sewage, including land dedicated to the disposal of sewage sludge, with a design flow of 1.0 mgd or more, or facilities required to have an approved pretreatment program under 40 CFR part 403, will be required to apply for a storm water permit. However, permit applications will not be required to address land where sludge is beneficially reused such as farm lands and home gardens or lands used for sludge management that are not physically located within the confines (offsite facility) of the facility or where sludge is beneficially reused in compliance with section 405 of the Clean Water Act (proposed rules were published on February 6, 1989, at 54 FR 5746). EPA believes that such activity is not "industrial" since it is agricultural or domestic application (non-industrial) unconnected to the facility generating the material.

EPA received many comments on the necessity and appropriateness of requiring permit applications for storm water discharges from POTW lands. It was anticipated by numerous commenters that the above cited sludge regulations would adequately address storm water discharges from lands where sludge is applied. However, the sewage sludge regulations do not directly address NPDES permit requirements for storm water discharges from POTW lands and related areas to the extent required by today's rulemaking: the regulations cover only permits for use or disposal of sludge. Also, the regulations proposed on February 4, 1989, cover primarily the technical standards for the composition of sewage sludge which is to be used or disposed. They do not include detailed permitting requirements for discharges of storm water from lands where sludge has been applied to the land. To that extent, EPA is not persuaded by these commenters that POTWs and POTW lands should be excluded from these storm water permit application requirements.

Two commenters noted that some States already regulate sludge use or disposal activities substantially and that EPA should refrain from further regulation. EPA disagrees that this is a basis for excluding facilities from Federal requirements. Notwithstanding regulations in existence under State law, EPA is required by the CWA to promulgate regulations for permit application for storm water associated with industrial activity. Under the NPDES program, States are able to promulgate more rigorous requirements. However a minimum level of control is required under Federal law. One commenter also indicated that a State's sludge land application sites must follow a well defined plan to ensure there is no sludge related runoff. Notwithstanding that a State may require storm water controls for sludge land applications, as noted above, EPA is required to promulgate regulations requiring permit applications from appropriate facilities. EPA views facilities such as waste treatment plants that engage in on-site sludge composting, storage of chemicals such as ferric chloride, alum, polymers, and chlorine, and which may experience spills and bubbleovers are suitable candidates for storm water permits. Facilities using such materials are not characteristic of commercial or retail activities. Use and storage of chemicals and the production of material such as sludge, with attendant heavy metals and organics, is activity that is industrial in nature. The size and scope of activities at the facility will determine the extent to which such activities are undertaken and such materials used and produced at the facility. Accordingly, EPA believes limiting the facilities covered under this category to those of 1.0 mgd and those covered under the industrial pretreatment program is appropriate.

To the extent that permit applicants are already required to employ certain management practices regarding storm water, these may be incorporated into permits and permit conditions issued by Federal and State permitting authorities. EPA has selected facilities identified under 40 CFR part 501 (*i.e.* those with a design flow of 1.0 mgd or more or those required to have an approved pretreatment program) since these facilities will have largest contribution of industrial process discharges. Sludge from such facilities will contain higher concentrations of heavy metal and organic pollutants.

One commenter stated that sludge disposal is a public activity that should be addressed in a public facility's storm water management program under a municipal storm water management program. EPA disagrees. Industrial facilities, whether publicly owned or not, are required to apply for and obtain permits when they are designated as industrial activity.

Another comment stated that a permit should not be required for facilities that collect all runoff on site and treat it at the same POTW. EPA believes that a permit application should be required from such facilities. However, the above practice can be incorporated as a permit condition for such a facility. One commenter stated storm water from sludge and chemical handling areas can be routed through the headworks of the POTW. The agency agrees that this may be an appropriate management practice for POTWs as long as other NPDES regulatory requirements are fulfilled with regard to POTWs.

(x) Construction activities, including clearing, grading and excavation activities except operations that result in the disturbance of less than five acre total land area which are not part of a larger common plan of development or sale. EPA addresses whether these facilities should be covered by today's rule in section VI.F.8.

The December 7, 1988, proposal also requested comments on including the following other categories of discharges in the definition of industrial activities: (xii) Automotive repair shops classified as Standard Industrial Classification 751 or 753; (xiii) Gasoline service stations classified as Standard Industrial Code 5541; (xiv) Lands other than POTW lands (offsite facilities) used for sludge management; (xv) Lumber and building materials retail facilities classified as Standard Industrial Classification 5211; (xvi) Landfills, land application sites, and open dumps that do not receive industrial wastes and that are subject to regulation under subtitle D of RCRA; (xvii) Facilities classified as Standard Industrial Classification 46 (pipelines, except natural gas), and 492 (gas production and distribution); (xviii) Major electrical powerline corridors.

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EPA received numerous comments on whether to require permit applications for these particular facilities. The December 7, 1988, proposal reflected EPA's intent not to require permits for these facilities, but rather to address these facilities in the two studies required by CWA sections 402(p)(5) and (6). After reviewing the comments on this issue, EPA believes that these facilities should be addressed under these sections of the CWA. Most of these facilities are classified as light commercial and retail business establishments; agricultural facilities where residential or domestic waste is received, or land use activities where there is no manufacturing. It should be noted that although EPA is not requiring the facilities identified as categories (xii) to (xviii), in the December 7, 1988, proposal to apply for a permit application under this rulemaking, such facilities may be designated under section 402(p)(2)(E) of the CWA.

Three commenters recommended that EPA clarify that non-exempt Department of Energy and Department of Defense facilities should be covered by the storm water regulation. The regulation clearly states that Federal Facilities that are engaged in industrial activity (i.e. those activities in § 122.26(b)(14)(i)–(xi)) are required to submit permit applications. Those applying for permits covering Federal facilities should consult the Standard Industrial Classifications for further clarification.

One commenter questioned how EPA intended to regulate municipal facilities engaged in industrial activities. Municipal facilities that are engaged in the type of industrial activity described above and which discharge into waters of the United States or municipal separate storm sewer systems are required to apply for permits. These facilities will be covered in the same manner as other industrial facilities. The fact that they are municipally owned does not in any way exclude them from needing permit applications under this rulemaking.

One commenter suggested exempting those facilities that have total annual sales less than five million dollars or occupy less than five acres of land. Another commenter thought that all minor permittees should be exempt. EPA believes that the quality of storm water and the extent to which discharges impact receiving water is not necessarily related to the size of the facility or the dollar value of its business. What is important in this regard, is the extent to which steps are taken at facilities to curb the quantity and type of material that may pollute storm water discharges from these facilities. Therefore EPA has not excluded facilities from permitting on such a basis. This same commenter stated that the proposed rules should not address facilities with multiple functions (industrial and retail). EPA disagrees. If a facility engages in activity that is defined in paragraphs (i) through (xi) above, it is required to apply for a permit regardless of the fact that it also has a retail element. Such facilities need only submit a permit application for the industrial portion of the facility (as long as storm water from the non-industrial portion is segregated, as discussed above). This commenter also felt that more studies needed to be undertaken to determine the best way to regulate industries. EPA agrees that storm water problems need further study and for that reason EPA has devoted substantial manpower and resources to complete comprehensive studies under section 402(p)(5), while also addressing industrial sources that need immediate attention under this rulemaking.

One commenter requested that EPA give examples of storm water discharges from each of the facilities that have been designated for submitting permit applications. Agency believes that this is unnecessary and impractical since every facility, regardless of the type of industry, will have different terrain, hydrology, weather patterns, management practices and control techniques. However, EPA intends to issue guidance on filing permit applications for storm water discharges from industrial facilities which details how an industry goes about filing an industrial permit and dealing with storm water discharges.

Today's rulemaking for storm water discharges associated with industrial activity at § 122.26(c)(1)(i) includes special conditions for storm water discharges originating from mining operations, oil or gas operations (§ 122.26(c)(1)(iii)), and from the construction operations listed above (§ 122.26(c)(1)(ii)). These requirements are discussed in more detail in section VI.F.7 and section VI.F.9 of today's notice.

3. Individual Application Requirements

Today's rule establishes individual and group permit application requirements for storm water discharges associated with industrial activity. These requirements will address facilities precluded from coverage under the general permits to be proposed and promulgated by EPA in the near future. EPA considers it necessary to obtain the information required in individual permit applications from certain facilities because of the nature of their industrial activity and because of existing institutional mechanisms for issuing and tracking NPDES permits. Furthermore, some States will not have general permitting authority. Facilities located in such States will be required to submit individual applications or participate in a group application. The following response to comments received on these requirements pertains to these facilities.

Under the September 26, 1984, regulation operators of Group I storm water discharges were required to submit NPDES Form 1 and Form 2C permit applications. In response to post-regulation comments received on that rule, EPA proposed new permit application requirements (March 7, 1985, (50 FR 9362) and August 12, 1985, (50 FR 32548)) which would have decreased the analytical sampling requirements of the Form 2C and provided procedures for group applications. Passage of the WQA in 1987 gave the EPA additional time to consider the appropriate permit application requirements for storm water discharges. On December 7, 1988, application requirements were proposed and numerous comments were received. Based upon these comments, modifications and refinements have been made to the industrial storm water permit application.

Some commenters expressed the view that the permit application requirements are too burdensome, require too much paperwork, are of dubious utility, and focus too greatly on the collection of quantitative data. EPA disagrees. In comparison to prior approaches for permitting storm water discharges and other existing permitting programs, EPA has streamlined the permit application process, limited the quantitative data requirements, and required narrative information that will be used to determine permit conditions that relate to the quality of storm water discharge. To the extent that EPA needs non-quantitative information to develop appropriate permit conditions, EPA disagrees with the view of some commenters that the information required is excessive. In response to comments on earlier rulemakings and a comment received on the December 7, 1988, proposal (stressing that the emphasis should be on site management, rather than monitoring, sampling, and reporting) EPA has shifted the emphasis of the permit application requirements for storm water discharges associated with industrial activity from the existing requirements for collection o'

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quantitative data (sampling data) in Form 2C towards collection of less quantitative data supplemented by additional information needed for evaluation of the nature of the storm water discharges.

The permit application requirements proposed for storm water discharges reduce the amount of quantitative data required in the permit application and exempt discharges which contain entirely storm water (*i.e.* contain no other discharge that, without the storm water component, would require an NPDES permit), from certain reporting requirements of Form 2C. The proposed modifications also would exempt applicants for discharges which contain entirely storm water from several non-quantitative information collection provisions currently required in the Form 2C. The proposed modifications would rely more on descriptive information for assessing impacts of the storm water discharge. One commenter proposed that information that the applicant has submitted for other permits be incorporated by reference into the storm water permit application. EPA disagrees that incorporation by reference is appropriate. The permitting authority will need to have this information readily available for evaluating permit application and permit conditions. Furthermore, EPA feels that the applicant is in the best position to provide the information and verify its accuracy. However, if the applicant has such information and it accurately reflects current circumstances, then the applicant can rely on the information for meeting the information requirements of the application. Another commenter suggested that EPA should only require the information in § 122.26(c)(1) (A) and (B) (*i.e.*, the requirement for a topographic map indicating drainage areas and estimate of impervious areas and material management practices). As explained in greater detail below, EPA is convinced that some quantitative data and the other narrative requirements are necessary for developing appropriate permit conditions.

Form 2F addressing permit applications for storm water discharges associated with industrial activity is included in today's final rule. A complete permit application for discharges composed entirely of storm water, will be comprised of Form 2F and Form 1. Operators of discharges which are composed of both storm water and non-storm water will submit where required, a Form 1, an entire Form 2C (or Form 2D) and Form 2F when applying. In this case, the applicant will provide quantitative data describing the discharge during a storm event in Form 2F and quantitative data describing the discharge during non-storm events in Form 2C. Non-quantitative information reported in the Form 2C will not have to be reported again in the Form 2F.

Under today's rule, Form 2F for storm water discharges associated with industrial activity would not require the submittal of all of the quantitative information required in Form 2C, but would require that quantitative data be submitted for:

- Any pollutant limited in an effluent guideline for an industrial applicant's subcategory;
- Any pollutant listed in the facility's NPDES permit for its process wastewater;
- Oil and grease, TSS, COD, pH, BOD5, total phosphorus, total Kjeldah. nitrogen; nitrate plus nitrite nitrogen; and
- Any information on the discharge required under 40 CFR 122.21(g)(7) (iii) and (iv).

In order to characterize the discharge(s) sampled, applicants need to submit information regarding the storm event(s) that generated the sampled discharge, including the date(s) the sample was taken, flow measurements or estimates of the duration of the storm event(s) sampled, rainfall measurements or estimates from the storm event(s) which generated the sampled runoff, and the duration between the storm event sampled and the end of the previous storm event. Information regarding the storm event(s) sampled is necessary to evaluate whether the discharge(s) sampled was generally representative of other discharges expected to occur during storm events and to characterize the amount and nature of runoff discharges from the site.

One commenter stated that the quantitative information should be limited to those pollutants that are expected to be known to the applicant. EPA believes this would be inappropriate since there will be no way of determining initially whether these pollutants are present despite the expectations of the applicant. Once the data is provided, permits can be drafted which address specific pollutants. This rulemaking requires that the applicant test for oil and grease, COD, pH, BOD5, TSS, total Kjeldahl nitrogen, nitrate plus nitrite nitrogen and total phosphorus. Oil and grease and TSS are a common component of storm water and can have serious impacts on receiving waters. Oxygen demand (COD and BOD5) will help the permitting authority evaluate the oxygen depletion potential of the discharge. BOD5 is the most commonly used indicator of potential oxygen demand. COD is considered a more inclusive indicator of oxygen demand, especially where metals interfere with the BOD5 test. The pH will provide the permitting authority with important information on the potential availability of metals to the receiving flora, fauna and sediment. Total Kjeldahl nitrogen, nitrate plus nitrite nitrogen and total phosphorus are measures of nutrients which can impact water quality. Because this data is useful in developing appropriate permit conditions, EPA disagrees with the argument made by one commenter that quantitative data requirements should be a permit condition and not part of the application process.

In the proposed rule, the Agency used total nitrogen as a parameter. This has been changed to total Kjeldahl nitrogen and nitrate plus nitrite nitrogen for clarity.

Today's rule defines sampling at industrial sites in terms of sampling for those parameters that have effluent limits in existing NPDES permits, as well as for any other conventional or nonconventional parameter that might be expected to be found at the outfall. Comments on the appropriateness of the defined parameters were solicited by the proposal. Numerous commenters maintained that either the parameter list be made industry specific, or that pollutant categories not detected in the initial screen be exempted from further testing. Some suggested that only conventional pollutants, inorganics, and metals be sampled unless reason for others is found.

In terms of specific water quality parameters, it was recommended that surfactants not be tested for unless foam is visible. One commenter also suggested that fecal coliform sampling is inappropriate for industrial permits applications. One commenter favored testing for TOC instead of VOC. In response, VOC has been eliminated from the list of parameters because it will not yield specific usable data. VOC is not specifically required in any sampling in today's rule, except where priority pollutant scans are required.

Some recommended that procedures be modified to facilitate quicker, less expensive lab analyses. Concern was also raised that industry might be required to collect its own rainfall data if there is no nearby observation station. Some commenters stated that EPA should not allow automatic sampling for either biological or oil and grease sampling due to the potential for contamination in sampling equipment.

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In response, EPA believes that the sampling requirements for industry in today's rule are reasonable and not burdensome. These requirements address parameters that have effluent limits in existing NPDES permits, as well as for any other conventional or nonconventional parameter that might be expected to be found at the applicants outfall. Under this procedure both industry-specific and site-specific contaminants are already identified in the existing permit. Whether all these parameters need to be made a part of any discharge characterization plans, under the terms of the permit, will be a case-by-case determination for the permitting authority. EPA maintains that the test for surfactants (if in effluent guidelines or in the facility's NPDES permit for process water) is justifiable even when a foam is not obvious at the outfall. The presence of detergents in storm water may be indicated by foam, but the absence of foam does not indicate that detergents are not present.

EPA requested comments on fecal coliform as a parameter. Fecal coliform was included on the list as an indicator of the presence of sanitary sewage. In large concentrations, fecal coliform may be an effective indicator of sanitary sewage as opposed to other animal wastes. EPA believes that sanitary cross connections will also be found at industrial facilities. Furthermore, the test for fecal coliform is an inexpensive test and its inclusion or exclusion should make little impact financially on the individual application costs. Sampling for volatile organic carbon shall be accomplished when required, as it is an appropriate indicator of industrial solvents and organic wastes.

In response to comments, EPA acknowledges that there are certain pollutants that are capable of leaving residues in automatic sampling devices that will potentially contaminate subsequent samples. In these cases, such as for biological monitoring, if such a problem is perceived to exist and it is expected that the contaminant will render the subsequent samples unusable, manual grab samples may be needed. This would include grab samples for pH, temperature, cyanide, total phenols, residual chlorine, oil and grease, fecal coliform, and fecal streptococcus. EPA is not disallowing the use of automatic sampling because of possible contamination, as this type of sampling may be the best method for obtaining the necessary samples from a selected storm event.

In addition to the conventional pollutants listed above, this final rule requires applicants, when appropriate, to sample other pollutants based on a consideration of site-specific factors. These parameters account for pollutants associated with materials used for production and maintenance, finished products, waste products and non-process materials such as fertilizers and pesticides that may be present at a facility. Applicants must sample for any pollutant limited in an effluent guideline applicable to the facility or limited in the facility's NPDES permit. These pollutants will generally be associated with the facility's manufacturing process or wastes. Other process and non-process related pollutants, will be addressed by complying with the requirements of 40 CFR 122.21(g)(7) (iii) and (iv).

Section 122.21(g)(7)(iii) requires applicants to indicate whether they know or have reason to believe that any pollutant listed in Table IV (conventional and nonconventional pollutants) of appendix D to 40 CFR part 122 is discharged. If such a pollutant is either directly limited or indirectly limited by the terms of the applicant's existing NPDES permit through limitations on an indicator parameter, the applicant must report quantitative data. For pollutants that are not contained in an effluent limitations guideline, the applicant must either report quantitative data or describe the reasons the pollutant is expected to be discharged. With regard to pollutants listed in Table II (organic pollutants) or Table III (metals, cyanide and total phenol) of appendix D, the applicant must indicate whether they know or have reason to believe such pollutants are discharged from each outfall and, if they are discharged in amounts greater than 10 parts per billion (ppb), the applicant must report quantitative data. An applicant qualifying as a small business under 40 CFR 122.21(g)(8), (*e.g.*, coal mines with a probable total annual production of less than 100,000 tons per year or, for all other applicants, gross total annual sales averaging less than $100,000 per year (in second quarter 1980 dollars)), is not required to analyze for pollutants listed in Table II of appendix D (the organic toxic pollutants).

Section 122.21(g)(7)(iv) requires applicants to indicate whether they know or have reason to believe that any pollutant in Table V of appendix D to 40 CFR part 122 (certain hazardous substances) is discharged. For every pollutant expected to be discharged, the applicant must briefly describe the reasons the pollutant is expected to be discharged and report any existing quantitative data it has for the pollutant.

When collecting data for permit applications, applicants may make use of 40 CFR 122.21(g)(7), which provides that "when an applicant has two or more outfalls with substantially identical effluents, the Director may allow the applicant to test only one outfall and report that the quantitative data also applies to the substantially identical outfalls." Where the facility has availed itself of this provision, an explanation of why the untested outfalls are "substantially identical" to tested outfalls must be provided in the application. Where the amount of flow associated with the outfalls with substantially identical effluent differs, measurements or estimates of the total flow of each of the outfalls must be provided. Several commenters stated that the time and expense associated with sampling and analysis would be saved if the applicant was able to pick substantially identical outfalls without prior approval of the permitting authority. EPA disagrees that this would be an appropriate devolution of authority to the permit applicant. The permitting authority needs to ensure that these outfalls have been grouped according to appropriate criteria (for example do the outfalls serve similar drainage areas at the facility). Furthermore, EPA is not requiring that the permit applicant engage in sampling to demonstrate that the outfalls are indeed substantially identical, because that would of course defeat the purpose of § 122.21(g)(7). The procedure for establishing identical outfalls is not that onerous and provides a means for industry to save substantially on time and resources for sampling.

EPA proposed and requested comment on a requirement that the facility must sample a storm event that is typical for the area in terms of duration and severity. The storm event must be greater than 0.1 inches and must be at least 96 hours from the previously measurable (greater than 0.1 inch rainfall) storm event. In general, variance of the parameters (such as the duration of the event and the total rainfall of the event) should not exceed 50 percent from the parameters of the average rainfall event in that area. EPA also requested comments on addressing snow melt events under this definition.

Commenters stated that: median or average rainfall is not an acceptable approach; the minimum depth and duration of rainfall must be specified; the allowable 50% variation is questionable; the total depth of the storm is irrelevant; and the storm shou be viewed based on the average intensity of the storm. One commenter

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suggested that using the median rainfall event would be a better approach than the average rainfall event.

Others insisted that "representative" or typical storms do not exist in semi-arid climates and that representative rainfall must be site-specific (regional) and seasonal. Several commenters contended that the requirement for 96 dry hours between events is not acceptable, with 48 and 72 hours identified as possible alternatives.

One commenter believed that a typical standard design storm, such as the 1-year, 24-hour, or 10-year, 1-hour, would be preferable. Another commenter felt that the storm event should be based on the rainfall required to generate a minimum discharge level. One commenter questioned whether the storm is to be sampled at all sites simultaneously.

To clarify its decision on what storm event should be sampled, EPA notes that its selection of the storm event considers both regional and seasonal variation of precipitation. This is evidenced in the rule with regard to sites in the municipal application (three events sampled), and in the requirements for industrial group applications (a minimum of two applicants, or one applicant in groups of less than 10, to be represented in each precipitation zone (see section VI.F.4 below).

The definition of a 0.1 inch minimum was determined by NURP and other studies to be the minimum rainfall depth capable of producing the rainfall/runoff characteristics necessary to generate a sufficient volume of runoff for meaningful sample analysis. EPA believes by requiring the average storm to be used as the basis for sampling that depth, duration, and therefore average rainfall intensity are being regionally defined. The Agency has also added the option of using the median rainfall event instead of the average. The potential for monitoring events that may not meet this specification should be minimized by allowing the proposed 50 percent variation in rainfall depth and/or duration from event statistics. However, the 50 percent variation need only be met when possible. Further, there is flexibility in the rule where the Director may allow or establish site specific requirements such as the minimum duration between the previous measurable storm event and the storm event sampled, the amount of precipitation from the storm event to be sampled, and the form of precipitation sampled (snowmelt or rainfall). If data is obtained from a rain event that does not meet the criteria above, the Director has the discretion to accept the data as valid.

The December 7, 1988, proposal called for a 96-hour period between events of measurable rainfall, here defined as 0.1 inch, which provided a four day minimum for the accumulation of pollutants on the surface of the outfalls' tributary areas. The key word in the definition is "measurable", which means that the 96-hour period did not necessarily have to be dry, only that no cleansing rainfall (*i.e.* 0.1 inch rain event) has occurred. However, after reviewing comments on this issue EPA has decided to change the period to 72 hours. Many commenters indicated that 96 hours is too restrictive and that securing a sample under such circumstances would be unnecessarily difficult. EPA agrees that the quality or representativeness of the sample would not be adversely affected by this change.

EPA does not agree with comments that the requirement of a particular "design" storm would be appropriate. Many commenters have expressed concern that they might sample an event not meeting the requirements for industrial group applications as defined. Because there is no way to know with sufficient certainty beforehand that an upcoming event will approximate a one-year, twenty-four hour storm, many events would be unnecessarily sampled before this event is realized.

EPA does not intend that a municipality or industry be required to sample all required outfalls for a single storm. This would represent a unmanageable investment in equipment and manpower. In some areas, it may be necessary to sample multiple sites for a single event due to the irregularity of rainfall, but not all sites.

EPA described parameters for selecting storm events for sampling of municipal and industrial outfalls in the December 7, 1988, proposal. EPA has received several comments regarding the problems that rainfall measurement in general presents. A recurring comment relative to reporting rainfall, and in verifying that the storm itself is representative, deals with the spatial distribution of rainfall. The rainfall measured at an airport does not always represent rainfall at the site, particularly in summer months when thunderstorms are prevalent. One commenter stated that it would be easier to base the selected storm on either a minimum discharge, or on a discharge duration other than on the total precipitation, because these parameters are easily measured at the site and are not dependent on the airport gauges receiving the same rainfall as the site. A few commenters questioned how to determine typical storm characteristics. One commenter advised that NOAA rainfall reporting stations provide data that represent only daily rainfall totals, not storm event data. One commenter pointed out that the time frame of the sampling requirement does not consider that a particular region may be in the midst of a multi-year drought cycle, and that what little rainfall occurs may have uncharacteristically high levels of pollutants.

The type of rain event sampled is an important parameter in any attempt to characterize system-wide loads based on the sampling results. Rainfall gauges that report only event total depth will provide the information necessary to characterize most events, provided that a reasonable estimate of the event duration can be made. If simulation models are to be used in estimating system-wide loads, rainfall measurement based on time and depth of rainfall will be needed. If the recording stations are not believed to accurately reflect this distribution, then the data will need to be collected by the applicant at a location central to the tributary area of the outfall.

The rainfall data collected by NOAA are in most cases available in the form of hourly rainfall depths. This information can be analyzed to develop characteristic storm depths and durations. In some cases, this information has already been analyzed for many long term reporting stations by various municipalities, states, and universities. The results of these investigations should be available to the applicants.

EPA realizes that prolonged rainless periods occur for both semi-arid areas and areas experiencing droughts and that the first storm after a prolonged dry period may well not be representative of "normal" runoff conditions. In order for the appropriate system-wide characterization of loads to be made, data must be collected. With regard to the municipal permit application, today's rule states that runoff characterization data will be collected during three events at from five to ten sites. The rule gives the Director the flexibility of modifying these requirements.

EPA has defined the parameters for selecting the storm event to be sampled such that at the discretion of the Director, seasonal, including winter, sampling might be required. EPA has received several comments regarding the problems that snowmelt sampling may present. Several commenters are

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opposed to monitoring of snowmelt events. The reasons cited include equipment problems and the unreasonableness of expecting this sampling, because of temperatures and the time required for personnel to be waiting for events. A few comments addressed the issues of snow pack depth, ambient temperature, and solar radiation levels, and that the snow pack may filter suspended solids or refreeze such that final melting is uncharacteristically over-polluted relative to normal conditions. Another commenter contended that it is impossible to manage the melting process and therefore unreasonable to expect controls to be implemented relative to snowmelt. In essence, it is contended that there is no first discharge unless the snow pack depth is low and melts quickly.

A few commenters favor monitoring snowmelt, for precisely the same reason that most oppose it: that the runoff from snowmelt is the most polluted runoff generated in some areas on an annual basis. Where this is the case, sampling snowmelt should be undertaken in order to accurately assess impacts to receiving streams. EPA is confident that in areas where automated sampling cannot be relied upon, grab sampling can probably be performed because the nature of the snowmelt process tends to make the timing of samples less of a problem when compared to typical rainfall events. EPA disagrees that management practices, either at industrial facilities or with regard to municipalities, cannot address snowmelt. Some areas may need to reassess their salt application procedures. In addition retention and detention devices may address snowmelt, as well as erosion controls at construction sites. Thus, obtaining samples of snowmelt is appropriate to allow development of such permit conditions.

Today's rule also modifies the Form 2C requirements by exempting applicants from the requirements at § 122.21(g)(2) (line drawings), (g)(4) (intermittent flows), (g)(7) (i), (ii), and (v) (various sampling requirements to characterize discharges) if the discharge covered by the application is composed entirely of storm water. Permit applications for discharges containing storm water associated with industrial activity would require applicants to provide other non-quantitative information which will aid permit writers to identify which storm water discharges are associated with industrial activity and to characterize the nature of the discharge.

Numerous comments were received regarding the requirement to submit a topographic map and site drainage map. Many of these comments offered alternatives to EPA's proposal. Two commenters suggested that a simple sketch of the site would be sufficient. Two commenters stated that one or the other should be adequate. One commenter believed that the drainage map was a good idea, but that the topographic map should be optional. Several commenters submitted that a topographic map was sufficient and that only SPCC plans or SARA submittals should supplement that. Another commenter argued that information relating to the location of the nearest surface water or drinking wells would be sufficient. Other commenters believed that a drainage map alone would indicate all relevant site specific information. Numerous commenters expressed concern that the drainage area map would be too detailed and that one which depicts the general direction of flow should be sufficient. Clarification was requested on whether the final rule would require the location of any drinking water wells. One commenter stated that a U.S.G.S. 7.5 quadrangle map will not illustrate drainage systems in all cases, and that therefore the requirement should be optional.

Several commenters agreed with EPA's proposal. One commenter maintained that drainage maps should be required from developments greater than three acres and from all individual applicants. Several commenters agreed with EPA's proposal that both maps should be provided, with arrows indicating site drainage and entering and leaving points. It was advised that drainage maps are useful in locating sources of storm water contamination, and it is useful to identify areas and activities which require source controls or remedial action. One commenter recommended that the map should extend far enough offsite to demonstrate how the privately owned system connects to the publicly owned system.

After considering the merits of all the comments and the reasons supporting EPA's proposal, EPA is convinced that a topographic map and a site drainage map are necessary components of the industrial application. Existing permit application regulations at 40 CFR 122.21(f)(7) require all permit applicants to submit as part of Form 1 a topographic map extending one mile beyond the property boundaries of the source depicting the facility and each intake and discharge structure; each hazardous waste treatment, storage, or disposal facility; each well where fluids from the facility are injected underground; and those wells, springs, other surface water bodies, and drinking water wells listed in the map area in public records or otherwise known to the applicant within one-quarter mile of the facility property boundary. (*See* 47 FR 15304, April 8, 1982.) However, as indicated by the comments the information provided under § 122.21(f)(7) is generally not sufficient by itself for evaluating the nature of storm water discharges associated with industrial activity.

As stated in comments, a drainage map can provide more important site specific information for evaluating the nature of the storm water discharge in comparison to existing requirements, which require a larger map with only general information. The volume of storm water discharge and the pollutants associated with it will depend on the configuration and activities occurring at the industrial site. One commenter suggested that it would be appropriate to submit an aerial photograph of the site with all the topographic and drainage information superimposed on the photograph. EPA agrees that this may be an appropriate method of providing this information. EPA is not requiring a specific format for submitting this information.

EPA is also requiring that a narrative description be submitted to accompany the drainage map. The narrative will provide a description of on-site features including: existing structures (buildings which cover materials and other material covers; dikes; diversion ditches, etc.) and non-structural controls (employee training, visual inspections, preventive maintenance, and housekeeping measures) that are used to prevent or minimize the potential for release of toxic and hazardous pollutants; a description of significant materials that are currently or in the past have been treated, stored or disposed outside; and the method of treatment, storage or disposal used. The narrative will also include: a description of activities at materials loading and unloading areas; the location, manner and frequency in which pesticides, herbicides, soil conditioners and fertilizers are applied; a description of the soil; and a description of the areas which are predominately responsible for first flush runoff. This requirement is unchanged from the proposal.

Some commenters believed that information on pesticides, herbicides, and fertilizers and similar products is irrelevant, incidental to the facility's production activities, and should not be

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addressed by this rulemaking. EPA disagrees. As these materials are applied outside and hence subject to storm events, they are significant sources of pollutants in storm water discharges whether applied in residential or industrial settings. By providing this information in the permit application the permit writer will be able to determine whether such activity is associated with industrial activity and the subject of appropriate permit conditions. Nominal or incidental application of these materials at industrial facilities and non-detects in sampling of storm water discharges for the permit application will result, in most cases, in these materials not being addressed specifically in storm water permits.

Today's rule also requires that permit applicants for storm water discharges associated with industrial activity certify that all of the outfalls covered in the permit application have been tested or evaluated for non-storm water discharges which are not covered by an NPDES permit. (The applicant need not test for nonstorm water if the certification of the plant storm water discharges can be evaluated through the use of schematics or other adequate method). Section 405 of the WQA added section 402(p)(3)(B)(ii) to the CWA to require that permits for municipal separate storm sewers effectively prohibit non-storm water discharges to the storm sewer system. As discussed in part VI.F.7.b of today's preamble, untreated non-storm water discharges to storm sewers can create severe, widespread contamination problems and removing such discharges presents opportunities for dramatic improvements in the quality of such discharges. Although section 402(p)(3)(B)(ii) specifically addresses municipal separate storm sewers, EPA believes that illicit non-storm water discharges are as likely to be mixed with storm water at a facility that discharges directly to the waters of the United States as it is at a facility that discharges to a municipal storm sewer. Accordingly, EPA feels that it is appropriate to consider potential non-storm water discharges in permit applications for storm water discharges associated with industrial activity. The certification requirement would not apply to outfalls where storm water is intentionally mixed with process waste water streams which are already identified in and covered by a permit.

This rulemaking requires applicants for individual permits to submit known information regarding the history of significant spills at the facility. Several commenters indicated that the extent to which this information is required should be modified. One commenter stated that the requirement should be limited to those spills that resulted in a complaint or enforcement action. EPA disagrees. EPA believes that significant spills at a facility should generally include releases of oil or hazardous substances in excess of reportable quantities under section 311 of the Clean Water Act (see 40 CFR 110.10 and 40 CFR 117.21) or section 102 of CERCLA (see 40 CFR 302.4). Such a requirement is consistent with these regulations and the perception that such spills are significant enough to mandate the reporting of their occurrence. Some commenters stated that industries have already submitted this information in other contexts and should not be required to have to do it again. For the same reason another commenter felt that submittal of this information represents a waste of manpower and resources. EPA disagrees that requiring this information is unduly burdensome. If this information has already been provided for another purpose it follows that it is readily available to the industrial applicant. Thus, the burden of providing this information cannot be considered undue. Furthermore, the permit authority will need to have this available in order to determine which drainage areas are likely to generate storm water discharges associated with industrial activity, evaluate pollutants of concern, and develop appropriate permit conditions. However, to keep this information requirement within reasonable limits and limited to information already available to individual facilities, EPA has declined to expand the reporting requirements to spills of other materials, such as food as one commenter has suggested. However, EPA has decided to add raw materials used in food processing or production to the list of significant materials. Materials such as these may find their way into storm water discharges in such quantities that serious water quality impacts occur. These materials may find there way into storm water from transportation vehicles carrying materials into the facility, loading docks, processing areas, storage areas, and disposal sites.

One commenter urged that any information requested should be limited to a period of three years, which is the general NPDES records retention requirement under 40 CFR 122.21(p) and 40 CFR 112.7(d)(8). EPA agrees with this comment and has limited historical information requirements to the 3 years prior to the date the application is submitted. In this manner this regulation will be consistent with records keeping practices under the NPDES and Oil Spill Prevention programs, except sludge programs.

The December 7, 1988, proposal required the applicant to submit a description of each past or present area used for outdoor storage or disposal of significant materials. One commenter felt that the definition of significant material was too imprecise. EPA disagrees that the language should be made more precise by delineating every conceivable material that may add pollutants to storm water. Rather the definition is broad, to encourage permit applicants to list those materials that have the potential to cause water quality impacts. Stating what materials are addressed in meticulous detail may result in potentially harmful materials remaining unconsidered in permits. However, EPA has decided to add "fertilizers, pesticides, and raw materials used in the production or processing of food" to the definition in response to the comment of one State authority that such materials need to be accounted for due to their potential danger to storm water discharge quality. This same commenter recommended that "hazardous chemicals" should be added. EPA agrees, and will delineate those chemicals as "hazardous substances" which are designated under section 101(14) of CERCLA. Further clarification has been added by requiring the listing of any chemical the facility is required to report pursuant to section 313 of title III of SARA.

Another commenter felt that EPA should not require information of past storage of significant materials. EPA agrees that this proposed requirement is overbroad and has limited the time frame to those materials that were stored in areas 3 years or fewer from the date of the permit application. The 3-year limit is consistent with other Agency reporting requirements as discussed above.

One commenter questioned EPA's proposal not to provide for a waiver from the requirement to submit quantitative data if the applicant can demonstrate that it is unnecessary for permit issuance. Another commenter said that a waiver is inappropriate. EPA believes relevant quantitative data are essential to the process, but in this rulemaking the number of pollutants that must be sampled and analyzed is reduced compared to previous regulations. The proposed requirements for quantitative data are limited to pollutants that are appropriate for given

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site-specific operations, thereby making a waiver unnecessary.

Although the concept of a waiver is attractive because of the perceived potential reduction in burdens for applicants, EPA believes that because the storm water discharge testing requirements have already been streamlined, a waiver would not in practice provide significant reductions in burden for either applicants or permit issuing authorities. Requirements to provide and verify data demonstrating that a waiver is appropriate for a storm water discharge may prove to be more of a burden to the applicant and the permitting authorities. Establishing such a waiver procedure would be administratively complex and time-consuming for both EPA and the applicants, without any justifiable benefit. Therefore, this rulemaking does not include a waiver provision.

In response to one commenter, EPA wishes to emphasize that if a facility has zero storm water discharge because it is discharging to a detention pond only, a permit application is not required. Only those discharges to the waters of the United States or municipal systems need submit notifications, individual or group permit applications, or notices of intent where applicable. However, if the detention pond overflows or the discharger anticipates that it may overflow, then a permit application should be submitted.

Two commenters agreed with EPA's proposed requirement to have a description of past and present material management practices and controls. EPA believes that this is important information directly relating to the quality of storm water that can be expected at a particular facility and this requirement is retained in today's rule. However, as with other historical information requirements, EPA is limiting past practices to those that occurred within three years of the date that the application is submitted. One commenter argued that past practices should not be considered unless there is evidence that past practices cause current storm water quality problems. EPA anticipates that the information submitted by the applicant will be used to make this determination and that appropriate permit conditions can be developed accordingly.

One commenter requested clarification on the certification requirement that the data and information in the application is true and complete to the best of the certifying officer's knowledge. This is a fundamental and integral part of all NPDES permit applications. It essentially requires the signatory to assure the permit writer, based upon his or her personal knowledge, that the information has been submitted without a negligent, reckless, or purposeful misrepresentation. EPA intends to interpret this requirement in the same manner for storm water applications as other applications.

4. Group Applications

Today's final rule provides some industries with the option of participating in a group application, in lieu of submitting individual permits. There are several reasons for the group application. First, the group application procedure provides adequate information for issuing permits for certain classes of storm water discharges associated with industrial activity. Second, numerous commenters supported the concept of the group application as a way to reduce the costs and administrative burdens associated with storm water permit applications. Third, group applications will reduce the burden on the regulated community by requiring the submission of quantitative data from only selected members of the group. Fourth, the group application process will reduce the burden on the permit issuing authority by consolidating information for reviewing permit applications and for developing general permits suited to certain industrial groups. Where general permits are not appropriate or cannot be issued, a group application can be used to develop model individual permits, which can significantly reduce the burden of preparing individual permits.

As noted above in today's preamble, EPA intends to promulgate a general permit that will cover many types of industrial activity. Industrial dischargers eligible for such permits will generally be required to seek coverage by submittal of a notice of intent. Facilities that are ineligible for coverage under the general permit will be required to submit an individual permit application or submit a group application. The group application process promulgated today will serve as an important component to implement Tier III of EPA's industrial storm water permitting strategy discussed above. The general permit which EPA intends to promulgate in the near future shall set forth what types of facilities are eligible for coverage.

Some commenters criticized the group application procedure as an abdication of EPA's responsibility to effectively deal with pollutants in storm water discharges. One commenter stated that every facility subject to these regulations should be required to submit quantitative data. In response EPA believes, as do numerous commenters, that the group application procedure is a legitimate and effective way of dealing with a large volume of currently uncontrolled discharges. The only difference between the group application procedure and issuing individual permits based on individual applications is that the quantitative data requirements from individual facilities will be less if certain procedures are followed. EPA is convinced that marked improvements in the process of issuing permits will be achieved when these procedures are followed. Where the storm water discharge from a particular facility is identified as posing a special environmental risk, it can be required to submit individual applications and therefore separate quantitative data. It should also be noted that submittal of a group application does not exempt a facility from submitting quantitative data on its storm water discharge during the term of the permit.

The final rule refines and clarifies some of the requirements of the group application approach set forth in the December 7, 1988 proposal. Several commenters requested that EPA add a provision which would allow a facility that becomes subject to the regulations to "add on" to a group application after that group application has already been submitted. One commenter indicated that some trade associations are prohibited from engaging in an activity which would not apply to all its members, and that an "add on" provision was needed in the event such a prohibition was invoked. Another commenter noted that where a group is particularly large, for example one that consists of several thousand members, that it would be a logistical feat to ensure that all facilities eligible as members of the group are properly identified and listed on the application within the 120 day deadline for submitting part 1A of the application.

EPA believes that a group applicant should have a limited ability to add facilities to the group after part 1A has been submitted and that a provision which allows a group or group representative an unbridled ability to "add on" is impractical for a number of reasons. First, 10% of the facilities must submit quantitative data. Adding facilities after the group has been formed and approved would change the number of facilities that have to submit quantitative data on behalf of the group. This would result in an unwarranted administrative burden on the reviewing authority, which is in the position of having to examine the quantitative data and determine the appropriateness of group members (and those that are

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required to submit quantitative data) within 2 months of receiving part 1 of the group application. Further, during the permit application process permitting authorities will be developing permit conditions for an identified and pre-determined group of facilities. Allowing potentially significant numbers of permit applicants to suddenly inject themselves into a group application could unnecessarily hamper or disrupt the timely development of general and model permits. In addition, if a facility were "added on" the number of facilities having to submit quantitative data may drop below 10%. Thus the facility desiring to "add on" may be put in the position of having to submit the quantitative data themselves, which would clearly defeat the purpose of being a part of the group application.

Nevertheless, EPA has added a provision to 122.26(e) which enables facilities to add on to a group application at the discretion of the EPA's Office of Water Enforcement and Permits, and upon a showing of good cause by the group applicant. For the reasons noted above, EPA anticipates this provision will be invoked only in limited cases where good cause is shown. Facilities not properly identified in the group application, and which cannot meet the good cause test will be required to submit individual permit applications. EPA will advise such facilities within 30 days of receiving the request as to whether the facility may add on.

However, the "add on" facility must meet the following requirements: The application for the additional facility is made within 15 months of the final rule; and the addition of the facility does not reduce the percentage of the facilities that are required to submit quantitative data to below 10% unless there are over 100 facilities that are submitting quantitative data. Approval to become part of a group application is obtained from the group or the trade association and is certified by a representative of the group; approval for adding on to a group is obtained from the Office of Water Enforcement and Permits.

Several commenters stated that the application requirements for groups are so burdensome that the advantages of the process are undermined. These concerns are addressed in greater detail below. Among the requirements which commenters objected are the requirements to list every group member's company by name and address. EPA is convinced that a condition precedent to approving a group application is at least identifying the members of the group. Without such information it would be impossible to determine if all the facilities are sufficiently similar. EPA disagrees that industries will be dissuaded from using the group application process because the advantages of the process are undermined. Although commenters perceived many burdens associated with individual permit applications, by far the most significant burden identified by the comments is the requirement for obtaining and submitting quantitative data. The group application significantly reduces this burden by requiring only10% of the facilities to submit quantitative data if the number in the group is over 100. If the number in the group is over 1000, then only 100 of the facilities need submit quantitative information. If group applicants develop cost sharing procedures to reduce the financial and administrative burdens of submitting quantitative data, it is evident that utilizing the group application could save industries as much as 90% on the most economically burdensome aspect of the application.

Several commenters perceived that the group application procedure did not offer them significant savings because under the proposal their particular industry would only be required to test for COD, BOD5, pH, TSS, oil and grease, nitrogen, and phosphorous. These commenters stated that sampling for these pollutants is not particularly expensive. EPA believes that even if a group is required only to submit minimal quantitative data on particular pollutants, substantial savings can accrue to a particular industry if the group has many members. This is particularly true when the number of outfalls to be sampled, the information on storm events, and flow measurements are factored into the cost analysis. An additional benefit for members of the group as well as for permit issuing agencies is that the process of developing a permit, including drafting and responding to public comments on the permit, is consolidated by the group application process. Accordingly, it is less resource intensive for the group to work with permit issuance authorities to develop well founded permit conditions.

One commenter raised a concern about the situation where one of the facilities that is designated for submitting quantitative data drops out of the group. If this happened, then another facility would have to submit quantitative data. In response, EPA notes that one approach would be for the group to have one or two more facilities submit quantitative data than needed to avoid problems from such a departure or to account for new additions to the group. Certainly this issue goes directly to the facility selection process which is a critical component of the group application: the facilities need to be carefully selected and reviewed by the group to prevent such difficulties.

Several comments indicated a confusion over what facilities are eligible to take advantage of the group application procedure. Any industry or facility that is required to submit a storm water permit application under these regulations is eligible to participate in a group application. However, whether a facility can obtain a storm water permit under a group application procedure will depend upon whether that facility is a member of the same effluent guideline subcategory, or is sufficiently similar to other members of the group to be appropriate for a general permit or individual permit issued pursuant to the group application. Accordingly, group applications are not limited to national trade associations. The agency believes that the language in § 122.26(c)(2) adequately addresses these concerns. The process does not prohibit a particular company with multiple facilities from filing a group application as long as those facilities are sufficiently similar.

One commenter expressed concern that a single company would not be able to take advantage of the group application benefits unless the company had more than ten facilities. Under such circumstances the company would have to become integrated with a larger group of facilities owned by other companies in order to take advantage of the benefits afforded by the group application procedure. In response, the Agency is providing for a group application of between four and ten members, however at least half the facilities must submit data. One commenter stated that the number of facilities required to submit quantitative data should be determined on a case by case basis. EPA believes that 10 percent for groups with over ten members will be easiest to implement for both industry and EPA, and will ensure that adequate representative quantitative data are obtained so that meaningful determinations of facility similarity can be made and appropriate permit conditions in general or model permits can be developed.

Another commenter suggested that one facility with a multitude of storm water discharge points should be able to use the group permit application to reduce the amount of quantitative data

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that it is required to submit. This is an accurate observation but only to the extent that the facility combines with several other facilities to form a group, in which case only 10% of the facilities need submit quantitative data. The group application procedure in today's rule is designed for use by multiple facilities only. However, if an individual facility has 10 outfalls with ten substantially identical effluents the discharger may petition the Director to sample only one of the outfalls, with that data applying to the remaining outfalls. See § 122.21(g)(7). Thus, existing authority already allows for a "group-like" process for sampling a subset of storm water outfalls at a single facility.

Concern was expressed that the spill reporting requirement from each facility in part 1B would preclude any group from demonstrating that the facilities sampled are "representative," because the incidence of past spills is very site-specific. EPA notes that since it has dropped the part 1B requirements for other reasons discussed below, this comment is now moot.

Numerous commenters noted that if a facility is part of a group application and is subsequently rejected as a group applicant, such an entity would not have a full year to submit an individual permit application. EPA agrees that this is a significant concern. Accordingly, those facilities that apply as a member of a group application will be afforded a full year from the time they are notified of their rejection as a member of the group to file an individual application. EPA notes that it intends to act on group application requests within 60 days of receipt; thus this approach will only provide facilities that are rejected from a group application a short extension of the deadline for other individual applications.

One commenter complained that the cost of defending a group's choice of representative facilities may exceed the cost of submitting an individual permit application, thereby reducing the incentive to apply as group. The agency anticipates that the selection process will be one open to negotiation between the affected parties and one that will end in a mutually satisfactory group of facilities. It is the intent of EPA to reduce the costs of submitting a permit application as much as possible, while providing adequate information to support permitting activities.

Another commenter argued that the use of model permits will create a disincentive for participating in a group because model permits may be used by the permit issuing authority to issue individual permits for discharges from similar facilities that did not participate in the group application. EPA does not agree. The benefit of applying as a group applicant is to take advantage of reduced representative quantitative data requirements. This incentive will exist regardless of whether or how model permits are used. Further, technology transfer can occur during the development of permits based on individual applications as well as those based on group applications.

One commenter suggested moving some of the facility specific information requirements of part 1 of the group application to part 2 of the group application in order to provide more incentive to apply as a group. EPA has considered this and believes such a change would be inappropriate. Part 1 information will be used to make an informed decision about whether individual facilities are appropriate as group members and appropriate for submitting representative quantitative data. Furthermore, information burdens from providing site specific factors in part 1 is relatively minimal, and the information requirements in the proposed part 1B application have been eliminated.

One commenter suggested that trade associations develop model permits since they have the most knowledge about the characteristics of the industries they represent. As noted above, EPA expects that the industries and trade associations will have input, through the permit application process, as to how permit conditions for storm water discharges are developed. While the applicant can submit proposed permit conditions with any type of application, EPA however cannot delegate the drafting of model permits to the permittees. EPA is developing and publishing guidance in conjunction with this rulemaking for developing permit conditions.

One commenter suggested that new dischargers should be able to take advantage of general permits developed pursuant to group applications. As with other general permits, EPA anticipates that such discharges will be able to fall within the scope of a general permit based on a group application where appropriate.

One commenter stated that the group application does not benefit municipalities since there is no requirement for industrial discharges through municipal sewers to apply for a permit. As noted in a previous discussion, industrial discharges through municipal sewers must be covered by an NPDES permit. Such facilities may avail themselves of the group application procedure. Also, municipalities are not precluded from developing a group application procedure under their management plan for industries that discharge into their municipal system, in order to streamline developing controls for such industries.

One industry wanted clarification that facilities located within a municipality would be eligible to participate in a group application. All industrial activities required to submit an individual permit are entitled to submit as part of group application, except those with existing NPDES permits covering storm water. Those facilities that discharge through a municipal separate storm sewer systems required to submit an individual application (because they do not fall within a general permit) are not precluded from using the group application procedure if appropriate.

Other municipalities expressed confusion over the industrial group application concept. The following responds to these comments. First, municipalities are not eligible for participation in a group application because the group application process is designed for industrial activities. Sampling requirements for municipal permit applications are already limited to a small subset of the outfalls from the system, as discussed below. Furthermore, permits for municipal separate storm sewer systems will be issued on a system-wide or jurisdiction-wide basis, rather than individually for each outfall. Thus, today's regulation already incorporates a "grouplike" permit application process for municipalities. Furthermore, it is highly unlikely that various municipal storm sewer systems would be "substantially similar" enough to justify group treatment in the same way as industrial facilities. In response to another comment, this regulation does not directly give the municipality enforcement power over members of an industrial group who may be discharging through its system. Only the permitting authority and private citizens and organizations (including the municipality acting in such a capacity) will have enforcement power over members of the group once permits are issued to those members.

One commenter believed that the States with authorized NPDES programs rather than EPA should establish permit terms for permits based on group applications. In response to this comment, EPA wishes to clarify its role in the group application process. Group applications will be submitted to EPA headquarters where they will be reviewed and summarized. The

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summaries of the group application will be distributed to authorized NPDES States. EPA wishes to emphasize that NPDES States are not bound by draft model permits developed by EPA. States may adopt model permits for use in their particular area, making adjustments for local water quality standards and other regional characteristics. Where general permit coverage is believed to be inappropriate, facilities may be required to apply for individual permits. One commenter objected to the group application procedure because it is not consistent with existing Federal permitting procedures, which will lead to confusion in the regulated community. The agency disagrees with this assessment. The group application is a departure from established NPDES program procedures. However, the comments, when viewed in their entirety, reflect widespread support from the regulated community for a group application procedure. Further, the comments reflect that those affected by this rulemaking understand the components of the group application and the procedures under which permits will be obtained pursuant to the group application.

One commenter expressed concern regarding how BAT limits for groups of similar industries will be developed. Technology based limits will be developed based on the information received from the group applicants. If the group applicants possess similar characteristics in terms of their discharge, BAT/BCT limitations and controls will be developed accordingly for those members of the group. If the discharge characteristics are not similar then applying industries are not appropriate for the group.

One commenter has suggested that the proposed group application is too complex with regard to the part 1A, part 1B, and part 2 group application requirements and that EPA should repropose these provisions. As discussed below, EPA has simplified the industrial group application requirements by eliminating the part 1B application. Thus, reproposal is unnecessary.

One commenter criticized the group application concept as not achieving any type of reduction in administrative burden for NPDES States. EPA disagrees with this assessment. If industries take advantage of the group application procedure, EPA will have an opportunity to review information describing a large number of dischargers in an organized manner. EPA will perform much of the initial review and analysis of the group application, and provide NPDES States with summaries of the applications thereby reducing the burden on the States. Furthermore, the procedure encourages a potentially large number of facilities to be covered by a general permit, which will clearly reduce the administrative burden of issuing individual permits.

The final rule establishes a regulatory procedure whereby a representative entity, such as a trade association, may submit a group application to the Office of Water Enforcement and Permits (OWEP) at EPA headquarters, in which quantitative data from certain representative members of a group of industrial facilities is supplied. Information received in the group application will be used by EPA headquarters to develop models for individual permits or general permits. These model permits are not issued permits, but rather they will be used by EPA Regions and the NPDES States to issue individual or general permits for participating facilities in the State. In developing such permits, the Region or NPDES State will, where necessary, adapt the model permits to take into account the hydrological conditions and receiving water quality in their area. One commenter expressed the view that having this procedure managed by EPA headquarters would cause delays and it should be delegated to the States and Regions. EPA disagrees that delay will ensue using this procedure. Furthermore, consistency in development of model and general permits can be achieved if application review is coordinated at EPA headquarters.

a. Facilities Covered. Under this rule the group application is submitted for only the facilities specifically listed in the application and not necessarily for an entire industry. The facilities in the group application selected to do sampling must be representative of the group, not necessarily of the industry.

Facilities that are sufficiently similar to those covered in a general permit (issued pursuant to a group application) that commence discharging after the general permit has been issued, must refer to the provisions of that general permit to determine if they are eligible for coverage. Facilities that have already been issued an individual permit for storm water discharges will not be eligible for participation in a group application. Several commenters believed that this restriction is inequitable since they have experienced the administrative burden of submitting a permit application. EPA disagrees. Industries that have already obtained a permit for storm water discharges have developed a storm water management program, engaged in the collection of quantitative data, and possess familiarity and experience with submitting storm water permit applications. The Agency sees no point to instituting an entirely new permit application process for facilities that have storm water permits issued individually. It makes little sense for these industries to be involved with submitting another permit application before their current permit expires.

As noted above, once a general permit has been issued to a group of dischargers, a new facility may request that they be covered by the general permit. The permitting authority can then examine the request in light of the general permit applicability requirements and determine whether the facility is suitable or not.

b. Scope of Group Applications. Numerous comments were received on how facilities should be evaluated as members of a group application. Several commenters stated that effluent limitation guideline subcategories are not relevant to pollutants found in storm water, but rather to the facility's everyday activities, and therefore similarity should be based on each facility's discharge or the similarity of pollutants expected to be found in a facility's discharge. Other commenters felt that similarity of operations at facilities should be the criteria. Others believed that an examination of the facility's impact on storm water quality should be the applied criteria. Other commenters suggested that EPA provide more guidance as to how broadly groups can be defined and that a failure to do so would discourage facilities from going to the trouble and expense of entering into the group application process. Some commenters were concerned that facilities would be rejected as a group because of variations in processes and process wastewater characteristics.

EPA does not agree that effluent limitation guideline subcategories are inappropriate as a method for determining group applications. EPA guideline subcategories are functional classifications, breaking down facilities into groups, for purposes of setting effluent limitations guidelines. The use of EPA subcategories will save time for both applicants and permitting authorities in determining whether a particular group is appropriate for a group application. Furthermore, EPA believes that this method of grouping provides adequate guidance for determining what facilities are grouped together. Establishing groups on the extent to which a facility's discharge

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affects storm water quality would not provide applicants with sufficient guidance as to the appropriateness of individual industries for group applications and would not provide information needed to draft appropriate model permit conditions for potentially different types of industries, industrial processes, and material management practices.

However, EPA recognizes that the subcategory designations may not always be available or an effective methodology for grouping applicants. Also, there are situations where processes that are subject to different subcategories are combined. EPA agrees that the group application option should be flexible enough to allow groups to be created where subcategories are too rigid or otherwise inappropriate for developing group applications or where facilities are integrated or overlap into other subcategories. For these reasons, this rulemaking does not limit the submission to EPA subcategories alone, but rather allows groups to be formed where facilities are similar enough to be appropriate for general permit coverage.

In determining whether a group is appropriate for general permit coverage, EPA intends that the group applicant use the factors set forth in 40 CFR 122.28(a)(2)(ii), the current regulations governing general permits, as a guide. If facilities all involve the same or similar types of operations, discharge the same types of wastes, have the same effluent limitation and same or similar monitoring requirements, where applicable, they would probably be appropriate for a group application. To that extent, facilities that attempt to form groups where the constituent makeup of its process wastewater is dissimilar may run the risk of not being accepted for purposes of a group application.

Some commenters expressed the view that categories formed using general permit factors are too broad or that the language is too vague. One commenter expressed the view that the standard is too subjective and that permit writers will be evaluating the similarity of discharge too subjectively, while other commenters felt that the criteria should be broad and flexible. Other commenters stated that the effluent guideline subcategory or general permit coverage factors are not related to storm water discharges, because much of the criteria are based upon what is occurring inside the plant, rather than activities outside of the plant. EPA believes that these criteria are reasonable for defining the scope of a group application. EPA disagrees that the procedure, which is adequate for the issuance of general permits, is inadequate for the development of a group application. EPA believes that the activities inside a facility will generally correspond to activities outside of the plant that are exposed to storm events, including stack emissions, material storage, and waste products. Furthermore, if facilities are able to demonstrate their storm water discharge has similar characteristics, that is one element in the analysis needed for establishing that the group is appropriate. EPA disagrees that the criteria are too vague. If facilities are concerned that general permit criteria is insufficient guidance, then subcategories under 40 CFR subchapter N should be used. EPA believes that the program will function best if flexibility for creating groups is maintained.

If a NPDES approved State feels that a tighter grouping of applicants is appropriate individual permit applications can be requested from those permit applicants. One commenter indicated that it was not clear whether the group application procedure could be used for all NPDES requirements EPA would clarify that the group application is designed only to cover storm water discharges from the industrial facilities identified in § 122.26(b)(14).

As noted above, EPA wishes to clarify that facilities with existing individual NPDES permits for storm water are not eligible to participate in the group application process. From an administrative standpoint EPA is not prepared to create an entirely different mechanism for permitting industries which already have such permits.

c. Group Application Requirements. The group application, as proposed, included the following requirements in three separate parts. Part 1A of a group application included: (A) Identification of the participants in the group application by name and location; (B) a narrative description summarizing the industrial activities of participants; (C) a list of significant materials stored outside by participants; and (D) identification of 10 percent of the dischargers participating in the group application for submitting quantitative data. A proposed part 1B of the group application included the following information from each participant in the group application. (A) A site map showing topography (or indicating the outline of drainage areas served by the outfall(s) and related information; (B) an estimate of the area of impervious surfaces (including paved areas and building roofs) and the total area drained by each outfall and a narrative description of significant materials; (C) a certification that all outfalls that should contain storm water discharges associated with industrial activity have been tested for the presence of non-storm water discharges; (D) existing information regarding significant leaks or spills of toxic or hazardous pollutants at the facility; (E) a narrative description of industrial activities at the facility that are different from or that are in addition to the activities described under part 1A; and (F) a list of all constituents that are addressed in a NPDES permit issued to the facility for any of non-storm water discharge. Part 2 of a group application required quantitative data from 10 percent of the facilities identified.

Some commenters felt that spill histories, drainage maps, material management practices, and information on significant materials stored outside are too burdensome or meaningless for evaluating similarity of discharges among group applicants. Several commenters stated that such requirements where the group may consist of several thousand facilities were impractical and would not assist EPA in developing model permits. Many commenters insisted that the requirements imposed in part 1B would effectively discourage use of the group application procedure. EPA agrees in large part with these comments. After reevaluating the components of part 1B, and the entire rationale for instituting the group application procedure, EPA has decided to excise part 1B from the requirements, and rely on part 1A and part 2 for developing appropriate permit condition. Where appropriate, EPA may require facilities to submit the information, formerly in part 1B, during the term of the permit. In other cases, EPA will establish which facilities must submit individual permit applications where more site specific permits are appropriate.

Under the revised part 1 and part 2, EPA will receive information pertaining to the types of industrial activity engaged in by the group, materials used by the facilities, and representative quantitative data. EPA can use such information to develop management practices that address pollutants in storm water discharges from such facilities. For most facilities, general good housekeeping or management practices will eliminate pollutants in storm water. Such requirements can be further refined by determining the nature of a group's industrial activity and by obtaining information on material used at the facility and representative quantitative data from a

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percentage of the facilities. Thus, EPA is confident that model permits and general permits can be developed from the information to be submitted under part 1 and part 2.

One commenter felt that more guidance on what makes a facility representative for sampling as part of a group is needed. In response, the Agency believes the rule as currently drafted provides adequate notice.

Another commenter asked how much sampling needed to be done and how much monitoring will transpire over the life of the permit for members of a group. This will vary from permit to permit and will be determined in permit proceedings. This rulemaking only covers the quantitative data that is to be submitted in the context of the group permit application.

One commenter indicated that because of the amount of diversity in the operations of a particular industry, obtaining a sample that could be considered representative would be extremely difficult. EPA recognizes that obtaining representative quantitative data through the group application process will prove to be difficult; however, EPA has sought to minimize these perceived problems. Under the group application concept, industries must be sufficiently similar to qualify. Industries which have significantly different operations from the rest of the group that affects the quality of their storm water discharge may be required to obtain an individual permit. Use of the nine precipitation zones will enable the data in the permit application to be more easily analyzed and patterns observed on the basis of hydrology and other regional factors. How EPA will evaluate the representativeness of the sample is discussed below.

Several commenters asked why the precipitation zone of group members is relevant to the application. The need to identify precipitation zones arises because the amount of rainfall is likely to have a significant impact on the quality of the receiving water. According to an EPA study (Methodology for Analysis of Detention Basins for Control of Urban Runoff Quality; Office of Water, Nonpoint Source Branch, Sept. 1986) the United States can be divided into nine general precipitation zones. These zones are characterized by differences in precipitation volume, precipitation intensity, precipitation duration, and precipitation intervals. Industrial facilities that seek general permits via the group application option may show significantly different loading rates as a result of these regional precipitation differences. As an example, precipitation in Seattle, Washington, located in Zone 7, approaches the mean annual storm intensity of .024 inches/hour with a mean annual storm duration of 20 hours for that Zone. In contrast, precipitation in Atlanta, Georgia, located in Zone 3 approaches the mean annual storm intensity of .102 inches/hour and a mean storm duration of 6.2 hours for that Zone. Atlanta, receives on the average four times more precipitation per hour with storms lasting one-third as long. As a result of these differences, if identical facilities within a group application were situated in each of these areas, their storm water discharges would likely exhibit different pollutant characteristics. Accordingly, data should be submitted from facilities in each zone.

One commenter felt that the EPA should abandon or modify its rainfall zone concept, because storm water quality will depend more on what materials are used at the facility than rainfall. EPA disagrees. Because storm water loading rates may differ significantly as a result of regional precipitation differences, it is necessary that for each precipitation zone containing representatives of a group application, the group must provide samples from some of those representatives. In comments to previous rulemakings it was argued that the amount of rainfall will affect the degree of impact a storm water discharge may have on the receiving stream.

One commenter stated that the precipitation zones illustrated in appendix E of the proposed rulemaking do not adequately reflect regional differences in precipitation and that in some cases the zones cut through cities where there are concentrations of industries without differences in their precipitation patterns. The rainfall zone map is a general guide to determining what areas of the country need to be addressed when determining representative rainfall events and quantitative data. When dealing with rainfall on a national scale, it is near impossible to make generalized statements with a great deal of accuracy. In the case of rainfall zones, rainfall patterns may be similar for facilities in close proximity to each other but none the less in different rainfall zones. In response, EPA has created these zones to reflect regional rainfall patterns as accurately as possible. Because of the variable nature of rainfall such circumstances are sure to arise. However, in order to obtain a degree of representativeness EPA is convinced that the use of these rainfall zones as described is appropriate for the submittal of group applications and the quantitative data therein.

The second and third requirements of part 1 of the group application instruct the applicant to describe the industrial activity (processes) and the significant materials used by the group. For the significant materials listed, the applicant is to discuss the materials management practices employed by members of the group. For example, the applicant should identify whether such materials are commonly covered, contained, or enclosed, and whether storm water runoff from materials storage areas is collected in settling ponds prior to discharge or diverted away from such areas to minimize the likelihood of contamination. Also, the approximate percentage of facilities in the group with no practices in place to minimize materials stored outside is to be identified.

EPA considers that the processes and materials used at a particular facility may have a bearing on the quality of the storm water. Thus, if there are different processes and materials used by members of the group, the application must identify those facilities utilizing the different processes and materials, with an explanation as to why these facilities should still be considered similar.

One commenter felt that a facility should be able to describe in its permit application the possibility of individual materials entering receiving waters. EPA supports the applicant adding site specific information which will assist the permit writer making an informed decision about the nature of the facility, the quality of its storm water discharge, and appropriate permit conditions.

The fourth element of part 1 of the group application is a commitment to submit quantitative data from ten percent of the facilities listed. EPA proposed that there must be a minimum of ten and a maximum of one hundred facilities within a group that submit data. Comments reflected some dissatisfaction with this requirement. Some commenters asserted that ten percent was too high a number and would discourage group applications, while one commenter suggested a lesser percentage would be appropriate where the group can certify that facilities are representative. One commenter suggested that EPA have the discretion to allow for a smaller percentage. Several commenters argued that EPA should be satisfied with fewer than ten percent because EPA often relies on data from less than ten percent of the plants in a subcategory when promulgating effluent guidelines and that EPA should rely on data collection goals

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with affected groups as was done in the 1985 storm water proposal. Other commenters pointed out that an anomalous situation could arise where the group was small and facilities were scattered throughout the precipitation zones. For example, if a group consisted of 20 members where a minimum of ten facilities had to submit samples, and two or more members were in each precipitation zone; a total of 18 facilities (90% of the group) would have to submit quantitative data. EPA believes that there must be a sufficient number of facilities submitting data for any patterns and trends to be detectable. However, in light of these comments EPA has decided to modify the language in § 122.26(c) to allow 1 discharger in each precipitation zone to submit quantitative data where 10 or fewer of the group members are located in a particular precipitation zone. EPA believes, however, that one hundred facilities would in most cases be sufficient to characterize the nature of the runoff and thus 100 should remain the maximum. If the data are insufficient, EPA has the authority to request more sampling under section 308 of the CWA.

One commenter suggested that the ten facility cutoff was unreasonable, and that instead of cutting off the group at ten, allow a smaller number in the group and allow the facilities to sample ten percent of their outfalls instead. EPA agrees, in part, and will allow groups of between four and ten to submit a group application. However, the ten percent rule would not be effective in such cases. Therefore, at least half the facilities in a group of four to ten will be required to provide quantitative data from at least one outfall, with each precipitation zone represented by at least one facility.

For any group application, in addition to selecting a sufficient number of facilities from each precipitation zone, facilities selected to do the sampling should be representative of the group as a whole in terms of those characteristics identifying the group which were described in the narrative, i.e., number and range of facilities, types of processes used, and any other relevant factors. If there is some variation in the processes used by the group (40 percent of the group of food processors are canners and 60 percent are canners and freezers, for example), the different processes are to be represented. Also, samples are to be provided from facilities utilizing the materials management practices identified including those facilities which use no materials management practices. The representation of these different factors, to the extent feasible, is to be roughly equivalent to their proportion in the group.

EPA wishes to emphasize that the provision that ten percent of the facilities need to submit quantitative data only applies to the permit application process. The general or individual permit itself may require quantitative data from each facility.

Submittal of Part 2 of the Group Application. As with part 1, part 2 of the Group Application would be submitted to the Office of Water Enforcement and Permits, in Washington, DC. If the information is incomplete, or simply is found to be an inadequate basis for establishing model permit limits, EPA has the authority under section 308 of the Clean Water Act to require that more information be submitted, which may include sampling from facilities that were part of the group application but did not provide data with the initial submission. If the group application is used by a Region or NPDES State to issue a general permit, the general permit should specify procedures for additional coverage under the permit.

If a part 2 is unacceptable or insufficient, EPA has the option to request additional information or to require that the facilities that participated in the group application submit complete individual applications (e.g. facilities that have submitted Form 1 with the group application may be required to submit Form 2F, or facilities which have submitted complete Form 1 and Form 2F information in the group application generally would not have to submit additional information).

Once the group applications are reviewed and accepted, EPA will use the information to establish draft permit terms and conditions for models for individual and general permits. NPDES approved States and EPA regional offices will continue to be the permit-issuing authority for storm water discharges. The NPDES approved States accepting the group application approach and the EPA Regions may then take the model permits and adapt them for their particular area, making adjustments for local water quality standards and other localized characteristics, and making determinations as to the need for an individual storm water permit where general permit coverage is felt to be inappropriate. Permits would be proposed by the Region or NPDES approved State in accordance with current regulations for public comment before becoming final. In NPDES States without general permit authority, or where an individual permit is deemed appropriate, the model permit can serve as the basis for issuing an individual permit.

The group application is an NPDES permit application just like any other and, as such, would be handled through normal permitting procedures, subject to the regulatory provisions applicable to permit issuance. Incomplete or otherwise inadequate submissions would be handled in the same manner as any other inadequate permit application. The permit issuing authority would retain the right to require submission of Form 1, Form 2C and Form 2F from any individual discharger it designates.

Some commenters offered other procedures for developing a group application procedure; however, these were frequently entirely different approaches or so novel that a reproposal would be required. One commenter suggested that those industries that are identified as being likely to pollute should be required to submit quantitative data. Numerous commenters contended that a generic approach for meeting the required information requirements for group applications would allow EPA to develop adequate general permits. EPA does not view these approaches as appropriate.

5. Group Application: Applicability in NPDES States

Many commenters expressed concern about how the group application procedure will work within the framework of an NPDES approved State. The relationship between EPA and the States that are authorized to administer the NPDES program, including implementation of the storm water program, is a complicated aspect of this rulemaking. Approved States (there are 38 States and one territory so approved) must have requirements that are at least as stringent as the Federal program; they may be more stringent if they choose. Authority to issue general permits is optional with NPDES States.

EPA has determined that ten percent of the facilities must provide quantitative data in the permit application as noted above. Furthermore, these applications are submitted to EPA headquarters. Consequently States, whether NPDES approved or not, are not in a position to reject or modify this requirement. Such States may determine the amount of sampling to be done pursuant to permit conditions. If they choose to issue general permits they may include such authority in their NPDES program and,

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upon approval of the program by EPA, may then issue general permits. Within the context of the NPDES provisions of the CWA, if States do not have general permitting authority, then general permits are not available in those States.

In response to one comment, EPA does not have authority to issue general or individual permits to facilities in NPDES approved states. Todey's rule provides a means for affected industries to be covered by general permits developed via the group application procedure as well as from general permits developed independently of the group application process. Accordingly, today's rule anticipates that most NPDES States will seek general permit issuance authority to implement the storm water program in the most efficient and economical way. Without general permit issuance authority NPDES States will be required to issue individual permits covering storm water discharges to potentially thousands of industrial facilities.

One commenter recommended that States with approved NPDES programs should be involved in determining what industries ere representative for submitting quantitative data. EPA recognizes that States will heve an interest in this determination and may possess insight as to the appropriateness of using some facilities. However, EPA may be managing hundreds of group epplications and approving or disapproving them as expeditiously as possible. EPA believes that involving the States in this already administratively complex and time consuming undertaking would be counterproductive. In any event, NPDES approved States are not bound by the determinations of EPA as to the appropriateness of groups or the issuance of permits based on model permits or individual permits. However, States will be encouraged to use model permits that are developed by EPA. EPA will endeavor to design general and model permits that are effective while also adaptable to the concerns of different States. Again, States are able to develop more stringent standards where they deem it to be appropriate. There are currently seventeen States that have authority to issue general permits: Arkansas, Colorado, Illinois, Kentucky, Minnesota, Missouri, Montana, New Jersey, North Dakota, Oregon, Rhode Island, Utah, Washington, West Virginia and Wisconsin. As suggested in the comments, EPA is encouraging more States to develop general permit issuin. authority in order to facilitate the permitting process.

One commenter advised that the rules should state that a NPDES epproved State may accept a group application or require additional information. EPA has decided not to explicitly state this in the rule. However, this comment does raise some points that need to be addressed. Because the group application option is a modification of existing NPDES permit application requirements, the State is free to adopt this option, but is not required to. If the State chooses to adopt the group application and it does not have general permit authority, the group application can be used to issue individual permits. If an approved NPDES State chooses to not issue permits based on the group application, facilities that discharge storm water associated with industrial activity that are located in that State must submit individual applications to the State permitting authority. Before submitting a group application, facilities should ascertain from the State permitting authority whether that State intends to issue permits based upon a group application approved by EPA for the purpose of developing general permits. For facilities that discharge storm water associated with industrial activity which are named in a group application, the Director may require an individual facilty to submit an individual application where he or she determines that general permit coverage would be inappropriate for the particular facility.

One commenter stressed that EPA should streamline the procedure for States desiring to obtain general permit coverage. EPA has, over the last year, streamlined this procedure and encourages States to take advantage of this procedure. EPA recommends that States consider obtaining general permit authority as a means to efficiently issue permits for storm water discharges. These States should contact the Office of Water Enforcement and Permits at EPA Headquarters as soon as possible.

6. Group Application: Procedural Concerns

One commenter claimed that the proposed group epplication process and procedures violated federal law. This commenter claimed that EPA was abrogating its responsibility by allowing a trade association to design a data collection plan in lieu of completing an NPDES application form designed by EPA, thus violating the Federal Advisory Committee Act. The commenter stated that EPA would be improperly influenced by special interests if trade associations were able to design their own storm water data gathering plans. The commenter further asserted that any decisions by EPA on the content of specific group applicetions would be rulemakings and thus subject to the provisions of the Administrative Procedure Act.

EPA disagrees with the comment that the group application violates the Federal Advisory Committee Act (FACA). FACA governs only those groups that are established or "utilized" by an agency for the purpose of obtaining "advice" or "recommendations." The group application option does not solicit or involve any "advice" or "recommendations." It simply allows submission of data by certain members of a group in accordance with specific regulatory criteria for determining which facilities are "representative" of a group. As such, the group application is merely a submission in accordance and in compliance with specific regulatory requirements and does not contain discretionary uncircumscribed "advice" or "recommendations" as to which facilities are representative of a group.

Thus, the determination of which facilities should submit testing data in accordance with regulatory criteria is little different from many other regulatory requirements where an applicant must submit information in accordance with certain criteria. For example, under 40 CFR 122.21 all outfalls must be tested except where two or more have "substantially identical" effluents. Similarly, quantitative data for certain pollutants are to be provided where the applicant knows or "has reason to believe" such pollutants are discharged. Both of these provisions allow the applicant to exercise discretion in making certain judgments but such action is circumscribed by regulatory standards. EPA further has authority to require these facilities to submit individual applications. In none of these instances are "recommendations" or "advice" involved. EPA also notes that it is questionable whether, in providing for group applications, it is "soliciting" advice or recommendations from groups or that such groups are being "utilized" by EPA as a "preferred source" of advice. See 48 FR 19324 (April 28, 1983). Furthermore, this data collection effort may be supplemented by EPA if, after review of the data, EPA determines additional data is necessary for permit issuance. Other information gathering may act as a check on the group applications received.

EPA also does not agree with this commenter's claim that the group application scheme represents an

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impermissible delegation of the Administrator's function in violation of the CWA regarding data gathering. The Administrator has the broadest discretion in determining what information is needed for permit development as well as the manner in which such information will be collected. The CWA does not require every discharger required to obtain a permit to file an application. Nor does the CWA require that the Administrator obtain data on which a permit is to be based through a formal application process (see 40 CFR 122.21). For years "applications" have not been required from dischargers covered by general permits. EPA currently obtains much information beyond that provided in applications pursuant to section 308 of the CWA. This is especially true with respect to general permit and effluent limitations guidelines development. The group application option is simply another means of data gathering. The Administrator may always collect more data should he determine it necessary upon review of a groups' data submission. And, he may obtain such additional data by whatever means permissible under the Statute that he deems appropriate. Thus, it can hardly be said that by this initial data gathering effort the Administrator has delegated his data gathering responsibilities. In addition, since groups are required to select "representative" facilities, etc., in accordance with specific regulatory requirements established by the Administrator and because EPA will scrutinize part 1 of the group applications and either accept or reject the group as appropriate for a group application, no impermissible delegation has occurred. EPA will make an independent determination of the acceptability of a group application in view of the information required to be submitted by the group applicant, other information available to EPA (such as information on industrial subcategories obtained in developing effluent limitations guidelines as well as individual storm water applications received as a result of today's rule) and any further information EPA may request to supplement part 1 pursuant to section 308 of the CWA. Moreover, any concerns that a general permit may be based upon biased data can be dealt with in the public permit issuance process.

Finally, EPA also does not agree that the group application option violates the Administrative Procedures Act. Again, the group application scheme is simply a data gathering device. EPA could very well have determined to gather data informally via specific requests pursuant to section 308 of the CWA. In fact, general permit and effluent limitations guideline development proceed along these lines. It would make little sense if the latter informal data gathering process were somehow illegal simply because it is set forth in a rule that allows applicants some relief upon certain showings. In this respect, several of EPA's existing regulations similarly allow an applicant to be relieved from certain data submission requirements upon appropriate demonstrations. For example, testing for certain pollutants and or certain outfalls may be waived under certain circumstances. Most importantly, the operative action of concern that impacts on the public is individual or general permit issuance based upon data obtained. As previously stated, ample opportunity for public participation is provided in the permit issuance proceeding.

7. Permit Applicability and Applications for Oil and Gas and Mining Operations

Oil, gas and mining facilities are among those industrial sites that are likely to discharge storm water runoff that is contaminated by process wastes, toxic pollutants, hazardous substances, or oil and grease. Such contamination can include disturbed soils and process wastes containing heavy metals or suspended or dissolved solids, salts, surfactants, or solvents used or produced in oil and gas operations. Because they have the potential for serious water quality impacts, Congress recognized, throughout the development of the storm water provisions of the Water Quality Act of 1987, the need to control storm water discharges from oil, gas, and mining operations, as well as those associated with other industrial activities.

However, Congress also recognized that there are numerous situations in the mining and oil and gas industries where storm water is channeled around plants and operations through a series of ditches and other structural devices in order to prevent pollution of the storm water by harmful contaminants. From the standpoint of resource drain on both EPA as the permitting agency and potential permit applicants, the conclusion was that operators that use good management practices and make expenditures to prevent contamination must not be burdened with the requirement to obtain a permit. Hence, section 402(1)(2) creates a statutory exemption from storm water permitting requirements for uncontaminated runoff from these facilities.

To implement section 402(1)(2), EPA intends to require permits for contaminated storm water discharges from oil, gas and mining operations. Storm water discharges that are not contaminated by contact with any overburden, raw material, intermediate products, finished product, byproduct or waste products located on the site of such operations will not be required to obtain a storm water discharge permit.

The regulated discharge associated with industrial activity is the discharge from any conveyance used for collecting and conveying storm water located at an industrial plant or directly related to manufacturing, processing or raw materials storage areas at an industrial plant. Industrial plants include facilities classified as Standard Industrial Classifications (SIC) 10 through 14 (the mining industry), including oil and gas exploration, production, processing, and treatment operations, as well as transmission facilities. See 40 CFR 122.26(b)(14)(iii). This also includes plant areas that are no longer used for such activities, as well as areas that are currently being used for industrial processes.

a. Oil and Gas Operations. In determining whether storm water discharges from oil and gas facilities are "contaminated", the legislative history reflects that the EPA should consider whether oil, grease, or hazardous materials are present in storm water runoff from the sites described above in excess of reportable quantities (RQs) under section 311 of the Clean Water Act or section 102 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). [Vol. 132 Cong. Rec. H10574 (daily ed. October 15, 1986) Conference Report].

Many of the comments received by EPA regarding this exemption focused on the concern that EPA's test for requiring a permit is and would subject an unnecessarily large number of oil and gas facilities to permit application requirements. Specific comments made in support of this concern are addressed below.

A primary issue raised by commenters centered on how to determine when a storm water discharge from an oil or gas facility is "contaminated", and therefore subject to the permitting program under section 402 of the CWA. Many of the comments received from industry representatives objected to the Agency's intent as expressed in the proposal to use past discharges as a trigger for submitting permit applications.

The proposed rule provided that the notification requirements for releases excess of RQs established under the CWA and CERCLA would serve as a

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basis for triggering the submittal of permit applications for storm water discharges from oil and gas facilities. As described in the proposal, oil and gas operations that have been required to notify authorities of the release of either oil or a hazardous substance via a storm water route would be required to submit a permit application. In other words, any facility required to provide notification of the release of an RQ of oil or a hazardous substance in storm water in the past would be required to apply for a storm water permit under the current rule. In addition, any facility required to provide notification regarding a release occurring from the effective date of today's rule forward would be required to apply for a storm water permit.

Commenters maintained that the use of historical discharges to require permit applications is inconsistent with the language and intent of section 402(1)(2) of the CWA, and relevant legislative history, both of which focus on present contamination. Requiring storm water permits based solely on the occurrence of past contaminated discharges, even where no present contamination is evident, would go beyond the statutory requirement that EPA not issue a permit absent a finding present contamination. Commenters also noted that the proposal did not take into account the fact that past problems leading to such releases may have been corrected, and that requiring an NPDES permit may no longer be necessary. The result of such a requirement, commenters maintained, would be an excessive number of unnecessary permit applications being submitted, at significant cost and minimal benefit to both regulated facilities and regulating authorities.

Commenters also indicated that using the release of reportable quantities of oil, grease or hazardous substances as a permit trigger would identify discharges of an isolated nature, rather than the continuous discharges, which should be the focus of the NPDES permit program under section 402. Such an approach, commenters maintained, is inconsistent with existing regulations under section 311 of the CWA, and would result in permit applications from facilities that are more appropriately regulated under section 311.

Despite these criticisms, many commenters recognized that the Agency is left with the task of determining when discharges from oil and gas facilities are contaminated, in order to regulate them under section 402(1)(2). It was suggested by numerous commenters that the EPA adopt an approach similar to that used under section 311 of the CWA for Spill Prevention Control and Countermeasure (SPCC) Plans. Under SPCC, facilities that are likely to discharge oil into waters of the United States are required to maintain a SPCC plan. In the event the facility has a spill of 1,000 gallons or 2 or more reportable quantities of oil in a 12 month period, the facility is required to submit its SPCC plan to the Agency. The triggering events proposed by the commenters for storm water permits for oil and gas operations are six reportable sheens or discharges of hazardous substances (other than oil) in excess of section 311 or section 102 reportable quantities via a storm water point source route over any thirty-six month period. It was suggested that if this threshold is reached, an operator would then file a permit application (or join a group application) based upon the presumption that its current storm water discharges are contaminated.

In response to these comments, the Agency believes that past releases that are reportable quantities can be a valid indicator of the potential for present contamination of discharges. The legislative history as cited above supports this conclusion. EPA would note that the existence of a RQ release would serve only as a triggering mechanism for a permit application. Under the proposed rule, evidence of past contamination would merely require submission of a permit application and would not be used as conclusive evidence of current contamination. The determination as to whether a permit would be actually required due to current contaminated discharge would be made by the permitting authority after reviewing the permit application. The fact of a past RQ release does not necessarily imply a conclusive finding of contamination, only that sufficient potential for contamination exists to warrant a permit application or the collection of other further information. Today's rule does not change the proposed approach in this respect. Thus, EPA does not believe that today's rule exceeds the authority of section 402(1)(2).

EPA believes that there is no legal impediment to using past RQ discharges as a trigger for requiring a storm water permit application. EPA notes that, as mentioned above, even those commenters who objected to the proposed test on legal authority grounds merely offered an alternate test that requires more releases to have occurred within a shorter period of time before a permit application is required.

Therefore, the only disagreement that remains is over what constitutes a reasonable test that will identify facilities with the potential for storm water contamination. EPA notes that neither the statute nor the legislative history provides any guidance on this question. Furthermore, EPA disagrees with the commenters who suggested that 6 releases in the past 3 years or 2 releases in the past year are necessarily more valid measures of the potential for current contamination than EPA's proposed test. There is no statistical or other basis for preferring one test to the other. However, EPA does agree with those commenters that suggest that a single release in the distant past may not accurately reflect current conditions and the current potential for contamination.

EPA has therefore amended today's rule to provide that only oil and gas facilities which have had a release of an RQ of oil or hazardous substances in storm water in the past three years will be required to submit a permit application. EPA believes that limiting the permit trigger to events of the past three years will address commenters' concerns regarding the use of "stale history" in determining whether an application is required. EPA notes that the three year cutoff is consistent with the requirement for industrial facilities to report significant leaks or spills at the facility in their storm water permit applications. See 40 CFR 122.26(c)(1)(i)(D).

Commenters asserted that EPA and the States must have some reasonable basis for concluding that a storm water discharge is contaminated before requiring permit applications or permits. Commenters believed that § 122.26(c)(1)(iii)(B) as proposed implied that the Agency's authority in this respect is unrestricted. In response, EPA may collect such data by whatever appropriate means the statute allows, in order to obtain information that a permit is required. Usually, the most practical tool for doing so is the permit application itself. However, if necessary to supplement the information made available to the Agency, EPA has broad authority to obtain information necessary to determine whether or not a permit is required, under section 308 of the Clean Water Act. Given the plain language of the CWA and the Congressional intent as manifested in the legislative history, the Agency is convinced that the approach described above is appropriate. Yet, as further discussed below, EPA has also deleted as redundant § 122.26(c)(1)(iii)(B).

Regarding the types of facilities included in the storm water regulation, a number of commenters suggested that the Agency has misconstrued the meaning of facilities "associated with

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industrial activity", and has proposed an overly broad definition of such facilities in the oil and gas industry. Specifically, commenters suggested that only the manufacturing sector of the oil and gas industry should be subject to storm water permit application requirements, and that exploration and production activities, gas stations, terminals, and bulk plants should all be exempted from storm water permitting requirements. Commenters maintain that this broad interpretation would subject many oil and gas facilities to the storm water permit requirements, when these were not intended by Congress to be so regulated. As a second point related to this issue, some commenters felt that transmission facilities were not intended to be regulated under the storm water provisions, and should be exempted from permit requirements. This would be consistent, it was argued, with legislative history which concluded that transmission facilities do not significantly contribute to the contamination of water.

The Agency disagrees that these facilities do not fall under the storm water permitting requirements as envisioned by Congress. SIC 13, which is relied upon by EPA to identify these oil and gas operations, describes oil and gas extraction industries as including facilities related to crude oil and natural gas, natural gas liquids, drilling oil and gas wells, oil and gas exploration and field services. Moreover, legislative history as it applies to industrial activities, and thus to oil and gas (mining) operations, expressly includes exploration, production, processing, transmission, and treatment operations within the purview of storm water permitting requirements and exemptions. EPA's intent is for storm water permit requirements (and the exemption at hand) to apply to the activities listed above (exploration, production, processing, treatment, and transmission) as they relate to the categories listed in SIC 13.

Commenters requested clarification from the Agency that storm water discharges from oil and gas facilities require a permit or the filing of a permit application only when they are contaminated at the point of discharge into waters of the United States. Commenters noted that large amounts of potentially contaminated stormwater may not enter waters of the United States, or may enter at a point once the discharge is no longer "contaminated". In these cases, it should be clear that no permit or permit application is required.

EPA agrees that oil and gas exploration, production, processing, or treatment operations or transmission facilities must only obtain a storm water permit when a discharge to waters of the U.S. (including those discharges through municipal separate storm sewers) is contaminated. A permit application will be required when any discharge in the past three years or henceforth meets the test discussed above.

Under the proposed rule, the Agency stated at § 122.26(c)(1)(iii)(B) that the Director may require on a case-by-case basis the operator of an existing or new storm water discharge from an oil or gas exploration, production, processing, or treatment operation, or transmission facility to submit an individual permit application. The Agency has removed this section since CWA section 402(l)(2), as codified in 122.26(c)(1)(iii)(A), adequately addresses every situation where a permit should be required for these facilities.

b. Use of Reportable Quantities to Determine if a Storm Water Discharge from an Oil or Gas Operation is Contaminated. Section 311(b)(5) of the CWA requires reporting of certain discharges of oil or a hazardous substance into waters of the United States (see 44 FR 50766 (August 29, 1979)). Section 304(b)(4) of the Act requires that notification levels for oil and hazardous substances be set at quantities which may be harmful to the public health or welfare of the United States, including but not limited to fish, shellfish, wildlife, and public or private property, shorelines and beaches. Facilities which discharge oil or a hazardous substance in quantities equal to or in excess of an RQ, with certain exceptions, are required to notify the National Response Center (NRC).

Section 102 of CERCLA extended the reporting requirement for releases equal to or exceeding an RQ of a hazardous substance by adding chemicals to the list of hazardous substances, and by extending the reporting requirement (with certain exceptions) to any releases to the environment, not just those to waters of the United States.

Pursuant to section 311 of the CWA, EPA determined reportable quantities for discharges by correlating aquatic animal toxicity ranges with 5 reporting quantities, i.e., 1-, 10-, 100-, 1000-, and 5000- pounds per 24 hour period levels. Reportable quantity adjustments made under CERCLA rely on a different methodology. The strategy for adjusting reportable quantities begins with an evaluation of the intrinsic physical, chemical, and toxicological properties of each designated hazardous substance. The intrinsic properties examined, called "primary criteria," are aquatic toxicity, mammalian toxicity (oral, dermal, and inhalation), ignitability, reactivity, and chronic toxicity. In addition, substances that were identified as potential carcinogens have been evaluated for their relative activity as potential carcinogens. Each intrinsic property is ranked on a five-tier scale, associating a specific range of values on each scale with a particular reportable quantity value. After the primary criteria reportable quantities are assigned, the hazardous substances are further evaluated for their susceptibility to certain extrinsic degradation processes (secondary criteria). Secondary criteria consider whether a substance degrades relatively rapidly to a less harmful compound, and can be used to raise the primary criteria reportable quantity one level.

Also pursuant to section 311, EPA has developed a reportable quantity for oil and associated reporting requirements at 40 CFR part 110. These requirements, known as the oil sheen regulation, define the RQ for oil to be the amount of oil that violates applicable water quality standards or causes a film or sheen upon or discoloration of the surface of the water or adjoining shorelines or causes a sludge or emulsion to be deposited.

Reportable quantities developed under the CWA and CERCLA were not developed as effluent guideline limitations which establish allowable limits for pollutant discharges to surface waters. Rather, a major purpose of the notification requirements is to alert government officials to releases of hazardous substances that may require rapid response to protect public health, welfare, and the environment. Notification based on reportable quantities serves as a trigger for informing the government of a release so that the need for response can be evaluated and any necessary response undertaken in a timely fashion. The reportable quantities do not themselves represent any determination that releases of a particular quantity are actually harmful to public health, welfare, or the environment.

EPA requested comment on the use of RQs for determining contamination in discharges from oil and gas facilities. As noted above numerous commenters supported the concept of using reportable quantities under certain circumstances. Comments on the measurement of oil sheens for the purpose of triggering a permit application were divided. Some commented that it is much too stringent because the amount of oil creating a

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sheen may be a relatively small amount. Others viewed the test as a quick, easy, practical method that has been effective in the past.

In relying on the reporting requirements associated with releases in excess of RQs for oil or hazardous substances to trigger the submittal of permit applications for oil and gas operations, the Agency believes that the use of the reporting requirements for oil will be particularly useful. The Agency believes that the release of oil to a storm water discharge in amounts that cause an oil sheen is a good indicator of the potential for water quality impacts from storm water releases from oil and gas operations. In addition, given the extremely high number of such operations (the Agency estimates that there are over 750,000 oil wells alone in the United States), relying on the oil sheen test to determine if storm water discharges from such sites are "contaminated" will be a far easier test for operators to determine whether to file a storm water permit application than a test based on sampling. The detection of a sheen does not require sophisticated instrumentation since a sheen is easily perceived by visual observation. EPA agrees with those comments calling the oil sheen test an appropriate measure for triggering a storm water permit application. In adopting this approach, EPA recognizes, as pointed out by many commenters that an oil sheen can be created with a relatively small amount of oil.

One commenter suggested that contamination must be caused by contact with on-site material before being subject to permit application requirements. The Agency agrees with this comment. Those facilities that have had releases in excess of reportable quantities will generally have contamination from contact with on-site material as described in the CWA. Thus, use of the RQ test is an appropriate trigger. As discussed above, determination of whether contamination is present to warrant issuance of a permit will be made in the context of the permit proceeding.

One commenter believed that the use of RQs is inappropriate because "the statute intended to exempt only oil and gas runoff that is not contaminated at all." The Agency wishes to clarify that reportable quantities are being used to determine what facilities need to file permit applications and to describe what is meant by the term "contaminated." The Director may require a permit for any discharges of storm water runoff contaminated by contact with any overburden, raw material, intermediate product, finished product, by product or waste product at the site of such operations. The use of RQs is solely a mechanism for identifying the facilities most likely to need a storm water permit consistent with the legislative history of section 402(l)(2).

c. Mining Operations. The December 7, 1988 proposal would establish background levels as the standard used to define when a storm water discharge from a mining operation is contaminated. When a storm water discharge from a mining site was found to contain pollutants at levels that exceed background levels, the owner or operator of the site was required to submit a permit application for that operation. The proposal was founded upon language in the legislative history stating that the determination of whether storm water is contaminated by contact with overburden, raw material, intermediate product, finished product, byproduct, or waste products "shall take into consideration whether these materials are present in such stormwater runoff . . . above natural background levels". [Vol. 132 Cong. Rec. H10574 (daily ed. Oct. 15, 1986) Conference Report].

Comments received on this component of the rule suggested that background levels of pollutants would be very difficult to calculate due to the complex topography frequently encountered in alpine mining regions. For example, if a mine is located in a mountain valley surrounded on all sides by hills, the site will have innumerable slopes feeding flow towards it. Under such circumstances, determining how the background level is set would prove impractical. Commenters indicated that it is very difficult to measure or determine background levels at sites where mining has occurred for prolonged periods. In many instances, data on original background levels may not be available due to long-term site activity. As a result, any background level established will vary based on the type and level of previous activity. In addition, mining sites typically have background levels that are naturally distinct from the surrounding areas. This is due to the geologic characteristics that makes them valuable as mining sites to begin with. This also makes it difficult to establish accurate background levels.

Because of these concerns EPA has decided to drop the use of background levels as a measure for determining whether a permit application is required. Accordingly, a permit application will be required when discharges of storm water runoff from mining operations come into contact with any overburden, raw material, intermediate product, finished product, byproduct, or waste product located on the site. Similar to the RQ test for oil and gas operations, EPA intends to use the "contact" test solely as a permit application trigger. The determination of whether a mining operation's runoff is contaminated will be made in the context of the permit issuance proceedings.

If the owner or operator determines that no storm water runoff comes into contact with overburden, raw material, intermediate product, finished product, byproduct, or waste products, then there is no obligation to file a permit application. This framework is consistent with the statutory provisions of section 402(1)(2) and is intended to encourage each mining site to adopt the best possible management controls to prevent such contact.

Several commenters stated that EPA's use of total pollutant loadings for determining permit applicability is not consistent with the general framework of the NPDES program. Their concern is that such evaluation criteria depart from how the NPDES program has been administered in the past, based on concentration limits. In addition, commenters requested that EPA clarify that information on mass loading will be used for determining the need for a permit only. Since the analysis of natural background levels as a basis for a permit application has been dropped from this rulemaking, these issues are moot.

Commenters noted that the proposed rule did not specify what impact this rulemaking has on the storm water exemptions in 40 CFR 440.131. The commenters recommended not changing any of these provisions. Some commenters indicated that mining facilities that have NPDES permits should not be subject to additional permitting under the storm water rule. EPA does not intend that today's rule have any effect on the conditional exemptions in 40 CFR 440.131. Where a facility has an overflow or excess discharge of process-related effluent due to stormwater runoff, the conditional exemptions in 40 CFR 440.131 remain available.

Several commenters note that the term overburden, as used in the context of the proposed storm water rule, is not defined and recommended that this term should be defined to delineate the scope of the regulation. EPA agrees that the term overburden should be defined to help properly define the scope the storm water rule. In today's rule, the term

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overburden has been clarified to mean any material of any nature overlying a mineral deposit that is removed to gain access to that deposit, excluding topsoil or similar naturally-occurring surface materials that are not disturbed by mining operations. This definition is patterned after the overburden definition in SMCRA, and is designed to exclude undisturbed lands from permit coverage as industrial activity. However, the definition provided in this regulation may be revised at a later date, to achieve consistency with the promulgation of RCRA Subtitle D mining waste regulations in the future.

Numerous commenters raised issues pertaining to the inclusion of inactive mining areas as subject to the stormwater rule. Some commenters indicated that including inactive mine operations in the rule would create an unreasonable hardship on the industry. EPA has included inactive mining areas in today's rule because some mining sites represent a significant source of contaminated stormwater runoff. EPA has clarified that inactive mining sites are those that are no longer being actively mined, but which have an identifiable owner/operator. The rule also clarifies that active and inactive mining sites do not include sites where mining claims are being maintained prior to disturbances associated with the extraction, beneficiation, or processing of mined materials, nor sites where minimal activities required for the sole purpose of maintaining the mining claim are undertaken. The Agency would clarify that claims on land where there has been past extraction, beneficiation, or processing of mining materials, but there is currently no active mining are considered inactive sites. However, in such cases the exclusion discussed above for uncontaminated discharges will still apply.

EPA's definition of active and inactive mining operations also excludes those areas which have been reclaimed under SMCRA or, for non-coal mining operations, under similar applicable State or Federal laws. EPA believes that, as a general matter, areas which have undergone reclamation pursuant to such laws have concluded all industrial activity in such a way as to minimize contact with overburden, mine products, etc. EPA and NPDES States, of course, retain the authority to designate particular reclaimed areas for permit coverage under section 402(p)(2)(E).

The proposed rule had included an exemption for areas which have been reclaimed under SMCRA, although the language of the proposed rule inadvertently identified the wrong universe of coal mining areas. The final rule language has been revised to clarify that areas which have been reclaimed under SMCRA (and thus are no longer subject to 40 CFR part 434 subpart E) are not subject to today's rule. Today's rule thus is consistent with the coal mining effluent guideline in its treatment of areas reclaimed under SMCRA.

In response to comments, EPA has also expanded this concept to exclude from coverage as industrial activity non-coal mines which are released from similar State or Federal reclamation requirements on or after the effective date of this rule. EPA believes it is appropriate, however, to require permit coverage for contaminated runoff from inactive non-coal mines which may have been subject to reclamation regulations, but which have been released from those requirements prior to today's rule. EPA does not have sufficient evidence to suggest that each State's previous reclamation rules and/or Federal requirements, if applicable, were necessarily effective in controlling future storm water contamination.

8. Application Requirements for Construction Activities

As discussed above, EPA has included storm water discharges from activities involving construction operations that result in the disturbance of five acres total land in the regulatory definition of storm water discharges associated with industrial activity.

This is a departure from the proposed rule which required permit applications for discharges from activities involving construction operations that result in the disturbance of less than one acre total land area and (which are not part of a larger common plan of development or sale; or operations that are for single family residential projects, including duplexes, triplexes, or quadruplexes, that result in the disturbance of less than five acre total land areas and which are not part of a larger common plan of development or sale). The reasons for this change are noted below.

Many commenters representing municipalities, States, and industry requested that clearing, grading, and excavation activities not be included in the definition of storm water discharges associated with industrial activity. It was suggested that EPA delay including construction activities until after the studies mandated in section 402(p)(5) of the CWA are completed. Other commenters felt that NPDES permits are not appropriate for construction discharges due to their short term, intermediate and seasonal nature. Another commenter felt that only the construction activities on the sites of the industrial facilities identified in the other subsections of the definition of "associated with industrial activity" should be included.

EPA believes that storm water permits are appropriate for the construction industry for several reasons. Construction activity at a high level of intensity is comparable to other activity that is traditionally viewed as industrial, such as natural resource extraction. Construction that disturbs large tracts of land will involve the use of heavy equipment such as bulldozers, cranes, and dump trucks. Construction activity frequently employs dynamite and/or other equipment to eliminate trees, bedrock, rockwork, and to fill or level land. Such activities also engage in the installation of haul roads, drainage systems, and holding ponds that are typical of the industrial activity identified in § 122.26(b)(14)(i-x). EPA cannot reasonably place such activity in the same category as light commercial or retail business.

Further, the runoff generated while construction activities are occurring has potential for serious water quality impacts and reflects an activity that is industrial in nature. Where construction activities are intensive, the localized impacts of water quality may be severe because of high unit loads of pollutants, primarily sediments. Construction sites can also generate other pollutants such as phosphorus, nitrogen and nutrients from fertilizer, pesticides, petroleum products, construction chemicals and solid wastes. These materials can be toxic to aquatic organisms and degrade water for drinking and water-contact recreation. Sediment runoff rates from construction sites are typically 10 to 20 times that of agricultural lands, with runoff rates as high as 100 times that of agricultural lands, and 1,000 to 2,000 times that of forest lands. Even small construction sites may have a significant negative impact on water quality in localized areas. Over a short period of time, construction sites can contribute more sediment to streams than was previously deposited over several decades.

EPA is convinced that because of the impacts of construction discharges that are directly to waters of the United States, such discharges should be addressed by permits issued by Federal or NPDES State permitting authorities. It is evident from numerous studies and reports submitted under section 319 of the CWA that discharges from construction sites continue to be a majo source of water quality problems and water quality standard violations.

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Accordingly EPA is compelled to address these source under these regulations and thereby regulate these sources under a nationally consistent program with an appropriate level of enforcement and oversight.

Techniques to prevent or control pollutants in storm water discharges from construction are well developed and understood. A primary control technique is good site planning. A combination of nonstructural and structural best management practices are typically used on construction sites. Relatively inexpensive nonstructural vegetative controls, such as seeding and mulching, are effective control techniques. In some cases, more expensive structural controls may be necessary, such as detention basins or diversions. The most efficient controls result when a comprehensive storm water management system is in place. Another reason that EPA has decided to address this class of discharges is that it is part of the Agency's recent emphasis on pollution prevention. Studies such as NURP indicate that it is much more cost effective to develop measures to prevent or reduce pollutants in storm water during new development than it is to correct there problems later on. Many of these prevention and control practices, which can take the form of grading patterns as well as other controls, generally remain in place after the construction activities are compieted.

a. Permit Applicction Requirements. In today's rulemaking, EPA has set forth distinct permit application requirements for these construction activities, at § 122.26(c)(1)(ii), to be used where general permits to be developed and promulgated by EPA are inapplicable. Such facilities will be required to provide a map indicating the site's location and the name of the receiving water and a narrative description of:

- The nature of the construction activity;
- The total area of the site and the area of the site that is expected to undergo excavation during the life of the permit;
- Proposed measures, including best management practices, to control pollutants in storm water discharges during construction, including a description of applicable Federal requirements and State or local erosion and sediment control requirements;
- Proposed measures to control pollutants in storm water discharges that will occur after construction operations have been completed, including a description of applicable State or local requirements, and
- An estimate of the runoff coefficient (fraction of total rainfall that will appear as runoff) of the site and the increase in impervious area after the construction addressed in the permit application is completed, a description of the nature of fill material and existing data describing the soil or the quality of the discharge.

Permit application requirements for construction activities do not include the submission of quantitative data. EPA believes that the changing nature of construction activities at a site to be covered by the permit application requirements generally would not be adequately described by quantitative data. The comments received by EPA support this determination. One State commented that a program they instituted has been based on quantitative data for the past 10 years and has proven to be very awkward, even unworkable.

Twenty commenters responded to the issue of appropriate construction site application deadlines including: Three towns (<100,000 population); one medium municipality; one large municipality; one agency associated with a large municipality; three agencies associated counties; three agencies associated with States; two industries; five industrial associations; and one private organization representing industry. The commenters primarily focused on actual deadlines and permitting authority response time.

Applicants for permits to discharge storm water into the waters of the United States from a construction site would normally be required to submit permits in the same time frame as new sources and new discharges. This rulemaking requires permit applications from such sources to be submitted at least 180 days prior to the date on which the discharge is to commence. Four commenters agreed with the application deadline of 180 days prior to commencement of discharge. Three commenters felt it would be difficult to apply 180 days prior to when the discharge was to begin. Three commenters recommended shortening the time period to 90 days. Numerous other commenters were concerned over delays during the permitting authority's review of the permit application. The commenters requested that a maximum response time be set in the regulation. Suggested maximum response times were 90 and 30 days.

In response to these comments, EPA has changed the application deadline for construction permits from at least 180 days prior to discharge to at least 90 days prior to the date when construction is to commence. This change reflects EPA's recognition of the nature of construction operations in that developers/builders may not be aware of projects 180 days before they are scheduled to begin.

Numerous commenters expressed concern over who should be responsible for applying for the permit. Two commenters felt the owner should be responsible so that construction bid documents can include the storm water management requirements and to avoid confusion among multiple subcontractors. One commenter thought that either the owner/developer, or general contractor should be responsible. Another commenter suggested that the designer should obtain the permit which would allow all necessary erosion controls to be part of the project plan. Several commenters requested that the responsibility simply be more clearly defined.

In response to these comments, EPA would clarify that the operator will generally be responsible for submitting the permit application. Under existing regulations at § 122.21(b), when a facility is owned by one person but operated by another, then it is the duty of the operator to apply for the permit. Due to the temporary nature of construction activities, EPA believes that the operator is the most appropriate person to be responsible for both short and long term best management practices included on the site. EPA considers the term "operator" to include a general contractor, who would generally be familiar enough with the site to prepare the application or to ensure that the site would be in compliance with the permit requirements. General contractors, in many cases, will often be on site coordinating the operation among his/her staff and any subcontractors. Furthermore, the operator/general contractor would be much more familiar with construction site operations than the owner and should be involved in the site planning from its initial stages. The application requirements in today's rule are designed to provide flexibility in developing controls to reduce pollutants in storm water discharges from construction sites. A significant aspect to this is the role of State and local authorities in control of construction storm water discharges. Sixty-three commenters addressed the question of what the role of State and local authorities should be. Most of these commenters supported local government control of construction discharges and that qualified State programs should satisfy Federal requirements.

Many commenters representing municipalities, States, and industry, felt that local government should have full control over construction storm water

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discharges, either under existing programs or those required by their municipal permit. EPA agrees with these comments as far as discharges through municipal storm sewers are concerned. EPA is requiring municipalities that are required to submit municipal permit applications under this regulation to describe their program for controlling storm water discharges from construction activities into their separate storm sewers. It is envisioned that municipalities will have primary responsibility over these discharges through NPDES municipal storm water permits. However, EPA also plans to cover such discharges under general permits to be promulgated in the near future.

In response to several comments that the regulation should provide flexibility for qualified State programs to satisfy Federal requirements, the application requirements recognize that many States have implemented erosion and sediment control programs. The permit application requires a brief description of these programs. This is intended to ensure consistency between NPDES permit requirements and other State controls. Permit applicants will be in the best position to pass on this site-specific information to the permitting authority. States or Federal NPDES authorities will have the ability to exercise authority over these discharges as will other State and local authorities responsible for construction. EPA envisions NPDES permitting efforts will be coordinated with any existing programs.

The proposed rule requested comments on appropriate measures to reduce pollutants in construction site runoff. Numerous commenters representing municipalities, States, and industry responded. Some commenters recommended specific best management practices (BMPs) whereas others suggested ways in which the measures should be incorporated into the program. One commenter suggested that EPA establish design and performance standards for appropriate BMPs. One State commenter recommended requiring a schedule or sequence for use of BMPs. A municipality suggested developing guidance on erosion control at construction sites and disseminating the guidance to educate contractors and construction workers in proper erosion control techniques. The Agency is continuing to review these recommendations for the purposes of permit development and issuance.

Another commenter suggested that further research be done to determine the effectiveness of particular BMPs in reducing pollutants in construction site runoff. EPA agrees that more research and studies can be undertaken to develop methodologies for more effective storm water controls and will continue to look at these concerns pursuant to section 402(p)(5) studies. However, EPA is convinced that enough information, technology, and proven BMP's are available to address these discharges in this regulation.

Specific BMPs suggested by the commenters include: wheel washing; locked exit roadways, street cleaning methods which exclude sheet washing; clearing and grading codes; construction standards; riparian corridors; solids retention basins; soil erosion barriers, selected excavation; adequate collection systems; vegetate disturbed areas; proper application of fertilizers; proper equipment storage; use of straw bales and filter fabrics; and use of diversions to reduce effective length of slopes. EPA is continuing to evaluate these suggestions for developing appropriate permit conditions for construction activity.

b. Administrative Burdens. Many commenters representing municipalities, States, and industry commented on the administrative burdens of individually permitting each construction site discharging to waters of the United States. The extensive use of general permits for storm water discharges from construction activities that are subject to NPDES requirements is anticipated to minimize administrative delays associated with permit issuance. Many commenters strongly endorsed extensive use of general permits. In addition the Agency will provide as much assistance as possible for developing appropriate permit conditions.

Many commenters responded to the use of acreage limits in determining which construction sites are required to submit a permit application, including several cities, counties and States. Some commenters generally supported the use of an acre limit. Many commenters suggested increasing the acreage limit. Several suggested using a five acre limit for both residential and nonresidential development. Others suggested greater acreage as the cutoff. Two commenters concurred with the proposed limit of one acre/five acres and one commenter suggested lowering the residential limit to one acre.

Other factors were suggested as a means to create a cutoff for requiring permit applications. Several commenters suggested exempting construction that would be completed with a certain time frame, such as construction of less than 12 months. EPA believes that this is inappropriate because some construction can be intensive and expansive, but nonetheless take place over a short period of time, such as a parking lot. One commenter suggested basing the limit on the quantity of soil moved, i.e., cubic yards. In response, this approach would not be particularly helpful since removal of soil will not necessarily relate to the amount of land surface disturbed and exposed to the elements. Another commenter suggested that where there is single family detached housing construction that should trigger applications as well as the proposed acreage limit. This would not be appropriate since EPA is attempting to focus only on those construction activities that resemble industrial activity. After considering these and similar comments EPA has limited the definition of "storm water discharge associated with industrial activity" by exempting from the definition those construction operations that result in the disturbance of less than five acres of total land area which are not part of a larger common plan of development or sale. In considering the appropriate scope of the definition of storm water discharge associated with industrial activity as it relates to construction activities, EPA recognizes that a wide variety of factors can affect the water quality impacts associated with construction site runoff, including the quality of receiving waters, the size of the area disturbed, soil conditions, seasonal rainfall patterns, the slope of area disturbed, and the intensity of construction activities. These factors will be considered by the permit writer when issuing the permit. However, as noted above, EPA views such site-specific factors to be too difficult to define in a regulatory framework that is national in scope. For example, attempting to adjust permit application triggers based upon a myriad of regional rainfall patterns is not a practical solution. However, permit conditions adjusted for specific geographical areas may be appropriate.

Under the December 7, 1988, proposal the definition of industrial activity exempted: construction operations that resulted in the disturbance of less than one acre total land area which was not part of a larger common plan of development or sale; or operations for single family residential projects, including duplexes, triplexes, or quadruplexes, that result in the disturbance of less than five acre total land areas which were not part of a larger common plan of development o sale. EPA distinguished between singl family residential development and

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other commercial development because other commercial development is more likely to occur in more densely developed areas. Also, it was reasoned that other commercial development provides a more complete opportunity to develop controls that remain in place after the construction activity is completed, since continued maintenance after the permit has expired, is more feasible.

However, EPA has decided to depart from the proposal and use an unqualified five acre area in today's final rule. This limit has been selected, in part, because of administrative concerns. EPA recognizes that State and local sediment and erosion controls may address construction activities disturbing less five acres for residential development; the five acre limit in today's rule is not intended to supersede more stringent State or local sediment and erosion controls. In light of the comments, EPA is convinced that the acreage limit is appropriate for identifying sites that are amount to industrial activity. Several comments suggested higher acreage limits without giving a supporting rationale except administrative concerns. Several commenters agreed that the five acre limit is suitable, but again without specifying why they agreed. EPA is convinced, however, that the acreage limits as finalized in today's rule reflect an earth disturbance and/or removal effort that is industrial in magnitude. Disturbances on large tracts of land will employ more heavy machinery and industrial equipment for removing vegetation and bedrock.

For construction facilities that are not included in the definition of storm water discharge associated with industrial activity, EPA will consider the appropriate procedures and methods to reduce pollutants in construction site runoff under the studies authorized by section 402(p)(5) of the CWA. EPA will also consider under section 402(p)(5) appropriate procedures and methods during post-construction for maintaining structural controls developed pursuant to NPDES permits issued for storm water discharges associated with industrial activity from construction sites.

Numerous commenters requested clarification as to whether permits for storm water discharges from construction activities at an industrial facility are required. EPA is requiring permits for all storm water discharges from construction activities where the land disturbed meets the requirements established in § 122.26(b)(14)(x) and which discharge into waters of the United States. The location of the construction activity or the ultimate land use at the site does not factor into the analysis.

G. Municipal Separate Storm Sewer Systems

1. Municipal Separate Storm Sewers

Today's rule defines "municipal separate storm sewer" at § 122.26(b)(8) to include any conveyance or system of conveyances that is owned or operated by a State or local government entity and is designed for collecting and conveying storm water which is not part of a Publicly Owned Treatment Works (POTW) as defined at 40 CFR 122.2. It is important to note that today's permit application requirements for discharges from municipal separate storm sewer systems serving a population of 100,000 or more do not apply to discharges from combined sewers (systems designed as both a sanitary sewer and a storm sewer). For purposes of calculating whether a municipal separate storm sewer system meets the large or medium population criteria, a municipality may petition to have the population served by a combined sewer deducted from the total population. Section 122.26(f) of today's rule describes this procedure.

EPA requested comments on whether different language for the definition of municipal separate storm sewer would clarify responsibility under the NPDES permit system. Comments were also requested on whether the definition needed to be clarified by explicitly stating that municipal streets and roads with drainage systems (curb and gutter, ditches, etc.) are part of the municipal storm sewer system, and that the owners or operators of such roads are responsible for such discharges. Numerous comments were received by EPA on this issue. Some commenters questioned whether road culverts and road ditches were municipal separate storm sewers, while others specifically recommended that further clarifying language should be added so that owners and operators of roads and streets understand that they are covered by this regulation. In light of these comments, EPA has clarified that municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains that discharge into the waters of the United States are municipal separate storm sewers. One commenter asked if "other wastes" in the proposed definition of municipal separate storm sewer (40 CFR 122.26 (b)(8)(i)) included storm water. In response, EPA has added "storm water" to this definition in order to clarify that the rule addresses such systems.

EPA requested comments on whether legal classifications such as "storm sewers that are not private (e.g. public, district or joint district sewers)" would provide a clearer definition of municipal separate storm sewer than an owner or operator criterion, especially for the purpose of determining responsibility under the NPDES program. Most commenters agreed that the owner/operator concept, and the additional language noted above, is sufficient for this purpose. EPA also requested comments on to what extent the owner/operator concept should apply to municipal governments with land-use authority over lands which contribute storm water runoff to the municipal storm sewer system, and how the responsibility should be clarified. In response to comments on this point, EPA has addressed these concerns in the context of clarifying what municipal entities are responsible for applying for a permit covering storm water discharges from municipal systems in section VI.H. below.

One commenter expressed a desire for clarification as to whether conveyances that were once used for the conveyance of storm water, but are no longer used in that manner, are covered by the definition. EPA emphasizes that this rulemaking only addresses conveyances that are part of a separate storm sewer system that discharges storm water into waters of the United States.

One commenter stated that if EPA intends to regulate roadside collection systems then EPA must repropose since these were not considered by the public. EPA disagrees with this comment since one of the options specifically addressed the inclusion of roadside drainage systems and roads in the definition of municipal separate storm sewer system. In addition, the public recognized the issue in comments on the proposal. EPA would note that several commenters specifically endorsed EPA's inclusion of these conveyances.

2. Effective Prohibition on Non-Storm Water Discharges

Section 402(p)(3)(B)(ii) of the amended CWA requires that permits for discharges from municipal storm sewers shall include a requirement to effectively prohibit non-storm water discharges into the storm sewers. Based on the legislative history of section 405 of the WQA, EPA does not interpret the effective prohibition on non-storm water discharges to municipal separate storm sewers to apply to discharges that are not composed entirely of storm water, as long as such discharge has been issued a separate NPDES permit. Rather,

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an "effective prohibition" would require separate NPDES permits for non-storm water discharges to municipal storm sewers. In many cases in the past, applicants for NPDES permits for process wastewaters and other non-storm water discharges have been granted approval to discharge into municipal separate storm sewers, provided that the permit conditions for the discharge are met at the point where the discharge enters into the separate storm sewer. Permits for such discharges must meet applicable technology-based and water-quality based requirements of Sections 402 and 301 of the CWA. If the permit for a non-storm water discharge to a municipal separate storm sewer contains water-quality based limitations, then such limitations should generally be based on meeting applicable water quality standards at the boundary of a State established mixing zone (for States with mixing zones) located in the receiving waters of the United States.

All options will be considered when an applicant applies for a NPDES permit for a non-storm water discharge to a municipal separate storm sewer. In some cases, permits will be denied for discharges to storm sewers that are causing water quality problems in receiving waters. However, not all discharges present such problems; and in these cases EPA or State permit writers may allow such discharges to municipal separate storm sewers within appropriate permit limits.

Today's rule has two permit application requirements that are designed to begin implementation of the effective prohibition. The first requirement discussed in VI.H.6.a., below, addresses a screening analysis which is intended to provide sufficient information to develop priorities for a program to detect and remove illicit discharges. The second provision, discussed in VI.H.7.b., requires municipal applicants to develop a recommended site-specific management plan to detect and remove illicit discharges (or ensure they are covered by an NPDES permit) and to control improper disposal to municipal separate storm sewer systems.

Several commenters suggested that either the definition of "storm water" should include some additional classes of nonprecipitation sources, or that municipalities should not be held responsible for "effectively prohibiting" some classes of nonstorm water discharges into their municipal storm sewers. The various types of discharges addressed by these comments include detention and retention reservoir releases, water line flushing, fire hydrant flushing, runoff from fire fighting, swimming pool drainage and discharge, landscape irrigation, diverted stream flows, uncontaminated pumped ground water, rising ground water, discharges from potable water sources, uncontaminated waters from cooling towers, foundation drains, non-contact cooling water (such as heating, ventilation, air conditioning (HVAC) water that POTWs require to be discharged to separate storm sewers rather than sanitary sewers), irrigation water, springs, roofdrains, water from crawl space pumps, footing drains, lawn watering, individual car washing, flows from riparian habitats and wetlands. Most of these comments were made with regard to the concern that these were commonly occurring discharges which did not pose significant environmental problems.

EPA disagrees that the above described flows will not pose, in every case, significant environmental problems. At the same time, it is unlikely Congress intended to require municipalities to effectively prohibit individual car washing or discharges resulting from efforts to extinguish a building fire and other seemingly innocent flows that are characteristic of human existence in urban environments and which discharge to municipal separate storm sewers. It should be noted that the legislative history is essentially silent on this point. Accordingly, EPA is clarifying that section 402(p)(3)(B) of the CWA (which requires permits for municipal separate storm sewers to 'effectively' prohibit non-storm water discharges) does not require permits for municipalities to prohibit certain discharges or flows of nonstorm water to waters of the United States through municipal separate storm sewers in all cases. Accordingly, § 122.26(d)(2)(iv)(B)(1) states that the proposed management program shall include: "A description of a program, including inspections, to implement and enforce an ordinance, orders or similar means to prevent illicit discharges to the municipal separate storm sewer system; the program description shall address the following categories of non-storm water discharges or flows only where such discharges are identified by the municipality as sources of pollutants to waters of the United States: Water line flushing, landscape irrigation, diverted stream flows, rising ground waters, uncontaminated ground water infiltration (as defined at 40 CFR 35.2005(20)) to separate storm sewers, uncontaminated pumped ground water discharges from potable water sources, foundation drains, air conditioning condensation, irrigation water, springs, water from crawl space pumps, footing drains, lawn watering, individual residential car washing, flows from riparian habitats and wetlands, dechlorinated swimming pool discharges, and street wash waters. Program descriptions shall address discharges from fire fighting only where such discharges or flows are identified as significant sources of pollutants to waters of the United States."

However, the Director may include permit conditions that either require municipalities to prohibit or otherwise control any of these types of discharges where appropriate. In the case of fire fighting it is not the intention of these rules to prohibit in any circumstances the protection of life and public or private property through the use of water or other fire retardants that flow into separate storm sewers. However, there may be instances where specified management practices are appropriate where these flows do occur (controlled blazes are one example).

Conveyances which continue to accept other "non-storm water" discharges (e.g. discharges without an NPDES permit) with the exceptions noted above do not meet the definition of municipal separate storm sewer and are not subject to section 402(p)(3)(B) of the CWA unless the non-storm water discharges are issued separate NPDES permits. Instead, conveyances which continue to accept non-storm water discharges which have not been issued separate NPDES permits are subject to sections 301 and 402 of the CWA. For example, combined sewers which convey storm water and sanitary sewage are not separate storm sewers and must comply with permit application requirements at 40 CFR 122.21 as well as other regulatory criteria for combined sewers.

3. Site-Specific Storm Water Quality Management Programs for Municipal Systems

Section 402(p)(3)(iii) of the CWA mandates that permits for discharges from municipal separate storm sewers shall require controls to reduce the discharge of pollutants to the maximum extent practicable (MEP), including management practices, control techniques and systems, design and engineering methods, and such other provisions as the Director determines appropriate for the control of such pollutants.

When enacting this provision, Congress was aware of the difficulties in regulating discharges from municipal

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separate storm sewers solely through traditional end-of-pipe treatment and intended for EPA and NPDES States to develop permit requirements that were much broader in nature than requirements which are traditionally found in NPDES permits for industrial process discharges or POTWs. The legislative history indicates, municipal storm sewer system "permits will not necessarily be like industrial discharge permits. Often, an end-of-the-pipe treatment technology is not appropriate for this type of discharge." [Vol. 132 Cong. Rec. S16425 (daily ed. Oct. 16, 1986)].

A shift towards comprehensive storm water quality management programs to reduce the discharge of pollutants from municipal separate storm sewer systems is appropriate for a number of reasons. First, discharges from municipal storm sewers are highly intermittent, and are usually characterized by very high flows occurring over relatively short time intervals. For this reason, municipal storm sewer systems are usually designed with an extremely high number of outfalls within a given municipality to reduce potential flooding. Traditional end-of-pipe controls are limited by the materials management problems that arise with high volume, intermittent flows occurring at a large number of outfalls. Second, the nature and extent of pollutants in discharges from municipal systems will depend on the activities occurring on the lands which contribute runoff to the system. Municipal separate storm sewers tend to discharge runoff drained from lands used for a wide variety of activities. Given the material management problems associated with end-of-pipe controls, management programs that are directed at pollutant sources are often more practical than relying solely on end-of-pipe controls.

In past rulemakings, much of the criticism of the concept of subjecting discharges from municipal separate storm sewers to the NPDES permit program focused on the perception that the rigid regulatory program applied to industrial process waters and effluents from publicly owned treatment works was not appropriate for the site-specific nature of the sources which are responsible for the discharge of pollutants from municipal storm sewers.

The water quality impacts of discharges from municipal separate storm sewer systems depend on a wide range of factors including: The magnitude and duration of rainfall events, the time period between events, soil conditions, the fraction of land that is impervious to rainfall, land use activities, the presence of illicit connections, and the ratio of the storm water discharge to receiving water flow. In enacting section 405 of the WQA, Congress recognized that permit requirements for municipal separate storm sewer systems should be developed in a flexible manner to allow site-specific permit conditions to reflect the wide range of impacts that can be associated with these discharges. The legislative history accompanying the provision explained that "[p]ermits for discharges from municipal separate stormwater systems * * * must include a requirement to effectively prohibit non-stormwater discharges into storm sewers and controls to reduce the discharge of pollutants to the maximum extent practicable. * * * These controls may be different in different permits. All types of controls listed in subsection [(p)(3)(C)] are not required to be incorporated into each permit" [Vol. 132 Cong. Rec. H10576 (daily ed. October 15, 1986) Conference Report]. Consistent with the intent of Congress, this rule sets out permit application requirements that are sufficiently flexible to allow the development of site-specific permit conditions.

Several commenters agreed with this approach. One municipality recommended that there be as much flexibility as possible so that the permitting authority can work with each municipality in developing meaningful long-term goals with plans for improving storm water quality. This commenter noted that too many specific regulations that apply nationwide do not take into consideration the climatic and governmental differences within the States. EPA agrees that as much flexibility as possible should be incorporated into the program. However, flexibility should not be built into the program to such an extent that all municipalities do not face essentially the same responsibilities and commitment for achieving the goals of the CWA. EPA believes that these final regulations build in substantial flexibility in designing programs that meet particular needs, without abandoning a nationally consistent structure designed to create storm water control programs.

4. Large and Medium Municipal Storm Sewer Systems

During the 1987 reauthorization of the CWA, Congress established a framework for EPA to implement a permit program for municipal separate storm sewers and establishing phased deadlines for its implementation. The amended CWA establishes priorities for EPA to develop permit application requirements and issue permits for discharges from three classes of municipal separate storm sewer systems. The CWA requires that NPDES permits be issued for discharges from large municipal separate storm sewer systems (systems serving a population of more than 250,000) by no later than February 4, 1991. Permits for discharges from medium municipal separate storm sewer systems (systems serving a population of more than 100,000, but less than 250,000) must be issued by February 4, 1992. After October 1, 1992, the requirements of sections 301 and 402 of the CWA are restored for all other discharges from municipal separate storm sewers.

The priorities established in the Act are based on the size of the population served by the system. Municipal operators of these systems are generally thought to be more capable of initiating storm water programs and discharges from municipal separate storm sewers serving larger populations are thought to present a higher potential for contributing to adverse water quality impacts. NURP and other studies have verified that the event mean concentration of pollutants in urban runoff from residential and commercial areas remains relatively constant from one area to another, indicating that pollutant loads from urban runoff strongly depend on the total area and imperviousness of developed land, which in turn is related to population.

The term "municipal separate storm sewer system" is not defined by the Act. By not defining the term, Congress intended to provide EPA discretion to define the scope of municipal systems consistent with the objectives of developing site-specific management programs in NPDES permits. EPA considered two key issues in defining the scope of municipal separate storm sewer system: (1) What is a reasonable definition of the term "system," and (2) how to determine the number of people "served" by a storm sewer system. EPA found these two issues to be intertwined. Different approaches to defining the scope of a system allowed for greater or lesser certainty in determining the population served by the system.

In the December 7, 1988, proposal, EPA described seven options for defining "municipal separate storm sewer system." In developing these options the EPA considered:

- The inter-jurisdiction complexities associated with municipal governments;
- The fact that many municipal storm water management programs have traditionally focused on water quantity

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concerns, and have not evaluated water quality impacts of system discharges or developed measures to reduce pollutants in such discharges;

• The advantages of developing system-wide storm water management programs for municipal systems;

• The geographic basis necessary for planning of comprehensive management programs to reduce pollutants in discharges from municipal separate storm sewers to the maximum extent practicable;

• The geographic basis necessary to provide flexibility to target controls on areas where water quality impacts associated with discharges from municipal systems are the greatest and to provide an opportunity to develop cost effective controls;

• The need to establish a reasonable number of permits for municipal systems during the initial phases of program development that will provide an adequate basis for a storm water quality management program for over 13,000 municipalities after the October 1, 1992 general prohibition on storm water permits expires; and

• Congressional intent to allow the development of jurisdiction-wide, comprehensive storm water management programs with priorities given to the most heavily populated areas of the country.

a. Overview of Proposed Options and Comments. The December 7, 1988, proposal requested comment on seven options for defining large and medium municipal separate storm sewer system. With the addition of a watershed-based approach suggested by certain commenters, eight options or approaches were addressed by the over 200 commenters on this issue: Option 1—systems owned or operated by incorporated places augmented by integrated discharges; Option 2—systems owned or operated by incorporated places augmented with significant other municipal discharges; Option 3—systems owned or operated by counties; Option 4—systems owned and operated by States or State departments of transportation; Option 5—systems within the boundaries of an incorporated place; Option 6—systems within the boundaries of counties; Option 7—systems in census designated urbanized areas; and Option 8—systems defined by watershed boundaries.

Generally, these options can be classified into two categories. The first category of options, Options 1, 2 and 3, define municipal systems in terms of the municipal entity which owns or operates storm sewers within municipal boundaries of the requisite population. The second category of options would define municipal systems on a geographic basis. Under Options 4, 5, 6, 7 and 8 all municipal separate storm sewers within the specified geographic area would be part of the municipal system, regardless of which municipal entity owns or operates the storm sewer. EPA did not propose to define the scope of a municipal separate storm sewer system in engineering terms because of practical problems determining the boundaries of and the populations served by "systems" defined in such a manner. In addition an engineering approach based on physical interconnections of storm sewer pipes by itself does not provide a rational basis for developing a storm water program to improve water quality where a large number of individual storm water catchments are found within a municipality.

In the December 7, 1988, proposal, EPA favored those options that relied primarily on the municipal entity which owns or operates or otherwise has jurisdiction over storm sewers. These options were preferred because it was anticipated that the administrative complexities of developing the permit programs would be reduced by decreasing the number of affected municipal entities. However, most commenters were not satisfied that such an approach would reduce administrative burdens or complexities.

The diversity of arguments and rationales offered in comments justifying the selection of particular option, or combinations thereof, were generally a function of geographic, climatic, and institutional differences around the country. As such, there was little substantive agreement with how this program should be implemented as far as defining large and medium municipal separate storm sewer systems. Of all the options, Option 1 generally received the most favorable comment. However, the overwhelming majority of comments suggested different options or other alternatives. Having reviewed the comments at length, EPA is convinced that the definition of municipal separate storm sewers should possess elements of several of the options enumerated above and a mechanism that enables States or EPA Regions to define a system that best suits their various political and geographical conditions.

The following comments were the most pervasive, and represent those issues and concerns of greatest importance to the public: (1) The approach chosen initially must be realistic and achievable administratively; (2) the definition must be flexible enough to accommodate development of the program on a watershed basis, and incorporate elements of existing programs and frameworks and regional differences in climate, geography, and political institutions; (3) permittees must have legal authority and control over land use; (4) discharges from State highways, identified as a significant source of runoff and pollutants, should be included in the program and combined in some manner with one or more of the other options; (5) the definition should address how the inclusion of interrelated discharges into the municipal separate storm sewer system are timed, decided upon, dealt with, etc.; (6) any approach must address the major sources of pollutants; (7) development of co-permittee management plans must be coordinated or developed on a regional basis and in the same time frame—fragmented or balkanized programs must be avoided; (8) municipalities should be regulated as equitably as possible; (9) flood control districts should be addressed as a system or part of a system; (10) the definition must conform to the legal requirements of the Clean Water Act; and (11) the definition should limit the number of co-permittees as much as possible.

b. Definition of large and medium municipal separate storm sewer system. A combination of the options outlined in the 1988 proposal would address most of these concerns, while achieving a realistic and environmentally beneficial storm water program. Accordingly, EPA has adopted the following definition of large and medium municipal separate storm sewer systems. Large and medium separate storm sewer systems are municipal separate storm sewers that:

(i) Are located in an incorporated place with a population of 100,000 or more or 250,000 or more as determined by the latest Decennial Census by the Bureau of Census (see appendices F and G of part 122 for a list of these places based on the 1980 Census);

(ii) Are located within counties having areas that are designated as urbanized areas by latest decennial Bureau of Census estimates and where the population of such areas exceeds 100,000, after the population in the incorporated places, townships or towns within such counties is excluded (see appendices H and I for a listing of these counties based on the 1980 census) (incorporated places, towns, and townships within these counties are excluded from permit application requirements unless they fall under paragraph (i) or are designated under paragraph (iii)); or (iii) are owned or

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operated by a municipality other than those described in paragraph (i) or (ii) that are designated by the Director as part of the large or medium municipal separate storm sewer system due to the interrelationship between the discharges of the designated storm sewer and the discharges from municipal separate storm sewers described under paragraphs (i) or (ii). In making this determination the Director may consider the following factors:

(A) Physical interconnections between the municipal separate storm sewers;

(B) The location of discharges from the designated municipal separate storm sewer relative to discharges from municipal separate storm sewers described in subparagraph (i);

(C) The quantity and nature of pollutants discharged to waters of the United States;

(D) The nature of the receiving waters; or

(E) Other relevant factors.

(iv) The Director may, upon petition, designate as a system, any municipal separate storm sewers located within the boundaries of a region defined by a storm water management regional authority based on a jurisdictional, watershed, or other appropriate basis that includes one or more of the systems described in paragraphs (i), (ii), and (iii).

Under today's rule at § 122.26(a)(3)(iii) the regional authority shall be responsible for submitting a permit application under the following guidelines: The regional authority together with co-applicants shall have authority over a storm water management program that is in existence, or shall be in existence at the time part 1 of the application is due; the permit applicant or co-applicants shall establish their ability to make a timely submission of part 1 and part 2 of the municipal application; each of the operators of municipal separate storm systems described in paragraphs 122.26(b)(4) (i), (ii), and (iii) and (7)(i), (ii), and (iii), that are under the purview of the designated regional authority, shall comply with the application requirements of § 122.26(d).

As noted above, the finalized definition of large and medium municipal separate storm sewer system is combination of the approaches as proposed. (In the following discussion "paragraph (i)" refers to §§ 122.26 (b)(4)(i) and (b)(7)(i); "paragraph (ii)" refers to §§ 122.26(b)(4)(ii) and (b)(7)(ii); "paragraph (iii)" refers to §§ 122.26 (b)(4)(iii) and (b)(7)(iii); and "paragraph (iv)" refers to §§ 122.26 (b)(4)(iv) and (b)(7)(iv)). Paragraph (i) originates from proposed Option 5 (boundaries of incorporated places); paragraph (ii) originates from Option 6 (boundaries of counties) and Option 7 (urbanized areas); paragraph (iii) originates from Options 1 and 5; and paragraph (iv) is an outgrowth of comments on all options, especially Option 4 (State owned systems/State highways) and Option 8 (watersheds).

This definition creates a system by virtue of the fact that storm sewers within defined geographical and political areas, and the owner/operators of seperate storm sewers in those areas, are addressed or required to obtain permits. Although within these systems, different segments and discharges of storm water conveyances may be owned or operated by different public entities, EPA is convinced by comments that discharges from such conveyances are interrelated to such an extent that all of these conveyances may be properly considered a "system." These comments are identified and discussed in greater detail below.

c. Response to comments. Many commenters urged that the approach taken must be administratively achievable. Option 5 of the proposal (boundaries of incorporated places), which can be equated to paragraphs (i) and (iii) above, was identified by several commenters as the most workable of all the options. Many commenters stated that Option 1 (systems owned or operated by incorporated places) was inappropriate because of special districts and other owners of systems within the incorporated area; and although EPA proposed a designation provision for interrelated discharges in Option 1, commenters advised that it would be impossible to identify these systems, account for their discharges, and exclude or include them in a timely manner if Option 1 was selected (Option 1 only addresses those systems owned or operated by the incorporated place). The final rule would obviate these concerns, since all the publicly owned sewers within the boundaries of the municipality will be required to be covered by a permit.

Other commenters noted that cities sometimes have storm water conveyances owned or operated by numerous entities. One municipality commented that these problems could be more easily resolved using a unified permit/district wide approach, which the final approach outlined above can accomplish. One county stated that Option 1 of the proposal would result in a permanent balkanization of stormwater programs and that a regional approach focusing on the entire system should be established. Another municipality recommended that all the systems of conveyances within the incorporated city bounderies be issued a permit. In rejecting Option 1 of the proposal, one municipality stated that program inefficiencies would result from implementing a piecemeal program in a contiguous urban environment with different owners and operators. One State conveyed similar concerns. Using a geographical approach, as described in paragraph (i) of the final definition, will best address all of these concerns.

One commenter criticized proposed Option 1 as being contrary to the legal requirements of the WQA, and a further example of EPA's continuing attempt to minimize the scope of a national storm water program. It was noted that the legislative history regarding requirements for large and medium municipal separate storm sewer systems in section 402(p) of the CWA generally does not reference incorporated cities or towns. As a result, the commenter recommended that the term "municipal" in municipal separate storm sewer system refer to separate storm sewers operated by municipal entities meeting the definition of "municipality" in section 502 of the CWA and that the scope of the term "municipal separate storm sewer system" be defined as broadly as possible. This approach would result in defining large and medium municipal separate storm sewer systems to include all municipal separate storm sewers within the 410 counties with a population of 100,000 or more. EPA has adopted the commenter's recommendation to extend the scope of the program to the extent that today's rule covers all municipal separate storm sewers within certain areas rather than only those operated by an incorporated place. EPA disagrees however that it must define the term "system" to include sewers within any municipal boundary of sufficient population with reference to section 502(4). By not providing explicit definitions, section 402(p)(3)(B) of the CWA gives EPA discretion to define how municipal seperate storm sewer systems are defined. There is no indication in the language of the CWA or the legislative history that Congress intended that the scope of "municipality" and the scope of "municipal separate storm sewer system" to be identical, particularly since the latter term is not defined in the statute. Furthermore, for the reasons discussed elsewhere in this section, EPA believes that today's definition is a reasonable accommodation of the many conflicting concerns surrounding the proper way to delineate the extent of a

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municipal separate storm sewer system serving over 100,000 people.

Several commenters concluded that EPA should be flexible enough to allow the permitting authority broad discretion to establish system wide permits, with flood control districts and/or counties acting as co-permittees with the various incorporated cities within the district boundaries. Commenters expressed concern that Option 1 would not allow for such flexibility.

Arguments that were advanced by commenters in support of proposed Option 1 are equally applicable to paragraph (i), above. Like proposed Option 1, the approach outlined above targets major cities. However, it also has the advantage of addressing municipal separate storm sewer systems which may be interrelated to those owned by the city, a benefit recognized by one municipality that endorsed the selection of proposed Option 5. This will also give the permitting authority more discretion to establish co-permittee relationships.

Paragraph (ii) of the final definition also uses a geographical approach to the definition of municipal storm sewer systems to include municipal storm sewers within urbanized counties. Thus, it closely resembles Option 2 of the proposal. The counties identified in paragraph (ii) have, based on the 1980 Census, a population of 100,000 or more in urbanized,[8] unincorporated portions of the county. In the unincorporated areas of these counties (or in the 20 States where the Census recognizes minor civil divisions, unincorporated county areas outside of towns or townships), the county is the primary local government entity. In these cases, the county performs many of the same functions as incorporated cities with a population of 100,000, and is generally expected to have the necessary legal and land use authority in these areas to begin to implement storm water management programs. Due to the urbanized nature of their population, discharges from the municipal separate storm sewers in these counties will have many similarities to discharges from municipal systems in incorporated cities with a population of 100,000 or more. Addressing these counties in this fashion will not adversely affect small municipalities (incorporated places, towns and townships) within the county, as municipal separate storm sewers that are located in the small incorporated places, townships or towns within these counties are not automatically included as part of the system.

EPA has focused on the unincorporated areas because permit applications cannot be required from systems that serve a population less than 100,000, unless designated. EPA received the comment that if the sewers in incorporated places within such counties were included as part of the system for that county, there would be the potential for systems serving a population less than 100,000 to be improperly subject to permit requirements. EPA agrees with the comment, except that EPA reserves the authority to designate sewers in small incorporated places as part of the system subject to permitting, pursuant to paragraph (iii) of the final definition. Incorporated areas within the identified counties will be required to file permit applications if the population served by the municipal separate storm sewer system is 100,000 or more.

As one commenter noted, the counties addressed by the definition will generally be areas of high growth with a growing tax base that can finance a storm water management program. Numerous counties affected by paragraph (ii) commented on the proposal. Several of these indicated a preference for the county government as the permittee. Others indicated that their county had the ability to perform the functions of the permit applicant and permittee. One county brought to EPA's attention that the county had laid plans for a storm water utility scheduled to be in operation in 1989. Several of the counties supported the use of watersheds, or flexible regional approaches, as the basis for the definition of municipal separate storm sewer systems. The modified definition should satisfy these concerns.

EPA recognizes that some of the counties addressed by today's rule have, in addition to areas with high unincorporated urbanized populations, areas that are essentially rural or uninhabited and may not be the subject of planned development. While permits issued for these municipal systems will cover municipal system discharges in unincorporated portions of the county, it is the intent of EPA that management plans and other components of the programs focus on the urbanized and developing areas of the county. Undeveloped lands of the county are not expected to have many, if any, municipal separate storm sewers.

Paragraphs (i) and (ii) above will help resolve the problems associated with permittees not having adequate land use controls, the legal authority to implement controls, and the ownership of the conveyances. This factor was mentioned by numerous commenters on the proposed options, especially county governments. Under paragraphs (i) and (ii), all publicly owned separate storm sewers within the appropriate municipal boundaries will be defined as part of the municipal system. In many cases, a number of municipal operators of these storm sewers will be responsible for discharges from these systems. Since a number of co-permittees may be addressed in the permits for these discharges, problems associated with the ability to control pollutants that are contributed from interrelated discharges will be minimized. State highways or flood control districts, which may have no land use authority in incorporated cities, will be co-permittees with the city which does possess land use authority. EPA envisions that permit conditions for these systems will be written to establish duties that are commensurate with the legal authorities of a co-permittee. For example, under a permit, a flood control district may be responsible for the maintenance of drainage channels that they have jurisdiction over, while a city is responsible for implementing a sediment and erosion ordinance for construction sites which relates to discharges to the drainage channel. Confusion over ownership of conveyances or systems, at least for the purposes of determining whether they require a permit, will be minimized since all conveyances will be covered. Similarly, under paragraph (ii), the affected counties are expected to have the necessary legal and land use authority to implement programs and controls in unincorporated, urbanized areas because the county government is the primary political or governing entity in these geographical areas.

Many commenters from all levels of State and local government expressed concern about controlling pollutants from State highways. Paragraphs (i) and (ii) will result in discharges from separate storm sewers serving State highways and other highways through storm sewers that are located within incorporated places with the appropriate population or highways in unincorporated portions of specified counties being included as part of the large or medium municipal separate storm sewer system, since all municipal separate storm sewers within the boundaries of these political entities are included. Paragraph (iv) can facilitate

[8] The Bureau of Census defines urbanized areas to provide a description of high-density development. Urbanized areas are comprised of a central city (or cities) with a surrounding closely settled area. The population of the entire urbanized area must be greater than 50,000 persons, and the closely settled area outside of the city, the urban fringe, must generally have a population density greater than 1,000 persons per square mile (must over 1.5 persons per acre) to be included.

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the submission of a permit application for storm sewers operated as part of an entire State highway system. Paragraph (iv) would allow an entire system in a geographical region under the purview of a State agency (such as a State Department of Transportation) to be designated, where all the permit application requirements and requirements established under § 122.26(a)(iii)(C) can be met.

Paragraphs (i) and (ii) can effectively deal with many of the major sources of pollutants. One municipality noted that Option 5 (paragraph (i)) would require all systems in the incorporated boundaries to obtain permits and institute control measures, rather than just the few owned or operated by incorporated cities. Another municipality noted that this approach could deal with many of the regional variations in sources of pollution. Many commenters, including environmental groups, believed that proposed Option 5 (systems owned or operated by counties), Option 6 (systems within the boundaries of counties), and Option 7 (system in urbanized areas) were good approaches because more sources of pollution would be addressed. It was also maintained that Options 5, 6 and 7 could incorporate watershed planning which, in the view of some commenters, is the only effective way to address pollutants in storm water.

Commenters noted that addressing counties and urbanized areas would focus attention on developing areas which would otherwise be left out in the initial phases of permitting. One commenter noted that most new development in large urbanized areas occurs outside of core cities (incorporated cities with a population of 100,000 or more). Newly developing areas provide opportunities for installing pollutant controls cost effectively. EPA agrees with these comments and notes that paragraph (ii) addresses a significant number of counties with highly developed or developing areas.

However, EPA is convinced that addressing all counties or urbanized areas in the initial phases of the storm water program is ill-advised. Commenters noted that some counties have inappropriate or nonexistent governmental structures, and that a program that addressed all counties in the country with a population of 100,000 or more would be unmanageable, because too many municipal entities nationwide would be involved in the program initially. Commenters advised that defining municipal storm sewer systems solely in terms of the boundaries of census urbanized areas (Option 7) would result in systems which did not correspond to jurisdictions that are in a position to implement a storm water programs. Thus, EPA has modified Option 7 and combined it with Option 6 to create paragraph (ii) above.

Paragraph (iii) incorporates a designation authority such that municipalities that own or operate discharges from separate storm sewers systems other than those described in paragraph (i) or (ii) may be designated by the Director as part of the large or medium municipal separate storm sewer system due to the interrelationship between the other discharges of the designated storm sewer and the discharges from the large or medium municipal separate storm sewers. In making this determination the physical interconnections between the municipal separate storm sewers, the location of discharges from the designated municipal separate storm sewer relative to discharges from large or medium municipal separate storm sewers, the quantity and nature of pollutants discharged to waters of the United States, the nature of the receiving waters, or other relevant factors may be considered.

Comments indicated that the designation authority as proposed and described above should be retained. One State noted that this approach gives the most flexibility in making the case-by-case designations, while also delineating in sufficient detail what criteria are used to make the determination. This commenter was concerned about being able to regulate many of the interrelated discharges from counties surrounding incorporated cities.

Paragraph (iv) of the final definition allows the permitting authority, upon petition, to designate as a medium or large municipal separate storm sewer system, municipal separate storm sewers located within the boundaries of a region defined by a storm water management regional authority based on a jurisdictional, watershed, or other appropriate basis that includes one or more of the systems described in paragraphs (i), (ii), (iii).

Paragraph (iv) was added to the final definitions to respond to a variety of concerns of commenters. One of the prime concerns of commenters was that the definition of large and medium municipal separate storm sewer systems must be flexible enough to accommodate: Programs on a watershed basis, existing storm water programs and frameworks and regional differences in climate, geography, and political institutions. Some States were particularly expressive regarding this concern. One State maintained that an inflexible program could totally disrupt ongoing State efforts. Other commenters urged that the regulation encourage the establishment of regional storm water authorities or other mechanisms that can deal with storm water quality on a watershed basis. One State proposed defining the municipal separate storm sewer system to include all municipal separate storm sewers within a core incorporated place of 100,000 or more, and all surrounding incorporated places within the State defined watershed. One of the State water districts advised that the regulations should be flexible enough to allow regional water quality boards to apply the regulations geographically. One national association expressed concern that existing institutional arrangements for flood control and drainage would be ignored, while another warned against fostering a proliferation of inconsistent patchwork programs based on arbitrary definitions and jurisdictions which bear no relationship to water quality.

EPA is convinced that the mechanism described in paragraph (iv) provides a means whereby the mechanisms and concepts identified above can be utilized or created in appropriate circumstances. In addition, § 122.26(f)(4) provides a means for State or local government agencies to petition the Director for the designation of regional authorities responsible for a portion of the storm water program. For example, some States or counties may currently or in the near future have regional storm water management authorities that have the ability to apply for permits under today's rule and carry out the terms of the permit. Some of these authorities may encompass within their jurisdiction large or medium municipal separate storm sewer systems as defined in today's rule. EPA wishes to encourage such entities to assume the role as permittee under today's rule. That is the purpose of paragraph (iv). Such authorities may petition the Director to assume such a role.

Many commenters expressed the view that municipal management plans must be coordinated or developed among co-permittees on a regional basis and in the same timeframe. Paragraphs (i), (iii) and (iv) would bring in all appropriate municipal entities with jurisdiction over a specified geographical area in the same timeframe. Several commenters, including one State, noted proposed Option 1 would lead to fragmented, ill-coordinated programs. Paragraphs (i), (iii), and (iv) do not suffer this drawback

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to the same extent since all the municipal separate storm sewers are addressed within the incorporated place, instead of only those owned or operated by the incorporated place.

Equal treatment of municipalities within a watershed or other specified area was a major subject of comment. Many commenters urged that a degree of fairness could be achieved by requiring permit applications, and the concomitant expenditure of municipal dollars and resources, from all municipalities within an entire urban area that contributes to storm water pollution, rather than from a discrete system within an arbitrary political boundary. Paragraph (i), especially when coupled with paragraphs (ii), (iii), and (iv), can best accomplish a more equitable approach, because all owners and operators of municipal separate storm sewers within a system have responsibilities. In addition, some of the areas outside the incorporated city limits which are engaged in expansive urban or suburban development will be brought into the program. Paragraph (iv) will provide a means for State or regional authorities to use existing or emerging mechanisms to set up storm water management programs, and would require multiple agencies either to become regional co-permittees or to be subject to a regional permit.

Paragraphs (i), (ii), (iii), and (iv) could also require flood control districts to be co-permittees, which was a major concern of counties and numerous cities. One municipality stated that the inclusion of flood control districts would greatly reduce the administrative burden required to prepare a single inter-city discharge agreement and would establish a common legal authority to implement the program. Numerous county agencies believed it imperative that flood control districts be brought into a system-wide permit strategy.

Paragraphs (i) and (iii) may not accommodate the concern of several commenters that the number of co-permittees be kept to a minimum. The fact that all the municipal separate storm sewers within the boundaries of the appropriate incorporated places will be addressed dictates that some permits will have several co-permittees. This is a major concern since it goes directly to achieving an effective initial storm water program. There is concern about being able to bring all the co-permittees together under intra-municipal agreements or contracts within regulatory deadlines. This problem would be resolved in the short term by selecting Option 1. However, Option 1 may still require inter-municipal agreements because of the designation authority under § 122.26 (b)(4)(ii) and (b)(7)(ii) of the proposal. In addition, such inter-jurisdictional problems will arise after October 1, 1992 when the moratorium on requiring NPDES permits for discharges from other municipal separate storm sewers ends. Under the permitting goals established by the CWA, multi-jurisdictional storm water programs and agreements cannot be avoided. Despite interest in limiting the number of co-permittees, EPA decided not to adopt Option 1 for the reasons already stated.

Section 402(p)(3)(B)(i) of the amended CWA provides that permits for municipal discharges from municipal storm sewers may be issued on a system-wide or jurisdiction-wide basis. This provision is an important mechanism for developing the comprehensive storm water management programs envisioned by the Act.

Under the permit application requirements of today's rule, if the appropriate co-applicants are identified, one permit application may be submitted for a large or medium municipal separate storm sewer system (see section VI.G.4 above). System-wide permit applications can in turn be used to issue system-wide permits which could cover all discharges in the system.

Where several municipal entities are responsible for obtaining a permit for various discharges within a single system, EPA will encourage system-wide permit applications involving the several municipal entities for a number of reasons. The system-wide approach not only provides an appropriate basis for planning activities and coordinating development, but also provides municipal entities participating in a system-wide application the means to spread the resource burden of monitoring, evaluating water quality impacts, and developing and implementing controls.

The system-wide approach provided in today's rule recognizes differences between individual municipalities with responsibilities for discharges from the municipal system. Today's application rule requires information to be submitted that enables the permit issuing authorities to develop tailored programs for each permittee with responsibility for certain components, segments, or portions of the municipal separate storm sewer system. The permit application requirements allow individual municipal entities, participating in system-wide applications, to submit site specific information regarding storm water quality management programs to reduce pollutants in system discharges as a whole, or from specific points within the system.

In some cases, it may be undesirable for all municipal entities with storm water responsibility within a municipal system to be co-permittees under one system-wide permit. The permit application requirements in today's rule allow individual municipal entities within the system to submit permit applications and obtain a permit for that portion of the storm sewer system for which they are responsible. Thus, several permits may be issued to cover various subdivisions of a single municipal system.

In summary, EPA believes that the definition of municipal storm sewer system adopted in today's rule has several distinct advantages that were identified in comments:

- The definition adopts features of several options;
- The definition targets areas that have the necessary police powers and land use authority to implement the program;
- The definition can utilize watersheds or accommodate existing administrative frameworks and storm water programs;
- The definition provides that all systems within a geographical area including highways and flood control districts will be covered, thereby avoiding fragmented and ill-coordinated programs;
- The definition has flexible designation authority; and
- The definition addresses major sources of pollutants without being overly broad.

H. Permit Application Requirements for Large and Medium Municipal Systems

1. Implementing the Permit Program

Given the differing nature of discharges from municipal separate storm sewer systems in different parts of the country and the varying water quality impacts of municipal storm sewer discharges on receiving waters, today's permit application requirements are designed to lead to the development of site-specific storm water management programs. In order to effectively implement this goal, EPA intends to retain the overall structure of the municipal permit application as proposed in the December 7, 1988, proposal.

2. Structure of the Permit Application

EPA proposed a two-part permit application designed to meet the goal of

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developing site-specific storm water quality management programs in NPDES permits. In response to a request for comments on this aspect of the proposal, numerous comments were received. After reviewing these comments, EPA has decided to retain the two-part permit application. Many commenters agreed that the approach as proposed is appropriate for phasing in and developing site specific storm water management programs. One large municipality strongly endorsed the two-part application, stating that it would facilitate the identification of water quality problem areas and the development of priorities for control measures, thereby allowing for more cost-effective program development. Two State agencies expressed the same view, and noted that the two-part approach is reasonable and well structured for efficient development of programs. One large municipality noted it would allow the permit authority and the permit applicant the time needed to gain the knowledge and data to develop site-specific permits. A medium municipality expressed similar views.

Numerous commenters submitted endorsements of a proposal offered by one of the national municipal associations. This approach responded to EPA's request for comments on alternatives to a two-part application process. These comments recommended having permit applicants submit information regarding their existing legal authority, prepare source identification information, describe existing management plans, provide discharge characterization information based on existing data, and prepare a monitoring, characterization and illicit discharge and removal plan in a one-part application. The remaining requirements such as: implementing plans to remove illicit connections, obtaining legal authority, monitoring and characterization, plans for structural controls, preparation of control assessments, preparation of fiscal analysis, and management plan implementation would be part of the permit and take place during the compliance period of the permit. It was argued that this would result in a more orderly development of stormwater management programs while allowing for quick implementation of efforts to eliminate illicit discharges and initiate some BMPs.

After careful review and consideration of these comments, EPA is convinced that this approach would not meet the goals and requirements of section 402 of the Clean Water Act. Section 402(p)(3)(B) of the CWA requires that permits effectively prohibit non-storm water discharges into storm sewers and incorporate controls that reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques, and system design and engineering methods. The above comments suggesting an alternative for achieving this goal are not entirely compatible with these requirements. In light of the language in the statute, permit conditions should do more than plan for controls during the term of the permit. A strong effort to have the necessary police powers and controls based on pollutant data should be undertaken before permits are issued. In short, the one-part application described by these comments would result in permits that would focus too much on preparation and not enough on implementing controls for pollutants.

In comparison, EPA's approach requires municipalities to submit a two-part application over a two year period. Part one of the application would require information regarding existing programs and the means available to the municipality to control pollutants in its storm water discharges. In addition, part one would require field screening of major outfalls to detect illicit connections. Part two of the permit application would require a limited amount of representative quantitative data and a description of proposed storm water management plans. The purpose of the two-part application process is to develop information, in a reasonable time frame, that would build successful municipal storm water management programs and allow the permit writer to make informed decisions with regard to developing permit conditions. This will include initiating efforts to effectively prohibit non-storm water discharges into storm sewers, and initially implementing controls that reduce the discharge of pollutants to the maximum extent practicable, including management practices and control techniques during the term of the permit. Such an approach clearly meets the statutory mandate of section 402(p)(3)(B).

c. Part 1 Application. Part 1 of the permit application is intended to provide an adequate basis for identifying sources of pollutants to the municipal storm sewer system, to preliminarily identify discharges of storm water that are appropriate for individual permits, and to formulate a strategy for characterizing the discharges from municipal separate storm sewer systems. Several commenters supported retaining these components of the application process. The components of part 1 of the permit application include:

- General information regarding the permit applicant or co-applicants (§ 122.26(d)(1)(i));
- A description of the existing legal authority of the applicant(s) to control pollutants in storm water discharges and a plan to augment legal authority where necessary (§ 122.26(d)(1)(ii));
- Source identification information including: a topographic map, description of the historic use of ordinances or other controls which limited the discharge of non-storm water discharges to municipal separate storm sewer systems, the location of known municipal separate storm sewer outfalls, projected growth, location of structural controls, and location of waste disposal facilities (§ 122.26(d)(1)(iii));
- Information characterizing the nature of system discharges including existing quantitative data, the results of a field screening analysis to detect illicit discharges and illegal dumping to the municipal system, an identification of receiving waters with known water quality impacts associated with storm water discharges, a proposed plan to characterize discharges from the municipal storm sewer system by estimating pollutant loads and the concentration of representative discharges, and a plan to obtain representative data (§ 122.26(d)(1)(iv)); and
- A description of existing structural and non-structural controls to reduce the discharge of pollutants from the municipal storm sewer (§ 122.26(d)(1)(v)).

One commenter disagreed that source identification should be made part of the permit application process beyond the identification of major municipal storm sewer outfalls. In reply, EPA is convinced that the other elements of the source identification are critical for identifying sources of pollutants and creating a base of knowledge from which informed decisions about permit conditions and further data requirements can be determined. One county stated that it already had engaged in extensive monitoring and modeling of watersheds and that its programs should be substituted for EPA's. In response, EPA anticipates that information collected under various State, county or city programs that matches the information requirements in this rulemaking may be used by the applicants in submissions under this rulemaking where the requirements of the rule are met. However, because of the divergence in data collection techniques and information collected by

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these programs, EPA disagrees that it would be appropriate to accept a substitution in its entirety without tailoring such a program to today's specific information requirements. One municipality noted that municipal systems are not well documented and responsibility for them is in question. In response, EPA notes that the source identification procedure is designed, in part, to address such shortcomings.

Several municipalities suggested that legal authority could be demonstrated by providing EPA with copies of appropriate local ordinances to demonstrate their legal authority and a statement from the city attorney. EPA agrees that these methods are appropriate for making this demonstration.

Several commenters noted that there was adequate existing municipal legal authority to carry out the program requirements or such authority could be obtained by the municipality. Other commenters stated that municipalities possess some authority over certain activities but may not have authority over discharges from roads and construction. Numerous commenters, however, claimed that certain municipalities had no existing legal authority to carry out the permit requirements and that obtaining all the necessary legal authority could take several years due to cumbersome legislative and political processes. In response, part 1 of the permit application will establish a schedule for the development of legal authority that will be needed to accomplish the goals of the permit application and permits. Some municipalities will have more advanced storm water programs with appropriate legal authority or the ability to establish necessary ordinances. Providing an appropriate schedule will not present difficulties in these circumstances. EPA also notes that the definitions of large and medium municipal separate storm sewer systems finalized in today's rule will in many cases result in a number of co-applicants participating in a system wide application. It is anticipated that the development of adequate inter-jurisdictional agreements specifying the various responsibilities of the co-permittees may in some cases be very complex, thereby justifying the development of a schedule to complete the task. For example, clarifying the authority over discharges from roads may present difficulties where a number of municipal entities operate different roads in a given jurisdiction. In other limited cases, the MEP standard for municipal permits may translate into permit conditions that extend the schedule for obtaining necessary legal authority into the term of the permit. These situations will be evaluated on a case-by-case basis by permit issuing authorities.

Numerous commenters supported the field screening analysis as proposed. Comments from three municipalities noted that it would be a cost effective means of identifying problem areas. One municipality noted that illicit connections can be reliably detected by the screening method proposed. In view of these comments EPA has decided to retain this portion of the regulation. However many commenters expressed concern over how the proposed approach would work given the particular circumstances under which some municipal storm water systems are arranged. Several commenters questioned the effectiveness of dry weather monitoring for several reasons, including the shallow depth of some cities' water tables. Accordingly, an alternative approach may be utilized by the municipal permittee, and this is discussed later in section VI.H.3.

Some comments suggested that if any field screening is required that it be done during the term of the permit. EPA believes that field screening should not be done during the term of the permit exclusively. Unless a field screening is accomplished during the permit application phase there will be scant knowledge, if any, upon which illicit connection programs can be established for the term of the permits. EPA views field screening during the application process as an appropriate means of beginning to meet the CWA's requirement of effectively prohibiting non-storm water discharges into municipal separate storm sewers.

The submittal of part 1 of the permit application will allow EPA, or approved NPDES States, to adjust part 2 permit application requirements to assure flexibility for submitting information under part 2, given the site specific characteristics of each municipal storm sewer system.

EPA agrees with the concerns of commenters regarding the estimate of the reduction of pollutant loads from existing management programs. EPA agrees that sufficient data may not be available to establish meaningful estimates. Therefore this component of the proposed part 1 is not a requirement of today's rule.

b. Part 2 Application. Part 2 of the proposed permit application is designed to supplement information found in part 1 and to provide municipalities with the opportunity of proposing a comprehensive program of structural and non-structural control measures that will control the discharge of pollutants, to the maximum extent practicable, from municipal storm sewers. The components of the proposed part 2 of the permit application included:

- A demonstration that the legal authority of the permit applicant satisfies regulatory criteria (§ 122.26(d)(2)(i));
- Supplementation of the source identification information submitted in part 1 of the application to assure the identification of all major outfalls and land use activities (§ 122.26(d)(2)(ii);
- Information to characterize discharges from the municipal system;
- A proposed management program to control the discharge of pollutants to the maximum extent practicable, from municipal storm sewers (§ 122.26(d)(2)(iv));
- Assessment of the performance of proposed controls (§ 122.26(d)(2)(v));
- A financial analysis estimating the cost of implementing the proposed management programs along with identifying sources of revenue § 122.26(d)(2)(vi);
- A description of the roles and responsibilities of co-applicants (§ 122.26(d)(2)(vii)).

One municipality agreed that the assessment of the performance of controls was a critical component of establishing a viable program and one that could be accomplished within the time frame of the permit application deadlines. One commenter suggested that the applicant describe what financial resources are currently available. In response, EPA will require applicants to describe the municipality's existing budget for storm water programs in part 1 of the permit application requirements. This information will be useful to evaluate the municipality's ability to prepare and implement management plans. In response to other comments, this information will also include an overview of the municipality's financial resources and a description of the municipality's budget, including overall indebtedness and assets.

EPA has retained the financial analysis in this portion of the rule on the advice of two municipal commenters, who agreed that this was an important component of establishing a viable program and one that could be accomplished within the time frame of the permit application deadlines. Another commenter noted that this requirement is appropriate to justify a municipality's proposed management plan.

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3. Major Outfalls

In past rulemakings, a controversial issue has been the appropriate sampling requirements for municipal separate storm sewer systems. Earlier storm water rulemakings have been based primarily on the principle that all discharges to waters of the United States from municipal separate storm sewers located in urban areas must be covered by an individual permit. This approach requires that individual permit applications contain quantitative data to be submitted for all such discharges. This approach was criticized because of a potentially unmanageable number of outfalls in some municipal separate storm sewer systems. Most incorporated cities with a population of 100,000 or more do not know the exact number of outfalls from their municipal systems, but based on the comments, the number ranges from 500 to 8,000 or more.

In light of the increased flexibility provided by the WQA and the development of EPA's system-wide approach for regulating municipal separate storm sewer discharges, today's rule will not require submittal of individual permit applications with quantitative data for each outfall of a municipal system. Rather today's rule will encourage system-wide permit applications to provide information suitable for developing effective storm water management programs. Under this approach, not all outfalls of the municipal system will be sampled, but rather more specific and accurate models for estimating pollutant loads and discharge concentrations will be used. The use of these models will require the identification of sources which are responsible for discharging pollutants into municipal separate storm sewers and will not require as much data to calibrate due to the source-specific nature of the model. A number of standard and localized models have been developed for estimating pollutant loads from storm water discharges.

Several commenters support the use of models for developing management plans and estimating pollutant loadings and concentrations. EPA encourages their use where applicable to particular systems.

By adopting an approach that incorporates source identification measures, the amount of quantitative data required to characterize discharges from the municipal system will be reduced because of the increased accuracy of the site-specific models which can be used. Consistent with a system-wide permit application approach, EPA proposed to focus source identification measures on "major outfalls." The proposed definition of major outfalls includes any municipal separate storm sewer outfall that discharges from a pipe with a diameter of more than 36 inches or its equivalent (discharges from a drainage area of more than 50 acres), or for municipal separate storm sewers that receive storm water from lands zoned for industrial activities, an outfall that discharges from a pipe with a diameter of more than 12 inches or its equivalent (discharges from a drainage area of 2 acres or more).

Numerous entities offered comments on this definition. Several commenters concurred with this proposed definition. One commenter maintained that the data collected at such outfalls would be sufficient to estimate pollutant loads as well as concentrations using well calibrated models. Another municipality stated that 50 acres was an excellent approximation for the average drainage area served by a 36-inch storm sewer. Two States and one county supported the definition as proposed. One large municipal entity supported the definition, stating that screening major outfalls could be accomplished with available staff over a three month period. In light of these comments, EPA has decided to retain, in part, the definition as proposed.

Numerous commenters suggested alternative definitions or otherwise disagreed with the proposed definition. Most of these comments expressed concern about the number of outfalls that would have to be tested or screened if the definition was retained. For this reason EPA has decided to limit the total number of major outfalls or equivalent sampling points that have to be tested to 250 or 500 for medium or large systems respectively. This change is discussed in further detail below.

The following are examples of comments that opposed the definition of a "major outfall" as proposed. Several commenters stated that, in the southwest, 6 to 12 foot outfalls are the norm, and that smaller outfalls should not be addressed unless there is a compelling reason to suspect illicit connections. One commenter suggested a size of 84 inches and 50 acres, while another commenter suggested that 48 inches would be appropriate. One commenter suggested that the diameter for industrial pipes should be 18 inches, while another commenter suggested that 50 acres should be the only criterion.

One commenter noted that pipe size will vary according to rainfall patterns and that a single approach would not work universally. This comment, and other similar points of view as noted herein, convinces that Agency that a more flexible approach is needed to identify field screening and sampling locations. However, EPA is also convinced that a universal standard is necessary for purposes of identifying drainage areas within the municipal system and discrete areas of land use that are drained by certain sized outfalls. This information is critical since these conveyances, and lands they drain, are sources of pollutants to waters of the United States from municipal systems and are properly the subject of appropriate permit conditions.

Many commenters suggested placing a limit on the number of major outfalls addressed during the field screening phase of the permit application. Two municipalities stated that the proposed definition of major outfalls in terms to the pipe diameter was too small and that too many outfalls would be covered. One municipality stated that under the proposed definition, it would have over 4700 "major outfalls," a number viewed as being unacceptably large. Several municipalities argued that they would be penalized for over-design of their storm drain system. One municipality stated field screening of outfalls should be limited to 200 for medium cities and 500 for large cities. Some commenters suggested EPA set a percentage of major outfalls for screening, because all pipes in some municipalities meet the definition of major outfall. One commenter suggested that a sliding scale be used to determine the number of outfalls tested: those with 50 test all, those with 100–200 test 50%, etc. Other commenters suggested a flat percentage of outfalls or flat number such as 100.

4. Field Screening Program

EPA also received several comments in response to the proposed field screening methodology. Among the major concerns were: End of pipe sampling may not be practical and the more appropriate and accessible location is likely to be the nearest upstream manhole; the type of discharge should be the criterion for selecting sampling points as opposed to pipe size; a system wide evaluation is more appropriate than checking each outfall; within some systems, major outfalls or pipe size will not reflect discharges from suspect or old land use areas; efforts should be focused on locations where illicit connections are expected; sites should be determined by looking at sites within drainage basin areas based on land use within those basins; land use and hydrology of the watershed should be the criteria for selecting points;

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screening should be performed at locations that will allow for the location of upstream discharges; the focus should be exclusively on drainage areas rather than pipe size, since pipe size will vary with slope; a prescribed percentage of total flow may be more appropriate; state water quality standards should be utilized along with focusing on actual quality in the reaches of a stream.

EPA is convinced by these comments that today's rule should allow applicants to either field screen all major outfalls as proposed (first procedure) or use a second procedure to provide for the strategic location of sampling points to pinpoint illicit connections. EPA agrees with comments that the size of the outfall will not always reflect the chance of uncovering illicit connections or discharges, and that field screening points should be easily accessible.

This second procedure is as follows: field screening points and/or outfalls are randomly located throughout the storm sewer system by placing a grid over a drainage system map and identifying those cells of the grid which contain a major outfall or segment of the storm sewer system. The grid shall be established using the following guidelines and criteria:

(1) A grid system consisting of perpendicular north-south and east-west lines spaced 1/4 mile apart shall be overlaid on a map of the municipal storm sewer system, creating a series of cells;

(2) All cells that contain a segment of the storm sewer system shall be identified; one field screening point shall be selected in each cell, major outfalls may be used as field screening points;

(3) Field screening points or major outfalls should be located downstream of any sources of suspected illegal or illicit activity;

(4) Field screening points shall be located to the degree practicable at the farthest manhole or other accessible location downstream in the system, within each cell; however, safety of personnel and accessibility of the location should be considered in making this determination;

(5) The assessment and selection of cells shall use the following criteria: Hydrological conditions; total drainage area of the site; population density of the site; traffic density; age of the structures or buildings in the area; history of the area; land use types.

(6) For medium municipal separate storm sewer systems, no more than 250 cells need have identified field screening points, in large municipal separate storm sewer systems, no more than 500 cells need to have identified field screening points for detecting illicit connections; cells established by the grid that contain no storm sewer segments will be eliminated from consideration; if fewer than 250 cells in medium municipal sewers are created, and fewer than 500 in large systems are created by the overlay on the municipal sewer map, then all those cells which contain a segment of the sewer system shall be subject to field screening (unless access to the separate storm sewer system is impossible);

(7) Large or medium municipal separate storm sewer systems which are unable to utilize the procedures described in paragraphs (1) through (6) above, because a sufficiently detailed map of the separate storm sewer systems is unavailable, shall field screen at least 250 or 500 major outfalls respectively using the following method: the applicant shall establish a grid system consisting of north-south and east-west lines spaced 1/4 mile apart overlaid on a map of the boundaries of a large or medium municipal entity described at § 122.26(b), thereby creating a series of cells; major outfalls in as many different cells as possible shall be selected until 500 major outfalls (large municipalities) or 250 major outfalls (medium municipalities) are selected; a field screening analysis shall be undertaken at these major outfalls.

The methodology outlined above is in response to public comments which indicated that the field screening and sampling of major outfalls as proposed would lead to insurmountable logistical problems in some municipal systems. EPA believes that the above is an effective approach to pinpointing suspected problem points along a given trunkline or segment of separate storm sewer system. Jurisdictions with no extensive or previous history of monitoring, or lack of an intensive monitoring program can utilize the methods described in establishing a program. Furthermore, the approach will allow for the prioritization of outfalls, sampling points, or areas within the municipality where there are suspected illicit connections or discharges, or other circumstances creating higher concentrations and loadings of pollutants.

Paragraph (7) enables municipalities to select major outfalls without regard to the municipal sewer system map that is required for using the procedure described in paragraphs (1) through (6) However, the applicant must still select outfalls within the cells created by overlaying a 1/4 mile grid over a map of the boundaries of the large or medium municipal entity defined under § 122.26(b), and select major outfalls within as many of those cells as possible, up to 500 (large municipal systems) or 250 (medium municipal systems). In this manner, as many different areas and land uses within the municipal system will be covered by the field screening component of the municipal application.

In order to keep the costs of the program within the anticipated limits of the proposed regulation, the number of outfalls or sampling locations using the grid system is to be limited to 500 for large municipal separate storm sewer systems and 250 for medium municipal separate storm sewer systems.

In response to several comments, EPA has clarified the definition of major outfalls with regard to the words, "pipe with an inside diameter of 36 inches or more or its equivalent" and "a pipe with an inside diameter of 12 inches or more or its equivalent." This definition has been modified to specify that single pipes or single conveyances with the appropriate diameter or equivalent are covered.

EPA's proposal required municipal permit applicants to submit a fiscal analysis of expenditures that will be required in order to implement the proposed management plans required in part 2 of the application. The description of fiscal resources should include a description of the source of the funds. Some commenters felt that a fiscal analysis should only be required during the term of the permit. In response, EPA believes that during the two years of permit application development, the permit applicant should be in a position to submit information on the ability and means for financing storm water management programs during the term of the permit. EPA views this information as an important means of evaluating the scope of program and whether the permittee will be devoting adequate resources to implementing the program before that program is mapped out in the permit itself.

5. Source Identification

The identification of sources which contribute pollutants to municipal separate storm sewers is a critical step in characterizing the nature and extent of pollutants in discharges and in developing appropriate control measures. Source identification can be useful for providing an analysis of pollutant source contribution and for identifying the relationship between pollutant sources and receiving water quality problems. In cases where end-of-pipe controls alone are not practicable it is essential to identify the source of pollutants into the municipal storm

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sewer systems to support a targeted approach to control pollutant sources.

The relative contribution of pollutants from various sources will be highly site-specific. The first step in developing a targeted approach for controlling pollutants in discharges from municipal storm sewer systems is identifying the various sources in each drainage basin that will contribute pollutants to the municipal storm sewer system.

This rulemaking phases in the source identification requirements of the permit program by establishing minimum objectives in part 1 of the application and by requiring applicants to submit a source identification plan in part 2 of the application to provide additional information during the term of the permit. The minimum source identification requirements of part 1 of the application have been designed to provide sufficient information to provide an initial characterization of pollutants in the discharges from the municipal storm sewer system. EPA realizes that with many large, complex municipal storm sewer systems, it may be difficult to identify all outfalls during the permit application process. Accordingly, EPA is requiring that known outfalls be reported in part 1 of the application. Part 1 of the application will also include: A description of procedures and a proposed program to identify additional major outfalls; the identification of the drainage area associated with known outfalls; a description of major land use classifications in each drainage area, descriptions of soils, the location of industrial facilities, open dumps, landfills or RCRA hazardous waste facilities which discharge storm water to the municipal storm sewer system; and ten year projections of population growth and development activities (population data and development projections will be useful for future predictions of loadings to receiving waters from municipal storm sewer systems, and capacities required for treatment systems). In general, population projections should reflect various scenarios of development (high, medium, low relative to recent trends).

Part 2 of the application will supplement the information reported in part 1 of the application so that, at a minimum, all major outfalls are identified.

Under today's rule, municipal or public entities responsible for applying for and obtaining an NPDES permit will be required to identify the location of an open dump, sanitary landfill, municipal incinerator or hazardous waste treatment, storage, and disposal facility under RCRA which may discharge storm water to the system as well as all facilities which discharge storm water associated with industrial activity into a large or medium municipal separate storm sewer system.

Requiring these source identification measures is supported by the legislative history of section 405 of the WQA, which instructs that "[i]n writing any permit for a municipal separate storm sewer, EPA or the State should pay particular attention to the nature and uses of the drainage area and the location of any industrial facility, open dump, landfill, or hazardous waste treatment, storage, or disposal facility which may contribute pollutants to the discharge." (emphasis added) [Vol 133 Cong. Rec. S752 (daily ed. Jan. 14, 1987].

One municipality questioned the purpose of the topographic map and commented that the scale of the topographic map is too large to indicate any of the required outfall, drainage, industrial or structural control information. In response, the purpose of the topographic map is to identify receiving waters, major storm water sewer lines that contribute discharges to these waters, and potential sources of storm water pollution. EPA disagrees that a USGS 7.5 scale map is inappropriate for identifying these features within a municipal system. The scale afforded by such a map provides sufficient detail to allow specified delineation of outfalls, while not requiring an overly burdensome map in terms of size. Numerous commenters noted the value of source identification information and generally supported submitting this information in the permit application.

Many commenters questioned the value of the source identification information for the purpose of characterizing pollutant loads and concentrations. Conversely, one commenter opined that the requirement would provide sufficient information to estimate pollutant loadings from each outfall using loading models to estimate loadings by watershed. In response, the source identification information serves several purposes. It is the first step for identifying potential sources of pollutants from which more in depth analysis can be accomplished, under the discharge characterization component of the application. Also, where appropriate, it may be used in conjunction with models to estimate loadings and concentrations. EPA has also taken note of the many comments that question or dismiss the concept of determining pollutant loads and concentrations solely from source identification. Accordingly, EPA is convinced that at least some of the sampling requirements as proposed are necessary to facilitate more accurate system specific estimates of pollutant concentrations and loadings. These are discussed below, in the discharge characterization section.

One commenter suggested that aerial photos be submitted in lieu of topographic maps. EPA agrees that an aerial photograph of the appropriate scale that communicates the same information as a topographic map may be substituted. Today's final rule reflects this flexibility.

The source identification component of the municipal application also requires that municipal applicants identify the industrial activity within the drainage area associated with each major outfall. One commenter stated that where multiple storm sewers outfalls discharge to a stream reach, municipalities should be allowed to delineate a single sewer-shed for identifying sources of industrial activity. In response, the rule does not delimit an applicant's ability to identify industries in groups according to a common series of storm sewer outfalls, if that is an easier or more appropriate methodology for that particular applicant. However, EPA would view this as appropriate only where the land use is of one type, such as industrial. Where land use is mixed within the drainage area associated with each major outfall, such differences need to be identified.

In response to comments, to the extent that EPA is requesting that applicants identify the types of industrial facilities operating within the municipality, the municipality is free to use Standard Industrial Classification (SIC) or other systems which identify the principal products or services of the facility. One commenter disagreed with EPA's decision to require a list of water bodies that are listed under CWA sections 304(1), 319(a), 314(a), and 320, because the States already have this information and that requesting it from permittees could result in "omissions, misunderstandings, and mistakes." EPA believes that these waters should be identified in the application so that appropriate permit conditions can be developed that address storm water discharges that are adversely effecting such waters. EPA believes that having this information immediately at the disposal of the municipality and the permit writer will speed the process and alert the municipality of storm water discharges to listed water bodies and potentially polluted storm water discharges to those waters.

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6. Characterization of Discharges

The characterization plan and data collection required in today's rule as elements of Part-one and Part-two of the municipal permit application is comprised of several major components:

- A screening analysis to provide information to develop a program for detecting and controlling illicit connections and illegal dumping to the municipal separate storm sewer system;
- Initial quantitative data to allow the development of a representative sampling program to be incorporated as a permit condition;
- System-wide estimates of annual pollutant loadings and the mean concentration of pollutants in storm water discharges, and a schedule to provide estimates during the term of the permit for each major outfall of the seasonal pollutant loadings and the event mean concentration of pollutants in storm water discharges; and
- An identification of receiving waters with known water quality impacts associated with storm water discharges.

Several commenters noted the importance of developing and targeting management programs based on discharge characterization data and monitoring. Numerous other commenters stressed the importance of a program to identify and eliminate illicit connections and improper disposal. EPA agrees that discharge characterization is an important component of developing management programs. Most of the discharge characterization components of the municipal application procedure have been retained as proposed. However some changes and clarifications have been made, and these are noted below.

a. *Screening analysis for illicit discharges (part 1 of application).* Illicit discharges (non-storm water discharges without a NPDES permit), and illegal dumping to municipal separate storm sewer systems occur in a relatively haphazard manner. Due to the unpredictability of such discharges, today's permit applications require a field analysis for the development of priorities for detecting and controlling such discharges. A field screening approach will provide a means of detecting high levels of pollutants in dry weather flows, which is one indicator of illicit connections. Results of a field test of such discharges will provide further information about the nature of the discharge to determine if further investigation is warranted. Visual observation of dry weather flows has been shown to be one the most effective means for tracking down illicit connections and improper disposal.

As discussed in greater detail in section VI.H.7.b of today's preamble, EPA is proposing to require that municipal applicants submit a comprehensive plan to develop a program to detect and control illicit connections and illegal dumping. In order to develop appropriate priorities for these programs, applicants shall submit the results of a screening analysis to be performed on major outfalls or "field screening points" in the systems to detect the presence of illicit hookups and illegal dumping. The results of the screening analysis, referred to as the field screen, would be reported in part 1 of the permit application.

Under the requirements for a field screen, the applicant or co-applicants will submit a description of observations of dry weather discharges from major outfalls or "field screening points" identified in part 1 of the application. At a minimum, the field screen would include a description of visual observations made during a dry weather period. If any flow is observed during a dry weather period, two grab samples will be collected during a 24 hour period with a minimum period of four hours between samples. For all such samples, a description of the color, odor, turbidity, the presence of an oil sheen or surface scum as well as any other relevant observation regarding the potential presence of non-storm water discharges or illegal dumping would be provided. In addition, the applicant should provide the results of a field screen which includes on-site estimates of pH, total chlorine, total copper, total phenol, detergents (or surfacants) along with a description of the flow. EPA is not requiring analytical methods approved under 40 CFR part 136 be used exclusively in the field screen. Rather, the use of inexpensive field sampling techniques such as the use of colorimetric detection methods is anticipated. Where the field screen does not involve analytical methods approved under 40 CFR part 136, the applicant is required to provide a description of the method used which includes the name of the manufacturer of the test method, including the range and accuracy of the test. Appropriate field techniques for a field screen of dry weather discharges are discussed in EPA guidance for municipal storm water discharge permit applications.

It should be clarified that data from the field screen is generally not appropriate for comprehensive evaluation of water quality impacts, or estimating pollutant loadings. Rather, the information from the field screen in part 1 of the application will be used along with other information, such as the age of development and degree of industrial activity in the drainage basin, to identify areas or outfalls which are appropriate targets for management programs and for investigations directed at identifying and controlling non-storm water discharges to separate storm sewers during the term of the permit.

In the December 7, 1988, proposal, EPA proposed a second phase of the screening analysis requiring that wet-weather and dry-weather samples be collected and analyzed in accordance with analytical methods approved under 40 CFR part 136 from designated major outfalls for a larger set of pollutants identified with illicit connections. Comments essentially viewed this proposal as too ambitious for the permit application. One commenter recommended that this procedure could best be accomplished during the term of the permit. Some comments maintained that the collection of analytical samples as a follow up to an initial field screen analysis was not the most cost-effective, practicable or efficient method for pinpointing illicit connections. EPA recognizes that several municipal programs to detect and control illicit connections and other non-storm water discharges have been successfully developed and implemented without the use of extensive analytical sampling (for example, programs in Fort Worth, TX and Washtenaw County, MI). After identifying and analyzing the comments on this aspect of the proposal EPA has withdrawn this element of the proposal from today's rule. EPA believes that a follow-up phase to the initial field screening is more appropriate during the term of the permit. Thus, EPA has dropped the field screening requirement proposed for Part 2 of the application.

b. *Representative data (Part 2 of application).* The NURP study showed that pollutant concentrations in urban runoff can exhibit significant variation. Pollutant concentrations in such discharges vary during storm events and from storm event to storm event. Given the complex, variable nature of storm water discharges from municipal systems, EPA favors a permit scheme where the collection of representative data is primarily a task that will be accomplished through monitoring programs during the term of the permit. Permit writers have the necessary flexibility to develop monitoring requirements that more accurately reflect the true nature of highly variable and complex discharges

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Today's rule provides for an initial assessment of the quality of discharges from municipal separate storm sewers based primarily on source identification measures and existing information received in the permit application. This information will be used to begin to characterize system discharges. The analysis developed under this approach will not rely soley on sampling data collected during the application process, but will also incorporate existing data bases such as the one developed under the NURP study. Today's rule requires that some quantitative data will be collected to ensure the system discharges can be appropriately represented by the various existing data bases and to provide a basis for developing a monitoring plan to be implemented as a permit condition.

Today's rule requires that quantitative data be submitted for discharges from selected storm events at between 5 and 10 outfalls or field screening points. The municipality will recommend and the Director will then designate the outfalls or field screening points as representative of the commercial, residential and industrial land use activities of the drainage area contributing to the system, on the basis of information received in part 1 of the application. The applicant will be required to collect samples of a storm discharge from three storm events occurring one month apart for each designated outfall or field screening point. This is a modification to the December 7, 1988, proposal wherein only one of the 5 to 10 outfalls was to be sampled during three storm events, and the remaining sampled only once. This requirement may be modified by the Director if the type and frequency of storm events require different sampling. The Director may require samples of discharges to be collected during snow melts or during specified seasons. The Director may also require additional testing during a single event if it is unlikely that there will be three storm events suitable for sampling during the year. Furthermore, the Director may allow exemptions to the three storm event requirement when climatic conditions create good cause for such exemptions; for example, arid regions or areas experiencing drought conditions during the period when applications are developed could be exempted.

EPA has added requirements to sample more storm events in response to comments that the sampling procedure proposed would not necessarily yield representative data. Commenters indicated that: rain events of different intensity may yield different levels and types of pollutants; a rain event after a dry spell of several months will not be representative when compared to rain events occurring closer together, due to the build up of constituents; one sample may reflect short term effects such as improper disposal rather than long term effects; and that rain events are generally too variable to rely on the limited sampling as proposed. Clearly the data collected from sampling storm water discharges has a tendency to vary greatly. The more sampling that is accomplished, the greater extent to which this variability may be accounted for and appropriate management programs developed.

In selecting the amount of data to be collected during the permit application process, EPA has attempted to balance the usefulness of this data against the economic and logistical constraints in actually obtaining it. In some cases the data obtained will support initial loading and concentration estimates obtained using various modeling techniques, from which appropriate permit conditions can be developed. Data obtained may be supplemented with further data collection during the term of the permit.

EPA believes that the requirement that selected major municipal outfalls or "field screening points" be sampled for more than one event will provide verification that the characterization of discharge is valid. Where an ongoing sampling program is defined for the term of the permit, samples taken during the first few years of this period can be used to verify the application results. If a municipality or an industry questions the conclusions drawn from the characterization sampling, it may at its discretion choose to perform additional sampling to either confirm or dispel these concerns.

All samples collected will be analyzed for all pollutants listed in Table II (organic pollutants), and Table III (toxic metals, cyanide and total phenol) of appendix D of 40 CFR part 122, and for the pollutants listed in Table M-1 below:

Table M-1

Total suspended solids (TSS)	Total dissolved solids.
COD	BOD.
Oil and grease	Fecal coliform.
Fecal streptococcus	pH.
Dissolved phosphorus	
Total ammonia plus organic nitrogen.	Total phosphorus.
Total Kjeldahl nitrogen	Nitrate plus nitrite.

A portion of the NURP program involved monitoring 120 priority pollutants in storm water discharges from lands used for residential, commercial and light industrial activities. The NURP program excluded testing for asbestos and dioxin. Results for seven other organic priority pollutants were not considered valid due to changes in, or constraints on test methods. Seventy-seven priority pollutants were detected in samples of storm water discharges from lands used for residential, commercial and light industries taken during the NURP study, including 14 inorganic and 63 organic pollutants. Table M-2 shows the priority pollutants which were detected in at least ten percent of the discharge samples which were sampled for priority pollutants.

TABLE M-2.—PRIORITY POLLUTANTS DETECTED IN AT LEAST 10% OF NURP SAMPLES

(In percent)

Metals and inorganics	Frequency of detection
Antimony	19
Arsenic	82
Beryllium	12
Cadmium	46
Chromium	86
Copper	91
Cyanides	23
Lead	94
Nickel	43
Selenium	11
Zinc	94
Pesticides:	
Alpha-hexachlorocyclohexane	20
Alpha-endosulfan	10
Chlordane	17
Lindane	16
Halogenated aliphatics:	
Methane, dichloro-	11
Phenols and cresols:	
Phenol	14
Phenol, pentachloro-	10
Phenol, 4-nitro	10
Phthalate esters:	
Phthalate, bis(2-ethylhexyl)	22
Polycyclic aromatic hydrocarbons:	
Chrysene	10
Fluoranthene	10
Phenanthrene	12
Pyrene	15

The NURP data also showed a significant number of these samples exceeded various freshwater water quality criteria. The exceedence of water quality criteria does not necessarily imply that an actual violation of standards will exist in the receiving water body in question. Rather, the enumeration of exceedences serves as a screening function to identify those constituents whose presence in urban storm water runoff may warrant high priority for further evaluation.

Members of this group represent all of the major organic chemical fractions

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found in Table II of appendix D of 40 CFR part 122 (volatiles, acid compounds, base/neutrals, pesticides). Today's rule requires testing for all organic constituents in Table II rather than limiting the sampling requirements to the 24 toxic constituents found in the NURP study because they will provide a better description of the discharge at essentially the same cost. (The cost of analyzing samples for organic chemicals strongly depends on the number of major organic chemical fractions tested). The NURP study focused on characterizing storm water discharges from lands used for residential, commercial and light industrial activities. In general, the NURP study did not focus on other sources of pollutants to municipal separate storm sewer systems and, therefore, does not reflect all potential pollutants that may be present in discharges from municipal separate storm sewer systems.

The sampling requirements for the permit application address a limited number of sampling locations but require analysis for a wide range of pollutants. Sampling for a wide range of pollutants as a permit application requirement should provide permit writers with appropriate data to target more specific pollutants when developing requirements for a monitoring program during the term of the permit.

Numerous commenters stated that monitoring for all priority pollutants seemed excessive. However, EPA is convinced that it is more appropriate for permit conditions to focus on and prioritize particular pollutant problems after data covering a broad spectrum of pollutants are developed. As noted above, NURP identified 77 priority pollutants in urban runoff, but only from residential, commercial, and light industrial (*e.g.* industrial parks) areas. One municipal entity stated that this approach is a reasonable and realistic means of providing some useful baseline data, while others recommended sampling a variety of parameters that are included in Tables M-1 and M-2. Another municipal entity stated that characterization of outfall discharge quality during storm events is necessary as a means of targeting source control activities.

EPA is working with the United States Geological Survey (USGS) to evaluate the availability of USGS technical assistance to municipalities through cooperative funding programs to aid in collecting representative quantitative data of storm water discharges from municipal systems.

USGS data collection programs with municipalities typically include storm water discharge samples obtained at various times during a storm hydrograph event. Various USGS field procedures can be used to obtain discharge data for pipes, culverts, etc., typically found in urban areas. Pollutant models can be calibrated with data and long-term rainfall records to simulate the quality of system discharges and compared to other storm water models.

In addition, EPA recognizes that many municipalities have participated in studies, such as NURP, that involve sampling of urban runoff as well as other components of discharges from municipal separate storm sewer systems. All existing storm water sampling data along with relevant water quality data, sediment data, fish tissue data or biosurvey data taken over the last ten years is considered relevant and, under today's rule, must be submitted with part 1 of the application. Sampling data that is submitted must be accompanied with a narrative description of the drainage area served by the outfall monitored, a description of the sampling and quality control program, and the location of receiving water monitoring.

EPA requested comments on the use of existing data, such as that generated under the NURP study, to satisfy the requirement of providing representative sampling data. Commenters did not agree on the value of NURP results as an indicator of representative data. Several commenters expressed the view that existing data could be used to satisfy in whole or in part the representative sampling requirements of the storm water permit application. However, commenters generally did not offer suggested criteria that could be used to verify the validity of existing data. One commenter believed that intensive sampling over a period of ten years in 12 basins, when combined with NURP data, would be adequate.

One commenter supported the use of data, such as that obtained from the NURP study, to target sampling programs. EPA supports such a methodology and has retained this portion of the proposed discharge characterization component. EPA received strong support from an environmental group for retaining this information requirement in part 1 of the application.

In light of these comments EPA believes it is appropriate to retain the representative sampling requirements without resorting to the use of existing data exclusively. Because of the inherent variability in reliability and applicability of existing data, EPA is convinced that a nationally consistent methodology for collecting data is appropriate. This data can then be used in conjunction with other existing data and models to develop appropriate site specific management programs and more generalized management program strategies. Where existing data and data collected under today's rule varies or does not match, further sampling under the term of the permit will be accomplished to more accurately assess the discharge of pollutants.

c. Loading and Concentration Estimates (part 2 of application). The assessment of the water quality impacts of discharges from municipal separate storm sewer systems on receiving waters requires the analysis of both pollutant loadings and concentrations of pollutants in discharges.

The loading and concentration estimates in today's rule will be used to evaluate two types of water quality impacts: (1) Short-term impacts; and (2) long-term impacts. Specifically, the regulation requires estimates of the annual pollutant load of the cumulative discharges to waters of the United States from municipal outfalls and the event mean concentration of the cumulative discharges to waters of the United States municipal outfalls during a storm event for BOD_5, COD, TSS, dissolved solids, total nitrogen, total ammonia plus organic nitrogen, total phosphorus, dissolved phosphorus, cadmium, copper, lead, and zinc. Estimates shall be accompanied by a description of the procedures for estimating constituent loads and concentrations, including any modelling, data analysis, and calculation methods. Municipalities have options in the use of methodologies, including those presented in NURP for calculating loads.

Short term impacts from discharges from municipal separate storm sewers involve changes in water quality that occur during and shortly after storm events. Examples of short-term impacts that can lead to impairments include periodic dissolved oxygen depression due to the oxidation of contaminants, high bacteria levels, fish kills, acute effects of toxic pollutants, contact recreation impairments and loss of submerged macrophytes. Characterization of instream pollutant concentrations based on estimated pollutant concentrations in system discharges are important for evaluating these types of impacts.

Long-term water quality impacts from discharges from municipal separate storm sewers may be caused by contaminants associated with suspended solids that settle in receiving water sediments and by nutrients which enter receiving water systems with long

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retention times. Pollutant loading data are important for evaluation of impairments such as loss of storage capacity in streams, estuaries, reservoirs, lakes and bays, lake eutrophication caused by high nutrient loadings, and destruction of benthic habitat. Other examples of the long-term water quality impacts include depressed dissolved oxygen caused by the oxidation of organics in bottom sediments and biological accumulation of toxics as a result of uptake by organisms in the food chain. An estimate of annual pollutant loading associated with discharges from municipal storm water sewer systems is necessary to evaluate the magnitude and severity of the environmental impacts of such discharges and to evaluate the effectiveness of controls which are imposed at a later time.

Municipal storm water sewer systems generally handle runoff from large drainage areas and the sources of pollution are usually very diffuse. The concentrations of many pollutants in discharges from these systems are often low relative to many industrial process and POTW discharges. The water quality impacts of low concentration pollution discharges tend to be cumulative and need to be evaluated in terms of aggregate loadings as well as pollutant concentrations. A site-specific loading analysis can be used to evaluate the relative contribution of various pollutant sources.

7. Storm Water Quality Management Plans

Today's rule facilitates the development of site-specific permit conditions by requiring large and medium municipal permit applicants to submit, along with other information, a description of existing structural and non-structural prevention and control measures on discharges of pollutants from municipal storm sewers in part 1 of the permit application. Section 122.26(d)(2)(iv) requires the applicant to identify in part 2 of the application, to the degree necessary to meet the MEP standard, additional prevention or control measures which will be implemented during the life of the permit. Although, in many cases, it will not be possible to identify all prevention and control measures that are appropriate as permit conditions, EPA believes that the process of identifying components of a comprehensive prevention and/or control program should begin early and that applicants should be given the opportunity to identify and propose the components of the program that they believe are appropriate for first preventing or controlling discharges of pollutants.

As noted earlier, EPA recognizes that problems associated with storm water, combined sewer overflows (CSOs) and infiltration and inflow (I&I) are all interrelated even though they are treated somewhat differently under the law. EPA believes that it is important to begin linking these programs and activities and, because of the potential cost to local governments, to investigate the use of innovative, nontraditional approaches to reducing or preventing contamination of storm water. The application process for developing municipal storm water management plans provides an ideal opportunity between steps 1 and 2 for considering the full range of nontraditional, preventive approaches.

The permit application requirements in today's rule require the applicant or co-applicants to develop management programs for four types of pollutant sources which discharge to large and medium municipal storm sewer systems. Discharges from large and medium municipal storm sewer systems are usually expected to be composed primarily of: (1) Runoff from commercial and residential areas; (2) storm water runoff from industrial areas; (3) runoff from construction sites; and (4) non-storm water discharges. Part 2 of the permit application has been designed to allow the applicant the opportunity to propose MEP control measures for each of these components of the discharge. Discharges from some municipal systems may also contain pollutants from other sources, such as runoff from land disposal activities (leaking septic tanks, landfills and land application of sewage sludge). Where other sources, such as land disposal, contribute significant amounts of pollutants to a municipal storm sewer system, appropriate control measures should be included on a site-specific basis. Proposed management programs will then be evaluated in the development of permit conditions.

There is some overlap in the manner in which these pollutant sources are characterized and their sources identified. For instance, improper disposal of oil into storm drains is often associated with do-it-yourself automobile oil changes in residential areas, or improper application or overuse of herbicides and pesticides in residential areas can also occur in industrial areas. Also, some control measures will reduce pollutant loads for multiple components of the municipal storm sewer discharge. These measures should be identified under all appropriate places in the application; as discussed below, however, double counting of pollutant removal must be avoided when the total assessment of control measures is performed.

Although many land use programs have multiple purposes, including the reduction of pollutants in discharges from municipal separate storm sewer systems, the proposed management programs in today's rule are intended to address only those controls which can be implemented by the permit applicant or co-applicants. EPA cannot abrogate its responsibilities under the CWA to implement the NPDES permit program by relying on pollution control programs that are outside the NPDES program. For example, municipal permit management programs may not rely exclusively on erosion or sediment control laws for implementing that portion of management programs that address discharges from construction sites, unless such laws implement NPDES permit program requirements entirely and that such implementation is a part of the permit.

EPA anticipates that storm water management programs will evolve and mature over time. The permits for discharges from municipal separate storm sewer systems will be written to reflect changing conditions that result from program development and implementation and corresponding improvements in water quality. The proposed permit applications will require applicants to provide a description of the range of control measures considered for implementation during the term of the permit. Flexibility in developing permit conditions will be encouraged by providing applicants an opportunity to identify in the permit application priority controls appropriate for the initial implementation of management programs. Many commenters endorsed the flexible site-specific storm water program approach as proposed as a method for addressing regional water quality control programs in a cost effective manner. To this extent, EPA agrees with one municipality that management programs should focus on more serious problems and sources of pollutants identified in the municipal system. However, EPA believes that to implement section 402(p)(3), comprehensive storm water management programs which address a number of major sources of pollutants to a system are necessary. Municipal programs should not be focused solely on a single source of pollution, such as illicit connections.

One commenter maintained that management program development

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should be flexible enough to allow for consideration of what is attainable based on the area's climate, vegetation, hydrology, and land uses. EPA agrees with this comment. Some strategies for reducing pollutants in the northeast will not be practical in the southwest, such as management programs for deicing activities. The permit application process will determine what strategies are appropriate in different locations.

Several commenters supported addressing storm water pollutant problems through management practices or programs rather than end of pipe controls or treatment. EPA agrees with this comment to the extent that storm water management practices are a general theme of this rulemaking with regard to municipal permits. However, there will be cases where such discharges are best eddressed through technology such as retention, detention or infiltration ponds.

One commenter reacted unfavorably to the flexible site-specific management plan approach stating that there is no hard criteria upon which to judge the adequacy of programs. Another commenter felt that there should be a BAT standard for municipal permits. Another commenter stated that the rule should contain specific BMPs that the permittee must comply with. EPA disagrees with these comments. The Clean Water Act requires municipalities to apply for permits that will reduce pollutants in discharges to the maximum extent practicable and sets out the types of controls that are contemplated to deal with storm water discharges from municipalities. The language of CWA section 402(p)(3) contemplates that, because of the fundamentally different characteristics of many municipalities, municipalities will have permits tailored to meet particular geographical, hydrological, and climatic conditions. Management practices and programs may be incorporated into the terms of the permit where appropriate. Permit conditions, which require that storm water management programs be developed and implemented or require specific practices, are enforceable in accordance with the terms of the permit. EPA disagrees with the notion that this regulation, which addressed permit application requirements, should create mandatory permit requirements which may have no legitimate application to a particular municipality. The whole point of the permit scheme for these discharges is to avoid inflexibility in the types and levels of control. Further, to the degree that such mandatory requirements may be appropriate, these requirements should be established under the authority of section 402(p)(6) of the CWA and not in this rulemaking, which addresses permit application requirements.

Some commenters suggested that management programs should be developed as part of the permit conditions and not as part of the permit application. EPA agrees that management programs and their ongoing development should be part of the permit term. However, EPA is convinced, and many commenters agree, that the permit application should contain information on what the permittee has done to date and what it proposes and plans to do during the permit term based upon its discharge characterization and source identification data. This is a reasonable and logical approach and one that meets the intent and letter of section 402(p)(3) of the CWA. As stated above, this would be an appropriate method for implementing storm water management programs that should mature and evolve over time.

Applicants will propose priorities based on a consideration of appropriate controls including, but not limited to, consideration of controls that address: reducing pollutants to municipal separate storm sewer system discharges that are associated with storm water from commercial and residential areas (§ 122.25(d)(2)(iv)(A)); illicit discharges and illegal disposal (§ 122.26(d)(2)(iv)(B)); storm water from industrial areas (§ 122.26(d)(2)(iv)(C)); and runoff from construction sites (§ 122.26(d)(2)(iv)(D)). Permits for different municipalities will place different emphasis on controlling various components of discharges from municipal storm sewers. For example, the potential for cross-connections (such as municipal sewage or industrial process wastewater discharges to a municipal separate storm sewer) is generally expected to be greater in municipalities with older developed areas. On the other hand, municipalities with larger areas of new development will have a greater opportunity to focus controls to reduce pollutants in storm water generated by the area after it is developed, discharges from construction sites, and other planning activities.

EPA requested comments on the process and methods for developing appropriate priorities in management programs proposed in applications and how the development of these priorities can be coordinated with controls on other discharges to ensure the achievement of water quality standards and the goals of the CWA.

Discharges from diffuse sources in residential areas was recognized by several commenters as a significant source of pollutants. Accordingly, these elements of the management plans have been retained. In conjunction with the importance of developing programs for illicit connections, numerous commenters stated that education programs are a priority. Another commenter emphasized that ordinances prohibiting such discharges and their enforcement is a crucial means of a successful program in this regard. EPA agrees with these comments and consequently will retain those portions of management program development that include a description of a program for educational activities such as public information for the proper disposal of oil and toxic materials and the use of herbicides, pesticides and fertilizers.

Some commenters noted that discharge characterization is necessary for development of appropriate management plans. EPA agrees with these comments and has retained the discharge characterization components in this rulemaking. However, EPA disagrees that the results of all discharge characterization procedures (*i.e.*, part 1 and part 2) are necessary to describe and propose a program as required in part 2 of the application. The application of various models is available to permit applicants, where needed, to develop appropriate management programs. All available site specific discharge characterization data should be available to the permit writer to draft appropriate conditions for the term of the permit.

One commenter noted that an important aspect of developing management plans is establishing the necessary legal authority to improve water quality. EPA agrees with this comment and has retained those aspects of the regulation which call for development and attainment of adequate legal authority in both parts of the municipal application.

One commenter stated that programs should address previously identified water quality problems in other programs that are required by section 304(1) of the CWA. EPA agrees that identified water quality problems need to be addressed by management programs, and the municipal permit application will call for an identification of these waters. However, EPA does not endorse addressing these waters to the exclusion of all others within the boundaries of the municipal separate storm sewer system. Some waters may experience substantial degradation after rain events and still not be listed under

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section 304(1). Further, water quality impacts in listed waters may not be related to storm water discharges, while other non-listed waters do have water quality impacts from storm water discharges. Similarly, EPA agrees with one commenter that it may be desirable to focus attention and resources on certain problem watersheds within a municipality, and controls may be imposed and programs prioritized on that basis. However, such a focus should not be to the exclusion of other waters and watersheds that have water quality problems (although less troublesome) traceable to storm water discharges. The CWA requires that permits address discharges to waters of the United States, not just waters previously targeted under special programs.

Some commenters expressed concern that the permit application requires the design of management programs before knowing what will be in the permits. EPA disagrees with the thrust of this comment, that is that the order of requirements is inappropriate. The permit applicant will have two years to develop proposed plans which can be considered by permit writers in the development of the permit. Based upon a consideration of the management program proposed by the municipality and other relevant information, permits can be tailored for individual programs. One commenter stated that the cornerstone of management programs are inspection and enforcement programs. EPA agrees that these two elements are important components. Without inspection and enforcement mechanisms the programs will undoubtedly falter. Accordingly these requirements in the description of management programs in the permit application have been retained. In a similar vein, one commenter emphasized the importance of developing legal authority, financial capability, and administrative infrastructure. EPA agrees with this comment and has retained those aspects of the regulation that call for a description of applicants plans and resources in these areas.

One commenter stressed that control of discharges into the municipal system from industries is an important goal of municipal storm water management programs. EPA agrees with this comment and has retained the proposed description of management programs to address discharges from industrial sources. Other commenters identified industries as the principal contributors of pollutants to municipal separate storm sewer systems.

In addition, EPA will continue to evaluate procedures and methods to control storm water discharges to the extent necessary to mitigate impacts on water quality in the studies required under section 402(p)(5) of the CWA. One purpose of these studies will be to evaluate the costs and water quality benefits associated with implementing these procedures and methods. This evaluation will address a number of factors which impact the implementation costs associated with these programs, such as the extent to which similar municipal ordinances are currently being implemented, the degree to which existing municipal programs (such as flood management programs or construction site inspections) can be expanded to address water quality concerns, the resource intensiveness of the control, and whether the control program will involve public or private expenditures. This information, along with information gained during permit implementation will aid in the dynamic long-term development of municipal storm water management programs.

a. *Measures to reduce pollutants in runoff from commercial and residential areas.* The NURP program evaluated runoff from lands primarily dedicated to residential and commercial activities. The areas evaluated in the study reflect some other activities, such as light industry, which are commonly dispersed among residential and commercial areas. The NURP study selected sampling locations that were thought to be relatively free of illicit discharges and storm water from heavy industrial sites including storm water runoff from heavy construction sites. Of course, in a study such as NURP it was impossible to totally isolate various contributions to the runoff. In developing the permit application requirements in today's rule EPA has, in general, relied on the NURP definition of urban runoff—runoff from lands used for residential, commercial and light industrial activities.

NURP and numerous other studies have shown that runoff from residential and commercial areas washes a number of pollutants into receiving waters. Of equal importance is the volume of storm water runoff leaving urban areas during storm events. Large intermittent volumes of runoff can destroy aquatic habitat. As the percentage of paved surfaces increases, the volume and rate of runoff and the corresponding pollutant loads also increase. Thus, the amount of storm water runoff from commercial and residential areas and the pollutant loadings associated with storm water runoff increases as development progresses; and they remain at an elevated level for the lifetime of the development.

Proposed § 122.26(d)(2)(iv)(A) requires municipal storm sewer system applicants to provide in part 2 of the application a description of a proposed management program that will describe priorities for implementing management programs based on a consideration of appropriate controls including:

- A description of maintenance activities and a maintenance schedule for structural controls;
- A description of planning procedures including a comprehensive master plan to control after construction is completed, the discharge of pollutants from municipal separate storm sewers which receive discharges from new development and significant redevelopment after construction is completed (in response to comment this contemplates an engineering policy and procedure strategy with long term planning);
- A description of practices for operating and maintaining public highways and procedures for reducing the impact on receiving waters of such discharges from municipal storm sewer system;
- A description of procedures to assure that flood management projects assess the impacts on the water quality of receiving water bodies; and
- A description of a program to reduce to the maximum extent practicable, pollutants in discharges from municipal separate storm sewers associated with the application of pesticides, herbicides and fertilizer which will include, as appropriate, controls such as educational activities and other measures for commercial applicators and distributors, and controls for application in public right-of-ways and at municipal facilities.

Water quality problems caused by municipal storm sewer discharges will generally be most acute in heavily developed areas. Prevention measures may be desirable and cost effective. However, structural control measures may also be effective, although opportunities for implementing these measures may be limited in previously developed areas. Commonly used structural technologies include a wide variety of treatment techniques, including first flush diversion systems, detention/infiltration basins, retention basins, extended detention basins, infiltration trenches, porous pavement, oil/grit separators, grass swales, and swirl concentrators. A major problem associated with sound storm water management is the need for operating

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and maintaining the system for its expected life.

The unavailability of land in highly developed areas often makes the use of structural controls infeasible for modifying many existing systems. Non-structural practices can play a more important role. Non-structural practices can include erosion control, streambank management techniques, street cleaning operations, vegetation/lawn maintenance controls, debris removal, road salt application management and public awareness programs.

As noted above, the first component of the proposed program to reduce pollutants in storm water from commercial and residential areas which discharge to municipal storm sewer systems is to describe maintenance activities and schedule. The second component of the proposed program to reduce pollutants in storm water from commercial and residential areas which discharge to municipal storm sewer systems provides that applicants describe the planning procedures and a comprehensive master plan that will assure that increases of pollutant loading associated with newly developed areas are, to the maximum extent practicable, limited. These measures should address storm water from commercial and residential areas which discharge to the municipal storm sewer that occur after the construction phase of development is completed. Controls for construction activities are addressed later in today's rule. One commenter noted the feasibility of developing management plans for newly developing areas. EPA agrees with this comment and has retained that portion of the regulation that deals with a description of controls for areas of new development. Similarly, one municipality stressed the importance and achievability of addressing storm water discharges from construction sites.

As urban development occurs, the volume of storm water and its rate of discharge increases. These increases are caused when pavement and structures cover soils and destroy vegetation which otherwise would slow and absorb runoff. Development also accelerates erosion through alteration of the land surface. Areas that are in the process of development offer the greatest potential for utilizing the full range of structural and non-structural best management practices. If these measures are to provide controls to reduce pollutant discharges after the area has been developed, comprehensive planning must be used to incorporate these measures as the area is in the process of developing. These measures offer an important opportunity to limit increases in pollutant loads.

The third component of § 122.26(d)(2)(iv)(A) provides a description of practices for operating and maintaining public roads and highways and procedures for reducing the impact on receiving waters of discharges from municipal storm sewer systems. General guidelines recommended for managing highway storm water runoff include litter control, pesticide/herbicide use management, reducing direct discharges, reducing runoff velocity, grassed channels, curb elimination, catchbasin maintenance, appropriate streetcleaning, establishing and maintaining vegetation, development of management controls for salt storage facilities, education and calibration practices for deicing application, infiltration practices, and detention/retention practices.

The fourth component of § 122.26(d)(2)(iv)(A) provides that applicants identify procedures that enable flood management agencies to consider the impact of flood management projects on the water quality of receiving streams. A well-developed storm water management program can reduce the amount of pollutants in storm water discharges as well as benefit flood control objectives. As discussed above, increased development can increase both the quantity of runoff from commercial and residential areas and the pollutant load associated with such discharges. Disturbing the land cover, altering natural drainage patterns, and increasing impervious area all increase the quantity and rate of runoff, thereby increasing both erosion and flooding potential. An integrated planning approach helps planners make the best decisions to benefit both flood control and water quality objectives.

The fifth component of § 122.26(d)(2)(iv)(A) would provide that municipal applicants submit a description of a program to reduce, to the maximum extent practicable, pollutants in discharges from municipal separate storm sewers associated with the application of pesticides, herbicides and fertilizer. Such a program may include controls such as educational activities and other measures for commercial applicators and distributors and controls for application in public rights-of-way and at municipal facilities. Discharges of these materials to municipal storm sewer systems can be controlled by proper application of these materials. Some commenters noted that insecticides used in residential areas are a probable source of pollutants in storm water discharges from residential areas, as well as salting and other de-icing activities. In response to this comment, part of a community management plan may include controls or education programs to limit the impacts of these sources of pollutants. One commenter noted that many communities already have household toxic disposal programs. Where appropriate these can be incorporated into municipal management programs.

Some commenters suggested substituting the management program description for residential and commercial areas with a simple identification of applicable management practices. EPA agrees that identification of appropriate management practices is a critical component of a program description for these areas. In essence, this is what the program description is designed to achieve. However, for the reasons discussed in greater detail above, EPA is convinced that an appropriate program must address all of the components of the management program for residential and commercial areas that are outlined in today's rule. Further, for the purposes of writing a permit with enforceable conditions, the application should identify a schedule to implement management practices. The applicant should be able to estimate the reduction in pollutant loads as a result of the development of certain management practices and programs (§ 122.26(d)(2)(v). A program may also include public education programs, which are not necessarily viewed as traditional BMPs.

b. *Measures for illicit discharges and improper disposal.* The CWA requires that NPDES permits for discharges from municipal storm sewers "shall include a requirement to effectively prohibit non-stormwater discharges into the storm sewers." In today's rule, EPA will begin to implement this statutory mandate by focusing on two types of discharges to large and medium municipal separate storm sewer systems. *See* § 122.26(d)(1)(iv)(D) and (d)(2)(iv)(B). One type of non-storm water discharges are illicit discharges which are plumbed into the system or that result from leakage of sanitary sewage system. The other class of non-storm water discharges result from the improper disposal of materials such as used oil and other toxic materials.

Illicit discharges. In some municipalities, illicit connections of sanitary, commercial and industrial discharges to storm sewer systems have had a significant impact on the water quality of receiving waters. Although the

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NURP study did not emphasize identifying illicit connections to storm sewers other than to assure that monitoring sites used in the study were free from sanitary sewage contamination, the study concluded that illicit connections can result in high bacterial counts and dangers to public health. The study also noted that removing such discharges presented opportunities for dramatic improvements in the quality of urban storm water discharges.

Other studies have shown that illicit connections to storm sewers can create severe, wide-spread contamination problems. For example, the Huron River Pollution Abatement Program inspected 660 businesses, homes and other buildings located in Washtenaw County, Michigan and identified 14% of the buildings as having improper storm drain connections. Illicit discharges were detected at a higher rate of 60% for automobile related businesses, including service stations, automobile dealerships, car washes, body shops and light industrial facilities. While some of the problems discovered in this study were the result of improper plumbing or illegal connections, a majority were approved connections at the time they were built. Many commenters emphasized the identification and elimination of illicit connections as a priority, including leakage from sanitary sewers. EPA agrees with these comments and intends to retain this portion of the program without modification.

A wide variety of technologies exist for detecting illicit discharges. The effectiveness of these measures largely depends upon the site-specific design of the system. Under today's rule, permit applicants would develop a description of a proposed management program, including priorities for implementing the program and a schedule to implement a program to identify illicit discharges to the municipal storm sewer system. This rulemaking will require the initial priorities for analyzing various portions of the system and the appropriate detection techniques to be used.

Improper disposal. The permit application requirements for municipal storm sewer systems include a requirement that the municipal permit applicant describe a program to assist and facilitate in the proper management of used oil and toxic materials. Improper management of used oil can lead to discharges to municipal storm sewers that in turn may have a significant impact on receiving water bodies. EPA estimates that, annually, 267 million gallons of used oil, including 135 million gallons of used oil from do-it-yourself automobile oil changes, are disposed of improperly. An additional 70 million gallons of used oil, most coming from service stations and repair shops, are used for road oiling. Many commenters emphasized the elimination of discharges composed of improperly disposed of oil and toxic material. One commenter identified motor oil as the major source of oil contamination and that EPA needs to encourage proper disposal of used oil. Several other commenters emphasized the importance of recycling programs for oil. EPA agrees with these comments and intends to retain this portion of the program without modification. One commenter identified public awareness and timely reporting of illegal dumping as critical components of this portion of the program. EPA agrees with this comment and intends for management programs to deal with this problem.

c. *Measures to reduce pollutants in storm water discharges through municipal separate storm sewers from municipal landfills, hazardous waste treatment, disposal and recovery facilities that are subject to section 313 of title III of SARA.* As discussed in section VI.C of today's preamble, industrial facilities that discharge storm water through a large or medium municipal separate storm sewer system are required to apply for a permit under § 122.26(c) or seek coverage under a promulgated general permit. Today's rule also requires the municipal storm sewer permittee to describe a program to address industrial dischargers that are covered under the municipal storm sewer permit. Today's rule requires the municipal applicant to identify such discharges (*see* source identification requirements under § 122.26(d)(2)(ii)), provide a description of a program to monitor pollutants in runoff from certain industrial facilities that discharge to the municipal separate storm sewer system, identify priorities and procedures for inspections, and establish and implement control measures for such discharges. Should a municipality suspect that an individual discharger is discharging pollutants in storm water above acceptable limits, and the owner/operator of the system has no authority over the discharge, the municipality should contact the NPDES permitting authority for appropriate action. Two example of possible action are: if the facility already has an individual permit, the permit may be reopened and further controls imposed, or if the facility is covered by a promulgated general permit, then an individual site-specific permit application may be required.

In the December 7, 1988, proposal, EPA requested comments concerning what storm water discharges from industrial facilities through municipal systems should be monitored. One of the proposed approaches was to require data on portions of the municipal system which receive storm water from facilities which are listed in the proposed regulatory definition at § 122.26(b)(14) of "storm water discharge associated with industrial activity" (with the exception of construction activities and uncontaminated storm water from oil and gas operations) which discharge through the municipal system. However, given the large number of facilities meeting this definition that discharge through municipal systems, a monitoring program that requires the submission of quantitative data regarding portions of the municipal systems receiving storm water from such facilities may not be practicable. Such a requirement could, for some systems, potentially become the most resource intensive requirements in the municipal permit. Therefore, EPA proposed various ways to develop appropriate targeting for monitoring programs.

EPA requested comments on a requirement that, at a minimum, monitoring programs address discharges from municipal separate storm sewer outfalls that contain storm water discharges from municipal landfills, hazardous waste treatment, disposal and recovery facilities, and runoff from industrial facilities that are subject to section 313 of title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). Section 313 of title III requires that operators of certain facilities that manufacture, import, process, or otherwise use certain toxic chemicals report annually their releases of those chemicals to any environmental media. Section 313(b) of title III specifies that a facility is covered for the purposes of reporting if it meets all of the following criteria.

- The facility has ten or more full-time employees;
- The facility is in Standard Industrial Classification (SIC) codes 20 through 39;
- The facility manufactured (including quantities imported), processed, or otherwise used a listed chemical in amounts that exceed certain threshold quantities during the calendar year for which reporting is required.

Listed chemicals include 329 toxic chemicals listed at 40 CFR 372.65. After 1989, the threshold quantities of listed chemicals that the facility must manufacture, import or process (in order to trigger the submission of a release

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report) is 25,000 pounds per year. The threshold for a use other than manufacturing, importing or processing of listed toxic chemicals is 10,000 pounds per year. EPA promulgated a final regulation clarifying these reporting requirements on February 16, 1988. (53 FR 4500).

EPA received numerous comments regarding limiting the types of facilities that are initially subject to monitoring and municipal management programs. Numerous municipalities agreed that focusing on the above facilities is an appropriate means for setting priorities for the development of control measures to eliminate or reduce pollutants associated with industrial facilities. Commenters agreed that the potential for toxic materials in discharges is high because of the high volume of such materials at these facilities and that information regarding discharges and material management practices will be available through section 313 of SARA. One commenter noted that building on an established program will contribute to establishing an effective storm water program. Accordingly, EPA has specified at § 122.26(d)(2)(ii)(C) that the municipal applicant must describe a program that identifies priorities and procedures for inspections and establishing and implementing control measures for these facilities.

Several commenters suggested that these facilities should not be singled out because the presence of the threshold amounts of SARA 313 chemicals does not indicate that significant quantities of those chemicals are likely to enter the facility's storm water runoff. Instead it was suggested that municipalities should monitor storm sewers as a whole to determine what chemicals are present and therefore what facilities are responsible. EPA disagrees with these comments. The object of these requirements is initially to set priorities for monitoring requirements. Then, if the situation requires, controls can be developed and instituted. If a facility is a member of this class of facilities and does not discharge excessive quantities of SARA 313 chemicals, then it may not be subjected to further monitoring and controls. As noted above, the selection of facilities is only a means of setting priorities for facilities for the development of municipal plans.

EPA agrees, however, that there will be other facilities that are significant sources of pollutants and should be addressed by municipalities as soon as possible under management programs. Accordingly, those industrial facilities that the municipal permit applicant determines to be contributing a substantial pollutant loading to the municipal storm sewer system shall be addressed in this portion of the municipal management program.

EPA also requested comments on monitoring programs for municipal discharges including the submission of quantitative data on the following constituents:

- Any pollutants limited in an effluent guidelines for the industry subcategories, where applicable;
- Any pollutant listed in a discharging facility's NPDES permits for process wastewater, where applicable;
- Oil and grease, pH, BOD5, COD, TSS, total phosphorus, total Kjeldahl nitrogen, and nitrate plus nitrite nitrogen;
- Any information on discharges required under 40 CFR 122.21(g)(7)(iii) and (iv).

These are the same constituents that are to be addressed in individual permit applicants for storm water discharges associated with industrial activity.

Several industries and municipalities submitted comments on this issue. Some commenters agreed that these are appropriate parameters. Some commenters advised that the ability of municipalities to implement this aspect of the program depended on industries submitting this data. Several industries provided comments suggesting that the approach should allow the permittee flexibility in determining which parameters are chosen because of the burdens of monitoring and the complexity of materials and flows in municipal systems.

In light of these comments, EPA has retained § 122.26(d)(2)(iv)(C) as proposed requiring municipalities to describe a monitoring program which utilizes the above parameters. Monitoring for these parameters provides consistency with the individual application requirements for industries, provides uniformity in municipal applications, and will narrow the parameters to conform to the types of industries discharging into the municipal systems. Monitoring programs may consist of programs undertaken by the municipality exclusively or requirements imposed on industry by the municipality, or a combination of approaches. Appropriate procedures are discussed in municipal permit application guidance.

EPA requested comments on appropriate means for municipalities to determine what facilities are contributing pollutants to municipal systems. Many commenters responded with numerous methodologies. Some of these have been addressed in guidance. Municipalities will have options in selecting the most appropriate methodology given their circumstances as described in their permit applications.

EPA initially favors establishing monitoring requirements to be applied to those outfalls that directly discharge to waters of the United States. EPA received one comment from a municipality with regard to this issue which agreed that this was the most logical approach. Monitoring of outfalls close to the point of discharge to waters of the United States is generally preferable when attempting to identify priorities for developing pollutant control programs. However, under certain circumstances, it may be preferable to monitor at the point where the runoff from the industrial facility discharges to the municipal system. For example, if many facilities discharge substantially similar storm water to a municipal system it may be more practicable to monitor discharges from representative facilities in order to characterize pollutants in the discharge.

As noted by numerous industries, if municipal characterization plans reveal problems from certain industrial dischargers, then such facilities may be required to provide further data from their own monitoring. As noted above, EPA envisions that this data could then be used to develop appropriate control practices or techniques and/or require individual permit applications if a general permit covering the facility proves inadequate.

Comments were also solicited as to whether end-of-pipe treatment generally was more appropriate than source controls for storm water from industrial facilities which discharge to municipal systems. Many commenters, including both municipalities and industries, stated that source controls are the only practical and feasible means of controlling pollutants in storm water runoff, and specifically opposed the concept of end-of-pipe treatment or other controls. Some commenters maintained that, from an economic and environmental standpoint, end-of-pipe treatment may be the only effective means. One advised that the prompt cleanup of spills, controlled wash down of process areas, covering of material loading areas, storm water runoff diversion, covered storage areas, detention basins or other such mechanisms would prevent storm water from mixing with pollutants and possibly discharging them into receiving waters. Another noted that in the urban areas, there is little potential for treatment, consequently, it would seem

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that controls and/or retrofitting existing facilities would be necessary when violations are found and that citizens will be better served by source controls appropriate to the individual problem.

EPA agrees with these comments to the extent that source controls and management programs are the general thrust of these regulations. However, in some situations end-of-pipe treatment, such as holding ponds, may be the only reasonable alternative. EPA disagrees with one industrial commenter that the municipalities should be almost entirely responsible for treating municipal discharges at the end of the pipe without reliance on source controls by industrial dischargers. Municipal programs may require controls on industrial sources with demonstrated storm water discharge problems. One industrial association noted that its member companies already have incentive to properly handle their materials and facilities because of other environmental programs with spill and erosion controls.

Numerous commenters stated that the program addressing industrial dischargers through municipal systems needs to be clearly defined in order to eliminate, as much as possible, potential conflicts between the system operator and dischargers. EPA has provided a framework for development of management plans to control pollutants from these particular sources. However, because of the differences in municipal systems and hydrology nationwide, EPA is not convinced that program specificity is an appropriate approach. The concept of the management program is to provide flexibility to the permit applicants to develop regional site specific control programs.

One commenter suggested that required controls should be limited to a facility's proportional contribution (based on concentration) of pollutants. EPA disagrees. Most facilities discharging through a municipal separate storm sewer will need to be covered by a general or individual permit. These permits will control the introduction of pollutants from that facility through the municipal storm sewer to the waters of the U.S. Any additional controls placed on the facility by the municipality will be at the discretion of the municipality. EPA is not requiring municipalities to adopt a particular level of controls on industrial facilities as suggested by the commenter.

One commenter questioned how dischargers that discharged both into the waters of the United States and through a municipal system will be addressed and whether there is a potential for inconsistent requirements. Industries that discharge storm water associated with industrial activity into the waters of the United States are required to be covered by individual permits or general permits for such discharges. Dischargers of storm water associated with industrial activity through municipal separate storm sewer systems will be subject to municipal management programs that address such discharges as well as to an individual or general NPDES permit for those discharges. EPA does not believe there is a significant risk of inconsistent requirements, since each industrial facility must meet BAT/BCT-level controls in its NPDES permit. EPA doubts that municipalities will impose much more stringent controls.

Many commenters stated that if cities and municipalities are to be responsible for industrial storm water discharges through their system, then municipalities should have authority to make determinations as to what industries should be regulated, how they are regulated, and when enforcement actions are undertaken. In response, EPA notes that the proposal has been changed and that municipalities will not be solely responsible for industries discharging through their system. Nonetheless, municipalities will be required to meet the terms of their permits related to industrial dischargers. Municipalities may undertake programs that go beyond the threshold requirements of the permit. Some municipal entities stated that municipal permittees should be able to require permit applications from industries in the same manner that EPA does and also require permits. In response, if operators of large and medium municipal separate storm sewer systems wish to employ such a program, then this portion of the management program may incorporate such practices.

d. *Measures to reduce pollutants in runoff from construction sites into municipal systems.* Section VI.F.8 of today's rule discusses EPA's proposal to define the term "storm water discharge associated with industrial activity" to include runoff from construction sites, including preconstruction activities except operations that result in the disturbance of less than 5 acres total land area which are not part of a larger common plan of development or sale. Under today's rule, facilities that discharge runoff from construction sites that meet this definition will be required to submit permit applications unless they are to be covered by another individual or general NPDES permit. Permit application requirements for such discharges are at 40 CFR 122.26(c)(1)(ii).

Section 122.26(d)(2)(iv)(D) of today's rule requires applicants for a permit for large or medium municipal separate storm sewer systems to submit a description of a proposed management program to control pollutants in construction site runoff that discharges to municipal systems. Under this provision, municipal applicants will submit a description of a program for implementing and maintaining structural and non-structural best management practices for controlling storm water runoff at construction sites. The program will address procedures for site planning, enforceable requirements for nonstructural and structural best management practices, procedures for inspecting sites and enforcing control measures, and educational and training measures. Generally, construction site ordinances are effective when they are implemented. However, in many areas, even though ordinances exist, they have limited effectiveness because they are not adequately implemented. Maintaining best management practices also presents problems. Retention and infiltration basins fill up and silt fences may break or be overtopped. Weak inspection and enforcement point to the need for more emphasis on training and education to complement regulatory programs. Permits issued to municipalities will address these concerns.

8. Assessment of Controls

EPA proposed that municipal applicants provide an initial assessment of the effectiveness of the control method for structural or non-structural controls which have been proposed in the management program. Some commenters stated that the assessment of controls should be left to the term of the permit because the effectiveness of controls will be hard to establish. EPA believes that an initial estimate or assessment is needed because the performance of appropriate management controls is highly dependent on site-specific factors. The assessment will be used in conjunction with the development of pollutant loading and concentration estimates (*see* VI.H.6.c) and the evaluation of water quality benefits associated with implementing controls. Such assessments do not have to be verified with quantitative data, but can be based on accepted engineering design practices. Further more precise assessments based upon quantitative data can be undertaken during the term of the permit.

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I. Annual Reports

As discussed earlier in today's preamble EPA has provided for proposed flexible permit application requirements to facilitate the development of site-specific programs to control the discharge of pollutants from large and medium municipal separate storm sewer systems. Many municipalities are in the early stages of the complex task of developing a program suitable for controlling pollutants in discharges under a NPDES permit, while other municipalities have relatively sophisticated programs in place. In order to ensure that such site-specific programs are developed in a timely manner, EPA proposed to require permittees of municipal separate storm sewer systems to submit status reports every year which reflect the development of their control programs.

The reports will be used by the permitting authority to aid in evaluating compliance with permit conditions and where necessary, modify permit conditions to address changed conditions. EPA requested comments on the appropriate content of the annual reports. Based on these comments EPA has added the following in these reports: an analysis of data, including monitoring data, that is accumulated throughout the year; new outfalls or discharges; annual expenditures; identification of water quality improvements or degradation on watershed basis; budget for year following each annual report; and administrative information including enforcement activities, inspections, and public education programs. EPA views this information as important for evaluating the municipal program. Annual monitoring data and identified water quality improvements are important for evaluating the success of management programs in reducing pollutants. If new outfalls come into existence during the term of the permit, these may be sources of pollutants and appropriate permit conditions will be developed. Annual reports should reflect the level of enforcement activity and inspections undertaken to ensure that the legal authority developed by the municipality is properly exercised. Many of the management programs depend upon an ongoing high level of public education. Accordingly, the undertaking of these programs on an annual basis should be documented.

J. Application Deadlines

The CWA provided a statutory time frame for implementing the storm water permit application process and issuance and compliance with permits.

The CWA requires EPA to promulgate permit application requirements for storm water discharges associated with industrial activity and for large municipal separate storm sewer systems by "no later than two years" after the date of enactment (*i.e.* no later than February 4, 1989). In conjunction with this requirement, the Act requires that permit applications for these classes of discharges be submitted within one year after the statutory date by which EPA is to promulgate permit application requirements by providing that such applications "shall be filed no later than three years" after the date of enactment of the WQA (*i.e.*, no later than February 4, 1990).

The CWA also requires EPA to promulgate final regulations governing storm water permit application requirements for discharges from municipal separate storm sewer systems serving a population of 100,000 or more but less than 250,000 by "no later than four years" after enactment (*i.e.* no later than February 4, 1991). Permit applications for medium municipal separate storm sewer systems "shall be filed no later than five years" after the date of enactment of the CWA (*i.e.*, no later than February 4, 1992). The CWA did not establish the time period between designation and permit application submittal for case-by-case designations under section 402(p)(2)(E).

Comments on earlier rulemakings involving storm water application deadlines have established that applicants need adequate time to obtain "representative" storm water samples. Many commenters have indicated that at least one full year is needed to obtain such samples. This is because many discharges are located in areas where testing during dry seasons or winter would not be feasible. The intermittent and unpredictable nature of storm water discharges can result in difficult and time-consuming data gathering. Moreover, some operators of municipal separate storm sewer systems have many storm water discharges associated with industrial activity, which can require considerable time to identify, analyze, and submit applications. This creates a tremendous practical problem for the extremely high number of unpermitted storm water discharges. The public's interest in a sound storm water program and the development of a useful storm water data base is best served by establishing an application deadline which will allow sufficient time to gather, analyze, and prepare meaningful applications. Based on a consideration of these factors, EPA proposed that individual permit applications for storm water discharges associated with industrial activity which currently are not covered by a permit and that are required to obtain a permit, be submitted one year after the final rule is promulgated.

EPA received numerous comments from industries on the one year requirement for submitting applications. Several commenters supported the proposed deadline as realistic, while others believed more time was needed to meet the information and quantitative requirement.

EPA rejects the assertion by some commenters that a year is too short a period of time to obtain the required quantitative data. Today's rule generally requires applications for storm water discharges associated with industrial activity to be submitted on or before November 18, 1991. Operators of storm water discharges associated with industrial activity which discharge through a municipal separate storm sewer are subject to the same application deadline as other storm water discharges associated with industrial activity. Since final regulation at § 122.21(g)(7) provides considerable latitude for selecting rain events for quantitative data, EPA is convinced that in most cases data can be obtained during the one year time frame. If data cannot be collected during the one year time frame because of anomalous weather (*e.g.* drought conditions), then permitting authorities may grant additional time for submitting that data on a case-by-case basis. *See* § 122.21(g)(7).

Operators of storm water discharges which are currently covered by a permit will not be required to submit a permit application until their existing permit expires. In recognition of the time required to collect storm water discharge data, EPA will allow facilities which currently have a NPDES permit for a storm water discharge and which must reapply for permit renewal during the first year following promulgation of today's permit application requirements the option of applying in accordance with existing Form 1 and Form 2C requirements (in lieu of applying in accordance with the revised application requirements).

As discussed in section VI.D.4 and section VI.F.6 of today's preamble, EPA has established a two part permit application both for both group applications for sufficiently similar facilities that discharge storm water associated with industrial activity and for operators of large or medium municipal separate storm sewer systems. The deadlines for submitting

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permit applications in today's rule provide adequate time for: (1) Applicants to prepare Part 1 of the application; (2) EPA or an approved State to adequately review applications; and (3) applicants to prepare the contents of the part 2 application.

Part 1 of the group application for storm water discharges associated with industrial activity must be submitted within 120 days from the publication of these final permit application regulations. This time is necessary to form groups and for individual members of the group to prepare the non-quantitative information required in part 1 of the application. Part 1 of the group application will be submitted to EPA Headquarters in Washington, DC and reviewed within 60 days after being received. Part 2 of the application would then be submitted within one year after the part 1 application is approved. It should be noted that many facilities located in States in which general permits can be issued, will be eligible for coverage by a storm water general permit to be promulgated in the near future. Such facilities may either seek coverage under such general permits or participate in the group application.

Several comments were received by EPA that indicated that a period of 120 days was too short a period for groups to be formed. EPA disagrees with these comments. The information that EPA is requiring to be submitted by the group or group representative is information that is generally available such as the location of the facility, its industrial activity, and material management practices. EPA believes that 120 days is sufficient to gather and submit this information along with an identification of 10% of the facilities which will submit quantitative data. To ameliorate any difficulties for applicants, EPA has provided a means for late facilities to "add on" where appropriate, on a case-by-case basis, as discussed in section VI.F.4. above.

Several comments were received with regard to the requirement that new dischargers submit an application at least 180 days before the date on which the discharge is to commence. One commenter noted that it will be difficult for a facility to know when a storm water discharge is to commence since precipitation and runoff cannot be predicted to any degree of accuracy. In response, new dischargers must apply for a storm water permit application 180 days before that facility commences manufacturing, processing, or raw material storage operations which may result in the discharge of pollutants from storm water runoff, and 90 days for new construction sites.

For large municipal separate storm sewer systems (systems serving a population of more than 250,000), EPA proposed that part 1 of the permit application be submitted within one year of the date of the final regulations, with approval or disapproval by the permit issuing authority of the provisions of the part 1 permit application within 90 days after receiving part 1 of the application. The Part 2 portion of the application was to be submitted within two years of the date of promulgation.

For medium municipal separate storm sewer systems (systems serving a population of more than 100,000, but less than 250,000), EPA proposed that permit applications would be required nine months after the date of the final rule, with approval or disapproval of the provisions of the part 1 permit application within 90 days after receiving the part 1 application. The part 2 portion of the application would then be submitted no later than one year after the part 1 application has been approved.

Numerous comments were received by EPA from municipalities on these proposed deadlines. Many of these comments reflect the sentiment that the deadlines are too tight and that the required information would not be available for submission within the required time frame. Some commenters suggested deadlines that would add over three years to the permit application process. Other commenters suggested a revamped application process and a shorter deadline of 18 months. Some commenters explained that additional time would be needed to obtain adequate legal authority, while another stated that an inventory of outfalls required more time. One commenter maintained that intergovernmental agreements will require more time to prepare, and others expressed the view that more time was needed for the review of part 1 of the application by permitting authorities. Others felt more time was needed for collecting data, or hiring additional staff to accomplish the work. Most of these commenters did not provide specific details regarding what would be an appropriate amount of time and why.

After reviewing these comments EPA has decided to modify some of the deadlines as proposed. EPA is convinced that to properly achieve the goals of the CWA, the permit application requirements as discussed in previous sections are appropriate; but that the deadlines for medium municipal separate storm sewer systems should be adjusted so that the program's goals can be properly accomplished. After reviewing comments, EPA believes that medium municipalities will have fewer resources and existing institutional arrangements than large cities and therefore more time should be granted to these cities for submitting parts 1 and 2 of the application.

Accordingly EPA will require large municipal systems to submit part 1 of the permit application no later than November 18, 1991. Part 1 will be reviewed and approved or disapproved by the Director within 90 days. Part 2 of the application will then be submitted November 18, 1992. Medium municipal systems will submit part 1 of the application on May 18, 1992. Approval or disapproval by the Director will be accomplished within 90 days. Part 2 of the application will be submitted by May 17, 1993. These deadlines will give large systems two years to complete the application process, and medium systems 2 years and 6 months to submit applications. EPA is convinced that the permit application schedule is warranted and should provide adequate time to prepare the application.

In establishing these regulatory deadlines EPA is fully aware that they are not synchronized with the statutory deadlines as established by Congress. One commenter argued that the deadlines as proposed were contrary to the deadlines established by Congress and that EPA had no authority to extend these deadlines. (For large municipal separate storm sewer systems and storm water discharges associated with industrial activity, Congress established a deadline of February 4, 1990, for submission of permit applications; for medium municipal separate storm sewer systems, the deadline is February 4, 1992.) In response, this regulation provides certain deadlines for meeting the substantive requirements of this rulemaking—requirements which EPA is convinced are necessary for the development of enforceable and sound storm water permits. EPA believes it is important to give applicants sufficient time to reasonably comply with the permit application requirements set out today. EPA will therefore accept applications for storm water discharge permits up to the dates specified in today's rule. By establishing these regulatory deadlines, however, EPA is not attempting to waive or revoke the statutory deadlines established in Section 402(p) of the CWA and does not assert the authority to do so. The statutory permit application deadlines

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continue to be enforceable requirements.

EPA was not able to promulgate the final application regulations for storm water discharges before the February 4, 1990, deadline for industrial and large municipal dischargers despite its best efforts. Further, as noted above, EPA is not able to waive the statutory deadline. Dischargers concerned with complying with the statutory deadline should submit a permit application as required under this rulemaking as expeditiously as possible.

Operators of storm water discharges that are not specifically required to file a permit application under today's rule may be required to obtain a permit for their discharge on the basis of a case-by-case designation by the Administrator or the NPDES State.

The Administrator or NPDES State may also designate storm water discharges (except agricultural storm water discharges), that contribute to a violation of a water quality standard or that are significant contributors of pollutants to waters of the United States for a permit. Prior to a case-by-case determination that an individual permit is required for a storm water discharge, the Administrator or NPDES State may require the operator of the discharge to submit a permit application. 40 CFR 124.52(c) requires the operator of designated storm water discharges to submit a permit application within 60 days of notice, unless permission for a later date is granted. The 60-day deadline is consistent with the procedures for designating other discharges for a NPDES permit on a case-by-case basis found at 40 CFR 124.52. The 60-day deadline recognizes that case-by-case designations often require an expedited response, however, flexibility exists to allow for case-by-case extensions.

The December 7, 1988, proposal also proposed Part 504 State Storm Water Management Programs. The Agency has not included this component in today's rule. The Agency believes this program element is appropriate for addressing in regulations promulgated under section 402(p)(6) of the CWA.

VII. Economic Impact

EPA has prepared an Information Collection Request for the purpose of estimating the information collection burden imposed on Federal, State and local governments and industry for revisions to NPDES permit application requirements for storm water discharges codified in 40 CFR part 122. EPA is promulgating these revisions in response to Section 402(p)(4) of the Clean Water Act, as amended by the Water Quality Act of 1987 (WQA). The revisions would apply to: Storm water discharges associated with industrial activity; discharges from municipal separate storm sewer systems serving a population of 250,000 or more and discharges from municipal separate storm sewer systems serving a population of 100,000 or more, but less than 250,000.

The estimated annual cost of applying for NPDES permits for discharges from municipal separate storm sewer systems is $4.2 million. EPA estimates that an average permit application for a large municipality will cost $76,681 and require 4,534 hours to prepare. The average application for a medium municipality will cost $49,249 (2,912 hours) to prepare. The annual respondent cost for NPDES permit applications, notices of intent, and notifications for facilities with discharges associated with industrial activity is estimated to be $9.5 million (271,248 hours). EPA estimates that the average preparation cost of an individual industrial permit application would be $1,007 (28.6 hours). Average Group application will cost $74.00 per facility (2.1 hours). The average cost of the notification and notice of intent to be covered by general permit is $17.00 (0.5 hours).

The annual cost to the Federal Government and approved States for administration of the program is estimated to be $588,803. The total cost for municipalities, industry, and State and Federal authorities is estimated to be $14.5 million annually.

In general, the cost estimates provided in the ICR focus primarily on the costs associated with developing, submitting and reviewing the permit applications associated with today's rule. EPA will continue to evaluate procedures and methods to control storm water discharges to the extent necessary to mitigate impacts on water quality in the studies required under section 402(p)(5) of the CWA. Executive Order 12291 requires EPA and other agencies to perform regulatory analyses of major regulations. Major rules are those which impose a cost on the economy of $100 million or more annually or have certain other economic impacts. Today's proposed amendments would generally make the NPDES permit application regulations more flexible and less burdensome for the regulated community. These regulations do not satisfy any of the criteria specified in section 1(b) of the Executive Order and, as such, do not constitute a major rule. This regulation was submitted to the Office of Management and Budget (OMB) for review.

VIII. Paperwork Reduction Act

The information collection requirements in this rule have been submitted for approval to the Office of Management and Budget (OMB) under provision of the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq.* and have been assigned OMB control number 2040-0086.

Public reporting burden for permit applications for storm water discharges associated with industrial activity (other than from construction facilities) is estimated to average 28.6 hours per individual permit application, 0.5 hours per notice of intent to be covered by general permit, and 2.1 hours per group applicant. The public reporting burden for permit applications for storm water discharges associated with industrial activity from construction activities submitting individual applications is estimated to average 4.5 hours per response. The public reporting burden for facilities which discharge storm water associated with industrial activity to municipal separate storm sewers serving a population over 100,000 to notify the operator of the municipal separate storm sewer system is estimated to average 0.5 hours per response.

The reporting burden for system-wide permit applications for discharges from municipal separate storm sewer systems serving a population of 250,000 or more is estimated to average 4,534 hours per response. The reporting burden for system-wide permit applications for discharges from municipal separate storm sewer systems serving a population of 100,000 or more, but less than 250,000 is estimated to average 2,912 hours per response. Estimates of reporting burden include time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

IX. Regulatory Flexibility Act

Under the Regulatory Flexibility Act, 5 U.S.C. 601 *et seq.*, EPA is required to prepare a Regulatory Flexibility Analysis to assess the impact of rules on small entities. No Regulatory Flexibility Analysis is required, however, where the head of the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities.

Today's amendments to the regulations would generally make the NPDES permit applications regulations more flexible and less burdensome for permittees. Accordingly, I hereby

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certify, pursuant to 5 U.S.C. 605(b), that these amendments do not have a significant impact on a substantial number of small entities.

List of Subjects in 40 CFR Parts 122, 123, and 124

Administrative practice and procedure, Environmental protection, Reporting and recordkeeping requirements, Water pollution control.

Authority: Clean Water Act, 33 U.S.C. 1251 *et seq.*

Dated: October 31, 1990.

William K. Reilly,

Administrator.

For the reasons stated in the preamble, parts 122, 123, and 124 of title 40 of the Code of Federal Regulations are amended as follows:

PART 122—EPA ADMINISTERED PERMIT PROGRAMS; THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

Subpart B—Permit Application and Special NPDES Program Requirements

1. The authority citation for part 122 continues to read as follows:

Authority: Clean Water Act, 33 U.S.C. 1251 *et seq.*

2. Section 122.1 is amended by revising paragraph (b)(2)(iv) to read as follows:

§ 122.1 Purpose and scope.

* * * * *

(b) * * *

(2) * * *

(iv) Discharges of storm water as set forth in § 122.26; and

* * * * *

3. Section 122.21 is amended by revising paragraph (c)(1), by removing the last sentence of paragraph (f)(7), by removing paragraph (f)(9), by adding two sentences at the end of paragraph (g)(3), by revising paragraph (g)(7) introductory text, by removing and reserving paragraph (g)(10) and by revising the introductory text of paragraph (k) to read as follows:

§ 122.21 Application for a permit (applicable to State programs, see § 123.25).

* * * * *

(c) *Time to apply.* (1) Any person proposing a new discharge, shall submit an application at least 180 days before the date on which the discharge is to commence, unless permission for a later date has been granted by the Director. Facilities proposing a new discharge of storm water associated with industrial activity shall submit an application 180 days before that facility commences industrial activity which may result in a discharge of storm water associated with that industrial activity. Facilities described under § 122.26(b)(14)(x) shall submit applications at least 90 days before the date on which construction is to commence. Different submittal dates may be required under the terms of applicable general permits. Persons proposing a new discharge are encouraged to submit their applications well in advance of the 90 or 180 day requirements to avoid delay. See also paragraph (k) of this section and § 122.26 (c)(1)(i)(G) and (c)(1)(ii).

* * * * *

(g) * * *

(3) * * * The average flow of point sources composed of storm water may be estimated. The basis for the rainfall event and the method of estimation must be indicated.

* * * * *

(7) *Effluent characteristics.* Information on the discharge of pollutants specified in this paragraph (except information on storm water discharges which is to be provided as specified in § 122.26). When "quantitative data" for a pollutant are required, the applicant must collect a sample of effluent and analyze it for the pollutant in accordance with analytical methods approved under 40 CFR part 136. When no analytical method is approved the applicant may use any suitable method but must provide a description of the method. When an applicant has two or more outfalls with substantially identical effluents, the Director may allow the applicant to test only one outfall and report that the quantitative data also apply to the substantially identical outfalls. The requirements in paragraphs (g)(7) (iii) and (iv) of this section that an applicant must provide quantitative data for certain pollutants known or believed to be present do not apply to pollutants present in a discharge solely as the result of their presence in intake water; however, an applicant must report such pollutants as present. Grab samples must be used for pH, temperature, cyanide, total phenols, residual chlorine, oil and grease, fecal coliform and fecal streptococcus. For all other pollutants, 24-hour composite samples must be used. However, a minimum of one grab sample may be taken for effluents from holding ponds or other impoundments with a retention period greater than 24 hours. In addition, for discharges other than storm water discharges, the Director may waive composite sampling for any outfall for which the applicant demonstrates that the use of an automatic sampler is infeasible and that the minimum of four (4) grab samples will be a representative sample of the effluent being discharged. For storm water discharges, all samples shall be collected from the discharge resulting from a storm event that is greater than 0.1 inch and at least 72 hours from the previously measurable (greater than 0.1 inch rainfall) storm event. Where feasible, the variance in the duration of the event and the total rainfall of the event should not exceed 50 percent from the average or median rainfall event in that area. For all applicants, a flow-weighted composite shall be taken for either the entire discharge or for the first three hours of the discharge. The flow-weighted composite sample for a storm water discharge may be taken with a continuous sampler or as a combination of a minimum of three sample aliquots taken in each hour of discharge for the entire discharge or for the first three hours of the discharge, with each aliquot being separated by a minimum period of fifteen minutes (applicants submitting permit applications for storm water discharges under § 122.26(d) may collect flow weighted composite samples using different protocols with respect to the time duration between the collection of sample aliquots, subject to the approval of the Director). However, a minimum of one grab sample may be taken for storm water discharges from holding ponds or other impoundments with a retention period greater than 24 hours. For a flow-weighted composite sample, only one analysis of the composite of aliquots is required. For storm water discharge samples taken from discharges associated with industrial activities, quantitative data must be reported for the grab sample taken during the first thirty minutes (or as soon thereafter as practicable) of the discharge for all pollutants specified in § 122.26(c)(1). For all storm water permit applicants taking flow-weighted composites, quantitative data must be reported for all pollutants specified in § 122.26 except pH, temperature, cyanide, total phenols, residual chlorine, oil and grease, fecal coliform, and fecal streptococcus. The Director may allow or establish appropriate site-specific sampling procedures or requirements, including sampling locations, the season in which the sampling takes place, the minimum duration between the previous measurable storm event and the storm event sampled, the minimum or maximum level of precipitation required for an appropriate storm event, the form of precipitation sampled (snow melt or rain fall), protocols for collecting samples under 40 CFR part 136, and additional time for submitting data on a

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case-by-case basis. An applicant is expected to "know or have reason to believe" that a pollutant is present in an effluent based on an evaluation of the expected use, production, or storage of the pollutant, or on any previous analyses for the pollutant. (For example, any pesticide manufactured by a facility may be expected to be present in contaminated storm water runoff from the facility.)

* * * * *

(k) *Application requirements for new sources and new dischorges.* New manufacturing, commercial, mining and silvicultural dischargers applying for NPDES permits (except for new discharges of facilities subject to the requirements of paragraph (h) of this section or new discharges of storm water associated with industrial activity which are subject to the requirements of § 122.26(c)(1) and this section (except as provided by § 122.26(c)(1)(ii)) shall provide the following information to the Director, using the application forms provided by the Director:

* * * * *

4. Section 122.22(b) introductory text is revised to read as follows:

§ 122.22 Signatories to permit applications and reports (applicable to State programs, see § 123.25).

* * * * *

(b) All reports required by permits, and other information requested by the Director shall be signed by a person described in paragraph (a) of this section, or by a duly authorized representative of that person. A person is a duly authorized representative only if:

* * * * *

5. Section 122.26 is revised to read as follows:

§ 122.26 Storm water discharges (applicable to State NPDES programs, see § 123.25).

(a) *Permit requirement.* (1) Prior to October 1, 1992, discharges composed entirely of storm water shall not be required to obtain a NPDES permit except:

(i) A discharge with respect to which a permit has been issued prior to February 4, 1987;

(ii) A discharge associated with industrial activity (see § 122.26(a)(4));

(iii) A discharge from a large municipal separate storm sewer system;

(iv) A discharge from a medium municipal separate storm sewer system;

(v) A discharge which the Director, or in States with approved NPDES programs, either the Director or the EPA Regional Administrator, determines to contribute to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States. This designation may include a discharge from any conveyance or system of conveyances used for collecting and conveying storm water runoff or a system of discharges from municipal separate storm sewers, except for those discharges from conveyances which do not require a permit under paragraph (a)(2) of this section or agricultural storm water runoff which is exempted from the definition of point source at § 122.2. The Director may designate discharges from municipal separate storm sewers on a system-wide or jurisdiction-wide basis. In making this determination the Director may consider the following factors:

(A) The location of the discharge with respect to waters of the United States as defined at 40 CFR 122.2;

(B) The size of the discharge;

(C) The quantity and nature of the pollutants discharged to waters of the United States; and

(D) Other relevant factors.

(2) The Director may not require a permit for discharges of storm water runoff from mining operations or oil and gas exploration, production, processing or treatment operations or transmission facilities, composed entirely of flows which are from conveyances or systems of conveyances (including but not limited to pipes, conduits, ditches, and channels) used for collecting and conveying precipitation runoff and which are not contaminated by contact with or that has not come into contact with, any overburden, raw material, intermediate products, finished product, byproduct or waste products located on the site of such operations.

(3) *Large and medium municipal separate storm sewer systems.* (i) Permits must be obtained for all discharges from large and medium municipal separate storm sewer systems.

(ii) The Director may either issue one system-wide permit covering all discharges from municipal separate storm sewers within a large or medium municipal storm sewer system or issue distinct permits for appropriate categories of discharges within a large or medium municipal separate storm sewer system including, but not limited to: all discharges owned or operated by the same municipality; located within the same jurisdiction; all discharges within a system that discharge to the same watershed; discharges within a system that are similar in nature; or for individual discharges from municipal separate storm sewers within the system.

(iii) The operator of a discharge from a municipal separate storm sewer which is part of a large or medium municipal separate storm sewer system must either:

(A) Participate in a permit application (to be a permittee or a co-permittee) with one or more other operators of discharges from the large or medium municipal storm sewer system which covers all, or a portion of all, discharges from the municipal separate storm sewer system;

(B) Submit a distinct permit application which only covers discharges from the municipal separate storm sewers for which the operator is responsible; or

(C) A regional authority may be responsible for submitting a permit application under the following guidelines:

(*1*) The regional authority together with co-applicants shall have authority over a storm water management program that is in existence, or shall be in existence at the time part 1 of the application is due;

(*2*) The permit applicant or co-applicants shall establish their ability to make a timely submission of part 1 and part 2 of the municipal application;

(*3*) Each of the operators of municipal separate storm sewers within the systems described in paragraphs (b)(4)(i), (ii), and (iii) or (b)(7) (i), (ii), and (iii) of this section, that are under the purview of the designated regional authority, shall comply with the application requirements of paragraph (d) of this section.

(iv) One permit application may be submitted for all or a portion of all municipal separate storm sewers within adjacent or interconnected large or medium municipal separate storm sewer systems. The Director may issue one system-wide permit covering all, or a portion of all municipal separate storm sewers in adjacent or interconnected large or medium municipal separate storm sewer systems.

(v) Permits for all or a portion of all discharges from large or medium municipal separate storm sewer systems that are issued on a system-wide, jurisdiction-wide, watershed or other basis may specify different conditions relating to different discharges covered by the permit, including different management programs for different drainage areas which contribute storm water to the system.

(vi) Co-permittees need only comply with permit conditions relating to discharges from the municipal separate storm sewers for which they are operators.

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(4) *Discharges through large and medium municipal separate storm sewer systems.* In addition to meeting the requirements of paragraph (c) of this section, an operator of a storm water discharge associated with industrial activity which discharges through a large or medium municipal separate storm sewer system shall submit, to the operator of the municipal separate storm sewer system receiving the discharge no later than May 15, 1991, or 180 days prior to commencing such discharge: the name of the facility; a contact person and phone number; the location of the discharge; a description, including Standard Industrial Classification, which best reflects the principal products or services provided by each facility; and any existing NPDES permit number.

(5) *Other municipal separate storm sewers.* The Director may issue permits for municipal separate storm sewers that are designated under paragraph (a)(1)(v) of this section on a system-wide basis, jurisdiction-wide basis, watershed basis or other appropriate basis, or may issue permits for individual discharges.

(6) *Non-municipal separate storm sewers.* For storm water discharges associated with industrial activity from point sources which discharge through a non-municipal or non-publicly owned separate storm sewer system, the Director, in his discretion, may issue: a single NPDES permit, with each discharger a co-permittee to a permit issued to the operator of the portion of the system that discharges into waters of the United States; or, individual permits to each discharger of storm water associated with industrial activity through the non-municipal conveyance system.

(i) All storm water discharges associated with industrial activity that discharge through a storm water discharge system that is not a municipal separate storm sewer must be covered by an individual permit, or a permit issued to the operator of the portion of the system that discharges to waters of the United States, with each discharger to the non-municipal conveyance a co-permittee to that permit.

(ii) Where there is more than one operator of a single system of such conveyances, all operators of storm water discharges associated with industrial activity must submit applications.

(iii) Any permit covering more than one operator shall identify the effluent limitations, or other permit conditions, if any, that apply to each operator.

(7) *Combined sewer systems.* Conveyances that discharge storm water runoff combined with municipal sewage are point sources that must obtain NPDES permits in accordance with the procedures of § 122.21 and are not subject to the provisions of this section.

(8) Whether a discharge from a municipal separate storm sewer is or is not subject to regulation under this section shall have no bearing on whether the owner or operator of the discharge is eligible for funding under title II, title III or title VI of the Clean Water Act. *See* 40 CFR part 35, subpart L appendix A(b)H.2.j.

(b) *Definitions.* (1) *Co-permittee* means a permittee to a NPDES permit that is only responsible for permit conditions relating to the discharge for which it is operator.

(2) *Illicit discharge* means any discharge to a municipal separate storm sewer that is not composed entirely of storm water except discharges pursuant to a NPDES permit (other than the NPDES permit for discharges from the municipal separate storm sewer) and discharges resulting from fire fighting activities.

(3) *Incorporated place* means the District of Columbia, or a city, town, township, or village that is incorporated under the laws of the State in which it is located.

(4) *Large municipal separate storm sewer system* means all municipal separate storm sewers that are either:

(i) Located in an incorporated place with a population of 250,000 or more as determined by the latest Decennial Census by the Bureau of Census (appendix F); or

(ii) Located in the counties listed in appendix H, except municipal separate storm sewers that are located in the incorporated places, townships or towns within such counties; or

(iii) Owned or operated by a municipality other than those described in peragraph (b)(4) (i) or (ii) of this section and that are designated by the Director as part of the large or medium municipal separate storm sewer system due to the interrelationship between the discharges of the designated storm sewer and the discharges from municipal separate storm sewers described under paragraph (b)(4) (i) or (ii) of this section. In making this determination the Director may consider the following factors:

(A) Physical interconnections between the municipal separate storm sewers;

(B) The location of discharges from the designated municipal separate storm sewer relative to discharges from municipal separate storm sewers described in paragraph (b)(4)(i) of this section;

(C) The quantity and nature of pollutants discharged to waters of the United States;

(D) The nature of the receiving waters; and

(E) Other relevant factors; or

(iv) The Director may, upon petition, designate as a large municipal separate storm sewer system, municipal separate storm sewers located within the boundaries of a region defined by a storm water management regional authority based on a jurisdictional, watershed, or other appropriate basis that includes one or more of the systems described in paragraph (b)(4) (i), (ii), (iii) of this section.

(5) *Major municipal separate storm sewer outfall* (or "major outfall") means a municipal separate storm sewer outfall that discharges from a single pipe with an inside diameter of 36 inches or more or its equivalent (discharge from a single conveyance other than circular pipe which is associated with a drainage area of more than 50 acres); or for municipal separate storm sewers that receive storm water from lands zoned for industrial activity (based on comprehensive zoning plans or the equivalent), an outfall that discharges from a single pipe with an inside diameter of 12 inches or more or from its equivalent (discharge from other than a circular pipe associated with a drainage area of 2 acres or more).

(6) *Major outfall* means a major municipal separate storm sewer outfall.

(7) *Medium municipal separate storm sewer system* means all municipal separate storm sewers that are either:

(i) Located in an incorporated place with a population of 100,000 or more but less than 250,000, as determined by the latest Decennial Census by the Bureau of Census (appendix G); or

(ii) Located in the counties listed in appendix I, except municipal separate storm sewers that are located in the incorporated places, townships or towns within such counties; or

(iii) Owned or operated by a municipality other than those described in paragraph (b)(4) (i) or (ii) of this section and that are designated by the Director as part of the large or medium municipal separate storm sewer system due to the interrelationship between the discharges of the designated storm sewer and the discharges from municipal separate storm sewers described under paragraph (b)(4) (i) or (ii) of this section. In making this determination the Director may consider the following factors:

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(4) *Discharges through large and medium municipal separate storm sewer systems.* In addition to meeting the requirements of paragraph (c) of this section, an operator of a storm water discharge associated with industrial activity which discharges through a large or medium municipal separate storm sewer system shall submit, to the operator of the municipal separate storm sewer system receiving the discharge no later than May 15, 1991, or 180 days prior to commencing such discharge: the name of the facility; a contact person and phone number; the location of the discharge; a description, including Standard Industrial Classification, which best reflects the principal products or services provided by each facility; and any existing NPDES permit number.

(5) *Other municipal separate storm sewers.* The Director may issue permits for municipal separate storm sewers that are designated under paragraph (a)(1)(v) of this section on a system-wide basis, jurisdiction-wide basis, watershed basis or other appropriate basis, or may issue permits for individual discharges.

(6) *Non-municipal separate storm sewers.* For storm water discharges associated with industrial activity from point sources which discharge through a non-municipal or non-publicly owned separate storm sewer system, the Director, in his discretion, may issue: a single NPDES permit, with each discharger a co-permittee to a permit issued to the operator of the portion of the system that discharges into waters of the United States; or, individual permits to each discharger of storm water associated with industrial activity through the non-municipal conveyance system.

(i) All storm water discharges associated with industrial activity that discharge through a storm water discharge system that is not a municipal separate storm sewer must be covered by an individual permit, or a permit issued to the operator of the portion of the system that discharges to waters of the United States, with each discharger to the non-municipal conveyance a co-permittee to that permit.

(ii) Where there is more than one operator of a single system of such conveyances, all operators of storm water discharges associated with industrial activity must submit applications.

(iii) Any permit covering more than one operator shall identify the effluent limitations, or other permit conditions, if any, that apply to each operator.

(7) *Combined sewer systems.* Conveyances that discharge storm water runoff combined with municipal sewage are point sources that must obtain NPDES permits in accordance with the procedures of § 122.21 and are not subject to the provisions of this section.

(8) Whether a discharge from a municipal separate storm sewer is or is not subject to regulation under this section shall have no bearing on whether the owner or operator of the discharge is eligible for funding under title II, title III or title VI of the Clean Water Act. *See* 40 CFR part 35, subpart I, appendix A(b)(1.2.).

(b) *Definitions.* (1) *Co-permittee* means a permittee to a NPDES permit that is only responsible for permit conditions relating to the discharge for which it is operator.

(2) *Illicit discharge* means any discharge to a municipal separate storm sewer that is not composed entirely of storm water except discharges pursuant to a NPDES permit (other than the NPDES permit for discharges from the municipal separate storm sewer) and discharges resulting from fire fighting activities.

(3) *Incorporated place* means the District of Columbia, or a city, town, township, or village that is incorporated under the laws of the State in which it is located.

(4) *Large municipal separate storm sewer system* means all municipal separate storm sewers that are either:

(i) Located in an incorporated place with a population of 250,000 or more as determined by the latest Decennial Census by the Bureau of Census (appendix F); or

(ii) Located in the counties listed in appendix H, except municipal separate storm sewers that are located in the incorporated places, townships or towns within such counties; or

(iii) Owned or operated by a municipality other than those described in paragraph (b)(4) (i) or (ii) of this section and that are designated by the Director as part of the large or medium municipal separate storm sewer system due to the interrelationship between the discharges of the designated storm sewer and the discharges from municipal separate storm sewers described under paragraph (b)(4) (i) or (ii) of this section. In making this determination the Director may consider the following factors:

(A) Physical interconnections between the municipal separate storm sewers;

(B) The location of discharges from the designated municipal separate storm sewer relative to discharges from municipal separate storm sewers described in paragraph (b)(4)(i) of this section;

(C) The quantity and nature of pollutants discharged to waters of the United States;

(D) The nature of the receiving waters; and

(E) Other relevant factors; or

(iv) The Director may, upon petition, designate as a large municipal separate storm sewer system, municipal separate storm sewers located within the boundaries of a region defined by a storm water management regional authority based on a jurisdictional, watershed, or other appropriate basis that includes one or more of the systems described in paragraph (b)(4) (i), (ii), (iii) of this section.

(5) *Major municipal separate storm sewer outfall* (or "major outfall") means a municipal separate storm sewer outfall that discharges from a single pipe with an inside diameter of 36 inches or more or its equivalent (discharge from a single conveyance other than circular pipe which is associated with a drainage area of more than 50 acres); or for municipal separate storm sewers that receive storm water from lands zoned for industrial activity (based on comprehensive zoning plans or the equivalent), an outfall that discharges from a single pipe with an inside diameter of 12 inches or more or from its equivalent (discharge from other than a circular pipe associated with a drainage area of 2 acres or more).

(6) *Major outfall* means a major municipal separate storm sewer outfall.

(7) *Medium municipal separate storm sewer system* means all municipal separate storm sewers that are either:

(i) Located in an incorporated place with a population of 100,000 or more but less than 250,000, as determined by the latest Decennial Census by the Bureau of Census (appendix G); or

(ii) Located in the counties listed in appendix I, except municipal separate storm sewers that are located in the incorporated places, townships or towns within such counties; or

(iii) Owned or operated by a municipality other than those described in paragraph (b)(4) (i) or (ii) of this section and that are designated by the Director as part of the large or medium municipal separate storm sewer system due to the interrelationship between the discharges of the designated storm sewer and the discharges from municipal separate storm sewers described under paragraph (b)(4) (i) or (ii) of this section. In making this determination the Director may consider the following factors:

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(A) Physical interconnections between the municipal separate storm sewers;

(B) The location of discharges from the designated municipal separate storm sewer relative to discharges from municipal separate storm sewers described in paragraph (b)(7)(i) of this section;

(C) The quantity and nature of pollutants discharged to waters of the United States;

(D) The nature of the receiving waters; or

(E) Other relevant factors; or

(iv) The Director may, upon petition, designate as a medium municipal separate storm sewer system, municipal separate storm sewers located within the boundaries of a region defined by a storm water management regional authority based on a jurisdictional, watershed, or other appropriate basis that includes one or more of the systems described in paragraphs (b)(7) (i), (ii), (iii) of this section.

(8) *Municipal separate storm sewer* means a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains):

(i) Owned or operated by a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law) having jurisdiction over disposal of sewage, industrial wastes, storm water, or other wastes, including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the CWA that discharges to waters of the United States;

(ii) Designed or used for collecting or conveying storm water;

(iii) Which is not a combined sewer, and

(iv) Which is not part of a Publicly Owned Treatment Works (POTW) as defined at 40 CFR 122.2.

(9) *Outfall* means a *point source* as defined by 40 CFR 122.2 at the point where a municipal separate storm sewer discharges to waters of the United States and does not include open conveyances connecting two municipal separate storm sewers, or pipes, tunnels or other conveyances which connect segments of the same stream or other waters of the United States and are used to convey waters of the United States.

(10) *Overburden* means any material of any nature, consolidated or unconsolidated, that overlies a mineral deposit, excluding topsoil or similar naturally-occurring surface materials that are not disturbed by mining operations.

(11) *Runoff coefficient* means the fraction of total rainfall that will appear at a conveyance as runoff.

(12) *Significant materials* includes, but is not limited to: raw materials; fuels; materials such as solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances designated under section 101(14) of CERCLA; any chemical the facility is required to report pursuant to section 313 of title III of SARA; fertilizers; pesticides; and waste products such as ashes, slag and sludge that have the potential to be released with storm water discharges.

(13) *Storm water* means storm water runoff, snow melt runoff, and surface runoff and drainage.

(14) *Storm water discharge associated with industrial activity* means the discharge from any conveyance which is used for collecting and conveying storm water and which is directly related to manufacturing, processing or raw materials storage areas at an industrial plant. The term does not include discharges from facilities or activities excluded from the NPDES program under 40 CFR part 122. For the categories of industries identified in paragraphs (b)(14) (i) through (x) of this section, the term includes, but is not limited to, storm water discharges from industrial plant yards; immediate access roads and rail lines used or traveled by carriers of raw materials, manufactured products, waste material, or by-products used or created by the facility; material handling sites; refuse sites; sites used for the application or disposal of process waste waters (as defined at 40 CFR part 401); sites used for the storage and maintenance of material handling equipment; sites used for residual treatment, storage, or disposal; shipping and receiving areas; manufacturing buildings; storage areas (including tank farms) for raw materials, and intermediate and finished products; and areas where industrial activity has taken place in the past and significant materials remain and are exposed to storm water. For the categories of industries identified in paragraph (b)(14)(xi) of this section, the term includes only storm water discharges from all the areas (except access roads and rail lines) that are listed in the previous sentence where material handling equipment or activities, raw materials, intermediate products, final products, waste materials, by-products, or industrial machinery are exposed to storm water. For the purposes of this paragraph, material handling activities include the storage, loading and unloading, transportation, or conveyance of any raw material, intermediate product, finished product, by-product or waste product. The term excludes areas located on plant lands separate from the plant's industrial activities, such as office buildings and accompanying parking lots as long as the drainage from the excluded areas is not mixed with storm water drained from the above described areas. Industrial facilities (including industrial facilities that are Federally, State, or municipally owned or operated that meet the description of the facilities listed in this paragraph (b)(14)(i)–(xi) of this section) include those facilities designated under the provisions of paragraph (a)(1)(v) of this section. The following categories of facilities are considered to be engaging in "industrial activity" for purposes of this subsection:

(i) Facilities subject to storm water effluent limitations guidelines, new source performance standards, or toxic pollutant effluent standards under 40 CFR subchapter N (except facilities with toxic pollutant effluent standards which are exempted under category (xi) in paragraph (b)(14) of this section);

(ii) Facilities classified as Standard Industrial Classifications 24 (except 2434), 26 (except 265 and 267), 28 (except 283), 29, 311, 32 (except 323), 33, 3441, 373;

(iii) Facilities classified as Standard Industrial Classifications 10 through 14 (mineral industry) including active or inactive mining operations (except for areas of coal mining operations no longer meeting the definition of a reclamation area under 40 CFR 434.11(l) because the performance bond issued to the facility by the appropriate SMCRA authority has been released, or except for areas of non-coal mining operations which have been released from applicable State or Federal reclamation requirements after December 17, 1990) and oil and gas exploration, production, processing, or treatment operations, or transmission facilities that discharge storm water contaminated by contact with or that has come into contact with, any overburden, raw material, intermediate products, finished products, byproducts or waste products located on the site of such operations; (inactive mining operations are mining sites that are not being actively mined, but which have an identifiable owner/operator; inactive mining sites do not include sites where mining claims are being maintained prior to disturbances associated with the extraction, beneficiation, or processing of mined

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materials, nor sites where minimal activities are undertaken for the sole purpose of maintaining a mining claim);

(iv) Hazardous waste treatment, storage, or disposal facilities, including those that are operating under interim status or a permit under subtitle C of RCRA;

(v) Landfills, land application sites, and open dumps that receive or have received any industrial wastes (waste that is received from any of the facilities described under this subsection) including those that are subject to regulation under subtitle D of RCRA;

(vi) Facilities involved in the recycling of materials, including metal scrapyards, battery reclaimers, salvage yards, and automobile junkyards, including but limited to those classified as Standard Industrial Classification 5015 and 5093;

(vii) Steam electric power generating facilities, including coal handling sites;

(viii) Transportation facilities classified as Standard Industrial Classifications 40, 41, 42 (except 4221-25), 43, 44, 45, and 5171 which have vehicle maintenance shops, equipment cleaning operations, or airport deicing operations. Only those portions of the facility that are either involved in vehicle maintenance (including vehicle rehabilitation, mechanical repairs, painting, fueling, and lubrication), equipment cleaning operations, airport deicing operations, or which are otherwise identified under paragraphs (b)(14) (i)–(vii) or (ix)–(xi) of this section are associated with industrial activity;

(ix) Treatment works treating domestic sewage or any other sewage sludge or wastewater treatment device or system, used in the storage treatment, recycling, and reclamation of municipal or domestic sewage, including land dedicated to the disposal of sewage sludge that are located within the confines of the facility, with a design flow of 1.0 mgd or more, or required to have an approved pretreatment program under 40 CFR part 403. Not included are farm lands, domestic gardens or lands used for sludge management where sludge is beneficially reused and which are not physically located in the confines of the facility, or areas that are in compliance with section 405 of the CWA;

(x) Construction activity including clearing, grading and excavation activities except: operations that result in the disturbance of less than five acres of total land area which are not part of a larger common plan of development or sale.

(xi) Facilities under Standard Industrial Classifications 20, 21, 22, 23, 2434, 25, 265, 267, 27, 283, 285, 30, 31 (except 311), 323, 34 (except 3441), 35, 36, 37 (except 373), 38, 39, 4221-25, (and which are not otherwise included within categories (ii)–(x));

(c) *Application requirements for storm water discharges associated with industrial activity*—(1) *Individual application.* Dischargers of storm water associated with industrial activity are required to apply for an individual permit, apply for a permit through a group application, or seek coverage under a promulgated storm water general permit. Facilities that are required to obtain an individual permit, or any discharge of storm water which the Director is evaluating for designation (*see* 40 CFR 124.52(c)) under paragraph (a)(1)(v) of this section and is not a municipal separate storm sewer, and which is not part of a group application described under paragraph (c)(2) of this section, shall submit an NPDES application in accordance with the requirements of § 122.21 as modified and supplemented by the provisions of the remainder of this paragraph. Applicants for discharges composed entirely of storm water shall submit Form 1 and Form 2F. Applicants for discharges composed of storm water and non-storm water shall submit Form 1, Form 2C, and Form 2F. Applicants for new sources or new discharges (as defined in § 122.2 of this part) composed of storm water and non-storm water shall submit Form 1, Form 2D, and Form 2F.

(i) Except as provided in § 122.26(c)(1)(ii)–(iv), the operator of a storm water discharge associated with industrial activity subject to this section shall provide:

(A) A site map showing topography (or indicating the outline of drainage areas served by the outfall(s) covered in the application if a topographic map is unavailable) of the facility including: each of its drainage and discharge structures; the drainage area of each storm water outfall; paved areas and buildings within the drainage area of each storm water outfall, each past or present area used for outdoor storage or disposal of significant materials, each existing structural control measure to reduce pollutants in storm water runoff, materials loading and access areas, areas where pesticides, herbicides, soil conditioners and fertilizers are applied, each of its hazardous waste treatment, storage or disposal facilities (including each area not required to have a RCRA permit which is used for accumulating hazardous waste under 40 CFR 262.34); each well where fluids from the facility are injected underground; springs, and other surface water bodies which receive storm water discharges from the facility;

(B) An estimate of the area of impervious surfaces (including paved areas and building roofs) and the total area drained by each outfall (within a mile radius of the facility) and a narrative description of the following: Significant materials that in the three years prior to the submittal of this application have been treated, stored or disposed in a manner to allow exposure to storm water; method of treatment, storage or disposal of such materials; materials management practices employed, in the three years prior to the submittal of this application, to minimize contact by these materials with storm water runoff; materials loading and access areas; the location, manner and frequency in which pesticides, herbicides, soil conditioners and fertilizers are applied; the location and a description of existing structural and non-structural control measures to reduce pollutants in storm water runoff; and a description of the treatment the storm water receives, including the ultimate disposal of any solid or fluid wastes other than by discharge;

(C) A certification that all outfalls that should contain storm water discharges associated with industrial activity have been tested or evaluated for the presence of non-storm water discharges which are not covered by a NPDES permit; tests for such non-storm water discharges may include smoke tests, fluorometric dye tests, analysis of accurate schematics, as well as other appropriate tests. The certification shall include a description of the method used, the date of any testing, and the on-site drainage points that were directly observed during a test;

(D) Existing information regarding significant leaks or spills of toxic or hazardous pollutants at the facility that have taken place within the three years prior to the submittal of this application;

(E) Quantitative data based on samples collected during storm events and collected in accordance with § 122.21 of this part from all outfalls containing a storm water discharge associated with industrial activity for the following parameters:

(*1*) Any pollutant limited in an effluent guideline to which the facility is subject;

(*2*) Any pollutant listed in the facility's NPDES permit for its process wastewater (if the facility is operating under an existing NPDES permit);

(*3*) Oil and grease, pH, BOD5, COD, TSS, total phosphorus, total Kjeldahl nitrogen, and nitrate plus nitrite nitrogen;

(*4*) Any information on the discharge required under paragraph § 122.21(g)(7)(iii) and (iv) of this part;

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(5) Flow measurements or estimates of the flow rate, and the total amount of discharge for the storm event(s) sampled, and the method of flow measurement or estimation; and

(6) The date and duration (in hours) of the storm event(s) sampled, rainfall measurements or estimates of the storm event (in inches) which generated the sampled runoff and the duration between the storm event sampled and the end of the previous measurable (greater than 0.1 inch rainfall) storm event (in hours).

(F) Operators of a discharge which is composed entirely of storm water are exempt from the requirements of § 122.21 (g)(2), (g)(3), (g)(4), (g)(5), (g)(7)(i), (g)(7)(ii), and (g)(7)(v); and

(G) Operators of new sources or new discharges (as defined in § 122.2 of this part) which are composed in part or entirely of storm water must include estimates for the pollutants or parameters listed in paragraph (c)(1)(i)(E) of this section instead of actual sampling data, along with the source of each estimate. Operators of new sources or new discharges composed in part or entirely of storm water must provide quantitative data for the parameters listed in paragraph (c)(1)(i)(E) of this section within two years after commencement of discharge, unless such data has already been reported under the monitoring requirements of the NPDES permit for the discharge. Operators of a new source or new discharge which is composed entirely of storm water are exempt from the requirements of § 122.21 (k)(3)(ii), (k)(3)(iii), and (k)(5).

(ii) The operator of an existing or new storm water discharge that is associated with industrial activity solely under paragraph (b)(14)(x) of this section, is exempt from the requirements of § 122.21(g) and paragraph (c)(1)(i) of this section. Such operator shall provide a narrative description of:

(A) The location (including a map) and the nature of the construction activity;

(B) The total area of the site and the area of the site that is expected to undergo excavation during the life of the permit;

(C) Proposed measures, including best management practices, to control pollutants in storm water discharges during construction, including a brief description of applicable State and local erosion and sediment control requirements;

(D) Proposed measures to control pollutants in storm water discharges that will occur after construction ope stions have been completed, incl .ding a brief description of applicable State or local erosion and sediment control requirements;

(E) An estimate of the runoff coefficient of the site and the increase in impervious area after the construction addressed in the permit application is completed, the nature of fill material and existing data describing the soil or the quality of the discharge; and

(F) The name of the receiving water.

(iii) The operator of an existing or new discharge composed entirely of storm water from an oil or gas exploration, production, processing, or treatment operation, or transmission facility is not required to submit a permit application in accordance with paragraph (c)(1)(i) of this section, unless the facility:

(A) Has had a discharge of storm water resulting in the discharge of a reportable quantity for which notification is or was required pursuant to 40 CFR 117.21 or 40 CFR 302.6 at anytime since November 16, 1987; or

(B) Has had a discharge of storm water resulting in the discharge of a reportable quantity for which notification is or was required pursuant to 40 CFR 110.6 at any time since November 16, 1987; or

(C) Contributes to a violation of a water quality standard.

(iv) The operator of an existing or new discharge composed entirely of storm water from a mining operation is not required to submit a permit application unless the discharge has come into contact with, any overburden, raw material, intermediate products, finished product, byproduct or waste products located on the site of such operations.

(v) Applicants shall provide such other information the Director may reasonably require under § 122.21(g)(13) of this part to determine whether to issue a permit and may require any facility subject to paragraph (c)(1)(ii) of this section to comply with paragraph (c)(1)(i) of this section.

(2) *Group application for discharges associated with industrial activity.* In lieu of individual applications or notice of intent to be covered by a general permit for storm water discharges associated with industrial activity, a group application may be filed by an entity representing a group of applicants (except facilities that have existing individual NPDES permits for storm water) that are part of the same subcategory (*see* 40 CFR subchapter N, part 405 to 471) or, where such grouping is inapplicable, are sufficiently similar as to be appropriate for general permit coverage under § 122.28 of this part. The part 1 application shall be submitted to the Office of Water Enforcement and Permits, U.S. EPA, 401 M Street, SW., Washington, DC 20460 (EN-336) for approval. Once a part 1 application is approved, group applicants are to submit Part 2 of the group application to the Office of Water Enforcement and Permits. A group application shall consist of:

(i) *Part 1.* Part 1 of a group application shall:

(A) Identify the participants in the group application by name and location. Facilities participating in the group application shall be listed in nine subdivisions, based on the facility location relative to the nine precipitation zones indicated in appendix E to this part.

(B) Include a narrative description summarizing the industrial activities of participants of the group application and explaining why the participants, as a whole, are sufficiently similar to be a covered by a general permit;

(C) Include a list of significant materials stored exposed to precipitation by participants in the group application and materials management practices employed to diminish contact by these materials with precipitation and storm water runoff;

(D) Identify ten percent of the dischargers participating in the group application (with a minimum of 10 dischargers, and either a minimum of two dischargers from each precipitation zone indicated in appendix E of this part in which ten or more members of the group are located, or one discharger from each precipitation zone indicated in appendix E of this part in which nine or fewer members of the group are located) from which quantitative data will be submitted in part 2. If more than 1,000 facilities are identified in a group application, no more than 100 dischargers must submit quantitative data in Part 2. Groups of between four and ten dischargers may be formed. However, in groups of between four and ten, at least half the facilities must submit quantitative data, and at least one facility in each precipitation zone in which members of the group are located must submit data. A description of why the facilities selected to perform sampling and analysis are representative of the group as a whole in terms of the information provided in paragraph (c)(1)(i)(B) and (i)(C) of this section, shall accompany this section. Different factors impacting the nature of the storm water discharges, such as processes used and material management, shall be represented, to the extent feasible, in a manner roughly equivalent to their proportion in the group.

(ii) *Part 2.* Part 2 of a group application shall contain quantitative

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data (NPDES Form 2F), as modified by paragraph (c)(1) of this section, so that when part 1 and part 2 of the group application are taken together, a complete NPDES application (Form 1, Form 2C, and Form 2F) can be evaluated for each discharger identified in paragraph (c)(2)(i)(D) of this section.

(d) *Application requirements for large and medium municipal separate storm sewer discharges.* The operator of a discharge from a large or medium municipal separate storm sewer or a municipal separate storm sewer that is designated by the Director under paragraph (a)(1)(v) of this section, may submit a jurisdiction-wide or system-wide permit application. Where more than one public entity owns or operates a municipal separate storm sewer within a geographic area (including adjacent or interconnected municipal separate storm sewer systems), such operators may be a coapplicant to the same application. Permit applications for discharges from large and medium municipal storm sewers or municipal storm sewers designated under paragraph (a)(1)(v) of this section shall include:

(1) *Part 1.* Part 1 of the application shall consist of:

(i) *General information.* The applicants' name, address, telephone number of contact person, ownership status and status as a State or local government entity.

(ii) *Legal authority.* A description of existing legal authority to control discharges to the municipal separate storm sewer system. When existing legal authority is not sufficient to meet the criteria provided in paragraph (d)(2)(i) of this section, the description shall list additional authorities as will be necessary to meet the criteria and shall include a schedule and commitment to seek such additional authority that will be needed to meet the criteria.

(iii) *Source identification.* (A) A description of the historic use of ordinances, guidance or other controls which limited the discharge of non-storm water discharges to any Publicly Owned Treatment Works serving the same area as the municipal separate storm sewer system.

(B) A USGS 7.5 minute topographic map (or equivalent topographic map with a scale between 1:10,000 and 1:24,000 if cost effective) extending one mile beyond the service boundaries of the municipal storm sewer system covered by the permit application. The following information shall be provided:

(1) The location of known municipal storm sewer system outfalls discharging to waters of the United States;

(2) A description of the land use activities (e.g. divisions indicating undeveloped, residential, commercial, agricultural and industrial uses) accompanied with estimates of population densities and projected growth for a ten year period within the drainage area served by the separate storm sewer. For each land use type, an estimate of an average runoff coefficient shall be provided;

(3) The location and a description of the activities of the facility of each currently operating or closed municipal landfill or other treatment, storage or disposal facility for municipal waste;

(4) The location and the permit number of any known discharge to the municipal storm sewer that has been issued a NPDES permit;

(5) The location of major structural controls for storm water discharge (retention basins, detention basins, major infiltration devices, etc.); and

(6) The identification of publicly owned parks, recreational areas, and other open lands.

(iv) *Discharge characterization.* (A) Monthly mean rain and snow fall estimates (or summary of weather bureau data) and the monthly average number of storm events.

(B) Existing quantitative data describing the volume and quality of discharges from the municipal storm sewer, including a description of the outfalls sampled, sampling procedures and analytical methods used.

(C) A list of water bodies that receive discharges from the municipal separate storm sewer system, including downstream segments, lakes and estuaries, where pollutants from the system discharges may accumulate and cause water degradation and a brief description of known water quality impacts. At a minimum, the description of impacts shall include a description of whether the water bodies receiving such discharges have been:

(1) Assessed and reported in section 305(b) reports submitted by the State, the basis for the assessment (evaluated or monitored), a summary of designated use support and attainment of Clean Water Act (CWA) goals (fishable and swimmable waters), and causes of nonsupport of designated uses;

(2) Listed under section 304(l)(1)(A)(i), section 304(l)(1)(A)(ii), or section 304(l)(1)(B) of the CWA that is not expected to meet water quality standards or water quality goals;

(3) Listed in State Nonpoint Source Assessments required by section 319(a) of the CWA that, without additional action to control nonpoint sources of pollution, cannot reasonably be expected to attain or maintain water quality standards due to storm sewers, construction, highway maintenance and runoff from municipal landfills and municipal sludge adding significant pollution (or contributing to a violation of water quality standards);

(4) Identified and classified according to eutrophic condition of publicly owned lakes listed in State reports required under section 314(a) of the CWA (include the following: A description of those publicly owned lakes for which uses are known to be impaired; a description of procedures, processes and methods to control the discharge of pollutants from municipal separate storm sewers into such lakes; and a description of methods and procedures to restore the quality of such lakes);

(5) Areas of concern of the Great Lakes identified by the International Joint Commission;

(6) Designated estuaries under the National Estuary Program under section 320 of the CWA;

(7) Recognized by the applicant as highly valued or sensitive waters;

(8) Defined by the State or U.S. Fish and Wildlife Services's National Wetlands Inventory as wetlands; and

(9) Found to have pollutants in bottom sediments, fish tissue or biosurvey data.

(D) *Field screening.* Results of a field screening analysis for illicit connections and illegal dumping for either selected field screening points or major outfalls covered in the permit application. At a minimum, a screening analysis shall include a narrative description, for either each field screening point or major outfall, of visual observations made during dry weather periods. If any flow is observed, two grab samples shall be collected during a 24 hour period with a minimum period of four hours between samples. For all such samples, a narrative description of the color, odor, turbidity, the presence of an oil sheen or surface scum as well as any other relevant observations regarding the potential presence of non-storm water discharges or illegal dumping shall be provided. In addition, a narrative description of the results of a field analysis using suitable methods to estimate pH, total chlorine, total copper, total phenol, and detergents (or surfactants) shall be provided along with a description of the flow rate. Where the field analysis does not involve analytical methods approved under 40 CFR part 136, the applicant shall provide a description of the method used including the name of the manufacturer of the test method along with the range and accuracy of the test. Field screening points shall be either major outfalls or other outfall points (or

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any other point of access such as manholes) randomly located throughout the storm sewer system by placing a grid over a drainage system map and identifying those cells of the grid which contain a segment of the storm sewer system or major outfall. The field screening points shall be established using the following guidelines and criteria:

(*1*) A grid system consisting of perpendicular north-south and east-west lines spaced ¼ mile apart shall be overlayed on a map of the municipal storm sewer system, creating a series of cells;

(*2*) All cells that contain a segment of the storm sewer system shall be identified; one field screening point shall be selected in each cell; major outfalls may be used as field screening points;

(*3*) Field screening points should be located downstream of any sources of suspected illegal or illicit activity;

(*4*) Field screening points shall be located to the degree practicable at the farthest manhole or other accessible location downstream in the system, within each cell; however, safety of personnel and accessibility of the location should be considered in making this determination;

(*5*) Hydrological conditions: total drainage area of the site; population density of the site; traffic density; age of the structures or buildings in the area; history of the area; and land use types;

(*6*) For medium municipal separate storm sewer systems, no more than 250 cells need to have identified field screening points; in large municipal separate storm sewer systems, no more than 500 cells need to have identified field screening points; cells established by the grid that contain no storm sewer segments will be eliminated from consideration; if fewer than 250 cells in medium municipal sewers are created, and fewer than 500 in large systems are created by the overlay on the municipal sewer map, then all those cells which contain a segment of the sewer system shall be subject to field screening (unless access to the separate storm sewer system is impossible); and

(*7*) Large or medium municipal separate storm sewer systems which are unable to utilize the procedures described in paragraphs (d)(1)(iv)(D) (*1*) through (*6*) of this section, because a sufficiently detailed map of the separate storm sewer systems is unevailable, shall field screen no more than 500 or 250 major outfalls respectively (or all major outfalls in the system, if less); in such circumstances, the applicant shall establish a grid system consisting of north-south and east-west lines spaced ¼ mile apart as an overlay to the boundaries of the municipal storm sewer system, thereby creating a series of cells; the applicant will then select major outfalls in as many cells as possible until at least 500 major outfalls (large municipalities) or 250 major outfalls (medium municipalities) are selected; a field screening analysis shall be undertaken at these major outfalls.

(E) *Characterization plan.* Information and a proposed program to meet the requirements of paragraph (d)(2)(iii) of this section. Such description shall include: the location of outfalls or field screening points appropriate for representative data collection under paragraph (d)(2)(iii)(A) of this section, a description of why the outfall or field screening point is representative, the seasons during which sampling is intended, a description of the sampling equipment. The proposed location of outfalls or field screening points for such sampling should reflect water quality concerns (*see* paragraph (d)(1)(iv)(C) of this section) to the extent practicable.

(v) *Management programs.* (A) A description of the existing management programs to control pollutants from the municipal separate storm sewer system. The description shall provide information on existing structural and source controls, including operation and maintenance measures for structural controls, that are currently being implemented. Such controls may include, but are not limited to: Procedures to control pollution resulting from construction activities; floodplain management controls; wetland protection measures; best management practices for new subdivisions; and emergency spill response programs. The description may address controls established under State law as well as local requirements.

(B) A description of the existing program to identify illicit connections to the municipal storm sewer system. The description should include inspection procedures and methods for detecting and preventing illicit discharges, and describe areas where this program has been implemented.

(vi) *Fiscal resources.* (A) A description of the financial resources currently available to the municipality to complete part 2 of the permit application. A description of the municipality's budget for existing storm water programs, including an overview of the municipality's financial resources and budget, including overall indebtedness and assets, and sources of funds for storm water programs.

(2) *Part 2.* Part 2 of the application shall consist of:

(i) *Adequate legal authority.* A demonstration that the applicant can operate pursuant to legal authority established by statute, ordinance or series of contracts which authorizes or enables the applicant at a minimum to:

(A) Control through ordinance, permit, contract, order or similar means, the contribution of pollutants to the municipal storm sewer by storm water discharges associated with industrial activity and the quality of storm water discharged from sites of industrial activity;

(B) Prohibit through ordinance, order or similar means, illicit discharges to the municipal separate storm sewer;

(C) Control through ordinance, order or similar means the discharge to a municipal separate storm sewer of spills, dumping or disposal of materials other than storm water;

(D) Control through interagency agreements among coapplicants the contribution of pollutants from one portion of the municipal system to another portion of the municipal system;

(E) Require compliance with conditions in ordinances, permits, contracts or orders; and

(F) Carry out all inspection, surveillance and monitoring procedures necessary to determine compliance and noncompliance with permit conditions including the prohibition on illicit discharges to the municipal separate storm sewer.

(ii) *Source identification.* The location of any major outfall that discharges to waters of the United States that was not reported under paragraph (d)(1)(iii)(B)(*1*) of this section. Provide an inventory, organized by watershed of the name and address, and a description (such as SIC codes) which best reflects the principal products or services provided by each facility which may discharge, to the municipal separate storm sewer, storm water associated with industrial activity;

(iii) *Characterization data.* When "quantitative data" for a pollutant are required under paragraph (d)(a)(iii)(A)(*3*) of this paragraph, the applicant must collect a sample of effluent in accordance with 40 CFR 122.21(g)(7) and analyze it for the pollutant in accordance with analytical methods approved under 40 CFR part 136. When no analytical method is approved the applicant may use any suitable method but must provide a description of the method. The applicant must provide information characterizing the quality and quantity of discharges covered in the permit application, including:

(A) Quantitative data from representative outfalls designated by the Director (based on information received

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in part 1 of the application, the Director shall designate between five and ten outfalls or field screening points as representative of the commercial, residential and industrial land use activities of the drainage area contributing to the system or, where there are less than five outfalls covered in the application, the Director shall designate all outfalls) developed as follows:

(*1*) For each outfall or field screening point designated under this subparagraph, samples shall be collected of storm water discharges from three storm events occurring at least one month apart in accordance with the requirements at § 122.21(g)(7) (the Director may allow exemptions to sampling three storm events when climatic conditions create good cause for such exemptions);

(*2*) A narrative description shall be provided of the date and duration of the storm event(s) sampled, rainfall estimates of the storm event which generated the sampled discharge and the duration between the storm event sampled and the end of the previous measurable (greater than 0.1 inch rainfall) storm event;

(*3*) For samples collected and described under paragraphs (d)(2)(iii)(A)(*1*) and (A)(*2*) of this section, quantitative data shall be provided for: the organic pollutants listed in Table II; the pollutants listed in Table III (toxic metals, cyanide, and total phenols) of appendix D of 40 CFR part 122, and for the following pollutants:

Total suspended solids (TSS)
Total dissolved solids (TDS)
COD
BOD_5
Oil and grease
Fecal coliform
Fecal streptococcus
pH
Total Kjeldahl nitrogen
Nitrate plus nitrite
Dissolved phosphorus
Total ammonia plus organic nitrogen
Total phosphorus

(*4*) Additional limited quantitative data required by the Director for determining permit conditions (the Director may require that quantitative data shall be provided for additional parameters, and may establish sampling conditions such as the location, season of sample collection, form of precipitation (snow melt, rainfall) and other parameters necessary to insure representativeness).

(B) Estimates of the annual pollutant load of the cumulative discharges to waters of the United States from all identified municipal outfalls and the event mean concentration of the cumulative discharges to waters of the United States from all identified municipal outfalls during a storm event (as described under § 122.21(c)(7)) for BOD_5, COD, TSS, dissolved solids, total nitrogen, total ammonia plus organic nitrogen, total phosphorus, dissolved phosphorus, cadmium, copper, lead, and zinc. Estimates shall be accompanied by a description of the procedures for estimating constituent loads and concentrations, including any modelling, data analysis, and calculation methods;

(C) A proposed schedule to provide estimates for each major outfall identified in either paragraph (d)(2)(ii) or (d)(1)(iii)(B)(*1*) of this section of the seasonal pollutant load and of the event mean concentration of a representative storm for any constituent detected in any sample required under paragraph (d)(2)(iii)(A) of this section; and

(D) A proposed monitoring program for representative data collection for the term of the permit that describes the location of outfalls or field screening points to be sampled (or the location of instream stations), why the location is representative, the frequency of sampling, parameters to be sampled, and a description of sampling equipment.

(iv) *Proposed management program.* A proposed management program covers the duration of the permit. It shall include a comprehensive planning process which involves public participation and where necessary intergovernmental coordination, to reduce the discharge of pollutants to the maximum extent practicable using management practices, control techniques and system, design and engineering methods, and such other provisions which are appropriate. The program shall also include a description of staff and equipment available to implement the program. Separate proposed programs may be submitted by each coapplicant. Proposed programs may impose controls on a systemwide basis, a watershed basis, a jurisdiction basis, or on individual outfalls. Proposed programs will be considered by the Director when developing permit conditions to reduce pollutants in discharges to the maximum extent practicable. Proposed management programs shall describe priorities for implementing controls. Such programs shall be based on:

(A) A description of structural and source control measures to reduce pollutants from runoff from commercial and residential areas that are discharged from the municipal storm sewer system that are to be implemented during the life of the permit, accompanied with an estimate of the expected reduction of pollutant loads and a proposed schedule for implementing such controls. At a minimum, the description shall include:

(*1*) A description of maintenance activities and a maintenance schedule for structural controls to reduce pollutants (including floatables) in discharges from municipal separate storm sewers;

(*2*) A description of planning procedures including a comprehensive master plan to develop, implement and enforce controls to reduce the discharge of pollutants from municipal separate storm sewers which receive discharges from areas of new development and significant redevelopment. Such plan shall address controls to reduce pollutants in discharges from municipal separate storm sewers after construction is completed. (Controls to reduce pollutants in discharges from municipal separate storm sewers containing construction site runoff are addressed in paragraph (d)(2)(iv)(D) of this section;

(*3*) A description of practices for operating and maintaining public streets, roads and highways and procedures for reducing the impact on receiving waters of discharges from municipal storm sewer systems, including pollutants discharged as a result of deicing activities;

(*4*) A description of procedures to assure that flood management projects assess the impacts on the water quality of receiving water bodies and that existing structural flood control devices have been evaluated to determine if retrofitting the device to provide additional pollutant removal from storm water is feasible;

(*5*) A description of a program to monitor pollutants in runoff from operating or closed municipal landfills or other treatment, storage or disposal facilities for municipal waste, which shall identify priorities and procedures for inspections and establishing and implementing control measures for such discharges (this program can be coordinated with the program developed under paragraph (d)(2)(iv)(C) of this section); and

(*6*) A description of a program to reduce to the maximum extent practicable, pollutants in discharges from municipal separate storm sewers associated with the application of pesticides, herbicides and fertilizer which will include, as appropriate, controls such as educational activities, permits, certifications and other measures for commercial applicators and distributors, and controls for application in public right-of-ways and at municipal facilities.

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(B) A description of a program, including a schedule, to detect and remove (or require the discharger to the municipal separate storm sewer to obtain a separate NPDES permit for) illicit discharges and improper disposal into the storm sewer. The proposed program shall include:

(1) A description of a program, including inspections, to implement and enforce an ordinance, orders or similar means to prevent illicit discharges to the municipal separate storm sewer system; this program description shall address all types of illicit discharges, however the following category of non-storm water discharges or flows shall be addressed where such discharges are identified by the municipality as sources of pollutants to waters of the United States: water line flushing, landscape irrigation, diverted stream flows, rising ground waters, uncontaminated ground water infiltration (as defined at 40 CFR 35.2005(20)) to separate storm sewers, uncontaminated pumped ground water, discharges from potable water sources, foundation drains, air conditioning condensation, irrigation water, springs, water from crawl space pumps, footing drains, lawn watering, individual residential car washing, flows from riparian habitats and wetlands, dechlorinated swimming pool discharges, and street wash water (program descriptions shall address discharges or flows from fire fighting only where such discharges or flows are identified as significant sources of pollutants to waters of the United States);

(2) A description of procedures to conduct on-going field screening activities during the life of the permit, including areas or locations that will be evaluated by such field screens;

(3) A description of procedures to be followed to investigate portions of the separate storm sewer system that, based on the results of the field screen, or other appropriate information, indicate a reasonable potential of containing illicit discharges or other sources of non-storm water (such procedures may include: sampling procedures for constituents such as fecal coliform, fecal streptococcus, surfactants (MBAS), residual chlorine, fluorides and potassium; testing with fluorometric dyes; or conducting in storm sewer inspections where safety and other considerations allow. Such description shall include the location of storm sewers that have been identified for such evaluation);

(4) A description of procedures to prevent, contain, and respond to spills that may discharge into the municipal separate storm sewer;

(5) A description of a program to promote, publicize, and facilitate public reporting of the presence of illicit discharges or water quality impacts associated with discharges from municipal separate storm sewers;

(6) A description of educational activities, public information activities, and other appropriate activities to facilitate the proper management and disposal of used oil and toxic materials; and

(7) A description of controls to limit infiltration of seepage from municipal sanitary sewers to municipal separate storm sewer systems where necessary;

(C) A description of a program to monitor and control pollutants in storm water discharges to municipal systems from municipal landfills, hazardous waste treatment, disposal and recovery facilities, industrial facilities that are subject to section 313 of title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA), and industrial facilities that the municipal permit applicant determines are contributing a substantial pollutant loading to the municipal storm sewer system. The program shall:

(1) Identify priorities and procedures for inspections and establishing and implementing control measures for such discharges;

(2) Describe a monitoring program for storm water discharges associated with the industrial facilities identified in paragraph (d)(2)(iv)(C) of this section, to be implemented during the term of the permit, including the submission of quantitative data on the following constituents: any pollutants limited in effluent guidelines subcategories, where applicable; any pollutant listed in an existing NPDES permit for a facility; oil and grease, COD, pH, BOD$_5$, TSS, total phosphorus, total Kjeldahl nitrogen, nitrate plus nitrite nitrogen, and any information on discharges required under 40 CFR 122.21(g)(7) (iii) and (iv).

(D) A description of a program to implement and maintain structural and non-structural best management practices to reduce pollutants in storm water runoff from construction sites to the municipal storm sewer system, which shall include:

(1) A description of procedures for site planning which incorporate consideration of potential water quality impacts;

(2) A description of requirements for nonstructural and structural best management practices;

(3) A description of procedures for identifying priorities for inspecting sites and enforcing control measures which consider the nature of the construction activity, topography, and the characteristics of soils and receiving water quality; and

(4) A description of appropriate educational and training measures for construction site operators.

(v) *Assessment of controls.* Estimated reductions in loadings of pollutants from discharges of municipal storm sewer constituents from municipal storm sewer systems expected as the result of the municipal storm water quality management program. The assessment shall also identify known impacts of storm water controls on ground water.

(vi) *Fiscal analysis.* For each fiscal year to be covered by the permit, a fiscal analysis of the necessary capital and operation and maintenance expenditures necessary to accomplish the activities of the programs under paragraphs (d)(2) (iii) and (iv) of this section. Such analysis shall include a description of the source of funds that are proposed to meet the necessary expenditures, including legal restrictions on the use of such funds.

(vii) Where more than one legal entity submits an application, the application shall contain a description of the roles and responsibilities of each legal entity and procedures to ensure effective coordination.

(viii) Where requirements under paragraph (d)(1)(iv)(E), (d)(2)(ii), (d)(2)(iii)(B) and (d)(2)(iv) of this section are not practicable or are not applicable, the Director may exclude any operator of a discharge from a municipal separate storm sewer which is designated under paragraph (a)(1)(v), (b)(4)(ii) or (b)(7)(ii) of this section from such requirements. The Director shall not exclude the operator of a discharge from a municipal separate storm sewer identified in appendix F, G, H or I of part 122, from any of the permit application requirements under this paragraph except where authorized under this section.

(e) *Application deadlines.* Any operator of a point source required to obtain a permit under paragraph (a)(1) of this section that does not have an effective NPDES permit covering its storm water outfalls shall submit an application in accordance with the following deadlines:

(1) For any storm water discharge associated with industrial activity identified in paragraph (b)(14) (i)–(xi) of this section, that is not part of a group application as described in paragraph (c)(2) of this section or which is not covered under a promulgated storm water general permit, a permit application made pursuant to paragraph (c) of this section shall be submitted to the Director by November 18, 1991;

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(2) For any group application submitted in accordance with paragraph (c)(2) of this section:

(i) Part 1 of the application shall be submitted to the Director, Office of Water Enforcement and Permits by March 18, 1991;

(ii) Based on information in the part 1 application, the Director will approve or deny the members in the group application within 90 days after receiving part 1 of the group application.

(iii) Part 2 of the application shall be submitted to the Director, Office of Water Enforcement and Permits no later than 12 months after the date of approval of the part 1 application.

(iv) Facilities that are rejected as members of a group by the permitting authority shall have 12 months to file an individual permit application from the date they receive notification of their rejection.

(v) A facility listed under paragraph (b)(14) (i)–(xi) of this section may add on to a group application submitted in accordance with paragraph (a)(2)(i) of this section at the discretion of the Office of Water Enforcement and Permits, and only upon a showing of good cause by the facility and the group applicant; the request for the addition of the facility shall be made no later than February 18,1992; the addition of the facility shall not cause the percentage of the facilities that are required to submit quantitative data to be less than 10%, unless there are over 100 facilities in the group that are submitting quantitative data; approval to become part of group application must be obtained from the group or the trade association representing the individual facilities.

(3) For any discharge from a large municipal separate storm sewer system:

(i) Part 1 of the application shall be submitted to the Director by November 18, 1991;

(ii) Based on information received in the part 1 application the Director will approve or deny a sampling plan under paragraph (d)(1)(iv)(E) of this section within 90 days after receiving the part 1 application;

(iii) Part 2 of the application shall be submitted to the Director by November 18, 1992.

(4) For any discharge from a medium municipal separate storm sewer system:

(i) Part 1 of the application shall be submitted to the Director by May 18, 1992.

(ii) Based on information received in the part 1 application the Director will approve or deny a sampling plan under paragraph (d)(1)(iv)(E) of this section within 90 days after receiving the part 1 application.

(iii) Part 2 of the application shall be submitted to the Director by May 17, 1993.

(5) A permit application shall be submitted to the Director within 60 days of notice, unless permission for a later date is granted by the Director (*see* 40 CFR 124.52(c)), for:

(i) A storm water discharge which the Director, or in States with approved NPDES programs, either the Director or the EPA Regional Administrator, determines that the discharge contributes to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States (see paragraph (a)(1)(v) of this section);

(ii) A storm water discharge subject to paragraph (c)(1)(v) of this section.

(6) Facilities with existing NPDES permits for storm water discharges associated with industrial activity shall maintain existing permits. New applications shall be submitted in accordance with the requirements of 40 CFR 122.21 and 40 CFR 122.26(c) 180 days before the expiration of such permits. Facilities with expired permits or permits due to expire before May 18, 1992, shall submit applications in accordance with the deadline set forth under paragraph (e)(1) of this section.

(f) *Petitions.* (1) Any operator of a municipal separate storm sewer system may petition the Director to require a separate NPDES permit (or a permit issued under an approved NPDES State program) for any discharge into the municipal separate storm sewer system.

(2) Any person may petition the Director to require a NPDES permit for a discharge which is composed entirely of storm water which contributes to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States.

(3) The owner or operator of a municipal separate storm sewer system may petition the Director to reduce the Census estimates of the population served by such separate system to account for storm water discharged to combined sewers as defined by 40 CFR 35.2005(b)(11) that is treated in a publicly owned treatment works. In municipalities in which combined sewers are operated, the Census estimates of population may be reduced proportional to the fraction, based on estimated lengths, of the length of combined sewers over the sum of the length of combined sewers and municipal separate storm sewers where an applicant has submitted the NPDES permit number associated with each discharge point and a map indicating areas served by combined sewers and the location of any combined sewer overflow discharge point.

(4) Any person may petition the Director for the designation of a large or medium municipal separate storm sewer system as defined by paragraphs (b)(4)(iv) or (b)(7)(iv) of this section.

(5) The Director shall make a final determination on any petition received under this section within 90 days after receiving the petition.

8. Section 122.28(b)(2)(i) is revised to read as follows:

§ 122.28 General permits (applicable to State NPDES programs, see § 123.25).

* * * * *

(b) * * *

(2) *Requiring an individual permit.* (i) The Director may require any discharger authorized by a general permit to apply for and obtain an individual NPDES permit. Any interested person may petition the Director to take action under this paragraph. Cases where an individual NPDES permit may be required include the following:

(A) The discharger or "treatment works treating domestic sewage" is not in compliance with the conditions of the general NPDES permit;

(B) A change has occurred in the availability of demonstrated technology or practices for the control or abatement of pollutants applicable to the point source or treatment works treating domestic sewage;

(C) Effluent limitation guidelines are promulgated for point sources covered by the general NPDES permit;

(D) A Water Quality Management plan containing requirements applicable to such point sources is approved;

(E) Circumstances have changed since the time of the request to be covered so that the discharger is no longer appropriately controlled under the general permit, or either a temporary or permanent reduction or elimination of the authorized discharge is necessary;

(F) Standards for sewage sludge use or disposal have been promulgated for the sludge use and disposal practice covered by the general NPDES permit; or

(G) The discharge(s) is a significant contributor of pollutants. In making this determination, the Director may consider the following factors:

(*1*) The location of the discharge with respect to waters of the United States;

(*2*) The size of the discharge;

(*3*) The quantity and nature of the pollutants discharged to waters of the United States; and

(*4*) Other relevant factors;

* * * * *

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7. Section 122.42 is amended by adding paragraph (c) to read as follows:

§ 122.42 Additional conditions applicable to specified categories of NPDES permits (applicable to State NPDES programs, see § 123.25).

• • • • •

(c) *Municipal separate storm sewer systems.* The operator of a large or medium municipal separate storm sewer system or a municipal separate storm sewer that has been designated by the Director under § 122.26(a)(1)(v) of this part must submit an annual report by the anniversary of the date of the issuance of the permit for such system. The report shall include:

(1) The status of implementing the components of the storm water management program that are established as permit conditions;

(2) Proposed changes to the storm water management programs that are established as permit condition. Such proposed changes shall be consistent with § 122.26(d)(2)(iii) of this part; and

(3) Revisions, if necessary, to the assessment of controls and the fiscal analysis reported in the permit application under § 122.26(d)(2)(iv) and (d)(2)(v) of this part;

(4) A summary of data, including monitoring data, that is accumulated throughout the reporting year;

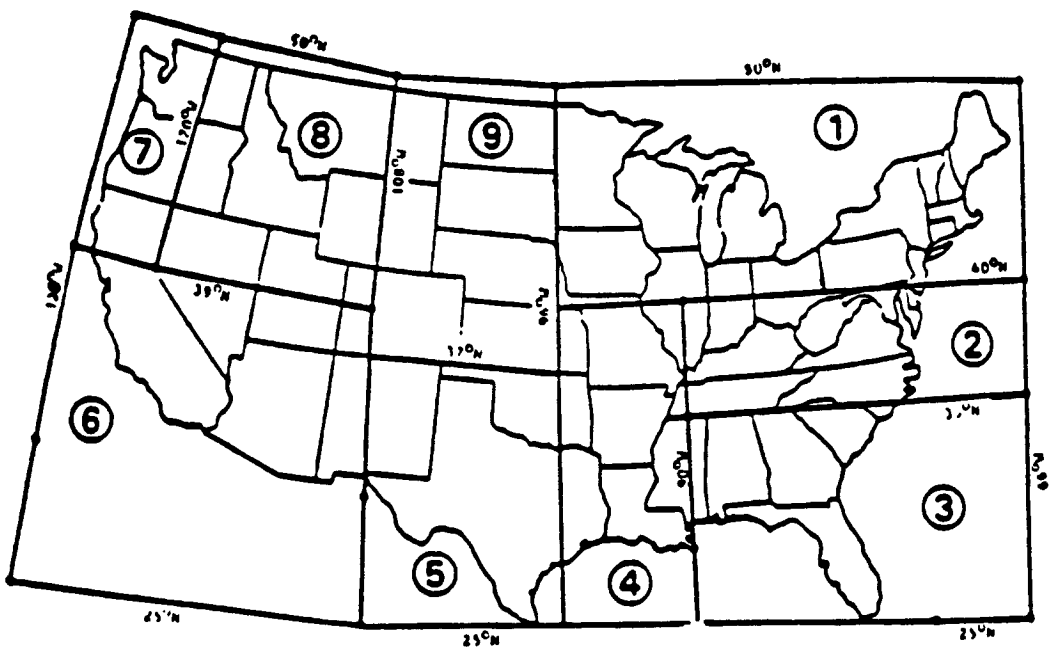
(5) Annual expenditures and budget for year following each annual report;

(6) A summary describing the number and nature of enforcement actions, inspections, and public education programs;

(7) Identification of water quality improvements or degradation;

7a. Part 122 is amended by adding appendices E through I as follows:

Appendix E to Part 122—Rainfall Zones of the United States



Not Shown: Alaska (Zone 7); Hawaii (Zone 7); Northern Mariana Islands (Zone 7); Guam (Zone 7); American Samoa (Zone 7); Trust Territory of the Pacific Islands (Zone 7); Puerto Rico (Zone 3) Virgin Islands (Zone 3).

Source: Methodology for Analysis of Detention Basins for Control of Urban Runoff Quality, prepared for U.S. Environmental Protection Agency, Office of Water, Nonpoint Source Division, Washington, DC. 1986.

Appendix F to Part 122—Incorporated Places With Populations Greater Than 250,000 According to Latest Decennial Census by Bureau of Census.

State	Incorporated place
Alabama	Birmingham
Arizona	Phoenix
	Tucson
California	Long Beach
	Los Angeles
	Oakland
	Sacramento
	San Diego
	San Francisco
	San Jose
Colorado	Denver
District of Columbia	
Florida	Jacksonville
	Miami
	Tampa
Georgia	Atlanta
Illinois	Chicago
Indiana	Indianapolis
Kansas	Wichita
Kentucky	Louisville
Louisiana	New Orleans
Maryland	Baltimore
Massachusetts	Boston
Michigan	Detroit
Minnesota	Minneapolis
	St. Paul

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State	Incorporated place
Missouri	Kansas City
	St. Louis
Nebraska	Omaha
New Jersey	Newark
New Mexico	Albuquerque
New York	Buffalo
	Bronx Borough
	Brooklyn Borough
	Manhattan Borough
	Queens Borough
	Staten Island Borough
North Carolina	Charlotte
Ohio	Cincinnati
	Cleveland
	Columbus
	Toledo
Oklahoma	Oklahoma City
	Tulsa
Oregon	Portland
Pennsylvania	Philadelphia
	Pittsburgh
Tennessee	Memphis
	Nashville/Davidson
Texas	Austin
	Dallas
	El Paso
	Fort Worth
	Houston
	San Antonio
Virginia	Norfolk
	Virginia Beach
Washington	Seattle
Wisconsin	Milwaukee

Appendix G to Part 122—Incorporated Places With Populations Greater Than 100,000 and Less Than 250,000 According to Latest Decennial Census by Bureau of Census

State	Incorporated place
Alabama	Huntsville
	Mobile
	Montgomery
Alaska	Anchorage
Arizona	Mesa
	Tempe
Arkansas	Little Rock
California	Anaheim
	Bakersfield
	Berkeley
	Concord
	Fremont
	Fresno
	Fullerton
	Garden Grove
	Glendale
	Huntington Beach
	Modesto
	Oxnard
	Pasadena
	Riverside
	San Bernadino
	Santa Ana
	Stockton
	Sunnyvale
	Torrance
Colorado	Aurora
	Colorado Springs
	Lakewood
	Pueblo
Connecticut	Bridgeport
	Hartford
	New Haven
	Stamford
	Waterbury
Florida	Fort Lauderdale
	Hialeah
	Hollywood
	Orlando
	St. Petersburg
Georgia	Columbus
	Macon
	Savannah
Idaho	Boise City
Illinois	Peoria
	Rockford
Indiana	Evansville
	Fort Wayne
	Gary
	South Bend
Iowa	Cedar Rapids
	Davenport
	Des Moines
Kansas	Kansas City
	Topeka
Kentucky	Lexington-Fayette
Louisiana	Baton Rouge
	Shreveport
Massachusetts	Springfield
	Worcester
Michigan	Ann Arbor
	Flint
	Grand Rapids
	Lansing
	Livonia
	Sterling Heights
	Warren
Mississippi	Jackson
Missouri	Independence
	Springfield
Nebraska	Lincoln
Nevada	Las Vegas
	Reno
New Jersey	Elizabeth
	Jersey City
	Paterson
New York	Albany
	Rochester
	Syracuse
	Yonkers
North Carolina	Durham
	Greensboro
	Raleigh
	Winston-Salem
Ohio	Akron
	Dayton
	Youngstown
Oregon	Eugene
Pennsylvania	Allentown
	Erie
Rhode Island	Providence
South Carolina	Columbia
Tennessee	Chattanooga
	Knoxville
Texas	Amarillo
	Arlington
	Beaumont
	Corpus Christi
	Garland
	Irving
	Lubbock
	Pasadena
	Waco
Utah	Salt Lake City
Virginia	Alexandria
	Chesapeake
	Hampton
	Newport News
	Portsmouth
	Richmond
	Roanoke
Washington	Spokane
	Tacoma
Wisconsin	Madison

Appendix H to Part 122—Counties with Unincorporated Urbanized Areas With a Population of 250,000 or More According to the Latest Decennial Census by the Bureau of Census

State	County	Unincorporated urbanized population
California	Los Angeles	912,694
	Sacramento	449,856
	San Diego	304,758
Delaware	New Castle	257,184
Florida	Dade	781,949
Georgia	DeKalb	386,379
Hawaii	Honolulu	686,178
Maryland	Anne Arundel	271,456
	Baltimore	601,366
	Montgomery	447,980
	Prince George's	460,188
Texas	Harris	409,801
Utah	Salt Lake	304,832
Virginia	Fairfax	527,179
Washington	King	536,809

Appendix I to Part 122—Counties With Unincorporated Urbanized Areas Greater Than 100,000, But Less Than 250,000 According to the Latest Decennial Census by the Bureau of Census

State	County	Unincorporated urbanized population
Alabama	Jefferson	182,917
Arizona	Pima	111,479
California	Alameda	187,474
	Contra Costa	158,452
	Kern	117,231
	Orange	210,883
	Riverside	115,719
	San Bernardino	148,844
Florida	Broward	159,370
	Escambia	147,892
	Hillsborough	236,752
	Orange	245,325
	Palm Beach	167,088
	Pinellas	194,389
	Polk	104,150
	Sarasota	118,009
Georgia	Clayton	180,742
	Cobb	304,121
	Richmond	118,529
Kentucky	Jefferson	224,958
Louisiana	Jefferson	140,836
North Carolina	Cumberland	142,727
Nevada	Clark	201,775
Oregon	Multnomah	141,980
	Washington	188,348
South Carolina	Greenville	135,388
	Richland	124,684
Virginia	Arlington	152,599
	Henrico	161,204
	Chesterfield	108,348
Washington	Snohomish	183,483
	Pierce	188,113

PART 123—STATE PROGRAM REQUIREMENTS

8 The authority citation for part 123 continues to read as follows:

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Authority: Clean Water Act, 33 U.S.C. 1251 *et seq.*

8. Section 123.25 is amended by revising paragraph (a)(9) to read as follows:

§ 123.25 Requirements for permitting.

(a) * * *

(9) § 122.26—(Storm water discharges);

* * * * *

PART 124—PROCEDURES FOR DECISIONMAKING

10. The authority citation for part 124 continues to read as follows:

Authority: Resource Conservation and Recovery Act, 42 U.S.C. 6901 *et seq.*; Safe Drinking Water Act, 42 U.S.C. 300f *et seq.*; Clean Water Act, 33 U.S.C. 1251 *et seq.*; and Clean Air Act, 42 U.S.C. 1857 *et seq.*

11. Section 124.52 is revised to read as follows:

§ 124.52 Permits required on a case-by-case basis.

(a) Various sections of part 122, subpart B allow the Director to determine, on a case-by-case basis, that certain concentrated animal feeding operations (§ 122.23), concentrated aquatic animal production facilities (§ 122.24), storm water discharges (§ 122.26), and certain other facilities covered by general permits (§ 122.28) that do not generally require an individual permit may be required to obtain an individual permit because of their contributions to water pollution.

(b) Whenever the Regional Administrator decides that an individual permit is required under this section, except as provided in paragraph (c) of this section, the Regional Administrator shall notify the discharger in writing of that decision and the reasons for it, and shall send an application form with the notice. The discharger must apply for a permit under § 122.21 within 60 days of notice, unless permission for a later date is granted by the Regional Administrator. The question whether the designation was proper will remain open for consideration during the public comment period under § 124.11 or § 124.118 and in any subsequent hearing.

(c) Prior to a case-by-case determination that an individual permit is required for a storm water discharge under this section (*see* 40 CFR 122.26 (a)(1)(v) and (c)(1)(v)), the Regional Administrator may require the discharger to submit a permit application or other information regarding the discharge under section 308 of the CWA. In requiring such information, the Regional Administrator shall notify the discharger in writing and shall send an application form with the notice. The discharger must apply for a permit under § 122.26 within 60 days of notice, unless permission for a later date is granted by the Regional Administrator. The question whether the initial designation was proper will remain open for consideration during the public comment period under § 124.11 or § 124.118 and in any subsequent hearing.

Note: The following form will not appear in the Code of Federal Regulations.

BILLING CODE 6560-50-M

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Please print or type in the unshaded areas only.

EPA ID Number (copy from Item 1 of Form 1)

Form Approved OMB No 2040-0086
Approval expires 5/31/92

Form 2F NPDES

EPA

United States Environmental Protection Agency
Washington, DC 20460

Application for Permit To Discharge Stormwater Discharges Associated with Industrial Activity

Paperwork Reduction Act Notice

Public reporting burden for this application is estimated to average 38.6 hours per application, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate, any other aspect of this collection of information, or suggestions for improving this form, including suggestions which may decrease or reduce this burden to: Chief, Information Policy Branch, PM-223, U.S. Environmental Protection Agency, 401 M St., SW, Washington, DC 20460, or Director, Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC 20503.

I. Outfall Location

For each outfall, list the latitude and longitude of its location to the nearest 15 seconds and the name of the receiving water.

A. Outfall Number (list)	B. Latitude	C. Longitude	D. Receiving Water (name)

II. Improvements

A. Are you now required by any Federal, State, or local authority to meet any implementation schedule for the construction, upgrading or operation of wastewater treatment equipment or practices or any other environmental programs which may affect the discharges described in this application? This includes, but is not limited to, permit conditions, administrative or enforcement orders, enforcement compliance schedule letters, stipulations, court orders, and grant or loan conditions.

1. Identification of Conditions, Agreements, Etc	2. Affected Outfalls		3. Brief Description of Project	4. Final Compliance Date	
	number	source of discharge		a. req.	b. proj.

B. You may attach additional sheets describing any additional water pollution (or other environmental projects which may affect your discharges) you now have under way or which you plan. Indicate whether each program is now under way or planned, and indicate your actual or planned schedules for construction.

III. Site Drainage Map

Attach a site map showing topography (or indicating the outline of drainage areas served by the outfall(s) covered in the application if a topographic map is unavailable) depicting the facility including: each of its intake and discharge structures; the drainage area of each storm water outfall; paved areas and buildings within the drainage area of each storm water outfall; each known past or present areas used for outdoor storage or disposal of significant materials; each existing structural control measure to reduce pollutants in storm water runoff; materials loading and access areas; areas where pesticides, herbicides, soil conditioners and fertilizers are applied; each of its hazardous waste treatment, storage or disposal units (including each area not required to have a RCRA permit which is used for accumulating hazardous waste under 40 CFR 262.34); each well where fluids from the facility are injected underground; springs; and other surface water bodies which receive storm water discharges from the facility.

Continue on Page 2

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Continued from the Front

IV. Narrative Description of Pollutant Sources

A. For each outfall, provide an estimate of the area (include units) of impervious surface (including paved areas and building roofs) drained to the outfall, and an estimate of the total surface area drained by the outfall.

Outfall Number	Area of Impervious Surface (provide units)	Total Area Drained (provide units)	Outfall Number	Area of Impervious Surface (provide units)	Total Area Drained (provide units)

B. Provide a narrative description of significant materials that are currently or in the past three years have been treated, stored or disposed in a manner to allow exposure to storm water; method of treatment, storage, or disposal; past and present materials management practices employed, in the last three years, to minimize contact by these materials with storm water runoff; materials loading and access areas; and the location, manner, and frequency in which pesticides, herbicides, soil conditioners, and fertilizers are applied.

C. For each outfall, provide the location and a description of existing structural and nonstructural control measures to reduce pollutants in storm water runoff, and a description of the treatment the storm water receives, including the schedule and type of maintenance for control and treatment measures and the ultimate disposal of any solid or fluid wastes other than by discharge.

Outfall Number	Treatment	List Codes from Table 2F-1

V. Nonstormwater Discharges

A. I certify under penalty of law that the outfall(s) covered by this application have been tested or evaluated for the presence of nonstormwater discharges, and that all nonstormwater discharges from these outfall(s) are identified in either an accompanying Form 2C or Form 2E application for the outfall.

Name and Official Title (type or print)	Signature	Date Signed

B. Provide a description of the method used, the date of any testing, and the onsite drainage points that were directly observed during a test.

VI. Significant Leaks or Spills

Provide existing information regarding the history of significant leaks or spills of toxic or hazardous pollutants at the facility in the last three years, including the approximate date and location of the spill or leak, and the type and amount of material released.

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Continued from Page 2

EPA ID Number (copy from Item 1 of Form 1)

VII. Discharge Information

A,B,C, & D: See instructions before proceeding. Complete one set of tables for each outfall. Annotate the outfall number in the space provided. Tables VII-A, VII-B, and VII-C are included on separate sheets numbered VII-1 and VII-2

E: Potential discharges not covered by analysis - Is any pollutant listed in Table 2F-2 a substance or a component of a substance which you currently use or manufacture as an intermediate or final product or byproduct?

☐ Yes (list all such pollutants below) ☐ No (go to Section VIII)

VIII. Biological Toxicity Testing Data

☐ Yes (list results below) ☐ No (go to Section IX)

IX. Contract Analysis Information

☐ Yes ☐ No (go to Section X)

A. Name	B. Address	C. Area Code & Phone No	D. Pollutants Analyzed

X. Certification

A. Name & Official Title (type or print)	B. Area Code and Phone No
C. Signature	D. Date Signed

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EPA ID Number (copy from item I of Form 1)

Form Approved. OMB No. 2040-0086
Approval expires 5/31/92

VII. Discharge Information (Continued from page 3 of Form 2F)

Part A - You must provide the results of at least one analysis for every pollutant in this table. Complete one table for each outfall. See instructions for additional details.

Pollutant and CAS Number (if available)	Maximum Values (include units)		Average Values (include units)		Number of Storm Events Sampled	Sources of Pollutants
	Grab Sample Taken During First 30 Minutes	Flow-weighted Composite	Grab Sample Taken During First 30 Minutes	Flow-weighted Composite		
Oil and Grease						
Biological Oxygen Demand (BOD5)						
Chemical Oxygen Demand (COD)						
Total Suspended Solids (TSS)						
Total Kjeldahl Nitrogen						
Nitrate plus Nitrite Nitrogen						
Total Phosphorus						
pH	Minimum	Maximum	Minimum	Maximum		

Part B - List each pollutant that is limited in an effluent guideline which the facility is subject to or any pollutant listed in the facility's NPDES permit for its process wastewater (if the facility is operating under an existing NPDES permit). Complete one table for each outfall. See the instructions for additional details and requirements.

Pollutant and CAS Number (if available)	Maximum Values (include units)		Average Values (include units)		Number of Storm Events Sampled	Sources of Pollutants
	Grab Sample Taken During First 30 Minutes	Flow-weighted Composite	Grab Sample Taken During First 30 Minutes	Flow-weighted Composite		

Continued from the Front

Part C - List each pollutant shown in Tables 2F-2, 2F-3, and 2F-4 that you know or have reason to believe is present. See the instructions for additional details and requirements. Complete one table for each outfall.

Pollutant and CAS Number (if available)	Maximum Values (include units)		Average Values (include units)		Number of Storm Events Sampled	Sources of Pollutants
	Grab Sample Taken During First 30 Minutes	Flow-weighted Composite	Grab Sample Taken During First 30 Minutes	Flow-weighted Composite		

Instructions - Form 2F
Application for Permit to Discharge Storm Water Associated with Industrial Activity

Who Must File Form 2F

Form 2F must be completed by operators of facilities which discharge storm water associated with industrial activity or by operators of storm water discharges that EPA is evaluating for designation as a significant contributor of pollutants to waters of the United States, or as contributing to a violation of a water quality standard.

Operators of discharges which are composed entirely of storm water must complete Form 2F (EPA Form 3510-2F) in conjunction with Form 1 (EPA Form 3510-1).

Operators of discharges of storm water which are combined with process wastewater (process wastewater is water that comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, byproduct, waste product, or wastewater) must complete and submit Form 2F, Form 1, and Form 2C (EPA Form 3510-2C).

Operators of discharges of storm water which are combined with nonprocess wastewater (nonprocess wastewater includes noncontact cooling water and sanitary wastes which are not regulated by effluent guidelines or a new source performance standard, except discharges by educational, medical, or commercial chemical laboratories) must complete Form 1, Form 2F, and Form 2E (EPA Form 3510-2E).

Operators of new sources or new discharges of storm water associated with industrial activity which will be combined with other nonstormwater new sources or new discharges must submit Form 1, Form 2F, and Form 2D (EPA Form 3510-2D).

Where to File Applications

The application forms should be sent to the EPA Regional Office which covers the State in which the facility is located. Form 2F must be used only when applying for permits in States where the NPDES permits program is administered by EPA. For facilities located in States which are approved to administer the NPDES permits program, the State environmental agency should be contacted for proper permit application forms and instructions.

Information on whether a particular program is administered by EPA or by a State agency can be obtained from your EPA Regional Office. Form 1, Table 1 of the "General Instructions" lists the addresses of EPA Regional Offices and the States within the jurisdiction of each Office.

Completeness

Your application will not be considered complete unless you answer every question on this form and on Form 1. If an item does not apply to you, enter "NA" (for not applicable) to show that you considered the question.

Public Availability of Submitted Information

You may not claim as confidential any information required by this form or Form 1, whether the information is reported on the forms or in an attachment. Section 402(j) of the Clean Water Act requires that all permit applications will be available to the public. This information will be made available to the public upon request.

Any information you submit to EPA which goes beyond that required by this form, Form 1, or Form 2C you may claim as confidential, but claims for information which are effluent data will be denied.

If you do not assert a claim of confidentiality at the time of submitting the information, EPA may make the information public without further notice to you. Claims of confidentiality will be handled in accordance with EPA's business confidentiality regulations at 40 CFR Part 2.

Definitions

All significant terms used in these instructions and in the form are defined in the glossary found in the General Instructions which accompany Form 1.

EPA ID Number

Fill in your EPA Identification Number at the top of each odd-numbered page of Form 2F. You may copy this number directly from Item I of Form 1.

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Item I

You may use the map you provided for Item XI of Form 1 to determine the latitude and longitude of each of your outfalls and the name of the receiving water.

Item II-A

If you check "yes" to this question, complete all parts of the chart, or attach a copy of any previous submission you have made to EPA containing the same information.

Item II-B

You are not required to submit a description of future pollution control projects if you do not wish to or if none is planned.

Item III

Attach a site map showing topography (or indicating the outline of drainage areas served by the outfall(s) covered in the application if a topographic map is unavailable) depicting the facility including:

each of its drainage and discharge structures;

the drainage area of each storm water outfall;

paved areas and building within the drainage area of each storm water outfall, each known past or present areas used for outdoor storage or disposal of significant materials, each existing structural control measure to reduce pollutants in storm water runoff, materials loading and access areas, areas where pesticides, herbicides, soil conditioners and fertilizers are applied;

each of its hazardous waste treatment, storage or disposal facilities (including each area not required to have a RCRA permit which is used for accumulating hazardous waste for less than 90 days under 40 CFR 262.34);

each well where fluids from the facility are injected underground; and

springs, and other surface water bodies which receive storm water discharges from the facility;

Item IV-A

For each outfall, provide an estimate of the area drained by the outfall which is covered by impervious surfaces. For the purpose of this application, impervious surfaces are surfaces where storm water runs off at rates that are significantly higher than background rates (e.g., predevelopment levels) and include paved areas, building roofs, parking lots, and roadways. Include an estimate of the total area (including all impervious and pervious areas) drained by each outfall. The site map required under Item III can be used to estimate the total area drained by each outfall.

Item IV-B

Provide a narrative description of significant materials that are currently or in the past three years have been treated, stored, or disposed in a manner to allow exposure to storm water; method of treatment, storage or disposal of these materials; past and present materials management practices employed, in the last three years, to minimize contact by these materials with storm water runoff; materials loading and access areas; and the location, manner, and frequency in which pesticides, herbicides, soil conditioners, and fertilizers are applied. Significant materials should be identified by chemical name, form (e.g., powder, liquid, etc.), and type of container or treatment unit. Indicate any materials treated, stored, or disposed of together. "Significant materials" includes, but is not limited to: raw materials; fuels; materials such as solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances designated under Section 101(14) of CERCLA; any chemical the facility is required to report pursuant to Section 313 of Title III of SARA; fertilizers; pesticides; and waste products such as ashes, slag and sludge that have the potential to be released with storm water discharges.

Item IV-C

For each outfall, structural controls include structures which enclose material handling or storage areas, covering materials, berms, dikes, or diversion ditches around manufacturing, production, storage or treatment units, retention ponds, etc. Nonstructural controls include practices such as spill prevention plans, employee training, visual inspections, preventive maintenance, and housekeeping measures that are used to prevent or minimize the potential for releases of pollutants.

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Item V

Provide a certification that all outfalls that should contain storm water discharges associated with industrial activity have been tested or evaluated for the presence of non-storm water discharges which are not covered by an NPDES permit. Tests for such non-storm water discharges may include smoke tests, fluorometric dye tests, analysis of accurate schematics, as well as other appropriate tests. Part B must include a description of the method used, the date of any testing, and the onsite drainage points that were directly observed during a test. All non-storm water discharges must be identified in a Form 2C or Form 2E which must accompany this application (see beginning of instructions under section titled "Who Must File Form 2F" for a description of when Form 2C and Form 2E must be submitted).

Item VI

Provide a description of existing information regarding the history of significant leaks or spills of toxic or hazardous pollutants at the facility in the last three years.

Item VII-A, B, and C

These items require you to collect and report data on the pollutants discharged for each of your outfalls. Each part of this item addresses a different set of pollutants and must be completed in accordance with the specific instructions for that part. The following general instructions apply to the entire item.

General Instructions

Part A requires you to report at least one analysis for each pollutant listed. Parts B and C require you to report analytical data in two ways. For some pollutants addressed in Parts B and C, if you know or have reason to know that the pollutant is present in your discharge, you may be required to list the pollutant and test (sample and analyze) and report the levels of the pollutants in your discharge. For all other pollutants addressed in Parts B and C, you must list the pollutant if you know or have reason to know that the pollutant is present in the discharge, and either report quantitative data for the pollutant or briefly describe the reasons the pollutant is expected to be discharged. (See specific instructions on the form and below for Parts A through C.) Base your determination that a pollutant is present in or absent from your discharge on your knowledge of your raw materials, material management practices, maintenance chemicals, history of spills and releases, intermediate and final products and byproducts, and any previous analyses known to you of your effluent or similar effluent.

A. **Sampling:** The collection of the samples for the reported analyses should be supervised by a person experienced in performing sampling of industrial wastewater or storm water discharges. You may contact EPA or your State permitting authority for detailed guidance on sampling techniques and for answers to specific questions. Any specific requirements contained in the applicable analytical methods should be followed for sample containers, sample preservation, holding times, the collection of duplicate samples, etc. The time when you sample should be representative, to the extent feasible, of your treatment system operating properly with no system upsets. Samples should be collected from the center of the flow channel, where turbulence is at a maximum, at a site specified in your present permit, or at any site adequate for the collection of a representative sample.

For pH, temperature, cyanide, total phenols, residual chlorine, oil and grease, and fecal coliform, grab samples taken during the first 30 minutes (or as soon thereafter as practicable) of the discharge must be used (you are not required to analyze a flow-weighted composite for these parameters). For all other pollutants both a grab sample collected during the first 30 minutes (or as soon thereafter as practicable) of the discharge and a flow-weighted composite sample must be analyzed. However, a minimum of one grab sample may be taken for effluents from holding ponds or other impoundments with a retention period of greater than 24 hours.

All samples shall be collected from the discharge resulting from a storm event that is greater than 0.1 inches and at least 72 hours from the previously measurable (greater than 0.1 inch rainfall) storm event. Where feasible, the variance in the duration of the event and the total rainfall of the event should not exceed 50 percent from the average or median rainfall event in that area.

A grab sample shall be taken during the first thirty minutes of the discharge (or as soon thereafter as practicable), and a flow-weighted composite shall be taken for the entire event or for the first three hours of the event.

Grab and composite samples are defined as follows:

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Grab sample: An individual sample of at least 100 milliliters collected during the first thirty minutes (or as soon thereafter as practicable) of the discharge. This sample is to be analyzed separately from the composite sample.

Flow-Weighted Composite sample: A flow-weighted composite sample may be taken with a continuous sampler that proportions the amount of sample collected with the flow rate or as a combination of a minimum of three sample aliquots taken in each hour of discharge for the entire event or for the first three hours of the event, with each aliquot being at least 100 milliliters and collected with a minimum period of fifteen minutes between aliquot collections. The composite must be flow proportional, either the time interval between each aliquot or the volume of each aliquot must be proportional to either the stream flow at the time of sampling or the total stream flow since the collection of the previous aliquot. Aliquots may be collected manually or automatically. Where GC/MS Volatile Organic Analysis (VOA) is required, aliquots must be combined in the laboratory immediately before analysis. Only one analysis for the composite sample is required.

Data from samples taken in the past may be used, provided that:

All data requirements are met;

Sampling was done no more than three years before submission; and

All data are representative of the present discharge.

Among the factors which would cause the data to be unrepresentative are significant changes in production level, changes in raw materials, processes, or final products, and changes in storm water treatment. When the Agency promulgates new analytical methods in 40 CFR Part 136, EPA will provide information as to when you should use the new methods to generate data on your discharges. Of course, the Director may request additional information, including current quantitative data, if they determine it to be necessary to assess your discharges. The Director may allow or establish appropriate site-specific sampling procedures or requirements, including sampling locations, the season in which the sampling takes place, the minimum duration between the previous measurable storm event and the storm event sampled, the minimum or maximum level of precipitation required for an appropriate storm event, the form of precipitation sampled (snow melt or rainfall), protocols for collecting samples under 40 CFR Part 136, and additional time for submitting data on a case-by-case basis.

B. **Reporting:** All levels must be reported as concentration and as total mass. You may report some or all of the required data by attaching separate sheets of paper instead of filling out pages VII-1 and VII-2 if the separate sheets contain all the required information in a format which is consistent with pages VII-1 and VII-2 in spacing and in identification of pollutants and columns. Use the following abbreviations in the columns headed "Units."

Concentration		Mass	
ppm	parts per million	lbs	pounds
mg/1	milligrams per liter	ton	tons (English tons)
ppb	parts per billion	mg	milligrams
ug/1	micrograms per liter	g	grams
kg	kilograms	T	tonnes (metric tons)

All reporting of values for metals must be in terms of "total recoverable metal," unless:

(1) An applicable, promulgated effluent limitation or standard specifies the limitation for the metal in dissolved, valent, or total form; or

(2) All approved analytical methods for the metal inherently measure only its dissolved form (e.g., hexavalent chromium); or

(3) The permitting authority has determined that in establishing case-by-case limitations it is necessary to express the limitations on the metal in dissolved, valent, or total form to carry out the provisions of the CWA. If you measure only one grab sample and one flow-weighted composite sample for a given outfall, complete only the "Maximum Values" columns and insert "1" into the "Number of Storm Events Sampled" column. The permitting authority may require you to conduct additional analyses to further characterize your discharges.

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If you measure more than one value for a grab sample or a flow-weighted composite sample for a given outfall and those values are representative of your discharge, you must report them. You must describe your method of testing and data analysis. You also must determine the average of all values within the last year and report the concentration mass under the "Average Values" columns, and the total number of storm events sampled under the "Number of Storm Events Sampled" columns.

C. Analysis: You must use test methods promulgated in 40 CFR Part 136; however, if none has been promulgated for a particular pollutant, you may use any suitable method for measuring the level of the pollutant in your discharge provided that you submit a description of the method or a reference to a published method. Your description should include the sample holding time, preservation techniques, and the quality control measures which you used. If you have two or more substantially identical outfalls, you may request permission from your permitting authority to sample and analyze only one outfall and submit the results of the analysis for other substantially identical outfalls. If your request is granted by the permitting authority, on a separate sheet attached to the application form, identify which outfall you did test, and describe why the outfalls which you did not test are substantially identical to the outfall which you did test.

Part VII-A

Part VII-A must be completed by all applicants for all outfalls who must complete Form 2F.

Analyze a grab sample collected during the first thirty minutes (or as soon thereafter as practicable) of the discharge and flow-weighted composite samples for all pollutants in this Part, and report the results except use only grab samples for pH and oil and grease. See discussion in General Instructions to Item VII for definitions of grab sample collected during the first thirty minutes of discharge and flow-weighted composite sample. The "Average Values" column is not compulsory but should be filled out if data are available.

Part VII-B

List all pollutants that are limited in an effluent guideline which the facility is subject to (see 40 CFR Subchapter N to determine which pollutants are limited in effluent guidelines) or any pollutant listed in the facility's NPDES permit for its process wastewater (if the facility is operating under an existing NPDES permit). Complete one table for each outfall. See discussion in General Instructions to Item VII for definitions of grab sample collected during the first thirty minutes (or as soon thereafter as practicable) of discharge and flow-weighted composite sample. The "Average Values" column is not compulsory but should be filled out if data are available.

Analyze a grab sample collected during the first thirty minutes of the discharge and flow-weighted composite samples for all pollutants in this Part, and report the results, except as provided in the General Instructions.

Part VII-C

Part VII-C must be completed by all applicants for all outfalls which discharge storm water associated with industrial activity, or that EPA is evaluating for designation as a significant contributor of pollutants to waters of the United States, or as contributing to a violation of a water quality standard. Use both a grab sample and a composite sample for all pollutants you analyze for in this part except use grab samples for residual chlorine and fecal coliform. The "Average Values" column is not compulsory but should be filled out if data are available. Part C requires you to address the pollutants in Table 2F-2, 2F-3, and 2F-4 for each outfall. Pollutants in each of these Tables are addressed differently.

Table 2F-2: For each outfall, list all pollutants in Table 2F-2 that you know or have reason to believe are discharged (except pollutants previously listed in Part VII-B). If a pollutant is limited in an effluent guideline limitation which the facility is subject to (e.g., use of TSS as an indicator to control the discharge of iron and aluminum), the pollutant should be listed in Part VII-B. If a pollutant in table 2F-2 is indirectly limited by an effluent guideline limitation through an indicator, you must analyze for it and report data in Part VII-C. For other pollutants listed in Table 2F-2 (those not limited directly or indirectly by an effluent limitation guideline), that you know or have reason to believe are discharges, you must either report quantitative data or briefly describe the reasons the pollutant is expected to be discharged.

Table 2F-3: For each outfall, list all pollutants in Table 2F-3 that you know or have reason to believe are discharged. For every pollutant in Table 2F-3 expected to be discharged in concentrations of 10 ppb or greater, you must submit quantitative data. For acrolein, acrylonitrile, 2,4 dinitrophenol, and 2-methyl-4,6 dinitrophenol, you must submit quantitative data if any of these four pollutants is expected to be discharged

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in concentrations of 100 ppb or greater. For every pollutant expected to be discharged in concentrations less than 10 ppb (or 100 ppb for the four pollutants listed above), then you must either submit quantitative data or briefly describe the reasons the pollutant is expected to be discharged.

Small Business Exemption - If you are a "small business," you are exempt from the reporting requirements for the organic toxic pollutants listed in Table 2F-3. There are two ways in which you can qualify as a "small business". If your facility is a coal mine, and if your probable total annual production is less than 100,000 tons per year, you may submit past production data or estimated future production (such as a schedule of estimated total production under 30 CFR 795.14(c)) instead of conducting analyses for the organic toxic pollutants. If your facility is not a coal mine, and if your gross total annual sales for the most recent three years average less than $100,000 per year (in second quarter 1980 dollars), you may submit sales data for those years instead of conducting analyses for the organic toxic pollutants. The production or sales data must be for the facility which is the source of the discharge. The data should not be limited to production or sales for the process or processes which contribute to the discharge, unless those are the only processes at your facility. For sales data, in situations involving intracorporate transfer of goods and services, the transfer price per unit should approximate market prices for those goods and services as closely as possible. Sales figures for years after 1980 should be indexed to the second quarter of 1980 by using the gross national product price deflator (second quarter of 1980 = 100). This index is available in National Income and Product Accounts of the United States (Department of Commerce, Bureau of Economic Analysis).

Table 2F-4: For each outfall, list any pollutant in Table 2F-4 that you know or believe to be present in the discharge and explain why you believe it to be present. No analysis is required, but if you have analytical data, you must report them. **Note:** Under 40 CFR 117.12(a)(2), certain discharges of hazardous substances (listed at 40 CFR 177.21 or 40 CFR 302.4) may be exempted from the requirements of section 311 of CWA, which establishes reporting requirements, civil penalties, and liability for cleanup costs for spills of oil and hazardous substances. A discharge of a particular substance may be exempted if the origin, source, and amount of the discharged substances are identified in the NPDES permit application or in the permit, if the permit contains a requirement for treatment of the discharge, and if the treatment is in place. To apply for an exclusion of the discharge of any hazardous substance from the requirements of section 311, attach additional sheets of paper to your form, setting forth the following information:

1. The substance and the amount of each substance which may be discharged.
2. The origin and source of the discharge of the substance.
3. The treatment which is to be provided for the discharge by:
   a. An onsite treatment system separate from any treatment system treating your normal discharge;
   b. A treatment system designed to treat your normal discharge and which is additionally capable of treating the amount of the substance identified under paragraph 1 above; or
   c. Any combination of the above.

See 40 CFR 117.12(a)(2) and (c), published on August 29, 1979, in 44 FR 50766, or contact your Regional Office (Table 1 on Form 1, Instructions), for further information on exclusions from section 311.

Part VII-D

If sampling is conducted during more than one storm event, you only need to report the information requested in Part VII-D for the storm event(s) which resulted in any maximum pollutant concentration reported in Part VII-A, VII-B, or VII-C.

Provide flow measurements or estimates of the flow rate, and the total amount of discharge for the storm event(s) sampled, the method of flow measurement, or estimation. Provide the date and duration of the storm event(s) sampled, rainfall measurements, or estimates of the storm event which generated the sampled runoff and the duration between the storm event sampled and the end of the previous measurable (greater than 0.1 inch rainfall) storm event.

Part VII-E

List any toxic pollutant listed in Tables 2F-2, 2F-3, or 2F-4 which you currently use or manufacture as an intermediate or final product or byproduct. In addition, if you know or have reason to believe that 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) is discharged or if you use or manufacture 2,4,5-trichlorophenoxy acetic

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acid (2,4,5,-T); 2-(2,4,5-trichlorophenoxy) propanoic acid (Silvex, 2,4,5,-TP); 2-(2,4,5-trichlorophenoxy) ethyl, 2,2-dichloropropionate (Erbon); O,O-dimethyl O-(2,4,5-trichlorphenyl) phosphorothioate (Ronnel); 2,4,5-trichlorophenol (TCP); or hexachlorophene (HCP); then list TCDD. The Director may waive or modify the requirement if you demonstrate that it would be unduly burdensome to identify each toxic pollutant and the Director has adequate information to issue your permit. You may not claim this information as confidential; however, you do not have to distinguish between use or production of the pollutants or list the amounts.

Item VIII

Self explanatory. The permitting authority may ask you to provide additional details after your application is received.

Item X

The Clean Water Act provides for severe penalties for submitting false information on this application form.

Section 309(c)(4) of the Clean Water Act provides that "Any person who knowingly makes any false material statement, representation, or certification in any application, . . . shall upon conviction, be punished by a fine of not more than $10,000 or by imprisonment for not more than 2 years, or by both. If a conviction of such person is for a violation committed after a first conviction of such person under this paragraph, punishment shall be by a fine of not more than $20,000 per day of violation, or by imprisonment of not more than 4 years, or by both." 40 CFR Part 122.22 requires the certification to be signed as follows:

(A) For a corporation: by a responsible corporate official. For purposes of this section, a responsible corporate official means (i) a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy- or decision-making functions for the corporation, or (ii) the manager of one or more manufacturing, production, or operating facilities employing more than 250 persons or having gross annual sales or expenditures exceeding $25,000,000 (in second-quarter 1980 dollars), if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.

Note: EPA does not require specific assignments or delegation of authority to responsible corporate officers identified in 122.22(a)(1)(i). The Agency will presume that these responsible corporate officers have the requisite authority to sign permit applications unless the corporation has notified the Director to the contrary. Corporate procedures governing authority to sign permit applications may provide for assignment or delegation to applicable corporate position under 122.22(a)(1)(ii) rather than to specific individuals.

(B) For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or

(C) For a municipality, State, Federal, or other public agency: by either a principal executive officer or ranking elected official. For purposes of this section, a principal executive officer of a Federal agency includes (i) the chief executive officer of the agency, or (ii) a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., Regional Administrators of EPA).

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Table 2F-1
Codes for Treatment Units

	Physical Treatment Processes		
1-A	Ammonia Stripping	1-M	Grit Removal
1-B	Dialysis	1-N	Microstraining
1-C	Diatomaceous Earth Filtration	1-O	Mixing
1-D	Distillation	1-P	Moving Bed Filters
1-E	Electrodialysis	1-Q	Multimedia Filtration
1-F	Evaporation	1-R	Rapid Sand Filtration
1-G	Flocculation	1-S	Reverse Osmosis (Hyperfiltration)
1-H	Flotation	1-T	Screening
1-I	Foam Fractionation	1-U	Sedimentation (Settling)
1-J	Freezing	1-V	Slow Sand Filtration
1-K	Gas-Phase Separation	1-W	Solvent Extraction
1-L	Grinding (Comminutors)	1-X	Sorption
	Chemical Treatment Processes		
2-A	Carbon Adsorption	2-G	Disinfection (Ozone)
2-B	Chemical Oxidation	2-H	Disinfection (Other)
2-C	Chemical Precipitation	2-I	Electrochemical Treatment
2-D	Coagulation	2-J	Ion Exchange
2-E	Dechlorination	2-K	Neutralization
2-F	Disinfection (Chlorine)	2-L	Reduction
	Biological Treatment Processes		
3-A	Activated Sludge	3-E	Pre-Aeration
3-B	Aerated Lagoons	3-F	Spray Irrigation/Land Application
3-C	Anaerobic Treatment	3-G	Stabilization Ponds
3-D	Nitrification-Denitrification	3-H	Trickling Filtration
	Other Processes		
4-A	Discharge to Surface Water	4-C	Reuse/Recycle of Treated Effluent
4-B	Ocean Discharge Through Outfall	4-D	Underground Injection
	Sludge Treatment and Disposal Processes		
5-A	Aerobic Digestion	5-M	Heat Drying
5-B	Anaerobic Digestion	5-N	Heat Treatment
5-C	Belt Filtration	5-O	Incineration
5-D	Centrifugation	5-P	Land Application
5-E	Chemical Conditioning	5-Q	Landfill
5-F	Chlorine Treatment	5-R	Pressure Filtration
5-G	Composting	5-S	Pyrolysis
5-H	Drying Beds	5-T	Sludge Lagoons
5-I	Elutriation	5-U	Vacuum Filtration
5-J	Flotation Thickening	5-V	Vibration
5-K	Freezing	5-W	Wet Oxidation
5-L	Gravity Thickening		

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Table 2F-2

Conventional and Nonconventional Pollutants Required To Be Tested by Existing Discharger If Expected To Be Present

Bromide
Chlorine, Total Residual
Color
Fecal Coliform
Fluoride
Nitrate-Nitrite
Nitrogen, Total Kjeldahl
Oil and Grease
Phosphorus, Total Radioactivity
Sulfate
Sulfide
Sulfite
Surfactants
Aluminum, Total
Barium, Total
Boron, Total
Cobalt, Total
Iron, Total
Magnesium, Total
Molybdenum, Total
Magnesium, Total
Tin, Total
Titanium, Total

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Table 2F-3

Toxic pollutants required to be identified by applicant if expected to be present

Toxic Pollutants and Total Phenol

Antimony, Total	Copper, Total	Silver, Total
Arsenic, Total	Lead, Total	Thallium, Total
Beryllium, Total	Mercury, Total	Zinc, Total
Cadmium, Total	Nickel, Total	Cyanide, Total
Chromium, Total	Selenium, Total	Phenols, Total

GC/MS Fraction Volatiles Compounds

Acrolein	Dichlorobromomethane	1,1,2,2,-Tetrachloroethane
Acrylonitrile	1,1-Dichloroethane	Tetrachloroethylene
Benzene	1,2-Dichloroethane	Toluene
Bromoform	1,1-Dichloroethylene	1,2-Trans-Dichloroethylene
Carbon Tetrachloride	1,2-Dichloropropane	1,1,1-Trichloroethane
Chlorobenzene	1,3-Dichloropropylene	1,1,2-Trichloroethane
Chlorodibromomethane	Ethylbenzene	Trichloroethylene
Chloroethane	Methyl Bromide	Vinyl Chloride
2-Chloroethylvinyl Ether	Methyl Chloride	
Chloroform	Methylene Chloride	

Acid Compounds

2-Chlorophenol	2,4-Dinitrophenol	Pentachlorophenol
2,4-Dichlorophenol	2-Nitrophenol	Phenol
2,4-Dimethylphenol	4-Nitrophenol	2,4,6-Trichlorophenol
4,6-Dinitro-O-Cresol	p-Chloro-M-Cresol	

Base/Neutral

Acenaphthene	2-Chloronaphthalene	Fluoranthene
Acenaphthylene	4-Chlorophenyl Phenyl Ether	Fluorene
Anthracene	Chrysene	Hexachlorobenzene
Benzidine	Dibenzo(a,h)anthracene	Hexachlorobutadiene
Benzo(a)anthracene	1,2-Dichlorobenzene	Hexachloroethane
Benzo(a)pyrene	1,3-Dichlorobenzene	Indeno(1,2,3-cd)pyrene
3,4-Benzofluoranthene	1,4-Dichlorobenzene	Isophorone
Benzo(ghi)perylene	3,3'-Dichlorobenzidine	Naphthalene
Benzo(k)fluoranthene	Diethyl Phthalate	Nitrobenzene
Bis(2-chloroethoxy)methane	Dimethyl Phthalate	N-Nitrosodimethylamine
Bis(2-chloroethyl)ether	Di-N-Butyl Phthalate	N-Nitrosodi-N-Propylamine
Bis(2-chloroisopropyl)ether	2,4-Dinitrotoluene	N-Nitrosodiphenylamine
Bis(2-ethylhexyl)phthalate	2,6-Dinitrotoluene	Phenanthrene
4-Bromophenyl Phenyl Ether	Di-N-Octylphthalate	Pyrene
Butylbenzyl Phthalate	1,2-Diphenylhydrazine (as Azobenzene)	1,2,4-Trichlorobenzene

Pesticides

Aldrin	Dieldrin	PCB-1254
Alpha-BHC	Alpha-Endosulfan	PCB-1221
Beta-BHC	Beta-Endosulfan	PCB-1232
Gamma-BHC	Endosulfan Sulfate	PCB-1248
Delta-BHC	Endrin	PCB-1260
Chlordane	Endrin Aldehyde	PCB-1016
4,4'-DDT	Heptachlor	Toxaphene
4,4'-DDE	Heptachlor Epoxide	
4,4'-DDD	PCB-1242	

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Table 2F-4

Hazardous substances required to be identified by applicant if expected to be present

Toxic Pollutant

Asbestos

Hazardous Substances

Acetaldehyde
Allyl alcohol
Allyl chloride
Amyl acetate
Aniline
Benzonitrile
Benzyl chloride
Butyl acetate
Butylamine
Carbaryl
Carbofuran
Carbon disulfide
Chlorpyrifos
Coumaphos

Cresol
Crotonaldehyde

Cyclohexane
2,4-D (2,4-Dichlorophenoxyacetic acid)
Diazinon
Dicamba
Dichlobenil
Dichlone
2,2-Dichloropropionic acid
Dichlorvos
Diethyl amine
Dimethyl amine
Dinitrobenzene
Diquat
Disulfoton
Diuron
Epichlorohydrin
Ethion
Ethylene diamine
Ethylene dibromide
Formaldehyde
Furfural
Guthion
Isoprene
Isopropanolamine
Kelthane

Kepone
Malathion

Mercaptodimethur
Methoxychlor

Methyl mercaptan
Methyl methacrylate
Methyl parathion
Mevinphos
Mexacarbate
Monoethyl amine
Monomethyl amine
Naled
Naphthenic acid
Nitrotoluene
Parathion
Phenolsulfonate
Phosgene
Propargite
Propylene oxide
Pyrethrins
Quinoline
Resorcinol
Strontium
Strychnine
Styrene
2,4,5-T (2,4,5-Trichlorophenoxyacetic acid)
TDE (Tetrachlorodiphenyl ethane)
2,4,5-TP [2-(2,4,5-Trichlorophenoxy) propanoic acid]
Trichlorofon
Triethylamine

Trimethylamine
Uranium
Vanadium
Vinyl acetate
Xylene
Xylenol
Zirconium

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Federal Register

Friday
August 16, 1991

Part II

Environmental Protection Agency

40 CFR Part 122
NPDES General Permits and Reporting Requirements for Storm Water Discharges Associated With Industrial Activity; Proposed Rule

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ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 122

[FRL 3758-1]

RIN 2040-AA79

National Pollutant Discharge Elimination System General Permits and Reporting Requirements for Storm Water Discharges Associated With Industrial Activity

AGENCY: Environmental Protection Agency (EPA).

ACTION: Proposed rule and Notice of draft general NPDES permits for Storm Water Discharges Associated with Industrial Activity.

SUMMARY: Section 405 of the Water Quality Act of 1987 (WQA) added section 402(p) of the Clean Water Act (CWA) which requires the Environmental Protection Agency (EPA) to develop a phased approach to regulating storm water discharges under the National Pollutant Discharge Elimination System (NPDES) program. EPA published a final regulation on November 16, 1990, (55 FR 47990) establishing permit application requirements for storm water discharges associated with industrial activity and for discharges from municipal separate storm sewer systems serving a population of 100,000 or more. In the permit application regulations, EPA defined the term "storm water discharge associated with industrial activity" in a comprehensive manner to cover a wide variety of facilities. This definition greatly expanded the number of industrial facilities subject to the NPDES program.

This notice requests comments on a National NPDES permitting strategy to address the large number of storm water discharges associated with industrial activity. To assist in implementing the strategy, this notice requests comments on proposed regulatory changes to existing minimum requirements for NPDES permits with regard to annual monitoring reports and minimum requirements for filing notices of intent to be authorized to discharge under NPDES general permits.

This notice also requests comments on separate general permits for the majority of storm water discharges associated with industrial activity in 12 States (MA, ME, NH, FL, LA, TX, OK, NM, SD, AZ, AK, ID), and 8 Territories (District of Columbia, the Commonwealth of Puerto Rico, Guam, American Samoa, the Commonwealth of the Northern Mariana Islands, and the Trust Territory of the Pacific Islands) without authorized NPDES State programs: on Indian lands in AL, CA, GA, KY, MI, MN, MS, MT, NC, ND, NY, NV, SC, TN, UT, WI, and WY; located within Federal facilities and Indian lands in CO and WA; and located within Federal facilities in Delaware. Separate general permits are being noticed for each State.

DATES: Comments on this proposed rule and permits must be received on or before October 15, 1991. See Supplementary Information for information on hearings.

ADDRESSES: The public should also send an original and two copies of their comments addressing any aspect of this notice to Kevin Weiss, Permits Division (EN-336), Environmental Protection Agency, 401 M Street SW., Washington, DC 20460. Comments addressing factors or issues which are specific to one or several general permits (e.g., specific requirements for the general permit authorizing storm water discharges associated with industrial activity in MA), should clearly indicate the applicability of the comment to a particular State. The public record is located at EPA Headquarters, EPA Public Information Reference Unit, room 2402, 401 M Street SW., Washington, DC 20460. A reasonable fee may be charged for copying.

FOR FURTHER INFORMATION CONTACT: For further information on the proposed rule and draft general permits contact the NPDES Storm Water Hotline at (703) 821-4823 or: Kevin Weiss, Office of Wastewater Enforcement and Compliance (EN-336), United States Environmental Protection Agency, 401 M Street SW., Washington, DC 20460, (202)-475-9516. The Fact Sheet accompanying this rule provides additional contacts for information regarding the issuance of general permits in specific States.

SUPPLEMENTARY INFORMATION:

Hearings

Public hearings to discuss general permits for the State in which the hearing is held are scheduled as follows:

(1) September 23, 1991, question and answer session from 3 p.m. to 5 p.m. and hearing from 7 p.m. to 10 p.m., Reunion Ballroom, Hyatt Regency Hotel, 300 Reunion Blvd., Dallas, TX 75207.

(2) September 20, 1991, question and answer session from 3 p.m. to 5 p.m. and hearing from 7 p.m. to 10 p.m., Lincoln Plaza Hotel, Gold Crown Room, 4445 North Lincoln Boulevard, Oklahoma City, OK 73105.

(3) September 24, 1991, question and answer session from 3 p.m. to 5 p.m. and hearing from 7 p.m. to 10 p.m., Rameda Hotel, 1480 Nicholson Drive, Baton Rouge, LA.

(4) September 25, 1991, question and answer session from 3 p.m. to 5 p.m. and hearing from 7 p.m. to 10 p.m., Hyatt Regency, Grand Pavilion Ballroom, 330 Tijeras NW., Albuquerque, NM 87102.

(5) September 26, 1991, 1 p.m. to 4 p.m., Parkplace Building, 1200 Sixth Avenue, 12A (12th Floor), Seattle, WA 98101.

(6) September 16, 1991, 1 p.m. to 4 p.m., Holiday Inn Convention Center, 3300 Vista Avenue, Boise, ID 83705.

(7) September 18, 1991, 1 p.m. to 4 p.m., Centennial Hall (Sheffield Ballroom #2), 101 Egan Drive, Juneau, AK 99801.

(8) September 30, 1991, 1 p.m. to 6 p.m., Best Western, Kings Inn, 220 South Pierre Street, Pierre, SD 54501. (Note: This hearing will address the general permit for SD as well as the general permit for Indian lands in MT, ND, UT and WY, and the general permit for Indian lands and Federal facilities in CO).

(9) September 18, 1991, two hearings will be held at the following times 10 a.m. to 12 noon, 1:30 p.m. to 5 p.m., a third hearing will start at 7 p.m. and continue as necessary, Phoenix Civic Plaza, Flagstaff Room, 225 East Adams Street, Phoenix, AZ 85004.

(10) September 10, 1991, public meeting from 1 p.m. to 4 p.m., public hearing from 7 p.m. to 10 p.m., Civic Convention Center, 9800 International Drive, Orlando, FL 32819.

(11) September 12, 1991, public meeting from 1 p.m. to 4 p.m., public hearing from 7 p.m. to 10 p.m., Tallahassee Leon County Civic Center, 505 West Pensacola, Tallahassee, FL.

(12) September 25, 1991, 1 p.m. to 4 p.m., University of Maine at Augusta, Jewitt Hall Auditorium, University Heights, Augusta, ME 04330.

(13) September 24, 1991, 1 p.m. to 4 p.m., Federal Reserve Bank, Ground Floor Auditorium, 600 Atlantic Avenue, Boston, MA 02106.

(14) September 26, 1991, 7 p.m. to 10 p.m., Holiday Inn, Ballroom Area, 700 Elm Street, Manchester, NH 03101.

Persons wishing to make an oral presentation must restrict them to 15 minutes and are encouraged to have written copies of their complete comments for inclusion in the official record.

I. Background
A. NRDC v. Costle
B. Water Quality Act of 1987
II. Framework of NPDES System
A. State Programs
B. Requirements in NPDES Permits

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III. Prior Storm Water Permitting Efforts
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V. Burdens on Permitting Agencies
VI. Today's Notice
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B. Proposed Changes to Annual Monitoring Reporting Requirements
C. Application Requirements for General Permits
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VII. Economic Impact
VIII. Executive Order 12291
IX. Paperwork Reduction Act
X. Regulatory Flexibility Act

I. Background

The 1972 amendments to the Federal Water Pollution Control Act (FWPCA, also referred to as the Clean Water Act or CWA), prohibited the discharge of any pollutant to navigable waters from a point source unless the discharge is authorized by a NPDES permit. Efforts to improve water quality under the NPDES program have focused traditionally on reducing pollutants in discharges of industrial process waste water and from municipal sewage treatment plants. This program emphasis has developed for a number of reasons. At the onset of the program in 1972, many sources of industrial process waste water and municipal sewage were not controlled adequately, and represented pressing environmental problems. In addition, sewage outfalls and industrial process discharges were easily identified as responsible for poor, often drastically degraded water quality conditions. However, as pollution control measures were developed initially for these discharges, it became evident that more diffuse sources (occurring over a wide area) of water pollution, such as agricultural and urban runoff, were also major causes of water quality problems. Some diffuse sources of water pollution, such as agricultural storm water discharges and irrigation return flows, are exempted statutorily from the NPDES program. Controls for other diffuse sources have been slow to develop under the NPDES program.

Several National assessments have been conducted to evaluate impacts on receiving water quality. For the purpose of these assessments, urban runoff was considered to be a diffuse source or nonpoint source pollution, although legally, most urban runoff is discharged through conveyances such as separate storm sewers or other conveyances which are point sources under the CWA and subject to the NPDES program. The "National Water Quality Inventory, 1988 Report to Congress" provides a general assessment of water quality based on biennial reports submitted by the States under section 305(b) of the CWA. In preparing section 305(b) reports, the States were asked to indicate the fraction of the States' waters that were assessed, as well as the fraction of the States' waters that were fully supporting, partly supporting, or not supporting designated uses. The report indicates that of the rivers, lakes, and estuaries that were assessed by States (approximately one-fifth of stream miles, one-third of lake acres and one-half of esturine waters), roughly 70 percent to 75 percent are supporting the uses for which they are designated. For waters with use impairments, States were asked to determine impacts due to diffuse sources (agricultural and urban runoff and other categories of diffuse sources), municipal sewage, industrial (process) wastewaters, combined sewer overflows, and natural sources, then combine impacts to arrive at estimates of the relative percentage of State waters affected by each source. In this manner, the relative importance of the various sources of pollution causing use impairments was assessed and weighted national averages were calculated. Based on 37 States that provided information on sources of pollution, industrial process wastewaters were cited as the cause of use impairment for 7 percent of rivers and streams, 10 percent of lakes, 6 percent of estuaries, 41 percent of the Great Lakes shoreline and 6 percent of coastal waters. Municipal sewage was the cause of use impairment for 13 percent of rivers and streams, 5 percent of lakes, 68 percent of estuaries, 41 percent of the Great Lakes shoreline and 11 percent of coastal waters.

The Assessment also concluded that pollution from diffuse sources such as runoff from agricultural, urban areas, construction sites, land disposal activities, and resource extraction activities is cited by the States as the leading cause of water quality impairment.[1] Diffuse sources appear to be increasingly important contributors of use impairment as discharges of industrial process wastewaters and municipal sewage plants come under control and intensified data collection efforts provide additional information. Some examples where use impairments are cited as being caused by diffuse sources include: rivers and streams, where 9 percent are caused by separate storm sewers, 4 percent are caused by construction and 11 percent are caused by resource extraction; lakes where 8 percent are caused by separate storm sewers and 7 percent are caused by land disposal; the Great Lakes shoreline, where 35 percent are caused by separate storm sewers, 46 percent are caused by resource extraction, and 19 percent are caused by land disposal; for estuaries where, 41 percent are caused by separate storm sewers; and for coastal areas, where 20 percent are caused by separate storm sewers and 29 percent are caused by land disposal.

The States conducted a more comprehensive study of diffuse pollution sources under the sponsorship of the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA) and EPA. The study resulted in the report "America's Clean Water—The States' Nonpoint Source Assessment, 1985" which indicated that 38 States reported urban runoff as a major cause of beneficial use impairment. In addition, 21 States reported construction site runoff as a major cause of use impairment.

Studies conducted by the National Oceanic and Atmospheric Administration (NOAA)[2] indicate that urban runoff is a major pollutant source which adversely affects shellfish growing waters. The NOAA studies identified urban runoff as affecting over 578,000 acres of shellfish growing waters on the East Coast (39 percent of harvest-limited area); 2,000,000 acres of shellfish growing waters in the Gulf of Mexico (98% of the harvest-limited area); and 130,000 acres of shellfish growing waters on the West Coast (52% of harvest-limited areas).

A. *NRDC* v. *COSTLE*[3]

The appropriate means of regulating storm water point sources within the National Pollutant Discharge Elimination System (NPDES) program has been a matter of serious concern since implementing the NPDES program in 1972. In 1973, EPA promulgated its first storm water regulations exempting from permit requirements those point source conveyances carrying storm water runoff uncontaminated by industrial or commercial activity unless the particular storm water discharger had been identified by the NPDES Director as a significant contributor of pollution (38 FR 13530 (May 22, 1973)). The Agency maintained that, while these sources fell within the definition of

[1] Major classes of diffuse sources that include, in part, storm water point source discharges are: urban runoff conveyances, construction sites, agriculture (feedlots), resource extraction sites, and land disposal facilities.

[2] See "The Quality of Shellfish Growing Waters on the East Coast of the United States", NOAA, 1989, "The Quality of Shellfish Growing Waters in the Gulf of Mexico", NOAA, 1988 and "The Quality of Shellfish Growing Waters on the West Coast of the United States", NOAA, 1990.

[3] 503 F.2d 1369 (D.C. Cir. 1977).

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a point source, they were nonetheless ill-suited to the traditional, end-of-pipe controls that are the basis of the NPDES program for process discharges and discharges from Publicly Owned Treatment Works [4] (POTWs). The Agency also justified its decision by noting that issuing individual NPDES permits for the hundreds of thousands of storm water point sources in the United States would create an overwhelming administrative burden and would divert resources away from control of industrial process waste water and municipal sewage, which at the time, were more pressing and identifiable environmental problems.

In a series of challenges to the storm water regulations, the Natural Resources Defense Council (NRDC) brought suit in the U.S. District Court for the District of Columbia, challenging the Agency's authority to exempt selectively categories of point sources from permit requirements. *NRDC* v. *Train*, 396 F. Supp. 1393 (D.D.C. 1975), *aff'd. NRDC* v. *Costle*, 568 F.2d 1369 (D.C. Cir. 1977). The District Court held that EPA could not exempt discharges identified as point sources from regulation under the NPDES permit program. The District Court was convinced that the permit program would be manageable even without the exemptions sought by EPA. The court recognized two alternatives for reducing the permit workload:

(1) Discretion to define what constitutes a point source; and

(2) Discretion to use certain administrative devices, such as general permits, to help manage the workload.

With respect to the appropriate administrative mechanisms, the Court recognized that EPA has wide latitude to rank categories and subcategories of point sources of different importance and treat them differently within a permit program. On review, the Court of Appeals stated that technological or administrative infeasibility was a reason for adjusting Court mandates to realize the general objectives of the Act and may result in adjustments in the permit program (568 F.2d 1369, 1379 (1977)). The Court of Appeals recognized that section 402 of the CWA gives EPA considerable flexibility in framing the permit to achieve a desired reduction in pollutant discharges. One area of flexibility is that permits may regulate industry practices to lessen point source pollution problems. The Court of Appeals noted that in certain cases, it may be appropriate for EPA to require a permittee simply to monitor and report effluent levels.

The Court of Appeals encouraged EPA to use its interpretation authority to mitigate burdens in establishing a practical regulatory scheme. Section 402 provides the Agency with flexibility in determining the appropriate scope and form of an NPDES permit. As a result, the Court suggested using area or general permits.

B. Water Quality Act of 1987

The Water Quality Act (WQA) of 1987 added section 402(p) to the CWA to provide a comprehensive framework for EPA to address storm water discharges. Section 402(p)(1) provides that EPA or NPDES States cannot require a permit for certain storm water discharges until October 1, 1992, except for storm water discharges listed under section 402(p)(2). Section 402(p)(2) lists five types of storm water discharges which are required to obtain a permit before October 1, 1992:

(A) A discharge with respect to which a permit has been issued prior to February 4, 1987;

(B) A discharge associated with industrial activity;

(C) A discharge from a municipal separate storm sewer system serving a population of 250,000 or more;

(D) A discharge from a municipal separate storm sewer system serving a population of 100,000 or more, but less than 250,000; or

(E) A discharge for which the Administrator or the State, as the case may be, determines that the storm water discharge contributes to a violation of a water quality standard or is a significant contributor of pollutants to the waters of the United States.

Section 402(p)(4) establishes deadlines to implement the permit program for: Storm water discharges associated with industrial activity; discharges from large municipal separate storm sewer systems (systems serving a population of 250,000 or more); and discharges from medium municipal separate storm sewer systems (systems serving a population of 100,000 or more but less than 250,000). This section of the Act specifies deadlines for EPA to promulgate permit application requirements, applicants to submit permit applications, EPA and authorized NPDES States to issue NPDES permits, and for permit compliance for the identified storm water discharges.

NPDES permits for all other storm water discharges cannot be required until October 1, 1992, unless a permit for the discharge was issued prior to the date of enactment of the WQA (i.e., February 4, 1987), or the discharge is determined to be a significant contributor of pollutants to waters of the United States or is contributing to a violation of water quality standards.

The WQA clarified and amended the requirements for permits for storm water discharges in the new CWA section 402(p)(3). The Act clarified that permits for discharges associated with industrial activity must meet all of the applicable provisions of section 402 and section 301 including BAT/BCT technology-based requirements and that permits for discharges from municipal separate storm sewer must meet a new statutory standard requiring controls to reduce the discharge of pollutants to the maximum extent practicable (MEP). As with all point source discharges under the CWA, storm water discharges are subject to applicable water quality-based standards.

EPA, in consultation with the States, is required to conduct two studies on storm water discharges that are in the class of discharges for which EPA and NPDES States cannot require permits prior to October 1, 1992. The first study will identify those storm water discharges or classes of storm water discharges for which permits are not required prior to October 1, 1992 and determine, to the maximum extent practicable, the nature and extent of pollutants in such discharges. The second study is for the purpose of establishing procedures and methods to control storm water discharges to the extent necessary to mitigate impacts on water quality. Based on the two studies, EPA in consultation with State and local officials, is required to issue regulations by no later than October 1, 1992, which designate additional storm water discharges to be regulated to protect water quality and establish a comprehensive program to regulate such designated sources. This program must establish, at a minimum, (A) priorities, (B) requirements for State storm water management programs, and (C) expeditious deadlines. The program may include performance standards, guidelines, guidance, and management practices and treatment requirements, as appropriate.

II. Framework of NPDES System

Congress established the NPDES program with the 1972 Amendments to the FWPCA. Section 402 of the Act requires EPA to administer a national permit program to regulate point source discharges of pollutants to waters of the United States and sets out the basic elements of the program.

[4] Note that since 1973 the scope of NPDES permitting efforts, particularly for POTWs, has expanded significantly to address program-oriented pollution control approaches. Examples of program-oriented requirements in permits for POTWs are initiatives for pretreatment, sludge, and combined sewer overflows.

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A. State Programs

The Act allows States to request EPA authorization to administer the NPDES program instead of EPA. Under section 402(b), EPA must approve a State's request to operate the permit program once it determines that the State has adequate legal authorities, procedures, and the ability to administer the program.

EPA is also directed by section 304(i) of the FWPCA to adopt procedural and programmatic requirements for State NPDES programs, including guidelines on monitoring, reporting, enforcement, personnel and funding, and to develop uniform national forms for use by both EPA and approved States. At all times following authorization, State NPDES programs must be consistent with minimum Federal requirements, although they may always be more stringent.

Upon authorization of a State program, the State is primarily responsible for issuing permits and administrating the NPDES program in that State. At the same time, EPA suspends the issuance of Federal permits for those activities subject to the approved State program.

State NPDES authority is divided into four parts: the core program (POTW and industrial permitting), Federal facilities, pretreatment, and general permitting. At this point in time, 39 States or Territories are authorized to, at a minimum, issue NPDES permits for municipal and industrial sources. Of these 39 States, 23 are currently authorized by EPA to issue NPDES general permits. In the 12 States (MA, ME, NH, FL, LA, TX, OK, NM, SD, AZ, AK, and ID) and 6 territories (District of Columbia, the Commonwealth of Puerto Rico, Guam, American Samoa, the Commonwealth of the Northern Mariana Islands, and the Trust Territory of the Pacific Islands) without NPDES authorized programs, EPA issues all NPDES permits. In 5 of the 39 States that are authorized to issue NPDES permits for municipal and industrial sources, EPA retains authority to issue permits for discharges from Federal facilities.

B. Requirements in NPDES Permits

The CWA establishes two types of standards for conditions in NPDES permits: technology-based standards and water quality-based standards. These standards are used to develop effluent limitations, special conditions, and monitoring requirements in NPDES permits. Numeric effluent limitations that establish pollutant concentration or mass limits for effluents at the point of discharge (end-of-pipe conditions) are generally at the heart of permits for discharges from POTWs and industrial process discharges. More recent permitting efforts have also addressed limiting the toxicity of effluents through specific toxicity limitations included in permits. Section 402(a)(1) authorizes the inclusion of other types of conditions that are determined to be necessary, known as special conditions, in NPDES permits. Special conditions include requirements for best management practices (BMPs).

1. Technology-Based Standards

Technology-based requirements under section 301(b) of the Act represent the minimum level of control that must be imposed in a permit issued under section 402 of the Act. Two technology-based requirements are appropriate for existing storm water discharges associated with industrial activity:

(1) Best conventional pollutant control technology (BCT); and

(2) Best available technology economically achievable (BAT). The BCT standard applies to the control of conventional pollutants, while the BAT standard applies to the control of all toxic pollutants and for all pollutants which are neither toxic nor conventional pollutants. Section 306 of the CWA provides for EPA to establish new source performance standards for new sources.

Technology-based requirements may be established through one of two methods:

(1) Application of national BAT/BCT effluent limitations guidelines promulgated by EPA under section 304 of the CWA and new source performance standards promulgated under section 306 of the CWA applicable to dischargers by category or subcategory; and

(2) On a case-by-case basis under section 402(a)(1) of the Act, using best professional judgement (BPJ), for pollutants or classes of discharges for which EPA has not promulgated national effluent limitations guidelines.

(Note: EPA only establishes new source performance standards under section 306 of the CWA when developing national effluent limitations guidelines, and not when establishing permit conditions on a case-by-case basis).

2. Water Quality-Based Standards for Controls

In addition to technology-based controls, section 301(b) of the CWA also requires that NPDES permits must include any conditions more stringent than technology-based controls necessary to meet State water quality standards. Water quality-based requirements are established under this provision on a case-by-case basis.

III. Prior Storm Water Permitting Efforts

Between 1976 and 1984, EPA regulations required that permit applications be submitted for a wide range of storm water discharges. Many facilities that were required to submit applications for storm water discharges did not apply. In addition, many of the permit applications received by EPA and authorized NPDES States were never acted upon for a number of reasons, including: Lack of resources for permitting, lack of technical understanding of the causes and controls for pollutants in storm water, reluctance of industrial dischargers to accept requirements for best management practices (BMPs) in NPDES permits, and a general perception that storm water discharges, when considered one at a time, were of low priority. In 1984, EPA again promulgated permit application requirements and deadlines for storm water discharges. However, these regulations were never implemented. The regulations were in litigation when Congress enacted the Water Quality Act (WQA) on February 4, 1987, which directly specified a new national strategy for storm water control.

Despite the lack of a comprehensive permitting program for all storm water discharges prior to the passage of the WQA of 1987, permitting efforts nonetheless proceeded in some areas. Between 1974 and 1982, EPA promulgated effluent limitations guidelines for storm water discharges from ten categories of industrial discharges:

- Cement Manufacturing.
- Feedlots.
- Fertilizer Manufacturing.
- Petroleum Refining.
- Phosphate Manufacturing.
- Steam Electric.
- Coal Mining.
- Ore Mining and Dressing.
- Mineral Mining and Processing.
- Asphalt Emulsion.

Permitting efforts for storm water discharges have focussed on industrial facilities subject to these effluent limitations guidelines. In addition, some EPA Regions and States with authorized State NPDES programs have, to varying degrees, written permits for storm water discharges from other industrial facilities. For example, in some States and Regions, storm water discharges from industrial facilities are often addressed when NPDES permits for process wastewaters of a facility are reissued.

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IV. November 16, 1990 Permit Application Regulations

On November 16, 1990, (55 FR 47990), EPA published NPDES permit application requirements for: Storm water discharges associated with industrial activity; and discharges from municipal separate storm sewer systems serving a population of 100,000 or more. The rulemaking accomplished three major tasks:

(1) The rule defined the initial scope of the NPDES storm water program;

(2) The rule established a permitting scheme with respect to storm water discharges associated with industrial activity through municipal separate storm sewer systems; and

(3) The rule established permit application requirements for those storm water discharges which are initially subject to the program.

A. Scope of NPDES Storm Water Program

The initial scope of the NPDES storm water program is defined by two key regulatory definitions, "storm water discharges associated with industrial activity" and "large and medium municipal separate storm sewer systems". The term "storm water discharge associated with industrial activity" is defined at 40 CFR 122.26(b)(14) and addresses point source discharges of storm water from eleven major categories of facilities. (This definition is reprinted in the definition section of the draft general permits published in the appendix to today's notice).

The terms "large and medium municipal separate storm sewer systems" (systems serving a population of 100,000 or more) are defined at 40 CFR 122.26(b) (4) and (7) to include municipal separate storm sewers located in: 173 incorporated places (cities) with a population of 100,000 or more; unincorporated portions of 47 counties identified as having large populations in unincorporated, urbanized portions of the county; and other municipal storm sewers which are designated by the Director on a case-by-case basis.

The definitions of "storm water discharge associated with industrial activity" and "large and medium municipal separate storm sewer system" only address point source discharges. Section 502(14) of the CWA defines the term "point source" broadly to include "any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, * * * from which pollutants are or may be discharged."

In most court cases, the term "point source" has been interpreted broadly. For example, the holding in *Sierra Club v. Abston Construction Co., Inc.*, 620 F.2d 41 (5th Cir., 1980) indicates that changing the surface of land or establishing grading patterns on land will result in a point source where the runoff from the site ultimately is discharged to waters of the United States:

> Simple erosion over the material surface, resulting in the discharge of water and other materials into navigable waters, does not constitute a point source discharge, absent some effort to *change the surface*, to *direct* the water flow or otherwise impede its progress * * * Gravity flow, resulting in a discharge into a navigable body of water, may be part of a point source discharge if the (discharge) at least initially collected or channeled the water and other materials. A point source of pollution may also be present where (dischargers) design spoil piles from discarded overburden such that, during periods of precipitation, erosion of spoil pile walls results in discharges into a navigable body of water by means of ditches, gullies and similar conveyances, even if the (dischargers) have done nothing beyond the mere collection of rock and other materials * * * Nothing in the Act relieves [dischargers] from liability simply because the operators did not actually construct those conveyances, so long as they are reasonably likely to be the means by which pollutants are ultimately deposited into a navigable body of water. Conveyances of pollution formed either as a result of natural erosion or by material means, and which constitute a component of a * * * drainage system, may fit the statutory definition and thereby subject the operators to liability under the Act. (emphasis added) 620 F.2d 41, 45 (1980).

Under this approach, point source discharges of storm water result from structures that increase the imperviousness of the ground that acts to collect runoff, with runoff being conveyed along the resulting drainage or grading patterns.

The Agency will embrace the broadest possible definition of point source consistent with the legislative intent of the CWA and court interpretations to include any identifiable conveyance from which pollutants might enter the waters of the United States.

B. Industrial Storm Water Discharges Through Municipal Separate Storm Sewer Systems

The November 16, 1990 notice clarifies that storm water discharges associated with industrial activity to waters of the United States, including those through municipal separate storm sewers to waters of the United States, must obtain NPDES permit coverage. However, storm water discharges associated with industrial activity to municipal sanitary sewer systems (i.e. those systems which are part of a POTW collection system), including combined sewer systems, generally do not need to obtain NPDES permit coverage, although they may be subject to pretreatment requirements. (Note that municipalities which operate combined sewer overflows (CSOs) need NPDES permit coverage for the CSO discharge).

C. Permit Application Requirements

The November 16, 1990 rule established individual (40 CFR 122.26(c)(1)) and group (40 CFR 122.26(c)(2)) application requirements for storm water discharges associated with industrial activity. The requirements associated with individual application requirements for storm water discharges associated with industrial activity are incorporated into Forms 1 and 2F, which are generally to be submitted to the Director by November 18, 1991. In addition, operators of storm water discharges associated with industrial activity through large and medium municipal separate storm sewer systems are required to submit a notification of their discharge to the operator of the municipal separate storm sewer system receiving the discharge by no later than May 15, 1991 or 180 days prior to commencing such discharge (40 CFR 122.26(a)(4)).

The rule also established permit application requirements for discharges from large and medium municipal separate storm sewer systems at 40 CFR 122.26(d).

V. Burdens on Permitting Agencies

The focal issue in developing appropriate requirements for the NPDES storm water program continues to be addressing the resource burdens of implementing an effective regulatory program for the extremely large number of storm water discharges. Understanding the burdens of the program on permitting Agencies is a first step towards developing a workable regulatory program.

Implementing the NPDES permitting program is a complex process. Major steps to issue a permit include:

- *Training of Permit Writers.* Permit writers must acquire the appropriate expertise necessary for writing permits.
- *Permit Application Review.* Permit applications (or notices of intent to be covered under a general permit) that are received initially must be screened and reviewed for completeness. When this

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review indicates that necessary information is not provided, the applicant must be notified and an explanation of the deficiency provided. Applications that are complete must be assigned to a permit writer and filed.

• *Preparing a Draft Permit.* Preparing a draft permit and fact sheet involves a technical evaluation of the discharge based on a review of the permit application or other appropriate information. The appropriate factors associated with technology-based or water quality-based standards must be evaluated. Appropriate effluent limitations, monitoring requirements, and any special conditions need to be developed.

• *Public Notice of the Draft Permit.* Draft permits must undergo appropriate public notice. In some cases public hearings must be held.

• *Permit Issuance.* Public comments must be received, evaluated, and responded to in developing a final permit. Any request for an evidentiary hearing must be addressed.

• *Compliance Monitoring/Enforcement.* A number of compliance monitoring activities can be conducted including reviewing discharge monitoring reports, conducting site inspections, and evaluating other information. Enforcement actions include assessing penalties and issuing administrative orders. In some cases, enforcement actions lead to litigation.

In addition to these steps, a number of administrative functions, such as responding to public inquiries, can create burdens for permit issuing agencies. The number of such inquiries can be particularly high when a new regulation is involved.

As discussed earlier in this notice, efforts to permit point source discharges under the CWA have focussed primarily on industrial process discharges and discharges from POTWs. EPA and authorized NPDES States have issued more than 46,600 NPDES permits for industrial process discharges, 15,600 NPDES permits for POTWs, and approximately 59 general permits have been issued covering at least 7,200 facilities. The Agency estimates that over 100,000 facilities (not including oil and gas exploration and production operations) discharge storm water associated with industrial activity. Most of the facilities that discharge storm water associated with industrial activity have not been addressed under the NPDES program in the past. Today's notice incorporates several elements of EPA's initial attempts to establish a workable NPDES program that reflects the realities of these administrative burdens.

VI. Today's Notice

Today's notice requests public comment on four major areas:

(1) EPA's long-term permitting strategy for storm water discharges associated with industrial activity;

(2) Proposed changes to 40 CFR 122.44(i)(2) addressing annual monitoring and reporting requirements;

(3) Proposed changes to 40 CFR 122.28(b)(2) addressing notice of intent requirements for general permits; and

(4) Proposed baseline general permits for storm water discharges associated with industrial activity in 12 States (MA, ME, NH, FL, LA, TX, OK, NM, SD, AZ, AK, ID), and 6 Territories (District of Columbia, the Commonwealth of Puerto Rico, Guam, American Samoa, the Commonwealth of the Northern Mariana Islands, and the Trust Territory of the Pacific Islands) without authorized NPDES State programs; on Indian lands in AL, CA, GA, KY, MI, MN, MS, MT, NC, ND, NY, NV, SC, TN, UT, WI, and WY; located within Federal facilities and Indian lands in CO and WA; and located within Federal facilities in Delaware.

A. Long-Term Permitting Strategy

Many of the comments received during the storm water NPDES permit application rulemaking focussed on the difficulties that EPA Regions and authorized NPDES States, with their finite resources, will have in implementing an effective permitting program for the large number of storm water discharges associated with industrial activity. Many commenters noted that problems with implementing a permit program are caused not only by the large number of industrial facilities subject to the program, but by the difficulties associated with identifying and assessing appropriate technologies and other measures for controlling storm water at various sites and the differences in the nature and extent of storm water discharges from different types of industrial facilities. The Agency recognizes these concerns, and is developing an approach to serve as a foundation for future program development.

Based on a consideration of comments from authorized NPDES States, municipalities, industrial facilities and environmental groups on the permitting framework and permit application requirements for storm water discharges associated with industrial activity, EPA is developing a strategy for permitting storm water discharges associated with industrial activity. In developing this strategy, the Agency recognizes that the CWA provides flexibility in the manner in which NPDES permits are issued.* The Agency intends to use this flexibility in designing a workable and reasonable permitting system. In accordance with these considerations, in today's notice the Agency is publishing and requesting comments on a discussion of its draft strategy for implementing the NPDES storm water program. The Strategy establishes two major components, a framework for developing permitting priorities and a framework for the development of State Storm Water Permitting Plans.

1. Permitting Priorities

The Agency believes that most permitting activities can be described in terms of the following four classes of activities:

• *Tier I—Baseline Permitting:* One or more general permits will be developed to initially cover the majority of storm water discharges associated with industrial activity;

• *Tier II—Watershed Permitting:* Facilities within watersheds shown to be adversely impacted by storm water discharges associated with industrial activity will be targeted for individual or watershed-specific general permits.

• *Tier III—Industry-Specific Permitting:* Specific industry categories will be targeted for individual or industry-specific general permits; and

• *Tier IV—Facility-Specific Permitting:* A variety of factors will be used to target specific facilities for individual permits.

These four classes of activities will be implemented over time and will reflect priorities within given States. In most States, Tier I activities, issuance of baseline permits, will be the initial starting point. As priorities and risks within the State are evaluated, classes of storm water discharges or individual storm water discharges will be identified for Tier II, III or IV permitting activities. Usually a storm water discharge or a class of discharges will not go through a sequence that involves all four of the Tiers associated with the strategy, but may for example, go from initial coverage under a Tier I baseline

* As discussed earlier in this notice, the Court in *NRDC v. Train*, 396 F.Supp. 1393 (D.D.C. 1975) *aff'd. NRDC v. Costle*, 568 F.2d 1369 (D.C.Cir. 1977), has acknowledged the administrative burden placed on the Agency by requiring individual permits for a large number of storm water discharges. These courts have recognized EPA's discretion to use certain administrative devices, such as area permits or general permits to help manage its workload. In addition, the courts have recognized flexibility in the type of permit conditions that are established, including requirements for best management practices.

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permit to coverage under a Tier III industry specific general permit.

a. *Tier I—Baseline permitting.* The Agency intends to issue general permits that initially cover the majority of storm water discharges associated with industrial activity in States without authorized NPDES programs. These permits also will serve as models for States with authorized NPDES programs.

Consolidating many sources under one permit will greatly reduce the administrative burden of permitting storm water discharges associated with industrial activity. This approach will allow:

- Pollution prevention and control requirements to be established for discharges covered by the permit;
- Facilities whose discharges are covered by the permit to be certain of their legal responsibilities and have an opportunity to comply with the CWA;
- EPA and authorized NPDES States will begin to collect and review data on storm water discharges from priority industries, thereby supporting subsequent permitting activities;
- The public, including municipal operators of municipal separate storm sewers which may receive storm water discharges associated with industrial activity, to have access under section 308(b) of the CWA to monitoring data and certain other information developed by the permittee;
- Applicable requirements of municipal storm water management programs established in permits for discharges from municipal separate storm sewer systems to be enforceable directly against noncomplying industrial facilities that generate the discharges where the permit for the storm water discharge includes a condition requiring compliance with the municipal storm water management program;
- The public to have the opportunity to review data and reports developed by industrial permittees and to be given an opportunity to comment on permitting activities;
- The baseline permits will provide a basis for bringing selected enforcement actions by eliminating many issues which might otherwise arise in an enforcement proceeding; and
- The baseline permit, along with the State storm water permitting plans (discussed below), will provide a focus for public comment on subsequent phases of the permitting strategy for storm water discharges.

Initially, the coverage of the baseline permits will be broad. However, the coverage will shrink as other permits are issued for storm water discharges associated with industrial activity pursuant to Tier II through Tier IV activities. The Agency believes that Tier I permits can establish the appropriate balance between monitoring requirements and implementable controls that will initiate facility-specific controls and provide sufficient data for compliance monitoring and future program development. Baseline general permits are flexible enough to allow the introduction of Tier II, III or IV types of activities, such as industry specific monitoring or control conditions. (See the draft general permits in this notice for examples of how this balance may be achieved). The Agency requests comments on the appropriate role of sampling requirements and on facility-specific controls in Tier I permits.

b. *Tier II—Watershed permitting.* Facilities within watersheds shown to be adversely impacted by storm water discharges associated with industrial activity will be targeted for individual and general permitting activities. This process can be initiated by identifying receiving waters (or segments of receiving waters) where storm water discharges associated with industrial activity have been identified as a source of use impairment or are suspected to be contributing to use impairment. Information developed under sections 304(l), 305(b), and 319(a) of the CWA, along with information from other sources (including information developed under the baseline general permits for storm water discharges), can be used in evaluating impacts on receiving waters. This information may identify classes of storm water discharges that are of particular concern and portions of watersheds where the sources of concern are located. Appropriate classes of storm water discharges in these locations can be targeted for additional permit conditions which may provide additional information to characterize the discharge (e.g., additional monitoring and reporting requirements) or where appropriate for more stringent controls.

Information gathered under initial permits for storm water discharges as well as information from other sources can be used to upgrade lists of impacted receiving waters and reassess water quality-based controls. As discussed in more detail below, State storm water permitting strategies are expected to have a major role in this process.

c. *Tier III—Industry-Specific Permitting.* Specific industry categories will be targeted for individual or industry-specific general permits. These permits will allow permitting authorities to focus attention and resources on industry categories of particular concern and/or industry categories where tailored requirements are appropriate. The Agency will work with the States to develop model permits for selected classes of industrial storm water discharges. EPA is also working to identify priority industrial categories in the two Reports to Congress required under section 402(p)(5) of the CWA. In addition, the group application process adopted in the final regulation published on November 16, 1990, (55 FR 47990) will provide an additional mechanism for developing industry-specific general permits. Group applications that are received can be used to develop model permits for the appropriate industries.

d. *Tier IV—Facility-specific permitting.* Individual permits will be appropriate for some storm water discharges in addition to those identified under Tier II and Tier III activities. Individual permits should be issued where warranted by: The pollution potential of the discharge, the need for individual control mechanisms, and where reduced administrative burdens exist. For example, individual NPDES permits for facilities with process discharges should be expanded during the normal process of permit reissuance to cover storm water discharges from the facility. This provides an opportunity to develop individual controls where the incremental administrative burden is not greatly increased.

2. Relationship of Strategy to Permit Application Requirements

The long-term permitting Strategy described above identifies several permit approaches that the Agency anticipates will be used in addressing storm water discharges associated with industrial activity. One issue that arises with this Strategy is determining the appropriate information needed to develop and issue permits for these discharges. The NPDES regulatory scheme provides three potential routes for applying for permit coverage for storm water discharges associated with industrial activity:

(1) Individual permit applications;
(2) Group applications; and
(3) Case-by-case requirements developed for general permit coverage.

Individual Permit Application Requirements

Individual permit application requirements are applicable to all storm water discharges associated with industrial activity except where the operator of the discharge is participating in a group application, or a general permit is issued to cover the discharge

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and the general permit provides alternative means to obtain permit coverage.

The requirements for an individual permit application are reflected in Form 1 and Form 2F. These forms require the development and submission of relatively detailed site-specific information, including: A drainage site map, an estimate of the area of impervious surfaces and the total area drained by each outfall, a narrative description of specified features that may impact the pollution potential of a discharge, a list of significant spills and leaks of toxic or hazardous pollutants that occurred at the facility after the effective date of the permit, a certification that the discharge has been tested for the presence of non-storm water discharges, and sampling data from a representative storm event. This information is intended to be used to develop the site-specific conditions generally associated with individual permits.

Individual permit applications will play an important role in all tiers of the Strategy, even where general permits are used. Although general permits may provide for notification requirements that operate instead of the requirement to submit individual permit applications, the individual permit applications may be needed under several circumstances. Examples include: general permits requiring the submission of a permit application as the notice of intent to be covered by the permit; where the owner or operator of a discharge authorized by a general permit requesting to be excluded from the coverage of the general permit by applying for a permit (see 40 CFR 122.28(b)(2)(iii) for EPA-issued general permits); and a Director requiring an owner or operator of a discharge authorized by a general permit to apply for an individual permit (see 40 CFR 122.28(b)(2)(ii) for EPA-issued general permits).

Group Applications

On November 16, 1990, (55 FR 47990), EPA promulgated requirements for group applications for storm water discharges associated with industrial activity. These applications provide participants of groups with sufficiently similar storm water discharges an alternative mechanism for applying for permit coverage.

The group application requirements provide information for developing industry-specific general permits. (Group applications can also be used to issue individual permits in authorized NPDES States without general permit authority or where otherwise appropriate). As such, group application requirements correlate with the Tier III permitting activities identified in the long-term permitting Strategy.

Requirements in General Permits

40 CFR 122.21(a) excludes persons covered by general permits from requirements to submit individual permit applications. In section VI.C of this preamble, the Agency is proposing minimum requirements for filing notices of intent (NOI) to be authorized to discharge under general permits. NOI requirements established in general permits operate instead of individual permit application requirements for the discharges covered by the general permit. (NOI requirements are discussed in more detail below).

3. State Storm Water Permitting Plans

The CWA provides a framework for the long-term development of the NPDES program to address storm water discharges. Section 402(p)(2) of the CWA identifies those storm water discharges, including storm water discharges associated with industrial activity, which are the initial priorities for permitting. Section 402(p)(5) of the CWA requires the Agency to study other storm water discharges. Section 402(p)(6) of the CWA requires EPA, in consultation with State and local officials, to issue regulations by no later than October 1, 1992 which designates additional storm water discharges to be regulated to protect water quality and establish a comprehensive program to regulate such designated sources. The Act provides that this regulatory program include requirements for State Storm Water Management Programs.

Although section 402(p)(6) contemplates that State Storm Water Management Programs address Phase II storm water discharges identified in section 402(p)(5) studies (e.g., a subset of storm water discharges other than storm water discharges associated with industrial activity, and discharges from large and medium municipal separate storm sewer systems), the Agency believes that permitting activities for storm water discharges associated with industrial activity and for discharges from large and medium municipal separate storm sewer systems under Phase I should also be considered and evaluated when developing the scope of comprehensive State Storm Water Management Programs.

As EPA and NPDES authorized States implement efforts to permit storm water discharges, it is necessary to ensure adequate public input, evaluate program activities and provide for program oversight. The Agency believes that State Storm Water Management Programs can provide an appropriate basis for these activities, particularly during the earlier stages of program development. EPA has outlined below a number of the components and elements of a State Storm Water Permitting Plan which it believes are essential to assure successful implementation of the storm water initiative called for in section 402(p) of the CWA, and which can serve as a foundation for subsequent development of State Storm Water Management Programs. These plans will provide an effective coordination and tracking mechanism for evaluating the initial permitting activities for storm water discharges required under section 402(p) of the CWA. In addition, these plans will facilitate the technology transfer among the States.

State Storm Water Permitting Plans should include a description of a strategy to issue NPDES permits for discharges from large and medium municipal separate storm sewer systems; storm water discharges associated with industrial activity; and case-by-case designations of storm water discharges needing a permit. Plans should be developed for each State. EPA will request that the Director of the NPDES program provide a copy of the draft State Storm Water Permitting Plan to the Office of Wastewater Enforcement and Compliance within 12 months after the date of publication of this final regulation. EPA anticipates that States will update these plans on a regular basis. EPA intends to continue to review these plans while evaluating the manner in which Phase II storm water discharges are addressed in State Storm Water Management Programs developed under section 402(p)(6) of the CWA. These plans will assist EPA in technology transfer activities, evaluating the progress of States in implementing storm water permitting activities, and identifying problems with program implementation.

EPA believes that at a minimum, the initial State Storm Water Permitting Plans should address permitting of large and medium municipal separate storm sewer systems; storm water discharges associated with industrial activity; and case-by-case designations of storm water discharges needing a permit. Much of the information in the first phase of the plan will be generated from storm water applications required by the November 16, 1990 application rule and the industry specific analysis required by the rule. The basic framework for the Plan should address on a State-wide basis:

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Municipal Separate Storm Sewer Systems

- A list of municipal separate storm sewer systems serving a population of 100,000 or more within the State;
- For systems identified, a summary of the estimated pollutant loadings as provided in the permit application for such discharges, or as otherwise updated; and
- The status of permitting activities for discharges from municipal separate storm sewer systems serving a population of 100,000 or more, including any NPDES permit number for such discharges.

Storm Water Discharges Associated with Industrial Activity

- A description of the status and objectives of activities to issue and implement a baseline general permit, including a copy of any final general permit for storm water discharges associated with industrial activity; *
- A list of categories of industrial facilities that have storm water discharges associated with industrial activity that are being considered for industry-specific general permits for their storm water discharges associated with industriel activity;
- A description of procedures, including activities conducted under any general permit (such as inspections, review of notices of intent or review of monitoring reports) to identify specific storm water discharges associated with industrial activity that are appropriate for individual permits;
- A description of how permits for discharges from municipal separate storm sewer systems require the development of municipal storm water management programs addressing the control of pollutants in storm water discharges associated with industrial activity.

Impacted Waters

- A description of procedures to identify receiving waters where discharges from municipal separate storm sewers, storm water discharges associated with industrial activity, or any other class of storm water discharges are, or have the potential to, cause or contribute to a violation of a water quality standard, including a list of waters identified by these procedures.

* EPA is not requesting permits in as part of these Plans for the purpose of commenting on the adequacy of the permit. Rather the Agency is requesting the copies of the permit to coordinate technology transfer regarding permitting approaches and classes of storm water discharges addressed, and to provide a general evaluation of the status of National permitting activities.

Case-by-Case Designations

- A description of procedures to identify storm water discharges (other than those currently subject to requirements for obtaining a permit) that contribute to a violation of a water quality standard or significantly contribute pollutants to the waters of the United States.
- A list of storm water discharges considered for designation or designated under section 402(p)(2)(E) as needing a permit.

EPA strongly encourages public participation and comment at the State level during the development of these plans.

These initial State storm water permitting components will ensure that permitting efforts are implemented adequately for storm water discharges associated with industrial activity and other priority storm water discharges by creating a framework for planning State storm water permitting activities, and providing EPA information for technology transfer purposes and evaluating State permit issuance efforts. The State Storm Water Permitting Plans will provide a framework for implementing the tiered long-term strategy for permitting storm water discharges associated with industrial activity. Provisions for State Storm Water Management Programs will be expanded in the future to address other storm water discharges in accordance with section 402(p)(6) of the CWA. EPA requests comments on the appropriate scope and content of State Storm Water Permitting Plans. The Agency also requests comments on whether the guidelines for Plans should be made requirements that are incorporated into EPA regulations, or remain non-binding recommendations for States. EPA notes that it may require preparation of such Plans pursuant to sections 304(i)(2) and 402(p)(6) of the CWA.

4. States without NPDES General Permit Authority

As noted, the issuance of general permits is a very important component in the recommended permit issuing strategy. Presently 38 States (and 1 territory) have been authorized to implement the NPDES permit program. However, only 23 of these States have been authorized to issue general permits. If NPDES authority is not obtained for any of the remaining 15 States, storm water controls will have to be implementation based on the submission of individual or group permit applications, and the development of individual permits. Under the CWA, EPA cannot issue general permits in States that have been authorized to administer the NPDES program.

EPA strongly recommends that States with authorized State NPDES programs, but without general permit authority, consider obtaining general permit authority as soon as possible. EPA is currently working with States to expedite the authorization process.

B. Proposed Changes To Annual Monitoring and Reporting Requirements

Section 308 of the CWA authorizes EPA to require information, monitoring, and recordkeeping to carry out the objectives of the Act including but not limited to: (1) Characterization of discharges to assist in the development of permit conditions and controls; and (2) compliance monitoring to determine whether a discharger is in violation of a permit condition. The authority to collect information under section 308 is broad and can include requirements for record keeping, making reports, effluent monitoring, and other information reasonably required. EPA and authorized NPDES States implement this authority in a number of ways, including permit application requirements, permit monitoring and reporting requirements, and specific information requests under section 308 (section 308 letters). In addition, section 402(a)(2) of the CWA provides that NPDES permits shall prescribe requirements to assure compliance with permit conditions, including requirements on data and information collection, reporting, and such other requirements deemed appropriate.

Monitoring data serves a number of functions under the NPDES program. Discharge monitoring data can be used to assist in the evaluation of the risk of the discharge by indicating the types and the concentrations of pollutant parameters in the discharge. Monitoring of storm water from an industrial site can assist in evaluating sources of pollutants. Discharge monitoring data can be used in evaluating the potential of the discharge to cause or contribute to water quality impacts and water quality standards violations.

Discharge monitoring data can also be used to evaluate the effectiveness of controls on reducing pollutants in discharges. This function of monitoring can be important in evaluating the effectiveness of source control or pollution prevention measures as well as evaluating the operation of end-of-pipe treatment units. Where numeric or toxicity effluent limits are incorporated into permits, discharge monitoring data plays a critical role by providing EPA and authorized NPDES States with data

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to evaluate compliance with effluent limits. The use of discharge monitoring data to determine permit compliance greatly enhances the ability of EPA and authorized NPDES States to enforce permit conditions.

As part of efforts to obtain sufficient information to run the program effectively, the existing regulations at 40 CFR 122.44(i) specify factors to consider in developing monitoring requirements in permits. These regulations indicate that permit monitoring requirements are to be established on a case-by-case basis to ensure, as noted above, compliance with permit limitations. In addition, 40 CFR 122.44(i)(2) provides that requirements to report monitoring results to the permitting authority shall in no case be less than once a year.

To date, the minimum requirement that permittees submit an annual discharge monitoring report (DMR) has proved to be a valuable baseline for NPDES permitting efforts for POTWs and industrial process discharges. Among the most important functions of DMRs is to assess compliance with numeric effluent limits contained in permits. However, some important administrative, technical, and policy concerns regarding DMRs arise as the Agency begins to fully implement permit requirements for storm water discharges. The Agency is considering the following factors in addressing this issue:

Administrative Burdens on Permitting Agencies. Requiring annual DMRs from each facility that discharges storm water associated with industrial activity would result in an enormous increase in the number of DMRs received by EPA Regions and authorized NPDES States. The Agency estimates that nationwide, over 100,000 facilities (not including oil and gas exploration and production operations) discharge storm water associated with industrial activity. Receiving annual DMRs containing complex technical information from each of these facilities would demand a large amount of permitting resources dedicated to reviewing and filing these reports. The Agency believes that such an increase in information would overwhelm permitting agencies who would have limited opportunities to review or otherwise analyze the information.

Difficulties in Sample Collection. Where storm water is not collected in a retention pond, the collection of storm water samples may pose a number of difficulties. These difficulties include determining when a discharge will occur, safety considerations, the potential for a large number of discharge points at a given facility, the limited duration of the event, the limited number of events that occur in some parts of the country, and variability in flow rates.

Variability of Data. The types and concentrations of pollutants in storm water discharges associated with industrial activity depend on a number of factors, including the nature of industrial activities occurring at the site, the nature of the precipitation event generating the discharge, and the time period from the last storm. Variations in these parameters at a site may result in variation from event to event in the concentrations and types of pollutants in a given discharge.

Types of Permit Conditions. Permits for industrial process discharges and discharges from POTWs traditionally have incorporated numeric and/or toxicity effluent limitations as conditions. Monitoring reports for these discharges provide a direct indication whether the discharge complies with permit conditions. However, it is anticipated that permits for storm water discharges will contain a variety of types of controls. While numeric or toxicity limitations are expected to be appropriate for some storm water discharges, permits for other storm water discharges are expected to contain requirements to implement best management or pollution prevention practices. In these cases, monitoring information may not provide as direct a link to compliance with permit conditions. However, monitoring data can still play an important role in identifying priority facilities, providing information on sources and types of pollutants which can be evaluated when designing or modifying best management or pollution prevention practices, and evaluating the effectiveness of best management practices and pollutant prevention measures.

Focussed Permitting Efforts

The long-term permitting strategy discussed earlier in today's notice provides for a flexible system for conducting permit issuance and reissuance activities. Flexibility has been incorporated into the strategy to facilitate EPA and authorized NPDES States permit issuance activities which reflect Regional and State prioritization of storm water impacts on particular watersheds and specific receiving waters, and on specific classes of facilities. In most States, the issuance of baseline permits (Tier I activities), will be the initial starting point. As priorities and risks within a State are evaluated, classes of facilities will be identified for more specific permit issuance activities (Tiers II, III and IV of the strategy). Storm water discharge monitoring data will have an important role, along with other information, in identifying facilities or classes of facilities where Tier II, III and IV permit issuance activities are appropriate. In addition, monitoring data will play an important role in developing appropriate permit conditions.

1. Options for Regulatory Modifications

EPA requests comments on five options (plus a no change option) for modifying the existing regulatory provision that NPDES permits at a minimum require the submittal of DMRs annually for permits for storm water discharges associated with industrial activity. It should be clarified that these options only address *minimum* requirements for discharge monitoring in NPDES permits. All options for modifying these regulations would retain authority to require more stringent monitoring requirements where appropriate. The six options [1] are as follows:

No Change Option: Case-by-case monitoring conditions in permits for storm water discharges, with a minimum requirement to report monitoring results at least annually.

Under this approach, EPA would not change its existing regulations which provide that monitoring conditions in NPDES permits be established on a case-by-case basis, but at a minimum, must contain requirements to report monitoring results at least annually.

Option 1: Case-by-case monitoring conditions in permits for storm water discharges with a minimum requirement to report monitoring results at least twice per permit term.

This option would change the minimum requirement for reporting monitoring results at least annually to reporting monitoring at a different frequency, such as twice during a five year period (during the term of a permit). This approach would provide permit writers with additional flexibility to develop monitoring requirements in

[1] EPA will consider developing a final regulation which combines aspects of several of the options articulated below. For example, the Agency may determine that it is appropriate to issue a final regulation which provides that, at a minimum, NPDES permits will require annual monitoring (without reporting) for all storm water discharges associated with industrial activity except for permits for targeted storm water discharges associated with industrial activity located in the watershed of receiving waters that are sensitive to or impacted by storm water discharges which at a minimum would be required to sample quarterly and be required to report information to the permitting authority

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permits that were less burdensome to the permittee. Reducing monitoring and reporting requirements would also be less burdensome to the entity that reviewed the monitoring report.

The Agency also requests comments on providing permit writers with flexibility to establish requirements for conducting biological surveys of receiving waters as part of efforts to comply with minimum monitoring requirements. Under this approach, permittees could be required to conduct a survey of the biological health of the receiving water, to provide information on existing conditions. (See, "Biological Criteria, National Program Guidance for Surface Waters," Office of Water Regulations and Standards (WH-585), EPA-440/5-90-004 and "A Survey of the Status of Biomonitoring in State NPDES and Nonpoint Source Monitoring Programs," 1989, Office of Policy, Planning and Evaluation, U.S. EPA, RTO/7639/02-03F).

Data from a biological survey can be used by a permitting authority when assessing biological criteria to evaluate surface water quality. In this manner, the biological survey data can identify locations where water quality impacts are thought to be occurring. Where such impacts occur, additional monitoring or control requirements could be pursued.

Chemical specific monitoring, toxicity monitoring and biosurveys have unique as well as overlapping attributes, sensitivities, and program applications. No single approach for detecting impact should be considered uniformly superior to any other approach. EPA is encouraging States to implement and integrate all three approaches into their water quality programs, while applying them in combination or independently as site-specific conditions and assessment objectives dictate (See draft Final "Policy on the Use of Biological Assessments and Criteria in the Water Quality Program", EPA, January 1990).

Option 2: Case-by-case monitoring conditions in permits for storm water discharges with a minimum requirement that facilities conduct annual sampling. Facilities would not be required to report monitoring information unless the information was requested in a permit or by the Director, but would be required to retain information.

Under this approach, permits for storm water discharges associated with industrial activity will, at a minimum, require the discharger to sample storm water discharges at least annually. However, permits would not have to require dischargers to submit monitoring reports. Facilities could use this data to review the effectiveness of BMPs or storm water pollution prevention practices conducted at the site. Monitoring data would be available to the Director or the public upon request. In addition, dischargers could be required to submit a summary of their monitoring results they had collected during the previous permit term every five years when they resubmit permit applications or notices of intent to be covered under a general permit.

This approach could provide additional flexibility to permit writers for developing reasonable and workable permit conditions which can limit the administrative burdens associated with receiving and reviewing monitoring results from a large number of facilities. Facilities would still be required to conduct discharge monitoring at least annually even where permits require the development of pollution prevention or best management practices instead of numeric or toxicity effluent limits. The permittee would evaluate discharge monitoring data as part of efforts to identify pollutant sources, evaluate risks, and evaluate the effectiveness of its pollution prevention/best management practices program. In addition, requiring monitoring data would ensure that the permitting authority would be able to request information from the facility either during the term of the permit, or when the discharger is reapplying for permit coverage. This would allow the permit writer to identify pollutant sources, evaluate priorities based on the nature of pollutants in the discharge and the potential for the discharge to contribute to a water quality standard violation, and to evaluate the effectiveness of controls at the facility.

The Agency remains concerned about the ability of permitting authorities to adequately review annual monitoring reports from all facilities that discharge storm water associated with industrial activity. EPA requests comments on whether providing permit writers with the flexibility to require permittees to retain monitoring information until the information is requested or until a permit is reissued is an adequate and appropriate manner in which to address this problem.

Option 2 could be modified to provide minimum requirements to establish reporting of monitoring results in permits in specified situations. One approach would be to provide that permits for storm water discharges associated with industrial activity to receiving waters that are sensitive to or impacted by storm water discharges must require dischargers to report monitoring results at least annually (or at a higher minimum frequency). This approach would assist permitting agencies in evaluating causes of water quality impairment. The discussion accompanying Option 4 describes how receiving waters that are sensitive to or impacted by storm water discharges may be identified.

The second approach would be to provide that permits for storm water discharges associated with industrial activity must require dischargers to report monitoring results where pollutants are detected above specified threshold concentrations. Maximum pollutant threshold concentrations which would trigger reporting requirements could be established by regulation. These concentrations would apply to all storm water discharges associated with industrial activity nationally. (For example, values which could be established at the high end of the range of pollutant concentrations typically found in urban runoff. The NURP data base indicates that high values within the typical range for urban runoff may include concentrations such as 50 mg/l five-day biochemical oxygen demand, 30 mg/l oil and grease, 400 mg/l total suspended solids. Alternatively, for parameters with water quality standards, EPA could require that concentrations in excess of the numeric water quality criteria be reported). Alternatively, pollutant threshold concentrations could be established on a State-by-State basis, with different sets of pollutant threshold concentrations for different classes of receiving waters. The Agency requests comments on appropriate pollutant threshold concentrations under this approach. As stated above, dischargers could be required to submit summaries of all of the monitoring information that they collected during the previous permit term when they resubmit applications or notices of intent for permit coverage.

Option 3: Case-by-case monitoring conditions in permits for storm water discharges with a minimum requirement that facilities (other than those from oil and gas exploration or production operations and inactive mining operations where a past or present mine operator cannot be identified) conduct annual sampling. Facilities would not be required to report information unless the information was requested in a permit or by the Director, but would be required to retain information. For contaminated storm water discharges from oil and gas exploration or production operations or from inactive mining operations where a past or present mine operator cannot be identified, either case-by-case monitoring conditions in permits for

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storm water discharges with a minimum requirement of annual sampling (without reporting) or, instead of sampling, a Professional Engineer's certification attesting that good engineering practices were being employed to meet appropriate permit conditions.

This option is identical to Option 2 for storm water discharges associated with industrial activity from facilities other than: oil and gas exploration or production operations; and inactive mining operations where a past or present mine operator cannot be identified. However, for contaminated storm water discharges associated industrial activity from oil and gas exploration or production operations (e.g. drilling or well operations) or from inactive mining operations where a past or present mine operator cannot be identified, this option would provide permit writers with flexibility to require, at a minimum, either annual monitoring or, instead of monitoring, a certification by a Professional Engineer (PE) attesting that good engineering practices were being employed to meet appropriate permit conditions.

Under this approach, permit writers would be provided with two options for developing minimum monitoring requirements for storm water discharges from oil and gas exploration and production operations. The first option satisfying the minimum requirement would be to require owners or operators of storm water discharges from oil and gas exploration and production operations to conduct annual monitoring of representative storm water discharges. Where dischargers are not required to report monitoring results to the Director, permits must require that monitoring results be retained by the discharger for at least the term of the permit and be made available to the Director upon request. In such cases, results of any monitoring conducted during the term of the permit should be submitted as part of a permit application or NOI requirement prior to permit reissuance.

A second option for minimum requirements for permits for storm water discharges from oil and gas exploration and production operations or from inactive mine sites where a past or present mine operator cannot be identified would be available where a permit requires the facility owner or operator to develop and implement a storm water pollution prevention plan or a storm water best management practices plan. In such a case, the permit writer could require the discharger to obtain a Registered Professional Engineer's certification that the plan has been prepared and is being implemented in accordance with good engineering practices. Such certification would be obtained at a minimum of once every three years. The Agency believes that a minimum requirement of once every three years is necessary to evaluate changing site conditions and practices. Of course permit writers would retain discretion to, where appropriate, establish monitoring and certification requirements in excess of these minimum requirements.

EPA is proposing this option to address some of the specific concerns associated with storm water from oil and gas operations and from inactive mining operations where a past or present operator cannot be identified.

Information from sources such as nonpoint source assessments developed pursuant to section 319(a) of the CWA indicate that significant water quality impacts can be caused by wet-weather failure of on-site waste disposal systems at oil and gas exploration and production operations (such as storm induced overflows of reserve pits used to hold spent drilling muds and cuttings). Periodic sampling of discharges may not be sufficient to identify or predict these events. Rather, a PE certification may provide a more appropriate link for evaluating the potential for and preventing these types of events. Further, many oil and gas exploration and production with contaminated storm water discharges are already required to obtain similar PE certifications for Spill Prevention Control and Countermeasure (SPCC) Plans for discharges of oil under 40 CFR part 112. The Agency believes that developing an approach under the NPDES program for storm water discharges from oil and gas operations that is consistent with existing regulatory programs (e.g. the SPCC program) will potentially reduce industry burdens and provide for a greater degree of industry compliance. EPA is also considering other factors in evaluating requirements for oil and gas exploration and production operations, including the potentially large number of facilities subject to the program and that such facilities are typically found at remote locations and may have a limited operating staff.

Monitoring contaminated storm water discharges associated with industrial activity from inactive mining operations where a past or present mine operator cannot be identified can pose unique problems, particularly on Federal lands which have many thousands of inactive mines without identifiable mine operators. The Agency will be developing draft general permits in several States for inactive mining operations on Federal lands where a past or present mine operator cannot be identified and where EPA retains NPDES permit issuance responsibilities (these discharges are excluded from the draft general permits noticed elsewhere in today's Federal Register). The Agency believes that requiring the appropriate Federal land manager to monitor discharges from every one of the thousands of inactive mines on their lands is not appropriate. Rather, the Agency is evaluating the appropriate combination of discharge monitoring requirements for selected inactive mining operations and requirements to assess water quality impacts, such as biosurveys, instream sampling and sediment sampling. Further, the Agency recognizes that many of the methods used to control pollutant discharges and reclaim inactive mining operations can be evaluated from site inspections, and that unique resource problems may arise where a past or present operator cannot be identified. (Note that SMCRA regulations applicable to coal mining operations incorporate PE certifications (see 30 CFR 816.133(d)(5) and 30 CFR 817.133(d)(5).)

EPA requests comments on whether providing that NPDES permits for contaminated storm water discharges associated with industrial activity from oil and gas exploration and production operations and from inactive mining operations where a past or present mine operator cannot be identified, a PE certification instead of annual monitoring is an effective mechanism to ensure compliance with permit conditions.

EPA requests comments on other classes of industries where a PE certification may be an appropriate alternative to discharge sampling (e.g. construction activities where conditions change dramatically and frequently; portions of active mining operations which are not subject to effluent limitations guidelines, inactive industrial operations where an operator is not identifiable and which are not expecte

[8] The American Petroleum Institute (API) estimates that there are about 850,000 active oil and gas wells, 219,000 tank batteries and 150,000 injection wells in the United States. API also estimates that SPCC plans have been developed for about 130,000 of these facilities. The Agency anticipates that many sites are composed of multiple components (e.g. active wells, a tank battery, and injection wells). The Agency also anticipates that not all sites discharge contaminated runoff. EPA requests comments on the number of sites with oil and gas exploration and production operations that discharge contaminated storm water to waters of the United States and hence would be subject to NPDES storm water requirements.

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to undergo extensive changes and small businesses [9] which may not have the expertise to monitor). In addition, the Agency requests comment on portions of industrial facilities, such as haul roads, where a PE certification may be an appropriate alternative to discharge sampling.

EPA also requests comments on the costs of obtaining Professional Engineer's certification for two scenarios: (1) Where the engineer is a company employee and (2) where the company does not have an appropriate Professional Engineer on staff and must hire a consultant. In addition, EPA requests comments on the appropriate minimum frequency for obtaining such a certification.

The proposed changes to the language of 40 CFR 122.44(i) found in the back of today's notice reflects this option.

Option 4: Case-by-case monitoring conditions in permits for storm water discharges with a minimum requirement that monitoring reports be submitted at least annually for targeted classes of storm water discharges associated with industrial activity located in the watershed of receiving waters that are sensitive to or impacted by storm water discharges.

Option 4 differs from the other options presented in this notice in that it establishes a minimum requirement for DMRs in NPDES permits for storm water discharges associated with industrial activity based on receiving water concerns. This approach would focus permitting resources and controls on discharges to receiving waters that are sensitive to or impacted by storm water discharges. This option would establish a minimum requirement that facilities report monitoring results at least annually for those storm water discharges associated with industrial activity that are located within the watershed of any receiving water (or receiving water segment) that is determined by an NPDES State or EPA to be impacted by or sensitive to storm water discharges. Monitoring requirements in permits for storm water discharges associated with industrial activity which are not located within such watersheds would be established on a case-by-case basis. These storm water discharges would not be subject to a minimum requirement to submit or otherwise collect discharge monitoring information, although monitoring and reporting requirements could still be established in permits on a case-by-case basis.

A key aspect of this approach would be developing a list of waters that are either impacted by or sensitive to storm water discharges associated with industrial activity. All States would be required to submit lists for their State for the review and approval or disapproval by EPA. EPA would develop the list of waters for States that fail to develop approved lists.

The Agency anticipates that such lists could be based on existing and readily available data. The CWA provides a number of mechanisms for identifying impacted surface waters which could be useful in developing lists of waters impacted by or sensitive to storm water discharges, including the identification of lists of receiving waters under Sections 304(l),[10] 305(b),[11] 314(a),[12] 319(a),[13] and 320.[14] Additional sources of information which may be appropriate for identifying impacted or sensitive surface waters include the waters identified by the International Joint Commission,[15] the Chesapeake Bay program, and other EPA and State programs.

Several of the lists of receiving waters developed under the CWA also identify sources of water quality impairment and classes of pollutants associated with the water quality impairment. For example, the general classes of sources of water quality impairment addressed in section 305(b) reports which would be of particular interest when addressing storm water discharges associated with industrial activity, include separate storm sewers/urban runoff, construction, waste disposal, and resource extraction.[16] Sources of pollutants identified in section 305(b) reports include nutrients, organic enrichment, pathogens, siltation, and metals.[17] Under this option, these

[9] For the purposes of developing permit application requirements, EPA defines small businesses at 40 CFR 122.21(g)(8) as coal mines with a probable total annual production of less than 100,000 tons per year, and for all other applicants, businesses with gross total annual sales averaging less than $1,000,000 per year (in second quarter 1980 dollars or approximately $1,500,000 in 1990 dollars). This provision exempts small businesses from permit application monitoring requirements for certain organic chemicals.

[10] Section 304(l) of the CWA requires States to develop three lists of waters in the State. Section 304(l)(1)(A)(i) requires the development of a list of all waters which after the application of effluent limitations required under the CWA cannot reasonably be anticipated to attain or maintain newly adopted numeric water quality standards due to toxic pollutants. Section 304(l)(1)(A)(ii) requires the development of a list of all waters which, after the application of effluent limitations required under the CWA, cannot reasonably be anticipated to attain or maintain water quality that assures protection of public health, public water supplies, agricultural and industrial uses, and the protection and propagation of a balanced population of shellfish, fish and wildlife, and allows recreational activities in and on the water. Section 304(l)(1)(B) requires the development of a list of all waters for which the State does not expect the applicable standard under section 303 of the CWA will be achieved after the requirements of sections 301(b), 306, and 307(b) are met, due entirely or substantially to discharges from point sources or any toxic pollutants listed pursuant to section 307(a) of the CWA.

[11] Section 305(b) of the CWA provides that every two years States shall submit to the EPA a report describing the water quality of all navigable waters in a State during the preceding year. The report shall also include, among other things, an analysis of the extent to which those waters protect and support shellfish, fish and wildlife and allow recreational use, the basis for the assessment (evaluated or monitored), and causes of nonsupport of designated uses.

[12] Section 314(a) requires States to submit biennial reports that identify and classify publicly owned lakes according to their eutrophic condition. In addition, Section 314(a) reports should describe those publicly owned lakes for which uses are known to be impaired; procedures, processes, and methods to control sources of pollutants to such lakes; and methods and procedures to restore the quality of such lakes.

[13] Section 319(a) of the CWA provides for States to submit to EPA a report that identifies those navigable waters which, without additional action to control nonpoint sources of pollution, cannot reasonably be expected to attain or maintain applicable water quality standards or the goals and requirements of the CWA, and to identify those categories and subcategories of nonpoint sources that add significant pollution to each portion of the navigable waters identified.

[14] Section 320 of the CWA provides for EPA to designate estuaries of national significance based on a nomination of the Governor of any State in which the estuary lies in whole or in part and convene a management conference to develop a comprehensive management plan for the estuary.

[15] The International Joint Commission has identified areas of concern in the Great Lakes.

[16] EPA has issued a number of guidance materials to assist States in the section 305(b) process to identify sources of pollution that impact water quality. "The Water Body System User's Guide" provides a detailed list of subcategories of sources to develop section 305(b) reports. The list includes: separate storm sewers; discharges from separate storm sewers, construction, resource extraction; Runoff and process fluids from mining, petroleum drilling and mine tailing sites, and land disposal; Runoff and leachate from landfills, septic tanks, and hazardous waste disposal sites.

[17] The "National Water Quality Inventory, 1988 Report to Congress" provides a general assessment of water quality based on biennial reports submitted by the States under section 305(b) of the CWA. The National Water Quality Inventory summarizes sources of water quality impairment identified under section 305(b) in terms of the following classes: industrial, POTW's, combined sewer overflows, separate storm sewers/urban runoff, agriculture, silviculture, construction, resource extraction, land disposal, and hydro modification/habitat modification. The Agency believes the classes of separate storm sewers/urban runoff, construction, resource extraction, and land disposal correlate well with certain classes of storm water discharges associated with industrial activity.

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additional parameters could be used to develop minimum monitoring requirements for those general classes of storm water discharges associated with industrial activity that are specifically identified as causing water quality impairment.

The Agency is concerned that Option 4 would place large burdens on permitting Agencies and the regulated community during the initial phases of developing the storm water program. The Agency is also concerned that significant storm water discharges would not be addressed by this option because the discharge is to waters which were not assessed or to waters that were impacted by storm water but not identified for the purpose of this regulation. The Agency also recognizes that as storm water permitting programs develop, they must focus on controlling pollutant discharges located with watersheds of impacted and sensitive waters. The Agency is requesting comments on addressing these concerns by modifying the DMR regulation such that minimum DMR requirements would not be established for the initial set of permits to be issued under the new storm water permitting initiative (e.g., the minimum DMR requirements for storm water discharges in impacted or sensitive watershed would not be effective until three years after the date of promulgation of this regulation). However, after a specified time, at a minimum, annual DMRs for storm water discharges associated with industrial activity in watersheds that are impaired by or sensitive to storm water discharges would be required.

This approach would provide permit issuing agencies with an opportunity to initiate storm water permitting efforts and to identify those watersheds impacted by storm water discharges. In addition, this approach would also ensure that storm water discharges in watersheds of sensitive or impacted waters were appropriately evaluated and addressed.

Option 5: Case-by-case monitoring conditions in permits for storm water discharges with no minimum requirement to report monitoring results.

Under this approach, the existing regulations at 40 CFR 122.44(i)(2) would be modified to allow permit writers to require discharge monitoring and reporting on a case-by-case basis. However, under this option, there would be no minimum requirement to submit or otherwise collect discharge monitoring information for most storm water discharges, except for certain facilities, such as those with effluent limitation guidelines for storm water discharges. The existing regulations would be modified to provide minimum requirements for annual monitoring only for certain facilities, such as those with storm water discharges that are subject to national effluent limitation guidelines, those within specified industrial categories, or those that have a storm water discharge that is subject to a numeric or toxicity limitation in a permit that has been established on a case-by-case basis.

Under this option, some facilities may not be required to sample their storm water discharges associated with industrial activity. However, the broad authorities of sections 308 and 402(a)(2) provide other means, such as information collection and reporting, that can ensure compliance with permit conditions. Even under this approach, monitoring programs would play an important role for some facilities in determining compliance with numeric limitations and/or the effectiveness of requirements in a storm water pollution prevention plan that the facility is required to develop under a NPDES permit. However, in other cases, limited storm water sampling data may not provide adequate information regarding the effectiveness of the controls in the storm water pollution prevention plan. (For example, the primary focus of a storm water pollution prevention plan at a facility may be directed towards preventing a catastrophic event like a spill. Where no spill has occurred at the facility, sampling of the storm water discharge would convey little information regarding the effectiveness of the spill controls.)

Option 5 would provide permit writers with the discretion to require the submission of DMRs while limiting burdens on permittees and permit issuing agencies. This option would provide permit writers with the maximum flexibility to adopt a wide range of permit monitoring strategies (including strategies consistent with other options addressed in this notice) on a case-by-case basis. The flexibility in establishing monitoring requirements in permits could significantly reduce the burden that monitoring samples annually would place on permittees.

The Agency also requests comments on whether a minimum regulatory monitoring reporting requirement should be established for storm water discharges from industrial categories that have a high pollutant potential (such as landfills, wood preserving facilities, airports, facilities subject to SARA title III, primary metal manufactures, etc.). Conversely, the Agency requests comments on whether minimum annual monitoring requirements should be developed for all but specified industry groups or for small businesses, and the appropriate basis for excluding such groups from minimum monitoring requirements. For example, small businesses may lack the expertise to conduct sampling or sampling costs may be too high.

Option 6: Case-by-case monitoring conditions in permits for storm water discharges, with a minimum requirement for the first permit for the discharge that monitoring results be reported at least once a year. After a facility has submitted five years of data, monitoring conditions for storm water would be established on a case-by-case basis with no minimum requirement to conduct annual sampling.

Under this approach, the minimum monitoring requirement for permits for storm water discharges associated with industrial activity would change with time. This approach would allow permit writers to evaluate a minimum of five years of storm water monitoring data. This data would assist permit writers in determining appropriate monitoring conditions when reissuing permits. In addition, data collection activities required under the first set of NPDES permits for storm water discharges associated with industrial activity can be used to develop priorities for implementing Tiers II through IV of the long term permitting strategy for storm water discharges.

C. Application Requirements for General Permits

As discussed above, EPA intends to increase its use of general permits to address the expansion of the scope of the NPDES program to address storm water discharges associated with industrial activity as well as other classes of discharges other than storm water, and encourages States with general permit authority to do so as well. The Agency intends to increase the use of general permits to address other sources as well. General permits are an important tool for assuring adequate environmental safeguards for large numbers of similar facilities without the administrative and resource burdens involved in individual permit issuance. In order to improve administration and operation of the general permits program, the Agency is proposing to facilitate and clarify general permit requirements and procedures.

EPA wants to emphasize that, except for the procedural differences set out at § 122.28 in the NPDES regulations, general permits are analogous to individual permits in every respect. General permits are still subject to the same reporting and monitoring

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requirements, limitations, enforcement provisions, penalties, and other substantive requirements as individual permits. General permits should be viewed as an administrative tool enabling the issuance of one permit to authorize a group of dischargers.

Although the general permit program has been available to authorized NPDES States since its inception in 1979, some States have been reluctant to seek and use general permit authority. This has created an administrative dilemma. Even in circumstances where a general permit is appropriate, EPA is unable to issue a general permit in an authorized NPDES State. Of the 39 States with NPDES authorization, 23 have been authorized to issue general permits. In the other 16 authorized NPDES States neither EPA nor the State has the authority to issue general permits.

As discussed above in the storm water context, full individual permit applications (e.g., Form 2C for process discharges or Form 2F for storm water discharges associated with industrial activity) containing a significant amount of site-specific information from each discharger may not be necessary for developing general permits. 40 CFR 122.21(a) excludes persons covered by general permits from requirements to submit individual permit applications. Existing general permit regulations at 40 CFR 122.28, however, do not address the issue of how a potential permittee is to apply to be covered under a general permit. Rather, conditions for filing an application to be covered by a general permit (typically called a Notice of Intent (NOI)) are established on a case-by-case basis.

Under existing practice, general permit coverage is by two methods. First, as applied under federal law and where authorized under State law, the Director may issue a general permit covering a particular class of dischargers (or treatment works treating domestic sewage) informing potential permittees of their coverage by public notice. Second, the Director may issue a general permit where eligible dischargers (or treatment works treating domestic sewage) are not authorized to discharge under the permit until they have submitted a NOI to be covered by the general permit. The public notice for a general permit specifies whether an NOI is required prior to coverage. In almost all cases, general permits require the submittal of NOIs containing basic information such as the name and address of the facility and a brief description of the discharge and receiving water.

NOIs serve a number of functions. NOI requirements in general permits can establish a clear accounting of the number of permittees covered by the general permit, the nature of operations at the facility generating the discharge, and their identity and location. NOIs can be used to develop a data base of facility-specific information. NOIs can be used as a screening tool to identify discharges where individual permits are appropriate. For example, the identification of discharges to impacted receiving waters can be used in the development of water quality-based permit conditions. Also, the NOI can be used to identify classes of discharges appropriate for more specific general permits covering a more limited set of discharges. The NOI can provide information needed by the Director to notify dischargers that a more specific general permit was issued. The NOI also can identify the permittee to provide a basis to develop and implement enforcement and compliance monitoring strategies and priorities. In addition, the administrative burdens on the permitting issuing agency and the costs to dischargers can be reduced by replacing more complicated permit application requirements with simplified requirements.

To encourage the use of general permits, to provide for more consistent NOI requirements, and to ensure that dischargers covered by general permits provide appropriate information, the Agency is proposing to modify the regulatory framework for general permits to provide minimum requirements for NOIs. (These proposed changes would apply to a number of other classes of general permits for non-storm water discharges as well as storm water discharges.)

Proposed § 122.28(b)(2) would require that, at a minimum, NOIs include the legal name and address of the owner or operator, the facility name and address, the number and type of facilities or discharges, the receiving stream(s), and other information necessary to ascertain whether the discharger should be included under the terms of the general permit as specified in the final general permit. This provision would be a minimum requirement. Permits may require additional information where appropriate.

The proposal also provides guidelines for deadlines to submit NOIs. The guidelines recommend that general permits be written to require dischargers to submit NOIs 60 days before the date of intended permit coverage. Under the proposal, the Director may specify different time periods in the general permit for these submissions.

Under the proposal, unless otherwise provided in the permit, dischargers would automatically be authorized to discharge under the general permit by submitting an NOI in accordance with the terms of the permit. This provision would still allow general permits to specify that the permittee must receive notification of coverage under the general permit from the Director before discharges would be authorized.

The proposal provides for two situations where an NOI would not have to be submitted to authorize discharges under a general permit. The first situation is where the Director notifies the discharger that its discharge is covered by the permit. The second situation is where the Director decides that an NOI is inappropriate for a general permit. To make the latter decision, the Director would consider the type of discharge, the expected nature of the discharge, the potential for toxic and conventional pollutants in the discharges, the expected volume of the discharges, other means of identifying discharges covered by the permit, and the estimated number of discharges to be covered by the permit. Also, if this approach is pursued, the Director would be required to describe the reasons for not requiring an NOI in the fact sheet of the general permit. This notice proposes that such a finding could only be made for discharges other than discharges from POTWs, combined sewer overflows (CSOs), primary industrial facilities, contaminated runoff from mining operations or oil and gas operations and other storm water discharges associated with industrial activity. The Agency believes that, given the potential environmental significance and NPDES program priorities associated with discharges from POTWs, CSOs, primary industrial facilities, contaminated runoff from mining operations or oil and gas operations and other storm water discharges associated with industrial activity, it is appropriate to require NOIs in all general permits for these discharges. However, the Agency requests comments on whether general permits without NOI requirements are appropriate for the large number of storm water discharges associated with industrial activity from oil and gas exploration or production operations. Oil and gas exploration or production operations that discharge storm water associated with industrial activity are typically subject to Spill Prevention Control and Countermeasure (SPCC) program requirements at 40 CFR part 112, which may provide an alternative means for tracking these facilities.

Public accessibility to this information would be enhanced by proposed

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§ 122.28(d), which provides that such lists would be available to the public.

D. Fact Sheet for Draft General Permit

The following portion of this notice provides notice for draft NPDES general permits and accompanying fact sheets for storm water discharges associated with industrial activity in AK, AZ, FL, ID, LA, MA, ME, NH, NM, OK, SD, TX, District of Columbia, the Commonwealth of Puerto Rico, Guam, American Samoa, the Commonwealth of the Northern Mariana Islands, and the Trust Territory of the Pacific Islands; on Indian lands in AL, CA, GA, KY, MI, MN, MS, MT, NC, ND, NY, NV, SC, TN, UT, WI and WY; located within Federal facilities and Indian lands in CO and WA; and located within Federal facilities in Delaware. Separate general permits are being noticed for each State. These draft general permits are intended to cover storm water discharges associated with industrial activity to waters of the United States, including discharges through large and medium municipal separate storm sewer systems, and through other municipal separate storm sewer systems. Publication of this draft general permit and fact sheet is designed to comply with the requirements of 40 CFR 124.10 simultaneously for all 35 draft general permits being noticed today. Public hearings on selected permits will be held as indicated at the beginning of this notice.

The language of the draft general permits is provided as an appendix to the preamble of this notice. In general, most conditions of the draft general permits are intended to apply to all of the general permits indicated above. Where conditions in different permits vary, these differences are indicated in the draft general permit in the appendix.

1. Background

In 1972, the Federal Water Pollution Control Act (also referred to as the Clean Water Act (CWA)) was amended to provide that the discharge of any pollutants to waters of the United States from any point source is unlawful, except if the discharge is in compliance with an National Pollutant Discharge Elimination System (NPDES) permit.

For a number of reasons, EPA and authorized NPDES States have failed to issue NPDES permits for the majority of point source discharges of storm water. Recognizing this, Congress added section 402(p) to the CWA in 1987 to establish a comprehensive framework for addressing storm water discharges under the NPDES program. Section 402(p)(4) of the CWA clarifies the requirements for EPA to issue NPDES permits for storm water discharges associated with industrial activity. On November 16, 1990 (55 FR 47990), EPA published final regulations which define the term "storm water discharge associated with industrial activity". The final regulations also establish requirements for submitting individual permit applications and group applications.

EPA estimates that about 100,000 facilities nationwide discharge storm water associated with industrial activity (not including oil and gas exploration and production operations). The large number of facilities addressed by the regulatory definition of "storm water discharge associated with industrial activity" will place correspondingly large administrative burdens on EPA and States with authorized NPDES programs to issue and administer permits for these discharges.

To provide a reasonable and rational approach to addressing this permitting task, the Agency is developing a Strategy for issuing permits for storm water discharges associated with industrial activity. In developing this Strategy, the Agency recognizes that the CWA provides flexibility in the manner in which NPDES permits are issued,[10] and will use this flexibility to design a workable permitting system. In accordance with these considerations, the draft permitting Strategy (described in more detail earlier in today's notice) describes a four-tier set of priorities for issuing permits for these discharges. The four-tier set of priorities for issuing permits under the policy are:

- *Tier I—Baseline Permitting:* One or more general permits will be developed to initially cover the majority of storm water discharges associated with industrial activity;
- *Tier II—Watershed Permitting:* Facilities within watersheds shown to be adversely impacted by storm water discharges associated with industrial activity will be targeted for individual or watershed-specific general permits.
- *Tier III—Industry-Specific Permitting:* Specific industry categories will be targeted for individual or industry-specific general permits; and
- *Tier IV—Facility-Specific Permitting:* A variety of factors will be used to target specific facilities for individual permits.

The draft general permits accompanying this fact sheet will initiate Tier I activities for storm water discharges associated with industrial activity in Alaska, Arizona, Idaho, Louisiana, Massachusetts, Maine, New Hampshire, New Mexico, Oklahoma, South Dakota, Texas, the District of Columbia, the Commonwealth of Puerto Rico, Guam, American Samoa, the Commonwealth of the Northern Mariana Islands, and the Trust Territory of the Pacific Islands; for Federal facilities and Indian lands in Colorado and Washington, and for Indian lands in Alabama, California, Georgia, Kentucky, Michigan, Minnesota, Mississippi, Montana, New York, Nevada, North Carolina, North Dakota, New York, Nevada, South Carolina, Tennessee, Utah, Wisconsin, and Wyoming, and for Federal facilities in Delaware [10] by proposing baseline general permits for the majority of storm water discharges in these States.

In addition to establishing baseline requirements for the majority of storm water discharges associated with industrial activity in these States, the draft general permits have some of the features of Tier III permitting activities in that they establish requirements for specific industries.

Consolidation of many sources and one permit will greatly reduce the otherwise overwhelming administrative burden associated with storm water discharges associated with industrial activity. This approach has a number of additional advantages:

- General requirements will be established for discharges covered by the permit;
- Facilities whose discharges are covered by the permit will have an opportunity to comply with the CWA;
- The Agency will have the opportunity to collect and review data on storm water discharges for priority industries;
- The public will have the opportunity to review data and reports and to comment on permitting activities;
- Applicable requirements of municipal storm water management programs established in permits for

[10] The court in *NRDC v. Train*, 396 F.Supp. 1393 (D.D.C. 1975) *aff'd NRDC v. Costle*, 568 F.2d 1369 (D.C. Cir. 1977), has acknowledged the administrative burden placed on the Agency by requiring permits for a large number of storm water discharges. The courts have recognized EPA's discretion to use certain administrative devices, such as area permits or general permits, to help manage its workload. In addition, the courts have recognized flexibility in the type of permit conditions that can be established, including the use of requirements for best management practices

[10] In 9 of the 39 States that are authorized to issue NPDES permits for municipal and industrial sources, EPA issues permits for discharges from Federal facilities. State programs do not generally address permitting of discharges from Indian lands, so EPA retains this responsibility. However, this fact sheet only addresses general permits as indicated above. Where EPA is the permit issuing authority for other storm water discharges, either individual permits or a different general permit will be issued.

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discharges from municipal separate storm sewer systems will be enforceable directly against noncomplying industrial facilities that generate the discharge;

• The baseline permits will provide a basis for bringing selected enforcement actions by eliminating many issues which might otherwise arise in an enforcement proceeding (e.g., clarifying requirement to obtain NPDES permit coverage); and

• Finally, the baseline permit will provide a focus for public comment on developing subsequent phases of the permitting strategy for storm water discharges, including the priorities for State storm water management programs developed under section 402(p)(6) of the CWA.

Initially, the coverage of the baseline permits will be broad, but will decrease as other permits are issued for storm water discharges associated with industrial activities pursuant to Tier II through IV activities.

2. Types of Discharges Covered

On November 16, 1990, (55 FR 47990), EPA promulgated the regulatory definition of "storm water discharges associated with industrial activity" which addresses point source discharges of storm water from eleven major categories of facilities. (This definition is reprinted in the definition section of the draft general permits found in the Appendix of today's notice).

The draft general permits do not cover storm water discharges associated with industrial activity from inactive mining or inactive oil and gas operations occurring on Federal lands where an operator cannot be identified. Given the long history of mining activity on the extensive tracts of Federal lands, and the relationship of the Federal land management Agencies to prior operators of these sites, the Agency believes that a distinct set of permits are generally appropriate to control pollutants in storm water discharges from these sites. EPA is currently working with a number of Federal land management Agencies, including the Bureau of Land Management and the Forest Service, to develop permits to address the unique circumstances associated with these sites in an appropriate manner.

3. Description of Discharges Covered

The volume and quality of storm water discharges associated with industrial activity will depend on a number of factors, including the industrial activities occurring at the facility, the nature of precipitation, and the degree of surface imperviousness. Rain water may pick up pollutants from structures and other surfaces as it drains from the land. In addition, sources of pollutants other than storm water, such as illicit connections,[20] spills, and other improperly dumped materials may increase the pollutant loads discharged from separate storm sewers. The sources which contribute pollutants to storm water discharges differ with the type of industry operation and facility-specific features. For example, air emissions may be a significant source of pollutants at some facilities, material storage operations may be important at different operations, while other facilities may discharge storm water associated with industrial activity with relatively low levels of pollutants.

The most extensively studied storm water discharges have been those from residential and commercial areas (urban runoff). Evaluating these discharges will provide a starting point for understanding the pollutants that can be expected in storm water discharges associated with industrial activity.

[20] Illicit connections are point source discharges of pollutants that are not composed entirely of storm water, that are not covered by an existing NPDES permit, and which are discharged through separate storm sewers to waters of the United States.

Many storm water discharges are expected to contain the pollutants typically associated with urban runoff, along with additional pollutants that result from the specific industrial operations of the facility.

From 1978 through 1983, EPA provided funding and guidance to the Nationwide Urban Runoff Program (NURP) to study the nature of runoff from commercial and residential areas. The NURP program included 28 projects across the Nation, conducted separately at the local level but centrally reviewed, coordinated, and guided.

One focus of the NURP program was to characterize the water quality of discharges from separate storm sewers which drain residential, commercial, and light industrial (industrial parks) sites. The majority of samples collected in the NURP study were analyzed for seven conventional pollutants and three metals. Table 1 summarizes the pollutant concentrations from the NURP data base is presented in Table 1 for these 10 constituents and fecal coliform. Data collected in NURP indicated that on an annual loading basis, suspended solids in discharges from separate storm sewers draining runoff from residential, commercial and light industrial areas are around an order of magnitude or more greater than effluent from sewage treatment plants receiving secondary treatment. The study also indicated that annual loadings of chemical oxygen demand (COD) are comparable to effluent from sewage treatment plants receiving secondary treatment. When analyzing annual loadings associated with urban runoff, it is important to recognize that discharges of urban runoff are highly intermittent, and that the short-term loadings associated with individual events will be high and may have shock loading effects on receiving water such as sag in dissolved oxygen levels.

TABLE 1.—QUALITY CHARACTERISTICS OF RUNOFF FROM RESIDENTIAL AND COMMERCIAL AREAS

Constituent	Average residential or commercial site concentration	Weighted mean residential or commercial site concentration	NURP recommendations for load estimates
TSS	238 mg/l	180 mg/l	180–648 mg/l
BOD	12 mg/l	12 mg/l	12–18 mg/l
COD	84 mg/l	82 mg/l	83–178 mg/l
Total phosphorus	0.6 mg/l	0.42 mg/l	0.42–0.86 mg/l
Soluble phosphorus	0.18 mg/l	0.15 mg/l	0.15–0.26 mg/l
Total Kjeldahl nitrogen	2.3 mg/l	1.80 mg/l	1.80–4.18 mg/l
Nitrate-nitrite	1.37 mg/l	0.68 mg/l	0.86–2.31 mg/l
Total copper	53 µg/l	43 µg/l	43–118 µg/l
Total lead	238 µg/l	182 µg/l	182–443 µg/l
Total zinc	363 µg/l	202 µg/l	202–633 µg/l
Fecal coliform:			
Warm weather	80,240 counts/.00 ml	27,806 counts/100 ml	
Cold weather	22,918 counts/100 ml	7,057 counts/100 ml	

Source: Developed from *Results of the Nationwide Urban Runoff Program, Vol. I—Final Report*, EPA 1983.

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The NURP program also involved monitoring 120 priority pollutants. Seventy-seven priority pollutants were detected in samples of storm water discharges from residential, commercial, and light industrial lands taken during the NURP study, including 14 inorganic and 63 organic pollutants. Table 2 shows the priority pollutants that were detected in at least ten percent of the discharge samples that were sampled for priority pollutants. The NURP data also showed a significant number of these samples exceeded various freshwater water quality criteria.

Although NURP did not evaluate oil and grease, other studies have demonstrated that urban runoff is an extremely important source of oil pollution to receiving waters, with hydrocarbon levels in urban runoff typically being reported at a range of 2 mg/l to 10 mg/l. These hydrocarbons tend to accumulate in bottom sediments where they may persist for long periods of time, and exert adverse impacts on benthic organisms.

TABLE 2.—PRIORITY POLLUTANTS DETECTED IN AT LEAST 10% OF NURP SAMPLES

	Frequency of detection (percent)
Metals and inorganics:	
Antimony	13
Arsenic	52
Beryllium	12
Cadmium	48
Chromium	58
Copper	91
Cyanides	23
Lead	84
Nickel	43
Selenium	11
Zinc	84
Pesticides:	
Alpha-hexachlorocyclohexane	20
Alpha-endosulfan	19
Chlordane	17
Lindane	15
Halogenated aliphatics: Methane dichloro-	11
Phenols and cresols:	
Phenol	14
Phenol, pentachloro-	19
Phenol, 4-nitro	10
Phthalate esters: Phthalate, bis(2-ethylhexyl)	22
Polycyclic aromatic hydrocarbons:	
Chrysene	10
Fluoranthene	16
Phenanthrene	12
Pyrene	15

Other studies have shown that many storm sewers contain illicit discharges of non-storm water, and that large amounts of wastes are disposed improperly in storm sewers. Removal of these discharges present opportunities for dramatic improvements in the quality of storm water discharges. Storm water discharges from industrial facilities may contain, in addition to illicit connections and improperly disposed wastes, toxics and conventional pollutants when material management practices allow exposure to storm water.

In some municipalities, illicit connections of sanitary, commercial, and industrial discharges to storm sewer systems have had a significant impact on the water quality of receiving waters. Although the NURP study did not characterize illicit connections to storm sewers other than to ensure that monitoring sites used in the study were free from sanitary sewage contamination, the study concluded that illicit connections can result in high bacterial counts and dangers to public health.

Studies have shown that illicit connections to storm sewers can create severe, widespread contamination problems. For example, the Huron River Pollution Abatement Program inspected 860 businesses, homes, and other buildings located in Washtenaw County, Michigan. The program identified that 14 percent of the buildings had improper storm drain connections. Illicit discharges were detected at a higher rate of 80 percent for automobile-related businesses, including service stations, automobile dealerships, car washes, body shops, and light industrial facilities. While some of the problems discovered in this study were due to improper plumbing or illegal connections, a majority were approved connections at the time they were built, but have since become unlawful discharges.

Intensive construction activities may result in severe localized impacts on water quality because of high unit loads of pollutants, primarily sediments. Construction sites can also generate other pollutants such as phosphorus and nitrogen from fertilizer, pesticides, petroleum products, construction chemicals, and solid wastes. These materials can be toxic to aquatic organisms and degrade water for drinking and water-contact recreation. Sediment runoff rates from construction sites are typically 10 to 20 times that of agricultural lands, with runoff rates as high as 100 times that of agricultural lands, and typically 1,000 to 2,000 times that of forest lands. Even a small amount of construction may have a significant negative impact on water quality in localized areas. Over a short period of time, construction sites can contribute more sediment to streams than was deposited previously over several decades.

The NURP study and other studies of urban runoff provide insight on what can be considered background levels of pollutants for urban runoff, as these studies have focused primarily on monitoring runoff from residential, commercial, and light industrial areas. However, NURP concluded that the quality of urban runoff can be impacted adversely by several sources of pollutants that were not evaluated directly in the study and which are generally not reflected in the NURP data, such as illicit connections, construction site runoff, industrial site runoff and illegal dumping.

For some industrial facilities, the types and concentrations of pollutants in storm water discharges will be similar to the types and concentrations of pollutants generally found in storm water discharges from residential and commercial areas. However, storm water discharges from other industrial facilities will have a significant potential for higher pollutant levels. In addition, pollutant loadings per unit area from some industrial facilities may be high because of a high degree of imperviousness.

Six activities can be identified as major potential sources of pollutants in storm water discharges associated with industrial activity: (1) Loading or unloading of dry bulk materials or liquids; (2) outdoor storage of raw materials or products; (3) outdoor process activities; (4) dust or particulate generating processes; (5) illicit connections or management practices; and (6) waste disposal practices. The potential for pollution from many of these activities may be influenced by the use and presence of toxic chemicals. These activities are discussed in more detail below.

(1) Loading and unloading operations typically are performed along facility access roads, railways, and at loading/unloading docks and terminals. These operations include pumping of liquids or gases from truck or rail car to a storage facility or vice versa, pneumatic transfer of dry chemicals to or from the loading or unloading vehicle, transfer by mechanical conveyor systems, and transfer of bags, boxes, drums, or other containers from vehicle by forklift trucks or other materials handling equipment. Material spills or losses in areas can

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discharge directly to the storm drainage systems, or may accumulate in soils or on surfaces, and be washed away during a storm event or facility washdowns.

(2) Outdoor storage activities include the storage of fuels, raw materials, byproducts, intermediates, final products, and process residuals. Storage can be accomplished in various ways, for example, using storage containers (e.g., drums or tanks), platforms or pads, bins, silos, boxes, or piles. Materials, containers, and material storage areas that are exposed to rainfall and/or runoff can contribute pollutants to storm water when solid materials wash off or materials dissolve into solution.

(3) Other outdoor activities include certain types of manufacturing and commercial operations and land-disturbing operations. Although many manufacturing activities are performed indoors, some activities, such as timber processing, rock crushing, and concrete mixing, typically occur outdoors. Processing operations can result in liquid spillage and losses of material solids to the drainage system or surrounding surfaces, or creation of dusts or aerosols, which can be deposited locally. Some outdoor industrial activities cause substantial physical disturbance of land surfaces that result in soil erosion by storm water.

Examples where disturbed land occurs include construction and mining. Disturbed land can result in soil losses and other pollutant loadings associated with increased runoff rates. Facilities whose major process activities are conducted indoors may still apply chemicals such as herbicides, pesticides, and fertilizer outdoors for a variety of purposes.

(4) Dust or particulate generating processes include industrial activities with stack emissions or process dusts that settle on plant surfaces. Localized atmospheric deposition is a particular concern with heavy manufacturing industries. For example, monitoring of areas surrounding smelting industries has shown much higher levels of metals at sites nearest the smelter (Bearington 1977). Other industrial sites, such as mines, cement manufacturing, and refractories, will generate significant levels of dusts.

(5) Illicit connections or inappropriate management practices result in improper non-storm water discharges to storm sewer systems. The likelihood of illicit discharges to storm water collection systems is expected to increase for older facilities as well as for those facilities that use high volumes of process water or that dispose of significant amounts of liquid wastes, including process waste waters, cooling waters, and rinse waters.

Pollutants from non-storm water discharges to the storm sewer system of individual facilities are caused typically by a combination of improper connections, spills, improper dumping, and a belief that the absence of visible solids in a discharge is equivalent to the absence of pollution. Illicit connections are often associated with floor drains that are connected to separate storm sewers. Rinse waters used to clean or cool objects discharge to floor drains that may be connected to separate storm sewers. Large amounts of rinse waters may originate from industries that use regular wash down procedures; for example, bottling plants use rinse waters for removing waste products, debris, and labels. Rinse waters can be used to cool materials by dipping, washing, or spraying objects with cool water, for example, rinse water is sometimes sprayed over the final products of a metal plating facility for cooling purposes. Condensate return lines of heat exchangers often discharge to floor drains. Heat exchangers, particularly those used under stressed conditions such as in the metal finishing and electroplating industry, typically develop pin-hole leaks, which may result in contamination of condensate by process wastes. These and other non-storm water discharges to a storm sewer may be intentional, based on the belief that the discharge (condensate in the example previously discussed), does not contain pollutants, or it may be inadvertent, as the operator may be unaware that a floor drain is connected to the storm sewer.

(6) Waste management practices include operating landfills, waste piles, and land application sites that involve land disposal. Outdoor waste treatment operations also include waste water and solid waste treatment and disposal processes, such as waste pumping, additions of treatment chemicals, mixing, aeration, clarification, and solids dewatering. Facilities often conduct some waste management on site.

Coal pile runoff. The following description of coal pile runoff is summarized from the "Final Development Document for Effluent Limitations Guidelines and Standards and Pretreatment Standards for the Steam Electric Point Source Category", (EPA-440/1-82/029), EPA, November 1982. A more complete description of coal pile runoff can be found in the Development Document.

The pollutants in coal pile runoff can be classified into specific types according to chemical characteristics. The type relates to pH of the coal pile drainage. The pH tends to be of an acidic nature, primarily as a result of the oxidation of iron sulfide in the presence of oxygen and water. The potential influence of pH on the behavior of toxic and heavy metals is of particular concern. Many of the metals are amphoteric with regard to their solubility behavior. The factors affecting acidity, pH and the subsequent leaching of trace metals are:

- Concentration and form of pyritic sulfur in coal;
- Size of the coal pile;
- Method of coal preparation and clearing prior to storage;
- Climatic conditions, including rainfall and temperature;
- Concentrations of $CaCO_3$ and other neutralizing substances in the coal;
- Concentration and form of trace metals in the coal; and
- The residence time in the coal pile.

Table 3 shows data of selected pollutants in coal pile runoff at two steam electric plants. Both facilities generated runoff with low pH values, with the acid values being quite variable in both cases. The suspended solids levels observed went up to 2,500 mg/l. The metals present in the greatest concentrations were copper, iron, aluminum, nickel and zinc. Others present in trace amounts include chromium, cadmium, mercury, arsenic, selenium, and beryllium.

TABLE 3.—POLLUTANTS IN COAL PILE RUNOFF

Plant	pH	Acidity (mg/l $CaCO_3$)	Sulfate (mg/l)	Dissolved solids (mg/l)	Total suspended solids (mg/l)	Mn (mg/l)
1 Range	2.3–3.1	300–7100	1800–9600	2500–16000	8–2300	8.9–45
Mean	2.8	3400	5180	7900	470	28.7
N	18	18	18	18	18	18

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TABLE 3.—POLLUTANTS IN COAL PILE RUNOFF—Continued

Plant	pH	Acidity (mg/l CaCO)	Sulfate (mg/l)	Dissolved solids (mg/l)	Total suspended solids (mg/l)	Mn (mg/l)
2 Range	2.5–3.1	980–2100	1800–4000	2900–5000	88–270	2.4–10
Mean	2.7	1380	2780	3600	190	4.1
N	6	6	6	6	6	6
2 [1] Range	2.5–2.7	800–1400	870–5500	1200–7300	90–2500	0.9–5.4
Mean	2.6	710	2300	2700	650	2.3
N	14	14	14	14	14	14
	Cu (mg/l)	Zn (mg/l)	Al (mg/l)	Ni (mg/l)	Fe (mg/l)	As (mg/l)
1 Range	0.43–1.4	2.3–16	66–440	0.74–04.5	240–1800	.005–0.6
Mean	0.86	6.68	260	2.59	940	0.17
N	19	19	19	19	19	19
2 Range	0.01–0.46	1.1–8.7	22–60	0.24–0.46	280–480	.0008–0.046
Mean	0.23	2.18	43.3	0.33	380	0.02
N	6	6	6	6	6	4
	Cr (mg/l)	Hg (mg/l)	Se (mg/l)	Be (mg/l)	Cd (mg/l)	
1 Range	<0.005–.011	<.0002–.0025	<.001–.03	<.001–.03	<.001	
Mean	.007	.0004	0.006	0.044	<.001	
N	17	20	16	16	19	
ND	11	12	4	0	18	
2 Range	<0.005–.011	<.001–.001	<.01–.03	<.001–.003	<0.001–.003	
Mean	0.007	0.001	0.014	0.002	0.002	
N	6	4	4	6	6	
ND	3	3	3	2	2	

N=Number of samples
ND=Below detection levels

Source: Final Development Document for Effluent Limitations Guidelines and Standards and Pretreatment Standards for the Steam Electric Point Source Category. (EPA-440/1-82/029), EPA, November 1982.

[1] Discrete Storm.

4. Summary of Options for Controlling Pollutants

Options for controlling pollutants in storm water discharges associated with industrial activities (other than from construction activities) will be discussed in terms of two major pollutant sources: (1) Materials discharged to separate storm sewers via illicit connections, improper dumping, and spills; and (2) pollutants associated with runoff collected by separate storm sewers. Options for controlling pollutants in storm water discharges associated with industrial activities from construction activities are addressed separately.

a. *Non-storm water discharges to separate storm sewers.* As discussed earlier, in some cases, a substantial portion of the pollutant load from separate storm sewers which discharge storm water associated with industrial activity is associated with non-storm water discharges. Non-storm water discharges to separate storm sewers include a wide variety of sources, including illicit connections, improper dumping, spills, or leakage from storage tanks and transfer areas. Measures to control spills and visible leakage can be incorporated into storm water pollution prevention plans (see below).

In many cases, operators of industrial facilities may be unaware of illicit discharges or leakage from underground storage tanks or other non-visible systems. In some cases, illicit connections to storm sewers were installed before their legal prohibition, and forgotten about. For example, illicit connections are often associated with floor drains that are connected to separate storm sewers. Rinse waters used to clean or cool objects, and other process wastewaters may be discharged to the separate storm sewer by an improperly connected floor drain. These non-storm water discharges to a storm sewer may be inadvertent with the operator unaware that the floor drain is connected to the storm sewer. In this case, the key to controlling these discharges is to identify them.

Methods to identify non-storm water discharges to separate storm sewers. Several methods for identifying the presence of non-storm water discharges are discussed below.[21 22] A comprehensive evaluation of the storm sewers at a facility may incorporate several methods.

[21 22] A more complete discussion of methods to identify illicit connections can be found in the draft "Manual of Practice Identification of Illicit Connections", U.S. EPA, Sept. 1990

• *Schematics.* Where they exist, accurate piping schematics can be inspected as a first step in evaluating the integrity of the separate storm sewer system. The use of schematics is limited because schematics usually reflect the design of the piping system and may not reflect the actual configuration constructed. Schematics should be updated or corrected based on additional information found during inspections.

• *Evaluation of drainage map and inspections.* Drainage maps should identify the key features of the drainage system: each of the inlet and discharge structures, the drainage area of each inlet structure, and units such as storage or disposal units or material loading areas, which may be the source of an illicit discharge or improper dumping. In addition, floor drains and other water disposal inlets that are thought to be connected to the sanitary sewer can be identified. A site inspection can be used to augment and verify map development. These inspections, along with the use of the drainage map, can be coordinated with other best management practices discussed below.

• *End-of-pipe screening.* Discharge points or other access points such as manhole covers can be inspected for th

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presence of dry weather discharges and other signs of non-storm water discharges. Dry weather flows can be screened by a variety of methods. Inexpensive onsite tests include measuring pH; observing for oil sheens, scums and discoloration of pipes and other structures; as well as colorimetric detection tests for chlorine, detergents, metals and other parameters. In some cases, it may be appropriate to collect samples for more expensive analysis in a laboratory for fecal coliform, fecal streptococcus, conventional pollutants, volatile organic carbon, or other appropriate parameters.

• *Water balance.* Many sewage treatment plants require that industrial discharges measure the volume of effluent discharged to the sanitary sewer system. Similarly, the volume of water supplied to a facility is generally measured. A significantly higher volume of water supplied to the facility relative to that discharged to the sanitary sewer and other consumptive uses may be an indication of illicit connections. This method is limited by the accuracy of the flow meters used.

• *Dry weather testing.* Where storm sewers do not discharge during dry weather conditions, water can be introduced into floor drains, toilets and other points where non-storm water discharges are collected. Storm drain outlets are then observed for possible discharges.

• *Dye testing.* Dry weather discharges from storm sewers can occur for a number of legitimate reasons including ground water infiltration or the presence of a continuous discharge subject to an NPDES permit. Where storm sewers do have a discharge during dry weather conditions, dye testing for illicit connections can be used. Dye testing involves introducing fluorometric or other types of dyes into floor drains, toilets and other points where non-storm water discharges are collected. Storm drain outlets are then observed for possible discharges.

• *Manhole and Internal TV Inspection.* Physical inspection of manholes and internal inspection of storm sewers either physically or by television are used to identify potential entry points for illicit connections. Dry weather flows, material deposits, and stains are often indicators of illicit connections. TV inspections are relatively expensive and generally should be used only after a storm sewer has been identified as having illicit connections.

b. *Options for preventing pollutants in storm water.* The following five categories describe options for reducing pollutants in storm water discharges from industrial plants:

(i) Providing end-of-pipe treatment;

(ii) Implementing Best Management Practices to prevent pollution;

(iii) Diverting storm water discharge to municipal sewage treatment plants;

(iv) Using traditional storm water management practices; and

(v) Eliminating pollution sources.

A comprehensive storm water management program for a given plant may include controls from each of these categories. Development of comprehensive control strategies should be based on a consideration of plant characteristics.

i. *End-of-pipe treatment.* End-of-pipe treatment requirements are typically imposed through numeric effluent limitations, which provide the discharger with flexibility to design the most cost effective type of treatment for the given facility.

At many types of industrial facilities, it may be appropriate to collect and treat the runoff from targeted areas of the facility. This approach was taken with 10 industrial categories with national effluent guideline limitations for storm water discharges. There are several basic similarities among the national effluent guideline limitations for storm water discharges:

• To meet the numeric effluent limitation, most, if not all, facilities must collect and temporarily store onsite runoff from targeted areas of the plant;

• The effluent guideline limitations do not apply to discharges whenever rainfall events, either chronic or catastrophic, cause an overflow of storage devices designed, constructed, and operated to contain a design storm. The 10-year, 24-hour storm, or the 25-year, 24-hour storm commonly are used as the design storm in the effluent guideline limitations; and

• Most technology-based treatment standards are based on relatively simple technologies such as settling of solids, neutralization, and drum filtration. Potential ground water impacts should also be considered by operators when designing storage devices.

ii. *Best management practices.* The term best management practices (BMPs) can describe a wide range of management procedures, schedules of activities, prohibitions on practices, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include operating procedures, treatment requirements and practices to control plant site runoff, drainage from raw materials storage, spills or leaks. BMPs can be established in two ways: BMP plans and site or pollutant-specific BMPs.

BMP plans. EPA has worked with industry to identify the generic BMPs which most well-operated facilities use for pollution control, fire prevention, occupational safety and health, or product loss prevention. EPA often establishes NPDES permit conditions that require generic BMPs to be identified and implemented through BMP plans. Many of the BMPs in a typical BMP plan involve planning, reporting, training, preventive maintenance, and good housekeeping.

Many industrial facilities currently employ BMPs as part of normal plant operation. For example, preventive maintenance and good housekeeping are routinely used in the chemical and related industries to reduce equipment downtime and to promote a safe work environment for employees. Good housekeeping BMPs generally are aimed at preventing spills and similar environmental incidents by stressing the importance of proper management and employee awareness. Experience has shown that many spills of hazardous chemicals can be attributed, in one way or another, to human error. Improper procedures, lack of training, and poor engineering are among the major causes of spills. Experience has shown that BMPs can be used appropriately and BMP plans can effectively reduce pollutant discharges in a cost-effective manner. BMP plans should reflect requirements for Spill Prevention Control and Countermeasure (SPCC) plans required under section 311 of the CWA, and many incorporate any part of the SPCC plan into the BMP plan by reference. BMP plans should also ensure that solid and hazardous waste is managed in accordance with requirements established under the Resource Conservation and Recovery Act (RCRA). Management practices required under RCRA should be expressly incorporated into the BMP plan.

In addition, each of the following nine specific requirements should be addressed in the BMP plan to reduce pollutants in runoff from the plant:

- Statement of policy;
- Spill Control Committee;
- Material inventory;
- Material compatibility;
- Employee training;
- Visual inspections;
- Preventive maintenance;
- Reporting and notification procedures;
- Housekeeping;
- Security.

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Additional technical information on BMPs and the elements of a BMP plan is contained in the publication entitled "NPDES Best Management Practices Guidance Document," U.S. EPA, June 1991.

Site or pollutant-specific best management practices. In addition to the requirements of BMP plans discussed above, more advance site or pollutant-specific BMP requirements can be developed. The following four categories described these site or pollutant-specific BMPs:

- Prevention;
- Containment;
- Mitigation;
- Ultimate Disposition.

Table 4 lists BMPs associated with each category. Requirements for SPCC plans for oil pollution prevention (see 40 CFR part 112) illustrate how pollutant-specific BMPs can be implemented.

TABLE 4.—ADVANCED BMP ALTERNATIVES

Prevention	Containment	Mitigation		Waste disposal
		Cleanup	Treatment	
Monitoring	Secondary containment	Physical	Liquid-solids separation	Landfill.
Nonstructurative	Flow diversion to secondary containment.	Mechanical	Volatilization	Land treatment.
Labeling	Vapor control	Chemical	Coagulation/precipitation	Reclamation.
Covering	Dust control		Neutralization	Discharge to surface water.
Pneumatic and vacuum conveying.	Sealing		Ion exchange	Deep well injection.
Vehicle positioning			Chemical oxidation	Discharge to POTW.
Dry cleanup			Biological treatment	Offsite disposal.
			Thermal oxidation	

iii. *Diversion of discharge to sewage treatment plant.* Where storm water discharges contain significant amounts of pollutants that can be removed by a sewage treatment plant, the storm water discharge can be discharged to the sanitary sewage system. Such diversions must be coordinated with the operators of the sewage treatment plant and the collection system to avoid worsening problems with either combined sewer overflows (CSOs), basement flooding or wet weather operation of the treatment plant. Where CSO discharges, flooding or plant operation problems can result, onsite storage followed by a controlled release during dry weather conditions may be considered.

iv. *Traditional storm water management practices.* In some situations, traditional storm water management practices such as grass swales, catch basin design and maintenance, infiltration devices, unlined retention or detention basins, water reuse, and oil and grit separators can be applied to an industrial setting. However, care must be taken to evaluate the potential of many of these traditional devices for ground water contamination. In some cases, it is appropriate to limit traditional storm water management practices to those areas of the drainage system that generate storm water with relatively low levels of pollutants (e.g., many rooftops, parking lots, etc.). At facilities located in northern areas of the country, snow removal activities may play an important role in a storm water management program. In addition, other types of controls such as spill prevention measures can be considered to prevent catastrophic events that can lead to surface or ground water contamination.

v. *Elimination of pollution sources.* In some cases, the elimination of pollution source may be the most cost-effective way to control pollutants in storm water discharges associated with industrial activity. Options for eliminating pollution sources include reducing onsite air emissions affecting runoff quality, changing chemicals used at the facility, and modification of material management practices such as moving storage areas into buildings.

c. Options for Controlling Pollutants in Storm Water Discharges Associated With Industrial Activity From Construction Activities.

Most controls for construction activities can be broken into two groups: (1) Sediment and erosion controls; and (2) storm water controls. Sediment and erosion controls are generally those controls which address pollutants in storm water generated from the site during the time when construction activities are occurring. Storm water controls are generally those controls which are installed during the construction process, but primarily result in reductions of pollutants in storm water discharged from the site after the construction has been completed. Additional measures can be classified as housekeeping best management practices.

(i) *Sediment and erosion controls.* Erosion controls provide the first line of defense in preventing off-site sediment movement and are designed to prevent erosion by protecting soils. Sediment controls are designed to remove sediment from runoff before the runoff is discharged from the site. Sediment and erosion controls can be further divided into two major classes of controls: vegetative practices and structural practices. Major types of sediment and erosion practices are summarized below. A more complete description of these practices is described in "Draft—Sediment and Erosion Control, An Inventory of Current Practices", U.S. EPA, OWEC, April 20, 1990.

(A) *Sediment and erosion controls: vegetative practices.* Vegetation, as discussed here, refers to covering or maintaining an existing cover over soils. The cover may be grass, trees, vines, shrubs, bark, mulch or straw. The establishment and maintenance of vegetation are one of the most important factors in minimizing erosion while construction activities are occurring. A vegetation cover reduces the erosion potential of a site by: Absorbing the kinetic energy of raindrops which would otherwise impact soil; intercepting water so it can infiltrate into the ground instead of running off carrying surface soils; and by slowing the velocity of runoff promoting deposition of sediment in the runoff. Vegetative controls are often the most important measures taken to prevent off-site sediment movement, and can provide a six-fold

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reduction in discharge suspended sediment levels.[85]

Temporary seeding. Temporary seeding provides for temporary stabilization by establishing vegetation of areas of the site which will be disturbed at some time during the construction operation, and where work (other than the initial disturbance) is not conducted until some time later in the project. Soils at these areas may be exposed to precipitation for an extended time period, even though work is not occurring on these areas. In most climates, temporary seeding is typically appropriate for areas exposed by grading or clearing for more than seven to fourteen days. Temporary seeding practices have been found to be up to 95% effective in reducing erosion.[86]

Permanent seeding. Permanent seeding involves establishing a sustainable ground cover at a site. Permanent seeding stabilizes the soil to reduce sediment in runoff from the site. Permanent seeding is typically required at most sites for aesthetic reasons.

Mulching. Mulching is typically conducted as part of permanent and temporary seeding practices. Where temporary and permanent seeding is not feasible, exposed soils can be stabilized by applying plant residues or other suitable materials to the soil surface. Although generally not as effective as seeding practices, mulching, by itself, does provide some erosion control. Mulching in conjunction with seeding practices provides erosion protection prior to the onset of vegetation growth. In addition, mulching protects seeding practices, providing a higher likelihood of their success. To maintain optimum effectiveness, mulches must be anchored to resist wind displacement.

Sod stabilization. Sod stabilization involves establishing long-term stands of grass with sod in sediment producing areas. When installed and maintained properly, sodding can be 99% effective in reducing erosion,[86] making it the most effective vegetation practice available. The higher cost of sod stabilization relative to other vegetative controls typically limits its use to exposed soils where a quick vegetative cover is desired and on sites which can be maintained with ground equipment. In addition, sod is sensitive to climate and may require intensive watering and fertilizing.

Vegetative buffer strips. Vegetative buffer strips are preserved or planted strips of vegetation at the top and bottom of a slope, outlining property boundaries, or adjacent to receiving waters such as streams or wetlands. Vegetative buffer strips can slow runoff flows at critical areas, decreasing erosion and allowing sediment deposition.

Protection of trees. This practice involves preserving and protecting selected trees that were on the site prior to development. Mature trees have extensive canopy and root systems which help to hold soil in place. Shade trees also keep soil from drying rapidly and becoming susceptible to erosion. Measures taken to protect trees can vary significantly, from simple measures such as installing tree fencing around the drip line and installing tree armoring, to more complex measures such as building retaining walls and tree wells.

(B) *Sediment and erosion controls: structural practices.* Structural practices involve the installation of devices to divert flow, store flow or limit runoff. Structural practices can have several objectives. First, structural practices can be designed to prevent water from crossing disturbed areas where sediment may be removed. This involves diverting runoff from undisturbed upslopes areas by use of earth dikes, temporary swales, perimeter dike/swales, or diversions that outlet in stable areas. A second objective of structural practices can be to remove sediment from site runoff before the runoff leaves the site. Several approaches to removing sediment from site runoff include diverting flows to a trapping or storage device, or filtering diffuse flow through straw bale dikes, silt fences, or brush barriers before it leaves the site. All structural practices require proper maintenance (removal of sediment) to remain functional.

Earth dike. Earth dikes are temporary berms or ridges of compacted soil which channel water to a desired location. Earth dikes should be stabilized with vegetation.

Straw bale dikes. Straw bales are temporary barriers of straw or similar material used to intercept sediment in runoff from small drainage areas of disturbed soil. When installed and maintained properly, straw bale dikes can remove approximately 87% of the sediment in runoff.[88] This optimum efficiency can only be achieved through careful maintenance with special attention to replacing rotten or broken bales.

Silt fence. Silt fences are a barrier of geotextile fabric (filter cloth) used to intercept sediment in diffuse runoff. Care must be taken in maintaining silt fences with an emphasis on maintaining the structural stability of the silt fence and removal of excessive sedimentation.

Brush barriers. Brush barriers are sediment barriers composed of tree limbs, weeds, vines, root mat, soil, rock and other cleared materials placed at the toe of a slope.

Drainage swales. A drainage swale is a drainage way with a lining of grass, riprap, asphalt, concrete, or other materials. Drainage swales are installed to convey runoff without causing erosion.

Check dams. Check dams are small temporary dams constructed across a swale or drainage ditch to reduce the velocity of runoff flows, thereby reducing erosion of the swale or ditch. Check dams should not be used in a live stream. Check dams reduce the need for more stringent erosion control practices in the swale due to the decreased velocity and energy of runoff. Materials, which can be used to install a check dam include rock, logs and covered straw bales.

Level spreader. Level spreaders are outlets for dikes and diversions consisting of an excavated depression constructed at zero grade across a slope. Level spreaders convert concentrated runoff into diffuse runoff and release it onto areas stabilized by existing vegetation.

Subsurface drain. Subsurface drains transport water to an area where it can be managed effectively. Drains can be made of tile, pipe or tubing.

Pipe slope drain. A pipe slope drain is a temporary structure placed from the top of a slope to the bottom of a slope to convey surface runoff down slopes without causing erosion.

Temporary storm drain diversion. Temporary storm drain diversions are used to re-direct flow in a storm drain to discharge into a sediment trapping device.

Storm drain inlet protection. Storm drain inlet protection can be provided by a sediment filter or an excavated impounding area around a storm drain inlet. These devices prevent sediment from entering storm drainage systems prior to permanent stabilization of the disturbed area.

Rock outlet protection. Rock protection placed at the outlet end of culverts or channels can reduce the

[85] "Performance of Current Sediment Control Measures at Maryland Construction Sites", January 1980. Metropolitan Washington Council of Governments.

[86] "Guides for Erosion and Sediment Control in California", USDA—Soil Conservation Service, Davis CA. Revised 1988.

[87] "Guides for Erosion and Sediment Control in California", USDA—Soil Conservation Service, Davis, CA. Revised 1988.

[88] "Draft—Sediment and Erosion Control. An Inventory of Current Practices", U.S. EPA, OWEC, April 20, 1990.

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depth, velocity and energy of water such that the flow will not erode the receiving downstream reach.

Sediment traps. Sediment traps can be installed in a drainageway, at a storm drain inlet, or other points of discharge from a disturbed area.

Other controls. Other controls include temporary sediment basins, sump pits, entrance stabilization measures, waterway crossings, and wind breaks.

(ii) *Storm water management controls.* Storm water controls are generally those controls which are installed during the construction process, but primarily result in reductions of pollutants in storm water discharged from the site after the construction has been completed. Construction activities often result in a significant change in land use. These changes in land use typically involve an increase in the overall imperviousness of the site, which can result in dramatic changes to the runoff patterns of a site. As the amount of runoff from a site increases, the amount of pollutants carried by the runoff increases. In addition, activities such as automobile travel on roads can result in higher pollutant concentrations in runoff than preconstruction levels. Traditional storm water management controls do not influence the change in land use associated with construction. Rather, traditional storm water management controls attempt to limit the increases in the amount of runoff and the amount of pollutants discharged from a site associated with the change in land use.

Major classes of storm water management controls include: infiltration of runoff onsite; flow attenuation by vegetation or natural depressions; outfall velocity dissipation devices; storm water retention structures and artificial wetlands; and storm water detention structures. For many sites, a combination of these controls may be appropriate. A summary of storm water management controls is provided below. A more complete description of storm water management controls is found in "Draft—Construction Site Storm Water Discharge Control—An Inventory of Practices", EPA, OWEC, 1991.

(A) *Infiltration of runoff onsite.* A variety of infiltration technologies can be used to reduce the volume and pollutant loadings of storm water discharges from a site, including infiltration trenches and infiltration basins. Infiltration devises tend to mitigate changes to pre-development hydrologic conditions. Properly designed and installed infiltration devices can reduce peak discharges, provide groundwater recharge, augment low flow conditions of receiving streams, reduce storm water discharge volumes and pollutant loads, and protect downstream channels from erosion. Infiltration devices are a feasible option where soils are permeable and the water table and bedrock are well below the surface. Infiltration basins can also be used as sediment basins during construction.[87] Infiltration trenches can be more easily placed into under utilized areas of a development, and can be used for small sites and infill developments. However trenches may require regular maintenance to prevent clogs, particularly where grass inlets or other pollutant removing inlets are not used. In some situations, such as low density areas of parking lots, porous pavement can provide for infiltration.

(B) *Flow attenuation by vegetation or natural depressions.* Flow attenuation provided by vegetation or natural depressions can provide pollutant removal, infiltration, and lower the erosive potential of flows.[88] In addition, these practices can enhance habitat values and the appearance of a site. Vegetative flow attenuation devises include grass swales and filter strips as well as trees that are either preserved or planted during construction.

Typically the costs of vegetative controls are small relative to other storm water practices. The use of check dams incorporated into flow paths can provide additional infiltration and flow attenuation.[89] Given the limited capacity to accept large volumes of runoff, and potential erosion problems associated with large concentrated flows, vegetative controls should typically be used in combination with other storm water devices.

Grass swales are typically used in low or medium residential development and highway medians as an alternative to curb and gutter drainage systems.[90]

(C) *Outfall velocity dissipation devices.* Outfall velocity dissipation devises include riprap and stone or concrete flow spreaders. Outfall velocity dissipation devices slow the flow of water discharged from a site to lessen the amount of erosion caused by the discharge.

(D) *Storm water retention structures.* Properly designed and maintained storm water retention structures, also referred to as wet ponds, can achieve a high removal rate of sediment, BOD, organic nutrients and metals. Retention basins are most cost-effective in larger, more intensively developed sites. Retention ponds can also create wildlife habitat, recreation, and landscape amenities, and corresponding higher property values.

(E) *Retention structures/artificial wetlands.* Retention structures include ponds and artificial wetlands that are designed to maintain a permanent pool of water. Properly installed and maintained retention structures (also known as wet ponds) and artificial wetlands[91, 92] can achieve a high removal rate of sediment, BOD, organic nutrients and metals, and are most cost-effective when used to control runoff from larger, intensively developed sites.[93] These devises rely on settling and biological processes to remove pollutants.

(F) *Water quality detention structures.* Storm water detention structures include extended detention ponds, which control the rate at which the pond drains after a storm event. Extended detention ponds are usually designed to completely drain in about 24 to 40 hours, and will remain dry at other times. They can provide pollutant removal efficiencies that are similar to those of retention ponds.[94] Extended detention systems are typically designed to provide both water quality and water quantity (flood control) benefits.[95]

iii. *Housekeeping BMPs.* Pollutants that may enter water from construction sites due to poor housekeeping include oils, grease, paints, gasoline, concrete truck washdown, concrete raw materials used in the manufacture of concrete, including sand, aggregate, and cement, solvents, litter, debris and sanitary wastes. Construction site management plans can address the following to prevent the discharge of these pollutants:

- Designate areas for equipment maintenance and repair;
- Provide waste receptacles at convenient locations and provide regular collection of wastes;

[87] "Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs", July, 1987, Metropolitan Washington Council of Governments

[88] "Urban Targeting and BMP Selection", United States EPA, Region V, November 1990

[89] "Standards and Specifications for Infiltration Practices", 1984, Maryland Water Resources Administration

[90] "Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs", Metropolitan Washington Council of Governments, July 1987

[91] "Wetland basins for Storm Water Treatment: Discussion and Background", Maryland Sediment and Stormwater Division, 1987

[92] "The Value of Wetlands for Nonpoint Source Control—Literature Summary", Strecker, E., et al., 1990

[93] "Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs", Metropolitan Washington Council of Governments, 1987

[94] "Urban Targeting and BMP Selection", United States EPA, Region V, November 1990

[95] "Urban Surface Water Management", Wade S.G. Wiley, 1985

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• Locate equipment washdown areas on site, and provide appropriate control of washwaters;

• Provide protected storage areas for chemicals, paints, solvents, fertilizers and other potentially toxic materials; and

• Provide adequately maintained sanitary facilities.

d. *Coal pile runoff treatment technology.* The primary technology options for treating coal pile runoff considered in the final "Development Document for Effluent Limitations Guidelines and Standards and Pretreatment Standards for the Steam Electric Point Source Category", (EPA-440/182/029), November 1982, EPA, were:

(1) Equalization, pH adjustment, settling; and

(2) Equalization, chemical precipitation treatment, settling, pH adjustment.

Metals may be removed from wastewater by raising the pH of the wastewater to precipitate them out as hydroxides. Typically, wastewater pH's of 9 to 12 are required to achieve the desired precipitation levels. Lime is frequently used for pH adjustment. Wastewaters which have a pH greater than 9 after lime addition will require acid addition to reduce the pH before final discharge. Polymer addition may be required to enhance the settling characteristics of the metal hydroxide precipitate. Typical polymer feed concentrations in the wastewater are 1 to 4 ppm. The metal hydroxide precipitate is separated from the wastewater in a clarifier or a gravity thickener. Unlike settling ponds, these units continually collect and remove the sludge formed. Filters are typically used for effluent polishing and can reduce suspended solids levels below 10 mg/1. Sand or coal are the most common filter media. Vacuum filtration is a common technique for dewatering sludge to produce a cake that has good handling properties and minimum volume.

The major equipment requirements for such a system include a lime feed system, mix tank polymer feed system, flocculator/ clarifier, deep bed filter, and acid feed system. For wastewaters which have a pH of less than 6, mixers and mixing tanks are made of special materials of construction (stainless steel or lined-carbon steel). For wastewaters with pH's greater than 6, concrete tanks are typically used. The underflow from the clarifier may require additional treatment with a gravity thickener and a vacuum filter to provide sludge which can be transported economically for landfill disposal.

5. The Federal/Municipal Partnership: The Role of Municipal Operators of Large and Medium Municipal Separate Storm Sewer Systems

A key issue in developing a workable regulatory program for controlling pollutants in storm water discharges associated with industrial activity is the proper use and coordination of limited regulatory resources. This is especially important when addressing the appropriate role of municipal operators of large and medium municipal separate storm sewer systems in the control of pollutants in storm water associated with industrial activity which discharge through municipal separate storm sewer systems.

Several key policy factors arise when considering the appropriate strategy for regulating storm water discharges associated with industrial activity through municipal separate storm sewer systems. These factors include the following:

• The role and responsibilities of municipalities to control pollutants from nonmunicipal facilities which are discharged through a storm sewer owned or operated by the municipality;

• The large number of storm water discharges through municipal systems (the Agency anticipates that the majority of storm water discharges associated with industrial activity from many industrial classes discharge through municipal separate storm sewer systems);

• The ability of municipalities to recognize and represent local concerns and considerations;

• The ability of municipal operators to assist EPA and authorized NPDES States in identifying local priorities for controlling storm water discharges associated with industrial activity through specific municipal systems;

• The ability of municipal operators to assist EPA and authorized NPDES States to oversee effectively the development of appropriate site-specific controls for storm water discharges associated with industrial activity through municipal systems and to effectively require compliance with such controls;

• The authorities provides by the CWA (including those provided to the public) to review information developed under the NPDES program and to enforce NPDES permits; and

• The requirements of the CWA to develop and implement the NPDES permit program.

On November 16, 1990 (55 FR 47990), EPA promulgated a permitting scheme where controls for storm water discharges associated with industrial activity through large and medium municipal separate storm sewer systems may be addressed by two permits issued in a coordinated manner. This complementary permit approach envisions cooperative efforts by the permit issuing agency and municipal operators of large and medium municipal separate storm sewer systems to develop programs that will result in controls on pollutants in storm water discharges associated with industrial activity which discharge through municipal systems.

Under the complementary permit approach, storm water discharges associated with industrial activity which discharge through large and medium municipal separate storm sewer systems are required to obtain permit coverage. Permits for these discharges will establish requirements (such as controls or monitoring) for industrial operators of the discharge into the municipal system. In addition, these permits provide a basis for enforcement actions directly against the owner or operator of storm water discharges associated with industrial activity.

A second permit, issued to the operator of the large or medium municipal separate storm sewer, establishes the responsibilities of the municipal operators in controlling pollutants from storm water associated with industrial activity which discharges through their system. The framework for permits for discharges from large and medium municipal separate storm sewer systems has been developed to establish the responsibilities of the municipal operator to control pollutants discharged through these municipal systems. At the heart of the permit program for discharges from municipal separate storm sewer systems serving a population of 100,000 or more are requirements that municipal applicants develop and implement municipal storm water management programs. The municipal storm water management programs that will be incorporated into NPDES permits for discharges from municipal separate storm sewer systems will generally address (in addition to other possible requirements) the following three major components:

• Reducing pollutants in storm water discharges from municipal landfills; hazardous waste treatment, storage and disposal facilities; facilities subject to SARA Title III, Section 313; and other priority industrial facilities through municipal separate storm sewers;

• Reducing pollutants in construction site runoff through municipal separate storm sewers, and

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• Identifying and controlling non-storm water discharges to municipal separate storm sewer systems.

These components of a municipal program can initiate the role of the municipality in assisting EPA and authorized NPDES States in implementing controls to reduce pollutants in storm water discharges associated with industrial activity which discharge into large and medium municipal separate storm sewer systems. Municipal programs to reduce pollutants in industrial site runoff and construction site runoff through municipal separate storm sewer systems specifically will address municipal responsibilities in controlling pollutants from industrial facilities. In addition, programs to identify and control non-storm water discharges to municipal separate storm sewer systems will in many cases focus on industrial areas because these areas often have a high potential for illicit connections, spills or improper dumping.

Consistent with the final permit applications regulations published on November 16, 1990 (55 FR 47990), the general permits accompanying this fact sheet have been developed to assist in establishing a cooperative approach between EPA and municipal operators of large and medium municipal separate storm sewer systems for controlling pollutants from storm water discharges associated with industrial activity which discharge through large and medium municipal separate storm sewer systems. These requirements will be coordinated with requirements in permits for discharges from large and medium municipal separate storm sewer systems. Major features of the draft general permits which establish the framework for this cooperative approach include:

• Operators of storm water discharges associated with industrial activity which discharge through a large or medium municipal separate storm sewer system may be required to submit a copy of the notice of intent to the municipal operators of large or medium municipal system receiving the discharge;

• Requirements to monitor and reduce pollutants in discharges will be established for storm water discharges associated with industrial activity which discharge through large and medium municipal separate storm sewer systems (as well as other storm water discharges associated with industrial activity). Any records, reports, or information obtained by the Director as part of the permit implementation process, including site-specific storm water pollution prevention programs that are developed pursuant to the draft general permit, are available to municipalities under section 308(b) of the CWA. This will assist municipalities in reviewing the adequacy of such requirements and developing priorities among industrial storm water sources; and

• Industrial permittees with discharges through large and medium municipal systems may be required to submit discharge monitoring reports to municipal operators of these systems (as well as to the permitting issuing agency) or other monitoring results as required by the operator of the municipal separate storm sewer to assist the municipal operator in identifying priorities.

These permit conditions, along with appropriate conditions in permits for discharges from large and medium municipal separate storm sewer systems, will allow municipal operators of these systems to:

• Assist EPA in identifying priority storm water discharges associated with industrial activity to their system;

• Assist EPA in reviewing and evaluating storm water pollution prevention plans that industrial facilities are required to develop under the draft general permit; and

• Assist EPA in compliance efforts regarding storm water discharges associated with industrial activity to their municipal systems.

6. Notification Requirements

EPA's regulations at 40 CFR 122.21(a) exclude persons covered by general permits from requirements to submit individual permit applications. Under these existing regulations, conditions for NOIs to be covered by the general permit are established in the permits on a case-by-case basis. Elsewhere in today's notice, EPA is proposing to amend the general permit regulations at 40 CFR 122.28 to establish minimum requirements for NOIs in general permits.

The draft general permits associated with this fact sheet would establish limited NOI requirements that would operate instead of individual permit application requirements and that are consistent with the minimum regulatory requirements for NOIs proposed in this notice.

These draft general permits have the following NOI requirements for discharges covered by each permit:

• Name, mailing address, and location of the facility for which the notification is submitted;

• Up to four 4-digit Standard Industrial Classification (SIC) codes that best represent the principal products or activities provided by the facility;

• The operator's name, address, telephone number, ownership status and status as Federal, State, private, public, or other entity;

• The latitude and longitude of the approximate center of the facility to the nearest 15 seconds, or the nearest quarter section (if the section, township, or range is provided) that the facility is located in;

• The name of the receiving water(s), or if the discharge is to a municipal separate storm sewer, the name of the municipal operator of the storm sewer and the ultimate receiving water(s); and

• Existing quantitative data describing the concentration of pollutants in discharges.

The permits in AZ, Guam and American Somoa will, in addition to the information described above, require that an estimate of the size of the drainage area (in square feet) and an estimate of the runoff coefficient of the drainage are (e.g. low under 40%), medium (40% to 65%) or high (above 65%)) be provided. This information will be used to estimate the volume of storm water discharged from the facility, which will assist in evaluating pollutant loads.

The proposed NOI requirements for storm water discharges associated with industrial activity from a construction site include, in addition to the information required above, a brief description of the project, estimated timetable for major activities, and estimates of the number of acres of the site that will be disturbed.

The NOI requirements of the draft general permits are intended to establish a mechanism that will provide a clear accounting of the number of permittees covered by the general permit, the nature of operations at the facility generating the discharge, their identity and location. In addition, the NOI can identify the permittee to provide a basis for enforcement and compliance monitoring strategies. The NOI can be used as an initial screening tool to determine discharges where individual permits are appropriate. Also, the NOI can be used to identify classes of discharges appropriate for general permits with more specific requirements, as well as provide information needed to notify such dischargers of the issuance of a more specific general permit.

The NOI requirements in the draft general permit have been designated to provide much of the information needed for these purposes, and will be supplemented by other information obtained through processes such as section 308 information requests.

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EPA is considering developing a central address for receiving all NOIs required under these general permits. This would assist the Regional Offices in handling and filing NOIs. EPA is also considering developing a form for NOIs that can be read by automatic data processing equipment. Operations of storm water discharges associated with industrial activity which discharge through a large or medium municipal separate storm sewer system must, in addition to submitting an NOI to the Director, submit a copy of the NOI to the municipal operator of the system receiving the discharge. This additional notice will assist municipal operators in developing inventories of industrial facilities which discharge to their municipal separate storm sewer systems. This will be an initial step in implementing municipal storm water management programs to reduce pollutants from runoff from industrial facilities. This also will assist municipal operators in overseeing the implementation of permit conditions.

Individuals who intend to obtain coverage under the general permit must notify their intent within 180 days of the effective date of this general permit or at least 30 days prior to the commencement of construction of a new storm water discharge associated with industrial activity.

The deadlines for submitting NOIs under the draft general permit differ from the deadlines for submitting individual permit applications under 40 CFR 122.26(e) in several respects. First, the deadline for submitting NOIs for existing storm water discharges associated with industrial activity is 180 days from issuance of the general permits rather than the November 18, 1991, deadline for submitting individual permit applications.[96] The Agency believes that it is appropriate to base the NOI submittal date on the issuance date of the final general permit establishing the NOI requirement. The Agency also believes that 180 days provides the discharger with adequate opportunity to prepare and submit an NOI, particularly because dischargers are not required to conduct sampling activities to submit a complete NOI. Second, the draft permits provide that NOIs be submitted at least 30 days before construction of a new storm water discharge associated with industrial activity begins. This time is less than the 60 days prior to commencement of construction that 40 CFR 122.26(e) provides for submitting permit applications for individual permits for new storm water discharges associated with industrial activity. The Agency believes that under these general permits, less time is necessary to review NOIs than to review individual permit applications and to issue permits for new storm water discharges associated with industrial activity. In addition, reducing the minimum time to a 30 day period to submit NOIs before beginning construction will assist dischargers in complying with the permit.

[96] EPA has proposed to extend this deadline to May 18, 1992. (56 FR 12101, March 21, 1991)

7. Description of Draft Permit Conditions

The conditions of these draft permits have been designed to comply with the technology-based standards of the CWA (BAT/BCT). Based on a consideration of the appropriate factors for BAT and BCT requirements, and a consideration of the factors and options discussed in this fact sheet for controlling pollutants in storm water discharges associated with industrial activity, the draft general permits propose two prohibitions, a set of tailored requirements for developing and implementing storm water pollution prevention plans, and for selected discharges, two effluent limitations.[97]

Part 4 of this fact sheet summarizes the options for controlling pollutants in storm water discharges associated with industrial activity. The draft general permit proposes numeric effluent limitations for two classes of discharges, coal pile runoff, and runoff that comes into contact with certain chemical storage or handling facilities at SARA title III, section 313 facilities.

For other discharges covered by the permit, the draft permit conditions reflect EPA's decision to select a number of best management practices and traditional storm water management practices which prevent pollution in storm water discharges as the BAT/BCT level of control for the majority of storm water discharges covered by these permits. The draft permit conditions applicable to these discharges are not numeric effluent limitations, but rather are flexible requirements for developing and implementing site specific plans to minimize and control pollutants in storm water discharges associated with industrial activity.

EPA is authorized under 40 CFR 122.44(k)(2) to impose BMPs in lieu of numeric effluent limitations in NPDES permits when the Agency finds numeric effluent limitations to be infeasible. EPA may also impose BMPs which are "reasonably necessary * * * to carry out the purposes of the Act" under 40 CFR 122.44(k)(3). Both of these standards for imposing BMPs were recognized in *NRDC* v. *Costle*, 568 F.2d 1369, 1380 (D.C. Cir. 1977). The conditions in the draft general permits are proposed under the authority of both of these regulatory provisions. The pollution prevention or BMP requirements in these permits operate as limitations on effluent discharges that reflect the application of BAT/BCT. This is because the BMPs identified require the use of source control technologies which, in the context of these general permits, are the best available of the technologies economically achievable (or the equivalent BCT finding). See, e.g. *NRDC* v. *EPA*, 822 F.2d 104, 122–23 (D.C. Cir. 1987) (EPA has substantial discretion to impose non-quantitative permit requirements pursuant to section 402(a)(1)).

a. *Prohibitions.* The draft general permits prohibit non-storm water discharges as a component of discharges authorized by this permit. This permit is intended to authorize discharges composed entirely of storm water associated with industrial activity. The prohibition on non-storm water discharges in these permits ensures that non-storm water discharges are not inadvertently authorized by these permits. Where a storm water discharge is mixed with process wastewaters or other sources of non-storm water prior to discharge, and the discharge is currently not authorized by an NPDES permit, the discharger should submit the appropriate application forms to obtain permit coverage. The Agency believes that these mixed discharges are addressed more appropriately through individual NPDES permits or other general permits as individual or other general permits will allow development of more tailored and specific permit conditions appropriate for such discharges.

The draft general permits also prohibit discharges that contain a hazardous substance in excess of reporting quantities established at 40 CFR 117.3 or 40 CFR 302.4, and clarifies that where such a discharge occurs, the permit does not relieve the permittee of the reporting

[97] Part I.C.2 of the draft general permits provide that facilities with storm water discharges associated with industrial activity which, based on an evaluation of site specific conditions, believe that the appropriate conditions of these permits do not adequately represent BAT and BCT requirements for the facility may request to be excluded from the coverage of the general permit by either submitting to the Director an individual application (Form 1 and Form 2F) with a detailed explanation of the reasons supporting the request, including any supporting documentation showing that certain permit conditions are not appropriate, or participating in a group application (see 40 CFR 122.26(c)).

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requirements of 40 CFR part 117 and 40 CFR part 302. The Agency believes that the vast majority of discharges that contain a hazardous substance in excess of reporting quantities will be associated with non-storm water sources (e.g. chemical spill events). Where a discharge composed entirely of storm water associated with industrial activity containing a hazardous substance in excess of reporting quantities occurs or is expected to occur, the Agency believes that the potential risks associated with the discharge are such that it is more appropriate to address the discharge with an individual permit which contains more specific permit conditions based on industry specific or site specific factors and a consideration of receiving water characteristics. Since discharges containing a hazardous substance in excess of reporting quantities are not authorized by these permits, such releases are not exempted from reporting requirements by 40 CFR 117.12(a)(1), and hence the permits do not relieve the permittee of the reporting requirements of 40 CFR part 117 and 40 CFR part 302.

EPA anticipates that storm water discharges that contain oil in excess of reporting quantities established under 40 CFR 110.6 (e.g. exhibit an oil sheen) will be more common. For example, many storm water discharges from parking lots or roads, as well as from industrial facilities, contain an oil sheen. Although discharges composed entirely of storm water associated with industrial activity are authorized by these permits where the discharge complies with the other applicable requirements of the permit and 40 CFR part 110, it should be noted that where a discharge of oil in excess of reporting quantities is caused by a nonstorm water discharge (e.g. a spill of oil into a separate storm sewer), the spill is not authorized by this permit, and the discharger is not relieved of their obligation to report the spill under 40 CFR part 110. In this regard, the requirements of section 311 of the CWA and otherwise applicable provisions of sections 301 and 402 of the CWA continue to apply.

b. *Tailored pollution prevention plan requirements.* All facilities covered by the storm water general permits must prepare, retain and implement a storm water pollution prevention plan. The storm water permits address tiered sets of pollution prevention plan requirements for a number of categories of industries: Construction activities; baseline requirements for all industries except construction activities; special requirements for certain facilities subject to SARA title III, section 313; special requirements for storm water discharges associated with industrial activity to large and medium municipal separate storm sewer systems; and special requirements for facilities with outdoor salt storage piles. These tailored requirements have been developed to allow the implementation of site-specific measures that address features, activities, or priorities for control associated with the identified storm water discharges.

The Agency is using the term "pollution prevention" in the context of these plans because the term emphasizes that requirements in the plans provide a flexible basis for developing site-specific measures to minimize and control the amounts of pollutants that would otherwise enter storm water. The term 'pollution prevention' distinguishes this source reduction approach from traditional pollution control measures that typically rely on end-of-pipe treatment to remove pollutants in the discharges. The plan requirements are based primarily on traditional storm water management, pollution prevention and BMP concepts which have been tailored to pollutants in storm water discharges associated with industrial activity.

The pollution prevention approach adopted in the storm water pollution prevention plans in the draft general permits focuses on two major objectives:

(1) To identify sources of pollution potentially affecting the quality of storm water discharges associated with industrial activity from the facility; and

(2) Describe and ensure that practices are implemented to minimize and control pollutants in storm water discharges associated with industrial activity from the facility and to ensure compliance with the terms and conditions of this permit.

The Agency believes that it is not appropriate, at this time, to require a single set of effluent guidelines or a single design or operational standard for all facilities which discharge storm water associated with industrial activity. Rather, this permit establishes a framework for the development and implementation of site-specific storm water pollution prevention plans. This framework provides the necessary flexibility to address the variable risk for pollutants in storm water discharges associated with the different types of industrial activity that are addressed by these permits, while ensuring procedures to prevent storm water pollution at a given facility are appropriate given the processes employed, engineering aspects, functions, costs of controls, location, and age of facility (as contemplated by 40 CFR 125.3). The approach taken allows flexibility to establish controls which can appropriately address different sources of pollutants at different facilities.

1. *Plan requirements for construction activities.* The requirements for storm water pollution prevention plans for operations that discharge storm water associated with industrial activity from construction activities differ from the requirements for other types of facilities.

In developing these draft permits, the Agency has reviewed a significant number of existing State and local requirements for sediment and erosion controls, and storm water management controls for construction activities/new development addressing a wide range of climates and types of construction activities.

(A) *Source Identification.* Storm water pollution prevention plans must be based on an accurate understanding of the pollution potential of the site. The first part of the plan requires an evaluation of the sources of pollution at a specific construction site. The source identification components for pollution prevention plans for construction activities proposed in these permits include, at a minimum, a description of the following:

- A description of the nature of the construction activity;
- Estimates of total area of the site and the area of the site that is expected to undergo excavation or grading;
- An estimate of the runoff coefficient of the site and existing data describing the soil or the quality of any discharge from the site. Estimates of the runoff coefficient can be based on estimates of the site size, the increase in impervious area after the construction is completed, and the location of structures that will be built on the site;
- A site map indicating, at a minimum, drainage patterns and approximate slopes anticipated after major grading activities, areas used for the storage of soils or wastes, the location of major control structures identified in the plan, and surface waters; and
- The name of the receiving water(s), or if the discharge is to a municipal separate storm sewer, and the ultimate receiving water(s).

EPA requests comments on whether the permits should require information describing other major features which may provide a better understanding of site runoff or other major pollutant sources, such as identification of areas

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intended to be used for the storage of soils or wastes, be included in plans.

(E) *Controls to reduce pollutants.* Many municipalities and States have developed sediment and erosion control requirements for construction activities. A significant number of municipalities and States have also developed storm water management controls. This permit requires that facilities which discharge storm water associated with industrial activity from construction activities must reflect in their storm water pollution prevention plan procedures and requirements specified in applicable sediment and erosion site plans or storm water management plans approved by State or local officials. Applicable requirements specified in sediment and erosion plans or storm water management plans approved by State or local officials are, upon submittal of an NOI to be authorized to discharge under this permit, incorporated by reference and are enforceable under this permit even if they are not specifically included in a storm water pollution prevention plan required under this permit.[58]

The sediment and erosion controls for construction activities proposed in this permit have three goals: 1) to divert upslope water around disturbed areas of the site; 2) to limit the exposure of disturbed areas to the shortest duration possible; and 3) to remove sediment from storm water before it leaves the site.

Each construction operation covered by the permit is required to develop a description of three classes of controls appropriate for inclusion in the facility's plan, and implement controls identified in the plan in accordance with the plan. The description of controls must address erosion and sediment controls, storm water management and a specified set of other controls.

Erosion and sediment controls include both vegetative practices and structural practices. Vegetative practices are the first line of defense for preventing erosion. These controls are to be based on a consideration of temporary seeding, permanent seeding, mulching, sod stabilization, vegetative buffer strips, and protection of trees. Temporary seeding practices are often cited as the single most important factor in reducing erosion at construction sites.[59]

Since vegetative practices play such an important role in preventing erosion, it is critical that they are rapidly employed in appropriate areas. The draft permits provide that the operator shall initiate appropriate vegetative practices on all disturbed areas within 7 calendars days of the last activity at that area. Appropriate vegetative practices may include temporary seeding, permanent seeding, mulching or sod stabilization procedures, or equivalent measures that protect exposed soils. EPA requests comments on the application of this criterion or other appropriate criteria (such as criterion that would only be applicable during specified seasons) for initiating appropriate vegetative practices in arid areas (areas with less than 10 inches average annual rainfall) and semi-arid areas (areas with between 10 and 20 inches average annual rainfall) with well defined seasonal rainfall patterns. For example, it may be appropriate to only apply the requirement to initiate appropriate vegetative practices within 7 days of the last activity in a given area during seasons or months which have a reasonable probability of a rain event occurring. However, EPA has concerns about its ability to define appropriate dry weather periods, and requests comments on this approach.

Structural controls provide a second line of defense by capturing pollutants before they leave the site. Structural controls are necessary because vegetative controls cannot be employed at areas of the site which are continually disturbed and because a finite time period is required before vegetative practices are fully effective. Structural practices selected for incorporation into a plan are to be based on a consideration of the attainability at a given site of implementing particular controls. Options for such controls include straw bale dikes, silt fences, earth dikes, brush barriers, drainage swales, check dams, subsurface drain, pipe slope drain, level spreaders storm drain inlet protection, rock outlet protection, sediment traps, and temporary sediment basins. For sites with more than 10 disturbed acres at one time which are served by a common drainage location, a detention basin providing storage for runoff from disturbed areas from a 24 hour, 10 year storm or equivalent controls (such as suitably sized dry wells or infiltration structures), shall be provided where sufficient space and other factors allow these controls to be attained. For drainage locations with more than 10 disturbed acres at one time which are served by a common drainage location where a detention basin providing storage or equivalent controls for runoff from disturbed areas from a 10 year, 24-hour storm is not attainable, silt fences, straw bale dikes, or equivalent sediment controls are required for all sideslope and downslope boundaries of the construction area.

For drainage locations serving 10 or less acres, at a minimum, silt fences, straw bale dikes, or equivalent sediment controls are required for all sideslope and downslope boundaries of the construction area or a detention basin providing storage for runoff from disturbed areas.

EPA requests comment on the use of the 10 acre limit and the 24 hour, 10 year storm for this requirement.[60] Although sediment basins are generally viewed as being more effective than other structural controls, flexibility has been added to the proposed requirements for drainage locations serving 10 or less acres since these smaller sites may have more difficulty finding an appropriate location for a basin.

"Storm water management" controls[61] are to include a description of measures or controls to minimize pollutants in storm water discharges that will be installed during construction, but that will continue to control pollutants in storm water discharges after the construction operations have been completed. Options for "storm water management" controls that are to be evaluated in the development of plans include: infiltration of runoff onsite; flow attenuation by use of open vegetated swales and natural depressions; storm water retention structures and storm water detention structures. Often it is appropriate to incorporate several of these measures at a site.

Developing land often significantly increases peak discharge volumes and velocities. These increased discharge velocities can greatly accelerate erosion near the outlet of on-site structural controls. To mitigate these effects, the

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[58] Facilities with storm water discharges associated with industrial activity related to construction activities which, based on an evaluation of site specific conditions, believe that State and local plans do not adequately represent BAT and BCT requirements for the facility may request to be excluded from the coverage of the general permit by submitting to the Director an individual application with a detailed explanation of the reasons supporting the request, including any supporting documentation showing that certain permit conditions are not appropriate.

[59] "New York Guidelines for Urban Erosion and Sediment Control", USDA—Soil Conservation Service, March, 1988.

[60] This control is a BCT control, and hence the design storm differs from design storms used elsewhere in this permit as BAT controls. (See "Staff Analysis of Implementing Permitting Activities for Storm Water Discharges Associated with Industrial Activity" (EPA, 1991).)

[61] For the purpose of the special requirements for construction activities, the term "storm water management controls" refers to controls that will primarily reduce the discharge of pollutants in storm water from sites after construction activities have been completed.

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draft permits require velocity dissipation devices to be placed at the outfall of detention or retention structures and along the length of outfall channels to provide a non-erosive velocity flow from the structure to a water course needed to ensure that erosion is prevented or minimized.

These permits do not establish specific standards for "storm water management" (e.g. controls to reduce pollutants in storm water discharges from a site after construction is completed) (other than requirements in approved State and local storm water site plans and requirements for velocity dissipation devices). However, the permittee must evaluate the appropriateness of various options for storm water measures at the site when developing their plan and provide a summary of the evaluation and justification for not selecting a given practice. The Agency requests comment on the appropriateness of establishing performance standards,[48] or design standards.[49] While the Agency recognizes that such requirements will often be appropriate in individual permits or in other permit issuing efforts, the Agency has concerns about the extensive use of such standards in this Tier I general permit. The Agency will continue to evaluate appropriate standards for storm water management applicable to new developments along with the need to provide flexibility in allowing for site-specific modifications of the standard based on project constraints, local conditions and the location of the discharge within the watershed.

Other controls to be addressed in storm water pollution prevention plans for construction activities require that no non-storm water wastes, including building material waster shall be discharged at the site, unless the facility is licensed for such disposal.

The draft permit proposes that off-site vehicle tracking of sediments shall be minimized. This can be accomplished by measures such as providing gravel or paving at access entrance and exit drives, parking areas, and unpaved roads on the site carrying significant amounts of traffic (e.g. more than 25 vehicles per day). These measures, along with other appropriate measures, can limit erosion and the transport of sediment offsite from these areas.

In addition, the plan shall ensure and demonstrate compliance with applicable State or local sanitary sewer, septic [50] system and waste disposal regulations.

Erosion and sediment controls can become ineffective if they are inappropriately disturbed or otherwise damaged. Maintenance of controls has been identified as a major part of effective erosion and sediment programs. Plans are required to provide a description of procedures to maintain in good and effective condition and promptly repair or restore all grade surfaces, walls, dams and structures, vegetation, erosion and sediment control measures and other protective measures identified in the site plan At a minimum, procedures in a plan must provide that all erosion controls on the site are inspected at a minimum of once every seven calendar days and at other suitable times (e.g. within 24 hours after any storm event of greater than 0.5 inches of rain per 24 hour period). Diligent inspections are necessary to assure adequate implementation of onsite sediment and erosion controls, particularly in the later stages of construction when the volume of runoff is greatest and the storage capacity of the sediment basins has been reduced.[51]

ii. Plan requirements for facilities other than construction activities. In 1979, EPA completed a technical survey of industry best management practices (BMPs) which was based on a review of practices used by industry to control the non-routine discharge of pollutants from non-continuous sources including runoff, drainage from raw material storage area, spills, leaks, and sludge or waste disposal. This review included analysis and assessment of published articles and reports, technical bulletins, and discussions with industry representatives through telephone contacts, written questionnaires and site visits.

The review identified two classes of pollution control measures. The first class of controls are those management practices which are generally considered to be essential to a good BMP program, low in cost, and applicable to broad categories of industry and types of substances. These practices are independent of the type of industry, ancillary sources, specific chemicals, group of chemicals, or plant-site locations. The survey concluded that these controls were broadly applicable to all industry types and activities, and should be viewed as minimum requirements in any effective BMP program. The second class of controls are management practices controls which provide a second line of defense against the release of pollutants and included prevention measures, containment measures, mitigation and cleanup measures, and treatment methods.[52]

Since that time, EPA has, on a case-by-case basis, imposed BMP requirements in NPDES permits. The Agency has also continued to review and evaluate case studies involving the use of BMPs [53] and the use of pollution prevention measures associated with spill prevention and containment measures for oil.[54] During the development of NPDES permit application requirements for storm water discharges associated with industrial activity, the Agency evaluated appropriate means for identifying and evaluating the potential risk of pollutants in storm water from industrial sites. Public comments received during the rulemaking provided additional insight regarding storm water risk assessment, as well as appropriate

[48] One approach to performance standards commonly adopted in State or local controls is to require no increase in the rate and volume of runoff from predevelopment conditions. Another common approach is to require on-site control for a specified storm event (e.g. the first inch of runoff from a site).

[49] Design standards are commonly used by State and local governments as part of the plan approval process. Such requirements can address a wide range of requirements, such as providing infiltration for runoff from roofs or paved areas exceeding a specified area or requiring that residential driveways slope toward adjacent landscaped areas.

[50] In rural and suburban areas that are served by septic systems malfunctioning septic systems can contribute pollutants to storm water discharges. Malfunctioning septic tanks may be a more significant surface runoff pollution problem than a ground water problem. This is because a malfunctioning septic system is less likely to cause ground water contamination where a bacterial mat in the soil retards the downward movement of wastewater. Surface malfunctions are caused by clogged or impermeable soils, or when stopped up or collapsed pipes forces untreated wastewater to the surface. Surface malfunctions can vary in degree from occasional damp patches on the surface to constant pooling or runoff of wastewater. These discharges have high bacteria, nitrate and nutrient levels and can contain a variety of household chemicals. This permit does not establish new criteria for septic systems, but rather addresses existing State or local criteria.

[51] "Performance of Current Sediment Control Measures at Maryland Construction Sites", January 1988 Metropolitan Washington Council of Governments.

[52] For a complete description of the BMP survey, see "NPDES Best Management Practices Guidance Document", U.S. EPA, December 1979, EPA-600/9-79-045. See also the 1981 document of the same name, "NPDES Best Management Practices Guidance Document" which provides a more complete discussion of baseline BMPs.

[53] For example, see "Best Management Practices: Useful Tools for Cleaning Up", Theron H. Rogoshewski, P. 1982 Proceedings of the 1982 Hazardous Material Spills Conference; "The Chemical Industries' Approach to Spill Prevention" Thompson C. Goodier J., 1980 Proceedings of the 1980 National Conference on Control of Hazardous Material Spills and a series of EPA memorandum entitled "Best Management Practices in NPDES Permits—Information Memorandum", 1983, 1985, 1986, 1987, 1988.

[54] See Oil Pollution Prevention requirements including Spill Prevention Control and Countermeasure Plan requirements at 40 CFR part 112.

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pollution prevention and control measures and strategies. During this time, the Agency again reviewed storm water control practices and measures.[60] These experiences have shown the Agency that pollution prevention measures such as BMPs can be appropriately used and that permits containing BMP requirements can effectively reduce pollutant discharges in a cost-effective manner. EPA again indicates that BMP requirements are being imposed in this general permit in lieu of numeric effluent limitations pursuant to 40 CFR 122.44(k)(2).

(A) *Source identification.* Storm water pollution prevention plans must be based on an accurate understanding of the pollution potential of the site. The first part of the plan requires an evaluation of the sources of pollution at a specific industrial site. The permit proposes that the source identification components of the plan identify all activities and significant materials which may potentially be significant pollutant sources. Plans shall include:

- A drainage site map and a topographic map;
- A list of significant spills and leaks of toxic or hazardous pollutants that occurred at the facility after the effective date of the permit;
- A narrative description of significant materials that have been treated, stored or disposed in a manner to allow exposure to storm water between the time of three years prior to the date of the issuance of this permit and the present; method of on-site storage or disposal; materials management practices employed to minimize contact of these materials with precipitation and storm water runoff between the time of three years prior to the date of the issuance of this permit and the present; materials loading and access areas; the location and a description of existing structural and non-structural control measures to reduce pollutants in storm water runoff; and a description of any treatment the storm water receives;
- For each area of the plant that generates storm water discharges associated with industrial activity with a reasonable potential for containing significant amounts of pollutants, a prediction of the direction of flow, and an estimate of the types of pollutants that are likely to be present in storm water discharges associated with industrial activity; and
- A summary of existing sampling data describing pollutants in storm water discharges.

Activities associated with (1) loading and unloading of dry bulk materials or liquids, (2) outdoor storage of raw materials, intermediary products or products, (3) outdoor process activities, (4) dust or particulate generating processes, (5) illicit connections or management practices, and (6) waste disposal practices should be evaluated to see if they are likely to be significant sources of pollutants to storm water discharges.

The prediction of the direction of flow and the rate of flow will typically be based on an evaluation of the area of impervious surfaces and total area drained by each outfall, along with estimates of appropriate representative rainfall events, or actual measurements of discharge volumes. Impervious surfaces include paved areas and buildings within the drainage area of each discharge point.

Estimates of the total quantity of pollutants that are likely to be present in storm water discharges associated with industrial activity should be made from assessments of sampling data, and other information describing significant materials that are used or otherwise found at the site, and that, because of potential exposure to storm water may be significant pollutant sources. Although the monitoring requirements of this permit are limited to conventional pollutants for most discharges, the estimates of the types of pollutants that may be present in storm water required as part of the source identification information should address all types of pollutants (conventional and toxic) that may be present. Examples of information that should be evaluated when estimating pollutants in storm water discharges include information describing of significant materials that have been treated, stored or disposed in a manner to allow exposure to storm water between the time of three years prior to the date of the issuance of this permit and the present; method of on-site storage or disposal; materials management practices employed to minimize contact of these materials with storm water runoff between the time of three years prior to the date of the issuance of this permit and the present; materials loading and access areas; the location and a description of existing structural and non-structural control measures to reduce pollutants in storm water runoff; and a description of any treatment the storm water receives. Other information to consider, if applicable, include the manner and frequency in which pesticides, herbicides, fertilizers or soil enhancers are applied at the site and an evaluation of significant spills or leaks of conventional, toxic and hazardous pollutants based on a description of the materials released, an estimate of the volume of the release, the location of the release, and any remediation or cleanup measures taken. Information and data used for these predictions and estimates must be clearly identified in the storm water pollution prevention plan.

The Agency requests comments on what other types of information may be appropriate for source identification purposes.

(B) *Practices and program elements to control pollutants.* The second major section of the storm water pollution prevention plan addresses practices and program elements to reduce pollutants in areas identified as being potential pollutant sources for storm water discharges associated with industrial activity. In developing these requirements, the Agency has selected those practices identified in studies of BMPs which are widely used by industrial facilities with storm water discharges associated with industrial activity which it believes to be best available technology for the purpose of this permit.[60] In addition, the Agency has also addressed widely-used pollution prevention measures for storm water discharges (traditional storm water management and sediment and erosion prevention) and a requirement for facilities to certify that storm water discharges have been tested for the presence of non-storm water pollution sources.[61]

(1) pollution prevention committee;
(2) risk identification and assessment/ material inventory;
(3) preventive maintenance;
(4) good housekeeping;
(5) spill prevention and response procedures;
(6) traditional storm water management;
(7) sediment and erosion prevention;
(8) employee training;
(9) visual inspections; and

[60] "Staff Analysis of Implementing Permitting Activities for Storm Water Discharges Associated with Industrial Activity" (EPA, 1991)

[60] See "Staff Analysis of Implementing Permitting Activities for Storm Water Discharges Associated with Industrial Activity" EPA, 1991)

[61] The certification requirement that storm water discharges associated with industrial activity have been tested for the presence of non-storm water pollution sources is similar to the certification requirement in the Form 2F application for storm water discharges associated with industrial activity (see November 16, 1990 (55 FR 47990)). EPA is including this certification provision in these general permits since dischargers may obtain coverage under these permits without the submittal of Form 2F.

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(10) recordkeeping and internal reporting procedures; and

(11) certification that storm water discharges have been tested for the presence of non-storm water pollution sources.

These permits establish the framework and the basic elements for storm water pollution prevention measures. However, the plan requirements provide flexibility to allow the development of site-specific measures. At a given site, specific measures incorporated into the pollution prevention plan will reflect the sources of pollutants that have been identified at the site. For example, a facility that has identified dust and particulate generating processes as potential sources of storm water pollution will incorporate appropriate good housekeeping and traditional storm water management practices to address these sources. However, a facility without dust and particulate generating processes would not have to incorporate measures to address dust and particulate generating processes into their plan.

Pollution Prevention Committee. The Storm Water Pollution Prevention Committee identifies specific individuals within the plant organization who are responsible for developing the storm water pollution prevention plan and assisting the plant manager in its implementation, maintenance, and revision. The activities and responsibilities of the committee should address all aspects of the facility's storm water pollution prevention plan. However, EPA prefers that plant management, not the committee, have overall responsibility and accountability for the quality of the storm water pollution prevention plan, to ensure adequate implementation of the plan.

Risk identification and assessment/ material inventory. The storm water pollution prevention plan is to assess the potential of various sources at the plant to contribute pollutants to storm water discharges associated with industrial activity. These activities should assist in assessing the pollution potential of runoff from specific areas of the plant. The plan must contain an inventory the types of materials handled, the location of material management activities, and types of material management activities. Facilities subject to SARA title III, section 313 must include in the plan a description of releases to land or water of SARA title III water priority chemicals that have occurred at any time after the date of three years prior to the issuance of this permit.

The layout and activities at the plant identified as high-priority areas with a significant potential for contributing pollutants to the drainage system must be assessed. Factors to consider when evaluating the reasonable pollution potential of runoff from various portions of an industrial plant include:

- Loading and unloading operations;
- Outdoor storage activities;
- Outdoor manufacturing or processing activities;
- Significant dust or particulate generating processes; and
- On-site waste management and disposal practices.

Other factors that are to be considered include the toxicity of chemicals; quantity of chemicals used, produced, or discharged; the likelihood of these materials coming into contact with storm water, and the history of significant leaks or spills of toxic or hazardous pollutants.

Chemicals should be compatible with the materials used in storage and process equipment, including the piping, valves and pumps. Incompatibility of materials can cause equipment failure resulting from corrosion, fire, or explosion. Equipment failure can be prevented by ensuring that the materials of construction for containers handling hazardous substances or toxic pollutants are compatible with the container's contents and surrounding environment.

Preventive maintenance. A preventive maintenance program involves inspection and maintenance of storm water management devices (cleaning oil/water separators, catch basins) as well as inspecting and testing plant equipment and systems to uncover conditions that could cause breakdowns or failures resulting in discharges of pollutants to surface waters. A good preventive maintenance program includes identifying equipment or systems used in the program; periodically inspecting or testing equipment and systems; adjusting, repairing, or replacing items, and maintaining complete records on the equipment and systems.

Good housekeeping. Good housekeeping requires the maintenance of a clean, orderly facility. Good housekeeping includes establishing housekeeping protocols to reduce the possibility of mishandling chemicals or equipment and training of employees in housekeeping techniques. These measures also ensure that discharges of wash waters to separate storm sewers are avoided.

Spill prevention and response procedures. Areas where potential spills can occur, and their accompany drainage points should be iden clearly in the storm water pollution prevention plan. Where appropriate, specifying material handling procedure and storage requirements in the plan should be considered. Procedures for cleaning up spills should be identified i the plan and made available to the appropriate personnel. The necessary equipment to implement a clean up should be available to personnel. Spill response procedures should avoid discharging to separate storm sewers unless necessary because of immediate safety considerations.

Appropriate storm water management. Based on an assessment of the potential of various sources at the plant to contribute pollutants to storm water discharges associated with industrial activity, the plan shall provide that traditional storm water management measures determined to be reasonable and appropriate shall be implemented and maintained.

For the purposes of these permits, traditional storm water management practices are measures which reduce pollutant discharges by reducing the volume of storm water discharges associated with industrial activity, such as directing storm water to vegetati... swales, or preventing storm wate... onto areas of the site which condu... industrial activity. Low-cost measures that can be applied to an industrial setting may include diverting rooftop or other drainage across grass swales, cleaning catch basins, and installing and maintaining oil and grit separators. Other measures that may be appropriate include infiltration devices and unlined retention and detention basins. Traditional storm water management practices can include water reuse activities, such as the collection of storm water for later uses such as irrigation or dust control. Appropriate snow removal activities may be considered, such as selecting a site for removed snow and selecting and using deicing chemicals. The Agency requests comment on whether a facility that reuses substantially all of its storm water (for example, a facility that provides for storage and reuse of storm water from a 24 hour, 25 year storm) should be exempt from certain other storm water pollution prevention plan requirements. Such facilities would have already minimized their discharge in manner that may provide equivalent pollution removal benefits to other measures in a storm water pollution prevention plan.

However, care must be taken to evaluate whether these traditional devices cause ground water

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contamination. In some cases, it is appropriate to limit traditional storm water management practices to those areas of the drainage system that generate storm water with relatively low levels of pollutants (e.g., many rooftops, parking lots, etc.).

Sediment and erosion prevention. The plan shall identify areas which, due to topography, activities, or other factors, have a high potential for soil erosion, and identify and ensure the implementation of measures to limit erosion.

Employee training. Employee training programs are necessary to inform personnel at all levels of responsibility of the components and goals of the storm water pollution prevention plan. Training should address topics such as spill response, good housekeeping and material management practices. A pollution prevention plan should identify periodic dates for such training.

Visual inspection and records. Qualified plant personnel should be identified to inspect designated equipment and plant areas. Typical inspections should include examination of pipes, pumps, tanks, supports, foundations, dikes, and drainage ditches. Material handling areas should be inspected for evidence of, or the potential for, pollutants entering the drainage system. A tracking or followup procedure must be used to ensure that appropriate and adequate response and corrective actions have been taken. Records of inspections are required to be maintained.

Recordkeeping and reporting procedures. A recordkeeping system ensures adequate implementation of the storm water pollution prevention plan. Incidents such as spills, leaks and improper dumping, along with other information describing the quality and quantity of storm water discharges should be included in the records. Inspections and maintenance activities such as cleaning oil and grit separators or catch basins should be documented and recorded.

Records of releases of a hazardous substance in excess of reporting quantities established at 40 CFR 117.3 or 40 CFR 302.4 describing each release that has occurred at any time after the date of three years prior to the issuance of this permit, measures taken in response to the release, and measures taken to prevent recurrence must be included in plans.

Non-storm discharges. Plans shall include a certification that the discharge has been tested for the presence of non-storm water discharges. The certification shall include a description of the results of any test for the presence of non-storm water discharges, the method used, the date of any testing, and the on-site drainage points that were directly observed during the test. Such certification may not be feasible if the facility operating the storm water discharge associated with industrial activity does not have access to an outfall, manhole, or other point of access to the ultimate conduit which receives the discharge. In such cases, the source identification section of the storm water pollution plan shall indicate why the certification required by this part was not feasible.

iii. *Special requirements for storm water discharges associated with industrial activity from facilities subject to SARA title III, section 313 requirements.* The Superfund Amendments and Reauthorization Act (SARA) of 1986 resulted in the enactment of title III of SARA, the Emergency Planning and Community-Right-to-Know Act. Section 313 of title III of SARA requires operators of certain facilities that manufacture, import, process, or otherwise use listed toxic chemicals to report annually their releases of those chemicals to any environmental media. Listed toxic chemicals include 329 chemicals listed at 40 CFR part 372.

Facilities that meet all of the following criterion for a calendar year are subject to title III reporting requirements for that calendar year and must report under 40 CFR 372.30:

- The facility has 10 or more full-time employees;
- The facility is a multi-establishment complex where all establishments have a primary SIC code of 20 through 39;
- The facility is a multi-establishment complex in which one of the following is true:

—The sum of the value of products shipped and/or produced from those establishments that have a primary SIC code of 20 through 39 is greater than 50 percent of the total value of all products shipped and/or produced from all establishments at the facility;
—One establishment has a primary SIC code of 20 through 39 and contributes more in terms of value of products shipped and/or produced than any other establishment within the facility;

- The facility manufactured (including imported), processed, or otherwise used a toxic chemical in excess of an applicable threshold quantity of that chemical set forth in 40 CFR 372.25.

After 1989, the threshold quantity of listed chemicals that the facility must manufacture, import or process in order to be required to submit a release report is 25,000 pounds per year. The threshold for a use other than manufacturing, importing or processing of listed toxic chemicals is 10,000 pounds per year. EPA estimates that 22,000 facilities nationwide will be subject to SARA title III reporting requirements after 1990. EPA promulgated a final regulation clarifying these reporting requirements on February 16, 1988 (53 FR 4500). EPA believes that the information received through reporting is a "front end" of the toxics program to which EPA is already committed and ultimately will assist in better controls for routine toxics releases and improved industrial practices to prevent and respond to accidents involving toxics.

Of the 329 toxic chemicals listed at 40 CFR 372 which are used to define the scope of SARA title III, section 313 requirements, the Agency has identified approximately 175 chemicals which it is classifying, for the purposes of this general permit, as 'section 313 water priority chemicals'. For the purposes of this general permit, "section 313 water priority chemicals" are defined as chemicals or chemical categories which also:

(1) Are listed at 40 CFR 372.65 pursuant to SARA title, section 313;

(2) Are present at or above threshold levels at a facility subject to SARA title III, section 313 reporting requirements; and

(3) That meet at least one of the following criteria:

(i) Are listed in appendix D of 40 CFR part 122 on either table II (organic priority pollutants), table III (certain metals, cyanides, and phenols) or table V (certain toxic pollutants and hazardous substances);

(ii) Are listed as a hazardous substance pursuant to section 311(b)(2)(A) of the CWA at 40 CFR 116.4; or

(iii) Are pollutants for which EPA has published an acute or a chronic toxicity criteria.

The Agency estimates that about 9,000 facilities with storm water discharges associated with industrial activity nationwide have section 313 water priority chemicals in threshold amounts.

The large amounts of toxic chemicals at facilities with section 313 water priority chemicals raises concerns regarding the potential of material handling and storage operations to add pollutants to storm water discharges associated with industrial activity. As discussed earlier in this fact sheet, the material management practices associated with the storage and use of toxic chemicals is a major potential source of pollutants in storm water

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discharges associated with industrial activity. The Agency believes that the threshold criteria established in SARA title III, section 313, along with the regulatory definition of storm water discharge associated with industrial activity, which for many facilities in SIC codes 20–39, only includes storm water from areas where material handling equipment or activities, materials or industrial machinery are exposed to storm water (see 40 CFR 122.26(b)(14)), identify potential risks in a manner that is appropriate for use in developing priorities for establishing the applicability of specialized monitoring and pollution prevention measures for facilities which use and manage toxic chemicals.

In evaluating risks and establishing regulatory priorities for facilities with storm water discharges associated with industrial activity, the Agency believes that the large amounts of toxic chemicals found at facilities with section 313 water priority chemicals pose sufficient risk to warrant special permit conditions for these facilities. The Agency is requesting comments on two primary options for developing special permit conditions for these facilities.

Under Option A, the permit would provide for:

(1) In addition to baseline requirements for storm water pollution prevention plans, special pollution prevention measures, including spill prevention and containment requirements for areas of the facility used for material management of these chemicals;

(2) An acute WET limit for storm water associated with industrial activity that comes into contact with any equipment, tank, container, or other vessel used for section 313 water priority chemicals; and for truck and rail car loading and unloading areas for liquid section 313 water priority chemicals; and

(3) Biannual (twice a year) monitoring and reporting requirements for a number of parameters including acute whole effluent toxicity.

Under Option B, the general permits would provide for:

(1) An acute WET limit for storm water associated with industrial activity that comes into contact with any equipment, tank, container, or other vessel used for section 313 water priority chemicals; and for truck and rail car loading and unloading areas for liquid section 313 water priority chemicals; and

(2) Monitoring and reporting requirements at a higher frequency [68] than biannual (twice a year) monitoring for acute whole effluent toxicity for discharges of storm water that comes into contact with any equipment, tank, container, or other vessel used for section 313 water priority chemicals. Under Option B, the Agency is considering and requests comment on a range of monitoring options for the WET limitation, including monitoring biannually, quarterly, or every discharge event. Under Option B, facilities would remain subject to the baseline requirements for storm water pollution prevention plans, but would not be subject to the technology-based spill prevention and containment requirements outlined in Option A.

Option B would provide dischargers with more flexibility than Option A for complying with the permit. By providing additional flexibility by not requiring spill prevention and containment requirements, Option B may reduce compliance costs at facilities whose storm water discharges are not toxic. In addition, by not prescribing the specific method for controlling toxic storm water discharges, facilities can better take into account local factors in designing an appropriate cost-effective approach for meeting the WET test performance standard. Establishing a performance standard also encourages the development of new innovative and more cost-effective approaches for controlling toxic storm water discharges.

EPA requests comments on whether the criteria used for identifying priority facilities subject to specialized containment provisions and the WET effluent limitation are appropriate or whether these requirements should address a smaller or larger set of facilities including whether any set of facilities should be subject to the provisions of Option A or B.

One alternative on which EPA specifically requests comments would be to impose the requirements of Options A or B only on facilities (including facilities that are not subject to SARA title III, section 313) that have had a discharge of a hazardous substance in excess of reporting quantities established at 40 CFR 117.3 or 40 CFR 302.4 at any time after the date of three years prior to the issuance of these general permits which either discharge through a separate storm sewer systems or that otherwise comes into contact with storm water.

The Agency also requests comment on alternative approaches, including either alternative design standards or performance standards,[69] to establishing permit requirements which target containment requirements for chemical storage and handling activities where aquatically toxic chemicals are likely to be exposed to, or otherwise come into contact with, storm water. Comments addressing alternative approaches should also provide a description of the alternative performance standards or design standards. The Agency requests comments on the advantages and disadvantages of using design standards or performance standards for controlling storm water discharges associated with industrial activity. Comments can also address other regulatory or market incentives that can assure sufficient spill control and material managing practices that would make the imposition of containment requirements unnecessary.

Under Option A, the general permit would provide that storm water pollution prevention plans for facilities with section 313 water priority chemicals must, in addition to the requirements associated with the baseline pollution prevention plans, provide for spill prevention and containment-oriented controls.[69]

[68] Under Option A, the draft permit proposes biannual monitoring for storm water discharges from containment areas. The Agency believes that if the final permit follows Option B (e.g. provides for an effluent limitation but does not require containment), then a higher frequency of monitoring may be appropriate for a number of reasons. First, where containment is required, such controls may provide the operator with a better opportunity to evaluate and correct periodic releases of chemicals which may influence the toxicity of the discharge prior to discharge. Second, facilities with containment systems are expected to discharge storm water less frequently than facilities without containment systems thereby reducing the variability of system discharges. Third, discharges from containment systems may exhibit less variability due to mixing occurring in the containment unit, thereby requiring less frequent monitoring to characterize the discharge. EPA requests comment on the appropriate monitoring frequency for these discharges if the permit does not require containment.

[69] The most commonly used performance standards under the CWA are numeric effluent limitations and whole effluent toxicity limitations.

[69] The spill prevention and containment provisions for hazardous substances were analyzed in the 1979 survey of BMPs (see "NPDES Best Management Practice Guidance Document", U.S. EPA, December 1979 EPA-600/9-79-045) and the draft "Analysis of Implementing Permitting Activities for Storm Water Discharges Associated With Industrial Activity", EPA, 1991. EPA has also analyzed similar pollution prevention requirements for oil in the Spill Prevention, Control, and Countermeasure (SPCC) plan requirements at 40 CFR part 112 (see "The Oil Spill Prevention, Control, and Countermeasures Program Task Force Report", EPA, May 1988).

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Containment involves the use of physical structures or collection/drainage equipment used to confine a release of material after it escapes from its physical location or containment. Dikes, berms, retaining walls, impounding basins, diversion ponds, and retention ponds surrounding material storage tanks are the most common examples of containment. Containment systems must be sufficiently impervious to contain spilled Section 313 water priority chemicals. The spill prevention and containment provision of these general permits are designed to mitigate the discharge of toxic chemicals to waters of the United States from both significant spill events and from more routine material management practices and leaks.

Under Option A, the spill prevention and containment control requirements would only apply to priority areas of facilities with section 313 water priority chemicals (e.g. portions of the facility where section 313 water priority chemicals are stored or managed and which generate storm water discharges associated with industrial activity).[65] Secondary containment requirements would only be required for liquid storage areas where storm water comes into contact with equipment, tank, container, or other vessel used for section 313 water priority chemicals; and truck and rail car loading and unloading areas for liquid section 313 water priority chemicals. In developing the containment-oriented provisions of Option A, the Agency has provided flexibility to allow facilities to use or modify appropriate existing containment approaches that facilities currently employ.

EPA believes that where, economically achievable, containment structures for storm water associated with industrial activity that comes into contact with any equipment, tank, container, or other vessel used for section 313 water priority chemicals; and for truck and rail car loading and unloading areas for liquid section 313 water priority chemicals can prevent discharges of toxic chemicals after releases associated with spills, chronic leaks, and other material management practices occur.

Option B can also result in the implementation of measures to prevent discharges of toxic chemicals associated with spills, chronic leaks, and other material management practices.

Option A provides that if the installation of secondary containment structures or equipment is not economically achievable at a given facility, the facility operator must develop and implement a spill contingency and integrity testing plan which provides, as an alternative to secondary containment, a description of measures to ensure that discharges of toxic amounts of section 313 water priority chemicals do not occur. In these situations, a spill contingency and integrity plan must include:

- A detailed description which demonstrates that secondary containment requirements are not economically achievable based on the appropriate factors described at 40 CFR 125.3(d)(3);
- A spill contingency plan must include, at a minimum: a description of response plans, personnel needs, and methods of mechanical containment (such as the use of sorbants, booms, collection devices, etc.); steps to be taken for removal of spilled section 313 water priority chemicals; access to and availability of sorbents and other equipment; and such other information as required by the Director;
- The testing component of the plan must provide for conducting integrity testing of storage tanks at least once every five years, and conducting integrity and leak testing of values and piping a minimum of at least once every year; and
- A written and actual commitment of manpower, equipment and materials required to comply with the permit and to expeditiously control and remove any quantity of section 313 water priority chemicals that may result in a toxic discharge.

Spill contingency and integrity plans can prevent discharges of toxic chemicals by minimizing the potential for spills or leaks of toxic chemicals to occur or for material management practices to release toxic chemicals. In addition, where such releases occur, this approach can minimize the potential for contact of storm water with toxic chemicals. Option A requires secondary containment where achievable because of the degree of certainty that such containment will prevent toxic discharges. Nonetheless, where effectively implemented, a spill contingency and integrity testing plan may result in a level of control similar to that of installing containment structures, (e.g. the prevention of discharges of toxic amounts of section 313 water priority chemicals). Thus, spill contingency and integrity plans constitute an acceptable alternative set of requirements for some facilities based on the appropriate factors at 40 CFR 125.3(d)(3) (iii) and (v). Option B would also result in actions which would prevent toxic discharges.

EPA requests comment on the frequency and cost of integrity testing for tanks, valves, or pipes and whether integrity testing is an appropriate alternative to containment provisions where secondary containment is not economically achievable.

The Agency also notes that under both Options A and B, facilities with storm water discharges associated with industrial activity which, based on an evaluation of site specific conditions, believe that the appropriate conditions of these permits do not adequately represent BAT and BCT requirements for the facility may request an individual permit by submitting to the Director an individual application (Form 1 and Form 2F). Under Option A, the storm water pollution prevention plans at facilities with section 313 water priority chemicals and with storm water discharges associated with industrial activity must be reviewed and certified by a Registered Professional Engineer. With the certification, the Engineer must attest that the storm water pollution prevention plan has been prepared in accordance with good engineering practice. Such certifications will in no way relieve the owner or operator of a facility covered by the plan of their duty to prepare and fully implement such a plan.

The spill prevention and containment provision of Option A are designed to mitigate the discharge of toxic chemicals to waters of the United States from both significant spill events and from more routine material management practices and leaks. The Agency requests comment on a number of other approaches to meet these objectives. EPA requests comments on providing permittees with the option of Professional Engineer's certification that material management practices and controls provide equivalent control as the design specifications in the draft

[65] It should be noted that many facilities which are subject to SARA title III, section 313 reporting requirements because they manage section 313 water priority chemicals do not generate storm water discharges associated with industrial activity. The regulatory definition of "storm water associated with industrial activity" (40 CFR 122.26(b)(14)) addresses facilities in all Standard Industrial Classification (SIC) codes between 20 and 39 (as well as additional classes of facilities). However, facilities under SIC codes 20, 21, 22, 23, 2434, 25, 265, 267, 27, 283, 285, 30, 31 (except 311), 323, 34 (except 3441), 35, 36, 37 (except 373), 38, 39 which are not otherwise addressed in other parts of the regulatory definition only generate storm water associated with industrial activity where material handling equipment or activities, raw materials, intermediate products, final products, waste materials, by-products, or industrial machinery are exposed to storm water. Such facilities which do not generate storm water discharges associated with industrial activity are not subject to these permits (see [illegible] 26(b)(14)(ii))).

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permit. The Agency requests comment on what level of assurance is appropriate to determine that material management practices and controls are sufficient to provide equivalent control as the design specifications in the draft permit.

Storm water collected in containment areas can pick up significant levels of pollutants where material management practices result in leaks, spills or other exposure to chemicals. Rather than attempt to establish specific numeric limits of each type of pollutant subject to section 313, the Agency believes that it is more appropriate to establish acute whole-effluent toxicity limits for these discharges. For this reason, under both Options A and B, the general permit would establish an acute whole-effluent toxicity effluent limitation applied as a technology-based performance standard for discharges of storm water that comes into contact with any equipment, tank, container, or other vessel used for section 313 water priority chemicals, and for storm water discharged from truck and rail car loading and unloading areas for liquid section 313 water priority chemicals.

Toxicity monitoring and WET limits have been used in the NPDES program to address a wide range of discharges, including intermittent discharges. Applying numeric or toxicity limits on a technology-basis to intermittent discharges such as storm water protects against periodic releases of high levels of pollutants. Establishing limits for intermittent discharges is consistent with the approach taken in the NPDES program which does not allow for periodic exceedances of limits by continuous discharges.

For the purpose of this permit, EPA is defining toxicity for use as a technology-based limit as not being lethal to 20% or more of the more sensitive of either appropriate fish or invertebrate test organisms. EPA is requesting comment as whether this is the appropriate definition of the toxicity parameter as a technology-based limit for the purposes of this permit.

Since these discharges are generated from limited-sized, specific storage and material handling areas, a wide range of technologies are available to reduce the toxicity of the limited volume of storm water that is subject to the WET effluent limitation. The Agency anticipates that most storm water discharges from these areas at well-maintained facilities with good housekeeping practices will not exhibit acute toxicity. For the majority of storm water discharges that do exhibit acute toxicity, the toxicity can be reduced by improving storage or material handling procedures, practices or equipment. Other classes of discharges may require various types of end-of-pipe treatment or various offsite disposal options such as discharging to a POTW.[86]

EPA requests comments on possible alternatives to the WET effluent limitation for storm water discharges that come into contact with any equipment, tank, container, or other vessel used for section 313 water priority chemicals, or from truck and rail car loading and unloading areas for liquid section 313 water priority chemicals, including: (1) Establishing an effluent limitation that provides for zero discharge (compliance determinations based on the level of detection) for the specific Section 313 water priority chemicals used at the site, along with the containment provisions of the draft general permits. (Any untreated overflow from containment facilities properly designed, constructed and operated to treat the volume of runoff associated with a 25 year, 24 hour rainfall event would not be subject to the effluent limitation). This approach would be based on the showing that the best available technology for these facilities would include containment requirements and material management practices and other measures that ensured that storm water did not come into contact with SARA title III, section 313 chemicals; (2) establishing a zero discharge effluent limitation (compliance determinations based on the level of detection) without the containment provision of the draft general permit, and requiring discharge sampling at a higher frequency (such as quarterly or at every storm event) to ensure permit compliance. This approach is similar to approach 1, but would not rely on containment provisions to ensure and assist in meeting the zero discharge effluent limitation; (3) modifying approach 1 and 2 by establishing a non-zero effluent limitation for specific section 313 water priority chemicals based on BAT/BCT criteria (the Agency requests comment on which chemicals this approach would be appropriate for); (4) using an alternative indicator parameter other than toxicity for establishing limitations (the Agency requests comments on what indicator parameters would be appropriate for this purpose); and (5) instead of the WET effluent limitation, require facilities that detect a statistical difference in acute toxicity between the control and 100% effluent to submit a toxicity reduction evaluation (TRE) to the Director within one year.[87] Under this last approach, a TRE could be used in issuing an individual permit containing technology or water quality-based requirements based on an evaluation of site-specific conditions.

The Agency believes that the increased use of toxicity testing in the NPDES program has resulted in the development of adequate laboratory capacity to conduct the toxicity testing required by these permits. The Agency requests comment on any anticipated problems with inadequate laboratory capacity to conduct toxicity testing in the States addressed by these permits.

The draft general permits provide that any untreated overflow from containment facilities properly designed, constructed and operated to treat the volume of runoff associated with a 24 hour, 25 year rainfall event is not subject to the WET limitation. The 24 hour, 25 year rainfall event is the most commonly used design storm for BAT national effluent limitations guidelines which address storm water. The 24 hour, 25 year rainfall event provides a reasonable margin of safety when sizing secondary containment units.[88] EPA requests comments on the use of alternative storm events to a 25 year, 24 hour rainfall event in association with both the WET effluent limitation and containment provisions of the general permits.

iv. *Special requirements for storm water discharges associated with industrial activity from salt storage facilities.* The draft permits provide that storm water pollution prevention plans for facilities with storage piles of salt used for deicing or other commercial or industrial purposes must, in addition to the requirements associated with the baseline pollution prevention plans, enclose or cover their salt storage to prevent exposure to precipitation.[89]

v. *Special requirements for storm water discharges associated with industrial activity through large and medium municipal separate storm sewer systems.* Facilities covered by these

[86] See "Staff Analysis of Implementing Permitting Activities for Storm Water Discharges Associated with Industrial Activity" EPA, 1991

[87] EPA has developed the following guidance documents which describe methods and procedures for conducting TREs and Toxicity Identification Evaluations: (1) "Generalized Methodology for Conducting Industrial Toxicity Reduction Evaluations" (EPA/600/2-88/070). (2) "Methods for Aquatic Toxicity Identification Evaluations" Phase 1 Toxicity Characterization Procedures (EPA/600/3-88/034) Phase 2 Toxicity Identification Procedures (EPA/600/3-88/035) Phase 3 Toxicity Confirmation Procedures (EPA/600/3-88/036)

[88] "NPDES Best Management Practices Guidance Document", EPA, 1979 (EPA-600/9-79-045)

[89] See "Staff Analysis of Implementing Permitting Activities for Storm Water Discharges Associated with Industrial Activity" (EPA, 1991)

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permits must comply with applicable requirements in municipal storm water management programs developed under NPDES permits issued for the discharge of the municipal separate storm sewer system that receives the facility's discharge, provided the discharger has been notified of such conditions. Part 5 of this fact sheet discusses how permits for discharges from large and medium municipal separate storm sewer systems will typically require municipal permittees to develop storm water management programs which address storm water associated with industrial activity which discharges through their system.

vi. *Special requirements for storm water discharges associated with industrial activity composed of coal pile runoff.*

The draft general permits establish effluent limitations of 50 mg/l total suspended solids (TSS) and a pH range of 6 to 9 for storm water discharges associated with industrial activity.[60] This effluent limitation is similar to the effluent guideline limitation for coal pile runoff from facilities in the steam electric power generating point source category (see 40 CFR 423.12(b)(9)).

The limitation does not apply to any untreated overflow from facilities properly designed, constructed and operated to treat the volume of coal pile runoff which is associated with a 25 year, 24 hour rainfall event. Providing a limit to effluent guidelines for events that exceed a specified storm event provides operators with a basis for installing and operating a treatment system, as the design of the system, particularly the collection devices, will depend on the design storm chosen. The 25 year, 24 hour storm is most commonly used in the BAT national effluent limitations guideline that have been developed by EPA.[61] The effluent guideline limitation for coal pile runoff from facilities in the steam electric power generating point source category at 40 CFR 423.12(b)(9) incorporates a 10 year, 24 hour design storm into a best practicable control technology currently available (BPT) limit. BCT and BAT effluent limitation guidelines for coal pile runoff are currently reserved. The Agency believes that the appropriate design storm for coal pile runoff addressed by these permits is the more stringent 25 year, 24 hour design storm as these permits establish BAT/BCT limits (which are typically more stringent than BPT limits), and the 25 year, 24 hour storm is more commonly used in effluent guideline limitations based on the BAT or BCT standards. The Agency requests comments on the appropriate design storm (e.g. the 25 year, 24 hour, or the 10 year, 24 hour) for this limitation.

vii. *Public Availability.* The draft general permits clarify that all storm water pollution prevention plans required under the permit are considered reports that shall be available to the public under section 308(b) of the CWA. However, the permittee may claim any portion of a storm water pollution plan as confidential in accordance with 40 CFR part 2.

8. Monitoring and Reporting Requirements

a. *Monitoring requirements.* The draft permits have been developed to provide different monitoring requirements for certain classes of discharges. Monitoring and reporting requirements are established for storm water discharges associated with industrial activity from six classes of industries: SARA title III, section 313 facilities with water priority chemicals; primary metal facilities; land disposal units; wood treatment facilities (wood preservers) using chlorophenolic/creosote formulations; wood treatment facilities (wood preservers) using arsenic/chromium preservatives; and coal pile runoff. These categories and the associated monitoring and reporting requirements are discussed in more detail below. These categories of industrial facilities have been selected as priority sites in terms of monitoring requirements based on an evaluation of activities at these types of facilities which have the potential for contributing toxic pollutants to storm water discharges. EPA believes that requiring these facilities to submit monitoring reports will allow the Agency to continue to assess the nature of pollutants in storm water discharges from these types of facilities. EPA requests comments on the appropriateness of categories specific monitoring and reporting requirements for other categories of industrial facilities.

The draft general permit provides that operators of storm water discharges associated with industrial activity from oil and gas operations have the option of either monitoring their storm water discharges associated with industrial activity annually or, in lieu of the monitoring, a facility may have a Registered Professional Engineer certify that a storm water pollution plan has been prepared and is being implemented in accordance with the requirements o the permit.

Operators of other storm water discharges associated with industrial activity covered by the draft general permits which are not addressed by one of the industry-specific monitoring requirements are required to conduct annual monitoring of a set of specified parameters. Facilities subject to these 'baseline' monitoring requirements are subject to record keeping requirements, but generally do not have reporting requirements. Although EPA is proposing to not require the reporting of monitoring data for facilities without industry-specific monitoring requirements, the Agency believes that monitoring requirements remain appropriate as they will assist operators of storm water discharges in identifying sources of pollutants and in evaluating the effectiveness of the implementation of their storm water pollution prevention plans. In addition, EPA may review monitoring data during the term of the permit or during the permit reissuance process for the purposes of evaluating the effectiveness of a facility's storm water pollution prevention plan and for determining priorities for future permit issuance or modification.

i. *Monitoring requirements—Baseline monitoring requirements.* The following eight parameters have been identified as baseline parameters that generally form the foundation for different monitoring requirements in the permit: Oil and grease, pH, five-day biochemical oxygen demand (BOD5), chemical oxygen demand (COD), total suspended solids (TSS), total phosphorus, total Kjeldahl nitrogen (TKN), and nitrate plus nitrite nitrogen.

Oil and grease is a common industrial pollutant which can be indicative of material management, housekeeping and transportation activities. TSS is a common pollutant found in storm water discharges that reflects surface disturbances and material management practices, and can have significant impacts on receiving waters. Oxygen demand (COD and BOD5) will help the permitting authority evaluate the oxygen depletion potential of the discharge. BOD5 is the most commonly used indicator of oxygen demand. COD is considered a more inclusive indicator o. oxygen demand, especially where metals interfere with the BOD5 test, and generally is better suited for comparing the oxygen demand of a storm water discharge with that of other discharges. The pH will provide important

[60] See "Staff Analysis of Implementing Permitting Activities for Storm Water Discharges Associated with Industrial Activity" (EPA, 1991)

[61] BAT effluent limitations guidelines that incorporate a 25-year 24-hour storm event include animal feedlots (40 CFR part 412), fertilizer manufacturing (40 CFR part 418), and phosphate manufacturing (40 CFR part 422).

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information on the potential availability of metals to the receiving flora, fauna, and sediment. In some cases it will provide information regarding material management. Total phosphorus, TKN, nitrate plus nitrite nitrogen are measures of nutrients that can impact water quality. In addition, most of the monitoring requirements contain a requirement to monitor pollutants subject to effluent limitation guidelines. Effluent limitation guidelines can identify industry-specific pollutants which may be of concern.

SARA title III, section 313 Facilities. The large amounts of toxic chemicals stored and utilized at SARA title III, section 313 facilities with section 313 water priority chemicals raises concerns regarding the potential of material handling and storage operations to add pollutants to storm water discharges associated with industrial activity. Storm water discharges associated with industrial activity that comes into contact with any equipment, tank, container, or other vessel used for title III, section 313 water priority chemicals; and for truck and rail car loading and unloading areas for liquid title III, section 313 water priority chemicals must be monitored semiannually (2 times per year) for: Oil and grease; biochemical oxygen demand (BOD5), chemical oxygen demand (COD), total suspended solids, total Kjeldahl nitrogen (TKN), total phosphorus, pH, nitrate plus nitrite nitrogen, acute whole effluent toxicity, and any chemical constituent for which the operator is subject to reporting requirements under section 313 of the Emergency Planning and Community Right to Know Act of 1986 for chemicals which are classified as "section 313 water priority chemicals".

The monitoring requirements for storm water discharges associated with industrial activity that comes into contact with any equipment, tank, container, or other vessel used for title III, section 313 water priority chemicals; and for truck and rail car loading and unloading areas for liquid title III, section 313 water priority chemicals modify the baseline parameters for other storm water discharges by adding the requirement to test for any chemical constituent for which the operator is subject to reporting requirements under section 313 and acute whole effluent toxicity. Acute whole effluent toxicity monitoring requirements are being established for two reasons: (1) Acute whole effluent toxicity is a non-chemical specific parameter suitable for characterizing the potential impacts of the wide range of chemicals and chemical formulations expected to be found at the wide variety of section 313 facilities; and (2) To support the acute whole effluent toxicity limitation proposed in the draft general permits. Requirements to test chronic toxicity have not been included in this permit because discharges from the containment areas are expected to be generally less frequent than other storm water discharges (e.g. containment system discharges are typically not expected to occur with each event) and relatively low volume where the area generating the storm water discharges associated with industrial activity subject to the containment requirements described in the pollution prevention plans developed under this permit is relatively small. Monitoring requirements for storm water discharges from containment areas are not applicable where there is not a discharge to a waters of the United States (including discharges through municipal separate storm sewer systems to waters of the United States), such as where the discharge is to a POTW.

Storm water discharges associated with industrial activity from other portions of SARA title III section 313 facilities (e.g. those storm water discharges associated with industrial activity that are not composed of storm water that comes into contact with any equipment, tank, container, or other vessel used for title III, section 313 water priority chemicals, or from truck and rail car loading and unloading areas for liquid title III, section 313 water priority chemicals) are subject to baseline monitoring requirements of the permit.

Primary Metal Facilities. Facilities classified as Standard Industrial Classification (SIC) 33 (Primary Metal Industry) include steel works, blast furnaces, rolling and finishing mills, iron and steel foundries, primary and secondary smelting and refining of nonferrous metals, rolling, drawing and extruding of nonferrous metals, and nonferrous foundries. These facilities typically have significant dust or particulate generating processes, as well as other activities, which can contribute a wide range of pollutants, including metals, to storm water discharges associated with industrial activity.

Under the draft general permits facilities classified as SIC 33 must monitor semiannually (2 times per year) all storm water discharges associated with industrial activity that are discharged from the facility for: oil and grease, pH, BOD5, COD, TSS, total phosphorus, total Kjeldahl nitrogen, nitrate plus nitrite nitrogen, any pollutant limited in an effluent guideline to which the facility is subject, acute whole effluent toxicity, total lead, total cadmium, total copper, total arsenic, and total chromium.

The monitoring requirements for storm water discharges associated with industrial activity from primary metal facilities modify the baseline monitoring requirements by adding requirements to monitor acute whole effluent toxicity, and five metals. The five metals selected are typically the most common toxic metals generally expected in storm water from primary metal facilities. However, dust or particulate generating processes or material management activities at primary metal facilities can result in a number of other metals and pollutants in storm water discharges associated with industrial activity from primary metal facilities. Acute whole effluent toxicity is a non-chemical specific parameter suitable for characterizing the potential impacts of these additional pollutants.

Land Disposal Units. Land disposal units with storm water discharges associated with industrial activity may receive a diverse range of industrial wastes. EPA has summarized case studies documenting surface water impacts and ground water contamination incidents of land disposal units (see August 30, 1988 (53 FR 33372)[1] Evaluation of 163 case studies revealed surface water impacts at 73 facilities. Elevated levels of organics, including pesticides, and metals have been found in ground water and/or surface water at many sites.

Facilities that discharge storm water associated with industrial activity from any active or inactive landfill, land application site, or open dump that received any industrial wastes are required to monitor semiannually (2 times per year) for: ammonia, bicarbonate, calcium, chloride, total iron, magnesium (total), magnesium (dissolved), nitrate plus nitrite nitrogen, potassium, sodium, sulfate, chemical oxygen demand (COD), total dissolved solids (TDS), total organic carbon (TOC), pH, total arsenic, total barium, total cadmium, total chromium, total cyanide, total lead, total mercury, total selenium, total silver, volatile organic carbon (VOC) acute whole effluent toxicity.

The parameters addressed by the monitoring requirements for storm water discharges associated with industrial activity from land disposal units is similar to the parameters addressed by proposed ground water monitoring requirements for municipal solid waste landfills established under subtitle D of RCRA (see August 30, 1988 (53 FR

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33372)). The Agency believes that the pollutants identified for the purpose of evaluating ground water quality at land disposal units should also be considered when evaluating storm water discharges. Given the wide range of materials that may be disposed at land disposal units, many other pollutants may potentially be found in storm water discharges from land disposal units. For this reason, the draft permits require sampling of acute whole effluent toxicity. The toxicity parameter is particularly relevant in situation, since the evaluation of the toxicity parameter does not require specific chemical identification.

Wood Treatment (chlorophenolic/creosote formulations). Pollutants in storm water runoff from treated material storage yards at wood-preserving facilities were studied by EPA in 1981 in support of effluent guidelines development, and in support of a proposed hazardous waste listing in 1988 (December 30, 1988 (53 FR 53287)). Several organic pollutants were found at significant concentrations, including pentachlorophenol, fluoranthene, benzo(a)anthracene, chrysene, phenanthrene, and pyrene.

All storm water discharges associated with industrial activity from areas that are used for wood treatment, wood surface application or storage of treated or surface protected wood at any wood preserving or wood surface facilities that currently use chlorophenolic formulations and/or creosote formulation shall be monitored semiannually (2 times per year) for: oil and grease, pH, BOD5, COD, TSS, total phosphorus, total Kjeldahl nitrogen, nitrate plus nitrite nitrogen, acute whole effluent toxicity, and pentachlorophenol.

The monitoring requirements for storm water discharges associated with industrial activity from wood treatment facilities modify the baseline monitoring requirements by adding requirements to monitor pentachlorophenol, acute whole effluent toxicity. Pentachlorophenol is a major constituent of preservatives used at these facilities, and acute whole effluent toxicity testing will assist in assessing the presence of other toxics in these discharges.

Wood Treatment (arsenic/chromium preservatives). Arsenic/chromium preservatives consist of mixtures of bivalent copper, pentavalent arsenic, hexavalent chromium or fluorides. The three most widely used compounds for commercial wood treatment include chromanic copper arsenate (CCA); ammoniacal copper arsenate (ACA); and fluorochrome-arsenate phenol (FCAP). Pollutants in storm water runoff from treated material storage yards at wood-preserving facilities were studied by EPA in 1981 in support of effluent guidelines development, and in support of a proposed hazardous waste listing in 1988. Certain metals, including chromium, copper, and arsenic, were found at high levels in storm water from wood-preserving facilities using inorganic arsenical preservatives.

All storm water discharges associated with industrial activity from areas that are used for wood treatment or storage of treated wood at any wood preserving facilities that currently use inorganic preservatives containing arsenic or chromium shall be monitored semiannually (2 times per year) for: Oil and grease, pH, BOD5, COD, TSS, total phosphorus, total Kjeldahl nitrogen, nitrate plus nitrite nitrogen, total arsenic, total chromium, and total copper.

The monitoring requirements for storm water discharges associated with industrial activity from wood treatment or storage of treated wood at any wood preserving facilities that currently use inorganic preservatives containing arsenic or chromium modify the baseline monitoring requirements by adding requirements to monitor arsenic, chromium and copper, three major toxic constituents found in the preservatives used by these facilities.

Coal Pile Runoff. Coal pile runoff has been shown to contain significant levels of suspended solids, copper, iron, aluminum, nickel, zinc and other trace metals. (See "Development Document for Effluent Limitations Guidelines and Standards and Pretreatment Standards for the Steam Electric Point Source Category", (EPA-440/182/029j).

All storm water discharges associated with industrial activity from coal piles shall be monitored semiannually (2 times per year) for: Oil and grease, pH, TSS, total copper, total nickel and total zinc.

The monitoring requirements for storm water discharges associated with industrial activity from coal piles support the effluent limitations for pH and TSS in these permits. The three metals, total copper, total nickel, and total zinc have been shown to be at concentrations of concern in coal pile runoff (see Table 3 above). Oil and grease is a common industrial pollutant which can be indicative of material management, housekeeping and transportation activities.

Oil and gas exploration or production operations. Operators of storm water discharges associated with industrial activity from oil and gas exploration or production operations have the option of either monitoring their storm water discharges associated with industrial activity annually or, in lieu of the monitoring, a facility may have a Registered Professional Engineer certify that a storm water pollution plan has been prepared and is being implemented in accordance with the requirements of the permit.

Oil and Gas Exploration or Production Operations (Sampling Option). Operators of storm water discharges associated with industrial activity from oil and gas exploration and production operations which elect to conduct monitoring rather than obtain a Professional Engineer's certification are required to analyze samples annually (once a year) for the following parameters: Oil and grease, pH, BOD5, COD, TSS, total phosphorus, total Kjeldahl nitrogen, nitrate plus nitrite nitrogen, and any pollutant limited in an effluent guideline to which the facility is subject. The rationale for selecting these baseline parameters is discussed above.

Oil and Gas Exploration or Production Operations (Certification Option). Operators of storm water discharges associated with industrial activity from oil and gas exploration or production operations have the option of obtaining a Professional Engineer's certification that a storm water pollution plan has been prepared by the facility and is being implemented in accordance with the requirements of the permit. Dischargers pursuing this option are required to obtain recertification of the plan every three years. By means of certification, the Engineer shall attest that: The Engineer has visited and examined the facility and is familiar with the provisions of this part; the Plan has been prepared in accordance with good engineering practice; reserve pits used to hold spent drilling muds or cuttings have been designed and built to prevent storm induced overflows; and the Plan is adequate for the facility. Such certifications will in no way relieve the owner or operator of a facility covered by the plan of their duty to prepare and fully implement such plan.

Information from sources such as non-point source assessments developed pursuant to section 319(a) of the CWA indicate that significant water quality impacts can be caused by wet-weather failure of on-site waste disposal systems at oil and gas exploration and production operations (such as storm induced overflows of reserve pits used to hold spent drilling muds and cuttings). Periodic sampling of discharges may not be sufficient to identify or predict these events. Rather, a PE certification may provide a more appropriate link for evaluating the

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potential for and preventing these types of events.

Allowing this class of dischargers the option of obtaining Professional Engineer's certifications addresses a number of concerns. First, Professional Engineering certifications will provide a direct link to the implementation of the central provision of the general permits, the requirement to develop and implement storm water pollution prevention plans. Second, providing dischargers with the option of either conducting annual sampling or obtaining a Professional Engineer's certification will provide the discharger with flexibility to select the most cost-effective manner to comply with the draft permits. Third, this approach will reduce the administrative burdens on EPA while not limiting its ability to ensure permit compliance.

Storm Water Discharges Not Otherwise Addressed. Operators of storm water discharges covered by the draft general permits which are not subject to an industry specific monitoring requirement under the permits shall monitoring their storm water discharges associated with industrial activity annually (once a year) for the following baseline parameters: oil and grease, pH, BOD5, COD, TSS, total phosphorus, total Kjeldahl nitrogen, nitrate plus nitrite nitrogen, and any pollutant limited in an effluent guideline to which the facility is subject. The rationale for selecting these baseline parameters is discussed above.

ii. *Volume estimates.* The draft general permits take two approaches for estimating volumes associated with storm water discharges. The first approach, which is applicable to two classes of facilities, discharges from SARA title III section 313 containment areas for chemicals which are classified as 'Section 313 water priority chemicals' and discharges from land disposal units, requires that an estimate of the total volume of the discharge monitored be provided. This approach is taken for these types of facilities because it is anticipated that some degree of retention will be provided for the storm water discharges associated with industrial activity from these facilities [62] and that providing volume estimates will be more practicable.

Other classes of storm water discharges covered by the general permits (wood preserving facilities, primary metal facilities, and other discharges without industry specific requirements) are required to provide an estimate of the size of the drainage area (in square feet) and an estimate of the runoff coefficient of the drainage area (e.g. low (under 40%), medium (40% to 65%) or high (above 65%)). This information assists in characterizing the magnitude of the volume of discharges that will occur for different magnitude storm events. In addition, this information will generally be easier for dischargers to provide.

iii. *Sampling waiver.* The draft general permits have an "adverse climatic conditions" provision allowing a discharger to submit a description of why samples could not be collected in lieu of sampling data when the discharger is unable to collect samples due to climatic conditions which prohibit the collection of samples including weather conditions that create dangerous conditions for personnel (such as local flooding, high winds, hurricane, tornadoes, electrical storms, etc.) or otherwise make the collection of a sample impracticable (drought, extended frozen conditions, etc.).

iv. *Sample type.* The requirements for the type of samples taken vary depending on the nature of the discharge. A minimum of one grab sample may be taken for discharges from holding ponds or other impoundments with a retention period greater than 24 hours. For all other discharges, data shall be reported for both a grab sample and a composite sample. All such samples shall be collected from the discharge resulting from a storm event that is greater than 0.1 inches and at least 72 hours from the previously measurable (greater than 0.1 inch rainfall) storm event. The grab sample shall be taken during the first thirty minutes of the discharge (or as soon thereafter as practicable). The composite sample shall either be flow-weighted or time-weighted. Composite samples may be taken with a continuous sampler or as a combination of a minimum of three sample aliquots taken in each hour of discharge for the entire discharge or for the first three hours of the discharge, with each aliquot being separated by a minimum period of fifteen minutes. Only grab samples must be used for pH, cyanide, and oil and grease.

v. *Reporting requirements.* Dischargers addressed by the sampling requirements for the six classes of storm water discharges associated with industrial activity (SARA Title III, land disposal units, primary metal, wood preserving (chlorophenolic/creosote formulations), wood preserving (arsenic/chromium preservatives), and coal pile runoff) are required to submit signed discharge monitoring reports (DMRs) to the appropriate EPA Regional Office biannually.

Dischargers with at least one storm water discharge associated with industrial activity through a large or medium municipal separate storm sewer system (systems serving a population of 100,000 or more) in addition to filing copies of the DMR to the Regional Office, must submit signed copies to the operator of the municipal separate storm sewer system biannually.

Operators of storm water discharges associated with industrial activity from oil and gas exploration or production operations and that conduct sampling requirements rather than obtaining a Professional Engineer's certification, as well as operators of other storm water discharges that are not subject to industry specific monitoring requirements, are not required to submit monitoring reports unless specifically requested by the Director. These dischargers must maintain sampling data collected during the term of the permit. Upon reissuance of a new general permit, the permittee will be required to notify the Director of their intent to be covered by the new general permit. The Agency intends that NOI provisions for the reissued permits will require dischargers to summarize the quantitative data they had collected during the previous permit term. This approach will reduce the administrative burdens associated with reviewing annual DMRs for these discharges, while providing for an opportunity for Agency review at least every five years. Further, reviewing discharger data during the permit reissuance process will assist in efforts to implement the permitting strategy to address industry specific or individual permitting. The Agency requests comment as to whether facilities covered by these permits should be required to submit an annual certification that a pollution prevention plan has been developed for the site and is being implemented.

vi. *Relationship between permit requirements and proposed rule change.* These monitoring requirements of the draft general permits are consistent with the proposed regulatory modifications to 40 CFR 122.28(b)(2)(ii), discussed earlier in today's notice. The final permits will be consistent with the regulatory requirements regarding this provision that are in existence at the time of

[62] For example, EPA has proposed requirements for run-off control systems from the active portion of the municipal solid waste landfills to collect and control all the water volume resulting from a 24 hour 25-year storm (see August 30 1988 (53 FR 33408)).

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permit issuance.[68] If EPA promulgates less stringent regulations specifying minimum monitoring requirements, the monitoring requirements in these permits may be limited to priority facilities. The Agency believes that classes of industrial facilities that may be considered priority facilities for monitoring include the classes of facilities for which industrial specific monitoring requirements are proposed in these draft permits, deicing activities at airports, steam electric facilities, pulp and paper facilities, and organic chemical facilities with storm water discharges associated with industrial activity. EPA requests comment on classes of facilities that should be considered a priority for retaining monitoring requirements in these permits.

B. *Other reporting requirements.* The draft general permits provide that any facility that is unable to provide the certification that separate storm sewer outfalls have been tested for illicit connections must notify the Director within 180 days of the effective date of the permit. Such notification shall describe: The procedure of any test conducted for the presence of non-storm water discharges, the results of such test or other relevant observations, potential sources of non-storm water discharges to the storm sewer, and why adequate tests for such storm sewers were not feasible.

C. *Retention of records.* The permittee is required to retain records of all monitoring information, copies of all reports required by this permit, and records of all data used to complete the Notice of Intent to be covered by the permit, for a period of at least three years from the date of the measurement, report, or application. This period may be extended by request of the Director.

8. Cost estimates

a. *Pollution prevention plan implementation.* Storm water pollution prevention plans for the majority of facilities will address relatively low cost baseline controls for the majority of industrial facilities. EPA's analysis of storm water pollution prevention plans indicates that the cost of developing and implementing the costs of these plans is variable and will depend on a number of factors, including: The size of the facility, chemicals stored or used at a facility, the nature of the plant operations and plant designs and the housekeeping measures employed. Table 5 provides estimates of the range of costs of preparing and implementing a storm water pollution prevention plan. It is expected that the low cost estimates provided in Table 5 is appropriate for the majority of smaller facilities. High cost estimates are also provided.

Additional information regarding the estimates of the costs required to comply with the conditions proposed in this permit are provided in "Staff Analysis of Implementing Permitting Activities for Storm Water Discharges Associated with Industrial Activity" (EPA, 1991). The Agency requests comments on these cost estimates.

b. *SARA Title III Facilities.* Table 6 provides estimates of the range of costs of preparing and implementing a storm water pollution prevention plan for facilities which are subject to the special requirements for facilities subject to SARA title III section 313 reporting requirements for chemicals which are classified as "section 313 water priority chemicals". EPA anticipates that the majority of facilities are expected to have existing containment systems that will meet the majority of the requirements of these permits. High cost estimates correspond to facilities that are expected to be required to undertake some actions to upgrade existing containment systems to meet the requirements of these permits. Costs associated with meeting the toxicity limitation in this permit only apply to facilities whose discharges exhibit toxicity, and are based on an assumption that the toxicity of discharge can be reduced by: Modifying material handling practices; by modifying existing storage equipment to eliminate leaks and other sources of chemical exposure; or by discharging waters collected by a containment system to a POTW. Costs of treatment where the facility does not have existing treatment capacity or off site disposal is typically expected to be higher.

Additional information regarding the estimates of the costs required to comply with the conditions proposed in this permit are provided in "Staff Analysis of Implementing Permitting Activities for Storm Water Discharges Associated with Industrial Activity" (EPA, 1991). The Agency requests comments on these cost estimates.

[68] Elsewhere in today's notice, the Agency is requesting comments on six options for modifying the existing regulatory provisions addressing permit monitoring. EPA intends to issue final general permits based on the draft permits noticed here either at the same time or after the Agency has completed the permit monitoring rulemaking. The monitoring requirements in the final general permits may be modified from those appearing in the draft general permits to reflect the promulgated regulatory changes.

TABLE 5.—SUMMARY OF ESTIMATED COSTS FOR COMPLIANCE WITH STORM WATER POLLUTION PREVENTION PLANS WITH BASELINE REQUIREMENTS

Control measure	Costs in 1988 dollars			
	Low costs		High costs	
	Capital costs (annualized)	Annual O & M Costs	Capital costs (annualized)	Annual O & M costs
Plan Preparation	2,000		75,000	19,860
Plan Revisions	200		7,500	1,985
Material Inventory/Risk Assessment		80		840
Spill prevention/response Procedures		80		700
Employee Training		100		1,115
Visual Inspections		100		1,025
Preventive Maintenance/Housekeeping				4,180
Storm Water Management			8,000	800
Sediment and Erosion Prevention		100	800	1,000
Recordkeeping		80	100	100
Non-storm water certification	200		14,000	
Total Fixed cost [1]	2,400		102,100	

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TABLE 5.—SUMMARY OF ESTIMATED COSTS FOR COMPLIANCE WITH STORM WATER POLLUTION PREVENTION PLANS WITH BASELINE REQUIREMENTS—Continued

Control measure	Costs in 1988 dollars			
	Low costs		High costs	
	Capital costs (annualized)	Annual O & M Costs	Capital costs (annualized)	Annual O & M costs
Total Annual costs		830		80,866

This table identifies estimated low and high costs to develop and implement storm water pollution prevention plans.
Low costs of implementing program components are zero where existing programs, procedures or security is assumed adequate.
Annualized costs are based upon a 5 year permit and 10% discount.
[1] Total costs only address situation where storm water pollution plan needs to be developed and not the lower cost situation where a plan is existing and needs revision.

TABLE 6.—SUMMARY OF ESTIMATED COSTS FOR COMPLIANCE WITH STORM WATER POLLUTION PREVENTION PLANS PER APPLICABLE UNIT OPERATION FOR FACILITIES SUBJECT TO SECTION 313 OF SARA TITLE III WITH WATER PRIORITY CHEMICALS

Control measure	Low costs		High costs	
	Capital costs (annualized)	Annual O & M Costs	Capital Costs (annualized)	Annual O & M costs
Liquid Storage Curbing	0		1,120	
Raw Material Storage Tarpaulin	0	0	400	160
Runon Diversion Trench	0	0	1,100	250
Collection System	0	0	15,000	5,000
Toxicity Reduction Evaluation/Remediation	0	0	25,000	500
Total Fixed Costs	0		42,620	
Total Annual Costs		0		5,910

This table identifies estimated additional low and high costs to develop and implement storm water pollution prevention plans for SARA Title III, Section 313 facilities subject to special conditions.
Low costs of implementing program components are zero where existing programs, procedures or security is assumed adequate.
Annualized costs are based upon a 5 year permit and 10% discount rate.

c. *Construction sites.* The two major costs associated with pollution prevention plans for construction activities include the costs of sediment and erosion controls (see Table 7), and the costs of storm water management controls (see Table 8). The draft general permits provide flexibility in developing controls for construction activities. Typically, most construction sites will employ several types of sediment and erosion controls and storm water management controls, but not all of the controls listed in Tables 7 and 8. In general, sites which disturb a larger area will incur higher pollution prevention costs.

TABLE 7.—SEDIMENT AND EROSION CONTROL COSTS

Vegetative practices	
Temporary seeding	$1.00 per square yard.
Permanent seeding	$1.00 per square yard.
Mulching	$1.25 per square yard.
Sod stabilization	$4.00 per square yard.
Vegetative buffer strips	$1.00 per square yard.
Protection of trees	$30.00 to $200 per tree set.
Earth dikes	$5.50 per linear foot.
Straw bale dikes	$5.00 per linear foot.
Silt fences	$6.00 per linear foot.
Brush barriers	
Drainage swales—grass	$3.00 per square yard.
Drainage swales—sod	$4.00 per square yard.
Drainage swales—riprap	$45.00 per square yard.
Drainage swales—asphalt	$35.00 per square yard.
Drainage swales—concrete	$65.00 per square yard.
Check dams—rock	$100 per dam.
Check dams—covered straw bales	$50 per dam.
Level spreader—earthen	$4.00 per square yard.
Level spreader—concrete	$65.00 per square yard.
Subsurface drain	$2.25 per linear foot.
Pipe slope drain	$5.00 per linear foot.
Temporary storm drain diversion	Variable.
Storm drain inlet protection	$300 per inlet.
Rock outlet protection	$45 per square yard.
Sediment traps	$500 to $7,000 per trap.
Temporary sediment basins	$5,000 to $50,000 per basin.
Sump pit	$500 to $7,000.
Entrance stabilization	$1,500 to $5,000 per entrance.
Entrance wash rack	$2,000 per rack.
Temporary waterway crossing	$500 to $1,500.
Wind breaks	$2.50 per linear foot.

Practices such as sod stabilization and tree protection increase property values and satisfy consumer aesthetic needs.

TABLE 8.—COSTS OF STORM WATER MANAGEMENT FOR CONSTRUCTION SITES

	Cost for 5 acre developed area	Cost for 20 acre developed area
Wet ponds	$5,770	$16,300
Dry ponds	12,000	39,330
Dry ponds with extended detention	6,950	16,900
Infiltration trenches	8,500	34,100

Estimates based on methodology presented in "Cost of Urban Runoff Quality Controls", Wiegand, C., Schueler, T., Chrisensen, W., and Jellick, D., Urban Runoff Quality-Impact and Quality Enhancement Technology, Proceedings of an Engineering Foundation Conference, ASCE, 1986, edited by B. Urbonas and L.A. Roesner.

d. *Oil and gas production or exploration operations.* Facilities with contaminated storm water discharges associated with industrial activity, in addition to the baseline requirements for storm water pollution prevention plans, are required to obtain professional engineer certifications or monitor their discharges. The estimated cost of a professional engineer certification is

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$200. Some oil and gas exploration or production facilities are expected to monitor their storm water discharges instead of obtaining professional engineer certifications. This additional cost is not applicable to such facilities.

e. *Salt storage facilities.* Salt pile covers or tarpaulins are anticipated to have a fixed cost of $400 and an annual cost of $160 for medium sized piles, and a fixed cost of $4,000 and an annual cost of $2,000 for very large piles. Structures such as salt domes are generally expected to have a fixed cost of between $30,000 for small piles ($70 to $80 per cubic yard) and $100,000 for larger piles ($18 per cubic yard) with costs depending on their size and other construction parameters.

f. *Coal pile runoff.* The effluent limitations for coal pile runoff in the draft permits can be achieved by two primary methods: by limiting exposure to coal by use of covers or tarpaulins; and by collecting and treating the runoff. In some cases, coal pile runoff may be in compliance with the effluent limitations without covering the pile or collecting or treating the runoff. In these cases, the operator of the discharge would not have a control cost.

The use of covers or tarpaulins to prevent or minimize exposure of the coal pile to storm water is generally expected to be practical only for relatively small piles. Coal pile covers or tarpaulins are anticipated to have a fixed cost of $400 and annual cost of $160.

Table 8 provides estimates of the cost of treating coal pile runoff.[a], [a] These costs are based on a consideration of a treatment train requiring equalization, pH adjustment and settling, including the costs for impoundment (for equalization), a lime feed system and mixing tanks for pH adjustment, and a clarifier for settling. The costs for the impoundment area include diking and containment around each coal pile and associated sumps and pumps and piping from runoff areas to impoundment area. The costs for land are not included. The lime feed system employed for pH adjustment includes a storage silo, shaker, feeder, and lime slurry storage tank, instrumentation, electrical connections, piping and controls.

[a], [a] The type and degree of treatment required to meet the effluent limitations of these permits will vary depending upon factors such as the amount of sulfur in the coal. This section describes a model treatment scheme for the purposes estimating costs for compliance with the proposed effluent limitations. Dischargers may implement other less expensive treatment approaches to enable them to discharge in accordance with these limits where appropriate.

Additional costs may be incurred if a polymer system is needed. In such a case, costs would include impoundment for equalization, a lime feed system, mixing tank, and polymer feed system for chemical precipitation, a clarifier for settling and an acid feeder and mixing tank to readjust the pH within the range of 8 to 9. The equipment and system design, with the exception of the polymer feeder, acid feeder and final mixing tank, is essentially the same as shown in Table 8. Two tanks are required for a treatment train with a polymer system, one for pecipitation and another for final pH adjustment with acid. The cost of mixing is therefore twice that shown in Table 8. The polymer feed system includes storage hoppers, chemical feeder, solution tanks, solution pumps, interconnecting piping, electrical connections and instrumentation. The costs of clarification is identical to that of Table 8. A treatment train with a polymer system requires the use of an acid additional system to readjust the pH within the range of 8 to 9. The components of this system include a lined acid storage tank, two feed pumps, an acid pH control loop, and associated piping, electrical connections and instrumentation.

Additional information regarding the cost of these technologies can be found in: "Development Document for Effluent Limitations Guidelines and Standards and Pretreatment Standards for the Steam Electric Point Source Category", ((EPA-440/182/029), November 1982, EPA).

TABLE 8.—SUMMARY OF ESTIMATED COSTS FOR TREATMENT OF COAL PILE RUNOFF

	30,000 cubic meter coal pile	1,200,000 cubic meter coal pile
Impoundment:		
Installed Capital Cost (dollars)	6,300	12,600.
Operation and Maintenance (dollars/year)	negligible	negligible.
Lime feed system:		
Installed Capital Cost (dollars)	127,000	381,000.
Operation and Maintenance (dollars/year)	6,300	16,100.
Energy Requirements (kwh/yr)	3.6 x 10**4	3.6 x 10**4.
Land Requirements (ft**2)	5,000	5,000.
Mixing Equipment:		
Installed Capital Cost (dollars)	60,800	167,600.
Operation and Maintenance (dollars/year)	2,100	2,400.
Energy Requirements (kwh/yr)	1.3 x 10**3	1.3 x 10**3.
Land Requirements (ft**2)	2,000	2,000.
Clarification:		
Installed Capital Cost (dollars)	169,000	360,000.
Operation and Maintenance (dollars/year)	3,000	3,000.
Energy Requirements (kwh/yr)	1.3 x 10**3	1.3 x 10**3.
Land Requirements (ft**2)	3,000	7,000.

Source: "Development Document for Effluent Limitations Guidelines and Standards and Pretreatment Standards for the Steam Electric Point Source Category", (EPA-440/182/029), November 1982, EPA). Costs estimates have been revised to account for inflation.

10. *Effective date requirements.* This permit shall be effective upon issuance.

11. *EPA contacts.*

MA, ME, NH

United States EPA, Region I, Water Management Division, (WCP-2109), John F. Kennedy Federal Building, Room 2203, Boston, MA 02203. Contact: Veronica Harrington, (617) 565-3525.

NY (Indian lands), Puerto Rico

United States EPA, Region II, Water Management Division, (WM-WPC), Jacob K. Javits Federal Building, 26 Federal Plaza, New York, NY 10278. Contact: Jose Rivera (WM-WPC), (212) 264-1858.

District of Columbia, DE (Federal facilities)

United States EPA, Region III, Water Management Division, (3WM56), 841 Chestnut Building, Philadelphia, PA 19107. Contact: Kevin Magerr, (215) 597-1651.

AL (Indian lands), FL, GA (Indian lands), KY (Indian lands), MS (Indian lands), NC (Indian lands), SC (Indian lands), TN (Indian lands)

United States EPA, Region IV, Water Management Division, (FPB-3), 345 Courtland Street, NE, Atlanta, GA 30365. Contact: Chris Thomas, (404) 347-3021.

MI (Indian lands), MN (Indian lands), WI (Indian lands)

United States EPA, Region V, Water Quality Branch (5WQP), 230 South Dearborn Street, Chicago, IL 60604. Contact: Irving Dzikowski, (312) 353-2105.

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United States EPA, Region VI, Water Management Division, (6W-PM), First Interstate Bank Tower at Fountain Place, 1445 Ross Avenue, 12th Floor, Suite 1200, Dallas, TX 75202. Contact: Craig Weeks, (214) 665-7180.

SD, CO (Federal facilities and Indian lands), MT (Indian lands), ND (Indian lands), UT (Indian lands), WY (Indian lands)

United States EPA, Region VIII, Water Management Division, Compliance Branch (8WM-C), 999 18th Street, Suite 500, Denver, CO 80202-2405. Contact: Vera Berry, (303) 293-1280.

AZ, CA (Indian lands), NV (Indian lands), Guam, American Samoa

United States EPA, Region IX, Water Management Division, (W-6-1), 75 Hawthorne Street, San Francisco, CA 94105. Contact: Eugene Bromley, (415) 744-1806.

AK, ID, WA (Federal facilities and Indian lands)

United States EPA, Region X, Water Management Division, (WD-134), 1200 Sixth Street, Seattle, WA 98101. Andrea Lindsay, (206) 553-6399.

12. *Proposed schedule for general permits issuance.*

Draft Permits Transmitted to State requesting section 401 certification: August 16, 1991.

Notice of Draft Permits in Federal Register: August 16, 1991.

Comment Period Closed: October 15, 1991.

Notice of Final Permit Expected in Federal Register: 12/91

VII. Economic Impact

EPA has prepared an Information Collection Request (ICR) for the purpose of estimating the information collection burden imposed on Federal, State and local governments and industry by proposed revisions to requirements to submit annual monitoring reports, minimum notice of intent (NOI) requirements for NPDES general permits, and for States to submit State Storm Water Permitting Plans. (A summary of the costs of compliance with the general permit notice herein is provided in the fact sheet presented earlier in today's notice).

The ICR evaluates five options for modifying the existing regulatory requirement that NPDES permits for storm water discharges associated with industrial activity must, at a minimum, require dischargers to report monitoring data annually. All options considered would lower the burdens on the Federal government, State governments and industry. The burden savings to the Federal and State governments range from a savings of 6,743 hours per year ($105,724 per year) for Option 4 to a savings of 14,848 hours per year ($232,617 per year) for Options 2, 3 and 5. Option 3 is currently favored by EPA. The burden savings to industry range from a savings of 66,300 hours per year (2.2 million per year) for Option 2 to a savings of 795,600 hours per year ($26 million per year) for Option 5. The option currently favored by EPA (Option 3) would result in a burden savings to industry of 231,300 hours/year ($7.5 million/year).

EPA believes that the regulatory modifications to the notice of intent requirements for general permits will codify existing practices. Therefore, this regulatory change, while ensuring national consistency, will not increase the burdens to the Federal government, State governments or industry.

The reporting burden for State Storm Water Permitting Plans is estimated to range from 340 hours ($5,350) per response to 1,500 hours ($23,500) per response. The national total burden for the 57 States (including 7 Territories), averaged over a three year period, is 14,794 hours per year or $231,965 per year. The Agency also estimates that the costs to the Federal Government 20 hours ($315) to review each State Storm Water Permitting Plan. The total burden of reviewing these plans, averaged over a three year period is 380 hours per year or $5,958 per year.

VIII. Executive Order 12291

EPA has submitted this notice to the Office of Management and Budget for review under Executive Order 12291.

IX. Paperwork Reduction Act

The information collection requirements associated with the proposed regulatory changes have been submitted for approval to the Office of Management and Budget (OMB) under the *Paperwork Reduction Act*, 44 U.S.C. 3501 *et seq.* An Information Collection Request (ICR) document has been prepared by EPA (ICR No. 0229.05) and a copy may be obtained from: Florice Farmer, Information Policy Branch; EPA; 401 M St., SW. (PM-2234); Washington, DC or by calling (202) 382-2740.

The ICR document estimates the information collection burdens imposed on the Federal Government, State governments and industry associated with the proposed revisions to requirements to: submit annual monitoring reports for storm water discharges under 40 CFR 122.44; establish minimum notice of intent requirements for general permits under 40 CFR 122.28. In addition, the ICR estimates the information collection burdens imposed on the Federal government and the States to submit State Storm Water permitting plans and the burden imposed on the Federal government to review these plans.

The ICR estimates that the reporting burdens on industry for collecting information associated with discharge monitoring reports (DMRs) typically ranges from 6 hours to 10.5 hours per response. The ICR estimates that the EPA or NPDES States will require 0.2 hours to review each DMR submitted.

The ICR estimates that the reporting burdens on industry for collecting information associated with a notice of intent (NOI) is one hour per response. The ICR estimates that the EPA or NPDES States will require 0.25 hours to review each NOI submitted.

The reporting burden for State Storm Water Management Programs is estimated to range from 340 hours per response for small States to 1,500 hours per response for large States. Estimates of reporting burden include reviewing guidance, planning activities, analyzing existing data, analyzing other data, developing the strategy, public review and comment and reviewing the strategy. The Agency also estimates the Federal Government will require 20 hours to review each State Storm Water Permitting Strategy.

Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, Chief, Information Policy Branch, PM-223Y, U.S. Environmental Protection Agency, 401 M St., SW., Washington, DC 20490; and to the Office of Management and Budget, Washington, DC 20503, marked "Attention: Desk Officer for EPA." The final rule will respond to OMB or public comments on the information collection requirements contained in this proposal.

X. Regulatory Flexibility Act

Under the Regulatory Flexibility Act, 5 USC 601 *et seq.*, EPA is required to prepare a Regulatory Flexibility Analysis to assess the impact of rules on small entities. No Regulatory Flexibility Analysis is required, however, where the head of the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities.

Today's proposed amendments to the regulations would generally make the NPDES regulations more flexible and less burdensome for permittees. Accordingly, I hereby certify, pursuant to 5 U.S.C. 605(b), that these amendments, if promulgated, and that these general permits, when issued, will not have a significant impact on a substantial number of small entities.

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List of Subjects in 40 CFR Part 122

Administrative practice and procedure, Environmental protection, Reporting and record keeping requirements, Water pollution control.

Dated: July 31, 1991.

William K. Reilly,

Administrator.

For the reasons stated in the preamble, part 122 of title 40 of the Code of Regulations is proposed to be amended as follows:

PART 122—EPA ADMINISTERED PERMIT PROGRAMS; THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

1. The authority citation for part 122 is revised to read as follows:

Authority: 33 U.S.C. 1251 *et seq.*

Subpart C—Permit Conditions

2. Section 122.28 is amended by redesignating current paragraph (b)(3) as (b)(3) and by adding a new paragraph (b)(2) to read as follows:

§ 122.28 General permits (applicable to State NPDES programs, see § 123.25).

* * * * *

(b) * * *

(2) *Authorization to discharge, or to engage in sludge use and disposal practices.* (i) Except as provided in paragraphs (b)(2)(v) and (b)(2)(vi) of this section, dischargers (or treatment works treating domestic sewage) seeking coverage under a general permit shall submit to the Director a written notice of intent to be covered by the general permit. A discharger (or treatment works treating domestic sewage) who fails to submit a notice of intent in accordance with the terms of the permit is not authorized to discharge, or in the case of a sludge disposal permit, to engage in a sludge use or disposal practice, under the terms of the general permit unless the general permit, in accordance with paragraph (b)(2)(v) of this section, contains a provision that a notice of intent is not required or the Director notifies a discharger (or treatment works treating domestic sewage) that it is covered by a general permit in accordance with paragraph (b)(2)(vi) of this section. A complete and timely notice of intent to be covered constitutes a permit application for purposes of §§ 122.6, 122.21 and 122.28.

(ii) The notice of intent shall include, at a minimum, the legal name and address of the owner or operator, the facility name and address, type of facilities or discharges, the receiving stream(s), and such other information as is reasonably necessary to ascertain whether the discharger (or treatment works treating domestic sewage) should be included under the terms of the general permit as specified in the final general permit. General permits for storm water discharges associated with industrial activity from inactive mining or inactive oil and gas operations occurring on Federal lands where an operator cannot be identified may contain alternative notice of intent requirements.

(iii) Unless the general permit specifies different time periods, the notice of intent to be covered (including notices of intent to be covered for new dischargers) shall be submitted within 60 days before the date of intended coverage.

(iv) After a discharger (or treatment works treating domestic sewage) has filed its notice of intent to be covered, the discharger (or treatment works treating domestic sewage) shall be deemed covered on the date specified in the permit and may discharge or, in the case of a sludge disposal permit, engage in a sludge use or disposal practice under the general permit, unless the Director notifies the discharger (or treatment works treating domestic sewage) that it is not covered by the general permit and instead must obtain coverage under an individual permit or an alternative general permit. The Director may specify in the general permit that this paragraph shall not apply and that dischargers (or treatment works treating domestic sewage) submitting a notice of intent to be covered by the permit will not be authorized to discharge or, in the case of a sludge disposal permit, to engage in a sludge use or disposal practice until notified of their inclusion under the permit by the Director.

(v) Discharges other than discharges from publicly owned treatment works, combined sewer overflows, primary industrial facilities, contaminated runoff from mining operations or oil and gas operations and other storm water discharges associated with industrial activity, may, at the discretion of the Director, be authorized to discharge under a general permit without submitting a notice of intent where the Director finds that a notice of intent requirement would be inappropriate. In making such a finding, the Director shall consider: The type of discharge; the expected nature of the discharge; the potential for toxic and conventional pollutants in the discharges; the expected volume of the discharges; other means of identifying discharges covered by the permit; and the estimated number of discharges to be covered by the permit. The Director shall provide in the public notice of the general permit the reasons for not requiring a notice of intent.

(vi) The Director may notify a discharger (or treatment works treating domestic sewage) that it is covered by a general permit, even if the discharger (or treatment works treating domestic sewage) has not submitted a notice of intent to be covered. A discharger (or treatment works treating domestic sewage) so notified may request an individual permit under paragraph (b)(3)(iii) of this section.

* * * * *

3. Section 122.44 is amended by revising paragraph (i)(2) and adding paragraphs (i)(3) through (i)(6) to read as follows:

§ 122.44 Establishing limitations, standards, and other permit conditions (applicable to State NPDES programs, see § 123.25).

* * * * *

(i) * * *

(2) Except as provided in paragraphs (i)(4) and (i)(5) of this section, requirements to report monitoring results with a frequency dependent on the nature and effect of the discharge, but in no case less than once a year. For sewage sludge use or disposal practices, requirements to monitor and report results with a frequency dependent on the nature and effect of the sewage sludge use or disposal practice; minimally this shall be as specified in 40 CFR part 503 (where applicable), but in no case less than once a year.

(3) Requirements to report monitoring results for storm water discharges associated with industrial activity which are subject to an effluent limitation guideline shall be established on a case-by-case basis with a frequency dependent on the nature and effect of the discharge, but in no case less than once a year.

(4) Requirements to monitor storm water discharges associated with industrial activity (other than those addressed in paragraphs (i)(3) and (i)(5) of this section) shall be established on a case-by-case basis with a frequency dependent on the nature and effect of the discharge, however, at a minimum, a permit for such a discharge must require annual monitoring of representative storm water discharges associated with industrial activity. Where dischargers are not required to report monitoring results to the Director, permits must require that the results of monitoring be retained for at least the term of the permit and be made available to the Director upon request. In such cases,

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results of any monitoring conducted during the term of the permit shall be submitted as part of a permit application or notice of intent requirement prior to permit reissuance.

(5) Requirements to monitor contaminated storm water discharges associated with industrial activity from oil and gas exploration or production operations or from inactive mining operations where a past or present mine operator cannot be identified shall be established on a case-by-case basis with a frequency dependent on the nature and effect of the discharge. However, at a minimum, a permit for such a discharge must require either:

(i) Annual monitoring of representative contaminated storm water discharges associated with industrial activity from oil and gas exploration or production operations or inactive mines where a past or present mine operator cannot be identified. Where dischargers are not required to report monitoring results to the Director, permits must require that the results of monitoring be retained for at least the term of the permit and be made available to the Director upon request. In such cases, results of any monitoring conducted during the term of the permit shall be submitted as part of a permit application or notice of intent requirement prior to permit reissuance; or

(ii) the facility owner or operator to develop and implement a storm water pollution prevention plan or a storm water best management plan which includes a Registered Professional Engineer's certification that the plan had been prepared and is being implemented in accordance with good engineering practices, with such certification being obtained at a minimum frequency of at least once every three years. Such certification shall in no way relieve the owner or operator of a storm water discharge associated with industrial activity of their duty to prepare and fully implement such plan in accordance with the requirements of their permit. Where dischargers are not required to report results of such certification to the Director, permits must require that the certification be retained for at least the term of the permit and be made available to the Director upon request. In such cases, an indication of whether the certification was received should be submitted as part of a permit application or notice of intent requirement prior to permit reissuance.

(6) Permits which do not require the submittal of monitoring result reports at least annually shall require that the permittee report all instances of noncompliance not reported under paragraphs 122.41(l)(1), (4), (5), and (6) at least annually.

* * * * *

Appendix—Draft General Permits

Note: The following Appendix will not appear in the Code of Federal Regulations.

Draft General Permits

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Part I. Coverage Under this Permit

A. *Permit Area.* The permit covers all areas of the State of _____[1]

B. *Eligibility.*

1. Except for storm water discharges identified under paragraph I.B.2, this permit may cover all new and existing discharges composed entirely of storm water discharges associated with industrial activity.

2. *Limitations on Coverage.* The following storm water discharges associated with industrial activity are not covered by this permit:

a. Storm water discharges associated with industrial activity from facilities with existing effluent guideline limitations for storm water;[2]

b. Storm water discharges associated with industrial activity from facilities with an existing NPDES individual or general permit for the storm water discharges or which are issued a permit in accordance with paragraph I.C of this permit;

c. Storm water discharges associated with industrial activity that the Director has shown to be or may reasonably be expected to be contributing to a violation of a water quality standard; and

d. Storm water discharges associated with industrial activity from inactive mining or inactive oil and gas operation occurring on Federal lands where an operator cannot be identified.

C. *Requiring an individual permit or an alternative general permit.*

1. The Director may require any person authorized by this permit to apply for and obtain either an individual NPDES permit or an alternative NPDES general permit. Any interested person may petition the Director to take action under this paragraph. The Director may require any owner or operator authorized to discharge under this permit to apply for an individual NPDES

[1] Note that the Agency is noticing distinct draft general permits in Alaska, Arizona, Florida, Idaho, Louisiana, Massachusetts, Maine, New Hampshire, New Mexico, Oklahoma, South Dakota, Texas, District of Columbia, the Commonwealth of Puerto Rico, Guam, American Samoa, the Commonwealth of the Northern Mariana Islands, and the Trust Territory of the Pacific Islands, on Indian lands in AL, CA, GA, KY, MI, MN, MS, MT, NC, ND, NY, NV, SC, TN, UT, WI, and WY; from Federal facilities and Indian lands in CO and WA; and from Federal facilities in Delaware.

[2] For the purpose of this permit, the following effluent guideline limitations address storm water: cement manufacturing (40 CFR part 411); feedlots (40 CFR part 412); fertilizer manufacturing (40 CFR part 418); petroleum refining (40 CFR part 419); phosphate manufacturing (40 CFR part 422); steam electric (40 CFR part 423); coal mining (40 CFR part 434); mineral mining and processing (40 CFR part 436); ore mining and dressing (40 CFR part 440); and asphalt emulsion (40 CFR part 443).

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permit only if the owner or operator has been notified in writing that a permit application is required. This notice shall include a brief statement of the reasons for this decision, an application form, a statement setting a deadline for the owner or operator to file the application, and a statement that on the effective date of the individual NPDES permit or the alternative general permit as it applies to the individual permittee, coverage under this general permit shall automatically terminate. The Director may grant additional time to submit the application upon request of the applicant. If an owner or operator fails to submit in a timely manner an individual NPDES permit application required by the Director under this paragraph, then the applicability of this permit to the individual NPDES permittee is automatically terminated at the end of the day specified for application submittal.

2. Any owner or operator authorized by this permit may request to be excluded from the coverage of this permit by applying for an individual permit or participating in an applicable group application. The owner or operator shall submit an individual application (Form 1 and Form 2F) with reasons supporting the request, or participate in a group application in accordance with the requirements of 40 CFR 122.28, to the Director. The request shall be granted by issuing of any individual permit or an alternative general permit if the reasons cited by the owner or operator are adequate to support the request.

3. When an individual NPDES permit is issued to an owner or operator otherwise subject to this permit, or the owner or operator is approved for coverage under an alternative NPDES general permit, the applicability of this permit to the individual NPDES permittee is automatically terminated on the effective date of the individual permit or the date of approval for coverage under the alternative general permit, whichever the case may be. When an individual NPDES permit is denied to an owner or operator otherwise subject to this permit, or the owner or operator is denied for coverage under an alternative NPDES general permit, the applicability of this permit to the individual NPDES permittee is automatically terminated on the date of such denial, unless otherwise specified by the Director.

D. *Authorization.* Owners or operators of storm water discharges associated with industrial activity must submit a Notice of Intent (NOI) in accordance with the requirements of part II of this permit to be authorized to discharge under this general permit. Unless notified by the Director to the contrary, owners or operators who submit such notification are authorized to discharge storm water associated with industrial activity under the terms and conditions of this permit. Upon review of the NOI, the Director may deny coverage under this permit and require submittal of an application for an individual NPDES permit.

Part II. Notice of Intent Requirements

A. *Deadlines for notification.* Individuals who intend to obtain coverage for an existing storm water discharge associated with industrial activity under this general permit shall submit a Notice of Intent (NOI) in accordance with the requirements of this part within 180 days of the date of issuance of this general permit or at least 30 days prior to the commencement of construction of a new storm water discharge associated with industrial activity.

B. *Failure to notify.* Owners (or operators when owners do not operate the facility), who fail to notify the Director of their intent to be covered, and discharge pollutants to waters of the United States without an NPDES permit, are in violation of the Clean Water Act.

C. *Contents of notice of intent.* The Notice of Intent shall include the following information:

1. Name, mailing address, and location of the facility for which the notification is submitted;

2. Up to four 4-digit SIC codes that best represent the principal products or activities provided by the facility;

3. The operator's name, address, telephone number, ownership status and status as Federal, State, private, public or other entity;

4. The latitude and longitude of the approximate center of the facility to the nearest 15 seconds, or the nearest quarter section (if the section, township and range is provided) that the facility is located in;

5. The name of the receiving water(s), or if the discharge is through a municipal separate storm sewer, the name of the municipal operator of the storm sewer and the ultimate receiving water(s); and

6. Existing quantitative data describing the concentration of pollutants in storm water discharges.

7. *Additional requirements for construction activities.* The Notice of Intent for a storm water discharges associated with industrial activity from a construction site shall, in addition to the information required above, include a brief description of the project, estimated timetable for major activities, estimates of the number of acres of the site on which soil will be disturbed, and a certification that the storm water pollution prevention plan for the facility provides compliance with approved State or local sediment and erosion plans or storm water management plans in accordance with part III.C.5.b.(3) of this permit.

D. *Where to Submit.* Facilities which discharge storm water associated with industrial activity must submit signed copies of the Notice of Intent to the Director of the NPDES program at the following address:

Address of Central Receiving Office to be determined later

E. *Additional Notification.*

1. Except for facilities subject to part II.E.2, facilities which discharge storm water associated with industrial activity to a large or medium municipal separate storm sewer system (systems serving a population of 100,000 or more) must, in addition to filing copies of the Notice of Intent in accordance with paragraph II.D, shall submit signed copies of the Notice of Intent to the operator of the municipal separate storm sewer to which they discharge.

2. Facilities which discharge storm water associated with industrial activity from construction activities and are operating under approved State or local sediment and erosion or storm water management plans, in addition to filing copies of the Notice of Intent in accordance with paragraph II.D, shall submit signed copies of the Notice of Intent to the State or local agency approving such plans.

F. *Renotification.* Upon reissuance of a new general permit, the permittee is required to notify the Director of his intent to be covered by the new general permit.

Part III. Special conditions, management practices, and other non-numeric limitations

A. *Prohibition on non-storm water discharges.* All discharges covered by this permit shall be composed entirely of storm water. Discharges of material other than storm water must be in compliance with a NPDES permit (other than this permit) issued for the discharge.

B. *Releases in excess of Reportable Quantities.* This permit does not relieve the permittee of the reporting requirements of 40 CFR part 117 and 40 CFR part 302. The discharge of hazardous substances in the storm water discharge(s) from a facility shall be minimized in accordance with th applicable storm water pollution

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prevention plan for the facility, and in no case, during any 24-hour period, shall the discharge(s) contain a hazardous substance equal to or in excess of reporting quantities.

C. *Storm water pollution prevention plans.* A storm water pollution prevention plan shall be developed for each facility covered by this permit. Storm water pollution prevention plans shall be prepared in accordance with good engineering practices. The plan shall identify potential sources of pollution which may reasonably be expected to affect the quality of storm water discharges associated with industrial activity from the facility. In addition, the plan shall describe and ensure the implementation of practices which are to be used to reduce the pollutants in storm water discharges associated with industrial activity at the facility and to assure compliance with the terms and conditions of this permit.

1. The plan shall be signed in accordance with part VI.G, and be retained on site in accordance with part V.A of this permit. It shall be completed within 180 days of the effective date of this permit (and updated as appropriate), or, in the case of new facilities, prior to submitting a NOI to be covered under this permit. Plans shall provide for compliance with the terms of the plan within 365 days of the effective date of this permit, or, in the case of new facilities, prior to submitting a NOI to be covered under this permit. The owner or operator of a facility with storm water discharges covered by this permit shall make plans available upon request to the Director, or authorized representative, or in the case of a storm water discharge associated with industrial activity which discharges through a municipal separate storm sewer system with an NPDES permit, to the municipal operator of the system.

2. If the plan is reviewed by the Director, or authorized representative, the Director, or authorized representative, may notify the permittee at any time that the plan does not meet one or more of the minimum requirements of this Part. After such notification from the Director, or authorized representative, the permittee shall make changes to the plan and shall submit to the Director a written certification that the requested changes have been made. Unless otherwise provided by the Director, the permittee shall have 30 days after such notification to make the changes necessary.

3. The permittee shall amend the plan whenever there is a change in design, construction, operation, or maintenance, which has a significant effect on the potential for the discharge of pollutants to the waters of the United States or if the storm water pollution prevention plan proves to be ineffective in achieving the general objectives of controlling pollutants in storm water discharges associated with industrial activity. Amendments to the plan may be reviewed by EPA in the same manner as part III.C.2 above.

4. Except for storm water discharges associated with industrial activity from construction activities, which are subject to the requirements of paragraph III.C.5, the plan shall include, at a minimum, the following items:

a. *Description of Potential Pollutant Sources.* Each plan shall provide a description of potential sources which may be reasonably expected to add significant amounts of pollutants to storm water discharges or which may result in the discharge of pollutants during dry weather from separate storm sewers draining the facility. Each plan shall identify all activities and significant materials which may potentially be significant pollutant sources. Each plan shall include:

(1). A site map indicating, an outline of the drainage area of each storm water outfall; each existing structural control measure to reduce pollutants in storm water runoff; and surface water bodies.

(2). A topographic map (or other map if a topographic map is unavailable), extending one-quarter of a mile beyond the property boundaries of the facility. The requirements of this paragraph may be included in the site map required under part III.C.4.a.(1) if appropriate.

(3). A narrative description of significant materials that have been treated, stored or disposed in a manner to allow exposure to storm water between the time of three years prior to the date of the issuance of this permit and the present; method of on-site storage or disposal; materials management practices employed to minimize contact of these materials with storm water runoff between the time of three years prior to the date of the issuance of this permit and the present; materials loading and access areas; the location and a description of existing structural and nonstructural control measures to reduce pollutants in storm water runoff, and a description of any treatment the storm water receives.

(4). A list of significant spills and significant leaks of toxic or hazardous pollutants that occurred at the facility after the effective date of this permit.

(5). For each area of the plant that generates storm water discharges associated with industrial activity with a reasonable potential for containing significant amounts of pollutants, a prediction of the direction of flow, and an estimate of the types of pollutants which are likely to be present in storm water discharges associated with industrial activity; and

(6). A summary of existing sampling data describing pollutants in storm water discharges.

b. *Storm Water Management Controls.* Each facility covered by this permit shall develop a description of storm water management controls appropriate for the facility, and implement such controls. The appropriateness and priorities of controls in a plan shall reflect identified potential sources of pollutants at the facility. The description of storm water management controls shall address the following minimum components, including a schedule for implementing such controls:

(1). *Pollution Prevention Committee.* The description of the storm water Pollution Prevention Committee shall identify specific individuals within the plant organization who are responsible for developing the storm water pollution prevention plan and assisting the plant manager in its implementation, maintenance, and revision. The activities and responsibilities of the committee should address all aspects of the facility's storm water pollution prevention plan.

(2). *Risk Identification and Assessment/Material Inventory.* The storm water pollution prevention plan shall assess the potential of various sources at the plant to contribute pollutants to storm water discharges associated with industrial activity. The plan shall include an inventory of the types of materials handled. Facilities subject to SARA title III, section 313 shall include in the plan a description of releases to land or water of SARA Title III water priority chemicals that have occurred at any time after the date of three years prior to the issuance of this permit. Each of the following shall be evaluated for the reasonable potential for contributing pollutants to runoff: loading and unloading operations; outdoor storage activities; outdoor manufacturing or processing activities, significant dust or particulate generating processes; and on-site waste disposal practices. Factors to consider include the toxicity of chemicals; quantity of chemicals used, produced, or discharged, the likelihood of contact with storm water; and history of significant leaks or spills of toxic or hazardous pollutants.

(3). *Preventive Maintenance.* A preventive maintenance program shall involve inspection and maintenance o-

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storm water management devices (cleaning oil/water separators, catch basins) as well as inspecting and testing plant equipment and systems to uncover conditions that could cause breakdowns or failures resulting in discharges of pollutants to surface waters.

(4). *Good Housekeeping.* Good housekeeping requires the maintenance of a clean, orderly facility.

(5). *Spill Prevention and Response Procedures.* Areas where potential spills can occur, and their accompanying drainage points shall be identified clearly in the storm water pollution prevention plan. Where appropriate, specifying material handling procedures and storage requirements in the plan should be considered. Procedures for cleaning up spills shall be identified in the plan and made available to the appropriate personnel. The necessary equipment to implement a clean up should be available to personnel.

(6). *Storm Water Management.* The plan shall contain a narrative consideration of the appropriateness of traditional storm water management practices (practices other than those which control the source of pollutants). Based on an assessment of the potential of various sources at the plant to contribute pollutants to storm water discharges associated with industrial activity (see Part III.C.4.b.(2) of this permit), the plan shall provide that measures determined to be reasonable and appropriate shall be implemented and maintained.

(7). *Sediment and Erosion Prevention.* The plan shall identify areas which, due to topography, activities, or other factors, have a high potential for significant soil erosion, and identify measures to limit erosion.

(8). *Employee Training.* Employee training programs shall inform personnel at all levels of responsibility of the components and goals of the storm water pollution prevention plan. Training should address topics such as spill response, good housekeeping and material management practices. A pollution prevention plan shall identify periodic dates for such training.

(9). *Visual Inspections.* Qualified plant personnel shall be identified to inspect designated equipment and plant areas. Material handling areas shall be inspected for evidence of, or the potential for, pollutants entering the drainage system. A tracking or followup procedure shall be used to ensure that appropriate response has been taken in response to the inspection. Records of inspections shall be maintained.

(10). *Recordkeeping and Internal Reporting Procedures.* Incidents such as spills, or other discharges, along with other information describing the quality and quantity of storm water discharges shall be included in the records. Inspections and maintenance activities shall be documented and recorded.

(11). *Non-Storm Discharges.* A certification that the discharge has been tested for the presence of non-storm water discharges. The certification shall include a description of the results of any test for the presence of non-storm water discharges, the method used, the date of any testing, and the on-site drainage points that were directly observed during the test. Such certification may not be feasible if the facility operating the storm water discharge associated with industrial activity does not have access to an outfall, manhole, or other point of access to the ultimate conduit which receives the discharge. In such cases, the source identification section of the storm water pollution plan shall indicate why the certification required by this part was not feasible. A discharge that is unable to provide the certification required by this paragraph must notify in accordance with part V.A of this permit.

c. *Site inspection.* A site inspection shall be conducted annually by appropriate personnel named in the storm water pollution prevention plan to verify that the description of potential pollutant sources required under part III.C.4.a is accurate, the drainage map has been updated or otherwise modified to reflect current conditions; and the controls to reduce pollutants in storm water discharges associated with industrial activity identified in the storm water pollution prevention plan are being implemented and are adequate. Records documenting significant observation made during the site inspection shall be retained as part of the storm water pollution prevention plan for three years.

d. *Special requirements for storm water discharges associated with industrial activity through municipal separate storm sewer systems serving a population of 100,000 or more.* Facilities covered by this permit must comply with applicable requirements in municipal storm water management programs developed under NPDES permits issued for the discharge of the municipal separate storm sewer system that receives the facility's discharge, provided the discharger has been notified of such conditions.

e. *Consistency with other plans.* Storm water management programs may reflect requirements for Spill Prevention Control and Countermeasure (SPCC) plans under section 311 of the CWA or Best Management Practices (BMP) Programs otherwise required by an NPDES permit and may incorporate any part of such plans into the storm water pollution prevention plan by reference.

f. *Special requirements for storm water discharges associated with industrial activity from facilities subject to SARA title III, section 313 requirements.* (Option A would include part III.C.4.f. as shown below. See section 7.B of the Fact Sheet for a discussion of Option A and Option B.) Storm water pollution prevention plans for facilities subject to reporting requirements under SARA title III, section 313 for chemicals which are classified as ('Section 313 water priority chemicals') in accordance with the definition in Part VII of this permit are required to include, in addition to the information listed above, a discussion of the facility's conformance with the appropriate guidelines listed:

(1). In areas where Section 313 water priority chemicals are stored, processed or otherwise handled, appropriate containment, drainage control and/or diversionary structures shall be provided. At a minimum, one of the following preventive systems or its equivalent shall be used:

(a) Curbing, culverting, gutters, sewers or other forms of drainage control to prevent or minimize the potential for storm water run-on to come into contact with significant sources of pollutants; or

(b) Roofs, covers or other forms of appropriate protection to prevent storage piles from exposure to storm water, and wind blowing.

(2) If the installation of structures or equipment listed in parts III.C.4.f.(3).(a).(ii), or III.C.4.f.(3).(c) of this permit is not economically achievable at a given facility, the facility operator shall develop and implement a spill contingency and integrity testing plan which provides a description of measures that ensure spills or other releases of toxic amounts of Section 313 water priority chemicals do not occur as an alternative to the requirements of parts III.C.4.f.(3) (a) (ii), or III.C.4.f.(3).(c) of this permit. A spill contingency and integrity plan developed under this paragraph shall comply with the minimum requirements listed in parts III.C.4.f.(2). (a) through (d).

(a) The plan shall include a detailed description which demonstrates that the requirements of Parts III.C.4.f.(3).(a).(ii) and III.C.4.f.(3).(c) of this permit are not economically achievable;

(b) A spill contingency plan must include, at a minimum: a description of response plans, personnel needs, and methods of mechanical containment; steps to be taken for removal of spilled Section 313 water priority chemicals;

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access to and availability of sorbents and other equipment, and such other information as required by the Director.

(c) The testing component of the alternative plan must provide for conducting integrity testing of storage tanks at least once every five years, and conducting integrity and leak testing of valves and piping a minimum every year; and

(d) A written and actual commitment of manpower, equipment and materials required to comply with the provisions of Part III.C.4.f.(2). (b) and (c) of this permit and to expeditiously control and remove quantity of Section 313 water priority chemicals that may result in a toxic discharge.

(3) In addition to the minimum standards listed under Part III.C.4.f.(1) of this permit, the storm water pollution prevention plan shall include a complete discussion of measures taken to conform with the following applicable guidelines, other effective storm water pollution prevention procedures, and applicable State rules, regulations and guidelines:

(a) *Liquid storage areas where storm water comes into contact with any equipment, tank, container, or other vessel used for Section 313 water priority chemicals.*

(i) No tank or container shall be used for the storage of a Section 313 water priority chemical unless its material and construction are compatible with the material stored and conditions of storage such as pressure and temperature, etc.

(ii) Secondary containment, sufficient to contain the capacity of the largest single container or tank in a drainage system where section 313 water priority chemicals are stored shall be provided. If the secondary containment area and its upstream drainage system are subject to precipitation, an allowance for drainage from a 25-year, 24-hour precipitation event shall be provided over and above the volume necessary to contain the largest single tank or container. Secondary containment systems shall be sufficiently impervious to contain spilled section 313 water priority chemicals until they can be removed or treated. The plant treatment system may be used to provide secondary containment, provided it has sufficient excess holding capacity always available to hold the contents of the largest container in the drainage area plus an allowance for drainage from a 25-year, 24-hour precipitation event.

(b) *Material storage areas for section 313 water priority chemicals other than liquids.* Material storage areas for section 313 water priority chemicals other than liquids which are subject to runoff, leaching, or wind blowing shall incorporate drainage or other control features which will minimize the discharge of section 313 water priority chemicals. Drainage control shall minimize storm water contact with section 313 water priority chemicals.

(c) *Truck and rail car loading and unloading areas for liquid section 313 water priority chemicals* shall contain sufficient secondary containment or treatment capacity to hold or treat the largest tank truck or rail car or the largest compartment of a tank truck or rail car if the tanks are compartmented, which is loaded or unloaded at the facility. If secondary containment is provided in the treatment system, it must be designed so that adequate hydraulic capacity always exists to contain a spill of the largest container from the loading and unloading areas, including an allowance for drainage from a 25-year, 24-hour precipitation event.

(d) *In plant areas where section 313 water priority chemicals are transferred, processed or otherwise handled,* piping, processing equipment and materials handling equipment shall be designed and operated so as to prevent discharges of section 313 chemicals. Materials used in piping and equipment shall be compatible with the substances handled. Drainage from process and materials handling areas shall be designed as described in paragraphs (a), (b) and (c) of this section. Additional protection such as covers or guards to prevent wind blowing, spraying or releases from pressure relief vents from causing a discharge of Section 313 water priority chemicals to the drainage system shall be provided as appropriate.

(e) *Discharges from areas covered by paragraphs (a), (b), (c) or (d).*

(i) Drainage from areas covered by paragraphs (a), (b), (c) or (d) of this part shall be restrained by valves or other positive means to prevent a spill or other excessive leakage of section 313 water priority chemicals into the drainage system. Containment areas may be emptied by pumps or ejectors, however, these shall be manually activated.

(ii) Flapper-type drain valves shall not be used to drain containment areas. Valves used for the drainage of containment areas shall, as far as is practical, be of manual, open-and-closed design.

(iii) If plant drainage is not engineered as above, the final discharge of all in-plant storm sewers should be equipped to be equivalent with a diversion system that could, in the event of an uncontrolled spill of section 313 water priority chemicals, return the spilled material to the facility.

(iv) Records shall be kept of the frequency and estimated volume (in gallons) of discharges from containment areas.

(f) *Plant site runoff other than from areas covered by (a), (b), (c) or (d).* Other areas of the facility (those not addressed in paragraphs (a), (b), (c) or (d)), from which runoff which may contain section 313 water priority chemicals or spills of section 313 water priority chemicals could cause a discharge shall incorporate the necessary drainage or other control features to prevent discharge of spilled or improperly disposed material and ensure the mitigation of pollutants in runoff or leachate.

(g) *Preventive maintenance and housekeeping.* All areas of the facility shall be inspected at specific intervals for leaks or conditions that could lead to discharges of section 313 water priority chemicals or direct contact of storm water with raw materials, intermediate materials, waste materials or products. In particular, plant piping, pumps, storage tanks and bins, pressure vessels, process and material handling equipment, and material bulk storage area shall be examined for any conditions or failures which could cause a discharge. Inspection shall include examination for leaks, wind blowing, corrosion, support or foundation failure, or other forms of deterioration or noncontainment. Inspection intervals shall be specified in the plan and shall be based on design and operational experience. Different areas may require different inspection intervals. Where a leak or other condition is discovered which may result in significant releases of section 313 water priority chemicals to the drainage system, corrective action shall be immediately taken or the unit or process shut down until corrective action can be taken. When a leak or noncontainment of a section 313 water priority chemical has occurred, contaminated soil, debris, or other material must be promptly removed and disposed in accordance with Federal, State, and local requirements and as described in the plan.

(h) *Facility security.* Facilities shall have the necessary security systems to prevent accidental or intentional entry which could cause a discharge. Security systems described in the plan shall address fencing, lighting, vehicular traffic control, and securing of equipment and buildings.

(i) *Training.* Facility employees and contractor personnel using the facility shall be trained in and informed of

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preventive measures at the facility. Employee training shall be conducted at intervals specified in the plan, but not less than once per year, in matters of pollution control laws and regulations, and in the storm water pollution prevention plan and the particular features of the facility and its operation which are designed to minimize discharges of section 313 water priority chemicals. The plan shall designate a person who is accountable for spill prevention at the facility and who will set up the necessary spill emergency procedures and reporting requirements so that spills and emergency releases of section 313 water priority chemicals can be isolated and contained before a discharge of a section 313 water priority chemical can occur. Contractor or temporary personnel shall be informed of plant operation and design features in order to prevent discharges or spills from occurring.

(i) *Engineering Certification.* No storm water pollution prevention plan for facilities subject to SARA title III, section 313 requirements for chemicals which are classified as "Section 313 water priority chemicals" shall be effective to satisfy the requirements of part III.C.4.g of this permit unless it has been reviewed by a Registered Professional Engineer and certified to by such Professional Engineer. A Registered Professional Engineer shall recertify the plan every three years thereafter. By means of these certifications the engineer, having examined the facility and being familiar with the provisions of this part, shall attest that the storm water pollution prevention plan has been prepared in accordance with good engineering practices. Such certifications shall in no way relieve the owner or operator of a facility covered by the plan of their duty to prepare and fully implement such plan.

(Option B—Under option B, facilities subject to SARA title III, section 313 would not be subject to the requirements of part III.C.4.f. Such facilities would remain subject to other applicable requirements of parts III (baseline plan requirements) and IV (effluent limitations). In addition, under Option B, the monitoring frequencies for such facilities could be raised from biannually (2 times per year) (see part V.B.1 of this permit) to monitoring of discharges at a higher frequency (e.g. quarterly).)

g. *Salt storage.* Storage piles of salt used for deicing or other commercial or industrial purposes shall be enclosed or covered to prevent exposure to precipitation.

5. *Alternative requirements for construction activities.* Operations that discharge storm water associated with industrial activity from construction activities are not subject to the requirements of part III.C.4 of this permit, but are instead subject to the following requirements. The storm water pollution prevention plan shall include the following items:

a. *Site description.* Each plan shall provide a description of the following:

(1). A description of the nature of the construction activity;

(2). Estimates of the total area of the site and the area of the site that is expected to undergo excavation or grading;

(3). An estimate of the runoff coefficient of the site and existing data describing the soil or the quality of any discharge from the site;

(4). A site map indicating drainage patterns and approximate slopes anticipated after major grading activities, the location of major control structures identified in the plan, and surface waters; and

(5). The name of the receiving water(s) and the ultimate receiving water(s).

b. *Controls.* Each construction operation covered by this permit shall develop a description of controls appropriate for the facility, and implement such controls. The description of controls shall address the following minimum components:

(1). *Erosion and sediment controls.*

(a). *Vegetative practices.* A description of vegetative practices designed to preserve existing vegetation where attainable and revegetate open areas as soon as practicable after grading or construction. Such practices may include: temporary seeding, permanent seeding, mulching, sod stabilization, vegetative buffer strips, and protection of trees. The operator shall initiate appropriate vegetative practices on all disturbed areas within 7 calendar days of the last activity at that area.

(b). *Structural practices.* A description of structural practices to the degree attainable divert flows from exposed soils, store flows or otherwise limit runoff from exposed areas of the site. Such practices may include straw bale dikes, silt fences, earth dikes, brush barriers, drainage swales, check dams, subsurface drain, pipe slope drain, level spreaders, storm drain inlet protection, rock outlet protection, sediment traps, and temporary sediment basins.

(i) For sites with more than 10 disturbed acres at one time which are served by a common drainage location, a detention basin providing storage or equivalent controls for runoff from disturbed areas from a 10 year, 24-hour storm, shall be provided where attainable. For drainage locations with more than 10 disturbed acres at one time which are served by a common drainage location where a detention basin providing storage or equivalent controls for runoff from disturbed areas from a 10 year, 24-hour storm is not attainable, silt fences, straw bale dikes, or equivalent sediment controls are required for all sideslope and downslope boundaries of the construction area.

(ii) For drainage locations serving 10 or less acres, silt fences, straw bale dikes, or equivalent sediment controls are required for all sideslope and downslope boundaries of the construction area or a detention basin providing storage for runoff from disturbed areas from a 10 year, 24-hour storm shall be provided.

(2). *Storm water management.* A description of measures to control pollutants in storm water discharges that will occur after construction operations have been completed. Such practices may include: infiltration of runoff onsite; flow attenuation by use of open vegetated swales and natural depressions; storm water retention structures and storm water detention structures. Where such controls are needed to prevent or minimize erosion, velocity dissipation devices shall be placed at the outfall of all detention or retention structures and along the length of any outfall channel as necessary to provide a non-erosive velocity flow from the structure to a water course. Justification shall be provided by the permittee for rejecting each practice based on site conditions.

(3). *Other controls.*

(a). *Waste disposal.* No solid waste, including building materials, shall be discharged.

(b) Off-site vehicle tracking of sediments shall be minimized.

(c). The plan shall ensure and demonstrate compliance with applicable State or local waste disposal, sanitary sewer or septic system regulations.

(4). *Approved state or local plans.* Facilities which discharge storm water associated with industrial activity from construction activities must include in their storm water pollution prevention plan procedures and requirements specified in applicable sediment and erosion site plans or storm water management plans approved by State or local officials. Applicable requirements specified in sediment and erosion plans or storm water management plans approved by State or local officials are, upon submittal of an NOI to be

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authorized to discharge under this permit; incorporated by reference and are enforceable under this permit even if they are not specifically included in a storm water pollution prevention plan required under this permit. Operators of facilities seeking alternative permit requirements shall submit an individual permit application in accordance with part I.C.2 of the permit, along with a description of why requirements in approved State or local plans should not be applicable as a condition of an NPDES permit.

(5). *Maintenance.* A description of procedures to maintain in good and effective operating condition vegetation, erosion and sediment control measures and other protective measures identified in the site plan. Procedures in a plan shall provide that all erosion controls on the site are inspected at least once every seven calendar days.

(6). All storm water pollution prevention plans required under this permit are considered reports that shall be available to the public under section 308(b) of the CWA. The owner or operator of a facility with storm water discharges covered by this permit shall make plans available to members of the public upon request by the public. However, the permittee may claim any portion of a storm water pollution plan as confidential in accordance with 40 CFR part 2.

(7). No condition of this permit shall release the permittee from any responsibility or requirements under other environmental statutes or regulations.

Part IV. Numeric Effluent Limitations

A. *SARA title III, section 313 Facilities.* The effluent (100%) composed in part or in whole of storm water associated with industrial activity from facilities subject to reporting requirements pursuant to SARA title III, section 313 for chemicals which are classified as "section 313 water priority chemicals" that comes into contact with any equipment, tank, container or other vessel used for storage of a section 313 chemical, or located at a truck or rail car loading or unloading area, shall not be lethal to 20% or more of the more sensitive of either appropriate fish or invertebrate test organisms (96 hour static replacement toxicity tests (96-hr. LC20 > 100% effluent) for fish test organisms and 48 hour static replacement toxicity tests (48-hr. LC20 > 100% effluent) for invertebrate test organisms). Failure to demonstrate compliance with the acute whole effluent toxicity requirement after the compliance date of three years after the date of issuance of this permit will constitute a violation of this permit (see part V.D of this permit). Any untreated overflow from facilities designed, constructed and operated to treat the volume of runoff from areas identified above which is associated with a 25 year, 24 hour rainfall event shall not be subject to the limitations of this part.

B. *Coal pile runoff.* Subject to the provisions of part IV.D, any composed in part or in whole of coal pile runoff shall not exceed a maximum concentration for any time of 50 mg/l total suspended solids. The pH of such discharges shall be within the range of 6.0–9.0. Any untreated overflow from facilities designed, constructed and operated to treat the volume of coal pile runoff which is associated with a 25 year, 24 hour rainfall event shall not be subject to the limitations of this part.

Part V. Monitoring and Reporting Requirements

A. Failure to Certify. Any facility that is unable to provide the certification required under paragraph III.C.4.b.(11) (testing for illicit connections), must notify the Director within 180 days of the effective date of this permit. Such notification shall describe: the procedure of any test conducted for the presence of non-storm water discharges, the results of such test or other relevant observations; potential sources of non-storm water discharges to the storm sewer; and why adequate tests for such storm sewers were not feasible.

B. Monitoring Requirements:

1. Section 313 of SARA title III facilities. During the period beginning on the effective date and lasting through the expiration date of this permit, facilities subject to requirements to report releases into the environment under section 313 of SARA title III for chemicals which are classified as "section 313 water priority chemicals" are subject to the following monitoring requirements for storm water discharges associated with industrial activity that are discharged from any containment area:

a. Parameters. The parameters to be measured include: Oil and Grease (mg/L), Five Day Biochemical Oxygen Demand (BOD5) (mg/L); Chemical Oxygen Demand (COD) (mg/L); Total Suspended Solids (mg/L); Total Kjeldahl Nitrogen (TKN) (mg/L); Total Phosphorus (mg/L); pH; acute whole effluent toxicity; and any Section 313 water priority chemical for which the facility is subject to reporting requirements under section 313 of the Emergency Planning and Community Right to Know Act of 1986. In addition the date and duration (in hours) of the storm event(s) sampled; rainfall measurements or estimates (in inches) of the storm event which generated the sampled runoff; the duration between the storm event sampled and the end of the previous measurable (greater than 0.1 inch rainfall) storm event; and an estimate of the total volume (in gallons) of the discharge sampled shall be provided.

b. Frequency of Monitoring. Sampling shall be conducted at least semi-annually (2 times per year) except as provided by paragraph V.B.10, V.B.11 or V.C.1.

2. Primary metal industries. During the period beginning on the effective date and lasting through the expiration date of this permit, facilities classified as Standard Industrial Classification (SIC) 33 (Primary Metal Industry) are subject to the following monitoring requirements for storm water discharges associated with industrial activity that are discharged from the facility:

a. Parameters. The parameters to be measured include: oil and grease (mg/L); five day biochemical oxygen demand (BOD5) (mg/L); chemical oxygen demand (COD) (mg/L); total suspended solids (mg/L); total Kjeldahl nitrogen (TKN) (mg/L); nitrate plus nitrite nitrogen (mg/L); total phosphorus (mg/L); pH; acute whole effluent toxicity; total lead (mg/L); total cadmium (mg/L); total copper (mg/L); total arsenic (mg/L); and total chromium (mg/L). In addition: the date and duration (in hours) of the storm event(s) sampled; rainfall measurements or estimates (in inches) of the storm event which generated the sampled runoff; the duration between the storm event sampled and the end of the previous measurable (greater than 0.1 inch rainfall) storm event; and an estimate of the size of the drainage area (in square feet) and an estimate of the runoff coefficient of the drainage area (e.g. low (under 40%), medium (40% to 65%) or high (above 65%)) shall be provided.

b. Frequency of monitoring. Sampling shall be conducted at least semi-annually (2 times per year) except as provided by paragraph V.B.10, V.B.11 or V.C.1.

3. Land disposal units. During the period beginning on the effective date and lasting through the expiration date of this permit, storm water discharges associated with industrial activity from any active or inactive landfill, land application site, or open dump that received any industrial wastes are subject to the following monitoring requirements:

a. Parameters. The parameters to be measured include: Ammonia (mg/L),

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Bicarbonate (mg/L), Calcium (mg/L), Chloride (mg/L), Total Iron (mg/L), Magnesium (total) (mg/L), Magnesium (dissolved) (mg/L), nitrate plus nitrite nitrogen (mg/L), Potassium (mg/L), Sodium (mg/L), Sulfate (mg/L), Chemical Oxygen Demand (COD) (mg/L), Total Dissolved Solids (TDS) (mg/L), Total Organic Carbon (TOC) (mg/L), oil and grease (mg/L), pH, Total Arsenic (mg/L), Total Barium (mg/L), Total Cadmium (mg/L), Total Chromium (mg/L), Total Cyanide (mg/L), Total Lead (mg/L), Total Mercury (mg/L), Total Selenium (mg/L), Total Silver (mg/L), acute whole effluent toxicity. In addition: the date and duration (in hours) of the storm event(s) sampled; rainfall measurements or estimates (in inches) of the storm event which generated the sampled runoff; the duration between the storm event sampled and the end of the previous measurable (greater than 0.1 inch rainfall) storm event; and an estimate of the total volume (in gallons) of the discharge sampled shall be provided;

b. *Frequency of monitoring.* Sampling shall be conducted at least semi-annually (2 times per year) except as provided by paragraph V.B.10, V.B.11 or V.C.1;

4. *Wood treatment (chlorophenolic/creosote formulations).* During the period beginning on the effective date and lasting through the expiration date of this permit, storm water discharges associated with industrial activity from areas that are used for wood treatment, wood surface application or storage of treated or surface protected wood at any wood preserving or wood surface facilities that currently use chlorophenolic formulations and/or creosote formulations are subject to the following monitoring requirements:

a. *Parameters.* The parameters to be measured include: oil and grease (mg/L), pH, BOD5 (mg/L), COD (mg/L), TSS (mg/L), total phosphorus (mg/L), total Kjeldahl nitrogen (mg/L), nitrate plus nitrite nitrogen (mg/L), acute whole effluent toxicity, and pentachlorophenol (mg/L). In addition: the date and duration (in hours) of the storm event(s) sampled; rainfall measurements or estimates (in inches) of the storm event which generated the sampled runoff; the duration between the storm event sampled and the end of the previous measurable (greater than 0.1 inch rainfall) storm event; and an estimate of the size of the drainage area (in square feet) and an estimate of the runoff coefficient of the drainage area (e.g. low (under 40%), medium (40% to 65%) or high (above 65%)) shall be provided;

b. *Frequency of monitoring.* Sampling shall be conducted at least semi-annually (2 times per year) except as provided by paragraph V.B.10, V.B.11 or V.C.1;

5. *Wood treatment (arsenic or chromium preservatives).* During the period beginning on the effective date and lasting through the expiration date of this permit, storm water discharges associated with industrial activity from areas that are used for wood treatment or storage of treated wood at any wood preserving facilities that currently use inorganic preservatives containing arsenic or chromium are subject to the following monitoring requirements:

a. *Parameters.* The parameters to be measured include: oil and grease (mg/L), pH, BOD5 (mg/L), COD (mg/L), TSS (mg/L), total phosphorus (mg/L), total Kjeldahl nitrogen (mg/L), nitrate plus nitrite nitrogen (mg/L), total arsenic (mg/L), total chromium (mg/L), and total copper (mg/L). In addition: the date and duration (in hours) of the storm event(s) sampled; rainfall measurements or estimates (in inches) of the storm event which generated the sampled runoff; the duration between the storm event sampled and the end of the previous measurable (greater than 0.1 inch rainfall) storm event; and an estimate of the size of the drainage area (in square feet) and an estimate of the runoff coefficient of the drainage area (e.g. low (under 40%), medium (40% to 65%) or high (above 65%)) shall be provided;

b. *Frequency of monitoring.* Sampling shall be conducted at least semi-annually (2 times per year) except as provided by paragraph V.B.10 or V.B.11;

6. *Coal pile runoff.* During the period beginning on the effective date and lasting through the expiration date of this permit, storm water discharges associated with industrial activity from coal pile runoff are subject to the following monitoring requirements:

a. *Parameters.* The parameters to be measured include: oil and grease (mg/L), pH, TSS (mg/L), copper, nickel and zinc. In addition: the date and duration (in hours) of the storm event(s) sampled; rainfall measurements or estimates (in inches) of the storm event which generated the sampled runoff; the duration between the storm event sampled and the end of the previous measurable (greater than 0.1 inch rainfall) storm event; and an estimate of the size of the drainage area (in square feet) and an estimate of the runoff coefficient of the drainage area (e.g. low (under 40%), medium (40% to 65%) or high (above 65%)) shall be provided;

b. *Frequency of monitoring.* Sampling shall be conducted at least semi-annually (2 times per year) except as provided by paragraph V.B.10 or V.B.11;

7. *Oil and gas exploration or production operations.* During the period beginning on the effective date and lasting through the expiration date of this permit, storm water discharges associated with industrial activity from oil and gas exploration or production operations are, except as provided in part V.B.7.c, subject to the following monitoring requirements:

a. *Parameters.* The parameters to be measured include: oil and grease (mg/L), pH, BOD5 (mg/L), COD (mg/L), TSS (mg/L), total phosphorus (mg/L), total Kjeldahl nitrogen (mg/L), nitrate plus nitrite nitrogen (mg/L), and any pollutant limited in an effluent guideline to which the facility is subject. In addition: The date and duration (in hours) of the storm event(s) sampled; rainfall measurements or estimates (in inches) of the storm event which generated the sampled runoff; the duration between the storm event sampled and the end of the previous measurable (greater than 0.1 inch rainfall) storm event; and an estimate of the size of the drainage area (in square feet) and an estimate of the runoff coefficient of the drainage area (e.g. low (under 40%), medium (40% to 65%) or high (above 65%)) shall be provided;

b. *Frequency of monitoring.* Sampling shall be conducted at least annually (1 time per year) except as provided by paragraph V.B.10 or V.B.11;

c. *Engineering certification.* In lieu of the monitoring requirements specified in parts V.B.7.a and b, a facility may have a Registered Professional Engineer certify that a storm water pollution plan has been prepared and is being implemented in accordance with the requirements of part III.C. A Registered Professional Engineer shall recertify the plan every three years. By means of these certifications the engineer, having examined the facility and being familiar with the provisions of this part, shall attest that the storm water pollution prevention plan has been prepared in accordance with good engineering practices. Such certifications shall in no way relieve the owner or operator of a facility covered by the plan of their duty to prepare and fully implement such plan.

8. *Other facilities.* During the period beginning on the effective date and lasting through the expiration date of this permit, storm water discharges associated with industrial activity which are covered by this permit, but are not subject to sampling requirements under parts V.B.1 through V.B.7 are subject to the following monitoring requirements:

a. *Parameters.* The parameters to be measured include: oil and grease (mg/L),

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pH, BOD5 (mg/L), COD (mg/L), TSS (mg/L), total phosphorus (mg/L), total Kjeldahl nitrogen (mg/L), nitrate plus nitrite nitrogen (mg/L), and any pollutant limited in an effluent guideline to which the facility is subject. In addition: The date and duration (in hours) of the storm event(s) sampled; rainfall measurements or estimates (in inches) of the storm event which generated the sampled runoff; the duration between the storm event sampled and the end of the previous measurable (greater than 0.1 inch rainfall) storm event; and an estimate of the size of the drainage area (in square feet) and an estimate of the runoff coefficient of the drainage area (e.g. low (under 40%), medium (40% to 65%) or high (above 65%)) shall be provided.

b. *Frequency of monitoring.* Sampling shall be conducted at least annually (1 time per year) except as provided by paragraph V.B.10 or V.B.11.

9. *Sample type.* For discharges from holding ponds or other impoundments with a retention period greater than 24 hours (estimated by dividing the volume of the detention pond by the estimated volume of water discharged during the 24 hours previous to the time that the sample is collected), a minimum of one grab sample may be taken. For all other discharges, data shall be reported for both a grab sample and a composite sample. All such samples shall be collected from the discharge resulting from a storm event that is greater than 0.1 inches in magnitude and that occurs at least 72 hours from the previously measurable (greater than 0.1 inch rainfall) storm event. The grab sample shall be taken during the first thirty minutes of the discharge. If the collection of a grab sample during the first thirty minutes is impracticable, a grab sample can be taken during the first hour of the discharge, and the discharger shall submit with the monitoring report a description of why a grab sample during the first thirty minutes was impracticable. The composite sample shall either be flow-weighted or time-weighted. Composite samples may be taken with a continuous sampler or as a combination of a minimum of three sample aliquots taken in each hour of discharge for the entire discharge or for the first three hours of the discharge, with each aliquot being separated by a minimum period of fifteen minutes. Only grab samples must be collected and analyzed for the determination of pH, cyanide, and oil and grease.

10. *Sampling waiver.* When a discharger is unable to collect samples due to adverse climatic conditions, the discharger must submit in lieu of sampling data a description of why samples could not be collected, including available documentation of the event. Adverse climatic conditions which may prohibit the collection of samples includes weather conditions that create dangerous conditions for personnel (such as local flooding, high winds, hurricane, tornadoes, electrical storms, etc.) or otherwise make the collection of a sample impracticable (drought, extended frozen conditions, etc.).

11. *Representative discharge.* When a facility has two or more outfalls that, based on a consideration of features and activities within the area drained by the outfall, the permittee reasonably believes discharge substantially identical effluents, the permittee may test the effluent of one of such outfalls and report that the quantitative data also applies to the substantially identical outfalls. In addition, for each outfall that the permittee believes is representative, an estimate of the size of the drainage area (in square feet) and an estimate of the runoff coefficient of the drainage area (e.g. low (under 40%), medium (40% to 65%) or high (above 65%)) shall be provided.

C. *Toxicity testing.* In accordance with Parts IV and V of this permit, permittees that are required to monitor for acute whole effluent toxicity shall initiate the series of tests described below within 180 days after the issuance of this permit or within 30 days after the commencement of a new discharge.

1. The permittee shall conduct an acute 48 hour static replacement toxicity test on an appropriate invertebrate test species (EPA/600/4-85/013, Table 1) and an acute 96 hour static replacement toxicity test using an appropriate fish test species (EPA/600/4-85/013, Table 1). (Recommendation: A Daphnidae species, and the fathead minnow (Pimephales promelas)). All test organisms, procedures and quality assurance criteria used shall be in accordance with Methods for Measuring the Acute Toxicity of Effluent to Freshwater and Marine Organisms, EPA-600/4-85/013 (Rev. March 1985). EPA has proposed to establish regulations regarding these test methods (December 4, 1989, (53 FR 50216). Tests shall be conducted semiannually. Such tests shall be conducted on a grab sample of the discharge at 100% strength (no dilution). Compliance with the acute whole effluent toxicity limit of no significant difference from the control at the 95% confidence interval will be determined using the "t-test" statistical method described in Appendix H of Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms (Second Edition, EPA/600/4-89/001, March 1989 and subsequent editions). Results of all tests conducted with any species shall be reported according to EPA/600/4-85/013, Section 13, Report Preparation and Data Utilization, or its latest revision, and shall be submitted to EPA with the quarterly discharge monitoring report. The permittee's monthly Discharge Monitoring Reports (DMR's) will report "0" if there is no statistical difference between the control mortality and the effluent mortality.[8]

2. If acute whole effluent toxicity is found in storm water discharges subject to the effluent limitation of Part IV.A in any samples collected after the compliance date of two years after the date of issuance of this permit, it will constitute a violation of this permit. The permittee will then be subject to the enforcement provisions of the Clean Water Act. In the event a violation of toxicity limits results in an enforcement action, any different or more stringent monitoring requirements imposed in that enforcement action shall apply in lieu of the requirements of this permit condition for whatever period of time is specified by EPA in the enforcement action.

3. If acute whole effluent toxicity is detected in storm water discharges subject to the effluent limitation of part IV.A before the compliance date of two years after the date of issuance of this permit, and it is determined by the permit issuing authority that a toxicity reduction evaluation (TRE) is necessary, the permittee shall be so notified and shall initiate a TRE immediately thereafter. The purpose of the TRE will be to establish the cause of the toxicity.

[8] In order to provide consistency with other permits written in Region VIII, the permits for dischargers in CO, WY, MT, ND and UT would substitute the following language for Part V.C.1: "The permittee shall conduct an acute 48-hour static replacement toxicity test using *Ceriodaphnia* sp. and an acute 96-hour static replacement toxicity test using fathead minnows. The replacement static toxicity tests shall be conducted in general accordance with the procedures set out in the latest revision of "Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms", EPA-600/4-85-013 (Rev. March 1985) and the "Region VIII EPA NPDES Acute Test Conditions—Static Renewal Whole Effluent Toxicity Tests". Tests shall be conducted semiannually. Such tests shall be conducted on a grab sample of the discharge at 100% strength (no dilution). After four (4) sets of tests of two (2) species, the permittee may limit subsequent testing to the most sensitive of the two (2) species, based on the results of the previous tests. Results of all tests shall be reported in a format consistent with the latest revision of the "Region VIII Guidance for Acute Whole Effluent Reporting", and shall include all chemical and physical data as specified

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locate the source(s) of the toxicity, and control or provide treatment for the toxicity priority to the compliance date of two years after the date of issuance of this permit.

D. *Noncompliance reporting:*

1. *Anticipated noncompliance.* The permittee shall give advance notice, if possible, at least ten days before the date of any planned changes in the permitted facility or activity which may result in any bypass, upset, or other noncompliance with permit requirements.

2. *Unanticipated bypass or upset.* The permittee shall submit notice of an unanticipated bypass or upset. Any information regarding the unanticipated bypass or upset shall be provided orally within 24 hours from the time the permittee became aware of the circumstances. A written submission shall also be provided within 5 days of the time the permittee became aware of the circumstances. The written submission shall contain a description of the bypass or upset and its cause; the period of the bypass or upset, including exact dates and times, and if the bypass or upset has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the bypass or upset.

E. *Reporting: where to submit:*

1. a. Permittees which are required to conduct sampling pursuant to parts V.B.1, V.B.2, and V.B.3 must submit monitoring results obtained during the previous 6 months on Discharge Monitoring Report Form(s) postmarked no later than the 20th day of the month following the completed reporting period. The reports are due on the 28th day of January and July. The first report may include less than the 6 months of information.

b. Permittees which are required to conduct sampling pursuant to parts V.B.4, V.B.5, and V.B.6 must submit monitoring results obtained during the previous 6 months on Discharge Monitoring Report Form(s) postmarked no later than the 28th day of the month following the completed reporting period. The reports are due on the 28th day of April and October. The first report may include less than the 6 months of information.

c. Signed copies of discharge monitoring reports required under parts V.E.1.a and V.E.1.b, and all other reports required herein, shall be submitted to the Director of the NPDES program at the following address:

Regional Office

2. Except as provided in part V.E.1 of this permit, for discharges subject to sampling requirements pursuant to parts V.B.7 and V.B.8, permittees are not required to submit monitoring results pursuant to part V.E.1. However, such permittees must retain monitoring results in accordance with part V.F.

3. Additional Notification. Facilities with at least one storm water discharge associated with industrial activity through a large or medium municipal separate storm sewer system (systems serving a population of 100,000 or more) in addition to filing copies of discharge monitoring reports in accordance with paragraph V.E.1, must submit signed copies to the operator of the municipal separate storm sewer system of monitoring results obtained during the previous 6 months on Discharge Monitoring Report Form(s) postmarked no later than the 28th day of the month following the completed reporting period. For permittees which are required to conduct sampling pursuant to parts V.B.1, V.B.2, and V.B.3 the reports are due on the 28th day of January and July. For permittees which are required to conduct sampling pursuant to parts V.B.4, V.B.5, and V.B.6 the reports are due on the 28th day of April and October. The first report may include less than the 6 months of information.

F. Retention of records:

1. The permittee shall retain records of all monitoring information, copies of all reports required by this permit, and records of all data used to complete the Notice of Intent to be covered by this permit, for a period of at least three years from the date of the measurement, report, or application. This period may be explicitly modified by alternative provisions of this permit (see Part V.F.2 of this permit) or extended by request of the Director at any time.

2. For discharges subject to sampling requirements pursuant to part V.B., in addition to the requirements of part V.F.1, permittees are required to retain for a three-year period from the date of sample collection or for the term of this permit, which ever is greater, records of all monitoring information collected during the term of this permit. Permittees must submit such monitoring results to the Director upon the request of the Director, and submit a summary of such result as part of renotification requirements in accordance with part II.F.

Part VI. Standard Permit Conditions

A. Duty to Comply. The permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of CWA and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or for denial of a permit renewal application.

1. Toxic pollutants. The permittee shall comply with effluent standards or prohibitions established under section 307(a) of the CWA for toxic pollutants within the time provided in the regulations that establish these standards or prohibitions, even if the permit has not yet been modified to incorporate the requirement.

2. Penalties for violations of permit conditions. Section 309 of the CWA provides significant penalties for any person who violates a permit condition implementing sections 301, 302, 306, 307, 308, 318, or 405 of the CWA, or any permit condition or limitation implementing any such sections in a permit issued under section 402. Any person who violates any permit condition of this permit is subject to a civil penalty not to exceed $25,000 per day of such violation, as well as any other appropriate sanction provided by section 309 of the CWA.

B. Continuation of the expired general permit. An expired general permit continues in force and effect until a new general permit is issued. Only those facilities authorized to discharge under the expiring general permit are covered by the continued permit.

C. Need to halt or reduce activity not a defense. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

D. Duty to mitigate. The permittee shall take all reasonable steps to minimize or prevent any discharge in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.

E. Duty to provide information. The permittee shall furnish to the Director, within a reasonable time, any information which the Director may request to determine compliance with this permit. The permittee shall also furnish to the Director upon request copies of records required to be kept by this permit.

F. Other information. When the permittee becomes aware that he or she failed to submit any relevant facts or submitted incorrect information in the Notice of Intent or in any other report to the Director, he or she shall promptly submit such facts or information.

G. Signatory requirements. All Notices of Intent, storm water pollution prevention plans, reports, certifications or information either submitted to the Director or the operator of a large or

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medium municipal separate storm sewer system, or that this permit requires be maintained by the permittee, shall be signed.

1. All Notices of Intent shall be signed as follows:

a. For a corporation: By a responsible corporate officer. For the purpose of this section, a responsible corporate officer means:

(1) A president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation; or

(2) The manager of one or more manufacturing, production or operating facilities employing more than 250 persons or having gross annual sales or expenditures exceeding $25,000,000 (in second-quarter 1980 dollars) if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures;

b. For a partnership or sole proprietorship: By a general partner or the proprietor, respectively; or

c. For a municipality: State, Federal, or other public agency: by either a principal executive officer or ranking elected official. For purposes of this section, a principal executive officer of a Federal agency includes (1) the chief executive officer of the agency, or (2) a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g. Regional Administrators of EPA).

2. All reports required by the permit and other information requested by the Director shall be signed by a person described above or by a duly authorized representative of that person. A person is a duly authorized representative only if:

a. The authorization is made in writing by a person described above and submitted to the Director.

b. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of manager, operator, superintendent, or position of equivalent responsibility or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position).

c. Changes to authorization. If an authorization under paragraph IV.D.2. is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of paragraph I.D.2 must be submitted to the Director prior to or together with any reports, information, or applications to be signed by an authorized representative.

H. *Certification.* Any person signing documents under this section shall make the following certification:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

I. *Penalties for falsification of reports.* Section 309(c)(4) of the Clean Water Act provides that any person who knowingly makes any false material statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including reports of compliance or noncompliance shall, upon conviction, be punished by a fine of not more than $10,000, or by imprisonment for not more than 2 years, or by both.

J. *Penalties for falsification of monitoring systems.* The CWA provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by fines and imprisonment described in section 309 of the CWA.

K. *Oil and hazardous substance liability.* Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under section 311 of the CWA.

L. *Property rights.* The issuance of this permit does not convey any property rights of any sort, nor any exclusive privileges, nor does it authorize any injury to private property nor any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

M. *Severability.* The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit shall not be affected thereby.

N. *Transfers.* This permit is not transferable to any person except after notice to the Director. The Director may require the operator to apply for and obtain an individual NPDES permit as stated in part I.C.

O. *State laws.* Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable State law or regulation under authority preserved by section 510 of the Act.

P. *Proper operation and maintenance.* The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit and with the requirements of storm water pollution prevention plans. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. Proper operation and maintenance requires the operation of backup or auxiliary facilities or similar systems, installed by a permittee only when necessary to achieve compliance with the conditions of the permit.

Q. *Monitoring and records:*

1. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.

2. The permittee shall retain records of all monitoring information including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of the reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least 3 years from the date of the sample, measurement, report or application. This period may be extended by request of the Director at any time.

3. *Records contents.* Records of monitoring information shall include:

a. The date, exact place, and time of sampling or measurements;

b. The initials or name(s) of the individual(s) who performed the sampling or measurements;

c. The date(s) analyses were performed;

d. The time(s) analyses were initiated

e. The initials or name(s) of the individual(s) who performed the analyses;

f. References and written procedures, when available, for the analytical techniques or methods used; and

g. The results of such analyses, including the bench sheets, instrument

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readouts, computer disks or tapes, etc., used to determine these results.

4. Monitoring must be conducted according to test procedures approved under 40 CFR part 136, unless other test procedures have been specified in this permit.

5. The Clean Water Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than 2 years per violation, or by both.

K. *Bypass of treatment facilities.*

1. Notice:

a. *Anticipated bypass.* If the permittee knows in advance of the need for a bypass, he or she shall submit prior notice, if possible, at least ten days before the date of the bypass; including an evaluation of the anticipated quality and effect of the bypass.

b. *Unanticipated bypass.* The permittee shall submit notice of an unanticipated bypass. Any information regarding the unanticipated bypass shall be provided orally within 24 hours from the time the permittee became aware of the circumstances. A written submission shall also be provided within 5 days of the time the permittee become aware of the circumstances. The written submission shall contain a description of the bypass and its cause; the period of the bypass, including exact dates and times, and if the bypass has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the bypass.

2. Prohibition of bypass:

a. Bypass is prohibited and the Director may take enforcement action against a permittee for a bypass. Unless:

(1). The bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;

(2). There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if the permittee should, in the exercise of reasonable engineering judgement, have installed adequate backup equipment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and

(3). The permittee submitted notices as required under Part R.1 of this section.

b. The Director may approve an anticipated bypass after considering its adverse effects, if the Director determines that it will meet the three conditions listed in part VIR.2.a. of this section.

S. *Upset conditions.*

1. An upset constitutes an affirmative defense to an action brought for noncompliance with technology-based permit limitations if the requirements of paragraph 2 below are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, if final administrative action subject to judicial review.

2. A permittee who wishes to establish the affirmative defense of an upset shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence, that:

a. An upset occurred and that the permittee can identify the specific cause(s) of the upset;

b. The permitted facility was at the time being properly operated;

c. The permittee submitted notice of the upset as required under Part V; and

d. The permittee complied with any remedial measures required under III.F.

3. In any enforcement proceeding the permittee seeking to establish the occurrence of an upset has the burden of proof.

T. *Inspection and entry.* The permittee shall allow the Director or an authorized representative of EPA, the State, or, in the case of a facility which discharges through a municipal separate storm sewer, an authorized representative of the municipal operator or the separate storm sewer receiving the discharge, upon the presentation of credentials and other documents as may be required by law, to:

1. Enter upon the permittee's premises where a regulated facility or activity is located or conducted or where records must be kept under the conditions of this permit;

2. Have access to and copy at reasonable times, any records that must be kept under the conditions of this permit; and

3. Inspect at reasonable times any facilities or equipment (including monitoring and control equipment).

U. *Permit actions.* This permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any permit condition.

Part VII. Reopener Clause

A. If there is evidence indicating potential or realized impacts on water quality due to any storm water discharge associated with industrial activity covered by this permit, the owner or operator of such discharge may be required to obtain individual permit or an alternative general permit in accordance with part I.C of this permit or the permit may be modified to include different limitations and/or requirements.

B. Permit modification or revocation will be conducted according to 40 CFR 122.62, 122.63, 122.64 and 124.5.

Part VII. Definitions

Best Management Practices (BMPs) means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

Bypass means the intentional diversion of waste streams from any portion of a treatment facility.

Coal pile runoff means the rainfall runoff from or through any coal storage pile.

CWA means Clean Water Act or the Federal Water Pollution Control Act.

Director means the Regional Administrator or an authorized representative.

Flow-weighted composite sample means a composite sample consisting of a mixture of aliquots collected at a constant time interval, where the volume of each aliquot is proportional to the flow rate of the discharge.

Landfill means an area of land or an excavation in which wastes are placed for permanent disposal, and which is not a land application unit, surface impoundment, injection well, or waste pile.

Land application unit means an area where wastes are applied onto or incorporated into the soil surface (excluding manure spreading operations) for treatment or disposal.

Large and Medium municipal separate storm sewer systems means all municipal separate storm sewers that are either:

(i) Located in an incorporated place with a population of 100,000 or more as determined by the latest Decennial Censes by the Bureau of Censes; or

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(ii) Located in the counties with unincorporated urbanized populations of 100,000 or more, except municipal separate storm sewers that are located in the incorporated places, townships or towns within such counties; or

(iii) Owned or operated by a municipality other than those described in paragraph (i) or (ii) and that are designated by the Director as part of the large or medium municipal separate storm sewer system.

NOI means notice of intent to be covered by this permit (see part II of this permit.)

Runoff coefficient means the fraction of total rainfall that will appear at the conveyance as runoff.

Section 313 water priority chemical means a chemical or chemical categories which are:

(1) Are listed at 40 CFR 372.65 pursuant to section 313 of Title III of the Superfund Amendments and Reauthorization Act (SARA) of 1986, also titled the Emergency Planning and Community Right-to-Know Act of 1986;

(2) Are present at or above threshold levels at a facility subject to SARA title III, section 313 reporting requirements; and

(3) That meet at least one of the following criteria:

(i) Are listed in appendix D of 40 CFR part 122 on either Table II (organic priority pollutants), Table III (certain metals, cyanides, and phenols) or Table V (certain toxic pollutants and hazardous substances);

(ii) Are listed as a hazardous substance pursuant to section 311(b)(2)(A) of the CWA at 40 CFR 116.4; or

(iii) Are pollutants for which EPA has published acute or chronic water quality criteria.

Severe Property Damage means substantial physical damage to property damage to treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

Significant materials includes, but is not limited to: Raw materials; fuels; materials such as solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances designated under section 101(14) of CERCLA; any chemical the facility is required to report pursuant to section 313 of title III of SARA; fertilizers; pesticides; and waste products such as ashes, slag and sludge that have the potential to be released with storm water discharges.

Significant spills includes, but is not limited to: releases of oil or hazardous substances in excess of reportable quantities under section 311 of the Clean Water Act (see 40 CFR 110.10 and CFR 117.21) or section 102 of CERCLA (see 40 CFR 302.4).

Storm Water means storm water runoff, snow melt runoff, and surface runoff and drainage.

Storm Water Associated with Industrial Activity means the discharge from any conveyance which is used for collecting and conveying storm water and which is directly related to manufacturing, processing or raw materials storage areas at an industrial plant. The term does not include discharges from facilities or activities excluded from the NPDES program. For the categories of industries identified in subparagraphs (i) through (x) of this subsection, the term includes, but is not limited to, storm water discharges from industrial plant yards; immediate access roads and rail lines used or traveled by carriers of raw materials, manufactured products, waste material, or by-products used or created by the facility; material handling sites; refuse sites; sites used for the application or disposal of process waste waters (as defined at 40 CFR part 401); sites used for the storage and maintenance of material handling equipment; sites used for residual treatment, storage, or disposal; shipping and receiving areas; manufacturing buildings; storage areas (including tank farms) for raw materials, and intermediate and finished products; and areas where industrial activity has taken place in the past and significant materials remain and are exposed to storm water. For the categories of industries identified in subparagraph (xi), the term includes only storm water discharges from all areas listed in the previous sentence (except access roads) where material handling equipment or activities, raw materials, intermediate products, final products, waste materials, by-products, or industrial machinery are exposed to storm water. For the purposes of this paragraph, material handling activities include the: storage, loading and unloading, transportation, or conveyance of any raw material, intermediate product, finished product, by-product or waste product. The term excludes areas located on plant lands separate from the plant's industrial activities, such as office buildings and accompanying parking lots as long as the drainage from the excluded areas is not mixed with storm water drained from the above described areas. Industrial facilities (including industrial facilities that are Federally or municipally owned or operated that meet the description of the facilities listed in this paragraph (i)–(xi)) include those facilities designated under 122.26(a)(1)(v). The following categories of facilities are considered to be engaging in "industrial activity" for purposes of this subsection:

(i) Facilities subject to storm water effluent limitations guidelines, new source performance standards, or toxic pollutant effluent standards under 40 CFR Subchapter N (except facilities with toxic pollutant effluent standards which are exempted under category (xi) of this paragraph);

(ii) Facilities classified as Standard Industrial Classifications 24 (except 2434), 26 (except 265 and 267), 28, 29, 30, 311, 32, 33, 3441, 373;

(iii) Facilities classified as Standard Industrial Classifications 10 through 14 (mineral industry) including active or inactive mining operations (except for areas of coal mining operations meeting the definition of a reclamation area under 40 CFR 434.11(l)) and oil and gas exploration, production, processing, or treatment operations, or transmission facilities that discharge storm water contaminated by contact with or that has come into contact with, any overburden, raw material, intermediate products, finished products, byproducts or waste products located on the site of such operations; inactive mining operations are mining sites that are not being actively mined, but which have an identifiable owner/operator;

(iv) Hazardous waste treatment, storage, or disposal facilities, including those that are operating under interim status or a permit under Subtitle C of RCRA;

(v) Landfills, land application sites, and open dumps that have received any industrial wastes (waste that is received from any of the facilities described under this subsection) including those that are subject to regulation under Subtitle D of RCRA;

(vi) Facilities involved in the recycling of materials, including metal scrapyards, battery reclaimers, salvage yards, and automobile junkyards, including but limited to those classified as Standard Industrial Classification 5015 and 5093;

(vii) Steam electric power generating facilities, including coal handling sites;

(viii) Transportation facilities classified as Standard Industrial Classifications 40, 41, 42, 44, and 45 which have vehicle maintenance shops equipment cleaning operations, or airport deicing operations. Only those portions of the facility that are either involved in vehicle maintenance

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(including vehicle rehabilitation, mechanical repairs, painting, fueling, and lubrication), equipment cleaning operations, airport deicing operations, or which are otherwise identified under paragraphs (i)-(vii) or (ix)-(xi) of this subsection are associated with industrial activity;

(ix) Treatment works treating domestic sewage or any other sewage sludge or wastewater treatment device or system, used in the storage treatment, recycling, and reclamation of municipal or domestic sewage, including land dedicated to the disposal of sewage sludge that are located within the confines of the facility, with a design flow of 1.0 mgd or more, or required to have an approved pretreatment program under 40 CFR part 403. Not included are farm lands, domestic gardens or lands used for sludge management where sludge is beneficially reused and which are not physically located in the confines of the facility, or areas that are in compliance with 40 CFR part 503;

(x) Construction activity including clearing, grading and excavation activities except: operations that result in the disturbance of less than five acres of total land area which are not part of a larger common plan of development or sale;

(xi) Facilities under Standard Industrial Classifications 20, 21, 22, 23, 2434, 25, 265, 267, 27, 283, 31 (except 311), 34 (except 3441), 35, 36, 37 (except 373), 38, 39, 4221-25, (and which are not otherwise included within categories (i)-(x));

Time-weighted composite means a composite sample consisting of a mixture of equal volume aliquots collected at a constant time interval.

Waste pile means any noncontainerized accumulation of solid, nonflowing waste that is used for treatment or storage.

25-year, 24-hour precipitation event means the maximum 24-hour precipitation event with a probable reoccurrence interval of once in 25 years. This information is available in "Weather Bureau Technical Paper No. 40,", May 1961 and "NOAA Atlas 2," 1973 for the 11 Western States, and may be obtained from the National Climatic Center of the Environmental Data Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

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Federal Register

Tuesday
November 5, 1991

Part II

Environmental Protection Agency

40 CFR Part 122

National Pollutant Discharge Elimination System Permit Application Regulations for Storm Water Discharges; Application Deadlines; Final Rule and Proposed Rule

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ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 122

[FRL-3984-8]

RIN 2040-AB89

National Pollutant Discharge Elimination System Permit Application Regulations for Storm Water Discharges; Application Deadlines

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final rule.

SUMMARY: EPA is extending the deadline for submission of National Pollutant Discharge Elimination System (NPDES) individual permit applications for storm water discharges associated with industrial activity from November 18, 1991, to October 1, 1992. EPA is also establishing a fixed deadline of no later than October 1, 1992, for submission of individual permit applications from dischargers rejected from group applications. These changes will reduce confusion in the regulated community over application requirements and deadlines. The changes made by this final rule will also serve to treat all regulated facilities as equitably as possible, and help to avoid serious delays in the issuance of storm water permits and the implementation of necessary controls leading to the desired water quality benefits.

EFFECTIVE DATE: November 18, 1991.

FOR FURTHER INFORMATION CONTACT: For information on this rule contact the NPDES Storm Water Hotline at (703) 821-4823, or Thomas J. Seaton, Office of Wastewater Enforcement and Compliance (EN-336), United States Environmental Protection Agency, 401 M Street, SW., Washington, DC 20460, (202) 260-9518.

SUPPLEMENTARY INFORMATION:

I. Background

The 1972 amendments to the Federal Water Pollution Control Act (FWPCA, also referred to as the Clean Water Act or CWA), prohibited the discharge of any pollutant to navigable waters from a point source unless the discharge is authorized by a NPDES permit. The appropriate means of regulating storm water discharges under the NPDES program has been a matter of serious concern and controversy since that time. EPA promulgated NPDES storm water regulations in 1973, 1976, 1979, 1980, and 1984. These regulations have resulted in much litigation and none were successfully implemented despite EPA's efforts.

A. Environmental Impacts

Several National assessments have been conducted to evaluate impacts on receiving water quality. For the purpose of these assessments, urban runoff was considered to be a diffuse source or nonpoint source pollution, although legally, most urban runoff is discharged through conveyances such as separate storm sewers or other conveyances which are point sources under the CWA and subject to the NPDES program.

The "National Water Quality Inventory, 1988 Report to Congress" provides a general assessment of water quality based on biennial reports submitted by the States under section 305(b) of the CWA. In preparing section 305(b) Reports, the States were asked to indicate the fraction of the States' waters that were assessed, as well as the fraction of the States' waters that were fully supporting, partly supporting, or not supporting designated uses. The Report indicates that of the rivers, lakes, and estuaries that were assessed by States (approximately one-fifth of stream miles, one-third of lake acres and one-half of esturine waters), roughly 70 percent to 75 percent are supporting the uses for which they are designated. For waters with use impairments, States were asked to determine impacts due to diffuse sources (agricultural and urban runoff and other categories of diffuse sources), municipal sewage, industrial (process) wastewaters, combined sewer overflows, and natural sources, then combine impacts to arrive at estimates of the relative percentage of State waters affected by each source. In this manner, the relative importance of the various sources of pollution causing use impairments was assessed and weighted national averages were calculated.

Based on 37 States that provided information on sources of pollution, the Assessment also concluded that pollution from diffuse sources such as runoff from agricultural, urban areas, construction sites, land disposal activities, and resource extraction activities is cited by the States as the leading cause of water quality impairment.[1] Diffuse sources appear to be increasingly important contributors of use impairment as discharges of industrial process wastewaters and municipal sewage plants come under control and intensified data collection efforts provide additional information. Some examples where use impairments are cited as being caused by diffuse sources include: Rivers and streams, where 9 percent are caused by separate storm sewers, 4 percent are caused by construction and 11 percent are caused by resource extraction; lakes where 8 percent are caused by separate storm sewers and 7 percent are caused by land disposal; the Great Lakes shoreline, where 35 percent are caused by separate storm sewers, 46 percent are caused by resource extraction, and 19 percent are caused by land disposal; for estuaries where, 41 percent are caused by separate storm sewers; and for coastal areas, where 20 percent are caused by separate storm sewers and 29 percent are caused by land disposal.

The States conducted a more comprehensive study of diffuse pollution sources under the sponsorship of the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA) and EPA. The study resulted in the report "America's Clean Water-The States' Nonpoint Source Assessment, 1985" which indicated that 38 States reported urban runoff as a major cause of beneficial use impairment. In addition, 21 States reported construction site runoff as a major cause of use impairment.

Studies conducted by the National Oceanic and Atmospheric Administration (NOAA) [2] indicate that urban runoff is a major pollutant source which adversely affects shellfish growing waters. The NOAA studies identified urban runoff as affecting over 578,000 acres of shellfish growing waters on the East Coast (39 percent of harvest-limited area); 2,000,000 acres of shellfish growing waters in the Gulf of Mexico (56% of the harvest-limited area); and 130,000 acres of shellfish growing waters on the West Coast (52% of harvest-limited areas).

B. Water Quality Amendments of 1987

In an attempt to resolve the controversy over the proper regulation of storm water discharges, Congress enacted the Water Quality Act of 1987 which, among other things, added Section 402(p) to the CWA. Section 402(p) of the CWA was enacted in recognition of the Agency's inability to implement comprehensive requirements for storm water discharges under the NPDES program. Section 402(p) provides a framework for EPA to implement NPDES program requirements for storm water discharges. Section 402(p)(1)

[1] Major classes of diffuse sources that include, in part, storm water point source discharges are: Urban runoff conveyances construction sites, agriculture (feedlots) resource extraction sites, and land disposal facilities.

[2] See "The Quality of Shellfish Growing Waters on the East Coast of the United States", NOAA, 1989, "The Quality of Shellfish Growing Waters in the Gulf of Mexico", NOAA, 1988, and "The Quality of Shellfish Growing Waters on the West Coast of the United States", NOAA, 1990.

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provides that EPA or authorized NPDES States cannot require a permit for certain storm water discharges until after October 1, 1992, except for storm water discharges listed under section 402(p)(2). Section 402(p)(2) lists five types of storm water discharges which are required to obtain a permit before October 1, 1992:

(A) A discharge with respect to which a permit has been issued prior to February 4, 1987;

(B) A discharge associated with industrial activity;

(C) A discharge from a municipal separate storm sewer system serving a population of 250,000 or more;

(D) A discharge from a municipal separate storm sewer system serving a population of 100,000 or more, but less than 250,000; or

(E) A discharge for which the Administrator or the State, as the case may be, determines that the storm water discharge contributes to a violation of a water quality standard or is a significant contributor of pollutants to the waters of the United States.

With respect to storm water discharges associated with industrial activity, section 402(p)(4)(A) of the CWA requires EPA to promulgate regulations governing permit applications requirements by "no later than two years" after the date of enactment (i.e. no later than February 4, 1989). Section 402(p)(4)(A) also provides that permit applications for storm water discharges associated with industrial activity "shall be filed no later than three years" after the date of enactment (i.e. no later than February 4, 1990). Permits for these discharges are to be issued by no later than four years after the date of enactment (i.e. no later than February 4, 1991). Permits must provide for compliance as expeditiously as practicable, but in no event later than three years after the date of permit issuance.

C. November 16, 1990 Permit Application Requirements

EPA promulgated permit application regulations for the storm water discharges identified under section 402(p)(2)(B), (C), and (D) of the CWA, including storm water discharges associated with industrial activity, on November 16, 1990 (55 FR 47990). The November 16, 1990 regulations address requirements, including deadlines, for two sets of application procedures for storm water discharges associated with industrial activity: Individual permit applications and group applications. In addition, the notice recognizes a third set of application procedures for storm water discharges associated with industrial activity: Those associated with general permits. With these requirements, EPA is attempting to implement a flexible, cost-effective approach for storm water permit applications.

The requirements for individual applications for storm water discharges associated with industrial activity are set forth at 40 CFR 122.26(c)(1). Generally, the applicant must provide comprehensive facility specific narrative information including: (1) A site map; (2) an estimate of impervious areas; (3) the identification of significant materials treated or stored on site together with associated materials management and disposal practices; (4) the location and description of existing structural and non-structural controls to reduce pollutants in storm water runoff; (5) a certification that all storm water outfalls have been evaluated for any unpermitted non-storm water discharges; and (6) any existing information regarding significant leaks or spills of toxic or hazardous pollutants within three years prior to application submittal. In addition, an individual application must include quantitative analytical data based on samples collected on site during storm events. Under § 122.26(e)(1) of the November 16, 1990 rule, individual applications must be submitted by November 16, 1991.

The group application process allows for facilities with similar storm water discharges to file a single two part permit application. Part 1 of a group application includes a list of the facilities applying, a narrative description summarizing the industrial activities of participants of the group, a list of significant materials exposed to precipitation that are stored by participants and material management practices employed to diminish contact of these materials by precipitation (see 40 CFR 122.26(c)(2)(i)). Under the November 16, 1990 regulations, part 1 of the group application was to be submitted to EPA no later than March 18, 1991. The regulation provides that EPA has a 60 day period after receipt to review the part 1 applications and notify the groups as to whether they have been approved or denied as a properly constituted "group" for purposes of this alternative application process. Part 2 of the group application contains detailed information, including sampling data, on roughly 10 percent of the facilities in the group (see 40 CFR 122.26(c)(2)(ii) for a complete description of the requirements of part 2 group applications). Under the November 16, 1990 regulations, part 2 applications were to be submitted no later than 12 months after the date of approval of the part 1 application. Also under the November 16, 1990 regulation, facilities that are rejected as members of a group were to have 12 months from the date they receive notification of their rejection to file an individual permit application (or obtain coverage under an appropriate general permit).

The group application process has been designed by EPA as a one-time administrative procedure to ease the burden on the regulated community and permitting authorities in the initial stage of the storm water program.

The third application procedure entails seeking coverage under a general permit for storm water discharges associated with industrial activity. Dischargers covered by a general permit are excluded under 40 CFR 122.21(e) from requirements to submit individual or group permit applications. Conditions for filing an application to be covered by a general permit (typically called a Notice of Intent (NOI)) are established on a case-by-case basis. In almost all cases, general permits require the submittal of NOIs containing basic information such as the name and address of the facility and a brief description of the discharge and receiving water.

The November 16, 1990 regulations also establish a two part application process for discharges from municipal separate storm sewer systems serving a population of 100,000 or more. The regulations lists 220 cities and counties that are defined as having municipal separate storm sewer systems serving a population of 100,000 or more and allows for case-by-case designations of other municipal separate storm sewers to be part of these systems (55 FR 48073, 48074). The regulations provide that part 1 applications for discharges from large municipal separate storm sewer systems (systems serving a population of 250,000 or more) are due November 18, 1991. Part 2 applications for discharges from large systems are due on November 16, 1992. Part 1 applications for discharges from medium municipal separate storm sewer systems (systems serving a population of 100,000 or more, but less than 250,000) are due May 18, 1992. Part 2 applications for discharges from medium systems are due on May 18, 1993.

D. March 21, 1991 Final Rule

Despite extensive public outreach efforts, EPA received a significant number of requests to extend the March 18, 1991, deadline for filing part 1 of the group application. Numerous parties expressed concern that although they were currently forming groups, they

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would not be able to file the part 1 application by the March 18, 1991 deadline. In particular, concerns were raised by municipal governments.[3] EPA learned that a number of small municipalities were largely unaware of the impact of the new storm water regulations. Many of these municipalities apparently mistakenly believed that since their municipal separate storm sewer systems were not covered by the November 16, 1990 rule, they were also not required to submit applications for storm water discharges associated with industrial activity that they owned or operated.

EPA also became aware that many industrial facilities were having difficulty determining whether the new regulations apply to them. EPA defined the scope of coverage in the November 16, 1990 rule on the basis of SIC codes. However, many facilities engage in operations that can be classified under more than one SIC code; some of these operations are covered, while others are not. The Agency estimates that over half of the twenty-three thousand phone inquiries received by the storm water hotline asked questions about the scope of the final rule as it applies to industrial activity. Since many facilities could not quickly determine whether they were covered by the regulation, many got a late start in developing applications to meet the requirements and deadlines of the November 16, 1990 storm water rule.

To address these concerns, EPA extended the part 1 group application deadline from March 18, 1991 to September 30, 1991. (56 FR 12098 (March 21, 1991)). EPA indicated that it believed that a six month extension to the part 1 group application deadline was an appropriate amount of time for members of the regulated community to determine their status under the November 16, 1990 rule, to organize groups, and to submit part 1 applications. In making this determination, the Agency noted that the part 1 application requires a list of facilities applying, a narrative description summarizing the industrial activities of participants of the group, a list of significant materials exposed to precipitation that are stored by participants and material management practices employed to diminish contact of these materials by precipitation.[4]

As part of the March 21, 1991 final rule, EPA also established May 18, 1992 as the fixed deadline for submission of part 2 of the group applications. The November 16, 1990 regulation had not established a fixed deadline for submitting part 2 of the group application, but rather provided that part 2 applications were not due until one year after the part 1 was approved by EPA. Under the March 21, 1991 final rule, part 2 applications were to be submitted by no later than May 18, 1992 even if EPA's approval of the part 1 occurred after May 18, 1991. In other words, groups that take advantage of the part 1 group application deadline extension would have less than the full year to complete their part 2.

E. March 21, 1991, Proposal

EPA also published a proposed rule on March 21, 1991, addressing two other deadlines for submitting permit applications for storm water discharges associated with industrial activity. The proposal requested comment on extending the deadline for submitting individual applications from November 18, 1991 to May 18, 1992. In addition, the notice proposed to provide that members of group applications that are rejected from the group application must file an individual application or obtain coverage under an appropriate general permit by no later than May 18, 1992. (56 FR 12101, (March 21, 1991)).

The objective of this proposal was to address and solicit comment on the relationship between extending part 1 group application deadlines and revising other application deadlines for storm water discharges associated with industrial activity.

EPA noted several goals associated with the proposed changes: to reduce confusion in the regulated community over what application requirements affect which facilities on which dates, to treat all regulated facilities as equitably as possible, and to avoid serious delays in the issuance of permits for storm water discharges and the implementation of necessary controls leading to the desired water quality benefits.

F. Progress to Date

As discussed above, EPA has wrestled with storm water issues for 20 years. Since the adoption of the 1987 amendments to the CWA, EPA has been committed to prompt and effective implementation of section 402(p). The November 16, 1990 regulations reflect EPA's goal of addressing high risk sources of storm water quickly and without excessive burdens to the regulated community. To that end, the November 16 regulations established a flexible regulatory framework by providing dischargers with the option of participating in a group application and by encouraging the issuance of general permits through the development of a risk-based four tiered strategy for permitting storm water discharges associated with industrial activity.

EPA believes Congress, in adopting section 402(p), wished to strike a balance between the risks associated with industrial storm water discharges and the burdens of controlling the large number of industrial sources in a short time frame, and that the November 16, 1990 regulations represent a good faith effort to achieve Congress' intent. Nonetheless, EPA is aware that the regulated community has already encountered significant difficulties in attempting to comply with the regulations, as further discussed below. Despite what EPA believes to be a general acceptance in the regulated community of the need to address risks associated with storm water, the implementation problems discussed below have caused confusion and frustration.

EPA has taken a number of steps to improve the implementation of the storm water program since the adoption of the November 16, 1990 regulations. Processing permit applications for the large number of storm water discharges associated with industrial activity is expected to place significant burdens on EPA and authorized NPDES States. In response to concerns about these burdens, the Agency has developed a preliminary four-tiered permit issuance strategy for storm water discharges associated with industrial activity (see 55 FR 48002, (November 16, 1990)). General permits are expected to play an important role in the strategy.

On August 16, 1991 (56 FR 40948), EPA published draft general permits for the majority of storm water discharges associated with industrial activity in those States where the Agency is the permitting authority. A major emphasis of the draft general permits is to establish requirements for storm water pollution prevention measures and best management practices. The comment period for these permits closed on October 15, 1991. The Agency intends to issue final general permits for storm water discharges associated with industrial activity as soon as possible after the comment period closes. EPA is also developing a form for NOIs for the draft general permits that can be read

[3] The November 16, 1990 rule establishes permit applications for storm water discharges associated with industrial activity, including such discharges owned or operated by Federal, State, or municipal entities (see 40 CFR 122.26(b)(14)).

[4] Several commenters on the March 21, 1991 notices expressed confusion over the requirements of Part 1 of the group application. The Agency wants to clarify that the NPDES Form 1 application is not required from each facility that is participating in a group application.

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by automatic data processing equipment. This will assist the Regional Offices and authorized NPDES States which use the NOI form in handling and filing the NOIs.

EPA cannot issue a general permit in an authorized NPDES State. In addition, general permits can only be issued for discharges in States with authorized NPDES programs where the State is authorized to issue general permits. EPA has worked closely with authorized NPDES States to assist them in obtaining the necessary authority to issue general permits. During 1991, 11 authorized NPDES States obtained general permit authority. Currently an additional 11 authorized NPDES States do not have authority to issue general permits. EPA is working closely with the 11 authorized NPDES States without general permit authority to assist them in obtaining the necessary authority to issue general permits. Appendix A of this notice provides a list of authorized NPDES States, and the status of general permit approval. Those 28 States that presently have authority to issue general permits for storm water discharges may do so without waiting for EPA to issue EPA's general permits. Initial information from authorized NPDES States indicates that at least 23 of the authorized NPDES States are in the process of developing or have already issued general permits for storm water discharges.

EPA also received over 1,200 group applications by the September 30, 1991 deadline for part 1 of the application. The Agency estimates that these group applications represent over 45,000 industrial facilities. Currently, the Agency has completed an initial review of over 900 part 1 applications. The Agency anticipates that the part 1 review process for all applications will be completed by December, 1991.

As part of the process of implementing the national storm water initiative called for by section 402(p) of the Clean Water Act, the Agency has undertaken substantial efforts to provide the public with notice of the new storm water program requirements and explain the different application alternatives. As part of this outreach effort, EPA's Office of Wastewater Enforcement and Compliance (OWEC) established a hotline which has fielded over twenty-three thousand telephone inquiries on the scope of the program, application requirements, and related issues. Over ten thousand copies of the November 16, 1990 rule were printed and distributed to States, EPA regions, interest groups and members of the public. In addition, OWEC has held full day workshops in ten cities across the country during the first six weeks of 1991 and has addressed storm water requirements at over 30 other conferences and speaking engagements. State and EPA regional representatives have also contributed to this effort by participating in numerous local workshops and conferences on storm water discharge permit application requirements.

G. Future Directions

EPA will increase its outreach efforts to work with and listen to the States, regulated community, environmental groups and other customers to more fully identify issues and problems with storm water regulatory requirements.

EPA has already outlined above a number of activities to be taken in the next year to assist program implementation. These activities include issuances of general permits, development of automatic data processing equipment for handling NOIs, assisting authorized NPDES States to obtain general permit authority and to issue general permits, and review of group applications. In addition, the Agency will continue its outreach efforts by developing guidance and conducting and attending additional workshops. The Agency is actively working on improving the efficiency and scope of the storm water hotline. In addition, the Agency is developing a question and answer document and information brochures for public dissemination. The Agency is also developing two permit writer's guidance documents for preparing industrial and municipal storm water permits.

These and other broader efforts will assist the Agency in identifying major issues of concern with implementation of the storm water permitting program, such as, whether the program is appropriately targeting high risk discharges, the potential for pollution prevention alternatives, the potential for cross-media impacts, and whether further adjustments to the program are needed. EPA will use the feedback from its outreach efforts to enhance the ability of all the key players to succeed in accomplishing the important goal of reducing risk from contaminated storm water.

II. Today's Final Rule and Response to Comment

EPA received over 120 comments on the March 21, 1991 proposal. After careful consideration of these comments, the Agency is extending the deadline for submitting individual applications for storm water discharges associated with industrial activity from November 18, 1991 to October 1, 1992. Today's rule also establishes a fixed date of no later than October 1, 1992 by which facilities rejected from group applications must either file an individual application or be covered by an appropriate general permit for their storm water discharges associated with industrial activity.

EPA is granting these extensions to allow rejected members of groups additional time to obtain sampling data, and to ensure that all individual applications for storm water discharges that are currently not authorized by a permit are due at the same time to avoid further confusion in the regulated community. The extension for individual applications will also provide facilities that are currently unaware of their responsibilities under the storm water program additional opportunities to comply with appropriate regulatory requirements. Also, operators of storm water discharges in many areas of the country will have additional opportunities to collect data during summer months. EPA also notes that establishing a deadline of October 1, 1992 for these applications will provide additional time for permit issuing agencies to issue general permits for storm water discharges associated with industrial activity.

This notice also provides a technical amendment to 40 CFR 122.26(e)(6). This technical amendment is necessary to avoid ambiguity. The technical amendment provides that facilities with existing NPDES permits for storm water discharges associated with industrial activity which expire on or after May 18, 1992 shall submit a new application in accordance with the requirements of 40 CFR 122.21 and 40 CFR 122.26(c) (Form 1, Form 2F, and other applicable Forms) 180 days before the expiration of such permits. This technical amendment does not represent a substantive change from the November 16, 1990 rulemaking. Under the November 16, 1990 rulemaking, facilities with existing NPDES permits for storm water discharges that have to reapply for permit renewal during the first year following promulgation of the rule have the option of either applying in accordance with existing Form 1 and Form 2C requirements or applying in accordance with Form 1 and the new Form 2F requirements. However, the existing regulatory language addressing this requirement (at 40 CFR 122.26(e)(6)) refers both to May 18, 1992 [8] and 40 CFR

[8] Note that 40 CFR 122.21(f) requires facilities with existing NPDES permits to submit a new

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122.26(e)(1) (the deadline for submitting individual applications changed by today's rule).

The deadline for facilities with an existing permit was primarily intended to provide facilities with existing NPDES permits for storm water discharges with a period of one year during which they could submit either Form 2C or Form 2F (see 55 FR 48059). Thus it is necessary to provide a technical amendment at 40 CFR 122.26(e)(8) to maintain the original intent of the provision (i.e., to require all facilities with existing permits to start using Form 2F one year after the November 16, 1990 rule). EPA does not believe that it is necessary to extend the deadline for these facilities to use the Form 2F requirements because facilities with existing NPDES permits for storm water discharges are generally familiar with the NPDES program. In addition, even if EPA extended this deadline, these facilities would still be required to submit Form 2C for their storm water discharge.

Elsewhere in today's **Federal Register**, EPA is publishing a notice of proposed rulemaking requesting comment on extending the regulatory deadline for submitting part 2 of a group application from May 18, 1992 to October 1, 1992.

EPA wishes to emphasize that today's final rule does not affect the application deadlines for discharges from municipal separate storm sewer systems that are specified in the November 16, 1990 rule. Part 1 applications for discharges from large municipal separate storm sewer systems are still due by November 18, 1991. Part 1 applications for discharges from medium municipal separate storm sewer systems are due by May 18, 1992. EPA has no information to suggest that operators of these systems, which are specifically enumerated in the final regulation (see 55 FR 48073–74 (Appendices F–I to part 122)) or were specifically designated on a case-by-case basis, are unaware of the November 18, 1990 regulations.

A. Deadline for Individual Applications

The vast majority of comments received on the March 21, 1991 proposal supported extending the deadline for submitting individual permit applications. A variety of reasons were given to support the proposed extension. A significant number of commenters identified the complexity of the permit application requirements published on November 16, 1990, as the reason for their support of the proposed deadline extension. Other commenters focused on the need for additional time to obtain representative storm water samples to complete the individual application.

Some commenters urged EPA to extend the deadline for submitting individual permit applications for storm water discharges associated with industrial activity beyond May 18, 1992, to a suitable date after general permits are issued for storm water discharges. These commenters indicated that such an approach had the advantage of ensuring that dischargers would have three options for submitting applications (e.g., individual applications, group applications, or obtaining coverage under an appropriate general permit). This would allow dischargers to select the most cost-effective approach allowable under the NPDES regulatory framework.

Based on a consideration of these comments, the Agency is extending the regulatory deadline for submitting individual permit applications for storm water discharges associated with industrial activity from November 18, 1991 to October 1, 1992. As discussed in more detail below and in the proposed rule appearing elsewhere in today's **Federal Register**, the Agency also believes that it is appropriate to extend certain deadlines associated with the group application process to October 1, 1992 to provide a full year for affected facilities to conduct the necessary discharge sampling. Establishing the same deadline for individual applications and applications associated with the group application process will provide equitable treatment of dischargers while minimizing confusion over the deadlines. Based on comments received on the March 21, 1991 proposal, as well as those received on EPA's storm water proposals in 1985 and 1988, one year is generally an appropriate minimum amount of time to assure that the required sampling can be completed, in light of arid conditions in some areas in the summer, and cold conditions in other areas in the winter.

The extension of the deadline for individual applications will provide facilities that are currently unaware of their responsibilities under the storm water program additional opportunities to comply with appropriate regulatory requirements. This extension will also provide operators of storm water discharges in areas of the country with extended winter conditions a better opportunity to collect representative sampling data of their storm water discharge. A number of commenters have expressed concerns that difficulties may arise in collecting storm water discharge sampling data during the winter months due to the potential for limited numbers of discharge events and adverse weather conditions coupled with lack of sampling experience of many facilities that are submitting applications for the first time.

EPA notes that this extension will also provide authorized NPDES States with additional time to issue general permits for storm water discharges associated with industrial activity consistent with EPA's long-term permitting strategy for storm water discharges associated with industrial activity.[6] On August 18, 1991, (56 FR 40948), EPA published a proposal requesting public comment on draft general permits for storm water discharges associated with industrial activity in States and territories without authorized NPDES programs.[7] The Agency intends to make every effort to issue these general permits in the spring of 1992.

However, EPA has decided against basing the deadline for submitting individual permit applications on the date that general permits are issued because of the potential confusion and uncertainty that would arise. The Agency is also concerned that unacceptable delays may result under this approach in States where the issuance of a general permit is delayed.

Although the Agency is proposing draft general permits for storm water discharges in States without authorized State NPDES programs in one notice, it may not finalize all of these permits on the same date. The Agency expects that various region-specific, State-specific, or industrial category-specific issues may take different amounts of time to address. It should also be noted that the August 18, 1991 proposal does not address general permits in authorized NPDES States. Each authorized NPDES State that will issue general permits for storm water discharges associated with industrial activity will have to go through the procedures for issuing

application at least 180 days before the expiration date of the existing permit. November 18, 1991 is 180 days prior to May 18, 1992.

[6] EPA has requested public comment on a four tiered long-term permitting strategy for storm water discharges associated with industrial activity (see August 18, 1991, (56 FR 40948) and November 16, 1990 (55 FR 47990)). Tier 1 of the strategy relies on baseline general permits for the majority of storm water discharges associated with industrial activity.

[7] The notice addresses draft general permits in 12 States (MA, ME, NH, FL, LA, TX, OK, NM, SD, AZ, AK, ID), and six Territories (District of Columbia, the Commonwealth of Puerto Rico, Guam, American Samoa, the Commonwealth of the Northern Mariana Islands, and the Trust Territory of the Pacific Islands) without authorized NPDES State programs on Indian lands in AL, CA, GA, KY, MI, MN, MS, MT, NC, ND, NY, NV, SC, TN, UT, WI, and WY, located within federal facilities and Indian lands in CO and WA, and located within federal facilities in Delaware.

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general permits of that State. Different permit issuance procedures, along with other factors, will result in these permits being issued at different times. All of these factors indicate that a tremendous amount of uncertainty and confusion would result if EPA attempted to tie regulatory deadlines for submitting permit applications to the dates when general permits are issued.

In addition, the Agency anticipates that there will be situations where the permitting authority determines that general permits are inappropriate for a given class of storm water discharges. Additional confusion would arise in these situations if application deadlines were tied to the dates of general permit issuance.

One comment stated that EPA's extension of permit application deadlines for storm water discharges associated with industrial activity was illegal in light of the deadline in section 402(p)(4)(A) of the CWA. In response, EPA first notes that section 402(p)(4)(A) of the CWA requires EPA to promulgate regulations governing permit application requirements for storm water discharges associated with industrial activity by no later than February 4, 1989. Section 402(p)(4)(A) also provides that permit applications for storm water discharges associated with industrial activity shall be filed within one year (i.e., no later than February 4, 1990).

EPA is fully aware of the deadlines in section 402(p) of the CWA that address when EPA is to establish permit application requirements for storm water discharges, when applications are to be submitted and when permits are to be issued. The Agency notes that, despite its best efforts, it was not able to promulgate application requirements for storm water discharges associated with industrial activity by the February 4, 1989 deadline provided by the CWA. EPA recognizes that the deadlines finalized in the November 16, 1990 notice, the March 21, 1991 final rule and today's rule do not synchronize with the deadlines provided in the CWA. The Agency believes that it is reasonable and necessary to establish regulatory deadlines for submitting applications, which occur after the statutory deadlines, to give applicants sufficient time to comply with the regulatory requirements for permit applications. The Agency is convinced that this approach is necessary for the development of enforceable and sound permits for storm water discharges. The public's interest in a sound storm water permitting program is best served by establishing application deadlines that will allow sufficient time to gather, analyze, and prepare meaningful applications. EPA believes this extension of the application deadline is necessary to accomplish this goal because a significant number of facilities have not had adequate time to prepare applications because they were unaware of the regulatory requirements or because of uncertainty regarding the scope and applicability of the regulatory definition of storm water discharge associated with industrial activity, or, for some facilities, that they would be rejected from a group application.

By establishing later regulatory application deadlines, EPA is not attempting to waive or revoke the statutory deadlines established in section 402(p) of the CWA, and the Agency does not assert the authority to do so. Dischargers concerned with complying with the statutory deadline should submit a permit application as expeditiously as possible.

B. Deadline for Facilities Rejected from Group Applications

Some commenters supported an extension of one year from the date that facilities are rejected from a group application. These commenters argued that such an extension was appropriate to ensure that all facilities rejected from a group application had a sufficient opportunity to collect sampling data.

A number of commenters expressed their belief that the deadline for facilities that are rejected from a group application to submit individual applications should be extended beyond the date proposed by EPA, May 18, 1992. Several suggestions for a later deadline were made, including providing one year after the date EPA rejects the facility from the group application, and basing the deadline on when general permits for storm water discharges associated with industrial activity are issued.

EPA believes that establishing a fixed deadline of October 1, 1992 for facilities that are rejected from a group application is warranted for the same reasons that the Agency articulated above and in the proposal. This approach provides an equitable deadline for these facilities, reduces confusion and uncertainty in the regulated community, and provides sufficient time to complete the sampling necessary to obtain quantitative data. The extension will also have the side benefit of giving permit issuance authorities additional time to issue baseline general permits for storm water discharges associated with industrial activity.

Commenters supporting the position that the application deadline for facilities that are rejected from a group application be based on the date of issuance of a general permit indicated that such an approach would ensure that dischargers would have three options for applying for a permit. EPA declines to adopt this approach out of the same concerns about potential confusion and uncertainty indicated above in the context of the individual application deadline. To reiterate, EPA believes that such an approach is unmanageable because general permits will be issued on different dates and because the approach would not clearly establish deadlines for discharges that the permit authority did not intend to cover with a general permit.

Again, one commenter contended that this extension was illegal because the deadline exceeded the statutory date of February 4, 1990 for submitting applications. EPA's response on this issue is noted above.

III. Regulatory Requirements

Today's rule makes no change in the substantive requirements of the storm water program, places no additional information collection or record-keeping burden on respondents. The rule meets none of the criteria for a major rule under Section 1(b) of Executive Order 12291. The information collection requirements in this rule have already been approved by the Office of Management and Budget and been assigned OMB control number 2040-0086. An additional information collection request has not been prepared and submitted to the Office of Management and Budget (OMB) under the Paperwork Reduction Act. Since this rule does not change any existing substantive requirements, I certify that it will not have a significant impact on a substantial number of small entities under the Regulatory Flexibility Act.

Today's rule is effective on November 18, 1991. EPA believes there is good cause under the Administrative Procedure Act to make this rule effective in less than 30 days. Given the pre-existing November 18, 1991 deadline, it is necessary for this rule to be effective on or before that date to avoid confusion in the regulated community. (5 U.S.C. 553(d)).

List of Subjects in 40 CFR Part 122

Administrative practice and procedure, Reporting and recordkeeping requirements, Water pollution control.

Dated: October 24, 1991.

William K. Reilly,

Administrator.

For the reasons set out above, part 122, chapter I of title 40 of the Code of

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Federal Regulations is amended as follows:

PART 122—EPA ADMINISTERED PERMIT PROGRAMS: THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

1. The authority citation for part 122 continues to read as follows:

Authority: The Clean Water Act, 33 U.S.C. 1251 *et. seq.*

Subart B—Permit Application and Special NPDES Program Requirements

§ 122.26 [Amended]

2. In § 122.26(e)(1), "November 18, 1991" is revised to read "October 1, 1992".

3. In § 122.26, paragraphs (e)(2)(iv) and (e)(6) are revised to read as follows:

§ 122.26 Storm water discharges (applicable to State NPDES programs, see § 122.25).

* * * * *

(e) * * *

(2) * * *

(iv) Facilities that are rejected as members of the group shall submit an individual application no later than 12 months after the date of receipt of the notice of rejection or October 1, 1992, whichever comes first.

* * * * *

(6) Facilities with existing NPDES permits for storm water discharges associated with industrial activity shall maintain existing permits. Facilities with permits for storm water discharges associated with industrial activity which expire on or after May 18, 1992 shall submit a new application in accordance with the requirements of 40 CFR 122.21 and 40 CFR 122.26(c) (Form 1, Form 2F, and other applicable Forms) 180 days before the expiration of such permits.

* * * * *

Note: The following appendices will not appear in the Code of Federal Regulations.

APPENDIX A—STATE NPDES PROGRAM STATUS AS OF SEPTEMBER 20, 1991

	Approved State NPDES permit program	Approved general permits program
Alabama	10/19/79	06/26/91
Arkansas	01/01/86	11/01/86
California	05/14/73	09/22/89
Colorado	03/27/75	03/04/83
Connecticut	09/26/73	
Delaware	04/01/74	
Georgia	06/28/74	01/28/91
Hawaii	11/28/74	09/30/91
Illinois	10/23/77	01/04/84
Indiana	01/01/75	04/02/91
Iowa	08/10/78	

APPENDIX A—STATE NPDES PROGRAM STATUS AS OF SEPTEMBER 20, 1991—Continued

	Approved State NPDES permit program	Approved general permits program
Kansas	06/28/74	
Kentucky	09/30/83	09/30/83
Maryland	09/05/74	09/30/91
Michigan	10/17/73	
Minnesota	06/30/74	02/15/87
Mississippi	05/01/74	09/27/91
Missouri	10/30/74	12/12/85
Montana	06/10/74	04/29/83
Nebraska	06/12/74	07/20/88
Nevada	09/19/75	
New Jersey	04/13/82	04/13/82
New York	10/28/75	
North Carolina	10/19/75	09/06/91
North Dakota	06/13/75	01/22/90
Ohio	03/11/74	
Oregon	09/26/73	02/23/82
Pennsylvania	06/30/78	09/02/91
Rhode Island	09/17/84	09/17/84
South Carolina	06/10/75	
Tennessee	12/28/77	04/15/91
Utah	07/07/87	07/07/87
Vermont	03/11/74	
Virgin Islands	06/30/78	
Virginia	03/31/75	06/20/91
Washington	11/14/73	09/26/89
West Virginia	06/10/82	06/10/82
Wisconsin	02/04/74	12/19/86
Wyoming	01/30/75	09/24/91
Totals	30	28

APPENDIX B

	Deadline Established in November 16, 1990 Rulemaking	Revised Deadline
Regulatory Application Deadlines for Storm Water Discharges Associated with Industrial Activity [1]:		
Individual Application	November 18, 1991 [2]	October 1, 1992.
Individual Application from facility rejected from group application	12 months from the date of notification of rejection [3]	October 1, 1992.
Group Application: Part 1	March 18, 1991 [4]	September 30, 1991.
Group Application: Part 2	12 months after the date of approval of Part 1 application [5]	May 18, 1992. [6]
Individual Application from facility with existing NPDES permit	180 days prior to date that permit expires	Same.
Individual Application for construction activities disturbing 5 or more acres	90 days prior to commencement of construction	Same
Individual Application for new storm water discharges (other than construction activities)	180 days before the discharge is to commence	Same.
Regulatory Application Deadlines for discharges from Municipal Separate Storm Sewer Systems [1]:		
Municipal Separate Storm Sewer Systems Serving a Population of 250,000 or more.	Part 1	November 18, 1991.
Do	Part 2	November 18, 1992
Municipal Separate Storm Sewer Systems Serving a Population of 100,000 or more, but less than 250,000.	Part 1	May 18, 1992.
Do	Part 2	May 17, 1993.

Note: Persons covered by general permits are excluded from requirements to submit individual permit applications (see 40 CFR 122.21(a)) Instead, application requirements and deadlines for a general permit, referred to as a notice of intent (NOI), are established in the general permit. Operators of storm water discharges associated with industrial activity which are currently not authorized by an NPDES permit must submit an individual application, comply with Part 2 group application requirements, or obtain coverage under an appropriate general permit by May 18, 1992.

[1] Permit application requirements for storm water discharges associated with industrial activity including requirements for appropriate discharges owned or operated by Federal, State or municipal entities (see 40 CFR 122.26(b)(14)).

[2] Modified by today's rule.

[3] Modified by today's rule.

[4] Modified on March 21, 1991 (56 FR 12098).

[5] Elsewhere in today's FEDERAL REGISTER, EPA is proposing to extend the deadline for submitting Part 2 of the group application from May 18, 1992 to October 1, 1992.

[6] Modified on March 21, 1991 (56 FR 12098).

[7] Unchanged from November 16, 1990 rule (55 FR 47990).

[FR Doc. 91-26322 Filed 11-4-91; 8:45 am]

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ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 122

[FRL-4027-2]

National Pollutant Discharge Elimination System Permit Application Regulations for Storm Water Discharges; Application Deadlines

AGENCY: Environmental Protection Agency (EPA).

ACTION: Notice of proposed rulemaking.

SUMMARY: As a result of issues and concerns raised in comments on the March 21, 1991 (56 FR 12098) proposal, EPA requests public comments on extending the regulatory deadline for submitting Part 2 of group applications for storm water discharges associated with industrial activity from May 18, 1992 to October 1, 1992. The Agency believes that this extension will provide an appropriate opportunity to conduct sampling to support the Part 2 application and will allow for permit issuing agencies to issue general permits.

DATES: Comments on this notice must be received on or before December 5, 1991.

ADDRESSES: The public should send an original and two copies of their comments to Thomas J. Seaton, Office of Wastewater Enforcement and Compliance (EN-336), United States Environmental Protection Agency, 401 M Street, SW., Washington, DC 20460. The public record is located at EPA Headquarters, EPA Public Information Reference Unit, room 2402, 401 M Street SW., Washington, DC 20460.

FOR FURTHER INFORMATION CONTACT: For information on this rule contact the NPDES Storm Water Hotline at (703) 821-4823, or Thomas J. Seaton, Office of Wastewater Enforcement and Compliance (EN-336), United States Environmental Protection Agency, 401 M Street, SW., Washington, DC 20460, (202) 260-9518.

SUPPLEMENTARY INFORMATION:

I. Background

On November 16, 1990 (55 FR 47990), EPA published regulatory requirements, including deadlines, for group applications for storm water discharges associated with industrial activity. The group application process allows for facilities with similar storm water discharges to file a single two part permit application.

Part 1 of a group application includes a list of the facilities applying, a narrative description summarizing the industrial activities of participants of the group, a list of significant materials exposed to precipitation that are stored by participants and material management practices employed to diminish contact of these materials by precipitation (see 40 CFR 122.26(c)(2)(i)). Under the November 16, 1990 regulations, part 1 of the group application was to be submitted to EPA no later than March 18, 1991. The regulation provided that EPA has a 60 day period after receipt to review the Part 1 applications and notify the groups as to whether they have been approved or denied as a properly constituted "group" for purposes of this alternative application process.

Part 2 of the group application contains detailed information, including sampling data, on roughly ten percent of the facilities in the group (see 40 CFR 122.26(c)(2)(ii) for a complete description of the requirements of part 2 group applications). Under the November 16, 1990 regulations, part 2 of the group application was to be submitted no later than 12 months after the date of approval of the part 1 application.

On March 21, 1991 (56 FR 12098), EPA published a final rulemaking extending the part 1 group application deadline from March 18, 1991 to September 30, 1991. EPA indicated that it believed that a six month extension to the part 1 group application deadline was an appropriate amount of time for members of the regulated community to determine their status under the November 16, 1990 rule, to organize groups, and to submit part 1 applications. As part of the March 21, 1991 final rule, EPA also established May 18, 1992 as the fixed deadline for submission of Part 2 of the group applications.

EPA also published a proposed rule on March 21, 1991, addressing two other deadlines for submitting permit applications for storm water discharges associated with industrial activity. The proposal requested comment on extending the deadline for submitting individual applications from November 16, 1991 to May 18, 1992. In addition, the notice proposed to provide that members of a group application that are rejected from the group application must file an individual application or obtain coverage under an appropriate general permit by no later than May 18, 1992. (56 FR 12101, (March 21, 1991)).

II. Today's Notice

As a result of issues and concerns raised in comments on the March 21, 1991 proposed deadline extensions, EPA is requesting comments on extending the deadline for submitting part 2 of the group application from May 18, 1992 to October 1, 1992. The Agency believes that this extension will provide an appropriate opportunity to conduct sampling to support the part 2 application. It will also allow for permit issuing agencies to issue general permits.

Part 1 of the group applications were required to be submitted by September 30, 1991. The existing regulatory deadline for submitting part 2 of the group application is May 18, 1992. Under the existing regulatory deadline for part 2 of the group application, groups that submitted part 1 applications on or shortly before the September 30, 1991 deadline would only have a limited amount of time, approximately seven and one-half months, to collect and organize sampling data. To complicate matters, parts of the country will experience winter conditions for significant parts of the time period between September 30 and May 18, making sample collection difficult. Today's proposal would ensure that one year would be available to complete the required sampling. This is consistent with comments received on the March 21, 1991 proposal suggesting that one year for completing permit applications is appropriate to assure completion of storm water sampling in various parts of the country with lengthy arid or winter seasons.

It should also be noted that on October 1, 1992 deadline for part 2 of group applications would be consistent with the October 1, 1992 deadline for individual permit applications for storm water discharges associated with industrial activity (see the final rulemaking published elsewhere in today's notice addressing the deadline for individual permit applications). Identical deadlines for part 2 of the group application and individual applications will result in equal treatment of facilities with storm water discharges. This will also reduce confusion in the regulatory community over the proper application deadlines.

The Agency believes that extending the deadline for submitting part 2 group applications beyond October 1, 1992 is inappropriate. An additional extension would create unnecessary and unacceptable delays in implementing the NPDES storm water program. The November 16, 1990 regulations provide considerable latitude for selecting rain events for sampling data (see 40 CFR 122.21(g)(7)). If data cannot be collected prior to the application deadline because of anomalous weather (e.g., drought conditions), then permitting authorities may grant additional time for submitting that data on a case-by-case basis (also see 40 CFR 122.21(g)(7)). The

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Agency believes that with the combination of extending deadlines for individual permit applications and part 2 of group applications for storm water discharges associated with industrial activity, there is no basis for further consideration of extending application deadlines for storm water discharges associated with industrial activity.

III. Regulatory Requirements

Today's proposed rule makes no change in the substantive requirements of the storm water program, only the date by which certain applications are due. Thus, the rule meets none of the criteria for a major rule under section 1(b) of Executive Order 12291. The information collection requirements in this rule have already been approved by the Office of Management and Budget and been assigned OMB control number 2040-0086. Since this proposed rule does not change any existing substantive requirements, I certify that it will not have a significant impact on a substantial number of small entities under the Regulatory Flexibility Act.

List of Subjects in 40 CFR Part 122

Administrative practice and procedure, Reporting and recordkeeping requirements, Water pollution control.

Dated: October 24, 1991.

William K. Reilly,

Administrator.

For the reasons set out above, part 122, chapter I of title 40 of the Code of Federal Regulations is proposed to be amended as follows:

PART 122—EPA ADMINISTERED PERMIT PROGRAMS: THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

1. The authority citation for part 122 continues to read as follows:

Authority: The Clean Water Act, 33 U.S.C. 1251 *et. seq.*

Subpart B—Permit Application and Special NPDES Program Requirements

§ 122.26 [Amended]

2. In § 122.26(e)(2)(iii), "May 18, 1992" is revised to read "October 1, 1992".

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SIC

The following pages list Standard Industrial Classifications, or SICs, used by the U.S. federal government. The pages are copied from the *Standard Industrial Classification Manual*, published in 1987 by the U.S. Office of Management and Budget. The complete manual includes much more descriptive information on SICs, and may be useful in determining the SIC of a particular facility. The manual is available from the National Technical Information Service (NTIS), as Order No. PB 87-100012.

The SIC system is intended to describe the operations of each commercial and industrial operation in the U.S. by a 4-digit code. The system is hierarchical, so that each industrial operation has a 4-digit code that is categorized under a broader 3-digit code, that in turn is categorized under a broader 2-digit code. For each industrial operation, the first two digits of its 4-digit code are its 2-digit code; and the first three digits are its 3-digit code.

For example, the broad 2-digit SIC 28 encompasses many manufacturing operations related to Chemicals and Allied Products. Part of this 2-digit grouping is the 3-digit category SIC 287, Agricultural Chemicals, that apply to only some of the SIC 28 operations. Part of the 3-digit SIC 287 grouping is SIC 2873, Nitrogenous Fertilizers. So a facility that manufactures nitrogenous fertilizers has a 4-digit SIC of 2873, a 2-digit SIC of 287, and a 2-digit SIC of 28. Further, it is part of the Manufacturing SIC group, which is all 2-digit SICs between 20 and 39, designated as D. in the 1987 Office of Management and Budget publication.

A. AGRICULTURE, FORESTRY, AND FISHING

Code	Short Title
01	AGRICULTURAL PRODUCTION—CROPS
011	Cash Grains
0111	Wheat
0112	Rice
0115	Corn
0116	Soybeans
0119	Cash grains, nec
013	Field Crops, Except Cash Grains
0131	Cotton
0132	Tobacco
0133	Sugarcane and sugar beets
0134	Irish potatoes
0139	Field crops, except cash grains, nec
016	Vegetables and Melons
0161	Vegetables and melons
017	Fruits and Tree Nuts
0171	Berry crops
0172	Grapes
0173	Tree nuts
0174	Citrus fruits
0175	Deciduous tree fruits
0179	Fruits and tree nuts, nec
018	Horticultural Specialties
0181	Ornamental nursery products
0182	Food crops grown under cover
019	General Farms, Primarily Crop
0191	General farms, primarily crop
02	AGRICULTURAL PRODUCTION—LIVESTOCK
021	Livestock, Except Dairy and Poultry
0211	Beef cattle feedlots
0212	Beef cattle, except feedlots
0213	Hogs
0214	Sheep and goats
0219	General livestock, nec
024	Dairy Farms
0241	Dairy farms
025	Poultry and Eggs
0251	Broiler, fryer, and roaster chickens
0252	Chicken eggs
0253	Turkeys and turkey eggs
0254	Poultry hatcheries
0259	Poultry and eggs, nec
027	Animal Specialties
0271	Fur-bearing animals and rabbits
0272	Horses and other equines
0273	Animal aquaculture
0279	Animal specialties, nec
029	General Farms, Primarily Animal
0291	General farms, primarily animal
07	AGRICULTURAL SERVICES
071	Soil Preparation Services
0711	Soil preparation services
072	Crop Services
0721	Crop planting and protecting
0722	Crop harvesting
0723	Crop preparation services for market
0724	Cotton ginning
074	Veterinary Services
0741	Veterinary services for livestock
0742	Veterinary services, specialties
075	Animal Services, Except Veterinary
0751	Livestock services, exc. veterinary
0752	Animal specialty services
076	Farm Labor and Management Services
0761	Farm labor contractors
0762	Farm management services
078	Landscape and Horticultural Services
0781	Landscape counseling and planning
0782	Lawn and garden services
0783	Ornamental shrub and tree services
08	FORESTRY
081	Timber Tracts
0811	Timber tracts
083	Forest Products
0831	Forest products
085	Forestry Services
0851	Forestry services
09	FISHING, HUNTING, AND TRAPPING
091	Commercial Fishing
0912	Finfish
0913	Shellfish
0919	Miscellaneous marine products
092	Fish Hatcheries and Preserves
0921	Fish hatcheries and preserves
097	Hunting, Trapping, Game Propagation
0971	Hunting, trapping, game propagation

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B. MINING

Code	Short Title
10	METAL MINING
101	Iron Ores
1011	Iron ores
102	Copper Ores
1021	Copper ores
103	Lead and Zinc Ores
1031	Lead and zinc ores
104	Gold and Silver Ores
1041	Gold ores
1044	Silver ores
106	Ferroalloy Ores, Except Vanadium
1061	Ferroalloy ores, except vanadium
108	Metal Mining Services
1081	Metal mining services
109	Miscellaneous Metal Ores
1094	Uranium-radium-vanadium ores
1099	Metal ores, nec
12	COAL MINING
122	Bituminous Coal and Lignite Mining
1221	Bituminous coal and lignite—surface
1222	Bituminous coal—underground
123	Anthracite Mining
1231	Anthracite mining
124	Coal Mining Services
1241	Coal mining services
13	OIL AND GAS EXTRACTION
131	Crude Petroleum and Natural Gas
1311	Crude petroleum and natural gas
132	Natural Gas Liquids
1321	Natural gas liquids
138	Oil and Gas Field Services
1381	Drilling oil and gas wells
1382	Oil and gas exploration services
1389	Oil and gas field services, nec
14	NONMETALLIC MINERALS, EXCEPT FUELS
141	Dimension Stone
1411	Dimension stone
142	Crushed and Broken Stone
1422	Crushed and broken limestone
1423	Crushed and broken granite
1429	Crushed and broken stone, nec
144	Sand and Gravel
1442	Construction sand and gravel
1446	Industrial sand
145	Clay, Ceramic, & Refractory Minerals
1455	Kaolin and ball clay
1459	Clay and related minerals, nec
147	Chemical and Fertilizer Minerals
1474	Potash, soda, and borate minerals
1475	Phosphate rock
1479	Chemical and fertilizer mining, nec
148	Nonmetallic Minerals Services
1481	Nonmetallic minerals services
149	Miscellaneous Nonmetallic Minerals
1499	Miscellaneous nonmetallic minerals

C. CONSTRUCTION

Code	Short Title
15	GENERAL BUILDING CONTRACTORS
152	Residential Building Construction
1521	Single-family housing construction
1522	Residential construction, nec
153	Operative Builders
1531	Operative builders
154	Nonresidential Building Construction
1541	Industrial buildings and warehouses
1542	Nonresidential construction, nec
16	HEAVY CONSTRUCTION, EX. BUILDING
161	Highway and Street Construction
1611	Highway and street construction
162	Heavy Construction, Except Highway
1622	Bridge, tunnel, & elevated highway
1623	Water, sewer, and utility lines
1629	Heavy construction, nec
17	SPECIAL TRADE CONTRACTORS
171	Plumbing, Heating, Air-Conditioning
1711	Plumbing, heating, air-conditioning
172	Painting and Paper Hanging
1721	Painting and paper hanging
173	Electrical Work
1731	Electrical work

Code	Short Title
174	Masonry, Stonework, and Plastering
1741	Masonry and other stonework
1742	Plastering, drywall, and insulation
1743	Terrazzo, tile, marble, mosaic work
175	Carpentry and Floor Work
1751	Carpentry work
1752	Floor laying and floor work, nec
176	Roofing, Siding, and Sheet Metal Work
1761	Roofing, siding, and sheet metal work
177	Concrete Work
1771	Concrete work
178	Water Well Drilling
1781	Water well drilling
179	Misc. Special Trade Contractors
1791	Structural steel erection
1793	Glass and glazing work
1794	Excavation work
1795	Wrecking and demolition work
1796	Installing building equipment, nec
1799	Special trade contractors, nec

D. MANUFACTURING

Code	Short Title
20	FOOD AND KINDRED PRODUCTS
201	Meat Products
2011	Meat packing plants
2013	Sausages and other prepared meats
2015	Poultry slaughtering and processing
202	Dairy Products
2021	Creamery butter
2022	Cheese, natural and processed
2023	Dry, condensed, evaporated products
2026	Ice cream and frozen desserts
2027	Fluid milk
203	Preserved Fruits and Vegetables
2032	Canned specialties
2033	Canned fruits and vegetables
2034	Dehydrated fruits, vegetables, soups
2035	Pickles, sauces, and salad dressings
2037	Frozen fruits and vegetables
2038	Frozen specialties, nec
204	Grain Mill Products
2041	Flour and other grain mill products
2043	Cereal breakfast foods
2044	Rice milling
2045	Prepared flour mixes and doughs
2046	Wet corn milling
2047	Dog and cat food
2048	Prepared feeds, nec
205	Bakery Products
2051	Bread, cake, and related products
2052	Cookies and crackers
2053	Frozen bakery products, except bread
206	Sugar and Confectionery Products
2061	Raw cane sugar
2062	Cane sugar refining
2063	Beet sugar
2064	Candy & other confectionery products
2066	Chocolate and cocoa products
2067	Chewing gum
2068	Salted and roasted nuts and seeds
207	Fats and Oils
2074	Cottonseed oil mills
2075	Soybean oil mills
2076	Vegetable oil mills, nec
2077	Animal and marine fats and oils
2079	Edible fats and oils, nec
208	Beverages
2082	Malt beverages
2083	Malt
2084	Wines, brandy, and brandy spirits
2085	Distilled and blended liquors
2086	Bottled and canned soft drinks
2087	Flavoring extracts and syrups, nec
209	Misc. Food and Kindred Products
2091	Canned and cured fish and seafoods
2092	Fresh or frozen prepared fish
2095	Roasted coffee
2096	Potato chips and similar snacks
2097	Manufactured ice
2098	Macaroni and spaghetti
2099	Food preparations, nec
21	TOBACCO PRODUCTS
211	Cigarettes
2111	Cigarettes
212	Cigars
2121	Cigars
213	Chewing and Smoking Tobacco
2131	Chewing and smoking tobacco
214	Tobacco Stemming and Redrying
2141	Tobacco stemming and redrying
22	TEXTILE MILL PRODUCTS
221	Broadwoven Fabric Mills, Cotton

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Code	Short Title
2211	Broadwoven fabric mills, cotton
222	Broadwoven Fabric Mills, Manmade
2221	Broadwoven fabric mills, manmade
223	Broadwoven Fabric Mills, Wool
2231	Broadwoven fabric mills, wool
224	Narrow Fabric Mills
2241	Narrow fabric mills
225	Knitting Mills
2251	Women's hosiery, except socks
2252	Hosiery, nec
2253	Knit outerwear mills
2254	Knit underwear mills
2257	Weft knit fabric mills
2258	Lace & warp knit fabric mills
2259	Knitting mills, nec
226	Textile Finishing, Except Wool
2261	Finishing plants, cotton
2262	Finishing plants, manmade
2269	Finishing plants, nec
227	Carpets and Rugs
2273	Carpets and rugs
228	Yarn and Thread Mills
2281	Yarn spinning mills
2282	Throwing and winding mills
2284	Thread mills
229	Miscellaneous Textile Goods
2296	Coated fabrics, not rubberized
2296	Tire cord and fabrics
2297	Nonwoven fabrics
2298	Cordage and twine
2299	Textile goods, nec
23	APPAREL AND OTHER TEXTILE PRODUCTS
231	Men's and Boys' Suits and Coats
2311	Men's and boys' suits and coats
232	Men's and Boys' Furnishings
2321	Men's and boys' shirts
2322	Men's & boys' underwear & nightwear
2323	Men's and boys' neckwear
2325	Men's and boys' trousers and slacks
2326	Men's and boys' work clothing
2329	Men's and boys' clothing, nec
233	Women's and Misses' Outerwear
2331	Women's & misses' blouses & shirts
2335	Women's, juniors', & misses' dresses
2337	Women's and misses' suits and coats
2339	Women's and misses' outerwear, nec
234	Women's and Children's Undergarments
2341	Women's and children's underwear
2342	Bras, girdles, and allied garments
235	Hats, Caps, and Millinery
2353	Hats, caps, and millinery
236	Girls' and Children's Outerwear
2361	Girls' & children's dresses, blouses
2369	Girls' and children's outerwear, nec
237	Fur Goods
2371	Fur goods
238	Miscellaneous Apparel and Accessories
2381	Fabric dress and work gloves
2384	Robes and dressing gowns
2386	Waterproof outerwear
2386	Leather and sheep-lined clothing
2387	Apparel belts
2389	Apparel and accessories, nec
239	Misc. Fabricated Textile Products
2391	Curtains and draperies
2392	Housefurnishings, nec
2393	Textile bags
2394	Canvas and related products
2395	Pleating and stitching
2396	Automotive and apparel trimmings
2397	Schiffli machine embroideries
2399	Fabricated textile products, nec
24	LUMBER AND WOOD PRODUCTS
241	Logging
2411	Logging
242	Sawmills and Planing Mills
2421	Sawmills and planing mills, general
2426	Hardwood dimension & flooring mills
2429	Special product sawmills, nec
243	Millwork, Plywood & Structural Members
2431	Millwork
2434	Wood kitchen cabinets
2435	Hardwood veneer and plywood
2436	Softwood veneer and plywood
2439	Structural wood members, nec
244	Wood Containers
2441	Nailed wood boxes and shook
2448	Wood pallets and skids
2449	Wood containers, nec
245	Wood Buildings and Mobile Homes
2451	Mobile homes
2452	Prefabricated wood buildings
249	Miscellaneous Wood Products
2491	Wood preserving
2493	Reconstituted wood products
2499	Wood products, nec
25	FURNITURE AND FIXTURES
251	Household Furniture
2511	Wood household furniture
2512	Upholstered household furniture
2514	Metal household furniture

Code	Short Title
2515	Mattresses and bedsprings
2517	Wood TV and radio cabinets
2519	Household furniture, nec
252	Office Furniture
2521	Wood office furniture
2522	Office furniture, except wood
253	Public Building & Related Furniture
2531	Public building & related furniture
254	Partitions and Fixtures
2541	Wood partitions and fixtures
2542	Partitions and fixtures, except wood
259	Miscellaneous Furniture and Fixtures
2591	Drapery hardware & blinds & shades
2599	Furniture and fixtures, nec
26	PAPER AND ALLIED PRODUCTS
261	Pulp Mills
2611	Pulp mills
262	Paper Mills
2621	Paper mills
263	Paperboard Mills
2631	Paperboard mills
265	Paperboard Containers and Boxes
2652	Setup paperboard boxes
2653	Corrugated and solid fiber boxes
2655	Fiber cans, drums & similar products
2656	Sanitary food containers
2657	Folding paperboard boxes
267	Misc. Converted Paper Products
2671	Paper coated & laminated, packaging
2672	Paper coated and laminated, nec
2673	Bags: plastics, laminated, & coated
2674	Bags: uncoated paper & multiwall
2675	Die-cut paper and board
2676	Sanitary paper products
2677	Envelopes
2678	Stationery products
2679	Converted paper products, nec
27	PRINTING AND PUBLISHING
271	Newspapers
2711	Newspapers
272	Periodicals
2721	Periodicals
273	Books
2731	Book publishing
2732	Book printing
274	Miscellaneous Publishing
2741	Miscellaneous publishing
275	Commercial Printing
2752	Commercial printing, lithographic
2754	Commercial printing, gravure
2759	Commercial printing, nec
276	Manifold Business Forms
2761	Manifold business forms
277	Greeting Cards
2771	Greeting cards
278	Blankbooks and Bookbinding
2782	Blankbooks and looseleaf binders
2789	Bookbinding and related work
279	Printing Trade Services
2791	Typesetting
2796	Platemaking services
28	CHEMICALS AND ALLIED PRODUCTS
281	Industrial Inorganic Chemicals
2812	Alkalies and chlorine
2813	Industrial gases
2816	Inorganic pigments
2819	Industrial inorganic chemicals, nec
282	Plastics Materials and Synthetics
2821	Plastics materials and resins
2822	Synthetic rubber
2823	Cellulosic manmade fibers
2824	Organic fibers, noncellulosic
283	Drugs
2833	Medicinals and botanicals
2834	Pharmaceutical preparations
2835	Diagnostic substances
2836	Biological products exc. diagnostic
284	Soap, Cleaners, and Toilet Goods
2841	Soap and other detergents
2842	Polishes and sanitation goods
2843	Surface active agents
2844	Toilet preparations
285	Paints and Allied Products
2851	Paints and allied products
286	Industrial Organic Chemicals
2861	Gum and wood chemicals
2865	Cyclic crudes and intermediates
2869	Industrial organic chemicals, nec
287	Agricultural Chemicals
2873	Nitrogenous fertilizers
2874	Phosphatic fertilizers
2875	Fertilizers, mixing only
2879	Agricultural chemicals, nec
289	Miscellaneous Chemical Products
2891	Adhesives and sealants
2892	Explosives
2893	Printing ink
2895	Carbon black
2899	Chemical preparations, nec

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Code	Short Title
29	**PETROLEUM AND COAL PRODUCTS**
291	Petroleum Refining
2911	Petroleum refining
295	Asphalt Paving and Roofing Materials
2951	Asphalt paving mixtures and blocks
2952	Asphalt felts and coatings
299	Misc. Petroleum and Coal Products
2992	Lubricating oils and greases
2999	Petroleum and coal products, nec
30	**RUBBER AND MISC. PLASTICS PRODUCTS**
301	Tires and Inner Tubes
3011	Tires and inner tubes
302	Rubber and Plastics Footwear
3021	Rubber and plastics footwear
305	Hose & Belting & Gaskets & Packing
3052	Rubber & plastics hose & belting
3053	Gaskets, packing and sealing devices
306	Fabricated Rubber Products, NEC
3061	Mechanical rubber goods
3069	Fabricated rubber products, nec
308	Miscellaneous Plastics Products, NEC
3081	Unsupported plastics film & sheet
3082	Unsupported plastics profile shapes
3083	Laminated plastics plate & sheet
3084	Plastics pipe
3085	Plastics bottles
3086	Plastics foam products
3087	Custom compound purchased resins
3088	Plastics plumbing fixtures
3089	Plastics products, nec
31	**LEATHER AND LEATHER PRODUCTS**
311	Leather Tanning and Finishing
3111	Leather tanning and finishing
313	Footwear Cut Stock
3131	Footwear cut stock
314	Footwear, Except Rubber
3142	House slippers
3143	Men's footwear, except athletic
3144	Women's footwear, except athletic
3149	Footwear, except rubber, nec
315	Leather Gloves and Mittens
3151	Leather gloves and mittens
316	Luggage
3161	Luggage
317	Handbags and Personal Leather Goods
3171	Women's handbags and purses
3172	Personal leather goods, nec
319	Leather Goods, NEC
3199	Leather goods, nec

Code	Short Title
32	**STONE, CLAY, AND GLASS PRODUCTS**
321	Flat Glass
3211	Flat glass
322	Glass and Glassware, Pressed or Blown
3221	Glass containers
3229	Pressed and blown glass, nec
323	Products of Purchased Glass
3231	Products of purchased glass
324	Cement, Hydraulic
3241	Cement, hydraulic
325	Structural Clay Products
3251	Brick and structural clay tile
3253	Ceramic wall and floor tile
3255	Clay refractories
3259	Structural clay products, nec
326	Pottery and Related Products
3261	Vitreous plumbing fixtures
3262	Vitreous china table & kitchenware
3263	Semivitreous table & kitchenware
3264	Porcelain electrical supplies
3269	Pottery products, nec
327	Concrete, Gypsum, and Plaster Products
3271	Concrete block and brick
3272	Concrete products, nec
3273	Ready mixed concrete
3274	Lime
3275	Gypsum products
328	Cut Stone and Stone Products
3281	Cut stone and stone products
329	Misc. Nonmetallic Mineral Products
3291	Abrasive products
3292	Asbestos products
3295	Minerals, ground or treated
3296	Mineral wool
3297	Nonclay refractories
3299	Nonmetallic mineral products, nec
33	**PRIMARY METAL INDUSTRIES**
331	Blast Furnaces and Basic Steel Products
3312	Blast furnaces and steel mills
3313	Electrometallurgical products
3315	Steel wire and related products
3316	Cold finishing of steel shapes
3317	Steel pipe and tubes
332	Iron and Steel Foundries
3321	Gray and ductile iron foundries
3322	Malleable iron foundries
3324	Steel investment foundries
3325	Steel foundries, nec
333	Primary Nonferrous Metals
3331	Primary copper
3334	Primary aluminum

Code	Short Title
3339	Primary nonferrous metals, nec
334	Secondary Nonferrous Metals
3341	Secondary nonferrous metals
335	Nonferrous Rolling and Drawing
3351	Copper rolling and drawing
3353	Aluminum sheet, plate, and foil
3354	Aluminum extruded products
3355	Aluminum rolling and drawing, nec
3356	Nonferrous rolling and drawing, nec
3357	Nonferrous wiredrawing & insulating
336	Nonferrous Foundries (Castings)
3363	Aluminum die-castings
3364	Nonferrous die-casting exc. aluminum
3365	Aluminum foundries
3366	Copper foundries
3369	Nonferrous foundries, nec
339	Miscellaneous Primary Metal Products
3398	Metal heat treating
3399	Primary metal products, nec
34	**FABRICATED METAL PRODUCTS**
341	Metal Cans and Shipping Containers
3411	Metal cans
3412	Metal barrels, drums, and pails
342	Cutlery, Handtools, and Hardware
3421	Cutlery
3423	Hand and edge tools, nec
3425	Saw blades and handsaws
3429	Hardware, nec
343	Plumbing and Heating, Except Electric
3431	Metal sanitary ware
3432	Plumbing fixture fittings and trim
3433	Heating equipment, except electric
344	Fabricated Structural Metal Products
3441	Fabricated structural metal
3442	Metal doors, sash, and trim
3443	Fabricated plate work (boiler shops)
3444	Sheet metal work
3446	Architectural metal work
3448	Prefabricated metal buildings
3449	Miscellaneous metal work
345	Screw Machine Products, Bolts, Etc.
3451	Screw machine products
3452	Bolts, nuts, rivets, and washers
346	Metal Forgings and Stampings
3462	Iron and steel forgings
3463	Nonferrous forgings
3465	Automotive stampings
3466	Crowns and closures
3469	Metal stampings, nec
347	Metal Services, NEC
3471	Plating and polishing
3479	Metal coating and allied services

Code	Short Title
348	Ordnance and Accessories, NEC
3482	Small arms ammunition
3483	Ammunition, exc. for small arms, nec
3484	Small arms
3489	Ordnance and accessories, nec
349	Misc. Fabricated Metal Products
3491	Industrial valves
3492	Fluid power valves & hose fittings
3493	Steel springs, except wire
3494	Valves and pipe fittings, nec
3496	Wire springs
3498	Misc. fabricated wire products
3497	Metal foil and leaf
3498	Fabricated pipe and fittings
3499	Fabricated metal products, nec
35	**INDUSTRIAL MACHINERY AND EQUIPMENT**
351	Engines and Turbines
3511	Turbines and turbine generator sets
3519	Internal combustion engines, nec
352	Farm and Garden Machinery
3523	Farm machinery and equipment
3524	Lawn and garden equipment
353	Construction and Related Machinery
3531	Construction machinery
3532	Mining machinery
3533	Oil and gas field machinery
3534	Elevators and moving stairways
3535	Conveyors and conveying equipment
3536	Hoists, cranes, and monorails
3537	Industrial trucks and tractors
354	Metalworking Machinery
3541	Machine tools, metal cutting types
3542	Machine tools, metal forming types
3543	Industrial patterns
3544	Special dies, tools, jigs & fixtures
3545	Machine tool accessories
3546	Power-driven handtools
3547	Rolling mill machinery
3548	Welding apparatus
3549	Metalworking machinery, nec
356	Special Industry Machinery
3552	Textile machinery
3553	Woodworking machinery
3554	Paper industries machinery
3555	Printing trades machinery
3556	Food products machinery
3559	Special industry machinery, nec
356	General Industrial Machinery
3561	Pumps and pumping equipment
3562	Ball and roller bearings
3563	Air and gas compressors

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Code	Short Title
3564	Blowers and fans
3565	Packaging machinery
3566	Speed changers, drives, and gears
3567	Industrial furnaces and ovens
3568	Power transmission equipment, nec
3569	General industrial machinery, nec
357	Computer and Office Equipment
3571	Electronic computers
3572	Computer storage devices
3575	Computer terminals
3577	Computer peripheral equipment, nec
3578	Calculating and accounting equipment
3579	Office machines, nec
358	Refrigeration and Service Machinery
3581	Automatic vending machines
3582	Commercial laundry equipment
3585	Refrigeration and heating equipment
3586	Measuring and dispensing pumps
3589	Service industry machinery, nec
359	Industrial Machinery, NEC
3592	Carburetors, pistons, rings, valves
3593	Fluid power cylinders & actuators
3594	Fluid power pumps and motors
3596	Scales and balances, exc. laboratory
3599	Industrial machinery, nec
36	ELECTRONIC & OTHER ELECTRIC EQUIPMENT
361	Electric Distribution Equipment
3612	Transformers, except electronic
3613	Switchgear and switchboard apparatus
362	Electrical Industrial Apparatus
3621	Motors and generators
3624	Carbon and graphite products
3625	Relays and industrial controls
3629	Electrical industrial apparatus, nec
363	Household Appliances
3631	Household cooking equipment
3632	Household refrigerators and freezers
3633	Household laundry equipment
3634	Electric housewares and fans
3635	Household vacuum cleaners
3639	Household appliances nec
364	Electric Lighting and Wiring Equipment
3641	Electric lamps
3643	Current carrying wiring devices
3644	Noncurrent-carrying wiring devices
3645	Residential lighting fixtures
3646	Commercial lighting fixtures
3647	Vehicular lighting equipment
3648	Lighting equipment, nec
365	Household Audio and Video Equipment
3651	Household audio and video equipment
3652	Prerecorded records and tapes
366	Communications Equipment
3661	Telephone and telegraph apparatus
3663	Radio & TV communications equipment
3669	Communications equipment, nec
367	Electronic Components and Accessories
3671	Electron tubes
3672	Printed circuit boards
3674	Semiconductors and related devices
3675	Electronic capacitors
3676	Electronic resistors
3677	Electronic coils and transformers
3678	Electronic connectors
3679	Electronic components, nec
369	Misc. Electrical Equipment & Supplies
3691	Storage batteries
3692	Primary batteries, dry and wet
3694	Engine electrical equipment
3695	Magnetic and optical recording media
3699	Electrical equipment & supplies, nec
37	TRANSPORTATION EQUIPMENT
371	Motor Vehicles and Equipment
3711	Motor vehicles and car bodies
3713	Truck and bus bodies
3714	Motor vehicle parts and accessories
3715	Truck trailers
3716	Motor homes
372	Aircraft and Parts
3721	Aircraft
3724	Aircraft engines and engine parts
3728	Aircraft parts and equipment, nec
373	Ship and Boat Building and Repairing
3731	Ship building and repairing
3732	Boat building and repairing
374	Railroad Equipment
3743	Railroad equipment
375	Motorcycles, Bicycles, and Parts
3751	Motorcycles, bicycles, and parts
376	Guided Missiles, Space Vehicles, Parts
3761	Guided missiles and space vehicles
3764	Space propulsion units and parts
3769	Space vehicle equipment, nec
379	Miscellaneous Transportation Equipment
3792	Travel trailers and campers
3795	Tanks and tank components
3799	Transportation equipment, nec
38	INSTRUMENTS AND RELATED PRODUCTS
381	Search and Navigation Equipment
3812	Search and navigation equipment

Code	Short Title
382	Measuring and Controlling Devices
3821	Laboratory apparatus and furniture
3822	Environmental controls
3823	Process control instruments
3824	Fluid meters and counting devices
3825	Instruments to measure electricity
3826	Analytical instruments
3827	Optical instruments and lenses
3829	Measuring & controlling devices, nec
384	Medical Instruments and Supplies
3841	Surgical and medical instruments
3842	Surgical appliances and supplies
3843	Dental equipment and supplies
3844	X-ray apparatus and tubes
3845	Electromedical equipment
385	Ophthalmic Goods
3851	Ophthalmic goods
386	Photographic Equipment and Supplies
3861	Photographic equipment and supplies
387	Watches, Clocks, Watchcases & Parts
3873	Watches, clocks, watchcases & parts
39	MISCELLANEOUS MANUFACTURING INDUSTRIES
391	Jewelry, Silverware, and Plated Ware
3911	Jewelry, precious metal
3914	Silverware and plated ware
3915	Jewelers' materials & lapidary work
393	Musical Instruments
3931	Musical instruments
394	Toys and Sporting Goods
3942	Dolls and stuffed toys
3944	Games, toys, and children's vehicles
3949	Sporting and athletic goods, nec
395	Pens, Pencils, Office, & Art Supplies
3951	Pens and mechanical pencils
3952	Lead pencils and art goods
3953	Marking devices
3955	Carbon paper and inked ribbons
396	Costume Jewelry and Notions
3961	Costume jewelry
3965	Fasteners, buttons, needles, & pins
399	Miscellaneous Manufactures
3991	Brooms and brushes
3993	Signs and advertising specialties
3995	Burial caskets
3996	Hard surface floor coverings, nec
3999	Manufacturing industries, nec

E. TRANSPORTATION AND PUBLIC UTILITIES

Code	Short Title
40	RAILROAD TRANSPORTATION
401	Railroads
4011	Railroads, line-haul operating
4013	Switching and terminal services
41	LOCAL AND INTERURBAN PASSENGER TRANSIT
411	Local and Suburban Transportation
4111	Local and suburban transit
4119	Local passenger transportation, nec
412	Taxicabs
4121	Taxicabs
413	Intercity and Rural Bus Transportation
4131	Intercity & rural bus transportation
414	Bus Charter Service
4141	Local bus charter service
4142	Bus charter service, except local
415	School Buses
4151	School buses
417	Bus Terminal and Service Facilities
4173	Bus terminal and service facilities
42	TRUCKING AND WAREHOUSING
421	Trucking & Courier Services, Ex. Air
4212	Local trucking, without storage
4213	Trucking, except local
4214	Local trucking with storage
4215	Courier services, except by air
422	Public Warehousing and Storage
4221	Farm product warehousing and storage
4222	Refrigerated warehousing and storage
4225	General warehousing and storage
4226	Special warehousing and storage, nec
423	Trucking Terminal Facilities
4231	Trucking terminal facilities
43	U.S. POSTAL SERVICE
431	U.S. Postal Service
4311	U.S. Postal Service
44	WATER TRANSPORTATION
441	Deep Sea Foreign Trans. of Freight
4412	Deep sea foreign trans. of freight

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Code	Short Title
442	Deep Sea Domestic Trans. of Freight
4424	Deep sea domestic trans. of freight
443	Freight Trans. on the Great Lakes
4432	Freight trans. on the Great Lakes
444	Water Transportation of Freight, NEC
4449	Water transportation of freight, nec
448	Water Transportation of Passengers
4481	Deep sea passenger trans., ex ferry
4482	Ferries
4489	Water passenger transportation, nec
449	Water Transportation Services
4491	Marine cargo handling
4492	Towing and tugboat service
4493	Marinas
4499	Water transportation services, nec
45	TRANSPORTATION BY AIR
451	Air Transportation, Scheduled
4512	Air transportation, scheduled
4513	Air courier services
452	Air Transportation, Nonscheduled
4522	Air transportation, nonscheduled
458	Airports, Flying Fields, & Services
4581	Airports, flying fields, & services
46	PIPELINES, EXCEPT NATURAL GAS
461	Pipelines, Except Natural Gas
4612	Crude petroleum pipelines
4613	Refined petroleum pipelines
4619	Pipelines, nec
47	TRANSPORTATION SERVICES
472	Passenger Transportation Arrangement
4724	Travel agencies
4725	Tour operators
4729	Passenger transport arrangement, nec
473	Freight Transportation Arrangement
4731	Freight transportation arrangement
474	Rental of Railroad Cars
4741	Rental of railroad cars
478	Miscellaneous Transportation Services
4783	Packing and crating
4785	Inspection & fixed facilities
4789	Transportation services, nec
48	COMMUNICATIONS
481	Telephone Communications
4812	Radiotelephone communications
4813	Telephone communications, exc. radio
482	Telegraph & Other Communications
4822	Telegraph & other communications
483	Radio and Television Broadcasting
4832	Radio broadcasting stations
4833	Television broadcasting stations
484	Cable and Other Pay TV Services
4841	Cable and other pay TV services
489	Communications Services, NEC
4899	Communications services, nec
49	ELECTRIC, GAS, AND SANITARY SERVICES
491	Electric Services
4911	Electric services
492	Gas Production and Distribution
4922	Natural gas transmission
4923	Gas transmission and distribution
4924	Natural gas distribution
4925	Gas production and/or distribution
493	Combination Utility Services
4931	Electric and other services combined
4932	Gas and other services combined
4939	Combination utilities, nec
494	Water Supply
4941	Water supply
495	Sanitary Services
4952	Sewerage systems
4953	Refuse systems
4959	Sanitary services, nec
496	Steam and Air-Conditioning Supply
4961	Steam and air-conditioning supply
497	Irrigation Systems
4971	Irrigation systems

F. WHOLESALE TRADE

Code	Short Title
50	WHOLESALE TRADE—DURABLE GOODS
501	Motor Vehicles, Parts, and Supplies
5012	Automobiles and other motor vehicles
5013	Motor vehicle supplies and new parts
5014	Tires and tubes
5015	Motor vehicle parts, used

Code	Short Title
502	Furniture and Homefurnishings
5021	Furniture
5023	Homefurnishings
503	Lumber and Construction Materials
5031	Lumber, plywood, and millwork
5032	Brick, stone, & related materials
5033	Roofing, siding, & insulation
5039	Construction materials, nec
504	Professional & Commercial Equipment
5043	Photographic equipment and supplies
5044	Office equipment
5045	Computers, peripherals & software
5046	Commercial equipment, nec
5047	Medical and hospital equipment
5048	Ophthalmic goods
5049	Professional equipment, nec
505	Metals and Minerals, Except Petroleum
5051	Metals service centers and offices
5052	Coal and other minerals and ores
506	Electrical Goods
5063	Electrical apparatus and equipment
5064	Electrical appliances, TV & radios
5065	Electronic parts and equipment
507	Hardware, Plumbing & Heating Equipment
5072	Hardware
5074	Plumbing & hydronic heating supplies
5075	Warm air heating & air-conditioning
5078	Refrigeration equipment and supplies
508	Machinery, Equipment, and Supplies
5082	Construction and mining machinery
5083	Farm and garden machinery
5084	Industrial machinery and equipment
5085	Industrial supplies
5087	Service establishment equipment
5088	Transportation equipment & supplies
509	Miscellaneous Durable Goods
5091	Sporting & recreational goods
5092	Toys and hobby goods and supplies
5093	Scrap and waste materials
5094	Jewelry & precious stones
5099	Durable goods, nec
51	WHOLESALE TRADE—NONDURABLE GOODS
511	Paper and Paper Products
5111	Printing and writing paper
5112	Stationery and office supplies
5113	Industrial & personal service paper
512	Drugs, Proprietaries, and Sundries
5122	Drugs, proprietaries, and sundries
513	Apparel, Piece Goods, and Notions
5131	Piece goods & notions
5136	Men's and boys' clothing
5137	Women's and children's clothing
5139	Footwear
514	Groceries and Related Products
5141	Groceries, general line
5142	Packaged frozen foods
5143	Dairy products, exc. dried or canned
5144	Poultry and poultry products
5145	Confectionery
5146	Fish and seafoods
5147	Meats and meat products
5148	Fresh fruits and vegetables
5149	Groceries and related products, nec
515	Farm-Product Raw Materials
5153	Grain and field beans
5154	Livestock
5159	Farm-product raw materials, nec
516	Chemicals and Allied Products
5162	Plastics materials & basic shapes
5169	Chemicals & allied products, nec
517	Petroleum and Petroleum Products
5171	Petroleum bulk stations & terminals
5172	Petroleum products, nec
518	Beer, Wine, and Distilled Beverages
5181	Beer and ale
5182	Wine and distilled beverages
519	Misc. Nondurable Goods
5191	Farm supplies
5192	Books, periodicals, & newspapers
5193	Flowers & florists' supplies
5194	Tobacco and tobacco products
5198	Paints, varnishes, and supplies
5199	Nondurable goods, nec

G. RETAIL TRADE

Code	Short Title
52	BUILDING MATERIALS & GARDEN SUPPLIES
521	Lumber and Other Building Materials
5211	Lumber and other building materials
523	Paint, Glass, and Wallpaper Stores
5231	Paint, glass, and wallpaper stores
525	Hardware Stores
5251	Hardware stores
526	Retail Nurseries and Garden Stores

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Code	Short Title
5761	Retail nurseries and garden stores
527	Mobile Home Dealers
5271	Mobile home dealers
53	GENERAL MERCHANDISE STORES
531	Department Stores
5311	Department stores
533	Variety Stores
5331	Variety stores
539	Misc. General Merchandise Stores
5399	Misc. general merchandise stores
54	FOOD STORES
541	Grocery Stores
5411	Grocery stores
542	Meat and Fish Markets
5421	Meat and fish markets
543	Fruit and Vegetable Markets
5431	Fruit and vegetable markets
544	Candy, Nut, and Confectionery Stores
5441	Candy, nut, and confectionery stores
545	Dairy Products Stores
5451	Dairy products stores
546	Retail Bakeries
5461	Retail bakeries
549	Miscellaneous Food Stores
5499	Miscellaneous food stores
55	AUTOMOTIVE DEALERS & SERVICE STATIONS
551	New and Used Car Dealers
5511	New and used car dealers
552	Used Car Dealers
5521	Used car dealers
553	Auto and Home Supply Stores
5531	Auto and home supply stores
554	Gasoline Service Stations
5541	Gasoline service stations
556	Boat Dealers
5551	Boat dealers
558	Recreational Vehicle Dealers
5561	Recreational vehicle dealers
557	Motorcycle Dealers
5571	Motorcycle dealers
559	Automotive Dealers, NEC
5599	Automotive dealers, nec
56	APPAREL AND ACCESSORY STORES
561	Men's & Boys' Clothing Stores
5611	Men's & boys' clothing stores
562	Women's Clothing Stores
5621	Women's clothing stores
563	Women's Accessory & Specialty Stores
5632	Women's accessory & specialty stores
564	Children's and Infants' Wear Stores
5641	Children's and infants' wear stores
565	Family Clothing Stores
5651	Family clothing stores
566	Shoe Stores
5661	Shoe stores
569	Misc. Apparel & Accessory Stores
5699	Misc. apparel & accessory stores
57	FURNITURE AND HOMEFURNISHINGS STORES
571	Furniture and Homefurnishings Stores
5712	Furniture stores
5713	Floor covering stores
5714	Drapery and upholstery stores
5719	Misc. homefurnishings stores
572	Household Appliance Stores
5722	Household appliance stores
573	Radio, Television, & Computer Stores
5731	Radio, TV, & electronic stores
5734	Computer and software stores
5735	Record & prerecorded tape stores
5736	Musical instrument stores
58	EATING AND DRINKING PLACES
581	Eating and Drinking Places
5812	Eating places
5813	Drinking places
59	MISCELLANEOUS RETAIL
591	Drug Stores and Proprietary Stores
5912	Drug stores and proprietary stores
592	Liquor Stores
5921	Liquor stores
593	Used Merchandise Stores
5932	Used merchandise stores
594	Miscellaneous Shopping Goods Stores
5941	Sporting goods and bicycle shops
5942	Book stores
5943	Stationery stores
5944	Jewelry stores
5945	Hobby, toy, and game shops
5946	Camera & photographic supply stores
5947	Gift, novelty, and souvenir shops
5948	Luggage and leather goods stores
5949	Sewing, needlework, and piece goods
596	Nonstore Retailers
5961	Catalog and mail-order houses
5962	Merchandising machine operators

Code	Short Title
5963	Direct selling establishments
598	Fuel Dealers
5983	Fuel oil dealers
5984	Liquefied petroleum gas dealers
5989	Fuel dealers, nec
599	Retail Stores, NEC
5992	Florists
5993	Tobacco stores and stands
5994	News dealers and newsstands
5995	Optical goods stores
5999	Miscellaneous retail stores, nec

H. FINANCE, INSURANCE, AND REAL ESTATE

Code	Short Title
60	DEPOSITORY INSTITUTIONS
601	Central Reserve Depositories
6011	Federal reserve banks
6019	Central reserve depository, nec
602	Commercial Banks
6021	National commercial banks
6022	State commercial banks
6029	Commercial banks, nec
603	Savings Institutions
6035	Federal savings institutions
6036	Savings institutions, except federal
606	Credit Unions
6061	Federal credit unions
6062	State credit unions
608	Foreign Bank & Branches & Agencies
6081	Foreign bank & branches & agencies
6082	Foreign trade & international banks
609	Functions Closely Related to Banking
6091	Nondeposit trust facilities
6099	Functions related to deposit banking
61	NONDEPOSITORY INSTITUTIONS
611	Federal & Fed.-Sponsored Credit
6111	Federal & fed sponsored credit
614	Personal Credit Institutions
6141	Personal credit institutions
615	Business Credit Institutions
6153	Short-term business credit
6159	Misc. business credit institutions
616	Mortgage Bankers and Brokers
6162	Mortgage bankers and correspondents
6163	Loan brokers
62	SECURITY AND COMMODITY BROKERS
621	Security Brokers and Dealers
6211	Security brokers and dealers
622	Commodity Contracts Brokers, Dealers
6221	Commodity contracts brokers, dealers
623	Security and Commodity Exchanges
6231	Security and commodity exchanges
628	Security and Commodity Services
6282	Investment advice
6289	Security & commodity services, nec
63	INSURANCE CARRIERS
631	Life Insurance
6311	Life insurance
632	Medical Service and Health Insurance
6321	Accident and health insurance
6324	Hospital and medical service plans
633	Fire, Marine, and Casualty Insurance
6331	Fire, marine, and casualty insurance
636	Surety Insurance
6361	Surety insurance
636	Title Insurance
6361	Title insurance
637	Pension, Health, and Welfare Funds
6371	Pension, health, and welfare funds
639	Insurance Carriers, NEC
6399	Insurance carriers, nec
64	INSURANCE AGENTS, BROKERS, & SERVICE
641	Insurance Agents, Brokers, & Service
6411	Insurance agents, brokers, & service
65	REAL ESTATE
651	Real Estate Operators and Lessors
6512	Nonresidential building operators
6513	Apartment building operators
6514	Dwelling operators, exc apartments
6515	Mobile home site operators
6517	Railroad property lessors
6519	Real property lessors, nec
653	Real Estate Agents and Managers
6531	Real estate agents and managers
654	Title Abstract Offices
6541	Title abstract offices
655	Subdividers and Developers

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Code	Short Title
6552	Subdividers and developers, nec
6553	Cemetery subdividers and developers
67	HOLDING AND OTHER INVESTMENT OFFICES
671	Holding Offices
6712	Bank holding companies
6719	Holding companies, nec
672	Investment Offices
6722	Management investment, open-end
6726	Investment offices, nec
673	Trusts
6732	Educational, religious, etc. trusts
6733	Trusts, nec
679	Miscellaneous Investing
6792	Oil royalty traders
6794	Patent owners and lessors
6798	Real estate investment trusts
6799	Investors, nec

I. SERVICES

Code	Short Title
70	HOTELS AND OTHER LODGING PLACES
701	Hotels and Motels
7011	Hotels and motels
702	Rooming and Boarding Houses
7021	Rooming and boarding houses
703	Camps and Recreational Vehicle Parks
7032	Sporting and recreational camps
7033	Trailer parks and campsites
704	Membership-Basis Organization Hotels
7041	Membership-basis organization hotels
72	PERSONAL SERVICES
721	Laundry, Cleaning, & Garment Services
7211	Power laundries, family & commercial
7212	Garment pressing & cleaners' agents
7213	Linen supply
7215	Coin-operated laundries and cleaning
7216	Drycleaning plants, except rug
7217	Carpet and upholstery cleaning
7219	Industrial launderers
7219	Laundry and garment services, nec
722	Photographic Studios, Portrait
7221	Photographic studios, portrait
723	Beauty Shops
7231	Beauty shops
724	Barber Shops
7241	Barber shops
725	Shoe Repair and Shoeshine Parlors
7251	Shoe repair and shoeshine parlors
726	Funeral Service and Crematories
7261	Funeral service and crematories
729	Miscellaneous Personal Services
7291	Tax return preparation services
7299	Miscellaneous personal services, nec
73	BUSINESS SERVICES
731	Advertising
7311	Advertising agencies
7312	Outdoor advertising services
7313	Radio, TV, publisher representatives
7319	Advertising, nec
732	Credit Reporting and Collection
7322	Adjustment & collection services
7323	Credit reporting services
733	Mailing, Reproduction, Stenographic
7331	Direct mail advertising services
7334	Photocopying & duplicating services
7335	Commercial photography
7336	Commercial art and graphic design
7338	Secretarial & court reporting
734	Services to Buildings
7342	Disinfecting & pest control services
7349	Building maintenance services, nec
735	Misc. Equipment Rental & Leasing
7352	Medical equipment rental
7353	Heavy construction equipment rental
7359	Equipment rental & leasing, nec
736	Personnel Supply Services
7361	Employment agencies
7363	Help supply services
737	Computer and Data Processing Services
7371	Computer programming services
7372	Prepackaged software
7373	Computer integrated systems design
7374	Data processing and preparation
7375	Information retrieval services
7376	Computer facilities management
7377	Computer rental & leasing
7378	Computer maintenance & repair
7379	Computer related services, nec
738	Miscellaneous Business Services
7381	Detective & armored car services

Code	Short Title
7382	Security systems services
7383	News syndicates
7384	Photofinishing laboratories
7389	Business services, nec
75	AUTO REPAIR, SERVICES, AND PARKING
751	Automotive Rentals, No Drivers
7513	Truck rental and leasing, no drivers
7514	Passenger car rental
7515	Passenger car leasing
7519	Utility trailer rental
752	Automobile Parking
7521	Automobile parking
753	Automotive Repair Shops
7532	Top & body repair & paint shops
7533	Auto exhaust system repair shops
7534	Tire retreading and repair shops
7536	Automotive glass replacement shops
7537	Automotive transmission repair shops
7538	General automotive repair shops
7539	Automotive repair shops, nec
754	Automotive Services, Except Repair
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811	Legal Services

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INDUSTRIAL STORM WATER HANDBOOK

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SANTA CLARA VALLEY NPS INDUSTRIAL STORM WATER HANDBOOK

THE SANTA CLARA VALLEY
NONPOINT SOURCE POLLUTION CONTROL PROGRAM
STEP-BY-STEP GUIDANCE FOR COMPLYING WITH
THE REGIONAL WATER QUALITY CONTROL BOARD'S
INDUSTRIAL STORM WATER GENERAL PERMIT

2 6144



Santa Clara Valley
Nonpoint Source
Pollution Control Program

PROGRAM PARTICIPANTS:
Campbell, Cupertino, Los Altos, Los Altos Hills, Los Gatos, Milpitas, Monte Sereno, Mountain View, Palo Alto, San Jose, Santa Clara, Saratoga, Sunnyvale, County of Santa Clara, and the Santa Clara Valley Water District

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GUIDANCE HANDBOOK

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What is the Regional Board's Industrial Storm Water General Permit?

2. COMPLIANCE REQUIREMENTS
Do you need to comply? Overview, components, schedule, and deadlines

3. NOI: THE NOTICE OF INTENT TO COMPLY
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7. STORM WATER DISCHARGE MONITORING
Preparing a Monitoring Program, sampling in the field, and analyzing results

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1. INTRODUCTION

The Industrial Storm Water General Permit is the latest in a long series of efforts that are being used to prevent contaminants from moving with storm water into surface waters of the U.S. The information in this handbook specifically refers to the General Permit for the Santa Clara Valley. The handbook is intended to help operators of industrial facilities in the Santa Clara Valley to control pollutants that may enter storm water and to comply with the General Permit.

In January 1992, the General Permit was adopted by the California Regional Water Quality Control Board, San Francisco Bay Region. This agency, referred to as the Regional Board throughout this handbook, is a state agency empowered to administer and enforce water pollution control programs in the San Francisco Bay area.

The Regional Board's regulations were adopted pursuant to regulatory requirements of the U.S. Environmental Protection Agency under the federal Clean Water Act. This means that the regulations are subject to enforcement under the terms of U.S. federal law, with the same incentives and penalties that are provided by other regulations under the Clean Water Act. At their most severe, Clean Water Act penalties include fines of up to $25,000 per day per violation plus jail time.

The storm water regulations that the Regional Board adopted are contained in an NPDES Storm Water General Permit, Order Number 92-011. This order is referred to throughout this document as the General Permit. The General Permit is written in a way that applies to a large number of facilities in the Santa Clara Valley. Your facility needs to be covered if it has one or more *industrial activities which are exposed to storm water*. This phrase has a specific definition under the regulations, and is explained in detail in Section 2 of this handbook.

The General Permit defines facilities that need to be covered as *dischargers of storm water associated with industrial activities, or dischargers*. If your facility needs to be covered, you are required to file a Notice of Intent by April 30, 1992. If your facility meets the definitions in the General Permit and you do not file an NOI, you will be considered to be *discharging industrial storm water without a permit.*

If you need to comply with the General Permit, you are required to prepare a Storm Water Pollution Prevention Plan (SWPP Plan) and a Storm Water Monitoring Program by October 1, 1992. Dischargers will be required to file an annual permit fee of $250. The requirements of this permit will be in effect until January 15, 1997. It may be renewed and possibly revised at that time.

If you operate an industrial facility in Santa Clara Valley and are only recently becoming aware of new storm water requirements, you should understand that you are not alone. A similar General Permit that applies to other parts of California was adopted by the State Water Resources Control Board. In other states, industrial facilities are regulated either by state agencies or U.S. EPA regulations, and they may be subject to different requirements than California facilities. Throughout the United States, industrial facilities will be required within the next year or two to implement storm water pollution controls similar to the ones required by the Santa Clara Valley General Permit.

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ORGANIZATION OF THIS HANDBOOK

The purpose of this handbook is to provide guidance to industrial facilities which are covered by the General Permit in their efforts to comply with those regulations.

Section 2 provides some detailed guidelines on how to determine whether your facility needs to be covered under the General Permit. The *concept* of "who should be covered" is straightforward: Facilities that conduct industrial operations should manage all storm water that may contact those operations. The *legal definition*, and the method for determining whether a specific facility meets that definition, is not so straightforward for many facilities. If you have any doubt whether you need to be covered, refer to Section 2.

Section 2 also provides an overview of the General Permit, including the schedule and deadlines for conducting required investigations and completing required compliance documents.

The other sections of the handbook each describe a compliance document that is required by the General Permit. Section 3 discusses the Notice of Intent, or NOI. A facility's operators need to submit an NOI to demonstrate that they understand the facility is covered by the General Permit. The NOI also commits the operators to complying with the regulations.

Sections 4, 5, and 6 describe the three parts of the Storm Water Pollution Prevention Plan, or SWPP Plan, that each regulated facility needs to prepare. Section 4 gives guidance to help you identify potential sources of storm water pollutants related to your facility's industrial activities, and for completing the Source Identification, SWPP Plan Part 1.

Section 5 describes the SWPP Plan Part 2, which will identify the Storm Water Management Controls that the individual facility will implement. (These controls are also widely known as Best Management Practices, or BMPs.)

Section 6 of this handbook contains information on how to inspect your facility for improper discharges of non-storm water to the storm drain system. This certification is required to complete the SWPP Plan Part 3: a legally-binding certification that you have identified and eliminated all improper discharges.

Section 7 describes how you can meet the requirements for a Monitoring Program. Your facility's Monitoring Program will outline the times and locations at which you intend to collect storm water samples on site, and the chemical parameters you will test the samples for in a laboratory analysis. The section also describes how to report the results to the Regional Board.

THE SANTA CLARA VALLEY NPS PROGRAM

The handbook has been prepared by the Santa Clara Valley Nonpoint Source Pollution Control Program, or NPS Program. All information in this handbook is provided by the NPS Program purely as guidance, and does not have the weight of regulation or the explicit approval of the Regional Board. However, we have closely analyzed the Regional Board's regulations and received ongoing clarification of their intent. The information in this handbook is our best judgment of effective means to comply with the letter and the spirit of the regulations. This handbook will be modified occasionally as regulations and compliance procedures continue to evolve under the Regional Board's actions.

The Program's intent is to help industrial facilities control storm water pollutants from their sites in the most effective way possible, while also helping businesses to comply with their regulatory requirements under the General Permit.

In this way the NPS Program will help reduce pollutants that enter the South San Francisco Bay in storm water. The NPS Program is an association of 15 agencies in Santa Clara County,

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including 11 cities, 2 towns, the County government, and the Santa Clara Valley Water District. You can get more information about the Program's activities and further guidance about information contained in this handbook by calling 1-800-794-2482.

Controlling pollutants in storm water has been an important concern in the Bay Area, and in the Santa Clara Valley in particular, since the late 1980s. If you received this handbook as part of the Program's binder at a Workshop in March 1992, a more detailed description of the regulatory development history is available in the binder.

The Santa Clara Valley Nonpoint Source Pollution Control Program

Program participants.

City of Campbell
City of Cupertino
City of Los Altos
Town of Los Altos Hills
Town of Los Gatos
City of Milpitas
City of Monte Sereno
City of Mountain View
City of Palo Alto
City of San Jose
City of Santa Clara
City of Saratoga
City of Sunnyvale
Santa Clara County
Santa Clara Valley Water District

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2. WHO MUST COMPLY? GENERAL PERMIT OVERVIEW

The January 1992 General Permit applies to many industrial facilities.

A general permit is unlike other environmental regulatory permits in a number of ways. The most striking difference is that the regulated facility does not individually apply for a permit, does not commit to site-specific compliance actions specified in advance by a regulatory agency, and does not receive a document that states it is "in compliance." In this respect, the General Permit is somewhat akin to the Permit by Rule regulations that California EPA has issued for some hazardous waste facilities.

Instead, the operators of a regulated facility need only to file a Notice of Intent, or NOI. By filing this NOI, the operators state that they understand they are covered by the regulation, and they commit to identifying and implementing whatever actions are necessary for their facility. The individual facility does not have site-specific numerical effluent discharge standards for concentration of pollutants in the storm water it discharges.

The standards specify only that facility operators must prevent storm water pollution "to the maximum extent practicable." Under this performance requirement, dischargers are expected to implement structural and non-structural "Best Management Practices" or BMPs. BMPs are measures ranging from employee training to covering waste storage areas which will keep pollutants out of storm water discharges. BMPs are discussed in Section 5 of this handbook, and in a separate BMP Manual developed by the NPS Program. (Additional standards that might apply to some facilities specify water quality standards for streams or creeks that receive their discharges.)

The Santa Clara Valley Industrial Storm Water General Permit

Effective date:
January 15, 1992

Regulating agency:
The San Francisco Bay Regional Water Quality Control Board (the Regional Board)

Conforming to regulations from:
- The California State Water Resources Control Board
- The U.S. Environmental Protection Agency

Regulated community:
- All manufacturing facilities
  some mandatory, other conditional
- Certain other industrial facilities

See Part I of this section for further definitions

Regulatory purpose:
To prevent contamination of surface waters by pollutants carried in "storm water associated with industrial activity"
(As defined by the regulation)

Principal requirements:
- Submit Notice of Intent, April 30, 1992
- Eliminate non-storm water discharges to storm drains, July 1, 1992
- Prepare and implement Storm Water Pollution Prevention Plan (SWPP Plan), October 1, 1992
- Prepare Monitoring Plan, October 1, 1992
- Collect and chemically analyze samples of storm water runoff from industrial sites, twice a year beginning October 1, 1992
- Submit annual fee of $250 to the State Board

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The General Permit is unlike the Permit by Rule approach in one respect: Permit by Rule does not require any site-specific compliance documents, but the General Permit requires the operators of the facility to prepare two site-specific documents, the Storm Water Pollution Prevention Plan (SWPP Plan) and the Monitoring Plan.

The advantage is that while each facility is automatically covered by the same General Permit, each facility's operators may design compliance plans that are tailored to the needs of the individual facility. A large heavy manufacturing facility with outdoor machinery may need a much more comprehensive plan than a small manufacturer with all the operations under a single roof. The Regional Board is free to accept any plan that it feels does an adequate job of preventing pollutants from reaching storm water. It does not need to force every facility to stick firmly to arbitrary guidelines that may be very costly and not effective at storm water pollution control for some smaller or "cleaner" facilities.

A disadvantage of the general permit approach, from the viewpoint of the regulated facility, is that the facility never receives a "stamp of approval" from the Regional Board: the facility does not receive a document that is verified to be complete and sufficient for the life of a permit. As a result, the covered facility must certify that *from this point forward* the facility's operators will work in good faith to install, maintain, and operate whatever physical or operational controls are necessary, to the best of their ability, to prevent pollutants from leaving the site with storm water.

Compliance does not need to be burdensome. The General Permit is not designed to punish facilities that violate it unintentionally. It does, however, require that the facility operators continue to document their "good faith" effort toward preventing storm water pollution for as long as the facility remains active.

The General Permit specifies that an adequate SWPP Plan and Monitoring Plan need to be certified by a responsible officer of the firm and kept on site for possible inspection by a regulatory inspector. If the Plans are unsatisfactory, or if the facility operators are not implementing the plans correctly, the Regional Board may request the Plans to be changed. The facility needs only to submit a time schedule to make the required changes. (This information is drawn from Provision 3, Section A, page 4 of the January 1992 General Permit, Order No. 92-011.) The agencies may levy fines or take other enforcement actions if the facility's plan is not changed as requested.

ORGANIZATION OF THIS SECTION

This section has two main parts:

Must I apply for coverage by the General Permit (NOI)?

This section contains a series of worksheets that you may work through to help determine whether you need to apply for coverage under the General Permit for your facility. If you need to be covered by the General Permit, you will need to comply with all the provisions described throughout this handbook.

How to comply with the General Permit

This section contains a general overview of the General Permit, and the various steps you need to take if you operate a facility that needs to be covered by the General Permit.

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DOES YOUR FACILITY NEED TO BE COVERED BY THE GENERAL PERMIT?

Industrial Storm Water Permit Worksheet

The intention of this worksheet is to assist municipal and industrial facility personnel in determining whether they are covered by the industrial storm water general permit. Note that this worksheet applies only to municipal and industrial facilities located in the Santa Clara Valley. Facilities located in other areas of the state should contact the SWRCB for more information.

General Instructions: This worksheet consists of several pages, of which only a few will apply to your facility. Start by answering the questions on Worksheet 1. Your answers will lead you to additional worksheets that will ultimately assist you in determining if you are covered by the storm water general permit. Note that construction sites are required to obtain a special storm water general permit for construction, which is not addressed in this worksheet.

Please note that this worksheet is not intended to provide a definitive answer for every facility but is rather provided as guidance to assist facility personnel in deciding whether or not they are covered by the storm water general permit.

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Worksheet 1: General Information

1-1	Is your facility a manufacturing facility?	y ☐	n ☐
1-2	Is your facility an oil and gas or mining facility?	y ☐	n ☐
1-3	Are you responsible for a municipality with industrial facilities such as corporation yards, airports, or landfills?	y ☐	n ☐
1-4	Is your facility primarily involved with the treatment, storage, or disposal of hazardous wastes?	y ☐	n ☐
1-5	Is your facility primarily involved with operating landfills, land application sites or open dumps that receive(d) industrial waste?	y ☐	n ☐
1-6	Is your facility a recycling operation such as a metal or other scrap yard, battery reclaiming facility, salvage yard, or automobile yard?	y ☐	n ☐
1-7	Is your facility a steam electric power generating plant?	y ☐	n ☐
1-8	Is your facility primarily involved with transportation such as trucking or railroad transport, or do you operate an airport?	y ☐	n ☐
1-9	Is your facility a sewage treatment plant or industrial wastewater treatment plant with over 1.0 mgd volume?	y ☐	n ☐
1-10	Is your facility within one of the categories listed in Table A that is subject to existing storm water effluent guidelines? (Please refer to Table A)	y ☐	n ☐

Instructions: Read each question and check the appropriate yes or no box on the right. If you answered yes to one or more question, go to Worksheet 2. If you answered no to all of the questions, it is likely that you do not need to apply for coverage and comply with General Permit. Turn to Worksheet 5.

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Worksheet 2: Facilities Answering Yes to One or More Questions on Worksheet 1.

2-1	Is your facility most closely described by a category listed in column 1 or column 2?	1 ☐ 2 ☐

Column 1	Column 2
Lumber/Wood Products	Food Processing/Kindred Products
Paper/Paper Products	Tobacco Products
Chemicals	Textiles/Apparel
Petroleum Refining	Wood Kitchen Cabinets
Stone/Clay/Glass/Concrete	Furniture and Fixtures
Primary Metals	Paperboard/Cardboard Containers
Structural Metal Products	Printing/Publishing
Ship/Boat Manufacturing/Repairing	Drugs/Pharmaceuticals
Mining--Metals, Non-metals, or Coal	Rubber/Plastic Products
Oil and Gas	Leather/Artificial Leather
Hazardous Materials Treatment, Storage and/or Disposal (i.e., U.S. or CA regulated TSDF)	Glass Products (from purchased glass)
Landfills, Land Application Sites, Open Dumps (municipal or private)	Metal Products (non-structural)
Automobile Dismantling (scrap)	Industrial/Commercial Machinery and Components
Metal and Miscellaneous Scrap	Electrical/Electronic Equipment
Transportation Facility (including municipal maintenance, airports, or corporation yards)*	Transportation Equipment (except ships and boats)
Sewage or Wastewater Treatment (municipal or private)	Measuring, Analyzing and Controlling Equipment, Photographic, Medical, Optical Goods
	Warehousing and Storage

Instructions: Find the category in Column 1 or 2 that best describes your facility. If your facility is best described by a category in Column 1, turn to Worksheet 3. If your facility is best described by a category in Column 2, turn to Worksheet 4.

*Note: Municipal corporate yards apparently are included in this list only if they maintain vehicles that transport *passengers or freight*.

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Worksheet 3: Facilities Best Described by a Category in Column 1 of Worksheet 2, or that Answered Yes to One or More Questions on Worksheet 4.

3-1	Does some or all storm water from your facility discharge to a municipal separate storm sewer?	y ☐ n ☐
3-2	Does some or all storm water from your facility discharge directly to a receiving water (via a ditch, creek, or sheet flow)?	y ☐ n ☐

If you have answered yes to either of these questions, your facility is covered by the industrial storm water general permit. If you are certain that your storm water does not discharge to a municipal separate storm sewer or a receiving water, answer questions 3-3 through 3-6. If you do not know where your storm water goes after leaving your site, you should find out NOW.

3-3	Does all storm water that contacts industrial activities (items where you checked "yes" on Worksheet 4) from your facility discharge to a sanitary sewer or process waste water stream, or otherwise is kept out of storm drains?	y ☐ n ☐
3-4	Does all storm water from your facility discharge to evaporation ponds or the permissible structures that prevent it from leaving your site?	y ☐ n ☐
3-5	Do you have an existing NPDES permit that covers all storm water at your facility?	y ☐ n ☐
3-6	Does all storm water from your facility discharge to a municipal combined sewer* (a sewer that carries both storm water and sanitary discharge)?	y ☐ n ☐

If you have answered yes to any of Questions 3-3, 3-4, 3-5, or 3-6, it is likely that you are NOT covered by the storm water general permit. Go to Worksheet 5.

*Note: There are no combined sewer systems in the Santa Clara Valley; however, cities located in other parts of California may have combined sewers. This question is included for purposes of completeness.

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Table A.

FACILITIES THAT ARE SUBJECT TO EXISTING STORM WATER EFFLUENT GUIDELINES*

- Cement Manufacturing
- Feedlots
- Fertilizer Manufacturing
- Petroleum Refining
- Phosphate Manufacturing
- Steam Electric Power Plants
- Coal Mining
- Mineral Mining and Processing
- Ore Mining and Dressing
- Asphalt Emulsion

*Reference: 40 CFR Subchapter N

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Worksheet 4: Facilities Best Described by a Category in Column 2 of Worksheet 2.

4-1	Does your facility have areas (exposed to storm water) that are used for storing raw materials, intermediate or finished products (including tank farms), or wastes?	y ☐ n ☐
4-2	Does your facility have loading docks or shipping and receiving areas for equipment, machinery, or materials that are exposed to storm water?	y ☐ n ☐
4-3	Do you maintain vehicles, forklifts, cranes, or other industrial equipment at your facility such that they are exposed to storm water?	y ☐ n ☐
4-4	Do you wash, clean, or fuel vehicles or industrial equipment at your facility such that they are exposed to storm water?	y ☐ n ☐
4-5	Does any part of your manufacturing process take place at your facility such that they are exposed to storm water?	y ☐ n ☐
4-6	Have you had reportable quantities of leaks or spills of hazardous materials at your facility in the past 3 years?	y ☐ n ☐
4-7	Do you dispose of refuse, process water, or waste water on the facility site outdoors where it is exposed to storm water?	y ☐ n ☐
4-8	Are there locations on your facility site where no industrial activities are now conducted but industrial activities have taken place at any time in the past 3 years, and significant wastes or materials still remain at the location, which are exposed to storm water?	y ☐ n ☐
4-9	Does storm water falling on the roofs of manufacturing buildings (not administrative buildings) contact any process exhaust vents or other industrial gases or fumes?	y ☐ n ☐

Instructions: Read each question and check the appropriate yes or no box at the right. If you answered yes to one or more of the questions, you apparently do discharge "storm water associated with industrial activities" and you may be covered by the Industrial General Permit. Turn to Worksheet 3. If you answered no to all of the questions, it is likely that you do not need to apply for coverage and comply with the General Permit. Turn to Worksheet 5.

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Worksheet 5: Facilities whose Answers on Other Worksheets Suggest that They are not Covered by the General Permit.

5-1	Are you certain that you have categorized your facility type correctly (Worksheets 1 and/or 2)?	y ☐ n ☐
5-2	If you answered Worksheet 4, are you reasonably confident of your knowledge of the facility and of the regulatory definitions of "industrial activity exposed to storm water"?	y ☐ n ☐
5-3	If you answered Worksheet 3, are you reasonably confident that you understand where storm water goes when it leaves your facility?	y ☐ n ☐

If you answered no to any of the above questions, you should seek the assistance of other facility personnel or the Regional Water Quality Control Board before deciding not to seek coverage under the general permit. More detailed descriptions of federal and state regulations are available to guide your decision if you do not reach a definite conclusion using these simplified worksheets. Failure to comply with the storm water permitting regulations is considered a violation of the Clean Water Act, which could result in large fines and penalties and incarceration of corporation officers.

Whether you need to comply with the General Permit or not, your facility must comply with local requirements and avoid contaminating storm water.

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HOW TO COMPLY WITH THE GENERAL PERMIT: OVERVIEW

The General Permit requires a few documents to be prepared by all covered facilities at specified times during 1992 and thereafter. Just as important, the Permit contains schedules for *actions the facilities must take* to complete the documents. The only way to effectively prepare some of the required documents for your site is to first complete some analysis and planning, and occasionally to implement some structural changes on your site. This section provides an overview of how to comply with the General Permit--both the documents that are explicitly required and the actions that you need to take to complete the documents.

Figure 2-1 is an overall timetable for the General Permit compliance process. Three documents need to be completed:

- Notice of Intent (NOI), before April 30, 1992
- Monitoring Program for your facility
  - Group Monitoring Plan application (if you intend to be part of a group), before August 1, 1992
  - Site-specific plan, before October 1, 1992
- Three-part Storm Water Pollution Prevention Plan, also before October 1, 1992.

If you begin operating a new facility after October 1, 1992, you must submit an NOI at least 30 days before beginning operations. You must also complete an SWPP Plan and Monitoring Program before submitting the NOI, and begin implementing the SWPP Plan and Monitoring Program when you begin operations.

The NOI

Completing the NOI is straightforward. After you have determined that a facility must apply for coverage (as described in Part I of this section), you need only complete the form provided by the Regional Board. Section 3 of this handbook provides some guidance on completing the NOI.

The NOI is the only document you need to send to the Regional Board to be covered by the Permit. Since it is a *general permit*, you do not need to "apply for a permit" or submit any permit to the Board. The other documents that the permit requires--the SWPP Plan and monitoring information--are to be kept on your site, not filed with any regulatory agency. The documents are to describe activities you conduct on site, and you can design them to be convenient *for you to use* as well as for the Regional Board to evaluate.

The SWPP Plan

The SWPP Plan has three parts, all of which must be completed by October 1, 1992. Sections 4, 5, and 6 of this handbook contain guidance on preparing the three parts, so they are not discussed in detail here. In general, however, you need to be aware that this is a part of the General Permit where the document itself is the explicit requirement, but in order to prepare the document you need to perform certain activities on your site.

Regulatory Requirement:
The Storm Water Pollution Prevention Plan (SWPP Plan)

Due date:
October 1, 1992

Where to submit:
- Keep on site at the facility.
- Subject to inspection by Regional Board or local agency inspectors.
- Need not be submitted to an agency.

Must Include:
Part 1: Source Identification
Part 2: Storm Water Management Controls
Part 3: Certification of Elimination of Non-Storm Water Discharges

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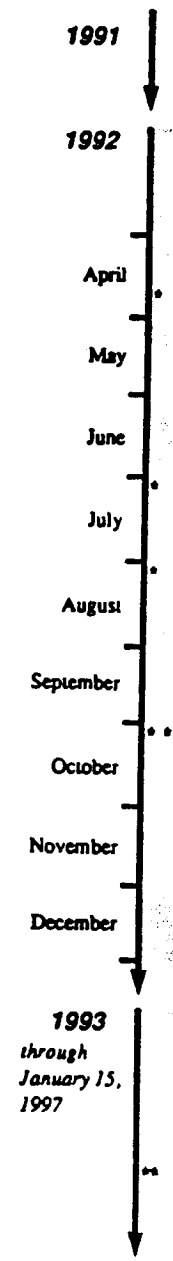
Figure 2-1: The Regional Board's Industrial Storm Water General Permit: Schedule and Deadlines



1991

May 1 — **Submit Notification of Discharge.**
Notify municipalities. Required by U.S. EPA.
This is not part of the Regional Board's General Permit.

1992

Begin now--throughout summer: — Decide whether your facility is covered.
Identify potential storm water pollution sources.
Search for and eliminate improper connections.
Document maintenance/operational BMPs;
adapt them for improved storm water pollution prevention.

April

April 30 — **Submit NOI and $250 annual fee to State Board.**

May

by June 1: — Decide whether to participate in a group monitoring plan;
if so, contact the Regional Board to verify acceptability.

June

July 1 — **Eliminate non-storm water discharges to storm drains.**

July

August 1 — Submit Group Monitoring Plan to Regional Board.
(if you choose a group monitoring approach)

August

September

October 1 — **Complete Monitoring Program and begin monitoring.**
Complete SWPP Plan and begin implementing.
- Certify source identification.
- Certify continuation of maintenance/operational BMPs.
- Certify elimination of improper connections.
- Make plan available on your site
if requested by RWQCB or other inspectors.

October

November

December

1993
through January 15, 1997

Identify, select, develop,and implement additional BMPs, if any.
Modify SWPP Plan and BMPs based on monitoring results.
Modify Monitoring Program based on previous years' results.
Inspect facility annually; modify SWPP Plan
and Monitoring Plan when operational changes warrant.

July 1 — **Submit $250 annual fee to State Board.**
Submit monitoring results to Regional Board
and Santa Clara Valley NPS Program.

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Part 1 of the SWPP Plan is a Source Identification. You are required to identify as fully as possible all the locations or activities at your facility that are potential sources of pollutants in storm water. You can't do this by completing a pre-prepared form like the NOI form, but need to identify the particular locations on your site. Thus, even though the deadline for completing the Plan is October 1, 1992, you need to spend the preceding months fully evaluating your facility.

Part 2 of the SWPP Plan builds on that same facility evaluation that you need to complete for Part 1. Part 2 describes Storm Water Management Controls that you intend to implement on your site, including those you may be already implementing. Here, too, the Regional Board has not specified a list of actions that you may check off, but instead gives a list of general ideas and requires you to commit to implementing *those controls that are appropriate for your facility*. It is left to you to define "appropriate." This handbook offers some guidance.

Your SWPP Plan needs to show *which* controls you plan to implement, *why* you think those controls will be effective for your facility, and why those controls are *sufficient* to prevent storm water pollution at your facility. Clearly, this effort extends beyond preparing the necessary paperwork. You need to analyze your facility to determine the appropriate controls to prevent storm water pollution *at your facility*, and you need to do so in the months preceding completion of the SWPP Plan itself.

A number of guidance documents will be available to help select appropriate storm water management controls. The Santa Clara Valley NPS Program is preparing a manual of Best Management Practices, or BMPs, that describes the baseline, everyday operating practices that the Regional Board will expect most industrial facilities to implement for pollution prevention.

Also, the State of California is preparing a more extensive BMP manual that will include more detailed specifications for pollution control devices and structural controls, and the kinds of facilities that should install them. Section 5 of this handbook provides some guidance on completing this portion of the SWPP Plan.

The central point here is that neither the regulators, your municipality, nor the NPS Program can prepare this plan for you. You need to evaluate your own facility and select the appropriate components. When the Regional Board or other regulatory agencies send inspectors to your site, you need to be prepared to describe why the controls you have selected are adequate for your site. The regulators will need to see not only that you are implementing the controls as your plan promises, they will also require that you show that these are the appropriate controls. Be prepared to show the process you went through to select the controls and the evidence you used to reach the conclusions.

Part 3 of the SWPP Plan is a legally binding certification that you have eliminated any potential discharges of non-storm water to the storm water conveyance facilities. The certification must state that you have fully examined the facility and found no improper connections to the storm drains; or that, if you did locate any such connections, you have eliminated them. Such improper connections are quite common on industrial sites, especially older sites.

This clearly requires some actions in advance of completing the document. You need to sign this certification by October 1, 1992; so you need to have field crews checking your facility long in advance of that date, with enough lead time that you can remove any unexpected connections that they find. In fact, Provision C.4 of the General Permit requires you to eliminate non-storm water discharges by July 1, 1992. If you have done this, signing the certification is just a formality. Section 6 of this handbook describes the process in more detail.

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The Monitoring Program

All industrial facilities covered by the General Permit need to conduct monitoring to demonstrate the presence or absence of contaminants that originate from your facility's industrial activities. Monitoring means collecting samples of storm water that leave your site, and sending them to a qualified laboratory for chemical analysis.

Site-Specific Monitoring Program

If you conduct monitoring at your facility, you need to develop a program plan to identify the locations and frequency of sampling, and the substances for which you will analyze the samples.

Choosing the kinds of chemicals for which you analyze can be very important. First you need to analyze for substances that you have identified as possible contaminants from your industrial activities. On the other hand, each additional substance for which you analyze leads to an additional fee from the chemical laboratory.

The times and locations at which you collect samples must be *representative* of storm water discharges from your site. The General Permit includes some specifications for collecting representative samples. More detailed formation on preparing and implementing a Monitoring Program will be available at a later date.

Group Monitoring Plan

The General Permit allows facilities to conduct monitoring as part of a group. This gives some financial advantages, because not every facility in a group needs to conduct monitoring. However, you need to demonstrate that the facilities you select for are representative of discharges from all industrial facilities in the group. The Regional Board intends to develop procedures for approving monitoring groups and accepting group monitoring data. Also, the Santa Clara Valley NPS Program is developing proposed support efforts for monitoring. More information on these programs will be available at a later date.

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CONCLUSION: HOW DO THE DOCUMENTS HELP ME COMPLY?

The three-part SWPP Plan is not to be submitted for approval to the Regional Board or another agency, but is designed to be kept on your site for inspection. (It is also considered to be a public report, available to the public as specified in Section 308(b) of the Clean Water Act.) In this respect, it is similar to a Spill Prevention Control and Countermeasures (SPCC) plan that you may be required to prepare if you handle hazardous materials on your site.

Inspectors from the Regional Board or a municipal agency may visit your site to examine the effectiveness of your storm water pollution prevention measures, as described in your SWPP Plan and as implemented at your facility. You need to do your best to implement reasonable measures to prevent storm water pollution at your site, and to document the rationale for your decisions, because there is no formal "buy-in" by the Regional Board about the acceptability of the plan.

We understand that it is not the intent of the Regional Board to inspect and issue citations in the fashion of the Occupational Safety and Health Administration, whose duty is to ensure that safe working practices are followed all day, every day. The Regional Board's intent is to use its inspection authority to visit facilities that appear to be discharging pollutants to storm water, and to inspect them to identify ways to improve their SWPP Plans.

The Regional Board's primary concern is that you avoid discharging pollutants to the storm water. If you accomplish this, and demonstrate it by the documents required in the General Permit, the regulators will not dictate *how* you accomplish it. Whatever way you choose is perfectly satisfactory. If you implement a well-designed SWPP Plan and maintain a clean site, you should comply with the regulations.

The Santa Clara Valley NPS Program shares the concern that we all do what we can to prevent storm water pollution. That is why we have prepared this guidance handbook, to help you comply with regulations and also to help you identify the most effective way to keep from unintentionally contaminating storm water and the San Francisco Bay.

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3. NOTICE OF INTENT

This section describes how to prepare a Notice of Intent--an NOI, for short. The NOI is your formal application to be covered by the General Permit. If your facility needs to be covered according to U.S. and State regulations, and you do not file an NOI, you may be considered to be "discharging storm water without a permit."

The NOI is required if you discharge *storm water associated with industrial activity*, as defined by its regulations, and therefore need to comply with the General Permit. Section 2 of this handbook provides guidance on how to tell whether you must apply for coverage. The NOI does not address how much of your site is affected, or which portions of the storm water from the site are subject to the controls. If any part of the facility is covered by this regulation, you need to file an NOI.

This NOI is *not* the same notification that the Santa Clara Valley NPS Program asked you to file before May 1991. That was to notify your *municipality* that you *may discharge storm water* from part or all of your facility into municipal storm drain lines. The May notification was required by the U.S. EPA and was directed to your municipality. If you are covered by the January 1992 General Permit, you need to file this NOI regardless of whether you returned the questionnaire distributed by the NPS Program during 1991.

The questions you need to complete on the NOI are intended only to gather some basic information about your facility for the Regional Board. This is the only document you need to send to the board to be covered by the General Permit.

Regulatory Requirement: The NOI.

Due date:
April 30, 1992

Send to:
State Water Resources Control Board
Division of Water Quality
Attention: Storm Water Permit Unit
P.O. Box 11977
Sacramento, CA 95812-1977

When you mail the form, include:
- The completed 1-page NOI Form
- A site map, on the form provided or another map that is convenient for you
- A check for $250, payable to State Water Resources Control Board

Please send a copy to:
The Santa Clara Valley NPS Program,
5750 Almaden Expressway
San Jose, CA 95118
(Do not send a fee.)

You will receive:
A copy of the General Permit with a discharger number for your facility at the top, shown as "WDID number"

ORGANIZATION OF THIS SECTION

This section of the handbook consists of three parts. First is a copy of the general information and line-by-line instructions issued by the Regional Board for filling out the NOI. The second part provides some additional suggestions from the Program. These suggestions address

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questions which are not easy to answer, or for which the Program can provide some information that the Regional Board's guidance does not include. The third part contains a copy of the NOI form provided by the Regional Board, plus a form suggested by the Program to make your site map easier to complete.

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The Regional Board's NOI Instructions

ATTACHMENT 1

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

NOTICE OF INTENT (NOI) - GENERAL INSTRUCTIONS

FOR COVERAGE UNDER NPDES GENERAL PERMIT NO. CAG612001 (ORDER NO. 91-011)

Who Must Apply

Facilities which have been defined by the U.S. Environmental Protection Agency as having "storm water discharges associated with industrial activity" must obtain coverage under an NPDES permit for their storm water discharges. Facilities requiring coverage are defined in 40 CFR Section 122.26 (b)(14). All facilities in Santa Clara County which discharge to South San Francisco Bay or its tributaries either directly or through municipal storm water systems may seek coverage under this General Permit, except existing discharges which have been issued NPDES permits including provisions regulating discharges of storm water, discharges of storm water from construction activities, or storm water discharges from industrial facilities determined ineligible by the Regional Board.

Where to Apply

The NOI should be mailed to the State Water Resources Control Board at the following address:

State Water Resources Control Board
Division of Water Quality
P.O. Box 944213
Sacramento, CA 94244-2130
Attn: Storm Water Permitting Section

A copy of the NOI shall be mailed to the Santa Clara Valley Nonpoint Source Pollution Control Program at the following address:

Santa Clara Valley Nonpoint Source Pollution Control Program
5750 Almaden Expressway
San Jose, CA 95118

When to Apply

Owners/operators of existing facilities must file a NOI, along with the appropriate annual fee, no later than April 30, 1992. Owners/operators of new facilities (those beginning operations after April 30, 1992) must file a NOI at least 30 days prior to the beginning of operations.

Fees

The annual fee is $250.00 for each facility. Checks should be made payable to the State Water Resources Control Board.

Completing the NOI

Completion and submittal of the attached NOI (Form NOI-1) is required to gain coverage under the General Permit. It must be completely and accurately filled out. A facility will be considered to be covered by the General Permit upon filing a complete and accurate NOI and submitting the appropriate annual fee. A copy of the General Permit with a distinct identification number (this number will appear at the top of the permit as the WDID No.) will be sent to the owner/operator upon receipt of the NOI and fee.

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The Regional Board's NOI Instructions

NOI–LINE BY LINE INSTRUCTIONS

The NOI consists of two parts–an NOI Form (Form NOI-1) and a site map. Please type or print when completing the NOI Form and site map.

Mark one of the three boxes at the top portion of the NOI. Check box 1 if the NOI is being completed for an existing facility, box 2 if the facility is new (has not started business), and box 3 if the NOI is being submitted to report changes to a facility already covered by the General Permit. An example of a change that warrants a resubmittal of the NOI would be a change of owner/operator of a facility. Complete only those portions of the NOI that apply to the changes (the NOI must always be signed). If box 3 is checked, the WDID No. must be included. The WDID No. is found at the top of the General Permit issued to the facility.

SECTION I–OWNER/OPERATOR

Give the name, as it is legally referred to, of the person, company, firm, public organization, or any other entity which owns the facility (or operates the facility when the owner does not operate the facility) and check the box corresponding to the appropriate ownership status of the facility. The owner/operator information may or may not be the same as the facility information requested in Section II.

SECTION II–FACILITY/SITE INFORMATION

Enter the facility's official or legal name and provide the address, county, and contact person information for the facility. Facilities that do not have a street address must provide parcel number(s) information. The contact person should be the plant or site manager completely familiar with the facility and charged with compliance and oversight of the General Permit.

SECTION III–BILLING ADDRESS

Use this section to indicate where annual fee invoices and other correspondences should be sent.

SECTION IV–RECEIVING WATER INFORMATION

In Part A of this section, the owner/operator is required to indicate whether the facilities' storm water runoff discharges to a separate storm drain system, directly to a water of the United States, or indirectly to waters of the U.S.

Discharges to separate storm drain systems are those that discharge to a collection system operated by municipalities, flood control districts, utilities, or similar entities. Storm water discharges directly to waters of the U.S. will typically have an outfall structure directly from the facility to a river, creek, lake, ocean, etc. Indirect discharges are those that may flow over adjacent properties or right-of-ways prior to discharging to waters of the U.S.

Regardless of point of discharge, the applicant must determine the closest receiving water for its storm water discharge. If discharge is to a separate storm drain system, the purveyor of that system should know the receiving water. The name of the receiving water of a direct discharge should be easily available while the receiving water of an indirect discharge may require some effort to identify.

SECTION V–INDUSTRIAL INFORMATION

Part A of this section requests the owner/operator to provide the standard industrial classification (SIC) code(s) which best describes the industrial activity taking place at your facility. Briefly describe the nature of business in Part B. In Part C, check the general industrial activities that take place at the facility.

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The Regional Board's NOI Instructions

SECTION VI–MATERIAL HANDLING

Part A of this section requires identification of the type(s) of materials stored and handled outdoors. If other types of materials other than those listed are maintained on-site, please check other and describe the type of material.

Part B of this section requests information on any existing management practices employed at the facility. Check the appropriate categories or list other control measures you use at your facility. If none are used, leave this part blank.

SECTION VII–FACILITY INFORMATION

List the size, in acres or square feet, of the facility and the percentage of the site that is impervious.

SECTION VIII–REGULATORY STATUS

Check the appropriate box(es) and indicate the identification number of any permits currently in affect at the facility.

SECTION IX–COMMENTS

This section is provided to allow for additional parcel numbers and billing information, if needed.

SECTION X–CERTIFICATION

This section should be read by the owner/operator. The certification provides for assurances that the NOI and site map were completed in an accurate and complete fashion and with the knowledge that penalties exist for providing false information. It also requires the owner/operator to certify that the provisions in the General Permit will be complied with.

The NOI must be signed by:

For a Corporation: a responsible corporate officer.

For a Partnership or Sole Proprietorship: a general partner or the proprietor, respectively.

For a Municipality, State, or other Non-Federal Public Agency: either a principal executive officer or ranking elected official.

For a Federal Agency: either the chief or senior executive officer of the agency.

SITE MAP

Provide a "to scale" drawing of the site and its immediate surroundings. Include as much detail about the site as possible. At a minimum show buildings, material handling areas, roadways, storm water collection and discharge points, a north arrow, and the names of adjacent streets. The attached site map may be used, if convenient. The township, section, and range of each facility must be provided on the site map.

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FURTHER GUIDANCE FROM THE SANTA CLARA VALLEY NPS PROGRAM

This section contains information on some of the less clear-cut sections of the NOI form. This information applies particularly to the Santa Clara Valley. Some of this advice reflects the Program's judgment about the level of information that is likely to satisfy the Regional Board for a typical industrial facility. Specific facility situations may be different.

Each heading of this section is numbered to correspond to a section in the NOI form. The information under each heading pertains to that NOI section.

NOI Question IV. Receiving Water Information

Box 1. Box 1 is the appropriate response for most facilities. If you have storm drains on site, the drains probably discharge to a storm drain system (unless you operate your own direct storm water discharge system). If you operate a very small facility and have no storm drains, your storm water runs to a gutter or a storm drain in the street, which is a municipal system. In either case, check box 1 on the NOI form.

The blank that requests the name of *the owner of the storm drain system* should be filled with one of two possibilities. The first possibility includes all smaller storm drains, including street drains. These are owned by the municipality in which the facility is located. If the industrial facility is not in an incorporated municipality and you discharge to a street drain, the owner of the system is Santa Clara County.

The second possibility is that the facility is operated by the Santa Clara Valley Water District. If you discharge directly to a flood control channel, including a natural stream bed that is maintained and operated for flood control and storm drainage, the owner of the system is the Santa Clara Valley Water District.

Box 2. Box 2 is the appropriate response if you operate your own storm drain system which discharges to a surface stream or the Bay. If water discharges to a drainage ditch or creek, you should trace where this ditch or creek leads. It may be a point of direct discharge to a receiving water. It is more likely that it discharges to a creek that is operated by the Santa Clara Valley Water District as a flood control facility. (All the creeks named in the box on page 3-7 are Water District conveyances). There are very few facilities in the Santa Clara Valley that do not discharge to a municipality or Water District drainage facility, and that need to check this box.

Box 3. The third box, for discharges that flow *indirectly to waters of the U.S.*, is for facilities where storm water runs off the site and flows over adjacent properties prior to entering surface waters.

IV. RECEIVING WATER INFORMATION

A Does your facility's storm water discharge directly to (Check one)

1. ☐ Storm drain system

Owner of storm drain system: (Name) _____

2 ☐ Directly to waters of U.S. (e.g., river, lake, creek, ocean)

3 ☐ Indirectly to waters of U.S.

B Name of closest receiving water.

_____

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If you operate an evaporation pond to retain storm water on your site, you may not be a discharger (and, if so, do not need to file this NOI). However, consider carefully whether you may be an indirect discharger.

If your pond has the potential to overflow, the water will run across land and may enter a surface water. Even if the rainfall that generated this water occurred long before the overflow or release, such a release, however large, is considered by the regulations to be a discharge of storm water. You may wish to consider filing an NOI so that you are covered in the event of such a discharge. Otherwise, if it happens, you will be discharging storm water without a permit and may be subject to enforcement actions.

Part B. Identify the name of the water body that your facility's storm water enters, whether you discharge directly to a stream or not. If you discharge to a storm drain system (and checked box 1 of part A), you need to identify the receiving water to which your storm water is conveyed through pipes or channels operated by your municipality or the Santa Clara Valley Water District. (The Regional Board needs to know this so that it can identify which industrial facilities' discharges contribute to a particular stream's water quality.) This is not an easy question to answer, even for the municipalities that operate the storm drains, because the pipes and channels in urban areas of Santa Clara Valley have been modified and added to over many decades. Storm water is conveyed across natural and political boundaries.

Try to select the receiving water that is nearest to you, from the list in the box on this page. Unless your facility is in the small area that drains directly to the Bay, you should *not* list San Francisco Bay, but instead the major creek or river that receives your water en route to the Bay. If your facility is anywhere in the Santa Clara Valley, your receiving water is one of those listed in the box. It may be useful to consult a topographic map for your area to determine the location of local creeks and streams.

As initial guidance, the maps on the following two pages show appropriate boundaries of watersheds in the Santa Clara Valley. You might be able to located your facility on these maps, and identify the receiving water that drains your area. Since the NOI's purposes are not to precisely define your location at this time, a rough estimate using these maps may be enough to satisfy the NOI.

Receiving Waters in Santa Clara Valley
Listed from west to east

San Francisco Bay
San Francisquito Creek
Adobe/Matadero/Barron creek system
Permanente Creek
Stevens Creek
Sunnyvale West Channel
Sunnyvale East Channel
Calabazas Creek
Saratoga Creek
San Tomas Aquino Creek
Guadalupe River
Los Gatos Creek
Coyote Creek
Penentencia Creek

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WATERSHEDS AND POLITICAL JURISDICTIONS IN THE SANTA CLARA VALLEY

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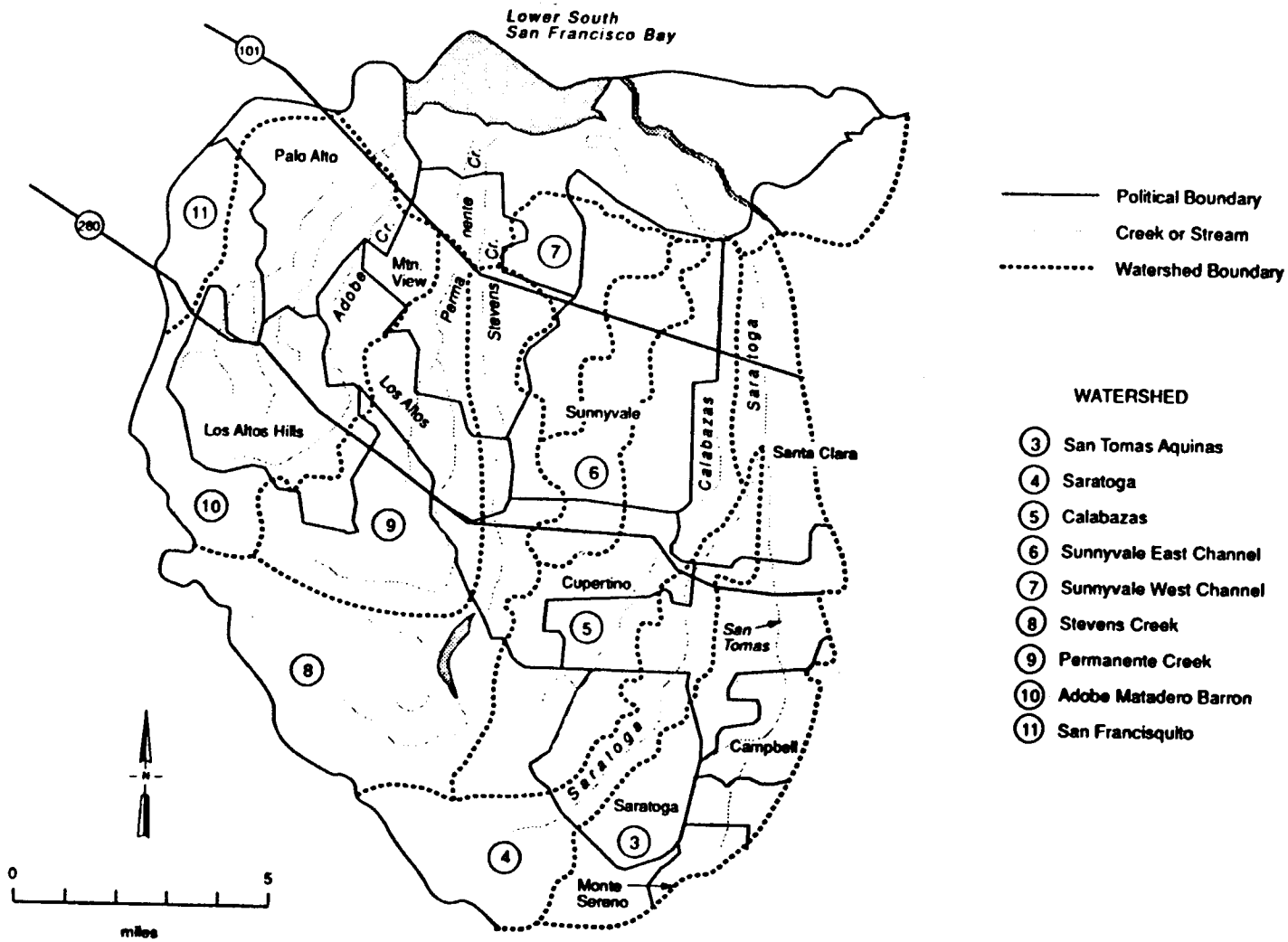

WATERSHEDS AND POLITICAL JURISDICTIONS
IN THE SANTA CLARA VALLEY

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NOI Question V. Industrial Information

This section needs to be completed with the codes for the Standard Industrial Classifications, or SICs, that pertain to your facility.

SIC is a system of classification originated by the Department of Commerce that is intended to describe the kinds of activities that take place in a commercial facility or corporation. The codes are not limited to "industrial" activities in the usual sense. The system includes a designated SIC code to match the activities of private businesses, non-profit activities, and many public agencies. Regardless of whether you know the SIC for your activity, you can be sure that one or more SICs can be used to identify your facility's activities.

For purposes of the General Permit, the SIC of interest is the one that describes the industrial activities *at an individual facility*. To correctly complete this section of the NOI, and to comply with other sections of the General Permit, you need to determine the primary SIC for the facility.

This may *not* be the same as the SIC for your business as a whole. Many larger corporations have a single SIC under which they report to the Bureau of the Census or which they use in reports on commercial activities. But the purpose of the General Permit is to regulate *facilities* which conduct industrial activities, so the requested SIC is intended to describe activities at the specific site for which a permit is to be obtained.

Regardless of the SIC you use in annual reports, to complete the NOI you should consider the principal activity at the facility and enter the 4-digit SIC that describes that activity. One convenient approach may be to first answer part B of the NOI's Question V: describe in words the principal activity or activities at the facility. Then locate on a list the SIC(s) that describes the activity. If you are reading this Handbook as part of the NPS Program's Compliance Binder, you can find a list of 4-digit SICs in Section 3 of the binder. Section V provides space for up to four SICs. In the case of facilities that perform more than one industrial activity up to four 4-digit SICs may be entered.

The State Water Resources Control Board has provided some guidance on determining a facility's primary and auxiliary SICs. The state recognizes that using SICs in this way is somewhat of a force fit--the codes were developed to report on economic activities, and do not exactly match the goal of determining which facilities need to conduct pollution prevention activities. Nevertheless, the Federal regulations specify that the SIC is the unit to use for the purpose. So, the guidance on determining primary SIC is based on economic guidelines: The primary activity at a facility is the product or service that contributes the largest share to the economic value of goods or services added at the facility. Economic value may be gross production, sales, receipts, or revenues.

Many facilities will list more than one SIC in the NOI. The first listed should be the primary SIC. Include other, or "auxiliary," SICs to describe other kinds of operations that take place at the facility.

V. INDUSTRIAL INFORMATION

A SIC Code(s)	B Type of Business
1. ☐☐☐☐ 2. ☐☐☐☐ 3. ☐☐☐☐ 4. ☐☐☐☐	

C Industrial activities at facility. (Check all that apply)

1 ☐ Manufacturing	2 ☐ Vehicle Maintenance	3 ☐ Hazardous Waste Treatment, Storage, or Disposal Facility (RCRA Subtitle C)	
4 ☐ Material Storage	5 ☐ Vehicle Storage	6 ☐ Material Handling	7 ☐ Wastewater Treatment
8 ☐ Power Generation	9 ☐ Recycling	10 ☐ Landfill	99 ☐ Other

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Determining Facility SICs: Examples

Example 1

A large electronics corporation conducts a range of activities at a number of sites: products assembly, electroplating, long distance trucking, and others. The corporation's primary SIC is 3426, and it has a number of auxiliary SICs. A facility in Santa Clara Valley that is operated by the corporation and dedicated to electroplating parts would report economic data under SIC 3426, but for the purposes of the General Permit would have a facility primary SIC of 3471, electroplating.

Example 2

A school district operates a vehicle repair and maintenance facility for school buses. The school district has SIC 8211 for its overall reporting number, and might appear not to be covered under these regulations. But the bus maintenance facility conducts activities like those described in SIC 4151 (which is included in the industrial activities named in the General Permit). The maintenance facility should be covered in an NOI and list 4151 as its primary SIC.

If you conduct several kinds of industrial activities on site and it is not clear which is the primary, the order in which you list them is not important. Simply list several SICs in the spaces provided. If any of your major activities is clearly covered under the General Permit, then there is little difference which of them you list first in this section--your facility will need to comply in any case.

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NOI Question VII. Facility Information

VII. FACILITY INFORMATION

A. Total size of site. (Check one)	B. Percent of site impervious: (including rooftops)
_____ ☐ Acres ☐ Sq Ft	_____ %

Total size of site and percent impervious surface may be *estimates*. Try to estimate reasonably accurately, but if you don't know the exact size, a good-faith estimate to the nearest tens of square feet is adequate for a smaller facility.

For a multi-acre facility, in general you need not estimate fractions of acres.

Part A. Total size of site

Total size of the site includes all the area within the property line of any facility that is covered by the NOI. This is not limited to industrial areas on the site--include office buildings, parking lots, and any undeveloped land that you own.

Part B. Percent of site impervious

Impervious areas on your site are those that will not allow rainwater to pass through to the ground underneath. This includes paved parking lots or access roads, concrete sidewalks, and buildings and other roofed areas. Gravel parking lots and similar graveled areas are "pervious" because rain water can percolate through.

The percent of your site that is impervious is the number of square feet (or acres) of impervious area divided by the total area of the site, as you estimated in part A of the question. This need be only a rough estimate. You can make estimates from the map you attach to the NOI. The work box shown below includes some suggestions of the kinds of impervious areas you might find on your site. Estimate the area covered by the following categories, add them, and divide by the total site area to get the number to enter in Section VI, Part A of the NOI form.

Calculating the impervious area of your facility site

Buildings:	_____ ft x _____ ft = _____ sq ft
	_____ ft x _____ ft = _____ sq ft
Paved areas:	_____ ft x _____ ft = _____ sq ft
(parking, materials storage, other)	_____ ft x _____ ft = _____ sq ft
Sidewalk:	_____ ft x _____ ft = _____ sq ft
Other:	_____ ft x _____ ft = _____ sq ft
Total impervious area:	_____ sq ft
Divide impervious area by total site area to find percent impervious:	_____ sq ft/ _____ sq ft = _____ (fraction)
	fraction x 100 = _____ percent

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Site Map

The NOI form provided by the Regional Board includes a site map form. You are not required to use this form; any map is acceptable as long as it includes all the items that the Regional Board requests. (See the box on this page.) Another map form suggested by the Santa Clara Valley NPS Program is also included here. It has all the information required by the Regional Board and includes a checklist of the items the Board requires, the same as the list in the box on this page. If you already have a site map that you can easily mark to include the Regional Board's requirements, feel free to use that instead.

The Board's instructions specify a "to scale" map, with "as much detail about the site as possible." You should not read this to be too burdensome, or to require a first-rate drafting job on an all-new site map for this purpose. A map drawn to *approximate* scale is generally sufficient. It needs to include enough detail so that any site inspector, when visiting your facility, can walk around the site and locate all the items you have marked on the map.

Information to Include on the Site Map

- Buildings
- Material handling areas
- Roadways on your property
- Adjacent streets, with names
- An arrow showing (approximate) north
- Facility township, section, and range
- Storm water collection points
- Storm water conveyances:
  - underground drains, drain inlets, ditches, gutters, roof downspout exit points, other
- Storm water discharge points:
  - all locations where storm water leaves the property

The checklist includes a request for the *township, section, and range* of your facility. These are numbers that derive from a uniform geographical locating system used throughout the U.S. They are probably not the first thing you think of when you describe the location of your facility, and may not be readily known to anyone in your plant. They may be included in a legal description, such as the deed to the property. If you lease the property, contact your landlord and ask whether the township, section, and range are available.

Alternately, you may be able to locate your facility on a high-quality map, such as a U.S. Geological Survey 7.5-minute quadrangle, and read the township, section, and range from the map. Or, you may be able to find the information at your local public library.

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State of California
State Water Resources Control Board

NOTICE OF INTENT

FOR GENERAL PERMIT TO DISCHARGE STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITY IN SANTA CLARA COUNTY TO SOUTH SAN FRANCISCO BAY OR ITS TRIBUTARIES

San Francisco Bay Regional Water Quality Control Board Order No. 92-011

MARK ONLY ONE ITEM	1. ☐ Existing Facility 2. ☐ New Facility	3. ☐ Change of Information WDID # _____

I. OWNER/OPERATOR

Name:	A. Owner/Operator Type: (Check one) 1. ☐ City 2. ☐ County 3. ☐ State 4. ☐ Federal 5. ☐ Special District 6. ☐ Government Combo 7. ☐ Private
Mailing Address:	
City:	State: Zip: Phone: ( ) -
Contact Person:	B. 1. ☐ Owner 2. ☐ Operator 3. ☐ Owner/Operator

II. FACILITY/SITE INFORMATION

Facility Name:	County:
Street Address:	Contact Person:
City:	State: CA Zip: - Phone: ( ) -
Parcel Number(s) (If more than 4 apply to facility, enter additional numbers in SECTION IX. A):	
A _____ B _____ C _____ D _____	

III. BILLING ADDRESS

Send Billing Statements To: A ☐ Owner/Operator B ☐ Facility C ☐ Other (Specify in SECTION IX. B)

IV. RECEIVING WATER INFORMATION

A. Does your facility's storm water discharge directly to: (Check one)

1. ☐ Storm drain system

Owner of storm drain system: (Name) _____

2. ☐ Directly to waters of U.S. (e.g., river, lake, creek, ocean)

3. ☐ Indirectly to waters of U.S.

B. Name of closest receiving water:

_____

V. INDUSTRIAL INFORMATION

A. SIC Code(s):

1. ____ 2. ____ 3. ____ 4. ____

B. Type of Business: _____

C. Industrial activities at facility. (Check all that apply)

1 ☐ Manufacturing 2 ☐ Vehicle Maintenance 3 ☐ Hazardous Waste Treatment, Storage, or Disposal Facility (RCRA Subtitle C)
4 ☐ Material Storage 5 ☐ Vehicle Storage 6 ☐ Material Handling 7 ☐ Wastewater Treatment
8 ☐ Power Generation 9 ☐ Recycling 10 ☐ Landfill 99 ☐ Other _____

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VI. MATERIAL HANDLING/MANAGEMENT PRACTICES

A. Types of materials handled and/or stored outdoors: (Check all that apply)

1. ☐ Solvents
2. ☐ Scrap Metal
3. ☐ Petroleum Products
4. ☐ Plating Products
5. ☐ Pesticides
6. ☐ Hazardous Wastes
7. ☐ Paints
8. ☐ Wood Treating Products
99. ☐ Other (Please list)

B. Identify existing management practices employed to reduce pollutants in industrial storm water discharges: (Check all that apply)

1. ☐ Oil/Water Separator
2. ☐ Containment
3. ☐ Berms
4. ☐ Leachate Collection
5. ☐ Overhead Coverage
6. ☐ Recycling
7. ☐ Retention Facilities
8. ☐ Chemical Treatment
99. ☐ Other (Please list)

VII. FACILITY INFORMATION

A. Total size of site: (Check one)	B. Percent of site impervious: (Including rooftops)
_____ ☐ Acres ☐ Sq. Ft.	_____ %

VIII. REGULATORY STATUS (Check all that apply)

A. ☐ Regulated by Storm water Effluent Guidelines (40 CFR Subchapter N)	B. ☐ Waste Discharge Requirements (Order Number) _____	C. ☐ NPDES Permit CA _____
D. ☐ RCRA Permit Number _____	E. ☐ Regulated by California Code of Regulations Article 6, Chapter 15 (Facilities)	

IX. COMMENTS (Enter additional information for SECTIONS II AND III)

A. Additional Parcel Numbers:

B. Billing Information: (Enter Name and Address)

X. CERTIFICATION

"I certify under penalty of law that this document and all attachments were prepared under my direction and supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment." In addition, I certify that the provisions of the permit, including the development and implementation of a Storm Water Pollution Prevention Plan and a Monitoring Program Plan, will be complied with.

Printed Name: _____

Signature: _____ Date: _____

Title _____

STATE USE ONLY

WDID:	Regional Board Office:	Date Permit Issued:	
NPDES Permit Number: CA_____	Order Number: _____	Fee Amount Received: $_____	Date NOI Received: _____

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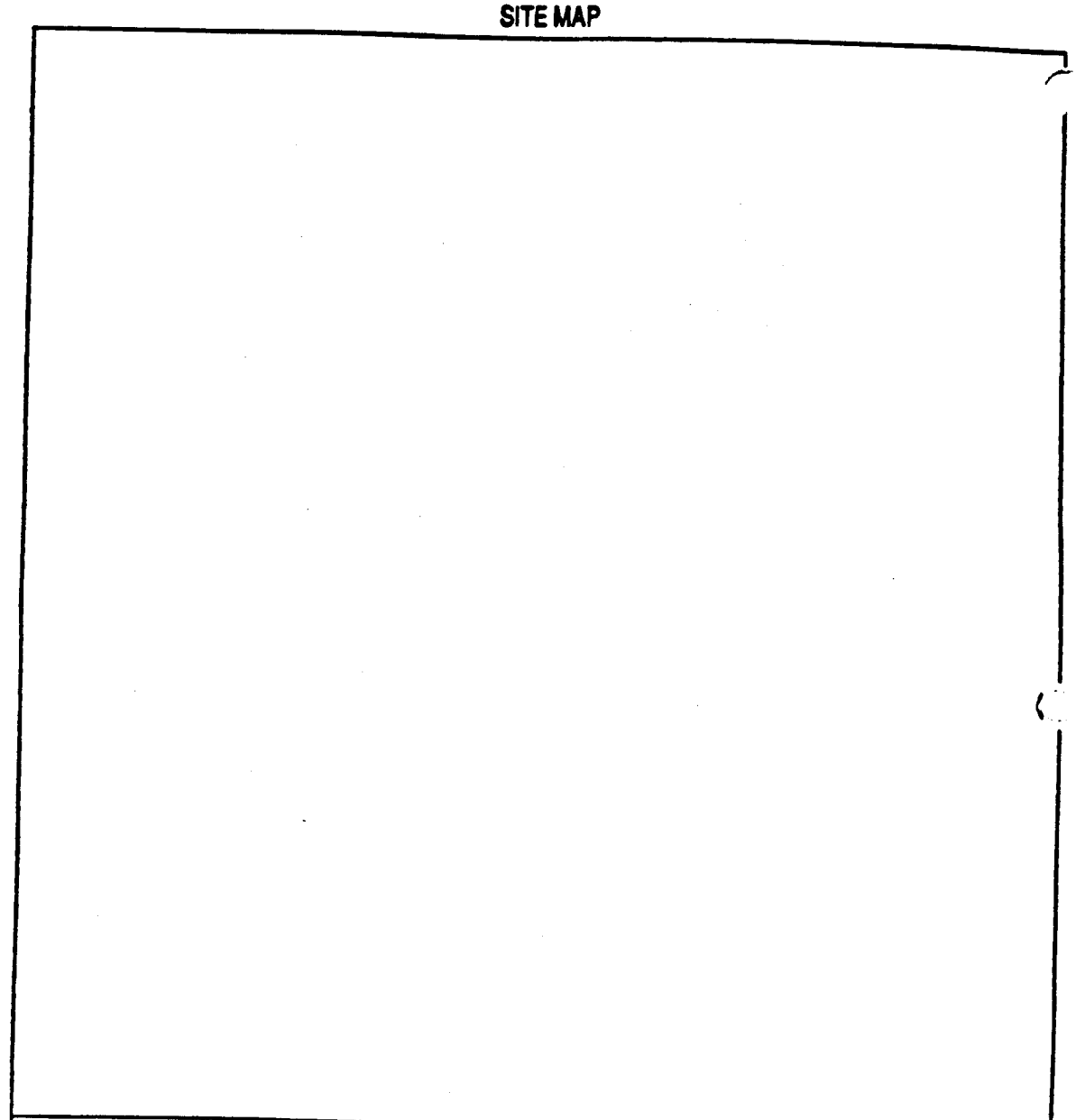
NOTICE OF INTENT
SITE MAP



MAP INFORMATION	STATE OF CALIFORNIA STATE WATER RESOURCES CONTROL BOARD
TYPE	FACILITY
NUMBER	COUNTY
SCALE	DATE / DRAWN / CHECKED

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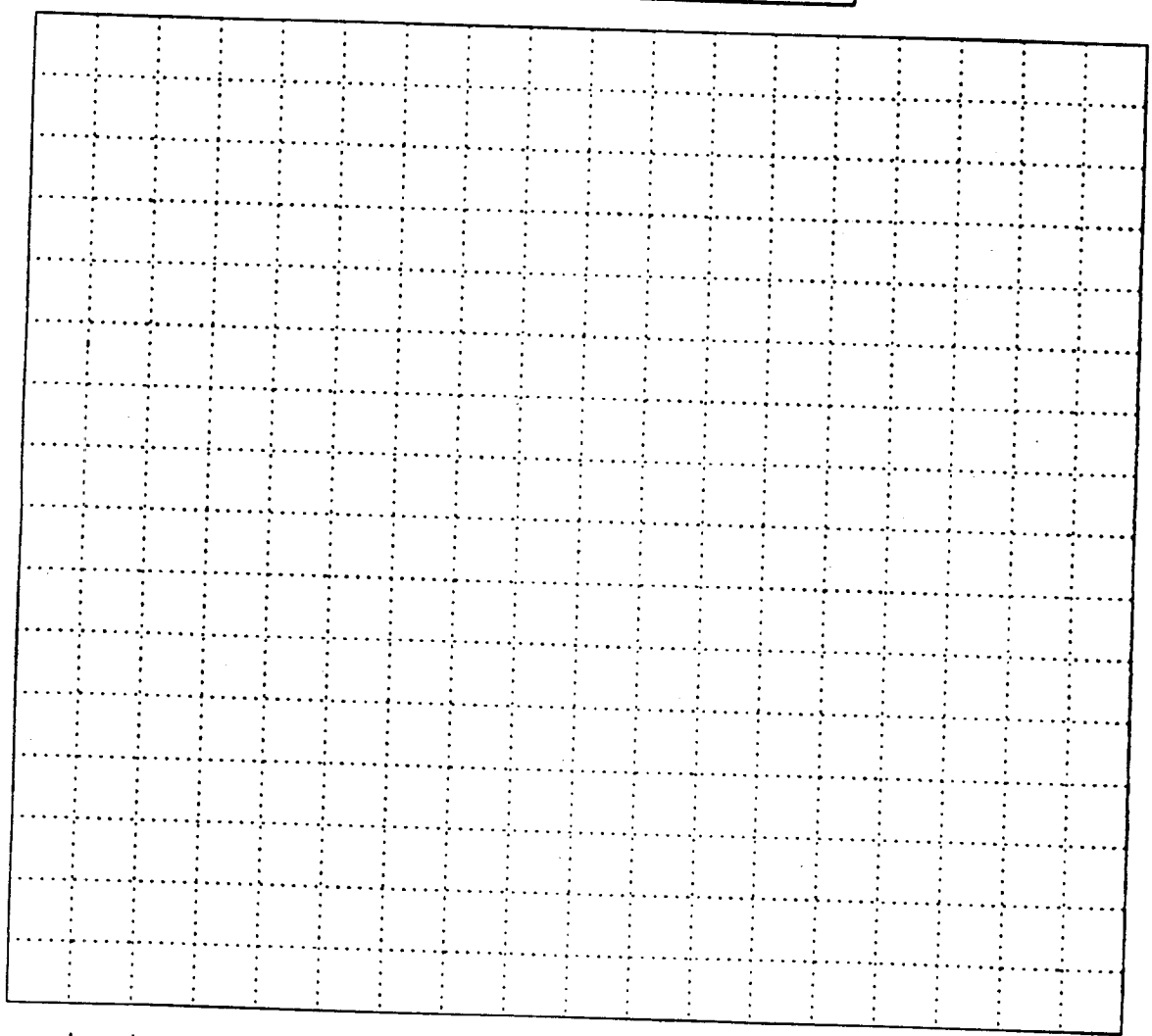
NOTICE OF INTENT SITE MAP
CALIFORNIA WATER RESOURCES CONTROL BOARD, SAN FRANCISCO REGION

Santa Clara County

Facility name: _____

Prepared by: _____ **Date:** _____



Legend

Property line
Building outline
Storm water conveyances
(gutters, ditches, downspout discharges, others)

Approximate scale: 1 block = _____ feet

Site location: Township: _____ Section: _____ Range: _____

Checklist

- ☐ Material handling areas
- ☐ Roadways (on the property)
- ☐ Storm water discharge points (where storm water leaves the property)
- ☐ North arrow
- ☐ Names of adjacent streets

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4. SWPP PLAN PART 1: SOURCE IDENTIFICATION

This section is not yet complete at the time of publication for the March 1992 workshops. Further information will be provided in future updates to this binder.

The first part of the SWPP Plan is a detailed description of potential sources of contaminants that may be exposed to storm water at your facility. The intent of identifying these sources for your site can be seen as two-fold.

The primary purpose is to encourage you to identify the important potential storm water pollution sources at your facility. This will assist you in more directly addressing your SWPP Plan and monitoring program to pollutants from these sources at your facility. Effective source identification is important to your compliance process. This will help you to eliminate potential sources or, if this is not possible, to design effective BMPs to prevent storm water pollution.

The second purpose intended by the General Permit is to direct any future site inspectors toward locations on your site that they should determine whether your SWPP Plan is satisfactory in preventing storm water pollution.

If your facility and operations are designed and conducted effectively from a storm water pollution prevention viewpoint, you may be able to complete this section with a minimal description. You may have *no* areas where contaminants could be exposed to storm water. This may be an unattainable ideal for the typical industrial facility, since many manufacturing processes are "dirty" by nature. The intent of the permit is not to cause you to cease operations, just to conduct them in a way that is effective at preventing storm water pollution. Still, a clear (if unstated) purpose of this section of the SWPP Plan is to encourage you to look at the areas on your site that may lead to storm water contamination, and to alter or eliminate them, even *before* your SWPP Plan goes into effect. If you eliminate the potential of a particular activity or location to contribute polluants to storm water, then you do not need to list the activity or certify that you will take continuing actions to minimize pollutants that enter storm water.

ORGANIZATION OF THIS SECTION

Section 4 of the Guidance Handbook describes how to conduct a source identification for your facility and how to complete Part 1 of the SWPP Plan. The guidance on conducting a source identification provided here is only one possible approach to conducting such an identification. These steps are not part of the General Permit, but are suggested by the Santa Clara Valley NPS Program.

IDENTIFYING POTENTIAL SOURCES OF STORM WATER POLLUTION AT AN INDUSTRIAL FACILITY

The Source Identification part of the SWPP Plan is the record of a process that you conduct at your facility. You, the facility operator, carry the burden of identifying sources and potential sources of storm water pollution at your facility. The General Permit does not specify a list of areas that you must check, allowing you to acknowledge that once you have looked at them you've completed the job. The General Permit language instead requires you to identify *all* potential sources *specific to your facility*, and then to address these in the other parts of your SWPP Plan.

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Your source identification needs to be a list that is specialized for your own facility. The Regional Board's definition of "storm water associated with industrial activities" *includes but is not limited to* some activities and materials listed in the EPA's 1990 regulations. The activities that are definitely included appears in the box on page 4-2. The intent is to lead you to identify activities that are potential sources of storm water pollution, whether or not they are specifically listed. Activities that are not considered industrial activities are *not* included in the SWPP Plan.

The General Permit instructions state that you may *leave off the list* activities and locations that are clearly and demonstrably *not* related to industrial activities, even though they are on an industrial site and even though they may be sources of contaminants. A prime example is employee parking lots, where motor oil leaks. Another is office buildings or commercial facilities on the industrial site, where loading docks or air conditioning equipment could drip contaminants. If these turn out to be significant sources of storm water pollutants, you may need to work with your local municipality to identify means to control the pollutants. However, they are not covered by the General Permit and need not be included in your SWPP Plan.

Some activities are definitely included, and some are definitely excluded. Many other activities fall into a grey area between the two. You will need to evaluate how and where they are conducted at your facility to determine whether they are potential sources. You should include in your source identification any locations on your site where you conduct industrial activities that may be exposed to storm water, whether or not they appear on the General Permit's list.

Because the source identification is a process, and every site is different, this guidance document does not provide a complete check list for your facility. This section provides general guidance about the kinds of operations that could be sources of storm water pollution on your site.

The regulations are intended to address "industrial activities exposed to storm water." Exposure to storm water is not always obvious. The Regional Board's General Permit and the U.S. EPA's storm water regulations both make clear that they are *not* restricted to outdoor activities. Direct rainfall onto an outdoor activity is one obvious exposure

Storm Water Associated with Industrial Activity

Includes but is not limited to items on this list, developed as part of U.S. EPA regulations.

If any of these are exposed to storm water:

- Material handling equipment or activities
- Raw materials
- Intermediate products
- Final products
- By-products
- Waste products
- Industrial machinery

which are located in one of these areas of your facility:

- Industrial plant yards
- Material handling sites
- Refuse sites
- Sites used for the application and disposal of process waste waters
- Sites used for residual treatment, storage or disposal
- Shipping and receiving areas
- Manufacturing buildings
- Storage areas (including tank farms) for raw materials, intermediate and final products
- Areas where industrial activity has taken place in the past and significant materials remain and are exposed to storm water

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to storm water. Another is storm water that flows across the site and contacts the activity or contacts residues left by the activity.

Equipment that is used in an indoor manufacturing operation and then moved to a location where contact storm water contacts it is an industrial activity exposed to storm water. A less obvious circumstance is storm water that contacts particles, dust, liquid spills, or other residues that are created by an activity *inside a building*. Contaminants may be carried outdoors, for example on the tires of a forklift or through a roof vent, and build up on outdoor surfaces. These contaminants are the results of industrial activities which are exposed to storm water, and may need to be identified as potential sources.

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LINE-BY-LINE GUIDANCE ON COMPLETING THE SWPP PLAN PART 1

This section contains some guidance on preparing Part 1 of the SWPP Plan to conform to the "letter of the law" as put forth in the General Permit. The headers of this section correspond to specific items in the provisions of the General Permit. The headers also correspond to sections of the sample SWPP Plan prepared by the NPS Program for a fictitious industrial facility. The sample SWPP plan is included as an Appendix to this handbook. (If you received this handbook as part of a binder distributed at the NPS Program Workshops, the sample SWPP Plan is included in Section V of the binder.)

1.0 INTRODUCTION AND BACKGROUND

Provide a brief description of your facility. Describe in a few sentences where the facility is and what work happens on the site.

2.0 SITE LOCATION AND REGIONAL INFORMATION

This section addresses permit section 5.a. which requires inclusion of a topographic or other map. The map should extend 1/4 mile beyond the facility boundary, and should show the facility, surface water bodies (including springs and wells), and the point(s) where the facility discharges storm water to a municipal storm drain system or other body of water. The requirements here may be included on the site map for Section 3.0.

2.1 Location

Briefly describe the facility location. Include descriptions of roads or railroads that serve as site boundaries. Describe the uses of the land bordering each side of the facility (e.g. other industrial uses, undeveloped, residential, agricultural).

2.2 Topography

Reference your attached topographic map. If you are using the site map in section 3.0 as your topographic map, state this fact.

2.3 Surface Water Bodies within 1/4 Mile

Describe any surface water bodies within 1/4 mile of your facility, including springs and wetlands. This should include FORMER surface water bodies as well. Include creeks or intermittent streams that are dry now due to the drought and/or creeks that are dry during summer months but are flowing during the rainy season.

2.4 Wells within 1/4 Mile

Identify any drinking water, water supply, or injection wells in the vicinity.

2.5 Regional Rainfall

Describe typical rainfall for the area. This information is available from the National Weather Service.

3.0 SITE DESCRIPTION

3.1 Introduction

Your introductory text will meet requirements in permit section 5.b. Briefly describe the facility, including the overall size in acres or square feet, the number of buildings on the site, and major activities at the site. Provide a site map that identifies:

- storm water conveyance, drainage, and discharge structures
- an outline of the storm water drainage areas for each storm water discharge point
- paved areas and buildings
- areas of pollutant contact with storm water or release to storm water. Include potential areas as well as known areas. Examples of areas include outdoor storage or process areas, loading and

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unloading areas, or waste treatment, storage or disposal areas
- location of existing storm water structural control measures (i.e., berms, etc.)
- surface water locations, including springs and wetlands
- vehicle service areas
- location of each well where fluids from the facility are injected underground.

It may be more convenient to provide the required information on several maps or map layers rather than on a single map. The provided map(s) may be hand sketched, but the detail and scale must be sufficiently accurate to provide a clear illustration of storm water movement, control, and potential points of pollutant contact.

3.2 Buildings

Provide a brief description of the buildings located on your site. This section should include a description of the activities performed in the building, the materials utilized in the building, and (briefly) the management structures and procedures used in the building to minimize potential for contact of raw materials and wastes with stormwater (e.g., berms or other secondary containment structures, oil/water separators, spill response procedures, etc.). You should reference any documents that you already have that contain this information. Examples include Best Management Practice (BMP) Manuals or Spill Prevention and control documents. It may be possible for you to satisfy this requirement entirely using information from existing documents.

3.3 Outdoor Storage, Manufacturing, and/or Processing Areas

Describe any areas of outdoor activities at your site. Include all storage, maintenance, and manufacturing/processing areas. Describe the activities for each area, the materials handled, and any management structures and procedures used to minimize potential for contact of raw materials and wastes with storm water. Identify any processes or activities that generate significant quantities of dust or particulate matter. Again, you may use references to any applicable existing documents to satisfy this requirement.

3.4 Loading/Unloading Areas

Describe all loading/unloading areas. Describe the materials that are handled in each area and any management structures or procedures used to minimize potential for spills. Again, you may use references to any applicable existing documents to satisfy this requirement.

3.5 Site Paving and Drainage

Using best available estimates, describe the site paving and drainage. Estimate the percent of the facility that has impervious covering, that is, the percent that is paved or covered by buildings. Describe all paving (e.g., concrete or asphalt). Identify those areas that are not impervious.

Describe the drainage structures for the site, including trenches, storm drain lines, and holding ponds or tanks. Include a discussion of drainage areas that describes what areas drain to each drainage structure. Note that a small site may consist of a single drainage area.

3.6 Storm Drain System

Describe the storm drain system to which runoff from the site will drain. Identify the owner/operator of the system (typically, the city or municipality in which your facility is located) and the nearest receiving water (body of water into which runoff is discharged from the storm sewer). (See Section 3 of this handbook, describing the NOI, for advice on locating your receiving water.) Identify all connections to the storm drain, and certify that no non-storm water discharges to the system are permitted. The certification should include a description of any tests for the presence of non-storm water discharges, the test methods used, dates of testing, and any on-site drainage points that were identified during testing.

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(Section 6 of this handbook describes the process in more detail.)

If this certification is not immediately possible because (a) this requirement necessitates significant structural changes or (b) you have applied for but not yet received an NPDES permit for non-storm water discharges, you must notify the Regional Board, the Program, and local agencies that a non-storm water discharge cannot be eliminated. The notification must include justification for a time extension, and a schedule (subject to modification by the Regional Board) indicating when non-storm water discharges will be eliminated. Note that the elimination of all non-storm water discharges must be complete prior to July 1, 1993.

3.7 Sanitary Sewer System

Describe the sanitary sewer system for the facility. You must certify that there are no connections between the sanitary sewer and the storm water sewer. This certification may be incorporated into the above certification for the storm drain system.

3.8 Underground and Above Ground Storage Tanks

Describe all underground and above ground storage tanks at your site. Describe the materials that are handled in each tank and any management structures or procedures used to minimize potential for spills or leaks. Again, you may use references to any applicable existing documents to partly or completely satisfy this requirement.

4.0 DESCRIPTION OF POTENTIAL SOURCES OF POLLUTANTS IN STORM WATER DISCHARGES

4.1 Potential Pollutants

This section will discuss any materials or wastes that may be potential pollutants to storm water. These will include raw materials used in your process or maintenance activities and products and wastes generated by your process or maintenance activities.

4.1.1 List of potential pollutants to storm water

Identify potential pollutants that have a reasonable potential to be present in storm water. Any materials that are handled or stored out of doors (even for short time periods such as during delivery) should be listed. Potential pollutants may include raw materials, products, or wastes. Potential pollutants may derive from process or maintenance activities. Be sure to include potential pollutants not directly related with your processes (for example, materials associated with vehicle maintenance). Dust or other particulate matter generated by your site activities should be included. If your facility includes unpaved areas that are bare (no vegetation), eroded soil should be included as a potential pollutant.

4.1.2 Estimate of annual quantities of potential pollutants in storm water runoff

Identify those potential pollutants that may be present in strom water in significant quantities. Include any materials or wastes that are stored outside or in uncovered areas for any length of time. Include materials that are delivered or picked up on a regular basis and/or that have been leaked or spilled in the past (for example, bags of powdered raw materials that have been dropped and/or ripped, fuels, oils, or liquid raw materials or product that have been spilled or dripped).

Estimate the annual quantities of each of these identified potential pollutants that may be present in run off. Utilize any existing sampling data describing pollutants in storm water discharge. If you have no sampling data you may have to give rough initial guesses that will be verified by later sampling and analysis activities.

You may feel that your pollutant containment structures coupled with your management practices (e.g., spill prevention and response, erosion control, employee training, storm water treatment

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proceudres, etc.) are such that the annual quantities of the identified potential pollutants in storm water are likely not significant. If this is the case you may state this in this section. Be sure to document your containment and management practices thoroughly in the management section of the SWPP Plan (Part 2).

If you have identified potential pollutants that may be present in significant quantities in run off, but you have also developed management or containment practices that are to be initiated soon to eliminate or minimize the pollutants, you may summarize the practices here. Upon implementation, you may establish that the pollutants are no longer likely to be present in significant quantities in run off. This will likely require some sampling and analysis activity, but it may then also minimize your strom water monitoring requirements.

4.1.3 Existing sampling data describing pollutants in storm water discharge

Provide any existing storm water analytical data. Data summaries may be provided in tabular or text form. Graphs or other pictorial data representations may also be included.

4.2 Isolation of Storm drain from Sanitary Sewer

Summarize inspection, testing and other information that documents that your sanitary sewer lines do not discharge to the storm drain at any point. This information may be brief if it is provided in more detail in Part 3 of the SWPP Plan.

4.3 Handling of Liquids and Dry Bulk Materials

Identify any materials handling that may serve as a source of potential pollutants to storm water run off. Describe practices used in materials handling to minimize exposure of pollutants to storm water.

4.4 Equipment Maintenance and Cleaning

Describe equipment maintenance and cleaning procedures that are used to:

- Ensure that equipment is operating properly, and
- Minimize potential contact between storm water run off and materials and wastes associated with maintenance/cleaning activities.

4.5 Waste Collection, Recycling, and Disposal Practices

Describe waste handling practices used to minimize potential contact between wastes and storm water run off. Be sure to discuss methods of waste storage prior to final disposal or removal from your site. Identify any areas where wastes may be directly exposed to storm water (e.g., scrap metal yards, open waste bins or burial areas). Discuss any proposed improved management practices that will eliminate these potential exposures.

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5. SWPP PLAN PART 2: STORM WATER MANAGEMENT CONTROLS

This section is not yet complete at the time of publication for the March 1992 workshops. Further information will be provided in future updates to this binder.

Part 2 of the SWPP Plan is a description of storm water management controls that you commit to implementing at your facility. The intention is for you to develop an integrated approach to controlling storm water pollutants from industrial activities at your facility. The SWPP Plan should show how your facility will prevent pollutants that originate in industrial activities from contaminating storm water.

Part 2 of the Plan is centered on a list of storm water management controls that you commit to implementing at your facility. You are expected to develop your own list of controls, and to address effectively all of the sources identified in Part 1 of your SWPP Plan.

This is another part of the General Permit where you must develop your own site-specific plan. Neither the Regional Board nor any other agency is prepared to develop a specific list of requirements for you. The Regional Board presumes that the facility operator knows the facility best, and is best qualified to develop controls that will control storm water pollution at that facility. If you find a particular source of pollutants to be difficult (or costly) to control, it may be to your advantage to take steps to eliminate it instead.

Storm water management controls to consider for this part of your SWPP Plan may include a number of approaches:

- operating changes that will not interfere with industrial activities, but may prevent pollutants from contacting storm water;
- improved maintenance activities that will prevent inadvertent leaks and spills that may reach storm water;
- structural changes to the facility; and
- equipment that may be installed to remove pollutants from storm water before discharge.

The General Permit directs you to consider certain kinds of controls, as shown in the box on this page. The Regional Board has indicated that it will require Part 2 of your SWPP Plan to include controls from each of these categories, or, if no controls from a particular category apply to you, to demonstrate that you have considered the category and to demonstrate why no controls apply. Further, the General Permit specifies that every facility's operators implement some particular aspects of storm water pollution prevention. For example, every facility is expected to conduct employee training, perform periodic inspections, and keep records on the premises. These, too, are shown in the box.

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Storm Water Management Controls: The General Permit's Categories

Storm water pollution prevention personnel
Preventive maintenance
Good housekeeping
Spill prevention and response
Source control
including use of alternative raw materials that have less environmental impact
Storm water management practices
(i.e., treatment devices or practices)
Sediment and erosion prevention
Employee training
Inspections
Records

Source: NPDES Storm Water General Permit for Santa Clara Valley, order no. 92-011, January 1992; Part A, no. 6, sections a - j.

A number of guidance documents are available that provide assistance in identifying, developing, and selecting storm water management controls. A term that is commonly used for these controls is Best Management Practices, or BMPs.

The NPS Program is developing a BMP Manual that concentrates on operational procedures for manufacturing facilities. It is expected to be available in the spring of 1992. (For readers who receive this handbook as part of the NPS Program's Industrial Compliance Binder, a draft of the NPS Program's BMP Manual is included in Part VI of the Binder.) The State of California is developing a BMP Manual that is expected to include design specifications for equipment and structural BMPs. It is expected to be available during the summer of 1992.

As stated in Section 4 of this handbook, the General Permit requires that you prepare the SWPP Plan by October 1, 1992. The controls that you identify in the SWPP Plan do not all need to be implemented at once. The General Permit specifies that you implement maintenance practices and other low-cost practices by October 1, the date your SWPP Plan takes effect. All other controls that you identify in your Plan are to be implemented no later than July 1, 1993. This allows you an additional reasonable period to implement measures such as structural changes, equipment installation, other costly measures, and measures that require a lead time to obtain approval from public agencies (such as a construction permit or a sanitary sewer discharge permit).

The deferment period also allows you several months' lead time to implement some lower-cost, operational controls before implementing the higher-cost measures that you commit to in your SWPP Plan. If monitoring results from the 1992-1993 wet weather season demonstrate (to your satisfaction, and the Regional Board's) that the low-cost controls are adequate by themselves, you may not have to install the more costly measures. This is a powerful incentive to find the most effective operational controls possible, and to implement them to the utmost at your facility. It is also yet another incentive to eliminate industrial activities exposed to storm water thus eliminating potential sources and avoiding the need to control them.

ORGANIZATION OF THIS SECTION

This section of the handbook is not yet complete as of the current draft publication date (March 9, 1992). Further material will be prepared during spring and summer 1992 and will be available to you then. This section will provide guidance on how to evaluate your facility and select a reasonable set of storm water management controls that meet your facility's characteristics and are both cost-effective and effective at preventing pollution.

Two parts of this section are complete at this time. The first, "Order of Preference in Selecting BMPs," is some general guidance. The second part is line-by-line guidance for completing the SWPP Plan Part 2.

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ORDER OF PREFERENCE IN SELECTING BMPs

As you can easily see, there is a wide array of possible BMPs that can provide some storm water pollution prevention. For every particular facility, some BMPs are more effective than others. But in nearly every case, a number of different BMPs or approaches using a combination of BMPs could do the job, perhaps equally as well as another approach. As a general rule, we recommend selecting BMPs from the following hierarchy. This order of preference is generally most effective at minimizing pollutants in your storm water discharge, and often most cost-effective in the long run as well.

1. **Alter the activity** to avoid contaminating storm water, either by avoiding creating a pollutant or by making sure the pollutant never reaches the environment. If you operate a "conditional" facility, and you eliminate all potential sources, you can avoid the costs of regulation and monitoring under the General Permit.

2. **Enclose the activity** in a building or a fully-bermed and roofed area, or take other steps so that no contaminants reach the storm drains, paved surfaces where they easily wash into the storm drains, or unpaved surfaces where they sorb to soil particles that may wash into the storm drains.

3. **Cover the activity** to keep storm water off, perhaps using tarpaulins or temporary covering that is watertight for the duration of a storm. This may not be quite as effective as fully enclosing the activity, but may be employed quickly to avoid contaminants contacting runoff from a particular storm.

4. **Segregate the activity** so that contaminants reach only a small portion of the storm water that runs off your site. This includes preventing runoff from the activity from reaching other storm water, and preventing rainfall from other parts of the site from running across the activity and becoming contaminated. The volume of contaminated water from the activity can then be kept to a minimum and handled by one of the following two methods. Remember that runoff from parking lots, commercial activities and other non-industrial activities at the facility does not need to be covered under the General Permit if it is segregated from water that contacts industrial activities.

5. **Reroute the activity's wastewater** to the sanitary sewer or to your on-site pretreatment facilities. Most sanitary authorities prefer to avoid adding rainwater to their treatment capacity, but if you cannot avoid contaminating the water you must obtain a sanitary sewer discharge permit. At present in the Santa Clara Valley, the wastewater authorities will require a pretreatment device on any discharge before they will accept it. Depending on the nature and volume of your wastewater, they may have other requests.

6. **Treat storm water that contacts the activity** before discharging it to the storm drains. This often is the most costly approach, but may occasionally be necessary if other options fail. It is often also the least effective at minimizing pollutants. The order of preference suggests that you implement all applicable pollution prevention BMPs first, but if storm water still contacts contaminants, and it cannot be accepted by the wastewater authority, then treatment BMPs may be called for.

The Program thanks the Washington State Dept. of Ecology, which developed the Storm Water Management Manual for the Puget Sound Basin, from which this list is borrowed and adapted.

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LINE-BY-LINE GUIDANCE FOR COMPLETING THE SWPP PLAN PART 2

This section contains guidance on preparing Part 2 of your SWPP Plan in a way that conforms to the specific items called for in the General Permit (Part A, Provision 6). The headers are numbered to correspond to sections of the sample SWPP Plan, prepared by the NPS Program, that appears in the appendices. These sections begin with number 6 because numbers 1 through 5 refer to sections of Part 1 of the SWPP Plan.

6.0 SITE OPERATIONS AND MANAGEMENT PRACTICES

This section of your SWPP Plan consists of information regarding operations and management practices and controls used at your site to minimize potential discharge of pollutants to storm water. Many of the items required in the section may be partially or completely covered in your Spill Prevention, Control, and Countermeasures (SPCC) plan or other existing documents. You may use references to these documents; however, note that the requirements here refer particularly to storm water pollution prevention. If practices described in existing documents do not address storm water considerations, you should address those considerations here.

The controls and practices described in this section will be critical to the level of effort that will be needed for you to meet the requirements of this permit. If you demonstrate that your controls (e.g., containment, isolation and separation of wastes and materials) effectively minimize potential for pollutant contact with storm water and that your management practices (e.g., maintenance, spill prevention and response, erosion controls, training) are sufficiently well-designed to minimize accidental discharges and their impacts, you will significantly reduce the list of potential pollutants at your site. This will result in a lower level of effort required for permit completion and for monitoring.

6.1 Structural Source Controls

Structural source controls refer to the permanent structures at your site that are used for potential pollutant containment and isolation. All such structures should be described in this section. In addition, any structures that are planned or under construction should be discussed. The form of the control and the scheduled completion date for construction should be provided.

6.1.1 Secondary containment and roofing of potential pollutants

Identify secondary containment structures for all potential pollutants. Such structures may include berms, dikes, or roofed enclosures. However, note that such secondary containment, even complete enclosure in a building, does not necessarily eliminate a material as a potential pollutant. Activities such as washdown of associated equipment or transport of materials between areas may result in potential pollutant discharge. These possibilities should be carefully considered when designing containment structures and associated management practices.

6.1.2 Separation and structural isolation of wastes

Identify structures used to separate and isolate wastes in each area of your site. Such structures may include sumps or tanks used to collect or store wastes prior to recycling or disposal.

6.2 Management Practices

This section should describe management practices you use to reduce contact between storm water and potential pollutants. As discussed above, these practices, in conjunction with effective control structures, can greatly reduce the effort required to comply with permit requirements. All pertinent management practices should be thoroughly explained in this section. Further, any management practices scheduled for

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implementation should be identified (along with scheduled implementation date).

Management practices described in existing documents may be included in your SWPP Plan by reference. However, you should be sure that the referenced practices are appropriate for storm water pollution prevention.

6.2.1 Spill prevention and response procedures

Describe the spill prevention and response procedures used at your site. Note that such procedures may vary according to the various kinds of potential pollutants. Effective procedures should be described for all potential pollutants. Identify areas where significant materials can spill into or otherwise enter the storm water conveyance systems. Describe specific material handling procedures, storage requirements, clean up equipment and procedures. Identify the available spill clean up equipment and describe training for all personnel in use of the equipment and in spill response in general. Identify the internal spill reporting procedures used at the site.

If you have an SPCC plan for controlling hazardous materials on your site, you may incorporate it by reference into your SWPP Plan, and do not need to describe those controls here.

6.2.2 List of significant spills since November 19, 1988

Tabulate all significant spills of potential pollutants that have occurred since November 19, 1988.

6.2.3 Maintenance schedules

This section requires you to develop inspection and maintenance procedures for all structures and equipment at your site that are identified in Part 1 as potential sources of storm water pollutants. Maintenance schedules should be provided. Maintenance log books or other records kept at your site should also be described. Preventive maintenance involves inspection and maintenance of storm water conveyance systems, and inspection and testing of site equipment and systems that could fail and result in discharges of pollutants to storm water. Again, information in your SPCC plan (if you have one) need not be repeated.

6.2.4 Erosion control measures

Measures to limit erosion should be described. These may include paving, riprap, revegetation, and slope stabilization.

6.2.5 Personnel responsible for storm water pollution prevention

Identify specific individuals (and job titles) who are responsible for developing, implementing and revising the SWPP Plan. Update this section each year when you conduct the annual evaluation and revision of the SWPP Plan.

6.2.6 Employee training

Describe your employee training program. The program should be used to educate all personnel responsible for implementing the SWPP Plan. Training should address spill response, good housekeeping, and material management practices. Identify the periodic dates for training of all personnel.

6.2.7 Industrial storm water discharge treatment procedures (if any)

Describe any existing or planned storm water discharge treatment procedures.

6.3 Inspection Program

Develop inspection procedures to identify evidence of, or the potential for, pollutants entering the storm water discharges. Inspections should be performed by trained personnel. Records of inspections should be maintained for at least five years and will include details of tracking or follow-

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up procedures. Inspections must include:

- Inspection of buildings
- Inspection of loading docks and outside areas
- Inspection of storm water control system
- Facility inspection for verification of SWPP Plan accuracy

6.4 Record Keeping and Reporting Procedures

Describe your record-keeping and follow-up procedures to ensure that corrective actions have been taken in response to results of inspections and/or spill response.

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6. NON-STORM WATER DISCHARGE ELIMINATION

A non-storm water discharge is any discharge other than storm water that flows into a storm water conveyance system or receiving water. It commonly consists of process water, wastewater, or washing water that is improperly plumbed so that the discharge enters the storm system. It may also include materials such as oil or hazardous materials that are dumped or improperly disposed of to the storm system. Improper plumbing connections are frequently referred to as "illicit connections"; however, non-storm water discharges may result from inadvertent as well as intentional sources. For example, floor drains in older industrial facilities may be plumbed to discharge into the storm drain, which was acceptable practice in the past. Unauthorized discharges to the storm drain, whether they are intentional or inadvertent, fall into a category that the General Permit defines as "illegal dumping."

Discharges of non-storm water resulting from such illicit connections and other improper discharges are of concern because they may be sources of pollutants in storm water. While some non-storm water discharges are not harmful, the regulations prohibit use of the storm drain system for their discharge. With certain reasonable exceptions, storm water conveyance and receiving waters should receive only storm water. Table 1 of the General Permit (reproduced on the following three pages) lists a number of common water wastes from industrial plants and indicates whether they are allowed to be discharged to the storm drain.

ORGANIZATION OF THIS SECTION

This chapter defines and describes the problems associated with non-storm water discharges to separate storm sewer systems and receiving waters. It describes various methods available to identify and eliminate non-storm water discharges and discusses the steps involved in obtaining a certification that such discharges have been eliminated. This certification is required by the California general permit.

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IDENTIFYING IMPROPER CONNECTIONS

As stated above, the General Permit requires that you investigate your facility, identify any improper connections that may exist, and eliminate them. There are several methods available for identifying such connections. The General Permit does not specify which method you must use, so you should read through the various methods and select one that best fits your needs.

Piping Schematic Inspection/Visual Inspection

At many smaller or less complex facilities, it may be possible to identify improper connections by reviewing piping schematic drawings and performing several spot checks to verify their accuracy. Many facilities (particularly newer facilities) have carefully-drawn plans that illustrate piping connections, locations of floor drains, sanitary lines, storm drains, and water supply lines. To perform the inspection, trace each discharge line to its intersection with a major trunk line. Floor drains, sanitary lines, process and wastewater lines, etc. should not discharge to the storm drain system. As you do the inspection, note the locations where any non-storm water lines are connected to the storm drain system. If no such connections are apparent, spot check several connections shown on the plans to ensure that the plans are accurate.

If you do not have piping schematics for your facility or if the schematics are incomplete or inaccurate, you can try to trace pipes visually to see where they discharge. If this is not possible, you should use a different identification method, such as one of the tests described below.

Smoke Tests and Dye Tests

At many facilities, it may not be possible to identify improper connections through simple inspection of piping schematics. In this case, it will be necessary to perform physical tests on the piping system. Smoke tests and dye tests allow you to trace the pipes to observe where they discharge.

The two tests are described in some detail below. However, unless your employees have specific experience in conducting these tests, you should retain a qualified person or contractor to perform them, since the procedure is complex and can yield inaccurate results if improperly performed.

Smoke Tests. A smoke test is performed by injecting a slug of non-toxic smoke into a pipe (e.g., floor drain) and tracing it to its ultimate discharge point. The smoke will travel along the pipes and into whatever conveyance to which the pipe connects. For example, improper connections may be identified if smoke is seen rising from storm drain catch basins or culverts.

Dye Tests. In other facilities, use of dye tests is more appropriate. Dye tests follow a similar principle to smoke tests in that a slug of non-toxic dye is injected in water at one end of the pipe and is traced to its discharge point. If dye is observed in the storm drain system, then the pipe is improperly connected.

Television Camera Survey

Finally, there is a more advanced—and consequently more costly—method of identifying improper connections by using a television camera specially designed to work inside a pipe. Such cameras can "see" the inside perimeter of the pipe as they are moved along the length of the pipe. All connections coming into the pipe can be observed, as well as the ultimate discharge point.

While this method yields the most complete information of all methods described here, it is costly, and thus is not recommended except for very large, complex facilities. Note that TV camera surveys must be performed by a qualified contractor.

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ELIMINATING IMPROPER CONNECTIONS

The methods described above have to do with identifying improper connections. If any of your inspections reveal such a connection, the next step is to eliminate it. Eliminating an improper connection may require expensive plumbing work to re-route discharge points. For example, all floor drain connections to the storm system must be changed so they connect to the sanitary system or process/wastewater discharge line. The certification required for the general permit cannot be completed until every improper connection is eliminated.

ILLICIT CONNECTION ELIMINATION CERTIFICATION

Once you have completed your inspection and eliminated all improper connections at your facility, you can complete the required certification. The certification must be completed prior to implementation of the storm water pollution prevention plan, or *before October 1, 1992.*[*] It should include a signed statement that all illicit connections have been eliminated. In addition, it should include:

- Facility name and address
- Description of all tests and specific methods used to identify the presence of non-storm water discharges
- Dates of testing
- Any on site drainage points observed during the testing
- Signature of facility officer

In the event that you cannot obtain the certification prior to October 1, 1992, you should notify the Regional Board and the Santa Clara Valley NPS program, in writing (before October 1, 1992) and request an extension. You will be required to provide justification for the requested extension, along with a schedule and date by which you will eliminate the connection(s). The time limit for completing the elimination is three years from the date you submit your NOI, or by July 1, 1993.

An example illicit connection elimination certification is provided in Section V-4, below.

Signatory Requirements

A certification that all non-storm water discharges have been eliminated must be certified and signed. Signatory requirements are as follows:

- For a corporation: a responsible corporate officer
- For a partnership or sole proprietorship: a general partner or the proprietor, respectively
- For a municipality, State, Federal, or other public agency: either a principal executive officer or ranking elected official.

[*] Note: such certification may be infeasible if major structural plumbing changes are required.

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TABLE 1. DISCHARGE CONTROL OPTIONS

		Preferred Disposal Options				Primary Control Approach			
Type of Discharge	When is the Discharge to the Storm Sewer Permissible	Storm Sewer	Sanitary Sewer	Recycle /Reuse	Hazardous Waste or other Disposal	Public Education	Regulatory	Illegal Dumping and Illicit Connection Elimination Program	Note
17. Uncontaminated Groundwater Infiltration	Always	x		x				x	7
18. Contaminated Groundwater Infiltration	Only if in compliance with NPDES permit	NPDES Permit Required		x				x	7

* except when super-chlorinated or chemically cleaned - then discharge goes to sanitary sewer

** except when it is contaminated and the situation allows for containment and offsite disposal

‡ [Note from the Santa Clara Valley NPS Program: We interpret this to mean that a storm water NPDES permit may be required.]

Notes:

1. The illegal dumping program should concentrate on eliminating the dumping of oil, anti-freeze and other pollutants in industrial and commercial areas. The public education program will concentrate on eliminating dumping in residential areas.

2. It would be impracticable to prevent individuals from washing their cars and the illegal dumping program should not devote resources in this area. However, if the public are going to wash their cars, the public education part of the program can provide information to individuals about how to minimize the environmental effects of car washing (biodegradable soaps, wash on permeable surfaces, etc.).

3. All industrial discharges to storm drains should not be permitted. If discharge appears contaminated, then record as an illicit connection or illegal dumping.

4. Chlorinated swimming pool water should not be discharged to the storm sewer. Some sewer districts do not allow swimming pool water to the sanitary sewer. In these cases the water will have to be dechlorinated before discharging to the storm sewer. Filter back wash water is not allowed in the storm sewer and must go the sanitary sewer. Public education program needed.

5. Cooling water should always have a NPDES permit to discharge. Recycle is checked as a preferred disposal option. This is not practicable for all industries. Where possible, industries should be encouraged to either construct cooling ponds so the water is reusable or possibly find other uses on site for the water.

6. Wash waters from commercial and industrial facilities include runoff from vehicle and equipment washing, steam cleaning and cleaning of areas used for industrial or commercial activities.

7. Check with SCVWD to determine if site is located within a known groundwater contamination plume.

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TABLE 1. DISCHARGE CONTROL OPTIONS

Type of Discharge	When is the Discharge to the Storm Sewer Permissible	Preferred Disposal Options: Storm Sewer	Sanitary Sewer	Recycle /Reuse	Hazardous Waste or other Disposal	Primary Control Approach: Public Education	Regulatory	Illegal Dumping and Illicit Connection Elimination Program	Note
1. Residential Lawn Irrigation	Always	x				x			
2. Dumping of oil, anti-freeze, paint, household liquids	Never			x	x	x		x	1
3. Residential Car Washing	Always	x				x			2
4. Commercial Car Wash	Never		x	x				x	
5. Industrial Discharger (excluding cooling water)	Never		x	x	x when above pretreatment limits			x	3
6. Swimming Pool Water	only when dechlorinated	x		x		x			4
7. Water Line Flushing	Always*	x		x					
8. Fire Fighting Flows	Emergency Only	x			x when heavily contaminated				
9. Potable Water Sources	Always	x		x					

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TABLE 1. DISCHARGE CONTROL OPTIONS

Type of Discharge	When is the Discharge to the Storm Sewer Permissible	Preferred Disposal Options: Storm Sewer	Sanitary Sewer	Recycle /Reuse	Hazardous Waste or other Disposal	Primary Control Approach: Public Education	Regulatory	Illegal Dumping and Illicit Connection Elimination Program	Note
10. Uncontaminated Foundation Drains	Always	Permit Required ‡		x				x	
11. Contaminated Foundation Drains	Never		x	x				x	
12. Pumped Groundwater for Clean-up Operations	Only if in compliance with NPDES permit	NPDES Permit Required		x				x	
13. Cooling Water	Never unless no chemicals added and has NPDES permit	Permit Required ‡	x	x				x	5
14. Roof Drains	Always except when contaminated or drains industrial area	x					x		
15. Air Conditioner Condensation	Always	x							
16. Wash waters from Commercial Industrial Facilities	Never		x	x				x	6

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7. MONITORING PROGRAM

Section B of the General Permit requires each facility to prepare and implement a Monitoring Program. Industrial facilities are to collect storm water samples at all discharge points from their site, and have the samples tested in a laboratory to see whether they contain substances considered pollutants that should not be discharged to the creeks of Santa Clara Valley and the San Francisco Bay.

The Monitoring Program, like the SWPP Plan, is to be completed by October 1, 1992 and held on your site for inspection by the Regional Board or municipal agencies. Monitoring begins for regulated industrial facilities during the 1992-1993 wet weather season; officially, each year's wet weather season begins on October 1.

You will need to collect samples of storm water at least twice during the 1992-1993 season, including the first storm event of the season. The second sampling may be conduted during any storm event of the season but should have volume and duration that are *representative* for the area.

Your Monitoring Program must also specify which substances you will instruct a laboratory to look for when it chemically analyzes the storm water sample. This is an important determination, because you must pay the laboratory for each chemical analysis it conducts, and some analyses cost more than others. Several chemicals must be analyzed by all facilities; however, in addition, you should sample for any other toxic substances that you believe may be present in the runoff, and other substances that may be needed to characterize your facility. These substances will be determined by the potential sources of storm water pollution identified in Part 1 of your SWPP Plan.

To be less burdensome to the regulated community, the General Permit includes a provision for industrial facilities to participate in a Group Monitoring Plan, so that not every facility needs to collect storm water samples and pay for laboratory analysis.

Contents of Monitoring Program

Rationale for selection of methods
Parameters to be analyzed for
Analytical methods to detect parameters
Quality assurance/quality control program
Procedures and schedules to periodically evaluate effectiveness of Monitoring Program

Monitoring Program Activities: To be Conducted Each Wet Season

One storm event per month:
- Conduct visual observations of each storm water discharge point for visible pollutants (as specified)

Two specified storm events:
- Measure or estimate total volume of discharge
- Collect samples
- Analyze samples for specified parameters

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ORGANIZATION OF THIS SECTION

This section of the Handbook is not yet complete as of the publication date (March 9, 1992). This section will provide: guidance on how to develop a facility-specific Monitoring Program; description of technical methods such as field sampling procedures; determining when a sample is representative; laboratory analyses that can be expected; and general cost information for various types of monitoring and analysis. It will also describe monitoring options a facility may elect, group monitoring plans, and options the Santa Clara Valley NPS Program may provide to supplement or replace facility requirements.

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SAMPLE COMPLIANCE
DOCUMENTS

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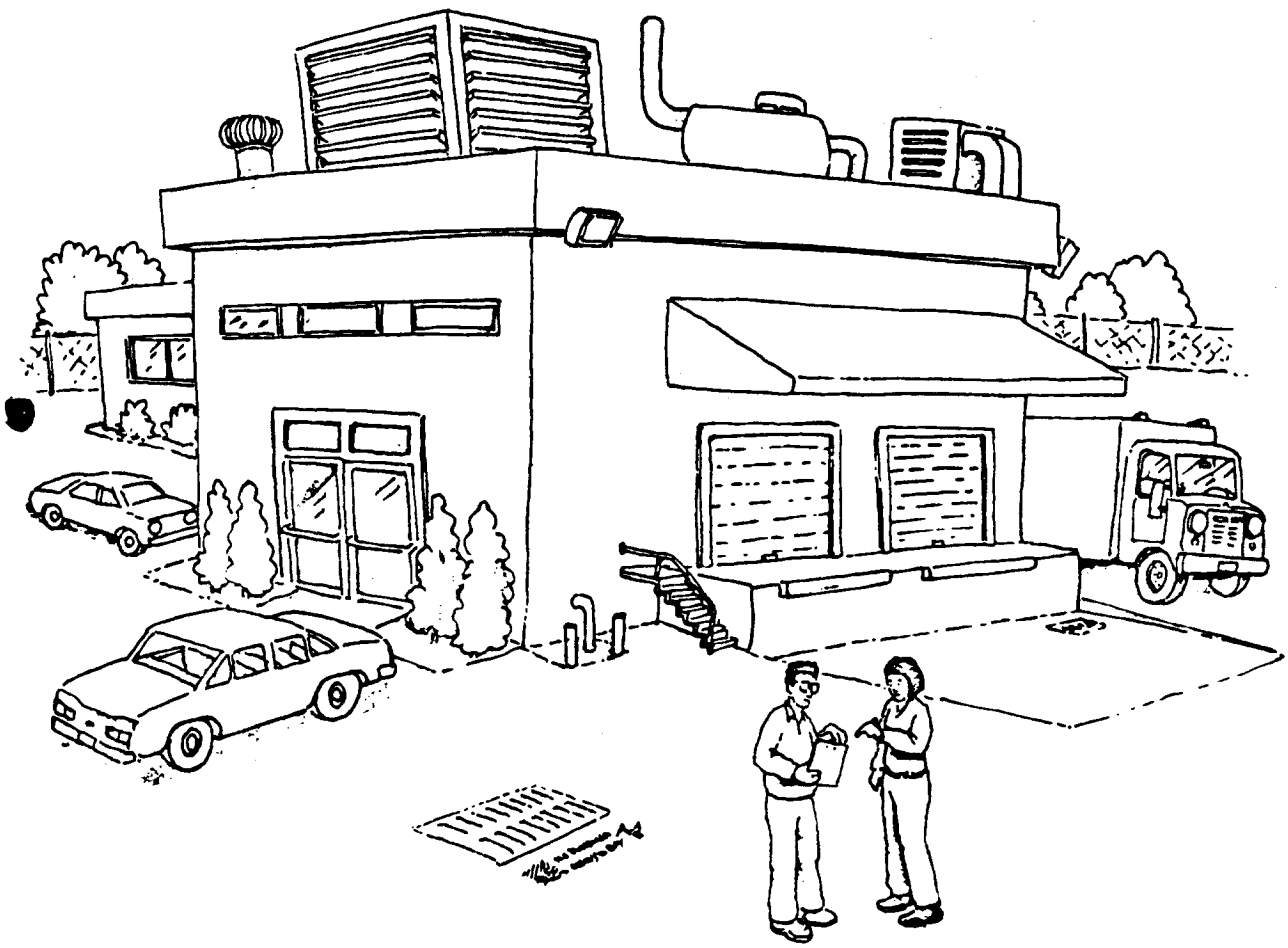
SANTA CLARA VALLEY
NPS PROGRAM BMP MANUAL

R0059495

Best Management Practices for Industrial Storm Water Pollution Control



Santa Clara Valley
Nonpoint Source
Pollution Control Program

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Introduction: Storm Water Pollution Control for Industrial Facilities

Storm water is a source of pollutants in San Francisco Bay. Storm drains carry runoff from streets, urban centers, industrial sites, and open spaces into streams, creeks, marshes, and Bay waters. Industrial operations are only one contributor to this problem, but they are known to be a source of heavy metals, oily wastes, and other substances. Manufacturing, shipping, and storage operations that are exposed to storm water can be sources of pollutants in storm water.

Federal and state storm water regulations now require many kinds of industrial facilities to take steps to prevent storm water pollution. Your facility may need to be covered under the Regional Board's January 1992 Industrial Storm Water General Permit for the Santa Clara Valley. If so, you need to prepare a ***Storm Water Pollution Prevention Plan***, or SWPP Plan, that is in part a collection of BMPs like the ones described in this manual. If your facility is *not* covered under the General Permit, you may still need to implement BMPs to comply with local pollution prevention requirements.

Storm water pollution, unlike some pollution problems, cannot be covered by one set of rules that applies to all industrial facilities. Regulated industrial facilities in the Santa Clara Valley range from manufacturing facilities that cover several square miles to storefront distributors. Different plants can have very different storm water quantities, flow patterns, and potential pollutants. Even different facilities of the same general industry may need different approaches to preventing storm water pollution.

The BMPs in this manual are recommended by the Santa Clara Valley Nonpoint Source Pollution Control Program to help you prevent storm water pollution; protect water quality in streams, the groundwater basin, and the Bay; and comply with storm water regulations. This manual is intended to help you identify and implement the best practices that are necessary and economically feasible for your facility to prevent storm water pollution.

The BMPs include both operating practices and structural controls that can reduce the amounts of pollutants in storm water. You need to determine which of these may apply to your facility, and implement them as necessary. Specific regulations may vary from one municipality to another, so you should become familiar with local storm water ordinances in your community.

This manual consists of two parts. The recommended BMPs in Part 1 are basic, everyday operational practices and relatively small structural or equipment requirements that can be effective in ***preventing*** pollution, reducing potential pollutants ***at the source***.

In many industrial facilities, storm water pollution can be prevented with common-sense precautions and modest changes in routine operations or maintenance practices. The numbered sections are keyed to some industrial operations that are common to many kinds of facilities. The sections describe BMPs that typically can be applied to the operations. These practices alone might be sufficient to control storm water pollution for some industrial facilities.

In other cases, to prevent storm water pollution it will be necessary to establish new practices or build physical controls. Part 2 of this manual consists of "advanced management practices." The advanced BMPs require more costly or more intensive efforts to address pollutants that are not adequately controlled by the simpler operational BMPs. The advanced BMPs describe possible approaches if you need to go beyond the Part 1 BMPs.

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Recommended BMPs for Storm Water Pollution Prevention

Part 1 of this manual contains BMPs that are recommended to control storm water pollution from particular industrial activities. Part 1 is divided into numbered sections. Each section describes industrial activities common to many kinds of industrial facilities, and contains a collection of BMPs tailored to that kind of industrial activity or operation.

As a rule the recommended BMPs in this part of the manual are intended to describe "state of the practice." These are the preferred operational techniques that pertain to each of the industrial activities, recommended to control potential storm water pollution that could result from that activity. Many of these practices are straightforward housekeeping activities, and many may already be in place at your facility. In general, the recommended BMPs are *pollution prevention* measures: they are geared toward reducing pollutants at the source, preventing the release of potential pollutants to storm water.

The recommended BMPs are to be implemented on an ongoing basis for the indefinite future. Operators of industrial facilities in the Santa Clara Valley should expect to implement these BMPs or similar controls, wherever they would be effective at preventing pollutants from flowing with storm water from the site.

Review your current operating practices and, where they differ from the Part 1 preferred BMPs, modify your practices and train your employees in the new procedures. You need to evaluate your own facility and decide what works best, because storm water pollution control practices take a number of forms, and may include a wide range of solutions that are not included in this manual. Storm water pollution control may be guided by three general principles:

Prevent water from contacting working areas.

Shipping areas, outdoor equipment, material storage areas, vehicle maintenance spaces, and working areas of all sorts are subject to contamination with raw materials, process liquids, grease, oily wastes, heavy metals, and miscellaneous potential pollutants. If you prevent storm water, wash water, or water from other sources from contacting areas exposed to pollutants, you won't discharge pollutants into your storm drains.

- Keep rainfall from directly contacting working areas, by installing roofs, placing structures, or moving industrial operations indoors.
- Prevent *run-on* storm water from contacting industrial areas, indoors or out by using properly designed berms or grading. Run-on is water that flows across the industrial area. It picks up pollutants as it flows.
- Avoid practices where you use water that later enters the storm drains—for instance, washing in outdoor areas. Most of these practices, including many that were acceptable in the past, are now considered to be "illegal dumping" of non-storm water to the storm drain.

Keep pollutants off surfaces that come into contact with water.

Evaluate your site carefully to identify all areas that are contacted by storm water, wash water, cooling water that is otherwise unpolluted, or other water that is allowed to be discharged to the storm drain. Then take special care to keep pollutants off these surfaces. That means controlling minor leaks and spills that you might otherwise overlook, and taking a close look at your operating routines and equipment to determine whether any substances are exposed to storm water that do not need to be.

Manage storm water before it is discharged to the storm drain.

If you can't avoid adding pollutants to storm water, you may need to remove pollutants to meet water quality requirements before discharge. Storm water control regulations, and this manual, consider treatment as a last resort and emphasize source control options because they are usually less costly and more effective in the long run. In this manual, treatment measures appear only under Advanced Management Practices.

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1. Training and Education for Employees and Customers

Successful storm water pollution control relies in large part on proper training and education of employees. Many of the recommended BMPs in this part of the manual identify specific training needs for employees who conduct the activities. Train your employees in best management practices for storm water pollution control.

Train employees in these BMPs because a single employee's mistake or misunderstanding at the wrong time, in the wrong place, can lead to a costly pollution incident. When you have selected the BMPs that apply to your facility, add training in the BMPs to your regular employee training procedures.

Train employees to routinely inspect industrial activities and equipment that may be exposed to storm water. A once-a-week walk-through can help identify potential difficulties before they become major problems. Inspect structural BMPs to be sure that they continue to function properly.

Continue your training procedures in the future. Assign experienced workers to train new employees. Review procedures as a group at least once a year. You can coordinate this with worker safety training programs or "worker right-to-know" training for hazardous materials.

Periodically check employees' work practices to be sure the BMPs are implemented properly. Post informational and reminder signs, such as: proper equipment wash procedures at designated washing areas; "Close the cover" signs at dumpsters and other storage areas; and others. Stencil "No dumping! — flows to Bay" messages at storm drains. (Stencils are available from the NPS Program.)

Provide general information as well, because employees often respond best if they understand *why* they are being asked to conduct a new procedure. Employees' suggestions in return can help identify cost-effective storm water controls for your facility. Provide positive feedback so employees understand the difference they each make in protecting the Bay.

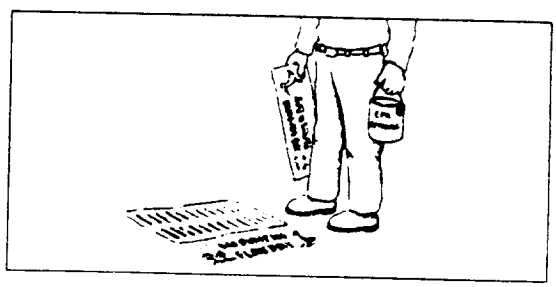
Emphasize the importance of keeping pollutants out of the storm drain, because the drains flow directly to streams and the Bay without benefit of the wastewater treatment that the sanitary sewers receive. Educate plant personnel about the harmful environmental effects of improper disposal of materials into the storm drain, so they understand the importance of preventing storm water pollution. Also, educate employees on what they can do at home to reduce storm water pollution in the Bay. Public information pamphlets are available from your municipality or the NPS Program — see the back cover.

If you subcontract for small construction jobs or other work on your premises, write contracts with your BMPs as conditions. Provide contractors with proper disposal options for wastes. Monitor contractors to be sure they comply with your BMPs.

To keep abreast of new developments, participate in workshops, trade association meetings, and seminars. Trade association publications can be valuable sources of information. Modify your practices whenever you find a new idea that serves your shop better.

If you serve customers at your facility, be aware of customer activities onsite. If they dispose of materials improperly, *you* will be responsible for the violation. Ask your customers not to discard liquids into your trash cans or storm drains. If you have persistent problems, you may need to monitor your customers more carefully at trash cans, storm drains, and other potential disposal areas on your property.

Let your customers know how you are minimizing wastes and recycling fluids to show that you are a "good neighbor," and encourage your customers to be the same. Showing clients what you are doing to protect the Bay is good public relations. Some businesses make the customer aware of their environmental requirements by including a modest environmental compliance fee, itemized on customers' billing statements, to cover handling and disposal costs for hazardous materials.



Label storm drain inlets so employees do not dispose waste there.

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2. Eliminating Improper Discharges to Storm Drains

The Industrial Storm Water General Permit generally prohibits discharges of ***anything but storm water*** to the storm drains. There are many ways in which non-storm water from industrial plants can enter the storm drainage system. In most cases, the discharges result from practices that are now illegal, even though they may be inadvertent or may have been permissible in the past. Industrial process water, building wastewater, and water from other sources are prohibited, with a few exceptions described in Table 1. Inspect your facility and yard to be sure no unauthorized discharges enter your storm drains.

Unauthorized discharges take two forms. **Illicit connections** are improper permanent connections that allow wastewaters to enter storm drains, including some that may have been allowed in the past. Connections that allow sanitary or process wastewater to enter the storm drain are prohibited, including all storm drain connections from indoor drains or sinks. More information on identifying and removing illicit connections is available in the Santa Clara Valley NPS Program's Guide to Compliance with the General Permit.

Illegal dumping is water that has been exposed to industrial activities, and then released to the properly-connected storm drainage system. Pollutants may be introduced to storm drains inadvertently, by routine practices that discharge water outdoors; or by routinely discharging wastes, wash water, and other materials to storm drains, catch basins, and other conveyance facilities either on your property or in the street. A large part of this improper discharge results from employees' lack of understanding, coupled with a lack of readily-available proper routes for the discharge.

You need to make a long-term ongoing effort to assure that no illegal discharges will occur. This requires continuing observation to identify potential sources of intentional or inadvertent improper discharges. Discontinue or re-route the water from those activities. Continuing employee training will be needed. Measures to help prevent illegal discharges include:

- Provide well-marked proper disposal or collection methods for waste water wherever you frequently use wash water, discharge cooling water, or produce a liquid waste that might otherwise reach the storm drain.
- Employee training should especially emphasize proper disposal of non-storm water (see Section 1). Educate employees to understand that storm drains connect directly to streams and the Bay without treatment.
- Label all storm drain inlets and catch basins "No dumping—flows to Bay" so employees will know which inlets are part of the storm drain system.
- Periodically inspect and maintain storm drain inlets. Clean out catch basins so that accumulated pollutants do not wash down the storm drains.

Table 1 is a summary of a 3-page table included in the Storm Water Industrial General Permit for the Santa Clara Valley. The table identifies some common sources of water in industrial plants that can enter storm drains. For each source, the table lists the preferred disposal option for facilities in the Santa Clara Valley. For water that is allowable for discharge to the storm drain, Table 1 lists conditions or restrictions on discharge.

A few discharge categories of special interest are:

- **Cooling tower condensate** for industrial process water must be discharged to the sanitary sewer, with the appropriate permits.
- **Internal coolant** for refrigeration or building air conditioning is prohibited from the storm drains.
- **Building air conditioner condensate** may be discharged to the storm drain *only* if it is not treated with algae inhibitors, corrosion control chemicals, or other additives. Do not allow it to run across parking lots or other paved surfaces that may be contact pollutants on its way to the storm drain; use a pipe or trough to direct the flow. In most Santa Clara Valley cities, the preferred course is to discharge to the sanitary sewer. (Some cities have made this a legal requirement.)

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Table 1. Preferred disposal options for water discharges

Water source	Preferred disposal option	Restrictions or permit needed	Possible options for reuse or recycle
Industrial process wastewater	Sanitary sewer	POTW permit	Reuse in-plant whenever possible.
Non-contact cooling water			
• Uncontaminated*	Onsite reuse Storm drain if reuse is impossible	Storm water NPDES permit	Reuse in closed-loop cooling system (cooling tower).
• Contaminated	Sanitary sewer	POTW permit	Treat and reuse
Industrial cooling equipment condensation		Storm water NPDES permit	Hold and apply to landscape
• Uncontaminated*	Storm drain	Must be tested and shown to be uncontaminated.	
• Contaminated	Sanitary sewer	POTW permit	
Building air conditioner condensation	Storm drain (if city allows)	Some localities require discharge to POTW with permit	
Building air conditioner coolant			Reuse in-plant whenever possible.
• Uncontaminated*	Storm drain	Storm water NPDES permit	
• Contaminated	Sanitary sewer	POTW permit	
Storm water in outdoor secondary containment			
• Uncontaminated*	Storm drain	Test to determine contamination.	Pump and apply to landscaping. (See Section 5)
• Contaminated	Sanitary sewer	POTW permit	
Storm water from outdoor material storage			
• Covered	No discharge	Zero contact with storm water.	
• Open	Storm drain	Water quality inlet or similar treatment. (See Section 20) Storm water NPDES permit	
Roof drain water	Storm drain if no pollutants	Roof vents may be source of pollutants. See BAAQMD air emissions regulations and Section 4.	
Industrial equipment wash water	Sanitary sewer	POTW permit	Reuse in-plant whenever possible
Vehicle maintenance wash water	Sanitary sewer	POTW permit	Capture and reuse for washing
One-time vehicle wash water	Storm drain (See Section 7)	Water only (no soap or solvents)	Minimize water; prevent flow across paved area.
Wash water from paved walkways in commercial and business districts	Storm drain	Sweep sidewalks before washing. No cleaning chemicals may be used.	Minimize water use and direct to landscape.**
Commercial exterior building wash water	Storm drain	Filter prior to entering catch basin.	Minimize water use and direct to landscape.**
Landscape irrigation	Storm drain		Minimize water so none runs off.**
Potable water and potable line flushing	Storm drain	Must be dechlorinated***	
Fire fighting flows	Storm drain	Block downstream channels to detain for testing as hazardous waste.	

Source: Storm Water Industrial General Permit for the Santa Clara Valley, Regional Water Quality Control Board /S. F. Bay Region, January 1992.
POTW permit: Permit to pretreat and discharge is required from your wastewater authority (Publicly Owned Treatment Works)
BAAQMD: Bay Area Air Quality Management District

* Biocides, corrosion inhibitors, or other additives are contaminants from a storm water point of view.

** Must comply with local water use restrictions during drought conditions.

*** Potable water, swimming pool water and other chlorinated sources must be dechlorinated by aeration, retention, or chemical additives to a "no measurable chlorine" standard before reaching receiving water. If the water is not dechlorinated it must be discharged to the sanitary sewer under a POTW permit

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3. Spill Prevention, Control, and Cleanup

Small spills can have cumulative effects that add up to a significant source of potential pollutants in your storm water discharge. The best approach by far is to prevent spills and leaks: maintain a regular inspection and repair schedule, and correct potential spill situations before a spill can occur. Some prevention techniques are described in Sections 4, 5, and 6.

When a spill does occur, quick and effective response is the best way to prevent pollutants from reaching storm water. Prepare a set of well-defined procedures for responding to a spill of any liquids in an area that might be exposed to storm water. The procedures can be specific for your facility, and should consider all circumstances from small, minor releases that can be easily handled to a large emergency spill — including who to call to respond to the situation before it gets out of hand. Train employees in the procedures (Section 1).

The basic procedures should emphasize that spills be cleaned up promptly, not allowed to evaporate. Otherwise, pollutants remain on the pavement and may be washed to the storm drains with the next rain, or will remain in the soil to become a possible groundwater pollutant. If the spill is on an unpaved surface, determine whether you need to remove the contaminated soil to prevent it from being a source of future storm water pollutants.

Also, the standard procedures should specify cleaning up leaks, drips, and other spills without water whenever possible. Do not use a hose or wet mop to clean up a spill area. Hosing may remove the spill from the immediate area, but does not keep the pollutant out of the environment. On the contrary, it adds to the volume of the spill and spreads the spilled material around a larger area.

If you handle hazardous materials, spill prevention and response procedures are described in your hazardous materials management plan, filed with your fire department or other hazardous materials ("HazMat") authority (see Section 6). If a spill occurs, notify the authorities as required in your emergency response plan. Contain and collect the spilled substance, then dispose of the substances and any contaminated soil in compliance with hazardous materials regulations.

Small spills are those which can be wiped up with a shop rag. Don't put wet rags in the dumpster with the shop trash: store them in a covered rag bin, of the kind used at auto service stations. Avoid paper towels. You can avoid making this a waste stream by sending used rags to a professional cleaning service. (You need to inform your cleaning service of what the shop rags have been used for.) Do not saturate rags with gasoline, solvents, or other volatile liquids.

Medium-sized spills are too large to wipe up with a rag and require more attention. Contain and soak up the liquid using dry absorbent material such as vermiculite, specially-prepared sawdust, or "cat litter." Absorbent "snakes" may be used as temporary booms to contain and soak up the liquid. Sweep up the used absorbent and snakes and dispose of them appropriately: with the shop trash if non-hazardous, with the hazardous wastes if necessary. Another convenient option is to use a wet/dry shop vacuum cleaner to collect spills, and dispose of the liquid with your liquid or hazardous wastes. *Do not* use vacuums for gasoline, solvents or other volatile fluids, because the enclosed vacuum may become an explosion hazard.

Larger spills must be contained, then cleaned up. For spills of food waste or other non-hazardous liquid, take steps to contain and clean up the liquid, and minimize the wash water used in cleanup. Shut off or plug storm drain inlets or sewer inlets where the spill may enter. If necessary, keep temporary plugs on hand to fit your inlets and train employees in when and how to use them. For hazardous materials spills, implement your emergency procedures and alert your HazMat authority.



Wipe up small spills immediately with shop rags.

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4. Outdoor Process Equipment Operations and Maintenance

Storm water from your site can accumulate pollutants by exposure to numerous small leaks, spills, and other discharges of outdoor equipment. Large equipment may require specially-designed structural or advanced BMPs to reduce the potential for storm water to contact pollutants. Ordinary precautions, such as those below, may suffice for smaller equipment.

As a first step, identify all equipment at your site that may be exposed to storm water, or may discharge potential pollutants that may be exposed to storm water. Identify the kinds of pollutants each piece of equipment may generate — lubricants, coolants, and other possible sources of leaks or discharges.

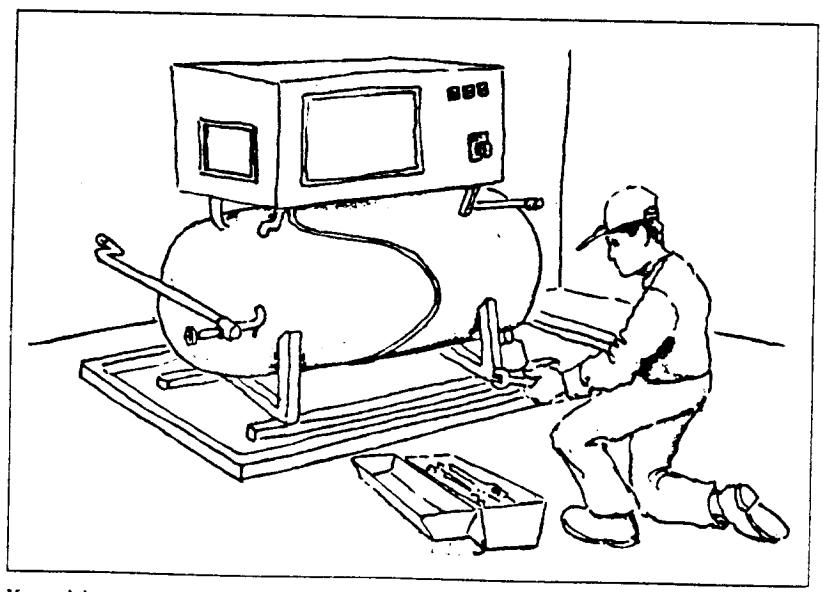
Be creative and thorough in developing your list. The inventory should include rooftop cooling towers or air conditioners; rooftop air vents for industrial equipment; outdoor air compressors and other service equipment; indoor wet processes where leaks or discharges may discharge to outdoor areas; and material transfer areas, such as loading areas where forklifts or trucks may carry pollutants outdoors on their tires.

Using the equipment inventory, assign an employee to inspect each piece of equipment on a regular basis to see that it is functioning properly. This could be the employee responsible for operating the equipment if it is used regularly, or may be a maintenance staff member for equipment on the roof or in seldom-seen places. Inspect for leaks, malfunctions, and staining on and around the equipment, and other evidence of leaks and discharges. Assign the inspecting person to be responsible for reporting a spill. Develop a routine for taking actions on the report: cleaning up the spill, and repairing the leak to prevent future spills.

Where possible, take the next step toward full pollution prevention and make modifications to prevent storm water from contacting the equipment or its discharges. Place equipment on an impermeable surface, or install a drip pan beneath potential leak points. To minimize the amount of rainwater that contacts the equipment, you may construct a simple roof and install a berm to prevent run-on and runoff. If the equipment requires a "wet" process — that is, operations inevitably releases wash water or process liquids — place it on a paved surface and install a connection to the sanitary sewer. Check with your municipality or wastewater authority to identify appropriate permits.

Air compressors and other equipment sometimes produce small quantities of automatic blowdown water, which commonly contains lubricating oil or other potential pollutants. This may not be discharged to the storm drain. Connect the blowdown to the sanitary sewer. Or, if the compressor has a frequent small bleed, place a drip pan or catchment to collect the water — do not let it soak into unpaved surfaces or run off paved surfaces.

Condensate on exterior surfaces of compressors, building cooling equipment, and other machinery need not be collected for discharge to the sanitary sewer, but may be directed to the storm drain. Prevent buildup of puddles or pools of condensate under the equipment; route it to a storm drain so it does not pick up pollutants while it flows across your site.



Keep drip pans under outdoor equipment to contain drips and leaks, especially during maintenance.

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5. Outdoor Materials Storage and Handling

If you handle **bulk solid materials** outdoors, keep them covered, in appropriate containments, and protected from storm water. Apply this policy for raw materials, products, by-products, and construction materials or supplies. Materials of concern include gravel, sand, lumber, topsoil, compost, concrete, packing materials, metal products, and others.

Store the material in one of these ways:

- The preferred method is storage on a paved surface with a roof or covering so that no direct rainfall contacts them, and with appropriate berms or mounding to prevent run-on of storm water. Roofs are required by most municipalities for new facilities.
- Where a roof is not feasible, store on a specially constructed paved area with a drainage system. Pave the area with a slope of about 1.5% to minimize water pooling. Prevent runoff and run-on with berms or curbing along the perimeter. For many materials, the preferred alternative will be the installation of ***no drain*** and the testing and pumping of ponded water to the sanitary sewer, a treatment sytem, or offsite disposal as appropriate. Discharge to the storm drain is not allowed for many materials.
- Where a drain is allowed, install longitudinal drains that lead to treatment facilities or water quality catch basins along the lower edge of the pad. You may need a permit from your wastewater authority to discharge to the sanitary sewer, or may need the Regional Board to allow special provisions in your storm water NPDES permit (the General Permit).
- As a temporary arrangement, place the material on a paved surface and cover it with plastic sheeting, secured with weighted tires or sand bags. If possible, choose a mounded or bermed area that will prevent run-on of storm water through the material. Move the materials to a permanent storage place as soon as possible.

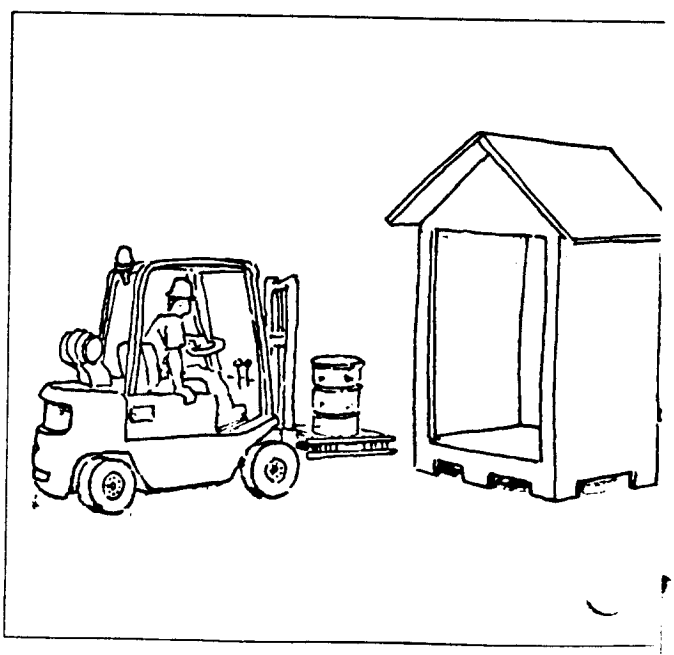
Parking lots or other surfaces near bulk materials storage facilities should be swept periodically to remove fines that may wash out of the materials, which will otherwise wash away with storm water. Larger bulk material storage facilities will need more extensive structural controls designed for the specific facility and material.

Hazardous materials need to be stored in accordance with federal, state, and local HazMat requirements. The requirements are generally more than adequate to prevent storm water pollution — for instance, HazMat secondary containment may have ***no drain***.

If you store **liquid containers**, implement a plan and a design to control unexpected leaks and spills so the liquid does not reach storm drains or surfaces that will be exposed to storm water. If you store hazardous materials, the spill prevention plans required by your HazMat authority are adequate to ensure storm water protection. Non-hazardous materials storage should also incorporate spill control designs and procedures.

Select a storage method appropriate for the type of material. Keep liquid tanks in a designated area on a paved impermeable surface and within a berm or other secondary containment. Keep outdoor storage containers especially in good condition. Inspect containers regularly for damage or leaks, as described

"Doghouse" sheds are one way to keep storm water away from barrels and materials kept outdoors, and provide spill control at the same time.



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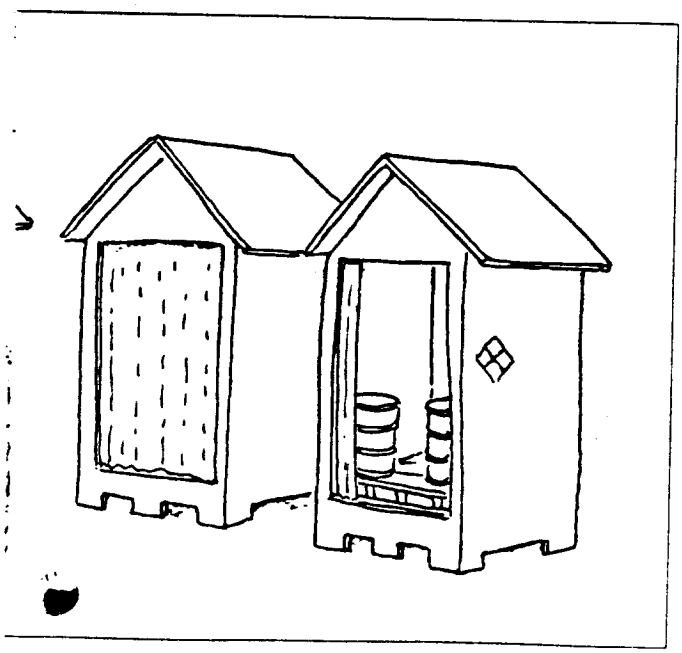
in Section 4. Clean up any leaks or spills immediately (using dry methods, described in Section 3), and repair the leaks promptly.

If the materials frequently leak during transfer, or the materials generally cause a wet environment when using or storing them, the area may need to be connected to the sanitary sewer (permitted by your wastewater authority), and should be covered and bermed to minimize contact with storm water.

Some localities *require* that secondary containments be connected to sanitary sewers, and prohibit any hard-plumbed storm drain connections within the secondary containment. On the other hand, large storage facilities and tank farms that have high-capacity bermed areas may receive rainfall over a wide area, and much of it may not contact the tanks or equipment; these might be better-served by a storm drain. As a rule, large facilities like this need site-specific storm water pollution prevention designs.

For smaller storage tanks, storage in roofed areas can prevent all contact with storm water (in combination with well-designed spill control procedures). Store liquids in a shed where one is available. New sheds, even if temporary, can be costly because of building permits and fire-code requirements. A possible option is the "doghouse" design used by some firms (illustrated). The roof and flooring prevent contact with direct rain or run-on storm water. Since it has only two walls, most fire departments do not require sprinklers. The flooring is wire mesh above secondary containment, so most HazMat authorities accept the structure for storing hazardous materials. (A permit may be required by local building or planning departments.)



Storm water in secondary containments often accumulates from direct rainfall into open containments. Water that has contacted storage vessels, or the pumping and transfer equipment associated with storage and handling, is considered to have contacted industrial activities and may not be discharged to the storm drains.

You may wish to roof the containment to avoid this problem. If that is not possible, or you wish to avoid the cost, you need to identify an acceptable disposal for water from the containment. One common solution is a portable pumping system that can be moved to accommodate separate containment structures on your site. The equipment can pump water into a truck or portable temporary holding tank. The water then can be tested and disposed according to whether any pollutants are present. Some disposal options are:

- If it meets criteria to be defined as hazardous waste, employ a certified hazardous waste hauler for disposal at a permitted hazardous waste facility.
- If it contains constituents similar to process wastewater for which your onsite wastewater pretreatment facilities are designed, pretreat the water and discharge to the sanitary sewer.
- If it meets standards for your industrial discharge permit, discharge it to the sanitary sewer without pretreatment (if your wastewater authority permits).
- Reuse it on your site in an appropriate manner: industrial process water, equipment wash water, steam cleaning makeup, or another use where the water will eventually be discharged as industrial or sanitary wastewater. You may need to invest in a truck or plumbing to convey the water to its reuse location.
- If it is free of hazardous constituents, use it on your facility grounds for landscape watering. Don't apply the water to landscaping if hazardous pollutants are present — even if not concentrated enough to be hazardous waste — because the pollutants may accumulate in the soil or vegetation, and create a health hazard over the long term.

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6. Waste Handling and Disposal

Table 2 summarizes the preferred storage and disposal practices for some common industrial facility wastes. For many wastes, reusing or recycling is the most cost-effective means to prevent potential pollution. Fluids that you hold for recycling are special categories of hazardous waste. You may store them on your site only for short periods, in accordance with hazardous waste requirements, but they can be transported under somewhat less stringent requirements than other hazardous wastes. Many recycling services have special variances or permits that reduce your paperwork requirements and allow shipping at reduced cost.

Keep general shop trash in a dumpster with the lid closed. Put the dumpster in a paved area, not on unpaved soil or your lawn. Keep the area clean by picking up dropped trash and sweeping the area regularly (perhaps once a week), but don't use a hose to clean up — keep water off the area. Nearly all dumpsters and trash compactors leak; keep liquid wastes out of them, and keep them closed to keep storm water out.

If you can't prevent leakage from trash containers, install a roof or lean-to that keeps direct rainfall off, and place asphalt curbing or berms around the dumpster to contain the leaks. (Check with your local agencies and comply with fire codes and building permits.)

If you store **scrap metal** or other materials outdoors, keep them under a roof, cover, or tarpaulin. Keep scrap parts or other used metals indoors. Oils and other potential pollutants can wash off long after you think the parts have been washed clean. Collect waste metal, such as used parts and metal lathe filings, for delivery to a scrap metal dealer.

If you store **empty drums** outdoors, do not hold them longer than necessary. Ship them to a drum reconditioner or another facility.

- Drain them completely to avoid spills.
- Seal them properly watertight, to keep storm water from entering; otherwise, the water would become a process wastewater, and can't be dumped to the storm drain.

Store and handle **hazardous wastes** properly. Hazardous materials or wastes are not a storm water problem if they are handled in accord with state and federal regulations, and the requirements of your local HazMat control authority.

Keep hazardous waste and materials indoors or under cover in a locked area, to keep nighttime trespassers away. Store them before disposal in special hazardous waste containers, or closed drums within a secondary containment that is approved by your HazMat authority.

Table 2. Preferred waste handling & disposal methods

		Recommended storage	Preferred disposal	Hazardous waste?
General plant wastes	Used parts: clean metal scrap	Bin (covered or indoors)	Scrap collector	No
	Used oily parts, contaminated	Drum	Hazardous waste hauler	Yes
	Metal shavings	Bin (covered or indoors)	Scrap collector	No
	Used rags	Rag bin with lid	Rag laundry	Possibly
	Soiled cleanup absorbent	Drum	Hazardous waste hauler	Yes
	Coolant from air conditioner or refrigeration equipment	Recycling machine	Reuse in-house (HVAC service company)	No
Liquid wastes	Paints*	Original container, with lid	Hazardous waste hauler	Yes
	Waste lubricating oil	Drum (segregate)	Oil recycler	Special**
	Solvents, thinners, and miscellaneous fluids*	Tank ("hot" waste) (Segregate different fluids to make recycling possible)	Solvent recycler (where possible) or waste hauler	Possibly
Liquid containers	Empty drums	Indoors or under cover	Drum reconditioner	
	Empty cans, bottles, aerosol cans, etc.	Drum	Municipal trash or hazardous waste hauler	Possibly
Vehicle wastes	Waste motor oil	Drum (segregate)	Oil recycler	Special**
	Brake fluid, gear oil, hydraulic fluids, etc.*	Bottle or tank ("hot" waste)	Hazardous waste hauler	Yes
	Antifreeze	Tank (segregate)	Recycler	Special**
	Batteries	Open rack	Battery supplier	Special**
	Tires	Covered or indoors	Tire hauler	No
	Oil filters	Drum (drain first)	Oil recycler	Special*

* Unused pure product may sometimes be returned to the vendor rather than disposed as waste. ** Recyclable under special hazardous materials restrictions.

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In most cities of Santa Clara County, the municipal fire department is the HazMat authority that controls hazardous materials storage, handling, and response. Some locales contract with the Central Fire District or the County Health Department. For information about handling solid wastes that might be controlled under hazardous waste regulations, contact the County's Environmental Health Department or Cal-EPA's Toxic Substances Control Division. (See the rear cover for a list of regulatory agencies.)

Empty containers such as storage barrels, oil cans, paint buckets, aerosol cans, and similar containers are hazardous wastes if they once held hazardous materials. You may not discard these with the regular trash. They must be stored properly so they do not leak outdoors. Some drum suppliers accept empty drums for reuse, under less-stringent hazardous material recycling regulations.

Vehicle maintenance waste materials often deserve special attention. Waste oil, antifreeze, spent solvents, and some other liquids can be recycled. Spent batteries may not be discarded with trash, but must either be disposed as hazardous waste, or returned to the dealer from whom you purchased them, for reclamation and reuse. Guidance on handling vehicle wastes may be found in the Automotive Industries BMP manual, available from the NPS Program and listed on the rear cover.

7. Equipment Washing and Steam Cleaning

Wash water for industrial equipment in most cases must be discharged as process wastewater to the sanitary sewer, and is not allowed in storm drains. To clean dirty, greasy field equipment or trucks you must install equipment to capture, pretreat, and discharge the wash water to the sanitary sewer as industrial process waste. It may be less costly in the long run to locate a commercial car wash which has all the appropriate equipment and municipal permits, and to contract with them for washing services offsite.

If you wash vehicles or equipment on your site, you may do so only in a designated area, designed and equipped as follows:

- Pave the area.
- Mark the area clearly as a wash area, and be sure all employees know they must wash in this area only. Post instructional signs that prohibit changing vehicle oil, washing with solvents, and other activities.
- Install sumps or drain lines to collect wash water for treatment and discharge to the sanitary sewer; reuse (for repeated washings); or recycle (used elsewhere onsite).
- If the equipment is a continuing source of grease or heavy dirt, cover the area to prevent contact with rain water when not in use.
- Grade or berm the area to prevent storm water from running on.
- If possible, wash inside a building designed for maintenance or equipment storage. Ensure that all drains connect to the sanitary sewers.

Steam cleaning should be done on your site ***only*** if you are equipped to capture all the water and other wastes. All the washing requirements above apply to steam cleaning as well. Steam cleaning wash water is prohibited from storm drains; requires a permit from your wastewater authority — including pretreatment requirements, such as an oil/water separator; and may require you to determine whether it is a hazardous waste treatment unit. If you steam clean, do it indoors or in a specially-prepared outdoor working area where you collect the wash water and treat it for discharge.

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8. Trucking and Shipping/Receiving

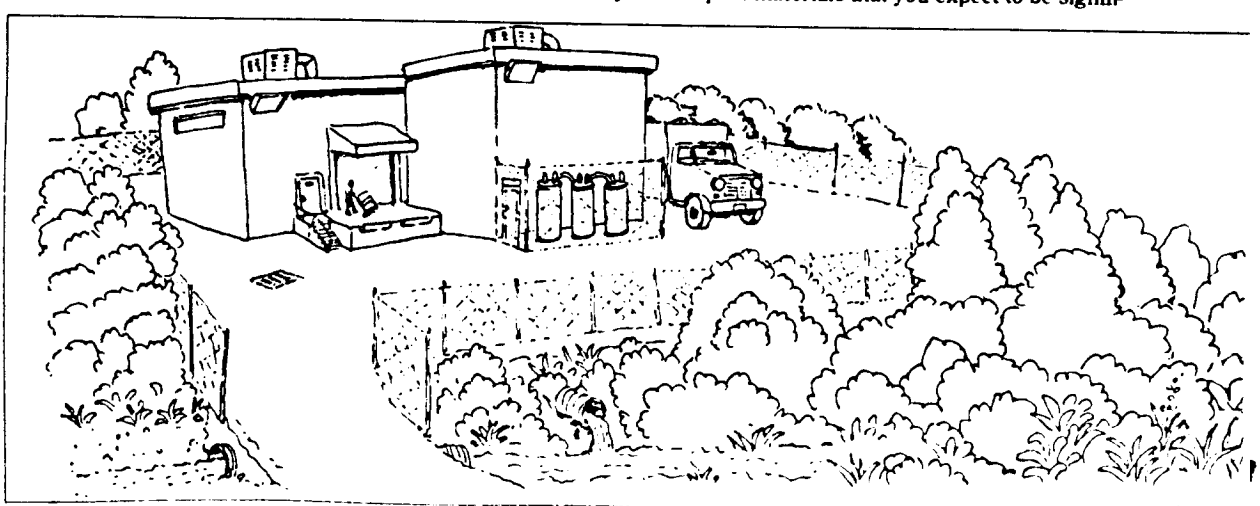
Truck loading and unloading are potential sources of pollutants when rainfall and run-on contact spilled raw materials, dust, and motor fluids that accumulate in this heavy-traffic area.

Load and unload raw materials, products, and other materials only at designated loading areas. In that way, you can isolate the potential source to areas that you can control, rather than unspecified areas throughout your site. The best areas from a storm water point of view are indoor bays. For facilities that must use an outdoor loading dock, some operational BMPs and simple design features can control storm water pollution.

- Cover the loading dock area with a roof overhang, or use a door skirt that fits snugly to both the building door and the truck door.
- Install curbs or berms around the loading area to prevent storm water from running on and any spilled material from running off. Accumulated liquids should be pumped out with a portable pump to the sanitary sewer unless concentrations exceed allowable limits. In those cases the material must be treated or shipped offsite.
- Designate the person who accepts the shipment, the truck driver, or someone else to check under the truck for leaked motor fluids, spilled materials, debris, and other foreign materials.
- If you own and operate the truck, make the driver responsible for identifying and reporting the spill — large or small.
- If you receive shipments from trucks operated by others (a trucking company or suppliers' trucks), i.e., the drivers are not your employees, have the person who signs for delivery responsible for inspecting for spills, leaks, and debris before the trucks leave.
- Detail a procedure so that a maintenance crew cleans up spilled materials promptly.
- If you have a small company that cannot spare a crew, make the driver responsible for cleaning up after unloading or before departing with a full load.
- If you identify the loading dock as a significant source of potential pollutants in your SWPP Plan, implement further control measures such as those described in Section 13.

If you load or unload liquids, you need further operational precautions and the loading dock needs further design features. If you handle hazardous materials, all the features you need are probably in place as part of a spill control and response plan. If they are not, you should select structural BMPs such as those described in Section 13.

Parking lots and access roads are sources of potential pollutants from the trucks themselves and from possible spills or leaks of the materials being transported. If you are re-grading roads and parking lots, or if you transport materials that you expect to be signifi-



Storm water runoff from industrial roofs, trucks, parking lots, and yards flows into storm drains and directly into streams and the Bay. It never receives treatment that would remove pollutants.

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cant sources of potential storm water pollutants, follow the structural BMPs recommended in Section 16. For existing facilities, especially smaller parking lots and short driveways where no hazardous materials are transported, you can effectively prevent storm water pollution by implementing routine maintenance activities, such as:

- Visually inspect your access roads and parking lots regularly to identify and clean up spills.
- Remove solid debris as soon as operations permit.
- Clean up liquid spills promptly, as if they were on your shop floor.

Conduct street sweeping-style cleanups periodically to remove loose debris, small amounts of spilled raw materials, road dust, and other potential pollutants.

- Smaller spaces can easily be swept by hand.
- Do not hose off paved surfaces.
- For larger spaces, use a vacuum truck or mechanical sweeper (that collects solids, not just brushes them aside). Whenever possible, do not use a wet-washing street sweeper unless you can collect the polluted wash water.
- Private corporations or your municipality might perform the work on a contract basis so you need not purchase the truck.

During the dry weather season, the appropriate frequency of sweeping for your facility depends on how heavily the road is used and the kinds of materials you transport. Some signs that you need to sweep more frequently:

- If your trucks commonly spill or drip bulk materials.
- If you notice debris or other materials accumulating on the access roads. The correct frequency is the one that prevents unwanted materials from accumulating.

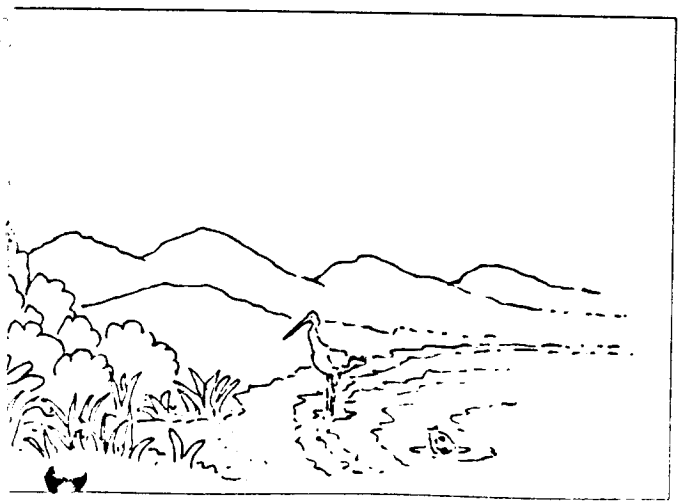
During the wet weather season, emphasize sweeping at times that will best prevent storm water from contacting potential pollutants:

- Clean the area once thoroughly in the fall, before the wet weather season begins.
- After that, you may stay close to your dry-season needs for debris removal, but add an additional thorough cleaning before a major rainfall (half an inch or more of rainfall forecast).

Dispose of the cleaned-up material with your regular facility trash if there are no hazardous materials. If you suspect it may be hazardous — if you handle hazardous materials, or if you know of a significant motor oil leak, for example — you should test the material or dispose of it with your facility's hazardous waste. You could face substantial penalties if you improperly dispose of hazardous waste.

If you **park trucks or heavy equipment** onsite, inspect the parking area for leaks of oil and motor fluids and design a procedure to report them, clean them up, and repair the leaking vehicle. Some practical techniques include:

- Designate consistent parking spots for each vehicle so that if a leak is indicated on the ground, the truck can be identified and repaired.
- Designate a responsible person to check under a vehicle for leaks or spills. If you employ drivers, the driver could be responsible as part of a vehicle check before driving.
- Clean up spills promptly, using dry cleanup procedures described in Section 3. Conduct the preferred cleanup procedures for unpaved as well as paved areas.
- Develop a reasonable procedure for identifying, reporting, repairing, and cleaning up leaking motor fluids and spilled materials. Make sure employees are fully trained in the procedures: who is responsible for checking each truck, who should be notified, and who should respond.



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9. Fleet Vehicle Maintenance

The Automotive BMP manual prepared by the Santa Clara Valley NPS Program addresses automotive and vehicle repair facilities. You should implement the BMPs in that manual if vehicle maintenance is a potentially significant source of pollutants on your site. Sections 9 and 10 of this manual merely summarize some of the appropriate BMPs for fleet maintenance at an industrial facility.

Whenever possible, perform vehicle maintenance in an indoor garage, not in outdoor parking areas. If you change oil and do other routine engine work outdoors, you need to create a designated area for vehicle maintenance. Keep the area clean as if it were part of your shop floor and use dry cleanup practices. The area should incorporate some specific design features, as described in Sections 14 and 15. Some operational methods also can be successful at preventing storm water pollution at vehicle maintenance areas. A few suggestions:

- Keep equipment clean; don't allow buildup of grease and oil, which will wash away when the equipment is exposed to rain.
- If you work on vehicles outdoors, keep drip pans or containers under the vehicles at all times while you work on them — leaks and spills occur unexpectedly. Place drip pans under vehicles as soon as you detect a leak.
- Drain fluids from any retired vehicles kept onsite for scrap or parts. Out-of-service vehicles you intend to restore and vehicles being held for resale should be checked periodically for leakage.
- Don't change motor oil or perform vehicle or equipment maintenance in the parking lot or storage yard; use the vehicle maintenance area. Don't allow customers or employees to change their personal vehicles' oil in your vehicle service areas.

Vehicle **parking or storage yards** need to be operated with some similar precautions:

- Inspect equipment in the yard for fluid leaks regularly — perhaps with a walk-by inspection for ground staining every day, and a closer visual inspection once a week.
- Keep the equipment yard clean and clear of debris, using dry sweeping methods as in Section 8. Do not hose off the area or wash with water, because any runoff becomes an illegal discharge to the storm drain.
- Maintain the yard's storm drain inlet(s) with special care. Clean them on a regular schedule and also after large storms. Pay attention to the kinds of potential pollutants that accumulate, so you can identify the sources and take measures to control the sources.

10. Fleet Vehicle and Equipment Fueling

If you have a vehicle fueling area it should be designed and operated to minimize spilled fuel and leaked fluids coming into contact with rain water. This section describes general principles, but simple operational controls may not be adequate for an industrial fueling facility. You may need to re-design your fueling area or install structural controls. Section 14 describes some general design approaches that may be useful in your eventual complete Storm Water Pollution Prevention Plan. In the near term, steps you can take for proper operation of a fueling area include:

- Use a paved area or provide a concrete slab for the fueling area — never place it on open ground. Concrete is preferred because fuel and oils cause asphalt to deteriorate.
- Clean up gasoline overflows and spills using dry methods as in Section 3. Do not allow spills to run off or evaporate, and do not flush the spill away with a hose. Spread absorbent material, sweep it up with a broom, and dispose of it as a hazardous waste.
- Post signs that instruct pump operators not to "top off" or overfill gas tanks. Keep dry cleanup materials in the fueling area, and instruct employees in the dry clean up methods described in Section 3. Assign someone responsibility to check the area every day for gasoline, motor oil, or other fluids that may have leaked.
- When you do routine cleaning, use a damp cloth on the pumps and a damp mop on the pavement rather than spraying with a hose to minimize clean water to the sump.

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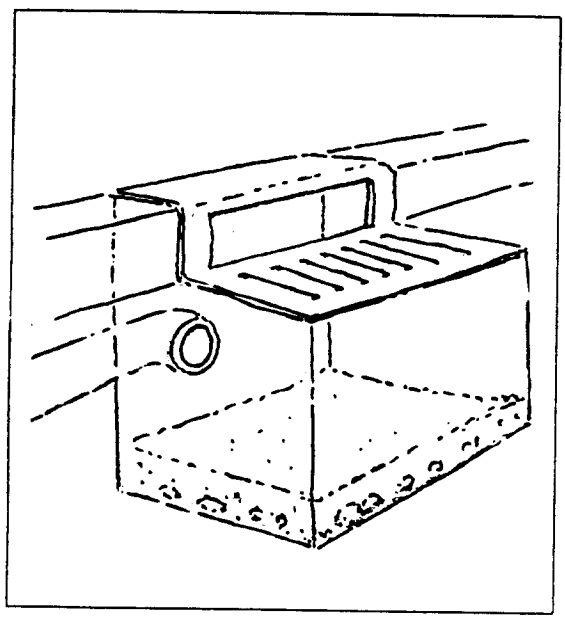
The main concept is to respond properly to fluid leaks in this spill-prone area. Even very small spills, when they happen every day, add up to a lot of fuel in the drainage system. This is an improper discharge that is illegal under the General Permit. Small spills do not present a problem if the fueling area is designed to handle spills — that is, if no storm water contacts it, and if it drains to a sump. But if the area drains to a valved-off storm drain or sewer connection, it must be pumped out before the valve may be opened during a rainfall.

Fuel tanks, including temporary tanks, need to be permitted by your HazMat authority. They will specify design features such as size of containments. Keep temporary fuel tanks in a bermed area that has an impervious lining, such as concrete or a heavy-gauge plastic liner.



A catch basin helps keep debris and sediments out of the storm drain, but needs to be cleaned out periodically.

11. Building Maintenance and Grounds Upkeep

Building maintenance and general outdoor cleanup should use the same principles as parking lot cleanup and spill prevention: clean up without water whenever possible, by sweeping or wiping; wash with as little water as possible; prevent and clean up spills; and clean up debris and solids so they do not reach the storm drains.

Arrange **rooftop** drains or downspouts so they don't drain directly onto paved surfaces. Connect them directly to a storm drain instead. Alternately, allow water to flow onto a grassy surface, if the grassy area is large enough that it can accept the roof's entire runoff from a medium-sized storm — that is, no water runs across the grassy area into a paved area except in the largest of storms.

Maintain the **storm water conveyance system** on your property. The "conveyance system" may be as simple as roof downspouts and a gutter in your driveway, or may be an extensive system of inlets, ditches, drainage channels, and underground lines. Keep all parts of the system clear of debris to avoid blockage that may cause storm water to back up. Remove from the system any spilled or leaked materials that can be transported by storm water.

Clean the storm drain inlets to remove sediment and debris at least twice a year — late in the dry weather season before the first storm, and after the first major storm of the wet weather season. After each large storm, inspect the inlet; remove debris; and determine whether you need to remove sediments or do other maintenance.

The storm drain inlet may have a **catch basin:** a below-grade chamber where the storm drain pipe connects. Catch basins are intended to collect debris and sediments to prevent clogging the lines. Therefore, the catch basins themselves must be cleaned out periodically to prevent flooding. If you clean catch basins annually, shortly before the wet weather season, you can keep them flowing freely and remove leaves, sediments, and other materials that would otherwise be washed down the storm drain. Don't flush the catch basin with water: use a shovel or vacuum device to remove the materials.

Other useful design features, such as vegetated ditches and water quality improvement inlets, are described in Sections 19, 20, and 21 as advanced BMPs.

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12. Building Repair, Remodeling, and Construction

This section describes some relatively simple BMPs that apply to minor building repairs, remodelling, and minor construction projects at an industrial facility that involve "industrial activity exposed to storm water."

Larger-scale projects, such as construction of new facilities, are covered under a separate General Permit for construction. These require more extensive storm water pollution prevention measures than described here. A separate BMP manual for construction activities is available from the Santa Clara Valley NPS Program. (See rear cover.)

The same practices are *recommended* for construction activities on industrial sites. Before you begin a construction or repair project, review the Construction BMP Manual to identify and implement the appropriate practices. If those BMPs do not apply, or are unduly elaborate for a simple construction activity that will be completed in a short time, consider the BMPs described in this section.

Store **building materials** under cover or in contained areas, using BMPs discussed above, in Section 5. For outdoor storage at a construction site, select a pollution prevention method such as:

- Put an impermeable tarp over piles of wood, gravel, or other materials. Don't wait for forecasts of rain — do this every day, to avoid being caught unaware. Also, it will keep materials from blowing off the pile and contributing pollutants to runoff later.
- Keep the working area clean every day for the same reason. Sweep up wood splinters, paint chips, and other residues every day, as well as a thorough cleanup at the end of the project.

Painting requires some basic procedures.

- Before painting, while you scrape to remove old paint, spread a ground cloth or tarpaulin to collect dust and paint chips. If the paint contains lead or tributyl tin, dispose of the paint chips as hazardous waste.
- Mix paints indoors before starting work.
- Use impermeable ground cloths, such as plastic sheeting, while you paint. Place in-use paint buckets in a pan or on plastic sheeting.
- At the end of the work day, store paint buckets and barrels of materials away from contact with storm water.
- Use a tarp or portable, inflatable berm to prevent spills.
- Treat a paint spill as a chemical spill: capture it before it flows to the storm drain, and clean it up promptly using dry methods.

During **painting cleanup**, proper procedures are:

- If you use water-based paint, clean brushes and equipment in a sink connected to the sanitary sewer.
- Clean up oil-based paint where you can collect the waste paint and solvents to be handled as small quantity hazardous waste — do not pour it to the sink or to a storm drain.
- Keep leftover paint, solvents, and other supplies for a later use, or deliver them to a solvent recycler with other plant wastes when you ship a batch.
- Handle empty paint cans and other containers as described in Section 6. Containers may be small-quantity hazardous waste. Latex paint cans are not hazardous waste if the paint is dry.

Do not fall back on old cleanup practices from days when storm water pollution was not known as a problem. Do not pour leftover paint down the storm drain or onto the ground. Do not clean brushes into the storm drain or pour buckets of cleanup water to the drain, or wash spilled paint down the storm drain with a hose. These practices are now categorized as "illegal dumping." Do not wipe brushes onto old newspapers, or pour leftover paint supplies into newspapers and discard the paper in the trash.

Spray painting requires a few extra precautions.

- Use temporary scaffolding to hang drop cloths or draperies to shield you from the wind and to collect overspray.
- Arrange the draperies to minimize the spreading of windblown materials.
- Be aware of air quality restrictions on spray paints that use volatile chemicals. Consider a water-based spray paint for better air quality compliance.

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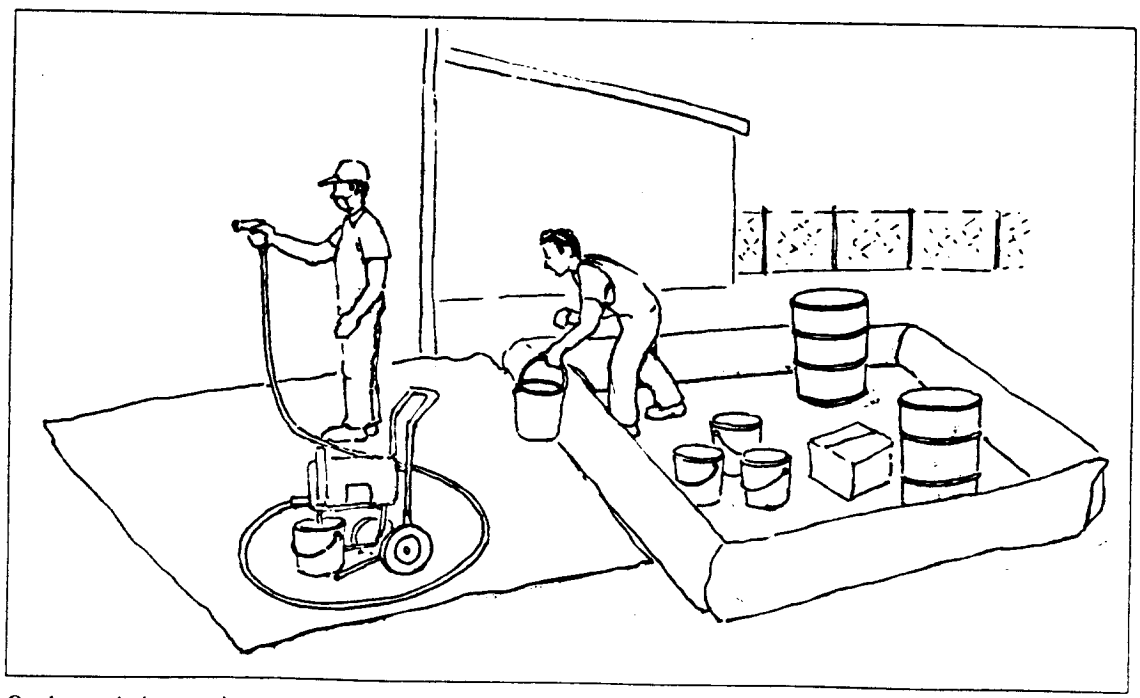
Sand blasting can be controlled to keep particles off of paved surfaces and out of storm drains. Ask your municipality whether building and construction codes place requirements on the size and type of blasting medium that is allowed. More complete instructions are available in the Construction BMP manual for full-sized jobs, but some basics should be applied for smaller projects, as well:

- Place a tarpaulin or ground cloth beneath your work to capture the blasting medium and particles from the surface being cleaned.
- Hang tarps or drop cloths to enclose the area, using temporary scaffolding if necessary. Arrange the drop cloths to protect the work area from wind, and to capture airborne particles.
- Curtail operations on a windy day.
- Clean up frequently: collect dust and particles from the drop cloths before you produce too large a pile to handle easily.

Wood preservatives, pavement seal coating, and other outdoor surface treatments commonly contain metals, pesticides, solvents, or polymers that are hazardous materials. Handle and dispose of them properly, as follows:

- Apply only as much of the chemical as the wood can absorb or as needed to cover the paved area.
- Soak up excess chemicals with absorbent material or rags rather than allowing them to flow to the storm drains or soak into the soil.
- If the chemicals spill, clean up promptly using dry techniques; see Section 3.
- When sealing a sidewalk, prevent the sealant from reaching the gutters or drains. Use absorbent booms, or stuff rags into storm drain openings.
- When treating a roof with wood preservative or sealant, line the gutters with rags. Dispose of the rags properly: with your hazardous waste if the substances you are using are hazardous.
- If you clean a roof or sidewalk before applying preservative, sweep thoroughly to remove loose particles first, then wash with water if necessary.
- Collect wash water from downspouts or drains where possible and remove particles.
- Avoid applying surface treatment chemicals during the wet weather season.



Outdoor painting requires practices to prevent paint and dust from becoming storm water pollutants.

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Advanced BMPS and Structural Controls

Some industrial operations and plant situations require more extensive measures to control storm water pollution. All but the smallest and least complex industrial facilities are likely to require some structural modifications. Depending on your facility, and your success at eliminating potential sources of storm water pollution, your long-term implementation plan may need to include more or fewer of these advanced BMPs.

The BMPs in this section are more extensive and, in general, more costly than the recommended BMPs in Part 1. These BMPs include structural controls — storm water management measures that require constructing new facilities or installing new equipment. Not all of the advanced practices are necessary for every facility, and some will not be of use in some facilities.

You will need to evaluate your own plant to determine which BMPs are applicable to your operations, and which combination will best succeed at controlling the storm water pollutants that may run off from your site. You may find you have a choice in selecting structural BMPs, unlike in implementing basic recommended practices. Evaluate and select controls that are adequate and most cost-effective for your site.

The BMP descriptions in Part 2 are not complete design standards, but describe the central principles you need to consider in identifying and controlling storm water pollution from various sources in your plant. Design standards, performance specifications, and detailed discussion of the design and application of structural and treatment BMPs are available in a BMP manual from the state of California, scheduled for publication in late 1992.

Advanced pollution control practices take a number of forms, and may include a wide range of solutions that are not listed here. You may develop other approaches that are more effective for your facility.

Or, you may need to develop and implement further BMPs than the ones described in this manual. If you conduct more complex activities, especially activities that are unavoidably exposed to storm water, you will need to develop more intensive source control and storm water management BMPs.

If you are renovating your shop or building a new facility, you should evaluate installing some of these structural controls even if the shop does not currently have a pollution problem with that specific area. Some of the structural measures in this section are much less costly to install during new construction than to retrofit afterwards.

For example, if you re-grade an equipment parking area, you should consider storm water design criteria even if the yard has not been in violation of standards in the past. If you put off implementing the measures, future more-stringent requirements may require these same measures to be retrofitted, which can be much more costly than if you do it while constructing a new facility or renovating for other reasons.

If your principal sources of pollutants do not originate with industrial activities, you may need to control sources that are not specifically named in the General Permit, such as: pesticides and fertilizers from landscape maintenance; oil and antifreeze from autos in large employee parking lots; and cooling water or equipment lubricants from large building ventilation and cooling equipment. Your municipality and the NPS Program hold their own permit that requires they reduce pollutants in storm water from *all* sources, and they may request your cooperation in developing controls for your pollutant sources that go beyond the BMPs in this manual.

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13. Loading Dock Design Features

Loading docks may require more intensive pollution controls than the operational BMPs described in Section 8. This is especially true of areas where you load or unload liquids in containers. Bulk liquid transfers are a more intensive industrial operation that requires specific control designs, and are not addressed in this manual.

Additional features of a properly-designed loading dock include:

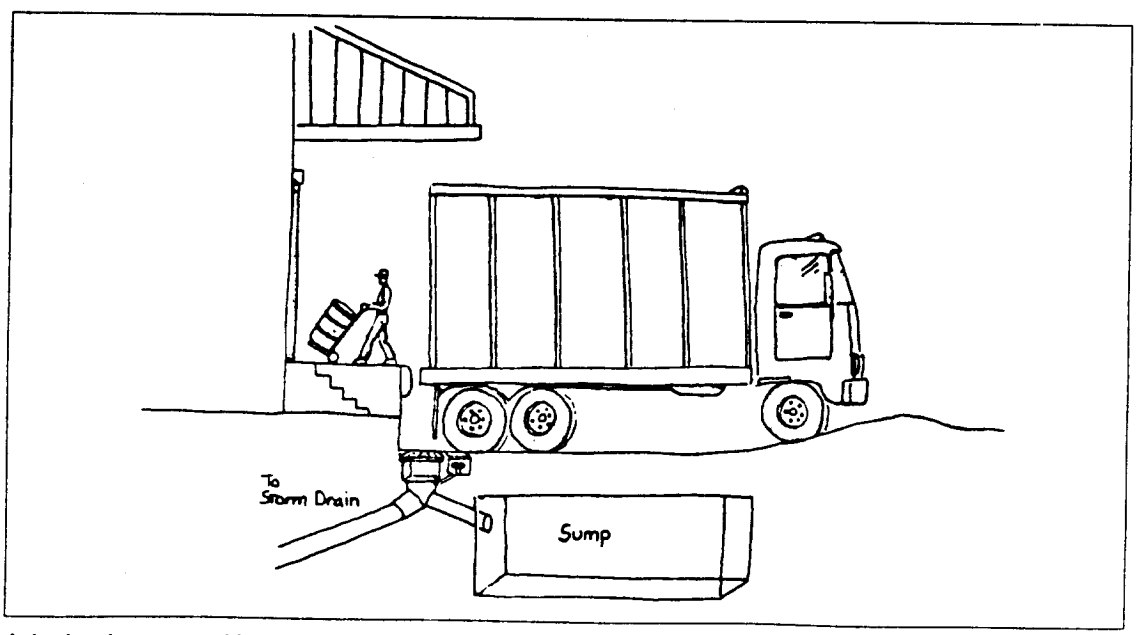
- Grade the loading area to be sloped or recessed to direct flow toward an inlet with a shutoff valve, or toward a dead-end sump.
- Make sure the inlet includes a sump with enough capacity to hold a spill while the valve is closed.
- Keep the valve closed at all times except when you need to release storm water or other liquids that are acceptable for discharge.
- Preferably, this inlet should connect to a sanitary sewer rather than a storm drain. Check with your wastewater treatment authority for permitting requirements.
- Consider completely preventing contact with storm water using a roof and berms, as described in Section 8. This will both avoid washing potential pollutants into the drain and avoid discharging clean storm water to the sanitary sewer.

If the inlet connects to a *storm drain*:

- Accumulated liquid must be tested and found to contain ***no pollutants*** before opening the valve for discharge.
- If the liquid does contain pollutants, you need to pump it from the sump and discharge to your sanitary sewer if the wastewater treatment authority agrees to accept it. (See the recommendation below.)

If the inlet connects to a *sanitary sewer*:

- Accumulated liquid must be tested and found to be within the parameters specified in your wastewater discharge permit before opening the valve for discharge.
- If you cannot discharge to the sanitary sewer, you need to convey the liquid to a hazardous waste disposal facility.



A dead-end sump provides secure spill control, but any accumulated liquids need to be pumped out, tested, and properly disposed. Use berms or slopes to prevent run-on so storm water is not added to waste in the sump.

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14. Equipment Yard Design Features

Parking and storage yards for large vehicles and heavy equipment generally require site-specific structural and operational controls. Follow the operational BMPs for vehicles recommended in Sections 7, 8, 9, and 10. Also assess your equipment yard to determine possible sources of pollutants, and install appropriate controls to keep potential pollutants out of the storm water. Design approaches may include:

- Grade the area to slope to a longitudinal drain, or install curbs to direct all storm water to a storm drain in the yard. If your yard is not too large and is properly designed, it should drain to a single storm drain. Even a small yard should include a storm drain on your property, and not rely on a city-operated drain in the street.
- If you determine that the equipment yard is a large source of oily materials in your storm water, consider fitting the inlet(s) with a sand filter (see Section 20) or removing oily pollutants (see Section 21).

Segregate the area where you service vehicles, and install special structural controls.

- If possible, perform all work indoors, or construct a roof over the specified area. This will require a building permit and compliance with appropriate fire codes.
- Pave the surface with concrete, not asphalt. Vehicle fluids may dissolve asphalt, or may be absorbed into the blacktop and released later.
- Drain the surface to a single drain, preferably connected to a sanitary sewer. The drain may require an oil/water separator or oil/grease trap, and must be approved by your wastewater treatment authority.
- Grade the working area to be higher than the parking lot, or surround it with a berm, to prevent storm water run-on.
- Construct a special area in which to segregate your "dirtiest" equipment (roof tar equipment, asphalt paving equipment, etc.) Handle its discharges, leaks, and runoff separately. This approach could save you from the need to treat *all* the runoff from the equipment yard.

15. Fleet or Equipment Fueling Area Design Features

If your facility's vehicle fueling area is one of the significant sources you identify in your SWPP Plan, you may need more intensive BMPs than the operational efforts described in Section 10. Some design features to consider are:

- Cover the fueling area to prevent rain from falling directly on the area. Install a roof over the fueling island, the area where vehicles park while fueling, and as much of the approach area as practical. Leaked engine fluids and spilled fuel inevitably accumulate on the pavement in these heavily-trafficked areas.
- Storm drain and sewer inlets that drain the fueling area must be equipped with a shutoff valve to keep fuel out of the drain in the event of a spill from the pumps. The valve should be kept closed at all times except during a rainfall.
- Curtail fueling activities when the valve must be open, or use extra precautions to capture any spilled fuel, such as a large drip pan under the vehicle.

A number of different approaches may serve as effective **drainage design.** The fueling area needs to be separated from the rest of the yard, both to contain any fuel spill and to prevent storm water from running on. Select or adapt a scheme such as one of these:

- Grade the fueling area to be "mounded" or elevated. The Automotive Industries BMP manual includes a suggested mounded grading scheme.
- Install berms around the area that are high enough to redirect water from a large storm.
- Grade the entire fueling area to drain to a single inlet. You can accomplish this with longitudinal drains at the perimeter along the "downhill" side of the fueling area, or with a depression in the middle of the fueling area. Either way, be sure to design the grading to avoid run-on.
- At the inlet, either install a sump, from which you will pump any accumulated liquids; or connect to a sanitary sewer, after checking to get all the permits the wastewater authority may require. The sump or connection should be operated as suggested for a loading dock area in Section 13.

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16. Access Roads and Rail Corridors

Access roads and rail corridors can be significant sources of pollutants for some industrial facilities. In the General Permit, access roads and rail corridors are defined as "industrial activities exposed to storm water" that you must include in identifying potential sources and selecting BMPs for your SWPP Plan.

Maintenance and operational BMPs for access roads are the same as those described for vehicle access and parking areas under Section 9. Some structural BMPs are described below.

Proper drainage design is a good place to start. Generally, this means the roads should be crowned and sloped outward; and that storm water should not be allowed to drain across the road, but be carried in ditches or culverts alongside the road. Grass-lining the roadside ditches can be an effective way to remove storm water pollutants — see Section 20. Maintain the ditch to be sure it does not clog or fill with sediments, allowing storm water to overflow. Plant vegetation by the roadside to control erosion and to promote rainwater infiltration.

If your site includes railroad access, an important source of pollutants is the preservatives on wooden railroad ties. Use a less-toxic preservative; avoid organic toxics such as creosote and pentachlorophenol. Or use concrete ties or other non-wooden ties.

Control spills and dust from railroad unloading. If your rail line delivers or picks up liquids, in bulk or in containers, you may need to add spill-control loading docks with shutoff valves. (See Section 3 for spill controls, and Section 13 for loading dock design features). If parked railroad cars drip, install a drip pan at the loading dock between the rails.

17. Onsite Storm Water Management

Some industrial facilities may still find potential pollutants exposed to storm water even after implementing source control measures like the operational BMPs in the first part of the manual and the structural source controls above. Further structural controls can be used to manage the storm water itself, either to control the flow of the runoff (described in Section 19), to remove some of the pollutants in passive devices (Section 20), or to remove pollutants using specially-designed equipment (Section 21).

The best way to avoid the need for storm water management or treatment is to use source controls, most likely in combination. The right combination for your facility will probably include conscientious implementation of BMPs such as those recommended in Sections 1 through 12 of this manual, attention to the sources of waste at your facility, and careful reduction of process wastes.

If you need to manage storm water onsite, the most important consideration is to minimize the quantity of storm water that contacts potential pollutants. For example, keep the area of industrial activities as small as possible; separate the area from parking lots, to prevent run-on; and roof or enclose the area if possible.

Design your storm water conveyance system to *isolate* the areas where storm water contacts potential pollutants, and convey water from those areas separately from water that runs off of "clean" and non-industrial parts of the site. This will allow you to control storm water with smaller and less-costly hydraulic or water quality controls. Or, if you plan to discharge to your wastewater treatment authority (Section 18), reducing the volume will reduce the discharge cost and increase the willingness of your wastewater authority to accept the discharge.

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18. Redirect Storm Water Discharge from Storm Drain to Sanitary Sewer

If source control BMPs are not adequate to prevent discharging pollutants in storm water from your facility, you may need to cease discharging storm water that contacts those pollutants. One way to avoid discharging potential pollutants with storm water is to isolate runoff from that part of your facility where the pollutants are contacted and discharge the storm water to the sanitary sewer rather than a storm drain.

Installing new connections and new piping can be quite costly, and the required permits may be a barrier, so this could be a costly BMP. Also, it will require a permit from your local wastewater authority. The permit will specify the volume of water you may discharge, the kind of pretreatment equipment you may need to install and operate, and requirements for monitoring your discharge.

Redirecting discharge to the sanitary sewer may not be allowable in all localities — some wastewater authorities have sections in their local ordinances that prohibit the discharge of storm water to the sanitary sewer. Requirements might differ from one municipality to another, so contact the authority that serves your area for information. (See the list on the rear cover.)

Your wastewater treatment authority, as a rule, would prefer to minimize the volume of storm water that passes through the treatment system. You should reduce the quantity of storm water you redirect, using techniques like those described in Section 17.

The wastewater authority may require temporary storage of your storm water onsite, to avoid overloading their facilities during a storm. Your authority is more likely to accept discharge of storm water that has contacted pollutants if you can store it temporarily and deliver it *after* the high flows from a storm event.

19. Storm Water Management: Hydraulic Controls

Hydraulic controls are intended to control ***quantity*** of storm water discharge, but can be useful for water *quality* as well by removing potential pollutants from storm water. BMPs of this type are widely used to control erosion of hillsides and to remove sediments from storm water runoff. Also, hydraulic-control BMPs can help to remove oils and heavy metals that adsorb to sediment particles in storm water.

Design standards and operating information for hydraulic controls are available in a number of references. The NPS Program is preparing a manual of "new development" BMPs recommended for newly-constructed buildings, which includes discussion of hydraulic BMPs for storm water pollution control and conditions under which hydraulic BMPs should be implemented. Design specifications for hydraulic controls will also be addressed in detail in a BMP manual being prepared by the state of California for storm water pollution control. Many local and regional regulations that target erosion control give specifications for hydraulic BMPs.

Hydraulic controls are designed for one of two purposes. One category serves to control the **rate of peak flow**, slowing the flow of water at the height of the storm to reduce its potential to carry away soils and other contaminants. The other type reduces **volume** of runoff, generally by causing some storm water to *infiltrate* (or soak into the soil) rather than running off into storm drains, streets, or streams. Some approaches control both peak rate and volume.

Hydraulic controls for a site are most effective if the overall site design is considered. The first step generally is to modify the site layout to increase the water-permeable surface, to increase infiltration and reduce runoff volume. If greater flow control is needed, the second step may be to strategically place *infiltration trenches* to intercept runoff and promote infiltration. (Infiltration may not be permitted in some areas — see Section 20.) For large quantities of flow, onsite ponds can be designed either to slow the peak flow of storm water or to hold water onsite until it infiltrates or evaporates. These are known as *detention ponds* or *retention ponds*. A variation is the *storm water wetland*, which similarly controls flow while wetland vegetation helps remove pollutants.

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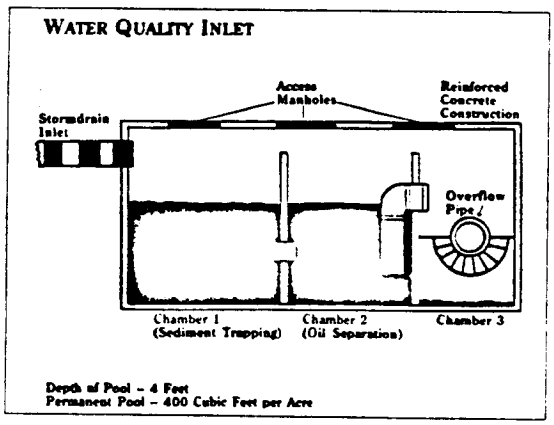
20. Storm Water Management: Water Quality Controls

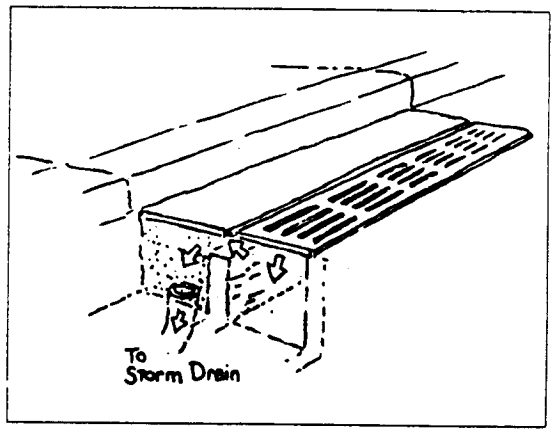
A number of specific storm water management controls are better suited to water quality control than hydraulic control. These features may be added to various parts of the storm water conveyance system on an industrial site to help control potential pollutants in the storm water before it leaves the site. They are for the most part passive design features rather than treatment devices in the usual sense. Information in existing references gives design parameters for these water quality controls, so this section merely summarizes a few types of controls.

A simple technique is a **vegetated swale** or **channel,** a ditch that carries storm water in which plants are permitted to grow. The plants provide some peak flow control by slowing the water. They also remove some pollutants by encouraging the deposition of sediments and minor oily wastes. This control can be retrofitted to some existing storm water conveyance ditches simply by allowing grasses to grow, if it does not interfere with storm water drainage and cause water to back up onto the site.



An API separator is only partly effective at removing oily wastes, but is more effective at removing sediments than an ordinary catch basin.

A **water quality inlet** is a simple multi-purpose device, shown in the diagram above. A storm drain inlet is fitted with an enlarged catch basin or grit chamber where solids and sediments settle out of the water. A baffle restricts the flow of surface-floating oil, which can be removed by hand later. Floatable debris also collects at the baffle. This type of inlet has in the past been used to help remove oily wastes, but is of limited effectiveness. Section 21 describes the inlet further, including its maintenance requirements.



A sand filter inlet can remove some pollutants before they enter the storm drain.

A **sand filter inlet** is a storm drain inlet that contains sand or another filter medium. The sand removes particulates and oily wastes from storm water as it enters the storm drain. An extension of the same concept is a **sand filter,** where storm water quality can be improved before discharge. Sand filters appear to be particularly effective if used in combination with detention or retention ponds, by diverting the first-flush of runoff (often carrying the most pollutants) to the filter and routing the remainder of the water to the pond.

Many of these water quality controls can be designed either of two ways: to control potential pollutants before discharging water to a storm drain; or to remove unwanted constituents and then direct the storm water into the ground as an *infiltration* device. Any of these controls that use infiltration techniques, or others designed specifically to promote infiltration, (porous pavement, infiltration trenches, and others), may be restricted or prohibited in some municipalities in the Santa Clara Valley as potential sources of ground water contamination. Dry wells for disposal of storm water are illegal under State and Federal Law.The Regional Board's newly-amended Basin Plan for the San Francisco Bay Region adopts some new policies that address infiltration devices. The NPS Program does not recommend them in areas where shallow ground water may be impacted. Check with your municipality before installing an infiltration device.

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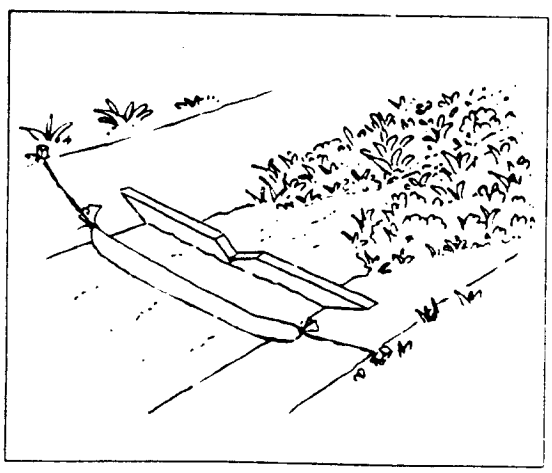
21. Storm Water Management: Removing Oily Pollutants

A simple technique to remove oils and grease from storm water uses **oil-absorbent materials** (or *oleophilic* materials), such as the booms used to contain oil spills. The absorbent material preferentially absorbs oil, and does not fill with water, so it can be used on storm water with small concentrations of oily materials.

Some facilities that have a storm water conveyance ditch where water flows season-long have found it convenient to install a permanent floating boom to control an occasional light surface sheen. When the boom is spent, it is full of oil and is visibly heavier, floating lower in the water. The booms are inexpensive enough that they may easily be replaced whenever the absorbent is saturated. Disposal is more costly, since they may be hazardous waste unless an oil recycler can accept the material.

Oil/water separators are a broad category of devices that are intended to remove oily constituents. There are many varieties of oil/water separators, and the term is not used in the same way by all equipment vendors or design specifications.

For most applications, oil/water separators are ***not recommended*** as a storm water management strategy. Source control BMPs are strongly preferred. Oil/water separators are fairly costly, and most designs do not operate best at the low concentrations commonly present in storm water. A sand filter inlet is typically more effective, and less costly, for the small quantities and low concentrations of oils in routine storm water runoff — that is, runoff that has not directly contacted oily industrial activities.



Oil-absorbent berms can remove oily sheen from storm water. Vegetation in an open ditch can slow the flow, helping sediments settle.

Separators may be useful in limited applications. They are sometimes useful as a retrofit measure, to temporarily help a facility comply while it installs more effective source control BMPs. Another use is in spill control sumps, upstream of a treatment process. The advanced designs are sometimes used as a treatment device (that will discharge to a sanitary sewer) for storm water that contacts industrial activities in isolated areas where contact cannot be avoided.

The **API oil/water separator** is a simple design, named for the American Petroleum Institute. The API separator is sometimes called an "oil and grease trap," to distinguish it from a true oil/water separator used for industrial wastewater. An API separator usually is a long basin with multiple chambers or vaults, typically installed below grade. It can be fitted to storm drains or storm water inlets in a variety of configurations — the water quality inlet described in Section 20 is one form. The intent is to slow water and stratify the flow so that oil rises. The floating oil is then retained by one or more baffles in the chambers.

An API separator removes the bulk of floating oily wastes, especially if the oil is not well-mixed but floats on top of the water. However, it is not highly efficient, so storm water can still be polluted unacceptably even after it flows through the inlet. The separator works by concentrating oily wastes within the chamber, so inevitably some of the collected wastes are carried away during heavier storms. It can be made somewhat more effective at oil removal if it includes pads or pillows of oleophilic material at the water surface level.

If you install an API separator, it ***must be maintained*** regularly. It requires a standing pool of water, which should be pumped out periodically and replaced with clean water. To clean, remove oil floating on the standing pool and greasy matter collected at the baffle. Some commercial oil recyclers accept this material for recycling; otherwise, it must be handled as hazardous waste. If you install oil-absorbent pillows, the pillows must be closely monitored and replaced when they are saturated, also disposed either as hazardous waste or to a recycler. If the inlet includes a sediment trap, as in the water quality inlet shown in Section 20, remove solids with a shovel between storms.

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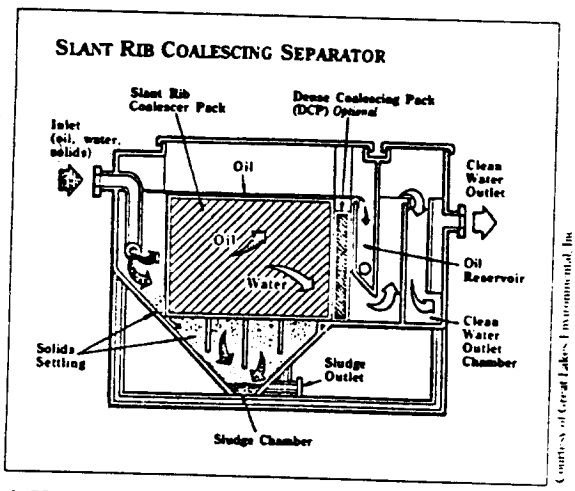
Develop a regular cleaning schedule appropriate for your facility. For inlets that don't carry much flow, three cleanings per year are sufficient: once before the rainy season (mid-September) to remove materials that have accumulated; once after the first major storm; and once at the end of the rainy season to prevent slow loss or evaporation of the collected oily wastes. If storm water flow is greater, the API separator may need to be cleaned monthly, or periodically between storms. As another guideline, clean the separator before three inches of oil accumulate in the entry chamber.

The **CPI,** or **coalescing plate interceptor** oil/water separator, is a more advanced design. These are common for treatment of oil-bearing industrial wastewater, but are less often cost-effective for storm water. The CPI separator generally achieves greater removal efficiency than an API type, but is more costly to purchase and operate. A CPI separator can attain a high removal efficiency, and accommodate a fairly high flow rate, but at ever-increasing capital costs for the equipment (by adding more separator plates). The best economics generally apply for relatively high concentrations of oil at low and constant flow rates.



A CPI separator can be very effective at removing oil but requires upstream sediment control and can be costly to maintain.

A few design features can improve the effectiveness of an oil-water separator. Pollution removal effectiveness is highest if the concentration is high when the storm water enters the unit. Avoid diluting the water to be treated with water from other parts of the site, where it does not contact the potential pollutants, both to save on the capital investment and to increase treatment effectiveness. For industrial process applications, an evaporator can be used reduce the volume of water treated.

An oil-water separator works best if sediment is not present in the water — limit your water to be treated to isolated areas, free of mud and soils if possible. Efficiency is highest with a fairly steady flow, so you may require upstream detention. Also, don't site the separator downstream of a pump, because the pump mixes the oil and water and partially emulsifies the oil, so separators are less effective.

Storm water treatment generally is ***not recommended*** as a BMP. Some of the devices described in Section 21 may be considered to be treatment by the state or by your local wastewater treatment authority, which can open the door to some burdensome regulatory restrictions and permitting requirements.

For most industrial facilities, the best advice about onsite storm water treatment is to avoid it, for a number of reasons. Most of the available treatment equipment is costly to purchase and to receive permitting approval for. Operational costs can also be significant — you must monitor the equipment to assure continued effectiveness, and may need to prepare and submit chemical analyses to demonstrate continued compliance.

Further, in most places in the Santa Clara Valley, treatment of storm water means you must discharge it to the sanitary sewer rather than the storm drain (as described in Section 17). In effect, water on which you perform treatment is no longer considered to be storm water, but industrial wastewater instead. You will need to obtain or modify a discharge permit from your local wastewater authority or your municipality.

The most troublesome permitting procedures are for hazardous materials. Before installing any treatment equipment, determine whether your waste water is a hazardous waste. Cal-EPA/Toxics or the County Environmental Health Department can describe the necessary testing and approval procedures. If the wastewater that would enter the pretreatment equipment is considered to be hazardous you must obtain a permit from Cal-EPA/Toxics to operate a hazardous waste treatment facility. At present this may be true even for a simple water quality inlet. If you determine that the waste stream is not hazardous, and do not apply for a hazardous waste treatment permit, keep your testing documentation on hand to show regulators.

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Pollution Control Agencies and Sources of Information

Santa Clara Valley Nonpoint Source Pollution Control Program

For information about storm water pollution control requirements, contact the Program or your local municipality.

Santa Clara Valley NPS Program
5750 Almaden Expressway
San Jose CA 95118 (800) 794-2482

City of Campbell	(408) 866-2150
City of Cupertino	(408) 252-4505
City of Los Altos	(415) 948-1491
Town of Los Altos Hills	(415) 941-7222
Town of Los Gatos	(408) 354-6864
City of Milpitas	(408) 942-2360
City of Monte Sereno	(408) 354-7635
City of Mountain View	(415) 903-6329
City of Palo Alto	(415) 329-2129
City of San Jose	(408) 277-5533
City of Santa Clara	(408) 984-3151
City of Saratoga	(408) 867-3438
City of Sunnyvale	(408) 730-7270
Santa Clara County	(408) 411-1195
Santa Clara Valley Water District	(800) 794-2482

Documents available from the Program:
- BMP Manual for Automotive Repair Facilities
- BMP Manual for Construction Activities
- Industrial Storm Water Compliance Guidance Handbook (guidance for the Regional Board's Industrial Storm Water General Permit)
- Industrial Storm Water Compliance Binder
- Integrated Pest Management Brochure

Wastewater Treatment Authorities

For information on wastewater permitting and on allowable discharges to the sanitary sewer, contact your wastewater treatment authority

San Jose/Santa Clara Wastewater Treatment Plant
Department of Industrial Waste (408) 945-5300

Sunnyvale Wastewater Treatment Plant
Industrial Pretreatment Program (408) 730-7270

Palo Alto Regional Water Quality Control Plant
Environmental Compliance Division (415) 329-2117

Documents available fromPalo Alto:
- Storm Drain Pollution Prevention Guidelines

Emergency Response: Dial 911

County of Santa Clara

For information about compliance with hazardous waste regulations, contact:

Environmental Health Department—Toxics Enforcement Program (408) 299-6930

For information on waste minimization and guidance on contacting other agencies, contact:

Hazardous Waste Management Program (408) 441-1195

Document available:
- Hazardous Waste Management and Reduction—A Guide for Small and Medium-Sized Businesses (City of San Jose and Santa Clara County)

California Environmental Protection Agency

Regional Water Quality Control Board: San Francisco Bay Region, Region 2
2101 Webster Street, Suite 500, Oakland, CA 94612

For information on permitting of transportation, treatment, recycling, and disposal of hazardous wastes, contact:

Department of Toxic Substances Control Division (Cal-EPA/Toxics), Region 2 (510) 540-3739
700 Heinz Avenue, Bldg. S, Berkeley, CA 94710

For information on waste minimization and hazardous waste management technologies, contact:

Alternative Technology Division (916) 324-1807
744 P Street P.O. Box 942732, Sacramento, CA 94234-7320

Documents available from Alternative Technology:
- California Waste Exchange: A Newsletter/Catalog
- Fact Sheet: Waste Reduction for Automotive Repair Shops
- Hazardous Waste Reduction for Automotive Repair Shops:
  - Part 1: Checklist
  - Part 2: Assessment Manual
- List of CA Licensed Hazardous Waste Haulers

Association of Bay Area Governments

P.O. Box 2050, Oakland, CA 94604-2050 (510) 464-7900

Documents available from ABAG:
- Manual of Standards for Erosion & Sediment Control Measures

These agencies are concerned with environmental requirements for industrial facilities. It may be necessary to contact other agencies to verify compliance. These contact points are current at time of publication.

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FACILITY SWPP PLAN

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FACILITY STORM WATER POLLUTION PREVENTION PLAN

This space in your binder is provided for keeping:

- a copy of your Storm Water Pollution Prevention (SWPP) Plan
- revisions to your SWPP Plan
- inspection records; you must retain these for 5 years
- schedule of employee training dates.

You are required to develop and implement an SWPP Plan for your facility by **October 1, 1992**, and it must be retained on site. You must make the Plan available upon request of a representative of the Regional Board, the Santa Clara Valley Nonpoint Source Pollution Control Program, and/or municipal agencies that have jurisdiction over storm water systems or water courses which receive the industrial storm water discharge.

THE SWPP PLAN

The SWPP Plan must address the following objectives:

- identify pollutant sources that may affect the quality of industrial storm water discharges
- identify, assign, and implement control measures and management practices to reduce pollutants in industrial storm water discharges.

The SWPP Plan shall include a time schedule for implementing control measures. The schedule shall provide for implementation of maintenance practices and other low-cost practices by **October 1, 1992**, and full compliance with all other terms of the SWPP Plan (such as implementing practices that require structural changes) by **July 1, 1993**.

CERTIFICATION

The SWPP Plan for your facility must be certified and signed. Signatory requirements are:

- for a corporation: a responsible corporate officer
- for a partnership or sole proprietorship: a general partner or the proprietor, respectively
- for a municipality, State, Federal, or other public agency: either a principal executive officer or ranking elected official.

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The person signing the SWPP Plan shall make the following certification:

> "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

REVISIONS

You must amend your SWPP Plan whenever there is a change in design, construction, operation, or maintenance which has a significant effect on the potential for the discharge of pollutants to surface waters, groundwaters, or a local agency's storm water system.

INSPECTIONS

You are required to conduct an annual facility inspection to verify that all elements of the SWPP Plan are accurate. All inspections shall be done by trained personnel. You must retain a report of the annual inspection and observations that require a response as part of the SWPP Plan. Inspection records shall be retained for 5 years.

EMPLOYEE TRAINING

You must provide employee training programs to inform all personnel responsible for implementing the SWPP Plan. The Plan should identify periodic dates for training.

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FACILITY CERTIFICATION OF
ELIMINATION OF NON-STORM
WATER DISCHARGES

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FACILITY CERTIFICATION OF ELIMINATION OF NON-STORM WATER DISCHARGES TO STORM DRAIN SYSTEMS

Before implementing your SWPP Plan, you must eliminate all non-storm water discharges to storm water conveyance systems. Provision C.4 of the General Permit requires you to eliminate unauthorized discharges by July 1, 1992. Unauthorized discharges include any discharges of non-storm water to the storm drain *except* those stated to be permissible in Table 1 of the General Permit.

Your SWPP Plan must include a certification that these discharges have been eliminated. The certification is a legally binding statement that you have fully investigated your facility and eliminated any unauthorized discharges. Part 3 of the SWPP Plan should also include a description of any tests for the presence of non-storm water discharges, the methods used, the dates of the testing, and any on-site drainage points observed during the testing. Like the other parts of the SWPP Plan, the certification needs to be completed by **October 1, 1992.**

Certification may not be possible if you:

- must make significant structural changes to eliminate the discharge of non-storm water discharges to the industrial storm water conveyance system, or
- have applied for, but not yet received, an NPDES permit for the non-storm water discharges.

If certification of your facility is not possible, you must notify the Regional Board, the Santa Clara Valley Nonpoint Source Pollution Control Program. Your notification shall include justification of a time extension and a schedule, subject to modification by the Regional Board, indicating when non-storm water discharges will be eliminated. In all cases, the elimination of non-storm water discharges must occur by **July 1, 1993.**

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FACILITY STORM WATER
MONITORING PROGRAM

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FACILITY MONITORING PROGRAM

This space is provided for you to keep:

- a description of the monitoring program for your facility
- records of all storm water monitoring information; you must retain records for 5 years.

MONITORING PROGRAM

You are required to develop and implement a monitoring program by **October 1, 1992.** The requirements are stated in the General Permit, Section B, pages 8 through 12. A description of the monitoring program shall be retained on site and made available upon request of a representative of the Regional Board, the Santa Clara Valley Nonpoint Source Pollution Control Program, and/or municipal agency that operates the storm drain system to which your storm water discharges.

The monitoring program shall be developed and amended, when necessary, to meet the following objectives:

- monitor the quality of storm water discharges relative to Discharge Prohibitions, Effluent Limitations, and Receiving Water Limitations
- aid in the implementation of the Storm Water Pollution Prevention Plan
- measure the effectiveness of best management practices (BMPs) in removing pollutants in the storm water discharge.

GROUP MONITORING

You may elect to participate in a group monitoring plan. This is permissible under the General Permit, Section B, Paragraphs 7b and 14.

A group monitoring plan may be designed and implemented by an entity representing a similar group of dischargers who are regulated by the General Permit or the Santa Clara Valley NPS Program. All participants in a group monitoring plan must discharge storm water within the boundaries of the Regional Board. The entity or the participants are responsible for submitting a group monitoring plan to the appropriate Regional Board and the NPS Program no later than August 1, 1992 (60 days prior to the beginning of the wet season). The participating industries or the entity are also responsible for revising the group monitoring plan if they are instructed to do so by the Regional Board or the NPS Program.

MONITORING REQUIREMENTS

During the wet weather season (October 1 to April 30), all dischargers are required to:

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- conduct visual observations of the storm water discharge locations on at least one storm event per month that produced significant storm water discharge; significant storm water discharge is defined as a continuous discharge of storm water for a minimum of one hour, or intermittent discharge of storm water for a minimum of three hours in a 12-hour period

- measure (or estimate) the total volume of storm water discharge from at least two storm events that produce significant storm water discharge, including the first such storm event of the wet season

- collect and analyze samples of storm water discharge from at least two storm events that produce significant storm water discharge, including the first such storm event of the wet season.

During the dry season (May to September), you shall conduct testing for the presence of non-storm water discharges at least twice at all storm water discharge locations.

REPORTING REQUIREMENTS

You are required to report all storm water monitoring results by **July 1** of each year to the Executive Officer of the California Regional Water Quality Control Board and the Santa Clara Valley Nonpoint Source Pollution Control Program. You must maintain records of all storm water monitoring information and copies of all reports required by the Permit for at least 5 years from the date of the sample, observation, measurement, or report.

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REFERENCE MATERIALS

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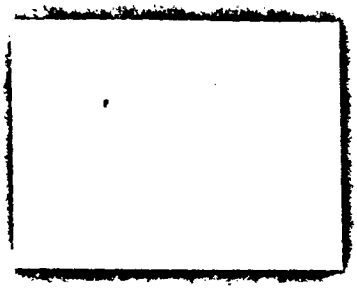

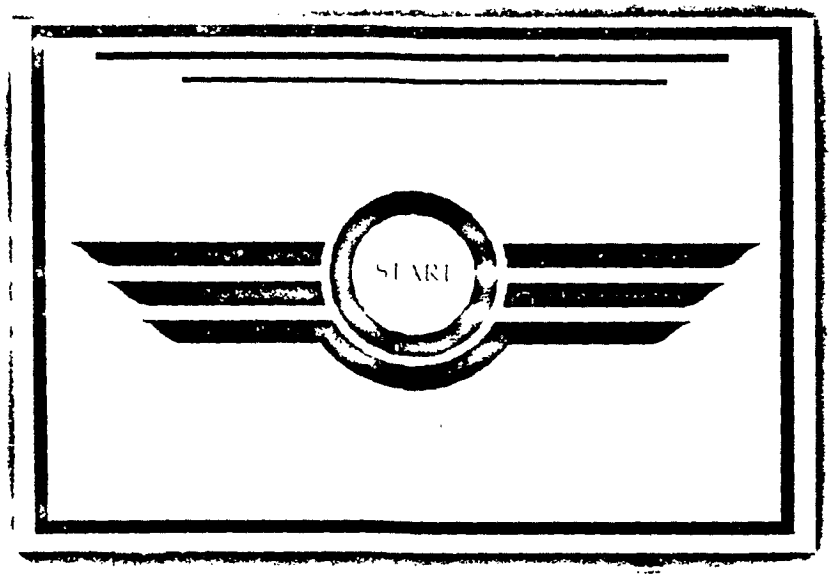

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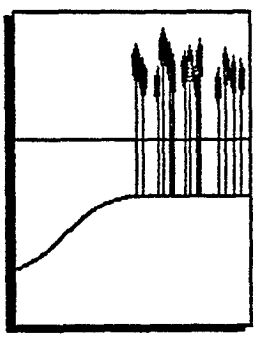
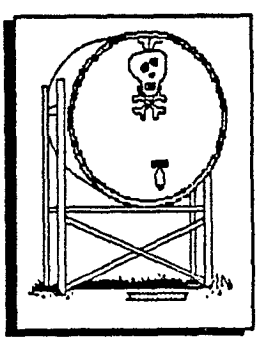
Water Quality

Best Management Practices MANUAL

For Commerical and Industrial Businesses







Prepared for the City of Seattle
by Resource Planning Associates
June 30, 1989

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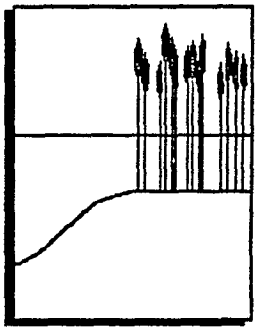
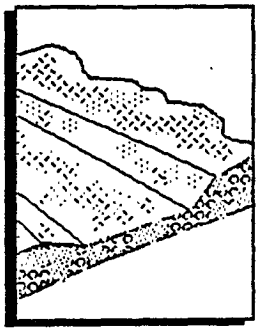
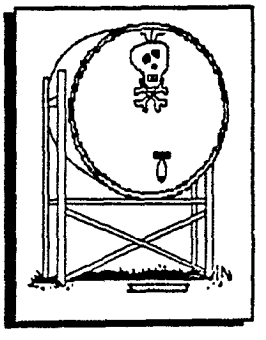
Water Quality

Best Management Practices
M A N U A L

For Commerical and Industrial Businesses







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WATER QUALITY

BEST MANAGEMENT PRACTICES

MANUAL

FOR COMMERCIAL AND INDUSTRIAL BUSINESSES
CITY OF SEATTLE

Prepared for the City of Seattle
Office for Long-range Planning
200 Municipal Building
Seattle, Washington 98104
(206) 684-8056

June 30, 1989

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MANUAL FORMAT

The Seattle Land Use Code specifies for the Industrial and Shoreline District Zones that:

> "THE LOCATION, DESIGN, CONSTRUCTION and management of all developments and uses shall protect the quality and quantity of surface and ground–water, and shall adhere to the guidelines, policies, standards, and regulations of applicable water quality management programs and regulatory agencies. **Best management practices**... may be required."

It is the responsibility of the City's Department of Construction and Land Use (DCLU) to implement the above requirement, with the assistance, directly or indirectly, of other City departments and regulatory agencies such as the Washington Department of Ecology (WDOE).

The manual provides guidance to City staff and the applicant on how to achieve the above requirement. In this manual are descriptions of commercial and industrial land uses, to the extent their activities affect water quality, and the required **Best Management Practices. The manual contains six parts.**

PART I INTRODUCTION

In Part I the manual user is introduced to water quality pollution and Best Management Practices (BMPs). The BMPs are divided into two general types: source-control BMPs and stormwater-treatment BMPs. A strategy, or preference, of which BMPs to emphasize is presented.

Implementing many of the BMPs requires coordination with other regulatory requirements, for example the Fire Code. These regulatory relationships are introduced in Part I with specific requirements presented in Part V of the Manual.

At the end of Part I the reader is shown how to use the manual.

PART II BUSINESSES AND REQUIRED BMPs

In Part II, the many types of commercial and industrial businesses are organized into about 40 groups. The nature of the business group and the types of pollutants it may generate are described. To control these pollutants specific Best Management Practices are prescribed.

PART III SOURCE-CONTROL BMPs

BMPs are listed in Part II for each type of business. If it is a source-control BMP, the manual user refers to Part III for the specific description and requirements of the BMP.

PART IV STORMWATER-TREATMENT BMPs

If, however, a stormwater-treatment BMP is required, the manual user refers to Part IV for the specific description and design criteria for the BMP.

PART V OTHER REGULATORY REQUIREMENTS

The requirements of other regulators, insofar as they support or affect the implementation of this manual, are described.

PART VI APPENDIX

Part VI includes a reference list, glossary and technical documentation.

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Introduction

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INTRODUCTION

Part I

Presented in Part I is an overview of stormwater pollution and its effects. The concept of Best Management Practices is defined, and a general strategy for their implementation is provided to achieve the intent of the City's zoning ordinance as well as the goals of the Puget Sound Water Quality Authority.

The manual user is also introduced to the relationships between the requirements of this manual and other agencies or City departments.

Part I concludes with an explanation of how to use the manual.

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INTRODUCTION

Part 1

WATER QUALITY POLLUTANTS AND THEIR EFFECTS

To appreciate the need for **Best Management Practices** we begin with an overview of the types of pollutants.

o **Oil and grease:** Concentrations in stormwater from commercial and industrial areas often exceed the Washington Department of Ecology (WDOE) standard of 10 mg/l.

o **Nutrients:** phosphorus and nitrogen can cause excessive or accelerated growth of aquatic vegetation. Such growth can significantly affect lakes and may also be of concern in Puget Sound.

o **Oxygen demanding organics:** Natural organic materials washed from paved surfaces are consumed by bacteria present in receiving-waters. Oxgyen is used in the process, threatening higher organisms such as fish.

o **Toxic organics:** A recent Metro study found 19 of the U.S. Environmental Protection Agency's 121 priority pollutants present in street runoff. Most frequently detected were pesticides, phenols, and polyaromatic hydrocarbons (PAHs).

o **Metals:** Stormwater contains metals such as lead, zinc, cadmium, and copper at concentrations that usually exceed water quality criteria.

Research in Puget Sound has found that metals and toxic organics concentrate in sediments and the water surface (microlayer) where they interfere with the reproductive cycle of many biotic species as well as cause tumors and lesions in fish.

o **Bacteria and viruses:** Research has shown that stormwater contains disease-causing bacteria and viruses, although not at concentrations found in sanitary sewage. Shellfish along Puget Sound near urban areas are usually unsafe for consumption unless thoroughly cooked.

o **Eroded soil:** Erosion of soil during construction by stormwater runoff carries soil particles into streams. These sediments destroy the desired habitat conditions for fish. The sediment may be carried to lakes or Puget Sound where their final deposition may interfere with boating or suffocate shellfish.

TYPICAL POLLUTANT CONCENTRATIONS

Research in western Washington has shown that the concentrations of many pollutants found in stormwater from residential, commercial, and industrial areas exceed water quality criteria. Examples are shown in Table 1.1. Although very little data exists for specific land uses (for example, shopping centers) it is expected that research would produce similar results.

WHAT ARE BMPs?

In its long range plan, the Puget Sound Water Quality Authority has stormwater control as one of 12 key action programs. And their control stategy is to emphasize the use of **Best Management Practices.**

The term **"Best Management Practices (BMPs)"** refers to a loose-knit group of dozens of pollution control techniques that rely heavily on the business owner altering his or her operating and housekeeping practices to keep pollutants out of our surface and ground waters.

BMPs may be placed into two general groups: **source-control BMPs** and **stormwater-treatment BMPs.** The former group includes those BMPs in which we keep the pollutant from ever coming in contact with the stormwater; the latter group consists of various methods of treating stormwater.

Source-control BMPs are preferred for two reasons: first, they are usually less expensive. Secondly, with few exceptions source-control keeps all of the pollutant from the environment. Stormwater treatment devices do not. However, most land uses require both types of BMPs.

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TABLE 1.1 COMPARISON OF SELECTED POLLUTANTS TO WATER QUALITY STANDARDS

POLLUTANT	CONCENTRATION[a]	WDOE/USEPA STANDARD OR CRITERIA[b]
Cadmium	5 ug/l	1.4 ug/l
Copper	240 ug/l	3.9 ug/
Lead	380 ug/l	10.5 ug/l
Zinc	275 ug/l	84.0 ug/l
Oil/grease	15 mg/l[c]	10 mg/l[c]
Fecal Coliform	980 organisms/100 mls	50 org/100mls

[a]Rounded mean values for a commercial area; concentrations of individual samples often exceeds mean by factor of 5 to 10. See Part IV.
[b]Acute criteria for freshwater.
[c]WDOE effluent standard, all other values are receiving water criteria.

A more complete picture of pollutant concentrations relative to both acute and chronic water quality criteria for both freshwater and saltwater is provided in Part VI.

BMP STRATEGIES AND PREFERENCES

With so many BMPs, are there some general strategies and do we have a preference? The answer is "yes"; and they are introduced below by preference.

Alter the activities

Our highest preference is to alter the practice that may contaminate the surface water or groundwater; in effect not producing the pollutant to begin with or controlling it in such a way as to keep it out of the environment. An example is recycling used oil rather than dumping it down a storm drain.

Enclose the activities

If the practice cannot be altered, placing it in a building is our next preferred BMP. Enclosure accomplishes two things. It keeps the precipitation from coming into contact with the activity. Secondly, drains inside a building must discharge to a sanitary sewer. In these situations, Metro defines the BMPs, not the City.

Cover the activities

Placing the activity inside a building may be infeasible or prohibitively expensive. But a less expensive structure with only a roof may be

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effective although it may not keep out all precipitation. Internal drains must be connected to the sanitary sewer to collect water used to wash down the area as well as any rain that may enter along the perimeter.

Segregate the activities

Segregating a business activity that is the most significant source of pollutants, from other activities that either cause no or little pollution, may lower the cost of enclosure or covering to a reasonable level.

If the segregated area is not too large Metro will allow discharge of the wash water and stormwater to the sanitary sewer, subject to Metro's discharge standards.

Discharging stormwater from a segregated area to the sanitary sewer is preferred as a municipal sewage treatment plant is more efficient and reliable than most stormwater treatment devices.

Discharge small, high frequency storms to sanitary sewer

This BMP would be limited to the few industries whose outside activities contribute unusually high concentrations of pollutants and/or pollutants of unusual concern. Limiting entry to these few special cases would not overtax the sanitary sewer.

The entry of stormwater to the sanitary or combined sewer can be limited to the small high-frequency storms that carry off the majority of pollutants over time. Storm flows in excess of the hydraulic capacity of the sanitary or combined sewer would be discharged to the storm sewer after treatment.

Treat the stormwater

Why is the treatment of stormwater the least preferred option? There are several reasons. As noted previously source-control BMPs keep the pollutants completely away from stormwater. In contrast, stormwater treatment devices are not 100% effective. Note from Table 1.1 that even if a stormwater treatment system is 90% effective, freshwater criteria are still not met.

In addition, inadequate maintenance can reduce a system's expected efficiency. Owners have little incentive to properly maintain and operate stormwater treatment systems. And it is not practical for regulatory agencies to monitor their efficiency because of the unpredictable nature of storms.

THE IMPORTANCE OF EFFECTIVE MAINTENANCE

Many BMPs require regular attention by the business owner to insure their effectiveness. For example, containers for liquid dangerous wastes must always be kept closed if they are stored outside. Allowing the entry of rain to an open container may cause the overflow of its contents to nearby street drains.

Stormwater treatment devices such as oil/water separators must be cleaned frequently. Unfortunately, due to lack of experience or oversight by the business owner inadequately maintained facilities are common.

It has been King County's experience that storm drainage control systems owned by businesses must be inspected by a public authority at least annually to ensure proper maintenance.

THE REQUIREMENTS OF OTHER REGULATORY AGENCIES

It has already been noted above that Metro has the regulatory responsibility to control all discharges to sanitary and combined sewers. Metro is one of several regulatory agencies or departments whose requirements must be taken into consideration when implementing this manual.

The requirements of each agency or department are introduced here, indicating their relationship to

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the possible actions by DCLU, with more detail presented in Part V.

Storm sewers - WDOE

When stormwater from a business property discharges directly to the surface water, for example Lake Union, that business is subject to the NPDES requirements of the Department of Ecology. NPDES refers to National Pollutant Discharge Elimination System, a Federal regulation that is administered by the WDOE. The NPDES permit specifies the allowable concentration of particular pollutants. The WDOE may also specify BMPs for controlling certain activities of the business, for example outside storage of chemicals.

In contrast, if the business discharges to a City storm drain, it is the City's responsibility to specify the BMP requirements. That is the purpose of this manual.

It is important that consistency exist between the two agencies in controlling the two types of storm discharge. To this end, the BMPs presented in this manual are intended to achieve current WDOE standards to the maximum extent practical.

Sanitary and combined sewers - Metro

Drains located inside a building or covered area must connect to the sanitary or combined sewer. Any discharge to the sanitary or combined sewer must meet the discharge requirements of Metro.

Peak-rate drainage control - City Engineering Dept.

The City requires that most developments install surface or underground detention facilities to control the rate of stormwater discharge. If properly designed, peak-rate control and stormwater treatment can be achieved in the same facility.

To improve the effectiveness of the treatment system and to reduce costs to the business owner, this manual calls for the segregation of runoff from work areas that are contaminated from areas of less concern such as roof tops. However, segregation must be done in a manner that still complies with the Engineering Department's requirements for peak-rate control.

Flammable materials - Fire Department

Any business that stores a flammable, ignitable, or reactive material must comply with the City's Fire Code.

Dangerous wastes - WDOE

The Washington Department of Ecology is responsible for enforcing the state regulations on Dangerous Wastes. With few exceptions, the WDOE's activities in this area encompass the federal laws on hazardous wastes (RCRA). Of interest to this manual is the temporary storage of accumulated wastes by a business until the waste is removed to a hazardous waste treatment and disposal site. Businesses that treat or dispose such wastes are strictly controlled by the WDOE and are therefore not included in this manual.

As described in Part V, the nature of the requirements and WDOE's involvement in their implementation depends upon the quantity generated and the period of its storage at the business.

Under certain circumstances relating to the quantity of waste generated and the time stored at the business, the business must obtain an identification number and a storage permit. The WDOE can therefore specify the appropriate BMPs and make the appropriate inspections.

However, the permit requirements are so onerous as to motivate businesses to move their wastes within the specified time limits. Although the businesses must still comply with WDOE technical requirements, WDOE would not be expected to see to their implementation because WDOE is unaware of the business activity. Therefore, by using this manual the City can insure that the appropriate BMPs are implemented by the smaller generators.

A recent survey by local health departments found that small businesses frequently do not properly store or dispose Dangerous Wastes.

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Other solid wastes - Health Department

Regulations of the Seattle-King County Health Department provide specifications to insure the integrity of containers. Containers failing to meet these requirements must be replaced.

Liquid transfer from marine vessels - Coast Guard

A transfer system that moves petroleum products to or from marine vessels to shore tanks must comply with Coast Guard requirements. Transfer of other liquid chemicals is not covered by current federal or state laws.

Underground storage tanks - WDOE

Underground storage tanks for the storage of chemicals or petroleum must comply with Federal and State requirements. Some tanks are excluded from this requirement as explained in Part V.

Spill control and cleanup plans

Businesses that generate Dangerous Wastes and produce, transport or store petroleum products are required by state and federal law, respectively, to prepare spill control and cleanup plans. Other types of liquids are not covered by state or federal law.

Air quality - Puget Sound Air Pollution Agency

Several areas in Seattle do not meet current air quality standards with regard to fugitive particulates. The Agency's action to rectify this condition is to require industries to pave or surface treat unpaved areas, and to sweep.

WHAT ASPECTS THIS MANUAL DOES NOT COVER

The manual does not provide BMPs for the control of discharges to sanitary or combined storm sewers. This is the responsibility of Metro. However, there are BMPs in this manual that although provided to cover activities that occur outside a building where they are exposed to precipitation, may also be appropriate for controlling enclosed or covered activities.

The manual does not cover erosion control techniques used during construction. Other manuals cover this topic.

With the exception of vehicle and equipment maintenance and repair, the manual does not cover the activities of the City's departments such as the maintenance of streets, reservoirs, and water and sewer lines. It does not cover municipal facilities such as parks, golf courses, and water and sewage treatment plants, airports and water ports, or public and private landfills.

It also does not cover several heavy industrial land uses specifically: aluminum smelters, pulp, paper and paperboard mills, feedlots, coal or ore mining and processing, petroleum refining, sawmills, plywood and shingle mills. These are excluded because none exist in Seattle.

Finally, the manual does not include businesses that transport, treat, process and/or permanently store dangerous or extremely hazardous wastes. WDOE and in some cases the USEPA have the primary responsibility for specifying controls for these businesses.

However, even though the above activities or business types are not covered, the BMPs provided in this manual are applicable and can be used where relevant.

WHEN ARE BMPs NOT REQUIRED

BMPs are not required if the business and all of its activities including parking, loading or unloading of liquids, or temporary storage of liquid or solid wastes are totally enclosed within a building.

Extensive stormwater treatment is not required for parking lots with less than 20 stalls; only a simple oil spill control separator (BMP 2.10 in Part IV) is required. However more extensive treatment may be required for retail businesses that experiences a high volume turnover of vechicles.

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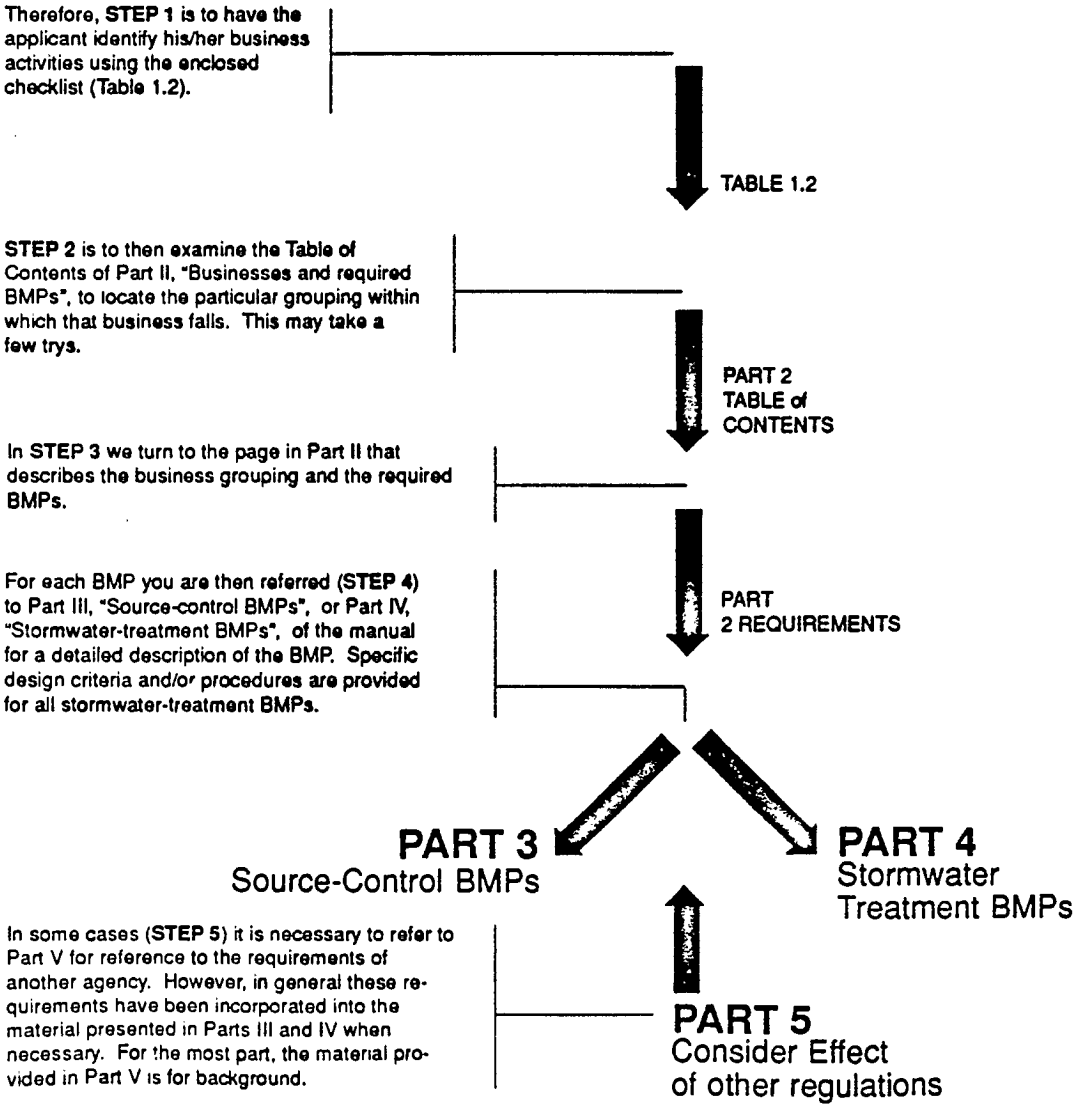
HOW TO USE THIS MANUAL

The figure illustrates how this manual is to be used. Many land uses have similar activities. For example, general purpose gas stations are not the only type of business that dispenses vehicle fuels. Fuel pumps are found at rental car agencies, 24-hour convenience stores, truck freight companies, and construction companies.



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Part 1

TABLE 1.2 APPLICANT CHECKLIST

DESCRIBE THE NATURE OF YOUR BUSINESS:

FOR YOUR BUSINESS, CHECK ACTIVITIES *THAT WILL OCCUR OUTSIDE.*

- ☐ Uncovered vehicle parking
  Indicate number of parking spaces
- ☐ Vehicle or equipment washing
- ☐ Vehicle or equipment repair or maintenance
- ☐ Vehicle or equipment fueling
- ☐ Loading or unloading of liquid materials
- ☐ Outside storage of feedstock, byproducts or products of manufacturing processes
- ☐ Above ground bulk storage of fuel, petroleum or chemicals
- ☐ Use of underground tanks
- ☐ Temporary storage of liquid or solid wastes.
  Indicate type of waste
  - ☐ Dangerous/Extremely Hazardous
  - ☐ Food wastes .
  - ☐ Used oil.
  - ☐ Other (briefly describe).
- ☐ Will you be obtaining a permit from the Department of Ecology to store Dangerous or Extremely Hazardous wastes?

DESCRIBE ANY OTHER OUTSIDE ACTIVITIES NOT COVERED ABOVE

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Businesses and Required BMPs

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BUSINESS DESCRIPTIONS AND REQUIRED BMPS

Part II

Provided in Part II are descriptions of land uses and required BMPs. Reference is made to Parts III and IV where BMPs are described. Most land use descriptions are for groupings of several land uses whose activities are similar in the manner in which they affect water quality.

Each description follows the same outline:

- Title of business group
- Standard industrial code (SIC)
- Description of business activities
- Characteristics of materials used and waste produced
- Required source-control BMPs
- Required stormwater-treatment BMPs

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BUSINESS DESCRIPTIONS AND REQUIRED BMPS

Part II

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Electrical: 2.7
Makers of electronic components

Food products: 2.9
Manufacturers of products from meat, dairy, fruits and vegetables; bakeries; sugar and candy, fats and oils; beverages; etc

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Industrial machinery and equipment, trucks/trailers: 2.13

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Mills producing basic metals from raw or recycled material, or produce primary metal forms such as sheets, flat bars, beams and large pipe; rolling mills; foundries; metal fabricators or finishers of tanks, cans, doors, office furniture, etc

Paper products: 2.19
Making paperboard containers, and all basic paper products such as envelopes

Petroleum products: 2.21
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Printing and publishing: 2.23
Newspapers, periodicals, commercial printing, bookbinding, book typesetting.

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Products from rubber or plastic resins such as tires, hoses, shoes, gaskets, plastic pipe, plumbing fixtures and foam products

Ship/boat building and repair yards: 2.27

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Planing mills, millwork, wood preserving, containers and prefab building components, glued-wood products, furniture, and mobile homes

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Part II

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Services: 2.69
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Part II

CEMENT

SIC: 3241

DESCRIPTION: These businesses produce Portland cement, the binder used in concrete for paving, buildings, pipe and other structural products.

MATERIALS USED AND WASTES GENERATED: The raw materials vary with the particular plant but may be limestone, chalk, marl, or shale. Waste materials from other industries are often used such as slag, fly ash and spent blasting sand.

The raw materials are crushed, mixed and fed into a kiln, a long cylindrical shell, in which the material is heated to produce the correct chemical composition. Natural gas has generally replaced coal as the heat source. The kiln is angled and as it rotates the material passes through by gravity. The output of the kiln is a clinker which is ground to produce the final product.

The basic process may be wet or dry. In the wet process water is mixed with the raw ingredients in the initial crushing operation and in some cases is used to wash the material prior to use. Water may also be used in the air pollution control scrubber. The most significant byproduct of cement production is the kiln dust. Kiln dust can be difficult to dispose.

Stormwater may be contaminated by the raw materials, kiln dust or the product. Analysis of stormwater samples from cement plants in the Seattle area has found the pH to be above 10 and metals concentrations to exceed acute water quality criteria.

Concrete products may also be produced on site such as ready-mix concrete. Refer to "Concrete products" for a description of these activities.

SOURCE-CONTROL BMPs: To the maximum extent practical all manufacturing activities are to be enclosed or covered (**BMP 1.70 in Part III**). All internal drains shall discharge to the sanitary sewer under pretreatment conditions defined by Metro (**R.1 in Part V**).

- o Liquid transfer areas, including loading/unloading docks shall comply with **BMP 1.30** in Part III.
- o Above ground storage tanks shall incorporate **BMP 1.40** to prevent contamination of surface and groundwater.

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- o Businesses generating Dangerous Wastes shall properly segregate and dispose such wastes as required by the WDOE **(R.4 in Part V).**
- o Containers storing Dangerous Wastes or other liquids shall be placed inside a building unless impractical due to site constraints. If placed outside the **BMP 1.50** described in Part III shall be used.
- o If raw materials are stored outside without cover the requirements of **BMP 1.60** shall be followed.
- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o The paved surfaces of the business site shall be swept at appropriate intervals to remove debris.

STORMWATER-TREATMENT BMPs: The industry is one of seven industrial groups for which effluent standards have been set for stormwater quality. According to Federal Regulations 40CFR411 the stormwater from a new cement plant is to have these characteristics: total suspended solids not to exceed 50 mg/l and the pH 6.0 to 9.0. In addition, the stormwater treatment system must be sized to handle at least a 10-year, 24-hour storm.

Stormwater draining from the general plant site including parking lots shall be treated by one of the treatment systems described in **Part IV.** Cement plants are known to control the pH by adding sulfuric acid to a detention basin as needed. The appropriate design criteria for this approach are described under **BMP 2.40 and 2.60 in Part IV.**

Stormwater runoff from rooftops shall discharge to the storm drain or combined sewer below the treatment system as long as the City's drainage requirements are met **(R.2 in Part V).**

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Part II

CHEMICALS

SIC: 2800, 3861

DESCRIPTION: This group involves the manufacturing of chemicals or products based on feed stock chemicals. This includes the production of acids, alkalies, chlorine, industrial gases, pigments, inks, chemicals used in the production of synthetic resins, fibers and plastics, synthetic rubber, soaps and cleaners, pharmeceuticals, cosmetics, paints, varnishes and resins. Included here are photographic materials and chemicals (3861).

Present in Seattle are pharmaceuticals(2834), soaps(2840), paint (2850), gums and resins (2861), organic chemicals (2869), agricultural chemicals (2879), adhesives and sealants (2891), and printing ink (2893).

MATERIALS USED AND WASTES GENERATED: The types of processes, materials and wastes generated are too numerous to catalog here. Wastewater can contain heavy metals and a variety of toxic organics.

Activities that may occur external to the manufacturing building include: bulk storage of liquid feedstock, byproducts or products; unloading and loading of liquid materials from truck or rail; washing of equipment outside the building; waste oil and solvents from cleaning manufacturing equipment; used equipment temporarily stored on site that could drip oil and residual process materials; and temporary storage of WDOE Dangerous Wastes.

With few exceptions all of these industries require treatment of wastewaters prior to disposal to the sanitary sewer. Such processes produce contaminated sludges which must be properly stored until disposed. The wastewater treatment processes may not be enclosed and therefore spillage to external pavement can occur.

Chemical businesses in the Seattle area surveyed for WDOE Dangerous Wastes have been found to produce caustic solutions and soaps, solutions with heavy metals, inorganic and organic chemicals, solvents, acids and alkaline wastes, waste paints and varnishes, waste pharmaceuticals and inks.

SOURCE-CONTROL BMPs: To the maximum extent practical all manufacturing activities are to be enclosed or covered (**BMP 1.70 in Part III**). All internal drains shall discharge to the sanitary sewer under pretreatment conditions defined by Metro (**R.1 in Part V**).

- o Liquid transfer areas, including loading/unloading docks shall comply with **BMP 1.30 in Part III.**

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- o Above ground storage tanks shall incorporate BMPs toprevent contamination of surface and ground waters (**BMP 1.40 in Part III.**
- o Businesses generating Dangerous Wastes shall properly segregate and dispose such wastes as required by the WDOE (**R.4 in Part V**).
- o Containers storing Dangerous Wastes or other liquids shall be placed inside a building unless impractical due to site constraints. If placed outside **BMP 1.50** described in Part III shall be used.
- o If the business has either above ground storage tanks or containers located outside the owner shall develop an emergency spill contingency plan (**BMP 1.80 in Part III**).
- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o The parking lot shall be swept at appropriate intervals to remove debris.

STORMWATER-TREATMENT BMPs: Stormwater from parking lots and outside areas where manufacturing processes are occurring shall be treated by one of the treatment systems described in **Part IV**.

Stormwater runoff from rooftops shall discharge to the storm drains or combined sewer below the treatment system as long as the City's drainage requirements are met (**R.2 in Part V**).

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Part II

CONCRETE PRODUCTS

SIC: 3270

DESCRIPTION: Businesses that manufacture concrete blocks and bricks, concrete sewer or drainage pipe, septic tanks, and prestressed concrete building components. Concrete is prepared on site and poured into molds or forms to produce the desired product.

This group also includes the production of ready-mix concrete and gypsum products.

MATERIALS USED AND WASTES GENERATED: The basic incredients for concrete are sand, gravel, Portland cement, and reinforcing steel for some products. Most businesses do not produce their own concrete; it is produced and delievered by ready-mix concrete plants.

Sources of pollution include the loss of raw materials from stockpiles, washing of waste concrete from trucks, forms, equipment and the general work area, and water from the curing of concrete products. Besides the basic incredients for making concrete products chemicals used in the curing of concrete and the removal of forms may end up in stormwater.

Trucks and equipment if maintained on site will generate waste oil and solvents, and other related waste materials.

Although there are no data of stormwater quality from concrete product businesses, it is likely the quality will be similar to that found at cement plants. Analysis of stormwater samples from cement plants in the Seattle area has found the pH to be above 10 and metals concentrations to exceed chronic water quality criteria.

SOURCE-CONTROL BMPs: To the maximum extent practical all manufacturing activities are to be enclosed or covered (**BMP 1.70 in Part III**). All drains shall discharge to the sanitary sewer under pretreatment conditions defined by Metro (**R.1 in Part V**).

- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o Businesses generating Dangerous Wastes shall properly segregate and dispose the wastes as required by the WDOE (**R.2 in Part V**).

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- o Containers storing Dangerous Wastes or other liquids shall be placed inside a building unless impractical due to site constraints. If placed outside **BMP 1.50** described in Part III shall be used.
- o Stockpiles of loose materal shall employ **BMP 1.60.**
- o The parking lot shall be swept at appropriate intervals to remove debris.

STORMWATER-TREATMENT BMPs: Stormwater draining from the general plant site including parking lots shall be treated by one of the treatment systems described in **Part IV.**

Stormwater runoff from rooftops shall discharge to the storm drains or combined sewers below the treatment system as long as the City's drainage requirements are met (**R.2 in Part V**). To control pH, concrete products firms can use the method employed by cement plants, of adding sulfuric acid as needed to a retention basin. The appropriate design criteria for this approach are described under **BMP 2.40 and 2.60 in Part IV.**

Ready-mix plants typically have settling basins to treat wash water from the cleaning of trucks. This function can be integrated with the treatment requirements specified above for stormwater.

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Part II

ELECTRICAL PRODUCTS

SIC: 3670

DESCRIPTION: This industry covers the manufacturing of a wide range of electrical products including electrical distributions systems, motors, household appliances, electric lighting and wiring equipment, communications equipment including radios and televisions, batteries and electronic components.

The only category covered here, given its prevalence in the City, is SIC 3670, electronic components. Possible products include electron tubes for radio, TV and other applications, semiconductors, resistors, capacitors, transformers, coils and other miscellaneous items.

Specialized processing that occurs includes etching, acid and alkaline cleaning, and electroplating.

MATERIALS USED AND WASTES GENERATED: Materials used include metals, ceramics, quartz, silicon, oxides, acids, alkali solutions, arsenides and phosphides, cyanides, solvents, and inorganic liquid chemicals,

Wastewater consists of solutions and rinses from electroplating operations, and the cleaning waters described above. Water may also be used to cool saws and grinding machines. All such wastewater is to be discharged to a sanitary sewer receiving treatment as specified by Metro (**R.1 in Part V**). Sludges are produced by the treatment process.

Activities that may occur outside the manufacturing building include: bulk storage of liquid feedstock or byproducts; unloading of liquid materials from truck or rail; washing of equipment outside the building; temporary storage of waste oil and solvents from cleaning manufacturing equipment; used equipment temporarily stored on site that could drip oil and residual process materials; and temporary storage of Dangerous Wastes.

Waste liquids that may be temporarily stored on site include spent acetone and solvents, ferric chloride solutions, soldering fluxes mixed with thinner or alcohol, oily water waste, and soiled rags.

SOURCE-CONTROL BMPs: Liquid transfer areas, including loading/unloading docks shall comply with **BMP 1.30 in Part III.**

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- o Above ground storage tanks shall incorporate BMPs to prevent contamination of surface and ground waters (**BMP 1.40 in Part III**)
- o Businesses generating Dangerous Wastes shall properly segregate and dispose the wastes as required by the WDOE (**R.4 in Part V**).
- o Containers storing Dangerous Wastes or other liquids shall be placed inside a building unless impractical due to site constraints. If placed outside **BMP 1.50** described in Part III shall be used.
- o If the business has either storage tanks or containers located outside the owner shall develop an emergency spill contingency plan (**BMP 1.80 in Part III**).
- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o The parking lot shall be swept at appropriate intervals to remove debris.

STORMWATER-TREATMENT BMPs: Stormwater from parking lots shall be treated by one of the treatment system described in **Part IV**.

Stormwater runoff from rooftops shall discharge to the storm drain or combined sewer below the treatment system as long as the City's drainage requirements are met (**R.2 in Part V**).

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FOOD PRODUCTS

SIC: 2000

DESCRIPTION: Includes any business that produces a finished food product including meat packing plants, poultry slaughtering and processing, sausage and prepared meats, dairy products, preserved fruits and vegetables, flour, bakery products, sugar and confectioneries, vegetable and animal oils, beverages, canned, frozen or fresh fish, pasta products, snack foods, and manufactured ice.

MATERIALS USED AND WASTES GENERATED: With most food processors all processing occurs inside buildings. Exceptions are meat packing plants where live animals may be kept, and fruit and vegetable plants where the raw material may be temporarily stored outside. Storm runoff from animal containment or transit areas and vegetable storage areas will be contaminated, the latter from earth attached to the vegetables. The nature of contamination of stormwater passing over fruits is unknown but is not likely to be significant as fruit is usually picked clean.

Wine processors often crush grapes outside the process building and/or store equipment outside when not in use. Significant liquid transfer will occur with some processors. Some wine producers use juice from grapes crushed elsewhere. Some vegetable and fruit processing plants may use caustic solutions.

SOURCE-CONTROL BMPs: To the maximum extent practical all manufacturing activities are to be enclosed or covered (**BMP 1.70**). All rains shall discharge to the sanitary sewer under pretreatment conditions defined by Metro (**R.1 in Part V**).

- o Liquid transfer areas, including loading/unloading docks shall comply with **BMP 1.30 in Part III.**
- o Above ground storage tanks shall incoporate **BMP 1.40** to prevent contamination of surface and ground waters.
- o Businesses generating Dangerous Wastes shall properly segregate and dispose the wastes as required by the WDOE (**R.4 in Part V**).
- o Containers storing Dangerous Wastes or other liquids shall be placed inside a building unless impractical due to site con

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straints. If placed outside BMP 1.50 described in Part III shall be used.

- o If the business has either above ground storage tanks or containers located outside the owner shall develop an emergency spill contingency plan (**BMP 1.80 in Part III**).
- o Any process equipment that is to be temporarily stored outside shall first be washed inside the process building.
- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o The parking lot shall be swept at appropriate intervals to remove debris.

STORMWATER-TREATMENT BMPs: Stormwater from parking lots shall be treated by one of the treatment systems described in **Part IV**. Stormwater from areas used to temporarily store vegetables shall be treated using one of the treatment systems described in **Part IV**.

Stormwater runoff from rooftops shall discharge to the storm drain or combined sewer below the treatment system as long as the City's drainage requirements are met (**R.2 in Part V**).

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Part II

GLASS PRODUCTS
SIC: 3210, 3220, 3230

DESCRIPTION: Manufacturers of glass and glass products from raw materials and/or recycled glass. The glass form produced may be flat or window glass, safety glass, container glass, tubing, glass wool or fibers. Glass containers may also be produced on the same site.

The raw materials are mixed and heated in a furnace. The resulting molten material is shaped by processes that vary with the intended product. The cooled glass may be edged, ground, polished, annealed and/or heat treated to produce the final product. Air emissions from the manufacturing buildings are scrubbed to remove particulates.

MATERIALS USED AND WASTES GENERATED: The basic raw materials are sand mixed with a variety of oxides such as aluminium, antimony, arsenic, lead, and barium. Metal salts for coloring such as copper or cobalt oxide may be used.

Raw materials are generally stored in silos except for crushed recycled glass. Consequently, contamination of stormwater is limited to raw material lost during unloading operations, errant flue dust, and engine fluids from mobile lifting equipment that is stored outside. The maintenance of the manufacturing equipment will produce used lubricants and cleaning solvents. The flue dust is likely to contain heavy metals such as arsenic, cadmium, chromium, mercury, and lead.

SOURCE-CONTROL BMPs: To the maximum extent practical all manufacturing activities are to be enclosed or covered (**BMP 1.70 in Part III**). All drains shall discharge to the sanitary sewer under pretreatment conditions defined by Metro (**R.1 in Part V**).

- o Businesses generating Dangerous Wastes shall properly segregate and dispose the wastes as required by the WDOE (**R.4 in Part V**).
- o Containers storing Dangerous Wastes or other liquids shall be placed inside a building unless impractical due to site constraints. If placed outside BMP 1.50 described in Part III shall be used.
- o Stockpiles of loose materials shall employ BMP 1.70 in PartII.

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- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o The parking lot shall be swept at appropriate intervals to remove debris.

STORMWATER-TREATMENT BMPs: Stormwater draining from the general plant site including parking lots shall be treated by one of the treatment systems described in **Part IV.**

Stormwater runoff from rooftops shall discharge to the storm drain or combined sewer below the treatment system as long as the City's drainage requirements are met **(R.2 in Part V).**

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Part II

INDUSTRIAL MACHINERY AND EQUIPMENT, TRUCKS AND TRAILERS

SIC: 3500, 3713/14

DESCRIPTION: Businesses that manufacture a variety of equipment including engines and turbines, farm and garden equipment, construction and mining, metal working machinery, pumps, computers and office equipment, automatic vending machines, refrigeration and heating equipment, and equipment for the manufacturing industries described elsewhere. This group also includes the many small machine shops. Also included here is the manufacturing of trucks and trailers, and parts (SIC 3713/14). Manufacturing processes will include various forms of metal working and finishing, and the production of plastic and fiberglass parts.

MATERIALS USED AND WASTES GENERATED: Manufacturers of engines or engine driven equipment can be expected to have fueling facilities. Larger equipment may be stored outside. Outside storage of gasoline, diesel, and cleaning fluids may occur. In contrast, smaller businesses may only have outside containers for the temporary storage of waste products.

Businesses making equipment in the Seattle area surveyed for Dangerous Wastes have been found to produce waste acids, used solvents, paints, metal chips with machine oil, and various chemicals. Used oil can also be expected.

SOURCE-CONTROL BMPs: If vehicles are fueled at the business site, the fuel island shall incorporate BMP 1.10 as described in Part III.

- Above ground storage tanks shall incorporate BMP 1.40 to prevent contamination of surface and groundwater.
- Businesses generating Dangerous Wastes shall properly segregate and dispose such wastes as required by the WDOE (R.4 n Part V).
- Containers storing Dangerous Wastes or other liquids shall be placed inside a building unless impractical due to site constraints. If placed outside BMP 1.50 described in Part III shall be used.

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- o If the business has either above ground storage tanks or containers located outside the owner shall develop an emergency spill contingency plan (**BMP 1.80 in Part III**).
- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o The parking lot shall be swept at appropriate intervals to remove debris.
- o All painting of products is to occur inside the manufacturing building.

STORMWATER-TREATMENT BMPs: Stormwater from outside equipment storage areas where dripping of oil or hydraulic fluids is likely to occur shall be treated by an API or CPI-separator (**BMP 2.10 in Part IV**).

Stormwater from parking lots shall also be treated either in conjunction with or separately from outside equipment storage areas using one of the systems described in **Part IV**.

Stormwater runoff from rooftops shall discharge to the storm sewer below the treatment system as long as the City's drainage requirements are met (**R.2 in Part V**).

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Part II

METAL PRODUCTS

SIC: 2514, 2522, 2542, 3312, 3315-17, 3320, 3350, 3360, 3400, 3590

DESCRIPTION: This group includes mills that produce the basic metals and primary products, as well as foundries, electroplaters, and fabricators of final metal products.

Basic metal production is limited in this manual to iron and steel. However any mill that reforms metal billets, either ferrous or nonferrous such as aluminum and copper, to primary metal products is included. Primary metal forms include sheets, flat bar, building components such as columns, beams and concrete reinforcing bar, and large pipe.

Steel mills in the Seattle area use only recycled metal and electric furnaces. The molten steel is cast into billets or ingots. These outputs may be reformed on site or shipped to rolling mills that produce primary products. As iron and steel billets may sit outside before reforming, surface treatment to remove scale may occur prior to reforming. The final product may also be stored outside.

Foundries are facilities that pour or inject molten metal into a mold to produce a shape that cannot be readily formed by other processes. The metal is first melted in a furnace. The mold is made of sand or metal die blocks that are locked together to make a complete cavity. The molten metal is ladled in and the mold is cooled. The rough product is finished by quenching, cleaning and chemical treatment. Quenching involves immersion in a plain water bath or water with an additive

Businesses that fabricate metal products from metal stock provide a wide range of products. The raw stock is manipulated in a variety of ways including machining of various types, grinding, heating, shearing, deformation, cutting and welding, soldering, sand blasting, brazing, and laminating. This group also includes businesses that make metal furniture (SIC 2500).

Fabricators may first clean the metal by sand blasting, descaling, or solvent degreasing. Final finishing may involve electroplating, painting, or direct plating by fusing or vacuum metalizing. Painting may involve paints, varnish, laquer, shellac, or plastics. Finishing may occur on site or at a specialized business such as electroplating.

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MATERIALS USED AND WASTE GENERATED: Raw materials in particular recycled metal are stored outside prior to use as are billets before reforming. The descaling process may use salt baths, sodium hydroxide, or acid (pickling).

Primary products often receive a surface coating treatment. Prior to the coating the product surface may be prepared by acid pickling to remove scale or alkaline cleaning to remove oils and greases. The two major classes of metallic coating operations are hot and cold coating. Zinc, terne and aluminum coatings are applied in molten metal baths, while tin and chromium are usually applied electrolytically from plating solutions.

In rolling operations where various steel products are made wastewater is produced from immersing the steel into an oil/water emulsion.

In foundries, the metal may be steel, iron, aluminum, copper, magnesium, zinc, lead or brass. Wastewaters come from quenching, cooling and rinsing operations. Lubricants are also used. These lubricants are often recycled within the plant. Foundries use sand and bentonite to make molds. Chemicals may be used to set the molds.

Fabricators produce wastewater from the rinsing of workpieces, cooling and lubrication, spray booths, quenching, and general cleanup. This wastewater may receive pretreatment from which sludges will be produced. Other waste products include scrap metal, used oil, acid and akaline wastes, heavy metal and cyanide bearing wastes, dyes, spent solvents, waste paints and other surface treatment materials. Electroplating businesses produce acid and alkaline solutions, and cyanide plating solutions and sludges.

Foundries and fabricators in the Seattle area surveyed for Dangerous Wastes have been found to produce waste acids, solvents, and various chemicals as well as used oil which is not a dangerous waste if properly recycled.

For all businesses in this group, activities that may occur outside include: bulk storage of chemicals, storage of metal feedstock, byproducts and finished products; unloading of chemical feedstocks and loading of waste liquids such as spent pickle liquor by truck or rail; quenching; waste oil and solvents from cleaning manufacturing equipment; and temporary storage of Dangerous Wastes, which may be a liquid or solid. Steel mills will produce slag and dust from the air scrubber.

SOURCE-CONTROL BMPs: To the maximum extent practical all manufacturing activities are to be enclosed or covered (**BMP 1.70 in Part III**). All drains shall discharge to the sanitary sewer under pretreatment conditions defined by Metro (**R.2 in Part V**).

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- o Liquid transfer areas, including loading/unloading docks shall comply with **BMP 1.30 in Part III.**
- o Above ground storage tanks shall incorporate BMPs to prevent contamination of surface and ground waters **(BMP 1.40 in Part III)**
- o Businesses generating Dangerous Wastes shall properly segregate and dispose the wastes as required by the WDOE **(R.4 in Part V).**
- o Containers storing Dangerous Wastes or other liquids shall be placed inside a building unless impractical due to site constraints. If placed outside BMP 1.50 described in Part III shall be used.
- o Stockpiles of loose materal shall use **BMP 1.60 in Part III.**
- o If the business has either storage tanks or containers located outside the owner shall develop an emergency spill contingency plan **(BMP 1.80 in Part III).**
- o Painting of products is to occur inside the manufacturing building.
- o Signs shall be painted on storm drain inlets to indicatethat they are not to receive liquid or solid wastes.
- o The parking lot shall be swept at appropriate intervals to remove debris.

STORMWATER-TREATMENT BMPs: Stormwater from parking lots and outside areas where raw materials, byproducts or products are stored shall be treated by one of the treatment systems described in **Part IV.**

Stormwater runoff from rooftops shall discharge to the storm drain or the combined sewer below the treatment system as long as the City's drainage requirements are met **(R.2 in Part V).**

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Part II

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Part II

PAPER PRODUCTS

SIC: 2650, 2670

DESCRIPTION: The manual covers businesses that take paper stock and produce basic paper products such as cardboard boxes and other containers, and stationery products such as envelopes and bond paper. Not included here are BMPs for pulp, paper and paperboard mills.

MATERIALS USED AND WASTES GENERATED: The basic feedstock is the bulk paper material. Repair and maintenance of manufacturing equipment will generate used oils and solvents. Coating operations can produce inks.

Outside activity is limited to unloading of liquid chemicals. Paper firms surveyed in the Seattle area for Dangerous Wastes have been found to produce waste solvents and caustic solutions, as well as used oil which is not a dangerous waste if properly recycled.

SOURCE-CONTROL BMPs: Liquid transfer areas, including loading/unloading docks shall comply with **BMP 1.30 in Part III.**

- o Businesses generating Dangerous Wastes shall properly segregate and dispose the wastes as required by the WDOE **(R.4 n Part V).**
- o Containers storing Dangerous Wastes or other liquids shall be placed inside a building unless impractical due to site constraints. If placed outside **BMP 1.50** in Part III shall be used.
- o The parking lot shall be swept at appropriate intervals to remove debris.
- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.

STORMWATER-TREATMENT BMPs: Stormwater from parking lots shall be treated by one of the treatment systems prescribed in **Part IV.**

Stormwater runoff from rooftops shall discharge to the storm drain or combined sewer below the treatment system as long as the City's drainage requirements are met **(R.2 in Part V).**

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Part II

R0059572

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PETROLEUM PRODUCTS

SIC: 2951

DESCRIPTION: Businesses in Seattle include the production of asphalt paving and roofing materials that use asphalt. Businesses that do the actual paving or seal roofs with asphalt roofing are discussed under Construction Businesses.

MATERIALS USED AND WASTES GENERATED: Asphalt paving consists of sand, gravel and the petroleum based asphalt that serves as the binder. Therefore located at such a business are stockpiles of sand and gravel. The asphalt emulsion is stored in above ground tanks. The business may own trucks that are maintained on-site.

Wastes products may include small dumps of unused asphalt and the expected materials from vehicle maintenance (see Vehicle Maintenance and Repair Businesses). Spillage of the asphalt emulsion could occur during transfer on to the business site.

SOURCE-CONTROL BMPs: If vehicles are fueled at the business site, the fuel island shall incorporate BMPs described in **BMP 1.10, Part III.**

- Liquid transfer areas, including loading/unloading docks shall comply with **BMP 1.30 in Part III.**
- Above ground storage tanks shall incorporate BMPs to prevent contamination of surface and ground waters **(BMP 1.40 in Part III)**
- Dangerous Wastes shall be properly segregated and disposed as required by the WDOE **(R.4 in Part V).**
- Containers storing Dangerous Wastes or other liquids shall be placed inside a building unless impractical due to site constraints. If placed outside **BMP 1.50** described in Part III shall be used.
- Rejected asphalt if temporarily stored onsite before disposal shall be covered following **BMP 1.70.**

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- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o The parking lot shall be swept at appropriate intervals to remove debris.

STORMWATER-TREATMENT BMPs: Stormwater from areas where contamination by the asphalt materials, by either the raw inputs or fianl products, shall be treated by an API or CPI-separator (**BMP 2.10 in Part IV**).

Stormwater from parking lots shall also be treated either in conjunction with or separately from the above areas by one of the treatment systems described in **Part IV**.

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R0059574

Part II

PRINTING AND PUBLISHING

SIC: 2700

DESCRIPTION: Preparation of newspapers, periodicals, commercial printing, bookbinding, typesetting, and business cards.

MATERIALS USED AND WASTES GENERATED: Various materials used in modifying the paper stock include inorganic and organic acids, resins, solvents, polyester film, developers, alcohol, vinyl laquer, dyes, acetates, and polymers. Waste products may include waste inks and ink sludges, solvents, acid and alkali solutions, chlorides, chromium, zinc, lead, spent formaldehyde, silver, and plasticizers. All of these waste products are Dangerous Wastes.

As the printing operations occur indoors, the only likely points of potential contact with stormwater are the temporary storage of waste materials outside the business owner's building and offloading of containerized chemicals through external unloading bays.

Printing and publishing businesses surveyed in the Seattle area for Dangerous Wastes were found to produce photographic chemicals and ink.

SOURCE-CONTROL BMPs: Liquid transfer areas, including loading/unloading docks shall use **BMP I.30 in Part III.**

- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o Businesses generating Dangerous Wastes shall properly segregate and dispose the wastes as required by the WDOE **(R.4 in Part V).**
- o The parking lot shall be swept at appropriate intervals to remove debris.

STORMWATER-TREATMENT BMPs: Stormwater from parking lots shall be treated by one of the treatment systems described in **Part IV.** Stormwater from rooftops shall discharge to the storm sewer below the treatment system as long as the City's drainage requirements are met **(R.2 in Part V).**

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Part II

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Part II

RUBBER AND PLASTIC PRODUCTS

SIC: 3000

DESCRIPTION: Although different in basic feedstocks and processes used, businesses that produce rubber and plastic products belong to the same SIC group and therefore are similarly grouped in this manual.

The rubber industry includes a wide variety of production activities ranging from polymerization reactions to extrusion of a rubber product from natural or synthetic stock.

MATERIALS USED AND WASTES GENERATED: The industry may use natural or synthetic rubber, new or recycled. Other materials used include pigments, paints, various filler and curing agents.

Activities that may occur outside the manufacturing building include: bulk storage of liquid feedstock or byproducts; unloading of liquid materials from truck or rail; washing of equipment outside the building; waste oil and solvents from cleaning manufacturing equipment; used equipment temporarily stored on site that could drip oil and residual process materials; and temporary storage of Dangerous Wastes.

Producers of plastic products in the Seattle area surveyed for Dangerous Wastes have been found to generate waste oils, solvents, inks and paints.

SOURCE-CONTROL BMPs: To the maximum extent practical all product storage areas are to be enclosed or covered (**BMP 1.70 in Part III**). All drains shall discharge to the sanitary sewer under treatment conditions defined by Metro (**R.2 in Part V**).

- o Liquid transfer areas, including loading/unloading docks shall comply with **BMP 1.30 in Part III.**
- o Above ground storage tanks shall incorporate BMPs to prevent contamination of surface and ground waters (**BMP 1.40 in Part III**)
- o Businesses generating Dangerous Wastes shall properly segregate and dispose the wastes as required by the WDOE (**R.4 in Part V**).

R0059577

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- o Containers storing Dangerous Wastes or other liquids shall be placed inside a building unless impractical due to site constraints. If placed outside the **BMP 1.50** described in Part III shall be used.
- o If the business has either storage tanks or containers located outside the owner shall develop a emergency spill contingency plan **(BMP 1.80 in Part III).**
- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o The parking lot shall be swept at appropriate intervals to remove debris.

STORMWATER-TREATMENT BMPs: Stormwater from parking lots and outside areas where products are stored shall be treated by one of the treatment systems prescribed in **Part IV.**

Stormwater runoff from rooftops shall discharge to the storm drain or combined sewer below the treatment system as long as the City's drainage requirements are met **(R.2 in Part V).**

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R0059578

Part II

SHIP AND BOAT BUILDING AND REPAIR YARDS

SIC: 3730

DESCRIPTION: Businesses that build new or repair existing ships and boats. Some provide a mobile service in which they come and work on the boat at its moorage. Repairs occur to the vessel hull, interior and engines. Typical activities include hull scaping, sandblasting, and finishing, metal fabrication, electrical repairs, engine overhaul, and welding, fiberglass repairs, hydroblasting and steam cleaning.

MATERIALS USED AND WASTES GENERATED: The above activities can cause direct entry of pollutants into water bodies, in addition to pollutants from storm runoff coming from shore facilities. Contaminated water may also come from drydock flooding, cooling water, ballast water, pump testing, wash downs, gray water, ships sanitary waste and bilge water.

Waste materials include blasting grit, paint chips, waste paints and other finishes, cleaners and solvents, used oils, and scrap materials.

SOURCE-CONTROL BMPs: The WDOE has developed BMPs for shipyards. These BMPs are:

- o The yard is to be cleaned on a regular basis to minimize loss of accumulated debris and sandblasting material to adjacent waters;
- o Catch basins in the drainage system are to be inspected on a monthly basis and cleaned as necessary;
- o Containers storing Dangerous Wastes or other liquids shall be placed inside a building unless impractical due to site constraints. If placed outside BMP 1.50 described in Part III shall be used.
- o Cleanup of spills is to begin immediately. No emulsifier or dispersant is to be used. Oil and hazardous spills are to be cleaned according to the Spill Prevention Control and Countermeasure Plan (R.8 in Part V). Oil containment booms shall be available for immediate usage.

R0059579

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- o Drip pans or other protective device shall be required for all transfers of oil, solvents and paints, and paint mixing (**BMP 1.30 in Part III**).
- o Paints and solvents shall not be mixed on floats.
- o Floatable and low density waste such as wood, plastic, insulation, etc, shall be removed from the drydock floor prior to flooding or sinking, and from the marine railway carriage and ramp before launching. Large density items may remain in place when between the wing walls of th drydock.
- o Dust and overspray shall be prevented from falling into the water to the degree feasible during abrasive blasting and spray painting. Feasible methods include plastic barriers beneath the hull, between the hull and drydock wingwalls; plastic barriers hung from the flying bridge of the drydock, from the bow or stern of the vessel or from temporary structures erected for that purpose.

  The bottom edge of the tarpaulins and plastic sheeting shall be weighted during a light breeze. When sandblasting, plywood and/or plastic sheeting shall be used to cover openings and open areas between decks including but not limited to scuppers, railings, freeing ports, ladders and doorways.
- o Prior to flooding of the drydock when a vessel is to be removed, accessible areas of the drydock are to be swept clean of debris. After a vessel has been removed and the dock raised the remaining shall be cleaned.
- o Shipboard cooling and process water shall be directed so as to minimize contact with spent abrasive, paint and other debris. Dock hosing shall be minimized when debris is present. When hosing occurs, methods shall be incorporated to prevent accumulation of debris in the drainage system.
- o Leaking connections, valves, pipes, hoses and soil chutes carrying either water or wastewater shall be replaced or repaired immediately.
- o Bilge and ballast water discharges shall not cause any visible sheen on receiving waters and shall not exceedan oil and grease concentration of 15 mg/l.

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- o Ballast water shall not be discharged to state waters if solvents, detergents, or other additives have been added unless a state water quality variance has been granted specific to that instance.

The above BMPs were developed by the WDOE for several existing businesses. For new businesses or businesses undergoing substantial rebuilding that requires City permits, the following BMPs are added:

- o To the maximum extent practical all activities are to be enclosed or covered. All interior drains shall discharge to the sanitary sewer under pretreatment conditions defined by Metro **(R.2 in Part V).**
- o Above ground storage tanks shall incorporate BMPs to prevent contamination of surface and ground waters **(BMP 1.40 in Part III)**
- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o Businesses generating Dangerous Wastes shall properly segregate and dispose the wastes as required by the WDOE **(R.4 in Part V).**

Mobile services shall abide with the applicable BMPs described above. Any cleaning, surfacing or resurfacing operation occurring over water that may result in the entry of debris such as paint chips, shall employ tarps temporarily affixed to the hull above the water line. Prior to removing the tarps, the accumulated contents shall be removed by vacuuming.

STORMWATER-TREATMENT BMPs: Stormwater from parking lots and outside areas where activities are occurring in addition to those noted above shall be treated by one of the treatment systems described in **Part IV.**

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Part II

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R0059582

Part II

WOOD PRODUCTS

SIC: 2430 - 2450, 2490, 2511/12, 2517, 2519, 2521, 2541

DESCRIPTION: This group incudes all businesses that make wood products using cut wood. It includes planing mills, millworks, and businesses that make wooden containers and prefab building components, mobile homes, and glued-wood products like laminated beams, as well as office and home furniture, partitions, and cabinets.

All businesses employ cutting equipment whose byproducts are chips and sawdust. Finishing occurs in many operations. Wood preserving involves more sophisticated operations such as steaming, boultonizing, kiln or air drying.

MATERIALS USED AND WASTES GENERATED: For this manual all businesses work with cut stock. No raw log material is present. Primary sources of contaminants are the trucks transporting stock lumber into and products from the businesses. Maintenance and repair of manufacturing equipment will produce waste oil and cleaning solvents that may be temporarily stored outside. Businesses may have finishing operations that produce waste paints and paint thinners, turpentine, shellac, and varnishes.

SOURCE-CONTROL BMPs: To the maximum extent practical all lumber and product are to be enclosed or covered (**BMP 1.70 in Part III**). All drains shall discharge to the sanitary sewer under pretreatment conditions defined by Metro (**R.1 in Part V**).

- o Liquid transfer areas, including loading/unloading docks shall comply with **BMP 1.30** in Part III.
- o Above ground storage tanks shall incorporate BMPs to prevent contamination of surface and ground waters (**BMP 1.40 in Part III**)
- o Businesses generating Dangerous Wastes shall properly segregate and dispose the wastes as required by the WDOE (**R.4 in Part V**).
- o Containers storing Dangerous Wastes or other liquids shall be placed inside a building unless impractical due to site constraints. If placed outside BMP 1.50 described in Part III shall be used.

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- o If the business has either storage tanks or containers located outside the owner shall develop a emergency spill contingency plan (**BMP 1.80 in Part III**).
- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o The parking lot shall be swept at appropriate intervals to remove debris.

STORMWATER-TREATMENT BMPs: Parking lots and outside areas in which feed lumber and/or products are stored require stormwater treatment (**Part IV**).

Stormwater runoff from rooftops shall discharge to the storm drain or combined sewer below the treatment system as long as the City's drainage requirements are met (**R.2 in Part V**).

R0059584

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Part II

OTHER MANUFACTURING BUSINESSES

SIC: 2200, 2300, 3100, 3250-69, 3280

DESCRIPTION: Includes manufacturing of textiles (SIC 2200) and apparel (SIC 2300), agricultural fertilizers (SIC 2873/74), leather products (SIC 3100), clay products such as bricks, pottery, bathroom fixtures (SIC 3200); and nonmetallic mineral products (SIC 3290). The group also includes manufacturing of airplanes and airplane parts, guided missiles, and space craft (SIC 3720), railroad equipment (SIC 3740), and instruments (SIC 3800).

All of the above manufacturers are represented in Seattle. Other manufacturing businesses specifically excluded from consideration in this group were listed in Part I.

MATERIALS USED AND WASTES GENERATED: A survey of businesses in the Seattle area found Dangerous Wastes being generated by all of the above types of manufacturers.

SOURCE-CONTROL BMPs: To the maximum extent practical all manufacturing activities are to be enclosed or covered (**BMP 1.70 in Part III**). All drains shall discharge to the sanitary sewer under pretreatment conditions defined by Metro (**R.1 in Part V**).

- o Liquid transfer areas, including loading/unloading docks shall comply with **BMP 1.30** in Part III.
- o Above ground storage tanks shall incoporate BMPs to prevent contamination of surface and ground waters (**BMP 1.40 in Part III**)
- o Businesses generating Dangerous Wastes shall properly segregate and dispose the wastes as required by the WDOE (**R.4 in Part V**).
- o Containers storing Dangerous Wastes or other liquids shall be placed inside a building unless impractical due to site constraints. If placed outside **BMP 1.50** described in Part III shall be used.

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- o If the business has either storage tanks or containers located outside the owner shall develop an emergency spill contingency plan (**BMP 1.80 in Part III**).
- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o The parking lot shall be swept at appropriate intervals to remove debris.

STORMWATER-TREATMENT BMPs: Stormwater from parking lots and outside areas where manufacturing processes are occurring shall be treated by one o

Stormwater runoff from rooftops shall discharge to the storm drain or combined sewer below the treatment system as long as the City's drainage requirements are met (**R.2 in Part V**).

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Part II

FLEET VEHICLE OWNERS

SIC: 4100, 4210, 4230, 7381/2, 7510

DESCRIPTION: Includes all businesses likely to own, operate and possibly maintain or repair large vehicle fleets, including taxis, buses, truck freight service, courier and armored car service, as well as renting or leasing of cars, trucks, and trailers.

Such businesses are likely to maintain, wash and fuel their own vehicles on site and therefore will possess many of the characteristics of general service gas stations or vehicle repair service shops. Washing may take place in enclosed and fully automated systems like commercial vehicle washers, or by hand on the parking area. Steam cleaning of engines and engine parts commonly occurs with owners of trucks and buses. Some fleet owners may store retired vehicles on site to be stripped for parts. A common practice with taxi fleets, this may result in the spills of engine fluids.

MATERIALS USED AND WASTES GENERATED: Both solid and liquid wastes are produced, as well as stormwater runoff from the paved surfaces. Waste materials generated by the various operations include: used oils, oil filters, used antifreeze, solvents, brake fluid, used batteries, sulfuric acid, battery acid sludges, empty contaminated containers and soiled rags. Spillage of gasoline and diesel fuels occurs, from the pumps and during transfer from tanker trucks to the underground storage tanks. Leaking underground storage tanks can cause groundwater contamination and a safety hazard.

Stormwater can be contaminated by: fuels and oil spilled on exposed paved surfaces; by solid and liquid wastes (noted above) that are not properly stored while awaiting disposal or recycling; dirt, oils and greases from steam cleaning and vehicle washing that occurs outside; and dripping of these same materials from parked vehicles. Stormwater conta-minated by fuels may contain significant concentrations of dissolved organics that cannot be removed by an oil/water separator. Water is produced from vehicle and parts washing and steam cleaning.

Research by Metro of its bus bases indicates that mean concentrations of oil and grease typically range from 10 to 20 mg/l with individual samples commonly exceeding 50 mg/l.

Deliberate disposal of materials to the storm sewer commonly occurs, in particular used oils and brake fluid, used antifreeze and radiator flush.

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It is currently common practice to temporarily store used oils, brake fluid, and solvent in underground fixed tanks although the latter is more frequently stored in steel drums.

SOURCE-CONTROL BMPs: The fuel pump islands shall be covered and provided a stormwater drainage system as described in **BMP 1.10 in Part III.**

- o Washing or steam cleaning of vehicles or vehicle parts outside shall occur in a designated area incorporating the requirements of **BMP 1.20 in Part III.**
- o If stored above ground waste-container drums shall be kept inside the service bay; or if kept outside, be covered by a "lean-to" structure that keeps rainfall from reaching the drums (**BMP 1.50 in Part III**).
- o Dumpsters that store items awaiting final disposal such as used oil filters shall also be located in a lean-to (**BMP 1.50**).
- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o Dangerous Wastes shall be properly segregated and disposed as required by the WDOE (**R.4 in Part V**).
- o No waste liquids or chemicals of any kind are to be discharged to the storm sewers. Antifreeze and radiator flush can be discharged to the sanitary sewers. All other liquids shall be recycled or properly disposed to permitted landfills.
- o Retired vehicles kept on site for scrap parts must be emptied of unused gas, transmission and hydraulic oil, radiator coolant, and any other fluid.

STORMWATER-TREATMENT BMPs: Stormwater from parking and maintenance areas where dripping oil or hydraulic fluids is likely to be occurring shall be treated by an API or CPI-separator (**BMP 2.10 in Part IV**). Stormwater from employee parking lots shall also be treated either in conjunction with or separately from the fleet vehicle parking areas using one of the systems described in **Part IV.**

Stormwater runoff from rooftops shall discharge to the storm drain or combined sewer below the treatment system as long as the City's drainage requirements are met (**R.2 in Part V**).

R0059588

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WAREHOUSES

SIC: 4220

DESCRIPTION: Businesses that store goods

MATERIALS USED AND WASTES GENERATED: Warehouse businesses that only provide storage will not produce any pollutants of concern except from the accidental spillage of liquids from containers that are dropped during loading and unloading. General stormwater contaminants will come from the paved areas surrounding the warehouse. Some warehouse businesses own their own fleet of trucks. Consequently, their characteristics will be similar to "Fleet Vehicle Yards".

SOURCE-CONTROL BMPs: Mini-warehouses used by the public are not required to install any BMPs with two exceptions: A SC-oil/water separator (**BMP 2.10 in Part IV**) shall be installed, and the paved area surrounding the warehouse shall be swept at appropriate intervals to remove debris.

If the warehouse business owns a fleet of vehicles, refer to "Fleet Vehicle Yards" for the appropriate BMPs. The following BMPs are for businesses that provide only a warehouse service.

Commercial warehouses shall carry out these BMPs:

- Loading/unloading docks shall comply with **BMP 1.3 in Part III.**
- Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- Businesses generating Dangerous Wastes shall properly segregate and dispose the wastes as required by the WDOE **(R.4 in Part V).**
- The parking lot shall be swept at appropriate intervals to remove debris.

STORMWATER TREATMENT BMPs: Stormwater from paved areas surrounding the warehouses shall be treated by one of the treatment systems described in **Part IV.**

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Part II

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Part II

OTHER TRANSPORTATION AND COMMUNICATION

SIC: 4700-4900

DESCRIPTION: This group includes travel agencies, and communication services such as TV and radio stations, cable companies, and electric and gas services. It does not include railroads, airplane transport services, airlines, pipeline companies, and airfields.

MATERIALS USED AND WASTES GENERATED: Gas and electric services are likely to own vehicles that are washed, fueled and maintained on site. A survey of communication service companies in the Seattle area has found the generation of used oils and WDOE dangerous wastes.

SOURCE-CONTROL BMPs: If vehicles are fueled at the business site, the fuel island shall incorporate **BMP 1.10** as described in Part III.

- o Washing or steam cleaning of vehicles or vehicle parts outside shall occur in a designated area incorporating the requirements of **BMP 1.20 in Part III.**
- o Fuel transfer shall comply with **BMP 1.30 in Part III.**
- o Above ground storage tanks shall incorporate BMPs to prevent contamination of surface and ground waters **(BMP 1.40 in Part III)**
- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o Businesses generating Dangerous Wastes shall properly segregate and dispose the wastes as required by the WDOE **(R.4 in Part V).**
- o Containers storing Dangerous Wastes or other liquids shall be placed inside a building unless impractical due to site constraints. If placed outside BMP 1.50 described in Part III shall be used.
- o The parking lot shall be swept at appropriate intervals to remove debris.

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Part II

STORMWATER-TREATMENT BMPs: Stormwater from parking lots shall be treated by one of the treatment systems described in **Part IV.**

Stormwater runoff from rooftops shall discharge to the storm drain or combined sewer below the treatment system as long as the City's drainage requirements are met **(R.2 in Part V).**

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R0059592

Part II

GASOLINE SERVICE STATIONS

SIC: 5540

DESCRIPTION: Gasoline service stations primarily sell gasoline and lubricating oils. Most perform minor repair and maintenance including: servicing of the engine's hydraulic systems, brakes, transmission, and differential; engine coolant; lubrication of the body chassis, and wheel bearings; engine cleaning; air-conditioning system; and the servicing of tires and batteries.

Ancilliary activities frequently present are: car washing and/or steam cleaning that may occur within the building or outside on the paved area; selling of food products; and, the rental of trucks or trailers.

MATERIALS USED AND WASTES GENERATED: Both solid and liquid wastes are produced, as well as stormwater runoff from the paved surfaces. Waste materials generated by the various operations include: used oils, oil filters, used antifreeze, solvents, brake fluid, used batteries, sulfuric acid, battery acid sludges, empty contaminated containers and soiled rags. Spillage of gasoline and diesel fuels occurs, from the pumps and during transfer from tanker trucks to the underground storage tanks. Leaking underground storage tanks can cause groundwater contamination and a safety hazard.

Stormwater can be contaminated by: fuels and oil spilled on exposed paved surfaces; by solid and liquid wastes (noted above) that are not properly stored while awaiting disposal or recycling; dirt, oils and greases from steam cleaning and vehicle washing that occurs outside; and dripping of these same materials from parked vehicles. Stormwater contaminated by fuels may contain significant concentrations of dissolved organics that cannot be removed by an oil/water separator.

Deliberate disposal of materials to the storm sewer commonly occurs, in particular used oils and brake fluid, used antifreeze and radiator flush. It is currently common practice to temporarily store used oils, brake fluid, and solvent in underground fixed tanks although the later is more frequently stored in steel drums.

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SOURCE-CONTROL BMPs: The fuel pump islands shall be covered and provided with a stormwater drainage system as described in **BMP 1.10 in Part III.**

- o Washing or steam cleaning of vehicles or vehicle parts outside shall occur in a designated area incorporating the requirements of **BMP 1.20 in Part III.**
- o Businesses generating Dangerous Wastes shall properly segregate and dispose the wastes as required by the WDOE **(R.4 in Part V).**
- o If stored above ground waste-container drums shall be kept inside the service bay; or if kept outside, be covered by a "lean-to" structure that keeps rainfall from reaching the drums **(BMP 1.50 in Part III).**
- o Dumpsters that store items awaiting transfer to a landfill such as used oil filters shall also be located in a lean-two **(BMP 1.50 in Part III).**
- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes
- o No waste liquids or chemicals of any kind are to be discharged to the storm sewers. Antifreeze and radiator flush can be discharged to the sanitary sewers. All other liquids shall be recycled or properly disposed to permitted landfills.

STORMWATER-TREATMENT BMPs: Stormwater from parking and maintenance areas where dripping oil or hydraulic fluids is likely to be occurring shall be treated by an API or CPI-separator **(BMP 2.10 in Part IV).**

Stormwater runoff from rooftops shall discharge to the storm sewer below the treatment system as long as the City's drainage requirements are met **(R.2 in Part V).**

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R0059594

Part II

RECYCLING AND SCRAP BUSINESSES

SIC: 5093, 5015

DESCRIPTION: Businesses that reclaim various materials for resale: construction materials, metals, and beverage containers and papers. This group also includes businesses that strip and sell parts from automobiles, trucks, and construction equipment.

MATERIALS USED AND WASTES GENERATED: These businesses generally conduct their operations in the open. The type of waste materials and contamination of stormwater will vary widely with the type of business. However, in general it can be expected that the stormwater will be contaminated by metals, trace organics, BOD, suspended solids, and oil.

SOURCE-CONTROL BMPs: To the maximum extent practical processing activities are to be enclosed or covered (**BMP 1.70 in Part III**). All internal drains shall discharge to the sanitary sewer under pretreatment conditions defined by Metro (**R.2 in Part V**).

- o Where enclosure or covering is not possible, consideration shall be given to segregating and covering or enclosing those activities that are particularly significant sources of pollutant.
- o Where segregation is not possible discharge of high-frequency storms to the sanitary sewer shall be considered (**BMP 1.70 in Part III**).
- o Engine fuels, oils, and all other fluids shall be drained from vehicles that are being scrapped before the onset of any scrapping operation.
- o Dangerous Wastes shall be properly segregated and disposed as required by the WDOE (**R.4 in Part V**).
- o Containers storing Dangerous Wastes or other liquids shall be placed inside a building unless impractical due to site constraints. If placed outside **BMP 1.50** described in Part III shall be used.
- o If the business has either storage tanks or containers located outside the owner shall develop an emergency spill contingency plan (**BMP 1.80 in Part III**).

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- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o The parking lot shall be swept at appropriate intervals to remove debris.

STORMWATER-TREATMENT BMPs: Stormwater from parking lots and outside processing areas shall be treated by one of the treatment systems described in **Part IV.**

Stormwater runoff from rooftops shall discharge to the storm sewer below the treatment system as long as the City's drainage requirements are met **(R.2 in Part V).**

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R0059596

Part II

RESTAURANTS AND FAST FOODS

SIC: 5800

DESCRIPTION: Businesses that provide food service to the general public.

MATERIALS USED AND WASTES GENERATED: Fast food restaurants experience very heavy usage. The two potential sources of stormwater contamination are the parking lots dumpsters exposed to precipitation.

SOURCE-CONTROL-BMPs: Dumpsters used to contain waste food shall be replaced if deterioration of their interior is allowing leakage; and, dumpsters used to contain waste food shall be placed under cover to prevent entry of stormwater (**BMP 1.50 in Part III**).

- o The parking lot shall be swept at appropriate intervals to remove debris.

STORMWATER-TREATMENT BMPs: Stormwater from parking lot surfaces located at restaurants shall be treated using one of the treatment systems described in **Part IV**. Stormwater from parking lots at fast food restaurants shall be treated by an API or CPI-separator (**BMP 2.10 in Part IV**).

Stormwater runoff from rooftops shall discharge to the storm drain or combined sewer below the treatment system as long as the City's drainage requirements are met (**R.2 in Part V**).

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R0059597

Part II

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R0059598

Part II

RETAIL GENERAL MERCHANDISE

SIC: 5300, 5600, 5700, 5900, 5990

DESCRIPTION: This group includes general merchandising stores such as department stores, shopping malls, variety stores, 24-hour convenience stores, and general retail stores that focus on a few product types such as clothing and shoes. It also includes furniture and appliance stores.

MATERIALS USED AND WASTES GENERATED: Of particular concern are the parking lots of shopping malls and 24-hour convenience stores; because of heavy vehicle usage, the concentration of oil and grease in stormwater likely exceeds the WDOE standard of 10 mg/l. Although there are no local data to confirm this view, limited research in the San Feancisco Bay area found the mean concentration of oil and grease in stormwater to exceed 10 mg/l. Larger stores may own delivery vehicles. It is likely that servicing these vehicles occurs elsewhere and is not done by the owner.

Furniture and appliance stores may provide a repair service in which Dangerous Wastes may be produced. Department stores and shopping malls may have restaurants that generate waste food.

SOURCE-CONTROL BMPs: Dumpsters used to contain waste food shall be replaced if deterioration of their interior is allowing leakage; and, shall be placed under cover to prevent entry of stormwater (**BMP 1.50**).

- Businesses owning their own vehicles are not to wash or steam steam clean them at the business site unless they comply with **BMP 1.20 in Part III.**
- Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- The parking lot shall be swept at appropriate intervals to remove debris.

STORMWATER-TREATMENT BMPs: Stormwater from parking lots of stores that experience heavy vehicle usage shall be treated by an API or CPI-separator (**BMP 2.10 in Part IV**). Stormwater runoff from rooftops shall discharge to the storm drain or combined sewer below the treatment system as long as the City's drainage requirements are met (**R.2 in Part V**).

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R0059599

Part II

VOL 12 2 6307

R0059600

Part II

RETAIL AND WHOLESALE VEHICLE AND EQUIPMENT DEALERS

SIC: 5010, 5080, 5500 excluding gas stations (5540)

DESCRIPTION: This group includes all retail and wholesale businesses that sell cars, trucks, boats, trailers, mobile homes, motorcycles and recreational vehicles. It includes both new and used vehicle dealers. It also includes sellers of heavy equipment for construction, farming, and industry.

With the exception of motorcycle dealers, these businesses have large lots for the parking of vehicles. Most retail dealers that sell new vehicles also provide repair and maintenance service. Sellers of large equipment may also provide maintenance and repair services.

MATERIALS USED AND WASTES GENERATED: Storm runoff from the parking areas will be contaiminated by oil and other materials that have dripped from parked vehicles. Frequent washing of vehicles occurs generating vehicle grime and detergent pollutants. The storm or washwater runoff will contain oils and various organics, metals, and phosphorus.

Repair and maintenance services generate a variety of waste liquids and solids including used oils and engine fluids, solvents, waste paint, and soiled rags, as well as dirty engine parts. Many of these materials are WDOE Dangerous Wastes.

SOURCE-CONTROL BMPs: If vehicles are fueled at the business site, the fuel island shall incorporate **BMP 1.10** as described in Part III.

- Washing or steam cleaning of vehicles or vehicle parts outside shall occur in accordance with **BMP 1.20** .
- Fuel unloading areas shall comply with **BMP 1.30 in Part III.**
- Businesses generating Dangerous Wastes shall properly segregate and dispose the wastes as required by the WDOE **(R.4 in Part V).**
- Containers storing Dangerous Wastes or other liquids shall be placed inside a building unless impractical due to site constraints. If placed outside **BMP 1.50** described in Part III shall be used.

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R0059601

- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o The parking lot shall be swept at appropriate intervals to remove debris.

STORMWATER-TREATMENT BMPs: Stormwater from parking lots shall be treated by one of the treatment systems described in **Part IV.**

Stormwater runoff from rooftops shall discharge to the storm drain or combined sewer below the treatment system as long as the City's drainage requirements are met (**R.2 in Part V**).

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R0059602

Part II

RETAIL AND WHOLESALE NURSERIES AND BUILDING MATERIALS

SIC: 5030, 5198, 5210, 5230, 5260

DESCRIPTION: These businesses are placed in a separate group as they are likely to store much of their merchandise outside of the main building. They include nurseries, and businesses that sell building and construction materials and equipment, as well as paint (5198, 5230) and hardware.

MATERIALS USED AND WASTES GENERATED: Storm runoff from exposed storage areas will contain suspended solids, oil and grease from vehicles and forklifts, and other pollutants. Runoff from nurseries may contain nutrients and pesticides or herbicides. Some businesses may have small fueling capabilities for forklifts and may also maintain and repair their equipment. They may have delivery vehicles.

Businesses in this group surveyed in the Seattle area for Dangerous Wastes were found to produce waste solvents, paints and used oil.

SOURCE-CONTROL BMPs: Liquid transfer areas, including loading/unloading docks shall comply with **BMP 1.30 in Part III.**

- o **BMP 1.60** shall be employed if materials such as topsoil, fertillizer, and building materials are stored outside.
- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o The parking lot shall be swept at appropriate intervals to remove debris.

STORMWATER-TREATMENT BMPs: Stormwater from parking lots and areas where products are stored in the open shall be treated using one of the treatment systems described in **Part IV.** Stormwatef from rooftops shall discharge to the storm drain or combined sewer below the treatment system as long as the City's drainage requirements are met **(R.2 in Part V).**

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Part II

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R0059604

Part II

WHOLESALE CHEMICALS AND PETROLEUM

SIC: 5160, 5170

DESCRIPTION: This group of businesses sells plastic materials, and chemicals and related products. The group also includes the bulk storage and selling of petroleum products such as diesel oil, automotive fuels, etc. Therefore, liquid transfer and storage are the major activities.

MATERIALS USED AND WASTES GENERATED: The general areas of concern at the spillage of chemicals or petroleum during loading and unloading, and the washing and maintenance of tanker trucks.

The WDOE already requires an API or CPI separator for tank farms and tanker truck loading areas. The concentration of oil in the influent to separators typically exceeds the WDOE standard. Runoff is also likely to contain significant concentrations of benzene, phenol, chloroform, lead, and zinc.

A survey of these businesses in the Seattle area found waste oil and solvents from vehicle and equipment maintenance.

The fire code requires that vegetation be controlled within the tank farm to avoid a fire hazard; herbicides are typically used.

SOURCE-CONTROL-BMPs: If tanker truck fueling is occurring at the business, the fuel pump island shall be covered and providedwith a storm-water drainage system as described in **BMP 1.10 in Part III.**

- o Washing or steam cleaning of vehicles or vehicle parts outside shall occur in accordance with the requirements of **BMP 1.20 in Part III.**
- o Liquid transfer areas, including loading/unloading docks shall comply with **BMP 1.30 in Part III.**
- o Above ground storage tanks shall incorporate BMPs to prevent contamination of surface and ground waters **(BMP 1.40 Part III).**
- o Businesses generating Dangerous Wastes shall properly segregate and dispose the wastes as required by the WDOE **(R.4 in Part V).**

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- o Containers storing Dangerous Wastes or other liquids shall be placed inside a building unless impractical due to site constraints. If placed outside **BMP 1.50** described in Part III shall be used.
- o Federal law requires businesses that handle petroleum to develop spill prevention and control plans (**R.8 in Part V**). These businesses must also comply with certain technical requirements if marine transfer is involved (**R.6 in Part V**).
- o Nonpetroleum businesses with above ground storage tanks or containers located outside the owner shall develop a emergency spill contingency plan (**BMP 1.80 in Part III**).
- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o The parking lot shall be swept at appropriate intervals to remove debris.

STORMWATER-TREATMENT BMPs: Stormwater from parking lots and loading/unloading areas shall be treated by one of the treatment systems described in Part IV. Stormwater runoff from rooftops shall discharge to the storm sewer below the treatment system as long as the City's drainage requirements are met (**R.2 in Part V**).

Stormwater from petroleum storage facilities shall be treated by an API or CPI-separator (**BMP 2.10 in Part IV**).

R0059606

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Part II

WHOLESALE BEVERAGES AND FOODS

SIC: 5140, 5180

DESCRIPTION: Included here are businesses serving retail food stores. Items covered are general groceries, fish and seafood, meats and meat products, dairy products, poultry, soft drinks, and alcoholic beverages.

MATERIALS USED AND WASTES GENERATED: These businesses are likely to own their delivery vehicles. Vehicles therefore may be fueled, washed and maintained at the business. Spillage of food and beverages may occur. Waste food and broken contaminated glass may be temporarily stored in containers located outside.

SOURCE-CONTROL BMPs: If vehicles are fueled at the business site, the fuel island shall incorporate **BMP 1.10** as described in Part III.

- o Washing or steam cleaning of vehicles or vehicle parts outside shall occur in accordance with **BMP 1.20.**
- o Liquid transfer areas, including loading/unloading docks shall comply with BMP **1.30 in Part III.**
- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o Businesses generating Dangerous Wastes shall properly segregate and dispose the wastes as required by the WDOE **(R.4 in Part V).**
- o Containers used to contain waste food or broken beverage-bottles shall be replaced if deterioration of their interior is allowing leakage; and, under cover to prevent entry of stormwater **(BMP 1.50 in Part III)**
- o The parking lot shall be swept at appropriate intervals to remove debris.

STORMWATER-TREATMENT BMPs: Stormwater from parking lots shall be treated by one of the treatment systems described in **Part IV.** Stormwater runoff from rooftops shall discharge to the storm drain or combined ewer below the treatment system as long as the City's drainage requirements are met **(R.2 in Part V).**

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Part II

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R0059608

Part II

WHOLESALE

SIC: 5010 (not 5012), 5040, 5060,5070, 5090

DESCRIPTION: This group includes all wholesale business not previously listed in any previous group. Examples are sellers of vehicles parts, tires, furniture and home furnishings, photographic and office equipment, electrical goods, sporting goods and toys, paper and paper products, drugs and apparel.

MATERIALS USED AND WASTES GENERATED: The only anticipated activity producing stormwater pollutants is the parking lot.

SOURCE-CONTROL BMPs: The parking lot shall be swept at appropriate intervals to remove debris.

- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.

STORMWATER-TREATMENT BMPs: Stormwater from parking lot surfaces shall be treated using one of the treatment systems described in **Part IV.**

Stormwater runoff from rooftops shall discharge to the storm drain or combined sewer below the treatment system as long as the City's drainage requirements are met **(R.2 in Part V).**

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Part II

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Part II

COMMERCIAL CAR AND TRUCK WASHES

SIC: 7542

DESCRIPTION: Facilities include automatic systems found at individual businesses or at gas stations and 24 hour convenience stores, as well as self-service. There are three main types: tunnels, rollovers and hand-held wands. The tunnel wash, the largest, is housed in a long building through which the vehicle is pulled. At a rollover wash the vehicle remains stationary while the equipment passes over. Wands are used at self-serve car washes. Some car washing businesses also sell gasoline.

MATERIALS USED AND WASTES GENERATED: The main ingredients are water and detergents. Waxes may be present in the commercial operations. Wastewaters are discharged to sanitary sewers. In self-service operations a drain is located inside each car bay.

Although these businesses discharge the wastewater to the sanitary sewer, some wash water can find its way to the storm sewer, particularly with the rollover and wand systems. Rollover systems often do not have air drying. Consequently, the car as it leaves the enclosure sheds water to the pavement. With the self-service system, wash water with detergents can spray outside the building and be lost to the storm sewer. Users of self-serve operations may also clean engines and change oil, dumping the used oil into the drain.

SOURCE-CONTROL BMPs: If gasoline is sold at the site, refer to Gasoline Service Stations on required BMPs.

With rollover systems that do not have air drying, a drain shall be located at the exit of the building to which extraneous wash water can drain. This drain shall be connected to the sanitary sewer.

The solution preventing loss of water at self-service businesses is to construct an embayment of sufficient length. Observation of several such operations indicates the individual bay should be at least 30 feet in length.

STORMWATER-TREATMENT BMPs: Stormwater from parking lot surfaces shall be treated by one of treatment systems described in **Part IV**. Downspouts from the wash building should be discharged downstream of any treatment BMP as long as the City's drainage control requirements can be met (**R.2 in Part V**)

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Part
II

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R0059612

Part II

EQUIPMENT REPAIR

SIC: 7353, 7600

DESCRIPTION: Includes several businesses that specialize in repairing different equipment including communications equipment, radio, TV, household appliances, refrigeration systems. Also included are businesses that rent or lease heavy construction equipment (7353) as miscellaneous repair and maintenance may occur on site.

MATERIALS USED AND WASTES GENERATED: A survey of several of these businesses indicates they produce used oil and solvents.

SOURCE-CONTROL BMPs: Containers storing Dangerous Wastes or other liquids shall be placed inside a building unless impractical due to site constraints. If placed outside BMP 1.50 described in Part III shall be used.

- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o The parking lot shall be swept at appropriate intervals to remove debris.

STORMWATER-TREATMENT BMPs: Stormwater from parking lots shall be treated by one of the treatment systems described in Part IV.

Businesses that repair, store, or reell used construction or other mobile industrial equipment such as fork lifts, log handline equipment, cranes, etc, shall treat stormwater from outside equipment and storage areas maintenance areas with an API or CPI-separator (BMP 2.10 in Part IV).

Stormwater runoff from rooftops shall discharge to the storm drain or combined sewer below the treatment system as long as the City's drainage requirements are met (R.2 in Part V).

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R0059613

Part II

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R0059614

Part II

LAUNDRIES AND DRY CLEANERS

SIC: 7211 through 721

DESCRIPTION: This category includes all types of cleaning services including laundries, linen supply, diaper service, coin-operated laundries and dry cleaning, retail dry cleaning, and carpet and upholstry service.

Materials used differ particularly between wet and dry cleaning. Wet washing may involve the use of acids, bleaches and/or multiple organic solvents. Dry cleaners use an organic based solvent, although small amounts of water and detergent is sometimes used. Solvents are generally recovered and filtered for further use. Less expensive solvents may be vented to the atmosphere.

Carpet and upholstery cleaning may be done on location or at the plant. On-location is done with dry materials or by a hot-water extraction process. In-plant processes usually use solvents followed by a detergent wash.

MATERIALS USED AND WASTES GENERATED: Wash liquids are discharged to sanitary sewers. Of concern is the loading and unloading of liquid materials, particularly at large commercial operations, and the disposal of spent solvents and solvent cans.

SOURCE-CONTROL BMPs: Containers storing Dangerous Wastes or other liquids shall be placed inside a building unless impractical due to site constraints. If placed outside, BMP 1.30 described in Part III shall be used.

- o Businesses generating Dangerous Wastes shall properly segregate and dispose such wastes as required by the WDOE (R.4 in Part V).
- o The parking lot shall be swept at appropriate intervals to remove debris.
- o Mobile cleaning units shall not discharge the accumulated wash water to storm drains.

STORMWATER-TREATMENT BMPs: Stormwater from parking lot surfaces shall be treated using one of the treatment systems described in Part IV. Stormwater runoff from rooftops shall discharge to the storm drain or combined sewer below the treatment system as long as the City's drainage requirements are met (R.2 in Part V).

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R0059615

Part II

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R0059616

Part II

MARINAS/YACHT CLUBS

SIC: 7999

DESCRIPTION: Marinas and yault clubs provide moorage for recreational boats. Marinas may also provide fueling and maintenance services. Other activities include cleaning and painting of boat surfaces, minor boat repair, and pumping of bilges and sanitary-holding tanks. Not all marinas have a system to receive pumped bilge water.

The Puget Sound Water Quality Authority plan calls for modification of state regulations to require the treatment of stormwater runoff; development of a model ordinance for sewer hookups by liveaboards, to be adopted voluntarly by local jurisdictions; and the formation of a task force that will prepare a comprehensive program to control the adverse effects of marinas.

MATERIALS USED AND WASTES GENERATED: Both solid and liquid wastes are produced, as well as stormwater runoff from the parking lot. Waste materials include sewage and bilge water. Maintenance by the tenants will produce used oils, oil filters, solvents, waste paints and varnishes, used batteries, and empty contaminated containers and soiled rags.

SOURCE-CONTROL BMPs: If stored above ground waste-container drums shall be kept inside an enclosed building; or if kept outside, be covered using **BMP 1.50** in Part III.

- Dumpsters that store items awaiting transfer to a landfill such as used oil filters shall also be located in a lean-to (**BMP 1.50 in Part III**).
- Where scraping or other preparation of the hull of the boat for resurfacing occurs over water, a tarp shall be affixed to the hull in a manner that traps any debris. The debris shall be vacuumed from the tarp before the tarp is removed.
- The marina/yault club shall provide pump out systems for sanitary sewage and these facilities shall be used by "liveaboards".
- Oil-absorbing materials shall be placed in the bilge, removed at appropriate intervals and disposed properly.

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- o Any spillage onto the docks or boat is to be cleaned up immediately.
- o The marina owner is to be notified immediately of any spill.
- o The marina owner shall post in prominent locations BMPs listed above that must be carried out by the boat-owner.
- o The business owner shall post in prominant places a list of the above BMPs that individual boat owners are to follow in their maintenance and repair activities.

STORMWATER-TREATMENT BMPs: Stormwater from the adjoining parking lot shall be treated using one of the treatment systems described in **Part IV**. Stormwater runoff from rooftops shall discharge directly to the surface water.

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Part II

SERVICES

SIC: 4959, 7260, 7312, 7332, 7333, 7340, 7395, 7641, 799 8411

DESCRIPTION: Includes a mix of service businesses that generate Dangerous Wastes. Included here are photographic studios, commercial photography, funeral services, amusement parks, and furniture and upholstery repair.

MATERIALS USED AND WASTES GENERATED: Building maintenance businesses produce wash and rinse solutions, oils, and solvents. Pest control businesses produce rinsewater with residual pesticides from washing application equipment and empty containers.

Outdoor advertising businesses will produce photographic chemicals, inks, waste paints, organic paint sludges containing metals.

Funeral services are known to produce formalin, formaldehyde and ammonia, which is usually legally discharged to the sink.

Upholstery and furniture repair businesses are known to produce, oil, stripping compounds, wood preservatives and solvents.

SOURCE-CONTROL BMPs: Containers storing Dangerous Wastes or other liquids shall be placed inside a building unless impractical due to site constraints. If placed outside BMP 1.30 described in Part III shall be used. The parking lot will be swept at appropriate intervals to remove debris.

STORMWATER-TREATMENT BMPs: Stormwater from parking lot shall be treated using one of the treatment systems described in **Part IV.** Stormwater runoff from rooftops shall discharge to the storm drain or combined sewer below the treatment system as long as the City's drainage requirements are met (**R.2 in Part V**)

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Part II

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R0059620

Part II

SERVICES

SIC: 6000, 7000 and 8000, not listed elsewhere

DESCRIPTION: Presented here are the remaining service businesses including theaters, hotels/motels, finance, banking, hospitals and medical services, nursing homes, schools and universities, and legal, financial and engineering services.

MATERIALS USED AND WASTES GENERATED: The primary concern is runoff from parking areas. Stormwater from parking lots will contain undesirable concentrations of oil and grease, suspended particulates, and metals such as lead, cadmium and zinc. It will also contain the organic byproducts of engine combustion. Some also produce Dangerous Wastes: hospitals, nursing homes and other medical services. These materials are stored within the building until disposal.

SOURCE-CONTROL BMPs: Dumpsters used to contain waste food shall be replaced if deterioration of their interior is allowing leakage; and shall be placed under cover to prevent entry of stormwater (BMP 1.50).

- o Businesses generating Dangerous Wastes shall properly segregate and dispose the wastes as required by the WDOE (R.4 in Part V).
- o Containers storing Dangerous Wastes or other liquids shall be placed inside a building unless impractical due to site constraints. If placed outside BMP 1.50 described in Part III shall be used.
- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o The parking lot shall be swept at appropriate intervals to remove debris.

STORMWATER-TREATMENT BMPs: Stormwater from parking lots shall be treated by one of the treatment systems described in Part IV. Stormwater from rooftops shall discharge to the storm drain or combined sewer below the treatment system as long as the City's drainage requirements are met (R.2 in Part V).

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Part II

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Part II

VEHICLE MAINTENANCE AND REPAIR

SIC: 4000, 7530

DESCRIPTION: Includes businesses that repair and maintain automobiles, trucks, and buses, excluding those businesses listed elsewhere in this manual. Businesses included here are tube and tune shops, auto repair and painting shops; truck repair, and battery, radiator, muffler, and tire shops. Excluded here are vehicle dealers and gasoline service stations that also repair vehicles.

MATERIALS USED AND WASTES GENERATED: Wastes generated are similar to that found with general purpose gas stations, although businesses that provide specialized with certain maintenance activities will not produce all the wastes listed below.

Materials include waste oil, solvents, degreasers, antifreeze, radiator flush, acid solutions with chromium, zinc, copper, lead and cadmium, brake fluid, soil rags, oil filters, sulfuric acid and battery sludges, and machine chips with residual machining oil.

A large number of vehicles may be parked in and around the service buildings.

SOURCE-CONTROL BMPs: No waste liquids or chemicals of any kind are to be discharged to the storm sewers. Antifreeze and radiator flush can be discharged to the sanitary sewers. All other liquids shall be recycled or properly disposed to permitted landfills.

- o Washing or steam cleaning of vehicles or vehicle parts outside shall occur in a designated area incorporating the requirements of **BMP 1.20 in Part III.**
- o Businesses generating Dangerous Wastes shall properly segregate and dispose the wastes as required by the WDOE **(R.4 in Part V).**
- o If stored above ground waste-container drums shall be kept inside the service bay; or if kept outside, be covered by a "lean-to" structure that keeps rainfall from reaching the drums **(BMP 1.50 in Part III).**

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- o Dumpsters that store items awaiting transfer to a landfill such as used oil filters shall also be located in a lean-to (**BMP 1.50 in Part III**).
- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o No waste liquids or chemicals of any kind are to be discharged to the storm sewers. Antifreeze and radiator flush can be discharged to the sanitary sewers. All other liquids shall be recycled or properly disposed to permitted landfills.

STORMWATER-TREATMENT BMPs: Stormwater from parking and maintenance areas where dripping oil or hydraulic fluids is likely to be occurring shall be treated by an API or CPI-separator (**BMP 2.10**).

Stormwater runoff from rooftops shall discharge to the storm sewer below the treatment system as long as the City's drainage requirements are met (**R.2 in Part V**).

R0059624

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APARTMENTS AND CONDOMINIUMS

SIC: NA

DESCRIPTION: Multifamily residential buildings. The activities of concern are vehicle parking, vehicle washing and oil changing, and waste food (garbage) containers.

MATERIALS USED AND WASTES GENERATED: Stormwater from parking lots will contain undesirable concentrations of oil and grease, suspended particulates, and metals such as lead, cadmium and zinc. It will also contain the organic byproducts of engine combustion. These conditions will be exacerbated by car owners washing their cars and changing oil which they may dump down the nearest storm drain.

SOURCE-CONTROL-BMPs: Washing of vehicles shall comply with **BMP 1.20 in Part III.**

- o Garbage dumpsters shall be replaced if deterioration of their interior is allowing leakage; and, shall be placed under cover to prevent entry ofstormwater **(BMP 1.50 in Part III).**
- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o The parking lot shall be swept at appropriate intervals to remove debris.
- o A designated container for used oil shall be provided and properly shielded from rain.

STORMWATER-TREATMENT BMPs: Stormwater from parking lots shall be treated using one of the treatment systems described in **Part IV.** Stormwater runoff from rooftops shall discharge to the storm drain or combined sewer below the treatment system as long as the City's drainage requirements are met **(R.2 in Part V).**

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Part II

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R0059626

Part II

CONSTRUCTION

SIC: 1500, 1600, 1700

DESCRIPTION: This is not the site of construction, but rather the location of the businesses themselves. It includes the builders of homes, commercial and industrial buildings. It also includes heavy equipment contractors who excavate, as well as specialized contractors such as plumbing, painting and paper hanging, carpentry, electrical, roofing and sheet metal, wrecking and demolition, stonework and masonry.

Maintenance and repair of equipment can occur at the site of business owners. Heavy equipment contractors may park thir equipment adjacent to their businesses. Repairs may occur in the parking area where contamination of the pavement or soil can occur. Demolition contractors may store reclaimed material before resale.

MATERIALS USED AND WASTES GENERATED: All of the materials used in construction as well as both mobile and stationary equipment. The majority of wastes are generated at the construction site. However, these materials may also be found in smaller quantities at the business sites. Potential materials include solvents, paints, batteries, strong acid and alkaline wastes, paint and varnish removers. These are Dangerous Wastes. Used oil is also produced.

With speciality contractors, the types of wastes vary substantially. Painting contractors will generate paint and other finishing residues, spent thinners, paint containers and used oil from servicing their vehicles.

Roofing contractors generate residual tars and sealing compounds, spent solvents and kerosene, and soap cleaners, as well as non-hazardous waste roofing materials.

Sheet metal contractors produce small quantities of acids and solvent cleaners such as kerosene, metal shavings, adhesive residues and enamel coatings, and in some cases old asbestos insulation that has been removed.

Asphalt paving contractors are likely to store at their businesses, application equipment such as dump trucks, pavers, tack coat tankers and pavement rollers. Stormwater passing through this equipment may be contaminated by the petroleum residuals. Maintenance of the equipment will generate waste fluids and solvents.

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SOURCE-CONTROL-BMPs: If company vehicles and equipment are fueled at the business, the fuel pump island shall be covered and provided with a stormwater drainage system as described in **BMP 1.10 in Part III.**

- o Washing or steam cleaning of vehicles or equipment, and/or parts outside shall occur in a designated area incorporating the requirements of **BMP 1.20 in Part III.**
- o The transfer of fuel and other engine fluids to above or below ground storage tanks shall comply with **BMP 1.30 in Part III.**
- o Above ground storage tanks shall incoporate BMPs to prevent contamination of surface and ground waters **(BMP 1.40 in Part III)**
- o Businesses generating Dangerous Wastes shall properly segregate and dispose the wastes as required by the WDOE **(R.4 in Part V).**
- o Containers storing Dangerous Wastes or other liquids shall be placed inside a building unless impractical due to site constraints. If placed outside, **BMP 1.50** described in Part III shall be used.
- o Signs shall be painted on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- o The parking lot shall be swept at appropriate intervals to remove debris.

STORMWATER-TREATMENT BMPs: Stormwater from parking lots and outside storage areas of construction materials and equipment shall be treated by one of the treatment systems described in **Part IV.** Stormwater runoff from rooftops shall discharge to the storm drain or combined sewer below the treatment system as long as the City's drainage requirements are met **(R.2 in Part V).**

Regarding contractors that install asphalt paving: stormwater from outside equipment storage areas shall be treated by an API or CPI-separator **(BMP 2.10 in Part IV),.**

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Source-Control BMPs

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SOURCE-CONTROL BMPS

Part III

The source-control BMPs are organized by the type of activity as presented in the checklist in Part I. In implementing the BMPs, the manual user should attempt to follow the strategy previously introduced in Part I.

The first consideration should be given to altering the activity. Specific recommendations are not provided as activities will vary substantially with each business. If the activity cannot be altered than it should be enclosed in a building. If the area of the activity is so extensive to make a building prohibitively expensive, then perhaps the activity can be covered with just a frame and roof.

Or there may be part of the outside activity that is the most significant contributor of pollution. This part of the activity can be segregated, and enclosed or covered. If the area is small it can be left uncovered and the drain can discharge to the sanitary sewer.

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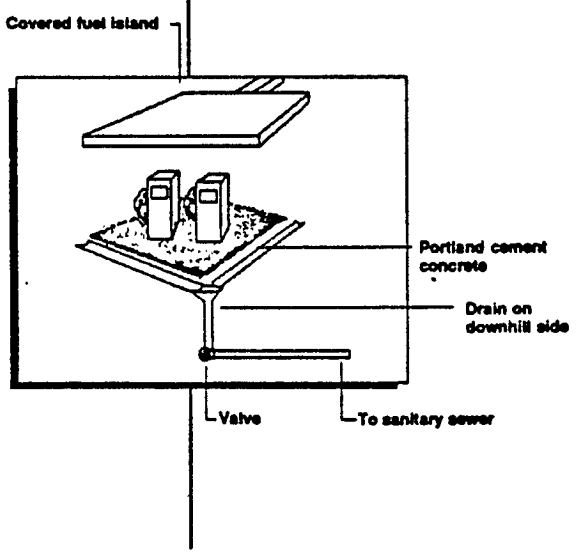
BMP 1.10

FUELING STATIONS

In addition to general service gas stations, fueling may also occur at 24-hour convenience stores, construction firms, warehouses, car washes, and businesses with fleet vehicles. Fuels contain organic compounds and metals that adversely affect aquatic life.

THE FOLLOWING BMPS ARE REQUIRED:

1. The fuel island shall be covered to prevent the direct entry of precipitation.
2. Longitudinal drains shall be located at the perimeter along the "downhill" side of the island. This drainshall be connected to the sanitary sewer. To comply with Metro and Fire Code requirements (R.2 and R.3 inPart V) the drain shall a valve to allow shutoff in the event of a large fuel spill.
3. The island shall be paved using Portland cement concrete, not asphalt.
4. Suitable cleanup materials shall be kept on site to allow prompt cleanup.



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Part III

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Part III

BMP 1.20 VEHICLE OR EQUIPMENT WASHING AND STEAM CLEANING

Washing of highway vehicles and parts, and equipment and parts such as construction equipment, is to occur in a building or in a designated area as described below. This requirement refers to all methods of washing in which water is used including low-pressure water, high-pressure water and steam cleaning.

Wash water from the above cleaning activity contains significant quantities of oil and grease, suspended solids, heavy metals, and organics, as well as pollutants from the detergents.

As the surfactants in detergents chemically stabilize free and dispersed oil, oil/water separators are ineffective.

Therefore, wash water from vehicle and equipment cleaning shall be discharged only to sanitary sewers. The business shall conduct washing operations in one of the following locations:

1. Inside the business owner's building; or,
2. At a commercial washing business in which the washing occurs in an enclosure (see **Part II, Car and Truck Wash Businesses**); or,
3. In a designated wash area at the owner's business that meets the requirements outlined below.

The use of mobile wash services is not allowed unless the wash water can be contained and discharged to a sanitary sewer.

If the business owner chooses to conduct washing operations at its business but outside the main building of the business, the owner must:

1. Construct a vehicle or equipment washing building, similar to a commercial car or truck washing business, in which all internal drains discharge to the sanitary sewer. The wash building shall comply with the same BMP requirements imposed on a commercial car or truck washing business (see **Part II**); or,

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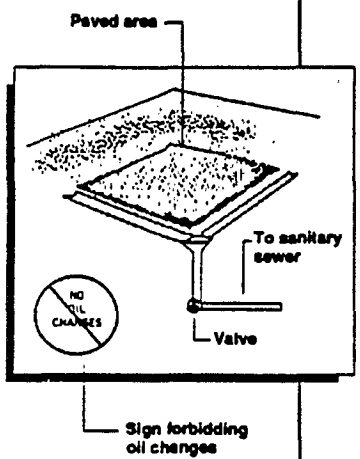

2. The business may establish a "designated area" for all washing operations that need not be enclosed or covered. However, the "designated area" shall meet the following requirements:

   - The area if left uncovered shall not exceed 200 square feet of (R.1 in Part V);
   - The area shall be paved;
   - The area shall be so designed as to prevent the runon stormwater from adjacent areas;
   - The area shall have a drain to collect all wash water.
   - The drain shall be connected to the sanitary sewer. The discharge shall pass through a SC-type oil/water separator (BMP 2.10 in Part IV) and in all respects shall comply with Metro requirements (R.1 in Part V).
   - The wash area shall be well marked at gas stations, multifamily residences and any other business where vehicles may be washed by non-employees. Included in the posting will be statement forbidding the changing of oil over the wash area.

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BMP 1.30 LOADING AND UNLOADING OF LIQUIDS

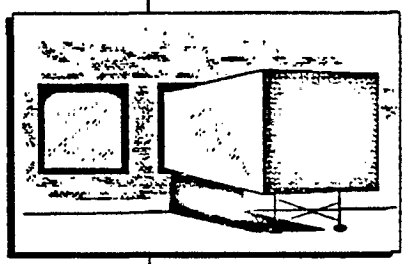
Loading or unloading of liquids occurs two ways: liquids contained in containers and direct liquid transfer.

Consistent with Fire Code requirements (R.3 in Part V) and to the maximum extent possible, unloading or loading of liquids should occur within the manufacturing building so that any spills that are not completely retained, and residual materials resulting from the cleanup are discharged to the sanitary sewer.

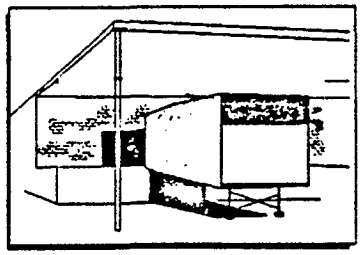
BMPs are prescribed below for loading or unloading that must occur outside where loss to storm drains could occur.

CONTAINED LIQUIDS AT LOADING AND UNLOADING DOCKS

1. Loading/unloading docks shall have overhangs or door skirts that enclose the trailer end.



Dock with door skirt



Dock with overhang

2. The loading/unloading area is to be appropriately designed to prevent runon of stormwater.

3. The business owner shall retain on site the appropriate materials for rapid cleanup of spills.

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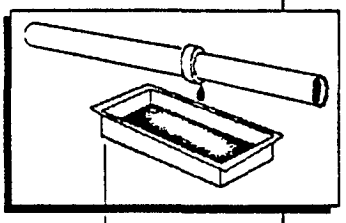
TANKER TRUCK TO ABOVE OR BELOW GROUND STORAGE TANKS

1. To minimize the risk of accidental spillage, the owner shall have a written "operations plan" that describes procedures for loading and/or unloading. Employees shall be trained in its execution.

2. As a part of the operations plan, or as separate document, the business owner shall have an Emergency Spill Cleanup Plan (BMP 1.80).

3. The area on which the transfer takes place, where the tanker truck is parked, shall be paved. If the liquid is reactive with asphalt (for example, gasoline) Portland cement concrete shall be used

4. To avoid loss from spills during the transfer a deadend sump or a secondary containment system similar to that illustrated shall be used.



Drip pan

5. Drip pans shall be placed at locations where spillage may occur such as hose connections, hose reels and filler nozzles. Drip pans shall always be used when making and breaking connections.

6. An employee trained in spill containment and cleanup shall be present during loading/unloading.

LOADING AND UNLOADING FROM OR TO MARINE VESSELS

Facilities and procedures for the loading or unloading of petroleum products must comply with Coast Guard requirements (R.6 in Part V).

TRANSFER OF SMALL QUANTITIES FROM TANKS AND CONTAINERS

See BMP 1.40 and BMP 1.50 regarding tanks and containers, respectively.

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RAIL TRANSFER TO ABOVE OR BELOW GROUND STORAGE TANKS

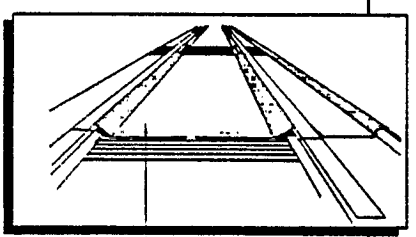
1. To minimize the risk of accidental spillage, the owner shall have a written "operations plan" that describes procedures for loading and/or unloading. Employees shall be trained in its execution.

2. As a part of the operations plan, or as a separate document, the business owner shall have an Emergency Spill Cleanup Plan (BMP 1.80).

3. Drip pans shall be placed at locations where spillage may occur such as hose connections, hose reels and filler nozzles. Drip pans shall always be used when making and breaking connections.

4. A drip pan system as illustrated shall be installed within the rails to collect spillage from tank cars.

5. An employee trained in spill containment and cleanup shall be present during loading/unloading.



Drip pan within rails

R0059637

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Part III

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R0059638

BMP 1.40

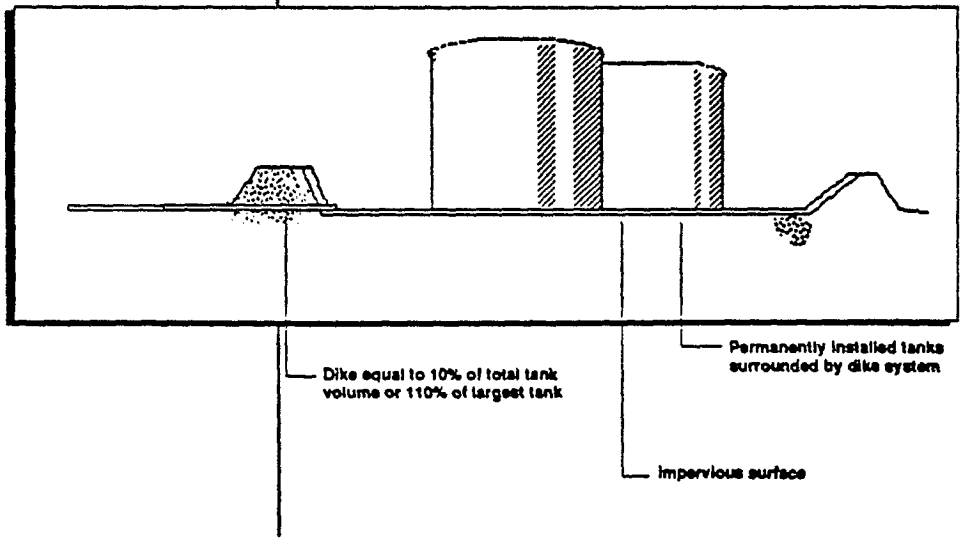
ABOVE GROUND TANK STORAGE

Storage of reactive, ignitable, or flammable liquids must comply with the Fire Code (R.3 in Part V). The following BMPs are to complement, not conflict, with current Fire Code requirements. Below ground tanks are to comply with WDOE requirements (R.7 in Part V).

PERMANENT TANK STORAGE

1. The tank shall include an overfill protection system to minimize the risk of spillage during loading.

2. Permanently installed tanks are to be surrounded by a dike system as illustrated below. The dike shall be of sufficient height to provide a volume within the diked area equal to 10% of the total tank storage or 110% volume of the largest tank whichever is greater.



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3. The dikes and the surface within the dike area shall be sufficiently impervious to prevent loss of the stored material in the event of spillage.

4. Outlets from the tank area shall have positive control to prevent the uncontrolled discharge from the tank area of spilled chemicals or petroleum products.

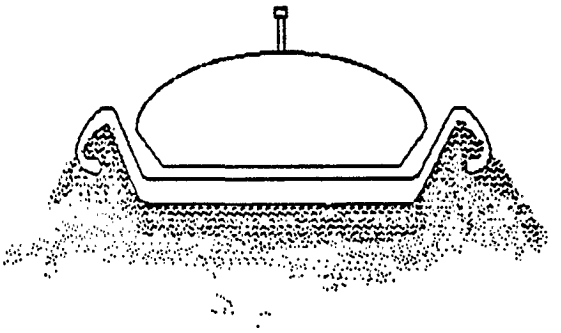
5. The outlet shall have a sump for the collection of small spills. It shall be cleaned weekly to minimize the contamination of stormwater.

6. During the wet season, accumulated stormwater shall be released frequently.

7. For petroleum tank farms the stormwater shall pass through an oil/water separator (BMP 2.10 in Part IV).

TEMPORARY TANK STORAGE OF LIQUIDS

1. A secondary containment system similar to that shown shall be used whenever liquids are temporarily stored in in a portable tank



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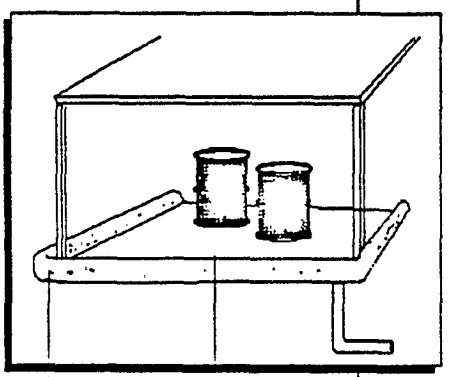
Part III

BMP 1.50

CONTAINER STORAGE

A container is any portable device in which material is stored. These BMPs apply to container(s) located outside a building used to temporarily store accumulated food wastes, vegetable or animal grease, used oil, liquid feedstock or cleaning chemical, or Dangerous Wastes (liquid or solid) unless the business is permitted by WDOE to store the wastes (R.4 in Part V).

Storage of reactive, ignitable, or flammable liquids must comply with the Fire Code (R.2 in Part V). The following BMPs are to complement, not conflict, with current Fire Code requirements.



1. Containers shall be located in a designated area.
2. The area shall be paved, free of cracks and gaps and sufficiently impervious to contain leaks and spills.
3. If liquid waste, the designated area shall be surrounded by a curb or dike to provide sufficient volume to contain ten percent of the volume of all the containers or 110% of the volume of the largest container whichever is greater. A curb is sufficient for food waste containers.
4. The designated area shall be covered.
5. The area inside the curb shall slope to a drain. If the material being stored is controlled by the Fire Code, is used oil or Dangerous Waste a deadend sump shall be installed.

For all other wastes or materials the drain shall be tied to the sanitary sewer. However, the drain must have positive control (for example, a locked drainage valve or plug) to prevent release of contaminated liquids.

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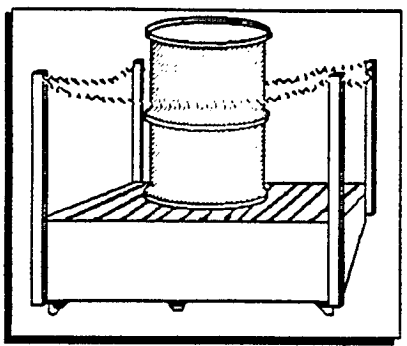
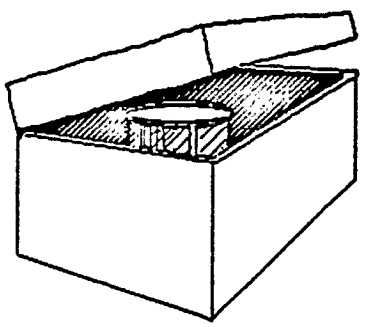


Elevated container

6. If the business is using roll-containers (for example, dumpsters) that are picked up directly by the collection truck, a filet can be placed on both sides of the curb to facilitate moving the dumpster.

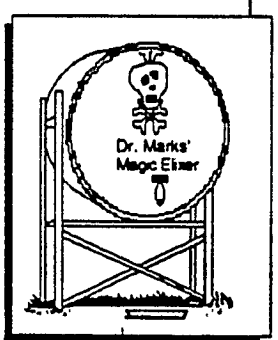
7. Businesses accumulating only Dangerous Wastes that do not contain free liquids need not carryout items #3 through #5 above provided that the designated area is sloped and the containers are elevated or otherwise protected from storm water runon.

8. Where material is stored in drums, a secondary containment system can be used as illustrated below, in lieu of the above system.



Secondary containment system

9. Containers mounted for direct removal of a liquid chemical for use by employees must be placed inside a containment area as described above. A drip pan shall be be used at all times.



Mounted container with drip pan

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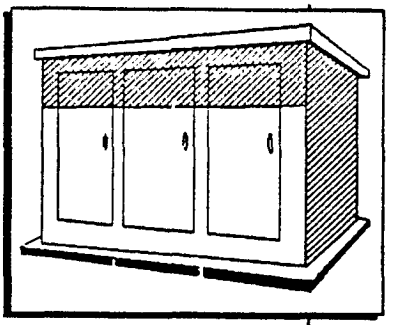
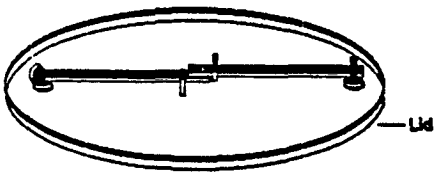


Storage building

10. Drums stored in an area to which unauthorized persons may gain access must be secured in a manner that prevents accidental spillage, pilferage or any unauthorized use.



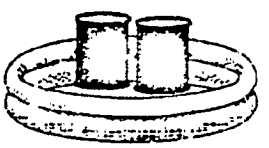
Locking system for drum lid

11. If the material is a Dangerous Waste, the business owner shall comply with any additional WDOE requirements (See R.4 in Part V) not presented above.

12. Large non-rolling type dumpsters that are to be loaded directly into a solid waste collection truck need not comply with the above requirements.

13. If a storage area is to be used on site for only a short period of time (less than 30 days), a portable secondary system like that shown below can be used in lieu of a permanent system as described above.





14. An employee trained in emergency spill cleanup procedures shall be present when Dangerous Wastes or liquid chemicals or wastes are loaded or unloaded.

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Part III

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Part III

BMP 1.60

OUTSIDE STORAGE OF RAW MATERIALS, BYPRODUCTS OR PRODUCTS

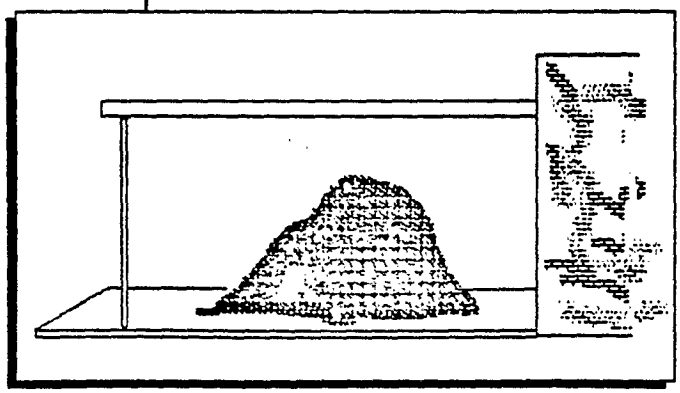
If the raw material, byproduct or product is a liquid see the previous pages. This section covers solid material.

These BMPs are for:

- o Loose material such as gravel, sand, topsoil, compost, sawdust, wood chips;
- o Lumber and other building materials;
- o Concrete and metal products

The business is to select one of the following BMPs appropriate to the type of material:

1. Build a covered area as shown below. The area upon which the materials is stored shall be paved;



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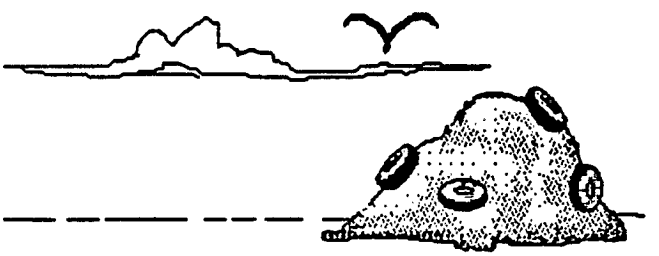
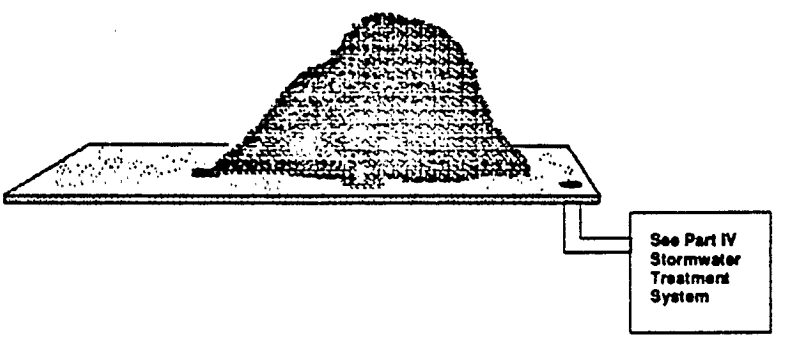
2. Or place temporary plastic sheeting over the material as illustrated;



3. Or, pave the area and install a drainage system. Stormwater from the area shall be treated using one of the treatment systems presented in Part IV of this Manual.



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Part III

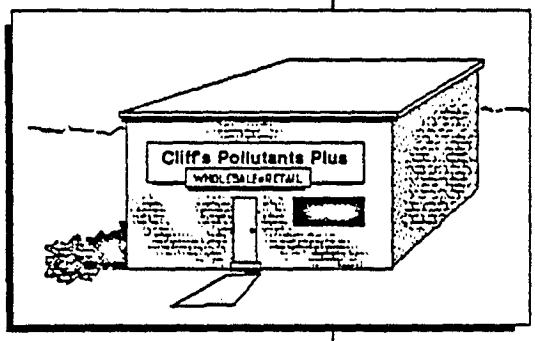
BMP 1.70

OUTSIDE MANUFACTURING ACTIVITY

These BMPs are for manufacturers identified in Part II that carry out manufacturing activities in an area exposed to precipitation.

ALTER THE ACTIVITY

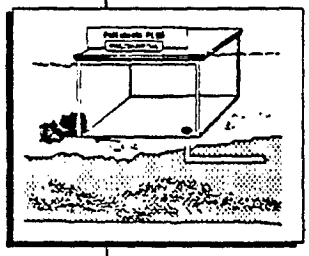
The first preference is to alter the activity so that it no longer discharges pollutants. If altering the practice will not significantly reduce the concentration of the pollutants further actions as described below must be taken.



Enclose activity

ENCLOSE THE ACTIVITY

The manufacturing activity can be completely enclosed in a building and the floor drains connected to the sanitary sewer. The allowable concentration of pollutants is then specified by Metro requirements (**R.1 in Part V**). In many cases the area used by the activity may so great as to make enclosure prohibitively expensive. Costs of this BMP are increased by current the City code that requires a certain number of parking spaces be provided with a building even though its construction will not alter the nature of the manufacturing activity and therefore the number of employees.



Cover activity

COVER THE ACTIVITY

The cost of a building can be significantly reduced by not covering the sides, eliminating the need for ventilating and lighting systems. Floor drains shall be connected to the sanitary sewer.

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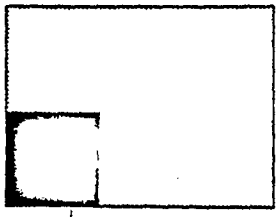

SEGREGATE THE ACTIVITY

Certain parts of the activity may be the worst sources of pollutants. These parts can be segregated and enclosed or covered. The drains can then be hooked to the sanitary sewer. If the segregated area is less than 200 square feet the area can be left uncovered and the drains can still be connected to the sanitary sewer (**R.1 in Part V**).

DISCHARGE OF HIGH FREQUENCY STORMS TO SANITARY SEWER

Although Metro currently limits open discharge to an area of 200 square feet (ft2), it is possible under unusual circumstances to connect a larger area to the sanitary sewer if the rate of stormwater discharge is matched to the capacity of the sewer. This approach will be limited to a small number of industries with outside activities that produce pollutants of particular concern.

Since the majority of the pollutants are carried overtime by the smaller, high frequency storms, the infrequent large storms can be bypassed to the storm drain. To comply with the goals of this manual the sanitary sewer must have sufficient capacity to take a peak stormwater flow rate of 0.20 cubic feet per sec(cfs)/acre of activity. Stormwater discharge rates in excess of this value are bypassed to the storm drain. The reasoning for this particular value is provided in Part VI.

If the sewer does not have the capacity to handle 0.20 cfs a peak-rate detention facility can be installed with a volume sufficient to reduce the peak rate to the capacity of the sewer.

Any discharge to a sanitary sewer must meet Metro discharge requirements (**R.1 in Part V**).

To implement this BMP the engineer will have to conduct a hydraulic evaluation of the "downstream" sewer system, and consult carefully with City and Metro engineering staff.

STORMWATER TREATMENT

If none of the above BMPs can be implemented than one of the treatment methods presented in Part IV shall be installed.

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Part III

BMP 1.80

EMERGENCY SPILL CLEANUP PLANS

Owners of facilities engaged in storing, processing, or refining oil and oil products are required by Federal Law to have a Spill Prevention and Control Plan (SPCC). Owners of businesses that produce Dangerous Wastes are required by State Law to have a spill cleanup plan. The above types of businesses are referred to Part V.

The remaining businesses identified in Part II of this manual that are required to have an Emergency Spill Cleanup Plan shall follow these general guidelines in its preparation.

1. The first part of the plan shall contain a description of the business including the business name and address, the nature of the business and the general types of chemicals used by the business.

2. The plan shall contain a site plan showing the location of storage areas for chemicals, storm drains, and the direction of slopes towards those drains, and the location and description of any devices to stop spills from leaving the site such as positive control valves.

3. The plan shall describe notification procedures to be used in the event of a spill, such as key business personnel, and agencies such as WDOE and Metro.

4. The plan shall provide explicit instructions regarding cleanup procedures.

5. The business shall have a designated person with overall spill response cleanup responsibility.

6. Key personnel shall be trained in the use of this plan.

7. A summary of the plan shall be written and posted at appropriate points in the business, identifying the spill cleanup coordinators, location of cleanup kits, and phone numbers of regulatory agencies to be contacted

8. Cleanup of spills shall begin immediately. No emulsifier or dispersant is to be used.

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9. Emergency spill containment and cleanup kit(s) shall be located at the business site. The contents of the kit shall be appropriate to the type and quantities of chemical liquids stored at the business. The kit might contain appropriately lined drums, absorbent pads, and granular or powdered materials for nuetralizing acids or alkaline liquids. Kits should be deployed in a manner that allows rapid access and use by employees.

10. The WDOE and Metro shall be notified if the spill reaches sanitary or storm sewers.

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Stormwater Treatment BMPs

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STORMWATER-TREATMENT BMPS

Part IV

As explained in Part IV there are many different stormwater treatment methods. As some methods are more effective they are presented in the order of preference. Site limitations or other technical factors may prevent the use of a particular method system.

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Part IV

Introduction to the Treatment Systems

In selecting a stormwater treatment system several factors must be considered, specifically:

* Must the City's drainage requirements be met (R.2 of Part V)?
* For the particular land use, what type of oil/water separator is required by Part II?
* For the particular land use, does Part II require treatment to remove the other types of pollutants?

With some treatment systems it is possible to integrate all of the requirements into one system. The type of treatment system used is therefore a function of the how many of the above requirements must be met and the technical constraints or opportunities of the particular business site.

Oil/water separation (BMP 2.10)

This Manual identifies three types of separators: one that only controls small spills, and two types that also remove dispersed oil. The type irequired depends on the business as described in Part II.

An oil/water separator also removes paper floatables and settleable solids. Under certain situations it is possible to achieve all of the pollutant removal objectives as well as the City's drainage requirements with one system.

The remaining treatment systems are similar in the types of pollutants they remove and are presented in order of descending preference.

Soil infiltration (BMP 2.20)

Infiltrating stormwater is preferred. Development decreases the amount of runoff that enters the groundwater. This modification of the hydrological cycle may reduce summer stream flows which adversely affects biological conditions in the stream.

Secondly, soil is the only practical mechanism for removing soluble pollutants and fecal coliform. Data provided in Table 4.1 illustrate the possible importance of removing soluble pollutants.

With exception of nitrogen, zinc, copper, and bacteria, the majority of each pollutant is in the particulate form. Therefore, most of the pollutant can be removed by settling or filtration. However, as shown in Table 4.1, even if 100% of the particulate is removed, water quality criteria are not met.

Constructed wetlands (BMP 2.30)

A constructed wetland is an excavated basin with wetland vegetaion purposely placed in the basin. It is preferred over the remaining treatment methods for two reasons. First, emergent plants in wetlands improve the hydraulic conditions for the settling of suspended pollutants. Secondly, the growth of the plants removes soluble pollutants, although the percentage removed may be small because the majority of rainfall occurs during the winter when biological growth is very low.

Wet-settling basins (BMP 2.40)

A settling basin may be on the surface or under ground as a vault or large pipe. A surface settling basin differs from wetland in that there is little or no emergent vegetation within the basin and the depth of the permanent water pool is greater, on the order of three feet, in comparision of 12 to 18" in the wetland.

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TABLE 4.1
Comparison of Typical Pollutant Concentrations[a] to water quality standards

Pollutant	Commercial	Industrial	Particulate Fraction	FRESHWATER Acute	FRESHWATER Chronic	SALTWATER Acute	SALTWATER Chronic
Cadmium	5 ug/l	5	60	1.4	0.32	43.0	9.3
Copper	245	105	60	3.9	3.0	2.9	2.9
Lead	380	245	90	10.5	0.41	140.0	5.6
Zinc	275	275	60	84.0	47.0	95.0	86.0

[a]See Part VI for sources of data and explanation.

As the word "wet" implies, the basin has a permanent pool of water between storms: at least three feet. The outflow orifice or weir is therefore located at the height needed to maintain the pool.

Like wetlands soluble pollutants are removed by the plant growth, particularly algae. Again however, the removal rates are limited by the lack of coincidence between wet and growth seasons.

Vegetated biofilters (BMP 2.50)

Like wetlands, biofilter vegetation enhances pollutant removal. Biofilters are however given a lower preference. Why? A practical concern with biofilters is their potential for abuse, having the appearance of a narrow strip of grass or lawn. As a result the biofilter may lose its treatment effectiveness. In contrast, wet ponds and wetlands will always function reasonably well as long as they retain their water pool.

The most common biofilter is the vegetated channel. However, a biofilter channel is not the same as a drainage ditch that has grass. To be effective a biofilter channel must be designed with treatment in mind. The vegetation may be grass or plants like those found in wetlands such as cattails.

Dry-settling basins (BMP 2.60)

A dry basin differs from the wet basin in that a permanent pool of water is not retained between storms. The lack of a permanent pool lowers its treatment effectiveness.

Other systems

While not recommended, other systems can be used should the situation dictate and a rational sizing procedure can be shown by the applicant.

Maintenance

The treatment methods introduced in Part IV are only effective if they are properly maintained. Recommended procedures for maintenance are presented for each method.

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Treatment Efficiency

As previously indicated most pollutants are a part of or become affixed to particulates, that is suspended solids. Therefore, treatment by settling can remove a large percentage of most pollutants. Exceptions are noted in Table 4.1.

Presented in Table 4.2 is a comparison of the various treatment methods as to their ability to remove settleable and fine solids, and soluble pollutants. A distinction is made for fine solids because they represent most of the solids. Also, research suggests that a disproportionate fraction of the pollutants tend to affix to the fine solids.

TABLE 4.2
Relative Effectiveness of Treatment Systems

SYSTEM	Settleable SOLIDS	Fine SOLIDS	SOLUBLE	Spilt OIL	Dispersed OIL
Oil separation					
Spill control separator	Poor	None	None	Good	None
API-separator	Fair	Poor	None	Good	Fair
CPI-separator	Good	Fair	None	Good	Good
Treatment					
Soil infiltration	Excellent	Excellent	Excellent	a	b
Constructed wetland	Good	Fair	Fair	a	Good
Wet-settling basin	Good	Poor	Poor	a	Good
Biofilter	Good	Poor	Poor	a	Fair
Dry-settling basin	Fair	None	None	a	None

[a]All these systems are preceded or followed by a spill control device.

[b]Infiltration basins must be preceded by another treatment system which includes oil/water separation.

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Part IV

How to Use Part 4

Part IV provides many treatment methods, presented in order of preference. Complicating the choice of treatment method are possible requirements for oil/water separation and peak-rate control. The manual user should precede in these steps.

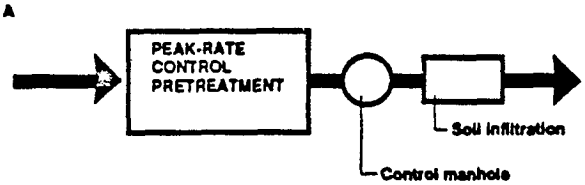
1. First refer to Part II and BMP 2.10, oil/water separation, to determine the type of separator that is required.
2. Next determine from the City Engineering Department if a peak-rate drainage facility is required (Part V).
3. Then proceed "step-wise" through the treatment methods beginning with soil infiltration systems, BMP 2.20. The most preferred treatment method must be used unless the applicant can provide valid reasons for its elimination.
4. Once the appropriate treatment method has been selected, use the design criteria and sizing procedure provided for the particular system.

How integration is to be achieved depends on the type of treatment and oil/water separator systems that are used. The basic schemes are illustrated in the following text.

Where peak-rate drainage control is required

A soil infiltration must be preceded by the peak-rate drainage control facility which provides both hydraulic control and pretreatment. However, the peak-rate drainage control facility must be designed using the criteria outlined for either a wetland (BMP 2.30), wet (BMP 2.40) or dry settling-basin (BMP 2.60).

FIG. A



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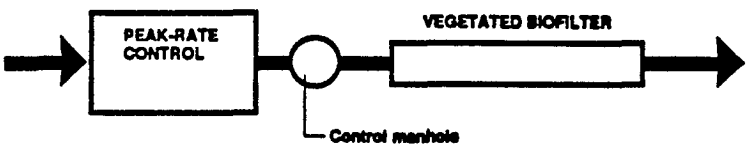
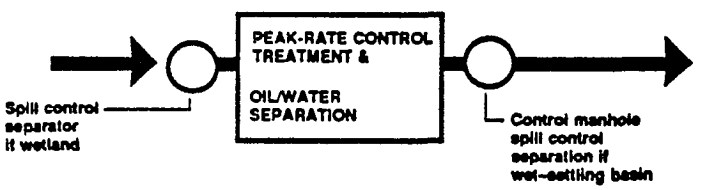
A biofilter may precede or follow the rate-control facility although the later is preferred and in most situations is likely to be the only feasible approach.

FIG. B



With a wetland, wet or dry-settling basin, treatment and hydraulic control can occur in the same facility if designed using the criteria in this manual.

FIG. C



Regarding oil/water separation: (FIG. C) if only a spill-control oil/ water separator is required it is the "T" located in the control manhole of the peak-rate drainage control facility.

If the removal of dispersed free oil droplets is required, the simple "T" spill control device is inadequate. More sophisticated separation is required using an API or CPI separator. If a wetland or wet-settling basin is used for hydraulic control and treatment, it will also be reasonably effective at removing dispersed oil droplets (FIG. C).

However, if the concentrations of oil and related materials are expected to be consistently high it may be necessary to place the separator ahead of a wetland to protect the vegetation. This will require an API or CPI oil/water separator.

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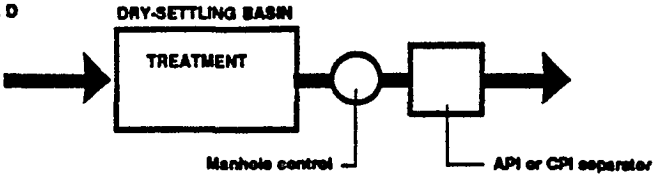
A dry-settling basin will not remove dispersed oil droplets. If an API or CPI oil/water separator is required it can follow the dry basin. The dry basin can also serve as the peak-rate control facility.

FIG. D DRY-SETTLING BASIN



Where peak-rate control is not required, but both oil/water separation and stormwater treatment are

A wetland or wet-settling basin can serve as the oil/water separator, although if the concentrations of oil and related materials are expected to be consistently high it may be necessary to place an API or CPI separator ahead of a wetland to protect the vegetation as previously noted above. Similarly the oil/water separator may have to precede a biofilter.

An oil/water separator must precede an infiltration system, and/or be integrated with the pretreatment system (FIG. A). If a dry-settling basin is used (FIG. D), and dispersed oil must be removed, the API or CPI separator can precede or follow the basin (FIG. D). If only an oil-spill control device is needed it can be located in a manhole at the outlet of the basin.

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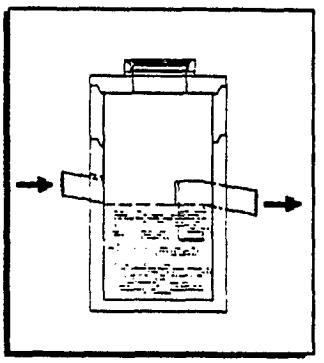
BMP 2.10

OIL/WATER SEPARATION

DESCRIPTION

There are three general types of separators. The first type is the spill control separator (SC). It is a simple underground vault or manhole with a "T" outlet . The SC-separator is effective at retaining only small spills. The SC-separator will not remove diluted oil droplets spread through the stormwater from oil contaminated pavement. Local jurisdictions already require these types of separators with peak-rate detention facilities.

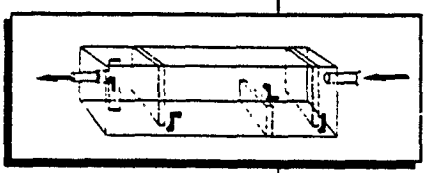


SC separator

The other two separators can remove dispersed oil: the American Petroleum Institute (API) separator and coalescing plate interceptor (CPI).

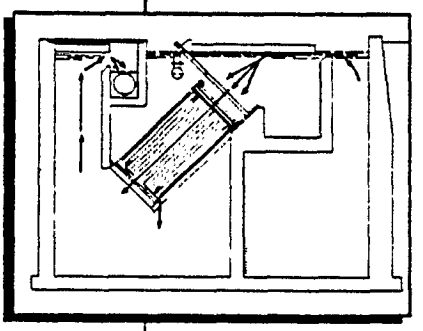
The API-separator is a long vault or basin with baffles to improve the hydraulic conditions for treatment. Large API-separators may have sophisticated mechanical equipment for removing oil from the surface and settled solids from the bottom. However, most applications to commercial and industrial land uses will use the simple system as illustrated.

The CPI-separator contains a bundle of plates made of fiberglass or polypropylene. The plates are closely spaced. Depending on the manufacturer and/or application the plates may be positioned in the bundle at an angle of 0 to 60° from the horizontal.



API separator

The closely spaced plates improve the hydraulic conditions in the CPI-separator promoting oil removal. Removal of fine suspended solids is also improved. The primary advantage of the CPI-separator is its ability to theoretically achieve equal removal efficiencies with one-fifth to one-half the space needed by the API separator, when designed to remove the same size droplets.



CPI separator

TYPE OF SEPARATOR REQUIRED

Land uses that must use an API or CPI-separator are identified in Part II. The owner may choose between the API or CPI-separator using the design criteria outlined below. All other land uses or businesses must use the SC-separator even if a peak-rate drainage control facility is not required.

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EFFLUENT REQUIREMENTS

The WDOE requires that stormwater have no visible sheen, average less than 10 mg/l daily and at not time exceed a daily maximum of 15 mg/l.

DESIGN CRITERIA

Requirements regardless of separator type

1. Appropriate removal covers must be provided that allow access for observation and maintenance;
2. Stormwater from building rooftops and other impervious surfaces not likely to be contaminated by oil shall discharge downstream of the separator, as long as City drainage requirements are met (R.2 in Part V).
3. Any pump mechanism shall be installed downstream of the separator to prevent oil emulsification;

Additional requirements for API and CPI-separators

1. These separators shall have a forebay to collect floatables and the larger settleable solids. Its surface area shall not be less than 20 square feet (ft2) per 10,000 ft2 of the area draining to the separator.
2. They shall have an afterbay in which absorbent pillows or similar material are placed. With the SC-separator, absorbent materials shall be placed in the manhole/vault. Used absorbent pillows shall be properly disposed.
3. If placed "downstream" of a detention facility, the separator is sized for the outlet flow of that facility.
4. If the separator is placed "upstream" of a peak-rate detention facility, or without a detention facility, the inlet to the separator and the separator shall be sized for a flow of 0.20 cfs/acre of drainage area. See Part IV for the derivation of this flow rate.

Additional requirements for CPI-separators

1. Plates shall not be less than 3/4" apart.
2. The angle of the plates shall be from 45° to 60° from the horizontal.

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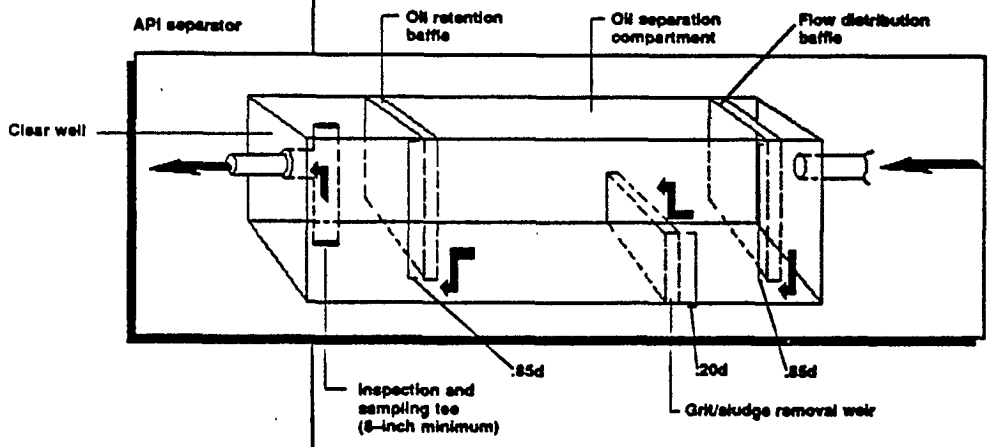
SIZING PROCEDURE

Oil droplets exist in water in a wide distribution of sizes. The separator therefore sized to remove all dropletsof particular size and greater which will insure that sufficient oil is removed to achieve the effluent standard.

API-separators are usually sized to remove oil droplets 150 micron in size and larger. Smaller droplets rise so slowly as to require a relatively large vault. CPI-separators are commonly sized to remove 60 or 90 micron and larger oil droplets.

However, there are no data on the size distribution of dispersed oil in stormwater from commercial or industrial land uses with the exception of petroleum products storage terminals. These data indicate that by volume-about 90% of the droplets are greater than 60 micron and 40% of the droplets are greater than 90 micron. Less than 10% are greater than 150 microns. For this manual both the API and CPI-separator are sized to remove 90 micron and larger droplets at a temperature of 10°C giving a rise rate of 0.066 feet per minute.



API-separator

API-separators are sized using these general guidelines:

- Horizontal velocity = 3 fpm or 15 times the rise rate whichever is smaller
- Depth of 3 to 8 feet
- Depth to width ratio of 0.3 to 0.5
- Width of 6 to 16 feet
- Baffle height to depth ratios of 0.85 for top baffles and 0.15 for bottom baffles

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The separator is first sized for depth using the equation:

Depth = $(Q/2V)^{1/2}$

where: Q = design flow (cfm)

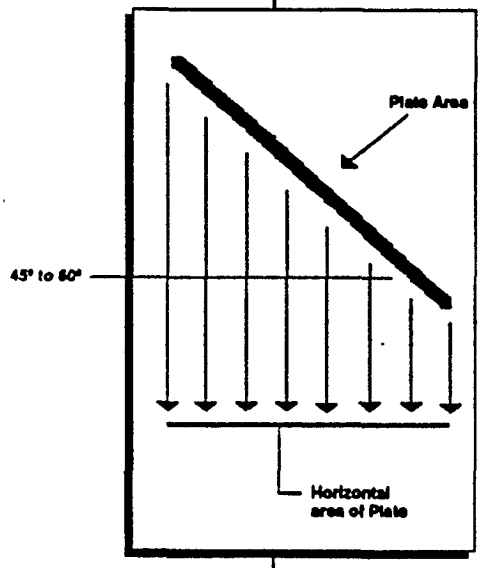
V = design horizontal velocity (fmp)

= 1.00 (15 times 0.066

Then calculate the width using the above ratios:

Then calculate length using the equation:

Length = Depth/Rise rate = Depth/0.066



CPI-separator

Calculate the surface area of plates required using the following equation:

$$\text{Area (square feet)} = \frac{\text{(Q/rise rate)}}{\text{Cosine(H)}} = \frac{\text{Q/0.066}}{\text{Cos(H)}}$$

where H = angle of the plates with the horizontal

Cosine (H) equals 0.70 and 0.50 for 45° and 60°, respectively, the two most commonly used angles.

Manufacturers of plate packs provide standard size packages which are rated at a particular flow (usually in gpm). However, as the manufacturer's flow rating is for conditions different than used above, the engineer must compare the actual plate surface area in a particular pack with the above calculation. When making this evaluation it is important not to confuse the horizontal area that the plates cover with the actual area of the plates.

The width, depth and length of the plate pack and the chamber in which the plate pack is placed is completely flexible and is a function of the plate sizes provided by the particular pack manufacturer and standard size vaults that are available for small sites.

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CONSTRUCTION

There are no special construction considerations.

MAINTENANCE

Oil/water separator(s) must be cleaned frequently to keep accumulated oil from escaping during an extreme storm. The separator must always be cleaned by October 15th to remove material that has accumulated during the dry season and again after the first significant storm. In addition:

1. The facility shall be inspected weekly by the owner;
2. Oil absorbent pads are to be replaced as needed but shall always be replaced in the fall prior to the wet season and in the spring;
3. The effluent shutoff valve is to be closed during cleaning operations;
4. Waste oil and residuals shall be disposed in accordance with current Seattle-King County Health Department requirements.
5. Any standing water removed during the maintenance operation must be disposed to a sanitary sewer at an approved discharge location.
6. Following removal of any standing water, it shall be replaced with clean water to prevent oil carry-over the outlet weir or orifice;

INTEGRATION WITH CITY DRAINAGE CONTROL REQUIREMENTS

If a peak-rate control facilitiy is required the oil/water separator must be carefully integrated. Where only the SC-separator is used, it serves for both oil spill and peak-rate control.

With the API and CPI-separators it is best to locate the facility "down-stream" as previously indicated. Design flows for either case have been provided above.

A special case is the use of constructed wetlands and wet-settling basins. The surface area of these systems are sufficient for effective removal of dispersed oil droplets. Therefore, for either of these systemns an API or CPI-separator is not required. Stormwater with heavy concentrations of oil (greater than say 20 mg/l) may cause problems in wetlands. Therefore, prior reduction of oil is necessary. If a wet-settling basin is used,a barrier must be placed near the outlet to prevent the loss of the accumulated oil.

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It is preferred that drainage from rooftops and other impervious areas that are not likely to be contaminated by oil be diverted to the storm drains located "downstream" of the oil/water separator. This improves the effectiveness of the separator and also allows the use of a smaller separator.

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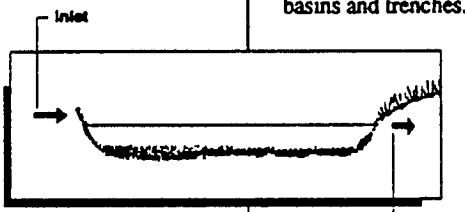
R0059664

Part IV

BMP 2.20 SOIL INFILTRATION

DESCRIPTION

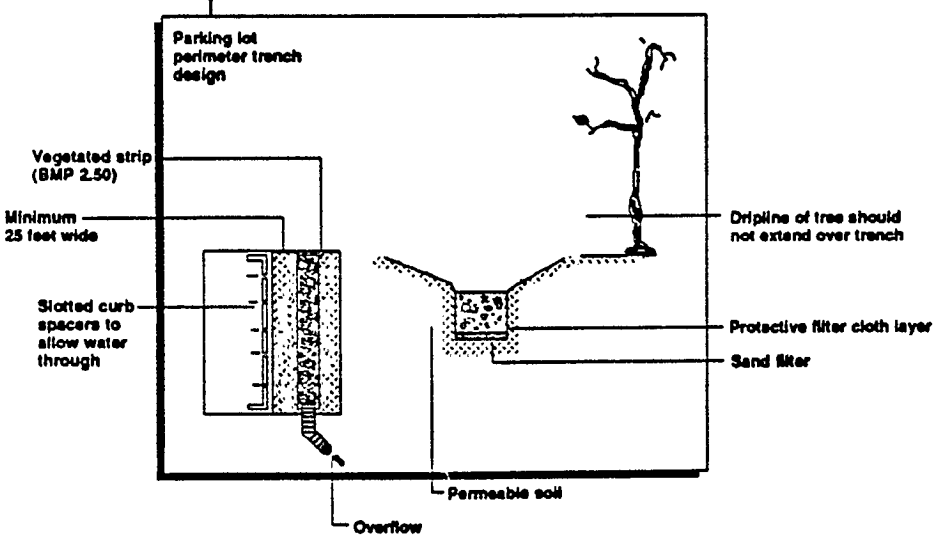
Two general methods of infiltrating stormwater are presented here: basins and trenches. Two other forms, dry wells and porous pavement are not recommended. Infiltration basins have the same appearance as a dry-settling pond. However, the water exits via the bottom of the pond into the soil rather than to surface waters via an outlet structure.



Soil infiltration basin

Growth of grass in the basin is to be encouraged. Grass protects the surface from abuse, helps maintain the pollutant and water adsorption capacity of the soil.

Trenches, already allowed by the City for drainage control, can be viewed as an elongated basin. Trenches may be more feasible for commericial and industrial land uses as they can be more easily integrated into the site. A trench can be placed along the edge of a parking lot (see figure).



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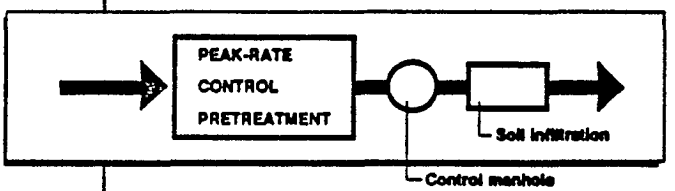
Both types must be carefully designed, constructed and maintained to avoid premature failure by the loss of the soil's infiltration capacity. Surface basins are preferred because the infiltrative capacity of the surface soils can be maintained with grass and entirely replaced if necessary.

An infiltration system shall be preceded by pretreatment to remove the larger settleable solids, floatables and oil/grease. Treatment systems described in Part IV can be used with the exception of the SC-type oil/water separator (**BMP 2.10**).



WHERE INFILTRATION SYSTEMS SHALL NOT BE USED

Infiltration systems shall not be used when any one of the following conditions exist (**R.2 of Part V**):

1. The seasonal groundwater is within three (3) feet of the proposed bottom surface of the basin or trench;
2. Slope stability problems may be created;
3. Flooding of nearby substructures is likely to occur;
4. The average percolation rate of the soil as measured in the field of the proposed basin bottom is less than 4 inches per hour;
5. An impermeable layer of soil exists within 5 feet of the proposed bottom surface of the basin or trench.

DESIGN CRITERIA

If none of the above conditions exists a soil infiltration system shall be used following these design criteria:

1. The stormwater shall be pretreated to remove floatables, settleable solids, and oil/grease. A wetland, wet or dry settling basin, or vegetated biofilter, or other equivalent types of filtration devices must be used for pretreatment using the design criteria presented in Part IV.
2. The infiltration system shall have a bypass or overflow device to allow passage of extreme storms.

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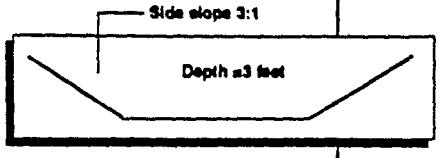

Additional criteria for infiltration basins:

1. The depth of an infiltration basin shall not be less than 3 feet.
2. Side slopes shall not be less than 3:1.
3. The bottom and slopes of the basin shall be properly fertilized and seeded using current City criteria.

Additional criteria for trenches:

1. Trenches shall not be placed under buildings or pavement.
2. Trenches shall be filled with 3/4" to 1 1/2" washed gravel, or pea gravel.
3. The bottom shall be level.
4. Fabric shall surround the gravel fill on all sides with 2 feet of overlap where fabric rolls are brought together. At the surface the fabric shall overlay on the surface by at least 6".
5. An observation well, 4" to 6" perforated pipe, shall be installed.

SIZING PROCEDURE

During each storm an infiltration basin will infiltrates a certain amount of the runoff: the larger the storm the more stormwater that is infiltrated. The amount of stormwater infiltrated over time represents the amount of pollution that is removed. Because of infrequent large storms it is not practical to remove 100% of the stormwater produced over time.

The required size of the basin depends on the infiltration rate of the soil and the removal goal. The following table identifies the amount of infiltration surface area needed per 10,000 ft2 of surface draining to the basin using Seattle rainfall statistics. To simplify design a standard criterion of 150 ft2 of infiltration area per 10,000 ft2 of catchment is to be used (See Part VI).

INFILTRATION AREA REQUIRED AS A FUNCTION OF SOIL INFILTRATION RATE AND A GIVEN POLLUTANT REMOVAL GOAL

REMOVAL GOAL	4"/HOUR	6"/HOUR	8"/HOUR
80%	100 ft2	70	60
90%	200	140	120
95%	350	240	200
98%	500	360	300

See Part VI for calculation of above figures

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CONSTRUCTION

Care must be taken to minimize compaction of the basin soil. The basin should also not be used for a temporary sediment pond during construction. With trenches care must be taken to prevent voids between the fabric and the trench surfaces. Fill gravel contaminated by soil during placement must be replaced. Where vertical excavation is difficult temporary sloping of the sides is necessary to prevent contamination of gravel during refill.

MAINTENANCE

The grass should be mowed at least twice during the growing season; early in the season to promote growth and in the fall before the grass dies and releases nutrients back to the system. Standing water removed during the maintenance operation must be disposed to a sanitary sewer at an approved discharge location. Residuals must be disposed in accordance with current Seattle-King County Health Department requirements.

INTEGRATION WITH CITY DRAINAGE REQUIREMENTS

Current City drainage design guidelines allow the use of infiltration trenches, and therefore presumably basins, for peak-rate drainage control. However, their application is for smaller residential developments. As the concentration of suspended material and oil is considerably higher from commercial and industrial properties, pretreatment is essential. Therefore, separation of the two functions is necessary. An exception is apartment and condominiums.

Where required a peak-rate drainage control facility using current City drainage requirements cannot serve as the pretreatment device. This is because the volume specified by current City requirements (about 700 to 1,300 ft3, depending on the fraction of impervious surface) is too small to provide good treatment. Therefore, the pretreatment system (constructed wetland, dry or wet settling basin) must be sized to provide effective treatment, as described later in Part IV, and depth is added to provide the necessary live storage for hydraulic control.

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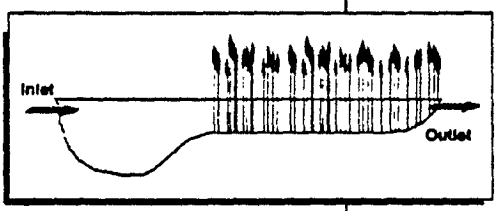
R0059668

Part IV

BMP 2.30 CONSTRUCTED WETLANDS

DESCRIPTION

Although natural wetlands have been found effective in treating stormwater, their use is not recommended due to the likely damage to the biological value of the wetland.



Constructed wetlands are excavated basin into which wetland-type vegetation are purposely placed to enhance pollutant removal. As shown in the illustration, the inflow first passes through a forebay where the larger solids are retained. The stormwater then passes through the emergent vegetation. The vegetation provides a quiescent area for the finer solids to settle. The vegetaion will also remove some of the soluble pollutants. Constructed wetlands are much preferred over natural wetlands. It avoids damage to the natural wetland, if that is the alternative under consideration. Also, harvesting is necessary to maintain the capability of the wetland to remove soluble pollutants. Harvesting natural wetlands is neither environmentally acceptable nor practical. However, a constructed wetland can be configured in a manner that eases the harvesting costs.

Two criterion dictate the feasibility of using a constructed wetland. Sufficient surface area must be present using the design criteria presented below, and the concentrations of pollutants in the discharge must be below values that could inhibit vegetation growth.

DESIGN CRITERIA

To maximize treatment effectiveness these criteria must be followed:

1. The total surface area of the wetland must be a minimum of 1% of the area draining to the wetland, or 100 square feet (ft2) per 10,000 ft2 of contributing area.
2. Include a forebay with a water depth of about three (3) feet.

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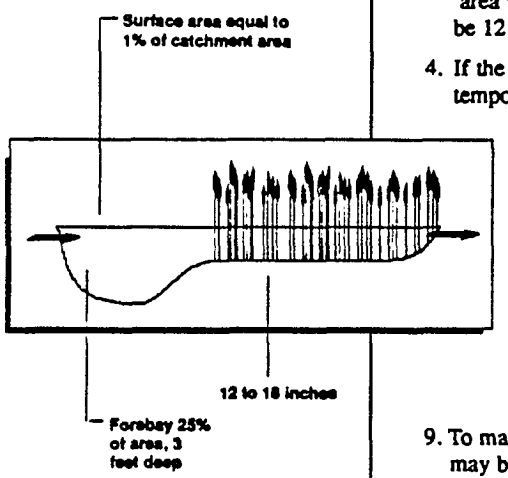

3. The depth of the standing water of the remaining surface area where the wetland vegetation is installed should be 12 to 18 inches.

4. If the wetland is also used for hydraulic detention, the temporary increase in water depth during the 10-year design storm shall not exceed one foot.

5. Preceding each forebay should be an SC-type oil spill control device (BMP 2.10).

6. Measures must be taken to avoid erosion around the wetland outlet and in the forebay.

7. Side slopes shall be 3:1. If the slope must be steeper a fence shall be installed

8. The length to width ratio shall be at least 3:1 and preferably 5:1.

9. To maintain the water level during the dry season it may be necessary to install a liner. The need for a liner shall be determined by appropriate examination of the infiltrative characteristics of the soil;

10. The species composition should maximize heterogeneity and value to birdlife

11. The soil in which the wetland plants will exist must be appropriate for the species selected. Either soil tests indicating the adequacy of the soil or a soil enhancement plan shall be submitted with the overall design.

12. A qualified wetland scientist shall prepare that portion of the design that relates to vegetation selection and installation..

Although not required measures to further enhance habitat for wildlife are encouraged. For example, maximizing vegetation density around the wetland will discourage the entry of domestic animals that would prey on wildlife. Provision of an island for nesting birds is encouraged.

SIZING PROCEDURES

The design criterion of 100 square feet (ft2) of wetland surface area per 10,000 ft2 of contributing development basin establishes the size. The depth of the storm or hydraulic storage shall be established using current Seattle drainage design procedures. If at 1% surface area, the storm depth is found to be greater than one foot, the area of the wetland must be enlarged accordingly.

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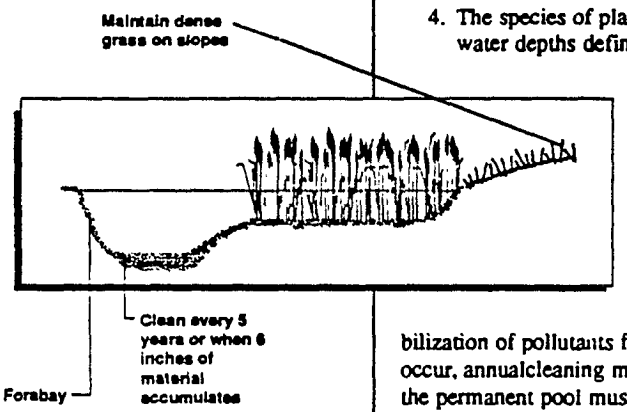
R0059670

CONSTRUCTION

To avoid undue loss of plants, these measures will be included:

1. The planting process is to be inspected or undertaken by a qualified wetland scientist;
2. All plant materials shall conform to the State of Washington Department of Agriculture "Washington State Standards for Nursery Stock Order No. 1627";
3. Prior to planting, plants located temporarily on site are kept moist, fresh and protected from wind and sun;
4. The species of plants used are appropriate for the water depths defined above;

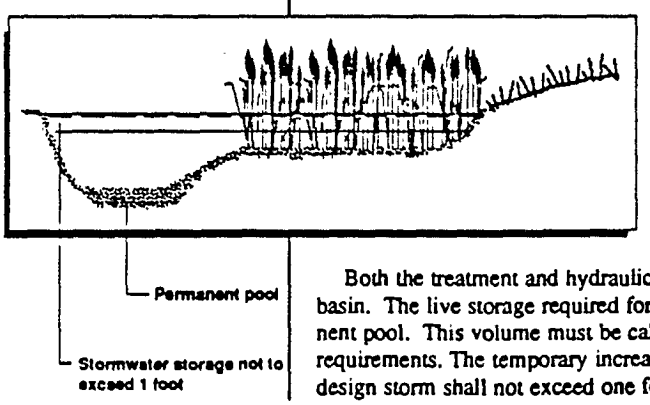


MAINTENANCE

Oil/water separator(s) preceding the wetland must be cleaned according to the procedures outlined in BMP 2.10. Floatables must be removed annually from the forebay; surface sheen shall be removed. The forebay bottom must be cleaned once every 5 years, or when 6" of the permanent pool in the forebay is lost to accumulated material, whichever comes first. However, if solubilization of pollutants from accumulated bottom sediments is found to occur, annualcleaning may be necessary. Grass along the basin slopes above the permanent pool must be well maintained to prevent bank erosion.

Any standing water removed during the maintenance operation must be disposed to a sanitary sewer at an approved discharge location. Residuals must be disposed in accordance with current Seattle-King County Health Department requirements.

With constructed wetlands harvesting of vegetation shall occur annually. A written harvesting procedure will be prepared by a qualified wetland scientist and will be submitted with the drainage design submitted to the City.



INTEGRATION WITH CITY DRAINAGE CONTROL REQUIREMENTS

Both the treatment and hydraulic objectives can be achieved in the same basin. The live storage required for peak-rate control is added to the permanent pool. This volume must be calculated using current City drainage requirements. The temporary increase in water depth during the 10-year design storm shall not exceed one foot.

R0059671

Part IV

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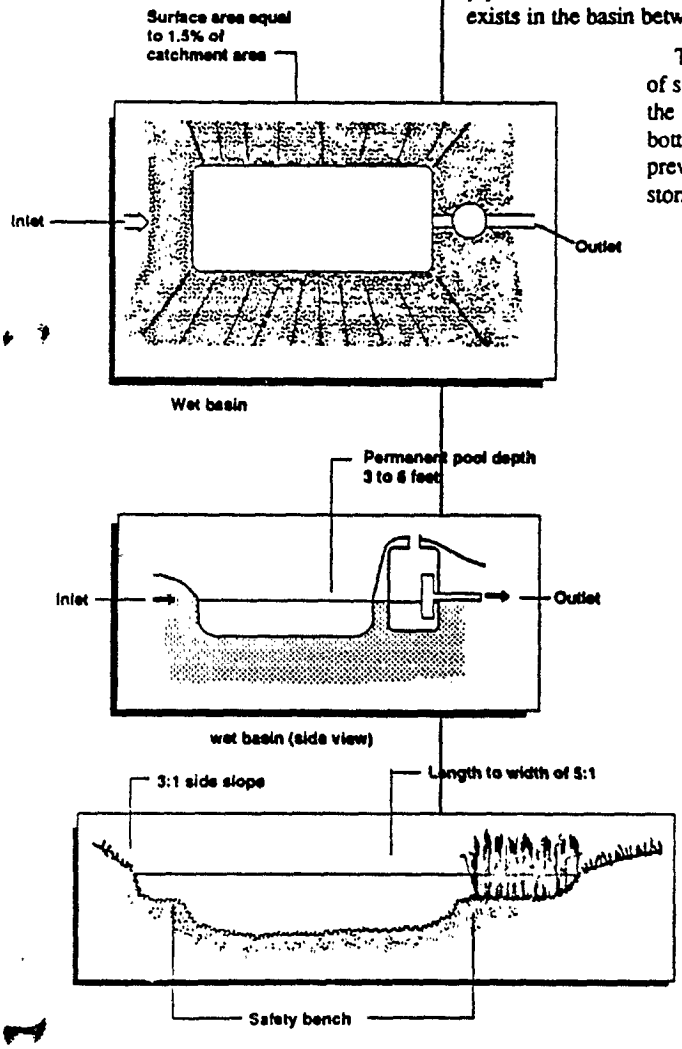
BMP 2.40

WET-SETTLING BASINS

DESCRIPTION

A wet basin may be a surface pond, underground vault, or an oversized pipe. The basin is considered "wet" because a permanent pool of water exists in the basin between storms.

The permanent pool improves the removal efficiency of suspended solids. It quiets the stormwater as it enters the basin; it prevents scour of material settled to the bottom; and fresh stormwater that exchanges with the previously captured water has additional time between storms to settle pollutants.



DESIGN CRITERIA

1. The surface area of the basin must be a minimum of 1.5% of the development surface contributing to the basin, or 150 square feet (ft2) per 10,000 ft2.

2. Depth of the permanent water from 3 to 6 feet.

3. Length to width ratio of at least 3:1 and preferably 5:1. If the wet basin is used in lieu of an API or CPI oil/water separator (BMP 2.10) the ratio shall be at least 5:1.

4. Inlet and outlet at opposite ends of the basin.

5. Side slopes of 3:1 or greater unless a fence is placed around the basin.

6. If the pond surface exceeds 20,000 ft2 include a safety bench around the basin with a width of five (5) feet, with a water depth not exceeding 12" during non-storm periods.

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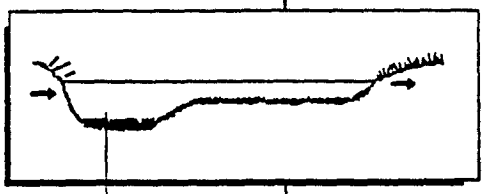
7. Emergent vegetation such as cattails should be placed on the bench to inhibit entry by unauthorized people.

8. Either preceding or following the wet basin shall be a SC oil/water separator unless an API or CPI separator is required for the particular business (BMP 2.10).



With a surface basin or vault, facility maintenance can be eased by installing a forebay. The forebay should comprise about the first one-fourth of the basin. The forebay in a vault can be achieved with a baffle. A porous rock dike placed across the width of the basin will achieve the same result with a surface basin.

SIZING PROCEDURE

The design criteria of 150 ft2 of basin surface per 10,000 ft2 of contributing area establishes the size of the basin. The depth of the storm or hydraulic storage shall be established using current Seattle drainage design procedures.

USE OF WET-SETTLING BASINS TO CONTROL pH

As indicated in Part II there are certain land uses where the stormwater will have a pH exceeding 9, the WDOE standard. Unless the business practices can be altered or enclosed, the only solution is to use acid to reduce the pH.

Adding acid continuously to a stormwater discharge while the discharge is entering the receiving water is inadvisable since a malfunction could result in adverse impacts. Therefore, a basin must be installed to retain the entire specified storm volume. The acid is added the basin after the storm and then released. The volume of the basin shall be 2,000 cubic feet per acre of catchment draining to the basin. Any flow in excess of this volume discharges to the storm drain. The technical basis for the specified design volume is provided in Part VI.

The basin shall have valving to allow complete retention of the specified design volume. The retained stromwater shall be treated and released within 24-hours after each storm to make the basin available for the next storm. If a peak-rate drainage control facility is required, it may precede or follow the pH basin.

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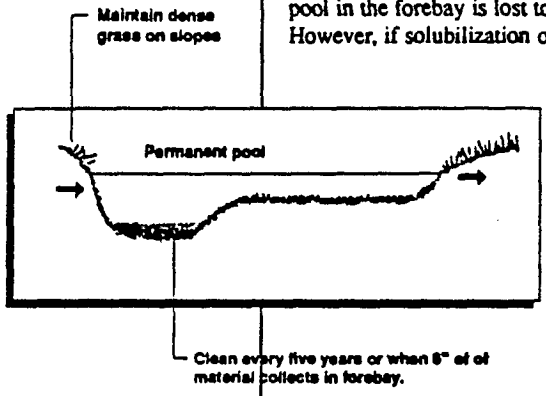
CONSTRUCTION

There are no special construction considerations.

MAINTENANCE

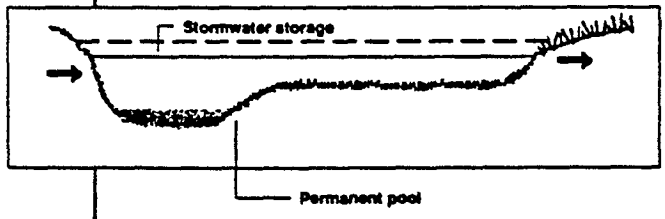
Underground basins must be cleaned annually of accumulated solids and floatables. Floatables must be removed annually from a surface basin; its bottom must be cleaned once every 5 years, or when 6" of the permanent pool in the forebay is lost to accumulated material, whichever comes first. However, if solubilization of particulate pollutants from accumulated bottom sediments is found to occur annual cleaning will be necessary. Grass along the basin slopes above the permanent pool must be maintained to prevent bank erosion.



Any standing water removed during the maintenance operation must be disposed to a sanitary sewer at an approved discharge location. Residuals must be disposed in accordance with current Seattle-King County Health Department requirements.

INTEGRATION WITH CITY DRAINAGE CONTROL REQUIREMENTS

Both the treatment and hydraulic objectives can be achieved in the same basin. The live storage required for peak-rate control is added to the permanent pool. This volume must be calculated using current City drainage requirements.



The basin inlet and outlet must be at opposite ends of the basin. A control manhole with an outlet system that backs water into the facility is not acceptable.

R0059675

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Part IV

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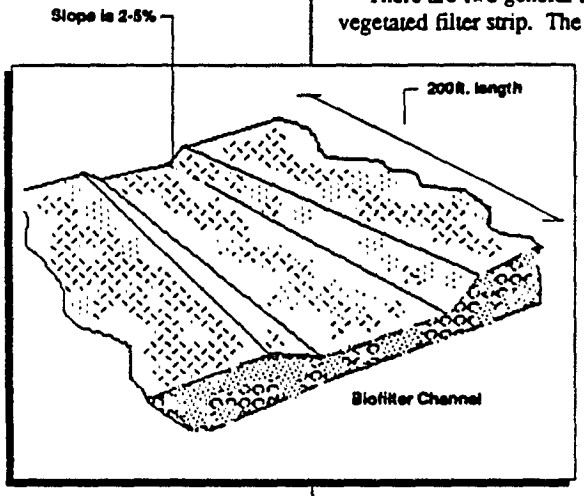
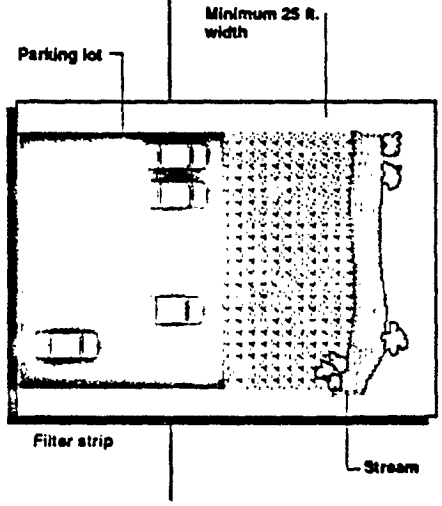
Part IV

BMP 2.50 VEGETATED BIOFILTER

DESCRIPTION

There are two general types of biofilters: vegetated channel and the vegetated filter strip. The vegetated channel is sloped like a standard storm drain channel; the stormwater treated as it passes through the channel. With filter strips the flow is distributed broadly along the width of the vegetated area.





Which method to use depends upon the drainage patterns of the site. A vegetated strip would function well where the water can be spread along the length of a parking lot. Gaps in the lot curb provide the entry points. Of course the grade of the parking lot must be flat parallel to the strip.

Unless a bypass is included, the biofilter must be sized as both a treatment device and to pass the peak hydraulic flows specified by the City drainage utility. But to be effective, the depth of the stormwater during treatment must not exceed the height of the grass.

If a peak-rate drainge control facility is required, the biofilter can be placed eitehr before or after the facility.

DESIGN CRITERIA

Based on limited research it is recommended that a biofilter channel have a length of 200 feet (Part VI). The channel width is calculated for the design flow using the design criteria presented below:

1. A grass height of 6 inches;
2. Depth of stormwater during the design storm is 4 inches;

R0059677

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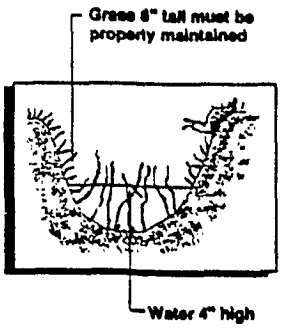

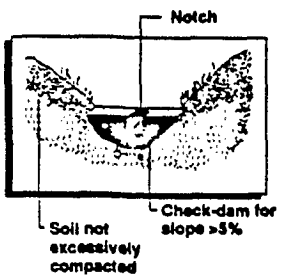

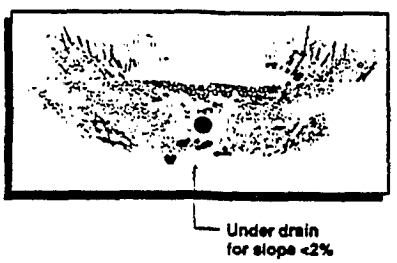

3. The channel slope between 2 and 5%;

4. A slope less than 2% can be used if underdrains are are placed beneath the channel to prevent ponding;

5. A slope greater than 5% can be used if check dams are placed in the channel to slow the flows;

6. Biofilter width for effecative long-term treatment is to be calculated using a design flow of 0.2 cfs/acre of area contibuting to the biofilter. The rationale for this particular flow is provided in Part VI.

7. Channel width and/or height is added as needed to pass the peak hydraulic flow, or a bypass is included.

8. The biofilter can be less than 200 feet in length as long as the width is increased proportionally to maintain the treatment surface area, as defined below. However, minimum length is 25 feet, at which point the channel has become a filter strip. The minimum biofilter width shall be 18".

9. Either preceding or following the biofilter shall be a SC oil/water separator or an API or CPI seporator if required for the particular business (BMP 2.10)

SIZING PROCEDURE

Engineers have proposed that the width of vegetated biofilters be determined using various forms of the Manning's equation. For reasons provided in Part VI, this methodology has been simplified to the simple rule of thumb that the biofilter shall have a total surface area of 500 square feet (ft2) per acrea of catchment surface that is draining to the biofilter. The biofilter may be of any length or width as long as it is within the constraints previously identified.

CONSTRUCTION

The subsurface of the biofilter must be carefully constructed to avoid undue compaction of the soil. Compacted soil reduces the infiltration and inhibits growth of the grass. Restoration of grass shall not be left to chance. The soil must be properly fertilized and seeded using current City requirements for site restoration.

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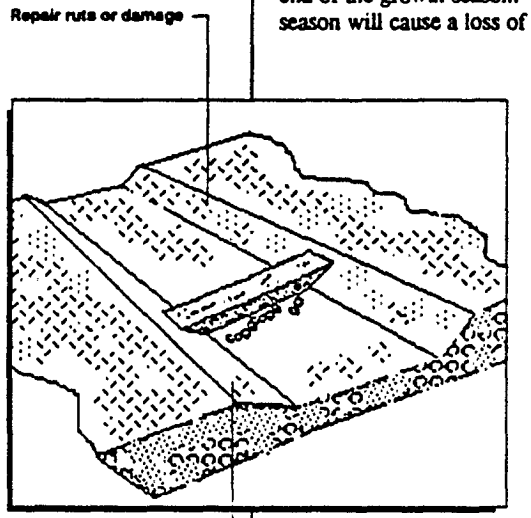
MAINTENANCE

To be effective the biofilter must be properly maintained. It should be mowed several times during the growth season and the clippings must be removed from the channel. Mowing encourages growth thereby improving the removal of soluble pollutants. The final mowing should occur near the end of the growth season. Failure to remove the growth before the dormant season will cause a loss of pollutants back to the stormwater.



A standardized grass height for all designs is proposed to simplify maintenance and post-construction facility inspection programs. If every biofilter were sized using a different height, it would be impossible to retain agency memory of how each biofilter in the City is to be mowed.

Research has not yet identified proper mowing strategies. For now all mowings during the spring and summer must keep the grass at the 6" design height. In some commercial applications where 6" may cause an aesthetic problem the grass can be cut to 4" but the last mowing of the season must not be below 6".

Any damage to the channel such as rutting must be repaired with suitable soil, properly tamped and seeded. The grass cover should be thick; if it is not reseeding is necessary.

Any standing water removed during the maintenance operation must be disposed to a sanitary sewer at an approved discharge location. Residuals must be disposed in accordance with current Seattle-King County Health Department requirements.

INTEGRATION WITH CITY DRAINAGE CONTROL REQUIREMENTS

As described above, the biofilter can be placed before or after the rate control facility. After is preferred as the drainage facility will moderate hydraulic flows through the channel. The control manhole will also remove paper floatables and oil spills before the stormwater reaches the biofilter.

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Part IV

R0059680

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BMP 2.60

DRY-SETTLING BASINS

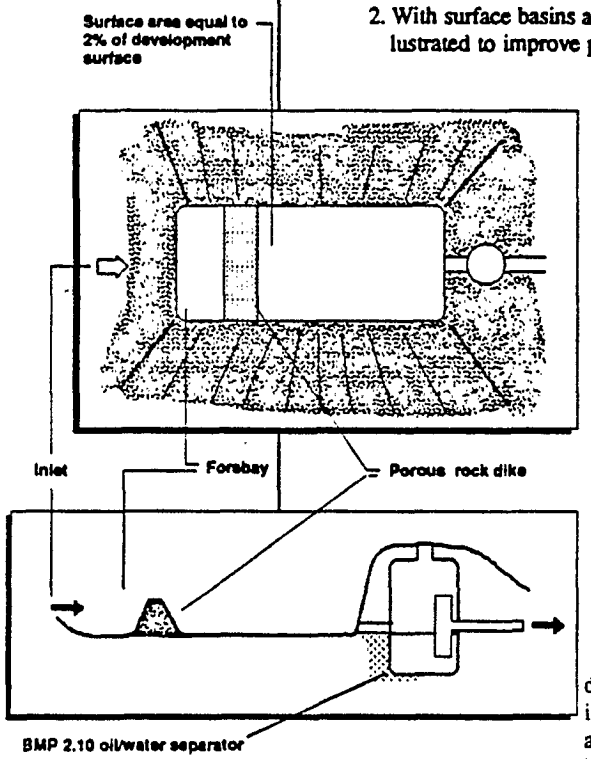
DESCRIPTION

A dry-settling basin has a similar appearance to a wet basin but has no permanent pool. It may be a surface basin, underground vault or oversized pipe.

DESIGN CRITERIA

1. The surface area of the basin must be a minimum of 2% of the development surface contributing to the basin, or 200 square feet (ft2) per 10,000 ft2.

2. With surface basins a porous rock dike shall be located as illustrated to improve performance.



3. Length to width ratio of at least 3:1 and preferably 5:1.

4. Inlet and outlet at opposite ends of the basin.

5. Side slopes of 3:1 or greater unless a fence is placed around the basin.

6. The outlet structure shall be a multiport system sized for the 2- and 10-year return storm.

7. Either preceding or following the biofilter shall be a SC oil/water separator or an API or CPI separator if required for the particular business (BMP 2.10).

The above criteria differs from current City drainage requirements. The 2-year storm is included in the specification to increase the average residence time of storm flows in the basin thereby improving removal efficiency.

R0059681

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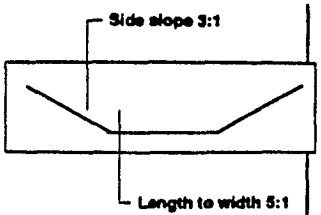

The use of the 2-year storm shall be implemented within the limitations of current City policy regarding the minimum size orifice.

With a surface basin or vault, facility maintenance can be eased by installing a forebay. The forebay should comprise about the first one-fourth of the basin. The forebay in a vault can be achieved with a baffle. A porous rock dike placed across the width of the basin will achieve the same result with a surface basin.

SIZING PROCEDURE

Using the above critiera, the basin volume shall be 4,500 cubic feet (ft3) per acre of the catchmenta area draining to the basin. The design criteria of 200 ft2 of basin surface per 10,000 ft2 of drainage area establishes the depth of the basin.

USE OF DRY-SETTLING BASINS TO CONTROL pH

As indicated in Part II there are certain land uses where the stormwater will have a pH exceeding 9, the WDOE standard. Unless the business practices can be altered or enclosed, the only solution is to use acid to reduce the pH.

Adding acid continuously to a stormwater discharge while the discharge is entering the receiving water is inadvisable since a malfunction could result in adverse impacts. Therefore, a basin must be installed to retain the entire specified storm volume. The acid is added the basin after the storm and then released. The volume of the basin shall be 2,000 cubic feet per acre of catchment draining to the basin. Any flow in excess of this volume discharges to the storm drain. The technical basis for the specified design volume is provided in Part VI.

The basin shall have valving to allow complete retention of the specified design volume. The retained stromwater shall be treated and released within 24-hours after each storm to make the basin available for the next storm. If a peak-rate drainage control facility is required, it may precede or follow the pH basin.

CONSTRUCTION

There are no special construction considerations. The soils of the bottom and slopes of the basin shall be fertilized and seeded according to current City restoration requirements to insure a vigorous grass growth.

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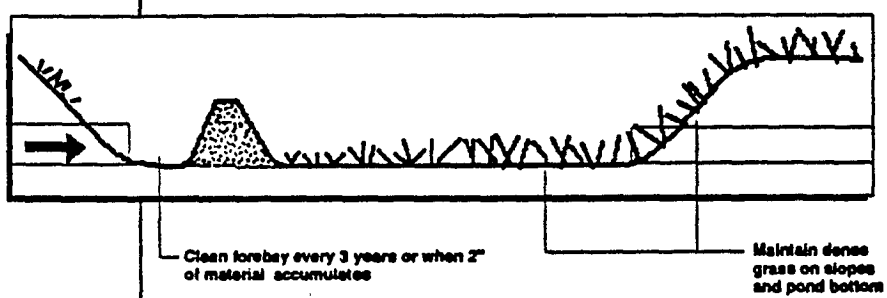
MAINTENANCE

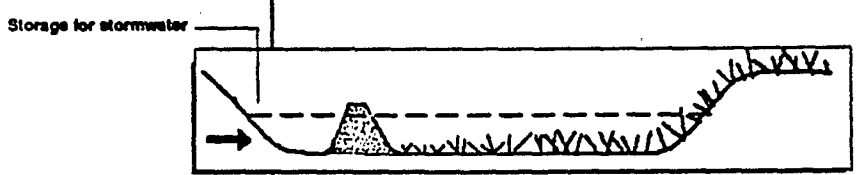
Floatables should be removed annually ; the bottom shall be cleaned of solids once every 3 years or or when 2" of material has accumulated, whichever occurs first. A vigorous grass growth must be maintained to prevent resuspension of pollutants and erosion .

Standing water removed during the maintenance operation must be disposed to a sanitary sewer at an approved discharge location. Residuals must be disposed in accordance with current Health Department requirements.



INTEGRATION WITH CITY DRAINAGE CONTROL REQUIREMENTS

Both the treatment and hydraulic objectives are achieved in the same basin using the above design criteria. The basin inlet and outlet must be at opposite ends of the basin. A control manhole with outlet system that backs water into the facility is not acceptable.



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Other Regulatory Requirements

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RELATED REGULATORY REQUIREMENTS

Part V

Provided in Part V are brief overviews of requirements from regulations that affect postively or negatively the ability to implement the requirements of this manual.

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Part V

R.1 METRO SEATTLE REQUIREMENTS TO DISCHARGE TO SANITARY SEWERS

Stormwater cannot be discharged into a separated sanitary sewer unless the following conditions are met:

1. Treatment by all known and available technology will not meet WDOE standards for discharge to receiving waters or will cause unreasonable financial burden;
2. The discharge will not exceed the hydraulic capacity of the collection system or the Metro treatment plant;
3. The contaminants will not damage the collection system or the Metro treatment plant; impact the health and safety of Metro plant workers; pass through the Metro treatment process; or limit use of Metro's sludge for land application;
4. The stormwater shall not contain any gas or substance which by itself or by interaction with other waste may cause corrosive damage to sewer works or treatment facilities with a pH never less than 5.5;
5. The stormwater shall not contain heat in amounts that interfere with the treatment plant;
6. The concentration of fats, oils and greases of animal or vegetable origin, petroleum oil, nonbiodegradable cutting oil or mineral oils shall not exceed 100 mg/l;
7. Prohibited from discharge to the sanitary sewers are flammable or explosive materials including gasoline, kerosene, naphtha, benzene, toulene, xylene, ethers, alcohols, ketones, aldehydes, peroxides, chlorates, perchlorates, bromates, carbides, hydrides and sulfides and any other substance which the City, State or EPA have indicated is a fire hazard.
8. The following parameters shall not exceed the concentrations indicated: arsenic, 1 mg/l; cadmium, 3 mg/l; chromium, 6 mgl/l; copper, 3 mg/l; lead, 3 mg/; mercury, 0.1 mg/l; nickel, 6 mg/l; silver, 1 mg/l; zinc, 5 mg/l; cyanide, 2 mg/l.

The user should refer to Metro literature for a more detailed explanation of the above items.

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R.2 CITY OF SEATTLE DRAINAGE REQUIREMENTS

Provided is a summary pertinent to this manual. The reader is referred to City Engineering Department publications for a more detailed presentation.

1. A Drainage Control Plan must be developed for "an addition to developed property of 2,000 square feet or more; for construction of new building with a total of 2,000 square feet or more, after demolition of existing structures; all developmental coverage additions fr 2,000 or more square feet; for the construction of single family or duplex residences."

2. Post-development runoff controlled to 0.20 cfs per acre.

3. The Rational and Yrjaninen/Warren methods are used to size detention facilities. The "C" values are: 0.3 for undeveloped areas, golf courses and parks; 0.5, single-family; 0.6, mixed residential; 0.7, commercial; 0.8, industrial; 0.9 for the downtown CBD. The City specifies the required volume in cubic feet per acre of site. The volumes for the post-development C are: C=0.3, 225 cubic feet; 0.5, 548; 0.6, 729; 0.7, 917; 0.8, 1113; 0.9, 1313.

4. Up to 20% of the development can drain uncontrolled as long as the orifice is downsized accordingly to provide a weighted site runoff of 0.20 cfs at the design storm.

5. The minimium size of the orifice is 3/4".

6. Drainage requirement is waived if the site discharges directly into the Duwamish River, Puget Sound, Lakes Washington or Union, or the Ship Canal, or into a storm drain which ca carry anticipated loads to one of the above receiving waters.

7. Infiltration trenches are allowed if: percolation rate > 4 inches per hour; no soil stability problems will occur; site is not in a slide hazard area; groundwater does not interfere with drainage.

8. Storm drains are sized for full gravity flow at the 10-year event; at a 25-year event the drain can surcharge no higher than four feet below the gutter grade or one foot below the service elevation of the adjacent property.

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R.3 CITY OF SEATTLE FIRE CODE REQUIREMENTS

Storage of flammable, ignitive and reactive chemicals and materals must comply with City Fire Codes, in particular as it relates to this manual: Article 50, Storage of raw materials and finished products; Article 79, Storage of Flammable and combustible liquids; and Article 80, Storage cabinets for hazardous materials. Storage requires a permit from the Fire Department.

Specific points of relevance are presented briefly below.

1. Finished products that are flammable and combustible liquids can be stored inside the manufacturing building as long as they are stored in a room separated from the processing area by a two-hour occupancy separation.
2. Container and tank storage areas are to be protected against trespassers by fencing or other control measures. The area is also to be kept free of weeds, debris, and other combustible materials.
3. The storage area is to be graded to divert spills away from buildings or surrounded by a 6" curb. If a curb is used, a drain shall be provided for draining of accumulations of rainwater or spills.
4. An operator or other competent person shall be in attendance at all times while a tank vehicle or tank car is discharging.
5. The area surrounding a tank or group of tanks shall be provided with drainage or shall be diked to prevent accidental discharge of liquid from endangering adjacent tanks, adjoining property or reaching waterways.
6. The area within the dikes shall be sloped not less than 1 percent towards an impounding basin or an approved means of disposal.
7. The volume of the diked area shall not be less than the greatest amount of liquid released from the largest tank.

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8. Provision is to be made for draining or removing excess water from the diked area. Such drains shall not discharge into natural water courses, public sewers or public drainage channels unless the drain is so designed as to prevent the release of flammable or combustible liquids. A valve operable from outside the dike shall be provided in the dike system and shall normally be kept closed.

9. Regarding loading and unloading, provision shall be made to prevent liquids from entering public sewers and drainage systems or natural waterways. Connections to such sewers, drains or waterways by which liquids might enter shall be provided with separator boxes.

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Part V

R.4 WDOE REQUIREMENTS FOR GENERATORS OF DANGEROUS WASTES

The State's Dangerous Waste Regulations (Chapter 173-303 WAC) cover accumulation, storage, transportation, treatment and disposal. However, of interest to this manual are those businesses that accumulate the waste at their business until taken from the site by a contract hauler. Consequently, only those aspects of the regulations that apply to waste generators and accumulation is considered here.

Regarding accumulation, State regulations require businesses to obtain a WDOE Identification Number if they generate more than 220 pounds per month (2.2 pounds if the waste is defined as Extremely Hazardous).

In addition, under certain circumstances as described below the business must obtain a permit to store accumulated dangerous wastes at their businesses. Where storage permits are required the WDOE assumes the responsibility of ensuring that stringent technical requirements are met.

The City must be concerned about those situations where a WDOE storage permit is not required. Although these businesses still fall under WDOE regulations, the technical requirements are rather general. The first opportunity to insure that a new business complys with the regulations occurs with the City's permitting process.

A storage permit is *not* required by WDOE under these circumstances:

1. If the business generates more than 2,200 pounds per month of dangerous waste but intends to store the accumulated material less than 90 days;
2. If the business generates between 220 and 2,200 per month of dangerous waste but intends to store less than 180 days; or,
3. If the business produces less than 220 pounds per month regardless of the length of storage.

Generators that produce more than 220 pounds per month and avoid the need for a permit must still fullfill these general regulations with regard to temporary storage:

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IF PLACED IN CONTAINERS

1. If the container is not in good condition (e.g severe rusting, apparent structural defects) or if it begins to leak, the owner must replace the container;
2. The container must be labeled as to its contents;
3. The container must be lined with a material that does not react with the waste;
4. The container must always be closed except when adding or removing waste;
5. The container must not be opened, handled, or stored in a manner which may cause a rupture or leak;
6. At least weekly examine the containers for leakage;
7. Containers storing reactive or ignitable waste must meet requirements of the Uniform Fire Code; and,
8. Incompatible wastes must be stored separately;
9. The WDOE *may*[1] require secondary containment of the storage area, specifically, the storage area must:
   a. be capable of collecting and holding spills and leaks;
   b. If uncovered, be capable of handling a 25 year storm;
   c. Have a base which is free of cracks or gaps and is sufficiently impervious to leaks, spills and rainfill;
   d. be sloped or designed such that liquids can drain to a point for removal;
   e. have positive drainage control (e.g. a valve) to insure containment until any liquid is removed which must occur in a timely manner;
   f. have a holding capacity equal to ten percent of the volume of all containers or the volume of the largest container whichever is greater.
   g. not allow runoff of rainfall from areas adjacent to the storage area.

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If the waste does not contain free liquids the above requirements need not be met provided that the area is sloped or the containers are elevated.

Inasmuch as a business need not approach WDOE unless an Identification Number is required. It is not clear how WDOE is able to determine the need for Item #9 above for businesses that do not need either an Identification Number or storage permit.

IF PLACED IN TANKS

1. The tank must be lined with a material that does not react with the waste;
2. The tank, tank area and its ancillary equipment must be inspected according to a written schedule;
3. If retired the tank is be cleaned of all contents;
4. Tanks storing reactive or ignitable waste must meet requirements of the Uniform Fire Code; and,
5. Incompatible wastes must be stored separately.

The above generators must also have a designated employee on site or on call with the responsibility for coordinating all emergency response measures. Any spills are to be contained and cleaned up as soon as practicable.

If the business produces less than 220[1] pounds per month it need not comply with the above regulations. It need only dispose the waste in a manner acceptable to the Seattle-King County Health Department which is:

1. Dispose the waste to a permitted facility; or
2. Dispose the material to a recycling facility; or
3. Dispose the waste to a permitted municipal or industrial landfill; or
4. Put the waste to a beneficial use.

[1]Some wastes are designated "Extremely hazardous" in which case the above controls are imposed if more than 2.2 pounds are produced per month.

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R.5 REQUIREMENTS OF THE SEATTLE-KING COUNTY HEALTH DEPARTMENT ON CONTAINERS

Rules and Regulations No. 8, Minimum Functional Standards for Solid Waste Handling, specify the characteristics of containers to insure their integrity. The Rule states:

"Reusable containers, except for detachable containers, shall be: rigid and durable; corrosion resistant; nonabsorbent and water tight; rodent-proof and easily cleanable; equipped with a close fitting cover; suitable for handling with no sharp edges or other hazardous conditions ..." (Part IV, Section 1.B).

Detachable containers are reusable containers that are mechanically loaded or handled such as a dumpster or drop box.

"Detachable containers shall be durable, corrosion-resistant, nonabsorbent, nonleaking and having either a solid cover or screen cover to prevent littering." (Part IV, Section 1.B).

"All wastewater from container cleaning shall be disposed to a sanitary sewer unless otherwise authorized by the health officer." (Part IV, Section 1.B).

"All persons collecting or transporting solid wastes shall avoid littering, or the creation of other nuisances at the loading point..." (Part IV, Section 1.C).

" ... solid waste shall be moved in such a manner that the contents will not fall, leak in quantities to cause a nuisance, or spill therefrom. Where such spillage or leakage does occur, the waste shall be picked up immediately ..." (Part IV, Section 1.C).

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R.6 COAST GUARD REQUIREMENTS FOR MARINE TRANSFER OF PETROLEUM PRODUCTS

Federal regulations 33CFR153, 154 and 155 cover, respectively, general requirements on spill response, spill prevention at marine transfer facilities, and spill prevention for vessels.

These regulations specify technical requirements for transfer hoses, loading arms, closure and monitoring devices. The regulations also cover small discharge containment: they require the use of "fixed catchments, curbing, and other fixed means" at each hose handling and loading arm area, and each hose connection manifold area. Portable containment means can be used in exceptional situations where fixed means are not feasible.

The capacity of the containment area varies from the volume of one barrel to four barrels depending on the size of the transfer hoses.

The regulations also require an operations plan and specifies its general contents. The plan is to describe the responsibilities of personnel, nature of the facility, hours of operation, sizes and of vessels using the facility, nature of the cargo, procedures if spills occur, petroleum transfer procedures. The plan must also include a description and location of equipment for monitoring, containment, and fire fighting.

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R.7 USEPA REQUIREMENTS FOR UNDERGROUND STORAGE TANKS

EXEMPT TANKS

Regulations are for underground tanks (tank system having 10% or more of its volume underground) containing petroleum or listed hazardous substances. It covers all tanks except:

1. Farm and residential tanks holding 1,100 gallons or less of motor fuel;
2. Tanks storing heating oil used on premises;
3. Tanks on or above floor of underground areas;
4. Septic tanks;
5. Tanks holding 110 gallons or less;
6. Emergency spill and overflow tanks.

NEW TANK REQUIREMENTS

(INSTALLED AFTER DECEMBER 1988)

1. Certify that tank and piping are installed properly according to industry codes;
2. Equip with devices that prevent spills and overfills;
3. Protect tank and piping from corrosion;
4. Equip tank and piping with leak detection.

EXISTING TANK REQUIREMENTS

(INSTALLED BEFORE DECEMBER 1988)

1. Implement tank filling procedures that will prevent spills and overfills;
2. By December 1998, tanks and piping equiped with corrosion prevention;
3. By December 1998, equip to prevent spills and overfills

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4. Equiped with leak detection by these dates:

If tank was installed	Leak detection by
Before 1965	1989
1965-1969	1990
1970-1974	1991
1975-1979	1992
1980 to December 1988	1993

If the tank does not have corrosion protection or internal lining and devices to prevent spills and overfill, a monthly inventory with tightness testing is required until December 1998.

5. Leak detection in piping installed by December 1990

Pressure piping: devices to automatically shut off or restrict flow or have an alarm that indicates leak. Conduct annual tightness testing or use monthly monitoring methods for tanks.

Suction piping: Monthly monitoring or tightness testing every 3 years at same schedule as leak detection. If suction piping is sloped to draw back to storage tank, if suction is released and only one check valve is included in each suction line directly below the suction pump - leak detection not is required.

6. If existing tank has been upgraded with corrosion protection and a device to prevent spills and overfills: a monthly inventory control and tank tightness test must be performed every 5 years. If the tank has not been upgraded, a monthly inventory control and tank tightness test must be performed every year.

REPORTING REQUIREMENTS

1. Notification of installation of tank;
2. Notification of any suspected releases;
3. Confirmed release/corrective action;
4. Notification 30 days before permanent closure.

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Part V

REPORTING OF SUSPECTED RELEASES

Owners/operators must report within 24 hours, or another reasonable time specified by WDOE and follow procedures outlined in the regulations for any of the following:

1. Discovery of release at tank site or surrounding area;
2. Unusual operation conditions such as sudden loss of product, equipment behavior, unexplained water in tank;
3. Monitoring results indicating a release may have occurred unless the monitoring device was found to be defective or, in the case of inventory control, if the second month does not confirm initial data.

RECORD KEEPING REQUIREMENTS

1. Records of leak detection performance and maintenance;- previous year monitoring results and most recent tightness test results, including:
   - leak detection manufacturing performance claims;
   - records of maintenance, repair; and,
   - calibration of leak detection.
2. Records of last two corrosion protection system inspections;
3. Expert analysis of corrosion potential if corrosion protection equipment is not used;
4. Minimum of 3 years after closure, records of site assessment results are required for permanent closure;
5. Records for repaired or upgraded tanks;
6. Check local regulatory requirements.

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R.8 USEPA AND WDOE EMERGENCY SPILL CLEANUP REQUIREMENTS

USEPA - SPCC PLANS (40 CFR 112)

The Federal Regulation requires that owners or operators of facilities engaged in drilling, producing, gathering, storing, processing, refining, transferring, or consuming oil and oil products are required to have a Spill Prevention and Control Plan (SPCC), provided that the facility is nontransportation related; and, that the above ground storage of a single container is in excess of 660 gallons, or an aggregate capacity greater than 1,320 gallons, or a total below ground capacity in excess of 42,000 gallons.

The Plan must:

1. Be well thought out in accordance with good engineering;
2. Achieve three objectives - prevent spills, contain a spill that occurs, cleanup the spill;
3. Identify name, location, owner, and type of facility;
4. Date of initial operation and oil spill history;
5. Designated person responsible;
6. Approval and certification by person in authority;
7. Facility analysis

WDOE DANGEROUS WASTES (WAC 173-303-350)

Businesses must have a Contingency Plan which must in general include:

1. Actions taken in the event of spill;
2. Descriptions of arrangements with local agencies;
3. The business's Emergency Coordinator;
4. List of emergency equipment;
5. Evaluation plan for business personnel.

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Appendix

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GLOSSARY

API separator: American Petroleum Institute, author of several publicaitons on oil/water separation.

Biofilter: see "vegetated biofilter"

BMP: "Best Management Practice" is a general name give to a variety of mostly simple methods for controlling nonpoint pollution.

Constructed wetland: A constructed, as opposed to a natural, wetland is one in which a basin as been purposely excavated and wetland plants have been installed. It is in essense a human-made biological treatment system.

Container: A container is any portable device in which material is stored such as a dumpster or 55 gallon drum.

CPI separator: "corrogated plate interceptor", refers to one type of sophisticated oil/water separator in which plates made of fiberglass or other artificial material are constructed in a pack at a slanted angle.

Dangerous Waste: The designation by Washington State Law of certain materials that must be stored, treated, and/or transported following strict regulatory procedures.

Dry-settling basin: A basin, located on the surface or underground, in which the primary mechanism of pollutant removal is settling of suspended solids or particulates. A "dry" basin is one in which stormwater appears in the basin only during a storm. Within a few minutes to a few hours after the end of the storm the basin is empty. It does not retain water between storms. See "wet-settling basin".

Parameter: A constiuent or characteristic of water that describes in part its quality. Examples are dissolved oxygen, temperature, nitrogen, phosphorus, and fecal coliform bacteria.

Runon: Refers to stormwater that passes onto and through an area of concern such as a storage area for hazardous wastes or materials. Diversion of the stormwater around the designated area may prevent unnecessary contamination.

SC separator: Refers to "spill control" separator which is the simple T-pipe device that is installed in manholes. Often referred to as an oil/water separator, it is not really effective at removing the finely dispersed oil droplets which constitute most of the oil presense in stormwater.

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SIC: Standard industrial classification as developed by the Federal Government and used in some regulatory programs to distinquish between types of businesses.

Source Control: Refers to the technique of stopping and/or controlling pollutants at their point of generation so that they do not come into contact with stormwater.

Vegetated biofilter: A stormwater treatment device in which vegetation is used to separate the pollutants from the stormwater. The primary mechanism is settling or filtration of the particulates. Some soluble pollutants may also be removed by biological growth and chemical fixation with the soil.

Wet-settling basin: A type of basin, located on the surface or underground, in which a permanent pool of water is retained between storms. The pool of water improves the treatment effectiveness by providing better conditions for settling of suspended solids. Some soluble pollutants may also be removed in surface basins, by the biological growth of algae or larger vegetation around the perimeter of the basin. See "dry-settling" basin.

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June 30, 1989

TO: Cliff Marks, Office for Long-range Planning

FROM: Gary Minton, Principal Manual Author
Resource Planning Associates

SUBJECT: Documentation for BMP decisions and design criteria in the Manual

It is cumbersome to document in the main sections of the manual the basis for various decisions such as BMP requirements or design criteria. Provided here is background on the more significant decisions. As this manual is the first of its type in the nation, little support is available from similar manuals. Consequently, the technical foundation of the manual has been almost totally derived by Resource Planning Associates (RPA).

Four areas are covered in this memo.

- Should BMPs be voluntary or required?
- What is the data base to support the requirement for oil/water separators for certain land uses.
- What is the technical basis for certain BMP requirements in Part III,
- What is the technical basis for certain design criteria in Part IV.

SHOULD BMPs BE REQUIRED?

For several reasons the manual takes the position that BMPs shall be required, the specific BMPs varying with the particular business grouping (Part II in the manual). First we observe that the concentration of many pollutants present in stormwater from most (and possibly all) land uses likely exceeds the water quality criteria for fresh and saltwater (compare Tables A.1 and A.2 at the end of this memo).

It should be recognized that the data in Table 1 are for runoff from general commercial, residential and industrial areas, not specific businesses. Therefore, runoff from roads is included in the sampling. There perhaps is a tendency to conclude from Table 1 that inasmuch as the pollutant concentrations from commercial and industrial areas are quite high, much higher than residential areas, the source of these pollutants are the businesses. This may not be a valid conclusion.

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The primary cause of higher pollutant concentrations from commercial and industrial areas may be higher traffic volume on the streets. However, although the data for runoff from specific commercial and industrial businesses is very meager it is not unreasonable to expect that the concentrations of key pollutants will exceed water quality criteria. The limited amount of data we were able to extract from Metro and DOE files is summarized in Table A.3. It shows that for those particular land uses, concentrations of one or more pollutants exceeds fresh or saltwater criteria.

It would therefore seem that unless BMPs are required the quality of stormwater from commercial and industrial land uses will not meet the desired quality of receiving waters.

Further, for many business types WDOE is already requiring stormwater discharge permits (eg shipyards and bulk petroleum storage). These discharge permits have specific effluent limits. Also, some jurisdictions (eg Bellevue, King County) are already requiring in certain circumstances that residential and commercial developments (eg shopping centers) integrate some form of treatment into the peak-rate drainage control facilities.

Finally, many of the BMPs presented in this manual are already required (eg hazardous waste storage, emergency spill control plans). It would be difficult to have a manual that contains both required and voluntary BMPs.

A possible exclusion from the requirement for stormwater treatment are employee and lightly used customer parking lots. However, although there are no data we would expect that the concentrations of pollutants from these types of parking lots are similar to that found for residential areas (Table A.1) where the streets are lightly traveled.

The manual does exclude the requirement for stormwater treatment if the parking lot has fewer than 20 stalls. The cutoff of 20 stalls is consistent with other development requirements by the City such as landscaping. One exception to the 20 stall cutoff: 24-hour convenience stores where a very high turnover of vehicles occurs.

REQUIREMENT FOR OIL/WATER SEPARATORS

All businesses are required to use at least the SC-separator if they have an outside parking area. Our discussion in this memo is in regard to the few business types that are required install the more sophisticated API or CPI separator.

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Presented below are the business types identified in Part II as requiring the API/CPI separator, with the rationale for the decision.

Industrial machinery/trucks: We were unable to locate any data on untreated stormwater. However, we included this business type (if it has outside storage of equipment that may drip oil) because WDOE already imposes the requirement (eg Kenworth).

We have not extended the requirement to other business types that store outside vehicles or equipment: eg dealers of used and new cars, trucks, boats, etc. We are presuming that maintenance activities are rather minor and/or the vehicles are new and therefore not likely to be dripping a large amount of vehicle fluids.

Petroleum bulk storage: WDOE already requires an API/CPI separator. Limited data (Table A.3) of the effluent from these separators suggests they are needed.

Fleet vehicle yards: Data from public (Metro) and private bus maintenance yards indicates mean concentrations of oil/grease typically exceeds the WDOE standard (Table A.3). Individual samples (not shown) often exceed 50 mg/l.

Gas stations: There are no data. The requirement is made entirely by inference from the data on fleet vehicle yards, and the expectation that gas stations typically park older cars outside the building.

It might seem reasonble to extend this requirement to specialized vehicle repair shops but we have not done so.

Retail merchandise stores: Limited data (Table A.3) are available from the San Francisco bay area; the data are for the parking lot of an undescribed department store. It seems reasonable to require sophisticated separation for the types of stores where a high turnover of vehicles occurs (eg. shopping malls, 24-hour convenience stores); but not specialized stores (eg furniture) where vehicle turnover is light.

Fast food restaurants: although there are no data, intuitively one would expect stormwater quality to be similar to shopping malls and 24-hour convenience stores.

Contractors - asphalt pavers: again, although there are no data, it is expected that stormwater from equipment storage yards is contaminated as the rain drains through the equipment.

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REQUIREMENTS ON CERTAIN SOURCE CONTROL BMPs (PART III)

Fueling: The manual requires that all fuel islands be covered (BMP 1.10). The manual also requires that a separate drainage system be installed to collect "fugitive" rainwater, wash water and minor spillage. The drainage system discharges to the sanitary sewer.

The supposition is that certain constituents of fuels dissolve in water and therefore it is best to divert these contaminated waters to the sanitary sewer. However, we have found no data specific to fuel islands. The conclusion is made by inference as to what is in fuel and some data from businesses that store bulk fuels (Table A.3).

Vehicle/equipment washing and stream cleaning: The manual requires enclosure of this activity with internal drains connected to the sanitary sewer. The exception is an open, designated area of less than 200 ft2.

We have been uable to locate any data on the quality of wash water. The requirement is based on supposition that such water will be contaminated by vehicle fluids, road dirt, etc. Because the detergent emulsifies the dispersed oil, sophisticated API or CPI separators are ineffective in treating the wash water. Therefore it is necessary to drain the wash water to the sanitary sewer after passing through an SC-separator.

Other BMPs in Part III: The inclusion of these BMPs is based entirely on judgment as the "reasonable thing to do".

Representative businesses of several of the groups in Part II were visited by the project team. The purpose of the visits was to determine the relevancy of certain BMPs. Business groups visited were: cement, concrete products, industrial equipment/truck manufacturing (truck), metal products (mills, foundries, fabricators, electroplating), petroleum products (asphalt emulsion and paving), fleet vehicles (bus, truck, taxi), vehicle maintenance (fleet), recycling and scrap yards (industrial metals and household wastes), commercial car washes, and construction (general contractors).

STORMWATER TREATMENT BMPs IN PART IV

Although the manual indicates that stormwater treatment is the "last line of defense", treatment will likely always be required unless the activity is enclosed. Even if housekeeping cleaning measures (eg sweeping) are employed, it expected that stormwater from parking lots and areas of outside manufacturing activity will not meet the criteria presented in Table A.2.

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It has been shown (Minton, 1987; USEPA, 1986; Wang, 1982; API, 1979) that treatment efficiency is a function of the design criteria. Therefore, it is appropriate to provide in Part IV a design procedure for each treatment method. The more conservative the criteria, the higher the treatment efficiency but also the cost. The discussion presented here provides the background on why a particular set of design criteria or a given sizing methodology was selected.

Storm size: In several places the manual states that a system shall be sized to handle a flow of 0.2 cfs/acre of catchment draining to the facility. The origin of this figure is presented herein.

It has been proposed (King County, 1989; Horner, 1988) that stormwater treatment systems be sized using the peak rate from the "2-year/24-hour" storm as calculated by the SCS runoff method. However, no analysis has been made of local storms to justify this criterion.

A limited analysis by RPA suggests the 2-year storm is very conservative. Analysis of 28 years (1950 through 1977) of data (daily, 24-hour accumulations) from the SeaTac Airport station indicates that during the record, there were only nine events in which the rainfall exceeded the 2-year/24-hour storm (2 inches from NOAA charts). These 9 storms represented about 23 inches of rainfall. Considering that over the 28 years about 1,100 inches of rainfall occurred, it is very conservative to size a system to operate at or less than its design capacity over 99% of the rainfall period. Further, none of the 9 events occurred during the dry season (April - September), when pollutant accumulation results in higher concentrations in the stormwater.

The record was examined to determine the appropriate design storm. The results are presented in Table A.4. We conclude from the table that the 6-month storm is reasonable; the rate of flow through a system sized for the 6-month storm will be less than its design capacity for at least 95% of the time there are flows. We also note that during the 28-year period there were only seven storms larger than the 6-month storm that occurred during the dry period (April through September), or about one every four years.

Further examination of Table A.4 suggests that sizing for the 1-month storm may be adequate. This storm size represents about 60% of the rainfall: when you consider that most of the runoff from the larger storms is also effectively treated (as the peak runoff rate is less than the design capacity of the treatment system for much of the storm) it could be argued that the 1-month event is adequate. However, until a detailed evaluation of rainfall is made we propose that the 6-month storm be used.

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Using the SCS runoff model as modified by King County, the peak runoff rate for the post-development condition is about 0.2 cfs/acre. The inputs used for this calculation were: rainfall of 1.3 inches; CN = 95; and, time of concentration equal to 10 minutes. Since the City's criterion for peak rate control is also 0.2 cfs/acre, the stormwater treatment device is sized for the same peak flow regardless of whether it precedes or follows the peak rate detention facility.

BMP 2.10, Oil/water separators: Two main points here.

- Those businesses where the manual requires sophisticated oil/water separation, the business may choose either the API or CPI separator.

- The manual uses 90 micron as the droplet size for design.

RPA would prefer that any land use where the oil concentration is consistently above 20 mg/l be required to use the CPI separator. The CPI separator is much more effective than the API even if they are sized according to the same design criteria. However, our conclusion is intuitive; the data are too limited to conclude that certain land uses do generate stormwater with a concentration consistently above 20.

Regarding droplet size: this is the key design parameter. As noted in the Draft Manual, the usual size selected for API separators (API, 1979) is 150 micron. Talking to salespersons of CPI separators, the usual design size is 60 to 90 microns.

The problem is that you want to pick a size to insure that the separator will remove sufficient oil to reach the WDOE standard of 10 mg/l. But to do this you need a size distribution for oil droplets in stormwater. Salesman of CPI plates frequently state that "90% of the droplets are larger than 90 micron, therefore use 90 micron". However, they have never been able to provide RPA any data, and API staff in Washington DC, who have just completed a new manual on oil/water separation, are not aware of any such data.

However, enclosed as Figure 1.2 are data RPA found on stormwater from petroleum refineries which indicates that about 80% (by volume) of the oil droplets are larger than 90 microns. So sizing for 90 microns seems reasonable.

The manual specifies 90 micron for the API separator, despite the statement noted above by API, since it is valid to require the same performance from both types of separators.

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Soil infiltration: Why is this method preferred over all others (not including oil/water separators)? All of the other methods presented in Part IV remove little if any of the soluble fraction of the pollutant. And if only the particulate portion of the pollutant is removed in some cases the criteria in Table A.2 will still not be met.

For example, if a wet pond removes 80% of the particulate fraction of zinc, the concentration of zinc in the effluent during the "average" situation (Table A.1) will still be above the fresh and saltwater criteria in Table A.2 (80% of 60% gives a removal of 48%, and therefore, the effluent concentration, using the data in Table A.1, is still about 140 ug/l (from commercial areas).

For soil infiltration systems, the key design parameter is surface area. The amount of surface area specified is a function of three factors: the infiltration rate of the soil, the pollutant removal goal; and the rainfall characteristics of the local area.

Using a computer model for simulating treatment by a soil infiltration system, RPA developed the information summarized in Table A.5. The numbers provided in the table are based on outputs generated from a computer model developed by RPA (Minton, 1987), based on original work by the USEPA (1986). The model uses mean rainfall statistics to estimate the amount of stormwater, and therefore pollutants, that will be captured over the long term by the treatment device given its surface area.

Conservative estimates are used in deriving Table A.5. First, the procedure used in the field to measure the soil infiltration rate typically underestimates the actual infiltration rate. Further, the long-term infiltration rate will be significantly lower than the actual field rate that exists at the time of the field measurement. It is reasonable to assume that the actual field rate is half the measured rate at the time of the measurement, and that the long-term field rate is about half the actual initial rate (Minton, 1987). These assumptions summarize to a long-term infiltration rate that is one-fourth the measured rate. This conservative factor has been included in Table A.5.

Regarding the removal of pollutants: To protect a soil infiltration system, the stormwater must be pretreated (eg wet pond). The pretreatment system will remove (using the design criteria in this manual) about 80% of the particulate fraction of each pollutant. The particulate fraction represents from 40 to 90% of the pollutant, depending on the particular pollutant. Assuming that in the aggregate, 70% of the pollution is represented in the particulate fraction, then the pretreatment system will remove 56% of the pollutants.

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Areas are defined in Table A.5 for four rates of stormwater infiltration: 50%, 75%, 90% and 95%. Adding this capture to the pretreatment system, gives overall removal rates from 78% to 98%. Based on the analysis in Table A.5 it is reasonable to simplify the design criteria by specifying a particular surface area that is used regardless of the measured infiltration rate. RPA proposes a value of 150% ft2/10,000 ft2 of catchment, or about 1.5%. This gives a overall pollutant removal rate of 85 to 92%, depending on the soil infiltration rate.

To increase the removal rate marginally by 5% (to a range of 90 to 97%) requires an area of 200 to 300 ft2/10,000 ft2, a significant increase. The lower rate of 1.5% seems reasonable given the assumptions made on the relationship between the measured and long-term infiltration rates.

Wetlands/wetponds/dry ponds: Again the key design parameter is surface area. The manual specifies the following:

- Wetlands - 1% of the area draining to the wetland, ie 100 ft2 per 10,000 ft2 of catchment.
- Wetponds - 1.5% of the area draining to the pond, ie 150 ft2 per 10,000 ft2 of catchment.
- Dry ponds - 2% of the area draining to the pond, ie 200 ft2 per 20,000 ft2 of catchment.

The above criteria are based on the same model used for infiltration basins mentioned above. Outputs from the model, modified for the type of treatment situation (settling of suspended solids) produced Figure 1.1. This figure is applicable to wet ponds or underground wet vaults. We selected 1.5% as a reasonable surface area for wet ponds; this fraction gives about 80% removal for commercial and industrial businesses (Rv 0.7 to 0.9). Increasing the surface area to, say, 2% does not significantly improve treatment.

For wetlands, RPA judgmentally decreased the required area because the emergent vegetation will improve the hydraulic efficiency of the wetland thereby improving the settling of suspended solids. It is assumed however that the vegetation covers 100% of the wetland, excluding the forebay.

RPA judgmentally increased the area for dry basins to 2% because without a permanent water pool the dry basin will not do as well as a wetland or wet pond. Water retained between storms in a wet basin provides additional settling time, and previously settled material will not be resuspended during each storm. Placing in the dry basin a porous rock dike and good grass cover will to an unknown extent mitigate these deficiencies.

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Biofiltration: The difficulty in deriving a rational design procedure for biofilters is that all of the research conducted to date has been on roadside ditches or swales that were convenient for research, rather than swales specifically designed to be biofilters. Some research shows that biofilters do not work and others show them to be effective.

From research for the Washington Department of Transportation, Wang (1982) was able to develop a relationship between channel length and the removal of particulate pollutants. This relationship was subsequently used in a WSDOT manual (WSDOT, 1982). However, the WSDOT manual does not use the relationship to design biofilters; rather, it uses the relationship to estimate how much pollution one might expect a grass covered median strip or shoulder to remove.

Despite the limited nature of Wang's work, many jurisdictions and the Federal Highway Administration (FHA, 1984) propose 200 feet as the standard length. However, in Wang's work there was no information provided on the area draining to the particular channels being examined, and no information on slope, width, height or condition of grass, or the size of storms measured.

It is further proposed that the width of the channel be determined using Manning's Equation (Horner, 1988; King County, 1989). A key decision when using this equation is the selection of "n", Manning's coefficient of roughness. It has been proposed (Horner, 1988; King County, 1989) that design curves from Chow (1964) and others, apparently originally developed (but not cited by Chow) by Ree and Palmer (1949), be used to select a value for "n". These relationships are shown in Figure A.3 in this memo. Note that "n" varies with the condition of the grass (A through E) which is related to the depth and thickness of grass (this relationship is not shown). It has been proposed that Retardance C and D represent the conditions of developments. Thus, "n" will vary between 0.03 and about 0.15. Given the size of most developments, the value for "n" will typically be about 0.05 to 0.08.

There are several technical inconsistencies in using the above approach. First, the purpose of the Manning's Equation is to size a channel for carrying, not treating, water. All of the information shown in Figure A.3, and supporting data not shown here, is for water flowing through a channel in which the water depth is considerably greater than the grass height. Therefore, any "n" value selected using the above approach is likely to be too low; the channel therefore will be too narrow.

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For effective treatment we do not want the depth of the stormwater to exceed the grass height. Under these conditions, the hydraulic situation is much different. It is possible that Manning's Equation does not "work" under these conditions. Regardless, Barfield (1978) indicates that "n" varies with the water depth: from a value of about 0.05 when the water is very shallow relative to the grass height, to a value on the order of 0.25 to 0.50 when the water depth is at or just above the grass height. The value decreases as the depth of the water increases above the grass height.

Another source of relevant "n" values is the SCS Engineering Manual. For sheet flow (which is what we want in a vegetated biofilter) they use "n" values on the order of 0.15 (for short grass) to 0.40 for thick grass.

Another contradiction in the use of Manning's Equation to size the width of a "treatment swale", or biofilter, is slope. In Manning's Equation an increase in the slope allows the width to be decreased. This makes sense if the objective is to carry water; it does not make sense if the objective is treatment since a steeper slope allows the water to flow faster. However, with treatment, the important parameter is the time spent in the biofilter: the more time, the higher the pollutant removal, all else being equal. Therefore, rational design would increase, not decrease, the channel width if treatment is the objective.

Horner (1988) and King County (1989) handle the above inconsistencies by specifying a maximum allowable flow velocity through the swale during the design storm (Horner, personal communication).

Despite the above objections to the use of 200 feet and Manning's Equation, there is little else one can use. However, it does not make sense to require that an applicant do substantial calculations, some which are at cross purposes (eg. slope). We therefore present in this memo some calculations for varying conditions of slope and "n" values, from which a "rule-of-thumb" design criterion is selected.

Using the 6-month storm, "n" values of 0.30 and 0.40, slopes between 1 and 5%, and two cross-sections, various widths of the channel bottom were determined using Manning's Equation. The results are shown in Table A.6. Multiplying the channel width times 200 feet gives the "treatment area".

From the above analysis we propose a design criterion of 500 square feet of swale area per acre of area draining to the swale. For the rectangular cross-section, this area represents the length times the bottom width. For the trapezoidal cross-section, this area is the length times the width of flow at the design storm using a 3:1 side slope.

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TABLE A.1 STORMWATER DATA ON GENERAL LAND USES[a,b]

PARAMETER	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	FREEWAY
BOD	15 mg/l	75	ND	ND
Oil/grease	0.8-13 mg/l[c]	8 - 31[c]	10-20	27-44
TSS	200 ug/l	340	128	185
Arsenic	10 ug/l	ND	23	3
Cadmium	3 ug/l	5	5	0.6
Copper	41 ug/l	243	106	41
Lead	230 ug/l	381	247	862
Nickel	12 ug/l	ND	ND	ND
Zinc	123 ug/l	274	273	481

a. Mean value for several storms; ranges are mean values of several storms. Concentrations of individual samples commonly exceed means by half to one order of magnitude.
b. Data from Metro (1988) or Bellevue (1984) unless otherwise noted.
c. From Snenstrom (1984)

TABLE A.2 EFFLUENT OR RECEIVING CRITERIA OR STANDARDS

	FRESHWATER[a]		SALTWATER	
	CHRONIC	ACUTE	CHRONIC	ACUTE
BOD/SS[b]	30 mg/l and 85% removal for municipal plants			
Oil/grease[b]	10 mg/l average day; 15 mg/l daily maximum			
Arsenic	48 ug/l	360	36	69
Cadmium	0.32 ug/l	1.40	9.3	43
Copper	3.0 ug/l	3.9	2.9	2.9
Lead	0.41 ug/l	10.5	5.6	140
Nickel	28 ug/l	542	8.3	75
Zinc	47 ug/l	84	86	95

[a]For a water hardness of 20
[b]Effluent standards

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TABLE A.3 DATA ON SPECIFIC LAND USES

PARAMETER	DOMESTIC RECYCLER	METALS RECYCLER	STEAM CLEANR	METAL FABRICATR	BUS YARD	SHOPPING CENTER	MOTOR FREIGHT	TRUCK RENTAL	PETROLEUM STORAGE[e]	PETROLEUM PRODUCTS[f]	CEMENT
BOD	ND	ND	ND	ND	ND				12-220		pH>10
Oil/grease	5.7 mg/l	<5-11	ND	<5-10	10-20[b]	8-31[c]	<10[d]	24;1900	11-33		
TSS	ND	ND	ND	ND	ND				8-78		110-225[g]
Arsenic	<50 ug/l	120	<50	<2	<17				4		
Cadmium	3 ug/l	33	17	13	87			160		13	
Copper	114 ug/l	6440	94	4	320			5690		632	20
Lead	30 ug/l	5880	130	80	200			4980	110-200	1240	560
Nickel	10 ug/l	50	10	20	80			300		637	
Zinc	200 ug/l	70	410	1640	880			5780	190	2320	130

a. Grab samples unless otherwise indicated; all data from DOE or Metro files unless noted
b. Mean values for several storms, or of individual storms. Concentrations of individual samples commonly exceed means by half order of magnitude.
c. Senstrom (1984), means of seven storms
d. 8 of 12 grab samples. Other 4 were 15, 58, 1900, and 7900 mg/l
e. Effluent from oil/water separator
f. Emulsions for asphalt paving and roofing
g. Turbidity

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TABLE A.4 ANALYSIS OF STORM EVENTS[a]

STORM EVENT	PRECIP	NUMBER OF EVENTS	RAINFALL AMOUNT OF LARGER STORMS
1-month	0.65"	390	415"
6-month	1.30"	58	101"
1-year	1.60"	31	55"
2-year	2.00	9	23"

[a]SeaTac record 1950-1977

TABLE A.5 SOIL INFILTRATION SYSTEMS - RELATIONSHIP BETWEEN SOIL INFILTRATION RATE, POLLUTANT REMOVAL RATE AND INFILTRATION AREA (ft2 per 10,000 ft2 of catchment area)

POLLUTANT REMOVAL RATE			SOIL INFILTRATION RATE[c]		
PRETREAT[a]	INFILTRATE[b]	TOTAL	4"/HR	6"/HOUR	8"/HOUR
56%[a]	50%[b]	78%	100 ft2	70	60
56%	75%	89%	200	140	120
56%	90%	96%	350	240	200
56%	95%	98%	500	360	300

[a]Assuming that on average 70% of the pollutants is in the particulate fraction and that 80% of this fraction is removed by the pretreatment unit.
[b]The amount of stormwater infiltrated over the long-term assumed equivalent to the amount of pollutants removed by the soil.
[c]The infiltration rate measured in the field at the time of construction, taken to be four times the actual long-term infiltration rate. The area shown represents the area needed to accomodate the long-term infiltration rate.

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TABLE A.6 SIZING OF BIOFILTERS[a]

SHAPE	SLOPE	BOTTOM WIDTH	TOP WIDTH[b]	TOP AREA[c]
"n" = 0.30				
Rectangular	1%	2.94 ft	2.94 ft	588 sq ft
	2%	2.08	2.08	416
	5%	1.32	1.32	264
Trapezoid	1%	1.96	3.96	792
	2%	1.09	3.09	618
	5%	0.46	2.46	492
"n" = 0.40				
Rectangular	1%	3.93	3.93	786
	2%	2.78	2.78	556
	5%	1.76	1.76	352
Trapezoid	1%	2.94	4.94	988
	2%	1.79	3.79	758
	5%	0.77	2.77	554

[a]Assuming one acre of catchment and a design flow of 0.2 cfs
[b]Using side slopes of 3:1 and a water depth of 4 inches
[c]Using a length of 200 feet

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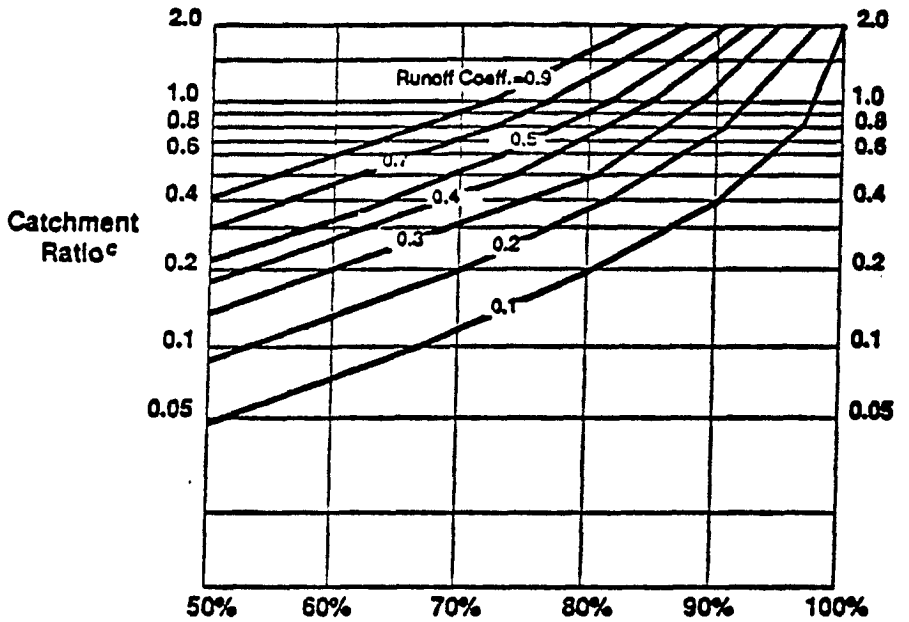
FIGURE 1.1

Predicted Removal of Suspended Solids in a Wet Pond as a Function of Runoff Cofficient[a] and Catchment Ratio[b]



a. Runoff coefficient - the fraction of rainfall that becomes runoff.
b. From Minton, 1987.
c. Catchment ratio is the ratio of the surface area of the pond to the surface area of the development expressed as a percentage.

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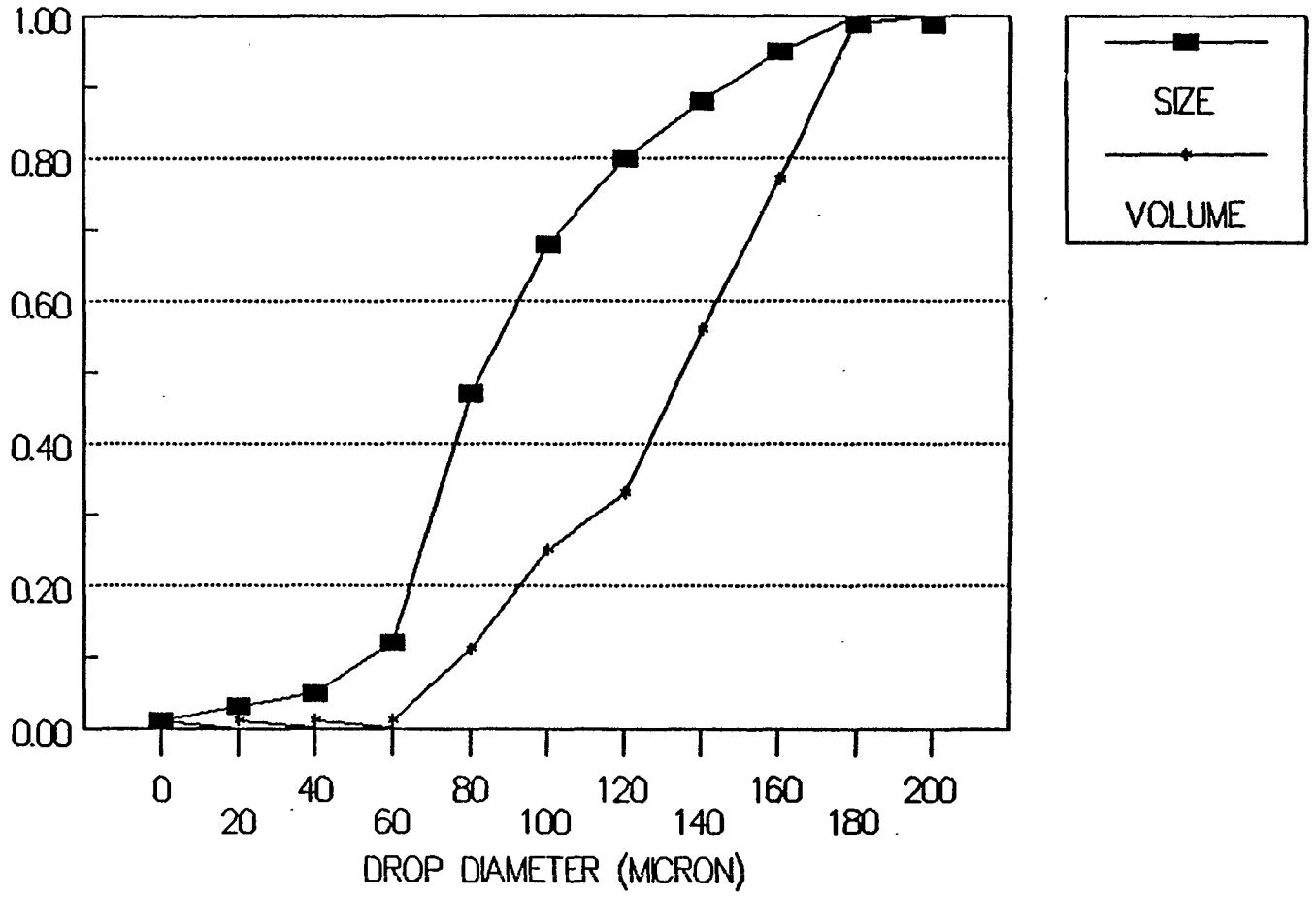
FIGURE 1.2 OIL FRACTIONS IN STORMWATER

size and volume distribution



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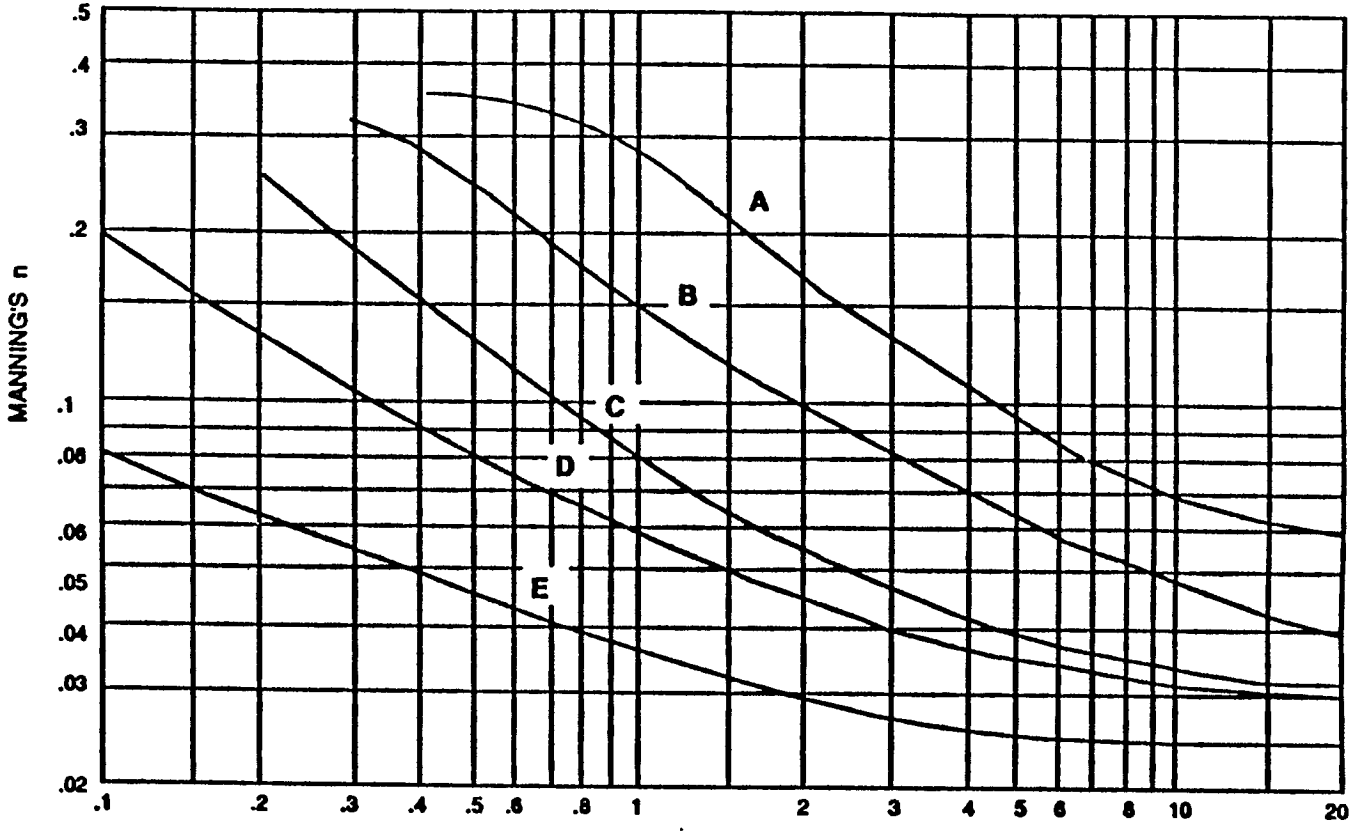

FIGURE 1.3 The Relationship of Manning's n with VR for Various Degrees of Flow Retardance (A-E) (from Livingston et al., 1984, after U.S. Soil Conservation Service, 1954).

R0059720

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CITY OF SEATTLE BEST MANAGEMENT PRACTICES MANUAL
LITERATURE REVIEW

FORMAT

Attached is a table that summarizes the literature found to be both pertinent and available. The information is presented in a format that allows rapid identification of key items in each article.

The first category, **Pollutant Loading Data**, notes three types of data: total, soluble and particle size/settling velocities. Soluble data is of interest because of the concern for the ability of several stormwater treatment methods to remove this fraction of the pollutant. Particle size and settling velocity data is important because it allows a rational design of those treatment methods that rely primarily on settling of particulates.

As there is relatively little stormwater data from specific (for example, shopping center), the **Land Use** category makes a distinction.

The third category, **BMPs**, identifies which BMPs are discussed or examined in the particular article.

The final category, **Other**, is a catch-all.

MOST SIGNIFICANT PUBLICATIONS

Within the long list of publications there are a few that are of most value to professionals involved with stormwater quality control. The manual authored by Tom Schueler of the Metropolitan Washington Council of Governments is the most complete. The State of Florida has also produced a very complete manual. However, caution must be exercised in using the design criteria from these manuals as they are for climatic conditions which are considerable different than western Washington. Other publications (Harrington, 1987; USFHWA, 1986; Maryland, 1983; New Jersey, 1986) are either precursors of Schueler's manual or lift their criteria from his manual.

The most complete and relevant data on stormwater quality are found in Pitt (1984), Galvin (1982), and Prych (1986), and other publications by the Municipality of Metro Seattle.

R0059721

PUBLICATIONS

Manuals	Pollutant Loading Data			Land Use	
	Total	Dissolved	Part. Sz/Settling Vel.	Gen.	Specif
AGCW, 1988. "Waste Disposal and Erosion/Sediment Control Methods", Association of General Contractors Water Quality Manual, 39 pp.				✔	
Austin, City of, 1988, "Environmental Criterial Manual".					✔
Davis, H., 1988. "Columbia South Shore Hazardous Materials Containment Facilities, Design Handbook, Portland Environmental Services.	✔	✔			✔
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Miller, S.A., 1983, "Critical Materials Handbook", Spokane County Public Works.				✔	
Minnesota Pollution Control Agency. 1988. Urban best management practices. Draft. Chapters 1-5. Minnesota Pollution Control Agency, Division of Water Quality. February, 1988.	✔	✔		✔	✔
Schueler, T.R., 1987, "Controlling Urban Runoff - A Practical Manual for Planning and Designing Urban BMPs". Metropolitan Washington Council of Governments.	✔	✔		✔	
State of Florida. 1988. The Florida development manual: A guide to sound land and water management. State of Florida, Department of Environmental Regulation. June, 1988.	✔	✔		✔	
State of Georgia. 1979. On-site erosion control. Management practices for construction activities. State Soil and Water Conservation Committee. November, 1979.				✔	
State of New Jersey. 1986. A guide to stormwater management practices in New Jersey. Division of Water Resources, Department of Environmental Protection. March, 1986.				✔	
USFHWA. 1986, "Retention, Detention, and Overland Flow for Pollutant Removal from Highway Stormwater Runoff", draft.	✔	✔	✔	✔	

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KEY WORDS

Use	BMPs						Other			
pecific	Sweeping	Source Ctrl.	Oil/H_2O Sep.	Det./Ret.	Infilt.	Biofilters/Swales	O & M	Design Specs	Rem. Effcy.	Cost
				✔	✔	✔	✔	✔		
✔				✔			✔	✔	✔	
✔				✔		✔	✔	✔		
				✔	✔		✔	✔		
				✔	✔	✔		✔		
								✔	✔	
					✔	✔	✔	✔	✔	
		✔		✔				✔		
✔			✔	✔	✔	✔	✔	✔		
					✔	✔	✔	✔	✔	
	✔	✔	✔	✔	✔	✔	✔	✔	✔	
				✔		✔		✔		
				✔	✔		✔	✔		
	✔	✔		✔	✔	✔	✔	✔	✔	

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PUBLICATIONS

Articles & Reports	Pollutant Loading Data			Land Use	
	Total	Dissolved	Part. Sz/Settling Vel.	Gen.	Specifi
Barfield, B.J., Hayes, J.C., 1980, "Modeling Sediment Filtration by Vegetative Filters", in Symposium on Watershed Management 1980, ASCE.	✔		✔	✔	
California State, 1980, "Infiltration Drainage of Highway Surface Water", Report No., FHWA/Ca/TL-80-04.				✔	
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Harper, H.H., Yousef, Y..A., Wanielista, M.,P, undated, "Effectiveness of Detention/Retention Basins for Removal of Heavy Metals in Highway Runoff", unpublished.	✔	✔			✔
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KEY WORDS

Use	BMPs						Other			
ecific	Sweeping	Source Ctrl.	Oil/H_2O Sep.	Det./Ret.	Infilt.	Biofilters/Swales	O & M	Design Specs	Rem. Effcy.	Costs
					✔	✔		✔	✔	
					✔			✔		
				✔		✔	✔	✔	✔	
					✔			✔		
✔					✔				✔	
✔						✔			✔	
✔				✔		✔			✔	
			✔	✔			✔	✔	✔	
						✔	✔	✔	✔	✔
✔		✔	✔	✔			✔			
✔					✔			✔		
✔						✔			✔	✔

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PUBLICATIONS

Articles & Reports	Pollutant Loading Data			Land Use	
	Total	Dissolved	Part. Sz/Settling Vel.	Gen.	Specifi
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KEY WORDS

se cific	BMPs						Other			
	Sweeping	Source Ctrl.	Oil/H_2O Sep.	Det./Ret.	Infilt.	Biofilters/Swales	O & M	Design Specs	Rem. Effcy.	Costs
✔				✔	✔	✔	✔	✔	✔	✔
				✔		✔			✔	
			✔						✔	
✔			✔	✔					✔	
✔				✔					✔	
✔						✔			✔	
				✔	✔		✔	✔		
✔	✔			✔			✔		✔	
✔	✔			✔						
				✔		✔			✔	
				✔						
	✔								✔	
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						✔		✔	✔	
						✔		✔	✔	

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PUBLICATIONS

Articles & Reports	Pollutant Loading Data			Land Use	
	Total	Dissolved	Part. Sz/Settling Vel.	Gen.	Specif
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KEY WORDS

l Use	BMPs						Other			
pecific	Sweeping	Source Ctrl.	Oil/H_2O Sep.	Det./Ret.	Infilt.	Biofilters/Swales	O & M	Design Specs	Rem. Effcy.	Cost
				✔				✔	✔	
✔										
✔				✔	✔				✔	✔
✔				✔					✔	
✔				✔					✔	

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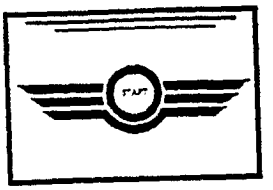

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STORM WATER RUNOFF MANAGEMENT LITERATURE REVIEW

Prepared for the
Environmental Division
California Department of Transportation
March 1996

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STORM WATER MANAGEMENT LITERATURE REVIEW

PART I DOCUMENTS REVIEWED.

Documents reviewed for this project were brought to our attention and obtained from a number of different sources. These sources include:

1. URS Literature Search
2. A Review and Evaluation of Literature Pertaining to the Quantity and Control of Pollution from Highway Runoff and Construction; Barrett et al; Center for Transportation Research, University of Texas at Austin; Research Report 1943-1, Apr. 1993.
3. Highway Runoff Water Quality Synthesis - Literature Search, GKY, June 1994
4. Current papers submitted to TRB meeting January 1996
5. Other published literature
6. Documents for NPDES permits, received from other states
7. Caltrans District Documents for NPDES permits
8. Local agency and consultant produced documents for NPDES permits.

Significant documents are listed below (alphabetically by italicized words) together with a brief review of relevant content. Part 2 of this document summarizes findings by subject matter.

Alameda County, Annual Monitoring Report, Woodward Clyde, Sept. 1995

Alameda County conducted monitoring between 1988 and 1991 to characterize storm water runoff discharges in the county and to estimate pollutant loads to San Francisco Bay. The annual monitoring has continued since then with annual objectives. Objectives for the 1993-94 year included keeping a long term data base for major streams, evaluating compliance with water quality objectives and the potential for toxic runoff, and comparing historical water quality to new EPA guidance.

The conclusions in this report include:

- Previous work likely overestimated the impact of metals on the streams in Alameda County
- Metals should continue to be de-emphasized as a cause of toxicity to aquatic life during storm events in Alameda County
- Storm event monitoring emphasis should continue to be placed on toxicity due to other compounds (organic pesticides, sediments) and other harmful processes and effects (eutrophication, sedimentation).
- Dry weather watershed-based monitoring should emphasize the process controlling the fate of sediment bound pollutants in the streams and bay to determine to what extent they may be impacting the ecosystem.
- Approximately 30 to 50% of the lead and zinc in storm water could be removed if adequate detention basins were constructed. Use of vegetated swales or channels is recommended because better treatment is often achieved through their use.
- Estimation of the fraction of metals that are deposited before reaching the Bay is difficult and, if the settled material is not removed by dredging, metals deposited in sediment may be released back into the stream if significant flow occurs in dry weather or if sediment becomes re-

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suspended in subsequent storms. Review of dredging records is recommended for estimation of the fraction of metal loads removed.

This is a very comprehensive report and the conclusions listed here do not cover the full scope of the findings.

Alameda County, Monitoring Plan for Grassed Swales, AVDO Facility, Newark, Woodward Clyde, Dec. 1995

This study which is scheduled to take place during this rainy season (1995-96) will determine the percentage reduction in EMC, and percentage reduction of total load from each storm, for TSS, total and dissolved metals (Copper, Lead, and Zinc) , and TOC. Another objective of the study is to determine the relationship between swale contact time and pollution removal. Monitoring for this study will be conducted at 6 grassed swale (five of these are described as turfed) surrounding the AVDO facility. Runoff comes from rooftops, parking lots, and open space. Data from the literature, presented in this report, show grassed swales to be quite effective, removing, for example, 59% to 98% of the TSS and 15 to 94% of the total lead load. None of the data found in the literature came from California.

Barrett et al., A Review and Evaluation of Literature Pertaining to the Quantity and Control of Pollution from Highway Runoff and Construction; Center for Transportation Research; University of Texas at Austin; Research Report 1943-1, April 1993.

The executive summary of the Texas literature review notes that, according to the literature and studies, factors affecting the loading in runoff include:

- Rain itself (contributing up to 48% of suspended solids in runoff)
- Dustfall
- Traffic volume DURING THE EVENT (ADT shows less clear relationship) Traffic volume may be more significant during low intensity storms. This is due to dust washing off vehicles and vehicles contributing to the removal process. Traffic volume during the event should be added to the list of data to be recorded during the storm being sampled for characterization of runoff. The information could be estimated from ADT and start and end time of the storm.
- Removal processes such as air turbulence and storm intensity

They also note that:

- Large storms result in lower concentrations and long storms result in greater total loading.
- Higher concentrations are found in "first flush" particularly for dissolved components. (particle associated pollutants show more complex temporal variation)
- Surface type (asphalt or pcc) is relatively unimportant.
- Type of collection and conveyance system is important
- Site specific factors are very influential.

This report is a major review of quantity and control of pollution from highway runoff and construction. The report is organized into five major section: 1) Sources of pollutants, 2) Factors affecting highway runoff, 3) Environmental effects on receiving waters, 4) Highway construction, and 5) Controlling pollution from highway runoff.

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The major sources of pollutants in highway storm runoff are:

- Vehicles
  Metals, COD, oil and grease, nitrate, sulfate, and phosphorus are contributed by vehicles either directly or indirectly. Direct contributions result from vehicle emission, leakage and friction. Indirectly, vehicles move particles from one area and deposit them into another. Vehicles contribute less than 5% of the particles on a given highway.

- Dustfall and Precipitation
  Dustfall and precipitation contribute particulates and ionic contaminants. The deposition of particulates can occur during precipitation or dry weather. It has been estimated that precipitation contribute 78% of the ionic contaminants and up to 48% of the suspended solids in highway runoff. Table 1.1, shows a summary of loadings of total dustfall on highway surfaces for winter and non-winter periods.

Table 1.1. Summary of Dustfall Loading (Gupta et al. 1981)

Site	1976		1977		1976 & 1977	
	Nonwinter	Winter	Nonwinter	Winter	Nonwinter	
	g/m²/day		g/m²/day		g/m²/event	
	Average	Average	Average	Average	Average	Range
Milwaukee- HW 794	0.30	0.87	0.56	0.15	3.8	.2 - 9.2
Milwaukee- HW 45	0.21	0.11	0.31	0.13	3.2	.4 - 9.2
Harrisburg	0.13	0.07	0.06	0.07	1.9	.2 - 8.2
Nashville	0.30	NS	0.90	1.43	3.7	.1 - 6.5
Denver	0.37	NS	0.32	0.34	2.4	.2 - 7.3

NS = No sample was collected.

The contaminant level in the dustfall is influenced by the land use of the surrounding area. Gupta et al. (1981) reported higher levels of pollutants in dustfall in urban areas compared to dustfall in rural areas.

- Other Sources
  Other sources of contaminants include spills, use of fertilizers and herbicides, and maintenance activities (e.g., deicing and sanding).

The factors that affect highway runoff quality depends on the removal mechanisms of deposited pollutants on the highway. The removal mechanisms include natural and vehicle-created wind action, runoff, resuspension and removal by vehicles. The wind removal mechanism is more prominent in low-precipitation areas. It was demonstrated that pollutants are carried away from the highway surface. In general, removal mechanisms are affected by traffic volume, precipitation characteristics, highway surface type, and site-specific characteristics.

- Traffic Volume:

Average daily traffic (ADT) and vehicles during storm (VDS) are two measures of traffic volumes. In general no significant correlation was observed between traffic volume and pollutant concentration in the runoff. Specifically, no significant correlation was found between ADT and total suspended solids (TSS), nitrogen, and phosphorus. There was some correlation between ADT and the concentration of lead and zinc. ADT was strongly correlated to COD. Driscoll et al. (1990) showed that the correlation between ADT and pollutant concentrations is weak in areas with high traffic volumes. The data shown in Table 1.2 contrast urban highways versus rural

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highways. ADT is not a useful measure to compare sites, but it is useful to broadly categorize highways.

Table 1.2. Runoff Median Concentrations (mg/L) as a Function of Traffic Volume (Driscoll et al., 1990).

Pollutant	Urban Highways ADT >30,000	Rural Highways ADT < 30,000
Total suspended solids	142	41
Volatile suspended solids	39	12
Total organic carbon	25	8
Chemical oxygen demand	114	49
Nitrate and nitrite	0.76	0.46
Total Kjeldhal nitrogen	1.83	0.87
Phosphate	0.4	0.16
Copper	0.054	0.022
Lead	0.4	0.08
Zinc	0.329	0.08

Traffic volume measured as vehicles during storm (VDS), have been shown to be a significant factor in determining pollutant loadings. Kerri et al. (Kerri et al., 1985, Forecasting Pollutant Loads from Highway Runoff, Transportation Research Record, 1017, pp. 39–46) have found that VDS is a better predictor of loads of lead, zinc, COD, TKN, and filterable residue than ADT or antecedent dry days.

- Precipitation Characteristics:
  The three precipitation characteristics that influences the quality of highway runoff are number of dry days before the event, intensity, and duration. The significance of the influence of antecedent dry period (ADP) on runoff quality is mixed. The results indicate that ADP plays a more significant role when ADP is short. That is, the longer the ADP the more likely that other removal mechanisms reduce the accumulated pollutant on highways.

  The intensity of storm influences the particle size that can be removed and hence the contaminants associated with that fraction are also removed. For low intensity storms, smaller particles are removed therefore the concentration of zinc for example would be higher than lead. For higher intensity storms, the concentration of lead increases because lead typically is associated with larger particle soil (> 45 microns). Metals are adsorbed on particulate matter and removed from highways with particulates. Strong correlation was reported between total solids and metal concentrations. Lead and copper were also reported to be associated with larger particle sizes (> 45 microns).

- Highway Surface Type:
  In general runoff is not influenced by the type of surface of the highway. The runoff quality is much more influenced by the land use of the area surrounding the highway segment.

- Other Factors:
  Other site specific factors that influences the quality of the storm runoff include: seasonal variation (precipitation, wind, traffic, and construction activities), use of salt or sand for deicing, use of studded tires, proximity to facility, and air quality.

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The impact of highway runoff on receiving waters is a site-specific problem. The impact depends on the type of receiving body, the size of the receiving water, drainage area, and biological diversity of the receiving water. Lang (Lang, 1990, The design and construction of treatment processes for highway runoff in the FRG, The Science of the Total Environment, Vol. 93, pp. 499-506) indicated that the highway runoff is a problem for watercourses with catchment areas less than 5 km^2 (2 mi^2), and can be neglected for watercourses with catchment areas more 20 km^2 (7.8 mi^2). The report reviews several studies which were conducted to evaluate the impact of highway runoff on receiving waters and the results are mixed. The following is a summary of some of the findings:

- A study compared water columns in a runoff pond and a relatively undeveloped lake in Florida. The results indicated about three times higher lead concentration in pond water compared to lake water. Zinc concentration was comparable. However, the concentrations of heavy metals in the pond sediment 1.7 to 22 times higher than concentrations in the lake sediment. The same results were found in other studies.
- A study investigated the effect of highway runoff from several highways with ADT ranging from 12,000 to 120,000. The study indicated that lead was the only parameter that affected the water at influenced stations compared to a control station. Toxicity studies indicated that the runoff from highways has no adverse effects on the biota of receiving waters.
- In another study, toxicity of highway runoff with dilution water indicated that it required 100 to 1 dilution water to runoff water for biota protection. A ratio of 4 to 1 was found to be needed to avoid oxygen depletion.
- Concentrations of lead, zinc, nickel and cadmium in the water column from streams near highways with traffic around 15000 ATD were comparable to concentration in uncontaminated waters. The concentrations in biota and fish (dry weight basis) were comparable to literature values reported for contaminated waters.

Highway construction impact on receiving waters is well documented in the literature. Sediments are among the problems that are associated with highway construction. As mentioned earlier heavy metals and organic chemicals are associated with particulate matter and hence movement of sediments represents a mechanism for movement of pollutants and eventually redistribution in environmental media. Mitigation measures to control movement of sediments include various mulches, blankets, chemical products, and other measures. The discussion of highway construction is not relevant at this moment, however, it may be revisited as the need develops if construction activities are included in the state-wide permit.

The discussion of the control of pollution from highway runoff in this summary will be limited to structural controls. These controls include:

- Detention ponds,
  Dry ponds,
  Extended dry ponds, and
  Wet ponds

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- Infiltration facilities,
  - Infiltration trenches and basins
  - Porous pavement,
  - Vegetative filter strip,
  - Grassed swales, and
  - Wetlands.

Table 1.3 shows a summary of performance of these structural controls. Pollutants associated with highway runoff moves with particulate matter that is transported by the storm runoff. Therefore, control of removal of suspended matter is very effective in controlling the contaminants in highway runoff.

Barrett et al, Water Quality Impacts of Highway Construction and Operation Texas, TR News 179, July-August 1995.

This paper describes a study of water quality and quantity of highway runoff and the effects of highway construction and operation on the quality of receiving waters in the Barton Springs segment of the Edwards aquifer recharge zone. The study was ordered under a court settlement of litigation involving Texas DOT and the Federal Highway Administration. During construction field sampling of creeks was undertaken. Downstream of the construction site and in the final stages of construction, total suspended solids were observed to be 10 times greater than before construction began. As part of this study silt fences were monitored for their effectiveness in sediment removal. They were not found to be very effective, probably because larger particles had already settled out and the remaining particles were smaller than the effective openings in the fabrics. They were also found to be subject to failure due to improper installation and maintenance.

To evaluate the potential effects of storm water runoff highway sites at three locations were equipped with automatic sampling devices. The sites differed in traffic count, amount of impervious cover, and drainage systems. The data indicated that the type of drainage system is more important than the traffic volume in predicting pollutant concentrations.

A large scale experiment using sprinklers to simulate rainfall was also conducted with the objective of developing a computer model to predict the quality of highway runoff, The Average Daily Traffic at the site was approximately 60,000. Vehicle counts were recorded during each simulation. Samples were collected during 32 synthetic rainstorms with traffic and three without traffic. The data showed that most of the variation observed in highway storm water loading could be explained by causal variable measured during the storm, the preceding dry period, and the previous storm. Dustfall during the preceding dry period, maintenance of pavements and rights-of-way, and the intensity of the runoff during the preceding storm were found to have a greater influence on the solids loadings from highways than the input of solids from vehicles and rainfall during the storm itself.

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Table 1.3. Pollutant Removal Comparison for Various Urban BMP designs (Dunn et al., 1995)

BMP/Design		Pollutant Removal Efficiency (%)							Comments
		Suspended sediments	Total Phosphorus	Total Nitrogen	Oxygen Demand	Trace Metals	Bacteria	Overall Removal Capability	
Extended detention pond									
	Design 1	60 - 80	20 - 40	20 - 40	20 - 40	40 - 60	Unknown	Moderate	
	Design 2	80 - 100	60 - 80	40 - 60	40 - 60	60 - 80	Unknown	High	
Wet pond									
	Design 3	60 - 80	40 - 60	20 - 40	20 - 40	20 - 40	Unknown	Moderate	
	Design 4	80 - 100	60 - 80	40 - 60	40 - 60	60 - 80	Unknown	High	
Infiltration trench									
	Design 5	60 - 80	40 - 60	40 - 60	60 - 80	60 - 80	60 - 80	Moderate	
	Design 6	80 - 100	60 - 80	60 - 80	80 - 100	80 - 100	80 - 100	High	
Infiltration basin									
	Design 5	60 - 80	40 - 60	40 - 60	60 - 80	40 - 60	60 - 80	Moderate	
	Design 6	80 - 100	60 - 80	60 - 80	80 - 100	80 - 100	80 - 100	High	
Porous pavement									
	Design 5	40 - 60	60 - 80	40 - 60	60 - 80	40 - 60	60 - 80	Moderate	
	Design 7	80 - 100	60 - 80	60 - 80	80 - 100	80 - 100	80 - 100	High	
Filter strip									
	Design 8	20 - 40	0 - 20	0 - 20	0 - 20	20 - 40	Unknown	Low	
	Design 9	80 - 100	40 - 60	40 - 60	40 - 60	80 - 100	Unknown	Moderate	
Grassed swale									
	Design 10	0 - 20	0 - 20	0 - 20	0 - 20	0 - 20	Unknown	Low	
	Design 11	20 - 40	20 - 40	20 - 40	20 - 40	0 - 20	Unknown	Low	
Sand filter									
	Design 12	85	40	35	Unknown	50 - 70	40	Moderate	
	Design 13	90	70	50	90	80	90	High	
Biofiltration swale		83	29	Unknown	Unknown	46 - 72	--	Moderate	

Design 1: First-flush runoff volume detained for 6-12 h. Design 2: Runoff volume produced by 25 mm (1.0 in) storm, detained 24 h, but with shallow marsh in bottom stage. Design 3: Permanent pool equal to 13 mm (0.5 in) storage per impervious acre. Design 4: Permanent pool equal to 4.0 (Vr), approximately 2 weeks retention. Design 5: Facility exfiltrates first-flush; 13 mm (0.5 in) runoff/impervious acre. Design 6: Facility exfiltrates all runoff, up to the 2-year design storm. Design 7: 11 m^3 (400 ft^3) wet storage per impervious acre. Design 8: 6-m (20-ft) wide turf strip. Design 9: 30-m (100-ft) wide forested strip, with level spreader. Design 10: High-slope swale with no check dams. Design 11: Low-gradient swales with check dams. Design 12: Non-peat (Austin-Texas) sand filters. Design 13: Peat-sand filters.

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Runoff control structures were built into new highways in the Austin area. The control systems consisted of a 10,000 gallon (38 cu. m.) hazardous material trap for accidental spills, and a sedimentation basin designed to capture the first 1.3 centimeters (0.5 inches) of runoff, and a sand filter. The runoff control systems cost $200,000 each accounting for 20% of the overall cost of highway construction. The systems have not performed well due to washing out of the sand filters in some cases and rapid clogging of the sand filters in other cases. Experimentation with different materials for filters showed that compost is a very effective medium out-performing other materials for removal of TSS, oil an grease, and metals. A medium grained sand filter also performed well. Studies are underway to establish a design basis and configuration for runoff control systems.

California Department of Transportation District 4; Oil and Grease and Suspended Solids in Highway Storm Water Runoff; *Dragomir Bordanic*; May 1995

This report focuses on a segment of I-680 where the Caltrans' drainage system connects into the drainage system of Rhone-Poulenc Basic Chemicals Company (RPBC). The runoff from I-680 enters RPBC drainage system via two conduits. One is a culvert and concrete V ditch and the other is a vegetated ditch and concrete V ditch. Three sampling points were selected. One was at the junction of the vegetated ditch and the concrete V ditch, another was at the drain inlet of the piped system and the third was at the junction of the piped system and the other concrete V ditch.. Grab samples were analyzed for total suspended solids and for oil and grease. Total suspended solids ranged from <4 to 94 mg/l and oil and grease concentrations were consistently below the detection limit of 5 mg/l. This study was undertaken because of high concentrations of oil and grease (701.2 mg/l) at an outfall of RPBC's drainage system. RPBC suggested that Caltrans might be responsible for the high concentrations.

The District 4 report states "it has been documented that average concentrations of oil and grease in highway storm water runoff, from highways with high traffic volumes range from 4 to 10 mg/l", and "average concentrations of TSS ranges between 1 and 80 mg/l". No reference is provided. The range for oil and grease is compatible with data we have seen but the range given for TSS is very low and is not supported by other data presented in this report (see Colorado DOT and Driscoll et al.).

California Department of Transportation District 7 Storm Water Management Plan May 1995

This report submitted to the Los Angeles Regional Water Quality Control Board, responded to the permit requirement that each co-permittee inventory sources of pollution and discharge, document existing storm water management practices and Best Management Practices (BMPs) and then initiate a plan with a schedule for early action BMPs. The report focuses on defining Good Management Practices and their implementation. The report also defines the direction and implementation schedule for a comprehensive storm water program for District 7. This SWMP is a good action plan indicating what will be done and how and when it will be implemented through training programs.

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Two guidance documents are available for preparation of a Storm Water Management Plan (SWMP). They are:

- Municipal Handbook; March 1993 , and
- State Water Resources Control Board and Regional Control Boards; Municipal Storm Water Management Plan Components - Draft Sept. 8 1994

The District 7 SWMP does not comply with the guidance provided in the Municipal Handbook which outlines six steps in the plan. The six steps are: Set goals; Assess existing conditions; Set priorities; Select near term BMPs; Implement near-term program; assess program effectiveness. a noticeable omission is Step 1 requiring the setting of goals and objectives for the plan. Other steps in the plan are more fully described in the second guidance document listed above and the District 7 SWMP's coverage of those steps is outlined below.

This SWMP differs from the SWRCB guide for Municipal Storm Water Plan Components in that it does not include characterization of the storm water drainage system, does not address the initial determination of pollutant loading, does not provide methodologies and performance standards for evaluation of effectiveness of activities (no measures of effectiveness are given for the pollution control benefit criteria used in the evaluation of effectiveness of GMPs); does not include design standards for new development (these standards are presumably provided elsewhere).

Another deficiency in the plan is that it does not address the questions of cost effectiveness and prioritization of efforts. These are essential components of any plan intended to produce change and prioritization is emphasized in the Municipal Handbook (Chapter 2 - How to develop a Storm Water Management Plan). The Handbook suggests that priorities should be based on what is known about the storm water quality problem and acknowledges that obtaining a firm scientific reading on the nature of the runoff quality problem is difficult and costly. Therefore the Handbook suggests that a "ballpark" assessment of existing conditions should be used to move the program forward.

The District 7 management plan is presented as if the effectiveness of management practices in well known and as if implementation of the Good Management Practices identified for adoption will achieve the desired results. Effectiveness is thus interpreted as effectiveness of implementation. The plan seems to be to implement the GMPs system wide and there is no recognition of greater or lesser need for improvement in run off quality at specific locations due to receiving water sensitivity, quantity of runoff, or quality of runoff

California Department of Transportation Districts 8 and 12 Storm Water Management Plan for Freeways and Highways Jan. 1995

This SWMP was prepared for the Santa Ana Regional Water Quality Control Board. Three objectives are identified for the plan. They are:

- Identify pollutant sources that may affect quality of storm water discharges associated with the operation and maintenance of Caltrans' freeways and highways.
- Identify Best Management Practices to reduce pollutants to the maximum extent practicable, in the storm water discharges from freeways and highways, and
- Provide direction to Caltrans Operations/Maintenance supervisors to implement measures to reduce impacts to receiving waters.

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The report includes a listing of Caltrans' freeways and highways in the Santa Ana region (the number of lanes and ADT are not included). In the appendix to the report all legal connections to Caltrans' storm drain facilities are identified, based on records of encroachment permits. There are about 250 connections including some as large as 66 inches in diameter. Drainage outlets, 36 inches or larger, are also listed. There are 138 such outlets in District 8 and 122 in District 12. Monitoring results from two sites, for a storm occurring in March 1994, are included in the report. The ADT at the sites is not reported but one location was on I-5 and the other on SR-55. The latter presumably has a lower ADT however the concentrations were not consistently lower at this site.

The SWMP identifies current practices emphasizing source controls for existing facilities and structural BMPs for possible use in new projects. Source control BMPs adopted for use by Districts 8 and 12 include:

Safer alternative products,	Vegetation controls,
Street cleaning,	Storm water inlet (catch basin) cleaning,
Culvert inspection,	Storm drain flushing and disposal of flushed material,
Roadway maintenance practices,	Storm channel/creek maintenance,

Illegal or illicit connection/discharge control.

Each BMP is described. A separate set of BMPs for highway maintenance stations are described in the report. The report does not address effectiveness of BMPs, methodologies for evaluating the effectiveness of the BMPs and the management program, and approaches to prioritization

California Regional Water Quality Control Board, Central Valley Region; A Compilation of Water Quality Goals; Staff Report May 1993

Water quality goals include water quality standards set by the Water Quality Control Plans and water quality objectives that are "limits, or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area". Water quality objectives are also found in the Water Quality Control Plans and may be in numerical or narrative form. There are several different types of numerical water quality limits for ground and surface waters. This document provides a uniform method and a convenient source of numerical limits for determining compliance with California's water quality standards. The numerical limits apply to the receiving water but the SWRCB adopts enforceable policies for water quality control and regulations to protect water quality from discharges of waste to water or to land where water quality could be affected.

California Storm Water Quality Task Force; Best Management Practices Handbook; (3 Volumes: Municipal, Commercial/Industrial/Construction) 1993

Chapter 2 of this handbook is titled "How to Develop a Storm Water management Plan". The outline for the SWMP is presented in 6 steps: Set goals; Assess existing conditions; Set priorities; Select near term BMPs; Implement near-term program; assess program effectiveness.

Assessment of existing conditions includes identification of pollutant sources, watershed characteristics, community character, and existing programs. Watershed characteristics include drainage system characteristics (page 2-7). It is recognized that obtaining a definitive answer to

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the question "what is the storm water quality problem" is difficult and costly. A broad brush assessment of existing conditions based on available data is therefore recommended.

The main purpose of assessment of existing conditions is to provide a basis for prioritization of effort in step 3. Prioritization questions are suggested (pg. 2-9) including: where are the worst problems, what are the easiest solutions, can I show that it works, can I learn something new, what has been successful for someone else. From prioritization a set of near term BMPs are selected (here the question of what can be afforded is important), and the last step is evaluation of effectiveness (monitoring water quality and non water quality indicators) for future planning. The Municipal Handbook suggests that assessment of the effectiveness of the SWMP in reducing pollutants should focus on small watersheds where one or more BMPs have been targeted. Sacramento County is following this approach.

Clark County Regional Flood Control District, 48 Month Annual Report for Las Vegas Valley NPDES Storm Water Discharge Permit, Dec. 1994

Nevada DOT is a co-permittee with Clark County, cities of Las Vegas, North Las Vegas, and Henderson; and Clark County Flood Control District in an NPDES permit issued in December 1990 by the Nevada Division of Environmental Protection.

This report contains results of monitoring in the Las Vegas Creek and other channels at outfalls to the Las Vegas Wash. Both dry weather and wet weather monitoring results are presented. Wet weather flows were found to contribute significantly higher loads of suspended solids, surfactants, BOD/COD, lead and phosphorous than dry weather flows. On the other hand dry weather flows contributed significantly higher loads of dissolved solids, oil and grease, nitrogen, and boron. Bacteria were identified as the primary pollutant of concern and the source of bacteria was identified as animal fecal matter. Total dissolved solids in dry weather flows and total suspended solids and sediment in wet weather flows are also of concern. Results have been consistent over the past three years of monitoring. Monitoring is scheduled to continue, possibly with a more limited set of constituents, eliminating those never or rarely found in amounts exceeding the detection limits (primarily some of the heavy metals).

This report also addresses progress in implementing the adopted BMPs which are:

catch basin maintenance,	storm drain maintenance,
street sweeping,	illegal/illicit connection elimination,
hazardous material elimination,	hazardous material disposal,
local ordinances,	regional storm water committee,
litter control,	standard plans and specifications,
storm water monitoring, and	public education.

Progress in implementation of adopted BMPs is assessed as excellent.

Detention basins were not identified as a BMP but they are used for flood control and are expected to have water quality benefits by allowing sediment to settle. The report states "modifications to the outlet works could be made to extend the detention time and improve pollutant removal efficiency, if warranted by storm water monitoring data". Air quality control measures for PM10 are also cited in the report as having benefits to storm water quality because airborne particles deposited on urban surfaces and on vehicles contribute to the pollutants in runoff.

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Regarding effectiveness of BMPs the report states "Overall effectiveness of BMPs, based on monitoring results and qualitative factors, is considered high". However this is based on the assessment that current practice has been effective in minimizing most urban runoff quality problems and not on trends in monitoring data over time as new BMPs are introduced. The report concludes that there is insufficient justification for the adoption of additional BMPs at this time.

Collins, Patrick S.; Financing the Future of Storm Water, Civil Engineering; March 1996

This paper reports on the establishment of a Storm Water Environmental Utility (SEU) for Sarasota County, Florida, in 1989. The SEU is responsible for developing and managing a basin master planning program. revenue is placed in trust funds and can only be used for the storm water management program. An advisory committee determines the countywide priority list for watershed planning efforts in a five year plan and recommends improvement alternatives to the County Board of Commissioners. The SEU also administers two interagency agreements..One is with the City and the other is with the five jurisdictions involved in a joint application for the NPDES permit. Florida Department of Transportation is one of these five jurisdictions.

The paper reports that 350 municipalities in the country have established storm water utilities. Sarasota County SEU is one of only a few charging property owners fees that vary depending on the problems of the watershed in which they are situated. The five year storm water capital improvement program for 1996 to 2000 is estimated at almost $40 million.

It is also reported that EPA is considering using the Sarasota SEU permit as a model throughout the country because it sets out "clear, precise milestones that allow EPA and the co-applicant to assess permit effectiveness and compliance".

Colorado DOT; Characterization Data: Dec. 1993

This report presents the results of monitoring at one site in Denver during one season. Three storm events were monitored. The results were compared with monitoring at one (different) site in Denver during the FHWA study. Means and maximums for some key constituents were:

	Colorado DOT site		FHWA site	
	Mean	Max.	Mean	Max.
TSS	1419 mg/l	2910 mg/l	469 mg/l	1185 mg/l
Copper	0.049	0.075	0.145	0.260
Lead	0.128	0.260	0.810	1.700
Zinc	0.470	0.690	0.748	1.500

The high average for TSS in the 1993 CDOT data was largely due to the maximum value which was recorded for the first storm event. It is thought that this high value may be due to unusual circumstances or error.

In this report CDOT used the event mean concentrations to estimate the pollutant load from state highways in the Denver metropolitan area. Based on the 1993 EMCs the loads for key constituents were: 1,781,267 pounds of TSS
62 pounds of copper
161 pounds of lead
591 pounds of zinc.

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These loads are maximum loads entering into the environment. The estimation procedure does not allow for natural removal of constituents as the run off passes through the drainage systems.

CDOT proposes to delay any further monitoring for characterization because much data already exists and the cost/benefit of obtaining additional data will be very low. Also, the monitoring site used in 1993 is not suitable for long term monitoring for safety reasons nor do any of the other 118 identified outfalls appear to have good potential as monitoring sites. CDOT proposes to assemble all available data that is at this time being collected across the country.

Driscoll, Eugene D., Philip E. Shelley, and Eric W. Strecker; Analytical Investigation of Pollutant Loading and Impact from Highway Storm Water Runoff; Woodward Clyde Consultants for FHWA, FHWA-RD-88-09; July 1988

We have only some of the data from this document which is one of the FHWA sponsored research reports also referenced in this report under FHWA. The data we have is for the California sites in the FHWA study of 31 sites in 11 states, copy is not very clear. Means and maximums for suspended solids were:

FHWA Sites

	Mean	Maximum	Number of storm events
Los Angeles *	345 mg/l	1630 mg/l	7
Sacramento	113 mg/l	279 mg/l	35
Walnut Creek	267 mg/l	587 mg/l	10

*One extremely high reading was left out of the Los Angeles data - other constituents did not show a comparable high reading for that storm event

Copper concentrations are reported only for Sacramento. The mean and maximums were 0.085 mg/l and 0.16 mg/l.

Lead was reported for all sites and the means and maximums were:

FHWA sites

	Mean	Maximum	Number of storm events
Los Angeles	1.233 mg/l	1.890 mg/l	7
Sacramento	0.387 mg/l	0.700 mg/l	35
Walnut Creek	1.291 mg/l	3.300 mg/l	10

Zinc was also reported for all three sites and the means and maximums were:

FHWA sites

	Mean	Maximum	Number of storm events
Los Angeles	0.935 mg/l	2.200 mg/l	7
Sacramento	0.300 mg/l	0.800 mg/l	35
Walnut Creek	0.375 mg/l	0.670 mg/l	10

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Dunn, Chris; et al; Current Water Quality Best Management Practices Design Guidance; Transportation Research Record No. 1483, 1995

This paper documents pollutant removal capability (Table 1) and current design guidance for:

Extended detention ponds,	Wet ponds (retention ponds),
Infiltration Trenches,	Porous pavement,
Sand Filters, and	Vegetative practices.

Vegetative practices include grassed swales, filter strips, and wetlands. Two alternative designs for each BMP are included in the table. Data for pollutant removal capabilities was taken from "Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs" by T. R. Schueler, Metropolitan Council of Governments, Washington DC., 1987. The paper does not document the work on which the data was based. Pollutants and factors included in the table are suspended sediments, total phosphorous, oxygen demand, trace metals, and bacteria. An example of criteria for adoption of specific BMPs for inclusion on new developments is included in the paper (Virginia Department of Conservation and Recreation Criteria). More stringent BMPs are recommended for areas greater than 5 acres and areas with higher percentages of impervious drainage areas. For example, infiltration methods are recommended only for drainage areas with more than 37% impervious area.

Entranco, WSDOT Storm Water Runoff Management, Overview; prepared for Washington State Department of Transportation, Sept. 1992.

Entranco was commissioned by the State legislature to inventory and assess the relative role of WSDOT's storm water runoff compared to storm water impacts from other areas, summarize the regulations, analyze runoff management techniques, discuss the cost to remedy identified highway storm water issues, and identify a priority list of recommendations.

In the case studies conducted, WSDOT's highway runoff pollutant contribution was estimated to range from 1 to 20% of all urban area contribution. The percentage varied by watershed and outfall location within each watershed. the cost for WSDOT to comply with storm water regulations was estimated at $75 to $220 million per year or about 7 to 20 percent of the current total annual WSDOT budget.

A set of actions were recommended by Entranco many of which are underway and described in the paper by Shari Schaftlein. *(Note cost stated in Schaftlein paper is upward of $200 million over the course of 20 years - $4.6 million was requested for the next two years)*

Environmental Protection Agency; Storm Water Pollution Abatement Technologies; EPA/600/R-94/129; Sept. 1994

As stated in the foreword "This publication covers the most current technologies and management practices employed in remediating contaminated urban storm water runoff" This widely disseminated document is not summarized here. Note is made, however, that catch basin cleaning is addressed in this publication. A catch basin is defined as having a sump below the outlet invert to capture settled solids. Pollutant control performance of catch basins is deemed "variable". Pollutants associated with settleable solids are removed (sediment buildup should be limited to 40 - 50% of the sump capacity) but the trapped liquid generally has a high dissolved pollutant content

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which is flushed out in subsequent storms. Experimentation with catch basin screens is mentioned in the publication. The publication does not include mention of self cleaning inlets.

Felstul, David, et al; Optimization of Maintenance for Storm Water Facilities to Enhance Performance; Eugene Oregon, Presented at WEFTEC 1995.

This paper addresses maintenance needs of storm water facilities, pointing out that performance of such facilities deteriorate if they are not adequately maintained. Criteria suggested are to be proactive in preventing flooding, to make best use of limited personnel and equipment resources, to obtain the most value for the maintenance dollar, and to ensure, where possible, that maintenance is environmentally friendly. Performance curves are proposed as a tool for establishing frequencies. Maximum frequency would be that above which little additional benefit is obtained. Minimum frequency would be that which has a predetermined significant effect, such as 50% removal of sediment in runoff. The minimum and maximum cleaning frequency for catch basins were assessed in the study to be once in 12 months and once in 6 months. Other types of facilities addressed in the paper include wet ponds, detention ponds, swales, and wetlands.

In Portland, Oregon, there are 4000 catch basins and less than 100 of any of the other types of facilities. The catch basins as a group trap the largest pollutant load (as much as all other facilities combined). On the other hand one wet pond trapped as much pollutant as 100 or more catch basins (estimated from figures in the paper). Mass of pollutants removed was obtained from the model METSET (Felstul, Modeling the reduction of sediment-bound toxics in detention basins. In: Aquatic Toxicology and Risk Assessment, Fourteenth Volume. (M. Mayers and M. Barron eds.). Philadelphia: American Society for Testing and Materials, 1991). Pollutant removal is based on the settling rate of nine particulate sizes and their associated pollutants. The paper was not entirely clear on whether pollutant removal or sediment removal was being used in the quoted efficiencies.

In the study area there were 4000 catch basins which, on average, store 0.23 cubic meters of material with density 1600 kg/cubic meter. Removal efficiency was 45% thus 0.104 cubic meters or 166 kilograms were removed per cleaning on average. This resulted in a maintenance cost effectiveness of $300 to $400 per ton of sediment removed.

Fortner, Brian; New Designs for Catch Basin Inserts, Study Concludes, Water Environment and Technology; Jan. 1996.

This is a short report on the findings in "Evaluation of Commercially Available Catch basin Inserts for the Treatment of Storm Water Runoff from Developed Sites", a study conducted by the Interagency Catch Basin Insert Committee representing five agencies in the Seattle area. The inserts evaluated cost between $100 and $1,500 and included an option to provide oil absorbing materials. Inserts require frequent cleaning especially when used for coarse sediment removal. Some inserts removed 50% of the oil and grease for up to six months without cleaning. development of new filter media and improved structural designs (allowing water to flow through the basin before treatment for example) may expand the range of conditions under which catch basin inserts are practical. Port of Seattle is conducting a study of new insert designs and considering their use in place of a $15 million wet vault for storm water control at a new container storage facility. This would save $8 million (presumably in initial cost).

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Forner, Brian; Zeolite Pulls in Pollutants from Leaking Underground Storage Tanks; Water Environment and Technology; Jan. 1996.

This short report describes an ongoing research project conducted by Professor Fernando Cadena of New Mexico State University. In the project zeolite is being used to clean ground water contaminated with benzene and toluene at a gas station with leaking underground storage tanks. Results are showing that benzene concentrations of 3.5 mg/l can be reduced to 0.7 mg/l.

GKY and Associates Inc., Highway Runoff Water Quality Synthesis - Literature Research Findings, Springfield Virginia, June 1994

This literature search and review provides abstracts and comments on the relevance of 83 documents. Each document was reviewed for relevance to :

1. Regulatory framework for highway runoff
2. Highway runoff quality
3. Surface and ground water impact assessment
4. Best management practices.

Only seven of the documents contained in the GKY literature search have been reviewed by the CSUS team. Therefore the GKY document is a valuable adjunct to the CSUS literature review and should be utilized in future more focused literature reviews.

Grisham, Donald M.; Designing for the First Flush; Civil Engineering Dec. 1995, pg. 67-69

This paper describes controls for water quality and peak discharge in two separate chambers. The author states that the water quality chamber should provide a minimum of 1 hour detention for at least 90% of the first flush. First flush is defined as the first half inch of rainfall. A goal of 75% suspended solids removal is suggested as adequate except in environmentally sensitive areas. The outlet flow from the water quality chamber (which empties into the peak discharge chamber) should be capable of emptying the chamber within 24 to 48 hours after the design (25 year) storm. For additional pollutant removal a filtration structure (filter berm, filter chamber, or sand filter bed) is recommended between the water quality chamber and the peak discharge chamber. The paper also includes descriptions of the filtration structures and of a computer program written by the author to model the division of flows and staging of the two chambers. Maintenance (removal of sediment and vegetative cover) of water quality chambers is recommended every 12 to 36 months. Inspection of filter structures is recommended every six months. A sand filter bed water quality control structure, constructed for the Irving Dallas Area Rapid Transit's North Irving Transit Center in Texas, is also described.

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Igloria et al; The Effect of Natural Organic Matter on Heavy Metal Transport during Infiltration; Washington State University; 1995

This paper describes work performed under the Washington State research program (paper by Shari Schaftlein lists all WSDOT's funded research). The objective of the research was to determine the extent to which transport of heavy metals is facilitated through their complexation with natural organic matter (NOM), a phenomenon which had been suggested by previous studies. Heavy metals studies were Cadmium, Copper, Lead, and Zinc. Large scale soil columns were tested under loading conditions similar to actual infiltration BMPs. Results show that high concentrations of NOM actually improved soil column performance in removing metals, especially copper and zinc.

Igloria et al; Transport of Heavy Metals During Infiltration of Simulated Highway Runoff Through Large Scale Soil Columns; Washington State University; Submitted to TRB for January 1996

This research addresses the use of infiltration as a BMP. Three Washington State soils were evaluated for removal of cadmium, copper, lead, and zinc. Large scale soil columns (0.3 meter diameter and 1 meter deep) were used for the research in contrast to earlier studies which used small scale columns. Contaminated water was loaded on the soil columns periodically in time to simulate field conditions. Metal transport was observed as a function of depth. Loamy sand soil showed the most potential for metal removal. Metals speciation and background metals present in the soil are important factors influencing the metal removal rates. The hydraulics of the system plays a secondary role to the geochemistry. The soil-water system's assimilative capacity should be taken into account because over time the attenuated metals will accumulate and eventually (probably after a long period of time) the soil column may not be able to remove any more metals. Changes in the chemistry of the water infiltrating the site should also be evaluated as this may result in the release of stored metals.

Jones, Alexander P., and Richard Watts; Photocatalytic Pavement Borders for Controlling Non Point Hydrocarbon Runoff, Washington State University; 1995

In this research titanium dioxide was studied for its ability to enhance rates of hydrocarbon photolysis. Application of titanium dioxide to pavement surfaces in concrete sealants and in paint were investigated. In concrete sealant titanium dioxide was effective in promoting degradation of hexadecane (a common hydrocarbon constituent of gasoline, diesel, and oil), providing more than 99% removal in 48 hours. Titanium dioxide in a paint base was somewhat less effective (98.2%) and took longer (72 hours) to achieve the effect. The paper concludes that this technology has potential to become an effective control measure applied to pavement borders. Costs were not investigated in the paper.

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Lee, Fred G., and Anne Jones-Lee; Are real Water Quality Problems Being Addressed by Current Structural Best Management Practices?; Public Works; Part 1, Nov. 1994; Part 2, Jan. 1995.

In this paper the authors caution public works directors and regulatory agencies against spending money on structural BMPs without first determining whether any real water quality problem is created by the storm water runoff. They suggest that prudent use of public funds calls for greater effort (and expenditure of funds) on monitoring to determine the effectiveness of proposed structural BMPs in protecting the beneficial use of the receiving water.

In the paper the authors point out that there is a lack of strong scientific evidence to support the conclusion that chemical constituents in storm water discharges are causing water quality problems. The existence of a particular constituent in storm water is typically measured by its mean concentration. However, since chemical contaminants exist in a wide variety of chemical forms, and since only some of those forms are available to adversely affect the water quality, mean concentration does not measure potential for causing an adverse effect. Furthermore, the impact of a constituent in a storm water discharge depends on the chemistry of the receiving water and exposure of organisms to the raw concentrations is short as the discharge mixes with the receiving water.

The authors suggest that, since a wide variety of contaminants (including copper) in storm water runoff are present in the non-toxic, unavailable, particulate form, and since most structural BMPs remove only particulates, the BMPs are not effective in reducing impacts due to toxic constituents. The overemphasis on sediments in storm water runoff management has led to the promotion of structural BMPs such as detention basins which remove only the unavailable partition of the toxic substances.

The authors suggest that an "aquatic-life hazard assessment framework" should be used to identify real water quality problems. (Ref.: *Lee, Fred G., and Anne Jones-Lee;* Suggested Approach for Assessing Water Quality Impacts of Urban Storm water Drainage; Symposium Proceedings on Urban Hydrology; American Water Resources Association Symposium, Nov. 1990.)

Lee, Fred G., and Anne Jones-Lee; Storm Water Runoff Quality Monitoring: Chemical Constituents vs. Water Quality; Feb. 1995; Submitted for publication.

The authors point out that current monitoring practice (characterization and some toxicity testing of discharge) fall short of determining the potential impacts of the storm water discharge. They suggest that neither the presence of a constituent in storm water nor the toxicity of a storm water discharge is evidence that the discharge will in fact adversely impact the beneficial uses of the receiving water. Toxicity in storm water runoff is of potential concern. The question which must be addressed is whether the toxicity found in the discharge occurs for a sufficient distance and time to significantly adversely impact the designated beneficial uses of the receiving water. This means that focal point of evaluation of the impact of storm water runoff should be on the quality of the receiving waters.

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Lee, Fred G., and Anne Jones-Lee Significance of Eroded Suspended Sediment-Associated Constituents; Erosion and Sediment Control, Jan./Feb. 1996

In this paper the authors make the point that detention basins and filters to remove suspended sediments may be appropriate to prevent physical impacts of suspended sediments but have not been demonstrated to be technically appropriate for removal of pollutants because chemicals attached to the sediments are generally in an unavailable form.

Lee, Fred G., and Anne Jones-Lee Unreliable reporting of Water Quality Impairment by the US EPA's National Water Quality Inventory; Submitted for publication, Feb. 1996.

This paper suggests that significant exceedances of US EPA numerical water quality criteria can occur without causing real use impairment of the water body. Recommendations are made for improvement of the National Water Quality Inventory data collection to more reliably report to Congress and the public the quality of the waters of the USA. While it is acknowledged that there is no doubt that non-point diffuse sources of chemical constituents, such as those from urban and rural runoff, can have adverse impacts on designated beneficial uses, it is suggested that the US EPA's assessment of the extent to which this is occurring is to some unknown extent overestimated. The main concern arising from this overestimation of the problem is mis-application of funds. The authors suggest that chemical concentrations in the water column should not be used as an absolute standard for identifying impaired water quality, but should be used as a trigger for toxicity or other assessment (toxicity, bioaccumulation, etc.).

Lee, Fred G., and Anne Jones-Lee; Storm Water Detention Basins for Pollutant Removal; Submitted for publication Journal of Environmental Engineering Feb. 1996

This paper elaborates on the misapplication of detention basins as BMPs to control chemical constituents in storm water runoff, acknowledging their usefulness in controlling sediment when there is a siltation or turbidity problem in the receiving water.

Lee, Fred G., and Anne Jones-Lee; Evaluation Monitoring for Storm Water Runoff Monitoring and BMP Development; Feb. 1996, unpublished paper.

An approach to determination of beneficial use impairment of receiving waters and storm water runoff contribution to such impairment is presented. The following notes are paraphrased from the summary of the paper.

- Toxicity: Measure aquatic life toxicity in receiving waters (associated with runoff events) using larval fish, shellfish, and zoo plankton to determine if constituents in runoff are causing sufficient aquatic life toxicity to be potentially adverse to the designated beneficial use of the water body.
- Bioaccumulation: Measure edible tissue residues of non-migratory fish and shell fish in the area of the runoff discharge to determine if they contain concentrations of runoff derived constituents that are hazardous to the species or to wildlife consuming the species.
- Sanitary Quality: Determine the relative contribution of waterborne pathenogenic indicator organisms to the receiving water, from runoff compared to other sources.

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- Eutrophication: Determine the relative contribution of available forms of nutrients to the receiving water, from runoff compared with other sources.
- Contaminate sediments: Determine whether sediments in the receiving water are the cause of a significant use impairment. Determine which specific chemical constituent, and its form, is causing the impairment. Determine the sources of this constituent. If storm water runoff is a significant source of that constituent, trace the source of the constituent in storm water.
- Petroleum hydrocarbons: Evaluate potential impact of petroleum hydrocarbons on receiving water quality on a site specific basis focusing on whether those conditions for petroleum hydrocarbon accumulation are occurring in the receiving water. Assess significance of accumulation occurring and the sensitivity of the beneficial use of receiving water to the accumulation.
- Litter: Visual inspection of receiving water to determine whether litter derived from runoff is present and whether it is causing use impairment.
- Domestic water supply: The significance of storm water runoff as a source of the constituents that cause domestic water supply problems (increased need for treatment and/or increased cost) should be determined
- Ongoing Evaluation Monitoring: In order to detect subtle water quality impacts or new impacts due to introduction of new constituents into the storm water runoff an ongoing evaluative monitoring program should be conducted (The evaluation monitoring components summarized above should be re-initiated once every five years).
- Development of BMPs: If use-impairment / pollution has been identified site specific studies should be conducted to determine the specific sources of the constituents in storm water runoff that are causing the problem. Develop BMPs starting with source controls. If source controls do not eliminate the impact then implement site-specially developed BMPs. The implementation should be part of an area wide, watershed based implementation program to control similar types of runoff.

Lopes, Thomas J., and Kenneth D. Fossum, Selected Chemical Characteristics and Acute Toxicity of Urban Storm Water Streamflow and Bed Materials, Maricopa County, Arizona; USGS Water resources Investigation Report 95-4074; Tucson 1995.

Toxicity tests on highway runoff showed that 71% of the first flush samples and 36% of the flow weighted samples were toxic to fathead minnows. Also 28% of the first flush samples and 14% of the flow weighted samples were toxic to waterfleas. Stream flow samples from the Salt River were not toxic to fathead minnows and water fleas. The authors conclude from this that urban storm water could degrade the quality of the Salt River

Oil and grease, organophosphate pesticides, dissolved zinc, copper, cadmium, nickel, chromium, and cobalt were detected in 28% to 100% of the storm water runoff samples but were below the detection limit in the river. Again the authors concluded that this shows potential for the storm water runoff to degrade the quality of the river.

Bed material in the Salt River was compared with those in ephemeral channels. Statistical analysis indicated that urban activity increases recoverable concentrations of ammonia, lead, cadmium, and zinc. In some locations copper and phosphorous were also higher. Pesticide concentrations were not significantly different. Zinc and cadmium concentrations showed positive correlation with percentage of organic carbon but lead did not, indicating that some metals released by urban activity may be associated with organic matter.

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The sampling sites included two locations where a road had recently been repaved and a parking lot surface had recently been resealed. These sites yielded the most toxic samples during a few months after the repair work.

Runoff was diluted to determine the dilution at which no toxicity was observed. In most cases there was no observed toxicity at dilution less than or equal to 1:2. Those cases which required a dilution of 1:4 (6 out of 62 cases) or 1:16 or more (5 out of 62 cases) were mostly associated with the roadway repaving or the parking lot resealing.

Lord, Byron; Nonpoint Source Pollution from Highway Storm Water Runoff; The Science of the Total Environment, 59 (1987) 437-44

This paper describes the Federal Highway Administration research program "Nonpoint Source Pollution from Highway Runoff", and summarizes results of phases 1 through 3 and interim results of phase 4. Phase 1 consisted of development of the data base (data for California sites are reported in this literature review). A prediction procedure for mass of solids washed off in storm events was also developed. In phase 2 the sources and migration of pollutants were studied, while in phase 3 the effects of highway runoff were studied using toxicity tests. Phase 4 addresses management practices.

The FHWA research program is widely quoted in other literature and is well known to most practitioners in the field.. In this CSUS review the research documents have been identified but not reviewed. Lord's paper provides a good overview of the research for readers who are not familiar with the FHWA sponsored research.

Luthy, Gail; and Stephanie Reid; Inventory of Sewer Collection Facilities; Nov., 1995, (Paper provided by Brown and Caldwell in a proposal for the Storm Water Retrofit Study)

This paper describes the field inventory of existing surface storm water facilities in the City of Portland. Information available on maps and plans was verified and supplemented by field inspections. The data was placed into a CADD mapping format with layering , by scanning available acetate maps and adding additional information. Tools used include Access, Mapinfo, and AutoCAD. More than 80,000 facilities were catalogued in approximately eight months

Maestri, Bruno; and Byron M. Lord; Guide for Mitigation of Highway Storm water Runoff Pollution; The Science of the Total Environment, 59 (1987) 467-476

This paper reports on work which was a part of the Federal Highway Administration's study of nonpoint source pollution from highway storm water. The primary measures identified for control of pollution from highways were vegetative controls, wet detention basins, infiltration systems, and wetlands.

Several measures were identified as ineffective. Studies (cited in this paper) have shown that street cleaning has virtually no effect on pollutant loads in the runoff. Catch basins were considered ineffective because "from a pollutant removal standpoint" most catch basins are not adequately

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maintained". Dry detention basins are ineffective because "detention time is generally only a few hours and is inadequate to settle out the smaller fraction of suspended material", also "materials....may be washed out by a subsequent event". Porous pavements was ruled out for highways because of the pavement design need to maintain a dry base and subbase. Filtration systems such as straw bales, sand bags, filter cloth fences, gravel, and sand filters, used extensively as temporary sediment control measures during construction and while vegetative cover is being established, were ruled out for highway runoff pollutant removal because finer solids are not effectively trapped.

Some low cost procedures that can be incorporated into existing highway design and maintenance procedures were identified as follows:

1. Curb elimination
2. Litter control
3. Pesticide/herbicide management
4. Reduction of discharges directly to receiving water (including ground water)
5. Reduction of runoff velocities to non erosive level
6. Grassy channels
7. Overland (sheet) flow over dense grass cover
8. Vegetation along highway right-of-way, particularly dense grass cover.

Maestri, Dorman, and Hartigan; Managing Pollution from Highway Storm Water Runoff; Versar Inc.; Springfield VA; Transportation Research Record 1166; 1988

This paper quotes results of research work using bioassays and concludes that highway runoff does have the potential to adversely affect water quality and aquatic biota of receiving waters; that the extent of the impact is variable by highway, receiving water, and runoff event, that urban highways with high ADT have relatively high potential to cause adverse effects while runoff from highways with low ADT have low potential to cause adverse effects.

Mitigation measures should be designed bearing in mind that: discharges from frequent minor storms are more critical than infrequent major storms; first flush results in relatively high pollutant concentrations; heavy metals tend to be of greater concern than nutrients and BOD, and they occur in suspended form .

The author advocates as effective measures: curb elimination; litter control; deicing chemical use management; pesticide/herbicide use management; reduction of direct discharge of runoff to receiving waters by collection and conveyance through effective management measures; reduction of runoff velocities; establishment and maintenance of vegetation. Effective management measures through which run off can be routed are vegetative controls, wet detention basins, wetlands, and infiltration systems. Each of these controls are discussed in the paper.

Ineffective measures are listed in this paper as: street cleaning, catch Basins; dry detention basins (with detention time of only a few hours); porous pavement; and, contrary to conclusions of other researchers, filtration systems

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Mangarella, Peter, Eric Strecker, and Gail Boyd; Targeting and Selection Methodology for Urban Best Management Practices; National Conference on Urban Runoff Management: Enhancing Urban Watershed Management at the Local, County, and State Level; March 30 to April 2, 1993.

This paper contains lists of manuals for design of BMPs; documents addressing control effectiveness ; and one document addressing BMP costs.

McEwen, Malcolm A. et al.; Watching Out for Water Quality, Water Environment and Technology; Aug. 1993

This paper describes the Sacramento Coordinated Water Quality Monitoring Program (CMP) focusing on the Ambient Water Quality Monitoring Program (the Ambient Program). The CMP offers an electronic database for centralized storage of regional water quality information. American River and Sacramento River data collected by various local, state, and federal agencies are not directly comparable because of differences in sampling and analytical methods. The criteria for water quality objectives adopted by the state, California Inland Surface Water Plan Criteria for Trace Elements (ISWP), are based on total recoverable concentrations of pollutants. Several other states have adopted the EPA national criteria which are based on dissolved concentrations. A table of ISWP criteria for trace elements is included in the paper. Criteria for maximum 4-day and 1 hour averages are presented for fresh water aquatic life (except for silver which has an instantaneous maximum criteria) and a 30 day average for human health.

Constituents selected for monitoring are:

Antimony	Arsenic	Cadmium	Chromium	Copper
Lead	Mercury	Nickel	Selenium	Silver
Thallium	Zinc	Cyanide		

Both the total recoverable and dissolved concentrations are measured. Hardness, total suspended solids, temperature, pH, electrical conductivity, and dissolved oxygen are also measured. Trace organics were not included in the initial phase of the Ambient Program because prior monitoring had not detected organic constituents in concentrations or frequencies to warrant long term monitoring.

According to EPA guidelines, the author states, "ambient waters are considered to attain water quality criteria for protection of aquatic life if, on average, ambient concentrations exceed chronic criteria during no more than one 4 day period per three year period, or exceed acute criteria no more than one 1-hr period per 3-year period" The monitoring plan called for 24 hour composite samples drawn every 15 days. Six sites were recommended for the first years monitoring (considered to be the minimum number to adequately characterize ambient water quality in the region.)

No data was available from the Ambient Program at the time of writing but some initial data for samples collected at one site using methods similar to those recommended for the Ambient Program are presented. The data showed that ambient levels of copper and lead occasionally exceeded the ISWP water quality criteria while mercury frequently exceeded the criteria. Other constituents were consistently below applicable criteria (cadmium and chromium were at times close to the criteria). It is expected to take 5 to 10 years to collect the data needed to properly characterize ambient conditions.

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Mumley, Tom and Geoff Brosseau; Actions Speak Louder than Legislation; Water Environment and Technology; Jan. 1996.

This paper describes legislation pertaining to urban storm water runoff and compares various regulatory approaches (voluntary implementation, direct regulation, and regulatory incentives.) Regardless of which regulatory approach is taken the authors point out that successful urban storm water runoff programs stem from local initiative. "Where local individuals have taken charge of their programs urban runoff management has been successful".

The authors note that a good management program includes a decision making process that allows early action to be taken while allowing managers to continue to gather new information and phase in additional actions as needed. Important program elements identified an described in the paper include:

- Program management
- Public information and participation
- Illicit discharge elimination and prevention
- Industrial and commercial source identification
- New development and redevelopment control measures
- Public agency activities (modification for storm water benefits)
- Program evaluation

Beyond this framework successful programs have been found to have a comprehensive scope, a watershed approach (and the implied collaboration among agencies within the watershed), consensus based partnerships, phased approach and continuous improvement, and local leadership.

Mumley, Thomas E.; Urban Runoff Pollution Prevention and Control Planning: San Francisco Bay Experiences; National Conference on Urban Runoff Management: Enhancing Urban Watershed Management at the Local, County, and State Level; March 30 to April 2, 1993.

This paper reports on extensive monitoring and modeling programs conducted by Santa Clara and Alameda counties. The programs cost $1 to $2 million each. Heavy metal concentrations in receiving waters were found to increase in wet weather. The heavy metals detected were Cadmium, copper, lead, nickel;, and zinc. High metal concentrations were associated with industrial and commercial/residential land uses. Pesticides and hydrocarbons were found to be prevalent in sediments. It was found that urban runoff pollutant loads were equal to or greater than treated wastewater discharges, depending on the amount of precipitation.

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Muschack, Werner; Pollution of Street Runoff by Traffic and Local Conditions; The Science of the Total Environment, 93 (1990) 419-431

In Germany receiving water measurements at locations where storm water runoff is presently showed elevated concentrations of constituents, particularly after long periods of drought and in small receiving waters. In the 1960s various investigations began but they used different parameters. In 1985 a research project was funded to obtain an overall record of the situation. Parameters analyzed were based on traffic related sources of pollution: tire abrasion; brake linings abrasion; hydrocarbon leakage, residues from combustion; road cleaning materials; and abrasion particles from surface of roadway.

This paper presents estimates, in kg/km for constituents released from the above listed sources. For example a road with 1000 automobiles per day is estimated to create 0.12 kg/km of tire abrasion particles which are mostly inorganic and contain heavy metal oxides. Mean pollutant concentrations are presented for 22 constituents at 6 sites in Germany (data is not clear)...

In terms of effects on receiving water the long term, rather than acute short term effects, were considered to be most important.

Oregon Department of Transportation, Draft Storm Water Quality Data Report for Samples Collected from Jan. 1995 - June 1995 prepared by Woodward Clyde Consultants

Oregon Department of Transportation (ODOT) began developing a monitoring program in March 1994. Two flow-weighted composite sampling sites were established to represent sites typical of ODOT's NPDES permit area. A grab sampling program was also developed for runoff and snow sampling outside the NPDES permit area. This report covers the first monitoring results obtained between January and June 1995. The report also includes a comparison of ODOT data with other studies of runoff from highways and from residential, industrial, and commercial sites in Oregon and Washington (Table A-8). Results were consistent with data from other highway runoff sites. For many constituents highway runoff data was comparable with data from residential, commercial, and industrial sites but total and dissolved lead, dissolved copper, and oil and grease concentrations were generally higher for the highway runoff sites while total Kjeldahl nitrogen, total phosphorous and fecal coliform concentrations were generally lower for the highway runoff sites.

The ODOT sites were at locations with ADTs of 50,000 and 100,000 vehicles. The drainage systems were piped systems and the areas drained were a 1.08 kilometer (0.67 mile) segment of the I-105 bridge (7.4 hectares - 18.2 acres, including some portions of a park), and a 1.54 kilometer (0.96 mile) section of Interstate 5 (9.3 hectares - 23.1 acres). For most constituents the concentrations were higher at the site with the larger ADT.

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Paulson, Cynthia and Gary Amy; Metal Partitioning and Speciation in Storm Water Runoff - Implications for Water Quality Regulation; Project funded in part by Region VIII EPA; Nov. 1994

This report covers the same topic as the published paper by these authors and is based on the same data sources (with the addition of storm water samples collected at three sites in Boulder, Colorado. Additional conclusions reached in this report are:

- In a typical storm water environment metals (Cu, Pb, and Zn) are found primarily in particulate and organically complexed forms which are not bioavailable.
- Partitioning and speciation of zinc is less sensitive to changes in water chemistry than either copper or lead.
- Metal partitioning and speciation shifts towards more bioavailable forms when storm water mixes with receiving water therefore the assessment of impact requires consideration of the receiving water chemistry.
- Effective control of metals in storm water runoff may require removal of dissolved as well as particulate forms.

Paulson, Cynthia and Gary Amy; Regulating Metal Toxicity in Storm Water; Water Environment and Technology, Volume 5 No. 7, pages 44-49, July 1993

This paper deals with the issues surrounding regulation of metals by total concentrations versus regulating bioavailable metals. The paper refers to EPA draft guidance released in 1992 and the (then) pending final guidance in 1993. Pointing to a drawback of the proposed EPA alternatives (reliance on site specific data to describe metal toxicity) the paper proposes the use of a predictive model to improve the transferability of data. The chemical processes controlling partitioning and speciation of metals are reviewed in the paper. NURP data and data from Fresno were reevaluated to:

- Characterize storm water with focus on factors that could affect metal form
- Define key processes and factors that control partitioning and speciation of metals in storm water, and
- Compare metal concentrations in storm water runoff to acute instream criteria to test the initial NURP conclusion that storm water metals could threaten aquatic life.

Data from Fresno, Salt Lake City, and NURP are included in the paper. Constituents with higher concentrations than in average river water were identified as suspended solids (3 to 6 times), dissolved organic carbon (3 to 5 times), ammonia (5 to 20 times), dissolved phosphorous (10 to 100 times), and metals (manganese, iron, copper, lead, and zinc) (5 to 50 times). The dissolved fractions of metals were relatively constant at 25% or less for copper and lead and 20 to 40% for zinc. Bioavailable metal concentrations predicted using an equilibrium model (MINETEQA2) adapted to the Fresno and Salt Lake City data were 6% or less of total copper and lead, and 10% to 35% of total zinc. These results were obtained assuming that all metals were initially present in dissolved form.

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The most important factors controlling the distribution of metals among dissolved and bioavailable fractions include:

- suspended solid types and concentrations
- pH
- total metal concentrations, and
- dissolved organic carbon concentration and character.

Dissolved and bioavailable fractions are higher when suspended solid concentrations are low, pH is low (5 to 6), total metal concentrations are high. The effect of dissolved organic carbon is very complex.

Dissolved and bioavailable metal concentrations in storm water runoff were found to exceed instream criteria much less frequently, and to a lesser degree, than total concentrations. The authors note that applying instream criteria to storm water is a conservative measure because metal concentrations are typically diluted in receiving waters. Differences in receiving water chemistry also affect metal partitioning and speciation after mixing therefore a predictive model should include receiving water characteristics. (The study reported in this paper considered only partitioning and speciation before mixing with receiving water)

Pitt, Robert, Richard Field, Melinda Lalor, and Michael Brown; Urban Storm Water Toxic Pollutants: Assessment, Sources, and Treatability; Water Environment Research, Volume 67, Number 3, 1995.

In phase 1 of this study grab samples of runoff from various different sources were analyzed. The sources included roofs, parking areas, storage areas, streets, loading docks, vehicle service areas, and landscaped areas. Grab samples were also taken from urban creeks and detention ponds. Samples were analyzed for constituent concentrations and for toxicity (using the Microbics Inc. Microtox^{R} 100% sample toxicity screening test). The objective of Phase 1 was to compare relative toxicity of runoff from various sources (not to determine absolute toxicity).

Roof, parking area, and vehicle service area samples had the greatest detected frequencies for organic toxicants. Of these vehicle service areas had several of the observed maximum organic compound concentrations. (Urban creeks also had several of the observed maximum organic compound concentrations.) Heavy metals, on the other hand were found in almost all samples. With the exception of zinc, heavy metals were mostly associated with suspended solids. Vehicle service areas and street runoff had the highest concentrations of lead. Nickel concentrations were highest in storage areas and parking areas.

Approximately 9% of the samples were found to be highly toxic. The greatest percentage of these were from industrial storage and parking areas. Approximately 32% of the samples were considered moderately toxic, 59% were found to be non-toxic. The data indicates that variations in toxicity and in concentrations of organic toxicant concentrations may be better explained by rain characteristics and antecedent dry periods than by differences in sampling locations (and land use).

In Phase 2 runoff from storage areas, parking facilities, and vehicle service areas (those found to have the greatest detected frequencies for organic toxicants) was used to study the effectiveness of

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treatment methods. Toxicant reductions were obtained by settling for at least 24 hours, screening through at least a 40-μm screen and aeration and/or photodegradation for at least 24 hours.

Polasik, Stanley; John Knutson, and James Lenhart; Water Quality Mitigation for the San Joaquin Hills Transportation Corridor; presented at Transportation Research Board Annual Meeting, Jan. 1996.

This paper describes a Compost Storm Water Filter (CSF^R) installed on a new toll road in Orange County. This compost treatment system was considered for the project as an alternative to oil and gas separators, which would have required very large structures, and infiltration basins, which were impractical in the area due to very fine grained underlying soils. The compost filter is similar to the sand filter but granulated stable leaf compost is used instead of sand. High percentage removal efficiencies are indicated by existing field data, for the pollutants of concern identified in the Environmental Impact Statement for the project (Zinc, Lead, TKN, TSS, COD, oil and grease). Efficiencies range from 66% to 93% for first flush and 22% to 91% for flow paced measurements. (Data from 185th Avenue CSF^R treatment systems in Portland Oregon.) Detention basins placed instream before the compost filter serve to reduce the peak flow rate and, by removing some of the sediments, reduce the maintenance needs of the filters. The basins needed for the compost filter system were found to be smaller than those needed for an infiltration system and the availability of CSF^R in various system sizes allowed the designers flexibility in fitting the system into the available right of way.

Powell, Mary; Building a National Water Quality Monitoring Program; Environmental Science and Technology; Vol. No. 10, 1995.

Plans are underway to establish a national water Quality Monitoring Council to coordinate and integrate ongoing water monitoring programs. The objective of this effort is to assess whether overall Clean Water Act (CWA) goals have been achieved and whether increasingly stringent point source treatment is yielding measurable benefits nationwide. Since 1992 a three year project - the Intergovernmental Task Force on Monitoring Water Quality (ITFM) has been evaluating water quality monitoring in the United States. The ITFM is the forerunner of the planned Council which will be co-chaired by USGS and EPA.

Most current monitoring is compliance based focusing on sources of pollution. Monitoring results provide little information with which to evaluate ambient water quality conditions and trends. There is a need to combine ground water and surface water data bases for watershed evaluation. The historical emphasis of monitoring programs on chemical specific analyses has been important for determining loading, assessing compliance, and measuring point source contributions. Now unmet information needs are being addressed, such as, nonpoint source pollution, ecological conditions, and low level chronic effects of multiple toxicants on aquatic biota and human health. The limited local studies, which have shown build up and reduction trends of pollutants at various locations, cannot be readily aggregated or even compared. Coordination is lacking, even among the newer Federal ambient water quality monitoring programs implemented by NOAA, USGS, and EPA. Three intergovernmental pilot studies, initiated by ITFM, are underway in Arizona, Florida, and Wisconsin and statewide monitoring integration efforts are being established in Florida, Idaho, Maryland, Minnesota, New Jersey, and Wisconsin. The ITFM monitoring program framework is also being used on other state, EPA, and Army Corps of Engineers projects

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Price, Falcon A. and David R. Younge; Enhancing Contaminant Removal in Storm Water Detention Basins by Coagulation. Transportation Research Record No. 1483, 1995

In this research a scale model of a detention basin was constructed to investigate removal capabilities of existing detention basins. Coagulants were introduced in a blend tank through which water flowed before entering the detention basin. Four coagulants were evaluated for their ability to enhance removal of sediments and metals. Particular attention was paid to removal of smaller sized particles. Significant increases in sediment and metal removal capabilities was observed. For example lead removal was increased from 15 to 35%, without coagulant, to 38 to 77% with coagulant. Increases in percent removal were greater at higher flow rates. Introduction of an influent baffle further increased removal capability by causing inflow to circulate in the detention basin rather than simply flowing over the top of water already in the basin. Ferric Chloride and SWT 848 were found to be effective as coagulants. Cost effectiveness and handling and disposal procedures were not addressed in this paper.

Racin, Jim, Richard Howell, Gary Winters, and Earl Shirley, 1982. Estimating Highway Runoff Quality, Office of Transportation Laboratory, California Department of Transportation, FHWA/CA/TL-82/11.

This study evaluated seventeen regression models to estimate the quality of storm water runoff from highways. The data were collected during 1980-81 from I-405 in Los Angeles and I-680 in Walnut Creek. In addition, data that were collected during 1979-80 wet season at U. S. Highway 50 in Sacramento, were also used in this study. This study indicated that the number of vehicles during the storm is correlated with the loads of total lead, total zinc, filterable residue, chemical oxygen demand (COD), and total Kjeldahl nitrogen. The following equation was recommended:

$CL = a + b\ (VDS)$

where,

a, b = regression constants
CL = cumulative constituent loading (g)
VDS = vehicle during storm (in thousands)

Regression parameters are summarized in table below.

Constituent	a	b
Total lead	14.3	0.00189
Total zinc	14.3	.000600
Filterable residue	5360	0.140
COD	3590	0.221
TKN	150.0	0.00342

Note: These parameters were developed based on the data from Los Angeles, Walnut Creek, and Sacramento

The total residue was correlated with the loadings of COD, nonfilterable residue, and total zinc. The study also indicated that the antecedent dry days was not a significant independent variable.

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The equations that were developed in this study were only recommended for use in highways with at least 30,000 ADT.

The first flush indicated high concentrations and loadings of sulfate, iron, chromium, copper, manganese, nickel, bicarbonate ion, carbonate ion, calcium, magnesium, chloride, mercury, molybdenum, potassium, silica, and sodium.

Roesner, Larry, and Ron Ott, Common-Sense City, County Controls: Water Environment and Technology; Sept. 1995.

The cost of compliance with the NPDES urban runoff requirements of the Clean Water Act (CWA) has been estimated at $6,000 per square mile of drainage area for simple source controls to $3.5 million per square mile for implementation of treatment controls as well as source controls to reduce pollutants in runoff to the maximum extent practicable. EPA and state agencies have broadly interpreted "maximum extent practicable" to mean application of source controls on existing urban development and source controls plus treatment controls on new development.

Source controls include:
- Public education
- Planning management
- Material use controls
- Material exposure controls
- Material disposal and recycling
- Spill prevention and cleanup
- Illegal dumping controls
- Illicit connection controls
- Street/Storm drain maintenance.

Street and storm drain maintenance includes street cleaning, catch basin cleaning, vegetation controls, storm drain flushing, roadway/bridge maintenance, detention/infiltration maintenance, storm channel/creek maintenance. To date no data have been generated to quantify the pounds of pollutant removed per dollar spent on source control however these measures can be considered to be good housekeeping and seem to be good common sense.

Treatment controls, which are expensive, include wet ponds, constructed wetlands, biofilters, extended detention basins, media filtration, and oil-water separators. Treatment controls are resisted by developers because of their cost and because of the absence of proof of ecological impairment resulting from specific urban developments. The cost of retrofitting existing facilities with treatment controls is even greater and their cost effectiveness is being questioned. Lack of trained operators and the cost of operation and maintenance of treatment facilities can also be a problem.

This paper suggests that the most damaging result of urban development is loss of habitat from stream bank erosion, smothering of benthic communities with silt, and changes in hydrologic regime, rather than changes in water chemistry. One of the most important mitigation measures is therefore effective control of erosion.

Urban development changes the hydrologic conditions by producing more frequent peak flow rates. The writer suggests that existing runoff management technologies can be modified to ensure that the peak flow frequency curve in a natural stream approximates the pre-development curve. He also suggests that existing detention basins can be retrofitted with multiple outlets to provide flow control over the full range of storms from small to large. The author makes the case for hydrologic mitigation rather than controlling pollutants because of lack of documented cases where receiving waters have been impaired because of the quality of urban runoff.

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This paper also addresses the agricultural nonpoint sources of pollution, pointing out that agriculture has been identified by EPA as the nation's largest, but still unregulated, contributor to nonpoint source pollution. *(Note Ron Ott is Director of Water Resources at CH2M Hill in Sacramento)*

Sacramento County, Water Resources Division, Final Comprehensive Storm Water Management Program Report, June 1994.

Prior to preparation of this report the permittees had focused on monitoring and program management. Results of monitoring which are important to the CSWMP include:

- Identification of constituents of concern
- Baseline dry weather concentrations
- Evaluation of watershed differences showing few discernible differences in runoff quality from one watershed to another indicating that no specific watershed should be selected for priority implementation of BMPs
- Evaluation of first flush data showed that optimum pollution removal opportunities occur during the first 30% of runoff during early season storms

The report states that source identification and BMPs will focus, in large part, on reducing concentrations of constituents of concern (pg. 1-4). The preferred approach to evaluation of overall effectiveness is to monitor at points of discharge or in creeks. Ambient river monitoring data (from the Coordinated Monitoring Program) will also be evaluated. Indirect measurement of effectiveness through field screening for before and after concentrations and estimation of pounds of constituents removed is also proposed.

- The CSWMP consists of seven programs which are:
- Construction Site Management Program
- New Development Management Program
- Public Education and Awareness Program
- Industrial Discharge Management Program
- Illegal Discharge Program
- Illicit Connection Program
- Public Agency Program

The program identifies 5 construction program BMPs, 4 new development program BMPs, 4 public education program BMPs, three industrial discharge program BMPs, two illicit connection program BMPs, and 4 public agency program BMPs. In each case evaluation of the existing activity is planned, followed by pilot studies if necessary, implementation procedures for new or improved methods, and evaluation of effectiveness. The BMPs are prioritized for implementation in three ranks. The program also identifies 6 monitoring goals which include prioritizing constituents of concern, prioritizing sources of constituents of concern, evaluating BMP and storm water program effectiveness in reducing constituents of concern. A work plan for evaluating program effectiveness is presented.

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Sacramento County Water Agency, City of Sacramento, City of Folsom, City of Galt, Sacramento Storm Water Management Program. Effectiveness Evaluation Report, March 1995

This report includes an evaluation of the effectiveness of the CSWMP to date and an Effectiveness Evaluation Plan for the term of the next NPDES permit (July 1995 through June 2000). Overall effectiveness of the CSWMP and effectiveness of program elements and BMPs are evaluated. Evaluation methods include:

- Non-water quality measurements such as the number of storm drain stencils,
- Indirect water quality measurements such as removal efficiencies of structural controls,
- Predictive water quality measurements such as statistical water quality modeling, and
- Direct water quality measurements.

The first and last of these methods have been used to date. Non water quality evaluation has been used to assess implementation efficiency of specific BMPs and direct water quality monitoring has been implemented at three major storm water discharge points and in the rivers. The monitoring objective has been to establish baseline conditions and to establish a data base for assessing long term trends. Monitoring data for the runoff discharge points and the rivers are included in the report. Upstream and downstream monitoring in the rivers was not effective in detecting impact of runoff. The limited monitoring record (1990-94) was found to be insufficient to detect statistical trends.

Future plans for effectiveness evaluation include termination of monitoring to identify constituents of concern (COCs) after the 1994/95 season. (This is being negotiated with the RWQCB.) Attention would then be turned to prioritizing COCs, identifying sources and developing plans to reduce COCs. Specific activities proposed for the next permit period include:

- Sub-watershed pilot projects for COC reduction programs (high priority COCs)
- Feasibility study of statistical methods and water quality models for predicting the effectiveness of the CSWMP as a whole. Feasible methods will be incorporated into the evaluation process during the last years of the permit term.
- Non-water quality and indirect water quality measurement methods (special studies) for BMPs. The report includes guidelines for performance of monitoring studies of best management practices (appendix A)
- Point of discharge monitoring at the three outfalls will continue for detection of long term water quality trends.
- Receiving water monitoring will continue only through the Coordinated monitoring program

To facilitate the effectiveness evaluation process a Monitoring Program Focus group has been established and under their purview an ad hoc association of Central Valley storm water agencies has been set up to begin the process of coordinating special studies. The report includes, in Appendix A, a nationwide storm water special study/BMP data base developed by the City of Sacramento.

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Sansalone, John J. et al; Correlation between Heavy Metals and Suspended Solids in Highway Runoff: Implications for Control Strategies, Transportation Research Record No. 1483, 1995

This research, analyzing data from 8 highway sites in the United States and Europe, shows a strong positive correlation between heavy metal concentrations and suspended solids for snow wash off and a weaker positive correlation for rain runoff. The author argues that this result supports the use of partial exfiltration trenches (PET) which have been shown to have a high removal efficiency for suspended solids. PET are underground drainage trenches which can be incorporated alongside the highway, possibly under paved shoulders in which a porous pavement section is incorporated to allow run off to flow into the exfiltration trench. The trench is filled with material which immobilizes dissolved metals by sorption into oxide coated granular media and particulate bound metals are immobilized by straining and filtration mechanisms. However, the author acknowledges that the potential for clogging of PET requires further study. No mention is made of the sorption capacity of the media, what happens as the sorption capacity is approached, or what must be done after the sorption capacity is reached.

Sansalone, John J. et al; Characterization of Metals and Solids in Urban Highway Winter Snow and Spring Rainfall-Runoff; Submitted to Transportation Research Board, Jan. 1996

This research demonstrates that metal elements in snow along highways show increased accumulation over time while metal elements at a control site did not. The difference is thought to be due to metal deposition from traffic activities and winter maintenance. The elevated accumulation of metals in snow along highways raises questions about BMPs to deal with the problem.

The research also showed that, for the predominantly dissolved metals (Zinc, Nickel, Cadmium, and Copper) the dissolved metal response preceded the particulate-bound metal response. The particulate-bound metal response is a function of flow intensity, dissolved metal response may be affected by the time runoff spends on the road surface. The predominantly dissolved nature of some metals in rainwater runoff has implications for the selection of structural BMPs. (See PET described in previous paper by Sansalone).

Santa Clara Valley Water District, Annual Monitoring Report, Executive Summary, Woodward Clyde August 1993

Santa Clara Valley Water District has been engaged in monitoring since 1986. Of 10 monitoring stations, mostly in streams and at industrial locations, two are at transportation corridors. The transportation corridor stations have been monitored since 1989. One of the major findings for the transportation corridors is that the total and dissolved lead in the runoff is greater than that at industrial and residential/commercial sites, but significantly lower than level detected in the late 1970's (4 times lower). This lower level is expected. Another finding, however, was that the lead concentrations are not as low as expected. Based on the concentrations found in the 3 years of monitoring, the lead load to the San Francisco Bay, from highway runoff, was calculated at 6.8% of that from all storm water run off from Santa Clara County. This is 1.6 times the percentage calculated using pre-monitoring assumptions about lead concentrations.

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This information was obtained from the Executive Summary. The report itself does not include the monitoring activities for transportation corridors which are presented in the FY 92-93 Annual Special Studies Report.

Santa Clara Valley, Amendments to Annual Monitoring Report, Sept. 1993, Feb. 14 1994.

This report amendment covers the topics of "Duration of Water Quality Exceedance" and "Persistence of Pollutant Concentrations After Storm Events). The average duration of exceedance of acute water quality objectives was 60%, 40%, and 20% of the duration of the storm, for total copper, total zinc, and total lead respectively. Total copper, lead, and zinc were lower in post-storm samples than in samples collected during storms by about 6 to 23 times. No post storm concentrations exceeded acute water quality objectives. Concentrations of the three metals were generally less than 0.010 mg/l.

Schaftlein, Shari; WSDOT's Storm Water Management Program, Washington State Department of Transportation, Environmental Affairs, Paper submitted to Transportation Research Board Jan. 1996.

This paper describing the management program lists program elements as: Illicit Connections; Construction Site Runoff; New Construction and Retrofit BMPs; Maintenance; Sampling; and Public Education. Tasks that are described in the paper are the storm water drainage inventory, field screening and water sampling results, illicit connections, retrofit program, the highway runoff manual, and WSDOT funded research.

In the storm water drainage inventory, conducted by field crews, outfalls, BMPs, and connections to WSDOT drainage systems were documented. Outfalls were put into four categories which are:

- Culverts 12 inches or larger, or under this size if they drain directly into surface water
- Open channels discharging to surface water
- Interconnection between the municipal storm water drain systems and WSDOT drainage system
- Dry Wells (these were also inventoried as BMPs as they remove runoff from the surface and discharge it to aquifers)

In all 2,198 outfalls were characterized and inventoried, of these 485 have BMPs. The inventory was accomplished in 12 months at a cost of about $732,000

Best Management Practices were grouped by type including: Infiltration trenches; Dry ponds; Dry wells; Wet vaults; Wet ponds; Oil/water separators; Biofiltration swales; and Spill control structures. Ecology ditches and catch basins were inventoried as experimental BMPs. Erosion control measures such as hay bales, rock check dams, silt fences, were also noted when associated with permanent BMPs.

Connections to WSDOT drainage system (pipes and open channels) were identified and records were checked to determine whether a permit had been applied for and recorded. Non permitted or unrecorded connections were listed as illicit connections. In all 66 connections were identified.

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A field observation and sampling process was used to screen for illicit connections. No illicit connections were discovered by sampling alone. The most effective method was visual inspection of connections to the WSDOT system and tracing these connections back to their origin. Sampling was useful to confirm already suspect sites. However, due to the excessive labor involved in identifying all connections only connections in close proximity to outfalls were observed. It is recommended that maintenance crews be alerted to observation of discharges during their normal inspection routines and that surveys be carried out in response to reports of flooding or contamination.

Regarding retrofit for highways where storm water management improvements have been identified, the cost for Puget Sound alone has been estimated at upwards of $200 million over the next 20 years. The actual funding level will be determined on a biennial basis by the Legislature and the Governor. $4.6 million has been requested for the next two years. A prioritization scheme has been developed which takes into account the receiving water body type, beneficial use of the receiving water, the pollutant loading (assumed to be directly proportional to the average Daily Traffic), and the percentage contribution of highway runoff to the watershed. Outfalls were first divided into high, medium, and low priority based on judgment. The 498 outfalls in the high priority group were then prioritized based on the above factors and a group of 210 outfalls were identified as having the highest priority. Further ranking of these locations also took into consideration the cost/effectiveness of the proposed BMP retrofit and local environmental and societal factors.

Seiber, Philip; Effects of Storm Water Regulations in Colorado; **Transportation Research Record No. 1483, 1995**

This paper describes how the NPDES regulations are implemented by Colorado Department of Transportation (CDOT) and the effects implementation has had on CDOT. The paper describes characterization of the system by identifying all CDOT outfalls to receiving waters (119 in all) and development of a GIS data base for the outfalls. Dry weather screening revealed that only ten of the 119 outfalls had dry weather flows. One monitoring site was selected at an outfall draining 7.59 hectares (18.76 acres) of paved and vegetated surfaces. The ADT on the 0.72 mile segment of roadway was 95,000.

Monitoring consisted of characterization of runoff for the entire suite of constituents required by EPA. Results from three storms in 1993, for those constituents detected, are presented in the paper. Results were comparable with earlier data obtained in an FHWA study at a site in Denver. In general a reduction in metals was observed. The cost of monitoring was quoted as approximately $50,000 per site (presumably annually). CDOT does not expect to engage in further monitoring except for research purposes.

In the paper conclusions from the widely quoted FHWA study undertaken in the late 1970s and early 1980s are presented. These conclusions include:

- There is little to no impact on the aquatic component of most receiving waters from runoff for highways with ADT <30,000 and no curb and gutter.
- Annual pollutant loading from highways are low compared to loads from entire watersheds

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- Of five species (Mayfly, isopod, water flea, gammarid, and fathead minnow) used in acute laboratory bioassays, only gammarid exhibited a toxic response to undiluted highway runoff.

The reference for these conclusions is "Effects of Highway Runoff on Receiving Waters. Vols. 062, 063, 064, 065, 066, FHWA-RD84, FHWA, US. Department of Transportation, 1995"

Construction and sand and gravel mining (industrial) activities related to NPDES permits are also discussed in the paper.

Shueler, Thomas, and David Shepp; Hydrocarbon Hotspots in the Urban Landscape; National Conference on Urban Runoff Management: Enhancing Urban Watershed Management at the Local, County, and State Level; March 30 to April 2, 1993.

This study was sponsored by the Maryland Department of the Environment under an EPA Chesapeake Bay implementation grant. The paper points out that there is a possible, but not conclusive, link between runoff from hydrocarbon hot spots and estuarine sediment contamination. Leakage, spills, and improper handling and disposal of automotive products were considered to be the key source of many pollutants observed in hydrocarbon hotspots. Effective source control strategies are therefore indicated as a pollution prevention practice. Oil and gas separators were studied in the project and the need for frequent and costly cleanout, to ensure that trapped pollutants are retained, was noted. The trapped sediments in the oil and gas separators did not quite meet the criteria considered hazardous for land filling, but they came close thus the disposal of the trapped material may be costly. For these two reasons serious questions are raised about the effectiveness of the current generation of oil and gas separators. Several design improvements seem to have potential for increasing retention of pollutants but have not yet been proved in the field.

State Water Resources Control Board and Regional Control Boards; Municipal Storm Water Management Plan Components - Draft Sept. 8 1994

This document addresses the Storm Water Management Plan required in the permit renewal process. The plan components are:

1. Program Management
2. Illicit Discharges
3. Industrial/Commercial Sources
4. New Development and Re-development
5. Public Agency Activities
6. Residential Activities
7. Public Information and Participation
8. Program Evaluation
9. Monitoring

Program management includes the structure under which participatory agencies work together on a unified plan and in focused sub-groups on specific program action areas. Institutional arrangements for cooperation between government entities and interagency agreements should also be described. Estimates of the costs of each element of the program should be included as well as

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funding sources for implementation of the program. Legal authority for carrying out the storm water program should also be cited.

A plan for finding and preventing illegal discharges is required. If a survey of the system was not completed as required during the first permit period the plan should contain a proposal for such a system survey. The plan should also state what will be done if an illicit connection is discovered, legal authority for dealing with offenders should be cited. There should also be a plan for ongoing system inspections and a description of the reporting system. Mechanisms for reporting and following up on illegal dumping or spills should also be described.

The plan for managing runoff from new development and re-development must cover both construction sites falling under the State Construction Storm Water General Permit and construction sites under 5 acres. The plan should address both during and post construction runoff controls and should include the planning process, construction site management, training and outreach, and permanent control measures.

Public agency activities encompasses all of the operational and maintenance activities associated with vehicle maintenance facilities, park areas and public facilities, storm drain systems, road systems, etc. The plan should include descriptions of these activities and identification of all significant sources of pollutants from these facilities and activities. A program to reduce to the maximum extent practicable, pollutants from pesticides, herbicides, and fertilizer should be described as should practices for operating and maintaining public streets, roads and highways with procedures for reducing the impact on receiving waters, of discharges, including pollutants resulting from deicing. Descriptions should include procedures for saw-cut slurry management, paving practices, pressure blasting/cleaning of sidewalks and other concrete areas, and all activities which are significant sources of pollutants.

The public information and participation component includes general outreach, focused outreach (pollutants specific or practice/activity specific), education programs, and citizen participation. The plan should address a process by which effectiveness of these efforts can be judged and through which program changes can be made.

Program evaluation requires that the program developed under the SWMP must be evaluated on a regular basis. The plan must include a methodology and a schedule for effectiveness evaluation, and a mechanism for following up on the information generated by the evaluation. The permittees must devise a way to evaluate the effectiveness of their activities and control measures. Control measure studies can be coordinated with other agencies and locations. Annual reports should be more than a simple compilation of activities, they should include an evaluation of the program and the effectiveness of the management measures. Any revision off the five year plan resulting from the evaluation of past activities should be included in the annual report.

Monitoring, not limited to water sampling, should be used to obtain baseline characterizations, to identify problems, to determine what is appropriate, and to evaluate effectiveness. Characterization of the systems was required under previous permits and the information gathered during the previous permit period should be described in the SWMP. Characterization includes descriptions of the watersheds, the storm drain system (including all major outfalls), and receiving waters which should be characterized and prioritized. The permitee should state the monitoring objectives for the permit period. These objectives may include source identification (focused monitoring), control measure effectiveness, determination of pollutant loading. (If characterization

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is not complete that would presumably also be an appropriate objective.) The SWMP should identify the information that will be collected, how it will be collected and used, and how it will be analyzed, reported, and stored.

URS Consultants; Literature Review and Attachments; Sacramento, Sept., 1995

URS provided a compilation of references obtained from in house resources and U. C. Berkeley database search; abstracts of publications in the TRIS data base; a list of Turner-Fairbank Highway Research Center titles; a list of the Virginia Water Resources Research Center publications; and excerpts from a research report: "Analytical Investigation of Pollutant Loading and Impacts from Highway Storm Water Runoff" by Driscoll et al, Woodward Clyde Consultants.

URS indicated that they had requested some of the documents pertaining to inlet cleaning, we have not received copies of these documents....Should try to get.

The most useful portion of the literature review is the section containing the TRIS abstracts. The following records in that set of abstracts are of most interest: Records # 2, 5, 10, 12, 13, 14, 16, 27, 28, 32, 44, 46, 50, 59 to 62, 65, 70, 84, 85. These records indicate that the following agencies are active in research and studies into effective methods of control of the quality of storm water runoff. Virginia DOT, Florida DOT, Washington DOT, New York DOT, Maryland DOT, Texas DOT, Perth, Australia; and Ontario, Canada. Although studies into the effectiveness of structural BMPs are few, there seems to be a consensus that settlement methods (wet ponds, detention basins, vegetated channels, grassy swales) can be effective. One study showed that 65 to 80% of solids were removed in a sediment basin but only 28 to 40% of metals were removed. This lower reduction in metals load is due to the fact that much of the metal load is attached to smaller particles which are not removed in sedimentation. Infiltration methods are considered excellent for removal of pollutants but they have very high maintenance costs. New York DOT has used ground "water recharge basins" and has investigated the use of enclosed underground leaching basins to reduce some of the maintenance problems. Maryland Department of Transportation attempted (in 1989) to compare the effectiveness of infiltration structures (SWMIS) with detention basins but the study failed. Virginia DOT has a "Manual of Practice for Planning Storm Water Management" in which BMPs are described.

Washington State Department of Transportation; Highway Runoff Manual; Environmental and Engineering Service Center, 1995.

This document is a guide for the design and operation of transportation facilities that are related to and affect storm water runoff. The guide provides uniform procedures for implementing design and maintenance decisions regarding runoff practice to ensure a continuity of quality of these facilities. Both permanent and construction related facilities are covered in the guide.

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Washington State Department of Transportation; Water Quality Unit Research Projects, '95-'98.

This is a list and brief description of research underway 1995-1998. Research topics are:

1. Assessment of Relative Storm Water Runoff Control Advantages of Alternative Roadway Shoulder Pavements (principally porous pavement)
2. Cost/Benefit Analysis of Storm Water Retrofits
3. Assessment and Application of Highway Slopes for Highway Storm Water Contaminant Removal (filter strip design)
4. Enhancing Contaminant Removal in Storm Water Detention Basins by Coagulation
5. The assessment of Ground Water Pollution Potential Resulting from Storm Water Infiltration BMPs
6. Catalytic Pavement Borders (see Jones and Watts paper reviewed in this document)
7. BMP Evaluation for Handling and Treating Storm Water in Confined Situations
8. Filter Strips and Ecology Ditch Field Monitoring and Assessment
9. Wet detention Pond Design for Highway Runoff Pollutant Control.

Wilber, William G., and Joseph V Hunter; Distribution of Metals in Street Sweepings, Storm Water Solids, and Urban Aquatic Sediments; Journal WPCF, Vol. 51, No. 12; Dec. 1979.

This paper presents information on the association of heavy metals in street sweepings, storm water solids, and sediments, with various chemical fractions. Chemical fractions include soluble form, ion-exchangeable form, easily reducible manganese oxides, organic fraction, and moderately reducible iron. The research was conducted in the lower reaches of the Saddle River in New Jersey. The soluble fraction in street sweepings was less than 1% on the average. Percentages were somewhat higher for sediments. On the average 16.7% of the metals were bound to organic matter. Other results are presented in the paper

Yousef, A. Yousef et al; Maintenance Guidelines for Accumulated sediments in retention/Detention Ponds receiving Highway Runoff; University of Central Florida; FL-ER-47-91; May 1991

This study of 9 ponds in the State of Florida had as its objectives, determination of:

- The vertical accumulation rates of bottom sediments and the distance from the input pipe that bottom sediments can be detected;
- The characteristics of the accumulated sediments;
- The particle size distribution of bottom sediments;
- The potential toxicity of the bottom sediments;
- Relationships between drainage basin characteristics and frequency of sediment removal; and accumulation rates.

The goal of the project was development of recommendations for maintenance and disposal of sediment, and recommendations for desirable design features of detention ponds which will reduce the need for maintenance or optimize maintenance procedures.

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The project included a literature survey which indicated that efficient removal of small size particles can greatly enhance the effectiveness of wet ponds and that a 90% removal efficiency for suspended solids can be achieved with three days of detention time. The literature reviewed also indicated that providing for settlement of 90% of suspended solids can lead to a large volume of bottom sediments possibly around 13% of the ponds storage volume over a 10 year period; and accumulation of bottom sediments in detention ponds can also lead to unwanted growth of aquatic plants.

As a result of the study dredging frequency is recommended to be once every 25 years. Bottom sediments did not fall into the hazardous waste category. Herbicide treatment was recommended twice yearly with a maximum of 10 to 25% of the pond area being sprayed at any one application. Experimentation with herbicide frequency was recommended along with study of side effects was said to be urgently needed in order to develop a defensible herbicide program. Recommended design features pertained to providing access for maintenance equipment (rather than design features which will reduce the need for maintenance), providing stable banks and slopes, and restricting pond width to 100 to 200 feet to ensure that available equipment can reach to the middle of the pond. The importance of routine visits annually or twice yearly and the keeping of good maintenance records was stressed. Study of release of pollutants and nutrients into water beneath the ponds was also called for.

Yu, Shaw; Storm Water Management for Transportation Facilities, National Cooperative Highway Research Program Synthesis of Highway Practice No. 174, 1993

This report covers all aspects of storm water runoff management. The report lists common highway runoff constituents and their primary sources drawing on the widely quoted 1984 FHWA document titled "Sources and Migration of Highway Runoff Pollutants" (FHWA/RD-84/057). Summaries of data collected in the FHWA monitoring study of 31 sites in 11 states are presented in Yu's report but the summaries are for a select number of sites, not all 31 sites. Conclusions from the FHWA study were summarized as:

- Amount of constituents generally increased with ADT
- Total solids is a good index parameter that relates to other quality parameters.
- The major portion of the priority pollution load was attributed to metals such as lead, zinc, and copper. A significant number of organic priority pollutants were also present.
- There were no significant concentrations of pesticides and herbicides but sizable concentrations of coliform bacteria were observed at all sites

Yu cites other studies. One in particular (Ellis, J. B., "Pollution Aspects of Urban Runoff" in Urban Runoff Pollution edited by H. C. Torno et al., NATO ASI Series, Springer-Verlag (1985)) concluded that urban highway runoff can be a significant source of pollution discharging high metal and hydrocarbon loadings. This study was based on data from European and Australian sources.

Yu's report contains a chapter on management of storm water quantity and a chapter on management of quality. Measures to control quality are subdivided, as they typically are, into non structural and structural measures. There is no discussion of street sweeping or catch basin cleaning. The report includes descriptions and design considerations for structural controls. Tools for planning and decision making are presented and institutional aspects are also discussed in the report.

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PART 2 MAJOR FINDINGS SUMMARIZED BY SUBJECT MATTER

1. Constituents and their concentrations in highway storm water runoff

Characterization data for highway runoff was found in the following sources:

- The mid 1970 to mid 1980 FHWA study
- 1993 monitoring data for Colorado Department of Transportation
- 1995 monitoring data for Oregon Department of Transportation
- 1992-93 monitoring data at transportation corridors for Santa Clara Valley Water District
- 1994-95 monitoring data for Caltrans Districts 3 and 6, and 8 and 12.

Priority pollutants in runoff are considered to be heavy metals and organics. Generally highway runoff has been found (Oregon Department of Transportation) to be comparable with data from residential, commercial and industrial sites, but dissolved lead (Santa Clara Valley Water District), dissolved copper, and oil and grease are often higher for highway runoff sites. On the other hand total Kjeldhal nitrogen, total phosphorous, and fecal coliform are generally lower for highway runoff sites (Oregon Department of Transportation). In Alameda County recent conclusions indicate that "metals should be de-emphasized as a cause of toxicity during storm events" and that monitoring emphasis should be placed on toxicity due to organics, pesticides, sediments (and sedimentation), and eutrophication. Earlier studies (Maestri, 1988) had indicated that metals were of greater concern than nutrients while recently (1994) Clark County found that bacteria was their primary pollutant of concern. Organic toxicants have been found in relatively greater frequencies from parking areas and vehicle service areas, and relatively high concentrations of lead have been found in runoff from vehicle service areas and streets (Pitt, 1995).

Available data are assembled in Part 3 of this report. Some observations, based on the literature are summarized here.

Highway Runoff Quality Data in California

Available data are assembled in Part 3 of this report. Some observations, based on the literature are summarized here. The data available for sites in California includes:

- FHWA data for the three sites in California (Los Angeles, Sacramento, and Walnut Creek). These data were collected in 1979, 1980, and 1981.
- Monitoring data in Districts 3, 4, 6 and 8 as required by their respective permits.

A summary of the FHWA storm water quality data from the three sites in California are shown in Table 2.1. Nationwide data reported in the literature (Barrett et al., 1993) and recent data collected by Caltrans Districts 3 and 6 are presented in Table 2.2. As seen in Tables 2.1 and 2.2 the mean concentrations reported for California sites (both by FHWA and Caltrans) are within the range of mean concentrations that were reported in the literature. Caltrans data are being compiled into a data base in MS Excel spreadsheet. The data base is preliminary and requires a quality control review before any statistical analysis can be performed.

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Table 2.1. Characterization of Highway Runoff in California (FHWA Data)

Constituent	Los Angeles Data					Walnut Creek Data				
Solids	N	Min	Max	Median	Mean	N	Min	Max	Median	Mean
Total										
Dissolved	31	16	461	87	130	28	16	197	63	74
Suspended	32	18	15800	108	1330	30	66	1110	191	267
Volatile, dissolved										
Volatile, suspended										
Volatile, total										
Metals										
Zn	32	0.10	2.20	.525	0.67	31	0.08	0.67	0.25	0.29
Cd	15	ND	0.02	0.01	–	9	ND	0.01	ND	–
As										
Ni										
Cu										
Fe										
Pb	32	0.17	4.10	0.53	1.00	31	0.08	3.30	0.48	0.76
Cr										
Mg										
Hg, x 10^{-3}										
Nutrients										
Ammonia, total as N	29	0.06	4.60	0.54	0.87	29	0.06	1.40	0.25	0.31
Nitrite, total as N										
Nitrate, total as N	29	0.09	8.40	1.00	1.48	29	0.09	1.20	0.46	0.456
Nitrite + Nitrate										
Organic, total as N										
TKN	29	0.6	14	2.3	3.94	29	0.1	6.3	1.7	1.93
Nitrogen, total as N										
Orthophosphate, as P	26	ND	0.07	0.04	–	29	0.01	1.10	0.05	0.10
Phosphorus, total as P	29	0.06	1.70	0.21	0.44	29	0.09	1.80	0.38	0.43
Other Parameters										
Total coliforms, MPN/100 ml										
Fecal coliforms, MPN/100 ml										
Sodium										
Chloride										
pH										
TOC										
COD	29	23	724	112	193	30	22	282	116	131
BOD_5										
Polyaromatic Hydrocarbons (PAH)										
Oil and grease										
Specific conductance (μmhos/cm) 25° C										
Turbidity (NTU)										
Boron	26	ND	4.3	0.2	–	27	ND	0.3	0.1	–

Data were summarized from Racin et al. (1982), FHWA/CA/TL-82-11. Data sheets were not reviewed.

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Table 2.1. Characterization of Highway Runoff in California (FHWA Data) (Continued)

Constituent	Sacramento Data				
Solids	N	Min	Max	Median	Mean
Total	34	68	411	191	194
Dissolved					
Suspended	34	12	279	94	103
Volatile, dissolved					
Volatile, suspended	25	7	46	20	21
Volatile, total	25	20	93	56	54
Metals					
Zn	34	0.09	0.80	0.27	1.29
Cd	28	ND	0.04	0.02	–
As	2	ND	0.03	–	–
Ni	28	ND	0.2	0.1	–
Cu	28	ND	0.16	0.06	–
Fe	34	0.4	10.7	3.5	4.8
Pb	34	ND	0.7	0.4	–
Cr	28	ND	0.04	0.02	–
Mg					
Hg, x 10^{-3}	7	ND	0.01	ND	–
Nutrients					
Ammonia, total as N					
Nitrite, total as N					
Nitrate, total as N					
Nitrite + Nitrate	18	0.04	1.7	0.26	1.3
Organic, total as N					
TKN	18	ND	6	2	–
Nitrogen, total as N					
Orthophosphate, as P	18	0.03	4.45	0.11	1.28
Phosphorus, total as P					
Other Parameters					
Total coliforms, MPN/100 ml					
Fecal coliforms, MPN/100 ml					
Sodium	5	2.6	60	2.8	13
Chloride	24	3	110	6	
pH					
TOC	12	4	46	21	21
COD	12	16	99	49	53
BOD5					
Polyaromatic Hydrocarbons (PAH)					
Oil and grease	9	3	21	10	10
Specific conductance (µmhos/cm) 25° C					
Turbidity (NTU)					
Boron					

Data were summarized from Racin et al. (1982), FHWA/CA/TL-82-11. Data sheets were not reviewed.

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Table 2.2. Caltrans Runoff Data Compared to the Literature Highway Runoff Characterization.

Constituent	Concentration[1] (mg/l unless noted)	Load[1] (kg/ha/year)	Load[1] (kg/ha/event)	Caltrans Data[2] (mg/l unless noted)
Solids				
Total	457 - 1147		58.2	
Dissolved	356	148		4 - 575 (5)
Suspended	45 - 798	314 - 11,862	1.84 - 107.6	ND - 1410 (7)
Volatile, dissolved	131			
Volatile, suspended	4.3 - 79	45 - 961	.89 - 28.4	
Volatile, total	.57 - 242	179 - 2518	10.5	
Metals				
Zn	.056 - .929	.22 - 10.40	.004 - .025	0.05 - 50 (8)
Cd	ND - .04	.0072 - .037	.002	ND (8)
As	.058			ND - .033 (4)
Ni	.053	.07		ND (8)
Cu	.022 - 7.033	.030 - 4.67	.0063	ND - 35
Fe	2.429 - 10.3	4.37 - 28.81	.56	ND - 42.8 (6)
Pb	.073 - 1.78	.08 - 21.2	.008 - .22	ND - 20
Cr	ND - .04	.012 - 0.10	.0031	ND - .077 (8)
Mg	1.062			1.1 - 5.4 (2)
Hg. x 10^{-3}	3.22	.007	.0007	ND (4)
Nutrients				
Ammonia, total as N	.07 - .22	1.03 - 4.60		ND - 1.8 (3)
Nitrite, total as N	.013 - .25			ND - .8 (4)
Nitrate, total as N	.306 - 1.4			ND - 9.9
Nitrite + Nitrate	.15 - 1.636	.8 - 8.00	.078	
Organic, total as N	.965 - 2.3			
TKN	.335 - 55.0	1.66 - 31.95	.17	1.6 - 13 (4)
Nitrogen, total as N	4.1	9.80	.02 - .32	3.5 - 4.6
Phosphorus, total as P	.113 - .998	.6 - 8.23		ND - 5.5 (4)
Other Parameters				
Total coliforms, organisms/100 ml	570 - 6200			≥ 1600 - 17000
Fecal coliforms, organisms/100 ml	50 - 590			10 - ≥ 1600
Sodium		1.95		ND - 51
Chloride		4.63 - 1344		11.3 - 52.8
pH	7.1 - 7.2			4.7 - 8.3 (5)
TOC	24 - 77	31.3 - 342.1	.38 - 2.35	ND (1)
COD	14.7 - 272	128 - 3868	2.90 - 66.9	ND - 283 (5)
BOD_5	12.7 - 37	30.60 - 164	0.98	9 - 23.2 (3)
Polyaromatic Hydrocarbons (PAH)		.005 - .018		
Oil and grease	2.7 - 27	4.85 - 767	.09 - .16	ND - 38 (7)
Specific conductance (µmhos/cm) at 25° C	337 - 500			140 - 650
Turbidity (JTU)	84 - 127			
Turbidity (NTU)	19			24 - 1300 (4)

[1] The reported values (the first three columns with data) are for the average values that were reported in the literature (Barrett, 1993).

[2] Caltrans data are summarized for Districts 3, 4, 6, and 8. This summary is preliminary and should not be cited. The numbers indicate the range of reported concentrations and the number of measurements are shown in parentheses. ND is for Not detected

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Oregon Department of Transportation (ODOT) Monitoring Program:

ODOT has developed a monitoring program with two flow-weighted composite sampling locations (near Portland (I-5) and Eugene (I-105)), five grab sampling locations to represent the western region of Oregon, and five snow sampling locations to represent snow melt runoff quality. The monitoring program sampling plan is summarized in Table 2.3. Samples were collected for the first cycle during January 1995 through June 1995, except for the grab sampling locations. A summary of the monitoring data is shown in Table 2.4.

Colorado Department of Transportation (CDOT) Monitoring Program:

CDOT's monitoring program is focused on testing for parameters that were detected during the first sampling episode (during 1993) and in the 1970s FHWA data that were collected in Colorado. The constituents included in the monitoring program are shown in Table 2.5.

A summary of the CDOT and FHWA monitoring data for Colorado is shown in Table 2.6. The data shown in Table 2.6 were collected in 1993 and 1980 for CDOT and FHWA monitoring, respectively. The data shown are comparable except for TSS and lead. The TSS difference was attributed to a single high TSS reading during one storm. The difference in lead concentration is attributed to switching to unleaded gasoline.

2. Factors affecting constituents and their concentrations in storm water runoff

Factors affecting the quality of storm water runoff are reported in Barrett et al (1993). The most influential factors are the rainfall itself, dustfall, traffic volume during the event, and removal processes such as air turbulence and storm intensity. It is recognized that there is a correlation between heavy metals and suspended solids (Sansalone, 1995), that some pollutants (e.g. lead) are associated with large particles and others (e.g. zinc) are associated with small particles (Barrett et al, 1993). Organics have been found to be more prevalent at locations where people get out of their vehicles, such as parking lots and vehicle service areas (Pitt et al, 1995).

It is clear that there are many factors affecting constituents found in storm water runoff from highways and associated right-of-way. The variability and complex combinations of these factors cause great variability in concentrations of constituents found in runoff. In reviewing available runoff data, information on the causal factors is generally not provided or is inconsistently provided. It is important to consistently record all of the factors which may contribute to runoff quality when data is collected. A composite list of factors has been drawn up by Caltrans and a task order has gone out to Woodward Clyde to compile the data for all of the appropriate factors for locations at which monitoring is being conducted in 1995/96. This data will be useful in seeking explanations for variability of concentrations in the results obtained this year. The compilation of data for contributing factors will also enable Caltrans to determine whether the 1995/96 monitoring has captured the full range of runoff quality. This can be done by looking for combinations of factors that are expected to result in concentrations at the high and the low end of the spectrum.

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Table 2.3. A Summary of Oregon Department of Transportation Sampling Plan[f]

Constituent	Composite Sampling Locations			Grab Sampling locations	
Solids	Composite (a)	Grab (b)	Field (c)	Grab (b,d)	Field (e)
Total					
Dissolved					
Suspended	x			x	
Volatile, dissolved					
Volatile, suspended					
Volatile, total					
Metals					
Zn	x			x	
Cd	x			x	
As					
Ni					
Cu	x			x	
Fe					
Pb	x			x	
Cr					
Mg					
Hg x 10⁻⁶					
Nutrients					
Ammonia, total as N	x			x	
Nitrite, total as N					
Nitrate, total as N	x			x	
Nitrite + Nitrate					
Organic, total as N					
TKN	x			x	
Nitrogen, total as N					
Phosphorus, total as P	x			x	
Other Parameters					
Total coliforms, organisms/100 ml					
Fecal coliforms, organisms/100 ml		x			
Sodium					
Chloride					
pH			x		x
TOC					
COD					
BOD_5	x				
Polyaromatic Hydrocarbons (PAH)					
Oil and grease		x		x	
Specific conductance (μmhos/cm) 25° C	x		x	x	
Turbidity (JTU)					
Turbidity (NTU)					

(a) Composite samples were analyzed for orthophosphate, hardness, and total and dissolved metals.
(b) Grab samples were analyzed for Total Petroleum Hydrocarbon (TPH) and E. Coli bacteria in addition to the list shown above.
(c) Field measurements included temperature and dissolved oxygen.
(d) Grab samples were analyzed for orthophosphate, hardness, and total and dissolved metals.
(e) Field measurements included temperature in addition to pH.
(f) Snow samples were analyzed for same parameters as the grab sampling locations except for TKN, bacteria (both fecal and E. coli), DO, pH, and temperature.

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Table 2.4. A Summary of ODOT Monitoring Data

Constituent	Composite Sampling (mg/l unless noted)	Snow Sampling (mg/l unless noted)
Solids		
Suspended	240 - 520	
Metals		
Zn	0.11 - 0.49	0.004 - 0.064
Cd	0.0005 - 0.0015	< 0.0002 - 0.0006
Cu	0.014 - 0.066	0.002 - 0.035
Pb	0.03 - 0.38	0.001 - 0.060
Nutrients		
Ammonia, total as N	< 0.2 - 1.15	< 0.2
Nitrate, total as N	0.18 - 1.5	0.02 - 0.04
TKN	1 - 3.55	
Orthophosphate	0.02 - 0.05	< 0.01
Phosphorus, total as P	0.31 - 0.90	0.26 - 0.63
Other Parameters		
Total coliforms, organisms/100 ml	600 - 8700	
pH	6.1 - 8.1	
COD	90, 140	
BOD_5	3 - 23	< 3
Total Petroleum Hydrocarbons	5.0 - 8.5	< 4
Oil and grease	6.5 - 12.0	< 2 - 5
Dissolved oxygen	6.7 - 10.2	
Temperature, °C	9.7 - 25	

Table 2.5. Constituents Monitored in Highway Runoff Samples by Colorado DOT

Solids	Metals	Nutrients	Other Parameters
Suspended	Copper (total)	Total nitrogen	BOD5
Dissolved	Zinc (total)	Nitrite + Nitrate	COD
	Cadmium (total)	TKN	Fecal Coliform
	Lead (total)	Ammonia	Fecal streptococci
	Chromium (total)	Nitrite	Oil and Grease
	Nickel (total)	Dissolved phosphorus	pH
	Arsenic	Total phosphorus	Sodium (dissolved)
	Mercury (total)		Chloride (dissolved)
			Calcium (dissolved)
			Potassium (dissolved)
			Sulfate (dissolved)
			Magnesium (dissolved)
			Phenols (total)
			Alkalinity
			Specific conductance
			TOC
			Bis(2-ethylhexyl) phthalate

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Table 2.6. A Summary of CDOT Monitoring Data

Constituent (mg/l unless noted)	EMCs (CDOT) (I-225 site)	EMCs (FHWA) (I-25/I-70 site)
TSS	1419.138	344.737
TDS	154.573	N/A
BOD5	34.077	33.293
Total nitrogen	5.388	N/A
TKN	3.748	2.835
Total phosphorus	0.575	0.649
Dissolved phosphorus	0.458	N/A
Cadmium (total), µg/l	1.578	17.137
Copper (total), µg/l	49.359	108.664
Lead (total), µg/l	128.462	579.323
Zinc (total), µg/l	470.653	477.256

3. Need for continued monitoring for characterization of runoff

Because of the extreme variability of concentrations of constituents found in storm water runoff and the number of factors contributing to that variability a large amount of data would be needed to develop and verify models relating the concentrations to the factors. Continued monitoring at a few sites across California is not likely to yield sufficient data for modeling. The objective of monitoring for characterization of runoff should therefore be examined carefully.

One possible objective is to determine the likely range of concentrations of constituents in highway runoff and to compare these concentrations with those found in California municipal and industrial runoff, to data for highway runoff in other states, and to water quality criteria. After the 1995/96 monitoring season there may be enough data to achieve this objective. Another objective could be monitoring for trends in runoff quality. This would require fewer sites. Those sites should be selected to capture the most important factors contributing to runoff quality. Monitoring will also be needed for special studies. A data base compiling all monitoring data for transportation facilities in California would be useful.

4. Other objectives of monitoring.

There are many objectives for monitoring beyond those discussed above. The objectives can be divided into two categories which are identification of the problem and study of the effectiveness of solutions. Monitoring is often used in special studies. The literature review, and discussions with other permitted agencies has revealed the following objectives and associated monitoring:

- Estimation of contribution of wet weather and dry weather flow contributions to loads of pollutants, by monitoring at outfalls to receiving water. (Clark County regional Flood Control District)
- Estimation of cost effectiveness of catch basin cleaning by monitoring removal efficiency (Felstul et al, Oregon)
- Estimation of contribution of highway runoff (or constituents in the runoff) as a percentage of all contributions in a drainage area.

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- Identification of overall effectiveness by monitoring at point of discharge
- Comparison of before and after concentrations when BMPs are implemented
- Comparison of concentrations upstream and downstream of a BMP
- Estimation of pounds of pollutants removed by a BMP
- Prioritization of pollutants of concern
- Prioritization of sources of pollutants of concern

Monitoring should be targeted at objectives that will be most useful to the discharger in the storm water management program

5. Cost and effectiveness of monitoring

No discussion of the cost effectiveness of monitoring has been found. Colorado Department of Transportation estimates the cost of monitoring at $50,000 per site per year. *(Can follow up with local agencies that have permits - now have a list)*

6. Application of toxicity testing and microtox tests

The limited number of studies that have included toxicity testing of highway runoff (see Seiber, 1995, quoting from FHWA 1990, and Lopes, 1995) indicate some toxicity at 100% concentration of runoff.

FHWA results showed that, of five species (Mayfly, isopod, water flea, gammarid, and fathead minnow) used in acute laboratory bioassays, only gammarid exhibited a toxic response to undiluted highway runoff.

Lopes (1995) found toxicity to flathead minnows and to waterfleas. The percentage of first flush samples exhibiting toxicity was larger than the percentage of flow weighted samples. In most cases dilution of the storm water runoff at 1 in 2 or 1 in 4 removed the toxicity. For some samples, mostly associated with recent repaving or oiling of paved surfaces, dilution's in excess of 1 to 16 were required to remove toxicity.

Since the expected dilution of storm water runoff, on entering receiving waters is generally very large (with the exception of local creeks), the toxicity results described above do not suggest that receiving waters will become toxic due to the addition of constituents in storm water. In fact increases in concentrations of constituents in receiving water may and often do remain undetected upstream and downstream of an outfall in the receiving water.

Toxicity testing accompanied by Toxicity Identification Evaluation (TIE) to identify the constituent(s) causing the toxicity could be useful for studying hot spots or for monitoring the improvements achieved by specific structural BMPs. However there is often no toxicity at 100% concentration of runoff.

7. Identification of hot spots

No discussion of this topic has been found (except for identification of illicit connections and discharges) however information about the factors affecting runoff quality are useful in prioritizing

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efforts in the search for hot spots. In one study (Lopes et al, 1995) the most toxic samples were found at sites which had recently been reparved or resealed.

8. System inventories/definition of major outfalls

The Washington State Storm Water Management Program provides a good example of the inventories needed in order to plan an effective management system.

9. Receiving water monitoring, sensitivity, and impacts

Impacts on receiving waters are site specific. Therefore it is important to have information about the receiving water. Some of this information is available but the literature reviewed has not covered this topic. One paper discusses establishment of a National Water Quality Monitoring Program (Powell, 1995). A limited number of local (California) studies have been done, these are generally a cooperative effort...need to explore more *(We have a list of local agencies with permits and can follow up on this)*

10. BMPs and their effectiveness

The initial response to NPDES requirement for implementation of BMPs is generally focused on source controls and general "good housekeeping" practices for highway operation and maintenance. Both source controls and structural BMPs are being implemented on construction sites, in maintenance yards, and at parking lots. The high costs and often high maintenance required for structural BMPs makes them unattractive to developers, for use in new developments, and to public agencies for use on highways. Roesner and Ott, 1995, estimate the cost of control measures at $6,000 per square mile of drainage area for simple source controls, and up to $3.5 million per square mile of drainage area for implementation of treatment controls as well as source controls. The literature contains many lists and descriptions of structural BMPs

11. Prioritizing efforts

The generally recognized best approach to allocation of limited resources is to use both need and cost effectiveness as prioritization criteria. Need is established by the constituent concentrations or level of toxicity of run off at any particular location and the sensitivity of the receiving water based on its uses and its existing condition.

The Best Management Practices Handbook (Municipal) area for makes the point that, in order to move the program forward, a plan should be formulated based on what is known and that the plan should include work to learn more about the problem and the alternative solutions. Each permittee is at liberty to propose their own unique plan and devise ways to evaluate the effectiveness of the plan and the BMPs for future planning efforts.

Need has been used extensively in prioritizing efforts. The identification of illicit discharges and illegal dumping which may cause hot spots in the system has received high priority. The sensitivity of the receiving water, though elusive to pin down, is considered of importance in prioritizing

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effort. Construction sites which can contribute large quantities of sediment to storm drains; maintenance yards which have the potential to discharge pollutants; and parking lots where oil, gasoline, and debris accumulate are generally targeted for implementation of structural BMPs. Now, within each of these programs and within the highway maintenance and operation program, further prioritization should be based on cost effectiveness.

Using the guidelines in the Best Management Practices Handbook (Municipal) it would be logical to base prioritization of need on known factors that affect runoff quality. For example drainage from high ADT roadways would receive highest priority, drainage systems delivering the largest volume of runoff to a receiving water would receive highest priority, or drainage systems affecting drinking water or sensitive receiving waters would receive highest priority. The State of Washington DOT has taken this approach to prioritization (see Schaftlein).

It is expected that the SWRCB will want to see plans for measuring effectiveness in the resulting quality of runoff. Pamela Barkdale of the Central Valley RWQCB specifically mentioned the need to evaluate the effectiveness of source controls. It can be argued that several years of monitoring for trends in event mean concentrations are needed to evaluate the bottom line effectiveness of the system wide BMPs being implemented now and that this time should be provided before more costly (retrofit) measures are implemented. This seemed to be indicated as an acceptable approach when we interviewed Bruce Fujimoto and Mary Anne Jones. If District 7 is required to implementation costly retrofit BMPs pilot projects to study the effectiveness of such retrofit BMPs can be proposed in the SWMP as special studies.

(Note: The District 7 SWMP appears to arrive at a set of near term BMPs without going through the process of setting goals and prioritization. It could be argued that since the highway runoff pollution problem - to the extent that there is one - is pervasive and low level, BMPs should principally be "good housekeeping" and should be implemented system wide. Construction activities and maintenance yard activities are rightly selected as high priority areas because of their higher potential for creating problems in runoff. Evaluation of effectiveness, for future planning is not addressed well in the District 7 SWMP)

12. Cost/Effectiveness of BMPs

Cost effectiveness of structural BMPs can be based on the cost per pound to remove undesirable constituent(s). However, even if this cost per pound could be estimated (data on costs has not been found), nothing in the literature reviewed provides a basis for evaluating the result as cost effective or not cost effective.

A fair amount of information is available on structural BMP design and effectiveness. Settlement and infiltration are the two most commonly cited processes. Settlement effectively removes large particles and their associated constituents but infiltration, which is much more costly is needed for removal of finer particles. One of the major problems is selection of the design storm size and the required capacity of the BMP. Effectiveness is generally measured by the percentage reduction in sediments and in specific constituents, particularly metals. Percentage effectiveness for various measures are cited in the literature (Barrett et al, 1993; Dunn et al, 1995). The city of Sacramento has initiated a nationwide storm water special study/BMP data base (Sacramento County Water Agency, 1995)

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Although most agencies are implementing source controls and "good housekeeping" BMPs, because these are less costly than retrofitting existing facilities with structural BMPs, very little is known about their cost or their effectiveness. The use of performance curves for optimization of maintenance activities is proposed by Felstul et al., 1995. Costs generally will be absorbed into the day to day operating budget of the agency and will diminish funds available for other maintenance activities.

Since the non-structural BMPs are generally being implemented on a system wide basis it will not be possible to measure their individual effectiveness. Their combined effectiveness will not be easy to determine either because there will be a phasing in period and their full implementation would have to be ensured before their combined effectiveness could be determined. Long term monitoring may provide trend data which will give some indication of the effectiveness of non-structural BMPs. The only agency known to be attempting to evaluate the effectiveness of non-structural BMPs is Sacramento County where a small watershed will be selected for intense implementation of non-structural BMPs and motoring to evaluate their effectiveness.

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POSSIBLY ADD TO PART 1

Reporting results from 3 storm events at one site in Denver during 1993, Colorado DOT shows average TSS concentrations of 1419 mg/l. Sampling was done at the last inlet located in the median just before the outfall to a creek. The three storms occurred in July and August and had antecedent dry periods of 144, 120, and 48 hours. TSS was highest for the first storm event (2910 mg/l). The earlier FHWA study monitored 16 storm events at a different site in Denver and reported an average TSS of 345 mg/l. Highest concentrations of TSS were 1185 mg/l and 1029 mg/l and both occurred in spring (April an May).

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CONTROLLING TOXIC POLLUTION IN URBAN STORMWATER RUNOFF

Options For Local Governments

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This is one of a series of policy initiatives produced by the Communities Controlling Toxics Project, a program of the Local Government Commission.

The Local Government Commission is a nonprofit, membership organization of local elected officials interested in finding community level solutions to problems of state and federal significance.

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Controlling Toxic Pollution In Urban Stormwater Runoff:

Options for Local Governments

WHAT IS URBAN RUNOFF?

Urban runoff consists of material deposited on land which is washed from urban surfaces by storms or other sources of flowing water, through the flood control system, into creeks, lakes and bays, and the ocean. Urban runoff contributes many pollutants to receiving waters. This contamination includes bacteria and viruses, toxic heavy metals and organic compounds. Prior to its discharge into receiving water, urban runoff is considered "nonpoint source pollution" (sources that are diffuse and difficult to identify). "Point source" pollution is easily traced to a specific discharge pipe such as a municipal sewage treatment plant.

WHERE DOES THE POLLUTION FROM URBAN RUNOFF ORIGINATE?

Sources of pollution in urban runoff include oil and grease, diesel emissions and leakage, car exhaust, pesticides and fertilizers, urban bird and pet waste, street litter accumulation, road surface abrasion by traffic, vehicle tire wear, sedimentation from construction, and the illegal disposal of toxic wastes by businesses, industry and individuals.

HOW MUCH WATER POLLUTION IS ATTRIBUTED TO URBAN RUNOFF?

In recent years evidence has accumulated indicating that in most urbanized areas **stormwater is one of the most significant sources of water pollution.** A recent study by the Aquatic Habitat Institute indicates that urban runoff accounts for one-third of the PCBs and PAHs found in the San Francisco Bay, in addition to one-sixth of the hydrocarbons, one-fourth of the mercury and one-tenth of the lead. Nonpoint pollution expert Michael Stenstrom from UCLA estimates that about 50% of the oil and grease pollutants in Southern California oceans and bays comes from runoff.

WHO IS TAKING RESPONSIBILITY FOR CONTROLLING POLLUTION FROM RUNOFF?

The State of California has not yet developed a coherent management strategy for controlling pollution from urban runoff.

Section 208 of the National Clean Water Act requires states to develop a statewide nonpoint source assesment program describing the measures the state will take to address nonpoint source pollution, however federal funding for this program has been eliminated. The State of California has proceeded, without funding, and has developed a draft assessment plan and a management plan.

This preliminary document has begun the process of determining the impact of nonpoint source pollution on California's receiving waters. Some regional water quality control boards have gone further. The San Francisco Bay Area Regional Water Board is working with Santa Clara and Alameda Counties to institute a planning program. The City of Los Angeles is currently evaluating its runoff problem with a $3.3 million study of the relative contributions of different land uses to nonpoint pollution.

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Section 405 of the Clean Water Act will require municipalities to acquire a NPDES (National Permit Discharge Elimination System) permit for stormwater discharges. The specific requirements of these permits should be released by the EPA in February, 1989. In general, cities and counties will be required to identify pollutants in the outfall and to list pollution control measures. Measures to control illegal dumping will receive specific attention.

City and county public works departments will usually be the responsible agencies. Cities and counties with combined sewer/storm runoff systems will not be affected.

Most steps toward cleaning up pollution from urban runoff will require local government action. **Local governments can and should take responsibility today for leading the way in addressing the control of pollution from urban runoff.**

URBAN RUNOFF POLLUTION CONTROL OPTIONS

Pollution control of urban runoff can be addressed either at the point of pollution generation or at the point of pollution transport.

Intervention at the point of generation attempts to stop the introduction of the pollutant to the storm drain system. Intervention at the point of transport is designed to "treat", contain or minimize the effluent after it has been introduced into the environment, mainly through structural measures. To control the level of pollution in urban runoff, it is necessary to control the transportation of sediments. Most toxic materials are hydro-phobic -- they naturally seek out particles in the flow (such as pebbles or grains of sand) and attach to the surface of these solids. Thus, dealing with sedimentation is viewed as the principal strategy for the structural control of urban runoff quality.

INTERVENTION AT THE POINT OF POLLUTION GENERATION

When it can be accomplished, it is obviously preferable to prevent the introduction of toxic substances into urban runoff rather than to put a band-aid on the problem. The measures listed below are preventive strategies. All are important steps to take and can be implemented alone or in tandem with one another.

Automobile Tune-ups

A significant portion of the hydrocarbons which occur in urban runoff can be traced to incomplete combustion of automobile fuels or dripping oil pans. A well functioning smog control device and regular automobile tune-ups can dramatically reduce auto pollutants. Local governments should make their citizens aware of the importance of proper automobile maintenance to the preservation of their rivers, oceans and bays.

Oil Recycling Facilities

20 to 30% of waste lubricating oil disappears and is apparently improperly disposed of in landfills or storm drains. Local governments should take steps to assure that oil recycling centers are available to the citizens of the community and should promote their use by community residents. In Ventura County, when a hazardous waste generator agrees to serve as a waste oil recycling collection site, the business's local hazardous waste fees are reduced by 75%.

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Small Business Programs

Small businesses are the group most likely to improperly dispose of toxic waste. Local governments have several options to encourage proper disposal:

- o Spur development of small business cooperative waste recycling and disposal ventures;
- o Provide small business with educational programs; and
- o Incorporate small businesses into existing regulatory programs: local generator inspection programs and industrial wastewater permit programs.

(See Local Government Commission Guidebooks: Low Cost Ways to Promote Hazardous Waste Minimization: A Resource Guide for Local Governments; and POTWs Can Help Industry Reduce Toxic Waste and Discharges.)

Waste Reduction Programs

Once a specific site has been identified as a contributor to nonpoint pollution, e.g. a parking lot or construction site, local government can develop educational, technical assistance or regulatory programs to help identify and correct the particular practices that are leading to the contamination.

Educational programs provide hazardous waste reduction information to the operators of the problem site. Technical assistance programs provide in-depth, direct assistance through on-site consultations. Regulatory programs promote reduction through additions to codes, licences, permits and permit applications. (For a general understanding of these three program options, see LGC guidebooks: Low Cost Ways to Promote Hazardous Waste Minimization: A Resource Guide for Local Governments; POTWs Can Help Industry Reduce Toxic Waste: and Discharges; and Local Government Regulatory Options for Reducing Hazardous Waste.)

Reducing Pesticide and Fertilizer Use

Reducing pesticide and fertilizer use at the source may be the only viable way to remove these pollutants from urban runoff. Local governments should adopt Integrated Pest Management programs for use on their own public grounds in addition to promoting their use to community residents. (Integrated Pest Management (IPM) is an agricultural strategy for reducing reliance on synthetic pesticides and fertilizers. It is a systems approach that employs techniques such as crop rotation, conservation tillage and natural insect predators to ward off crop pests and prevent soil depletion.)

Institute Household Hazardous Waste Disposal Programs

Household chemicals are among the most harmful to receiving waters: contributing foul odors, killing aquatic life, destroying visual aesthetics and making water unsuitable for swimming. All local governments should provide their residents and small businesses with a safe method of disposal of household hazardous wastes and consumer education regarding less toxic product alternatives. The general public should be informed of the dangers of using the sewers or the storm drains to dispose of household toxics, including hazards to the environment, food chain etc.. (See Golden Empire Health Planning Center guidebooks available through the Local Government Commission for assistance in establishing a household hazardous waste disposal program: Alternatives to Landfilling Household Toxics; Household Hazardous Waste: Solving the Disposal Dilemma; and Making the Switch: Alternatives to Using Toxic Chemicals in the Home.)

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Local Enforcement of Disposal Waste Laws

Experts feel that illegal dumping is a major source of nonpoint pollution, thus more aggressive enforcement of existing laws will prevent this source of contamination. Local enforcement involves tracing the point at which the contaminant is introduced to the system and eliminating the illegal activity. This could involve the creation of a toxics strike force. (See Local Government Commission guidebook for information on the establishment of a toxics strike force: Toxics Law Enforcement: Taking Local Action.)

Prevention of the Erosion of Construction Sites

Newly excavated sites tend to contribute significant amounts of sediments and toxic materials to the drainage system. Certain steps can be taken to minimize this process.

- Minimization of stripped areas
- Straw bale filters
- Temporary seeding and mulching of all stripped areas
- Conservation cultivation practices on steep slopes
- Traffic control on construction sites
- Berms and crushed stone on construction roads
- Temporary water diversion on steeply sloping sites and temporary chutes
- Temporary checkdams on all waterways draining more than one-half acre of land under construction
- Entrapment of sediment from runoff prior to discharge from construction sites
- Reduction of effective slope length in critical areas with benches or terraces
- Establishment of protective vegetation on steep slopes

All San Francisco communities are recommended to have erosion control ordinances by the San Francisco Bay Area Regional Water Board. For an example of an erosion control ordinance, see Attachment B, Alameda County Ordinance 82-17. For an example of a watercourse protection ordinance, see Attachment C, Alameda County Ordinance 82-18.

Intervention at the Point of Pollution Transport

The structural interventions listed below are but a few of the many possible strategies for dealing with urban runoff. If we are to effectively deal with the problem, it is necessary to conceive of the issue comprehensively. The following alternatives will work best if they are implemented conjunctively, in addition to the preventive measures listed above.

Street Sweeping

Street sweeping is one of the most common means of controlling pollution from urban runoff. Sweeping picks up the dust and dirt particles to which all sorts of pollutants adhere. Sediment picked up includes contaminants such as heavy metals, oils and grease, floatables and salts. Sweeping is less effective at capturing nutrients, bacteria, and pesticides and herbicides because these adhere to the finest dust particles, which sweepers do not capture well.

Because it is the rain which is responsible for carrying street pollutants into waterways, the most important times to sweep are prior to storms -- especially just before the first flush of the rainy season and then frequently during the rainy months. Cleaning commercial and industrial areas three times per week, just before and during the rainy season, is recommended.

New technologies using wet-sweeping methods have been found to be much more effective than the traditional sweepers that often simply wash contaminants into storm drains. New sweepers use non-toxic solvents to loosen particles from street surfaces and vacuum them.

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Oil-Water Separators

An oil-water separator is a tank or box which reduces turbulence. The oil, being lighter than the water, rises to the surface and is skimmed off.

Runoff from commercial properties and parking lots contains oil and grease concentrations three times higher than runoff from residential areas, thus oil-water separators are most useful placed in these locations.

Reduction in the Amount of Impervious Surfaces

A study by Michael Stenstrom and Associates determined that if the flow from parking and commercial property could be controlled, oil and grease emissions into local receiving waters would be reduced by over 50%. Planning greenbelts and reducing the amount of impervious surfaces and replacing them with porous alternatives such as porous asphalt paving and precast lattice concrete and bricks will allow for some of the runoff to percolate into the soil underneath the paved surface. It is crucial that this strategy be employed only where there is no danger of polluting groundwater supplies.

Detention /Retention Basins

Detention basins are ponds which hold back some of the runoff for delayed release to prevent flooding. During this period much of the debris settles, thereby improving water quality. Detention basins do not reduce the total volume of stormwater to the streams. Because dissolved solids can percolate down to the water table, detention basins should not be used where there is a danger of contaminating groundwater.

Retention basins operate on the same principal as the detention basins but are designed to retain a portion of the runoff for evaporation or infiltration back into the ground. Retention basins will not work in areas where clay and other impervious soils exist and should not be used in areas where groundwater could be contaminated. Wet basins which maintain a permanent water pool have been demonstrated by the National Urban Runoff Program, run by the EPA, to remove 90% of the particulates.

Catch Basins in Stormdrain Openings

A catch basin is a box placed underneath a gutter which catches solids and allows liquid to flow over the edge.

Used in the mouths of stormdrain openings, catch basins could act as the first point of sediment settling for urban runoff. However, to be effective, catch basins must be cleaned periodically, especially during the storm season.

Grassy Swales

The placement of vegetation on the sides of stormdrain channels has been demonstrated to significantly reduce the amount of pollutants in stormwater. The velocity of the water is slowed, which allows for sedimentation. Periodic maintenance is required to remove accumulated materials in order to prevent clogging and the release of accumulated contaminants into the water of later storms.

Gravel and Small Stones in Stormdrains

Working with the principal that most toxics are hydro-phobic, gravel and small stones tend to attract the chlorinated hydrocarbons and heavy metals suspended in the flow. The toxics naturally adhere to the surface of these solids in the flow. Periodic maintenance is required to clean contaminants from the channels and to prevent clogging.

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Natural and Artificial Wetlands

As demonstrated by the San Diego Water Reclamation Agency and several Bay Area cities, wetlands have been shown to significantly improve the water quality of urban runoff. Sedimentation appears to be the primary method of water quality improvement in wetlands. Heavy metals tend to be absorbed by the peat in wetlands as well as by the suspended particles. Petroleum hydrocarbons may be evaporated, dissolved in water or digested by bacteria. Nutrients will be taken up by wetland plants. However the eventual effects of cumulative sedimentation and concentration of contaminants on the wetland's vegetation and wildlife are unknown.

Treatment

Experience with storm drains that are combined with sewer systems has shown that large storms can cause an overflow in the sewer system, causing severe health and management problems. There are steps which might be taken to avoid this problem. Only the first few hours of a storm, or a small storm (the period most damaging in terms of picking up toxics) would be routed into the treatment system. Another alternative would be to divert the flow from commercial and industrial areas to specifically designed primary treatment plants. Detention ponds would hold the flow for later treatment.

One of the most promising new technologies for the treatment of urban runoff is the Coordinate Chemical Bonding and Absorption (CCBA) process (Appendix C). The San Diego Water Reclamation Agency has already demonstrated the capability of the process to remove toxics and organics from industrial, municipal and urban runoff waste. Since CCBA plants only cost one-fourth of that of a conventional treatment plant and only take up a quarter of the space, it may be possible to use the CCBA process to treat both sewage and urban runoff.

CRITERIA TO USE IN EVALUATING CONTROL OPTONS

Criteria to use in judging the most desirable control options would include the following:

- Addressing the largest pollutant contributors
- Reducing the most damaging pollutants
- Giving the biggest "bang for the buck"
- Choosing options that are relatively easy to implement
- Keeping or restoring the beneficial uses of receiving waters
- Judging whether the control option simply transfers pollution from one medium to another, or whether it actually reduces pollution at the source.

No single control method provides the answer to reducing pollution from urban runoff, no single technology offers a panacea. To control the pollution of our rivers, bays and oceans, local elected officials must take a strong leadership position, implementing many of the interventions listed above.

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LIST OF ATTACHMENTS

Attachment A Key Contacts

Attachment B Alameda County Erosion Control Ordinance

Attachment C Alameda County Watercourse Protection Ordinance

Attachment D Fact Sheet References:

Chemical Bonding and Absorption
The San Diego Water Reclamation Agency
The Bellevue Storm and Surface Water Utility
Bibliography

Attachment E Helpful Publications for Controlling Urban Runof (Order Form)

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ATTACHMENT A

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ATTACHMENT B

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ORDINANCE NO. 82-17

AN ORDINANCE ESTABLISHING MINIMUM STANDARDS AND PROVIDING REGULATIONS FOR GRADING, CONSTRUCTION AND MAINTENANCE OF LAND FILLS AND EXCAVATION AND FOR CONTROL OF EROSION AND SEDIMENT

The Board of Supervisors of Alameda County, State of California, do ordain as follows:

SECTION I

CHAPTER 9 (Commencing with Section 7-110.0) is hereby added to Title 7 of the Ordinance Code of the County of Alameda to read as follows:

CHAPTER 9

GRADING, EROSION AND SEDIMENT CONTROL

ARTICLE 1. PURPOSE AND DEFINITIONS

Sec. 7-110.0 Title. This Chapter shall be known as the Grading Ordinance of Alameda County.

Sec. 7-110.1 Purpose. This Chapter is enacted for the purpose of regulating grading on private property within the unincorporated area of Alameda County to safeguard life, limb, health, property and public welfare; to avoid pollution of watercourses with nutrients, sediments, or other earthen materials generated on or caused by surface runoff on or across the permit area; and to ensure that the intended use of a graded site is consistent with the Alameda County General Plan, any Specific Plans adopted thereto and applicable Alameda County Ordinances including the Zoning Ordinance.

Sec. 7-110.2 Definitions: Unless the particular provision or the context otherwise requires, wherever the following terms are used in this Chapter, they shall have the meaning ascribed to them in this section:

(a) AGRICULTURAL OPERATION is any land related activity for the purpose of cultivating or raising plants or animals or conserving or protecting lands for such purposes when conducted on agriculturally zoned lands and is not surface mining or borrow pit operations nor preparation for construction or construction of any structure for human occupancy.

(b) BEDROCK is the solid undisturbed rock in place either exposed at the ground surface or beneath surficial deposits of loose rock or soil.

(c) BENCH is a relatively level step excavated into sloping natural ground on which engineered fill or embankment is to be placed.

(d) CIVIL ENGINEER is a professional engineer registered as a Civil Engineer by the State of California.

(e) COMPACTION is the increase of density of a soil or rock fill by mechanical means.

(f) CUT. See Excavation.

(g) DEPTH OF FILL is the vertical dimension from the exposed fill surface to the original ground surface.

(h) DEPTH OF EXCAVATION (Cut) is the vertical dimension from the exposed cut surface to the original ground surface.

(i) DIRECTOR OF PUBLIC WORKS is the Director of Public Works of Alameda County, California, acting either directly or through his authorized deputies.

(j) EMBANKMENT. See Fill.

(k) ENCROACHMENT PERMIT is a written permit authorizing certain work within a publicly maintained right-of-way.

(l) ENGINEERING GEOLOGIST is a registered geologist certified as an Engineering Geologist by the State of California.

(m) ENGINEERING GEOLOGY is the application of geologic knowledge in the investigation and evaluation of naturally occurring rock and soil for use in the design of civil works.

(n) EROSION is the wearing away and transporting of earth material as a result of the movement of wind, water or ice.

(o) EXCAVATION (Cut) is the removal of naturally occurring earth materials by mechanical means, and includes the conditions resulting therefrom.

(p) EXISTING GRADE is the elevation of the ground surface at a given point prior to excavating or filling.

(q) EXPANSIVE SOIL is any soil which exhibits significant expansive properties as determined by a Geotechnical Engineer or the Director of Public Works.

(r) FILL (Embankment) is the deposit of soil, rock or other materials placed by man and includes the conditions resulting therefrom.

(s) FINISH GRADE is the final grade of the site after excavating or filling which conforms to the approved final grading plan. The finish grade is also the grade at the top of a paved surface.

(t) GEOLOGIC HAZARD is any condition in naturally occurring earth materials which may endanger life, health or property. Geologic hazards include, but are not limited to: faults; existing or potential landslides, mudslides or rock falls; weak, expansive or creeping soil; subsidence; earthquake induced shaking, ground movement, ground failure or liquefaction; and seiche or tsunami inundation.

(u) GEOTECHNICAL ENGINEER is a Civil Engineer registered by the State of California who is qualified in the field of soil mechanics and soil engineering.

(v) GEOTECHNICAL ENGINEERING is the application of the principles of soil mechanics in the investigation, evaluation and design of civil works involving the use of earth materials and may include the inspection, testing and construction thereof.

(w) GRADING is any land excavation, or filling or combination thereof, or the removal, plowing under or burial or vegetative groundcover.

(x) GRADING PLAN is a plan prepared in accordance with this Chapter showing grading and related work.

(y) GRADING WORK is grading and related work, such as, but not limited to, drainage improvements and erosion and sediment control.

(z) KEYWAY is a special backfilled excavation which is constructed beneath the toe area of a planned fill slope on sloping ground to improve the stability of the slope.

(aa) LANDSCAPE ARCHITECT is a landscape architect registered by the State of California.

(bb) LOT — see Parcel.

(cc) OWNER is the person shown as the legal owner of the property on the latest equalized assessment roll in the Office of the County Assessor.

(dd) PARCEL (Lot) is land described as a lot or parcel in a recorded deed or shown as a lot or parcel on a subdivision map or parcel map on file in the County Recorder's Office.

(ee) PERMIT is a written grading permit issued pursuant to this Chapter authorizing certain grading work.

(ff) PERMITTEE is any person to whom a permit is issued pursuant to this Chapter.

(gg) PERSON is any natural person, firm, corporation or public agency whether principal, agent, employee, or otherwise.

(hh) PRELIMINARY GRADING PLAN is a plan that shows the proposed grading work in relation to the existing site prepared and submitted with the application for a grading permit.

(ii) RAINY SEASON is the period of the year during which there is a substantial risk of rainfall. For the purpose of this Chapter, the rainy season is defined as from October 1 to April 15, inclusive.

(jj) ROUGH GRADE is the stage at which the grade approximately conforms to the approved plan. It is also the subgrade required for construction of a road or other paved surface.

(kk) SEDIMENT is any material transported or deposited by water, including soil and debris or other foreign matter.

(ll) SITE is any lot or parcel of land or combination of contiguous lots or parcels of land, whether held separately or joined together in common ownership or occupancy, where grading is to be performed or has been performed.

(mm) SLOPE is an inclined ground surface the inclination of which may be expressed as the ratio of horizontal distance to vertical distance.

(nn) SOIL is all earth material of any origin that overlies bedrock and may include the decomposed zone of bedrock which can be excavated readily by mechanical equipment.

(oo) TERRACE is a relatively level step constructed in the face of a graded slope surface for drainage, maintenance or other purposes.

(pp) VEHICULAR WAY is a private roadway or driveway.

(qq) WATERCOURSE is any natural or manmade channel flowing continuously or intermittently in a definite direction and course or used for the holding, delay or storage of waters, which functions at any time to convey or store stormwater runoff. Natural channels shall generally be limited to those designated by a solid line or a dash and three dots as shown in blue on the most recent U. S. Geological Survey 7 5 minute series of topographic maps. At the discretion of the Director of Public Works, the definition of natural channel may be limited to those channels having a watershed area of 50 acres or more, and this definition will be commonly used in connection with the administration of this Ordinance except for those cases in which the Director of Public Works determines that the definition must be extended to a natural channel with a watershed smaller than 50 acres in order to prevent a condition which is a menace to life and limb, endangers property, is a hazard to public safety, adversely affects the safety, use of serviceability of adjacent property, public way or drainage channel, or could adversely affect the water quality of any water bodies or watercourses were the definition not extended to a particular natural channel with a watershed below 50 acres.

(rr) WORK. See Grading Work.

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ARTICLE 2. GENERAL REQUIREMENTS

Sec. 7-111.0 **Grading Permit Required:** Except for the specific exemptions listed hereinafter, no person shall do or permit to be done any grading on any site in the unincorporated area of Alameda County without a valid permit obtained from the Director of Public Works.

Sec. 7-111.1 **Exemptions:** The following grading may be done without obtaining a permit:

(a) Minor projects which have cuts or fills, each of which is less than five feet in vertical depth at its deepest point measured from the existing ground surface, and which include all of the following:
  (1) Less than 150 cubic yards of graded material.
  (2) The removal, plowing under or burial of less than 10,000 square feet of vegetation on slopes ten percent or greater or any amount of vegetation on slopes less than ten percent.
  (3) Do not create unstable or erodible slopes.

(b) Grading done by or under the supervision or construction control of a public agency that assumes full responsibility for the work.

(c) Excavations in connection with a building, swimming pool, retaining wall, or other structure authorized by a valid building permit.

(d) Grading necessary for agricultural operations unless such grading will create a cut or fill whose failure could endanger any structure intended for human or animal occupancy or any public road, or could obstruct any watercourse or drainage conduit.

(e) Trenching and grading incidental to the construction or installation of approved underground pipe lines, septic tank disposal fields, conduits, electrical or communication facilities, and drilling or excavation for approved wells or post holes. Such work shall be backfilled and the surface restored to its original condition, including reseeding or otherwise restoring vegetation on all disturbed earth surfaces if slopes exceed 2 percent, as soon as possible after such grading work is completed.

(f) Excavations for soil or geological investigations by a Geotechnical Engineer or Engineering Geologist. Such work shall be backfilled and shaped to the original contour of the land under the direction of the Geotechnical Engineer or Engineering Geologist as soon as possible after the investigation.

(g) Grading in accordance with plans incorporated in an approved surface mining permit, reclamation plan or sanitary landfill.

(h) Maintenance of existing firebreaks and roads to keep the firebreak or road substantially in its original condition.

(i) Routine cemetery excavations and fills.

(j) Performance of emergency work necessary to protect life or property when an urgent necessity therefor arises. The person performing such emergency work shall notify the Director of Public Works promptly of the problem and work required and shall apply for a permit therefor within ten calendar days after commencing said work.

Exemption from the requirement of a permit shall not be deemed to be permission to violate any provision of this Chapter.

Sec. 7-111.2 **Grading:** No person shall do or permit to be done any grading in such a manner that quantities of dirt, soil, rock, debris, or other material substantially in excess of natural levels are washed, eroded, or otherwise moved from the site, except as specifically provided for by a permit.

Sec. 7-111.3 **Water Obstruction:** No person shall do or permit to be done any grading which may obstruct, impede or interfere with the natural flow of storm waters, whether such waters are unconfined upon the surface of the land or confined within land depressions or natural drainage ways, unimproved channels or watercourses, or improved ditches, channels or conduits, in such manner as to cause flooding where it would not otherwise occur, aggravate any existing flooding condition or cause accelerated erosion except where said grading is in accordance with all applicable laws, including but not limited to permit requirements.

Sec. 7-111.4 **Safeguarding of Watercourses:** Any proposed grading work which could result in a connection or discharge into or modification of the flow of a watercourse may, at the discretion of the Director of Public Works, require a separate permit under the provisions of the Alameda County Watercourse Protection Ordinance or the Alameda County Flood Control and Water Conservation District Permit Ordinance.

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Sec. 7-111.5 **Levee Work:** No person shall excavate or remove any material from or otherwise alter any levee required for river, creek, bay, or local drainage control channel, without prior approval of the local governmental agency responsible for the maintenance of the levee.

Sec. 7-111.6 **Construction in Public Rights-of-Way:** No person shall perform any grading work within the right-of-way of a public road or street, or within a public easement, without prior approval of the Director of Public Works.

Sec. 7-111.7 **Hazards:** Whenever the Director of Public Works determines that any grading on private property constitutes a condition which is a hazard to public safety, endangers property, adversely affects the safety, use or stability of adjacent property, or an overhead or underground utility, or a public way, watercourse or drainage channel, or could adversely affect the water quality of any water bodies or watercourses, the owner of the property upon which the condition is located, or other person or agent in control of said property, upon receipt of notice in writing from the Director of Public Works shall, within the period specified therein, abate such condition and render the grading in conformance with the requirements of this Chapter. The Director of Public Works may require the submission of plans or soil or geological reports, detailed construction recommendations, or other engineering data prior to and in connection with any corrective or proposed work or activity.

Sec. 7-111 8 **Not Retroactive:** This Chapter shall be prospective in operation only. The provisions of this Chapter shall not apply to existing construction for which all previously necessary permits were obtained. Said provisions shall also not apply to a project or development not yet constructed provided than an appropriate permit has been obtained and said permit bears a date prior to the effective date of this Chapter.

Sec. 7-111 9 **Administration:** This Chapter shall be administered for Alameda County by the Alameda County Flood Control and Water Conservation District.

ARTICLE 3. PROCEDURES

Sec. 7-112 0 **Filing:** Applications for permits shall be filed with the Director of Public Works on forms furnished by his office. Each application shall include a plan checking fee and other fees as required, preliminary or final grading plans and a statement of the intended use of the site. Only one application and permit is allowed for grading work to be done on a site at one time. The Director of Public Works shall determine whether the application is complete in accordance with provisions of Article 4 herein and may require additional information from the applicant before accepting the application as complete.

Sec. 7-112.1 **Compliance with CEQA:** The California Environmental Quality Act (CEQA) may require the preparation of environmental documents concerning a proposed grading project. In such event, Alameda County will be a Responsible Agency or may function as the Lead Agency. The Director of Public Works will advise the applicant as to any additional information required with the permit application.

Sec. 7-112.2 **Referral to Other Public Agencies:** The Director of Public Works may refer an application to other interested public agencies for their recommendations.

Sec. 7-112.3 **Permit Conditions:**

(a) No permit shall be granted until the Director of Public Works is satisfied that a proposed project conforms with the Alameda County General Plan, any Specific Plan adopted thereto, and applicable Alameda County Ordinances including the Zoning Ordinance.

(b) Where a proposed grading project requires the filing of a tentative map or the intended use requires approval of a discretionary zoning permit, no grading permit shall be granted prior to approval by the applicable planning authority.

(c) The permit shall be limited to work shown on the grading plans approved by the Director of Public Works. In granting a permit, the Director of Public Works may impose any condition deemed necessary to protect the health, safety and welfare of the public, to prevent the creation of a nuisance or hazard to public or private property, and to assure proper completion of the grading, including but not limited to:
   (1) Mitigation of adverse environmental impacts.
   (2) Improvement of any existing grading to comply with the standards of this Chapter.
   (3) Requirements for fencing or other protection of grading which would otherwise be hazardous.
   (4) Requirements for dust, erosion, sediment and noise control, hours of operation and season of work, weather conditions, sequence of work, access roads and haul routes.
   (5) Requirements for safeguarding watercourses from excessive deposition of sediment or debris in quantities exceeding natural levels
   (6) Assurance that the land area in which grading is proposed and for which habitable structures are proposed is not subject to hazards of land slippage or significant settlement or erosion and that the hazards of seismic activity or flooding can be eliminated or adequately reduced.

Sec. 7-112.4 **Permission of Other Agencies or Owners:** No permit shall relieve the permittee of responsibility for securing other permits or approvals required for work which is regulated by any other department or agency of the County, or other public agency, or for obtaining any easements or authorization for grading on property not owned by the permittee.

Sec. 7-112.5 **Location of Property Lines:** Whenever the location of a property line or easement or the title thereto is disputed during the application process or during a grading operation, a survey by a licensed Land Surveyor or Civil Engineer or resolution of title all at the expense of the applicant may be required by the Director of Public Works

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Sec. 7-112.6 Time Limits:

(a) The permittee shall perform and complete all the work required by the permit within time limits specified in the permit. If the work cannot be completed within the specified time, a request for an extension of time setting forth the reasons for the requested extension shall be presented in writing to the Director of Public Works no later than 30 days prior to the expiration of the permit. The Director of Public Works may grant additional time for the work.

(b) If all the permit work required is not completed within the time limit specified in Subsection (a) above, no further grading shall be done without renewing the permit. A written request for renewal shall be submitted to the Director of Public Works who may require a new application and fees depending on the time between the expiration date and the renewal request, revisions in County regulations, or changed circumstances in the immediate area. Any revised plan shall be submitted to the Director of Public Works for review, and any costs thereof shall be at the applicant's expense.

Sec. 7-112.7 **Validity:** The issuance of a permit or approval of plans and specifications shall not be construed as an approval of any violation of the provisions of this Chapter or of any other applicable laws, ordinances, rules or regulations; and shall not prevent the Director of Public Works from thereafter requiring the correction of errors in said plans and specifications or from preventing work being carried on thereunder in violation of this Chapter, or any other applicable law, ordinance, rule or regulation.

Sec. 7-112.8 **Appeals:** Appeals from decisions pursuant to this Chapter shall be made to the Board of Supervisors in writing setting forth the specific grounds thereto within 15 calendar days from the date of such decision.

ARTICLE 4. PLANS AND SPECIFICATIONS

Sec. 7-113.0 **Application — Plans:** Two or more complete sets of plans, as determined by the Director of Public Works, including but not limited to profiles, cross sections, topographic maps and specifications shall be submitted to the Director of Public Works with each application for a grading permit, or when otherwise required by the Director of Public Works for enforcement of any provision of this Chapter. At the time of application, the applicant may provide preliminary grading plans. Prior to the issuance of a grading permit the applicant must furnish final grading plans. Preliminary grading plans with appropriate changes and additions thereto may be accepted as final grading plans. When the final grading plans and other required documents have been approved, a grading permit will be issued by the Director of Public Works. The work shall be done in strict compliance with the approved plans and specifications which shall not be changed or altered except in accordance with the provisions of this article.

Sec. 7-113.1 **Preliminary Grading Plans:** Preliminary grading plans provide for review and determination of grading permit requirements prior to approval of final plans and issuance of a grading permit. Precise design at this stage is not required. The plans shall be clearly and legibly drawn and entitled "Preliminary Grading Plans," shall contain a statement of the purpose of the proposed grading, and shall include the following, unless waived by the Director of Public Works:

(a) On a map of appropriate scale, but not smaller than 1" = 100':
   (1) A plan entitled "Preliminary Grading Plan" and the name and signature of preparer and date of preparation.
   (2) A vicinity sketch (not a map scale) indicating the location of the site relative to the principal roads, lakes and watercourses in the area.
   (3) A site plan indicating the site of the work and any proposed divisions of land.
   (4) The complete site boundaries and locations of any easements and rights-of-way traversing and adjacent to the property, appropriately labeled and dimensioned.
   (5) The location of all existing and proposed roads, buildings, wells, pipelines, watercourses, and other structures, facilities and features of the site, and the location of all improvements on adjacent land within 50 feet of the proposed work.
   (6) Location and nature of known or suspected soil or geologic hazard areas.
   (7) Contour lines of the existing terrain and proposed approximate finished grade at intervals not greater than five feet, showing all topographic features and drainage patterns throughout the area where proposed grading is to occur. The contour lines shall be extended to a minimum of 50 feet beyond the affected area, and further if needed to define intercepted drainage, and shall be extended a minimum of 100 feet outside of any future road rights of way.
   (8) Approximate location of cut and fill lines and the limits of grading for all the proposed grading work, including borrow and stockpile areas. A written description of offsite locations of said areas will suffice.
   (9) Location, width, direction of flow and approximate location of tops and toes of banks of any watercourses.

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(10) Approximate boundaries of any areas with a history of flooding.
(11) Proposed provisions for storm drainage control and any existing or proposed flood control facilities or septic tank disposal fields in the vicinity of the grading.
(12) A conceptual plan for erosion and sediment control including both temporary facilities and long term site stabilization features such as planting or seeding for the area affected by the proposed grading. This requirement may be waived by the Director of Public Works for sites having no slopes greater than five percent unless the large size of the site, its proximity to sensitive areas or other conditions make an erosion or sediment discharge hazard possible.
(13) North arrow and scale.
(14) General location and character of vegetation covering the site and the locations of trees with a trunk diameter of twelve inches or more, measured at a point three feet above average ground level, within the area to be disturbed by the proposed grading. The plans shall indicate which trees are proposed to remain and how they are to be protected.

(b) Typical cross sections (not less than two) of all existing and proposed graded areas taken at intervals exceeding 200 feet and at locations of maximum cuts and fills.

(c) An estimate of the quantities of excavation and fill, including quantities to be moved both on and off site.

(d) The estimated starting and completion dates of grading.

(e) Such supplemental information as required for processing and approval of the design concept and the application as required by the Director of Public Works.

Sec. 7-113.2 Final Grading Plans — Engineer Required: Final grading plans and specifications shall be prepared and signed by a Civil Engineer, except as otherwise provided herein, on sheets at least 24" x 36". The plans shall include the following, in addition to all requirements for preliminary grading plans, unless waived by the Director of Public Works.

(a) A title block. Plans shall be entitled "Grading Plan" and state the purpose of the proposed grading and the name of the engineer or firm by whom this plan is prepared.

(b) Accurate contour lines at intervals not greater than five feet, showing topographic features and drainage patterns and the configuration of the ground before and after grading, relative to a bench mark established on site.

(c) Location, extent and finished surface slopes of all proposed grading and final cut and fill lines.

(d) Cross sections, profiles, elevations, dimensions and construction details based on accurate field data.

(e) Construction details for roads, watercourses, culverts, bridges and drainage devices, retaining walls, cribbing, dams, and other improvements existing or to be constructed, together with supporting calculations and maps as required.

(f) Complete construction specifications.

(g) A detailed erosion and sediment control plan including specific locations, construction details, and supporting calculations for temporary and permanent sediment control structures and facilities, when required by the Director of Public Works.

(h) A landscaping plan, when required by the Director of Public Works, including temporary erosion control plantings, permanent slope plantings, replacement of temporary groundcover, and irrigation facilities.

(i) An estimate of the quantities of excavation and fill, adjusted for anticipated swell or shrinkage.

(j) The location of any borrow site or location for disposal of surplus material.

(k) A projected schedule of operations, including, as a minimum, the dates of:
(1) Commencement of work.
(2) Start and finish of rough grading.
(3) Completion of drainage facilities.
(4) Completion of work in any watercourse.
(5) Completion of erosion and sediment control facilities.
(6) Completion of hydromulching and other landscaping. If rough grading is proposed between October 1 and April 15, a more detailed schedule of grading activities and use of erosion and sediment control facilities may be required.

(l) Itemized cost estimated of the proposed grading and related work.

(m) Other information as may be required by the Director of Public Works.

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Sec. 7-113.3 **Final Grading Plans — Engineer Not Required:** All plans and specifications shall be prepared and signed by a Civil Engineer except that the Director of Public Works may waive this requirement if the grading is minor in nature, would not endanger the public health, safety or welfare as determined by the Director of Public Works; and would not involve or require any of the following:

(a) Cuts and fills with a combined total of 1500 cubic yards or more.

(b) An access road serving three or more existing or potential residences.

(c) A cut or fill that is intended to support structures.

(d) A cut or fill that is located so as to cause unduly increased pressure or reduce support upon any adjacent structure or property.

(e) The construction of any extensive drainage or sediment control structures, culverts, or facilities or alteration of any existing drainage course.

(f) The creation or aggravation of an unstable slope condition.

Sec. 7-113.4 **Modification of Approved Plans:**

(a) Proposed modifications of an approved final plan shall be submitted to the Director of Public Works for his written approval.

(b) All necessary soils and geological information and design details shall accompany any proposed modification.

(c) The modification shall be compatible with any subdivision map or land use requirements.

Sec. 7-113.5 **Seasonal Requirements:** Implementation of erosion and sediment control plans shall be based on the season of the year and the stage of construction at forecasted periods of rainfall and heavy storms. Erosion and sediment control plans shall allow for possible changes in construction scheduling, unanticipated field conditions, and relatively minor changes in grading. Modifications to plans may be required after initial plan approval.

Sec. 7-113.6 **Distribution and Use of Approved Plans:** Two sets of approved plans and specifications shall be retained by the Director of Public Works and one or more sets of approved and dated plans and specifications shall be provided to the applicant or his engineer. One set of approved plans and permit shall be retained on the site at all times during the work.

ARTICLE 5. PERMIT REQUIREMENTS

Sec. 7-114.0 **General:** The Director of Public Works may deny the issuance of a grading permit if final grading plans fail to satisfy the provisions of this Chapter or any of the conditions imposed. The Director of Public Works shall identify the provision, requirement or condition which has not been met or performed by the applicant.

Sec. 7-114.1 **Fees:**

(a) The schedule of fees and costs shall be those established and adopted by the Board from time to time by resolution. Before a permit is issued, the applicant shall deposit with the Director of Public Works cash or a certified or cashier's check, in a sufficient sum to cover the fee for issuance of the permit, charges for review of plans, specifications and reports, other engineering services, field investigations, necessary inspection or other work and routine laboratory tests of materials and compaction, all in accordance with schedules established and adopted by the Board.

(b) No fee shall be required of public agencies.

(c) Public utilities may, at the option of the Director of Public Works, make payment for the above charges as billed by the Director of Public Works instead of by advance deposit as required above.

(d) If, upon completion of any work under a permit there remains any excess of deposit or of fees or charges, the Director of Public Works shall certify the same to the Auditor for refund to the permittee or refund the same from any trust fund established under his jurisdiction for such purposes.

(e) If, upon completion of any work under a permit there is an insufficient deposit to cover the cost of the work, the Director of Public Works may require the permittee to reimburse the amount equal to the cost deficit.

(f) If grading work is done in violation of this Chapter or such work is not done in accordance with an approved permit, a fee covering investigation of any violation and inspection and plan checking of work required to correct such violation shall be charged to the violator to cover all actual costs.

Sec. 7-114.2 **Geotechnical Investigation Required:** A soil or geologic investigation report shall accompany the application in any of the following circumstances:

(a) When the proposed grading includes a cut or fill exceeding five feet in depth at any point and the slope of the natural ground within 30 feet of the cut or fill exceeds ten percent; however, for vehicular ways, a soil investigation shall not be required unless the grading includes a proposed cut or fill that exceeds ten feet in depth and the slope of the natural ground exceeds 20 percent.

(b) When highly expansive soils are present.

(c) In areas of known or suspected geological hazards, including landslide hazards and hazards of ground failure stemming from seismically induced ground shaking.

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Sec. 7-114.3 **Investigations:** Those portions of the soil or geologic investigation that constitute "civil engineering" as defined by Section 6734 of the Business and Professions Code of the State of California shall be conducted by a Geotechnical Engineer. Those portions of the investigation that involve the practice of "geology" as defined by Section 7802 of the Business and Professions Code of the State of California shall be conducted by an Engineering Geologist.

The investigations shall be based on observation and tests of the material exposed by exploratory borings or excavations and inspections made at appropriate locations. Additional studies may be necessary to evaluate soil and rock strength, the effect of moisture variation on soil, bearing capacity, compressibility, expansiveness, stability and other factors.

Sec. 7-114.4 **Reports — General:** Any soil or geologic investigation report shall be subject to the approval of, and supplemental reports and data may be required by, the Director of Public Works. Recommendations included in the reports and approved by the Director of Public Works shall be incorporated in the final plans and specifications.

Sec. 7-114.5 **Soil Geologic Investigation Report:** The soil or geologic investigation report shall contain all of the following as they may be applicable to the subject site:

(a) An index map showing the regional setting of the site.

(b) A site map showing the topographic features of the site and locations of all soil borings and test excavations.

(c) A classification of the soil types (Unified Soil Classification); pertinent laboratory test data; and consequent evaluation regarding the nature, distribution and strength of existing soils.

(d) A description of the geology of the site and the geology of the adjacent areas when pertinent to the site.

(e) A suitably scaled map and cross sections showing all identified areas of land slippage.

(f) A description of any encountered groundwater or excessive moisture conditions.

(g) A description of the soil and geological investigative techniques employed.

(h) A log for each soil boring and test excavation showing elevation at ground level and the depth of each soil or rock strata.

(i) An evaluation of the stability of pertinent natural slopes and any proposed cut and fill slopes.

(j) An evaluation of settlement associated with the placement of any fill.

(k) Recommendations for grading procedures and specifications, including methods for excavation and subsequent placement of fill.

(l) Recommendations regarding drainage and erosion control.

(m) Recommendations for mitigation of geologic hazards.

Sec. 7-114.6 **Final Report:** Upon completion of rough grading work, the Director of Public Works may require a final geotechnical report that includes, but is not necessarily limited to the following:

(a) A complete record of all field and laboratory tests including location and elevation of all field tests.

(b) A professional opinion regarding slope stability, soil bearing capacity, and any other pertinent information.

(c) Recommendations regarding foundation design, including soil bearing potential, and building restrictions or setbacks from the top or toe of slopes.

(d) A declaration by the Geotechnical Engineer or Engineering Geologist in the format required by the Director of Public Works that all work was done in substantial accordance with the recommendations contained in the soil or geologic investigation reports as approved and in accordance with the approved plans and specifications.

Sec. 7-114.7 **Changed Conditions:** Where soil or geologic conditions encountered in the grading operation deviate from that anticipated in the soil and geologic investigation reports or where such conditions warrant changes to the recommendations contained in the original soil investigation, a revised soil or geologic report shall be submitted for the approval of the Director of Public Works.

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Sec. 7-114 8 **Special Inspection:**

(a) The Director of Public Works may require the permittee to provide a private Geotechnical Engineer to perform continuous inspection work, and upon completion of the work to provide a written statement acknowledging that he has inspected the work and that in his professional judgment the work was performed in accordance with the approved plans and specifications. The permittee shall make his own contractual arrangements for such services and be responsible for payment of all costs. Continuous inspection by a Geotechnical Engineer shall include but not be limited to the following situations:
   (1) During the preparation of a site for the placement of fills which exceed five feet indepth on slopes which exceed ten percent and during the placing of such fills; however, for vehicular pathways, fill placement shall be continuously inspected when fills exceed ten feet in height.
   (2) During the preparation of a site for the placement of any fill and during the placement of such fill which is intended to support any building or structure.
   (3) During the installation of subsurface drainage facilities.
   (4) Such other inspections as may be required by the Director of Public Works.

(b) Reports filed by the private Geotechnical Engineer regarding special inspection shall state in writing that from his personal knowledge the work performed during the period covered by the report has been performed in substantial accordance with the approved plans and specifications.

(c) The use of a private Geotechnical Engineer for inspections shall not preclude the Director of Public Works from conducting inspections using his or other authorized inspectors as may be necessary.

Sec. 7-114.9 **Non-Compliance Notification by Private Geotechnical Engineer:** The permittee shall cause the work to be done in accordance with the approved plans. If during the course of construction the private Geotechnical Engineer finds that the work is not being done substantially in accordance with the approved plans and specifications, he shall immediately notify the person in charge of the work and the Director of Public Works of the non-conformity and the corrective measures to be taken. When changes in the plans are required, he shall prepare such proposed changes and submit them to the Director of Public Works for approval.

Sec. 7-114.10 **Periodic Progess Reports by Private Geotechnical Engineer:** Periodic progress reports shall be rendered by the private Geotechnical Engineer as required by the Director of Public Works including, but not limited to, laboratory tests, slope stability, placement of materials, retaining walls, drainage, utilities and any special permit or plan requirements.

Sec. 7-114.11 **Progress Report by Permittee:** Periodic progress reports shall be rendered by permittee on specified calendar dates and at commencement and completion of major key grading and erosion and sediment control operations. The dates of operations upon which such reports are required and their content shall be as required by the Director of Public Works in the permit.

Sec. 7-114.12 **Submit "As-Built" Plan:** Permittee shall submit the the Director of Public Works an "As-Built" grading plan following completion of grading operations.

Sec. 7-114.13 **Performance of Work — Inspection:** The Director of Public Works may inspect any work done pursuant to a permit under this Chapter. No permittee shall be deemed to have complied with this Chapter until a final inspection of the work has been made by the Director of Public Works and he has certified in writing that the work has been competed in accordance with all requirements and conditions of the permit. The permittee shall provide adequate access to the site for inspection by the Director of Public Works during the performance of all work and for a minimum period of one year after acceptance by the Director of Public Works of all improvements pursuant to Subsections 7-116.0(b) and 7-116.0(c) herein.

Sec. 7-1114.14 **Other Responsibilities of Permittee:** The permittee shall also be responsible for the following:

(a) **Protection of Utilities.** The permittee shall be responsible for the prevention of damage to any public utilities or services.

(b) **Protection of Adjacent Property.** The person doing or causing the grading is responsible for the prevention of damage to adjacent property. No person shall excavate on land sufficienty close to the property line to endanger any adjoining public street, sidewalk, alley or other public or private property, without supporting and protecting such property from damage which might result.

(c) **Advance Notice.** The permittee shall notify the Director of Public Works at least 24 hours prior to the start of work.

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(d) **Erosion and Sediment Control.** It shall be the responsibility of the permittee to prevent discharge of sediment from the site in quantities greater than before grading occurred, to any watercourse, drainage system, or adjacent property and to protect watercourses and adjacent properties from damage by erosion, flooding, or deposition which may result from the permitted grading. Permittee shall implement all measures necessary to discharge this responsibility even if such measures exceed the requirements of an approved Erosion and Sediment Control Plan prepared pursuant to this Chapter.

Sec. 7-114 15 **Transfer of Permit:** No permit issued under this Chapter may be transferred or assigned in any manner whatsoever, voluntarily or by operation of law, without the express consent of the Director of Public Works.

ARTICLE 6. DESIGN STANDARDS

Sec. 7-115.0 **Excavation:** Excavations shall be constructed or protected so that they do not endanger life or property.

Sec. 7-115.1 **Excavation Slope:** The slope of cut surfaces of permanent excavations shall not be steeper than two horizontal to one vertical exclusive of terraces and exclusive of roundings described herein. Steeper slopes may be permitted in competent bedrock provided such slope inclinations are in accordance with recommendations contained in the geotechnical or geological report. The bedding planes or principal joint sets in any formation when dipping towards the cut face shall not be daylighted by the cut slope unless the soils and geologic investigations contain recommendations for steeper cut slopes. The Director of Public Works may require the excavation to be made with a cut face flatter in slope than two horizontal to one vertical for stability and safety. Cut slopes shall be rounded into the existing terrain to produce a contoured transition from cut face to natural ground.

Sec. 7-115 2 **Fill Placement:** Fills shall be constructed in layers. The loose thickness of each layer of fill material before compaction shall not exceed eight inches. Completed fills shall be stable masses of well integrated material bonded to adjacent materials and to the materials on which they rest. Fills shall be competent to support anticipated loads and be stable at the design slopes shown on the plans. Proper drainage and other appropriate measures shall be taken to ensure the continuing integrity of fills. Earth materials shall be used which have no more than minor amounts of organic substances and have no rock or similar irreducible materials with a maximum dimension greater than six inches.

Sec. 7-115.3 **Fill Compaction:** All fills shall be compacted throughout their full extent to a minimum of 90 percent of maximum density as determined by appropriate ASTM standard method or other alternate methods approved by the Director of Public Works. Tests to determine the density of compacted fills shall be made on the basis of not less than one test for each two-foot vertical lift of the fill but not less than one test for each 1000 cubic yards of material placed. Additional density tests at a point approximately one-foot below the fill slope surface shall be made on the basis of not less than one test for each 1000 square feet in slope surface but not less than one test for each ten-foot vertical increase of slope height. Additional tests may be required throughout the fill as determined by the inspector for the Director of Public Works. All tests shall be reasonably uniformly distributed within the fill or fill slope surface. Results of such testing and location of tests shall be presented in the periodic and final reports. Compaction may be less than 90 percent of maximum density, as determined by the above test, within six inches of the slope surface when such surface material is placed and compacted by a method acceptable to the Director of Public Works for the planting of the slopes. Compaction of temporary storage fills, to be used for a period of not greater than six months, shall not be required, except where the Director of Public Works determines that compaction is necessary as a safety measure to aid in preventing saturation, sliding, or erosion of the fill. Where compaction is required, it shall be done as specified by the Director of Public Works.

Sec. 7-115.4 **Ground Preparation For Fill Placement:** The natural ground surface shall be prepared to receive fill by removing vegetation, non-complying fill, top soil, and other unsuitable material, and where slopes are five horizontal to one vertical or steeper, by benching into competent material in a manner acceptable to the Director of Public Works. They keyway under the toe, if specified, shall be at least ten feet wide.

Sec. 7-115.5 **Fill Slopes:** The slope of permanent fills shall not be steeper than two horizontal to one vertical exclusive of terraces and exclusive of roundings described herein. The Director of Public Works may require that the fill be constructed with an exposed surface flatter than two horizontal to one vertical or may require such other measures as he deems necessary for stability and safety. Fill slopes shall be rounded into existing terrain to produce a contoured transition from fill face to natural ground or to abutting cut or fill surfaces where conditions permit.

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Sec. 7-115.6 **Adjacent Structures Protection:** Footings which may be affected by any excavation shall be underpinned or otherwise protected against settlement and shall be protected against lateral movement. Fills or other surcharge loads shall not be placed adjacent to any building or structure unless such building or structure is capable of withstanding the additional loads caused by such fill or surcharge. The rights of coterminous owners shall be as set forth in Section 832 of the Civil Code of the State of California.

Sec. 7-115.7 **Setbacks — General:** Unless otherwise recommended in a soil and geologic investigation report, Figures 1 and 2 and Table 70c on Pages 683 and 684 of the 1976 Uniform Building Code or said similar provisions as provided for in adopted successor code shall be used for establishing setbacks for property boundaries, buildings and structures other than fences and retaining walls.

Sec. 7-115.8 **Drainage — General:** The drainage structures and devices required by this Chapter shall be designed and contructed in accordance with standards and criteria authorized by the Director of Public Works.

Sec. 7-115.9 **Drainage — Disposal Requirements:** All drainage facilities shall be designed to carry surface and subsurface waters to the nearest adequate street, storm drain, natural water course or other juncture, and shall be subject to the approval of the Director of Public Works. Drainage areas shall conform to patterns established by the Director of Public Works.

Sec. 7-115.10 **Drainage — Water Accumulation:** All areas shall be graded and drained so that water will not pond or accumulate. Drainage shall be effected in such a manner that it will not cause erosion or endanger the stability of any cut or fill slope or any building or structure.

Sec. 7-115.11 **Drainage Protection of Adjoining Property:** When surface drainage is discharged onto any adjoining property, it shall be discharged in such a manner that it will not cause erosion or endanger any cut or fill slope or any building or structure.

Sec. 7-115.12 **Terrace Drainage:** Terraces at least eight feet in width shall be established at not more than 25 feet in height intervals for all cut and fill slopes exceeding 30 feet in height. Where only one terrace is required, it shall be at approximately mid-height. Suitable access shall be provided to permit proper cleaning and maintenance of terraces and terrace drains. Swales or ditches on terraces shall have a minimum depth of one foot, a minimum longitudinal grade of four percent, a maximum longitudinal grade of twelve percent, and must be paved with reinforced concrete not less than three inches in thickness or an approved equivalent paving. Down-drains or drainage outlets shall be provided at approximately 300-foot intervals along the drainage terrace. Down-drains and drainage outlets shall be of approved materials and of adequate capacity to convey the intercepted waters to the point of disposal. If the drainage discharges onto natural ground, adequate erosion protection shall be provided.

Sec. 7-115.13 **Subsurface Drainage:** Cut and fill slopes shall be provided with subsurface drainage as necessary for stability.

Sec. 7-115.14 **Erosion and Sediment Control:** The following shall apply to the control of erosion and sediment from grading operations:

(a) Grading plans shall be designed with long term erosion and sediment control as a primary consideration.

(b) No grading operations shall be conducted during the rainy season except upon a clear demonstration, to the satisfaction of the Director of Public Works, that at no stage of the work will there be any substantial risk of increased sediment discharge from the site.

(c) Should grading be permitted during the rainy season, the smallest practicable area of erodible land shall be exposed at any one time during grading operations and the time of exposure shall be minimized.

(d) Natural features, including vegetation, terrain, watercourses and similar resources shall be preserved wherever possible. Limits of grading shall be clearly defined and marked to prevent damage by construction equipment.

(e) Permanent vegetation and structures for erosion and sediment control shall be installed as soon as possible.

(f) Adequate provision shall be made for long term maintenance of permanent erosion and sediment control structures and vegetation.

(g) No topsoil shall be removed from the site unless otherwise directed or approved by the Director of Public Works. Topsoil overburden shall be stockpiled and redistributed within the graded area after rough grading to provide a suitable base for seeding and planting. Runoff from the stockpiled area shall be controlled to prevent erosion and resultant sedimentation of receiving water.

(h) Runoff shall not be discharged from the site in quantities or at velocities substantially above those which occurred before grading except into drainage facilities whose design has been specifically approved by the Director of Public Works.

(i) Permittee shall take reasonable precautions to ensure that vehicles do not track or spill earth materials into public streets and shall immediately remove such materials if this occurs.

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Sec. 7-115.15 **Emergency Conditions:** Should increased sediment discharge occur or become imminent permittee shall take all necessary steps to control such discharge. Such steps may include construction of additional facilities or removal or alteration of facilities required by approved erosion and sediment control plans. Facilities removed or altered shall be restored as soon as possible afterward or appropriate changes in the plan shall be immediately requested pursuant to this Chapter. Permittee shall take prompt action to resolve emergency problems; otherwise the Director of Public Works may institute abatement proceedings pursuant to provisions of Section 7-117.1 herein.

Sec. 7-115.16 **Erosion and Sediment Control Plans:** Erosion and sediment control plans prepared pursuant to this Chapter shall comply with all of the following:

(a) The erosion and sediment control plan need not be a separate sheet if all facilities and measures can be shown on the grading sheets without obscuring the clarity of either the grading plan or the erosion and sediment control plan.

(b) An erosion and sediment control plan shall be required whenever:

1. The graded portion of the site includes more than 10,000 square feet of area having a slope greater than five percent.
2. There is a significant risk that more than 2,500 square feet will be unprotected or inadequately protected from erosion during any portion of the rainy season.
3. Grading will occur within 20 feet of any watercourse.
4. The Director of Public Works determines that the grading will or may pose a significant erosion or sediment discharge hazard for any reason.

(c) The applicant shall submit, with his erosion and sediment control plans, a detailed cost estimate covering this work.

(d) Erosion and sediment control plans shall include an effective revegetation program to stabilize all disturbed areas which will not be otherwise protected. All such areas where grading has been completed between April 1 and September 15 shall be planted by October 1. Graded areas completed at other times of the year shall be planted within 15 days. If revegetation is infeasible or cannot be expected to stabilize an erodible area with assurance during any part of the rainy season and the unstable area exceeds 2,500 square feet, additional erosion and sediment control measures or irrigation of planted slopes may be required as appropriate to prevent increased sediment discharge.

(e) Erosion and sediment control plans shall be designed to prevent increased discharge of sediment at all stages of grading and development from initial disturbance of the ground to project completion. Every feasible effort shall be made to ensure that site stabilization is permanent. If grading occurs in distinct phases or the site will remain unstable through more than one rainy season, more than one set of plans may be required. Plans shall indicate the implementation period and the stage of construction where applicable.

(f) Erosion and sediment control plans shall comply with the recommendations of any Civil Engineer, Geotechnical Engineer, Engineering Geologist, or Landscape Architect involved in preparation of the grading plans.

(g) The structural and hydraulic adequacy of all storm water containment or conveyance facilities shown on the erosion and sediment control plans shall be verified by a Civil Engineer, and he shall so attest on the plans. Sufficient calculations and supporting material to demonstrate such adequacy shall accompany the plans when submitted.

(h) Erosion and sediment control plans shall be designed with sufficient flexibility to meet unanticipated field conditions.

(i) Erosion and sediment control plans shall provide for inspection and repair of all erosion and sediment control facilities at the close of each working day during the rainy season and for specific sediment cleanout and vegetation maintenance criteria.

(j) Erosion and sediment control plans shall comply with any and all standards and specifications adopted by the Director of Public Works for the control of erosion and sedimentation on grading sites.

The Director of Public Works may waive the requirement for an erosion and sediment control plan if, in his opinion, no significant erosion or sediment discharge hazard exists.

Sec. 7-115.17 **Vehicular Ways — General:** Vehicular ways shall conform to the grading requirements of this Chapter.

Sec. 7-115.18 **Vehicular Ways — Cut Slopes:** The Director of Public Works may approve grading for a vehicular way where a cut slope is steeper than two horizontal to one vertical if all of the following are met:

(a) The daylight line of a plane sloping at two horizontal to one vertical is more than 20 feet from any adjoining property line, building and structure.

(b) It is necessary to avoid excessive grading. However, the steeper slope shall not be allowed where the proposed vehicular way can be realigned so as to reduce excessive grading.

(c) The owner executes and records a hold harmless agreement in a form approved by the Director of Public Works relieving the County from any liability for this exception.

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Sec. 7-115.19 **Vehicular Ways — Drainage:** Vehicular ways shall be graded and drained in such a manner that will not allow erosion or endanger the stability of any adjacent slope. Surface discharge onto adjoining property shall be controlled in such a manner that it does not cause erosion. Bridges and culverts installed in watercorses shall be approved by the Alameda County Flood Control and Water Conservation District.

ARTICLE 7. IMPROVEMENT SECURITY

Sec. 7-116.0 **Security Required:**

(a) As a condition for the issuance of a permit, the Director of Public Works may require the deposit of improvement security in sufficient amount deemed necessary by him to assure faithful performance of the work or the cost of removing the work or otherwise reconstructing or restoring a site to conditions existing prior to such work in the event of default on the part of permittee or, in the case of a subdivision, where the permittee does not proceed with preparations and obtaining the approval of a final map. Said security shall be in the form of cash, a certified or cashier s check, a letter of credit, or a faithful performance bond executed by the applicant and a corporate surety authorized to do business in this state.

(b) In the case of subdivisions, the improvement shall remain in effect until final inspections have been made, all grading work and subdivision improvements have been accepted by the Director of Public Works, and all other requirements of the subdivision contract have been satisfied.

(c) For projects other than subdivisions, the improvement security shall remain in effect until final inspections have been made and all grading work has been accepted by the Director of Public Works.

(d) In addition to the improvement security, the Director of Public Works may also require the deposit of maintenance security in sufficient amount deemed necessary by him to guarantee and maintain the grading work to assure the proper functioning of drainage systems and adequate erosion and sedimentation control. Said maintenance security shall be in the form of cash, a certified or cashier's check, a letter of credit, or a faithful performance bond executed by the applicant and a corporate surety authorized to do business in this state and shall remain in effect for a period of one year after the date of expiration of the improvement security as designated in Subsections (b) and (c) above.

(e) Any bond or deposit required by the Director of Public Works pursuant to this ordinance shall be payable to the Alameda County Flood Control and Water Conservation District.

(f) Upon satisfaction of applicable provisions of this Chapter, the improvement and maintenance security deposits or bonds will be released. However, upon failure to complete the work, failure to comply with all of the terms of the permit, or failure of the completed site to function properly to provide proper drainage or erosion and sedimentation control, the County may do the required work, or cause it to be done and collect from the permittee or surety all costs incurred thereto, including administrative and inspection costs. Any unused portion of a deposit or bond shall be refunded to the permittee after deduction by the county of the cost of the work.

ARTICLE 8. ENFORCEMENT

Sec. 7-117.0 **Suspension and Revocation of Permit:** The Director of Public Works may suspend or revoke a permit for good cause, subject to appeal to the Board of Supervisors. However, no work shall be performed pending appeal except as authorized by the Director of Public Works.

Sec. 7-117.1 **Abatement:** Whenever the Director of Public Works determines that any hazard exists, such as is described in Section 7-111.7 herein, or that any violation of this Chapter exists, any such condition or violation may be declared to be a public nuisance and may be abated pursuant to the provisions of Chapter 7 of Title 7 of this Code.

Sec. 7-117.2 **Injunction:** The County Counsel, at the direction of the Board of Supervisors shall, or in the case of an emergency at the request of the Director of Public Works may, petition the Superior Court for the issuance of a temporary restraining order, temporary injunction, or permanent injunction, or combination thereof, as may be appropriate, requiring any person not complying with this Chapter to comply therewith.

Sec. 7-117.3 **Nonexclusive Remedies:** The remedies provided herein are not exclusive, and are in addition to any other remedy or penalty provided by law for violation of this Chapter.

ARTICLE 9. ADDITIONAL PROVISIONS

Sec. 7-118.0 **Enforcement Official:** The Director of Public Works shall enforce the provisions of this Chapter.

Sec. 7-118.1 **Right of Entry:** Whenever necessary to enforce the provisions of this Chapter the Director of Public Works may enter the premises at all reasonable times in the manner provided by law to perform any duty imposed by this Chapter. If such entry is refused, the Director of Public Works shall have recourse to every remedy provided by law to secure entry.

Sec. 7-118.2 **Stop Work Orders:** Whenever any work is being done contrary to the provisions of this Chapter or any other applicable law, ordinance, rule or regulation, the Director of Public Works may order the work stopped by serving written notice on any persons engaged in, doing, or causing such work to be done. Any such person shall forthwith stop such work until authorized by the Director of Public Works to proceed with the work. If there are no persons present on the premises, the notice may be posted in a conspicuous place. The notice shall state the nature of the violation. Any person violating a stop work order shall be guilty of a misdemeanor

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Sec. 7-118 3 Liability: Neither issuance of a permit under the provisions of this Chapter nor compliance with the provisions hereof or with any conditions imposed in a permit issued hereunder shall relieve any person from responsibility for damage to any person or property or impose any liability upon the County of Alameda for damage to any person or property.

Sec. 7-118.4 Denial of Other Permits: No building permit, septic tank, water, sewer, electrical permit, or any other permit shall be issued by the County to any person for any premises or portion thereof which is in violation of this Chapter and which violation is not corrected or approved for correction by the Director of Public Works.

Sec. 7-118 5 Notice to Adjacent Owners: Upon the filing of an application for a permit, the Director of Public Works may notify by mail the owners of property abutting the site, as shown on the latest equalized assessment roll, that an application for a grading permit has been submitted pursuant to this Chapter, that they may comment at any stage of the procedure, and may lodge an appeal pursuant to the provisions of this Chapter

Sec. 7-118 6 Severability: If any section, subsection, paragraph, subparagraph, sentence, clause or phrase of this Chapter is for any reason held to be invalid or unconstitutional, such invalidity or unconstitutionality shall not affect the validity or constitutionality of the remaining portions of this Chapter; and the Board declares that this chapter and each section, subsection, paragraph, subparagraph, sentence, clause, and phrase thereof would have been adopted irrespective of the fact that one or more of such section, subsection, paragraph, subparagraph, sentence, clause or phrase be declared invalid or unconstitutional.

SECTION II

Section 7-12 0 of Chapter 1 of Title 7 of the Alameda County Ordinance Code is amended to read:

Section 7-12 0 Permit required: No person, firm or corporation or organization shall install, erect, construct, enlarge, add to, alter, repair, move, remove, demolish, convert, occupy, equip or improve any building or structure, any electrical, plumbing or mechanical installation or cause the same to be done without first obtaining a permit from the Building Official.

A separate permit shall be required for each building or structure, but the permit may include pertinent accessories such as fences, retaining walls, exterior lighting, underground utilities and sprinkler systems, providing such work is shown on the approved plans or described on the application. The Building Official may authorize issuance of a single permit for several buildings where in his opinion the convenience of the County will be served.

Prior to issuance of a permit by the Building Official, a separate permit or approval shall be secured from the Health Officer for private water supply and private sewage disposal systems. In addition, separate permits for wells are required pursuant to Article 14, Chapter 6, Title. 5.

Additional permits shall be required for pertinent accessories regulated by this Title which are proposed to be constructed but not shown on the approved plans or described on the application.

A grading permit may also be required subject to provisions of the Alameda County Grading Ordinance.

Subsection 7-22.19 (b) of Chapter 2 of Title 7 of the Alameda County Ordinance Code is amended to read:

(b) Excavations. Except when permitted under a valid grading permit as set forth in Section 7-115.1 of Chapter 9 of Title 7 of the Alameda County Ordinance Code, the slope of cut surfaces of permanent excavations shall not be steeper than 2 horizontal to 1 vertical. The slope of cut surfaces shall not be steeper than the bedding planes or principal joint sets in any formation where the cut slope will lie on the dip side of the strike line unless the soils and geologic investigations contain recommendations for steeper slopes. Footings which may be affected by any excavation shall be underpinned or otherwise protected against settlement and shall be protected against lateral movement.

SECTION III

This Ordinance shall take effect and be in force thirty (30) days from and after the date of its passage and before the expiration of fifteen (15) days after its passage it shall be published once with the names of the members voting for and against the same in The Inter-City Express, a newspaper published in the said County of Alameda.

Adopted by the Board of Supervisors of the County of Alameda, State of California, on the 16th day of March, 1982, by the following called vote:

AYES: Supervisors Cooper, Excell, Santana and Chairman Bort — 4.

NOES: None.

EXCUSED: Supervisor George — 1.

JOSEPH P. BORT,
Chairman of the Board of Supervisors of the
County of Alameda, State of California.

ATTEST:

WILLIAM MEHRWEIN,
Clerk of the Board of Supervisors,
County of Alameda, State of California.
By: WILLIAM MEHRWEIN.

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ATTACHMENT C

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ORDINANCE NO. 82-18
AN ORDINANCE ESTABLISHING REQUIREMENTS FOR PROTECTION OF WATERCOURSES

The Board of Supervisors of Alameda County, State of California, do ordain as follows:

SECTION I

CHAPTER 10 (Commencing with Section 7-200.0) is hereby added to Title 7 of the Ordinance Code of the County of Alameda to read as follows:

CHAPTER 10
WATERCOURSE PROTECTION
ARTICLE 1. GENERAL PROVISIONS

Sec. 7-200.0 **Title:** This Chapter shall be known as the Watercourse Protection Ordinance of Alameda County.

Sec. 7-200.1 **Purpose:** This Chapter is enacted to safeguard and preserve watercourses, protect lives and property, prevent damage due to flooding, protect drainage facilities, control erosion and sedimentation, restrict discharge of polluted materials and enhance recreational and beneficial uses of watercourses.

Sec. 7-200.2 **Definitions:** Unless the context clearly requires a different meaning, the meanings given for the following words and phrases shall apply when said words and phrases are used in this Chapter:

(a) AGRICULTURAL OPERATION means any land related activity for the purpose of cultivating or raising plants or animals or conserving or protecting lands for such purposes when conducted on agriculturally zoned lands, and is not surface mining or borrow pit operations nor preparation for construction or construction of any structure for human occupancy.

(b) BANK means any embankment, dike, levee, weir or similar feature of natural or man-made origin which adjoins or parallels any watercourse and which has as a function the confinement of the water of said watercourse.

(c) BOARD means the Board of Supervisors of Alameda County.

(d) CITY means an incorporated city in Alameda County.

(e) DEVELOPMENT means any act of filling, depositing, excavating or removing any natural material, or constructing, reconstructing or enlarging any structure, which requires a permit issued by the Director of Public Works.

(f) DIRECTOR OF PUBLIC WORKS means the Director of Public Works of Alameda County, California, acting either directly or through his authorized deputies.

(g) DISTRICT means the Alameda County Flood Control and Water Conservation District.

(h) FLOODWAY means the channel of a watercourse and adjacent land areas that must be reserved in order to convey flood flows as determined by the Director of Public Works. Where shown on a Flood Boundary and Floodway Map of the Federal Insurance Administration, "Floodway" means such a designation on said map.

(i) MAINTENANCE means the desilting, pruning or removal of vegetation, the removal of trash and debris, the removal of algae, water treatment, mosquito abatement activities, repair, or any other work required to maintain conveyance or storage capacities of watercourses or purity and quality of water, or to safeguard public health.

(j) PERMIT means a permit issued by the Director of Public Works pursuant to the provisions of this Chapter.

(k) PERMITTEE means any person granted a permit under the provisions of this Chapter.

(l) PERSON means any individual or group of individuals, firm, corporation or public agency.

(m) PUBLIC AGENCY means any Federal, State, regional or local government entity or any subdivision thereof.

(n) SETBACK means a distance adjacent to an open channel watercourse within which development shall be controlled. Setback limits are defined in Article 5.

(o) STRUCTURE means any works or constructions of any kind, including those of earth or rock, permanent or temporary, and including fences, poles, buildings, pavings, inlets, levees, tide gates, spillways, drop structures and similar facilities.

(p) WATERCOURSE means any conduit or appurtenant structure or any natural or man-made channel through which water flows continuously or intermittently in a definite direction and course or which is used for the holding, delay or storage of water. Natural channels shall generally be limited to those designated by a solid line or dash and three dots as shown in blue on the most recent U. S. Geological Survey 7.5 minute series of topographic maps. At the discretion of the Director of Public Works, the definition of natural channel may be limited to those channels having a watershed area of 50 acres or more, and this definition will be commonly used in the administration of this Chapter except for those cases in which the Director of Public Works determines that the definition must be extended to a natural channel with a watershed area smaller than 50 acres in order to prevent a condition which is a menace to life and limb, endangers property, is a hazard to public safety, adversely affects the safety, use or serviceability of adjacent property, public way or drainage channel, or could adversely affect the water quality of any water body or watercourse were the definition not extended to a particular natural channel with a watershed area below 50 acres.

Sec. 7-200 3 **Jurisdiction:** This Chapter shall apply to the unincorporated area of Alameda County.

Sec. 7-200 4 **Responsibility of Director of Public Works:** It shall be the responsibility of the Director of Public Works to enforce the provisions of this Chapter and he is hereby so authorized.

Sec. 7-200 5 **Owner's and Tenant's Responsibility:** Every person owning property through which a watercourse passes, or said person's lessee or tenant, shall keep and maintain that part of the watercourse within said property reasonably free of trash, debris, excessive vegetation and other obstacles which would pollute, contaminate or significantly retard the flow of water through the watercourse; shall maintain existing privately owned structures within or adjacent to a watercourse, so that such structures will not become a hazard to the use, function or physical integrity of the watercourse; and shall not remove healthy bank vegetation beyond that actually necessary for said maintenance or other maintenance specified in Sec. 7-201.10 (c) herein, nor remove said vegetation in such a manner as to increase the vulnerability of the watercourse to erosion.

Sec. 7-200 6 **Not Retroactive:** This Chapter shall be prospective in operation only. The provisions of this Chapter shall not apply to existing construction for which all previously necessary permits were obtained. Said provisions shall also not apply to a project or development not yet constructed provided that an appropriate permit has been obtained and said permit bears a date prior to the effective date of this Chapter.

Sec. 7-200.7 **Administration:** This Chapter shall be administered for Alameda County by the District.

ARTICLE 2. PERMIT PROCEDURES

Sec. 7-201.0 **Requirements:** No person shall commit or cause to be committed any of the following acts, unless a written permit has first been obtained from the Director of Public Works:

(a) Discharge into or connect any pipe or channel to a watercourse;

(b) Modify the natural flow of water in a watercourse;

(c) Carry out development within a setback, as defined in Article 5;

(d) Deposit in, plant in, or remove any material from a watercourse including its banks, except as required for necessary maintenance;

(e) Construct, alter, enlarge, connect to, change, or remove any structure in a watercourse; or

(f) Place any loose or unconsolidated material along the side of or within a watercourse or so close to the side as to cause a diversion of the flow, or to cause a probability of such material being carried away by storm waters passing through said watercourse.

Sec. 7-201.1 **Restrictions:** The intent of this Chapter is to safeguard watercourses. A permit shall not be granted where, in the opinion of the Director of Public Works, a proposed activity in or adjacent to a watercourse could result in disposal or deposition of oils, chemicals, poisons, trash, or other materials harmful to said watercourse.

Sec. 7-201.2 **District Ordinance in Effect:** Nothing contained herein shall in any way supersede, void or preempt requirements of District Ordinance No. 34 (Alameda County Ordinance No. 441 N.S.). Said Ordinance includes permit requirements for activities in District-owned rights-of-way or facilities.

Sec. 7-201.3 **Other Permits:** Nothing contained herein shall in any way supersede, void or preempt requirements of other governmental agencies, including federal, state, and local agencies, in regard to activities affecting watercourses. Also, the requirements of this Chapter are not intended to duplicate the requirements of another agency. If, in the opinion of the Director of Public Works, the requirements of this Chapter will be substantially met by conditions prescribed by a permit granted by another agency, the Director of Public Works may waive the permit requirements of this Chapter. Any violation, however, of the requirements of this Chapter, regardless of whether such violation may have occurred under provisions of another permit, may be subject to enforcement procedures and penalties prescribed by this Chapter.

Sec. 7-201.4 **Permit Applications:** Permit applications shall be filed with the Director of Public Works on forms furnished by his office. A schedule of fees and costs and a list of requirements and instructions shall be furnished each applicant. The Director of Public Works may require any additional information he considers necessary to establish the identity of the applicant, the location of the project site, details concerning the proposed project, a timetable of proposed activities, existing site conditions, and anticipated site conditions following the proposed activities. An application shall be accepted as complete upon receipt of all required information and payment of fees.

Sec. 7-201.5 **Permit Issuance:**

(a) In issuing a permit, the Director of Public Works may prescribe conditions reasonably necessary to safeguard the affected watercourse pursuant to provisions of this Chapter. Non-compliance with said conditions is deemed a violation of this Chapter.

(b) A permit may be issued for any reasonable term and may be renewed if good cause therefor is shown. A written request for renewal shall be submitted to the Director of Public Works who may require a new application and required fees, considering the time between the expiration date and the renewal request, revisions in County regulations, or changed circumstances in the immediate area of the site. Any revised plan shall be submitted to the Director of Public Works for review, and any costs thereof shall be at the applicant's expense.

(c) If a proposed activity could significantly affect the physical characteristics of a watercourse in another jurisdiction such as an unincorporated city or an adjoining county, or could result in disposal or deposition of a foreign material in a watercourse upstream from such jurisdiction, that jurisdiction shall be notified prior to issuing a permit

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Sec. 7-201 6 **Prosecution of Work:** The permittee shall begin the work or use authorized by a permit issued pursuant to this Chapter within 90 days from the date of issuance unless a different period is provided in the permit. Failure to begin said work or use on time or to prosecute it diligently shall be deemed a violation of this Chapter.

Sec. 7-201.7 **Appeals:** The issuance, denial, cancellation, or conditioning of a permit pursuant to this Chapter may, within 15 calendar days of such action, be appealed in writing by any person to the Board. An appeal shall set forth the grounds therefor, the work proposed to be done and the method of accomplishing said work, together with sufficient factual, engineering and technical data to set forth the basis and the reasons for the appeal. Board shall make a final interpretation of requirements and shall announce its decision within 30 calendar days after receipt of said written appeal.

Sec. 7-201.8 **Responsibility:**

(a) Neither the issuance of a permit nor compliance with the conditions thereof, nor with the provisions of this Chapter, shall relieve any person from any responsibility otherwise imposed by law for damage to persons or property; nor shall the issuance of a permit hereunder serve to impose any liability upon the County of Alameda, the District, a City, a special district, or its officers or employees, for injury or damage to persons or property. A permit issued pursuant to this Chapter does not relieve the permittee of the responsibility of securing and complying with any other permit which may be required by any other public agency ordinance, directive or law.

(b) It shall be the responsibility of any person whose operation may result in discharge into a watercourse to comply with applicable Federal, State and local water quality standards and regulations.

Sec. 7-201.9 **Fees:**

(a) The schedule of fees and costs shall be those established and adopted by the Board from time to time by resolution. Before a permit is issued, the applicant shall deposit with the Director of Public Works cash or a certified or cashier's check, in a sufficient sum to cover the fee for issuance of the permit, charges for review of plans, specifications and reports, other engineering services, field investigations, and necessary inspection or other work, all in accordance with schedules established and adopted by the Board.

(b) No fee shall be required of public agencies.

(c) Public utilities may, at the option of the Director of Public Works, make payment as billed by the Director of Public Works instead of in advance.

(d) If, upon completion of any work under a permit there remains any excess of deposit or of fees or charges, the Director of Public Works shall certify the same to the auditor for refund to the permittee or refund the same from any trust fund established under his jurisdiction for such purposes.

(e) If, upon completion of any work under a permit there is an insufficient deposit to cover the District's cost, the Director of Public Works may require the Permittee to reimburse the District in an amount equal to the cost deficit.

Sec. 7-201.10 **Exemptions:** The following activities are exempted from the provisions of this Article except as provided herein:

(a) Agricultural operations, as long as these activities do not significantly pollute or damage watercourses or cause excessive erosion of banks and deposition of sediments in watercourses thereby requiring abatement measures and imposing cost burdens on the District and its taxpayers.

(b) Work within a public roadway right-of-way, where said public roadway right-of-way crosses a watercourse. The affected jurisdiction shall advise the District of details and schedule for such work.

(c) Minor or routine maintenance work performed by a property owner or his tenant on a watercourse flowing through his property pursuant to Sec. 7-200.5 herein. Said maintenance work shall be limited to pruning and removal of excessive vegetation and removal of trash and debris.

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(d) Performance of emergency work necessary to protect life or property when an urgent necessity therefor arises. The person performing such emergency work shall notify the Director of Public Works promptly of the problem and work required and shall apply for a permit therefor within ten calendar days after commencing said work.

(e) The Director of Public Works may, at his discretion, exempt the permit requirements of this article when an Alameda County Grading Permit has been obtained and all applicable requirements of this Chapter have been satisfied.

Sec. 7-201.11 **Performance of Work — Inspection:** The Director of Public Works may inspect any work done pursuant to a permit under this Chapter. No permittee shall be deemed to have complied with this Chapter until a final inspection of the work has been made by the Director of Public Works and he has certified in writing that the work has been completed in accordance with all requirements and conditions of the permit.

Sec. 7-201.12 **Security:** At the discretion of the Director of Public Works, a permit may be withheld until the applicant has posted security in an amount satisfactory to the Director of Public Works for the faithful performance of the work or the cost of removing the work or otherwise reconstructing or restoring a watercourse to conditions existing prior to such work in the event of default on the part of permittee. Said security shall be in the form of cash, a certified or cashier's check, a letter of credit, or a faithful performance bond executed by the applicant and a corporate surety authorized to do business in this state.

Sec. 7-201.13 **Transfer of Permit:** No permit issued under this Chapter may be transferred or assigned in any manner whatsoever, voluntarily or by operation of law, without the express consent of the Director of Public Works.

ARTICLE 3. ENFORCEMENT

Sec. 7-202.0 **Suspension and Revocation of Permit:** The Director of Public Works may suspend or revoke a permit for good cause, subject to appeal to the Board of Supervisors. However, no work shall be performed pending appeal except as authorized by the Director of Public Works.

Sec. 7-202.1 **Abatement:** Whenever the Director of Public Works determines that any existing condition is a hazard to life or limb, or endangers structures, or adversely affects the use, function or physical integrity of a watercourse, or that any violation of this Chapter exists, any such condition or violation is hereby declared to be a public nuisance and may be abated pursuant to the provisions of Chapter 7 of Title 7 of this Code.

Sec. 7-202.2 **Injunction:** The County Counsel, at the direction of the Board of Supervisors shall, or in the case of an emergency at the request of the Director of Public Works may, petition the Superior Court for the issuance of a temporary restraining order, temporary injunction, or permanent injunction , or combination thereof, as may be appropriate, requiring any person not complying with this Chapter to comply therewith.

Sec. 7-202.3 **Nonexclusive Remedies:** The remedies provided herein are not exclusive, and are in addition to any other remedy or penalty provided by law for violation of this Chapter.

ARTICLE 4. ADDITIONAL PROVISIONS

Sec. 7-203 0 **Right of Entry:** Whenever necessary to enforce the provisions of this Chapter the Director of Public Works may enter the premises at all reasonable times in the manner provided by law to perform any duty imposed by this Chapter.

Sec. 7-203.1 **Liability:** Neither issuance of a permit under the provisions of this Chapter nor compliance with the provisions hereof or with any conditions imposed in a permit issued hereunder shall relieve any person from responsibility for damage to any person or property or impose any liability upon the County for damage to any person or property.

Sec. 7-203.2 **Denial of Other Permits:** No building, septic tank, water, sewer, electrical, or any other permit shall be issued by the County to any person for any premises or portion thereof which is in violation of this Chapter and which violation is not corrected or approved for correction by the Director of Public Works.

Sec. 7-203.3 **Notice to Adjacent Owners:** Upon the filing of an application for a permit, the Director of Public Works may notify by mail the owners of property abutting the site, as shown on the latest equalized assessment roll, that an application for a watercourse protection permit has been submitted pursuant to this Chapter, that they may comment at any stage of the procedure, and may lodge an appeal pursuant to the provisions of this Chapter.

Sec 7-203.4 **Severability:** If any section, subsection, paragraph, subparagraph, sentence, clause or phrase of this Chapter is for any reason held to be invalid or unconstitutional, such invalidity or unconstitutionality shall not affect the validity or constitutionality of the remaining portions of this Chapter; and the Board declares that this chapter and each section, subsection, paragraph, subparagraph, sentence, clause, and phrase thereof would have been adopted irrespective of the fact that one or more of such section, subsection, paragraph, subparagraph, sentence, clause or phrase be declared invalid or unconstitutional.

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ARTICLE 5. SETBACKS

Sec 7-204.0 Requirements:

(a) Setbacks are hereby established adjacent to open channel watercourses in conformance with details shown in Sec. 7-204.1.

(b) The purpose of setbacks is to safeguard watercourses by preventing activities that would contribute significantly to flooding, erosion or sedimentation, would inhibit access for watercourse maintenance, or would destroy riparian areas or inhibit their restoration. Accordingly, no development shall be permitted within setbacks, except as otherwise provided herein.

(c) In certain situations, where, in the opinion of the Director of Public Works, it would be in the public interest to permit limited development within a setback, the Director of Public Works may grant a permit for said development provided that the above specified purpose would be satisfied. In such cases, the permit applicant shall submit sufficiently detailed plans and specifications, and any additional material required by the Director of Public Works, to demonstrate that a proposed development adjacent to an open channel watercourse would meet said requirements.

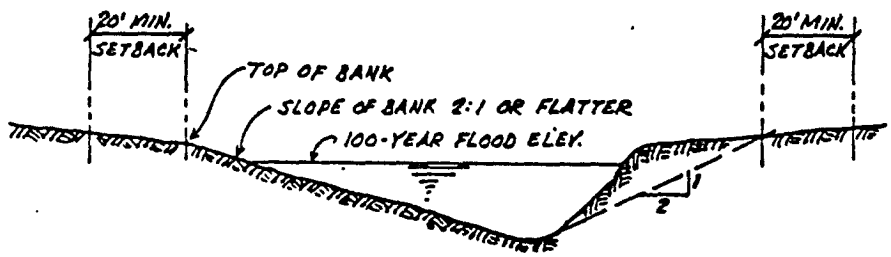
(d) In all cases where development adjacent to an open channel is permitted within setback limits, the owner of the developed property shall assume all responsibility for any damage whatsoever to his property or to any structures erected thereon.

(e) No development shall be permitted within a setback where it would conflict with the requirements of any applicable County, District or City ordinance, regulation, directive or law.

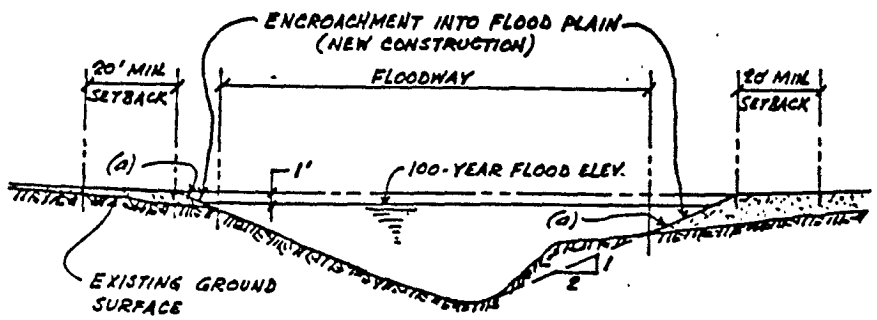
(f) Setbacks shall be located outside of floodways.

(g) The Director of Public Works shall make the determination as to setback limits and any permitted development within a setback.

Sec. 7-204.1 Setback Criteria:



SECTION A — TYPICAL WHERE 100-YEAR STORM FLOW IS CONTAINED WITHIN BANKS OF EXISTING WATERCOURSE



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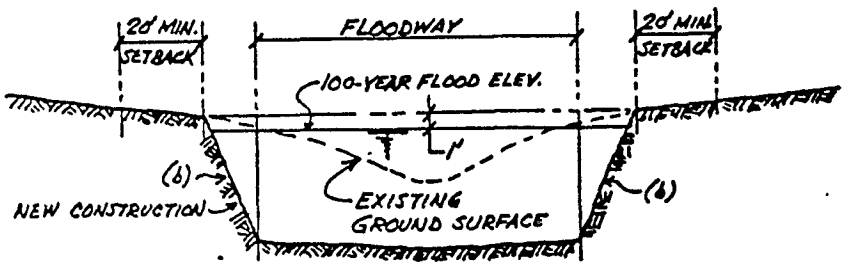
(a) Slope of bank shall be 2 horizontal to 1 vertical or flatter, as determined by Director of Public Works.

SECTION B — TYPICAL WHERE EXISTING CHANNEL IS SUFFICIENTLY LARGE TO ALLOW SIDE ENCROACHMENT



(b) Sides of channel shall be structurally stable. If sides are of earth, they shall have a maximum slope of 2 horizontal to 1 vertical..

SECTION C — TYPICAL FOR A FLOOD PLAIN WHERE THE WATERCOURSE MUST BE ENLARGED TO PERMIT DEVELOPMENT

NOTES:

1. Sections B and C shall be based on maximum development under existing General Plan.
2. Sections A, B and C are not applicable to developed areas where provisions of Sec. 7-200.6 (Not Retroactive) apply.

SECTION II

This Ordinance shall take effect and be in force thirty (30) days from and after the date of its passage and before the expiration of fifteen (15) days after its passage it shall be published once with the names of the members voting for or against the same in The Inter-City Express, a newspaper published in the said County of Alameda.

Adopted by the Board of Supervisors of the County of Alameda, State of California, on March 16, 1982, by the following called vote:

AYES: Supervisors Cooper, Excell, Santana and Chairman Bort — 4.

NOES: None.

EXCUSED: Supervisor George — 1.

JOSEPH P. BORT,
Chairman of the Board of Supervisors of the
County of Alameda, State of California.

ATTEST:

WILLIAM MEHRWEIN,
Clerk of the Board of Supervisors of the
County of Alameda, State of California,
By: WILLIAM MEHRWEIN.

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ATTACHMENT D

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COORDINATE, CHEMICAL BONDING AND ADSORPTION

Coordinate, Chemical Bonding and Adsorption (CCBA) is an innovative new process which has been developed by the San Diego Water Reclamation Agency for the treatment and reclamation of industrial wastewater, municipal wastewater, and hazardous waste. The process produces water which is clean enough for unrestricted recreational use, and converts the residual sludge from the treatment process into a valuable and useful lightweight ceramic aggregate. Thus, the CCBA process produces cleaner water than conventional primary treatment and does not create hazardous and useless solid waste, as conventional biological treatment plants do.

The CCBA process adds clay, polyacrylic acid, and alum to wastewater. The mix is then flocculated and the heavy floc is settled out of the water in a clarifier. The water from the clarifier will meet secondary treatment requirements. The sludge from the process is pumped from the clarifier and fired in a kiln, producing pellets of a ceramic material. The exhaust from the process is channeled back into the original mix, where the particulate matter becomes, once again, part of the floc which is ceramicized. The water from the CCBA process can be used for recreation and irrigation, and the ceramic aggregate can be best used for the construction industry (replacing cinder blocks).

CCBA is now in its fourth stage of testing and evaluation, which began in June, 1986. Phase one demonstrated that the CCBA process can:

1. Treat and reclaim raw municipal wastewater economically.

2. Turn the sludge into a lightweight ceramic aggregate which has uses in the building and other industries.

3. Treat waste water at a quarter of the capital cost of an activated sludge secondary treatment facility.

4. Treat the same volume of wastewater in 25% of the space of a standard primary, secondary biological facility.

5. The operations and maintenance costs of the CCBA plant can be greatly reduced by the revenue from the sale of the resources (ceramic aggregate) recovered.

Phase II studied the ability of the CCBA process to remove heavy metals and toxic organics from mixed municipal and industrial waste. Nearly 150,000 gallons of raw sewage from Tijuana, Mexico was processed in the CCBA pilot plant. The process removed 100% of the chromium and silver, and between 77% to 96% of all

cadmium, zinc, lead, nickel, and copper from the wastewater. The process also removed between 36% to 99% of the toxic organics in the sewage, including 96% of the methylene chloride and 98% of the napthalene to 36% of the chlorobenzene and 44% of the chloroform.

Phase II also demonstrated that the heavy metals captured in the ceramic pellets were converted to metal silicates and silicates of glasses in such a manner as to be trapped and therefore no longer a threat to the environment. In addition, this stage of the pilot program demonstrated the capacity of CCBA to remove bacterial and viral indicators from the sewage. The pilot plant removed 78.6% of total coliform bacteria and 78.5% of F-specific bacteriophages. These removal rates are comparable to the rates of conventional secondary treatment by activated sludge.

Phase III of the project demonstrated that the CCBA process can:

1. take dewatered industrial sludge and convert it to ceramic aggregate;

2. take liquid industrial sludge containing heavy metals and convert it to ceramic aggregate, and

3. take liquid industrial sludge containing toxic organics and destroy the toxics while producing the ceramic aggregate.

Phase IV involves demonstrating the ability of the CCBA process to meet state standards for the removal of viruses and bacteria so that the reclaimed water can be safely used. The final report on this phase will be complete in January of 1989. An economic analysis is also currently in progress.

Prepared by: Cliff Gladstein
Office of Assemblyman Tom Hayden

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THE SAN DIEGO WATER RECLAMATION AGENCY

The goal of this agency, which is comprised of municipalities, county agencies, and special districts which provide sewer and/or water service, is to advance the technology of wastewater reclamation and to promote its reuse as a supplemental water supply. The San Diego Water Reclamation Agency (SDWRA) attempts to fill the gap between research and its application in the community. To do so, SWDRA has established four objectives:

1. "To jointly study the methods and technology of water reclamation, water management, and the reuse of wastewater."

2. "To establish one or more centers for the conduct of such studies."

3. "To experiment, test and apply in an operational setting advanced techniques for the reclamation and reuse of water."

4. "To develop water reclamation plans and programs that may be adopted by the members of the agency for use and application within their respective jurisdictions."

The Reclamation Agency is funded by assessments against each of the member agencies and through grants.

SDWRA has accomplished the following:

1. Found that artificial wetlands can provide an economic alternative to dentrifying secondary treatment systems which also remove BOD and suspended solids. Artificial wetlands can also provide secondary treatment of primary effluent and provide a high degree of nitrogen removal. In addition, the SDWRA study found that artificial wetlands can remove certain heavy metals, such as copper, zinc and cadmium from effluent.

2. Demonstrated the feasibility of maintaining live-streams by supplementing existing streambeds with reclaimed waters. The agency has shown that it is possible to develop and maintain water-oriented recreational parks and campgrounds in urban areas.

4. Pioneered the conversion of organic matter resulting from wastewater treatment into energy or other valuable products. This process is known as Coordinate, Chemical Bonding and Adsorption.

Prepared by: Cliff Gladstein
Office of Assemblyman Tom Hayden

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THE BELLEVUE (WASHINGTON) STORM AND SURFACE WATER UTILITY

The Bellevue Storm and Surface Water Utility (BBSWU) was created to address the problems of increased erosion, flooding and the conveyance of surface pollutants to receiving waters. The BBSWU was created to manage the drainage system while providing protection from property damage, maintain hydrologic balance, and protect water quality. The drainage utility attempts to manage stormwaters using as much of the natural drainage system as possible without degrading the natural system.

The BSSWU has five major programs:

1. Administration -- involves policy development, financial management, rates administration, comprehensive drainage planning, general administration, and support for the City council and Utility Commission.

2. Development regulation -- entails reviewing plans and making inspections to ensure all new development complies with utility policies and standards.

3. Capital improvement -- plans, design, acquires property and constructs flood control, water quality treatment and stream enhancement projects.

4. Operations and maintenance -- involves the repair and replacement of structural facilities, the operations of small dams and other control structures for flood control, and the emergency storm response program.

5. Water quality control program -- includes drainage system cleaning, routine monitoring of receiving waters, investigative monitoring and emergency response for water pollution events, stream enhancement programs, lake restoration studies, and coordination with other water quality control agencies.

The utility interacts closely with other government agencies, working with the Washington Department of Ecology and the Pudget Sound Water Quality Authority to assure that the requirements of the local water quality plan are fulfilled, monitored and enforced.

The five programs listed above are financed the same as for water and sewer utilities. Rates are charged on the basis of contribution to run-off and the rate structure is based on the amount of run-off produced. Since the level of run-off actually produced cannot be measured directly, an estimate is made on the basis of the extent of impervious surface on a property and its size.

The drainage utility computes its rate classifications on the basis of a system of run-off coefficients. These coefficients are developed primarily from the amount of developed surface on a parcel of land and on whether the property has other physical improvements which alter the hydrology. The rate ratios of the five classifications--undeveloped, light development, moderate development, heavy development, and very heavy development--are multiplied by property area and the total revenue requirement to determine the service charge.

The utility receives the majority of its revenue from the rates charged property owners. BBSWU also collects permit fees to offset the costs of its development regulation program. The utility also receives a buy-in charge at the time of development, similar to the fee charged by water and sewer utilities for capital costs. Latecomer and developer extension agreements are another source of revenue. The former requires the utility to collect from future developments which benefit from privately funded capital improvements to reimburse the original financier. Thus, the utility is expanded at no cost to the taxpaying public.

Federal funds have financed a recent education and enforcement program: "Stream Teams" have been formed which provide neighborhood surveillance for illegal dumping. A program in the schools teaches children the effects on the ecosystem of the inappropriate disposal of garbage.

Another recent addition is a recycling program for crank case oils.

The Bellevue Utility is regarded as highly successful. King County is now beginning a county-wide program based on the Bellevue model.

Prepared by : Cliff Gladstein
Office of Assemblyman Tom Hayden

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ATTACHMENT E

HELPFUL PUBLICATIONS FOR COMMUNITIES CONTROLLING URBAN RUNOFF

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___ Household Hazardous Waste: Solving the Disposal Dilemma ($18.50)

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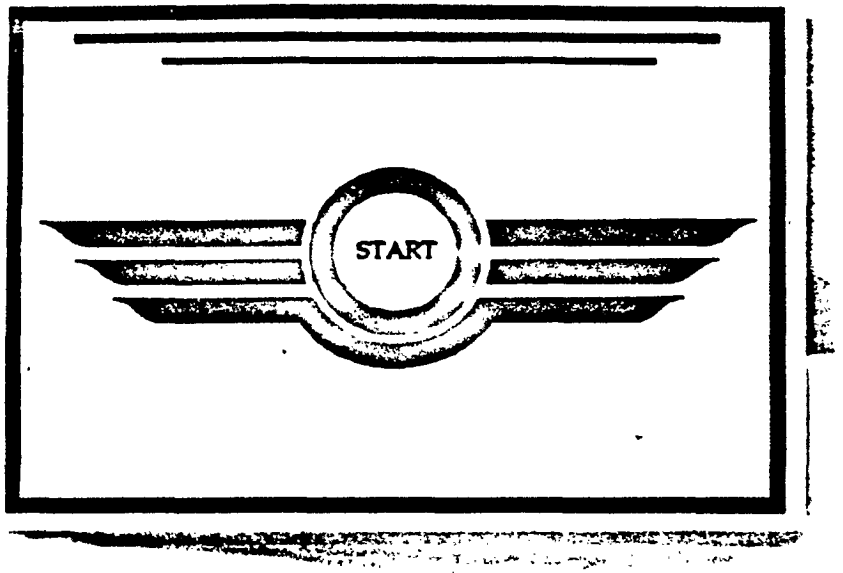

LOS ANGELES REGIONAL WATER QUALITY CONTROL BOARD

ADMINISTRATIVE RECORD INDEX

City of Long Beach

v.

State Water Resources Control Board et al.

VOLUME 16: Speaker Cards from the July 15, 1996 Regional Board Hearing

Available in the File

Volume ~~16~~ 13
(Speaker Cards)
& Comment Cards

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VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☒ I DO NOT WISH TO SPEAK ON ITEM _____
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: _____

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

For Office Use Only:

Summary of all yellow cards:

FOR - 89

Against - 15

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California Regional Water Quality Control Board
Los Angeles Region

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: I'm concerned for the water quality of our bay.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

For Office Use Only:

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R0059827

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS:
Continuing illnesses from contact w/ water in S.M. Bay.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

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California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I DO NOT WISH TO SPEAK ON ITEM #8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: Storm Drain Runoff is the #1 Source of Pollution in SM Bay. A Polluted Bay is bad for business.

☐ I DO NOT WISH TO SPEAK ON ITEM #8
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Michael Stokes / Membership Field Manager

Company Calpirg

Representing

VOL 13

00005

R0059829

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS:
Die head for SW pollution reduction

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Dr. Mark Gold Exactive Director
Company Heal the Bay
Representing Heal the Bay

0006

R0059830

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: _____

_____

_____

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title DOUGLASS STAHELI ASST. MGR.

Company BEL AIR BAY CLUB

Representing BABC

0007

R0059831

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: A clean, healthy bay for future generations to enjoy.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

0008

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: _____

_____

_____

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

0009

R0059833

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: We are with Heal the Bay, and I want the ocean life to remain healthy + out of danger

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

0010

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: in with heal the bay.

☒ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Stephanie Fidel

Company Camp JCA

Representing heal the bay

For Office Use Only:

0011

R0059835

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: _____

_____

_____

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

0012

R0059836

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☞ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: for "heal the bay"

☑ I DO NOT WISH TO SPEAK ON ITEM 9
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title

Company

Representing

For Office Use Only:

0013

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: We are with Heal the Bay. I want to keep these ocean clean & the people & animals healthy

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

For Office Use Only:

0014

R0059838

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: With Heal the Bay

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

For Office Use Only:

0015

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: MY FAMILY AND I ARE HEAVY USERS OF LOS ANGELES BEACHES + S.M. BAY, AND WE WANT TO KEEP STORM DRAIN FLOW CLEAN.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title SUSAN H. ROGERS

Company (INDIVIDUAL CITIZEN)

Representing _____

0016

R0059840

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: The water is a very precous resource, & by passing this permit, it saves the water & makes it more enjoyable.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

0017

R0059841

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: I am concerned about the safety of our beaches & the quality of our water

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Andi Nussbaum

Company _____

Representing Camp Ick Shalom + Heal the Bay

For Office Use Only:

0018

R0059842

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM #8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: Concern for water safety and support of Heal the Bay

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

0019

R0059843

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: I am concerned for the health of the bay and the people who use it.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Daniel Miller

Company _____

Representing Heal the Bay

00220

R0059844

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM _____
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: This permit is the most important part of a comprehensive pollution control system for the SM. Bay

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Leo C. Trujillo Cox Leo Cox

Company _____

Representing UCLA School of Law

0021

R0059845

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☆ I DO NOT WISH TO SPEAK ON ITEM _____
BUT WISH TO REGISTER MY POSITION AS:

☆ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: Future health of coastal waters

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Joan Hatmaker

Company An Ocean Companion

Representing "

0022

R0059846

California Regional Water Quality Control Board
Los Angeles Region

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: The Bay needs to be clear for my children and grandchildren. We need to maintain excellence in public health.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

For Office Use Only:

VOL 13

0023

R0059847

California Regional Water Quality Control Board
Los Angeles Region

☒ I DO NOT WISH TO SPEAK ON ITEM #8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: I want to be able to swim in the ocean without getting sick

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Delphina Bastel

Company _____

Representing self

For Office Use Only:

VOL 13

00024

R0059848

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I DO NOT WISH TO SPEAK ON ITEM _____
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: We have to begin the process of protecting public health by dealing w/ storm water pollution.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Evelyn Lansberry / teacher - concerned citizen

Company _____

Representing self

0025

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM #8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: This is the single most important act the Board can take to clean up the Sta. Monica Bay.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Maribel Marin

Company _____

Representing Self

0026

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM #8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: Passing the permit is essential to ensuring a cleaner, safer Santa Monica Bay.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Michelle Hudson

Company Natural Resources Defense Council

Representing _____

0027

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: The economics of source control (preventative) BMP's are far cheaper than treatment control BMP's.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

0028

R0059852

California Regional Water Quality Control Board
Los Angeles Region

☑ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: Our health & our economy cannot afford any further delay; The negotiation process has included all interest parties

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title STEVE GRAY-BARKAN
Company 6645 LOOKOUT MTN AVE
Representing LOS ANGELES, CA 90046

For Office Use Only:

VOL 13

00029

R0059853

VCL 13

California Regional Water Quality Control Board
Los Angeles Region

☑ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: YOU HAVE ALREADY DELAYED TOO LONG!

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title TRACY GRAY-BARKAN

Company _____

Representing MYSELF

For Office Use Only:

00330

R0059854

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: WE NEED THIS FOR THE SAKE OF OUR ECONOMY AND OUR HEALTH.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

0031

R0059855

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: Essential second step to clean the Bay and Beaches of L.A.

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title DR. PIERCE J. FLYNN, Executive Director

Company Surfrider Foundation

Representing

0032

R0059856

California Regional Water Quality Control Board
Los Angeles Region

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: Ocean Purification

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Lauren Rem

Company Student

Representing Heal the Bay

For Office Use Only: 62/21

Total 83/2 85

VOL 13

0033

R0059857

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: CLEAN

CLEAN

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title TENNA POSTAL

Company [illegible]

Representing [illegible]

VOL 13

0034

R0059858

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only: 60

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: _____

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Roger Gorke / Staff Scientist

Company Heal the Bay

Representing _____

0035

R0059859

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM _____
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: Storm Water Permit (I believe good water quality is very important to our health & our economy)

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Eduardo Perez

Company Pers Foods 321-0260

Representing Half Moon Bay

0036

R0059860

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: For the health and safety of those people that swim in the ocean. Also for the ocean/beach biodiversity

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

0037

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: The permit is economically favorable for cities to implement. And, it's the best option for a healthy Bay.

☐ I DO NOT WISH TO SPEAK ON ITEM ____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Claire McConnico

Company

Representing Myself

0038

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM _____
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST #8

FOR THE FOLLOWING REASONS: I like to swim in ocean

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Joanna Powell 9yrs

Company St James School

Representing children

0039

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM #8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: We need a good permit to protect our beaches.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title VIRGINIA CALVANO

Company 8029 First Street

Representing PARAMOUNT, CA 90723

VOL 13

00400

R0059864

VOL 13

56

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: _____

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Toni Pogue / Communications Dir.

Company Heal the Bay

Representing _____

0041

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: Absolutely necessary to improve water quality in Santa Monica Bay

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Juliette Anthony, Board

Company Coalition for Clean Air

Representing _____

0042

R0059866

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM _____
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: To clean up the Bay.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title SUSAN MCCABE

Company Rose & Kindel

Representing Santa Monica Bay Restoration Project

0043

R0059867

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: Clean water
Public Health

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title JEFFREY PRANG

Company _____

Representing _____

For Office Use Only:

0044

R0059868

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I DO NOT WISH TO SPEAK ON ITEM #8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: I want to be able to swim safely in Santa Monica Bay.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Rich Thigpen, Systems Manager

Company TMP Worldwide

Representing self

0045

R0059869

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: work.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Roger P. Kintz

Company L.A. C.F.D. Health Hazardous Materials Div.

Representing Private Citizen

0046

R0059870

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: _____

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title JULIA LOUIS-DREYFUS

Company NBC

Representing _____

VOL 13

0047

R0059871

California Regional Water Quality Control Board
Los Angeles Region

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: clean water makes dollars & sense

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Scott McVarish

Company YO

Representing self

For Office Use Only:

VOL 13

0048

R0059872

California Regional Water Quality Control Board
Los Angeles Region

☑ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS:
CLEAN THE BAY

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Tom Boer

Company Concerned citizen.

Representing _____

For Office Use Only:

VOL 13

0049

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: So that I can swim in the water and not worry about pollutants.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Michael Jose Torres

Company private citizen

Representing _____

0050

R0059874

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: STORM WATER CONTROL TO PROTECT OCEANS FROM POLLUTION

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title LISA HOLTZMAN

Company HEAL THE BAY

Representing _____

0051

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: _____

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title L. Kronmal

Company _____

Representing Self

0052

R0059876

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: _____

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title MARILYN KRONMAL

Company HEAL THE BAY

Representing _____

0053

R0059877

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM _____
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: LA needs clean beaches!

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

0054

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: Clean the Santa Monica Bay

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title ANGELA MAINS

Company Heal the Bay

Representing _____

For Office Use Only:

0055

R0059879

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: As an individual who has suffered from many ear infections caused by surfing in polluted waters, I am for any measure that will help clean our polluted waters

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title KATHY ADIBI, member Malibu Chapter

Company

Representing SURFRIDER FOUNDATION

0056

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: STORM DRAIN RUNOFF SPREADS ILLNESS AND BACTERIA ALL OVER OUR BEACHES

☒ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title JOSEPH A. TRAINA

Company _____

Representing HEAL THE BAY

0057

R0059881

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: _____

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title GLORIA MORALES

Company _____

Representing HEAL THE BAY

0058

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☑ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS:
Clean up agreement pollution now!

☑ I DO NOT WISH TO SPEAK ON ITEM 8
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Inge Forrest, Scientist
Company Heal the Bay
Representing

For Office Use Only:

0059

R0059883

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: _____

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Katherine Rubin

Company LA City Dept. of Water & Power

Representing _____

VOL 13

00660

R0059884

California Regional Water Quality Control Board
Los Angeles Region

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☐ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: _____

_____

_____

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

For Office Use Only:

21
+2
23

VOL 13

0061

R0059885

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: STORM DRAIN WATER is very unpleasant, and is NOT suitable for our people TO SWIMM in the BAY AREA.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

VOL 13

00662

R0059886

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: STORM DRAIN WATER CAUSES ILLNESS - The OCEAN is to polute d ALL READY! Living in PLAYA I see this pollution on a daily basis. It is really Bad.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

VOL 13

00063

R0059887

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS:
STORM WATER POLLUTES
RIVERS + OCEAN

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title JACOB GREEN

Company —

Representing _____

0064

R0059888

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS:
Restore & clean up the Bay

☑ I DO NOT WISH TO SPEAK ON ITEM 8
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Founding Pres. Dorothy Green

Company Heal the Bay

Representing

0065

R0059889

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: I like [redacted]
to swim at the beach.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Karen

Company

Representing

0066

R0059890

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☐ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: I like the

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

VOL 13

00067

R0059891

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: I like the Beach and I like to SWIM and the Beach

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Evelyn Molina

Company _____

Representing _____

0068

R0059892

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: I want to Swim like the older people did when they were little boys

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Julie Cruz

Company _____

Representing _____

0069

R0059893

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I DO NOT WISH TO SPEAK ON ITEM 2.8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: I like to go [redacted] boat Fishing & Swimming.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Freddy Paniagua

Company _____

Representing _____

00070

R0059894

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: I want to Swim in Clean water

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Oscar Chavez

Company _____

Representing _____

For Office Use Only:

0071

R0059895

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: I Like the Beach and d want It to Be there (Clean when d grow up

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

0072

R0059896

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: _____

_____

_____

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

For Office Use Only:

0073

R0059897

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: I like to go to the beach. I like to play with the sand

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

0074

R0059898

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I DO NOT WISH TO SPEAK ON ITEM _____
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: Because its fun

☑ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company P.A.C.T

Representing _____

0075

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT WISH TO REGISTER MY POSITION AS:

☐ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: _____

_____

_____

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

00076

R0059900

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: _____

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Mayra

Company _____

Representing _____

0077

R0059901

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☒ I DO NOT WISH TO SPEAK ON ITEM 6
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: I want to Keep the beach clean.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title RONY

Company _____

Representing _____

For Office Use Only:

0078

California Regional Water Quality Control Board
Los Angeles Region

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: _____

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title ~~[illegible]~~ Luis

Company _____

Representing _____

For Office Use Only:

VOL 13

0079

R0059903

California Regional Water Quality Control Board
Los Angeles Region

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: [illegible]

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Marcia

Company _____

Representing _____

For Office Use Only:

VOL 13

0080

R0059904

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☐ I DO NOT WISH TO SPEAK ON ITEM 7
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: Karen

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

For Office Use Only:

0081

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: Diana

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

For Office Use Only:

00082

R0059906

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: zanaca

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

00083

R0059907

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: _____

_____

_____

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Ericka Rodriguez

Company _____

Representing _____

0084

R0059908

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: LETTER ATTACHED

☑ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title CHRISTOPHER JONES

Company SURFRIDER FOUNDATION - SO. BAY CHP.

Representing PO BOX 3825, MANHATTAN BEACH
CA 90266

00085

R0059909

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☒ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: _____

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Tatiana Diaz

Company _____

Representing _____

0086

R0059910

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:
☒ FOR ☐ AGAINST STORMWATER PERMIT

FOR THE FOLLOWING REASONS: (OVER) →
+ SEE ATTACHED LETTER

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title JEFFREY NEIL JONES
Company SIERRA CLUB
Representing COASTAL PROTECTION COMMITTEE

VOL 13

00087

R0059911

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☑ FOR ☐ AGAINST

FOR THE FOLLOWING REASONS: It is critical to begin a comprehensive education program for our county to stop stormwater pollution.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Ruben Aroman, Mgr. Director

Company Earth Communications Office

Representing Entertainment Community

8
FOR

0088

R0059912

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT WISH TO REGISTER MY POSITION AS:

☐ FOR ☑ AGAINST

FOR THE FOLLOWING REASONS: _____

☑ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title JAY T. IMPERIAL

Company CITY OF ROSEMEAD / MAYOR PRO TEM

Representing CITY OF ROSEMEAD

For Office Use Only: 10 + 5

Total — 15 against

0089

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☐ FOR ☒ AGAINST

FOR THE FOLLOWING REASONS: Request extension of time to work out problems

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Mayor Margaret Clark

Company City of Rosemead

Representing California Contract Cities Assoc.

00990

R0059914

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☐ FOR ☒ AGAINST

FOR THE FOLLOWING REASONS: TOO MANY UNFUNDED MANDATES FOR THE CITY. LATEST DRAFT HAS NOT BEEN SUFFICIENTLY REVIEWED.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title CHARLES REDDEN/ ADMIN. ANALYST

Company CITY OF COVINA

Representing CITY OF COVINA

VOL 13

00911

R0059915

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☐ FOR ☒ AGAINST

FOR THE FOLLOWING REASONS: It has not been properly presented, issues raised by SDG etc have not been addressed.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title John O. Robertson / Councilman

Company City of Cudahy

Representing City of Cudahy

VOL 13

0092

R0059916

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☐ FOR ☑ AGAINST

FOR THE FOLLOWING REASONS: issues and Concerns have not been fully addressed.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title CUDAHY COUNCILMAN LARRY GALVAN

Company _____

Representing CUDAHY CONSTITUENTS

00993

R0059917

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☐ FOR ☒ AGAINST

FOR THE FOLLOWING REASONS: NOT THOUGHT OUT.
"DELAY"

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title HOFMANN MAYOR

Company CITY OF LAWNDALE

Representing LAWNDALE

0094

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I DO NOT WISH TO SPEAK ON ITEM #8
BUT WISH TO REGISTER MY POSITION AS:

☐ FOR ☑ AGAINST

FOR THE FOLLOWING REASONS: Insufficient time provided to review most recent and comment on most recent revisions to Permit issued on July 5, 1996

☑ I DO NOT WISH TO SPEAK ON ITEM #8
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title CHARLES D. HERBERTSON / Dir. of Public Works

Company City OF Hawthorne

Representing

VOL 13

0095

R0059919

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☐ FOR ☒ AGAINST

FOR THE FOLLOWING REASONS: SEE ATTACHED SHEET

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title ROBERT BRONKALL / ASSISTANT CIVIL ENGINEER

Company CITY OF LA HABRA HTS

Representing _____

0096

R0059920

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☐ FOR ☒ AGAINST

FOR THE FOLLOWING REASONS: _____

_____

_____

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title ROSEMARIE PETERSON, NPDES STORMWATER

Company CITY OF SAN DIMAS

Representing _____

00097

R0059921

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM #8
BUT WISH TO REGISTER MY POSITION AS:

☐ FOR ☒ AGAINST

FOR THE FOLLOWING REASONS: The health of everyone who swims & enjoys our beaches is at stake. We need a cleaner SM Bay.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title Judy Martinez

Company _____

Representing public citizen

0098

R0059922

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☐ FOR ☒ AGAINST

FOR THE FOLLOWING REASONS: ATTACHED CITY OF MONROVIA RESOLUTION NO. 96-40 REGARDING TENTATIVE NPDES PERMIT

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title ROBERT BAMMES / DIRECTOR OF PUBLIC WORKS

Company CITY OF MONROVIA

Representing _____

0099

R0059923

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☐ FOR ☒ AGAINST

FOR THE FOLLOWING REASONS: see attached resolution adopted by San Marino City Council on July 10, 1996

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title John Bingham, Assistant to the City Manager

Company _____

Representing City of San Marino

0100

R0059924

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM 8
BUT WISH TO REGISTER MY POSITION AS:

☐ FOR ☒ AGAINST

FOR THE FOLLOWING REASONS: SEE ATTACHED LETTER FROM THE MAYOR, CITY OF COMMERCE.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title ROBERT SEPULVEDA / DIRECTOR OF PUBLIC SERVICES

Company CITY OF COMMERCE.

Representing _____

VOL 13

01-01

R0059925

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I DO NOT WISH TO SPEAK ON ITEM NPDES Permit
BUT WISH TO REGISTER MY POSITION AS:

☐ FOR ☒ AGAINST

FOR THE FOLLOWING REASONS: TOO Complex, NOT
WELL ENOUGH DEFINED. AGAINST RECEIVING LIMITS.
BIOASSAY & REPORTING REQUIREMENTS TOO DEMANDING.

☐ I DO NOT WISH TO SPEAK ON ITEM _____
BUT I AM AVAILABLE TO ANSWER QUESTIONS

Name / Title _____

Company _____

Representing _____

01102

R0059926

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I Wish to Speak on Item 8

Item Title: Municipal Stormwater Permit

Your Name / Title Andy Goodman, President

Company Environmental Media Association

Representing

Estimated duration of testimony 3 minutes

0103

R0059927

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

3 min each

☒ I Wish to Speak on Item 8

Item Title: Storm Water

Your Name / Title John Parsons, President

Company So Bay Association of Chambers of Commerce

Representing

Estimated duration of testimony 1 minutes

0104

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I Wish to Speak on Item 8

Item Title: MS4 Storm Water Permit

Your Name / Title: Gerald Brettbart

Company: Calif Restaurant Assn

Representing: Calif Restaurant Assn

Estimated duration of testimony 3 minutes

0105

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I Wish to Speak on Item No. 8

Item Title: Stormwater Discharge - Vehicle washing

Your Name / Title GREGORY MASTIN / OWNER

Company Froggys TRUCKWASH NEXT Generation LLC.

Representing SAME

Estimated duration of testimony 2 minutes

0106

R0059930

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☐ I Wish to Speak on Item No. 8

Item Title: SM Bay Permit

Your Name / Title [illegible]

Company State Senate.

Representing

Estimated duration of testimony 5 minutes

19 [illegible]

For Office Use Only:

STATE SENATOR

X minutes each

~~2:45~~

1:30

01107

R0059931

VOL 13

SHEILA JAMES KUEHL
ASSEMBLYWOMAN, 41ST DISTRICT

LAURIE NEWMAN
FIELD REPRESENTATIVE

STATE CAPITOL
SACRAMENTO, CA 95814
(916) 445-4956

DISTRICT OFFICE
16150 VENTURA BLVD., SUITE 230
ENCINO, CA 91436
(818) 501-8991

Company Assemblymember Sheila Kuehl

Representing _____

_____

Estimated duration of testimony _____ minutes

For Office Use Only:

Assemblymember Sheila Kuehl

01108

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☑ I Wish to Speak on Item 8

Item Title: _____

Your Name / Title Laurie Newman

Company ~~Assemblymember~~ Sheila Kuehl

Representing _____

_____

Estimated duration of testimony _____ minutes

For Office Use Only:

Assemblymember Sheila Kuehl

0109

R0059933

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I Wish to Speak on Item 8

Item Title: Public Testimony on Stormwater NPDES

Your Name / Title Robert Wyld

Company None

Representing Myself

Estimated duration of testimony 2-3 minutes

0110

R0059934

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I Wish to Speak on Item No. 8

Item Title: MUNICIPAL STORM WATER PERMIT

Your Name / Title KENNETH FIELDS

Company FIELDS & PEARL

Representing PUBLIC

Estimated duration of testimony 5 minutes

0111

R0059935

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I Wish to Speak on Item 8

Item Title: LA Co Stormwater Permit

Your Name / Title Martin Byhower

Company Chadwick School

Representing Non Human Biota

Estimated duration of testimony 3 minutes

0112

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I Wish to Speak on Item No. 8

Item Title: 8, LA County Stormwater Permit

Your Name / Title Mark Ryan Vice

Company American Oceans Campaign

Representing American Oceans Campaign
Environmental

Estimated duration of testimony 2-3 minutes

0113

R0059937

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I Wish to Speak on Item 8

Item Title: Stormwater Permit

Your Name / Title Jennifer Taggart

Company Demetrious, Del Guercio, Springer, Hayes, LLP

Representing Valley Industry & Commerce Association, Environment & Water Committee

Estimated duration of testimony 3 minutes

0114

R0059938

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I Wish to Speak on Item No. 8

Item Title: Stormwater Permit

Your Name / Title John PERENCHIO

Company Malibu Bay Co., ~~Incorporated~~ Owner/Vice President

Representing Malibu Bay Co.

23705 W. Malibu Rd., D-2, Malibu 90265

Estimated duration of testimony 3 minutes

0115

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

X I Wish to Speak on Item 8 (NPDES)

Item Title: NPDES Permit

Your Name / Title Jonathan A. Stein

Company Law Office of Jon Stein

Representing Business owner

Estimated duration of testimony 5 minutes

0116

R0059940

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I Wish to Speak on Item No. 8

Item Title: Municipal Stormwater Permit

Your Name / Title DOUGLAS GARDNER - Senior Vice President

Company Maguire Thomas Partners

Representing Private Business

Estimated duration of testimony 2 minutes

01117

R0059941

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I Wish to Speak on Item No. 8

Item Title: Municipal Stormwater Permit

Your Name / Title Jayce L. Lawrence Mayor

Company City of Downey

Representing " "

Estimated duration of testimony 1 minutes

VOL 13

0118

R0059942

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I Wish to Speak on Item 8

Item Title: Storm Water Issues

Your Name / Title Marilyn White - Mayor Pro. Tem

Company City of Palmdale Board

Representing City Council / Palmdale

Estimated duration of testimony 1 minutes

0119

R0059943

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☐ I Wish to Speak on Item 8

Item Title: NPDES Permit

Your Name / Title Dennis Washburn

Company Calabasas Councilmember &

Representing President - Resource Conservation District of the Santa Monica Mountains

Estimated duration of testimony 2 minutes

For Office Use Only:
~~Mayor~~ of City of Calabasas
Council Member

0120

R0059944

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☑ I Wish to Speak on Item 8

Item Title: LA STORMWATER PERMIT

Your Name / Title MAYOR PAUL RISENSTEIN

Company CITY OF SANTA MONICA

Representing

Estimated duration of testimony 3 minutes

For Office Use Only:

BOB,
MAYOR OF
SANTA MONICA

0121

R0059945

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I Wish to Speak on Item No. 8

Item Title: Municipal Storm Water Permit

Your Name / Title Cristina Madrid

Company Azusa City Council

Representing City of Azusa

Estimated duration of testimony 3 minutes

0122

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

X I Wish to Speak on Item No. 8

Item Title: NPDES PERMIT

Your Name / Title ROBERT W BRUESCH, COUNCILMEMBER

Company CITY OF ROSEMEAD

Representing + TREASURER, SAN GABRIEL VALLEY COG.

8838 E VALLEY BLVD. ROSEMEAD

Estimated duration of testimony 5 minutes

0123

R0059947

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I Wish to Speak on Item 8

Item Title: Municipal Stormwater Permit

Your Name / Title Francisco Alonso; Councilmember

Company City of Monterey Pk.

Representing

Estimated duration of testimony _____ minutes

0124

R0059948

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I Wish to Speak on Item No. 8

Item Title: _____

Your Name / Title HARRY Baldwin City Council Mbr.

Company City of San Gabriel

Representing San Gabriel City and Chamber of Commerce

Estimated duration of testimony 4 minutes

0125

R0059949

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I Wish to Speak on Item 7.2

Item Title: TOLAND ROAD LANDFILL

Your Name / Title MARK ZIRBEL - GENERAL COUNSEL

Company VENTURA REGIONAL SANITATION DISTRICT

Representing SPOKES PERSON FOR DISTRICT

Estimated duration of testimony 15 minutes

14 min

0126

R0059950

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

3 min

☑ I Wish to Speak on Item No. 7.2

Item Title: Toland Landfill

Your Name / Title Orvane Carpenter City

Company Council

Representing City Port Hueneme

Estimated duration of testimony _____ minutes

0127

R0059951

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

11 [redacted] min

I Wish to Speak on Item No. 7.2

Item Title: Toland Landfill

Your Name / Title Gary Huftile / Geologist

Company Oregon State University

Representing Ventura Co Citizens to stop Toland Landfill

Estimated duration of testimony 12 minutes

VOL 13

0128

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I Wish to Speak on Item No. 8

Item Title: Storm Drain Permit

Your Name / Title Tom Boer

Company

Representing Self

Estimated duration of testimony 3 minutes

0129

R0059953

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☑ I Wish to Speak on Item No. 8 Public Agency

Item Title: LA NPDES Permit

Your Name / Title SARA WAN, Calif Coastal Commissioner

Company

Representing California Coastal Commission

Estimated duration of testimony 2 minutes

only 1 - for 20 minutes ?

For Office Use Only:

0130

R0059954

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I Wish to Speak on Item No. 8

Item Title: PUBLIC HEARING...

Your Name / Title PETER PICCARO / BETH KUDLICKI

Company SURFRIDER FOUNDATION, SOUTH BAY CHAPTER

Representing SAME.

Estimated duration of testimony 3 minutes

0131

R0059955

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☒ Wish to Speak on Item No. 8

Item Title: 8 LA County Stormwater Permit

Your Name / Title José Louis Sedano

Company Latino ~~Esso~~ Scholastic Corp.

Representing Business Community

Estimated duration of testimony 2 minutes

For Office Use Only:

0132

R0059956

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☒ I Wish to Speak on Item No. 8

Item Title: L.A. County Stormwater

Your Name / Title Dr. David Kay

Company Southern California Edison

Representing Same

Estimated duration of testimony 3 minutes

For Office Use Only:

Bee, This person wrote a letter of support.

0133

R0059957

California Regional Water Quality Control Board
Los Angeles Region

Public Interest Groups-6

For Office Use Only:

5 min each

☑ I Wish to Speak on Item No. 8

Item Title: Public Hearing re Municipal Stormwater Permit

Your Name / Title Gail Ruderman Feuer ↳ Senior Attorney

Company

Representing Natural Resources Defense Council

Estimated duration of testimony 3 minutes

VOL 13

0134

R0059958

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I Wish to Speak on Item No. 8

Item Title: Municipal Storm water Permit

Your Name / Title Michael Stokes (Field Coordinator)

Company Calpirg

Representing Calpirg

Estimated duration of testimony 2 minutes

0135

R0059959

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I Wish to Speak on Item No. 8

Item Title: STORMWATER PERMIT

Your Name / Title TERRY TAMMINEN, BAYKEEPER

Company SANTA MONICA BAYKEEPER

Representing 500 MEMBERS

Estimated duration of testimony 2 minutes

0136

R0059960

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☐ I Wish to Speak on Item 8

Item Title: Stormwater Permit

Your Name / Title DR. Pierce Flynn, Exec Tre Director

Company Surfrider Foundation

Representing

Estimated duration of testimony 1 minutes

For Office Use Only:

Have to choose one rep -

0137

R0059961

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

Other Interested parties (5)

☐ I Wish to Speak on Item 8

Item Title: MUNICIPAL STORMWATER PERMIT

Your Name / Title MADELYN GLICKFELD

Company

Representing Self

Estimated duration of testimony ~5 minutes

For Office Use Only:

6 min ea.

0138

R0059962

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I Wish to Speak on Item No. 8

Item Title: MUNICIPAL STORM WATER PERMIT

Your Name / Title ROBERT BRONKALL

Company

Representing MYSELF

Estimated duration of testimony 2 minutes

0139

R0059963

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I Wish to Speak on Item No. 8

Item Title: ~~55~~ ~~MP~~ NPDES

Your Name / Title Mrs Barbara Taylor

Company —

Representing Self

Estimated duration of testimony 3 minutes

0140

R0059964

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

3 min

☒ I Wish to Speak on Item No. 7.2

Item Title: Toland Road Landfill

Your Name / Title Ray Payne / City Manager

Company City of Fillmore

Representing

Estimated duration of testimony 3 minutes

0141

R0059965

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☒ I Wish to Speak on Item No. 7.2

Item Title: Toland RD. Landfill

Your Name / Title Ken Gose - Bd Member of VRSD + Camarillo City Council

Company City of Camarillo

Representing VRSD

Estimated duration of testimony 2 minutes

For Office Use Only:

2 min

0142

R0059966

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

3 min

☒ I Wish to Speak on Item No. 7.2

Item Title: TOLAND LANDFILL

Your Name / Title MAYOR JOHN A.F. MELTON

Company CITY OF SANTA PAULA

Representing " " "

Estimated duration of testimony 4-5 minutes

0143

R0059967

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☑ I Wish to Speak on Item 7.2

Item Title: Toland Landfill

Your Name / Title Judy Lazar, Mayor Pro Tem

Company City of Thousand Oaks

Representing City of Thousand Oaks

Estimated duration of testimony 2-3 minutes

For Office Use Only:

3 min each max

0144

R0059968

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I Wish to Speak on Item No. _____

Item Title: _____

Your Name / Title BOB PINKERTON

Company COUNCILMAN - ELECTED REPRESENTATIVE OF COASTAL CITIES

Representing SM. BAY REST. PROJECT

Estimated duration of testimony _____ minutes

0145

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I Wish to Speak on Item 8

Item Title: NPDES PERMIT

Your Name / Title JOHN FASANA COUNCILMEMBER

Company @

Representing CITY OF DUARTE

Estimated duration of testimony 2 minutes

0146

R0059970

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☐ I Wish to Speak on Item No. 8

Item Title: MAYOR OF Lomita

Your Name / Title Lawson Pedigo

Company

Representing City of Lomita

Estimated duration of testimony 2 minutes

For Office Use Only:

may appear to speak.
If not here by 10:45, a yellow card will be submitted.
per RAY TAHIR

0147

R0059971

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I Wish to Speak on Item No. 8

Item Title: NPDES

Your Name / Title Carolyn Van Horn, Councilmember

Company Malibu City

Representing Malibu City

Estimated duration of testimony 3 minutes

0148

R0059972

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I Wish to Speak on Item 8

Item Title:

Your Name / Title John O. Robertson

Company City Cudahy Councilman

Representing City of Cudahy

Estimated duration of testimony 1 minutes

0149

R0059973

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I Wish to Speak on Item No. 8

Item Title: 8

Your Name / Title Dee Hardison, Mayor

Company City of Torrance

Representing

Estimated duration of testimony 3 minutes

0150

R0059974

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I Wish to Speak on Item 8

Item Title: NPDES Permit

Your Name / Title Don Wolfe Deputy Director

Company LA County Public Works

Representing LA County - Principal Permittee

Estimated duration of testimony _____ minutes

bcc: CT
DS
JLL
OM

0151

R0059975

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I Wish to Speak on Item 3

Item Title: Public Forum

Your Name / Title Christopher Lee

Company Lee's Ladd Liquor

Representing

Estimated duration of testimony 1 minutes

all public Forum cards (3) are for same UST issue.

0152

R0059976

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I Wish to Speak on Item 8

Item Title: NPDES

Your Name / Title Richard Burtt - Engineering Director

Company City of Torrance

Representing

Estimated duration of testimony 3 minutes

0153

R0059977

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I Wish to Speak on Item 8

Item Title: NPDES / STORM WATER PERMIT

Your Name / Title TED SEMAAN, CEA

Company CITY OF LYNWOOD

Representing SAME

Estimated duration of testimony 2 minutes

0154

R0059978

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I Wish to Speak on Item No. 8

Item Title: PUB HEARING - STORMWATER PERMIT

Your Name / Title CHARLES SIHLER

Company CITY OF POMONA

Representing CITY OF POMONA

Estimated duration of testimony 4 minutes

0155

R0059979

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I Wish to Speak on Item No. 8

Item Title: NPDES

Your Name / Title Sid Mousavi / Director of Public Works

Company City of Baldwin Park

Representing City of Baldwin Park

Estimated duration of testimony 2 minutes

0156

R0059980

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I Wish to Speak on Item No. 8

Item Title: LA Co. Stormwater Permit

Your Name / Title Daniel W. Keesey, Administrative Superintendent

Company City of La Verne.

Representing

Estimated duration of testimony 2-3 minutes

VOL 13

0157

R0059981

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I Wish to Speak on Item 8

Item Title: Storm

Your Name / Title Mayor - Eileen Ansari

Company

Representing City of Diamond Bar California

Estimated duration of testimony 2 minutes

0158

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I Wish to Speak on Item 8

Item Title: NPDES Permit Revised LA Co. Munic. Stormwater permit

Your Name / Title Mayor Margaret Clark

Company California Contract Cities Assoc.

Representing City of Rosemead

Estimated duration of testimony 3 minutes

0159

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I Wish to Speak on Item 8

Item Title: NPDES

Your Name / Title Beatrice LaPisto-Kirtley, Councilmember, City of Bradbury

Company President, San Gabriel Valley Council of Governments

Representing

Estimated duration of testimony 2 minutes

0160

R0059984

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I Wish to Speak on Item No. 8 Elected official.

Item Title: Stormwater Permit

Your Name / Title Councilmember Ruth Galanter

Company City of Los Angeles, Sixth District

Representing City of Los Angeles

Estimated duration of testimony 3 minutes

0161

R0059985

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I Wish to Speak on Item 3

Item Title: PUBLIC FORUM

Your Name / Title MARC VON BURGER, PRES

Company SAV-MOR OIL

Representing 3RD + SORLANO
ROCKET CLEANERS

Estimated duration of testimony _____ minutes

0162

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I Wish to Speak on Item 3

Item Title: PUBLIC FORUM

Your Name / Title GARY CARLIN, PRES

Company G & S REMEDIATION

Representing SAN-MON O/C

Estimated duration of testimony _____ minutes

0163

R0059987

VOL 13

CALIFORNIA LEGISLATURE

DEBRA BOWEN

ASSEMBLYWOMAN, FIFTY-THIRD DISTRICT

DISTRICT OFFICE
18411 CRENSHAW BLVD., SUITE 280
TORRANCE, CA 90504
(310) 523-4031

CAPITOL OFFICE
STATE CAPITOL
SACRAMENTO, CA 95814
(916) 445-8520

California Regional Wa
Los Ang

For Office Use Only:

☒ I Wish to Speak on Item 8

Item Title: Stormwater Permit

Your Name / Title Assemblywoman Debra Bowen

Company State Legislature

Representing 53rd Assembly District

Estimated duration of testimony 2 minutes

0164

R0059988

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

4 min

☒ I Wish to Speak on Item 7.2

Item Title: WDR Revision Ventura Reg San

Your Name / Title Ed McCombs General MgR

Company Ventura Regl San District

Representing

Estimated duration of testimony 5 minutes

0165

R0059989

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☐ I Wish to Speak on Item No. 7.2

Item Title: TOLAND ROAD LANDFILL

Your Name / Title Jim Acosta BOARD Member

Company VENTURA REGIONAL SANITATION DISTRICT

Representing _____

_____

Estimated duration of testimony 2 minutes

2 min

0166

R0059990

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I Wish to Speak on Item 7.2

Item Title: Toland Landfill

3 min

Your Name / Title Carolyn Greene

Company City of Thousand Oaks

Representing

Estimated duration of testimony 2-3 minutes

0167

R0059991

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☐ I Wish to Speak on Item No. 7.2

Item Title: Toland Road Landfill

Your Name / Title Katharine E. Stone

Company Myers, Widders Gibson & Long

Representing Cities of Filmore and Santa Paula

Estimated duration of testimony 5 minutes

For Office Use Only:

3 min

0168

R0059992

VOL 13

0169

California Regional Water Quality Control Board
Los Angeles Region

☒ I Wish to Speak on Item No. 7.2

Item Title: Toland Landfill

Your Name / Title Robert Palmer

Company Gibson, Dunn & Crutcher

Representing Ventura County Citizens To Stop Toland Landfill

Estimated duration of testimony 6 minutes

For Office Use Only:

min ~~each~~
5

R0059993

VOL 13

0170

California Regional Water Quality Control Board
Los Angeles Region

☒ I Wish to Speak on Item No. 7.2

Item Title: TOLAND ROAD LANDFILL

Your Name / Title Ki Nuan / JOHN TOMMY ROSAS JR INDIAN CHUMASH NATION

Company MYSELF / IN MY OWN BEHALF

Representing AS CHUMASH INDIAN AND U.S. CITIZEN

Estimated duration of testimony 3-4 MIN minutes

For Office Use Only:

Other Interested Party

4 min.

R0059994

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

Permittees

☒ I Wish to Speak on Item 8

Item Title: Stormwater Permit

Your Name / Title OKA LAMPMAN / Public Works Dept.

Company Burbank

Representing

Estimated duration of testimony 2 minutes

For Office Use Only:

20 minutes each

01771

R0059995

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☒ I Wish to Speak on Item 8

Item Title: L.A. County Municipal Storm Water Permit

Your Name / Title Desi Alvarez, City Engineer

Company City of Glendale

Representing City of Glendale

Estimated duration of testimony 2 minutes

0172

R0059996

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

I Wish to Speak on Item 8

Item Title: PUBLIC HEARING - NPDES

Your Name / Title ~~CRAIG CARDIFF, CITY ENGINEER~~

Company CITY OF CLAREMONT

Representing MAYOR LEAGUE / CITY

Estimated duration of testimony 3 minutes

0173

R0059997

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

I Wish to Speak on Item 8

Item Title: LAC NPDES PERMIT

Your Name / Title Ed Schroder, Public Works Director

Company City of El Segundo

Representing

Estimated duration of testimony 2 minutes

0174

R0059998

VOL 13

CITY OF LONG BEACH

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RAYMOND T. HOLLAND
Director

Department of Public Works
333 West Ocean Boulevard
Long Beach, CA 90802

Water Permit

LAND, DIRECTOR OF PUBLIC WORKS

CH, CA

Representing CITY OF LONG BEACH

Estimated duration of testimony 3 minutes

For Office Use Only:

Same Permittee - have to choose

0175

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

X I Wish to Speak on Item 8

Item Title: LA CoMun. Stormwater Permit

Your Name / Title RAYMOND T. HOLLAND, DIRECTOR OF PUBLIC WORKS

Company CITY OF LONG BEACH, CA

Representing CITY OF LONG BEACH

Estimated duration of testimony 3 minutes

For Office Use Only:

Same Permittee - here to choose

0176

R0060000

California Regional Water Quality Control Board
Los Angeles Region

☒ I Wish to Speak on Item No. 8

Item Title: LA Co. NPDES Permit

Your Name / Title Lisa Peskay Malmsten Dep. City Atty

Company City of Long Beach

Representing

Estimated duration of testimony 5 minutes

For Office Use Only:

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0177

R0060001

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

☑ I Wish to Speak on Item No. 8

Item Title: City Engineer for Azusa

Your Name / Title Nasser Abbaszadeh

Company City of Azusa

Representing San Gabriel COG Storm Drain Task force

Estimated duration of testimony 4 minutes

0178

R0060002

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☐ I Wish to Speak on Item 8

Item Title: MUNICIPAL STORMWATER PERMIT

Your Name / Title RUFUS C YOUNG, JR

Company BURKE, WILLIAMS & SORENSEN

Representing 4 CITIES

Estimated duration of testimony 4 minutes

For Office Use Only:

Representing 4 cities - but same issues

0179

R0060003

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

For Office Use Only:

Request postponement

☒ I Wish to Speak on Item No. 8

Item Title: STORM WATER PERMIT

Your Name / Title RAY TAHIR

Company CITY OF WHITTIER

Representing CITY OF WHITTIER

Estimated duration of testimony 5 minutes

0180

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☐ I Wish to Speak on Item 8

Item Title: STORM WATER PERMIT / LA RO

Your Name / Title RAY TAHIR

Company TETRA ENVIRONMENTAL

Representing CITY OF LAKEWOOD

Estimated duration of testimony 2-5 minutes

For Office Use Only:

Request postponement representing 3 cities but same issues

0181

R0060005

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☒ I Wish to Speak on Item 8

Item Title: STORM WATER PERMIT/LA

Your Name / Title RAY TAHIR

Company FIBS ENVIRONMENTAL

Representing City of Alhambra - Dept of Public Works

Manny J. Magana

Estimated duration of testimony 10 minutes

For Office Use Only:

0182

R0060006

VOL 13

California Regional Water Quality Control Board
Los Angeles Region

☒ I Wish to Speak on Item 8

Item Title: Stormwater Permit

Your Name / Title Gary Hildebrand / Stormwater Program Manager

Company LA County Dept Public Works

Representing

Estimated duration of testimony 5 minutes

For Office Use Only:
LAST SPEAKER AS PERMITTEE (TO ANSWER ISSUES RAISED, if any)

0183 L

R0060007

HEARING BEFORE THE

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD

LOS ANGELES REGION

ORIGINAL

107 SOUTH BROADWAY
LOS ANGELES, CALIFORNIA

MONDAY, JULY 15, 1996
9:28 a.m.

ITEM 7.2 AND ITEM 8 ONLY

Reported By:

DEBBIE STRICKLAND, CSR 9036

Karyn Abbott & Associates, Inc.
Certified Shorthand Reporters
714 West Olympic Boulevard, Suite 1112
Los Angeles, California 90015
(213) 749-1234

VOL 14

00002

VOL 14

0003

HEARING BEFORE THE

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD

LOS ANGELES REGION

107 South Broadway
Los Angeles, California

Monday, July 15, 1996
9:28 a.m.

ITEM 7.2 AND ITEM 8 ONLY

A P P E A R A N C E S :

HEARING OFFICER:	JACK J. COE
BOARD MEMBERS:	CHARLES C. VERNON CLARK DRANE JOHN A. SLEZAK CHARLOTTE CRAVEN BETH ROGERS MICHAEL I. KESTON LARRY ZARIAN
STAFF:	ROBERT P. GHIRELLI CATHERINE TYRRELL ROD NELSON CARLOS URRUNAGA ROBYN L. SHIPLEY
	JORGE LEON Sr. Staff Counsel STATE WATER RESOURCES CONTROL BOARD 901 "P" Street Sacramento, California 95814

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for the next item. Thank you.

MR. COE: We are going to have a short break here at this time.

(A brief recess was taken.)

MR. COE: This is Item No. 8 on your agenda, Waste Discharge Requirements and the NPDES permit for Municipal Storm Water and Urban Runoff Discharges within the County of Los Angeles.

At this time I would like to call on staff to present the opening statement. That's Carlos Urrunaga.

MR. URRUNAGA: Thank you, Mr. Chairman.

Mr. Chairman, members of the Board, ladies and gentlemen, my name is Carlos Urrunaga, and I am an Environmental Specialist 3 with the Regional Water Quality Control Board. My business address is 101 Centre Plaza Drive in Monterey Park.

This is a hearing for this Board to consider adoption of Waste Discharge Requirements and a National Pollutant Discharge Elimination System permit, herein after referred to as NPDES, for the control of pollutants and discharges of storm water and urban runoff by the county of Los Angeles and 85 municipalities within the county.

These discharges flow into municipal

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separate storm sewer systems, also called storm drain systems, and any water courses within the county that are under the jurisdiction of this Regional Board.

This hearing is being held in accordance with state and federal regulations. This hearing and the Board's intent to provide Waste Discharge Requirements and issue an NPDES permit were publicly noticed as follows:

Published in the Los Angeles Times on June 12, 1996, and the change of location and time of this hearing on July 7, 1996.

Copies of the tentative NPDES permit and revisions thereof were mailed on May 25, 1996, and July 6, 1996, respectively, to the principal permittee, the permittees, the U.S. Environmental Protection Agency, the State Water Resources Control Board, and other interested agencies, organizations, associations, and persons.

The tentative permit and revisions thereof are also accessible to the Regional Board's electronic bulletin board system and listed in the Regional Board's meeting agenda mailed on July 2, 1996 to the permittees and to all known interested agencies, parties, and persons.

The agenda is also accessible to the Regional Board's electronic bulletin board system. And copies of the agenda are available on the table at the back

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of this room.

Testimony during today's hearing will cover requirements for the control of pollutants and discharges of storm water and urban runoff contained in the proposed NPDES permit and whether the Board should adopt the proposed NPDES permit.

The storm drain permit will take place 15 days after Regional Board adoption provided Regional Administrator of the U.S. Environmental Protection Agency Region 9 has no objection.

After the close of the hearing, the Board may consider the proposed NPDES permit, written comments received, and written and oral testimony presented at this hearing, and consider adoption of the permit.

Those who desire to record their position on the permit but not speak are asked to please fill out a yellow card and give it to a Regional Board staff member. The yellow cards are located on the table at the back of this room. The yellow cards will be given to the Board members during this hearing.

Those who desire to give testimony should fill out a blue card and give it to a Regional Board staff member. The blue cards are also located on the table at the back of this room.

The order of the presentation will be as

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follows:

Regional Board staff and state board panel presentation, 40 minutes; elected officials, 30 minutes; permittees other than those represented by elected officials, 30 minutes; other public agencies, 20 minutes; business associations, 30 minutes; public interest groups, 30 minutes; other interested parties, 30 minutes.

Each person testifying should begin by stating his or her name, address, and whom he or she represents. The hearing will not be conducted according to technical rules of evidence. The Board reserves the right to limit any evidence or testimony which is irrelevant or repetitious. Only one representative will be allowed to speak from each permittee, agency, organization or association.

Based on the number of individuals under each category who wish to speak, the Chair will announce the time limit for each speaker at the beginning of that category. For example, if there are ten elected officials who wish to speak, each official will be given three minutes to speak. It is recommended that parties having similar concerns be represented by a spokesperson. At his discretion, the Chair may give that spokesperson additional time to address the Board.

The Board, Staff, and Counsel may ask

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questions to clarify the testimony of a witness at any time. Limited cross examination of any witness by others will be allowed following the completion of direct testimony by all persons.

This proceeding is being recorded on magnetic tape. Any person wishing a copy of the master tape, at their own expense, may make appropriate arrangements through the Board's Executive Assistant, Robyn Shipley.

This proceeding is also being recorded by a court reporter. Any person wishing a copy of the record must make his or her on arrangements directly with the court reporter.

I would like to end my opening statement by entering into the administrative record of this hearing all comments, letters, resolutions received, and all files Staff has pertaining to the NPDES permit.

Chairman Coe, will you now please administer the oath to those testifying and open the hearing.

MR. COE: Thank you.

All persons who wish to testify at this hearing, if you will now stand and raise your right hand and take the following oath.

(Oath administered.)

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MR. COE: I want to welcome everyone to this hearing today. We have got a long agenda, as you can tell. The time has been allocated among groups.

To get through the hearing on time and provide an opportunity for everyone who wishes to speak today, all should abide by the time limits. We are not trying to be rude, but, to be practical and considering the number of people here and the number of people who took the oath, you know it's going to be an extensive exercise.

The allocation of time was provided you in the agenda which was mailed out in advance. As Staff has indicated in the opening statement, the amount of time that any one individual will have to testify will depend on the number of speaker cards that were turned in.

I want to also encourage people to use the yellow cards similar to the process we used earlier for the hearing on the Toland Road Landfill. These cards will be passed among the Board members, and these are the cards where you want to indicate your comments or position without speaking. And these cards will be distributed to the Board members during the process.

Secondly, I strongly suggest that parties having similar concerns select a spokesperson to represent your group. We want to avoid repetition wherever possible. If we all cooperate in this way, I believe

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everyone will have an opportunity to have their views recorded for the administrative record and we can complete the hearing in a reasonable amount of time.

As it is, even if we do not deviate a minute from the time schedule announced by our staff, we are looking at about three and a half hours of testimony, at least that's how much has been allocated, after which the Board will conduct its deliberations on this matter.

There will be a lunch break. We are sort of looking at 12:30. It will sort of depend on when the logical break between groups occurs.

At this time, Staff will make its presentation, and Catherine Tyrrell will lead that.

MS. TYRRELL: Good morning, Mr. Chairman, members of the Board, and Dr. Ghirelli. My name is Catherine Tyrrell, and I am the Assistant Executive Officer for Service Water Programs at the Regional Board. My business address is 101 Centre Plaza Drive in Monterey Park.

Before I begin the staff presentation today, I'd like to do two things. First, I would very much like to thank the staff of the Regional Board that worked with me on the Storm Water Permit. It's been a very intense effort, and they have worked very hard to bring this forward to you today.

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In particular, I would like to thank Winnie Jesena, who was the unit chief who led this effort, Xavier Swamikannu, who is a Senior Environmental Specialist, and Carlos Urrunaga, and also other members of Winnie Jesena's staff who have also pitched in and worked very hard.

MR. COE: Are they here? If they would stand.

MS. TYRRELL: Yes, they are. Would you like to stand up.

(Applause.)

MR. COE: It's been about a year and a half, 51 meetings or something like that?

MS. TYRRELL: Something like that, yes.

I'd like to also show a short video before we get to the staff presentation that was produced by two elected officials active on the Santa Monica Bay Restoration Project along with other members of the Bay Restoration Project who were responsible for the video. It was sent to every City Council in the county in early June as a background for today's meeting.

So if we could show the video over here.

(Video shown.)

MS. TYRRELL: With that excellent background, I would like to begin this panel presentation by

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introducing the panel members. They are Jorge Leon, Staff Counsel who you know very well; Catherine Kuhlman, who is the Chief of Permits and Compliance Grants at U.S.P.A. Region 9; Don Wolfe, the Executive Director of the L.A. County Department of Public Works; Amy Glad, Vice President of the Building Industry Association; and Mike Kissel, Environmental Specialist with Carl Karcher Enterprises on behalf of Carl's Jr., and Dr. Mark Gold, the Executive Director of Heal the Bay.

After I complete a short staff presentation, they will each present comments from the various perspectives that they represent. They each have been involved in some aspect in shaping the ultimate permit that we have before you today. And they will also be available to answer questions.

Okay. Over here we are going to have the staff presentation. And the permit before you today is for the reissuance of a Storm Water and Urban Runoff Pollution Control Permit first issued by this Board back in 1990. It is currently one year overdue.

The permit is being issued to the County of Los Angeles as the principal permittee and the 85 municipalities of Los Angeles County as permittees. However, to keep to the schedule, I will emphasize basically three things: the contents of the permit, which

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is the overview that we will pursue today; changes made; and lastly, issues that we see as still being remaining.

The 1987 amendments to the Clean Water Act in Section 402(p) are the origin of this permit. This section states that permits for discharges for municipal storm sewers may be issued on a system- or jurisdiction-wide basis and shall include requirements to effectively prohibit non-storm water discharges into the storm sewers and storm drains and shall require controls to reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques, et cetera.

In 1990, EPA issued regulations which require activities in these listed areas to be undertaken by municipalities. Because a permit had been issued here in Los Angeles County before the EPA regulations were issued, the Part 1/Part 2 application process ordinarily necessary is not required. However, the permit must accomplish the objectives and meet any minimum requirements set out in the regulations.

The permit revision process began back in December of 1994 with the submittal of the application for reissuance of the 1990 permit by the county and the cities. The permit now before you is the result of 18 months of discussions with affected parties and countless

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meetings to hammer out differences, including those arising from differing municipal perspectives.

Great care was taken to thoroughly review comments received and to make responsive changes as evidenced in our May tentative permit. Additional modifications to clarify meaning have been made based on comments on the May draft as well as final comments which I will discuss.

Now I'd like to summarize the contents of the permit. Note that the permit has a table of contents which serves as a useful outline. Because it is impossible to go into detail in a ten-minute overview, I am going to run through several of the key parts of the permit.

The first is program management, a very important part of the permit considering the complexity of issuing a permit to 85 cities in the county.

The program management portion of the permit addresses the roles and responsibilities of the principal permittee, permittees, and the Watershed Committee. It also calls for the principal permittee to provide a budget summary format for permittees to use and asks permittees to provide budget information within 60 days of budget adoption.

Program management also calls for permittees to demonstrate that they have legal authority to

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prohibit or require various activities. And if not, to provide a schedule for obtaining it.

As stated on page 23 of the permit, the requirement that permittees possess legal authority to control specified discharges does not require inspection of private property, something that I think some cities had feared. So we made some very specific changes to that regard. Its purpose is to assure that municipalities can abate problems when they are identified.

This section also includes a procedure for substituting alternative BMPs or programs for those required within the permit. This is some of the language on program substitution, so you can see that we created that kind of flexibility in the permit. This shows that a permittee may petition the Executive Officer to substitute or eliminate any BMP or program with appropriate documentation as identified in the permit.

Program management also contains -- the section also contains various procedures for review and acceptance of reports and documents for resolving differences in compliance expectations and for public review of documents submitted to the Executive Officer for review.

And the next two, first this one. This is a quote from the permit dealing with public review

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opportunities.

The principal permittee shall distribute for public comment the initial Storm Water Management Plan and other storm water program requirements that are submitted to the Executive Officer for approval.

And then other parts of the permit, wherever there are BMPs for various kinds of activities being submitted by the county and the co-permittees, there are -- they actually are going to bring those to the Regional Board. We will bring these to the Regional Board for discussion and approval.

MR. COE: Ms. Rogers, do you have a question?

MS. ROGERS: Yes, sir.

Catherine, was this subset of all the materials that are in the permit selected because they are less controversial?

MS. TYRRELL: Yes.

They affect the various players, businesses, et cetera, more than anything else. So that's why we selected those for coming to the Board.

MS. ROGERS: So they will have hearings down the road so, when we have read all if these materials that have brought up these issues, we will have another shot and hear discussions on these?

MS. TYRRELL: On these specific items, they

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will come back to the Board.

The permit calls for action in four key areas. Effectively prohibiting pollution to the MS-4, that's the storm drain system, from first illicit connections and discharges, from future development and construction, for permittees' own public agency activities, and also by providing public information and education to the residential sector, business, and industry.

In each of these first three areas, the permit follows a basic pattern of, first, development of a model by the principal permittee with consultation from other permittees. Secondly, submitting that model to the Regional Board's E.O. and other interested parties. Thirdly, approval of the model by the Executive Officer. And then, lastly, implementation by the permittees.

For instance, within the illicit connection program, the objective is to develop a program to find and eliminate any connections to the storm drain that do not have a permit, excluding things like roof drains and other similar kinds of connections.

The principal permittee could also model a program, with the input of the permittees, submit it to the Executive Officer for review, and after the 45-day public review period and within 120 days as called for in the Administrative Review Procedures, the Executive Officer

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must respond on its adequacy. Then the permittees implement their own program based on the model.

And the timing is related to the city's budget approval process. That was an addition that we added so that there would be adequate time in each city to consider the issues and then act and put it into the budget as appropriate.

Also under this section of the permit is a listing of non-storm water discharges that need not be prohibited. After much discussion of what should or should not be in this listing, we decided to list exactly the same categories as in the EPA regulations.

As there are many possible additions, the permit has a procedure for exemptions. So we also included a procedure there for the various parties to bring forward additional exemptions.

The pattern described above of model development, review, and implementation applies here as well in the development planning and construction portion of the permit. And it applies here also to the public agency activities.

The public education program is a central component of the permit, much of it aimed at the general public and the residential sector.

Added to this section in the May draft

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was the development of industrial/commercial BMP lists and educational site visits to businesses. In previous drafts, these programs were not just site visits for educational purposes but actual inspections.

Additional changes were made in the July final permit such that cities do not need to report when the businesses they visit need to file NOIs with the Regional Board under the state industrial storm water permit. However, cities do need to notify the Board of those they visit so that we can coordinate the state program with the local program as envisioned in the federal regulations.

Also in the area of site visits there is a provision for a permittee to substitute with an equally effective program.

A number of changes have been made in response to comments. Again, to save time, I'm not going to discuss each of these in detail but simply show that significant changes have been made in a number of different areas.

We have made changes to the receiving water limitations language such that compliance with the permit is equal to compliance with receiving water limits. We do need to have a receiving water limit section in the permit. In fact, having it here this way is more

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protective for the permittees because, as you know, the basic plan is there regardless of whether we put it in the permit. So this actually provides greater protection for permittees.

We have also made changes to program management and reporting based on the comments we have received.

We have made changes to new development and construction planning along the lines that you see here.

We have made changes to the industrial/commercial program; in particular, the one dealing with we no longer have inspections but, rather, we have education site visits.

And then lastly we made changes to the monitoring program and projects where they are not actually required any longer on the part of cities, only the county is implementing these major programs.

And then lastly we made changes to the implementation schedules, first adopting the county's recommendations and then refining it in the latest draft so that the cities have adequate time to review it in their budgets and put it in their budget for the next fiscal year.

In the last few days we have also had a

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few calls from some of the various parties, and we do have a change sheet with these changes on it. I'm not going to go into a lot of detail other than indicate that they were considered priority by some of the permittees and others.

The first one is prior to revising the pollution control efforts and including additional language, considering beneficial use and permits as a basis. And I think we will just, in the interest of time, just skip through these next two. You have the change sheet there. If you have any questions on those, we can talk about them later.

Now, the permittee issues, this is sort of what's it's come down to now in terms of key issues. Vulnerability to enforcement action, cost, unfunded mandate, scientific evidence of local problems requiring permit issues, cities doing the state's work, and adequacy of public review.

In spite of the many changes made, and in some cases because of them, the permittees and other interested parties are either more satisfied or less satisfied with the permit. Relative to permittee issues remaining, we are primarily hearing these kinds of concerns.

In spite of these changes, including the drafting of receiving water limitations section, the

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Regional Board cannot completely protect permittees from third-party lawsuits. That provision is part of the Clean Water Act.

We do believe, however, that any city implementing this permit in good faith will be protected from lawsuits by their demonstrated implementation.

The cities are also concerned about the cost of implementing this permit. The Regional Board cannot make the permit cost free. However, modifications made to the permit --

MR. COE: We have a question.

MS. ROGERS: Catherine, on the vulnerability of enforcement action, is the vulnerability increased, decreased, or stay the same as it currently is given there is currently the laws in place and so on and so forth?

In other words, when we are saying vulnerability to enforcement action, there are always lawsuits.

MS. TYRRELL: Right.

MS. ROGERS: Is there a change in terms of vulnerability based on this?

MS. TYRRELL: We believe we have made it much -- we have made cities less vulnerable by including the receiving water limitations language we have and various other provisions that I think show that, if a

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permittee is implementing in good faith and in a timely way, it would be very difficult to bring a lawsuit against them.

MS. ROGERS: So relative to the current status quo, you feel it's either equal or better?

MS. TYRRELL: I think it's better, yes.

DR. GHIRELLI: Ms. Rogers, I think the point should be made that the language in this permit is unprecedented. No other NPDES permit issued by this Board has language that we think tries to do what the cities have been asking for in terms of protection, at least to the extent we can, to third-party lawsuits.

MS. ROGERS: I guess that's what my question really went to because there is no such thing as protection against third-party lawsuits.

DR. GHIRELLI: That's correct.

MS. ROGERS: I mean, I don't care who you are or what you are doing. And so I think it's a relative level of protection, and there is a relative current risk. That's why I asked, what is the change in their relative status since it's never an absolute under any circumstance?

MS. TYRRELL: We worked very hard to put appropriate protections, including administrative review proceedings, into the permit that assure as much security as is possible.

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Then relative to cost, although substantiated cost information is hard to come by, a comparison of costs estimated by the San Gabriel Valley Association of Governments, with a study done of costs of programs in other parts of California, show that costs here are equal or possibly lower than elsewhere in the state.

Of course, many benefits are derived from clean water as alluded to in the opening video. We are working with the State Board to pursue a more accurate cost benefit analysis for future use.

Some permittees have also asked for the permit to be delayed until scientific proof of a problem is identified by the Regional Board. However, the federal regulations do not really require that regulatory agencies prove there is a problem. Nonetheless, we believe that it is evident that there are problems out there that have resulted from the storm water.

Other concerns such as cities doing state work and public review adequacy we believe have been addressed in the permit revisions very clearly as we have alluded to in some of the examples we have shown you.

There are also issues that have been raised by interested parties. They are not necessarily completely happy with the permit either. They are concerned that the permit lacks inspections and

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enforcement; that cities should be doing additional monitoring or pilot EMT projects; that schedules for implementation are really too general; and that permitees are not really required to involve other stakeholders in the process.

So, in conclusion, I urge you to issue this NPDES permit today for a number of reasons.

First, it implements the federal regulations that the current permit does not.

Secondly, 18 months of discussions with many stakeholders have transpired in creating this permit, which is already a year past its renewal due date.

Third, as shown in the previous discussion of stakeholder issues, a reasonable balance between competing concerns has been established. If anything, we believe we have stretched our interpretation of the regulations in favor of municipalities in the interest of a cooperative partnership for storm water management. Cities really do need to be partners in this effort, and we would like them to be good faith partners if at all possible.

Lastly, the permit does include a reopener clause should the process laid out fail in some way.

For all of these reasons, I recommend

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your approval of the permit today. And before questions, I'd like to introduce Jorge Leon and then actually have the rest of the panel complete the presentation as I think they have perspectives that will add to this.

Thank you.

MR. LEON: Mr. Chairman, thank you very much.

One of the first things that I want to point out is that, as I mentioned earlier with respect to the other major item on the permit, ex parte communications are prohibited by law. And what may have happened in this matter, as well as in other matters, is that if you attempted to communicate with the Board members and did not receive a call back or a written communication back from the Board members, please don't assume that they were just refusing to comment or to talk to you, but, rather, I advised them that it's a problem for us if they communicate with the parties on an item that's on the agenda or will be on the agenda.

So, with that, I would like to address some of the issues. And as you know, since the first draft was issued sometime back, we have received many written comments, many verbal comments. There have been lots of meetings. We have received lots of legal issues that have been raised through those comments.

We prepared and I issued a memorandum on

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April 17th of this year that attempted to deal with the issues that we were aware of at that point. Since that time, some of the issues have persisted and some other twists have occurred to the issues. And basically today I'm just going to deal, in a summary fashion, with those remaining issues.

One of the very first is sort of a procedural, large issue, and that is whether we ought to be involved today in permit issuance at all. Some parties have commented that what we should be doing in order to implement the Clean Water Act requirements and the federal regulations is to, instead of involving ourselves in this, we ought to be -- what we are trying to do is to control storm water dischargers to rule making.

Rule making is the same thing as regulation writing. This Board is technically authorized to draft and issue regulations; however, in the past, historically, none of the Regional Boards have actually embarked on rule making simply because it would create a problem in performing the EMT. Rather, the State Board is the agency that typically gets involved in issues of regulations.

Now, some other comments have come in to the effect that, in fact, while we are calling it permit issuance, the activity that we are engaged in today by

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proposing the adoption of this permit is rule making. And the arguments, in summary, are that it is rule making because Staff has taken guidance from other documents and inserted it into the draft document that you see before you today, and in the earlier drafts, and is applying those requirements to the parties.

Well, I completely disagree with those arguments simply because the Clean Water Act requires that the Board issue a permit; and that the staff has engaged in drafting the permit pursuant to the applicable regulations and codes.

To the proceeding today, under Water Code Section 13377 regarding NPDES permits under the state delegated authority, Government Code Section 15375 provides a definition of what a permit is. And 11352 of the Government Code also, out of the Administrative Procedure Act, exempts permit writing from rule making requirements.

One of the reasons I believe that the argument has been made that we ought to be engaged in rule making is because it gives a further opportunity for another level of review. At this point in the permit issuance process, the Regional Board adopts the permit and it becomes law, subject, of course, to appeals to the State Board and perhaps the courts.

Under the APA procedure, however, if we

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were, instead, engaged in rule making, there would be a further level of review, and that would be at the Office of Administrative Law. However, that process simply does not apply because we are, in fact, involved in permit issuance.

The other reason perhaps for arguing for rule making is that it is a connected issue involving state mandates. If a state agency issues regulations, or purports to issue regulations, that cost cities or the districts additional money, there is a provision in the Constitution that says that that agency has to provide for that funding. And you have perhaps heard the arguments that this permit creates unfunded mandates.

Well, as Catherine pointed out, it's certainly true that issuing this permit will cost significant amounts of money to those that have to implement it, the permittees. However, by not involving ourselves in rule making, we do not come under the state unfunded mandates type requirements. We are exempt from that.

Therefore, those arguments about a procedural remedy for unfunded remedies -- I'm sorry -- unfunded mandates doesn't apply.

MR. COE: Isn't it also true because it's a Clean Water Act that comes from a federal law or

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regulation?

MR. LEON: That's correct.

AUDIENCE MEMBER: We can't hear.

MR. LEON: The question was, isn't it also true that it's because the Clean Water Act requires issuance of this permit? And the answer is, yes, that's correct. We are, in fact, engaged in implementing a federal requirement as opposed to a state law.

Another comment that came up, another legal issue has to do with jurisdiction for the Board even to issue a permit. There were lengthy filings by the city of Vernon that basically argued that the Board does not have jurisdiction to issue the permit, and, in part, it's because what we are doing has the resemblance to rule making.

Again, I completely disagree with those arguments as well. Again, we are proceeding under the permit issuance requirements and provisions of the Clean Water Act. The city of Vernon's arguments, while well thought out, I think take provisions out of the Clean Water act -- I'm sorry -- out of the Porter-Cologne Act, the state law, and apply them to an argument that just doesn't fit into the permit issuance authority of the Regional Board. They are basically irrelevant to the activity of the Regional Board today.

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We have also heard, and even as late as today I noticed, that there was submissions from cities that recommend modifications in the findings of the permit. The permit, as every other permit, basically consists of two general parts where the findings establish the background, the historical, factual, legal side for the provisions. The provisions constitute that portion of the permit which is legally enforceable and that portion of the permit that lays out what activity is expected of the permittee.

Clearly it's within your discretion to determine which findings are appropriate and which are not and to entertain the comments of the parties. But you should be aware that it is those provisions that are enforceable. The findings are not enforceable. They are merely an attempt to lay down the factual, scientific, historical background that is relied upon to develop the provisions.

And, finally, one argument that has permeated throughout is that the provisions of the permit are greatly in excess of the Clean Water Act requirements. In one of the slides that you saw up here, basically you saw the whole text, virtually the whole text, of the Clean Water Act requirements.

It's a very general provision within

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Section 402(p) of the Clean Water Act. It basically says that the states must control waste dischargers to storm water drainage systems through permitting. It does not provide detail.

The permit regulations issued by the federal government provide some guidance as to the meaning of the Clean Water Act, but again, they don't provide sufficient detail to embark upon an application of an actual permit to have jurisdiction the size of L.A. County.

And my review of the draft permit shows that the provisions, while much more detailed than the Clean Water Act, the provisions are completely consistent with the requirements of the Clean Water Act. And, therefore, we do not run into any kind of problem in exceeding the requirements of the Clean Water Act.

Thank you.

MR. COE: Thank you.

Catherine, were you going to introduce the panel?

MR. SLEZAK: I have a question.

This was basically asked of Catherine Tyrrell, but I think it's a legal question. Are the permittees more or less subject to third-party suits with this permit?

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What's your opinion?

MR. LEON: Well, I agree with Catherine that the issuance of this permit basically narrows the focus, narrows the objectionable conduct by the permittees a great degree.

Right now there is very limited guidance as to what is required of the cities and whether or not the activities that are currently adopted and being implemented by the cities are efficient, leaving the cities with alternatives quite exposed, in my opinion.

However, the permit provisions, particularly in receiving water limitations, make it very clear that, as long as the parties are implementing the provisions in good faith, then they are not considered by the Regional Board to be in violation of the permit or the Clean Water Act. That provides a great deal of protection.

MR. COE: Any other questions? Do you want me just to go ahead, Catherine?

MS. TYRRELL: Yes. I have notified them of the order.

MR. COE: Fine. Ms. Kuhlman is up first.

MS. KUHLMAN: My name is Catherine Kuhlman, and I'm with the Environmental Protection Agency in San Francisco. My business address is 75 Hawthorne Street,

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San Francisco, California.

Thank you for providing the opportunity to speak on these permits. It's been a long, long road. I just want to briefly cover three major areas.

The first is just to reaffirm that L.A. has a major environmental issue around urban runoff. And this permit is a second good step to making sure that that pollution that comes from the rivers and affects both the rivers and the groundwater and the ocean in this basin will be better protected. And I say second because it will be the second issuance of this permit.

The amount of pollution coming out from the rivers themselves now is about equal to, in terms of loadings, to what the ocean is receiving from the POTWs. It's a very significant set of loadings that are coming in. And this is then information that I summarized and presented to the Board in tabular form, I think it was, April 1st of this year.

I think, finally, on the environmental points, the recent epidemiological study that came out made it clear that swimmers are at risk when they are swimming near storm drains.

The second point I'd like to make is that this permit is fully consistent with other permits that are being issued within the state of California and

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around the country in terms of both the content and the scope of the coverage as well as cost.

I'm also looking forward to a more -- some better cost information both from the cities as well as from the State Board. I think that will be a very useful tool as we move down the road towards implementation of this permit.

I guess, just in conclusion, I feel that this permit is a good mixture of trading off various interests by some pretty different points of view. And I think people have really done a good job in trying to balance viewpoints in this permit. And it's been 18 months in negotiation, and it's a year past the time the permit should have been issued.

So I would just urge this Board to adopt the permit and move on to implementation. There are a lot of really tough issues to be faced down the line. I think the permit gives the flexibility to adjust this permit as necessary as we learn more.

Thank you

MR. COE: Thank you.

Any comments by the Board?

We are going to change something here. I understand there's some students that have a 12:30 bus to catch, and they have come a long ways, and they have

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something to say. They may or may not have a spokesman. But with everyone's permission, we will hear from the students at this time.

A spokesperson would be helpful, whoever is in charge of the students. How is this going to be arranged? Is there one spokesperson? I understand there's going to be one spokesman; am I correct?

AUDIENCE MEMBER: Yes.

MR. COE: Okay. There will be some introductions. You will have to speak right into the mic.

MR. RAMIREZ: My name is Andre Ramirez from Venice, and I go to Mark Twain.

MR. COE: From Venice?

MR. RAMIREZ: Yes, Venice.

And these students are from Santa Monica Boulevard Elementary.

I would just like to say that the storm drain is a big problem and that you shouldn't put so much trash into it. And the storm drain shouldn't go into the ocean because I like to swim in the ocean and ride my boogie board in it or go bodysurfing. And I hate it when I dig for a sand crab and then I pick up a piece of trash instead. It's really disturbing.

MR. COE: Do you know what city this trash comes from?

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MR. RAMIREZ: So we want to stop the pollution going in. Because there's trash cans all over the beach, you know. And pollution is a horrible problem, so you should really just not be lazy and just put it in the trash can.

I'm here because I love the ocean and the beach and it's one of my favorite places to go. And I don't want to stop going there just because of the pollution.

Thank you.

MR. COE: Thank you very much. We appreciate it. The leaders of tomorrow.

Don Wolfe I guess is next. That's a tough act to follow.

MR. WOLFE: That is a tough act to follow, and I should just say ditto and sit down.

MS. ROGERS: You are responsible for knowing which city it came from.

MR. WOLFE: I think we all feel the same way. We all actually feel the same way. This young gentleman just expressed them very well.

I am Don Wolfe of with Los Angeles County Department of Public Works. I am representing the County of Los Angeles as principal permittee, and I'm also representing --

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MS. CRAVEN: Excuse me. It's still very hard to hear you.

MR. COE: I just got a report from the back of the room that some people are being heard and others aren't; and that those being heard are the ones speaking directly into the microphone. I know it's difficult. It shouldn't be this difficult, but that's the way the electronics are.

Speak directly in and speak loud.

MR. WOLFE: Okay.

I'm also representing all the permittees as Chairman of the Executive Advisory Committee, a committee made up of representatives from the city of Los Angeles, county of Los Angeles, and city representatives from the various watersheds elected by the watersheds.

First I'd like to speak as representative of the principal permittee, the county of Los Angeles. A few months ago I thought I would be here with a very large ax to grind on behalf of the county of Los Angeles, the principal permittee. And I am happy to say that that is not the case.

We had a lot of concerns with the drafts of the permit. And the staff of your Board and the other interested parties in this permit have worked very closely

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with us. And all of the concerns that the principal permittee in the permit had, as of this afternoon, have been resolved.

As principal permittee, which is a voluntary position on our part, we have committed significant resources to the success of this permit and for developing the programs and the coordination necessary for the evaluations and the water quality monitoring that's required under this permit.

We estimate that, in our role as principal permittee, we will spend $16 million in the first fiscal year of this permit. This was our goal as principal permittee. That does not include the cost of the various county departments for implementing the programs that they are going to have to implement.

So we are committed to doing this, and we are not sorry anymore that we volunteered to be principal permittee. And we are very much looking forward to engaging in the roles that are required of us under the permit.

Some of those would be that we have entered into a contract that cost $1.2 million to develop a county-wide storm water management plan and monitoring program. This important role has been a concern to a lot of people, and continues to be, because it requires that we

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submit, in a various time frame, various elements of the Storm Water Management Plan which must be implemented by ourselves and the other cities. And that is a big unknown.

I'm here to promise, to make a commitment to your Board and to the other interested parties, the cities, environmental community, industry, that we have a plan that will include all interested parties in the development of the various elements of the Storm Water Management Plan. And it's going to require a lot of work on everybody's part, but we are definitely going to include everybody who is interested in the loop and try our best to resolve all those issues that come up before we submit the elements to your staff for the approval of your Executive Officer.

We also have the lion's share, if not all, of the monitoring requirements under the permit. And we have entered into a contract with the USCC Grant Program, USC Santa Barbara at a cost of about $650,000 to study impacts of storm water on the coastal receiving waters. And, in addition, we have a multi-million dollar commitment to do monitoring of all of the contributing drains.

We have committed to a $5.2 million educational program which will go a long ways towards

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meeting the educational requirements under the permit for all the permittees.

One of the biggest issues for us and for the other permittees has been what's called the Site Educational Program or the site visits that's going to be required for us to go into all industries, commercial facilities, and do an education program on what their requirements are under the storm water program.

We looked at that. If you have a stand-alone program, it's going to be very expensive. So we have entered into negotiations with the Department of Health Services and the County Fire Department to include those inspections or those site visits in their annual inspections of businesses. That will be a very efficient way to do it.

We have set up a pilot program. And it's our intent, and we have so notified the Board of Supervisors in a letter to the Board, that if that program is successful and the agencies who are already inspecting the facilities continue to agree to cooperate, that we make that process available to all the cities that contract with the county, and those that don't contract we would commit an equal amount of money per inspection to their programs.

Our follow-up with the Board of Supervisors on that is vague, but it's been very positive.

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That's not a commitment but it definitely is, I think, a program that's going to work and go a long ways toward satisfying the concerns and having a very effective and consistent program across the board.

As you are probably aware, the L.A. County Board of Supervisors passed a motion July 2 which basically asked your Board, Board's staff, to work very closely with the cities, the permittees, to resolve all their main concerns and then encourage your Board to pass this permit today, hopefully having worked out all of those concerns.

Changing hats real quickly and speaking as Chairman of the Executive Advisory Committee, having said all the concerns of the principal permittee have been resolved, you are going to hear today, I'm sure, that all the concerns of the other permittees have not been resolved. They have many great concerns, and I'm not going to state them because you're going to hear from the individual cities.

But as Chairman of the EAC, I respectfully request that you listen very carefully. I think that their concerns are legitimate and that, in your decision-making process today, that you consider their concerns and make any appropriate changes to the permit to satisfy those if you can.

Thank you very much.

MR. COE: Thank you, Mr. Wolfe.

We have a question here, Mr. Wolfe.

MS. CRAVEN: I have a question.

You spoke of all these programs and contracting and the $5 million and the $60 million dollars and other millions of dollars. I'm wondering where these come from. Do you have a benefit assessment of these established or are you collecting fees from --

MR. WOLFE: It depends on what the program is, ma'am.

For example, our department is basically -- when we say the principal permittee is the county of Los Angeles, it's basically the principal permittee is the County Flood Control District.

Those tasks that are distinctly those of the principal permittee; for example, the county-wide educational program and other county-wide programs, will be funded from our benefit assessment.

We have twice gone to the L.A. County Board of Supervisors and gotten very minor increases in that assessment for the specific purpose of funding our duties as a principal permittee. The other programs will be funded out of the funds that are allotted to the various programs.

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For example, there will be a lot of road-related issues in the permit, but it will all come out of the road fund. The permit and construction issues will all come out of the General Fund, and, for our airports, it will be out of the airport fund, et cetera. It depends on the activity.

So there will be an impact on almost every fund that the county of Los Angeles has.

MS. CRAVEN: Thank you.

MS. ROGERS: This may come out further down the road. But as the principal permittee, of the 80 cities, how many support the ordinance right now and how many are opposed? Do you know what the current count is?

MR. WOLFE: No, we don't. And we tried to do that. We did a survey of the cities. And, of course, when you do that, the only official position the city can give is that their Council has passed a motion; okay?

So in most cases there has -- of the 85 cities, I think only a small handful have passed motions; a small handful in favor, a small handful in opposition. And those numbers I don't know.

So we kind of up gave up in frustration in trying to get a feel or a sense of, even those cities that talked to us, many of them wouldn't talk to us, said, "I will only say this if you promise to us you won't make

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it public."

MS. ROGERS: We have enough paper to create an environmental problem here because of the number of letters that have come in. And it's a little hard to distinguish out of this what is officially the cities in support, but we don't know officially what that is for the individuals or the cities who oppose or whatever.

So you are saying right now that you can't officially give a count. Does this have to end up going through an ordinance process or a City Council vote at each city?

MR. WOLFE: It's my understanding no. But Jorge should answer that.

MR. LEON: With respect to the legal authority provisions of the requirements of the permit, many cities already have the ordinances that they need to meet the requirements. The others who don't need to tell us what kind of schedule they will adopt for the ordinances to provide the enforcement of the permit requirements.

So the answer is yes for some.

MR. WOLFE: Wasn't your question, Ms. Rogers, whether the City Council had to adopt this permit?

MS. ROGERS: Yes.

Ultimately, I think we are trying to sort through, we have 80 -- basically, you are the

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principal permittee, but we have 80 permittees. And I'm trying to get some gross feeling, while it's not a majority rule or anything, just where the different groups come out.

And I just wondered if there would be any -- I mean, have we got as much of a yea or a nae as we are going to get, or is there any other process we are going to have to go through?

MR. WOLFE: It's my understanding that, once the Board issues a permit, that there's no vote of a City Council or a Board of Supervisors that has to be made. That's it.

MS. ROGERS: Right.

That's all. If there was any other procedural thing that we will be seeing down the road?

MR. LEON: No.

MR. COE: Thank you.

MS. GLAD: Members of the Board, my name is Amy Glad. I am the Executive Vice President for the Building Industry Association of Southern California. My office address is 1330 South Valley Vista Drive in Diamond Bar, California. Our member companies engage in residential and light commercial and industrial development within a six-county Southern California region, including Los Angeles County.

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I just want to give you a brief synopsis of our experience on this permit. Like Don, I did not believe I would be here today saying that we have resolved most of our major problems. But since December when the first draft of the permit was issued for public review, your Board's staff, county and city staff, and other interested groups have met with us as well.

We were strongly opposed to that December draft and have come here today being able to state that our major issues have been resolved. Obviously, we are mostly interested in the development, planning, and construction portion of the permit. We believe it has been substantially improved to incorporate the streamlining necessary for a workable storm water management program.

There is an emphasis on cities and counties working together to develop guidance material. Hopefully that will stop people from having to reinvent the wheel in every city.

Further, we support the concept of watershed planning. The permit addresses the fact that more work must be done to adequately identify the types and sources of pollutions in watersheds in this region. My outstanding comment ended up on one of the overheads in Catherine's presentation; and that is, whereas the original draft permit in December included stakeholder organizations

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on watershed management committees, the current permit before you today does not.

And should you choose not to make that change today, I would just hope that staff and others would emphasize the need to work with stakeholder organizations in doing the watershed planning that is considered in this permit.

Finally, we appreciate the emphasis on education in all areas of this permit. Our organization has worked with the counties of San Bernardino and Riverside in the Inland Empire to do videos that are at their building official offices for construction workers to look at to understand the storm water issue and their responsibilities under this permit.

Further, we are interested in continuing our work as a designated stakeholder organization and all the work that is yet to do after you adopt this permit today.

I'm happy to answer any questions.

MR. DRANE: How many members do you have?

MS. GLAD: I think we have 1,500 member companies within Los Angeles County. I can't tell you of that portion in L.A. County.

MR. DRANE: How do you derive at the consensus of your judgment on this issue with your members?

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MS. GLAD: Well, we have Government Affairs Committees within our trade organization. We have two Chapters within Los Angeles County that are affected by this permit, and that would be our greater Los Angeles/Ventura Chapter and our Los Angeles County East Chapter. And they both also have Government Affairs Committees that have building members on them.

And we have let them know since the beginning about this permit. We have worked with those two committees. They have come to the meetings, not only individual building company members but staff such as myself, and other of our Chapter Executive Officers that worked on the legislative issues.

MR. DRANE: But you didn't actually make any poll by voting --

MS. GLAD: No. That's not our regular routine.

MR. DRANE: -- where you send each member a ballot to vote yes or no?

MS. GLAD: No, not at all. We never do that on government issues.

MR. DRANE: Because I understand a number of your members are really not that enthralled in this.

MS. GLAD: I can only do what our organization does in terms of membership development.

MR. DRANE: Thank you.

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MR. KISSEL: Good morning everybody. My name is Mike Kissel. I am an Environmental Specialist with Carl's Jr. Restaurants. We are at 1200 North Harbor Boulevard in Anaheim, California. And I am here to give our perspective on what our involvement has been with the Storm Water Pollution Prevention Plan.

Our involvement actually occurred some years ago. We had certain cities bringing to our attention certain practices that were not considered acceptable for the prevention of the contamination of storm water, such as housekeeping areas outside.

Since then we have incorporated into our standard operating procedures ways that restaurants can accommodate this by certain practices as far as good housekeeping outside, the way of washing the floor mats inside, keeping trash in its place, and a host of other areas that we have already set up. And that's how our awareness first came to fruition.

We have had plenty of these in our operation guidelines, in our procedures, and cleanup prevention and basic housekeeping. We just found that this not only looks good, it's good business sense, and we found this is something that is doable in training.

The challenges for that are in training and making sure we can implement this on a consistent basis

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throughout our restaurants. And this is in all of our Carl's Jr. corporate restaurants, not just in Los Angeles County.

We have worked with the L.A. County D.P.W. in setting up -- gave our input in the checklist they had set up for inspections that would come by on an advisory basis, which we appreciate, with our restaurants and certain areas that they were looking at that may have needed improvement in handling certain practices in preventing the contamination of storm water. And a lot of them are housekeeping practices, best management plans, if you will.

We do -- we have worked with, also, the Water Quality Board, with Catherine, and we appreciate the cooperation that they have extended to us and the opportunity to work in a partnership with them.

However, we have had and do have certain concerns that we are sort of wondering, and we have shared this, of course, with Catherine. And they are areas where post-consumer waste that are at issue, post-consumer waste being that kind of waste that comes from a take-out order or a drive-thru situation, is to be removed from our site.

And sometimes certain members of the public will not be as consciencious as others are and dispose of the waste. And we feel that this is something

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beyond our control. Post-consumer waste is an unfortunate reality. We certainly provide trash receptacles and encourage the proper disposal of waste on our site, and we try to do this also by example by keeping our facilities clean.

But we do want to make clear that post-consumer waste is an issue that is something that is beyond the control of the restaurant industry.

Another concern is how the funding of this will occur as far as taking care of the inspections when the inspections are made at our facility. We are concerned about, down the road, maybe certain fees arising that would be beyond us. And we feel like we can accomplish this goal without the necessity of having that kind of thing happen.

Again, thank you for the opportunity, and I can answer any questions that you might have.

MS. ROGERS: When you raised your concerns, do you have any specific comments in terms of the permit that's in front of us that you want to see changed?

MR. KISSEL: Well, I don't know if they are that clear in the permit. And there are items that maybe are not in the permit but that we are concerned about that, administratively, it may come down the road, whether it's in the permit or not, and this involves the fee-making that

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would occur probably at the city level, is what I'm talking about, because it would be probably the cities that would be enforcing this on us as far as any fees we have to have on an annual basis or whatever. And I think that's what we are talking about.

And I don't know if that would be something that would be covered necessarily in the permit per se.

MR. COE: Thank you very much.

MR. KISSEL: Okay. Thank you.

Mark Gold.

MR. GOLD: Good afternoon Board members. I am Dr. Mark Gold, Executive Director of Heal the Bay located at 2701 Ocean Park Boulevard, Suite 150, in Santa Monica.

On behalf of Heal the Bay, I strongly urge the Regional Water Board to approve the tentative permit without further delay. As demonstrated in a ground-breaking study by USC, swimming near storm drains and swimming in water with high indicator bacteria density can make you sick, even in dry weather.

Storms, the cause of winter swells, incredibly attract tens of thousands of surfers in the region, leaving most of the county's coast with densities of indicator bacteria that pose a significant health risk.

Nearly two thirds of the 62 beaches

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monitored by the city and county receive a "C", "D", or "F" on our beach pollution report card during wet weather.

Storm water runoff leaves our beaches looking like trash dumps after every rain, costing millions of dollars annually to clean up while our catch basins cause extensive and costly property damage.

Storm drains dump sediment which cause swimming hazards at our marina and ports and smother precious wetlands and our aquarian habitats. According to the Southern California Coastal Waters Research Projects and UCLA study, both dry weather runoff and storm water runoff from local drains are toxic to marine life. Contaminated sediments carried by runoff have posed toxicity problems to marine life for decades.

Hot spots have been found at the mouth of Ballona Creek, Marina Del Rey, the L.A. and San Gabriel Rivers, and Dominguez Creek. There is no question that runoff is the most significant source of coastal pollution in Southern California today.

85 cities in the county have been operating under a broad, ambiguous permit for over six years. The tentative permit before you today is the product of 18 long, tedious, and contentious months of negotiations with seemingly every interested party in the entire region.

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As all of you know, most NPDES permits have one draft and a 30-day comment period. For this permit there have been four delays, at least three drafts, and countless discussions with cities, business people, regulators, government agencies, and environmental groups.

One year of delays is already one year too many for the 50 million annual visitors to county beaches and those business that are part of the county's $2 billion a year coastal tourism industry.

As a negotiator on behalf of the environmental committee, it's my responsibility to inform you how far we have compromised on this permit in order to reduce the regulatory and financial burden on cities in the county comparing the current tentative permit to the December 18th draft. Here are just a few of those changes.

The industrial/commercial facility inspection regulatory requirements have been eliminated and subsequently replaced by educational site visit requirements with no threat, no threat, of enforcement to businesses.

One recent change, the elimination of the requirement to pass Phase I industrial facilities staff if they file a Notice of Intent to Comply form, or if they have a Storm Water Pollution Prevention Plan on site as

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required, was eliminated over our vehement objection. We have little faith that the Water Board has the staff to implement this program without at least minimal assistance.

Also, municipalities have been encouraged to add these education elements to existing inspection programs like health, fire, and industrial waste in order to reduce or eliminate the cost of new personnel.

The requirement for cities to draft a new comprehensive storm water pollution control ordinance have been replaced by simple, common-sense prohibition, many of which have been watered down, again over our objections.

It's impossible to meet receiving water requirements that they eliminate largely thanks to environmental communities' lobbying efforts of the EPA and the State Water Board. Construction requirements, once opposed by the BIA as too burdensome and costly, are now evidently acceptable to the BIA.

There has been an 85-percent reduction in reporting requirements, and the schedules have been pushed very far back. All city monitoring requirements have been eliminated. Also over our objections, all requirements to implement watershed-specific projects have been eliminated for cities.

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The environmental committee has gone as far as it can go. Further delay means further weakening of the permit. It's as simple as that. As it is, the teeth in the permit have been largely extracted. When only asked to look at the many, many cuts and substitutions in the last three drafts, it's proof that further delay means less water quality protection.

Please don't be swayed by unfunded mandate arguments. They have already been responsible for many of the changes I have listed previously.

Also, don't be swayed by some cities' arguments that they already are spending millions of dollars on storm water pollution control. Look closely at those buttons. They include recycling programs mandated by AB-939. They include Department of Integrated Waste Management funded oil recycling programs, and street sweeping, public trash receptacles, and catch basin cleaning programs that existed long before Congress ever required municipalities to control their storm water pollution.

Recently, some elected officials have stated that they haven't had enough time to thoroughly analyze the cost impacts of the permit. Considering the fact that an Executive Advisory Committee to the cities has existed for over a year and the fact that numerous

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drafts have been disseminated by Board's staff since December, one has to question who is at fault for this miscommunication, your staff or, more likely, public work staff in some cities.

The permit, even with all these changes, is still supported by most of the environmental community. As you have seen, hundreds of businesses, numerous Chambers of Commerces, thousands of individuals, the city of L.A., the county, and the Coastal Commission have expressed their support for this permit, a Storm Water Pollution Prevention Plan that primarily focused on targeted public education.

This permit is as close a consensus as we are ever going to get. We realize that all nine million people in the county are potential pollution sources to our coast. Nothing less than a fundamental change in the waste disposal behavior of every person and every business in the county is needed to enhance and protect our region's most important resource, our coast.

Failure to adopt this permit today doesn't only reflect on the Water Board's commitment to protecting the region's beneficial uses. If the permit does not get approved, the action would be a direct reflection on the failure of the Santa Monica Bay Restoration Project to implement a plan that will result in a healthier bay ecosystem and cleaner and safer beaches.

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The Bay Restoration Plan, approved by Governor Wilson, targeted urban runoff as the No. 1 pollution problem in the bay. Here we are $8 million later, thousands of volunteer hours, and seven years later at the threshold of making a decision on the single most important action within the plan.

If the Board supports the permit, then all of this time, money, and energy was well worth it. If not, then this Board's commitment to true watershed management will have proven to be little more than a permit rescheduling exercise.

Thank you.

(Applause.)

MR. COE: Did you bring all your cousins here, Mark?

Mr. Vernon has a comment.

MR. VERNON: I will ask you the question, Mark, and hope maybe at least your answer will go through the P.A. system.

Nobody is more up on research on receiving waters in the Santa Monica Bay than Heal the Bay. And as a part of trying to take a very broad look at the situation in macro terms, right currently are bay waters declining in quality, holding steady, or improving? Just take a flash look at it.

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MR. GOLD: As a scientist, it's one of those questions that's not really easy to answer. And one thing I would say is, from the standpoint of the center of the bay, obviously the POTWs are well on their way of doing an excellent job for reducing pollution to the bay.

So from the standpoint of the marine life, we have seen, I think already, a tremendous improvement most notably on hyperion discharges. But from the standpoint of beach pollution, storm water pollution, there's been no progress.

As long as we continue to develop the region at the rate we are, and I don't see that really stopping, then we are going to continue to have increasingly worse beach pollution problems, and we are going to continue to have the health risks that we currently see today from people swimming in runoff contaminated waters.

MR. COE: Thank you very much.

I think I indicated a little earlier that we were going to try to break at 12:30. Obviously, we didn't.

We had a straw vote up here, among most of the Board members I could reach, to go another 30 minutes to try to pick up the elected officials, which is the next category. 30 minutes was allocated to them. We

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do have 19 who have indicated a desire to express themselves, not for very long individually.

But we are going to have to reduce the time that they have asked to about a minute and a half in order to stay within the total allocated time because of the number of people.

There will be a couple-minute break right now to change the paper for the court reporter.

(A brief recess was taken.)

MR. HAYDEN: Mr. Chairman, members, my name is Tom Hayden. I am a Senator representing the area of Santa Monica Bay. I have been involved with this problem for 17 years. I have been following these negotiations for 18 months. I attend meetings with the restoration project.

And I read every line of the permit and the amendments and would ask for more than a minute and a half. Because a legislative hearing will occur on this anyway. So I would like to see at least three minutes' opportunity to go into some of the details. But if not, I will simply submit the testimony.

MR. COE: Go ahead, and we will see how this works out.

MR. HAYDEN: I struggled last night and this morning, actually wrote a statement in which I struggled to be able to say that I support this permit. But in

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conscience, I cannot support, as an environmentalist, this permit.

I can comment on it and tell you that the reason that I'm here in support is because I support the children and the environmentalists and the Mark Gold's of the world who, I think, are such devoted defenders of Santa Monica Bay that they are committed and will be committed to lobbying you and hounding you and, if necessary, suing you for the next five years. In that sense, I am here as a supporter.

17 years ago, my children, who were then smaller than the children you saw today, were playing as part of a play group in the storm drain runoff at Pico-Kenter. That is an act of official neglect, which I think you can understand as a parent, an act of neglect not telling people, not doing anything about it, and it is not easy to forget.

Before my attention to this issue, there were defenders of the bay like Rim Fay. And after I'm gone, there will be people like Mark Gold and Terry Tamminen, and Gail Feuer, and Marabelle Marin who have labored to negotiate this permit today.

But I would like to say this about history; that institutions that promote excessive growth and rampant pollution have a life of their own while the

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bay itself is always dependent upon official promises made after a few dedicated citizens bring bay pollution briefly to public attention.

From the long view, therefore, my concern is this. I am convinced that while this permit is good in the sense of requiring best management practices to reduce pollutants and good in the sense of promoting public education so that future generations are not as illiterate ecologically as we have been, it still is a permit to stall any serious action on the bay's programs until the 21st century.

There are at least four very serious deficiencies. The three-year delays are endless throughout. And one might be asking what the regulatory agency has been doing about such things as reporting and eliminating these illicit discharges all along, and why it is still necessary in 1996 to develop a model program for doing something about them three years after the model program. Today's amendments, which I just got, actually promote further delay.

Secondly as a deficiency, there are loopholes everywhere that allow stalling. I count a minimum of 18 having to do with conditional language like the extent practicable, I don't know if that's the word, but that's the word the permit uses, and other

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representations that cost to business should always be balanced against public health benefits. My own view is that golf courses with pesticides on them get more consideration than a swimmer's lungs in the writing of this permit.

The third deficiency is it marks a further retreat from enforcement, as Mark Gold said, by capitulating on the issue of inspection programs. Inspection programs contain the implicit obligation to enforce the law against violators. Those have been replaced by so-called site education for dischargers combined with reliance on self-assessment, the words of the permit, for how the programs are working.

The Regional Board, as you know my view, has given only lip service to enforcement for a number of years. This permit pulls the last of its teeth.

The fourth serious deficiency is the reduction or even elimination of public participation in the so-called Watershed Management Committees, which the language even implies an attempt to eliminate the state requirement for open meetings. But there's no public representation on the Watershed Management Committees.

This is particularly offensive because there would be no progress whatever on cleaning up the bay were it not for the public participation of public interest

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groups like Heal the Bay, Baykeeper, and NRDC.

The permit to stall has to be understood in the context of the past year and a half this permit is overdue. It has given polluters or permittees an extra year's license for business as usual already. And since the stalling of the past must be considered a hint of things to come, no one should be surprised if the proposed three-year deadlines in this permit are renegotiated and stalled in the future.

I understand why certain cities are unhappy. I understand that well. But if they believe that spending money on programs to clean up the bay is not a good investment by local government, I can't agree.

If, on the other hand, they believe that this particular permit is a waste of money because it's not tough enough, fine. They should have been advocating that the Regional Board pursue polluters more and process paperwork less. They have had plenty of time to do that.

Let me conclude by asking you this. Would you stall if a member of your own family was sick and needed medical treatment? Would you stall to see how sick they were, then give them the cheapest treatment possible and practicable? That's what this permit does for Santa Monica Bay as a marine environment and for the people who enjoy its shores.

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As Mark pointed out, while this stalling goes on, thousands of swimmers, hundreds of thousands of swimmers and beach-goers are getting infections and diarrhea from swimming near the storm drains as my children did.

The recent study of health defects referred to only skim the surface of the bay. It did not analyze the impact of toxic chemicals in addition to sewage. It did not analyze the effect of pollution on marine life. The cancer risk from white croaker latent with DDT and PCB is incredibly high, and still nothing has been done about it.

Given all this, it is incredible that there should be any opposition to passing this permit framework a year too late.

As Chairman of the National Resources Committee and the Senate, I can tell you that the Senate is increasingly concerned with the official retreat from our coastal water quality and environmental laws. We have recently dumped an appointee to the Fish & Game Commission, and we are now battling against the threatened destruction of the Coastal Commission.

This fall we will be holding investigative hearings into the retreat from enforcement and protection of Santa Monica Bay and the coastline. We

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will be looking at this regulatory agency here and the Coastal Commission, seeking new alternatives to the failed policies of the past.

I call on you to approve this permit today and work with us tomorrow towards a new covenant with the sea around us.

Thank you.

MR. COE: Senator, I have a question if you have a moment here.

Do you recommend that this Board approve this permit today?

MR. HAYDEN: Yes.

MR. COE: Okay.

MR. HAYDEN: The good argument for approving it is that I don't like it. I tried to communicate that with Governor Wilson's administration. They know my position. They know my doggedness. I will be around. I will be on your back. I will be breathing down your neck. And we will enjoy our relationship.

It is a permit so feable, so loopholed that this Board should have nothing to fear in approving it.

Thank you.

MR. DRANE: Now, we don't want you to go away mad.

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MR. HAYDEN: I'm not mad.

MR. DRANE: You just want to get even; right?

Without me commenting whether I'm for the permit or against the permit, I think, as one of our great Americans once said, our government is the art of compromise.

And you, as the Senator, would you agree to the fact there has to be some compromise on most issues that ride within the government's spectrum?

MR. HAYDEN: I think you should fight for what you believe in until you can get nothing more. If you call that a compromise, so be it.

This measure, this permit, turns the corner on promoting greater public education. My concern is that these kids you saw today will be the Mark Gold's and Terry Tamminens of tomorrow fighting in the year 2010 on the next version of the permit still trying to make the bay better.

But the public education is a step forward. And as the earlier gentleman said, nobody can oppose good housekeeping methods, which are essentially what best management practices are.

My worry is that, if the polluters don't get the message that there are consequences, including penalties, fines, and jail time, and if you allow

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unmitigated growth to continue in the Los Angeles basin, even with good housekeeping, the net impact on the bay will far outweigh the cleanup measures that are so gradually being implemented. And, therefore, these kids will come back in 10 or 15 years before you as activists or advocates, and they will be before you again.

So there's nothing wrong with compromise. But if you view this in a 20- or 30-year framework, which I have experienced, and if your kids were playing in the storm drains without your knowledge that they were latent with this stuff in 1978 or 1979, it would get a bit tiring to be told that we have to compromise again.

Thank you very much.

MR. COE: Thank you very much.

MS. ROGERS: Given the Senator's standing and importance on all of these issues in the state, I think the extra time is appropriate. But I would like to request that we go back to our shortened up time, whatever it is, to get to our other officials because we have a very long day.

MS. NEWMAN: Good morning. My name is Laurie Newman. I am the field deputy for Assembly member Sheila Kuel whose district includes the coastal cities from Santa Monica to Malibu.

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As Sheila's representative, I sit on both the Oversight Committee and the Watershed Council of the Santa Monica Bay Restoration Project. I am speaking here today as Assembly Member Kuel's representative and as an active member of the bay project.

Assembly Member Kuel urges you to approve this Storm Water Permit which will aid us on a regional level in improving the health of Santa Monica Bay.

The Santa Monica Bay Restoration Project was established by the state in 1988 and was charged with the responsibility of assessing the bay's problems, developing solutions, and most important of all, putting them into action.

The project's membership is quite diverse. We are an active partnership of government representatives, environmentalists, scientists, and representatives of industry and the general public.

Storm water management is a key component of the Bay Plan, which is a product of a five-year consensus-based effort by the bay's stakeholders. The Bay Plan recommends that a number of actions be taken to improve storm water management.

Among the recommended actions, this storm water permit is one of the most important tools

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needed to achieve the goals of the Bay Plan. Your approval of the permit today will be a huge step forward in reaching our goal of restoring the bay and protecting it for years to come.

We urge you to approve the permit and to ensure that it is environmentally sound, consistent with conservation principles of aquatic biology; that it incorporates the recommendations contained in the Bay Plan; and that it provides for timely implementation of the monitoring program.

Thank you very much for your time and consideration.

MR. COE: Thank you.

Debra Bowen.

MS. BOWEN: Good afternoon, Mr. Chair and Board members. I am Assemblywoman Debra Bowen. My business address is 18411 Crenshaw Boulevard, Suite 280, in Torrance. And my assembly district stretches from the Venice/Santa Monica border down the coast to Palos Verdes Estates, including not only a great deal of coastline but also a thriving tourism industry.

I am pleased to join today the broad coalition of business people, local government leaders, and environmentalists in support of the immediate adoption of this storm water permit. I commend you for the work you

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have done so far to reach a consensus, particularly the staff. And I encourage you to continue working with those who are not yet fully engulfed in this process, no pun intended, to bring them into the water with you.

I understand that no one can possibly be satisfied with every single aspect of the permit, but I think there has been a great deal of progress made. As you know, the coastal economy, which is a $3 billion a year tourism industry, is highly dependent on the health of the bay.

While there are costs of local government to implement this permit, I think, in the long run, there are much greater costs of not implementing the permit. I think we would see not only a decline in our municipalities' local sales tax base as tourism declines but also a decline in property values which would threaten our property tax assessments that we use to provide other services to our citizens.

With my wishful thinking cap on, as you begin to implement the permit, I urge you to work with cities of all sizes to help them implement the permit in the most cost-effective way. Cities in California are undoubtedly in a difficult situation. They have been placed in that situation by the federal and state governments, mostly before I was there, of course, and

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despite my efforts to protect cities from unfair raids on their treasury.

And, of course, the will of the voters has also created fiscal constraints on local governments. But the federal Clean Water Act clearly gives cities the responsibility of monitoring pollutants through the storm drain.

I am here today primarily to assure you that I will be taking a leadership role in the state legislature in assisting the cities to find the resources to comply with this federal mandate.

I understand that there are existing resources that are available to cities that we may look at as well as some possible piggy-backing on existing educational visits that we can use to minimize the fiscal impact on cities as we move forward with this attempt to clean up the bay.

I also believe that the $5 million program that the county of Los Angeles is undertaking will help reduce costs to the cities.

There are also, I believe, some state responsibilities that can be undertaken again to assist the cities in this, recognizing that the financial and economic health of the cities and the businesses in those cities is not just a benefit to the city governments but also to the

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state government as a whole.

So the legislature and the state government also have a role to play in this. And I am pleased to be in a position to be able to press that role on behalf of all of the cities in Los Angeles County, not just those that I represent.

The fact that this permit is supported currently by business leaders and environmentalists, a broad coalition from realtors, businesses, to Heal the Bay I think is testament to the importance of this issue. And I think it proves once again that good environmental policies can be good business policies and vice versa. The two can come together. All of these concerns can come together. Or, as the hot dog vendor said to the vend master, make we one with everything.

In closing, I urge you to adopt this permit without further delay. I think it will help us strengthen our economy in the long run as well as cleaning up our environment.

Thank you.

MR. COE: Thank you.

We will hear now from Council Member Ruth Galanter followed by Beatrice LaPisto-Kirtley followed by Mayor Margaret Clark.

MS. GALANTER: Thank you, Mr. Chairman and

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members. I am Ruth Galanter, Council Member of the Sixth District of the city of Los Angeles. I also live in Venice like the young man you heard before, but I know we have got everybody's trash at the beach. I think he knows it too.

I am here primarily to present you with a resolution adopted unanimously by the City Council urging that you adopt this permit today and not put it off any further. In a rare moment of unaminity, we not only had the entire Council, we also had the support of the Mayor.

And I am proud to say that I believe that that support, which was expressed in a joint news conference that also included some of our business interests and some of our environmental interests held last Friday, that support derives from a recognition throughout the city of Los Angeles that, even though some of these things cost money, this is an investment in not only our environment but our economic health and also in our ability to continue to function as a region.

I know that not all of the cities feel as we do. I hope that they will come to feel as we do. But in the meantime, I think it is important that we get the show on the road here, or the boat in the water as the case may be.

So I brought you copies of our unanimous resolution and hope you already have them. But just in

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case, I have some more. And I do hope that you will act today. We are all getting tired, as I know you are, of having to come back to rehash the issues that have already been worked out.

The last thing I would like to say is I'd like to express the appreciation of the City of Los Angeles for the work your staff has done in being available to meet with us, to talk with us, to resolve problems as they came up.

We didn't start out loving this permit. We had some concerns. But your staff has been particularly helpful and receptive. And our staff is here if you have any specific technical questions for the city.

Thank you.

MR. COE: Thank you.

MS. LA PISTO-KIRTLEY: Nice size podium.

My name is Beatrice LaPisto-Kirtley. My business address 234 North El Molino Avenue, Suite 202, Pasadena. I am President of the San Gabriel Valley Council of Governments.

Mr. Chairman and members of the Board, I am here this morning to speak to you on behalf of the San Gabriel Valley Council of Governments. The COG is a joint-powered agency comprised of 26 cities working together to serve the more than 1.7 million residents

living in the San Gabriel Valley.

The Board of Directors formed a task force of our cities' public works directors to evaluate the draft rules and regulations, including the anticipated financial impact relating to this program.

In April, the task force submitted their report and identified four areas of concern. We issued a letter to the Water Resources Board questioning that these points be -- requesting that these points be reviewed and addressed prior to the issuance of the final draft rules and regulations.

Two weeks ago, our task force members and other elected officials in our cities met with Catherine Tyrrell to review our list of concerns and corresponding adjustments that were made to the document being discussed today. We were pleased to learn that several of those previously raised issues have been addressed. And we thank the staff for their attention and responsiveness to our concerns.

Mr. Nasser Abbaszadeh, Chair of our NPDES task force, is here today and will speak under separate comments about some specific technical issues that remain unresolved regarding this proposed program and its implementation.

Perhaps the most important to our Board,

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which is comprised of elected officials in our 26 member cities, is the financial impact resulting from this program for our respective cities.

Our staff analysis, which has been reviewed by your staff, indicates that this program will cost San Gabriel Valley cities between $8.00 and $10.00 annually per resident to implement. This represents an estimated $10 million in increased cost to our cities for this new program. Clearly it will require new user fees and charges.

More important, should Jarvis II pass in November, it is likely that such new fees will require voter approval. Should that approval not be successful at the ballot box, these new costs will become yet another in a never-ending series of General Fund liability hits to our cities; for example, it could cost the City of Pasadena a million dollars per year.

Our Board supports the objectives of this program; however, this means does not justify the end. We are strongly opposed to this unfunded mandate and urge you to withhold approval of the new regulations until those technical issues to be discussed by Mr. Nasser Abbaszadeh are met and until which time the federal government provides the resources to us to fund its implementation.

As cities serving the more than 1.7

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million California taxpayers living in the San Gabriel Valley, we cannot and should not bear the financial burden for this federal government mandated program.

I thank you very much. I am also immediate past President of California Contract Cities Association. And on behalf of the president, its current president, I have letters for all of you asking that you defer your consideration for 90 days so we can have input from public elected officials.

I wanted to let you know that the video that you saw this morning, elected officials saw that the first time in June at the league meeting. And we have not been aware of this process. I realize everyone says it's been going on for a year or over a year, but elected officials have not been aware of this. We support you but would like input into this.

Thank you very much for your consideration.

MR. COE: Margaret Clark is next followed by Joyce Lawrence and Marilyn White.

MS. CLARK: I am Margaret Clark, Mayor of the city of Rosemead. My address is 8838 East Valley Boulevard in Rosemead.

I would like to clarify something that Ms. Kirtley mentioned. We have been aware of the process.

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However, in March, for example, I serve on the Southern California Association of Governments Energy Environment Committee, and we brought the issues before the SCAG Committee and before Ms. Tyrrell.

Some of those issues were not addressed. We asked for another meeting in June, and we were given only a conference call and told at that time that the Board members on the call could not respond. And I understand your problem that the Board couldn't. But I'm wondering why Board members were put on that call if we could not, by their presence, be able to discuss the specifics?

All we are asking here is an extension of time to work out the details. None of us disputes the fact that there is a tremendous pollution problem. None of us is opposed to clean water. We simply want more time to work out the problems.

And my main concern is that, if there are lawsuits involved in this, either with third parties or by other means, it will delay the cleanup. Money will merely go to the pockets of attorneys instead of prevention and cleanup. This has been the case with cities. In one suit we were sued as third parties for merely arranging for the trash to be hauled there. The Cartwright/Simpson case with the sewer was another example where monies, precious, scarce taxpayer dollars, went to attorneys' fees instead of

solving the problem.

So I plead with you, we are on your side. We want clean water. We want the process to go forward. However, we need more time to work out the problem so we can avoid the lawsuits that will take place.

Assembly Member Dominic Cortese phoned me this morning and told me that he -- he is the Chair of the Water and Wildlife and Parks Committee in the Assembly. And he informed me that he was attempting to schedule a hearing in this process in order for us to have more input into the problems that we have.

I do appreciate very much Senator Hayden's and Assembly Member Bowen's concerns for our financial needs, and we want to see that happen.

I also am very concerned about the buck stopping where we are. The children that were before you have legitimate concerns, but their parents are the ones that are going to be asked to pay for these programs. And if the public is oversaturated with the fees, they are going to turn around and not want to pass the SB-900, the water issue that was just signed in to put it on the ballot by the Governor last week, I believe. And that will have an effect on the water issues in the state. And it would be a shame to have this, if it's passed without the refinements that we need, to stand in the way of that

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issue.

So I would ask you -- I have brought letters from Assembly Members Dominic Cortese and Diane Martinez who have concerns, share our concerns that the process be left open. We are not opposed to the permit. We are opposed to passing it today before we have had the chance to work out the problems.

So we plead with you to please consider our comments.

MS. LAWRENCE: Good afternoon. My name is Joyce Lawrence. I am the Mayor of the city of Downey, 11111 Brookshire, Downey 90241.

Bea LaPisto-Kirtley made some good points about the Jarvis initiative, and that's hanging over all of our cities' heads, including ours, but it's a charter city. We are concerned about that.

I brought you a copy, a certified copy, of our resolution asking you to defer for many of the same reasons. I don't know who to present it too.

And I feel badly that some of us that were going to express city concerns are characterized in advance as whining or otherwise dragging our feet. That bothers me. Polarization bothers me.

The time schedule here was very crucial for our cities, and our attorney may speak later. But the

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time from the revised draft that we got, which was dated July 5, our city received it July 8. There were 111 pages of material to go through. There were changes in all but six pages of the permit, and we had it in our hands for one week.

We had this resolution on our agenda the next night after asking please for some more time. We don't like dirty water either. We have had voluntary programs in Downey for 20 years, not until just when we got AB-939 money. We have been recycling 20 years. We have been having volunteer cleanups of our city. We know it goes in the river. We want to stop it. We support clean water.

We are in a joint group with all of our other cities in our region to enhance the economic value for our cities.

One final thing. I know it's probably a minute and a half. I was pleased that the large businesses like Carl's Jr. found a way to support these things. It makes we very happy. We have that business in our community. But we also have hundreds and hundreds of small businesses that make up the bulk of our jobs in our city.

These inspections, educational or whatever, are going to be just as labor intensive. We can't go to the headquarters of Carl's Jr. and say, "Tell

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all your units." We have to go to each one for our educational things, so it is labor intensive. We are worried about the funds. We would like a little bit more time.

Thank you.

MR. COE: I want to again ask that we shorten this up a little bit.

MS. WHITE: I will be as quick as I possibly can. I am Marilyn White. I am the Mayor Pro Tem for Redondo Beach.

MR. COE: I would like Eileen Ansari to follow you and Paul Rosenstein to follow.

MS. WHITE: All right. Is that a go?

MR. COE: That's a go.

MS. WHITE: Okay.

I also have a resolution that was considered and passed at our meeting of July 2nd of 1996. And I would move that you receive that. The dates that are coming for these resolutions at this hearing are I think something that should be considered.

We are a beach community. We have a wonderful city. We are concerned with water quality and perhaps have been more so than a lot of other cities from perhaps even a greater period of time. But we have to also have input with the people who are going to be paying the

bills on this one.

I won't repeat the obvious comments made from other speakers because they are also much our concerns. But if we, as a city, are to be held responsible for the plan and its implementation and the payments and the penalties, then we should have input from not only our Council but the people who are going to be paying this.

Our city, like others in the area, are experiencing a lower tax base and higher expectations from the citizens. How do we pay for this? How much? Because we cannot any longer arbitrarily say, "Oh, we are going to raise your taxes." That bird won't fly.

I would respectfully request that you please give us a period of time. At our meeting on July 2 at the Redondo Beach City Council we adopted the resolution requesting you to defer issuing the proposed tentative order and to direct your staff to work with our city. Come to our city, send your staff to our city. Let's have a public hearing. Let's get the input. We would like to hear from you.

Thank you very much.

MS. ANSARI: Good afternoon. Thank you very much for letting me speak. I am Eileen Ansari. I am Mayor of the City of Diamond Bar. I am a delegate from District 37 to the SCAG Regional Government, and I am also on the

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Energy Environment Committee. I am an environmentalist. I started to save Tonner Canyon, and that is how I got involved in politics.

I am concerned, as many people in our community of Los Angeles, that we need clean water and we need healthy water for our children to be playing in and drinking.

As Margaret Clark mentioned before, as a member of the SCAG Energy Committee, we did contact Cathy Tyrrell. We met with her. We expressed our concerns many times. We met with her in March, and we had a conference call in June.

Our concern as cities is that we want to be not adversarial. We want to be part of the process and work with you.

Our City Attorney, Richard Watkins, had worked with us to try to modify and change the revisions. And some of the revisions we have gone along with gladly. The latest revision as of July 15, our attorneys answered you on July 12, and you have a copy of that, I think each of you, that we sent to you.

We ask for you to give us at least two to three months to respond to cities. The cities have not been part. And us, as elected officials, have to answer to our members of our city and our population. We have not

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been part of the process. We would like to give you and speak with you about our concerns. Many of these are things that have been addressed today.

One is the receiving waters area. Another is the fact that policy makers have only -- have not been part of the process. We have tried to work with you and we would like to continue working with you and ask that you postpone this for two or three months so that all of our cities can be more involved.

Policy makers were not informed. We have not been part of the process. There have been maybe two or three policy makers involved with that, and that's our area of concern. We wish to be part of the process, but give us two or three months.

Thank you.

MR. WASHBURN: Mr. Chairman, members of the Board. I'm Dennis Washburn, Councilman from the city of Calabasas and Director and President of the Resource Conservation District of the Santa Monica mountains and a member of the Bay Restoration Project Bay Watershed Council and Oversight Committee.

I worked with staff and with a fellow Council Member, Bob Pinzler from Redondo Beach, Mark Ryback and Dorothy Greene and others from Heal the Bay, to produce the video which you saw. And I think that it's been

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successful in stirring dialogue and engagement in the process. I am happy to see that. Maybe we have been a little too successful in terms of generating interest of the elected officials looking at the number of us who are trying to talk in the minute and a half that we have to speak.

I used to be critical of the media and government-derived phrase "the peace process." Peace, to me, is a state of being as opposed to a dynamic process. But I think the new President of Israel has indicated that peace is not possible without security and security is not possible without peace. That kind of, I guess, dependency is what we are being faced with here.

And pollution control is a process that we are embarked upon. A healthy ecosystem is not possible without awareness and action. And awareness and action are not possible without self-control and a sense of responsibility.

We are stepping up the program to heal our ecosystems by prevention, which is probably most economical; source reduction, which is probably most efficient; remediation, which is the most practical given what we are facing today; mitigation, which is probably most needed; and ultimately enforcement, which is most feared as you have heard today from some of my colleagues.

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We have to develop the concept of a pollution control process. And I don't think it ends with a meeting here today. It's ongoing and it needs to be high profile. I am excited to see that we have at least stimulated the debate where this is not a routine passage of a permit, like in 1990, but instead has brought out a lot of great thinking and a lot of dedicated people to be able to deal with the problems that are ours to share.

To avoid or alleviate the inequities that will likely arise out of the passage and implementation of this permit I think is what we are dealing with at this time. And I hope that the process is established by which this can be ongoing, dynamic, flexible, and resilient.

Calabasas has passed a resolution of support for this permit. I believe, personally, that it has not gone far enough, and I concur with many of the things that Senator Hayden has said.

But we are, at this point, prepared and have budgeted for what we think will be the program described in this permit. We are seeking creative solutions to our common problems. Our city will have a storm water ordinance for review by the council by the end of this month. And we would be happy to share our discoveries in that process with anyone who is interested.

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On the other hand, we don't want to exacerbate the problem of the unfunded mandates that are clearly a potential in this problem. Yes, again, we must heighten our awareness of the problems and solve rebuilding the permit process to be just that, a dynamic and flexible process to prevent economic inequities, an important factor that we will have to consider.

I do urge, and my Council urges, your passage of this permit. This is just the beginning. We need to work together to make sure we can accomplish the goals that we have here and some of those, in fact, that have not been addressed and need to be.

Thank you very much.

MR. COE: I called Paul Rosenstein earlier to be followed by Dee Hardinson and Cristina Madrid.

MR. ROSENSTEIN: Thank you. I will try and be brief.

My name is Paul Rosenstein. I am the Mayor of the city of Santa Monica. And my City Council has passed a resolution last week urging you to strongly support the proposed permit.

When I hear the discussion here, I begin to have mixed feelings because I see that, on the one hand, the staff has made such valiant efforts to respond to the concerns that the cities have raised, but they have

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developed a lot of flexibility in the system. And the more they do that, the more I have to be concerned about the ultimate effectiveness of this program.

But we are here to support the program. And we say it is the single most important mechanism to ensure the protection and restoration of the Santa Monica Bay.

Now, the effect on business is something I think we have to really be concerned about. And our business community has studied this issue very carefully, and our Chamber of Commerce in the City of Santa Monica has unanimously approved a motion urging the adoption of this permit. They feel they can live within the restrictions that are being contemplated.

Many cities are saying that they can't afford this and there's cost issues. One thing we would like to point out is things that we have down in Santa Monica where we tried to look at innovative ways to be cost effective. For example, we have taken some of our inspection pretreatment permitting and we have combined that with inspection programs that prohibit the discharge of commercial and industrial waste water into the storm drain system.

Our inspectors who regularly go out into various sites are trained and are able to deal with this,

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like fire inspectors and others, so that we found ways to be cost-effective as well as being effective in dealing with waste water treatment.

It's important also to notice that the latest draft of the permit is sensitive to the cities' budgetary process and gives the cities the ability to understand what they are getting into when they adopt a budget.

Hearing some of the requests to delay further reminds me of what we go through in the cities when we have assessment hearings on sidewalk repair, gutter repair, things like that, where we send notices, we make valiant efforts to communicate with those involved. And somehow some people do not pay attention and do not hear the efforts. And then when we hold the hearing and get ready to make a decision, we have very similar requests to delay.

I would say that our city has been involved in this for a year and a half. And if other cities are not aware of what's going on, maybe it's their staff that's the program. But somebody in their cities has been informed about what's going on, and they were derelict in forwarding that information to their City Councils.

I'd like to conclude on this note, about the health studies of the bay. Some people think that

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coastal cities like Santa Monica, yes, we are sensitive to the need to heal the bay, we are very sensitive to that, but some people think it's just an issue for coastal cities. And, yet, as we see it, it's an issue for all those in the region.

For example, people in inland cities come to our beaches to enjoy themselves and to recreate. And they are in danger, their health is in danger, by what they experience when they are there.

So it seems to me that if cities inland are concerned about the health of their own residents and the ability of their residents to enjoy the bay, they will see that they have common cause with the coastal cities.

So we see this as a regional issue. It affects tourism, and it affects the ability of our residents also to enjoy the bay. So we urge you as strongly as we can to adopt this permit today and then help us move forward so that we can implement it and really clean up the bay and make this a more attractive bay for people to enjoy.

Thank you.

MR. COE: We have a question for you.

MS. ROGERS: The last gentleman took five minutes, and I estimate we will be here until 9:00 if we don't run on a tighter time frame. I think we have got to

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put, like, a sign up saying one minute or a minute and a half and say stop and whatnot or it's going to be midnight before anybody gets out.

MR. COE: Let me suggest that those who are in favor, like the last speaker from Santa Monica, if you just say, "Hey, we think it's great. We favor it," and then maybe step aside. And that will provide some time for those who oppose it and their ideas, which can be considered.

But I'm going to raise my -- you are going to raise your hand from now on after a minute and a half. You can see my attorney if you don't like it.

MS. HARDISON: New ground rules. My Council in my community loves that when you do that to them.

MR. COE: I said a minute and a half at the beginning of this section.

MS. HARDISON: But no one spoke for a minute and a half.

I am Dee Hardison, the Mayor of the City of Torrance. I'm also the newly elected Chairperson of the South Bay Council of Cities, which is speaking for 15 cities here.

You have our printed material. We passed a resolution from the COG. You have that. And you have a letter of our Council meeting of July 9, so I'm not

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going to give you any more paper.

Our concerns in the city of Torrance are obviously two. One is the process that we went through. And the concerns have been that the elected officials didn't become part of this process until late into the process. I became aware of it in March when Catherine Tyrrell came out to the South Bay COG and spoke.

And at that point, yes, my staff had been involved before then. But until our staff got the answers back to the questions that the cities asked, and we didn't get those answers until late May, early June, there was really nothing our staff could bring to our City Council to take a position on. So we have not had time --

(Applause.)

MS. HARDISON: Don't clap, folks. You are taking part of my time.

Anyway, so it is the time issue. But we are beyond that now. And I know we weren't part of the original process.

Again, I think we all want the clean water. That's not the question. Again, it is the financial impacts to our city.

A little different perspective. When Catherine Tyrrell came out to the South Bay cities meeting in March, I asked her if a study had been done on the

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financial impacts to the city. I even volunteered the city of Torrance to be a part of that study.

And I have to tell you, I'm still waiting today for that study or for some results to be given to me. I understand there's something from San Gabriel. But I have to tell you not a piece of paper has come to my desk to indicate what those thoughts are.

So we know it will cost more in the city of Torrance. We have already done some financial analysis. But we would like to have that opportunity to know those cost figures, to have the time to know what the impact would be to our city.

And, with that, I have other comments, but we will stop. Thank you very much.

MR. COE: We want Mr. John Robinson and Carolyn Van Horn to follow Christina.

Christina is not here?

John Robinson is next.

AUDIENCE MEMBER: John left.

MR. COE: Carolyn Van Horn followed by Francisco Alonso and Robert Bruesch.

MS. VAN HORN: Thank you very much. I am Carolyn Van Horn, Malibu City Council, and I'm speaking on behalf of the City Council.

We have supported the NPDES all along.

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I am -- I regret that it is, in my view, weakened, but I urge you to support. I think it's a beginning.

We are a little over five years old as an incorporated area, and we have been involved with the Santa Monica Bay Restoration project, with the Malibu Canyon Watershed Council, and everything that we could be in terms of reducing the contamination of our ocean waters.

As adults, I can speak as a parent and as a Council member. As adults, we are very good at making things complicated, and I think we can work through it. I think we are going to have to. What we have heard here today is sort of an adult's position of adults making things very complicated and then figuring out how to get through it and children who really get very simply right down to the point.

I am a little appalled as a parent and as an elected official that we are debating the health of children versus a pocketbook because prevention is always the cheaper way to go. And I urge you --

MR. COE: So you support?

MS. VAN HORN: Yes. The city unanimously supports the resolution. Thank you.

MR. COE: Are you Mr. Alonso?

MR. BRUESCH: No. I'm Bob Bruesch.

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MR. COE: Go ahead, Mr. Bruesch.

MR. BRUESCH: I am Robert W. Bruesch. I am Councilperson for the city of Rosemead and Treasurer of the San Gabriel Valley Association of Council and Governments. And I am Bob Bruesch. I am the environmental teacher in the city of Rosemead who has taken at least 40 classrooms on floating laboratories in the very bay you are talking about to discover the issues that are before us. So I'm caught in the middle.

We all know that the bay needs cleaning up. But I represent a contract city, and the costs are real to us. Let me give you a quick rundown of what happened to our city NOI. We too were told that we were protected from third-party lawsuits. We too were told that our amount of trash would not be considered in the litigation.

And when the judge threw that issue out, we paid $800,000, $800,000, five percent of my city budget. So this is a real issue to us. And if that language isn't cleared up, we cannot, we cannot, be in favor of language like that.

Being a contract city, we contract all our inspections out. We do not have hired city staff. What do we do when there is a choice between a site visit to look at the pollution going into the storm drain or a

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home visit to see if the latches on a window -- the bars on the window are safe enough?

MR. COE: Can I ask you if the city of Rosemead support this?

MR. BRUESCH: No, we do not.

We oppose the language in there as such absolutely against the legal aspects, legal authority. We need to know more clarification. We have to have more language on what we are expected to do, what we are required to do. And we need to know -- that's why we need the time to look at this. We need the City Attorney to look at this and find out exactly what we are required to do.

May I just say one thing as a teacher?

MR. COE: One sentence.

MR. BRUESCH: Please do not make --

MS. ROGERS: You know, we are not going to get through the evening. I think this gentleman said his position. I would like to move on.

MR. COE: Mr. Alonso followed by Lawson Pedigo and Harry Baldwin. And let's get up to bat Bob Pinzler and John Fasana, and that will complete the elected officials.

MR. ALONSO: Board members, I am Francisco Alonso. I am a Council member of the city of Monterey Park. Business address, 320 West Newmark, Monterey Park.

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While our staff has not had any difficulties with this permit, it has been brought to my attention that nearby cities such as Rosemead, that they do have a difficulty in some of the language in the permit that has been presented. And we are trying to see if, per chance, an extension of time so some of these concerns can be addressed. I think it would be wise and prudent to do so.

Thank you.

MR. COE: Thank you.

MS. ROGERS: Thank you for the time you took.

MR. PEDIGO: My name is Lawson Pedigo. I am the Mayor of the small town of Lomita. It's a little contract city in the South Bay, 1.7 square miles.

I oppose this permitting language for economic reasons. It would cost us approximately $50,000 for enforcement and implementation of storm drain water that doesn't even flow to the ocean from our town. We go into a small lake in our area which is used for cooling for an industrial area.

So we have already spent a lot of money and we are involved in a program that is rather ambiguous. I believe that it would be very costly, and I think that a lot more study needs to be done before we spend any more money in our city in economic hard times.

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So, again, I oppose this. And thank you for my time.

MR. COE: Thank you.

MR. PINZLER: My name is Bob Pinzler. I am a member of the Board of the Santa Monica Bay Restoration Project. I am the elected representative of coastal cities, and I was given credit for the writing and directing of the video that you saw earlier. And it's that perspective that I would like to speak to for just a moment.

I think one of the problems that we have here is the lack of communication that has occurred over time. Much of the discussion that went on in our Council -- I am a Council member from the city of Redondo Beach whom you have had representation.

But one of the issues that was raised at that time was that so much information is going to be coming down the line. Those are the open questions. Those are the things that are of greatest concern to people. The great unknown.

I think that an effort must be made and can be made through the way that you work through the language of the permit, as well as what comes down later, to make sure there is conclusiveness in the process that will be coming down, even, perhaps, using the dispute

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resolution services that are available to make sure that those things that are still to be decided -- and there are things that are still to be decided and there are things that are primarily what is of concern to the cities -- that a joint effort is made to make sure that those things are solved to the satisfaction of both sides.

So I was part of the process. I am one of those policy makers that they spoke about who was involved in this process. I have got a lot of scars on my back from what this whole process is all about. And I understand what both sides are speaking about.

And it is from that perspective that I wanted to address you, not exclusively about the permit itself, but about the process itself.

Thank you.

MR. COE: Thank you.

MS. CRAVEN: Excuse me. I still don't understand. Do you want me to support it? Do you want a delay? Do you oppose it?

MR. PINZLER: My Council has voted to ask for a delay. I am bound by what my Council has voted.

MS. CRAVEN: Thank you very much.

MR. COE: Did Harry Baldwin go? I called Harry Baldwin.

MR. FASANA: I think Harry Baldwin had to

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leave.

MR. COE: All right. You are John Fasana?

MR. FASANA: I am John Fasana. I am Council member of the city of Duarte. My city is opposed, to get that on the record, at this point.

A couple of facts. First of all to talk about the unfunded mandates. It's not an abstract issue when you are faced with daily choices as far as public safety, police and fire, parks and recreation programs that deal with at risk youths. There are many choices that need to be made.

I think the big problem that I am hearing both from the supporters of this permit and the opponents, one thing we both agree on, is that there are no teeth basically because the resources have not been identified here.

We agree with the opponents that resources have not been identified. And until we see some resolution, basically from the state level -- because, frankly, we think this permit goes above and beyond what the federal guidelines stated. Some of the members from the state that have been here, they are part and parcel to the loss of the funding that we experienced as cities. That money has not been restored even as the state moves to prosperity.

And we think that up front, if this issue of funding is not addressed thoroughly, particularly now with Prop 62, the decision there and the Jarvis initiative coming forward, we don't have the flexibility to implement revenue increases without going to the voters.

We think it may be fair to step back, look at a process that squarely identifies the funding that's going to be required so we can get on with restoration because I think that's something we all agree needs to be done.

Thank you.

MR. COE: Thank you very much.

We will now break for a late lunch. I know it's difficult for people to find places to eat in the civic center, but let's try to get back at 1:45 -- 2:45. We are going to start at 2:45 whether you are here or not.

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(At the hour of 1:55 p.m., a luncheon recess was taken, the hearing to be resumed at 2:45 p.m.)

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LOS ANGELES, CALIFORNIA; MONDAY, JULY 15, 1996

2:50 p.m.

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DR. GHIRELLI: Mr. Chairman, members of the Board, and members of the audience, I have been asked by the Board to keep a close watch on the clock here. So when your time is up, I am going to hold up a yellow card. And that will be your statement that your time is up.

MR. COE: This is a public hearing and the testimony is under oath. And if there are some people who came in after I gave the oath that are going to testify, if so, if you will rise.

(Oath administered.)

MR. COE: We will start off with Sarah Wan.

MS. WAN: Thank you.

I'm Sarah Wan. I live at 22250 Carbon Mesa Road in Malibu, and I am a California Coastal Commissioner. And I am here to present a letter that was voted on and approve unanimously on Thursday by the Commission.

It says that the California Coastal Commission urges the Los Angeles Regional Water Quality Control Board to adopt the issue of the Los Angeles County Municipal Storm Water Permit. The Commission believes that

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taking this action will advance coastal act policies and implementation of the Santa Monica Bay Restoration Plan as well as the goals of Section 6217 of the Coastal Zone authorization amendments of 1990.

The California Coastal Act contains policies that will be heard by adopting a comprehensive storm water permit for the Los Angeles Region. These provisions call for the protection and restoration of coastal waters, including streams, wetlands, and related waters.

The proposed permit will help accomplish this by focusing attention on the reduction of pollutants for both existing and new development. Adoption of this permit is critical to the successful implementation of the Santa Monica Bay Restoration Project which relies upon the county and the cities having an effective urban runoff control program.

The Commission is of the opinion that the proposed permit is an important step towards ensuring comprehensive programs throughout the region.

Lastly, this permit is designed in a manner that is supportive of the state of California's efforts to meet the goals and objectives of CZARA. This proposed permit will help advance a consistent approach to implementing management measures to control runoff from

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both new and existing developments. And we applaud that Regional Water Quality Control Board's attention to these matters.

In conclusion, the Commission found that the proposed permit is a significant improvement over the 1990 permit and supports its adoption. And the Commission acknowledges the difficult negotiations and compromises that have been a part of the reissuance process and looks forward to the improvements to coastal water quality that can be anticipated from an effective implementation of the new permit.

And might I add personally that this is a long overdue first step. And I urge that it should be passed.

Thank you.

MR. COE: We are getting into the category now of permittees that have not been represented previously during this hearing by elected officials.

And based on the number of blue cards submitted, the average would be two minutes apiece. Please keep that in mind. And you will see a yellow card when your time is up.

The first is Oka Lampman followed by Daniel Keesey and followed by Desi Alvarez.

MR. LAMPMAN: Mr. Chairman, member of the

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Commission, Dr. Ghirelli, it's Oral Lampman.

MR. COE: I'm sorry.

MR. LAMPMAN: That's all right.

I'm Oral Lampman, Public Works Director for the city of Burbank.

Last Tuesday evening, I presented to the City Council a resolution taking a position that the meeting or the hearing be continued for certain corrections. Frankly, it was that day we had received the latest revised permit. And as I mentioned to the City Council, I think that the Board's staff has fairly adequately responded to the concerns we have.

So we are not taking a position of supporting. Our City Council isn't taking a position of supporting the resolution, but we don't oppose it. As I told the City Council, I have been working with the EAC on this issue for two years, and I'm tired of it.

We will implement the program, and I think, in cooperation both with the county and Regional Board, we will be able to accomplish the ultimate goal.

I would also say that, frankly, I don't see, from Burbank's perspective, and I have to speak simply for Burbank, we don't see it, as it's presently written, as being a major cost obligation on the part of the city. We have already implemented some of the programs in the

initial permit.

MR. COE: Do you foresee that your city, after reviewing the revision, will come out and support officially the permit?

MR. LAMPMAN: I think yes. I would have, no problem going to the City Council supporting the permit. Because, again, as I've mentioned in the past, the city of Burbank has had an NPDES permit in our water reclamation plant for 30 years, and we have worked well with the staff over that period of time.

MR. COE: Thank you very much.

MR. KEESEY: Mr. Chairman, members of the Board, thank you.

First of all, I'd like to say that I work for the city of La Verne. I am representing the city of La Verne and the Council. My name is Dan Keesey. The business address 3660 East "D" Street, La Verne, California.

First of all, I wanted to thank the Board and the staff for the work they have done on this permit. I have been very active in helping put the permit together. I have served on the Executive Advisory Committee. And we, in La Verne, are comfortable with the permit now.

The Board has -- the staff has done a

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great job in responding to the comments that we had on the December 18th graft. However, there are a few issues that I would like to point out to you and ask that they be resolved prior to your adopting the permit. And I will just briefly mention what those are.

First, it has been mentioned before that the cost associated with this permit is unknown really. We have estimated anywhere from a couple hundred thousand dollars to half a million dollars, depending upon the types of projects that may be implemented by the permit and the subsequent plans that are required in the program.

The permit contains ambiguous enforcement. Language such as "to the extent practicable" is very difficult to define. And in any court of law I think you will find that we are going to be going back and forth with things like that.

One major concern we have is that it's state-delegated responsibilities. The Board's staff is trying to ask the cities or demand that the cities carry on obligations of the Board for permits that this Board issues, various industries and construction activities. We feel that the time lines to implement many of the programs in the permit are unrealistic considering the scheduling of Board hearings, public notices, and things of that nature that have to occur.

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And lastly, that it contains too many levels of bureaucracy.

Thank you for your time.

MR. COE: Thank you.

Mr. Alvarez followed by -- what's that last name -- Leiga, who would like to interject himself at this point, and Ed Schroder please.

MR. ALVAREZ: Good afternoon, Mr. Chairman, members of the Board. I am Desi Alvarez representing the city of Glendale. My business address 633 South Broadway, Glendale, California.

We do agree that the tentative order before you today is a tremendous improvement from the earlier drafts that we have seen, and we would like to commend the staff on their work.

The city of Glendale prides itself on a lot of environmental programs, and currently it's spending in excess of three and three quarter million dollars a year in compliance with the requirements of the current permit.

We believe that the proposed tentative order needs some additional work to address some of the concerns remaining with our city. We think that the permit still imposes regulations which go beyond federal requirements and is going to propose unwarranted additional requirements for residential and unfairly target small

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businesses in our community.

The permit will require the city to conduct educational site visits. These are educational site visits that we have to conduct at specified time intervals. We believe that this requirement demonstrates a lack of flexibility concerning cost effectiveness. If the intent is truly to have an educational program, we believe that the cities should be allowed to develop the best approach that meets their community requirements.

We believe that the permit shifts some of the state's responsibilities with respect to their facilities on the city without any compensation, and it's unfair to require the cities to do so.

The permit will require the cities to fund and carry out unknown programs. And these are programs that are going to be developed that are in the terms of the permit. This is probably the area of greatest concern to us. Many of these programs will require the implementations of requirements, all at some cost, and that cost is unknown at this time.

We believe that some of the language in the permit is still vague and exposes the city to litigation. The findings that are underlying the permit fail to establish a complete scientific basis for regulating all waters in the county, and some of the

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discharge requirements exceed federal standards.

In summary, the City Council, on July 9, considered the permit and unanimously adopted a resolution urging you to delay action on this until some of those issues can further be resolved.

I would like to enter a copy of that resolution into the record.

MR. COE: Thank you.

MR. LEIGA: Thank you, Mr. Chairman, members of the Board. I am Al Leiga, Mayor of the city of Claremont, 207 North Harvard, Claremont, California 91711.

Last week our City Council looked at the available permit we have on it and unanimously passed a resolution opposing the new revisions of the permit and actually spelled out why. And I will give you a copy of that.

Basically we said we find it completely unacceptable. It's an unfunded mandate that will put a burden on all cities and not likely to produce the necessary results to clean up the storm drain outflows to the ocean. There are some additional details in here, and I will pass that along.

Also last week we received the latest revisions to the permit, substantial as they are, and today there is more revisions. Although the permit has gone

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through 18 months of reviews, more changes probably occurred during the past month than the previous 17.

I think this is a permit in process. There has been no chance to review the series of the latest changes to see what the impact to the cities truly will be. I think elected officials would like to have a chance to provide some meaningful input on the permit as it keeps changing.

There's really been no analysis of the current permit -- who has been implementing the best management practices. We don't know what we are accomplishing at this point to see where we go from here.

The issue of cost has been brought up by a number of other speakers. There has been no serious analysis of the cost. The Council of Governments has done some. We looked at that. And the funding is certainly not there. It's clearly an unfunded mandate which is going to have soma serious implications if the new Jarvis initiative passes as well. I think these kinds of programs should be funded by federal or state to have some success.

We also have a very serious concern about third-party lawsuits. It looks like we are almost federalizing some local ordinances, in fact. Considerable time and funds have been spent during the first permit with these various lawsuits if you look at cities like Burbank,

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Azusa, L.A. County, et cetera.

Our request is that the adoption of the permit be postponed so we can provide appropriate analysis. I know there are a lot of people here with T-shirts on and slogans. But I think this is a very serious matter, and it should be addressed in a serious manner and not be intimidated by that.

I think we need some response so we can get a proper analysis of what these latest significant changes really mean.

Thank you for your time.

MR. COE: Thank you.

Ed Schroder to be followed by Sid Mousari and Raymond Holland.

MR. SCHRODER: Thank you, Mr. Chair. I am Ed Schroder. I am a public worker for the city of El Segundo.

The city of El Segundo also passed a resolution urging the Board to refer this item back to Staff to resolve some of the issues that we are concerned with.

Just as an example, I had an opportunity to review the changes of July 7. And as it turns out, those changes have raised another issue that I think is significant and hasn't been addressed yet; and that is, on page 21, on Item No. 4, it talks about "prohibit the

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discharge of untreated runoff." And that statement makes an implication that treated runoff is allowed, in which case the question then arises, what level of treatment is approved and who authorizes it? Who issues a permit to allow that discharge?

I have been involved in this for 18 months, and I have not once ever discussed cities issuing permits, okay. I did call Catherine last week and raise the question to her as to whether the Board would be issuing permits to any business that wants to discharge something in the storm drain system.

At that time, she said she didn't know and she would get back to me. We talked about it this morning. And as of right now, it's still an unresolved issue. I don't know of a city in this room that has considered a permitting process as part of this program.

So again, I have given you a copy of our resolution for your record, but I also urge you to help us and resolve these issues so we know what we are getting into before we are tasked with these responsibilities.

Thank you very much.

MR. MOUSARI: Good morning. My name is Sid Mousari, and I am Director of Public Works for the city of Baldwin Park. I am here representing the city of Baldwin Park.

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The city of Baldwin Park also passed a resolution last week opposing the permit the way it was presented to them, and that was the previous permit.

Since then, there has been some changes to that permit that the Council is not aware of. The Council's concerns were the litigation resulting from the permit and also the financial impact on the city.

The City Council requests that the Board would postpone the matter until such time all these issues are resolved and further time is alloted them to evaluate the details.

With that, thank you very much. And if it's possible, I would like to defer some of my time to one of my colleagues so he can talk about another issue.

Is that possible?

MR. COE: Representing the city of Baldwin Park?

MR. MOUSARI: I'm sorry?

MR. COE: Is your colleague from the city of Baldwin Park?

MR. MOUSARI: No. He is from the city of Whittier. His name is Ray Tahir.

MR. COE: Why didn't he turn in a blue card?

MR. MOUSARI: He has already.

MR. COE: Oh. Well, we will get to him.

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MR. MOUSARI: Okay. I was just deferring some of my time to him.

MR. COE: Oh, all right. Thank you very much.

MR. HOLLAND: Mr. Chair, members of the Board, Staff, my name is Ray Holland. I am the Director of Public Works for the city of Long Beach. And I want to read to you a portion of a letter from James Hagman, the City Manager of Long Beach. And I have just given a copy of that letter, as well as some attachments, which I would like to have all of them entered into the record and distributed to the Board members and key staff.

Submitted herewith for your consideration is a resolution adopted on July 2 by unanimous vote of the city of Long Beach representing over 425,000 citizens urging you to defer the issuance of the tentative order to the Municipal Storm Water and Urban Runoff Discharges within the county of Los Angeles.

The City Council makes this request because they believe this permit is deficient in a number of areas; and that the permit, as written, does not comply with state and federal law, exposing Los Angeles County cities to an unreasonable risk of lawsuits.

Therefore, please direct your staff to respond to the issues set forth here in this letter in our resolution and in the City Attorney's letter to

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Dr. Ghirelli dated June 26, 1996, and to make corresponding revisions to the draft permit.

Long Beach firmly believes the tentative order greatly exceeds the legal authority of the Regional Board and that it exceeds the requirements of the Clean Water Act and does not comply with the Porter-Cologne Water Quality Act.

The following are some of the city's major concerns outlined in the resolution. These concerns are based on review of the tentative order received on May 29, 1996. I'm just going to read two of many.

The findings and permit requirements do not comply with the Clean Water Act. Additionally, they are not based on any sound scientific examination of the impact of storm water and urban runoff on the receiving waters of Long Beach, and I want to stress the receiving waters of Long Beach. Most of the testimony you have heard here today relates to the Santa Monica Bay. We are not with the Santa Monica Bay.

MR. COE: Mr. Holland, may I interrupt? I just have a question here.

The city of Long Beach has two minutes, and I see two blue cards here for different people from the city of Long Beach.

MR. HOLLAND: I don't know who the other person

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is.

AUDIENCE MEMBER: I'd be happy to waive my time.

MR. COE: Is that the City Attorney?

AUDIENCE MEMBER: I'd be happy to waive my time. But I understood that, in the past, if there have been multiple representatives from a city, they have each gotten the opportunity to speak. If that's not the rule you are going to apply, then I will defer to Mr. Holland.

MR. COE: All right.

MR. HOLLAND: Thank you, Mr. Chairman.

The second point of many, and the only one that I'm going to read at this point, is requirements will impose significant additional costs on the city of Long Beach estimated at 3.5 million the first year. That's on top of a $30 million deficit in our General Fund.

The city of Long Beach calls on this Regional Water Quality Control Board to defer issuance of this tentative order and to direct its staff to revise the tentative order as follows in your letter that has eight points. I would like you to read those. I object that I don't have enough time to read it. Other speakers have had time. We haven't.

I'm going to summarize one point. This is the perspective of the City Staff and the City Council

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of Long Beach.

We believe that when the citizens and business owners of Los Angeles County fully realize the significant impacts this tentative order has on their daily lives and business operations, we will see a reaction similar to what happens when one swats a hornet's nest. If you are prepared to swat such a nest, it seems to me you would want a solid foundation for doing so. Respectfully, Long Beach does not believe you have such a foundation.

Please, as I've already said, incorporate this letter and the attached documents as part of the official record, and we thank you for allowing us to speak.

MR. COE: The city of Azusa is next, Nasser Abbaszadeh, followed by Rufus Young followed by Richard Burtt from the city of Torrance.

MR. ABBASZADEH: Thank you, Mr. Chairman. My name is Nasser Abbaszadeh for the city of Azusa.

I wanted to enter into the record that Resolution No. 96-690, which the city of Azusa City Council unanimously adopted, and urges the Board to delay action on this permit until all the issues have been resolved. This document is eight pages long. I won't go through all the points made in there.

However, just to bring up a couple of

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the items that we've addressed, we have objected to the tentative order being a work in progress. There have been changes since December almost on a daily basis. We would like to see a finalized document before we can thoroughly evaluate it and figure out the fiscal impact and all the requirements that are imposed on us.

The second point I wanted to raise was our great concern with site visits. If the goal is to disseminate educational information to businesses, the cities should be allowed the flexibility to handle that internally instead of forcing the city's hand and imposing the site visits on the cities.

Thank you very much.

MR. YOUNG: Good afternoon, Mr. Chair, members of the Board. My name is Rufus C. Young, Jr. I am an attorney with Burke, Williams & Sorensen. My address is 611 West Sixth Street, Los Angeles, 90017. I appear today on behalf of the cities of Downey, Bellflower, Alhambra, and El Segundo. I'll make as many points as I can before time expires.

The first is that the time period has not been 18 months; it's closer to ten days. The permit is dated the 5th of July. It was not received by the cities until the 8th or 9th, making it a seven- or eight-day old permit.

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Second, the cities have been hampered in their preparation for comment on this permit and the analysis of the permit by delays by the Board in responding to several Public Records Act requests, the first one of which was dated the 15th of February. We did not receive a written response to that Public Records Act request until the 11th of July, four days ago.

The third point -- well, I will add to that; that we did receive an opportunity to review some documents, in some cases boxes of documents, that were unidentified as to just what they referred to.

The third point, receiving water limitations. We understand the importance of the receiving water limitations. We understand that the language in the permit about discharge of storm water does not cause nuisance or recurring impairment, and we support these concepts.

The flaw in this permit is that much of what the cities do with respect to storm water is beyond their control. Cities cannot control gravity and the cities cannot control storms. And storms sweep things into storm water systems, particularly what's called automobile manure; that is, the things, the effluent, from automobiles and trucks: brake pads, oil, transmission fluid, coolants. All that is beyond the cities' control.

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The fourth point, rule making. We believe that what has occurred with the preparation of this permit, improved as it may be, has encompassed rule making. Mr. Leon suggests otherwise. We take the view that, if you look at this permit, it's apparent that it is replete with shalls, musts, timetables. It is a rule.

When we commented on this earlier to Mr. Leon, he said, "Well, we can go beyond the Clean Water Act requirements because we have the Porter-Cologne Act." Well, if you are relying on the Porter-Cologne Act, you are making rules, and making rules is subject to administrative procedures.

Finally, with respect to the County's support for the permit, that should come as no surprise if you read the settlement agreement between NRDC and the County. That settlement agreement calls for County to use its best efforts to gain the approval of this permit.

So I would not infer, from the County's support, that they view this as just a peachy-keen permit that ought to be supported on its merits.

Thank you very much for your time.

MR. COE: Richard Burtt. I guess your Mayor testified a little earlier. Theoretically this is supposed to be group permittees where public officials have not testify, so please keep it brief, followed by Charles

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Silher and Ted Semaan.

MR. BURTT: Thank you, Mr. Chairman. I appreciate the opportunity to speak to you and the members of the Board.

The City Council of Torrance last week took an action on mainly four issues in opposition to the tentative order that you have before you today. The concerns can probably be best summarized as a matter of uncertainty and a matter of cost from the standpoint of the city of Torrance.

The first issue is that, from our estimate, the initial cost for the city of Torrance over the next 12 months will be some $300,000 purely for administrative and monitoring costs for which we do not see any sort of product being returned. Again, there is no funding for this.

The second issue is the development of programs and studies that will require actions to be taken in the future which we cannot quantify now.

The third issue imposes future financial obligations that are presently unknown.

And fourthly, the permit should recognize the relative costs and the environmental benefits in relation to competing public needs, or I should say, public works needs.

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Many things that are mentioned in the tentative order mention things such as the storm water system, the sewer system, the street system. Each one of these elements are, in most communities in Southern California, in dire need of investment. If they are not properly invested into, they again become part of the problem.

We have a very limited source of funds to work with. Anything that we take away from our current efforts to improve our street system, our sewer system, our drainage system is also going to have an impact on what we are all trying to achieve here.

I thank you.

MR. SIHLER: Charles Sihler, city of Pomona Public Works Department, 505 South Garey, Pomona 91769.

I am not going to go into the detail that everybody has in the past because I think they have beaten the subject quite nicely. However, a couple of points I'd like to go to.

For those who object to the 36-month time frame to allow us to implement this does allow the cities to try and at least develop some revenue sources which was not included in the earlier points.

However, the final draft, as received, did not allow our community adequate time to make any

response whatsoever. I personally received this on my desk on Tuesday, last Tuesday afternoon, and was asked to get a response back to the Board, which I did.

Sitting in here listening to earlier comments and reading parts of the report, I found parts that I fully missed and omitted in my review that would have been included in my letter to the Board.

However, there were two points that we looked at in the discussion that we felt really needed to be addressed properly, the public information, public outreach, which is a real forward step on the part of the Board to look at the best way of solving the problem is to educate the people.

But in the training materials, developing educational materials for training of employees, unlike the balance of the permit, this is not put on the principal permittee. And having run a training program in the Navy Reserve, I know that if you have a good training module to work from, it's rather easy to implement and modify and do your own.

There is only one thing worse than no curriculum at all and it's a bad curriculum. If we want our employees to be properly trained, we are going to need to come up with a good directive to do so.

In the immediate outreach, there is a

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comment regarding "shall maintain a list of qualified personnel." I think that who defines that should be clearly identified within the permit.

And the final item was in the attachments in the glossary of terms. There was a little thing in there that our code says, you know, as an allowable, permissible discharge, and that's clean, dechlorinated swimming pool water. And you had eliminated, in the body of your permit, a clean and swimmable verbiage which basically points the thing to a point of failure.

All in all, I would like to congratulate the Board on working hard. I wish we had gotten this permit to us two months ago so we could have actually done an adequate review and could have come up with an official city position. We weren't able to do so. But all in all, I congratulate them on the effort they have done.

Thank you.

MR. COE: Is Ted Semaan here? Gone.

Ray Tahir has made out three cards, so this requires some explanation.

MR. TAHIR: Well, I represent three cities, Alhambra, Whittier, and Lakewood, all three of which adopted resolutions the other night essentially opposing the proposed permit.

MR. COE: We just heard somebody represent four

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cities, and they still had just the two minutes.

MR. TAHIR: Could I have four and a half minutes? I'll be out of here in four and a half.

MR. COE: No. We just had an attorney who represented four cities, and he had two minutes.

MR. TAHIR: Well, I don't know if he represents them on an ongoing basis or he is specifically representing them today. I know one of those cities, Alhambra, has designated me to speak on their behalf today.

MR. COE: You had better start.

MR. TAHIR: My name is a Ray Tahir. My business address is 11500 West Olympic Boulevard in Los Angeles. I am a consultant to several cities in Los Angeles County on NPDES matters. As I mentioned to you, three of these cities have asked me to urge you to return to your staff the proposed tentative order to correct several problems which I believe --

MR. DRANE: Sir, I think you need to slow down a little bit for the court reporter.

MR. TAHIR: I'm sorry. I'm on a time limit, though.

MR. COE: Why don't you just summarize your written statement rather than read it.

MR. TAHIR: Hey, okay.

With regard to industrial/commercial

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site visits, contrary to what staff has asserted, the proposed order does not remove the enforcement aspect from the permit. This is something you need to note. While the permit may emphasize public education, it also compels cities to impose on businesses, by ordinance, some 17 storm water pollution prevention practices, practices such as requiring parking lots with 25 or more spaces to be free of visible oil leaks and debris.

The problem is that, if city or county fire departments, or code enforcement personnel --

MR. LEON: Excuse me, Mr. Tahir. If you could slow down. I don't think the reporter is catching most of this. So it's up to you whether you want to be recorded or not.

MR. TAHIR: I will take it slow.

The problem is that, if the city or county fire department, or code enforcement personnel, visits a facility for public education purposes and discovers an on-site violation of one or more of the 17 ordained requirements, that individual would also be compelled by duty to cite that facility.

If the Regional Board Staff really believes that no enforcement is required, then it should remove the 17 legal authority requirements affecting businesses.

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Now, with regard to non-storm water discharges. Under one section of the order, only non-storm water discharges that are exempted under the order or that are covered by an NPDES permit are allowed to enter the municipal storm water system.

However, under the legal authority section of the permit, quite contradictorily, the permit says that it is okay to discharge treated storm water or wash water to the municipal storm water system. But under the non-storm water discharge exemption section of the proposed order, treated wash waters are not listed as permissible non-storm water discharges. That is a conflict that must be resolved or it will lead to inconsistency and possibly litigation against cities and businesses.

The proposed order also raises another problem connected to non-storm water discharges. Although NPDES provisions of the Clean Water Act exempt potable water, that is ordinary tap water discharges to the municipal storm water system --

MR. COE: You have a yellow card.

MR. TAHIR: Let me just make one point and I'm out of here.

The proposed order exempts such discharges conditionally. Specifically, potable water may be discharged to the municipal storm water system only if

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it is managed in accordance with industry-wide Storm Water Pollution Prevention Practices developed by the American Water Works Association. As you know, Chairman Coe, these practices were developed for water production industries and do not relate and shouldn't apply to residences or businesses.

MR. COE: Will Gary Hildebrand please approach.

MR. TAHIR: Second, that non-storm water discharge prohibitions apply to residential, commercial, and indusrial facilities as well, not just to water production activities, activities such as hyperchlorinating water lines. Therefore, how can a resident apply these practices to the discharge of potable water discharged from a garden hose to a sidewalk or to a driveway?

I have a few other points. I'm sorry I don't have the opportunity to share them with you.

MR. COE: You can leave that written statement for the record.

Thank you.

MR. HILDEBRAND: My name is Gary Hildebrand. I am with the Los Angeles County Department of Public Works.

AUDIENCE MEMBER: Didn't Los Angeles County already get their two minutes? You have to treat them all the same.

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MR. COE: Go ahead.

MR. HILDEBRAND: My address is 900 South Fremont, Alhambra, California. Yes, Don Wolfe did present the County's position earlier.

MR. COE: Yes. Don Wolfe was an invited member of the Panel. He was part of the staff presentation.

MR. HILDEBRAND: And as part of the Panel presentation, he did state the County's position. So I'm not here to repeat the comments that he stated before.

However, I would like to address the issue that was raised by Rufus Young concerning the county and its NRDC settlement.

I was involved directly in the developing of the terms of the settlement, and I can confidently say that there is nothing in that particular settlement that requires the county to support the tentative permit that's before the Board today.

The county based its support of the permit on the evaluation of the requirements of that permit and its relative merits versus of county's responsibilities and obligations.

So, to repeat, there is nothing in our settlement agreement that specifically requires the County to support this particular permit that's before you today.

Thank you.

MR. COE: The next group is public agencies. And nobody turned a blue card in from public agencies as such, so we will go to business associations.

According to the blue cards here, a maximum of three minutes each. If we can reduce that, we may get back on schedule.

John Parsons followed by Jennifer Taggart followed by Gerald Brgitbart.

Is John Parsons here?

AUDIENCE MEMBER: John Parsons had to leave.

MR. COE: Jennifer Taggart?

AUDIENCE MEMBER: She is going to come back. She is not back yet.

MR. COE: Gerald Brgitbart followed by Joe Louis Sedano. Excuse me. I'm sorry. Jose Luis Sedano and Dr. David Kay.

MR. BRGITBART: Mr. Chairman, I am Gerald Brgitbart, and I am with the California Restaurant Association. Our address is 3435 Wilshire Boulevard, Los Angeles, 90010.

While we commend the staff and group that put this permit together, we feel that we have been unfairly singled out as an industry group within here; that finger pointing at us as a singular group is not fair.

We feel that it will have tremendous

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financial impact because the cities don't have the money to enforce the rules that will be imposed here; and that we will again have another fee imposed upon us.

We would like to have been brought into this process a whole lot earlier than finding out about it about four months ago or five months ago. So we feel that this permit needs to be held back until such time as all of the stakeholders are permitted to have something of their concerns addressed.

Thank you very much.

MR. COE: Thank you.

Is Mr. Sedano here?

Dr. David Kay followed by Gregory Mastin followed by Andy Goodman.

DR. KAY: Good afternoon, Chairman Coe, members of the Board, Dr. Ghirelli. I'm David Kay, Senior Environmental Specialist at Southern California Edison, an Edison International Company located at 2244 Walnut Grove Avenue in the city of Rosemead. And I have taken the oath.

Edison is the nation's second largest privately-owned electric utility serving nearly eight million customers in over 200 cities throughout a 50,000 square mile service territory within Central and Southern California.

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Edison recommends that the Board adopt the Waste Discharge Requirements before you. Edison believes these Waste Discharge Requirements represent a reasonable cost-effective approach toward controlling pollution in our urban runoff and consequently improving the local coastal water quality pursuant to the federal Clean Water Act.

Edison actively participated in the Santa Monica Bay Restoration Project and continues to work with Board's staff and other stakeholders on implementing the Bay Restoration Plan. This permit is one of the most important elements of that plan.

As a major permitted discharger to the coastal waters, Edison has a direct interest in seeing that the pollution of the coastal zone from urban runoff is reduced. We are privileged to be able to use the coastal waters to cool our El Segundo, Redondo, Long Beach, and Alamitos generating stations.

We recognize that our ability to retain that privilege may depend, at least in part, on efforts to restore our near-shore water quality, efforts that include the Bay Restoration Plan and the Waste Discharge Requirements before you today.

In addition, many of the commercial and industrial enterprises located in our coastal cities also

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depend on either the ability to discharge regulated waste waters or on the recreational and tourism revenues that a clean coastline address. Many of these enterprises are also Edison customers, and so we also have an economic interest in seeing them prosper.

We are aware that some of the cities we serve who are also affected by these Waste Discharge Requirements still feel important issues remain unresolved. We are sympathetic to their concerns and urge you to direct staff to continue working to resolve these issues.

Thanks for your consideration.

MR. COE: Thank you.

Is Gregory Mastin here?

Andy Goodman?

When I call your name, if you want to work your way up, followed by Douglas Gardner and Jonathan Stein.

MR. GOODMAN: Mr. Chairman, the reason for my delay -- my name is Andy Goodman -- is I think I would probably be more properly grouped with the public interest groups. But since I have to pick up my son from day camp in 15 minutes, if I could take the opportunity to speak now, I'd appreciate it.

MR. COE: As long as you keep within your time

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limit.

MR. GOODMAN: My name is Andy Goodman. I am President of the Environmental Media Association based at 3679 Motor Avenue in Los Angeles.

Because you have probably never heard of us, we are a group that works with other environmental groups around the country helping them get out their message and communicate to the public and helping them work towards solutions. And I think that gives me a somewhat unique perspective on what's happened today, and I just want to share that with you because that perspective is about this process that has brought together government groups and business and environmental groups working together for a solution.

Groups around the country are trying to do the same thing. And right now this is the whole new wave of environmentalism that is probably the most productive wave that we have ever experienced. It's not environmentalists shouting at business or shouting at industry and saying, "This is what you must do, and the cost of the reality be damned."

These are people sitting down at the table together, the stakeholders, and trying to come up with solutions and doing it. And it's working all around the country. So what's happening today is an opportunity

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for you to say that this process works; that collaboration does work.

To reject this proposal, to delay, is to send a message that cooperation doesn't work; that you will be tied up in red tape; or that you will ultimately be turned away, even if you sit down and look across the table at the people who have other interests.

So on behalf of my group and on behalf of the environmental groups all over the country who are trying to work constructively toward solutions, I urge you to adopt the permit. It is not perfect, as everyone has said to you. It is clearly not perfect, but it is progress.

So on behalf of the process, I urge you to vote for progress.

Thank you.

MR. GARDNER: Mr. Chairman, my name is Doug Gardner. My address is 13250 Jefferson Boulevard in Los Angeles. I am with McGuire/Thomas Partners, a large development company headquartered in Los Angeles. And I am the project manager for the Playa Vista project, a major project located on the west side of Los Angeles.

Since my firm's initial involvement with Playa Vista in 1989, we have been continuously reminded of the critical importance of water quality in general, and

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helping Santa Monica Bay in specific, which, in turn, relates to the economic wellbeing of our entire region.

From our perspective, the permit before you is reasonable and workable; and that this investment today will pay great dividends in terms of the long-term health of our economy. Responsible developments in environmental protection can not only co-exist but is mutually supportive and mutually competitive.

We support the permit and urge its approval, an action which will both enhance our economic resurgency and improve a vital resource.

And I should add, in conclusion, that we are only one of a large group of businesses supporting this permit. You have heard some today. You will hear a few more, including Southern California Gas, Jon Douglas, NBC Entertainment, the L.A. County Boards of Real Estate, West Side Council and Chambers of Commerce, and many others.

Thank you for your time.

MR. COE: Jonathan Stein followed by John Perenchio, who would be the last presentation under this category.

MR. STEIN: Yes. Thank you.

I am Jonathan Stein. I am a lawyer. My office is 1244 Sixth Street in Santa Monica.

I have three points, but the first one

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doesn't have to do with being a lawyer. It has to do with being a resident of Manhattan Beach. I swim in or run along the ocean several times a week year-round for many years now.

And you should know that I'm used to going to court for oral arguments broken out from bacteria in the water. I convinced my doctor to give me an unending prescription of penicillin so that every time I get a sore throat from swimming, I can pop two or three days' worth of penicillin. These are standard operating procedures for anybody who swims a lot in the ocean.

My second point is lawsuits. You have heard a lot about lawsuits. Moliere once said he was ruined twice in his life; once when he lost a lawsuit, the second time when he won one.

There is a lot of difficulty hearing lawsuits. Right now a small city has a 50/50 chance of getting hit by environmental lawsuits. They are cookie cutters. They are very simple. You come up with one complaint, pop in $200.00 in court, you can put that same complaint in against 40 cities. Cookie cutter stuff, very easy to do. Maybe they have a 50 percent chance of being sued, 80 percent chance of losing.

They are supposed to implement stuff to the maximum extent practicable. They are not; okay? 50

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percent chance of being sued; 80 percent chance of losing.

If you go with this permit today, the chance of being sued by an environmental law organization probably drops to less than five percent. It's a permit. A judge is going to give deference to the State Board. It's going to give deference to a city. It's going to solve all but about five percent of the problem.

The chance of winning that lawsuit goes from 20 percent probably up to 75 percent. You're probably going to win it because you are going forward in good faith. It's very hard to show bad faith on the city. Have you seen anybody here proceeding in bad faith or arguing that we want to screw up the bay? No.

Third point, unfunded state mandate. Six years ago, you fulfilled the requirement, as close as you are going to get to fulfilling the requirement, of unfunded state mandate. You go forward to the Office of State Mandates to petition, and then you argue to your legislature, through assemblymen and state senators like you've seen, give us money for it.

In six years, has anybody gone forward with that? Is there a single petition pending with the State Mandates Office?

Thank you.

MR. PERENCHIO: I am John Perenchio. I am with

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the Malibu Bay Company. I am a principal and owner of the company. We are a real estate development and management company situated in Malibu. We happen to be the largest commercial property owner. We have developed properties and undeveloped properties.

We are very familiar with the proposed permit and we are very supportive of it. Actually, we have been very successful in making an argument, a pro business argument, about the permit with other business leaders throughout the county.

And the argument is very simple, and I think you should really heed it; and that is, our coastal resources are an asset. Besides being a natural asset and a natural amenity for all of us to enjoy, it also is a very important asset for our community, our business community.

Right now I can tell you I'm a member of the Malibu Chamber. Our Chamber office gets numerous calls daily about the water quality issues in the local Malibu waters. Those same calls are also happening in other Chamber offices along the coastal strip.

If people don't come to visit our local waters in the County, it ends up having a negative ripple effect throughout the County. And that ends up being an adverse consequence for all businesses. Because as you know, an active growing business population and base is

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really important for all the business throughout the County.

So this really ends up being a pro business permit that is before you. And I really urge you to support it based upon that argument.

Thank you very much.

MR. COE: Did Jennifer Taggart return? I guess not.

The next category is public interest groups. And based on the number of cards, we have a maximum of five minutes. Please adhere to that.

Gail Roderman Feuer followed by Mark Ryavec followed by Michael Stokes.

MS. FEUER: Mr. Chair, members of the Board, I am Gail Roderman Feuer. I am Senior Attorney with the Natural Resources Defense Council.

I am here on behalf of the Natural Resources Defense Council and our 50,000 members in California who are here to say -- I am here on their behalf to say we want clean waters.

We hear a lot of people here today, including a number of the cities, who come here and say, "We oppose the permit" or "We want more delay, but we want clean water." Those two things are inconsistent.

A vote today against the permit or a

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vote today even for a three-month delay means that we are not going to have clean beaches; that we are going to continue to have trash and pollution on our beaches and in our waters.

Because of the time limits, let me address three points today.

One, is, what is this permit? Is it a compromise or is it a permit, as suggested by some, to benefit, perhaps, environmental groups at the detriment of cities?

Second, as an attorney, I would like to address the many points that were raised with respect to, will this open cities up to more lawsuits or fewer lawsuits?

And third, I would like to address the permit.

First, there has been some suggestion by cities that this is a permit that really is there to benefit the environmental groups and not the cities and to the detriment of the cities.

It's important for you all to know that the environmental group, at the beginning of this process, came to the table with a long list of what we wanted in the permit. Many of those concerns that we had addressed are not addressed in this permit. And we have submitted

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written comments -- and I'm not going to go through them now -- that list many things in the permit that we think should be stronger. And we said, from day one, we want more.

We wanted, from day one, yearly inspections of industrial facilities, restaurants, and auto repair shops and other facilities. That's not there now. At most, you have a frequency of once every two years, and these are educational visits.

The important thing is that we support the permit because environmental groups, cities, governmental entities, the business community came together and worked out a compromise. And I'm not here today to say please change the permit.

There are 40 things, if we sat down, I'd tell you, "This is what we want." But it's time to end the process. The process has been going on for 18 months. And the cities that come here today, the elected officials that say, "We were not part of that process," that's not true.

Their Public Works Directors and their people from the city came to the table. They submitted comments to their cities. And if they chose not to involve their public officials in the process, that was their option. We have been trying to get public officials involved in this process.

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And I have a list here I just wanted to show you. Regional Board Staff can show you this list. This is a stack of the comments that were received on the December 1995 draft of this permit over seven months ago. And there were comments in here from many of the cities that spoke today saying they don't like the permit. Alhambra, Azusa, Bellflower, Downey, El Segundo, Lakewood, Lomita, Long Beach, Rosemead and Torrance. They submitted comments. Those comments were addressed. Many changes were made to the permit.

It is disingenuous for them to come here today and say, seven months later, "Gee, we just got this two weeks ago." The reality is the permit before you today is much weaker than the permit we saw in December. You have heard from several people, the inspection requirement is now a site visit requirement. The frequency is, at most, once every two years. The monitoring requirement, you heard them say, that is gone. Cities have no requirement regarding monitoring.

Receiving water limitations. The environmental groups, as Dr. Gold said earlier, we helped make the change so that cities have no concern. If they comply with the permit, they can't be sued because oil and grease and other pollutants are still going into the ocean.

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The deadlines. We started this process saying a lot of the things in this permit are required by the old permit, and we want to see them implemented in a year. Well, now the deadlines, many of them, say within three years. I don't like that.

But I'm here to say this is a good start and we support it. But to have cities come in and say, "We need more than three years" is very frustrating to us because a lot of those requirements were in there before.

Two other quick things. I know my time is running.

Lawsuits. NRDC, as you may have heard, along with the Baykeeper, has filed a number of the lawsuits that have said that the cities are out of compliance with the 1990 permit. One of those cases went to trial against Caltrans. And a judge, who himself professed that he was not a huge fan of the Clean Water Act, went on to issue a fair amount of injunctions against Caltrans finding them in violation of the permit. We reached settlements with three cities.

The old permit said cities have to implement best management practices to the maximum extent practicable. That's the whole permit.

What we have said to cities who have complained for years there is no specificity, how do we

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know what to do? here is what you need to do. This permit is an insurance policy. It says to the cities, "This is what you need to do. And if you do it, you won't see NRDC or the other environmental groups at your front door." And that's a good thing.

We have already been talking with the cities under the old permit. You may know that the word is out. We even drafted notice letters to some cities saying, "We think that you are in violation of the old permit." We put them in a file cabinet. We sent the letters to cities, to many cities, saying, "We think you are in violation," but we packed them away.

My time is up. Let me just quickly sum up. We packed those away. We said, we are going to negotiate with you. We don't want to be in the litigation business. Here is a permit that says what the cities need to do. And if they comply, then they won't be sued. And that's the best thing the cities can have.

The approval today that you will act and you will adopt this permit tells them what to do. And if they do it, they won't be sued. So we urge you to to adopt it today. Please don't delay it any further.

Three months from now if we are still negotiating, our list of 40 concerns is going to come back on the table and we are going to say, "We want these 40

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things. We don't support the permit anymore." And there's 2,000 people who will say, who sent you letters, they don't support it anymore either. So please adopt it the way it is today.

Thank you very much.

MR. COE: Thank you very much.

MR. RYAVEC: Good afternoon. My name is Mark Ryavec. I am a Board member of the American Oceans Campaign. American Oceans Campaign is a nonprofit environmental organization created by actor Ted Danson approximately ten years ago.

The incident that occasioned Mr. Danson to create American Oceans Campaign was taking his two young daughters to Will Rogers Beach and finding that there were signs posted that said, "Polluted Runoff. No swimming."

He had trouble believing and understanding how we could have allowed our bay to come to the point that we couldn't swim in it. And now we are gathered here ten years later to finally try to start some serious efforts to turn that issue around.

I would like to speak to you about three issues that have been discussed before you. One of them is the question of the legal mandate under which this permit is being issued. The other issue is unfunded mandates. And the final issue is cost. And I will try to keep this

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as brief as I can.

The Clean Water Act requires the NPDES permit to be issued in order to reduce storm water discharges to the waters of the United States. Amendments to the Coastal Zone Act that occurred subsequently require reductions of urban runoff flowing specifically to coastal waters.

Cities, as operators of storm water systems that discharge to the waters of the U.S., are subject to these requirements. I don't think there is any debate about that. The tentative permit is designed to meet those legal requirements.

Although the Board used a consensus process to determine how to comply with these requirements, whether to comply is not an option. The Board must issue an NPDES permit that reduces urban runoff, the sources of 50 to 60 percent of our water pollution.

There will never be unanimous support for any change, but the consensus process has narrowed many differences. And it's now time for the Board to exercise its leadership and fulfill its legal obligations and to adopt the document that has resulted from the consensus process.

On the issue of unfunded mandates, some cities continue to claim that the permit represents an

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unfunded mandate. We do not believe that this is true.

First, the permit has been modified so that educational visits replace inspections. Cities are not saddled with enforcement responsibilities that they believe belong properly to the Water Board.

Second, much to the dismay of the environmental community, the permit was modified to dispense with key industry reporting requirements; for example, the requirement of filing a Notice of Intent and having a plan, thus removing any vestige of there being an unfunded mandate.

And then on the issue of cost, some cities, complaining that the permit is too costly, have not been entirely forthcoming in their cost calculations. And may I speak as a bit of an expert witness. I've served as both a legislative analyst for the city of Los Angeles and as the Chief Deputy Assessor for the county of Los Angeles.

The cities claim that the storm water program will cost them hundreds of thousands, if not millions, of dollars, despite the fact that cities as small as Santa Monica have been willing to take this on, and big cities like the city of Los Angeles have been willing to take this on. There still is this continual Red Herring brought up that this is going to be terribly expensive.

The truth is that storm water management

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is a multi-purpose, multi-benefit undertaking whose costs must be allocated to a range of benefits, not just to pollution control.

For example, street sweeping. It's not just a cost that's allocated to polluted runoff control. Sweeping streets helps to prevent clogged storm drains, and thus is a flood control measure. It prevents road hazards, injury, and legal liability and is thus a safety measure. It enhances the attractiveness of the urban environment. And it's very important in improving property values.

It is unfair for cities, for example, to harp on this thing, the street sweeping, and other mandates that will come from this permit as being totally related to pollution and runoff control. An honest assessment would allocate costs according to the array of benefits derived from the activity and not, as some have done, assign all the costs exclusively to -- excuse me. I'm repeating myself. I'll move to the next paragraph.

With regard to storm water management, more generally, the discussions have lost sight of an essential truth. Either we pay up front to prevent polluted runoff or we pay more in the end. We spent huge sums to rake debris from beaches, especially after heavy rains. We pay millions to dredge and dispose of contaminated sediments that flow into marinas and harbors.

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Not only must these sediments be handled as hazardous waste, because they are contaminated, they can't be used to replenish our beaches, which means we miss the opportunity of using that in that setting.

Let me give you one classic example of how this saves money, this provision will save money.

Let me give you one classic example of how this saves money. The city of Santa Monica has found that controlling polluted runoff will indeed save money. The city installed barriers in high-traffic pedestrian areas during the dry season to prevent trash from getting into the storm drain system.

Instead of having to clean out storm basins, catch basins, four times a year, as they did before, they only have to do it once a year; so that they have a significant cost saving in labor cost by having put the barriers up in the first place.

I'm sorry. I'm going over my time. If I can simply urge you to --

MR. COE: Come to a conclusion.

MR. RYAVEC: If I can. Thank you.

We have spent 18 months in intense negotiations over this permit. Frankly, enough is enough. I don't find that the concerns of the city at this juncture are fair in light of the fact that they had 18 months to --

did make their comments. As the previous speaker indicated, they have all participated in this process even though they would like you to believe otherwise.

The Board has a legal duty to act and should do so now without any additional delay or any amendment.

Thank you.

MR. COE: Is Michael Stokes here?

Terry Tamminen, Santa Monica Baykeeper, followed by Martin Byhower.

MR. TAMMINEN: Thank you for your time. My name is Terry Tamminen. I am the Santa Monica Baykeeper. And I'm disturbed to see that they haven't given you one of these T-shirts. So in the spirit of compromise, let me give you the shirt off my back, Mr. Chair. And we will ask someone to come give shirts to the other members.

MR. COE: If you take a picture of this, I'm in big trouble.

MR. TAMMINEN: Thank you for your time.

Unlike the other speakers that you have heard here today, I live and work on and in the waters of Santa Monica Bay and our local coastal waters every single day of my life. And I wish I could show you firsthand the things that I see coming out of the storm drains every day.

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If I did, there wouldn't be a debate here. If I could show the people from these cities and others who are opposing this permit or suggesting it be amended or delayed, there would be no debate here today.

When I go diving in Ballona Creek, and yes, I do, to collect scientific samples, if I could show you the acres and acres and acres of ten-foot deep of tires and Christmas trees and plastic bags that smother the ocean habitat and come washing back up on our beaches where Baywatch is filmed every week where a billion people a week see that program, it has an impact not only on the environment but on the economy of this area. If I could show you that, there wouldn't be a debate.

If I could show you the oil and paint that comes out of the storm drains that ends up on birds and sea lions every single day, there wouldn't be a debate here today.

But this permit, although I'm the first one to tell you it does not begin to thoroughly enough address these issues, it does so in a way better than the permit we currently have. And that's why I'm here to support it. I'm here to support it somewhat under protest because I think we have weakened it as far as we possibly can.

The inland cities have come up in front

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of you and told you it's too expensive and that they need delays for one reason or another. It seems to me that we are starting to polarize the inland cities versus the beach cities. And this is all of our economies, and this is all of our places to recreate. This is all of our environment. And it's all of us contributing pollution to these important coastal resources.

So I ask you to be fair to those cities like Santa Monica who spoke eloquently about the fact that they found ways to make this work. It doesn't bust the budget. They have been doing it for five years, not just for the last 18 months or thinking about it for the last week.

I am willing to say, fine, let's forget about the permit as it exists today. Let's take that as a five-year learning curve, and now let's start over basically where we should have been five years ago. It's taken us this long to learn. That's fine.

But I, for one, am saying that's enough. This environmental coalition that you are hearing from today I believe will disintegrate if you vote to delay or modify this permit after today. Because as far as I'm concerned, a delay or a change to this permit is a no vote. If that happens, I, for one, will start tomorrow enforcing the existing permit we have even more than we

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have done so far. I, tomorrow, will go to war.

So I am asking you today to do the right thing and pass the permit now. Pass the permit now. Pass the permit now. Pass the permit now. Pass the permit now. Pass the permit now. Pass the permit now.

How much more time do I have?

Thank you.

MR. COE: I have two cards on the Surfriders Foundation, Dr. Pierce Flynn and Pierre Mataro. I may not have gotten that right. Does somebody represent Surfriders? You will be it.

MS. KUDLICKI: Yes.

I am Beth Kudlicki, and I am on the Executive Committee with the South Bay Chapter of Surfriders.

MR. COE: All right.

And you are taking the five minutes for Surfriders?

MS. KUDLICKI: Yes, I am. Pierce Flynn had to leave, but he gives our full support.

I am also a business woman and a surfer. The Surfrider Foundation is dedicated to education, research, and conservation of our nation's natural coastal resources.

As a nonprofit volunteer organization of

surfers and bodyboarders, water men and women of all types with a deep love and respect for the ocean, we spend much of our time in and around the shoreline. We have a vested interest in the quality of these waters.

We recognize that the NPDES permit and implementation of federal Clean Water Act requirements is a valuable and necessary step in addressing the damaging effects of urban runoff and non-point source pollution on the waters in which we swim and surf daily. We commend the Board and its staff on the consensus approach taken in drafting this permit. We applaude the emphasis on public and private sector education.

Many responsible individuals lack the information needed for the necessary lifestyle or business changes which could result in dramatically reduced pollution of this type. Last week a neighbor of mine dumped his septic tank into the storm drain because he didn't know any better. He said he had no idea. So this is kind of the education that we need to really get out there.

We look to the Board for leadership and strong enforcement of all permit requirements once adopted. Enforcement of water quality standards, or the lack of same, will have a direct impact on our members each and every day.

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We ask the Board to unanimously approve and furthermore to strictly enforce and implement all provisions of this permit as a beginning step in curbing pollution runoff and cleaning our local waters.

We pledge our continued sort and personal assistance in whatever ways we can to help in this endeavor. And I invite all of you to our next beach cleanup because you will get an entirely different perspective once you start picking up styrofoam and syringes.

Thank you.

MR. COE: I understand that Jose Luis Sedano has returned?

You are in the category of the three minutes. You have three minutes.

MR. SEDANO: Fine. Thank you.

Good afternoon. My name is Jose Luis Sedano, and I live at 588 East Avenue 28 here in Los Angeles. Thank you for allowing me the time.

I am with the Latino Scholastic Achievement Corporation, a 501(C)3 corporation.

California is known for its beaches. A day at the beach enjoyed free by anyone, regardless of household income, there should be no question that this is one of the enjoyments of living in Los Angeles.

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Our community, the Latino community, the Mexican American community of Los Angeles, because of our household medium income, enjoys the beach more than anyone else in our community.

As a businessman and one that works as a public information officer working in the media, I would like to point out to you that there should be no question that you should pass this permit. I'm here to speak in support of the permit because it's obvious there is a need for clean waters, clean coastal environment. This is what we are known for. And our community is very much needed by -- this permit is needed.

I hope that you will take this into consideration because a majority of our community is, what, 55 percent of the population? And some 67 percent of the students in the Los Angeles city school system are also of our community.

That's all I have to say. But it is a wonderful start, and you should definitely pass this.

Thank you very much.

MR. COE: Thank you.

We now come to the last category. It's called other interested parties. And the first -- based on the number of cards, there's a maximum of six minutes each.

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Madelyn Glockfeld followed by Robert Bronkall followed by Kenneth Fields please.

Is Madelyn here? Is Robert Bronkall here? Kenneth Fields? Barbara Taylor?

Barbara Taylor followed by Robert Wright, which is the last one.

Barbara Taylor, you are next. The other people weren't here. I'm sorry I didn't make that clear.

MS. TAYLOR: I'm sorry. I didn't understand that either.

Well, I'm here just as an interested citizen. I have lived in the Pacific Palisades since 1965 with my children. I've taken them to the beach every other day, and they are grown now.

But I still continue to enjoy the beach. I take my boogie board and I go down below Santa Monica Pier and I ride the waves too. And I take my windsurfer and I go out at Marina Del Rey to windsurf in the harbor. And unlikely though it may seem, relative to my age, I do all those things.

And my daughter also rowed for a UCLA crew team on Ballona Creek, and I've seen the trash accumulate. And I'd like to have you do whatever it is in your power to make our beaches better because I think they are a resource of value to all of us.

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I think we all receive not only enrichment due to our athletic activities down there but, if I can say, an almost spiritual quality to going down and feeling that sun on your skin and the breeze blowing and the water moving past your body when you swim in it. And that's too important to lose. And that should also be beyond a few dollars and cents.

I would like to say that I also represent a group of people who will never be heard here or seen here, and they are the people who don't mind paying some more money in taxes. I know it would put me in a real minority to say I don't think I pay enough in taxes, but I think that's true. I think we have been very spoiled in thinking that we can have this good life with all of the benefits that we have in this country without paying for it.

And I don't think that we can do it by saving paper clips or managing our businesses more effectively. I think it's going to take more money, but it's well worth it.

And I think if you think back on some of your experiences outdoors, you will agree that this is just one way we can save the planet. Because we are just talking about the ocean, but we can make the same argument for our good air and our good water and all the other

things that we enjoy.

We have become too big a population, probably, so it's doubly important that we use every means at our disposal to control our trash, our garbage, our poop, our effluent, and everything else.

And I just hope you will take into your consideration these items that maybe aren't costly and aren't business oriented too.

Thank you.

MR. COE: Thank you.

Is Robert Wright here? Robert Wright?

MR. WRIGHT: Thank you for letting us have a little time. I have heard everything that's said here today. My name is Robert Wright, and it says on the card that I am representing myself.

I have been involved with the Santa Monica Bay since I was two years old. And somebody got polio down in the Las Pulgas Pond.

MR. LEON: Mr. Wright, would you get closer to the microphone.

MR. WRIGHT: Did anybody hear that?

I have been involved with the Santa Monica Bay since I was two years old, 42 years ago. And someone got polio in Las Pulgas Pond on the sand in Santa Monica Bay.

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And a lot of people have addressed a lot of issues here, and I would like to take those as my own statements as a question of saving time.

Can anybody phrase that sentence better?

So anyways, there's a number of things. And we currently have a lack of enforcement on our litter laws. And there's another thing that was brought up as -- somebody said they got sick when they ran along the coast in Redondo Beach and they want a lifetime prescription of, whatever, I don't know what they said. But that institute over in France where -- who has a biochem background here?

MR. COE: I think he said penicillin.

MR. WRIGHT: There you go.

And who was that guy that was involved with the wine making? Who invented penicillin?

MR. COE: We want to stay on the subject here.

MR. WRIGHT: You want to understand the subject?

MR. COE: No. We want you to stay on the subject.

MR. WRIGHT: That is the subject is our scientific knowledge of what's going on. We have a lot of people who haven't been here who have the knowledge, whether it's the head of Hyperion, I got to speak with him,

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whether it's our U.S. Fish & Wildlife Service who is under duress from our current national administration, who I don't believe have yet signed the EPA science -- the head of the science department for the EPA yet. It's only been three years. Maybe they will get around to it. Maybe they need a background check on it.

But other than these other -- so there's a lot of trash in the bay. We spent a lot of money to create the huge digesters down at Hyperion. Perhaps this document needs a little scrupulous going over to make sure that it can have its greatest benefit for the costs involved.

Thank you very much.

MR. COE: Mr. Wright, there is a question here.

MS. CRAVEN: I have a question. I thought I was with you until you said it needs some more scrupulous going over.

In just one word, do you oppose or approve of this?

MR. WRIGHT: I haven't read the whole thing yet.

MS. CRAVEN: So you testified not telling us whether you were opposing it or supporting it?

MR. WRIGHT: Well, if you didn't understand something, what would you do?

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MS. CRAVEN: Well, I'm going to tell you what I'm going to do in a little while. I'm trying to find out what you, as a person testifying --

MR. WRIGHT: What are you going to do in a little while?

MS. CRAVEN: You will find out.

MR. WRIGHT: Well, see, your mind is already made up, so why are you bothering to ask me?

MR. COE: We are going to have a discussion right now, actually. You are the last one to testify.

MR. WRIGHT: I wanted to get a sound bite in too.

MS. CRAVEN: Okay. Thank you.

MR. COE: Thank you very much.

We are all out of cards, so this concludes the testimony, and I declare the hearing closed. And I would like to open up the Board discussion. So we can start out with Chuck.

MR. VERNON: Mr. Chairman, I will make just a few comments here. I'll try to be brief, and I hope that the comments will help frame our discussion.

First, I think that we need to keep this permit discussion relatively simple because there are some very powerful, simple elements to it. And some elements that are not simple are elements that we can deal with.

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First, one of the simple things is that we do have a health risk, and we have a very credible epi study to demonstrate this. The epi study has even been adopted as a model by EPA with a possibility, in their minds, that it may apply to every storm drain system in the country to some degree.

Secondly, another simple fact is that protection of receiving waters is the responsibility of this Board. And as far as the storm drains go and the bays and the ocean waters, our Board has been involved in the effort to protect those waters, now Mark Gold said for seven years, I count eight.

Secondly, I want to just go through and highlight a couple of the points in the history of that eight years.

Eight years ago we formed a committee under SCAG, and I was your representative on that committee. And at that time there were two major sources of pollution of our ocean waters that were identified. One was sewage and the other was storm drain. And our efforts first focused on sewage.

And we had exactly -- we could replay this whole hearing if we go through the whole thing to do with, what people are politely calling, POTWs. We had the specter of costs as being entirely unreasonable and

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unmanageable, and we had the request for delays and delays further and delays.

But finally we worked through that. And after we worked through it, the very agencies that said the costs were too high and requested delays became strong supporters. And now those two agencies are supporters of this storm drain permit.

Then in the proceeding, then, as you were told today, by cleaning the sewage, if you don't mind my just using that word because that's what it is, to a higher level, we have eliminated many of the problems of the bay. We have eliminated, maybe not eliminated, but we have made great progress on the kind of problems that inadequately treated sewage causes to a marine environment, and we are all proud of them.

Then proceeding along with the brief history, the next step was the 1990 permit. And this Board issued that 1990 permit, and it was indeed a voluntary type of permit. What happened under that permit is again reflected in what you heard today. We had cities that were very, very conscientious indeed about trying to carry out the permit.

The Board's approach to it would make it voluntary. Staff, please work with the cities. Please help educate them. And please help them come up to

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compliance.

Well, we had other cities that, in spite of the very best efforts that we made, the message never even got through to the City Council, never got past staff or whatever. You heard that discussed, the problem of communication from the Board, the Board's staff to city representatives, and then from city representatives onto the elected representatives.

And, finally, you have heard from NRDC that actually they filed suit. They felt maybe that our Board wasn't doing enough, so they had to file a suit, those suits against those cities that had done nothing under the 1990 permit, and they were highly successful in court. That is also behind us.

But we heard a great deal today from the cities opposed to the permit. We heard a great deal of mistrust. We heard mistrust in regulations. We heard fear of costs. And yet, at the same time, we have model permits, not only throughout the country but throughout the state, where regional agencies working together with the cities have been successful in keeping the cost within line. And you had testimony to that effect today, that they can be kept in line.

Probably this issue has received the maximum of public interest of any issue that we have dealt

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with here, the number of letters we received, the number of phone calls and so on.

Finally, kind of based on what I've said so far, what you've heard about the legal liability is actually reduced and the fact that some cities say the cost is manageable, what I would like to do is I would like to just place a motion before the Board that will contain direction to the staff that would address some of the remaining issues, and then that would, I think, provide a good basis for the Board discussion.

I'd like to move approval of the permit. At the same time, along with the motion to approve, let there be direction from this Board to the staff to assist the cities in implementing cost-effective manners in compliance and to continue the involvement of stakeholders in the development of the permit.

The reason for these directions to staff, I think we have had ample indication here today that we have a flexible permit and that a lot of things are left open for development. Well, who is going to develop them? I think the cities -- a lot of the cities fear that it's not going to be development but it's going to be demand and control from the staff.

Therefore, my proposal is that we add this language, this direction to staff, to the motion to

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approve the permit.

Thank you.

MR. COE: Mr. Drane.

MR. DRANE: There's a motion. Shall we discuss it?

MR. COE: We should have got into a round-table discussion. My script says we get into a discussion.

MR. DRANE: If we've got a motion, we ought to have a second.

MR. SLEZAK: I will second the motion.

MR. COE: We have got a second.

MR. DRANE: Well, I have some problems with it, and that's not to say that I am opposed to it. I think the cities have brought up some very worthy and bona fide issues. The cost factor cannot be overlooked or disregarded. That's a real fact of life that they face day in and day out. And also the lawsuit, of course, has to be looked at as an issue that is real and genuine.

I think we've really put a lot of credence in what the County had to say about their support of the permit. And they, for some unknown reason, indicated it had nothing to do with the lawsuit. But if you look on page 20, I think you will find that that was part of the agreement that they made. So I hope we will not put too much credence in that.

As I said before on this Board, for over 25 years I have owned property on the beach in Malibu, and I know the great natural resource that's available there. But these other issues must be taken into consideration.

I don't know whether we can hit a happy medium. Many of the cities are saying that some of the information they have received, they did not receive it on time. Certainly they are entitled to receive any changes in the timely manner so they can take it to the City Council and make some bona fide judgment on it.

The Assemblywoman said that she felt there was money to be obtained from the federal government. Well, if that's the case, then maybe we should get that money or see if it is available before we pass this expense along to the cities.

The scientific information probably needs to be refined and honed up a little bit. I think there is a whole multitude, array of issues that are still an open issue and open book. And I haven't decided which way I would vote

MR. COE: John.

MR. SLEZAK: First of all, from the perspective of legal obligations, the Clean Water Act requires the attainment of the goal that all waters be drinkable and

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swimmable. And specifically Section 402(p) requires permits for urban storm water discharged by municipal separate storm drains, and it requires that controls reduce discharge to the maximum extent practicable.

Now, we have, I think, credible scientific evidence, and we have a very specific epidemiological study that demonstrates that there is an increased risk of acute illness caused by swimming near flowing storm drains. We do have credible findings that storm water from urban runoff is a significant source of pollutants, causing impairment of water quality and beneficial uses of receiving water.

What are the beneficial uses we are talking about? We are talking about water contact and non-contact recreation: sport fishing, groundwater recharge, wildlife habitat, marine life.

Now, the majority of the public entities oppose. The Los Angeles County came before us and say they favor the permit. A large minority of cities argued that the permit would be too costly and asked us to defer it. Having been in the minority many times, I'm not going to automatically go with the majority. But here I think that the majority has demonstrated that this is a valid permit to be adopted now.

The findings I believe are based on

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valid studies. They do show that surface and groundwater recharge can be materially impaired by storm water pollution.

On the issue of the receiving water limits, the opponents argue that the receiving water limits necessary for maintaining beneficial uses should be deleted from this permit. I believe that that would be tantamount to a request for the dedesignation for the beneficial uses of recreation and fishing in coastal waters and the recharge of groundwater basins. And that is not appropriate to do.

However, under this permit, the permittees are deemed in compliance with the receiving water limits if they are fulfilling the implementing provisions of the permit even if the receiving water limits are not being met. And, frankly, I don't think they are being met with regard to the number of pollutants. But nevertheless, the cities will be protected in that event.

And as to third-party suits, I think the cities are measurably better off and safer from third-party litigation with this permit than without it. The Clean Water Act authorizes third-party suits, and they have been successfully brought without permits. And with the predecessor permit, specifically they were brought against Caltrans successfully and against other cities. So I think

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the permit will actually protect the cities.

As to the unfounded mandate and cost benefit arguments, I think the cost to municipalities are in line with other state programs. And I think that, with the augmentation of the motion to direct Staff to work with cities in utilizing cost-effective measures, that cost-effectiveness will be satisfied.

I think the benefits that would be lost by allowing continued storm water pollution far outweigh the costs of the program. And first and foremost, water contact recreation, the economic value of water quality sufficient for beach uses to safely swim is in the billions of dollars of Southern California's economy.

Secondly, the economic value of Southern California for the sport fishing industry is in the hundreds of millions of dollars.

Third, the economic value of groundwater recharge within Los Angeles County is in the tens of millions of dollars annually. And if you count the Santa Clara River Shed, it's probably in the hundreds of millions of dollars.

There is major recharge from the San Gabriel River and the Santa Clara River. And it is necessary that that water needs water quality parameters, otherwise it will impair the extremely valuable groundwater

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basins on which the Southern California economy depends.

The wildlife habitat values that are impaired by storm water pollution are significant but incalculable.

And then, finally, there are beneficial uses that have already been sacrificed to the development of Los Angeles infrastructure. The Wetlands and Riparian Corridors have been, in large part, paved over and taken. And those provided the function of oxydizing and decomposing. They are no longer present.

Now, the streambeds have been paved over. They served as the filters for pollutants. The inland fisheries have been, in large part, taken.

I also think that this permit represents a good compromise among the environmental groups as well as the needs of the cities and the county that represent all of us. And I, therefore, would support the permit as drafted for immediate adoption with the amendments.

MR. COE: Ms. Craven.

MS. CRAVEN: I think we have all heard the things that we have classified into several different types of reasons or arguments for delaying this today, and I would like to address several of those.

One of them came from cities regarding delay it because they didn't have time to respond. Many of

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you know that I am involved with the city, although the city I'm involved with is not in Los Angeles County, so I do not have a conflict of interest in this. I'm sure you have been sitting there wondering how I'm reacting to the cities' arguments.

Through the years, the ten years that I have been involved with my city, I have been part of many different efforts to get all the agencies to come together and discuss and agree. I remember sitting for 18 months discussing a Solid Waste Management Plan that ended with the state saying, "We are not going to do coastal problems anymore." And now all of a sudden you have got to stop all this and start all over again and move to a different type of thing.

And I can remember sitting around talking about water plans and discharge plans and all kinds of other plans, including funding plans and law enforcement plans with other cities in the county. And what's often happened is that many of us -- and please understand, in Ventura County, there are only ten cities in the county. So all ten of us will get together, and in the end there may be three of us sitting talking after 17 or 18 months.

I can appreciate the problem Staff had in trying to coordinate discussions with -- or facing a problem of coordinating discussions with 86 cities in the

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county plus other interested parties in Los Angeles County. And I think the unfortunate part is that only a handful of cities in the county, and probably more other interested groups than cities, were able to be involved.

I would hope that the next time around somehow all of the cities would be able to get minutes and updates of what's going on to keep them current. Because what always happens, even if the cities are supposed to be involved and they don't show up at the meetings, is that, in the end, they never heard of what was going on and it's a real shocker. And today what we heard were the results of the city saying, "This is a shock."

In reading the exemption -- in reading the things that came to us last week -- and I hope everybody out there knows, we got about this much stuff in the mail (indicating.) And in searching through it, I don't pretend to have read every letter that came, but you search through and you read representative letters from the various groups.

And in looking at the ones that came from the cities, when I first started reading them I thought, how can some of this be? And then I got into the permit and the requirements. And there is a misunderstanding in some of what they were saying. Because some of the things that some of them wrote to us telling us

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were going to be required are in the list of exemptions. So there are some misunderstandings there. And I hope that those things will get resolved.

But I'm not here as a city representative. I am here as a representative of the public, and our charge is to protect the waters. So I have to take all of that into the background in making my decision. I have to consider that this is a renewal of an existing permit. Perhaps the conditions and terms of the existing permits are not something that the existing council members are aware of either.

I recognize that the requirements in this permit are weaker than the requirements of some of the other permits in other parts of the state. And I'm not -- I think that the staff has done a very good job of trying to make a reasonable effort to compromise, compromise what all of the interested parties wanted and felt they could do.

Some of these best management practices that people are -- that these agencies are having a problem with are things that other agencies have been doing for quite a while. The other agencies adopted them as part of water conservation efforts, but they also were water quality efforts.

I was glad to hear that there was going

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to be some way to perhaps have staff work with the cities to try to determine some cost-effective ways to implement these conditions of the permit. And some of the things that some of the cities feel they can't do other cities have been doing.

I think, in looking at them, the ones that -- the cities that have been doing these for years are the ones that have their own treatment plants. And the cities that don't have treatment plants have not been implementing them. I think that's where we come into going into people's businesses and looking at what they're discharging. People who have treatment plants don't have any problem doing that because they have been checking on what's going into their sewer systems for a long time.

So I think maybe some more education with the public agencies needs to take place as to how this can be done. I'm not sure how Staff is going to do that.

But I do not understand -- the last thing I don't understand is the statement that we got from several cities of, "Gosh, we haven't had time to take this to our City Council to have them approve it." It wasn't my understanding this was something that required City Council approval. This was something that requires this Board's approval. The permit is for the cities. Once they get the permit and understand more what the conditions are, they

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will then have to comply with it. They don't have to vote on it.

So I believe that this is a fair permit. I believe it does what we have been charged with doing. Even though I recognize that the environmental groups believe it isn't strong enough, I believe that this is one that I can support.

MS. ROGERS: I think each one of us has spent a great deal of time trying to trade up on all the information to date, but I think we have killed the entire Redwood forest just to produce the paper that we got. That's an ancillary environmental issues in terms of paper that we consume in this process.

Since everybody is giving a little background, in 1992, I guess it was, I served on the California Competiveness Council and I gave speeches around the state regularly on all of the evils of regulation, including unfunded mandates. Unfunded mandates, they are really interpreted as anything the government says, and you have to pay for it, which can be a lot of stuff, including the school system or anything else in terms of unfunded mandates, which is a valid point.

Cumulative impact. Yes, it's fine for us to hit everybody with another 20 bucks, but it's us, and then it's the Air Board, and then it's the local hotel tax,

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and it's the local excise tax. And by the time you are done, it's no one group's fault.

But the tax rate in California gets so high that we have an exodus of businesses or a problem with the businesses in our community. That the dollars we are trading off are not business dollars, that's convenient, to say, "Oh, we are going to help a business, we are going to help a developer." And it's evil profits versus some aspect of the environment.

The dollars we are trading off, generally speaking, are your General Fund dollars. And if you take that three or four dollars and buy more ambulances, get a better school to teacher ratio, or do we do this, ultimately it all comes back to the same tax base.

So it's not usually people feeling evil about not wanting to help the ocean or not wanting to help this or that. It's a systematic look at, what are we trading off?

Layered in bureaucracy there are problems here. We have a Water Board and we have the County and we have cities involves, different lawyers that you have to run up and down and figure out who is on first, not to mention the fact we have to bring in the sanitation department and all sorts of other groups to do your

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partnering.

Fine. I liked the Lomita gentleman's comment, well, we just put ours over here in the lake and it never does go into the ocean. Or Long Beach's comment related to it's beach versus the Santa Monica area.

Delay, the fact that the paperwork goes out in a very short period of time, and I go along with Charlotte's comment, maybe that short period of time was the only time anyone bothered to pay attention, even though you've been 24 months in the process or had five years of the permit that should have been followed or not.

And I think there is another thing, speaking as someone who lives now most of the time up in Ventura County but grew up on the west side, I was there for 15 years, we have heard a great deal today from the coastal cities, specifically Santa Monica and Malibu. And, of course, these are affected. They have a large environmental community that's been very active that's been responsible for the creation of a great deal of the environmental body of law.

They are not San Dimas. They are not the inland areas. And they have a very particular niche of the environment that they relate to but a very important one. And that brings up probably some issues of the environmental equity because the west side is a very

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particular place.

Now, with all that that I'm looking at and I'm giving speeches on, that's why I decided to serve on a regional board. Because when you write up those speeches and you go up to Sacramento and you live in the ozone of all these committees, how does this really work on the ground? What are the inherent contradictions you are dealing with that you never see? And I think that's true of either side of this, whether you are in the boat business or environmental side. The real world is a lot more complex.

I must say, I began to lax over the whole issue just as Senator Hayden says he's against it. That peaked my interest no end because I've got to look at that carefully now, don't I? And when Mr. Perenchio stood up and said he was for it, I got completely confused.

Okay. Those are all the negatives. Then I come to read this document with all those negatives very clearly in my mind and state that they are kind of there inherently or generically in these processes.

I think we have to look at several things; one John said. It is true, we have no choice. We will have a storm water non-point source pollution program. And, frankly, the more I got into this, I absolutely think we should. And I think it goes back to what several other

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members of the Board have said here.

This isn't just a single-purpose event. It has a lot to do with keeping the streets clean, keeping all kinds of bacteria out of the water system. While I'm saying to West L.A. that, for example, we turn to Santa Monica who uses this, what's the ultimate use of the groundwater, the ocean water, L.A. has -- going to Jose Luis' comment, Los Angeles has only one acre per 5,000 people of park in Los Angeles. And the Latin culture is based around parks and families.

And if you go out to the beach, you have millions of people there in the summer. It is our only park. It is the only place people can go.

What I find, I think where I want to come down -- maybe it takes, Chuck, adding a little more to your language. The cities who came in have told us all the things that are not right with this permit, and there's got to be a ton of them, as has the environmental community. But the fact is this permit has been written to try to go to the local level, which is the whole push of getting away from unfunded mandates, and say to the local cities, "We are going to give you a relatively flexible document. And in that flexibility you have some stuff that looks like command and control, and you have a whole lot of language that's really quite ambiguous."

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And it is my understanding of the basic intent here, and I believe the intent of the Board, is to turn around and say to the cities, "Within some guidelines we want you to come up with and get on with a non-point source pollution program."

And I think we all have to be realists. The cities wouldn't have shown up today if we weren't going to vote, and we have their attention. And I think we need to have permits in these areas.

I've looked over what we have in Ventura County, and Charlotte served there. For a very reasonable amount of money, and we have some charts in here, they have had a much more stringent, not much more, but a more stringent ordinance and been able to handle fiscally in a very practical way.

So I find it a bit disingenuous when we hear categorically it can't be done rather than seeing some stabs at doing it. I will be the first, if we can have some of those stabs at doing it -- if Long Beach comes in and shows it goes bankrupt and has no ambulances, no schools, no police, and no civic life based on this, you have, believe me, an argument.

I'm only being lighthearted here because really there isn't staff at the Board to go out and know your problems. If you really have a set of problems with

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how this is structured when you sit down to do your own program, I think that's true of all the cities here, you have a Board that will be responsive to you.

But this document will get you to go draft a program, and that's what we need to see. And I think that the effort that has been put out, what I'm happy to hear is that everybody is unhappy a little bit and very few people are unhappy a lot. And I think that means there has been a process that has worked.

And I would like to see, Chuck, something a little more -- a little stronger, like, at the end of six months, we have three or four of the cities who have strong objections come back with their pilot programs and they can show us what it costs, or we can bring in models from Ventura County that can show people how it works.

I think that, as a Board, this is so important, we ought to be responsive. But I have to be responsive in the concrete. I have got to see the actual cost, the actual programs, the actual problems that you are going to have before I can do anything else.

MR. VERNON: The maker of the motion has no objection to an expansion of the motion. And I think that if monitoring and reporting back to the Board and hearing from some of our stakeholders is going to give people more

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of a feeling that we are really in this together, I am in favor of it.

MS. ROGERS: If Simi and Moorpark and Camarillo can do it, we can find a way for 80 cities in L.A. to come up with a good program.

And with that caveat in mind, I support it.

MS. CRAVEN: Mr. Chair, could I ask for a clarification?

MS. ROGERS: It's not a six-month permit. I'm just saying whatever is a bench mark -- maybe, Catherine, you could comment on a bench mark time period where groups such as Rosemead and Long Beach, once this is submitted, to get back to us within a reasonable work period that relates to the permit. And you could pick the time period.

MS. TYRRELL: We will do that. Unless you want to do it right now, we will work with the cities to determine what a good time period would be.

MR. COE: I'd like to see some language now.

If either Chuck or Beth would like to restate the motion.

MS. ROGERS: Chuck, you have done this a lot more than me. You give it a go.

MR. VERNON: I think that, if I understand, what we would like would be a clear-cut, additional

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directive to staff, and that would have to do with the progress report to the Board. Am I on target? Is it confusing, Charlotte?

MS. CRAVEN: Well, you know, a minute ago I wanted to ask a question for clarification, and everybody talked and I didn't ask my question. So let me ask my question and maybe that will help you in answering the question how to rephrase the motion.

I guess what I'm not understanding is if you want this to come back as a progress report after development of their program or if you want it to come back for another vote? What did you want?

MS. ROGERS: No.

Charlotte, I just want a progress report in the following sense, not just Staff making a progress report, but the cities here today that feel particularly their ox is being gored when they have taken the time to look at models in other areas such as Simi and Camarillo that would be acceptable, as I understand it, within the framework, that they should come back to us if they have any continuing problems.

I just don't, as a Board, want to hear about it again five years from now when we do another renewal. I'd like to have us stay apprised of what issue the city has run up against. And if there are some

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substantive areas where we can be of assistance in helping them get through their financial or organization or bureaucratic or unfunded mandates, or any and all of those other horrors, if they really had some kind of a problem, I just would like us to stay involved with it more in the process.

MR. VERNON: I think one of the things the Board has been trying to avoid from the beginning is a command and control approach. And when we went to the State Board meeting and meeting those 85 cities, and so on, we were, in essence, putting command and control behind us.

And so I will just throw something out with the idea that it will be a point for departure.

If Staff -- I know that it's going to take some time, with a permit this flexible and with this many cities and with this many concerns of those that are not on board yet, no matter what the reason, it might be whether it was the Staff not getting back to them in a timely manner, or whatever the reason may have been, it's going to take a little time.

And if the amendment is that our staff would work with the cities to help them implement on a cost-effective basis and not something we are going to do overnight, I think we have to bear in mind that the terms

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of the permit are so flexible that if a city is implementing the permit, in the broadest terms, they are considered in compliance.

So, therefore, suppose that -- I'll throw this out. Suppose we have an additional direction to Staff that they return with a progress report to the Board, not with the idea that we are going to revise the permit, a progress report to the Board; and that we would ask Staff to set a reasonable time for that. And then that, at the progress report, that the stakeholders would be invited to the Board meeting at which the progress report was given; and that they would have the opportunity for input at that time.

MR. COE: But not another hearing?

MR. VERNON: Not another hearing, no. A progress report with a section of the progress report from Staff and a response as part of the same progress report from the stakeholders who wish to address the Board.

MR. DRANE: Mr. Chairman.

MR. COE: Let me point out that there will be -- I'm visualizing a problem with 35 cities reporting to the Board. There will be a mechanism, sort of an informal EAC or coordinating committee, that will assist perhaps with that group representing the cities --

MR. VERNON: That's right. That would be

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done.

So I would just amend the language and make it with the EACs having their section of the party.

MR. COE: Mr. Drane.

MR. DRANE: I am just wondering, if you follow that procedure, what would attract the stakeholders or the other cities who partake if they just have discussion and no input as far as an official standpoint? It wouldn't change the situation at all. What would be any reason for them to participate?

MR. VERNON: In my opinion, listening to the testimony and listening to the same thing hashed out in the Santa Monica Bay project, the thing that -- if I can quote history to you. Some of you may remember that Stonewall Jackson was asked why he was so successful, and he said, "Because I don't make council of my peers."

We have heard a great deal of that today. And I think what would motivate the cities to come back here, or the EACs to come back here, was if we were not keeping our promises.

I believe that we have heard from cities that said, "We are implementing it, and it can be done, and it can be done cost-effectively." And we have been in this area, and we know that other cities in other regions -- we have indications from EPA of they are implementing it

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cost-effectively and within the same framework and costs, apparent costs that are in our permit. We have got that as background information.

If we are not being successful in helping our cities and within our region to fall within what we have told them is reasonable and being done elsewhere, I think that is what would motivate them to come back. We need to leave that door open.

MR. COE: So it should be clear that the implementation of the permit should start immediately.

MR. VERNON: Yes. And I will make reference to that.

MS. ROGERS: I think this is just the point you are making, Chuck, to underscore it. Up in Ventura County we have been told, as they have, over the last couple of years, implemented what we are asking for and felt comfortable with it, it's not just reports from out in the outer Mongolian. We actually have people we know, cities we know, that have done this successfully.

And if the cities, therefore, that we have heard from today feel very strongly they can't do it and give it the old college try, we would like to understand why they can't when these other cities feel they can.

So I think they are going to go forward

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and do it, but we want to understand if they can't get there from here. Because a lot of them are saying they can't get there from here, but other cities have been able to.

Where is the difference?

MR. COE: Any further discussion? Could I try to state the motion?

Well, I believe there's a pollution problem. No question about that. I think some of the water quality objectives in the basin plan upon the coastal waters, particularly as to recreation, have been violated. I think the Clean Water Act requires us to act. It's been over one and a half years of meet and confer, over 60 meetings.

I also realize that many of the cities will have some significant cost problems, financial problems, that they will have to work out. I think overall, however, that this permit represents a fair compromise, and I will vote for its support.

Any further discussion before I try to restate the motion?

MR. DRANE: Call the roll.

MR. COE: Should I try to restate the motion or is that clear enough? Is it clear enough?

Call the roll.

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MS. SHIPLEY: Ms. Craven?

MS. CRAVEN: Support.

MS. SHIPLEY: Mr. Drane?

MR. DRANE: I'm very dissatisfied with the answers and response we gave the cities in not giving it consideration, so I will give it a reluctant aye.

MS. SHIPLEY: Ms. Rogers?

MS. ROGERS: Aye.

MS. SHIPLEY: Mr. Slezak?

MR. SLEZAK: Aye.

MS. SHIPLEY: Mr. Vernon?

MR. VERNON: Aye.

MS. SHIPLEY: And Mr. Coe?

MR. COE: Aye.

Thank you very much. The permit is adopted. Thank you all for coming and spending the day with us.

(At the hour of 4:55 p.m., the hearing on Item 8 was concluded.)

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STATE OF CALIFORNIA)
) SS.
COUNTY OF LOS ANGELES)

I, Debbie Strickland, CSR 9036, a certified shorthand reporter in and for the county of Los Angeles, state of California, do hereby certify;

That on Monday, July 15, 1996, I did report in stenograph writing all of the testimony and proceedings in the foregoing hearing before the California Regional Water Quality Control Board, Los Angeles/Ventura Region;

That said proceedings were thereafter reduced to typewriting under my direction.

I further certify that the foregoing is a full, true, and correct transcript of said testimony and proceedings.

I further certify that I am neither counsel for nor related to any party to said action, nor in anywise interested in the outcome thereof.

Dated this 24th day of July, 1995.

Debbie Strickland
CERTIFIED SHORTHAND REPORTER
IN AND FOR THE COUNTY OF
LOS ANGELES
STATE OF CALIFORNIA

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ITEM	NAME	REPRESENTING	ADDRESS	MAIL LIST
7.2	Gary Hattik	Oregon State University	Dept. Geosciences Corvallis OR 97331	
7.2	LARRY DIAMOND	MYSELF	4200 TIMBER CYN Rd SANTA PAULA CA 93060	X
7.2	Pete Fallini	self	341 San Clemente St. Santa Paula, CA 93060	X
	Don Koepp	Ven. Co. EHD/LEA	800 S. VICTORIA Ven. CA	
7.2	William Stratton	Vent. Co. EHD/LEA	800 S. Victoria Ventura	
8	ED SCHRODER	City of El SEGUNDO	350 MAIN ST EL SEGUNDO	X
8	Mike Stokes	Calping	323 5th Ave Venice CA 90291	
8	LORI Bender	Calping	519 South St #210 Glendale 91202	
	ANGELA + MADELINE MAINS	Healthe Bay	2944 16th ST. SM 90405	
8	Andi Nussbaum	Camp JCA Sholom + Healthe Bay	34342 Mulholland Hwy Malibu, CA 90265	
8	Cat Kuhlman	EPA	75 Hawthorne St San Francisco CA	

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ITEM	NAME	REPRESENTING	ADDRESS	MAIL LIST
	JOSEPH A. TRAINA	HEAL THE BAY	SANTA MONICA	
	GLORIA MORALES	HEAL THE BAY	SANTA MONICA	
	Marilyn White	City Redondo Beach	415 Diamond	
	John Parsons	So Bay Association of Chambers of Commerce	1860 S. Elena Ave #B Redondo Beach Ca 90277	
	Nasser Abbaszadeh	City of Azusa	213 E. Foothill Blvd. Azusa, CA 91702	
	ROBERT BAMMES	CITY OF MONROVIA	415 So. Ivy, Monrovia	
	LAURA KEDDINGTON	CITY OF LA MIRADA	15515 PHOENIX AVE	
	Shelly Inchu-Holmes	Rogers & Assoc.	1875 C. Park East #300	
	Yang Tacn	Rogers & Assoc.	1875 C. PKE #300 L.A. 90067	
	Ken Schiff	So CA Coastal Water Research	7171 Fenwick Ln Westminster CA 92683	
	JEFFREY NEIL JONES	SIERRA CLUB COASTAL PROTECTION CHAIR (ANGEL. CHAPTER	10852 BLIX ST. (#6) TOLUCA LAKE, CA 91602-1335	

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ITEM	NAME	REPRESENTING	ADDRESS	MAIL LIST
8	Cristina Madrid	Azusa	213 E Foothill Azusa City Hall	
8	Charles Sihler	Pomona	505 So Garey Ave Pomona, 91768 City Hall	
8	MARY ELLEN VOJTEK	COMPLIANCE STRATEGIES	375 S. 3RD ST #218 BURBANK, CA 91502	

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ITEM	NAME	REPRESENTING	ADDRESS	MAIL LIST
	Von Burger	SAV-MOR OIL	5150 WILSHIRE	
	Gary Carlin	SAV-mor Oil	" "	
	JACQUELINE LAMBRIGHT	PUBLIC		
	Steve Gray-Barkan	Heal the Bay 2701 Ocean Park Bl #150 Santa Monica 90405	~~c/o Skelton, Grover & Assoc 6305 Ocean St. #304 LA 90038~~	
	Katherine Stone	Cities of Fillmore & Santa Paula	3540 WPCH Ventura, Ca 93001	✓
	Jun M. Lee	Lee Clean Technology	PO Box 1972 Whittier, CA 90609-1972	
	P.G. Thyamagondalu	City of Burbank	275 E. Olive Ave Burbank, 91502	
	Nancy B Kimball	Individual	89 Pino Ct. Camarillo, CA	
	Charlene S. Bailey	INDIVIDUAL	12454 Mountain Trail Moorpark 93021	
	Jennifer Heighton	Individual	1221 Boosey Rd Santa Paula Ca 93060	
	Dolores Taylor	Ventura Co. PWA-FC	800 So Victoria, Vta 93009	

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ITEM	NAME	REPRESENTING	ADDRESS	MAIL LIST
2	[illegible]	[illegible]	13502 [illegible] [illegible] CA 91[illegible]	X
8	Virginia Calvano	80	8029 First St. Paramount, CA 90723	
8	James McCarthy	Caltrans	120 S. Spring L.A. CA 90012	
8	Raymond T. Holland	City of Long Beach	333 W. Ocean Blvd LB 90802	X
8	Alison Flesch	Environmental Media Assoc.	3679 Motor Ave LA 90034	
8	Joyce Shelby	Environmental Media Assoc	3679 Motor Ave LA 90034	
8	Harry Baldwin	City of San Gabriel	443 N Penn SG 91775	
8	Dennis Washburn	City of Calabasas Bay Watershed Council	26135 Mureau Rd Calabasas, CA 9[illegible]	

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ITEM	NAME	REPRESENTING	ADDRESS	MAIL LIST
7.2	Greene, Carolyn	City of Thousand Oaks	2100 T.O. Blvd. TO 91362	X
7.2	James O'Toole	County of Ventura	800 S Victoria Ventura CA	
8	John Wise	City of Carson	701 E Carson St PO Box 6234 Carson CA 90749	X
8	Lawrence Rudolph	City of Lomita	24200 Narbonne Ave Lomita CA	X
7.2	Bill Irwin	Bio Geo	5628 Calpine Dr Malibu CA 90265	X
8	Kathy Adibi	Surfrider Foundation	PO Box 10213 Beverly Hills, CA 90213	X
8	Robert W Bruesch	City of Rosemead San Gabriel Valley COG	8838 E Valley Blvd Rosemead, CA	
8	Bea La Pisto Kirtley	Bradbury - SGVCOG		
	Mike Kissel	Carollo Engineers	1200 N. Harbor Blvd Anaheim, CA 92801	X
8	Pierce Flynn	Surfrider Foundation		

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ITEM	NAME	REPRESENTING	ADDRESS	MAIL LIST
7.2	Brian J. Gusman	Toland LD Fill	823 N. Oak Ave.	Y
8	Robert Bronkall	City of La Habra Hts	Walnut, CA 91789 398 So Lemon Creek Dr #E	N
8	Robert Bronkall	City of Walnut	398 So. Lemon Creek Dr #E Walnut, CA 91789	N
8	Robert Bronkall	City of La Puente	398 So. Lemon Creek Dr #E Walnut, CA 91789	N
8	Ray Tahir	City of Whittier	11501 W. Olympic L.A. 90064	Y
7.2	Jay Duncan	City of Oxnard	1060 Pacific Ave. Oxnard Ca 93030	N
8	Frank Kuo	LA County DPW	900 S. Fremont Alhambra CA 91803	
7.2	Don Gunderson	VRSD/City of Fillmore	311 Forrest St Fillmore CA 93015	Y
7.2	Jim Acosta	VRSD	1001 Partridge #100 Ventura, CA 93004	
7.2	Peggy Kelly	SP Times	825 Railroad Ave SP 93060	Y
8	Sharon Perlstein	West Hollywood	8300 Santa Monica Bl West Hollywood, CA 90069	

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ITEM	NAME	REPRESENTING	ADDRESS	MAIL LIST
6	Danielle Chupa	SCE	2244 Walnut Grove Rosemead, CA 91770	Y
6,8	David Kay	SCE	"	Y
7.2	JOHN TOMMY ROSAS KINUAH / INDIAN CHUMASH NATION	MYSELF	POB 4033 SATICOY, CA 93007	Y
8	Jeff McConaghy	Myself	101 Ocean Ave 502E Santa Monica, CA 90402	no
	DOUG STAHELI	BEL AIR BAY CLUB	16801 PACIFIC CST HWY	
8	Gary Hildebrand	LA County Public Works	900 S. Fremont Alhambra, Ca. 91803	
7.2	JOHN A. F. MELTON	CITY OF SANTA PAULA	P.O. BOX 569 SANTA PAULA CA 93060	Y
7.2	Robert M. Sawyer	attorney	840 County Sq. Dr., 3d Fl. Ventura CA 93060	Y
7.2	Doris L. Bradshaw	self	19044 Santa Rita St Tarzana 91356	yes
8	Maryann Jones	SWRCB	901 P St Sacramento 95814	
8	MADELYN GLICKFELD Madelyn Glickfeld	self	28907 GRAYFOX ST MALIBU, CA 90265	Y

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ITEM	NAME	REPRESENTING	ADDRESS	MAIL LIST
8	Phil Richardson	City of LA	650 S. Spring St. Rm 700	
8	Rosemarie Peterson	City of San Dimas	245 E. Bonita Ave San Dimas CA 91773	
8	Councilman Larry Galvan	People of Cudahy	4810½ Elizabeth St Cudahy Ca 90201	
8	Farid Hentabli	City of Glendale	633 E. Broadway #204 Glendale, CA 91206	✓
8	John Hunter	JLH & Assoc	13310 Firestone Av Santa Fe Spgs CA 90670	
9	Sheila Kennedy	JLH & Asso	" "	
8	Heather Lee Wurtz (Morenda)	CAA	371 Van Ness Way #200 Torrance 90501	✓
	Beatrice LaPisto-Kirtley	S.G.V. COG	Pasadena	
8	Evelyn Langberry	concerned Santa Monica resident	817 Euclid #E Santa Monica 90403	
8	Dolphina Bastel	self	2639 Highland Ave Santa Monica 90405	X
8	Jim Van Winkle	South Pasadena	1414 Mission St South Pasadena	

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ITEM	NAME	REPRESENTING	ADDRESS	MAIL LIST
8	James Leserman	Water Replenishment Dist. of So. Calif.	12621 E. 166th St. Cerritos, CA 90703	Y
8	Steven Castellanos	City of Pico Rivera	6615 S Passons Bl Pico Rivera, CA 90660	X
8	Peter Piccaro	Surfrider Foundation South Bay Chap.	405 17th St Manhattan Bch 90266	X
8	Beth Kudlicki	Surfrider Foundation, South Bay Chap	1831 Hillcrest Dr. Hermosa Beach, CA 90254	X
8	Victor Laury	L.A.C.M.T.A.	P.O. Box 194108105 L.A., Ca. 90053	
8	Bettye Werthman	SCAG		
8	John Kao	C&C Engineering City of Industry	255 N. Hacienda Blvd. Ste. 222 Industry CA 91744	Y
8	Jerry Wedding	City of San Fernando	117 MacNeil San Fernando 91340	Y
8	Katherine Rubin	LA City Dept. of Water & Power	111 N. Hope St. Rm. 1116 Los Angeles, Ca. 90012	Y
8	ALGIRD LEIGA	CITY OF CLAREMONT	P.O. Box 880 CLAREMONT, CA 91711	Y

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ITEM	NAME	REPRESENTING	ADDRESS	MAIL LIST
8	MIKE KANTOR	CITY of LA	650 S. SPRING	✓
8	Laurie Newman	Assemblymember Sheila Kuehl	State Capitol	✓
8	Scott McVarish	NRDC		

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ITEM	NAME	REPRESENTING	ADDRESS	MAIL LIST
8	Chris Salvaggio	City of Los Angeles/Stormwater	650 S. Spring St, Suite 700	X
8	CHARLES REDDEN	CITY OF COVINA	125 E. College St. Covina CA 91723	X
8	Dorothy Green	Heal the Bay	2701 Ocean Park Blvd Santa Monica	
8	JACOB GREEN	801 HOLMBY AVE	LOS ANGELES 90024	
8	Gail Ruderman Feyer	Natural Resources Defense Council	6310 San Vicente, LA 90048	X
8	TERRY TAMMINEN	BAYKEEPER	POB 10096 MDR 90295	X
8	Picicq Flynn	Surfrider Foundation	[illegible] S. El Camino Real San Clemente, Ca	
8	Andy Goodman	Environmental Media Assoc.	3679 Motor Ave, LA 90034	
8	Mike Jenkins	Richards, Watson + Gerhart	333 S. Hope St. 38th Fl. L.A. 90071	X
8	PAUL ROSENSTEIN	MAYOR - CITY OF SANTA MONICA	1685 MAIN ST., SANTA MONICA	✓

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VOL 14

LOS ANGELES REGIONAL WATER QUALITY CONTROL BOARD
Regular 395th Board Meeting

State Office Building, 107 S. Broadway, Los Angeles

ITEM	NAME	REPRESENTING	ADDRESS	MAIL LIST
8	CHRISTOPHER JONES	SURFRIDER FOUNDATION SOUTH BAY CHAPTER	PO BOX 3825 MANHATTAN BEACH, CA 90266	✓
8	Royall Brown	Coalition of WC Homeowns	2153 Aroma Dr West Covina Ca 91791	✓
8	Toni Pogue	Heal the Bay	7720 Kyle St. Tujunga, CA 91042	
8	B. Garrett	City of Los Angeles	200 N. Spring, Rm 288 Los Angeles 90012	✓
8	~~Ora~~ Lampman	Burbank	275 E. Olive Ave. Burbank	

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VOL 14

LOS ANGELES REGIONAL WATER QUALITY CONTROL BOARD
Regular 395th Board Meeting

State Office Building, 107 S. Broadway, Los Angeles

ITEM	NAME	REPRESENTING	ADDRESS	MAIL LIST
7.2	Ed McCombs	Ventura Regional San	1500 Partridge ST Ventura Ca 93003	
	LaVern Hoffman	County of Ventura Public Works Agency	800 south Victoria Av Ventura, CA 93009	
7.2	Robert Palmer Gibson Dunn & Crutcher	Ventura County Citizens to Stop Toland Landfill	4 Park Plaza Irvine, CA 92714	
7.2	Alan N. Bick Gibson, Dunn & Crutcher	Ventura County Citizens To Stop Toland Landfill	"	
7.2	Ben Curtis	Self	805 Orcutt Rd. Santa Paula, CA 93060	
7.2	Anita S. Nelson	Self	735 Hale Rd. Santa Paula CA	
7.2	Craig Prentice	Fugro West, Inc Ventura Regional Sanitation Dist.	5855 Olivas Park Dr Ventura, CA 93003	
7.2	Rhonda Cation	VRSD	1001 Partridge Dr #150 Ventura 93003	
7.2	R K Brown	Coalition of WC Homeowners	2153 Aroma Dr West Cov 91791	✓
8.	Desi Alvarez	Glendale	633 S. Broadway Av 205, Glendale CA	

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VOL 14

LOS ANGELES REGIONAL WATER QUALITY CONTROL BOARD
Regular 395th Board Meeting

State Office Building, 107 S. Broadway, Los Angeles

ITEM	NAME	REPRESENTING	ADDRESS	MAIL LIST
	Council member Francisco Alonso	City of Monterey Park	320 W. Newmark Ave Monterey Pk., 91754	
	melissa B. Clack	Burger King Corp.	473 Washington St SF, CA 94111	
	Joyce L. Lawrence Mayor	City of Downey	11111 Brookshire Ave. Downey CA 90241	✓
8	J. Forrest	HtB	2701 Ocean Park SM 90402	
	Jane M. Bray	Consulting	734 E Rowland Covina	
	EDWARD PUTZ	CITY OF LONG BEACH	333 W OCEAN BLVD L.B.	
	Richard Schacht	Same		
	Rufus C Young Jr	Burke, Williams & Sorensen	611 West 6th St Los Angeles, 90017	✓
	Shelly Linder Holmes	Rogers + Anoe		✓
	Nancy Tack	1875 Century Park East Suite 300 Los Angeles 90067		✓

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COUNTY OF LOS ANGELES
DEPARTMENT OF PUBLIC WORKS
900 SOUTH FREMONT AVENUE
ALHAMBRA, CALIFORNIA 91803-1331
Telephone: (818) 458-5100

HARRY W. STONE, Director

ADDRESS ALL CORRESPONDENCE TO:
P.O.BOX 1460
ALHAMBRA, CALIFORNIA 91802-1460

December 20, 1994

IN REPLY PLEASE REFER TO FILE
WM-3

Dr. Robert P. Ghirelli
California Regional Water Quality
Control Board, Los Angeles Region
101 Centre Plaza Drive
Monterey Park, CA 91754-2156

Dear Dr. Ghirelli:

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
PERMIT NO. CA 0061654 - CI6948
REPORT OF WASTE DISCHARGE SUBMITTAL

As required by Task 5.2 of the current Permit, enclosed is an original and one copy of the subject Report. The Report is comprised of eight volumes. With submittal of the Report, we have provided the information requested under Tasks 5.2.1 through 5.2.6 of the current Permit.

We have received your letter dated October 31, 1994, providing comments on the draft Report provided to you on October 17, 1994. All comments were considered and, where feasible within the constraints of finalizing the Report for submittal to you, appropriate revisions were made. Comments that could not be addressed at this time will be addressed through the Permit renewal process and the further development of the stormwater management plans.

Volume 1 consists of a summary of Best Management Practices being developed and/or implemented by each Permittee, and a summary and evaluation of the baseline BMPs listed in your letter of January 11, 1993. Volume 1 was prepared to satisfy Task 5.2.2-5.2.4. It was prepared using information collected from a survey questionnaire which was sent to all Permittees. The questionnaire was prepared with the input and cooperation of your staff, and was designed to collect all information currently available from the Permittees on their existing stormwater programs. The data gathered in these surveys reflects the best information available to date regarding the required activities under the current Permit. Some of your comments on Volume 1, as stated in your October 31, 1994 letter, could not be fully addressed at this time. Addressing these comments would require information on the BMPs that has not been compiled by the Permittees through their current programs. With the transition to a watershed-wide approach to stormwater management under the upcoming Permit, a tracking system to collect this information will be built into the program.

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Volumes 2 through 7 are Stormwater Management Plans for the six watersheds proposed for the next Permit. These volumes satisfy Tasks 5.2.5 and 5.2.6 of the current Permit. The stormwater management plans are to serve as an overall framework to allow for further development of a watershed-wide approach to stormwater management. This reflects the refocusing of the stormwater program from an agency-oriented program (each Permittee developing and implementing their own program), as provided for under the current Permit, to a watershed-oriented program (all Permittees within each watershed jointly developing and implementing the same program). The watershed-oriented program was developed referencing the guidelines developed by the Regional Board staff. The comments in your October 31, 1994 letter concerning watershed-wide issues which require collective input from all agencies in the watershed will be addressed as the stormwater management plan for each watershed is fully developed under the next Permit. It should be noted that the current Permit separated the Co-Permittees into three Phases, each having a three-year program. Phase III, consisting of 30 new Co-Permittees did not begin their program until July 1993. In order to reorient the stormwater program into a watershed-oriented focus, a transitional period is needed. The Report documents the needed time to develop such a watershed-oriented program.

Volume 8 is an evaluation of the water quality data collected during the current Permit by the existing monitoring program. It also includes the work plan for the stormwater/urban runoff monitoring program being established in Phases I, II, and III. This volume satisfies Task 5.2.1 of the current Permit. We have incorporated your comments in this volume where appropriate.

If you have any questions regarding the Report, please contact Mr. Gary Hildebrand, of my staff, Monday through Thursday, 7:00 a.m. to 5:30 p.m.

Very truly yours,

HARRY W. STONE
Director of Public Works

DAVE YAMAHARA
Assistant Deputy Director
Waste Management Division

FK:ll
LETTERS\ROWD.SUB

Enc.

cc: All Permittees

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NPDES PERMIT NO. CA 0061654

TASK 5.2

REPORT OF WASTE DISCHARGE (ROWD)

VOLUME 1 OF 8 (TASK 5.2.2 - 5.2.4)

INTRODUCTION

SECTION (A) - Summary of Best Management Practices (BMPs) by Cities
SECTION (B) - Summary and Evaluation of Baseline BMPs

LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS
WASTE MANAGEMENT DIVISION
WATER QUALITY SECTION

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INTRODUCTION

SECTION (A) Summary of Best Management Practices by Cities

i. Sample Questionnaire
ii. BMP Matrix
iii. Summary of Questionnaire

SECTION (B) Summary and Evaluation of Baseline BMPs

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INTRODUCTION

On June 18, 1990, the National Pollutant Discharge Elimination System (NPDES) Permit - Order #90-079, NPDES #CA0061654-CI6948 was issued to the County of Los Angeles and 17 cities tributary to Santa Monica Bay. During the subsequent years 2 newly incorporated cities within the Santa Monica Bay Watershed, Caltrans, and the County of Ventura also became Co-Permittees. This Permit outlined a three-year program which required each Permittee to: characterize drainage areas; develop and schedule the implementation of Best Management Practices to enhance the quality of stormwater/urban runoff within its jurisdictional boundaries and storm drains it owns and operates. On July 1, 1992, 36 additional cities were initiated into the Permit and began their three-year program. By July 1, 1993, the remaining 30 cities in Los Angeles County within the drainage basin were initiated into their three-year program. The cities were grouped according to their starting dates and referred to as Phases I, II, and III, respectively (See Table A). In general, the boundaries of each Phase did not encompass whole watersheds but portions of various watersheds (See Figure 1).

The Permit has a five-year duration and although Phase III cities have only completed year one of their three year program, the Permit requires the submittal of a Report of Waste Discharge (ROWD) which serves as an application for a subsequent NPDES Permit to replace NPDES Permit #CA0061654, which expires on June 18, 1995. Therefore, the County of Los Angeles, the County of Ventura, Caltrans, and the 85 cities are submitting this Report in compliance with Task 5.2 of the current Permit. The Report comprises eight volumes: Volume 1, will consist of a summary of Best Management Practices by city and a summary and evaluation of baseline BMPs. This is prepared to satisfy Task 5.2.2 through 5.2.4 of the current Permit.

Volumes 2 through 7 are six Watershed Management Plans which joint covers all the area within the current Permit. These watersheds are: Santa Monica Bay - Malibu Creek and Other Rural Areas; Santa Monica Bay - Ballona Creek and Other Urban Areas; Dominguez Channel/Los Angeles Harbor Drainage; Los Angeles River; San Gabriel River; and Santa Clara River (See Figure 2). The agencies represented in each of the watersheds are outlined in Table B and Figure 2. These volumes are to satisfy Task 5.2.5 and 5.2.6 of the current Permit.

Volume eight will evaluate the results of the existing Monitoring Program on a Countywide basis and by the various watersheds. This volume also includes the work plans for the Monitoring Program in Phases I, II, and III of the current Permit. This volume is prepared to satisfy Task 5.2.1 of the current Permit.

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TABLE A

Grouping of Permittees by Phases

PHASE I

Agoura Hills
Beverly Hills
Calabasas
Caltrans***
Culver City
El Segundo
Hermosa Beach
Inglewood
Los Angeles***
Los Angeles County***
Malibu
Manhattan Beach
Palos Verdes Estates
Rancho Palos Verdes
Redondo Beach
Rolling Hills
Rolling Hills Estates
Santa Monica
Torrance
Ventura County
West Hollywood
Westlake Village

PHASE II

Alhambra
Arcadia
Azusa
Baldwin Park
Bradbury
Burbank
Calabasas*
Caltrans***
Claremont
Covina
Diamond Bar
Duarte
El Monte
Glendale
Glendora
Hidden Hills
Industry
Irwindale
La Canada Flintridge
La Habra Heights
La Puente
La Verne
Los Angeles***
Los Angeles County***
Monrovia
Montebello
Monterey Park
Pasadena
Pomona
Rosemead
San Dimas
San Fernando
San Gabriel
San Marino
Sierra Madre
South El Monte
South Pasadena
Temple City
Walnut
West Covina

PHASE III

Alhambra**
Artesia
Bell
Bell Gardens
Bellflower
Caltrans***
Carson
Cerritos
Commerce
Compton
Cudahy
Downey
El Segundo*
Gardena
Glendale**
Hawiian Gardens
Hawthorne
Huntington Park
Inglewood*
La Canada Flintridge**
La Habra Heights**
La Mirada
Lakewood
Lawndale
Lomita
Long Beach
Los Angeles***
Los Angeles County***
Lynwood
Maywood
Montebello**
Norwalk
Palos Verdes Estates*
Paramount
Pasadena**
Pico Rivera
Rancho Palos Verdes*
Redondo Beach
Rolling Hills*
Rolling Hills Estates*
Santa Clarita
Santa Fe Springs
Signal Hill
South Gate
South Pasadena**
Torrance*
Vernon
Whittier

Note:
* The agency is also in Phase I.
** The agency is also in Phase II.
*** The agency is in all Phases.

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FIGURE 1

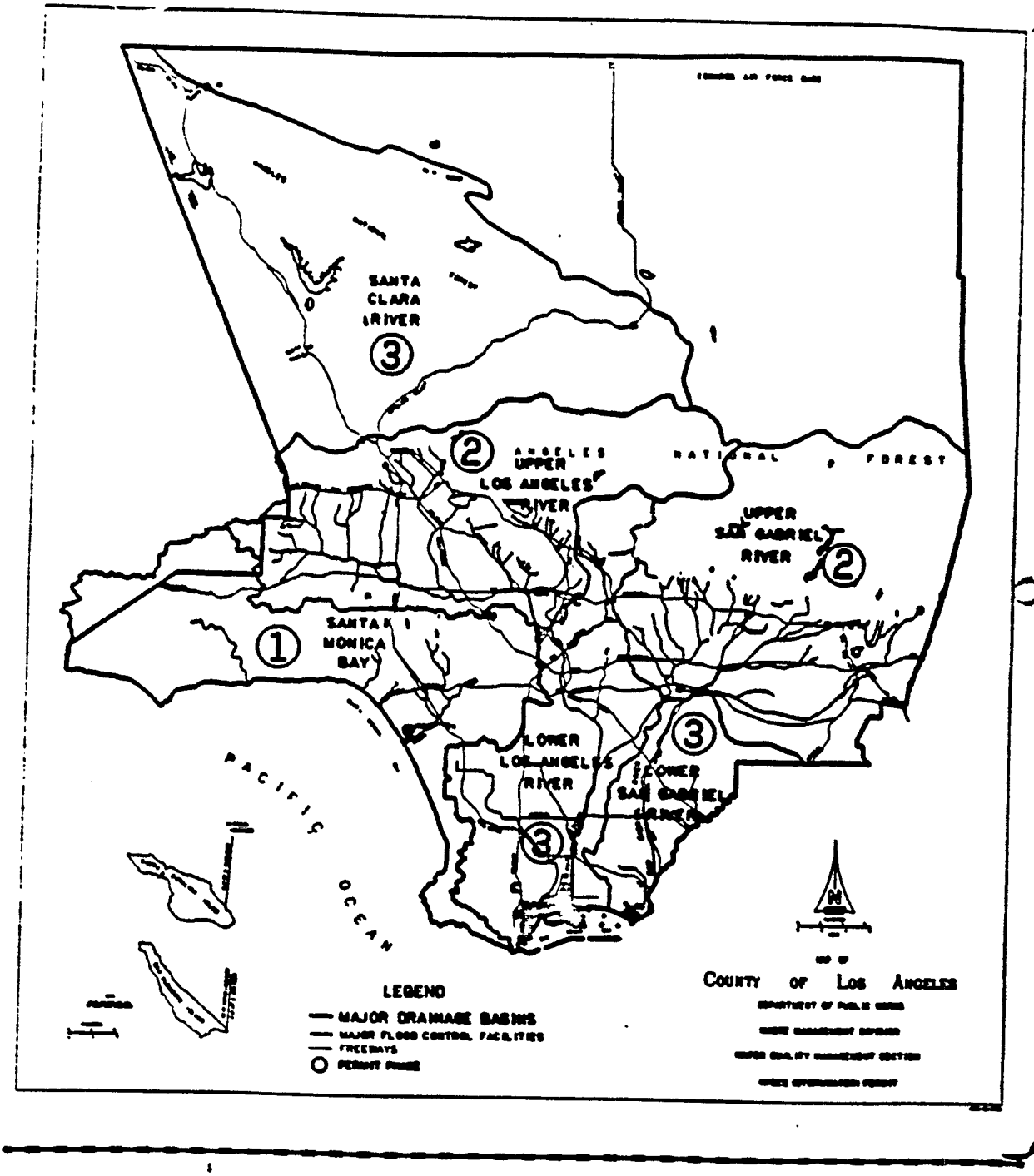

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TABLE 8

NPDES Stormwater Permit Renewal
Proposed Watershed Breakup

Santa Monica Bay

Malibu Creek and Other Rural

Agoura Hills
Calabasas
Caltrans
Los Angeles County
Malibu
Westlake Village
Ventura County

Ballona Creek and Other Urban

Beverly Hills
Caltrans
Culver City
El Segundo
Hermosa Beach
Los Angeles
Los Angeles County
Manhattan Beach
Palos Verdes Estates
Rancho Palos Verdes
Redondo Beach
Rolling Hills
Rolling Hills Estates
Santa Monica
West Hollywood

Dominguez Channel/
Los Angeles Harbor Drainage

Caltrans
Carson
Gardena
Hawthorne
Inglewood
Lawndale
Lomita
Los Angeles
Los Angeles County
Torrance

Los Angeles River

Alhambra
Arcadia
Bell
Bell Gardens
Burbank
Caltrans
Commerce
Compton
Cudahy
El Monte
Glendale
Hidden Hills
Huntington Park
La Canada Flintridge
Long Beach
Los Angeles
Los Angeles County
Lynwood
Maywood
Monrovia
Montebello
Monterey Park
Paramount
Pasadena
Rosemead
San Fernando
San Gabriel
San Marino
Sierra Madre
Signal Hill
South El Monte
South Gate
South Pasadena
Temple City
Vernon

San Gabriel River

Artesia
Azusa
Baldwin Park
Bellflower
Bradbury
Caltrans
Cerritos
Claremont
Covina
Diamond Bar
Downey
Duarte
Glendora
Hawaiian Gardens
Industry
Irwindale
La Habra Heights
La Mirada
La Puente
La Verne
Lakewood
Long Beach
Los Angeles County
Norwalk
Pomona
Pico Rivera
San Dimas
Santa Fe Springs
Walnut
West Covina
Whittier

Santa Clara River

Caltrans
Los Angeles County
Santa Clarita

Italicized agencies are present in more than one watershed.

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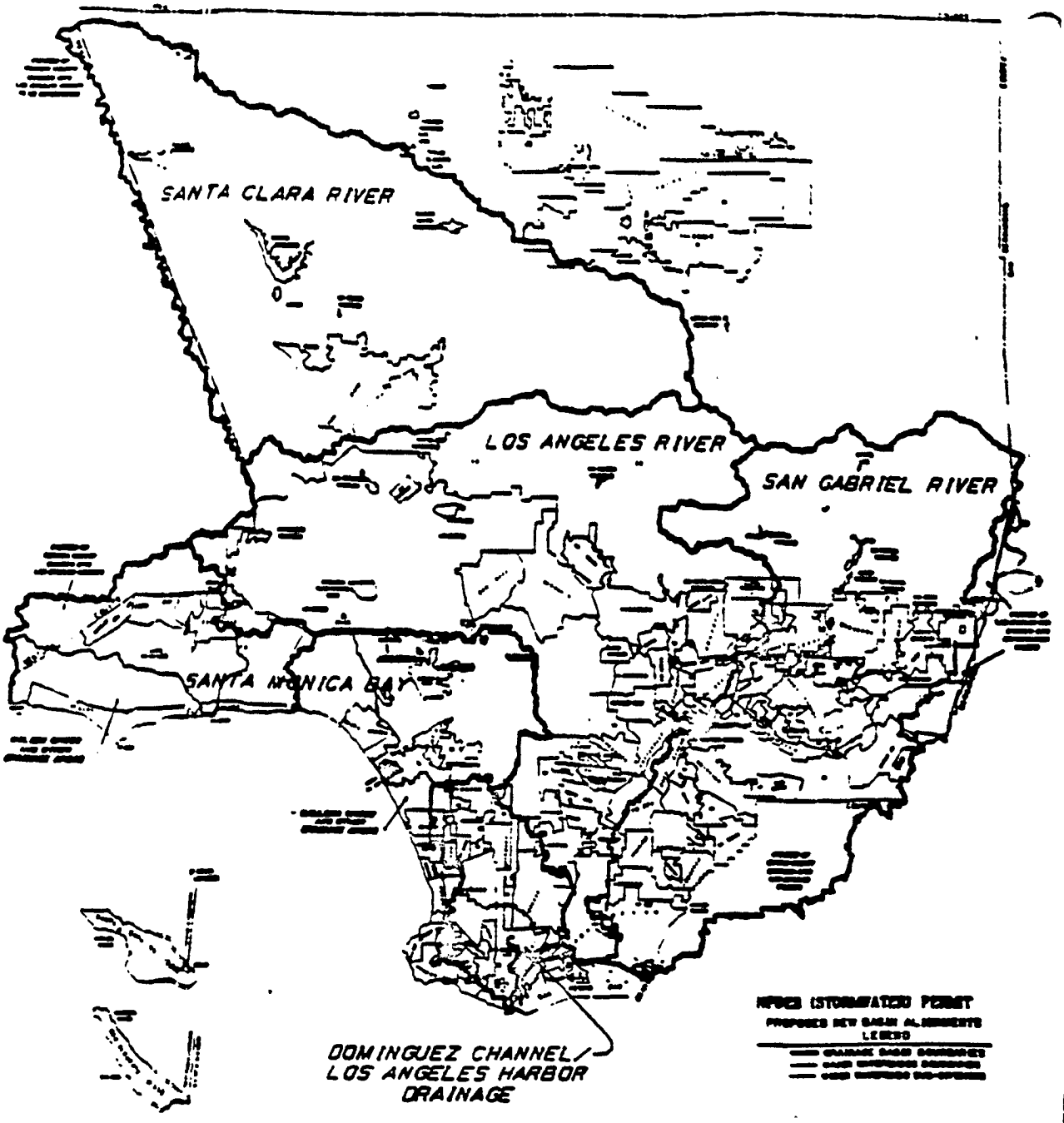
FIGURE 2



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VOL 15

REPORT OF WASTE DISCHARGE

VOLUME 1

SECTION (A)

SUMMARY OF BEST MANAGEMENT PRACTICES BY CITIES

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The original returned questionnaires and the comments sent in by Co-Permittees after the first draft of this summary was released for their review, are kept in file at the Los Angeles County Department of Public Works, Waste Management Division, Water Quality Section. Interested individuals should make arrangements with the above agency to review these documents. A copy of the original eight-page questionnaire is included as reference in the next page for the reader.

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JURISDICTION: _____ **SAMPLE QUESTIONNAIRE**

STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

OUR STORMWATER PERMIT REQUIRES THE PREPARATION OF A REPORT OF WASTE DISCHARGE WHICH IS TO INCLUDE A SUMMARY OF ALL BMP's BEING IMPLEMENTED BY EACH CO-PERMITTEE. THE PURPOSE OF THIS QUESTIONNAIRE IS TO COLLECT INFORMATION FROM EACH CO-PERMITTEE ON THE STATUS OF IMPLEMENTING THE 13 "BASELINE" BMP's AND ALL OTHER BMP's THAT ARE A PART OF YOUR PROGRAM. WE ALSO WOULD LIKE YOU TO USE THE QUESTIONNAIRE TO SUGGEST ANY OTHER BMP's THAT YOU ARE AWARE OF THAT SHOULD BE CONSIDERED FOR IMPLEMENTATION IN LOS ANGELES COUNTY.

- PLEASE BE AS COMPLETE AND CONCISE AS POSSIBLE; "BEST ESTIMATES" WILL GENERALLY BE SUFFICIENT WHERE NUMBERS ARE NEEDED. USE BACK OF PAGE IF MORE SPACE IS NEEDED; INDICATE "NA" FOR QUESTIONS THAT DO NOT APPLY.
- REFERENCES TO "CURRENT PERMIT PERIOD" MEAN THE TIME PERIOD BEGINNING WITH THE DATE YOUR AGENCY WAS REQUIRED TO COMPLY WITH THE STORMWATER/URBAN RUNOFF DISCHARGE REQUIREMENTS OF THE CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD, LOS ANGELES REGION.
- IF YOU HAVE QUESTIONS, PLEASE CALL SORIN ALEXANIAN OR LEE STARK AT (213) 974-6425 (MONDAY-THURSDAY, 7:30 AM - 6:00 PM)

---

1. STENCIL CATCH BASINS

- DO YOU OWN AND MAINTAIN CATCH BASINS? YES ___ NO ___
- HAVE YOU IMPLEMENTED A PROGRAM FOR MESSAGE STENCILING ON CATCH BASINS? YES ___ NO ___
- STENCIL DESIGN? HEAL THE BAY ___ OTHER ___ (PLEASE ATTACH COPY)
- HOW MANY HAVE BEEN STENCILED? _____ TOTAL COST TO DATE? _____
  DO YOU PLAN TO STENCIL THE OTHERS? YES ___ NO ___
- BRIEFLY EXPLAIN YOUR PROGRAM (VOLUNTEERS OR EMPLOYEES, TYPE OF MATERIALS, ETC.)_____
  _____
  _____
- DESCRIBE ANY PROBLEMS ENCOUNTERED (VANDALISM, GRAFFITI, DURABILITY, APPLICATION PROCESS, ETC.) _____
  _____
  _____
- HOW WOULD YOU DESCRIBE THE GENERAL EFFECTIVENESS OF THE CATCH BASIN STENCILING PROGRAM? _____
  _____
- CAN YOU SUGGEST ANY CATCH BASIN STENCILING PROGRAM MODIFICATIONS?_____
  _____
  _____

2. DEVELOP PROGRAMS TO PROMOTE PUBLIC REPORTING OF ILLEGAL DISCHARGES/DUMPING

- HAVE YOU IMPLEMENTED ANY PROGRAMS TO ENCOURAGE AND FACILITATE PUBLIC REPORTING OF ILLEGAL DISCHARGES/DUMPING? YES ___ NO ___

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• OTHER THAN THE COUNTY HOTLINE, HAVE YOU ESTABLISHED ANY OTHER HOTLINE OR REPORTING SYSTEM? YES ___ NO ___WHEN? _____ DESCRIBE: ____
_____

• HOW MANY REPORTINGS HAVE YOU RECEIVED? _____

• HOW DID YOU INFORM THE PUBLIC OF THE HOTLINE SERVICE AND/OR YOUR OWN REPORTING SYSTEM? _____
_____

• HAS THE HOTLINE BEEN EFFECTIVE IN DISCOURAGING ILLEGAL DISCHARGES/ DUMPING INTO THE STORMDRAIN SYSTEM? EXPLAIN: _____
_____
_____

• ARE THERE OTHER PROGRAMS THAT YOU USE OR COULD SUGGEST TO ENCOURAGE PUBLIC REPORTING? DESCRIBE: _____
_____
_____

3. <u>ADOPT RUNOFF CONTROL ORDINANCE</u>

• HAVE YOU IMPLEMENTED URBAN RUNOFF CONTROL MEASURES? Y___ N___
DESCRIBE (INCLUDE MUNICIPAL CODE NUMBERS IF APPLICABLE): _____
_____
_____

• WHEN WERE THESE MEASURES ADOPTED OR APPROVED? _____
• DO YOU THINK THESE MEASURES HAVE BEEN EFFECTIVE IN REDUCING POLLUTANTS IN URBAN RUNOFF? Y___ N___ EXPLAIN: _____
_____
_____

• HAVE YOU MODIFIED YOUR ORDINANCES THAT CONTROL URBAN RUNOFF DURING THE CURRENT PERMIT PERIOD IN RESPONSE TO REQUIREMENTS OF THE CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD? YES___ NO___
EXPLAIN: _____
_____
_____
_____

• CAN YOU SUGGEST OTHER ORDINANCE MODIFICATIONS THAT MAY BE EFFECTIVE? _____
_____

4. <u>DEVELOP PUBLIC EDUCATION AND OUTREACH PROGRAMS</u>

• HAVE YOU IMPLEMENTED PROGRAMS TO EDUCATE THE PUBLIC ON THE PROBLEM OF STORMWATER POLLUTION? Y___ N___ DESCRIBE: _____
_____
_____

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• HOW EFFECTIVE DO YOU THINK THESE OUTREACH AND EDUCATIONAL PROGRAMS HAVE BEEN IN THE REDUCTION OF STORMWATER POLLUTION?
EXPLAIN: _____

• CAN YOU SUGGEST OTHER TECHNIQUES THAT MIGHT BE EFFECTIVE IN INFORMING THE PUBLIC ON STORMWATER POLLUTION? _____

5. CLEAN CATCH BASINS REGULARLY

• DO YOU HAVE A CATCH BASIN CLEANING PROGRAM? YES___ NO___
• DESCRIBE YOUR CLEANING PROGRAM. (HOW OFTEN, WHEN, METHOD OF CLEANING, ETC.) _____

• HOW EFFECTIVE HAS YOUR CATCH BASIN CLEANING PROGRAM BEEN IN PREVENTING DEBRIS FROM ENTERING THE STORM DRAINS? EXPLAIN: _____

• HAVE YOU MODIFIED YOUR CATCH BASIN CLEANING PROGRAM DURING THE CURRENT PERMIT PERIOD IN RESPONSE TO REQUIREMENTS OF THE CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD? YES ___ NO ___ EXPLAIN: _____

6. INCREASE ROADSIDE TRASH RECEPTACLE USAGE

• DOES YOUR JURISDICTION PROVIDE PUBLIC ROADSIDE TRASH RECEPTACLES? YES___ NO___ HOW MANY? _____
• HOW OFTEN ARE THE RECEPTACLES EMPTIED? _____
• HAVE YOU IDENTIFIED PROBLEM LITTER AREAS AND, IF SO, HAVE YOU MADE SPECIAL PROVISIONS TO COLLECT THIS LITTER? EXPLAIN: _____

• HAVE YOU MODIFIED YOUR ROADSIDE TRASH RECEPTACLE PROGRAM DURING THE CURRENT PERMIT PERIOD IN RESPONSE TO REQUIREMENTS OF THE CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD? YES ___ NO ___
EXPLAIN:___ _____

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7. INCREASE STREET SWEEPING

• DO YOU HAVE A ROUTINE STREET SWEEPING PROGRAM? YES___ NO___

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• HOW MANY MILES OF IMPROVED STREETS ARE THERE IN YOUR JURISDICTION? ___
• NUMBER OF CURB MILES SWEPT? ____ NUMBER OF SWEEPER TYPE: VACUUM ___ BROOM____
• CURB MILES USING THIS EQUIPMENT: VACUUM ____ BROOM ____
• SWEEPING FREQUENCY: RESIDENTIAL ____ COMMERCIAL ____ INDUSTRIAL ____
• HAVE YOU MODIFIED YOUR STREET SWEEPING PROGRAM DURING THE CURRENT PERMIT PERIOD IN RESPONSE TO REQUIREMENTS OF THE CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD? YES ___ NO ___ EXPLAIN: _____

• HOW EFFECTIVE HAS YOUR INCREASED STREET SWEEPING PROGRAM BEEN IN PREVENTING DEBRIS THAT HAVE COLLECTED IN STREETS AND GUTTERS FROM ENTERING THE STORM DRAIN SYSTEM? _____

8. <u>DISCOURAGE IMPROPER DISPOSAL OF LITTER, LAWN CLIPPINGS AND PET FECES</u>

• DO YOU HAVE PROGRAMS DESIGNED TO DISCOURAGE IMPROPER DISPOSAL OF LITTER, LAWN CLIPPINGS AND PET FECES? YES ___ NO ___ DESCRIBE: ___

• ARE THERE PENALTIES FOR IMPROPER TRASH DISPOSAL? YES ___ NO ___
• HAVE YOU MODIFIED THIS PROGRAM DURING THE CURRENT PERMIT PERIOD IN RESPONSE TO REQUIREMENTS OF THE CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD? YES ___ NO ___ EXPLAIN: _____

• CAN YOU SUGGEST OTHER TYPES OF PROGRAMS TO DISCOURAGE IMPROPER LITTER DISPOSAL? _____

9. <u>INSPECT AUTO PARTS, REPAIR AND BODY SHOPS; GASOLINE STATIONS AND RESTAURANTS</u>

• DO YOU HAVE AN INDUSTRIAL WASTE INSPECTION PROGRAM? DESCRIBE: _____

• DO YOU INSPECT FOR NON-STORM WATER DISCHARGES TO THE STORM DRAIN SYSTEM? YES ___ NO ___ EXPLAIN: _____

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• AS PART OF YOUR PROGRAM, DO YOU INSPECT THE FOLLOWING TYPES OF BUSINESSES? IF SO, HOW OFTEN?

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- AUTO PARTS: YES ___ NO ___ _____
- AUTO REPAIR: YES ___ NO ___ _____
- AUTOBODY SHOPS: YES ___ NO ___ _____
- GASOLINE STATIONS: YES ___ NO ___ _____
- RESTAURANTS: YES ___ NO ___ _____
- OTHER? _____

• UNDER WHAT LEGAL AUTHORITY DO YOU CONDUCT YOUR INSPECTIONS? _____
_____

• WHAT IS THE APPROXIMATE PERCENTAGE OF NON-COMPLIANCE? _____
• DO YOU TRACK VIOLATIONS BY INDUSTRY TYPE YES ___ NO ___
• HOW ARE VIOLATIONS ENFORCED? _____
_____

• HAVE YOU MODIFIED YOUR INDUSTRIAL WASTE INSPECTION PROGRAM DURING THE CURRENT PERMIT PERIOD IN RESPONSE TO REQUIREMENTS OF THE CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD? YES ___ NO ___ EXPLAIN: _____
_____
_____

10. ENCOURAGE REMOVAL OF DIRT, RUBBISH AND DEBRIS FROM SIDEWALKS AND ALLEYS

• DO YOU HAVE A PUBLIC OUTREACH/EDUCATION PROGRAM TO ENCOURAGE THE PUBLIC TO REMOVE DIRT, RUBBISH AND DEBRIS FROM SIDEWALKS AND ALLEYS? EXPLAIN: _____
_____
_____
_____

• HOW WELL HAVE THE FOLLOWING SECTORS OF THE COMMUNITY RESPONDED TO THE PROGRAM? RESIDENTIAL _____ COMMERCIAL _____
INDUSTRIAL _____
• HAVE YOU MODIFIED THIS OUTREACH PROGRAM DURING THE CURRENT PERMIT PERIOD IN RESPONSE TO REQUIREMENTS OF THE CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD? YES ___ NO ___ EXPLAIN: _____
_____
_____

• CAN YOU SUGGEST OTHER OUTREACH PROGRAMS THAT COULD BE EFFECTIVE? ____
_____
_____

11. PROMOTE RECYCLING

• HAVE YOU IMPLEMENTED A RECYCLING PROGRAM? YES ___ NO ___
• DO YOU HAVE A PERMANENT RECYCLING CENTER? YES ___ NO ___

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• DO YOU ROUTINELY COLLECT MATERIALS AT CURBSIDE? YES ___ NO ___
• WHAT MATERIALS ARE RECYCLED? _____

• HAVE YOU ESTABLISHED A COMPREHENSIVE PUBLIC OUTREACH AND EDUCATION PROGRAM ON THE BENEFITS OF RECYCLING? YES ___ NO___

• WHAT ARE THE ELEMENTS OF THIS PROGRAM? _____

• DESCRIBE OTHER COMPONENTS OF YOUR RECYCLING PROGRAM:_____

• PLEASE ESTIMATE THE PERCENTAGE OF RUBBISH THAT IS BEING DIVERTED FROM LAND FILLS AT THIS TIME _____
• HAVE YOU MODIFIED YOUR RECYCLING PROGRAM DURING THE CURRENT PERMIT PERIOD IN RESPONSE TO REQUIREMENTS OF THE CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD? YES ___ NO ___ EXPLAIN: _____

• DESCRIBE ANY ALTERNATIVES TO YOUR PRESENT PROGRAM THAT YOU HAVE TRIED, CONSIDERED OR PLAN TO IMPLEMENT: _____

12. <u>MOTIVATE RESIDENTS TO PROPERLY DISPOSE OF HOUSEHOLD HAZARDOUS WASTE</u>

• DO YOU PARTICIPATE IN THE COUNTYWIDE HOUSEHOLD HAZARDOUS WASTE MANAGEMENT PROGRAM?
YES ___ NO ___

• DO YOU CONDUCT ADDITIONAL HOUSEHOLD HAZARDOUS WASTE COLLECTIONS?
YES ___ NO ___ EXPLAIN (PERMANENT FACILITY, FREQUENCY OF COLLECTION, ETC): _____

• DO YOU HAVE OTHER METHODS TO HELP ENSURE PROPER DISPOSAL OF HOUSEHOLD HAZARDOUS WASTE? EXPLAIN: _____

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• HAVE YOU MODIFIED YOUR HOUSEHOLD HAZARDOUS WASTE COLLECTION/DISPOSAL PROGRAM DURING THE CURRENT PERMIT PERIOD IN RESPONSE TO REQUIREMENTS OF THE CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD? YES ___ NO ___ EXPLAIN:
_____

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• HOW EFFECTIVE DO YOU THINK YOUR PROGRAM IS IN ENCOURAGING THE PROPER DISPOSAL OF HOUSEHOLD HAZARDOUS WASTE? _____

• CAN YOU SUGGEST OTHER WAYS OF ENCOURAGING PROPER DISPOSAL OF HOUSEHOLD HAZARDOUS WASTE? _____

13. ENCOURAGE CONSERVATION OF WATER

• DO YOU HAVE A WATER CONSERVATION PROGRAM THAT REDUCES RUNOFF TO STORM DRAINS FROM OUTDOOR WATER USE? YES ___ NO ___ EXPLAIN: _____

• DO YOU HAVE A PROGRAM TO INFORM THE PUBLIC REGARDING THE SEDIMENTS, WASTE MATERIALS AND CONTAMINANTS CARRIED TO THE DRAINAGE SYSTEM ASA RESULT OF RUN-OFF FROM OVER-WATERING LANDSCAPING, WASHING SIDEWALKS, CARS, ETC. YES ___ NO ___ EXPLAIN: _____

• HAVE YOU MODIFIED YOUR WATER CONSERVATION PROGRAMS DURING THE CURRENT PERMIT PERIOD IN RESPONSE TO REQUIREMENTS OF THE CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD? YES ___ NO ___ EXPLAIN: __

14. OTHER BMP PROGRAMS

• PLEASE USE THIS SECTION TO DESCRIBE ALL OTHER BMP'S BEING IMPLEMENTED OR PROPOSED FOR IMPLEMENTATION BY YOUR AGENCY. ALSO, IF YOU HAVE HEARD ABOUT OTHER BMP PROGRAMS THAT SHOULD BE CONSIDERED FOR USE IN THE LOS ANGELES BASIN, WE WOULD LIKE TO HEAR ABOUT THEM. PLEASE USE A SEPARATE SHEET FOR EACH PROGRAM AND PROVIDE THE SAME TYPE OF INFORMATION ASKED FOR THE ABOVE BMP'S, INCLUDING (BUT NOT LIMITED TO):

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- THE TITLE OF PROGRAM (PUBLIC OUTREACH, STORMDRAIN INSPECTION, CONSTRUCTION POLLUTION CONTROL, ETC.) _____

- THE STATUS OF THE PROGRAM: 1) IN OPERATION YES ___ NO ___, 2) BEING CONSIDERED YES___ NO ___ 3) SCHEDULED FOR *

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IMPLEMENTATION YES ___ NO ___ IF YES FOR 3) ONLY INCLUDE SCHEDULE.

_____

_____

- THE PROGRAM OBJECTIVES _____

_____

- THE DESCRIPTION OF PROGRAM OPERATIONS, INCLUDING ANY STANDARDS USED AND MODIFICATIONS THAT MAY HAVE BEEN MADE TO ORIGINAL PROGRAM _____

_____

- PENALTIES, IF ANY, FOR NON-COMPLIANCE _____
- THE LENGTH OF TIME PROGRAM HAS BEEN IN OPERATION _____
- THE EFFECTIVENESS OF THE PROGRAM, OR FOR PROGRAMS NOT IMPLEMENTED, DESCRIBE POTENTIAL.

_____

_____

- CITE OTHER RELEVANT INFORMATION, INCLUDING POTENTIAL PROGRAM USEFULNESS. _____

_____

_____

PLEASE INCLUDE ANY ORDINANCES OR OTHER WRITTEN MATERIAL THAT MAY HELP US UNDERSTAND THE ABOVE PROGRAM

• • •

WHO CAN WE CONTACT IF WE NEED ADDITIONAL INFORMATION?

NAME _____

POSITION _____

PHONE _____

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BMP MATRIX: RATING CRITERIA

The following criteria were used to create the preceding draft matrix, summarizing the status of BMP's by jurisdiction. It should be noted that: a) status is based on current achievements, not programs that may be in the planning stages and b) criteria level was based on the information provided through the questionnaires.

1. STENCIL CATCH BASINS

FULLY IMPLEMENTED.....All catch basins stenciled.
PARTIALLY IMPLEMENTED.....Some catch basins stenciled.
PLANNED/PROPOSED.....Indication that City is developing program.
NOT IMPLEMENTED.....No indication that City will implement program.

2. DEVELOP PROGRAMS TO PROMOTE PUBLIC REPORTING OF ILLEGAL DISCHARGES/DUMPING

FULLY.....City participates in reporting and has an active public outreach program.
PARTIALLY.....City participates in reporting and is planning a public outreach program.
PLANNED.....Indication that City plans to promote hotline.
NOT.....No indication that City is addressing BMP.

3. ADOPT RUNOFF ORDINANCE

FULLY.....Adopt or modify codes to improve runoff control.
PARTIALLY.....Identify or draft codes/ordinances.
PLANNED.....Indication that work is planned.
NOT.....No indication that City plans to control runoff.

4. DEVELOP PUBLIC EDUCATION AND OUTREACH PROGRAMS

FULLY.....Articles in newsletter and/or similar publication. Also, developed 2 or more pamphlets/brochures.
PARTIALLY.....Pamphlets/brochures available for public.
PLANNED.....Indication that outreach programs will begin.
NOT.....No indication that City is addressing outreach.

5. CLEAN CATCH BASINS REGULARLY

FULLY.....Cleaned at least once a year.
PARTIALLY.....Cleaned in response to complaints only.
PLANNED.....Indication that City will implement program.
NOT.....No indication that City will implement program.

6. INCREASE ROADSIDE TRASH RECEPTACLE USAGE

FULLY.....Receptacles emptied on a regular basis. Litter prone areas inspected and receptacles added as needed.
PARTIALLY.....Cleaned as needed; no inspection of litter prone areas.
PLANNED.....Indication that City will provide receptacles.
NOT.....No indication that City will provide receptacles.

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7. INCREASE STREET SWEEPING

FULLY.....All streets swept at least once a month.
PARTIALLY.....Streets swept in response to complaints only.
PLANNED.....City plans to implement street sweeping.
NOT.....No indication that City will sweep streets.

8. DISCOURAGE IMPROPER DISPOSAL OF LITTER, LAWN CLIPPING, PET FECES

FULLY.....Articles in City newsletters and/or ordinance. Also, at least one handout and penalties for improper disposal.
PARTIALLY.....Pamphlets/brochures available for public.
PLANNED.....Indication that City will implement program.
NOT.....No indication that City will implement program.

9. INSPECT AUTOMOBILE USES AND RESTAURANTS

FULLY.....Regular inspection program in place, including illegal discharge.
PARTIALLY.....Officials inspect on as needed basis.
PLANNED.....Indication that program is being developed.
NOT.....No indication that City will implement inspections.

10. ENCOURAGE REMOVAL OF DIRT, RUBBISH & DEBRIS FROM SIDEWALKS/ALLEYS

FULLY.....Articles in newsletters/other similar format. Also, at least one handout.
PARTIALLY.....Pamphlets/brochures available for public.
PLANNED.....Indication that program is being developed.
NOT.....No indication that City will implement program.

11. PROMOTE RECYCLING

FULLY.....Established recycling program, including scheduled curbside pickup and public education.
PARTIALLY.....Recycling facilities provided and/or non-scheduled curbside pickup and no education program.
PLANNED.....Indication that City is developing recycling program.
NOT.....No indication that City will implement recycling.

12. MOTIVATE RESIDENTS TO PROPERLY DISPOSE OF HOUSEHOLD HAZARDOUS WASTE

FULLY.....Participates in either the County round-up or has own waste collections.
PARTIALLY.....N/A
PLANNED.....Indication that City will implement program.
NOT.....No indication that City will implement program.

13. ENCOURAGE CONSERVATION OF WATER

FULLY.....Articles in newsletter and/or ordinance. Also, at least one handout.
PARTIALLY.....Pamphlets/brochures available to public.
PLANNED.....Indication that City will develop program.
NOT.....No indication that city will develop program.

* * *

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BEST MANAGEMENT PRACTICES
Matrix

Revision: 11/08/94

Num	CITY	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1.	AGOURA HILLS	10	10	10	10	10	10	10	10	10	X	10	10	10
2.	ALHAMBRA	P	10	10	10	10	10	10	10	10	10	10	10	10
3.	ARCADIA	P	5	P	10	10	10	10	5	P	X	10	10	5
4.	ARTESIA	P	10	5	P	10	10	10	P	10	X	10	10	X
5.	AZUSA	P	P	P	P	5	5	10	5	5	P	P	10	P
6.	BALDWIN PARK	P	10	X	P	10	10	10	5		5	5	10	
7.	BELL	P	P	P	P	10	P	10	5	P	P	P	10	P
8.	BELLFLOWER	10	10	10	P	10	10	10	5	10	P	10	10	P
9.	BELL GARDENS	P	P	P	P	P	5	10	P	P	P	10	10	P
10.	BEVERLY HILLS	10	10	10	5	10	10	10	10	10	10	10	10	10
11.	BRADBURY													
12.	BURBANK	X	X	10	P	10	10	10	5	5	P	10	10	5
13.	CALABASAS	5	10	5	P	10	10	10	5	X	X	10	10	5
14.	CAL TRANS	5	5	10	5	5	5	5	5	* NA	* NA	* NA	* NA	10
15.	CARSON	5	10	10	10	10	5	10	5	10	5	10	10	5
16.	CERRITOS	P	10	P	P	10	5	10	5	5	X	X	10	5
17.	CLAREMONT	P	P	P	P	10	5	10	X	5	X	5	10	5
18.	COMMERCE	P	P	5	P	10	10	10	10	5	P	10	10	5
19.	COMPTON	P	5	X	P	10	5	10	10	10	5	10	10	5
20.	COVINA	P	5	10	5	5	5	10	P	P	P	10	10	5
21.	CUDAHY	P	P	P	P	10	10	10	5	10	P	P	10	P
22.	CULVER CITY	10	10	10	10	10	10	10	10	10	10	10	10	5
23.	DIAMOND BAR	10	10	10	5	10	* NA	10	5	10	5	10	10	5
24.	DOWNEY	5	5	10	P	10	10	10	5	5	5	10	10	5
25.	DUARTE	P	10	10	10	10	10	10	5	10	5	10	10	5

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BEST MANAGEMENT PRACTICES
Matrix

Revision: 11/08/94

Num	CITY	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
26.	EL MONTE	10	P	10	S	10	S	10	S	10	S	S	10	X
27.	EL SEGUNDO	10	10	S	10	10	10	10	10	10	10	10	10	10
28.	GARDENA	P	P	S	P	10	X	10	P	10	P	10	10	P
29.	GLENDALE	X	S	P	X	10	S	10	S	10	X	10	10	X
30.	GLENDORA	10	10	P	10	10	10	10	P	S	10	10	10	10
31.	HAWAIIAN GARDENS	P	10	X	P	10	10	10	S	S	S	X	10	S
32.	HAWTHORNE	10	10	10	S	10	10	10	10	S	S	10	10	10
33.	HERMOSA BEACH	10	10	P	10	10	S	10	10	P	P	10	10	P
34.	HIDDEN HILLS	P	10	10	10	10	S	10	S	* NA	* NA	10	10	10
35.	HUNTINGTON PARK	P	S	P	P	10	10	10	10	P	P	S	10	S
36.	INDUSTRY	P	10	10	S	10	10	10	10	S	10	P	10	10
37.	INGLEWOOD	10	X	P	10	10	10	10	S	S	S	S	10	10
38.	IRWINDALE	P	S	P	X	10	10	10	X	10	P	10	10	X
39.	LA CANADA-FLINTRIDGE	P	10	10	10	10	10	10	S	10	10	10	10	X
40.	LA HABRA HEIGHTS	P	10	S	P	10	X	X	X	X	X	S	10	S
41.	LAKEWOOD	P	10	P	P	10	10	10	P	10	X	S	10	10
42.	LA MIRADA	P	10	S	10	10	X	10	P	X	S	P	10	10
43.	L.A. CO. PUBLIC WORKS	S	10	10	10	10	10	10	10	10	10	10	10	10
44.	LA PUENTE	P	10	S	10	10	10	10	X	10	S	10	10	P
45.	LA VERNE	P	X	X	X	S	S	10	S	S	X	10	10	10
46.	LAWNDALE	P	X	P	X	10	S	10	X	10	X	S	10	X
47.	LOMITA	P	X	X	X	10	S	10	X	10	X	10	10	S
48.	LONG BEACH	P	10	P	S	10	10	10	P	10	S	10	10	P
49.	LOS ANGELES	S	10	S	10	10	S	10	10	10	S	10	10	10
50.	LYNWOOD	P	10	P	10	10	10	10	S	10	P	X	10	X

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BEST MANAGEMENT PRACTICES
Matrix

Revision: 11/08/94

Num	CITY	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
51.	MALIBU	10	10	10	10	5	• NA	10	10	P	10	10	10	5
52.	MANHATTAN BEACH	10	10	10	10	10	10	10	10	5	10	10	10	10
53.	MAYWOOD	P	P	P	P	10	P	10	5	P	P	P	10	P
54.	MONROVIA	X	10	P	10	10	10	10	5	P	P	10	10	5
55.	MONTEBELLO	5	10	10	P	10	10	10	10	5	5	10	10	5
56.	MONTEREY PARK	P	5	5	10	10	10	10	5	P	5	10	10	5
57.	NORWALK	P	10	10	P	10	10	10	5	10	5	P	10	10
58.	PALOS VERDES ESTATES	10	10	10	10	10	10	10	5	5	5	10	10	10
59.	PARAMOUNT	P	P	P	P	10	10	10	5	P	5	5	10	5
60.	PASADENA	P	10	10	10	10	10	10	10	10	P	10	10	10
61.	PICO RIVERA	10	P	10	5	10	10	10	10	5	5	5	10	5
62.	POMONA	P	10	10	P	10	10	10	5	10	5	10	10	10
63.	RANCHO PALOS VERDES	10	10	5	10	10	10	10	10	P	10	10	10	10
64.	REDONDO BEACH	10	10	10	5	10	10	10	10	5	5	10	10	5
65.	ROLLING HILLS	5	10	10	10	10	• NA	• NA	10	• NA	• NA	10	10	10
66.	ROLLING HILLS ESTATES	10	10	10	10	10	10	10	10	10	10	10	10	10
67.	ROSEMEAD	P	10	P	5	10	10	10	5	P	5	10	10	5
68.	SAN DIMAS	5	10	10	P	10	10	10	5	10	X	10	10	5
69.	SAN FERNANDO	10	10	10	P	10	10	10	5	10	5	10	10	10
70.	SAN GABRIEL	P	10	X	5	10	10	10	X	5	X	10	10	5
71.	SAN MARINO	10	10	10	10	10	10	10	10	P	10	10	10	10
72.	SANTA CLARITA	5	10	10	10	5	10	10	X	10	5	10	10	10
73.	SANTA FE SPRINGS	X	10	10	5	10	10	10	5	10	10	5	10	5
74.	SANTA MONICA	10	10	10	10	10	10	10	5	10	10	10	10	10
75.	SIERRA MADRE	X	X	X	X	10	10	10	X	5	X	10	10	5

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BEST MANAGEMENT PRACTICES
Matrix

Revision: 11/08/96

Num	CITY	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
76.	SIGNAL HILL	P	10	10	10	10	10	10	10	10	10	10	10	10
77.	SOUTH EL MONTE	P	10	X	10	10	10	10	5	10	10	10	10	10
78.	SOUTH GATE	P	5	10	10	10	10	10	P	10	5	10	10	10
79.	SOUTH PASADENA	X	X	X	X	10	10	10	5	10	X	10	10	5
80.	TEMPLE CITY	X	X	X	X	10	10	10	5	10	5	10	10	5
81.	TORRANCE	5	10	10	10	10	10	10	10	5	10	10	10	10
82.	VENTURA COUNTY	P	X	10	10	5	* NA	10	5	10	5	10	10	10
83.	VERNON	P	10	10	5	10	10	10	5	10	5	10	10	P
84.	WALNUT	P	10	10	P	10	10	10	5	10	10	10	10	5
85.	WEST COVINA	5	5	10	5	10	10	10	5	10	5	5	10	5
86.	WEST HOLLYWOOD	10	10	10	10	10	10	10	10	10	10	10	10	10
87.	WESTLAKE VILLAGE	10	10	5	10	10	* NA	10	5	5	10	10	10	10
88.	WHITTIER	5	X	10	5	10	10	10	5	10	P	10	10	5
Total	Fully Implemented (10)	23	55	44	36	79	61	84	26	45	20	64	86	33
	Partially Implemented (5)	13	11	12	16	7	16	1	43	21	31	12	0	35
	Planned/Proposed (P)	44	11	21	27	1	2	0	9	14	17	7	0	11
	Not Implemented (X)	7	10	10	8	0	3	1	9	3	17	3	0	7
	NA/No City Response	1	1	1	1	1	6	2	1	5	3	2	2	2
%	Fully Implemented (10)	26.14%	62.50%	50.00%	40.91%	89.77%	69.32%	95.45%	29.55%	51.14%	22.73%	72.73%	97.73%	37.50%
	Partially Implemented (5)	14.77%	12.50%	13.64%	18.18%	7.95%	18.18%	1.14%	48.86%	23.86%	35.23%	13.64%	0.00%	39.77%
	Planned/Proposed (P)	50.00%	12.50%	23.86%	30.68%	1.14%	2.27%	0.00%	10.23%	15.91%	19.32%	7.95%	0.00%	12.50%
	Not Implemented (X)	7.95%	11.36%	11.36%	9.09%	0.00%	3.41%	1.14%	10.23%	3.41%	19.32%	3.41%	0.00%	7.95%
	NA/No City Response	1.14%	1.14%	1.14%	1.14%	1.14%	6.82%	2.27%	1.14%	5.68%	3.41%	2.27%	2.27%	2.27%

**SYMBOLS
10 Fully Implemented
5 Partially Implemented
P Planned/Proposed
X Not Implemented
* NA Not Applicable
No City Response

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SUMMARY
STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF AGOURA HILLS

City of Agoura Hills: Phase I Co-Permittee
Population (1994): 21,000
Land area: 8.05 sq. mi.

Agoura Hills is located along the Ventura (101) Freeway, 32 miles west of downtown Los Angeles. In 1994 it ranked 64th in population in Los Angeles County. The City land use mix is overwhelmingly low density residential and it has a small job base with services being the predominant sector. Its median family income was $76,361 in 1989.

1. The City has stenciled all of its 105 catch basins with the Heal the Bay design. Los Angeles County Public Works completed the painting and maintains the catch basins.

2. City publicity (newspaper articles, City newsletter, information brochures, etc) encourage reporting of illegal discharges to either the City Public Works Department or the Sheriff's.

3. An urban runoff ordinance is in place in the City. It addresses urban runoff, low head drainage, water efficient landscapes and overspray. A water conservation ordinance was also adopted.

4. Public education pamphlet series promotes "good housekeeping" practices for the construction trades. Two most recent City newsletters address NPDES issues.

5. Catch basins are cleaned annually by County Public Works in the fall and as needed.

6. Six trash receptacles are emptied three times weekly. Litter prone areas are monitored by City staff and cleaned as needed.

7. All 62 miles of streets (1631 curb miles) are swept 1 time per month. 164 tons of material is collected yearly.

8. City ordinance requires proper disposal of materials. Penalty provisions are included in the ordinance.

9. The City contracts with Los Angeles County Public Works for industrial waste services. The inspection program is the same as that provided in the unincorporated areas. City responds to "dumping in progress" calls.

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10. County Code Title 16, adopted by reference, requires that rights-of-way be kept clean. City code enforcement officer assists private owners and encourages fencing to deter illegal dumping. No expansion of this program is anticipated due to budget constraints.

11. A recycling program is in effect, diverting 14% of rubbish from landfills. Commercial recycling is planned.

12. The City participates in the County's hazardous waste management program. City distributes a booklet on proper waste disposal.

13. City ordinances address runoff, low head drainage, water efficient landscape and overspray and water conservation. City newsletter with articles on water conservation is delivered to all residents.

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SUMMARY
STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF ALHAMBRA

City of Alhambra: Phase II Co-Permittee
Population (1994): 86,300
Land area: 7.626 sq. mi.

Alhambra is located 8 miles northeast of the Los Angeles Civic Center, in the West San Gabriel Valley. It was incorporated in 1903 and ranks 19th among Los Angeles County cities in terms of its 1994 population. Its land uses are primarily residential but it also has a large job base dominated by services and retail trade. The City median family income in 1989 was $34,170.

1. The City is in the process of obtaining City Council approval for stenciling catch basins.

2. City publicity via public education, mailers, newsletter and outreach events inform the public of the County hotline.

3. An urban runoff ordinance was adopted by the City a few years ago. It prohibits illicit discharges into municipal sewers, streets, alleys and public property. Future ordinance will address stormwater run-off pollution.

4. Public education campaigns used include City sponsored events, mailers, newsletters, flyers, school presentations, City Hall tours.

5. 356 City owned catch basins are cleaned manually at least annually and more frequently as needed.

6. 135 trash receptacles are emptied three times a week.

7. All 150 miles of improved streets (300 curb miles) are swept weekly in residential areas and daily in commercial and industrial areas.

8. City ordinance prohibits disposal of refuse, debris, garbage etc. on public rights of ways. Penalties are included in ordinance. Program supported by articles in City newsletters and brochures.

9. The Los Angeles County Sanitation District is contracted to perform annual inspections and to issue industrial waste discharge permits. Legal authority falls under the Alhambra Municipal Code, Fire Prevention and Hazardous Material Code.

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10. The Alhambra Municipal Code requires individual property owners to maintain public areas adjacent to their property. Program supported by articles in City newsletters and brochures.

11. A recycling program including a recycling center is in effect. Public outreach is established to involve all waste generators in the City. The City's goal is to divert 25% of the rubbish by 1995.

12. The City is a participant in the Countywide household hazardous waste management program. A contract will shortly be finalized to allow Chief Auto Parts to collect waste motor oil from Alhambra residents.

13. A water conservation ordinance is in place. Outreach programs via fliers, mailers and presentations educate residents about water conservation and water conserving nozzles are provided to residents.

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SUMMARY
STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF ARCADIA

City of Arcadia: Phase II Co-Permittee
Population (1994): 49,800
Land area: 11.36 sq. mi.

Arcadia was incorporated in 1903 and it is located 16.5 miles northeast of the Los Angeles Civic Center along the 210 (Foothill) Freeway. In 1994 it is the 38th most populous City in Los Angeles County. Arcadia has primarily residential land uses but it also has a large job base, mainly in the retail trade and service industries. It had a median family income of $57,238 in 1989.

1. The City intends to contract with the Los Angeles County Department of Public Works to stencil all City-owned catch basins. An alternate design than Heal the Bay's is planned.

2. Arcadia's Police and Fire Communications Center will handle calls regarding illegal dumping. The City is developing a water bill insert listing the County's and the City's Hotline phone numbers.

3. A draft Stormwater and Discharge Control Ordinance (No. 2010) is anticipated to be adopted August 16, 1994.

4. Articles related to stormwater discharge have, and will continue to appear in the City's newsletter as well as water bill inserts.

5. Catch basins are cleaned annually, inspected after heavy rainstorms for debris, and problem basins are inspected regularly.

6. Arcadia has 200 roadside trash receptacles that are emptied weekly. Problem litter areas are inspected after weekends and holidays.

7. Six broom type sweepers are used to sweep all 146 miles (24,000 curb miles/year) of city streets. Residential areas are swept once a week; non-residential areas twice a week.

8. The City has anti-littering and leash laws. Modifications to these are proposed as part of the pending Stormwater Ordinance.

9. Arcadia has no set program to inspect for illegal waste discharges into the storm drains. Violations are reported as the result of other regular inspections.

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10. The City does not have a public education program about removal of dirt, rubbish and debris from sidewalks and alleys.

11. Arcadia estimates that it is diverting 11% of all rubbish from landfills through recycling programs that include single family, multi-family and backyard composting.

12. Arcadia participates in the countywide household hazardous waste management program, has implemented a local motor oil recycling program, and distributes public information.

13. A voluntary water conservation program is in effect that discourages hosing of sidewalks and driveways, and encourages use of drought resistant vegetation and efficient watering.

14. Supplemental Best Management Practices:

A. Contractors and utility companies are required to use construction methods in roadways to minimize the amount of pollutants entering storm drains.

B. Fire hydrant use is restricted, and downstream catch basins are cleaned of any debris prior to testing of fire hydrants.

C. Downstream catch basins are checked and cleaned of debris prior to testing, flushing or construction of water mains.

D. All new development that may cause stormwater erosion are required to erect controls to contain or reduce runoff.

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SUMMARY STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF ARTESIA

City of Artesia: Phase III Co-Permittee
Population (1994): 16,100
Land area: 1.61 sq. mi.

Artesia is located 18.8 miles southeast of downtown Los Angeles, and it ranks 69th in population among Los Angeles County cities. The City was incorporated in 1959 and has a large job base, dominated by the service industry. Its' land use mix is mainly residential with some commercial. In 1989 the City had a median family income of $37,332.

1. The County will stencil catch basins in the near future.

2. The City has designated a phone line for community reporting. Press releases, cable television and community meetings are used to inform the public of the City hotline. Two reportings have been received in a 6 month period.

3. The City's Municipal Code contains provisions related to sanitary sewers and industrial waste. Presently reviewing these ordinances in order to recommend modifications.

4. The City has not implemented programs to educate the public on the problem of stormwater pollution, however it is in the process of developing such a program.

5. The Los Angeles County Department of Public Works cleans the City's catch basins regularly.

6. The 26 roadside trash receptacles are emptied twice a week.

7. The 29.6 miles of improved streets are swept every two weeks. This program is currently being evaluated.

8. Recycling program being implemented in compliance with State mandated Reduction and Recycling program. The City has established specially scheduled clean-up days.

9. The Los Angeles County Department of Public Works is contracted to conduct the industrial waste inspection program. Businesses are inspected routinely or when reported.

10. The City conducts Clean-Up-Days and encourages citizen participation. Code Enforcement and City Rehabilitation staff promote beautification of neighborhoods.

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11. A recycling program including a recycling center has been implemented. 12.6 percent of the collected rubbish is being diverted at this time. The benefits of recycling are explained in City newsletters, fliers and bulletins distributed to community residents.

12. The City participates in the Countywide Household Hazardous Waste Collection program but does not conduct additional hazardous waste collections.

13. The City does not have a water conservation program.

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SUMMARY
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CITY OF AZUSA

City of Azusa: Phase II Co-Permittee
Population (1994): 42,900
Land area: 8.83 sq. mi.

Azusa is located 24.5 miles east of central Los Angeles. It was incorporated in 1898 and it currently ranks 42nd in the County by population. Azusa has a large job base, dominated by manufacturing and retail trade. Its land uses are mixed, with some residential, extensive industrial, quarries, retail and vacant land. The City median family income in 1989 was $34,200.

1. The City plans to contract with Los Angeles County to stencil all catch basins.
2. The County hotline number will be advertised when the City begins its public outreach program.
3. The City plans to adopt a runoff ordinance by February 1995.
4. The City is in the planning stages of developing a public outreach program.
5. Catch basins are cleaned on an as needed basis.
6. Thirty roadside trash receptacles are emptied once a week.
7. The street sweeping program includes 78 street miles and 156 curb miles. Sweeping frequency is weekly in residential and industrial areas and bi-weekly in commercial areas.
8. The Azusa Municipal Code prohibits illegal disposal of litter.
9. City code enforcement action will be taken against illegal dischargers with reported to or observed by City officers.
10. The public outreach/education program should be in place by the end of January 1995.
11. City is discussing plans for a recycling program--perhaps a joint effort with adjacent cities--and plans a public outreach/education program.
12. The City participates in the Countywide Household Hazardous Waste Management program but does not conduct its own program.
13. A water conservation program has not been developed however a public outreach program will be in place by the end of January 1995.

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CITY OF BALDWIN PARK

City of Baldwin Park: Phase II Co-Permittee
Population (1994): 72,000
Land area: 6.77 sq. mi.

Baldwin Park is located 17.7 miles east of downtown Los Angeles, and was incorporated in 1956. It has a small but growing job base, dominated by service, manufacturing and retail trade industries. Baldwin Park land uses are primarily residential and its median family income was $33,029 in 1989.

1. City employees began stenciling city owned catch basins in July 1994.

2. Other than the county hotline, the city has not established any other reporting system.

3. The City has not adopted a runoff control ordinance.

4. A City newsletter sent to all residents describes the problem of stormwater pollution.

5. The City cleans its catch basins twice a year in November and February.

6. The City maintains trash receptacles in parks and commercial areas. They are emptied twice a week.

7. The 103 miles of streets are swept as follows: residential twice a month; commercial and industrial weekly.

8. A City newsletter article mailed to all residents described the problems with the improper disposal of litter, lawn clippings and pet feces.

9. **NO ANSWER PROVIDED**

10. Article published in City newsletter encouraged the removal of dirt, rubbish and debris from sidewalks and alleys.

11. Glass, newspaper and plastic is recycled in the City. 26% of rubbish is diverted from landfills.

12. In addition to the County's program, the City conducts a hazardous waste collection once a year.

13. Water is supplied by three water companies - the City is not involved.

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SUMMARY
STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF BELL

City of Bell: Phase III Co-Permittee
Population (1994): 35,800
Land area: 2.81 sq. mi.

Bell was incorporated in 1957 and it is located 8.1 miles southeast of downtown Los Angeles. Its current population ranks the City 49th in Los Angeles County. Bell is located within the central, older industrial areas of Los Angeles County, next to the L.A. River. Its land uses are mixed and include residential, commercial and industrial. The job base is moderate and it is concentrated in manufacturing, utilities, retail trade and services. The median income in the City was $23,262 in 1989.

1. Stenciling of city-owned catch basins will be contracted with County in Fiscal Year 94-95.

2. Other than the County Hotline, the City has not established any other reporting system.

3. Bell will consider adoption of Model Runoff Control Ordinance in F.Y. 1994-95.

4. Public education and outreach program will be developed in Fiscal Year 94-95.

5. The cleaning of catch basins is contracted with the County.

6. No City does not provide any trash receptacles. The program is planned for Fiscal Year 94-95.

7. The 14 miles of improved streets (28 curb miles) are swept weekly in residential areas, and four times a week in commercial and industrial areas.

8. Municipal and other codes prohibit the improper disposal of litter, lawn clippings and pet feces. Enforcement and public outreach will be developed in Fiscal Year 94-95.

9. No industrial waste program at this time -- will be contracted with the County in Fiscal Year 94-95.

10. No program at this time -- will develop in Fiscal Year 94-95.

11. No program at this time -- will develop in Fiscal Year 94-95.

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12. The City participates in the Countywide Household Hazardous Waste program but does not conduct any additional waste collections.

13. A water conservation program will be developed in Fiscal Year 94-95.

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SUMMARY
STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF BELLFLOWER

City of Bellflower: Phase III Co-Permittee
Population (1994): 63,900
Land area: 6.14 sq. mi.

Bellflower, incorporated in 1957, is traversed by Artesia Freeway (91), 17.7 miles southeast of the Los Angeles Civic Center. This city ranks 26th in population size among Los Angeles County cities. Land uses are primarily mixed residential with some commercial and industrial. It has a small job base, the main employers being the service and retail industries. Median family income in 1989 was $37,026.

1. The 160 City owned catch basins were stenciled with white and blue paint by Cub scouts.

2. In addition to the County hotline, residents can call the Sheriff's Office to report illegal discharges.

3. The City has adopted ordinances in 1957 making it illegal to drain, wash, run or divert water into or upon any public street.

4. The City is in the process of airing Public Service announcements on cable TV.

5. City crews clean catch basins yearly and twice a year if needed.

6. The 60 roadside trash receptacles are emptied once a week.

7. The 100 miles of improved streets are swept weekly in residential and industrial areas and twice a week in commercial areas. Alleys and centerlines are cleaned monthly.

8. The City has adopted an anti-litter ordinance.

9. The City contracts with the County for industrial waste inspections which are performed annually. Non-storm water discharges inspections are limited to code enforcement, observation and/or complaint.

10. The City is developing an education program that will include encouragement to remove dirt and litter

11. The City has established a recycling program and maintains a recycling center. Three to five percent of rubbish is being diverted from landfills. The City is modifying program based on AB 939 requirements.

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12. The City is a participant in the Countywide Household Hazardous Waste Management program but does not conduct additional hazardous waste collections.

13. The City has adopted a drought tolerant landscaping requirement as part of the Zoning Code.

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CITY OF BELL GARDENS

City of Bell Gardens: Phase III Co-Permittee
Population (1994): 43,700
Land area: 2.39 sq. mi.

Bell Gardens, incorporated in 1961, is located 9.1 miles southeast of the Los Angeles City Hall. It ranks 41st in terms of population in Los Angeles County, and had a median family income of $23,308 in 1989. Like Bell, the City is located in the industrial core of the County, next to the L.A. river and contains mixed residential, with some industrial and commercial land uses. The job base is moderate in size, dominated by manufacturing and services.

1. Bell Gardens has budgeted to have Los Angeles County Public Works stencil approximately 22 catch basins.

2. A budget has been approved to begin a public outreach program and hotline for reporting illegal dumping.

3. The City anticipates adopting an ordinance, to control urban runoff, this fiscal year.

4. The City has approved a budget to establish a public outreach program on the problem of stormwater pollution this fiscal year.

5. Beginning this fiscal year, catch basins will be checked and cleaned as needed every two months, under a contract to the County Department of Public Works.

6. The Belvedere Trash District provides 22 roadside trash receptacles in the City. Problem areas have not been identified.

7. The City has one vacuum-type street sweeper which maintains 120 curb miles within the city. Residential areas are cleaned once a week and commercial areas three times per week.

8. A budget has been approved to conduct public outreach concerning proper disposal of litter, lawn clippings and pet feces.

9. A budget has been approved to begin an industrial waste inspection program this fiscal year. Frequency of inspections is yet to be determined.

10. A budget has been approved to conduct public outreach concerning removal of dirt, rubbish and debris from sidewalks and alleys.

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11. The City has implemented a curbside recycling program collecting paper, glass, aluminum and green waste. It does not have a recycling center, but has implemented a promotional campaign. Approximately 22% of rubbish is being diverted.

12. The City participates in and conducts public outreach about the County's household hazardous waste collections.

13. Bell Gardens has a water conservation program in effect during severe drought that would indirectly reduce runoff to storm drains. The proposed public education program will include water conservation information.

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SUMMARY
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CITY OF BEVERLY HILLS

City of Beverly Hills: Phase I Co-Permittee
Population (1994): 32,600
Land area: 5.69 sq. mi.

Beverly Hills, incorporated in 1914, lies 10.9 miles west of the Los Angeles Civic Center. This City's upscale and designer shops are an attraction for tourists, providing a very strong job base dominated by services and finance. Its land uses include low density residential and high density residential, commercial and office. Its population ranks 53rd among L.A. County cities and the City had an $83,272 median family income in 1989, one of the highest in the County.

1. The City has stenciled 1230 catch basins with the Heal the Bay design.

2. In addition to the County hotline, the City has established a hotline in 1992 to allow the reporting of illicit/illegal discharges or dumping.

3. The City has adopted ordinances encouraging water conservation and a reduction in run-off in 1993. A water mitigation ordinance and stormwater run-off ordinance is now being considered by the City Council.

4. The City has utilized brochures to inform the public about stormwater pollution.

5. All catch basins are cleaned annually, with some cleaned bi-weekly due to deciduous tree problem.

6. Hundreds of trash receptacles are emptied daily with those near bus stops, parking garages and heavy pedestrian areas monitored more often.

7. The City's street sweeping program includes daily sweeping in commercial and industrial areas and weekly in residential.

8. The City uses outreach brochures in utility bills, the recycling program, municipal ordinances and catch basin stenciling to discourage improper disposals.

9. The City has a contractual agreement with the County to inspect businesses on an annual basis.

10. Outreach brochures are sent to all utility customers and distributed at community affairs to encourage the public's assistance in maintaining sidewalks and alleys.

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11. The City's recycling program includes material recycling, public outreach through newspaper advertising, direct mailings and two annual hazardous round-ups. At this time 14% of rubbish is recycled. Most solid waste now goes to energy plant to generate electricity.

12. Two City round-ups are conducted every year in addition to the County's Household Hazardous Waste program.

13. The City has adopted erosion and run-off control provisions, and water conservation ordinances.

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STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF BURBANK

City of Burbank: Phase II Co-Permittee
Population (1994): 98,700
Land area: 17.12 sq. mi.

Burbank was incorporated in 1911, lies 10.9 miles northwest of central Los Angeles, and it has the 12th largest population in the County. Burbank has a very strong job base, relying primarily on manufacturing and services, with a very strong presence by the motion picture and related industries. Burbank is also the home of the Burbank-Glendale-Pasadena Airport, one of the busiest in the region after LAX. Its land uses are diverse with single family residential the most common. Median income in Burbank was $42,148 in 1989.

1. The City has not implemented a catch basin stenciling program because it would provide little benefit and require continuous maintenance.

2. The City has not implemented any programs to facilitate public reporting of illegal discharges/dumping. Since 1976 listings in the phone book have been maintained for the Fire Department and Public Works Department.

3. Urban runoff control measures were adopted many years ago.

4. The City is in the process of developing a public outreach program to educate the public on the problem of stormwater pollution.

5. The City has recently implemented an annual catch basin cleaning program.

6. The City provides 205 roadside receptacles which are emptied once per week to once per day. Receptacles are placed in high traffic areas and collected frequently.

7. The street sweeping program includes 470 curb miles and services residential, commercial and industrial areas at a rate of twice per month. The City is planning to assess the benefits of increasing street sweeping in several areas.

8. The City has automated curbside pickup of green waste, garbage and recyclables with public outreach.

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9. The City inspects land uses three times per year for industrial discharge to sanitary sewer only and conducts inspections for non-storm water discharges on a complaint basis. The City is currently working on a storm drain inspection program as a BMP.

10. The City is developing a program to encourage the public to remove dirt, rubbish and debris from sidewalks and alleys.

11. The recycling program consists of curbside collections of recyclables, public outreach/education to school grades 1-8, adult service organizations and businesses. At this time 38% of rubbish is being diverted from landfills.

12. The City participates in the Countywide Household Hazardous Waste Management program but does not conduct additional waste collections. Public outreach is used to ensure proper disposal of hazardous waste.

13. Programs of public education are being developed and water conservation program was developed during the drought years to reduce water consumption.

14. <u>Additional BMP's</u>

A. Construction Pollution Control ordinance requires erosion control plan for grading permit.

B. Demolition Construction Pollution Control ordinance being considered will set standards for pollution control during demolition of structures.

C. Stormdrain Inspection being considered will require field inspection of stormdrains to determine connections and reduce pollution sources.

D. Stormdrain Inspection being considered will survey system to determine areas of greatest pollution.

E. Discharge Assessment being considered will survey and assess type and number of non-storm water discharges into the storm drain system.

F. Program for Control of Illegal Discharges being considered will regulate discharges to storm drain, establish permit program and procedure.

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SUMMARY
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CITY OF CALABASAS

City of Calabasas: Phase II Co-Permittee
Population (1994): 17,700
Land Area: 12.85 sq. mi.

The City of Calabasas is located 28.2 miles west of the L.A. Civic Center along the Ventura (101) freeway and was incorporated in 1991. Land uses in the city are primarily residential with some commercial along the Ventura freeway.

1. The County has stenciled all basins that are owned by the City. Basins that have not yet been stenciled are located within gated communities which are maintained by individual Homeowners Associations.

2. The City has established an 800 hotline number. The public was informed of the hotline through advertisement jointly with recycling program.

3. The City has drafted an urban runoff control ordinance presently under review by City staff.

4. Public outreach has begun through the local cable channel airing of L.A. County and Heal the Bay videos.

5. The County of Los Angeles provides catch basin cleaning annually.

6. The City's roadside trash receptacles are emptied weekly.

7. The City contracts with a private street sweeping firm to maintain all non-gated roadways. Streets are swept once per week. Gated communities are maintained by the respective Homeowners Associations.

8. The public service announcement on local cable channel discusses the improper disposal of litter, lawn clippings and pet feces.

9. An industrial waste inspection program has not been implemented. The City addresses industrial waste control in the review of new applications for industrial and commercial development and in the plan checking process. The City's Building and Safety Division monitors the installation of the required trap systems.

10. The City has not implemented a public outreach/education program to encourage the public to remove dirt, rubbish and debris from sidewalks and alleys.

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11. The City recycles materials at curbside. Approximately 19% of rubbish is diverted. Mailers, recycling hotline, exhibits and Earthday recycling art contest are the elements of the outreach/education program.

12. The City participates in the Countywide Household Hazardous Waste Management program but does not conduct additional waste collections.

13. The Las Virgenes Municipal Water Company promotes water conservation by providing a free exterior audit and review of sprinkler heads/system and a free self-guided tour is available showing low-flow irrigation systems to be duplicated at home. Additionally, the public is further encouraged to conserve water by recorded messages on Water District telephones during transferring of calls or when callers are placed on hold.

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SUMMARY STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CALTRANS Phase I, II, III Co-Permittee

1. Caltrans has implemented a Stenciling Program and to date has completed approximately 1083 catch basins. The rest will be completed by November 30, 1994.

2. A 24-hour Caltrans hot line where the public can report illegal discharges and dumping is in place for more than a year.

3. Urban runoff control measures were adopted in November 1993. These measures appear to be effective.

4. A limited public outreach program has commenced. Flyers have been distributed and bumper stickers and informational brochures are being prepared for distribution.

5. Catch basins are generally cleaned every 2 years, and more frequently when inspection by Maintenance forces show the pipe is clogged. Also, erodible materials and debris are regularly removed from retention/detention basins, preventing them from going into streams or waterways.

6. Roadside trash receptacles are provided and are emptied according to demand.

7. 1,166 centerline miles are swept when accumulated debris reaches a certain prescribed level.

8. Improper disposal of litter is discouraged by highway signs stating: No Littering (plus a fine).

9. Every 90 days clarifiers are pumped out; storm drains are constantly monitored. Auto related facilities are inspected daily, gas stations are lead tested once a year.

10. This item is not applicable to Caltrans.

11. Curbside recycling is not applicable to Caltrans; however, Caltrans utilizes recycled materials and estimates that it has diverted approximately 5% of rubbish from landfills due to recycling efforts. A pilot program to allow usage of 15% recycled asphalt concrete has been started. Shops recycle used oil, anti-freeze, oil filters and aluminum.

12. Caltrans does not participate in the Countywide Household Hazardous Waste Management Program.

13. Water Conservation is encouraged by the water policy/action plan. Measures include: use of non-potable water when possible, cooperation with local water agency conservation

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plans, fertilize only when absolutely necessary, increase chipping and mulching. Signs noting use of reclaimed water remind the public for need of water conservation.

14. ADDITIONAL BMP's

A. Leaking Underground Storage Tanks Five Year Plan

Included in this program will be site investigation, leak detection of tanks, removal, remediation and installation of fuel canopies over fuel islands.

B. Right-of-Way Maintenance Vegetation Control Program

Vegetation when properly maintained and controlled provides the benefits of motorists' safety and erosion control.

C. Public Information and Participation Program--Adopt a Highway

This program removes litter from roads. Permits are issued to organizations, clubs or individuals who agree to "adopt" a 2 mile section of a highway. Participants are provided with tools and equipment and are required to clean their section at least 12 times per year.

D. Personnel Training Program

Personnel is educated on highway maintenance or related subjects and available BMP's on a regular basis. Some of the courses are: Hazardous Substance Spill Awareness and Pesticide Safety and Vegetation Management.

E. Erosion and Sediment Control Practices

Where slopes show evidence of erosion, slides and or slipouts, remedial measures are taken to stabilize the slope. Efforts are made to dispose of eroded soil, rock and debris at approved dumping sites.

F. Priority Lists of Drains and Pump Houses

A priority list of drains and pump houses requiring cleaning based on the following will be developed: recent flooding or historically poor drainage areas, and amounts of sediments. Drainage facilities requiring cleaning will be sampled and tested and then cleaned.

G. Inspection of Excess Land Parcels

Investigation, identification and remediation program for hazardous waste and debris on excess parcels.

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H. Contractor Water Pollution Control Program

A requirement has been added that contractors submit a plan for water pollution control during construction operations. Operations may be temporarily halted if inadequate provision has been made for water quality protection.

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SUMMARY: STORMWATER/URBAN RUNOFF PROGRAM QUESTIONNAIRE

CITY OF CARSON

City of Carson: Phase III Co-Permittee
Population (1994): 86,300
Land area: 19.24 sq. mi.

Carson lies 18.5 miles south of Los Angeles City Hall, just east of the 110 (Harbor) Freeway and was incorporated in 1968. It has the 20th largest population in the County and a very large job base with manufacturing and wholesale trade dominating. Land uses reflect the job base of this city with significant commercial and industrial sectors. There are also single family residential uses and some vacant lands. Median family income was $47,387 in 1989.

1. The City has purchased stencils and received donated paints. City staff has painted several basins in and industrial area and all basins in the vicinity of the Civic Center. Citizen groups are organized to begin a concerted painting effort in late September.

2. The City has established its own illegal dumping hotline in addition to the County's. The City has informed the public of the hotline services in its newsletter and brochures. Additionally, City staff has been informed of the importance of reporting illegal dumping.

3. An urban runoff control ordinance dating from 1968 is in effect that the city thinks has been effective. The City expects to adopt a model ordinance in 1995.

4. An outreach program with newsletter articles, fliers, and handouts sent to the public and pamphlets available at City Hall has been implemented.

5. Carson's catch basins are maintained by Los Angeles County once a year.

6. The City provides trash receptacles at all bus stops which are emptied daily.

7. Carson has 1 vacuum and 3 broom sweepers that are used to clean all 407 miles of City curbs once weekly.

8. The City has an ordinance to discourage improper disposal of litter, lawn clippings and pet feces. Penalties are included.

9. Under a contract, the County inspects non-storm water discharges from industrial sites.

10. Carson has annual alley and street clean up days with citizen volunteers. They work well in the residential and industrial

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areas and fair in the commercial areas. In addition to annual clean up program, the municipal code, section 5302, requires all property owners to clean sidewalks and alleys.

11. The City has implemented a curbside recycling program collecting newspaper, glass, and plastic. It does not have a recycling center, but does offer oil recycling, and green waste recycling. About 16% of rubbish is being diverted.

12. The City participates in the countywide household hazardous waste management program.

13. The Dominguez Water Company which serves the City has a water conservation program. Additionally, the City has completed a demonstration xeriscape garden at the Civic Center. The emphasis of the garden is water conservation.

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SUMMARY: STORMWATER/URBAN RUNOFF PROGRAM QUESTIONNAIRE

CITY OF CERRITOS

City of Cerritos: Phase III Co-Permittee
Population (1994): 54,200
Land area: 8.79 sq. mi.

Cerritos is located 18.8 miles southeast of the Los Angeles Civic Center along the Santa Ana Freeway and adjacent to the Orange County line. It has a large job base with manufacturing, retail trade and services dominating. Land uses are primarily single family residential with substantial industrial and commercial sectors. The City was incorporated in 1956 and it has the 33rd largest population in the County. Median family income was $60,689 in 1989.

1. The County will be stenciling the City's catch basins with the Heal the Bay design.

2. The City has promoted the County's illegal dumping hotline through its city newsletter.

3. Cerritos is now preparing an urban runoff ordinance.

4. Public education and outreach programs on stormwater runoff are in the conceptual stage (see note below).

5. The City contracts with the County Public Works Department to annually clean out its catch basins.

6. Cerritos has roadside trash receptacles that are emptied weekly.

7. Broom type sweepers are contracted for to clean 400 curb miles weekly.

8. Cerritos uses its newsletter to build public awareness of proper disposal of litter and other materials.

9. The City inspects businesses periodically for compliance with waste disposal regulations. Storm drains are checked frequently for non-storm water discharges.

10. Cerritos does not have any program to encourage removal of dirt and other materials from sidewalks and alleys.

11. The City intends to begin a recycling program in January 1995.

12. The City participates in the countywide household hazardous waste management program.

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13. Cerritos has an ordinance prohibiting hosing of driveways during MWD-declared drought periods.

14. Additional BMP's

A. Cerritos indicates that it is considering implementation of a Public Outreach and Pollution Prevention Program, to educate residents and businesses about stormwater pollution prevention.

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SUMMARY: STORMWATER/URBAN RUNOFF PROGRAM QUESTIONNAIRE

CITY OF CLAREMONT

City of Claremont: Phase II Co-Permittee
Population (1994): 33,200
Land area: 13.43 sq. mi.

Claremont was incorporated in October, 1907, and is located 32.4 miles east of Los Angeles City Hall along the San Bernardino County line, just north of the San Bernardino Freeway. Its job base is moderate, dominated by the service and retail sales sectors. City land uses are mixed with mostly single family residential and commercial. 1989 median family income was $62,203.

1. The County will be stenciling a majority of the catch basins. City-owned catch basins will be stenciled by volunteers. The Heal the Bay design will be used.

2. The City has promoted the County's illegal dumping hotline through its city newsletter.

3. Claremont is in the process of creating an urban runoff control measure, however it is already conditioning all grading permits for erosion control.

4. The City has placed educational articles in the City newsletter concerning stormwater pollution.

5. Claremont has started to clean catch basins once a year.

6. The City has 30 roadside trash receptacles that are emptied as needed. This year it is considering further actions for litter control.

7. Claremont uses 2 vacuum and 1 broom type sweepers to clean all 105 miles of city streets once per month.

8. Code enforcement efforts help to discourage improper disposal of litter and other materials.

9. The City does not have a formal program to inspect industrial waste disposal. There are very few industrial users. The employees are informally on the lookout for illegal discharges. Restaurants are inspected as needed.

10. Claremont does not have any program to encourage removal of dirt and other materials from sidewalks and alleys.

11. The City has a recycling program and a permanent recycling center, however the program is just beginning and there is no curbside collection of materials yet.

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12. The City participates in the countywide household hazardous waste management program.

13. Claremont has published water conservation articles in its City newsletter, and completed major renovation of its own landscaping and irrigation systems.

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SUMMARY STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF COMMERCE

City of Commerce: Phase III Co-Permittee
Population (1994): 12,400
Land area: 6.55 sq. mi.

Incorporated in 1960, Commerce is located 7 miles east/southeast of the Los Angeles Civic Center, primarily between the Los Angeles river and the Santa Ana Freeway. This is the heart of the County's industrial base with predominant land uses being manufacturing, some commercial and some residential. Commerce has a very strong job base with a very high ratio of 3 jobs for every resident. Manufacturing and wholesale trade are the two dominant industries. Median family income was $29,331 in 1989 and the City ranks 75th in population among Los Angeles County cities in 1994.

1. All catch basins within the City are owned and maintained by Los Angeles County. The City plans to request the county to stencil all of its catch basins using the 8 inch Heal the Bay stencil.

2. No awareness program has been implemented yet but the City plans to encourage residents and businesses to report illegal dumping.

3. The City has an existing ordinance, section 9.04.070, which prohibits illegal dumping in/upon any public or private road, highway, street, alley, public way or any public or private property of any kind. Section 12.16.060 prohibits non-storm water discharge. The City also plans to adopt a storm water/urban runoff control ordinance prior to June 18, 1995.

4. No programs have been established but the City intends to develop and implement a public education and outreach program in FY 95-96.

5. Catch basins are cleaned by the County Department of Public Works once a year. They are also cleaned on an as-needed basis in response to complaints throughout the year.

6. The City provides approximately 100 receptacles placed at bus stops, parks, city facilities and commuter train station. Those at the city parks are emptied once a day. Receptacles at other locations are emptied twice a week. Receptacles have been added in litter prone areas and are emptied as necessary to prevent overflow.

7. 120 curb miles are swept once per week. The City feels that this frequency is adequate to maintain an absence of debris but feels street sweeping does not prevent debris from entering storm drains-it only reduces a quantity of it from entering receiving waters.

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8. Section 904.070 of the City Code prohibits littering of any material including lawn clippings on public property. In addition, 8.04.500 prohibits the disposal of pet feces except into street gutters. Penalties, including fines and imprisonment, are imposed for improper disposal.

9. Industrial waste inspections are contracted to Los Angeles County. No non-storm water discharges are inspected as part of the industrial waste program but City code enforcement staff is responsible for citing those who illegally discharge. Auto related businesses, gas stations and restaurants are not inspected.

10. The City has not implemented a public education/outreach program to encourage the public to remove dirt, rubbish, and debris from sidewalks and alleys. However, these practices are required by ordinance and enforced by code enforcement. During FY 1994-95, the City plans to promote these good housekeeping BMPs as part of its comprehensive storm water/runoff pollution prevention public education/outreach program.

11. Curbside recycling collection is provided to residents and businesses. Various media is employed to encourage participation in the program including cable tv, newsletters, information packets, brochures and other literature. The City estimates that approximately 50% of rubbish is being diverted from landfills.

12. The City encourages residents and small businesses to participate in the HHW round-ups and informs the public when these events are occurring.

13. The City has a water conservation in landscaping ordinance which indirectly reduces non-storm water discharge. Section 12.16.060 prohibits the discharge of any water flow. The City plans to incorporate water conservation into its storm water pollution prevention outreach program.

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CITY OF COMPTON

City of Compton: Phase III Co-Permittee
Population (1994): 91,600
Land area: 10.11 sq. mi.

Compton lies 11.6 miles south of downtown Los Angeles, north of the Artesia Freeway (91), between the Long Beach (710) and the Harbor (110) Freeways. Its population makes it the 16th largest city in Los Angeles County and the City maintains a large job base. The largest employers are manufacturing, trade and services. Land uses are mainly residential and industrial with some commercial. Median family income in 1989 was $25,699.

1. The City has not implemented a stenciling program. A service request/purchase order for Los Angeles County to do the work is in progress.

2. The City public works field office number, (310) 605-5691, is open for complaints on infrastructure problems and can be used to report illegal dumping. City staff and the public have been informed of the existence of this phone number.

3. The City's Water Department has policies related to water conservation measures and periodically informs the residents by fliers and displays at City Hall.

4. The City is in the process of developing the program.

5. The catch basin cleaning program consists of annual cleaning prior to the rainy season, and, also on an "on-call" basis, as problems of clogging are reported.

6. Roadside trash receptacles are placed in commercial areas and emptied once a week. An inspection program of problem litter areas has not been established but General Services Department makes sure that receptacles are emptied as necessary and are in good condition.

7. The street sweeping program covers all areas of the City on a weekly frequency.

8. The improper disposal of litter, lawn clippings and pet feces is discouraged through public outreach fliers, and block club meetings. Penalties are in place for improper trash disposal.

9. The County Sanitation District performs the industrial waste inspections for the City.

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10. Removal of dirt, rubbish and debris from sidewalks and alleys is and has been an on-going function of City field crews. Public outreach and employee participation was developed in 1988 to report existence.

11. The recycling program includes curbside pick up, an education program and source reduction. 21% of rubbish is diverted.

12. The City participates in the Countywide Household Hazardous Waste program but does not conduct its own collections. It sends out fliers from L.A. County to inform the public.

13. The water conservation program consists of voluntary compliance. The City's Water Department sends fliers periodically. No penalties. Also, the school district has an on-going program getting the school children involved by having a display of their drawings and sketches on the importance of conserving water. The City is in the process of developing a program to inform the public regarding the problems of urban runoff.

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SUMMARY: STORMWATER/URBAN RUNOFF PROGRAM QUESTIONNAIRE

CITY OF COVINA

City of Covina: Phase II Co-Permittee
Population (1994): 44,450
Land area: 6.995 sq. mi.

Covina is located 22.9 miles east/northeast of downtown Los Angeles, north of the San Bernardino Freeway. It was incorporated in 1901 and it is 39th in population among Los Angeles County cities. Covina has a strong job base dominated by the service, manufacturing and retail trade sectors. Land uses are mixed and include single family residential, industrial and commercial. Median family income in 1989 was $44,375.

1. Covina has about 70 catch basins to stencil. The City will use volunteers and will purchase templates from the County.

2. The City is distributing fliers to developers and the public and publishing articles that advertise the County's hotline number for reporting illicit dumping. City staff is receiving training in identifying illegal dumping sources.

3. An urban runoff ordinance became effective in Covina on July 23, 1994. The ordinance is already being used to enforce against two auto shops.

4. The City does not have a comprehensive program to educate the public about stormwater pollution, but has published articles about it in the City newsletter.

5. Covina personnel inspect catch basins throughout the year, and before the storm season, and clean them as necessary.

6. Approximately 100 roadside trash receptacles are located in Covina and they are emptied weekly. Staff plans to evaluate additional capacity needs in the coming months, and will address the problem of scavengers scattering trash.

7. Covina uses broom sweepers to clean 525 curb miles per month. Residential and industrial areas are cleaned once per month; commercial areas are cleaned up to 12 times per month.

8. The City has not yet created a program to discourage improper disposal of litter and other materials. Improper trash disposal is a misdemeanor under local codes.

9. Covina is just beginning to inspect specifically for non-storm water discharges to the storm drain system.

10. The City has not yet implemented a public education program to encourage removal of dirt and other material from sidewalks and alleys.

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11. A comprehensive recycling program has been established which includes curbside pick-up of recyclables, public outreach and education, and recycling of motor oil at Chief Auto Parts.

12. The City widely publicizes the County's household hazardous waste round-ups, and has the local motor oil recycling program.

13. Covina has not yet created a water conservation program. It is installing low maintenance, water conserving landscaping at one of its parks.

14. Additional Best Management Practices:

A. Covina can require the cleaning of privately owned storm drains.

B. The City requires all refuse containers to have covers, and endeavors to insure that covers are kept closed.

C. Covina has modified handling of its own green waste so that it is less likely to be scattered by wind.

D. Open storm channels in two parks are cleaned monthly and before predicted storms.

E. The City is expanding its efforts to recycle materials and intercept debris from its own vehicle maintenance program.

F. Covina is beginning to notify contractors about containment of construction debris and proper disposal practices.

G. Contractors working in public rights of way are required to prevent discharge of non storm water run-off into the storm drain system.

H. Dirt and other materials transported over paved roadways must be covered.

I. Newly developed land must have 90% landscape coverage within 1 year and 100% coverage within 3 years.

J. Covina will work to improve interdepartmental communication and responsibilities for responding to hazardous materials incidents.

K. The City has created an equipment management brochure to distribute to developers and construction crews.

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SUMMARY: STORMWATER/URBAN RUNOFF PROGRAM QUESTIONNAIRE

CITY OF CUDAHY

City of Cudahy: Phase III Co-Permittee
Population (1994): 23,750
Land area: 1.09 sq. mi.

Cudahy was incorporated in 1960, and is located 12.2 miles south/southeast of the Los Angeles Civic Center. The City has a very small job base with less than 10 jobs per 100 residents, primarily found in the retail trade. Land uses are primarily medium density residential with some commercial. Its median family income was $22,245 in 1989.

1. Cudahy will contract with the County in FY 94-95 to have its catch basins stenciled.

2. The City will develop a public outreach program concerning illegal discharges in FY 94-95.

3. Adoption of the model runoff control ordinance will be considered in FY 94-95.

4. Public education and outreach on the problem of stormwater pollution will be developed in FY 94-95.

5. Cudahy contracts with the County to clean out catch basins prior to the storm season. Will reevaluate program in FY 94-95.

6. Cudahy has 9 public roadside trash receptacles which are emptied weekly. Heavily used receptacles are emptied more often.

7. A broom type sweeper is used to clean all 26 curb miles within the City twice weekly.

8. Several municipal code sections prohibit improper disposal of debris and other materials. A public outreach program will be developed in FY 94-95.

9. Businesses with industrial waste permits are inspected annually under a contract with the County. The inspection program will be expanded in FY 94-95 to comply fully with this BMP.

10. A public outreach program, concerning removal of dirt and other materials from sidewalks and alleys, will be developed in FY 94-95.

11. Cudahy will be developing a recycling program in FY 94-95.

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12. Cudahy participates in Countywide Household Hazardous Waste Management Program.

13. A public outreach program will be developed in FY 94-95 to inform the community of water runoff pollution.

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CULVER CITY

Culver City: Phase I Co-Permittee
Population (1994): 39,450
Land area: 4.97 sq. mi.

Culver City incorporated in 1917, lies 10.9 miles west of L.A. City Hall, south of the Santa Monica Freeway, and it has the 44th largest population among cities in Los Angeles County. Culver City also has a very large job base with services, retail trade and manufacturing dominating the job market. Land uses are primarily single family residential, with some commercial and industrial. Median family income was $50,411 in 1989.

1. Culver City has stenciled all of the approximately 750 catch basins in the City with the Heal the Bay design. After 1 1/2 years, some stencils are fading and will have to be re-done.

2. The City has actively publicized the County's storm water hotline by (1) distributing door hanger-type flyers to all residents; (2) publishing several newsletter articles about runoff pollution; (3) distributing brochures containing the hotline number at Ballona Creek Clean-up Day; and (4) airing runoff pollution-related videos on the City's cable television channel.

3. The City has adopted several ordinances that operate to reduce contaminants in storm water and non-storm water runoff and has incorporated by reference into its municipal code the Uniform Building Code which, among other things, prohibits sediment discharges associated with construction activities.

4. The City has implemented the following programs to educate the public on stormwater pollution: distributed door-hangers explaining the problem of runoff pollution; has aired storm water pollution videos on local cable; and, has published storm water pollution awareness articles in City newsletter.

5. Culver City cleans its catch basins annually just prior to the storm season. County owned catch basins in the City are cleaned by the County on about the same schedule. Thereafter basins are cleaned on an as-needed basis.

6. The City has approximately 200 refuse receptacles in place in litter-prone areas--most are not roadside. These receptacles are emptied once to twice a week.

7. Street sweeping is conducted on all 160 curb miles of the City once a week. 3-4 vacuum type sweepers are used to clean alleys, public parking lots, as well as streets.

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8. The City's municipal code prohibits the littering and improper disposal of lawn clippings and pet feces. Violating these ordinance provisions is punishable by fines and other sanctions. The City has encouraged compliance with these requirements through (1) door hanger fliers; (2) articles in the City newsletter; and (3) airing of storm water management videos.

9. The City conducts inspections of auto parts, auto repair, and body shops, as well as gas stations and restaurants. Generally, auto parts, repair, and body shops are subject to industrial waste water permit requirements as required by City ordinance. The City contracts with Los Angeles County to perform annual inspections. The City's Fire Department also performs annual inspections of facilities that handle and store hazardous materials.

10. The City has encouraged residents to remove dirt, rubbish, and debris from sidewalks and alleys through brochures and other print media.

11. Culver City has implemented a single and multi-family residential recycling program, and operates 11 drop-off centers. About 23% of rubbish is being diverted.

12. The City encourages residents to participate in the Countywide household hazardous waste round-ups and to drop-off hazardous materials at the City of Santa Monica's waste collection facility.

13. Culver City has an ordinance which prohibits residents and businesses from using water in a way as to cause runoff into City streets.

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CITY OF DIAMOND BAR

City of Diamond Bar: Phase II Co-Permittee
Population (1994): 54,500
Land Area: 14.77 sq. mi.

Diamond Bar is located 31.1 miles east/southeast of the L.A. Civic Center, along the Pomona (60) freeway, adjacent to the San Bernardino County line. The city is primarily residential with some retail commercial. It ranks 32nd in the County in terms of population

1. The City contracted with L.A. County who has stenciled approximately 260 catch basins with the Heal the Bay design. The stenciling program has been effective in increasing general public awareness.

2. In addition to the County hotline the City operated a hotline in cooperation with the Sheriff since December 1993. In August 1994, the City will implement a 24-hour dumping reporting telephone number at City Hall. The public has been informed through community newsletters and informational brochures.

3. In January of 1990 the City adopted by reference the L.A. County Code, Title 20 relating to Sanitary Sewers and Industrial Waste.

4. Flier/brochures have been developed to increase awareness and to provide encouragement for proper disposal of materials.

5. The catch basins are cleaned annually prior to the storm season. This program has not been changed in response to RWQCB requirements.

6. The City does not provide roadside trash receptacles. However, there is a litter abatement program utilizing private contractors.

7. Sweeping of 215 curb miles is done bi-weekly. This program has been in effect since 1989.

8. Since November 1993, the City has required waste haulers to provide compost bins to single family residences. This helps to discourage the improper disposal of lawn clippings. "Adopt a Street" program is suggested as a way to discourage improper litter disposal.

9. The L.A. County Department of Public Works provides industrial waste and non-storm water discharge inspections. Industrial

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users are inspected on a regular schedule based on types of processes, industrial classification and inspection fee class. Auto related businesses and gas stations are inspected 1-3 times per year and restaurants are inspected once per year. Less than 10% of businesses are found to not be in compliance.

10. The City has developed fliers/brochures to encourage the proper disposal of materials.

11. A curbside recycling program has been implemented. Aluminum, glass, plastics, and newspapers are included in the program. The City has established a comprehensive public outreach program and estimates that approximately 32% of rubbish is being diverted from landfills. A greenwaste and a commercial sector program are being considered.

12. The City participates in the Countywide program and conducts curbside collection of used motor oil. Increased public education efforts will augment its collection program.

13. The City has water efficient landscape regulations. Developers are required to provide information to buyers/tenants on water efficient techniques.

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CITY OF DOWNEY

City of Downey: Phase III Co-Permittee
Population (1994): 94,800
Land Area: 12.7 sq. mi.

Located 13 miles southeast of the Los Angeles Civic Center, just east of the Long Beach (710) and north of the Century (105) Freeways, Downey was incorporated in 1956. Its land uses are mixed urban with well established residential, industrial and commercial areas. Service and manufacturing industries provide Downey with a large job base. The 1994 population ranks Downey 15th among L.A. County cities. Median family income for the City was $41,897 in 1989.

1. 720 catch basins have been stenciled with the Heal the Bay design by local boy scouts. There are plans to stencil the remaining ones.

2. The City uses the "WE TIP" program in addition to the County hotline to encourage reporting of illegal dumping. Cash rewards are given out anonymously. 20-25 reports have been received.

3. Section 8218 of the Downey Municipal Code and Chapter 70 of the UBC address urban runoff control. These measures, adopted in 1988, are being more rigorously enforced.

4. The City is waiting for formal approval for L.A. County to send out a county non-point source pollution publication to residents.

5. Catch basins are cleaned by City personnel twice per year. This program has been very effective and has not been modified in response to RWQCB requirements.

6. The City provides 20 roadside trash receptacles which are emptied weekly. "Operation Brightside" addresses citywide clean-up while the "Adopt a Street" program is a business area clean-up.

7. 512 curb miles are swept; residential and industrial areas weekly and commercial areas bi-weekly. This program has not been modified in response to RWQCB requirements.

8. The City sponsors "Waste in Place" programs in elementary schools to discourage littering. Penalties exist for improper trash disposal. The city suggests that enforcement of current litter laws would discourage improper litter disposal.

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9. Field investigations are conducted of all complaints regarding industrial waste. Auto related businesses, gas stations, and restaurants are all inspected based on complaints under the authority of Sections 4116 and 4117 of the Downey Municipal Code.

10. A yearly clean-up is held and response to the program has been good. The City has become more pro-active due to the RWQCB regulations.

11. The City has implemented a voluntary curbside recycling program. Newspaper, aluminum, tin and steel cans, glass and certain plastic containers are collected. Fliers and brochures were sent to the public, programs were conducted at schools and community group meetings to publicize the program. Currently, 6%-7% of rubbish is being diverted from landfills. The City plans to make the recycling program mandatory in late 1994.

12. The City participates and promotes County Hazardous Waste roundups. A used oil recycling program will be implemented this year.

13. The public is informed about the problems of overwatering in a publication to residents. Per the Downey Municipal Code, runoff water from landscaped area is not allowed in the streets. Field personnel constantly monitor.

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SUMMARY
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CITY OF DUARTE

City of Duarte: Phase II Co-Permittee
Population (1994): 21,300
Land Area: 6.8 sq. mi.

Duarte is located 19.8 miles northeast of the downtown Los Angeles Civic Center along the Foothill (210) Freeway and the northern end of the San Gabriel River (605) Freeway. It was incorporated in 1957 and currently ranks 63rd in population size among L.A. County cities. Duarte has a large job base dominated by the manufacturing and service industries. Dominant land uses are institutional (hospital), residential and commercial, with some industrial. Median family income in 1990 was $37,965.

1. The City plans to stencil catch basins and it is estimated that all stenciling will completed by October 1994.

2. In addition to the County hotline, the City has established a city hall contact and has publicized information in the city quarterly newsletter. An article on pollution effects and prevention measures was also included.

3. Several ordinances/code sections/city policies address urban runoff control. Contractors are required to control dust, restore drainage ditches, clean catch basins and culverts, prevent water, soil and debris from depositing in gutters and to remove excess materials. These measure have been enhanced in response to RWQCB requirements.

4. The City has established a public education program which includes articles published in the City newsletter and video broadcasts. Awareness has been enhanced thanks to this program.

5. Catch basins are cleaned each October and as needed during the year.

6. 120 roadside trash receptacles are provided and they are emptied weekly or more often as required. This program has been enhanced due to RWQCB requirements.

7. 128 curb miles are swept every other week in residential areas and twice per week in commercial and industrial areas. Sweeping frequency has been increased in response to RWQCB requirements.

8. Improper litter disposal is addressed in several city regulations and policies. Penalties exist for improper disposal. No modifications have been made in response to RWQCB requirements.

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9. The City contracts with L.A. County for industrial waste and storm drain system inspections. Inspections are conducted on a regular basis per County requirements.

10. The City has encouraged the removal of dirt, rubbish and debris through video broadcast on local cable TV, and an article in the City newsletter.

11. The City has a curbside recycling program for plastic, glass, aluminum, paper, cardboard, junk mail, newspaper and green waste. Information on this program is provided in the quarterly newsletter, from the refuse company and in a school education program. Approximately 18% of rubbish is being diverted at this time. The City may consider expanding the program to multi-family units, and industrial and commercial businesses.

12. The City participates in the Countywide program and publishes information in the city newsletter and in handouts.

13. The City prohibits draining of pools into the gutter and has informed the public on the problem of overwatering etc. in the quarterly newsletter.

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SUMMARY: STORMWATER/URBAN RUNOFF PROGRAM QUESTIONNAIRE

CITY OF EL MONTE

City of El Monte: Phase II Co-Permittee
Population (1994): 111,000
Land Area: 9.57 sq. mi.

El Monte was incorporated in 1912 and lies 12.3 miles east of Los Angeles City Hall along the San Bernardino Freeway east of the San Gabriel river. Land uses are mixed urban with residential, industrial and commercial most common. Its population ranks 7th among Los Angeles County cities. Dominating the job market are the manufacturing and retail trade sectors, providing El Monte with a large job base. Median family income in 1989 was $28,004.

1. The City of El Monte has stenciled all 200 of its catch basins.

2. The City has just established a hotline to the Fire Department for reporting illegal discharges, and plans to conduct public outreach through city newsletter articles.

3. El Monte adopted an ordinance that provides urban runoff controls on 5/23/94.

4. El Monte has a school program on stormwater pollution given by its Fire Department personnel.

5. The City contracts out yearly inspection and cleaning of its catch basins.

6. El Monte provides 70 roadside trash receptacles which are emptied daily. It has not identified problem litter areas.

7. El Monte uses 1 vacuum and 3 broom sweepers to clean all 260 curb miles within the city. Residential and industrial areas are swept weekly, and commercial areas are swept daily.

8. City codes include penalties for littering and the improper disposal of other trash materials.

9. The County Public Works Department provides industrial waste inspections in the City of El Monte.

10. The City's public outreach program includes distribution of the booklet "About Managing Yard Waste", which partially addresses the need for removal of dirt, rubbish, and debris from sidewalks and alleys.

11. The City provides for curbside collection of glass, plastics and paper. It has not established a comprehensive outreach program on recycling.

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12. The City indicates that it participates in the countywide household hazardous waste management program.

13. The City has a water conservation program primarily to regulate household interior water usage; there are no programs to discourage outdoor runoff.

14. Additional Best Management Practices:

A. Underpass pumps are cleaned quarterly &/or before the rainy season.

B. Maintenance of drainage culverts is done once a year.

C. Construction sites must submit a satisfactory control plan to eliminate illegal discharges.

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SUMMARY STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF EL SEGUNDO

City of El Segundo: Phase I, III Co-Permittee
Population (1994): 15,650
Land Area: 5.51 sq. mi.

El Segundo was incorporated in 1917. Located 19.5 miles southwest of the Los Angeles Civic Center along the coast, with LAX adjacent to the north, the City ranks 70th in population size among L.A. County cities. El Segundo has a very large job base dominated by aerospace and high-tech, and includes major petroleum refineries. There are also significant commercial/office and residential land uses. El Segundo had a family median income of $53,215 in 1989.

1. All catch basins have been stenciled by Boy Scout volunteers with a stencil/logo contest winning design.

2. The City has established reporting hotlines through the water department, police, city engineer, etc. Cable TV and local newspaper have been extensively used for public outreach.

3. The City has existing runoff control measures and has prepared a draft Runoff Control Ordinance which was scheduled for City Council consideration in July 1994.

4. The City has established many public outreach programs. These include storm drain video, cable TV bulletin board, newspaper articles, water bill notices, and stencil logo contest.

5. Catch basins are cleaned twice per year.

6. The City provides 40 roadside trash receptacles which are emptied twice weekly. City's Street Maintenance Supervisor monitors the program, adding additional containers where necessary.

7. Residential and industrial streets within the city are swept weekly. Commercial streets are swept daily.

8. The City actively enforces its No Littering Ordinance, and has trained its staff to be more aware of illegal dumping and reporting procedures. Cable TV is used to educate the community.

9. Annual inspections of all commercial and industrial site (includes auto related businesses, gas stations and restaurants) are conducted by L.A. County under contract. Dry weather flows and new connections are inspected.

10. The municipal code addresses responsibility for removal of dirt and debris. Fliers and articles have informed the public. Future fliers and TV outreach will improve program.

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11. The City has a curbside recycling program for newspapers, plastics, glass, metal and aluminum. Used oil and batteries are accepted by the city maintenance facility. Approximately 20% of rubbish is being diverted from landfills at this time.

12. The City participates in the Countywide Household Hazardous Waste Management program. The City also provides yearly HHW collection service. Fliers, newspaper and TV notification publicize these events.

13. The City has a voluntary 10% conservation program which includes restrictions on lawn and landscape irrigation, sprinkler overwatering, washing of facilities, vehicles or other mobile equipment, etc. In addition, water rate schedules have been changed recently to encourage use of recycled water. Also, a reclaimed water plant is under construction.

14. ADDITIONAL BMP'S

A. Industrial Waste Study for the City Maintenance Facility

The City has had an environmental consultant do an industrial waste study and prepare a Storm Water Pollution Prevention Plan (SWPP) for the City Maintenance Facility.

B. Illegal Discharges/Illicit Disposal Practices

The City has developed a check list for plan checking. Necessary storm water requirements for inclusion in building and grading permits are identified.

C. Flow Monitoring and Analysis

Monitoring and analysis of dry weather flows to the city's 5 pump stations could help to determine the origin of these minor flows.

D. Closed Circuit Television of Wastewater Mains (CCTV)

The City has videotaped the interior of all 46 miles of sanitary sewer mains. This allows for locating problems and preventing overflows into the storm drains. It allows the city to set up a program to identify immediate problems and to set up a long range repair and replacement program.

E. Hydro Flush Program

The City has a yearly hydroflush program for the 46 miles of sanitary sewers. This program essentially precludes wastewater overflows.

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F. Wastewater Lift Stations

A rehab program for sewage lift stations keeps the wastewater plants in good operating condition. This prevents failures and overflows and keeps sewage out of the storm drains.

G. New Telemetering System

A modern telemetering system, the Supervisory Control and Data Acquisition System, will improve monitoring and reliability of the City's storm water and wastewater pumping plants.

H. New Storm Water Forms

Public Works has developed new forms and a standard storm water enforcement letter to improve documentation and provide records for projections and program management. These include: plan check list of review items concerning storm water, construction inspectors report, storm water catch basin cleaning record form, and standard storm water enforcement letter.

I. Participation in the Santa Monica Bay Restoration Project

City officials and residents have been part of the Santa Monica Bay Restoration Project Management Committee, the Technical Advisory Committee and the Public Works department has provided support to those efforts.

J. Storm Water City Drawings

During catch basin stenciling an update of the City Catch Basin Plan was prepared. The City will coordinate with L.A. County Public Works as to ownership and maintenance.

K. Control of Surface Runoff and Pollutants from Construction Sites

Permits are required for all construction work in the city. Site grading plans are required to identify possible drainage problems in the planning stages. Building inspectors check for permit conformance and code requirements for residential projects. The City will be using new standards forms to assist Public Works inspectors and planning department staff.

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CITY OF GARDENA

City of Gardena: Phase III Co-Permittee
Population (1994): 53,900
Land Area: 5.67 sq. mi.

Gardena lies 14.2 miles southwest of downtown Los Angeles, west of the 110 (Harbor) Freeway. It was incorporated in 1930 and has an area of 5.67 square miles. Gardena ranks 34th in population among Los Angeles County cities. The job base is very large with manufacturing, retail trade and service industries providing the major sources of jobs. In addition, land uses include significant residential and retail commercial. Median family income was $37,096 in 1989.

1. Gardena is a Phase III city. It will stencil its catch basins in compliance with permit deadlines. Currently no catch basins have been stenciled.

2. The City has not begun any programs to encourage reporting of illegal discharges. It plans to begin a hotline as part of its overall public outreach program.

3. A number of City code sections are cited as having the effect of reducing storm water pollution. The City plans to adopt a comprehensive storm water ordinance before June 1995.

4. Gardena is currently developing a public outreach program that will be implemented prior to permit deadlines.

5. The City cleans catch basins every fall and inspects catch basins during storms to remove trapped debris.

6. Roadside trash receptacles are not provided by the City. The City increases street sweeping in problem areas.

7. All 193 curb miles within the City are swept. Residential areas are swept once weekly; commercial and industrial areas are swept two to three times weekly.

8. Several sections of Gardena's codes require all materials such as litter, lawn clippings and pet feces to be picked up immediately. City staff anticipates further code changes as part of its planned comprehensive Storm Water Ordinance.

9. Gardena contracts with Los Angeles County for Industrial Waste Inspections, which are conducted annually.

10. Gardena plans to have public outreach encouraging removal of dirt, rubbish and debris from sidewalks and alleys as part of its planned comprehensive outreach program. It also intends to inspect alleys every 3 months.

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11. The City has a permanent recycling center, provides curbside pick-up of aluminum, steel, glass, plastics and wood products, and conducts public outreach through articles in the City newsletter and cable TV. Staff estimates that 30.8% of rubbish is being diverted from landfills.

12. Gardena participates in the countywide household hazardous waste management program. It plans to begin accepting used motor oil for recycling and to publicize the waste roundups.

13. Encouraging conservation of water will be made part of Gardena's planned comprehensive public outreach program.

14. Additional Best Management Practices:

A. Gardena has an existing weed and rubbish abatement program for both developed and undeveloped properties.

B. City crews report and clean up illegally deposited non-hazardous materials in City rights of way.

C. Gardena has an abandoned vehicle removal program.

D. The City's own vehicle maintenance program ensures that all vehicles are washed in areas that drain only to the sewer. Used engine oil, filters and batteries are stored in contained areas and are recycled.

E. Gardena has a program in place to respond rapidly to contain hazardous materials spills.

F. The City has a landscaping program to reduce landscape-related constituents in stormwater.

G. The City plans to require sandbagging at all construction sites between October 15 and May 15 to collect all runoff.

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SUMMARY: STORMWATER/URBAN RUNOFF PROGRAM QUESTIONNAIRE

CITY OF GLENDALE

City of Glendale: Phase II, III Co-Permittee
Population (1994): 190,200
Land Area: 30.49 sq. mi.

Glendale is located 7.1 miles north of Los Angeles City Hall, was incorporated in 1906, and has the 3rd largest population among all cities in Los Angeles County. Glendale has a very large job base dominated by retail trade, manufacturing, finance and service industries. It is a major center within the County and it also contains extensive residential areas. The 1989 median family income in Glendale was $39,652.

1. The City of Glendale owns and maintains catch basins but has not implemented a stenciling program.

2. The City has established a 24-hour hotline number for reporting illegal discharges, but has not yet informed the public of its availability.

3. Glendale is in the process of modifying its municipal code to address runoff control.

4. The City has not yet implemented a program to educate the public on the problem of stormwater pollution.

5. Glendale has a program of cleaning its catch basins before rainstorms and on an as-needed basis.

6. The City has 204 public roadside trash receptacles that are emptied 3 times per week.

7. All 800 curb miles of streets in Glendale have street sweeping service. Residential and industrial areas are swept every 2 weeks, and commercial areas are swept 4 times per week.

8. To discourage improper disposal of lawn clippings and other materials, the City has bi-weekly curb pick-up of yard trimmings. The Parks Department, on a trial basis, is providing bags for dog owners to use to dispose of feces.

9. Glendale has an industrial waste inspection program under which it inspects for non-stormwater discharges. It inspects all permittees under the program once a year.

10. The City does not have a public outreach program concerning removal of dirt and other materials from sidewalks and alleys.

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11. Glendale has a comprehensive recycling program that includes a permanent recycling center; curbside pickup of paper, glass, aluminum and other cans, plastics, and yard waste; and, an outreach program that includes mailed pamphlets, door hangers, and news articles. About 32% of rubbish is being diverted.

12. The City participates in the County's household hazardous waste program and also regularly collects household hazardous waste at its recycling center.

13. Glendale has not implemented a program that reduces runoff to storm drains from outdoor water use.

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SUMMARY
STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF GLENDORA

City of Glendora: Phase II Co-Permittee
Population (1994): 49,850
Land Area: 19.16 sq. mi.

Glendora was incorporated in 1911 and lies 25.9 miles northeast of the Los Angeles Civic Center, along the foothills of the Angeles National Forrest and north of the Foothill (210) Freeway. It is the 37th largest city in Los Angeles County in terms of population. Glendora has a small job base, of which the largest employers are in retail trade and services. Its land uses include single family residential, some industrial and commercial, and significant vacant areas. The 1989 median family income was $51,444.

1. The City has stenciled all of its catch basins with the Heal the Bay design.

2. In addition to the County hotline, on 4/14/94 the Glendora Administrative Policy manual established a reporting procedure, which was disseminated to the public through newsletters and public service announcements.

3. A draft urban runoff pollution ordinance is being considered by the City.

4. Library displays, school presentations, pamphlets, video presentations on cable T.V. have been used to educate the public on the problem of stormwater pollution.

5. The County of Los Angeles Department of Public Works cleans all catch basins regularly.

6. The City's 20 roadside trash receptacles are emptied weekly and the business district is monitored to ensure adequate coverage.

7. The City's 310 curb miles are swept once a week in commercial areas and every two weeks in residential and industrial areas Commercial areas were recently upgraded to once a week.

8. The City' draft runoff ordinance addresses improper disposal. Penalties are included in the proposed ordinance.

9. The City does not have an industrial waste inspection program. However, on a complaint basis, Code Enforcement will take action to abate illegal non-storm water discharges.

10. Community newsletter and cable T.V. announcements is used as a pro active educational approach to encourage the public to remove dirt, rubbish and debris from sidewalks and alleys.

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11. The City has implemented a routine curbside recycling pickup and newsletters, articles and public informational announcements to inform the public of the benefits of recycling. Approximately 13% of rubbish is being diverted from landfills.

12. The City participates in the Countywide Household Hazardous Waste Management program.

13. City ordinance identifies prohibited conduct and establishes enforcement capability. Public information brochures are used to inform the public regarding water conservation.

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SUMMARY
STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF HAWAIIAN GARDENS

City of Hawaiian Gardens: Phase III Co-Permittee
Population (1994): 14,250
Land Area: 0.96 sq. mi.

Hawaiian Gardens is located 21.8 miles southeast of the Los Angeles Civic Center and was incorporated in 1964. The population ranks the City 72nd among Los Angeles County cities. It has a small job base, led by construction, retail trade and service industries. Land uses are primarily residential with some commercial. Median family income in 1989 was $29,379.

1. The City has not yet implemented a stenciling program but plans to stencil all catch basins with the County's stencil. The program will begin in summer 1994.

2. A 24 hour City hotline has been established. The hotline was publicized though the city newsletter and community meetings. 6 reports have been received.

3. No runoff control ordinance has been adopted.

4. No public education program has been established but the City mentions that articles will be published in the City newsletter in both English and Spanish to inform residents about illegal dumping.

5. Catch basins are cleaned yearly which is very effective in keeping debris from entering the storm drains.

6. The City provides 20 trash receptacles which are emptied weekly. Problem areas at major bus stops have been identified and the receptacles there are emptied bi-weekly. In response to the requirements of the RWQCB the City now assures that all bus stops, parks, agency owned shopping centers and City facilities have enough trash receptacles.

7. 78 curb miles are swept twice per week. This program has been very successful in preventing debris from entering the storm drain system and has not been modified in response to RWQCB requirements.

8. The City's 24 hour hotline is used to discourage improper disposal of litter, lawn clippings and pet feces.

9. Industrial waste inspections are provided by L.A. County Fire Department. Public Works staff inspects drains and notes any evidence of illegal discharge. No inspections are made of auto related businesses, gas stations or restaurants.

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10. The City's 24 hour hotline is used to encourage removal or dirt, rubbish and debris. In response to the RWQCB requirements the City has a program for residents to call in for items that are not normally picked-up in regular curb side collection. The City also provides a block clean-up program where bins are placed on the street for periods of time to allow residents to dispose of junk.

11. No recycling program has been implemented.

12. The City participates in the County household hazardous waste management program and seeks to expand the block clean-up program to include hazardous materials.

13. The City has adopted an ordinance for the usage of drought tolerant plants in new construction and for all City facilities.

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SUMMARY
STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF HAWTHORNE

City of Hawthorne: Phase III Co-Permittee
Population (1994): 74,400
Land Area: 5.99 sq. mi.

Incorporated in 1922, Hawthorne is located 15 miles southwest of downtown Los Angeles and it has the 23rd largest population in the County. Hawthorne is a mixed use city with various types of residential, commercial and industrial land uses. The job base is very large with manufacturing being the strongest sector, containing 59% of the total jobs. Median family income was $35,366 in 1989.

1. The City has stenciled all of its catch basins during summer of 1994.

2. The City has not established any programs to promote public reporting of illegal discharges in addition to the County hotline. The hotline number has been advertised on the city cable channel.

3. Existing Municipal Code Sections 12.30.010, 13.40.010, and 12.28.020 address runoff control. In addition, the City plans to adopt a more stringent ordinance based on the model ordinance produced by the working group.

4. Information and education pamphlets have been distributed; notices will be inserted with the next water bill; Hawthorne Cable Television plans a video program which will show stenciling and cleaning catch basins and explain the NPDES program, City will place article in local newspaper and use direct mail to send information to local businesses.

5. The catch basins are cleaned yearly before the rainy season and on an as needed basis. In response to the RWQCB requirements, the City plans to increase the frequency of catch basin cleaning.

6. 32 roadside trash receptacles are provided and they are emptied once a week. A continuous inspection and cleaning program has been implemented especially in litter prone areas.

7. 231 curb miles are swept, once per week in residential areas, and three times per week in commercial areas. This program has not been modified in response to RWQCB requirements.

8. The City's program to discourage improper disposal of litter, lawn clippings and pet feces includes the use of the recycling program, outreach pamphlets, water bill inserts, and direct-

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mail notices. The City recently established 2 locations for used oil recycling and advertised for them in Hawthorne's newspaper and on cable television. In addition, Hawthorne Municipal Code regulates any improper disposal of litter and imposes fees for clean up. A citation program handled by code enforcement personnel is suggested.

9. The City has developed the database necessary for the industrial waste inspection program. Code enforcement personnel are making daily observations for non-storm water discharges. A yearly inspection program will be implemented in the future using either Los Angeles County Department of Public Works (L.A. C.D.P.W.) or the City of Hawthorne inspectors. Los Angeles County Sanitation District currently conducts industrial Waste Water inspections in the City of Hawthorne.

10. The City is implementing a program encouraging the public to remove dirt and debris. Notices were mailed out for cleaning all alleys and sidewalks; door-to-door hanger-type fliers were distributed; an article will be placed in local newspaper. The City also encourages removal of dirt and debris by having the engineering department send letters asking residents to clean up debris.

11. The City has a curbside recycling program. Paper, glass, tins, aluminum, plastic, printed materials and cardboard are collected. Approximately 10% of rubbish is being diverted from landfills at this time.

12. The City participates in the Countywide Household Hazardous Waste Management Program. The City also joins with neighboring cities and major industries in their hazardous waste collection programs.

13. The City has a water conservation program which has reduced water use by 10% from 1989 levels. The programs asks for less watering, prohibits washing of sidewalks, driveways, parking areas and cars. The public is informed of the problem of overwatering through this program.

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SUMMARY
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CITY OF HERMOSA BEACH

City of Hermosa Beach: Phase I Co-Permittee
Population (1994): 18,700
Land Area: 1.36 sq. mi.

Hermosa Beach is a beach city, located 21 miles southwest of the Los Angeles Civic Center. It was incorporated in 1907 and it ranks 67th by population size among L.A. County cities. Primarily residential, it has a small job base, mainly retail. Median family income in 1989 was $65,085.

1. All City catch basins have been stenciled. Problem: Water-based paint is already eroding. Suggestion: Stencil sides of curbs so message is visible to vehicular traffic.

2. The City actively promotes use of the County Hotline. Its public education encourages reporting to either the City or the County; door-hanger fliers and City publications sent to all residents are program components. The City intends to adopt a Storm Water and Urban Runoff Pollution Control Ordinance to provide them with increased enforcement authority.

3. The City has not as yet implemented urban runoff control measures, although a draft Storm Water Pollution Prevention Ordinance is scheduled for adoption by October 1994.

4. The City's public outreach program has included: 1) CATV public service announcements (Heal-the-Bay video); 2) distribution of information packets to downtown business owners; 3) distribution of door hanger-type fliers to 50% of all City residents; 4) preparation and distribution at special events of educational fliers, including encouragement of participation in the City's "Neighborhood Gutter Patrol" program; and 5) presentations on pollution prevention education at the City's public schools.

5. The City cleans all catch basins every 3 months.

6. The City empties its 300 public trash receptacles at least three times a week--daily in the downtown area.

7. All City streets, alleys and parking lots are swept once a week.

8. City ordinances, supported by fines and sanctions, prohibit improper litter disposal.

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9. Industrial waste inspections are made of all industrial and related uses, as permitted by the City's fire prevention and hazardous materials codes. To increase their authority to inspect the storm drain system for non-storm water discharges, the City is planning to adopt a Storm Water Pollution Prevention Ordinance.

10. While the City does not have a direct public outreach program to encourage trash removal from sidewalks and alleys, they do enforce a City ordinance prohibiting the placing of trash in these areas. The City plans to add this facet to their public education program for runoff pollution prevention.

11. Aluminum cans, glass, plastics and newspaper is collected at curbside for recycling. Cable TV and quarterly articles in the City's newsletter promote the program.

12. The City's Environmental Coordinator informs residents and businesses of the County's hazardous waste round-up program.

13. The City's water supplier and a City resolution encourage residents and businesses to conserve water. The draft Storm Water Pollution Prevention Ordinance will discourage excessive outdoor water use by prohibiting non-storm water discharge to the storm drain system.

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SUMMARY: STORMWATER/URBAN RUNOFF PROGRAM QUESTIONNAIRE

CITY OF HIDDEN HILLS

City of Hidden Hills: Phase II Co-Permittee
Population (1994): 1,850
Land Area: 1.72 sq. mi.

Located between Ventura County and the Ventura (101) Freeway, Hidden Hills is 27 miles northwest of downtown Los Angeles. Established in 1961, Hidden Hills is a small residential community with exclusively low density residential land uses. There are only a few jobs in the city and are in either services or construction. Median income in 1989 was $150,001.

1. Hidden Hills does not own catch basins; the County owns the catch basins and will stencil them in the future.

2. The City has publicized the County's hotline for reporting illegal discharges through its city newsletter, city access cable, notice posting and handouts.

3. Hidden Hills has ordinances in effect to control liquid waste and runoff. These were last revised in 1993.

4. The City has used its newsletter, handouts, cable TV and posting to educate the public on the problem of stormwater pollution.

5. The catch basins in Hidden Hills are owned, and therefore maintained by the County.

6. The City does not provide roadside trash receptacles. All streets are privately owned and maintained daily by Community Association-hired crews.

7. A vacuum and a broom sweeper are used by the City to clean all 25 curb miles within the city twice a month.

8. To discourage improper disposal of lawn clippings and other materials, the City provides green waste and horse manure recycling.

9. Hidden Hills has no industrial uses or restaurants within its borders, therefore it does not have an inspection program.

10. Hidden Hills does not contain any sidewalks or alleys.

11. The City has two drop-off recycling centers and has curbside pick-up of newspaper, paper, glass, aluminum and plastics. Public education and outreach is conducted through the City newsletter cable, and handouts. About 17% of all rubbish is being diverted.

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12. County household hazardous waste collection dates are advertised by the City through fliers, cable TV, the City newsletter, and announcements at City Council meetings.

13. Hidden Hills adopted a water efficient landscaping ordinance in 1993. It has a program to inform the public about the polluting effects of runoff that includes handouts, articles in the City newsletter and cable TV.

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SUMMARY
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CITY OF HUNTINGTON PARK

City of Huntington Park: Phase III Co-Permittee
Population (1994): 58,600
Land Area: 3.00 sq. mi.

Five miles south of the Los Angeles Civic Center lies the City of Huntington Park, incorporated in 1906. With its unusual shape, it borders 6 cities and the unincorporated area of Florence. The job base of the city is small. Manufacturing is the leading industry, followed by services and retail trade. Land uses include industrial, commercial and mixed residential. Huntington Park is the 31st most populous city in the County and had a median family income of $24,268 in 1989.

1. The City has not yet implemented stenciling but a program is budgeted for fiscal year 1994-95.

2. In addition to the County hotline the police department 24 hour hot line can be used to report illegal dumping.

3. The City is in the process of adopting a runoff control ordinance. This would be accomplished in the 1994-95 fiscal year.

4. The City has not yet implemented any educational programs but they are budgeted for the 1994-95 fiscal year.

5. Catch basins are cleaned twice yearly. This program has been modified in response to the RWQCB requirements.

6. Approximately 250 roadside trash receptacles are provided. They are emptied daily.

7. 130 curb miles are swept weekly in residential and industrial areas and daily in commercial areas. This program has not been modified in response to the RWQCB requirements.

8. The City has regulations in the Municipal Code to discourage improper trash disposal. There are penalties for improper disposal.

9. The City does not have an industrial waste inspection program. However, a continuous program under contract with the County Waste Management division is being considered. Non-storm water discharges are inspected by the L.A. County Sanitation District. There are no inspections of auto related businesses, gas stations, or restaurants. Any inspections are completed under the authority of building permits.

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10. An ordinance to encourage removal of dirt, rubbish and debris from sidewalks and alleys is pending.

11. The City has implemented a recycling program for phone books and Christmas trees and has a mobile center where residents can take aluminum cans, glass and plastics. Outreach programs have been established for local schools and businesses. The City estimates that 30% of rubbish is being diverted from landfills at this time.

12. The City participates in the Countywide household hazardous waste management program. The City is a co-sponsor of roundups and distributes advertising material to publicize the event. A used oil facility will soon be sited in the City. The hazardous waste collection program has been modified in response to the RWQCB requirements. The City suggests requiring a deposit at the point of sale as an incentive to return used oil.

13. The City has an existing water conservation program though no details are provided. No program to notify the public on the results of overwatering or washing off of sidewalks etc. has been established.

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SUMMARY
STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF INDUSTRY

City of Industry: Phase II Co-Permittee
Population (1989): 680
Land Area: 11.94 sq. mi.

The City of Industry is located 22 miles east of downtown Los Angeles and is the second smallest city in the County by population, ranked 87th. Established in 1957, the City is named for its primary land use. Industry's job base is very large with manufacturing dominating, followed by wholesale trade and services. Median family income in 1989 was $34,000.

1. No catch basins have yet been stenciled but the City does plan to implement a stenciling program and to use their own design.

2. In addition to the County hotline the City has sent a flier to all city addresses regarding the NPDES program and giving the City Hall telephone number. 2 reports have been received.

3. The City, on July 14, 1994, adopted ordinance No. 609 establishing storm water and urban runoff pollution prevention controls.

4. A public outreach program to educate the public on the problem of stormwater pollution has been established. The program includes the use of fliers and presentations to public groups. The City feels that informing the public will be effective.

5. Catch basins are cleaned once per year and as needed as determined by visual inspection. This program has been modified in response to RWQCB requirements and is estimated to be very effective.

6. The City provides roadside trash receptacles which are emptied weekly. Modifications in response to RWQCB requirements include increased number of receptacles and closer inspection.

7. The City sweeps 100 curb miles weekly (commercial and industrial areas). Inspection frequency and quality have been increased in response to RWQCB requirements.

8. The City discourages improper litter disposal through a public outreach program and Ordinance No. 609. These programs have been developed and implemented in conjunction with the NPDES program.

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9. An industrial waste inspection program will be implemented per Ordinance No. 609. The City does inspect for non-storm water discharges. Auto related businesses, gas stations and restaurants are inspected under the authority of Ordinance 609.

10. The City has an outreach/education program to encourage removal of dirt and debris. Fliers and presentations inform the public. This program was implemented in response to RWQCB requirements.

11. The City has a recycling program but no curbside collection. A 5,700 ton materials recovery facility is planned for construction. It is estimated that 38% of rubbish is being diverted from landfills at this time. The City will augment the public outreach program to encourage recycling of oil, antifreeze, glass, plastic etc.

12. The City participates in the Countywide Household Hazardous Waste Management Program and promotes roundups through fliers and other information.

13. The City as well as the City of Industry Waterworks System has developed and implemented a water conservation program as part of the public outreach program. The outreach program includes information on problems of overwatering and washing of sidewalks etc.

14. ADDITIONAL BMP'S

A. Applicants for grading permits on sites of 5 acres or more will be required to provide copies of their Notice of Intent (NOI) and Storm Water Pollution Prevention Plan (SWPPP) prior to issuance of their grading permit. City inspectors will monitor the implementation of SWPP's.

B. All field personnel attend an initial NPDES information session conducted by the NPDES Program Coordinator. Annual refresher information sessions will be conducted, which will also allow for feedback to the program coordinator regarding observations, concerns, recommendations and problems encountered.

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SUMMARY
STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF INGLEWOOD

City of Inglewood: Phase I, III Co-Permittee
Population (1989): 113,600
Land Area: 9.04 sq. mi.

Inglewood is 13 miles southwest of downtown Los Angeles and was incorporated in 1908. It is home to the Forum (L.A. Lakers and Kings) and a racetrack at the Hollywood Turf Club. Its job base is large with over 1/3 of the jobs in services. Inglewood is the 9th largest city in the County in terms of population and had a median income of $32,077 in 1989.

1. All catch basins in the City have been stenciled with the Heal the Bay design. The City estimates that there has been a 10% reduction in accumulation due to the stenciling program.

2. No programs have been established to promote public reporting of illegal discharges. The County hotline is not publicized.

3. No runoff control measures have been implemented. Presently, an RFP is being prepared for obtaining a consultant to develop a stormwater ordinance.

4. The City has educated the public through published articles and circulated bulletins. Some aspects of the education effort appear to have a significant effect.

5. All catch basins are cleaned annually prior to the rainy season. Problem basins are cleaned as often as weekly in some cases. Estimates are that 50-80 tons of debris are removed annually.

6. 102 roadside trash receptacles are provided and are emptied weekly. Some districts with problem litter areas are serviced daily. This program has not been modified in response to RWQCB requirements.

7. 195 miles of improved streets are swept weekly in residential and industrial areas and daily in commercial areas.

8. Improper disposal of lawn clippings is discouraged through workshops and containers for household composting. No specific pet feces regulations exist.

9. City staff does not specifically inspect for industrial waste except as related to issuance of Los Angeles County Industrial Waste Permits. Non-storm drain discharges are not specifically inspected. No program exists for inspection of auto related businesses, gas stations and restaurants.

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10. The City encourages removal of dirt and debris by co-sponsoring bi-annual clean-up days and existing codes prohibiting placement of materials in public right of way are enforced by code enforcement officers, building inspectors, and engineering inspectors.

11. Curbside recycling has not been implemented. Outreach programs to local businesses, schools and citizens groups have been established to promote recycling. Green waste and used oil recycling programs have been established. The City estimates that 10% of rubbish is being diverted from landfills at this time.

12. The City participates in the County Household Hazardous Waste Management Program. City staff has promoted used oil collection at retail outlets and circulated fliers to inform the public.

13. Landscape Ordinance No.93-20 regulates runoff and maintenance of irrigation systems. Some of the issues of overwatering have been addressed but no on-going program exists.

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SUMMARY
STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF IRWINDALE

City of Irwindale: Phase II Co-Permittee
Population (1994): 1,060
Land Area: 9.47 sq. mi.

Established in 1957, Irwindale is located 17.5 miles northeast of the Los Angeles Civic Center. Irwindale has a very large employment base though it is the 4th smallest L.A.. County city by population. Approximately half of the jobs are in the manufacturing sector, while services come in a distant second. Land uses are primarily industrial with some commercial, residential and vacant. Median family income was $29,917 in 1989.

1. The City will stencil its catch basins beginning September 1, 1994.

2. The City has implemented a hotline or reporting system.

3. A runoff control ordinance has not been adopted, however the City is in the process of developing one.

4. The City has not implemented programs to educate the public on the problem of stormwater pollution.

5. The City cleans its catch basins annually.

6. The seven roadside trash receptacles are emptied weekly and litter areas are inspected on a regular basis.

7. Street sweeping on the 52 curb-miles of improved streets is performed weekly.

8. The City has not implemented programs to discourage the public from improper disposal of litter, lawn clippings and pet feces.

9. The City contracts with the county for the industrial waste inspection program.

10. The City will implement a public outreach/education program during Fiscal Year 94-95.

11. The City's recycling program includes curbside pick up of recyclables, and public outreach/education.

12. The City participates in the Countywide household hazardous waste management program but does not conduct additional collections.

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13. The water conservation program consists of voluntary water conservation and drought tolerant landscaping. No outreach or education programs have been implemented yet -- expected in Fiscal Year 94-95.

14. ADDITIONAL BMP's

A. A comprehensive public education program is planned in Fiscal Year 94-95. This will include informational fliers, handouts, newsletters.

B. During Fiscal Year 94-95, building inspectors will be trained to identify illicit discharges/connections. Also the City will develop contract specifications intended to reduce pollutants from paving operations.

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SUMMARY
STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF LA CANADA-FLINTRIDGE

City of La Canada-Flintridge: Phase II, III Co-Permittee
Population (1994): 19,700
Land Area: 8.61 sq. mi.

At the base of the Angeles National Forest and just over 13 miles north of downtown Los Angeles lies the City of La Canada-Flintridge, which was established in 1976. The Foothill Freeway (210) passes through the southern part of the city. Its job base is small with retail trade and services being the leading sectors. Land uses are overwhelmingly low density residential with substantial open space and vacant land. Median family income was $87,041 in 1989.

1. Although it owns and maintains catch basins, the City has not implemented a stenciling program primarily because of budget constraints. However, L.A. County catch basins are currently being stenciled by the County.

2. In addition to the County hotline, the City through newsletter articles has informed the public that they may call the Sheriff after 5:00 p.m. and on weekends to report illegal discharges/dumping.

3. The City has L.A. County's Industrial Waste and Urban Runoff Ordinance as its Industrial Waste and Urban Runoff Ordinance.

4. The City newsletter has been used to inform the public regarding stormwater pollution.

5. The City cleans its catch basins annually and in cases of emergency.

6. Roadside receptacles (no number given) are emptied once a week.

7. The City sweeps its 50 miles of improved streets every other week.

8. The City newsletter has been used to inform the public regarding proper disposal of litter, lawn clippings and pet feces.

9. The City contracts with L.A. County for industrial waste inspection.

10. The City newsletter has been used to inform and encourage the public regarding the removal of dirt, rubbish and debris from sidewalks and alleys.

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11. The City recycles various materials and diverts approximately 14% of refuse collected. An educational program, primarily but not solely aimed at new residents regarding the benefits of recycling has been established.

12. The City participates in the Countywide Household Hazardous Waste Management program conducts its own curbside collection of motor oil.

13. The City does not have a water conservation program; however the City Council has repeatedly stressed the importance of water conservation in light of the drought.

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SUMMARY STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF LA HABRA HEIGHTS

City of La Habra Heights: Phase II, III Co-Permittee
Population (1994): 6,500
Land Area: 6.39 sq. mi.

Incorporated in 1978, La Habra Heights is located 23.5 miles southeast of the Los Angeles Civic Center, at the Orange County boundary. Most of the City land uses are residential, with a very small job base. La Habra Heights has one of the smallest populations in L.A. County, ranking 81st among all the cities.

1. Although the City owns and maintains catch basins, it has not implemented a stenciling program at this time. The City is planning to implement the program in the near future.

2. In addition to the County hotline, residents can report illegal discharges/dumping incidents to the City's Volunteer Fire Department. The hotline number is published in community newspapers.

3. The City requires erosion control plans and governs amount of impervious coverage on each lot.

4. Although not implemented yet, the City is preparing articles/information to be included in community publications.

5. The City contracts with Los Angeles County Public Works for the annual cleaning of the catch basins.

6. The City does not provide roadside trash receptacles.

7. The City does not have a routine street sweeping program primarily because the majority of the streets in the community are private and do not have curb/gutter.

8. The City promotes residents/businesses to leave their grass clippings on the lawn.

9. The City does not have an industrial waste inspection program, primarily because there are no industrial uses within the City.

10. A public outreach/education program is not implemented because most streets in the City do not have sidewalks and there are no alleys within the City.

11. A recycling program/recycling center is in operation with 3% of rubbish diverted from landfills (glass, cans, newspaper). Articles and a pamphlet are sent to residents describing the benefits of recycling. Volunteers work the recycling center on Saturdays.

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12. The City participates in the Countywide Household Hazardous Waste Management program but does not conduct its own hazardous waste collections.

13. The La Habra Heights Water District provides brochures for water conservation. Also, the District provides workshops on irrigation and rebates for replacing toilets.

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SUMMARY
STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF LAKEWOOD

City of Lakewood: Phase III Co-Permittee
Population (1994): 75,300
Land Area: 9.54 sq. mi.

Lakewood is 19.5 miles southeast of downtown Los Angeles and was incorporated in 1954. With a large retail mall within its boundaries, over half the city's employment is comprised of retail trade. Overall, the job base is small. Lakewood has the 22nd largest population in the County. Land uses are primarily low density residential. Median family income was $48,519 in 1989.

1. All catch basins, with the exception of three, are owned and operated by the County of Los Angeles.

2. The City has developed programs to promote public reporting of illegal discharges/dumping to the extent of (a) participating in the storm water hotline program; (b) publicizing the toll-free hotline number in Lakewood Living, the City's newsletter; (c) airing storm water pollution prevention videos; and (d) incorporating the storm water hotline into its existing program of encouraging residents and businesses to report hazardous material/waste leaks or spills, discovery of suspicious containers on public or private property for investigation by City personnel or Los Angeles County Fire Department Haz-Mat.

3. The City has not adopted an urban runoff control ordinance but plans to enact such an ordinance by June 18, 1995.

4. The City has not implemented programs to educate the public on stormwater pollution but intends to do so during Fiscal Year 94-95.

5. The County of Los Angeles cleans catch basins annually and as needed.

6. Approximately 100 trash receptacles are placed at bus stops and parks and emptied at least every other day. Litter prone areas have receptacles which are cleaned as often as necessary.

7. The approximately 400 curb miles in the City are swept once a week.

8. City ordinances prohibit the improper disposal of litter, lawn clippings and pet feces. The City intends to implement a comprehensive stormwater/urban runoff pollution prevention public education/outreach program during Fiscal Year 94-95.

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9. The City currently contracts with Los Angeles County to provide industrial waste water inspections. City plans to extend its contract to include storm water inspections of auto repair, auto body, auto parts shops, gas stations, restaurants, and other industrial and commercial facilities that handle, store, and dispose significant materials.

10. The City has not implemented a public outreach/education program to encourage the public to remove dirt, rubbish and debris from sidewalks and alleys. These practices are required by ordinance and compelled through code enforcement.

11. The City recycling program includes ten recycling centers where residents can drop off recyclables. Residents are encouraged to recycle through the City's public education program. City also encourages commercial facilities to require their refuse collection companies to recycle a variety of waste products. City's landfill diversion rate is approximately 17%.

12. The City is a participant in the Countywide Household Hazardous Waste Management program, but does not conduct additional waste collections. Residents are encouraged to drop off used oil at recycling centers.

13. City water conservation ordinance prohibits the use of water which causes runoff. Public outreach/education regarding water conservation will be incorporated in the stormwater pollution program to be implemented in the near future.

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SUMMARY
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CITY OF LA MIRADA

City of La Mirada: Phase III Co-Permittee
Population (1994): 44,250
Land Area: 7.78 sq. mi.

Bordering Orange County, La Mirada is 19.5 miles southeast of the Los Angeles Civic Center area and it has the 40th largest population among County cities. La Mirada was incorporated in 1960. The job base is large with three sectors, manufacturing, retail trade and services contributing 75% of all jobs. Land uses are primarily residential with some industrial and commercial. Median family income was $48,519 in 1989.

1. The City has authorized L.A. County Public Works, as of July 27, 1994, to stencil County owned catch basins. City owned catch basins have not yet been stenciled.

2. The City encourages residents to report illegal dumping to the Environmental Services Department, Customer Service Center(CSC), or the County hotline. The CSC was publicized through press releases, articles in newsletter and newspapers, and reports on cable TV.

3. Construction sites are required to have erosion control plans under the UBC and La Mirada Code 17.04, adopted 1992. In addition to the erosion control plans the City also inspects construction sites to detect and prevent erosion.

4. The City publishes newsletter articles, and issues press releases on storm drain maintenance throughout the year.

5. The City contracts with L.A. County Public Works for catch basin cleaning twice per year. Also, the City removes debris when needed. In response to RWQCB requirements the City uses a broom or a shovel to remove debris from catch basins instead of flushing them.

6. The City does not provide roadside trash receptacles.

7. 230 curb miles are swept once a week. This program has been in effect for many years and has not been modified. In addition, special service is provided as needed between scheduled sweepings.

8. The City has many programs and codes to discourage improper disposal including receptacle requirements, special item pick-up, and illegal dumping provisions. Community composting and greenwaste recycling are being considered. The City suggests regular public workshops and environmental education in schools to discourage improper disposal.

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9. There is no proactive industrial waste inspection program though illegal discharges are reported to the proper authorities. Auto related businesses, gas stations, and restaurants are not inspected.

10. The City's newsletter that is periodically mailed to all residents provides public outreach to encourage removal of dirt, rubbish and debris from sidewalks and alleys.

11. Curbside recycling, to replace a drop-off program, is scheduled for implementation in December 1994. The program will be publicized through brochures, local cable commercials, press releases, public meetings and newsletters. Presently, 11% of rubbish is being diverted from landfills. The City has also adopted a Source Reduction and Recycling Element.

12. The City has adopted a Household Hazardous Waste Element, and promotes roundups through press releases, City Hall marquee and cable TV. In addition, a used oil program is being developed.

13. The City implemented a comprehensive Water Conservation Program for its residents and City employees in 1991. City landscape projects use drought resistant and water efficient plants. Brochures on water conservation are distributed by the City and water purveyors, newsletter articles promote conservation and the local schools participate in water conservation programs.

14. Other BMP's

a. Emergency/Major Spill Clean-up Procedures. Spills and cleanup of gasoline products or other toxics, or fires extinguished by foam can leave contaminants that could easily be washed into the storm drain system. Policies and procedures to block such flow and properly dispose of the residue are in place in the City.

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STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

LOS ANGELES COUNTY

Los Angeles County — Principal Permittee

Population (Total including cities) (1994): 9,230,600
Population (Unincorporated): 961,800
Land Area (Total): 4,083 sq. mi.
Land Area (Uninc.): 2,668 sq. mi.

Los Angeles County has by far the largest population of all counties in the nation and, by many measures, is larger than most countries in the world. It has more than 3,700,000 jobs and its median family income in 1994 was $45,200.

1. 12,114 catch basins have so far been stenciled. Before stenciling County owned catch basins within a city, the City must submit a letter of support. Public awareness of the stenciling program has been increased due to transit shelter signs displaying the stencil located throughout the County. Magnets with the stencil design and program mascot will soon be distributed at public education events. The stencil program is estimated to be completed in three years. The program has not encountered any major problems and it appears to be effective. A maintenance program needs to be developed.

2. The County 800 hotline and 458-HELP are used to report illegal dumping. Tracking of hotline complaints has been established. A follow-up letter has been implemented for minor dumping violations. Hotline number is advertised in newspapers, and in literature distributed at County events. The program appears effective due to the increasing number of calls received. The hotline could be further advertised by utilizing free cable channels, radio broadcasts and other public service announcement media.

3. The County Building Code has provisions on erosion control for sites with active grading. These measures have been in effect since 1965 and are effective in improving the quality of urban runoff. Ordinance 92-0127 strengthened the erosion control provisions and includes penalties for violations. Modifications could include, erosion control programs to cover all building sites and phases of construction, and improve enforcement.

4. The County has established a campaign for increasing public awareness of stormwater pollution. Brochures, booklets, television, radio and newspaper advertisements, and bus stop shelters are methods used for distributing information. Public awareness and outreach programs are effective as long as they educate citizens and make them more environment-conscious. Surveys will be conducted to determine

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effectiveness of programs. Advertising campaigns utilizing billboards, bus shelters and bus posters , point of purchase campaigns, business and industry outreach, and school programs are suggested.

5. County catch basins are cleaned annually by hired contractor prior to rainy season. This is an effective program because a large amount of debris can accumulate. Data on the quantity of debris is being collected and could justify additional cleaning.

6. Roadside trash receptacles are provided but the number in the unincorporated area is not recorded. Receptacles are emptied weekly and additional ones, some lined with plastic, are added to problem litter areas. Modification to the program in response to the RWQCB requirements includes adding receptacles in identified area for service by County personnel until added to trash collection company's route.

7. 3025 curb miles (both sides of streets) are swept using vacuum and broom equipment. Residential, commercial and industrial areas are swept once per week. In response to RWQCB requirements double sweeping has been started on selected streets. In addition, areas along parkways and shoulders that experience frequent dumping are being cleaned so that these materials do not get into the storm drain system. Additional personnel including juvenile camp crews and general relief workers are being used to provide cleaning. Enforcement of no parking on street sweeping days has been requested.

8. County Health Department, Fire Department and Animal Control regulations govern disposal of litter, lawn clippings, and pet feces. Any persons violating the above Ordinances will be asked to terminate such practices and take corrective actions, or face enforcement actions. The brochure "The Ocean Begins at Your Front Door!" is used to educate the public on the impact of improper disposal on stormwater quality.

9. All commercial and industrial facilities which generate industrial wastes are issued permits subject to inspection. Inspection frequency is based on industry type and special circumstances. Field personnel investigate any non-stormwater discharges promptly. The following businesses are investigated: auto parts (2/year), auto repair(3/year), autobody shops(2/year), gas stations(1/year), restaurants(1/year). Auto accessory, car washes and truck maintenance facilities are also inspected. Only those facilities with an Industrial Waste permit are inspected regularly. Authority is provided through the Industrial Waste agreement with the contract city and under Los Angeles County Code Title 20, Division 2. Presently, ordinances are being reviewed by the RWQCB to comply with legal authority requirements of the stormwater permit. A program for identifying all connections to the storm drain system is

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scheduled for implementation in 1995. A pilot field study is being conducted during summer 1994.

10. An Adopt-a-Highway program has been fully implemented in all County Road Maintenance Districts to encourage and help with litter cleanup along roadways. The County publicizes the program's activities periodically in local and regional papers. Signs setting along the adopted highways and roadways add to the exposure of the program. Several groups are already participating in the program and the County has received many inquiries from citizens and referrals from cities. The application has detailed information on the program and is used as a handout to inform the public. Other outreach programs that could be effective are: televising the conditions of littered sidewalks and alleys, school education programs on hygiene; and promoting city's cleanliness to aesthetics.

11. The County does have a curbside recycling program and a permanent recycling center. Materials recycled include, aluminum and metal cans, newspapers, glass bottles and jars and plastics in some areas. The program has been publicized though an elementary school education program (video, booklets, presentations), outreach to residents through participation in environmental fairs, exhibitions and events, Woody Woodpecker calendar contest, and outreach materials such as brochures, fact sheets, comic books, and slide shows. The recycling program was established in response to AB939 and is adequate to handle current solid waste demand. The County is expanding the program to accommodate future needs.

12. The County Department of Public Works along with the County Sanitation Districts conduct and administer Household Hazardous Waste (HHW) Roundup events throughout the county. Residents are able to drop off leftover hazardous products for free. 90% of the materials collected are recycled. The program has an educational component that educates the public on proper disposal. In addition to the HHW roundups, a mobile collection program is also operated. The HHW program has been modified in response to RWQCB requirements in that the program has been made permanent and a used oil recycling program is in the process of being established.

13. The County had a Water Wasting Ordinance, in effect during the previous drought seasons, to reduce runoff to the storm drains by prohibiting various kinds of wasting of water such as hosing off driveways and overwatering lawns. A similar ordinance could be adopted under another critical drought condition as needed. In terms of public education, a brochure is used to inform the public of the consequences of wasting water in carrying waste materials and contaminants to the storm drain system. The water conservation regulations are meant to minimize the effect of a shortage of water supplies on customers.

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14. ADDITIONAL BMP'S

A. Ballona Creek Debris Fence

A fence was installed on July 19, 193 and is used to reduce the amount of debris entering the ocean by detaining floatable trash and debris for later collection. The Department of Beaches and Harbors reports a 40% decrease in trash accumulation at Marina del Rey.

B. County Airport Runoff Structural Controls

To reduce contaminants from stormwater, structural controls have been added at airports. These include: fuel pumps located under a roof, stormwater diversion system with clarifiers, concrete berms for secondary containment of waste oil, oil and water separator at floor drains, retention ponds, infiltration basins, and sand filters. These controls either eliminate the pollutants or reduce a significant amount of them from entering the storm drain system.

C. County Airport Cleaning and Maintenance

These non-structural controls are good management practices for aircraft cleaning and maintenance. Washing of aircraft in designated area with oil and water separator, aircraft maintenance performed indoors, waste oil recycling. Warnings are issued and penalties include removal of plumbing fixture. Program is effective and reduces non-point source pollution and illegal dumping.

D. County Airport Materials Handling and Storage Controls

These measures prevent spills of polluting materials. Aircraft fueling at fuel pit, filling of fuel tanks at storage sites, underground fuel tanks with secondary containment, overfill protection, automatic leak detection systems, daily inventory monitoring and quality control procedures, waste oil tanks with secondary containment covered by a roof and disposal performed by a contract vendor, paint storage monitored and elevated from dampness and corrosive water, absorbent material on hand. This program has been very effective. In last four years there has been a perfect record of no fuel spillage.

E. Airport Operations and Disposal Controls

This project, scheduled for implementation in September 1994, will advise tenants and users of County airports on proper operation and disposal of products. Handouts explaining the problems of non-point source pollution and prevention measures will be distributed to airport users and mailed to tenants to increase awareness.

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F. State Approved NPDES Industrial Activity Permit

Required at all County airports to ensure compliance with State Water Resources Control Board requirements.

G. County Airport Hazardous Waste Storage and Disposal Controls

Each airport lessee is responsible for reporting the presence or release of hazardous materials to appropriate public agencies. The program has just begun so effectiveness cannot yet be determined. The program can potentially reduce stormwater pollution.

H. County Airport Drainage Collection Structures Stenciling

This program, similar to the catch basin stenciling program, is scheduled to begin in August 1994 and should discourage dumping of wastes.

I. In-House Task Force

Members of various Public Works divisions meet to discuss the development and implementation of BMP's. This program has been in operation for 2 years.

J. Open Channel Inspections/ Sump Inspections

To reduce the amount of debris entering the ocean, field personnel inspect open channels and sumps to pump plants after storms and clean up any debris.

K. Construction of Inflatable Rubber Dam

Beginning in September 1994, an inflatable dam will be built across the San Gabriel River to impound surface runoff which will be recharged into the aquifer. Pollutants are removed during this process and therefore the quantity of pollutants reaching the ocean is reduced.

L. Storm Drain Plan Review Procedures for Private Development

Standard notes have been added to private drain and miscellaneous transfer drain plans, erosion control plans, and connection permit sheets stating that NPDES permits are required from the RWQCB prior to discharge.

M. Containment Procedures and Equipment Evaluation

An evaluation of latest developments regarding improved containment procedures and equipment has been done and procedures were found to be adequate. However, new reporting procedures are being developed.

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N. Department Directive to Report Water Quality Problem

A department directive has been issued requesting all employees to report any observed water quality problems to facilitate early action. This program has increased awareness of water quality problems.

O. Storm Drain System Identification Program

Detailed maps showing the location of each storm drain, its manholes, and catch basin connector pipes are being prepared. The location and source of discharge for all connections is being inventoried. A GIS system is being developed to allow for the management and analysis of this data. When developed, monitoring of illegal connections and discharges can be done more efficiently.

P. Sewage Overflow Response Procedures Revision/ Root Control Review

This involves improvement of procedures for containment and cleanup of spilled sewage resulting from overflow. Sandbags are carried by crews at all times to stop flow into catch basins. Crews will also patrol critical pump stations during severe storms to correct any malfunction and minimize response time. In addition to this program, a map of the Palos Verdes area is being prepared which will identify lines with root problems. Sewage overflow due to root stoppage in sewer lines will be controlled.

Q. Standby Maintenance Crew

This on-going program places a maintenance crew on stand-by during heavy rainfall for the Trancas and Malibu Sewage Treatment plants which minimizes response time if vacuuming is needed to prevent overflows.

R. Reline Sewer Lines

Two locations will undergo relining of existing sewer lines to prevent infiltration and exfiltration.

S. Sewer Pipeline Reconstruction

Reconstruction of pipelines prevents pollution by sewage. 127 miles of cement pipelines will be televised and analyzed and replaced or rehabilitated within 5 years.

T. Sealing of Manhole Covers and Bar Holes

This program has sealed manhole covers and bar holes in areas subject to flooding. This prevents infiltration of stormwater into the sanitary sewer system.

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U. Expansion of Emergency Call List

To improve response to sewage system failures, all supervisors, superintendents and standby crews beeper numbers were added to emergency call list.

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SUMMARY
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CITY OF LA PUENTE

City of La Puente: Phase II Co-Permittee
Population (1994): 39,300
Land Area: 3.45 sq. mi.

Eighteen and a half miles east/southeast of the Los Angeles Civic Center lies La Puente, which is bounded by the City of Industry along 2/3 of its border. The job base is very small and its population places La Puente in 45th place among L.A. County cities. Land uses are primarily residential. The majority of jobs are in the service and retail trade sectors. Median family income was $33,997 in 1989.

1. Although the City owns and maintains catch basins, it has not implemented a catch basin stenciling program. The City plans to implement the program in the near future.

2. In addition to the County hotline, City staff is trained to handle illegal discharges/dumping calls at City Hall. The telephone numbers are published in English/Spanish in City newsletter.

3. City ordinance requires erosion control plans.

4. City newsletter includes information about stormwater pollution and telephone number to report incidents.

5. The City contracts with Los Angeles County Public Works for the annual cleaning of catch basins.

6. The seventy roadside trash receptacles are emptied twice a week. High traffic areas have more trash receptacles.

7. The 66 miles of improved streets (140 curb miles) are swept once a week in residential and industrial areas and four times a week in the commercial areas.

8. The City collects green waste separately.

9. The City contract with the Los Angeles County Public Works Department for industrial waste inspections.

10. Articles are published in the City newsletter regarding litter.

11. The City recycling program and private recycling center include curbside collection of recyclables and printed handbooks describing the benefits of recycling.

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12. The City participates in the Countywide Household Hazardous Waste Management program and plans to hold two waste collections per year starting in the fall of 1994.

13. The City does not have a water conservation program. However, future plans include articles regarding water conservation.

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SUMMARY
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CITY OF LA VERNE

City of La Verne: Phase II Co-Permittee
Population (1994): 31,500
Land Area: 8.42 sq. mi.

Incorporated in 1906, La Verne is over 31 miles east of the Los Angeles Civic Center. La Verne is to the north of the San Bernardino Freeway, extending northward to the Angeles National Forest. Mostly residential, La Verne also contains several large parks and reservoirs. The job base is very small. Top industries include retail trade, manufacturing and services. The City ranks 55th in population size among L.A. County cities. Median family income in 1989 was $53,431.

1. The City owned catch basins will be stenciled in the future by volunteers, scouts and city employees.

2. Other than the County hotline, the City has not established any other hotline or reporting system.

3. **NO ANSWER PROVIDED**

4. The City has not implemented programs aimed at educating the public on the problem of stormwater pollution.

5. The City conducts an annual inspection of city owned catch basins and cleans those catch basins containing excessive debris.

6. The City provides an unknown number of roadside trash receptacles. No specific answer was provided for emptying frequency.

7. The City's street sweeping program includes the 96.7 miles of improved streets (383 curb miles) with residential areas swept once every 30 days and commercial and industrial areas once every 20 days. The City recently increased sweeping in commercial and industrial areas and alleys and problem areas.

8. The City's Municipal Code prohibits the disposal of trash onto any public streets and/or private property.

9. The County of Los Angeles Public Works Department is contracted to perform industrial waste inspections. Non-storm water discharges to the stormdrains are inspected upon complaint.

10. The City does not have a public outreach/education program aimed at removing dirt, rubbish and debris from sidewalks and alleys.

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11. The City has implemented a recycling program which includes plastics, newspaper, glass aluminum and tin cans. Other components include Christmas tree recycling, phone book recycling and commercial recycling. Thirty-seven percent of rubbish is diverted form landfills. The elements of the public outreach program include neighborhood block leaders, information network, workshops and school visits.

12. The City participates in the Household Hazardous Waste Management program sponsored by the County and in the future will establish used oil recycling drop off centers.

13. The City's water conservation program consists of ordinances prohibiting the watering of paved areas. The ordinance, adopted in 1991 was disseminated to the residents of the City through newsletters, articles in local newspapers and reminders about water conservation.

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SUMMARY
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CITY OF LAWNDALE

City of Lawndale: Phase III Co-Permittee
Population (1994): 28,750
Land Area: 1.93 sq. mi.

Over 19 miles southwest of downtown Los Angeles lies the City of Lawndale which was incorporated in 1959. Its population size ranks it 58th in Los Angeles County. Primarily a residential community, it has a small job base. However, Hawthorne Boulevard, a major commercial artery, bisects this city and results in most of its employment to be in the retail trade and service sectors. The San Diego Freeway also runs through Lawndale. Median family income in 1989 was $36,604.

1. The City has not implemented a program of catch basin stenciling but plans to stencil catch basins in the near future.

2. The City has not implemented programs to encourage the public reporting of illegal discharges/dumping nor a City hotline or reporting system.

3. The City has not adopted any urban runoff control measures however plans to adopt such an ordinance in the near future.

4. The City has not implemented programs intended to educated the public on the problem of stormwater pollution.

5. The Los Angeles County Department of Public Works cleans the catch basins annually.

6. The City's trash receptacles are placed at all bus shelters and emptied twice a week.

7. Street sweeping on the city's 26 miles of streets (52 curb miles) is done one time a week in residential areas and two times per week in commercial and industrial areas.

8. The City has not implemented programs designed to discourage improper disposal of litter, lawn clippings and pet feces.

9. The Los Angeles County Department of Public Works conducts the industrial waste program.

10. The City has not implemented a public outreach/education program to encourage the public to remove dirt, rubbish and debris from sidewalks and alleys.

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11. The City's recycling program consists of collections at curbside of recyclables with an estimate of 15% being diverted from landfills. The City has obtained grants to implement public education/outreach and used oil collections.

12. The City participates in the Countywide Household Hazardous Waste Management program but does not conduct any additional waste collections.

13. The City does not have a water conservation program but plans to implement a public education/outreach program in the near future.

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SUMMARY
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CITY OF LOMITA

City of Lomita: Phase III Co-Permittee

Population (1994): 19,650
Land Area: 1.89 sq. mi.

Lomita lies 21.5 miles south of central Los Angeles, just west of the Harbor (10) Freeway. Incorporated in 1964, Lomita is the 66th most populous city in the County. It has a very small job base, spread thinly among the various industries, the largest being services and retail trade. Land uses are primarily residential with some retail commercial. Median family income was $42,284 in 1989.

1. The City has not implemented a catch basin stenciling program but intends to in the future with assistance from Los Angeles County.

2. The City has not implemented any programs to promote public reporting of illegal discharges/dumping.

3. The City has not implemented a runoff control ordinance.

4. The City has not implemented programs to educate the public on the problem of stormwater pollution.

5. The County conducts annual cleaning of the City's catch basins.

6. The City's ten roadside receptacles are emptied as needed.

7. The street sweeping program covering the 65 curb miles includes weekly sweeping in residential, commercial and industrial areas.

8. The City has not implemented programs designed to discourage improper disposal of litter, lawn clippings and pet feces.

9. The Los Angeles County Department of Public Works conducts the industrial waste inspection program.

10. The City does not have a public outreach/education program to encourage the public to remove dirt, rubbish and debris from sidewalks and alleys.

11. The City's recycling program includes the collection of recyclables at curbside and an outreach program encouraging recycling through city newsletters, cable television. direct mailing, workshops and water billing inserts. 16.4% of rubbish is diverted from landfills.

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12. The City participates in the Countywide Household Hazardous Waste Management program but does not conduct additional hazardous waste collections.

13. The City's water conservation program consists of a voluntary 10% water usage reduction.

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SUMMARY
STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF LONG BEACH

City of Long Beach: Phase III Co-Permittee
Population (1994): 436,800
Land Area: 49.72 sq. mi.

Long Beach is located 23.9 miles south of central Los Angeles along the southern coastline and it has the second largest population among L.A. County cities. Long Beach has a large job base led by services, manufacturing and retail trade. Land uses are mixed urban with residential, major commercial and industrial well represented. Long Beach was incorporated in 1897 and had a median family income of $36,305 in 1989.

1. The City has not stenciled any of its catch basins; they plan to develop a stenciling program during the upcoming year-two NPDES activities.

2. The City supports the County Hotline by publishing the phone number in a flood control brochure that is distributed annually with a billing statement to all utility users in the City.

3. The City has no urban runoff control ordinance, although they plan to enact one as part of their second year NPDES activities.

4. The City has numerous public outreach programs, including brochures, that result in public education on stormwater pollution, including "Adopt-A-Gutter", Coastal Awareness Day and recycling programs.

5. All City catch basins are cleaned annually, before the rainy season.

6. The City empties its ±500 public roadside trash receptacles on a weekly basis.

7. The City sweeps all its streets on a weekly basis.

8. The City does not have programs to discourage improper trash disposal; such programs will be developed during the NPDES second year program.

9. The City has an industrial waste annual inspection program for businesses generating hazardous waste, including all vehicle service facilities. Inspections do not include review of storm drain discharge practices.

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10. The City sweeps all alleys on a weekly basis. They plan to develop a formal public outreach/education program in NPDES year two.

11. Aluminum cans, glass, plastic, cardboard, newspaper and motor oil are routinely collected curbside. There are about 10 privately owned recycling centers in the City. An extensive recycling program exists, that includes numerous printed materials.

12. The City promotes the Countywide Household Hazardous Waste Roundups using utility bill inserts, grocery bag inserts and newspaper advertisements. A City hotline is available for information on the County roundups.

13. The City has a water conservation program, but it does not specifically address surface runoff; there is no public education component.

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SUMMARY STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF LOS ANGELES

City of Los Angeles: Phase I, II, III Co-Permittee

Population (1994): 3,620,500
Land Area: 468.797 sq. mi.

Los Angeles was incorporated in 1850 and is the oldest and largest city in Los Angeles County, both by population and land area. It has a large job base spread among most major industry categories although manufacturing, services and retail trade dominate. Los Angeles also enjoys a diversity of geographic features, stretching from the northern edges of the San Fernando Valley to the Santa Monica Bay, San Pedro and the Western boundaries of the San Gabriel Valley. Median family income in the city in 1989 was $34,364.

1. City has stenciled approximately 15,000 catch basins as of June 30, 1994, and plans to stencil an additional 10,000 by the end of 1994. Volunteer workers are recruited from areas being stenciled, and information on the program is distributed throughout those areas.

2. In addition to supporting the County Hotline, the City has had a reporting system at their Bureau of Sanitation for the past eight years, and has a newly implemented Stormwater Management Division HOTLINE and reporting system. The City's reporting system helps identify dischargers who have not been evaluated for the required permits. The new HOTLINE--publicized through printed brochures, refrigerator magnets and press releases--is designed to achieve the quickest possible response to reports of illegal dumping.

3. The City has numerous provisions in their Municipal Code for regulating urban runoff. To provide more effective control over storm drain discharges, the City is currently in the process of developing a Stormwater Pollution Control Ordinance.

4. The City has implemented a comprehensive public education/outreach program, divided into the following three categories: 1) General Outreach Program--includes television, billboard and media outreach campaigns; 2) Grass Roots Community Outreach Program--focusing on the publicity for the catch basin stenciling program, including a minority outreach component to adjust the program for greatest effectiveness in the various City communities and 3) School Education Program--primarily the K-6 "Magical City Forest" curriculum pilot program involving incentives for both students and teachers. A specific outreach group has been private industry; the City conducted a mass mailing to facilities that potentially would be required to file a Notice of Intent for the General Industrial Stormwater Permit.

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5. The City has grouped their catch basins into "routes" that are inspected monthly and cleaned as needed. An increase in cleaning has resulted in a decrease in the number of odor complaints and emergency calls regarding plugged basins during a rain event. A computer-assisted pilot Stormwater Information Management and Maintenance system has been initiated for three drainage areas.

6. All 970 of the City's roadside trash receptacles are emptied weekly. A private vendor contract is expected to provide a total of 2,500 trash receptacles by 1997.

7. Of the City's residential streets, approximately 1/3 of them are posted and swept weekly; the remaining unposted 2/3 are swept monthly. Commercial and most industrial streets are swept at night; the frequency varies form once per week to seven nights per week, depending on needs. A pilot street cleaning study employing a vacuum sweeper and an air regenerative sweeper is being planned, to begin in January 1995; the study will include benefit/cost analysis, pollutant removal efficiency, etc.

8. Numerous City codes--with penalties--prohibit the improper disposal of litter. Public service television and radio campaigns, along with other public education programs create public awareness of the problem. Recycling programs and public trash receptacles help make it convenient to comply.

9. The City has an extensive program to issue, inspect and enforce Industrial Wastewater Permits issued for non-stormwater discharges to the storm drain system. Permit conditions include compliance with numerical as well as aesthetic quality standards. Industrial and related operations are inspected between 1 and 4 times per year. Violations for unpermitted discharges are usually detected as a result of public reports on the HOTLINE, described in 2, above. A specialized inspection group focusing on improving stormwater quality and eliminating illegal discharges and illicit disposal practices is staffed by the Bureau of Engineering.

10. All City BMP public information materials include admonitions to remove and properly dispose of materials on and around their property. Focus group research and surveys are being used to gauge the level of public awareness and the effectiveness of the BMP program components.

11. Yard trimmings, tin and aluminum cans, glass, plastic, newspaper, cardboard and brown paper bags are routinely collected at curbside and recycled. The City's Public Education and Outreach Program promotes recycling; a speakers bureau is available.

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12. The City participates in the countywide household hazardous waste management program as well as provides a hazardous waste mobile (Hazmobile) that travels to various sites throughout the City and accepts waste products by appointment. A used oil recycling program is being co-sponsored with an oil company, who collects used motor oil at participating stations. The City suggests coordinated/ expanded public education programs to encourage use of less toxic products and cleaning methods.

13. The City implements the "Water Conservation Plan of the City of Los Angeles" that contains specific prohibitions against excessive/ unnecessary outdoor water usage. Public education programs include tips on how to control excess runoff.

14. Other BMP's:

a. Low-flow Storm Water Reclamation Plant. Project currently undergoing a feasibility study; if determined to be effective, plant would be constructed to treat storm water from the Pico-Kenter storm drain to reduce pollutant loading to the Santa Monica Bay.

b. Storm Drain Pollution Sensor System. Construction scheduled for FY 95-96 to detect levels of pollution in the storm drain system to that flow could be diverted to treatment plant for clean-up.

c. Geographic Information System. Designed to support the information management need of the City's stormwater pollution abatement efforts, the heart of this System is a Water Quality Model which will estimate and predict pollutant runoff by drainage areas. It will also provide computer-based tools for further analysis.

d. Street Inspection Program. At present, the Bureau of Street Maintenance enforces violations of excess water and other fluids into the street system primarily on a complaint basis; this program--when funded--would add two inspection teams to more aggressively and systematically monitor street discharges.

e. Closed Circuit Television (CCTV) of Storm Drain Lines. Contract executed on July 29, 1994 to provide closed circuit television of storm drain interiors to detect cracks, misalignments, deposits, debris and illegal connections and/or discharges.

f. Oil/Water Separator. Special equipment has been installed at Ranch Park Golf Course to remove oils and oil-based cleaning agents, as well as organic material, from surface water that drains into the storm drain system. The three sub-systems are effective, but expensive to operate; two of the

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sub-systems have experienced recurring clogging problems and are being retrofitted.

g. Stormwater Drainage Component of General Plan Infrastructure Element. Amendment to City's General Plan includes general requirements of Federal and State stormwater regulatory program as well as policies and programs for stormwater pollution abatement; City ordinances must be based on adopted policy.

h. Centralized Hazardous Waste Storage Facility. Three pre-fabricated storage buildings have been installed at the Los Angeles Aqueduct Filtration Plant to isolate hazardous materials from other buildings. One building is for storage of hazardous material; the other two are for temporary storage of hazardous waste generated within the plant.

i. Revisions to Storm Drain Design Manual. Standards for flood control projects are being modified to incorporate stormwater pollution reduction components. Consideration is being given to adopting Los Angeles County standards for hydrology and sedimentation. Further evaluation of available references is expected to result in either revisions to Standard Plans or a new manual.

j. Inter-jurisdictional Stormwater Reuse Task Force. City has formed and participates in a multi-jurisdictional task force to implement diversion, capturing and possibly reusing high quality stormwater runoff. Background issues, existing practices and new alternatives were presented in a "Capture and Conservation of Stormwater Runoff" report prepared in 1993 by the Stormwater Detention and Reuse Task Force.

k. Stormwater Pollution Abatement--Street Maintenance Yards. Four street maintenance yards, including an asphalt processing plant, are being studied as potential sources for storm water pollution. Findings and operation modifications will be applied to other maintenance yards.

l. Illegal Discharge/Illicit Disposal Screening. A comprehensive program is in operation to identify all outfalls in the city's storm drain system and their tributary drainage areas and to gather as much information as possible for incorporation into a computer database. Both visual observations and outfall samplings are used to identify and prioritize drainage areas for investigation of possible pollutant discharges.

m. Investigation of Storm Drain Lines. This program is designed to stop discharge of pollutants from specific facilities by monitoring maintenance holes around suspected sources.

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n. Spill Prevention, Containment and Response Procedures--City Facilities. Program is to ensure that facilities have adequate spill prevention, containment and emergency response procedures. City is identifying all City-owned facilities that do not have adequate procedures as they relate to stormwater pollution abatement and will implement improved procedures as needed.

o. Limitation of Sewage Infiltration into Storm Drain System. The City traces the infrequent instances of sewage infiltration into the storm drain system using a variety of techniques, including smoke testing, dye testing and video inspection of sewer and storm drain lines.

p. Manual of BMP Construction Guidelines. Screening guidelines and construction standards are being prepared aimed at reducing stormwater pollution from construction sites, based on established BMP's as well as "good housekeeping" practices.

q. Enhanced Construction Site Inspection and Enforcement Program. City plans to review Municipal Code requirements for construction sites to ensure that they are sufficient and consistent with the State of California General Construction Activity Stormwater Permit requirements.

r. Construction Education and Training Program. City's aim in this three phase program, currently in progress, is to increase the awareness of those involved tn the construction process with regard to stormwater pollution abatement activities. Video and printed materials are in preparation that address erosion control and sedimentation issues.

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CITY OF LYNWOOD

City of Lynwood: Phase III Co-Permittee
Population (1994): 64,300
Land Area: 4.85 sq. mi.

Lynwood is located 10.6 miles south of the Los Angeles Civic Center, crossed by the Century (105) Freeway, immediately to the west of Long Beach (710) Freeway and the L.A. River. The City was incorporated in 1921 and it is the 25th most populous city in the County. It has a small job base concentrated in retail trade, services and manufacturing. Land uses in the City are mixed urban dominated by residential. Median family income in 1989 was $26,439.

1. A program is in progress to stencil all City catch basins.

2. In addition to the County Hotline, the City has a Fire Department dispatched Hotline for reporting of illegal discharges/dumping. The program is publicized through handouts.

3. While the City has not as yet implemented urban runoff control measures, they expect to be adopting a model ordinance during the 1994-95 FY.

4. The City provides public education and outreach on the problem of stormwater pollution by participating in block watch meetings to distribute handouts and explain the goals of the NPDES program.

5. The City routinely cleans all its catch basins at least once a year and responds to complaints with additional cleaning, as needed.

6. The City empties its 50 public roadside trash receptacles twice a week, with special pick-ups of overflowing receptacles as needed.

7. The City sweeps all public streets once a week.

8. The City discourages improper litter disposal through its public outreach program (speakers, handouts). They plan to include additional provisions in a model ordinance to be adopted in FY 1994-95.

9. The City contracts with Los Angeles County for industrial waste inspections.

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10. City crews and students clean streets, sidewalks and alleys, working each day on debris and rubbish removal.

11. The City does not have a recycling program.

12. The City participates in the countywide household hazardous waste management program.

13. The City has no water conservation program.

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CITY OF MALIBU

City of Malibu: Phase I Co-Permittee
Population (1994): 11,350
Land Area: 19.61 sq. mi.

Malibu is one of the most recently incorporated cities in the County. It is located 24.5 miles west of the L.A. Civic Center, along Pacific Coast Highway and the Pacific coast. It ranks 76th in population among L.A. County cities and its land uses are primarily residential and open space.

1. All City catch basins have been stenciled. Refrigerator magnets distributed to residents in "door hanger" to publicize stencil program.

2. The City supports the County Hotline to promote public reporting of illegal discharges/dumping. The hotline number is included on the refrigerator magnet distributed by the city. Public Works inspector seeks voluntary compliance by violators; there has been full compliance, without question, to date. Publicity has included newspaper articles on clean water and door-to-door distribution of information.

3. City ordinances provide for erosion control and post-development pollution controls for both new construction and remodeling. Active inspection and compliance monitoring program. City developing a staff education program, specifically focusing on construction site operations. City has program for Short-term Erosion and Sediment Control in place to respond in emergency situations such as heavy rains/flooding. Long-term Erosion Control program scheduled for implementation.

4. The City has reached all Malibu residents with their public education and outreach programs that includes city newsletters, door-to-door material and a Gutter Patrol program. Following are important points of contact: schools, homeowners associations, adjoining public agencies and prominent environmental groups.

5. Most of the catch basins within the City are maintained by the County. The City's catch basins are cleaned as needed and upon request.

6. City does not have receptacles. Most debris accumulations occur along Pacific Coast Highway which has roadside trash receptacles that are maintained by Caltrans.

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7. All City streets are swept bi-weekly. Pacific Coast Highway is maintained by Caltrans; City is attempting to coordinate sweeping schedules.

8. City Municipal Code includes provisions for enforcing improper trash disposal.

9. An inspection/reporting program for non-storm water drain discharges will be expanded in 1995 to include an industrial waste inspection program.

10. City's recently implemented public outreach program encourages cleaning of sidewalks and alleys.

11. Glass, plastics and paper are routinely collected at curbside. Public outreach programs include press releases to local newspapers, newsletters and homeowners associations, and distribution of recycling newsletters to City residents and businesses.

12. The City aggressively promotes the County's household hazardous waste "roundups".

13. The City's public outreach program addresses the problem of overwatering and urban runoff.

14. Other BMP's: Storm Water Quality Management Plan--scheduled for implementation by fall 1994, this comprehensive management plan would coordinate objectives and activities of all BMP's and related programs.

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CITY OF MANHATTAN BEACH

City of Manhattan Beach: Phase I Co-Permittee
Population (1994): 33,100
Land Area: 3.87 sq. mi.

Manhattan Beach is a coastal city lying 22.0 miles southwest of downtown Los Angeles and was incorporated in 1912. It ranks 52nd by population among L.A. County cities. The job base is small and dominated by retail trade and services. Land uses are primarily residential. Median family income was $79,027 in 1989.

1. The City, with the help of volunteers, has stenciled all its catch basins with the Heal the Bay design. The program has been effective in bringing the storm water pollution problem to the attention of the public.

2. In addition to the County hotline the City has established a phone number for reporting. Approximately 35 reportings have been received. To publicize the need to report illegal dumping, presentations have been made at local schools, articles have been published in local papers, brochures have been made available and banners have been displayed.

3. The City has several codes (7.04.010, 7.16.160, 12.08.230, 12.08.24) which cover runoff related activities which were adopted during the 1970's. These measures have been effective in the past but will be even more so with an increased enforcement program which is underway.

4. The public outreach program includes brochures, school programs, newspaper articles and street banners.

5. Under contract, Los Angeles County cleans all catch basins at least once per year. City staff inspects them twice a week and cleans them as needed.

6. The City provides both trash and recycling receptacles citywide. They are emptied once a week generally though those in high traffic areas are emptied daily. Improvements to this program have been in response to RWQCB and Waste Management Board requirements.

7. 237 curb miles are swept once per week in residential areas, and at least once per week in commercial and industrial areas. The street sweeping program has been expanded in response to RWQCB requirements and a public education program beginning in August 1994 will encourage no on street parking on street sweeping days.

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8. The Ocean Safe program brochure includes information on improper litter disposal. Community Services Officers are able to cite anyone who engages in improper disposal. Recycling and composting program teach how to reuse litter and lawn clippings.

9. A combination of City and County personnel conduct industrial waste and non-storm water discharge inspections on a complaint basis. The plan check process is also used to prevent discharges. Auto related businesses and gas stations are inspected on a complaint basis while restaurants are regularly inspected.

10. The Ocean Safe program includes information on dirt and debris removal from sidewalks and alleys. This program has been modified in response to RWQCB requirements.

11. The City has a curbside recycling program for plastic, glass, paper, metal and green waste. The program has been publicized through information in brochures and fliers. The City estimates that 25% of rubbish is being diverted from landfills at this time.

12. The City participates in and promotes, through brochures and newspaper articles, the Countywide program. The City suggests school programs to teach proper disposal of hazardous materials.

13. Water conservation is part of the message of the Ocean Safe program. Brochures distributed to residents include information on the result of overwatering etc. Modifications have been in response to drought conditions and RWQCB requirements

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SUMMARY
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CITY OF MAYWOOD

City of Maywood: Phase III Co-Permittee
Population (1994): 28,850
Land Area: 1.18 sq. mi.

Maywood lies 7.9 miles south of central Los Angeles, west of the L.A river, and has mostly residential land uses, though it is surrounded by industry. It became a City in 1924, and by population ranks 57th among Los Angeles County cities. It has a very small job base with manufacturing and wholesale industries slightly ahead. Median family income was $25,559 in 1989.

1. Stenciling program is not yet underway. Stenciling of City owned catch basins will be contracted with L.A. County Public Works in fiscal year 1994-95.

2. No program has been established yet but the City plans to develop a public outreach program in 94-95 to inform the community of the hotline reporting system.

3. No runoff control measures have yet been implemented. Adoption of the model runoff ordinance will be considered in fiscal year 94-95.

4. No public education program to inform the public on the problem of stormwater pollution has been implemented but the City will develop an outreach program in the 94-95 fiscal year.

5. The City contracts with the County for catch basin cleaning prior to storm season. The catch basin cleanout program will be evaluated in 1994-95 to determine if modifications are required.

6. No trash receptacles are currently provided but a city-wide program is planned for fiscal year 94-95.

7. 28 curb miles are swept weekly in all areas (residential, commercial, industrial). The street sweeping program will be evaluated in 94-95 to determine if modifications are required.

8. Municipal Code 5-22.01 and other codes prohibit improper disposal of debris. An enforcement and public outreach program will be developed in 1994-95.

9. There is no industrial waste inspection program at this time. An industrial waste inspection program will be contracted with the County in FY 94-95.

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10. A public outreach/education program will be developed in FY 94-95 to increase community awareness.

11. No recycling program presently exists. The contract trash hauler is developing a M.R.F. program.

12. The City does participate in the Countywide Household Hazardous Waste Management Program.

13. No water conservation program has been implemented. The City plans to develop a public outreach program in FY 94-95.

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CITY OF MONROVIA

City of Monrovia: Phase II Co-Permittee

Population (1994): 37,550
Land Area: 13.69 sq. mi.

Monrovia is located 19.1 miles northeast of the Los Angeles Civic Center just north of the Foothill (210) Freeway in the foothills of the San Gabriel Mountains. It ranks 47th in population among L.A. County cities and was incorporated in 1886. It has a large job base, heavily concentrated in the manufacturing, service and retail trade industries. Land uses are mixed but mostly residential with some vacant land also present. Median family income was $40,803 in 1989.

1. The City maintains catch basins but has not begun a stenciling program and does not plan one at this time. The City feels that a stenciling program encourages graffiti and is not cost effective.

2. The City encourages the reporting of illegal discharges to the County hotline. Information has been mailed out in water utility bills and public announcements on cable have been made.

3. The City will adopt a runoff control ordinance in October 1994. The ordinance will give the City authority to inspect and enforce.

4. The City has prepared a brochure covering various BMP's for residential, commercial, industrial and construction practices. Also, information is included in utility bills and public services announcements are made on local cable TV.

5. The City cleans its catch basins yearly and estimates that the program has reduced debris from entering the storm drain by 98%. This program has been expanded from a response to complaint basis.

6. The City provides 35 roadside trash receptacles which are emptied weekly. Additional receptacles and more frequent cleanup have been installed in certain areas. City staff and citizens have been informed to report areas requiring clean-up to public works dept.

7. 145 miles of improved streets are swept weekly. Prior to March 1994, streets were swept every other week.

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8. To discourage improper disposal of litter, lawn clippings and pet feces the City sends out a BMP brochure to residents and to landscape contractors with their annual business license renewal.

9. Beginning October 1994, a program will be established for City staff to increase awareness of discharges needing permits. Auto related business, gas stations and restaurants will be inspected annually under authority of the storm water ordinance. Businesses with NPDES and County Sanitation permits will also be inspected.

10. Beginning in October 1994, the city will encourage the removal of dirt/debris by distributing a brochure with quarterly water bill.

11. The City has established a curbside recycling program for a wide variety of materials. Yard waste and commercial recycling was also recently established. Public announcements on cable TV and utility bill mailings publicize the program. The City estimates that 28% of rubbish is being diverted from landfills.

12. The City participates in and publicizes the Countywide Household Hazardous Waste Program and has also arranged for HHZ drop off at the local rubbish facility. The City has secured a state grant for curbside oil collection and is seeking funding for a HHZ hotline.

13. The City encourages water conservation though water bill mailings and local cable TV public service announcements.

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CITY OF MONTEBELLO

City of Montebello: Phase II, III Co-Permittee
Population (1994): 60,900
Land Area: 7.73 sq. mi.

Montebello lies 9.2 miles east of downtown Los Angeles, south of the Pomona Freeway. It is the 29th most populous city in the County and was incorporated in 1920. The job base is large and concentrated in services, manufacturing and trade. Land uses are also mixed with residential, commercial and industrial. Median family income in 1989 was $34,416.

1. So far 240 County owned catch basins have been stenciled with the Heal the Bay design. The L.A. County Department of Public Works will complete the stenciling of the City owned catch basins in Aug. 1994.

2. No programs or additional hotlines to encourage public reporting of illegal dumping have been established. The County hotline has been publicized through newspaper advertising and 5 reports have been received. Cable TV and radio ads could help to encourage reporting.

3. The City's Grading Code and Street Code address urban runoff control. These measures were adopted in 1963 and revised in 1992.

4. The City plans to soon develop newspaper articles, news releases and brochures to educate the public on stormwater pollution.

5. The City cleans debris from catch basins every 6 months. This program is effective and has not been modified.

6. 50 roadside trash receptacles are provided and they are emptied twice per week. The City has found that problem litter areas occur near bus stops. This program has not been modified in response to RWQCB requirements.

7. 291 curb miles are swept using vacuum equipment. Residential and industrial areas are swept weekly, commercial areas 3 times per week. This program was modified in response to RWQCB requirements.

8. The City has posted "No litter" signs throughout the city, especially near the Rio Hondo channel and has begun a green waste collection program to discourage improper disposal practices.

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9. The City does not have an industrial waste program and does not inspect for non-storm water discharges. Auto parts business, gas stations and restaurants are inspected once a year, auto repair shops are inspected twice per year and auto body shops are inspected 4 times per year under authority of the Montebello Fire Department.

10. Property owners are required to maintain sidewalks by Municipal Code 12.8.050. There has been good response to the program which was modified in response to RWQCB requirements. The City plans to start publishing information in newsletters, and local newspaper.

11. The City has implemented a curbside recycling program and has a permanent recycling facility. Newspaper, plastic, tin, aluminum and glass are recycled. Seminars, community meetings and publications have been used to publicize the program. The City plans to expand the program to include commercial and industrial sectors.

12. The City participates in the Countywide household hazardous waste management program and suggests advertising safe disposal and storage practices. A used oil recycling program is being started.

13. The City's 5 water districts encourage water conservation and have ordinances specifying penalties but they presently are not enforced.

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CITY OF MONTEREY PARK

Monterey Park: Phase II Co-Permittee
Population (1994): 63,100
Land Area: 7.73 sq. mi.

Located 7.8 miles east of the Los Angeles Civic Center between the San Bernardino and the Pomona Freeways, Monterey Park has the 27th largest population in the County. It has a small job base concentrated in the service, manufacturing and retail trade industries. Land uses are mainly residential and the median family income in 1989 was $36,808.

1. The City has not stenciled any catch basins to date, although they plan to begin the program later this year and stencil all basins by March 1995.

2. The City supports the County Hotline and plans to begin publicizing the program by distributing brochures and promoting it on their cable channel and in newspapers.

3. Industrial waste ordinance currently provides limited runoff controls; a specific Runoff Control Ordinance is being drafted.

4. The City of Monterey Park has started its public education and outreach program. The City has placed articles in a local City newsletter, prepared handouts available to the public, advertised the NPDES program on local cable television and has initiated a school outreach program.

5. The City cleans all catch basins as needed, generally before the rainy season and after storms.

6. The City provides public roadside trash receptacles that are emptied twice weekly. They plan to analyze the effectiveness of the program and make modifications, as necessary.

7. The City sweeps all residential and industrial streets once a week and commercial streets twice a week. They plan to analyze the effectiveness of the program and make modifications, as necessary.

8. The City discourages improper disposal of litter, lawn clippings and pet feces through public outreach and NPDES literature.

9. The City does not presently have an industrial waste inspection program, although they do have a sewer and industrial waste code that provides for prosecution of

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violators. They are currently purchasing equipment and hiring a consultant to implement a program during this fiscal year that will provide for annual inspections of industrial and related businesses.

10. The City encourages the removal of dirt, rubbish and debris from sidewalks and alley through public outreach and literature. The City has a public works summer program that uses children to remove trash from public streets.

11. Plastic, glass, aluminum cans and newspapers are routinely collected at curbside. A green waste recycling program is planned for implementation during this fiscal year. Brochures are distributed that provide basic recycling information.

12. The City participates in the countywide household hazardous waste management program. They plan to distribute brochures containing proper disposal practices and listing disposal collection stations.

13. The City promotes water conservation and prevention of runoff in brochures--currently being revised and expanded, and will be including information on water conservation in City water bills.

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CITY OF NORWALK

City of Norwalk: Phase III Co-Permittee
Population (1994): 97,300
Land Area: 9.35 sq. mi.

Norwalk is located 15.7 miles southeast of central Los Angeles, at the eastern end of the Century (105) Freeway. Incorporated in 1957, Norwalk has the 14th largest population among L.A. County cities. Most of its small job base is concentrated in the service and retail trade industries. Land uses are primarily residential with some industrial and commercial. Median family income was $40,369 in 1989.

1. No stenciling of catch basins has been completed yet but a program has been approved. L.A. County will do the stenciling using the "universal icon" stencil developed by Heal the Bay and the City of L.A."

2. The City has a graffiti/vandalism hotline which can be used to report illegal dumping. Many calls have been received but there is no record of how many are related to stormwater pollution. This hotline was advertised in the city newsletter and at public meetings. The City states that the public needs to be made aware of the NPDES goals and what it can do to help achieve those goals. The City has established two telephone "hotlines", to facilitate the public reporting of illegal discharges and/or dumping.

3. Ordinances which control illegal discharges/illicit connections and stormwater/urban runoff from commercial, industrial, residential, and construction sites were adopted prior to the NPDES Permit. The City has evaluated existing ordinances, in the context of the NPDES Permit requirements, and plans to prepare and adopt a single stormwater ordinance which will provide all of the legal authority the City must have under the NPDES Permit. Existing ordinances may be revised, if necessary, to better support the City's needs in the implementation of the NPDES Permit requirements. The implementation of these activities, new ordinance adoption and existing ordinance revision, is planned for fiscal year 1994-95.

4. The City anticipates initiation of a comprehensive stormwater management public outreach program in fiscal year 1994-95. Although the City has implemented some stormwater management type public outreach activities, to-date efforts have centered on the accumulation of information in preparation for the comprehensive program.

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5. L.A. County Public Works cleans catch basins annually. No information on effectiveness or need to modify is available at this time. Efforts will be made to acquire such information.

6. 18 public roadside trash receptacles are provided by the City and are emptied and cleaned weekly. High use areas are monitored twice weekly and cleaned as necessary. This additional aspect was implemented in 1993.

7. 400 curb miles are swept weekly. Increased street sweeping began in Feb. 1994 in response to citizen concern. There is a positive difference in visible debris but amount has not been quantified.

8. The City has an Anti-Litter and Weed Control ordinance (Section 5-14 of the Municipal Code) and an "Animal Control Ordinance" which prohibit improper disposal and specify penalties. The City has evaluated its ordinances and will consider their modification; moreover, the City plans to prepare and adopt a single, comprehensive stormwater management ordinance which will provide the City with the legal authority required by the NPDES Permit. A greenwaste program is planned for 1995.

9. L.A. County Sanitation District inspectors and Public Works inspectors enforce Title 20 of the County Code. City staff sometimes assists. No program for regular inspection of auto business, gas stations or restaurants. Facilities are inspected on an "as needed" basis.

10. Although some activities have been implemented, no comprehensive public education program on stormwater management has yet been established.

11. A curbside recycling program is planned for implementation in October 1994. Informative articles have been printed in city newsletter. The City is currently in the process of implementing a used oil recycling program. A used oil program has been in effect at the Public Works Maintenance yard for years. Approximately 11% of rubbish is estimated to be diverted from landfills.

12. The City participates in the County household hazardous waste program. The use of household hazardous wastes should be reduced and the City suggests that information be posted at retail stores to remind purchasers that unused hazardous material must be disposed of in a proper manner.

13. A water conservation ordinance adopted in 1991 prohibits hosing down paved surfaces and runoff to streets. A Water Efficient Landscaping Ordinance was adopted January 1993 to reduce landscaping watering and runoff.

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CITY OF PALOS VERDES ESTATES

City of Palos Verdes Estates: Phase I, III Co-Permittee
Population (1994): 13,650
Land Area: 4.77 sq. mi.

Palos Verdes Estates is located on the west side of the Palos Verdes Peninsula, 27.4 miles southwest of the Los Angeles Civic Center. It was incorporated in 1939 and currently ranks 73rd in population in L.A. County. Its job base is very small and concentrated in the service industry. Land uses are almost entirely low density residential. Median family income was $109,244 in 1989.

1. Local boy scouts stenciled all 450 catch basins with the Heal the Bay design. The City feels that the program effectively discourages people from throwing waste in the catch basin.

2. In addition to the County hotline, residents can call the city or the police to report illegal dumping. An informational article was published in the quarterly city newsletter.

3. Ordinance #093-563 prohibits dumping unlawful substances into open channels, gutters, inlets, storm drains etc. No other modifications have been made in response to the RWQCB requirements.

4. Informational articles have been published in the city newsletter to educate the public on the problem of stormwater pollution. The City feels the program has been effective since phone calls have been received reporting illegal dumping.

5. The City issues an annual contract for catch basin cleaning prior to the rainy season and the City cleans out individual catch basins when necessary.

6. 50 roadside trash receptacles are provided and are emptied 3 times per week. This program has not been modified in response to RWQCB requirements.

7. 2,000 curb miles of residential streets are swept once a week. The two commercial areas, Lunada Bay Plaza and Malaga Cove Plaza, are swept once a week.

8. City codes 8.16, 12.24.130, and 12.24.180 prohibit improper disposal of litter, lawn clippings, and pet feces. There are penalties for improper disposal.

9. No industrial sites exist within the City so there is no waste inspection prog.am. Auto related businesses are not inspected

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but gas stations and restaurants are inspected in response to complaints under the authority of ordinance 093-563.

10. A public instruction program intended to invite the public to report illegal rubbish and debris dumping is mentioned as a way to encourage removal of debris from sidewalks and alleys. Phone numbers are periodically published in the City news.

11. The City has a backyard recycling program. Plastic, glass, aluminum, tin and newspapers are recycled and the program has resulted in 12% of rubbish being diverted from landfills.

12. The City participates in the County household hazardous waste management program. In addition the City sponsors a hazardous waste collection day which had an overwhelming response.

13. The City passed the Water Efficient Landscape Ordinance (7/93) which imposes watering regulations on new development. Resolution R-91-21 encourages residents to conserve by not hosing off hard surfaces.

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CITY OF PARAMOUNT

City of Paramount: Phase III Co-Permittees
Population (1994): 52,700
Land Area: 4.66 sq. mi.

Paramount lies 16.5 miles south/southeast of downtown Los Angeles, just east of the Long Beach (710) Freeway and was incorporated in 1957. Its population ranks 36th largest among Los Angeles County cities. It has a large job base heavily concentrated in the manufacturing and service industries. Land uses are mixed urban with large industrial tracts dominating. Median family income in 1989 was $30,540.

1. Stenciling of catch basins will be done during fy 94-95. It is expected that L.A. County will paint the stencil under a City purchase order.

2. Public outreach program is anticipated to be developed during 1994-95. Quarterly newsletter will used for public outreach.

3. It is anticipated that a runoff control ordinance similar to the model ordinance drafted by the subcommittee formed by L.A. County will be adopted by the City.

4. Public outreach program will be initiated during Fiscal Year 94-95.

5. L.A. County cleans the catch basins annually. A monitoring program to inspect the catch basins every two months to determine if additional cleaning is necessary will be initiated in the 1994-95 fiscal year.

6. 55 trash receptacles are provided and are emptied once per week. Receptacles in problem areas around convenience stores are emptied twice per week. Only modification to the program has been additional emptying.

7. 160 curb miles are swept; once per week in residential and industrial areas and twice per week in commercial areas. Program has not been modified.

8. Existing ordinances prohibit improper disposal of litter, lawn clippings and pet feces. These ordinances are enforced by code enforcement officers. An outreach program will be established in 1994-95 to inform the public on the benefits of proper disposal.

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9. An industrial waste program which will probably include inspection for non-storm water discharges will be initiated in 1994-95. It is anticipated that the new ordinance will authorize yearly inspections of auto related businesses, gas stations, and restaurants.

10. City ordinances prohibit illegal dumping of dirt, debris and rubbish on private and public property. The City provides flyer inserts in utility bills that encourage removal of such materials from sidewalks and alleys. They plan to expand this program to include additional printed materials.

11. Trash hauler has the responsibility for separating glass, newspaper, aluminum and green waste for recycling. Approximately 12% of rubbish (per day) is being diverted.

12. The City participates in the Countywide household hazardous waste management program. The City does propose a public outreach program.

13. The present water rate schedule is graduated based on usage. Also, when the water supply is determined to be endangered by drought conditions, a conservation program is placed in effect which requires the reduction of water use for irrigation, car washing etc.

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SUMMARY STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF PASADENA

City of Pasadena: Phase II, III Co-Permittee
Population (1994): 134,800
Land Area: 23.14 sq. mi.

At the foot of the Angeles National Forest, Pasadena is 10 miles northeast of downtown Los Angeles and was the sixth most populous City in Los Angeles County in 1994. Incorporated in 1886, Pasadena is the second oldest City in the County as well. Noted for a century of annual Rose Parades and as host of the Rose Bowl Football game, Pasadena has a very large job base. Services account for about 50% of jobs, followed by retail trade, finance and manufacturing. Land uses are primarily residential with commercial and some industrial. Median family income was $40,435 in 1989.

1. The City is selecting 20 - 25 manhole covers in areas where catch basins collect considerable debris. Covers, rather than sidewalks, will be stenciled and monitored for one year. If surveys determine that stenciling decreases catch basin debris, program will be expanded. At this point, the City does not want to apply stencil to over 900 sidewalk locations, due to aesthetic concerns.

2. The City has a 24 hour Spill Response telephone number at their Police Department to facilitate public reporting of illegal discharges/dumping. The service was publicized in the City's In-Focus flyer, distributed to all City residents and businesses. Expansion of public outreach will include hotline phone number display on the City's cable channel.

3. Runoff control measures are required for any construction on land with a slope of 15% or greater. A Storm Water Management Ordinance was adopted in July 1994 that provides specific regulatory controls over construction grading.

4. The City's public outreach program includes articles in their bi-monthly newsletter regarding catch basins and storm drainage systems and their function. The City also plans special fliers to insert with utility bills and airing a special video on their cable TV channel. Attending City of Los Angeles Public Outreach Meetings have been helpful.

5. The City contracts to have all its catch basins cleaned at least annually in October. One hundred of the 920 basins which are in the vicinity of the Rose Parade and game are cleaned a second time in January.

6. The City's 252 public roadside trash receptacles are emptied 3 - 5 times per week. Special Pasadena events such as the Rose Bowl/ Parade and, this year, the World Soccer Cup require

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concentrations of receptacles and more frequent collections. Additional permanent receptacles will be added in Old Pasadena when a pedestrian environment improvement plan is implemented in 1995.

7. All City streets are swept, with recently approved frequency. Residential streets are now swept a minimum of twice per month; commercial and industrial areas 3 times per week.

8. The City's litter control ordinance permits penalty enforcement of improper disposal of litter. A public outreach program is planned. The City suggests using a universal logo on trash receptacles that are located around waterways and storm drain facilities.

9. The City's Fire Department conducts an industrial waste inspection program that checks waste disposal practices and the storage of hazardous waste. Auto parts, repair and body shops and gasoline stations are inspected once a year; restaurants are inspected 3 times per year. City and State ordinances provide enforcement authority.

10. The City is planning to implement a public outreach/education program. They cite the beneficial information available by attending City of Los Angeles Public Outreach meetings.

11. Aluminum and tin cans, glass, plastic, newspapers, junk mail, magazines, telephone books, used motor oil and cardboard are routinely collected at curbside for recycling. A permanent recycling center is available. Yard waste recycling and composting programs are also offered. A variable rate structure for refuse collection encourages waste reduction and recycling. A public information/outreach program includes direct mail brochures, information in libraries and public counters, speaking engagements and school presentations, special events, newspaper and City newsletter articles.

12. The City participates in the countywide household hazardous waste management program as well as provides used motor oil collection both curbside and at auto parts stores. A program to provide free containers for used motor oil is to begin this year. Brochures are mailed to residents explaining the program. The City suggests more displays at point-of-purchase to encourage proper disposal of hazardous products.

13. The City provides an indoor/outdoor water conservation counseling program, including preparation of a water use reduction plan whenever possible. During drought conditions a City ordinance requires all water users to follow conservation measures. Water conservation educational materials are distributed to the general public and at local schools. There is an annual Water Awareness Month.

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14. Additional BMP's

Replacement of a sewage pump station by construction of a gravity flow sewer, thereby eliminating the possibility of pump failure and greatly reducing the potential for sewage spills into the storm drain system. $1.6 million program scheduled for completion in November 1994.

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CITY OF PICO RIVERA

City of Pico Rivera: Phase III Co-Permittee
Population (1994): 60,600
Land Area: 8.23 sq. mi.

Located 13.5 miles southeast of the Los Angeles Civic Center, Pico Rivera was incorporated in 1958, and is generally north of the intersection of Santa Ana (5) and San Gabriel River (605) freeways. It has the 30th largest population among L.A. County cities. The employment base is large. Almost half of all jobs are found in manufacturing. Land uses are mixed urban with single family residential dominating. Median family income was $36,023 in 1989.

1. All catch basins have been stenciled with the Heal the Bay design. The City does not feel that the stencil will deter someone intent on illegal dumping into catch basin.

2. No program has been established to encourage reporting. The City plans to include County hotline number on cable TV message board.

3. Chapter 8.12, 8.16, and 12.56 of the Municipal Code (adopted 1-29-94) addresses urban runoff control. It is unknown what the net effects of these measures are.

4. Public education has been undertaken with occasional articles in City paper. This has probably had a minimal effect in reducing stormwater pollution.

5. Catch basins are inspected and cleaned at least twice per year. This program has not been modified in response to the requirements of the RWQCB and the City estimates that its effectiveness is fair.

6. The City provides trash receptacles at all bus stops which are emptied daily. Problem areas are cleaned in response to visual inspections. This program has not been modified in response to RWQCB requirements.

7. 280 curb miles are swept; every two weeks in residential areas and weekly in commercial and industrial areas. This program has not been modified.

8. Articles in City paper discourage improper disposal of litter, lawn clippings and pet feces. There are penalties for improper trash disposal. No modifications have occurred due to RWQCB requirements.

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9. No industrial waste inspection program exists but the City will implement a routine program beginning in August 1994. The City does respond to complaints and to visual observation of non-storm water discharges. Auto related businesses, gas stations, and restaurants are inspected quarterly under the authority of the municipal code. This program has been increased from periodic to regular.

10. The City encourages removal of dirt, rubbish and debris through occasional articles in City newspaper. Response has been fair. The program has not been modified.

11. A curbside recycling program for greenwaste and newspaper exists and 2 privately owned recycling centers are located in the City. The City estimates 15% of rubbish is being diverted. No outreach or education program has been established.

12. The City participates in the County household hazardous waste program. Suggestion that there be more centers to receive these wastes and that regular trash companies be allowed to pick them up.

13. Water conservation program for City parks and medians, businesses and residences with runoff problems are contacted.

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CITY OF POMONA

City of Pomona: Phase II Co-Permittee
Population (1994): 138,600
Land Area: 22.97 sq. mi.

Over 31 miles east of downtown Los Angeles lies the City of Pomona, incorporated in January, 1888. With three freeways passing through it, Pomona borders San Bernardino County to the east and is the 4th largest City in the County. The job base for Pomona is small, but relatively well diversified. The greatest number of jobs is in the service industries, followed by manufacturing, retail trade and government. Land uses are mixed with residential commercial and industrial. Median family income was $34,751 in 1989.

1. The City is implementing a program August 1 to stencil all catch basins.

2. In addition to supporting the County Hotline, the Pomona Fire Department has a hotline to encourage and facilitate public reporting of illegal discharges/dumping.

3. The City has adopted a Storm Water Management and Discharge Control Ordinance designed to: 1) eliminate non-storm water discharges to the City storm sewer, 2) control discharges to City storm sewers from spills, dumping or disposal of materials other than storm water and 3) reduce pollutants in storm water discharges to the maximum extent practicable.

4. A public awareness program will be implemented during the 1994-95 FY. City staff has been participating in County Public Information Committee meetings to determine most efficient methods of public education.

5. All catch basins are cleaned on a regular schedule during the year with additional cleaning as needed.

6. The City empties its 33 public roadside trash receptacles twice a week. It adds additional litter receptacles of special public events.

7. Sweeping of all public streets occurs twice per month.

8. The City's Municipal Code and public outreach programs discourage improper disposal of all litter. Staff is reviewing additional options to decrease illegal/improper disposal practices.

9. The City inspects auto repair and body shops, gasoline stations and restaurants annually under their Industrial Waste Inspection program.

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10. A City newsletter that provides general information and direction to residents on City policies and programs will supplemented during the 1994-95 FY by specific brochures and other materials being developed.

11. Glass, metal, paper, cardboard, aseptic packaging, aluminum, and plastics are routinely collected curbside for recycling. The program is being expanded to include white goods (appliances) and green waste. Handouts and water bill stuffers are currently used to publicize the program; a newsletter to all residents is being prepared.

12. The City supports the countywide household hazardous waste management program, promoting it in the City newsletter and other outreach materials. The City has targeted their public information program on the increased public awareness of proper hazardous material disposal practices.

13. City Code has significant prohibitions on wasting of water, promoted by a water "hotline" program, TV public service announcements and utility bill stuffers.

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CITY OF RANCHO PALOS VERDES

City of Rancho Palos Verdes: Phase I Co-Permittee
Population (1994): 42,200
Land Area: 13.43 sq. mi.

Incorporated in 1973, Rancho Palos Verdes is the 43rd most populous City in L.A. County. It is located along the southern coast of the County on Palos Verdes Peninsula, and is 27 miles southwest of the Los Angeles Civic Center. The City is predominantly residential and has a very small employment base. Almost 80% of the jobs are in government, retail trade and service sectors. Median family income was $87,528 in 1989.

1. Boy Scout volunteers have stenciled all 550 City owned catch basins with the Heal the Bay design. Heavy written public relations support explaining the stencil program is a suggested modification.

2. The City has implemented programs to encourage public reporting of illegal dumping. Only County hotline is available and it has been publicized through the City newsletter and cable public access channel. Too soon to determine effectiveness.

3. In October 1989, the City prohibited Discharge of Offensive or Damaging Substances (Municipal Code Section 20.36.010). Unknown if this measure has been effective in reducing pollutants. The City plans to adopt a runoff control ordinance in the next 4 months.

4. Quarterly City newsletter articles, brochures, direct mailing to businesses and cable public access have all been used to educate the public on stormwater pollution. It is felt that public education program will convince people to alter their behavior but a more coordinated countywide message would be helpful.

5. Catch basins are cleaned annually and monitored for problems. This program is effective and has not been modified.

6. 18 trash receptacles, emptied weekly, are provided. Bus stops will receive recycling containers. This program has been modified to meet RWQCB and AB939 mandates.

7. 260 curb miles are swept monthly in residential areas and the arterials are swept weekly. The City has added a City wide sweeping before first rain in response to RWCQB requirements which should be effective in reducing debris swept to ocean during first storm.

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8. Improper disposal is discouraged through education; newsletter articles and cable channel. This program has not been modified. The City has tried greenwaste recycling but it is presently on hold.

9. An industrial waste inspection program is being developed.

10. Public education program to encourage debris removal includes newsletter articles, newspaper articles, cable public access, and direct brochure mailing. This program has been modified in response to RWQCB requirements.

11. Newspaper, glass, plastics, aluminum and tin are recycled curbside. Recycler of the month promotion gives one year free trash collection to winner, Beautification award is funded by recycling revenue. A City program was established before RWQCB requirements.

12. The City participates in the County program. Used oil program will be established in FY 94-95.

13. Water conservation and runoff information is promoted through public education. The City now emphasizes water conservation as a method of saving resources and reducing pollution.

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CITY OF REDONDO BEACH

City of Redondo Beach: Phase I, III Co-Permittee
Population (1994): 62,700
Land Area: 6.35 sq. mi.

Located almost 23 miles southwest of downtown Los Angeles, Redondo Beach is a coastal City which was incorporated in 1892. The Pacific Coast Highway passes through the southern portion of the City which extends to the San Diego (405) Freeway to the east. The employment base is large, with retail trade, government and services being the dominant sectors. Redondo Beach ranks 28th by population among Los Angeles County cities and had a median family income of $58,760 in 1989.

1. The City has stenciled all 1200 of its catch basins with the Heal the Bay design. The City feels that this program has been very effective in promoting awareness.

2. The County hotline is used for reporting illegal dumping and it has been publicized in the Chamber newsletter and City quarterly newsletter. The City does not have a system for tracking reports of illegal dumping but suggests tracking, as well as promotion of reporting through schools as ways to encourage reporting.

3. On March 15, 1994 the City adopted amendments to Chapter 4 of Title 5 relating to the Waste Water and Storm Water Drainage system.

4. Public education/outreach is occurring through written media newsletters which has been somewhat effective in promoting awareness. Concentrating programs on schools should be effective.

5. Catch basins are cleaned twice per year and as needed. This cleaning program has not been modified.

6. Roadside trash receptacles are provided and are emptied once a week. Recycling containers have been provided in high impact areas. The City also maintains signs as part of the recycling display project to increase public awareness. Trash and litter problems are monitored by a private collection service and the City is notified of problems.

7. 260 curb miles are swept weekly in residential and twice per week in commercial areas. This was a preexisting program.

8. The City discourages improper disposal through a recycling program, promotion of composting and the recent adoption of the Source Reduction and Recycling Element. There are

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penalties for improper disposal. This program was underway prior to the mandatory BMP's.

9. There is no industrial waste inspection program at this time. Inspections for non-storm water discharges are made only if there is a known problem.

10. The public outreach/education program to encourage removal of dirt, rubbish and debris from sidewalks and alleys is tied to all other City recycling/water quality programs.

11. The City has a pretty extensive curbside recycling program. Public outreach/education is through regular notices, contract waste services, and use of block leaders. Approximately 25% of rubbish is being diverted from landfills.

12. The City does participate in the Countywide household hazardous waste program and there is also a permanent facility within the City and a once a year well publicized roundup for City residents.

13. No water conservation program has been adopted though the City does support programs sponsored by water purveyor.

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CITY OF ROLLING HILLS

City of Rolling Hills: Phase I, III Co-Permittee
Population (1994): 1,919
Land Area: 2.98 sq. mi.

Rolling Hills is located on the Palos Verdes Peninsula, 25 miles southwest of downtown Los Angeles. Incorporated in 1957, Rolling Hills is almost entirely residential, with a very small job base. Ninety percent of the jobs are in the service or construction sectors. Its population ranks 83rd among the 88 L.A. County cities and its median family income was $150,000 in 1989.

1. The County and Community Association maintain County-owned catch basins within the City. Storm drains have been stenciled by Los Angeles County Public Works.

2. Reports of illegal dumping can be made to City Hall in addition to the County hotline. The public continues to be informed of the County's hotline telephone number through the twice monthly newsletter sent to every household and at the City Hall counter handout display.

3. In 1993 the City adopted Good Housekeeping Requirements for Reduction of Urban Runoff, Urban Runoff Reduction Requirements for New Development Projects and Urban Runoff Reduction Requirements for Projects Under Construction and a water efficient landscape ordinance. These are part of the Rolling Hills Municipal Code, Section 5.04.142, and 17.27.020.

4. Every household receives the City newsletter twice-a-month that contains articles on issues of stormwater pollution. Two brochures on Household Hazardous Waste (County) and Hazardous Household Products (State) are available to residents at the City Hall counter handout display. Separate pamphlets are being developed on General Construction & Site Supervision, and Erosion Control Methods, & Landscaping, Gardening and Pool Maintenance. Residents are alerted to State-wide information that is also broadcast on radio, TV, and printed in newspapers.

5. The County maintains and cleans storm drains. The Rolling Hills Community Association also inspects and cleans catch basins each fall. No flooding due to storm drain backups have been reported.

6. No roadside trash receptacles are provided primarily due to the nature of the City. It is entirely residential and rural with private roads and estate sized lots.

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7. The City has no street sweeping program again due to the fact that all roads are private.

8. Ordinances control improper disposal. Articles printed in the City's twice-monthly newsletter discourage the improper disposal of litter, lawn clippings, and pet feces in this all residential community. All streets are private and maintained by the individual property owners. There are penalties for improper disposal and the program has been modified to include stormwater runoff control measures required by the Regional Water Quality Control Board. The City publishes notices, distributes fliers and publicizes nearby classes given by the County and USC on their Master Composting and Backyard Greenwaste Programs. The City distributes fliers announcing County coordinated Environmental Contests for children.

9. There are no auto related businesses, gas stations or restaurants within the City. Land use is entirely residential.

10. There are no sidewalks or alleys with the City.

11. The City of Rolling Hills has a recycling program with containers located at City Hall where residents deposit newspapers, glass, plastic, aluminum, and tin. Manure is collected by the waste hauler (BFI) for composting. Publicity is being formulated for the collection at the centrally located fire station of used telephone books that will be recycled. Program publicity in the twice-monthly newsletter includes articles, graphs and rates of recycling as well as the benefits of recycling. Approximately 28% of rubbish is being diverted from landfills. The City is negotiating with its trash hauler to offer residential recycling pick-up and a composting education program.

12. The City newsletter that is printed twice-monthly is used to publicize the County household hazardous waste management program and other programs.

13. The City has adopted a water efficient landscape ordinance and encourages the use of drought tolerant landscaping. Again the City newsletter is used to alert residents to the problem of overwatering etc.

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CITY OF ROLLING HILLS ESTATES

City of Rolling Hills Estates: Phase I, III Co-Permittee
Population(1994): 8,025
Land Area: 3.44 sq. mi.

Incorporated in 1957, Rolling Hills Estates is located on the Palos Verdes Peninsula, 23 miles southwest of downtown Los Angeles. The employment base is large, with 69% of the jobs in the service or retail trade sectors. The population is the 61st largest in the County and median family income was $90,698 in 1989.

1. All 75 City catch basins have been stenciled. City suggests use of more durable paint.

2. In addition to County Hotline, City has initiated a reporting system available 24 hours per day; phone number is included in directory of City services in every quarterly newsletter.

3. Municipal Code incorporates strict controls on urban runoff; emphasis is on grading/slope alteration, with violation penalties for contractors and builders. City also coordinates with county in providing sandbagging materials during rainy periods.

4. Every household receives regular City newsletter that contains articles on such issues as stormwater pollution; environmentally proactive community. City suggests using signs on beach trash receptacles to promote program.

5. All catch basins are cleaned annually in October, or more frequently if needed. Problem catch basins are inspected monthly.

6. City has 10 public roadside trash receptacles that are emptied twice weekly. To help prevent litter accumulation, City implements quarterly litter pickup program with volunteer community groups as well as an "Adopt-A-Trail" cleanup and maintenance program.

7. All City streets are swept--residential areas twice a month, commercial areas once a month. Per-mile costs were reduced by 40% when the City joined neighboring cities in a joint servicing contract; savings provides for extra sweeping when needed, such as during construction projects or during rainy periods.

8. Ordinances control improper disposal. City provides funding for community groups to regularly collect litter in the "Adopt-A-Street" program and backyard green waste composting program.

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9. Both City and County staff participate in an industrial waste inspection program under ordinances adopted by reference from L.A. County codes. Gasoline stations and restaurants are inspected annually. Currently adding enforcement personnel.

10. City public outreach/education programs, along with funding for services, result in neighborhood cleanup campaigns by community groups. There are approximately 20 residential programs per year and 15 in commercial areas (no industrial areas exist).

11. Newspaper, glass, plastic, aluminum, tin, used motor oil and manure from Municipal Stables are routinely recycled. Backyard composting is another type of recycling supported by the City. Grant applications have been filed with California Integrated Waste Management Board to fund used oil curbside collection and recycling programs. Program publicity includes articles in the City newsletter, spots on the local cable channel and notices in trash billings. As an incentive, trash hauler holds quarterly drawing of residents who routinely recycle: prize is 1 year free refuse service. City plans to add green waste collection and composting to program in January 1995.

12. The City supports countywide household hazardous waste management program by publicizing service to residents and providing City staff to answer questions. City suggests using commercial television to reach broader audience.

13. City ordinances prohibit excessive outdoor water usage and require water efficient landscaping. City newsletter, local press and cable channel provide public education on misuse of outdoor water.

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CITY OF ROSEMEAD

City of Rosemead: Phase II Co-Permittee
Population (1994): 53,800
Land Area: 4.96 sq. mi.

Eleven miles east/northeast of the Los Angeles Civic Center is the City of Rosemead, which was established in 1959. The San Bernardino (10) Freeway bisects the City. Rosemead's employment base is small. 32% of all jobs are in transportation/public utilities, followed by services, retail trade and manufacturing. Land uses are mixed with residential commercial and industrial. It is the 35th most populous City in the County and it median family income was $30,905 in 1989.

1. City is scheduled to have all 64 of its catch basins stenciled by the County during the 1994-95 fiscal year.

2. City supports County Hotline by publicizing service in quarterly newsletter.

3. While no runoff control ordinance is now in place, City anticipates adopting ordinance drafted by L.A. County Model Ordinance Subcommittee; City wants expanded authority to accommodate new programs dealing with illegal and illicit discharges into their storm drain system and the required inspection of auto related businesses.

4. A City newsletter to all residents is being used to inform residents of City programs and issues, including stormwater pollution. The program will be expanded in the 1994-95 FY to include additional materials and techniques for public communication, including pamphlets and brochures that will be delivered to each home and made available at all public counters.

5. All catch basins are inspected every two months and cleaned as needed. Program much more effective than previous schedule of single annual cleaning prior to October.

6. The City's 31 public roadside trash receptacles are emptied every week--or more frequently, if needed.

7. All City streets are swept at least once a week, with commercial and industrial areas swept twice a week.

8. City ordinances prohibit the improper disposal of litter, etc.; enforced by Police Department.

9. The City has funded a training program for City employees in order to implement an industrial waste inspection program during the 1994-95 FY. They plan to inspect all industrial and related uses at least once a year.

10. The City's newsletter informs all residents of the need to keep debris from washing into storm drains. An expanded

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public outreach program will be initiated during the 1994-95 FY.

11. Plastics, newspaper, glass, metal and green waste are routinely collected at curbside. To publicize program, full page announcements are printed twice each year in quarterly news letter, and notices included with monthly trash bills.

12. City participates in the countywide household hazardous waste management program; collection dates and locations are included in quarterly newsletter.

13. The City's public outreach program, notably their newsletter, has included educational information on the need for water conservation and how excessive outdoor water use directly affects quality of storm drain water.

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CITY OF SAN DIMAS

City of San Dimas: Phase II Co-Permittee
Population (1994): 33,900
Land Area: 15.35 sq. mi.

South of the 210 Freeway, San Dimas is located 29 miles east/northeast of downtown Los Angeles. Incorporated in 1960, it has the 50th largest population in the County. The Bonelli Regional County Park and the Puddingston Reservoir are recreational features of the area. The job base is small with half of the jobs in either services or manufacturing. Median family income was $55,790 in 1989.

1. The City has stenciled 65% of its catch basins with the L.A. County logo design. The remaining catch basins will also be stenciled.

2. The Public Works main telephone number can be used for reporting illegal dumping during business hours and after hours the County hotline is used. The public was informed of these phone numbers through a community newsletter. A suggestion to encourage public reporting: A "We Tip" hotline with some type of compensation.

3. Municipal Code section 14.04, 15.06, 18.180 pertain to water drainage requirements; all were adopted prior to NPDES requirements. The City is in the process of modifying the municipal code to provide additional regulations and penalties.

4. No outreach program has been implemented yet but the City is in the process of establishing one for the general public and school children.

5. L.A. County, under contract, cleans City catch basins. City crews also monitor for additional problems. City staff is receiving increased training on the need to keep basins clean.

6. Roadside trash receptacles are provided by the City and are emptied at least once per week. Additional receptacles are provided at bus stops and at civic functions.

7. 230 curb miles are swept twice monthly in residential and industrial areas and weekly in commercial areas. 200 cubic yards of trash/debris is collected each month.

8. Section 8.12 of the Municipal Code addresses garbage disposal requirements. The City has expanded the code enforcement program to monitor for improper disposal of litter and debris.

9. The City contracts with L.A. County Public Works for industrial waste services and follows up by investigating any questionable practices. Problems are immediately referred to

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DPW. All inspections of auto related businesses, gas stations and restaurants are done by L.A. County under the authority of Title 20.

10. There is no program to encourage removal of dirt, rubbish and debris from sidewalks and alleys.

11. Curbside recycling is part of normal residential trash collection. No estimate on percentage of rubbish being diverted.

12. The City participates in the Countywide household hazardous waste management program and in addition collects used motor oil. Newsletters, television and fliers will be used to remind residents of proper disposal.

13. Water conservation is addressed in the San Dimas Municipal Code Sections 18.14 and 18.124.

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CITY OF SAN FERNANDO

City of San Fernando: Phase II Co-Permittee
Population (1994): 23,700
Land Area: 2.37 sq. mi.

Incorporated in 1911, San Fernando is located 20.8 miles northwest of the Los Angeles Civic Center in the San Fernando Valley. San Fernando has a large employment base. Almost 50% of the jobs are in manufacturing, followed by 20% in the service sector. It is the 61st most populous City in the County and its median family income was $32,070 in 1989.

1. All City-owned catch basins have been stenciled with the Heal the Bay design by local Boy Scouts.

2. Residents can report illegal dumping to the City's 24 hour hotline. The public was informed of this hotline service through notice in the local newspaper.

3. The City says that it has adopted urban runoff control measures and goes on to state that it has adopted the City of Los Angeles Building and related codes. No additional information on the runoff measure is provided.

4. The City will distribute a brochure identifying what constitutes illegal dumping of household wastes to all single and 4 unit multi-family residences. It is also suggested that educational information can be combined with water conservation presentations at schools and during school tours of City Hall.

5. Catch basins are cleaned twice per year or more if necessary.

6. 35 roadside trash receptacles are provided and are emptied three times per week.

7. 90 curb miles are swept frequently. 40 curb miles are swept daily.

8. The City has a contract for curbside collection of yard clippings. City code specifies procedures for disposing of lawn clippings and pet feces. The City will be conducting a pollution reduction poster contest for children.

9. The City has a contract with Los Angeles County for City-wide industrial waste inspections. Auto related businesses, gas stations and restaurants are inspected once per year and as needed. The inspections are conducted under the authority of the City industrial waste ordinance.

10. Removal of dirt, rubbish and debris is encouraged through public outreach programs and the public is generally responsive.

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11. The curbside recycling program has diverted approximately 17% of rubbish from landfills. Newsletter informational brochure and ads on public access cable have publicized the program. The City has implemented a pilot home composting program and plans to distribute a commercial solid waste reduction informational brochure.

12. The City participates in the Countywide program. Hazardous waste left for normal trash collection are tagged with a non-collection notice.

13. Section 28.11 of the San Fernando Municipal Code encourages minimizing run-off from landscaped areas and discourages washing debris from hard surfaced areas. Brochures on landscape water conservation are distributed to single family residences.

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CITY OF SAN GABRIEL

City of San Gabriel: Phase II Co-Permittee
Population (1994): 38,700
Land Area: 4.10 sq. mi.

San Gabriel is located 10.4 miles northeast of downtown Los Angeles, with the San Bernardino (10) Freeway as its southern boundary. San Gabriel was incorporated in 1913 and it ranks 46th by population among L.A. County cities. The employment base in the City is large. 40% of the jobs are in the service sector, followed by 22% in retail trade and 14% in manufacturing. Median family income in 1989 was $35,991.

1. No catch basins have been stenciled but the City plans to stencil them during annual cleaning.

2. The City has informed the public of the County hotline through public access cable TV.

3. No runoff control ordinance has been adopted.

4. The City has prepared public counter handouts as a method of public education/outreach.

5. Catch basins are cleaned once per year in September and October.

6. Approximately 20 trash receptacles are provided and they are emptied 3 times per week.

7. 144 curb miles are swept every 10 days. Additional sweeping is done if necessary in problem areas.

8. The City has not established a program to discourage improper disposal of litter, lawn clippings and pet feces.

9. No industrial waste inspection program has been implemented but the City does make visual inspections for non-storm water discharges and responds to residents complaints. Auto body, auto repair and restaurants are inspected at change of occupancy under the authority of Section 25501 of the California Health & Safety Code.

10. The City has not established a program to encourage removal of dirt, rubbish, or debris but does suggest utilizing the City's public access cable station for outreach.

11. The City has a curbside recycling program and collects glass, plastic, aluminum, and newspaper. No estimate of the percentage of rubbish being diverted from landfills.

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12. The City does participate in the Countywide household hazardous waste management program and the "roundups" are publicized on the City's public access cable station.

13. The City has adopted a water efficient landscape ordinance.

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SUMMARY
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CITY OF SAN MARINO

City of San Marino: Phase II Co-Permittee
Population (1994): 13,050
Land Area: 3.75 sq. mi.

Established in 1913, San Marino is 10.5 miles northeast of the Los Angeles Civic Center, and ranks 74th in population among L.A. County cities. San Marino is a primarily residential City known for the Huntington Library and Art Museum. The employment base is small. Half of the City's jobs are in the service sector. Median family income was $105,123 in 1989.

1. All City catch basins have been stenciled with a RAIN WATER ONLY logo by high school volunteers.

2. In addition to supporting the County Hotline, the City's Environmental Network Committee has a hotline that can be used to report illegal dumping. The City's newsletter and Environmental Network meetings publicize the reporting systems.

3. The City has implemented numerous urban runoff control measures including construction procedures, prohibition of excessive irrigation and prohibition on sweeping of garden clippings into the street.

4. City newsletter articles, Environmental Network meetings and outreach programs have been used by the City to educate the public on the problem of stormwater pollution. The local water purveyor is being asked to insert notices in monthly bill envelopes.

5. All catch basins are cleaned at least annually by City staff before the first winter storm.

6. The City has 40-50 public roadside trash receptacles that are emptied weekly.

7. All City streets are swept at least weekly, with commercial areas swept 2-3 times per week. the streets and catch basins stay very clean.

8. City ordinances prohibit improper disposal of litter, lawn clippings and pet feces.

9. The City has very few industrial and related uses at present and have not implemented an industrial waste inspection program; a program is currently being developed, however.

10. Community pride results in uniformly clean sidewalks and general appearance on the part of residents and business owners.

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11. Paper, glass, tin, aluminum, plastic, cardboard and other periodically discarded materials are routinely collected; mandatory recycling will be implemented in fall of 1994, as will a green waste recycling program. Trash removal contractors and the Environmental Network provide public information on recycling programs.

12. The City participates in the countywide household hazardous waste management program and has sanctions against haulers who collect hazardous waste improperly.

13. A water conservation ordinance prohibits flooding of sidewalks and gutters and other forms of water waste.

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SUMMARY
STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF SANTA CLARITA

City of Santa Clarita: Phase III Co-Permittee
Population (1994): 128,800
Land Area: 42.63 sq. mi.

The City of Santa Clarita is located in the Santa Clarita Valley along the Golden State (5) freeway, 26 mile north of the L.A. civic center. It ranks 7th in population among L.A County cities. Its land uses are mixed with extensive residential and some industrial, commercial and vacant.

1. The City has stenciled about 50% of its catch basins with the Heal the Bay design. Eagle scouts have been doing the stenciling.

2. The City has a routine reporting system and also does press releases on the County hotline. The County number is included in City public information documents.

3. On 11-24-92 the City adopted a Hillside Development Ordinance which contains provisions for drainage, erosion control, run off and landscaping. $10,000 has been budgeted for the review of existing ordinances and adoption of an additional runoff ordinance is required.

4. In developing public education and outreach programs the City has held meetings with public information groups, the Chamber of Commerce, and business groups. A budget and study outlining the level of public education has been provided.

5. A new maintenance schedule for catch basin cleaning has not been established. Previously, they were cleaned whenever necessary. The new schedule will be covered in the Master Storm Drain study beginning after August 10, 1994.

6. 25 roadside receptacles are provided in problem litter areas. They are emptied weekly.

7. 275 miles of public streets are swept every other week in residential and industrial areas and weekly in commercial areas. The frequency of cleaning has been increased.

8. The City has been awarded a grant to implement parks and trails recycling and trash collection program. (Not yet established.)

9. The County handles industrial waste permits and inspections though the City is in the process of developing a system for NPDES inspections. Auto related businesses, gas stations and restaurants are inspected based on complaints or when information is obtained that an inspection is needed.

10. A debris removal program was started after the Jan. 17 earthquake.

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11. The City has a pretty extensive recycling program which has resulted in a diversion of 25% of rubbish from landfills. A speakers bureau, technical resource library, repair hotlines, education programs, composting demonstrations, business recycling assistance and motor oil drop off locations are all part of the program.

12. The City participates in the Countywide household hazardous waste management program and believes that public education programs help ensure proper disposal.

13. Ordinance 9.38 was adopted as a water conservation measure. Handouts and brochures inform the public on problems of overwatering, washing sidewalks, etc.

14. ADDITIONAL BMP'S

A. Rivers, washes and storm drains are periodically monitored for water quality. Samples are taken and analyzed to detect sources of upstream discharge.

B. The City has created a Stormwater Utility Enterprise Fund to fund the NPDES program.

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CITY OF SANTA FE SPRINGS

City of Santa Fe Springs: Phase III Co-Permittee
Population (1994): 15,550
Land Area: 8.72

Located 13.6 miles southeast of downtown Los Angeles, Santa Fe Springs ranks 71st in population among L.A. County cities. The Santa Ana (5) Freeway and the San Gabriel River form the western boundaries. Although known as primarily an industrial City, commercial and residential areas also exist. The job base is very large, with the leading sector being manufacturing. Median family income was $37,010 in 1989.

1. The City has not stenciled any of its catch basins at this time and does not plan to in the future. The City questions the effectiveness of the stenciling program and feels that there should be an emphasis on outreach and education programs. More permanent alternatives to stencils are being considered.

2. A 24 hour spill response telephone number has been implemented and has been publicized in the City newsletter and memos to the Chamber of Commerce and the Industrial League.

3. Runoff control measures are contained in various sections of the City code. A water pollution control ordinance for more specific regulations regarding urban runoff discharges is being reviewed for approval by Spring 1995.

4. The City supports outreach measures in various media. Suggests implementing school, business and general outreach program, the appointment of a public outreach coordinator and use billboards, radio and local cable television.

5. Catch basins are cleaned on a yearly basis and as needed.

6. 62 roadside trash receptacles are provided and are emptied weekly or as needed. Bus shelters have been identified as a problem area.

7. Sweeping of the 200 curb miles of street occurs bi-weekly for residential areas, weekly for commercial areas and monthly for industrial areas.

8. The City discourages improper disposal of litter etc. by installing "No dumping" signs in target areas. An "Adopt a Highway" program and property maintenance program also exist.

9. An industrial waste inspection program is handling through the City fire department and consists of an inspection program, plan review, permit issuance and enforcement activities. Industrial waste inspector requires a permit for disposal of wastewater to sewer. Auto related businesses, gas stations and restaurants are inspected annually and as needed under

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Section 18-1 of the City Code. Violations are enforced through County Code Section 20.24.160.

10. The City has property maintenance inspectors who reach out to the community plus a Beautification Committee, "Good Neighbor" and "Home Improvement" programs that encourage removal of debris.

11. The City does not presently have a curbside recycling program, but such a program is being considered at this time. Various materials are recycled commercially through several businesses in the City. The City has a Christmas tree recycling program and estimates that 30% of rubbish is being diverted from landfills at this time. City is working on establishment of a MERF facility.

12. The City participates and actively supports the Countywide program.

13. The City supports "Water Awareness Week" and other MWD programs. The public has been informed through pamphlets, fliers and notices, and water bill inserts.

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STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF SANTA MONICA

City of Santa Monica: Phase I Co-Permittee
Population (1994): 89,800
Land Area: 8.15 sq. mi.

Sixteen miles due west of downtown Los Angeles lies Santa Monica, the oldest beachside City (incorporated in 1886) with a strong residential community as well as commercial and recreational areas. Santa Monica has a very large, diversified job base, including service, retail and manufacturing sectors. It ranks 17th among L.A. County cities in population and had a median family income on $51,085 in 1989.

1. The City has stenciled all of its catch basins with the Heal the Bay design. Stenciling was initially done by the City and later by volunteers.

2. A hotline for reporting illegal dumping has been established through the fire emergency dispatcher and the City maintenance office. This service was publicized through the City newsletter.

3. Chapter 7.10 of the City municipal code requires runoff reduction and good housekeeping. Ordinance was passed 9/8/92.

4. Outreach programs include video on public television, various pamphlets and public education.

5. Catch basins are typically cleaned 4 times per year; more often if necessary/if complaints are received. The City is attempting to keep track of the debris removed.

6. Roadside trash receptacles are provided and are emptied twice a day or every other day as needed.

7. 42,000 curb miles and 3,350 alley miles are swept. Residential areas are swept weekly, while commercial and industrial areas are swept daily. The City is proud of its clean reputation.

8. The improper disposal of litter, lawn clippings and pet feces is illegal and subject to penalties according to the City Municipal Code Chapters 4.04, 7.10, and 7.48. Further a violation is considered a public nuisance that can be abated by Civil action in addition to the fines of $100 a day.

9. City inspectors at least annually check industrial waste sewer connections and check for violation or pollution problems. The following types of businesses are checked: auto parts, auto repair, auto body shops, gas stations, and restaurants under authority of the municipal code.

10. Various pamphlets, newspaper articles, newsletters and a video have been used to reach the public to encourage the removal of

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dirt, rubbish and debris from sidewalks and alleys. The City has also begun a "sustainable city" program.

11. 14% of rubbish is being diverted from landfills due to the recycling program. The City also subsidizes residents purchase of composting bins.

12. The City does not participate in the Countywide Hazardous Waste Management program but does maintain a permanent hazardous waste drop off facility. The City continuously expands and improves public outreach programs.

13. Low flow fixtures and runoff reduction for new construction are required through City ordinances. Pamphlets, newsletters, videos on City cable TV are used to inform and educate the public on water conservation.

14. ADDITIONAL BMP'S

A. The City has begun a program to install boards over the openings to about 80 catch basins. The boards keep the basins clean and discourage people from throwing debris into the basins.

B. The City is presently considered a program to treat storm water flows from the Pico Kenter and Pier storm drains to prevent pollution from entering the ocean.

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CITY OF SIERRA MADRE

City of Sierra Madre: Phase II Co-Permittee
Population (1994): 10,950
Land Area: 2.93 sq. mi.

Incorporated in 1907, Sierra Madre is located 16.5 miles northeast of the Los Angeles Civic Center at the base of the Angeles National Forest. Most of Sierra Madre's 2.9 square miles consist of single-family residential neighborhoods. It has a very small employment base, with over 1/3 of its jobs in the service sector. Sierra Madre ranks 77th among L.A. County cities and had a median family income of $56,668 in 1989.

1. The City has not implemented a stenciling program for its catch basins.

2. The City has no programs other than the County Hotline to promote public reporting of illegal discharges/dumping.

3. The City has not implemented urban runoff control measures.

4. The City has not implemented programs to educate the public on the problem of stormwater pollution.

5. City catch basins are cleaned annually.

6. The City's public roadside trash receptacles are emptied weekly.

7. All City streets are swept at least bi-weekly, with commercial areas swept weekly.

8. City has no programs to discourage improper disposal of litter, lawn clippings and pet feces.

9. The City has a hazmat handler disclosure program to regulate disposal of waste oil and coolant from auto repair shops. Auto parts and repair shops, gasoline stations and restaurants are inspected under City ordinance and California health and safety codes.

10. The City has no program to encourage removal of dirt, rubbish and debris from sidewalks and alleys.

11. Plastics, paper and green waste are routinely collected at curbside; an estimated 35% - 40% of rubbish is being diverted from landfills. Study sessions, public hearings and the media help promote public outreach and education.

12. The City participates in the Countywide household hazardous waste management program.

13. No water conservation programs are operative at this time. During drought (1991), water rates scaled to penalize excess use, and low flow hose nozzles were distributed.

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CITY OF SIGNAL HILL

City of Signal Hill: Phase III Co-Permittee
Population (1994): 8,800
Land Area: 2.14 sq. mi.

Twenty-three miles south of downtown L.A. and surrounded by Long Beach is the City of Signal Hill, incorporated in 1924. Signal Hill has a combination of residential, commercial and industrial uses, and has a large and diversified employment base. It ranks 78th in population among L.A. County cities and its median family income was $38,776 in 1989.

1. The City has contracted with the County to stencil all catch basins. In addition to Heal the Bay stencil, City suggests stenciling all curb faces, which would be visible to vehicular traffic.

2. The City supports the County Hotline to promote reporting of illegal discharges/dumping. The program is publicized in the City's newsletter which is mailed to all residents and businesses.

3. The City adopted the County's Industrial Waste Code in 1990 to provide them with the authority to inspect waste discharge facilities, require compliance and issue citations for non-compliance.

4. The NPDES video, prepared by the City of Los Angeles, was broadcast on the Signal Hill cable access channel. A City-prepared newsletter focusing on environmental issues--specifically storm water runoff--was mailed to all residents and businesses. City suggests using public service messages on bus shelter signboards.

5. All catch basins are cleaned at least annually, or as needed, prior to the rainy season. City in preliminary stages of developing new catch basin programs.

6. The City's approximately 25 roadside trash receptacles are emptied weekly.

7. City contracts with a private service for weekly sweeping of all streets. All City streets are posted "No Parking" during sweeping hours.

8. City newsletter notified residents/businesses to place improper items in trash receptacle, rather than sweeping or washing them into the street; penalties for improper trash disposal. City sent letters to homeowners associations requesting that they require their landscaping services to pick up debris, rather than blowing it into street.

9. Industrial waste consultant hired to monitor and provide annual inspections. Auto parts, repair and body shops and

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restaurants inspected 1 to 6 times per year under authority of Municipal Code. The 10% non-compliance cases are enforced through citations and/or jail terms.

10. Publicity by City has encouraged citizens to organize "Community Clean-Up" programs. City assists by sweeping all alleys monthly.

11. Paper, newspaper, plastic bottles, glass, cardboard and aluminum are routinely collected at curbside. Refuse rates are structured to encourage recycling. Recycling pamphlets mailed to all residents and businesses, recycling presentations made at City schools and meetings held with homeowners associations. Approximately 28% of rubbish is being recycled.

12. City participates in the countywide household hazardous waste management program as well as picks up and disposes of hazardous materials left at curbsides, alleys, etc. City suggests encouraging local businesses that sell motor oil, paints, etc. to provide collection services.

13. City has an adopted Water Conservation Ordinance, and has published newsletter articles asking residents to reduce watering of landscaped areas. Water rate structure penalizes excessive water usage.

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CITY OF SOUTH EL MONTE

City of South El Monte: Phase II Co-Permittee
Population (1994): 21,450
Land Area: 2.80 sq. mi.

South El Monte is 12 miles east of the Los Angeles Civic Center and was incorporated in 1957. It has a very large employment base. Manufacturing is the primary industry, accounting for over 60% of all jobs. It is the 62nd largest City by population in L.A. County and had a median family income of $27,157 in 1989.

1. City employees are scheduled to stencil all catch basins with the Heal the Bay design during August 1994.

2. City is promoting the County Hotline for reporting illegal discharges/dumping by announcements at City Council meetings, articles in bi-monthly City newsletter and postings of fliers in all City facilities.

3. Modifications to City ordinances that control urban runoff are in progress.

4. Using material developed by City of Los Angeles, City is distributing fliers at City facilities and including articles in the City newsletter that help educate the public on the problem of stormwater pollution.

5. All City catch basins are cleaned at least annually in the summer, with high-maintenance basins cleaned quarterly.

6. The City's 15 roadside trash receptacles are emptied weekly; City plans to increase number of receptacles at bus stops. Ordinance introduced to require waste receptacles for commercial establishments.

7. All City streets are swept weekly.

8. The City has anti-litter laws, an environmental damage ordinance and a mandatory residential green waste recycling program.

9. Observations for non-storm water discharges are made daily by field code enforcement personnel and street sweeper operators. Random inspections of industrial-related operations are conducted quarterly, with about 15% of the inspections found to be in violation of their business license or industrial waste permit.

10. Fliers available at City facilities and articles in the City's newsletter educate the public on the need to remove dirt, rubbish and debris from sidewalks and alleys.

11. Green waste, metals, plastic, paper, glass and cardboard are routinely collected at curbside. The program is promoted through school presentations, videos for loan to community

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groups and newsletter articles. An estimated 26% of rubbish is being diverted from landfills.

12. The City participates in the countywide household hazardous waste management program and is developing a pilot program for the collection of used motor oil.

13. Water efficient landscape ordinance in place for new developments; City Council currently reviewing proposed City-wide ordinance.

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SUMMARY
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CITY OF SOUTH GATE

City of South Gate: Phase III Co-Permittee
Population (1994): 88,900
Land Area: 7.32 sq. mi.

Incorporated in 1923, South Gate is 9.7 mile southeast of downtown Los Angeles and ranks 18th in population size among L.A. County cities. Major thoroughfares include Firestone Blvd. and the Long Beach (710) Freeway. Two rivers, the Los Angeles and Rio Hondo also pass through South Gate. The job base is small. Manufacturing accounts for over 1/3 of jobs, followed by services and retail trade. Median family income in 1989 was $28,980.

1. The County will be stenciling all City catch basins with the Heal the Bay design. City suggests use of bilingual stencils.

2. In addition to the County Hotline, in 1991 the City established a reporting system for reporting improper discharges. Approximately 800 inspections are made each year and stormwater information is distributed as needed.

3. Urban runoff controls were added to the City's Municipal Code, Industrial Waste Section, in 1991; emphasis is on runoff from industrial uses.

4. The City has developed public education and outreach programs through its industrial waste inspections, videos, brochures and pamphlets. City suggests greater emphasis on bilingual educational materials.

5. All catch basins are cleaned at least annually. A system of measuring removed debris is being developed.

6. The City has approximately 80 public trash receptacles that are emptied on a regular basis. They are located at bus stops, parks and busy streets. Litter prone areas are inspected and special pick-up is performed as needed.

7. All 128 miles of City streets are swept at least weekly, with commercial areas swept twice weekly.

8. City Public Works staff implements Municipal Code sections that discourage improper disposal; City is near implementation of a curbside green waste recycling program.

9. City has an industrial waste inspection program that includes inspection of all auto parts, repair and body shops; gasoline stations, restaurants and other target industries between 1 and 6 times per year. Approximately 10% of inspections are violations, which are enforced by citations, fines and possible jail sentences. City also investigates improper surface discharges.

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10. The City has a public outreach program to promote the disposal of rubbish and debris from sidewalks and alleys. The City has a program already in place to pick up materials in alleys and sidewalks in response to calls from the general public.

11. Newspaper, glass, plastic and cans are routinely recycled at curbside. Curbside pick-up of used oil, white goods and furniture is available; a collection center is used for green waste, although curbside service is planned. The City promotes their recycling program through public presentations, brochures, newspaper articles and multimedia presentations.

12. The City participates in the Countywide household hazardous waste management program. They suggest encouraging sellers of paints, oil, etc. to post addresses of recycling centers.

13. The City has a water conservation ordinance and has an active program to encourage water conservation. This includes school handouts and bilingual pamphlets and other public outreach materials.

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CITY OF SOUTH PASADENA

City of South Pasadena: Phase II, III Co-Permittee
Population (1994): 24,300
Land Area: 3.47 sq. mi.

Located 7.3 miles north of downtown Los Angeles, South Pasadena incorporated in 1887. Access is generally provided by the Pasadena (110) Freeway. Primarily a residential community, there are also small commercial areas. The employment base is small, with retail trade and services accounting for over 60% of all jobs. South Pasadena is the 59th City in L.A. County in terms of population size and had a median family income of $55,808 in 1989.

1. The City has no catch basin stenciling program.

2. The County Hotline is available for reporting of illegal discharges and dumping. No other related programs have been implemented by the City.

3. The City has not adopted urban runoff control measures.

4. The City has not implemented programs to educate the public on the problem of stormwater pollution.

5. All catch basins are cleaned by hand annually prior to the rainy season; additional cleaning is done as needed in response to public complaints.

6. The City empties all 20 of its roadside trash receptacles at least weekly--some are emptied daily. No problem litter areas have been identified.

7. The City has a contract service sweep all 50 miles of its streets. Residential areas are swept every three weeks; commercial areas are swept daily.

8. The Municipal Code discourages improper disposal of litter, lawn clippings and pet feces, and provides penalties for improper trash disposal.

9. The City utilizes the County's industrial waste inspection program to inspect auto parts, repair and body shops; gasoline stations and restaurants.

10. The City has no programs to encourage removal of dirt, rubbish and debris from sidewalks and alleys.

11. The City collects cans, glass and newspaper at curbside for recycling. They have established a permanent recycling center and provide educational materials through local schools and public mailings which promote recycling.

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12. The City participates in the Countywide household hazardous waste management program, which they judge to be effective, based upon strong public support and participation. No other household hazardous waste disposal programs have been established.

13. The Municipal Code restricts the use and wasting of water, and regulates water use for landscaping.

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SUMMARY
STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF TEMPLE CITY

City of Temple City: Phase II Co-Permittee
Population (1994): 32,200
Land Area: 3.85 sq. mi.

Temple City is in the San Gabriel Valley, 13.4 miles northeast of central Los Angeles and was incorporated in 1960. Its employment base is very small, with services as the leading sector. It is 49th in population in Los Angeles County and its median family income was $44,768 in 1989.

1. The City plans to stencil its catch basins but none have been completed. A contractor will stencil with the Heal the Bay design.

2. Other than the County hotline, no programs to promote public reporting of illegal discharges have been established.

3. No urban runoff control measures have been adopted.

4. The City has not established a public education or outreach program.

5. Los Angeles County cleans the catch basins once per year and on an "on-call" basis. This program has been very effective and has not been modified in response to the RWQCB requirements.

6. 106 roadside trash receptacles are provided and they are emptied weekly. No problem litter areas have been identified and the program has not been modified in response to the RWQCB requirements.

7. There are 112 miles of improved streets in the City and they are swept bi-weekly in residential and industrial areas and weekly in commercial areas.

8. The Temple City Municipal Code section 4105 prohibits illegal dumping. There are penalties for improper trash disposal. This program has not been modified in response to the RWQCB requirements.

9. The industrial waste inspection program is handled by L.A. County. Non-storm water discharges to the storm drain system are not inspected. Auto related businesses, gas stations, and restaurants are inspected yearly.

10. There is no public outreach/education program to encourage the public to remove dirt and debris from sidewalks. The Temple City Municipal Code does have regulations concerning depositing debris and vegetation not to obstruct sidewalks.

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11. The City has established a curbside recycling program and collects paper, plastic, cans, glass and green waste. The program has been publicized through the City newsletter. The City estimates that 20% of rubbish is being diverted from landfills at this time.

12. The City participates in the Countywide household hazardous waste management program.

13. Irrigation by the City is constantly monitored to insure little or no runoff. At this time no program has been established to inform the public regarding the sediments, waste materials and contaminants carried to the drainage system as a result of runoff from overwatering landscaping, washing sidewalks, cars, etc.

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SUMMARY
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CITY OF TORRANCE

City of Torrance: Phase I, III Co-Permittee
Population (1994): 136,700
Land Area: 19.94 sq. mi.

Incorporated in 1921, Torrance is 19 miles southwest of the Los Angeles Civic Center, on the western coast of the County. Torrance has a substantial industrial base, with emphasis on aerospace and oil refining. Torrance has a large and diversified employment base, with most jobs in the services, manufacturing and retail sectors. It is the 5th largest City by population size in the County and its 1989 median family income was $55,678.

1. The City has begun stenciling its catch basins with the Heal the Bay design. Approximately 60 have been completed and there are plans to stencil the rest. Areas where people tend to congregate have been targeted in the pilot program.

2. In addition to the County hotline the City's environmental quality officer investigates reports of illegal dumping/discharge reported to that office.

3. Construction permits include requirements for erosion control and prevention of practices that would carry dirt and debris onto public streets. However, other agencies ordinances are being reviewed for possible revisions to City code.

4. Public education and outreach programs include public works newsletter, water bill insert and information booth at the City's environmental and water conservation expo. A possible technique for informing the public could be through movie theaters previews/leaders.

5. Catch basins are cleaned each year prior to the start of the rainy season (and as needed) and approximately 9 tons of debris is removed annually.

6. Approximately 90 roadside trash receptacles are provided by the City and by Gannett Industries at problem litter locations. They are emptied weekly.

7. 600 curb miles of street are swept weekly. 200-300 tons of debris are removed from the streets each month.

8. Improper disposal of litter, lawn clippings, and pet feces has been discouraged through information included in public works newsletter and water bill inserts. Several positions, in addition to the environmental quality officers have been given power to cite violators.

9. Industrial waste inspections are done on a complaint basis only. Environmental quality officers issue warnings/citations. There are plans to expand this to a annual inspection.

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10. Public Works newsletters and water bill inserts have been used to encourage the public to remove dirt and debris from sidewalks.

11. The City has a recycling program which has diverted approximately 21% of rubbish from landfills. Yard waste composting workshops and promotion through distribution of fliers and inserts in water bills are part of the program.

12. The City participates in the Countywide hazardous waste management program and also maintains a list of recyclers for public inquiries.

13. The City has a water conservation program which includes inserts in water bills, pamphlets encouraging water conservation (i.e. don't hose down driveways and sidewalks, don't leave hose running while washing car, don't overwater lawns).

14. Additional BMP's

A. The City has implemented a storm water retention basin cleaning program.

B. Alarms have been installed in sewer and storm drain pump systems designed to decrease the potential of raw sewage entering the storm drain system. It has been in operation for 2 years.

C. For the past 1 1/2 years conditions have been added to construction/excavation permits requiring site cleanup.

D. The City has increased clean up of sewers and storm drains which has decreased the number of sewer backups.

E. For past 2 years large construction sites to have been required to have staging areas to free vehicles of debris/dirt prior to entering public ROW. This keeps sediments from entering storm drain system.

F. The City has developed water pollution control and conservation elements in the general plan. In effect since October 1992.

G. Control of pollutant section added to public works projects contracts. This program has been in operation for a year.

H. The City has a program to reduce surface application of fertilizers which has been in operation for 2 years.

I. For 2 years the City has required that tarping be used on City vehicles when hauling material. This prevents material from being blown or falling from trucks to street.

J. The irrigation systems on public property are inspected and repaired weekly to reduce volume of water flowing in gutters. This has been in operation for 2 years.

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K. The City restricts the use of leaf blowers by City staff to reduce the volume of yard waste and sediment entering the storm drain. This has been in operation for 2 years.

L. The City has evaluated the use of pesticides for replacement with less toxic materials to reduce the volume of toxic materials entering the storm drain system.

M. City used lawn mowers are required to have a collection system to keep lawn clippings from entering storm drain system.

N. Yard wastes from City property are collected and recycled.

O. The City is in the process of inspecting storm drain lines to identify illegal connections and determine pipe condition.

P. The City is identifying stationing of all connections to storm drain system. As built permits or disconnect notices are issued.

Q. The City is in the process of identifying businesses by SIC code.

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SUMMARY
STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

COUNTY OF VENTURA Phase I Co-Permittee

1. The catch basin stenciling program, using a customized design, was set to kick-off on July 21, 1994. Volunteers will do stenciling.

2. No programs to encourage the reporting of illegal dumping have been implemented.

3. It is expected that a stormwater ordinance consolidating all authority to control stormwater quality and drainage will be developed in the near future. Presently, runoff control is handled though a flood control watercourse ordinance, a floodplain management ordinance, control of water quality, soil erosion of new agriculture hillside development and building code regulations.

4. A public outreach program to educate the public on the problem of stormwater pollution has been implemented. Residents are also encouraged to: dispose of trash properly, recycle and not throw anything in catch basins. Door hangers, brochures, handouts, mail inserts and special event displays have been used.

5. Catch basins are inspected annually and cleaned "as needed".

6. No roadside trash receptacles are provided.

7. Residential street sweeping of 57 curb miles is done every other week.

8. Improper disposal of litter, lawn clippings, and pet feces is enforced through the Ventura County code. Solid Waste Management distributes public information on proper disposal. The "Resource Efficient Yard Care" brochure by Ventura County Solid Waste Management will be modified to include specific stormwater runoff information.

9. An illicit discharge control program has been initiated to inspect the storm drain system and identify suspected illegal sources. Presently none of the listed businesses (auto related etc.) exist in the watershed area. They will be inspected if they exist in the future and controlled initially through education/outreach.

10. A public outreach program encourages residents to properly dispose of trash, compost or recycle yard waste, and keep from disposing anything into catch basins or gutters.

11. 15% of rubbish is being diverted from landfills at this time. Recycling program includes public education through newsletters, brochures and inserts.

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12. Recyclable household hazardous wastes are accepted twice per month at a permanent facility established by the City of Thousand Oaks which has a contract with the County.

13. Water conservation program includes encouraging efficient use of water outdoors, low-water using plants, efficient irrigation systems to reduce runoff and use of spray nozzles on garden hoses.

14. ADDITIONAL BMP'S

A. Ordinance No. 3539 Control of Water Quality, Soil Erosion, and Sedimentation of New Agricultural Hillside Developments established standards within new agricultural developments to reduce environmental damage in critical erosion areas.

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SUMMARY
STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF VERNON

City of Vernon: Phase III Co-Permittee
Population (1994): 80
Land Area: 5.01 sq. mi.

Located 4.8 miles south of downtown Los Angeles and incorporated in 1905, Vernon is an overwhelmingly industrial City located in the industrial core of the L.A. basin. The Los Angeles River runs through this City, which has very large employment base. Over half of the jobs are in manufacturing. Median family income in 1989 was $16,250.

1. A Heal the Bay stencil has been ordered and when received the City will stencil approximately 340 catch basins. Los Angeles County Public Works has been requested to stencil the catch basins it owns within the City boundaries.

2. The public is encouraged to report any illegal dumping to the Community Services Department. Information on the hotline service was provided in the Vernon Journal quarterly newspaper. Future messages on utility bills will also encourage reporting.

3. Vernon Municipal Code 21.19 (adopted 5/7/68) prohibits discharge of any substance into the ground or catch basin. Education has been provided by inspectors who investigate sources.

4. As part of the public education program the City has published articles in the "Vernon Journal". The City also plans to educate through the bi-monthly mayor breakfasts and utility bill messages.

5. Catch basins are cleaned twice a year, more if necessary, by a vac truck. It is estimated that tons of debris have been kept out of the storm drain system over the years due to the cleaning program.

6. Receptacles are emptied as often as needed, but at least once each week. Litter prone areas have been inspected and the existing receptacles have been placed in these areas. City streets are under daily surveillance to identify litter prone areas and additional receptacles will be placed as necessary.

7. 97 curb miles of street are swept weekly.

8. Vernon Municipal Code 12.3 prohibits the improper disposal of litter and imposes a penalty. Vernon is a primarily industrial City and a great majority of properties have been developed with zero landscaping. Because of this, lawn clippings and pet feces are nearly nonexistent.

9. Auto related businesses and gas stations are inspected every other year, businesses with underground storage tanks every

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year and restaurants 3 times per year. Vernon Municipal Code 21.19 allows the inspections.

10. Public reporting of dirt, rubbish and debris accumulation is encouraged. Businesses are encouraged to maintain their frontages.

11. The recycling program has diverted 51% of rubbish from landfills. Pamphlets have been mailed to industries and distributed during inspections to increase public awareness of the program. The City has a source reduction and recycling element plan to evaluate waste reduction and is considering adoption of an ordinance to reduce the number of waste haulers to improve monitoring.

12. Vernon residents, of which there are less than 100, are more aware than most of the dangers of disposing of household hazardous wastes.

13. The City has no water conservation program but some public education efforts through newspaper articles and messages in utility bills will be made. The City is primarily industrial and has no mandatory landscape requirements.

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STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF WALNUT

City of Walnut: Phase II Co-Permittee
Population (1994): 30,850
Land Area: 8.61 sq. mi.

The City of Walnut is over 27 miles east of downtown Los Angeles south of the San Bernardino Freeway, and was incorporated in 1959. Walnut has a small employment base, with over half of the jobs in the service sector. It is the 56th City in the County by population size and its median family income in 1989 was $64,866.

1. The City is in the process of implementing the catch basin stenciling program. The design has not been chosen and it has not been determined who will do the stenciling. The City suggested that the catch basin stenciling program only be required where a problem is identified.

2. A 24 hour emergency telephone number has been established. The number was publicized in the Walnut Weekly and community awareness of illegal dumping has been heightened.

3. The City requires erosion control plans which help reduce water contaminated with soil from entering the storm drain system.

4. Code enforcement staff goes door to door educating businesses on storm water pollution. The City is also preparing brochures and considering expanding the door to door program.

5. Catch basins are cleaned annually through contract with Los Angeles County Public Works.

6. Roadside trash receptacles are provided and are emptied twice per week. The greatest amount of litter has been found to occur around bus stops.

7. 165 curb miles are swept twice per month. Brooming has been found to be more efficient than vacuuming.

8. Green wastes are collected separately and the City offers information on composting.

9. The City does not have an industrial waste inspection program but does inspect commercial business and especially focuses on several sites adjacent to a natural creek. Under the authority of the City code, auto related businesses, gas stations and restaurants are inspected annually and in response to complaints, they are inspected more frequently.

10. The City publishes newspaper articles and press releases and does door to door outreach to encourage the public to remove dirt and debris from sidewalks and alleys.

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11. The City recycling program has diverted 22% of rubbish from landfills. Expansion of the program to commercial areas is underway.

12. The City participates in the Countywide hazardous waste management program and is in the process of implementing a used oil recycling program.

13. A flyer to educate residents about water conservation is being prepared. The City uses reclaimed water for irrigation and landscapes with drought tolerant plants.

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SUMMARY
STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF WEST COVINA

City of West Covina: Phase II Co-Permittee
Population (1994): 99,800
Land Area: 16.15 sq. mi.

West Covina is located 20 miles east of the Los Angeles Civic Center, and has the 11th largest population of all L.A. County cities. The San Bernardino Freeway passes through the northern third of West Covina for over 10 miles. Incorporated in 1923, it has a small job base. West Covina had a median family income of $46,081 in 1989.

1. The City has implemented a stenciling program using a customized design. 131 catch basins have been stenciled and there are plans to complete the rest. The City suggests a stencil visible to drivers as well as pedestrians.

2. A 24 hour phone number to report emergencies to the City Hall operator also can be used for reporting illegal dumping.

3. On June 7, 1994 an ordinance to control urban runoff was adopted.

4. As a method of public education the City published an article on the problem of stormwater pollution in the quarterly newsletter. The City also suggests a PBS special documenting the origins of the NPDES program.

5. Catch basins are cleaned quarterly except for "hot spots" which are cleaned monthly.

6. The City provides 80 roadside trash receptacles which are emptied weekly. Receptacles are placed in identified problem areas.

7. 896 curb miles are swept, twice per month in residential areas and twice per week in commercial areas.

8. The City has an automated yard waste program to discourage improper disposal. There are penalties for improper disposal.

9. An industrial waste inspection is included in Citywide code enforcement activities as is non-storm water discharge. Auto related business and gas stations are inspected quarterly, restaurants are inspected monthly. Violators are referred to the City prosecutor.

10. The City has a "Clean-Up Saturday" program that encourages the public to remove rubbish and debris from their residence. This program was in effect prior to RWQCB requirements and has been successful.

11. The City has a greenwaste recycling program ONLY.

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12. The City participates in the Countywide household hazardous waste management program. Methods for ensuring proper disposal include public education via newspaper, clean-up campaign fliers and information inserted in the monthly trash bill.

13. A voluntary water conservation program exists in the City. Inserts are inserted in monthly water bill encouraging conservation and conservation kits are given to customers. The City plans to inform the public in the future with newspaper and newsletter articles.

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SUMMARY
STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF WEST HOLLYWOOD

City of West Hollywood: Phase I Co-Permittee
Population (1994): 37,050
Land Area: 1.981 sq. mi.

West Hollywood is located approximately 10 miles northwest of downtown Los Angeles. In 1994 it ranked 48th in population in Los Angeles County, and in terms of persons per square mile, West Hollywood is one of the most densely populated communities in California. The City's land uses can be characterized by a mixture of high density apartments/condominiums, entertainment and service related job base and light manufacturing. In 1990 the median family income was $33,657.

1. The City has stenciled 350 catch basins with the Heal the Bay design. In conjunction with the stenciling the City hosted "Storm Water Awareness Week" to draw attention to storm water issues.

2. A phone line has been established for reporting of illegal dumping. 24 hour per day emergency clean-up is provided though contract with Consolidated Waste Industries. 4 reports have been received.

3. The City adopted zoning ordinance amendments (ORD. 334) to prohibit non-storm water/urban runoff discharges without NPDES permit. Standard development permit conditions have been revised and require plans for management of water discharges during construction, and placement of dumpsters and construction equipment.

4. The public awareness program for the City includes: distribution of door hanger notices, Heal the Bay brochures, articles in newsletters, and Storm Water Awareness Week.

5. Catch basins are cleaned at least annually with those with especially significant debris accumulation cleaned every other week. This includes storm drain basins owned by the City of Los Angeles which have been ignored.

6. Approximately 150 roadside trash receptacles are placed on commercial streets and pedestrian areas Citywide. They are emptied up to 5 times per week depending on volume.

7. 93 curb miles of street are swept weekly. (Sunset and Santa Monica Blvds. are swept 3 times per week).

8. City municipal code prohibits: improper disposal of litter and lawn/garden and pet wastes, and leaf blowers. Code enforcement staff and public works inspectors have authority to issue citations.

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9. City contracts with L.A. County public works for industrial waste permit inspection. Facilities (including auto body, repair and parts shops, gas stations, restaurants, car washes, dry cleaners hotel and supermarkets) are inspected at least once per year.

10. The City has an aggressive code enforcement program to encourage the public to keep rubbish and debris off sidewalks and alleys. The City has informed the public of the need to clear debris, rubbish and dirt from sidewalks and alleys in the Neighborhood Watch newsletter and on a door-hang tag distributed to residents.

11. The recycling program has diverted 18% of rubbish from landfills. It is expected that starting in fiscal year 94-95 increased levels of recycling will occur. Commercial properties will also be included.

12. City code enforcement staff have been trained to issue citations for violation of disposal regulations.

13. City has adopted water conservation ordinances requiring low flow fixtures and drought tolerant landscaping on all new development. An outreach program has been initiated to alert the public to issues/hazards of runoff from excess use of water.

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SUMMARY
STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF WESTLAKE VILLAGE

City of Westlake Village: Phase I Co-Permittee
Population (1994): 7,650
Land Area: 5.43 sq. mi.

Westlake Village is located on the western edge of Los Angeles County, 35 miles from downtown Los Angeles and bordering Ventura County. The 101 Freeway passes through the northern portion of Westlake Village, which was incorporated in 1981. The City is known for its lake, waterfront residences and pleasant climate. Although a small community, there is a large job base with over half the jobs in manufacturing and services. Median family income was $79,976 in 1989.

1. Working with the City of Thousand Oaks and Ventura County Flood Control District, the City has begun stenciling catch basins with a customized design. City staff and volunteers have coordinated efforts. The first event, conducted in July 1994, resulted in the stenciling over 80 basins. The remainder of catch basins were stenciled on September 10, 1994.

2. Public reporting of illegal dumping has been encouraged through use of door hangers and magnets, as well as newspaper articles on clean water. Possible school outreach program is suggested as a way to encourage reporting. Door hangers and refrigerator magnets with 800-hotline number encourage reporting.

3. Based on current City policy, erosion control and post-development pollution controls are implemented by staff. City plans to adopt an ordinance (summer 1994) to give greater police power related to urban runoff control.

4. Public education programs, including newspaper articles, newsletters, and door hangers have been undertaken, and all residents have been reached by at least one. The City has spear-headed a task force of the five local cities to take a regional approach to public outreach and general NPDES compliance.

5. 95% of the storm drains in the City are maintained and cleaned annually by the County. Remaining drains are cleaned by the County via a service contract.

6. No roadside trash receptacles are provided. There are receptacles in City parks which are emptied daily.

7. 35 curb miles are swept bi-weekly (weekly in autumn). The City has modified its sweeping program by posting selected streets as no parking.

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8. Improper disposal of lawn clippings is prohibited by requiring City landscape contractors to pick up all green waste.

9. Non-storm water discharges are subject to an inspection and reporting program by public works staff. County waste management staff inspects some other businesses. The City is coordinating with the County to expand inspections. This expanded service should be implemented by the end of 1994.

10. Outreach to encourage removal of dirt, rubbish and debris from sidewalks and alleys is via newspaper and newsletter articles and door hangers.

11. The recycling program has resulted in 25% of rubbish being diverted from landfills. Press releases, newsletters and coordination with Homeowners associations has been part of this program.

12. The City participates in the Countywide household hazardous waste management program and aggressively promotes "roundups" at the Calabasas landfill.

13. The problem of overwatering has been addressed in the education program implemented by the City, and will continue to be a component. The City and Water District are currently preparing a reclaimed water conservation program addressing irrigation watering.

14. ADDITIONAL BMP'S

A. The City, working with L.A. County Flood Maintenance Division and the County Waste Management Division constructed a oil boom and debris fence across Lindero flood control channel. By measuring the quantity of materials removed, the City can gauge the magnitude of urban runoff pollution.

B. The City prepared a specific Storm Water Quality Management Plan which was completed in December 1993.

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SUMMARY
STORMWATER/URBAN RUNOFF PROGRAMS QUESTIONNAIRE

CITY OF WHITTIER

City of Whittier: Phase III Co-Permittee
Population (1994): 80,600
Land Area: 12.40 sq. mi.

Located almost 15 miles southeast of downtown Los Angeles, Whittier is just east of the 605 Freeway. Incorporated in 1898, the City is the 21st most populous City in the County with a large job base. Services and retail trade account for over half of all employment. Median family income was $44,224 in 1989.

1. The City has stenciled 55 of its catch basins so far with the Heal the Bay design and plans to stencil the others as well. Volunteer groups did the application.

2. The City has not implemented any programs to encourage public reporting of illegal dumping but suggested that a reward system would encourage public reporting.

3. Two water conservation ordinances (one apparently a modification of the first) have been adopted and the City feels they have been effective in reducing pollutants in runoff.

4. No public education programs have been implemented.

5. The catch basins in the City are shoveled out annually and the City also responds to requests for cleaning. This program has removed a lot of debris that would have entered the storm drain system.

6. Thirty roadside trash receptacles have been provided. They are emptied weekly unless in problem litter areas where frequency of collection has been increased.

7. 456 curb miles are swept on either a weekly (residential and industrial) or bi-weekly (commercial) schedule.

8. City ordinances discourage the improper disposal of litter, lawn clippings, and pet waste. The City also intends to promote these good housekeeping practices into its runoff pollution prevention public education program.

9. The Sanitation District of Los Angeles County provides industrial waste inspection program. The scope of its industrial waste water inspection program includes all industrial and commercial facilities that handle, store, and dispose of significant materials.

10. The City has not implemented a public education/outreach program to encourage the public to remove dirt, rubbish, and debris from sidewalks and alleys. However, these practices are required by ordinance and enforced by code enforcement.

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During FY 1994-95, the City plans to promote these good housekeeping BMPs as part of its comprehensive storm water/runoff pollution prevention public education/outreach program.

11. The City recycling program includes ten recycling centers where residents can drop off recyclables. Residents are encouraged to recycle through the City's well-developed public education program (newsletter and newspaper articles, door-to-door neighborhood recycling education campaign, and community events). City also encourages commercial facilities to require their refuse collection companies to recycle a variety of waste products. City's landfill diversion rate is approximately 17%.

12. The City participates in the County's hazardous waste management program and also provides oil collection facilities.

13. Residents are encouraged to conserve water by not washing down sidewalks or driveways. The public is informed of the sediments carried to the drainage system through a handout sent with water bill.

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REPORT OF WASTE DISCHARGE

VOLUME 1

SECTION (B)

SUMMARY AND EVALUATION OF BASELINE BMPs

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BMP 1: STENCIL CATCH BASINS

LEVEL OF IMPLEMENTATION	NUMBER OF JURISDICTIONS	PERCENTAGE
FULLY IMPLEMENTED	23	26.14
PARTIALLY IMPLEMENTED	13	14.77
PLANNED/PROPOSED	44	50.00
NOT IMPLEMENTED	7	7.95
NO CITY RESPONSE/NOT APPLICABLE	1	1.14
TOTALS	88	100.00

BMP DESCRIPTION AND PURPOSE:

Anything that is thrown or dumped on an impervious surface or directly into the catch basins will be washed down a gutter with the next rain, into a storm drain and the receiving water such as streams, lake or the ocean. The objective of this BMP is to remind the general public that any material that they place on the ground in such a way that it will be washed into the storm drain system will be deposited via stormwater, untreated, into the ocean. Eye-catching signs, painted on paving adjacent to storm drains or posted nearby, should be frequent reminders to the public of their responsibility to keep pollutants out of the storm drain system.

Short term BMP compliance requires stenciling of all high debris collecting catch basins; the long term goal is to stencil all catch basins.

ELEMENTS AND HIGHLIGHTS OF IMPLEMENTATION:

This program is the clearest of all BMP's to implement and measure--as a long-term goal, all storm drains are to have the same design developed by "Heal the Bay" and the City of Los Angeles or similar stencil painted near each drain, visible to the public.

Storm drain stenciling is a reasonably inexpensive program, for which many cities have used volunteer labor. Some cities have contracted with the County or outside vendors to provide stenciling of their catch basin.

Most jurisdictions have either completed their stenciling program or plan to have it completed shortly. While most use a stencil design developed by "Heal the Bay", some have designed their own--such as "Rain Water Only". There is a potential for both pedestrian and motor vehicle passengers to view such signs, and some cities have chosen to place the sign on the curb face so that it can be seen directly from the street. Standard paint seems to be wearing off rather quickly.

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Very few cities have chosen not to participate at all in this BMP. Of those few cities that show no indication of participating in this program, cited as reasons are cost, lack of stencil durability, ineffectiveness and the opinion that the stencils are a form of graffiti.

EFFECTIVENESS:

This is a public education program with indirect program effectiveness. While no measure of pollution reduction can be directly attributed to this program, several co-permittees have stated its value as a public outreach technique. The program is relatively inexpensive, although the stencils are likely to fade quickly and need repainting.

SUGGESTED MODIFICATIONS:

This BMP is labor intensive; several jurisdictions recommended using a high quality, water resistant paint to prolong the readable life of the stenciling. Some jurisdictions are using a horizontal-format stencil that can be applied to the curb face; the stencil could be read by passing motorists.

EVALUATION:

While this BMP has been or will soon be completed by a large majority of jurisdictions, it is not an active-involvement type of program with directly measurable results; its level of effectiveness is unknown.

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BMP 2: PUBLIC REPORTING PROGRAMS

LEVEL OF IMPLEMENTATION	NUMBER OF JURISDICTIONS	PERCENTAGE
FULLY IMPLEMENTED	55	62.50
PARTIALLY IMPLEMENTED	11	12.50
PLANNED/PROPOSED	11	12.50
NOT IMPLEMENTED	10	11.36
NO CITY RESPONSE/NOT APPLICABLE	1	1.14
TOTALS	88	100.00

BMP DESCRIPTION AND PURPOSE:

Individuals may be unaware, or unconcerned, that illegal dumping or discharges into the storm drain system is a serious problem. The purpose of this BMP is to encourage the public to report instances of illegal dumping, to allow for clean up and, if possible, identification of the violator. Establishment of reporting hotlines, along with promotion of these phone numbers should cut down on the incidence of illegal dumping.

Short term minimum compliance is simply the establishment of a countywide hotline which has already been done, plus development of programs to promote it. The long term goal is to incorporate the hotline as part of a comprehensive public outreach and education program.

ELEMENTS AND HIGHLIGHTS OF IMPLEMENTATION:

The majority of jurisdictions provide at least some information to the public on the availability of the County hotline number for the reporting of illegal discharges/dumping. Few jurisdictions indicated that they had established a separate phone number exclusively for such reporting, though many stated that their fire, police, or public works departments could be used to make a report. Some of the larger jurisdictions, however, have established their own hotlines and have extensive public outreach programs. A few jurisdictions send follow-up letters to violators. One small city provides a cash award for the reporting of violators.

Publicity has taken several forms; many cities--especially the smaller jurisdictions--use their newsletters to inform the public of the County hotline and any city reporting services. Other popular methods of disseminating information include: local newspaper articles, distribution of brochures to residents and businesses, cable television public service announcements, and in a few cases, community meetings and educational programs in local schools.

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BMP 2: PUBLIC REPORTING PROGRAMS--Page 2

EFFECTIVENESS:

In general, relatively few reportings have been received. In some instances this is due to the newness of the city programs and the lack of a tracking system. Obviously, larger jurisdictions have received a greater number of reports. The city with the anonymous cash award program has received a relatively large number of reports.

SUGGESTED MODIFICATIONS:

Several suggestions were made by various agencies on increasing the effectiveness of this measure. To increase awareness of the need for public reporting, handouts could be given at the County Fair, the public could be informed of the NPDES goals and what they can do to achieve them, a reporting system through local schools could be established and a "WE TIP" compensation system could be implemented.

EVALUATION:

The reporting hotline is an easy to establish measure that, if effective, could have a significant impact on the amount of materials illegally dumped. However, based on the few reportings so far, this BMP is not yet very useful. The publicity aspect of this program does not appear to be extensively implemented.

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BMP 3: ADOPT RUNOFF CONTROL ORDINANCE

LEVEL OF IMPLEMENTATION	NUMBER OF JURISDICTIONS	PERCENTAGE
FULLY IMPLEMENTED	44	50.00
PARTIALLY IMPLEMENTED	12	13.64
PLANNED/PROPOSED	21	23.86
NOT IMPLEMENTED	10	11.36
NO CITY RESPONSE/NOT APPLICABLE	1	1.14
TOTALS	88	100.00

BMP DESCRIPTION AND PURPOSE:

Surface runoff from construction sites and urbanized areas carries sediments, waste materials and/or other contaminants to the drainage system. To mitigate this problem, ordinances and or/policies for both new and existing developments must be adopted which will result in the reduction of pollutants found in urban runoff.

Short term minimum compliance constitutes the identification and/or the modification of existing codes or policies to achieve reduction of pollutants in urban runoff. The long term goal is to develop new ordinances and/or policies as needed, enforce ordinances/policies and prosecute violators.

ELEMENTS AND HIGHLIGHTS OF IMPLEMENTATION:

Half of the permittees have adopted or modified codes/policies to improve runoff quality. Components of these ordinances include erosion controls, industrial runoff controls, prohibitions on excessive irrigation, dust control, inspections of illegal discharges, enforcement and penalties.

Approximately 20% of the permittees are in the process of developing ordinances to control urban runoff. Some have indicated that the Model Runoff Control Ordinance developed by a consortium of permittees will be used and tailored to the needs of the individual jurisdiction.

Ten jurisdictions have not implemented nor indicated any intention to initiate work on an ordinance.

EFFECTIVENESS:

Most cities indicate that the ordinances they have adopted provide the legal authority to regulate illegal actions and prosecute violators. These ordinances are also effective in reducing runoff/erosion--especially in hillside areas. Others feel that educating the public and, in many cases, the applicant should be the emphasis; this has not been done.

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Finally, some respondents cannot determine effectiveness because no comparative data is available; also, it is too premature to make such judgments.

SUGGESTED MODIFICATIONS:

A few cities presented ideas intended to improve effectiveness. These include the development of a stormwater ordinance consolidating all legal authority to control stormwater quality and drainage, erosion controls to cover all building sites and the improvement of enforcement.

EVALUATION:

While this BMP has been implemented by 50% of the permittees, ordinance provisions seem to be different from city to city, and therefore not all aspects of urban runoff are addressed in the legislation. As with any other ordinance, enforcement is the key element in ensuring effective implementation.

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BMP 4: DEVELOP PUBLIC EDUCATION AND OUTREACH PROGRAMS

LEVEL OF IMPLEMENTATION	NUMBER OF JURISDICTIONS	PERCENTAGE
FULLY IMPLEMENTED	36	40.91
PARTIALLY IMPLEMENTED	16	18.18
PLANNED/PROPOSED	27	30.68
NOT IMPLEMENTED	8	9.09
NO CITY RESPONSE/NOT APPLICABLE	1	1.13
TOTALS	88	100.00

BMP DESCRIPTION AND PURPOSE:

The public, for the most part, is unaware that anything that enters the storm drain system goes untreated, directly into the ocean. A public outreach campaign would help educate the public about the function of the storm drain system and how residents can reduce non-point pollution at its source.

Short term minimum compliance includes articles in city newsletters to inform the general public, while the long term goal is to establish a comprehensive public outreach and education program.

ELEMENTS AND HIGHLIGHTS OF IMPLEMENTATION:

Two out of five respondents have fully implemented this BMP. Numerous methods are used to inform the public on ways to help keep the storm drain system free of pollutants. These include:

- Mailers, flyers, brochures, pamphlets, handouts, city newsletters, door hangers, utility bill inserts and information packets to downtown businesses.
- Radio and newspaper advertisements, press releases, movie theater previews, cable television announcements, and videos.
- City sponsored events and expos, school programs, block watch meetings, and stormwater awareness week.
- Neighborhood Gutter Patrol programs.
- Billboards, street banners, signs on beach receptacles, bus shelter posters and library displays.
- Appointment of public outreach coordinator.

Approximately one third of the respondents indicated that a public outreach program is being planned/proposed during the current Fiscal Year. Ten percent of the permittees have not, nor indicated that they will, implement this BMP.

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EFFECTIVENESS:

Outreach and education regarding stormwater pollution is a continuous process. Most cities are unable to quantify the success of the public outreach program; effectiveness is difficult to gauge and there is insufficient data. A few cities believe that public outreach is effective because it raises awareness of the issue and expect that the public will respond well.

SUGGESTED MODIFICATIONS:

Suggested modifications and additions to BMP No. 4 include more of a coordinated countywide message, the combination of educational information on discharges with water conservation, especially at school presentations, bilingual educational materials and surveys to determine effectiveness.

EVALUATION:

Almost two-thirds of the permittees have not yet implemented a public outreach program. An initial program consists of articles in the city newsletter and one or more brochures or pamphlets available at City Hall and/or other public places. If established by all permittees, this relatively inexpensive program could provide measurable results.

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BMP 5: CLEAN CATCH BASINS REGULARLY

LEVEL OF IMPLEMENTATION	NUMBER OF JURISDICTIONS	PERCENTAGE
FULLY IMPLEMENTED	79	89.77
PARTIALLY IMPLEMENTED	7	7.95
PLANNED/PROPOSED	1	1.14
NOT IMPLEMENTED	0	0.00
NO CITY RESPONSE/NOT APPLICABLE	1	1.14
TOTAL	88	100.00

BMP DESCRIPTION AND PURPOSE:

Dirt and debris that accumulate in catch basins is flushed down the storm drain system directly into the ocean. Regular cleaning of catch basins removes the debris, preventing it from reaching the ocean. The most effective time to perform the cleaning is just before the heavy rainy season begins in the fall.

Short term compliance is to make sure that catch basins are cleaned at least yearly; long term refinements includes evaluating the effectiveness of the cleaning program and making appropriate changes.

ELEMENTS AND HIGHLIGHTS OF IMPLEMENTATION:

Nearly all jurisdictions have implemented at least annual cleaning of their catch basins. Those who do not clean their catch basins on a regular schedule clean them "as needed", either in response to requests or when the amount of debris reaches a certain level. Less than yearly cleaning is generally due to budget constraints.

EFFECTIVENESS:

Overwhelmingly, cities feel that this program is effective. Estimates on the amount of debris removed from catch basins--which is prevented from being conveyed to the ocean--range up to 80 tons per year. Cities with more frequent street sweeping find that less debris accumulates in catch basins.

SUGGESTED MODIFICATIONS:

No specific suggestions are offered for modifications to this BMP.

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EVALUATION:

An at least annual catch basin cleaning program has been implemented by the majority of jurisdictions; most of them have stated that they find the program effective. Although only a few cities actually estimated total debris removed, it appears that the amount is substantial. A few cities indicated that they were developing a monitoring system.

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BMP 6: INCREASE ROADSIDE TRASH RECEPTACLE USAGE

LEVEL OF IMPLEMENTATION	NUMBER OF JURISDICTIONS	PERCENTAGE
FULLY IMPLEMENTED	61	69.32
PARTIALLY IMPLEMENTED	16	18.18
PLANNED/PROPOSED	2	2.27
NOT IMPLEMENTED	3	3.41
NO CITY RESPONSE/NOT APPLICABLE	6	6.82
TOTALS	88	100.00

BMP DESCRIPTION AND PURPOSE:

The more convenient it is to properly dispose of litter, the less trash there will be that is tossed on the ground to end up in the storm drain system. The convenient placement of trash receptacles encourages proper waste disposal. To be most effective, receptacles should be emptied often enough to prevent overflowing. This BMP encourages the placement and use of public trash receptacles, and includes program evaluation to determine if more frequent emptying or placement of additional receptacles are needed.

The BMP short term goal is to monitor litter prone areas and evaluate the need for additional receptacles and/or more frequent emptying of existing receptacles. The long term goal is to provide adequate trash receptacles and emptying program throughout the jurisdiction.

ELEMENTS AND HIGHLIGHTS OF IMPLEMENTATION:

Most jurisdictions provide and maintain trash receptacles in major commercial areas, parks, at bus stops and other places of public gathering. Most programs provide for emptying of receptacles at least weekly; some are emptied as often as twice per day. A few smaller cities--especially those that are predominantly residential--do not have public receptacles, but do generally provide for street clean-up.

"Overflow" problems may be encountered on weekends and for special events; for special events most jurisdictions either provide additional temporary receptacles or empty the existing ones on a more frequent basis. Where another jurisdiction has responsibility--such as Caltrans along State highways, that agency provides the service where needed. A relatively minor problem may arise in areas where scavengers tend to scatter trash. Bus stops were occasionally mentioned as areas prone to littering.

Equally effective to public receptacles are those provided and emptied privately by selected commercial uses such as drive-through fast food restaurants or shopping centers. Some jurisdictions require the placement and maintenance of receptacles as part of their commercial permit approvals.

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BMP 6: INCREASE ROADSIDE TRASH RECEPTACLE USAGE--Page 2

EFFECTIVENESS:

This BMP is at least partially implemented by over 80% of all jurisdictions. There was no mention of debris problems arising in areas due to lack of public trash receptacles. Assuming that without convenient receptacles that much of the trash collected would wind up on the ground, this BMP is clearly a cost-efficient way of keeping debris out of the storm drain system.

SUGGESTED MODIFICATIONS:

A recommended modification is to provide recycling containers adjacent to receptacles used for general, non-recyclable trash. While most jurisdictions use city staff to empty the receptacles, it may be more cost effective to have the city's refuse pick-up service empty the receptacles on their regular routes; if adjacent cities use the same refuse service, a coordinated program could be even more cost-effective.

EVALUATION:

This BMP is well received, implemented and effective in keeping large quantities of debris out of the storm drain system.

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BMP 7: INCREASED STREET SWEEPING

LEVEL OF IMPLEMENTATION	NUMBER OF JURISDICTIONS	PERCENTAGE
FULLY IMPLEMENTED	84	95.45
PARTIALLY IMPLEMENTED	1	1.14
PLANNED/PROPOSED	0	0.00
NOT IMPLEMENTED	1	1.14
NO CITY RESPONSE/NOT APPLICABLE	2	2.27
TOTALS	88	100.00

BMP DESCRIPTION AND PURPOSE:

Dirt and debris accumulate in the streets and gutters and, if not removed, eventually enter the storm drain system. Regular street sweeping helps reduce the amount of such dirt and debris from entering the system.

The short range, minimum compliance objective of this BMP is to sweep all streets within the jurisdiction at least once per month, monitored for maximum effectiveness and practicality. The long term goal is to increase sweeping, if warranted.

ELEMENTS AND HIGHLIGHTS OF IMPLEMENTATION:

This BMP has one of the highest percentages of full implementation. Cities that have not implemented at least monthly sweeping are rural communities with privately maintained streets, generally without curbs and gutters. Both broom and vacuum sweepers are used, though broom sweepers are more prevalent. Commercial streets are generally swept more frequently--in several jurisdictions even daily--than either residential or industrial streets. A few jurisdictions indicated that in areas that experience frequent dumping or excessive litter, sweeping frequency has been increased.

EFFECTIVENESS:

This is a highly effective program for removing debris which would otherwise eventually end up in the drainage system. A number of cities mentioned that their street sweeping program is important because it promotes the image of a "clean" city. A few cities are planning an analysis and monitoring program to determine program effectiveness.

SUGGESTED MODIFICATIONS:

No specific modifications were offered for enhancing this program.

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BMP 7: INCREASED STREET SWEEPING--Page 2

EVALUATION:

This program is effective and prevents a substantial amount of debris from entering the drainage system. The majority of cities have long-established sweeping programs; only a few have increased the frequency of sweeping in response to RWQCB requirements.

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BMP 8: DISCOURAGE IMPROPER DISPOSAL OF LITTER, LAWN CLIPPINGS AND PET FECES

LEVEL OF IMPLEMENTATION	NUMBER OF JURISDICTIONS	PERCENTAGE
FULLY IMPLEMENTED	26	29.55
PARTIALLY IMPLEMENTED	43	48.86
PLANNED/PROPOSED	9	10.23
NOT IMPLEMENTED	9	10.23
NO CITY RESPONSE/NOT APPLICABLE	1	1.14
TOTALS	88	100.00

BMP DESCRIPTION AND PURPOSE:

The public is generally unaware that anything discharged into the storm drain system goes untreated directly into the ocean. In order to raise public awareness and to achieve implementation and enforcement of current regulations of disposal practices, the public needs to become acquainted with the problems associated with illegal dumping.

Short term minimum compliance consists of articles in city newsletters informing the public of the problem of illegal discharges. The long term goal is to establish a comprehensive public outreach and education program.

ELEMENTS AND HIGHLIGHTS OF IMPLEMENTATION:

Most respondents indicate that they discourage the improper disposal of litter, lawn clippings and pet feces through City codes. In several jurisdictions the County's codes covering this subject have been adopted by reference. These codes include penalties for non-compliance.

A few respondents--one out of five--have also implemented a public outreach effort in conjunction with municipal code requirements. The typical public outreach includes brochures in utility bills, articles in City newsletters, cable television, handouts and highway signs.

Almost half of the permittees have partially implemented this BMP. 10% indicated plans to implement the program in the near future, while another 10% did not indicate any plans for implementation.

EFFECTIVENESS:

It appears that the legal authority, including penalties, to discourage improper disposals has been established within most jurisdictions. However, public education and outreach is an important element of this measure and therefore should be established concurrently; in this respect most permittees have faltered. There is no direct measure of debris collected as a BMP

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result of this indirect, public education/awareness program. Its impact overlaps with other programs such as recycling and roadside trash receptacles.

Full implementation of this BMP seems to be relatively inexpensive. The educational value and public awareness could have very positive results.

SUGGESTED MODIFICATIONS:

Suggested new programs and modifications to existing ones include:
- "Adopt a Street Program" to discourage improper litter disposal.
- Recycling programs which will render easier compliance with program.
- "No Dumping" Highway signs.
- Separate collection of green waste.

EVALUATION:

This BMP is relatively inexpensive to implement through ordinance adoption and public education and outreach. Nevertheless, only a small percentage of permittees have taken steps to implement the BMP fully.

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BMP 9: INSPECT AUTOMOBILE USES AND RESTAURANTS

LEVEL OF IMPLEMENTATION	NUMBER OF JURISDICTIONS	PERCENTAGE
FULLY IMPLEMENTED	45	51.14
PARTIALLY IMPLEMENTED	21	23.86
PLANNED/PROPOSED	14	15.91
NOT IMPLEMENTED	3	3.41
NO CITY RESPONSE/NOT APPLICABLE	5	5.68
TOTALS	88	100.00

BMP DESCRIPTION AND PURPOSE:

Auto parts, stores repair and body shops, gasoline stations, and restaurants generate waste materials that require proper disposal--a cost factor to the operation. Such facilities are generally inspected for their overall operations. Part of that inspection program should focus on the prevention of discharges of chemicals or other toxic materials or debris into the storm drain system. Inspection and enforcement require enactment of implementing ordinances.

Short term minimum compliance with this BMP includes incorporation of inspection of facilities for storm water concerns into existing industrial waste inspection programs. The long term goal is to develop a regular inspection program for industrial and related facilities, and to prosecute violators.

ELEMENTS AND HIGHLIGHTS OF IMPLEMENTATION:

While this BMP can be directly effective in preventing illegal or accidental discharges from industrial and related uses into the storm drain system, less than half of all jurisdictions have fully implemented this program by conducting regular inspections. Several others, however, have partially implemented the program by inspecting on an "as needed" or "complaint" basis. Many of the cities have adopted the County's regulating ordinances. The majority of the implementing cities contract with the County to administer the inspection program.

Of those jurisdictions that do not have an inspection program, some cite the costs involved, while others are basically residential cities and have no need for such a program.

EFFECTIVENESS:

In those jurisdictions with inspection programs, the mere knowledge that inspections will occur on a regular basis is a significant deterrent to would-be polluters--especially if the implementing ordinances incorporate violation penalties. This program provides direct interception in the process of illegal pollutant discharge. For those jurisdictions that provided data, typically about 10% of the inspections detected non-compliance conditions.

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BMP 9: INSPECT AUTOMOBILE USES AND RESTAURANTS--Page 2

SUGGESTED MODIFICATIONS:

Cost efficiencies are possible when a single inspection is able to consider multiple impact areas; potential pollution to the storm drain system should be directly considered when inspecting for industrial-type use operations. Smaller cities, especially, will likely find that it is more cost effective to contract with the County or a private agency for this service, rather than hire a full time specialist.

EVALUATION:

This program that has the potential to directly intervene in the discharge of toxics into the storm drain system is only partially implemented. The implementation that is occurring is preventing such products as gasoline, lubricants, motor oil and used cooking oil from polluting the ocean.

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BMP 10: ENCOURAGE REMOVAL OF DIRT, RUBBISH AND DEBRIS FROM SIDEWALKS AND ALLEYS

LEVEL OF IMPLEMENTATION	NUMBER OF JURISDICTIONS	PERCENTAGE
FULLY IMPLEMENTED	20	22.73
PARTIALLY IMPLEMENTED	31	35.23
PLANNED/PROPOSED	17	19.32
NOT IMPLEMENTED	17	19.32
NO CITY RESPONSE/NOT APPLICABLE	3	4.55
TOTALS	88	100.00

BMP DESCRIPTION AND PURPOSE:

Dirt, rubbish and debris left on sidewalks and alleys are washed into the street and into the storm drain system. An outreach and education program as to how the public can reduce non-point pollution at its sources should be established.

Short term minimum compliance consists of articles in city newsletters to inform the general public about this problem and encourage the removal of dirt, rubbish and debris from sidewalks and alleys. A long term goal for this BMP is the establishment of a comprehensive public outreach and education program.

ELEMENTS AND HIGHLIGHTS OF IMPLEMENTATION:

Approximately 23% of the respondents have fully implemented this BMP by disseminating information to the public regarding the removal of debris, and litter from sidewalks and alleys. Another 23% of the respondents did not indicate city implementation plans for this BMP.

Permittee responses for public education and outreach include the use of brochures, newsletters, door hangers, water bill inserts, cable television, and hot line for reporting debris accumulation or improper disposal. Some jurisdictions promote and conduct "Clean Up Days", "Clean-Up Saturdays, annual or bi-annual clean-ups. In some case volunteers, such as students or residents clean litter and debris from sidewalks and alleys.

Ordinances are in place in some cities, and penalties included to require owners to maintain areas adjacent to their properties. A few responses noted the frequency of alley cleaning or the vacuuming of problem sidewalk areas.

EFFECTIVENESS:

Public education and outreach is the primary objective of this BMP. Twenty-three percent of the permittees have implemented this relatively inexpensive public education/outreach-oriented program. As some of the respondents indicated, the effectiveness of public

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education/outreach is difficult to measure. However, it is generally agreed that raising public awareness is beneficial in the long range.

SUGGESTED MODIFICATIONS:

No specific or significant modifications have been offered for this BMP.

EVALUATION:

This BMP is relatively inexpensive to implement through public education and outreach. Since only a little over a fifth of the respondents have fully implemented education/outreach, an average rating is warranted.

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BMP 11: RECYCLING PROGRAM

LEVEL OF IMPLEMENTATION	NUMBER OF JURISDICTIONS	PERCENTAGE
FULLY IMPLEMENTED	64	72.73
PARTIALLY IMPLEMENTED	12	13.64
PLANNED/PROPOSED	7	7.95
NOT IMPLEMENTED	3	3.41
NO CITY RESPONSE/NOT APPLICABLE	2	2.27
TOTALS	88	100.00

BMP DESCRIPTION AND PURPOSE:

Material which is improperly disposed of may eventually enter the storm drain system. Encouraging citizens to recycle discarded products not only saves natural resources but also helps reduce the amount of material entering the drainage system. Recycling can also increase overall environmental awareness. Frequently recycled products include glass, plastic, aluminum and tin and newspapers and paper products. An increasing number of jurisdictions are providing for recycling of used motor oil and green waste.

Short term minimum compliance requires each permittee to have an active recycling program, which includes public education. The long term goal incorporates a comprehensive public outreach and education program.

ELEMENTS AND HIGHLIGHTS OF IMPLEMENTATION:

Most jurisdictions have implemented recycling program of some sort; curbside pick-up is usually, although not always, provided. In general, cities have established recycling programs in response to the requirements of AB939 and not exclusively in response to storm water/urban runoff concerns.

Outreach to publicize recycling is usually a part of the program; newsletter and newspaper articles, cable TV notices, brochures, handouts, school presentations and press releases are common methods. Estimates of the amount of rubbish being diverted from landfills range from 3% to 51%. Unique ideas to encourage recycling include refuse rate structure changes to make recycling cost-effective to residents; a recycler-of-the- month promotion, with one year free trash collection to the winner, is another incentive.

EFFECTIVENESS:

In most jurisdictions this program appears to be effective as a waste reduction measure. Though exact measurements were not given, most jurisdictions estimated at least a 10% reduction in materials being sent to landfills. This program will be more effective in the future as cities are required by AB939 to reduce landfill

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wastes even further. While landfill wastes are definitely reduced, the amount of material prevented from reaching the storm drain system due to this program has not been estimated.

SUGGESTED MODIFICATIONS:

Some jurisdictions feel that the addition of commercial/industrial recycling, composting programs and used oil drop off facilities are potential modifications which would increase the effectiveness of the recycling program. A few cities indicated that the modifications will soon be underway.

EVALUATION:

This program is highly effective in reducing the amount of materials currently being sent to landfills and will be even more effective in the future. However, it is not possible, or is at least very difficult, to quantify the degree to which this program prevents recyclable materials from entering the storm drain system. The effectiveness of this measure as a BMP is debatable.

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BMP 12: MOTIVATE RESIDENTS TO PROPERLY DISPOSE OF HOUSEHOLD HAZARDOUS WASTE

LEVEL OF IMPLEMENTATION	NUMBER OF JURISDICTIONS	PERCENTAGE
FULLY IMPLEMENTED	86	97.73
PARTIALLY IMPLEMENTED	0	0.00
PLANNED/PROPOSED	0	0.00
NOT IMPLEMENTED	0	0.00
NO CITY RESPONSE/NOT APPLICABLE	2	2.27
TOTALS	88	100.00

BMP DESCRIPTION AND PURPOSE:

Improper disposal of household hazardous waste materials such as paint-related products, motor oil, car batteries, pesticides and detergents results in pollution of storm drain water. The problem is both one of public education and the provision of proper disposal alternatives. This BMP is intended to ensure that proper disposal facilities are available to the public and that an outreach program be established to inform the public of the harm caused by improper disposal and of the availability of collection facilities.

Short term minimum compliance is to either establish a household hazardous waste roundup program or to participate in a regional program. The long term goal would add the establishment of a comprehensive public outreach and education program.

ELEMENTS AND HIGHLIGHTS OF IMPLEMENTATION:

Collection and disposal of hazardous wastes is a costly operation. The need for a convenient, cost efficient disposal program is not confined to city boundaries. In a cooperative effort, the County of Los Angeles sponsors hazardous waste "roundups" throughout the County for all residents, while the cities provide support by encouraging their residents to use these facilities. Nearly all cities participate by publicizing the program, with a few cities--generally the larger ones--holding "roundups" of their own.

In addition to the general collection of hazardous wastes, some jurisdictions provide for collection of used motor oil through agreements with auto parts stores and other private oil vendors.

Publicity for collection programs is often carried on local cable TV channels. Flyers in utility bills, posters and notices at point-of-sale are frequently-used public education techniques.

EFFECTIVENESS:

There are few options to the proper disposal of hazardous (generally liquid) wastes: a) dump into the sanitary sewer system,

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where it must then be processed at municipal treatment plants; b) discard in household trash, which is then placed in landfills where it may eventually contaminate groundwater or c) dump on the ground where it then may filter to, and contaminate, local groundwater or be washed into the storm drain system. The material collected at any of the facilities, then, would have otherwise contaminated groundwater or ocean water, or have been expensive to remove from liquid sewage. The "roundups"--the largest being Los Angeles County and City of Los Angeles--have collected large amounts of hazardous wastes from throughout the entire County. Publicity creating the impression that the roundups are "special opportunities" most likely helps to increase participation.

SUGGESTED MODIFICATIONS:

There are few suggestions for modifying this very effective BMP. Collection facilities are generally available, and there is extensive publicity about the need to properly dispose of hazardous wastes. Commercial TV could reach a greater audience, but at a much higher cost than the free services of cable channels. Since most people would avail themselves of collection facilities only infrequently, it would be helpful if disposal locations could be standardized throughout the County (all public facilities of a certain type or all private auto parts dealers, for example) so that there would be no need for someone to have to call to locate the nearest facility.

EVALUATION:

This BMP has widespread community support and is very effective in collecting household hazardous wastes. Even more could be done to publicize collection programs.

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BMP 13: ENCOURAGE WATER CONSERVATION

LEVEL OF IMPLEMENTATION	NUMBER OF JURISDICTIONS	PERCENTAGE
FULLY IMPLEMENTED	33	37.50
PARTIALLY IMPLEMENTED	35	39.77
PLANNED/PROPOSED	11	12.50
NOT IMPLEMENTED	7	7.95
NO CITY RESPONSE/NOT APPLICABLE	2	2.27
TOTALS	88	100.00

BMP DESCRIPTION AND PURPOSE:

Runoff from over-watering, washing sidewalks and cars, etc. carries sediments, waste materials and contaminants to the drainage system. Encouraging the proper use and conservation of outdoor water will prevent excessive runoff and the resultant negative impacts on storm water quality.

Short term minimum compliance includes the publication of articles in city newsletters for the general public. The long term goal would incorporate the establishment of a comprehensive public outreach and education program.

ELEMENTS AND HIGHLIGHTS OF IMPLEMENTATION:

Several cities have adopted ordinances to prevent excessive use of water--especially under drought conditions. While some of these regulations do prohibit washing sidewalks and cars, as well as restrictions on landscape watering, in general they are enforced only during droughts as a way to reduce water consumption. Some jurisdictions have restrictions on landscape watering of city-maintained properties, requirements for the installation of low flow equipment, guidelines for the use of drought tolerant plant species. Several jurisdictions mentioned that they use reclaimed water. The use of drought tolerant plants indirectly reduces runoff since less water is necessary. However, the use of reclaimed water, by itself, does not change the amount of runoff. It may adversely impact the quality of such runoff. Furthermore, low flow shower heads and toilets do not effect the storm drain system except by reducing the volume of sewage in the sanitary sewer line which could present an overflow in the event of line blockage or pump station breakdown.

The public is made aware of the importance of water conservation in a variety of ways. Education programs in schools, cable TV public access, city newsletters, and brochures are used by several cities. Other methods include an exterior audit of water usage and handouts with water bills which discuss costs savings for use reduction.

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BMP 13: ENCOURAGE WATER CONSERVATION--Page 2

EFFECTIVENESS:

Most of the water conservation programs discussed by the jurisdictions have the potential to reduce water usage and, indirectly, runoff. Very few actually address the problem of pollution prevention. Generally, reduced consumption is the goal. Another problem is that in non-drought situations it appears that enforcement of provisions is relaxed and cities simply "encourage" conservation rather than require it. Only a few cities have regulations that require a certain percentage use reduction.

SUGGESTED MODIFICATIONS:

The only modification suggested was to make existing voluntary programs mandatory, as they would be under drought conditions.

EVALUATION:

A reduction in water usage--particular outdoor use--has the potential to reduce runoff to the storm drain system. Presently, many of the conservation programs in effect have only indirect impact on runoff and are implemented in an effort to reduce water consumption only. Water conservation programs will have to be strengthened to have a significant effect on runoff.

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NPDES PERMIT NO. CA 0061654

TASK 5.2

REPORT OF WASTE DISCHARGE (ROWD)



VOLUME 2 OF 8 (TASK 5.2.5 - 5.2.6)

SANTA MONICA BAY -
MALIBU CREEK AND OTHER RURAL AREAS
STORMWATER MANAGEMENT PLAN

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SANTA MONICA BAY:
MALIBU CREEK AND OTHER RURAL AREAS
STORMWATER MANAGEMENT PLAN

INTRODUCTION

On June 18, 1990, the National Pollutant Discharge Elimination System (NPDES) Permit - Order #90-079, NPDES #CA0061654-CI6948 was issued to the County of Los Angeles and 17 cities tributary to Santa Monica Bay. During the subsequent years, two newly incorporated cities within the Santa Moncia Bay watershed, Caltrans, and the County of Ventura also became Co-Permittees. This Permit outlined a three-year program which required each Permittee to: characterize drainage areas; develop and schedule the implementation of Best Management Practices to enhance the quality of stormwater/urban runoff within its jurisdictional boundaries and storm drains it owns and operates. On July 1, 1992, 36 additional cities were initiated into the Permit and began their three-year program. By July 1, 1993, the remaining 30 cities in Los Angeles County within the drainage basin were initiated into their three-year program. The cities were grouped according to their starting dates and referred to as Phases I, II, and III respectively (See Table A). In general, the boundaries of each Phase did not encompass whole watersheds but portions of various watersheds (See Figure 1).

The Permit has a five year duration and although Phase III cities have only completed year one of their three year program, the Permit requires the submittal of a Report of Waste Discharge (ROWD) which serves as an application for a subsequent NPDES Permit to replace NPDES Permit #CA0061654, which will expire on June 18, 1995. Therefore, the County of Los Angeles, Ventura County, Caltrans, and the 85 cities are now parties to the subsequent NPDES Permit application utilizing the Municipal Stormwater Management Plan (herein after called the Plan) concept.

The Plan is based on the Stormwater Management Plan Components developed by the California Regional Water Quality Control Board, Los Angeles Region (Regional Board), and is proposed on behalf of the County of Los Angeles and the other participating agencies, see Table B. The Plan describes the stormwater management activities to be undertaken during the next single, five-year NPDES Municipal Stormwater Permit. The Plan involves the subdivision of the area of the County under a single, new Permit, into six watersheds, each with its own stormwater management plan. For these watersheds and the agencies in each of these watersheds, see Table B and Figure 2.

As required by the current Permit, all Permittees have proposed BMPs for their jurisdictions, described in Volume One and under prior submittals made to the Regional Board. These BMPs have already addressed many of the program areas discussed under the stormwater management plan. As required by the current Permit and continuing on under the new Permit, the Permittees will continue to implement these BMPs. This stormwater management plan will involve reorganizing the individual city-based BMP programs into a single stormwater plan for each watershed. The timeline shown in this document reflects the time needed for the transition from individual city-based programs to the preparation of a mutually agreed upon and collectively developed watershed plan by

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all parties of the new Permit for each of the watershed areas. The first step in beginning this process will be the reorganization of the current three-phase program into a new watershed based program. A reorganization of the Phases into watersheds which are based on hydrologic characteristics will allow for the consistent development and implementation of programs among Permittees, referencing land use and drainage infrastructure within their respective watersheds. Consistency of programs throughout the watershed will be beneficial in terms of targeting specific pollutant problems and areas.

This watershed is within the targeted area of the Santa Monica Bay Restoration Project (SMBRP), which was formed in 1988 when Santa Monica Bay was included in the National Estuary Program (NEP) as one of seventeen significant estuaries or coastal water bodies nationwide. The SMBRP has developed the Santa Monica Bay Restoration Plan, which identifies 74 Priority Actions to be implemented within the SMB Drainage Basin to improve the quality of Santa Monica Bay. The SMBRP has released its draft plan in April 1994 for public review, to be completed by the end of this year. Upon approval of U. S. Environmental Protection Agency, the State Water Resources Control Board, and other agencies, the priority actions discussed in the plan will be implemented by a variety of agencies and parties. Detailed development of the stormwater management plan for this watershed will incorporate those Priority Actions targeted for the improvement of stormwater/urban runoff quality.

This specific Plan will address the stormwater management issues for the Malibu Creek and Other Rural Areas watershed, which include the following cities and agencies:

- **Agoura Hills**
- **Calabasas**
- **Caltrans**
- **Los Angeles County**
- **Malibu**
- **Westlake Village**
- **Ventura County**

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TABLE A

Grouping of Permittees by Phases

PHASE I

Agoura Hills
Beverly Hills
Calabasas
Caltrans***
Culver City
El Segundo
Hermosa Beach
Inglewood
Los Angeles***
Los Angeles County***
Malibu
Manhattan Beach
Palos Verdes Estates
Rancho Palos Verdes
Redondo Beach
Rolling Hills
Rolling Hills Estates
Santa Monica
Torrance
Ventura County
West Hollywood
Westlake Village

PHASE II

Alhambra
Arcadia
Azusa
Baldwin Park
Bradbury
Burbank
Calabasas*
Caltrans***
Claremont
Covina
Diamond Bar
Duarte
El Monte
Glendale
Glendora
Hidden Hills
Industry
Irwindale
La Canada Flintridge
La Habra Heights
La Puente
La Verne
Los Angeles***
Los Angeles County***
Monrovia
Montebello
Monterey Park
Pasadena
Pomona
Rosemead
San Dimas
San Fernando
San Gabriel
San Marino
Sierra Madre
South El Monte
South Pasadena
Temple City
Walnut
West Covina

PHASE III

Alhambra**
Artesia
Bell
Bell Gardens
Bellflower
Caltrans***
Carson
Cerritos
Commerce
Compton
Cudahy
Downey
El Segundo*
Gardena
Glendale**
Hawaiian Gardens
Hawthorne
Huntington Park
Inglewood*
La Canada Flintridge**
La Habra Heights**
La Mirada
Lakewood
Lawndale
Lomita
Long Beach
Los Angeles***
Los Angeles County***
Lynwood
Maywood
Montebello**
Norwalk
Palos Verdes Estates*
Paramount
Pasadena**
Pico Rivera
Rancho Palos Verdes*
Redondo Beach*
Rolling Hills*
Rolling Hills Estates*
Santa Clarita
Santa Fe Springs
Signal Hill
South Gate
South Pasadena**
Torrance*
Vernon
Whittier

Note:
* The agency is also in Phase I.
** The agency is also in Phase II.
*** The agency is an all Phases.

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FIGURE 1

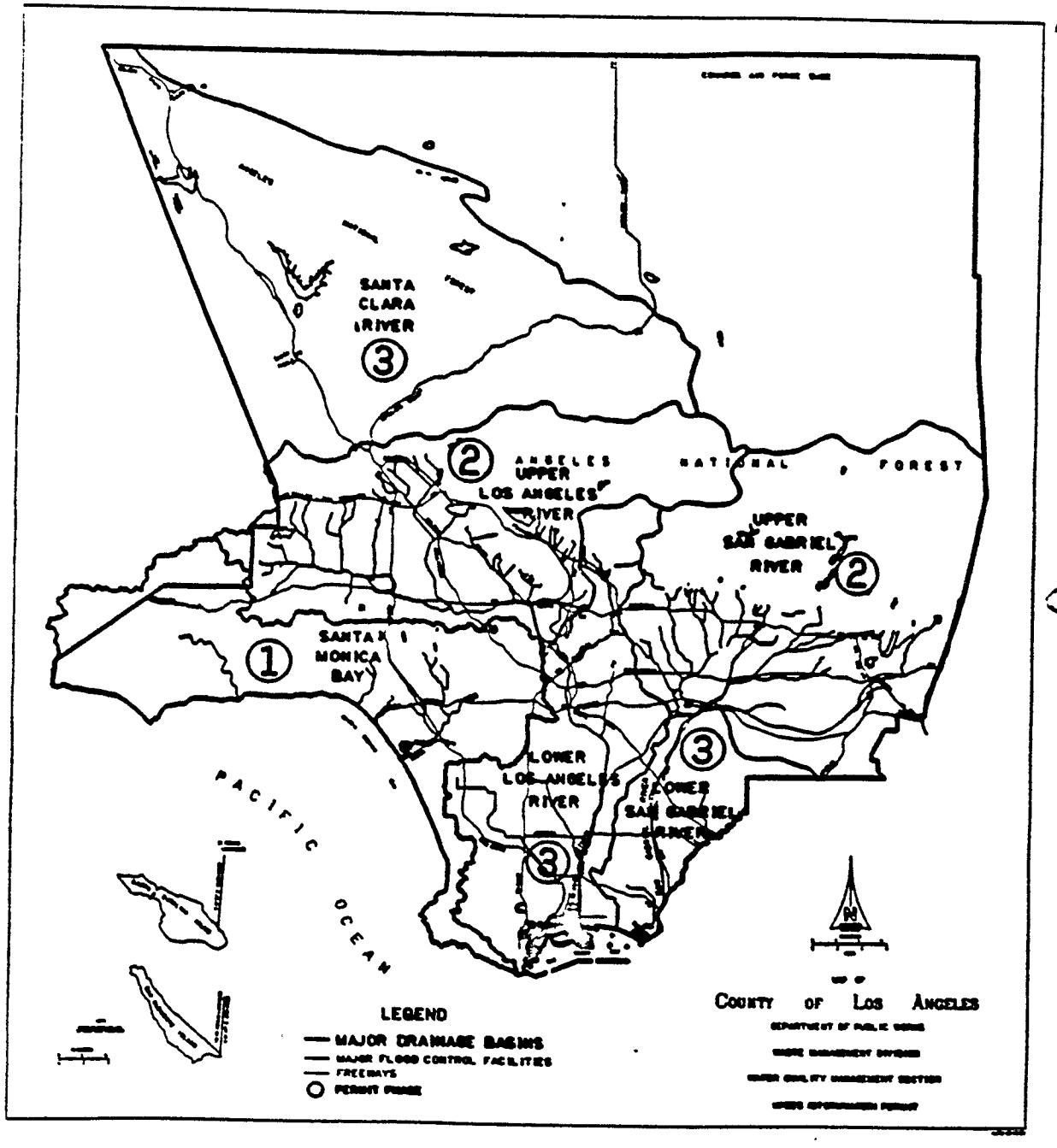

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TABLE B

NPDES Stormwater Permit Renewal
Proposed Watershed Breakup

Santa Monica Bay

Malibu Creek and Other Rural

Agoura Hills
Calabasas
Caltrans
Los Angeles County
Malibu
Westlake Village
Ventura County

Ballona Creek and Other Urban

Beverly Hills
Caltrans
Culver City
El Segundo
Hermosa Beach
Los Angeles
Los Angeles County
Manhattan Beach
Palos Verdes Estates
Rancho Palos Verdes
Redondo Beach
Rolling Hills
Rolling Hills Estates
Santa Monica
West Hollywood

Dominguez Channel/
Los Angeles Harbor Drainage

Caltrans
Carson
Gardena
Hawthorne
Inglewood
Lawndale
Lomita
Los Angeles
Los Angeles County
Torrance

Los Angeles River

Alhambra
Arcadia
Bell
Bell Gardens
Burbank
Caltrans
Commerce
Compton
Cudahy
El Monte
Glendale
Hidden Hills
Huntington Park
La Canada Flintridge
Long Beach
Los Angeles
Los Angeles County
Lynwood
Maywood
Monrovia
Montebello
Monterey Park
Paramount
Pasadena
Rosemead
San Fernando
San Gabriel
San Marino
Sierra Madre
Signal Hill
South El Monte
South Gate
South Pasadena
Temple City
Vernon

San Gabriel River

Artesia
Azusa
Baldwin Park
Bellflower
Bradbury
Caltrans
Cerritos
Claremont
Covina
Diamond Bar
Downey
Duarte
Glendora
Hawaiian Gardens
Industry
Irwindale
La Habra Heights
La Mirada
La Puente
La Verne
Lakewood
Long Beach
Los Angeles County
Norwalk
Pomona
Pico Rivera
San Dimas
Santa Fe Springs
Walnut
West Covina
Whittier

Santa Clara River

Caltrans
Los Angeles County
Santa Clarita

Italicized agencies are present in more than one watershed.

*

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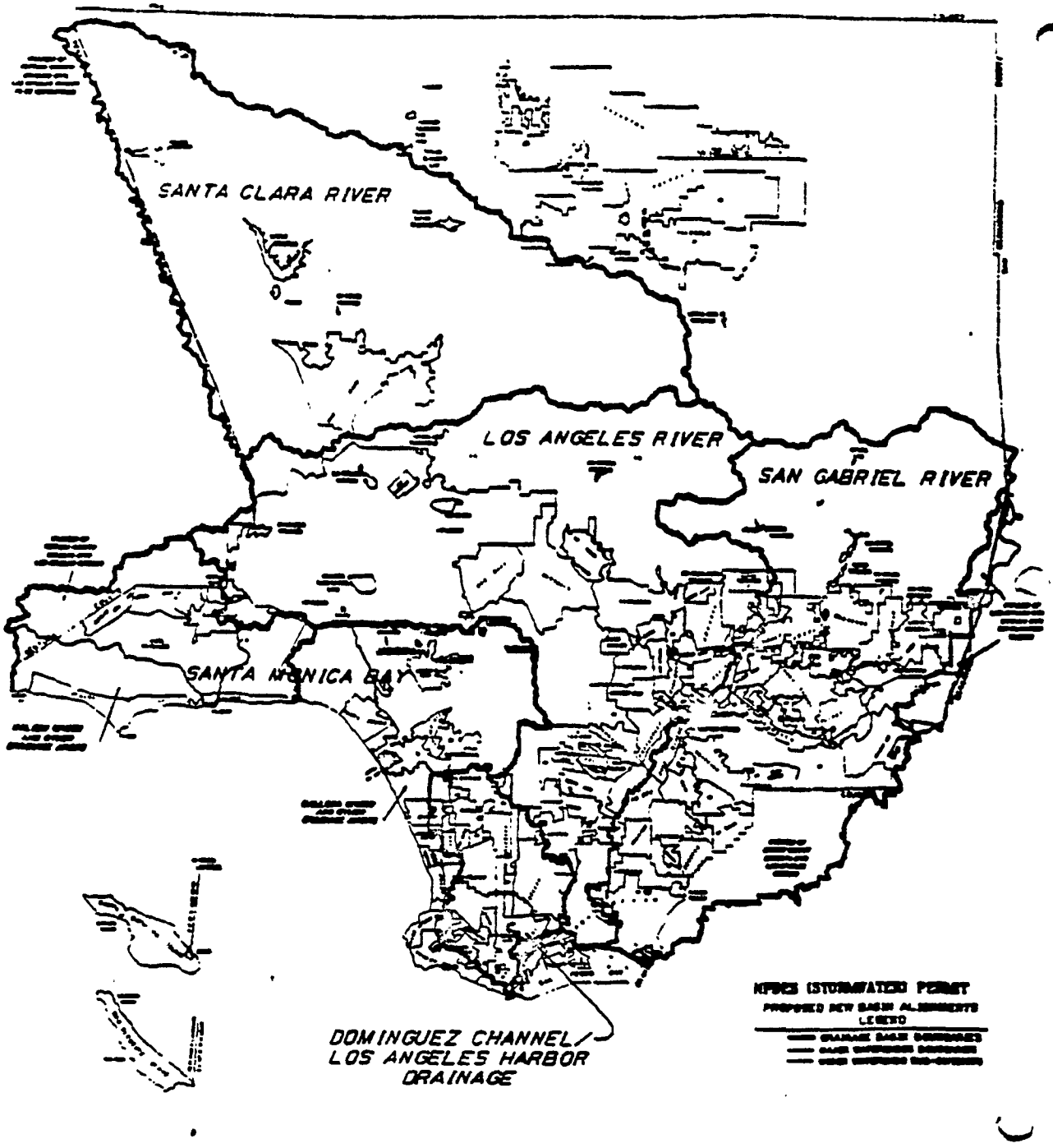
FIGURE 2



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County (Regional) Parks

- Landscape maintenance activities at public-owned parks will be reviewed as part of additional plan development to ensure the use of proper management measures.

Mosquito Abatement

- Coordination with the County Agricultural Commissions will be done for mosquito abatement programs to avoid adverse impact on the quality of stormwater/urban runoff.

Water Districts

- Activities with regards to the Water Districts activities will be reviewed and, when feasible, comply with the watershed program regulations and requirements.

Other entities, both private and public which have major land holdings and/or authorities that impact the quality of stormwater/urban runoff should be initiated to participate actively in the program.

3. CITY-SPECIFIC INTERAGENCY ARRANGEMENTS

Each city will need to develop the institutional framework to address operation, maintenance, construction, redevelopment, and other activities performed by city agencies such as Public Works, Parks and Recreation, Planning, and Public Owned Treatment Works (POTWs). These city agencies will need to participate in the planning and implementation of relevant plan program areas.

C. FISCAL RESOURCES

As each of the Plan chapters are completed, each Permittee will develop a budget for implementing that portion of the Plan. A complete budget for the Plan will be produced upon completion of development for all Plan components by December 1996. The budget will provide information such as funding sources, staff resources, contract services, and cost sharing arrangements.

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1. **AREA-WIDE**

In implementing the Plan, the Permittees may elect the jointly fund a single program for certain BMPs, such as Public Education, that are area wide in nature. Funding agreements including budgets and cost per agency would be developed.

2. **CITY-SPECIFIC**

Each Permittee will develop a budget detailing the cost of implementing Plan activities within its jurisdiction. Special funding in the form of grants, donations, or other forms of contribution should also be actively pursued to assist in funding special studies and/or BMPs.

D. LEGAL AUTHORITY

Each Permittee is responsible for implementing the Plan within its jurisdictional boundaries and therefore must acquire all needed legal authority. Each Permittee, being separate legal entities, are to have adopted as required by the existing Permit, ordinances that will provide them with the adequate legal authority to develop, administer, implement, and enforce storm water/urban runoff management programs within their own jurisdiction. The ordinance must provide for its enforcement and at a minimum specify that violators may be subject to penalties including, but are not limited to, fines and termination of the activity causing the violation. A plan for identifying any additional legal authorities needed by the Permittees will be included in the completed Plan for the Malibu Creek and Other Rural Areas watershed by December 1995. Upon completion of development of the Stormwater Management Plan, enforcing compliance with the Plan will be the responsibility of the Regional Board.

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II. ILLICIT DISCHARGES

The elimination of illegal connections and illicit disposal (IC/ID) practices is an important component for any program aiming to enhance the quality of stormwater/urban runoff.

Although more information is needed to assess fully the benefits and costs of conducting IC/ID programs, we can make logical decisions regarding application of best management practices (BMPs) to minimize such incidents. These BMPs will vary due to the jurisdictional differences which exist within each watershed. Each jurisdiction within the watershed will be developing and implementing those activities which adequately serve the jurisdiction and the watershed as a whole.

IC/ID practices are intermittent discharges of pollutants into the storm drain system that can degrade the quality of receiving waters. This can occur through catch basins, area drains and even on gutters and street surfaces. Some illegal dumping activities are done by individuals who do not know that such practices are illegal and can adversely impact the environment. Yet, others may be carrying out such practices with the full knowledge that such activities are prohibited.

A. ILLICIT CONNECTIONS

In order to implement an illicit connection management program, jurisdictions as a whole will need to develop and implement the procedures for investigating each of their respective storm drain systems.

Detailed procedures to eliminate illicit connections depends on the complexity of the storm drain system. A consistent watershed wide concept will be developed to investigate illicit connections to the storm drain system. Based on the results of field screening activities, or other appropriate information which indicates an area of reasonable potential of containing illicit connections, detection and follow up procedures would be followed. Priority should be established to focus on major problem areas and allow for a cost-effective approach to eliminate illegal connections. This concept will be developed by December 1995.

1. SYSTEM SURVEY

A system survey is a necessary component of an illicit connection elimination program. Although the basic concept is similar, the actual techniques and methods which jurisdictions within the watershed use to conduct system surveys can be quite different.

In conducting system surveys, the intent is to avoid costly investigations within areas not suspected of containing illicit connections. Field screening, map

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research, and land use investigation activities will be done initially to identify potential problem areas. Public outreach efforts will be used to inform citizens in the area about the problem. Enforcement action will be taken to terminate such illegal connections. It should be noted that more detailed and sophisticated techniques such as televised inspection and dye testing will only be used in special situations as needed.

Presently, Los Angeles County has begun a system survey. Maps detailing the location of each storm drain, its manholes and catch basin connector pipes are being prepared by Los Angeles County to facilitate monitoring of illegal connections and discharges. The location and source of discharge for connections is being inventoried. A GIS system to allow management and analysis of this data is also being developed. This information will be used in the storm drain inspection program which is ongoing. The program is targeting open channel storm drains. All open channels will be inspected for evidence of illegal discharges. The open channel inspections will also be used to collect information on dry weather discharges from underground drains for use in prioritizing future underground drain inspections.

2. ONGOING SYSTEM INSPECTIONS

Ongoing system inspections for illicit connections will involve the techniques identified in Section 1. above, along with some additional activities. In smaller systems where the storm drain goes into several pumping stations, a regular inspection of the pumping stations for, among other things, evidence of illicit discharges will be sufficient.

In larger and more complex systems, a program of field screening will be used. Evidence of pollution will be categorized and prioritized. The storm drain alignment tributary to the suspect illegal connection can then be further investigated for illicit connections. If a discharge can be traced to a particular facility, the facility will be investigated to identify where exactly the pollutants are coming from and efforts needed to stop the discharge.

Another means of detecting illicit connections may be to rely on reports of illicit discharge from the public. This will utilize the County's or another agency's established "hotline" number that the public can call and report such observations.

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3. REPORTING

A consistent recording system will be established to track report of illegal connections. This recording system will be used by the Permittees within the watershed.

B. ILLEGAL DUMPING

Due to the intermittent and unpredictable nature of illegal dumping, apprehension rate of violators could be quite low. The first course of action is to develop an area wide educational and reporting system along with prompt response procedures. This will be accomplished by December 1995.

1. OUTREACH

Reporting hotlines, in conjunction with outreach/publicity programs, can help minimize the problems of illegal dumping. The County has established an 800 hotline for the reporting of illegal dumping. In addition to this hotline the cities of Agoura Hills and Calabasas have established their own reporting numbers. All five cities in the watershed have public outreach programs to promote the reporting of illegal dumping. Newsletter articles, brochures, door hangers and refrigerator magnets are outreach methods which have been used.

2. SYSTEM SURVEILLANCE

Measures that may be used for this aspect of the program may include but not limited to regular inspections of vacant facilities, street use inspection programs to detect illegal discharges and dumping into the street system, and a public complaint and reporting system.

Caltrans' system surveillance program involves investigation, identification and remediation for hazardous waste and debris dumped on excess land parcels.

See **Chapter VII Public Information and Participation** of this report for a detailed discussion of the outreach program.

3. SPILL RESPONSE

The Health Hazardous Materials Division (HHMD) of the Los Angeles County Fire Department is generally the primary spill responder. If the material is found to be hazardous, the cleanup and disposal of the material will be done under the supervision of HHMD. If the material is non-hazardous, the responsibility will fall on local agencies to coordinate cleanup,

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disposal and attempt to identify and prosecute the violators. Cooperation among all agencies will be needed to allow for prompt action and joint effort to deter such violators. All agencies will have local authority against such illegal dumping activities.

4. COMPLAINT RESPONSE

The County and some local agencies have established a stormwater telephone "hotline" that can be utilized by all citizens. Public complaints are generated through these "hotlines" and also through regular channels such as calls to Fire or Police agencies or to public works or legislative offices. Although responses to these complaints will vary depending on the nature of the complaint, action shall be taken.

Only Los Angeles County has established a complaint response procedure. Hotline complaints are being tracked and a follow-up letter to violators has also been implemented.

5. COORDINATION OF ALTERNATIVE DISPOSAL

Alternative disposal is one way of reducing non-stormwater materials that can potentially find their way into the storm drain system. Recycling programs are one of the most effective ways to reduce waste material. The recycling program can either be at the curbside or through drop-off centers. Household hazardous wastes can be dropped at mobile collection centers or at fixed sites. Co-permittees in the basin generally participate in the County's Household Hazardous Waste collection program. Effectiveness of those programs may be enhanced by a public outreach program that will inform the public of the locations and/or schedules for such events. Technical assistance or information may also be provided to businesses that want to develop a pollution prevention, waste minimization or alternative disposal program.

Alternative disposal programs are effective and within this watershed they are very popular. With the exception of Caltrans, to which the program is not applicable, all jurisdictions have implemented curbside recycling programs. They have also publicized the program to increase participation. The Countywide Household Hazardous Materials Round-up is also successful. Ventura County accepts hazardous materials twice per month at a permanent facility. All cities participate and actively promote the events. Caltrans, who does not participate in the Countywide program recycles its own materials including, used oil, anti-freeze, oil filters and aluminum.

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6. REPORTING

Incidents involving a hazardous material entering the storm drain system are to be reported by the responsible party, or, if not known, the responding agency, to the California Regional Water Quality Control Board, Los Angeles Region (Regional Board). Complaints received through the County wide and local city hotlines will be tracked and reported to the Regional Board.

C. ENFORCEMENT PROCEDURES

Enforcement actions against discharges are done through either state hazardous and toxic materials statutes or through municipal ordinances that are already in the codes of the permittees. Industrial Waste Ordinances may be used in enforcement actions against illicit connections. Furthermore, anti-littering, health codes, plumbing codes and fire codes may be utilized for dumping or spill incidents. Enforcement actions can be taken by different municipal agents, including but not limited to, Industrial Waste Inspectors, Building or Plumbing Inspectors, Fire Department Inspectors, Park Rangers, Street Use Inspectors, Health Inspectors, Police Officers, Community Services Officers, Animal Control Officers, Code Enforcement Staff or Public Works Inspectors. Some of these agents are empowered to either issue citations, issue notices of violations, issue cease and desist orders, or even make arrests depending on the type of violation and the code provisions that they are enforcing. Some of these agents are also empowered to enforce not only municipal ordinances but also state laws. A review of the various enforcement tools used by the Permittees will be performed. A recommendation will result on a consistent enforcement approach for the watershed for consideration by all Permittees in their own enforcement programs. This recommendation will be developed by December 1995.

Four jurisdictions have ordinances within their Municipal Codes to prohibit illegal dumping/littering. In general these ordinances include penalties. Alternatively, one city relies on education programs to encourage the public not to litter, Caltrans posts No Littering signs with fines, and Westlake Village requires landscape contractors to pick up all green wastes. The cities rely on Code Enforcement officers, Health Department, Fire Department and Animal Control staff to enforce the regulations.

D. COORDINATION WITH STATE NON-STORMWATER PERMITS

In order to characterize the nature of the existing non-storm discharges in the receiving waters within the watershed, a list of NPDES Permits issued by the Regional Board will be obtained. This will help in determining unexpected discharge during dry weather and to allow enforcement actions to focus on illegal dumping activities.

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There is also a need to coordinate with other environmental agencies to ensure that requirements imposed by these agencies do not conflict with stormwater regulations. Requirements of many agencies do complement stormwater regulations. These agencies, include but not limited to, Fish and Game, DTSC, USEPA, and the Coastal Commission. Coordination with these agencies will help minimize overlapping investigations and result in a more efficient use of resources. A watershed wide concept will be developed by December 1995.

1. **IDENTIFICATION OF PERMISSIBLE/PERMITTABLE DISCHARGES**

   A list of non-stormwater discharges that can be allowed to discharge into the Waters of the State will be established by the Regional Board.

2. **APPROPRIATE MANAGEMENT PRACTICES**

   Continued communication with the Regional Board will allow current information to be circulated among all agencies.

3. **REPORTING**

   Any conflict in requirements of other environmental programs/agencies must be reported immediately to the Regional Board for ruling as to which one should take precedence.

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III. INDUSTRIAL/COMMERCIAL SOURCES

Each Permittee shall develop and implement a program that focuses on the identification and control of storm water pollutant discharges from industrial/commercial facilities within their jurisdiction. This program shall provide for the inspection of a facility's compliance with storm water regulations, as well as general outreach for all facilities that are potential industrial and commercial dischargers.

Each Permittee is responsible, under the requirements of the Municipal Stormwater Permit, for all discharges from commercial and industrial facilities within its jurisdiction. Many industries are also required to be permitted under the State General Industrial Activities Stormwater Permit. Enforcement of the specific provisions of the State General Permit is the responsibility of the State.

A. IDENTIFICATION OF SOURCES

As required under the current Permit, the Permittees have produced a listing of industries by SIC category for each drainage area. Also a breakdown of major land use types was also performed for each drainage area.

A pollutant source identification program will be designed to identify significant pollutant sources (ie. parking lots, industrial activities, etc.), with the hope that remedial action can be undertaken to reduce any significant impacts so identified. It will focus on monitoring very small areas (ie., less than five acres) where a specific and/or interrelated set of pollutant generating activities are occurring. Its objective is to provide data for selecting BMPs for specific activities rather than characterizing discharges for long-term pollutant loading estimates.

Identification of pollutant sources can be done using a number of methods. Potential sources of storm water pollutants can be identified by records of chemical use and/or storage, by studies of specific activities which lead to the deposition of pollutants throughout the watershed, and by field inspection or monitoring. Watersheds which may contain significant pollutant sources can be identified through land use information or by mass load estimates.

By mid January 1995, the County will begin targeted monitoring of a municipal corporation yard in the Santa Monica Watershed. This will provide data on industrial activities which can take place at such a facility such as vehicle maintenance and repair, materials storage, equipment storage and repair. A more comprehensive program to identify various pollutant sources will be developed by December 1995.

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1. CATEGORICAL LIST

Sources identified as a categorical industry regulated by the U.S. Environmental Protection Agency (EPA) will be grouped into a categorical listing of industries. The categorical list provides an organized overview of the target facilities that, based on land use, operation, and activities, could potentially contribute significant amounts of pollutants into storm water runoff. Some of the industrial categories regulated by the U.S. EPA include, but not limited to:

- Aluminum Forming
- Asbestos Manufacturing
- Battery Manufacturing
- Canned & Preserved Fruits & Vegetables
- Cement Processing
- Copper Forming
- Electroplating
- Glass Manufacturing
- Grain Mills
- Machinery Manufacturing & Rebuilding
- Soap & Detergent Manufacturing
- Metal Finishing
- Metal Molding & Casting
- Oil & Gas
- Organic Chemicals & Plastics & Synthetic fibers
- Paint Formulating
- Pesticides
- Plastic Molding & Forming
- Rubber Manufacturing
- Sugar Processing
- Textile Mills

2. RANKING

Industrial and commercial facilities identified as pollutant sources shall be ranked in order of priority for development of management measures. Facilities considered to be high priority are those whose operations and activities are determined to potentially contribute the most significant pollutant impacts to storm water discharge.

3. UPDATE PROCEDURE

Each year the Co-Permittees will evaluate the results of the monitoring program, the illicit discharge investigation program, and other available information , to identify likely sources of specific pollutants. The annual report to the California Regional Water Quality Control Board, Los Angeles Region (Regional Board) will recommend a strategy for pollutant source identification during the following year, including specific sites and/or activities to be monitored.

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B. CONTROL MEASURES

Specific urban runoff control programs for major potential pollution sources shall be developed by March 1996. Within these programs storm water pollution control measures shall be developed for various pollutant sources. Control measures such as source control and treatment control offer different, but complimentary approaches to storm water pollution control.

Source control measures focus on good housekeeping practices, pollution prevention and minimization, and education. They are also less costly than treatment controls.

Treatment controls involve physical treatment of the runoff, usually through structural means. Also treatment controls will not remove all pollutants and their removal efficiency is difficult to predict given the limited understanding of the relationship between facility design criteria and performance.

The initial focus will be on the development of source control measures. As information is collected under the pollutant source identification program regarding specific pollutant sources, specific control measures, including structural, will be evaluated as to their effectiveness in addressing these sources.

1. POLLUTION PREVENTION MEASURES

Source minimization and education are the first steps in effective source control. Other activities that contribute to source control are:

- Site design alternatives (ie. roof over fueling stations and carwash slab, provide spill containment curb around stored material, etc.)
- Good housekeeping practices

2. STRUCTURAL (TREATMENT) MEASURES

A variety of treatment control measures have been utilized throughout the country for storm water quality. However, the effectiveness of these controls are highly dependent on local conditions such as climate, hydrology, soils, groundwater conditions, and extent of urbanization.

Some of the more common treatment controls are:

- Oil/water separators - Oil/water separators are designed to remove one specific group of contaminants: petroleum compounds and grease. However, separators will also remove floatable debris and settleable solids.

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- Infiltration - A family of systems in which the majority of the runoff from small storms is infiltrated into the ground rather than discharged to a surface water body. Infiltration systems include: ponds, vaults, trenches, dry wells, porous pavement, and concrete grids.

- Wet ponds - A wet pond has a permanent water pool to treat incoming storm water.

- Constructed Wetlands - Constructed wetlands have a significant percentage of the facility covered by wetland vegetation.

- Biofilters - Biofilters are of two types: swale and strip. A swale is a vegetated channel that treats concentrated flow. A strip treats sheet flow and is placed parallel to the contributing surface.

- Extended Detention Basins - Extended detention basins are dry between storms. During a storm the basin fills. A bottom outlet releases the storm water slowly to provide time for sediments to settle.

- Media Filtration - Consists of a settling basin followed by a filter. The most common filter media is sand; some use peat/sand mixture.

- Multiple Systems - Multiple systems are a combination of two or more of the preceding controls in series.

C. OUTREACH

General outreach for all facilities that are potential industrial and commercial dischargers shall be set up area-wide by the Management Committee, to provide general guidance in complying with the storm water program by March 1996. It shall also serve as a reminder of pollution prevention measures and keep facilities informed of their obligations to the storm water program.

Subcommittees may be established to develop specific outreach materials for industrial and commercial categories and specific activities that are identified as high priority.

For additional information on outreach, refer to **Chapter VII Public Information and Participation.**

D. INSPECTIONS

Most municipalities have existing programs such as industrial waste, fire, and health in which industrial and commercial facilities are inspected on a regular basis. Each

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Permittee may elect to have inspections for the storm water program incorporated into these existing inspection programs, or be done as a completely separate program, depending on the needs of the Permittee.

The purpose of these inspections is to ensure that facilities are in full compliance with the storm water regulations and to ensure that control measures are being implemented. The frequency of inspection of facilities will be prioritized based on the operation and categorization of the facility.

Inspectors consisting of public personnel will be trained adequately to recognize and handle problematic activities concerning storm water pollution that may be existing or potential; and inspect for the deterioration of the storm drain system and illegal/improper connections. Training programs will be developed through the Watershed Management Committee and possibly specific Permittees for use by all Permittees.

Procedures for the identification, investigation, enforcement, and prosecution to the full extent of a jurisdiction's legal authority will be developed.

Only one co-permittee in the watershed has not implemented some type of inspection program at this time. Los Angeles County issues permits to all commercial and industrial facilities which generate industrial wastes. Included within this program are auto related businesses, gas stations, and restaurants. Facilities with industrial waste permits are regularly inspected. In addition to those businesses in the unincorporated areas, the County Department of Public Works also provides industrial waste inspections, under contract, for two cities in the watershed. One city is planning to expand its non-storm water discharge inspection program to include an industrial waste program in 1995. In Ventura County, an illicit discharge control program has been initiated. Caltrans inspections include daily examination of its auto related facilities, lead testing of the gas stations once per year, quarterly pumping of clarifiers, and constant storm drain monitoring. A program to inspect underground storage tanks is part of a five year plan.

1. CHECKLIST

Inspectors shall have a uniform checklist to use as guidance and reference throughout an inspection. It may also serve as a general guide for the public, providing information about the requirements necessary to comply with the storm water regulations.

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2. SCHEDULE

The inspection program shall be developed by March 1996. The frequency of inspections shall be scheduled according to the type of operation and the categorization of the facility. Revisit inspections shall be done on an as needed basis.

3. REPORTS

Inspectors shall report on all activities related to and/or violating the local storm water ordinance to the local governing agency. Standard reporting procedures will be developed.

4. FOLLOW-UP PROCEDURES

Individual Permittee review and assessment of the reports may result in the need for follow-up procedures, such as reinspection or legal action, provided the jurisdiction has the adequate legal authority to do so. Follow-up procedures will be developed to insure a uniform and consistent approach.

E. LOCAL INCENTIVE PROGRAMS

In developing the industrial/commercial program, the Permittees may consider the development of optional measures such as clean business incentive programs that may offer more focused control on industrial and commercial sources. Optional measures such as these may be developed by March 1996.

F. TRAINING

Development of training programs for industrial storm water inspection staff is projected to be completed by March 1996.

1. PUBLIC EMPLOYEES

All public employees shall be trained in the storm water regulations so that they abide by the regulations in the course of their work day. Also they need to be able to recognize and distinguish between legal and illegal activity so as to administer the proper protocol in handling the situation.

The Los Angeles County Department of Public Works has requested all employees to report any observed water quality problems. Caltrans employees have received education in hazardous substance spill awareness, pesticide safety and vegetation management.

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2. INSPECTORS

Inspectors who visit industrial and commercial facilities shall be adequately trained to determine compliance with the storm water regulations and educate the facilities about the requirements of the program. In addition, they should be able to recognize and handle immediate problems as they are encountered, during an inspection; and inspect for the deterioration of the storm drain system and illegal/improper connections. Citation training will be necessary for inspectors in agencies that have the citation authority.

G. COORDINATION WITH STATE INDUSTRIAL STORM WATER PERMIT

The Permittees have existing local ordinances governing industrial discharges and other non-stormwater discharge that require compliance activities similar to those in various State Regulations. Because coordination between the Permittees and the Regional Board is anticipated concerning the regulations of industries, a mutual agreement may be required regarding industrial inspections and enforcement. Additional issues could also be addressed. Federal stormwater regulations hold local municipalities responsible for stormwater discharges from all industrial/commercial facilities, including those covered by General Permit.

1. MEMORANDUM OF UNDERSTANDING

A Memorandum of Understanding (MOU) may be used to formalize the agreement between municipalities and the Regional Board on industrial compliance program issues. A MOU among all local agencies may also be needed to ensure co-operation between all the agencies. The need for and specific requirements for such agreements would be developed upon completion of development of the industrial/commercial program by March 1996.

2. REPORTS

The MOU discussed above may include the exchange of information between the Permittees and the Regional Board. Appropriate formats for such reports would be developed as required.

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IV. NEW DEVELOPMENT AND REDEVELOPMENT

Managing stormwater and runoff from both new construction and redevelopment, will reduce pollutants from entering the storm drain system and subsequently the receiving water.

A. PLANNING PROCESS

Quality of stormwater discussion should be included in the General Plan and the Zoning ordinances. Efforts to enhance the quality of storm water can filter into the Subdivision actions. Much of the storm water concerns can be channeled through the compliance effort of the California Environmental Quality Act (CEQA). A watershed wide concept will be developed by June 1996.

Two Permittees currently have programs addressing stormwater quality in the planning process. Caltrans has a contractor water pollution program which requires a plan for water pollution control during construction operations Caltrans' projects; and the City of Westlake Village through its Stormwater Quality Management Plan.

1. WATERSHED PROTECTION POLICIES

An integrated strategy will be developed for the watershed. Pollution control efforts should be prioritized. A variety of statutory and regulatory requirements could be used for this watershed oriented program. Watershed protection policies need to be adopted by the local jurisdictions which control land-use within the watershed.

2. COORDINATION WITH CEQA

The current CEQA "Environmental Checklist Form" that is used for initial studies assessment indirectly address potential impacts to stormwater. Additions could be made to the Form to directly assess stormwater quality impacts.

CEQA requires agencies to use feasible alternatives or mitigation measures to lessen potentially significant effects. The ability to identify a.) when an effect is significant, and b.) which mitigation measures could be adopted to reduce the effect, is critical to the CEQA process. A clear assessment of any development, its potential adverse impacts on stormwater quality will allow for a determination of "significance" which will enable the decision maker to make development decisions upon full disclosure of possible adverse impacts.

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3. SITE PLANNING PROCESSES

All development will require the review and approval of a site/plot plan or development drawings prior to issuance of a building permit. Incorporating the consideration of potential water quality impacts including erosion and sedimentation during the early stages of the planning process will allow these issues to be addressed before substantial investments in engineering and design have been made.

4. GENERAL PLAN CHANGES

The General Plan is the legal backbone of the planning process. All development approvals, zoning ordinances, subdivision approvals and public works projects must be consistent with the policies, objectives, and principles set forth in the General Plan. Discussion of stormwater issues in the General Plan could greatly enhance the awareness of the issues and encourage full assessment of possible adverse impacts on stormwater quality as the result of new and redevelopment.

5. USE OF MASTER PLANS

For agencies which utilizes master plans to guide their development activities, stormwater issues can be outlined in such documents. This will channel efforts to fully assess the possible adverse impacts on stormwater quality as the results of any development within the master plan area.

6. OTHER POLICIES

Numerous other policies or mechanisms could be used to incorporate stormwater management goals into the planning/development process. Other concepts will be evaluated for their feasibility during the more detailed development of this Chapter.

7. PLANNING-PUBLIC WORKS INTERFACE

A variety of mechanisms for coordinating planning and public works activities exist. An example could be some form of CIP (capital improvements program). Ideally, any planning documents which target or project population growth are coordinated with CIP. Integrating stormwater management into CIP will allow for mitigation of major adverse impacts on the quality of stormwater prior to any actual construction.

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8. IMPLEMENTATION PROCEDURES

Implementing policies to integrate stormwater management considerations with existing planning/development mechanisms will require a variety of approaches depending upon the existing conditions within each Co-Permittee and the particular remedies selected. It is anticipated that each Co-Permittee will propose procedures applicable to it's unique jurisdictional considerations at later stages in the permit process.

B. CONSTRUCTION SITES

Pollutants from construction activities can have a major impact on the quality of stormwater/urban runoff. A watershed wide concept to reduce such pollutants will be developed by December 1995.

1. EROSION CONTROL REQUIREMENTS

Federal stormwater regulations hold local municipalities responsible for stormwater discharges from all construction sites. In addition, construction sites involving a total of five acres or more of land disturbance are required to apply for the State General Construction Activity Storm Water Permit (GCASP). The GCASP: 1) eliminates or reduce to the extent feasible non-storm water discharges from construction sites and 2) permits stormwater discharges, but requires the use of controls to limit pollutant loading in site effluent. Preparation of a Stormwater Pollution Prevention Plan and identification/utilization of BMPs are the key components of this Permit.

Many local agencies also have erosion control requirements for any grading and construction activities. Regulation of pollutants from construction sites of five acres or less will be done by the local agency through its stormwater management plan.

Construction site erosion has the potential to introduce sediment into runoff. For example, fugitive dust control at construction sites typically use water. Minor modifications/clarification of existing fugitive dust practices could substantially address runoff pollution concerns. In addition to fugitive dust control practices, additional measures could be adopted to curtail dry weather runoff, and control pollutant laden storm water runoff. These measures may address 1) physical site design considerations and 2) temporal considerations such as seasonal timing and phasing of activities.

Five jurisdictions have adopted ordinances which provide for erosion control and slope stabilization. The City of Westlake Village has identified these components as part of an urban runoff control ordinance.

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Los Angeles County's ordinance has been in effect since 1965. However, in 1992 these provisions were strengthened to include stiffer penalties for violations.

2. CHEMICAL AND WASTE MANAGEMENT REQUIREMENTS

Chemical and waste handling activities are also currently subject to a variety of regulations. BMPs to address this pollution source are largely centered around "good housekeeping practices". It involves storing, handling, using, and disposing of these potential pollutant sources in ways that restrict opportunities for unintended introduction of the materials into site runoff. Proper chemical and waste management will reduce any accidental discharge into the storm drain system.

3. INSPECTIONS

Inspections are a routine part of local jurisdictions oversight of regulated construction activity. Its purpose is to ensure that construction site runoff control measures are being implemented. Existing practices should be examined and modified accordingly to satisfactory stormwater/urban runoff objectives.

a. Checklist

A checklist would encourage possible streamlining of any requirements. It could be cumbersome if an overly rigid approach were taken which resulted in unnecessary administrative burden. However, careful design of the checklist could avoid this pitfall.

b. Schedule

Inspection schedules will depend upon existing practices. It may be desirable to have several schedules, depending upon the types of activities/permits and/or the timing of activities.

c. Reports

A standardized reporting format is needed to allow for consistency among all jurisdictions. Furthermore reports are also a useful tool for future refinement of pollution control regulations.

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d. **Follow-up Procedures**

A format will be developed to do follow-up inspections on problem facilities. Its frequency will greatly depend on the land use and the degree of non-compliance of each facility.

C. LOCAL PERMITS

Permits are a form of "cross checking" by local agencies to ensure that regulations are being implemented. Prior to the issuance of a permit, information must be submitted for review and approved. A watershed wide concept to provide some consistency in local permits will be developed by June 1996.

1. COORDINATION WITH EXISTING PERMITS

Storm water issues should be incorporated into existing permits.

2. NEW PERMIT ISSUES

Storm water issues should be clearly stated in new permits to be issued for new and/or redevelopment activities.

D. TRAINING

Training will enable staff to keep current of the latest storm water regulations. A watershed wide staff training concept will be developed by June 1996.

1. PLANNING PERSONNEL

(See E.1.b. below)

2. PUBLIC WORKS PERSONNEL

(See E.1.b. below)

3. INSPECTORS

(See E.1.b. below)

E. CONTROL MEASURES

Best management practices for the control of construction related pollution can generally be divided into three categories:

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Nonstructural Source Controls for Reducing Urban Stormwater Pollutants:

- Practices that reduce the generation and accumulation of potential stormwater contaminants at or near their source.

Development Layout Stormwater Controls:

- Practices that are directed at controlling the volume and discharge rate of runoff from urban areas, as well as, reduction of the magnitude of pollutants in discharges through temporary storage or flow restrictions.

Erosion and Sediment Controls:

- Practices that can prevent or treat problems related to transport of eroded material from construction and other land disturbing activities.

Development layout stormwater controls are of particular interest. These control measures can be incorporated in the initial planning phase of any project. A watershed wide concept will be developed by June 1996.

1. POLLUTION PREVENTION MEASURES

a. Site Design

Effective implementation of urban BMPs requires integration of water quality control elements early in the site planning and design process. Development of the water quality controls should not only achieve maximum pollutant removal with minimal costs, but also reduce potential maintenance.

This may include incorporating water quality concerns into the site layout and design (ie. maximize pervious areas, minimize directly connected impervious areas, etc.) and/or treatment control measures proven to be cost effective for local climate, soil, and development conditions.

Due to the diversity of climate and local conditions, the development of BMPs vary from location to location, and even jurisdiction to jurisdiction. The selected management practices should be designed for the local site conditions and especially seasonal rainfall conditions that are experienced in Southern California. Suitability for the major land use and drainage characteristics should also be fully assessed.

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b. **Education/Training**

Education/training is imperative to the success of any BMPs selected for new or redevelopment projects. BMPs will fail if not properly designed, installed, and maintained. Only well trained personnel should be assigned to these responsibilities.

A program for effective education/training should be based on four objectives:

- Promote a clear identification and understanding of the problem, including activities with the potential to pollute stormwater;
- Identify solutions (structural and nonstructural BMPs);
- Make every employee responsible for stormwater pollution and its solution; and
- Integrate employee feedback into training and BMP implementation to improve BMPs.

c. **Other**

In many cases stormwater pollution control may already be achieved by existing regulations or programs. In California, the General Plan Law and the California Environmental Quality Act (CEQA) provide a basis for municipalities to review and comment on all projects within their jurisdiction. Under the General Plan Law, municipalities are required to develop policies and regulations which guide development within the municipality. Each development project is then reviewed for conformance with these policies. Under CEQA, projects are also subject to review and comment for any adverse impact the projects may have on the environment, including impacts from stormwater discharges.

2. **POST CONSTRUCTION (TREATMENT) MEASURES**

a. **Applicability**

Each site considered for development or redevelopment will (at the conclusion of construction) have final improvements and unique site characteristics such as: drainage patterns; soils; landscaping; topography; percent of impervious surfaces; rainfall; pollutants inherent with the use of the development; and pollutants that may be background to the area (existing vegetation, air fallout, etc.). The applicability of various treatment control BMPs for use in new

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development will be evaluated through the use of pilot studies and examination of studies done on treatment control measures by other agencies.

b. Effectiveness

Prior to implementing any treatment control measures, they will need to be evaluated for their effectiveness. This can be done through pilot studies which could include elements such as: pre and post storm event inspections; water quality monitoring; record keeping to document deficiencies in the BMPs; Operation and Maintenance requirements and cost effectiveness.

c. Retrofit Opportunities

The feasibility of retrofitting existing developments with treatment control measures will be evaluated. However, the effectiveness of a treatment control measure vs. its cost must be fully evaluated prior to considering its use as a retrofit measure.

3. OPERATION AND MAINTENANCE

a. Requirements

Jurisdictions within the watershed will need to insure that BMPs incorporated into a private development are properly maintained. Deed restrictions, covenants, conditions and restrictions (CC&R) could be used to direct such requirements and responsibilities.

b. Responsible Party

The contractor, during construction, must ensure that the post-construction BMPs are installed properly and that any maintenance that may be necessary during construction is performed. After the project is completed, it will then be the responsibility of the fee owner, private or public, to provide for long term operation and maintenance. This may be accomplished by deed restriction and/or CC&R.

4. CONFLICTS WITH OTHER MANDATES

Often regulations of various Federal, State, and local agencies would conflict with each other. Health, fire, and building codes often have requirements focusing on short term human health and safety and neglecting the impacts on the environment.

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a. **Identification of Conflicts**

As the Plan is developed, other regulatory requirements that conflict with the stormwater program requirements may be uncovered. Clarification of these regulations should be directed to the various responsible regulatory agencies.

b. **Conflict Resolution**

For regulatory conflict caused by local regulations, efforts will be taken to resolve them within the agencies. Input form other local, state, and federal agencies should be incorporated into a modification of current standards. The Regional Board should resolve conflicts involving other State and/or Federal requirements.

F. OUTREACH

See Chapter VII Public Information and Participation.

G. ENFORCEMENT

See Chapter II Illicit Discharges, Section C Enforcement Procedures.

H. COORDINATION WITH STATE GENERAL CONSTRUCTION ACTIVITIES STORM WATER PERMIT

Compliance with the GCASP requirements is the responsibility of the developer/contractor, and enforcement is the responsibility of the SWRCB/Regional Board staff.

1. MEMORANDUM OF UNDERSTANDING

An agreement between the Regional Board and Co-Permittees may be used to enhance compliance of construction site BMPs. The need for such an agreement will be evaluated. If found to be desirable, an agreement will be developed by June 1996.

2. REPORTS

The local enforcement agency of the State Construction Stormwater Permit, which is the Regional Board, should forward all information, including Notices of Intent filed and any inspections and enforcement actions taken, to the

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Permittees so that this information can be available to local municipal construction site inspectors to alert them of any specific concerns on the job site.

3. OTHER ISSUES

The Regional Board should explore funding to be channelled to the Co-Permittees so the Co-Permittee can be more actively involved with the State on the Permit.

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V. PUBLIC AGENCY ACTIVITIES

All municipalities perform functions that have an impact on stormwater quality. These include, among other things, vehicle maintenance, landscape maintenance, weed control, water body maintenance including swimming pool maintenance, etc. Other activities such as construction and maintenance of streets and roads, and construction and maintenance of the flood control system also could directly or indirectly cause adverse impact on the quality of stormwater/urban runoff. Since municipalities must address all significant sources of pollutants, all of these activities must be examined and mitigation measures be incorporated into the routines. As part of the requirements of the current Permit, many of the Permittees have already begun implementation of measures to address the above activities. An examination of these existing measures will be done on a watershed wide basis to establish the most effective approach to address these activities. Such approaches shall be developed and begin implementation by September 1996.

A. SEWAGE SYSTEMS

Sewage spills must not be allowed to enter the storm drain. Control procedures for identifying, repairing, and remediating sewer blockages, infiltration, inflow, and wet weather overflows from the sewers to the storm drain system should be implemented to protect stormwater quality. These procedures could include, but are not limited to, quick field response to overflows, follow-up testing, and complaint investigation.

When sewage spills do occur, they must be contained and collected for proper disposal. Individual permittees may need to modify their sewage overflow response procedures. The field personnel should also have procedural training for field screening, sampling, smoke/dye testing, and TV inspection, if appropriate, to be able to properly investigate any suspect connections or cross connections to the storm drain system.

Los Angeles County has a number of programs aimed at preventing sewage spills from entering the storm drain system. These include:

- Sewage Overflow Response Procedures Revision/Root Control Review. This involves improvement of procedures for containment and cleanup of spilled sewage resulting from overflow.
- Standby Maintenance Crew. This on-going program places a maintenance crew on stand by during heavy rainfall for Trancas and Malibu Sewage Treatment plants.
- Reline Sewer Lines. Two locations will undergo relining of existing sewer lines to prevent infiltration and exfiltration.

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- Sewer Pipeline Reconstruction. 127 miles of cement pipelines will be analyzed and replaced or rehabilitated within 5 years.

- Sealing of Manhole Covers. This program has sealed manhole covers and bar holes in areas subject to flooding.

- Expansion of Emergency Call List. Beeper numbers of all supervisors, superintendents and standby crews were added to emergency call list.

B. CORPORATION YARDS

Corporation yards include any area or facility that is used for vehicle maintenance or washing, other maintenance, chemical storage, paint facilities, and supportive activities for field crews. Permittees will need to incorporate pollutant control measures at these facilities and develop a plan for each facility outlining the measures to be implemented. Since these are industrial type activities, the corporate yards would need to implement measures as described in the Industrial/commercial Source Chapter.

1. STORM WATER POLLUTION PREVENTION PLANS (SWPPP)

Though not required, permittees may elect to use some form of SWPPP as a vehicle for compliance. Any BMPs to be implemented must be part of a comprehensive plan designed to address the various pollutant sources at each corporate yard. To achieve this goal, the municipalities should first identify the potential pollution sources and who is responsible for implementing the storm water management measures. Based on the facility type, management practices and schedule of implementation will be developed. BMPs that can be used to improve the quality of runoff include, but are not limited to, housekeeping practices, material storage control, vehicle leak and spill control, and illegal dumping control.

2. OUTDOOR LOADING/UNLOADING OF MATERIALS

Municipal employees who handle potentially harmful materials should be trained in good housekeeping practices to prevent or reduce the discharge of pollutants to storm water from outdoor loading/unloading of materials. Materials spilled, leaked or lost during loading/unloading may collect in the soil or on other surfaces and be carried away by runoff or when the area is cleaned.

Applicable BMPs should be selected based on the following four factors: 1) Extent of exposure of material to rainfall, 2) preventing stormwater run-on, 3) checking equipment regularly for leaks, and 4) containing spills during transfer operations.

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3. MATERIAL STORAGE CONTROL

A program should be developed to prevent or reduce the discharge of pollutants to storm water from outdoor container storage areas using measures such as installing safeguard again accidental releases, secondary containment, conducting regular inspections, and training employees in standard operating procedures and spill cleanup techniques. Employee education is paramount for successful implementation. Employees should be trained in emergency spill cleanup procedures.

To limit the possibility of storm water pollution, containers used to store dangerous waste or other liquids should be kept inside the building unless this is impractical due to site constraints. Storage of reactive, ignitible, or flammable liquids must comply with the fire and California OSHA codes. Practices such as placing containers in a designated area should be employed to enhance such requirements.

4. VEHICLE AND EQUIPMENT WASHING AND MAINTENANCE

Washing vehicles and equipment outdoors or in areas where wash water flows onto the ground can pollute storm water. For municipalities that wash vehicles or pieces of equipment on-site, it should be performed in a designated area equipped with an oil/water separator.

Vehicle or equipment maintenance is a potentially significant source of storm water pollution. Parts are cleaned with solvents. Many of these cleaners are harmful and must be disposed of as a hazardous waste. Appropriate BMPs are waste reduction, use of alternate products, recycling, and spill leak clean up control.

5. WASTE HANDLING AND DISPOSAL

Proper waste management is possible by tracking waste generation, storage, and disposal; reducing waste generation and disposal through source reduction; and preventing run-on and runoff from waste management areas.

C. PARKS AND RECREATION

Park Departments manage landscaping and swimming pools. Both of these activities involve the use of chemicals, waste management, and non-storm water discharges. In addition maintenance of swimming pools requires the periodic discharge of large quantities of swimming pool water.

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1. FERTILIZERS/PESTICIDES

a. Use/Application management

Municipal facilities should develop controls on the application of pesticides, herbicides, and fertilizers. Control may include:

- List of approved pesticides and selected use;
- Product and application information for users;
- Equipment use and maintenance procedures; and
- Record keeping.

Employees can be educated about environmentally sensitive alternative products by using information developed by various public agencies and other environmental organizations.

b. Storage

Improper storage of fertilizers and pesticides can lead to potential groundwater, soil, and stormwater contamination. To prevent or reduce their impact on stormwater pollution, material storage areas must be designed and maintained to reduce exposure to storm water. The following BMPs can help to achieve this goal:

- Store materials inside or under cover on paved surfaces,
- Use secondary containment,
- Minimize storage and handling of hazardous materials,
- Inspect storage areas regularly.

2. FACILITY MANAGEMENT

a. Wash Waters

Wash waters cannot be discharged into the storm drains untreated. The storage area should be slightly sloped for wash water collection. If the water is not discharged to the sanitary or process waste sewer, or to a dead-end sump, the outlet should be equipped with an oil/water separator or other treatment systems.

b. Maintenance

Landscape maintenance involves the use of pesticides and fertilizers. Proper use of these materials will reduce the risk of loss to storm water. Whenever possible, leave or plant native vegetation to reduce

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water, fertilizer, and pesticide needs. Integrated pest management should be employed where appropriate. The Park Departments should also establish a schedule for irrigation and fertilization. The chemicals will be carried from the site by the next storm if they are applied during the wet season. Overwatering leads to discharge of water that may have become contaminated with nutrients and pesticides.

Storm water from parking lots may contain undesirable concentrations of oil, grease, suspended particulates, and metals, as well as the petroleum byproducts of engine combustion. Possible maintenance BMPs include periodic sweeping and cleaning catch basins.

c. Swimming Pool Waters

The drainage of swimming pool water must insure that chlorine residual is below allowable water quality limits. The potential for recycle/reuse for irrigation of lawns and landscapes may be investigated. Swimming pool filter backwash waters should not be discharged to the storm drain, but should be allowed to settle and then disposed to the sanitary sewer. Other possible alternative measures would be to use the backwash for irrigation or disposal on a dirt area.

D. STORM DRAIN SYSTEM OPERATION AND MANAGEMENT

The maintenance and operation of the storm drain system has an impact on storm water quality and must be addressed. Material clogging storm drains cannot be discharged into drains. It must be disposed of properly.

1. INLET MAINTENANCE

Regular maintenance of public and private catch basins and inlets is necessary to ensure their proper function. Maintenance will remove pollutants, reduce high pollutant concentrations during the first flush of storms, prevent clogging of the downstream conveyance system, and restore the catch basin's functional capacity. Keys to effective catch basin cleaning include the following:

- All basins should be cleaned annually prior to the onset of the rainy season;
- Clean catch basins in known problem areas more frequently to remove sediments and debris accumulated during the dry weather months;
- Keep records of the number of catch basins cleaned; and
- Track the amount of waste collected.

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Caltrans will develop a priority list of drains and pump houses requiring cleaning.

Five jurisdictions within this watershed perform catch basin cleaning annually. The City of Malibu and Ventura County inspect catch basins and subsequently clean them as needed.

2. DRAIN MAINTENANCE

Open channel storm drains should be cleaned at least annually prior to the rainy season. Problem areas should be cleaned more frequently as needed. Channels should also be monitored during the rainy season for any debris buildup and cleaned where needed.

To reduce the amount of debris entering the ocean, Los Angeles County field personnel inspect open channels and sumps after storms and clean up any debris.

3. WASTE MANAGEMENT

Excessive waste buildup will decrease the capacity of the channel, it is therefore crucial to reduce pollutant levels in storm water by regularly removing illegally-dumped items and material from storm drainage channels and creeks. A program should be developed to identify problem areas of illegal dumping so regular inspection and clean up can maintain the channel's optimum capacity and prevent the discharge of contaminants.

4. NEW SYSTEM DESIGNS

Current design standards for the construction of new storm drain systems will be evaluated in light of currently available pollutant control measures. Design standards may be modified to incorporate measures deemed appropriate for local conditions.

5. RETRO-FIT OPPORTUNITIES

The majority of the existing storm drain systems are in highly urbanized areas providing little opportunity for cost effective retro-fitting. However, currently available pollutant control measures will be reviewed for their effectiveness and possible use. This may include pilot studies to evaluate the performance of management practices under local conditions.

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E. STREETS AND ROADS

Construction, operation, and maintenance of roads has an impact on storm water quality and will be addressed in the management plan.

1. SWEEPING

Street sweeping can collect refuse on street surfaces to prevent it from entering the storm drain system through catch basins.

a. Storm Water Quality Based Operation

In order to effectively implement the sweeping program, the permittees should keep accurate operation logs to track the program. Areas generating excessive refuse should be swept more frequently. Sweeping frequency may also be increased before the rainy season to reduce the amount of refuse entering the storm drain system. Parking on sweeping days should be regulated to facilitate the operation.

Three jurisdictions sweep roadways on a weekly basis while two perform this service bi-weekly. Ventura County's residential street sweeping is done every other week while Caltrans sweeps its roadways on a regular schedule determined by observable debris.

b. Waste Management

Two jurisdictions collect rubbish from roadside trash receptacles on a weekly schedule, while the City of Malibu and Ventura County do not provide any trash receptacles. The City of Agoura Hills' six trash receptacles are emptied three times a week while Westlake Village provides receptacles within City parks with a daily pick up schedule. Caltrans empties trash receptacles on an as needed basis.

2. STREET/PAVEMENT WASHING

Wash waters from street/pavement washing are contaminated and must be managed as non-storm water discharges.

3. MAINTENANCE

a. Saw-cut Slurry Management and Paving Practices

Existing saw-cut management and paving practices conducted by the permittees will be evaluated and appropriate control measures

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developed. Possible control measures to be considered that would help reduce the impacts to storm water:

- Avoid paving during wet weather;
- Regularly repair potholes and worn pavement to reduce sediment loading;
- Store materials away from drainage courses to prevent pollution of storm water run-on; and
- Follow the storm water permitting requirements for industrial activities when mixing concrete with an on-site plant.

b. Waste Management

Vehicles transporting waste should have spill prevention equipment that can prevent spills during transport. The refuse collected will be transported to the appropriate disposal facilities.

Good housekeeping practices will be implemented to insure proper management of any waste products that may be generated during maintenance activities. For example, to prevent concrete waste from entering the storm drain system, washout of concrete trucks should be conducted off-site or on-site in designated area. Excess concrete should not be dumped on site. Employees and subcontractors should be trained in proper concrete waste management.

The following steps will help reduce storm water pollution from concrete wastes:

- Store dry and wet materials under cover, away from drainage areas;
- Avoid mixing excess amounts of fresh concrete or cement on-site;
- Do not wash out concrete trucks into storm drains, open ditches, streets, or streams;
- Do not allow excess concrete to be dumped on-site, except in designated areas;
- Avoid paving during wet weather;
- Regularly repair potholes and worn pavement to reduce sediment loading; and
- Cover catch basins and manholes when applying seal coat, tack coat, slurry seal, fog seal, etc.

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Employee/subcontractor training to insure implementation of good housekeeping measures should be based on four objectives:

- Promote a clear identification and understanding of the problem, including activities with the potential to pollute storm water;
- Identify solutions (BMPs selection);
- Promote employee/subcontractor ownership of the problems and the solutions; and
- Integrate employee/subcontractor feedback into training and BMP implementation.

c. Medians/Landscaped Right-of-Way

i. Irrigation

Overwatering of landscaping produces runoff. A properly timed irrigation schedule should be set up to minimize overwatering. Drip irrigation system should be used when feasible in new installations.

ii. Fertilizers/Pesticides

The handling, storage, and usage of fertilizers/pesticides are addressed in Chapter V, Section C-1.

Caltrans has an existing Right-of-Way Maintenance Vegetation Control Program which provides Benefits for motorist' safety and erosion control.

F. FLOOD CONTROL

Common municipal practices, such as construction and operation and maintenance of the flood control system, may have a potentially adverse impact on storm water quality. Consequently, these practices shall be coordinated to the extent of preventing pollutants from impacting the water quality.

1. COORDINATION WITH NEW PROJECTS

Current design standards for the construction of new storm drain systems will be evaluated in light of currently available pollutant control measures. Design standards may be modified to incorporate measures deemed appropriate for local conditions. During construction, all appropriate BMPs will be utilized to control pollutants during the construction of the facility.

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2. COORDINATION OF MAINTENANCE ACTIVITIES

Current maintenance activities with regards to desilting/sediment removal, vegetation management, and waste management shall be reviewed to insure that appropriate management measures are developed to comply with the storm water regulations.

3. OPERATION OF FACILITIES

Flood control facility operations will be reviewed to identify where appropriate management measures could be incorporated. However, primary consideration will need to be given to the flood control function of the facility to protect health and safety.

4. RETROFIT OPPORTUNITIES

The majority of the existing storm drain systems are in highly urbanized areas providing little opportunity for cost effective retro-fitting. However, currently available pollutant control measures will be reviewed for their effectiveness and possible use. This may include pilot studies to evaluate the performance of management practices under local conditions.

The City of Westlake Village working with L. A. County Flood Control Maintenance division constructed an oil boom across Lindero flood control channel. By measuring the quantity of materials removed the City can gauge the magnitude of urban runoff pollution.

G. PUBLIC FACILITIES

Storm water runoff and non-storm water discharges from other public facilities must also be addressed, including chemical use by these facilities, pressure blasting/cleaning sidewalks and other surfaces.

1. PARKING FACILITIES

Storm water from parking lots may contain undesirable concentrations of oil, grease, suspended particulates, and metals. Some control measures such as periodic sweeping and cleaning catch basins should be implemented. The need for more advanced structural controls would be evaluated through the pollutant source identification program. Pilot studies would be conducted on candidate structural controls to evaluate their effectiveness prior to large scale implementation.

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2. GOLF COURSES

Golf courses require the use of large amount of water, fertilizers, and pesticides. Field personnel should be trained on the proper handling, storage, and usage of these chemicals (Refer to Chapter V, Section C-1 for detail). To prevent excess irrigation water from entering the storm drain system, proper management of watering schedules should be required.

3. SCHOOLS

The maintenance of playgrounds and athletic fields at schools require fertilizers and pesticides. Their safe storage and use affect not only the stormwater quality but also the health of the students and the staff. Therefore, BMPs under Chapter V, Section C-1-b should be implemented. Each municipality should develop a program to encourage these schools to use environmentally sensitive products for fertilizers, pesticides, detergents, and other chemicals. The schools should have proper material handling, storage, and disposal procedures for chemicals used in school laboratories.

4. HOSPITALS

Each hospital should have BMPs to control the handling and storage of medically related hazardous materials. All materials should be inventoried regularly, with record keeping protocols on supply and consumption. All personnel should be trained on the proper procedures on handling these materials, as well as emergency response. Each hospital should maintain a list of supervisors to be contacted if accident does occur. Disposal of these materials should be contracted out to commercial specialists.

5. PARKS/LANDSCAPES

Refer to **Section C Parks and Recreation**, of this Chapter, for information.

6. OTHER BUILDINGS/PLAZAS

Refer to **Section C-2 Parks and Recreation - Facility Management**, of this Chapter, for information.

H. PONDS, FOUNTAINS, AND OTHER PUBLIC WATER BODIES

Maintenance practices used on public water bodies, including waste management and non-stormwater discharges, must be addressed in the plan.

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1. ALGAE CONTROL

a. Use of Chemicals

The use of herbicides or other chemicals to control algae growth should be carefully controlled and monitored to insure strict adherence to manufacturers' guidelines for use. Water sampling may be necessary to insure effective control.

2. CHLORINE MANAGEMENT

The use of chlorine for disinfection should be controlled. High dosage of chlorine may be harmful to the aquatic habitats. Dechlorination of pools and other water bodies would be required prior to draining.

3. MAINTENANCE

Each municipality should develop BMPs to prevent and control trash, debris, and other pollutants from entering water bodies. These measures could include routine trash collection along and on water bodies, public outreach to educate the public about the impacts of illegal dumping, and increase enforcement for violations.

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VI. RESIDENTIAL

INTRODUCTION

Residential activities including private vehicle washing and maintenance; use of chemicals such as pesticides, herbicides, and paints; private swimming pool maintenance; and other household and landscape maintenance can contribute to storm water pollution. These are all examples of non-point source pollution, a significant impact on water quality. Measures that can be taken to improve the quality of the runoff from residential area all require active public participation. Feasible BMPS to mitigate the stormwater pollution problem should include practicing good housekeeping and the use of environmentally sensitive alternative products, vehicle leak and spill control, and water conservation. Development of the residential stormwater program will be completed by December 1995.

A. HOUSEKEEPING PRACTICES

This BMP involves the development of a program to promote efficient and safe housekeeping practices (storage, use, and cleanup) when handling materials which may pollute stormwater/urban runoff. This could include, but are not limited to, fertilizers, pesticides, cleaning solutions, paint products, automotive products, and swimming pool chemicals.

A public education program will be developed to provide information on stormwater pollution and the beneficial effects of proper disposal on water quality; reading product labels; safe storage, handling, and disposal of hazardous products; list of local agencies; and emergency phone numbers. The above information can be disseminated through brochures or booklets made available at places such as public information fairs, municipal offices, and household hazardous waste collection events and facilities. City newsletter to residents is another means to inform the public, especially for those who do not participate or visit any offices or events.

B. ENVIRONMENTALLY SENSITIVE ALTERNATIVE PRODUCTS

This BMP, promoting the use of less environmentally sensitive products, can be implemented in conjunction with housekeeping practices. Alternatives exist for most product classes including fertilizers, pesticides, cleaning solutions, and automotive and paint products. The key to success will be to promote a willingness to try alternatives and to modify old habits.

General information will be developed and made available to the public on such alternatives. The emphasis may be placed on the need to preserve the natural environment of the receiving waters (ocean, bay, stream, wetland, etc.) with the use of alternative products because of their less toxic nature and proper disposal after its use.

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C. VEHICLE LEAK AND SPILL CONTROL

This BMP prevents or reduces the discharge of pollutants to storm water/urban runoff from vehicle leaks and spills by reducing the chance for spills, stopping the source of spills, containing and cleaning up spills, and properly disposing of spill materials.

Vehicles will leak and spill fluids. The key to successful pollution management is to reduce the frequency and severity of leaks and spills; and when they do occur, to prevent or reduce the environmental impacts. Through education, the public should be encouraged to regularly inspect and maintain their vehicles. Guidelines should be developed to inform the public on spill containment and cleanup procedures such as having absorbent material on hand and disposing the material properly.

D. WATER CONSERVATION

Water is a scarce resource, especially so in Southern California. Wasteful use of water could channel pollutants into the receiving waters. Practices such as hosing the driveway and overwatering the landscape contribute not only to stormwater pollution, but also to the depletion of our natural resource. In order to prevent stormwater pollution, the public has to be educated on the mechanics of our storm drain system - discharges into the system will flow untreated into the receiving water. They have to know that the lawn clippings they wash down the road will end up in the ocean. Public awareness of the function of the storm drain system, of the important of environmental health, and of our necessity to slow down the depletion of water resources will be a long way in reducing the pollution of stormwater/urban runoff.

Ordinances could be use to endow the related officials with legal authority to enforce water conservation. An ordinance prohibiting the wasting of water is one way of enforcement.

In addition to the specific programs and plans outlined in this report, several watershed Co-Permittees have targeted activities occurring in and around the home that tend to contribute to degradation of storm water runoff quality. A practice that carries on-the-ground pollutants directly to storm drains is misuse of exterior water, namely the overwatering of landscaping, the hosing of driveways/sidewalks and the washing of cars in driveways--all of which allow water to run down the street into the nearest storm drain.

This situation can be addressed in two ways: 1) either reduce/prevent pollutants from being placed in areas where they may be carried by water into the streets or 2) minimize the amount of water allowed to flow on impervious surfaces that are connected to the street system.

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Water conservation measures can be designed to address the issue of impervious surface water flow. While conservation has historically been used to conserve domestic water, many jurisdictions are now recognizing the additional benefit of prohibiting water flows from private properties onto the street system. All co-permittees within this watershed implement water conservation programs. Public outreach is a component of all programs, many of which carry fines for water wasting practices. Most jurisdictions encourage water efficient landscape. While some ordinances were established specifically to conserve water during periods of drought, several jurisdictions are keeping such controls in place at all times as measures to control pollution runoff.

Domestic water for much of this area is supplied by the Las Virgenes Municipal Water District. That agency promotes water conservation by providing a free exterior audit and review of sprinkler heads/systems and a free self-guided tour showing low-flow irrigation systems that can be installed at home.

Other residential programs that reduce pollution include Agoura Hills' actions encouraging property owners to fence their property to reduce the possibility of future dumping. Malibu has developed erosion control measures; the mountainous areas are particularly vulnerable to runoff during heavy rains.

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VII. PUBLIC INFORMATION AND PARTICIPATION

It is necessary to involve the public in the stormwater program for it to be effective. The outreach program should be focused on the specific needs of the individual cities. Due to the inter-relationship among the stormwater issues, the public information and participation program should be recognized as a whole, rather than a number of separate outreach programs. All public awareness efforts should clarify to the public that they are the ultimate beneficiaries of a successful stormwater management program.

A. GENERAL OUTREACH

The targeted audiences of a general outreach will include municipal employees, local construction contractors, businesses in the area, and the general public. They should be made aware of their responsibility for both the problems and the solutions to stormwater pollution. In order to effectively communicate the stormwater pollution abatement message throughout the watershed; written, audio, and visual materials should be utilized. The actual level, priority, and schedule of public information activities must be based on the community's needs and resources to maximize program effectiveness. A watershed-wide concept will be developed by December, 1995.

All Co-Permittees within the watershed acknowledge the value of public outreach. Extensive efforts have been made or are planned by every agency to supply the public with information on a full range of storm water quality activities with the intention of achieving a high level of public cooperation and participation. The cities within this watershed are particularly aggressive in promoting multi-jurisdictional programs, citing both greater effectiveness and cost savings as benefits. Westlake Village initiated a regional public education program in cooperation with Agoura Hills, Westlake Village, Thousand Oaks, Hidden Hills and Calabasas. Advantages include a uniform approach and cost savings by the elimination of redundant programs.

1. WRITTEN MATERIAL

Co-Permittees should produce a variety of written materials to inform the residents within the watershed. Materials can include, but are not limited to, the following: flyers, brochures, door-hangers, newspaper articles, mail-inserts, banners, and posters. When necessary, these materials should be translated into a variety of foreign languages to reach minority residents in the community.

Print media outreach programs have been used extensively throughout the watershed, particularly by Westlake Village, Agoura Hills, Malibu, Caltrans,

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and Ventura and Los Angeles Counties. City newsletters in Agoura Hills, Malibu and Westlake Village mailed to all residents have included articles promoting various storm water programs. Utility bill inserts are also used extensively to promote public awareness. Billboard and bus stop shelter advertising are among the programs used by Los Angeles County. Door hangers and refrigerator magnets are distributed by Malibu, Westlake Village and Los Angeles County. The County will soon have a program mascot, Chilly Willy, to be used at public events.

2. AUDIO MATERIAL

Similarly, Co-Permittees may utilize audio materials to convey information regarding stormwater management. Examples of audio materials include radio advertisements/public service announcements and informational cassettes.

When calling the City of Calabasas, a caller placed on "hold" hears public service announcements that promote various City programs, including those that affect storm water quality.

3. VISUAL MATERIAL

Catch basin stenciling program is an excellent means of educating the public on the mechanics of the storm drain system. The intent of the program is to enhance public awareness of the impact of stormwater pollution on receiving waters and to discourage improper waste disposal practices. Another effective medium for communicating the importance of stormwater management is through television. Possible measures include producing a public service announcement, cable access programs, and/or an informational video.

The most universal of the general outreach programs--catch basin stenciling--is receiving full cooperation throughout the watershed. Extensive stenciling has already been done by all watershed jurisdictions, with some having completed the task. Westlake Village and Ventura County have used custom stencils; the others have used the stencil designed by Heal the Bay and City of Los Angeles.

Among broadcast media outreach, five cities--Westlake Village, Hidden Hills, Agoura Hills, Calabasas and Thousand Oaks--jointly sponsor cable TV public service announcements. Los Angeles County uses both television and radio outreach.

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4. DISTRIBUTION PLAN

General outreach efforts must be conducted throughout the entire watershed. Materials should be available at all public counters and distributed at public events such as environmental fairs and contests. A city newsletter is another effective method of conveying the pollution abatement message.

B. FOCUSED OUTREACH

Efforts should be made to target special groups. Focus could be on specific pollutants, practices and/or activities, or businesses. A watershed-wide concept will be developed by June 1996.

1. POLLUTANT SPECIFIC

For a particular watershed, there may be priority pollutants which are of more concern than others. The reduction of these pollutants may be addressed in a more focused public education and outreach program. Any of the methods used in the general outreach program may be utilized in a pollutant specific outreach program.

2. PRACTICE/ACTIVITY SPECIFIC

Everyone who lives or works in a particular watershed must realize that their actions have a direct affect on the quality of stormwater. These special groups must be made aware that their current practices/activities may be contributing to stormwater pollution. Practice/activity specific outreach programs should be developed and implemented throughout the watershed. The use of written, audio, or visual materials should convey three primary messages: (1) what activities can cause stormwater pollution, (2) how Best Management Practices are used to prevent pollution, and (3) how one can report occurrences of stormwater polluting activities.

Practice/activity specific outreach should promote, publicize, and facilitate public reporting of illegal dumping, illicit discharges, or water quality impacts associated with discharges from municipal separate storm sewers. An effective program should include the establishment, operation, and promotion of a reporting hotline. Timely reporting by the public of improper disposal and illicit discharges are critical in controlling such sources of stormwater pollution. Increase in public involvement may be achieved by sending a follow-up letter to callers or providing callers with some type of reward. Educational efforts throughout the watershed should inform the public about the existence of the Los Angeles County-wide hotline and any other local

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hotlines; provide them with information regarding what to look for, and guidelines/procedures on how to report incidents.

Another critical component of practice/activity outreach is the development of a program to facilitate the proper management and disposal of used oil and toxic materials. An effective program could include, but are not limited to, the operation of recycling facilities and the conduction of household hazardous waste round-ups. The program could also include information about alternatives to toxic materials. Educational efforts throughout the watershed should provide the public with detailed information regarding the Los Angeles County-wide Household Hazardous Waste Round-ups and any other local programs.

The varied sources/causes of storm water pollution have resulted in implementation activities that target specific types of pollutants, activities and land uses/types of businesses. Within this watershed co-permittees take part in public information and participation programs specifically aimed at preventing improper disposal of hazardous household products and encouraging actions that keep general wastes out of the storm drain system--such as recycling programs, public trash receptacles and the cleaning of sidewalks, alleys and vacant lots. Illegal dumping and discharges are also specific targets.

Such activities are encouraged through general outreach programs (discussed above) that promote such programs as toll-free phone hotlines for reporting illegal polluting activities, topic-specific brochures, speakers bureaus, special recycling facilities (used motor oil, hazardous products, etc.) Westlake Village promotes their recycling program through homeowners associations. Malibu's focused outreach includes promotion of their Gutter Patrol program. Ventura County is modifying its "Resource Efficient Yard Care" brochure to include specific storm water runoff information; this material can be used in conjunction with their yard waste composting workshops. Los Angeles County has a wide range of focused programs that can be tailored for special exhibits and interest groups, including elementary schools. Calabasas has an Earthday recycling art contest; the City also has a recycling hotline with recorded information. Agoura Hills has produced a series of seven pamphlets that outline good housekeeping practices for the construction trades.

3. BUSINESS SPECIFIC

Due to the fact that some business operation have a higher potential of discharging pollutants into the storm drain system, a more focused public education and outreach program should be developed for them. Employees of these businesses should be educated on the issue of nonpoint source

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pollution and the effectiveness of Best Management Practices in reducing pollution. Besides written, audio, or visual materials that focus on specific businesses and their practices, mass mailings or articles in a trade/industry magazines are other possible means of focused outreach.

C. EDUCATION PROGRAMS

Increasing awareness is the major goal of the Public Information and Participation Program. An ideal means of accomplishing this task is through educational programs. Programs should be developed for a variety of audiences, including public employees and school children. Educational programs can also be an important part of a general or focused outreach. A watershed-wide concept will be developed by June 1996.

1. PUBLIC EMPLOYEES

It is important to educate all of the public employees about the stormwater program so that they do not continue with any practices that are counter productive. Furthermore, they can participate in the implementation and enforcement of the program. Ideas and suggestions of employees can be used to modify the program for improved effectiveness. The outreach must involve employees on many different levels - from program managers to field personnel. Educational programs for public employees may include, but are not limited to, articles in City newsletters, training classes, checklists for field personnel, and interdepartmental forum or committee. Any of the materials utilized in an outreach program - written, audio, or visual materials - may be used in a public employee educational program.

Both general and focused outreach are essentially programs of public education. More formal training/education is also conducted by Caltrans and the County of Los Angeles. Caltrans personnel is educated on highway maintenance--specifically on such subjects as Hazardous Substance Spill Awareness and Pesticide Safety and Vegetation Management. County personnel meet regularly to discuss development of and evaluate storm water quality practices. Malibu is developing a staff education program, specifically focusing on construction site operations. Ventura County has a hands-on watershed model for use in public presentations. That county also conducts a joint teacher workshop on water conservation and storm water pollution prevention.

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2. K-12

School children can play an important role in a public information and participation program. First, children are generally more easily motivated and the behavior changes made at that point in life tend to stay with them through adulthood. Secondly, school children can convey the stormwater pollution prevention messages to the members in their family. School programs must include information on the storm drain system, stormwater quality awareness, and may also include, but are not limited to, illegal dumping awareness, source minimization, and pollution prevention. Written material, videos, assembly programs, and field trips are examples of effective components of a K-12 educational program.

3. OTHER

Educational programs can also be developed for professionals and technicians who are not public employees. Agencies should include public outreach material for business license renewal or outreach effort through professional and business associations.

D. CITIZENS PARTICIPATION

The residents of the watershed should not only be made aware of the stormwater program, they should be encouraged to participate in its implementation. Specific outreach programs should be developed to allow the public to participate and to inform them of available means for providing ideas and comments regarding the stormwater program. A watershed-wide concept will be developed by June 1996.

Residents can assist public agencies in the development and implementation of storm water quality programs. Several watershed jurisdictions have enlisted the assistance of neighborhood volunteers in the catch basin stenciling program. Caltrans' Adopt-A-Highway program relies on voluntary private participation to help with clean-up activities. Hotline programs also enlist the assistance of residents in active participation.

1. VOLUNTEER MONITORING

Volunteer monitoring is the result of increased public awareness and participation. The public can utilize the hotline for reporting suspected illegal practices. Such involvement, which is similar to the Neighborhood Watch Program on crime, usually has good results.

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2. COOPERATIVE OUTREACH

In order to promote public participation, cooperative outreach programs should be developed. These cooperative programs should help to create an awareness and an identification with the watershed. The catch basin stenciling and other signing programs are excellent examples of this type of cooperative effort. One possibility for cooperative outreach is an "Adopt-A-" program. Residents can "adopt" a highway, storm drain, catch basin, stream, etc. Other cooperative outreach efforts include events such as "Stormwater Pollution Awareness Week." The purpose of any of these activities is to inform and involve the local residents in regards to the stormwater management program.

3. COMPLAINT PROCEDURES

Public comments/complaints are important to the success of a stormwater program. A hotline is an excellent mechanism for allowing the public to provide information. In Section B, "Focused Outreach - Practice/Activity", the various aspect of outreach effort is discussed.

E. EFFECTIVENESS EVALUATION

Permittees should develop a process to evaluate the effectiveness of their programs. Methods such as surveys and focus groups can be used to assess program's effectiveness. Results should gauge the community's level of awareness. Surveys and focus groups can also be used to provide insight into the program's direction and the formulation of attainable goals. A watershed-wide concept will be developed by June 1996.

There have been no reports of formal programs to assess program effectiveness, although staff discussions and management reviews have provided subjective evaluations that have resulted in program development and modifications.

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VIII. PROGRAM EVALUATION

The effectiveness of the storm water programs developed under the Municipal Storm Water Management Plan (hereinafter called the Plan) must be assessed on a regular and consistent basis. The Plan for this evaluation must include a schedule for evaluation, a methodology for the evaluation, a discussion of who will carry out the evaluation, and what will be evaluated. In addition, there must be a mechanism to follow up on the information generated by the evaluation. The Plan should be adjusted based on the program evaluation.

A. PERFORMANCE STANDARDS

The Permittees will develop standards to judge the effectiveness of the activities and control measures proposed under each chapter of the Plan. The standards will serve as minimum performance levels to evaluate the implementation of control measures. The subsequently developed performance evaluation procedures/methodologies will be the tool to determine if a particular BMP has an impact on stormwater quality. In developing these procedures, we resolve to ensure that each BMP is implemented to the maximum extent practicable. The targeted completion of this phase will be December 1996.

1. DEVELOPMENT OF PROCEDURES

General performance standards for evaluating the effectiveness of the Best Management Practices (BMPs) will be developed for all the BMPs proposed in the Plan. The Watershed Management Committee will be responsible for developing and adopting these evaluation criterion. The Management Committee may elect to establish subcommittees to develop performance standards for specific program areas. The area-wide Executive Advisory Committee will then review and endorse the standards. Standard recording format and implementation schedule will be developed for each BMP by the Management Committee for use by all permittees. The permittees will be required to document BMP implementation using the standard format according to an established schedule. The utilization of quantitative approaches in measuring effectiveness will be used whenever possible. Methods that would yield comparable results for year to year evaluation will be developed.

2. ACTIVITY/SOURCE/ACTION AREA SPECIFIC

Program effectiveness will be performed based on the information generated by the performance evaluation procedures. Using street sweeping as an example, the Plan will propose a method of determining if street sweeping has

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an impact on water quality. This could include determining what kind of pollutants are removed by the sweeping, measuring the size of the pollutants and the amount removed. Methodologies would be developed for each BMP, which will assure that each control measure or action is implemented to the maximum extent practicable. For street sweeping; this may include the frequency of sweeping now, the method of sweeping, the equipment used, how the equipment is cleaned and maintained, and the method of disposal for the material collected. A schedule and format of evaluation shall be developed for all the BMPs.

The Regional Board has recommended 13 Baseline BMPs, to be developed and/or implemented by all permittees by the end of the current NPDES Permit. Existing Permit Task 5.2.5 requires an evaluation of the need for additional BMPs, source control, and/or structural control measures.

BMPs have only been implemented for a short time period by Phase I and Phase II cities. Phase III, which contains 30 new cities, has not yet implemented any BMPs. Therefore there is little or no data available to adequately assess effectiveness. In lieu of recommending any changes or additions to BMPs currently being implemented or proposed by the Permittees, a uniform data collection methodology will be established for each of the 13 baseline BMPs. This methodology would be used by all Permittees to compile data on their BMP implementation to allow for a uniform Countywide evaluation of BMP effectiveness. Priority will be given to the development of a uniform data collection methodology to document the success or effectiveness of these 13 BMPs. Upon reorganization of the NPDES Permit Program, as described in Chapter I, this will be the first task addressed by the Watershed Management Committee. The Uniform data collection methodology will be developed by January 15, 1995 for the Santa Monica Bay watershed and by July 1995 for all other watersheds with subsequent implementation by all permittees in each watershed.

B. ANNUAL REPORTS

An annual report for each watershed will be submitted to the Regional Board not more than 45 days after the end of each permit year. Each annual report will include a summary on the programs implemented during the previous year and plan activities that will be implemented during the current year. Any revisions to the Plan would be addressed in the report.

1. FORMAT/STRUCTURE

In order to insure uniform annual reporting by all watersheds, the Executive Advisory Committee will develop a uniform annual report outline for use by

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each watershed. Each Watershed Management Committee will develop a standard format to be used by all the permittees in its watershed in reporting the progress and the status of all stormwater programs implemented in its jurisdiction. The Principal Permittee will utilize this information to develop the annual report for the watershed. Upon approval by the Management Committee, the annual report will be provided to the Executive Advisory Committee which will compile the annual reports from all watersheds for submittal to the Regional Board.

2. EFFECTIVENESS MEASURES

Under Chapter VIII, Section A, the permittees will have developed performance standards for each BMP. These performance standards will be used to assess the effectiveness of the BMPs. By the end of each permit year, the findings of the previous program year will be evaluated and used to suggest changes that are appropriate for implementation during the next year. Focus should also be given to the use of empirical studies, in a control setting, to more fully assess the effectiveness of BMPs.

3. CONTENT

The annual report will include a matrix illustrating the levels of implementation for all permittees. Tables will be developed for each BMP listing all the participating Co-Permittees, describing the status of implementation by each Co-Permittee of the BMP, and documenting any modifications of the BMP from the standard program. The effectiveness of each program area will be assessed using the performance standards developed under Chapter VIII, Section A. For effectiveness measures, the findings should be presented graphically for ease of comparison with the established levels of effort. Fiscal budget for all the BMPs implemented should also be prepared, grouped by programs. An analysis and evaluation of the results of the past year's monitoring program data will also be included in the report. Any revisions to the Plan should be addressed here, with all the elements affected discussed in their entirety. All relevant information, such as water samples analyses and evaluation, should be included in the appendices.

C. SEMI-ANNUAL REPORTS

A semi-annual progress report will update the Regional Board on Permit compliance activities six months into each permit year. The semi-annual report will be provided to the Regional Board within 30 days after the end of the six-month period.

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1. PURPOSE

The semi-annual report will serve as a status report on the progress of the implementation of the Plan.

2. FORMAT/STRUCTURE

In order to insure uniform semi-annual reporting by all watersheds, the Co-Permittees will use the standard format developed for the annual report in reporting the progress and status of all the BMPs implemented in their jurisdictions. The Principal Permittee will utilize this information to develop the semi-annual report for the watershed for submittal to the Regional Board.

3. CONTENT

The semi-annual report will include a matrix illustrating the levels of implementation for all permittees. Tables will be developed for each BMP listing the participating Co-Permittees, describing the status of implementation by each Co-Permittee of the BMP, and documenting any modifications of the BMP from the standard program. The permittees will describe the problems encountered during implementation and discuss the modifications to the program in order to solve these problems.

D. INTERNAL REPORTING

In order to facilitate the preparation of semi-annual and annual reports, standard internal formats for use by all Permittees will be developed. The internal reporting procedures will be completed for all Plan chapter elements by December 1996.

1. STANDARD FORMS

The Watershed Management Committee will be responsible for developing standard forms for use by each Permittee. Standard forms will be developed for each BMP to monitor its progress. Some Permittees may have to customize the standard forms in order to reflect their programs' additional features. The forms will collect all the information essential to the preparation of the annual and semi-annual reports. In developing the standard report forms, information that is quantifiable and specific for each program area and/or BMP will be collected.

2. PROCEDURES

Co-Permittees will submit all the BMP report forms to the Principal Permittee at the end of the six-month period and the permit year, respectively.

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3. RECORD KEEPING

The Regional Board does not need to see all of the extraneous information, but the records will be retained by the Principal Permittee for 2 years. Each Permittee will keep a permanent copy of its reporting forms in case they are needed.

E. STORM WATER MANAGEMENT PLAN REVISIONS

There will be an annual review process that will allow the Permittees to revise the Plan for the next year and for the rest of the permit period. Revision procedures will be developed by December 1996.

1. PROCESS

In the annual report, Permittees will compare the progress made on all the BMPs with the established level of effort. If the level of implementation is inadequate, the program should be adjusted to accelerate the progress. If the progress made to date shows that the program is ineffective or inefficient in protecting the stormwater quality, a new program should be developed and implemented for the next fiscal year and the rest of the permit period.

2. REPORTING

All refinements or revisions to be made in the fiscal year will be documented in the annual report, with the dates of implementation proposed.

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IX. MONITORING

The Monitoring Program is a critical element in the Stormwater Management Plan. It will provide important data for use in characterizing existing stormwater/urban runoff quality, guiding future development, and modifications to the Plan and also to assess its effectiveness. A watershed wide monitoring program shall be developed by December 1996.

A. SYSTEM CHARACTERIZATION

The existing Permit subdivided the County into six drainage basins with information to be collected to characterize each of the basins.

1. WATERSHED

Each drainage basin has been subdivided into numerous drainage areas, based on an evaluation of the existing drainage system and surface flow patterns. For each drainage area, the following information has been compiled: size; breakdown of existing land use; imperviousness; description of soils; location of waste disposal facilities; and the location, type, and number of industries by Standard Industrial Classification (SIC) Code. This information has been submitted to the California Regional Water Quality Control Board, Los Angeles Region, for Phases I and II. Phase III watershed characterization is in progress and will be completed by the end of December 1994. Due to the volume of the watershed characterization data, this information has not been included herein, but is available for review at either the Regional Board or the Los Angeles County Department of Public Works.

This information will provide a basis for developing other monitoring program elements such as pollutant loading estimates from major land uses and watersheds; pollutant source identification, and identification of illegal discharges/illicit disposal practices.

2. STORM DRAIN SYSTEM

In subdividing each basin into drainage areas, the drainage area tributary to all major outfalls has been identified. Within each drainage area, the tributary storm drain system is being identified and mapped. Key information such as the size of the storm drain facilities, locations of manholes and inlets, and storm drain connections is being compiled. This information will be vital in conducting storm drain inspections to identify and eliminate illegal discharges.

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3. RECEIVING WATERS

Due to the extent of urbanization in Los Angeles County over the past decades, most of the streams designated as receiving waters in the Los Angeles basin have been replaced with man-made storm drainage systems to provide flood protection to the urbanized areas. These streams have been mapped as part of the storm drain system mapping done under A.2. above. The remaining natural streams are also being mapped.

The Los Angeles County Department of Public Works (Department) has been performing surface water quality monitoring on a voluntary basis since the late 1960s. Samples have been collected and analyzed from various receiving water streams and channels throughout the County to collect general information as to the quality of the surface runoff within our storm drain system.

The program in existence at the time the current Permit was issued was established in the mid 1980s. Twenty-eight sites are sampled monthly for dry weather flows. Twenty-one of the 28 sites are sampled for storm flows up to five times per year. The collected samples are analyzed for general minerals, pH, total dissolved solids, specific conductance, biochemical oxygen demand, bacteria, heavy metals, pesticides, PCBs, total organic carbon, volatile organic compounds, and total petroleum hydrocarbons.

The sample collection at these sites will continue while the new National Pollutant Discharge Elimination System (NPDES) Permit monitoring stations are established. Once all NPDES Permit monitoring stations are operational, sampling at these 28 sites will be discontinued.

In order to provide an initial assessment of the water quality in the major streams and channels in the County, an analysis has been performed on the data collected through the existing surface water monitoring program. The analysis has been done on a Countywide basis and also by major drainage basin. The report can be found in Volume 8.

To better assess the receiving water impacts of stormwater the Department will be developing a program to further study stormwater impacts on selected receiving waters, including conducting toxicity studies. Initial efforts will focus on the Santa Monica Bay Watershed. A Request for Proposal for the development of such a program will be advertized by January 15, 1995.

The water quality data collected by the new NPDES Monitoring Program will provide more detailed data to better assess in upcoming years the quality of our receiving waters. Ten monitoring stations have been proposed along the

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major streams in the County. A description of these site locations can be found in the monitoring work plans for Phases I, II, and III, previously submitted to the Regional Board, see Volume 8.

4. LAND USE

As described under Section A.1. above, the existing land use categories within each drainage area have been identified. This information has been used to select drainage areas comprised of a single homogeneous land use for land use specific monitoring. A total of 14 land use monitoring sites are being established in the County. Five sites are being installed in the Santa Monica Bay Watershed with the remaining nine to be selected from within the Los Angeles, San Gabriel, and Santa Clara River Watersheds. For a description of the sites, please see Volume 8. These sites will provide valuable information as to the types and levels of pollutants found in runoff from various land uses. This information can then be used to refine the Stormwater Management Plan to develop specific management measures to target identified problems.

B. SOURCE IDENTIFICATION

Identifying the sources of stormwater pollutants from both specific land uses and specific activities will provide the information needed to identify problem areas and allow specific management measures to be developed to address these problems.

1. SPECIFIC LAND USE

As described in Section A.4. above, major land use classifications will be subject to individual monitoring to determine the types and levels of pollutants present.

2. SPECIFIC ACTIVITIES

a. A pollutant source identification program will be designed to identify significant pollutant sources (i.e., parking lots, industrial activities, etc.), with the hope that remedial action can be undertaken to reduce any significant impacts so identified. It will focus on monitoring very small areas (i.e., less than five acres) where a specific and/or interrelated set of pollutant generating activities are occurring. Its objective is to provide data for selecting BMPs for specific activities rather than characterizing discharges for long-term pollutant loading estimates.

Identification of pollutant sources can be done using a number of methods. Potential sources of storm water pollutants can be identified

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by records of chemical use and/or storage, by studies of specific activities which lead to the deposition of pollutants throughout the watershed, and by field inspection or monitoring. Watersheds which may contain significant pollutant sources can be identified through land use information or by mass loading estimates.

By mid January 1995, the County will begin targeted monitoring of a municipal corporation yard in the Santa Monica Bay Watershed. A full program for pollutant sources identification will be developed by December 1996.

b. A storm drain inspection program has also been developed and is being implemented. The first phase of the inspection program will target the open channel storm drains to identify illegal discharges.

The open channel inspections will also be used to screen outfalls from underground storm drains for the presence of dry weather flows. This information will be used in the next phase of the storm drain inspection program to prioritized the underground storm drain system for further field screening and inspection of problem areas.

C. CONTROL MEASURE EFFECTIVENESS

It is unlikely that the effectiveness of the various control measures implemented by the storm water management plan can be determined solely through the data produced by monitoring the quality of storm drain flows, because it is difficult to obtain statistically significant comparisons of watershed-wide control measure performance with such data. For this reason the effectiveness of control measures will be assessed through other means.

Two general types of methods are available for assessment of control measure effectiveness: direct water quality (conventional) monitoring and indirect (non-conventional) monitoring. Direct water quality monitoring can be used to determine pollutant reduction by a specific facility or devise. This technique is commonly used for structural or treatment controls, such as detention basins and constructed wetlands, where there is an accessible inflow and outflow. Inflow and outflow results are compared to determine pollutant removal and effectiveness.

Direct water quality monitoring of site runoff before and after implementation of non-structural control measures is also possible. However, it is difficult to demonstrate effectiveness at a statistically significant level because of the high degree of variability in stormwater pollutant concentration and mass loading data. The water quality improvement due to non-structural control measures is generally expected to be less dramatic than that achieved through structural controls. A larger

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number of samples is therefore required to produce a statistically significant result. This is especially difficult in relation to the monitoring of the pre-control measure condition. Collection of adequate baseline information is necessary prior to the implementation of management practices. Direct monitoring of the effectiveness of non-structural controls is feasible typically only under experimentally controlled conditions (e.g., selection of small, well-defined watershed; control of management practice implementation; effective sitting and timing of monitoring activities), including a sufficient number of samples to achieve statistical significance.

Indirect monitoring currently is the primary method of choice of assessment of management plan effectiveness. A number of indirect monitoring techniques are available for assessment of management plan effectiveness.

Verification of program implementation is an indirect monitoring method that can be used to determine how a management plan is being implemented. Another indirect monitoring method, pollutant removal inventories, can be used to assess the amounts of pollutants that have been prevented from entering the municipal storm drain system.

The 13 Baseline BMPs recommended for implementation by the Regional Board plus other BMPs proposed by the various Co-Permittee are in general all non-structural control measures. In the short-term, a uniform data collection methodology will be developed for use by all Permittees to compile information on the level of implementation of the 13 Baseline BMPs. This will allow for a uniform watershed-wide evaluation of BMP effectiveness. For the Santa Monica Bay watershed, this uniform data collection methodology will be developed and begin implementation by January 15, 1995. For the other watersheds, implementation would begin July 1, 1995.

For the long-term, as the various chapters of the Plan are more fully developed, possibilities for the use of direct water quality monitoring for control measure assessment will be evaluates as opportunities arise.

D. POLLUTANT LOADING

One of the objectives of the monitoring program is to estimate the annual pollutant loadings from each watershed. Knowing the types and quantities of pollutants discharged into receiving waters are important in assessing the impacts of stormwater and, in turn selecting appropriate control measures to address problem areas.

The 24 permanent monitoring stations that are being established Permit-wide will be utilized to estimate pollutant loads from each watershed and also from various land uses. For a description of the methodology to be used to estimate pollutant loadings, please see Volume 8. For the Santa Monica Bay Watershed, the pollutant loading

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model will be tested and operational by January 15, 1995. Actual pollutant loadings will be calculated subsequent to storm events occurring for which water quality data has been obtained. For the other watersheds, a schedule for pollutant load modelling will be provided by January 15, 1995.

To more closely model pollutant loadings and evaluate control measure impacts, a more detailed dynamic modelling will be undertaken on a smaller, representative sub-watershed. The EPA-SWMM model has been selected for use in our dynamic modelling efforts. For the Santa Monica Bay Watershed, the Kenter Canyon Drain sub-watershed has been selected for this modelling efforts. This sub-watershed is typical of the urbanized areas in the Santa Monica Bay Watershed. It is comprised of multiple land uses, has well-defined boundaries, and has no upstream flow regulation. We are reviewing and identifying the existing drainage system, defining current and future land uses, and conducting field checks. The model will be tested and operational by January 15, 1995, with actual modelling results to be available later when local water quality data from our monitoring stations becomes available. Based on the results of the dynamic modelling of the Kenter Canyon sub-watershed, other sub-watersheds may be selected from the other major watersheds in the County.

E. COMPONENTS OF A MONITORING PROGRAM PLAN

The components of the monitoring program plan such as monitoring site locations, dry/storm sampling frequency and methodology, constituents to be sampled, field and laboratory procedures, QA/QC, etc., can be found in Volume 8 which has been previously provided to the Regional Board.

The Monitoring Program elements described in Volume 8 will be revised to address the Monitoring Program needs described in Section A - D above as agreed to in the letter from the County to the Regional Board dated September 22, 1994.

As the various chapters of the Plan are more fully developed, the Monitoring Program will be revised to address any additional monitoring needs that may result

F. DATA MANAGEMENT

For water quality data collected at the 24 monitoring stations, please see Volume 8 for data storage and reporting methods.

For each Section A - E of the Monitoring Program described above, an annual report will be prepared detailing the data collected, with an evaluation and interpretation the data including water quality impacts.

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NPDES PERMIT NO. CA 0061654

TASK 5.2

REPORT OF WASTE DISCHARGE (ROWD)



VOLUME 3 OF 8 (TASK 5.2.5 - 5.2.6)

SANTA MONICA BAY - BALLONA CREEK AND OTHER URBAN AREAS STORMWATER MANAGEMENT PLAN

LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS
WASTE MANAGEMENT DIVISION
WATER QUALITY SECTION

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SANTA MONICA BAY:
BALLONA CREEK AND OTHER URBAN AREAS
STORMWATER MANAGEMENT PLAN

INTRODUCTION

On June 18, 1990, the National Pollutant Discharge Elimination System (NPDES) Permit - Order #90-079, NPDES #CA0061654-CI6948 was issued to the County of Los Angeles and 17 cities tributary to Santa Monica Bay. During the subsequent years, two newly incorporated cities within the Santa Monica Bay Watershed, Caltrans and the County of Ventura also became Co-Permittees. This Permit outlined a three-year program which required each Permittee to: characterize drainage areas; develop and schedule the implementation of Best Management Practices to enhance the quality of stormwater/urban runoff within its jurisdictional boundaries and storm drains it owns and operates. On July 1, 1992, 36 additional cities were initiated into the Permit and began their three year program. By July 1, 1993, the remaining 30 cities in Los Angeles County within the drainage basin were initiated into their three year program. The cities were grouped according to their starting dates and referred to as Phases I, II, and III respectively (See Table A). In general, the boundaries of each Phase did not encompass whole watersheds but portions of various watersheds (See Figure 1).

The Permit has a five-year duration and although Phase III cities have only completed year one of their three year program, the Permit requires the submittal of a Report of Waste Discharge (ROWD) which serves as an application for a subsequent NPDES Permit to replace NPDES Permit #CA0061654, which will expire on June 18, 1995. Therefore, the County of Los Angeles, Ventura County, Caltrans, and the 85 cities are now parties to the subsequent NPDES Permit application utilizing the Municipal Stormwater Management Plan (herein after called the Plan) concept.

The Plan is based on the Stormwater Management Plan Components developed by the California Regional Water Quality Control Board, Los Angeles Region (Regional Board), and is proposed on behalf of the County of Los Angeles and the other participating agencies, see Table B.. The Plan describes the stormwater management activities to be undertaken during the next single, five-year NPDES Municipal Stormwater Permit. The Plan involves the subdivision of the area of the County under a single new Permit, into six watersheds, each with its own stormwater management plan. For these watersheds and the agencies in each of these watersheds, see Table B and Figure 2.

As required by the current Permit, all Permittees have proposed BMPs for their jurisdictions, described in Volume One and under prior submittals made to the Regional Board. These BMPs have already addressed many of the program areas discussed under the stormwater management plan. As required by the current Permit and continuing on under the new Permit, the Permittees will continue to implement these BMPs. This stormwater management plan will involve reorganizing the individual city-based BMP programs into a single stormwater plan for each watershed. The timeline shown in this

document reflects the time needed for the transition from individual city-based programs to the preparation of a mutually agreed upon and collectively developed watershed plan by all parties of the new Permit for each of the watershed areas. The first step in beginning this process will be the reorganization of the current three-phase program into a new watershed based program. A reorganization of the Phases into watersheds which are based on hydrologic characteristics will allow for the consistent development and implementation of programs among Permittees, referencing land use and drainage infrastructure within their respective watersheds. Consistency of programs throughout the watershed will be beneficial in terms of targeting specific pollutant problems and areas.

This watershed is within the targeted area of the Santa Monica Bay Restoration Project (SMBRP), which was formed in 1988 when Santa Monica Bay was included in the National Estuary Program (NEP) as one of seventeen significant estuaries or coastal water bodies nationwide. The SMBRP has developed the Santa Monica Bay Restoration Plan, which identifies 74 Priority Actions to be implemented within the SMB Drainage Basin to improve the quality of Santa Monica Bay. The SMBRP has released its draft plan in April 1994 for public review, to be completed by the end of this year. Upon approval of U. S. Environmental Protection Agency, the State Water Resources Control Board, and other agencies, the priority actions discussed in the plan will be implemented by a variety of agencies and parties. Detailed development of the stormwater management plan for this watershed will incorporate those Priority Actions targeted for the improvement of stormwater/urban runoff quality.

This specific Plan will address the stormwater management issues for the Ballona Creek and Other Urban Areas watershed, which include the following cities and agencies:

- **Beverly Hills**
- **Caltrans**
- **Culver City**
- **El Segundo**
- **Hermosa Beach**
- **Los Angeles**
- **Los Angeles County**
- **Manhattan Beach**
- **Palos Verdes Estates**
- **Rancho Palos Verdes**
- **Redondo Beach**
- **Rolling Hills**
- **Rolling Hills Estates**
- **Santa Monica**
- **West Hollywood**

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TABLE A

Grouping of Permittees by Phases

PHASE I

Agoura Hills
Beverly Hills
Calabasas
Caltrans***
Culver City
El Segundo
Hermosa Beach
Inglewood
Los Angeles***
Los Angeles County***
Malibu
Manhattan Beach
Palos Verdes Estates
Rancho Palos Verdes
Redondo Beach
Rolling Hills
Rolling Hills Estates
Santa Monica
Torrance
Ventura County
West Hollywood
Westlake Village

PHASE II

Alhambra
Arcadia
Azusa
Baldwin Park
Bradbury
Burbank
Calabasas*
Caltrans***
Claremont
Covina
Diamond Bar
Duarte
El Monte
Glendale
Glendora
Hidden Hills
Industry
Irwindale
La Canada Flintridge
La Habra Heights
La Puente
La Verne
Los Angeles***
Los Angeles County***
Monrovia
Montebello
Monterey Park
Pasadena
Pomona
Rosemead
San Dimas
San Fernando
San Gabriel
San Marino
Sierra Madre
South El Monte
South Pasadena
Temple City
Walnut
West Covina

PHASE III

Alhambra**
Artesia
Bell
Bell Gardens
Bellflower
Caltrans***
Carson
Cerritos
Commerce
Compton
Cudahy
Downey
El Segundo*
Gardena
Glendale**
Hawaiian Gardens
Hawthorne
Huntington Park
Inglewood*
La Canada Flintridge**
La Habra Heights**
La Mirada
Lakewood
Lawndale
Lomita
Long Beach
Los Angeles***
Los Angeles County***
Lynwood
Maywood
Montebello**
Norwalk
Palos Verdes Estates*
Paramount
Pasadena**
Pico Rivera
Rancho Palos Verdes*
Redondo Beach
Rolling Hills*
Rolling Hills Estates*
Santa Clarita
Santa Fe Springs
Signal Hill
South Gate
South Pasadena**
Torrance*
Vernon
Whittier

Note:
* The agency is also in Phase I.
** The agency is also in Phase II.
*** The agency is in all Phases.

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FIGURE 1

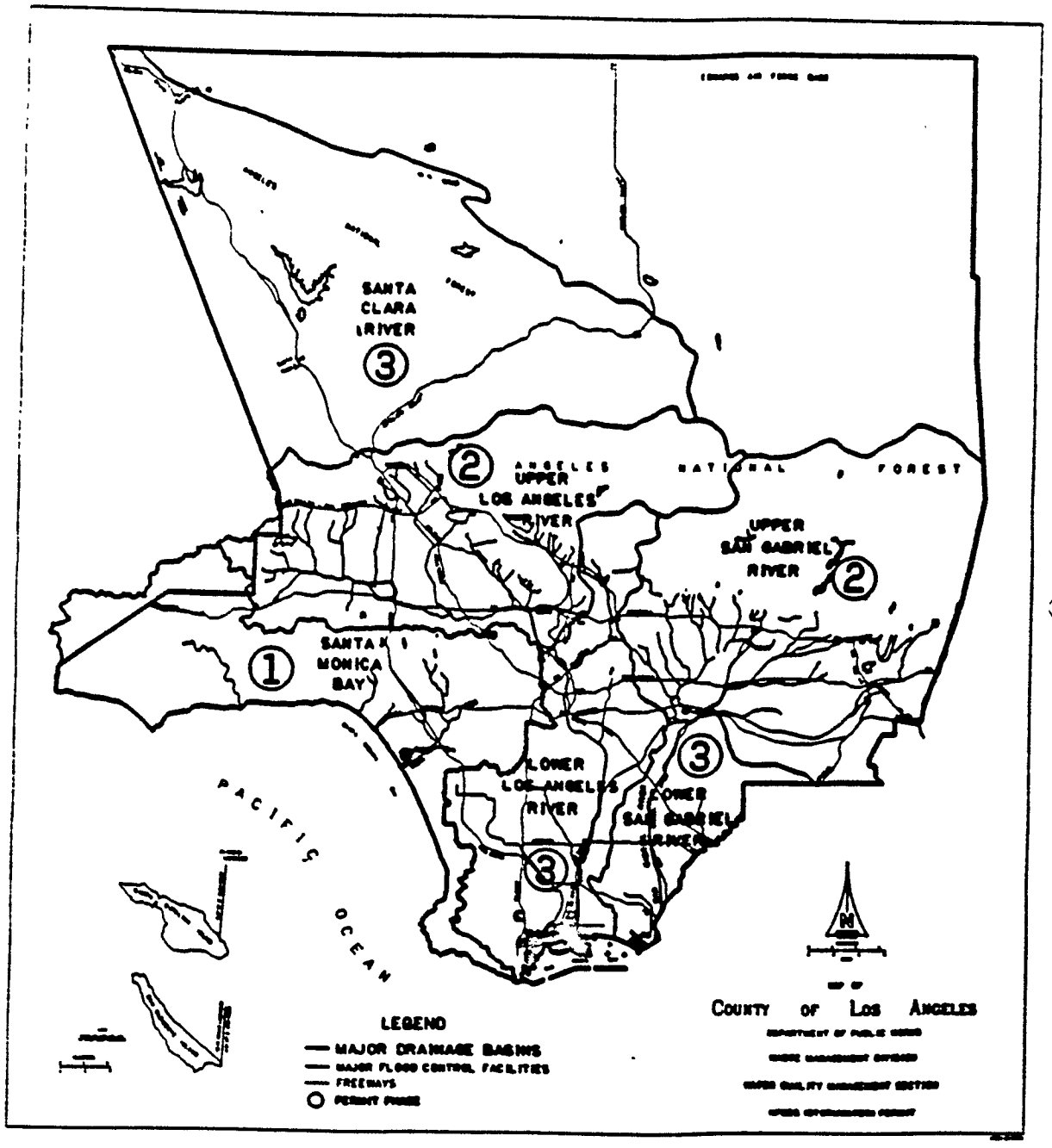

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TABLE B

NPDES Stormwater Permit Renewal
Proposed Watershed Breakup

Santa Monica Bay

Malibu Creek and Other Rural

Agoura Hills
Calabasas
Caltrans
Los Angeles County
Malibu
Westlake Village
Ventura County

Ballona Creek and Other Urban

Beverly Hills
Caltrans
Culver City
El Segundo
Hermosa Beach
Los Angeles
Los Angeles County
Manhattan Beach
Palos Verdes Estates
Rancho Palos Verdes
Redondo Beach
Rolling Hills
Rolling Hills Estates
Santa Monica
West Hollywood

Dominguez Channel/ Los Angeles Harbor Drainage

Caltrans
Carson
Gardena
Hawthorne
Inglewood
Lawndale
Lomita
Los Angeles
Los Angeles County
Torrance

Los Angeles River

Alhambra
Arcadia
Bell
Bell Gardens
Burbank
Caltrans
Commerce
Compton
Cudahy
El Monte
Glendale
Hidden Hills
Huntington Park
La Canada Flintridge
Long Beach
Los Angeles
Los Angeles County
Lynwood
Maywood
Monrovia
Montebello
Monterey Park
Paramount
Pasadena
Rosemead
San Fernando
San Gabriel
San Marino
Sierra Madre
Signal Hill
South El Monte
South Gate
South Pasadena
Temple City
Vernon

San Gabriel River

Artesia
Azusa
Baldwin Park
Bellflower
Bradbury
Caltrans
Cerritos
Claremont
Covina
Diamond Bar
Downey
Duarte
Glendora
Hawaiian Gardens
Industry
Irwindale
La Habra Heights
La Mirada
La Puente
La Verne
Lakewood
Long Beach
Los Angeles County
Norwalk
Pomona
Pico Rivera
San Dimas
Santa Fe Springs
Walnut
West Covina
Whittier

Santa Clara River

Caltrans
Los Angeles County
Santa Clarita

Italicized agencies are present in more than one watershed.

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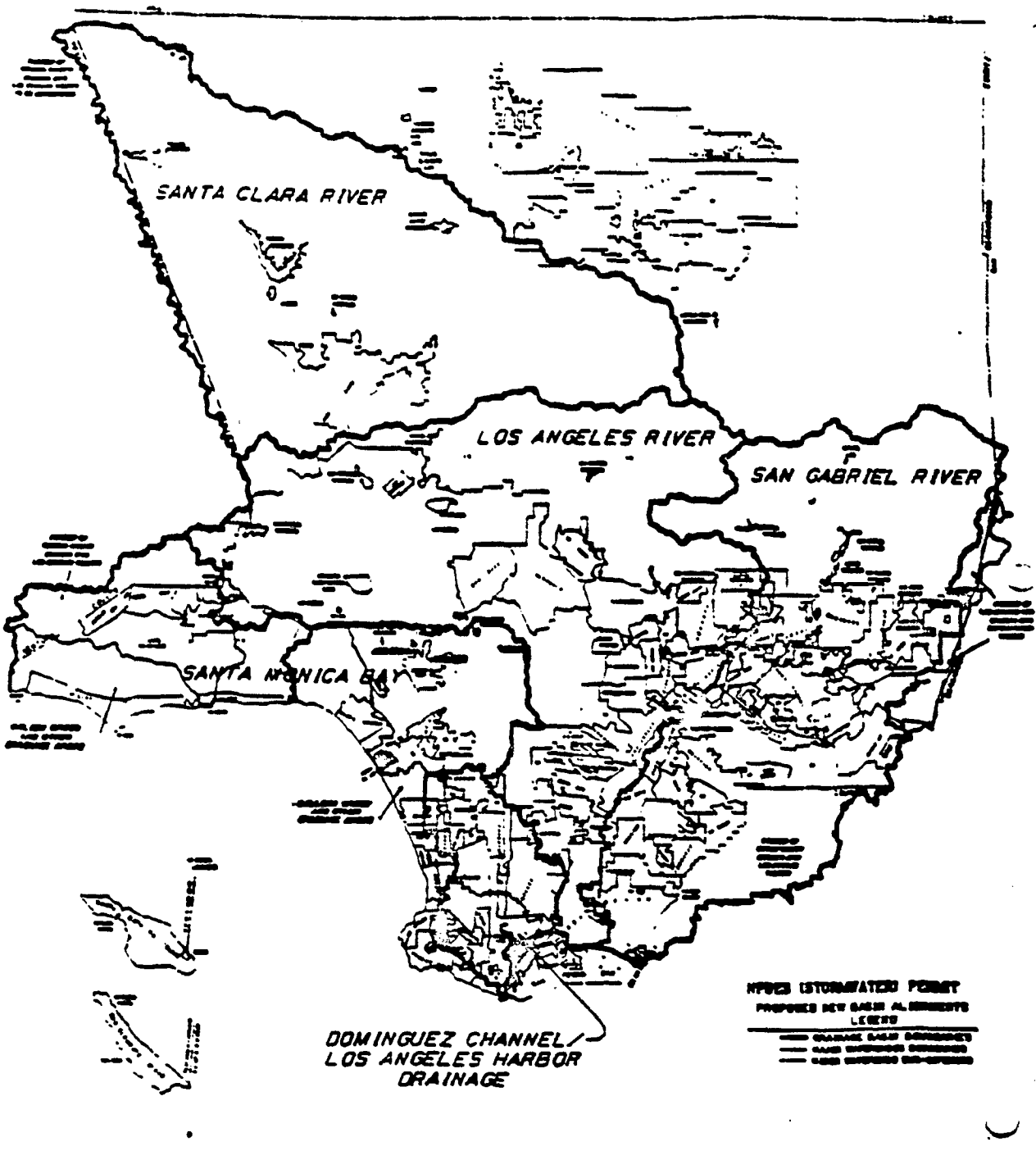
FIGURE 2



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I. PROGRAM MANAGEMENT

A. PROGRAM STRUCTURE

The County of Los Angeles is designated as the Principal Permittee. The other agencies are designated as Co-Permittees. The following are conditions that establish the responsibilities of all Permittees.

1. RESPONSIBILITIES OF PRINCIPAL PERMITTEE

Anticipated duties of the Principal Permittee include:

- Being the coordinators of permit activities and chairing the area-wide Executive Advisory Committee and the Watershed Management Committees;
- Providing the resources necessary for development of the stormwater management plan;
- Providing technical and administrative support for both the Executive Advisory and Management Committees;
- Implementing the monitoring program;
- Providing the resources necessary for developing annual reports including evaluating monitoring program data and BMP effectiveness;
- Complying with all the responsibilities of a Co-Permittee as outlined below.

2. RESPONSIBILITIES OF ALL CO-PERMITTEES

Each Co-Permittee is designated a number of duties under the proposed stormwater management plan:

- Participate in the development of the stormwater management plan;
- Implement the stormwater management plan within their jurisdictional boundaries and the storm drains they own and operate;
- Provide information needed by the Principal Permittee on program implementation for development of the annual reports.

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The area under the Permit will be subdivided into the six watersheds tributary to the following waterbodies: Santa Monica Bay, which is further divided into a) Malibu Creek and Other Rural Areas, and b) Ballona Creek and Other Urban Areas; Los Angeles River; San Gabriel River; Dominguez Channel/Los Angeles Harbor Drainage; and the Santa Clara River (See Figure 2). Managing these watersheds is a task that will require a collective and cooperative effort on the part of all governmental entities named in the Permit that are within each watershed.

The management structure of the Plan consists of an area-wide Executive Advisory Committee, Watershed Management Committees, and Subcommittees. This particular structure is intended to provide a suitable program for the unique characteristics of each watershed and shall be developed by April 1995.

The Co-Permittees tributary to the Ballona Creek and Other Urban Areas watershed shall adopt this watershed stormwater management program structure as a guide to allow for an area-wide uniformity of compliance of the Permit.

3. EXECUTIVE ADVISORY COMMITTEE

The area-wide Executive Advisory Committee shall consist of the County of Los Angeles, as Chair, and two representative Co-Permittees from each of the six watersheds. This Committee assumes no responsibility for the adequacy or inadequacy of any individual city's program and should not be viewed as the responsible agency in this sense. The Committee's main role is to facilitate programs within each watershed and to enhance consistency among all of the programs. Additional responsibilities of the committee are:

a. Making recommendations on area-wide issues to each of the Watershed Management Committees;

b. Reviewing the stormwater management plans as developed by each Watershed Management Committee and provide direction and guidance on the plans for consideration by the Watershed Management Committees;

c. Assessing the consistency of all area-wide BMPs;

d. Preparing and forwarding unified submittals to the Regional Board upon receipt of information and materials submitted by the Watershed Management Committee in compliance with Permit requirements;

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e. Scheduling and coordinating meetings and correspondence to allow for communication between the Co-Permittees and the Regional Board;

f. Acting as liaison between all Permittees and the Regional Board on Permit issues as well as mediating conflict among the Permittees.

4. WATERSHED MANAGEMENT COMMITTEE

A management committee within the watershed will be comprised of the County of Los Angeles, as Chair, and one representative from each of the Co-Permittees in the watershed. The committee shall be responsible for:

a. Establishing goals and objectives for the watershed;

b. Preparing the stormwater management plan for the watershed (This includes the development of all chapter components of the Plan);

c. Assessing the effectiveness of the plan and making appropriate changes;

d. Preparation of the semi-annual progress reports and annual Permit reports on Permit activities within the watershed for submittal to the Regional Board (For the annual Permit report, a draft will be circulated to each Co-Permittee and the Executive Advisory Committee for its review and comment. Final copies of reports shall be forwarded to the Executive Advisory Committee through which a compilation from all six watersheds shall be submitted to the Regional Board);

e. Enhancing the implementation of the storm water management plan within the Ballona Creek and Other Urban Areas watershed.

5. SUBCOMMITTEES

Subcommittees will be established where needed as determined by the Management Committee and/or the Executive Advisory Committee. The Subcommittees would be focused on specific program areas and can provide more specific oversight on the development, implementation, and evaluation of selected program areas. These subcommittees shall be scheduled to meet on a routine basis.

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B. INSTITUTIONAL ARRANGEMENTS

Management of the stormwater program requires the collective efforts and the cooperation of all Permittees. No Permittee has the ability and the legal authority to assume the responsibility of all activities of this Permit. Therefore, agreements will need to be formally developed amongst the Permittees to insure proper implementation of the Permit requirements.

1. PROGRAM PARTICIPANT ARRANGEMENTS

As the Principle Permittee, the County of Los Angeles will be designated as the lead agency for coordination of Permit activities and therefore shall chair the executive committee and the management committee meetings as they are scheduled. The lead agency is responsible for coordination of the Permit but is not responsible for the adequacy or inadequacy of any individual Permittee's program. All other entities are Co-Permittees and will be responsible for the Permit compliance of their own agency's program. An implementation agreement will be drafted formally detailing the responsibilities of the Principal Permittee and the Co-Permittees. The agreement would also address the funding of various watershed-wide activities such as plan development, annual evaluation and reporting, and monitoring. Execution of the agreement by all Permittees is targeted for December 1995.

2. AREA-WIDE INTERAGENCY

As the Plan for each watershed is more fully developed, the Watershed Management Committee will coordinate with special agencies and districts that also regulate and/or perform activities addressed under different elements of the Plan. This coordination will attempt to ensure that their functions and the Plan are compatible. A few of these agencies include:

County Hazmat

- Any overlap of waste regulations, Household hazardous waste programs and or Industrial inspections shall be recognized and addressed, by all entities that fall under this Permit, in reference to the watershed program.

County Health

- Inspections of restaurants and other food handling establishments shall be coordinated with the Permittees.

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Local Transportation/Congestion Management

- Local municipalities have limited authority over motor vehicle usage and regional transportation planning. Where feasible, plan development and implementation will be coordinated with local transportation agencies.

County (Regional) Parks

- Landscape maintenance activities at public-owned parks will be reviewed as part of additional plan development to ensure the use of proper management measures.

Mosquito Abatement

- Coordination with the County Agricultural Commissions will be done for mosquito abatement programs to avoid adverse impact on the quality of stormwater/urban runoff.

Water Districts

- Activities with regards to the Water Districts activities will be reviewed and, when feasible, comply with the watershed program regulations and requirements.

Other entities, both private and public which have major land holdings and/or authorities that impact the quality of stormwater/urban runoff should be initiated to participate actively in the program.

3. CITY-SPECIFIC INTERAGENCY ARRANGEMENTS

Each city will need to develop the institutional framework to address operation, maintenance, construction, redevelopment, and other activities performed by city agencies such as Public Works, Parks and Recreation, Planning, and Public Owned Treatment Works (POTWs). These city agencies will need to participate in the planning and implementation of relevant plan program areas.

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C. FISCAL RESOURCES

As each of the Plan chapters are completed, each Permittee will develop a budget for implementing that portion of the Plan. A complete budget for the Plan will be produced upon completion of development for all Plan components by December 1996. The budget will provide information such as funding sources, staff resources, contract services, and cost sharing arrangements.

1. AREA-WIDE

In implementing the Plan, the Permittees may elect to jointly fund a single program for certain BMPs, such as Public Education, that are area wide in nature. Funding agreements including budgets and cost per agency would be developed.

2. CITY-SPECIFIC

Each Permittee will develop a budget detailing the cost of implementing Plan activities within its jurisdiction. Special funding in the form of grants, donations, or other forms of contribution should also be actively pursued to assist in funding special studies and/or BMPs.

D. LEGAL AUTHORITY

Each Permittee is responsible for implementing the Plan within its jurisdictional boundaries and therefore must acquire all needed legal authority. Each Permittee, being separate legal entities, are to have adopted as required by the existing Permit, ordinances that will provide them with the adequate legal authority to develop, administer, implement, and enforce storm water/urban runoff management programs within their own jurisdiction. The ordinance must provide for its enforcement and at a minimum specify that violators may be subject to penalties including, but are not limited to, fines and termination of the activity causing the violation. A plan for identifying any additional legal authorities needed by the Permittees will be included in the completed Plan for the Ballona Creek and Other Urban Areas watershed by December 1995. Upon completion of development of the Stormwater Management Plan, enforcing compliance with the Plan will be the responsibility of the Regional Board.

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II. ILLICIT DISCHARGES

The elimination of illegal connections and illicit disposal (IC/ID) practices is an important component for any program aiming to enhance the quality of stormwater/urban runoff.

Although more information is needed to assess fully the benefits and costs of conducting IC/ID programs, we can make logical decisions regarding application of best management practices (BMPs) to minimize such incidents. These BMPs will vary due to the jurisdictional differences which exist within each watershed. Each jurisdiction within the watershed will be developing and implementing those activities which adequately serve the jurisdiction and the watershed as a whole.

IC/ID practices are intermittent discharges of pollutants into the storm drain system that can degrade the quality of receiving waters. This can occur through catch basins, area drains and even on gutters and street surfaces. Some illegal dumping activities are done by individuals who do not know that such practices are illegal and can adversely impact the environment. Yet, others may be carrying out such practices with the full knowledge that such activities are prohibited.

A. ILLICIT CONNECTIONS

In order to implement an illicit connection management program, jurisdictions as a whole will need to develop and implement the procedures for investigating each of their respective storm drain systems.

Detailed procedures to eliminate illicit connections depends on the complexity of the storm drain system. A consistent watershed wide concept will be developed to investigate illicit connections to the storm drain system. Based on the results of field screening activities, or other appropriate information which indicates an area of reasonable potential of containing illicit connections, detection and follow up procedures would be followed. Priority should be established to focus on major problem areas and allow for a cost-effective approach to eliminate illegal connections. This concept will be developed by December 1995.

1. SYSTEM SURVEY

A system survey is a necessary component of an illicit connection elimination program. Although the basic concept is similar, the actual techniques and methods which jurisdictions within the watershed use to conduct system surveys can be quite different.

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In conducting system surveys, the intent is to avoid costly investigations within areas not suspected of containing illicit connections. Field screening, map research, and land use investigation activities will be done initially to identify potential problem areas. Public outreach efforts will be used to inform citizens in the area about the problem. Enforcement action will be taken to terminate such illegal connections. It should be noted that more detailed and sophisticated techniques such as televised inspection and dye testing will only be used in special situations as needed.

Two jurisdictions, Los Angeles County and the City of Los Angeles have undertaken system surveys. The County is preparing maps showing the location of each storm drain, its manholes, and catch basin connector pipes. The location and source of discharge for all connections is being inventoried and a GIS system is also being developed. This information will be used in the storm drain inspection program which is ongoing. The program is targeting open channel storm drains. All open channels will be inspected for evidence of illegal discharges. The open channel inspections will also be used to collect information on dry weather discharges from underground drains for use in prioritizing future underground drain inspections.

Los Angeles has a comprehensive program in operation to identify all outfalls in the storm drain system and their tributary drainage areas for possible incorporation into a database. Visual observations and outfall samplings are used to identify and prioritize drainage areas for investigation of pollutant discharges. The City is also in the process of ongoing system inspections. Storm drain lines are inspected to stop discharge of pollutants from specific facilities by monitoring maintenance holes around suspected sources. Additionally, closed circuit television of storm drain interiors, provided by a contracted vendor on a "on call" basis, to detect cracks, misalignments, deposits, debris and illegal/illicit connections is underway. These programs will provide related information which will be used as reference materials for the development of a watershed wide program.

2. ONGOING SYSTEM INSPECTIONS

Ongoing system inspections for illicit connections will involve the techniques identified in Section 1. above, along with some additional activities. In smaller systems where the storm drain goes into several pumping stations, a regular inspection of the pumping stations for, among other things, evidence of illicit discharges will be sufficient.

In larger and more complex systems, a program of field screening will be used. Evidence of pollution will be categorized and prioritized. The storm drain alignment tributary to the suspect illegal connection can then be further

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investigated for illicit connections. If a discharge can be traced to a particular facility, the facility will be investigated to identify where exactly the pollutants are coming from and efforts needed to stop the discharge.

Another means of detecting illicit connections may be to rely on reports of illicit discharge from the public. This will utilize the County's or another agency's established "hotline" number that the public can call and report such observations.

3. REPORTING

A consistent recording system will be established to track reports of illegal connections. This recording system will be used by the Permittees within the watershed.

B. ILLEGAL DUMPING

Due to the intermittent and unpredictable nature of illegal dumping, apprehension rate of violators could be quite low at the outset. The first course of action is to develop an area wide educational and reporting system along with prompt response procedures. This will be accomplished by December 1995.

1. OUTREACH

Hotlines for reporting illegal dumping, plus an outreach program to publicize the phone numbers, can be very effective. The County has established an 800 hotline for reporting illegal dumping. Nine cities have additional hotlines, generally a 24 hour City Hall phone number. It is also possible to make reports to the Fire Department, Police and City Engineer in some cities. All the cities in the watershed have some type of outreach program to publicize the reporting hotlines. Methods include: an outreach brochure, door hangers, cable television announcements, banners on city streets and articles and phone numbers printed in city newsletter. The city newsletter was the most widely used. The cities of Los Angeles, Santa Monica and West Hollywood, as well as Los Angeles County, have extensive outreach programs.
See **Chapter VII Public Information and Participation** of this report for a detailed discussion of the outreach program.

2. SYSTEM SURVEILLANCE

Measures that may be used for this aspect of the program may include but not limited to regular inspections of vacant facilities, street use inspection programs to detect illegal discharges and dumping into the street system, and a public complaint and reporting system.

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Caltrans and Los Angeles have begun system surveillance programs. Caltrans inspects excess land parcels to identify and remediate hazardous waste and debris dumping. The Los Angeles Bureau of Street Maintenance enforces violations of excess water and other fluids into the street system, primarily on a complaint only basis.

3. SPILL RESPONSE

The Health Hazardous Materials Division (HHMD) of the Los Angeles County Fire Department is generally the primary spill responder. If the material is found to be hazardous and poses an imminent threat to public health and safety, the cleanup and disposal of the material will be done under the supervision of HHMD. If the material is non-hazardous, the responsibility will fall on local agencies to coordinate cleanup, disposal and attempt to identify and prosecute the violators. Cooperation among all agencies will be needed to allow for prompt action and joint effort to deter such violators. All agencies will have local authority against such illegal dumping activities.

Spill response procedures have been established by the Culver City Fire Department, who investigates hazardous materials spills, and West Hollywood, where 24 hour emergency clean-up is provided. The City of Los Angeles is ensuring that city-owned facilities have adequate spill prevention, containment and response procedures.

4. COMPLAINT RESPONSE

The County and some local agencies have established a stormwater telephone "hotline" that can be utilized by all citizens. Public complaints are generated through these "hotlines" and also through regular channels such as calls to Fire or Police agencies or to public works or legislative offices. Although responses to these complaints will vary depending on the nature of the complaint, action shall be taken.

5. COORDINATION OF ALTERNATIVE DISPOSAL

Alternative disposal is one way of reducing non-stormwater materials that can potentially find their way into the storm drain system. Recycling programs are one of the most effective ways to reduce waste material. The recycling program can either be at the curbside or through drop-off centers. Household hazardous wastes can be dropped at mobile collection centers or at fixed sites. Co-permittees in the basin generally participate in the County's Household Hazardous Waste collection program. Effectiveness of those programs may be enhanced by a public outreach program that will inform the public of the locations and/or schedules for such events. Technical assistance or

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information may also be provided to businesses that want to develop a pollution prevention, waste minimization or alternative disposal program.

Recycling programs and hazardous materials round-ups can help minimize illegal dumping. The implementation of recycling programs in this watershed is excellent. 13 of the 14 jurisdictions have curbside recycling programs and the city without curbside pick-up provides drop-off service at City Hall. Caltrans, which cannot participate in curbside recycling, does recycle used materials its shops. Notable is the City of Rancho Palos Verdes who sponsors a recycler of the month promotion which gives one year free trash collection to the winner as a inducement to participate in the recycling program. The majority of cities participate in the Countywide Household Hazardous Waste Round-ups. Only Santa Monica, who maintains its own drop-off facility, and Caltrans, who recycles its own materials, do not take part.

6. REPORTING

Incidents involving a hazardous material entering the storm drain system are to be reported by the responsible party, or, if not known, the responding agency, to the California Regional Water Quality Control Board, Los Angeles Region (Regional Board). Complaints received through the County wide and local city hotlines will be tracked and reported to the Regional Board.

C. ENFORCEMENT PROCEDURES

Enforcement actions against discharges are done through either state hazardous and toxic materials statutes or through municipal ordinances that are already in the codes of the permittees. Industrial Waste Ordinances may be used in enforcement actions against illicit connections. Furthermore, anti-littering, health codes, plumbing codes and fire codes may be utilized for dumping or spill incidents. Enforcement actions can be taken by different municipal agents, including but not limited to, Industrial Waste Inspectors, Building or Plumbing Inspectors, Fire Department Inspectors, Park Rangers, Street Use Inspectors, Health Inspectors, Police Officers, Community Services Officers, Animal Control Officers, Code Enforcement Staff or Public Works Inspectors. Some of these agents are empowered to either issue citations, issue notices of violations, issue cease and desist orders, or even make arrests depending on the type of violation and the code provisions that they are enforcing. Some of these agents are also empowered to enforce not only municipal ordinances but also state laws. A review of the various enforcement tools used by the Permittees will be performed. A recommendation will result on a consistent enforcement approach for the watershed for consideration by all Permittees in their own enforcement programs. This recommendation will be developed by December 1995.

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The majority of cities stated that municipal codes and ordinances have been adopted. Several of these regulations include penalties for non-compliance. City staff, Community Service Officers, Public Works staff, and Code Enforcement personnel are responsible for ensuring that citizens obey these rules.

D. COORDINATION WITH STATE NON-STORMWATER PERMITS

In order to characterize the nature of the existing non-storm discharges in the receiving waters within the watershed, a list of NPDES Permits issued by the Regional Board will be obtained. This will help in determining unexpected discharge during dry weather and to allow enforcement actions to focus on illegal dumping activities.

There is also a need to coordinate with other environmental agencies to ensure that requirements imposed by these agencies do not conflict with stormwater regulations. Requirements of many agencies do complement stormwater regulations. These agencies, include but not limited to, Fish and Game, DTSC, USEPA, and the Coastal Commission. Coordination with these agencies will help minimize overlapping investigations and result in a more efficient use of resources. A watershed wide concept will be developed by December 1995.

1. IDENTIFICATION OF PERMISSIBLE/PERMITTABLE DISCHARGES

A list of non-stormwater flows that can be allowed to discharge into the Waters of the State will be established by the Regional Board.

2. APPROPRIATE MANAGEMENT PRACTICES

Continued communication with the Regional Board will allow current information to be circulated among all agencies.

3. REPORTING

Any conflict in requirements of other environmental programs/agencies must be reported immediately to the Regional Board for ruling as to which one should take precedence.

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III. INDUSTRIAL/COMMERCIAL SOURCES

Each Permittee shall develop and implement a program that focuses on the identification and control of storm water pollutant discharges from industrial/commercial facilities within their jurisdiction. This program shall provide for the inspection of a facility's compliance with storm water regulations, as well as general outreach for all facilities that are potential industrial and commercial dischargers.

Each Permittee is responsible, under the requirements of the Municipal Stormwater Permit, for all discharges from commercial and industrial facilities within its jurisdiction. Many industries are also required to be permitted under the State General Industrial Activities Stormwater Permit. Enforcement of the specific provisions of the State General Permit is the responsibility of the State.

A. IDENTIFICATION OF SOURCES

As required under the current Permit, the Permittees have produced a listing of industries by SIC category for each drainage area. Also a breakdown of major land use types was also performed for each drainage area.

A pollutant source identification program will be designed to identify significant pollutant sources (i.e., parking lots, industrial activities, etc.), with the hope that remedial action can be undertaken to reduce any significant impacts so identified. It will focus on monitoring very small areas (i.e., less than five acres) where a specific and/or interrelated set of pollutant generating activities are occurring. Its objective is to provide data for selecting BMPs for specific activities rather than characterizing discharges for long-term pollutant loading estimates.

Identification of pollutant sources can be done using a number of methods. Potential sources of storm water pollutants can be identified by records of chemical use and/or storage, by studies of specific activities which lead to the deposition of pollutants throughout the watershed, and by field inspection or monitoring. Watersheds which may contain significant pollutant sources can be identified through land use information or by mass load estimates.

By mid January 1995, the County will begin targeted monitoring of a municipal corporation yard in the Santa Monica Bay watershed. This will provide data on industrial activities which can take place at such a facility such as vehicle maintenance and repair, materials storage, equipment storage and repair. A more comprehensive program to identify various pollutant sources will be developed by December 1995.

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1. CATEGORICAL LIST

Sources identified as a categorical industry regulated by the U.S. Environmental Protection Agency (EPA) will be grouped into a categorical listing of industries. The categorical list provides an organized overview of the target facilities that, based on land use, operation, and activities, could potentially contribute significant amounts of pollutants into storm water runoff. Some of the industrial categories regulated by the U.S. EPA include, but not limited to:

- Aluminum Forming
- Asbestos Manufacturing
- Battery Manufacturing
- Canned & Preserved Fruits & Vegetables
- Cement Processing
- Copper Forming
- Electroplating
- Glass Manufacturing
- Grain Mills
- Machinery Manufacturing & Rebuilding
- Soap & Detergent Manufacturing
- Metal Finishing
- Metal Molding & Casting
- Oil & Gas
- Organic Chemicals & Plastics & Synthetic fibers
- Paint Formulating
- Pesticides
- Plastic Molding & Forming
- Rubber Manufacturing
- Sugar Processing
- Textile Mills

2. RANKING

Industrial and commercial facilities identified as pollutant sources shall be ranked in order of priority for development of management measures. Facilities considered to be high priority are those whose operations and activities are determined to potentially contribute the most significant pollutant impacts to storm water discharge.

3. UPDATE PROCEDURE

Each year the Co-Permittees will evaluate the results of the monitoring program, the illicit discharge investigation program, and other available information , to identify likely sources of specific pollutants. The annual report to the California Regional Water Quality Control Board, Los Angeles Region (Regional Board) will recommend a strategy for pollutant source identification during the following year, including specific sites and/or activities to be monitored.

B. CONTROL MEASURES

Specific urban runoff control programs for major potential pollution sources shall be developed by March 1996. Within these programs storm water pollution control

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measures shall be developed for various pollutant sources. Control measures such as source control and treatment control offer different, but complimentary approaches to storm water pollution control.

Source control measures focus on good housekeeping practices, pollution prevention and minimization, and education. They are also less costly than treatment controls.

Treatment controls involve physical treatment of the runoff, usually through structural means. Also treatment controls will not remove all pollutants and their removal efficiency is difficult to predict given the limited understanding of the relationship between facility design criteria and performance.

The initial focus will be on the development of source control measures. As information is collected under the pollutant source identification program regarding specific pollutant sources, specific control measures, including structural, will be evaluated as to their effectiveness in addressing these sources.

1. POLLUTION PREVENTION MEASURES

Source minimization and education are the first steps in effective source control. Other activities that contribute to source control are:

- Site design alternatives (i.e., roof over fueling stations and carwash slab, provide spill containment curb around stored material, etc.)
- Good housekeeping practices

2. STRUCTURAL (TREATMENT) MEASURES

A variety of treatment control measures have been utilized throughout the country for storm water quality. However, the effectiveness of these controls are highly dependent on local conditions such as climate, hydrology, soils, groundwater conditions, and extent of urbanization.

Some of the more common treatment controls are:

- Oil/water separators - Oil/water separators are designed to remove one specific group of contaminants: petroleum compounds and grease. However, separators will also remove floatable debris and setable solids.
- Infiltration - A family of systems in which the majority of the runoff from small storms is infiltrated into the ground rather than discharged

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to a surface water body. Infiltration systems include: ponds, vaults, trenches, dry wells, porous pavement, and concrete grids.

- Wet ponds - A wet pond has a permanent water pool to treat incoming storm water.
- Constructed Wetlands - Constructed wetlands have a significant percentage of the facility covered by wetland vegetation.
- Biofilters - Biofilters are of two types: swale and strip. A swale is a vegetated channel that treats concentrated flow. A strip treats sheet flow and is placed parallel to the contributing surface.
- Extended Detention Basins - Extended detention basins are dry between storms. During a storm the basin fills. A bottom outlet releases the storm water slowly to provide time for sediments to settle.
- Media Filtration - Media filtration consists of a settling basin followed by a filter. The most common filter media is sand; some use peat/sand mixture.
- Multiple Systems - Multiple systems are a combination of two or more of the preceding controls in series.

C. OUTREACH

General outreach for all facilities that are potential industrial and commercial dischargers shall be set up area-wide by the Management Committee, to provide general guidance in complying with the storm water program by March 1996. It shall also serve as a reminder of pollution prevention measures and keep facilities informed of their obligations to the storm water program.

Subcommittees may be established to develop specific outreach materials for industrial and commercial categories and specific activities that are identified as high priority.

For additional information on outreach, refer to **Chapter VII Public Information and Participation.**

D. INSPECTIONS

Most municipalities have existing programs such as industrial waste, fire, and health in which industrial and commercial facilities are inspected on a regular basis. Each Permittee may elect to have inspections for the storm water program incorporated

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into these existing inspection programs, or be done as a completely separate program, depending on the needs of the Permittee.

The purpose of these inspections is to ensure that facilities are in full compliance with the storm water regulations and to ensure that control measures are being implemented. The frequency of inspection of facilities will be prioritized based on the operation and categorization of the facility.

Inspectors consisting of public personnel will be trained adequately to recognize and handle problematic activities concerning storm water pollution that may be existing or potential; and inspect for the deterioration of the storm drain system and illegal/improper connections. Training programs will be developed through the Watershed Management Committee and possibly specific Permittees for use by all Permittees.

Procedures for the identification, investigation, enforcement, and prosecution to the full extent of a jurisdiction's legal authority will be developed.

Facilities which generate industrial wastes are issued permits by Los Angeles County. Auto related businesses, gas stations, and restaurants are included within this program. Facilities with industrial waste permits are regularly inspected. In addition to those businesses in the unincorporated areas, the County Department of Public Works also provides industrial waste inspections, under contract, for five cities in the watershed. In two of these, city staff assists with the inspections. The City of Los Angeles has an extensive program to issue, inspect and enforce Industrial Wastewater Permits issued for non-stormwater discharges. Facilities are inspected between 1-4 times per year.

Three additional cities have inspection programs; Santa Monica conducts annual inspections of industrial waste sewer connections, and both Culver City and Hermosa Beach depend on their Fire Department staff to investigate facilities which utilize hazardous materials. One city in the watershed is developing an inspection program, while two cities, Rancho Palos Verdes and Rolling Hills, report no industrial uses within their boundaries. However, auto related businesses are inspected in Rancho Palos Verdes. Only one city reports not having a program at this time. Caltrans inspections include daily examination of auto related facilities, leak testing of gas stations once per year, quarterly pumping of clarifiers, and constant storm drain monitoring. A program to inspect underground storage tanks is part of a five year plan.

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1. CHECKLIST

Inspectors shall have a uniform checklist to use as guidance and reference throughout an inspection. It may also serve as a general guide for the public, providing information about the requirements necessary to comply with the storm water regulations.

2. SCHEDULE

The inspection program shall be developed by March 1996. The frequency of inspections shall be scheduled according to the type of operation and the categorization of the facility. Revisit inspections shall be done on an as needed basis.

3. REPORTS

Inspectors shall report on all activities related to and/or violating the local storm water ordinance to the local governing agency. Standard reporting procedures will be developed.

4. FOLLOW-UP PROCEDURES

Individual Permittee review and assessment of the reports may result in the need for follow-up procedures, such as reinspection or legal action, provided the jurisdiction has the adequate legal authority to do so. Follow-up procedures will be developed to insure a uniform and consistent approach.

E. LOCAL INCENTIVE PROGRAMS

In developing the industrial/commercial program, the Permittees may consider the development of optional measures such as clean business incentive programs that may offer more focused control on industrial and commercial sources. Optional measures such as these may be developed by March 1996.

F. TRAINING

Development of training programs for industrial storm water inspection staff is projected to be completed by March 1996.

1. PUBLIC EMPLOYEES

All public employees shall be trained in the storm water regulations so that they abide by the regulations in the course of their work day. Also they need

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to be able to recognize and distinguish between legal and illegal activity so as to administer the proper protocol in handling the situation.

The Los Angeles County Department of Public Works requested all employees to report any observed water quality problems. Caltrans has educated its employees in hazardous substance spill awareness, pesticide safety and vegetation management. The City of Los Angeles has a specialized inspection group trained to focus on improving storm water quality and eliminating illegal discharges and illicit disposal practices which is staffed by the Bureau of Engineering.

2. INSPECTORS

Inspectors who visit industrial and commercial facilities shall be adequately trained to determine compliance with the storm water regulations and educate the facilities about the requirements of the program. In addition, they should be able to recognize and handle immediate problems as they are encountered, during an inspection; and inspect for the deterioration of the storm drain system and illegal/improper connections. Citation training will be necessary for inspectors in agencies that have the citation authority.

G. COORDINATION WITH STATE INDUSTRIAL STORM WATER PERMIT

The Permittees have existing local ordinances governing industrial discharges and other stormwater discharges that require compliance activities similar to those in various State Regulations. Because coordination between the Permittees and the Regional Board is anticipated concerning the regulation of industries, a mutual agreement may be required regarding industrial inspections and enforcement. Additional issues could also be addressed. Federal stormwater regulations hold local municipalities responsible for stormwater discharges from all industrial/commercial facilities, including those covered by General Permit.

1. MEMORANDUM OF UNDERSTANDING

A Memorandum of Understanding (MOU) may be used to formalize the agreement between municipalities and the Regional Board on industrial compliance program issues. A MOU among all local agencies may also be needed to ensure co-operation between all the agencies. The need for and specific requirements for such agreements would be developed upon completion of development of the industrial/commercial program by March 1996.

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2. REPORTS

The MOU discussed above may include the exchange of information between the Permittees and the Regional Board. Appropriate formats for such reports would be developed as required.

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IV. NEW DEVELOPMENT AND REDEVELOPMENT

Managing stormwater and runoff from both new construction and redevelopment, will reduce pollutants entering the storm drain system and subsequently the receiving water.

A. PLANNING PROCESS

Quality of stormwater discussion should be included in the General Plan and the Zoning ordinances. Efforts to enhance the quality of storm water can filter into the Subdivision actions. Many of the storm water concerns can be channeled through the compliance effort of the California Environmental Quality Act (CEQA). A watershed wide concept will be developed by June 1996.

1. WATERSHED PROTECTION POLICIES

An integrated strategy will be developed for the watershed. Pollution control efforts should be prioritized. A variety of statutory and regulatory requirements could be used for this watershed oriented program. Watershed protection policies need to be adopted by the local jurisdictions which control land-use within the watershed.

The Contractor Water Pollution Control Program is required by Caltrans during construction activities. Construction activities may be halted if inadequate provisions have been made for water quality protection.

2. COORDINATION WITH CEQA

The current CEQA "Environmental Checklist Form" that is used for initial studies assessment indirectly address potential impacts to stormwater. Additions could be made to the Form to directly assess stormwater quality impacts.

CEQA requires agencies to use feasible alternatives or mitigation measures to lessen potentially significant effects. The ability to identify a.) when an effect is significant, and b.) which mitigation measures could be adopted to reduce the effect, is critical to the CEQA process. A clear assessment of any development, its potential adverse impacts on stormwater quality will allow for a determination of "significance" which will enable the decision maker to make development decisions upon full disclosure of possible adverse impacts.

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3. SITE PLANNING PROCESSES

All development will require the review and approval of a site/plot plan or development drawings prior to issuance of a building permit. Incorporating the consideration of potential water quality impacts including erosion and sedimentation during the early stages of the planning process will allow these issues to be addressed before substantial investments in engineering and design have been made.

4. GENERAL PLAN CHANGES

The General Plan is the legal backbone of the planning process. All development approvals, zoning ordinances, subdivision approvals and public works projects must be consistent with the policies, objectives, and principles set forth in the General Plan. Discussion of stormwater issues in the General Plan could greatly enhance the awareness of the issues and encourage full assessment of possible adverse impacts on stormwater quality as the result of new and redevelopment.

Amendment to Los Angeles City's General Plan includes general requirements of Federal and State storm water regulatory program as well as policies and programs for storm water pollution abatement.

5. USE OF MASTER PLANS

For agencies which utilize master plans to guide their development activities, stormwater issues can be outlined in such documents. This will channel efforts to fully assess the possible adverse impacts on stormwater quality as the results of any development within the master plan area.

The City of Los Angeles is currently reviewing standards and considering modifications for flood control projects to include storm water pollution reduction components.

6. OTHER POLICIES

Numerous other policies or mechanisms could be used to incorporate stormwater management goals into the planning/development process. Other concepts will be evaluated for their feasibility during the more detailed development of this Chapter.

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7. PLANNING-PUBLIC WORKS INTERFACE

A variety of mechanisms for coordinating planning and public works activities exist. An example could be some form of CIP (capital improvements program). Ideally, any planning documents which target or project population growth are coordinated with CIP. Integrating stormwater management into CIP will allow for mitigation of major adverse impacts on the quality of stormwater prior to any actual construction.

8. IMPLEMENTATION PROCEDURES

Implementing policies to integrate stormwater management considerations with existing planning/development mechanisms will require a variety of approaches depending upon the existing conditions within each Co-Permittee and the particular remedies selected. It is anticipated that each Co-Permittee will propose procedures applicable to it's unique jurisdictional considerations at later stages in the permit process.

B. CONSTRUCTION SITES

Pollutants from construction activities can have a major impact on the quality of stormwater/urban runoff. A watershed wide concept to reduce such pollutants will be developed by December 1995.

1. EROSION CONTROL REQUIREMENTS

Federal stormwater regulations hold local municipalities responsible for stormwater discharges from all construction sites. In addition, construction sites involving a total of five acres or more of land disturbance are required to apply for the State General Construction Activity Storm Water Permit (GCASP). The GCASP: 1) eliminates or reduces to the extent feasible non-storm water discharges from construction sites and 2) permits stormwater discharges, but requires the use of controls to limit pollutant loading in site effluent. Preparation of a Stormwater Pollution Prevention Plan and identification/utilization of BMPs are the key components of this Permit.

Many local agencies also have erosion control requirements for any grading and construction activities. Regulation of pollutants from construction sites of five acres or less will be done by the local agency through its stormwater management plan.

Construction site erosion has the potential to introduce sediment into runoff. For example, fugitive dust control at construction sites typically use water. Minor modifications/clarification of existing fugitive dust practices could

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substantially address runoff pollution concerns. In addition to fugitive dust control practices, additional measures could be adopted to curtail dry weather runoff, and control pollutant laden storm water runoff. These measures may address 1) physical site design considerations and 2) temporal considerations such as seasonal timing and phasing of activities.

Ten jurisdictions have adopted erosion control/urban runoff reduction requirements. Three jurisdictions have identified and/or drafted textual language, while two jurisdictions are planning to begin developing legislation.

2. CHEMICAL AND WASTE MANAGEMENT REQUIREMENTS

Chemical and waste handling activities are also currently subject to a variety of regulations. BMPs to address this pollution source are largely centered around "good housekeeping practices". This involves storing, handling, using, and disposing of these potential pollutant sources in ways that restrict opportunities for unintended introduction of the materials into site runoff. Proper chemical and waste management will reduce any accidental discharge into the storm drain system.

3. INSPECTIONS

Inspections are a routine part of local jurisdiction's oversight of regulated construction activity. Inspection activities should be enhanced to ensure that construction site runoff control measures are being properly implemented. Existing practices should be examined and modified accordingly to satisfactory stormwater/urban runoff objectives.

The City of Los Angeles plans to review current requirements for construction sites to ensure consistency with the State of California and establish an Enhanced Construction Inspection program. The City of El Segundo has developed new forms and a standard enforcement letter for record keeping and program management. These include plan check list of review items concerning storm water, construction inspectors report, storm water catch basin cleaning record form, and standard storm water enforcement letter.

a. Checklist

A checklist would encourage possible streamlining of any requirements. It could be cumbersome if an overly rigid approach were taken which resulted in unnecessary administrative burden. However, careful design of the checklist could avoid this pitfall.

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b. **Schedule**

Inspection schedules will depend upon existing practices. It may be desirable to have several schedules, depending upon the types of activities/permits and/or the timing of activities.

c. **Reports**

A standardized reporting format is needed to allow for consistency among all jurisdictions. Furthermore reports are also a useful tool for future refinement of pollution control regulations.

d. **Follow-up Procedures**

A format will be developed to do follow-up inspections on problem facilities and activities. Frequency of use will greatly depend on the land use and the degree of non-compliance of each facility.

C. LOCAL PERMITS

Permits are a form of "cross checking" by local agencies to ensure that regulations are being implemented. Prior to the issuance of a permit, information must be submitted for review and approved A watershed wide concept to provide some consistency in local permits will be developed June 1996.

El Segundo has developed a checklist for storm water requirements to be used during plan check. Site grading plans are also required to identify drainage problems in the planning stages.

1. COORDINATION WITH EXISTING PERMITS

Storm water issues should be incorporated into existing permits.

2. NEW PERMIT ISSUES

Storm water issues should be clearly stated in new permits to be issued for new and/or redevelopment activities.

D. TRAINING

Training will enable staff to keep current of the latest storm water regulations. A watershed wide staff training concept will be developed by June 1996. Los Angeles City's planned Construction Education and Training program is intended to increase the awareness of those involved in the construction process with regard to storm

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water pollution abatement activities. Videos and printed materials will be distributed.

1. PLANNING PERSONNEL

(See E.1.b. below)

2. PUBLIC WORKS PERSONNEL

(See E.1.b. below)

3. INSPECTORS

(See E.1.b. below)

E. CONTROL MEASURES

Best management practices for the control of construction related pollution can generally be divided into three categories:

Nonstructural Source Controls for Reducing Urban Stormwater Pollutants:

- Practices that reduce the generation and accumulation of potential stormwater contaminants at or near their source.

Site Planning Stormwater Controls:

- Practices that are directed at controlling the volume and discharge rate of runoff from urban areas, as well as, reduction of the magnitude of pollutants in discharges through temporary storage or flow restrictions.

Erosion and Sediment Controls:

- Practices that can prevent or treat problems related to transport of eroded material from construction and other land disturbing activities.

Site planning stormwater controls are of particular interest. These control measures can be incorporated in the initial planning phase of any project. A watershed wide concept will be developed by June 1996.

The City of Los Angeles is reviewing construction standards and considering modifications aimed at reducing storm water pollution from construction sites.

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1. POLLUTION PREVENTION MEASURES

a. Site Design

Effective implementation of urban BMPs requires integration of water quality control elements early in the site planning and design process. Development of the water quality controls should not only achieve maximum pollutant removal with minimal costs, but also reduce potential maintenance.

This may include incorporating water quality concerns into the site layout and design (ie. maximize pervious areas, minimize directly connected impervious areas, etc.) and/or treatment control measures proven to be cost effective for local climate, soil, and development conditions.

Due to the diversity of climate and local conditions, the development of BMPs will vary from jurisdiction to jurisdiction, and even location to location. The selected management practices should be designed for the local site conditions and especially seasonal rainfall conditions that are experienced in Southern California. Suitability for the major land use and drainage characteristics should also be fully assessed.

b. Education/Training

Education/training is imperative to the success of any BMPs selected for new or redevelopment projects. BMPs will fail if not properly designed, installed, and maintained. Only well trained personnel should be assigned these responsibilities.

A program for effective education/training should be based on four objectives:

- Promote a clear identification and understanding of the problem, including activities with the potential to pollute stormwater;
- Identify solutions (structural and nonstructural BMPs);
- Make every employee responsible for stormwater pollution and its solution; and
- Integrate employee feedback into training and BMP implementation to improve BMPs.

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c. **Other**

In many cases stormwater pollution control may already be achieved by existing regulations or programs. In California, the General Plan Law and the California Environmental Quality Act (CEQA) provide a basis for municipalities to review and comment on all projects within their jurisdiction. Under the General Plan Law, municipalities are required to develop policies and regulations which guide development within the municipality. Each development project is then reviewed for conformance with these policies. Under CEQA, projects are also subject to review and comment for any adverse impact the projects may have on the environment, including impacts from stormwater discharges.

2. POST CONSTRUCTION (TREATMENT) MEASURES

a. **Applicability**

Each site considered for development or redevelopment will (at the conclusion of construction) have final improvements and unique site characteristics such as: drainage patterns; soils; landscaping; topography; percent of impervious surfaces; rainfall; pollutants inherent with the use of the development; and pollutants that may be background to the area (existing vegetation, air fallout, etc.). The applicability of various treatment control BMPs for use in new development will be evaluated through the use of pilot studies and examination of studies done on treatment control measures by other agencies.

b. **Effectiveness**

Prior to implementing any treatment control measures, they will need to be evaluated for their effectiveness. This can be done through pilot studies which could include elements such as: pre and post storm event inspections; water quality monitoring; record keeping to document deficiencies in the BMPs; Operation & Maintenance requirements; and cost effectiveness.

c. **Retrofit Opportunities**

The feasibility of retrofitting existing developments with treatment control measures will be evaluated. However, the effectiveness of a treatment control measure vs. its cost must be fully evaluated prior to considering its use as a retrofit measure.

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3. OPERATION AND MAINTENANCE

a. Requirements

Jurisdictions within the watershed will need to insure that BMPs incorporated into a private development are properly maintained. Deed restrictions, covenants, conditions and restrictions (CC&R) could be used to direct such requirements and responsibilities.

b. Responsible Party

The contractor, during construction must ensure that the post-construction BMPs are installed properly and that any maintenance that may be necessary during construction is performed. After the project is completed, it will then be the responsibility of the fee owner, private or public, to provide for long term operation and maintenance. This may be accomplished by deed restriction and/or CC&R.

4. CONFLICTS WITH OTHER MANDATES

Often regulations of various Federal, State, and local agencies would conflict with each other. Health, fire, and building codes often have requirements focusing on short term human health and safety and neglecting the impacts on the environment.

a. Identification of Conflicts

As the Plan is developed, other regulatory requirements that conflict with the stormwater requirements may be uncovered. Clarification of these regulations should be directed to the various responsible regulatory agencies.

b. Conflict Resolution

For regulatory conflict caused by local regulations, efforts will be taken to resolve them within the agencies. Input form other local, state, and federal agencies should be incorporated into a modification of current standards. The Regional Board should resolve conflicts involving other State and/or Federal requirements.

F. OUTREACH

See Chapter VII Public Information and Participation.

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G. ENFORCEMENT

See Chapter II Illicit Discharges, Section C Enforcement Procedures. A watershed-wide concept will be developed by June 1996.

H. COORDINATION WITH STATE GENERAL CONSTRUCTION ACTIVITIES STORM WATER PERMIT

Compliance with the GCASP requirements is the responsibility of the developer/contractor, and enforcement is the responsibility of the SWRCB/Regional Board staff.

1. MEMORANDUM OF UNDERSTANDING

An agreement between the Regional Board and Co-Permittees may be used to enhance compliance of construction site BMPs. The need for such an agreement will be evaluated. If found to be desirable, and agreement will be developed by June 1996.

2. REPORTS

The local enforcement agency of the State Construction Stormwater Permit, which is the Regional Board, should forward all information, including Notices of Intent filed and any inspections and enforcement actions taken, to the Permittees so that this information can be available to local municipal construction site inspectors to alert them of any specific concerns on the job site.

3. OTHER ISSUES

The Regional Board should explore funding to be channelled to the Co-Permittees so the Co-Permittee can be more actively involved with the State on the Permit.

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V. PUBLIC AGENCY ACTIVITIES

All municipalities perform functions that have an impact on stormwater quality. These include, among other things, vehicle maintenance, landscape maintenance, weed control, water body maintenance including swimming pool maintenance, etc. Other activities such as construction and maintenance of streets and roads, and construction and maintenance of the flood control system also could directly or indirectly cause adverse impact on the quality of stormwater/urban runoff. Since municipalities must address all significant sources of pollutants, all of these activities must be examined and mitigation measures be incorporated into the routines. As part of the requirements of the current Permit, many of the Permittees have already begun implementation of measures to address the above activities. An examination of these existing measures will be done on a watershed wide basis to establish the most effective approach to address these activities. Such approaches shall be developed and begin implementation by September 1996.

A. SEWAGE SYSTEMS

Sewage spills must not be allowed to enter the storm drain. Control procedures for identifying, repairing, and remediating sewer blockages, infiltration, inflow, and wet weather overflows from the sewers to the storm drain system should be implemented to protect stormwater quality. These procedures could include, but are not limited to, quick field response to overflows, follow-up testing, and complaint investigation.

When sewage spills do occur, they must be contained and collected for proper disposal. Individual permittees may need to modify their sewage overflow response procedures. The field personnel should also have procedural training for field screening, sampling, smoke/dye testing, and TV inspection, if appropriate, to be able to properly investigate any suspect connections or cross connections to the storm drain system.

Los Angeles County has a number of programs aimed at preventing sewage spills from entering the storm drain system. These include:

- Sewage Overflow Response Procedures Revision/Root Control Review. This involves improvement of procedures for containment and cleanup of spilled sewage resulting from overflow.

- Standby Maintenance Crew. This on going program places a maintenance crew on stand by during heavy rainfall for Trancas and Malibu Sewage Treatment plants.

- Reline Sewer Lines. Two locations will undergo relining of existing sewer lines to prevent infiltration and exfiltration.

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- Sewer Pipeline Reconstruction. 127 miles of cement pipelines will be analyzed and replaced or rehabilitated within 5 years.

- Sealing of Manhole Covers. This program has sealed manhole covers and bar holes in areas subject to flooding.

- Expansion of Emergency Call List. Beeper numbers of all supervisors, superintendents and standby crews were added to emergency call list.

The City of El Segundo has implemented a number of programs intended to prevent spills from entering the storm drain system. They include:

- Closed Circuit Television of Wastewater Mains (CCTV). The videotaping of the interior of as sanitary sewer mains allows for locating immediate problems and to set up repair and replacement program.

- Hydro Flush Program. The yearly hydro flush program precludes wastewater overflows.

- Wastewater Lift Stations. The rehab program for sewage lift stations keeps wastewater plants in good operating condition and prevents failures and overflows.

Los Angeles City's Limitation of Sewage Infiltration into Storm Drain System traces sewage infiltration into the storm drain system using a variety of techniques.

B. CORPORATION YARDS

Corporation yards include any area or facility that is used for vehicle maintenance or washing, other maintenance, chemical storage, paint facilities, and supportive activities for field crews. Permittees will need to incorporate pollutant control measures at these facilities and develop a plan for each facility outlining the measures to be implemented. Since these are industrial type activities, the corporate yards would need to implement measures as described in the Industrial/commercial Source Chapter.

1. STORM WATER POLLUTION PREVENTION PLANS (SWPPP)

Though not required, permittees may elect to use some form of SWPPP as a vehicle for compliance. Any BMPs to be implemented must be part of a comprehensive plan designed to address the various pollutant sources at each corporate yard. To achieve this goal, the municipalities should first identify the potential pollution sources and who is responsible for implementing the storm water management measures. Based on the facility type, management

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practices and schedule of implementation will be developed. BMPs that can be used to improve the quality of runoff include, but are not limited to, housekeeping practices, material storage control, vehicle leak and spill control, and illegal dumping control.

The City of Los Angeles is presently undertaking the following studies: a) Storm Water Pollution Abatement--Street Maintenance Yards. Four street maintenance yards, including an asphalt processing plant, are being studied as potential sources of storm water pollution; and b) Spill Prevention, Containment and Response Procedures--City Facilities. This program, in the City of Los Angeles ensures that facilities have adequate spill prevention, containment and emergency response procedures.

The City of El Segundo has prepared an industrial waste study and prepare a Storm Water Pollution Prevention Plan for the City Maintenance Facility.

2. OUTDOOR LOADING/UNLOADING OF MATERIALS

Municipal employees who handle potentially harmful materials should be trained in good housekeeping practices to prevent or reduce the discharge of pollutants to storm water from outdoor loading/unloading of materials. Materials spilled, leaked or lost during loading/unloading may collect in the soil or on other surfaces and be carried away by runoff or when the area is cleaned.

Applicable BMPs should be selected based on the following four factors: 1) Extent of exposure of material to rainfall, 2) preventing stormwater run-on, 3) checking equipment regularly for leaks, and 4) containing spills during transfer operations.

3. MATERIAL STORAGE CONTROL

A program should be developed to prevent or reduce the discharge of pollutants to storm water from outdoor container storage areas using measures such as installing safeguards against accidental releases, secondary containment, conducting regular inspections, and training employees in standard operating procedures and spill cleanup techniques. Employee education is paramount for successful implementation. Employees should be trained in emergency spill cleanup procedures.

To limit the possibility of storm water pollution, containers used to store dangerous waste or other liquids should be kept inside the building unless this is impractical due to site constraints. Storage of reactive, ignitible, or flammable liquids must comply with the fire and California OSHA codes.

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Practices such as placing containers in a designated area should be employed to enhance such requirements.

The City of Los Angeles has a Certified Hazardous Waste Storage Facility. Three pre-fabricated storage buildings have been installed at the Los Angeles Aqueduct Filtration Plan to isolate hazardous materials.

4. VEHICLE AND EQUIPMENT WASHING AND MAINTENANCE

Washing vehicles and equipment outdoors or in areas where wash water flows onto the ground can pollute storm water. For municipalities that wash vehicles or pieces of equipment on-site, it should be performed in a designated area equipped with an oil/water separator.

Vehicle or equipment maintenance is a potentially significant source of storm water pollution. Parts are cleaned with solvents. Many of these cleaners are harmful and must be disposed of as a hazardous waste. Appropriate BMPs are waste reduction, use of alternate products, recycling, and spill leak clean up control.

5. WASTE HANDLING AND DISPOSAL

Proper waste management is possible by tracking waste generation, storage, and disposal; reducing waste generation and disposal through source reduction; and preventing run-on and runoff from waste management areas.

C. PARKS AND RECREATION

Park Departments manage landscaping and swimming pools. Both of these activities involve the use of chemicals, waste management, and non-storm water discharges. In addition maintenance of swimming pools requires the periodic discharge of large quantities of swimming pool water.

1. FERTILIZERS/PESTICIDES

a. Use/Application management

Municipal facilities should develop controls on the application of pesticides, herbicides, and fertilizers. Control may include:

- List of approved pesticides and selected use;
- Product and application information for users;
- Equipment use and maintenance procedures; and
- Record keeping.

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Employees can be educated about environmentally sensitive alternative products by using information developed by various public agencies and other environmental organizations.

b. Storage

Improper storage of fertilizers and pesticides can lead to potential groundwater, soil, and stormwater contamination. To prevent or reduce their impact on stormwater pollution, material storage areas must be designed and maintained to reduce exposure to storm water. The following BMPs can help to achieve this goal:

- Store materials inside or under cover on paved surfaces,
- Use secondary containment,
- Minimize storage and handling of hazardous materials,
- Inspect storage areas regularly.

2. FACILITY MANAGEMENT

a. Wash Waters

Wash waters cannot be discharged into the storm drains untreated. The storage area should be slightly sloped for wash water collection. If the water is not discharged to the sanitary or process waste sewer, or to a dead-end sump, the outlet should be equipped with an oil/water separator or other treatment systems.

b. Maintenance

Landscape maintenance involves the use of pesticides and fertilizers. Proper use of these materials will reduce the risk of loss to storm water. Whenever possible, leave or plant native vegetation to reduce water, fertilizer, and pesticide needs. Integrated pest management should be employed where appropriate. The Park Departments should also establish a schedule for irrigation and fertilization. The chemicals will be carried from the site by the next storm if they are applied during the wet season. Overwatering leads to discharge of water that may have become contaminated with nutrients and pesticides.

Storm water from parking lots may contain undesirable concentrations of oil, grease, suspended particulates, and metals, as well as the petroleum byproducts of engine combustion. Possible maintenance BMPs include periodic sweeping and cleaning catch basins.

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The City of Los Angeles has installed special equipment at Rancho Park Golf Course to remove oils and oil-based cleaning agents as well as organic material from surface water that drains into the storm drain system.

c. Swimming Pool Waters

The drainage of swimming pool water must insure that chlorine residual is below allowable water quality limits. The potential for recycle/reuse for irrigation of lawns and landscapes may be investigated. Swimming pool filter backwash waters should not be discharged to the storm drain, but should be allowed to settle and then disposed to the sanitary sewer. Other possible alternative measures would be to use the backwash for irrigation or disposal on a dirt area.

D. STORM DRAIN SYSTEM OPERATION AND MANAGEMENT

The maintenance and operation of the storm drain system has an impact on storm water quality and must be addressed. Material clogging storm drains cannot be discharged into drains. It must be disposed of properly.

1. INLET MAINTENANCE

Regular maintenance of public and private catch basins and inlets is necessary to ensure their proper function. Maintenance will remove pollutants, reduce high pollutant concentrations during the first flush of storms, prevent clogging of the downstream conveyance system, and restore the catch basin's functional capacity. Keys to effective catch basin cleaning include the following:

- All basins should be cleaned annually prior to the onset of the rainy season;
- Clean catch basins in known problem areas more frequently to remove sediments and debris accumulated during the dry weather months;
- Keep records of the number of catch basins cleaned; and
- Track the amount of waste collected.

Caltrans will develop a priority list of drains and pump houses requiring cleaning.

Nine jurisdictions clean their catch basins annually, while the cities of Santa Monica and Hermosa Beach perform this cleaning four times a year. Three other jurisdictions clean catch basins twice a year and the City of Los Angeles has grouped their catch basins into "routes" that are inspected and/ cleaned at least once a year.

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2. DRAIN MAINTENANCE

Open channel storm drains should be cleaned at least annually prior to the rainy season. Problem areas should be cleaned more frequently as needed. Channels should also be monitored during the rainy season for any debris buildup and cleaned where needed.

To reduce the amount of debris entering the ocean, Los Angeles County field personnel inspect open channels and sumps after storms and clean debris as needed.

3. WASTE MANAGEMENT

Excessive waste buildup will decrease the capacity of the channel, it is therefore crucial to reduce pollutant levels in storm water by regularly removing illegally-dumped items and material from storm drainage channels and creeks. A program should be developed to identify problem areas of illegal dumping so regular inspection and clean up can maintain the channel's optimum capacity and prevent the discharge of contaminants.

4. NEW SYSTEM DESIGNS

Current design standards for the construction of new storm drain systems will be evaluated in light of currently available pollutant control measures. Design standards may be modified to incorporate measures deemed appropriate for local conditions.

The City of El Segundo provides the following operations and maintenance of the storm drain system:

- Flow Monitoring and Analysis. Monitoring and analysis of dry weather flows to the city's 5 pump stations could help to determine the origin of these minor flows.
- New Telemetering System. This system will improve monitoring and reliability of the city's storm water and waste water pumping plants.
- Storm Water City Drawings. During catch basin stenciling an update of the City Catch Basin Plan was prepared.

The City of Los Angeles has formed an Inter-Jurisdictional Storm Water Re-Use Task Force to implement diversion, capturing and possibly re-using high quality storm water run-off; also the City is modifying standards for flood control projects by incorporating storm water pollution reduction components.

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5. RETRO-FIT OPPORTUNITIES

The majority of the existing storm drain systems are in highly urbanized areas providing little opportunity for cost effective retro-fitting. However, currently available pollutant control measures will be reviewed for their effectiveness and possible use. This may include pilot studies to evaluate the performance of management practices under local conditions.

The City of Santa Monica, with some assistance from the City of Los Angeles, is undergoing a feasibility study for a Low Flow Storm Water Reclamation Plant that would be constructed to treat storm water from the Pico Kenter storm drain. Also the City's Storm Drain Pollution Sensor System is scheduled for FY 95-96 to detect levels of pollution in the storm drain system.

The City of Santa Monica has begun the installation of boards over the openings of catch basins and is also presently considering a program to treat storm water flows from the Pico Kenter and Pier storm drains to prevent pollution into the ocean.

E. STREETS AND ROADS

Construction, operation, and maintenance of roads has an impact on storm water quality and will be addressed in the management plan.

1. SWEEPING

Street sweeping can collect refuse on street surfaces to prevent it from entering the storm drain system through catch basins.

a. Storm Water Quality Based Operation

In order to effectively implement the sweeping program, the permittees should keep accurate operation logs to track the program. Areas generating excessive refuse should be swept more frequently. Sweeping frequency may also be increased before the rainy season to reduce the amount of refuse entering the storm drain system. Parking on sweeping days should be regulated to facilitate the operation.

Nine jurisdictions perform street sweeping on a weekly basis, two jurisdictions twice a month and one jurisdiction once a month in residential areas while materials are swept weekly.

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The City of Rolling Hills does not provide street sweeping services because all of the roads are privately owned, Los Angeles City provides weekly sweeping in approximately 1/3 of the posted streets and monthly service in the remaining areas. Caltrans sweeps its roadways on a regular schedule determined by observable debris.

b. Waste Management

Seven jurisdictions empty roadside trash receptacles weekly, while two jurisdictions perform this service twice a week. Two other jurisdictions empty trash receptacles three times a week while the cities of Santa Monica, West Hollywood and Beverly Hills collect the rubbish as often as once per day. The City of Rolling Hills does not provide roadside trash receptacles because it is entirely residential with private streets.

2. STREET/PAVEMENT WASHING

Wash waters from street/pavement washing are contaminated and must be managed as non-storm water discharges.

3. MAINTENANCE

a. Saw-cut Slurry Management and Paving Practices

Existing saw-cut management and paving practices conducted by the permittees will be evaluated and appropriate control measures developed. Possible control measures to be considered that would help reduce the impacts to storm water:

- Avoid paving during wet weather;
- Regularly repair potholes and worn pavement to reduce sediment loading;
- Store materials away from drainage courses to prevent pollution of storm water run-on; and
- Follow the storm water permitting requirements for industrial activities when mixing concrete with an on-site plant.

b. Waste Management

Vehicles transporting waste should have spill prevention equipment that can prevent spills during transport. The refuse collected will be transported to the appropriate disposal facilities.

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Good housekeeping practices will be implemented to insure proper management of any waste products that may be generated during maintenance activities. For example, to prevent concrete waste from entering the storm drain system, washout of concrete trucks should be conducted off-site or on-site in designated area. Excess concrete should not be dumped on site. Employees and subcontractors should be trained in proper concrete waste management.

The following steps will help reduce storm water pollution from concrete wastes:

- Store dry and wet materials under cover, away from drainage areas;
- Avoid mixing excess amounts of fresh concrete or cement on-site;
- Do not wash out concrete trucks into storm drains, open ditches, streets, or streams;
- Do not allow excess concrete to be dumped on-site, except in designated areas;
- Avoid paving during wet weather;
- Regularly repair potholes and worn pavement to reduce sediment loading; and
- Cover catch basins and manholes when applying seal coat, tack coat, slurry seal, fog seal, etc.

Employee/subcontractor training to insure implementation of good housekeeping measures should be based on four objectives:

- Promote a clear identification and understanding of the problem, including activities with the potential to pollute storm water;
- Identify solutions (BMPs selection);
- Promote employee/subcontractor ownership of the problems and the solutions; and
- Integrate employee/subcontractor feedback into training and BMP implementation.

c. Medians/Landscaped Right-of-Way

i. Irrigation

Overwatering of landscaping produces runoff. A properly timed irrigation schedule should be set up to minimize overwatering.

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Drip irrigation system should be used when feasible in new installations.

Caltrans Right-of-Way Maintenance Vegetation Control Program provides benefits of motorists' safety and erosion control.

ii. **Fertilizers/Pesticides**

The handling, storage, and usage of fertilizers/pesticides are addressed in Chapter V, Section C-1.

F. FLOOD CONTROL

Common municipal practices, such as construction and operation and maintenance of the flood control system, may have a potentially adverse impact on storm water quality. Consequently, these practices shall be coordinated to the extent of preventing pollutants from impacting the water quality.

The City of Los Angeles is reviewing standards and considering modifications for flood control projects to incorporate storm water pollution reduction components. Evaluation of available references is expected to result in either revisions to Standard Plans or a new manual.

1. COORDINATION WITH NEW PROJECTS

Current design standards for the construction of new storm drain systems will be evaluated in light of currently available pollutant control measures. Design standards may be modified to incorporate measures deemed appropriate for local conditions. During construction, all appropriate BMPs will be utilized to control pollutants during the construction of the facility.

Los Angeles County's Ballona Creek Debris Fence was installed in July of 1993, to prevent debris from entering the ocean by detaining floatable trash and debris for later collection.

2. COORDINATION OF MAINTENANCE ACTIVITIES

Current maintenance activities with regards to desilting/sediment removal, vegetation management, and waste management shall be reviewed to insure that appropriate management measures are developed to comply with the storm water regulations.

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3. OPERATION OF FACILITIES

Flood control facility operations will be reviewed to identify where appropriate management measures could be incorporated. However, primary consideration will need to be given to the flood control function of the facility to protect health and safety.

4. RETROFIT OPPORTUNITIES

The majority of the existing storm drain systems are in highly urbanized areas providing little opportunity for cost effective retro-fitting. However, currently available pollutant control measures will be reviewed for their effectiveness and possible use. This may include pilot studies to evaluate the performance of management practices under local conditions.

The County of Los Angeles, in September 1994, has built an inflatable dam across the San Gabriel River to impound surface runoff which will be recharged into the aquifer. During this process any trash and debris accumulating will be removed.

G. PUBLIC FACILITIES

Storm water runoff and non-storm water discharges from other public facilities must also be addressed, including chemical use by these facilities, pressure blasting/cleaning sidewalks and other surfaces.

1. PARKING FACILITIES

Storm water from parking lots may contain undesirable concentrations of oil, grease, suspended particulates, and metals. Some control measures such as periodic sweeping and cleaning catch basins should be implemented. The need for more advanced structural controls would be evaluated through the pollutant source identification program. Pilot studies would be conducted on candidate structural controls to evaluate their effectiveness prior to large scale implementation.

2. GOLF COURSES

Golf courses require the use of large amount of water, fertilizers, and pesticides. Field personnel should be trained on the proper handling, storage, and usage of these chemicals (Refer to Chapter V, Section C-1 for detail). To prevent excess irrigation water from entering the storm drain system, proper management of watering schedules should be required.

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3. SCHOOLS

The maintenance of playgrounds and athletic fields at schools require fertilizers and pesticides. Their safe storage and use affect not only the stormwater quality but also the health of the students and the staff. Therefore BMPs under Chapter V, Section C-1-b should be implemented. Each municipality should develop a program to encourage these schools to use environmentally sensitive products for fertilizers, pesticides, detergents, and other chemicals. The schools should have proper material handling, storage, and disposal procedures for chemicals used in school laboratories.

4. HOSPITALS

Each hospital should have BMPs to control the handling and storage of medically related hazardous materials. All materials should be inventoried regularly, with record keeping protocols on supply and consumption. All personnel should be trained on the proper procedures on handling these materials, as well as emergency response. Each hospital should maintain a list of supervisors to be contacted if accident does occur. Disposal of these materials should be contracted out to commercial specialists.

5. PARKS/LANDSCAPES

Refer to **Section C Parks and Recreation**, of this Chapter, for information.

6. OTHER BUILDINGS/PLAZAS

Refer to **Section C-2 Parks and Recreation - Facility Management**, of this Chapter, for information.

H. PONDS, FOUNTAINS, AND OTHER PUBLIC WATER BODIES

Maintenance practices used on public water bodies, including waste management and non-stormwater discharges, must be addressed in the plan.

1. ALGAE CONTROL

a. Use of Chemicals

The use of herbicides or other chemicals to control algae growth should be carefully controlled and monitored to insure strict adherence to manufacturers' guidelines for use. Water sampling may be necessary to insure effective control.

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2. CHLORINE MANAGEMENT

The use of chlorine for disinfection should be controlled. High dosage of chlorine may be harmful to the aquatic habitats. Dechlorination of pools and other water bodies would be required prior to draining.

3. MAINTENANCE

Each municipality should develop BMPs to prevent and control trash, debris, and other pollutants from entering water bodies. These measures could include routine trash collection along and on water bodies, public outreach to educate the public about the impacts of illegal dumping, and increase enforcement for violations.

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VI. RESIDENTIAL

INTRODUCTION

Residential activities including private vehicle washing and maintenance; use of chemicals such as pesticides, herbicides, and paints; private swimming pool maintenance; and other household and landscape maintenance can contribute to storm water pollution. These are all examples of non-point source pollution, a significant impact on water quality. Measures that can be taken to improve the quality of the runoff from residential area all require active public participation. Feasible BMPS to mitigate the stormwater pollution problem should include practicing good housekeeping and the use of environmentally sensitive alternative products, vehicle leak and spill control, and water conservation. Development of the residential stormwater program will be completed by December 1995.

A. HOUSEKEEPING PRACTICES

This BMP involves the development of a program to promote efficient and safe housekeeping practices (storage, use, and cleanup) when handling materials which may pollute stormwater/urban runoff. This could include, but are not limited to, fertilizers, pesticides, cleaning solutions, paint products, automotive products, and swimming pool chemicals.

A public education program will be developed to provide information on stormwater pollution and the beneficial effects of proper disposal on water quality; reading product labels; safe storage, handling, and disposal of hazardous products; list of local agencies; and emergency phone numbers. The above information can be disseminated through brochures or booklets made available at places such as public information fairs, municipal offices, and household hazardous waste collection events and facilities. City newsletter to residents is another means to inform the public, especially for those who do not participate or visit any offices or events.

B. ENVIRONMENTALLY SENSITIVE ALTERNATIVE PRODUCTS

This BMP, promoting the use of less environmentally sensitive products, can be implemented in conjunction with housekeeping practices. Alternatives exist for most product classes including fertilizers, pesticides, cleaning solutions, and automotive and paint products. The key to success will be to promote a willingness to try alternatives and to modify old habits.

General information will be developed and made available to the public on such alternatives. The emphasis may be placed on the need to preserve the natural environment of the receiving waters (ocean, bay, stream, wetland, etc.) with the use of alternative products because of their less toxic nature and proper disposal after its use.

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C. VEHICLE LEAK AND SPILL CONTROL

This BMP prevents or reduces the discharge of pollutants to storm water/urban runoff from vehicle leaks and spills by reducing the chance for spills, stopping the source of spills, containing and cleaning up spills, and properly disposing of spill materials.

Vehicles will leak and spill fluids. The key to successful pollution management is to reduce the frequency and severity of leaks and spills; and when they do occur, to prevent or reduce the environmental impacts. Through education, the public should be encouraged to regularly inspect and maintain their vehicles. Guidelines should be developed to inform the public on spill containment and cleanup procedures such as having absorbent material on hand and disposing the material properly.

D. WATER CONSERVATION

Water is a scarce resource, especially so in Southern California. Wasteful use of water could channel pollutants into the receiving waters. Practices such as hosing the driveway and overwatering the landscape contribute not only to stormwater pollution, but also to the depletion of our natural resource. In order to prevent stormwater pollution, the public has to be educated on the mechanics of our storm drain system - discharges into the system will flow untreated into the receiving water. They have to know that the lawn clippings they wash down the road will end up in the ocean. Public awareness of the function of the storm drain system, of the importance of environmental health, and of our necessity to slow down the depletion of water resources will go a long way in reducing the pollution of stormwater/urban runoff.

Ordinances could be use to endow the related officials with legal authority to enforce water conservation. An ordinance prohibiting the wasting of water is one way of enforcement.

In addition to the specific programs and plans outlined in this report, several watershed co-permittees have targeted activities occurring in and around the home that tend to contribute to degradation of storm water runoff quality. A practice that carries on-the-ground pollutants directly to storm drains is misuse of exterior water, namely the overwatering of landscaping, the hosing of driveways/sidewalks and the washing of cars in driveways--all of which allow water to run down the street into the nearest storm drain.

This situation can be addressed in two ways: 1) either reduce/prevent pollutants from being placed in areas where they may be carried by water into the streets or 2) minimize the amount of water allowed to flow on impervious surfaces that are connected to the street system.

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Water conservation measures can be designed to address the issue of impervious surface water flow. While conservation has historically been used to conserve domestic water, many jurisdictions are now recognizing the additional benefit of prohibiting water flows from private properties onto the street system. All co-permittees within this watershed implement water conservation programs. Hermosa Beach has drafted a Storm Water Pollution Prevention Ordinance which will discourage excessive outdoor water use by prohibiting non-storm water discharges to the storm drain system. Public outreach is a component of all programs, many of which carry fines for water wasting practices. Most jurisdictions encourage water efficient landscape. While some ordinances were established specifically to conserve water during periods of drought, several jurisdictions are keeping such controls in place at all times as measures to control non-stormwater runoff.

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VII. PUBLIC INFORMATION AND PARTICIPATION

It is necessary to involve the public in the stormwater program for it to be effective. The outreach program should be focused on the specific needs of the individual cities. Due to the inter-relationship among the stormwater issues, the public information and participation program should be recognized as a whole, rather than a number of separate outreach programs. All public awareness efforts should clarify to the public that they are the ultimate beneficiaries of a successful stormwater management program.

A. GENERAL OUTREACH

The targeted audiences of a general outreach will include municipal employees, local construction contractors, businesses in the area, and the general public. They should be made aware of their responsibility for both the problems and the solutions to stormwater pollution. In order to effectively communicate the stormwater pollution abatement message throughout the watershed; written, audio, and visual materials should be utilized. The actual level, priority, and schedule of public information activities must be based on the community's needs and resources to maximize program effectiveness. A watershed-wide concept will be developed by December, 1995.

All Co-Permittees within the watershed have active, multi-media public outreach programs. Extensive efforts have been made or are planned by every agency to supply the public with information on a full range of storm water quality activities with the intention of achieving a high level of public cooperation and participation. West Hollywood has hosted "Storm Water Awareness Week" to draw attention to storm water issues.

1. WRITTEN MATERIAL

Co-Permittees should produce a variety of written materials to inform the residents within the watershed. Materials can include, but are not limited to, the following: flyers, brochures, door-hangers, newspaper articles, mail-inserts, banners, and posters. When necessary, these materials should be translated into a variety of foreign languages to reach minority residents in the community.

A diversity of print media outreach programs have been used extensively throughout the watershed. Newsletters and brochures mailed to all residents have often included articles on various storm water programs. Utility bill inserts are also used extensively to promote public awareness. Billboard and bus stop shelter advertising is used by both Los Angeles City and County. Street banners are one of the devices used by Manhattan Beach. Los Angeles

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City and County have refrigerator magnets to promote their programs. Door hangers are distributed by Culver City, Hermosa Beach, West Hollywood and Los Angeles City and County. Los Angeles City and Manhattan Beach have posters and street banners promoting storm water runoff quality.

2. AUDIO MATERIAL

Similarly, Co-Permittees may utilize audio materials to convey information regarding stormwater management. Examples of audio materials include radio advertisements/public service announcements and informational cassettes.

3. VISUAL MATERIAL

Catch basin stenciling program is an excellent means of educating the public on the mechanics of the storm drain system. The intent of the program is to enhance public awareness of the impact of stormwater pollution on receiving waters and to discourage improper waste disposal practices. Another effective medium for communicating the importance of stormwater management is through television. Possible measures include producing a public service announcement, cable access programs, and/or an informational video.

The most universal of the general outreach programs--catch basin stenciling--is receiving full cooperation throughout the watershed. Most jurisdictions have completed their stenciling program. El Segundo, Palos Verdes Estates and Rancho Palos Verdes received assistance from the Boy Scouts; Los Angeles, Manhattan Beach and Santa Monica also noted the use of volunteer groups. Particularly in the urban areas with stop-and-go traffic, it was suggested that by stenciling the curbsides motorists could read the signs. El Segundo has a stencil logo contest. Four cities commented that the stenciling was beginning to fade, suggesting that a more durable, water resistant paint be used.

Among broadcast media outreach, the City of Los Angeles has prepared a public service announcement which has been shown on cable access channels. With cable television service available throughout the watershed, most jurisdictions have used this medium for public service announcements and special programming. Los Angeles County uses both television and radio outreach.

4. DISTRIBUTION PLAN

General outreach efforts must be conducted throughout the entire watershed. Materials should be available at all public counters and distributed at public events such as environmental fairs and contests. A city newsletter is another effective method of conveying the pollution abatement message.

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General outreach to targeted groups is an objective of some co-permittees--especially Los Angeles City who has a student/teacher school education program (K-6 "Magical City Forest") and a mailing program directed at private industries likely to be required to obtain a General Industrial Storm Water Permit.

B. FOCUSED OUTREACH

Efforts should be made to target special groups. Focus could be on specific pollutants, practices and/or activities, or businesses. A watershed-wide concept will be developed by June 1996.

1. POLLUTANT SPECIFIC

For a particular watershed, there may be priority pollutants which are of more concern than others. The reduction of these pollutants may be addressed in a more focused public education and outreach program. Any of the methods used in the general outreach program may be utilized in a pollutant specific outreach program.

2. PRACTICE/ACTIVITY SPECIFIC

Everyone who lives or works in a particular watershed must realize that their actions have a direct affect on the quality of stormwater. These special groups must be made aware that their current practices/activities may be contributing to stormwater pollution. Practice/activity specific outreach programs should be developed and implemented throughout the watershed. The use of written, audio, or visual materials should convey three primary messages: (1) what activities can cause stormwater pollution, (2) how Best Management Practices are used to prevent pollution, and (3) how one can report occurrences of stormwater polluting activities.

Practice/activity specific outreach should promote, publicize, and facilitate public reporting of illegal dumping, illicit discharges, or water quality impacts associated with discharges from municipal separate storm sewers. An effective program should include the establishment, operation, and promotion of a reporting hotline. Timely reporting by the public of improper disposal and illicit discharges are critical in controlling such sources of stormwater pollution. Increase in public involvement may be achieved by sending a follow-up letter to callers or providing callers with some type of reward. Educational efforts throughout the watershed should inform the public about the existence of the Los Angeles County-wide hotline and any other local hotlines; provide them with information regarding what to look for, and guidelines/procedures on how to report incidents.

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Another critical component of practice/activity outreach is the development of a program to facilitate the proper management and disposal of used oil and toxic materials. An effective program could include, but is not limited to, the operation of recycling facilities and the conduction of household hazardous waste round-ups. The program could also include information about alternatives to toxic materials. Educational efforts throughout the watershed should provide the public with detailed information regarding the Los Angeles County-wide Household Hazardous Waste Round-ups and any other local programs.

The varied sources/causes of storm water pollution have resulted in implementation activities that target specific types of pollutants, activities and land uses/types of businesses. Within this watershed co-permittees take part in public information and participation programs specifically aimed at preventing improper disposal of hazardous household products and encouraging actions that keep general wastes out of the storm drain system–such as recycling programs, public trash receptacles and the cleaning of sidewalks, alleys and vacant lots. Illegal dumping and discharges are also specific targets.

Such activities are encouraged through general outreach programs (discussed above) that promote such programs as toll-free phone hotlines for reporting illegal polluting activities, topic-specific brochures, speakers bureaus and special recycling facilities (used motor oil, hazardous products, etc.). Redondo Beach has a Recycling Hotline. The trash hauler in Rolling Hills Estates holds a quarterly drawing of residents who routinely recycle; the prize is one free year of refuse service. Manhattan Beach has an Ocean Safe Enterprise campaign, complete with window decals, to encourage restaurants and other businesses to observe safe disposal practices. A companion program, Ocean Safe Community, is aimed at the entire area. Los Angeles County has an outreach program focusing on airport operations; a component of the program is structure stenciling. The City of Los Angeles has a wide range of focused programs that can be tailored for special exhibits and interest groups, including elementary schools.

3. BUSINESS SPECIFIC

Due to the fact that some business operations have a higher potential of discharging pollutants into the storm drain system, a more focused public education and outreach program should be developed for them. Employees of these businesses should be educated on the issue of nonpoint source pollution and the effectiveness of Best Management Practices in reducing pollution. Besides written, audio, or visual materials that focus on specific businesses and their practices, mass mailings or articles in a trade/industry magazines are other possible means of focused outreach.

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C. EDUCATION PROGRAMS

Increasing awareness is the major goal of the Public Information and Participation Program. An ideal means of accomplishing this task is through educational programs. Programs should be developed for a variety of audiences, including public employees and school children. Educational programs can also be an important part of a general or focused outreach. A watershed-wide concept will be developed by June 1996.

1. PUBLIC EMPLOYEES

It is important to educate all of the public employees about the stormwater program so that they do not continue with any practices that are counter productive. Furthermore, they can participate in the implementation and enforcement of the program. Ideas and suggestions of employees can be used to modify the program for improved effectiveness. The outreach must involve employees on many different levels - from program managers to field personnel. Educational programs for public employees may include, but are not limited to, articles in City newsletters, training classes, checklists for field personnel, and interdepartmental forum or committee. Any of the materials utilized in an outreach program - written, audio, or visual materials - may be used in a public employee educational program.

Both general and focused outreach are essentially programs of public education. More formal training/education is also conducted by Caltrans and the City and County of Los Angeles. Caltrans personnel is educated on highway maintenance--specifically on such subjects as Hazardous Substance Spill Awareness and Pesticide Safety and Vegetation Management. City and County personnel meet regularly to discuss development of and evaluate storm water quality practices. Rio Hondo Community College staff provides on-site hazardous materials training classes for West Hollywood employees.

2. K-12

School children can play an important role in a public information and participation program. First, children are generally more easily motivated and the behavior changes made at that point in life tend to stay with them through adulthood. Secondly, school children can convey the stormwater pollution prevention messages to the members in their family. School programs must include information on the storm drain system, stormwater quality awareness, and may also include, but are not limited to, illegal dumping awareness, source minimization, and pollution prevention. Written material, videos, assembly programs, and field trips are examples of effective components of a K-12 educational program.

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Los Angeles City also has a school education pilot program, "The Magical City Forest", for grades K-6. School programs are conducted in Hermosa Beach and Manhattan Beach, as well. The County will soon have a program mascot to be used at public events.

3. OTHER

Educational programs can also be developed for professionals and technicians who are not public employees. Agencies should include public outreach material for business license renewal or outreach effort through professional and business associations.

D. RESIDENTS PARTICIPATION

The residents of the watershed should not only be made aware of the stormwater program, they should be encouraged to participate in its implementation. Specific outreach programs should be developed to allow the public to participate and to inform them of available means for providing ideas and comments regarding the stormwater program. A watershed-wide concept will be developed by June 1996.

1. VOLUNTEER MONITORING

Volunteer monitoring is the result of increased public awareness and participation. The public can utilize the hotline for reporting suspected illegal practices. Such involvement, which is similar to the Neighborhood Watch Program on crime, usually has good results.

2. COOPERATIVE OUTREACH

In order to promote public participation, cooperative outreach programs should be developed. These cooperative programs should help to create an awareness and an identification with the watershed. The catch basin stenciling and other signing programs are excellent examples of this type of cooperative effort. One possibility for cooperative outreach is an "Adopt-A-" program. Residents can "adopt" a highway, storm drain, catch basin, stream, etc. Other cooperative outreach efforts include events such as "Stormwater Pollution Awareness Week." The purpose of any of these activities is to inform and involve the local residents in regards to the stormwater management program.

Residents can assist public agencies in the development and implementation of storm water quality programs. Several watershed jurisdictions have enlisted the assistance of such groups as the Boy Scouts and neighborhood volunteers in the catch basin stenciling program. Caltrans' Adopt-A-Highway program relies on voluntary private participation to help with clean-up activities. Rolling Hills

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Estates has a similar Adopt-a-Street program. Hermosa Beach residents and businesses are encouraged to participate in the City's "Neighborhood Gutter Patrol" program. Hotline programs also enlist the assistance of residents in active participation.

3. COMPLAINT PROCEDURES

Public comments/complaints are important to the success of a stormwater program. A hotline is an excellent mechanism for allowing the public to provide information. In Section B, "Focused Outreach - Practice/Activity", the various aspect of outreach effort is discussed.

E. EFFECTIVENESS EVALUATION

Permittees should develop a process to evaluate the effectiveness of their programs. Methods such as surveys and focus groups can be used to assess program's effectiveness. Results should gauge the community's level of awareness. Surveys and focus groups can also be used to provide insight into the program's direction and the formulation of attainable goals. A watershed-wide concept will be developed by June 1996.

The City of Los Angeles has conducted a pre-survey to determine the general level of public awareness about storm water pollution. They plan to conduct a post survey in 1995 to gauge the progress made in their public education program. There have been no other reports of formal programs to assess program effectiveness, although staff discussions and management reviews have provided subjective evaluations that have resulted in program development and modifications.

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VIII. PROGRAM EVALUATION

The effectiveness of the storm water programs developed under the Municipal Storm Water Management Plan (hereinafter called the Plan) must be assessed on a regular and consistent basis. The Plan for this evaluation must include a schedule for evaluation, a methodology for the evaluation, a discussion of who will carry out the evaluation, and what will be evaluated. In addition, there must be a mechanism to follow up on the information generated by the evaluation. The Plan should be adjusted based on the program evaluation.

A. PERFORMANCE STANDARDS

The Permittees will develop standards to judge the effectiveness of the activities and control measures proposed under each chapter of the Plan. The standards will serve as minimum performance levels to evaluate the implementation of control measures. The subsequently developed performance evaluation procedures/methodologies will be the tool to determine if a particular BMP has an impact on stormwater quality. In developing these procedures, we resolve to ensure that each BMP is implemented to the maximum extent practicable. The targeted completion of this phase will be December 1996.

1. DEVELOPMENT OF PROCEDURES

General performance standards for evaluating the effectiveness of the Best Management Practices (BMPs) will be developed for all the BMPs proposed in the Plan. The Watershed Management Committee will be responsible for developing and adopting these evaluation criterion. The Management Committee may elect to establish subcommittees to develop performance standards for specific program areas. The area-wide Executive Advisory Committee will then review and endorse the standards. Standard recording format and implementation schedule will be developed for each BMP by the Management Committee for use by all permittees. The permittees will be required to document BMP implementation using the standard format according to an established schedule. The utilization of quantitative approaches in measuring effectiveness will be used whenever possible. Methods that would yield comparable results for year to year evaluation will be developed.

2. ACTIVITY/SOURCE/ACTION AREA SPECIFIC

Program effectiveness will be performed based on the information generated by the performance evaluation procedures. Using street sweeping as an

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example, the Plan will propose a method of determining if street sweeping has an impact on water quality. This could include determining what kind of pollutants are removed by the sweeping, measuring the size of the pollutants and the amount removed. Methodologies would be developed for each BMP, which will assure that each control measure or action is implemented to the maximum extent practicable. For street sweeping; this may include the frequency of sweeping now, the method of sweeping, the equipment used, how the equipment is cleaned and maintained, and the method of disposal for the material collected. A schedule and format of evaluation shall be developed for all the BMPs.

The Regional Board has recommended 13 Baseline BMPs, to be developed and/or implemented by all permittees by the end of the current NPDES Permit. Existing Permit Task 5.2.5 requires an evaluation of the need for additional BMPs, source control, and/or structural control measures.

BMPs have only been implemented for a short time period by Phase I and Phase II cities. Phase III, which contains 30 new cities, has not yet implemented any BMPs. Therefore there is little or no data available to adequately assess effectiveness. In lieu of recommending any changes or additions to BMPs currently being implemented or proposed by the Permittees, a uniform data collection methodology will be established for each of the 13 baseline BMPs. This methodology would be used by all Permittees to compile data on their BMP implementation to allow for a uniform Countywide evaluation of BMP effectiveness. Priority will be given to the development of a uniform data collection methodology to document the success or effectiveness of these 13 BMPs. Upon reorganization of the NPDES Permit Program, as described in Chapter I, this will be the first task addressed by the Watershed Management Committee. The Uniform data collection methodology will be developed by January 15, 1995 for the Santa Monica Bay watershed and by July 1995 for all other watersheds with subsequent implementation by all permittees in each watershed.

B. ANNUAL REPORTS

An annual report for each watershed will be submitted to the Regional Board not more than 45 days after the end of each permit year. Each annual report will include a summary on the programs implemented during the previous year and plan activities that will be implemented during the current year. Any revisions to the Plan would be addressed in the report.

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1. FORMAT/STRUCTURE

In order to insure uniform annual reporting by all watersheds, the Executive Advisory Committee will develop a uniform annual report outline for use by each watershed. Each Watershed Management Committee will develop a standard format to be used by all the permittees in its watershed in reporting the progress and the status of all stormwater programs implemented in its jurisdiction. The Principal Permittee will utilize this information to develop the annual report for the watershed. Upon approval by the Management Committee, the annual report will be provided to the Executive Advisory Committee which will compile the annual reports from all watersheds for submittal to the Regional Board.

2. EFFECTIVENESS MEASURES

Under Chapter VIII, Section A, the permittees will have developed performance standards for each BMP. These performance standards will be used to assess the effectiveness of the BMPs. By the end of each permit year, the findings of the previous program year will be evaluated and used to suggest changes that are appropriate for implementation during the next year. Focus should also be given to the use of empirical studies, in a control setting, to more fully assess the effectiveness of BMPs.

3. CONTENT

The annual report will include a matrix illustrating the levels of implementation for all permittees. Tables will be developed for each BMP listing all the participating Co-permittees, describing the status of implementation by each Co-permittee of the BMP, and documenting any modifications of the BMP from the standard program. The effectiveness of each program area will be assessed using the performance standards developed under Chapter VIII, Section A. For effectiveness measures, the findings should be presented graphically for ease of comparison with the established levels of effort. Fiscal budget for all the BMPs implemented should also be prepared, grouped by programs. An analysis and evaluation of the results of the past year's monitoring program data will also be included in the report. Any revisions to the Plan should be addressed here, with all the elements affected discussed in their entirety. All relevant information, such as water samples analyses and evaluation, should be included in the appendices.

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C. SEMI-ANNUAL REPORTS

A semi-annual progress report will update the Regional Board on Permit compliance activities six months into each permit year. The semi-annual report will be provided to the Regional Board within 30 days after the end of the six-month period.

1. PURPOSE

The semi-annual report will serve as a status report on the progress of the implementation of the Plan.

2. FORMAT/STRUCTURE

In order to insure uniform semi-annual reporting by all watersheds, the Co-Permittees will use the standard format developed for the annual report in reporting the progress and status of all the BMPs implemented in their jurisdictions. The Principal Permittee will utilize this information to develop the semi-annual report for the watershed for submittal to the Regional Board.

3. CONTENT

The semi-annual report will include a matrix illustrating the levels of implementation for all permittees. Tables will be developed for each BMP listing the participating Co-Permittees, describing the status of implementation by each Co-Permittee of the BMP, and documenting any modifications of the BMP from the standard program. The permittees will describe the problems encountered during implementation and discuss the modifications to the program in order to solve these problems.

D. INTERNAL REPORTING

In order to facilitate the preparation of semi-annual and annual reports, standard internal formats for use by all Permittees will be developed. The internal reporting procedures will be completed for all Plan chapter elements by December 1996.

1. STANDARD FORMS

The Watershed Management Committee will be responsible for developing standard forms for use by each Permittee. Standard forms will be developed for each BMP to monitor its progress. Some Permittees may have to customize the standard forms in order to reflect their programs' additional features. The forms will collect all the information essential to the preparation of the annual and semi-annual reports. In developing the standard report forms, information that is quantifiable and specific for each program area and/or BMP will be collected.

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2. PROCEDURES

Co-Permittees will submit all the BMP report forms to the Principal Permittee at the end of the six-month period and the permit year, respectively.

3. RECORD KEEPING

The Regional Board does not need to see all of the extraneous information, but the records will be retained by the Principal Permittee for 2 years. Each permittee will keep a permanent copy of its reporting forms in case they are needed.

E. STORM WATER MANAGEMENT PLAN REVISIONS

There will be an annual review process that will allow the Permittees to revise the Plan for the next year and for the rest of the permit period. Revision procedures will be developed by December 1996.

1. PROCESS

In the annual report, Permittees will compare the progress made on all the BMPs with the established level of effort. If the level of implementation is inadequate, the program should be adjusted to accelerate the progress. If the progress made to date shows that the program is ineffective or inefficient in protecting the stormwater quality, a new program should be developed and implemented for the next fiscal year and the rest of the permit period.

2. REPORTING

All refinements or revisions to be made in the fiscal year will be documented in the annual report, with the dates of implementation proposed.

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IX. MONITORING

The Monitoring Program is a critical element in the Stormwater Management Plan. It will provide important data for use in characterizing existing stormwater/urban runoff quality, guiding future development, and modifications to the Plan and also to assess its effectiveness. A watershed wide monitoring program shall be developed by December 1996.

A. SYSTEM CHARACTERIZATION

The existing Permit subdivided the County into six drainage basins with information to be collected to characterize each of the basins.

1. WATERSHED

Each drainage basin has been subdivided into numerous drainage areas, based on an evaluation of the existing drainage system and surface flow patterns. For each drainage area, the following information has been compiled: size; breakdown of existing land use; imperviousness; description of soils; location of waste disposal facilities; and the location, type, and number of industries by Standard Industrial Classification (SIC) Code. This information has been submitted to the California Regional Water Quality Control Board, Los Angeles Region, for Phases I and II. Phase III watershed characterization is in progress and will be completed by the end of December 1994. Due to the volume of the watershed characterization data, this information has not been included herein, but is available for review at either the Regional Board or the Los Angeles County Department of Public Works.

This information will provide a basis for developing other monitoring program elements such as pollutant loading estimates from major land uses and watersheds; pollutant source identification, and identification of illegal discharges/illicit disposal practices.

2. STORM DRAIN SYSTEM

In subdividing each basin into drainage areas, the drainage area tributary to all major outfalls has been identified. Within each drainage area, the tributary storm drain system is being identified and mapped. Key information such as the size of the storm drain facilities, locations of manholes and inlets, and storm drain connections is being compiled. This information will be vital in conducting storm drain inspections to identify and eliminate illegal discharges.

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3. RECEIVING WATERS

Due to the extent of urbanization in Los Angeles County over the past decades, most of the streams designated as receiving waters in the Los Angeles basin have been replaced with man-made storm drainage systems to provide flood protection to the urbanized areas. These streams have been mapped as part of the storm drain system mapping done under A.2. above. The remaining natural streams are also being mapped.

The Los Angeles County Department of Public Works (Department) has been performing surface water quality monitoring on a voluntary basis since the late 1960s. Samples have been collected and analyzed from various receiving water streams and channels throughout the County to collect general information as to the quality of the surface runoff within our storm drain system.

The program in existence at the time the current Permit was issued was established in the mid 1980s. Twenty-eight sites are sampled monthly for dry weather flows. Twenty-one of the 28 sites are sampled for storm flows up to five times per year. The collected samples are analyzed for general minerals, pH, total dissolved solids, specific conductance, biochemical oxygen demand, bacteria, heavy metals, pesticides, PCBs, total organic carbon, volatile organic compounds, and total petroleum hydrocarbons.

The sample collection at these sites will continue while the new National Pollutant Discharge Elimination System (NPDES) Permit monitoring stations are established. Once all NPDES Permit monitoring stations are operational, sampling at these 28 sites will be discontinued.

In order to provide an initial assessment of the water quality in the major streams and channels in the County, an analysis has been performed on the data collected through the existing surface water monitoring program. The analysis has been done on a Countywide basis and also by major drainage basin. The report can be found in Volume 8.

To better assess the receiving water impacts of stormwater the Department will be developing a program to further study stormwater impacts on selected receiving waters, including conducting toxicity studies. Initial efforts will focus on the Santa Monica Bay Watershed. A Request for Proposal for the development of such a program will be advertized by January 15, 1995.

The water quality data collected by the new NPDES Monitoring Program will provide more detailed data to better assess in upcoming years the quality of our receiving waters. Ten monitoring stations have been proposed along the

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major streams in the County. A description of these site locations can be found in the monitoring work plans for Phases I, II, and III, previously submitted to the Regional Board, see Volume 8.

4. LAND USE

As described under Section A.1. above, the existing land use categories within each drainage area have been identified. This information has been used to select drainage areas comprised of a single homogeneous land use for land use specific monitoring. A total of 14 land use monitoring sites are being established in the County. Five sites are being installed in the Santa Monica Bay Watershed with the remaining nine to be selected from within the Los Angeles, San Gabriel, and Santa Clara River Watersheds. For a description of the sites, please see Volume 8. These sites will provide valuable information as to the types and levels of pollutants found in runoff from various land uses. This information can then be used to refine the Stormwater Management Plan to develop specific management measures to target identified problems.

B. SOURCE IDENTIFICATION

Identifying the sources of stormwater pollutants from both specific land uses and specific activities will provide the information needed to identify problem areas and allow specific management measures to be developed to address these problems.

1. SPECIFIC LAND USE

As described in Section A.4. above, major land use classifications will be subject to individual monitoring to determine the types and levels of pollutants present.

2. SPECIFIC ACTIVITIES

a. A pollutant source identification program will be designed to identify significant pollutant sources (i.e., parking lots, industrial activities, etc.), with the hope that remedial action can be undertaken to reduce any significant impacts so identified. It will focus on monitoring very small areas (i.e., less than five acres) where a specific and/or interrelated set of pollutant generating activities are occurring. Its objective is to provide data for selecting BMPs for specific activities rather than characterizing discharges for long-term pollutant loading estimates.

Identification of pollutant sources can be done using a number of methods. Potential sources of storm water pollutants can be identified

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by records of chemical use and/or storage, by studies of specific activities which lead to the deposition of pollutants throughout the watershed, and by field inspection or monitoring. Watersheds which may contain significant pollutant sources can be identified through land use information or by mass loading estimates.

By mid January 1995, the County will begin targeted monitoring of a municipal corporation yard in the Santa Monica Bay watershed. A full program for pollutant sources identification will be developed by December 1996.

b. A storm drain inspection program has also been developed and is being implemented. The first phase of the inspection program will target the open channel storm drains to identify illegal discharges.

The open channel inspections will also be used to screen outfalls from underground storm drains for the presence of dry weather flows. This information will be used in the next phase of the storm drain inspection program to prioritize the underground storm drain system for further field screening and inspection of problem areas.

C. CONTROL MEASURE EFFECTIVENESS

It is unlikely that the effectiveness of the various control measures implemented by the storm water management plan can be determined solely through the data produced by monitoring the quality of storm drain flows, because it is difficult to obtain statistically significant comparisons of watershed-wide control measure performance with such data. For this reason the effectiveness of control measures will be assessed through other means.

Two general types of methods are available for assessment of control measure effectiveness: direct water quality (conventional) monitoring and indirect (non-conventional) monitoring. Direct water quality monitoring can be used to determine pollutant reduction by a specific facility or device. This technique is commonly used for structural or treatment controls, such as detention basins and constructed wetlands, where there is an accessible inflow and outflow. Inflow and outflow results are compared to determine pollutant removal and effectiveness.

Direct water quality monitoring of site runoff before and after implementation of non-structural control measures is also possible. However, it is difficult to demonstrate effectiveness at a statistically significant level because of the high degree of variability in stormwater pollutant concentration and mass loading data. The water quality improvement due to non-structural control measures is generally expected to be less dramatic than that achieved through structural controls. A larger

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number of samples is therefore required to produce a statistically significant result. This is especially difficult in relation to the monitoring of the pre-control measure condition. Collection of adequate baseline information is necessary prior to the implementation of management practices. Direct monitoring of the effectiveness of non-structural controls is feasible typically only under experimentally controlled conditions (e.g., selection of small, well-defined watershed; control of management practice implementation; effective siting and timing of monitoring activities), including a sufficient number of samples to achieve statistical significance.

Indirect monitoring currently is the primary method of choice of assessment of management plan effectiveness. A number of indirect monitoring techniques are available for assessment of management plan effectiveness.

Verification of program implementation is an indirect monitoring method that can be used to determine how a management plan is being implemented. Another indirect monitoring method, pollutant removal inventories, can be used to assess the amounts of pollutants that have been prevented from entering the municipal storm drain system.

The 13 Baseline BMPs recommended for implementation by the Regional Board plus other BMPs proposed by the various Co-Permittees are in general all non-structural control measures. In the short-term, a uniform data collection methodology will be developed for use by all Permittees to compile information on the level of implementation of the 13 Baseline BMPs. This will allow for a uniform watershed-wide evaluation of BMP effectiveness. For the Santa Monica Bay watershed, this uniform data collection methodology will be developed and begin implementation by January 15, 1995. For the other watersheds, implementation would begin July 1, 1995.

For the long-term, as the various chapters of the Plan are more fully developed, possibilities for the use of direct water quality monitoring for control measure assessment will be evaluated as opportunities arise.

D. POLLUTANT LOADING

One of the objectives of the monitoring program is to estimate the annual pollutant loadings from each watershed. Knowing the types and quantities of pollutants discharged into receiving waters are important in assessing the impacts of stormwater and, in turn selecting appropriate control measures to address problem areas.

The 24 permanent monitoring stations that are being established Permit-wide will be utilized to estimate pollutant loads from each watershed and also from various land uses. For a description of the methodology to be used to estimate pollutant loadings, please see Volume 8. For the Santa Monica Bay Watershed, the pollutant loading

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model will be tested and operational by January 15, 1995. Actual pollutant loadings will be calculated subsequent to storm events occurring for which water quality data has been obtained. For the other watersheds, a schedule for pollutant load modelling will be provided by January 15, 1995.

To more closely model pollutant loadings and evaluate control measure impacts, a more detailed dynamic modelling will be undertaken on a smaller, representative sub-watershed. The EPA-SWMM model has been selected for use in our dynamic modelling efforts. For the Santa Monica Bay Watershed, the Kenter Canyon Drain sub-watershed has been selected for this modelling efforts. This sub-watershed is typical of the urbanized areas in the Santa Monica Bay Watershed. It is comprised of multiple land uses, has well-defined boundaries, and has no upstream flow regulation. We are reviewing and identifying the existing drainage system, defining current and future land uses, and conducting field checks. The model will be tested and operational by January 15, 1995, with actual modelling results to be available later when local water quality data from our monitoring stations becomes available. Based on the results of the dynamic modelling of the Kenter Canyon sub-watershed, other sub-watersheds may be selected from the other major watersheds in the County.

E. COMPONENTS OF A MONITORING PROGRAM PLAN

The components of the monitoring program plan such as monitoring site locations, dry/storm sampling frequency and methodology, constituents to be sampled, field and laboratory procedures, QA/QC, etc., can be found in Volume 8, which has been previously provided to the Regional Board.

The Monitoring Program elements described in Volume 8 will be revised to address the Monitoring Program needs described in Section A - D above as agreed to in the letter from the County to the Regional Board dated September 22, 1994.

As the various chapters of the Plan are more fully developed, the Monitoring Program will be revised to address any additional monitoring needs that may result.

F. DATA MANAGEMENT

For water quality data collected at the 24 monitoring stations, please see Volume 8 for data storage and reporting methods.

For each Section A - E of the Monitoring Program described above, an annual report will be prepared detailing the data collected, with an evaluation and interpretation the data including water quality impacts.

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NPDES PERMIT NO. CA 0061654

TASK 5.2

REPORT OF WASTE DISCHARGE (ROWD)

VOLUME 4 OF 8 (TASK 5.2.5 - 5.2.6)

DOMINGUEZ CHANNEL/LOS ANGELES HARBOR DRAINAGE STORMWATER MANAGEMENT PLAN

LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS
WASTE MANAGEMENT DIVISION
WATER QUALITY SECTION

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DOMINGUEZ CHANNEL/LOS ANGELES HARBOR DRAINAGE STORMWATER MANAGEMENT PLAN

INTRODUCTION

On June 18, 1990 the National Pollutant Discharge Elimination System (NPDES) Permit - Order #90-079, NPDES #CA0061654-CI6948 was issued to the County of Los Angeles and 17 cities tributary to Santa Monica Bay. During the subsequent years, two newly incorporated cities within the Santa Monica Bay watershed, Caltrans, and the County of Ventura also became Co-Permittees. This Permit outlined a three year program which required each Permittee to: characterize drainage areas; develop and schedule the implementation of Best Management Practices to enhance the quality of stormwater/urban runoff within its jurisdictional boundaries and storm drains it owns and operates. On July 1, 1992, 36 additional cities were initiated into the Permit and began their three year program. By July 1, 1993, the remaining 30 cities in Los Angeles County within the drainage basin were initiated into their three year program. The cities were grouped according to their starting dates and referred to as Phases I, II, and III respectively (See Table A). In general, the boundaries of each Phase did not encompass whole watersheds but portions of various watersheds (See Figure 1).

The Permit has a five year duration and although Phase III cities have only completed year one of their three year program, the Permit requires the submittal of a Report of Waste Discharge (ROWD) which serves as an application for a subsequent NPDES Permit to replace NPDES Permit #CA0061654, which will expire on June 18, 1995. Therefore, the County of Los Angeles, Ventura County, Caltrans, and the 85 cities are now parties to the subsequent NPDES Permit application utilizing the Municipal Stormwater Management Plan (herein after called the Plan) concept.

The Plan is based on the Stormwater Management Plan Components developed by the California Regional Water Quality Control Board, Los Angeles Region (Regional Board), and is proposed on behalf of the County of Los Angeles and the other participating agencies, see Table B. The Plan describes the stormwater management activities to be undertaken during the next single, five year NPDES Municipal Stormwater Permit. The Plan involves the subdivision of the area of the County under a single, new Permit, into six watersheds, each with its own stormwater management plan. For these watersheds and the agencies in each of these watersheds, see Table B and Figure 2.

As required by the current Permit, all Permittees have proposed BMPs for their jurisdictions, described in Volume One and under prior submittals made to the Regional Board. These BMPs have already addressed many of the program areas discussed under the stormwater management plan. As required by the current Permit and continuing on under the new Permit, the Permittees will continue to implement these BMPs. This stormwater management plan will involve reorganizing the individual city-based BMP programs into a single stormwater plan for each watershed. The timeline shown in this document reflects the time needed for the transition from individual city-based programs to the preparation of a mutually agreed upon and collectively developed watershed plan by all parties of the new Permit for each of the watershed areas. The first step in beginning this process will be the reorganization of the current three phase program into a new watershed based program. A reorganization of the Phases into watersheds which are based on hydrologic characteristics will allow for the consistent development and implementation of programs among Permittees, referencing land use and drainage infrastructure within their

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respective watersheds. Consistency of programs throughout the watershed will be beneficial in terms of targeting specific pollutant problems and areas.

This specific Plan will address the stormwater management issues for the Dominguez Channel/Los Angeles Harbor Drainage watershed, which includes the following cities and agencies:

- **Caltrans**
- **Carson**
- **Gardena**
- **Hawthorne**
- **Inglewood**
- **Lawndale**
- **Lomita**
- **Los Angeles**
- **Los Angeles County**
- **Torrance**

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TABLE A

Grouping of Permittees by Phases

PHASE I

Agoura Hills
Beverly Hills
Calabasas
Caltrans***
Culver City
El Segundo
Hermosa Beach
Inglewood
Los Angeles***
Los Angeles County***
Malibu
Manhattan Beach
Palos Verdes Estates
Rancho Palos Verdes
Redondo Beach
Rolling Hills
Rolling Hills Estates
Santa Monica
Torrance
Ventura County
West Hollywood
Westlake Village

PHASE II

Alhambra
Arcadia
Azusa
Baldwin Park
Bradbury
Burbank
Calabasas*
Caltrans***
Claremont
Covina
Diamond Bar
Duarte
El Monte
Glendale
Glendora
Hidden Hills
Industry
Irwindale
La Canada Flintridge
La Habra Heights
La Puente
La Verne
Los Angeles***
Los Angeles County***
Monrovia
Montebello
Monterey Park
Pasadena
Pomona
Rosemead
San Dimas
San Fernando
San Gabriel
San Marino
Sierra Madre
South El Monte
South Pasadena
Temple City
Walnut
West Covina

PHASE III

Alhambra**
Artesia
Bell
Bell Gardens
Bellflower
Caltrans***
Carson
Cerritos
Commerce
Compton
Cudahy
Downey
El Segundo*
Gardena
Glendale**
Hawaiian Gardens
Hawthorne
Huntington Park
Inglewood*
La Canada Flintridge**
La Habra Heights**
La Mirada
Lakewood
Lawndale
Lomita
Long Beach
Los Angeles***
Los Angeles County***
Lynwood
Maywood
Montebello**
Norwalk
Palos Verdes Estates*
Paramount
Pasadena**
Pico Rivera
Rancho Palos Verdes*
Redondo Beach
Rolling Hills*
Rolling Hills Estates*
Santa Clarita
Santa Fe Springs
Signal Hill
South Gate
South Pasadena**
Torrance*
Vernon
Whittier

Note:
* The agency is also in Phase I.
** The agency is also in Phase II.
*** The agency is in all Phases.

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FIGURE 1

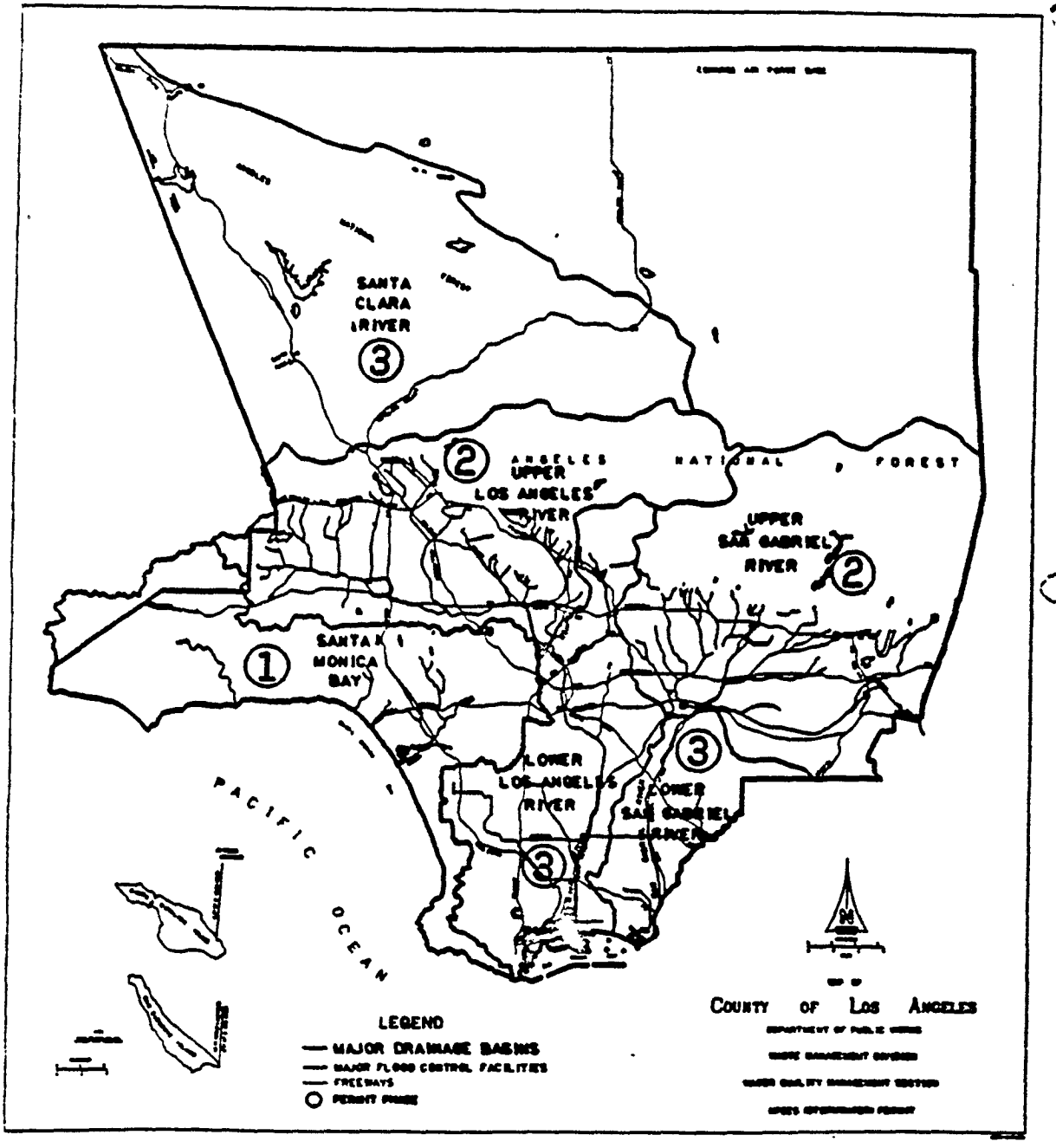

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TABLE B

NPDES Stormwater Permit Renewal
Proposed Watershed Breakup

Santa Monica Bay

Malibu Creek and Other Rural

Agoura Hills
Calabasas
Caltrans
Los Angeles County
Malibu
Westlake Village
Ventura County

Ballona Creek and Other Urban

Beverly Hills
Caltrans
Culver City
El Segundo
Hermosa Beach
Los Angeles
Los Angeles County
Manhattan Beach
Palos Verdes Estates
Rancho Palos Verdes
Redondo Beach
Rolling Hills
Rolling Hills Estates
Santa Monica
West Hollywood

Dominguez Channel/
Los Angeles Harbor Drainage

Caltrans
Carson
Gardena
Hawthorne
Inglewood
Lawndale
Lomita
Los Angeles
Los Angeles County
Torrance

Los Angeles River

Alhambra
Arcadia
Bell
Bell Gardens
Burbank
Caltrans
Commerce
Compton
Cudahy
El Monte
Glendale
Hidden Hills
Huntington Park
La Canada Flintridge
Long Beach
Los Angeles
Los Angeles County
Lynwood
Maywood
Monrovia
Montebello
Monterey Park
Paramount
Pasadena
Rosemead
San Fernando
San Gabriel
San Marino
Sierra Madre
Signal Hill
South El Monte
South Gate
South Pasadena
Temple City
Vernon

San Gabriel River

Artesia
Azusa
Baldwin Park
Bellflower
Bradbury
Caltrans
Cerritos
Claremont
Covina
Diamond Bar
Downey
Duarte
Glendora
Hawaiian Gardens
Industry
Irwindale
La Habra Heights
La Mirada
La Puente
La Verne
Lakewood
Long Beach
Los Angeles County
Norwalk
Pomona
Pico Rivera
San Dimas
Santa Fe Springs
Walnut
West Covina
Whittier

Santa Clara River

Caltrans
Los Angeles County
Santa Clarita

Italicized agencies are present in more than one watershed.

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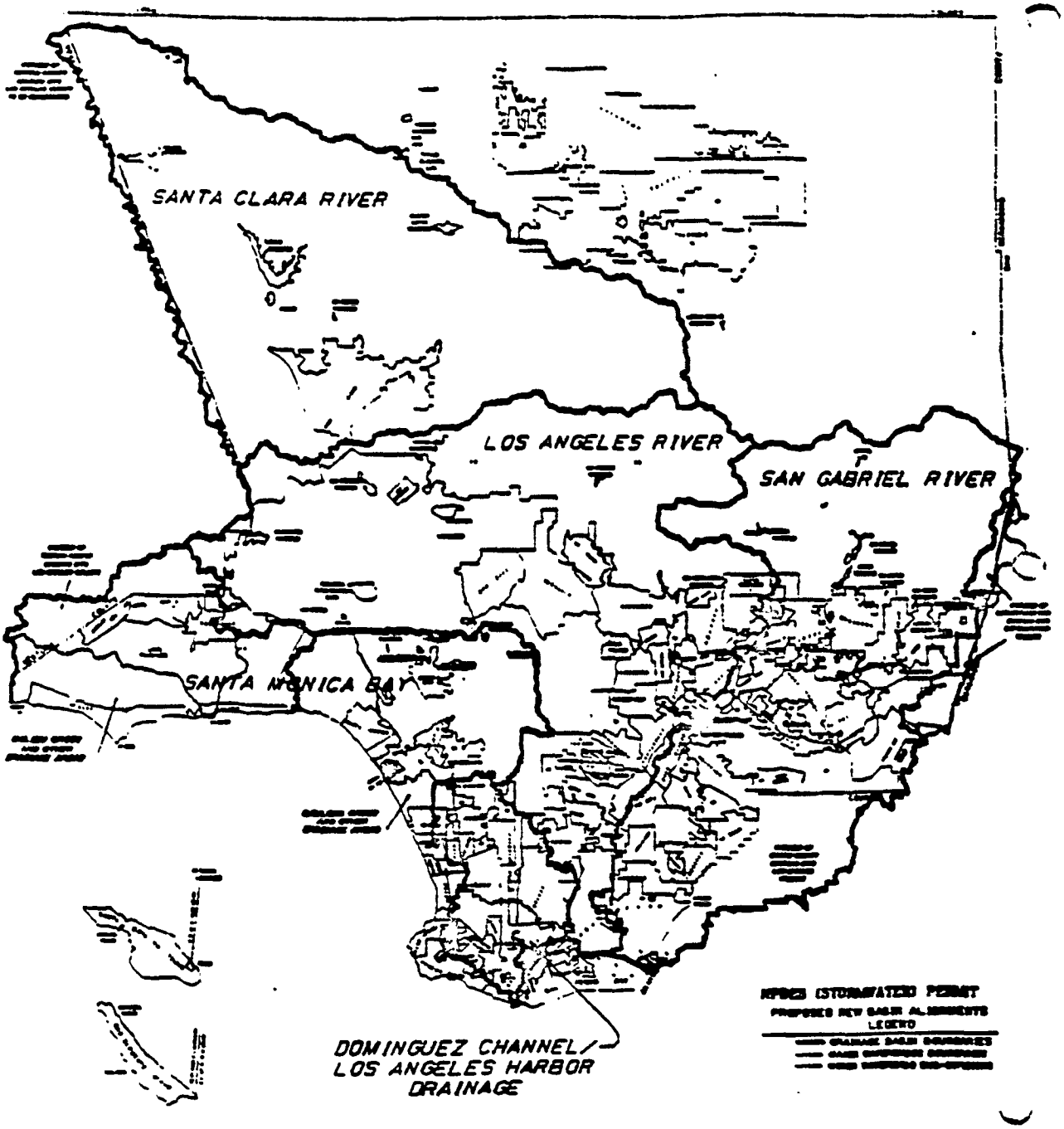
FIGURE 2



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I. PROGRAM MANAGEMENT

A. PROGRAM STRUCTURE

The County of Los Angeles is designated as the Principal Permittee. The other agencies are designated as Co-Permittees. The following are conditions that establish the responsibilities of all Permittees.

1. RESPONSIBILITIES OF PRINCIPAL PERMITTEE

Anticipated duties of the Principal Permittee include:

- Being the coordinators of permit activities and chairing the area-wide Executive Advisory Committee and the Watershed Management Committees;
- Providing the resources necessary for development of the Stormwater Management Plan.
- Providing technical and administrative support for both the Executive Advisory and Management Committees;
- Implementing the monitoring program;
- Providing the resources necessary for developing annual reports including evaluating monitoring program data and BMP effectiveness;
- Complying with all the responsibilities of a Co-Permittee as outlined below.

2. RESPONSIBILITIES OF ALL CO-PERMITTEES

Each Co-Permittee is designated a number of duties under the proposed stormwater management Plan:

- Participate in the development of the management plan;
- Implement the stormwater management plan within their jurisdictional boundaries and the storm drains they own and operate.
- Provide information needed by the Principal Permittee on program implementation for development of the annual reports.

The area under the Permit will be subdivided into the six watersheds tributary to the following waterbodies: Santa Monica Bay, which is further divided into a) Malibu Creek and Other Rural Areas, and b) Ballona Creek and Other Urban Areas; Los Angeles River; San Gabriel River; Dominguez Channel/Los Angeles Harbor Drainage; and the Santa Clara River (See Figure 2). Managing these watersheds is a task that will require a collective and cooperative effort on the part of all governmental entities named in the Permit that are within each watershed.

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The management structure of the Plan consists of an area-wide Executive Advisory Committee, Watershed Management Committees, and Subcommittees. This particular structure is intended to provide a suitable program for the unique characteristics of each watershed and shall be developed by April 1995.

The Co-Permittees tributary to the Dominguez Channel/Los Angeles Harbor Drainage watershed shall adopt this watershed stormwater management program structure as a guide to allow for an area-wide uniformity of compliance of the Permit.

3. EXECUTIVE ADVISORY COMMITTEE

The area-wide Executive Advisory Committee shall consist of the County of Los Angeles, as Chair, and two representative Co-Permittees from each of the six watersheds. This Committee assumes no responsibility for the adequacy or inadequacy of any individual city's program, and should not be viewed as the responsible agency in this sense. The Committee's main role is to facilitate programs within each watershed and to enhance consistency among all of the programs. Additional responsibilities of the committee are:

a. Making recommendations on area-wide issues to each of the Watershed Management Committees;

b. Reviewing the stormwater management plans as developed by each Watershed Management Committee and provide direction and guidance on the plans for consideration by the Watershed Management Committees;

c. Assessing the consistency of all area-wide BMPs;

d. Preparing and forwarding unified submittals to the Regional Board upon receipt of information and materials submitted by the Watershed Management Committee in compliance with Permit requirements;

e. Scheduling and coordinating meetings and correspondence to allow for communication between the Co-Permittees and the Regional Board;

f. Acting as liaison between all Permittees and the Regional Board on Permit issues as well as mediating conflict among the Permittees.

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4. WATERSHED MANAGEMENT COMMITTEE

A management committee within the watershed will be comprised of the County of Los Angeles, as Chair, and one representative from each of the Co-Permittees in the watershed. The committee shall be responsible for:

a. Establishing goals and objectives for the watershed;

b. Preparing the stormwater management plan for the watershed (This includes the development of all chapter components of the Plan);

c. Assessing the effectiveness of the Plan and making appropriate changes;

d. Preparing the semi-annual progress reports and annual Permit reports on Permit activities within the watershed for submittal to the Regional Board (For the annual Permit report, a draft will be circulated to each Co-Permittee and the Executive Advisory Committee for its review and comment. Final copies of reports shall be forwarded to the Executive Advisory Committee through which a compilation from all six watersheds shall be submitted to the Regional Board);

e. Enhancing the implementation of the storm water/management plan within the Dominguez Channel/Los Angeles Harbor Drainage watershed.

5. SUBCOMMITTEES

Subcommittees will be established where needed as determined by the Management Committee and/or the Executive Advisory Committee. The Subcommittees would be focused on specific program areas and can provide more specific oversight on the development, implementation, and evaluation of select program areas. These subcommittees shall be scheduled to meet on a routine basis.

B. INSTITUTIONAL ARRANGEMENTS

Management of the stormwater program requires the collective efforts and the cooperation of all Permittees. No Permittee has the ability and the legal authority to assume the responsibility of all activities of this Permit. Therefore, agreements will need to be formally developed amongst the Permittees to insure proper implementation of the Permit requirements.

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1. PROGRAM PARTICIPANT ARRANGEMENTS

As the Principle Permittee, the County of Los Angeles will be designated as the lead agency for coordination of Permit activities and therefore shall chair the executive committee and the management committee meetings as they are scheduled. The lead agency is responsible for coordination of the permit but is not responsible for the adequacy or inadequacy of any individual Permittee's program. All other entities are Co-Permittees and will be responsible for the permit compliance of their own agency's program. An implementation agreement will be drafted formally detailing the responsibilities of the Principal Permittee and the Co-Permittees. The agreement would also address the funding of various watershed-wide activities such as Plan development, annual evaluation and reporting, and monitoring. Execution of the agreement by all Permittees is targeted for December 1995.

2. AREA-WIDE INTERAGENCY

As the Plan for each watershed is more fully developed, the Watershed Management Committee will coordinate with special agencies and districts that also regulate and/or perform activities addressed under different elements of the Plan. This coordination will attempt to ensure that their functions and the Plan are compatible. A few of these agencies include:

County Hazmat

- Any overlap of waste regulations, Household hazardous waste programs and or Industrial inspections shall be recognized and addressed, by all entities that fall under this Permit, in reference to the watershed program.

County Health

- Inspections of restaurants and other food handling establishments shall be coordinated with the Permittees.

Local Transportation/Congestion Management

- Local municipalities have limited authority over motor vehicle usage and regional transportation planning. Where feasible, plan development and implementation will be coordinated with local transportation agencies.

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County (Regional) Parks

- Landscape maintenance activities at publicly owned parks will be reviewed as part of additional plan development to ensure the use of proper management measures.

Mosquito Abatement

- Coordination with the County Agricultural Commissions will be done for mosquito abatement programs to avoid adverse impact on the quality of stormwater/urban runoff.

Water Districts

- Activities with regards to the Water Districts activities will be reviewed and, when feasible, comply with the watershed program regulations and requirements.

Other entities, both private and public which have major land holdings and/or authorities that impact the quality of stormwater/urban runoff, should be initiated to actively participate in the program.

3. CITY-SPECIFIC INTERAGENCY ARRANGEMENTS

Each city will need to develop the institutional framework to address operation, maintenance, construction, redevelopment, and other activities performed by city agencies such as Public Works, Parks and Recreation, Planning and Public Owned Treatment Works (POTWs). These city agencies will need to participate in the planning and implementation of relevant plan program areas.

C. FISCAL RESOURCES

As each of the Plan chapters are completed, each Permittee will develop a budget for implementing that portion of the plan. A complete budget for the plan will be produced upon completion of development for all Plan components by December 1997. The budget will provide information such as funding sources, staff resources, contract services, and cost sharing arrangements.

1. AREA-WIDE

In implementing the Plan, the Permittees may elect to jointly fund a single program for certain BMPs such as Public Education that are area wide in

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nature. Funding agreements including budgets and cost per agency would be developed.

2. CITY-SPECIFIC

Each Permittee will develop a budget detailing the cost of implementing Plan activities within its jurisdiction. Special funding in the form of grants, donations, or other forms of contribution should also be actively pursued to assist in funding special studies and/or BMPs.

D. LEGAL AUTHORITY

Each Permittee is responsible for implementing the Plan within its jurisdictional boundaries and therefore must acquire all needed legal authority. Each Permittee, being separate legal entities are to have adopted as required by the existing Permit, ordinances that will provide them with the adequate legal authority to develop, administer, implement, and enforce storm water/urban runoff management programs within their own jurisdiction. The ordinance must provide for its enforcement and at a minimum specify that violators may be subject to penalties including, but are not limited to, fines and termination of the activity causing the violation. A plan for identifying any additional legal authorities needed by the Permittees will be included in the completed Plan for the Dominguez Channel/Los Angeles Harbor Drainage watershed by December 1996. Upon completion of development of the Stormwater Management Plan, enforcing compliance with the Plan will be the responsibility of the Regional Board.

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II. ILLICIT DISCHARGES

The elimination of illegal connections and illicit disposal (IC/ID) practices is an important component for any program aiming to enhance the quality of stormwater/urban runoff.

Although more information is needed to fully assess the benefits and costs of conducting IC/ID programs, we can make logical decisions regarding application of best management practices (BMPs) to minimize such incidents. These BMPs will vary due to the jurisdictional differences which exist within each watershed. Each jurisdiction within the watershed will be developing and implementing those activities which adequately serve the jurisdiction and the watershed as a whole.

IC/ID practices are intermittent discharges of pollutants into the storm drain system that can degrade the quality of receiving waters. This can occur through catch basins, area drains and even on gutters and street surfaces. Some illegal dumping activities are done by individuals who do not know that such practices are illegal and can adversely impact the environment. Yet, others may be carrying out such practices with the full knowledge that such activities are prohibited.

A. ILLICIT CONNECTIONS

In order to implement an illicit connection management program, jurisdictions as a whole will need to develop and implement the procedures for investigating each of their respective storm drain systems.

Detailed procedures to eliminate illicit connections depends on the complexity of the storm drain system. A consistent watershed wide concept will be developed to investigate illicit connections to the storm drain system. Based on the results of field screening activities, or other appropriate information which indicates an area of reasonable potential of containing illicit connections, detection and follow up procedures would be followed. Priority should be established to focus on major problem areas and allow for a cost-effective approach to eliminate illegal connections. This concept will be developed by December 1996.

1. SYSTEM SURVEY

A system survey is a necessary component of an illicit connection elimination program. Although the basic concept is similar, the actual techniques and methods which jurisdictions within the watershed use to conduct system surveys can be quite different.

In conducting system surveys, the intent is to avoid costly investigations within areas not suspected of containing illicit connections. Field screening, map

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research, and land use investigation activities will be done initially to identify potential problem areas. Public outreach efforts will be used to inform citizens in the area about the problem. Enforcement action will be taken to terminate such illegal connections. It should be noted that more detailed and sophisticated techniques such as televised inspection and dye testing will only be used in special situations as needed.

As mentioned above, a system survey is a necessary component of an illicit connection elimination program. At this time three jurisdictions have undertaken such a survey. Identification of all connections to the storm drain system, with the issuing of as-built permits or disconnect notices, has been undertaken by one city. Detailed maps showing the location of each storm drain, its manholes and catch basin connector pipes are being prepared by Los Angeles County to make monitoring of illegal connections and discharges more efficient. Also the location and source of all discharge connections is being inventoried and a GIS system is being developed. This information will be used in the storm drain inspection program which is ongoing. The program is targeting open channel storm drains. All open channels will be inspected for evidence of illegal discharges. The open channel inspections will also be used to collect information on dry weather discharges from underground drains for use in prioritizing future underground drain inspections.

The City of Los Angeles has contracted with a vendor to provide "on call" closed circuit television of storm drain interiors to detect cracks, misalignments, deposits, debris and illegal/illicit connections and discharges. The larger jurisdictions are the ones who have taken the lead in undertaking a system survey.

2. ONGOING SYSTEM INSPECTIONS

Ongoing system inspections for illicit connections will involve the techniques identified in Section 1. above, along with some additional activities. In smaller systems where the storm drain goes into several pumping stations, a regular inspection of the pumping stations for, among other things, evidence of illicit discharges will be sufficient.

In larger and more complex systems, a program of field screening will be used. Evidence of pollution will be categorized and prioritized. The storm drain alignment tributary to the suspect illegal connection can then be further investigated for illicit connections. If a discharge can be traced to a particular facility, the facility will be investigated to identify where exactly the pollutants are coming from and efforts needed to stop the discharge.

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Another means of detecting illicit connections may be to rely on reports of illicit discharge from the public. This will utilize the County's or another agency's established "hotline" number that the public can call and report such observations.

Ongoing system inspection was mentioned by only one city which is now in the process of inspecting storm drain lines to identify illegal connections and to determine the conditions of existing pipes.

3. REPORTING

A consistent recording system will be established to track reports of illegal connections. This recording system will be used by the Permittees within the watershed.

B. ILLEGAL DUMPING

Due to the intermittent and unpredictable nature of illegal dumping, apprehension rate of violators could be quite low. The first course of action is to develop an area wide educational and reporting system along with prompt response procedures. This will be accomplished by December 1996.

1. OUTREACH

See **Chapter VII Public Information and Participation** of this report for a detailed discussion of the outreach program.

2. SYSTEM SURVEILLANCE

Measures that may be used for this aspect of the program may include but not limited to regular inspections of vacant facilities, street use inspection programs to detect illegal discharges and dumping into the street system, and a public complaint and reporting system.

A couple of system surveillance programs have been established. A program for investigation and identification of hazardous waste and debris dumped on excess parcels has been undertaken by Caltrans and in the City of Los Angeles, the Bureau of Street Maintenance enforces violations of excess water and fluids in the street system. This program is primarily on a complaint basis but will be even more effective when funded. A program to investigate storm drain lines to stop discharge of pollutants from specific facilities is planned.

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3. SPILL RESPONSE

The Health Hazardous Materials Division (HHMD) of the Los Angeles County Fire Department is generally the primary spill responder. If the material is found to be hazardous and poses an imminent threat to public health and safety, the cleanup and disposal of the material will be done under the supervision of HHMD. If the material is non-hazardous, the responsibility will fall on local agencies to coordinate cleanup, disposal and attempt to identify and prosecute the violators. Cooperation among all agencies will be needed to allow for prompt action and joint effort to deter such violators. All agencies will have local authority against such illegal dumping activities.

Three jurisdictions have established specific procedures for responding to spills. These responses are: a program to respond rapidly to contain spills, establishment of adequate spill clean up procedures for city owned facilities and alarms installed in storm drains. One jurisdiction reports that an evaluation of the latest developments regarding improved containment and equipment was done, and although their procedures were found to be adequate, new procedures are being developed to continue further refinement of the program.

4. COMPLAINT RESPONSE

The County and some local agencies have established a stormwater telephone "hotline" that can be utilized by all citizens. Public complaints are generated through these "hotlines" and also through regular channels such as calls to Fire or Police agencies or to public works or legislative offices. Although responses to these complaints will vary depending on the nature of the complaint, action shall be taken.

The County has established an 800 hotline which is available to all county residents for reporting illegal dumping. This phone number has been publicized through outreach programs to some degree by over half the jurisdictions and agencies within this watershed. Three larger cities have established their own hotlines and outreach programs and one smaller city reports that it plans to begin a hotline as well. Methods used to publicize hotline phone numbers include advertisement on local cable television, notices on utility bills, articles in city newsletter and use of brochures, press releases and refrigerator magnets. Three jurisdictions report they are in the process of developing outreach programs to encourage public reporting at this time. Los Angeles County has established tracking of complaints. Hotline complaints are registered and minor dumping violations are followed up with a letter.

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5. COORDINATION OF ALTERNATIVE DISPOSAL

Alternative disposal is one way of reducing non-stormwater materials that can potentially find their way into the storm drain system. Recycling programs are one of the most effective ways to reduce waste material. The recycling program can either be at the curbside or through drop-off centers. Household hazardous wastes can be dropped at mobile collection centers or at fixed sites. Co-permittees in the basin generally participate in the County's Household Hazardous Waste collection program. Effectiveness of those programs may be enhanced by a public outreach program that will inform the public of the locations and/or schedules for such events. Technical assistance or information may also be provided to businesses that want to develop a pollution prevention, waste minimization or alternative disposal program.

Alternative disposal programs have been very successful. All jurisdictions/agencies have established some sort of recycling program. One city has only a green waste and used oil recycling program. Caltrans does not have a curbside recycling program, since such a program is not applicable to that agency. All other cities have curbside recycling of a variety of materials. Another method of alternative disposal, the Countywide Household Hazardous Waste Roundups are extremely popular. Only Caltrans, who recycles its own hazardous materials, does not participate in the countywide program. Also noteworthy, one smaller city joins with neighboring cities and major industries in waste collection programs and Los Angeles provides a special "Hazmobile" that travels to various sites and accepts wastes by appointment.

6. REPORTING

Incidents involving a hazardous material entering the storm drain system are to be reported by the responsible party, or, if not known, the responding agency, to the California Regional Water Quality Control Board, Los Angeles Region (Regional Board). Complaints received through the County wide and local city hotlines will be tracked and reported to the Regional Board.

C. ENFORCEMENT PROCEDURES

Enforcement actions against discharges are done through either state hazardous and toxic materials statutes or through municipal ordinances that are already in the codes of the permittees. Industrial Waste Ordinances may be used in enforcement actions against illicit connections. Furthermore, anti-littering, health codes, plumbing codes and fire codes may be utilized for dumping or spill incidents. Enforcement actions can be taken by different municipal agents, including but not limited to, Industrial Waste Inspectors, Building or Plumbing Inspectors, Fire Department Inspectors, Park

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Rangers, Street Use Inspectors, Health Inspectors, Police Officers, Community Services Officers, Animal Control Officers, Code Enforcement Staff or Public Works Inspectors. Some of these agents are empowered to either issue citations, issue notices of violations, issue cease and desist orders, or even make arrests depending on the type of violation and the code provisions that they are enforcing. Some of these agents are also empowered to enforce not only municipal ordinances but also state laws. A review of the various enforcement tools used by the Permittees will be performed. A recommendation will result on a consistent enforcement approach for the watershed for consideration by all Permittees in their own enforcement programs. This recommendation will be developed by December 1996.

Five jurisdictions and Caltrans have ordinances prohibiting improper disposal. All of these impose penalties on violators. One city is in the process of developing a program and another encourages proper disposal by providing composting containers, conducting workshops and sponsoring bi-annual clean-up days. The larger jurisdictions use a variety of personnel in enforcement. Health inspectors, Fire Department staff, Animal Control officers, Code Enforcement personnel and Environmental Quality officers are mentioned as those with authority to issue citations within the cities in the watershed. Two larger jurisdictions with active enforcement procedures also have programs to create public awareness. The City of Gardena deserves mention for having implemented extensive programs to discourage improper disposal including weed and rubbish abatement programs, alley inspections, and abandoned vehicle regulations.

D. COORDINATION WITH STATE NON-STORMWATER PERMITS

In order to characterize the nature of the existing non-stormwater discharges in the receiving waters within the watershed, a list of NPDES Permits issued by the Regional Board will be obtained. This will help in determining unexpected discharge during dry weather and to allow enforcement actions to focus on illegal dumping activities.

There is also a need to coordinate with other environmental agencies to ensure that requirements imposed by these agencies do not conflict with stormwater regulations. Requirements of many agencies do complement stormwater regulations. These agencies, include but not limited to, Fish and Game, DTSC, USEPA, and the Coastal Commission. Coordination with these agencies will help minimize overlapping investigations and result in a more efficient use of resources. A watershed wide concept will be developed by December 1996.

1. IDENTIFICATION OF PERMISSIBLE/PERMITTABLE DISCHARGES

A list of non-stormwater discharges that can be allowed to discharge into the Waters of the State will be established by the Regional Board.

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2. APPROPRIATE MANAGEMENT PRACTICES

Continued communication with Regional Board will allow current information to be circulated among all agencies.

3. REPORTING

Any conflict in requirements of other environmental programs/agencies must be reported immediately to the Regional Board for ruling as to which one should take precedence.

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III. INDUSTRIAL/COMMERCIAL SOURCES

Each Permittee shall develop and implement a program that focuses on the identification and control of storm water pollutant discharges from industrial/commercial facilities within their jurisdiction. This program shall provide for the inspection of a facility's compliance with storm water regulations, as well as general outreach for all facilities that are potential industrial and commercial dischargers.

Each Permittee is responsible, under the requirements of the Municipal Stormwater Permit, for all discharges from commercial and industrial facilities within its jurisdiction. Many industries are also required to be permitted under the State General Industrial Activities Stormwater Permit. Enforcement of the specific provisions of the State General Permit is the responsibility of the State.

A. IDENTIFICATION OF SOURCES

As required under the current Permit, the Permittees have produced a listing of industries by SIC category for each drainage area. Also a breakdown of major land use types was also performed for each drainage area.

A pollutant source identification program will be designed to identify significant pollutant sources (i.e., parking lots, industrial activities, etc.), with the hope that remedial action can be undertaken to reduce any significant impacts so identified. It will focus on monitoring very small areas (i.e., less than five acres) where a specific and/or interrelated set of pollutant generating activities are occurring. Its objective is to provide data for selecting BMPs for specific activities rather than characterizing discharges for long-term pollutant loading estimates.

Identification of pollutant sources can be done using a number of methods. Potential sources of storm water pollutants can be identified by records of chemical use and/or storage, by studies of specific activities which lead to the deposition of pollutants throughout the watershed, and by field inspection or monitoring. Watersheds which may contain significant pollutant sources can be identified through land use information or by mass load estimates.

By mid January 1995 the County will begin, targeted monitoring of a municipal corporation yard in the Santa Monica Bay watershed. This will provide data on industrial activities which can take place at such a facility such as vehicle maintenance and repair, materials storage, equipment storage and repair. A more comprehensive program to identify various pollutant sources will be developed by March 1997.

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1. CATEGORICAL LIST

Sources identified as a categorical industry regulated by the U.S. Environmental Protection Agency (EPA) will be grouped into a categorical listing of industries. The categorical list provides an organized overview of the target facilities that, based on land use, operation, and activities, could potentially contribute significant amounts of pollutants into storm water runoff. Some of the industrial categories regulated by the U.S. EPA include, but not limited to:

- Aluminum Forming
- Asbestos Manufacturing
- Battery Manufacturing
- Canned & Preserved Fruits & Vegetables
- Cement Processing
- Copper Forming
- Electroplating
- Glass Manufacturing
- Grain Mills
- Machinery Manufacturing & Rebuilding
- Soap & Detergent Manufacturing
- Metal Finishing
- Metal Molding & Casting
- Oil & Gas
- Organic Chemicals & Plastics & Synthetic fibers
- Paint Formulating
- Pesticides
- Plastic Molding & Forming
- Rubber Manufacturing
- Sugar Processing
- Textile Mills

2. RANKING

Industrial and commercial facilities identified as pollutant sources shall be ranked in order of priority for development of management measures. Facilities considered to be high priority are those whose operations and activities are determined to potentially contribute the most significant pollutant impacts to storm water discharge.

3. UPDATE PROCEDURE

Each year the Co-Permittees will evaluate the results of the monitoring program, the illicit discharge investigation program, and other available information , to identify likely sources of specific pollutants. The annual report to the Regional Board will recommend a strategy for pollutant source identification during the following year, including specific sites and/or activities to be monitored.

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B. CONTROL MEASURES

Specific urban runoff control programs for major potential pollution sources shall be developed by March 1997. Within these programs storm water pollution control measures shall be developed for various pollutant sources. Control measures such as source control and treatment control offer different, but complimentary approaches to storm water pollution control.

Source control measures focus on good housekeeping practices, pollution prevention and minimization, and education. They are also less costly than treatment controls.

Treatment controls involve physical treatment of the runoff, usually through structural means. Also treatment controls will not remove all pollutants and their removal efficiency is difficult to predict given the limited understanding of the relationship between facility design criteria and performance.

The initial focus will be on the development of source control measures. As information is collected under the pollutant source identification program regarding specific pollutant sources, specific control measures, including structural, will be evaluated as to their effectiveness in addressing these sources.

1. POLLUTION PREVENTION MEASURES

Source minimization and education are the first steps in effective source control. Other activities that contribute to source control are:

- Site design alternatives (i.e., roof over fueling stations and carwash slab, provide spill containment curb around stored material, etc.)
- Good housekeeping practices

2. STRUCTURAL (TREATMENT) MEASURES

A variety of treatment control measures have been utilized throughout the country for storm water quality. However, the effectiveness of these controls are highly dependent on local conditions such as climate, hydrology, soils, groundwater conditions, extent of urbanization, etc.

Some of the more common treatment controls are:

- Oil/water separators - Oil/water separators are designed to remove one specific group of contaminants: petroleum compounds and grease. However, separators will also remove floatable debris and settleable solids.

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- Infiltration - A family of systems in which the majority of the runoff from small storms is infiltrated into the ground rather than discharged to a surface water body. Infiltration systems include: ponds, vaults, trenches, dry wells, porous pavement, and concrete grids.

- Wet ponds - A wet pond has a permanent water pool to treat incoming storm water.

- Constructed Wetlands - Constructed wetlands have a significant percentage of the facility covered by wetland vegetation.

- Biofilters - Biofilters are of two types: swale and strip. A swale is a vegetated channel that treats concentrated flow. A strip treats sheet flow and is placed parallel to the contributing surface.

- Extended Detention Basins - Extended detention basins are dry between storms. During a storm the basin fills. A bottom outlet releases the storm water slowly to provide time for sediments to settle.

- Media Filtration - Consists of a settling basin followed by a filter. The most common filter media is sand; some use peat/sand mixture.

- Multiple Systems - Multiple systems are a combination of two or more of the preceding controls in series.

C. OUTREACH

General outreach for all facilities that are potential industrial and commercial dischargers shall be set up area-wide by the Management Committee, to provide general guidance in complying with the storm water program by March 1997. It shall also serve as a reminder of pollution prevention measures and keep facilities informed of their obligations to the storm water program.

Subcommittees may be established to develop specific outreach materials for industrial and commercial categories and specific activities that are identified as high priority.

For additional information on outreach, refer to **Chapter VII Public Information and Participation.**

D. INSPECTIONS

Most municipalities have existing programs such as industrial waste, fire, and health in which industrial and commercial facilities are inspected on a regular basis. Each

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Permittee may elect to have inspections for the storm water program incorporated into these existing inspection programs, or be done as a completely separate program, depending on the needs of the Permittee.

The purpose of these inspections is to ensure that facilities are in full compliance with the storm water regulations and to ensure that control measures are being implemented. The frequency of inspection of facilities will be prioritized based on the operation and categorization of the facility.

Inspectors consisting of public personnel will be trained adequately to recognize and handle problematic activities concerning storm water pollution that may be existing or potential; and inspect for the deterioration of the storm drain system and illegal/improper connections. Training programs will be developed through the Watershed Management Committee and possibly specific Permittees for use by all Permittees.

Procedures for the identification, investigation, enforcement, and prosecution to the full extent of a jurisdiction's legal authority will be developed.

Presently Los Angeles County issues permits to all commercial and industrial facilities which generate industrial wastes. Included within this program are auto related businesses, gas stations, and restaurants. Facilities with industrial waste permits are regularly inspected. In addition to those businesses in the unincorporated areas, the County Department of Public Works also provides industrial waste inspections, under contract, for four cities in the watershed. Los Angeles has an extensive program to issue, inspect and enforce Industrial Wastewater Permits issued for non-storm waster discharges. Facilities are inspected between 1-4 times per year. One city reported that industrial waste inspections are on a complaint basis, while another stated that certain city staff are alerted to look for non-storm water discharges. Caltrans inspections include daily examination of auto related facilities, lead testing of gas stations once per year, quarterly pumping of clarifiers, and constant storm drain monitoring. A program to inspect underground storage tanks is part of a five year plan.

1. CHECKLIST

Inspectors shall have a uniform checklist to use as guidance and reference throughout an inspection. It may also serve as a general guide for the public, providing information about the requirements necessary to comply with the storm water regulations.

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2. SCHEDULE

The inspection program shall be developed by March 1997. The frequency of inspections shall be scheduled according to the type of operation and the categorization of the facility. Revisit inspections shall be done on an as needed basis.

3. REPORTS

Inspectors shall report on all activities related to and/or violating the local storm water ordinance to the local governing agency. Standard reporting procedures will be developed.

4. FOLLOW-UP PROCEDURES

Individual Permittee review and assessment of the reports may result in the need for follow-up procedures, such as reinspection or legal action, provided the jurisdiction has the adequate legal authority to do so. Follow-up procedures will be developed to insure a uniform and consistent approach.

E. LOCAL INCENTIVE PROGRAMS

In developing the industrial/commercial program, the Permittees may consider the development of optional measures such as clean business incentive programs that may offer more focused control on industrial and commercial sources. It is projected that such programs shall be developed by March 1997.

F. TRAINING

Development of training programs for industrial storm water inspection staff is projected to be completed by March 1997.

The Los Angeles County Department of Public Works has issued a department directive requesting all employees to report any observed water quality problems. Caltrans employees have received education in hazardous substance spill awareness, pesticide safety, and vegetation management. In the City of Los Angeles, a specialized inspection group focusing on improving storm water quality and eliminating illegal discharges and illicit disposal practices is staffed by the Bureau of Engineering.

1. PUBLIC EMPLOYEES

All public employees shall be trained in the storm water regulations so that they abide by the regulations in the course of their work day. Also they need

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to be able to recognize and distinguish between legal and illegal activity so as to administer the proper protocol in handling the situation.

2. INSPECTORS

Inspectors who visit industrial and commercial facilities shall be adequately trained to determine compliance with the storm water regulations and educate the facilities about the requirements of the program. In addition, they should be able to recognize and handle immediate problems as they are encountered, during an inspection; and inspect for the deterioration of the storm drain system and illegal/improper connections. Citation training will be necessary for inspectors in agencies that have the citation authority.

G. COORDINATION WITH STATE INDUSTRIAL STORM WATER PERMIT

The Permittees have existing local ordinances governing industrial discharges and other stormwater discharges that require compliance activities similar to those in various State Regulations. Because coordination between the Permittees and the Regional Board is anticipated concerning the regulation of industries, a mutual agreement may be required regarding industrial inspections and enforcement. Additional issues could also be addressed. Federal stormwater regulations hold local municipalities responsible for stormwater discharges from all industrial/commercial facilities, including those covered by General Permit.

1. MEMORANDUM OF UNDERSTANDING

A Memorandum of Understanding (MOU) may be used to formalize the agreement between municipalities and the Regional Board on industrial compliance program issues. A MOU among all local agencies may also be needed to ensure co-operation between all the agencies. The need for and specific requirements for such agreements would be developed upon completion of development of the industrial/commercial program by March 1997.

2. REPORTS

The Mou discussed above may include the exchange of information between the Permittees and the Regional Board. Appropriate formats for such reports would be developed as required.

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IV. NEW DEVELOPMENT AND REDEVELOPMENT

Managing stormwater and runoff from both new construction and redevelopment, will reduce pollutants entering the storm drain system and subsequently the receiving water.

A. PLANNING PROCESS

Quality of stormwater discussion should be included in the General Plan and the Zoning ordinances. Efforts to enhance the quality of storm water can filter into the Subdivision actions. Many of the storm water concerns can be channeled through the compliance effort of the California Environmental Quality Act (CEQA). A watershed wide concept will be developed by June 1997.

1. WATERSHED PROTECTION POLICIES

An integrated strategy will be developed for the watershed. Pollution control efforts should be prioritized. A variety of statutory and regulatory requirements could be used for this watershed oriented program. Watershed protection policies need to be adopted by the local jurisdictions which control land-use within the watershed.

2. COORDINATION WITH CEQA

The current CEQA "Environmental Checklist Form" that is used for initial studies assessment indirectly address potential impacts to stormwater. Additions could be made to the Form to directly assess stormwater quality impacts.

CEQA requires agencies to use feasible alternatives or mitigation measures to lessen potentially significant effects. The ability to identify a.) when an effect is significant, and b.) which mitigation measures could be adopted to reduce the effect, is critical to the CEQA process. A clear assessment of any development, its potential adverse impacts on stormwater quality will allow for a determination of "significance" which will enable the decision maker to make development decisions upon full disclosure of possible adverse impacts.

3. SITE PLANNING PROCESSES

All development will require the review and approval of a site/plot plan or development drawings prior to issuance of a building permit. Incorporating the consideration of potential water quality impacts including erosion and sedimentation during the early stages of the planning process will allow these

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issues to be addressed before substantial investments in engineering and design have been made.

Caltrans requires a plan for water pollution control for construction projects. Construction may be halted if inadequate provisions have not been made for water quality protection.

4. GENERAL PLAN CHANGES

The General Plan is the legal backbone of the planning process. All development approvals, zoning ordinances, subdivision approvals and public works projects must be consistent with the policies, objectives, and principles set forth in the General Plan. Discussion of stormwater issues in the General Plan could greatly enhance the awareness of the issues and encourage full assessment of possible adverse impacts on stormwater quality as the result of new and redevelopment.

Two jurisdictions have amended their General Plans to include water pollution control, conservation elements and general requirements of federal and state storm water regulatory programs.

5. USE OF MASTER PLANS

For agencies which utilize master plans to guide their development activities, stormwater issues can be outlined in such documents. This will channel efforts to fully assess the possible adverse impacts on stormwater quality as the results of any development within the master plan area.

6. OTHER POLICIES

Numerous other policies or mechanisms could be used to incorporate stormwater management goals into the planning/development process. Other concepts will be evaluated for their feasibility during the more detailed development of this Chapter.

7. PLANNING-PUBLIC WORKS INTERFACE

A variety of mechanisms for coordinating planning and public works activities exist. An example could be some form of CIP (capital improvements program). Ideally, any planning documents which target or project population growth are coordinated with CIP. Integrating stormwater management into CIP will allow for mitigation of major adverse impacts on the quality of stormwater prior to any actual construction.

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8. IMPLEMENTATION PROCEDURES

Implementing policies to integrate stormwater management considerations with existing planning/development mechanisms will require a variety of approaches depending upon the existing conditions within each Co-Permittee and the particular remedies selected. It is anticipated that each Co-Permittee will propose procedures applicable to it's unique jurisdictional considerations at later stages in the permit process.

B. CONSTRUCTION SITES

Pollutants from construction activities can have a major impact on the quality of stormwater/urban runoff. A watershed wide concept to reduce such pollutants will be developed by December 1996.

1. EROSION CONTROL REQUIREMENTS

Federal stormwater regulations hold local municipalities responsible for stormwater discharges from all construction sites. In addition, construction sites involving a total of five acres or more of land disturbance are required to apply for the State General Construction Activity Storm Water Permit (GCASP). The GCASP: 1) eliminates or reduces to the extent feasible non-storm water discharges from construction sites and 2) permits stormwater discharges, but requires the use of controls to limit pollutant loading in site effluent. Preparation of a Stormwater Pollution Prevention Plan and identification/utilization of BMPs are the key components of this Permit.

Many local agencies also have erosion control requirements for any grading and construction activities. Regulation of pollutants from construction sites of five acres or less will be done by the local agency through its stormwater management plan.

Construction site erosion has the potential to introduce sediment into runoff. For example, fugitive dust control at construction sites typically use water. Minor modifications/clarification of existing fugitive dust practices could substantially address runoff pollution concerns. In addition to fugitive dust control practices, additional measures could be adopted to curtail dry weather runoff, and control pollutant laden storm water runoff. These measures may address 1) physical site design considerations and 2) temporal considerations such as seasonal timing and phasing of activities.

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Five jurisdictions have implemented ordinances intended to control erosion. Two jurisdictions have identified or drafted runoff control ordinances, while two others are planning to prepare one in the near future. Los Angeles County's 1965 Ordinance was strengthened in 1992 to include penalties for violations.

The City of Los Angeles is considering the development of a manual aimed at reducing runoff from construction sites. Also the City plans to review Municipal Code requirements to ensure consistency with the State of California General Construction Activity Storm water Permit Requirements.

2. CHEMICAL AND WASTE MANAGEMENT REQUIREMENTS

Chemical and waste handling activities are also currently subject to a variety of regulations. BMPs to address this pollution source are largely centered around "good housekeeping practices". This involves storing, handling, using, and disposing of these potential pollutant sources in ways that restrict opportunities for unintended introduction of the materials into site runoff. Proper chemical and waste management will reduce any accidental discharge into the storm drain system.

3. INSPECTIONS

Inspections are a routine part of local jurisdiction's oversight of regulated construction activity. Inspection activities should be enhanced to ensure that construction site runoff control measures are being properly implemented. Existing practices should be examined and modified accordingly to satisfactory stormwater/urban runoff objectives.

a. Checklist

A checklist would encourage possible streamlining of any requirements. It could be cumbersome if an overly rigid approach were taken which resulted in unnecessary administrative burden. However, careful design of the checklist could avoid this pitfall.

b. Schedule

Inspection schedules will depend upon existing practices. It may be desirable to have several schedules, depending upon the types of activities/permits and/or the timing of activities.

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c. **Reports**

A standardized reporting format is needed to allow for consistency among all jurisdictions. Furthermore reports are also a useful tool for future refinement of pollution control regulations.

d. **Follow-up Procedures**

A format will be developed to do follow-up inspections on problem facilities and activities. Frequency of use will greatly depend on the land use and the degree of non-compliance of each facility.

C. LOCAL PERMITS

Permits are a form of "cross checking" by local agencies to ensure that regulations are being implemented. Prior to the issuance of a permit, information must be submitted for review and approved. A watershed wide concept to provide some consistency in local permits will be developed by June 1997.

1. COORDINATION WITH EXISTING PERMITS

Storm water issues should be incorporated into existing permits.

2. NEW PERMIT ISSUES

Storm water issues should be clearly stated in new permits to be issued for new and/or redevelopment activities.

D. TRAINING

Training will enable staff to keep current of the latest storm water regulations. A watershed wide staff training concept will be developed by June 1997.

1. PLANNING PERSONNEL

(See E.1.b. below)

2. PUBLIC WORKS PERSONNEL

(See E.1.b. below)

3. INSPECTORS

(See E.1.b. below)

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E. CONTROL MEASURES

Best management practices for the control of construction related pollution can generally be divided into three categories:

Nonstructural Source Controls for Reducing Urban Stormwater Pollutants:

- Practices that reduce the generation and accumulation of potential stormwater contaminants at or near their source.

Site Planning Stormwater Controls:

- Practices that are directed at controlling the volume and discharge rate of runoff from urban areas, as well as, reduction of the magnitude of pollutants in discharges through temporary storage or flow restrictions.

Erosion and Sediment Controls:

- Practices that can prevent or treat problems related to transport of eroded material from construction and other land disturbing activities.

Site planning stormwater controls are of particular interest. These control measures can be incorporated in the initial planning phase of any project. A watershed wide concept will be developed by June 1997.

The City of Torrance imposes conditions on excavation/construction permits requiring site cleanup; also staging areas are required to free vehicles of debris/dirt prior to entering the public right of ways.

1. POLLUTION PREVENTION MEASURES

a. Site Design

Effective implementation of urban BMPs requires integration of water quality control elements early in the site planning and design process. Development of the water quality controls should not only achieve maximum pollutant removal with minimal costs, but also reduce potential maintenance.

This may include incorporating water quality concerns into the site layout and design (i.e., maximize pervious areas, minimize directly connected impervious areas, etc.) and/or treatment control measures proven to be cost effective for local climate, soil, and development conditions.

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Due to the diversity of climate and local conditions, the development of BMPs will vary from jurisdiction to jurisdiction, and even location to location. The selected management practices should be designed for the local site conditions and especially seasonal rainfall conditions that are experienced in Southern California. Suitability for the major land use and drainage characteristics should also be fully assessed.

b. Education/Training

Education/training is imperative to the success of any BMPs selected for new or redevelopment projects. BMPs will fail if not properly designed, installed, and maintained. Only well trained personnel should be assigned these responsibilities.

A program for effective education/training should be based on four objectives:

- Promote a clear identification and understanding of the problem, including activities with the potential to pollute stormwater;
- Identify solutions (structural and nonstructural BMPs);
- Make every employee responsible for stormwater pollution and its solution; and
- Integrate employee feedback into training and BMP implementation to improve BMPs.

c. Other

In many cases stormwater pollution control may already be achieved by existing regulations or programs. In California, the General Plan Law and the California Environmental Quality Act (CEQA) provide a basis for municipalities to review and comment on all projects within their jurisdiction. Under the General Plan Law, municipalities are required to develop policies and regulations which guide development within the municipality. Each development project is then reviewed for conformance with these policies. Under CEQA, projects are also subject to review and comment for any adverse impact the projects may have on the environment, including impacts from stormwater discharges.

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2. POST CONSTRUCTION (TREATMENT) MEASURES

a. Applicability

Each site considered for development or redevelopment will (at the conclusion of construction) have final improvements and unique site characteristics such as: drainage patterns; soils; landscaping; topography; percent of impervious surfaces; rainfall; pollutants inherent with the use of the development; and pollutants that may be background to the area (existing vegetation, air fallout, etc.). The applicability of various treatment control BMPs for use in new development will be evaluated through the use of pilot studies and examination of studies done on treatment control measures by other agencies.

b. Effectiveness

Prior to implementing any treatment control measures, they will need to be evaluated for their effectiveness. This can be done through pilot studies which could include elements such as: pre and post storm event inspections; water quality monitoring; record keeping to document deficiencies in the BMPs; Operation & Maintenance requirements; and cost effectiveness.

c. Retrofit Opportunities

The feasibility of retrofitting existing developments with treatment control measures will be evaluated. However, the effectiveness of a treatment control measure vs its cost must be fully evaluated prior to considering its use as a retrofit measure.

3. OPERATION AND MAINTENANCE

a. Requirements

Jurisdictions within the watershed will need to insure that BMPs incorporated into a private development are properly maintained. Deed restrictions, covenants, conditions and restrictions (CC&R) could be used to direct such requirements and responsibilities.

b. Responsible Party

The contractor, during construction, must ensure that the post-construction BMPs are installed properly and that any maintenance

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that may be necessary during construction is performed. After the project is completed, it will then be the responsibility of the fee owner, private or public, to provide for long term operation and maintenance. This may be accomplished by deed restriction and/or CC&R.

4. CONFLICTS WITH OTHER MANDATES

Often regulations of various Federal, State, and local agencies would conflict with each other. Health, fire, and building codes often have requirements focusing on short term human health and safety and neglecting the impacts on the environment.

a. Identification of Conflicts

As the Plan is developed, other regulatory requirement that conflict with the stormwater program requirements may be uncovered. Clarification of these regulations should be directed to the various responsible regulatory agencies.

b. Conflict Resolution

For regulatory conflict caused by local regulations, efforts will be taken to resolve them within the agencies. Input form other local, state, and federal agencies should be incorporated into a modification of current standards. The Regional Board should resolve conflicts involving other State and/or Federal requirements.

F. OUTREACH

An outreach program concerning new development and re-development shall be developed by each individual Permittee by June 1997.

The City of Los Angeles has initiated a three phase program intended to increase the awareness of those involved in the construction industry regarding storm water pollution abatement activities. Videos and printed materials will be distributed.

For additional outreach discussion see **Chapter VII Public Information and Participation.**

G. ENFORCEMENT

See **Chapter II Illicit Discharges, Section C Enforcement Procedures.**

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H. COORDINATION WITH STATE GENERAL CONSTRUCTION ACTIVITIES STORM WATER PERMIT

Compliance with the GCASP requirements is the responsibility of the developer/contractor, and enforcement is the responsibility of the SWRCB/Regional Board staff.

1. MEMORANDUM OF UNDERSTANDING

An agreement between the Regional Board and Co-Permittees may be used to enhance compliance of construction site BMPs. The need for such an agreement will be evaluated. If found to be desirable, and agreement will be developed by June 1996.

2. REPORTS

The local enforcement agency of the State Construction Stormwater Permit, which is the Regional Board, should forward all information, including Notices of Intent filed and any inspections and enforcement actions taken, to the Permittees so that this information can be available to local municipal construction site inspectors to alert them of any specific concerns on the job site.

3. OTHER ISSUES

The Regional Board should explore funding to be channelled to the Co-Permittees so the Co-Permittee can be more actively involved with the State on the Permit.

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V. PUBLIC AGENCY ACTIVITIES

All municipalities perform functions that have an impact on stormwater quality. These include, among other things, vehicle maintenance, landscape maintenance, weed control, water body maintenance including swimming pool maintenance, etc. Other activities such as construction and maintenance of streets and roads, and construction and maintenance of the flood control system also could directly or indirectly cause adverse impact on the quality of stormwater/urban runoff. Since municipalities must address all significant sources of pollutants, all of these activities must be examined and mitigation measures be incorporated into the routines. As part of the requirements of the current Permit, many of the Permittees have already begun implementation of measures to address the above activities. An examination of these existing measures will be done on a watershed wide basis to establish the most effective approach to address these activities. Such approaches shall be developed and begin implementation by September 1997.

A. SEWAGE SYSTEMS

Sewage spills must not be allowed to enter the storm drain. Control procedures for identifying, repairing, and remediating sewer blockages, infiltration, inflow, and wet weather overflows from the sewers to the storm drain system should be implemented to protect stormwater quality. These procedures could include, but are not limited to, quick field response to overflows, follow-up testing, and complaint investigation.

When sewage spills do occur, they must be contained and collected for proper disposal. Individual permittees may need to modify their sewage overflow response procedures. The field personnel should also have procedural training for field screening, sampling, smoke/dye testing, and TV inspection, if appropriate, to be able to properly investigate any suspect connections or cross connections to the storm drain system.

Los Angeles City's Limitation of Sewage Infiltration into Storm Drain System traces sewage infiltration into the storm drain system using a variety of techniques.

Los Angeles County has a number of programs aimed at preventing sewage spills from entering the storm drain system. These include:

- Sewage Overflow Response Procedures Revision/Root Control Review. This involves improvement of procedures for containment and cleanup of spilled sewage resulting from overflow.

- Reline Sewer Lines. Two locations will undergo relining of existing sewer lines to prevent infiltration and exfiltration.

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- Sewer Pipeline Reconstruction. 127 miles of cement pipelines will be analyzed and replaced or rehabilitated within 5 years.

- Sealing of Manhole Covers. This program has sealed manhole covers and bar holes in areas subject to flooding.

- Expansion of Emergency Call List. Beeper numbers of all supervisors, superintendents and stand-by crews were added to emergency call list.

B. CORPORATION YARDS

Corporation yards include any area or facility that is used for vehicle maintenance or washing, other maintenance, chemical storage, paint facilities, and supportive activities for field crews. Permittees will need to incorporate pollutant control measures at these facilities and develop a plan for each facility outlining the measures to be implemented. Since these are industrial type activities, the corporate yards would need to implement measures as described in the Industrial/commercial Source Chapter.

The City of Los Angeles has implemented and is expanding the following programs related to corporation yards:

- Spill Prevention, Containment and Response Procedures--City Facilities. This program ensures that facilities have adequate spill prevention, containment and emergency response procedures. The City is identifying all City-owned facilities that do not currently have adequate procedures as they relate to storm water pollution abatement.

- Certified Hazardous Waste Storage Facility. Three pre-fabricated storage buildings have been installed at the Los Angeles Aqueduct Filtration Plan to isolate hazardous materials.

- Storm water Pollution Abatement--Street Maintenance Yards. Four street maintenance yards, including an asphalt processing plant, are being studied as potential sources of storm water pollution.

The City of Gardena's vehicle maintenance program ensures that all vehicles are washed in areas that drain only to the sewer. Used engine oil, filters and batteries are stored in contained areas and are recycled. These practices are followed by many other agencies in the Watershed.

The City of Torrance yard wastes from city owned properties are collected and recycled.

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1. STORM WATER POLLUTION PREVENTION PLANS (SWPPP)

Though not required, permittees may elect to use some form of SWPPP as a vehicle for compliance. Any BMPs to be implemented must be part of a comprehensive plan designed to address the various pollutant sources at each corporate yard. To achieve this goal, the municipalities should first identify the potential pollution sources and who is responsible for implementing the storm water management measures. Based on the facility type, management practices and schedule of implementation will be developed. BMPs that can be used to improve the quality of runoff include, but are not limited to, housekeeping practices, material storage control, vehicle leak and spill control, and illegal dumping control.

2. OUTDOOR LOADING/UNLOADING OF MATERIALS

Municipal employees who handle potentially harmful materials should be trained in good housekeeping practices to prevent or reduce the discharge of pollutants to storm water from outdoor loading/unloading of materials. Materials spilled, leaked or lost during loading/unloading may collect in the soil or on other surfaces and be carried away by runoff or when the area is cleaned.

Applicable BMPs should be selected based on the following four factors: 1) Extent of exposure of material to rainfall, 2) preventing stormwater run-on, 3) checking equipment regularly for leaks, and 4) containing spills during transfer operations.

3. MATERIAL STORAGE CONTROL

A program should be developed to prevent or reduce the discharge of pollutants to storm water from outdoor container storage areas using measures such as installing safeguards against accidental releases, secondary containment, conducting regular inspections, and training employees in standard operating procedures and spill cleanup techniques. Employee education is paramount for successful implementation. Employees should be trained in emergency spill cleanup procedures.

To limit the possibility of storm water pollution, containers used to store dangerous waste or other liquids should be kept inside the building unless this is impractical due to site constraints. Storage of reactive, ignitible, or flammable liquids must comply with the fire and California OSHA codes. Practices such as placing containers in a designated area should be employed to enhance such requirements.

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4. VEHICLE AND EQUIPMENT WASHING AND MAINTENANCE

Washing vehicles and equipment outdoors or in areas where wash water flows onto the ground can pollute storm water. For municipalities that wash vehicles or pieces of equipment on-site, it should be performed in a designated area equipped with an oil/water separator.

Vehicle or equipment maintenance is a potentially significant source of storm water pollution. Parts are cleaned with solvents. Many of these cleaners are harmful and must be disposed of as a hazardous waste. Appropriate BMPs are waste reduction, use of alternate products, recycling, and spill leak clean up control.

5. WASTE HANDLING AND DISPOSAL

Proper waste management is possible by tracking waste generation, storage, and disposal; reducing waste generation and disposal through source reduction; and preventing run-on and runoff from waste management areas.

C. PARKS AND RECREATION

Park Departments manage landscaping and swimming pools. Both of these activities involve the use of chemicals, waste management, and non-storm water discharges. In addition maintenance of swimming pools requires the periodic discharge of large quantities of swimming pool water.

1. FERTILIZERS/PESTICIDES

a. Use/Application management

Municipal facilities should develop controls on the application of pesticides, herbicides, and fertilizers. Control may include:

- List of approved pesticides and selected use;
- Product and application information for users;
- Equipment use and maintenance procedures; and
- Record keeping.

Employees can be educated about environmentally sensitive alternative products by using information developed by various public agencies and other environmental organizations.

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The City of Torrance has evaluated the use of a replacement for pesticides that contains less toxic materials; also the City has implemented a program to reduce surface application of fertilizers.

The City of Los Angeles has installed special equipment at Rancho Park Golf Course to remove oils and oil-based cleaning agents, as well as organic material from surface water that drains into the storm drain system.

b. Storage

Improper storage of fertilizers and pesticides can lead to potential groundwater, soil, and stormwater contamination. To prevent or reduce their impact on stormwater pollution, material storage areas must be designed and maintained to reduce exposure to storm water. The following BMPs can help to achieve this goal:

- Store materials inside or under cover on paved surfaces,
- Use secondary containment,
- Minimize storage and handling of hazardous materials,
- Inspect storage areas regularly.

2. FACILITY MANAGEMENT

a. Wash Waters

Wash waters cannot be discharged into the storm drains untreated. The storage area should be slightly sloped for wash water collection. If the water is not discharged to the sanitary or process waste sewer, or to a dead-end sump, the outlet should be equipped with an oil/water separator or other treatment systems.

b. Maintenance

Landscape maintenance involves the use of pesticides and fertilizers. Proper use of these materials will reduce the risk of loss to storm water. Whenever possible, leave or plant native vegetation to reduce water, fertilizer, and pesticide needs. Integrated pest management should be employed where appropriate. The Park Departments should also establish a schedule for irrigation and fertilization. The chemicals will be carried from the site by the next storm if they are applied during the wet season. Overwatering leads to discharge of water that may have become contaminated with nutrients and pesticides.

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Storm water from parking lots may contain undesirable concentrations of oil, grease, suspended particulates, and metals, as well as the petroleum byproducts of engine combustion. Possible maintenance BMPs include periodic sweeping and cleaning catch basins.

c. Swimming Pool Waters

The drainage of swimming pool water must insure that chlorine residual is below allowable water quality limits. The potential for recycle/reuse for irrigation of lawns and landscapes may be investigated. Swimming pool filter backwash waters should not be discharged to the storm drain, but should be allowed to settle and then disposed to the sanitary sewer. Other possible alternative measures would be to use the backwash for irrigation or disposal on a dirt area.

D. STORM DRAIN SYSTEM OPERATION AND MANAGEMENT

The maintenance and operation of the storm drain system has an impact on storm water quality and must be addressed. Material clogging storm drains cannot be discharged into drains. It must be disposed of properly.

1. INLET MAINTENANCE

Regular maintenance of public and private catch basins and inlets is necessary to ensure their proper function. Maintenance will remove pollutants, reduce high pollutant concentrations during the first flush of storms, prevent clogging of the downstream conveyance system, and restore the catch basin's functional capacity. Keys to effective catch basin cleaning include the following:

- All basins should be cleaned annually prior to the onset of the rainy season;
- Clean catch basins in known problem areas more frequently to remove sediments and debris accumulated during the dry weather months;
- Keep records of the number of catch basins cleaned; and
- Track the amount of waste collected.

Eight jurisdiction clean their catch basins at least annually, while Caltrans catch basins are generally cleaned every two years. The City of Los Angeles has grouped its catch basins into "routes" that are inspected and/or cleaned at least once a year.

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2. DRAIN MAINTENANCE

Open channel storm drains should be cleaned at least annually prior to the rainy season. Problem areas should be cleaned more frequently as needed. Channels should also be monitored during the rainy season for any debris buildup and cleaned where needed.

Los Angeles County field personnel inspect open channels and sumps to clean debris and prevent them from entering the ocean.

Caltrans will develop a priority list of drains and pump houses requiring cleaning.

3. WASTE MANAGEMENT

Excessive waste buildup will decrease the capacity of the channel, it is therefore crucial to reduce pollutant levels in storm water by regularly removing illegally-dumped items and material from storm drainage channels and creeks. A program should be developed to identify problem areas of illegal dumping so regular inspection and clean up can maintain the channel's optimum capacity and prevent the discharge of contaminants.

The City of Torrance has increased clean up of sewers and storm drains to decrease the number of sewer back ups.

4. NEW SYSTEM DESIGNS

Current design standards for the construction of new storm drain systems will be evaluated in light of currently available pollutant control measures. Design standards may be modified to incorporate measures deemed appropriate for local conditions.

The City of Los Angeles has formed an Inter-Jurisdictional Storm Water Re-Use Task Force to implement diversion, capturing and possibly re-using high quality storm water run-off; also the City is reviewing standards and considering modifications for flood control projects by incorporating storm water pollution reduction components.

The City of Torrance has installed alarms in sewer and storm drain pump systems designed to decrease the potential of raw sewage entering the storm drain system.

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5. RETRO-FIT OPPORTUNITIES

The majority of the existing storm drain systems are in highly urbanized areas providing little opportunity for cost effective retro-fitting. However, currently available pollutant control measures will be reviewed for their effectiveness and possible use. This may include pilot studies to evaluate the performance of management practices under local conditions.

E. STREETS AND ROADS

Construction, operation, and maintenance of roads has an impact on storm water quality and will be addressed in the management plan.

1. SWEEPING

Street sweeping can collect refuse on street surfaces to prevent it from entering the storm drain system through catch basins.

Eight jurisdictions within this watershed sweep their streets at least weekly, while the City of Los Angeles's posted streets are swept weekly and the others monthly. Caltrans sweeps its roadways on a regular schedule determined by observable debris.

a. Storm Water Quality Based Operation

In order to effectively implement the sweeping program, the permittees should keep accurate operation logs to track the program. Areas generating excessive refuse should be swept more frequently. Sweeping frequency may also be increased before the rainy season to reduce the amount of refuse entering the storm drain system. Parking on sweeping days should be regulated to facilitate the operation.

b. Waste Management

Proper waste management practices shall be developed for the refuse collected through street sweeping.

Six jurisdictions empty their trash receptacles at least weekly, while in Lawndale they are emptied twice a week.

2. STREET/PAVEMENT WASHING

Wash waters from street/pavement washing may be contaminated and must be managed as non-storm water discharges.

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3. MAINTENANCE

a. Saw-cut Slurry Management and Paving Practices

Existing saw-cut management and paving practices conducted by the permittees will be evaluated and appropriate control measures developed. Possible control measures to be considered that would help reduce the impacts to storm water:

- Avoid paving during wet weather;
- Regularly repair potholes and worn pavement to reduce sediment loading;
- Store materials away from drainage courses to prevent pollution of storm water run-on; and
- Follow the storm water permitting requirements for industrial activities when mixing concrete with an on-site plant.

b. Waste Management

Vehicles transporting waste should have spill prevention equipment that can prevent spills during transport. The refuse collected will be transported to the appropriate disposal facilities.

The City of Torrance requires tarping on city vehicles when hauling material.

Good housekeeping practices will be implemented to insure proper management of any waste products that may be generated during maintenance activities. For example, to prevent concrete waste from entering the storm drain system, washout of concrete trucks should be conducted off-site or on-site in designated area. Excess concrete should not be dumped on site. Employees and subcontractors should be trained in proper concrete waste management.

The following steps will help reduce storm water pollution from concrete wastes:

- Store dry and wet materials under cover, away from drainage areas;
- Avoid mixing excess amounts of fresh concrete or cement on-site;
- Do not wash out concrete trucks into storm drains, open ditches, streets, or streams;

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- Do not allow excess concrete to be dumped on-site, except in designated areas;
- Avoid paving during wet weather;
- Regularly repair potholes and worn pavement to reduce sediment loading; and
- Cover catch basins and manholes when applying seal coat, tack coat, slurry seal, fog seal, etc.

Employee/subcontractor training to insure implementation of good housekeeping measures should be based on four objectives:

- Promote a clear identification and understanding of the problem, including activities with the potential to pollute storm water;
- Identify solutions (BMPs selection);
- Promote employee/subcontractor ownership of the problems and the solutions; and
- Integrate employee/subcontractor feedback into training and BMP implementation.

c. Medians/Landscaped Right-of-Way

i. Irrigation

Overwatering of landscaping produces runoff. A properly timed irrigation schedule should be set up to minimize overwatering. Drip irrigation system should be used when feasible in new installations.

The City of Torrance inspects its irrigation systems and repairs them weekly to reduce volume of water flowing into gutters.

ii. Fertilizers/Pesticides

The handling, storage, and usage of fertilizers/pesticides are addressed in Chapter V, Section C-1.

F. FLOOD CONTROL

Common municipal practices, such as construction and operation and maintenance of the flood control system, may have a potentially adverse impact on storm water quality. Consequently, these practices shall be coordinated to the extent of preventing pollutants from impacting the water quality.

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1. COORDINATION WITH NEW PROJECTS

Current design standards for the construction of new storm drain systems will be evaluated in light of currently available pollutant control measures. Design standards may be modified to incorporate measures deemed appropriate for local conditions. During construction, all appropriate BMPs will be utilized to control pollutants during the construction of the facility.

2. COORDINATION OF MAINTENANCE ACTIVITIES

Current maintenance activities with regards to desilting/sediment removal, vegetation management, and waste management shall be reviewed to insure that appropriate management measures are developed to comply with the storm water regulations.

The City of Torrance has implemented a storm water retention basin cleaning program. Also, lawn mowers used by City staff are required to have a collection system to keep lawn clippings from entering the storm drain system.

The City of Gardena has a City landscaping program to reduce landscape-related constituents in storm water.

3. OPERATION OF FACILITIES

Flood control facility operations will be reviewed to identify where appropriate management measures could be incorporated. However, primary consideration will need to be given to the flood control function of the facility to protect health and safety.

4. RETROFIT OPPORTUNITIES

The majority of the existing storm drain systems are in highly urbanized areas providing little opportunity for cost effective retro-fitting. However, currently available pollutant control measures will be reviewed for their effectiveness and possible use. This may include pilot studies to evaluate the performance of management practices under local conditions.

G. PUBLIC FACILITIES

Storm water runoff and non-storm water discharges from other public facilities must also be addressed, including chemical use by these facilities, pressure blasting/cleaning sidewalks and other surfaces.

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1. PARKING FACILITIES

Storm water from parking lots may contain undesirable concentrations of oil, grease, suspended particulates, and metals. Some control measures such as periodic sweeping and cleaning catch basins should be implemented. The need for more advanced structural controls would be evaluated through the pollutant source identification program. Pilot studies would be conducted on candidate structural controls to evaluate their effectiveness prior to large scale implementation.

2. GOLF COURSES

Golf courses require the use of large amount of water, fertilizers, and pesticides. Field personnel should be trained on the proper handling, storage, and usage of these chemicals (Refer to Chapter V, Section C-1 for detail). To prevent excess irrigation water from entering the storm drain system, proper management of watering schedules should be required.

3. SCHOOLS

The maintenance of playgrounds and athletic fields at schools require fertilizers and pesticides. Their safe storage and use affect not only the stormwater quality but also the health of the students and the staff. Therefore BMPs under Chapter V, Section C-1-b should be implemented. Each municipality should develop a program to encourage these schools to use environmentally sensitive products for fertilizers, pesticides, detergents, and other chemicals. The schools should have proper material handling, storage, and disposal procedures for chemicals used in school laboratories.

4. HOSPITALS

Each hospital should have BMPs to control the handling and storage of medically related hazardous materials. All materials should be inventoried regularly, with record keeping protocols on supply and consumption. All personnel should be trained on the proper procedures on handling these materials, as well as emergency response. Each hospital should maintain a list of supervisors to be contacted if accident does occur. Disposal of these materials should be contracted out to commercial specialists.

5. PARKS/LANDSCAPES

Refer to **Section C Parks and Recreation**, of this Chapter, for information.

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6. OTHER BUILDINGS/PLAZAS

Refer to Section C-2 Parks and Recreation - Facility Management, of this Chapter, for information.

H. PONDS, FOUNTAINS, AND OTHER PUBLIC WATER BODIES

Maintenance practices used on public water bodies, including waste management and non-stormwater discharges, must be addressed in the plan.

1. ALGAE CONTROL

a. Use of Chemicals

The use of herbicides or other chemicals to control algae growth should be carefully controlled and monitored to insure strict adherence to manufacturers' guidelines for use. Water sampling may be necessary to insure effective control.

2. CHLORINE MANAGEMENT

The use of chlorine for disinfection should be controlled. High dosage of chlorine may be harmful to the aquatic habitats. Dechlorination of pools and other water bodies would be required prior to draining.

3. MAINTENANCE

Each municipality should develop BMPs to prevent and control trash, debris, and other pollutants from entering water bodies. These measures could include routine trash collection along and on water bodies, public outreach to educate the public about the impacts of illegal dumping, and increase enforcement for violations.

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VI. RESIDENTIAL

INTRODUCTION

Residential activities including private vehicle washing and maintenance; use of chemicals such as pesticides, herbicides, and paints; private swimming pool maintenance; and other household and landscape maintenance can contribute to storm water pollution. These are all examples of non-point source pollution, a significant impact on water quality. Measures that can be taken to improve the quality of the runoff from residential area all require active public participation. Feasible BMPS to mitigate the stormwater pollution problem should include practicing good housekeeping and the use of environmentally sensitive alternative products, vehicle leak and spill control, and water conservation. Development of the residential stormwater program will be completed by December 1996.

A. HOUSEKEEPING PRACTICES

This BMP involves the development of a program to promote efficient and safe housekeeping practices (storage, use, and cleanup) when handling materials which may pollute stormwater/urban runoff. This could include, but are not limited to, fertilizers, pesticides, cleaning solutions, paint products, automotive products, and swimming pool chemicals.

A public education program will be developed to provide information on stormwater pollution and the beneficial effects of proper disposal on water quality; reading product labels; safe storage, handling, and disposal of hazardous products; list of local agencies; and emergency phone numbers. The above information can be disseminated through brochures or booklets made available at places such as public information fairs, municipal offices, and household hazardous waste collection events and facilities. City newsletter to residents is another means to inform the public, especially for those who do not participate or visit any offices or events.

B. ENVIRONMENTALLY SENSITIVE ALTERNATIVE PRODUCTS

This BMP, promoting the use of less environmentally sensitive products, can be implemented in conjunction with housekeeping practices. Alternatives exist for most product classes including fertilizers, pesticides, cleaning solutions, and automotive and paint products. The key to success will be to promote a willingness to try alternatives and to modify old habits.

General information will be developed and made available to the public on such alternatives. The emphasis may be placed on the need to preserve the natural environment of the receiving waters (ocean, bay, stream, wetland, etc.) with the use of alternative products because of their less toxic nature and proper disposal after its use.

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C. VEHICLE LEAK AND SPILL CONTROL

This BMP prevents or reduces the discharge of pollutants to storm water/urban runoff from vehicle leaks and spills by reducing the chance for spills, stopping the source of spills, containing and cleaning up spills, and properly disposing of spill materials.

Vehicles will leak and spill fluids. The key to successful pollution management is to reduce the frequency and severity of leaks and spills; and when they do occur, to prevent or reduce the environmental impacts. Through education, the public should be encouraged to regularly inspect and maintain their vehicles. Guidelines should be developed to inform the public on spill containment and cleanup procedures such as having absorbent material on hand and disposing the material properly.

D. WATER CONSERVATION

Water is a scarce resource, especially so in Southern California. Wasteful use of water could channel pollutants into the receiving waters. Practices such as hosing the driveway and overwatering the landscape contribute not only to stormwater pollution, but also to the depletion of our natural resource. In order to prevent stormwater pollution, the public has to be educated on the mechanics of our storm drain system - discharges into the system will flow untreated into the receiving water. They have to know that the lawn clippings they wash down the road will end up in the ocean. Public awareness of the function of the storm drain system, of the importance of environmental health, and of our necessity to slow down the depletion of water resources will go a long way in reducing the pollution of stormwater/urban runoff.

In addition to the specific programs and plans outlined in this report, several watershed co-permittees have targeted activities occurring in and around the home that tend to contribute to degradation of storm water runoff quality. A practice that carries on-the-ground pollutants directly to storm drains is misuse of exterior water, namely the overwatering of landscaping, the hosing of driveways/sidewalks and the washing of cars in driveways--all of which allow water to run down the street into the nearest storm drain.

This situation can be addressed in two ways: 1) either reduce/prevent pollutants from being placed in areas where they may be carried by water into the streets or 2) minimize the amount of water allowed to flow on impervious surfaces that are connected to the street system.

Water conservation measures can be designed to address the issue of impervious surface water flow. While water conservation has historically been used to conserve domestic water, many jurisdictions are now recognizing the additional benefit of prohibiting water flows from private properties onto the street system. Each Co-

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permittee within the Dominguez Channel/Los Angeles Harbor Drainage Watershed could develop regulations within an ordinance to endow the related officials with the legal authority to enforce water conservation.

Public outreach is a component of all programs, many of which carry fines for water wasting practices. Jurisdictions such as Inglewood have adopted specific standards for the control of runoff, including requirements for maintenance of irrigation systems. While some ordinances were established specifically to conserve water during periods of drought, several jurisdictions are keeping such controls in place at all times as measures to control pollution runoff.

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VII. PUBLIC INFORMATION AND PARTICIPATION

It is necessary to involve the public in the stormwater program for it to be effective. The outreach program should be focused on the specific needs of the individual cities. Due to the inter-relationship among the stormwater issues, the public information and participation program should be recognized as a whole, rather than a number of separate outreach programs. All public awareness efforts should clarify to the public that they are the ultimate beneficiaries of a successful stormwater management program.

A. GENERAL OUTREACH

The targeted audiences of a general outreach will include municipal employees, local construction contractors, businesses in the area, and the general public. They should be made aware of their responsibility for both the problems and the solutions to stormwater pollution. In order to effectively communicate the stormwater pollution abatement message throughout the watershed; written, audio, and visual materials should be utilized. The actual level, priority, and schedule of public information activities must be based on the community's needs and resources to maximize program effectiveness. A watershed-wide concept will be developed by December 1995.

All Co-Permittees within the watershed acknowledge the value of public outreach, although several jurisdictions are in the early phases of program implementation. Extensive efforts have been made or are planned by most agencies to supply the public with information on a full range of storm water quality activities with the intention of achieving a high level of public cooperation and participation.

The most universal of the general outreach programs--catch basin stenciling--is receiving full cooperation throughout the watershed. Extensive stenciling has already been done by Los Angeles City and County, Inglewood, Torrance and Caltrans. Some agencies have enlisted the assistance of volunteer groups. All co-permittees have plans to implement and complete a stenciling program in compliance with permit deadlines.

1. WRITTEN MATERIAL

Co-Permittees should produce a variety of written materials to inform the residents within the watershed. Materials can include, but are not limited to, the following: flyers, brochures, door-hangers, newspaper articles, mail-inserts, banners, and posters. When necessary, these materials should be translated into a variety of foreign languages to reach minority residents in the community.

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Print media outreach programs have been used extensively by Los Angeles City and County; Inglewood and Torrance have also been active in these aspects of public education. City newsletters mailed to all residents have often included articles on various storm water programs. Utility bill inserts and door-hangers are also used extensively to promote public awareness. The cities of Inglewood and Los Angeles, along with Los Angeles County, have printed brochures aimed at public education. Billboard and bus stop shelter advertising is used by both Los Angeles City and County. Los Angeles City and County have refrigerator magnets to promote their programs. Los Angeles City also has posters and street banners promoting storm water runoff quality.

2. AUDIO MATERIAL

Similarly, Co-Permittees may utilize audio materials to convey information regarding stormwater management. Examples of audio materials include radio advertisements/public service announcements and informational cassettes.

3. VISUAL MATERIAL

Catch basin stenciling program is an excellent means of educating the public on the mechanics of the storm drain system. The intent of the program is to enhance public awareness of the impact of stormwater pollution on receiving waters and to discourage improper waste disposal practices. Another effective medium for communicating the importance of stormwater management is through television. Possible measures include producing a public service announcement, cable access programs, and/or an informational video.

Among broadcast media outreach, the City of Los Angeles has prepared a public service announcement which has been shown on cable access channels. Several co-permittees use cable access for public outreach. Los Angeles County uses both television and radio. Torrance provides general outreach through a booth at the City's environmental and water conservation expo and suggests using movie theater leaders to further promote general public outreach.

4. DISTRIBUTION PLAN

General outreach efforts must be conducted throughout the entire watershed. Materials should be available at all public counters and distributed at public events such as environmental fairs and contests.

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General outreach to targeted groups is an objective of some co-permittees--especially Los Angeles City who has a student/teacher school education program (K-6 "Magical City Forest") and a mailing program directed at private industries likely to be required to obtain a General Industrial Storm water Permit.

B. FOCUSED OUTREACH

Efforts should be made to target special groups. Focus could be on specific pollutants, practices and/or activities, or businesses. A watershed-wide concept will be developed by September 1996.

1. POLLUTANT SPECIFIC

For a particular watershed, there may be priority pollutants which are of more concern than others. The reduction of these pollutants may be addressed in a more focused public education and outreach program. Any of the methods used in the general outreach program may be utilized in a pollutant specific outreach program.

2. PRACTICE/ACTIVITY SPECIFIC

Everyone who lives or works in a particular watershed must realize that their actions have a direct affect on the quality of stormwater. These special groups must be made aware that their current practices/activities may be contributing to stormwater pollution. Practice/activity specific outreach programs should be developed and implemented throughout the watershed. The use of written, audio, or visual materials should convey three primary messages: (1) what activities can cause stormwater pollution, (2) how Best Management Practices are used to prevent pollution, and (3) how one can report occurrences of stormwater polluting activities.

Practice/activity specific outreach should promote, publicize, and facilitate public reporting of illegal dumpings, illicit discharges, or water quality impacts associated with discharges from municipal separate storm sewers. An effective program should include the establishment, operation, and promotion of a reporting hotline. Timely reporting by the public of improper disposal and illicit discharges are critical in controlling such sources of stormwater pollution. Increase in public involvement may be achieved by sending a follow-up letter to callers or providing callers with some type of reward. Educational efforts throughout the watershed should inform the public about the existence of the Los Angeles County-wide hotline and any other local hotlines; provide them with information regarding what to look for, and guidelines/procedures on how to report incidents.

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Another critical component of practice/activity outreach is the development of a program to facilitate the proper management and disposal of used oil and toxic materials. An effective program could include, but is not limited to, the operation of recycling facilities and the conduction of household hazardous waste round-ups. The program could also include information about alternatives to toxic materials. Educational efforts throughout the watershed should provide the public with detailed information regarding the Los Angeles County-wide Household Hazardous Waste Round-ups and any other local programs.

The varied sources/causes of storm water pollution have resulted in implementation activities that target specific types of pollutants, activities and land uses/types of businesses. Within this watershed co-permittees take part in public information and participation programs specifically aimed at preventing improper disposal of hazardous household products and encouraging actions that keep general wastes out of the storm drain system--such as recycling programs, public trash receptacles and the cleaning of sidewalks, alleys and vacant lots. Illegal dumping and discharges are also specific targets.

Such activities are encouraged through general outreach programs (discussed above) that promote such programs as toll-free phone hotlines for reporting illegal polluting activities, topic-specific brochures, speakers bureaus and special recycling facilities (used motor oil, hazardous products, etc.). Torrance conducts yard waste composting workshops.

Los Angeles County has an outreach program focusing on airport operations; a component of the program is structure stenciling. The City of Los Angeles has a wide range of focused programs that can be tailored for special exhibits and interest groups, including elementary schools.

3. BUSINESS SPECIFIC

Due to the fact that some business operations have a higher potential of discharging pollutants into the storm drain system, a more focused public education and outreach program should be developed for them. Employees of these businesses should be educated on the issue of nonpoint source pollution and the effectiveness of Best Management Practices in reducing pollution. Besides written, audio, or visual materials that focus on specific businesses and their practices, mass mailings or articles in a trade/industry magazines are other possible means of focused outreach.

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C. EDUCATION PROGRAMS

Increasing awareness is the major goal of the Public Information and Participation Program. An ideal means of accomplishing this task is through educational programs. Programs should be developed for a variety of audiences, including public employees and school children. Educational programs can also be an important part of a general or focused outreach. A watershed-wide concept will be developed by September 1996.

Both general and focused outreach are essentially programs of public education. More formal training/education is also conducted by Caltrans and the City and County of Los Angeles.

1. PUBLIC EMPLOYEES

It is important to educate all of the public employees about the stormwater program so that they do not continue with any practices that are counter productive. Furthermore, they can participate in the implementation and enforcement of the program. Ideas and suggestions of employees can be used to modify the program for improved effectiveness. The outreach must involve employees on many different levels - from program managers to field personnel. Educational programs for public employees may include, but are not limited to, articles in City newsletters, training classes, checklists for field personnel, and interdepartmental forum or committee. Any of the materials utilized in an outreach program - written, audio, or visual materials - may be used in a public employee educational program.

Caltrans personnel is educated on highway maintenance--specifically on such subjects as Hazardous Substance Spill Awareness and Pesticide Safety and Vegetation Management. Los Angeles City and County personnel meet regularly to discuss development of and evaluate storm water quality practices.

2. K-12

School children can play an important role in a public information and participation program. First, children are generally more easily motivated and the behavior changes made at that point in life tend to stay with them through adulthood. Secondly, school children can convey the stormwater pollution prevention messages to the members in their family. School programs must include information on the storm drain system, stormwater quality awareness, and may also include, but are not limited to, illegal dumping awareness, source minimization, and pollution prevention. Written material, videos, assembly programs, and field trips are examples of effective components of a K-12 educational program.

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Los Angeles City also has a school education pilot program, "The Magical City Forest", for grades K-6. The County will soon have a program mascot to be used a public events.

3. OTHER

Educational programs can also be developed for professionals and technicians who are not public employees. Agencies should include public outreach material for business license renewal or outreach effort through professional and business associations.

D. RESIDENTS PARTICIPATION

The residents of the watershed should not only be made aware of the stormwater program, they should be encouraged to participate in its implementation. Specific outreach programs should be developed to allow the public to participate and to inform them of available means for providing ideas and comments regarding the stormwater program. A watershed-wide concept will be developed by September 1996.

1. VOLUNTEER MONITORING

Volunteer monitoring is the result of increased public awareness and participation. The public can utilize the hotline for reporting suspected illegal practices. Such involvement, which is similar to the Neighborhood Watch Program on crime, usually has good results.

2. COOPERATIVE OUTREACH

In order to promote public participation, cooperative outreach programs should be developed. These cooperative programs should help to create an awareness and an identification with the watershed. The catch basin stenciling and other signing programs are excellent examples of this type of cooperative effort. One possibility for cooperative outreach is an "Adopt-A-" program. Residents can "adopt" a highway, storm drain, catch basin, stream, etc. Other cooperative outreach efforts include events such as "Stormwater Pollution Awareness Week." The purpose of any of these activities is to inform and involve the local residents in regards to the stormwater management program.

Residents can assist public agencies in the development and implementation of storm water quality programs. Several watershed jurisdictions have enlisted the assistance of such groups as the Boy Scouts and neighborhood volunteers in the catch basin stenciling program. Caltrans' Adopt-A-Highway program

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relies on voluntary private participation to help with clean-up activities. Hotline programs also enlist the assistance of residents in active participation.

3. COMPLAINT PROCEDURES

Public comments/complaints are important to the success of a stormwater program. A "hotline" program is an excellent mechanism for allowing the public to provide information. In Section B, "Focused Outreach - Practice/Activity", the various aspect of outreach effort is discussed.

E. EFFECTIVENESS EVALUATION

Permittees should develop a process to evaluate the effectiveness of their programs. Methods such as surveys and focus groups can be used to assess program's effectiveness. Results should gauge the community's level of awareness. Surveys and focus groups can also be used to provide insight into the program's direction and the formulation of attainable goals. A watershed-wide concept will be developed by September 1996.

The City of Los Angeles has conducted a pre-survey to determine the general level of public awareness about storm water pollution. They plan to conduct a post survey in 1995 to gauge the progress made in their public education program. Many of the other watershed co-permittees are in the early phases of implementation; there have been no reports of formal programs to assess program effectiveness, although staff discussions and management reviews have resulted in program development and modifications.

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VIII. PROGRAM EVALUATION

The effectiveness of the storm water programs developed under the Municipal Storm Water Management Plan (hereinafter called the Plan) must be assessed on a regular and consistent basis. The Plan for this evaluation must include a schedule for evaluation, a methodology for the evaluation, a discussion of who will carry out the evaluation, and what will be evaluated. In addition, there must be a mechanism to follow up on the information generated by the evaluation. The Plan should be adjusted based on the program evaluation.

A. PERFORMANCE STANDARDS

The Permittees will develop standards to judge the effectiveness of the activities and control measures proposed under each chapter of the Plan. The standards will serve as minimum performance levels to evaluate the implementation of control measures. The subsequently developed performance evaluation procedures/methodologies will be the tool to determine if a particular BMP has an impact on stormwater quality. In developing these procedures, we resolve to ensure that each BMP is implemented to the maximum extent practicable. The targeted completion of this phase will be December 1997.

1. DEVELOPMENT OF PROCEDURES

General performance standards for evaluating the effectiveness of the Best Management Practices (BMPs) will be developed for all the BMPs proposed in the Plan. The Watershed Management Committee will be responsible for developing and adopting these evaluation criterion. The Management Committee may elect to establish subcommittees to develop performance standards for specific program areas. The area-wide Executive Advisory Committee will then review and endorse the standards. Standard recording format and implementation schedule will be developed for each BMP by the Management Committee for use by all permittees. The permittees will be required to document BMP implementation using the standard format according to an established schedule. The utilization of quantitative approaches in measuring effectiveness will be used whenever possible. Methods that would yield comparable results for year to year evaluation will be developed.

2. ACTIVITY/SOURCE/ACTION AREA SPECIFIC

Program effectiveness will be performed based on the information generated by the performance evaluation procedures. Using street sweeping as an example, the Plan will propose a method of determining if street sweeping has an impact on water quality. This could include determining what kind of

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pollutants are removed by the sweeping, measuring the size of the pollutants and the amount removed. Methodologies would be developed for each BMP, which will assure that each control measure or action is implemented to the maximum extent practicable. For street sweeping; this may include the frequency of sweeping now, the method of sweeping, the equipment used, how the equipment is cleaned and maintained, and the method of disposal for the material collected. A schedule and format of evaluation shall be developed for all the BMPs.

The Regional Board has recommended 13 Baseline BMPs, to be developed and/or implemented by all permittees by the end of the current NPDES Permit. Existing Permit Task 5.2.5 requires an evaluation of the need for additional BMPs, source control, and/or structural control measures.

BMPs have only been implemented for a short time period by Phase I and Phase II cities. Phase III, which contains 30 new cities, has not yet implemented any BMPs. Therefore there is little or no data available to adequately assess effectiveness. In lieu of recommending any changes or additions to BMPs currently being implemented or proposed by the Permittees, a uniform data collection methodology will be established for each of the 13 baseline BMPs. This methodology would be used by all Permittees to compile data on their BMP implementation to allow for a uniform Countywide evaluation of BMP effectiveness. Priority will be given to the development of a uniform data collection methodology to document the success or effectiveness of these 13 BMPs. Upon reorganization of the NPDES Permit Program, as described in Chapter I, this will be the first task addressed by the Watershed Management Committee. The Uniform data collection methodology will be developed by January 15, 1995 for the Santa Monica Bay watershed and by July 1995 for all other watersheds with subsequent implementation by all permittees in each watershed.

B. ANNUAL REPORTS

An annual report for each watershed will be submitted to the Regional Board not more than 45 days after the end of each permit year. Each annual report will include a summary on the programs implemented during the previous year and plan activities that will be implemented during the current year. Any revisions to the Plan would be addressed in the report.

1. FORMAT/STRUCTURE

In order to insure uniform annual reporting by all watersheds, the Executive Advisory Committee will develop a uniform annual report outline for use by each watershed. Each Watershed Management Committee will develop a

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standard format to be used by all the permittees in its watershed in reporting the progress and the status of all stormwater programs implemented in its jurisdiction. The Principal Permittee will utilize this information to develop the annual report for the watershed. Upon approval by the Management Committee, the annual report will be provided to the Executive Advisory Committee which will compile the annual reports from all watersheds for submittal to the Regional Board.

2. EFFECTIVENESS MEASURES

Under Chapter VIII, Section A, the permittees will have developed performance standards for each BMP. These performance standards will be used to assess the effectiveness of the BMPs. By the end of each permit year, the findings of the previous program year will be evaluated and used to suggest changes that are appropriate for implementation during the next year. Focus should also be given to the use of empirical studies, in a control setting, to more fully assess the effectiveness of BMPs.

3. CONTENT

The annual report will include a matrix illustrating the levels of implementation for all permittees. Tables will be developed for each BMP listing all the participating Co-Permittees, describing the status of implementation by each Co-Permittee of the BMP, and documenting any modifications of the BMP from the standard program. The effectiveness of each program area will be assessed using the performance standards developed under Chapter VIII, Section A. For effectiveness measures, the findings should be presented graphically for ease of comparison with the established levels of effort. Fiscal budget for all the BMPs implemented should also be prepared, grouped by programs. An analysis and evaluation of the results of the past year's monitoring program data will also be included in the report. Any revisions to the Plan should be addressed here, with all the elements affected discussed in their entirety. All relevant information, such as water samples analyses and evaluation, should be included in the appendices.

C. SEMI-ANNUAL REPORTS

A semi-annual progress report will update the Regional Board on Permit compliance activities six months into each permit year. The semi-annual report will be provided to the Regional Board within 30 days after the end of the six-month period.

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1. PURPOSE

The semi-annual report will serve as a status report on the progress of the implementation of the Plan.

2. FORMAT/STRUCTURE

In order to insure uniform semi-annual reporting by all watersheds, the Co-Permittees will use the standard format developed for the annual report in reporting the progress and status of all the BMPs implemented in their jurisdictions. The Principal Permittee will utilize this information to develop the semi-annual report for the watershed for submittal to the Regional Board.

3. CONTENT

The semi-annual report will include a matrix illustrating the levels of implementation for all permittees. Tables will be developed for each BMP listing the participating Co-Permittees, describing the status of implementation by each Co-Permittee of the BMP, and documenting any modifications of the BMP from the standard program. The permittees will describe the problems encountered during implementation and discuss the modifications to the program in order to solve these problems.

D. INTERNAL REPORTING

In order to facilitate the preparation of semi-annual and annual reports, standard internal formats for use by all Permittees will be developed. The internal reporting procedures will be completed for all Plan chapter elements by December 1997.

1. STANDARD FORMS

The Watershed Management Committee will be responsible for developing standard forms for use by each Permittee. Standard forms will be developed for each BMP to monitor its progress. Some Permittees may have to customize the standard forms in order to reflect their programs' additional features. The forms will collect all the information essential to the preparation of the annual and semi-annual reports. In developing the standard report forms, information that is quantifiable and specific for each program area and/or BMP will be collected.

2. PROCEDURES

Co-Permittees will submit all the BMP report forms to the Principal Permittee at the end of the six-month period and the permit year, respectively.

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3. RECORD KEEPING

The Regional Board does not need to see all of the extraneous information, but the records will be retained by the Principal Permittee for 2 years. Each Permittee will keep a permanent copy of its reporting forms in case they are needed.

E. STORM WATER MANAGEMENT PLAN REVISIONS

There will be an annual review process that will allow the Permittees to revise the Plan for the next year and for the rest of the permit period. Revision procedures will be developed by December 1997.

1. PROCESS

In the annual report, Permittees will compare the progress made on all the BMPs with the established level of effort. If the level of implementation is inadequate, the program should be adjusted to accelerate the progress. If the progress made to date shows that the program is ineffective or inefficient in protecting the stormwater quality, a new program should be developed and implemented for the next fiscal year and the rest of the permit period.

2. REPORTING

All refinements or revisions to be made in the fiscal year will be documented in the annual report, with the dates of implementation proposed.

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IX. MONITORING

The Monitoring Program is a critical element in the Stormwater Management Plan. It will provide important data for use in characterizing existing stormwater/urban runoff quality, guiding future development, and modifications to the Plan and also to assess its effectiveness. A watershed wide monitoring program shall be developed by December 1997.

A. SYSTEM CHARACTERIZATION

The existing Permit subdivided the County into six drainage basins with information to be collected to characterize each of the basins.

1. WATERSHED

Each drainage basin has been subdivided into numerous drainage areas, based on an evaluation of the existing drainage system and surface flow patterns. For each drainage area, the following information has been compiled: size; breakdown of existing land use; imperviousness; description of soils; location of waste disposal facilities; and the location, type, and number of industries by Standard Industrial Classification (SIC) Code. This information has been submitted to the California Regional Water Quality Control Board, Los Angeles Region, for Phases I and II. Phase III watershed characterization is in progress and will be completed by the end of December 1994. Due to the volume of the watershed characterization data, this information has not been included herein, but is available for review at either the Regional Board or the Los Angeles County Department of Public Works.

This information will provide a basis for developing other monitoring program elements such as pollutant loading estimates from major land uses and watersheds; pollutant source identification, and identification of illegal discharges/illicit disposal practices.

2. STORM DRAIN SYSTEM

In subdividing each basin into drainage areas, the drainage area tributary to all major outfalls has been identified. Within each drainage area, the tributary storm drain system is being identified and mapped. Key information such as the size of the storm drain facilities, locations of manholes and inlets, and storm drain connections is being compiled. This information will be vital in conducting storm drain inspections to identify and eliminate illegal discharges.

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3. RECEIVING WATERS

Due to the extent of urbanization in Los Angeles County over the past decades, most of the streams designated as receiving waters in the Los Angeles basin have been replaced with man-made storm drainage systems to provide flood protection to the urbanized areas. These streams have been mapped as part of the storm drain system mapping done under A.2. above. The remaining natural streams are also being mapped.

The Los Angeles County Department of Public Works (Department) has been performing surface water quality monitoring on a voluntary basis since the late 1960s. Samples have been collected and analyzed from various receiving water streams and channels throughout the County to collect general information as to the quality of the surface runoff within our storm drain system.

The program in existence at the time the current Permit was issued was established in the mid 1980s. Twenty-eight sites are sampled monthly for dry weather flows. Twenty-one of the 28 sites are sampled for storm flows up to five times per year. The collected samples are analyzed for general minerals, pH, total dissolved solids, specific conductance, biochemical oxygen demand, bacteria, heavy metals, pesticides, PCBs, total organic carbon, volatile organic compounds, and total petroleum hydrocarbons.

The sample collection at these sites will continue while the new National Pollutant Discharge Elimination System (NPDES) Permit monitoring stations are established. Once all NPDES Permit monitoring stations are operational, sampling at these 28 sites will be discontinued.

In order to provide an initial assessment of the water quality in the major streams and channels in the County, an analysis has been performed on the data collected through the existing surface water monitoring program. The analysis has been done on a Countywide basis and also by major drainage basin. The report can be found in Volume 8.

To better assess the receiving water impacts of stormwater the Department will be developing a program to further study stormwater impacts on selected receiving waters, including conducting toxicity studies. Initial efforts will focus on the Santa Monica Bay Watershed. A Request for Proposal for the development of such a program will be advertized by January 15, 1995.

The water quality data collected by the new NPDES Monitoring Program will provide more detailed data to better assess in upcoming years the quality of our receiving waters. Ten monitoring stations have been proposed along the

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major streams in the County. A description of these site locations can be found in the monitoring work plans for Phases I, II, and III, previously submitted to the Regional Board, see Volume 8.

4. **LAND USE**

As described under Section A.1. above, the existing land use categories within each drainage area have been identified. This information has been used to select drainage areas comprised of a single homogeneous land use for land use specific monitoring. A total of 14 land use monitoring sites are being established in the County. Five sites are being installed in the Santa Monica Bay Watershed with the remaining nine to be selected from within the Los Angeles, San Gabriel, and Santa Clara River Watersheds. For a description of the sites, please see Volume 8. These sites will provide valuable information as to the types and levels of pollutants found in runoff from various land uses. This information can then be used to refine the Stormwater Management Plan to develop specific management measures to target identified problems.

B. SOURCE IDENTIFICATION

Identifying the sources of stormwater pollutants from both specific land uses and specific activities will provide the information needed to identify problem areas and allow specific management measures to be developed to address these problems.

1. SPECIFIC LAND USE

As described in Section A.4. above, major land use classifications will be subject to individual monitoring to determine the types and levels of pollutants present.

2. SPECIFIC ACTIVITIES

a. A pollutant source identification program will be designed to identify significant pollutant sources (i.e., parking lots, industrial activities, etc.), with the hope that remedial action can be undertaken to reduce any significant impacts so identified. It will focus on monitoring very small areas (i.e., less than five acres) where a specific and/or interrelated set of pollutant generating activities are occurring. Its objective is to provide data for selecting BMPs for specific activities rather than characterizing discharges for long-term pollutant loading estimates.

Identification of pollutant sources can be done using a number of methods. Potential sources of storm water pollutants can be identified

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by records of chemical use and/or storage, by studies of specific activities which lead to the deposition of pollutants throughout the watershed, and by field inspection or monitoring. Watersheds which may contain significant pollutant sources can be identified through land use information or by mass loading estimates.

By mid January 1995, the County will begin targeted monitoring of a municipal corporation yard in the Santa Monica Bay watershed. A full program for pollutant sources identification will be developed by December 1996.

b. A storm drain inspection program has also been developed and is being implemented. The first phase of the inspection program will target the open channel storm drains to identify illegal discharges.

The open channel inspections will also be used to screen outfalls from underground storm drains for the presence of dry weather flows. This information will be used in the next phase of the storm drain inspection program to prioritize the underground storm drain system for further field screening and inspection of problem areas.

C. CONTROL MEASURE EFFECTIVENESS

It is unlikely that the effectiveness of the various control measures implemented by the storm water management plan can be determined solely through the data produced by monitoring the quality of storm drain flows, because it is difficult to obtain statistically significant comparisons of watershed-wide control measure performance with such data. For this reason the effectiveness of control measures will be assessed through other means.

Two general types of methods are available for assessment of control measure effectiveness: direct water quality (conventional) monitoring and indirect (non-conventional) monitoring. Direct water quality monitoring can be used to determine pollutant reduction by a specific facility or device. This technique is commonly used for structural or treatment controls, such as detention basins and constructed wetlands, where there is an accessible inflow and outflow. Inflow and outflow results are compared to determine pollutant removal and effectiveness.

Direct water quality monitoring of site runoff before and after implementation of non-structural control measures is also possible. However, it is difficult to demonstrate effectiveness at a statistically significant level because of the high degree of variability in stormwater pollutant concentration and mass loading data. The water quality improvement due to non-structural control measures is generally expected to be less dramatic than that achieved through structural controls. A larger

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number of samples is therefore required to produce a statistically significant result. This is especially difficult in relation to the monitoring of the pre-control measure condition. Collection of adequate baseline information is necessary prior to the implementation of management practices. Direct monitoring of the effectiveness of non-structural controls is feasible typically only under experimentally controlled conditions (e.g., selection of small, well-defined watershed; control of management practice implementation; effective siting and timing of monitoring activities), including a sufficient number of samples to achieve statistical significance.

Indirect monitoring currently is the primary method of choice of assessment of management plan effectiveness. A number of indirect monitoring techniques are available for assessment of management plan effectiveness.

Verification of program implementation is an indirect monitoring method that can be used to determine how a management plan is being implemented. Another indirect monitoring method, pollutant removal inventories, can be used to assess the amounts of pollutants that have been prevented from entering the municipal storm drain system.

The 13 Baseline BMPs recommended for implementation by the Regional Board plus other BMPs proposed by the various Co-Permittees are in general all non-structural control measures. In the short-term, a uniform data collection methodology will be developed for use by all Permittees to compile information on the level of implementation of the 13 Baseline BMPs. This will allow for a uniform watershed-wide evaluation of BMP effectiveness. For the Santa Monica Bay watershed, this uniform data collection methodology will be developed and begin implementation by January 15, 1995. For the other watersheds, implementation would begin July 1, 1995.

For the long-term, as the various chapters of the Plan are more fully developed, possibilities for the use of direct water quality monitoring for control measure assessment will be evaluated as opportunities arise.

D. POLLUTANT LOADING

One of the objectives of the monitoring program is to estimate the annual pollutant loadings from each watershed. Knowing the types and quantities of pollutants discharged into receiving waters are important in assessing the impacts of stormwater and, in turn selecting appropriate control measures to address problem areas.

The 24 permanent monitoring stations that are being established Permit-wide will be utilized to estimate pollutant loads from each watershed and also from various land uses. For a description of the methodology to be used to estimate pollutant loadings, please see Volume 8. For the Santa Monica Bay Watershed, the pollutant loading

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model will be tested and operational by January 15, 1995. Actual pollutant loadings will be calculated subsequent to storm events occurring for which water quality data has been obtained. For the other watersheds, a schedule for pollutant load modelling will be provided by January 15, 1995.

To more closely model pollutant loadings and evaluate control measure impacts, a more detailed dynamic modelling will be undertaken on a smaller, representative sub-watershed. The EPA-SWMM model has been selected for use in our dynamic modelling efforts. For the Santa Monica Bay Watershed, the Kenter Canyon Drain sub-watershed has been selected for this modelling efforts. This sub-watershed is typical of the urbanized areas in the Santa Monica Bay Watershed. It is comprised of multiple land uses, has well-defined boundaries, and has no upstream flow regulation. We are reviewing and identifying the existing drainage system, defining current and future land uses, and conducting field checks. The model will be tested and operational by January 15, 1995, with actual modelling results to be available later when local water quality data from our monitoring stations becomes available. Based on the results of the dynamic modelling of the Kenter Canyon sub-watershed, other sub-watersheds may be selected from the other major watersheds in the County.

E. COMPONENTS OF A MONITORING PROGRAM PLAN

The components of the monitoring program plan such as monitoring site locations, dry/storm sampling frequency and methodology, constituents to be sampled, field and laboratory procedures, QA/QC, etc., can be found in Volume 8 which has been previously provided to the Regional Board.

The Monitoring Program elements described in Volume 8 will be revised to address the Monitoring Program needs described in Section A - D above as agreed to in the letter from the County to the Regional Board dated September 22, 1994.

As the various chapters of the Plan are more fully developed, the Monitoring Program will be revised to address any additional monitoring needs that may result.

F. DATA MANAGEMENT

For water quality data collected at the 24 monitoring stations, please see Volume 8 for data storage and reporting methods.

For each Section A - E of the Monitoring Program described above, an annual report will be prepared detailing the data collected, with an evaluation and interpretation the data including water quality impacts.

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NPDES PERMIT NO. CA 0061654

TASK 5.2

REPORT OF WASTE DISCHARGE (ROWD)

VOLUME 5 OF 8 (TASK 5.2.5 - 5.2.6)

LOS ANGELES RIVER STORMWATER MANAGEMENT PLAN

LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS
WASTE MANAGEMENT DIVISION
WATER QUALITY SECTION

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LOS ANGELES RIVER
STORMWATER MANAGEMENT PLAN

INTRODUCTION

On June 18, 1990, the National Pollutant Discharge Elimination System (NPDES) Permit - Order #90-079, NPDES #CA0061654-CI6948 was issued to the County of Los Angeles and 17 cities tributary to Santa Monica Bay. During the subsequent years, two newly incorporated cities within the Santa Monica Bay watershed, Caltrans, and the County of Ventura also became Co-Permittees. This Permit outlined a three year program which required each Permittee to: characterize drainage areas; develop and schedule the implementation of Best Management Practices to enhance the quality of stormwater/urban runoff within its jurisdictional boundaries and in storm drains it owns and operates. On July 1, 1992, 36 additional cities were initiated into the Permit and began their three-year program. By July 1, 1993, the remaining 30 cities in Los Angeles County within the drainage basin were initiated into their three-year program. The cities were grouped according to their starting dates and referred to as Phases I, II, and III respectively (See Table A). In general, the boundaries of each Phase did not encompass whole watersheds but portions of various watersheds (See Figure 1).

The Permit has a five-year duration and although Phase III cities have only completed year one of their three-year program, the Permit requires the submittal of a Report of Waste Discharge (ROWD) which serves as an application for a subsequent NPDES Permit to replace NPDES Permit #CA0061654, which will expire on June 18, 1995. Therefore, the County of Los Angeles, the County of Ventura, Caltrans, and the 85 cities are now parties to the subsequent NPDES Permit application utilizing the Municipal Stormwater Management Plan (herein after called the Plan) concept.

The Plan is based on the Stormwater Management Plan Components developed by the California Regional Water Quality Control Board, Los Angeles Region (Regional Board), and is proposed on behalf of the County of Los Angeles and the other participating agencies, see Table B. This Plan describes the stormwater management activities to be undertaken during the next single, five-year NPDES Municipal Stormwater Permit. The Plan involves the subdivision of the area of the County under a single, new Permit, into six watersheds, each with its own stormwater management plan. For these watersheds and the agencies in each of these watersheds, see Table B and Figure 2.

As required by the current Permit, all Permittees have proposed BMPs for their jurisdictions, described in Volume One and under prior submittals made to the Regional Board. These BMPs have already addressed many of the program areas discussed under the stormwater management plan. As required by the current Permit and continuing on under the new Permit, the Permittees will continue to implement these BMPs. This stormwater management plan will involve reorganizing the individual city-based BMP programs into a single stormwater plan for each watershed. The timeline shown in this document reflects the time needed for the transition from individual city-based programs to the preparation of a mutually agreed upon and collectively developed watershed plan by all parties of the new Permit for each of the watershed areas. The first step in beginning

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this process will be the reorganization of the current three-phase program into a new watershed based program. A reorganization of the Phases into watersheds which are based on hydrologic characteristics will allow for the consistent development and implementation of programs among Permittees, referencing land use and drainage infrastructure within their respective watersheds. Consistency of program throughout the watershed will be beneficial in terms of targeting specific pollutant problems and areas.

This specific plan will address the stormwater management issues for the Los Angeles River watershed, which include the following cities and agencies:

Alhambra
Arcadia
Bell
Bell Gardens
Burbank
Caltrans
Commerce
Compton
Cudahy
El Monte
Glendale
Hidden Hills
Huntington Park
La Canada Flintridge
Long Beach
Los Angeles
Los Angeles County
Lynwood
Maywood
Monrovia
Montebello
Monterey Park
Paramount
Pasadena
Rosemead
San Fernando
San Gabriel
San Marino
Sierra Madre
Signal Hill
South El Monte
South Gate
South Pasadena
Temple City
Vernon

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TABLE A

Grouping of Permittees by Phases

PHASE I

Agoura Hills
Beverly Hills
Calabasas
Caltrans***
Culver City
El Segundo
Hermosa Beach
Inglewood
Los Angeles***
Los Angeles County***
Malibu
Manhattan Beach
Palos Verdes Estates
Rancho Palos Verdes
Redondo Beach
Rolling Hills
Rolling Hills Estates
Santa Monica
Torrance
Ventura County
West Hollywood
Westlake Village

PHASE II

Alhambra
Arcadia
Azusa
Baldwin Park
Bradbury
Burbank
Calabasas*
Caltrans***
Claremont
Covina
Diamond Bar
Duarte
El Monte
Glendale
Glendora
Hidden Hills
Industry
Irwindale
La Canada Flintridge
La Habra Heights
La Puente
La Verne
Los Angeles***
Los Angeles County***
Monrovia
Montebello
Monterey Park
Pasadena
Pomona
Rosemead
San Dimas
San Fernando
San Gabriel
San Marino
Sierra Madre
South El Monte
South Pasadena
Temple City
Walnut
West Covina

PHASE III

Alhambra**
Artesia
Bell
Bell Gardens
Bellflower
Caltrans***
Carson
Cerritos
Commerce
Compton
Cudahy
Downey
El Segundo*
Gardena
Glendale**
Hawaiian Gardens
Hawthorne
Huntington Park
Inglewood*
La Canada Flintridge**
La Habra Heights**
La Mirada
Lakewood
Lawndale
Lomita
Long Beach
Los Angeles***
Los Angeles County***
Lynwood
Maywood
Montebello**
Norwalk
Palos Verdes Estates*
Paramount
Pasadena**
Pico Rivera
Rancho Palos Verdes*
Redondo Beach
Rolling Hills*
Rolling Hills Estates*
Santa Clarita
Santa Fe Springs
Signal Hill
South Gate
South Pasadena**
Torrance*
Vernon
Whittier

Note:
* The agency is also in Phase I.
** The agency is also in Phase II.
*** The agency is in all Phases.

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FIGURE 1

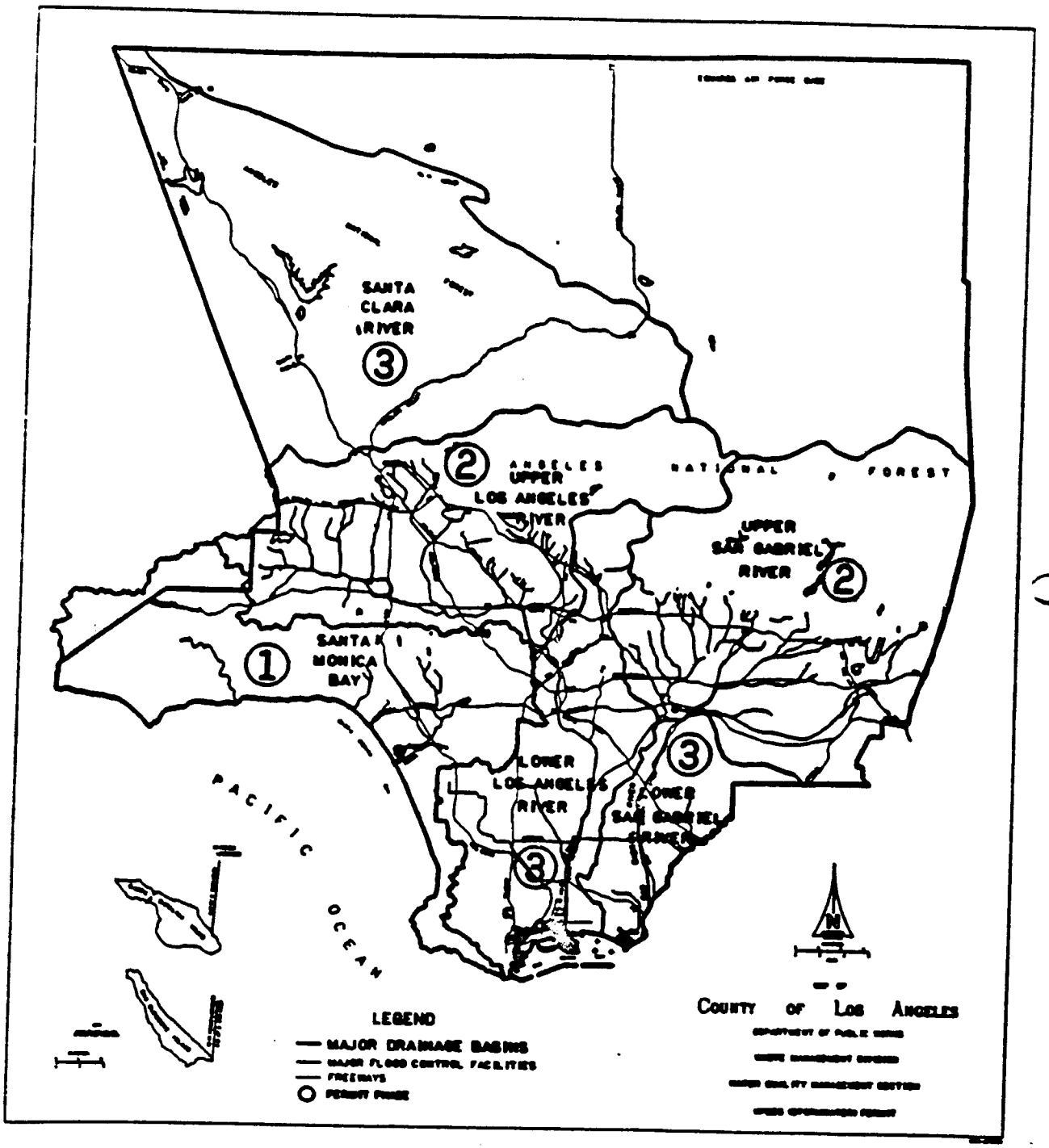

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TABLE B

NPDES Stormwater Permit Renewal
Proposed Watershed Breakup

Santa Monica Bay

Malibu Creek and Other Rural

Agoura Hills
Calabasas
Caltrans
Los Angeles County
Malibu
Westlake Village
Ventura County

Ballona Creek and Other Urban

Beverly Hills
Caltrans
Culver City
El Segundo
Hermosa Beach
Los Angeles
Los Angeles County
Manhattan Beach
Palos Verdes Estates
Rancho Palos Verdes
Redondo Beach
Rolling Hills
Rolling Hills Estates
Santa Monica
West Hollywood

Dominguez Channel/
Los Angeles Harbor Drainage

Caltrans
Carson
Gardena
Hawthorne
Inglewood
Lawndale
Lomita
Los Angeles
Los Angeles County
Torrance

Los Angeles River

Alhambra
Arcadia
Bell
Bell Gardens
Burbank
Caltrans
Commerce
Compton
Cudahy
El Monte
Glendale
Hidden Hills
Huntington Park
La Canada Flintridge
Long Beach
Los Angeles
Los Angeles County
Lynwood
Maywood
Monrovia
Montebello
Monterey Park
Paramount
Pasadena
Rosemead
San Fernando
San Gabriel
San Marino
Sierra Madre
Signal Hill
South El Monte
South Gate
South Pasadena
Temple City
Vernon

San Gabriel River

Artesia
Azusa
Baldwin Park
Bellflower
Bradbury
Caltrans
Cerritos
Claremont
Covina
Diamond Bar
Downey
Duarte
Glendora
Hawaiian Gardens
Industry
Irwindale
La Habra Heights
La Mirada
La Puente
La Verne
Lakewood
Long Beach
Los Angeles County
Norwalk
Pomona
Pico Rivera
San Dimas
Santa Fe Springs
Walnut
West Covina
Whittier

Santa Clara River

Caltrans
Los Angeles County
Santa Clarita

Italicized agencies are present in more than one watershed.

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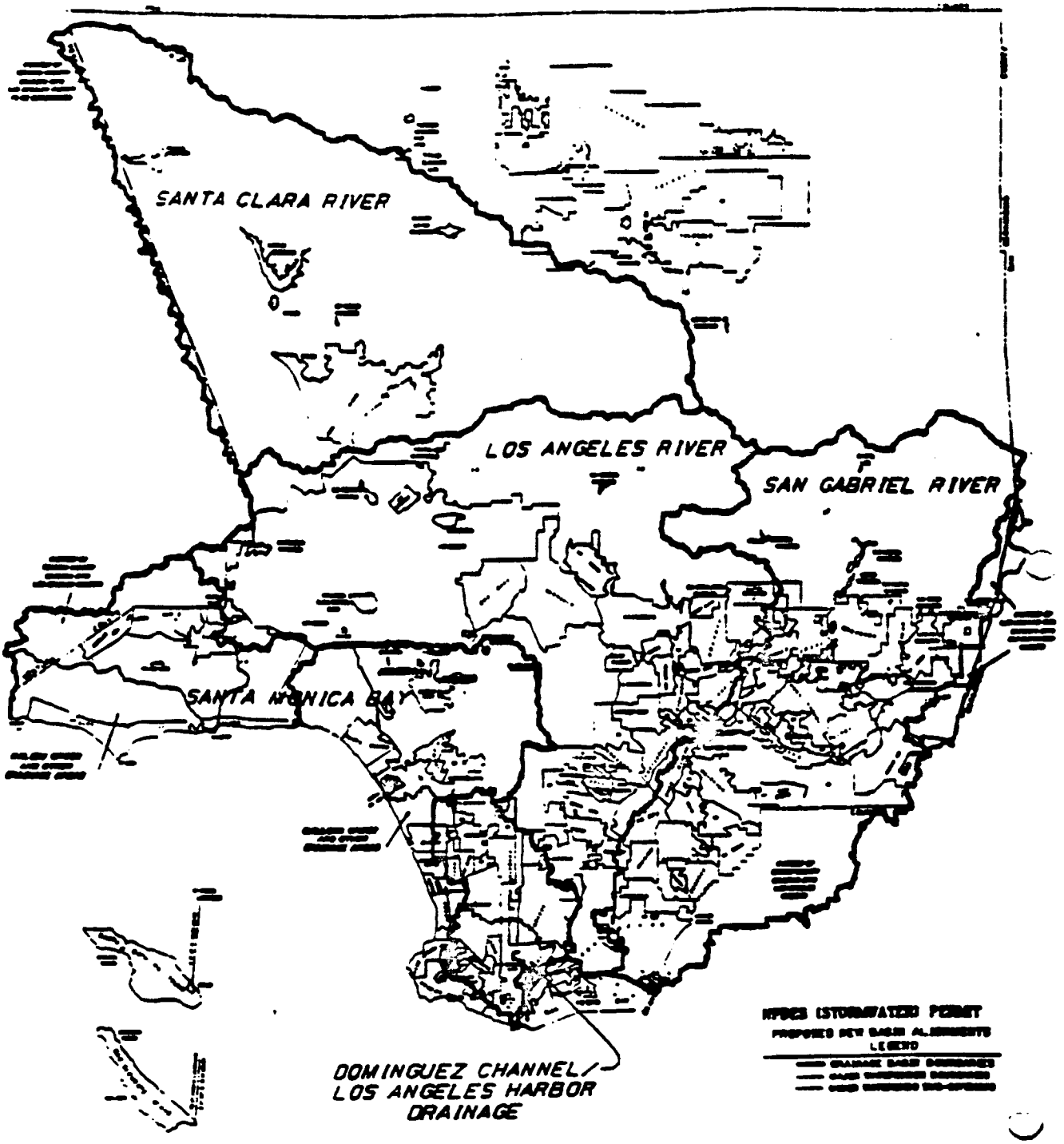
FIGURE 2



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I. PROGRAM MANAGEMENT

A. PROGRAM STRUCTURE

The County of Los Angeles is designated as the Principal Permittee. The other agencies are designated as Co-Permittees. The following are conditions that establish the responsibilities of all Permittees.

1. RESPONSIBILITIES OF PRINCIPAL PERMITTEE

Anticipated duties of the Principal Permittee include:

- Being the coordinators of permit activities and chairing the area-wide Executive Advisory Committee and the Watershed Management Committees;
- Providing the resources necessary for development of the stormwater management plans;
- Providing technical and administrative support for both the Executive Advisory and Management Committees;
- Implementing the monitoring program;
- Providing the resources necessary for developing annual reports including evaluating monitoring program data and BMP effectiveness;
- Complying with all the responsibilities of a Co-Permittee as outlined below.

2. RESPONSIBILITIES OF ALL CO-PERMITTEES

Each Co-Permittee is designated a number of duties under the proposed stormwater management plan:

- Participate in the development of the stormwater management plan;
- Implement the stormwater management plan within their jurisdictional boundaries and the storm drains they own and operate;
- Provide information needed by the Principal Permittee on program implementation for development of annual reports.

The area under the Permit will be subdivided into the six watersheds tributary to the following waterbodies: Santa Monica Bay, which is further divided into a) Malibu Creek and Other Rural Areas, and b) Ballona Creek

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and Other Urban Areas; Los Angeles River; San Gabriel River; Dominguez Channel/Los Angeles Harbor Drainage; and the Santa Clara River (See Figure 2). Managing these watersheds is a task that will require a collective and cooperative effort on the part of all governmental entities named in the Permit that are within each watershed.

The management structure of the Plan consists of an area-wide Executive Advisory Committee, Watershed Management Committees, and Subcommittees. This particular structure is intended to provide a suitable program for the unique characteristics of each watershed and shall be developed by April 1995.

The Co-Permittees tributary to the Los Angeles River watershed shall adopt this watershed stormwater management program structure as a guide to allow for an area-wide uniformity of compliance of the Permit.

3. EXECUTIVE ADVISORY COMMITTEE

The area-wide Executive Advisory Committee shall consist of the County of Los Angeles, as Chair, and two representative Co-Permittees from each of the six watersheds. This Committee assumes no responsibility for the adequacy or inadequacy of any individual city's program and should not be viewed as the responsible agency in this sense. The Committee's main role is to facilitate programs within each watershed and to enhance consistency among all of the programs. Additional responsibilities of the committee are:

a. Making recommendations on area-wide issues to each of the Watershed Management Committees;

b. Reviewing the stormwater management plans as developed by each Watershed Management Committee and provide direction and guidance on the plans for consideration by the Watershed Management Committees;

c. Assessing the consistency of all area-wide BMPs;

d. Preparing and forwarding unified submittals to the Regional Board upon receipt of information and materials submitted by the Watershed Management Committee in compliance with Permit requirements;

e. Scheduling and coordinating meetings and correspondence to allow for communication between the Co-Permittees and the Regional Board;

f. Acting as liaison between all Permittees and the Regional Board on Permit issues as well as mediating conflict among the Permittees.

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4. WATERSHED MANAGEMENT COMMITTEE

A management committee within the watershed will be comprised of the County of Los Angeles, as Chair, and one representative from each of the Co-Permittees in the watershed. The committee shall be responsible for:

a. Establishing goals and objectives for the watershed

b. Preparing the stormwater management Plan for the watershed (This includes the development of all chapter components of the Plan);

c. Assessing the effectiveness of the Plan and making appropriate changes;

d. Preparation of the semi-annual progress reports and annual Permit reports on Permit activities within the watershed for submittal to the Regional Board (For the annual Permit report, a draft will be circulated to each Co-Permittee and the Executive Advisory Committee for its review and comment. Final copies of reports shall be forwarded to the Executive Advisory Committee through which a compilation from all six watersheds shall be submitted to the Regional Board);

e. Enhancing the implementation of the stormwater/management plan within the Los Angeles River watershed.

5. SUBCOMMITTEES

Subcommittees will be established where needed as determined by the Management Committee and/or the Executive Advisory Committee. The Subcommittees would be focused on specific program areas and can provide more specific oversight on the development, implementation, and evaluation of selected program areas. These subcommittees shall be scheduled to meet on a routine basis.

B. INSTITUTIONAL ARRANGEMENTS

Management of the stormwater program requires the collective efforts and the cooperation of all Permittees. No Permittee has the ability and the legal authority to assume the responsibility of all activities of this Permit. Therefore, agreements will need to be formally developed amongst the Permittees to insure proper implementation of the Permit requirements.

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1. PROGRAM PARTICIPANT ARRANGEMENTS

As the Principle Permittee, the County of Los Angeles will be designated as the lead agency for coordination of Permit activities and therefore shall chair the executive committee and the management committee meetings as they are scheduled. The lead agency is responsible for coordination of the Permit but is not responsible for the adequacy or inadequacy of any individual Permittee's program. All other entities are Co-Permittees and will be responsible for the Permit compliance of their own agency's program. An implementation agreement will be drafted formally detailing the responsibilities of the Principal Permittee and the Co-Permittees. The agreement would also address the funding of various watershed-wide activities such as plan development, annual evaluation and reporting, and monitoring. Execution of the agreement by all Permittees is targeted for December 1995.

2. AREA-WIDE INTERAGENCY

As the Plan for each watershed is more fully developed, the Watershed Management Committee will coordinate with special agencies and districts that also regulate and/or perform activities addressed under different elements of the Plan. This coordination will attempt to ensure that their functions and the Plan are compatible. A few of these agencies include:

County Hazmat

- Any overlap of waste regulations, Household hazardous waste programs and or Industrial inspections shall be recognized and addressed, by all entities that fall under this Permit, in reference to the watershed program.

County Health

- Inspections of restaurants and other food handling establishments shall be coordinated with the Permittees.

Local Transportation/Congestion Management

- Local municipalities have limited authority over motor vehicle usage and regional transportation planning. Where feasible, plan development and implementation will be coordinated with local transportation agencies.

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County (Regional) Parks

- Landscape maintenance activities at public-owned parks will be reviewed as part of additional plan development to ensure the use of proper management measures.

Mosquito Abatement

- Coordination with the County Agricultural Commissions will be done for mosquito abatement programs to avoid adverse impact on the quality of stormwater/urban runoff.

Water Districts

- Activities with regards to the Water Districts activities will be reviewed and, when feasible, comply with the watershed program regulations and requirements.

Other entities, both private and public which have major land holdings and/or authorities that impact the quality of stormwater/urban runoff should be initiated to participate actively in the program.

3. CITY-SPECIFIC INTERAGENCY ARRANGEMENTS

Each city will need to develop the institutional framework to address operation, maintenance, construction, redevelopment, and other activities performed by city agencies such as Public Works, Parks and Recreation, Planning, and Public Owned Treatment Works (POTWs). These city agencies will need to participate in the planning and implementation of relevant plan program areas.

C. FISCAL RESOURCES

As each of the Plan chapters are completed, each Permittee will develop a budget for implementing that portion of the Plan. A complete budget for the plan will be produced upon completion of development for all Plan components (*December 1996*). The budget will provide information such as funding sources, staff resources, contract services, and cost sharing arrangements.

1. AREA-WIDE

In implementing the Plan, the Permittees may elect to jointly fund a single program for certain BMPs, such as Public Education, that are area wide in

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nature. Funding agreements including budgets and cost per agency would be developed.

2. CITY-SPECIFIC

Each Permittee will develop a budget detailing the cost of implementing Plan activities within its jurisdiction. Special funding in the form of grants, donations, or other forms of contribution should also be actively pursued to assist in funding special studies and/or BMPs.

D. LEGAL AUTHORITY

Each Permittee is responsible for implementing the Plan within its jurisdictional boundaries and therefore must acquire all needed legal authority. Each Permittee, being separate legal entities, are to have adopted as required by the existing Permit, ordinances that will provide them with the adequate legal authority to develop, administer, implement, and enforce storm water/urban runoff management programs within their own jurisdiction. The ordinance must provide for its enforcement and at a minimum specify that violators may be subject to penalties including, but are not limited to, fines and termination of the activity causing the violation. A plan for identifying any additional legal authorities needed by the Permittees will be included in the completed Plan for the Los Angeles River watershed *December 1995*. Upon completion of development of the Stormwater Management Plan, enforcing compliance with the Plan will the responsibility of the Regional Board.

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II. ILLICIT DISCHARGES

The elimination of illegal connections and illicit disposal (IC/ID) practices is an important component for any program aiming to enhance the quality of stormwater/urban runoff.

Although more information is needed to assess fully the benefits and costs of conducting IC/ID programs, we can make logical decisions regarding application of Best Management Practices (BMPs) to minimize such incidents. These BMPs will vary due to the jurisdictional differences that exist within each watershed. Each jurisdiction within the watershed will be developing and implementing those activities that will adequately serve the jurisdiction and the watershed as a whole.

IC/ID practices are intermittent discharges of pollutants into the storm drain system that can degrade the quality of receiving waters. This can occur through catch basins, area drains, and even on gutters and street surfaces. Some illegal dumping activities are done by individuals who do not know that such practices are illegal and can adversely impact the environment. Yet, others may be carrying out such practices with the full knowledge that such activities are prohibited.

A. ILLICIT CONNECTIONS

In order to implement an illicit connection management program, jurisdictions as a whole will need to develop and implement the procedures for investigating each of their respective storm drain systems.

Detailed procedures to eliminate illicit connections depends on the complexity of the storm drain system. A consistent watershed wide concept will be developed to investigate illicit connections to the storm drain system. Based on the results of field screening activities, or other appropriate information that indicates an area of reasonable potential of containing illicit connections, detection and follow up procedures would be followed. Priority should be established to focus on major problem areas and allow for a cost-effective approach to eliminate illegal connections. This concept will be developed by December 1995.

1. SYSTEM SURVEY

A system survey is a necessary component of an illicit connection elimination program. Although the basic concept is similar, the actual techniques and methods that jurisdictions within the watershed use to conduct system surveys can be quite different.

In conducting system surveys, the intent is to avoid costly investigations within areas not suspected of containing illicit connections. Field screening, map

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research, and land use investigation activities will be done initially to identify potential problem areas. Public outreach efforts will be used to inform citizens in the area about the problem. Enforcement action will be taken to terminate such illegal connections. It should be noted that more detailed and sophisticated techniques such as televised inspection and dye testing will only be used in special situations as needed.

Under the current Permit, three jurisdictions have undertaken a system survey. The County of Los Angeles is preparing maps detailing detail the location of each storm drain, its manholes and catch basin connector pipes to facilitate monitoring of illegal connections and discharges. The location and source of discharge for connections is also being inventoried. The County is developing a GIS system to allow management and analysis of this data. This information will be used in the storm drain inspection program which is ongoing. The program is targeting open channel storm drains. All open channels will be inspected for evidence of illegal discharges. The open channel inspections will also be used to collect information on dry weather discharges from underground from underground drains for use in prohibiting future underground drain inspections.

The City of Los Angeles has contracted with a vendor to provide "on call" closed circuit television inspection of storm drain interiors suspected of being damaged or containing illegal/illicit connections. The City has also in operation a program to identify all outfalls in the storm drain system and their tributary drainage areas. This information is being gathered for incorporation into a database that will be used to identify and prioritize drainage areas for investigation of possible illicit discharge. One city is considering a program that will require field inspections of storm drains to determine connections.

2. ONGOING SYSTEM INSPECTIONS

Ongoing system inspections for illicit connections will involve the techniques identified in Section 1 above, along with some additional activities. In smaller systems where the storm drain goes into several pumping stations, a regular inspection of the pumping stations for, among other things, evidence of illicit discharges will be sufficient.

In larger and more complex systems, a program of field screening will be used. Evidence of pollution will be categorized and prioritized. The storm drain alignment tributary to the suspect illegal connection can then be further investigated for illicit connections. If a discharge can be traced to a particular facility, the facility will be investigated to identify where exactly the pollutants are coming from and what efforts are needed to stop the discharge.

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Another means of detecting illicit connections may be to rely on reports of illicit discharge from the public. This will utilize the County's or another agency's established "hotline" number that the public can call and report such observations.

3. REPORTING

A consistent recording system will be established to track report of illegal connections. This recording system will be used by the Permittees within the watershed.

B. ILLEGAL DUMPING

Due to the intermittent and unpredictable nature of illegal dumping, apprehension rate of violators could be quite low. The first course of action is to develop an area wide educational and reporting system along with prompt response procedures. This will be accomplished by December 1995.

1. OUTREACH

See **Chapter VII Public Information and Participation** of this report for a detailed discussion of the outreach program.

2. SYSTEM SURVEILLANCE

Measures that may be used for this aspect of the program may include, but are not limited to, regular inspections of vacant facilities, street use inspection programs to detect illegal discharges and dumping into the street system, and a public complaint and reporting system.

Three jurisdictions have begun system surveillance programs. One city presently enforces violations of excess water and fluids in the street system on a complaint basis. This program, when funded, would add inspection teams to monitor street discharges aggressively. This city also has a storm drain line investigation program that is designed to stop discharge from specific facilities by monitoring maintenance holes around suspected sources. A program has been established for County-owned airports requiring lessees to report the release of hazardous materials to the proper agencies. Finally, one city is considering a storm drain inspection program, a discharge assessment, and a program for control of illegal discharges that would establish a permit procedure.

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3. SPILL RESPONSE

The Health Hazardous Materials Division (HHMD) of the Los Angeles County Fire Department is generally the primary spill responder. If the material is found to be hazardous and poses an imminent threat to public health and safety, the cleanup and disposal of the material will be done under the supervision of HHMD. If the material is non-hazardous, the responsibility will fall on local agencies to coordinate cleanup, disposal, and attempt to identify and prosecute the violators. Cooperation among all agencies will be needed to allow for prompt action and joint effort to deter such violators. All agencies will have local authority against such illegal dumping activities.

Spill response procedures have been established by three jurisdictions. One city is in the process of replacing a sewage pump station with a gravity flow sewer that eliminates the possibility of pump failure and reduces the potential for sewage spills. Another city is presently identifying all city-owned facilities to ensure that they have adequate spill containment procedures. Improved procedures for inadequate facilities are to be established. The third jurisdiction is developing new spill reporting procedures.

4. COMPLAINT RESPONSE

The County and some local agencies have established a stormwater telephone "hotline" that can be utilized by all citizens. Public complaints are generated through these "hotlines" and also through regular channels such as calls to either Fire or Police agencies, public works, or legislative offices. Although responses to these complaints will vary depending on the nature of the complaint, action shall be taken.

The use of reporting hotlines, in conjunction with outreach/publicity programs, can help minimize the problems of illegal dumping. The County has established an 800 hotline for the reporting of illegal dumping. In addition to this hotline, thirteen of the cities in the watershed have established their own reporting phone numbers. Generally these numbers are handled through the individual police or fire departments. However, one city has established a system through their Bureau of Sanitation and another through the city's Environmental Network. Approximately half of the co-permittees indicated that they are actively publicizing the hotlines. The most frequently used method to promote reporting hotlines is through city newsletters, with newspaper articles, handouts/flyers, press releases, water and utility bill inserts, and local cable television. Seven of the cities who do not currently have outreach procedures report that they have planned or budgeted for programs.

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A complaint response procedure has been established by Los Angeles County to track hotline complaints. A follow-up letter to violators has also been implemented.

5. COORDINATION OF ALTERNATIVE DISPOSAL

Alternative disposal is one way of reducing non-stormwater materials that can potentially find their way into the storm drain system. Recycling programs are one of the most effective ways to reduce waste material. The recycling program can either be at the curbside or through drop-off centers. Household hazardous wastes can be dropped at mobile collection centers or at fixed sites. Co-Permittees in the basin generally participate in the County's Household Hazardous Waste collection program. Effectiveness of those programs may be enhanced by a public outreach program that will inform the public of the locations and/or schedules for such events. Technical assistance or information may also be provided to businesses that want to develop a pollution prevention, waste minimization, or alternative disposal program.

All jurisdictions participate in the Countywide Household Hazardous Waste Round-ups and the majority of them presently use, or plan to use, a variety of methods to notify the public of the events. Nine cities have already developed, or plan to develop, used oil recycling and a few are considering green waste programs. Only Caltrans does not participate in the round-ups, but it does recycle its used oil and other hazardous materials at maintenance yards. Curbside recycling, another alternative disposal measure, has been implemented by a majority of the cities. Only 6 jurisdictions/agencies do not routinely pick-up materials. However, 5 of these either has drop off centers, seasonal programs (Christmas trees, phone books), or plan to begin programs by 1995.

6. REPORTING

Incidents involving a hazardous material entering the storm drain system are to be reported by the responsible party, or, if not known, the responding agency, to the California Regional Water Quality Control Board, Los Angeles Region (Regional Board). Complaints received through the County wide and local city hotlines will be tracked and reported to the Regional Board.

C. ENFORCEMENT PROCEDURES

Enforcement actions against discharges are done through either state hazardous and toxic materials statutes or through municipal ordinances that are already in the codes of the permittees. Industrial Waste Ordinances may be used in enforcement actions against illicit connections. Furthermore, anti-littering, health codes, plumbing codes,

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and fire codes may be utilized for dumping or spill incidents. Enforcement actions can be taken by different municipal agents, including but are not limited to, Industrial Waste Inspectors, Building or Plumbing Inspectors, Fire Department Inspectors, Park Rangers, Street Use Inspectors, Health Inspectors, Police Officers, Community Services Officers, Animal Control Officers, Code Enforcement Staff, or Public Works Inspectors. Some of these agents are empowered to either issue citations, issue notices of violations, issue cease and desist orders, or even make arrests depending on the type of violation and the code provisions that they are enforcing. Some of these agents are also empowered to enforce not only municipal ordinances but also state laws. A review of the various enforcement tools used by the Permittees will be performed. A recommendation will result on a consistent enforcement approach for the watershed for consideration by all Permittees in their own enforcement programs. This recommendation will be developed by December 1995.

Enforcement of regulations that discourage improper disposal are undertaken in a variety of ways by the cities within the watershed. Fourteen cities have adopted ordinances that generally include penalties for non-compliance. Eleven cities presently have no enforcement procedures but five of these are planning appropriate programs. An additional three have recycling programs that encourage proper litter disposal though these programs are not mandatory. Enforcement is handled by Code Enforcement officers, Public Works inspectors, Health Department, Fire Department and Animal Control staff, and in one city by the Police Department. Several cities have implemented educational programs in a effort to encourage compliance with regulations and to minimize the need for enforcement penalties. One such city, La Canada-Flintridge, includes educational information along with business license renewal.

D. COORDINATION WITH STATE NON-STORMWATER PERMITS

In order to characterize the nature of the existing non-storm discharges in the receiving waters within the watershed, a list of NPDES Permits issued by Regional Board will be obtained. This will help in determining unexpected discharge during dry weather and to allow enforcement actions to focus on illegal dumping activities.

There is also a need to coordinate with other environmental agencies to ensure that requirements imposed by these agencies do not conflict with stormwater regulations. Requirements of many agencies do complement stormwater regulations. These agencies include, but are not limited to, Fish and Game, DTSC, USEPA, and the Coastal Commission. Coordination with these agencies will help minimize overlapping investigations and result in a more efficient use of resources. A watershed wide concept will be developed by December 1995.

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1. **IDENTIFICATION OF PERMISSIBLE/PERMITTABLE DISCHARGES**

A list of non-stormwater discharges that can be allowed to discharge into the Waters of the State will be established by the Regional Board.

2. **APPROPRIATE MANAGEMENT PRACTICES**

Continued communication with the Regional Board will allow current information to be circulated among all agencies.

3. **REPORTING**

Any conflict in requirements of other environmental programs/agencies must be reported immediately to the Regional Board for ruling as to which one should take precedence.

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III. INDUSTRIAL/COMMERCIAL SOURCES

Each Permittee shall develop and implement a program that focuses on the identification and control of storm water pollutant discharges from industrial/commercial facilities within their jurisdiction. This program shall provide for the inspection of a facility's compliance with storm water regulations, as well as general outreach for all facilities that are potential industrial and commercial dischargers.

Each Permittee is responsible, under the requirements of the Municipal Stormwater Permit, for all discharges from commercial and industrial facilities within its jurisdiction. Many industries are also required to be permitted under the State General Industrial Activities Stormwater Permit. Enforcement of the specific provisions of the State General Permit is the responsibility of the State.

A. IDENTIFICATION OF SOURCES

As required under the current Permit, the Permittees have produced a listing of industries by SIC category for each drainage area. Also a breakdown of major land use types was also performed for each drainage area.

A pollutant source identification program will be designed to identify significant pollutant sources (i.e. parking lots, industrial activities, etc.), with the hope that remedial action can be undertaken to reduce any significant impacts so identified. It will focus on monitoring very small areas (i.e. less than five acres) where a specific and/or interrelated set of pollutant generating activities are occurring. Its objective is to provide data for selecting BMPs for specific activities rather than characterizing discharges for long-term pollutant loading estimates.

Identification of pollutant sources can be done using a number of methods. Potential sources of storm water pollutants can be identified by records of chemical use and/or storage, by studies of specific activities which lead to the deposition of pollutants throughout the watershed, and by field inspection or monitoring. Watersheds which may contain significant pollutant sources can be identified through land use information or by mass load estimates.

By mid January 1995, the County will begin targeted monitoring of a municipal corporation yard in the Santa Monica Bay watershed. This will provide data on industrial activities which can take place at such a facility such as vehicle maintenance and repair, materials storage, equipment storage and repair. A more comprehensive program to identify various pollutant sources will be developed by December 1995.

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1. CATEGORICAL LIST

Sources identified as a categorical industry regulated by the U.S. Environmental Protection Agency (EPA) will be grouped into a categorical listing of industries. The categorical list provides an organized overview of the target facilities that, based on land use, operation, and activities, could potentially contribute significant amounts of pollutants into stormwater runoff. Some of the industrial categories regulated by the U.S. EPA include, but are not limited to:

- Aluminum Forming
- Asbestos Manufacturing
- Battery Manufacturing
- Canned & Preserved Fruits & Vegetables
- Cement Processing
- Copper Forming
- Electroplating
- Glass Manufacturing
- Grain Mills
- Machinery Manufacturing & Rebuilding
- Soap & Detergent Manufacturing
- Metal Finishing
- Metal Molding & Casting
- Oil & Gas
- Organic Chemicals & Plastics & Synthetic fibers
- Paint Formulating
- Pesticides
- Plastic Molding & Forming
- Rubber Manufacturing
- Sugar Processing
- Textile Mills

2. RANKING

Industrial and commercial facilities identified as pollutant sources shall be ranked in order of priority for development of management measures. Facilities considered to be high priority are those whose operations and activities are determined to contribute potentially the most significant pollutant impacts to storm water discharge.

3. UPDATE PROCEDURE

Each year the Co-Permittees will evaluate the results of the monitoring program, the illicit discharge investigation program, and other available information , to identify likely sources of specific pollutants. The annual report to the California Regional Water Quality Control Board, Los Angeles Region (Regional Board) will recommend a strategy for pollutant source identification during the following year, including specific sites and/or activities to be monitored.

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B. CONTROL MEASURES

Specific urban runoff control programs for major potential pollution sources shall be developed by March 1996. Within these programs storm water pollution control measures shall be developed for various pollutant sources. Control measures such as source control and treatment control offer different, but complimentary approaches to storm water pollution control.

Source control measures focus on good housekeeping practices, pollution prevention and minimization, and education. They are also less costly than treatment controls.

Treatment controls involve physical treatment of the runoff, usually through structural means. Also treatment controls will not remove all pollutants and their removal efficiency is difficult to predict given the limited understanding of the relationship between facility design criteria and performance.

The initial focus will be on the development of source control measures. As information is collected under the pollutant source identification program regarding specific pollutant sources, specific control measures, including structural, will be evaluated as to their effectiveness in addressing these sources. None of the cities mentioned any programs.

1. POLLUTION PREVENTION MEASURES

Source minimization and education are the first steps in effective source control. Other activities that contribute to source control are:

- Site design alternatives (ie. roof over fueling stations and carwash slab, provide spill containment curb around stored material, etc.)
- Good housekeeping practices

2. STRUCTURAL (TREATMENT) MEASURES

A variety of treatment control measures have been utilized throughout the country for storm water quality. However, the effectiveness of these controls are highly dependent on local conditions such as climate, hydrology, soils, groundwater conditions, and extent of urbanization.

Some of the more common treatment controls are:

- Oil/water separators - Oil/water separators are designed to remove one specific group of contaminants: petroleum compounds and grease. However, separators will also remove floatable debris and settleable solids.

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- Infiltration - A family of systems in which the majority of the runoff from small storms is infiltrated into the ground rather than discharged to a surface water body. Infiltration systems include: ponds, vaults, trenches, dry wells, porous pavement, and concrete grids.

- Wet ponds - A wet pond has a permanent water pool to treat incoming storm water.

- Constructed Wetlands - Constructed wetlands have a significant percentage of the facility covered by wetland vegetation.

- Biofilters - Biofilters are of two types: swale and strip. A swale is a vegetated channel that treats concentrated flow. A strip treats sheet flow and is placed parallel to the contributing surface.

- Extended Detention Basins - Extended detention basins are dry between storms. During a storm the basin fills. A bottom outlet releases the storm water slowly to provide time for sediments to settle.

- Media Filtration - Media filtration consists of a settling basin followed by a filter. The most common filter media is sand; some use peat/sand mixture.

- Multiple Systems - Multiple systems are a combination of two or more of the preceding controls in series.

C. OUTREACH

General outreach for all facilities that are potential industrial and commercial dischargers shall be set up area-wide by the Management Committee, to provide general guidance in complying with the storm water program by March 1996. It shall also serve as a reminder of pollution prevention measures and keep facilities informed of their obligations to the storm water program.

Subcommittees may be established to develop specific outreach materials for industrial and commercial categories and specific activities that are identified as high priority.

For additional information on outreach, refer to **Chapter VII Public Information and Participation.**

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D. INSPECTIONS

Most municipalities have existing programs such as industrial waste, fire, and health in which industrial and commercial facilities are inspected on a regular basis. Each Permittee may elect to have inspections for the storm water program incorporated into these existing inspection programs, or be done as a completely separate program, depending on the needs of the Permittee.

The purpose of these inspections is to ensure that facilities are in full compliance with the storm water regulations and to ensure that control measures are being implemented. The frequency of inspection of facilities will be prioritized based on the operation and categorization of the facility.

Inspectors consisting of public personnel will be trained adequately to recognize and handle problematic activities concerning storm water pollution that may be existing or potential; and inspect for the deterioration of the storm drain system, and illegal/improper connections. Training programs will be developed through the Watershed Management Committee and possibly specific Permittees for used by all Permittees.

Procedures for the identification, investigation, enforcement, and prosecution to the full extent of a jurisdiction's legal authority will be developed.

Commercial and industrial facilities generating industrial wastes are issued permits by the Los Angeles County. Facilities issued this permit, which include auto related businesses, gas stations, and restaurants, are regularly inspected. In addition to those permitted businesses in the unincorporated areas, the County Department of Public Works also provides industrial waste inspections, under contract, for 9 cities in the watershed. The City of Los Angeles also issues and enforces Industrial Wastewater Permits for non-storm water discharges. Facilities are inspected between 1-4 times per year. Five cities reported that they have industrial waste, or non-storm water discharge inspection programs on a regular basis, while one reported inspections were done at random. Five cities inspect auto related businesses, and restaurants regularly and nine others are planning to implement an inspection program by the end of 1995. One city, Hidden Hills, has no commercial or industrial facilities within its boundary. Caltrans inspects its auto related facilities daily, tests its gas stations for leak yearly, and pump out its clarifiers quarterly. Besides, its storm drains are constantly monitored. Caltrans has also included a program to inspect underground storage tanks as part of its five-year plan.

1. CHECKLIST

Inspectors shall have a uniform checklist to use as guidance and reference throughout an inspection. It may also serve as a general guide for the public, providing information about the requirements necessary to comply with the storm water regulations.

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2. SCHEDULE

The inspection program shall be developed by March 1996. The frequency of inspections shall be scheduled according to the type of operation and the categorization of the facility. Revisit inspections shall be done on an as needed basis.

3. REPORTS

Inspectors shall report on all activities related to and/or violating the local storm water ordinance to the local governing agency. Standard reporting procedures will be developed.

4. FOLLOW-UP PROCEDURES

Individual Permittee's review and assessment of the reports may result in the need for follow-up procedures, such as reinspection or legal action, provided that the jurisdiction has the adequate legal authority to do so. Follow-up procedures will be developed to insure a uniform and consistent approach.

E. LOCAL INCENTIVE PROGRAMS

In developing the industrial/commercial program, the Permittees may consider the development of optional measures such as clean business incentive programs that may offer more focused control on industrial and commercial sources. This phase will be completed by March 1996.

F. TRAINING

The Los Angeles County Department of Public Works has issued a department directive requesting all employees to report any observed water quality problems. Caltrans has educated its staff on hazardous substance spill awareness, pesticide safety and vegetation management. The City of Los Angeles has a specialized inspection group trained to focus on improving storm water quality and to eliminate illegal discharges and illicit disposal practices. Development of training programs for industrial storm water inspection staff is projected to be completed by March 1996.

1. PUBLIC EMPLOYEES

All public employees shall be trained in the storm water regulations so that they abide by the regulations in the course of their work day. Also they need to be able to recognize and distinguish between legal and illegal activity so as to administer the proper protocol in handling the situation.

The Los Angeles County Department of Public Works has requested all employees to report any observed water quality problems. Caltrans has

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educated its staff on hazardous substance spill awareness, pesticide safety, and vegetation management.

2. INSPECTORS

Inspectors who visit industrial and commercial facilities shall be adequately trained to determine compliance with the storm water regulations and to educate the facilities about the requirements of the program. In addition, they should be able to recognize and handle immediate problems as they are encountered, during an inspection; and inspect for the deterioration of the storm drain system and illegal/improper connections. Citation training will be necessary for inspectors in agencies that have the citation authority.

G. COORDINATION WITH STATE INDUSTRIAL STORM WATER PERMIT

The Permittees have existing local ordinances governing industrial discharges and other stormwater discharges that require compliance activities similar to those in various State Regulations. Because coordination between the Permittees and the Regional Board is anticipated concerning the regulations of industries, a mutual agreement may be required regarding industrial inspections and enforcement. Additional issues could also be addressed. The Federal stormwater regulations hold local municipalities responsible for stormwater discharges from all industrial/commercial facilities including those covered by General Permit. The targeted completion date for this phase is March 1996.

1. MEMORANDUM OF UNDERSTANDING

A Memorandum of Understanding (MOU) may be used to formalize the agreement between municipalities and the Regional Board on industrial compliance program issues. A MOU among all local agencies may also be needed to ensure co-operation among all the agencies. The need and specific requirements for such agreements would be developed upon completion of development of the industrial/commercial program by March 1996.

2. REPORTS

The MOU discussed above may include the exchange of information between the Permittees and the Regional Board. Appropriate formats for such reports would be developed as required.

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IV. NEW DEVELOPMENT AND REDEVELOPMENT

Managing stormwater and runoff from both new construction and redevelopment, will reduce pollutants entering the storm drain system and subsequently the receiving water.

A. PLANNING PROCESS

Quality of stormwater discussion should be included in the General Plan and the Zoning ordinances. Efforts to enhance the quality of storm water can filter into the Subdivision actions. Many of the storm water concerns can be channeled through the compliance effort of the California Environmental Quality Act (CEQA). A watershed wide concept will be developed by June 1996.

1. WATERSHED PROTECTION POLICIES

An integrated strategy will be developed for the watershed. Pollution control efforts should be prioritized. A variety of statutory and regulatory requirements could be used for this watershed oriented program. Watershed protection policies need to be adopted by the local jurisdictions which control land-use within the watershed.

The City of Los Angeles is reviewing its standards and considering modifications for flood control projects to include storm water pollution reduction.

2. COORDINATION WITH CEQA

The current CEQA "Environmental Checklist Form" that is used for initial studies assessment indirectly address potential impacts to stormwater. Additions could be made to the Form to directly assess stormwater quality impacts.

CEQA requires agencies to use feasible alternatives or mitigation measures to lessen potentially significant effects. The ability to identify a.) when an effect is significant, and b.) which mitigation measures could be adopted to reduce the effect, is critical to the CEQA process. A clear assessment of any development, its potential adverse impacts on stormwater quality will allow for a determination of "significance" which will enable the decision maker to make development decisions upon full disclosure of possible adverse impacts.

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3. SITE PLANNING PROCESSES

All development will require the review and approval of a site/plot plan or development drawings prior to issuance of a building permit. Incorporating the consideration of potential water quality impacts including erosion and sedimentation during the early stages of the planning process will allow these issues to be addressed before substantial investments in engineering and design have been made.

4. GENERAL PLAN CHANGES

The General Plan is the legal backbone of the planning process. All development approvals, zoning ordinances, subdivision approvals and public works projects must be consistent with the policies, objectives, and principles set forth in the General Plan. Discussion of stormwater issues in the General Plan could greatly enhance the awareness of the issues and encourage full assessment of possible adverse impacts on stormwater quality as a result of new and redevelopment.

5. USE OF MASTER PLANS

For agencies which utilize master plans to guide their development activities, stormwater issues can be outlined in such documents. This will channel efforts to fully assess the possible adverse impacts on stormwater quality as a result of any development within the master plan area.

The City of Los Angeles is currently reviewing standards and considering modifications for flood control projects to include storm water pollution reduction components.

6. OTHER POLICIES

Numerous other policies or mechanisms could be used to incorporate stormwater management goals into the planning/development process. Others concepts will be evaluated for their feasibility during the more detailed development of this Chapter.

7. PLANNING-PUBLIC WORKS INTERFACE

A variety of mechanisms for coordinating planning and public works activities exist. An example could be some form of CIP (capital improvements program). Ideally, any planning documents which target or project population growth are coordinated with CIP. Integrating stormwater management into

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CIP will allow for mitigation of major adverse impacts on the quality of stormwater prior to any actual construction.

8. IMPLEMENTATION PROCEDURES

Implementing policies to integrate stormwater management considerations with existing planning/development mechanisms will require a variety of approaches depending upon the existing conditions within each Co-Permittee and the particular remedies selected. It is anticipated that each Co-Permittee will propose procedures applicable to its unique jurisdictional considerations at later stages in the permit process.

B. CONSTRUCTION SITES

Pollutants from construction activities can have a major impact on the quality of stormwater/urban runoff. A watershed wide concept to reduce such pollutants will be developed by December 1995.

1. EROSION CONTROL REQUIREMENTS

Federal stormwater regulations hold local municipalities responsible for stormwater discharges from construction sites. In addition, construction sites involving a total of five acres or more of land disturbance are required to apply for the State General Construction Activity Storm Water Permit (GCASP). The GCASP: 1) eliminates and reduces to the extent feasible non-storm water discharges from construction sites and 2) permits stormwater discharges, but requires the use of controls to limit pollutant loading in site effluent. Preparation of a Stormwater Pollution Prevention Plan and identification/utilization of BMPs are the key components of this Permit.

Many local agencies also have erosion control requirements for any grading and construction activities. Regulation of pollutants from construction sites of five acres or less will be done by the local agency through its stormwater management plan.

Construction site erosion has the potential to introduce sediment into runoff. For example, fugitive dust control at construction sites typically use water. Minor modifications/clarification of existing fugitive dust practices could substantially address runoff pollution concerns. In addition to fugitive dust control practices, additional measures could be adopted to curtail dry weather runoff, and control pollutant laden storm water runoff. These measures may address 1) physical site design considerations and 2) temporal considerations such as seasonal timing and phasing of activities.

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Fourteen jurisdictions have adopted or modified erosion control regulations within their municipal codes. Three jurisdictions have identified and/or drafted code regulations related to urban runoff, while eleven jurisdictions have indicated that formulation of these code requirements are planned or proposed. A Demolition Construction Pollution Control ordinance is being considered by the City of Burbank.

Erosion and sediment control practices and a contractor water pollution program have been established by Caltrans to stabilize slopes and protect water quality. The City of Los Angeles is preparing guidelines and construction standards aimed at reducing storm water pollution and an enhanced enforcement program for construction sites consistent with the State of California General Construction Activity Storm Water Permit requirements.

2. CHEMICAL AND WASTE MANAGEMENT REQUIREMENTS

Chemical and waste handling activities are also currently subject to a variety of regulations. BMPs to address this pollution source are largely centered around "good housekeeping practices". This involves storing, handling, using, and disposing of these potential pollutant sources in ways that restrict opportunities for unintended introduction of the materials into site runoff. Proper chemical and waste management will reduce any accidental discharge into the storm drain system.

3. INSPECTIONS

Inspections are a routine part of local jurisdiction's oversight of regulated construction activity. Inspection activities should be enhanced to ensure that construction site runoff control measures are being properly implemented. Existing practices should be examined and modified accordingly to satisfactory stormwater/urban runoff objectives.

a. Checklist

A checklist would encourage possible streamlining of any requirements. It could be cumbersome if an overly rigid approach were taken which resulted in unnecessary administrative burden. However, careful design of the checklist could avoid this pitfall.

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b. **Schedule**

Inspection schedules will depend upon existing practices. It may be desirable to have several schedules, depending upon the types of activities/permits and/or the timing of activities.

c. **Reports**

A standardized reporting format is needed to allow for consistency among all jurisdictions. Furthermore reports are also a useful tool for future refinement of pollution control regulations.

d. **Follow-up Procedures**

A format will be developed to do follow-up inspections on problem facilities and activities. Frequency of use will greatly depend on the land use and the degree of non-compliance of each facility.

C. LOCAL PERMITS

Permits are a form of "cross checking" by local agencies to ensure that regulations are being implemented. Prior to the issuance of a permit, information must be submitted for review and approved. A watershed wide concept to provide some consistency in local permits will be developed by June 1996.

1. COORDINATION WITH EXISTING PERMITS

Storm water issues should be incorporated into existing permits.

2. NEW PERMIT ISSUES

Storm water issues should be clearly stated in new permits to be issued for new and/or redevelopment activities.

D. TRAINING

Training will enable staff to keep current of the latest storm water regulations. No information is reported. A watershed wide staff training concept will be developed by June 1996. For example, Los Angeles City's planned Construction Education and Training program is intended to increase the awareness of those involved in the construction process with regard to storm water pollution abatement activities.

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1. PLANNING PERSONNEL

(See E.1.b. below)

2. PUBLIC WORKS PERSONNEL

(See E.1.b. below)

3. INSPECTORS

(See E.1.b. below)

E. CONTROL MEASURES

Best management practices for the control of construction related pollution can generally be divided into three categories:

Nonstructural Source Controls for Reducing Urban Stormwater Pollutants:

- Practices that reduce the generation and accumulation of potential stormwater contaminants at or near their source.

Site Planning Stormwater Controls:

- Practices that are directed at controlling the volume and discharge rate of runoff from urban areas, as well as, reduction of the magnitude of pollutants in discharges through temporary storage or flow restrictions.

Erosion and Sediment Controls:

- Practices that can prevent or treat problems related to transport of eroded material from construction and other land disturbing activities.

Site planning stormwater controls are of particular interest. For example, the City of Los Angeles is reviewing construction standards and is considering modifications aimed at reducing storm water pollution from construction sites. These control measures can be incorporated in the initial planning phase of any project. A watershed wide concept will be developed by June 1996.

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1. POLLUTION PREVENTION MEASURES

a. Site Design

Effective implementation of urban BMPs requires integration of water quality control elements early in the site planning and design process. Development of the water quality controls should not only achieve maximum pollutant removal with minimal costs, but also reduce potential maintenance.

This may include incorporating water quality concerns into the site layout and design (i.e. maximize pervious areas, minimize directly connected impervious areas, etc.) and/or treatment control measures proven to be cost effective for local climate, soil, and development conditions.

Due to the diversity of climate and local conditions, the development of BMPs will vary from jurisdiction to jurisdiction, and even location to location. The selected management practices should be designed for the local site conditions and especially seasonal rainfall conditions that are experienced in Southern California. Suitability for the major land use and drainage characteristics should also be fully assessed.

b. Education/Training

Education/training is imperative to the success of any BMPs selected for new or redevelopment projects. BMPs will fail if not properly designed, installed, and maintained. Only well trained personnel should be assigned these responsibilities.

A program for effective education/training should be based on four objectives:

- Promote a clear identification and understanding of the problem, including activities with the potential to pollute stormwater;
- Identify solutions (structural and nonstructural BMPs);
- Make every employee responsible for stormwater pollution and its solution; and
- Integrate employee feedback into training and BMP implementation to improve BMPs.

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c. **Other**

In many cases stormwater pollution control may already be achieved by existing regulations or programs. In California, the General Plan Law and the California Environmental Quality Act (CEQA) provide a basis for municipalities to review and comment on all projects within their jurisdiction. Under the General Plan Law, municipalities are required to develop policies and regulations which guide development within the municipality. Each development project is then reviewed for conformance with these policies. Under CEQA, projects are also subject to review and comment for any adverse impact the projects may have on the environment, including impacts from stormwater discharges.

2. POST CONSTRUCTION (TREATMENT) MEASURES

a. **Applicability**

Each site considered for development or redevelopment will (at the conclusion of construction) have final improvements and unique site characteristics such as: drainage patterns; soils; landscaping; topography; percent of impervious surfaces; rainfall; pollutants inherent with the use of the development; and pollutants that may be background to the area (existing vegetation, air fallout, etc.). The applicability of various treatment control BMPs for use in new development will be evaluated through the use of pilot studies and examination of studies done on treatment control measures by other agencies.

b. **Effectiveness**

Prior to implementing any treatment control measures, they will need to be evaluated for their effectiveness. This can be done through pilot studies which could include elements such as: pre and post storm event inspections; water quality monitoring; record keeping to document deficiencies in the BMPs; Operation and Maintenance requirements; and cost effectiveness.

c. **Retrofit Opportunities**

The feasibility of retrofitting existing developments with treatment control measures will be evaluated. However, the effectiveness of a treatment control measure versus its cost must be fully evaluated prior to considering its use as a retrofit measure.

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3. OPERATION AND MAINTENANCE

a. Requirements

Jurisdictions within the watershed will need to insure that BMPs incorporated into a private development are properly maintained. Deed restrictions, covenants, conditions and restrictions (CC&R) could be used to direct such requirements and responsibilities.

b. Responsible Party

The contractor, during construction must ensure that the post-construction BMPs are installed properly and that any maintenance that may be necessary during construction is performed. After the project is completed, it will then be the responsibility of the fee owner, private or public, to provide for long term operation and maintenance. This may be accomplished by deed restriction and/or CC&R.

4. CONFLICTS WITH OTHER MANDATES

Often regulations of various Federal, State, and local agencies would conflict with each other. Health, fire, and building codes often have requirements focusing on short term human health and safety and neglecting the impacts on the environment.

a. Identification of Conflicts

As the Plan is developed, other regulatory requirements that conflict with the stormwater program requirements may be uncovered. Clarification of these regulations should be directed to the various responsible regulatory agencies.

b. Conflict Resolution

For regulatory conflict caused by local regulations, efforts will be taken to resolve them within the agencies. Input form other local, state, and federal agencies should be incorporated into a modification of current standards. The Regional Board should resolve conflicts involving other State and/or Federal requirements.

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F. OUTREACH

See Chapter VII Public Information and Participation.

G. ENFORCEMENT

See Chapter II Illicit Discharges, Section C Enforcement Procedures.

H. COORDINATION WITH STATE GENERAL CONSTRUCTION ACTIVITIES STORM WATER PERMIT

Compliance with the GCASP requirements is the responsibility of the developer/contractor, and enforcement is the responsibility of the SWRCB or Regional Board staff.

1. MEMORANDUM OF UNDERSTANDING

An agreement between the Regional Board and Co-Permittees may be used to enhance compliance of construction site BMPs. The need for such an agreement will be evaluated. If found to be desirable, an agreement will be developed by June 1996.

2. REPORTS

The local enforcement agency of the State Construction Stormwater Permit, which is the Regional Board, should forward all information, including Notices of Intent filed and any inspections and enforcement actions taken, to the Permittees so that this information can be available to local municipal construction site inspectors to alert them to any specific concerns on the job site.

3. OTHER ISSUES

The Regional Board should explore funding to be channelled to the Co-Permittees so the Co-Permittee can be more actively involved with the State on the Permit.

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V. PUBLIC AGENCY ACTIVITIES

All municipalities perform functions that have an impact on stormwater quality. These include, among other things, vehicle maintenance, landscape maintenance, weed control, water body maintenance including swimming pool maintenance, etc. Other activities such as construction and maintenance of streets and roads, and construction and maintenance of the flood control system also could directly or indirectly cause adverse impact on the quality of stormwater/urban runoff. Since municipalities must address all significant sources of pollutants, all of these activities must be examined and mitigation measures be incorporated into the routines. As part of the requirements of the current Permit, many of the Permittees have already begun implementation of measures to address the above activities. An examination of these existing measures will be done on a watershed wide basis to establish the most effective approach to address these activities. Such approaches shall be developed and begin implementation by September 1996.

A. SEWAGE SYSTEMS

Sewage spills must not be allowed to enter the storm drain. Control procedures for identifying, repairing, and remediating sewer blockages, infiltration, inflow, and wet weather overflows from the sewers to the storm drain system should be implemented to protect stormwater quality. These procedures could include, but are not limited to, quick field response to overflows, follow-up testing, and complaint investigation.

When sewage spills do occur, they must be contained and collected for proper disposal. Individual permittees may need to modify their sewage overflow response procedures. The field personnel should also have procedural training for field screening, sampling, smoke/dye testing, and TV inspection, if appropriate, to be able to properly investigate any suspect connections or cross connections to the storm drain system.

Los Angeles County has a number of programs aimed at preventing sewage spills from entering the storm drain system. These include the following:

- Sewage Overflow Response Procedures Revision/Root Control Review. This involves improvement of procedures for containment and cleanup of spilled sewage resulting from overflow.
- Reline Sewer Lines. Two locations will undergo relining of existing sewer lines to prevent infiltration and exfiltration.
- Sewer Pipeline Reconstruction. 127 miles of cement pipelines will be analyzed and replaced or rehabilitated within 5 years.

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- Sealing of Manhole Covers. This program has sealed manhole covers and bar holes in areas subject to flooding.

- Expansion of Emergency Call List. Beeper numbers of all supervisors, superintendents and stand-by crews were added to emergency call list.

Los Angeles City's Limitation of Sewage Infiltration into Storm Drain System traces sewage infiltration into the storm drain system using a variety of techniques.

B. CORPORATION YARDS

Corporation yards include any area or facility that is used for vehicle maintenance or washing, other maintenance, chemical storage, paint facilities, and supportive activities for field crews. Permittees will need to incorporate pollutant control measures at these facilities and develop a plan for each facility outlining the measures to be implemented. Since these are industrial type activities, the corporate yards would need to implement measures as described in the Industrial/commercial Source Chapter.

1. STORM WATER POLLUTION PREVENTION PLANS (SWPPP)

Though not required, permittees may elect to use some form of SWPPP as a vehicle for compliance. Any BMPs to be implemented must be part of a comprehensive plan designed to address the various pollutant sources at each corporate yard. To achieve this goal, the municipalities should first identify the potential pollution sources and who is responsible for implementing the storm water management measures. Based on the facility type, management practices and schedule of implementation will be developed. BMPs that can be used to improve the quality of runoff include, but are not limited to, housekeeping practices, material storage control, vehicle leak and spill control, and illegal dumping control.

Los Angeles County has incorporated the following measures intended to control pollutants from entering the storm drain at County-owned airports.

- Airport Runoff Structural Controls. A number of structural controls including fuel pumps located under a roof, storm water diversion system with clarifiers, concrete beams for secondary containment of waste oil, oil and water separator at floor drains, retention ponds, infiltration basins and sand filters have been implemented at County airports.

- Airport Cleaning and Maintenance. A number of non-structural controls including washing of aircraft in designated areas with oil and

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water separator, aircraft maintenance performed indoors and waste oil recycling have been implemented at County airports.

- Airport Materials Handling and Storage Controls. Measures to prevent spills of polluting materials have been in effect at County airports.

- State Approved NPDES Industrial Activity Permit. This program requires all airports to ensure compliance with State Water Resources Control Board.

2. OUTDOOR LOADING/UNLOADING OF MATERIALS

Municipal employees who handle potentially harmful materials should be trained in good housekeeping practices to prevent or reduce the discharge of pollutants to storm water from outdoor loading/unloading of materials. Materials spilled, leaked or lost during loading/unloading may collect in the soil or on other surfaces and be carried away by runoff or when the area is cleaned.

Applicable BMPs should be selected based on the following four factors: 1) Extent of exposure of material to rainfall, 2) preventing stormwater run-on, 3) checking equipment regularly for leaks, and 4) containing spills during transfer operations.

3. MATERIAL STORAGE CONTROL

A program should be developed to prevent or reduce the discharge of pollutants to storm water from outdoor container storage areas using measures such as installing safeguards against accidental releases, secondary containment, conducting regular inspections, and training employees in standard operating procedures and spill cleanup techniques. Employee education is paramount for successful implementation. Employees should be trained in emergency spill cleanup procedures.

To limit the possibility of storm water pollution, containers used to store dangerous waste or other liquids should be kept inside the building unless this is impractical due to site constraints. Storage of reactive, ignitible, or flammable liquids must comply with the fire and California OSHA codes. Practices such as placing containers in a designated area should be employed to enhance such requirements.

Three pre-fabricated storage buildings have been installed at the Los Angeles Aqueduct Filtration Plan to isolate hazardous materials.

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4. VEHICLE AND EQUIPMENT WASHING AND MAINTENANCE

Washing vehicles and equipment outdoors or in areas where wash water flows onto the ground can pollute storm water. For municipalities that wash vehicles or pieces of equipment on-site, it should be performed in a designated area equipped with an oil/water separator.

Vehicle or equipment maintenance is a potentially significant source of storm water pollution. Parts are cleaned with solvents. Many of these cleaners are harmful and must be disposed of as a hazardous waste. Appropriate BMPs are waste reduction, use of alternate products, recycling, and spill leak clean up control.

Every 90 days, Caltrans will pump out its clarifiers. In the City of Arcadia fire hydrant use is restricted and downstream catch basins are cleaned of any debris prior to testing of fire hydrants. The City of Los Angeles has a program to ensure that its facilities have adequate spill prevention, containment and emergency response procedures.

5. WASTE HANDLING AND DISPOSAL

Proper waste management is possible by tracking waste generation, storage, and disposal; reducing waste generation and disposal through source reduction; and preventing run-on and runoff from waste management areas.

The City of Los Angeles is conducting a study of four street maintenance yards, including an asphalt processing plant for potential sources of stormwater pollution.

Caltrans Leaking Underground Storage Tanks Five Year Plan will include site investigation, leak detection of tanks, removal, remediation and installation of fuel canopies over fuel islands.

C. PARKS AND RECREATION

Park Departments manage landscaping and swimming pools. Both of these activities involve the use of chemicals, waste management, and non-storm water discharges. In addition maintenance of swimming pools requires the periodic discharge of large quantities of swimming pool water.

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1. FERTILIZERS/PESTICIDES

a. Use/Application management

Municipal facilities should develop controls on the application of pesticides, herbicides, and fertilizers. Control may include:

- List of approved pesticides and selected use;
- Product and application information for users;
- Equipment use and maintenance procedures; and
- Record keeping.

Employees can be educated about environmentally sensitive alternative products by using information developed by various public agencies and other environmental organizations.

b. Storage

Improper storage of fertilizers and pesticides can lead to potential groundwater, soil, and stormwater contamination. To prevent or reduce their impact on stormwater pollution, material storage areas must be designed and maintained to reduce exposure to storm water. The following BMPs can help to achieve this goal:

- Store materials inside or under cover on paved surfaces,
- Use secondary containment,
- Minimize storage and handling of hazardous materials,
- Inspect storage areas regularly.

2. FACILITY MANAGEMENT

a. Wash Waters

Wash waters cannot be discharged into the storm drains untreated. The storage area should be slightly sloped for wash water collection. If the water is not discharged to the sanitary or process waste sewer, or to a dead-end sump, the outlet should be equipped with an oil/water separator or other treatment systems.

b. Maintenance

Landscape maintenance involves the use of pesticides and fertilizers. Proper use of these materials will reduce the risk of loss to storm water. Whenever possible, leave or plant native vegetation to reduce

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water, fertilizer, and pesticide needs. Integrated pest management should be employed where appropriate. The Park Departments should also establish a schedule for irrigation and fertilization. The chemicals will be carried from the site by the next storm if they are applied during the wet season. Overwatering leads to discharge of water that may have become contaminated with nutrients and pesticides.

Storm water from parking lots may contain undesirable concentrations of oil, grease, suspended particulates, and metals as well as the petroleum byproducts of engine combustion. Possible maintenance BMPs include periodic sweeping and cleaning catch basins.

c. Swimming Pool Waters

The drainage of swimming pool water must insure that chlorine residual is below allowable water quality limits. The potential for recycle/reuse for irrigation of lawns and landscapes may be investigated. Swimming pool filter backwash waters should not be discharged to the storm drain, but should be allowed to settle and then disposed to the sanitary sewer. Other possible alternative measures would be to use the backwash for irrigation or disposal on a dirt area.

D. STORM DRAIN SYSTEM OPERATION AND MANAGEMENT

The maintenance and operation of the storm drain system has an impact on storm water quality and must be addressed. Material clogging storm drains cannot be discharged into drains. It must be disposed of properly.

1. INLET MAINTENANCE

Regular maintenance of public and private catch basins and inlets is necessary to ensure their proper function. Maintenance will remove pollutants, reduce high pollutant concentrations during the first flush of storms, prevent clogging of the downstream conveyance system, and restore the catch basin's functional capacity. Keys to effective catch basin cleaning include the following:

- All basins should be cleaned annually prior to the onset of the rainy season;
- Clean catch basins in known problem areas more frequently to remove sediments and debris accumulated during the dry weather months;
- Keep records of the number of catch basins cleaned; and
- Track the amount of waste collected.

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All jurisdictions within the Los Angeles River watershed clean their catch basins at least annually. Two exceptions are Caltrans whose catch basins are generally cleaned every two years and the City of Bell Gardens which will initiate a catch Basin cleaning program shortly. Caltrans will develop a priority list of drains and pump houses requiring cleaning.

2. **DRAIN MAINTENANCE**

Open channel storm drains should be cleaned at least annually prior to the rainy season. Problem areas should be cleaned more frequently as needed. Channels should also be monitored during the rainy season for any debris buildup and cleaned where needed.

Underpass pumps in the City of El Monte are cleaned quarterly and/or before the rainy season. Maintenance of drainage culverts is also performed once a year.

3. **WASTE MANAGEMENT**

Excessive waste buildup will decrease the capacity of the channel, it is therefore crucial to reduce pollutant levels in storm water by regularly removing illegally-dumped items and material from storm drainage channels and creeks. A program should be developed to identify problem areas of illegal dumping so regular inspection and clean up can maintain the channel's optimum capacity and prevent the discharge of contaminants.

The City of Arcadia requires contractors and utility companies to use construction methods in roadways to minimize the amount of pollutants entering storm drains.

4. **NEW SYSTEM DESIGNS**

Current design standards for the construction of new storm drain systems will be evaluated in light of currently available pollutant control measures. Design standards may be modified to incorporate measures deemed appropriate for local conditions.

The City of Los Angeles has formed an Inter-Jurisdictional Storm Water Re-Use Task Force to implement diversion, capturing and possibly re-using high quality storm water run-off. The City is also reviewing standards and considering modifications for flood control projects by incorporating storm water pollution reduction components.

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5. RETRO-FIT OPPORTUNITIES

The majority of the existing storm drain systems are in highly urbanized areas providing little opportunity for cost effective retro-fitting. However, currently available pollutant control measures will be reviewed for their effectiveness and possible use. This may include pilot studies to evaluate the performance of management practices under local conditions.

E. STREETS AND ROADS

Construction, operation, and maintenance of roads has an impact on storm water quality and will be addressed in the management plan.

1. SWEEPING

Street sweeping can collect refuse on street surfaces to prevent it from entering the storm drain system through catch basins.

a. Storm Water Quality Based Operation

In order to effectively implement the sweeping program, the permittees should keep accurate operation logs to track the program. Areas generating excessive refuse should be swept more frequently. Sweeping frequency may also be increased before the rainy season to reduce the amount of refuse entering the storm drain system. Parking on sweeping days should be regulated to facilitate the operation.

Twenty-four jurisdictions perform weekly street sweeping, while five jurisdictions perform this service twice weekly and four twice monthly. Caltrans sweeps its roadways on a regular schedule determined by observable debris. The City of Los Angeles's posted streets are swept weekly and others monthly.

b. Waste Management

Vehicles transporting waste should have spill prevention equipment that can prevent spills during transport. The refuse collected will be transported to the appropriate disposal facilities.

Eighteen of the jurisdictions in this watershed empty their roadside trash receptacles weekly. Three agencies collect rubbish twice a week, another three agencies empty on an as needed basis and three others do not provide any trash receptacles. Four jurisdictions provide collections three times a week while the cities of El Monte and

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Huntington Park provide this service on a daily basis. In Bell Gardens this program is being planned and in the City of Pasadena the emptying of trash receptacles occurs 3 to 5 times a week.

2. STREET/PAVEMENT WASHING

Wash waters from street/pavement washing may be contaminated and must be managed as non-storm water discharges.

3. MAINTENANCE

a. Saw-cut Slurry Management and Paving Practices

Existing saw-cut management and paving practices conducted by the permittees will be evaluated and appropriate control measures developed. Possible control measures to be considered that would help reduce the impacts to storm water:

- Avoid paving during wet weather;
- Regularly repair potholes and worn pavement to reduce sediment loading;
- Store materials away from drainage courses to prevent pollution of storm water run-on; and
- Follow the storm water permitting requirements for industrial activities when mixing concrete with an on-site plant.

The City of Arcadia requires contractors and utility companies to use construction methods in roadways to minimize the amount of pollutants entering storm drains.

b. Waste Management

Good housekeeping practices will be implemented to insure proper management of any waste products that may be generated during maintenance activities. For example, to prevent concrete waste from entering the storm drain system, washout of concrete trucks should be conducted off-site or on-site in designated area. Excess concrete should not be dumped on site. Employees and subcontractors should be trained in proper concrete waste management.

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The following steps will help reduce storm water pollution from concrete wastes:

- Store dry and wet materials under cover, away from drainage areas;
- Avoid mixing excess amounts of fresh concrete or cement on-site;
- Do not wash out concrete trucks into storm drains, open ditches, streets, or streams;
- Do not allow excess concrete to be dumped on-site, except in designated areas;
- Avoid paving during wet weather;
- Regularly repair potholes and worn pavement to reduce sediment loading; and
- Cover catch basins and manholes when applying seal coat, tack coat, slurry seal, fog seal, etc.

Employee/subcontractor training to insure implementation of good housekeeping measures should be based on four objectives:

- Promote a clear identification and understanding of the problem, including activities with the potential to pollute storm water;
- Identify solutions (BMPs selection);
- Promote employee/subcontractor ownership of the problems and the solutions; and
- Integrate employee/subcontractor feedback into training and BMP implementation.

The City of Los Angeles has installed special equipment at Rancho Park Golf Course to remove oils and oil-based cleaning agents, as well as organic material from surface water that drains into the storm drain system.

c. Medians/Landscaped Right-of-Way

i. Irrigation

Overwatering of landscaping produces runoff. A properly timed irrigation schedule should be set up to minimize overwatering. Drip irrigation system should be used when feasible in new installations.

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ii. **Fertilizers/Pesticides**

The handling, storage, and usage of fertilizers/pesticides are addressed in Chapter V, Section C-1.

Caltrans has an existing Right-of-Way Maintenance program and Maintenance Vegetation Control Program which provide benefits for motorists' safety and erosion control.

F. FLOOD CONTROL

Common municipal practices, such as construction and operation and maintenance of the flood control system, may have a potentially adverse impact on storm water quality. Consequently, these practices shall be coordinated to the extent of preventing pollutants from impacting the water quality.

1. COORDINATION WITH NEW PROJECTS

Current design standards for the construction of new storm drain systems will be evaluated in light of currently available pollutant control measures. Design standards may be modified to incorporate measures deemed appropriate for local conditions. During construction, all appropriate BMPs will be utilized to control pollutants during the construction of the facility.

2. COORDINATION OF MAINTENANCE ACTIVITIES

Current maintenance activities with regards to desilting/sediment removal, vegetation management, and waste management shall be reviewed to insure that appropriate management measures are developed to comply with the storm water regulations.

Los Angeles County performs open channel inspections/sump inspections and cleaning to reduce the amount of debris entering the ocean.

3. OPERATION OF FACILITIES

Flood control facility operations will be reviewed to identify where appropriate management measures could be incorporated. However, primary consideration will need to be given to the flood control function of the facility to protect health and safety.

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4. RETROFIT OPPORTUNITIES

The majority of the existing storm drain systems are in highly urbanized areas providing little opportunity for cost effective retro-fitting. However, currently available pollutant control measures will be reviewed for their effectiveness and possible use. This may include pilot studies to evaluate the performance of management practices under local conditions.

The City of Los Angeles is reviewing standards and considering modifications for flood control projects to incorporate storm water pollution reduction components.

G. PUBLIC FACILITIES

Stormwater runoff and non-storm water discharges from other public facilities must also be addressed, including chemical use by these facilities, pressure blasting/cleaning sidewalks and other surfaces.

1. PARKING FACILITIES

Stormwater from parking lots may contain undesirable concentrations of oil, grease, suspended particulates, and metals. Some control measures such as periodic sweeping and cleaning catch basins should be implemented. The need for more advanced structural controls would be evaluated through the pollutant source identification program. Pilot studies would be conducted on candidate structural controls to evaluate their effectiveness prior to large scale implementation.

2. GOLF COURSES

Golf courses require the use of large amount of water, fertilizers, and pesticides. Field personnel should be trained on the proper handling, storage, and usage of these chemicals (Refer to Chapter V, Section C-1 for detail). To prevent excess irrigation water from entering the storm drain system, proper management of watering schedules should be required.

3. SCHOOLS

The maintenance of playgrounds and athletic fields at schools require fertilizers and pesticides. Their safe storage and use affect not only the stormwater quality but also the health of the students and the staff. Therefore BMPs under Chapter V, Section C-1-b should be implemented. Each municipality should develop a program to encourage these schools to use environmentally sensitive products for fertilizers, pesticides, detergents,

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and other chemicals. The schools should have proper material handling, storage, and disposal procedures for chemicals used in school laboratories.

4. **HOSPITALS**

Each hospital should have BMPs to control the handling and storage of medically related hazardous materials. All materials should be inventoried regularly, with record keeping protocols on supply and consumption. All personnel should be trained on the proper procedures on handling these materials, as well as emergency response. Each hospital should maintain a list of supervisors to be contacted if accident does occur. Disposal of these materials should be contracted out to commercial specialists.

5. **PARKS/LANDSCAPES**

Refer to **Section C Parks and Recreation**, of this Chapter, for information.

6. **OTHER BUILDINGS/PLAZAS**

Refer to **Section C-2 Parks and Recreation - Facility Management**, of this Chapter, for information.

H. PONDS, FOUNTAINS, AND OTHER PUBLIC WATER BODIES

Maintenance practices used on public water bodies, including waste management and non-stormwater discharges, must be addressed in the plan.

1. ALGAE CONTROL

a. Use of Chemicals

The use of herbicides or other chemicals to control algae growth should be carefully controlled and monitored to insure strict adherence to manufacturers' guidelines for use. Water sampling may be necessary to insure effective control.

2. CHLORINE MANAGEMENT

The use of chlorine for disinfection should be controlled. High dosage of chlorine may be harmful to the aquatic habitats. Dechlorination of pools and other water bodies would be required prior to draining.

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3. MAINTENANCE

Each municipality should develop BMPs to prevent and control trash, debris, and other pollutants from entering water bodies. These measures could include routine trash collection along and on water bodies, public outreach to educate the public about the impacts of illegal dumping, and increase enforcement for violations.

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VI. RESIDENTIAL

INTRODUCTION

Residential activities including private vehicle washing and maintenance; use of chemicals such as pesticides, herbicides, and paints; private swimming pool maintenance; and other household and landscape maintenance can contribute to storm water pollution. These are all examples of non-point source pollution, a significant impact on water quality. Measures that can be taken to improve the quality of the runoff from residential area all require active public participation. Feasible BMPs to mitigate the stormwater pollution problem should include practicing good housekeeping and the use of environmentally sensitive alternative products, vehicle leak and spill control, and water conservation. Development of the residential stormwater program will be completed by December, 1995.

In addition to the specific programs and plans outlined in this report, several watershed Co-Permittees have targeted activities occurring in and around the home that tend to contribute to degradation of storm water runoff quality. A practice that carries on-the-ground pollutants directly to storm drains is misuse of exterior water, namely the overwatering of landscaping, the hosing of driveways/sidewalks and the washing of cars in driveways--all of which allow water to run down the street into the nearest storm drain.

This situation can be addressed in two ways: 1) either reduce/prevent pollutants from being placed in areas where they may be carried by water into the streets or 2) minimize the amount of water allowed to flow on impervious surfaces that are connected to the street system.

Water conservation measures can be designed to address the issue of impervious surface water flow. While conservation has historically been used to conserve domestic water, many jurisdictions are now recognizing the additional benefit of prohibiting water flows from private properties onto the street system. Most co-permittees within this watershed implement water conservation programs. Some water districts, such as Signal Hill and Paramount, have a rate structure that penalizes excessive water usage. Public outreach is a component of all programs, many of which carry fines for water wasting practices. Several jurisdictions encourage water efficient landscape. Pasadena provides a water usage counseling program.

While some ordinances were established specifically to conserve water during periods of drought, several jurisdictions are keeping such controls in place at all times as measures to control pollution runoff.

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A. HOUSEKEEPING PRACTICES

This BMP involves the development of a program to promote efficient and safe housekeeping practices (storage, use, and cleanup) when handling materials which may pollute stormwater/urban runoff. This could include, but are not limited to, fertilizers, pesticides, cleaning solutions, paint products, automotive products, and swimming pool chemicals.

A public education program will be developed to provide information on stormwater pollution and the beneficial effects of proper disposal on water quality; reading product labels; safe storage, handling, and disposal of hazardous products; list of local agencies; and emergency phone numbers. The above information can be disseminated through brochures or booklets made available at places such as public information fairs, municipal offices, and household hazardous waste collection events and facilities. City newsletter to residents is another means to inform the public, especially for those who do not participate or visit any offices or events.

B. ENVIRONMENTALLY SENSITIVE ALTERNATIVE PRODUCTS

This BMP, promoting the use of less environmentally sensitive products, can be implemented in conjunction with housekeeping practices. Alternatives exist for most product classes including fertilizers, pesticides, cleaning solutions, and automotive and paint products. The key to success will be to promote a willingness to try alternatives and to modify old habits.

General information will be developed and made available to the public on such alternatives. The emphasis may be placed on the need to preserve the natural environment of the receiving waters (ocean, bay, stream, wetland, etc.) with the use of alternative products because of their less toxic nature and proper disposal after its use.

C. VEHICLE LEAK AND SPILL CONTROL

This BMP prevents or reduces the discharge of pollutants to storm water/urban runoff from vehicle leaks and spills by reducing the chance for spills, stopping the source of spills, containing and cleaning up spills, and properly disposing of spill materials.

Vehicles will leak and spill fluids. The key to successful pollution management is to reduce the frequency and severity of leaks and spills; and when they do occur, to prevent or reduce the environmental impacts. Through education, the public should be encouraged to regularly inspect and maintain their vehicles. Guidelines should be developed to inform the public on spill containment and cleanup procedures such as having absorbent material on hand and disposing the material properly.

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D. WATER CONSERVATION

Water is a scarce resource, especially so in Southern California. Wasteful use of water could channel pollutants into the receiving waters. Practices such as hosing the driveway and overwatering the landscape contribute not only to stormwater pollution, but also to the depletion of our natural resource. In order to prevent stormwater pollution, the public has to be educated on the mechanics of our storm drain system - discharges into the system will flow untreated into the receiving water. They have to know that the lawn clippings they wash down the road will end up in the ocean. Public awareness of the function of the storm drain system, of the importance of environmental health, and of our necessity to slow down the depletion of water resources will go a long way in reducing the pollution of stormwater/urban runoff.

Ordinances could be use to endow the related officials with legal authority to enforce water conservation. An ordinance prohibiting the wasting of water is one way of enforcement.

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VII. PUBLIC INFORMATION AND PARTICIPATION

It is necessary to involve the public in the stormwater program for it to be effective. The outreach program should be focused on the specific needs of the individual cities. Due to the inter-relationship among the stormwater issues, the public information and participation program should be recognized as a whole, rather than a number of separate outreach programs. All public awareness efforts should clarify to the public that they are the ultimate beneficiaries of a successful stormwater management program.

Most Co-Permittees within the watershed acknowledge the value of public outreach. Efforts have been made or are planned by many co-permittees to supply the public with information on a full range of storm water quality activities with the intention of achieving a high level of public cooperation and participation. Many jurisdictions are in the early phases of NPDES program implementation and are just now beginning to budget for and develop outreach programs.

A. GENERAL OUTREACH

The targeted audiences of a general outreach will include municipal employees, local construction contractors, businesses in the area, and the general public. They should be made aware of their responsibility for both the problems and the solutions to stormwater pollution. In order to effectively communicate the stormwater pollution abatement message throughout the watershed; written, audio, and visual materials should be utilized. The actual level, priority, and schedule of public information activities must be based on the community's needs and resources to maximize program effectiveness. A watershed-wide concept will be developed by December 1995.

Most of the Phase III Co-Permittees are in the program development stages. Five co-permittees do not have and have not indicated plans for any type of public outreach involving printed or broadcast media (most are Phase III Co-Permittees and will likely be expanding their programs); Caltrans reaches the general motoring public, however, by posting State highways and freeways with "No Littering" signs. Temple City suggested that the Federal Government provide local public outreach.

General outreach to targeted groups is an objective of some Co-Permittees – especially Los Angeles City who has a student/teacher school education program (K-6 "Magical City Forest") and a mailing program directed at private industries likely to be required to obtain a General Industrial Storm Water Permit.

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1. WRITTEN MATERIAL

Co-Permittees should produce a variety of written materials to inform the residents within the watershed. Materials can include, but are not limited to, the following: flyers, brochures, door-hangers, newspaper articles, mail-inserts, banners, and posters. When necessary, these materials should be translated into a variety of foreign languages to reach minority residents in the community.

Print media outreach programs have been used extensively by Los Angeles City and County and several other Co-Permittees. City newsletters mailed to all residents have often included articles on various storm water programs. Utility bill inserts are also used extensively to promote public awareness.

2. AUDIO MATERIAL

Similarly, Co-Permittees may utilize audio materials to convey information regarding stormwater management. Examples of audio materials include radio advertisements/public service announcements and informational cassettes. Los Angeles County uses radio broadcast to conduct outreach.

3. VISUAL MATERIAL

Catch basin stenciling program is an excellent means of educating the public on the mechanics of the storm drain system. The intent of the program is to enhance public awareness of the impact of stormwater pollution on receiving waters and to discourage improper waste disposal practices. Another effective medium for communicating the importance of stormwater management is through television. Possible measures include producing a public service announcement, cable access programs, and/or an informational video.

The most universal of general outreach programs - catch basin stenciling - is receiving general cooperation throughout most of the watershed. Extensive stenciling has already been done by several jurisdictions; most of the remaining jurisdictions have plans to complete the stenciling program. Volunteers have been or will be used by many jurisdictions. Of the thirty-five Co-Permittees in this watershed, eight are not fully participating in the program at this time. Pasadena is stenciling selected manhole covers, rather than catch basins, in a pilot project because the City does not want to mark their sidewalks. Program suggestions from the permittees include the use of bilingual text and curb face stencils.

Billboard and bus stop shelter advertising is used by both Los Angeles City and County. Los Angeles City and County have refrigerator magnets and

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door hangers to promote their programs. The City also has a poster and street banners to promote storm water runoff quality. The County will soon have a program mascot, Chilly Willy, to be used at public events.

The City of Los Angeles has prepared a public service announcement which has been shown on cable access channels. Los Angeles County also uses television outreach. Other jurisdictions using broadcast media--generally public service cable TV--include Hidden Hills, La Canada-Flintridge, Monrovia, Pasadena, San Fernando, San Gabriel, Signal Hill, South El Monte and South Gate.

4. DISTRIBUTION PLAN

General outreach efforts must be conducted throughout the entire watershed. Materials should be available at all public counters and distributed at public events such as environmental fairs and contests. A city newsletter is another effective method of conveying the pollution abatement message.

B. FOCUSED OUTREACH

Efforts should be made to target special groups. Focus could be on specific pollutants, practices and/or activities, or businesses. A watershed-wide concept will be developed by June 1996.

1. POLLUTANT SPECIFIC

For a particular watershed, there may be priority pollutants which are of more concern than others. The reduction of these pollutants may be addressed in a more focused public education and outreach program. Any of the methods used in the general outreach program may be utilized in a pollutant specific outreach program.

2. PRACTICE/ACTIVITY SPECIFIC

Everyone who lives or works in a particular watershed must realize that their actions have a direct affect on the quality of stormwater. These special groups must be made aware that their current practices/activities may be contributing to stormwater pollution. Practice/activity specific outreach programs should be developed and implemented throughout the watershed. The use of written, audio, or visual materials should convey three primary messages: (1) what activities can cause stormwater pollution, (2) how Best Management Practices are used to prevent pollution, and (3) how one can report occurrences of stormwater polluting activities.

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Practice/activity specific outreach should promote, publicize, and facilitate public reporting of illegal dumping, illicit discharges, or water quality impacts associated with discharges from municipal separate storm sewers. An effective program should include the establishment, operation, and promotion of a reporting hotline. Timely reporting by the public of improper disposal and illicit discharges are critical in controlling such sources of stormwater pollution. Increase in public involvement may be achieved by sending a follow-up letter to callers or providing callers with some type of reward. Educational efforts throughout the watershed should inform the public about the existence of the Los Angeles County-wide hotline and any other local hotlines; provide them with information regarding what to look for, and guidelines/procedures on how to report incidents.

Another critical component of practice/activity outreach is the development of a program to facilitate the proper management and disposal of used oil and toxic materials. An effective program could include, but is not limited to, the operation of recycling facilities and the conduction of household hazardous waste round-ups. The program could also include information about alternatives to toxic materials. Educational efforts throughout the watershed should provide the public with detailed information regarding the Los Angeles Countywide Household Hazardous Waste Round-ups and any other local programs.

Co-Permittees take part in public information and participation programs specifically aimed at preventing improper disposal of hazardous household products and encouraging actions that keep general wastes out of the storm drain system - such as recycling programs, public trash receptacles and the cleaning of sidewalks, alleys and vacant lots. Illegal dumping and discharges are also specifically targeted.

These activities are encouraged through general outreach programs (discussed above) that promote such programs as toll-free phone hotlines for reporting illegal polluting activities, topic-specific brochures, speakers bureaus and special recycling facilities (used motor oil, hazardous products, etc.). Every co-permittee within this watershed either promotes or is planning to promote the County's illegal dumping hotline; some also have their own hotlines. Focused outreach to promote recycling programs is also conducted by nearly every jurisdiction.

Both the City and County of Los Angeles have outreach programs focusing on their airport operations; the County will have handouts for tenants and users of County airports explaining the problems and prevention of non-point source pollution.

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3. BUSINESS SPECIFIC

Due to the fact that some business operations have a higher potential of discharging pollutants into the storm drain system, a more focused public education and outreach program should be developed for them. Employees of these businesses should be educated on the issue of nonpoint source pollution and the effectiveness of Best Management Practices in reducing pollution. Besides written, audio, or visual materials that focus on specific businesses and their practices, mass mailings or articles in a trade/industry magazines are other possible means of focused outreach.

The City of Los Angeles has initiated a three phase program intended to increase the awareness of those involved in the construction industry regarding storm water pollution abatement activities. Videos and printed materials will be distributed.

C. EDUCATION PROGRAMS

Increasing awareness is the major goal of the Public Information and Participation Program. An ideal means of accomplishing this task is through educational programs. Programs should be developed for a variety of audiences, including public employees and school children. Educational programs can also be an important part of a general or focused outreach. A watershed-wide concept will be developed by June 1996.

1. PUBLIC EMPLOYEES

It is important to educate all of the public employees about the stormwater program so that they do not continue with any practices that are counter productive. Furthermore, they can participate in the implementation and enforcement of the program. Ideas and suggestions of employees can be used to modify the program for improved effectiveness. The outreach must involve employees on many different levels - from program managers to field personnel. Educational programs for public employees may include, but are not limited to, articles in City newsletters, training classes, checklists for field personnel, and interdepartmental forum or committee. Any of the materials utilized in an outreach program - written, audio, or visual materials - may be used in a public employee educational program.

More formal training/education is also conducted by Caltrans and the City and County of Los Angeles. Caltrans personnel is educated on highway maintenance - specifically on such subjects as Hazardous Substance Spill Awareness and Pesticide Safety and Vegetation Management. City and

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County personnel meet regularly to discuss development of and evaluate storm water quality practices.

2. K-12

School children can play an important role in a public information and participation program. First, children are generally more easily motivated and the behavior changes made at that point in life tend to stay with them through adulthood. Secondly, school children can convey the stormwater pollution prevention messages to the members in their family. School programs must include information on the storm drain system, stormwater quality awareness, and may also include, but are not limited to, illegal dumping awareness, source minimization, and pollution prevention. Written material, videos, assembly programs, and field trips are examples of effective components of a K-12 educational program.

Examples of diversified outreach programs include San Fernando's pollution reduction poster contest for children. The following are examples of other educational programs implemented by the cities. The City of Los Angeles has a school education pilot program, "The Magical City Forest", for grades K-6. El Monte has a school education program presented by the Fire Department. Pasadena, South El Monte, Signal Hill and Los Angeles County also offer school presentations - particularly to promote recycling. Long Beach is developing a Public Education Resource Portfolio.

3. OTHER

Educational programs can also be developed for professionals and technicians who are not public employees. Agencies should include public outreach material for business license renewal or outreach effort through professional and business associations.

Monrovia has a program to distribute BMP information to landscape contractors with their annual business license renewal.

D. RESIDENTS PARTICIPATION

The residents of the watershed should not only be made aware of the stormwater program, they should be encouraged to participate in its implementation. Specific outreach programs should be developed to allow the public to participate and to inform them of available means for providing ideas and comments regarding the stormwater program. A watershed-wide concept will be developed by June 1996.

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1. VOLUNTEER MONITORING

Volunteer monitoring is the result of increased public awareness and participation. The public can utilize the hotline for reporting suspected illegal practices. Such involvement, which is similar to the Neighborhood Watch Program on crime, usually has good results.

2. COOPERATIVE OUTREACH

In order to promote public participation, cooperative outreach programs should be developed. These cooperative programs should help to create an awareness and an identification with the watershed. The catch basin stenciling and other signing programs are excellent examples of this type of cooperative effort. One possibility for cooperative outreach is an "Adopt-A-" program. Residents can "adopt" a highway, storm drain, catch basin, stream, etc. Other cooperative outreach efforts include events such as "Stormwater Pollution Awareness Week." The purpose of any of these activities is to inform and involve the local residents in regards to the stormwater management program.

Several watershed jurisdictions have enlisted the assistance of such groups as the Boy Scouts, students and neighborhood volunteers in the catch basin stenciling program. Caltrans' Adopt-A-Highway program relies on voluntary private participation to help with clean-up activities. Long Beach has an "Adopt-A-Gutter" program. Hotline programs also enlist the assistance of residents in active participation.

3. COMPLAINT PROCEDURES

Public comments/complaints are important to the success of a stormwater program. A hotline is an excellent mechanism for allowing the public to provide information. In Section B, "Focused Outreach - Practice/Activity", the various aspect of outreach effort is discussed.

E. EFFECTIVENESS EVALUATION

Permittees should develop a process to evaluate the effectiveness of their programs. Methods such as surveys and focus groups can be used to assess program's effectiveness. Results should gauge the community's level of awareness. Surveys and focus groups can also be used to provide insight into the program's direction and the formulation of attainable goals. A watershed-wide concept will be developed by June 1996.

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The City of Los Angeles has conducted a pre-survey to determine the general level of public awareness about storm water pollution. They plan to conduct a post survey in 1995 to gauge the progress made in their public education program. Many watershed co-permittees are in the early phases of implementation; there have been no other reports of formal programs to assess program effectiveness, although staff discussions and management reviews have resulted in program development and modifications.

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VIII. PROGRAM EVALUATION

The effectiveness of the storm water programs developed under the Municipal Storm Water Management Plan (hereinafter called the Plan) must be assessed on a regular and consistent basis. The Plan for this evaluation must include a schedule for evaluation, a methodology for the evaluation, a discussion of who will carry out the evaluation, and what will be evaluated. In addition, there must be a mechanism to follow up on the information generated by the evaluation. The Plan should be adjusted based on the program evaluation.

A. PERFORMANCE STANDARDS

The Permittees will develop standards to judge the effectiveness of the activities and control measures proposed under each chapter of the Plan. The standards will serve as minimum performance levels to evaluate the implementation of control measures. The subsequently developed performance evaluation procedures/methodologies will be the tool to determine if a particular BMP has an impact on stormwater quality. In developing these procedures, we resolve to ensure that each BMP is implemented to the maximum extent practicable. The targeted completion of this phase will be December 1996.

1. DEVELOPMENT OF PROCEDURES

General performance standards for evaluating the effectiveness of the Best Management Practices (BMPs) will be developed for all the BMPs proposed in the Plan. The Watershed Management Committee will be responsible for developing and adopting these evaluation criterion. The Management Committee may elect to establish subcommittees to develop performance standards for specific program areas. The area-wide Executive Advisory Committee will then review and endorse the standards. Standard recording format and implementation schedule will be developed for each BMP by the Management Committee for use by all Permittees. The Permittees will be required to document BMP implementation using the standard format according to an established schedule. The utilization of quantitative approaches in measuring effectiveness will be used whenever possible. Methods that would yield comparable results for year to year evaluation will be developed.

2. ACTIVITY/SOURCE/ACTION AREA SPECIFIC

Program effectiveness will be performed based on the information generated by the performance evaluation procedures. Using street sweeping as an example, the Plan will propose a method of determining if street sweeping has an impact on water quality. This could include determining what kind of

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pollutants are removed by the sweeping, measuring the size of the pollutants and the amount removed. Methodologies would be developed for each BMP, which will assure that each control measure or action is implemented to the maximum extent practicable. For street sweeping; this may include the frequency of sweeping now, the method of sweeping, the equipment used, how the equipment is cleaned and maintained, and the method of disposal for the material collected. A schedule and format of evaluation shall be developed for all the BMPs.

The California Regional Water Quality Control Board, Los Angeles (Regional Board) has recommended 13 Baseline BMPs, to be developed and/or implemented by all Permittees by the end of the current NPDES Permit. Existing Permit Task 5.2.5 requires an evaluation of the need for additional BMPs, source control, and/or structural control measures.

BMPs have only been implemented for a short time period by Phase I and Phase II cities. Phase III, which contains 30 new cities, has not yet implemented any BMPs. Therefore there is little or no data available to adequately assess effectiveness. In lieu of recommending any changes or additions to BMPs currently being implemented or proposed by the Permittees, a uniform data collection methodology will be established for each of the 13 baseline BMPs. This methodology would be used by all Permittees to compile data on their BMP implementation to allow for a uniform Countywide evaluation of BMP effectiveness. Priority will be given to the development of a uniform data collection methodology to document the success or effectiveness of these 13 BMPs. Upon reorganization of the NPDES Permit Program, as described in Chapter I, this will be the first task addressed by the Watershed Management Committee. The Uniform data collection methodology will be developed by January 15, 1995 for the Santa Monica Bay watershed and by July 1995 for all other watersheds with subsequent implementation by all Permittees in each watershed.

B. ANNUAL REPORTS

An annual report for each watershed will be submitted to the Regional Board not more than 45 days after the end of each permit year. Each annual report will include a summary on the programs implemented during the previous year and plan activities that will be implemented during the current year. Any revisions to the Plan would be addressed in the report.

1. FORMAT/STRUCTURE

In order to insure uniform annual reporting by all watersheds, the Executive Advisory Committee will develop a uniform annual report outline for use by

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each watershed. Each Watershed Management Committee will develop a standard format to be used by all the permittees in its watershed in reporting the progress and the status of all stormwater programs implemented in its jurisdiction. The Principal Permittee will utilize this information to develop the annual report for the watershed. Upon approval by the Management Committee, the annual report will be provided to the Executive Advisory Committee which will compile the annual reports from all watersheds for submittal to the Regional Board.

2. EFFECTIVENESS MEASURES

Under Chapter VIII, Section A, the permittees will have developed performance standards for each BMP. These performance standards will be used to assess the effectiveness of the BMPs. By the end of each permit year, the findings of the previous program year will be evaluated and used to suggest changes that are appropriate for implementation during the next year. Focus should also be given to the use of empirical studies, in a control setting, to more fully assess the effectiveness of BMPs.

3. CONTENT

The annual report will include a matrix illustrating the levels of implementation for all permittees. Tables will be developed for each BMP listing all the participating Co-Permittees, describing the status of implementation by each Co-Permittee of the BMP, and documenting any modifications of the BMP from the standard program. The effectiveness of each program area will be assessed using the performance standards developed under Chapter VIII, Section A. For effectiveness measures, the findings should be presented graphically for ease of comparison with the established levels of effort. Fiscal budget for all the BMPs implemented should also be prepared, grouped by programs. An analysis and evaluation of the results of the past year's monitoring program data will also be included in the report. Any revisions to the Plan should be addressed here, with all the elements affected discussed in their entirety. All relevant information, such as water samples analyses and evaluation, should be included in the appendices.

C. SEMI-ANNUAL REPORTS

A semi-annual progress report will update the Regional Board on Permit compliance activities six months into each permit year. The semi-annual report will be provided to the Regional Board within 30 days after the end of the six-month period.

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1. **PURPOSE**

The semi-annual report will serve as a status report on the progress of the implementation of the Plan.

2. **FORMAT/STRUCTURE**

In order to insure uniform semi-annual reporting by all watersheds, the Co-Permittees will use the standard format developed for the annual report in reporting the progress and status of all the BMPs implemented in their jurisdictions. The Principal Permittee will utilize this information to develop the semi-annual report for the watershed for submittal to the Regional Board.

3. **CONTENT**

The semi-annual report will include a matrix illustrating the levels of implementation for all permittees. Tables will be developed for each BMP listing the participating Co-Permittees, describing the status of implementation by each Co-Permittee of the BMP, and documenting any modifications of the BMP from the standard program. The Permittees will describe the problems encountered during implementation and discuss the modifications to the program in order to solve these problems.

D. INTERNAL REPORTING

In order to facilitate the preparation of semi-annual and annual reports, standard internal formats for use by all Permittees will be developed. The internal reporting procedures will be completed for all Plan chapter elements by December 1996.

1. **STANDARD FORMS**

The Watershed Management Committee will be responsible for developing standard forms for use by each Permittee. Standard forms will be developed for each BMP to monitor its progress. Some Permittees may have to customize the standard forms in order to reflect their programs' additional features. The forms will collect all the information essential to the preparation of the annual and semi-annual reports. In developing the standard report forms, information that is quantifiable and specific for each program area and/or BMP will be collected.

2. **PROCEDURES**

Co-Permittees will submit all the BMP report forms to the Principal Permittee at the end of the six-month period and the permit year, respectively.

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3. RECORD KEEPING

The Regional Board does not need to see all of the extraneous information, but the records will be retained by the Principal Permittee for 2 years. Each Permittee will keep a permanent copy of its reporting forms in case they are needed.

E. STORM WATER MANAGEMENT PLAN REVISIONS

There will be an annual review process that will allow the Permittees to revise the Plan for the next year and for the rest of the permit period. The targeted completion date for this phase is December 1996.

1. PROCESS

In the annual report, permittees will compare the progress made on all the BMPs with the established level of effort. If the level of implementation is inadequate, the program should be adjusted to accelerate the progress. If the progress made to date shows that the program is ineffective or inefficient in protecting the stormwater quality, a new program should be developed and implemented for the next fiscal year and the rest of the permit period.

2. REPORTING

All refinements or revisions to be made in the fiscal year will be documented in the annual report, with the dates of implementation proposed.

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IX. MONITORING

The Monitoring Program is a critical element in the Stormwater Management Plan. It will provide important data for use in characterizing existing stormwater/urban runoff quality, guiding future development, and modifications to the Plan and also to assess its effectiveness. A watershed wide monitoring program shall be developed by December 1996.

A. SYSTEM CHARACTERIZATION

The existing Permit subdivided the County into six drainage basins with information to be collected to characterize each of the basins.

1. WATERSHED

Each drainage basin has been subdivided into numerous drainage areas, based on an evaluation of the existing drainage system and surface flow patterns. For each drainage area, the following information has been compiled: size; breakdown of existing land use; imperviousness; description of soils; location of waste disposal facilities; and the location, type, and number of industries by Standard Industrial Classification (SIC) Code. This information has been submitted to the California Regional Water Quality Control Board, Los Angeles Region, for Phases I and II. Phase III watershed characterization is in progress and will be completed by the end of December 1994. Due to the volume of the watershed characterization data, this information has not been included herein, but is available for review at either the Regional Board or the Los Angeles County Department of Public Works.

This information will provide a basis for developing other monitoring program elements such as pollutant loading estimates from major land uses and watersheds; pollutant source identification, and identification of illegal discharges/illicit disposal practices.

2. STORM DRAIN SYSTEM

In subdividing each basin into drainage areas, the drainage area tributary to all major outfalls has been identified. Within each drainage area, the tributary storm drain system is being identified and mapped. Key information such as the size of the storm drain facilities, locations of manholes and inlets, and storm drain connections is being compiled. This information will be vital in conducting storm drain inspections to identify and eliminate illegal discharges.

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3. RECEIVING WATERS

Due to the extent of urbanization in Los Angeles County over the past decades, most of the streams designated as receiving waters in the Los Angeles basin have been replaced with man-made storm drainage systems to provide flood protection to the urbanized areas. These streams have been mapped as part of the storm drain system mapping done under A.2. above. The remaining natural streams are also being mapped.

The Los Angeles County Department of Public Works (Department) has been performing surface water quality monitoring on a voluntary basis since the late 1960s. Samples have been collected and analyzed from various receiving water streams and channels throughout the County to collect general information as to the quality of the surface runoff within our storm drain system.

The program in existence at the time the current Permit was issued was established in the mid 1980s. Twenty-eight sites are sampled monthly for dry weather flows. Twenty-one of the 28 sites are sampled for storm flows up to five times per year. The collected samples are analyzed for general minerals, pH, total dissolved solids, specific conductance, biochemical oxygen demand, bacteria, heavy metals, pesticides, PCBs, total organic carbon, volatile organic compounds, and total petroleum hydrocarbons.

The sample collection at these sites will continue while the new National Pollutant Discharge Elimination System (NPDES) Permit monitoring stations are established. Once all NPDES Permit monitoring stations are operational, sampling at these 28 sites will be discontinued.

In order to provide an initial assessment of the water quality in the major streams and channels in the County, an analysis has been performed on the data collected through the existing surface water monitoring program. The analysis has been done on a Countywide basis and also by major drainage basin. The report can be found in Volume 8.

To better assess the receiving water impacts of stormwater the Department will be developing a program to further study stormwater impacts on selected receiving waters, including conducting toxicity studies. Initial efforts will focus on the Santa Monica Bay Watershed. A Request for Proposal for the development of such a program will be advertized by January 15, 1995.

The water quality data collected by the new NPDES Monitoring Program will provide more detailed data to better assess in upcoming years the quality of our receiving waters. Ten monitoring stations have been proposed along the

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major streams in the County. A description of these site locations can be found in the monitoring work plans for Phases I, II, and III, previously submitted to the Regional Board, see Volume 8.

4. **LAND USE**

As described under Section A.1. above, the existing land use categories within each drainage area have been identified. This information has been used to select drainage areas comprised of a single homogeneous land use for land use specific monitoring. A total of 14 land use monitoring sites are being established in the County. Five sites are being installed in the Santa Monica Bay Watershed with the remaining nine to be selected from within the Los Angeles, San Gabriel, and Santa Clara River Watersheds. For a description of the sites, please see Volume 8. These sites will provide valuable information as to the types and levels of pollutants found in runoff from various land uses. This information can then be used to refine the Stormwater Management Plan to develop specific management measures to target identified problems.

B. SOURCE IDENTIFICATION

Identifying the sources of stormwater pollutants from both specific land uses and specific activities will provide the information needed to identify problem areas and allow specific management measures to be developed to address these problems.

1. SPECIFIC LAND USE

As described in Section A.4. above, major land use classifications will be subject to individual monitoring to determine the types and levels of pollutants present.

2. SPECIFIC ACTIVITIES

a. A pollutant source identification program will be designed to identify significant pollutant sources (i.e., parking lots, industrial activities, etc.), with the hope that remedial action can be undertaken to reduce any significant impacts so identified. It will focus on monitoring very small areas (i.e., less than five acres) where a specific and/or interrelated set of pollutant generating activities are occurring. Its objective is to provide data for selecting BMPs for specific activities rather than characterizing discharges for long-term pollutant loading estimates.

Identification of pollutant sources can be done using a number of methods. Potential sources of storm water pollutants can be identified

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by records of chemical use and/or storage, by studies of specific activities which lead to the deposition of pollutants throughout the watershed, and by field inspection or monitoring. Watersheds which may contain significant pollutant sources can be identified through land use information or by mass loading estimates.

By mid January 1995, the County will begin targeted monitoring of a municipal corporation yard in the Santa Monica Bay watershed. A full program for pollutant sources identification will be developed by December 1996.

b. A storm drain inspection program has also been developed and is being implemented. The first phase of the inspection program will target the open channel storm drains to identify illegal discharges.

The open channel inspections will also be used to screen outfalls from underground storm drains for the presence of dry weather flows. This information will be used in the next phase of the storm drain inspection program to prioritize the underground storm drain system for further field screening and inspection of problem areas.

C. CONTROL MEASURE EFFECTIVENESS

It is unlikely that the effectiveness of the various control measures implemented by the storm water management plan can be determined solely through the data produced by monitoring the quality of storm drain flows, because it is difficult to obtain statistically significant comparisons of watershed-wide control measure performance with such data. For this reason the effectiveness of control measures will be assessed through other means.

Two general types of methods are available for assessment of control measure effectiveness: direct water quality (conventional) monitoring and indirect (non-conventional) monitoring. Direct water quality monitoring can be used to determine pollutant reduction by a specific facility or device. This technique is commonly used for structural or treatment controls, such as detention basins and constructed wetlands, where there is an accessible inflow and outflow. Inflow and outflow results are compared to determine pollutant removal and effectiveness.

Direct water quality monitoring of site runoff before and after implementation of non-structural control measures is also possible. However, it is difficult to demonstrate effectiveness at a statistically significant level because of the high degree of variability in stormwater pollutant concentration and mass loading data. The water quality improvement due to non-structural control measures is generally expected to be less dramatic than that achieved through structural controls. A larger

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number of samples is therefore required to produce a statistically significant result. This is especially difficult in relation to the monitoring of the pre-control measure condition. Collection of adequate baseline information is necessary prior to the implementation of management practices. Direct monitoring of the effectiveness of non-structural controls is feasible typically only under experimentally controlled conditions (e.g., selection of small, well-defined watershed; control of management practice implementation; effective siting and timing of monitoring activities), including a sufficient number of samples to achieve statistical significance.

Indirect monitoring currently is the primary method of choice of assessment of management plan effectiveness. A number of indirect monitoring techniques are available for assessment of management plan effectiveness.

Verification of program implementation is an indirect monitoring method that can be used to determine how a management plan is being implemented. Another indirect monitoring method, pollutant removal inventories, can be used to assess the amounts of pollutants that have been prevented from entering the municipal storm drain system.

The 13 Baseline BMPs recommended for implementation by the Regional Board plus other BMPs proposed by the various Co-Permittees are in general all non-structural control measures. In the short-term, a uniform data collection methodology will be developed for use by all Permittees to compile information on the level of implementation of the 13 Baseline BMPs. This will allow for a uniform watershed-wide evaluation of BMP effectiveness. For the Santa Monica Bay watershed, this uniform data collection methodology will be developed and begin implementation by January 15, 1995. For the other watersheds, implementation would begin July 1, 1995.

For the long-term, as the various chapters of the Plan are more fully developed, possibilities for the use of direct water quality monitoring for control measure assessment will be evaluated as opportunities arise.

D. POLLUTANT LOADING

One of the objectives of the monitoring program is to estimate the annual pollutant loadings from each watershed. Knowing the types and quantities of pollutants discharged into receiving waters are important in assessing the impacts of stormwater and, in turn selecting appropriate control measures to address problem areas.

The 24 permanent monitoring stations that are being established Permit-wide will be utilized to estimate pollutant loads from each watershed and also from various land uses. For a description of the methodology to be used to estimate pollutant loadings, please see Volume 8. For the Santa Monica Bay Watershed, the pollutant loading

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model will be tested and operational by January 15, 1995. Actual pollutant loadings will be calculated subsequent to storm events occurring for which water quality data has been obtained. For the other watersheds, a schedule for pollutant load modelling will be provided by January 15, 1995.

To more closely model pollutant loadings and evaluate control measure impacts, a more detailed dynamic modelling will be undertaken on a smaller, representative sub-watershed. The EPA-SWMM model has been selected for use in our dynamic modelling efforts. For the Santa Monica Bay Watershed, the Kenter Canyon Drain sub-watershed has been selected for this modelling efforts. This sub-watershed is typical of the urbanized areas in the Santa Monica Bay Watershed. It is comprised of multiple land uses, has well-defined boundaries, and has no upstream flow regulation. We are reviewing and identifying the existing drainage system, defining current and future land uses, and conducting field checks. The model will be tested and operational by January 15, 1995, with actual modelling results to be available later when local water quality data from our monitoring stations becomes available. Based on the results of the dynamic modelling of the Kenter Canyon sub-watershed, other sub-watersheds may be selected from the other major watersheds in the County.

E. COMPONENTS OF A MONITORING PROGRAM PLAN

The components of the monitoring program plan such as monitoring site locations, dry/storm sampling frequency and methodology, constituents to be sampled, field and laboratory procedures, QA/QC, etc., can be found in Volume 8, which has been previously provided to the Regional Board.

The Monitoring Program elements described in Volume 8 will be revised to address the Monitoring Program needs described in Section A - D above as agreed to in the letter from the County to the Regional Board dated September 22, 1994.

As the various chapters of the Plan are more fully developed, the Monitoring Program will be revised to address any additional monitoring needs that may result.

F. DATA MANAGEMENT

For water quality data collected at the 24 monitoring stations, please see Volume 8 for data storage and reporting methods.

For each Section A - E of the Monitoring Program described above, an annual report will be prepared detailing the data collected, with an evaluation and interpretation the data including water quality impacts.

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NPDES PERMIT NO. CA 0061654

TASK 5.2

REPORT OF WASTE DISCHARGE (ROWD)

VOLUME 6 OF 8 (TASK 5.2.5 - 5.2.6)

SAN GABRIEL RIVER
STORMWATER MANAGEMENT PLAN

LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS
WASTE MANAGEMENT DIVISION
WATER QUALITY SECTION

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SAN GABRIEL RIVER
STORMWATER MANAGEMENT PLAN

INTRODUCTION

On June 18, 1990, the National Pollutant Discharge Elimination System (NPDES) Permit - Order #90-079, NPDES #CA0061654-CI6948 was issued to the County of Los Angeles and 17 cities tributary to Santa Monica Bay. During the subsequent years, two newly incorporated cities within the Santa Monica Bay watershed, Caltrans, and the County of Ventura also became Co-Permittees. This Permit outlined a three year program which required each Permittee to: characterize drainage areas; develop and schedule the implementation of Best Management Practices to enhance the quality of stormwater/urban runoff within its jurisdictional boundaries and in storm drains it owns and operates. On July 1, 1992, 36 additional cities were initiated into the Permit and began their three-year program. By July 1, 1993, the remaining 30 cities in Los Angeles County within the drainage basin were initiated into their three-year program. The cities were grouped according to their starting dates and referred to as Phases I, II, and III respectively (See Table A). In general, the boundaries of each Phase did not encompass whole watersheds but portions of various watersheds (See Figure 1).

The Permit has a five-year duration and although Phase III cities have only completed year one of their three-year program, the Permit requires the submittal of a Report of Waste Discharge (ROWD) which serves as an application for a subsequent NPDES Permit to replace NPDES Permit #CA0061654, which will expire on June 18, 1995. Therefore, the County of Los Angeles, the County of Ventura, Caltrans, and the 85 cities are now parties to the subsequent NPDES Permit application utilizing the Municipal Stormwater Management Plan (herein after called the Plan) concept.

The Plan is based on the Stormwater Management Plan Components developed by the California Regional Water Quality Control Board, Los Angeles Region (Regional Board), and is proposed on behalf of the County of Los Angeles and the other participating agencies, see Table B. This Plan describes the stormwater management activities to be undertaken during the next single, five year NPDES Municipal Stormwater Permit. The Plan involves the subdivision of the area of the County under a single, new Permit, into six watersheds, each with its own stormwater management plan. For these watersheds and the agencies in each of these watersheds, see Table B and Figure 2.

As required by the current Permit, all Permittees have proposed BMPs for their jurisdictions, described in Volume One and under prior submittals made to the Regional Board. These BMPs have already addressed many of the program areas discussed under the stormwater management plan. As required by the current Permit and continuing on under the new Permit, the Permittees will continue to implement these BMPs. This stormwater management plan will involve reorganizing the individual city-based BMP programs into a single stormwater plan for each watershed. The timeline shown in this document reflects the time needed for the transition from individual city-based programs to the preparation of a mutually agreed upon and collectively developed watershed plan by

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all parties of the new Permit for each of the watershed areas. The first step in beginning this process will be the reorganization of the current three-phase program into a new watershed based program. A reorganization of the Phases into watersheds which are based on hydrologic characteristics will allow for the consistent development and implementation of programs among Permittees, referencing land use and drainage infrastructure within their respective watersheds. Consistency of programs throughout the watershed will be beneficial in terms of targeting specific pollutant problems and areas.

This specific plan will address the stormwater management issues for the San Gabriel River watershed, which include the following cities and agencies:

Artesia	**Azusa**	**Baldwin Park**
Bellflower	**Bradbury**	**Caltrans**
Cerritos	**Claremont**	**Covina**
Diamond Bar	**Downey**	**Duarte**
Glendora	**Hawaiian Gardens**	**Industry**
Irwindale	**La Habra Heights**	**La Mirada**
La Puente	**La Verne**	**Lakewood**
Long Beach	**Los Angeles County**	**Norwalk**
Pomona	**Pico Rivera**	**San Dimas**
Santa Fe Springs	**Walnut**	**West Covina**
Whittier		

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TABLE A

Grouping of Permittees by Phases

PHASE I

Agoura Hills
Beverly Hills
Calabasas
Caltrans***
Culver City
El Segundo
Hermosa Beach
Inglewood
Los Angeles***
Los Angeles County***
Malibu
Manhattan Beach
Palos Verdes Estates
Rancho Palos Verdes
Redondo Beach
Rolling Hills
Rolling Hills Estates
Santa Monica
Torrance
Ventura County
West Hollywood
Westlake Village

PHASE II

Alhambra
Arcadia
Azusa
Baldwin Park
Bradbury
Burbank
Calabasas*
Caltrans***
Claremont
Covina
Diamond Bar
Duarte
El Monte
Glendale
Glendora
Hidden Hills
Industry
Irwindale
La Canada Flintridge
La Habra Heights
La Puente
La Verne
Los Angeles***
Los Angeles County***
Monrovia
Montebello
Monterey Park
Pasadena
Pomona
Rosemead
San Dimas
San Fernando
San Gabriel
San Marino
Sierra Madre
South El Monte
South Pasadena
Temple City
Walnut
West Covina

PHASE III

Alhambra**
Artesia
Bell
Bell Gardens
Bellflower
Caltrans***
Carson
Cerritos
Commerce
Compton
Cudahy
Downey
El Segundo*
Gardena
Glendale**
Hawaiian Gardens
Hawthorne
Huntington Park
Inglewood*
La Canada Flintridge**
La Habra Heights**
La Mirada
Lakewood
Lawndale
Lomita
Long Beach
Los Angeles***
Los Angeles County***
Lynwood
Maywood
Montebello**
Norwalk
Palos Verdes Estates*
Paramount
Pasadena**
Pico Rivera
Rancho Palos Verdes*
Redondo Beach
Rolling Hills*
Rolling Hills Estates*
Santa Clarita
Santa Fe Springs
Signal Hill
South Gate
South Pasadena**
Torrance*
Vernon
Whittier

Note:
* The agency is also in Phase I.
** The agency is also in Phase II.
*** The agency is also in Phase III.

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FIGURE 1

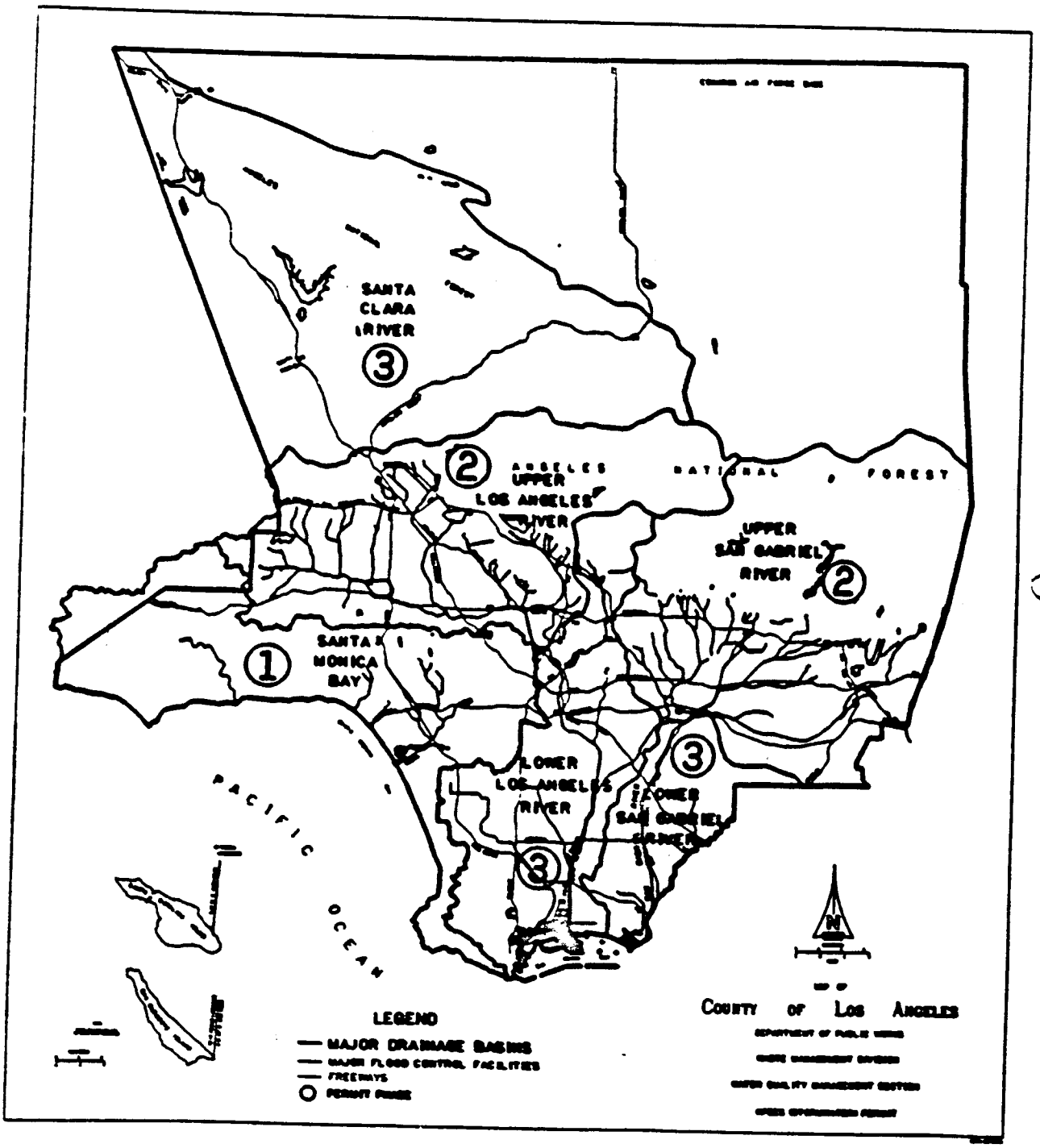

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TABLE B

NPDES Stormwater Permit Renewal
Proposed Watershed Breakup

Santa Monica Bay

Malibu Creek and Other Rural

Agoura Hills
Calabasas
Caltrans
Los Angeles County
Malibu
Westlake Village
Ventura County

Ballona Creek and Other Urban

Beverly Hills
Caltrans
Culver City
El Segundo
Hermosa Beach
Los Angeles
Los Angeles County
Manhattan Beach
Palos Verdes Estates
Rancho Palos Verdes
Redondo Beach
Rolling Hills
Rolling Hills Estates
Santa Monica
West Hollywood

Dominguez Channel/
Los Angeles Harbor Drainage

Caltrans
Carson
Gardena
Hawthorne
Inglewood
Lawndale
Lomita
Los Angeles
Los Angeles County
Torrance

Los Angeles River

Alhambra
Arcadia
Bell
Bell Gardens
Burbank
Caltrans
Commerce
Compton
Cudahy
El Monte
Glendale
Hidden Hills
Huntington Park
La Canada Flintridge
Long Beach
Los Angeles
Los Angeles County
Lynwood
Maywood
Monrovia
Montebello
Monterey Park
Paramount
Pasadena
Rosemead
San Fernando
San Gabriel
San Marino
Sierra Madre
Signal Hill
South El Monte
South Gate
South Pasadena
Temple City
Vernon

San Gabriel River

Artesia
Azusa
Baldwin Park
Bellflower
Bradbury
Caltrans
Cerritos
Claremont
Covina
Diamond Bar
Downey
Duarte
Glendora
Hawaiian Gardens
Industry
Irwindale
La Habra Heights
La Mirada
La Puente
La Verne
Lakewood
Long Beach
Los Angeles County
Norwalk
Pomona
Pico Rivera
San Dimas
Santa Fe Springs
Walnut
West Covina
Whittier

Santa Clara River

Caltrans
Los Angeles County
Santa Clarita

Italicized agencies are present in more than one watershed.

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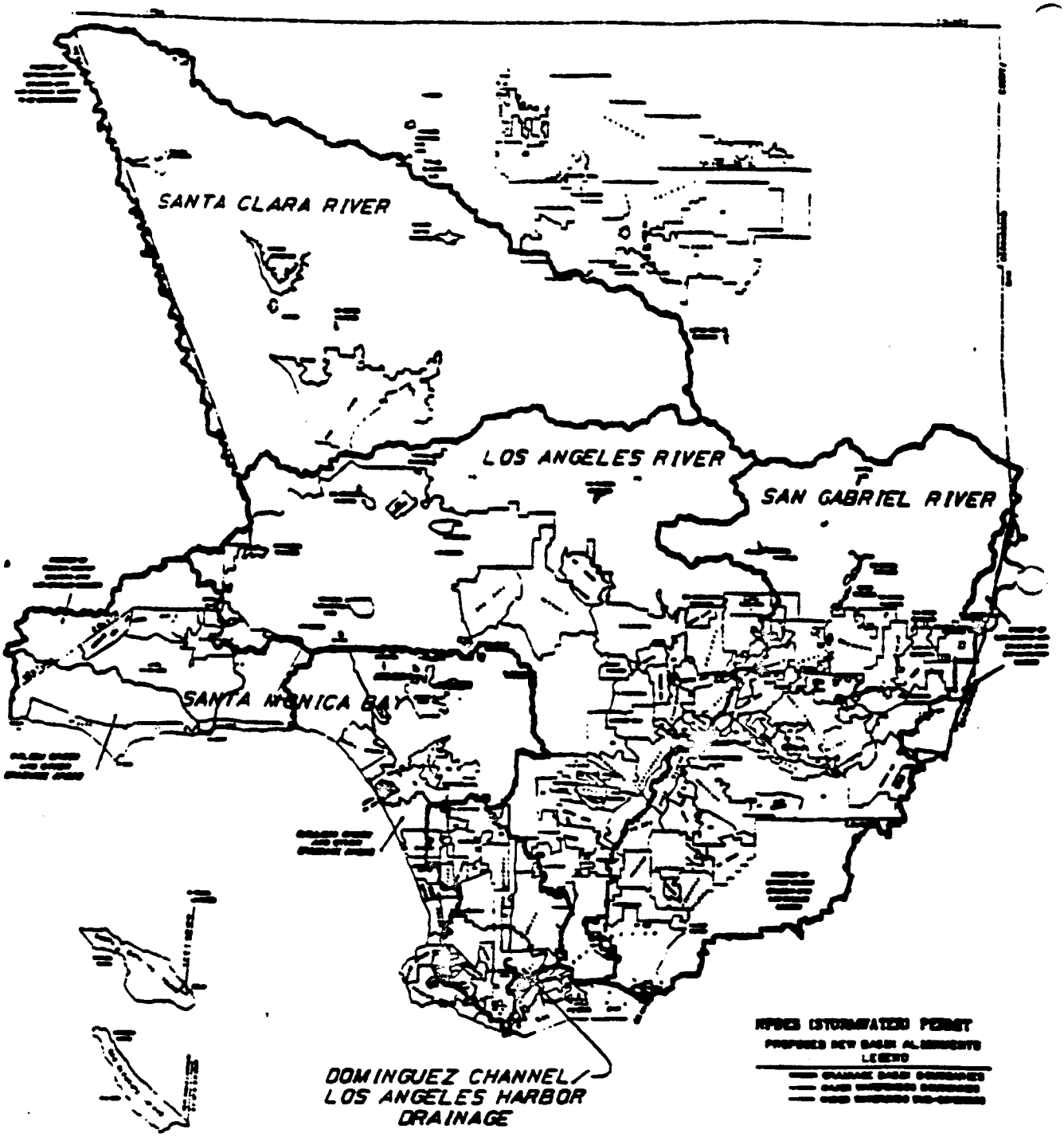
FIGURE 2



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I. PROGRAM MANAGEMENT

A. PROGRAM STRUCTURE

The County of Los Angeles is designated as the Principal Permittee. The other agencies are designated as Co-Permittees. The following are conditions that establish the responsibilities of all Permittees.

1. RESPONSIBILITIES OF PRINCIPAL PERMITTEE

Anticipated duties of the Principal Permittee include:

- Being the coordinators of permit activities and chairing the area-wide Executive Advisory Committee and the Watershed Management Committees;
- Providing the resources necessary for development of the stormwater management plans;
- Providing technical and administrative support for both the Executive Advisory and Management Committees;
- Implementing the monitoring program; and
- Providing the resources necessary for developing annual reports including evaluating monitoring program data and BMP effectiveness;
- Complying with all the responsibilities of a Co-Permittee as outlined below.

2. RESPONSIBILITIES OF ALL CO-PERMITTEES

Each Co-Permittee is designated a number of duties under the proposed stormwater management plan:

- Participate in the development of the stormwater management plan;
- Implement the stormwater management plan within their jurisdictional boundaries and the storm drains they own and operate.
- Provide information needed by the Principal Permittee on program implementation for development of the annual reports.

The area under the Permit will be subdivided into the six watersheds tributary to the following waterbodies: Santa Monica Bay, which is further divided into a) Malibu Creek and Other Rural Areas, and b) Ballona Creek and Other Urban Areas; Los Angeles River; San Gabriel River;

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Dominguez Channel/Los Angeles Harbor Drainage; and the Santa Clara River (See Figure 2). Managing these watersheds is a task that will require a collective and cooperative effort on the part of all governmental entities named in the Permit that are within each watershed.

The management structure of the Plan consists of an area-wide Executive Advisory Committee, Watershed Management Committees, and Subcommittees. This particular structure is intended to provide a suitable program for the unique characteristics of each watershed and shall be developed by April 1995.

The Co-Permittees tributary to the San Gabriel River watershed shall adopt this watershed stormwater management program structure as a guide to allow for an area-wide uniformity of compliance of the Permit.

3. EXECUTIVE ADVISORY COMMITTEE

The area-wide Executive Advisory Committee shall consist of the County of Los Angeles, as Chair, and two representative Co-Permittees from each of the six watersheds. This Committee assumes no responsibility for the adequacy or inadequacy of any individual city's program and should not be viewed as the responsible agency in this sense. The Committee's main role is to facilitate programs within each watershed and to enhance consistency among all of the programs. Additional responsibilities of the committee are:

a. Making recommendations on area-wide issues to each of the Watershed Management Committees;

b. Reviewing the stormwater management plans as developed by each Watershed Management Committee and provide direction and guidance on the plans for consideration by the Watershed Management Committees.

c. Assessing the consistency of all area-wide BMPs;

d. Preparing and forwarding unified submittals to the Regional Board upon receipt of information and materials submitted by the Watershed Management Committee in compliance with Permit requirements;

e. Scheduling and coordinating meetings and correspondence to allow for communication between the Co-Permittees and the Regional Board;

f. Acting as liaison between all Permittees and the Regional Board on Permit issues as well as mediating conflict among the Permittees.

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4. WATERSHED MANAGEMENT COMMITTEE

A management committee within the watershed will be comprised of the County of Los Angeles, as Chair, and one representative from each of the Co-Permittees in the watershed. The committee shall be responsible for:

a. Establishing goals and objectives for the watershed;

b. Preparing the stormwater management Plan for the watershed (This includes the development of all chapter components of the Plan);

c. Assessing the effectiveness of the plan and making appropriate changes;

d. Preparing the semi-annual progress reports and annual Permit reports on Permit activities within the watershed for submittal to the Regional Board (For the annual Permit report, a draft will be circulated to each Co-Permittee and the Executive Advisory Committee for its review and comment. Final copies of reports shall be forwarded to the Executive Advisory Committee through which a compilation from all six watersheds shall be submitted to the Regional Board);

e. Enhancing the implementation of the storm water/management plan within the San Gabriel River watershed.

5. SUBCOMMITTEES

Subcommittees will be established where needed as determined by the Management Committee and/or the Executive Advisory Committee. The Subcommittees would be focused on specific program areas and can provide more specific oversight on the development, implementation, and evaluation of selected program areas. These subcommittees shall be scheduled to meet on a routine basis.

B. INSTITUTIONAL ARRANGEMENTS

Management of the stormwater program requires the collective efforts and the cooperation of all Permittees. No Permittee has the ability and the legal authority to assume the responsibility of all activities of this Permit. Therefore, agreements will need to be formally developed amongst the Permittees to insure proper implementation of the Permit requirements.

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1. PROGRAM PARTICIPANT ARRANGEMENTS

As the Principle Permittee, the County of Los Angeles will be designated as the lead agency for coordination of Permit activities and therefore shall chair the executive committee and the management committee meetings as they are scheduled. The lead agency is responsible for coordination of the Permit but is not responsible for the adequacy or inadequacy of any individual Permittee's program. All other entities are Co-Permittees and will be responsible for the Permit compliance of their own agency's program. An implementation agreement will be drafted formally detailing the responsibilities of the Principal Permittee and the Co-Permittees. The agreement would also address the funding of various watershed-wide activities such as plan development, annual evaluation and reporting, and monitoring. Execution of the agreement by all Permittees is targeted for December 1995.

2. AREA-WIDE INTERAGENCY

As the Plan for each watershed is more fully developed, the Watershed Management Committee will coordinate with special agencies and districts that also regulate and/or perform activities addressed under different elements of the Plan. This coordination will attempt to ensure that their functions and the Plan are compatible. A few of these agencies include:

County Hazmat

- Any overlap of waste regulations, Household hazardous waste programs and or Industrial inspections shall be recognized and addressed, by all entities that fall under this Permit, in reference to the watershed program.

County Health

- Inspections of restaurants and other food handling establishments shall be coordinated with the Permittees.

Local Transportation/Congestion Management

- Local municipalities have limited authority over motor vehicle usage and regional transportation planning. Where feasible, plan development and implementation will be coordinated with local transportation agencies.

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County (Regional) Parks

- Landscape maintenance activities at public-owned parks will be reviewed as part of additional plan development to ensure the use of proper management measures.

Mosquito Abatement

- Coordination with the County Agricultural Commissions will be done for mosquito abatement programs to avoid adverse impact on the quality of stormwater/urban runoff.

Water Districts

- Activities with regards to the Water Districts activities will be reviewed and, when feasible, comply with the watershed program regulations and requirements.

Other entities, both private and public which have major land holdings and/or authorities that impact the quality of stormwater/urban runoff should be initiated to actively participate in the program.

3. CITY-SPECIFIC INTERAGENCY ARRANGEMENTS

Each city will need to develop the institutional framework to address operation, maintenance, construction, redevelopment, and other activities performed by city agencies such as Public Works, Parks and Recreation, Planning, and Public Owned Treatment Works (POTWs). These city agencies will need to participate in the planning and implementation of relevant plan program areas.

C. FISCAL RESOURCES

As each of the Plan chapters are completed, each Permittee will develop a budget for implementing that portion of the Plan. A complete budget for the Plan will be produced upon completion of development for all Plan components (*December 1997*). The budget will provide information such as funding sources, staff resources, contract services, and cost sharing arrangements.

1. AREA-WIDE

Stormwater Program activities such as Plan development, annual reporting, monitoring, and public education that are area wide in nature will have

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budgets developed indicating the total cost for these items and the portion to be funded by each Permittee.

2. CITY-SPECIFIC

In implementing the Plan, the Permittees may elect to jointly fund a single program for certain BMPs, such as Public Education, that are area-wide in nature. Funding agreements including budgets and cost per agency would be developed.

D. LEGAL AUTHORITY

Each Permittee is responsible for implementing the Plan within its jurisdictional boundaries and therefore must acquire all needed legal authority. Each Permittee, being separate legal entities, are to have adopted as required by the existing Permit, ordinances that will provide them with the adequate legal authority to develop, administer, implement, and enforce storm water/urban runoff management programs within their own jurisdiction. The ordinance must provide for its enforcement and at a minimum specify that violators may be subject to penalties including, but are not limited to, fines and termination of the activity causing the violation. A plan for identifying any additional legal authorities needed by the Permittees will be included in the completed Plan for the San Gabriel River watershed (*December 1996*). Upon completion of development of the Stormwater Management Plan, enforcing compliance with the Plan will be the responsibility of the Regional Board.

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II. ILLICIT DISCHARGES

The elimination of illegal connections and illicit disposal (IC/ID) practices is an important component for any program aiming to enhance the quality of stormwater/urban runoff.

Although more information is needed to assess fully the benefits and costs of conducting IC/ID programs, we can make logical decisions regarding application of best management practices (BMPs) to minimize such incidents. These BMPs will vary due to the jurisdictional differences which exist within each watershed. Each jurisdiction within the watershed will be developing and implementing those activities which adequately serve the jurisdiction and the watershed as a whole.

IC/ID practices are intermittent discharges of pollutants into the storm drain system that can degrade the quality of receiving waters. This can occur through catch basins, area drains and even on gutters and street surfaces. Some illegal dumping activities are done by individuals who do not know that such practices are illegal and can adversely impact the environment. Yet, others may be carrying out such practices with the full knowledge that such activities are prohibited.

A. ILLICIT CONNECTIONS

In order to implement an illicit connection management program, jurisdictions as a whole will need to develop and implement the procedures for investigating each of their respective storm drain systems.

Detailed procedures to eliminate illicit connections depends on the complexity of the storm drain system. A consistent watershed wide concept will be developed to investigate illicit connections to the storm drain system. Based on the results of field screening activities, or other appropriate information which indicates an area of reasonable potential of containing illicit connections, detection and follow up procedures would be followed. Priority should be established to focus on major problem areas and allow for a cost-effective approach to eliminate illegal connections. This concept will be developed by December 1996.

1. SYSTEM SURVEY

A system survey is a necessary component of an illicit connection elimination program. Although the basic concept is similar, the actual techniques and methods which jurisdictions within the watershed use to conduct system surveys can be quite different.

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In conducting system surveys, the intent is to avoid costly investigations within areas not suspected of containing illicit connections. Field screening, map research, and land use investigation activities will be done initially to identify potential problem areas. Public outreach efforts will be used to inform citizens in the area about the problem. Enforcement action will be taken to terminate such illegal connections. It should be noted that more detailed and sophisticated techniques such as televised inspection and dye testing will only be used in special situations as needed.

Presently, Los Angeles County has begun a system survey. Maps detailing the location of each storm drain, its manholes and catch basin connector pipes is being prepared by the Los Angeles County to facilitate monitoring of illegal connections and discharges. The location and source of discharge for connections is being inventoried. A GIS system to allow management and analysis of this data is also being developed. This information will be used in the storm drain inspection program which is ongoing. The program is targeting open channel storm drains. All open channels will be inspected for evidence of illegal discharges. The open channel inspections will also be used to collect information on dry weather discharges from underground drains for use in prioritizing future underground drain inspections.

An ongoing system inspection program is planned by the City of Irwindale to begin in Fiscal Year 94-95. Building inspectors will be trained to identify illicit discharges and connections. These programs will provide related information which will be used as reference materials for the development of a watershed wide program.

2. ONGOING SYSTEM INSPECTIONS

Ongoing system inspections for illicit connections will involve the techniques identified in Section 1. above, along with some additional activities. In smaller systems where the storm drain goes into several pumping stations, a regular inspection of the pumping stations for, among other things, evidence of illicit discharges will be sufficient.

In larger and more complex systems, a program of field screening will be used. Evidence of pollution will be categorized and prioritized. The storm drain alignment tributary to the suspect illegal connection can then be further investigated for illicit connections. If a discharge can be traced to a particular facility, the facility will be investigated to identify where exactly the pollutants are coming from and efforts needed to stop the discharge.

Another means of detecting illicit connections may be to rely on reports of illicit discharge from the public. This will utilize the County's or another

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agency's established "hotline" number that the public can call and report such observations.

3. REPORTING

A consistent recording system will be established to track reports of illegal connections. This recording system will be used by the Permittees within the watershed.

B. ILLEGAL DUMPING

Due to the intermittent and unpredictable nature of illegal dumping, apprehension rate of violators could be quite low. The first course of action is to develop an area wide educational and reporting system along with prompt response procedures. This will be accomplished by December 1996.

1. OUTREACH

See **Chapter VII Public Information and Participation** of this report for a detailed discussion of the outreach program.

2. SYSTEM SURVEILLANCE

Measures that may be used for this aspect of the program may include but not limited to regular inspections of vacant facilities, street use inspection programs to detect illegal discharges and dumping into the street system, and a public complaint and reporting system.

Caltrans has implemented a system surveillance program. The program is an investigation, identification, and remediation program targeted at hazardous waste and debris dumped on excess land parcels.

3. SPILL RESPONSE

The Health Hazardous Materials Division (HHMD) of the Los Angeles County Fire Department is generally the primary spill responder. If the material is found to be hazardous, the cleanup and disposal of the material will be done under the supervision of HHMD. If the material is non-hazardous, the responsibility will fall on local agencies to coordinate cleanup, disposal and attempt to identify and prosecute the violators. Cooperation among all agencies will be needed to allow for prompt action and joint effort to deter such violators. All agencies will have local authority against such illegal dumping activities.

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Spill response procedures have been established by Los Angeles County at County-owned airports which require lessees to report the presence or release of hazardous materials. The County has also evaluated the latest developments regarding containment procedures and equipment and will develop new reporting procedures. City of Covina is planning to work to improve interdepartmental communication and responsibilities for responding to hazardous materials incidents.

4. COMPLAINT RESPONSE

The County and some local agencies have established a stormwater telephone "hotline" that can be utilized by all citizens. Public complaints are generated through these "hotlines" and also through regular channels such as calls to Fire or Police agencies or to public works or legislative offices. Although responses to these complaints will vary depending on the nature of the complaint, action shall be taken.

Los Angeles County has established a complaint response procedure. The County is tracking hotline complaints and has implemented a follow-up letter for minor dumping violations.

5. COORDINATION OF ALTERNATIVE DISPOSAL

Alternative disposal is one way of reducing non-stormwater materials that can potentially find their way into the storm drain system. Recycling programs are one of the most effective ways to reduce waste material. The recycling program can either be at the curbside or through drop-off centers. Household hazardous wastes can be dropped at mobile collection centers or at fixed sites. Co-Permittees in the basin generally participate in the County's Household Hazardous Waste collection program. Effectiveness of those programs may be enhanced by a public outreach program that will inform the public of the locations and/or schedules for such events. Technical assistance or information may also be provided to businesses that want to develop a pollution prevention, waste minimization or alternative disposal program.

Alternative disposal programs are popular and effective. All jurisdictions, except for Caltrans who recycles its own used oil, anti-freeze, oil filters and aluminum, participate in the Countywide Hazardous Materials Round-ups and most have programs to promote the events. Three cities have additional hazardous materials collection programs. Recycling programs are equally prevalent. Seventeen cities have implemented curbside recycling programs. Approximately another third of the cities in the watershed have some recycling program such as drop-off centers, pick-up of seasonal materials, or they plan to begin programs. Eight cities have begun green waste/composting

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programs. One city does not have a recycling program and it did not indicate that one is planned. Curbside recycling is not applicable to Caltrans. Experiences from these programs will provide reference to further refine the practices.

6. REPORTING

Incidents involving a hazardous material entering the storm drain system are to be reported by the responsible party, or, if not known, the responding agency, to the California Regional Water Quality Control Board, Los Angeles Region (Regional Board). Complaints received through the County wide and local city hotlines will be tracked and reported to the Regional Board.

C. ENFORCEMENT PROCEDURES

Enforcement actions against discharges are done through either state hazardous and toxic materials statutes or through municipal ordinances that are already in the codes of the Permittees. Industrial Waste Ordinances may be used in enforcement actions against illicit connections. Furthermore, anti-littering, health codes, plumbing codes and fire codes may be utilized for dumping or spill incidents. Enforcement actions can be taken by different municipal agents, including but not limited to, Industrial Waste Inspectors, Building or Plumbing Inspectors, Fire Department Inspectors, Park Rangers, Street Use Inspectors, Health Inspectors, Police Officers, Community Services Officers, Animal Control Officers, Code Enforcement Staff or Public Works Inspectors. Some of these agents are empowered to either issue citations, issue notices of violations, issue cease and desist orders, or even make arrests depending on the type of violation and the code provisions that they are enforcing. Some of these agents are also empowered to enforce not only municipal ordinances but also state laws. A review of the various enforcement tools used by the Permittees will be performed. A recommendation will result on a consistent enforcement approach for the watershed for consideration by all Permittees in their own enforcement programs.A watershed wide enforcement approach for use by all Permittees will be developed by December 1996.

Improper disposal ordinances have been adopted by several of the cities in the watershed. These ordinances occasionally include fines for non-compliance. Code Enforcement personnel are the most likely to be given the authority to cite violators. Additionally, Fire Department, Health Department and Animal Control staff also enforce improper disposal regulations. The City of Santa Fe Springs and Caltrans also post signs stating No Dumping and No Littering to deter littering.

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D. COORDINATION WITH STATE NON-STORMWATER PERMITS

In order to characterize the nature of the existing non-storm discharges in the receiving waters within the watershed, a list of NPDES Permits issued by the Regional Board will be obtained. This will help in determining unexpected discharge during dry weather and to allow enforcement actions to focus on illegal dumping activities.

There is also a need to coordinate with other environmental agencies to ensure that requirements imposed by these agencies do not conflict with stormwater regulations. Requirements of many agencies do complement stormwater regulations. These agencies, include but not limited to, Fish and Game, DTSC, USEPA, and the Coastal Commission. Coordination with these agencies will help minimize overlapping investigations and result in a more efficient use of resources. A watershed wide concept will be developed by December 1996.

1. IDENTIFICATION OF PERMISSIBLE/PERMITTABLE DISCHARGES

A list of non-stormwater discharges that can be allowed to discharge into the Waters of the State will be established by the Regional Board.

2. APPROPRIATE MANAGEMENT PRACTICES

Continued communication with the Regional Board will allow current information to be circulated among all agencies.

3. REPORTING

Any conflict in requirements of other environmental programs/agencies must be reported immediately to the Regional Board for ruling as to which one should take precedence.

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III. INDUSTRIAL/COMMERCIAL SOURCES

Each Permittee shall develop and implement a program that focuses on the identification and control of storm water pollutant discharges from industrial/commercial facilities within their jurisdiction. This program shall provide for the inspection of a facility's compliance with storm water regulations, as well as general outreach for all facilities that are potential industrial and commercial dischargers.

Each Permittee is responsible, under the requirements of the Municipal Stormwater Permit, for all discharges from commercial and industrial facilities within its jurisdiction. Many industries are also required to be permitted under the State General Industrial Activities Stormwater Permit. Enforcement of the specific provisions of the State General Permit is the responsibility of the State.

A. IDENTIFICATION OF SOURCES

As required under the current Permit, the Permittees have produced a listing of industries by SIC category for each drainage area. Also a breakdown of major land use types was also performed for each drainage area.

A pollutant source identification program will be designed to identify significant pollutant sources (i.e., parking lots, industrial activities, etc.), with the hope that remedial action can be undertaken to reduce any significant impacts so identified. It will focus on monitoring very small areas (i.e., less than five acres) where a specific and/or interrelated set of pollutant generating activities are occurring. Its objective is to provide data for selecting BMPs for specific activities rather than characterizing discharges for long-term pollutant loading estimates.

Identification of pollutant sources can be done using a number of methods. Potential sources of storm water pollutants can be identified by records of chemical use and/or storage, by studies of specific activities which lead to the deposition of pollutants throughout the watershed, and by field inspection or monitoring. Watersheds which may contain significant pollutant sources can be identified through land use information or by mass load estimates.

By mid January 1995, the County will begin targeted monitoring of a municipal corporation yard in the Santa Monica Bay watershed. This will provide data on industrial activities which can take place at such a facility such as vehicle maintenance and repair, materials storage, equipment storage and repair. A more comprehensive program to identify various pollutant sources will be developed by March 1997.

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1. CATEGORICAL LIST

Sources identified as a categorical industry regulated by the U.S. Environmental Protection Agency (EPA) will be grouped into a categorical listing of industries. The categorical list provides an organized overview of the target facilities that, based on land use, operation, and activities, could potentially contribute significant amounts of pollutants into storm water runoff. Some of the industrial categories regulated by the U.S. EPA include, but not limited to:

- Aluminum Forming
- Asbestos Manufacturing
- Battery Manufacturing
- Canned & Preserved Fruits & Vegetables
- Cement Processing
- Copper Forming
- Electroplating
- Glass Manufacturing
- Grain Mills
- Machinery Manufacturing & Rebuilding
- Soap & Detergent Manufacturing
- Metal Finishing
- Metal Molding & Casting
- Oil & Gas
- Organic Chemicals & Plastics & Synthetic fibers
- Paint Formulating
- Pesticides
- Plastic Molding & Forming
- Rubber Manufacturing
- Sugar Processing
- Textile Mills

2. RANKING

Industrial and commercial facilities identified as pollutant sources shall be ranked in order of priority for development of management measures. Facilities considered to be high priority are those whose operations and activities are determined to potentially contribute the most significant pollutant impacts to storm water discharge.

3. UPDATE PROCEDURE

Each year the Co-Permittees will evaluate the results of the monitoring program, the illicit discharge investigation program, and other available information , to identify likely sources of specific pollutants. The annual report to the California Regional Water Quality Control Board, Los Angeles Region (Regional Board) will recommend a strategy for pollutant source identification during the following year, including specific sites and/or activities to be monitored.

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B. CONTROL MEASURES

Specific urban runoff control programs for major potential pollution sources shall be developed by March 1997. Within these programs storm water pollution control measures shall be developed for various pollutant sources. Control measures such as source control and treatment control offer different, but complimentary approaches to storm water pollution control.

Source control measures focus on good housekeeping practices, pollution prevention and minimization, and education. They are also less costly than treatment controls.

Treatment controls involve physical treatment of the runoff, usually through structural means. Also treatment controls will not remove all pollutants and their removal efficiency is difficult to predict given the limited understanding of the relationship between facility design criteria and performance.

The initial focus will be on the development of source control measures. As information is collected under the pollutant source identification program regarding specific pollutant sources, specific control measures, including structural, will be evaluated as to their effectiveness in addressing these sources.

1. POLLUTION PREVENTION MEASURES

Source minimization and education are the first steps in effective source control. Other activities that contribute to source control are:

- Site design alternatives (i.e., roof over fueling stations and carwash slab, provide spill containment curb around stored material, etc.)
- Good housekeeping practices

2. STRUCTURAL (TREATMENT) MEASURES

A variety of treatment control measures have been utilized throughout the country for storm water quality. However, the effectiveness of these controls are highly dependent on local conditions such as climate, hydrology, soils, groundwater conditions, and extent of urbanization.

Some of the more common treatment controls are:

- Oil/water separators - Oil/water separators are designed to remove one specific group of contaminants: petroleum compounds and grease. However, separators will also remove floatable debris and settleable solids.

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- Infiltration - A family of systems in which the majority of the runoff from small storms is infiltrated into the ground rather than discharged to a surface water body. Infiltration systems include: ponds, vaults, trenches, dry wells, porous pavement, and concrete grids.

- Wet ponds - A wet pond has a permanent water pool to treat incoming storm water.

- Constructed Wetlands - Constructed wetlands have a significant percentage of the facility covered by wetland vegetation.

- Biofilters - Biofilters are of two types: swale and strip. A swale is a vegetated channel that treats concentrated flow. A strip treats sheet flow and is placed parallel to the contributing surface.

- Extended Detention Basins - Extended detention basins are dry between storms. During a storm the basin fills. A bottom outlet releases the storm water slowly to provide time for sediments to settle.

- Media Filtration - Media filtration consists of a settling basin followed by a filter. The most common filter media is sand; some use peat/sand mixture.

- Multiple Systems - Multiple systems are a combination of two or more of the preceding controls in series.

C. OUTREACH

General outreach for all facilities that are potential industrial and commercial dischargers shall be set up area-wide by the Management Committee, to provide general guidance in complying with the storm water program by March 1997. It shall also serve as a reminder of pollution prevention measures and keep facilities informed of their obligations to the storm water program.

Subcommittees may be established to develop specific outreach materials for industrial and commercial categories and specific activities that are identified as high priority.

For additional information on outreach, refer to **Chapter VII Public Information and Participation.**

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D. INSPECTIONS

Most municipalities have existing programs such as industrial waste, fire, and health in which industrial and commercial facilities are inspected on a regular basis. Each Permittee may elect to have inspections for the storm water program incorporated into these existing inspection programs, or be done as a completely separate program, depending on the needs of the Permittee.

The purpose of these inspections is to ensure that facilities are in full compliance with the storm water regulations and to ensure that control measures are being implemented. The frequency of inspection of facilities will be prioritized based on the operation and categorization of the facility.

Inspectors consisting of public personnel will be trained adequately to recognize and handle problematic activities concerning storm water pollution that may be existing or potential; and inspect for the deterioration of the storm drain system and illegal/improper connections. Training programs will be developed through the Watershed Management Committee and possibly specific Permittees for use by all Permittees.

Procedures for the identification, investigation, enforcement, and prosecution to the full extent of a jurisdiction's legal authority will be developed.

Los Angeles County issues permits to all commercial and industrial facilities that generate industrial wastes. Included within this program are auto related businesses, gas stations, and restaurants. Facilities with industrial waste permits are regularly inspected. In addition to those businesses in the unincorporated areas, the County Department of Public Works also provides industrial waste inspections, under contract, to approximately one third of the cities in the watershed. Six cities report that they have implemented their own inspection programs, with a broad range coverage. One city has just begun its program; another city does periodic checks for compliance with waste disposal regulations. Inspections, in two cities, are made in response to complaints; one city handles the program through its code enforcement staff; and two more cities inspect only auto related businesses and restaurants on a regular basis.

Three additional cities, Industry, Santa Fe Springs and Long Beach report that they have extensive inspection programs. Caltrans inspections include daily examination of auto related facilities, leak testing of gas stations once per year, quarterly pumping of clarifiers, and constant storm drain monitoring.

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1. CHECKLIST

Inspectors shall have a uniform checklist to use as guidance and reference throughout an inspection. It may also serve as a general guide for the public, providing information about the requirements necessary to comply with the storm water regulations.

2. SCHEDULE

The inspection program shall be developed by March 1997. The frequency of inspections shall be scheduled according to the type of operation and the categorization of the facility. Revisit inspections shall be done on an as needed basis.

3. REPORTS

Inspectors shall report on all activities related to and/or violating the local storm water ordinance to the local governing agency. Standard reporting procedures will be developed.

4. FOLLOW-UP PROCEDURES

Individual Permittee review and assessment of the reports may result in the need for follow-up procedures, such as reinspection or legal action, provided the jurisdiction has the adequate legal authority to do so. Follow-up procedures will be developed to insure a uniform and consistent approach.

E. LOCAL INCENTIVE PROGRAMS

In developing the industrial/commercial program, the Permittees may consider the development of optional measures such as clean business incentive programs that may offer more focused control on industrial and commercial sources. The targeted completion date for this phase is March 1997.

F. TRAINING

Development of training programs for industrial storm water inspection staff is projected to be completed by March 1997.

1. PUBLIC EMPLOYEES

All public employees shall be trained in the storm water regulations so that they abide by the regulations in the course of their work day. Also they need to be able to recognize and distinguish between legal and illegal activity so as to administer the proper protocol in handling the situation.

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Caltrans employees have received education in hazardous substance spill awareness, pesticide safety and vegetation management. The Los Angeles County Department of Public Works has requested all employees to report any observed water quality problems.

2. INSPECTORS

Inspectors who visit industrial and commercial facilities shall be adequately trained to determine compliance with the storm water regulations and educate the facilities about the requirements of the program. In addition, they should be able to recognize and handle immediate problems as they are encountered, during an inspection; and inspect for the deterioration of the storm drain system and illegal/improper connections. Citation training will be necessary for inspectors in agencies that have the citation authority.

G. COORDINATION WITH STATE INDUSTRIAL STORM WATER PERMIT

The Permittees have existing local ordinances governing industrial discharges and other non-stormwater discharge that require compliance activities similar to those in various State Regulations. Because coordination between the Permittees and the Regional Board is anticipated concerning the regulations of industries, a mutual agreement may be required regarding industrial inspections and enforcement. Additional issues could also be addressed. Federal stormwater regulations hold local municipalities responsible for stormwater discharges from all industrial/commercial facilities, including those covered by General Permit.

1. MEMORANDUM OF UNDERSTANDING

A Memorandum of Understanding (MOU) may be used to formalize the agreement between municipalities and the Regional Board on industrial compliance program issues. A MOU among all local agencies may also be needed to ensure co-operation between all the agencies. The need for and specific requirements for such agreements would be developed upon completion of development of the industrial/commercial program by March 1997.

2. REPORTS

The MOU discussed above may include the exchange of information between the Permittees and the Regional Board. Appropriate formats for such reports would be developed as required.

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IV. NEW DEVELOPMENT AND REDEVELOPMENT

Managing stormwater and runoff from both new construction and redevelopment, will reduce pollutants from entering the storm drain system and subsequently the receiving water.

A. PLANNING PROCESS

Quality of stormwater discussion should be included in the General Plan and the Zoning ordinances. Efforts to enhance the quality of storm water can filter into the Subdivision actions. Much of the storm water concerns can be channeled through the compliance effort of the California Environmental Quality Act (CEQA). A watershed-wide concept will be developed by June 1997.

1. WATERSHED PROTECTION POLICIES

An integrated strategy will be developed for the watershed. Pollution control efforts should be prioritized. A variety of statutory and regulatory requirements could be used for this watershed oriented program. Watershed protection policies need to be adopted by the local jurisdictions which control land-use within the watershed.

Caltrans requires contractors to submit plans for water pollution controls during construction activities. Construction activities may be halted if inadequate provisions have been made for water quality protection.

2. COORDINATION WITH CEQA

The current CEQA "Environmental Checklist Form" that is used for initial studies assessment indirectly address potential impacts to stormwater. Additions could be made to the Form to directly assess stormwater quality impacts.

CEQA requires agencies to use feasible alternatives or mitigation measures to lessen potentially significant effects. The ability to identify a.) when an effect is significant, and b.) which mitigation measures could be adopted to reduce the effect, is critical to the CEQA process. A clear assessment of any development, its potential adverse impacts on stormwater quality will allow for a determination of "significance" which will enable the decision maker to make development decisions upon full disclosure of possible adverse impacts.

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3. SITE PLANNING PROCESSES

All development will require the review and approval of a site/plot plan or development drawings prior to issuance of a building permit. Incorporating the consideration of potential water quality impacts including erosion and sedimentation during the early stages of the planning process will allow these issues to be addressed before substantial investments in engineering and design have been made.

4. GENERAL PLAN CHANGES

The General Plan is the legal backbone of the planning process. All development approvals, zoning ordinances, subdivision approvals and public works projects must be consistent with the policies, objectives, and principles set forth in the General Plan. Discussion of stormwater issues in the General Plan could greatly enhance the awareness of the issues and encourage full assessment of possible adverse impacts on stormwater quality as the result of new and redevelopment.

5. USE OF MASTER PLANS

For agencies which utilizes master plans to guide their development activities, stormwater issues can be outlined in such documents. This will channel efforts to fully assess the possible adverse impacts on stormwater quality as the results of any development within the master plan area.

6. OTHER POLICIES

Numerous other policies or mechanisms could be used to incorporate stormwater management goals into the planning/development process. Other concepts will be evaluated for their feasibility during the more detailed development of this Chapter.

7. PLANNING-PUBLIC WORKS INTERFACE

A variety of mechanisms for coordinating planning and public works activities exist. An example could be some form of CIP (capital improvements program). Ideally, any planning documents which target or project population growth are coordinated with CIP. Integrating stormwater management into CIP will allow for mitigation of major adverse impacts on the quality of stormwater prior to any actual construction.

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8. IMPLEMENTATION PROCEDURES

Implementing policies to integrate stormwater management considerations with existing planning/development mechanisms will require a variety of approaches depending upon the existing conditions within each Co-Permittee and the particular remedies selected. It is anticipated that each Co-Permittee will propose procedures applicable to it's unique jurisdictional considerations at later stages in the permit process.

B. CONSTRUCTION SITES

Pollutants from construction activities can have a major impact on the quality of stormwater/urban runoff. A watershed wide concept to reduce such pollutants will be developed by December 1996.

1. EROSION CONTROL REQUIREMENTS

Federal stormwater regulations hold local municipalities responsible for stormwater discharges from all construction sites. In addition, construction sites involving a total of five acres or more of land disturbance are required to apply for the State General Construction Activity Storm Water Permit (GCASP). The GCASP: 1) eliminates or reduce to the extent feasible non-storm water discharges from construction sites and 2) permits stormwater discharges, but requires the use of controls to limit pollutant loading in site effluent. Preparation of a Stormwater Pollution Prevention Plan and identification/utilization of BMPs are the key components of this Permit.

Many local agencies also have erosion control requirements for any grading and construction activities. Regulation of pollutants from construction sites of five acres or less will be done by the local agency through its stormwater management plan.

Construction site erosion has the potential to introduce sediment into runoff. For example, fugitive dust control at construction sites typically use water. Minor modifications/clarification of existing fugitive dust practices could substantially address runoff pollution concerns. In addition to fugitive dust control practices, additional measures could be adopted to curtail dry weather runoff, and control pollutant laden storm water runoff. These measures may address 1) physical site design considerations and 2) temporal considerations such as seasonal timing and phasing of activities.

Sixteen jurisdictions within this watershed have existing erosion control requirements within their municipal codes. Seven jurisdictions plan to prepare runoff control ordinances, while four have already identified or

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drafted ordinance texts. The City of Covina requires 90% landscaping on newly developed land within one year and 100% landscaping within 3 years.

2. CHEMICAL AND WASTE MANAGEMENT REQUIREMENTS

Chemical and waste handling activities are also currently subject to a variety of regulations. BMPs to address this pollution source are largely centered around "good housekeeping practices". It involves storing, handling, using, and disposing of these potential pollutant sources in ways that restrict opportunities for unintended introduction of the materials into site runoff. Proper chemical and waste management will reduce any accidental discharge into the storm drain system.

3. INSPECTIONS

Inspections are a routine part of local jurisdictions oversight of regulated construction activity. Its purpose is to ensure that construction site runoff control measures are being implemented. Existing practices should be examined and modified accordingly to satisfactory stormwater/urban runoff objectives.

a. Checklist

A checklist would encourage possible streamlining of any requirements. It could be cumbersome if an overly rigid approach were taken which resulted in unnecessary administrative burden. However, careful design of the checklist could avoid this pitfall.

b. Schedule

Inspection schedules will depend upon existing practices. It may be desirable to have several schedules, depending upon the types of activities/permits and/or the timing of activities.

c. Reports

A standardized reporting format is needed to allow for consistency among all jurisdictions. Furthermore reports are also a useful tool for future refinement of pollution control regulations.

d. Follow-up Procedures

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A format will be developed to do follow-up inspections on problem facilities. Its frequency will greatly depend on the land use and the degree of non-compliance of each facility.

C. LOCAL PERMITS

Permits are a form of "cross checking" by local agencies to ensure that regulations are being implemented. Prior to the issuance of a permit, information must be submitted for review and approved. A watershed wide concept to provide some consistency in local permits will be developed by June 1997.

1. COORDINATION WITH EXISTING PERMITS

Storm water issues should be incorporated into existing permits.

2. NEW PERMIT ISSUES

Storm water issues should be clearly stated in new permits to be issued for new and/or redevelopment activities.

D. TRAINING

Training will enable staff to keep current of the latest storm water regulations. A watershed wide staff training concept will be developed by June 1997.

1. PLANNING PERSONNEL

(See E.1.b. below)

2. PUBLIC WORKS PERSONNEL

(See E.1.b. below)

3. INSPECTORS

(See E.1.b. below)

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E. CONTROL MEASURES

Best management practices for the control of construction related pollution can generally be divided into three categories:

Nonstructural Source Controls for Reducing Urban Stormwater Pollutants:

- Practices that reduce the generation and accumulation of potential stormwater contaminants at or near their source.

Development Layout Stormwater Controls:

- Practices that are directed at controlling the volume and discharge rate of runoff from urban areas, as well as, reduction of the magnitude of pollutants in discharges through temporary storage or flow restrictions.

Erosion and Sediment Controls:

- Practices that can prevent or treat problems related to transport of eroded material from construction and other land disturbing activities.

Development layout stormwater controls are of particular interest. These control measures can be incorporated in the initial planning phase of any project. A watershed wide concept will be developed by June 1997.

1. POLLUTION PREVENTION MEASURES

a. Site Design

Effective implementation of urban BMPs requires integration of water quality control elements early in the site planning and design process. Development of the water quality controls should not only achieve maximum pollutant removal with minimal costs, but also reduce potential maintenance.

This may include incorporating water quality concerns into the site layout and design (ie. maximize pervious areas, minimize directly connected impervious areas, etc.) and/or treatment control measures proven to be cost effective for local climate, soil, and development conditions.

Due to the diversity of climate and local conditions, the development of BMPs vary from location to location, and even jurisdiction to jurisdiction. The selected management practices should be designed

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for the local site conditions and especially seasonal rainfall conditions that are experienced in Southern California. Suitability for the major land use and drainage characteristics should also be fully assessed.

b. Education/Training

Education/training is imperative to the success of any BMPs selected for new or redevelopment projects. BMPs will fail if not properly designed, installed, and maintained. Only well trained personnel should be assigned to these responsibilities.

A program for effective education/training should be based on four objectives:

- Promote a clear identification and understanding of the problem, including activities with the potential to pollute stormwater;
- Identify solutions (structural and nonstructural BMPs);
- Make every employee responsible for stormwater pollution and its solution; and
- Integrate employee feedback into training and BMP implementation to improve BMPs.

c. Other

In many cases stormwater pollution control may already be achieved by existing regulations or programs. In California, the General Plan Law and the California Environmental Quality Act (CEQA) provide a basis for municipalities to review and comment on all projects within their jurisdiction. Under the General Plan Law, municipalities are required to develop policies and regulations which guide development within the municipality. Each development project is then reviewed for conformance with these policies. Under CEQA, projects are also subject to review and comment for any adverse impact the projects may have on the environment, including impacts from stormwater discharges.

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2. POST CONSTRUCTION (TREATMENT) MEASURES

a. Applicability

Each site considered for development or redevelopment will (at the conclusion of construction) have final improvements and unique site characteristics such as: drainage patterns; soils; landscaping; topography; percent of impervious surfaces; rainfall; pollutants inherent with the use of the development; and pollutants that may be background to the area (existing vegetation, air fallout, etc.). The applicability of various treatment control BMPs for use in new development will be evaluated through the use of pilot studies and examination of studies done on treatment control measures by other agencies.

b. Effectiveness

Prior to implementing any treatment control measures, they will need to be evaluated for their effectiveness. This can be done through pilot studies which could include elements such as: pre and post storm event inspections; water quality monitoring; record keeping to document deficiencies in the BMPs; Operation & Maintenance requirements; and cost effectiveness.

c. Retrofit Opportunities

The feasibility of retrofitting existing developments with treatment control measures will be evaluated. However, the effectiveness of a treatment control measure versus its cost must be fully evaluated prior to considering its use as a retrofit measure.

3. OPERATION AND MAINTENANCE

a. Requirements

Jurisdictions within the watershed will need to insure that BMPs incorporated into a private development are properly maintained. Deed restrictions, covenants, conditions and restrictions (CC&R) could be used to direct such requirements and responsibilities.

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b. Responsible Party

The contractor, during construction, must ensure that the post-construction BMPs are installed properly and that any maintenance that may be necessary during construction is performed. After the project is completed, it will then be the responsibility of the fee owner, private or public, to provide for long term operation and maintenance. This may be accomplished by deed restriction and/or CC&R.

4. CONFLICTS WITH OTHER MANDATES

Often regulations of various Federal, State, and local agencies would conflict with each other. Health, fire, and building codes often have requirements focusing on short term human health and safety and neglecting the impacts on the environment.

a. Identification of Conflicts

As the Plan is developed, other regulatory requirements that conflict with the stormwater program requirements may be uncovered. Clarification of these regulations should be directed to the various responsible regulatory agencies.

b. Conflict Resolution

For regulatory conflict caused by local regulations, efforts will be taken to resolve them within the agencies. Input form other local, state, and federal agencies should be incorporated into a modification of current standards. The Regional Board should resolve conflicts involving other State and/or Federal requirements.

F. OUTREACH

See **Chapter VII Public Information and Participation.**

G. ENFORCEMENT

The City of Industry requires a Storm Water Pollution Prevention Plan and copies of a Notice of Intent prior to issuance of a grading permit. Also, all field personnel must attend an NPDES information session.

See **Chapter II Illicit Discharges, Section C Enforcement Procedures** for additional information.

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H. COORDINATION WITH STATE GENERAL CONSTRUCTION ACTIVITIES STORM WATER PERMIT

1. MEMORANDUM OF UNDERSTANDING

An agreement between the Regional Board and Co-Permittees may be used to enhance compliance of construction site BMPs. The need for such an agreement will be evaluated. If found to be desirable, an agreement will be developed by June 1996.

2. REPORTS

The local enforcement agency of the State Construction Stormwater Permit, which is the Regional Board, should forward all information, including Notices of Intent filed and any inspections and enforcement actions taken, to the Permittees so that this information can be available to local municipal construction site inspectors to alert them to any specific concerns on the job site.

3. OTHER ISSUES

The Regional Board should explore funding to be channelled to the Co-Permittees so the Co-Permittees can be more actively involved with the State on the Permit.

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V. PUBLIC AGENCY ACTIVITIES

All municipalities perform functions that have an impact on stormwater quality. These include, among other things, vehicle maintenance, landscape maintenance, weed control, water body maintenance including swimming pool maintenance, etc. Other activities such as construction and maintenance of streets and roads, and construction and maintenance of the flood control system also could directly or indirectly cause adverse impact on the quality of stormwater/urban runoff. Since municipalities must address all significant sources of pollutants, all of these activities must be examined and mitigation measures be incorporated into the routines. As part of the requirements of the current Permit, many of the Permittees have already begun implementation of measures to address the above activities. An examination of these existing measures will be done on a watershed wide basis to establish the most effective approach to address these activities. Such approaches shall be developed and begin implementation by September 1997.

A. SEWAGE SYSTEMS

Sewage spills must not be allowed to enter the storm drain. Control procedures for identifying, repairing, and remediating sewer blockages, infiltration, inflow, and wet weather overflows from the sewers to the storm drain system should be implemented to protect stormwater quality. These procedures could include, but are not limited to, quick field response to overflows, follow-up testing, and complaint investigation.

When sewage spills do occur, they must be contained and collected for proper disposal. Individual permittees may need to modify their sewage overflow response procedures. The field personnel should also have procedural training for field screening, sampling, smoke/dye testing, and TV inspection, if appropriate, to be able to properly investigate any suspect connections or cross connections to the storm drain system.

Los Angeles County has a number of programs aimed at preventing sewage spills from entering the storm drain system. These include the following:

- Sewage Overflow Response Procedures Revision/Root Control Review - This involves improvement of procedures for containment and cleanup of spilled sewage resulting from overflow.
- Reline Sewer Lines - Two locations will undergo relining of existing sewer lines to prevent infiltration and exfiltration.
- Sewer Pipeline Reconstruction - One hundred and twenty-seven miles of cement pipelines will be analyzed and replaced or rehabilitated within 5 years.

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- Sealing of Manhole Covers - This program has sealed manhole covers and bar holes in areas subject to flooding.

- Expansion of Emergency Call List - Beeper numbers of all supervisors, superintendents and stand-by crews were added to emergency call list.

B. CORPORATION YARDS

Corporation yards include any area or facility that is used for vehicle maintenance or washing, other maintenance, chemical storage, paint facilities, and supportive activities for field crews. Permittees will need to incorporate pollutant control measures at these facilities and develop a plan for each facility outlining the measures to be implemented. Since these are industrial type activities, the corporate yards would need to implement measures as described in the Industrial/commercial Source Chapter.

1. STORM WATER POLLUTION PREVENTION PLANS (SWPPP)

Though not required, permittees may elect to use some form of SWPPP as a vehicle for compliance. Any BMPs to be implemented must be part of a comprehensive plan designed to address the various pollutant sources at each corporate yard. To achieve this goal, the municipalities should first identify the potential pollution sources and who is responsible for implementing the storm water management measures. Based on the facility type, management practices and schedule of implementation will be developed. BMPs that can be used to improve the quality of runoff include, but are not limited to, housekeeping practices, material storage control, vehicle leak and spill control, and illegal dumping control.

Los Angeles County has incorporated the following measures intended to control pollutants from entering the storm drain at County-owned airports:

- Airport Runoff Structural Controls - A number of structural controls including fuel pumps located under a roof, storm water diversion system with clarifiers, concrete beams for secondary containment of waste oil, oil and water separator at floor drains, retention ponds, infiltration basins and sand filters have been implemented at County airports.

- Airport Cleaning and Maintenance - A number of non-structural controls including washing of aircraft in designated areas with oil and water separator, aircraft maintenance performed indoors and waste oil recycling have been implemented at County airports.

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- Airport Materials Handling and Storage Controls - Measures to prevent spills of polluting materials have been in effect at County airports.

- State Approved NPDES Industrial Activity Permit - This program requires all airports to ensure compliance with State Water Resources Control Board.

Caltrans will develop a priority list of drains and pump houses requiring cleaning. Open storm channels in two City of Covina parks are cleaned monthly and before predicted storms. The City can also require the cleaning of privately owned storm drains.

2. OUTDOOR LOADING/UNLOADING OF MATERIALS

Municipal employees who handle potentially harmful materials should be trained in good housekeeping practices to prevent or reduce the discharge of pollutants to storm water from outdoor loading/unloading of materials. Materials spilled, leaked or lost during loading/unloading may collect in the soil or on other surfaces and be carried away by runoff or when the area is cleaned.

Applicable BMPs should be selected based on the following four factors: 1) Extent of exposure of material to rainfall, 2) preventing stormwater run-on, 3) checking equipment regularly for leaks, and 4) containing spills during transfer operations.

3. MATERIAL STORAGE CONTROL

A program should be developed to prevent or reduce the discharge of pollutants to storm water from outdoor container storage areas using measures such as installing safeguard again accidental releases, secondary containment, conducting regular inspections, and training employees in standard operating procedures and spill cleanup techniques. Employee education is paramount for successful implementation. Employees should be trained in emergency spill cleanup procedures.
To limit the possibility of storm water pollution, containers used to store dangerous waste or other liquids should be kept inside the building unless this is impractical due to site constraints. Storage of reactive, ignitible, or flammable liquids must comply with the fire and California OSHA codes. Practices such as placing containers in a designated area should be employed to enhance such requirements.

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4. VEHICLE AND EQUIPMENT WASHING AND MAINTENANCE

Washing vehicles and equipment outdoors or in areas where wash water flows onto the ground can pollute storm water. For municipalities that wash vehicles or pieces of equipment on-site, it should be performed in a designated area equipped with an oil/water separator.

Vehicle or equipment maintenance is a potentially significant source of storm water pollution. Parts are cleaned with solvents. Many of these cleaners are harmful and must be disposed of as a hazardous waste. Appropriate BMPs are waste reduction, use of alternate products, recycling, and spill leak clean up control.

The City of Covina is expanding its efforts to recycle materials and intercept debris from its own vehicle maintenance program.

5. WASTE HANDLING AND DISPOSAL

Proper waste management is possible by tracking waste generation, storage, and disposal; reducing waste generation and disposal through source reduction; and preventing run-on and runoff from waste management areas.

C. PARKS AND RECREATION

Park Departments manage landscaping and swimming pools. Both of these activities involve the use of chemicals, waste management, and non-storm water discharges. In addition maintenance of swimming pools requires the periodic discharge of large quantities of swimming pool water.

1. FERTILIZERS/PESTICIDES

a. Use/Application management

Municipal facilities should develop controls on the application of pesticides, herbicides, and fertilizers. Control may include:

- List of approved pesticides and selected use;
- Product and application information for users;
- Equipment use and maintenance procedures; and
- Record keeping.

Employees can be educated about environmentally sensitive alternative products by using information developed by various public agencies and other environmental organizations.

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b. **Storage**

Improper storage of fertilizers and pesticides can lead to potential groundwater, soil, and stormwater contamination. To prevent or reduce their impact on stormwater pollution, material storage areas must be designed and maintained to reduce exposure to storm water. The following BMPs can help to achieve this goal:

- Store materials inside or under cover on paved surfaces,
- Use secondary containment,
- Minimize storage and handling of hazardous materials,
- Inspect storage areas regularly.

2. **FACILITY MANAGEMENT**

a. **Wash Waters**

Wash waters cannot be discharged into the storm drains untreated. The storage area should be slightly sloped for wash water collection. If the water is not discharged to the sanitary or process waste sewer, or to a dead-end sump, the outlet should be equipped with an oil/water separator or other treatment systems.

b. **Maintenance**

Landscape maintenance involves the use of pesticides and fertilizers. Proper use of these materials will reduce the risk of loss to storm water. Whenever possible, leave or plant native vegetation to reduce water, fertilizer, and pesticide needs. Integrated pest management should be employed where appropriate. The Park Departments should also establish a schedule for irrigation and fertilization. The chemicals will be carried from the site by the next storm if they are applied during the wet season. Overwatering leads to discharge of water that may have become contaminated with nutrients and pesticides.

Storm water from parking lots may contain undesirable concentrations of oil, grease, suspended particulates, and metals as well as the petroleum byproducts of engine combustion. Possible maintenance BMPs include periodic sweeping and cleaning catch basins.

The City of Covina has modified handling of its own green waste so that it is less likely to be scattered by the wind.

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c. **Swimming Pool Waters**

The drainage of swimming pool water must insure that chlorine residual is below allowable water quality limits. The potential for recycle/reuse for irrigation of lawns and landscapes may be investigated. Swimming pool filter backwash waters should not be discharged to the storm drain, but should be allowed to settle and then disposed to the sanitary sewer. Other possible alternative measures would be to use the backwash for irrigation or disposal on a dirt area.

D. STORM DRAIN SYSTEM OPERATION AND MANAGEMENT

The maintenance and operation of the storm drain system has an impact on storm water quality and must be addressed. Material clogging storm drains cannot be discharged into drains. It must be disposed of properly.

1. INLET MAINTENANCE

Regular maintenance of public and private catch basins and inlets is necessary to ensure their proper function. Maintenance will remove pollutants, reduce high pollutant concentrations during the first flush of storms, prevent clogging of the downstream conveyance system, and restore the catch basin's functional capacity. Keys to effective catch basin cleaning include the following:

- All basins should be cleaned annually prior to the onset of the rainy season;
- Clean catch basins in known problem areas more frequently to remove sediments and debris accumulated during the dry weather months;
- Keep records of the number of catch basins cleaned; and
- Track the amount of waste collected.

Twenty-seven jurisdictions clean their catch basins at least annually. The Cities of Covina and Azusa clean their catch basins on an as needed basis, and Caltrans once every two years.

2. DRAIN MAINTENANCE

Open channel storm drains should be cleaned at least annually prior to the rainy season. Problem areas should be cleaned more frequently as needed. Channels should also be monitored during the rainy season for any debris buildup and cleaned where needed.

Los Angeles County field personnel inspect open channels and sumps to clean debris and prevent them from entering the ocean.

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Caltrans will develop a priority list of drains and pump houses requiring cleaning. Open storm channels in two City of Covina parks are cleaned monthly and before predicted storms. The City of Covina can also require the cleaning of privately owned storm drains.

3. WASTE MANAGEMENT

Excessive waste buildup will decrease the capacity of the channel, it is therefore crucial to reduce pollutant levels in storm water by regularly removing illegally-dumped items and material from storm drainage channels and creeks. A program should be developed to identify problem areas of illegal dumping so regular inspection and clean up can maintain the channel's optimum capacity and prevent the discharge of contaminants.

4. NEW SYSTEM DESIGNS

Current design standards for the construction of new storm drain systems will be evaluated in light of currently available pollutant control measures. Design standards may be modified to incorporate measures deemed appropriate for local conditions.

5. RETRO-FIT OPPORTUNITIES

The majority of the existing storm drain systems are in highly urbanized areas providing little opportunity for cost effective retro-fitting. However, currently available pollutant control measures will be reviewed for their effectiveness and possible use. This may include pilot studies to evaluate the performance of management practices under local conditions.

E. STREETS AND ROADS

Construction, operation, and maintenance of roads has an impact on storm water quality and will be addressed in the management plan.

1. SWEEPING

Street sweeping can collect refuse on street surfaces to prevent it from entering the storm drain system through catch basins.

a. Storm Water Quality Based Operation

In order to effectively implement the sweeping program, the permittees should keep accurate operation logs to track the program. Areas generating excessive refuse should be swept more frequently.

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Sweeping frequency may also be increased before the rainy season to reduce the amount of refuse entering the storm drain system. Parking on sweeping days should be regulated to facilitate the operation.

Twenty-nine jurisdictions sweep their street surfaces at least one time monthly. Some of these jurisdictions perform street sweeping once per week. Caltrans sweeps its roadways on a regular schedule determined by observable debris. The City of Long Beach sweeps its alleys on a weekly basis.

b. Waste Management

Vehicles transporting waste should have spill prevention equipment that can prevent spills during transport. The refuse collected will be transported to the appropriate disposal facilities.

The City of Pico Rivera provides trash receptacles at all bus stops. They are emptied daily. Lakewood's roadside trash receptacles are emptied every other day. Seventeen jurisdictions provide weekly service of roadside trash receptacles while 6 jurisdictions service them every other week. The City of Covina requires covers on all refuse containers.

2. STREET/PAVEMENT WASHING

Wash waters from street/pavement washing may be contaminated and must be managed as non-storm water discharges.

3. MAINTENANCE

a. Saw-cut Slurry Management and Paving Practices

Existing saw-cut management and paving practices conducted by the Permittees will be evaluated and appropriate control measures developed. Possible control measures to be considered that would help reduce the impacts to storm water:

- Avoid paving during wet weather;
- Regularly repair potholes and worn pavement to reduce sediment loading;
- Store materials away from drainage courses to prevent pollution of storm water run-on; and
- Follow the storm water permitting requirements for industrial activities when mixing concrete with an on-site plant.

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b. **Waste Management**

Good housekeeping practices will be implemented to insure proper management of any waste products that may be generated during maintenance activities. For example, to prevent concrete waste from entering the storm drain system, washout of concrete trucks should be conducted off-site or on-site in designated area. Excess concrete should not be dumped on site. Employees and subcontractors should be trained in proper concrete waste management.

The following steps will help reduce storm water pollution from concrete wastes:

- Store dry and wet materials under cover, away from drainage areas;
- Avoid mixing excess amounts of fresh concrete or cement on-site;
- Do not wash out concrete trucks into storm drains, open ditches, streets, or streams;
- Do not allow excess concrete to be dumped on-site, except in designated areas;
- Avoid paving during wet weather;
- Regularly repair potholes and worn pavement to reduce sediment loading; and
- Cover catch basins and manholes when applying seal coat, tack coat, slurry seal, fog seal, etc.

Employee/subcontractor training to insure implementation of good housekeeping measures should be based on four objectives:

- Promote a clear identification and understanding of the problem, including activities with the potential to pollute storm water;
- Identify solutions (BMPs selection);
- Promote employee/subcontractor ownership of the problems and the solutions; and
- Integrate employee/subcontractor feedback into training and BMP implementation.

The City of Irwindale will develop contract specifications intended to reduce pollutants from paving operations.

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c. Medians/Landscaped Right-of-Way

i. Irrigation

Overwatering of landscaping produces runoff. A properly timed irrigation schedule should be set up to minimize overwatering. Drip irrigation system should be used when feasible in new installations.

ii. Fertilizers/Pesticides

The handling, storage, and usage of fertilizers/pesticides are addressed in Chapter V, Section C-1.

Caltrans has an existing Right-of-Way Maintenance Vegetation Control Program which ensures that the Right-of-Way areas are properly maintained and erosion free.

F. FLOOD CONTROL

Common municipal practices, such as construction and operation and maintenance of the flood control system, may have a potentially adverse impact on storm water quality. Consequently, these practices shall be coordinated to the extent of preventing pollutants from impacting the water quality.

1. COORDINATION WITH NEW PROJECTS

Current design standards for the construction of new storm drain systems will be evaluated in light of currently available pollutant control measures. Design standards may be modified to incorporate measures deemed appropriate for local conditions. During construction, all appropriate BMPs will be utilized to control pollutants during the construction of the facility.

2. COORDINATION OF MAINTENANCE ACTIVITIES

Current maintenance activities with regards to desilting/sediment removal, vegetation management, and waste management shall be reviewed to insure that appropriate management measures are developed to comply with the storm water regulations.

3. OPERATION OF FACILITIES

Flood control facility operations will be reviewed to identify where appropriate management measures could be incorporated. However, primary

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consideration will need to be given to the flood control function of the facility to protect health and safety.

4. RETROFIT OPPORTUNITIES

The majority of the existing storm drain systems are in highly urbanized areas providing little opportunity for cost effective retro-fitting. However, currently available pollutant control measures will be reviewed for their effectiveness and possible use. This may include pilot studies to evaluate the performance of management practices under local conditions.

G. PUBLIC FACILITIES

Storm water runoff and non-storm water discharges from other public facilities must also be addressed, including chemical use by these facilities, pressure blasting/cleaning sidewalks and other surfaces.

1. PARKING FACILITIES

Storm water from parking lots may contain undesirable concentrations of oil, grease, suspended particulates, and metals. Some control measures such as periodic sweeping and cleaning catch basins should be implemented. The need for more advanced structural controls would be evaluated through the pollutant source identification program. Pilot studies would be conducted on candidate structural controls to evaluate their effectiveness prior to large scale implementation.

2. GOLF COURSES

Golf courses require the use of large amount of water, fertilizers, and pesticides. Field personnel should be trained on the proper handling, storage, and usage of these chemicals (Refer to Chapter V, Section C-1 for detail). To prevent excess irrigation water from entering the storm drain system, proper management of watering schedules should be required.

3. SCHOOLS

The maintenance of playgrounds and athletic fields at schools require fertilizers and pesticides. Their safe storage and use affect not only the stormwater quality but also the health of the students and the staff. Therefore BMPs under Chapter V, Section C-1-b should be implemented. Each municipality should develop a program to encourage these schools to use environmentally sensitive products for fertilizers, pesticides, detergents,

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and other chemicals. The schools should have proper material handling, storage, and disposal procedures for chemicals used in school laboratories.

4. **HOSPITALS**

Each hospital should have BMPs to control the handling and storage of medically related hazardous materials. All materials should be inventoried regularly, with record keeping protocols on supply and consumption. All personnel should be trained on the proper procedures on handling these materials, as well as emergency response. Each hospital should maintain a list of supervisors to be contacted if accident does occur. Disposal of these materials should be contracted out to commercial specialists.

5. **PARKS/LANDSCAPES**

Refer to **Section C Parks and Recreation**, of this Chapter, for information.

6. **OTHER BUILDINGS/PLAZAS**

Refer to **Section C-2 Parks and Recreation - Facility Management**, of this Chapter, for information.

H. PONDS, FOUNTAINS, AND OTHER PUBLIC WATER BODIES

Maintenance practices used on public water bodies, including waste management and non-stormwater discharges, must be addressed in the plan.

1. ALGAE CONTROL

a. Use of Chemicals

The use of herbicides or other chemicals to control algae growth should be carefully controlled and monitored to insure strict adherence to manufacturers' guidelines for use. Water sampling may be necessary to insure effective control.

2. CHLORINE MANAGEMENT

The use of chlorine for disinfection should be controlled. High dosage of chlorine may be harmful to the aquatic habitats. Dechlorination of pools and other water bodies would be required prior to draining.

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3. MAINTENANCE

Each municipality should develop BMPs to prevent and control trash, debris, and other pollutants from entering water bodies. These measures could include routine trash collection along and on water bodies, public outreach to educate the public about the impacts of illegal dumping, and increase enforcement for violations.

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VI. RESIDENTIAL

INTRODUCTION

Residential activities including private vehicle washing and maintenance; use of chemicals such as pesticides, herbicides, and paints; private swimming pool maintenance; and other household and landscape maintenance can contribute to storm water pollution. These are all examples of non-point source pollution, a significant impact on water quality. Measures that can be taken to improve the quality of the runoff from residential area all require active public participation. Feasible BMPs to mitigate the stormwater pollution problem should include practicing good housekeeping and the use of environmentally sensitive alternative products, vehicle leak and spill control, and water conservation. Development of the residential stormwater program will be completed by December 1996.

A. HOUSEKEEPING PRACTICES

This BMP involves the development of a program to promote efficient and safe housekeeping practices (storage, use, and cleanup) when handling materials which may pollute stormwater/urban runoff. This could include, but are not limited to, fertilizers, pesticides, cleaning solutions, paint products, automotive products, and swimming pool chemicals.

A public education program will be developed to provide information on stormwater pollution and the beneficial effects of proper disposal on water quality; reading product labels; safe storage, handling, and disposal of hazardous products; list of local agencies; and emergency phone numbers. The above information can be disseminated through brochures or booklets made available at places such as public information fairs, municipal offices, and household hazardous waste collection events and facilities. City newsletter to residents is another means to inform the public, especially for those who do not participate or visit any offices or events.

In addition to the specific programs and plans outlined in this report, several watershed Co-Permittees have targeted activities occurring in and around the home that tend to contribute to degradation of storm water runoff quality. A practice that carries on-the-ground pollutants directly to storm drains is misuse of exterior water, namely the overwatering of landscaping, the hosing of driveways/sidewalks and the washing of cars in driveways--all of which allow water to run down the street into the nearest storm drain.

This situation can be addressed in two ways: 1) either reduce/prevent pollutants from being placed in areas where they may be carried by water into the streets or 2) minimize the amount of water allowed to flow on impervious surfaces that are connected to the street system.

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B. ENVIRONMENTALLY SENSITIVE ALTERNATIVE PRODUCTS

This BMP, promoting the use of less environmentally sensitive products, can be implemented in conjunction with housekeeping practices. Alternatives exist for most product classes including fertilizers, pesticides, cleaning solutions, and automotive and paint products. The key to success will be to promote a willingness to try alternatives and to modify old habits.

General information will be developed and made available to the public on such alternatives. The emphasis may be placed on the need to preserve the natural environment of the receiving waters (ocean, bay, stream, wetland, etc.) with the use of alternative products because of their less toxic nature and proper disposal after its use.

C. VEHICLE LEAK AND SPILL CONTROL

This BMP prevents or reduces the discharge of pollutants to storm water/urban runoff from vehicle leaks and spills by reducing the chance for spills, stopping the source of spills, containing and cleaning up spills, and properly disposing of spill materials.

Vehicles will leak and spill fluids. The key to successful pollution management is to reduce the frequency and severity of leaks and spills; and when they do occur, to prevent or reduce the environmental impacts. Through education, the public should be encouraged to regularly inspect and maintain their vehicles. Guidelines should be developed to inform the public on spill containment and cleanup procedures such as having absorbent material on hand and disposing the material properly.

D. WATER CONSERVATION

Water is a scarce resource, especially so in Southern California. Wasteful use of water could channel pollutants into the receiving waters. Practices such as hosing the driveway and overwatering the landscape contribute not only to stormwater pollution, but also to the depletion of our natural resource. In order to prevent stormwater pollution, the public has to be educated on the mechanics of our storm drain system - discharges into the system will flow untreated into the receiving water. They have to know that the lawn clippings they wash down the road will end up in the ocean. Public awareness of the function of the storm drain system, of the important of environmental health, and of our necessity to slow down the depletion of water resources will be a long way in reducing the pollution of stormwater/urban runoff.

Ordinances could be use to endow the related officials with legal authority to enforce water conservation. An ordinance prohibiting the wasting of water is one way of enforcement.

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Water conservation measures can be designed to address the issue of impervious surface water flow. While conservation has historically been used to conserve domestic water, many jurisdictions are now recognizing the additional benefit of prohibiting water flows from private properties onto the street system. Most Co-Permittees within this watershed implement or plan to implement water conservation programs. Most programs are supported by ordinance, although a few jurisdictions rely on voluntary compliance. Public outreach is a component of all programs, many of which carry fines for water wasting practices. Most jurisdictions encourage water efficient landscape, with several agencies noting that local parks and other public landscapes are designed to be water conserving. The La Habra Heights Water District conducts workshops on irrigation.

While some ordinances were established specifically to conserve water during periods of drought, several jurisdictions are keeping such controls in place at all times as measures to control non-stormwater runoff.

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VII. PUBLIC INFORMATION AND PARTICIPATION

It is necessary to involve the public in the stormwater program for it to be effective. The outreach program should be focused on the specific needs of the individual cities. Due to the inter-relationship among the stormwater issues, the public information and participation program should be recognized as a whole, rather than a number of separate outreach programs. All public awareness efforts should clarify to the public that they are the ultimate beneficiaries of a successful stormwater management program.

A. GENERAL OUTREACH

The targeted audiences of a general outreach will include municipal employees, local construction contractors, businesses in the area, and the general public. They should be made aware of their responsibility for both the problems and the solutions to stormwater pollution. In order to effectively communicate the stormwater pollution abatement message throughout the watershed; written, audio, and visual materials should be utilized. The actual level, priority, and schedule of public information activities must be based on the community's needs and resources to maximize program effectiveness. A watershed-wide concept will be developed by December 1995.

All Co-Permittees within the watershed have or are planning active, multi-media public outreach programs. Extensive efforts are being made or are planned by most Co-Permittees to supply the public with information on a full range of storm water quality activities with the intention of achieving a high level of public cooperation and participation. While many jurisdictions are in the early phases of program participation, there appears to be little hesitancy to implement the major suggested programs.

1. WRITTEN MATERIAL

Co-Permittees should produce a variety of written materials to inform the residents within the watershed. Materials can include, but are not limited to, the following: flyers, brochures, door-hangers, newspaper articles, mail-inserts, banners, and posters. When necessary, these materials should be translated into a variety of foreign languages to reach minority residents in the community.

About half of the jurisdictions within this large watershed presently have printed outreach materials available. City newsletters and brochures on various programs are the most frequently used methods. Most of the remaining jurisdictions are developing or plan to prepare and distribute a variety of general outreach materials. Utility bill inserts, door hangers and

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refrigerator magnets are other forms of printed materials. Hawaiian Gardens plans to produce materials in both English and Spanish.

2. AUDIO MATERIAL

Similarly, Co-Permittees may utilize audio materials to convey information regarding stormwater management. Examples of audio materials include radio advertisements/public service announcements and informational cassettes. Los Angeles County uses radio outreach.

3. VISUAL MATERIAL

Catch basin stenciling program is an excellent means of educating the public on the mechanics of the storm drain system. The intent of the program is to enhance public awareness of the impact of stormwater pollution on receiving waters and to discourage improper waste disposal practices. Another effective medium for communicating the importance of stormwater management is through television. Possible measures include producing a public service announcement, cable access programs, and/or an informational video.

Catch basin stenciling is receiving widespread cooperation throughout the watershed. Many jurisdictions have implemented their stenciling program. With the exception of Santa Fe Springs, all other jurisdictions have plans to complete the stenciling of all catch basins. Some jurisdictions are receiving assistance from the Boy Scouts, Cub Scouts or other local volunteer groups. Some jurisdictions are using customized stencil designs, although most use the pattern developed by Heal the Bay and the City of Los Angeles.

With cable television service available throughout the watershed, eleven Co-Permittees use this medium for public service announcements and special programming. Los Angeles County uses television for outreach. Several other jurisdictions are planning to include this public outreach component in their programs.

Other visual materials such as billboard and bus stop shelter advertising are used by Los Angeles County. The City of Walnut is preparing multi-lingual "No Dumping" signs to educate its minority residents.

4. DISTRIBUTION PLAN

General outreach efforts must be conducted throughout the entire watershed. Materials should be available at all public counters and distributed at public events such as environmental fairs and contests. A city newsletter is another effective method of conveying the pollution abatement message.

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B. FOCUSED OUTREACH

Efforts should be made to target special groups. Focus could be on specific pollutants, practices and/or activities, or businesses. A watershed-wide concept will be developed by September 1996.

The varied sources/causes of storm water pollution have resulted in implementation activities that target specific types of pollutants, activities and land uses/types of businesses. Within this watershed most co-permittees implement or plan to implement public information and participation programs specifically aimed at preventing improper disposal of hazardous household products and encouraging actions that keep general wastes out of the storm drain system--such as recycling programs, use of public trash receptacles and the cleaning of sidewalks, alleys and vacant lots. Illegal dumping and discharges are also specific targets; Downey provides cash rewards for the reporting of illegal discharges/dumping into the storm drain system.

1. POLLUTANT SPECIFIC

For a particular watershed, there may be priority pollutants which are of more concern than others. The reduction of these pollutants may be addressed in a more focused public education and outreach program. Any of the methods used in the general outreach program may be utilized in a pollutant specific outreach program.

2. PRACTICE/ACTIVITY SPECIFIC

Everyone who lives or works in a particular watershed must realize that their actions have a direct affect on the quality of stormwater. These special groups must be made aware that their current practices/activities may be contributing to stormwater pollution. Practice/activity specific outreach programs should be developed and implemented throughout the watershed. The use of written, audio, or visual materials should convey three primary messages: (1) what activities can cause stormwater pollution, (2) how Best Management Practices are used to prevent pollution, and (3) how one can report occurrences of stormwater polluting activities.

Practice/activity specific outreach should promote, publicize, and facilitate public reporting of illegal dumpings, illicit discharges, or water quality impacts associated with discharges from municipal separate storm sewers. An effective program should include the establishment, operation, and promotion of a reporting hotline. Timely reporting by the public of improper disposal and illicit discharges are critical in controlling such sources of stormwater pollution. Increase in public involvement may be achieved by sending a

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follow-up letter to callers or providing callers with some type of reward. Educational efforts throughout the watershed should inform the public about the existence of the Los Angeles County-wide hotline and any other local hotlines; provide them with information regarding what to look for, and guidelines/procedures on how to report incidents.

Another critical component of practice/activity outreach is the development of a program to facilitate the proper management and disposal of used oil and toxic materials. An effective program could include, but are not limited to, the operation of recycling facilities and the conduction of household hazardous waste round-ups. The program could also include information about alternatives to toxic materials. Educational efforts throughout the watershed should provide the public with detailed information regarding the Los Angeles County-wide Household Hazardous Waste Round-ups and any other local programs.

The County of Los Angeles has an outreach program focusing on airport operations, which will have handouts for tenants and users of County airports explaining the problems and prevention of non-point source pollution. The County also has a wide range of focused programs that can be tailored for special exhibits and interest groups, including elementary schools.

3. BUSINESS SPECIFIC

Due to the fact that some business operation have a higher potential of discharging pollutants into the storm drain system, a more focused public education and outreach program should be developed for them. Employees of these businesses should be educated on the issue of non-point source pollution and the effectiveness of Best Management Practices in reducing pollution. Besides written, audio, or visual materials that focus on specific businesses and their practices, mass mailings or articles in a trade/industry magazines are other possible means of focused outreach.

The City of Covina notifies contractors about construction debris containment, proper disposal practices and distributes equipment management brochures to developers and construction crews.

C. EDUCATION PROGRAMS

Increasing awareness is the major goal of the Public Information and Participation Program. An ideal means of accomplishing this task is through educational programs. Programs should be developed for a variety of audiences, including public employees and school children. Educational programs can also be an important part

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of a general or focused outreach. A watershed-wide concept will be developed by September 1996.

1. **PUBLIC EMPLOYEES**

It is important to educate all of the public employees about the stormwater program so that they do not continue with any practices that are counter productive. Furthermore, they can participate in the implementation and enforcement of the program. Ideas and suggestions of employees can be used to modify the program for improved effectiveness. The outreach must involve employees on many different levels - from program managers to field personnel. Educational programs for public employees may include, but are not limited to, articles in City newsletters, training classes, checklists for field personnel, and interdepartmental forum or committee. Any of the materials utilized in an outreach program - written, audio, or visual materials - may be used in a public employee educational program.

Formal training/education is also conducted by Caltrans and the County of Los Angeles. Caltrans personnel are educated on highway maintenance - specifically on such subjects as Hazardous Substance Spill Awareness and Pesticide Safety and Vegetation Management. County personnel meet regularly to discuss development of and evaluate storm water quality practices.

2. **K-12**

School children can play an important role in a public information and participation program. First, children are generally more easily motivated and the behavior changes made at that point in life tend to stay with them through adulthood. Secondly, school children can convey the stormwater pollution prevention messages to the members in their family. School programs must include information on the storm drain system, stormwater quality awareness, and may also include, but are not limited to, illegal dumping awareness, source minimization, and pollution prevention. Written material, videos, assembly programs, and field trips are examples of effective components of a K-12 educational program.

School programs are components of the educational programs in Glendora, La Mirada, Whittier and Duarte. Glendora also uses library displays. Downey conducts "Waste In Place" programs in elementary schools to discourage littering.

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3. OTHER

Educational programs can also be developed for professionals and technicians who are not public employees. Agencies should include public outreach material for business license renewal or outreach effort through professional and business associations.

D. CITIZENS PARTICIPATION

The residents of the watershed should not only be made aware of the stormwater program, they should be encouraged to participate in its implementation. Specific outreach programs should be developed to allow the public to participate and to inform them of available means for providing ideas and comments regarding the stormwater program. A watershed-wide concept will be developed by September 1996.

1. VOLUNTEER MONITORING

Volunteer monitoring is the result of increased public awareness and participation. The public can utilize the hotline for reporting suspected illegal practices. Such involvement, which is similar to the Neighborhood Watch Program on crime, usually has good results.

An 800 hotline has been established by Los Angeles County which is available for reporting illegal dumping. A large number of jurisdictions in the watershed have also established their own reporting hotlines through their City Halls, fire departments or environmental services departments. To increase the effectiveness of the hotlines, outreach programs to encourage their use have been established. Approximately half of the cities have publicized the hotlines in their city newsletter. Other popular methods include articles in local newspapers, press releases, community meetings, and announcements on local cable channel. One city suggested the use of cash reward programs to encourage reporting. Downey, who has used the "WE TIP" system and anonymous cash rewards, reports that it has been successful.

La Puente publishes notices about the County's Hotline for the reporting of illegal dumping in both English and Spanish. Long Beach uses grocery bag inserts as one method to inform the public of the Hotline.

2. COOPERATIVE OUTREACH

In order to promote public participation, cooperative outreach programs should be developed. These cooperative programs should help to create an

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awareness and an identification with the watershed. The catch basin stenciling and other signing programs are excellent examples of this type of cooperative effort. One possibility for cooperative outreach is an "Adopt-A-" program. Residents can "adopt" a highway, storm drain, catch basin, stream, etc. Other cooperative outreach efforts include events such as "Stormwater Pollution Awareness Week." The purpose of any of these activities is to inform and involve the local residents in regards to the stormwater management program.

Residents can assist public agencies in the development and implementation of storm water quality programs. Several watershed jurisdictions have enlisted the assistance of such groups as the Boy Scouts and neighborhood volunteers in the catch basin stenciling program. Caltrans' and Los Angeles County's Adopt-A-Highway programs rely on voluntary private participation to help with clean-up activities. Santa Fe Springs, Downey and Diamond Bar have similar Adopt-a-Street programs; Long Beach has an Adopt-a-Gutter program. Artesia encourages resident participation in its Clean-Up-Days, and West Covina has a "Clean-Up-Saturday" program. Hotline programs also enlist the assistance of residents in active participation.

3. COMPLAINT PROCEDURES

Public comments/complaints are important to the success of a stormwater program. A hotline is an excellent mechanism for allowing the public to provide information. In Section B, "Focused Outreach - Practice/Activity", the various aspect of outreach effort is discussed.

E. EFFECTIVENESS EVALUATION

Permittees should develop a process to evaluate the effectiveness of their programs. Methods such as surveys and focus groups can be used to assess program's effectiveness. Results should gauge the community's level of awareness. Surveys and focus groups can also be used to provide insight into the program's direction and the formulation of attainable goals. A watershed-wide concept will be developed by September 1996.

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VIII. PROGRAM EVALUATION

The effectiveness of the storm water programs developed under the Municipal Storm Water Management Plan (hereinafter called the Plan) must be assessed on a regular and consistent basis. The Plan for this evaluation must include a schedule for evaluation, a methodology for the evaluation, a discussion of who will carry out the evaluation, and what will be evaluated. In addition, there must be a mechanism to follow up on the information generated by the evaluation. The Plan should be adjusted based on the program evaluation.

A. PERFORMANCE STANDARDS

The Permittees will develop standards to judge the effectiveness of the activities and control measures proposed under each chapter of the Plan. The standards will serve as minimum performance levels to evaluate the implementation of control measures. The subsequently developed performance evaluation procedures/methodologies will be the tool to determine if a particular BMP has an impact on stormwater quality. In developing these procedures, we resolve to ensure that each BMP is implemented to the maximum extent practicable. The targeted completion of this phase will be December 1997.

1. DEVELOPMENT OF PROCEDURES

General performance standards for evaluating the effectiveness of the Best Management Practices (BMPs) will be developed for all the BMPs proposed in the Plan. The Watershed Management Committee will be responsible for developing and adopting these evaluation criterion. The Management Committee may elect to establish subcommittees to develop performance standards for specific program areas. The area-wide Executive Advisory Committee will then review and endorse the standards. Standard recording format and implementation schedule will be developed for each BMP by the Management Committee for use by all Permittees. The Permittees will be required to document BMP implementation using the standard format according to an established schedule. The utilization of quantitative approaches in measuring effectiveness will be used whenever possible. Methods that would yield comparable results for year to year evaluation will be developed.

2. ACTIVITY/SOURCE/ACTION AREA SPECIFIC

Program effectiveness will be performed based on the information generated by the performance evaluation procedures. Using street sweeping as an example, the Plan will propose a method of determining if street sweeping has an impact on water quality. This could include determining what kind of

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pollutants are removed by the sweeping, measuring the size of the pollutants and the amount removed. Methodologies would be developed for each BMP, which will assure that each control measure or action is implemented to the maximum extent practicable. For street sweeping; this may include the frequency of sweeping now, the method of sweeping, the equipment used, how the equipment is cleaned and maintained, and the method of disposal for the material collected. A schedule and format of evaluation shall be developed for all the BMPs.

The California Regional Water Quality Control Board (Regional Board) has recommended 13 Baseline BMPs, to be developed and/or implemented by all Permittees by the end of the current NPDES Permit. Existing Permit Task 5.2.5 requires an evaluation of the need for additional BMPs, source control, and/or structural control measures.

BMPs have only been implemented for a short time period by Phase I and Phase II cities. Phase III, which contains 30 new cities, has not yet implemented any BMPs. Therefore there is little or no data available to adequately assess effectiveness. In lieu of recommending any changes or additions to BMPs currently being implemented or proposed by the Permittees, a uniform data collection methodology will be established for each of the 13 baseline BMPs. This methodology would be used by all Permittees to compile data on their BMP implementation to allow for a uniform Countywide evaluation of BMP effectiveness. Priority will be given to the development of a uniform data collection methodology to document the success or effectiveness of these 13 BMPs. Upon reorganization of the NPDES Permit Program, as described in Chapter I, this will be the first task addressed by the Watershed Management Committee. The Uniform data collection methodology will be developed by January 15, 1995 for the Santa Monica Bay watershed and by July 1995 for all other watersheds with subsequent implementation by all Permittees in each watershed.

B. ANNUAL REPORTS

An annual report for each watershed will be submitted to the Regional Board not more than 45 days after the end of each permit year. Each annual report will include a summary on the programs implemented during the previous year and plan activities that will be implemented during the current year. Any revisions to the Plan would be addressed in the report.

1. FORMAT/STRUCTURE

In order to insure uniform annual reporting by all watersheds, the Executive Advisory Committee will develop a uniform annual report outline for use by

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each watershed. Each Watershed Management Committee will develop a standard format to be used by all the permittees in its watershed in reporting the progress and the status of all stormwater programs implemented in its jurisdiction. The Principal Permittee will utilize this information to develop the annual report for the watershed. Upon approval by the Management Committee, the annual report will be provided to the Executive Advisory Committee which will compile the annual reports from all watersheds for submittal to the Regional Board.

2. EFFECTIVENESS MEASURES

Under Chapter VIII, Section A, the permittees will have developed performance standards for each BMP. These performance standards will be used to assess the effectiveness of the BMPs. By the end of each permit year, the findings of the previous program year will be evaluated and used to suggest changes that are appropriate for implementation during the next year. Focus should also be given to the use of empirical studies, in a control setting, to more fully assess the effectiveness of BMPs.

3. CONTENT

The annual report will include a matrix illustrating the levels of implementation for all permittees. Tables will be developed for each BMP listing all the participating Co-Permittees, describing the status of implementation by each Co-Permittee of the BMP, and documenting any modifications of the BMP from the standard program. The effectiveness of each program area will be assessed using the performance standards developed under Chapter VIII, Section A. For effectiveness measures, the findings should be presented graphically for ease of comparison with the established levels of effort. Fiscal budget for all the BMPs implemented should also be prepared, grouped by programs. An analysis and evaluation of the results of the past year's monitoring program data will also be included in the report. Any revisions to the Plan should be addressed here, with all the elements affected discussed in their entirety. All relevant information, such as water samples analyses and evaluation, should be included in the appendices.

C. SEMI-ANNUAL REPORTS

A semi-annual progress report will update the Regional Board on Permit compliance activities six months into each permit year. The semi-annual report will be provided to the Regional Board within 30 days after the end of the six-month period.

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1. **PURPOSE**

The semi-annual report will serve as a status report on the progress of the implementation of the Plan.

2. **FORMAT/STRUCTURE**

In order to insure uniform semi-annual reporting by all watersheds, the Co-Permittees will use the standard format developed for the annual report in reporting the progress and status of all the BMPs implemented in their jurisdictions. The Principal Permittee will utilize this information to develop the semi-annual report for the watershed for submittal to the Regional Board.

3. **CONTENT**

The semi-annual report will include a matrix illustrating the levels of implementation for all permittees. Tables will be developed for each BMP listing the participating Co-Permittees, describing the status of implementation by each Co-Permittee of the BMP, and documenting any modifications of the BMP from the standard program. The Permittees will describe the problems encountered during implementation and discuss the modifications to the program in order to solve these problems.

D. INTERNAL REPORTING

In order to facilitate the preparation of semi-annual and annual reports, standard internal formats for use by all Permittees will be developed. The internal reporting procedures will be completed for all Plan chapter elements by December 1997.

1. **STANDARD FORMS**

The Watershed Management Committee will be responsible for developing standard forms for use by each Permittee. Standard forms will be developed for each BMP to monitor its progress. Some Permittees may have to customize the standard forms in order to reflect their programs' additional features. The forms will collect all the information essential to the preparation of the annual and semi-annual reports. In developing the standard report forms, information that is quantifiable and specific for each program area and/or BMP will be collected.

2. **PROCEDURES**

Co-Permittees will submit all the BMP report forms to the Principal Permittee at the end of the six-month period and the permit year, respectively.

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3. RECORD KEEPING

The Regional Board does not need to see all of the extraneous information, but the records will be retained by the Principal Permittee for 2 years. Each Permittee will keep a permanent copy of its reporting forms in case they are needed.

E. STORM WATER MANAGEMENT PLAN REVISIONS

There will be an annual review process that will allow the permittees to revise the Plan for the next year and for the rest of the permit period. The targeted completion date for this phase is December 1997.

1. PROCESS

In the annual report, Permittees will compare the progress made on all the BMPs with the established level of effort. If the level of implementation is inadequate, the program should be adjusted to accelerate the progress. If the progress made to date shows that the program is ineffective or inefficient in protecting the stormwater quality, a new program should be developed and implemented for the next fiscal year and the rest of the permit period.

2. REPORTING

All refinements or revisions to be made in the fiscal year will be documented in the annual report, with the dates of implementation proposed.

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IX. MONITORING

The Monitoring Program is a critical element in the Stormwater Management Plan. It will provide important data for use in characterizing existing stormwater/urban runoff quality, guiding future development, and modifications to the Plan and also to assess its effectiveness. A watershed wide monitoring program shall be developed by December 1997.

A. SYSTEM CHARACTERIZATION

The existing Permit subdivided the County into six drainage basins with information to be collected to characterize each of the basins.

1. WATERSHED

Each drainage basin has been subdivided into numerous drainage areas, based on an evaluation of the existing drainage system and surface flow patterns. For each drainage area, the following information has been compiled: size; breakdown of existing land use; imperviousness; description of soils; location of waste disposal facilities; and the location, type, and number of industries by Standard Industrial Classification (SIC) Code. This information has been submitted to the California Regional Water Quality Control Board, Los Angeles Region, for Phases I and II. Phase III watershed characterization is in progress and will be completed by the end of December 1994. Due to the volume of the watershed characterization data, this information has not been included herein, but is available for review at either the Regional Board or the Los Angeles County Department of Public Works.

This information will provide a basis for developing other monitoring program elements such as pollutant loading estimates from major land uses and watersheds; pollutant source identification, and identification of illegal discharges/illicit disposal practices.

2. STORM DRAIN SYSTEM

In subdividing each basin into drainage areas, the drainage area tributary to all major outfalls has been identified. Within each drainage area, the tributary storm drain system is being identified and mapped. Key information such as the size of the storm drain facilities, locations of manholes and inlets, and storm drain connections is being compiled. This information will be vital in conducting storm drain inspections to identify and eliminate illegal discharges.

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3. RECEIVING WATERS

Due to the extent of urbanization in Los Angeles County over the past decades, most of the streams designated as receiving waters in the Los Angeles basin have been replaced with man-made storm drainage systems to provide flood protection to the urbanized areas. These streams have been mapped as part of the storm drain system mapping done under A.2. above. The remaining natural streams are also being mapped.

The Los Angeles County Department of Public Works (Department) has been performing surface water quality monitoring on a voluntary basis since the late 1960s. Samples have been collected and analyzed from various receiving water streams and channels throughout the County to collect general information as to the quality of the surface runoff within our storm drain system.

The program in existence at the time the current Permit was issued was established in the mid 1980s. Twenty-eight sites are sampled monthly for dry weather flows. Twenty-one of the 28 sites are sampled for storm flows up to five times per year. The collected samples are analyzed for general minerals, pH, total dissolved solids, specific conductance, biochemical oxygen demand, bacteria, heavy metals, pesticides, PCBs, total organic carbon, volatile organic compounds, and total petroleum hydrocarbons.

The sample collection at these sites will continue while the new National Pollutant Discharge Elimination System (NPDES) Permit monitoring stations are established. Once all NPDES Permit monitoring stations are operational, sampling at these 28 sites will be discontinued.

In order to provide an initial assessment of the water quality in the major streams and channels in the County, an analysis has been performed on the data collected through the existing surface water monitoring program. The analysis has been done on a Countywide basis and also by major drainage basin. The report can be found in Volume 8.

To better assess the receiving water impacts of stormwater the Department will be developing a program to further study stormwater impacts on selected receiving waters, including conducting toxicity studies. Initial efforts will focus on the Santa Monica Bay Watershed. A Request for Proposal for the development of such a program will be advertized by January 15, 1995.

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The water quality data collected by the new NPDES Monitoring Program will provide more detailed data to better assess in upcoming years the quality of our receiving waters. Ten monitoring stations have been proposed along the major streams in the County. A description of these site locations can be found in the monitoring work plans for Phases I, II, and III, previously submitted to the Regional Board, see Volume 8.

4. LAND USE

As described under Section A.1. above, the existing land use categories within each drainage area have been identified. This information has been used to select drainage areas comprised of a single homogeneous land use for land use specific monitoring. A total of 14 land use monitoring sites are being established in the County. Five sites are being installed in the Santa Monica Bay Watershed with the remaining nine to be selected from within the Los Angeles, San Gabriel, and Santa Clara River Watersheds. For a description of the sites, please see Volume 8. These sites will provide valuable information as to the types and levels of pollutants found in runoff from various land uses. This information can then be used to refine the Stormwater Management Plan to develop specific management measures to target identified problems.

B. SOURCE IDENTIFICATION

Identifying the sources of stormwater pollutants from both specific land uses and specific activities will provide the information needed to identify problem areas and allow specific management measures to be developed to address these problems.

1. SPECIFIC LAND USE

As described in Section A.4. above, major land use classifications will be subject to individual monitoring to determine the types and levels of pollutants present.

2. SPECIFIC ACTIVITIES

a. A pollutant source identification program will be designed to identify significant pollutant sources (i.e., parking lots, industrial activities, etc.), with the hope that remedial action can be undertaken to reduce any significant impacts so identified. It will focus on monitoring very small areas (i.e., less than five acres) where a specific and/or interrelated set of pollutant generating activities are occurring. Its objective is to provide data for selecting BMPs for specific activities rather than characterizing discharges for long-term pollutant loading estimates.

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Identification of pollutant sources can be done using a number of methods. Potential sources of storm water pollutants can be identified by records of chemical use and/or storage, by studies of specific activities which lead to the deposition of pollutants throughout the watershed, and by field inspection or monitoring. Watersheds which may contain significant pollutant sources can be identified through land use information or by mass loading estimates.

By mid January 1995, the County will begin targeted monitoring of a municipal corporation yard in the Santa Monica Bay watershed. A full program for pollutant sources identification will be developed by December 1996.

b. A storm drain inspection program has also been developed and is being implemented. The first phase of the inspection program will target the open channel storm drains to identify illegal discharges.

The open channel inspections will also be used to screen outfalls from underground storm drains for the presence of dry weather flows. This information will be used in the next phase of the storm drain inspection program to prioritized the underground storm drain system for further field screening and inspection of problem areas.

C. CONTROL MEASURE EFFECTIVENESS

It is unlikely that the effectiveness of the various control measures implemented by the storm water management plan can be determined solely through the data produced by monitoring the quality of storm drain flows, because it is difficult to obtain statistically significant comparisons of watershed-wide control measure performance with such data. For this reason the effectiveness of control measures will be assessed through other means.

Two general types of methods are available for assessment of control measure effectiveness: direct water quality (conventional) monitoring and indirect (non-conventional) monitoring. Direct water quality monitoring can be used to determine pollutant reduction by a specific facility or devise. This technique is commonly used for structural or treatment controls, such as detention basins and constructed wetlands, where there is an accessible inflow and outflow. Inflow and outflow results are compared to determine pollutant removal and effectiveness.

Direct water quality monitoring of site runoff before and after implementation of non-structural control measures is also possible. However, it is difficult to demonstrate effectiveness at a statistically significant level because of the high degree of variability in stormwater pollutant concentration and mass loading data. The

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water quality improvement due to non-structural control measures is generally expected to be less dramatic than that achieved through structural controls. A larger number of samples is therefore required to produce a statistically significant result. This is especially difficult in relation to the monitoring of the pre-control measure condition. Collection of adequate baseline information is necessary prior to the implementation of management practices. Direct monitoring of the effectiveness of non-structural controls is feasible typically only under experimentally controlled conditions (e.g., selection of small, well-defined watershed; control of management practice implementation; effective sitting and timing of monitoring activities), including a sufficient number of samples to achieve statistical significance.

Indirect monitoring currently is the primary method of choice of assessment of management plan effectiveness. A number of indirect monitoring techniques are available for assessment of management plan effectiveness.

Verification of program implementation is an indirect monitoring method that can be used to determine how a management plan is being implemented. Another indirect monitoring method, pollutant removal inventories, can be used to assess the amounts of pollutants that have been prevented from entering the municipal storm drain system.

The 13 Baseline BMPs recommended for implementation by the Regional Board plus other BMPs proposed by the various Co-Permittee are in general all non-structural control measures. In the short-term, a uniform data collection methodology will be developed for use by all Permittees to compile information on the level of implementation of the 13 Baseline BMPs. This will allow for a uniform watershed-wide evaluation of BMP effectiveness. For the Santa Monica Bay watershed, this uniform data collection methodology will be developed and begin implementation by January 15, 1995. For the other watersheds, implementation would begin July 1, 1995.

For the long-term, as the various chapters of the Plan are more fully developed, possibilities for the use of direct water quality monitoring for control measure assessment will be evaluates as opportunities arise.

D. POLLUTANT LOADING

One of the objectives of the monitoring program is to estimate the annual pollutant loadings from each watershed. Knowing the types and quantities of pollutants discharged into receiving waters are important in assessing the impacts of stormwater and, in turn selecting appropriate control measures to address problem areas.

The 24 permanent monitoring stations that are being established Permit-wide will be utilized to estimate pollutant loads from each watershed and also from various land

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uses. For a description of the methodology to be used to estimate pollutant loadings, please see Volume 8. For the Santa Monica Bay Watershed, the pollutant loading model will be tested and operational by January 15, 1995. Actual pollutant loadings will be calculated subsequent to storm events occurring for which water quality data has been obtained. For the other watersheds, a schedule for pollutant load modelling will be provided by January 15, 1995.

To more closely model pollutant loadings and evaluate control measure impacts, a more detailed dynamic modelling will be undertaken on a smaller, representative sub-watershed. The EPA-SWMM model has been selected for use in our dynamic modelling efforts. For the Santa Monica Bay Watershed, the Kenter Canyon Drain sub-watershed has been selected for this modelling efforts. This sub-watershed is typical of the urbanized areas in the Santa Monica Bay Watershed. It is comprised of multiple land uses, has well-defined boundaries, and has no upstream flow regulation. We are reviewing and identifying the existing drainage system, defining current and future land uses, and conducting field checks. The model will be tested and operational by January 15, 1995, with actual modelling results to be available later when local water quality data from our monitoring stations becomes available. Based on the results of the dynamic modelling of the Kenter Canyon sub-watershed, other sub-watersheds may be selected from the other major watersheds in the County.

E. COMPONENTS OF A MONITORING PROGRAM PLAN

The components of the monitoring program plan such as monitoring site locations, dry/storm sampling frequency and methodology, constituents to be sampled, field and laboratory procedures, QA/QC, etc., can be found in Volume 8, which has been previously provided to the Regional Board.

The Monitoring Program elements described in Volume 8 will be revised to address the Monitoring Program needs described in Section A - D above as agreed to in the letter from the County to the Regional Board dated September 22, 1994.

As the various chapters of the Plan are more fully developed, the Monitoring Program will be revised to address any additional monitoring needs that may result

F. DATA MANAGEMENT

For water quality data collected at the 24 monitoring stations, please see Volume 8 for data storage and reporting methods.

For each Section A - E of the Monitoring Program described above, an annual report will be prepared detailing the data collected, with an evaluation and interpretation the data including water quality impacts.

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NPDES PERMIT NO. CA 0061654

TASK 5.2

REPORT OF WASTE DISCHARGE (ROWD)

VOLUME 7 OF 8 (TASK 5.2.5 - 5.2.6)

SANTA CLARA RIVER STORMWATER MANAGEMENT PLAN

LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS
WASTE MANAGEMENT DIVISION
WATER QUALITY SECTION

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SANTA CLARA RIVER
STORMWATER MANAGEMENT PLAN

INTRODUCTION

On June 18, 1990, the National Pollutant Discharge Elimination System (NPDES) Permit - Order #90-079, NPDES #CA0061654-CI6948 was issued to the County of Los Angeles and 17 cities tributary to Santa Monica Bay. During the subsequent years, two newly incorporated cities, Caltrans, and the County of Ventura also became Co-Permittees. This Permit outlined a three-year program which required each Permittee to: characterize drainage areas; develop and schedule the implementation of Best Management Practices to enhance the quality of stormwater/urban runoff within its jurisdictional boundaries and in storm drains it owns and operates. On July 1, 1992, 36 additional cities were initiated into the Permit and began their three-year program. By July 1, 1993, the remaining 30 cities in Los Angeles County within the drainage basin were initiated into their three year program. The cities were grouped according to their starting dates and referred to as Phases I, II, and III respectively (See Table A). In general, the boundaries of each Phase did not encompass whole watersheds but portions of various watersheds (See Figure 1).

The Permit has a five-year duration and although Phase III cities have only completed year one of their three-year program, the Permit requires the submittal of a Report of Waste Discharge (ROWD) which serves as an application for a subsequent NPDES Permit to replace NPDES Permit #CA0061654, which will expire on June 18, 1995. Therefore, the County of Los Angeles, the County of Ventura, Caltrans, and the 85 cities are now parties to the subsequent NPDES Permit application utilizing the Municipal Stormwater Management Plan (herein after called the Plan) concept.

The Plan is based on the Stormwater Management Plan Components developed by the California Regional Water Quality Control Board, Los Angeles Region (Regional Board), and is proposed on behalf of the County of Los Angeles and the other participating agencies, see Table B. This Plan describes the stormwater management activities to be undertaken during the next single, five-year NPDES Municipal Stormwater Permit. The Plan involves the subdivision of the area of the County under a single, new Permit, into six watersheds, each with its own stormwater management plan. For these watersheds and the agencies in each of these watersheds, see Table B and Figure 2.

As required by the current Permit, all Permittees have proposed BMPs for their jurisdictions, described in Volume One and under prior submittals made to the Regional Board. These BMPs have already addressed many of the program areas discussed under the stormwater management plan. As required by the current Permit and continuing on under the new Permit, the Permittees will continue to implement these BMPs. This stormwater management plan will involve reorganizing the individual city-based BMP programs into a single stormwater plan for each watershed. The timeline shown in this document reflects the time needed for the transition from individual city-based programs to the preparation of a mutually agreed upon and collectively developed watershed plan by all parties of the new Permit for each of the watershed areas. The first step in beginning

this process will be the reorganization of the current three-phase program into a new watershed based program. A reorganization of the Phases into watersheds which are based on hydrologic characteristics will allow for the consistent development and implementation of programs among Permittees, referencing land use and drainage infrastructure within their respective watersheds. Consistency of programs throughout the watershed will be beneficial in terms of targeting specific pollutant problems and areas.

This specific Plan will address stormwater management for the following permittees:

Caltrans **Los Angeles County** **Santa Clarita**

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TABLE A

Grouping of Permittees by Phases

PHASE I

Agoura Hills
Beverly Hills
Calabasas
Caltrans***
Culver City
El Segundo
Hermosa Beach
Inglewood
Los Angeles***
Los Angeles County***
Malibu
Manhattan Beach
Palos Verdes Estates
Rancho Palos Verdes
Redondo Beach
Rolling Hills
Rolling Hills Estates
Santa Monica
Torrance
Ventura County
West Hollywood
Westlake Village

PHASE II

Alhambra
Arcadia
Azusa
Baldwin Park
Bradbury
Burbank
Calabasas*
Caltrans***
Claremont
Covina
Diamond Bar
Duarte
El Monte
Glendale
Glendora
Hidden Hills
Industry
Irwindale
La Canada Flintridge
La Habra Heights
La Puente
La Verne
Los Angeles***
Los Angeles County***
Monrovia
Montebello
Monterey Park
Pasadena
Pomona
Rosemead
San Dimas
San Fernando
San Gabriel
San Marino
Sierra Madre
South El Monte
South Pasadena
Temple City
Walnut
West Covina

PHASE III

Alhambra**
Artesia
Bell
Bell Gardens
Bellflower
Caltrans***
Carson
Cerritos
Commerce
Compton
Cudahy
Downey
El Segundo*
Gardena
Glendale**
Hawaiian Gardens
Hawthorne
Huntington Park
Inglewood*
La Canada Flintridge**
La Habra Heights**
La Mirada
Lakewood
Lawndale
Lomita
Long Beach
Los Angeles***
Los Angeles County***
Lynwood
Maywood
Montebello**
Norwalk
Palos Verdes Estates*
Paramount
Pasadena**
Pico Rivera
Rancho Palos Verdes*
Redondo Beach
Rolling Hills*
Rolling Hills Estates*
Santa Clarita
Santa Fe Springs
Signal Hill
South Gate
South Pasadena**
Torrance*
Vernon
Whittier

Note:
* The agency is also in Phase I.
** The agency is also in Phase II.
*** The agency is in all Phases.

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FIGURE 1

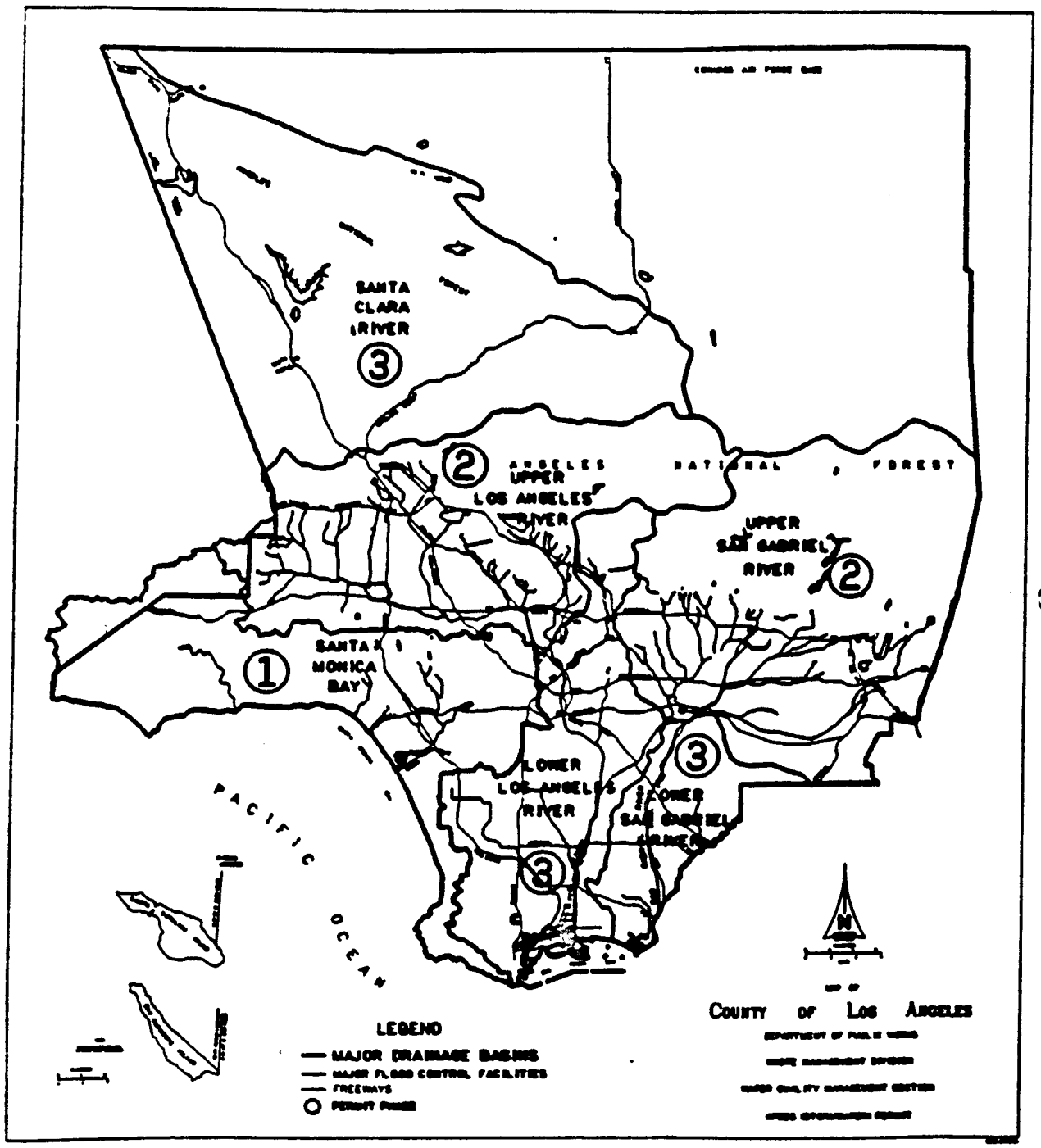

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TABLE B

NPDES Stormwater Permit Renewal
Proposed Watershed Breakup

Santa Monica Bay

Malibu Creek and Other Rural

Agoura Hills
Calabasas
Caltrans
Los Angeles County
Malibu
Westlake Village
Ventura County

Ballona Creek and Other Urban

Beverly Hills
Caltrans
Culver City
El Segundo
Hermosa Beach
Los Angeles
Los Angeles County
Manhattan Beach
Palos Verdes Estates
Rancho Palos Verdes
Redondo Beach
Rolling Hills
Rolling Hills Estates
Santa Monica
West Hollywood

Dominguez Channel/ Los Angeles Harbor Drainage

Caltrans
Carson
Gardena
Hawthorne
Inglewood
Lawndale
Lomita
Los Angeles
Los Angeles County
Torrance

Los Angeles River

Alhambra
Arcadia
Bell
Bell Gardens
Burbank
Caltrans
Commerce
Compton
Cudahy
El Monte
Glendale
Hidden Hills
Huntington Park
La Canada Flintridge
Long Beach
Los Angeles
Los Angeles County
Lynwood
Maywood
Monrovia
Montebello
Monterey Park
Paramount
Pasadena
Rosemead
San Fernando
San Gabriel
San Marino
Sierra Madre
Signal Hill
South El Monte
South Gate
South Pasadena
Temple City
Vernon

San Gabriel River

Artesia
Azusa
Baldwin Park
Bellflower
Bradbury
Caltrans
Cerritos
Claremont
Covina
Diamond Bar
Downey
Duarte
Glendora
Hawaiian Gardens
Industry
Irwindale
La Habra Heights
La Mirada
La Puente
La Verne
Lakewood
Long Beach
Los Angeles County
Norwalk
Pomona
Pico Rivera
San Dimas
Santa Fe Springs
Walnut
West Covina
Whittier

Santa Clara River

Caltrans
Los Angeles County
Santa Clarita

Italicized agencies are present in more than one watershed.

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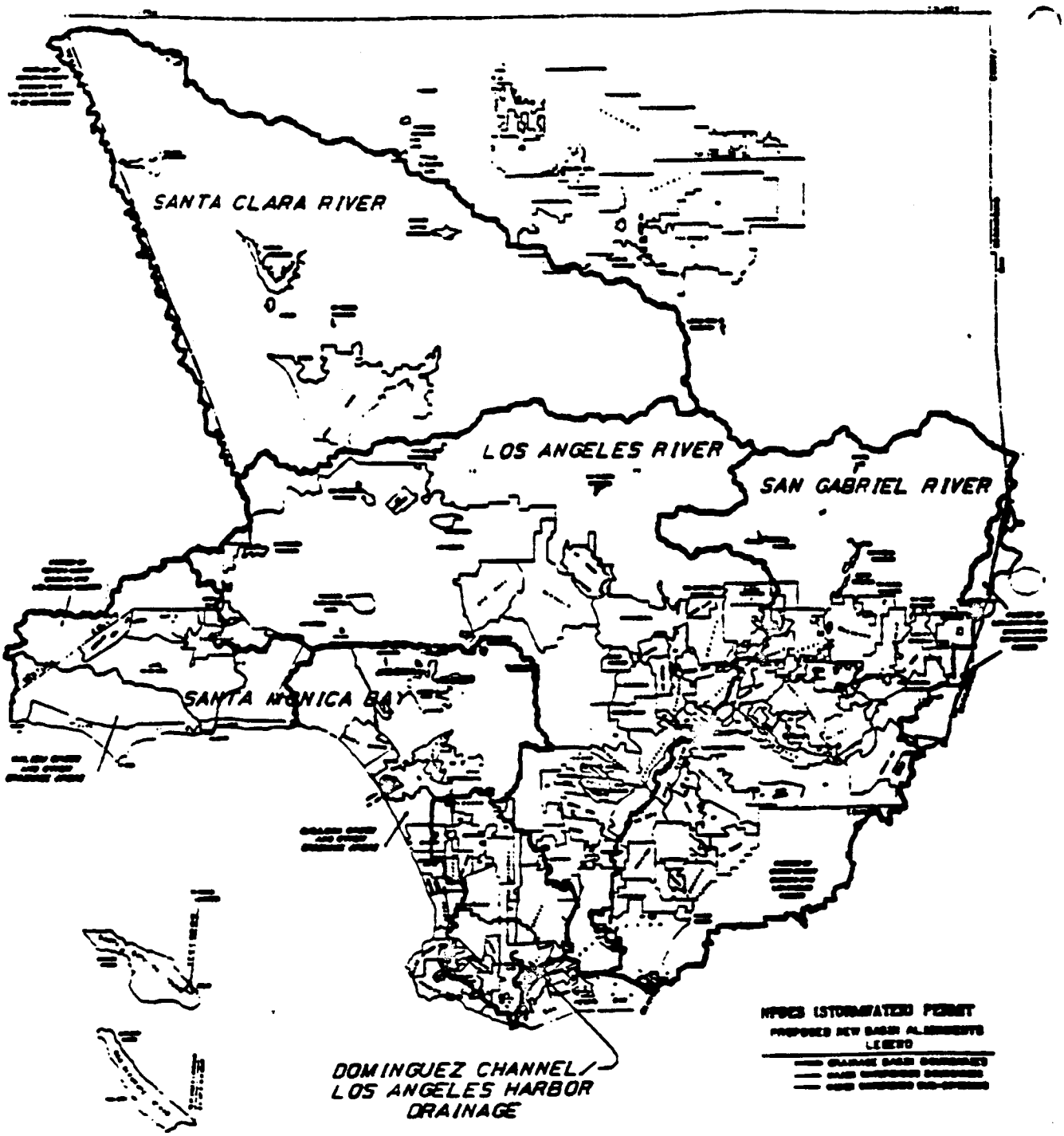
FIGURE 2



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I. PROGRAM MANAGEMENT

A. PROGRAM STRUCTURE

The County of Los Angeles is designated as the Principal Permittee. The other agencies are designated as Co-Permittees. The following are conditions that establish the responsibilities of all Permittees.

1. RESPONSIBILITIES OF PRINCIPAL PERMITTEE

Anticipated duties of the Principal Permittee include:

- Being the coordinators of permit activities and chairing the area-wide Executive Advisory Committee and the Watershed Management Committees;
- Providing the resources necessary for development of the stormwater management plans;
- Providing technical and administrative support for both the Executive Advisory and Management Committees;
- Implementing the monitoring program;
- Providing the resources necessary for developing annual reports including evaluating monitoring program data and BMP effectiveness;
- Complying with all the responsibility of a Co-Permittee as outlined below.

2. RESPONSIBILITIES OF ALL CO-PERMITTEES

Each Co-Permittee is designated a number of duties under the proposed stormwater management plan:

- Participate in the development of the stormwater management plan;
- Implement the stormwater management plan within their jurisdictional boundaries and the storm drains they own and operate;
- Provide information needed by the Principal Permittee on program implementation for development of the annual reports.

The area under the Permit will be subdivided into the six watersheds tributary to the following waterbodies: Santa Monica Bay, which is further divided into a) Malibu Creek and Other Rural Areas, and b) Ballona Creek and Other Urban Areas; Los Angeles River; San Gabriel River;

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Dominguez Channel/Los Angeles Harbor Drainage; and the Santa Clara River (See Figure 2). Managing these watersheds is a task that will require a collective and cooperative effort on the part of all governmental entities named in the Permit that are within each watershed.

The management structure of the Plan consists of an area-wide Executive Advisory Committee, Watershed Management Committees, and Subcommittees. This particular structure is intended to provide a suitable program for the unique characteristics of each watershed and shall be developed by April 1995.

The Co-Permittees tributary to the Santa Clara River watershed shall adopt this watershed stormwater management program structure as a guide to allow for an area-wide uniformity of compliance of the Permit.

3. EXECUTIVE ADVISORY COMMITTEE

The area-wide Executive Advisory Committee shall consist of the County of Los Angeles, as Chair, and two representative Co-Permittees from each of the six watersheds. This Committee assumes no responsibility for the adequacy or inadequacy of any individual city's program and should not be viewed as the responsible agency in this sense. The Committee's main role is to facilitate programs within each watershed and to enhance consistency among all of the programs. Additional responsibilities of the committee are:

a. Making recommendations on area-wide issues to each of the Watershed Management Committees;

b. Reviewing the stormwater management plans as developed by each Watershed Management Committee and provide directions and guidance on the plans for consideration by the Watershed Management Committees;

c. Assessing the consistency of all area-wide BMPs;

d. Preparing and forwarding unified submittals to the Regional Board upon receipt of information and materials submitted by the Watershed Management Committee in compliance with Permit requirements;

e. Scheduling and coordinating meetings and correspondence to allow for communication between the Co-Permittees and the Regional Board;

f. Acting as liaison between all Permittees and the Regional Board on Permit issues as well as mediating conflict among the Permittees.

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4. WATERSHED MANAGEMENT COMMITTEE

A management committee within the watershed will be comprised of the County of Los Angeles, as Chair, and one representative from each of the Co-Permittees in the watershed. The committee shall be responsible for:

a. Establishing goals and objectives for the watershed;

b. Preparing the stormwater management Plan for the watershed (This includes the development of all chapter components of the Plan);

c. Assessing the effectiveness of the Plan and making appropriate changes;

d. Preparing the semi-annual progress reports and annual Permit reports on Permit activities within the watershed for submittal to the Regional Board (For the annual Permit report, a draft will be circulated to each Co-Permittee and the Executive Advisory Committee for its review and comment. Final copies of reports shall be forwarded to the Executive Advisory Committee through which a compilation from all six watersheds shall be submitted to the Regional Board);

e. Enhancing the implementation of the storm water management programs within the Santa Clara River watershed.

5. SUBCOMMITTEES

Subcommittees will be established where needed as determined by the Management Committee and/or the Executive Advisory Committee. The Subcommittees would be focused on specific program areas and can provide more specific oversight on the development, implementation, and evaluation of selected program areas. These subcommittees shall be scheduled to meet on a routine basis.

B. INSTITUTIONAL ARRANGEMENTS

Management of the stormwater program requires the collective efforts and the cooperation of all Permittees. No Permittee has the ability and the legal authority to assume the responsibility of all activities of this Permit. Therefore, agreements will need to be formally developed amongst the Permittees to insure proper implementation of the Permit requirements.

1. PROGRAM PARTICIPANT ARRANGEMENTS

As the Principle Permittee, the County of Los Angeles will be designated as the lead agency for coordination of Permit activities and therefore shall chair

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the executive committee and the management committee meetings as they are scheduled. The lead agency is responsible for coordination of the Permit but is not responsible for the adequacy or inadequacy of any individual Permittee's program. All other entities are Co-Permittees and will be responsible for the Permit compliance of their own agency's program. An implementation agreement will be drafted formally detailing the responsibilities of the Principal Permittee and the Co-Permittees. The agreement would also address the funding of various watershed-wide activities such as plan development, annual evaluation and reporting, and monitoring. Execution of the agreement by all Permittees is targeted for December 1995.

2. AREA-WIDE INTERAGENCY

As the Plan for each watershed is more fully developed, the Watershed Management Committee will coordinate with special agencies and districts that also regulate and/or perform activities under different elements of the Plan. This coordination will attempt to ensure that their functions and the Plan are compatible. A few of these agencies include:

County Hazmat

- Any overlap of waste regulations, Household hazardous waste programs and or Industrial inspections shall be recognized and addressed, by all entities that fall under this Permit, in reference to the watershed program.

County Health

- Inspections of restaurants and other food handling establishments shall be coordinated with the Permittees.

Local Transportation/Congestion Management

- Local municipalities have limited authority over motor vehicle usage and regional transportation planning. Where feasible, plan development and implementation will be coordinated with local transportation agencies.

County (Regional) Parks

- Landscape maintenance activities at public-owned parks will be reviewed as part of additional plan development to ensure the use of proper management measures.

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Mosquito Abatement

- Coordination with the County Agricultural Commissions will be done for mosquito abatement programs to avoid adverse impact on the quality of stormwater/urban runoff.

Water Districts

- Activities with regards to the Water Districts activities will be reviewed and, when feasible, comply with the watershed program regulations and requirements.

Other entities, both private and public which have major land holdings and/or authorities that impact the quality of stormwater/urban runoff should be initiated to participate actively in the program.

3. CITY-SPECIFIC INTERAGENCY ARRANGEMENTS

Each city will need to develop the institutional framework to address operation, maintenance, construction, redevelopment, and other activities performed by city agencies such as Public Works, Parks and Recreation, Planning, and Public Owned Treatment Works (POTWs). These city agencies will need to participate in the planning and implementation of relevant plan program areas.

C. FISCAL RESOURCES

As each of the Plan chapters are completed, each Permittee will develop a budget for implementing that portion of the Plan. A complete budget for the Plan will be produced upon completion of development for all Plan components (*December 1997*). The budget will provide information such as funding sources, staff resources, contract services, and cost sharing arrangements.

1. AREA-WIDE

In implementing the Plan, the Permittees may elect to jointly fund a single program for certain BMPs, such as Public Education, that are area-wide in nature. Funding agreements including budgets and cost per agency would be developed.

2. CITY-SPECIFIC

Each Permittee will develop a budget detailing the cost of implementing Plan activities within its jurisdiction. Special funding in the form of grants, donations, or other forms of contribution should also be actively pursued to assist in funding special studies and/or BMPs.

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D. LEGAL AUTHORITY

Each Permittee is responsible for implementing the Plan within its jurisdictional boundaries and therefore must acquire all needed legal authority. Each Permittee, being separate legal entities, are to have adopted as required by the existing Permit, ordinances that will provide them with the adequate legal authority to develop, administer, implement, and enforce storm water/urban runoff management programs within their own jurisdiction. The ordinance must provide for its enforcement and at a minimum specify that violators may be subject to penalties including, but are not limited to, fines and termination of the activity causing the violation. A plan for identifying any additional legal authorities needed by the Permittees will be included in the completed Plan for the Santa Clara River watershed (*December 1996*). Upon completion of development of the Stormwater Management Plan, enforcing compliance with the Plan will be the responsibility of the Regional Board.

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II. ILLICIT DISCHARGES

The elimination of illegal connections and illicit disposal (IC/ID) practices is an important component for any program aiming to enhance the quality of stormwater/urban runoff.

Although more information is needed to assess fully the benefits and costs of conducting IC/ID programs, we can make logical decisions regarding application of Best Management Practices (BMPs) to minimize such incidents. These BMPs will vary due to the jurisdictional differences which exist within each watershed. Each jurisdiction within the watershed will be developing and implementing those activities which adequately serve the jurisdiction and the watershed as a whole.

IC/ID practices are intermittent discharges of pollutants into the storm drain system that can degrade the quality of receiving waters. This can occur through catch basins, area drains and even on gutters and street surfaces. Some illegal dumping activities are done by individuals who do not know that such practices are illegal and can adversely impact the environment. Yet, others may be carrying out such practices with the full knowledge that such activities are prohibited.

A. ILLICIT CONNECTIONS

In order to implement an illicit connection management program, jurisdictions as a whole will need to develop and implement the procedures for investigating each of their respective storm drain systems.

Detailed procedures to eliminate illicit connections depends on the complexity of the storm drain system. A consistent watershed wide concept will be developed to investigate illicit connections to the storm drain system. Based on the results of field screening activities, or other appropriate information which indicates an area of reasonable potential of containing illicit connections, detection and follow up procedures would be followed. Priority should be established to focus on major problem areas and allow for a cost-effective approach to eliminate illegal connections. This concept will be developed by December 1996.

1. SYSTEM SURVEY

A system survey is a necessary component of an illicit connection elimination program. Although the basic concept is similar, the actual techniques and methods which jurisdictions within the watershed use to conduct system surveys can be quite different.

In conducting system surveys, the intent is to avoid costly investigations within areas not suspected of containing illicit connections. Field screening, map

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research, and land use investigation activities will be done initially to identify potential problem areas. Public outreach efforts will be used to inform citizens in the area about the problem. Enforcement action will be taken to terminate such illegal connections. It should be noted that more detailed and sophisticated techniques such as televised inspection and dye testing will only be used in special situations as needed.

Presently, Los Angeles County has undertaken such a survey. Maps detailing the location of each storm drain, its manholes and catch basin connector pipes are being prepared to facilitate monitoring of illegal connections and discharges. The location and source of discharge for connections is being inventoried. A GIS system to allow for the management and analysis of this data is also being developed. This information will be used in the storm drain inspection program which is ongoing. The program is targeting open channel storm drains. All open channels will be inspected for evidence of illegal discharges. The open channel inspection will also be used to collect information on dry weather discharges from underground drains for use in prioritizing future underground drain inspections.

2. ONGOING SYSTEM INSPECTIONS

Ongoing system inspections for illicit connections will involve the techniques identified in Section 1 above, along with some additional activities. In smaller systems where the storm drain goes into several pumping stations, a regular inspection of the pumping stations for, among other things, evidence of illicit discharges will be sufficient.

In larger and more complex systems, a program of field screening will be used. Evidence of pollution will be categorized and prioritized. The storm drain alignment tributary to the suspect illegal connection can then be further investigated for illicit connections. If a discharge can be traced to a particular facility, the facility will be investigated to identify where exactly the pollutants are coming from and efforts needed to stop the discharge.

Another means of detecting illicit connections may be to rely on reports of illicit discharge from the public. This will utilize the County's or another agency's established "hotline" number that the public can call and report such observations.

3. REPORTING

A consistent recording system will be established to track report of illegal connections. This recording system will be used by the Permittees within the watershed.

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B. ILLEGAL DUMPING

Due to the intermittent and unpredictable nature of illegal dumping, apprehension rate of violators could be quite low. The first course of action is to develop an area wide educational and reporting system along with prompt response procedures. This will be accomplished by December 1996.

1. OUTREACH

See **Chapter VII: Public Information and Participation** of this report for a detailed discussion of the outreach program.

2. SYSTEM SURVEILLANCE

Measures that may be used for this aspect of the program may include, but are not limited to, regular inspections of vacant facilities, street use inspection programs to detect illegal discharges and dumping into the street system, and a public complaint and reporting system.

For example, Caltrans has established a system surveillance program for investigation, identification, and remediation of hazardous waste and debris dumped on excess parcels.

3. SPILL RESPONSE

The Health Hazardous Materials Division (HHMD) of the Los Angeles County Fire Department is generally the primary spill responder. If the material is found to be hazardous, the cleanup and disposal of the material will be done under the supervision of HHMD. If the material is non-hazardous, the responsibility will fall on local agencies to coordinate cleanup, disposal and attempt to identify and prosecute the violators. Cooperation among all agencies will be needed to allow for prompt action and joint effort to deter such violators. All agencies will have local authority against such illegal dumping activities.

To increase efficiency, Los Angeles County has evaluated the latest developments and equipment regarding improved containment procedures. Though their procedures were found to be adequate, new procedures are being developed. The County has also established a tracking system for complaints. While hotline complaints are registered, minor dumping violations will be followed up with a letter.

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4. COMPLAINT RESPONSE

The County and some local agencies have established a stormwater telephone "hotline" that can be utilized by all citizens. Public complaints are generated through these "hotlines" and also through regular channels such as calls to Fire or Police agencies or to public works or legislative offices. Although responses to these complaints will vary depending on the nature of the complaint, action shall be taken.

5. COORDINATION OF ALTERNATIVE DISPOSAL

Alternative disposal is one way of reducing non-stormwater materials that can potentially find their way into the storm drain system. Recycling programs are one of the most effective ways to reduce waste material. The recycling program can either be at the curbside or through drop-off centers. Household hazardous wastes can be dropped at mobile collection centers or at fixed sites. Co-Permittees in the basin generally participate in the County's Household Hazardous Waste collection program. Effectiveness of those programs may be enhanced by a public outreach program that will inform the public of the locations and/or schedules for such events. Technical assistance or information may also be provided to businesses that want to develop a pollution prevention, waste minimization or alternative disposal program.

One example of alternative disposal is the Household Hazardous Waste Roundup events sponsored by the Los Angeles County Department of Public Works and the County Sanitation Districts. Rather than participating in the roundups, Caltrans recycles its used oil, anti-freeze, and other wastes. In addition, Los Angeles County has established a curbside recycling program for various materials including, aluminum, newspaper, glass, metal, and plastic.

6. REPORTING

Incidents involving a hazardous material entering the storm drain system are to be reported by the responsible party, or, if not known, the responding agency, to the California Regional Water Quality Control Board, Los Angeles Region (Regional Board). Complaints received through the County wide and local city hotlines will be tracked and reported to the Regional Board.

C. ENFORCEMENT PROCEDURES

Enforcement actions against discharges are done through either state hazardous and toxic materials statutes or through municipal ordinances that are already in the codes of the Permittees. Industrial Waste Ordinances may be used in enforcement actions against illicit connections. Furthermore, anti-littering, health codes, plumbing codes

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and fire codes may be utilized for dumping or spill incidents. Enforcement actions can be taken by different municipal agents, including but not limited to, Industrial Waste Inspectors, Building or Plumbing Inspectors, Fire Department Inspectors, Park Rangers, Street Use Inspectors, Health Inspectors, Police Officers, Community Services Officers, Animal Control Officers, Code Enforcement Staff or Public Works Inspectors. Some of these agents are empowered to either issue citations, issue notices of violations, issue cease and desist orders, or even make arrests depending on the type of violation and the code provisions that they are enforcing. Some of these agents are also empowered to enforce not only municipal ordinances but also state laws. A review of the various enforcement tools used by the Permittees will be performed. A recommendation will result on a consistent enforcement approach for the watershed for consideration by all Permittees in their own enforcement programs. This recommendation will be developed by December 1996.

Both the Los Angeles County and Caltrans has regulations prohibiting improper disposal. The County regulations are enforced by Health Department, Fire Department, and Animal Control inspectors. Caltrans posts "No Littering" signs and fines violators. Santa Clarita has property maintenance inspections and a Beautification Committee that reach out to the community to discourage improper disposal.

D. COORDINATION WITH STATE NON-STORMWATER PERMITS

In order to characterize the nature of the existing non-storm discharges in the receiving waters within the watershed, a list of NPDES Permits issued by the Regional Board will be obtained. This will help in determining unexpected discharge during dry weather and to allow enforcement actions to focus on illegal dumping activities.

There is also a need to coordinate with other environmental agencies to ensure that requirements imposed by these agencies do not conflict with stormwater regulations. Requirements of many agencies do complement stormwater regulations. These agencies, include but not limited to, Fish and Game, DTSC, USEPA, and the Coastal Commission. Coordination with these agencies will help minimize overlapping investigations and result in a more efficient use of resources. A watershed wide concept will be developed by December 1996.

1. IDENTIFICATION OF PERMISSIBLE/PERMITTABLE DISCHARGES

A list of non-stormwater discharges that can be allowed to discharge into the Waters of the State will be established by the Regional Board.

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2. APPROPRIATE MANAGEMENT PRACTICES

Continued communication with the Regional Board will allow current information to be circulated among all agencies.

3. REPORTING

Any conflict in requirements of other environmental programs/agencies must be reported immediately to the Regional Board for ruling as to which one should take precedence.

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III. INDUSTRIAL/COMMERCIAL SOURCES

Each Permittee shall develop and implement a program that focuses on the identification and control of storm water pollutant discharges from industrial/commercial facilities within their jurisdiction. This program shall provide for the inspection of a facility's compliance with storm water regulations, as well as general outreach for all facilities that are potential industrial and commercial dischargers.

Each Permittee is responsible, under the requirements of the Municipal Stormwater Permit, for all discharges from commercial and industrial facilities within its jurisdiction. Many industries are also required to be permitted under the State General Industrial Activities Stormwater Permit. Enforcement of the specific provisions of the State General Permit is the responsibility of the State.

A. IDENTIFICATION OF SOURCES

As required under the current Permit, the Permittees have produced a listing of industries by SIC category for each drainage area. Also a breakdown of major land use types was also performed for each drainage area.

A pollutant source identification program will be designed to identify significant pollutant sources (i.e. parking lots, industrial activities, etc.), with the hope that remedial action can be undertaken to reduce any significant impacts so identified. It will focus on monitoring very small areas (i.e. less than five acres) where a specific and/or interrelated set of pollutant generating activities are occurring. Its objective is to provide data for selecting BMPs for specific activities rather than characterizing discharges for long-term pollutant loading estimates.

Identification of pollutant sources can be done using a number of methods. Potential sources of storm water pollutants can be identified by records of chemical use and/or storage, by studies of specific activities which lead to the deposition of pollutants throughout the watershed, and by field inspection or monitoring. Watersheds which may contain significant pollutant sources can be identified through land use information or by mass load estimates.

By mid January 1995, the County will begin targeted monitoring of a municipal corporation yard in the Santa Monica Bay watershed. This will provide data on industrial activities which can take place at such a facility such as vehicle maintenance and repair, materials storage, equipment storage and repair. A more comprehensive program to identify various pollutant sources will be developed by March 1997.

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1. CATEGORICAL LIST

Sources identified as a categorical industry regulated by the U.S. Environmental Protection Agency (EPA) will be grouped into a categorical listing of industries. The categorical list provides an organized overview of the target facilities that, based on land use, operation, and activities, could potentially contribute significant amounts of pollutants into storm water runoff. Some of the industrial categories regulated by the U.S. EPA include, but not limited to:

- Aluminum Forming
- Asbestos Manufacturing
- Battery Manufacturing
- Canned & Preserved Fruits & Vegetables
- Cement Processing
- Copper Forming
- Electroplating
- Glass Manufacturing
- Grain Mills
- Machinery Manufacturing & Rebuilding
- Soap & Detergent Manufacturing
- Metal Finishing
- Metal Molding & Casting
- Oil & Gas
- Organic Chemicals & Plastics & Synthetic fibers
- Paint Formulating
- Pesticides
- Plastic Molding & Forming
- Rubber Manufacturing
- Sugar Processing
- Textile Mills

2. RANKING

Industrial and commercial facilities identified as pollutant sources shall be ranked in order of priority for development of management measures. Facilities considered to be high priority are those whose operations and activities are determined to potentially contribute the most significant pollutant impacts to storm water discharge.

3. UPDATE PROCEDURE

Each year the Co-Permittees will evaluate the results of the monitoring program, the illicit discharge investigation program, and other available information , to identify likely sources of specific pollutants. The annual report to the Regional Board will recommend a strategy for pollutant source identification during the following year, including specific sites and/or activities to be monitored.

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B. CONTROL MEASURES

Specific urban runoff control programs for major potential pollution sources shall be developed by March 1997. Within these programs storm water pollution control measures shall be developed for various pollutant sources. Control measures such as source control and treatment control offer different, but complimentary approaches to storm water pollution control.

Source control measures focus on good housekeeping practices, pollution prevention and minimization, and education. They are also less costly than treatment controls.

Treatment controls involve physical treatment of the runoff, usually through structural means. Also treatment controls will not remove all pollutants and their removal efficiency is difficult to predict given the limited understanding of the relationship between facility design criteria and performance.

The initial focus will be on the development of source control measures. As information is collected under the pollutant source identification program regarding specific pollutant sources, specific control measures, including structural, will be evaluated as to their effectiveness in addressing these sources.

1. POLLUTION PREVENTION MEASURES

Source minimization and education are the first steps in effective source control. Other activities that contribute to source control are:

- Site design alternatives (i.e. roof over fueling stations and carwash slab, provide spill containment curb around stored material, etc.)
- Good housekeeping practices

2. STRUCTURAL (TREATMENT) MEASURES

A variety of treatment control measures have been utilized throughout the country for storm water quality. However, the effectiveness of these controls are highly dependent on local conditions such as climate, hydrology, soils, groundwater conditions, and extent of urbanization.

Some of the more common treatment controls are:

- Oil/water separators - Oil/water separators are designed to remove one specific group of contaminants: petroleum compounds and grease. However, separators will also remove floatable debris and settleable solids.

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- Infiltration - A family of systems in which the majority of the runoff from small storms is infiltrated into the ground rather than discharged to a surface water body. Infiltration systems include: ponds, vaults, trenches, dry wells, porous pavement, and concrete grids.

- Wet ponds - A wet pond has a permanent water pool to treat incoming storm water.

- Constructed Wetlands - Constructed wetlands have a significant percentage of the facility covered by wetland vegetation.

- Biofilters - Biofilters are of two types: swale and strip. A swale is a vegetated channel that treats concentrated flow. A strip treats sheet flow and is placed parallel to the contributing surface.

- Extended Detention Basins - Extended detention basins are dry between storms. During a storm the basin fills. A bottom outlet releases the storm water slowly to provide time for sediments to settle.

- Media Filtration - Media filtration consists of a settling basin followed by a filter. The most common filter media is sand; some use peat/sand mixture.

- Multiple Systems - Multiple systems are a combination of two or more of the preceding controls in series.

C. OUTREACH

General outreach for all facilities that are potential industrial and commercial dischargers shall be set up area-wide by the Management Committee, to provide general guidance in complying with the storm water program by March 1997. It shall also serve as a reminder of pollution prevention measures and keep facilities informed of their obligations to the storm water program.

Subcommittees may be established to develop specific outreach materials for industrial and commercial categories and specific activities that are identified as high priority.

For additional information on outreach, refer to **Chapter VII: Public Information and Participation** of this report.

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D. INSPECTIONS

Most municipalities have existing programs such as industrial waste, fire, and health in which industrial and commercial facilities are inspected on a regular basis. Each Permittee may elect to have inspections for the storm water program incorporated into these existing inspection programs, or be done as a completely separate program, depending on the needs of the Permittee.

The purpose of these inspections is to ensure that facilities are in full compliance with the storm water regulations and to ensure that control measures are being implemented. The frequency of inspection of facilities will be prioritized based on the operation and categorization of the facility.

Inspectors consisting of public personnel will be trained adequately to recognize and handle problematic activities concerning storm water pollution that may be existing or potential; and inspect for the deterioration of the storm drain system and illegal/improper connections. Training programs will be developed through the Watershed Management Committee and possibly specific Permittees for use by all Permittees.

Procedures for the identification, investigation, enforcement, and prosecution to the full extent of a jurisdiction's legal authority will be developed.

For example , Los Angeles County issues permits to all commercial and industrial facilities that generate industrial wastes. Included within this program are auto related businesses, gas stations, and restaurants. Facilities with industrial waste permits are regularly inspected. In addition to those businesses in the unincorporated areas, the County Department of Public Works also provides industrial waste inspections, under contract, for Santa Clarita. The City is in the process of developing an inspection program in which facility inspections are performed in response to complaints.

1. CHECKLIST

Inspectors shall have a uniform checklist to use as guidance and reference throughout an inspection. It may also serve as a general guide for the public, providing information about the requirements necessary to comply with the storm water regulations.

2. SCHEDULE

The inspection program shall be developed by March 1997. The frequency of inspections shall be scheduled according to the type of operation and the

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categorization of the facility. Revisit inspections shall be done on an as needed basis.

3. REPORTS

Inspectors shall report on all activities related to and/or violating the local storm water ordinance to the local governing agency. Standard reporting procedures will be developed.

4. FOLLOW-UP PROCEDURES

Individual Permittee review and assessment of the reports may result in the need for follow-up procedures, such as reinspection or legal action, provided the jurisdiction has the adequate legal authority to do so. Follow-up procedures will be developed to insure a uniform and consistent approach.

E. LOCAL INCENTIVE PROGRAMS

In developing the industrial/commercial program, the Permittees may consider the development of optional measures such as clean business incentive programs that may offer more focused control on industrial and commercial sources. The targeted completion date for this program is March 1997.

F. TRAINING

Development of training programs for industrial storm water inspection staff is projected to be completed by March 1997.

1. PUBLIC EMPLOYEES

All public employees shall be trained in the storm water regulations so that they abide by the regulations in the course of their work day. Also they need to be able to recognize and distinguish between legal and illegal activity so as to administer the proper protocol in handling the situation.

For example, the Los Angeles County Department of Public Works has requested all employees to report any observed water quality problems. Caltrans employees have received education in hazardous substance spill awareness, pesticide safety, and vegetation management.

2. INSPECTORS

Inspectors who visit industrial and commercial facilities shall be adequately trained to determine compliance with the storm water regulations and educate

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the facilities about the requirements of the program. In addition, they should be able to recognize and handle immediate problems as they are encountered, during an inspection; and inspect for the deterioration of the storm drain system and illegal/improper connections. Citation training will be necessary for inspectors in agencies that have the citation authority.

G. COORDINATION WITH STATE INDUSTRIAL STORM WATER PERMIT

The Permittees have existing local ordinances governing industrial discharges and other non-stormwater discharges that require compliance activities similar to those in various State Regulations. Because coordination between the Permittees and the Regional Board is anticipated concerning the regulation of industries, a mutual agreement may be required regarding industrial inspections and enforcement. Additional issues could also be addressed. Federal stormwater regulations hold local municipalities responsible for stormwater discharges from all industrial/commercial facilities, including those covered by General Permit.

1. MEMORANDUM OF UNDERSTANDING

A Memorandum of Understanding (MOU) may be used to formalize the agreement between municipalities and the Regional Board on industrial compliance program issues. A MOU among all local agencies may also be needed to ensure co-operation between all the agencies. The need for and specific requirements for such agreements would be developed upon completion of development of the industrial/commercial program by March 1997.

2. REPORTS

The MOU discussed above may include the exchange of information between the Permittees and the Regional Board. Appropriate formats for such reports would be developed as required.

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IV. NEW DEVELOPMENT AND REDEVELOPMENT

Managing stormwater and runoff from both new construction and redevelopment, will reduce pollutants from entering the storm drain system and subsequently the receiving water.

A. PLANNING PROCESS

Quality of stormwater discussion should be included in the General Plan and the Zoning ordinances. Efforts to enhance the quality of storm water can filter into the Subdivision actions. Much of the storm water concerns can be channeled through the compliance effort of the California Environmental Quality Act (CEQA). A watershed wide concept will be developed by June 1997.

1. WATERSHED PROTECTION POLICIES

An integrated strategy will be developed for the watershed. Pollution control efforts should be prioritized. A variety of statutory and regulatory requirements could be used for this watershed oriented program. Watershed protection policies need to be adopted by the local jurisdictions which control land-use within the watershed.

Both Caltrans and the City of Santa Clarita have regulations for watershed protection. Caltrans has established a requirement for water pollution control for construction projects. Construction may be halted if inadequate provisions have not been made for water quality. Santa Clarita, in November 1992, adopted a Hillside Development ordinance that contains provisions for drainage, erosion control, runoff, and landscaping. Los Angeles County has existing Ordinances that address drainage erosion control, runoff, and landscaping.

2. COORDINATION WITH CEQA

The current CEQA "Environmental Checklist Form" that is used for initial studies assessment indirectly address potential impacts to stormwater. Additions could be made to the Form to directly assess stormwater quality impacts.

CEQA requires agencies to use feasible alternatives or mitigation measures to lessen potentially significant effects. The ability to identify a) when an effect is significant, and b) which mitigation measures could be adopted to reduce the effect, is critical to the CEQA process. A clear assessment of any development, its potential adverse impacts on stormwater quality will allow

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for a determination of "significance" which will enable the decision maker to make development decisions upon full disclosure of possible adverse impacts.

3. SITE PLANNING PROCESSES

All development will require the review and approval of a site/plot plan or development drawings prior to issuance of a building permit. Incorporating the consideration of potential water quality impacts including erosion and sedimentation during the early stages of the planning process will allow these issues to be addressed before substantial investments in engineering and design have been made.

4. GENERAL PLAN CHANGES

The General Plan is the legal backbone of the planning process. All development approvals, zoning ordinances, subdivision approvals and public works projects must be consistent with the policies, objectives, and principles set forth in the General Plan. Discussion of stormwater issues in the General Plan could greatly enhance the awareness of the issues and encourage full assessment of possible adverse impacts on stormwater quality as the result of new and redevelopment.

5. USE OF MASTER PLANS

For agencies which utilizes master plans to guide their development activities, stormwater issues can be outlined in such documents. This will channel efforts to fully assess the possible adverse impacts on stormwater quality as the results of any development within the master plan area.

6. OTHER POLICIES

Numerous other policies or mechanisms could be used to incorporate stormwater management goals into the planning/development process. Other concepts will be evaluated for their feasibility during the more detailed development of this Chapter.

7. PLANNING-PUBLIC WORKS INTERFACE

A variety of mechanisms for coordinating planning and public works activities exist. An example could be some form of CIP (capital improvements program). Ideally, any planning documents which target or project population growth are coordinated with CIP. Integrating stormwater management into CIP will allow for mitigation of major adverse impacts on the quality of stormwater prior to any actual construction.

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2. CHEMICAL AND WASTE MANAGEMENT REQUIREMENTS

Chemical and waste handling activities are also currently subject to a variety of regulations. BMPs to address this pollution source are largely centered around "good housekeeping practices". It involves storing, handling, using, and disposing of these potential pollutant sources in ways that restrict opportunities for unintended introduction of the materials into site runoff. Proper chemical and waste management will reduce any accidental discharge into the storm drain system.

3. INSPECTIONS

Inspections are a routine part of local jurisdictions oversight of regulated construction activity. Its purpose is to ensure that construction site runoff control measures are being implemented. Existing practices should be examined and modified accordingly to satisfactory stormwater/urban runoff objectives.

a. Checklist

A checklist would encourage possible streamlining of any requirements. It could be cumbersome if an overly rigid approach were taken which resulted in unnecessary administrative burden. However, careful design of the checklist could avoid this pitfall.

b. Schedule

Inspection schedules will depend upon existing practices. It may be desirable to have several schedules, depending upon the types of activities/permits and/or the timing of activities.

c. Reports

A standardized reporting format is needed to allow for consistency among all jurisdictions. Furthermore reports are also a useful tool for future refinement of pollution control regulations.

d. Follow-up Procedures

A format will be developed to do follow-up inspections on problem facilities. Its frequency will greatly depend on the land use and the degree of non-compliance of each facility.

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C. LOCAL PERMITS

Permits are a form of "cross checking" by local agencies to ensure that regulations are being implemented. Prior to the issuance of a permit, information must be submitted for review and approved. A watershed wide concept to provide some consistency in local permits will be developed by June 1997.

1. COORDINATION WITH EXISTING PERMITS

Storm water issues should be incorporated into existing permits.

2. NEW PERMIT ISSUES

Storm water issues should be clearly stated in new permits to be issued for new and/or redevelopment activities.

D. TRAINING

Training will enable staff to keep current of the latest storm water regulations. A watershed wide staff training concept will be developed by June 1997.

1. PLANNING PERSONNEL

(See E.1.b. below)

2. PUBLIC WORKS PERSONNEL

(See E.1.b. below)

3. INSPECTORS

(See E.1.b. below)

E. CONTROL MEASURES

Best management practices for the control of construction related pollution can generally be divided into three categories:

Nonstructural Source Controls for Reducing Urban Stormwater Pollutants:

- Practices that reduce the generation and accumulation of potential stormwater contaminants at or near their source.

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Development Layout Stormwater Controls:

- Practices that are directed at controlling the volume and discharge rate of runoff from urban areas, as well as, reduction of the magnitude of pollutants in discharges through temporary storage or flow restrictions.

Erosion and Sediment Controls:

- Practices that can prevent or treat problems related to transport of eroded material from construction and other land disturbing activities.

Development layout stormwater controls are of particular interest. These control measures can be incorporated in the initial planning phase of any project. A watershed wide concept will be developed by June 1997.

1. POLLUTION PREVENTION MEASURES

a. Site Design

Effective implementation of urban BMPs requires integration of water quality control elements early in the site planning and design process. Development of the water quality controls should not only achieve maximum pollutant removal with minimal costs, but also reduce potential maintenance.

This may include incorporating water quality concerns into the site layout and design (i.e. maximize pervious areas, minimize directly connected impervious areas, etc.) and/or treatment control measures proven to be cost effective for local climate, soil, and development conditions.

Due to the diversity of climate and local conditions, the development of BMPs vary from location to location, and even jurisdiction to jurisdiction. The selected management practices should be designed for the local site conditions and especially seasonal rainfall conditions that are experienced in Southern California. Suitability for the major land use and drainage characteristics should also be fully assessed.

b. Education/Training

Education/training is imperative to the success of any BMPs selected for new or redevelopment projects. BMPs will fail if not properly designed, installed, and maintained. Only well trained personnel should be assigned to these responsibilities.

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A program for effective education/training should be based on four objectives:

- Promote a clear identification and understanding of the problem, including activities with the potential to pollute stormwater;
- Identify solutions (structural and nonstructural BMPs);
- Make every employee responsible for stormwater pollution and its solution; and
- Integrate employee feedback into training and BMP implementation to improve BMPs.

c. Other

In many cases stormwater pollution control may already be achieved by existing regulations or programs. In California, the General Plan Law and the California Environmental Quality Act (CEQA) provide a basis for municipalities to review and comment on all projects within their jurisdiction. Under the General Plan Law, municipalities are required to develop policies and regulations which guide development within the municipality. Each development project is then reviewed for conformance with these policies. Under CEQA, projects are also subject to review and comment for any adverse impact the projects may have on the environment, including impacts from stormwater discharges.

2. POST CONSTRUCTION (TREATMENT) MEASURES

a. Applicability

Each site considered for development or redevelopment will (at the conclusion of construction) have final improvements and unique site characteristics such as: drainage patterns; soils; landscaping; topography; percent of impervious surfaces; rainfall; pollutants inherent with the use of the development; and pollutants that may be background to the area (existing vegetation, air fallout, etc.). The applicability of various treatment control BMPs for use in new development will be evaluated through the use of pilot studies and examination of studies done on treatment control measures by other agencies.

b. Effectiveness

Prior to implementing any treatment control measures, they will need to be evaluated for their effectiveness. This can be done through pilot studies which could include elements such as: pre and post storm event inspections; water quality monitoring; record keeping to

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document deficiencies in the BMPs; Operation and Maintenance requirements; and cost effectiveness.

c. **Retrofit Opportunities**

The feasibility of retrofitting existing developments with treatment control measures will be evaluated. However, the effectiveness of a treatment control measure versus its cost must be fully evaluated prior to considering its use as a retrofit measure.

3. OPERATION AND MAINTENANCE

a. **Requirements**

Jurisdictions within the watershed will need to insure that BMPs incorporated into a private development are properly maintained. Deed restrictions, covenants, conditions and restrictions (CC&R) could be used to direct such requirements and responsibilities.

b. **Responsible Party**

The contractor, during construction, must ensure that the post-construction BMPs are installed properly and that any maintenance that may be necessary during construction is performed. After the project is completed, it will then be the responsibility of the fee owner, private or public, to provide for long term operation and maintenance. This may be accomplished by deed restriction and/or CC&R.

4. CONFLICTS WITH OTHER MANDATES

Often regulations of various Federal, State, and local agencies would conflict with each other. Health, fire, and building codes often have requirements focusing on short term human health and safety and neglecting the impacts on the environment.

a. **Identification of Conflicts**

As the Plan is developed, other regulatory requirements that conflict with the stormwater program requirements may be uncovered. Clarification of these regulations should be directed to the various responsible regulatory agencies.

b. **Conflict Resolution**

For regulatory conflict caused by local regulations, efforts will be taken to resolve them within the agencies. Input form other local, state, and federal agencies should be incorporated into a modification of current

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standards. The Regional Board should resolve conflicts involving other State and/or Federal requirements.

F. OUTREACH

See Chapter VII: Public Information and Participation for information.

G. ENFORCEMENT

See Chapter II: Illicit Discharges, Section C Enforcement Procedures for information.

H. COORDINATION WITH STATE CONSTRUCTION STORM WATER PERMIT

1. MEMORANDUM OF UNDERSTANDING

An agreement between the Regional Board and Co-Permittees may be used to enhance compliance of construction site BMPs. The need for such as agreement will be evaluated. If found to be desirable, an agreement will be developed by June 1996.

2. REPORTS

The local enforcement agency of the State Construction Stormwater Permit, which is the Regional Board, should forward all information, including Notices of Intent filed and any inspections and enforcement actions taken , to the Permittees so that this information can be available to local municipal construction site inspectors to alert them of any specific concerns on the job site.

3. OTHER ISSUES

The Regional Board should explore funding to be channelled to the Co-Permittees so the Co-Permittee can be more actively involved with the State on the Permit.

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V. PUBLIC AGENCY ACTIVITIES

All municipalities perform functions that have an impact on stormwater quality. These include, among other things, vehicle maintenance, landscape maintenance, weed control, water body maintenance including swimming pool maintenance, etc. Other activities such as construction and maintenance of streets and roads, and construction and maintenance of the flood control system also could directly or indirectly cause adverse impact on the quality of stormwater/urban runoff. Since municipalities must address all significant sources of pollutants, all of these activities must be examined and mitigation measures be incorporated into the routines. As part of the requirements of the current Permit, many of the Permittees have already begun implementation of measures to address the above activities. An examination of these existing measures will be done on a watershed wide basis to establish the most effective approach to address these activities. Such approaches shall be developed and begin implementation by September 1997.

A. SEWAGE SYSTEMS

Sewage spills must not be allowed to enter the storm drain. Control procedures for identifying, repairing, and remediating sewer blockages, infiltration, inflow, and wet weather overflows from the sewers to the storm drain system should be implemented to protect stormwater quality. These procedures could include, but are not limited to, quick field response to overflows, follow-up testing, and complaint investigation.

When sewage spills do occur, they must be contained and collected for proper disposal. Individual permittees may need to modify their sewage overflow response procedures. The field personnel should also have procedural training for field screening, sampling, smoke/dye testing, and TV inspection, if appropriate, to be able to properly investigate any suspect connections or cross connections to the storm drain system.

For example, the Los Angeles County has a number of programs aimed at preventing sewage spills from entering the storm drain system. These include the following:

- Sewage Overflow Response Procedures Revision/Root Control Review - This involves improvement of procedures for containment and cleanup of spilled sewage resulting from overflow.
- Reline Sewer Lines - Two locations will undergo relining of existing sewer lines to prevent infiltration and exfiltration.
- Sewer Pipeline Reconstruction - One hundred and twenty-seven miles of cement pipelines will be analyzed and replaced or rehabilitated within 5 years.

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- Sealing of Manhole Covers - This program has sealed manhole covers and bar holes in areas subject to flooding.

- Expansion of Emergency Call List - Beeper numbers of all supervisors, superintendents and stand-by crews were added to emergency call list.

B. CORPORATION YARDS

Corporation yards include any area or facility that is used for vehicle maintenance or washing, other maintenance, chemical storage, paint facilities, and supportive activities for field crews. Permittees will need to incorporate pollutant control measures at these facilities and develop a plan for each facility outlining the measures to be implemented. Since these are industrial type activities, the corporate yards would need to implement measures as described in the Industrial/commercial Source Chapter.

1. STORM WATER POLLUTION PREVENTION PLANS (SWPPP)

Though not required, permittees may elect to use some form of SWPPP as a vehicle for compliance. Any BMPs to be implemented must be part of a comprehensive plan designed to address the various pollutant sources at each corporate yard. To achieve this goal, the municipalities should first identify the potential pollution sources and who is responsible for implementing the storm water management measures. Based on the facility type, management practices and schedule of implementation will be developed. BMPs that can be used to improve the quality of runoff include, but are not limited to, housekeeping practices, material storage control, vehicle leak and spill control, and illegal dumping control.

2. OUTDOOR LOADING/UNLOADING OF MATERIALS

Municipal employees who handle potentially harmful materials should be trained in good housekeeping practices to prevent or reduce the discharge of pollutants to storm water from outdoor loading/unloading of materials. Materials spilled, leaked or lost during loading/unloading may collect in the soil or on other surfaces and be carried away by runoff or when the area is cleaned.

Applicable BMPs should be selected based on the following four factors: 1) Extent of exposure of material to rainfall, 2) preventing stormwater run-on, 3) checking equipment regularly for leaks, and 4) containing spills during transfer operations.

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3. MATERIAL STORAGE CONTROL

A program should be developed to prevent or reduce the discharge of pollutants to storm water from outdoor container storage areas using measures such as installing safeguard again accidental releases, secondary containment, conducting regular inspections, and training employees in standard operating procedures and spill cleanup techniques. Employee education is paramount for successful implementation. Employees should be trained in emergency spill cleanup procedures.

To limit the possibility of storm water pollution, containers used to store dangerous waste or other liquids should be kept inside the building unless this is impractical due to site constraints. Storage of reactive, ignitible, or flammable liquids must comply with the fire and California OSHA codes. Practices such as placing containers in a designated area should be employed to enhance such requirements.

4. VEHICLE AND EQUIPMENT WASHING AND MAINTENANCE

Washing vehicles and equipment outdoors or in areas where wash water flows onto the ground can pollute storm water. For municipalities that wash vehicles or pieces of equipment on-site, it should be performed in a designated area equipped with an oil/water separator.

Vehicle or equipment maintenance is a potentially significant source of storm water pollution. Parts are cleaned with solvents. Many of these cleaners are harmful and must be disposed of as a hazardous waste. Appropriate BMPs are waste reduction, use of alternate products, recycling, and spill leak clean up control.

5. WASTE HANDLING AND DISPOSAL

Proper waste management is possible by tracking waste generation, storage, and disposal; reducing waste generation and disposal through source reduction; and preventing run-on and runoff from waste management areas.

C. PARKS AND RECREATION

Park Departments manage landscaping and swimming pools. Both of these activities involve the use of chemicals, waste management, and non-storm water discharges. In addition maintenance of swimming pools requires the periodic discharge of large quantities of swimming pool water.

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1. FERTILIZERS/PESTICIDES

a. Use/Application management

Municipal facilities should develop controls on the application of pesticides, herbicides, and fertilizers. Control may include:

- List of approved pesticides and selected use;
- Product and application information for users;
- Equipment use and maintenance procedures; and
- Record keeping.

Employees can be educated about environmentally sensitive alternative products by using information developed by various public agencies and other environmental organizations.

b. Storage

Improper storage of fertilizers and pesticides can lead to potential groundwater, soil, and stormwater contamination. To prevent or reduce their impact on stormwater pollution, material storage areas must be designed and maintained to reduce exposure to storm water. The following BMPs can help to achieve this goal:

- Store materials inside or under cover on paved surfaces,
- Use secondary containment,
- Minimize storage and handling of hazardous materials,
- Inspect storage areas regularly.

2. FACILITY MANAGEMENT

a. Wash Waters

Wash waters cannot be discharged into the storm drains untreated. The storage area should be slightly sloped for wash water collection. If the water is not discharged to the sanitary or process waste sewer, or to a dead-end sump, the outlet should be equipped with an oil/water separator or other treatment systems.

b. Maintenance

Landscape maintenance involves the use of pesticides and fertilizers. Proper use of these materials will reduce the risk of loss to storm water. Whenever possible, leave or plant native vegetation to reduce

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water, fertilizer, and pesticide needs. Integrated pest management should be employed where appropriate. The Park Departments should also establish a schedule for irrigation and fertilization. The chemicals will be carried from the site by the next storm if they are applied during the wet season. Overwatering leads to discharge of water that may have become contaminated with nutrients and pesticides.

Storm water from parking lots may contain undesirable concentrations of oil, grease, suspended particulates, and metals, as well as the petroleum byproducts of engine combustion. Possible maintenance BMPs include periodic sweeping and cleaning catch basins.

c. Swimming Pool Waters

The drainage of swimming pool water must insure that chlorine residual is below allowable water quality limits. The potential for recycle/reuse for irrigation of lawns and landscapes may be investigated. Swimming pool filter backwash waters should not be discharged to the storm drain, but should be allowed to settle and then disposed to the sanitary sewer. Other possible alternative measures would be to use the backwash for irrigation or disposal on a dirt area.

D. STORM DRAIN SYSTEM OPERATION AND MANAGEMENT

The maintenance and operation of the storm drain system has an impact on storm water quality and must be addressed. Material clogging storm drains cannot be discharged into drains. It must be disposed of properly.

1. INLET MAINTENANCE

Regular maintenance of public and private catch basins and inlets is necessary to ensure their proper function. Maintenance will remove pollutants, reduce high pollutant concentrations during the first flush of storms, prevent clogging of the downstream conveyance system, and restore the catch basin's functional capacity. Keys to effective catch basin cleaning include the following:

- All basins should be cleaned annually prior to the onset of the rainy season;
- Clean catch basins in known problem areas more frequently to remove sediments and debris accumulated during the dry weather months;
- Keep records of the number of catch basins cleaned; and
- Track the amount of waste collected.

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The Los Angeles County cleans its catch basins annually by hired contractor prior to the rainy season. Data on the quantity of debris is being collected to determine whether additional cleaning is justified.

2. DRAIN MAINTENANCE

Open channel storm drains should be cleaned at least annually prior to the rainy season. Problem areas should be cleaned more frequently as needed. Channels should also be monitored during the rainy season for any debris buildup and cleaned where needed.

To reduce the amount of debris entering the ocean, the Los Angeles County field personnel inspect open channels and sumps to pump plants after storms and clean as needed. Caltrans is preparing a priority list of drains and pump houses requiring cleaning, based on data from recent flooding.

3. WASTE MANAGEMENT

Excessive waste buildup will decrease the capacity of the channel, it is therefore crucial to reduce pollutant levels in storm water by regularly removing illegally-dumped items and material from storm drainage channels and creeks. A program should be developed to identify problem areas of illegal dumping so regular inspection and clean up can maintain the channel's optimum capacity and prevent the discharge of contaminants.

4. NEW SYSTEM DESIGNS

Current design standards for the construction of new storm drain systems will be evaluated in light of currently available pollutant control measures. Design standards may be modified to incorporate measures deemed appropriate for local conditions.

5. RETRO-FIT OPPORTUNITIES

The majority of the existing storm drain systems are in highly urbanized areas providing little opportunity for cost effective retro-fitting. However, currently available pollutant control measures will be reviewed for their effectiveness and possible use. This may include pilot studies to evaluate the performance of management practices under local conditions.

E. STREETS AND ROADS

Construction, operation, and maintenance of roads has an impact on storm water quality and will be addressed in the management plan.

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1. SWEEPING

Street sweeping can collect refuse on street surfaces to prevent it from entering the storm drain system through catch basins.

a. Storm Water Quality Based Operation

In order to effectively implement the sweeping program, the permittees should keep accurate operation logs to track the program. Areas generating excessive refuse should be swept more frequently. Sweeping frequency may also be increased before the rainy season to reduce the amount of refuse entering the storm drain system. Parking on sweeping days should be regulated to facilitate the operation.

For example, the Los Angeles County sweep its 3025 curb miles weekly using vacuum and broom equipment. In response to the requirements of California Regional Water Quality Control Board (Regional Board), double sweeping has initiated on selected streets. Caltrans sweeps its roadways on a regular schedule determined by observable debris.

b. Waste Management

Vehicles transporting waste should have spill prevention equipment that can prevent spills during transport. The refuse collected will be transported to the appropriate disposal facilities.

Roadside trash receptacles are used by the Los Angeles County, Caltrans, and the City of Santa Clarita for waste management. The receptacles are emptied either weekly or on as needed basis.

2. STREET/PAVEMENT WASHING

Wash waters from street/pavement washing may be contaminated and must be managed as non-storm water discharges.

3. MAINTENANCE

a. Saw-cut Slurry Management and Paving Practices

Existing saw-cut management and paving practices conducted by the permittees will be evaluated and appropriate control measures developed. Possible control measures to be considered that would help reduce the impacts to storm water:

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- Avoid paving during wet weather;
- Regularly repair potholes and worn pavement to reduce sediment loading;
- Store materials away from drainage courses to prevent pollution of storm water run-on; and
- Follow the storm water permitting requirements for industrial activities when mixing concrete with an on-site plant.

b. Waste Management

Good housekeeping practices will be implemented to insure proper management of any waste products that may be generated during maintenance activities. For example, to prevent concrete waste from entering the storm drain system, washout of concrete trucks should be conducted off-site or on-site in designated area. Excess concrete should not be dumped on site. Employees and subcontractors should be trained in proper concrete waste management.

The following steps will help reduce storm water pollution from concrete wastes:

- Store dry and wet materials under cover, away from drainage areas;
- Avoid mixing excess amounts of fresh concrete or cement on-site;
- Do not wash out concrete trucks into storm drains, open ditches, streets, or streams;
- Do not allow excess concrete to be dumped on-site, except in designated areas;
- Avoid paving during wet weather;
- Regularly repair potholes and worn pavement to reduce sediment loading; and
- Cover catch basins and manholes when applying seal coat, tack coat, slurry seal, fog seal, etc.

Employee/subcontractor training to insure implementation of good housekeeping measures should be based on four objectives:

- Promote a clear identification and understanding of the problem, including activities with the potential to pollute storm water;
- Identify solutions (BMPs selection);
- Promote employee/subcontractor ownership of the problems and the solutions; and

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- Integrate employee/subcontractor feedback into training and BMP implementation.

c. Medians/Landscaped Right-of-Way

i. Irrigation

Overwatering of landscaping produces runoff. A properly timed irrigation schedule should be set up to minimize overwatering. Drip irrigation system should be used when feasible in new installations.

ii. Fertilizers/Pesticides

The handling, storage, and usage of fertilizers/pesticides are addressed in Chapter V, Section C-1.

F. FLOOD CONTROL

Common municipal practices, such as construction and operation and maintenance of the flood control system, may have a potentially adverse impact on storm water quality. Consequently, these practices shall be coordinated to the extent of preventing pollutants from impacting the water quality.

1. COORDINATION WITH NEW PROJECTS

Current design standards for the construction of new storm drain systems will be evaluated in light of currently available pollutant control measures. Design standards may be modified to incorporate measures deemed appropriate for local conditions. During construction, all appropriate BMPs will be utilized to control pollutants during the construction of the facility.

2. COORDINATION OF MAINTENANCE ACTIVITIES

Current maintenance activities with regards to desilting/sediment removal, vegetation management, and waste management shall be reviewed to insure that appropriate management measures are developed to comply with the storm water regulations.

3. OPERATION OF FACILITIES

Flood control facility operations will be reviewed to identify where appropriate management measures could be incorporated. However, primary

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consideration will need to be given to the flood control function of the facility to protect health and safety.

4. RETROFIT OPPORTUNITIES

The majority of the existing storm drain systems are in highly urbanized areas providing little opportunity for cost effective retro-fitting. However, currently available pollutant control measures will be reviewed for their effectiveness and possible use. This may include pilot studies to evaluate the performance of management practices under local conditions.

G. PUBLIC FACILITIES

Storm water runoff and non-storm water discharges from other public facilities must also be addressed, including chemical use by these facilities, pressure blasting/cleaning sidewalks and other surfaces.

1. PARKING FACILITIES

Storm water from parking lots may contain undesirable concentrations of oil, grease, suspended particulates, and metals. Some control measures such as periodic sweeping and cleaning catch basins should be implemented. The need for more advanced structural controls would be evaluated through the pollutant source identification program. Pilot studies would be conducted on candidate structural controls to evaluate their effectiveness prior to large scale implementation.

2. GOLF COURSES

Golf courses require the use of large amount of water, fertilizers, and pesticides. Field personnel should be trained on the proper handling, storage, and usage of these chemicals (Refer to Chapter V, Section C-1 for detail). To prevent excess irrigation water from entering the storm drain system, proper management of watering schedules should be required.

3. SCHOOLS

The maintenance of playgrounds and athletic fields at schools require fertilizers and pesticides. Their safe storage and use affect not only the stormwater quality but also the health of the students and the staff. Therefore BMPs under Chapter V, Section C-1-b should be implemented. Each municipality should develop a program to encourage these schools to use environmentally sensitive products for fertilizers, pesticides, detergents,

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and other chemicals. The schools should have proper material handling, storage, and disposal procedures for chemicals used in school laboratories.

4. HOSPITALS

Each hospital should have BMPs to control the handling and storage of medically related hazardous materials. All materials should be inventoried regularly, with record keeping protocols on supply and consumption. All personnel should be trained on the proper procedures on handling these materials, as well as emergency response. Each hospital should maintain a list of supervisors to be contacted if accident does occur. Disposal of these materials should be contracted out to commercial specialists.

5. PARKS/LANDSCAPES

Refer to **Section C Parks and Recreation**, of this Chapter, for information.

6. OTHER BUILDINGS/PLAZAS

Refer to **Section C-2 Parks and Recreation - Facility Management**, of this Chapter, for information.

H. PONDS, FOUNTAINS, AND OTHER PUBLIC WATER BODIES

Maintenance practices used on public water bodies, including waste management and non-stormwater discharges, must be addressed in the plan.

1. ALGAE CONTROL

a. Use of Chemicals

The use of herbicides or other chemicals to control algae growth should be carefully controlled and monitored to insure strict adherence to manufacturers' guidelines for use. Water sampling may be necessary to insure effective control.

2. CHLORINE MANAGEMENT

The use of chlorine for disinfection should be controlled. High dosage of chlorine may be harmful to the aquatic habitats. Dechlorination of pools and other water bodies would be required prior to draining.

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3. MAINTENANCE

Each municipality should develop BMPs to prevent and control trash, debris, and other pollutants from entering water bodies. These measures could include routine trash collection along and on water bodies, public outreach to educate the public about the impacts of illegal dumping, and increase enforcement for violations.

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VI. RESIDENTIAL

INTRODUCTION

Residential activities including private vehicle washing and maintenance; use of chemicals such as pesticides, herbicides, and paints; private swimming pool maintenance; and other household and landscape maintenance can contribute to storm water pollution. These are all examples of non-point source pollution, a significant impact on water quality. Measures that can be taken to improve the quality of the runoff from residential area all require active public participation. Feasible BMPS to mitigate the stormwater pollution problem should include practicing good housekeeping and the use of environmentally sensitive alternative products, vehicle leak and spill control, and water conservation. Development of the residential stormwater programs will be completed by December 1996.

A. HOUSEKEEPING PRACTICES

This BMP involves the development of a program to promote efficient and safe housekeeping practices (storage, use, and cleanup) when handling materials which may pollute stormwater/urban runoff. This could include, but are not limited to, fertilizers, pesticides, cleaning solutions, paint products, automotive products, and swimming pool chemicals.

A public education program will be developed to provide information on stormwater pollution and the beneficial effects of proper disposal on water quality; reading product labels; safe storage, handling, and disposal of hazardous products; list of local agencies; and emergency phone numbers. The above information can be disseminated through brochures or booklets made available at places such as public information fairs, municipal offices, and household hazardous waste collection events and facilities. City newsletter to residents is another means to inform the public, especially for those who do not participate or visit any offices or events.

B. ENVIRONMENTALLY SENSITIVE ALTERNATIVE PRODUCTS

This BMP, promoting the use of less environmentally sensitive products, can be implemented in conjunction with housekeeping practices. Alternatives exist for most product classes including fertilizers, pesticides, cleaning solutions, and automotive and paint products. The key to success will be to promote a willingness to try alternatives and to modify old habits.

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General information will be developed and made available to the public on such alternatives. The emphasis may be placed on the need to preserve the natural environment of the receiving waters (ocean, bay, stream, wetland, etc.) with the use of alternative products because of their less toxic nature and proper disposal after its use.

C. VEHICLE LEAK AND SPILL CONTROL

This BMP prevents or reduces the discharge of pollutants to storm water/urban runoff from vehicle leaks and spills by reducing the chance for spills, stopping the source of spills, containing and cleaning up spills, and properly disposing of spill materials.

Vehicles will leak and spill fluids. The key to successful pollution management is to reduce the frequency and severity of leaks and spills; and when they do occur, to prevent or reduce the environmental impacts. Through education, the public should be encouraged to regularly inspect and maintain their vehicles. Guidelines should be developed to inform the public on spill containment and cleanup procedures such as having absorbent material on hand and disposing the material properly.

D. WATER CONSERVATION

Water is a scarce resource, especially so in Southern California. Wasteful use of water could channel pollutants into the receiving waters. Practices such as hosing the driveway and overwatering the landscape contribute not only to stormwater pollution, but also to the depletion of our natural resource. In order to prevent stormwater pollution, the public has to be educated on the mechanics of our storm drain system - discharges into the system will flow untreated into the receiving water. They have to know that the lawn clippings they wash down the road will end up in the ocean. Public awareness of the function of the storm drain system, of the important of environmental health, and of our necessity to slow down the depletion of water resources will be a long way in reducing the pollution of stormwater/urban runoff.

Ordinances could be use to endow the related officials with legal authority to enforce water conservation. An ordinance prohibiting the wasting of water is one way of enforcement.

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VII. PUBLIC INFORMATION AND PARTICIPATION

It is necessary to involve the public in the stormwater program for it to be effective. The outreach program should be focused on the specific needs of the individual cities. Due to the inter-relationship among the stormwater issues, the public information and participation program should be recognized as a whole, rather than a number of separate outreach programs. All public awareness efforts should clarify to the public that they are the ultimate beneficiaries of a successful stormwater management program.

A. GENERAL OUTREACH

The targeted audiences of a general outreach will include municipal employees, local construction contractors, businesses in the area, and the general public. They should be made aware of their responsibility for both the problems and the solutions to stormwater pollution. In order to effectively communicate the stormwater pollution abatement message throughout the watershed; written, audio, and visual materials should be utilized. The actual level, priority, and schedule of public information activities must be based on the community's needs and resources to maximize program effectiveness. A watershed-wide concept will be developed by December 1995.

1. WRITTEN MATERIAL

Co-Permittees should produce a variety of written materials to inform the residents within the watershed. Materials can include, but are not limited to, the following: flyers, brochures, door-hangers, newspaper articles, mail-inserts, banners, and posters. When necessary, these materials should be translated into a variety of foreign languages to reach minority residents in the community.

A diversity of print media has been used, particularly by the Los Angeles County. County publications include specific information on various storm water programs. The County also uses billboard and bus stop shelter advertising. Door hangers and refrigerator magnets are also distributed by the County.

2. AUDIO MATERIAL

Similarly, Co-Permittees may utilize audio materials to convey information regarding stormwater management. Examples of audio materials include radio advertisements/public service announcements and informational cassettes.

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3. VISUAL MATERIAL

Catch basin stenciling program is an excellent means of educating the public on the mechanics of the storm drain system. The intent of the program is to enhance public awareness of the impact of stormwater pollution on receiving waters and to discourage improper waste disposal practices. Another effective medium for communicating the importance of stormwater management is through television. Possible measures include producing a public service announcement, cable access programs, and/or an informational video.

Catch basin stenciling is receiving full cooperation throughout the watershed. Portions of the catch basins within each Co-Permittee's jurisdiction have been stenciled, with plans by all to stencil the remainder. In terms of the use of public media, the Los Angeles County has used television to promote its activities through public service announcements and special programming.

4. DISTRIBUTION PLAN

General outreach efforts must be conducted throughout the entire watershed. Materials should be available at all public counters and distributed at public events such as environmental fairs and contests. A city newsletter is another effective method of conveying the pollution abatement message.

B. FOCUSED OUTREACH

Efforts should be made to target special groups. Focus could be on specific pollutants, practices and/or activities, or businesses. A watershed-wide concept will be developed by September 1996.

1. POLLUTANT SPECIFIC

For a particular watershed, there may be priority pollutants which are of more concern than others. The reduction of these pollutants may be addressed in a more focused public education and outreach program. Any of the methods used in the general outreach program may be utilized in a pollutant specific outreach program.

2. PRACTICE/ACTIVITY SPECIFIC

Everyone who lives or works in a particular watershed must realize that their actions have a direct affect on the quality of stormwater. These special groups must be made aware that their current practices/activities may be contributing to stormwater pollution. Practice/activity specific outreach programs should be developed and implemented throughout the watershed.

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The use of written, audio, or visual materials should convey three primary messages: (1) what activities can cause stormwater pollution, (2) how Best Management Practices are used to prevent pollution, and (3) how one can report occurrences of stormwater polluting activities.

Practice/activity specific outreach should promote, publicize, and facilitate public reporting of illegal dumpings, illicit discharges, or water quality impacts associated with discharges from municipal separate storm sewers. An effective program should include the establishment, operation, and promotion of a reporting hotline. Timely reporting by the public of improper disposal and illicit discharges are critical in controlling such sources of stormwater pollution. Increase in public involvement may be achieved by sending a follow-up letter to callers or providing callers with some type of reward. Educational efforts throughout the watershed should inform the public about the existence of the Los Angeles County-wide hotline and any other local hotlines; provide them with information regarding what to look for, and guidelines/procedures on how to report incidents.

Another critical component of practice/activity outreach is the development of a program to facilitate the proper management and disposal of used oil and toxic materials. An effective program could include, but are not limited to, the operation of recycling facilities and the conduction of household hazardous waste round-ups. The program could also include information about alternatives to toxic materials. Educational efforts throughout the watershed should provide the public with detailed information regarding the Los Angeles County-wide Household Hazardous Waste Round-ups and any other local programs.

Within this watershed, Co-Permittees take part in outreach programs specifically aimed at preventing improper disposal of hazardous household products and encouraging actions that keep general wastes out of the storm drain system. Examples of these programs include recycling programs, public trash receptacles, and the cleaning of sidewalks, alleys, and vacant lots. Illegal dumping and discharges are also specifically targeted.

3. BUSINESS SPECIFIC

Due to the fact that some business operation have a higher potential of discharging pollutants into the storm drain system, a more focused public education and outreach program should be developed for them. Employees of these businesses should be educated on the issue of non-point source pollution and the effectiveness of Best Management Practices in reducing pollution. Besides written, audio, or visual materials that focus on specific businesses and their practices, mass mailings or articles in a trade/industry magazines are other possible means of focused outreach.

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C. EDUCATION PROGRAMS

Increasing awareness is the major goal of the Public Information and Participation Program. An ideal means of accomplishing this task is through educational programs. Programs should be developed for a variety of audiences, including public employees and school children. Educational programs can also be an important part of a general or focused outreach. A watershed-wide concept will be developed by September 1996.

1. PUBLIC EMPLOYEES

It is important to educate all of the public employees about the stormwater program so that they do not continue with any practices that are counter productive. Furthermore, they can participate in the implementation and enforcement of the program. Ideas and suggestions of employees can be used to modify the program for improved effectiveness. The outreach must involve employees on many different levels - from program managers to field personnel. Educational programs for public employees may include, but are not limited to, articles in City newsletters, training classes, checklists for field personnel, and interdepartmental forum or committee. Any of the materials utilized in an outreach program - written, audio, or visual materials - may be used in a public employee educational program.

More formal training/education of employees are conducted or provided by all three Co-Permittees. The City of Santa Clarita has implemented a program to educate City staff while Caltrans personnel is educated on highway maintenance.

2. K-12

School children can play an important role in a public information and participation program. First, children are generally more easily motivated and the behavior changes made at that point in life tend to stay with them through adulthood. Secondly, school children can convey the stormwater pollution prevention messages to the members in their family. School programs must include information on the storm drain system, stormwater quality awareness, and may also include, but are not limited to, illegal dumping awareness, source minimization, and pollution prevention. Written material, videos, assembly programs, and field trips are examples of effective components of a K-12 educational program.

3. OTHER

Educational programs can also be developed for professionals and technicians who are not public employees. Agencies should include public outreach

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material for business license renewal or outreach effort through professional and business associations.

D. CITIZENS PARTICIPATION

The residents of the watershed should not only be made aware of the stormwater program, they should be encouraged to participate in its implementation. Specific outreach programs should be developed to allow the public to participate and to inform them of available means for providing ideas and comments regarding the stormwater program. A watershed-wide concept will be developed by September 1996.

1. VOLUNTEER MONITORING

Volunteer monitoring is the result of increased public awareness and participation. The public can utilize the hotline for reporting suspected illegal practices. Such involvement, which is similar to the Neighborhood Watch Program on crime, usually has good results.

The Los Angels County has established an 800 hotline number that is available to all County residents for reporting illegal dumping. Outreach programs to publicize the hotline include advertising in newspapers and distributing of literature at various events.

2. COOPERATIVE OUTREACH

In order to promote public participation, cooperative outreach programs should be developed. These cooperative programs should help to create an awareness and an identification with the watershed. The catch basin stenciling and other signing programs are excellent examples of this type of cooperative effort. One possibility for cooperative outreach is an "Adopt-A-" program. Residents can "adopt" a highway, storm drain, catch basin, stream, etc. Other cooperative outreach efforts include events such as "Stormwater Pollution Awareness Week." The purpose of any of these activities is to inform and involve the local residents in regards to the stormwater management program.

The following are two examples of residents assisting public agencies in the development and implementation of storm water quality programs:

- The City of Santa Clarita has enlisted the assistance of the Eagle Scouts in its catch basin stenciling program.

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- Caltrans and the Los Angeles County both have Adopt-A-Highway programs that rely on voluntary private participation to help with clean-up activities.

3. COMPLAINT PROCEDURES

Public comments/complaints are important to the success of a stormwater program. A hotline is an excellent mechanism for allowing the public to provide information. In Section B, "Focused Outreach - Practice/Activity", the various aspect of outreach effort is discussed.

E. EFFECTIVENESS EVALUATION

Permittees should develop a process to evaluate the effectiveness of their programs. Methods such as surveys and focus groups can be used to assess program's effectiveness. Results should gauge the community's level of awareness. Surveys and focus groups can also be used to provide insight into the program's direction and the formulation of attainable goals. A watershed-wide concept will be developed by September 1996.

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VIII. PROGRAM EVALUATION

The effectiveness of the storm water programs developed under the Municipal Storm Water Management Plan (hereinafter called the Plan) must be assessed on a regular and consistent basis. The Plan for this evaluation must include a schedule for evaluation, a methodology for the evaluation, a discussion of who will carry out the evaluation, and what will be evaluated. In addition, there must be a mechanism to follow up on the information generated by the evaluation. The Plan should be adjusted based on the program evaluation.

A. PERFORMANCE STANDARDS

The Permittees will develop standards to judge the effectiveness of the activities and control measures proposed under each chapter of the Plan. The standards will serve as minimum performance levels to evaluate the implementation of control measures. The subsequently developed performance evaluation procedures/methodologies will be the tool to determine if a particular BMP has an impact on stormwater quality. In developing these procedures, we resolve to ensure that each BMP is implemented to the maximum extent practicable. The targeted completion of this phase will be December 1997.

1. DEVELOPMENT OF PROCEDURES

General performance standards for evaluating the effectiveness of the Best Management Practices (BMPs) will be developed for all the BMPs proposed in the Plan. The Watershed Management Committee will be responsible for developing and adopting these evaluation criterion. The Management Committee may elect to establish subcommittees to develop performance standards for specific program areas. The area-wide Executive Advisory Committee will then review and endorse the standards. Standard recording format and implementation schedule will be developed for each BMP by the Management Committee for use by all permittees. The permittees will be required to document BMP implementation using the standard format according to an established schedule. The utilization of quantitative approaches in measuring effectiveness will be used whenever possible. Methods that would yield comparable results for year to year evaluation will be developed.

2. ACTIVITY/SOURCE/ACTION AREA SPECIFIC

Program effectiveness will be performed based on the information generated by the performance evaluation procedures. Using street sweeping as an example, the Plan will propose a method of determining if street sweeping has an impact on water quality. This could include determining what kind of

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pollutants are removed by the sweeping, measuring the size of the pollutants and the amount removed. Methodologies would be developed for each BMP, which will assure that each control measure or action is implemented to the maximum extent practicable. For street sweeping; this may include the frequency of sweeping now, the method of sweeping, the equipment used, how the equipment is cleaned and maintained, and the method of disposal for the material collected. A schedule and format of evaluation shall be developed for all the BMPs.

The California Regional Water Quality Control Board (Regional Board) has recommended 13 Baseline BMPs, to be developed and/or implemented by all permittees by the end of the current NPDES Permit. Existing Permit Task 5.2.5 requires an evaluation of the need for additional BMPs, source control, and/or structural control measures.

BMPs have only been implemented for a short time period by Phase I and Phase II cities. Phase III, which contains 30 new cities, has not yet implemented any BMPs. Therefore there is little or no data available to adequately assess effectiveness. In lieu of recommending any changes or additions to BMPs currently being implemented or proposed by the Permittees, a uniform data collection methodology will be established for each of the 13 baseline BMPs. This methodology would be used by all Permittees to compile data on their BMP implementation to allow for a uniform Countywide evaluation of BMP effectiveness. Priority will be given to the development of a uniform data collection methodology to document the success or effectiveness of these 13 BMPs. Upon reorganization of the NPDES Permit Program, as described in Chapter I, this will be the first task addressed by the Watershed Management Committee. The Uniform data collection methodology will be developed by January 15, 1995 for the Santa Monica Bay watershed and by July 1995 for all other watersheds with subsequent implementation by all permittees in each watershed.

B. ANNUAL REPORTS

An annual report for each watershed will be submitted to the Regional Board not more than 45 days after the end of each permit year. Each annual report will include a summary on the programs implemented during the previous year and plan activities that will be implemented during the current year. Any revisions to the Plan would be addressed in the report.

1. FORMAT/STRUCTURE

In order to insure uniform annual reporting by all watersheds, the Executive Advisory Committee will develop a uniform annual report outline for use by

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each watershed. Each Watershed Management Committee will develop a standard format to be used by all the permittees in its watershed in reporting the progress and the status of all stormwater programs implemented in its jurisdiction. The Principal Permittee will utilize this information to develop the annual report for the watershed. Upon approval by the Management Committee, the annual report will be provided to the Executive Advisory Committee which will compile the annual reports from all watersheds for submittal to the Regional Board.

2. EFFECTIVENESS MEASURES

Under Chapter VIII, Section A, the permittees will have developed performance standards for each BMP. These performance standards will be used to assess the effectiveness of the BMPs. By the end of each permit year, the findings of the previous program year will be evaluated and used to suggest changes that are appropriate for implementation during the next year. Focus should also be given to the use of empirical studies, in a control setting, to more fully assess the effectiveness of BMPs.

3. CONTENT

The annual report will include a matrix illustrating the levels of implementation for all Permittees. Tables will be developed for each BMP listing all the participating Co-Permittees, describing the status of implementation by each Co-Permittee of the BMP, and documenting any modifications of the BMP from the standard program. The effectiveness of each program area will be assessed using the performance standards developed under Chapter VIII, Section A. For effectiveness measures, the findings should be presented graphically for ease of comparison with the established levels of effort. Fiscal budget for all the BMPs implemented should also be prepared, grouped by programs. An analysis and evaluation of the results of the past year's monitoring program data will also be included in the report. Any revisions to the Plan should be addressed here, with all the elements affected discussed in their entirety. All relevant information, such as water samples analyses and evaluation, should be included in the appendices.

C. SEMI-ANNUAL REPORTS

A semi-annual progress report will update the Regional Board on Permit compliance activities six months into each permit year. The semi-annual report will be provided to the Regional Board within 30 days after the end of the six-month period.

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1. PURPOSE

The semi-annual report will serve as a status report on the progress of the implementation of the Plan.

2. FORMAT/STRUCTURE

In order to insure uniform semi-annual reporting by all watersheds, the Co-Permittees will use the standard format developed for the annual report in reporting the progress and status of all the BMPs implemented in their jurisdictions. The Principal Permittee will utilize this information to develop the semi-annual report for the watershed for submittal to the Regional Board.

3. CONTENT

The semi-annual report will include a matrix illustrating the levels of implementation for all permittees. Tables will be developed for each BMP listing the participating Co-Permittees, describing the status of implementation by each Co-Permittee of the BMP, and documenting any modifications of the BMP from the standard program. The Permittees will describe the problems encountered during implementation and discuss the modifications to the program in order to solve these problems.

D. INTERNAL REPORTING

In order to facilitate the preparation of semi-annual and annual reports, standard internal formats for use by all Permittees will be developed. The internal reporting procedures will be completed for all Plan chapter elements by December 1997.

1. STANDARD FORMS

The Watershed Management Committee will be responsible for developing standard forms for use by each Permittee. Standard forms will be developed for each BMP to monitor its progress. Some Permittees may have to customize the standard forms in order to reflect their programs' additional features. The forms will collect all the information essential to the preparation of the annual and semi-annual reports. In developing the standard report forms, information that is quantifiable and specific for each program area and/or BMP will be collected.

2. PROCEDURES

Co-Permittees will submit all the BMP report forms to the Principal Permittee at the end of the six-month period and the permit year, respectively.

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3. RECORD KEEPING

The Regional Board does not need to see all of the extraneous information, but the records will be retained by the Principal Permittee for 2 years. Each Permittee will keep a permanent copy of its reporting forms in case they are needed.

E. STORM WATER MANAGEMENT PLAN REVISIONS

There will be an annual review process that will allow the Permittees to revise the Plan for the next year and for the rest of the permit period. The targeted completion date for the phase is December 1997.

1. PROCESS

In the annual report, Permittees will compare the progress made on all the BMPs with the established level of effort. If the level of implementation is inadequate, the program should be adjusted to accelerate the progress. If the progress made to date shows that the program is ineffective or inefficient in protecting the stormwater quality, a new program should be developed and implemented for the next fiscal year and the rest of the permit period.

2. REPORTING

All refinements or revisions to be made in the fiscal year will be documented in the annual report, with the dates of implementation proposed.

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IX. MONITORING

The Monitoring Program is a critical element in the Stormwater Management Plan. It will provide important data for use in characterizing existing stormwater/urban runoff quality, guiding future development, and modifications to the Plan and also to assess its effectiveness. A watershed wide monitoring program shall be developed by December 1997.

A. SYSTEM CHARACTERIZATION

The existing Permit subdivided the County into six drainage basins with information to be collected to characterize each of the basins.

1. WATERSHED

Each drainage basin has been subdivided into numerous drainage areas, based on an evaluation of the existing drainage system and surface flow patterns. For each drainage area, the following information has been compiled: size; breakdown of existing land use; imperviousness; description of soils; location of waste disposal facilities; and the location, type, and number of industries by Standard Industrial Classification (SIC) Code. This information has been submitted to the California Regional Water Quality Control Board, Los Angeles Region, for Phases I and II. Phase III watershed characterization is in progress and will be completed by the end of December 1994. Due to the volume of the watershed characterization data, this information has not been included herein, but is available for review at either the Regional Board or the Los Angeles County Department of Public Works.

This information will provide a basis for developing other monitoring program elements such as pollutant loading estimates from major land uses and watersheds; pollutant source identification, and identification of illegal discharges/illicit disposal practices.

2. STORM DRAIN SYSTEM

In subdividing each basin into drainage areas, the drainage area tributary to all major outfalls has been identified. Within each drainage area, the tributary storm drain system is being identified and mapped. Key information such as the size of the storm drain facilities, locations of manholes and inlets, and storm drain connections is being compiled. This information will be vital in conducting storm drain inspections to identify and eliminate illegal discharges.

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3. RECEIVING WATERS

Due to the extent of urbanization in Los Angeles County over the past decades, most of the streams designated as receiving waters in the Los Angeles basin have been replaced with man-made storm drainage systems to provide flood protection to the urbanized areas. These streams have been mapped as part of the storm drain system mapping done under A.2. above. The remaining natural streams are also being mapped.

The Los Angeles County Department of Public Works (Department) has been performing surface water quality monitoring on a voluntary basis since the late 1960s. Samples have been collected and analyzed from various receiving water streams and channels throughout the County to collect general information as to the quality of the surface runoff within our storm drain system.

The program in existence at the time the current Permit was issued was established in the mid 1980s. Twenty-eight sites are sampled monthly for dry weather flows. Twenty-one of the 28 sites are sampled for storm flows up to five times per year. The collected samples are analyzed for general minerals, pH, total dissolved solids, specific conductance, biochemical oxygen demand, bacteria, heavy metals, pesticides, PCBs, total organic carbon, volatile organic compounds, and total petroleum hydrocarbons.

The sample collection at these sites will continue while the new National Pollutant Discharge Elimination System (NPDES) Permit monitoring stations are established. Once all NPDES Permit monitoring stations are operational, sampling at these 28 sites will be discontinued.

In order to provide an initial assessment of the water quality in the major streams and channels in the County, an analysis has been performed on the data collected through the existing surface water monitoring program. The analysis has been done on a Countywide basis and also by major drainage basin. The report can be found in Volume 8.

To better assess the receiving water impacts of stormwater the Department will be developing a program to further study stormwater impacts on selected receiving waters, including conducting toxicity studies. Initial efforts will focus on the Santa Monica Bay Watershed. A Request for Proposal for the development of such a program will be advertized by January 15, 1995.

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The water quality data collected by the new NPDES Monitoring Program will provide more detailed data to better assess in upcoming years the quality of our receiving waters. Ten monitoring stations have been proposed along the major streams in the County. A description of these site locations can be found in the monitoring work plans for Phases I, II, and III, previously submitted to the Regional Board, see Volume 8.

4. LAND USE

As described under Section A.1. above, the existing land use categories within each drainage area have been identified. This information has been used to select drainage areas comprised of a single homogeneous land use for land use specific monitoring. A total of 14 land use monitoring sites are being established in the County. Five sites are being installed in the Santa Monica Bay Watershed with the remaining nine to be selected from within the Los Angeles, San Gabriel, and Santa Clara River Watersheds. For a description of the sites, please see Volume 8. These sites will provide valuable information as to the types and levels of pollutants found in runoff from various land uses. This information can then be used to refine the Stormwater Management Plan to develop specific management measures to target identified problems.

B. SOURCE IDENTIFICATION

Identifying the sources of stormwater pollutants from both specific land uses and specific activities will provide the information needed to identify problem areas and allow specific management measures to be developed to address these problems.

1. SPECIFIC LAND USE

As described in Section A.4. above, major land use classifications will be subject to individual monitoring to determine the types and levels of pollutants present.

2. SPECIFIC ACTIVITIES

a. A pollutant source identification program will be designed to identify significant pollutant sources (i.e., parking lots, industrial activities, etc.), with the hope that remedial action can be undertaken to reduce any significant impacts so identified. It will focus on monitoring very small areas (i.e., less than five acres) where a specific and/or interrelated set of pollutant generating activities are occurring. Its objective is to

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provide data for selecting BMPs for specific activities rather than characterizing discharges for long-term pollutant loading estimates.

Identification of pollutant sources can be done using a number of methods. Potential sources of storm water pollutants can be identified by records of chemical use and/or storage, by studies of specific activities which lead to the deposition of pollutants throughout the watershed, and by field inspection or monitoring. Watersheds which may contain significant pollutant sources can be identified through land use information or by mass loading estimates.

By mid January 1995, the County will begin targeted monitoring of a municipal corporation yard in the Santa Monica Bay watershed. A full program for pollutant sources identification will be developed by December 1996.

b. A storm drain inspection program has also been developed and is being implemented. The first phase of the inspection program will target the open channel storm drains to identify illegal discharges.

The open channel inspections will also be used to screen outfalls from underground storm drains for the presence of dry weather flows. This information will be used in the next phase of the storm drain inspection program to prioritized the underground storm drain system for further field screening and inspection of problem areas.

C. CONTROL MEASURE EFFECTIVENESS

It is unlikely that the effectiveness of the various control measures implemented by the storm water management plan can be determined solely through the data produced by monitoring the quality of storm drain flows, because it is difficult to obtain statistically significant comparisons of watershed-wide control measure performance with such data. For this reason the effectiveness of control measures will be assessed through other means.

Two general types of methods are available for assessment of control measure effectiveness: direct water quality (conventional) monitoring and indirect (non-conventional) monitoring. Direct water quality monitoring can be used to determine pollutant reduction by a specific facility or devise. This technique is commonly used for structural or treatment controls, such as detention basins and constructed wetlands, where there is an accessible inflow and outflow. Inflow and outflow results are compared to determine pollutant removal and effectiveness.

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Direct water quality monitoring of site runoff before and after implementation of non-structural control measures is also possible. However, it is difficult to demonstrate effectiveness at a statistically significant level because of the high degree of variability in stormwater pollutant concentration and mass loading data. The water quality improvement due to non-structural control measures is generally expected to be less dramatic than that achieved through structural controls. A larger number of samples is therefore required to produce a statistically significant result. This is especially difficult in relation to the monitoring of the pre-control measure condition. Collection of adequate baseline information is necessary prior to the implementation of management practices. Direct monitoring of the effectiveness of non-structural controls is feasible typically only under experimentally controlled conditions (e.g. selection of small, well-defined watershed; control of management practice implementation; effective sitting and timing of monitoring activities), including a sufficient number of samples to achieve statistical significance.

Indirect monitoring currently is the primary method of choice of assessment of management plan effectiveness. A number of indirect monitoring techniques are available for assessment of management plan effectiveness.

Verification of program implementation is an indirect monitoring method that can be used to determine how a management plan is being implemented. Another indirect monitoring method, pollutant removal inventories, can be used to assess the amounts of pollutants that have been prevented from entering the municipal storm drain system.

The 13 Baseline BMPs recommended for implementation by the Regional Board plus other BMPs proposed by the various Co-Permittee are in general all non-structural control measures. In the short-term, a uniform data collection methodology will be developed for use by all Permittees to compile information on the level of implementation of the 13 Baseline BMPs. This will allow for a uniform watershed-wide evaluation of BMP effectiveness. For the Santa Monica Bay watershed, this uniform data collection methodology will be developed and begin implementation by January 15, 1995. For the other watersheds, implementation would begin July 1, 1995.

For the long-term, as the various chapters of the Plan are more fully developed, possibilities for the use of direct water quality monitoring for control measure assessment will be evaluates as opportunities arise.

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D. POLLUTANT LOADING

One of the objectives of the monitoring program is to estimate the annual pollutant loadings from each watershed. Knowing the types and quantities of pollutants discharged into receiving waters are important in assessing the impacts of stormwater and, in turn selecting appropriate control measures to address problem areas.

The 24 permanent monitoring stations that are being established Permit-wide will be utilized to estimate pollutant loads from each watershed and also from various land uses. For a description of the methodology to be used to estimate pollutant loadings, please see Volume 8. For the Santa Monica Bay Watershed, the pollutant loading model will be tested and operational by January 15, 1995. Actual pollutant loadings will be calculated subsequent to storm events occurring for which water quality data has been obtained. For the other watersheds, a schedule for pollutant load modelling will be provided by January 15, 1995.

To more closely model pollutant loadings and evaluate control measure impacts, a more detailed dynamic modelling will be undertaken on a smaller, representative sub-watershed. The EPA-SWMM model has been selected for use in our dynamic modelling efforts. For the Santa Monica Bay Watershed, the Kenter Canyon Drain sub-watershed has been selected for this modelling efforts. This sub-watershed is typical of the urbanized areas in the Santa Monica Bay Watershed. It is comprised of multiple land uses, has well-defined boundaries, and has no upstream flow regulation. We are reviewing and identifying the existing drainage system, defining current and future land uses, and conducting field checks. The model will be tested and operational by January 15, 1995, with actual modelling results to be available later when local water quality data from our monitoring stations becomes available. Based on the results of the dynamic modelling of the Kenter Canyon sub-watershed, other sub-watersheds may be selected from the other major watersheds in the County.

E. COMPONENTS OF A MONITORING PROGRAM PLAN

The components of the monitoring program plan such as monitoring site locations, dry/storm sampling frequency and methodology, constituents to be sampled, field and laboratory procedures, QA/QC, etc., can be found in Volume 8 which has been previously provided to the Regional Board.

The Monitoring Program elements described in Volume 8 will be revised to address the Monitoring Program needs described in Section A - D above as agreed to in the letter from the County to the Regional Board dated September 22, 1994.

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As the various chapters of the Plan are more fully developed, the Monitoring Program will be revised to address any additional monitoring needs that may result

F. DATA MANAGEMENT

For water quality data collected at the 24 monitoring stations, please see Volume 8 for data storage and reporting methods.

For each Section A - E of the Monitoring Program described above, an annual report will be prepared detailing the data collected, with an evaluation and interpretation the data including water quality impacts.

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NPDES PERMIT NO. CA 0061654

TASK 5.2

REPORT OF WASTE DISCHARGE (ROWD)

VOLUME 8 OF 8 (TASK 5.2.1)

SECTION A - Countywide Evaluation of Existing Stormwater Quality Monitoring Data (1 of 2)

LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS
WASTE MANAGEMENT DIVISION
WATER QUALITY SECTION

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SECTION A

Evaluation of the Stormwater and
Dry Weather Monitoring Data

This Report as required by Permit Task 5.2.1, evaluates the existing data for the Stormwater and Dry Weather Monitoring Programs. This Report evaluates the water quality data in comparison to the 1994 California Regional Water Quality Board's Basin Plan and the 1990 Ocean Plan. It also provides a long-term trend analyses and a comparison of water quality data to the Best Management Practices implemented by the Permittees.

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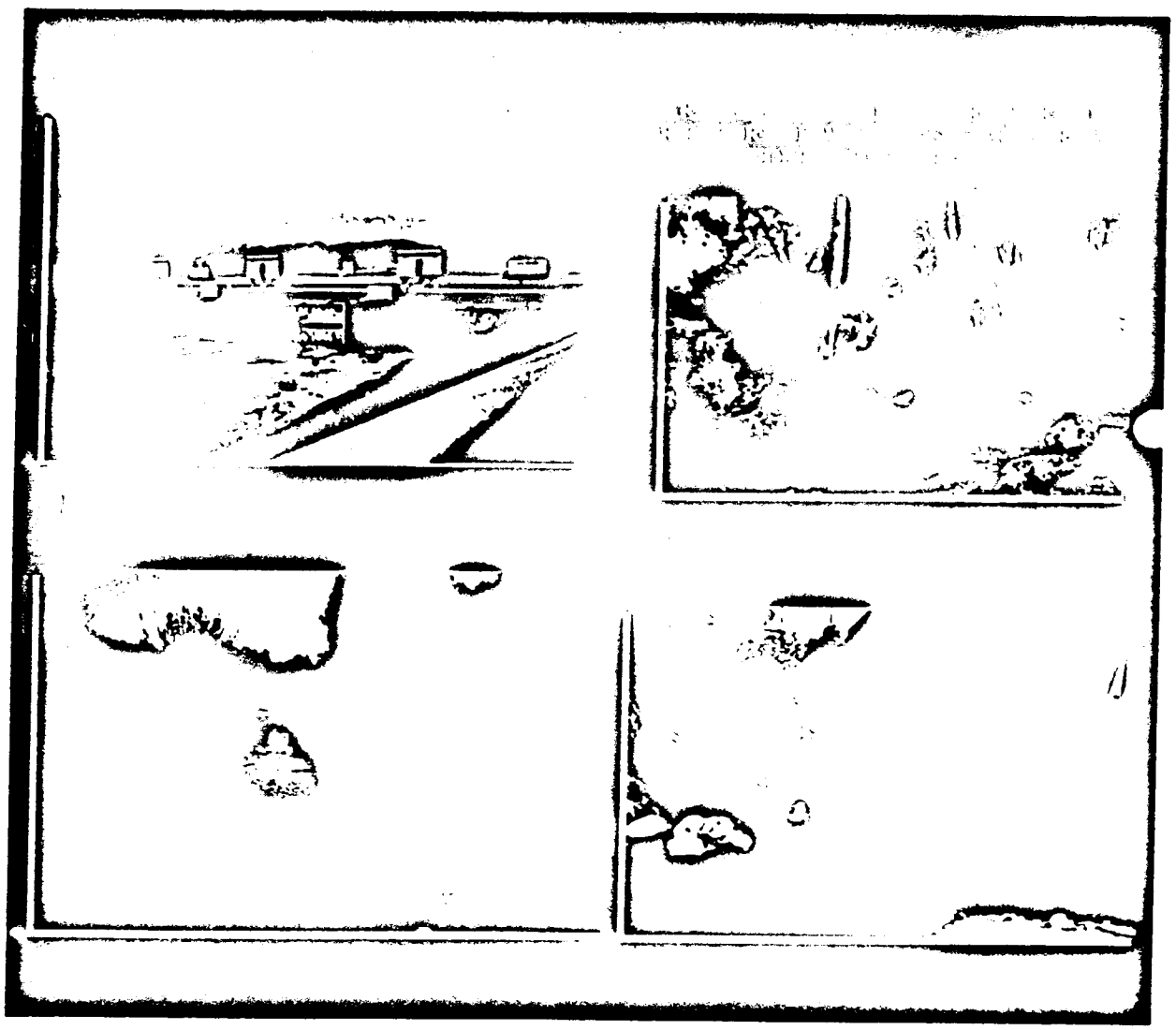

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EXHIBITS

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SECTION 1 - INTRODUCTION

1.0 PURPOSE

The Los Angeles County National Pollutant Discharge Elimination System (NPDES) Municipal Storm water Permit No. CA0061654 requires establishment of a monitoring program to assess the quality of storm water/urban runoff discharges and an analysis of the results of the monitoring program. The purpose of this report is to provide an evaluation of surface water quality monitoring data for inclusion in the "Report of Waste Discharge" (ROWD), which will be submitted by the Los Angeles County Department of Public Works (LADPW) to the California Regional Water Quality Control Board, Los Angeles Region (Regional Board) for the renewal of the existing NPDES permit. This report summarizes the results of the surface water quality monitoring data collected by LACDPW from 1988 through 1994.

1.1 PROJECT OUTLINE

This project includes an evaluation of pertinent historical water quality monitoring data in the Los Angeles County. The following is an outline of the general tasks performed and presented in this report:

1. A description of water quality monitoring activities under both dry weather and storm flow monitoring conditions.

2. An assessment of the monitoring sites, including locations in the regional basins, a description of their tributary watersheds, and an evaluation of the tributary basin land uses.

3. A description of sampling frequency and constituents analyzed.

4. An assessment of applicable regulatory guidelines including the "Basin Plan" and "Ocean Plan" water quality objectives.

5. A screening analysis to flag non-compliance with water quality objectives specified by the "Basin Plan" and "Ocean Plan". The "top ten" non-compliance parameters were used in performing spatial and trend analysis.

6. A spatial analysis to present average and maximum concentration of pollutants throughout the Los Angeles County and its regional watersheds.

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7. An assessment of trends over the sampling periods, including detecting periods of high concentrations and reductions. The trend analysis includes assessments of specific monitoring stations, as well as that in the regional watersheds and the entire Los Angeles County.

8. A comparison of water quality conditions at all stations to that at an undeveloped watershed station (Station 28-Monrovia Creek has been selected as the baseline for this study), and to the water quality objectives.

9. An assessment of urbanization impacts on water quality conditions.

10. An evaluation of the BMP programs implemented previously and their effectiveness (if any), on water quality.

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SECTION 2 - REGULATORY OVERVIEW

2.1 NPDES PERMIT

The NPDES (National Pollutant Discharge Elimination System) was previously required by the federal government for sanitary sewer systems. In 1972, the federal Clean Water Act (CWA) was amended by the EPA to provide that the discharge of pollutants to waters of the United States from storm water runoff effectively be prohibited, unless the discharge is in compliance with the NPDES permit. In 1987, Congress reauthorized the Clean Water Act, an edict which provided a comprehensive nationwide storm water management program under the NPDES permit program. The federal regulations were finalized in the Federal Register on November 16, 1990.

Federal regulations require that municipal storm system operators prepare monitoring programs for collection of representative water quality data at points of outfall or field screening points. The monitoring program is to indicate sampling frequency, constituents of concern, sampling equipment, and a description of samples representative here. The objectives are to identify the type, magnitude (both concentration and mass load), and sources of pollutants in the storm water systems in order to evaluate compliance and prevention measures.

In California, EPA's NPDES permit program is being administered by the State Water Resources Control Board (SWRCB) and on a regional basis through the nine State Water Resources Control Boards. The Regional Water Quality Control Boards (RWQCB) are charged with the responsibility for the protection of the waters of the State "for the use and enjoyment of the people of California." The RWQCB, Los Angeles Region (4) Board oversees implementation of the NPDES permit in the Los Angeles County area.

On June 18, 1990, Los Angeles County was issued a NPDES Municipal Storm water Permit by the California Regional Water Quality Control Board, Los Angeles Region, for its storm drain system (NPDES Permit No. CA 0061654). The permit expires June 18, 1995, with another five year permit to be issued at that time. One of the major requirements of the NPDES permit is the development and implementation of a monitoring program. On December 18, 1994, six months prior to the expiration of the existing NPDES permit a "Report of Waste Discharge" (ROWD) including an analysis of the results of the monitoring program, must be submitted to the Regional Board for permit renewal consideration.

The County of Los Angeles as the "Principal Permittee" of this Municipal Permit is responsible

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for administering the order and coordinating cooperation by "Co Permittees" (cities and recognized entities), including implementation of local self-monitoring programs and Best Management Practices (BMPs), and preparation/submittal of required reports. According to the permit, the constituents of concern and significance in Los Angeles County are:

- *total and fecal coliform and Enterococci bacteria*
- *total suspended solids*
- *biochemical oxygen demand*
- *oil and grease*
- *heavy metals*
- *nutrients (general minerals)*
- *polychlorinated biphenyls*
- *polycyclic aromatic hydrocarbons*
- *pesticides and herbicides*
- *petroleum hydrocarbons*

Although the Municipal Permit requires that waste discharge requirements issued by the Regional Boards shall include provisions to implement water quality based objectives, numerical water quality standards are not provided in the permit. The permit indicates that numerical water quality objectives will be developed by the Regional Board staff for consideration during the permit renewal process and utilized to evaluate the effectiveness of Best Management Practices.

The Municipal Permit partitions Los Angeles County and its adjacent areas into five regional drainage basins for the purposes of program implementation. These drainage basins have been delineated based on hydrological characteristics of the watersheds, perceived importance and beneficial uses of water bodies, and existence of adequate infrastructures for program implementation. The designation of the five-drainage basin map is shown in Exhibit "A" and will be described in detail in Section 4.

The SWRCB establishes water quality standards for all the waters in the State of California through development of the "Ocean Plan" and "Enclosed Bays and Estuaries Plan." The SWRCB adopted a Water Quality Control Policy for the Enclosed Bays and Estuaries of California on May 16, 1974. This policy prohibits discharge of industrial process waters to enclosed bays and estuaries. However, storm runoff is not considered an industrial processes water. The SWRCB subsequently adopted a revised Water Quality Control Plan for ocean waters of California ("Ocean Plan") on March 22, 1990, which amended the Plan adopted on September 22, 1988. The Regional Board further adopted a revised Water Quality Control Plan for the Los Angeles Region ("Basin Plan") in 1975, and reprinted it with changes in 1978, 1990,

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1991, and 1992. The "Basin Plan" was recently updated and a draft plan was presented on April 28, 1994. Although the numerical water quality standards have not been assigned to LADPW Municipal Storm water Permit No. CA0061654, The water quality objectives described in the "1994 draft Basin Plan" and "1990 Ocean Plan" are used in this study to compare with the values of monitoring parameters. It should be pointed out that such comparisons are strictly voluntary, with the intention of improving future monitoring activities. Therefore, the results of this study should not be interpreted as either violating or complying with these two plans.

2.2 BASIN PLAN REQUIREMENTS

The Water Quality Control Plan for the Los Angeles Region (4), which includes the Santa Clara River Basin and the Los Angeles River Basin, was originally prepared in 1975 and revised in 1978, 1990, 1991, and 1992. The "Basin Plan" is designed to preserve and enhance water quality and to protect the beneficial uses of all regional waters. The "Basin Plan" describes beneficial uses and water quality objectives for individual streams and water bodies in the LA Region. Beneficial use designations have been assigned to all hydrologic areas in order to protect against water quality degradations.

The "Basin Plan" was further revised recently with a draft plan presented on April 28, 1994. Communications with the Regional Board indicated that this plan is currently under review and is anticipated to be adopted by the end of 1994. The Regional Board does not anticipate any further modifications of the draft "Basin Plan."

The 1992 revised "Basin Plan" and 1994 draft "Basin Plan" beneficial uses assigned to drainage systems associated with the existing Los Angeles County monitoring stations are summarized on Tables 1 and 2, respectively. Exhibit "B" shows the locations of the Los Angeles County monitoring stations. The beneficial uses listed in these tables include objectives for inland surface waters and for the coastal monitoring stations include objectives assigned to coastal features. For the purpose of comparison, the 1994 draft "Basin Plan" objectives were utilized in the analysis and evaluations of water quality data presented in this report. The 1992 revised "Basin Plan" beneficial uses are provided for the purposes of comparison with the new, draft 1994 "Basin Plan." The following is a brief description of the beneficial uses listed on Tables 1 and 2

Municipal and Domestic Supply (MUN) - Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.

Agricultural Supply (AGR) - Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.

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Industrial Process Supply (PROC) - Uses of water for industrial activities that depend primarily on water quality.

Industrial Service Supply (IND) - Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well re-pressurization.

Ground water Recharge (GWR) - Uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers.

Freshwater Replenishment (FRSH) - Uses of water for natural or artificial maintenance of surface water quality (e.g., salinity) or quantity.

Water Contact Recreation (REC-1) - Uses of water for recreation activities involving body contact with water, where ingestion of water is reasonably possible. These include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

Non-contact Water Recreation (REC-2) - Uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

Commercial and Sport Fishing (COMM) - Uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.

Warm Freshwater Habitat (WARM) - Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

Cold Freshwater Habitat (COLD) - Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

Wetland Habitat (WET) - Uses of water that support wetland ecosystems, including, but not limited to, preservation or enhancement of wetland habitats, vegetation, fish, shellfish, or wildlife,

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and other unique wetland functions which enhance water quality, such as providing flood and erosion control, stream bank stabilization, and filtration and purification of naturally occurring contaminants.

Marine Habitats (MAR) - Uses of water that support marine ecosystems including, but not limited to, preservation or enhancement of marine habitats, vegetation such as kelp, fish, shellfish, or wildlife (e.g., marine mammals, shorebirds).

Wildlife Habitat (WILD) - Uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

Preservation of Biological Habitats (BIOL) - Uses of water that support designated areas or habitats, such as Areas of Special Biological Significance (ASBS), established refuges, parks, sanctuaries, ecological reserves, or other areas where the preservation or enhancement of natural resources requires special protection.

Rare, Threatened, or Endangered Species (RARE) - Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened, or endangered.

Migration of Aquatic Organisms (MIGR) - Uses of water that support habitats necessary for migration, acclimatization between fresh and salt water, or other temporary activities by aquatic organisms, such as anadromous fish.

Spawning, Reproduction, and/or Early Development (SPWN) - Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.

Shellfish Harvesting (SHELL) - Uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sports purposes.

Navigation (NAV) - Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.

Estuarine Habitat (EST) - Uses of water that support estuarine ecosystems including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds).

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The major difference between the revised 1992 "Basin Plan" and the draft 1994 "Basin Plan" is the addition of MUN beneficial uses to all inland surface waters (and ground waters) in the later plan. With the adoption of the State Board Resolution No. 88-63 in 1988 (Regional Board Resolution No. 89-03), the water bodies of the region are required to be protected as potential sources of drinking water ("Sources of Drinking Water Policy"). The Regional Board will consider reviewing the "Sources of Drinking Water Policy" to develop criteria to exempt a water body from the MUN designation. However, no new implementations are implied by the new MUN designations until the Regional Board officially adopts criteria to exempt water bodies. Water quality objectives included in the Basin Plan are the limits of water quality constituents which are established for the reasonable protection of beneficial uses of waters for a specific area.

Comparison of overall numerical water quality standards specified in the revised 1992 "Basin Plan," the draft 1994 "Basin Plan," and the "Ocean Plan" to compare the Los Angeles County monitoring activities (parameters) are summarized in Table 3. This comparison reveals lack of monitoring data in the following chemical groups: synthetics, chlorinated hydrocarbons, toxics, non-carcinogen toxics, carcinogen toxics, and other miscellaneous compounds. In addition, dissolved oxygen (DO) was not included in the monitoring program previously conducted (1988 to 1994).

Table 4 provides monitoring station specific numerical water quality standards limits. For coastal monitoring stations where both "Basin Plan" and "Ocean Plan" numerical water quality objectives apply, the more stringent standards were used.

On the other hand, the 1988 through 1994 water quality monitoring data examined includes many compounds without specific "Basin Plan" or "Ocean Plan" requirements. In the category of general minerals, these include: calcium, alkalinity, total hardness, iron, manganese, phosphate-P, specific conductance, and volatile suspended solids. The list includes all total heavy metals, chromium IV (dissolved), iron (dissolved), and manganese (dissolved). In the category of purgeable organics (Volatile), there are no limits associated with: bromoform, bromomethane, chloroethane, 2-chloroethylvinyl ether, chloromethane, dibromochloro-methane, dichlorodifluoromethane, and vinyl chloride. In the category of pesticides, these include: alpha-BHC, beta-BHC, delta-BHC, endosulfan I and II, and endosulfan sulfate. Finally, in the category of miscellaneous compounds, neither plan has any requirement for monitoring: TPH, TOC, organic nitrogen, COD, phenol, oil and grease, and silica. However, the compounds monitored are included in the NPDES Permit as the required compounds to be monitored.

2.3 OCEAN PLAN REQUIREMENTS

The SWRCB revised Water Quality Control Plan for Ocean Waters of California (March 22, 1990)

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contains water quality objectives for the coastal waters of California. According to the "Ocean Plan," the beneficial uses of the ocean waters of the State that shall be protected include industrial water supply, water contact and non-contact recreation, such as aesthetic enjoyment, navigation, commercial and sport fishing, mariculture, preservation and enhancement of Areas of Special Biological Significance (ASBS), rare and endangered species, marine habitat, fish migration, fish spawning and shellfish harvesting.

The "Ocean Plan" water quality numerical objectives are summarized on Table 3. The "Ocean Plan" objectives are either equal to, or more stringent than, the "Basin Plan" except Volatile Purgeable Organics. In addition, the "Ocean Plan" contains objectives under the categories of Toxics, Non-Carcinogen Toxics, and Carcinogen Toxics which are numerically absent in the "Basin Plan." For Los Angeles County monitoring stations (discussed in Section 4) with both "Basin Plan" and "Ocean Plan" numerical water quality objectives, the more stringent limits were selected and used in the evaluations presented in this report. Table 4 provides numerical water quality limits for specific monitoring stations.

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SECTION 3 - MONITORING ACTIVITIES

3.1 MONITORING PROGRAM

The LADPW has been actively monitoring surface water quality conditions in the County's principal storm drains and water conservation facilities, on a voluntary basis, since the late 1960s. Since the mid-1980s, a monitoring program consisting of 28 sampling sites has been in effect. Grab samples are collected from all 28 sites on a monthly basis (or more) for dry weather flows. Twenty-one of the 28 sites are also sampled (grab samples) for storm flows three to four times per year.

The dry weather monitoring data evaluated in this report includes data collected from May 1988 to April 1994 for all stations, except for Station 13 which includes data collected from January 1990 to April 1994. The wet weather monitoring data evaluated for Stations 12, 16, 8, 6, 3, and 26 started in February 1988; for Stations 22, 11, 14, 21, 20, 11, 5, 4, 2, 27, 25, 23, and 24 it atarted in October 1987; for Station 10 it started in February 1989; and for Station 13 it started in February 1990. April 1994 was the last date of sampling.

A detailed description of each monitoring station location, their tributary basins and land uses is provided in Section 4. The location of the monitoring stations are shown on Exhibit "B".

CHEMICAL CONSTITUENTS: Table 3 provides a list of chemicals monitored by the Los Angeles County. A distinction is made between dry and storm weather samples. Flow measurements were not available in the data set examined. The dry weather samples are generally analyzed for general minerals, pesticides, total petroleum hydrocarbons, heavy metals, and bacteria (total and fecal coliform, KF Streptococci and Enterococci). Volatile organic constituents are tested semi-annually at selected stations. Storm water runoff is monitored for minerals, pesticides, heavy metals (total and dissolved), bacteria, total and organic suspended solids, oil and grease, biochemical oxygen demand, total organic carbon, and volatile organics. Dissolved Oxygen (DO) was not monitored in the 1988 to 1994 period. Considering the importance of this parameter in water quality evaluation, storm weather DO data from 1980 to 1988 was added to the data and reviewed in this report. Overall, 54 additional compounds are analyzed for storm weather samples (127 compounds for storm weather samples verses 73 compounds for dry weather samples).

The Method of Detection Limits (MDLs) used in the analyses for storm and dry weather samples are listed on Table 3. Comparison of water quality objectives ("Basin Plan" and "Ocean Plan") with MDLs indicated that a total of seventeen compounds in four chemical groups have MDLs

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higher than the numerical objective standards. In the dissolved heavy metals category, MDLs for mercury and silver exceeded the "Ocean Plan" objectives. In the pesticides category, MDL for heptachlor exceeded both the "Basin Plan" and "Ocean Plan" objectives; epoxide MDL exceeded the "Basin Plan" objective; and aldrin, chlordane, dieldrin, pp:DDD, pp:DDE, and pp:DDT exceeded the "Ocean Plan" objectives. Efforts should be made to ensure that MDLs are set at or below the numerical objective standards. The MDLs for all seven PCBs analyzed exceeded the "Basin Plan" and "Ocean "Plan" objectives. The higher MDLs used for the last 5-year monitoring program were strictly adhere to the requirements of the old "Basin Plan" which specifies the analyses be conducted using the APWA (American Public Works Association) water and wastewater standard methods, as opposed to the Maximum Contamination Levels (MCLs) used in the 1994 draft plan. The later has a much lower MDLs.

The following provides a brief description of significant water quality parameters and their importance in detecting receiving water deterioration:

Temperature: Significant temperature changes could have severe impacts on receiving waters. As a rule of thumb, the rates of chemical reactions are double for every 10 degree C rise in temperature. Cooler waters usually have a wider diversity of biological species. At higher temperatures, dissolved oxygen levels are usually lower.

pH: pH is a measurement of the activity of hydrogen ions, present in water. Low and high pH values are indications of acidity and alkalinity of the water. Values outside the 6.5 - 8.5 range could have detrimental affects on aquatic organisms.

Total Dissolved Solids: Total Dissolved Solids (TDS) may be organic or inorganic. The major common ions in natural waters includes sodium, calcium, magnesium, bicarbonate, sulfate, chloride. The secondary constituents include iron, strontium, potassium, carbonate, nitrate, fluoride, boron, and silica. The common ions are measured separately and their sum on an equivalent basis represent TDS.

Total and Volatile Suspended Solids: Solid content in water is measured as suspended solids, volatile and nonvolatile suspended solids, turbidity, and settled solids. High solid concentrations cause reduced light transmission, reduced growth, clogging of fish gills, reduced spawning areas, rapid sedimentation of ponds, and reduced aesthetics values.

Total solids is the sum of dissolved and suspended solids. Volatile solids are those that burn off at a temperature of 550 degrees C and are considered to be organic in nature.

Bacteria (Fecal coliform): Fecal coliform is a pathogen indicator which may be present in

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elevated amounts in urban runoff. These organisms are found exclusively in the intestinal tract of warm-blooded animals and are excreted in large numbers with faces.

Nutrients: Nutrients are chemicals that stimulate the growth of algae and water plants as well as causing odors, algal scums, water discoloration, and toxic releases. The basic macronutrients are carbon, nitrogen, and phosphorous. Common measures include nitrates, ammonia, TKN (Total Kjeldahl Nitrogen), total phosphates, and ortho phosphates. In urban runoff theses nutrients may be present in landscaped runoff (washed or leached off fertilizers), accidental wastewater discharges, and animal waste. Excess nitrate levels in drinking water can cause health problems in humans (infants are most sensitive). High levels of nitrogen in surface water also leads to excess aquatic growth and can contribute to high levels of NO_3 in ground water as well.

Heavy Metals: A wide variety of metals are present in urban runoff. Most common metals in urban runoff include zinc, copper, and lead. Excessive concentrations of cadmium, chromium, mercury, nickel, selenium, silver, and arsenic may also be present. Toxic metals are harmful to humans and other organisms in small quantities.

Total Chlorine: Priority pollutants, such as chlorines, may be present in urban runoff. Due to extreme solubility, all washed off chlorines end up in surface or ground water. Low concentrations of chlorines are damaging to aquatic life.

Oil and Grease: Oil and grease are not readily soluble in water and form a film on the water surface. Oil and grease can have detrimental impacts on birds and aquatic life, as well as cause nuisance conditions.

Dissolved Oxygen and Chemical Oxygen Demand: Free oxygen is necessary in water to maintain life. Fish kills and reduction in aesthetic values have resulted from low-DO conditions. Oxygen demand is estimated by indirect measures, such as biochemical oxygen demand (BOD), chemical oxygen demand (COD), oil and greases, and total organic carbon (TOC). COD is a measure of amount of oxygen required to chemically oxidize organic matter to carbon dioxide and water.

DO is a good indicator of overall water pollution because it is usually the result of an over-enrichment by some other oxygen demanding pollutants, such as decaying organic matter. Also, slow shallow waters sometimes become over-heated resulting in lower saturated DO concentrations. Usually declines in DO levels are attributed to increased runoff from urban construction and increased wastewater due to increased population pressures.

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Specific Conductance: The ability of water to conduct electricity, known as specific conductance, is a function of its ionic strength. An approximate of Total Dissolved Solids are often made by determining the Specific Conductance. However, only ionized substances contribute to specific conductance. Specific conductance is often used in a qualitative basis to monitor changes in TDS. Also, as water temperature increases, specific conductance increases as well.

Pesticides/Purgeable Organics: Excess uses in agricultural operations and improper discharges from industrial areas may contribute these substances to receiving waters. Human and aquatic organism tolerance level to most of these substances is usually very low. As percentage of these substances increase, they become a substantial health problem.

Turbidity: Turbidity is a measure of the extent to which light is either absorbed or scattered by suspended material in water. It is an indirect measure of suspended solids in water.

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SECTION 4 - WATERSHED CONDITIONS

The Municipal permit divides the Los Angeles County area and immediate vicinity into five general regional basins. These regional basins have been delineated based on hydrological characteristics of the watersheds, perceived importance and beneficial uses of water bodies, and existence of adequate infrastructures for program implementation. The five drainage basins are:

I. Santa Monica Bay Drainage Basin;
II. Upstream Los Angeles River Drainage Basin, to and including Sycamore Canyon Channel (San Fernando Valley);
III. Upper San Gabriel River (San Gabriel Valley) Drainage Basin;
IV. Lower Los Angeles River Drainage Basin;
V. Lower San Gabriel River Drainage Basin (V-south); and Santa Clarita Valley Basin (V-north).

The five drainage basins are shown on Exhibits "A" and "B".

The principal surface waters of the Los Angeles area flow through mostly natural mountains in the upstream reaches, urbanized foothill and valley areas, high density developed coastal areas, and terminate at highly utilized beaches and harbors. The following presents a brief summary of watersheds and water quality conditions in the Los Angeles County regional basins, as presented in the 1994 (Draft) "Basin Plan":

Los Angeles River Watershed: The Los Angeles River is lined with concrete along the majority of its length except for the reach in the narrows area where the channel is unlined. In the unlined reach of the river ground water rises to the river streambed, providing a natural habitat for fish and other wildlife. The Los Angeles River Basin is highly urbanized. Urban runoff and illegal dumping are major contributors to impaired water quality in the watershed. Below the Sepulveda Basin, flows are dominated by tertiary-treated effluent from municipal wastewater treatment plants.

San Gabriel River Watershed: The upper San Gabriel River and its tributaries are mostly in a relatively pristine condition. Water quality problems in the upper reaches of the river are caused by recreational uses, eroding sediment, and improper sediment sluicing which have an impact on aquatic and riparian habitats and groundwater recharge areas. The middle reach of the river has been extensively modified and extensive sand and gravel operations exist along the river. The lower reach of the river has been mostly lined and flows are dominated by effluent

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from wastewater treatment plants and urban runoff. Impairment to the beneficial uses of the lower reaches of the river have been evidenced by ambient toxicity and bioaccumulation of metals in fish tissue.

Santa Clara River Watershed: The Santa Clara River comprises the largest river system in Southern California that has remained in a relatively natural state. There are currently many areas of high quality riparian habitat along the river. Threats to water quality in this river system include increasing development in the floodplain areas and channelization of the river which have resulted in increased flows and loss of natural habitat.

Santa Monica Bay Watershed: This area includes the Malibu Creek and ballona Creek Watersheds. Both watersheds have been developed extensively; and many of the river systems in the watersheds have been channelized. In the Malibu Creek Watershed, the pollutants of concern, many of which are discharged from nonpoint sources, include excess nutrients, sediment, and bacteria. In the Ballona Creek Watershed, pollutants of concern, which may be attributed to industrial and municipal effluents as well as urban runoff, include chlorides, sulfates, heavy metals, and bacteria. Several untreated sewage overflows discharged into Ballona Creek during the rainy season have caused beach closures along the Santa Monica Bay. Long-term water quality problems in the mouth of Ballona Creek and in Marina Del Rey are attributed to discharges with high concentrations of DDT (detected in sediments).

According to the "Basin Plan" (1994, Draft), general surface water problems in the Los Angeles County include the following:

- Poor mineral quality in some areas due to a variety of reasons including geology, agricultural runoff, discharge of highly mineralized ground water, and poor quality of some imported waters.
- Bioaccumulation of toxic compounds in fish and other aquatic life.
- Impacts from increased development and recreational uses.
- In-stream toxicity from point and nonpoint sources.
- Diversion of flows necessary for the propagation of fish and wildlife populations.
- Channelization, dredging, and other losses of habitat.
- Impacts from transient camps located along creeks and lagoons.

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. Illegal dumping.

. Introduction of non-native plants which are of little value to the biota and clog the streams.

. Natural oil seeps.

. Eutrophication and the accumulation of toxic pollutants in lakes.

The following provides a brief description of hydrology, major drainage systems, beneficial uses, land uses, and Los Angeles County monitoring stations within each drainage basin. Tables 1 and 2 summarize the beneficial uses for all monitoring stations based on the revised 1992 and draft 1994 "Basin Plans" respectively. However, the evaluations presented in this report are based on the Draft 1994 "Basin Plan" and the "Ocean Plan" objectives. The tributary area land usage at each monitoring station is summarized on Table 5.

4.1 SANTA MONICA BAY DRAINAGE BASIN (BASIN I)

Santa Monica Bay Drainage Basin (Basin I) is comprised of approximately 410 square miles of mixed natural and developed land in the southwestern portion of Los Angeles County. The majority of the area to the west is currently undeveloped and runoff in the natural canyons and streams flow in a generally southerly direction toward culverts underneath the Pacific Coast Highway and the Pacific Ocean. The central (Santa Monica) southeastern portions of the basin are more developed and urbanized. Runoff in this area flows in a generally southwesterly direction, in improved drainage facilities (i.e., lined channels, and pipes) towards the Pacific Ocean. There are currently nine monitoring stations in the Santa Monica Bay Drainage Basin. Dry weather flows have usually been present at all stations in this Basin, due to the soil type, the relatively high imperviousness of the tributary basins, as well as contributions from other individual point source dischargers (i.e., POTW, industrial NPDES discharger, illicit sources) .

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The following is a description of conditions and activities at each station:

Station 1 is located at Ballona Creek at Fairfax Avenue. Only dry weather samples are collected at this station. Runoff direction in this area is mostly southwesterly. The area upstream of the station is about 45 square miles, including improved drainage system laterals which discharge into the Ballona Creek, a lined channel. The overall imperviousness of the tributary watershed is about 53 percent. The land use in the basin includes 50 percent urbanized (highest among all monitoring station tributary areas), 29 percent partially urbanized, 20 percent natural, and 1 percent industrial uses.

The beneficial uses of the Ballona Creek at this location include: potential Municipal and Domestic Supply (MUN), potential Water Contact Recreation (REC-1), existing Non-contact Water Recreation (REC-2), potential Warm Freshwater Habitat (WARM), and existing Wildlife Habitat (WILD).

Station 2 is located at Ballona Creek at Sawtelle Boulevard. This station is downstream of Station 1. Dry and wet weather samples are collected at this station. Runoff direction in this area is mostly southwesterly and southeasterly. The area upstream of the station is about 88 square miles, including improved drainage system laterals which discharge into the Ballona Creek eventually drains into the Pacific Ocean in the Playa Del Rey area. The overall imperviousness of the tributary watershed is about 53 percent. The land use in the basin includes 46 percent urbanized, 30 percent partially urbanized, 21 percent natural, and 3 percent industrial uses.

The beneficial uses of the Ballona Creek at this location include: potential Municipal and Domestic Supply (MUN), potential Water Contact Recreation (REC-1), existing Non-contact Water Recreation (REC-2), potential Warm Freshwater Habitat (WARM), and existing Wildlife Habitat (WILD).

Station 9 is located at the Sepulveda Channel at Culver Boulevard. Only dry weather samples are collected at this station. Runoff direction in this area is mostly easterly and southeasterly, via improved drainage systems into the Sepulveda Channel, an improved channel. Further downstream and to the southeast of this station, Sepulveda Channel joins the Ballona Creek and eventually drains into the Pacific Ocean in the Playa Del Rey area. The area upstream of the station is about 23 square miles. The overall imperviousness of the tributary watershed is about 49 percent. The land use in the basin includes 42 percent urbanized, 29 percent partially urbanized, 26 percent natural, and 3 percent industrial uses.

The beneficial uses of the Sepulveda Channel at this location include: potential Municipal and Domestic Supply (MUN), potential Water Contact Recreation (REC-1), existing Non-contact

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Water Recreation (REC-2), potential Warm Freshwater Habitat (WARM), and existing Wildlife Habitat (WILD).

Station 3 is located at Centinela Creek at Centinela Boulevard. The Centinela Creek at this location is an improved channel which is a westerly tributary of Ballona Creek, located downstream. Ballona Creek eventually drains into the Pacific Ocean in the Playa Del Rey area. Dry and wet weather samples are collected at this station. Runoff direction in this area is mostly westerly. The area upstream of this station is about 9 square miles. The overall imperviousness of the tributary watershed is about 51 percent. The land use in the basin includes 54 percent partially urbanized, 27 percent urbanized, 13 percent natural, and 6 percent industrial uses.

The beneficial uses of the Centinela Creek at this location include: potential Municipal and Domestic Supply (MUN), potential Water Contact Recreation (REC-1), existing Non-contact Water Recreation (REC-2), potential Warm Freshwater Habitat (WARM), and existing Wildlife Habitat (WILD).

Station 5 is located at Kenter Drain at Pico Boulevard (project 249). Both dry and wet weather samples are collected at this station. Kenter Drain is aligned in a southwesterly direction and collects runoff from laterals in the area. Ultimately, it discharges into the Pacific Ocean, about 1100 feet downstream of the monitoring station and to the southwest of the Santa Monica Municipal Pier. The area upstream of the station is about 6 square miles. The overall imperviousness of the tributary watershed is about 39 percent. The land use in the basin includes 43 percent natural, 30 percent partially urbanized, 23 percent urbanized, and 4 percent industrial uses. Due to its close proximity to the ocean, this station is constantly under tidal influence which also affect the sample characteristics.

The "Ocean Plan" water quality objectives may have to be satisfied at this station. The beneficial uses of the Kenter Drain watershed have been designated as: potential Municipal and Domestic Supply (MUN); existing Navigation; existing Water Contact Recreation (REC-1); existing Non-contact Water Recreation (REC-2); existing Commercial and Sport Fishing (COMM); potential Warm Freshwater Habitat (WARM); existing Marine Habitat (MAR); existing Wildlife Habitat (WILD); existing Migration of Aquatic Organisms; existing Spawning, Reproduction, and/or Early Development (SPWN); existing Shellfish Harvesting (SHELL).

Station 8 is located at Santa Monica Canyon Channel at Short Street. The Santa Monica Canyon Channel at this location is an improved channel aligned in a southwesterly fashion which discharges into the Pacific Ocean, approximately 1100 feet southwest. Dry and wet weather samples are collected at this station. The area upstream of this station is about 16 square miles. The overall imperviousness of the tributary watershed is about 14 percent. The land use in the

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basin includes mostly natural (87 percent), 12 percent partially urbanized, and 1 percent urbanized uses.

Due to the monitoring station proximity to the Pacific Ocean, all "Ocean Plan" water quality objectives may have to be satisfied at this station. The beneficial uses of the Santa Monica Canyon Channel in this area include: potential Municipal and Domestic Supply (MUN); existing Navigation (NAV); existing Water Contact Recreation (REC-1); existing Non-contact Water Recreation (REC-2); existing Commercial and Sport Fishing (COMM); potential Warm Freshwater Habitat (WARM); existing Marine Habitat (MAR); existing Wildlife Habitat (WILD); existing Migration of Aquatic Organisms (MIGR); existing Spawning, Reproduction, and/or Early Development (SPWN); and existing Shellfish Harvesting (SHELL).

Station 10 is located at Topanga Canyon at Pacific Coast Highway. Topanga Canyon is a natural stream, aligned in a southerly direction, which crosses through culverts under the Pacific Coast Highway. The stream discharges into the Pacific Ocean, just downstream of this station. Dry and wet weather samples are collected at this station. The area upstream of the station is about 19 square miles. The overall imperviousness of the tributary watershed is about 8 percent. The land use in the basin includes mostly natural (90 percent), 9 percent partially urbanized, and 1 percent urbanized uses.

Due to the monitoring station proximity to the Pacific Ocean, all "Ocean Plan" water quality objectives may have to be satisfied at this station. The beneficial uses of the Topanga Canyon at this location include: potential Municipal and Domestic Supply (MUN); existing Navigation (NAV); existing Water Contact Recreation (REC-1); existing Non-contact Water Recreation (REC-2); existing Commercial and Sport Fishing (COMM); existing and intermittent Warm Freshwater Habitat (WARM); existing Estuarine Habitat (EST); existing and intermittent Marine Habitat (MAR); existing Wildlife Habitat (WILD); existing Rare, Threatened, or Endangered Species (RARE); existing Migration of Aquatic Organisms (MIGR); existing Spawning, Reproduction, and/or Early Development (SPWN); and existing Wetland Habitat (WET).

Station 6 is located at Malibu Creek at Cross Creek Road. Malibu Creek is a natural stream which meanders in a generally southerly direction and crosses through culverts under the Cross Creek Road. At about 4000 feet downstream, Malibu Creek flows through the Malibu Lagoon and finally discharges into the Pacific Ocean in the Malibu Point area. Both dry and wet weather samples are collected at this station. The area upstream of the station is about 110 square miles. The overall imperviousness of the tributary watershed is about 13 percent. The land use in the basin includes mostly natural (83 percent), 11 percent partially urbanized, 5 percent

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urbanized, and 1 percent industrial uses.

Due to the monitoring station proximity to the Pacific Ocean, all "Ocean Plan" water quality objectives may have to be satisfied at this station. The beneficial uses of the Malibu Creek in this area include: potential Municipal and Domestic Supply (MUN); existing Navigation; existing Water Contact Recreation (REC-1); existing Non-contact Water Recreation (REC-2); existing Warm Freshwater Habitat (WARM); existing Cold Freshwater Habitat (COLD); existing Estuarine Habitat (EST); existing Marine Habitat (MAR); existing Wildlife Habitat (WILD); existing Rare, Threatened, or Endangered Species (RARE); existing Migration of Aquatic Organisms (MAR); existing Spawning, Reproduction, and/or Early Development (SPWN); existing Shellfish Harvesting (SHELL); and existing Wetland Habitat (WET).

Station 13 is located at Corral Canyon Creek at Pacific Coast Highway. Corral Canyon Creek is a natural stream which meanders in a generally southerly direction and crosses through culverts under the Pacific Coast Highway toward the Pacific Ocean, located immediately to the south. Both dry and wet weather samples are collected at this station. The area upstream of this station is about 4 square miles. The overall imperviousness of the tributary watershed is about 3 percent. The land use in the basin includes mostly natural (97 percent), and 3 percent partially urbanized (very low density) uses.

Due to the monitoring station proximity to the Pacific Ocean, all "Ocean Plan" water quality objectives may have to be satisfied at this station. The beneficial uses of the Corral Canyon Creek at this location include: intermittent Municipal and Domestic Supply (MUN), existing Navigation (NAV); existing Water Contact Recreation (REC-1), existing Non-contact Water Recreation (REC-2), existing Commercial and Sport Fishing (COMM); intermittent Warm Freshwater Habitat (WARM); existing Marine Habitat (MAR); existing Wildlife Habitat (WILD); potential Spawning, Reproduction, and/or Early Development (SPWN); and existing Shellfish Harvesting (SHELL).

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4.2 UPSTREAM LOS ANGELES RIVER DRAINAGE BASIN, TO AND INCLUDING SYCAMORE CANYON Channel (SAN FERNANDO VALLEY - BASIN II)

The upstream Los Angeles River Drainage Basin (Basin II) is comprised of approximately 443 square miles of mostly natural land in its northern and northeastern areas and mixed developed land in the remainder of its area. Runoff in Basin II is conveyed in natural canyons in the upstream portions of the Basin and improved drainage facilities in the downstream portions, in a generally southerly direction, and the Los Angeles River, a major improved river system in Los Angeles County. The Los Angeles River flows in a mostly easterly and southerly direction in Basin II. The Los Angeles River enters Basin IV and flows in a southerly direction toward San Pedro Bay and the Pacific Ocean. There are currently only two monitoring stations in the Upstream Los Angeles River Drainage Basin. Dry weather flows have usually been present at both stations because of their very large tributary basins, and types of soils.

The following is a description of conditions and activities at each station:

Station 19 is the most upstream monitoring station in Basin II and is located at the Los Angeles River at the Tujunga Wash confluence. Hansen Basin and Sepulveda Basin are located in the basin upstream of this monitoring station. Runoff in this area is generally southerly via mostly improved drainage systems and toward the improved Los Angeles River which flows in a mostly easterly fashion. Only dry weather samples are collected at this station. The area upstream of this station is about 351 square miles. The overall imperviousness of this station's tributary watershed is about 32 percent. The land-use in the basin includes mostly natural (60 percent), 27 percent partially urbanized, 6 percent urbanized, and 7 percent industrial uses.

The beneficial uses of the Los Angeles River in this area include: potential Municipal and Domestic Supply (MUN); potential Industrial Service Supply (IND); existing Ground water Recharge (GWR); existing Water Contact Recreation (REC-1); existing Non-contact Water Recreation (REC-2); existing Warm Freshwater Habitat (WARM); existing Wildlife Habitat (WILD); and Wetland Habitat (WET).

Station 17 is located at the Los Angeles River at the Arroyo Seco confluence. Station 17 is downstream of Station 19 described above. Again, Hansen Basin and Sepulveda Basin are located in the basin upstream of this monitoring station. Runoff in this area is generally southerly and southwesterly in the undeveloped areas upstream and southerly via improved drainage facilities toward the improved Los Angeles River. The Los Angeles River flows in a mostly easterly and southerly fashion in the basin upstream of this station. Only dry weather samples are collected at this station. The area upstream of this station is about 443 square miles. The overall imperviousness of this station's tributary watershed is about 33 percent. The land use

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in the basin includes mostly natural (56 percent), 28 percent partially urbanized, 6 percent urbanized, and 10 percent industrial uses.

The beneficial uses of the Los Angeles River in this area include: potential Municipal and Domestic Supply (MUN), potential Industrial Service Supply (IND), existing Ground water Recharge (GWR), existing Water Contact Recreation (REC-1), existing Non-contact Water Recreation (REC-2), existing Warm Freshwater Habitat (WARM), existing Wildlife Habitat (WILD), and existing Wetland Habitat (WET).

4.3 UPPER SAN GABRIEL RIVER (SAN GABRIEL VALLEY) DRAINAGE BASIN (BASIN III)

The Upper San Gabriel River (San Gabriel Valley) Drainage Basin (Basin III) is comprised of approximately 553 square miles of mostly natural land in its northern and northeastern areas and mixed developed type land in the remainder of its area. Runoff in Basin III originates from the peaks in the San Gabriel Mountains and is mostly conveyed in natural canyons in the upstream portions of the Basin and improved drainage facilities in the downstream portions in a generally southerly and southwesterly direction. Basin III encompasses the eastern portions of the County. The three major improved channels in Basin III are the San Jose Creek, the Rio Hondo channel, and the San Gabriel River. The San Jose Creek is located to the east and is aligned in a generally westerly fashion; and the Rio Hondo and San Gabriel Rivers are aligned in a generally southerly fashion in the central portions of this Basin. There are many dams and flood control basins in Basin III. The largest include: Puddingstone Dam upstream of Walnut Creek Wash, San Gabriel Dam and Santa Fe Basin upstream of the San Gabriel River, and Whittier Narrows Basin downstream of the San Jose Creek and San Gabriel River. Whittier Narrows Basin is the final outlet from Basin III. Downstream of the Whittier Narrows, runoff splits via two separate channels into two separate basins, Basin IV and Basin V (south), in the Rio Hondo Channel and the San Gabriel River, respectively. The Rio Hondo flows in a southwesterly direction toward the Los Angeles River, which is aligned in a generally southerly direction toward San Pedro Bay and the Pacific Ocean. The San Gabriel River is also aligned in a generally southerly direction in Basin V (south) and finally discharges into the Pacific Ocean in the Seal Beach area of the Orange County. There are currently three monitoring stations in the Upper San Gabriel River Drainage Basin. Dry weather flows have usually been present at all stations because of their mostly very large tributary basins and types of soils.

The following is a description of conditions and activities at each station:

Station 28 is the most upstream monitoring station in Basin III and is located at Monrovia Creek above Sawpit Creek. Station 28 is considered the only station that samples an

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essentially one hundred percent undeveloped watershed. Natural condition water quality is expected at this station. The "1994 draft Basin Plan" states that the area is "relatively pristine". Accordingly, LADPW has designated this station as the "natural condition" station, essentially unaffected from urbanization impacts. In the analysis provided in Sections 4 and 6, comparisons and conclusions from data collected at this station are made to the other 27 stations to identify any noticeable differences and whether they might be attributed to urbanization. Runoff in the upstream watershed tributary to station 28 is generally southerly through the natural narrow and steep canyon. Runoff from Monrovia Creek flows toward Sawpit Creek, which itself flows in a southwesterly direction toward Rio Hondo Channel. The Rio Hondo Channel is aligned in a southwesterly direction, discharges into the Whittier Narrows Basin, and finally confluences with the Los Angeles River in Basin IV. The Los Angeles River alignment is mostly southerly and finally outlets into the Pacific Ocean in the San Pedro Bay area. Both dry and wet weather samples are collected at this station. The area upstream of this station is about 1.8 square miles. The overall imperviousness of this station's tributary watershed is about four percent. The land use in the basin is entirely natural (100 percent) comprised of fairly dense trees and shrubs typical of the upper San Gabriel range.

The beneficial uses of the Monrovia Creek in this area include: intermittent Municipal and Domestic Supply (MUN), intermittent Ground water Recharge (GWR), intermittent Water Contact Recreation (REC-1), intermittent Non-contact Water Recreation (REC-2), intermittent Warm Freshwater Habitat (WARM), existing and intermittent Wildlife Habitat (WILD), and existing Wetland Habitat (WET).

Station 23 is located at the Rio Hondo Channel at San Gabriel Boulevard. Station 23 is located at the downstream end of the Basin III watershed that discharges into Basin IV and at the downstream end of the Whittier Narrows Basin. Station 28 is located in the upstream eastern canyons of the watershed tributary to station 23. Runoff in this watershed flows in a generally southerly direction in natural canyons upstream and improved drainage systems downstream toward the Whittier Narrows Basin and the Rio Hondo Channel. The Rio Hondo Channel is aligned in a southwesterly direction, discharges into the Whittier Narrows Basin, and finally confluences with the Los Angeles River in Basin IV. The Los Angeles River alignment is mostly southerly and finally outlets into the Pacific Ocean in the San Pedro Bay area. Only dry weather samples are collected at this station. The area upstream of this station is about 116 square miles. The overall imperviousness of this station's tributary watershed is about 35 percent. The land use in the basin includes 40 percent natural, 39 percent partially urbanized, 11 percent urbanized, and 10 percent industrial uses.

The beneficial uses of the Rio Hondo Channel in this area include: potential Municipal and Domestic Supply (MUN); intermittent Ground water Recharge (GWR); intermittent Water Contact

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Recreation (REC-1); existing and intermittent Non-contact Water Recreation (REC-2); potential Warm Freshwater Habitat (WARM); intermittent and potential Wildlife Habitat (WILD); existing Rare, Threatened, or Endangered Species (RARE); and existing Wetland Habitat (WET).

Station 27 is located at the San Jose Creek at Workman Mill Road. Station 27 is located at the downstream end of the San Jose Creek right before its confluence with the improved San Gabriel River and discharge into the Whittier Narrows Basin. Station 27's tributary area includes the southeastern portions of Basin III. The San Gabriel River has a very large tributary area (almost 352 square miles) which encompasses the majority of Basin III. After confluence with the San Gabriel River and discharge into the Whittier Narrows Basin, the San Gabriel River continues on in Basin V (south) in a mostly southerly direction toward the Pacific Ocean in the Seal Beach area of Orange County. The improved San Jose Creek flows in a generally southwesterly and westerly direction and collects runoff from some natural streams upstream and many improved drainage facilities downstream. Contributors to dry weather flow typically include industrial and municipal NPDES dischargers such as the County Sanitation District POTW. Both dry and wet weather samples are collected at this station. The area upstream of this station is about 86 square miles. The overall imperviousness of this station's tributary watershed is about 39 percent. The land use in the basin includes 37 percent natural, 37 percent partially urbanized, 19 percent urbanized, and 7 percent industrial uses.

The beneficial uses of the San Jose Creek in this area include: potential Municipal and Domestic Supply (MUN), intermittent Ground water Recharge (GWR), potential Water Contact Recreation (REC-1), intermittent Non-contact Water Recreation (REC-2), intermittent Warm Freshwater Habitat (WARM), and existing Wildlife Habitat (WILD).

4.4 LOWER LOS ANGELES RIVER DRAINAGE BASIN (BASIN IV)

The Lower Los Angeles River Drainage Basin (Basin IV) extends from southern Los Angeles County in Long Beach all the way to the San Gabriel Range on the north. Basin IV is located downstream of Basins II and III, where the two large improved river systems, Los Angeles River and Rio Hondo Channel confluence (in the City of Lynwood). Following the confluence, the Los Angeles River flows in a southerly direction toward the San Pedro Bay and the Pacific Ocean. Basin IV is approximately 330 square miles, comprised of mostly natural land above its northern neck and mixed open space/developed land in the remainder of its area. Runoff in Basin IV originates from the peaks of the San Gabriel Mountains and is mostly conveyed in natural canyons in the upstream portions of the Basin and improved drainage facilities in the downstream portions in a generally southerly direction toward Rio Hondo Channel and the Los Angeles River. There are currently nine monitoring stations in the Lower Los Angeles River

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Drainage Basin. Dry weather flows have been usually present at all stations because of the large tributary basins, the soil types, and the presence of other NPDES point source dischargers (i.e., Burbank POTW).

The following is a description of conditions and activities at each station:

Station 18 is located at the Los Angeles River at Firestone Boulevard. Station 18 is downstream of Station 17 and Basin II, described above. Hansen Basin and Sepulveda Basin, two major flood control facilities, are located in Basin II, upstream of this monitoring station. Runoff in the watershed tributary to this station initiates from the San Gabriel Mountain Range on the north and the runoff direction is generally southerly through natural streams upstream and improved drainage facilities downstream and toward the improved Los Angeles River system. The Los Angeles River flows in a mostly southeasterly and southerly fashion in this basin. Just downstream of this monitoring station, Los Angeles River confluences with the Rio Hondo Channel, then continues southerly toward the San Pedro Bay and the Pacific Ocean. Both dry and wet weather samples are collected at this station. The area upstream of this station is about 567 square miles. The overall imperviousness of this station's tributary watershed is about 34 percent. The land use for the area's tributary to this monitoring station includes mostly natural (52 percent), 28 percent partially urbanized, 8 percent urbanized, and 12 percent industrial uses.

The beneficial uses of the Los Angeles River in this area include: potential Municipal and Domestic Supply (MUN), potential Industrial Service Supply (IND), existing Ground water Recharge (GWR), existing and potential Water Contact Recreation (REC-1), existing Non-contact Water Recreation (REC-2), existing and potential Warm Freshwater Habitat (WARM), and potential Wildlife Habitat (WILD).

Station 22 is located at the Rio Hondo Channel at the Rio Hondo Spreading Grounds. The runoff tributary to Station 22 originates from the western ridges of Basin III (San Gabriel Mountain). Stations 28 and 23, located in Basin III, are upstream of Station 22. The runoff tributary to this monitoring station flows in a generally southerly direction in natural canyons upstream and improved drainage systems downstream toward the Rio Hondo Channel. The Rio Hondo Channel is aligned in a southwesterly direction and discharges into the Whittier Narrows Basin upstream of Station 22. Downstream of Station 22, Rio Hondo Channel confluences with the Los Angeles River. From the point of this confluence, the Los Angeles River alignment is mostly southerly and finally outlets into the Pacific Ocean in the San Pedro Bay area. Both dry and wet weather samples are collected at this station. The area upstream of this station is about 128 square miles. The overall imperviousness of this station's tributary

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watershed is about 37 percent. The land use in the basin tributary to this station includes 40 percent partially urbanized, 37 percent natural, 12 percent urbanized, and 11 percent industrial uses.

The beneficial uses of the Rio Hondo Channel in this area include: potential Municipal and Domestic Supply (MUN), intermittent Ground water Recharge (GWR), potential Water Contact Recreation (REC-1), existing Non-contact Water Recreation (REC-2), potential Warm Freshwater Habitat (WARM), and intermittent and potential Wildlife Habitat (WILD).

Station 24 is located at the Rio Hondo Channel at Steward and Gray Road Intersection. The runoff tributary to Station 24 originates from the western ridges of Basin III (San Gabriel Mountain). Stations 28 and 23 located in Basin III, and Station 22 located in Basin IV, are upstream of Station 24. The runoff tributary to this monitoring station flows in a generally southerly direction in natural canyons upstream and improved drainage systems downstream toward the Rio Hondo Channel. The Rio Hondo Channel is aligned in a southwesterly direction and discharges into the Whittier Narrows Basin upstream of Station 24. Downstream of Station 24, Rio Hondo Channel confluences with the Los Angeles River. From the point of this confluence, the Los Angeles River alignment is mostly southerly and finally outlets into the Pacific Ocean in the San Pedro Bay area. Both dry and wet weather samples are collected at this station. The area upstream of this station is about 139 square miles. The overall imperviousness of this station's tributary watershed is about 39 percent. The land use in the basin tributary to this station includes 39 percent partially urbanized, 35 percent natural, 12 percent urbanized, and 14 percent industrial uses.

The beneficial uses of the Rio Hondo Channel in this area include: potential Municipal and Domestic Supply (MUN), intermittent Ground water Recharge (GWR), potential Water Contact Recreation (REC-1), existing Non-contact Water Recreation (REC-2), potential Warm Freshwater Habitat (WARM), and intermittent and potential Wildlife Habitat (WILD).

Station 14 is located at Compton Creek at Greenleaf Boulevard. Only dry weather samples (typically collected from the stagnant ponding water in the channel as a result of intermittent flows during the dry weather conditions) are collected at this station. The runoff direction in this area is mostly southerly and southeasterly via improved drainage systems into the Compton Creek, an improved channel. Further downstream and to the southeast of this station, Compton Creek joins the Los Angeles River. From this point on, the Los Angeles River flows in a southerly direction toward the San Pedro Bay and the Pacific Ocean. The area upstream of the station is about 39 square miles. The overall imperviousness of the tributary watershed is about 59 percent. The land use in the basin includes 40 percent partially urbanized, 37 percent

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urbanized, 17 percent industrial, and 6 percent natural uses.

The beneficial uses of the Compton Creek at this location include: potential Municipal and Domestic Supply (MUN), existing Ground water Recharge (GWR), existing and potential Water Contact Recreation (REC-1), existing Non-contact Water Recreation (REC-2), existing Warm Freshwater Habitat (WARM), existing Wildlife Habitat (WILD), and existing Wetland Habitat (WET).

Station 20 is located at the Los Angeles River at Wardlow Road. Station 20 is located in the southern portion of Basin IV, in the City of Compton. It receives runoff from Basin III via the Rio Hondo Channel, from Basin II via the Los Angeles River, and from a majority of the Basin IV area except the southern and southwestern areas. The major flood control facilities upstream of this monitoring station include the Whittier Narrows Basin, Hansen Basin, Sepulveda Basin, Rio Hondo Spreading Grounds, and Dominguez Spreading Grounds. Runoff in the watershed tributary to this station initiates from the San Gabriel Mountain Range on the north and the runoff direction is generally southerly through natural streams upstream and improved drainage facilities downstream and toward the improved Los Angeles River and Rio Hondo Channel systems. Downstream of this station, the Los Angeles River flows in a southerly direction toward the San Pedro Bay and the Pacific Ocean. Both dry and wet weather samples are collected at this station. The area upstream of this station is about 769 square miles, the largest tributary area among all monitoring stations. The overall imperviousness of this station's tributary watershed is about 37 percent. The land use for the areas tributary to this monitoring station includes mostly 45 percent natural, 32 percent partially urbanized, 13 percent industrial, and 10 percent urbanized uses.

The beneficial uses of the Los Angeles River in this area include: potential Municipal and Domestic Supply (MUN); potential Industrial Service Supply (IND); potential Industrial Process (PROC); existing Ground Water Recharge (GWR); existing and potential Water Contact Recreation (REC-1); existing Non-contact Water Recreation (REC-2); existing and potential Warm Freshwater Habitat (WARM); existing Marine Habitat (MAR); existing and potential Wildlife Habitat (WILD); existing Rare, Threatened, or Endangered Species (RARE); potential Migration of Aquatic Organisms (MIGR); potential Spawning, Reproduction, and/or Early Development (SPWN); and potential Shellfish Harvesting (SHELL).

Station 4 is located at the Dominguez Channel at Vermont Avenue. Station 4 is located in the southwestern portions of Basin IV, in the City of Gardena. It receives runoff from Basin IV's southwestern areas. Runoff in this area is conveyed in a mostly southerly and southeasterly fashion via improved drainage facilities toward the improved Dominguez Channel. Downstream of this monitoring station, Dominguez Channel flows in a southeasterly and southerly direction

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toward the Long Beach Harbor and the Pacific Ocean. Both dry and wet weather samples are collected at this station. The area upstream of this station is about 40 square miles. The overall imperviousness of this station's tributary watershed is about 62 percent, the second highest among all monitoring basin tributary areas. The land use for the area's tributary to this monitoring station includes 35 percent urbanized, 30 percent industrial, 25 percent partially urbanized, and 10 percent natural uses.

The beneficial uses of the Dominguez Channel in this area include: potential Municipal and Domestic Supply (MUN); potential navigation (NAV); existing Water Contact Recreation (REC-1); existing Non-contact Water Recreation (REC-2); existing Commercial and Sport Fishing (COMM); potential Warm Freshwater Habitat (WARM); existing Estuarine Habitat (EST); existing Marine Habitat (MAR); existing Wildlife Habitat (WILD); existing Rare, Threatened, or Endangered Species (RARE); existing Migration of Aquatic Organisms (MIGR) and existing Spawning, Reproduction, and/or Early Development (SPWN).

Station 11 is located at Torrance Lateral at Main Street (project 1232). Station 11 is located in the southwestern portions of Basin IV, in the City of Torrance. It receives local runoff from Basin IV's southwestern areas. Runoff in this area is conveyed in a mostly easterly direction via improved drainage facilities and private drains toward the Torrance Lateral, designated as project 1232, itself a tributary of the improved Dominguez Channel. About 6,000 feet east of this monitoring station, the Torrance Lateral discharges into the Dominguez Channel. From this point, the Dominguez Channel flows in a southeasterly and southerly direction toward the Long Beach Harbor and the Pacific Ocean. Both dry and wet weather samples are collected at this station. The area upstream of this station is about 10 square miles. The overall imperviousness of this station's tributary watershed is about 68 percent, the highest percent among all monitoring basin tributary areas. The land use for the area's tributary to this monitoring station includes 40 percent industrial (the highest industrial percent among all monitoring station tributary areas), 35 percent urbanized, 20 percent partially urbanized, and 5 percent natural uses.

The beneficial uses of the hydrologic unit associated with the Torrance Lateral include: potential Municipal and Domestic Supply (MUN); potential Navigation (NAV); existing Water Contact Recreation (REC-1); existing Non-contact Water Recreation (REC-2); existing Commercial and Sport Fishing (COMM); potential Warm Freshwater Habitat (WARM); existing Estuarine Habitat (EST); existing Marine Habitat (MAR); existing Wildlife Habitat (WILD); existing Rare, Threatened, or Endangered Species (RARE); existing Migration of Aquatic Organisms (MIGR); and existing Spawning, Reproduction, and/or Early Development (SPWN).

Station 12 is located at the Wilmington Drain at Pacific Coast Highway (project 9813).

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Station 12 is the southernmost station in Basin IV, in the Wilmington area. Among all monitoring stations, Station 12 has the smallest tributary area, an area of approximately 0.6 square miles. It receives local runoff from north and east. Project 9813 is aligned in a southerly and westerly direction for about 4,500 feet prior to joining Project 643, which shortly downstream discharges into Harbor Lake, located west of the Harbor Freeway (I-110). The flow out of Harbor Lake is conveyed in a storm drain system to the West Basin, and from there into the Pacific Ocean in the Los Angeles Harbor area. This station also contains stagnant ponding water during the dry weather conditions and is subject to tidal influence. Both dry and wet weather samples are collected at this station. The overall imperviousness of this station's tributary watershed is about 56 percent. The land use for the area's tributary to this monitoring station includes 68 percent partially urbanized (the highest percent among all monitoring station tributary areas), 30 percent urbanized, and 2 percent natural uses.

The beneficial uses of the hydrologic unit associated with the Wilmington Drain include: potential Municipal and Domestic Supply (MUN); potential Navigation (NAV); existing Water Contact Recreation (REC-1); existing Non-contact Water Recreation (REC-2); existing Commercial and Sport Fishing (COMM); potential Warm Freshwater Habitat (WARM); existing Estuarine Habitat (EST); existing Marine Habitat (MAR); existing Wildlife Habitat (WILD); existing Rare, Threatened, or Endangered Species (RARE); existing Migration of Aquatic Organisms (MIGR); and existing Spawning, Reproduction, and/or Early Development (SPWN).

4.5 LOWER SAN GABRIEL RIVER DRAINAGE BASIN (BASIN V [SOUTH])

The Lower Los Angeles River Drainage Basin (Basin V [south]) includes the eastern and southeastern portions of Los Angeles County. Basin IV is located downstream of Basins III's central and eastern portions, immediately downstream of the Whittier Narrows Dam. There are many dams and flood control basins in Basin III (upstream) and Basin V (south). The largest includes Puddingstone Dam upstream of Walnut Creek Wash, San Gabriel Dam and Santa Fe Basin upstream of the San Gabriel River, Whittier Narrows Basin downstream of the San Jose Creek and San Gabriel River, and San Gabriel Canyon Spreading Grounds. The Whittier Narrows Basin is the final outlet from Basin III. Downstream of the Whittier Narrows Basin, runoff is conveyed in mostly improved drainage laterals and some natural streams into the improved San Gabriel River. San Gabriel River is aligned in a generally southerly direction in Basin V (south) and finally discharges into the Pacific Ocean in the Seal Beach area of Orange County. Basin V (south) is approximately 160 square miles of mostly natural land in the eastern areas and mixed open/developed uses in the remainder of the area. Runoff in Basin V (south) originates from the peaks in the San Gabriel Mountains and is mostly conveyed in natural canyons in the upstream portions of the Basin and improved drainage facilities in the

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downstream portions and in a generally southerly direction. There are currently six monitoring stations in the Lower San Gabriel River Drainage Basin. Dry weather flows have been usually present at all stations because of their mostly very large tributary basins and types of soils.

The following is a description of conditions and activities at each station:

Station 25 is located at the San Gabriel River at San Gabriel Spreading Grounds. Station 25 is downstream of Basin III, described above. The Whittier Narrows, Puddingstone Dam, San Gabriel Dam, Santa Fe Basin, and San Gabriel Spreading Grounds comprise the largest flood control facilities upstream of this monitoring station. Runoff in the watershed tributary to this station initiates from the San Gabriel Mountain Range on the north; the runoff direction is generally southerly through natural streams upstream and improved drainage facilities downstream and toward the improved San Gabriel River. The San Gabriel River is aligned in a mostly southerly fashion downstream of this station toward the outlet into the Pacific Ocean. Both dry and wet weather samples are collected at this station. The area upstream of this station is about 445 square miles. The overall imperviousness of this station's tributary watershed is about 23 percent. The land use for the areas tributary to this monitoring station includes mostly natural (65 percent), 20 percent partially urbanized, 7 percent urbanized, and 8 percent industrial uses.

The beneficial uses of the San Gabriel River in this area include: potential Municipal and Domestic Supply (MUN); potential Industrial Service Supply (IND); potential Industrial Process (PROC); Intermittent Ground water Recharge (GWR); existing and intermittent Water Contact Recreation (REC-1); existing and intermittent Non-contact Water Recreation (REC-2); intermittent Warm Freshwater Habitat (WARM); existing and intermittent Wildlife Habitat (WILD); and existing and intermittent Rare, Threatened, or Endangered Species (RARE).

Station 26 is located at the San Gabriel River at Willow Street. Station 26 is downstream of Station 25, described above. The Whittier Narrows, Puddingstone Dam, San Gabriel Dam, Santa Fe Basin, and San Gabriel Spreading Grounds comprise the largest flood control facilities upstream of this monitoring station. Runoff in the watershed tributary to this station initiates from the San Gabriel Mountain Range on the north; and the runoff direction is generally southerly through natural streams upstream and improved drainage facilities downstream and toward the improved San Gabriel River. The San Gabriel River is aligned in a mostly southerly fashion downstream of this station toward the outlet into the Pacific Ocean. Both dry and wet weather samples are collected at this station. The area upstream of this station is about 471 square miles. The overall imperviousness of this station's tributary watershed is about 25 percent. The land use for the areas tributary to this monitoring station includes mostly natural (62 percent), 22 percent partially urbanized, 7 percent urbanized, and 9 percent industrial uses.

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The beneficial uses of the San Gabriel River in this area include: potential Municipal and Domestic Supply (MUN); existing Water Contact Recreation (REC-1); existing Non-contact Water Recreation (REC-2); potential Warm Freshwater Habitat (WARM); and potential Wildlife Habitat (WILD).

Station 15 is located at Coyote Creek at Orangethorpe Boulevard. Only dry weather samples are collected at this station. The runoff direction in this area is mostly southerly and southwesterly via natural streams and improved drainage systems into the improved Coyote Creek. Further downstream and to the southwest of this station, Coyote Creek joins the San Gabriel River. From this point on, the San Gabriel River flows in a southerly direction toward the Seal Beach Pier and the Pacific Ocean. The area upstream of the station is about 134 square miles. The overall imperviousness of the tributary watershed is about 42 percent. The land use in the basin includes 35 percent natural, 30 percent partially urbanized, 20 percent industrial, and 15 percent urbanized uses.

The beneficial uses of the Coyote Creek at this location include: potential Municipal and Domestic Supply (MUN); existing Industrial Service Supply (IND); potential Industrial Process (PROC); existing Navigation (NAV); existing Water Contact Recreation (REC-1); existing Non-contact Water Recreation (REC-2); existing Commercial and Sport Fishing (COMM); potential Warm Freshwater Habitat (WARM); existing Estuarine Habitat (EST); existing Marine Habitat (MAR); existing Wildlife Habitat (WILD); existing and intermittent Rare, Threatened, or Endangered Species (RARE); existing Migration of Aquatic Organisms (MIGR); existing Spawning, Reproduction, and/or Early Development (SPWN); and potential Shellfish Harvesting (SHELL).

Station 16 is located at Coyote Creek at Willow Street. Both dry and wet weather samples are collected at this station. The runoff direction in this area is mostly southerly and southwesterly via natural streams and improved drainage systems into the improved Coyote Creek. Shortly downstream and to the southwest of this station, Coyote Creek joins the San Gabriel River. From this point on, the San Gabriel River flows in a southerly direction toward the Seal Beach Pier and the Pacific Ocean. The area upstream of the station is about 177 square miles. The overall imperviousness of the tributary watershed is about 43 percent. The land use in the basin includes 38 percent partially urbanized, 28 percent natural, 17 percent industrial, and 17 percent urbanized uses.

The beneficial uses of the Coyote Creek at this location include: potential Municipal and Domestic Supply (MUN); existing Industrial Service Supply (IND); potential Industrial Process (PROC); existing Navigation (NAV); existing Water Contact Recreation (REC-1); existing Non-contact Water Recreation (REC-2); existing Commercial and Sport Fishing (COMM); potential Warm Freshwater Habitat (WARM); existing Estuarine Habitat (EST); existing Marine Habitat

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(MAR); existing Wildlife Habitat (WILD); existing and intermittent Rare, Threatened, or Endangered Species (RARE); existing Migration of Aquatic Organisms (MIGR); existing Spawning, Reproduction, and/or Early Development (SPWN); and potential Shellfish Harvesting (SHELL).

Station 21 is located at Los Cerritos Channel at Stearns. Both dry and wet weather samples are collected at this station. The runoff direction in this area is mostly southerly through improved drainage systems into the improved Los Cerritos Channel. The Los Cerritos Channel is aligned parallel to the San Gabriel River just south of Spring Street and collects runoff from a number of laterals in the area. Shortly downstream, Los Cerritos Channel outlets into the Marine Stadium of Alamitos Bay and finally the Pacific Ocean. The area upstream of the station is about 31 square miles. The overall imperviousness of the tributary watershed is about 50 percent. The land use in the basin includes 50 percent partially urbanized, 20 percent industrial, 16 percent urbanized, and 14 percent natural uses.

The beneficial uses of the Los Cerritos Channel at this location include: potential Municipal and Domestic Supply (MUN), potential Water Contact Recreation (REC-1), intermittent Non-contact Water Recreation (REC-2), intermittent Warm Freshwater Habitat (WARM), and existing and intermittent Wildlife Habitat (WILD).

4.6 SANTA CLARITA VALLEY BASIN (BASIN V- [NORTH])

The Santa Clarita Valley Basin (Basin V [north]), encompasses the northwesternmost portions of Los Angeles County. Among the regional basins delineated in the NPDES Permit, the Santa Clarita Valley Basin has the largest watershed area. Basin V (north) consists of approximately 680 square miles of mostly natural land with some mixed type developed areas. Castaic, Bouquet, and Palmdale Reservoirs are located within Basin V (north). Runoff in Basin V (north) originates from the peaks on the south, east, and west and is mostly conveyed in natural canyons and streams toward the Santa Clara River, a major river system aligned in a mostly east to west fashion in northern Los Angeles County and Ventura County. Santa Clara river has many small and large tributaries and finally discharges into the Pacific Ocean in the City of Ventura. There is currently only one monitoring station in the Santa Clarita Valley Drainage Basin. Dry weather flows have been usually present at this station because of the very large tributary basin.

The following is a description of conditions and activities at this station:

Station 7 Is at the Santa Clara River at the Old Road. Runoff in this area is generally through unimproved streams and canyons and in a northerly and southwesterly direction toward the

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Santa Clara River. The sediment accumulation in the Santa Clara River is known to be fairly high and runoff generated in this area usually has high sediment content. The Santa Clara River is aligned in a generally westerly direction and finally discharges into the Pacific Ocean in the City of Ventura. Both dry and wet weather samples are collected at this station. The area upstream of this station is about 441 square miles. The overall imperviousness of this station's tributary watershed is about 13 percent. The land use in the basin includes mostly natural (86 percent), 5 percent partially urbanized, 5 percent urbanized, and 4 percent industrial uses.

The beneficial uses of the Santa Clara River in this area include: potential Municipal and Domestic Supply (MUN); existing Industrial Service Supply (IND); existing Industrial Process (PROC); existing Agriculture (AGR); existing Ground water Recharge (GWR); existing Freshwater Replenishment (FRESH); existing Water Contact Recreation (REC-1); existing Non-contact Water Recreation (REC-2); existing Warm Freshwater Habitat (WARM); existing Wildlife Habitat (WILD); existing Prevention of Biological Habitats; existing Rare, Threatened, or Endangered Species (RARE); existing Shellfish Harvesting (SHELL); and existing Wetland Habitat (WET).

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SECTION 5 - SCREENING PROCEDURE

A screening procedure was utilized to select the chemical compounds exceeding the water quality objective limits (Table 4) during the 1988-1994 sampling period for the twenty-eight monitoring stations evaluated. This included comparing each data set with the objective limits and counting the total number of exceedences for the constituents analyzed at each monitoring station. Tables 6 and 7 summarize the total number of non-compliant compounds for each monitoring station under both dry and storm weather conditions, respectively.

Tables 6 and 7 only show compounds that exceed the objective limits. In other words, those compounds which were monitored (Table 3) and are not listed on these tables did not exceed the water quality objectives at any time during the monitoring period. The total number of samples taken during the monitoring period are also included on these two tables. Blank spaces in the tables indicate no analyses were performed for that particular compound at the specified sampling site. As can be seen, of the 127 compounds monitored during storm weather, only 17 exceeded the numerical water quality objectives during the monitoring period. For the dry weather samples, of the 73 compounds monitored, only 23 exceeded the numerical water quality objectives.

However, not all the exceedences reflect a sufficient significance to be included in the water quality evaluations. For example, of the 28 monitoring stations and more than five years of dry weather monitoring, barium exceeded the water quality objectives only once (Table 6). There were other compounds that also exhibited a small number of exceedences. Compounds with a very low number of exceedence may reflect data outliers, which may be attributed to a number of errors inherent in water quality data acquisition. Outliers are values which are obviously higher or lower than the majority of the data set.

The last column on Tables 6 and 7 provides the total number of times (for all monitoring stations) a compound exceeded the objective limits during the monitoring period. For example, in all dry weather monitoring data analyzed, fecal Enterococci exceeded the water quality limits 157 times. The total number of exceedences were counted and the top ten compounds were selected for the water quality evaluations of this report.

The following is a list of the ten compounds which exhibited the highest numbers of non-compliance with the numerical objectives for both dry and storm weather monitoring data:

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TOP TEN NON-COMPLIANCE MONITORING PARAMETERS (EXCEEDENCE)

Compound	Dry Weather Samples	Storm Weather Samples
Fecal coliform	1,152	320
TDS	738	14
Ammonium	310	4
Chloride	299	5
Nitrite-N	276	12
pH	246	49
Sulfate	234	15
Total coliform	160	112
Fecal Enterococci	157	60
Lead	113	10

Exhibit "C" and "D" display compounds which exceeded the water quality objectives at least five percent of the time for dry weather samples and wet weather samples, respectively. These exhibits provide a schematic summary of potential "pollutants of concern" at each monitoring station.

The long-term trend analysis and the evaluation of urbanization impacts presented in the following sections are performed on the top ten non-compliance compounds presented above. In the analysis of data, all measurements are included. This includes the extremely high and low data which, as mentioned previously, may represent outliers in the data set. Even though the accuracy of some of the data outliers seems questionable, they were included since there is not sufficient evidence to show that they are erroneous. As a result, outliers were included and analyzed with the rest of the data.

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SECTION 6 - LONG-TERM TREND ANALYSIS

A long-term trend analysis was performed for the ten water quality constituents selected through the screening procedure from all monitoring stations over the period from 1988 to 1994. The constituents analyzed include: ammonium, chloride, sulfate, pH, nitrite, total dissolved solids, lead, total coliform, fecal coliform, and fecal Enterococci. An analysis was also conducted to assess the trends of these water quality parameters on a county-wide basis and on a regional basis for each of the five drainage basins within the County. For comparison purpose, the water quality objectives from the "1994 draft Basin Plan" and "1990 Ocean Plan" were used to assess the previous monitoring data. It should be pointed out that a non-compliance parameter from such comparison does not constitute any legal enforcement actions or require any corrective actions, since currently there are no enforceable numerical water quality objectives assigned to LADPW under the existing NPDES permit.

6.1 TREND ANALYSIS FOR INDIVIDUAL SAMPLING SITE

The water quality data of the ten parameters analyzed was provided by LADPW for samples collected between 1988 and 1994. For each monitoring station, only the non-compliance parameters (parameters which exceeded the water quality objectives according to the screening procedures) were analyzed.

Among the top ten compounds selected in the screening process, long-term trend analysis for each monitoring station was performed using only those compounds which exceeded the water quality objectives in more than ninety (90) percent of samples taken. In other words, if 90 percent of the total samples taken exhibited higher concentrations than the objective limit value for a particular compound (or parameter), that compound/parameter was selected for performing long-term trend analysis at a particular station. Take Station 1 as an example, compounds that exceeded the water quality objectives 90 percent of the time or more, include: Total Dissolved Solids (66 out of the 68 samples taken exceed the objectives) and fecal coliform (62 out of the 68 samples taken exceed the objectives). Trends for samples collected during both dry and storm weather conditions were analyzed separately. Constituent concentrations were plotted against time for each monitoring site. Average concentrations over the monitoring period, specific water quality objectives, and data from Station 28 (used as a background or natural basin condition) are also provided in the graphs for comparison purposes. Results are summarized in Appendix "A".

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6.1.1 Dry Weather Analysis

Station 1: Ballona Creek at Fairfax Avenue

Two parameters were found to be of significance at Station 1, Total Dissolved Solids and fecal coliform. Throughout the sampling period, TDS exhibits an initial trend of increase between 1988 and 1992, then it shows a decreasing trend from 1992 until the present Fecal coliform remains relatively stable with maximum concentrations observed in the last quarter of 1990 and a generally increasing trend from 1991 through mid-1993. The average concentrations of both parameters exceeded those measured at Station 28 and the basin plan objectives.

Station 2: Ballona Creek at Sawtelle Blvd.

TDS, fecal coliform, and pH were the non-compliant parameters at Station 2. Both TDS and fecal coliform appear to be consistently above the values of Station 28 with average concentrations above the Basin Plan objective. The pH value varied between 7.6 and 9.0, and appeared to be very similar to those found at Station 28. The above average pH value is relatively close and below the upper limit of water quality objective specified in the Basin Plan.

Station 3: Centinela Creek at Centinela Blvd.

TDS, fecal coliform, and pH were the non-compliant parameters at Station 3. TDS concentrations reflect generally increasing trend from 1988 to mid-1990, a downward trend from mid-1990 to late 1993, and an upward trend from there on. TDS average concentration is above the Basin Plan objectives and those observed at Station 28. pH values indicate average pH concentrations are below the upper limit of the Basin Plan with an upward trend with peaks in 1992 ; which appears to be consistent with that analyzed at Station 28. Extreme fecal coliform were observed in 1989. Most concentrations are above the Basin Plan objectives and those observed at Station 28. The trend seems to be a fluctuating one with a general reduction past 1993.

Station 4: Dominiguez Channel at Vermont Avenue

Parameters of pH, Chloride, fecal coliform, and TDS were evaluated at Station 4. The average value of pH remained close to the water quality objective. The pH trend shows an increase from 1988 to 1991, and a decrease from 1991 to 1994. The trends of chloride and TDS remain relatively unchanged throughout the entire monitoring period and are similar to the water quality objectives, except for several isolated occasions. Fecal coliform shows more fluctuations, but in most cases with values above the water quality objective and those of Station 28.

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Station 5: Kenter Drain at Pico Blvd.

Fecal coliform, fecal Enterococci, total coliform, lead, TDS, chloride, and ammonium were analyzed for Station 5. Among the parameters, lead, total coliform, fecal coliform, fecal Enterococci, and ammonium show wide fluctuations between 1988 and 1990. After 1990, these parameters all became relatively steady and show a trend of reduction. Additionally, lead, total coliform, and ammonium are shown to approach the water quality objectives and the conditions at Station 28. TDS exhibits more variations with several extremes. These extremes may be attributed to data outliers (described previously) and due to errors made during sampling, data analysis, and/or reporting.

Station 6: Malibu Creek at Cross Creek Road

Ammonium, sulfate, pH, total coliform, fecal coliform, and fecal Enterococci were evaluated for Station 6. For most of the period analyzed, total coliform and fecal coliform show a horizontal trend and are close to the water quality objectives and those of Station 28. Fecal Enterococci shows a slight increasing trend from 1991 to mid-1994, follows the data observed at Station 28, and are mostly above or at the Ocean Plan water quality objectives. pH shows a slight increase between 1988 and 1992, but more fluctuating patterns between 1993 and 1994 similar to that of Station 28. But in general, the average value of pH is lower than the upper limit of Basin Plan objectives. Sulfate shows an increasing trend from 1991 to 1993 and largely exceeded that of Station 28. Nevertheless, the average value of sulfate is close to the water quality objective values.

Station 7: Santa Clara River at the Old Road

Ammonium, chloride, sulfate, nitrite, TDS, and total coliform were evaluated. The general trends of nitrite, total coliform, and sulfate remain relatively steady throughout the years, except some fluctuations occurred for each parameter at different times (i.e., a surge of coliform concentration in late 1993, sulfate changes between mid-1990 and early 1993). TDS and chloride correspond with each other closely and both show a slight decreasing trend from 1990 to 1994. Ammonium shows a trend of constant fluctuation throughout the years.

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Station 8: Santa Monica Canyon at Short Street

Fecal coliform, fecal Enterococci, total coliform, and lead were analyzed. The bacteria constituents show two different trends. The total coliform value remains steady throughout the years and shows very little fluctuation, which is similar to Station 28. Fecal coliform and Enterococci, on the other hand, show more variation. Several extremes may be due to sampling, analysis, and/or reporting errors. Lead concentrations appear to be high from 1988 to 1990 and decrease to a steady level similar to that in Station 28.

Station 9: Sepulveda Channel at Culver Blvd.

Fecal coliform, lead, TDS, pH, sulfate, and chloride were selected for analysis at Station 9. High lead concentrations were observed between 1988 and late 1992. It shows a reduction trend and is similar to those displayed at Station 28. Fecal coliform exhibits a fluctuating trend without specific patterns. TDS, sulfate, and chloride show much more variations and are all higher than those exhibited at Station 28. pH follows a similar pattern as that depicted at Station 28 with an average value slightly lower than the upper limit of the Basin Plan water quality objective.

Station 10: Topanga Canyon at Pacific Coast Highway

Total coliform, fecal coliform, fecal Enterococci, sulfate, and pH were analyzed. The bacteria parameters show a greater variation but similar pattern as that depicted at Station 28, with an increasing trend between 1991 and late 1993. The pH values show a slight increasing throughout the years and the average value is slightly lower than the water quality objective.

Station 11: Torrance Lateral at Main Street

Chloride, pH, TDS, and fecal coliform were analyzed at this station. Chloride and TDS correspond well with each other and show wide fluctuations. The average values of both parameters are above those shown for Station 28. The trends of pH and fecal coliform show greater fluctuation before 1990, and remain relatively close to those at Station 28.

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Station 12: Wilmington Drain at Pacific Coast Highway

Fecal coliform, TDS, sulfate, chloride, and ammonium were chosen for analysis. Fecal coliform and ammonium follow closely to those values depicted at Station 28. TDS, sulfate, and chloride are all showing similar pattern and displayed above the values at Station 28.

Station 13: Corral Canyon at Pacific Coast Highway

Fecal Enterococci, fecal coliform, and total coliform were analyzed. All of these parameters show some variations from those collected at Station 28. The average value of fecal coliform is less than the Ocean Plan water quality objective limits, while the average values of coliform and fecal Enterococci are slightly higher than the Ocean Plan objective limits.

Station 14: Compton Creek at Greenleaf Blvd.

Ammonium, pH, lead, and fecal coliform were analyzed. Ammonium exhibits a similar trend as that of Station 28. pH values are general in the more active range than that of Station 28, but relatively close to the upper limit of Basin Plan water quality objective. Several high lead concentrations were reported prior to 1991. Lead data between 1990 and 1994 appears to be consistent with that of Station 28. Fecal coliform concentrations are slightly higher than that of Station 28 and the Basin water plan quarterly objective limit.

Station 15: Coyote Creek at Orangethorpe Blvd.

Fecal coliform and TDS were evaluated for Station 15. Fecal coliform depicts a steady trend and the values appear to be higher than those of Station 28 and water quality objective limits. TDS shows a slight increasing trend and the average exceeds both the Basin Plan water quality objectives and data observed at Station 28.

Station 16: Coyote Creek at Willow Street

Fecal coliform, TDS, nitrite, and ammonium were analyzed. TDS shows a slight increasing trend and nitrite shows a slight descending trend from 1992 to 1994 parameters. Both are generally higher than those at Station 28 and the water quality objective limits. Fecal coliform trend appears steady and almost coincides with the trend at Station 28. Ammonium shows a slight decreasing trend since 1992 and is generally higher then that for Station 28.

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Station 17: Los Angeles River at Arroyo Seco

Fecal coliform, nitrite, chloride, and ammonium were evaluated. All of these parameters depict a horizontal trend with some fluctuations. Chloride and ammonium are higher than those at Station 28. However, the average value of chloride is less than the Basin Plan water quality objective limit. Nitrite and fecal coliform appear to be close to the values shown for Station 28.

Station 18: Los Angeles River at Firestone Blvd.

Chloride, fecal coliform, nitrite, pH, and ammonium were analyzed. All of these parameters depict a horizontal trend with some fluctuations. Chloride, nitrite, and ammonium are shown to be higher than the Station 28 data. Fecal coliform and pH are similar to those shown for Station 28. The average pH value is lower but closer to the Basin Plan objective.

Station 19: Los Angeles River at Tujunga

Nitrite, sulfate, chloride, fecal coliform, and ammonium were evaluated for Station 19. The concentrations of nitrite, chloride, sulfate, and ammonium are higher than those found at Station 28, with a wide range of fluctuations. Fecal coliform coincides with the trend depicted for Station 28. Sulfate shows an increasing trend from mid-1990.

Station 20: Los Angeles River at Wardlow Road

The trends of ammonium, total coliform, chloride, pH, and nitrite were investigated for this station. There seems to be no specific trends exhibited in any of these plots. Ammonium, chloride, and nitrite show wide fluctuations and exceed the values of Station 28. Total coliform and pH were relatively close to the trend of Station 28 and the water quality objectives.

Station 21: Los Cerritos Channel at Stearns

The samples of pH and fecal coliform were analyzed for this station. Both of these parameters show a similar trend to that of Station 28. The average pH remains close but below the upper limit of the Bain Plan objective.

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Station 22: Rio Hondo Channel at Rio Hondo Spreading Grounds

Ammonium, nitrite, and fecal coliform were analyzed. Ammonium shows wide fluctuations with most values exceeding that of Station 28. Nitrite and fecal coliform remained close to the trend of Station 28.

Station 23: Rio Hondo Channel at San Gabriel Blvd.

Nitrite, fecal coliform, and ammonium were analyzed. Nitrite shows a slight decreasing trend with the average value slightly lower than the Basin Plan water quality objective limit. Fecal coliform follows a similar trend as that of Station 28. Ammonium shows wide fluctuations and exceeded the values shown for Station 28.

Station 24: Rio Hondo Channel at Steward and Gray

Fecal coliform, pH, and chloride were evaluated for Station 24. All of these three compounds show no particular trends. Fecal coliform and pH followed closely to the values measured at Station 28. Chloride concentrations are higher than those found at Station 28. But pH values fluctuate above and below those of Station 28.

Station 25: San Gabriel River at San Gabriel Spreading Grounds

Ammonium, nitrite, and fecal coliform were plotted for trend analysis. Ammonium shows a generally reducing trend but the values are higher than those of Station 28. Nitrite concentrations are higher than those of Station 28, and its average value is slightly higher than the Basin Plan water quality objective limit. Fecal coliform follows very similar trend as that for Station 28.

Station 26: San Gabriel River at Willow Street

Fecal coliform, TDS, nitrite, and ammonium were evaluated. The concentrations for ammonium, TDS, and nitrite are generally higher than those at Station 28. Additionally, ammonium shows a slight decreasing trend after 1992. Nitrite and fecal coliform have average concentrations greater than the Basin Plan water quality objective. Fecal coliform are similar to that of Station 28.

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Station 27: San Jose Creek at Workman Mill Road

TDS, nitrite, sulfate, chloride, and ammonium were analyzed. All of these compounds show some fluctuations throughout the years. The concentrations of TDS, sulfate, and chloride are above those shown at Station 28. Nitrite and ammonium were similar to the trends shown at Station 28.

Both TDS and chloride show a slight increasing, but more steady trend since 1992 and their values are mostly above Station 28.

6.1.2 Storm Weather Analysis

Storm weather trend analysis for a number of the monitoring stations indicated extreme bacteria concentration peaks throughout the sampling period. These peaks may be attributed to sewage overflows discharged to storm drain systems during flooding events. The following is a general discussion of storm weather trend analysis at each monitoring station:

Station 2: Ballona Creek at Sawtelle Blvd.

Fecal coliform and pH were analyzed for Station 2. Fecal coliform appears to be steady and is close to the values depicted for Station 28 except for an increase from mid-1993. The pH value has a greater fluctuation but it seems to be closer to the lower limit of the Basin Plan water quality objectives. During the monitoring period, pH remained below the values obtained for Station 28.

Station 3: Centinela Creek at Centinela Blvd.

TDS, fecal coliform, pH, and chloride were analyzed for Station 3. TDS, chloride, and fecal coliform depict a horizontal trend with values close to those of Station 28. The pH values remains below those obtained from Station 28 and closer to the lower limit (acidic range) of the Basin Plan water quality objectives.

Station 4: Dominiguez Channel at Vermont Avenue

Parameters of Lead, pH, and fecal coliform were evaluated for Station 4. Fecal coliform appears to be consistent with conditions observed at Station 28. Lead shows a reducing trend with values reaching the same level as those at Station 28. The pH values are below those of Station 28 and close to the lower limit of the Basin Plan water quality objectives.

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Station 5: Kenter Drain at Pico Blvd.

Fecal coliform, fecal Enterococci, total coliform, TDS, and pH were analyzed for Station 5. Fecal coliform, fecal Enterococci, and TDS have similar values and follow the same trends as those of Station 28. The pH values are below those reported for Station 28 and are closer to the lower limit of the Basin Plan water quality objectives.

Station 6: Malibu Creek at Cross Creek Road

Sulfate, total coliform, fecal coliform, and fecal Enterococci were plotted for Station 6. Total coliform and fecal coliform show an increasing trend since 1990 and their concentrations are above the water quality objectives and those reported for Station 28 for the majority of the monitoring period. Fecal Enterococci shows a slight increasing trend, but remains close to values reported for Station 28 and the Ocean Plan water quality objective. Sulfate shows wide fluctuations and rises on one occasion above the Basin Plan water quality objective, but its average value does not exceed the objective limit. Sulfate values are above those reported for Station 28.

Station 7: Santa Clara River at the Old Road

Sulfate and total coliform were evaluated. Sulfate shows an increasing trend after 1991 and rises above the Basin Plan water quality objective and the Station 28 data on a few occasions. Total coliform data remains similar to those at Station 28.

Station 10: Topanga Canyon at Pacific Coast Highway

Total coliform, fecal coliform, and fecal Enterococci were analyzed. These bacteria parameters show an increasing trend since 1991 and exceed those values obtained from for Station 28.

Station 11: Torrance Lateral at Main Street

Fecal coliform and pH were plotted for trend analysis. The values of pH remain close to the lower limit of the Basin Plan water quality objective and are less than those obtained from Station 28. Fecal coliform shows a slight increasing trend after 1991, when it rises above the Station 28 data and the water quality objective.

Station 12: Wilmington Drain at Pacific Coast Highway

Fecal coliform and pH were analyzed. Fecal coliform depicts a slight increasing trend after 1991

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and stays above values reported for Station 28. pH shows a decreasing trend after 1992 and plunge below the lower limit of the Basin Plan water quality objective.

Station 16: Coyote Creek at Willow Street

Fecal coliform, TDS, and nitrite were analyzed. TDS and nitrite show a horizontal trend with wide fluctuations. For the majority of the monitoring period, TDS and nitrate concentrations remain below the water quality objectives with nitrite exceeding that of Station 28. Fecal coliform values remain similar to those of Station 28.

Station 18: Los Angeles River at Firestone Blvd.

Fecal coliform and pH were analyzed. Fecal coliform follows a horizontal trend and coincides with data observed at Station 28. The values of pH fluctuates and remains close to the lower limit of the water quality objectives and below those of Station 28.

Station 20: Los Angeles River at Wardlow Road

The trends of Total coliform and pH were plotted at this station. Total coliform follows a horizontal trend and coincides with the data obtained from Station 28. The values of pH fluctuates and remains close to the lower limit of the water quality objective and below those observed at Station 28.

Station 21: Los Cerritos Channel at Stearns

pH and fecal coliform trends were investigated at this station. Fecal coliform follows a horizontal trend and coincides with that observed at Station 28. The values of pH fluctuates around the lower limit of the water quality objective and remains below those observed at Station 28.

Station 22: Rio Hondo Channel at Rio Hondo Spreading Grounds

Fecal coliform and pH were analyzed. Fecal coliform follows a horizontal trend similar to that of Station 28's. The values of pH fluctuate and stay close to the lower limit of the water quality objectives and below Station 28 reported values.

Station 24: Rio Hondo Channel at Steward and Gray

Fecal coliform and pH were evaluated for Station 24. After 1991, fecal coliform shows an increasing trend as it rises above the Station 28 data. pH shows an increasing trend from 1988

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to 1992 and then a descending trend thereafter. After 1992, pH values drop below the lower limits of the Basin Plan water quality objectives.

Station 25: San Gabriel River at San Gabriel Spreading Grounds

Fecal coliform was investigated at this station. The data shows some fluctuations, but generally with concentrations higher than those of Station 28.

Station 26: San Gabriel River at Willow Street

Fecal coliform, TDS, and nitrite were evaluated. TDS and nitrite depict a slightly increasing trend from 1991. TDS generally remains below the water quality objective. Nitrite fluctuates and rises above the Station 28 data. The concentration average of nitrite is close to the water quality objective. Fecal coliform appears to follow a horizontal trend and very close to that of Station 28.

Station 27: San Jose Creek at Workman Mill Road

The Fecal coliform trend was investigated and The values coincided with those of Station 28.

6.2 TREND ANALYSIS ON A COUNTY-WIDE BASIS

The trend analysis performed for individual monitoring stations described above and presented in Appendix "A", were integrated for the entire Los Angeles County to identify the long-term trend for the County as a whole. The analysis presented here, incorporates all reported data throughout the County and for the entire monitoring period. Again, the trend analysis is performed for the ten compounds identified in Section 5 (non-compliance compounds). Constituent concentrations are plotted against time for the entire Los Angeles County. Average concentrations over the monitoring period and water quality objectives are also provided in the graphs for comparison purposes. Results are summarized in Appendix "B".

Storm weather trend analysis on a County-wide basis indicated extreme bacteria concentration peaks throughout the sampling period. These peaks may be attributed to sewage overflows discharged to storm drain systems during flooding events. The following represents a summary of water quality trends throughout the Los Angeles County:

- Total coliform

Dry weather monitoring: The data shows a general trend of reduction on total coliform

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concentration since 1988.

Storm weather monitoring: The total coliform concentration does not show any particular trend. However, a slight increase of coliform concentration is observed in 1994 but higher concentrations were observed in 1987 and 1988.

For both dry and storm weather conditions, the total coliform concentrations largely exceed the basin and ocean plan objectives.

Fecal coliform

Dry and storm weather monitoring: Higher fecal coliform concentrations are observed for both the dry and storm weather samples late in the 1980s. The trend shows a decreasing pattern thereafter, and then slightly increases in 1994.

Lead

Dry weather monitoring: The data shows a trend of reductions from 1988 to 1991, and generally exceeded the Basin Plan and Ocean Plan water quality objectives. From 1991 to 1994, lead concentration remains essentially constant and complied with the Basin and Ocean plan objectives.

Storm weather monitoring: The data shows a trend of reduction and lead concentrations generally complied with the Ocean and Basin Plan objectives, except that high concentrations of lead were observed in 1988.

Nitrite

Dry weather monitoring: There is no significant change in nitrite concentration from 1988 to 1994, and the values exceed the water quality objective throughout the entire period.

Storm weather monitoring: Nitrite concentrations show a trend of increase since 1990 with the highest concentrations detected in early 1994. The data also indicates that nitrite concentrations are mostly, but not always, in compliance with the Basin Plan Objective.

Total Dissolved Solids

Dry weather monitoring: The average total dissolved solid concentrations are lower between 1988 and 1991 than those between 1991 and 1994. Additionally, a significant number of

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samples exhibit concentrations above the Basin Plan objectives.

Storm weather monitoring: The total dissolved solids concentrations show an increasing trend and the data are mostly complied with the upper limit of the Basin Plan objective.

Sulfate

Dry weather monitoring: Sulfate shows a trend of slight increase from 1988 to 1994, with the majority of the values exceeding the Basin Plan objective.

Storm weather monitoring: A trend similar to that detected for the dry weather data.

Chloride

Dry weather monitoring: The chloride concentrations stay constant between 1988 and 1991 and slightly thereafter. Most of values exceed the upper limit of the Basin Plan objectives.

Storm weather monitoring: The chloride concentrations show an increasing trend and the data are mostly in compliance with the lower limits of Basin Plan objectives.

Ammonium

Dry and storm weather monitoring: The ammonium concentrations does not show any change over the years.

pH

Dry weather monitoring: pH does not show any significant change or trend between 1988 and 1994. Nevertheless, a significant number of the samples taken during the monitoring period are above the upper limit of the Basin Plan objectives.

Storm weather monitoring: pH stays mostly between the limits listed in the Basin Plan without any significant change between 1988 and 1994. The average pH concentrations are slightly more acidic for storm- than for dry-weather monitoring data.

6.3 TREND ANALYSIS ON A REGIONAL BASIN-WIDE BASIS

As mentioned in Section 4, the entire Los Angeles County and adjacent areas have been divided

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into five regional drainage basins (Exhibits A and B). The graphs, showing the water quality trends for individual monitoring stations of each regional basin, were integrated to show the overall water quality trend in the five basins. Basin-wide water quality trend curves were developed for the ten compounds selected in the screening process and are presented in Appendix "C".

The graphs in Appendix "C" were carefully examined in order to identify any specific water quality trends that might have occurred during the monitoring period. Specific trends were observed for a few compounds in each basin. In general, lead concentrations in all basins have shown to decrease since 1988, except that there are reoccurrences of elevated lead in the 1993 water samples. Most bacterial indicators, such as fecal Enterococci and coliforms, appear to have been reduced between 1988 and 1993, but their populations increase again in 1994. Storm weather trends indicate extreme bacteria concentrations throughout the sampling period. These peaks may be attributed to sewage overflows discharged to storm drain systems during flooding events. The following represents a summary of Total Dissolved Solids (TDS), chloride, and sulfate concentrations, have shown a gradual increase in Basin II. Sulfate concentrations have increased in Basins IV and V (both North and South). A similar trend has also been noted for nitrite in Basin V (North). The following provides a general description of specific trends observed in each basin:

6.3.1 Basin I - Santa Monica Bay Drainage Basin

Lead

Dry weather monitoring: The highest lead concentrations occurred in 1988, with most of the data exceeding the Basin Plan and Ocean Plan water quality objectives. Between 1988 and 1993, there was a significant reduction of lead in dry weather samples and most of the data obtained during this period was below the water quality objectives. A surge of lead concentrations was noted in 1993, with peaks exceeding the objective limits. However, this appeared to be only temporary and lead concentrations again dropped below the objective limits for the remaining monitoring period.

Storm weather monitoring: There is a rapid decreasing trend for lead in storm weather samples from 1988 to 1994. Most data obtained in 1988 exceeds the Basin Plan objective and some are above the Ocean Plan objective. After 1988, lead concentrations are in compliance with all water quality objective limits.

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Total Coliform

Dry weather monitoring: *Peak* coliform concentrations were observed in 1988. Although there has been a drastic reduction in total coliform since 1991, its populations still exceed the Basin Plan and Ocean Plan objective limits.

Storm weather monitoring: Peak concentrations were observed in 1987 and 1988. The trend seems to follow a gradual but increasing pattern from 1987 to 1988. A sharply decreasing trend is noted between 1988 and 1993, then total coliform concentrations increased slightly in 1994. Throughout the monitoring period, most data have been shown to exceed the Basin Plan and Ocean Plan objective limits.

Fecal Coliform and Fecal Enterococci

Storm weather monitoring: The concentrations of both bacterial indicators exhibit a rapidly decreasing trend from 1987 to 1993. However, an escalation in bacterial concentrations is noticed between 1993 and 1994. Overall, the concentrations of both indicators exceed the water quality objective limits.

6.3.2 Basin II - Upstream Los Angeles River Drainage Basin

Only dry weather monitoring was performed in Basin II.

Chloride

Chloride concentrations exhibit an increasing trend from 1988 to 1992, and a decreasing trend thereafter. Most data, except for some obtained in 1990 and 1992, are in compliance with the Basin Plan objective.

Sulfate

Sulfate concentrations have gradually increased over the monitoring period. Most data, except for some isolated peaks in 1991, 1992, and 1993, are in compliance with the Basin Plan objectives. The isolated peaks may be data outliers.

Lead

Significant reduction in lead concentrations is noted from 1990 to 1994, with a few isolated peaks occurring in 1993. The data obtained after 1990 generally falls below the limit of the Basin Plan

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objective limit.

Total Coliform

Since the late 1980's, there has been a rapid decrease in total coliform concentrations. However, elevated coliform populations were noted again in 1994. Throughout the entire monitoring period, most coliform data exceed the Basin Plan objective limit.

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Total Dissolved Solids

Although there is an increasing trend in TDS concentrations over the monitoring period, most of the existing TDS data are well below the Basin Plan objective limit.

6.3.3 Basin III - Upper San Gabriel River Drainage Basin

Ammonium

Dry weather monitoring: There is a very slight reducing trend detected for ammonium over the monitoring period. The majority of the data, however, are still above the Basin Plan objective limit.

Lead

Dry and storm weather monitoring: Peak lead concentrations are found in 1988 and 1989. Then concentrations decrease rapidly from 1989 to the end of the monitoring period. The levels after 1989 are below the Basin Plan objective limit.

Total Coliform

Dry and storm weather monitoring: After 1990, there appears to have been a notable decreasing trend in total coliform concentrations. However, such trend was reversed in 1994 and the coliform concentration raises again in 1994. Most data acquired throughout the years are above the Basin Plan objective limit.

6.3.4 Basin IV - Lower Los Angeles River Drainage Basin

Sulfate

Dry weather monitoring: There seems to be a gradual increase in sulfate concentrations over the monitoring period. Prior to 1991, most data are below the lower limit of the Basin Plan objective. Beyond 1991, a significant number of data escalates above the lower limit of the Basin Plan objective.

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Lead

Dry weather monitoring: There is a decreasing trend in the lead concentrations from 1988 to 1994, with a slight surge observed in 1993. Since 1991, most lead concentrations are in compliance with the Basin Plan objective.

Storm weather monitoring: Starting in 1989, a decreasing trend is observed in lead concentrations. After 1989, all lead data are below the Basin Plan objective limit.

Total Coliform

Dry and storm weather monitoring: The concentrations of total coliform appears to follow a decreasing trend over the monitoring period, with a slight increase in 1994. Nevertheless, most data are above the Basin Plan objective limit.

Fecal Coliform

Storm weather monitoring: Prior to May 1990 and after 1994, there seems to have been an increase in fecal coliform concentrations. The majority of the fecal coliform concentrations exceed the Basin Plan objective limit.

Dry weather monitoring: There is a drastic reduction in fecal coliform levels after 1989 and the concentrations become relatively steady throughout the remaining monitoring period. Most fecal coliform data, however, exceed the Basin Plan objective limit.

Fecal Enterococci

Storm weather monitoring: The concentrations of fecal Enterococci have shown a slight decreasing trend after 1990. However, a dramatic increase in fecal Enterococci concentrations is noted in 1994. Most data obtained during the monitoring period are above the Basin Plan objective limit.

6.3.5 Basin V - (South) Lower San Gabriel River Drainage Basin

Sulfate

Dry weather monitoring: Sulfate concentrations have shown to gradually increase over the monitoring period. Most measurements are below the upper limit of the Basin Plan objective limit; and during about half of the monitoring period, sulfate concentrations remain below the

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lower limit of the Basin Plan objective limit.

Total Dissolved Solids

Dry weather monitoring: There is a slight increase in TDS concentrations over the 5-year monitoring period. Beyond 1991, most of the TDS data exceed the upper limit of the Basin Plan objective.

Lead

Dry and storm weather monitoring: There is a decreasing trend in lead concentrations over the monitoring period for both dry and storm weather conditions. After 1990, most data plunges below the Basin Plan objective limit. In both cases, lead begins to show a decreasing trend since December 1988 and its concentrations are all below the Basin Plan objective limit. A surge of lead concentrations in water is noted between May and June 1994. However, this may be due to sampling/analytical errors or caused by other possible outliers.

Total Coliform

Dry weather monitoring: Total coliform concentrations have shown a drastic reduction after 1989. Nevertheless, most data still exceed the Basin Plan objective limit.

Fecal Coliform

Storm weather monitoring: Initially, a decreasing trend is noticed for fecal coliforms between 1989 and 1993; however, concentrations increase again in 1994. Most fecal coliform data collected from the last 5 years are above the Basin Plan objective limit.

Fecal Enterococci

Dry and storm weather monitoring: Initially, a decreasing trend for fecal Enterococci is noticed under storm weather conditions. Then, the concentration increases between 1993 and 1994. Over the monitoring period, most fecal Enterococci data are above the Basin Plan objective limit.

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6.3.6 Basin VI - North Santa Clarita Basin

Chloride

Dry weather monitoring: Chloride concentrations display a slightly decreasing trend between 1991 and 1994, with the majority of data below the Basin Plan objective limit.

Storm weather monitoring: There appears to have been an increasing trend in chloride concentrations between 1991 and 1994. However, all measured data are below the Basin Plan objective limit.

Sulfate

Storm weather monitoring: Sulfate concentrations exhibit an increasing trend from 1991 to 1994. After 1991, some sulfate data exceeds the Basin Plan objective limit.

Nitrite

Storm weather monitoring: Nitrite concentrations show a slight increasing trend between 1991 and 1994, with most data below the Basin Plan objective limit.

TDS

Storm weather monitoring: There is a trend of slight increase in TDS concentration for the last 5 years. High TDS fluctuation is also noted in recent years (1993 and 1994). Nevertheless, all data are below the Basin Plan objective limit.

Lead

Dry weather monitoring: There is a decreasing trend in lead concentrations from 1988 to 1994, with a slight surge observed in 1993. Beyond 1988, all lead data are in compliance with the Basin Plan objective limit.

Storm weather monitoring: Lead concentrations are reduced significantly over the monitoring period. Beyond 1988, all data are in compliance with the Basin Plan objective limit.

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Total Coliform

Dry and storm weather monitoring: The trend can be described as fluctuating, with no change until 1994, when escalated concentrations are observed. Most coliform concentrations are above the Basin Plan objective limit.

Fecal Coliform and Fecal Enterococci

Storm weather monitoring: Concentrations of fecal Enterococci seem to fluctuate in a horizontal pattern until 1994 when a sharp increase is noted. Most data collected during the last 5 years are above the Basin Plan objective limits.

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SECTION 7 - URBANIZATION IMPACTS

7.1 IMPACT OF WATER QUALITY DUE TO URBANIZATION AND INDUSTRIALIZATION

A land use analysis was performed to identify existing land use categories for the sub-basins tributary to the twenty-eight surface water quality monitoring sites and to assess the impact of land use on water quality. The analysis included identifying the areas tributary to the sites and estimating the land use percentages upstream. The land uses were grouped into four general categories: natural, partially urbanized, urbanized, and industrial. The results of the analysis is summarized on Table 5.

In order to evaluate the impact on water quality as a result of the urbanization of the areas, the monitoring sites with the highest percentages of industrial and urbanized upstream land uses were selected. These monitoring sites included the highly industrialized watersheds of Station 4 (30% industrial), Station 11 (40% industrial), Station 15 (20% industrial), and Station 21 (20% industrial), and the highly urbanized watersheds of Station 1 (50% urbanized), Station 2 (46% urbanized), Station 4 (35% urbanized), Station 9 (42% urbanized), and Station 14 (37% urbanized).

Tables 8 and 9 present the average and maximum concentration values of the water quality parameters for the 28 sampling sites for dry and storm weather conditions, respectively. The analysis included evaluating and comparing water quality data from the highly urbanized and highly industrialized stations with that at Station 28, a 100% natural basin. Plots summarized in Appendices A, B, and C compare water quality trends observed at Station 28 to water quality trends at individual monitoring stations throughout Los Angeles County and on a basin-wide level, respectively. Tables 8 and 9 summarize and group the water quality results for the regional Los Angeles County Basins, and from upstream to downstream. The evaluations included an assessment of the water quality conditions at individual monitoring stations, from upstream to downstream, incorporating changes in land use between stations. The following is a summary of our findings and a preliminary assessment of water quality impact associated with urbanization and industrialization of the watersheds:

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Industrialization Impact

Sampling Site	Parameters with High Concentration	Impact	
4	Chloride, sulfate, TDS, lead	Yes	
11	Total coliform, fecal coliform, TDS	No	
15	Chloride, TDS, lead, total coliform, fecal coliform		Yes
21	Chloride, TDS, total coliform, fecal coliform	No	

Urbanization Impact

Sampling Site	Parameters with High Concentration	Impact
1	Sulfate, nitrite, lead, TDS	Yes
2	Ammonium, lead, total coliform	Yes
4	Chloride, sulfate, TDS, lead	Yes
9	Ammonium, chloride, sulfate, TDS, lead	Yes
14	Lead, total coliform, fecal coliform	Yes

As mentioned above, Tables 8 and 9 group the water quality parameters for each monitoring station within the six regional drainage basins. The sites are listed in the order of most upstream to most downstream within each basin. The most urbanized basins are Basins IV and V South, shown on Exhibit B. In Basin IV, the concentrations of chloride, TDS, lead, total coliform, and fecal Enterococci increase from upstream to downstream, which may be due to increased urbanized uses of the tributary areas. In Basin V South, sulfate, TDS, nitrite, and lead show an increasing trend from the upstream to downstream, which again may be attributed to increased urban uses of the areas. The patterns in these two basins indicate that water quality conditions may have been impacted by increased urbanized uses of the tributary areas.

7.2 POTENTIAL POLLUTANT SOURCES

The potential sources for water quality pollutants include: industries, various activities in residential and commercial areas, vehicle exhaust, and agriculture. High concentrations of ammonium and nitrite can be attributed to agricultural and landscaping activities, including the use of fertilizers and pesticides. High chloride, sulfate, TDS, and lead concentrations are usually detected in runoff generated from industrial areas. Variation of the pH value is an indicator of the industrialization of the tributary watersheds. The pH levels monitored from the storm weather data, for most sites, exhibited greater acidity than the dry weather data. This may be attributed to higher acid levels in rain storms developed from industrial air pollution. The increased bacterial compound levels in surface flows may be attributed to contact with air, soil, living or

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decaying plants or animals, mineral sources, and fecal excrement.

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SECTION 8 - BEST MANAGEMENT PRACTICES EVALUATION

This section briefly describes the Best Management Practices (BMPs) implemented by the cities (Municipal Permit, Co-Permittees) located in the watersheds tributary to the monitoring stations evaluated. It is of particular importance to show whether any of the constituent reductions over the monitoring period described in the long-term trend analysis described in Section 6 are attributed to BMP implementations. The BMP information utilized in evaluations presented in this section were obtained from the Report entitled: "Summaries of Storm water/Urban Runoff Quality Management Programs Questionnaire (Draft)" prepared in August 1994, by the Department of Regional Planning for the Los Angeles County Department of Public Works Waste Management Division.

A rating criteria was used to rate the implementation of thirteen BMPs by the Co-Permittee cities. The BMPs implemented include a variety of non-structural measures. The following is a list of the BMPs:

1. Stencil Catch Basins
2. Develop Programs to Promote Public Reporting of Illegal Discharges /Dumping
3. Adopt Runoff Ordinance
4. Develop Public Education and Outreach Programs
5. Clean Catch Basins Regularly
6. Increase Roadside Trash Receptacle Usage
7. Increase Street Sweeping
8. Discourage Improper Disposal of Litter, Lawn Clipping, Pet Feces
9. Inspect Automobile Uses And Restaurants
10. Encourage Removal of Dirt, Rubbish, and Debris From Sidewalks/Alleys
11. Promote Recycling
12. Motivate Residents to Properly Dispose of Household Hazardous Waste
13. Encourage Conservation of Water

Four criteria were used in evaluating the BMPs listed above at each city. The four criteria and codes used to describe them by Los Angeles County include: Fully Implemented (10), Partially Implemented (5), Planned/Proposed (P), and Not Implemented (X). Appendix "D" provides a list of all co-permittees' BMP implementation ratings. Los Angeles County has indicated that the majority of these BMPs have been implemented in the near past and/or are planned for implementation.

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The long-term trend analysis for the twenty-eight monitoring stations is discussed in Section 6. Constituent reduction over the monitoring period (or increments of the monitoring period) were observed only for a few compounds at eight monitoring stations. Table 10 provides a summary of the monitoring stations exhibiting any reduced compound concentrations over the monitoring period, as well as a summary of upstream cities and their effective BMP implementation.

Table 10 also indicates that the majority of cities have fully implemented BMPs such as: cleaning catch basins on a regular basis, increasing street sweeping, and motivating residents to properly dispose of household hazardous waste. Other BMPs, such as: stenciling catch basins, adopting runoff ordinances, discouraging improper disposal of litter, and encouraging conservation of water, are partially implemented or planned to be implemented.

The most significant reductions have been observed in TDS, fecal coliform, lead, ammonium, and nitrite concentrations. Stations 25 and 26 (downstream of Station 25) with over fifteen upstream cities implementing or partially implementing various non-structural BMP programs have experienced a reduction in the total ammonium levels. Station 16, located in the same basin, has also experienced lower ammonium levels. A reduction in the nitrate levels was observed in the dry weather flows of Station 23. TDS levels have decreased in the dry weather flows of Station 1, with mostly fully implemented BMP programs in its upstream cities (Beverly Hills and Los Angeles). Station 3, in the same basin as Station 1 and downstream of Culver City, has experienced lower TDS and fecal coliform levels in its dry weather flows. Dry weather flows sampled at Station 9, located in the City of West Hollywood which has fully implemented all the BMPs, exhibit a reduction in fecal coliform and lead levels. However, lower lead levels have also been observed in storm weather flows of Station 4, with partially implemented or proposed BMP programs.

It should be noted that it is extremely difficult to make any conclusions as to the reduced trends being attributed to implementation of any of the BMP programs. As the matrix in Appendix "D" indicates, there were many other cities that implemented BMP programs upstream of monitoring stations which displayed no reduced pollutant levels over the monitoring period. The non-structural BMPs listed in Table 10 and Appendix "D" have all been implemented in the very recent past and/or are proposed to be implemented. It is usually rare to observe improvements in water quality conditions due to non-structural BMPs in a short time frame. More information, such as exact date of implementation of these programs and more water quality data, will be necessary before conclusions can be made regarding the effectiveness of the BMP programs.

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SECTION 9 - SUMMARY AND CONCLUSIONS

This report presents a general assessment of the surface water quality conditions within the Los Angeles County area by examination of the surface water quality data collected by LADPW between 1988 and 1994. The purpose of this report is to provide an evaluation of surface water quality monitoring data for inclusion in the "Report of Waste Discharge" (ROWD), which will be submitted to the California Regional Water Quality Control Board, Los Angeles Region pursuant to the requirement of the Los Angeles County National Pollutant Discharge Elimination System (NPDES) Municipal Storm water Permit No. CA0061654.

The Municipal permit divides the Los Angeles County area and immediate vicinity into five general regional basins. These regional basins include: (I.) Santa Monica Bay Drainage Basin; (II.) Upstream Los Angeles River Drainage Basin, to and including the Sycamore Canyon Channel (San Fernando Valley); (III.) Upper San Gabriel River (San Gabriel Valley) Drainage Basin; (IV.) Lower Los Angeles River Drainage Basin; (V.) Lower San Gabriel River Drainage Basin (V-south); and Santa Clarita Valley Basin (V-north).

The LADPW has been actively monitoring surface water quality conditions in the County's principal storm drains and water conservation facilities, on a voluntary basis, since the late 1960s. After the mid-1980s, a program of 28 sampling sites has been in effect. Grab samples are collected from all 28 sites on a monthly basis (or more) for dry weather flows. Twenty-one of the 28 sites are sampled (grab samples) for storm flows three to four times per year.

The dry weather samples are typically analyzed for general minerals, pesticides, total petroleum hydrocarbons, heavy metals, and bacteria (total and fecal coliform, KF streptococci and Enterococci). Volatile organic constituents are tested semi-annually at selected stations. Storm water runoff is monitored for minerals, pesticides, heavy metals (total and dissolved), bacteria, total and organic suspended solids, oil and grease, biochemical oxygen demand, total organic carbon and volatile organics. Overall, more compounds are analyzed from storm weather samples (127 compounds for storm weather samples versus 73 compounds for dry weather samples).

The prior sections of the report provided a description of water quality monitoring activities conducted by the LADPW and an assessment of the monitoring sites, including a description of their tributary watersheds and an evaluation of the tributary basin land uses.

The regulatory guidelines, including "Basin Plan" and "Ocean Plan" objectives and requirements, were fully investigated and a screening analysis was used to flag "non-compliance" parameters with the regulatory water quality objectives. It should be pointed out that the term "non-

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compliance" used throughout this study does not constitute a violation of LADPW's existing NPDES Permit, since no specific numerical water quality objective limits have been assigned. Additionally, the "Ocean Plan" includes an initial dilution clause, which implies it is for point sources of municipal and industrial origins and not from storm water runoff which is typically considered a non-point source. "The process which results in the rapid and irreversible turbulent mixing of wastewater with ocean water around the point of discharge" is the initial dilution and this factor is applied to the water objective standards. Permits are developed around models which define the dilution at the outfall. Permits are developed around models which define the dilution at the outfall. The State Water Resource Control Board, Division of Water Quality, Ocean Plan Unit, completed a California Control Ocean Plan Triennial Review 1991-4 (Doc 92-5WQ, October 22, 1992). On page 37, the "staff concluded that the Ocean Plan should be amended to clarify its applicability to storm water dischargers. A schedule of compliance for dischargers similar to the schedule in the Inland Surface Waters and the Enclosed Bays and Estuary Plans should be considered." Based on this, the quantitative data presented in this report cannot be directly evaluated for distribution and impact on health via the Ocean Plan. It is our opinion that the California Ocean Plan can be considered a state opinion of which chemicals are important to evaluate, but, not as having a direct quantitative relationship to the compounds that are present.

Furthermore, the comparisons between grab samples (as they have been collected by LADPW in the last five years) and some Ocean Plan criteria which are based on a 30-day average concentration, may not be objective. However, such problems will be eliminated by the installation of automatic sampling stations.

Average and maximum concentration of pollutants throughout Los Angeles County and its regional watersheds were computed and summarized. Long-term trend analysis was performed over the sampling period for the individual monitoring stations, the regional watersheds, and the overall Los Angeles County. The analysis included a comparison of water quality conditions at all stations with those obtained from the undeveloped watershed station (Station 28-Monrovia Creek), and to the applicable water quality objectives. Additionally, the impacts of urbanization on water quality conditions were examined. Finally, the BMP programs enforced previously were evaluated and their effectiveness on water quality conditions was assessed.

The screening analysis flagged the compounds that exceeded the water quality objectives ("Basin Plan" or "Ocean Plan") at any one time during the monitoring period. The top ten compounds with the highest numbers of exceedence were selected for a detailed analysis and investigation of the water quality conditions. These compounds include: fecal coliform, fecal Enterococci, TDS, ammonium, chloride, nitrite-N, pH, sulfate, total coliform, and lead. The long-term trend analysis and the evaluation of urbanization impacts were performed for these

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compounds.

The long-term trend analysis was performed on all twenty-eight dry weather samples and twenty-one storm weather samples collected over the period from 1988 to 1994. An analysis was also conducted to evaluate the trends of the water quality parameters on a Los Angeles County-wide basis and on each of the five regional watershed-wide basis.

Results indicated that for most water quality parameters there are no distinct trends of increase or reduction observed within this monitoring period. The majority of the monitoring stations in the lower basins (e.g., Basins V-south, and IV), show greater concentrations of chloride, sulfate, lead, and TDS than those located in the upstream areas (e.g., Basin II, V-north). The bacterial parameters, including total coliform, fecal coliform, and fecal Enterococci, monitored at stations in the urbanized areas generally exhibit similar trends to one another and to that observed at Station 28, which has a 100% natural tributary watershed. Lead concentration in many areas appears to have been reduced sharply after 1990 and remains below the water quality objective limits. The pH values for almost all monitoring stations follows a horizontal showing slightly alkaline pH during dry weather monitoring and slightly acidic pH during storm weather monitoring. On a county-wide basis, the pollutants of concern include: chloride, sulfate, TDS, nitrate, and lead, which are normally found in higher concentrations in the lower and more urbanized basins.

It should be noted that a great number of the data exhibited extreme peaks, especially those of the bacteria parameters. Some of this data may represent outliers, which may be attributed to a number of errors inherent in water quality data acquisition. Outliers are values which are obviously higher or lower than the majority of the data set. Even though the accuracy of some of the data outliers seems questionable, they were included in the analysis, since there is not enough evidence to show that they are erroneous. However, in the case of bacteria compounds, many of the extreme peaks may be attributed to sewage overflows discharging into storm drain systems during flooding events.

The land use analysis evaluated existing land uses at the watersheds tributary to the twenty-eight surface water quality monitoring sites and assessed the impacts of urbanization and industrialization on water quality when comparing with the conditions at Station 28 (mostly natural tributary area). Results indicated that several monitoring stations experienced higher total coliform, fecal coliform, lead, TDS, chloride, and sulfate concentrations which may be attributed to the highly industrial uses of their upstream watersheds. Higher chloride, sulfate, TDS, nitrate, ammonium, total coliform, and lead concentrations have been reported for stations with high urban type watersheds (as compared to Station 28). Several monitoring stations also appeared to have higher levels of bacterial count and chemical concentrations in their dry

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weather samples. These are thought to be caused by the following sources or reasons: POTW (Public Owned Treatment Works), industrial point source dischargers, illicit dischargers, ground water recharge, or sea water intrusion. Additionally, several monitoring sites are known to contain stagnant or semi-stagnant water which also tends to concentrate pollutants and bacterial populations.

Furthermore, water quality data between the upstream and downstream of the two most urbanized regional basins (IV and V) were compared. In Basin IV, the concentrations of chloride, TDS, lead, total coliform, and fecal Enterococci increase from upstream to downstream, which may be due to increased urbanized uses of the tributary areas. In Basin V South, sulfate, TDS, nitrite, and lead show an increasing trend from the upstream to downstream, which again may be attributed to increased urban uses of the tributary areas. The patterns in these two basins indicate that there is a direct negative impact on water quality caused by the urbanized uses of the tributary areas. The potential sources of water quality pollutants include: industries, various activities in residential and commercial areas, vehicle exhaust, and agriculture.

Finally, the effect of Best Management Practices (BMPs) implemented by the cities located in the watersheds tributary were evaluated to determine whether any of the constituent reductions over the monitoring period could be attributed to the BMP implementations. A rating criteria was used to rate the implementation of thirteen non-structural BMPs by the cities in the Los Angeles County. The most common fully implemented BMPs by the cities include cleaning catch basins on a regular basis, increasing street sweeping, and motivating residents to properly dispose of household hazardous waste. Other BMPs, such as stenciling catch basins, adopting runoff ordinances, discouraging improper disposal of litter, and encouraging conservation of water, are mostly partially implemented or planned to be implemented by the cities.

Results indicated that constituent reductions over the monitoring period (or increments of the monitoring periods) were observed only for a few compounds at eight monitoring stations. The most significant reductions are TDS, fecal coliform, lead, ammonium, and nitrate concentrations. Although several monitoring stations with non-structural BMPs implemented upstream have experienced reductions in certain compounds, it is extremely difficult to make any conclusions as to whether the reduced trends could be attributed to implementation of any of the BMP programs. It should be noted that the non-structural BMPs have all been implemented recently and therefore, it is uncommon to notice any immediate improvements in water quality conditions. More information needs to be collected through a systematic long-term monitoring program before conclusions can be made regarding the effectiveness of the BMP programs.

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SECTION 10 - REFERENCES

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TABLES

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TABLE 2 BENEFICIAL USES DRAFT 1994 "BASIN PLAN" FOR MONITORING STATIONS

Station	Hydrologic Unit	Watershed	Reach	BENEFICIAL USES MUN	IND	PROC	AGR	GWR	
1	405.15	Ballona Creek	Ballona Creek	P*					
2	405.15	Ballona Creek	Ballona Creek	P*					
3	405.15^	Ballona Creek	Ballona Creek	P*					
4	405.12	Dominguez Channel	Dominguez Channel to Estuary	P*					
5	405.13^	LA County Coastal Streams	Santa Monica Canyon Channel	P*					
6	404.21	Malibu Creek	Malibu Creek	P*					
7	403.51	Santa Clara River	Santa Clara River	P*	E*	E*	E*	E*	
8	405.13	LA County Coastal Streams	Santa Monica Canyon Channel	P*					
9	405.15^	Ballona Creek	Ballona Creek	P*					
10	404.11	LA County Coastal Streams	Topanga Canyon Creek	P*					
11	405.12	Dominguez Channel	Dominguez Channel to Estuary	P*					
12	405.12	Dominguez Channel	Dominguez Channel to Estuary	P*					
13	404.31	LA County Coastal Streams	Corral Canyon Creek	P*					
14	405.15	LA River	Compton Creek	P*				E*	
15	405.15	San Gabriel River	Coyote Creek to Estuary	P*	E	P			
16	405.15	San Gabriel River	Coyote Creek to Estuary	P*	E	P			
17	405.21	LA River	LA River	P*	E			E*	
18	405.15	LA River	LA River	P*	P			E*	
19	405.21	LA River	LA River	P*	P			E*	
20	405.12	LA River	LA River to Estuary	P*	P	P		E*	
21	405.15	LA County Coastal Streams	Los Cerritos Channel to Estuary	P*					
22	405.41	LA River	Rio Hondo below Spreading Grounds	P*				I*	
23	405.41	LA River	Rio Hondo	P*				I*	
24	405.41	LA River	Rio Hondo below Spreading Grounds	P*				I*	
25	405.15	San Gabriel River	Whittier Narrows - Firestone	P*	P	P		I*	
26	405.15	San Gabriel River	Firestone Blvd-Estuary	P*					
27	405.41	San Gabriel River	San Jose Creek	P*				I	
28	405.41	LA River	Monrovia Canyon Creek	I*				I*	

E Existing beneficial use

P Potential beneficial use

I Intermittent beneficial use

* Asterisked MUN designations are based on State Board Resolution No. 88-63.

c Coastal waterbodies which are also listed in Coastal Features Table 2-3 or in Wetlands Table 2-4

g Engineered channels. All references to Tidal Prisms in Regional Board documents are functionally equivalent to estuaries.

h Access prohibited by LA County DPW.

- Beneficial uses listed in the existing Basin Plan

◆ Proposed changes to beneficial uses

^ Station assigned beneficial uses relative to immediate downstream reach

f Aquatic organisms utilize all bays, estuaries, lagoons, and coastals wetlands, to a certain extent for spawning and development

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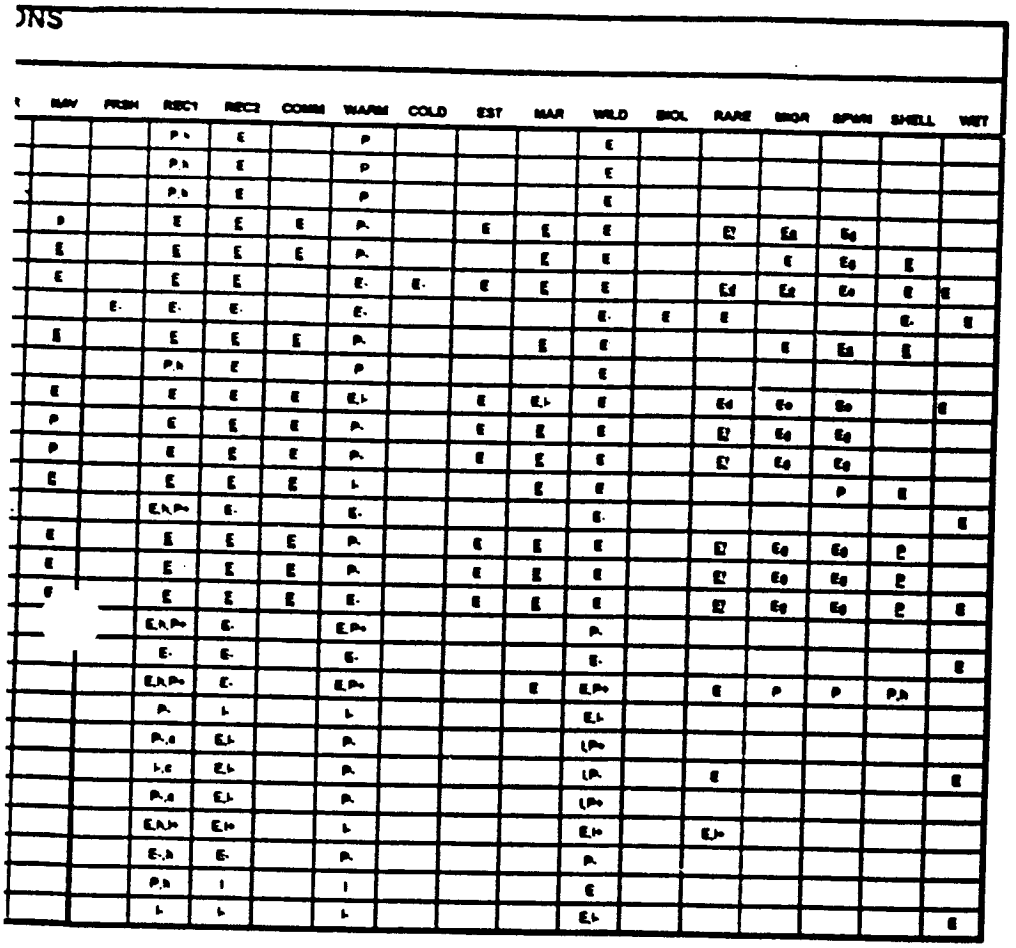

ONS

	NAV	FRSH	REC1	REC2	COMM	WARM	COLD	EST	MAR	WILD	BIOL	RARE	MIGR	SPWN	SHELL	WET
			P,h	E		P				E						
			P,h	E		P				E						
			P,h	E		P				E						
	P		E	E	E	P-		E	E	E		E?	Eg	Eg		
	E		E	E	E	P-			E	E			E	Eg	E	
	E		E	E		E-	E-	E	E	E		Ed	Ee	Ee	E	E
		E-	E-	E-		E-				E-	E	E			E-	E
	E		E	E	E	P-			E	E			E	Eg	E	
			P,h	E		P				E						
	E		E	E	E	E,L-		E	E,L-	E		Ed	Ee	Ee		E
	P		E	E	E	P-		E	E	E		E?	Eg	Eg		
	P		E	E	E	P-		E	E	E		E?	Eg	Eg		
	E		E	E	E	L-			E	E				P	E	
			E,h,P+	E-		E-				E-						E
	E		E	E	E	P-		E	E	E		E?	Eg	Eg	P	
	E		E	E	E	P-		E	E	E		E?	Eg	Eg	P	
	E		E	E	E	E-		E	E	E		E?	Eg	Eg	P	E
			E,h,P+	E-		E,P+				P-						
			E-	E-		E-				E-						E
			E,h,P+	E-		E,P+			E	E,P+		E	P	P	P,h	
			P-	L-		L-				E,L-						
			P-,d	E,L-		P-				L,P+						
			L-,d	E,L-		P-				L,P-		E				E
			P-,d	E,L-		P-				L,P+						
			E,h,L+	E,L+		L-				E,L+		E,L+				
			E-,h	E-		P-				P-						
			P,h	I		I				E						
			L-	L-		L-				E,L-						E

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R0060962

TABLE 1 BENEFICIAL USES REVISED 1992 "BASIN PLAN" FOR MONITORING STATIONS

Station	Hydrologic Unit	Watershed	Reach	BENEFICIAL MUN
1	405.15	Ballona Creek	Ballona Creek	
2	405.15	Ballona Creek	Ballona Creek	
3	405.15^	Ballona Creek	Ballona Creek	
4	405.12	Dominguez Channel	Dominguez Channel to Estuary	
5	405.13^	LA County Coastal Streams	Santa Monica Canyon Channel	
6	404.21	Malibu Creek	Malibu Creek	
7	403.51	Santa Clara River	Santa Clara River	
8	405.13	LA County Coastal Streams	Santa Monica Canyon Channel	
9	405.15^	Ballona Creek	Ballona Creek	
10	404.11	LA County Coastal Streams	Topanga Canyon Creek	
11	405.12	Dominguez Channel	Dominguez Channel to Estuary	
12	405.12	Dominguez Channel	Dominguez Channel to Estuary	
13	404.31	LA County Coastal Streams	Corral Canyon Creek	
14	405.15	LA River	Compton Creek	
15	405.15	San Gabriel River	Coyote Creek to Estuary	
16	405.15	San Gabriel River	Coyote Creek to Estuary	
17	405.21	LA River	LA River	
18	405.15	LA River	LA River	
19	405.21	LA River	LA River	
20	405.12	LA River	LA River to Estuary	
21	405.15	LA County Coastal Streams	Los Cerritos Channel to Estuary	
22	405.41	LA River	Rio Hondo below Spreading Grounds	
23	405.41	LA River	Rio Hondo	
24	405.41	LA River	Rio Hondo below Spreading Grounds	
25	405.15	San Gabriel River	Whittier N - Firestone	
26	405.15	San Gabriel River	Firestone Blvd-Estuary	
27	405.41	San Gabriel River	San Jose Creek	
28	405.41	LA River	Monrovia Canyon Creek	I

E Existing beneficial use

P Potential beneficial use

I Intermittent beneficial use

* Asterixed MUN designations are based on State Board Resolution No. 88-63.

c Coastal waterbodies which are also listed in Coastal Features Table 2-3 or in Wetlands Table 2-4

g Engineered channels. All references to Tidal Prisms in Regional Board documents are functionally eq

h Access prohibited by LA County DPW.

- Beneficial uses listed in the existing Basin Plan

+ Proposed changes to beneficial uses

^ Station assigned beneficial uses relative to immediate downstream reach

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ONS

NEFICIAL USES

RUN	MID	PROC	AQR	SWR	FRSH	REC1	REC2	COMM	WARM	CCLD	MAR	WILD	BIOL	RARE	MIGR	SPWN	SHELL	WET
						P	E		P			P						
						P	I		P			P						
						E	E		E	E		E			E	E		
	E	E	E	E	E	E	E		E			E						
						P	I		P			P						
						I	I		I			I						
						P	E		P			P						
						P	E		P			P						
						I	I		I			I						
				E		P	E		E			E						
						P	I		P			P						
						P	I		P			P						
				E		E	E		E			E						
				E		P	E		P			P						
				E		P	E		P			P						
						P	I		I			I						
				I		I	I		P			P						
				I		I	I		I			I		I				
I				I		I	I		I			I						

y equivalent to estuaries.

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TABLE 8
LAND USE SUMMARY

STATION	AREA (SM)	NATURAL	PERCENT LAND USE DESIGNATIONS *				OVERALL IMPERVIOUS-NESS (PERCENT)
			PARTIALLY URBANIZED	URBANIZED	INDUSTRIAL	TOTAL	
1	44.69	20	29	50	1	100	53
2	87.52	21	30	46	3	100	53
3	9.16	13	54	27	6	100	51
4	40	10	25	35	30	100	52
5	6.42	43	30	23	4	100	38
6	109.85	83	11	5	1	100	13
7	441	88	5	5	4	100	13
8	15.68	87	12	1	0	100	14
9	23.06	28	29	42	3	100	49
10	19.49	60	9	1	0	100	8
11	10	5	20	35	40	100	68
12	0.6	0	88	30	2	100	56
13	3.53	97	3	0	0	100	3
14	39	6	40	37	17	100	59
15	134	35	30	15	20	100	42
16	177	28	38	17	17	100	43
17	443	56	28	6	10	100	33
18	567	52	28	9	12	100	34
19	361	60	27	6	7	100	32
20	769	45	32	10	13	100	37
21	31	14	50	16	20	100	50
22	129	37	40	12	11	100	37
23	116	40	39	11	10	100	36
24	139	35	39	12	14	100	39
25	445.3	65	20	7	8	100	23
26	471.3	62	22	7	9	100	25
27	88.14	37	37	19	7	100	39
28	1.78	100	0	0	0	100	4

* LA County land use categories:

-Natural designation includes: open/agriculture (0% impervious-ness), light agriculture (10% impervious-ness), open space residential (4% impervious-ness), and low density residential (17% impervious-ness).

-Partially urbanized designation includes: single family residential (42% impervious-ness), duplex (42% impervious-ness), and high density residential (42% impervious-ness).

-Urbanized designation includes: multifamily residential (68-72% impervious-ness), transportation (90% impervious-ness), and commercial (86-92% impervious-ness).

Industrial designation includes: industrial (76-91% impervious-ness).

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TABLE 4 MONITORING STATION SPECIFIC OBJECTIVES ("BASIN PLAN" AND "OCEAN PLAN")

GROUP OF COMPOUNDS	COMPOUNDS	STATIONS														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Dieldrin (µg/l)					0.00004	0.00004		0.00004		0.00004			0.00004		
	Endosulfan I (µg/l)					0.027	0.027		0.027		0.027			0.027		
	Endosulfan II (µg/l)					0.027	0.027		0.027		0.027			0.027		
	Endosulfan Sulfate (µg/l)					0.027	0.027		0.027		0.027			0.027		
	Endrin (µg/l)	0.2	0.2	0.2	0.2	0.008	0.008	0.2	0.008	0.2	0.008	0.2	0.2	0.008	0.2	0.2
	Heptachlor (µg/l)	0.01	0.01	0.01	0.01	0.001	0.001	0.01	0.001	0.01	0.001	0.01	0.01	0.001	0.01	0.01
	Heptachlor Epoxide (µg/l)	0.01	0.01	0.01	0.01	0.001	0.001	0.01	0.001	0.01	0.001	0.01	0.01	0.001	0.01	0.01
	Toxaphene (µg/l)	5.00	5.00	5.00	5.00	0.00021	0.00021	5.00	0.00021	5.00	0.00021	5.00	5.00	0.00021	5.00	5.00
	PCB1016 (ng/l)					(1)	(1)		(1)		(1)			(1)		
	PCB1232 (ng/l)					(1)	(1)		(1)		(1)			(1)		
	PCB1248 (ng/l)					(1)	(1)		(1)		(1)			(1)		
	PCB1260 (ng/l)					(1)	(1)		(1)		(1)			(1)		
	PCB1221 (ng/l)					(1)	(1)		(1)		(1)			(1)		
	PCB1242 (ng/l)					(1)	(1)		(1)		(1)			(1)		
	PCB1254 (ng/l)					(1)	(1)		(1)		(1)			(1)		

(1) PCB sum(ug/l)<0.019 ng/l (30 days average)

(2) (sum of DDD DDE DDT) < 0.00017ug/l (30 days average)

(3) (sum of bromoform, bromomethane, chloromethane, chlorodibromomethane, dichlorobromomethane)<0.13 mg/l

(4) The objective is function of pH and temperature "Basin Plan" (1994 Draft) and "Ocean Plan" (1990)

Basin Plan Draft 1994 applies to station 1-4,7,9,11,12,14-20

Basin Plan 94/Ocean Plan 90 applies to station 5,6,8,10,13

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R0060967

TABLE 4 MONITORING STATION SPECIFIC OBJECTIVES ("BASIN PLAN" AND "OCEAN PLAN")

GROUP OF COMPOUNDS	COMPOUNDS	STATIONS													
		15	16	17	18	19	20	21	22	23	24	25	26	27	28
	Aldrin (µg/l)														
	Endosulfan I (µg/l)														
	Endosulfan II (µg/l)														
	Endosulfan Sulfate (µg/l)														
	Endrin (µg/l)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	Heptachlor (µg/l)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	Heptachlor Epoxide (µg/l)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	Toxaphene (µg/l)	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
	PCB1016 (ng/l)														
	PCB1232 (ng/l)														
	PCB1248 (ng/l)														
	PCB1260 (ng/l)														
	PCB1221 (ng/l)														
	PCB1242 (ng/l)														
	PCB1254 (ng/l)														

TABLE 4 MONITORING STATION SPECIFIC OBJECTIVES ("BASIN PLAN" AND "OCEAN PLAN")

GROUP OF COMPOUNDS	COMPOUNDS	STATIONS												
		16	17	18	19	20	21	22	23	24	25	26	27	28
PESTICIDES	Chlorpyrifos (µg/l)													
	Dichloroethylene (µg/l)													
	1,2 Dichloropropane (µg/l)	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100
	1,3 Dichloropropene (µg/l)													
	1,4 Dichlorobenzene (µg/l)	5	5	5	5	5	5	5	5	5	5	5	5	5
	1,1 Dichloroethane (µg/l)	5	5	5	5	5	5	5	5	5	5	5	5	5
	1,2 Dichloroethane (µg/l)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	1,1 Dichloroethene (µg/l)	6	6	6	6	6	6	6	6	6	6	6	6	6
	trans-1,2-Dichloroethene (µg/l)	10	10	10	10	10	10	10	10	10	10	10	10	10
	1,2-Dichloropropane (µg/l)	5	5	5	5	5	5	5	5	5	5	5	5	5
	cis-1,3-Dichloropropene (µg/l)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	trans-1,3-Dichloropropene (µg/l)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	Ethylbenzene (µg/l)	680	680	680	680	680	680	680	680	680	680	680	680	680
	Methylene Chloride (µg/l)	450	450	450	450	450	450	450	450	450	450	450	450	450
	1,1,2,2-Tetrachloroethane (µg/l)	1	1	1	1	1	1	1	1	1	1	1	1	1
	Tetrachloroethene (µg/l)	5	5	5	5	5	5	5	5	5	5	5	5	5
	1,2,4-Trichlorobenzene (µg/l)	32	32	32	32	32	32	32	32	32	32	32	32	32
	Trichloroethene (µg/l)	150	150	150	150	150	150	150	150	150	150	150	150	150
	1,2 Dichloroethene (µg/l)	6	6	6	6	6	6	6	6	6	6	6	6	6
	1,1 Dichloroethene (µg/l)	6	6	6	6	6	6	6	6	6	6	6	6	6
	p-Dichlorobenzene (µg/l)	5	5	5	5	5	5	5	5	5	5	5	5	5
	1,1,1 Trichloroethane (µg/l)	200	200	200	200	200	200	200	200	200	200	200	200	200
	Trichloroethene (µg/l)	5	5	5	5	5	5	5	5	5	5	5	5	5
	Vinyl Chloride (µg/l)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
	Aldrin (µg/l)	4	4	4	4	4	4	4	4	4	4	4	4	4
	Dieldrin (µg/l)													
	Alpha BHC (µg/l)													
	Beta BHC (µg/l)													
	Delta BHC (µg/l)													
	Chlordane (µg/l)													
	DDT (DDD) (µg/l)													
	DDE (µg/l)													
	pp DDT (µg/l)	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10

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TABLE 4 MONITORING STATION SPECIFIC OBJECTIVES ("BASIN PLAN" AND "OCEAN PLAN")

GROUP OF COMPOUNDS	COMPOUNDS	STATIONS															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	Chloromethane (µg/l)					(3)	(3)		(3)		(3)			(3)			
	Dibromochloromethane (µg/l)					(3)	(3)		(3)		(3)			(3)			
	1,2-Dichlorobenzene (µg/l)	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100
	1,3 Dichlorobenzene (µg/l)	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100	5,100
	1,4-Dichlorobenzene (µg/l)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	1,1-Dichloroethane (µg/l)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	1,2 Dichloroethane (µg/l)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	1,1-Dichloroethene (µg/l)	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	trans-1,2-Dichloroethene (µg/l)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
	1,2-Dichloropropane (µg/l)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	cis-1,3-Dichloropropene (µg/l)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	trans-1,3-Dichloropropene (µg/l)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	Ethyl Benzene (µg/l)	680	680	680	680	680	680	680	680	680	680	680	680	680	680	680	680
	Methylene Chloride (µg/l)	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450
	1,1,2,2-Tetrachloroethane (µg/l)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Tetrachloroethene (µg/l)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	Toluene (µg/l)					85,000	85,000		85,000		85,000			85,000			
	1,1,2-Trichloroethene (µg/l)	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
	Trichlorofluoromethane (µg/l)	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
	1,2 Dichloroethene (µg/l)	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	1,1-Dichloroethylene (µg/l)	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	p'-Dichlorobenzene (µg/l)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	1,1,1 Trichloroethane (µg/l)	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
	Trichloroethene (µg/l)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	Vinyl Chloride (µg/l)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
PESTICIDES	Aldrin (µg/l)					2.2E-05	2.2E-05		2.2E-05		2.2E-05			2.2E-05			
	Lindane (µg/l)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	Alpha BHC (µg/l)					0.12	0.12		0.12		0.12			0.12			
	Beta BHC (µg/l)					0.12	0.12		0.12		0.12			0.12			
	Delta BHC (µg/l)					0.12	0.12		0.12		0.12			0.12			
	Chlordane (µg/l)	0.10	0.10	0.10	0.10	2.3E-05	2.3E-05	0.10	0.00	0.10	2.3E-05	0.10	0.10	2.3E-05	0.10	0.10	
	pp'DDD (µg/l)					(2)	(2)		(2)		(2)			(2)			
	pp'DDE (µg/l)					(2)	(2)		(2)		(2)			(2)			
	pp'DDT (µg/l)					(2)	(2)		(2)		(2)			(2)			

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TABLE 4 MONITORING STATION SPECIFIC OBJECTIVES ("BASIN PLAN" AND "OCEAN PLAN")

GROUP OF COMPOUNDS	COMPOUNDS	STATIONS													
		15	16	17	18	19	20	21	22	23	24	25	26	27	28
	Temperature (°F)	80	80	80	80	80	80	80	80	80	80	80	80	80	80
GENERAL MINERALS	Ammonium (mg/l)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
	Chloride (mg/l)	250	250	150	150	150	150		150	150	150	150	250	150	150
	Fluoride (mg/l)	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
	Sulfate (mg/l)	500	500	300	350	300	350		300	300	350	300	500	300	300
	Boron (µg/l)	4000	4000									1000		1000	
	pH	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49
	Nitrate N (mg/l)	10	10	10	10	10	10	10	10	10	10	10	10	10	10
	Nitrite N (mg/l)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Dissolved Oxygen (mg/l)	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	Total Dissolved Solids (mg/l)	500	500	950	1500	950	1500		750	750	1500	750	500	750	950
HEAVY METALS DISSOLVED	Arsenic (µg/l)	50	50	50	50	50	50	50	50	50	50	50	50	50	50
	Barium (µg/l)	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
	Cadmium (µg/l)	10	10	10	10	10	10	10	10	10	10	10	10	10	10
	Chromium (µg/l)	50	50	50	50	50	50	50	50	50	50	50	50	50	50
	Copper (µg/l)														
	Lead (µg/l)	50	50	50	50	50	50	50	50	50	50	50	50	50	50
	Mercury (µg/l)	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	Nickel (µg/l)														
	Selenium (µg/l)	10	10	10	10	10	10	10	10	10	10	10	10	10	10
	Silver (µg/l)	50	50	50	50	50	50	50	50	50	50	50	50	50	50
	Zinc (µg/l)														
	Cyanide (mg/l)														
	MBAS (mg/l)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
	Total Coliform (MPN/100ml)						70								
	Fecal Coliform (MPN/100ml)	200	200	200	200	200		200	200	200	200	200	200	200	200
	Enterococcus (MPN/100ml)														
	Benzene (µg/l)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Bromodichloromethane (µg/l)														
	Bromoform (µg/l)														
	Bromomethane (µg/l)														
	Carbon Tetrachloride (µg/l)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
	Chlorobenzene (µg/l)	570	570	570	570	570	570	570	570	570	570	570	570	570	570
	Chloroform (µg/l)	130	130	130	130	130	130	130	130	130	130	130	130	130	130

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TABLE 4 MONITORING STATION SPECIFIC OBJECTIVES ("BASIN PLAN" AND "OCEAN PLAN")

GROUP OF COMPOUNDS	COMPOUNDS	STATIONS														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Temperature (°F)	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
GENERAL MINERALS	Ammonium (mg/l)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
	Chloride (mg/l)	250	250	250	250	250	800	100		250	250	250	250		180	250
	Fluoride (mg/l)	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
	Sulfate (mg/l)	500	500	500	500	500	500	150		500	250	500	500		350	500
	Boron (µg/l)						2000	1000			1000					4000
	pH	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49
	Nitrate-N (mg/l)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
	Nitrite-N (mg/l)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Dissolved Oxygen (mg/l)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	Total Dissolved Solids (mg/l)	500	500	500	500	500	2000	700		500	2000	500	500		1500	500
HEAVY METALS DISSOLVED	Arsenic (µg/l)	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
	Barium (µg/l)	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
	Cadmium (µg/l)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
	Chromium (µg/l)	50	50	50	50	20	20	50	20	50	20	50	50	20	50	50
	Copper (µg/l)					30	30		30		30			30		
	Lead (µg/l)	50	50	50	50	20	20	50	20	50	20	50	50	20	50	50
	Mercury (µg/l)	2	2	2	2	0.4	0.4	2	0.4	2	0.4	2	2	0.4	2	2
	Nickel (µg/l)					50	50		50		50			50		
	Selenium (µg/l)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
	Silver (µg/l)	50	50	50	50	7	7	50	7	50	7	50	50	7	50	50
	Zinc (µg/l)					200	200		200		200			200		
	Cyanide (mg/l)					10	10		10		10			10		
	MBAS (mg/l)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
	Total Coliform (MPN/100ml)					1000	70	70	1000		1000			1000		
	Fecal Coliform (MPN/100ml)	200	200	200	200	200	200		200	200	200	200	200	200	200	200
	Enterococcus (MPN/100ml)					24	24		24		24			24		
	Benzene (µg/l)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Bromodichloromethane (µg/l)					(3)	(3)		(3)		(3)			(3)		
	Bromoform (µg/l)					(3)	(3)		(3)		(3)			(3)		
	Bromomethane (µg/l)					(3)	(3)		(3)		(3)			(3)		
	Carbon Tetrachloride (µg/l)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
	Chlorobenzene (µg/l)	570	570	570	570	570	570	570	570	570	570	570	570	570	570	570
	Chloroform (µg/l)	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130

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TABLE 3 COMPARISON OF "BASIN PLAN" AND "OCEAN PLAN" OBJECTIVES TO L.A. COUNTY MONITORING

* Compounds monitored from 1987 to 1994

(1) See Table 5

(2) See Table 4

(3) Instantaneous Maximum

(4) Not to exceed limits specified in Title 17, Division 5, Chapter 4, Group 3, Article 3, Section 30269 of the California Code of Regulations

(5) Combined Radium-226 and 228 < 5 pCi/l, Gross alpha particle activity < 15pCi/l, Tritium < 20000 pCi/l, Strontium-90 < 8 pCi/l, Gross beta particle activity < 50 pCi/l, Uranium < 20 pCi/l,

(6) Average survival in undiluted effluent from any three consecutive 96-hour static or continuous flow bioassays test shall be at least 90%

(7) See Table 6

(8) See Table 7

(9) When natural turbidity is between 0 and 50 NTU increases should not exceed 20%. Where natural turbidity is greater than 50 NTU, increases shall not exceed 10%.

(10) The maximum concentration is 70 pg/l for human health protection, 14 ng/l for aquatic life protection.

(11) In waters designated as (REC1) fecal coliform concentration < 200/100ml, as (REC2) fecal coliform concentration <2000/100ml, as (SHELL) total coliformconcentration <70/100ml

(12) Sum of 4,4 DDT/ 2,4 DDT /2,4 DDE/4,4 DDE/4,4DDD/2,4 DDD/ has to be lower than 0.17ng/l (30 adys average)

(13) Sum of chlorinated biphenyls has to be lower than 0.019 ng/l

(14) 30 days average water quality objectives were used in the absence of instantaneous maximum limiting concentration as mentioned in Chapter IV (page11) of the Ocean Plan(1990)

* Compound monitored by LACFCD

R0060972

TABLE 3 COMPARISON OF "BASIN PLAN" AND "OCEAN PLAN" OBJECTIVES TO L.A. COUNTY MONITORING

Group of Compounds	Compounds	LACFCD MONITORING			OBJECTIVES		
		Storm weather	Dry weather	Method Det. Limit	Basin Plan 1994 (Draft)	Basin Plan (1992 Revised)	Ocean Plan (1999)
	dimethyl phtalate						820 mg/l(14)
	4,6-dinitro-2-methylphenol						220 ug/l(14)
	2,4-dinitrophenol						4.0 ug/l(14)
	fluoranthene						15 ug/l(14)
	hexahclorocyclopentadiene						58 ug/l(14)
	isophrone						150 mg/l(14)
	nitrobenzene						4.9 ug/l(14)
	thallium						14 ug/l(14)
	tributyltin						1.4 ng/l(14)
Carcinogens Toxics	acrylonotrile						.10 ug/l(14)
	benzidine						.069 ng/l(14)
	beryllium						33 ng/l(14)
	2-CHLOROETHYL ETHER						.045 ug/l(14)
	2-ETHYLHEXYL						3.5 ug/l(14)
	CHLOROFORM						.13 mg/l(14)
	3,3dichlorobenzidine						8.1 ng/l(14)
	dichloromethane						.45 mg/l(14)
	2,4 dinitrotoluene						2.6 ug/l(14)
	1,2 diphenyl hydrazine						.16 ug/l(14)
	hexachlorobenzene						.21 ng/l(14)
	hexachlorobutadiene						14 ug/l(14)
	hexachloroethane						2.5 ug/l(14)
	N-nitrosodimethylamines						7.3 ug/l(14)
	N nitrosodiphenylamines						2.5 ug/l(14)
	PAH's						8.8 ng/l(14)
	TCDD equivalents						.0039 pg/l(14)
	2,4,6 trichlorophenol						.29 ug/l(14)

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TABLE 3 COMPARISON OF "BASIN PLAN" AND "OCEAN PLAN" OBJECTIVES TO L.A. COUNTY MONITORING

Group of Compounds	Compounds	LACPCD MONITORING			OBJECTIVES		
		Storm weather	Dry weather	Method Det. Limit	Basin Plan 1994 (Draft)	Basin Plan (1992 Revised)	Ocean Plan (1990)
PCB	PCB1016 (µg/l)	•	•	<0.5	(10)		(13)
	PCB1232 (µg/l)	•	•	<0.5	(10)		(13)
	PCB1248 (µg/l)	•	•	<0.5	(10)		(13)
	PCB1260 (µg/l)	•	•	<0.5	(10)		(13)
	PCB1221 (µg/l)	•	•	<0.5	(10)		(13)
	PCB1242 (µg/l)	•	•	<0.5	(10)		(13)
	PCB1254 (µg/l)	•	•	<1.0	(10)		(13)
Synthetics	Atrazine				.003 mg/L		
	Bentazon				.018 mg/L		
	Carbofuran				.018 mg/L		
	1,2 Dibromo-3-chloropropane				.0002 mg/L		
	di(2-ethylexyl)phtalate				.0004 mg/L		
	Ethylene dibromide				.00002 mg/L		
	Glyphosphate				.7 mg/L		
	Molinate				.02 mg/l		
	Simazine				.010 mg/l		
	Thiobencarb				.07 mg/L		
	1,1,2 Trichloro-1,2,2 trifluoroethane				1.2 mg/L		
	Xylenes				1.750 mg/L		
	Metoxychlor(ug/l)				.1 mg/L	100	
	2,4 D				.1 mg/L	0.1 mg/l	
	2,4,5-TP Silvex				01 mg/L	0.01 mg/l	
Toxics	Non chlorinated phenolic comp						300 ug/l(14)
	Chlorinated phenolic com						10 ug/l(14)
	alpha,beta,gama isomers of hexachlorocyclohexadiononones						6 ng/l(14)
Non carcinogen	acrolein						220 ug/l(14)
Toxics	antimony						1.2 mg/l(14)
	2-CHLOROETOXY METHANE						4.4 ug/l(14)
	2-chloroisopropyl ether						1.2 mg/l(14)
	chromium(III)						190 mg/l(14)
	di n butyl phtalate						3.5 mg/l(14)
	diethyl phtalate						33 mg/l(14)

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TABLE 3 COMPARISON OF "BASIN PLAN" AND "OCEAN PLAN" OBJECTIVES TO L.A. COUNTY MONITORING

Group of Compounds	Compounds	LACFCD MONITORING			OBJECTIVES		
		Storm weather	Dry weather	Method Det. Limit	Basin Plan 1994 (Draft)	Basin Plan (1992 Revised)	Ocean Plan (1990)
	Ethyl Benzene (µg/l)	•		<1.0	680.00		4100(14)
	Methylene Chloride (µg/l)	•		<1.0	450		
	1,1,2,2-Tetrachloroethane (µg/l)	•		<0.5	1.00		1200(14)
	Tetrachloroethene (µg/l)	•		<0.5	5.00		
	Toluene (µg/l)	•		<1.0			85000(14)
	1,1,2-Trichloroethane (µg/l)	•		<1.0	32.00		43000(14)
	Trichlorofluoromethane (µg/l)	•		<1.0	150.00		
	1,2 Dichloroethene (µg/l)	•	•		6.00		
	1,1-Dichloroethylene (µg/l)	•	•		6.00		
	p'-Dichlorobenzene (µg/l)	•	•		5.00		
	1,1,1 Trichloroethane (µg/l)	•	•	<1.0	200.00		540000(14)
	Trichloroethene (µg/l)	•	•	<0.5	5.00		
	Vinyl Chloride (µg/l)	•	•	<0.5	0.50		
Pesticides	Aldrin (µg/l)	•	•	<0.05			0.000022(14)
	Lindane (µg/l)	•	•	<0.05	4.00	4	
	Alpha-BHC (µg/l)	•	•	<0.05			
	Beta-BHC (µg/l)	•	•	<0.05			
	Delta-BHC (µg/l)	•	•	<0.05			
	Chlordane (µg/l)	•	•	<0.05	0.10		0.000023(14)
	pp'DDD (µg/l)	•	•	<0.10			(12)
	pp'DDE (µg/l)	•	•	<0.10			(12)
	pp'DDT (µg/l)	•	•	<0.10			(12)
	Dieldrin (µg/l)	•	•	<0.10			0.00004(14)
	Endosulfan I (µg/l)	•	•	<0.10			
	Endosulfan II (µg/l)	•	•	<0.10			
	Endosulfan Sulfate (µg/l)	•	•	<0.10			
	Endrin (µg/l)	•	•	<0.10	0.20	0.2	
	Heptachlor (µg/l)	•	•	<0.05	0.01		0.00072(14)
	Heptachlor Epoxide (µg/l)	•	•	<0.05	0.01		
	Toxaphene (µg/l)	•	•	<1.0	5.00	5	
	Endrin Aldehyde	•					

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TABLE 3 COMPARISON OF "BASIN PLAN" AND "OCEAN PLAN" OBJECTIVES TO L.A. COUNTY MONITORING

Group of Compounds	Compounds	LACFCD MONITORING			OBJECTIVES		
		Storm weather	Dry weather	Method Det. Limit	Basin Plan 1994 (Draft)	Basin Plan (1992 Revised)	Ocean Plan (1990)
	Silica (mg/l)	•					
	chronic toxicity						1TUc(14)
	Toxicity				(6)		
	acute toxicity						
	total chlorine residual				0.1 mg/l		60 ug/l(3)
	Turbidity (NTU)	•			(9)	(9)	
	MBAS (mg/l)	•			0.5		
Bacteria	Total Coliform (MPN/100ml)	•	•	<20	Station Specific(2)	Station Specific(11)	Station Specific(2)
	Fecal Coliform (MPN/100ml)	•	•	<20	Station Specific(2)	Station Specific(11)	200/100ml
	KF Strepococcus ((MPN/100ml)	•	•	<20			
	Fecal Enterococcus (MPN/100ml)	•	•	<20		Station Specific(11)	24/100ml
Purgeable Organics	Benzene (µg/l)	•	•	<0.5	1.00		5.9(14)
Volatiles	Bromodichloromethane (µg/l)	•		<0.5	130.00		
	Bromoform (µg/l)	•		<0.5			
	Bromomethane (µg/l)	•		<0.5			
	Carbon Tetrachloride (µg/l)	•	•	<0.5	0.50		0.9(14)
	Chlorobenzene (µg/l)	•		<0.5	570.00		570(14)
	Chloroethane (µg/l)	•		<0.5			
	2-Chloroethylvinyl ether (µg/l)	•		<1.0			
	Chloroform (µg/l)	•		<0.5	130.00		
	Chloromethane (µg/l)	•		<0.5			
	Dibromochloromethane (µg/l)	•		<0.5			
	1,2-Dichlorobenzene (µg/l)	•		<0.5	5,100.00		5100(14)
	1,3-Dichlorobenzene (µg/l)	•		<0.5	5,100.00		5100(14)
	1,4-Dichlorobenzene (µg/l)	•		<0.5	5.00		18(14)
	Dichlorodifluoromethane (µg/l)	•		<0.5			
	1,1-Dichloroethane (µg/l)	•		<0.5	5.00		
	1,2-Dichloroethane (µg/l)	•		<0.5	0.50		130(14)
	1,1-Dichloroethene (µg/l)	•		<0.5	6.00		
	trans-1,2-Dichloroethene (µg/l)	•		<0.5	10.00		
	1,2-Dichloropropane (µg/l)	•		<0.5	5.00		
	cis-1,3-Dichloropropene (µg/l)	•		<0.5	0.50		8.9(14)
	trans-1,3-Dichloropropene (µg/l)	•		<0.5	0.50		8.9(14)

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TABLE 3 COMPARISON OF "BASIN PLAN" AND "OCEAN PLAN" OBJECTIVES TO L.A. COUNTY MONITORING

Group of Compounds	Compounds	LACFCD MONITORING			OBJECTIVES		
		Storm weather	Dry weather	Method Det. Limit	Basin Plan 1994 (Draft)	Basin Plan (1992 Revised)	Ocean Plan (1988)
	Nickel (µg/l)	•		<10			
	Selenium (µg/l)	•		<5			
	Silver (µg/l)	•		<10			
	Zinc (µg/l)	•		<50			
	Iron (µg/l)	•		<100			
	Lithium (µg/l)	•					
	Manganese (µg/l)	•		<30			
Heavy Metals	Arsenic (µg/l)	•	•	<10	50	50	80(3)
(Dissolved)	Barium (µg/l)	•	•	<100	1000	1000	
	Aluminium(mg/l)				1		
	Cadmium (µg/l)	•	•	<10	10	10	10(3)
	Chromium IV (µg/l)	•	•	<10			
	Chromium (µg/l)	•	•	<10	50	50	20(3)
	Copper (µg/l)	•	•	<10			30(3)
	Lead (µg/l)	•	•	<10	50.000	50	20(3)
	Mercury (µg/l)	•	•	<1	2.000	2	0.4(3)
	Nickel (µg/l)	•	•	<10			50(3)
	Selenium (µg/l)	•	•	<5	10	10	150(3)
	Silver (µg/l)	•	•	<10	50	50	7(3)
	Zinc (µg/l)	•	•	<50			200(3)
	Iron (µg/l)	•		<100			
	Manganese (µg/l)	•		<30			
Miscellaneous	Total Petroleum Hydrocarbons (mg/l)	•	•	<1			
	Oil & Grease (mg/l)	•	•	<1			
	Total Organic Carbon (mg/l)	•	•	<1			
	Biochemical Oxygen Demand (mg/l)	•	•	<2			
	Cyanide (mg/l)	•	•				10(3)
	Organic Nitrogen (mg/l)	•					
	Dissolved oxygen (mg/l)	•			5mg/l	5mg/l	
	Chemical Oxygen Demand (mg/l)	•					
	Radioactive substances				(5)	(5)	(4)
	Phenol (mg/l)	•					

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TABLE 3 COMPARISON OF "BASIN PLAN" AND "OCEAN PLAN" OBJECTIVES TO L.A. COUNTY MONITORING

Group of Compounds	Compounds	LACFCD MONITORING			OBJECTIVES		
		Storm weather	Dry weather	Method Det. Limit	Basin Plan 1994 (Draft)	Basin Plan (1992 Revised)	Ocean Plan (1990)
	Temperature (°F)	•	•		T<80F		
General Minerals	Ammonium (mg/l)	•	•	<0.1	Station Specific(1)		[NH3]-N < 6 mg/l (3)
	SAR	•	•		Station Specific(2)		
	Calcium (mg/l)	•	•	<2			
	Magnesium (mg/l)	•	•	<2			
	Potassium (mg/l)	•	•	<0.001			
	Sodium (mg/l)	•	•	<0.005			
	Chloride (mg/l)	•	•	<2	Station Specific(2)	Station Specific(8)	
	Fluoride (mg/l)	•	•	<0.1	(7)	(7)	
	Sulfate (mg/l)	•	•	<2	Station Specific(2)	Station Specific(8)	
	Alkalinity (mg/l)	•	•	<2			
	Total Hardness (mg/l)	•	•	<2			
	Iron (µg/l)	•	•	<100			
	Manganese (µg/l)	•	•	<30			
	Phosphate-P (mg/l)	•	•	<50			
	Boron (µg/l)	•	•	<250	Station Specific(2)		
	pH	•	•	0-14	6.5<pH<8.5	6.5<pH<8.5	
	Nitrate-N (mg/l)	•	•	<0.03	10 000	(as NO3) 45	
	Nitrite-N (mg/l)	•	•	<0.03	1.00		
	Specific Conductivity (uhmo/cm)	•	•	<1			
	Total Dissolved Solids (mg/l)	•	•	<2	Station Specific(2)	Station Specific(8)	
	settleable solids						
	Total Suspended Solids (mg/l)	•		<2			
	Volatile Suspended Solids (mg/l)	•		<2			
Heavy Metals (Totals)	Arsenic (µg/l)	•		<10			
	Barium (µg/l)	•		<100			
	Cadmium (µg/l)	•		<10			
	Chromium (VI) (µg/l)	•		<10			
	Chromium (µg/l)	•		<10			
	Copper (µg/l)	•		<10			
	Lead (µg/l)	•		<10			
	Mercury (µg/l)	•		<1			

TABLE 6 DRY WEATHER MONITORING
TOTAL NUMBER OF NON- COMPLIANCE
FOR COMPOUNDS EXCEEDING WATER QUALITY
OBJECTIVES (DRAFT 1994"BASIN PLAN" AND 1990 "OCEAN PLAN")

STATIONS	1	2	3	4	5	6	7	8	9	10	11
NUMBER OF SAMPLES TAKEN	68	68	68	67	59	60	65	65	65	64	66
COMPOUNDS											
Temperature (°F)	0	1	2	1	1	0	0	0	0	0	1
Ammonium *(mg/l)	0	1	0	0	1	0	1	0	1	0	1
Chloride (mg/l)	6	0	8	17	24	0	43	0	48	0	23
Flouride (mg/l)	1	0	0	2	7	0	1	0	13	1	2
Sulfate (mg/l)	0	0	0	5	5	36	61	0	12	63	0
Boron(ug/l)						0	4				
pH	6	21	13	26	2	5	0	6	10	10	13
Nitrate-N (mg/l)	1	0	1	0	1	6	1	0	0	0	0
Nitrite-N (mg/l)	2	2	0	0	3	0	9	0	4	0	0
Total Dissolved Solids (mg/l)	66	68	47	60	57	0	15	0	65	0	61
Arsenic (µg/l)	0	1	0	0	1	0	0	0	1	0	0
Barium (µg/l)	0	0	1	0	0	0	0	0	0	0	0
Cadmium (µg/l)	1	2	0	1	3	3	1	3	3	2	0
Chromium (µg/l)	0	1	0	1	4	1	0	0	2	0	1
Lead (µg/l)	3	1	3	5	19	4	2	7	10	6	2
Copper (ug/l)					4	2		2		2	
Mercury (µg/l)	0	0	0	0	0	0	0	2	0	0	0
Selenium (µg/l)	1	1	0	2	0	1	1	0	3	0	1
Silver (µg/l)	0	0	0	0	1	0	0	0	0	0	0
Total Coliform (MPN/100ml)					0	57	58	0		0	
Fecal Coliform (MPN/100ml)	62	62	58	54	52	0		57	59	8	59
Fecal Enterococcus (MPN/100ml)					4	41		48		34	
SAR	0	0	0	0		0	45	0	0	0	0

* Water Quality Objectives in the Basin (Draft 1994) and Ocean (1990) Plan were given in terms of ammonia NH3 (mg/l NH3) and Total Ammonia (mg/l NH3) and were converted to Ammonium (NH4-N) mg/l for comparison with LA County monitoring data using the following formulas:

[NH4](mg/l) = [Total Amonia](mg/l)-[NH3](mg/l)

NH4-N (mg/l) = (14/18)[NH4] (mg/l)

(Molecular Weight of N = 14 g/mol and Molecular Weight of NH4 = 18g/mol)

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11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	TOTALS
66	65	63	48	65	56	66	66	66	65	65	59	62	52	46	65	65	66	1765
1	1	0	3	0	3	0	6	1	2	4	0	0	8	0	4	0	0	38
1	1	0	1	1	40	27	41	42	35	0	14	22	1	19	49	11	1	310
23	12	0	2	6	3	14	18	20	16	0	1	1	21	0	1	14	1	299
2	1	1	0	0	0	0	0	2	1	0	0	0	1	0	0	0	0	33
0	10	0	0	3	2	4	0	7	0	0	0	0	4	0	0	22	0	234
				0	0									1		1		6
13	4	2	13	5	2	1	24	1	29	17	3	1	17	2	3	6	4	246
0	0	0	0	0	4	11	4	9	1	1	3	4	0	1	11	2	0	61
0	4	0	1	3	33	28	32	25	35	1	7	15	1	14	46	10	1	276
1	48	0	0	63	66	1	0	5	0	0	0	0	2	1	64	49	0	736
0		0	0	1	1	1	2	1	0	0	0	0	1	0	0	0	0	10
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	1	2	1	26
	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0	14
2	6	0	6	4	3	3	3	3	4	4	2	1	4	2	2	4	0	113
		1																11
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	4	0	0	2	1	0	1	0	0	1	0	1	1	1	1	2	0	25
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2
		0							45									160
0	55	4	39	55	57	59	52	58		51	49	34	37	21	48	58	4	1152
		30																157
	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	45

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TABLE 7 STORM WEATHER MONITORING
TOTAL NUMBER OF NON-COMPLIANCE
FOR COMPOUNDS EXCEEDING WATER QUALITY OBJECTIVES
(DRAFT 1994 "BASIN PLAN" AND 1990 "OCEAN PLAN")

STATIONS	2	3	4	5	6	7	8	10
NUMBER OF SAMPLES TAKEN	20	18	20	22	16	15	18	15
COMPOUNDS								
Ammonium-N* (mg/l)	0	1	0	0	0	0	0	0
Chloride (mg/l)	0	2	0	2	0	0	0	1
Sulfate (mg/l)	0	0	0	0	3	4	0	8
pH	6	4	5	3	1	0	0	0
Nitrate-N (mg/l)	0	0	0	0	1	1	0	0
Nitrite-N (mg/l)	0	0	0	0	0	1	0	0
Total Dissolved Solids	1	2	0	3	0	0	0	0
Zinc(ug/l)				2	0		0	0
Copper (ug/l)				1	0		1	0
Lead (µg/l)	1	1	2	0	0	1	0	1
Total Coliform(MPN/100ml)				22	16	15	17	14
Fecal Coliform (MPN/100 ml)	19	16	20	21	14		17	13
Fecal Enterococcus (MPN/100ml)				14	11		14	13
Benzene (µg/l)	1	0	1	0	0	0	0	0
Tetrachloroethene (µg/l)	0	1	0	0	0	0	0	0
1,1,1-Trichloroethane (µg/l)	0	0	0	0	0	0	0	0
1,1-Dichloroethene (µg/l)	0	0	0	0	0	0	0	0

* Water Quality Objectives in the Basin (Draft 1994) and Ocean (1990) Plan were given in terms of ammonia NH3 (mg/l NH3) and Total Ammonia (mg/l NH3) and were converted to ammonium (NH4-N) mg/l for comparison with LA County monitoring data using the following formulas:

(NH4)(mg/l) = [Total Amonia](mg/l)-[NH3](mg/l)

NH4-N (mg/l) = (14/18)[NH4] (mg/l)

(Molecular Weight of N = 14 g/mol and Molecular Weight of NH4 = 18g/mol)

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10	11	12	13	16	18	20	21	22	24	25	26	27	28	TOTAL
15	20	18	11	17	20	20	16	19	17	21	16	19	18	376
0	0	0	0	0	0	0	0	1	0	1	1	0	0	4
1	0	0	0	0	0	0	0	0	0	0	0	0	0	5
8	0	0	0	0	0	0	0	0	0	0	0	0	0	15
0	4	5	0	0	3	2	6	2	4	3	0	0	1	49
0	0	0	0	0	0	0	0	0	0	1	0	0	0	3
0	0	0	0	3	1	1	0	0	0	1	5	0	0	12
0	0	0	0	4	0	0	0	0	0	0	4	0	0	14
0			0											2
0			0											2
1	0	0	0	0	0	1	0	1	1	1	0	0	0	10
14			8			20								112
13	19	18	10	16	20		17	20	19	20	15	18	8	320
13			8											60
0	0	0	0	0	0	0	0	2	0	0	0	0	0	4
0	0	0	0	1	0	0	1	0	0	0	0	0	0	3
0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
0	1	0	0	0	0	0	0	0	0	0	0	0	0	1

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TABLE 8 DRY WEATHER MONITORING
AVERAGE AND MAXIMUM COMPOUND CONCENTRATION

BASIN	STATION	COMPOUNDS													
		Ammonium (mg/l)		Chloride (mg/l)		Sulfate (mg/l)		pH		Nitrate-N (mg/l)		Nitrite-N (mg/l)		Total Dissolved Solids	
		Av.	Max.	Av.	Max.	Av.	Max.	Av.	Max.	Av.	Max.	Av.	Max.	Av.	Max.
5 North	7	1.81	6.36	103	137	205	513	7.88	8.39	4.83	10.86	0.46	6.40	753	1,136
1	13	0.06	1.66	72	143	474	1,280	7.86	8.44	0.33	5.45	0.00	0.03	1,072	2,518
	6	0.03	0.85	139	186	537	785	8.13	8.88	4.86	11.01	0.01	0.11	1,201	1,583
	10	0.02	0.4	107	167	407	697	8.18	851.00	0.44	4.34	0.01	0.14	1,034	1,800
	8	0.07	1	109	169	306	512	8.23	8.86	3.20	9.11	0.03	0.34	907	1,254
	5	0.56	3.76	1,156	10,403	293	1,744	8.01	8.90	1.84	13.31	0.12	2.60	2,597	20,024
	1	0.15	1.22	155	307	306	467	8.20	8.79	3.11	10.80	0.12	1.56	1,010	1,452
	2	0.15	3.66	122	210	201	386	8.33	8.10	1.28	4.40	0.06	1.17	757	1,027
	9	0.27	3.87	1,311	4,776	360	764	8.24	8.75	3.22	9.12	0.19	5.17	2,965	7,800
	3	0.17	2.4	157	762	121	304	8.09	9.63	8.21	393.00	0.03	0.80	806	1,187
2	19	13.49	42.4	134	221	203	483	7.86	8.53	4.29	16.02	1.06	7.68	683	1,104
	17	10.07	36.3	128	226	183	370	7.88	8.54	6.03	17.81	1.14	8.70	669	972
4	18	8.23	25.7	129	184	186	330	8.32	9.40	4.43	11.68	1.20	8.33	669	912
	22	8.56	22.1	84	178	140	297	7.86	9.00	2.29	14.50	0.44	3.70	506	665
	24	0.36	2.25	181	559	201	483	8.23	9.66	0.47	3.80	0.13	4.60	765	2,020
	14	0.87	14.7	105	620	122	283	8.27	9.88	0.34	8.15	0.06	1.45	545	1,386
	20	3.42	9.74	133	205	188	307	8.43	10.20	3.74	10.80	1.33	7.41	696	926
	4	0.27	8.22	719	13,674	208	1,822	8.28	9.70	0.87	6.16	0.03	0.38	1,665	20,758
	11	0.20	4.66	223	373	103	321	8.20	9.30	0.23	3.57	0.03	0.66	793	1,174
	12	0.82	15	169	398	289	667	7.63	9.81	0.65	7.10	0.20	3.04	868.00	1,750
3	28	0.12	5.2	141	8,720	30	208	8.17	8.82	1.36	8.12	0.13	7.78	279	838
	23	8.33	27.1	72	152	128	252	7.87	9.60	2.33	17.67	0.89	7.40	483	653
	27	2.81	23.6	130	292	282	435	8.03	8.90	2.63	12.10	0.52	5.13	638	1,120
6 South	29	7.03	21.3	102	180	146	243	7.79	8.80	3.01	12.06	1.39	10.00	581	760
	26	12.54	25.7	164	291	172	450	7.85	8.89	4.61	19.84	2.36	12.00	764	1,456
	16	0.42	12.3	194	401	289	582	8.07	8.78	2.31	9.87	0.26	4.55	967	1,566
	15	12.43	39	163	369	230	577	7.81	8.70	2.72	15.46	1.76	11.50	884	1,922
	21	0.29	1.8	153	1,276	136	327	8.19	9.89	8.52	16.02	0.06	2.30	881	2,456

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TABLE 8 DRY WEATHER MONITORING
AVERAGE AND MAXIMUM COMPOUND CONCENTRATION

BASIN	STATION	COMPOUNDS											
		Arsenic (µg/l)		Barium (µg/l)		Cadmium (µg/l)		Chromium (µg/l)		Lead (µg/l)		Total Coliform	
		Av.	Max.	Av.	Max.	Av.	Max.	Av.	Max.	Av.	Max.	Av.	Max.
5 North	7	0.34	12.80	50	260	0.17	11.00	0.15	10.00	6	100	9,840	
1	13			191	382							1,090	9,000
	6	2.03	32.00	42	540	1.03	20.00	1.67	50.00	10	300	4,851	93000
	10	0.48	23.00	60	246	0.63	20.00	0.31	20.00	11	230	1,882	17000
	9	1.29	40.00	47	286	0.94	20.00	0.31	20.00	10	240	20,844	43000
	5	4.64	112.00	63	420	3.90	110.00	3.22	90.00	41	460	68,224	750000
	1	1.38	16.00	81	225	0.74	20.00	0.29	20.00	10	180	23,105	160000
	2	2.44	80.00	46	230	0.74	30.00	1.76	60.00	6	260	163,123	9300000
	9	7.32	62.00	108	449	2.09	70.00	2.88	64.00	28	280	30,474	430000
	3	3.07	24.00	72	1,200	0.15	10.00	0.44	20.00	6	140	51,084	490000
2	19	6.53	71.00	20	156	0.15	10.00	1.52	30.00	9	120	19,144	230000
	17	4.21	69.00	30	280			0.45	10.00	8	140	10,858	110000
4	18	6.83	190.00	36	290			1.82	70.00	5	80	85,207	930000
	22	0.59	11.00	48	430	0.17	10.00	0.88	20.00	4	80	12,412	170000
	24	3.04	87.00	60	180	0.19	10.00	1.70	30.00	12	110	24,177	230000
	14	1.35	28.00	64	240	0.21	10.00	1.67	40.00	17	200	80,302	790000
	20	4.18	37.00	43	630	1.11	42.00	0.92	20.00	6	120	21,750	330000
	4	0.62	6.00	76	274	0.30	20.00	2.03	106.00	13	290	35,469	330000
	11	4.80	35.00	83	300	0.15	10.00	3.82	210.00	8	80	305,363	9300000
	12	2	21.00	82.36	460	1	13.00	2.03	60.00	17.36	280	29,872	790000
3	26	0.44	11.00	49	182	0.56	18.00	0.76	10.00	2	40	1,026	16000
	23	1.15	44.00	41	275	0.32	20.00	0.85	20.00	2	70	10,646	160000
	27	0.54	11.00	57	228	1.06	30.00	3.38	150.00	10	170	26,101	330000
6 South	25	1.00	22.00	43	166	0.22	10.00	0.43	10.00	7	110	6,492	63000
	28	1.26	22.00	34	202	0.31	20.00	0.77	20.00	6	100	11,638	130000
	15	1.88	74.00	68	360	0.31	10.00	1.89	30.00	13	310	125,910	2300000
	16	2.86	61.00	64	800	0.15	10.00	2.89	80.00	7	150	36,429	430,000
	21	3.16	38.00	82	274	0.15	10.00	0.81	20.00	8	80	25,902	330,000

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TABLE 8 DRY WEATHER MONITORING
AVERAGE AND MAXIMUM COMPOUND CONCENTRATION

BASIN	STATION	COMPOUNDS			
		Fecal Coliform		Enterococcus	
		Av.	Max.	Av.	Max.
5 North	7	889	160,000	855	5,000
1	13	99	790	355	4,600
	6	637	14,000	470	2,800
	10	126	1,300	331	5,000
	8	2,169	16,000	2,324	16,000
	5	12,674	130,000	5,478	22,000
	1	6,070	160,000	3,031	16,000
	2	8,707	150,000	1,186	16,000
	9	3,990	43,000	1,700	11,000
	3	7,931	160,000	2,170	28,000
2	19	6,996	90,000	1,631	17,000
	17	2,247	24,000	788	9,000
4	18	10060	230,000		
	22	3,415	90,000	485	3,300
	24	3,196	23,000	1,091	5,000
	14	14,387	130,000	2,689	17,000
	20	8,611	93,000	1,209	11,000
	4	6,595	49,000	3,639	90,000
	11	53,667	930,000	3,401	24,000
	12	5,467	33,000	2,144	16,000
3	28	47	300	432	8,000
	23	990	16,000	1,327	22,000
	27	5,402	160,000	3,290	50,000
5 South	25	5,073	13,000	371	2,400
	26	1,141	13,000	523	7,000
	15	21,655	170,000	4,218	50,000
	16	10,667	240,000	859	7,800
	21	6,120	170,000	2,561	16,000

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TABLE 9 STORM WEATHER MONITORING
AVERAGE AND MAXIMUM COMPOUND CONCENTRATION

BASIN	STATION	COMPOUNDS											
		Ammonium-N (mg/l)		Chloride (mg/l)		Sulfate (mg/l)		pH		Nitrite-N (mg/l)		Total Dissolved Solids	
		Av.	Max.	Av.	Max.	Av.	Max.	Av.	Max.	Av.	Max.	Av.	Max.
5 north	7	1.08		34.40	96.90	119.57	368.00	7.49	8.06	0.15	1.16	365.20	744.00
1	13	0.09		46.15	100.00	319.63	925.00	7.75	8.22	0.03	0.10	692.36	1,600.00
	6	0.15		105.66	216.00	428.68	1,015.00	7.79	8.74	0.01	0.06	932.75	1,622.00
	10	1.08		76.42	252.00	263.77	533.00	7.78	8.35	0.03	0.15	665.27	1,376.00
	8	0.30		36.62	136.00	107.75	314.00	7.40	8.28	0.06	0.23	331.50	900.00
	5	0.51	1.05	77.88	639.00	30.38	144.00	6.93	7.85	0.14	0.2	241.00	1,240.00
	2	0.73		12.36	78.40	16.41	166.00	6.73	8.23	0.12	0.26	90.75	644.00
	3	1.66		114.57	18.87	22.98	1,369.00	6.66	106.00	0.07	7.72	299.61	0.20
4	18	1.55		20.17	95.60	35.83	111.00	6.87	7.42	0.17	1.52	161.85	508.00
	22	1.55	10.00	19.29	69.00	40.78	132.00	7.06	7.80	0.13	0.84	168.38	500.00
	24	0.65		6.73	13.70	14.84	36.10	6.77	7.57	0.11	0.24	82.53	160.00
	20	1.71		25.39	78.60	41.96	140.10	7.09	8.10	0.12	1.04	188.75	530.00
	4	0.73		12.36	40.00	16.41	40.00	6.73	7.50	0.12	0.22	90.75	184.00
	11	1.70		17.70	37.60	25.20	92.10	6.75	7.84	0.12	0.36	129.25	216.00
	12	0.62		25.60	160.00	40.71	229.00	6.80	7.20	0.12	0.44	161.89	884.00
3	26	0.37		6.82	8.79	21.29	46.10	51.97	801.00	0.02	0.10	226.94	340.00
	27	1.09		18.79	51.60	48.06	117.00	7.28	7.76	0.14	0.70	183.00	382.00
5 South	25	2.26	9.90	45.26	106.00	71.11	139.00	7.40	8.00	0.19	1.06	301.71	620.00
	28	5.72	18.40	70.77	170.00	79.11	165.00	7.32	7.76	0.92	4.64	356.31	708.00
	16	5.57		57.32	143.00	78.56	195.00	7.35	8.14	0.55	2.72	344.94	732.00
	21	0.69		10.27	34.70	12.03	41.40	6.58	7.13	0.12	0.21	85.72	356.00

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TABLE 9 STORM WEATHER MONITORING
AVERAGE AND MAXIMUM COMPOUND CONCENTRATION

BASIN	STATION	COMPOUNDS									
		Lead (µg/l)		Total Coliform		Fecal Coliform		Fecal Enterococcus		Benzene (µg/l)	
		Av.	Max.	Av.	Max.	Av.	Max.	Av.	Max.	Av.	Max.
5 north	7	8.01	60								
1	13			8,736	17,000	5,497	160,000	6,622	22,000		
	6	11.31	170	15,456	75,000	9,196	43,000	160,000	160,000		
	10	5.33	70	37,242	130,000	130,000	160,000	23,313	160,000		
	9	1.11	10	340,794	4300000	27,891	140,000	28,024	30,000		
	8	1.78	20	1264545	23000000	77,181	500,000	74,833	500,000		
	2	14.47	70			50,505	240,000			0.10	1.5
	3	11.70	2,574			43,822	240,000				
4	18	6.99	40			163,968	1600000				
	22	9.02	90			75,466	540,000			0.12	1.2
	24	16.24	240			33,195	220,000				
	20	10.06	60								
	4	14.47	80			58,665	500,000				
	11	10.00	40			34,395	240,000				
	12	7.78	80			36,227	240,000				
3	28					4,560	70,000				
	27	3.53	40			288,128	5100000				
5 South	25	4.01	60			39,163	220000				
	29	3.75	30			26,819	300000				
	16	2.35	40			66,501	350000				
	21	7.02	60			167,128	2000000				

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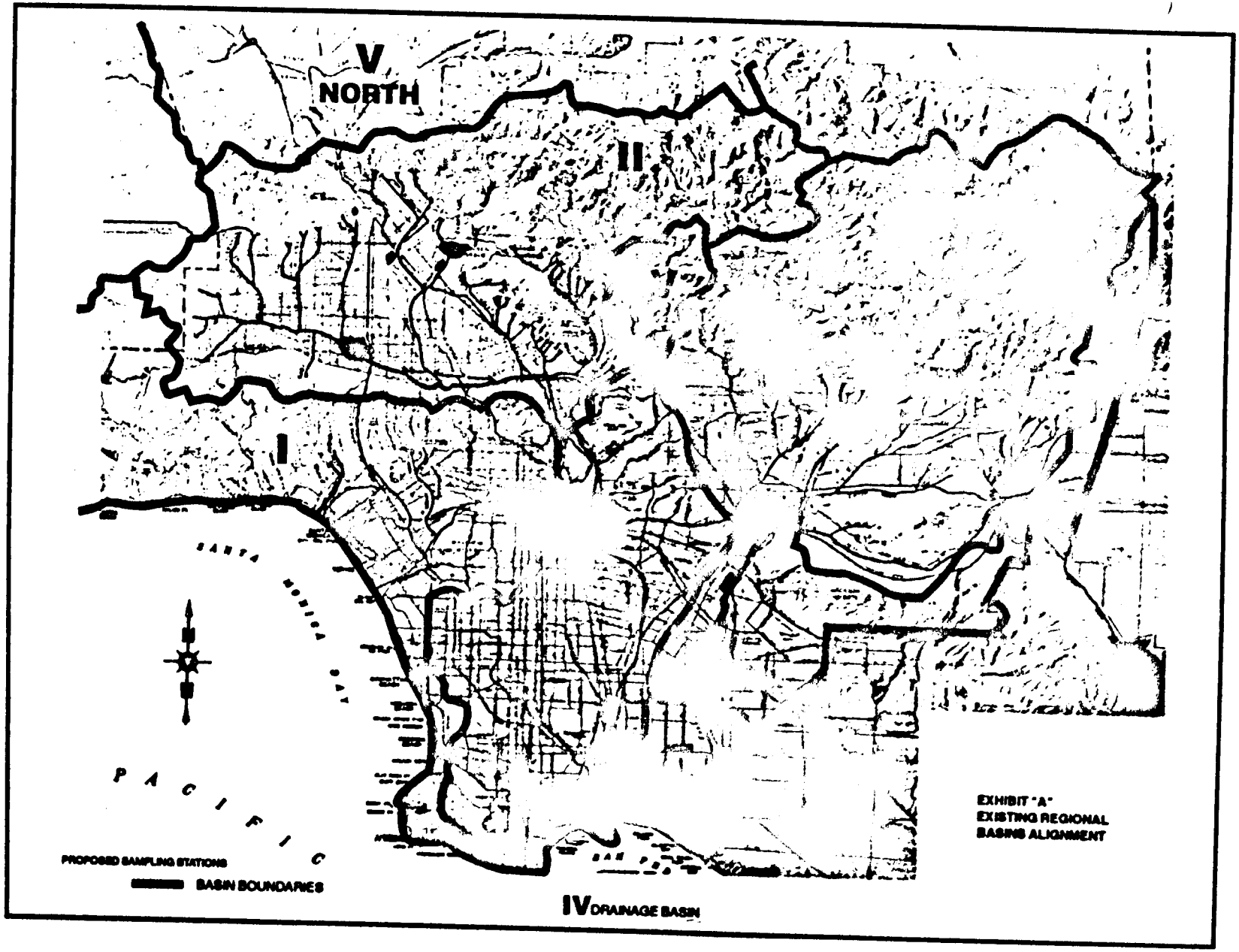

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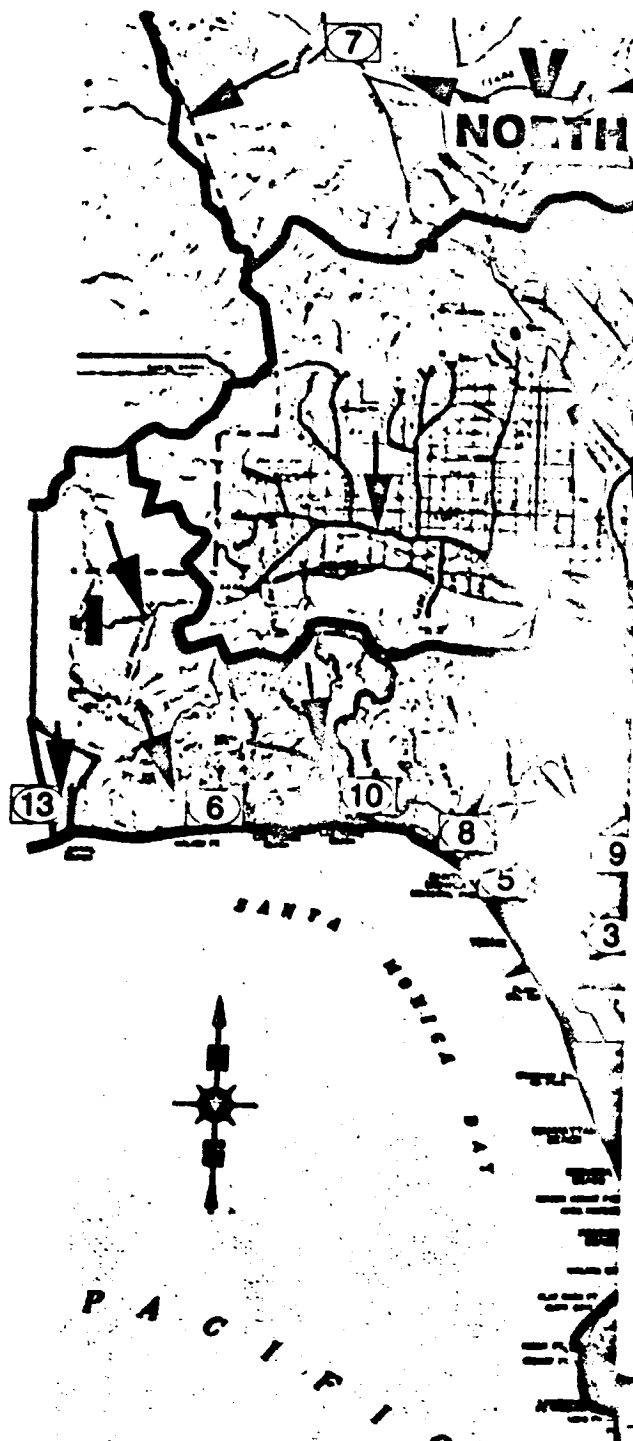
LEGEND

NO.	STATION
1	Ballona Creek @ Fairfax Avenue
2	Ballona Creek @ Sawtelle Boulevard
3	Centinela Creek @ Centinela Boulevard
4	Dominguez Channel @ Vermont Avenue
5	Kenter Drain @ Pico Boulevard
6	Malibu Creek @ Cross Creek Road
7	Santa Clara River @ The Old Road
8	Santa Monica Canyon Channel @ Short Street
9	Sepulveda Channel @ Culver Boulevard
10	Topanga Canyon @ Pacific Coast Highway
11	Torrance Lateral @ Main Street
12	Wilmington Drain @ Pacific Coast Highway
13	Corral Canyon Creek @ Pacific Coast Highway
14	Compton Creek @ Greenleaf Boulevard
15	Coyote Creek @ Orangethorpe Boulevard
16	Coyote Creek @ Willow Street
17	Los Angeles River @ Arroyo Seco
18	Los Angeles River & Firestone Boulevard
19	Los Angeles River @ Tujung
20	Los Angeles @ Wardlow Road
21	Los Cerritos Channel @ Stearns
22	Rio Hondo Channel @ Rio Hondo Spreading Grounds
23	Rio Hondo Channel @ San Gabriel Boulevard
24	Rio Hondo Channel @ Steward & Gray
25	San Gabriel River @ San Gabriel Spreading Grounds
26	San Gabriel River @ Willow Street
27	San Jose Creek @ Workman Mill Road
28	Monrovia Creek above Sawpit Creek



SAMPLING STATIONS

1	DRY WEATHER SAMPLES
2	STORM AND DRY WEATHER SAMPLES

BASIN BOUNDARIES

SUB

R0060989

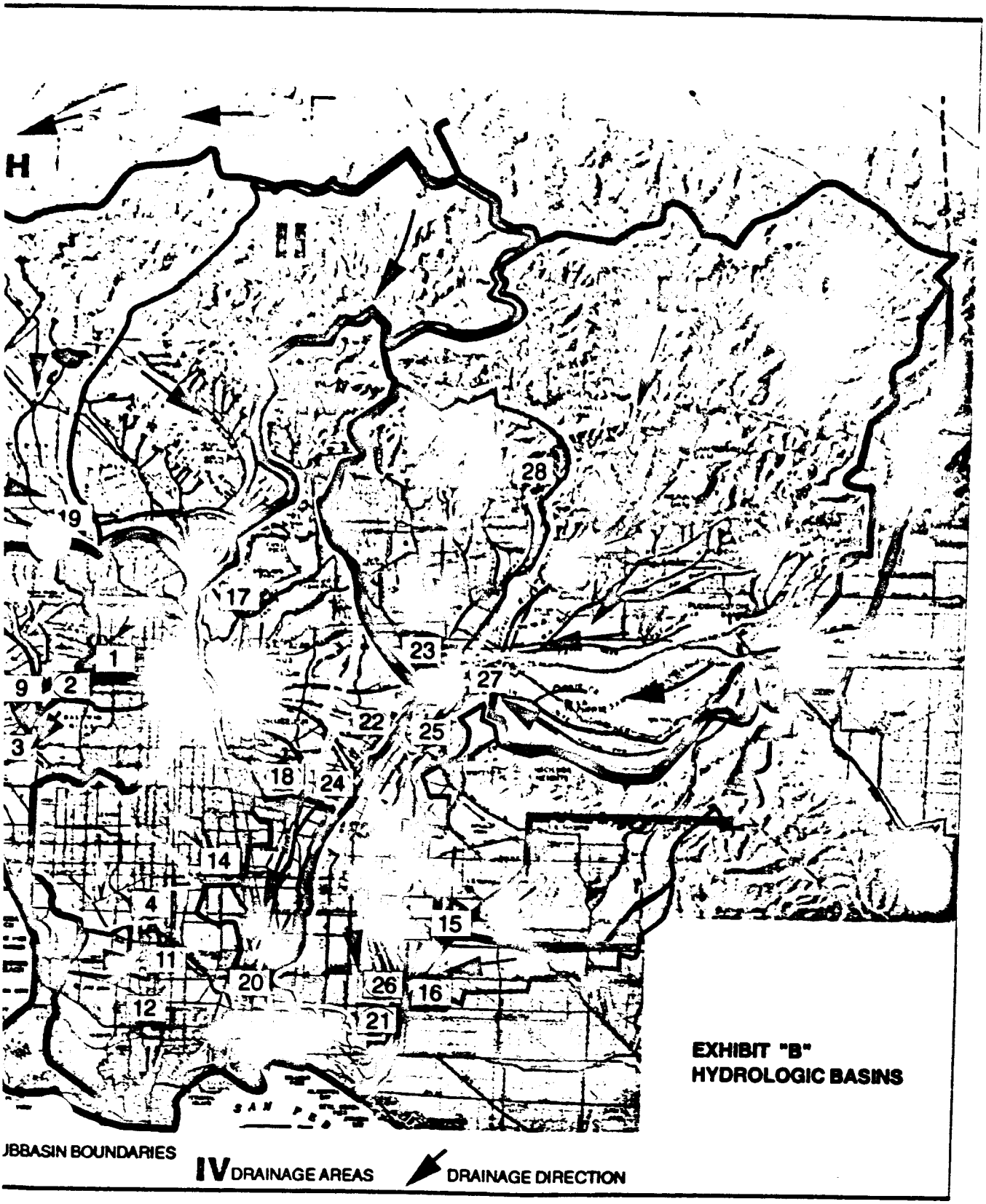


EXHIBIT "B"
HYDROLOGIC BASINS

VOL 15

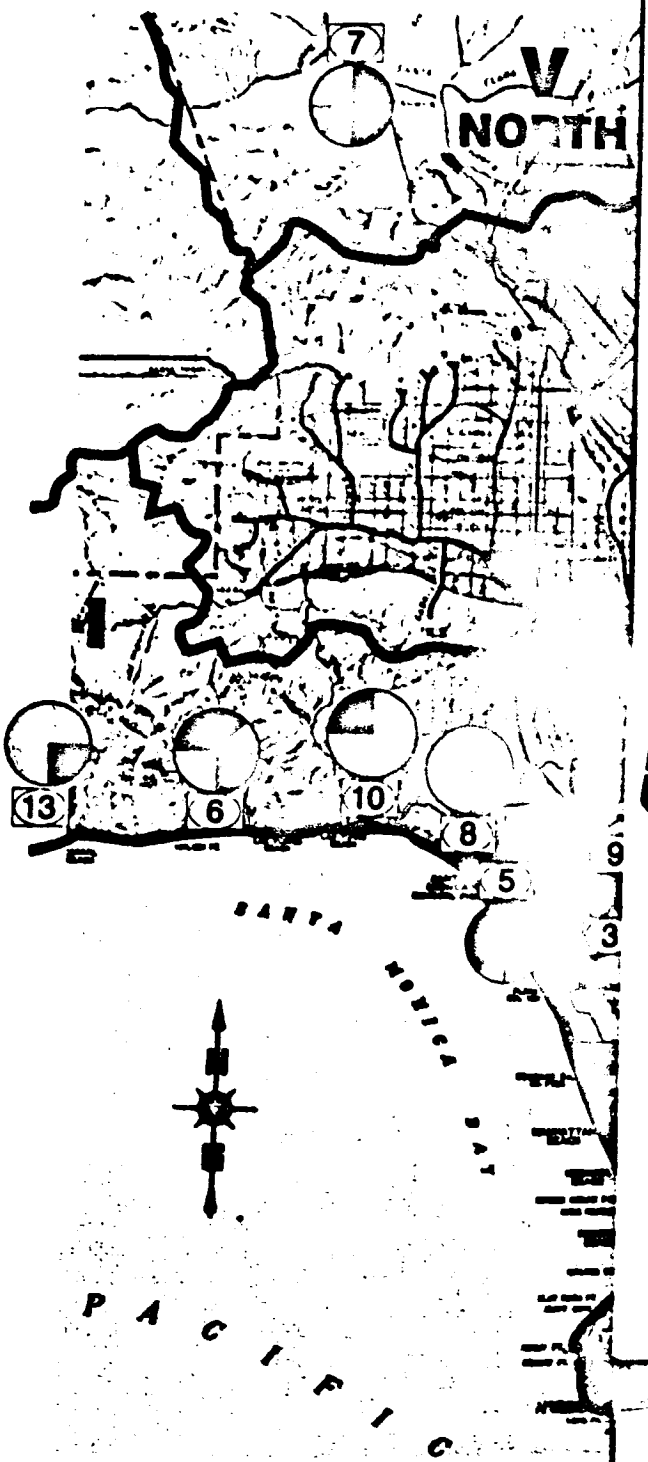
0770

R0060990

VOL 15

LEGEND

NO.	STATION
1	Ballona Creek @ Fairfax Avenue
2	Ballona Creek @ Sawtelle Boulevard
3	Centinela Creek @ Centinela Boulevard
4	Dominguez Channel @ Vermont Avenue
5	Kenter Drain @ Pico Boulevard
6	Malibu Creek @ Cross Creek Road
7	Santa Clara River @ The Old Road
8	Santa Monica Canyon Channel @ Short Street
9	Sepulveda Channel @ Culver Boulevard
10	Topanga Canyon @ Pacific Coast Highway
11	Torrance Lateral @ Main Street
12	Wilmington Drain @ Pacific Coast Highway
13	Corral Canyon Creek @ Pacific Coast Highway
14	Compton Creek @ Greenleaf Boulevard
15	Coyote Creek @ Orangethorpe Boulevard
16	Coyote Creek @ Willow Street
17	Los Angeles River @ Arroyo Seco
18	Los Angeles River & Firestone Boulevard
19	Los Angeles River @ Tujung
20	Los Angeles @ Wardlow Road
21	Los Cerritos Channel @ Steams
22	Rio Hondo Channel @ Rio Hondo Spreading Grounds
23	Rio Hondo Channel @ San Gabriel Boulevard
24	Rio Hondo Channel @ Steward & Gray
25	San Gabriel River @ San Gabriel Spreading Grounds
26	San Gabriel River @ Willow Street
27	San Jose Creek @ Workman Mill Road
28	Monrovia Creek above Sawpit Creek



SAMPLING STATIONS

1 DRY WEATHER SAMPLES

2 STORM AND DRY WEATHER SAMPLES

BASIN BOUNDARIES

0711

R0060991

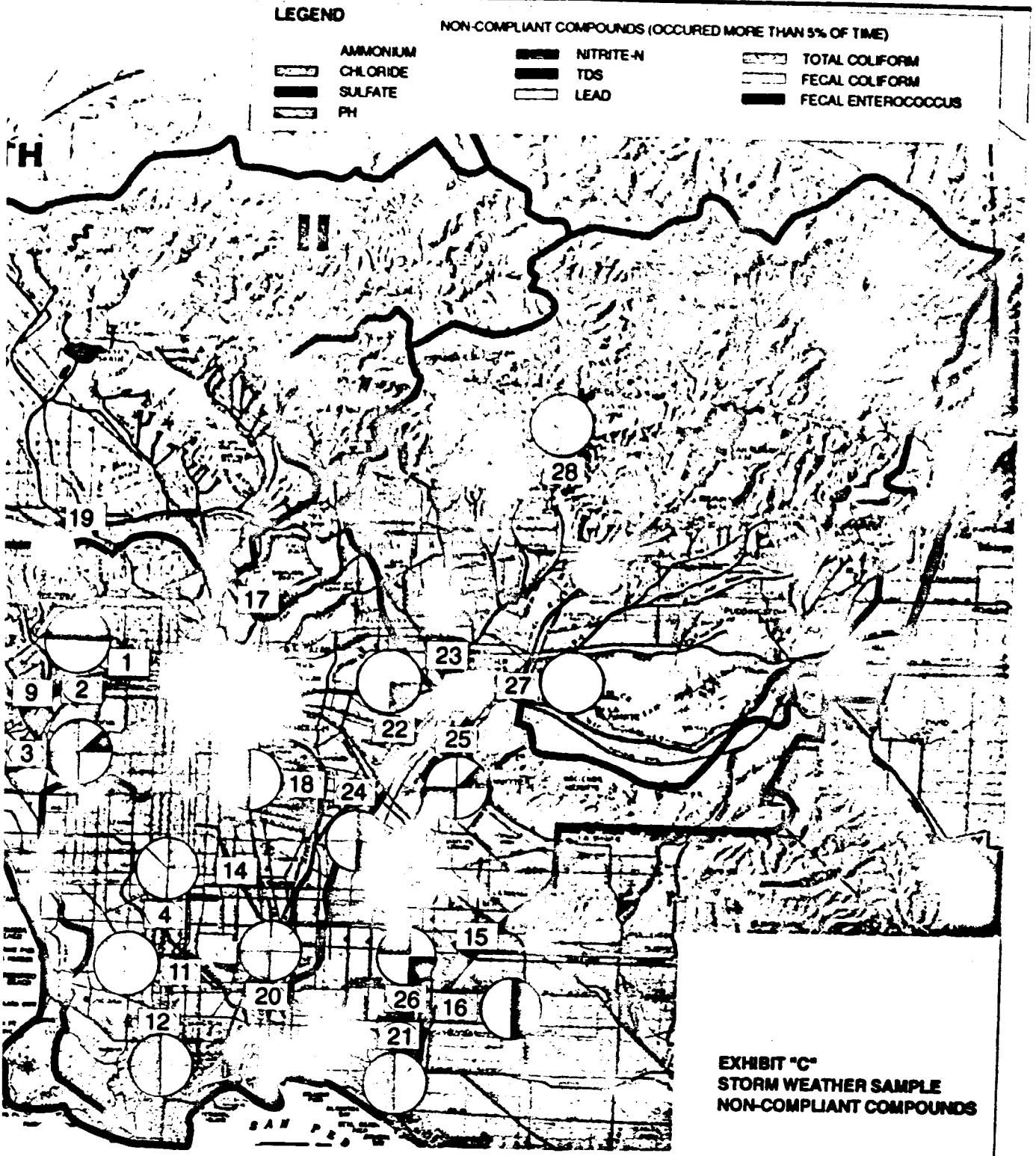


EXHIBIT "C"
STORM WEATHER SAMPLE
NON-COMPLIANT COMPOUNDS

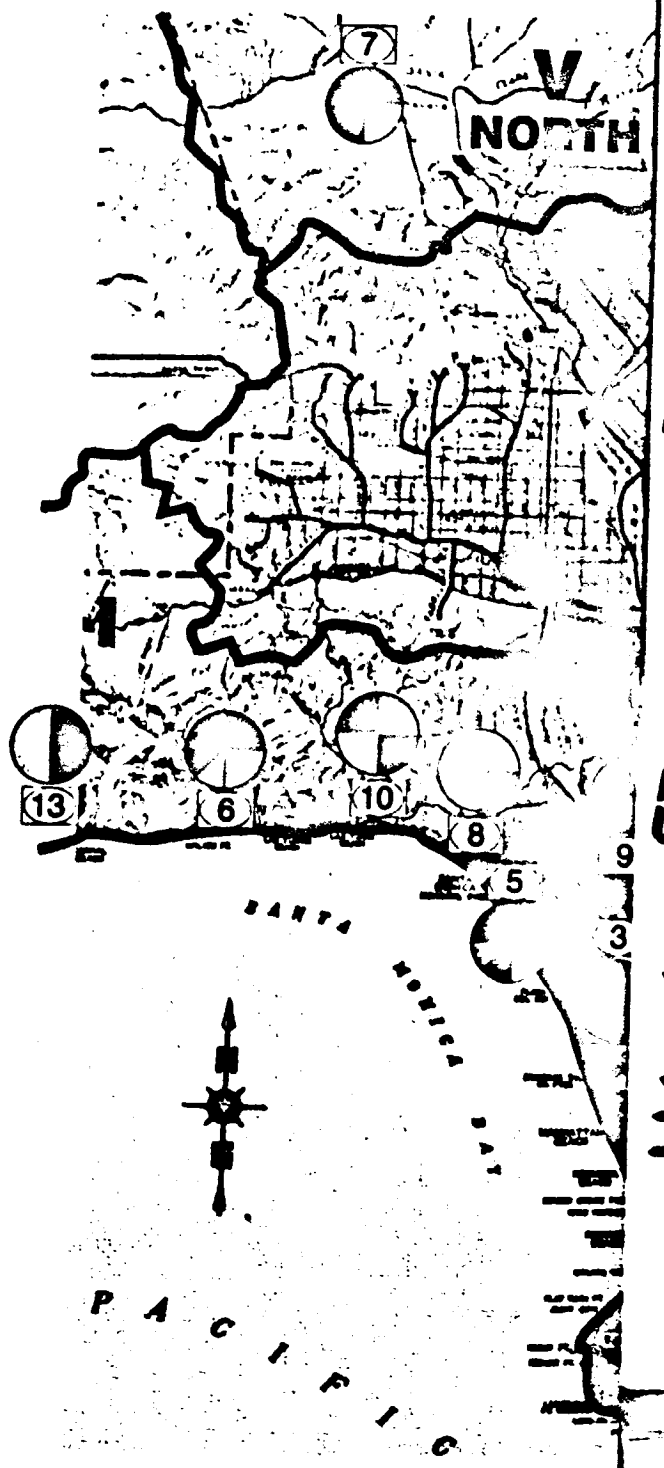
IV DRAINAGE AREAS

VOL 15 0712

R0060992

LEGEND

NO.	STATION
1	Ballona Creek @ Fairfax Avenue
2	Ballona Creek @ Sawtelle Boulevard
3	Centinela Creek @ Centinela Boulevard
4	Dominguez Channel @ Vermont Avenue
5	Kenter Drain @ Pico Boulevard
6	Malibu Creek @ Cross Creek Road
7	Santa Clara River @ The Old Road
8	Santa Monica Canyon Channel @ Short Street
9	Sepulveda Channel @ Culver Boulevard
10	Topanga Canyon @ Pacific Coast Highway
11	Torrance Lateral @ Main Street
12	Wilmington Drain @ Pacific Coast Highway
13	Corral Canyon Creek @ Pacific Coast Highway
14	Compton Creek @ Greenleaf Boulevard
15	Coyote Creek @ Orangethorpe Boulevard
16	Coyote Creek @ Willow Street
17	Los Angeles River @ Arroyo Seco
18	Los Angeles River & Firestone Boulevard
19	Los Angeles River @ Tujunga
20	Los Angeles @ Wardlow Road
21	Los Cerritos Channel @ Steams
22	Rio Hondo Channel @ Rio Hondo Spreading Grounds
23	Rio Hondo Channel @ San Gabriel Boulevard
24	Rio Hondo Channel @ Steward & Gray
25	San Gabriel River @ San Gabriel Spreading Grounds
26	San Gabriel River @ Willow Street
27	San Jose Creek @ Workman Mill Road
28	Monrovia Creek above Sawpit Creek



SAMPLING STATIONS

1 DRY WEATHER SAMPLES

2 STORM AND DRY WEATHER SAMPLES

BASIN BOUNDARIES

VOL 15 0713

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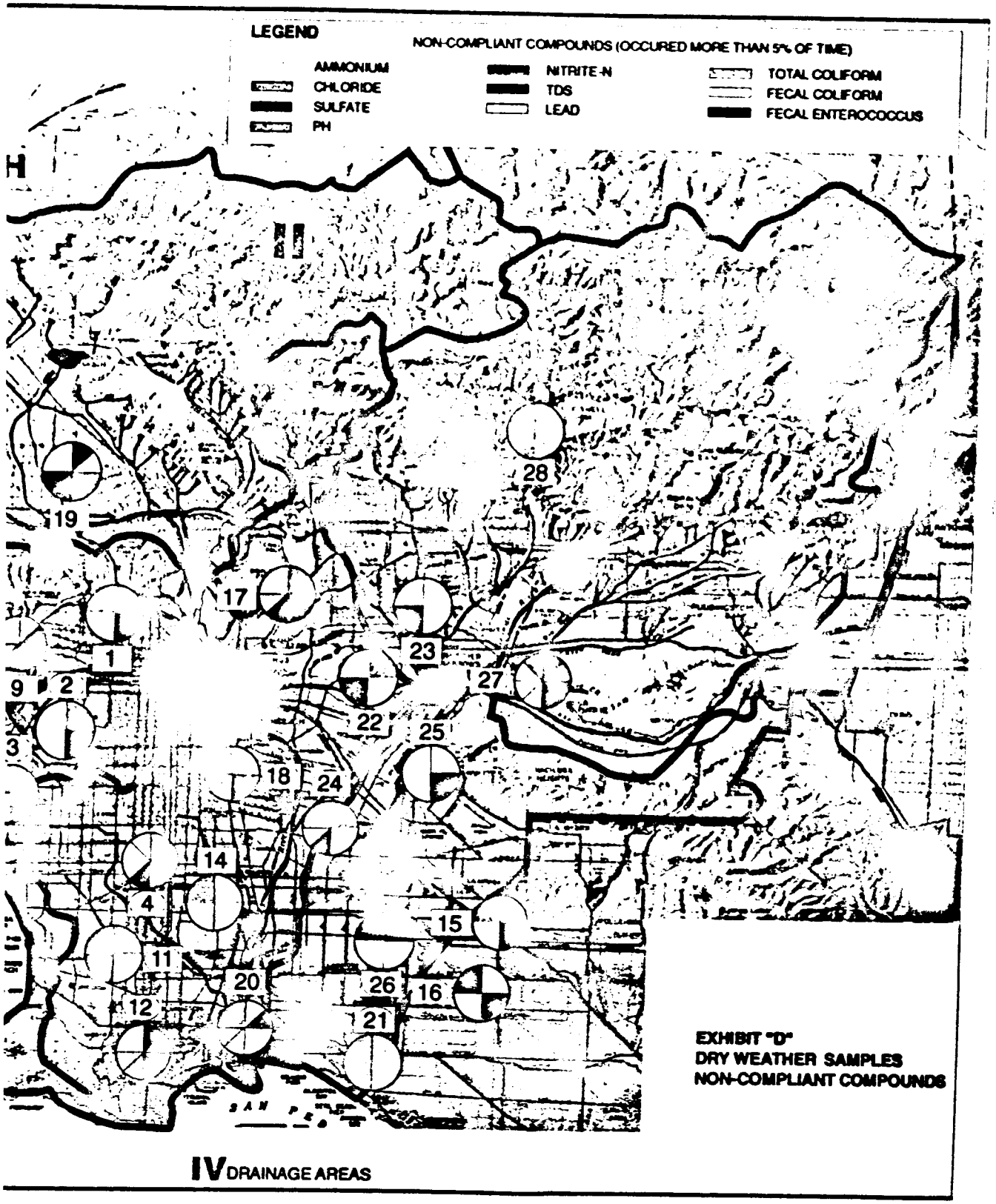


IV DRAINAGE AREAS

VOL 15 0774

R0060994

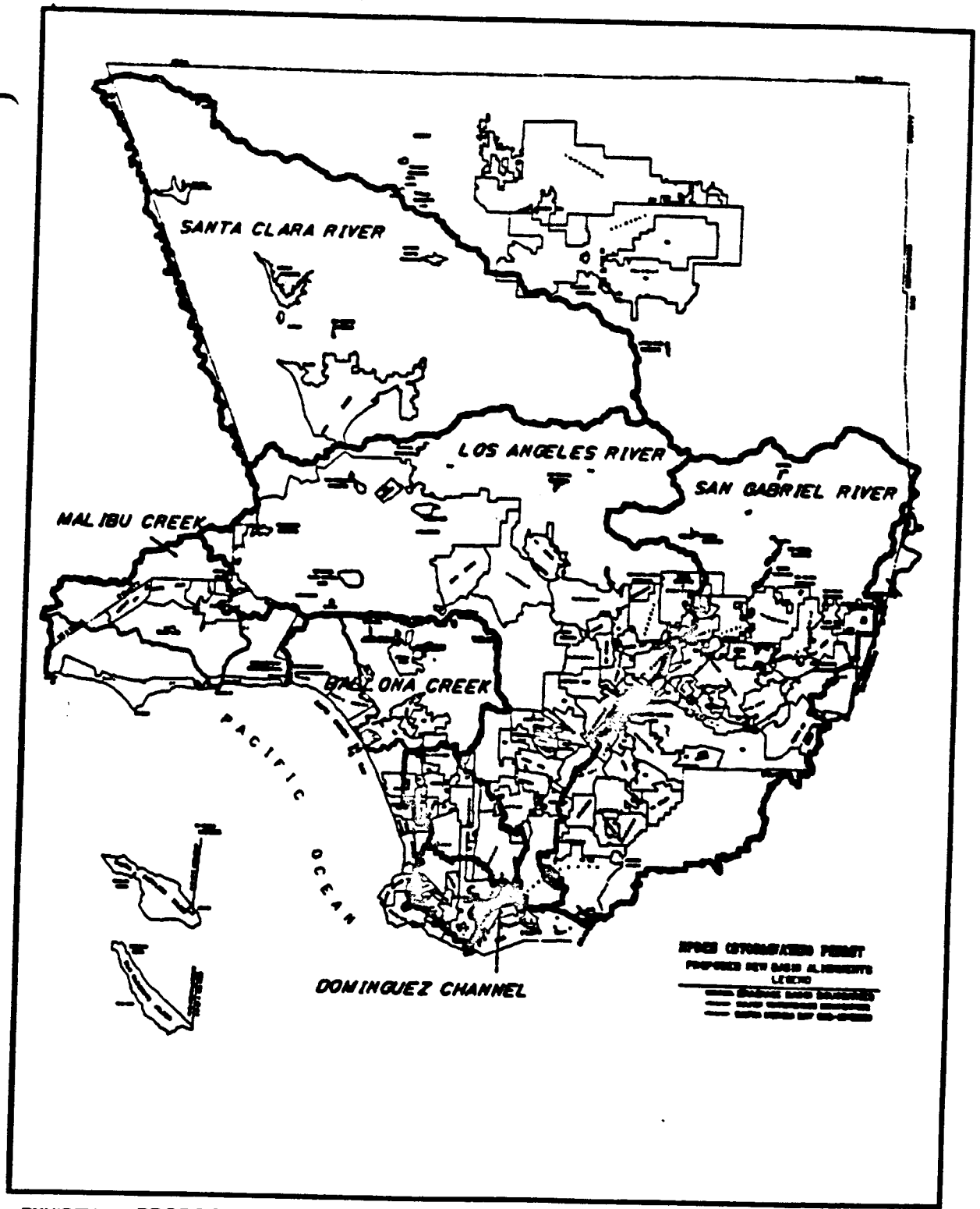


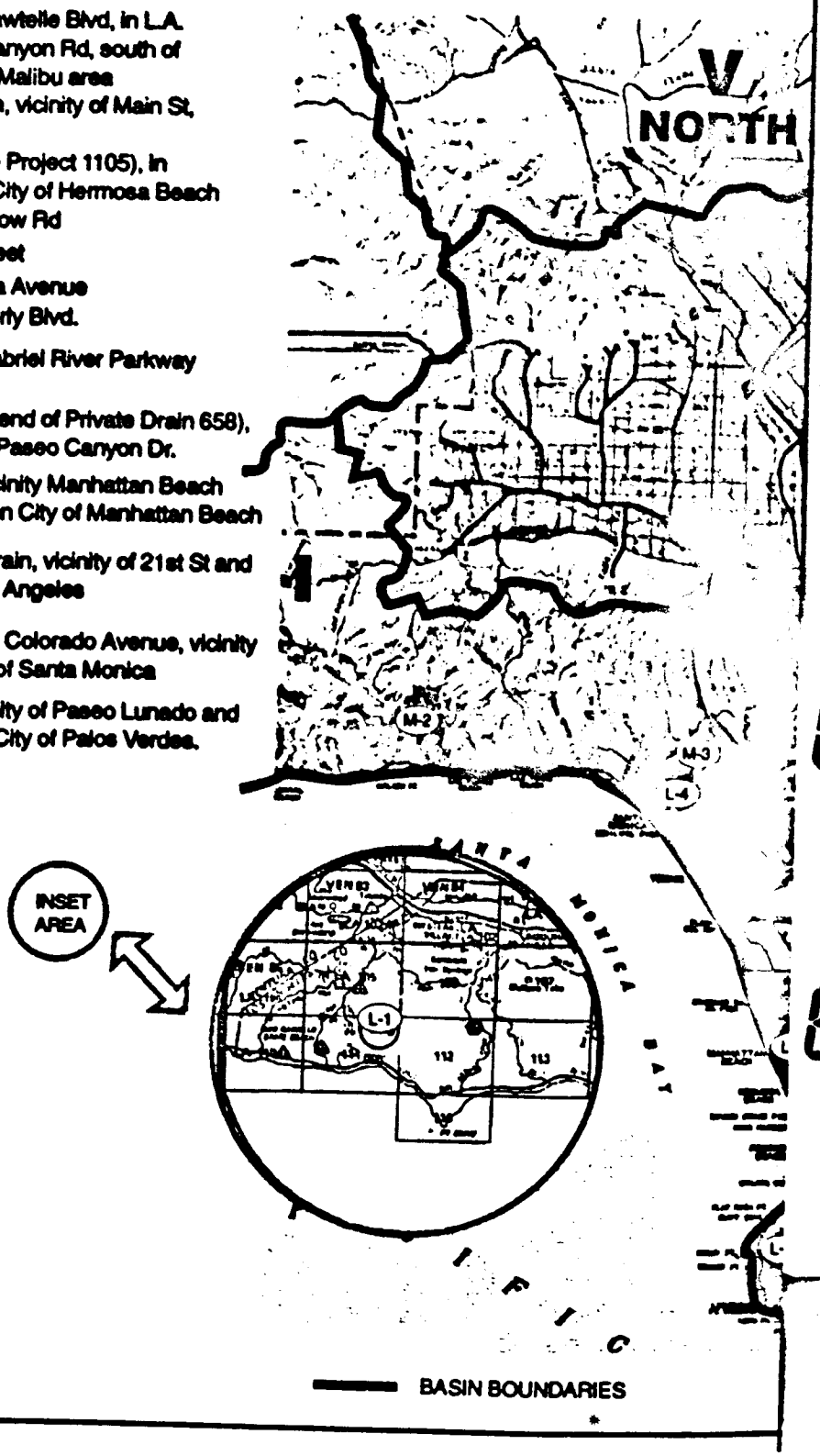
EXHIBIT "E" PROPOSED NEW BASIN ALIGNMENTS LEGEND

VOL 15

0715

LEGEND

M-1	Ballona Creek, between Sawtelle Blvd, in L.A.
M-2	Malibu Creek, off Malibu Canyon Rd, south of Pluma Rd, unincorporated Malibu area
M-3	Kenter Canyon Storm Drain, vicinity of Main St, in City of Santa Monica
M-4	Herondo Drain (Bond Issue Project 1105), in Herondo St and Valley Dr, City of Hermosa Beach
M-5	Los Angeles River at Wardlow Rd
M-6	Coyote Creek at Spring Street
M-7	Los Angeles River at Tujana Avenue
M-8	Fio Hondo Channel at Beverly Blvd.
M-9	San Gabriel River at San Gabriel River Parkway
L-1	Trancas Canyon (upstream end of Private Drain 658), adjacent to northerly end of Paseo Canyon Dr.
L-2	Bond Issue Project 5401, vicinity Manhattan Beach Blvd and Redondo Avenue, in City of Manhattan Beach
L-3	City of Los Angeles Storm Drain, vicinity of 21st St and Grand Avenue, in City of Los Angeles
L-4	Santa Monica Storm Drain in Colorado Avenue, vicinity of Santa Monica Mall in City of Santa Monica
L-5	Bond Issue Project 558, vicinity of Paseo Lunado and Palos Verdes Drive West, in City of Palos Verdes.
M	Mass Emission Sites
L	Land Use Specific Sites



VOL 15

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R0060996

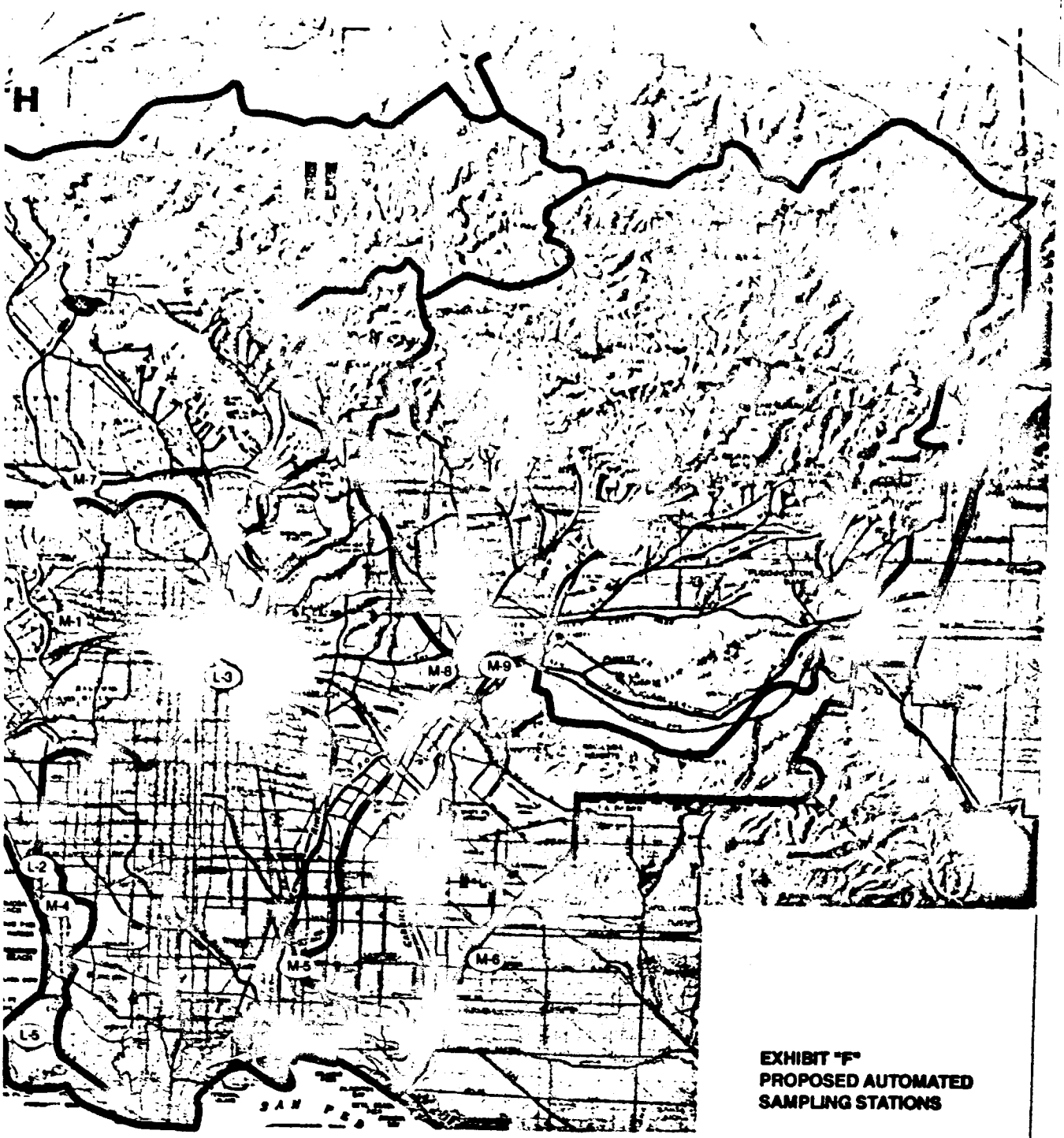


EXHIBIT "F"
PROPOSED AUTOMATED SAMPLING STATIONS

IV DRAINAGE AREAS

VOL 15 0777

NPDES PERMIT NO. CA 0061654

TASK 5.2

REPORT OF WASTE DISCHARGE (ROWD)

VOLUME 8 OF 8 (TASK 5.2.1)

SECTION A - Countywide Evaluation of Existing Stormwater Quality Monitoring Data
APPENDICES (2 of 2)

LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS
WASTE MANAGEMENT DIVISION
WATER QUALITY SECTION

VOL 15
0778
R0060998

APPENDICES

APPENDIX "A"	MONITORING STATION LONG-TERM TREND ANALYSIS
APPENDIX "B"	LOS ANGELES COUNTYWIDE LONG-TERM TREND ANALYSIS
APPENDIX "C"	REGIONAL BASIN-WIDE LONG-TERM TREND ANALYSIS
APPENDIX "D"	BEST MANAGEMENT PRACTICES MATRIX

VOL 15
0719
R0060999

VOL 15

APPENDIX A

MONITORING STATION TREND ANALYSIS

07800

R0061000

DRY WEATHER

VOL 15

07811

R0061001

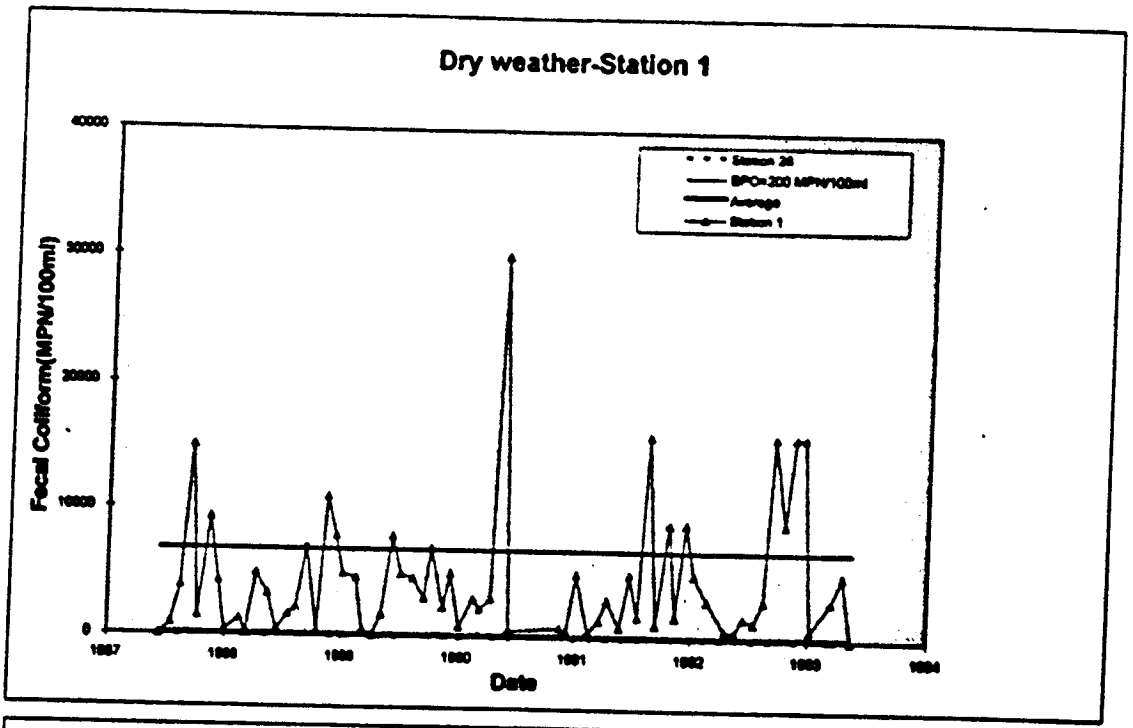
VOL 15

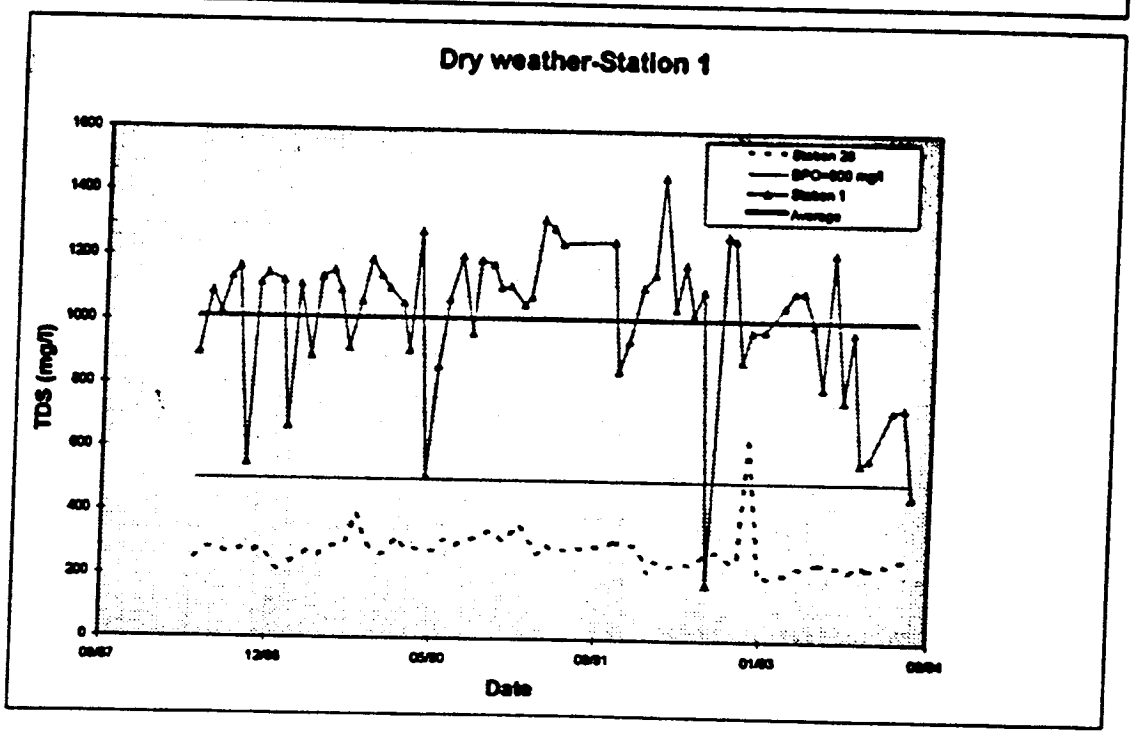
07182

GRAPH LEGEND

BPO: BASIN PLAN (DRAFT 1994) OBJECTIVE
OPO: OCEAN PLAN (1990) OBJECTIVE

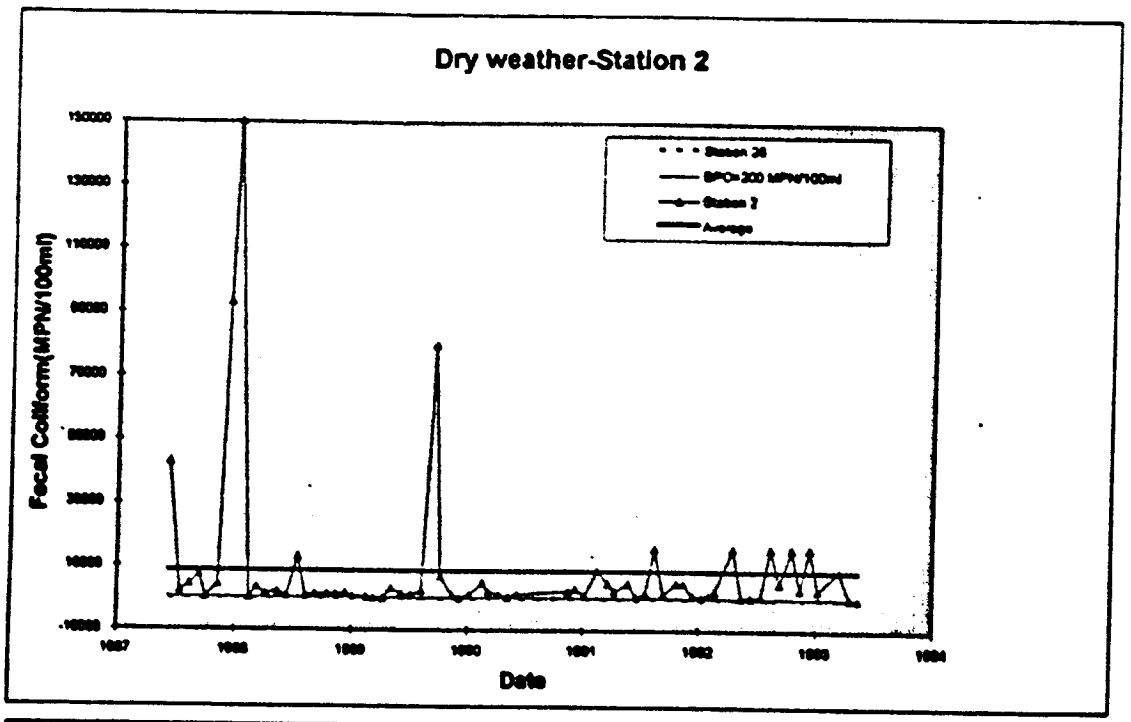
R0061002

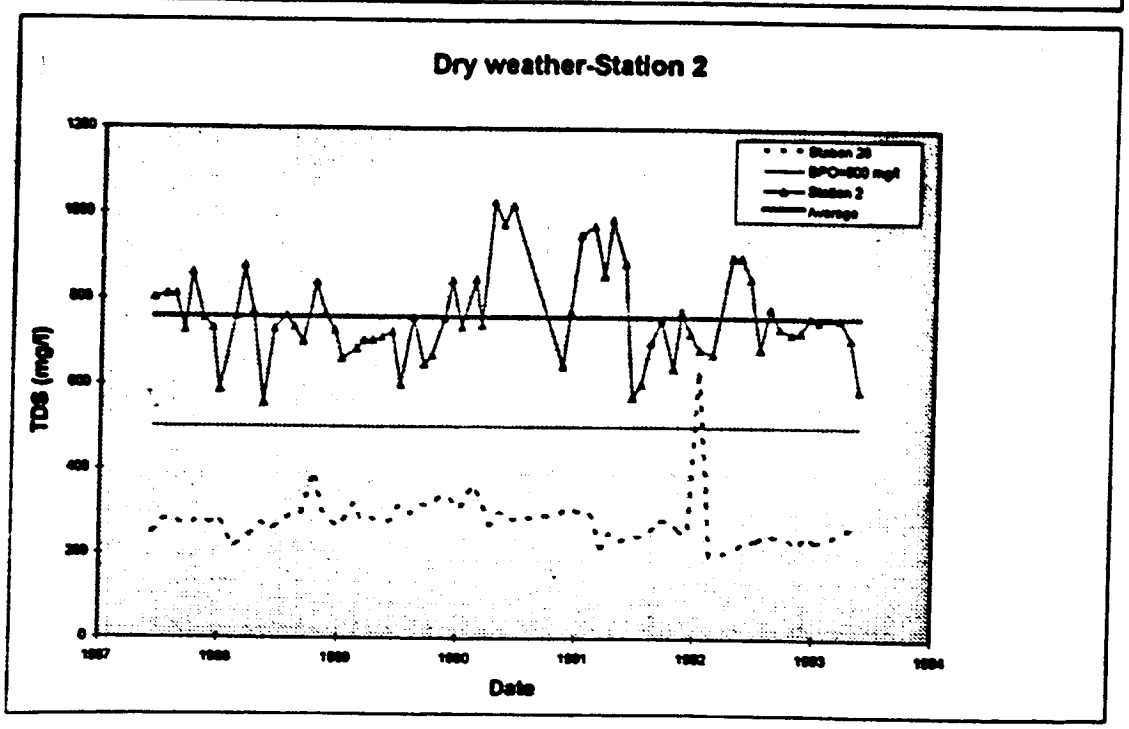

Dry weather-Station 1
Fecal Coliform(MPN/100ml)
40000
30000
20000
10000
0
1987
1988
1989
1990
1991
1992
1993
1994
Date
Station 28
BPO=200 MPN/100ml
Average
Station 1


Dry weather-Station 1
TDS (mg/l)
1600
1400
1200
1000
800
600
400
200
0
09/87
12/88
05/90
09/91
01/93
09/94
Date
Station 28
BPO=600 mg/l
Station 1
Average

VOL 15

07183

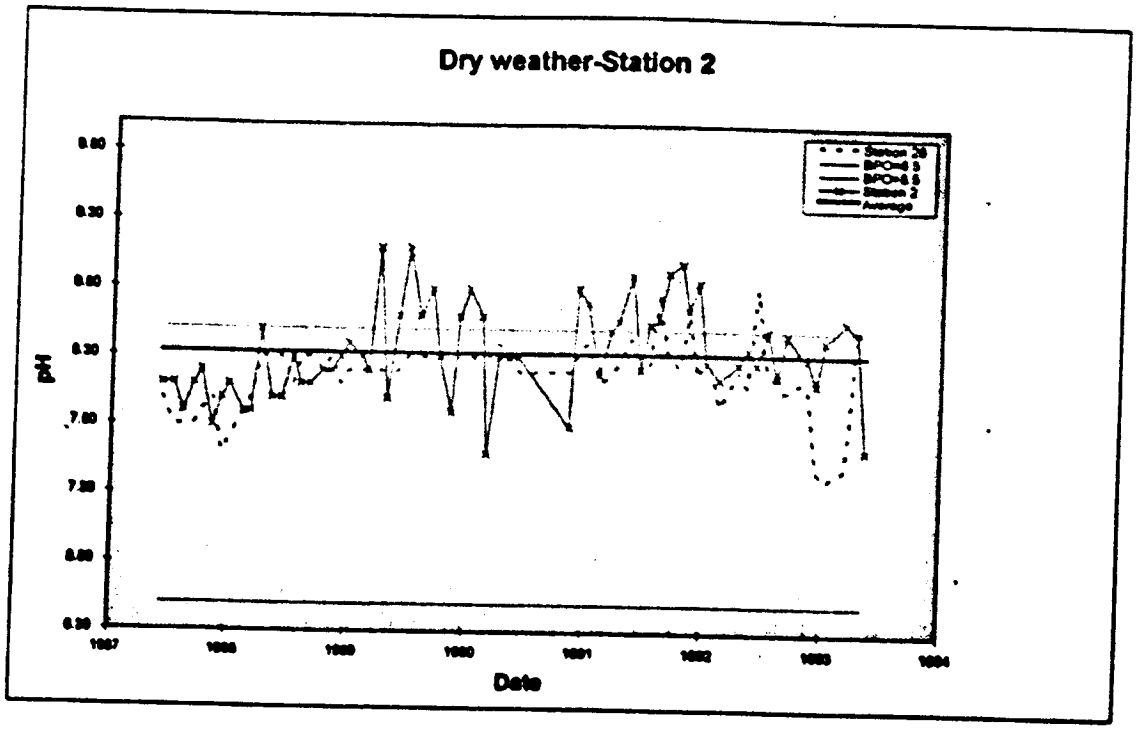




VOL 15

0784

R0061004



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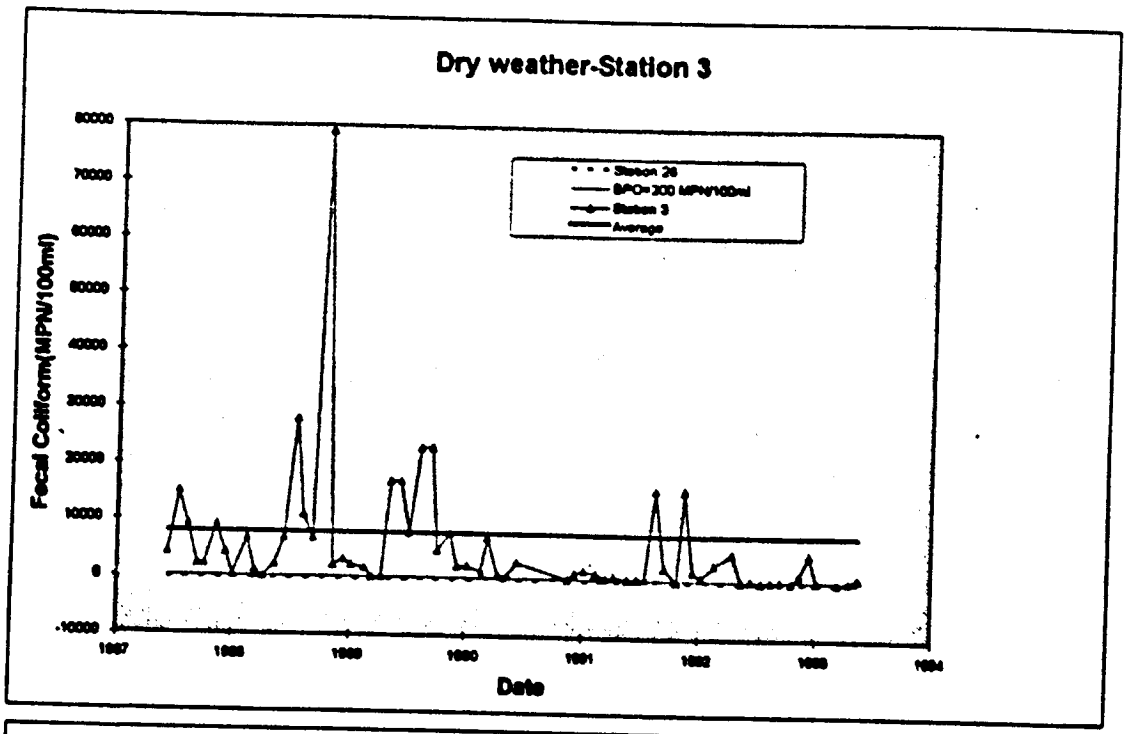

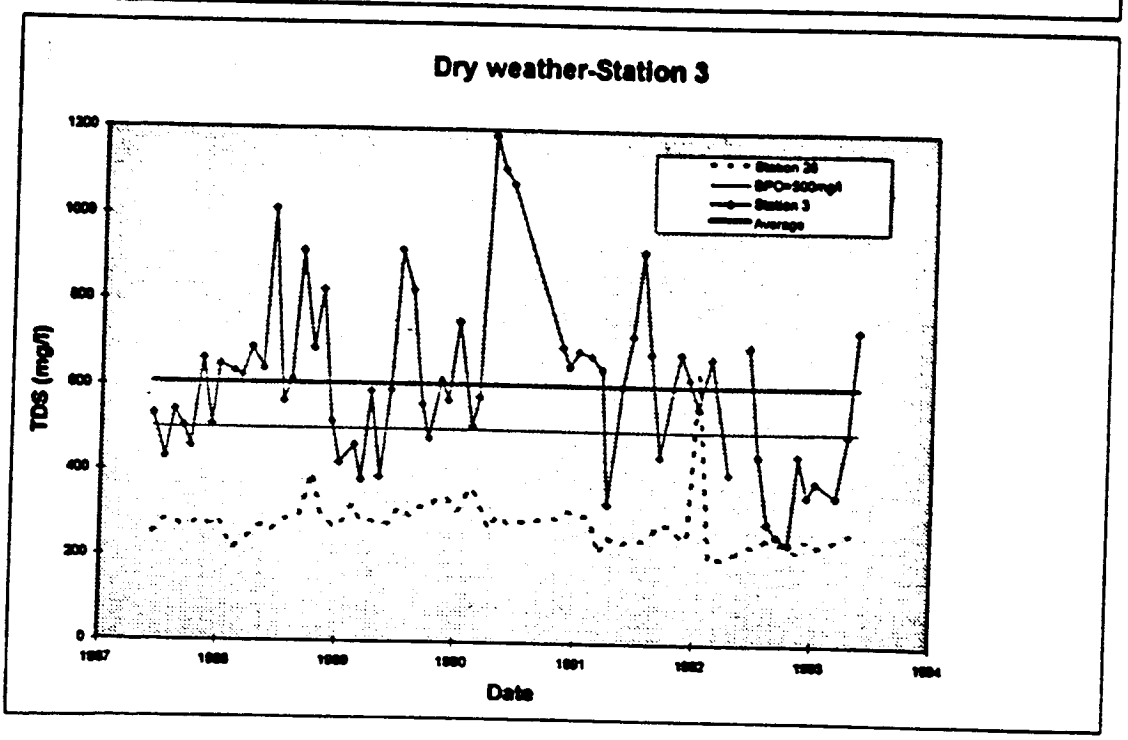

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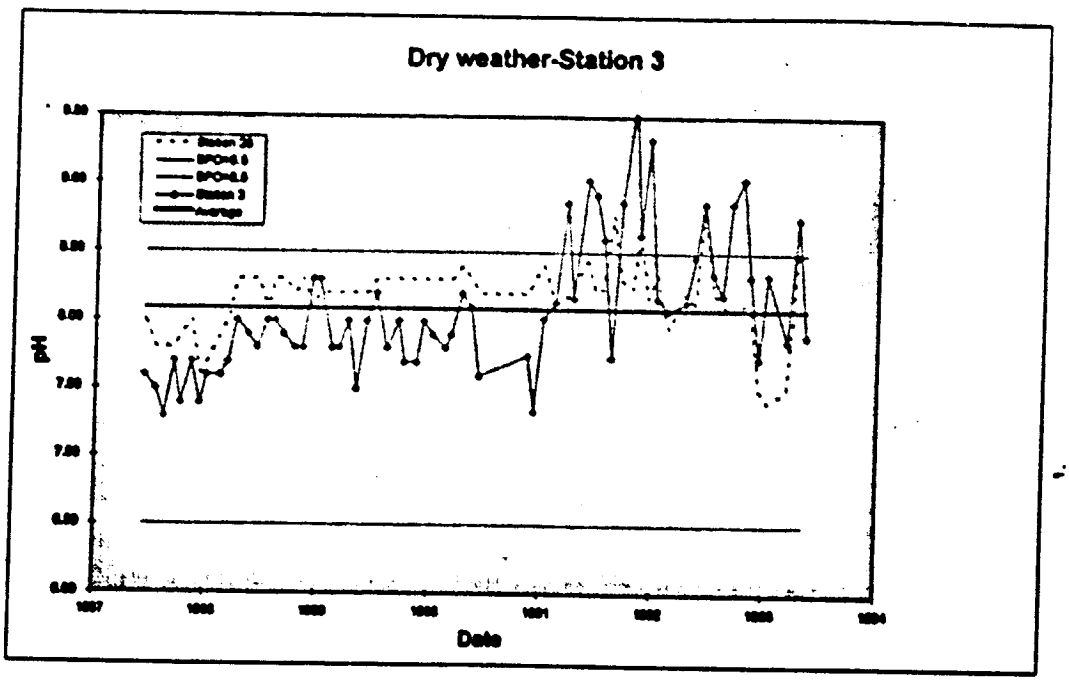

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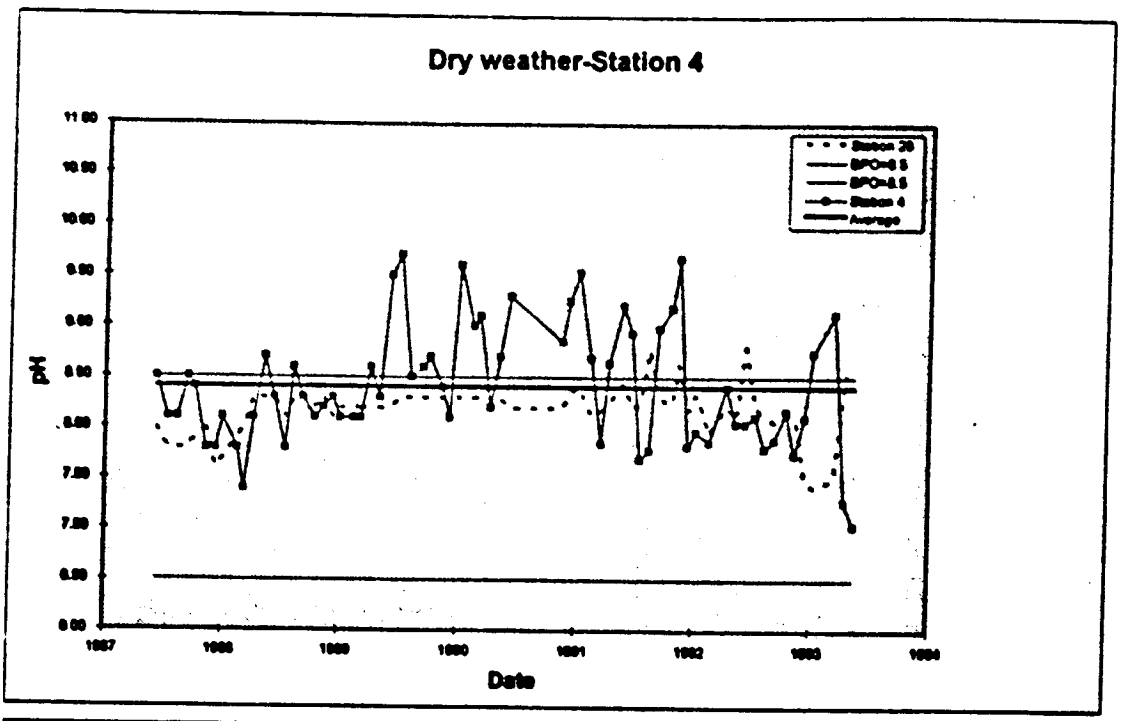

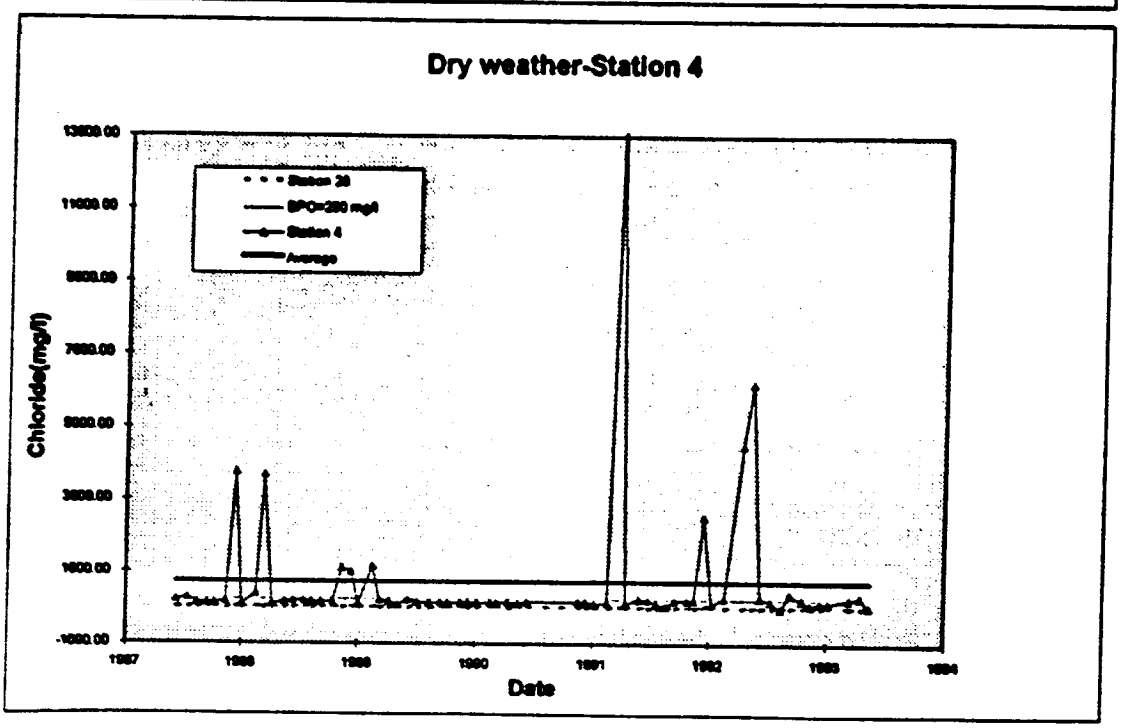

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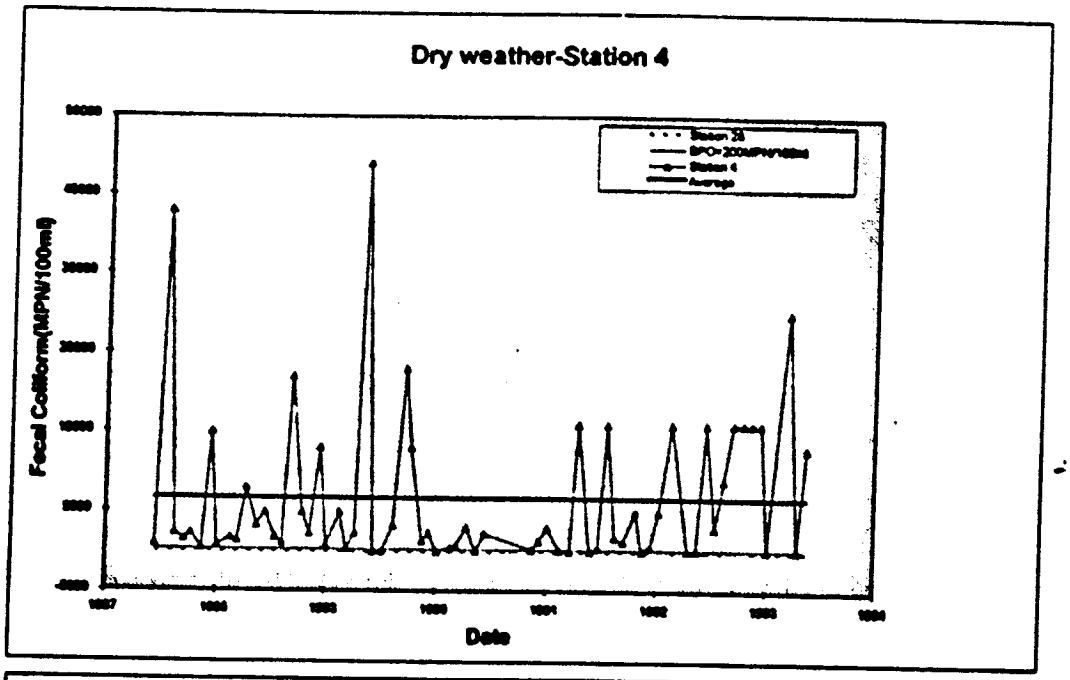

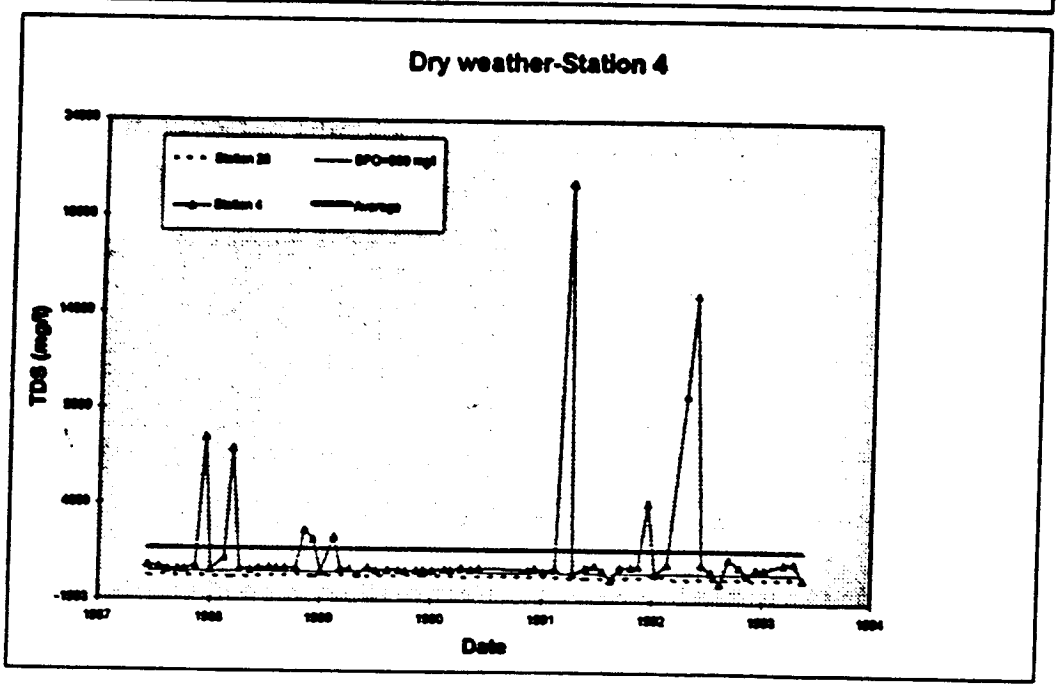

VOL 15

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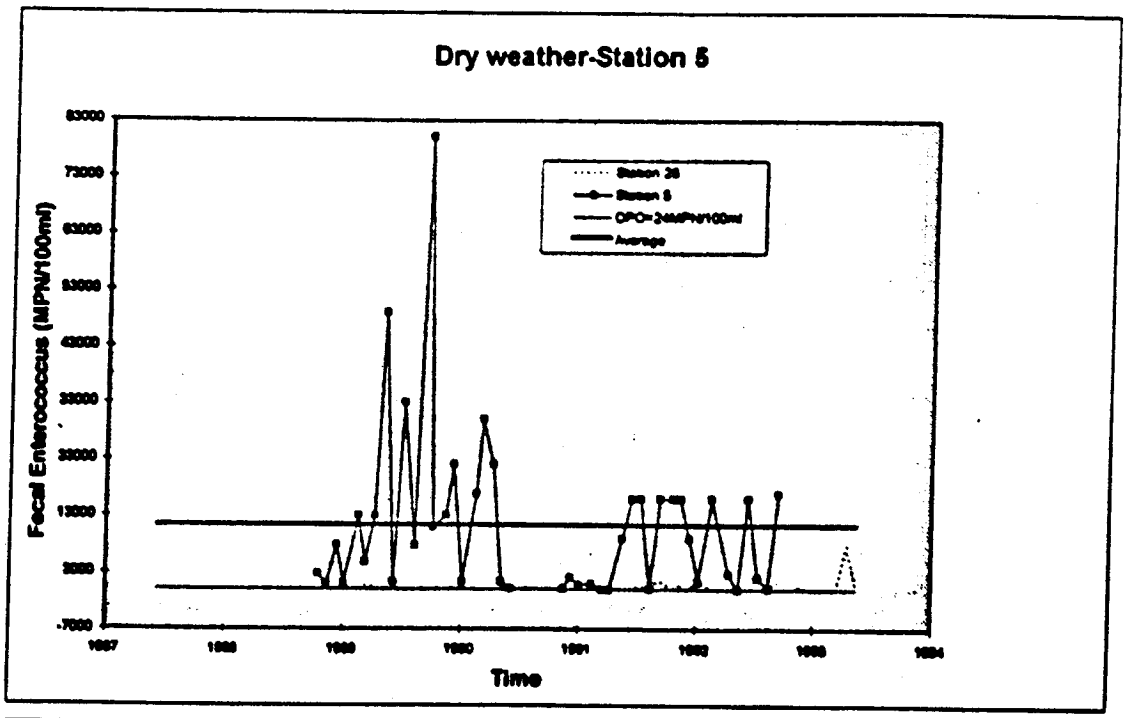

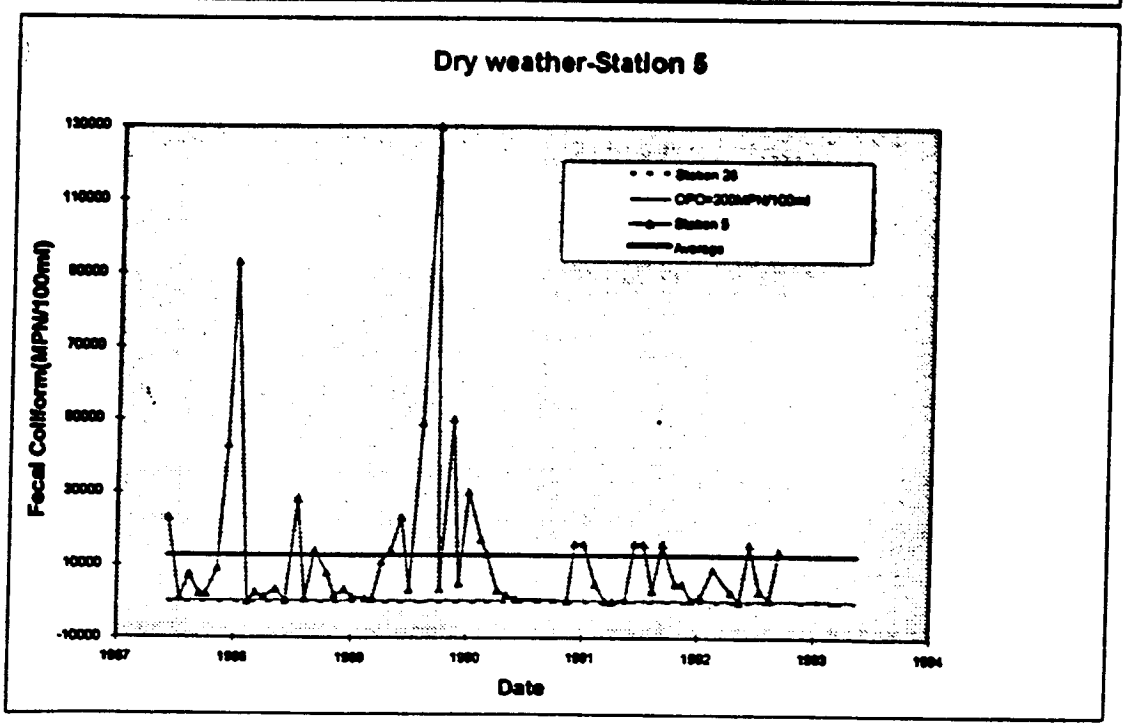

VOL 15

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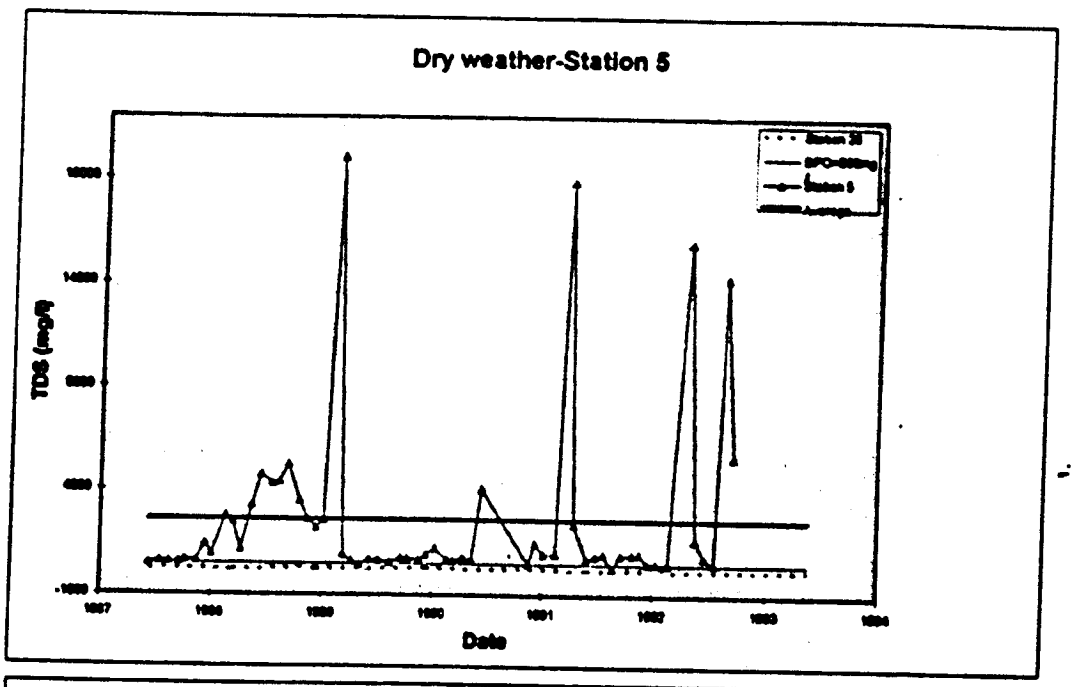

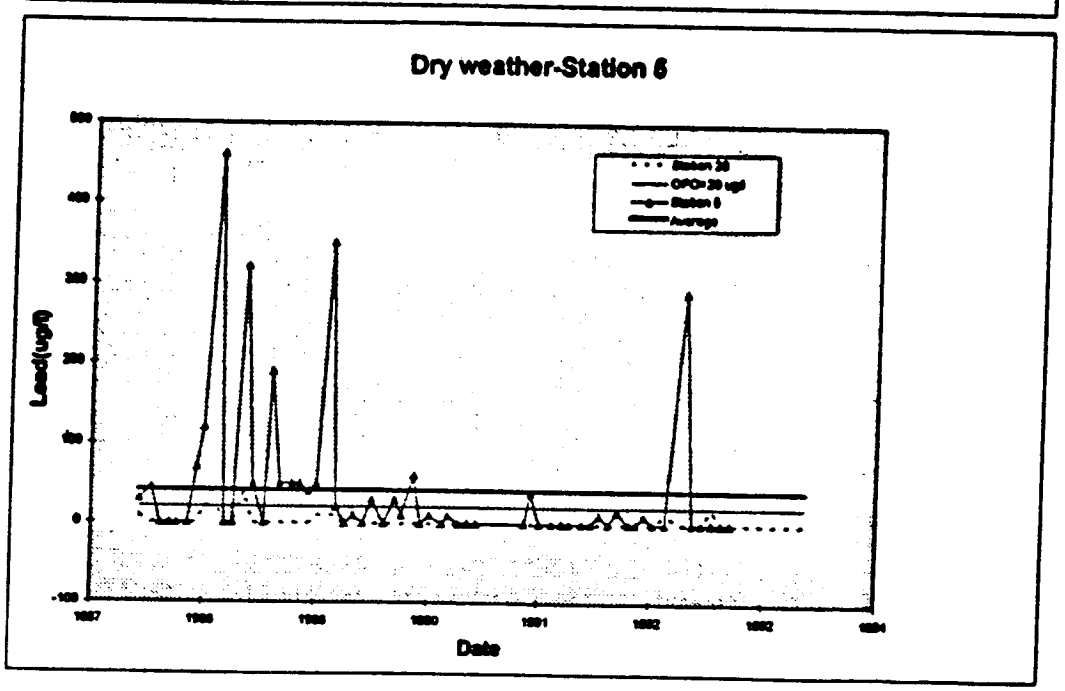

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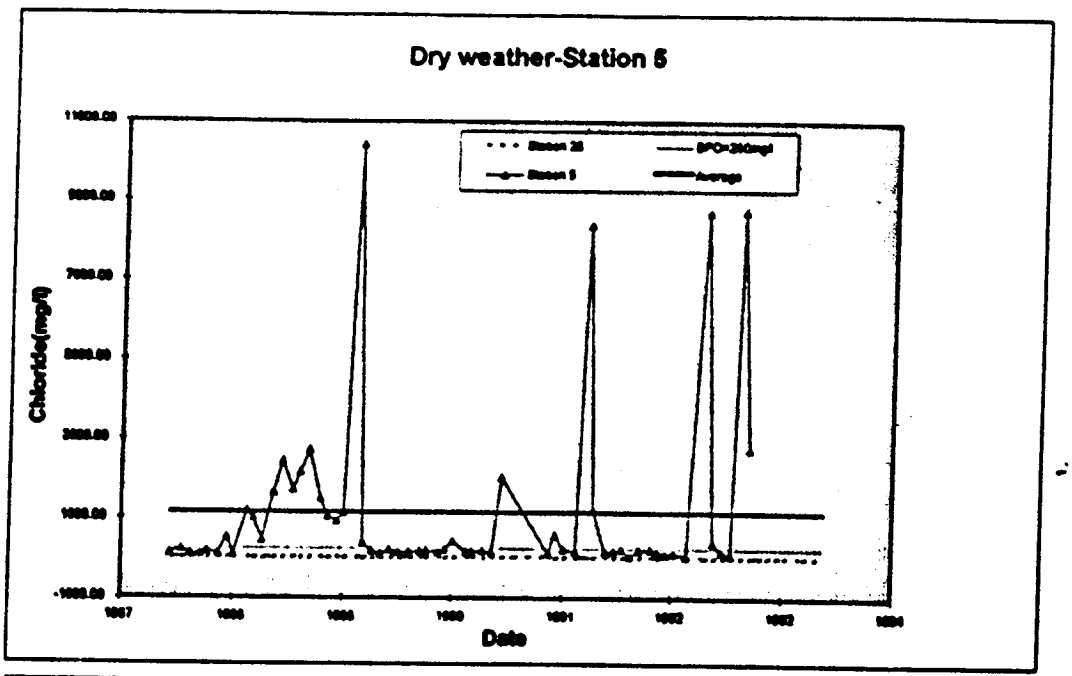

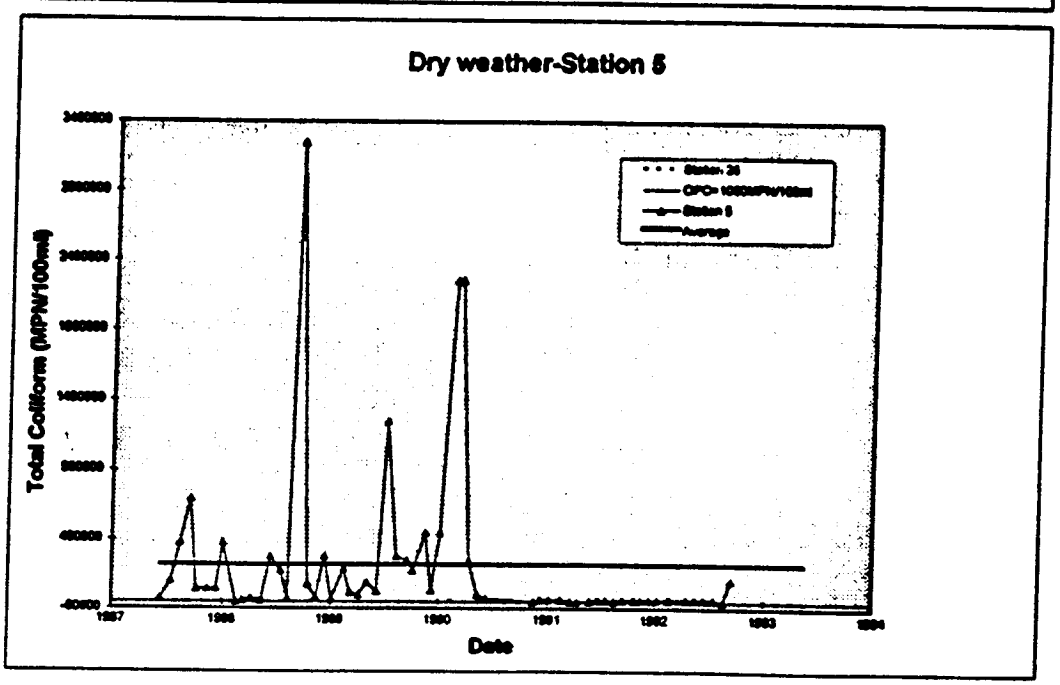

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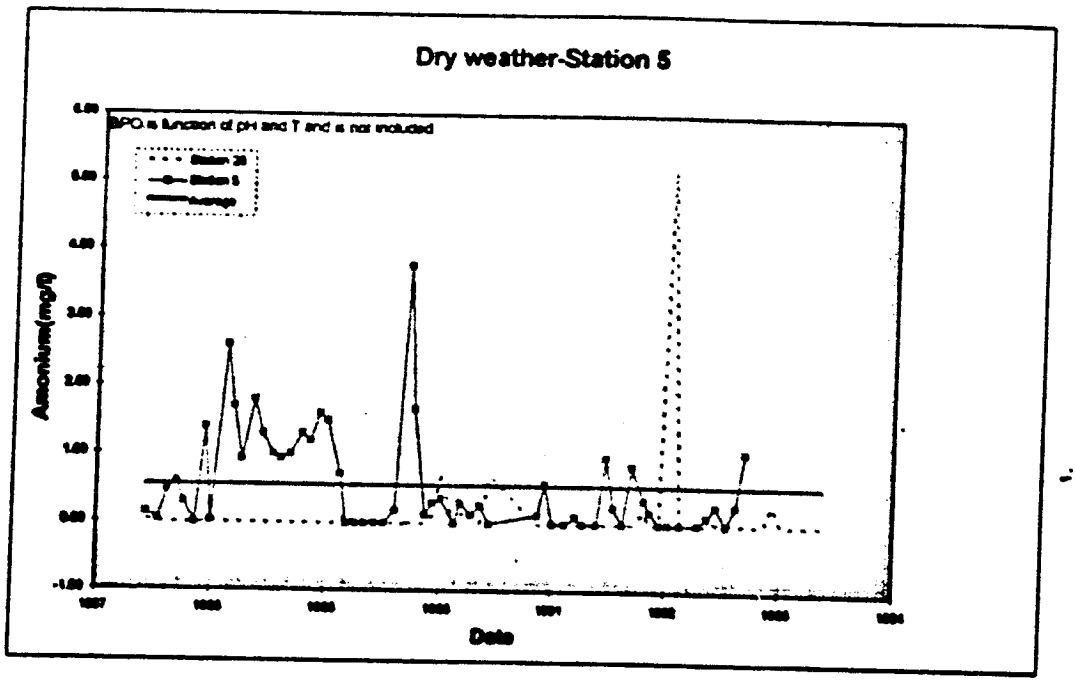

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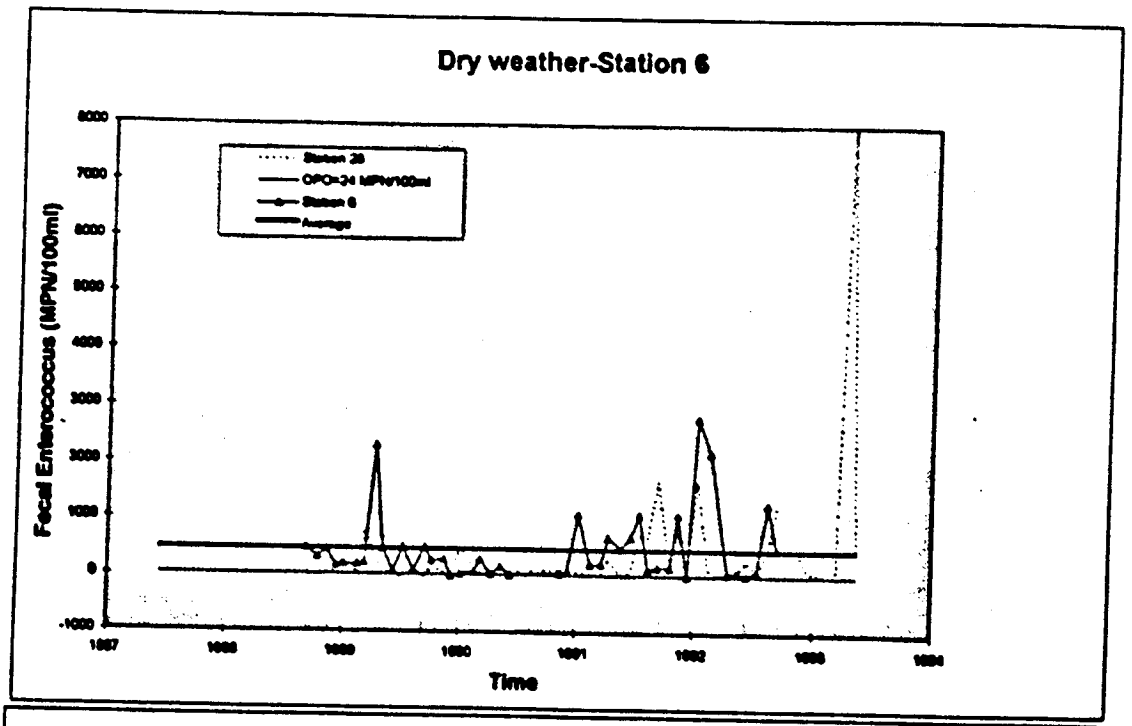

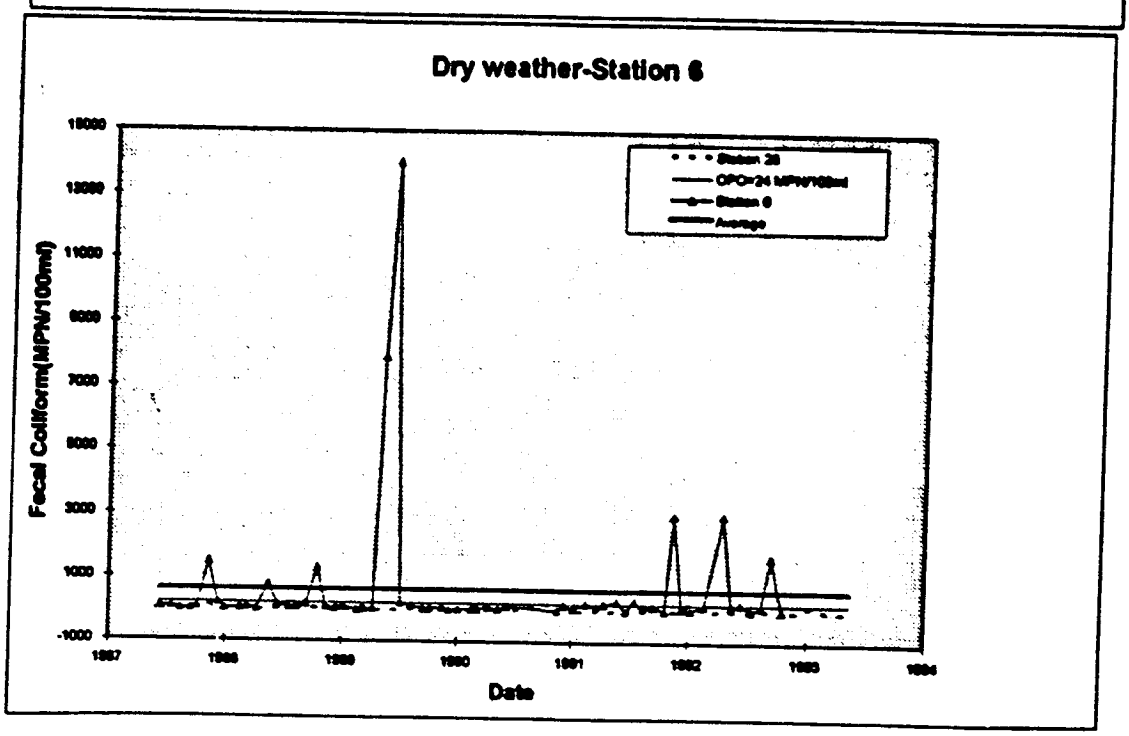

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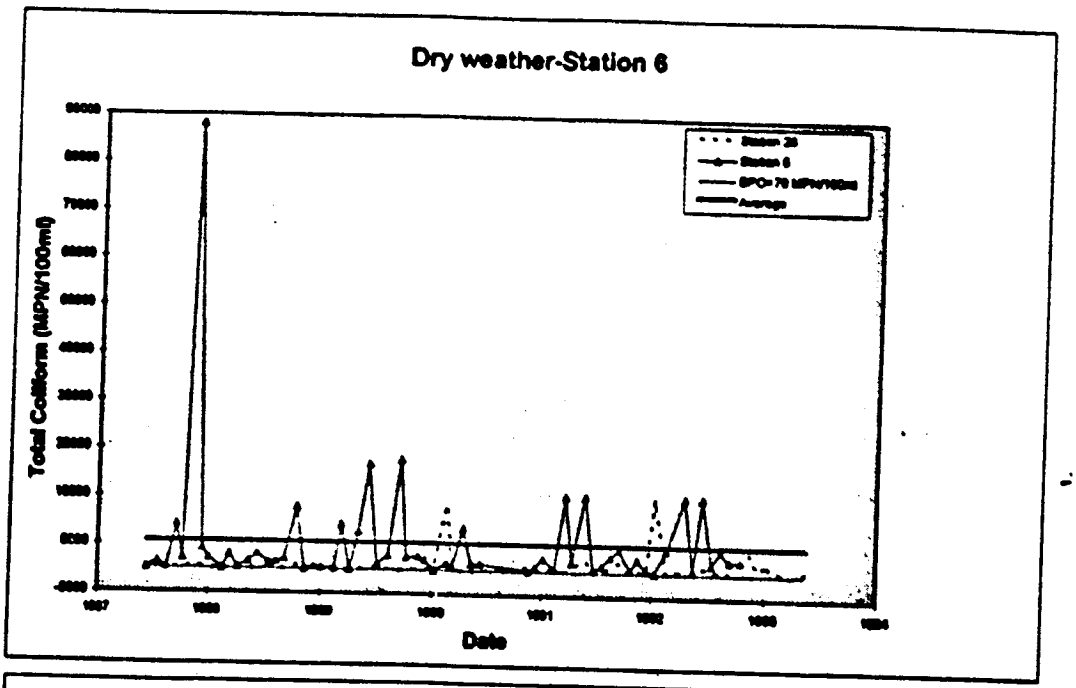

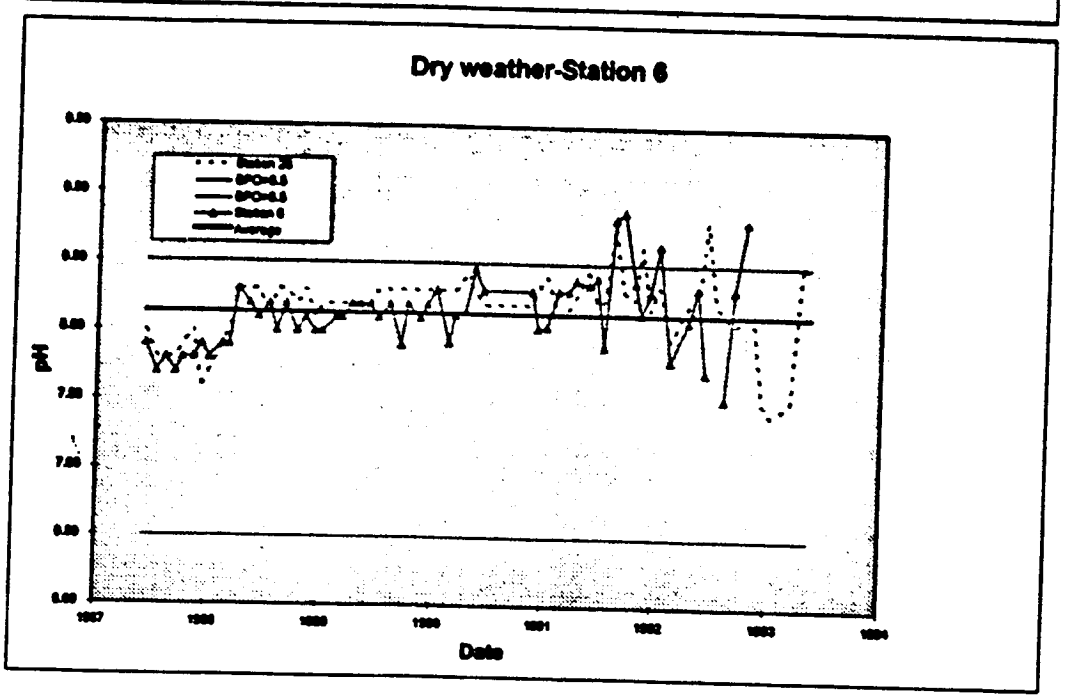

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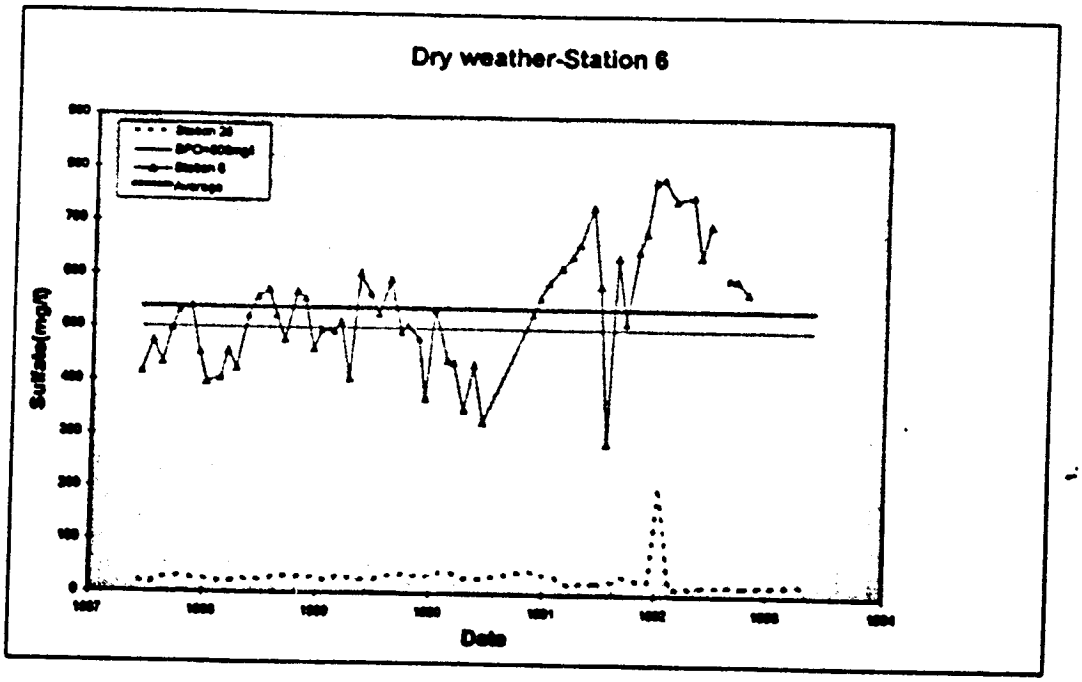

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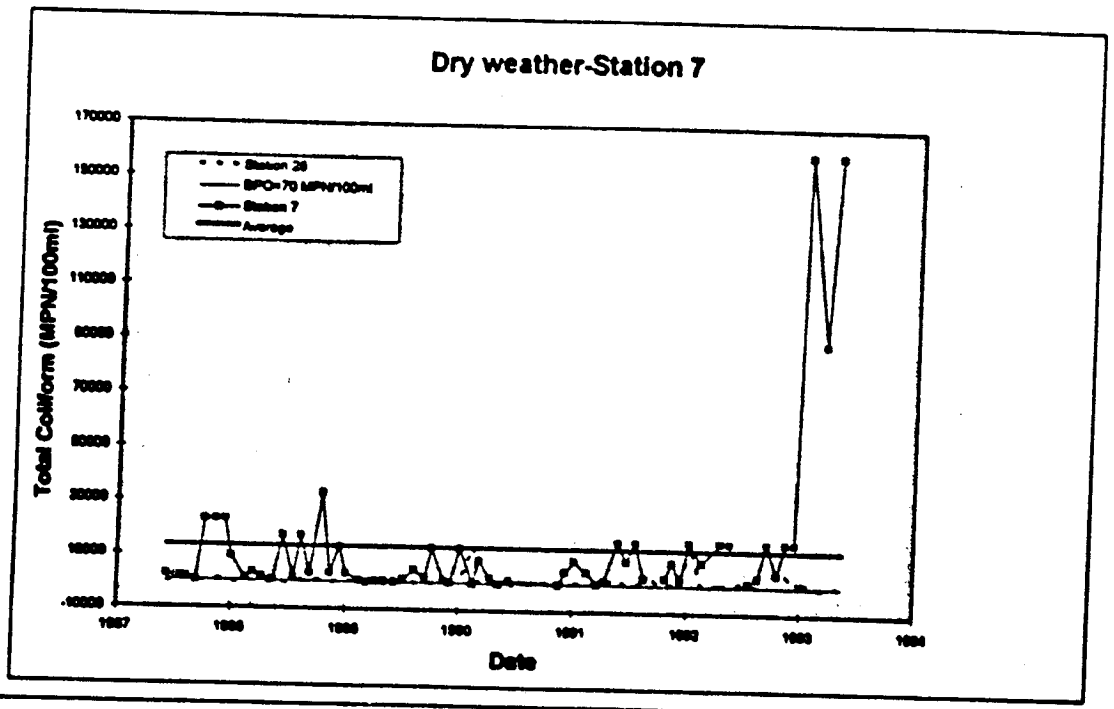

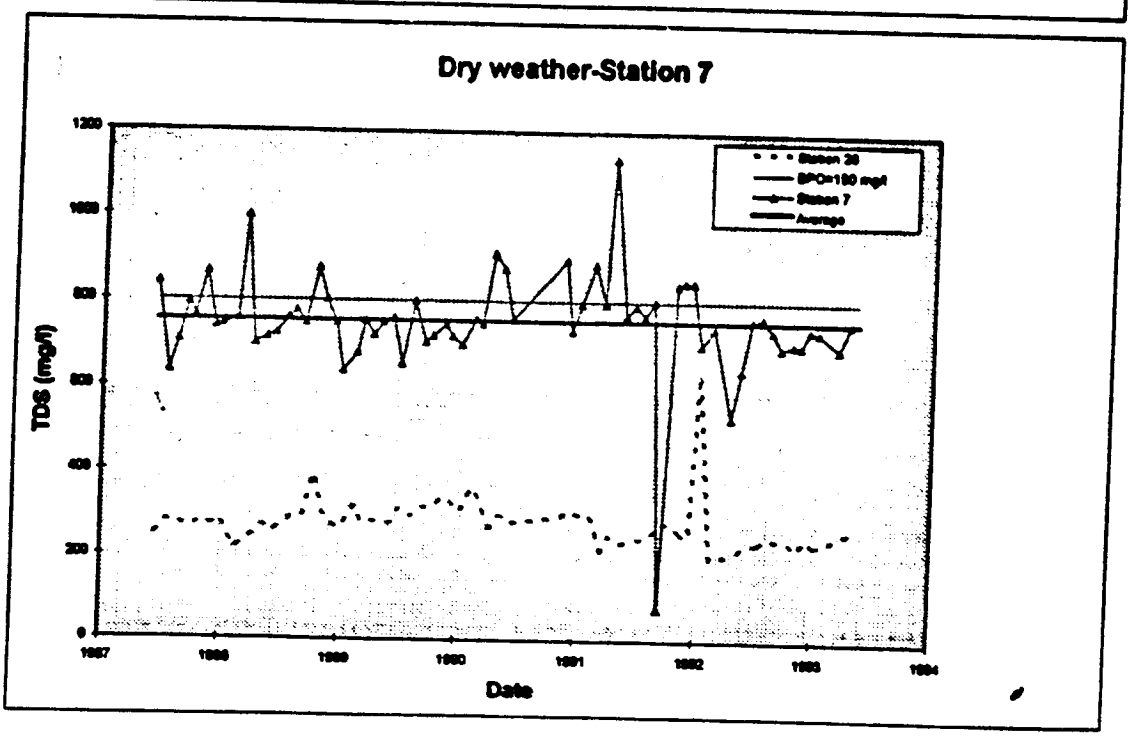

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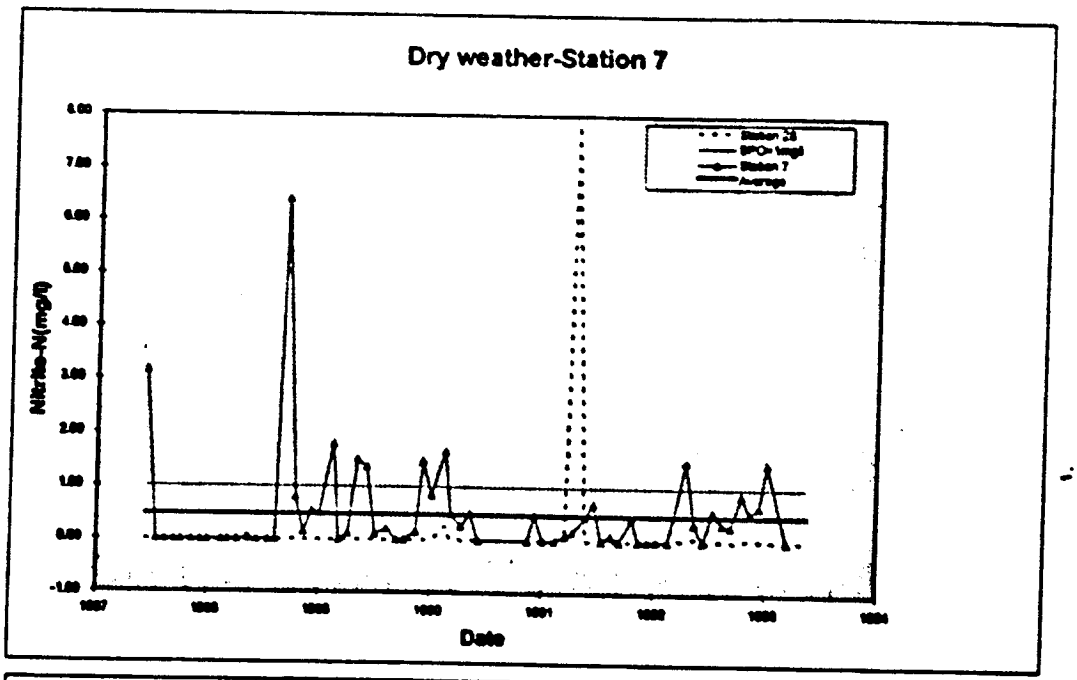

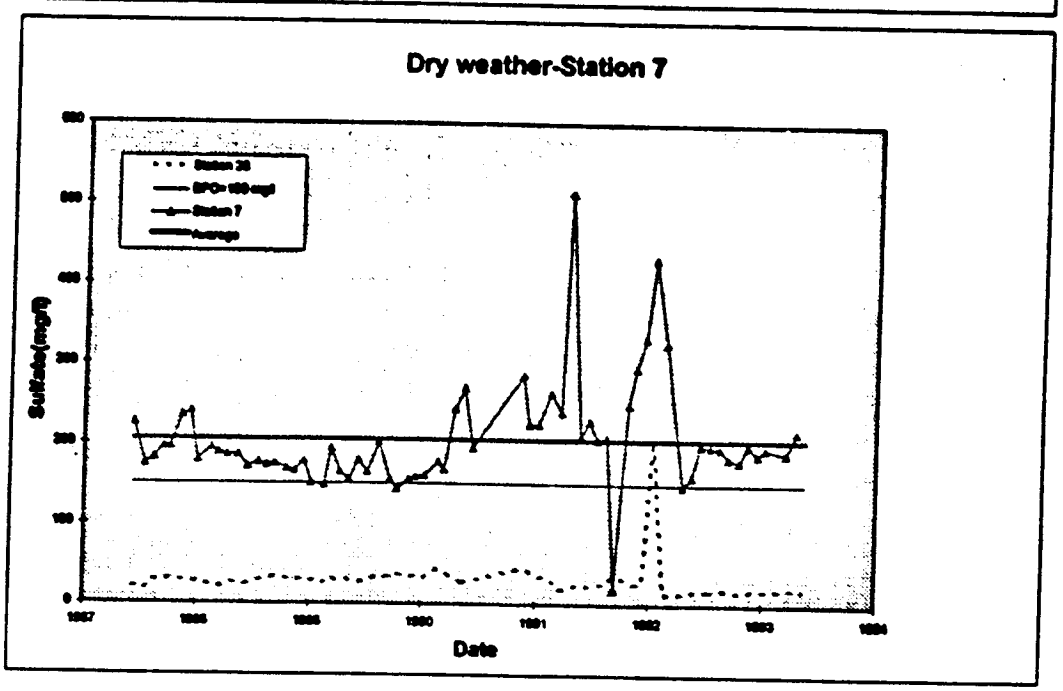

VOL 15

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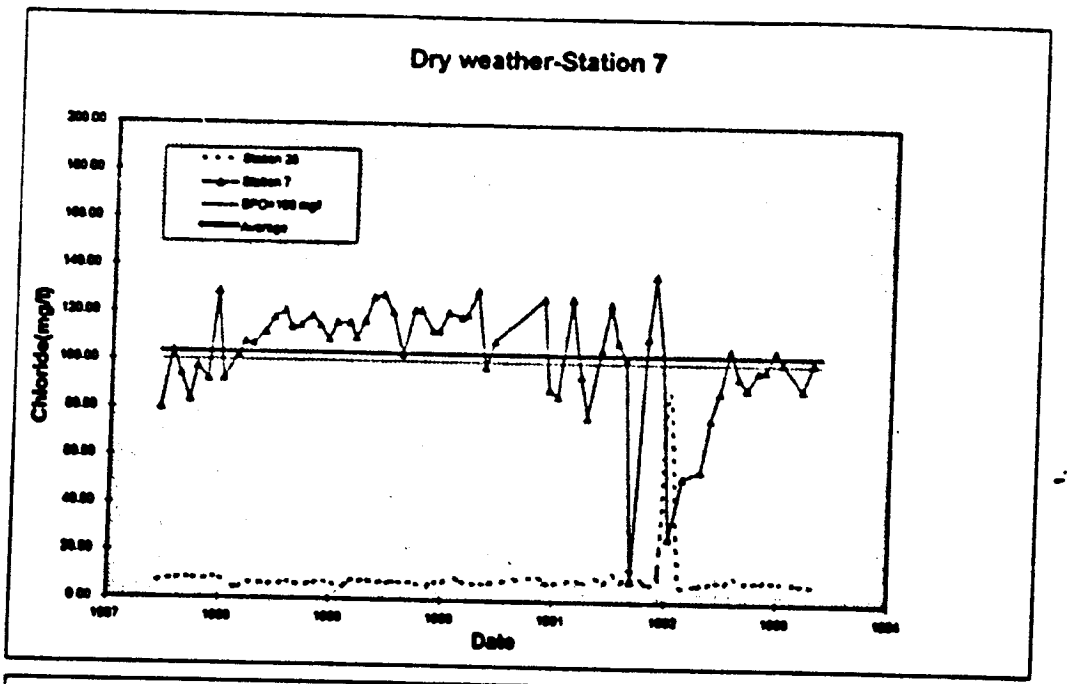

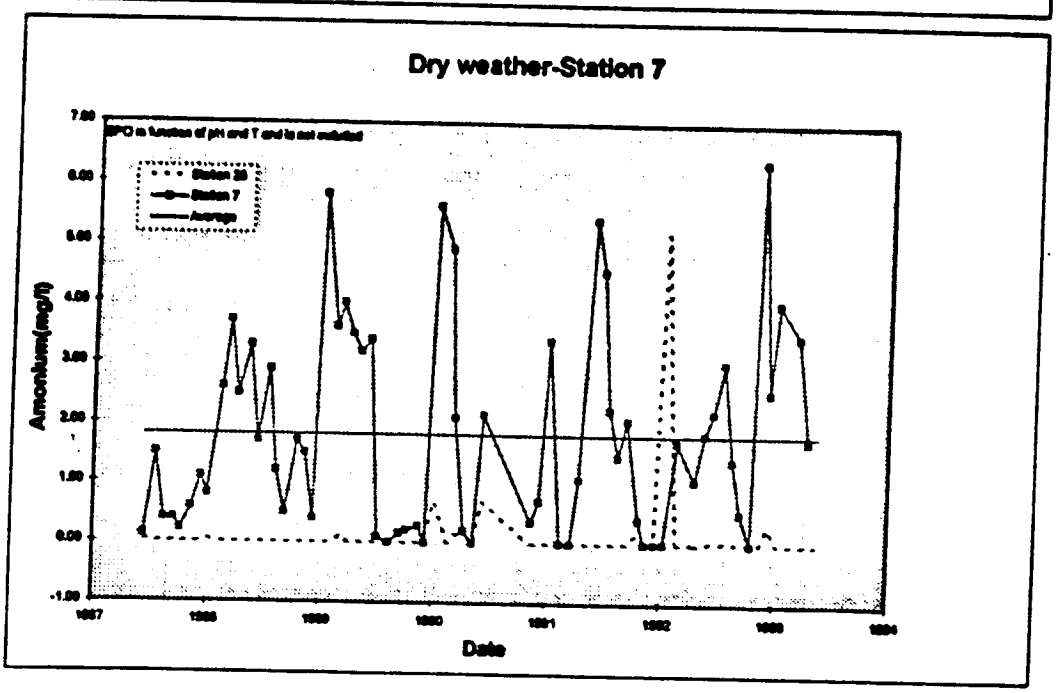

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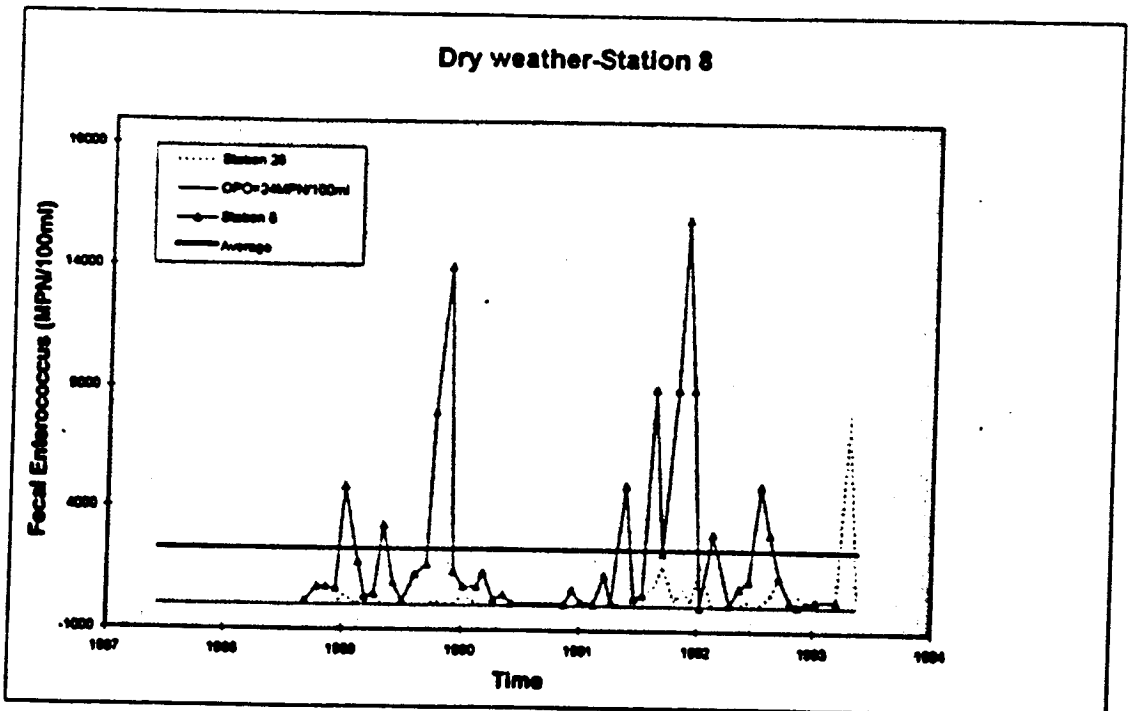

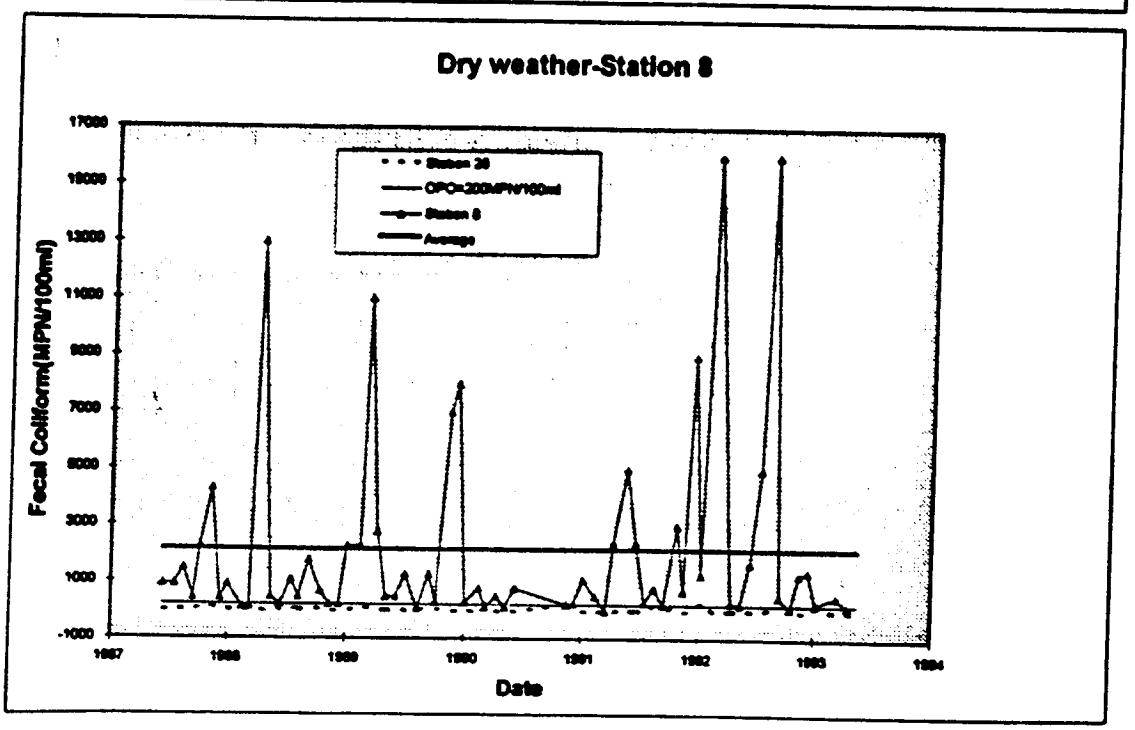

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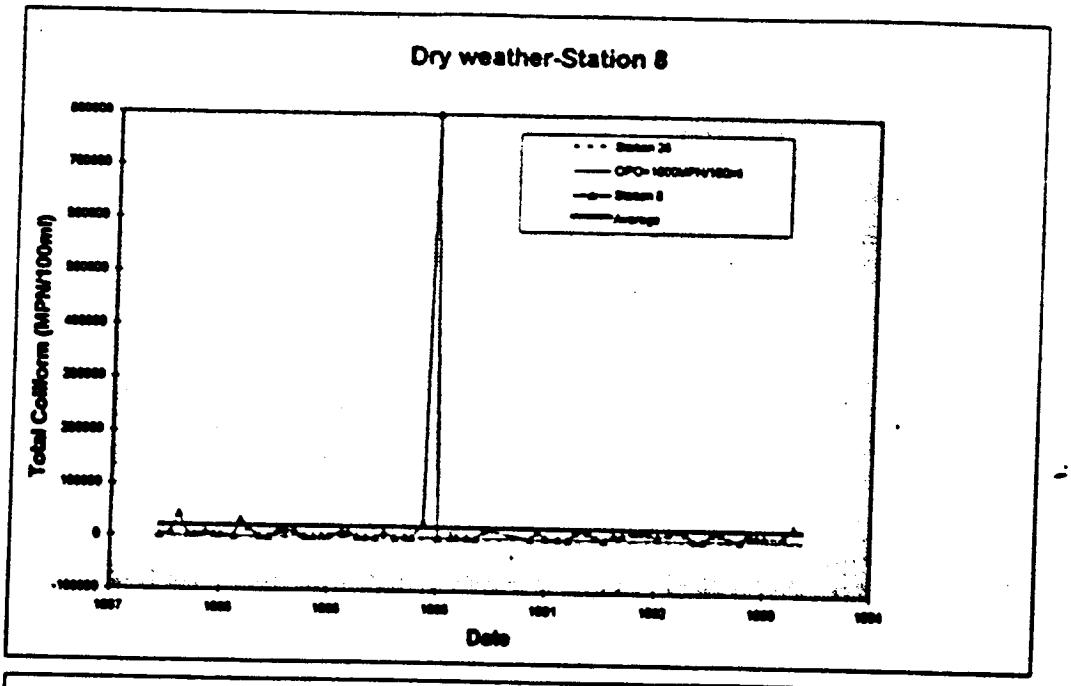

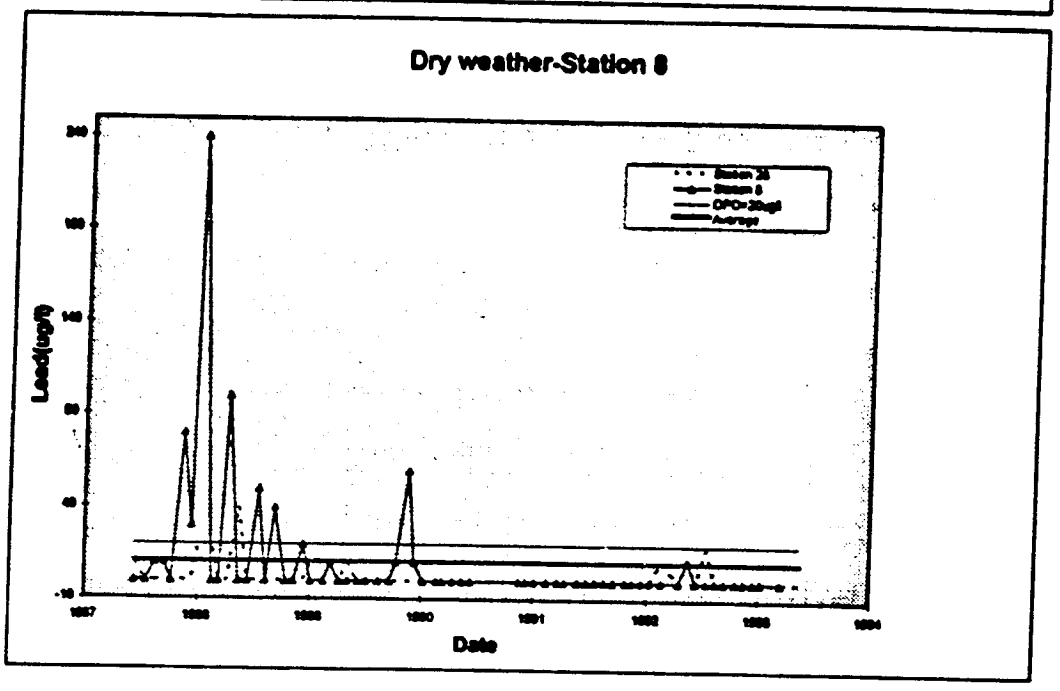

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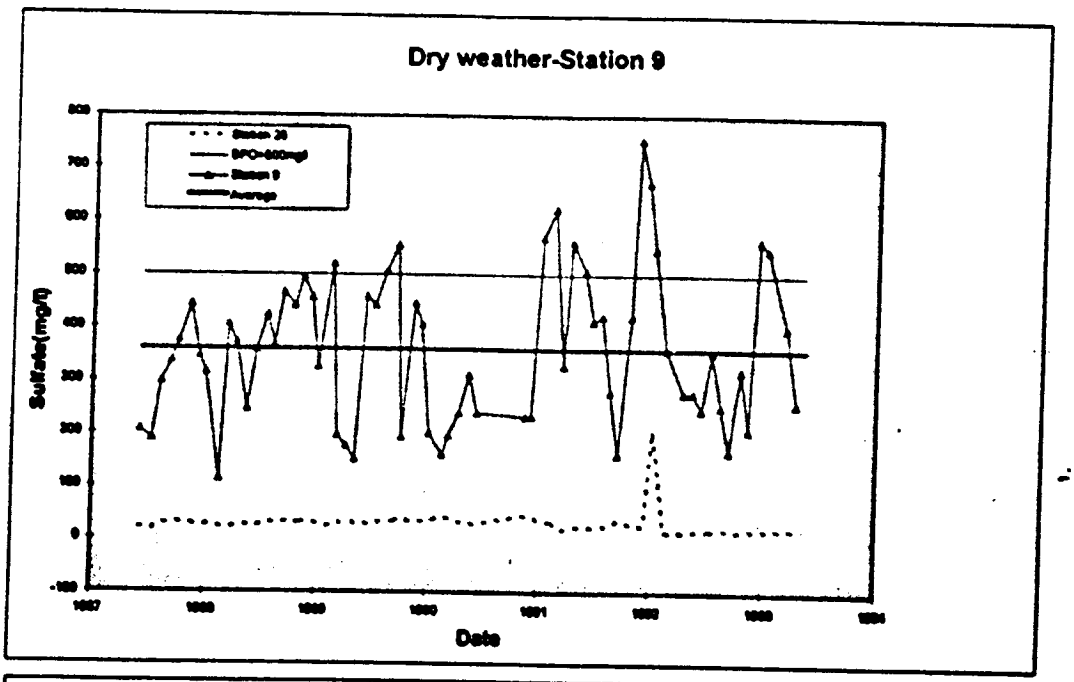

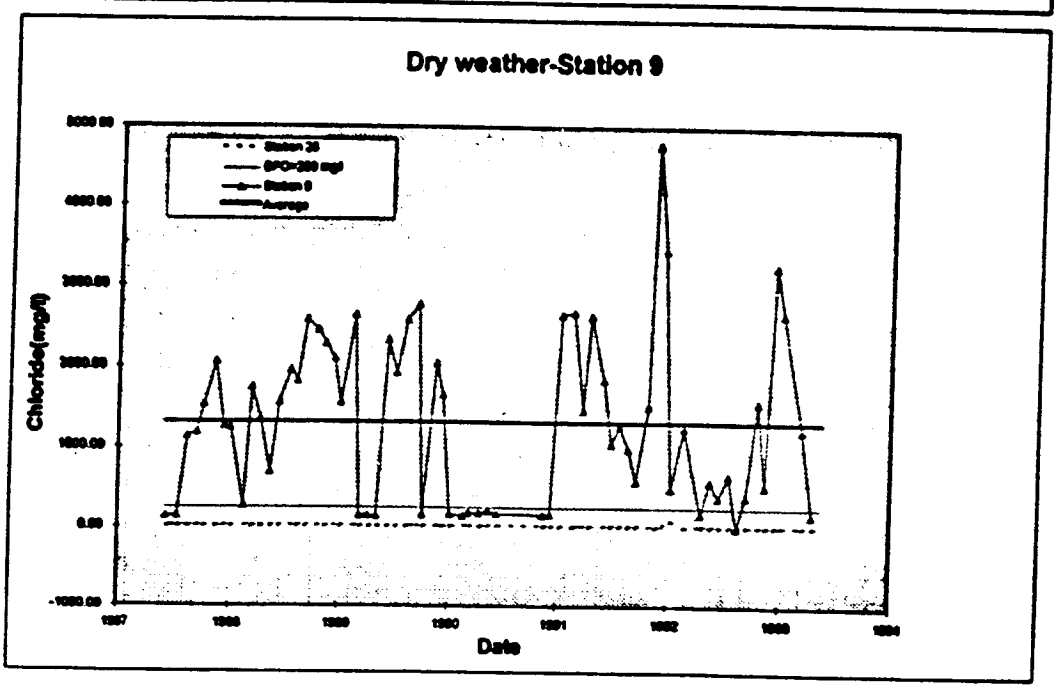

VOL 15

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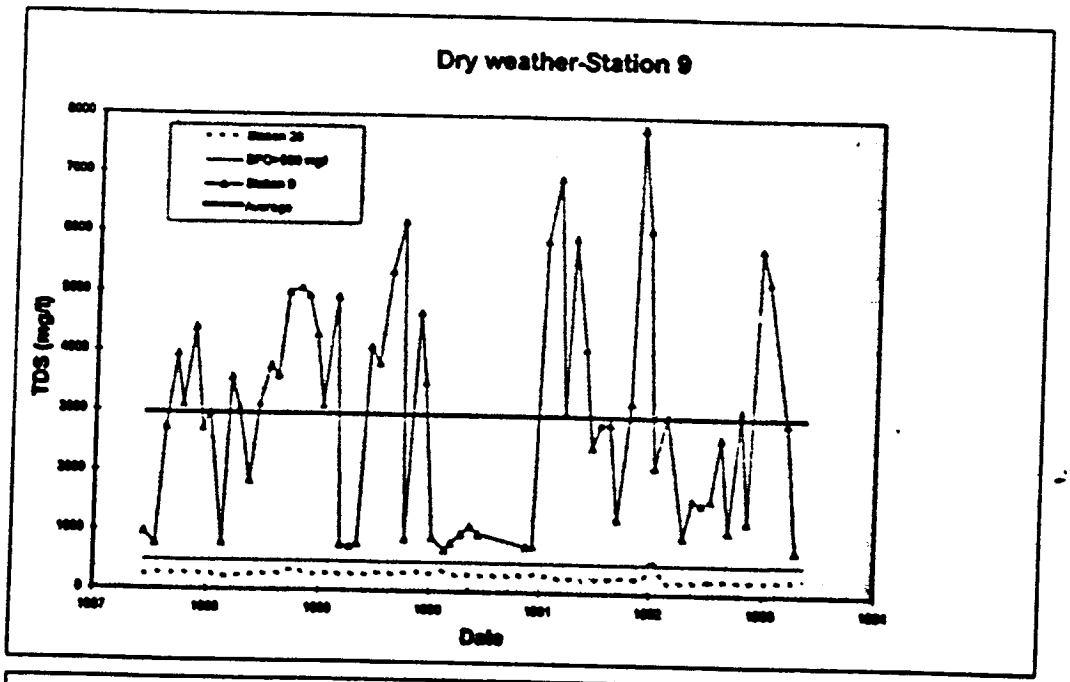
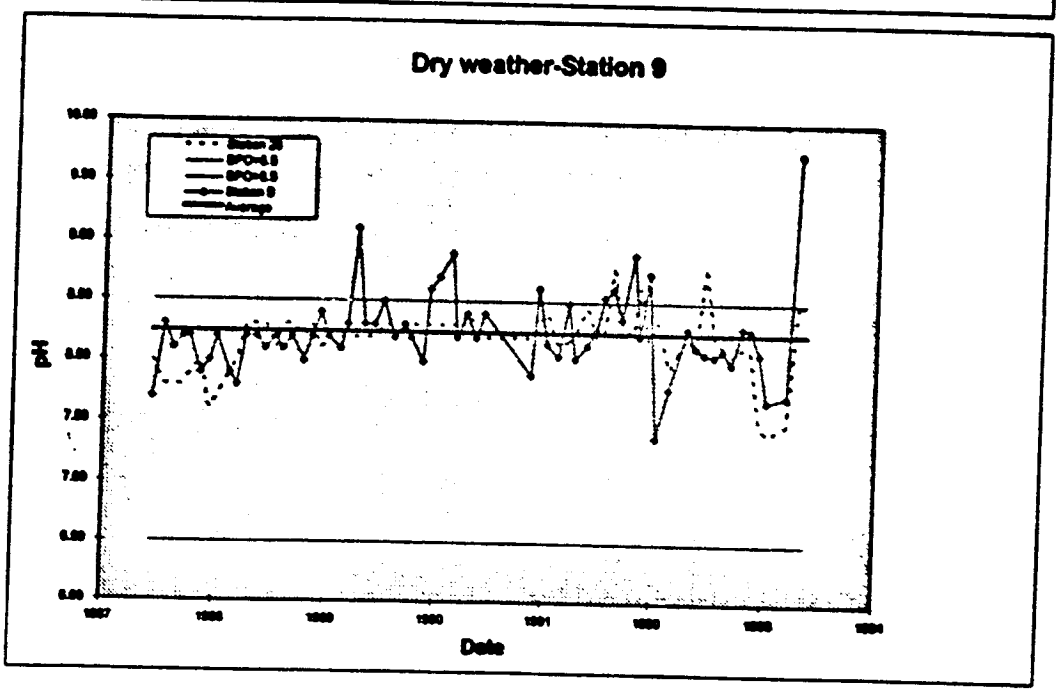
R0061022

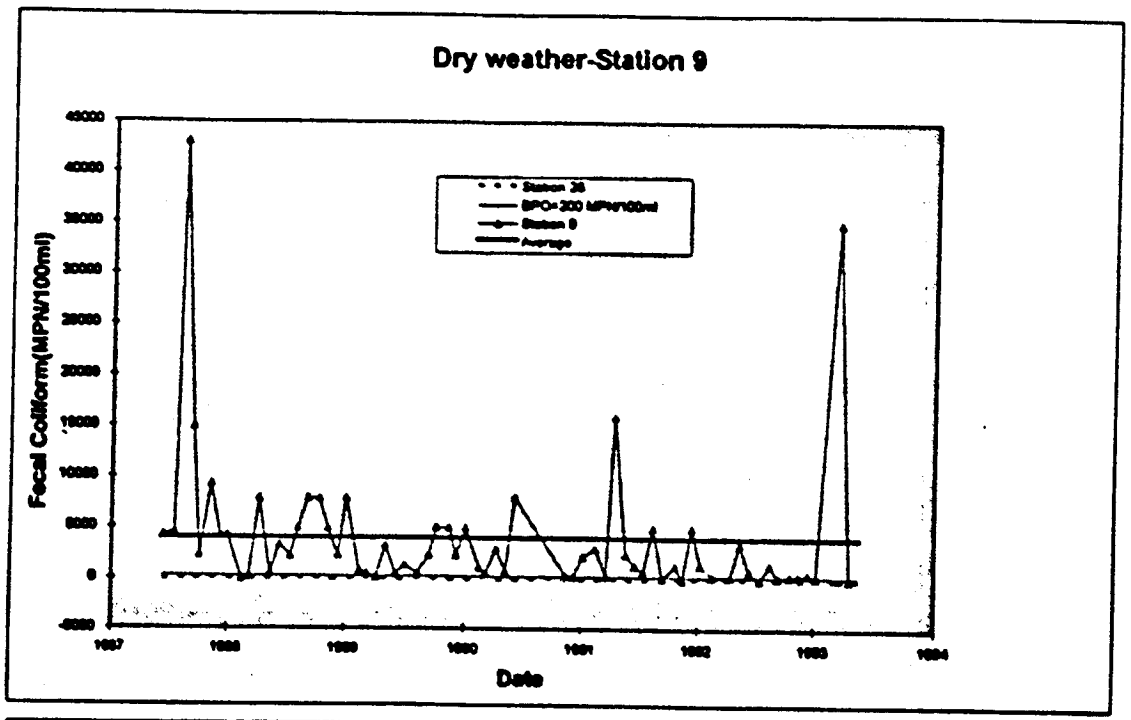


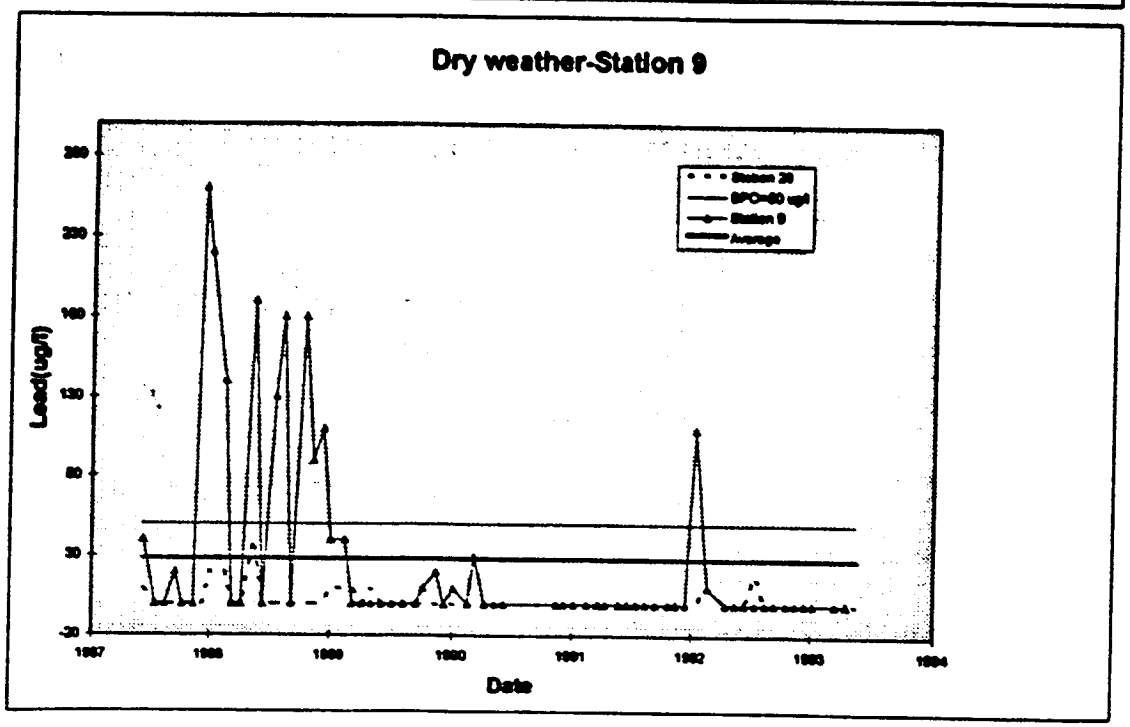


VOL 15

08003

R0061023

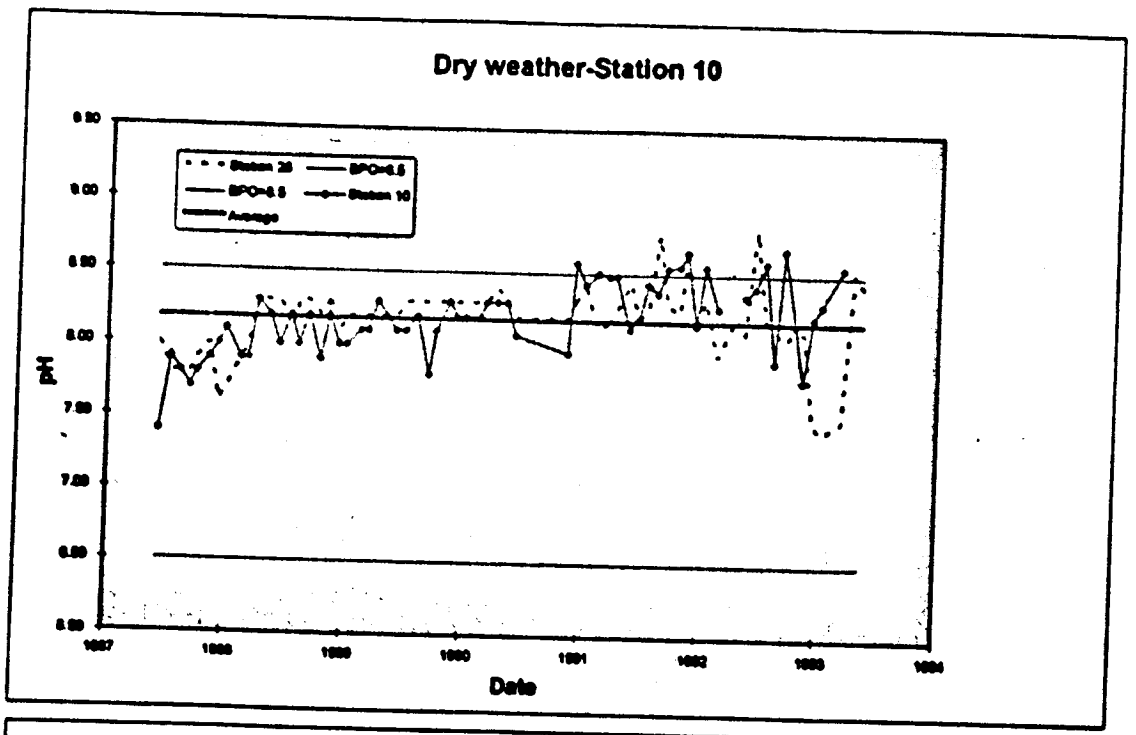


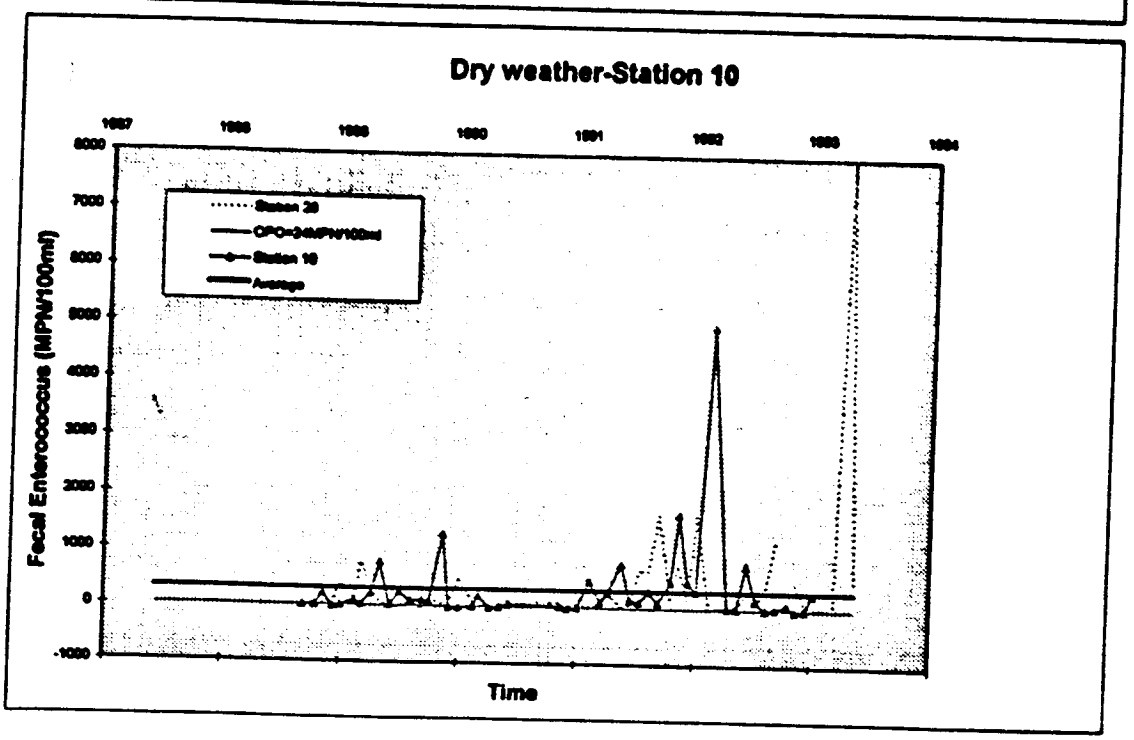


VOL 15

0804

R0061024

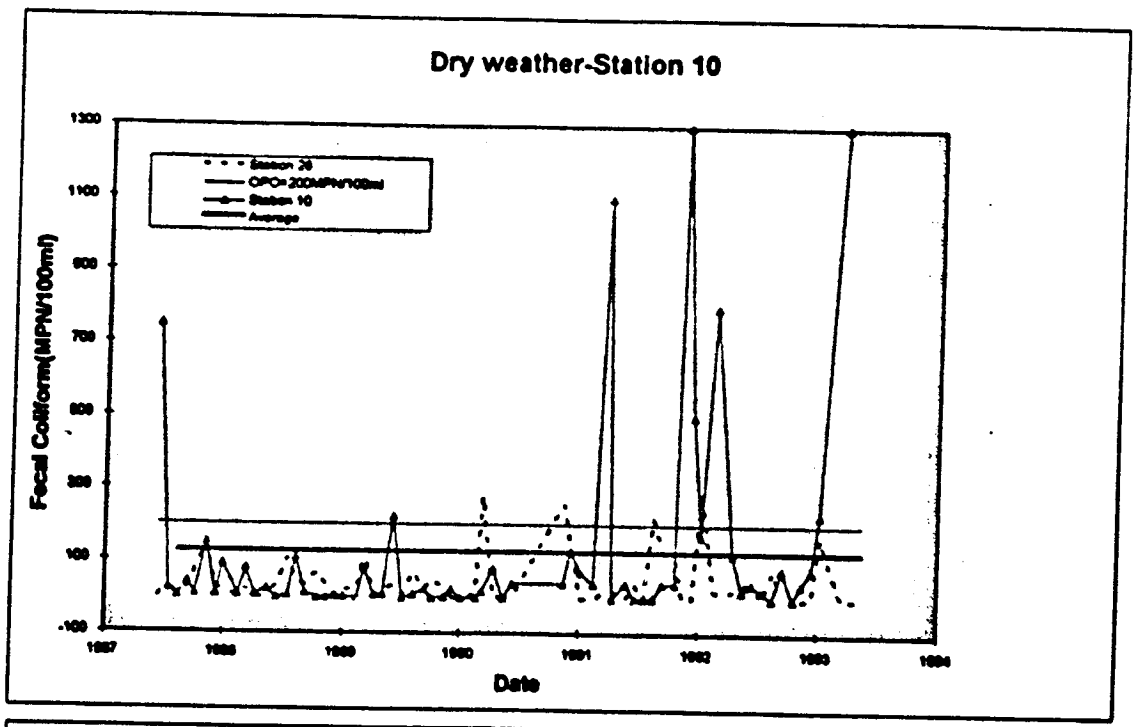


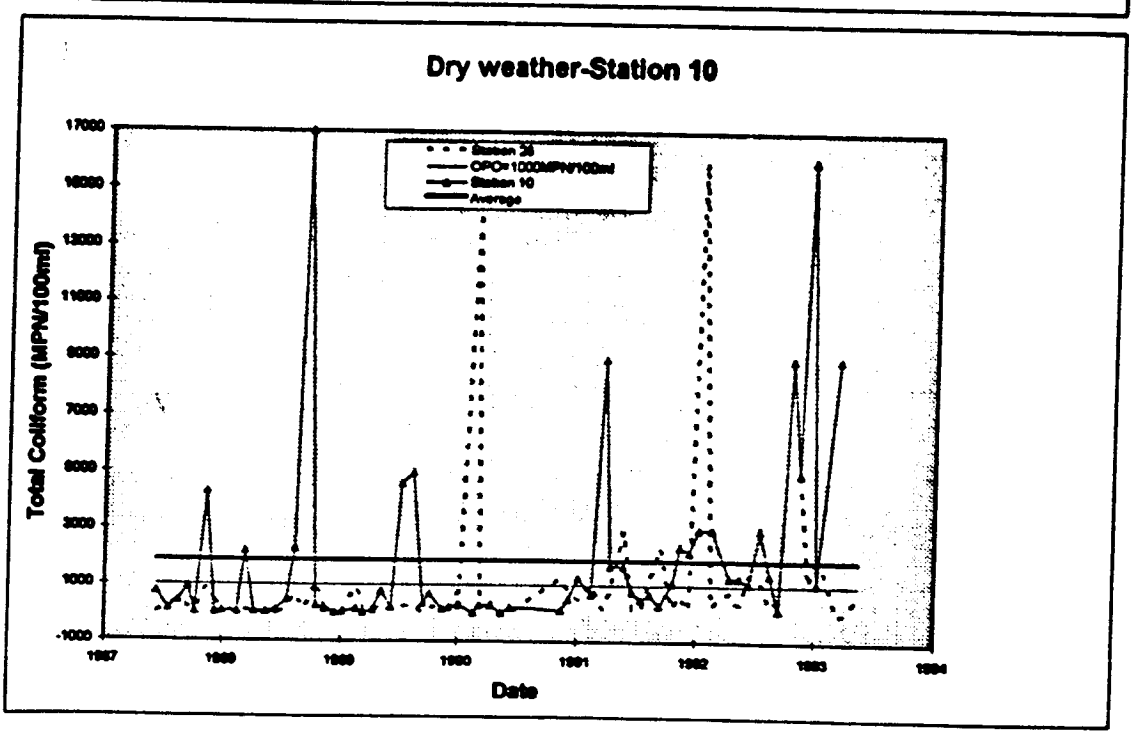


VOL 15

08005

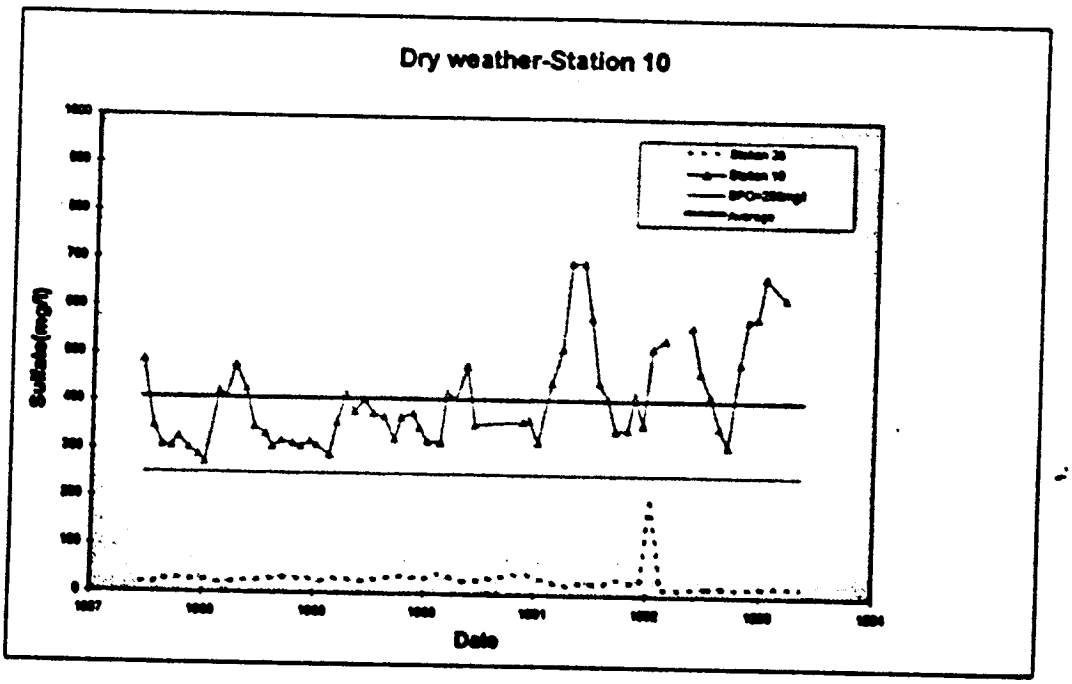
R0061025


Dry weather-Station 10
Fecal Coliform(MPN/100ml)
Date


Dry weather-Station 10
Total Coliform (MPN/100ml)
Date

VOL 15

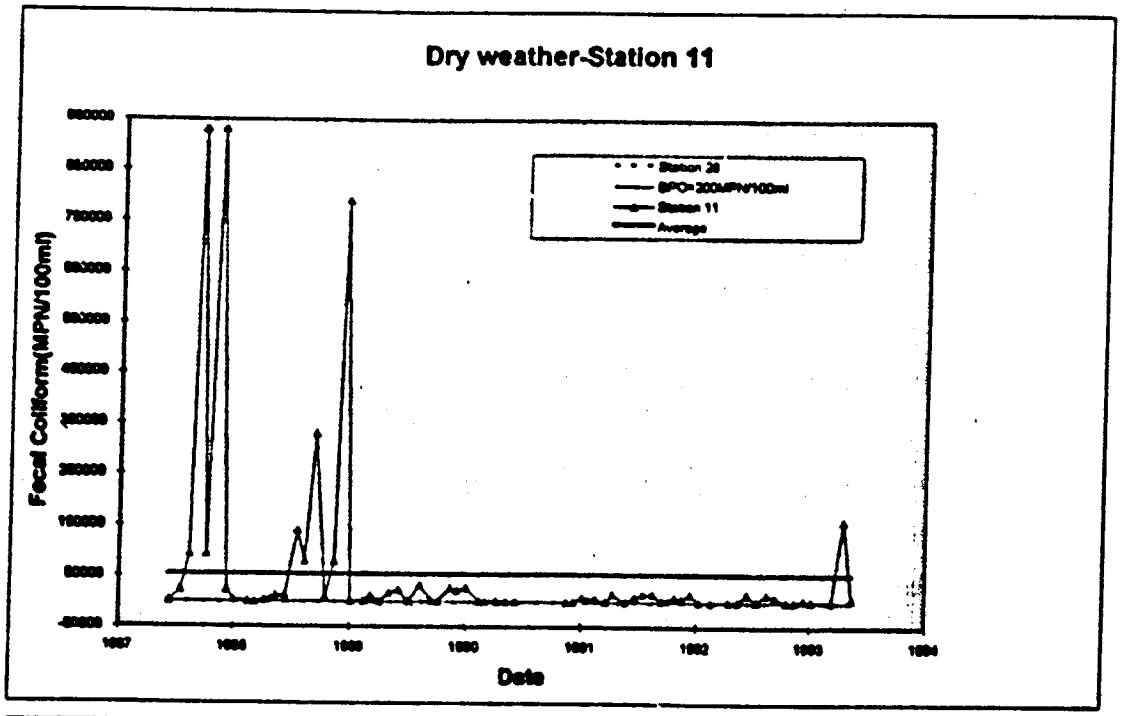
08006

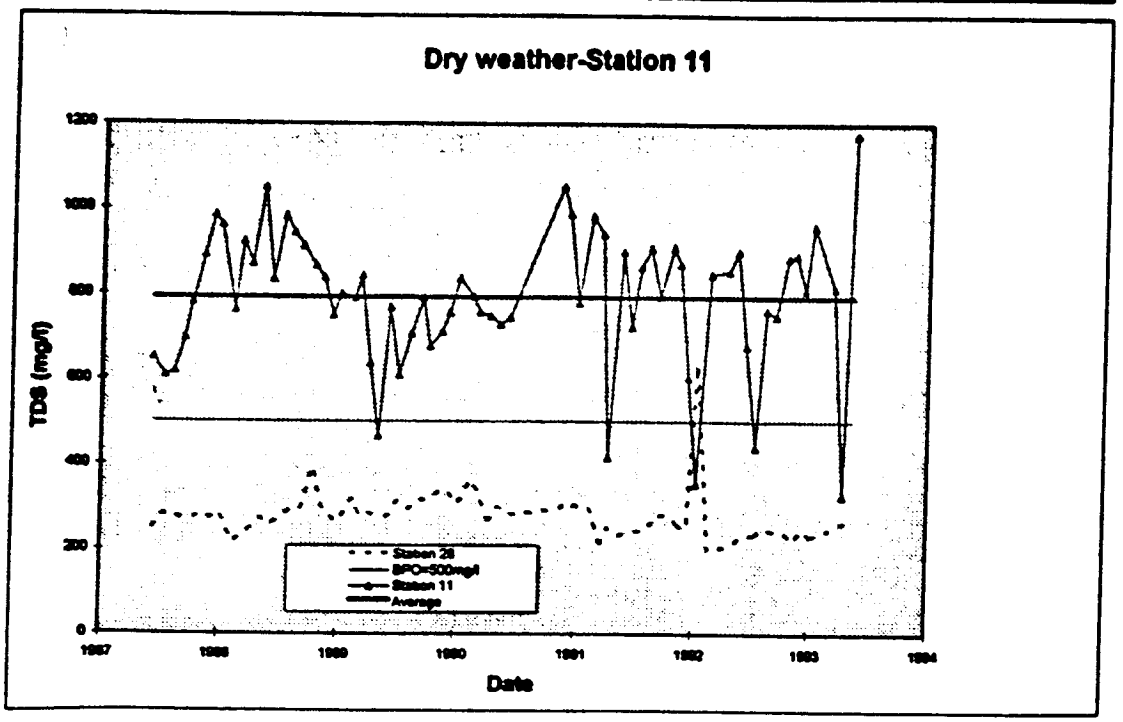


VOL 15

0807

R0061027

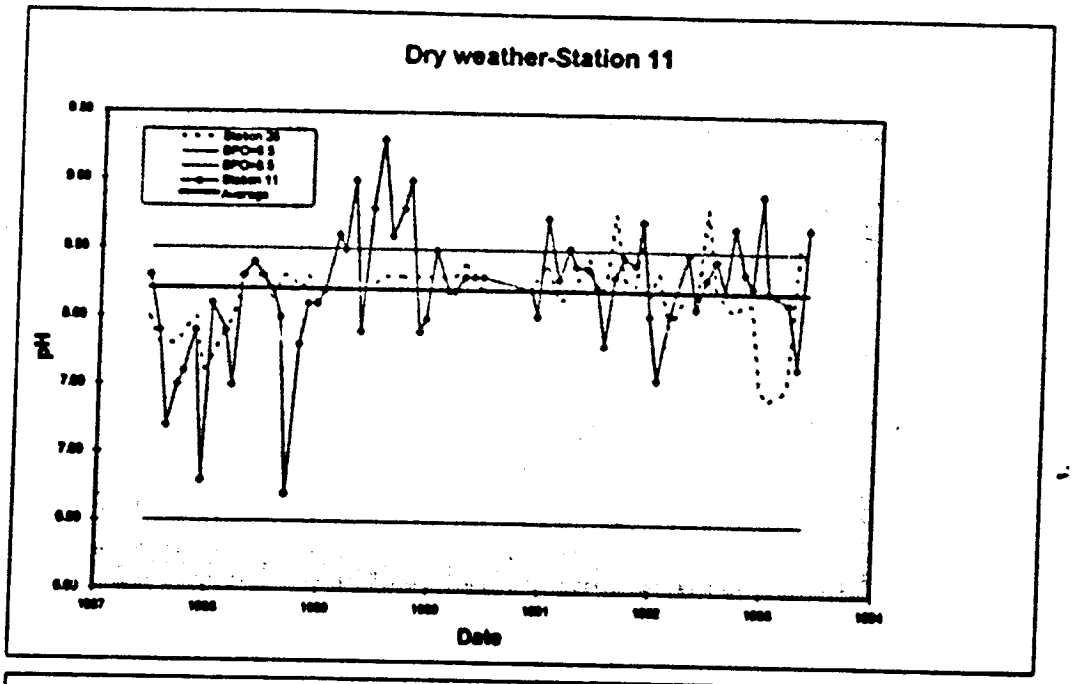


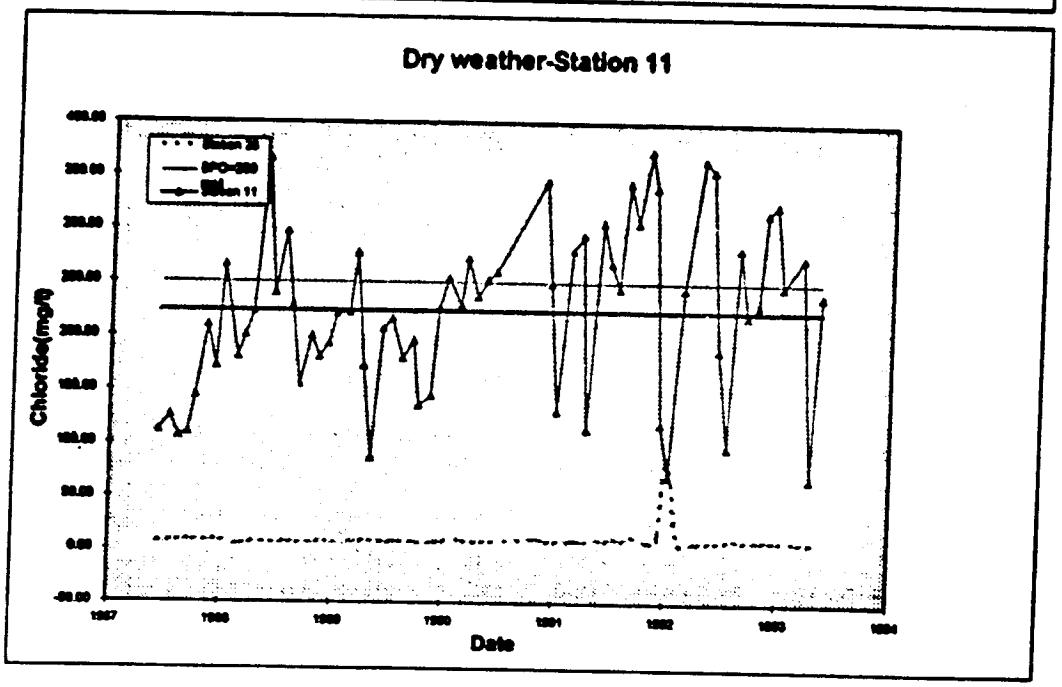


VOL 15

08008

R0061028

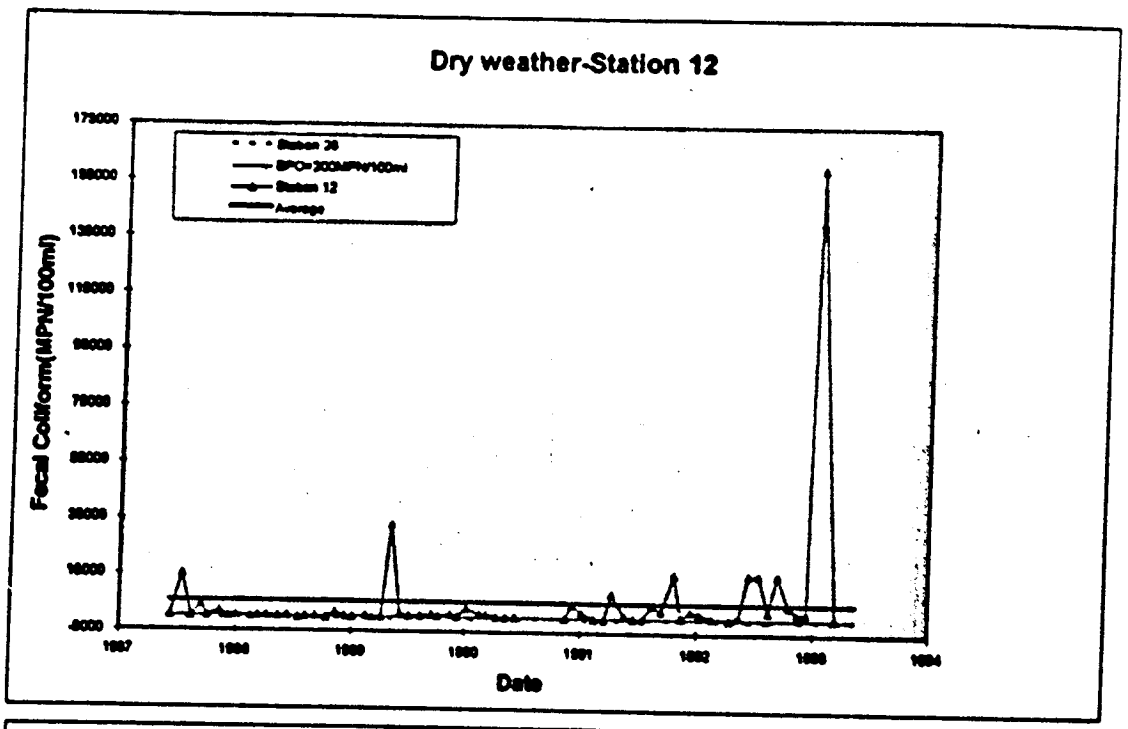


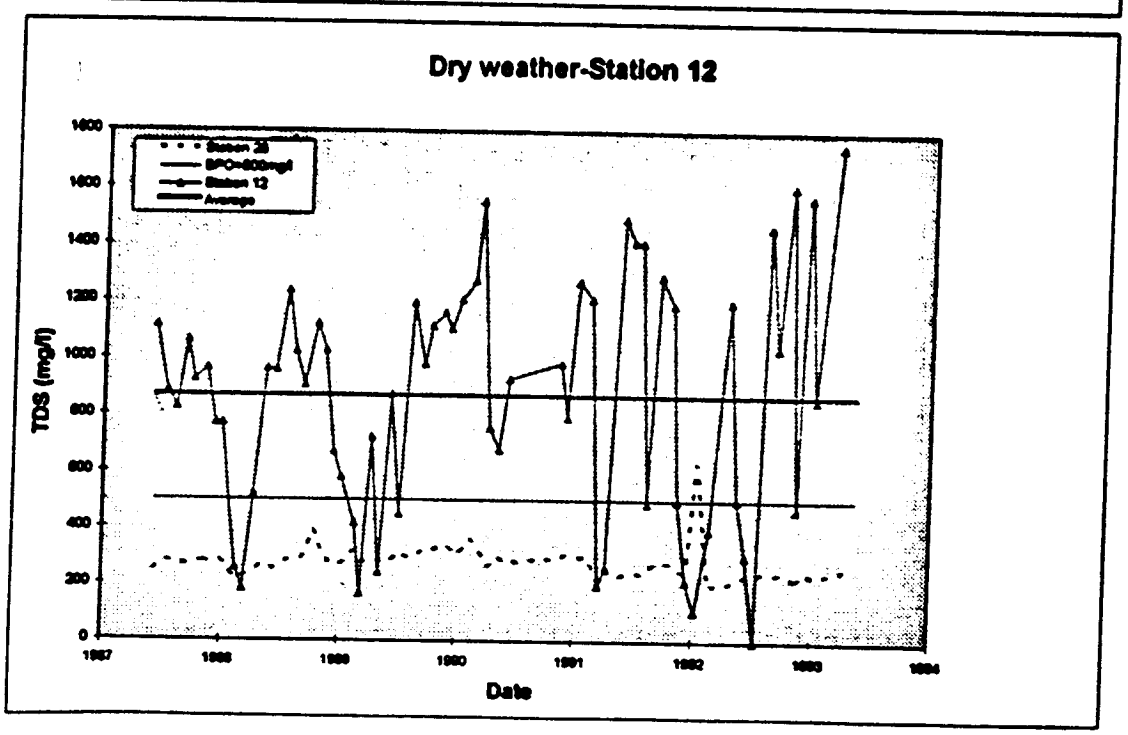


VOL 15

0809

R0061029

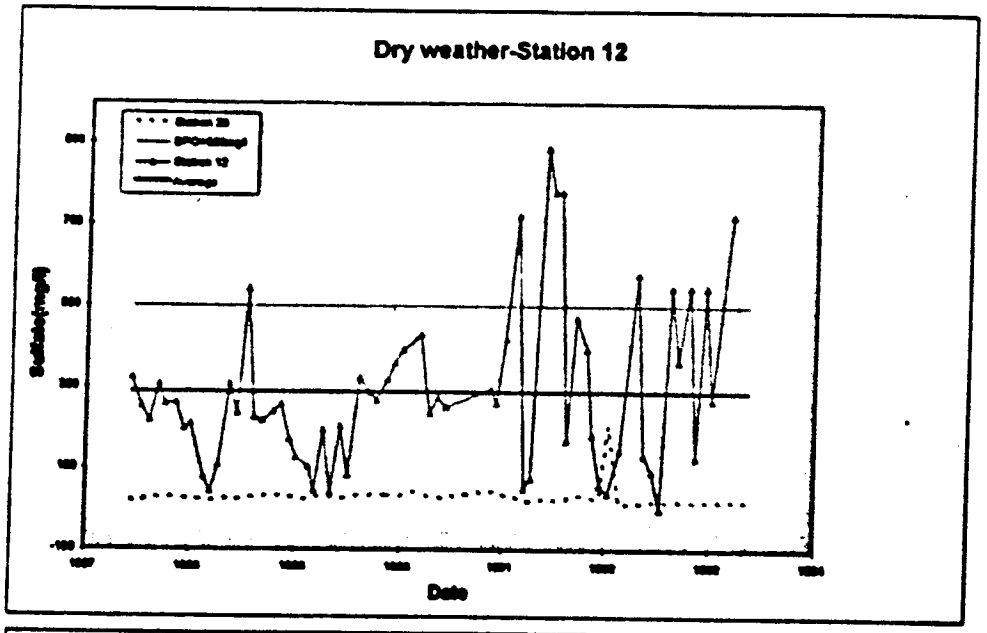


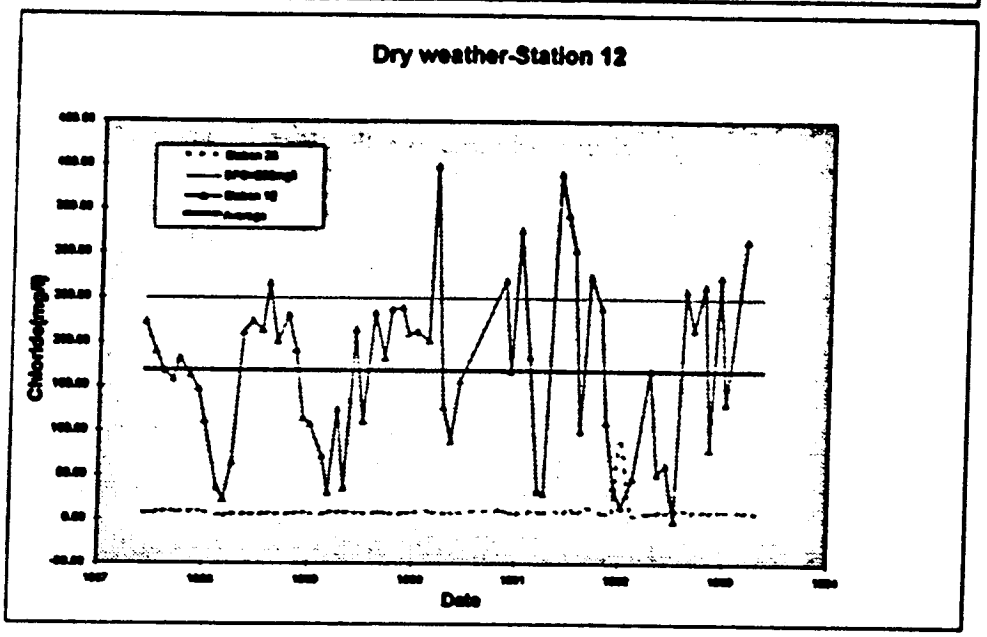


VOL 15

08-10

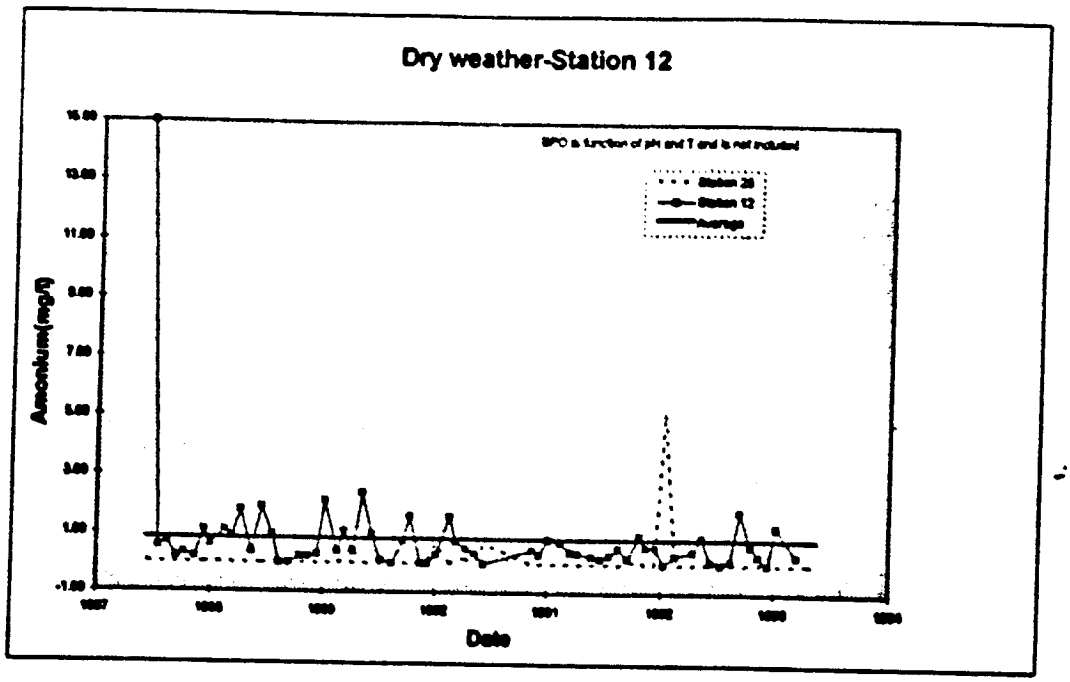
R0061030


Dry weather-Station 12
Sulfate(mg/l)
Date


Dry weather-Station 12
Chloride(mg/l)
Date

VOL 15

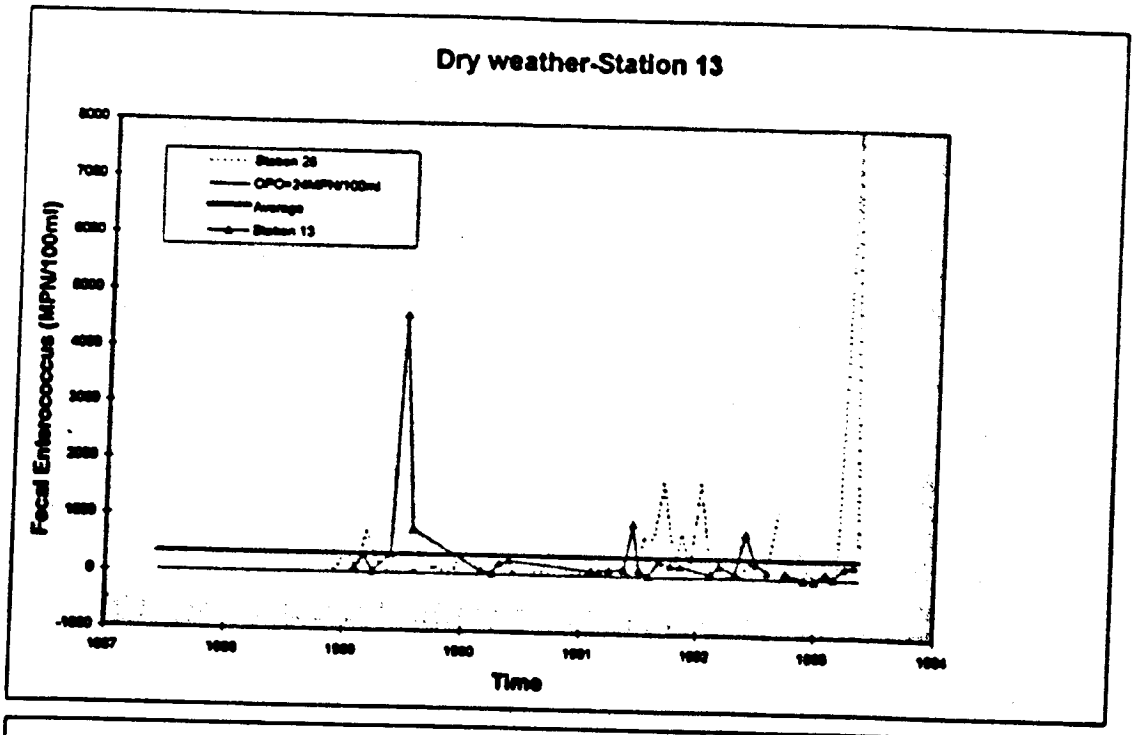
08-11

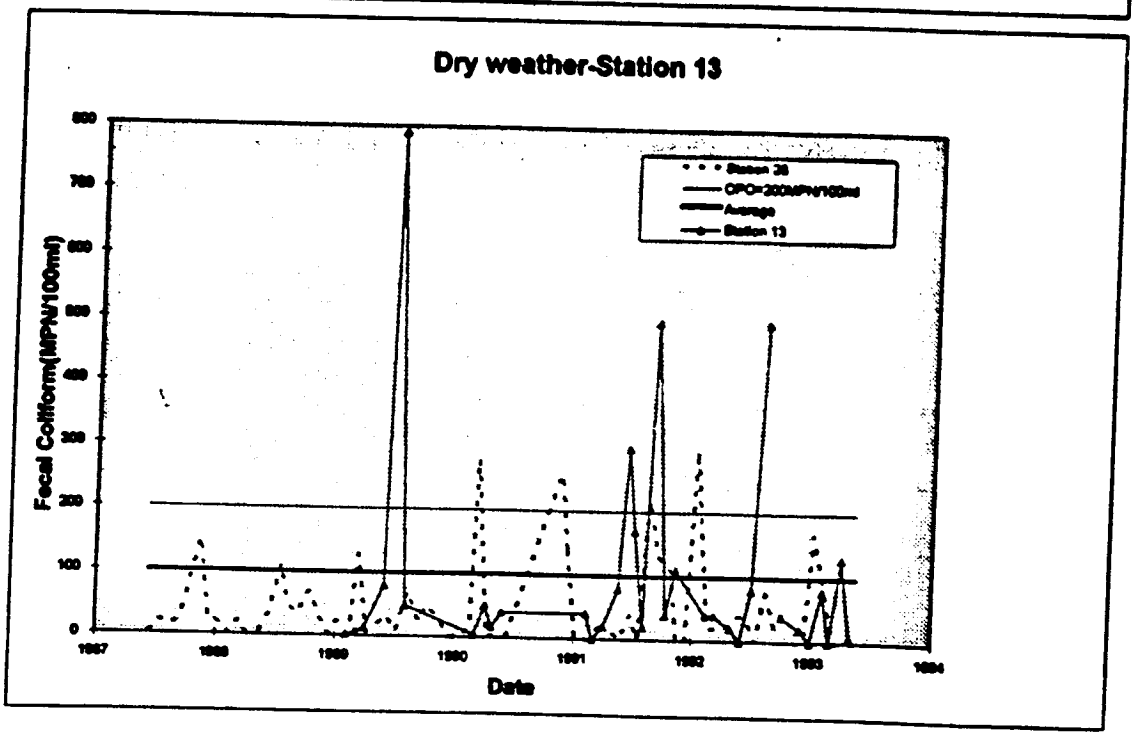


VOL 15

0812

R0061032

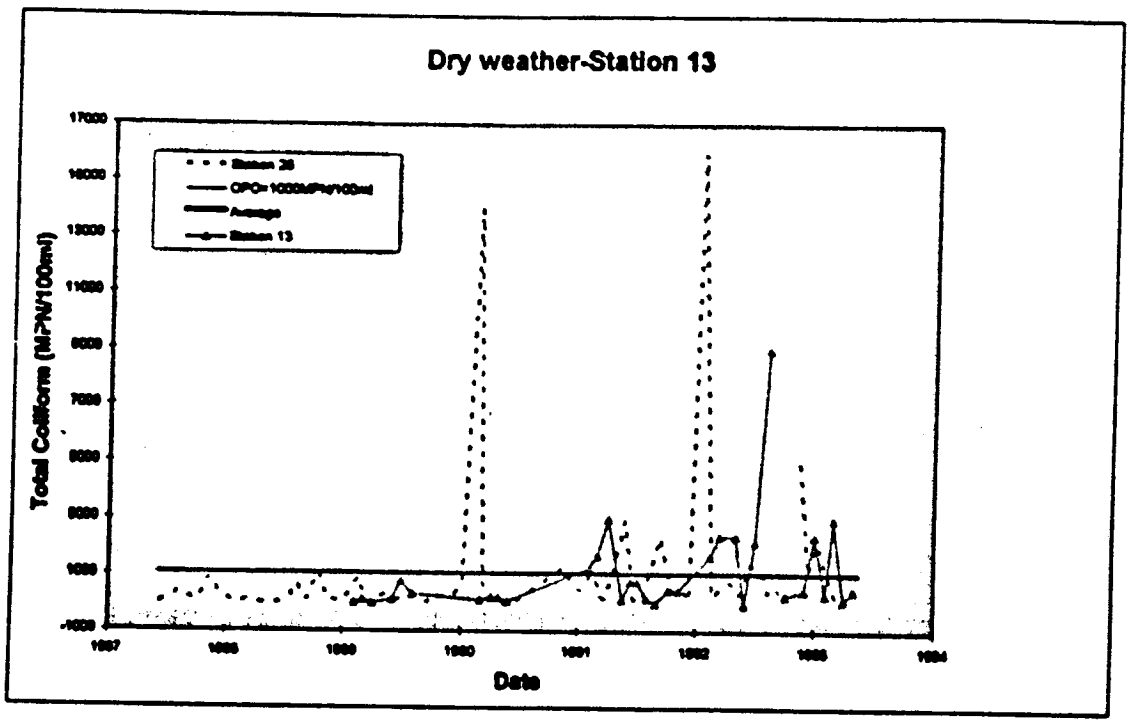




VOL 15

0813

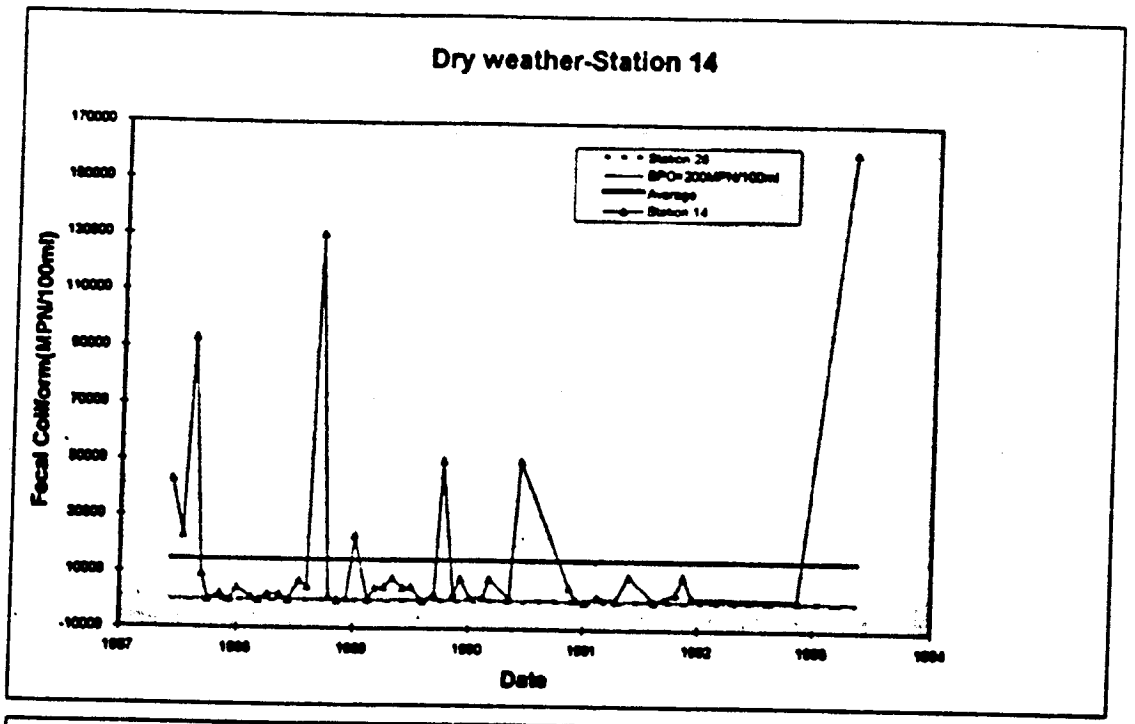
R0061033

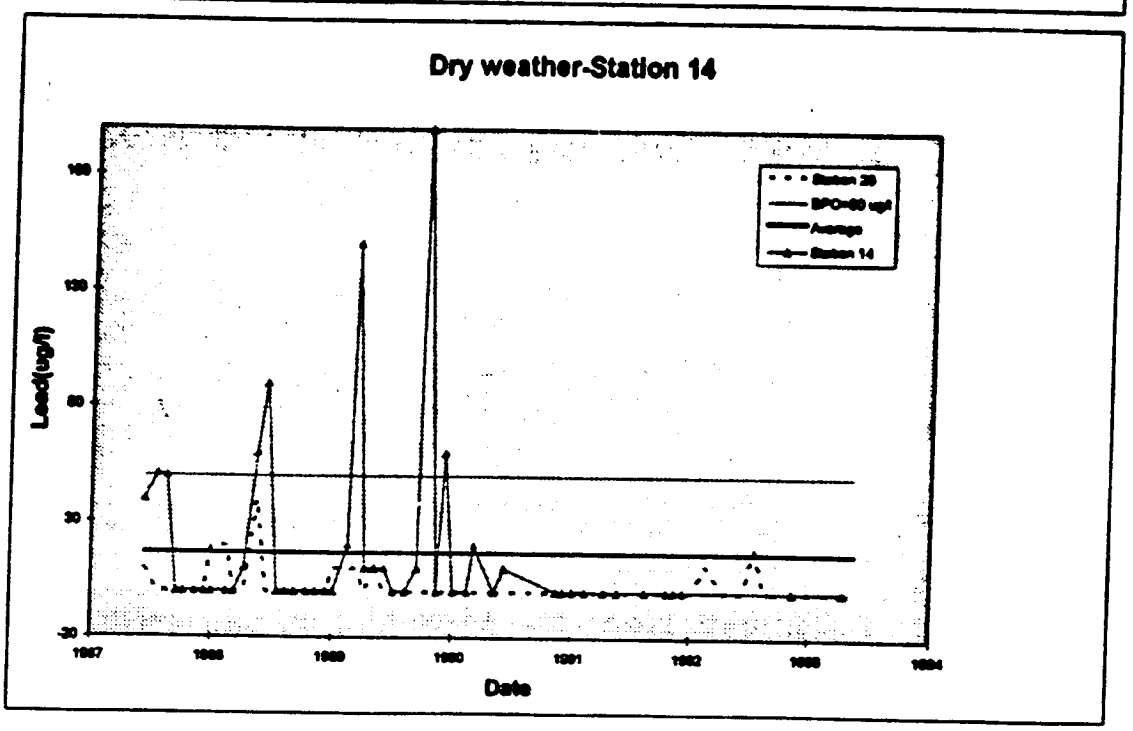


VOL 15

0814

R0061034

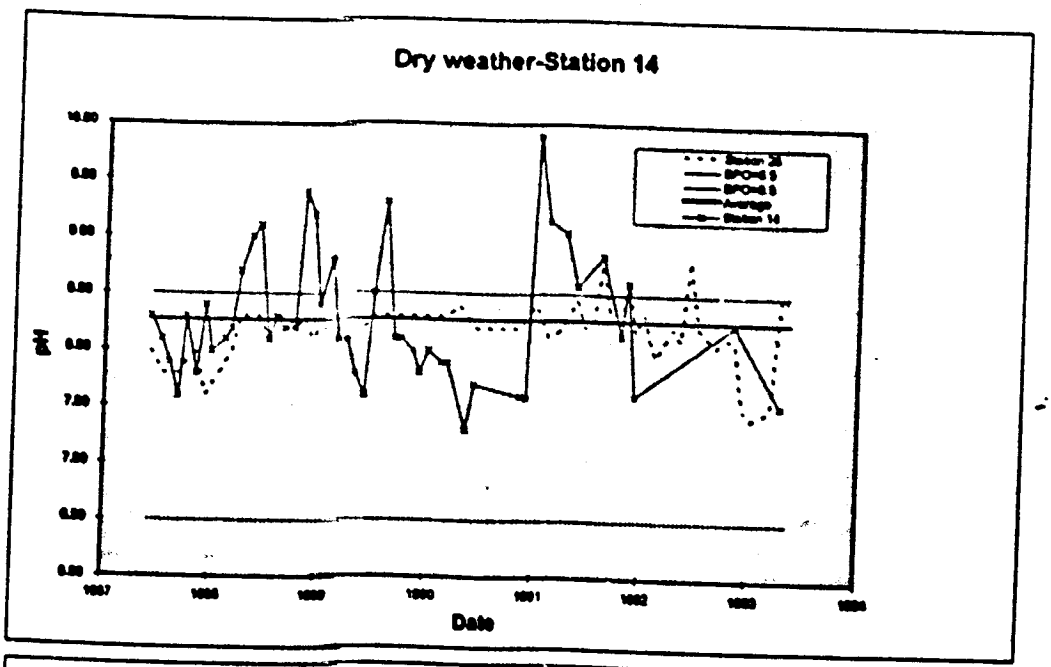


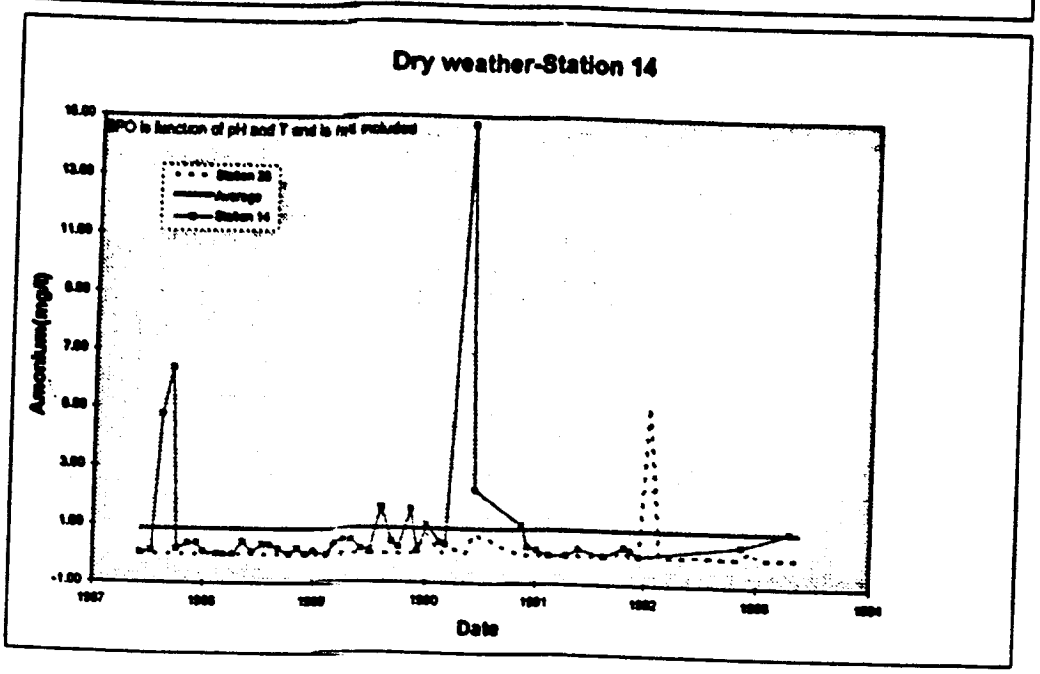


VOL 15

0815

R0061035

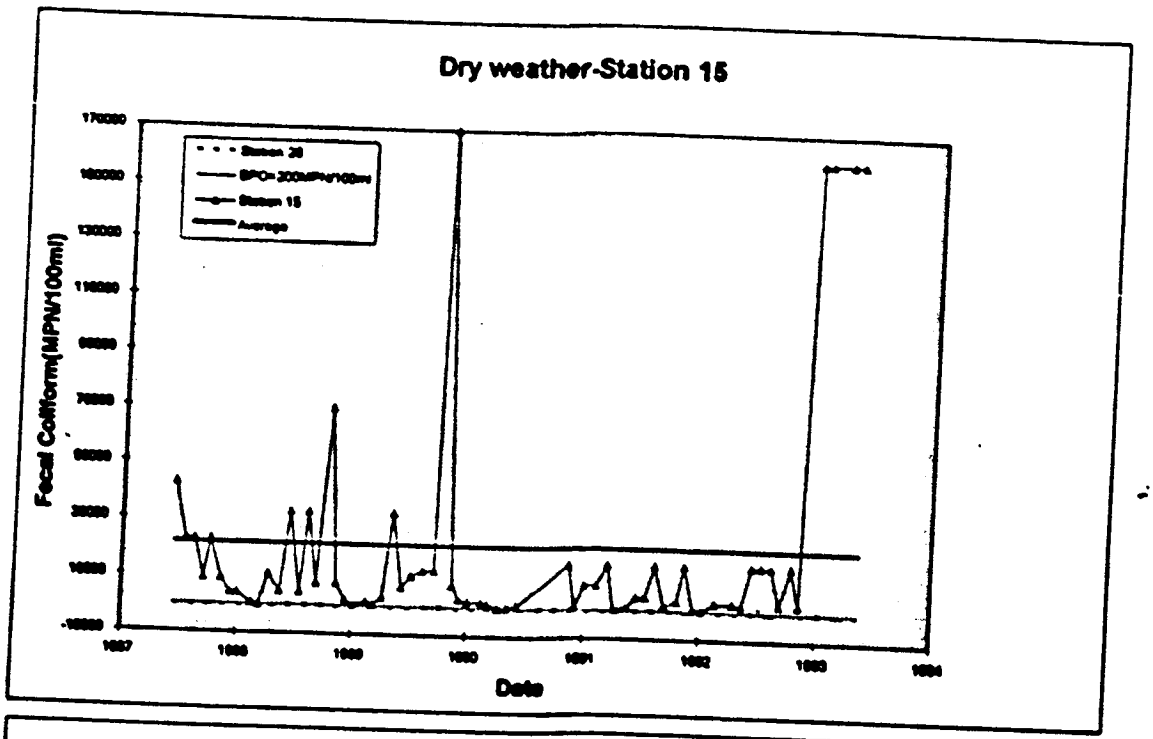


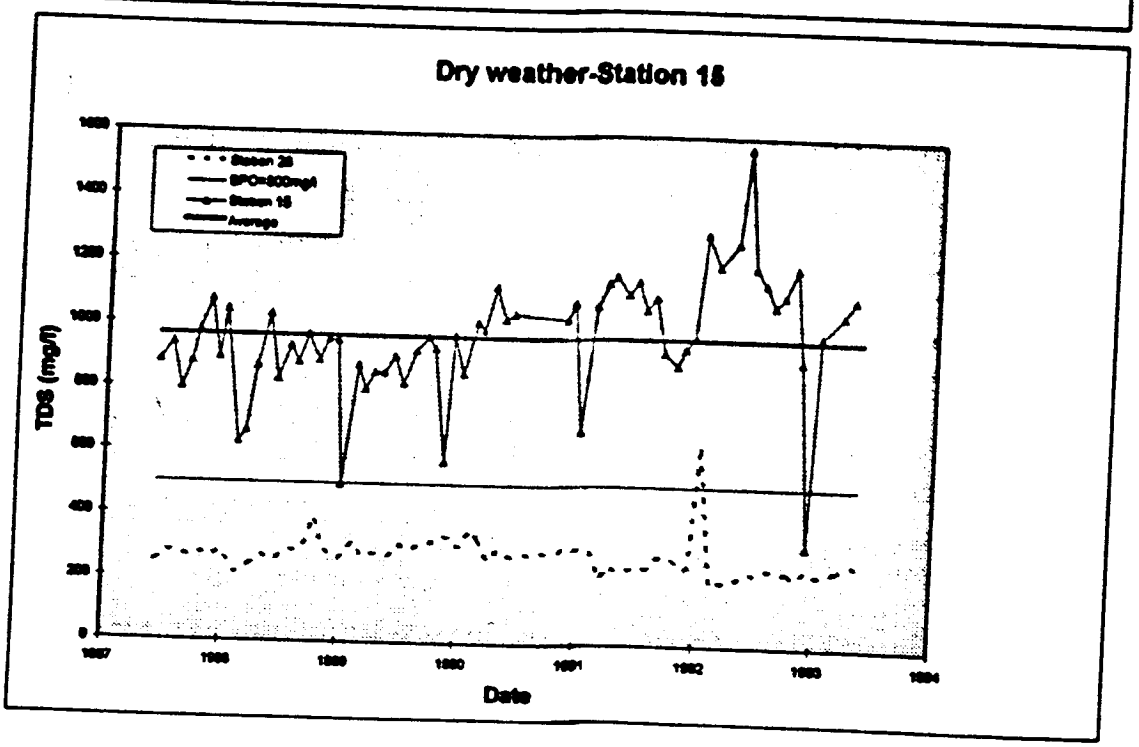


VOL 15

0816

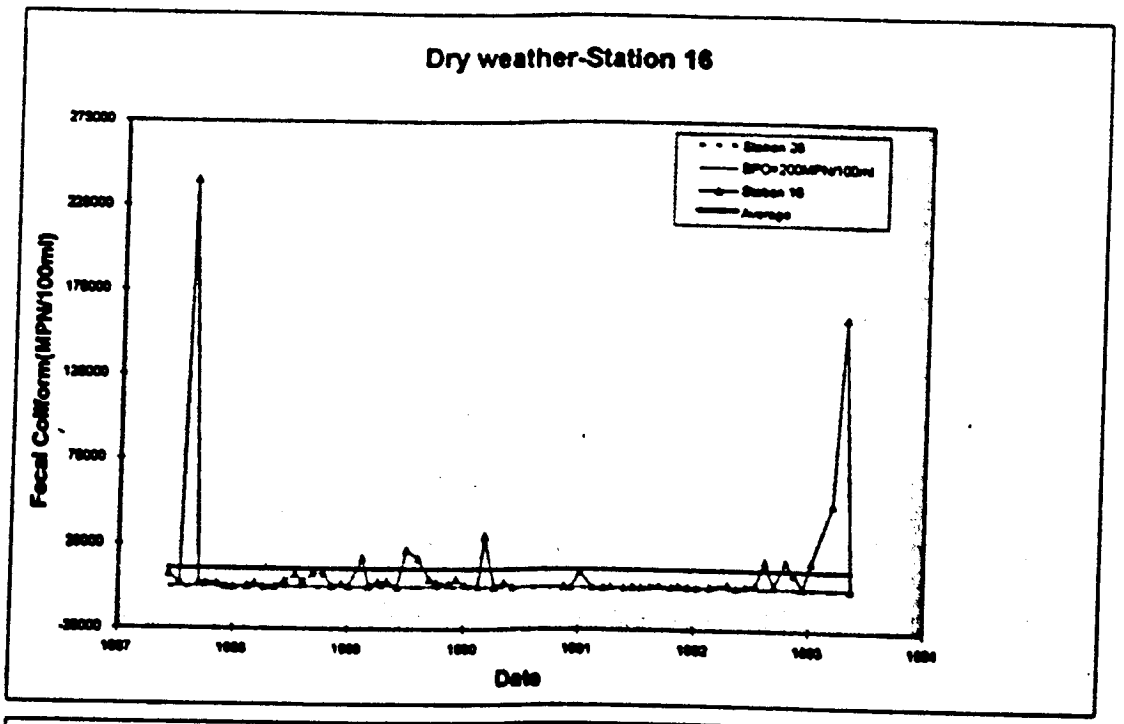
R0061036

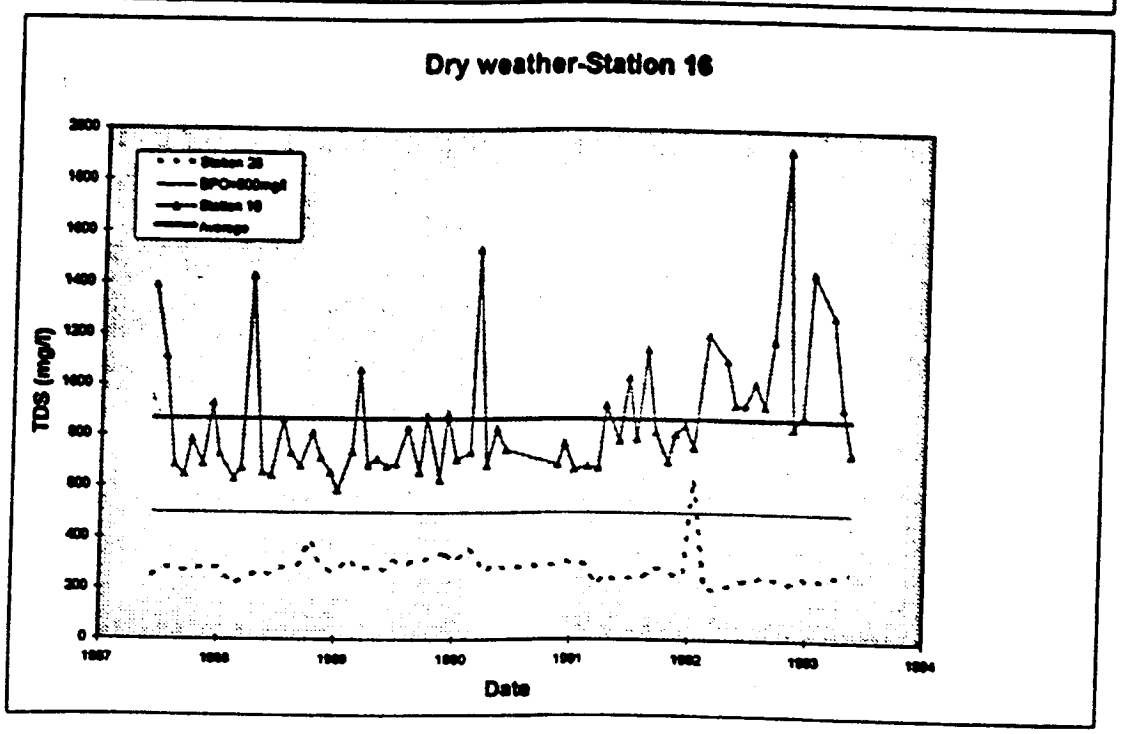

Dry weather-Station 15
Station 28
BPO=200MPN/100ml
Station 15
Average
Fecal Coliform(MPN/100ml)
Date


Dry weather-Station 15
Station 28
BPO=500mg/l
Station 15
Average
TDS (mg/l)
Date

VOL 15

0817

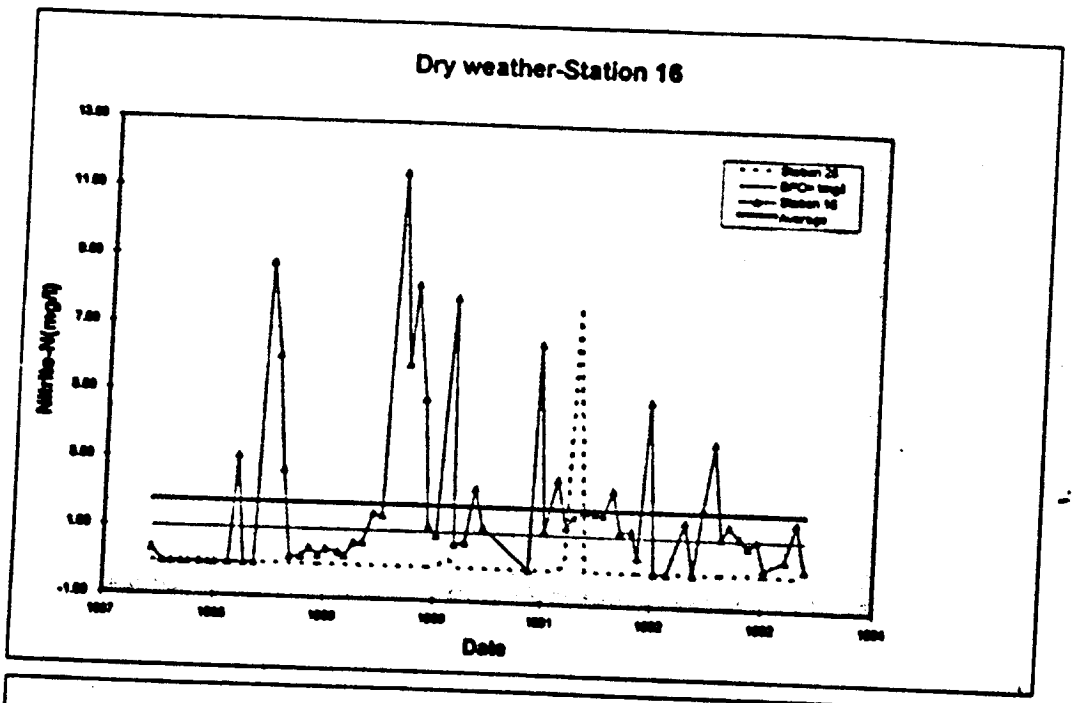


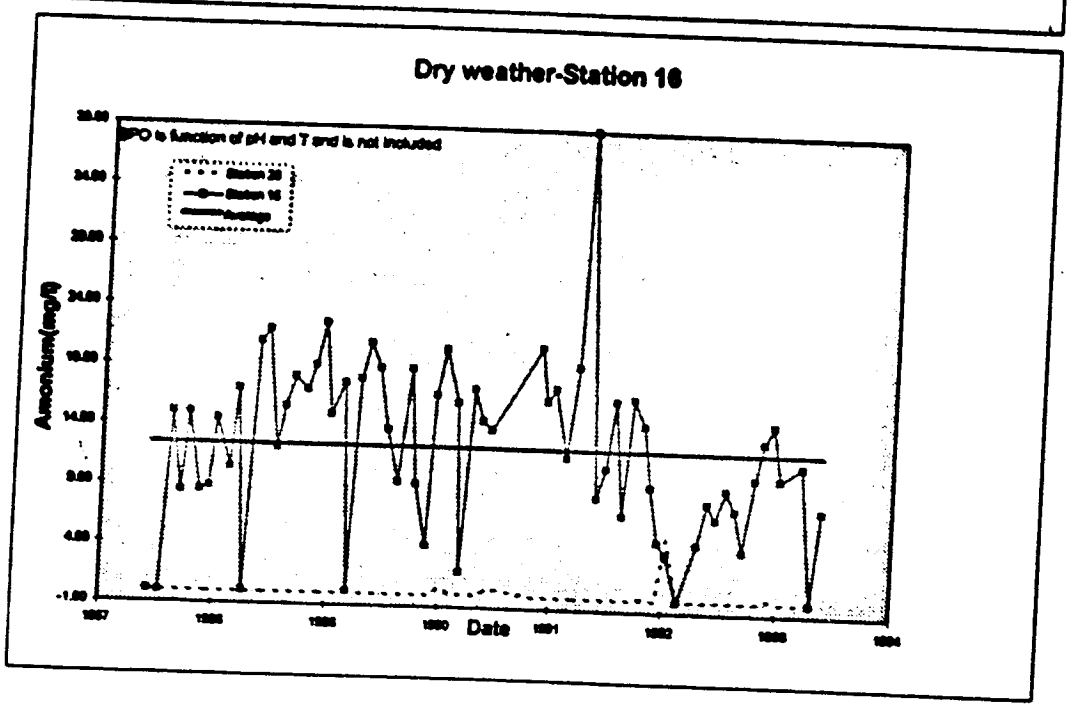


VOL 15

0818

R0061038

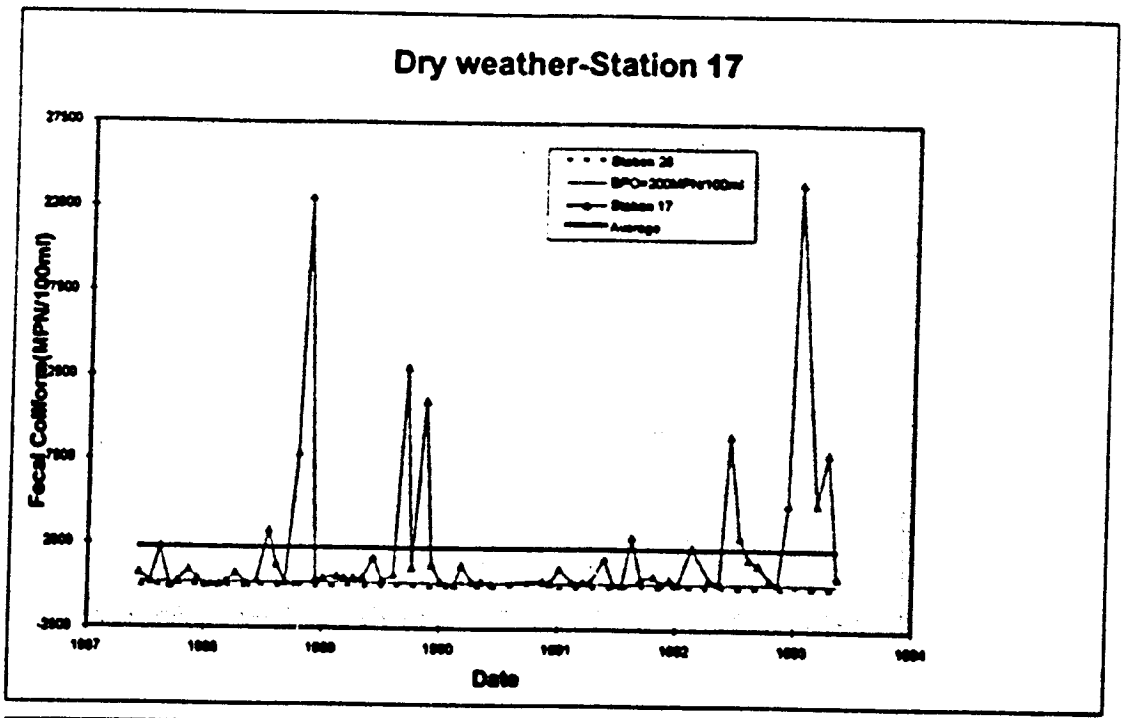


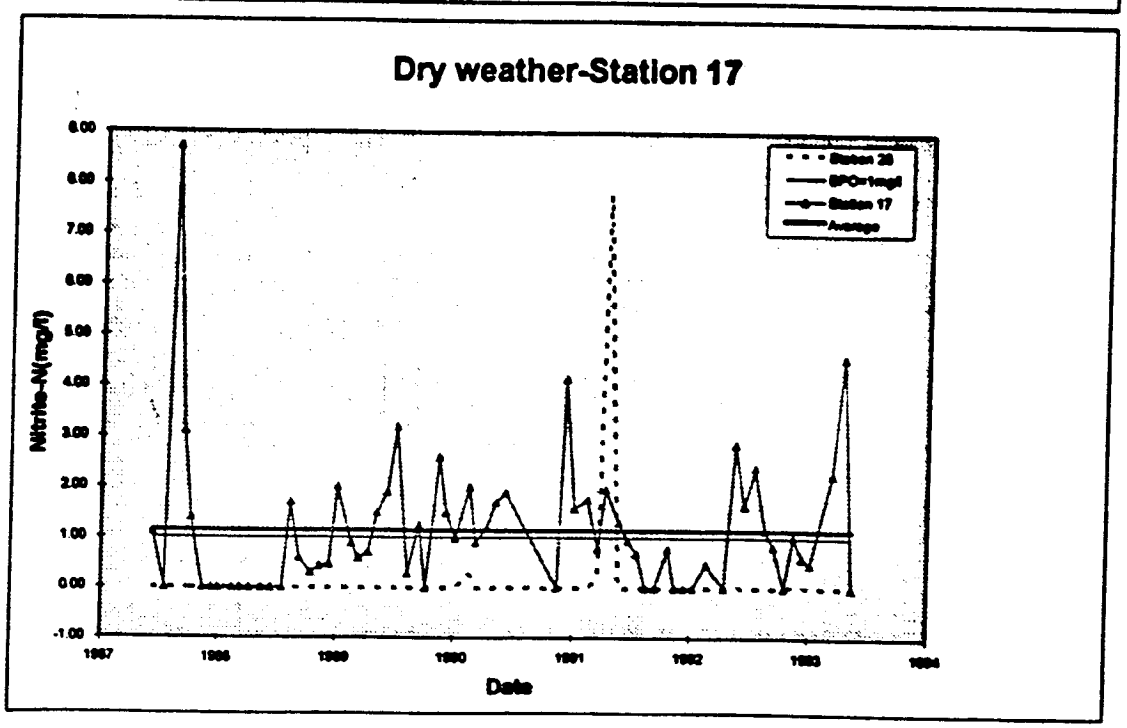


VOL 15

0819

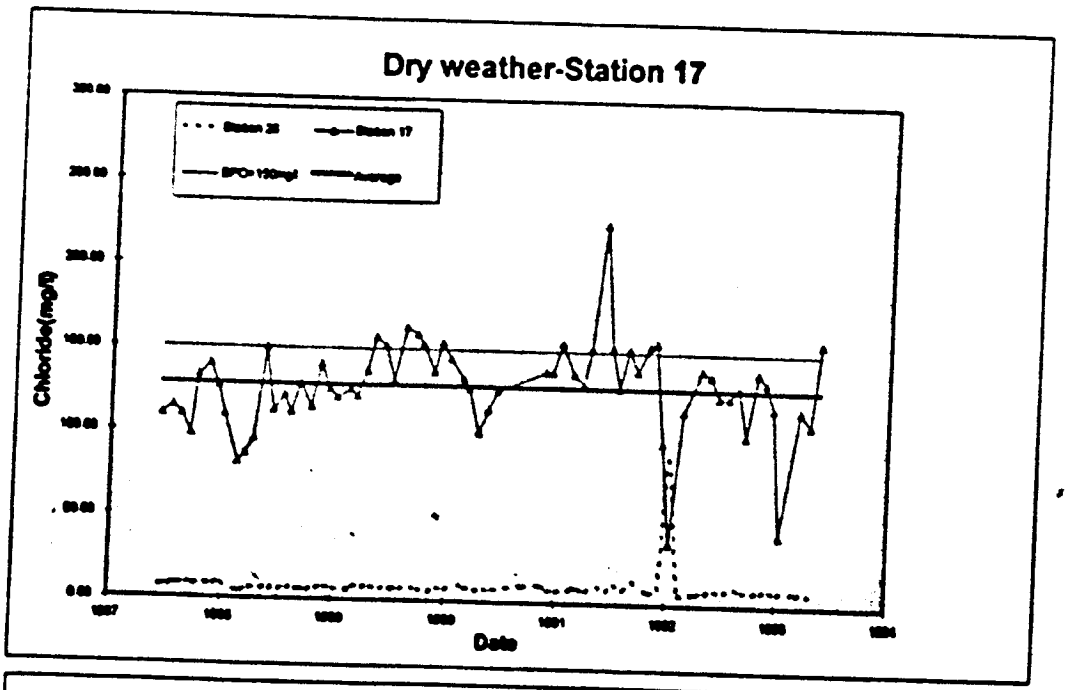
R0061039

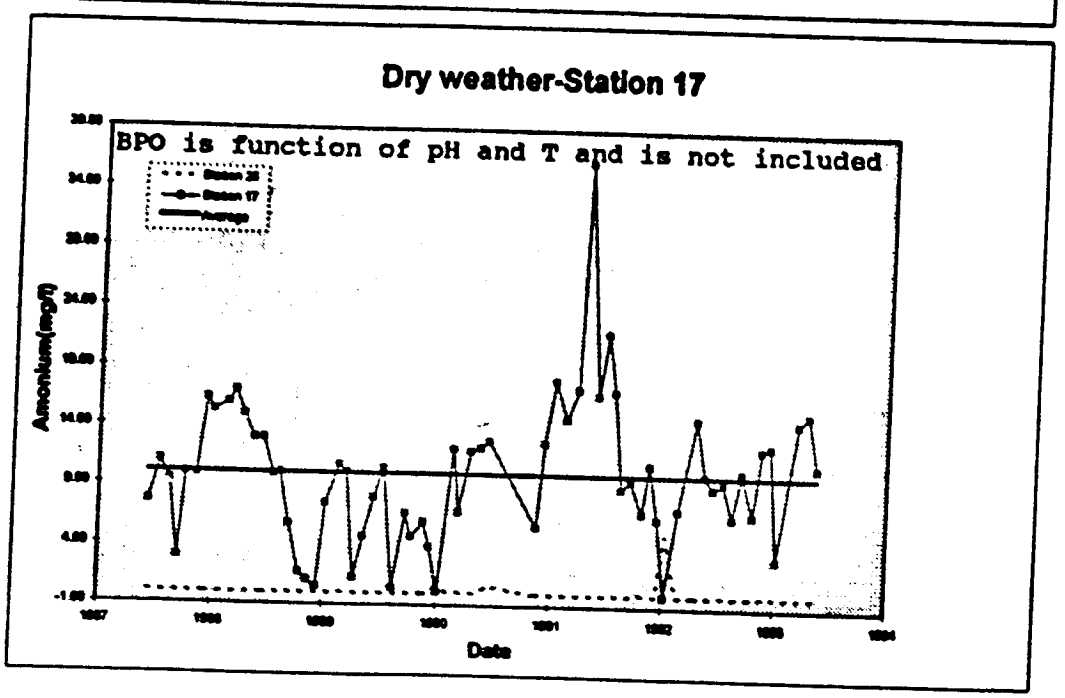

Dry weather-Station 17
Fecal Coliform(MPN/100ml)
Date


Dry weather-Station 17
Nitrite-N(mg/l)
Date

VOL 15

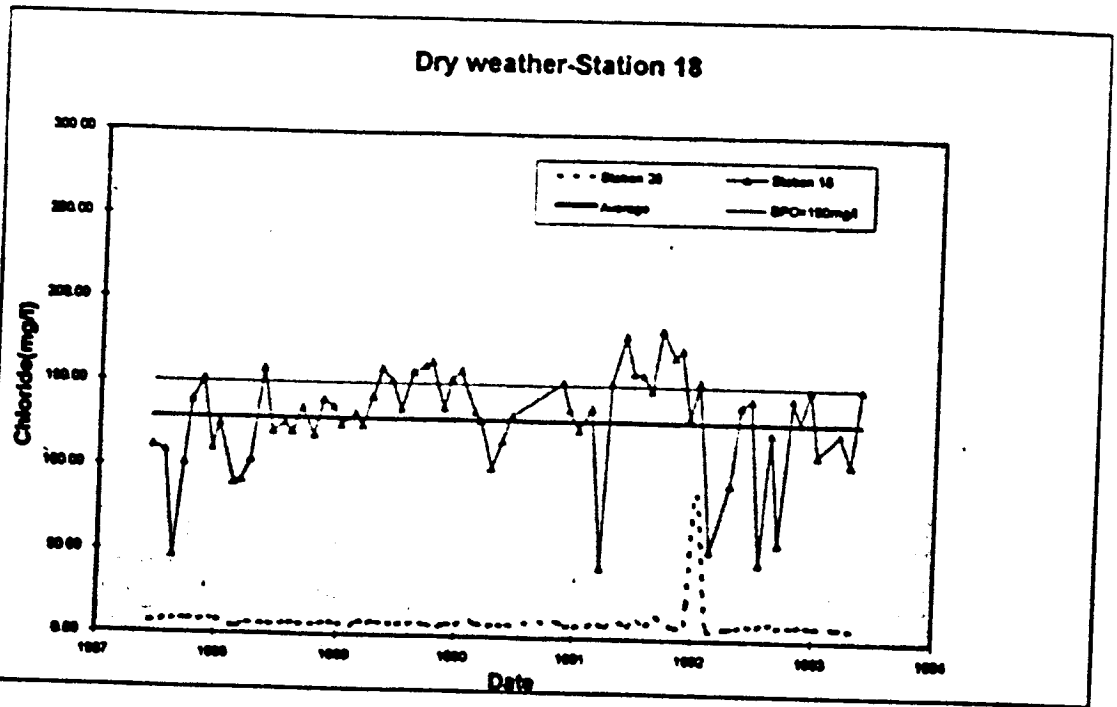
0820

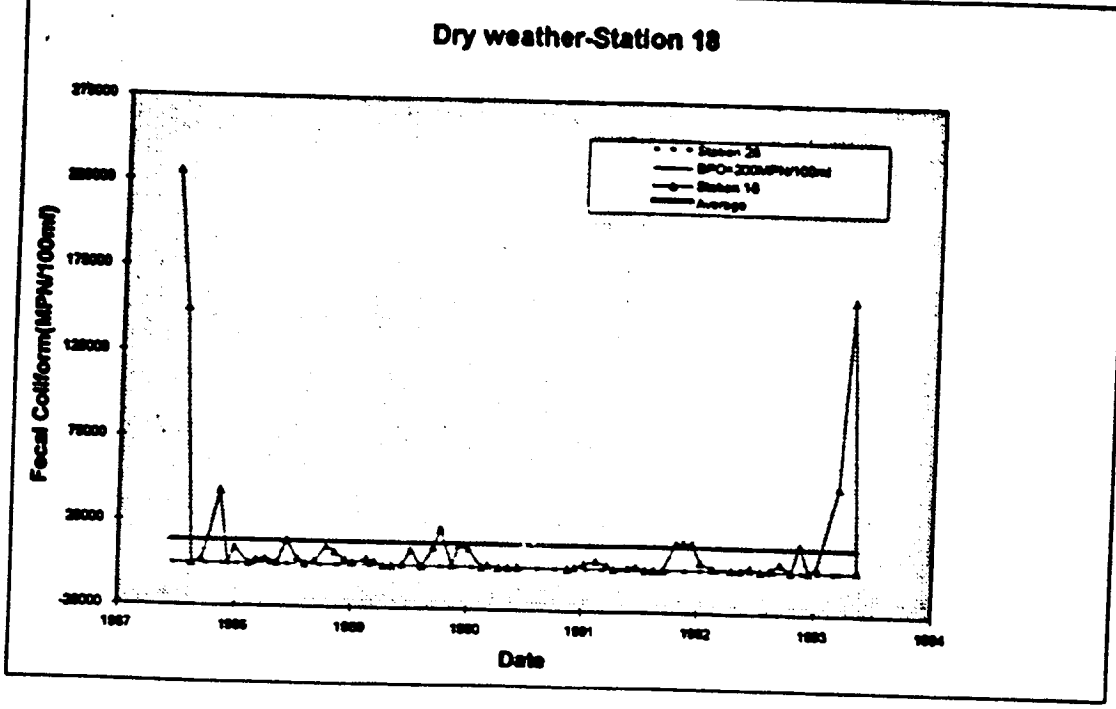

Dry weather-Station 17
Chloride(mg/l)
Date


Dry weather-Station 17
BPO is function of pH and T and is not included
Ammonium(mg/l)
Date

VOL 15

0821

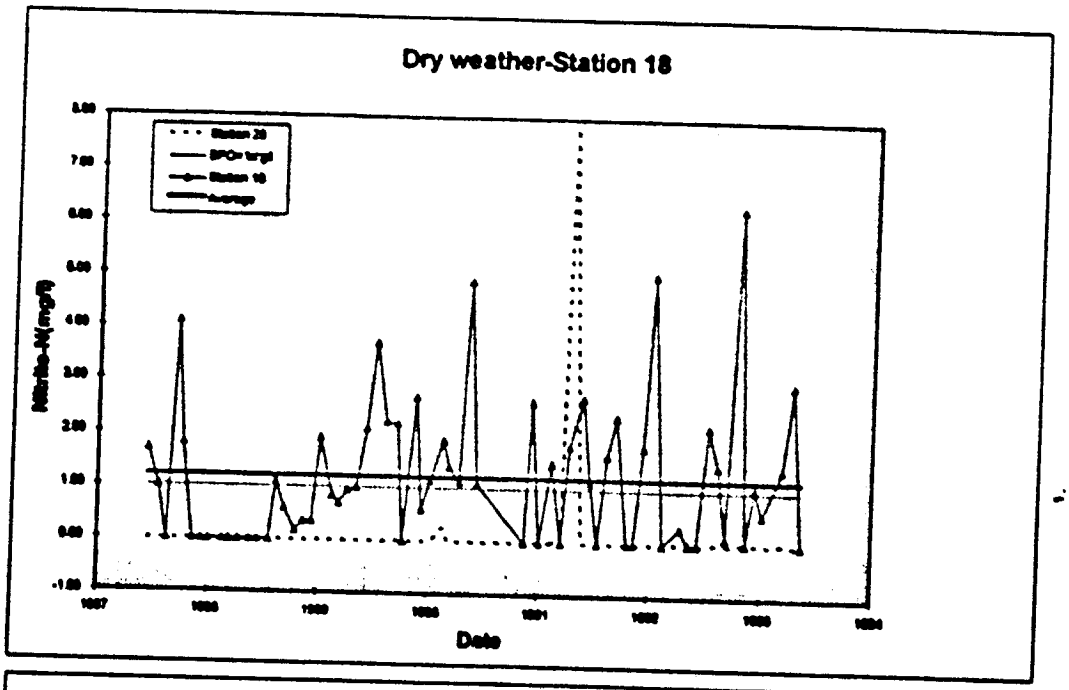


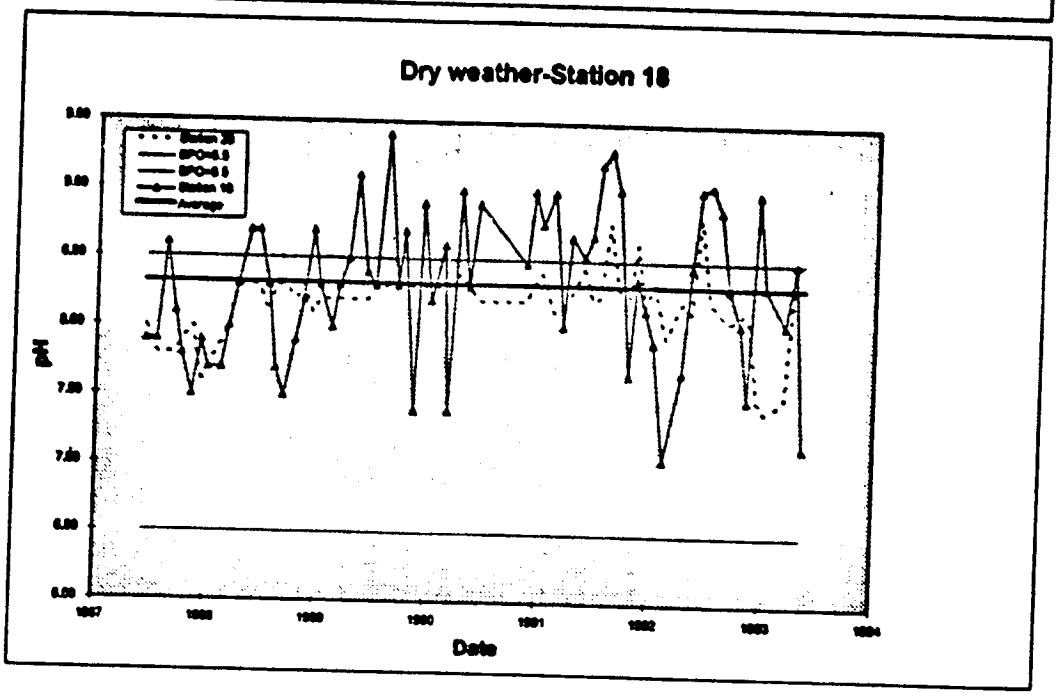


VOL 15

0822

R0061042

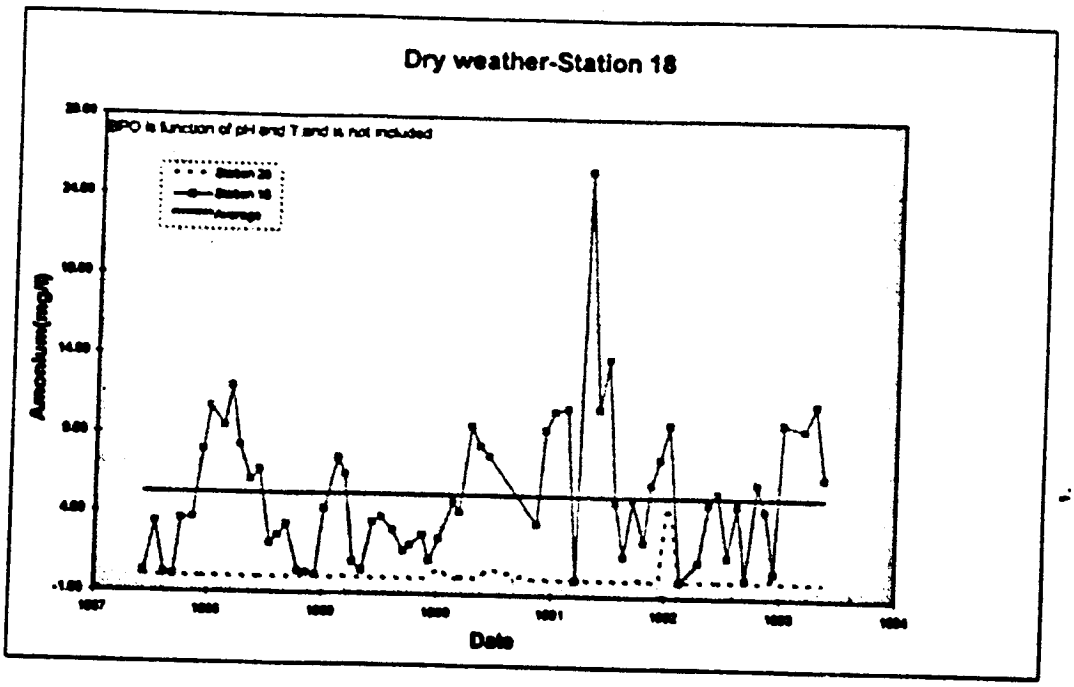




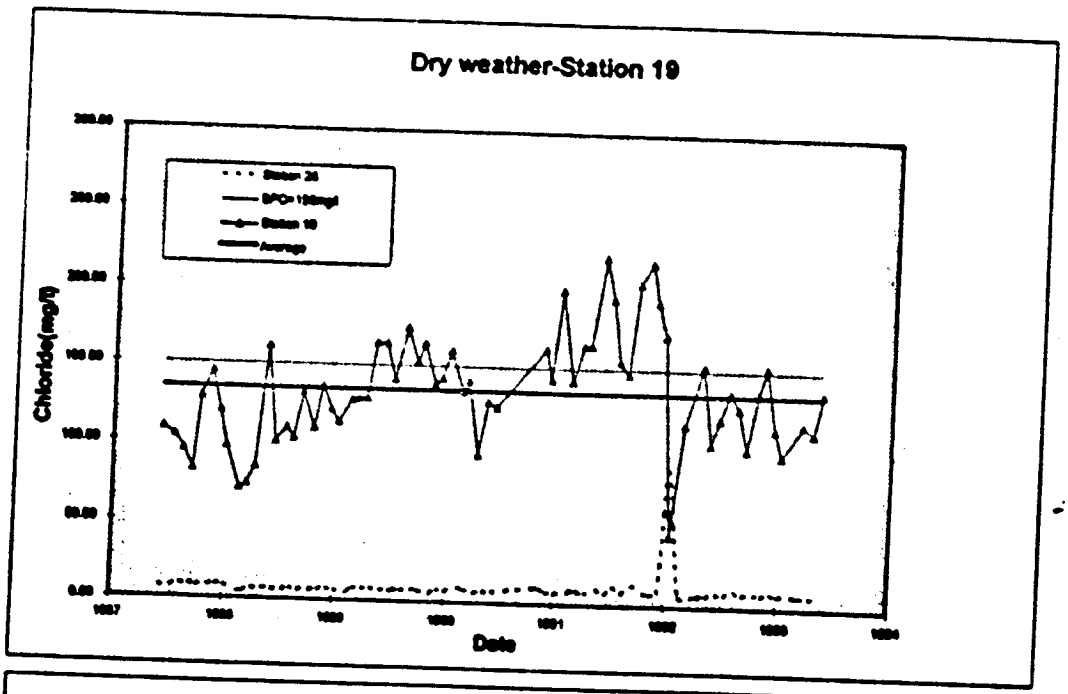
VOL 15

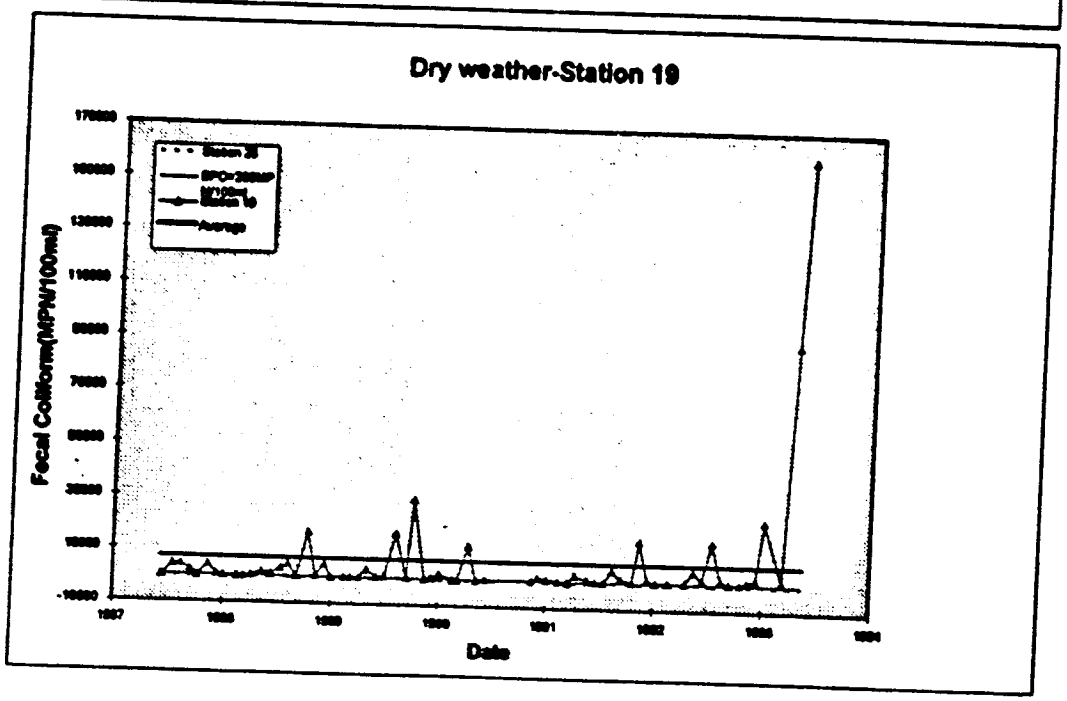
0823

R0061043



VOL 15
0824
R0061044

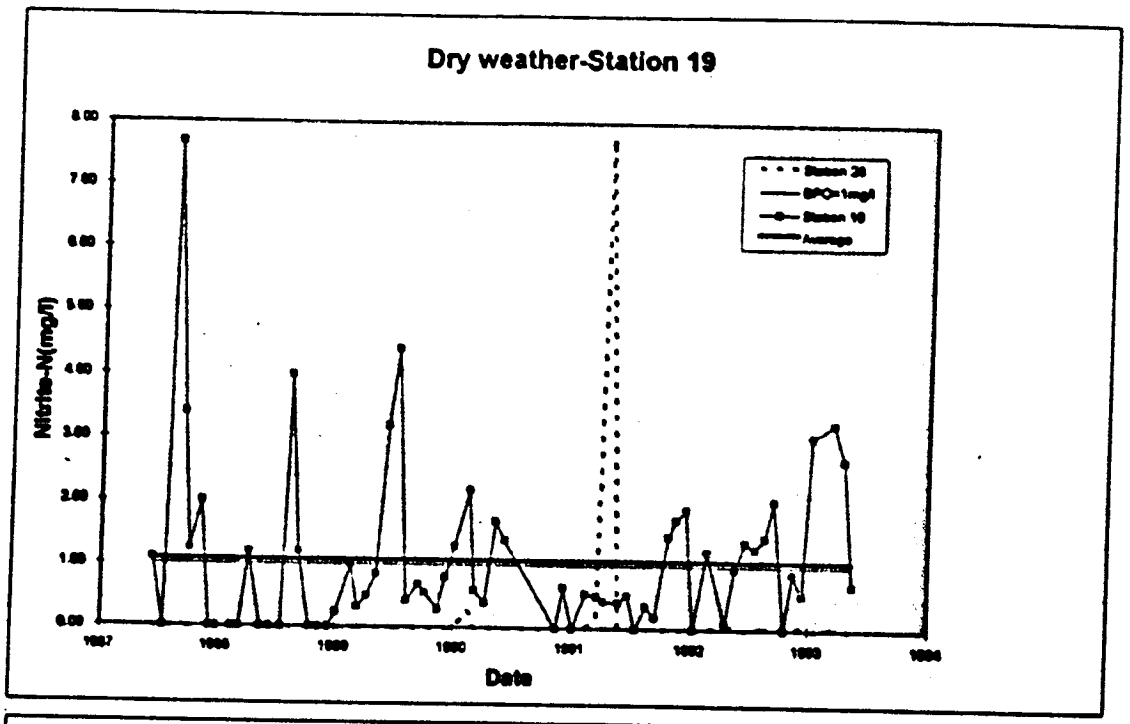


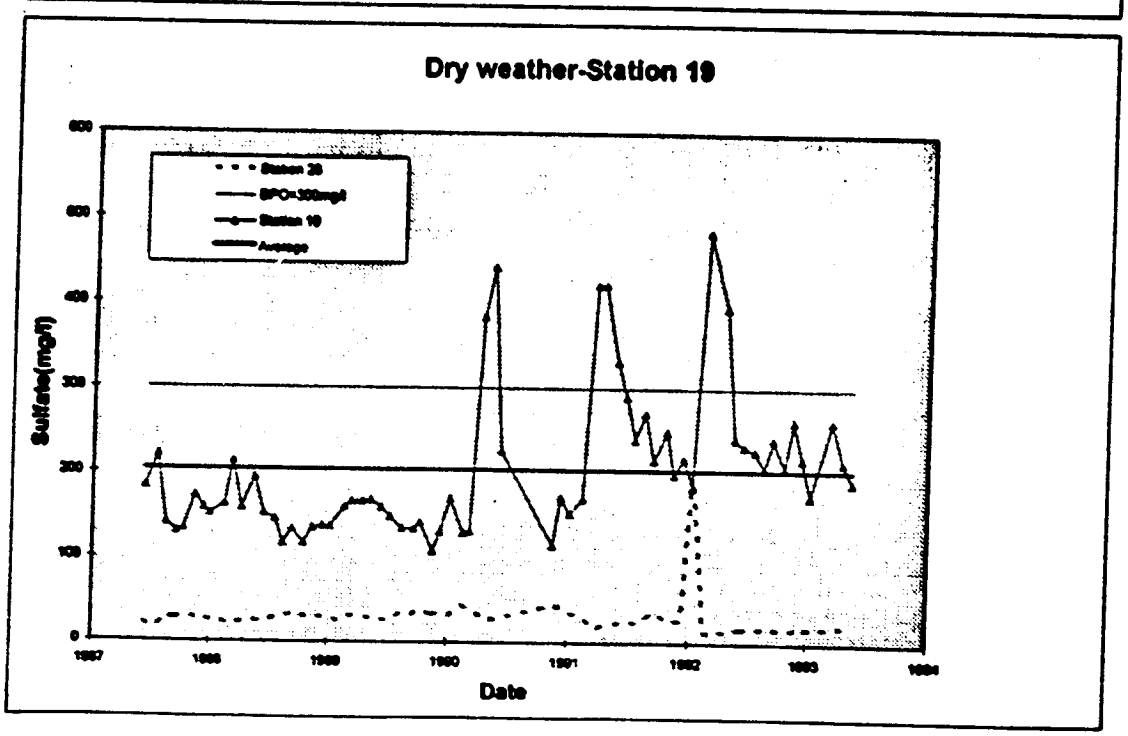


VOL 15

0825

R0061045

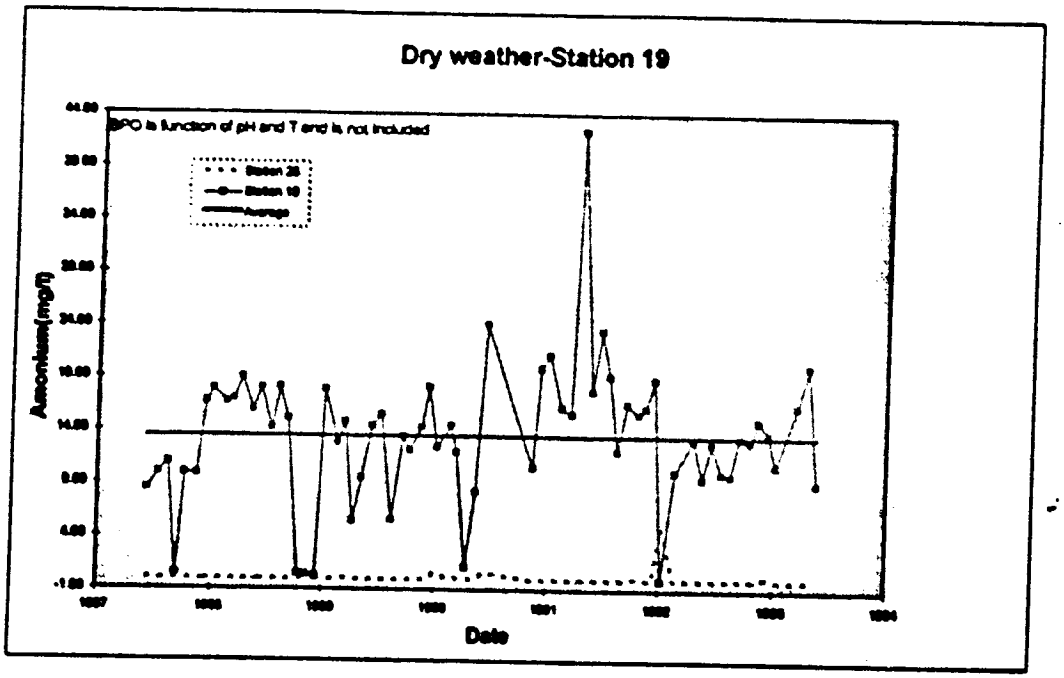




VOL 15

0826

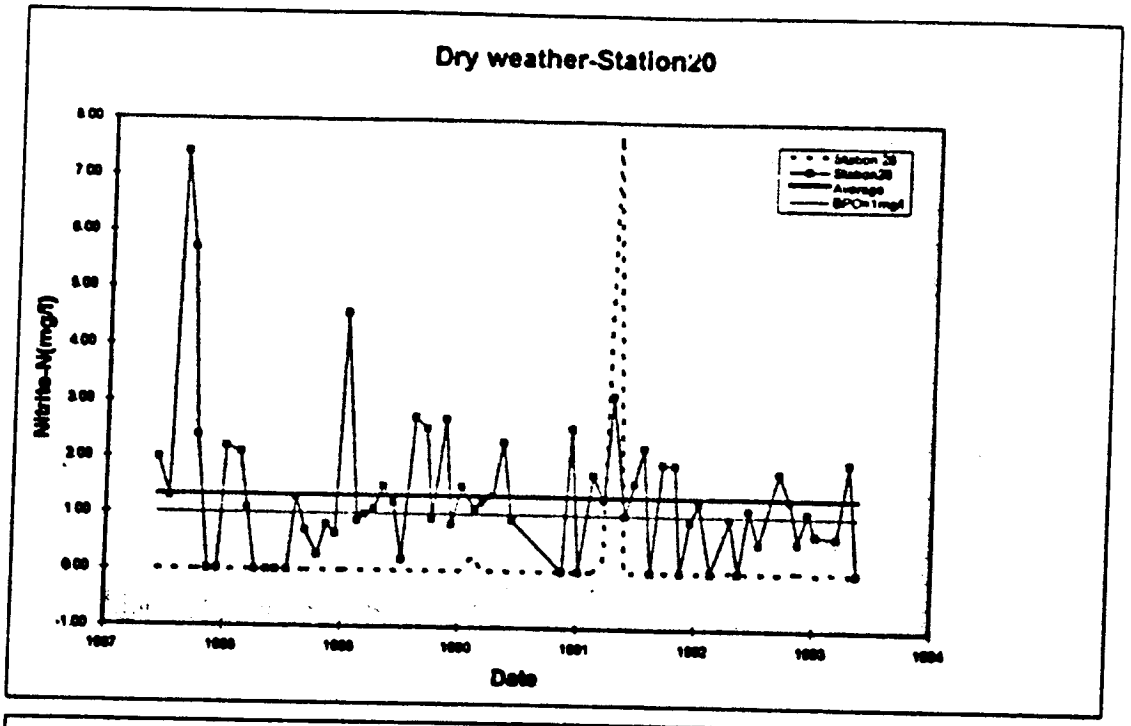
R0061046

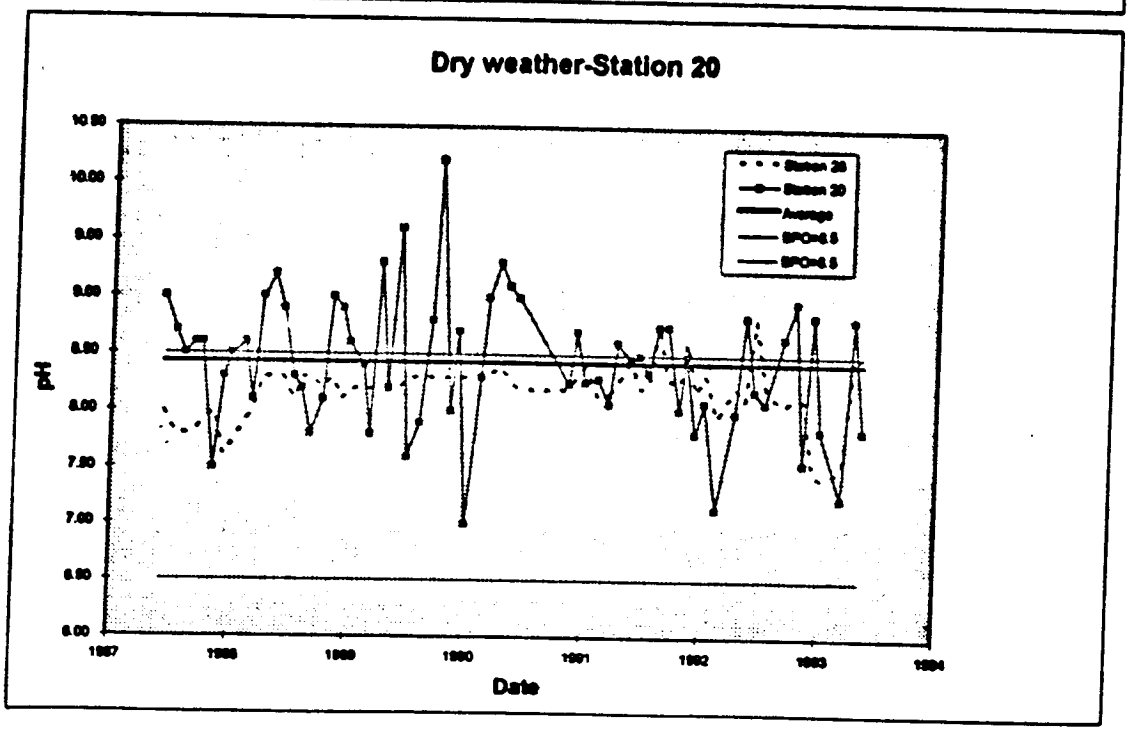


VOL 15

0827

R0061047

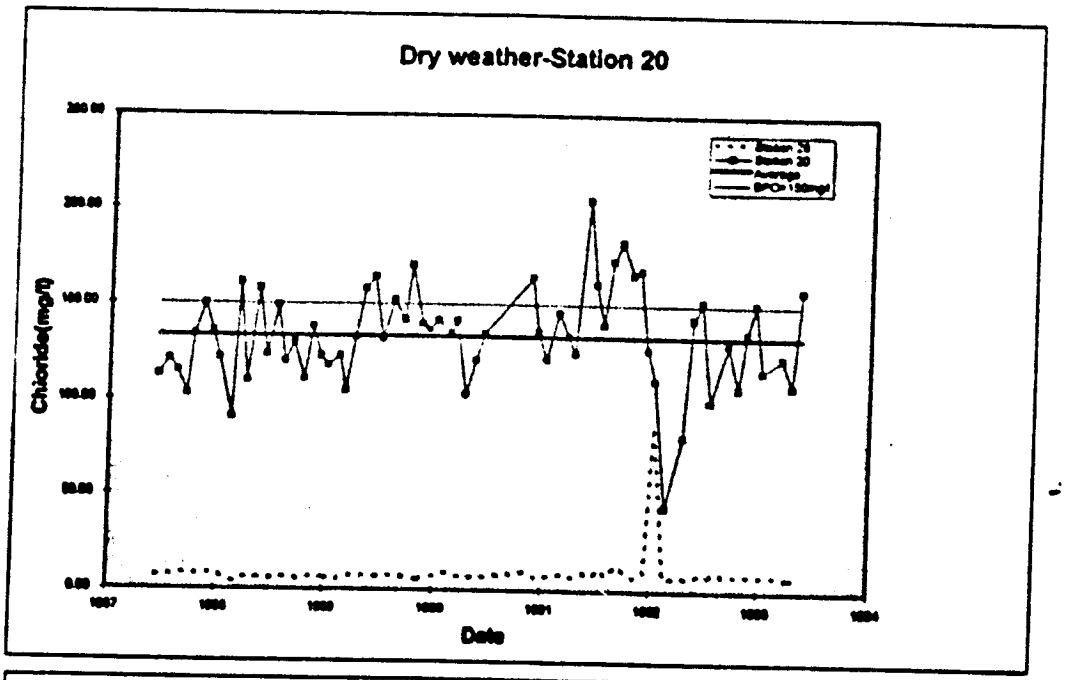


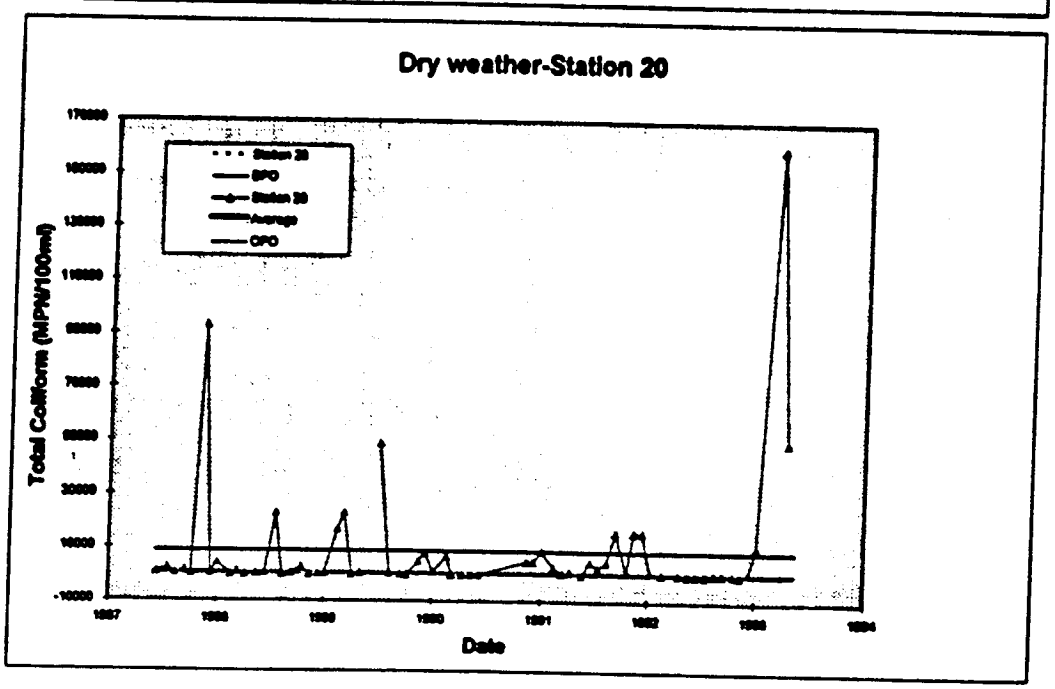


VOL 15

0828

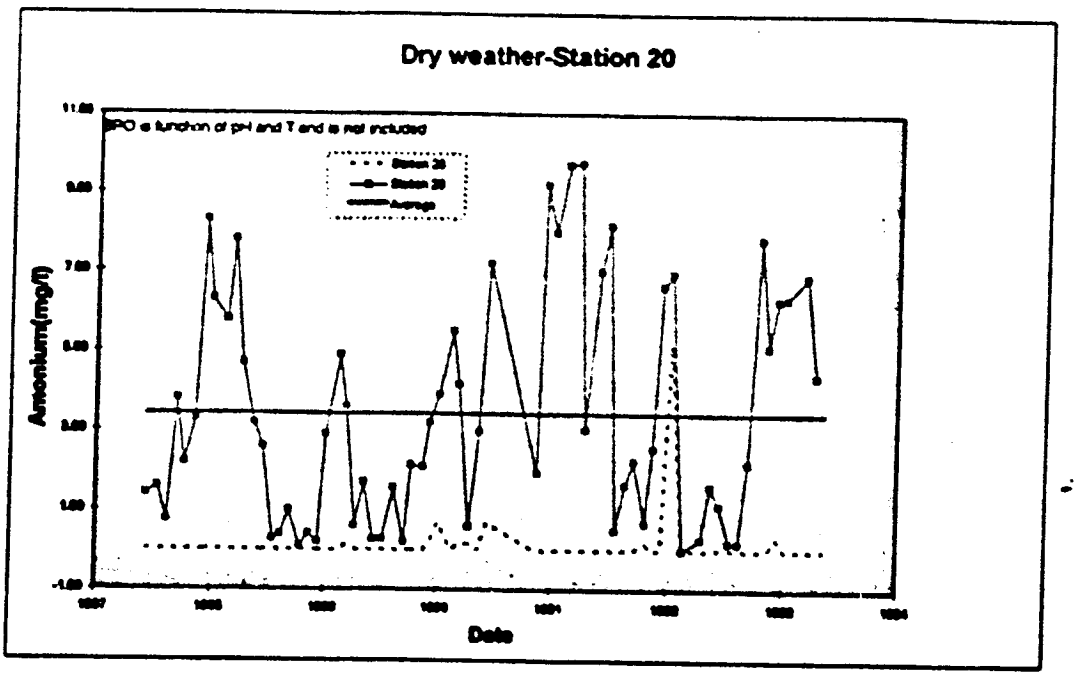
R0061048


Dry weather-Station 20
Chloride(mg/l)
Date


Dry weather-Station 20
Station 20
DPO
Station 20
Average
OPO
Total Coliform (MPN/100ml)
Date

VOL 15

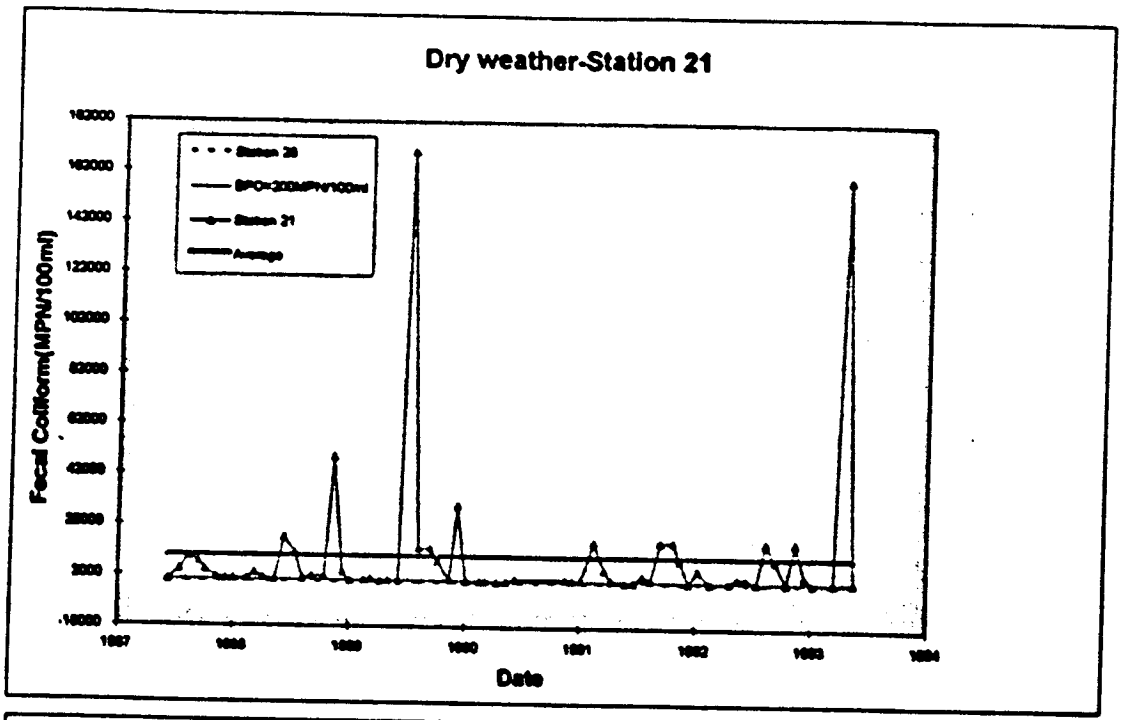
0829

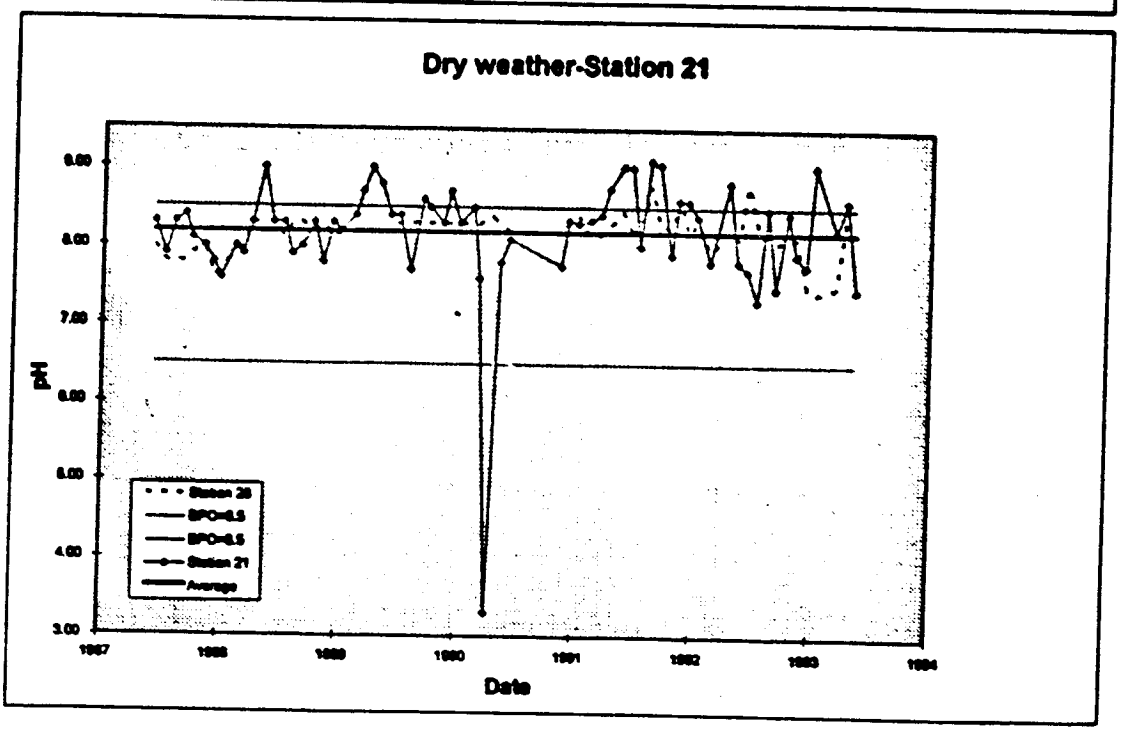


VOL 15

0830

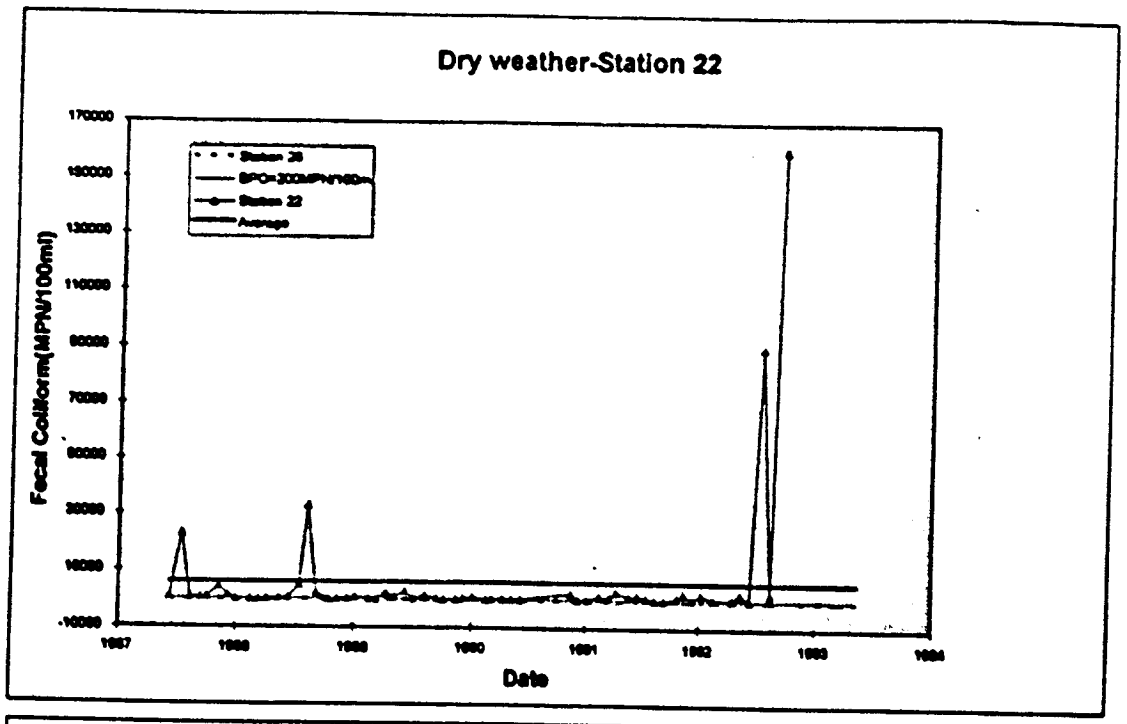
R0061050

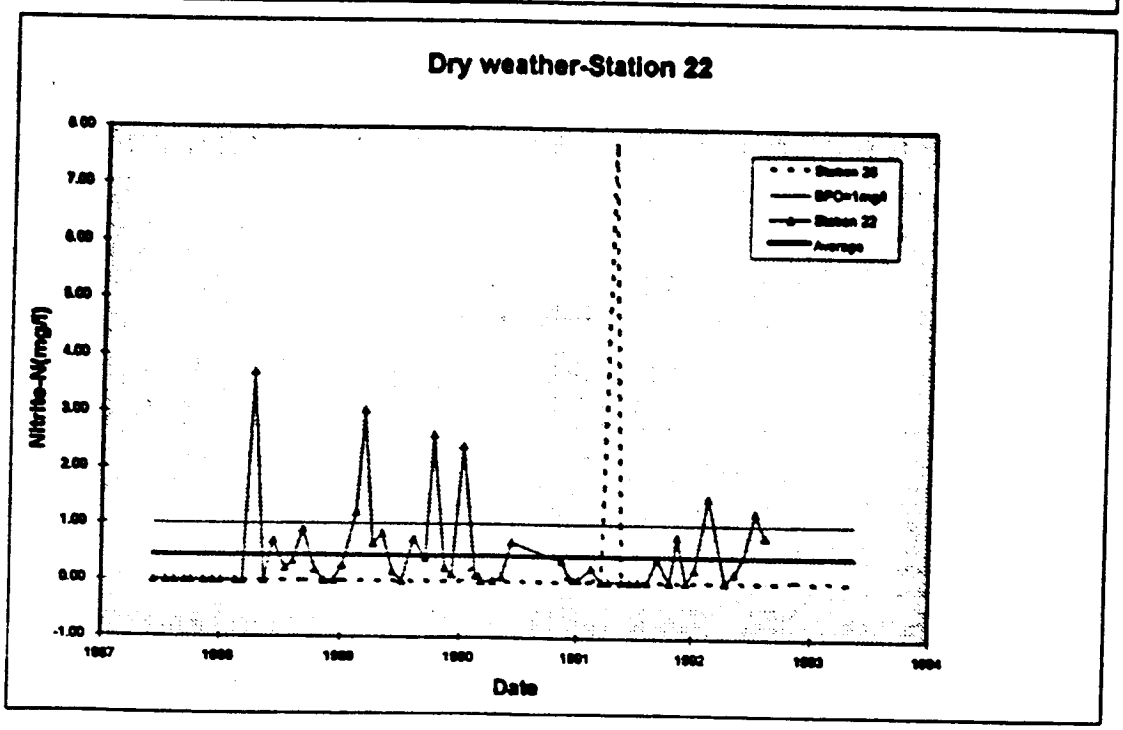

Dry weather-Station 21
Fecal Coliform(MPN/100ml)
Date


Dry weather-Station 21
pH
Date

VOL 15

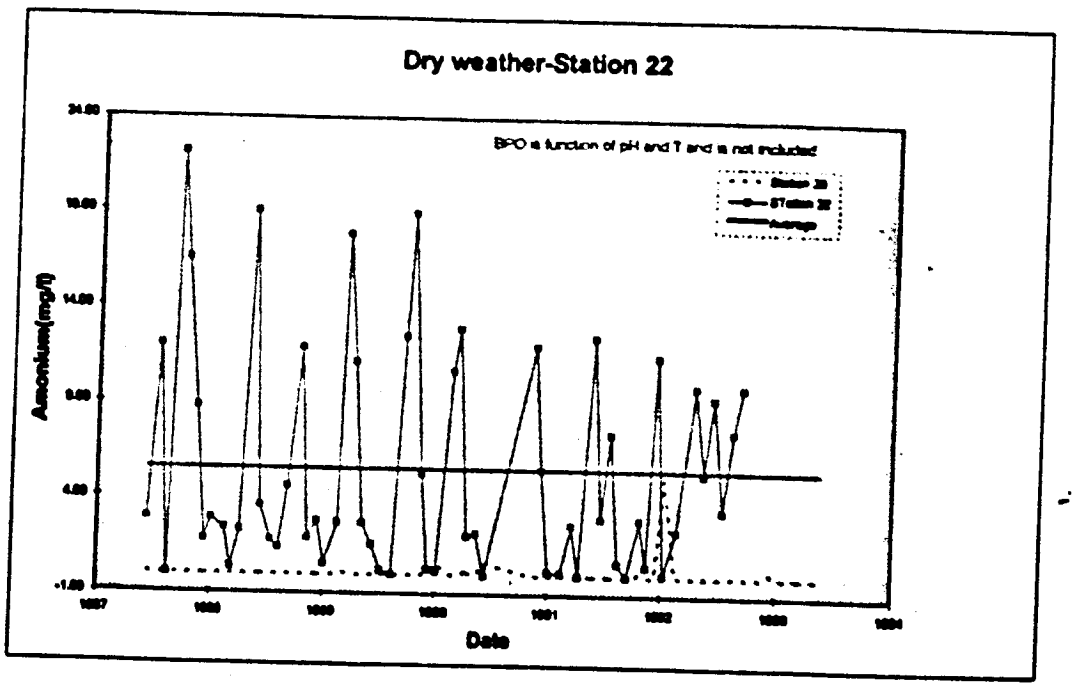
0831


Dry weather-Station 22
Fecal Coliform(MPN/100ml)
Date

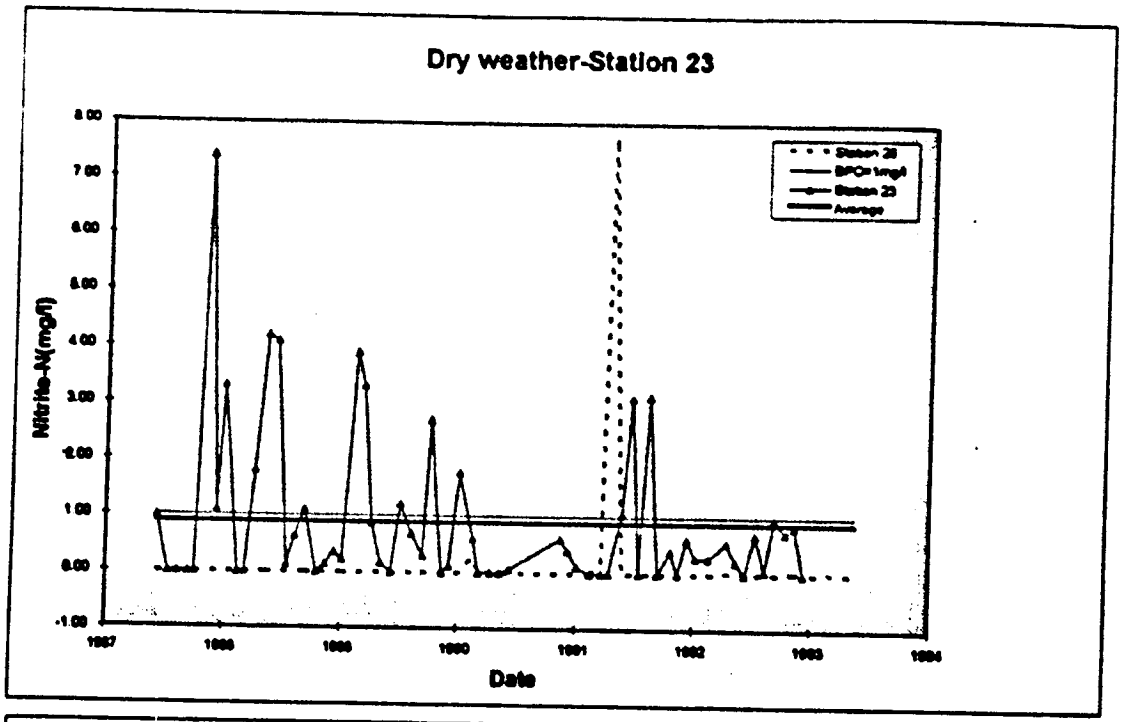

Dry weather-Station 22
Nitrite-N(mg/l)
Date

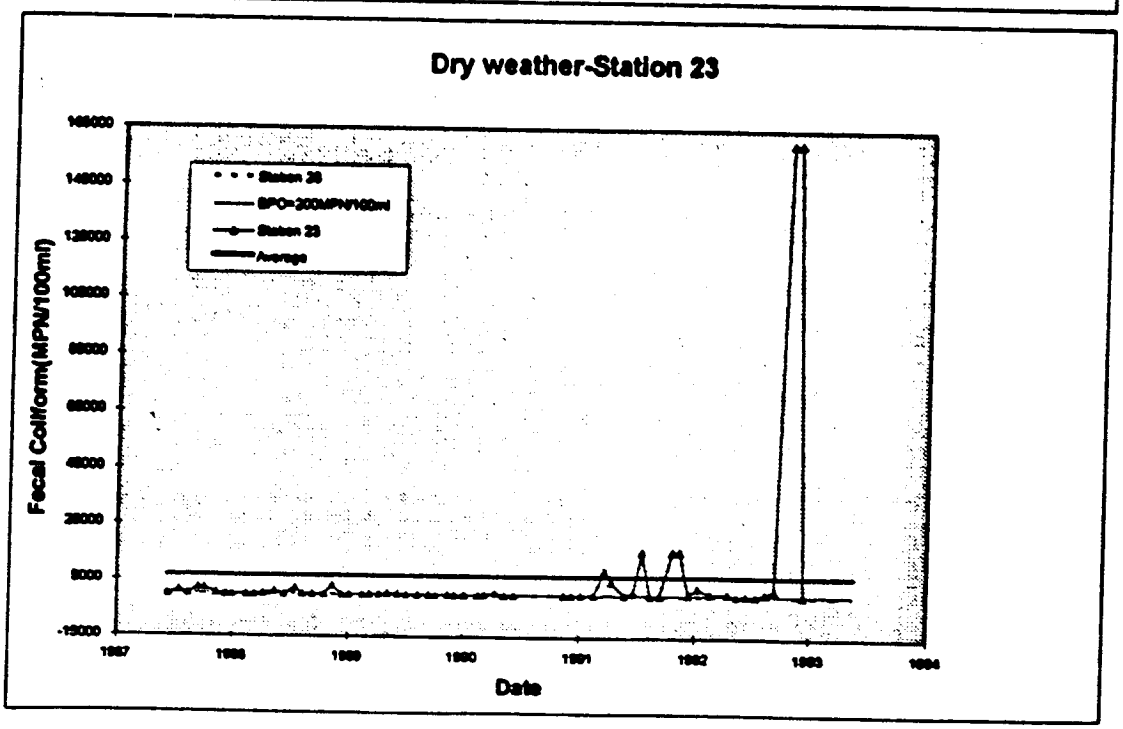
VOL 15

0832



VOL 15
0833
R0061053

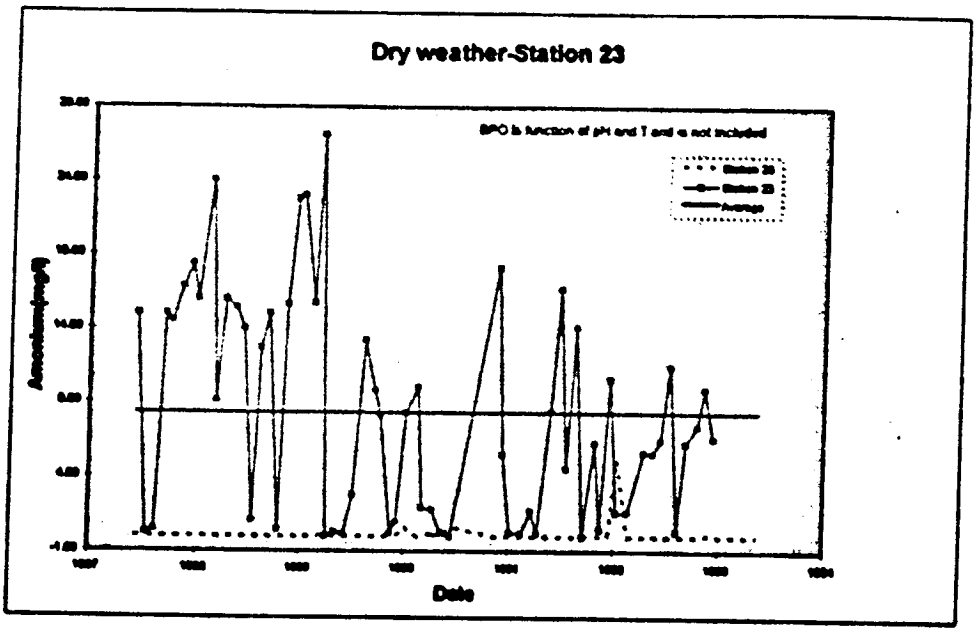




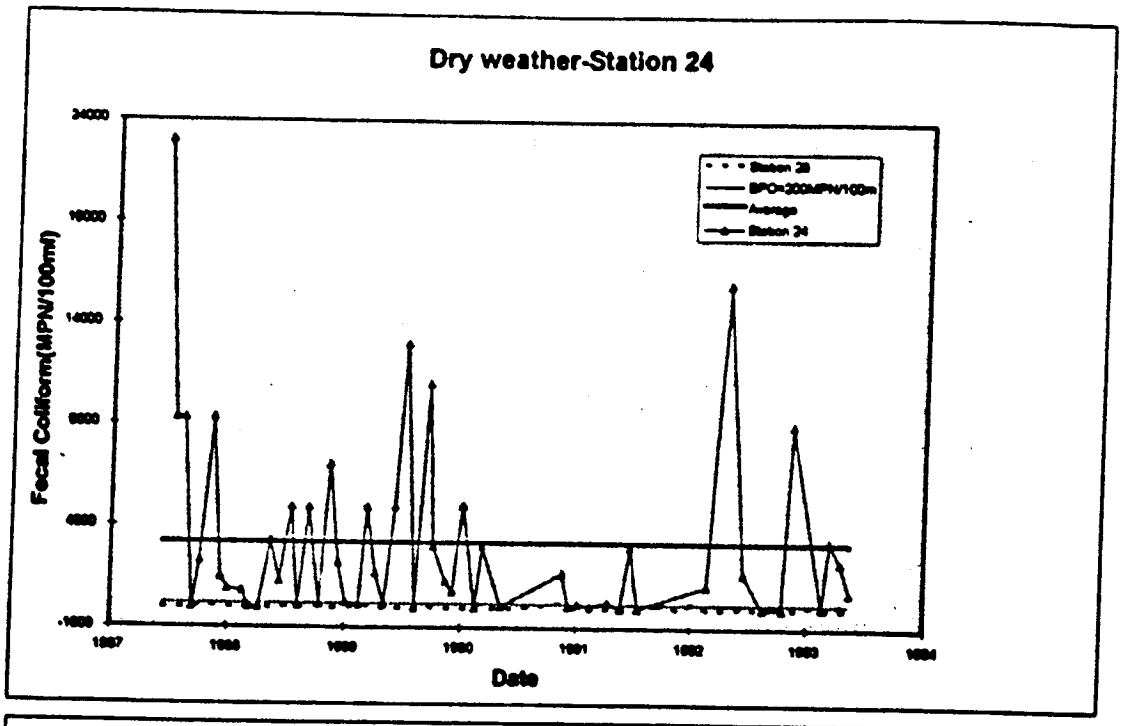
VOL 15

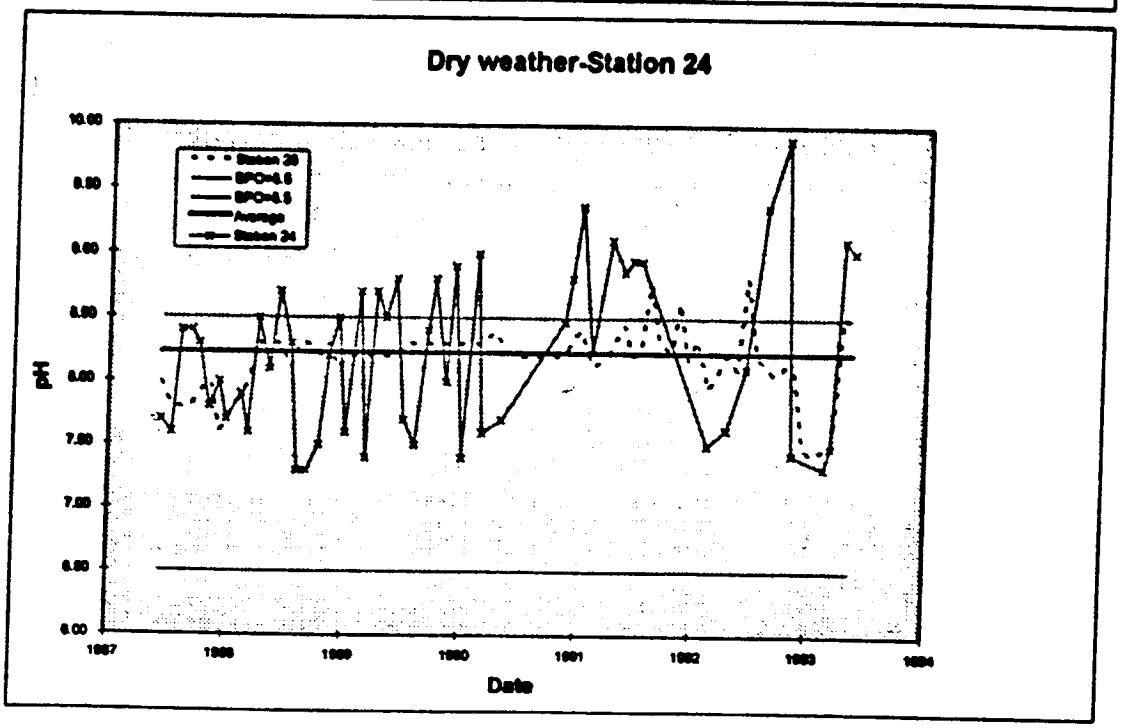
0834

R0061054



VOL 15
0835

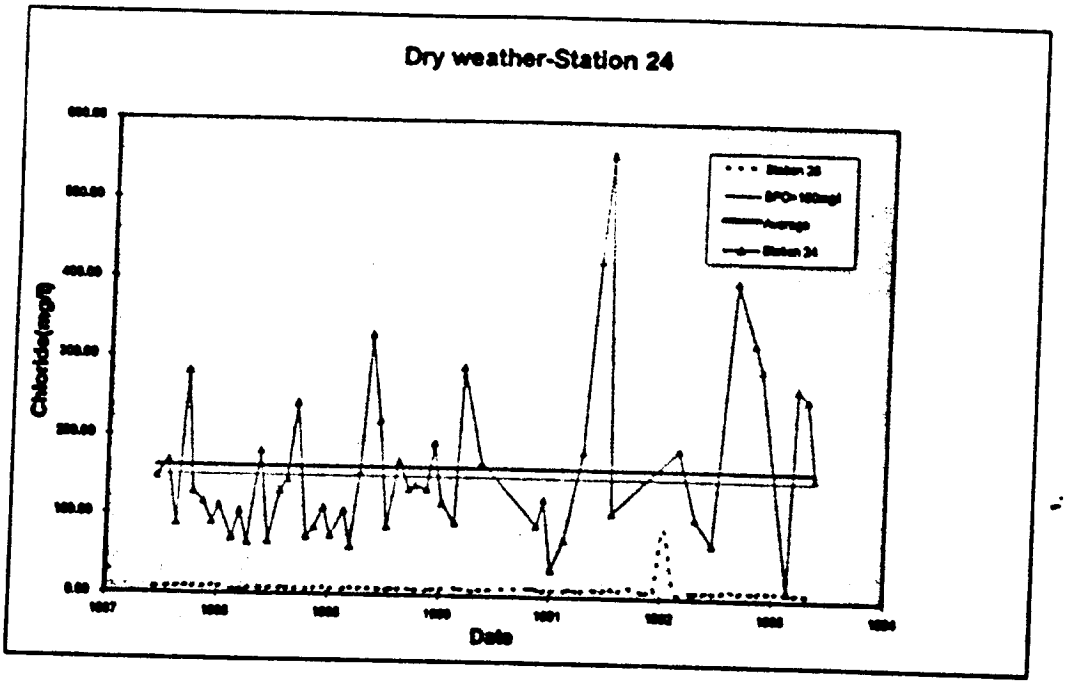




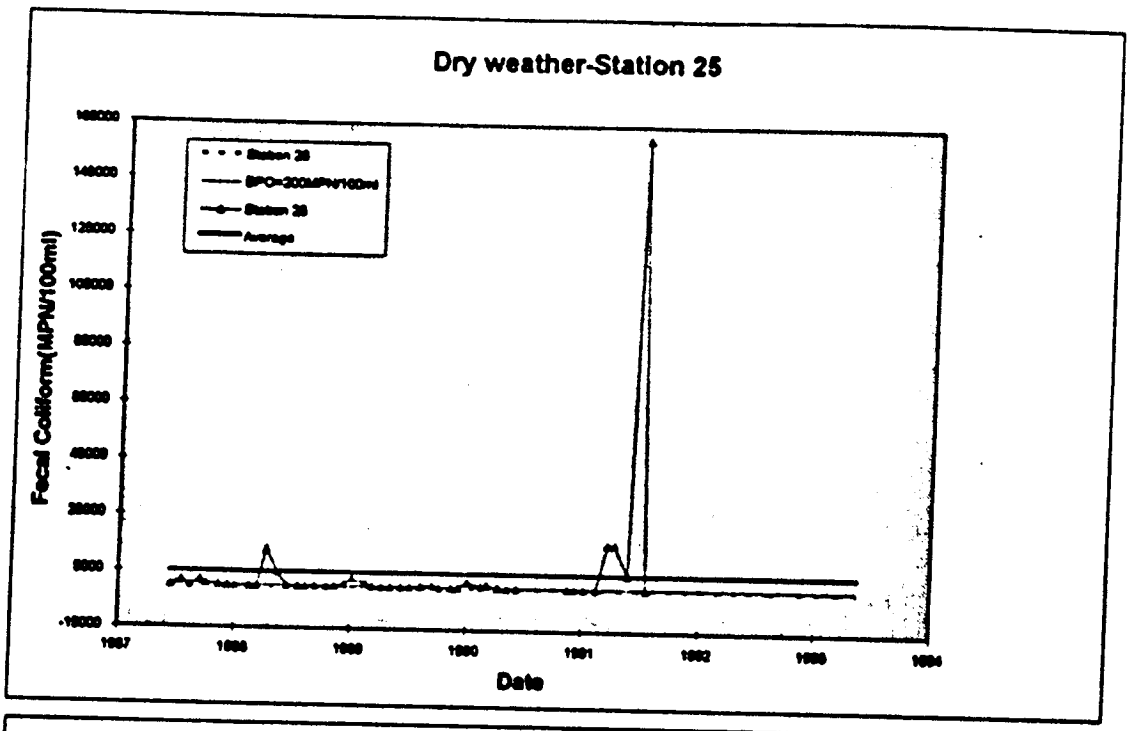
VOL 15

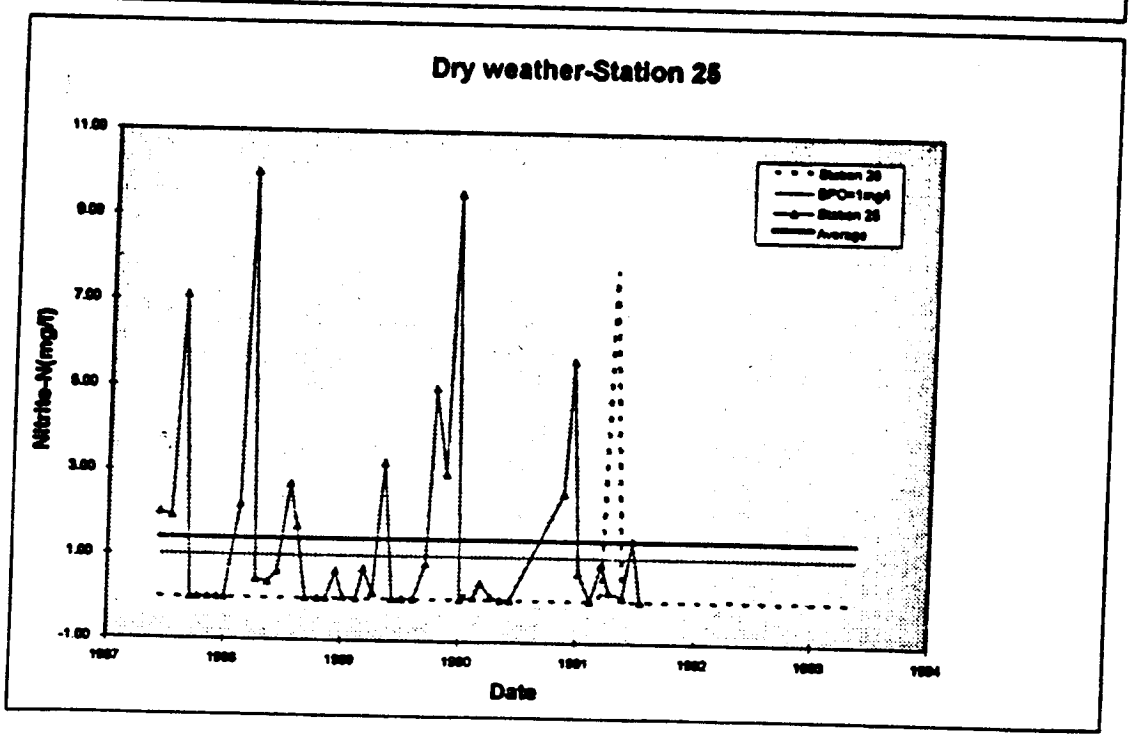
0836

R0061056



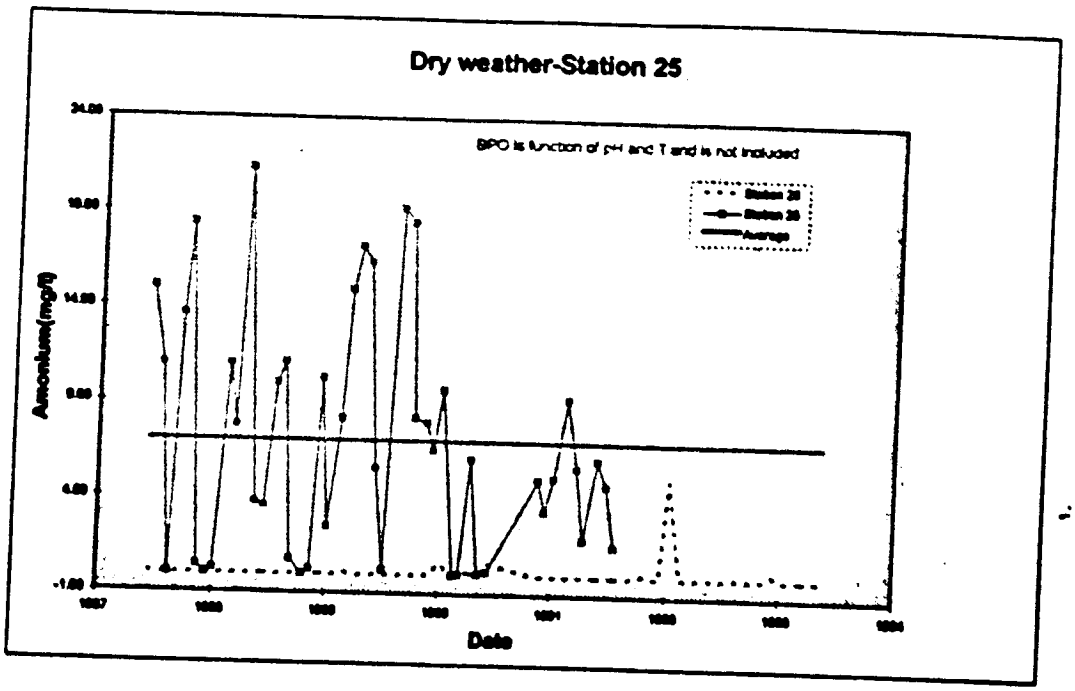
VOL 15
0837


Dry weather-Station 25
Fecal Coliform(MPN/100ml)
Date

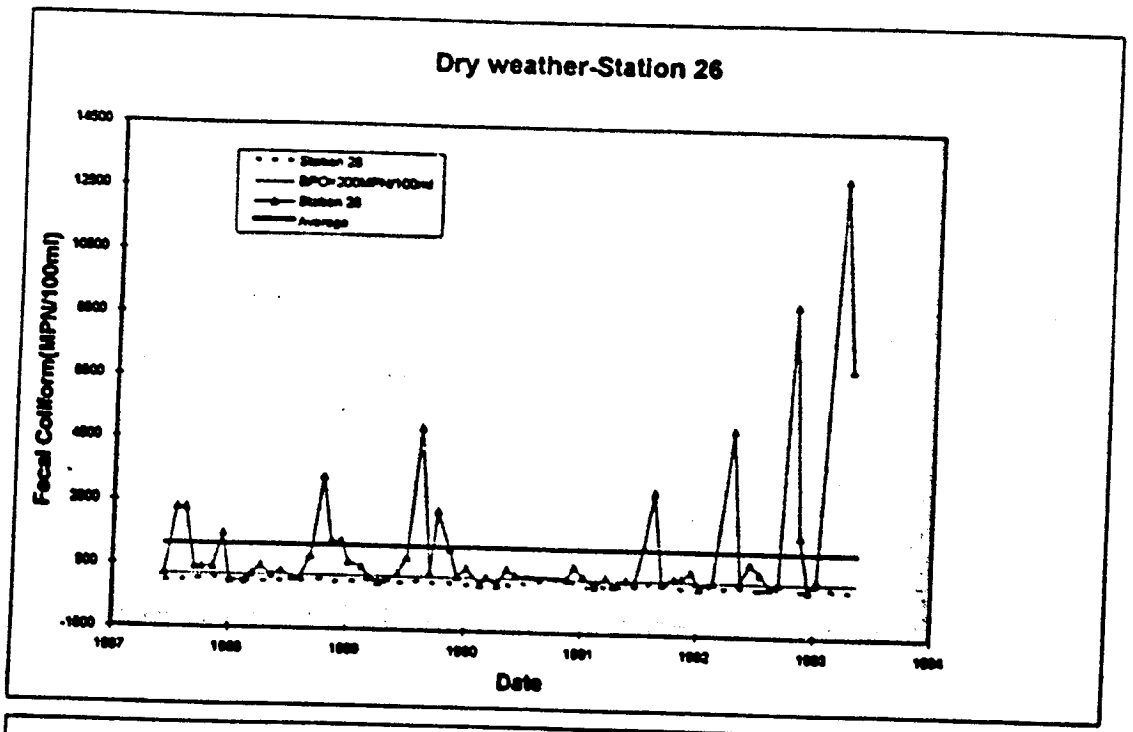

Dry weather-Station 25
Nitrite-N(mg/l)
Date

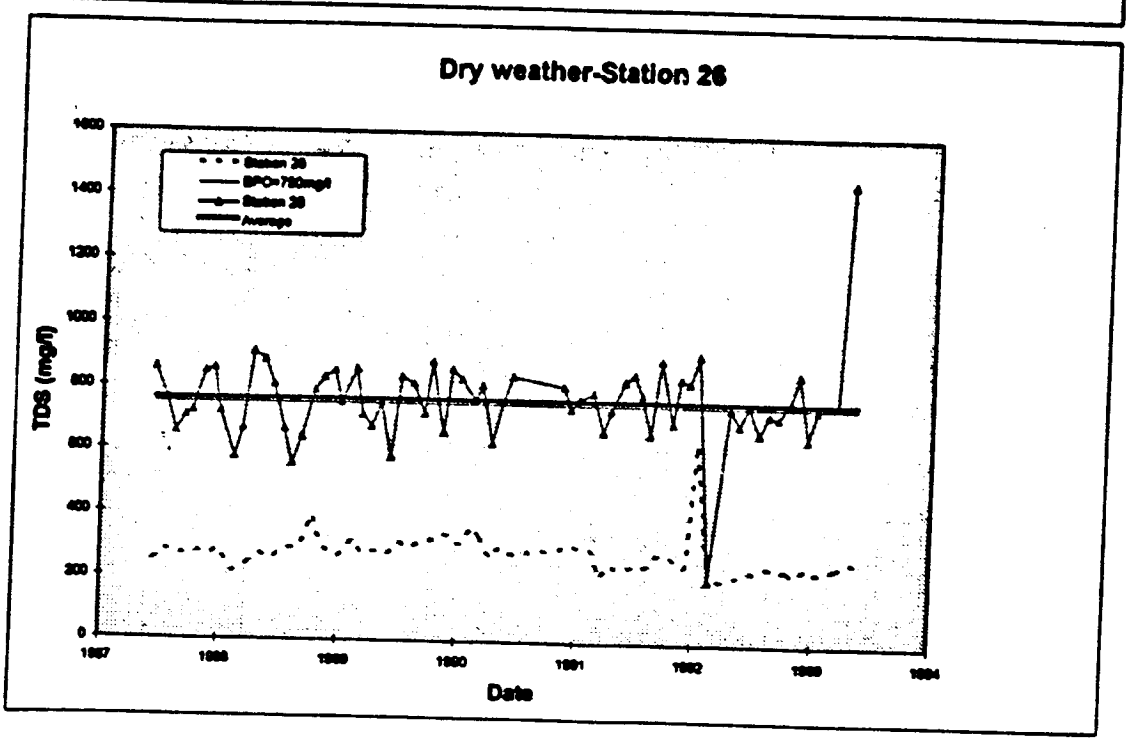
VOL 15

08378



VOL 15
0839
R0061059

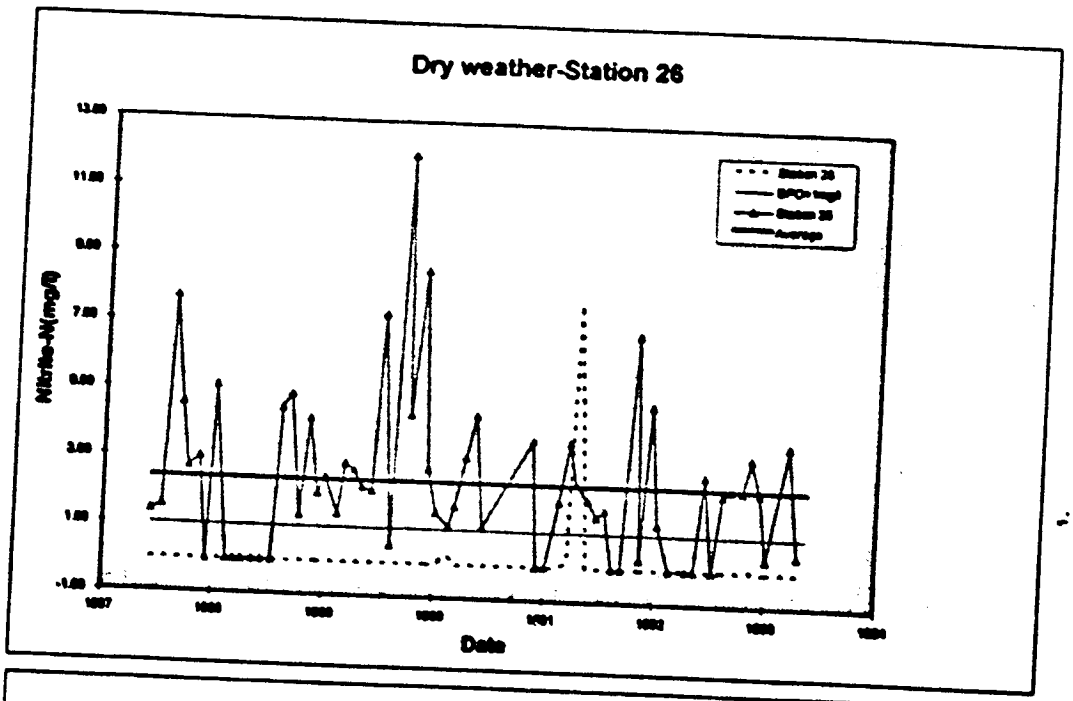


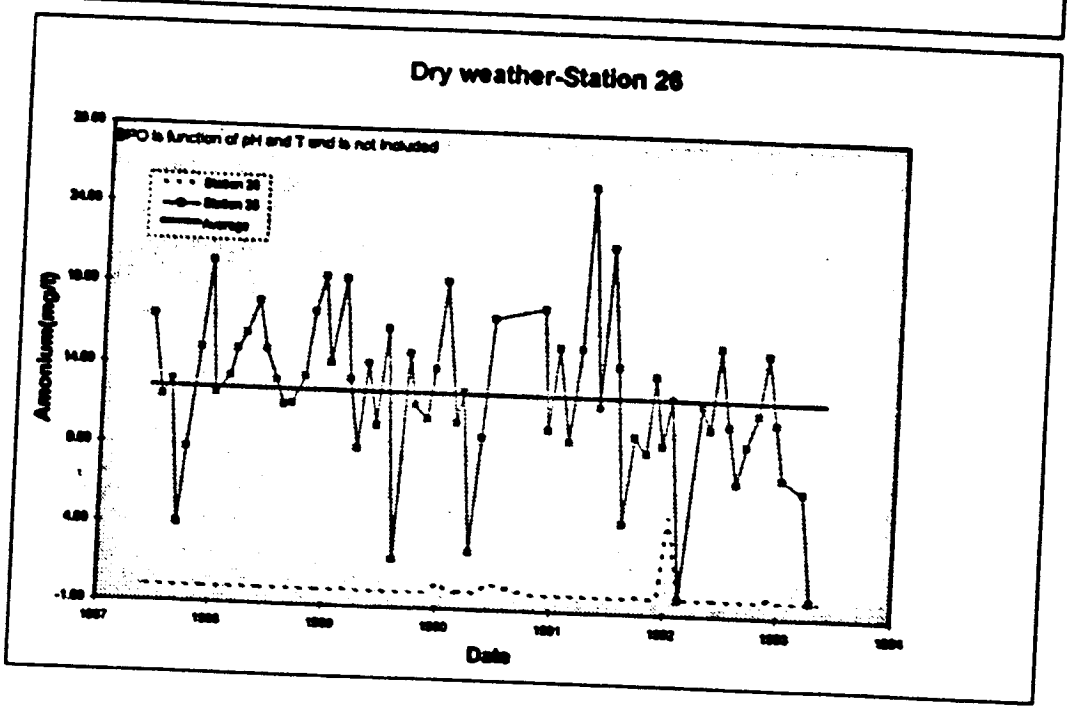


VOL 15

0840

R0061060

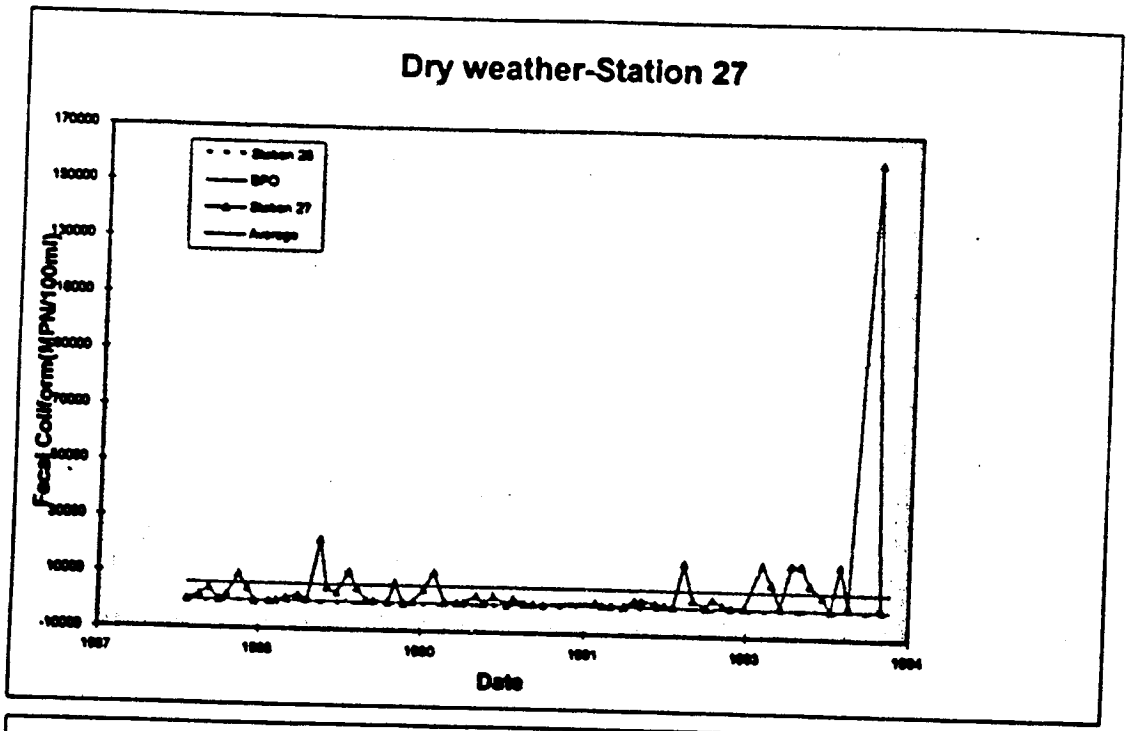


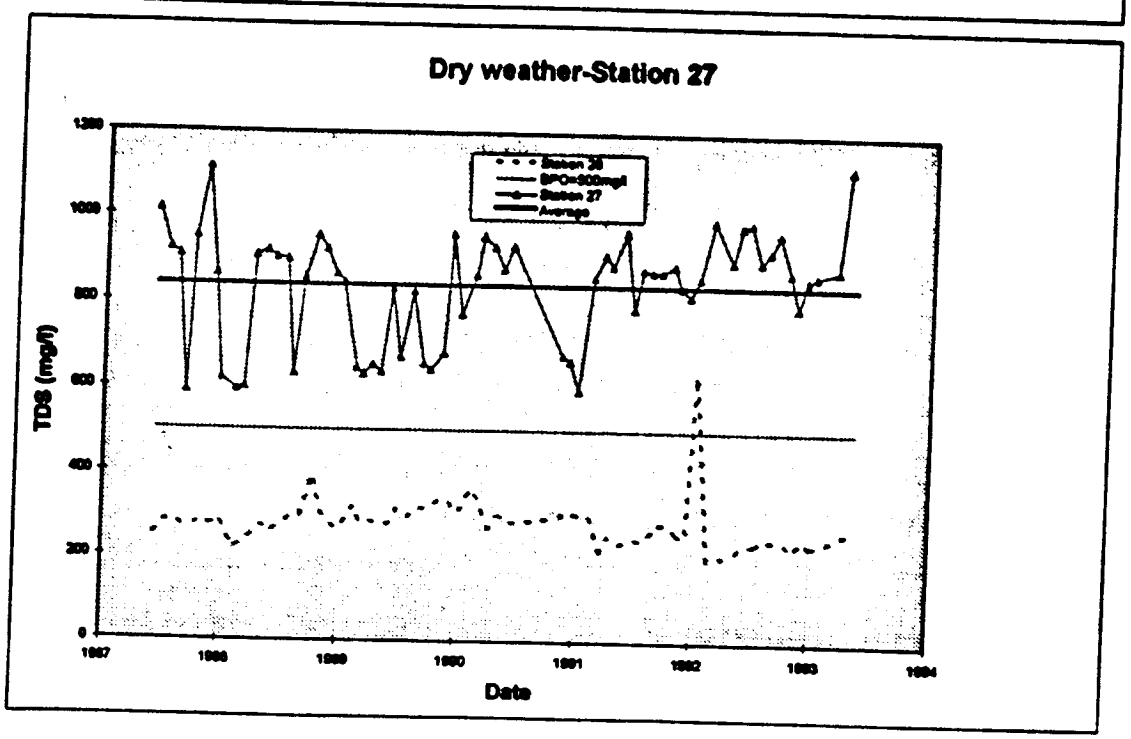


VOL 15

0841

R0061061

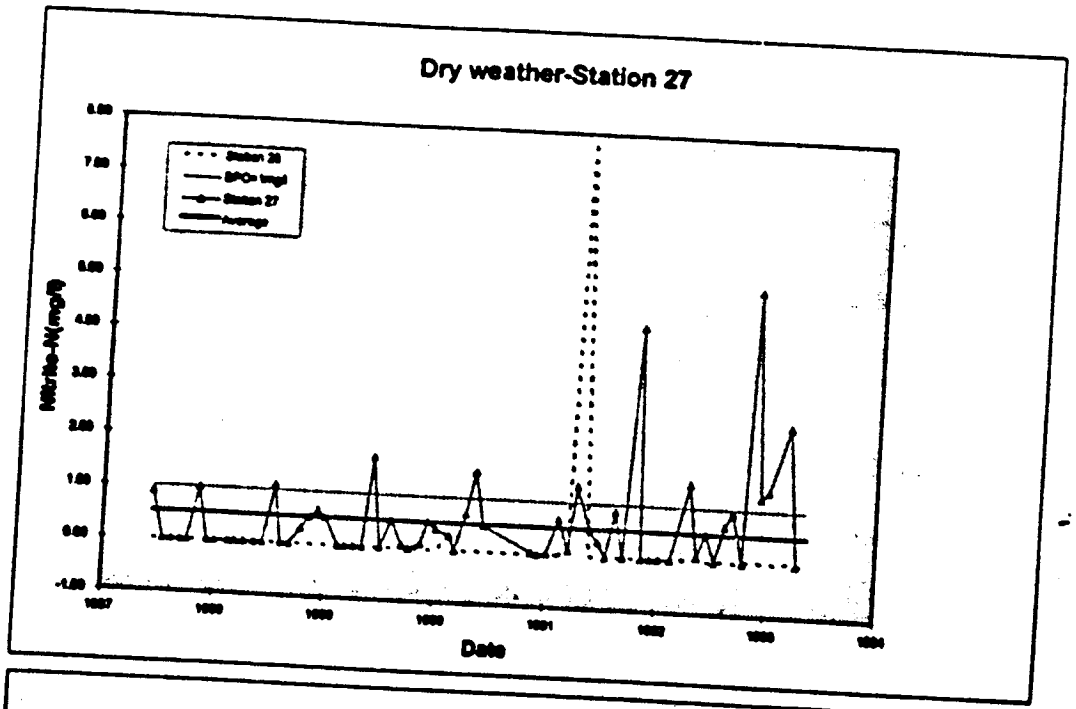


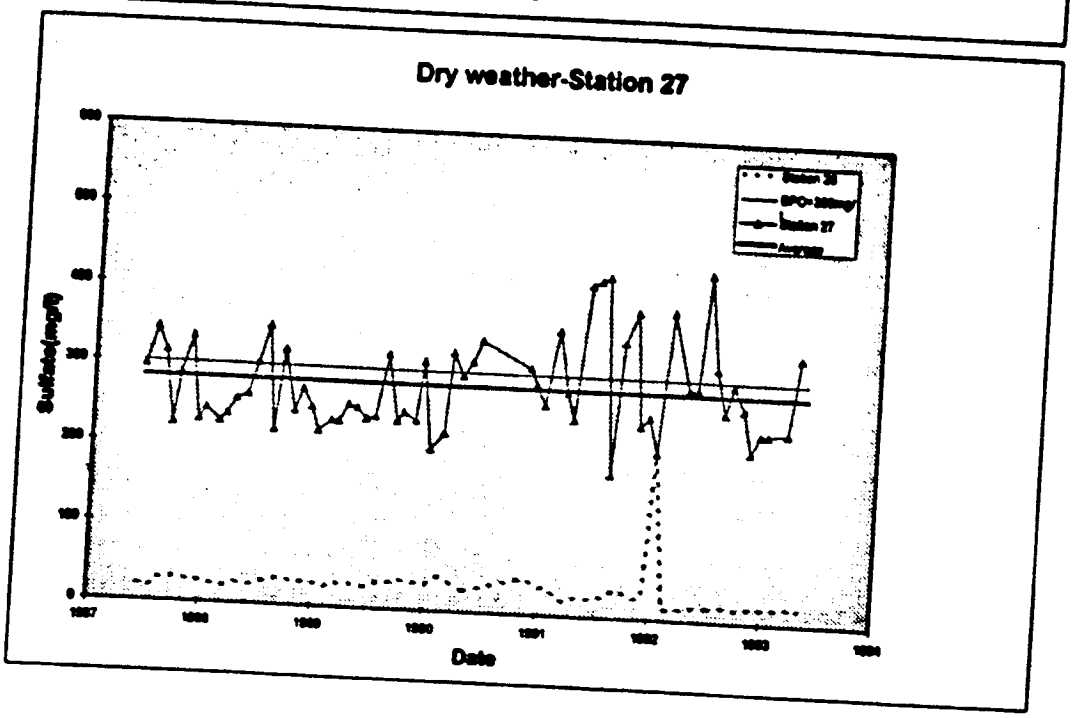


VOL 15

0842

R0061062

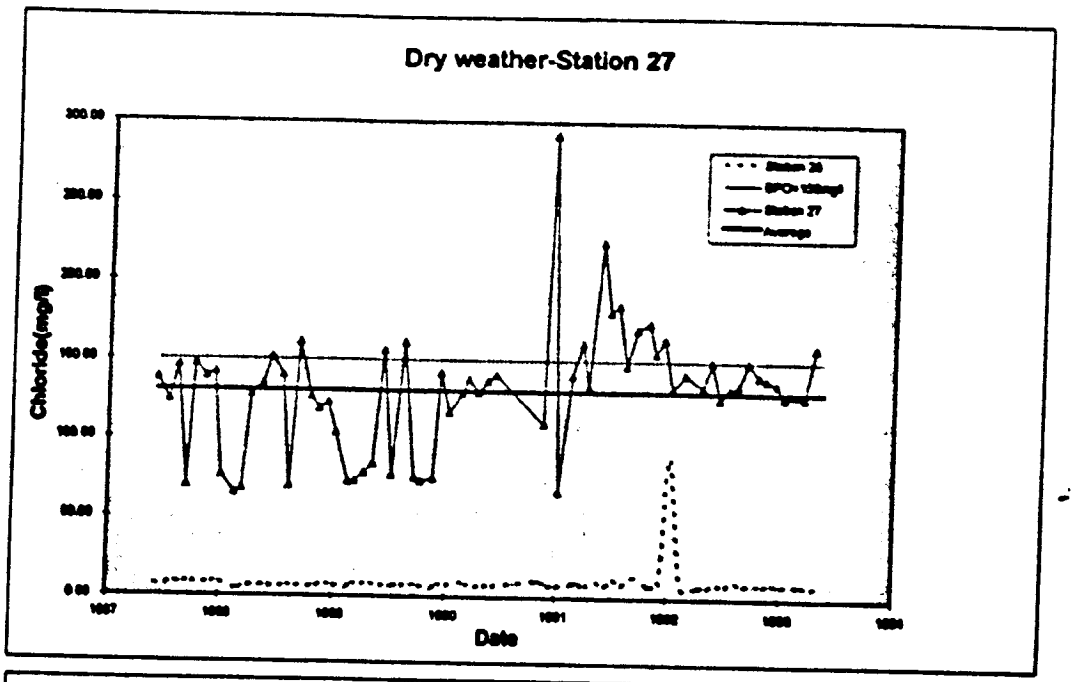


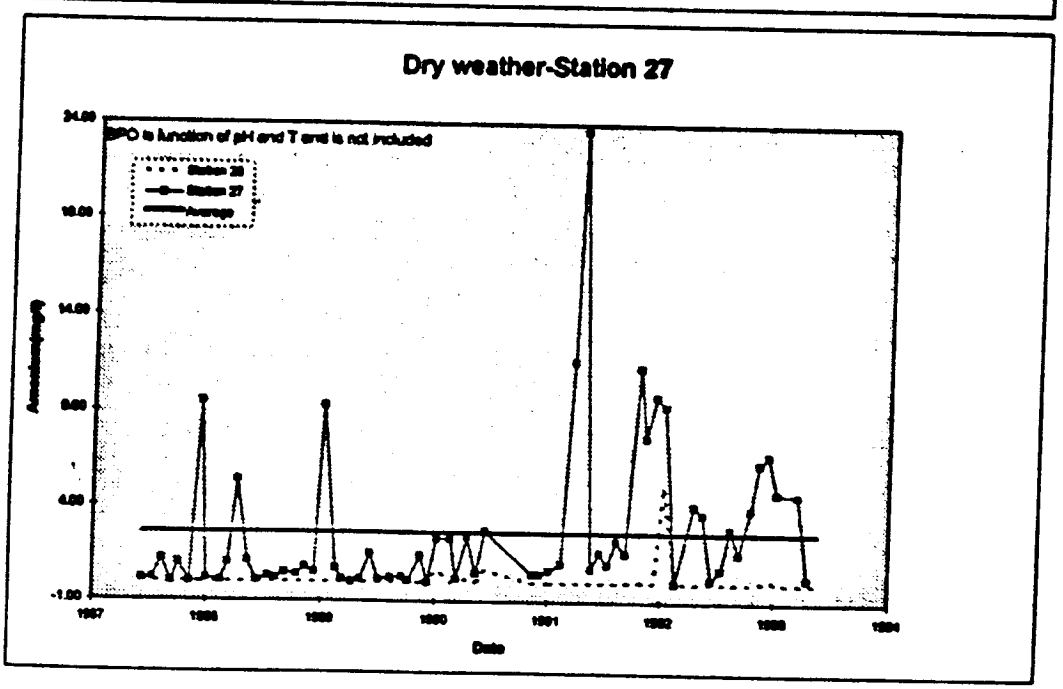


VOL 15

0843

R0061063





VOL 15

0844

R0061064

STORM WEATHER

VOL 15

0845

R0061065

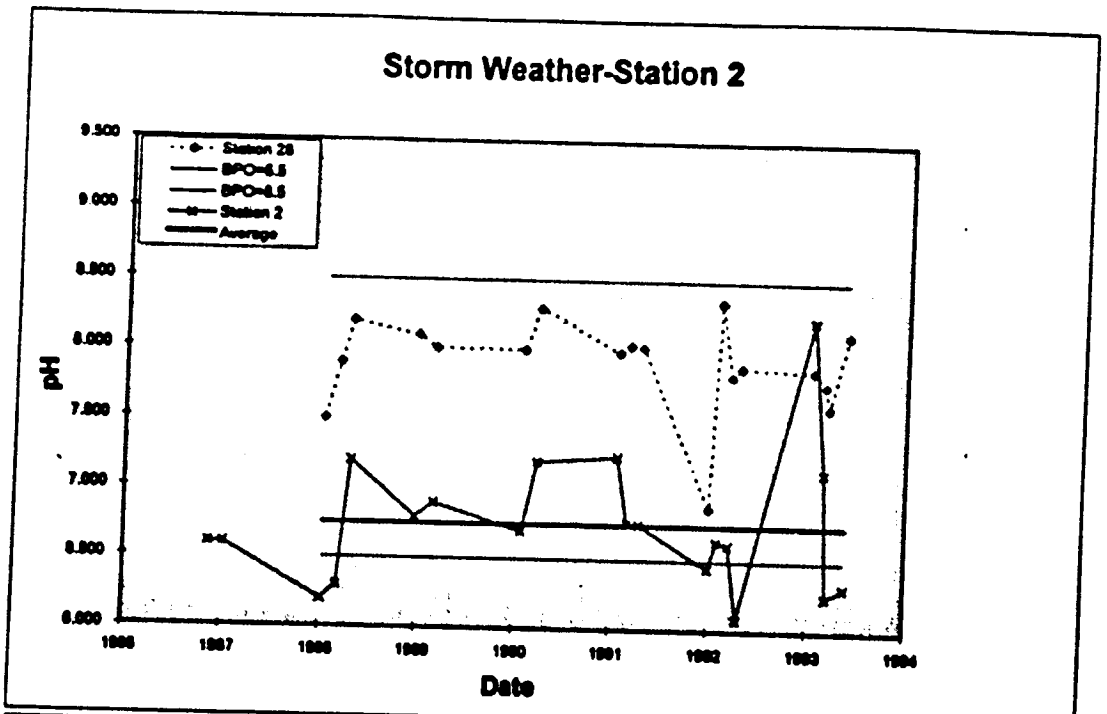
VOL 15

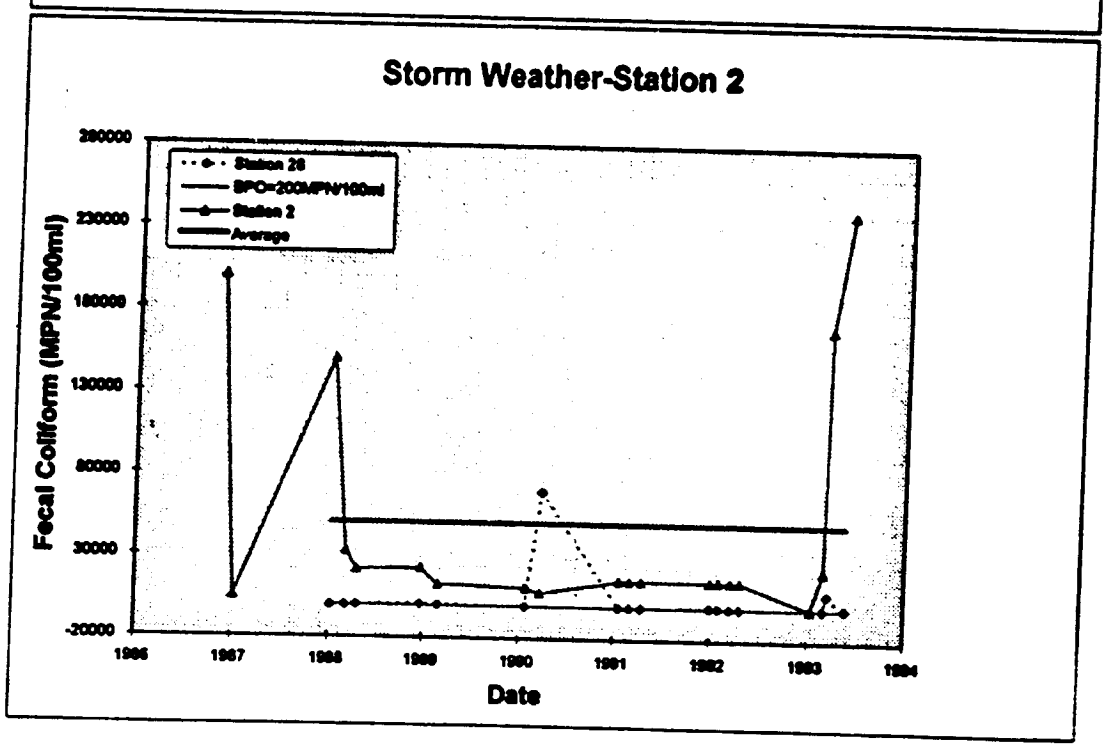
0846

GRAPH LEGEND

BPO: BASIN PLAN (DRAFT 1994) OBJECTIVE
OPO: OCEAN PLAN (1990) OBJECTIVE

R0061066

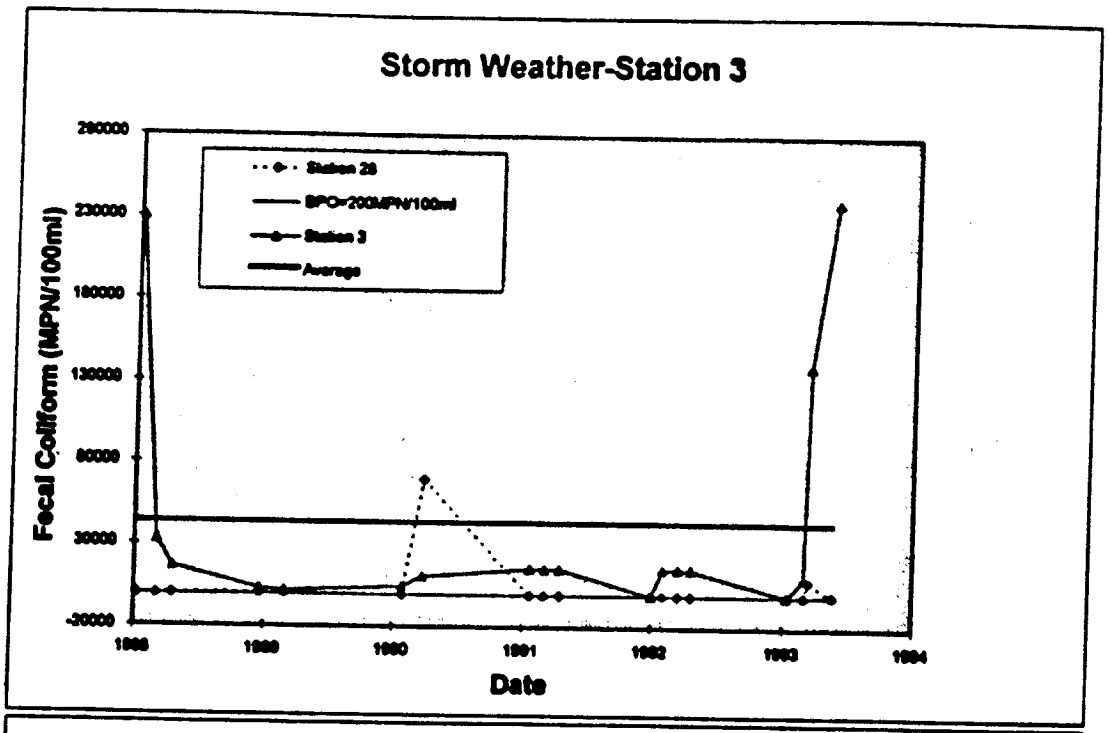

Storm Weather-Station 2
Station 28
BPO=6.5
BPO=8.5
Station 2
Average
pH
9.500
9.000
8.500
8.000
7.500
7.000
6.500
6.000
1986
1987
1988
1989
1990
1991
1992
1993
1994
Date

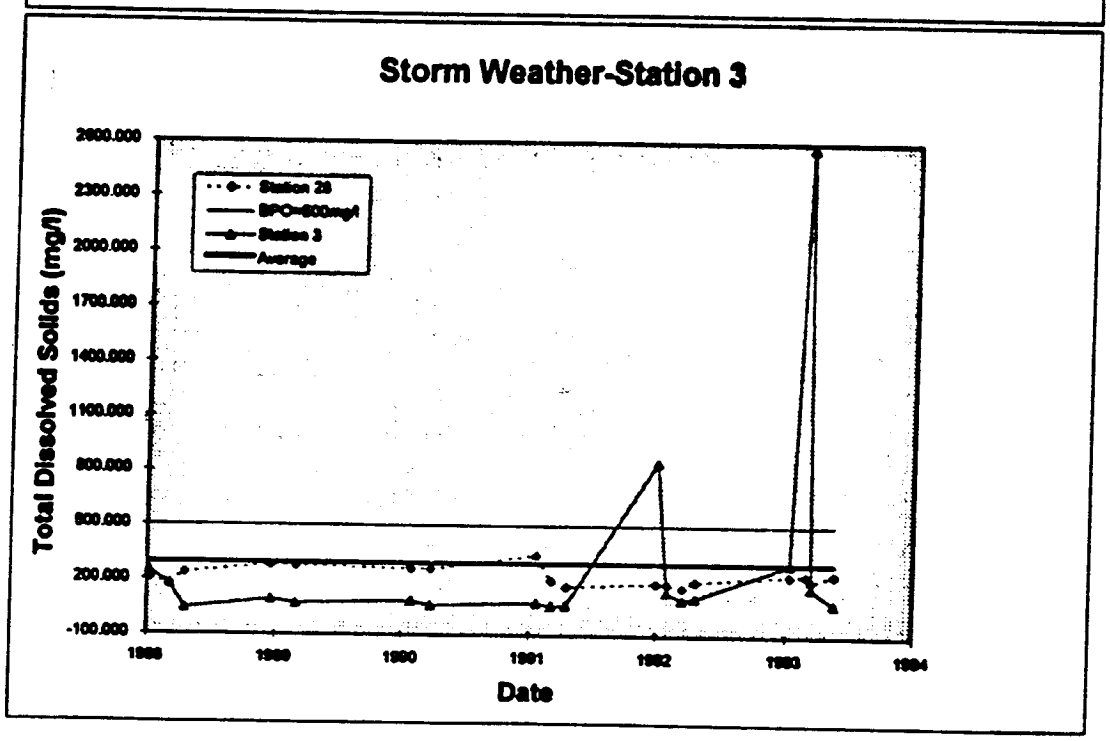

Storm Weather-Station 2
Station 28
BPO=200MPN/100ml
Station 2
Average
Fecal Coliform (MPN/100ml)
280000
230000
180000
130000
80000
30000
-20000
1986
1987
1988
1989
1990
1991
1992
1993
1994
Date

VOL 15

0847

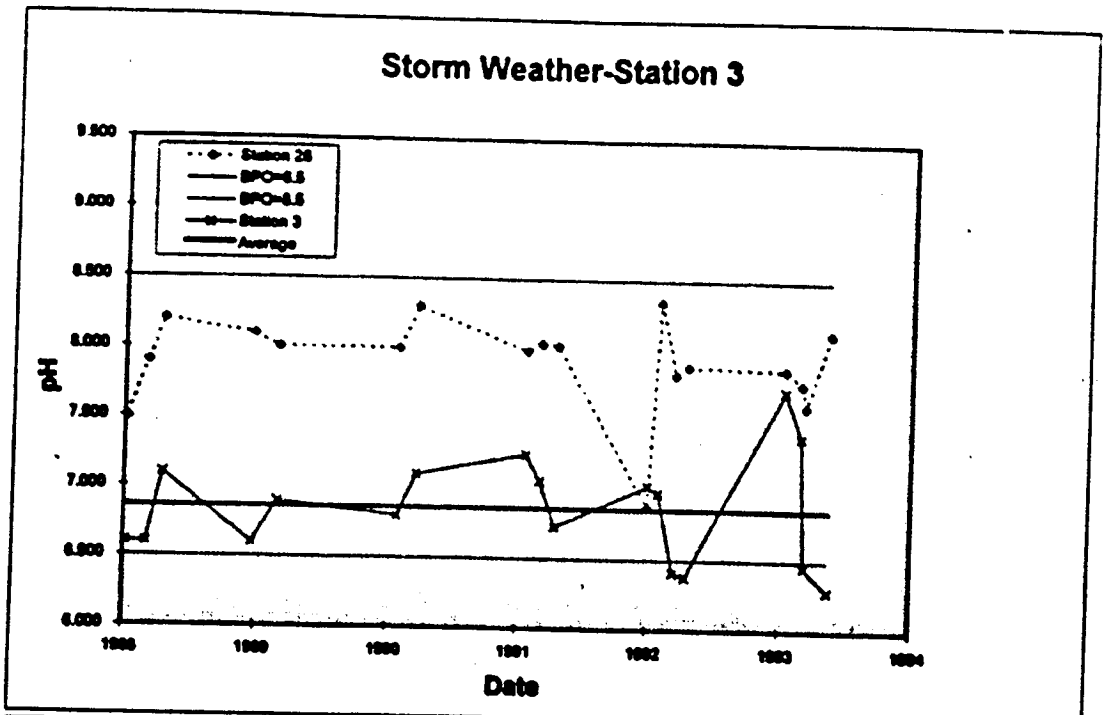
VOL 15

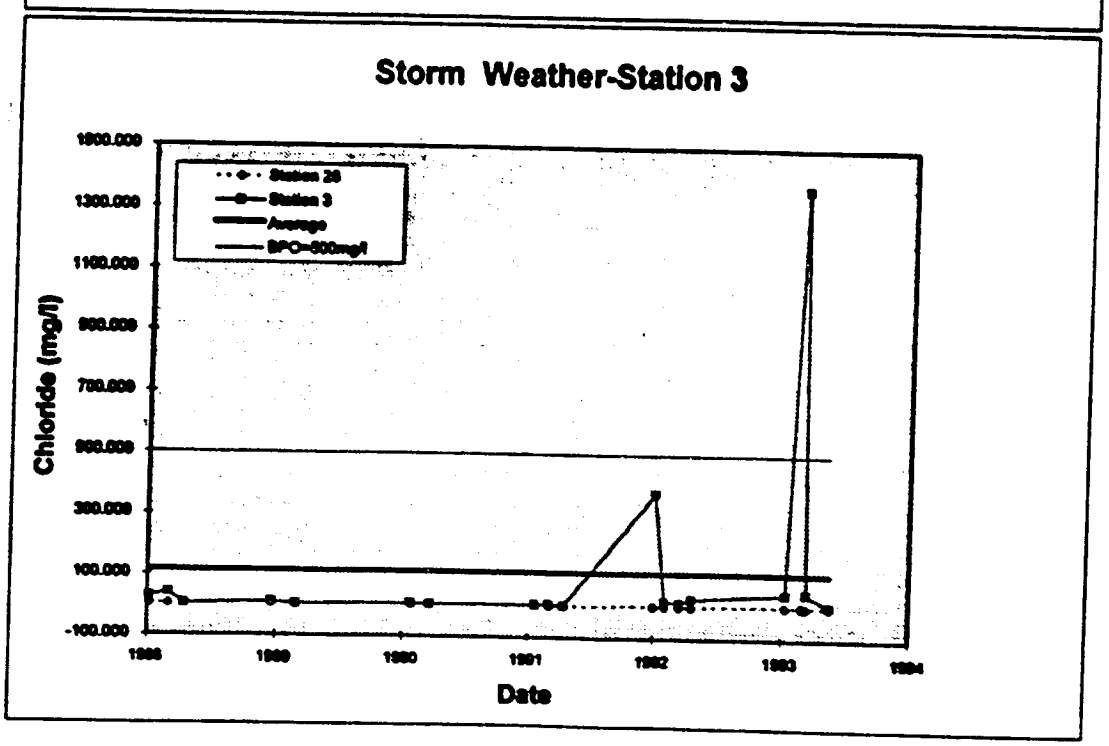




0848

R0061068

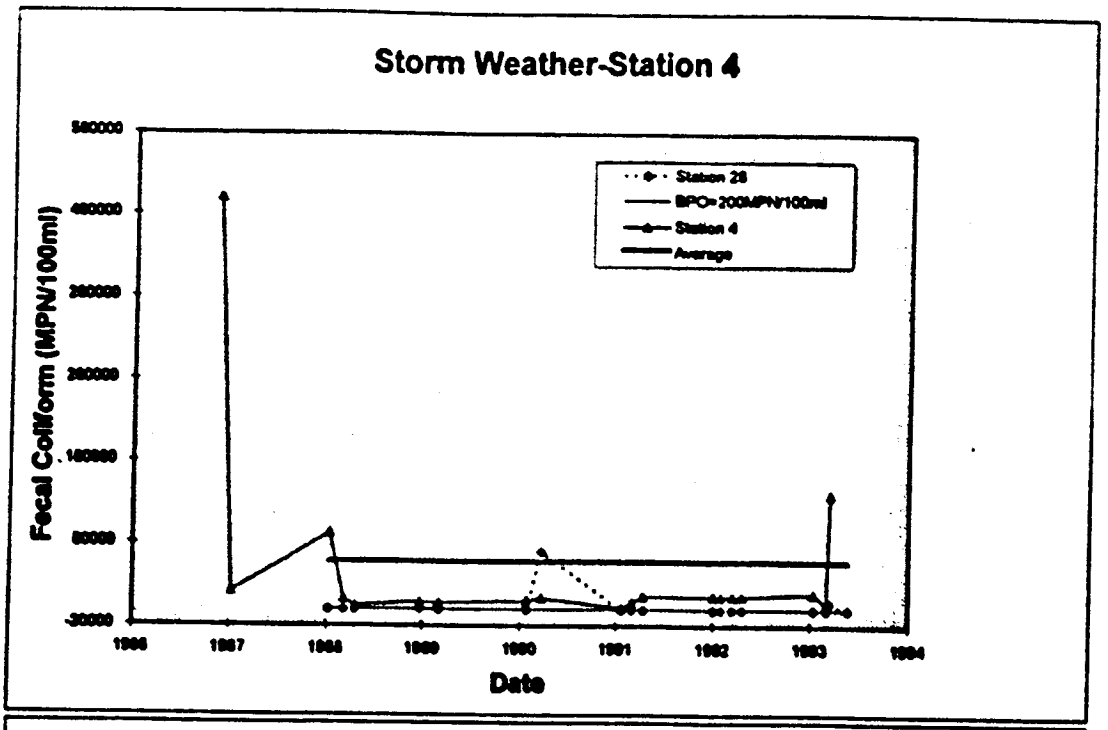


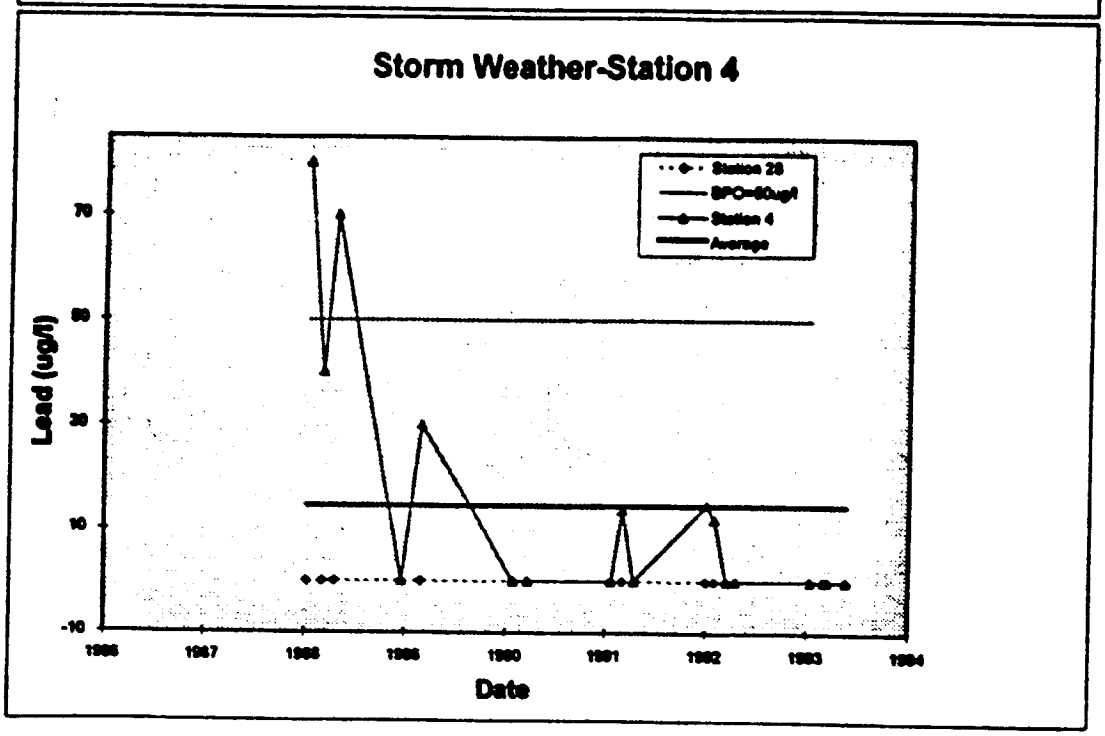


VOL 15

0849

R0061069

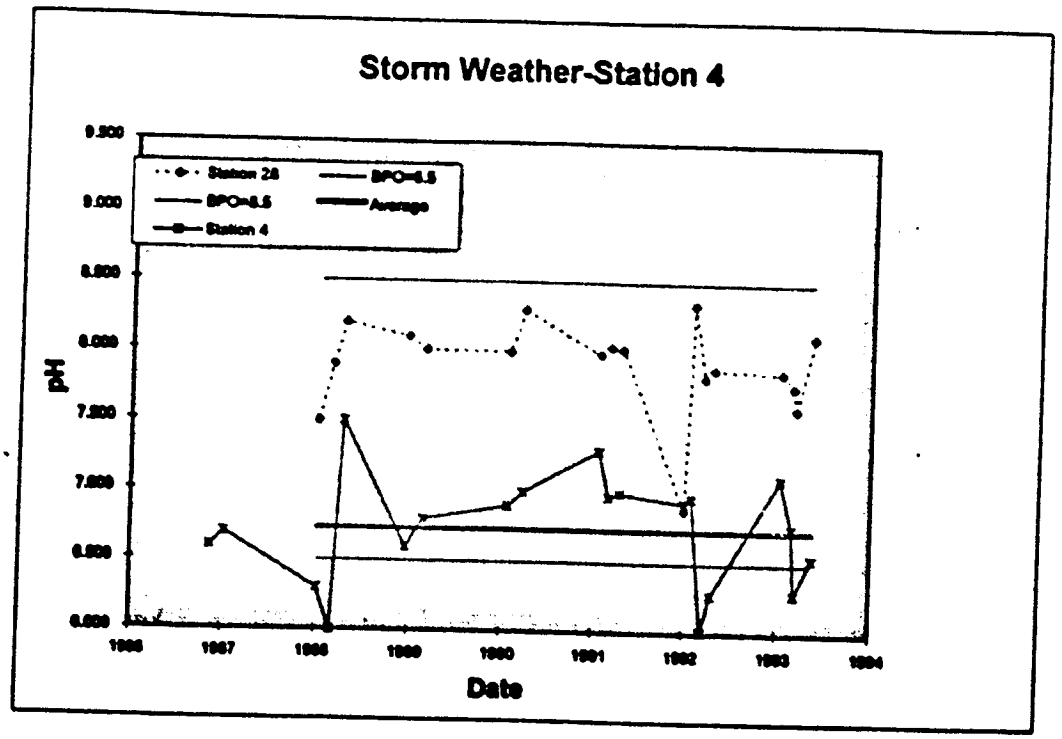




VOL 15

0850

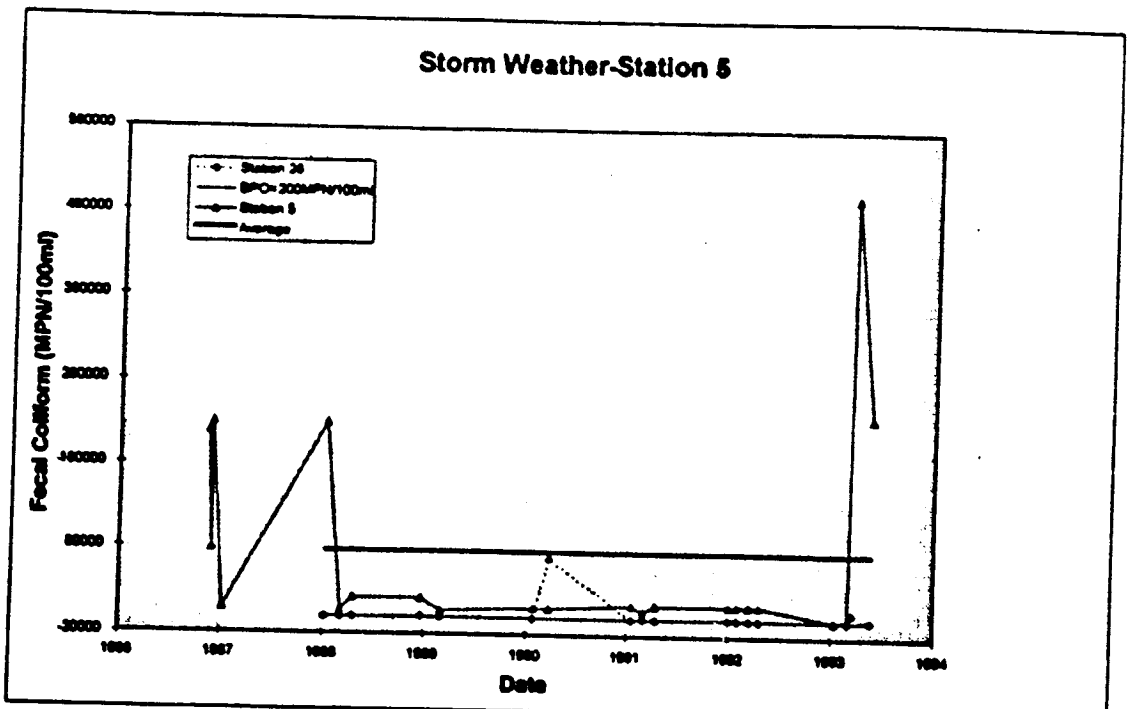
R0061070

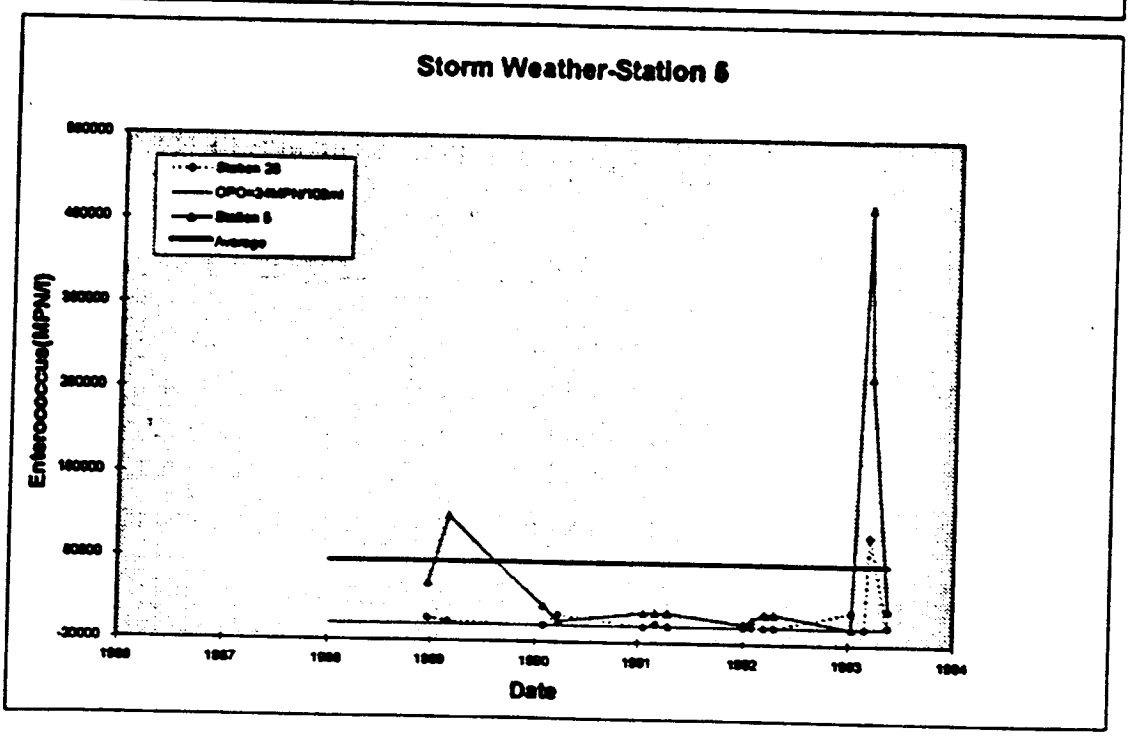


VOL 15

0851

R0061071

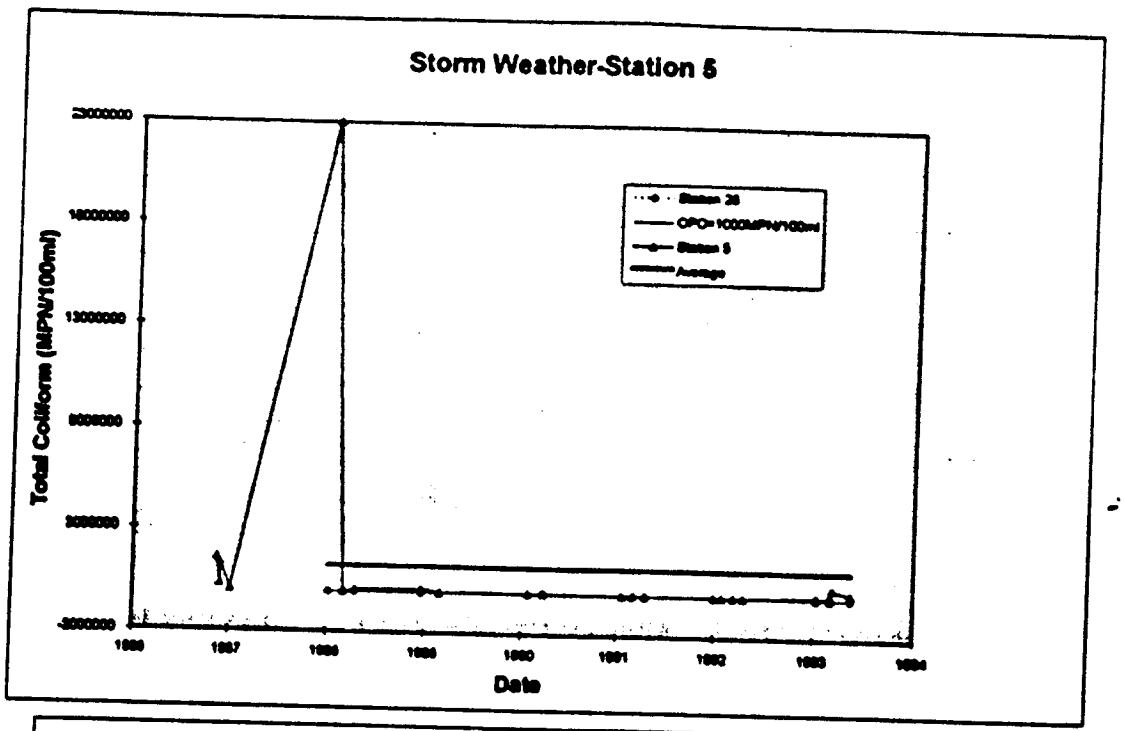


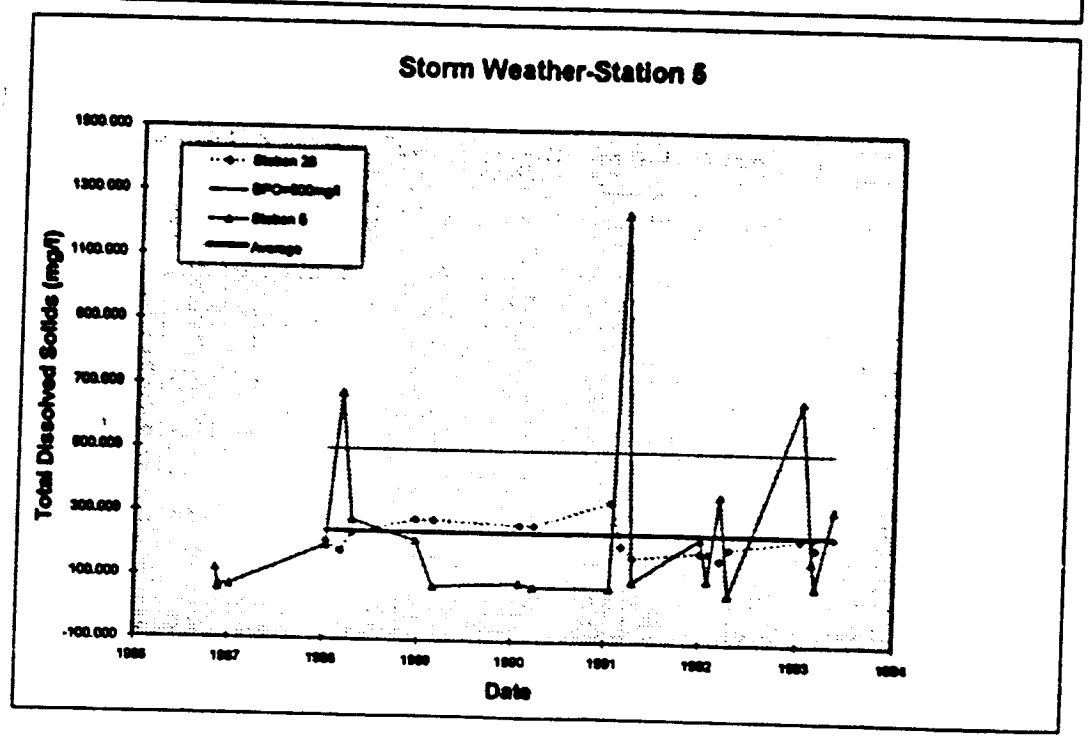


VOL 15

0852

R0061072

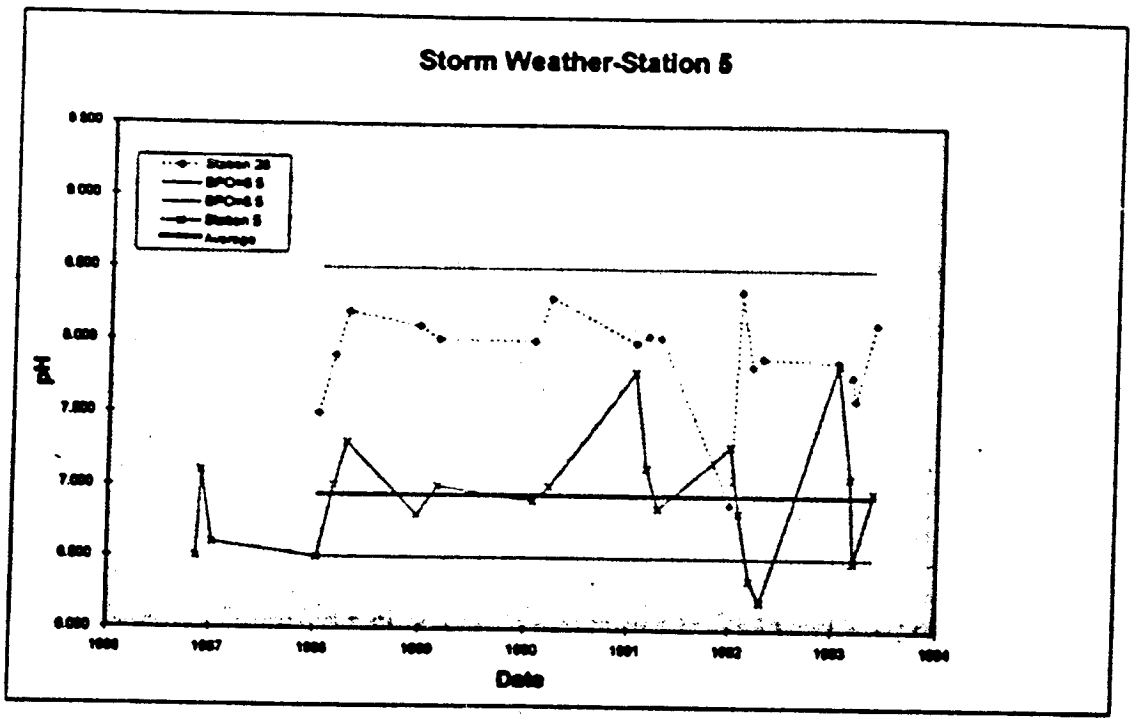




VOL 15

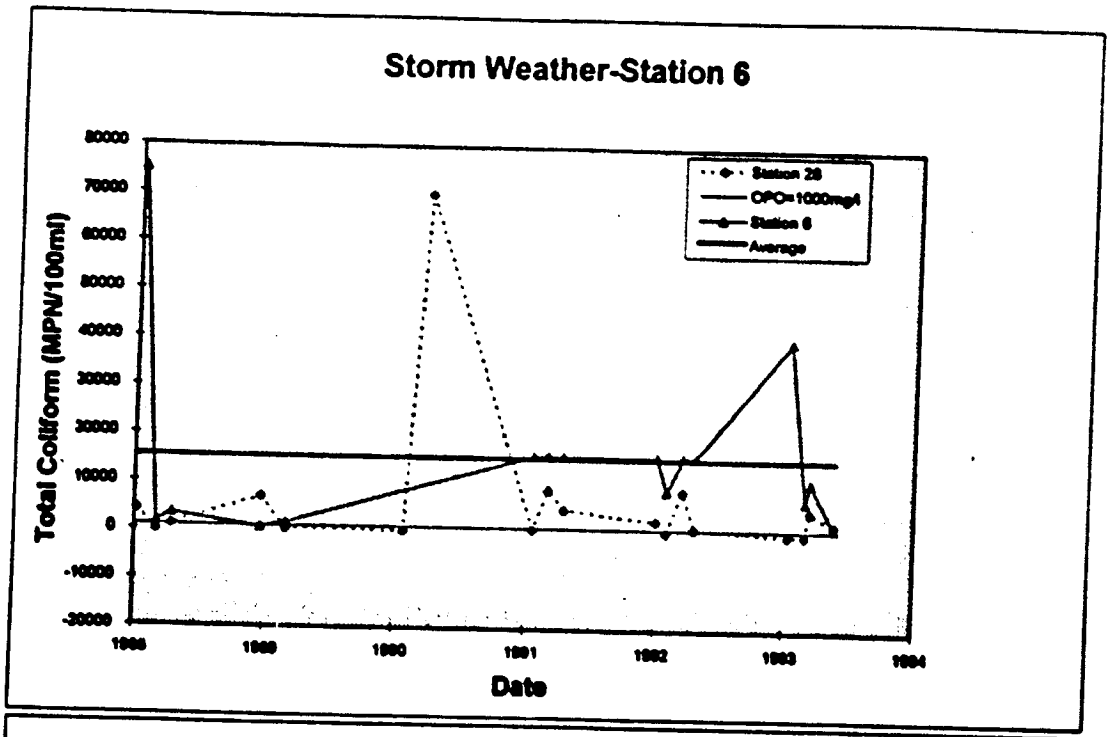
0853

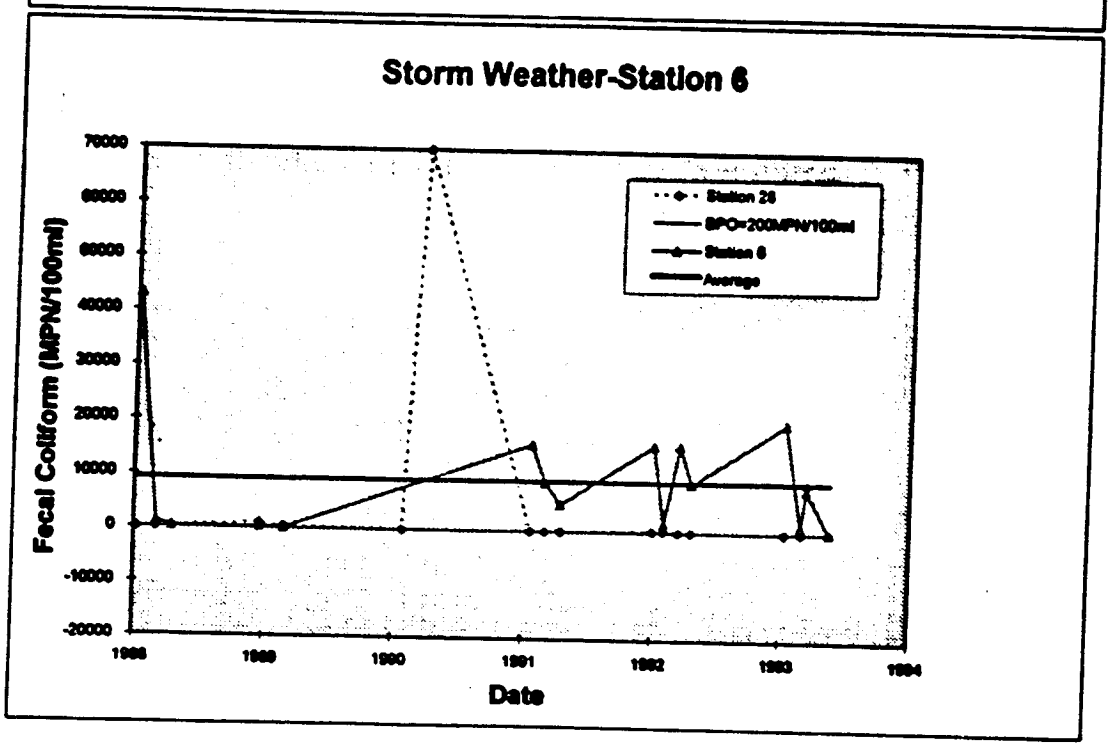
R0061073


Storm Weather-Station 5
Station 28
BPOHS 5
BPOHS 5
Station 5
Average
pH
9.000
8.000
7.000
6.000
5.000
1986
1987
1988
1989
1990
1991
1992
1993
1994
Date

VOL 15

0854

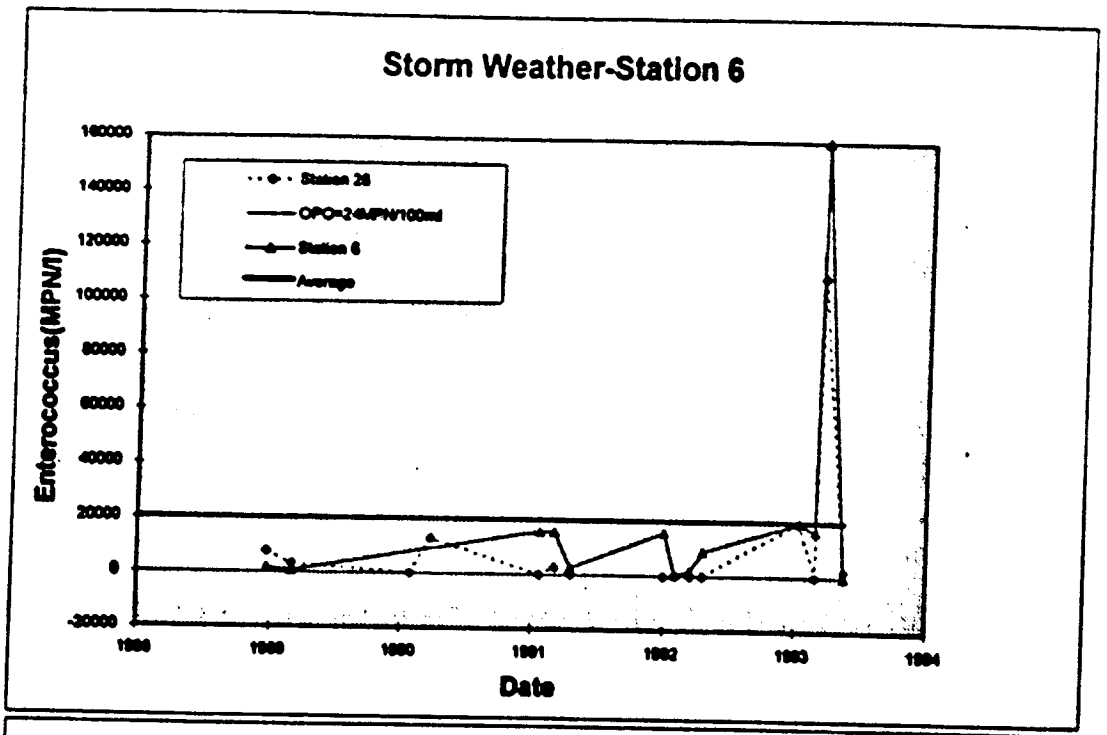


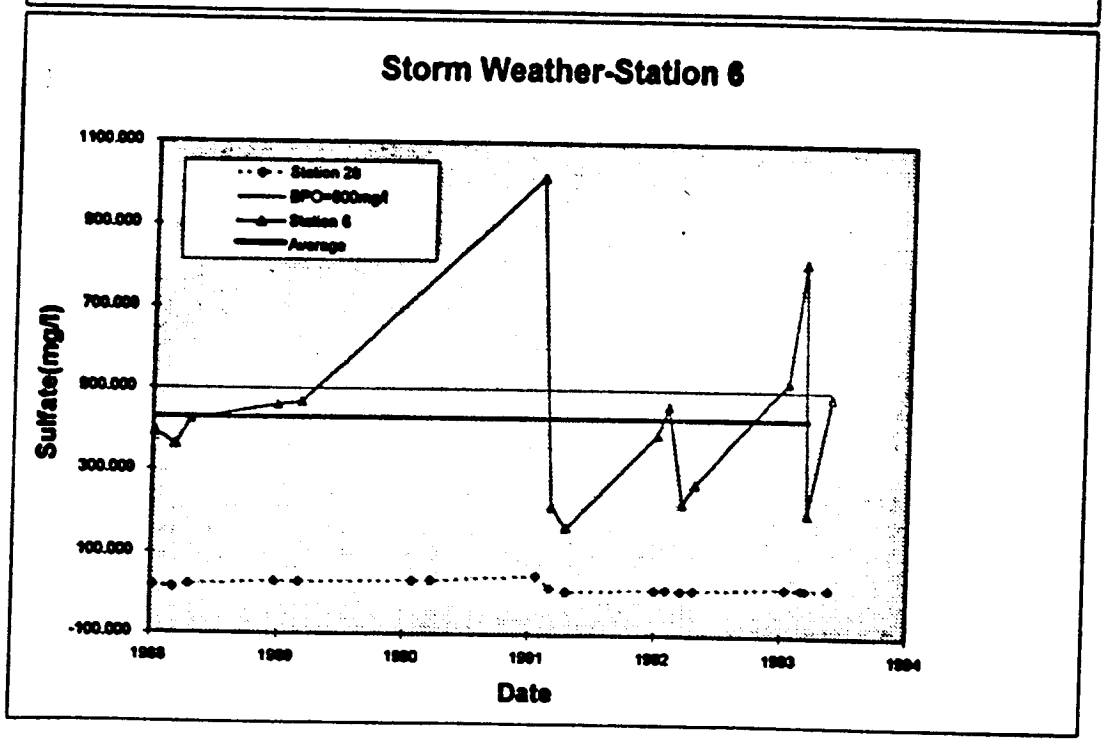


VOL 15

0855

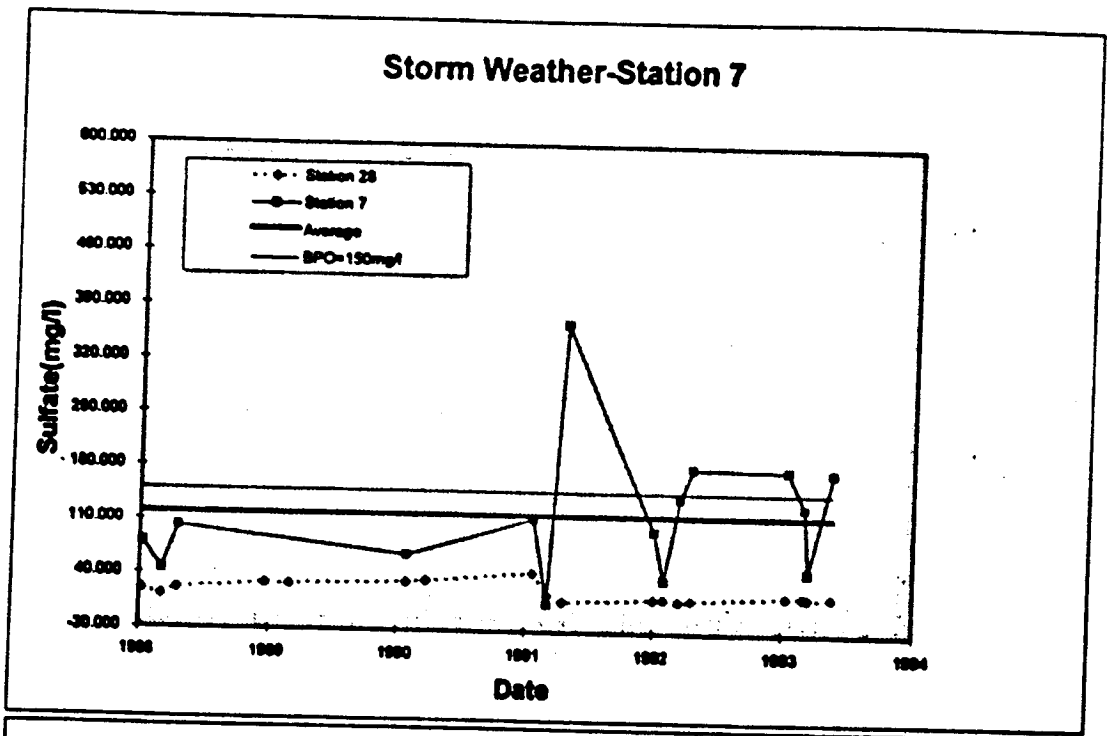
R0061075

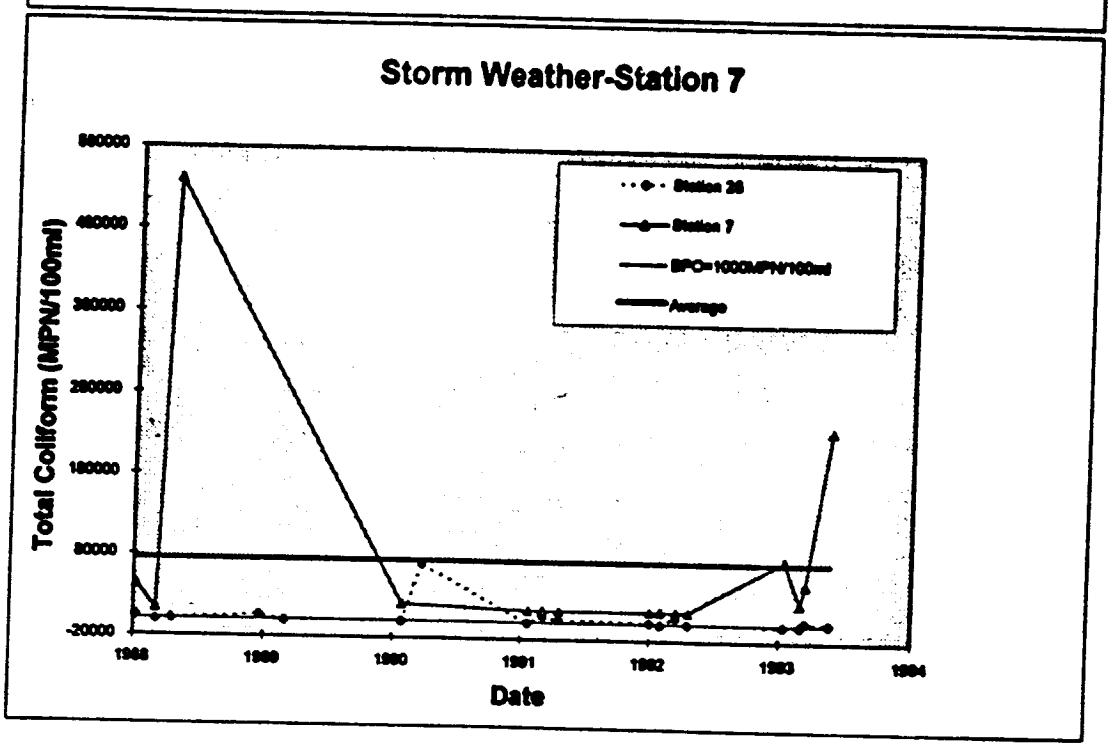

Storm Weather-Station 6
Station 28
OPO=24/PN/100ml
Station 6
Average
Enterococcus(MPN/l)
160000
140000
120000
100000
80000
60000
40000
20000
0
-20000
1988
1989
1990
1991
1992
1993
1994
Date


Storm Weather-Station 6
Station 28
BPO=600mg/l
Station 6
Average
Sulfate(mg/l)
1100.000
900.000
700.000
500.000
300.000
100.000
-100.000
1988
1989
1990
1991
1992
1993
1994
Date

VOL 15

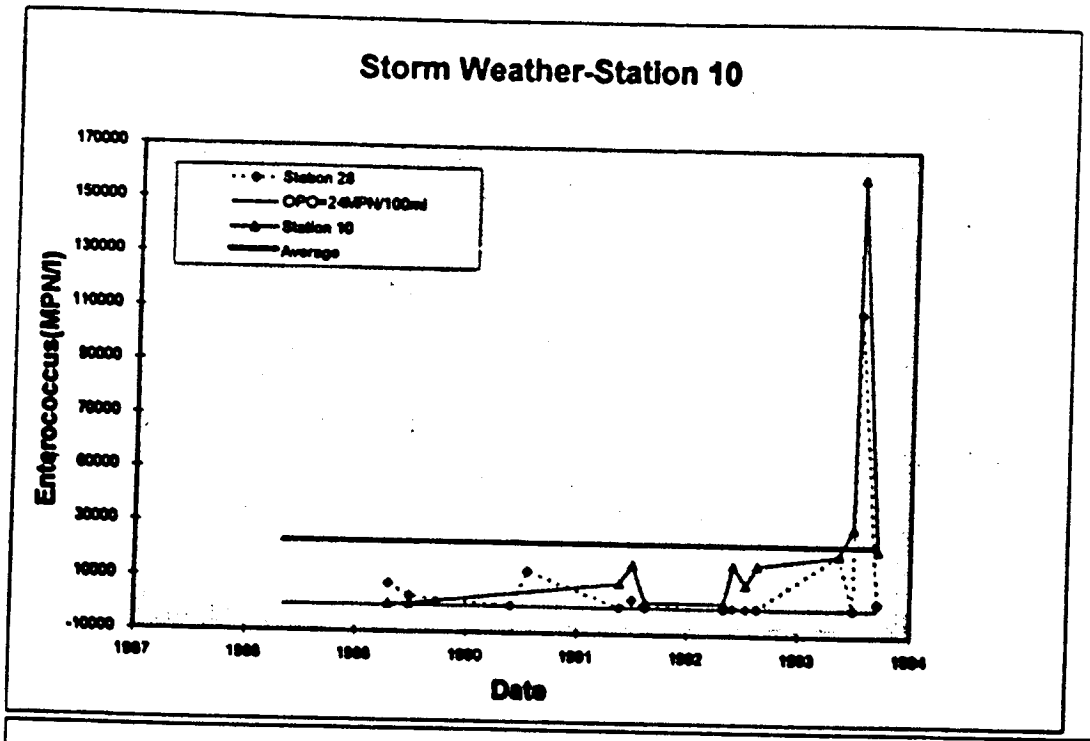
0856

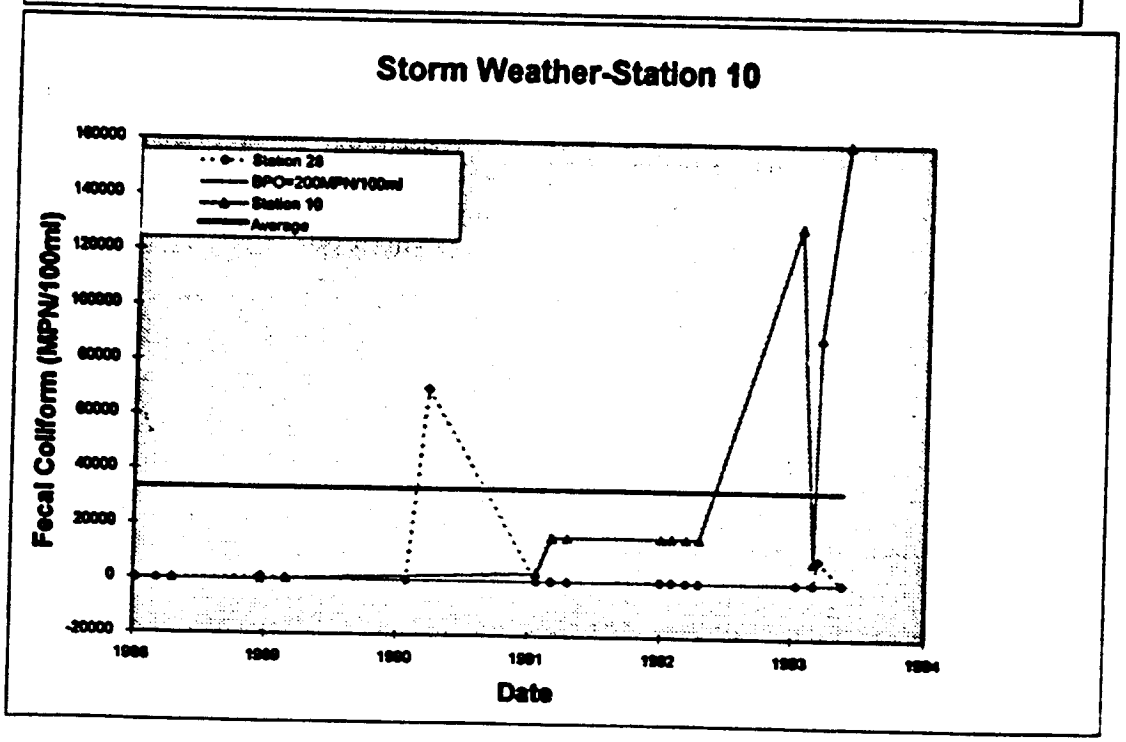

Storm Weather-Station 7
Station 28
Station 7
Average
BPO=150mg/l
Sulfate(mg/l)
800.000
530.000
460.000
390.000
320.000
250.000
180.000
110.000
40.000
-30.000
1988
1989
1990
1991
1992
1993
1994
Date


Storm Weather-Station 7
Station 28
Station 7
BPO=1000MPN/100ml
Average
Total Coliform (MPN/100ml)
460000
360000
260000
180000
80000
-20000
1988
1989
1990
1991
1992
1993
1994
Date

VOL 15

0857

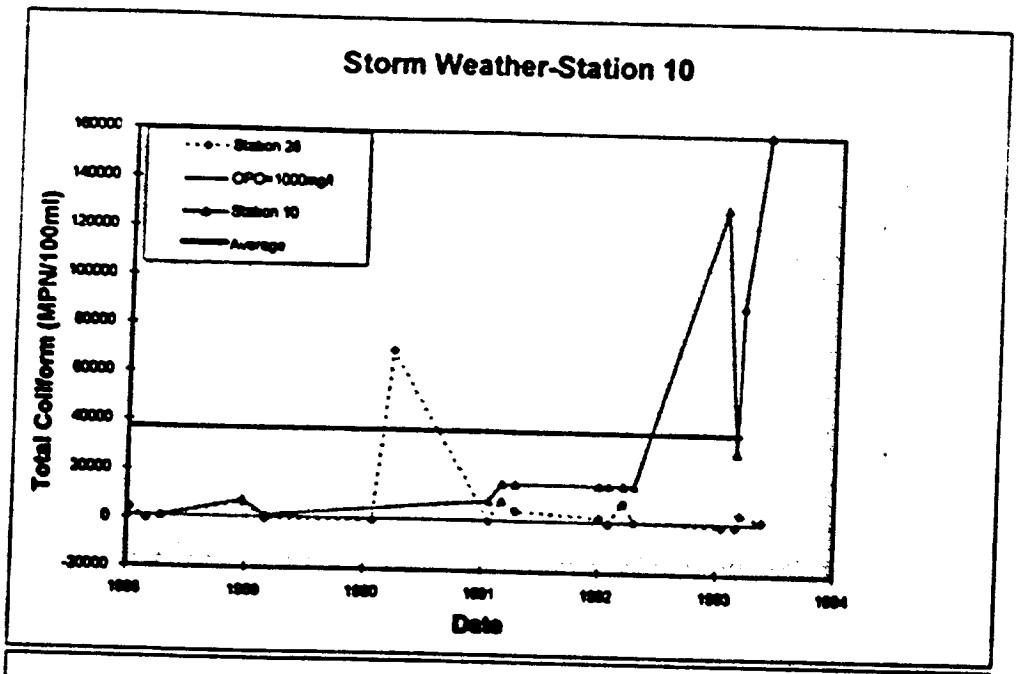


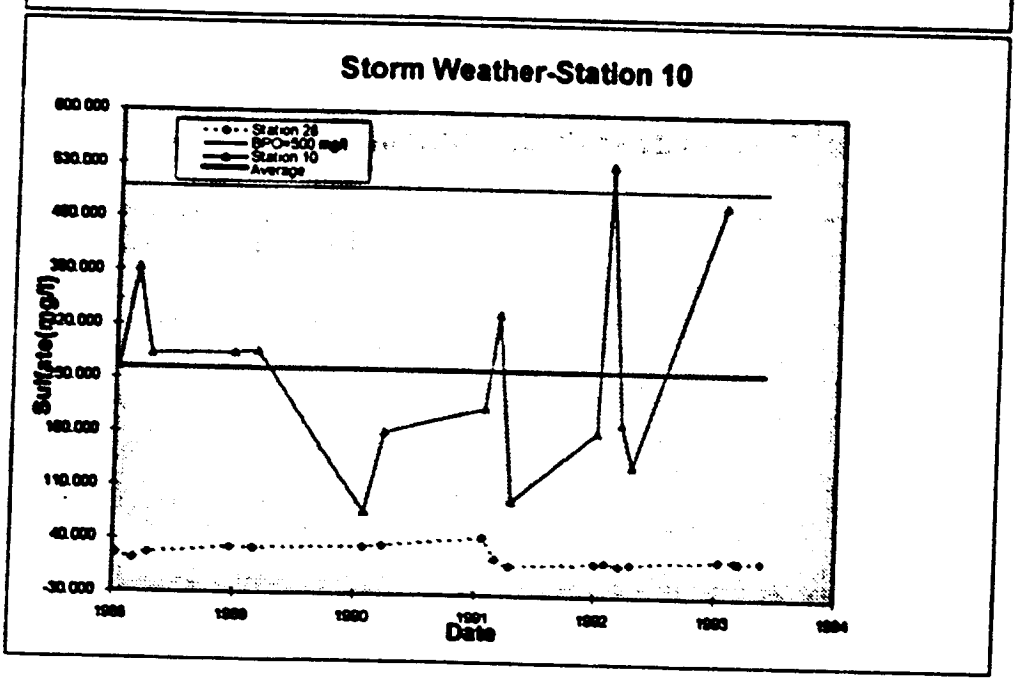


VOL 15

0858

R0061078

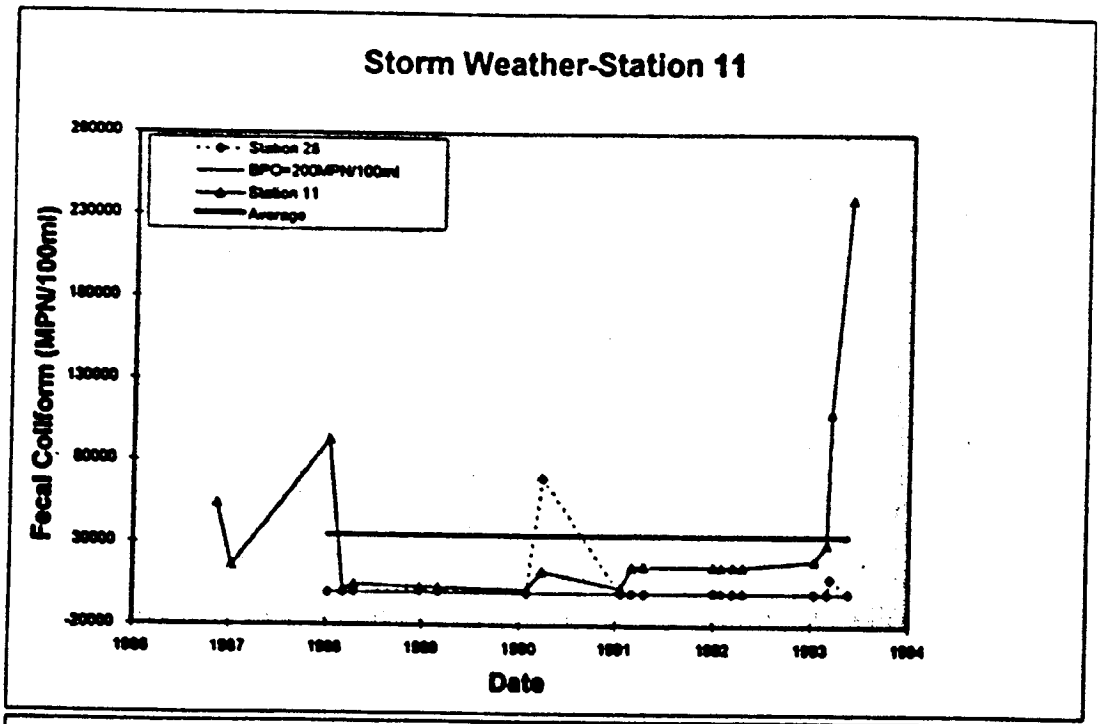


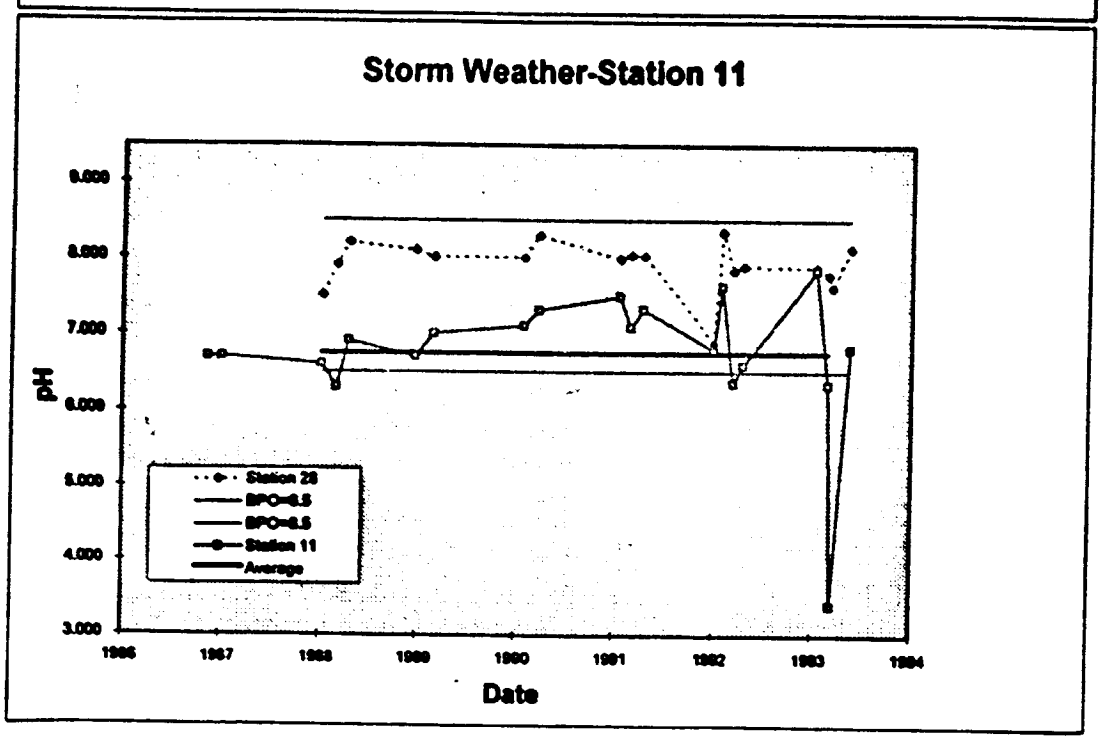


VOL 15

0859

R0061079

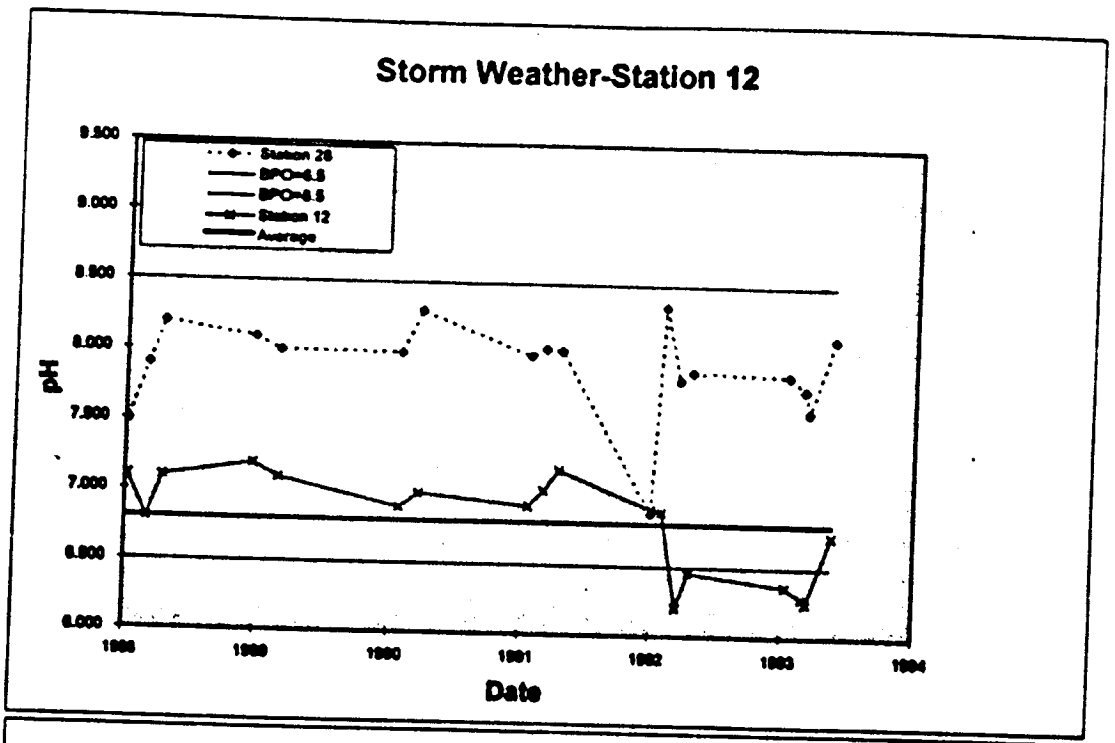


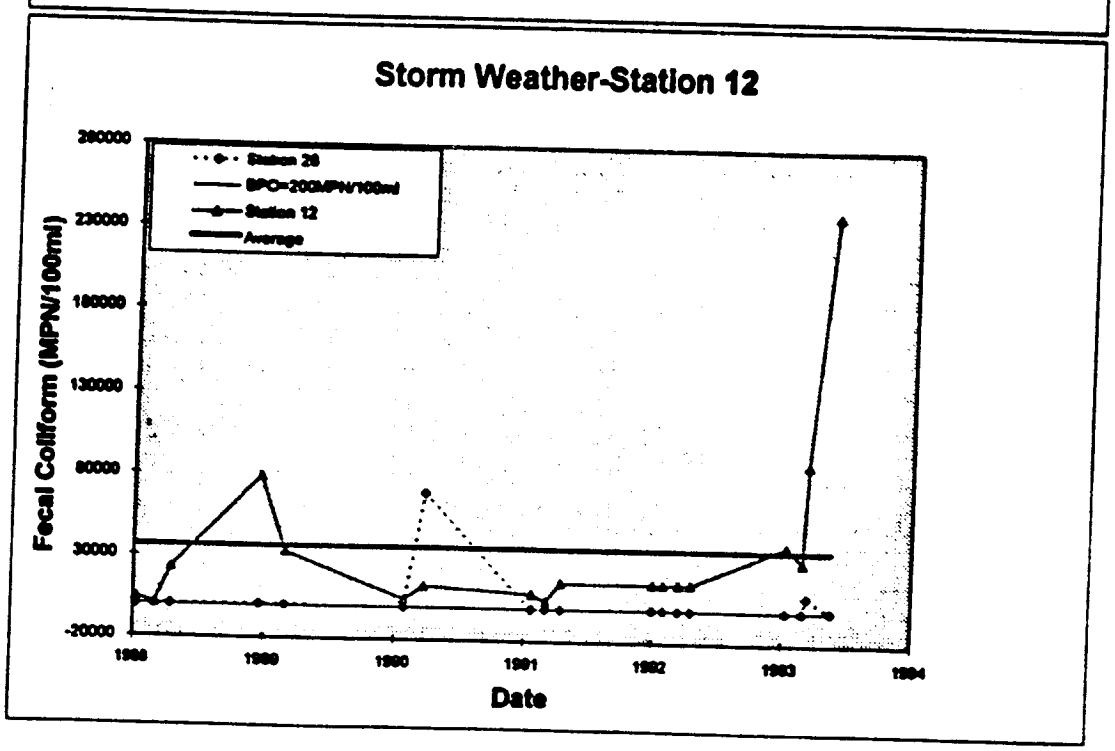


VOL 15

0860

R0061080

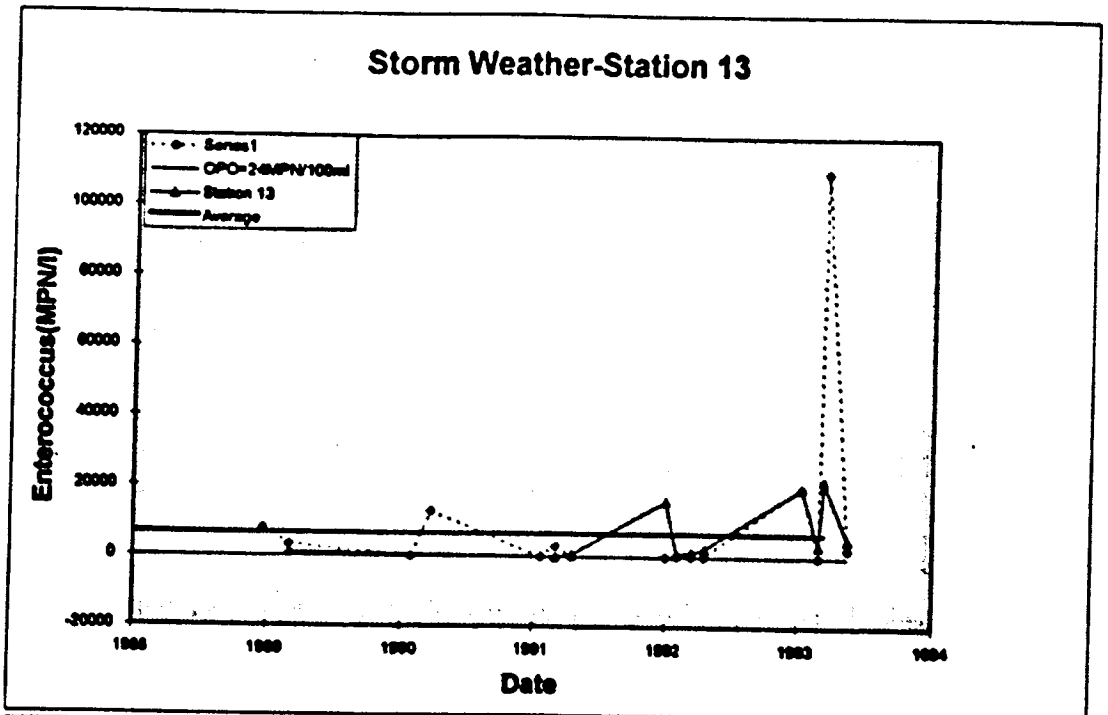


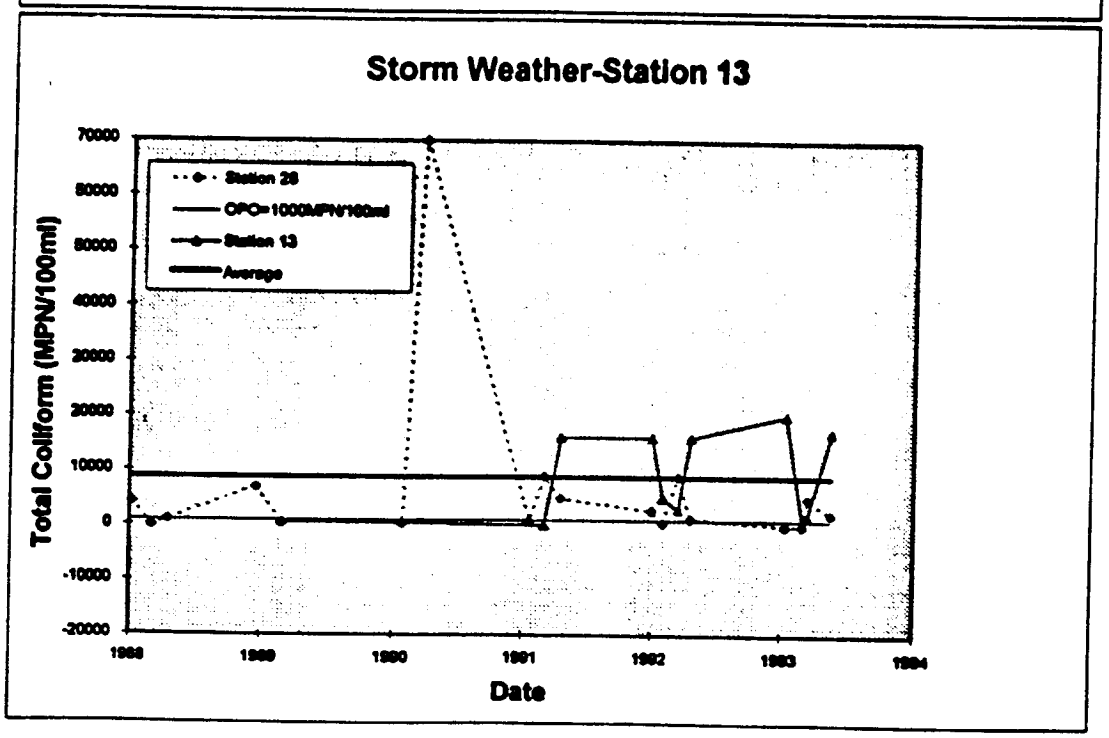


VOL 15

0861

R0061081

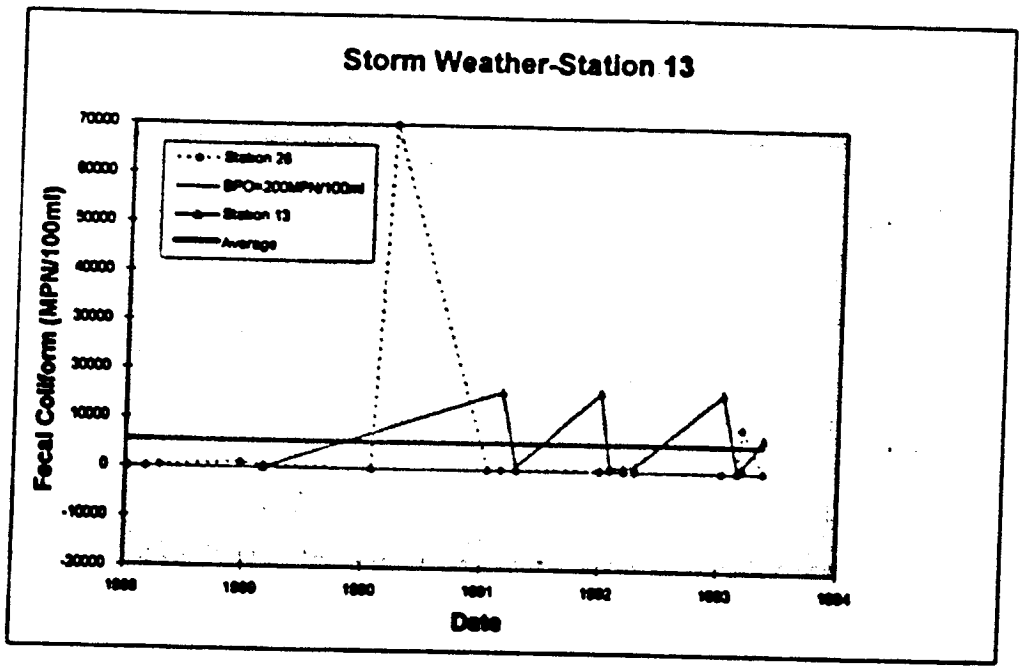




VOL 15

0862

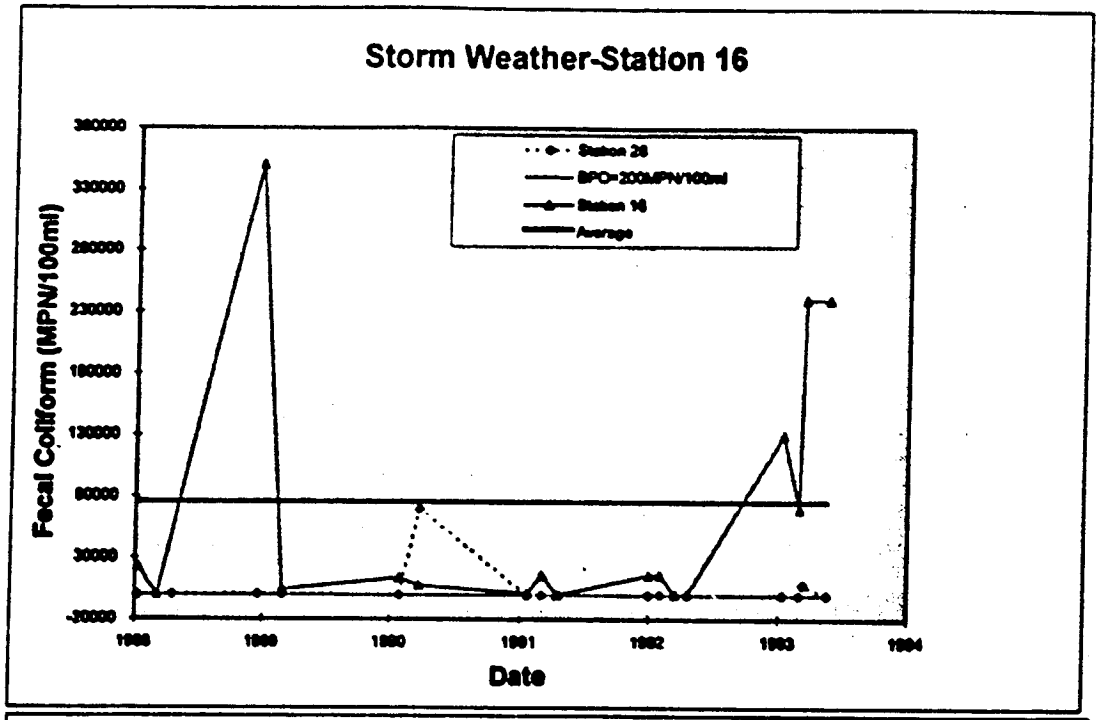
R0061082

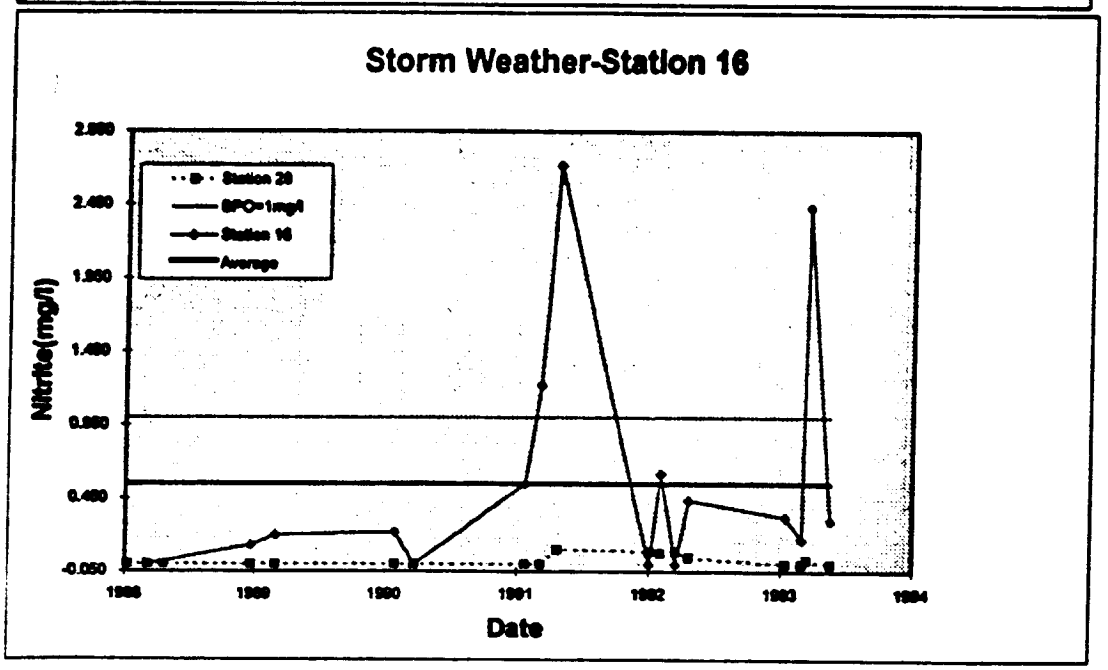


VOL 15

08633

R0061083

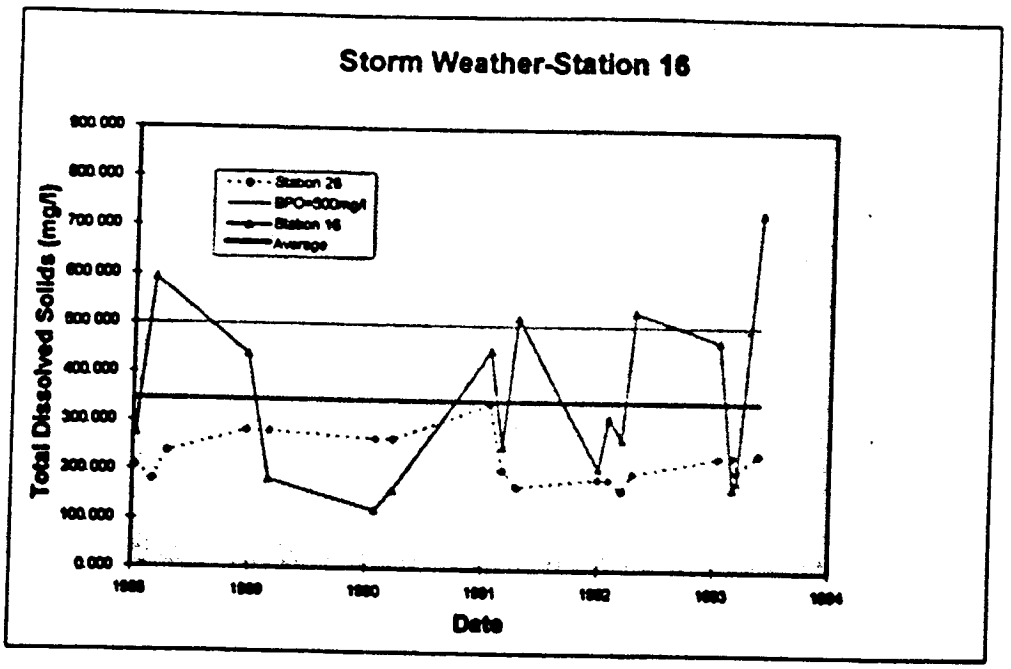




VOL 15

0864

R0061084



VOL 15
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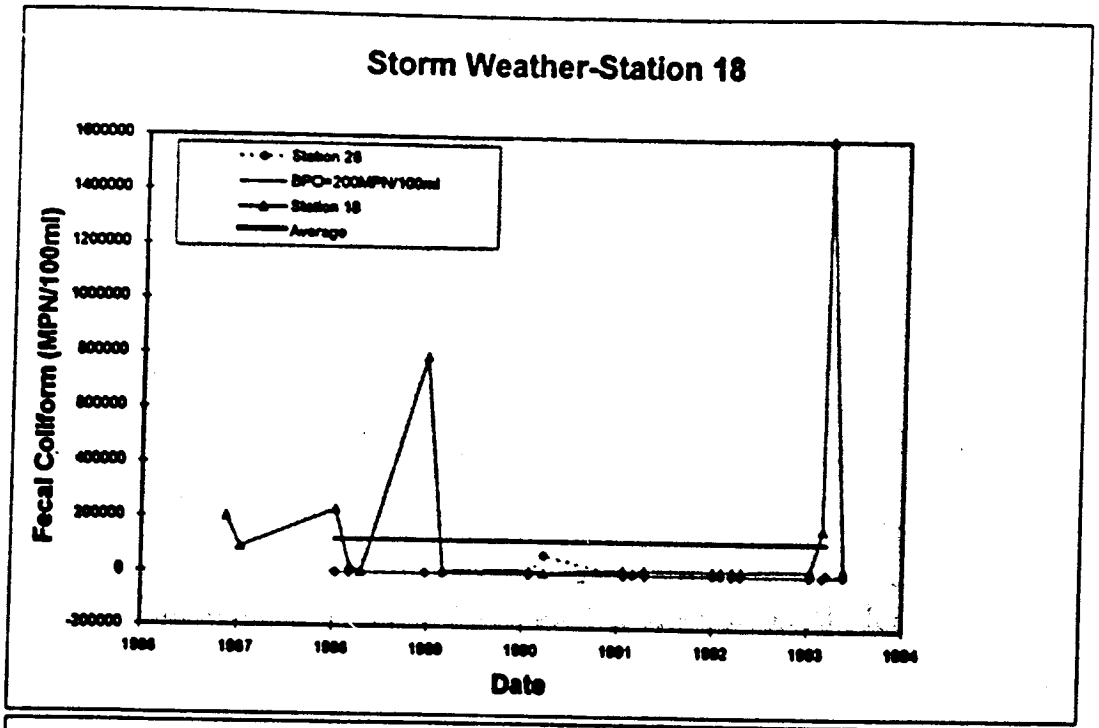
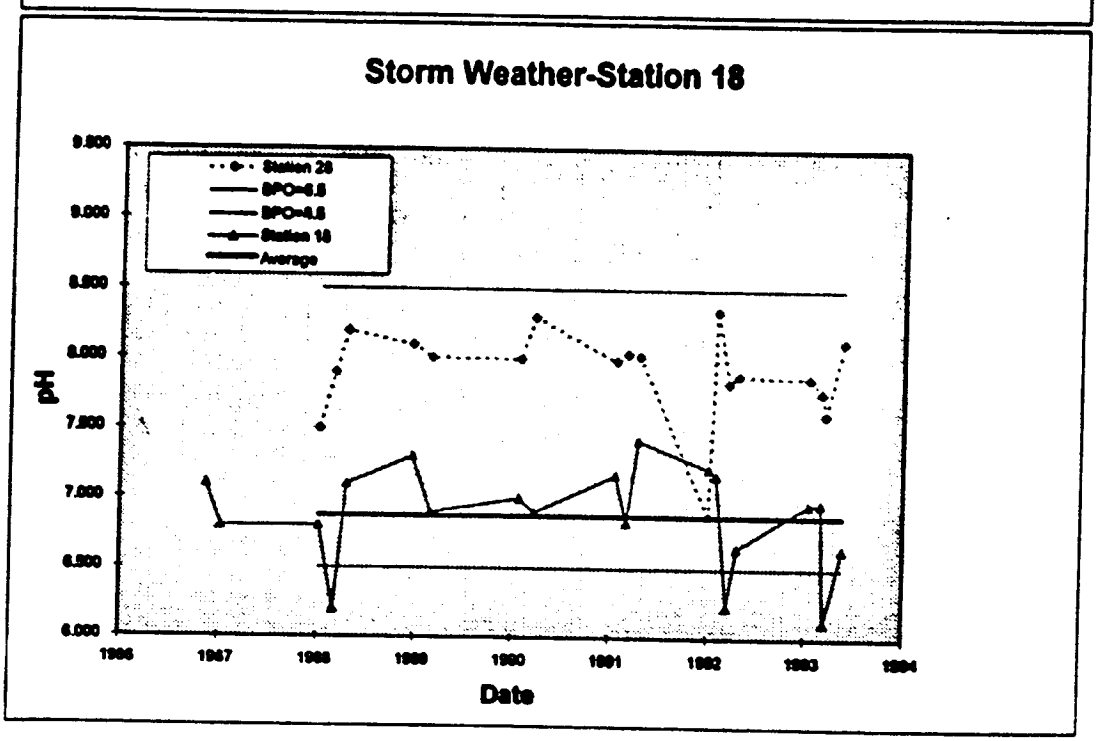
R0061085

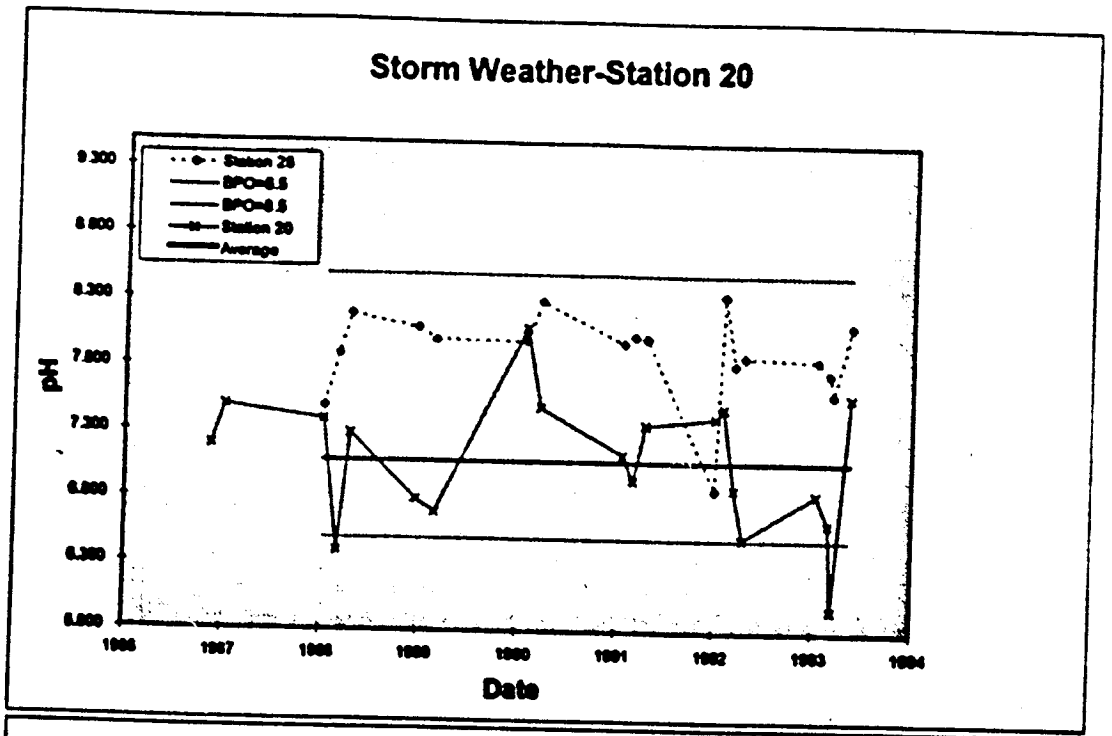


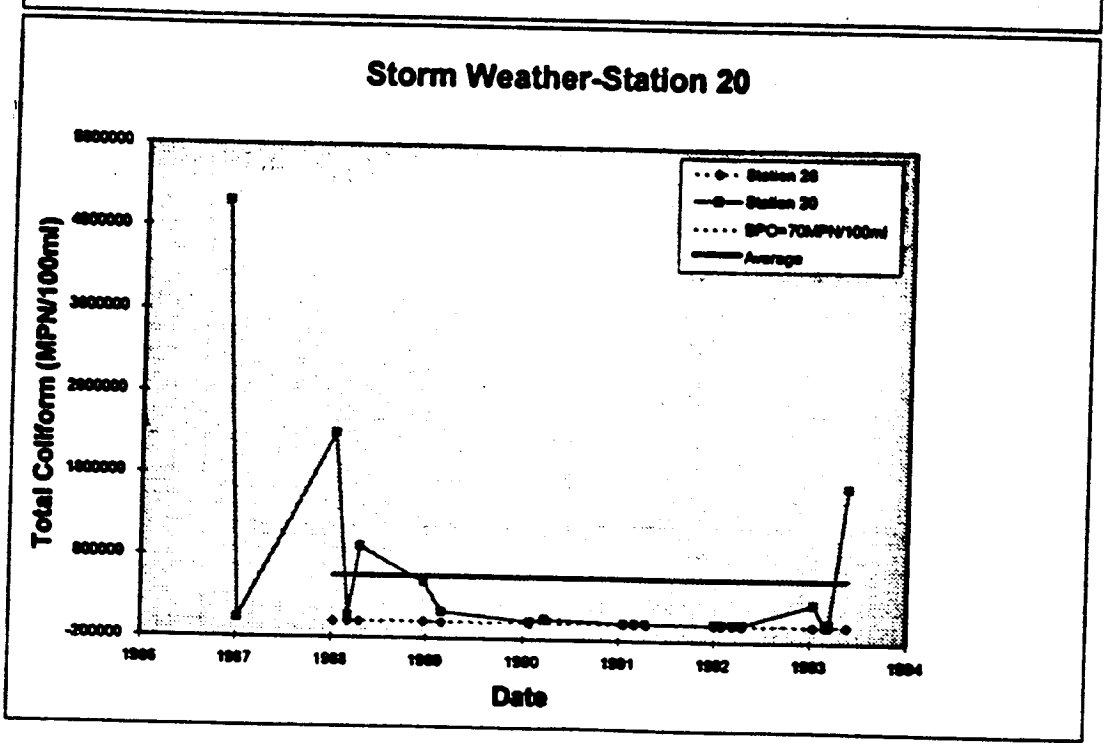


VOL 15

0866

R0061086

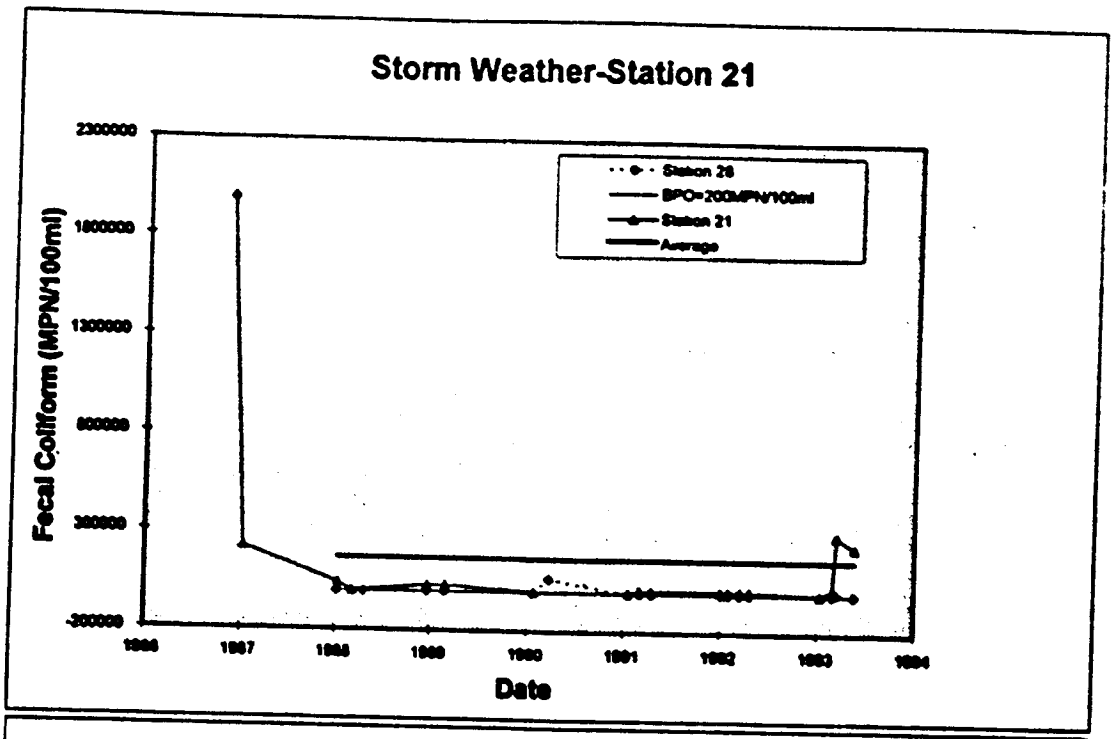


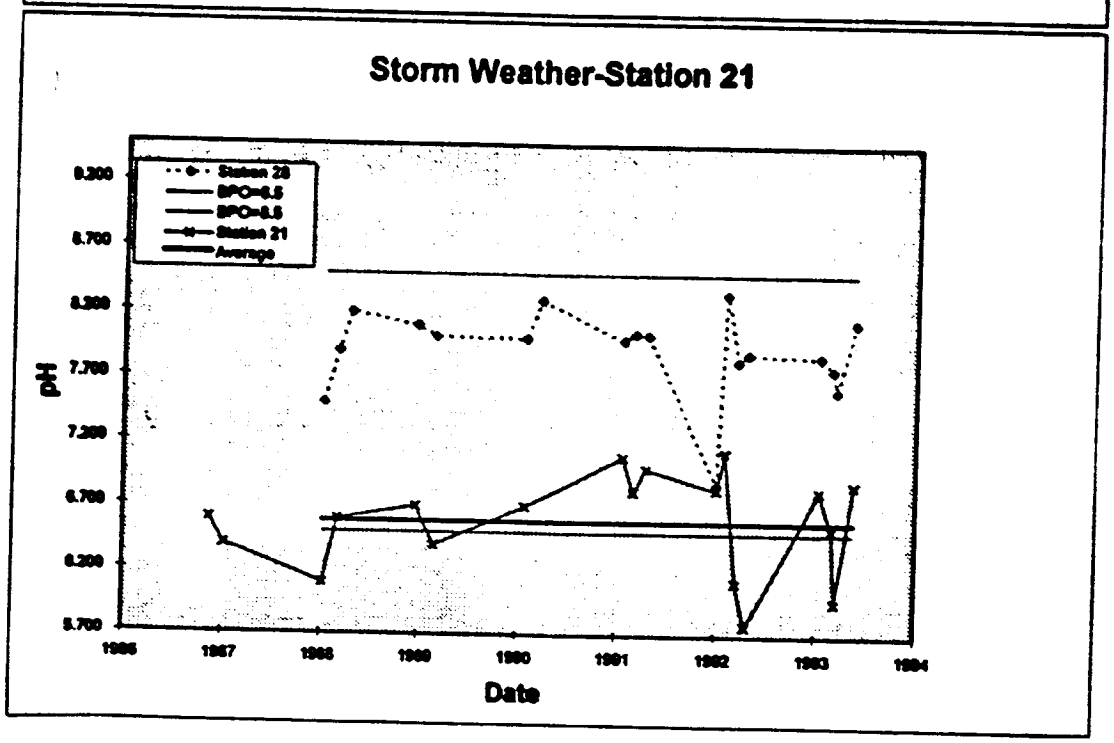


VOL 15

0867

R0061087

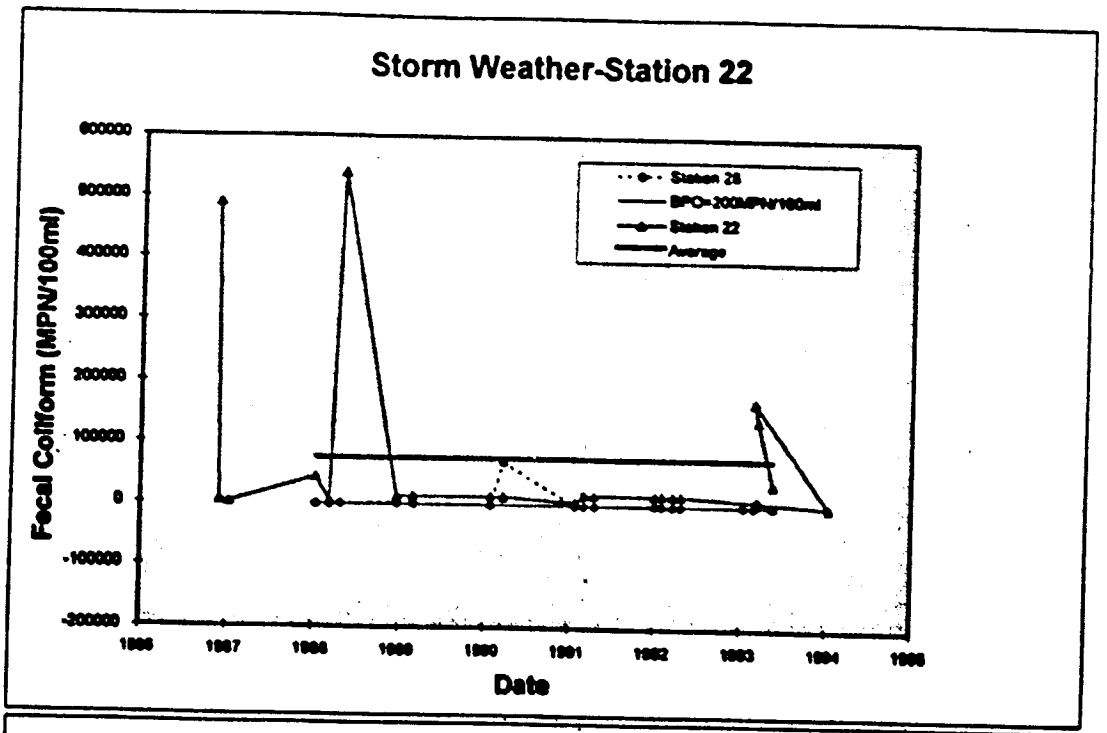


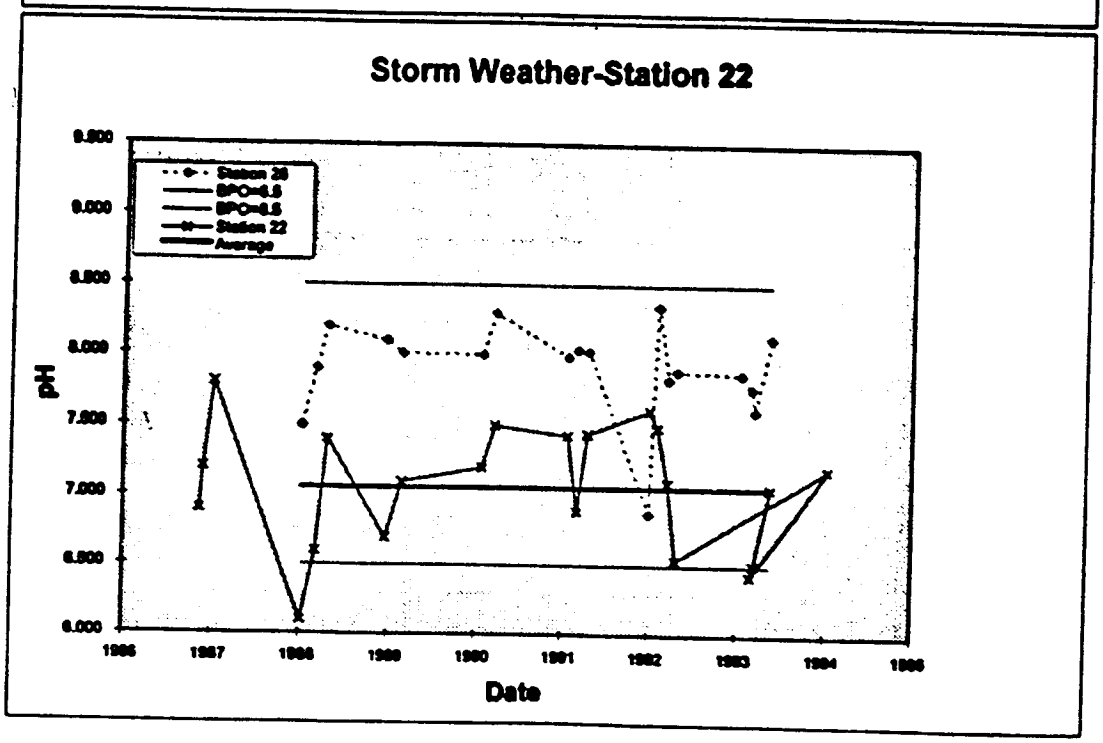


VOL 15

0868

R0061088

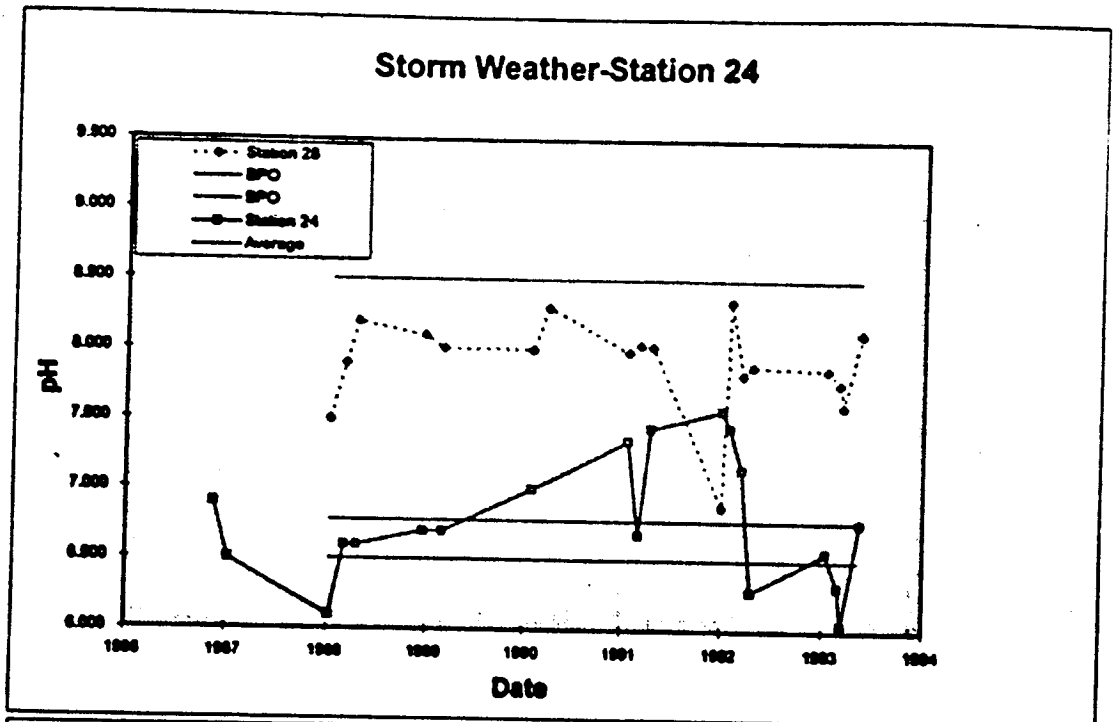


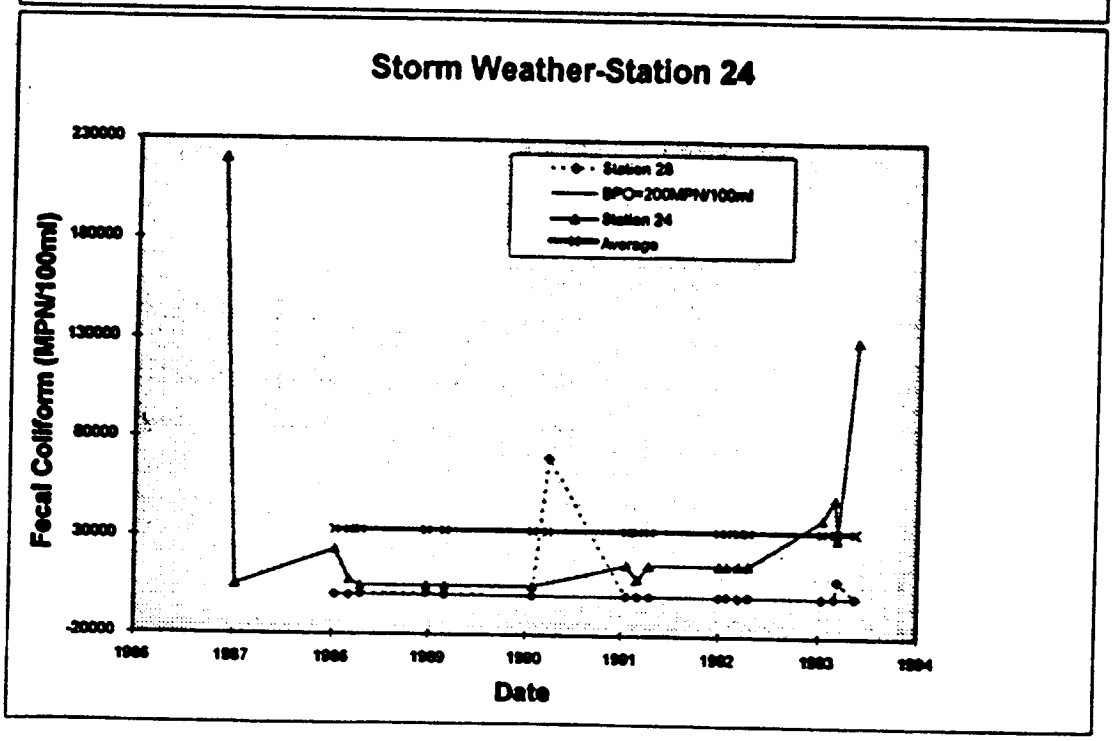


VOL 15

0869

R0061089

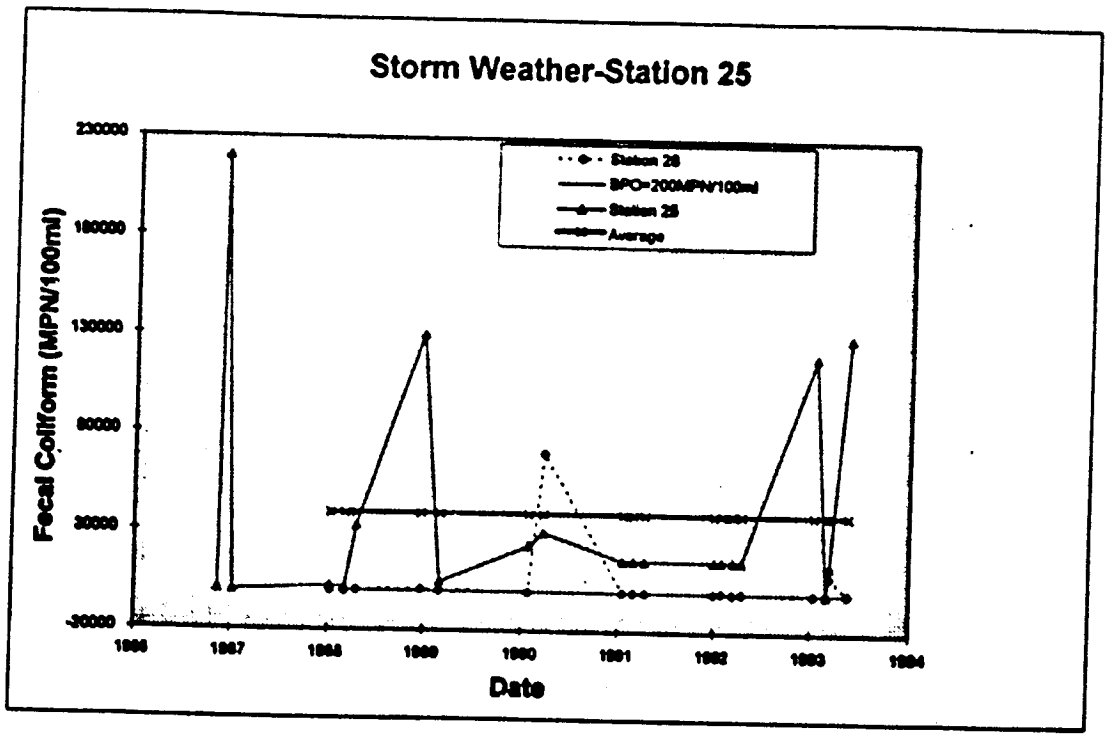




VOL 15

08700

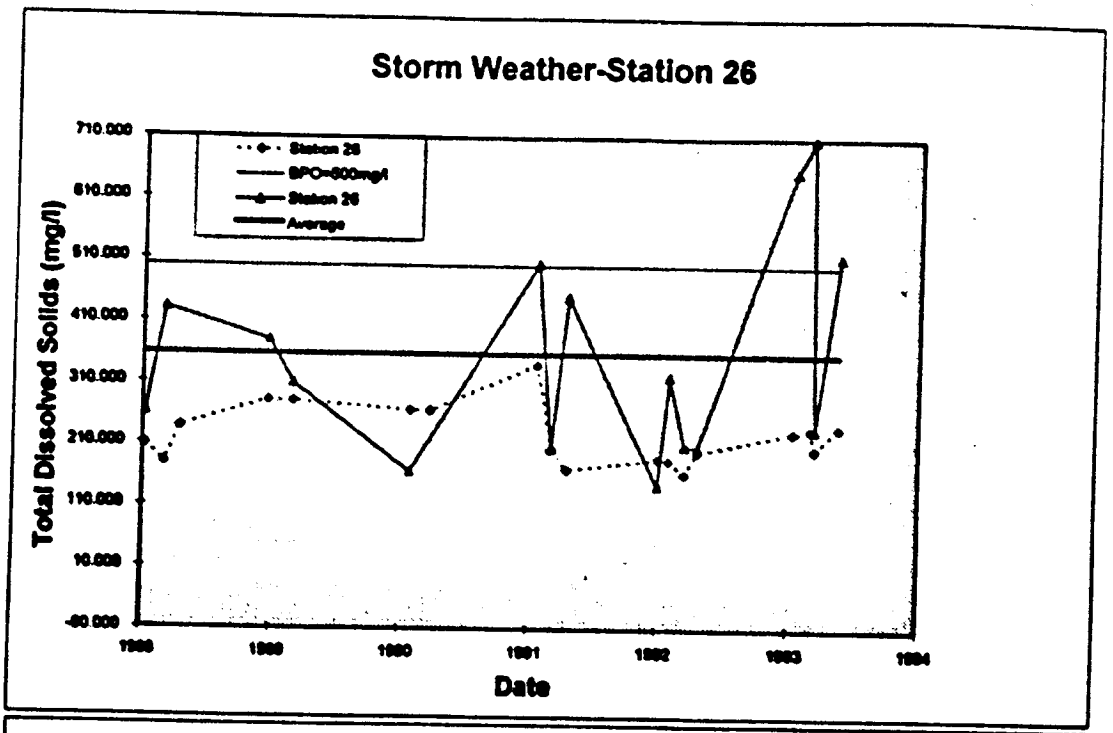
R0061090

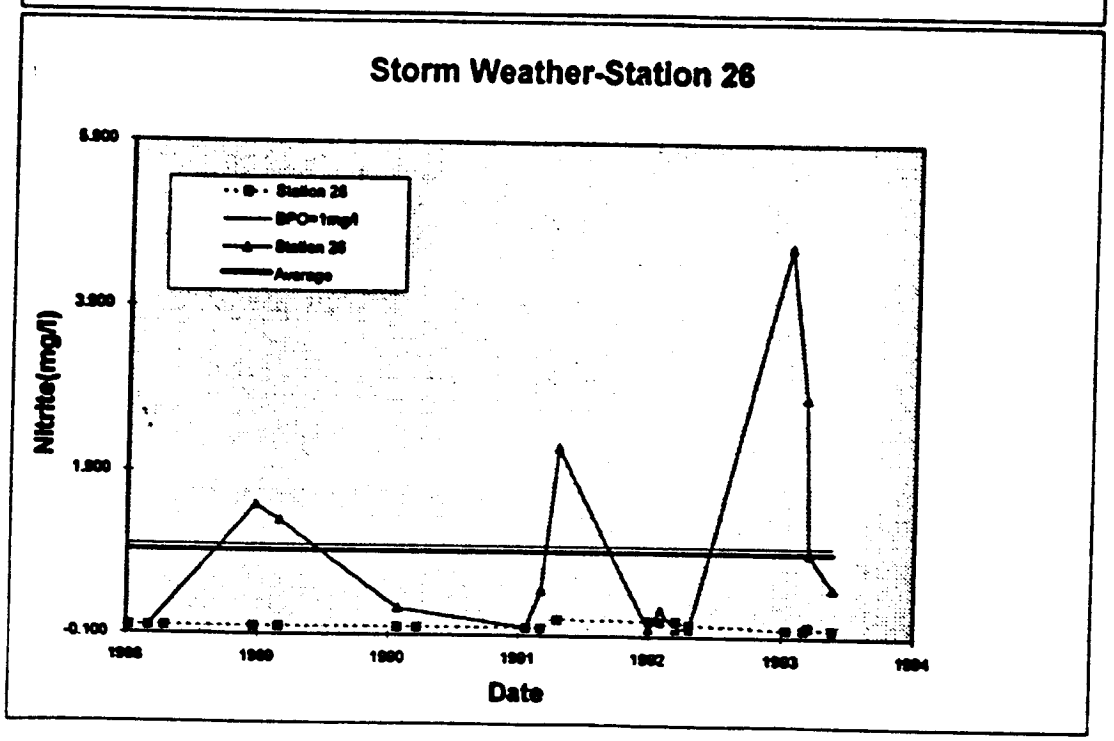


VOL 15

08711

R0061091

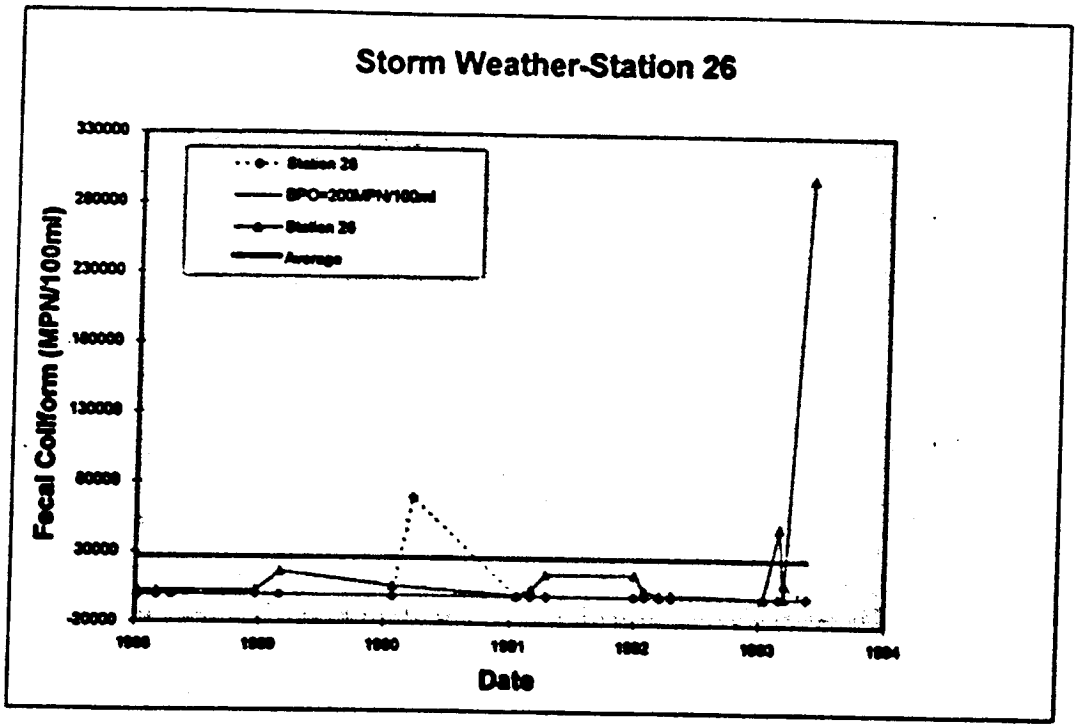




VOL 15

0872

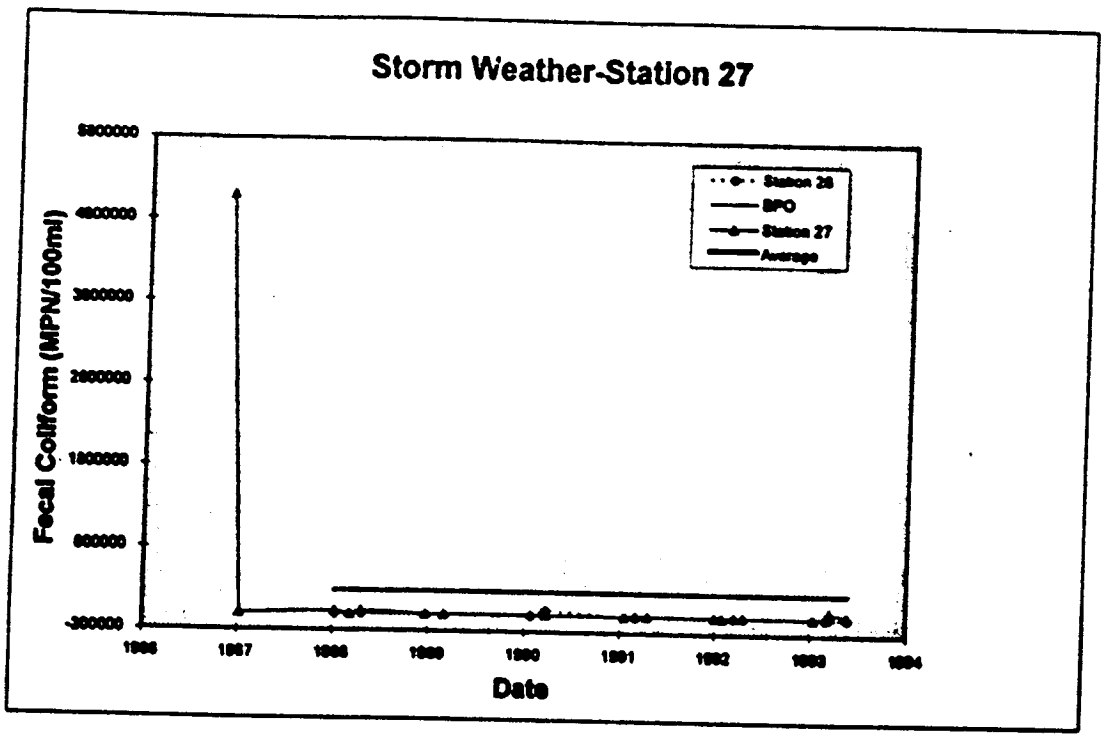
R0061092



VOL 15

08713

R0061093


Storm Weather-Station 27
Fecal Coliform (MPN/100ml)
5800000
4800000
3800000
2800000
1800000
800000
-300000
1986
1987
1988
1989
1990
1991
1992
1993
1994
Date
Station 28
BPO
Station 27
Average

VOL 15

08714

VOL 15

APPENDIX B

COUNTY WIDE TREND ANALYSIS

0875

VOL 15

0876

GRAPH LEGEND

BPO: BASIN PLAN (DRAFT 1994) OBJECTIVE
OPO: OCEAN PLAN (1990) OBJECTIVE

R0061096

DRY WEATHER

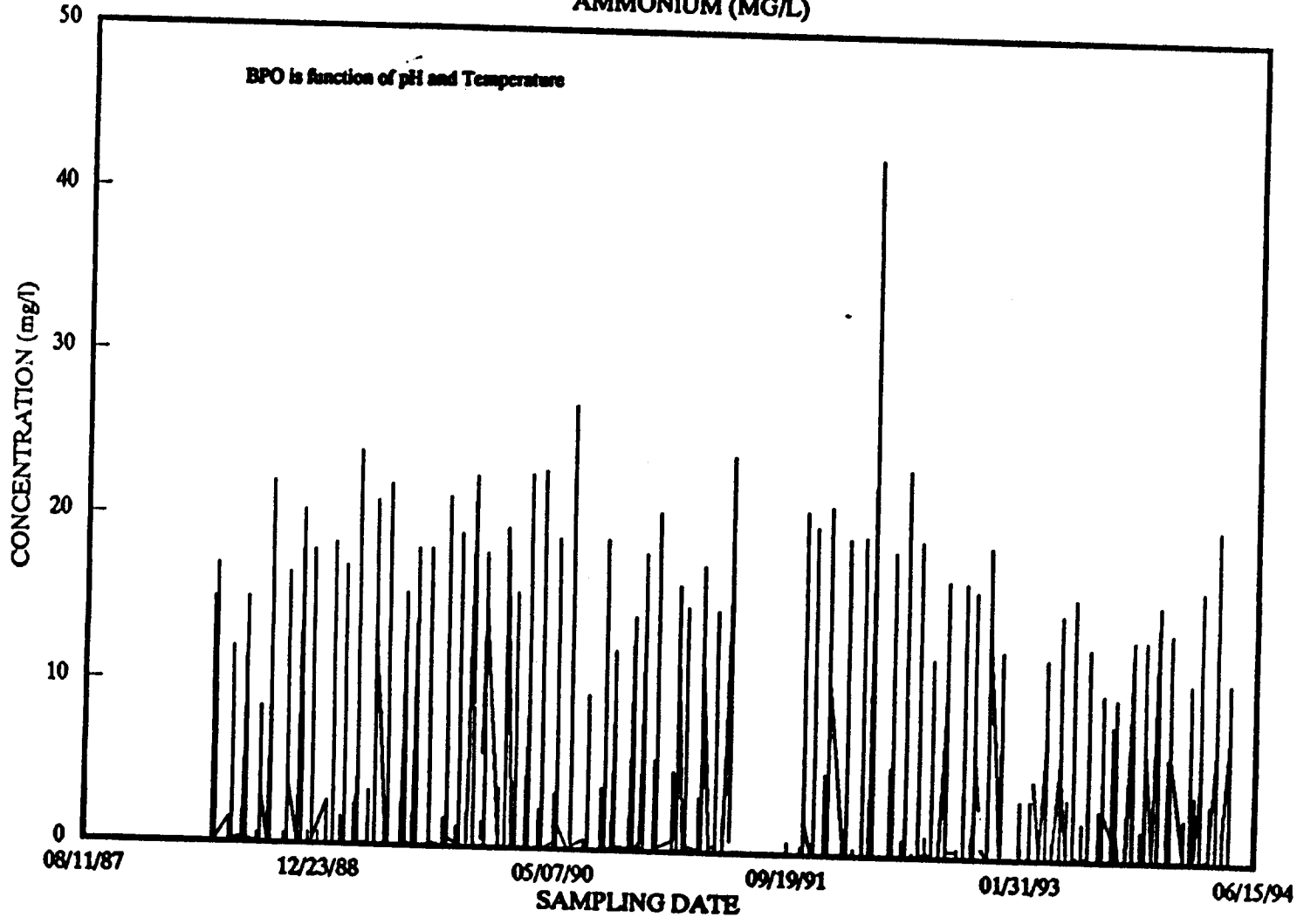
VOL 15

08777

R0061097

DRY WEATHER

WATER QUALITY TREND ANALYSIS



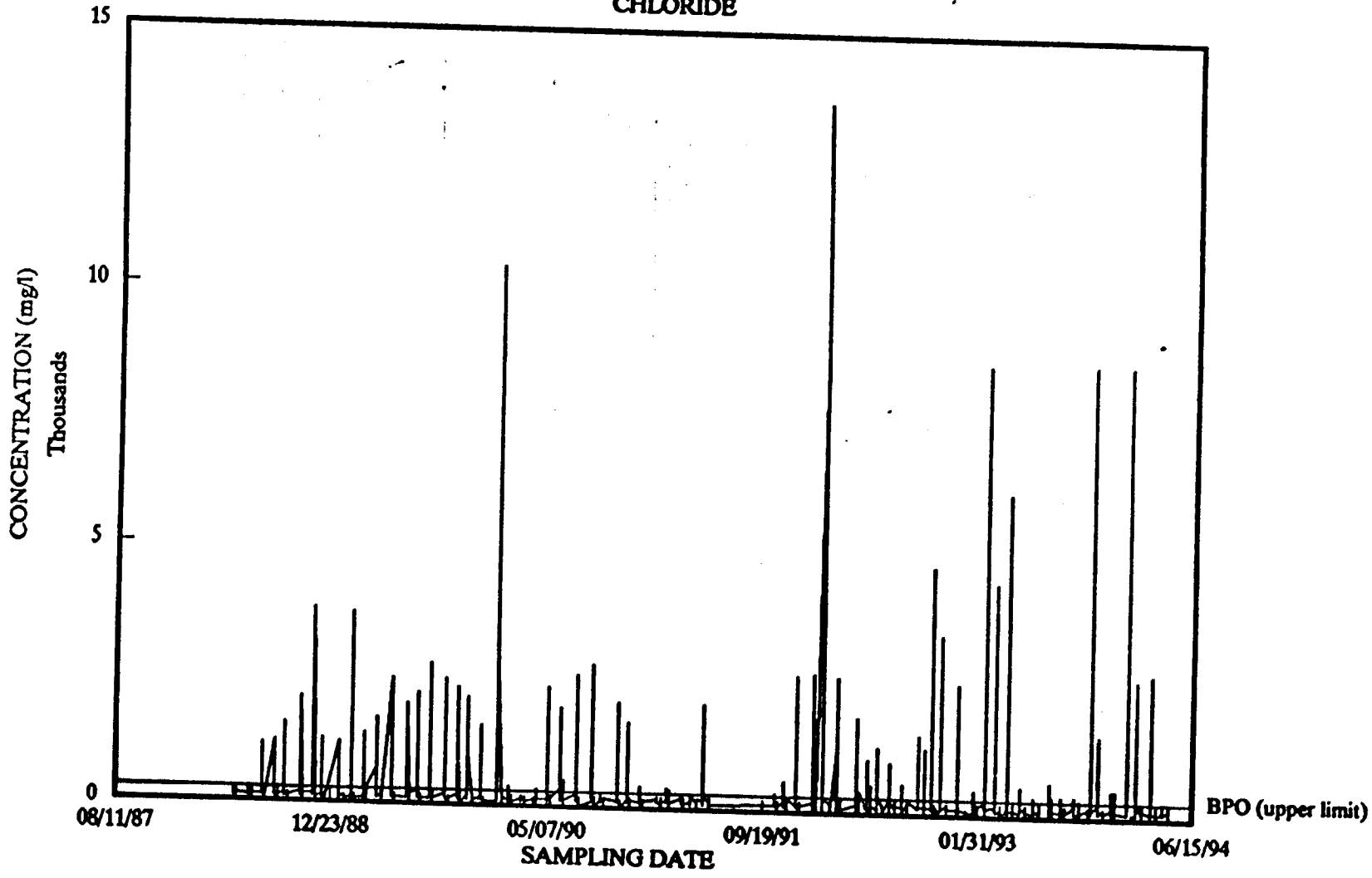
R0061098

8-J8C3
VOL 75

DRY WEATHER

WATER QUALITY TREND ANALYSIS

CHLORIDE

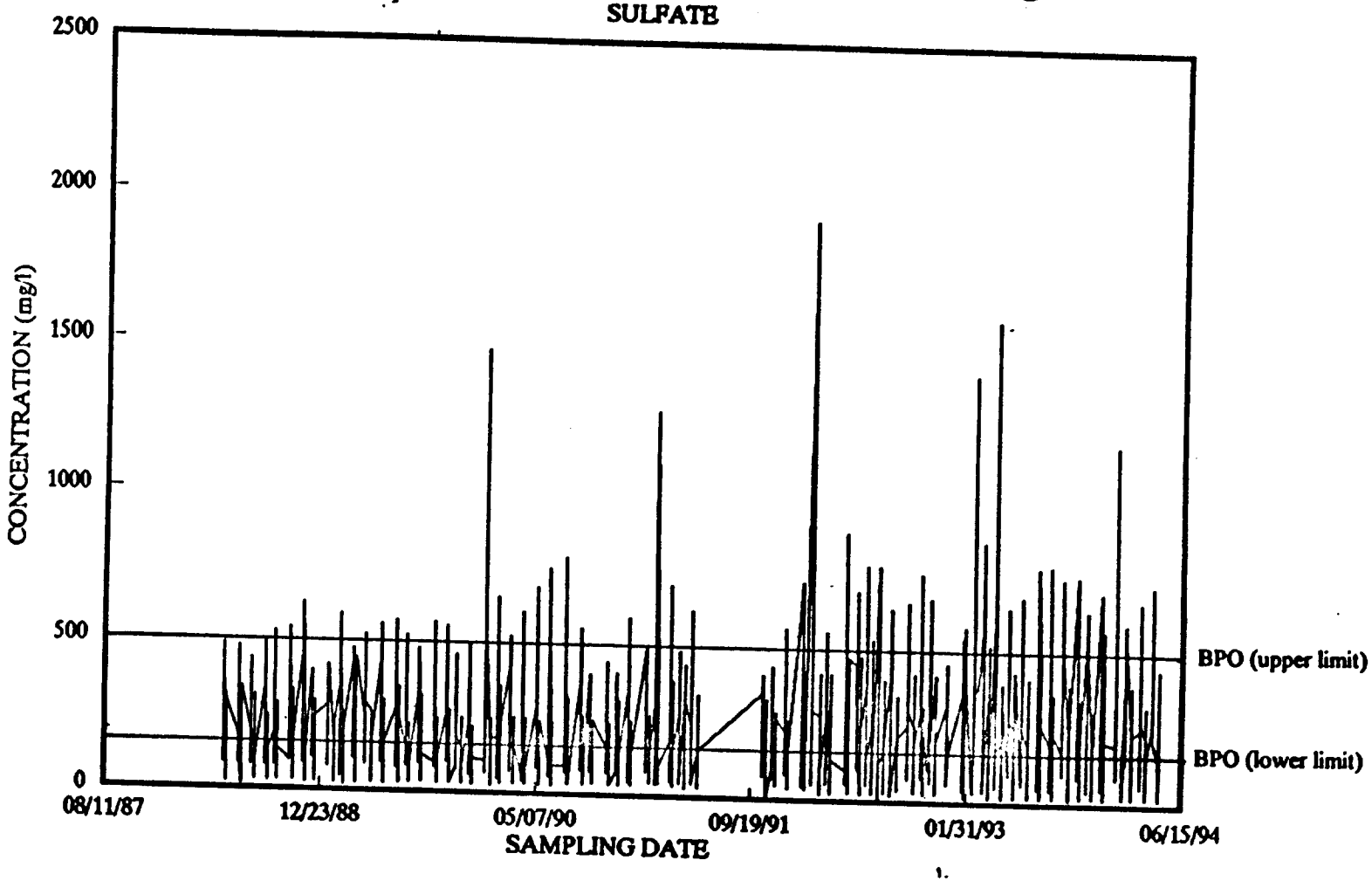


R0061099

VOL 15

DRY WEATHER

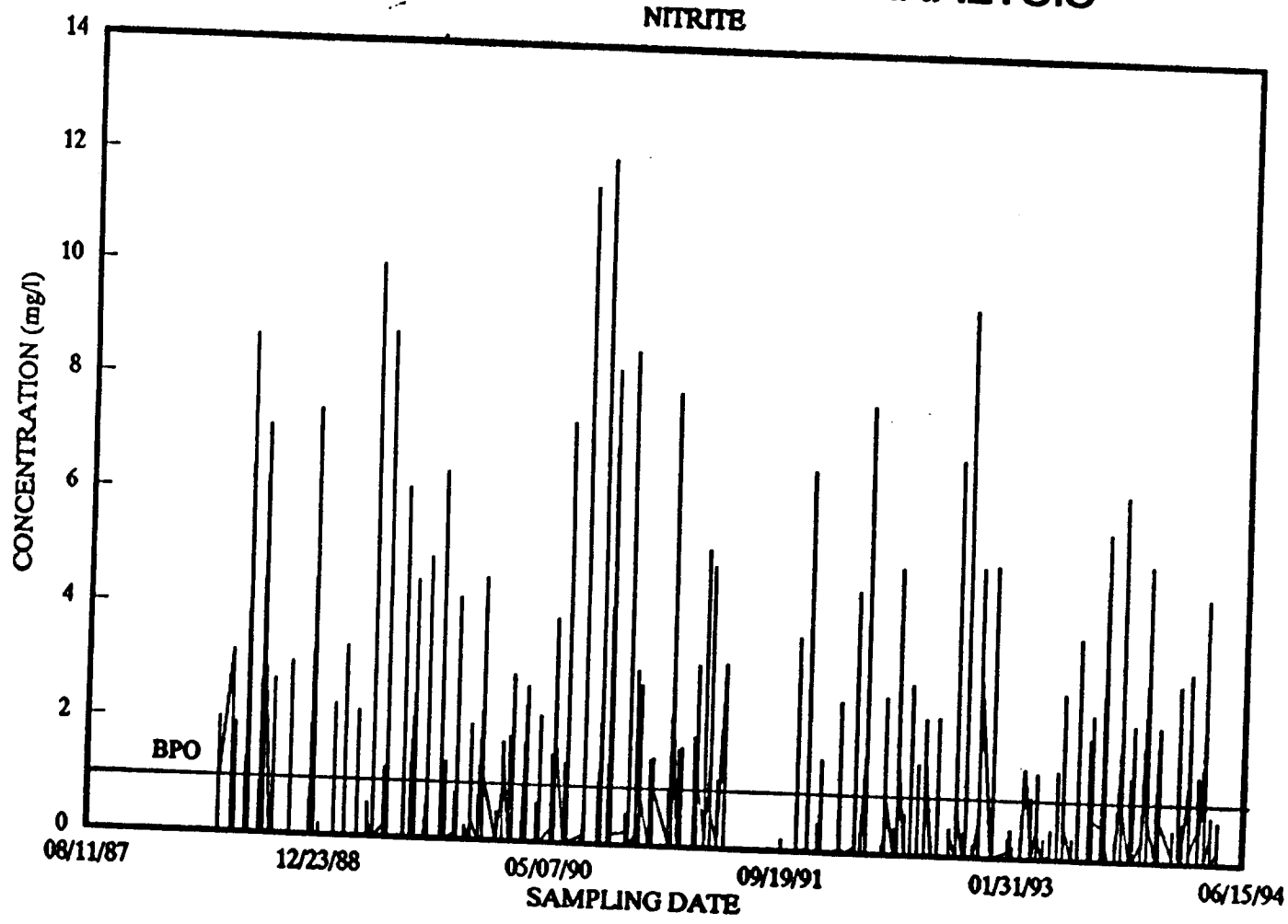
WATER QUALITY TREND ANALYSIS



R0061100

DRY WEATHER

WATER QUALITY TREND ANALYSIS



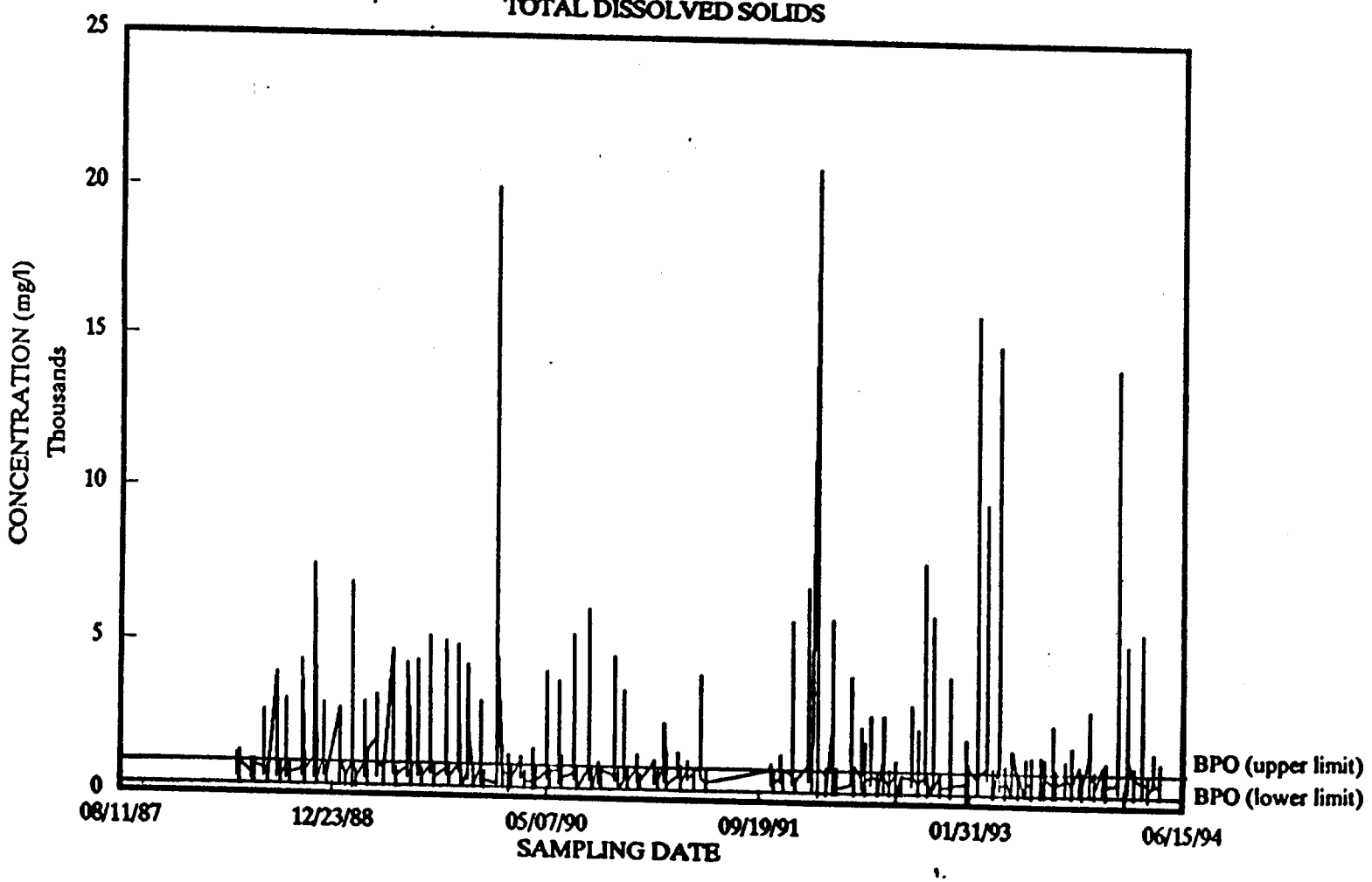
R0061101

VOL 15

DRY WEATHER

WATER QUALITY TREND ANALYSIS

TOTAL DISSOLVED SOLIDS



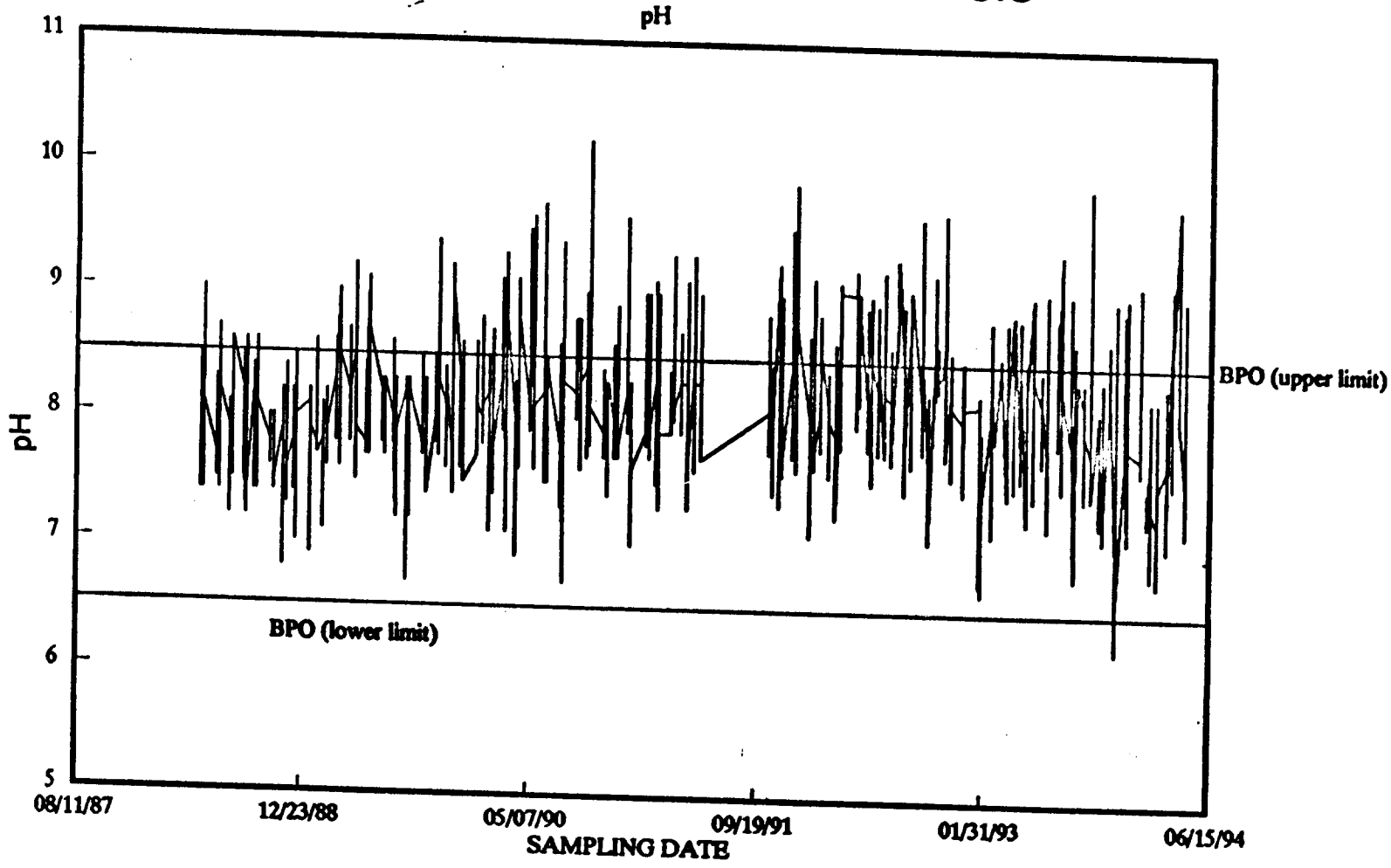
R0061102

2882

VOL 15

DRY WEATHER

WATER QUALITY TREND ANALYSIS



R0061103

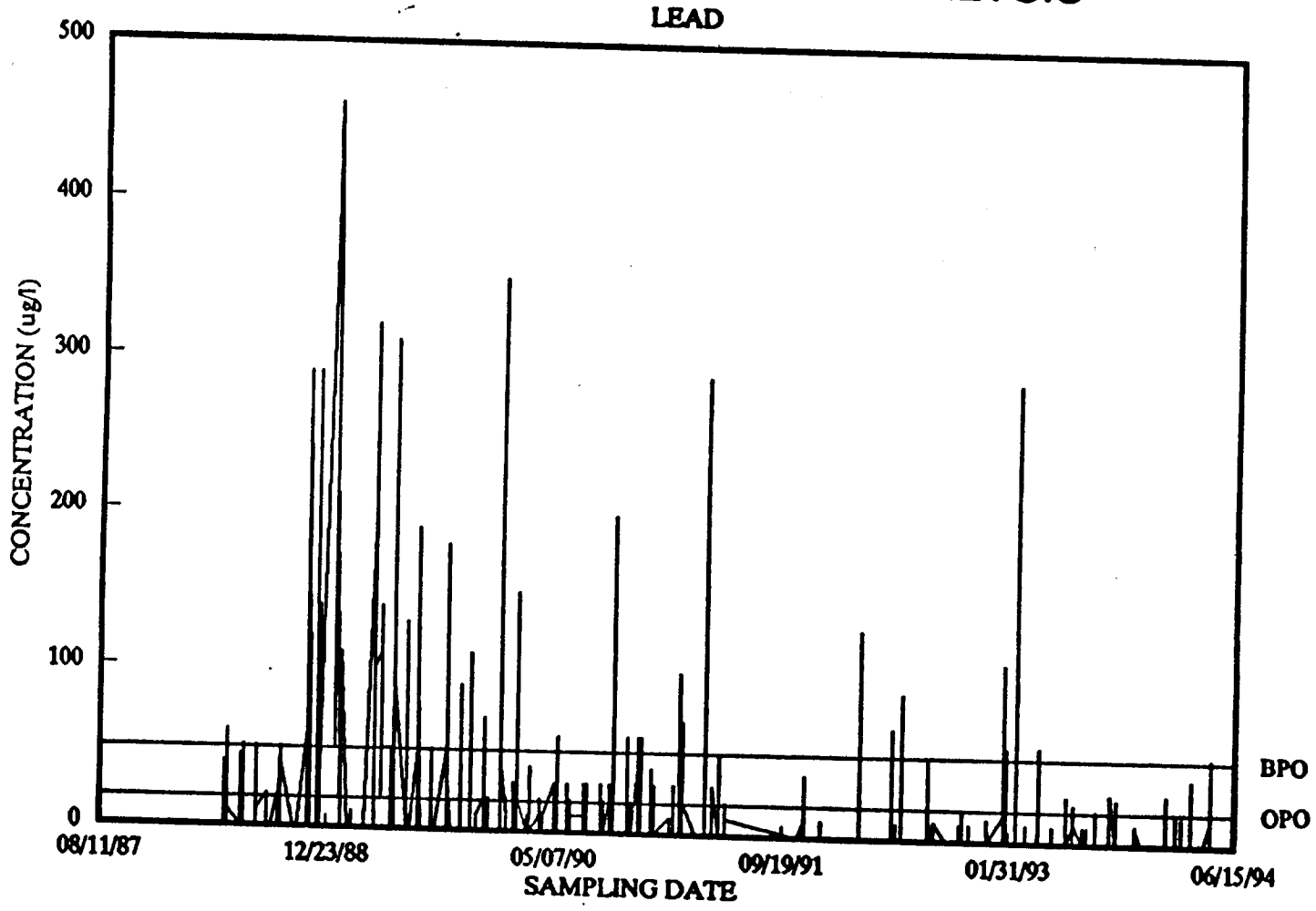
VOL 15

C883

DRY WEATHER

WATER QUALITY TREND ANALYSIS

LEAD



R0061104

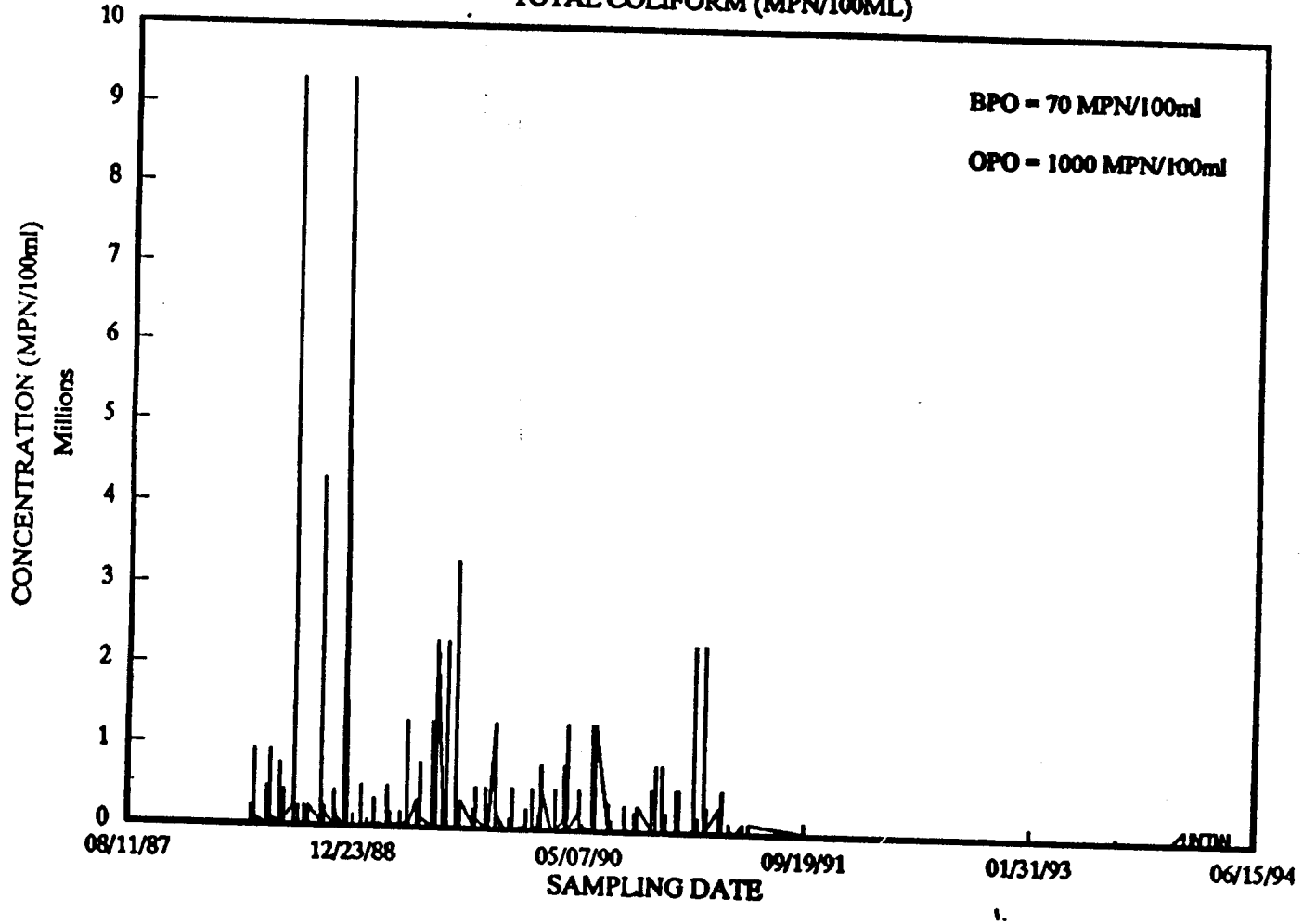
VOL 15

C884

DRY WEATHER

WATER QUALITY TREND ANALYSIS

TOTAL COLIFORM (MPN/100ML)



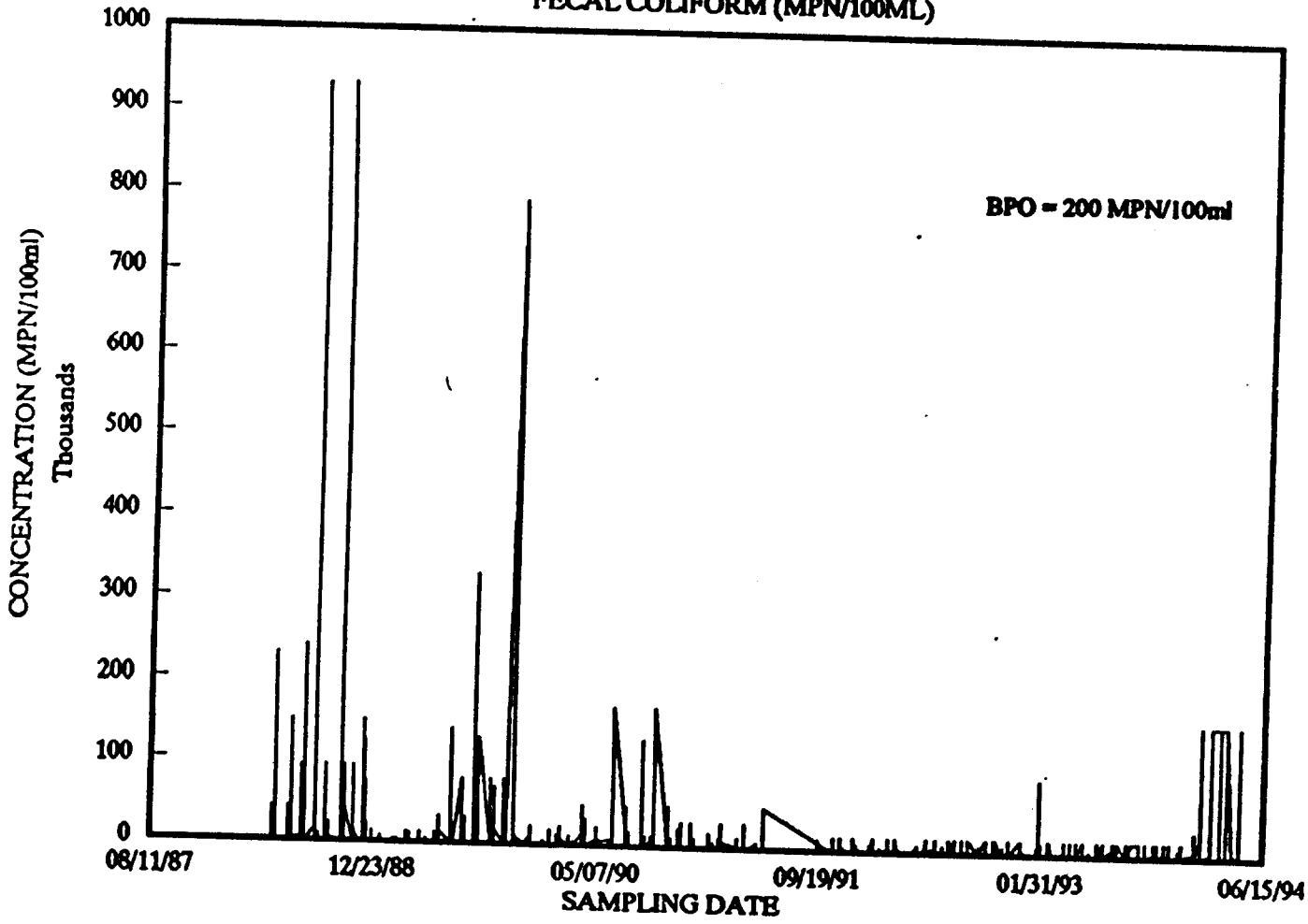
R0061105

VOL 15

DRY WEATHER

WATER QUALITY TREND ANALYSIS

FECAL COLIFORM (MPN/100ML)



R0061106

VOL 15

VOL 15

STORM WEATHER

0887

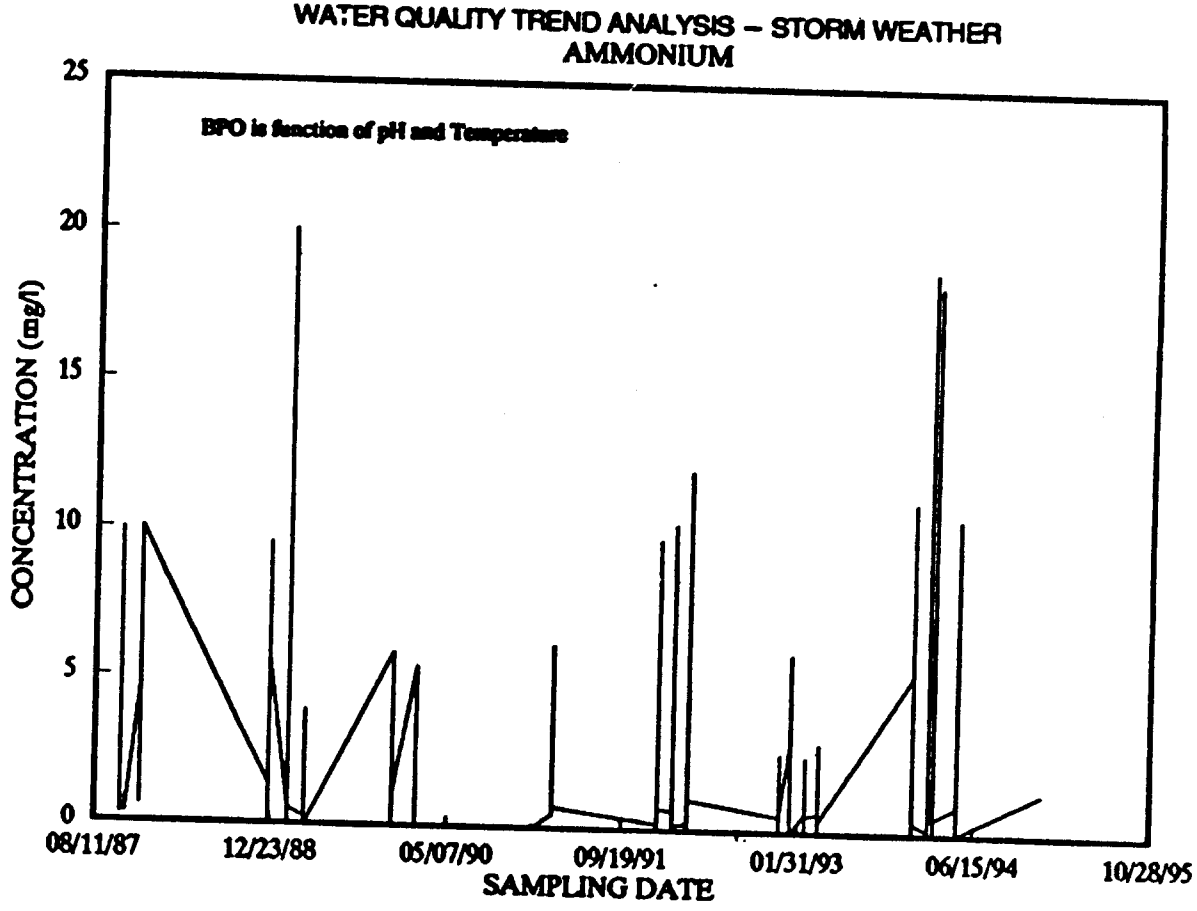
R0061107

VOL 15

0888

GRAPH LEGEND

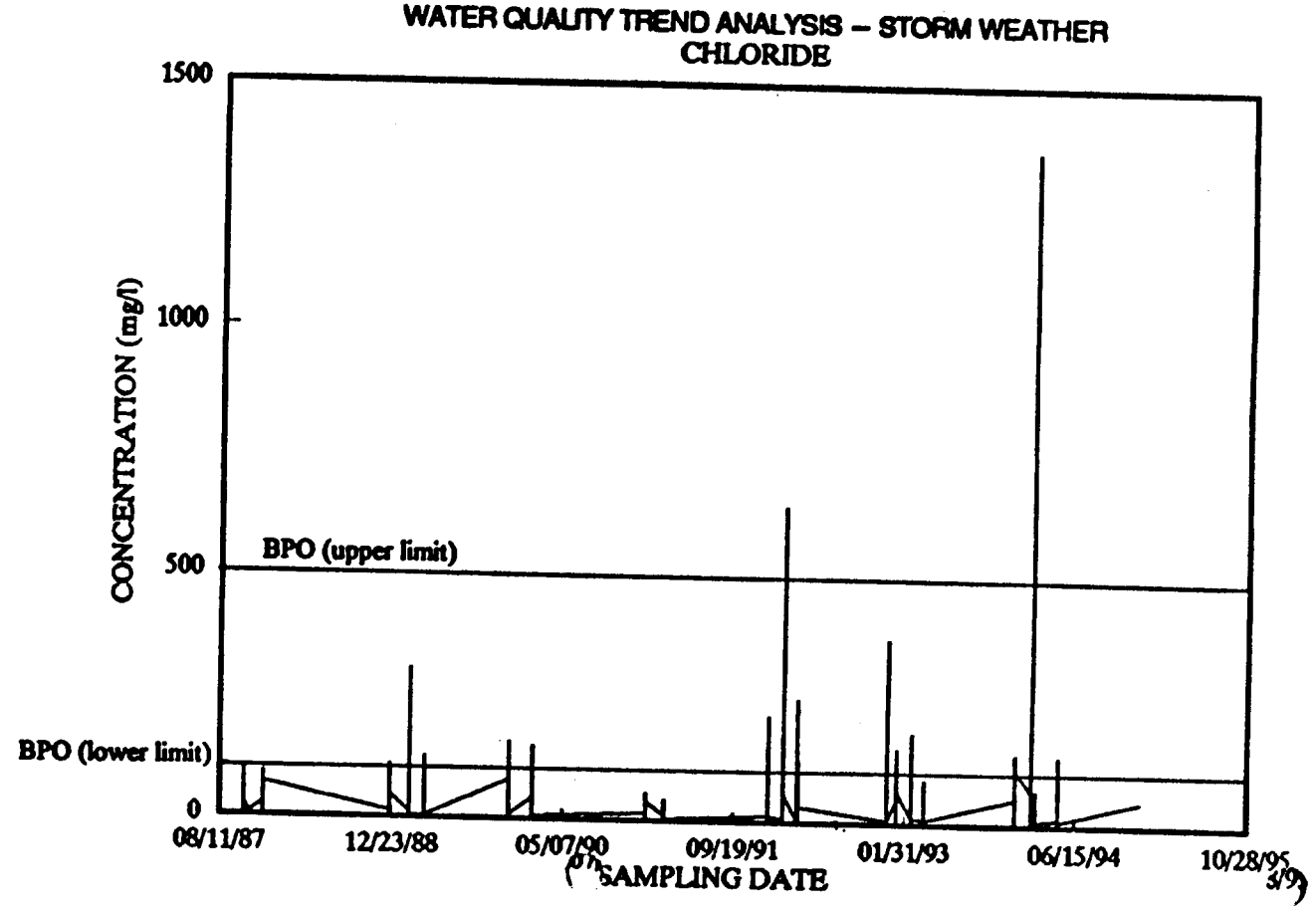
BPO: BASIN PLAN (DRAFT 1994) OBJECTIVE
OPO: OCEAN PLAN (1990) OBJECTIVE



R0061109

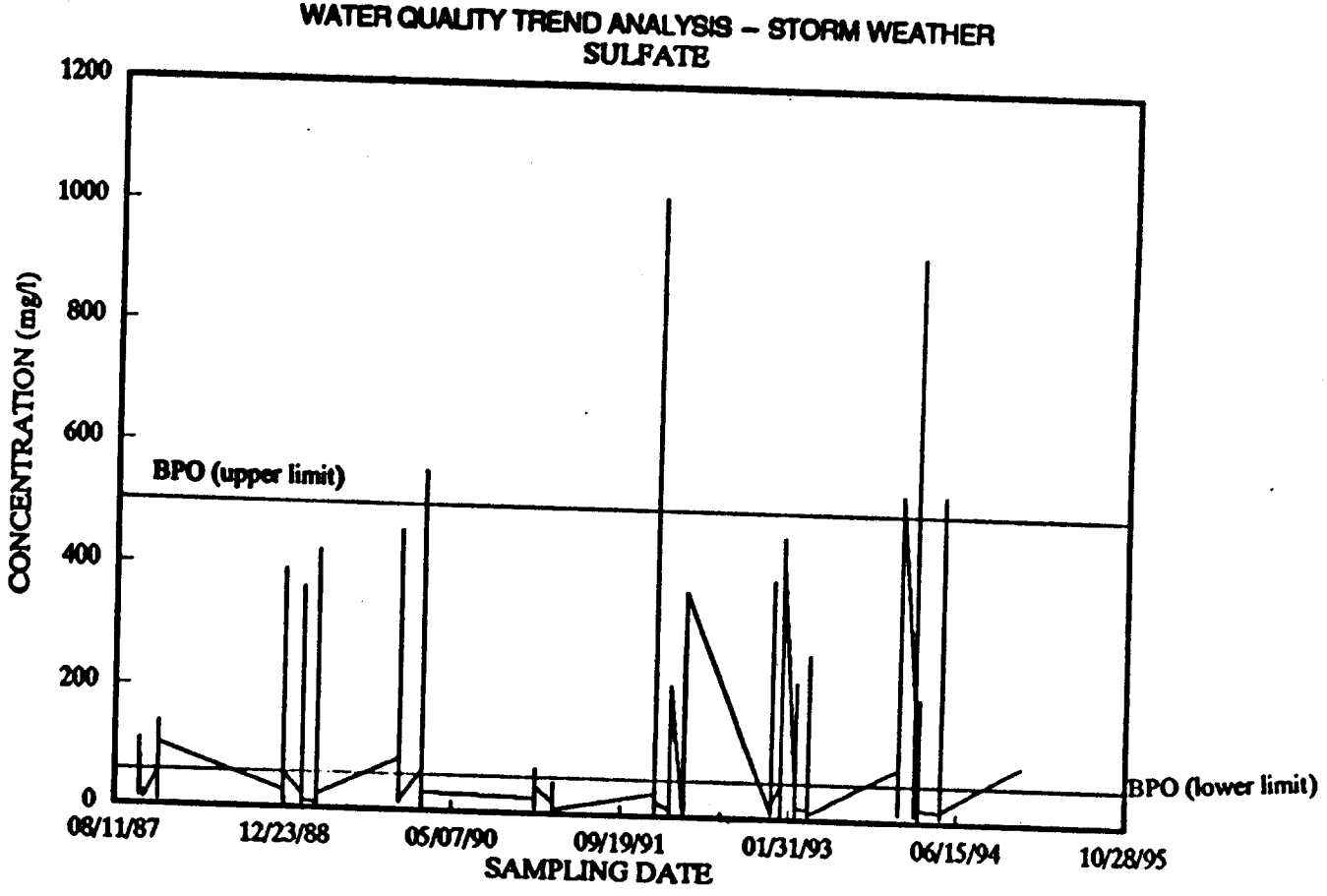
68863 VOL 75

WATER QUALITY TREND ANALYSIS – STORM WEATHER
CHLORIDE

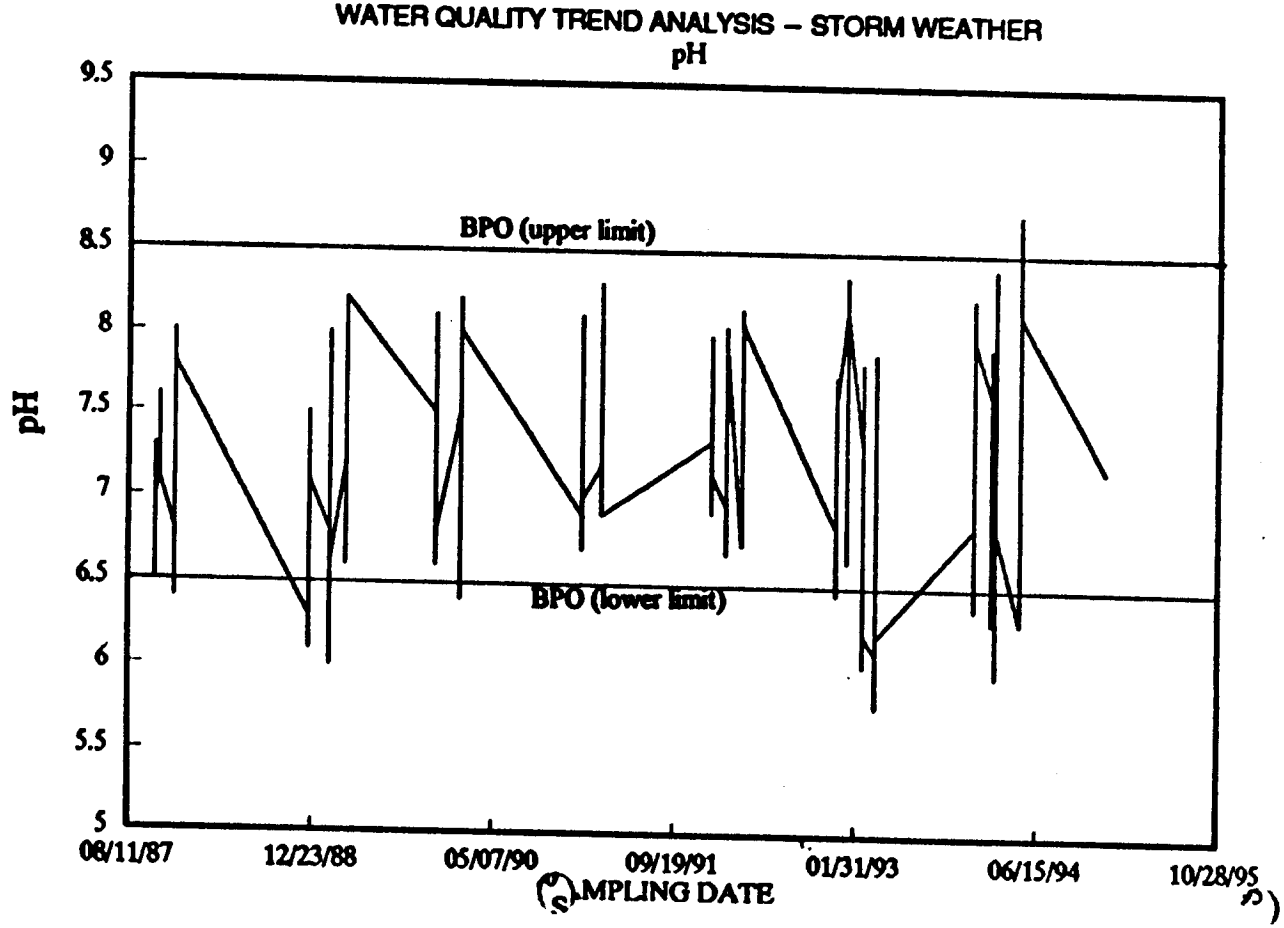


R0061110

VOL 15

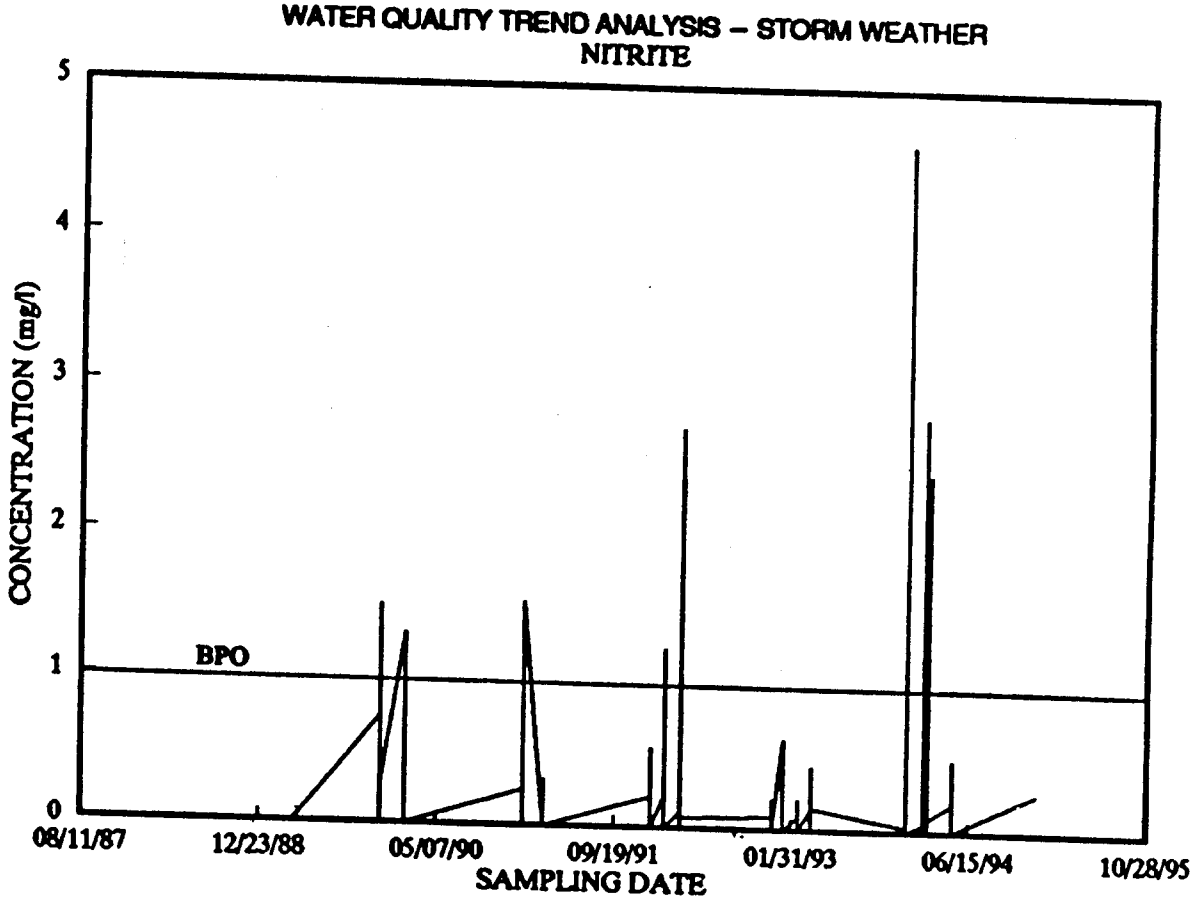

WATER QUALITY TREND ANALYSIS – STORM WEATHER
SULFATE
CONCENTRATION (mg/l)
1200
1000
800
600
400
200
0
BPO (upper limit)
BPO (lower limit)
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061111



R0061112

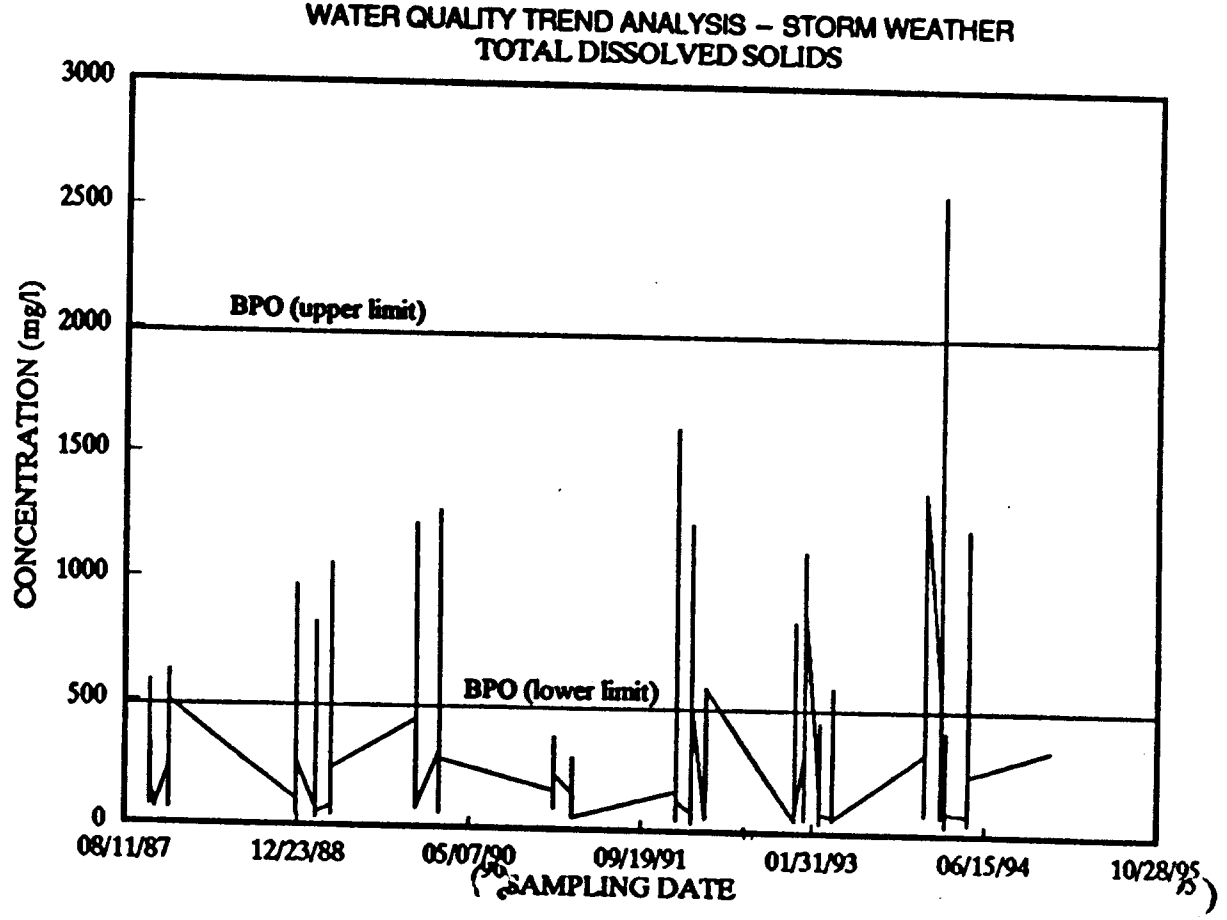
26863 VOL 715



R0061113

E6863
VOL 75

WATER QUALITY TREND ANALYSIS – STORM WEATHER
TOTAL DISSOLVED SOLIDS

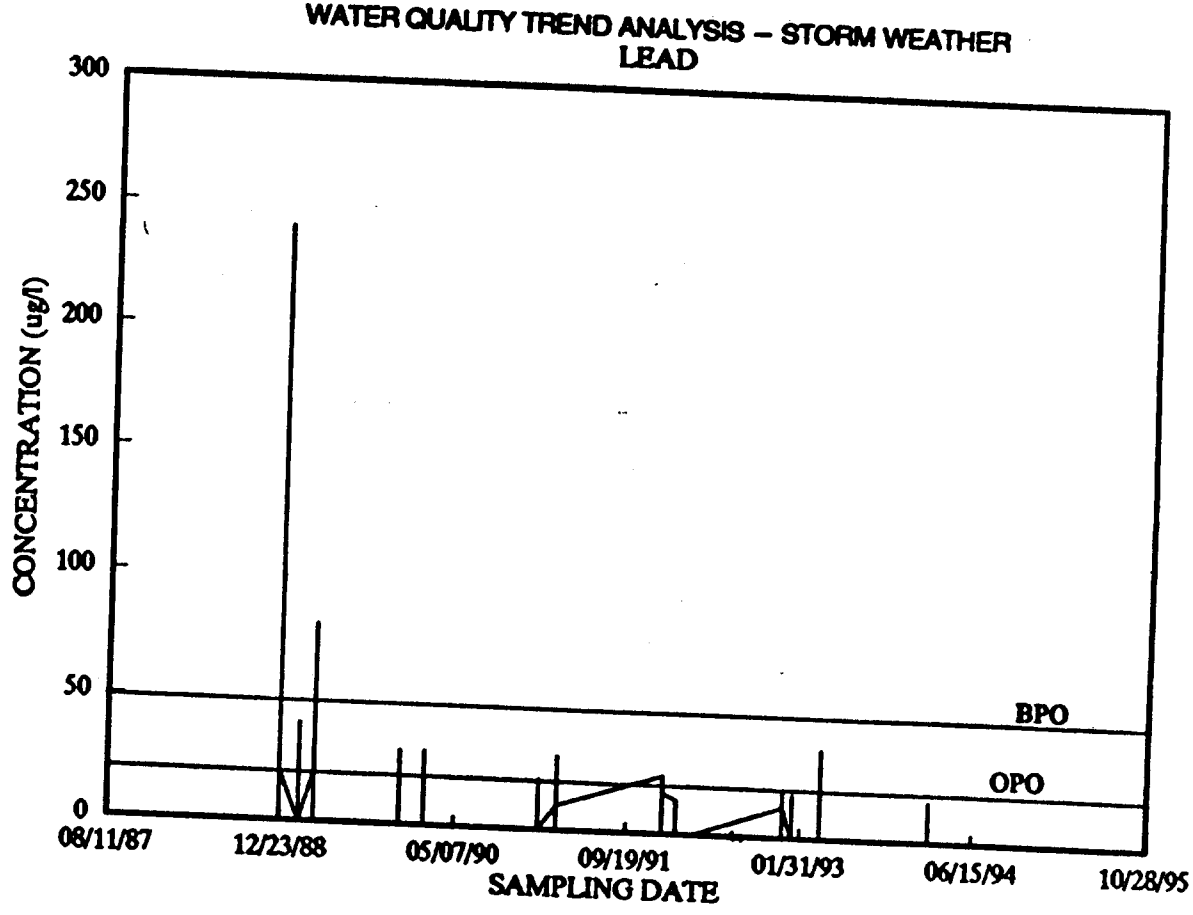


R0061114

VOL 15

C894

WATER QUALITY TREND ANALYSIS – STORM WEATHER
LEAD

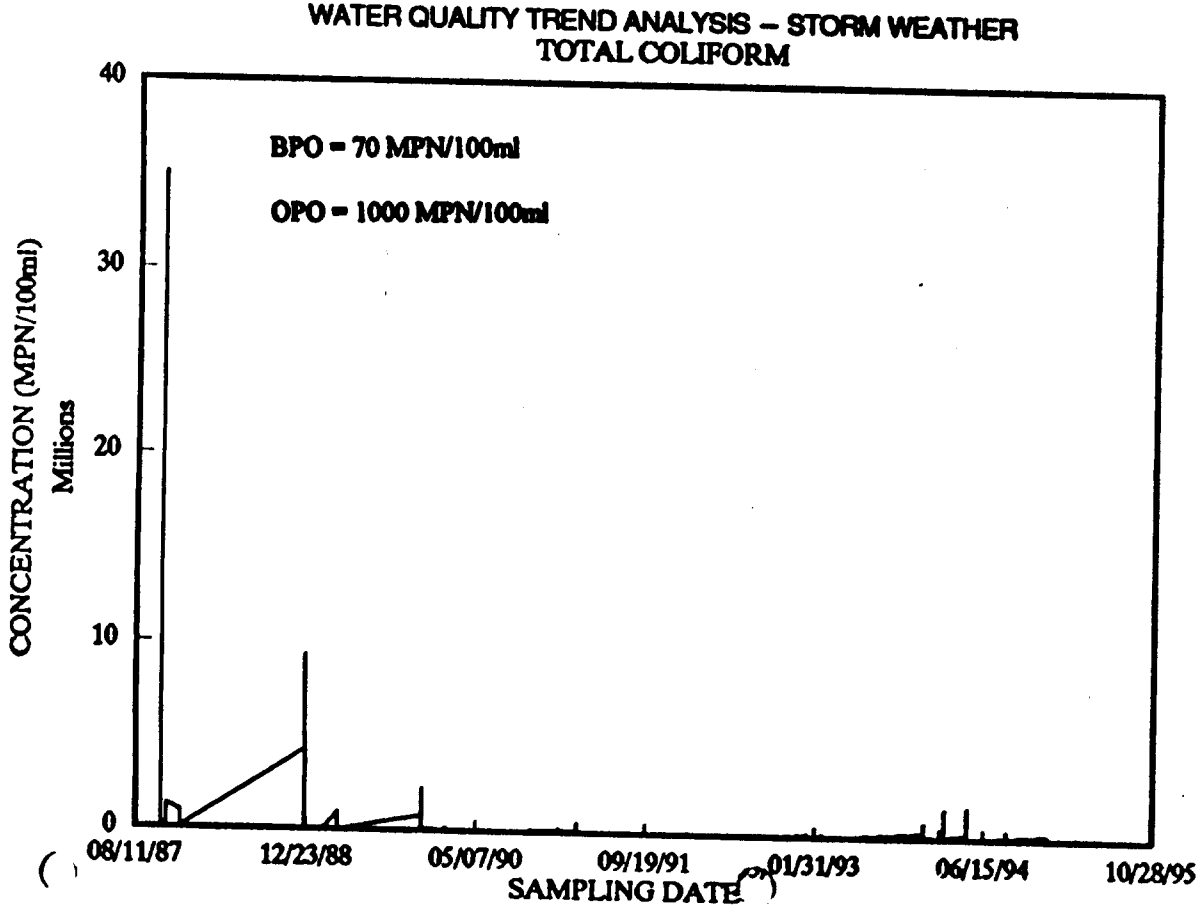


R0061115

VOL 15

C895

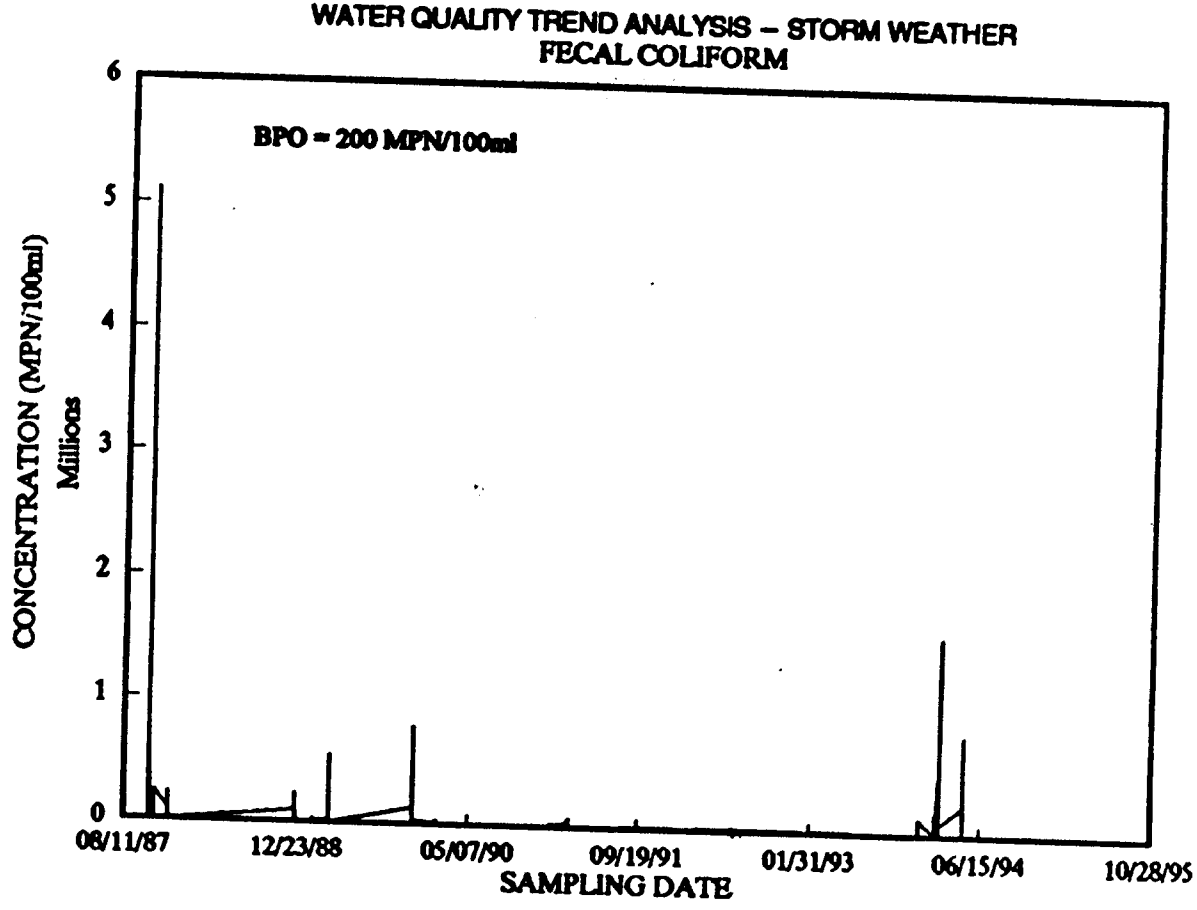
WATER QUALITY TREND ANALYSIS – STORM WEATHER
TOTAL COLIFORM



R0061116

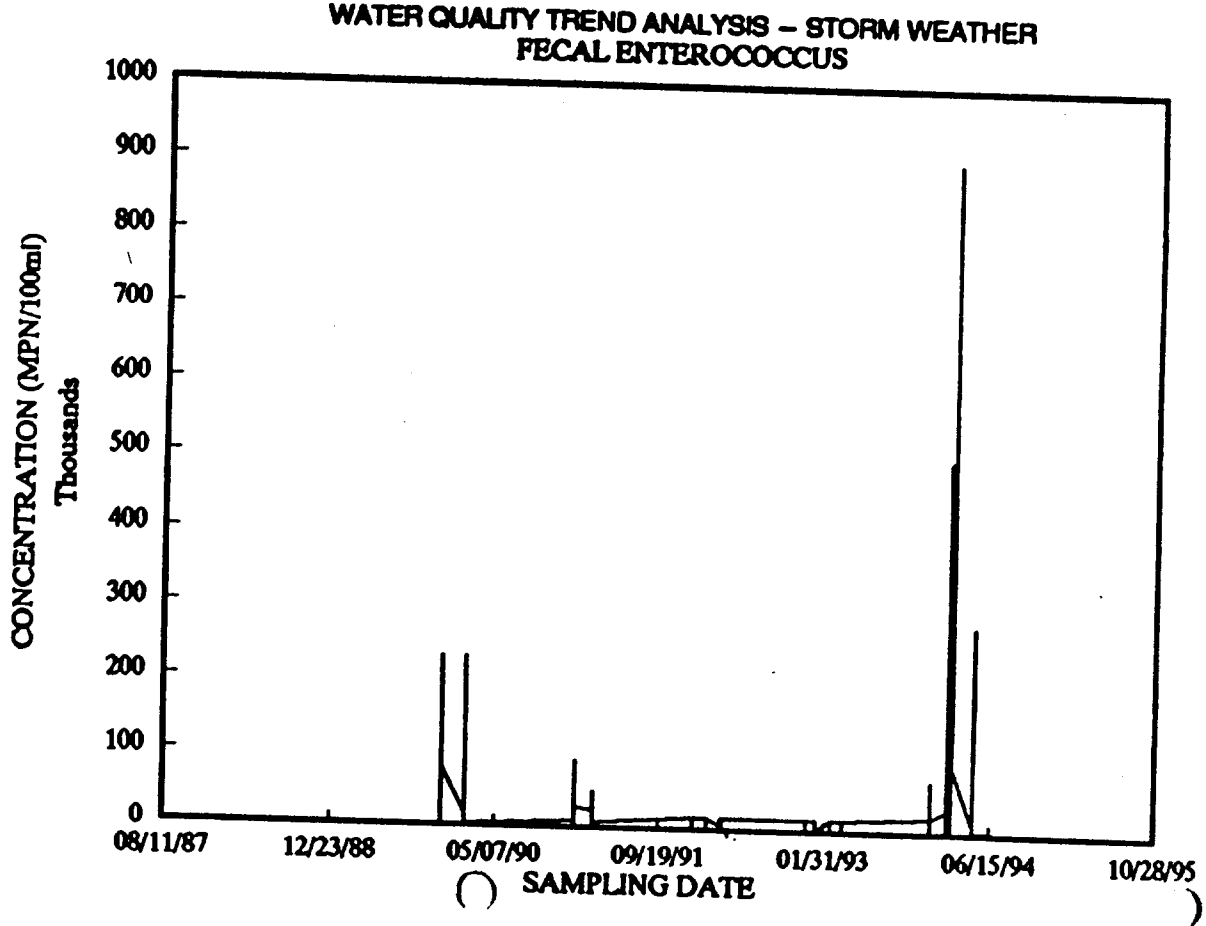
VOL 15

WATER QUALITY TREND ANALYSIS – STORM WEATHER
FECAL COLIFORM



R0061117

VOL 15



R0061118

VOL 15

VOL 15

APPENDIX C

BASIN WIDE TREND ANALYSIS

0899

DRY WEATHER

VOL 15

09900

R0061120

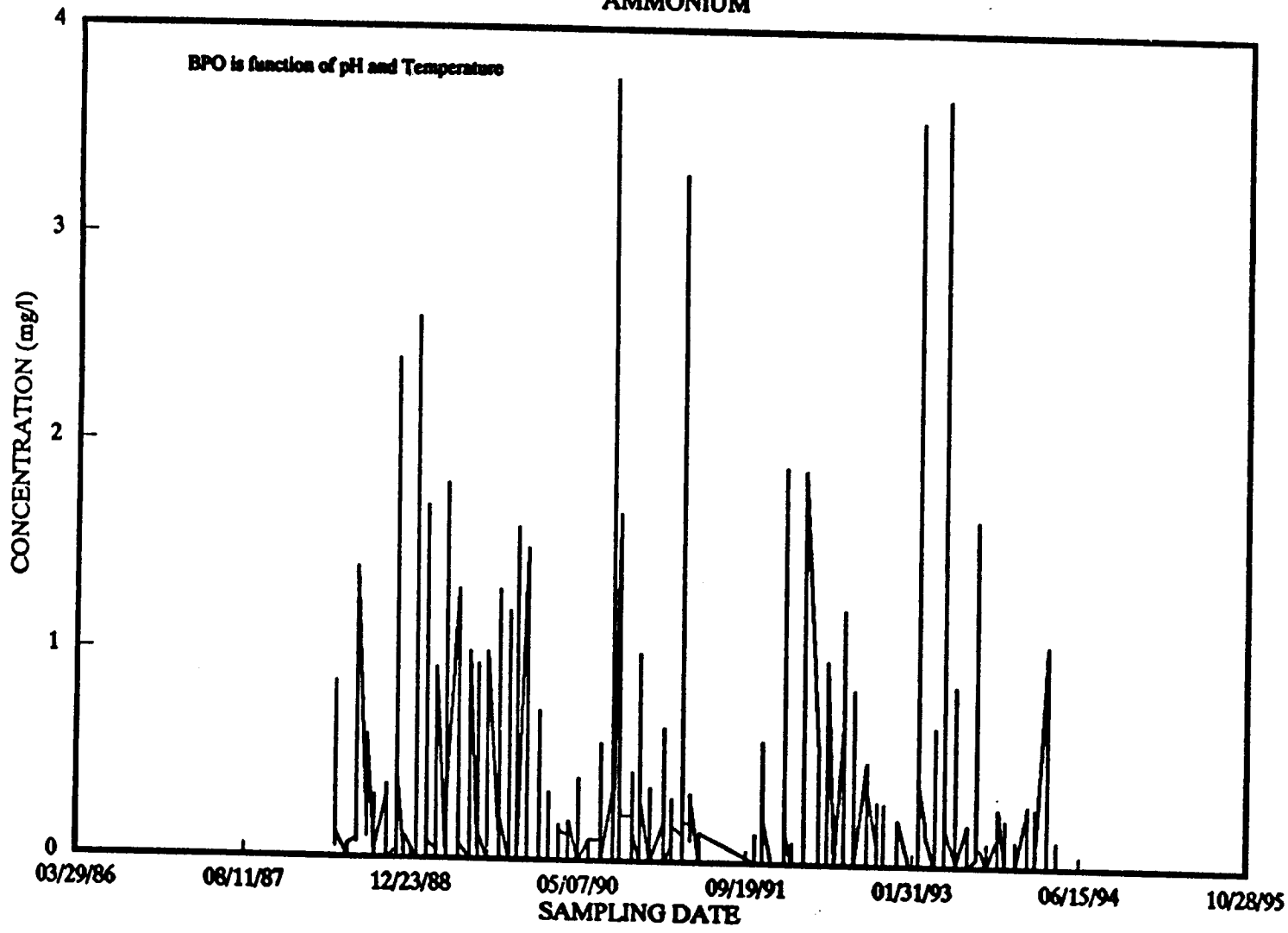
VOL 15

GRAPH LEGEND

BPO: BASIN PLAN (DRAFT 1994) OBJECTIVE
OPO: OCEAN PLAN (1990) OBJECTIVE

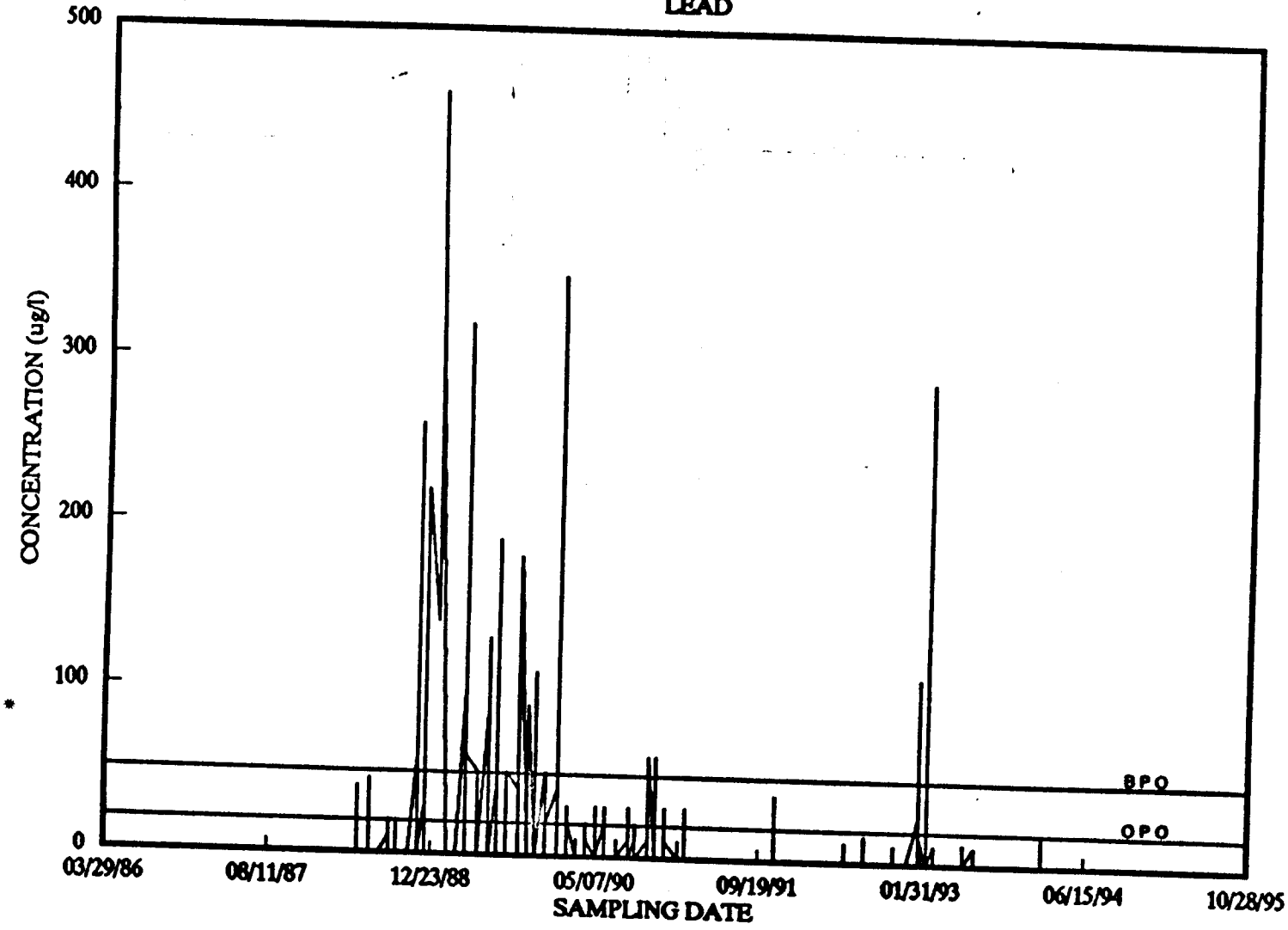
0901

BASIN I WATER QUALITY TREND ANALYSIS – DRY WEATHER
AMMONIUM



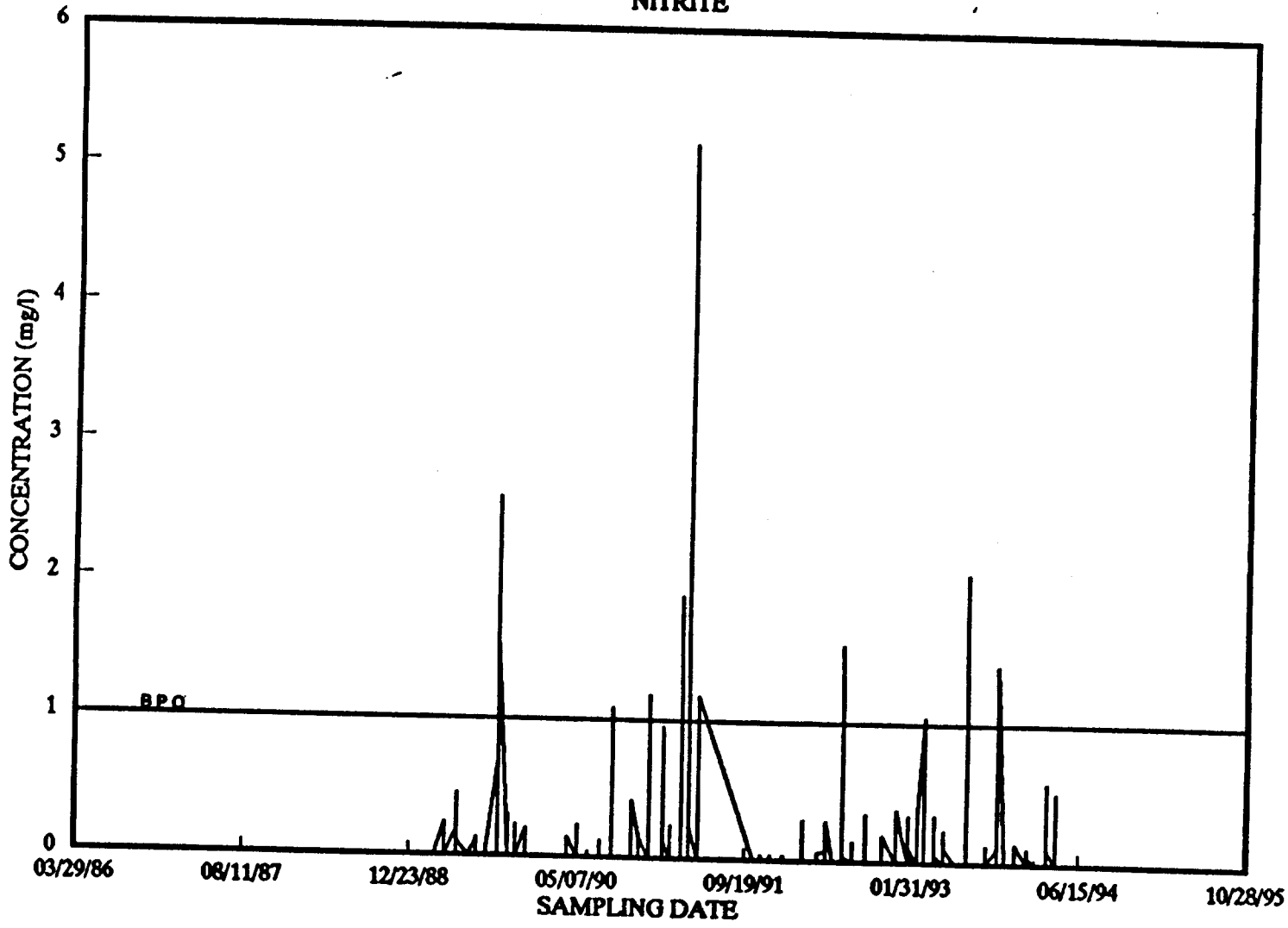
R0061122

23663
VOL 75


BASIN I WATER QUALITY TREND ANALYSIS – DRY WEATHER
LEAD
CONCENTRATION (ug/l)
500
400
300
200
100
0
BPO
OPO
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061123

BASIN I WATER QUALITY TREND ANALYSIS – DRY WEATHER
NITRITE

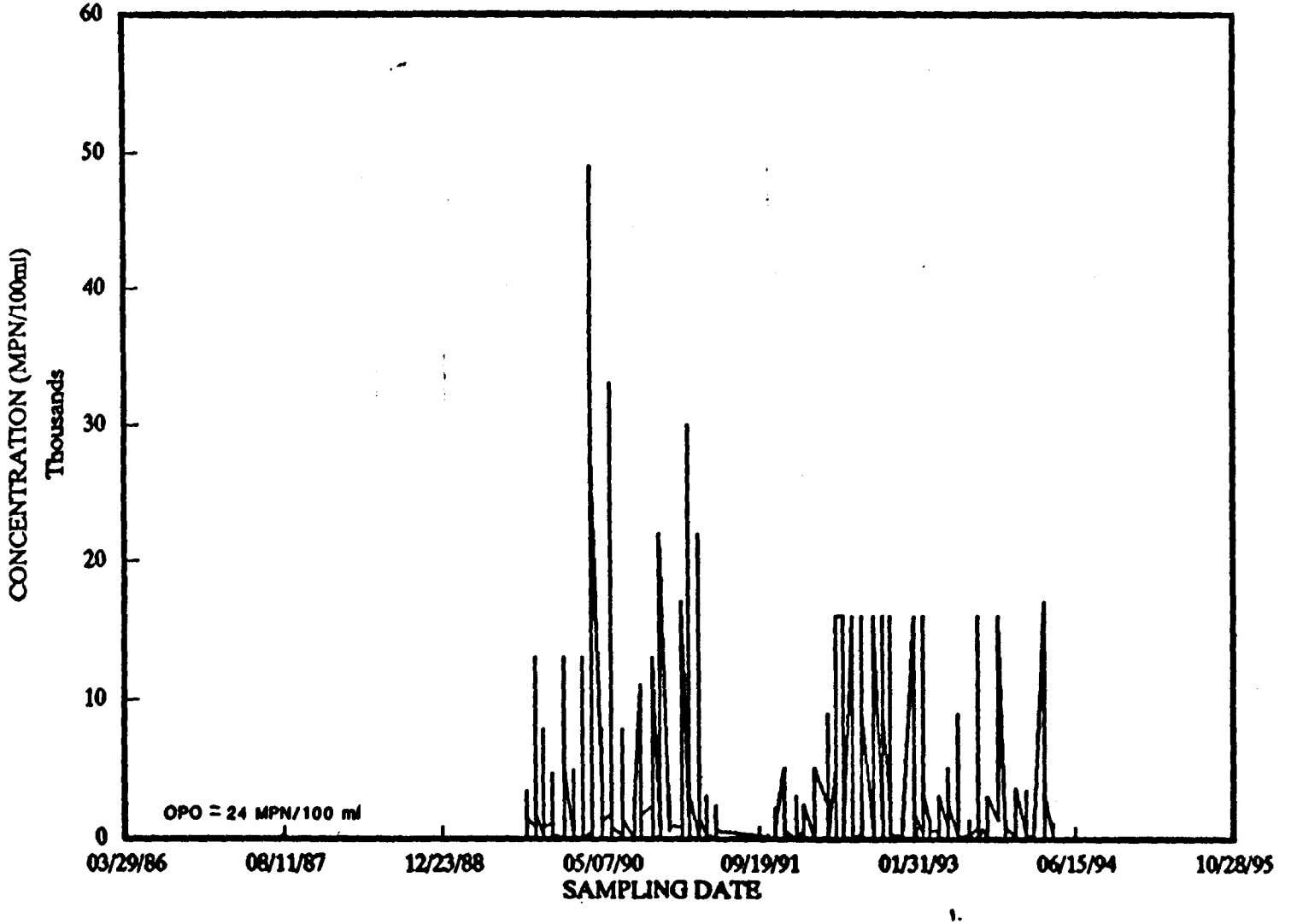


R0061124

VOL 15

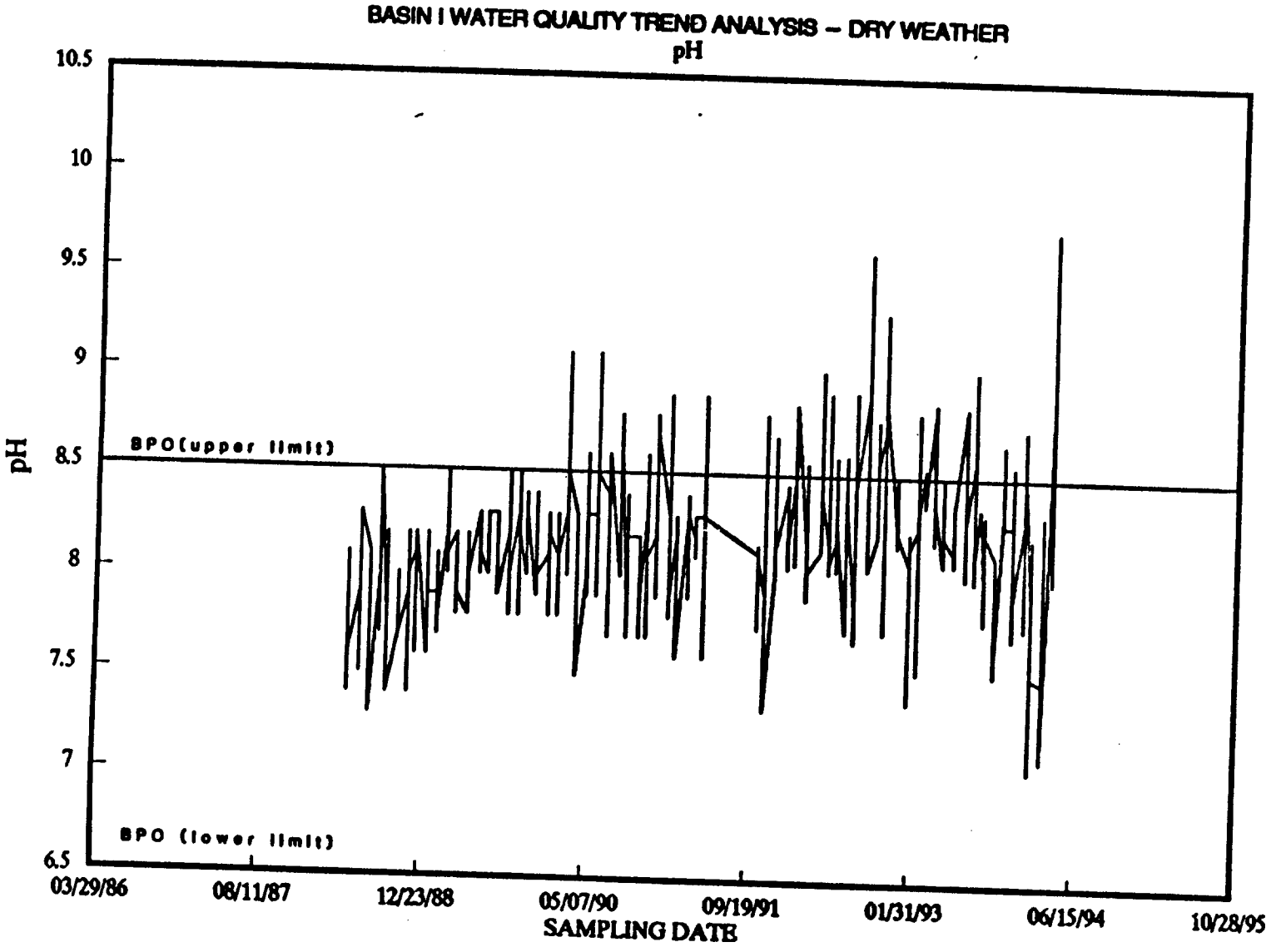
0904

BASIN I WATER QUALITY TREND ANALYSIS – DRY WEATHER
ENTEROCOCCUS



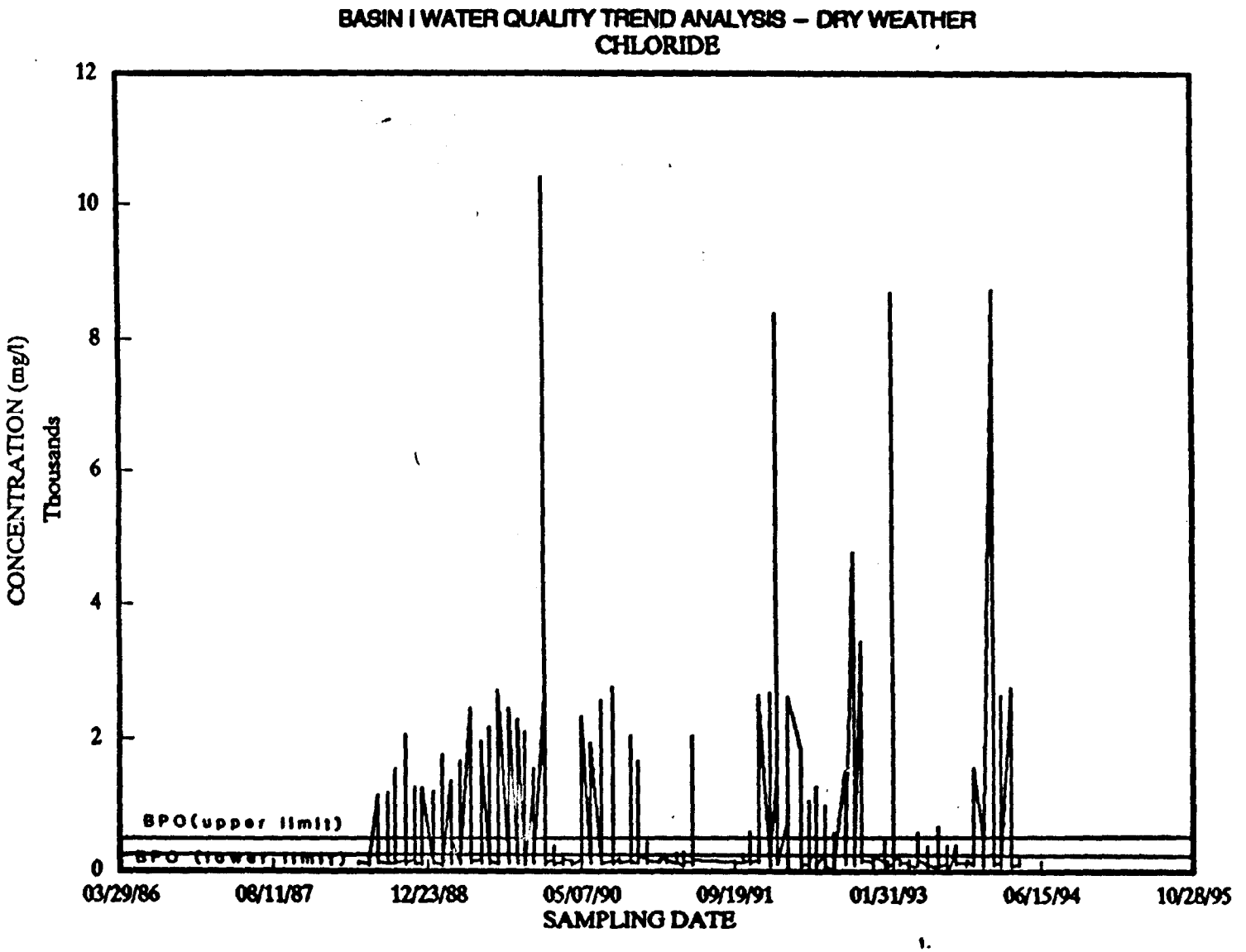
R0061125

VOL 15


BASIN I WATER QUALITY TREND ANALYSIS – DRY WEATHER
pH
10.5
10
9.5
9
8.5
8
7.5
7
6.5
pH
BPO(upper limit)
BPO (lower limit)
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

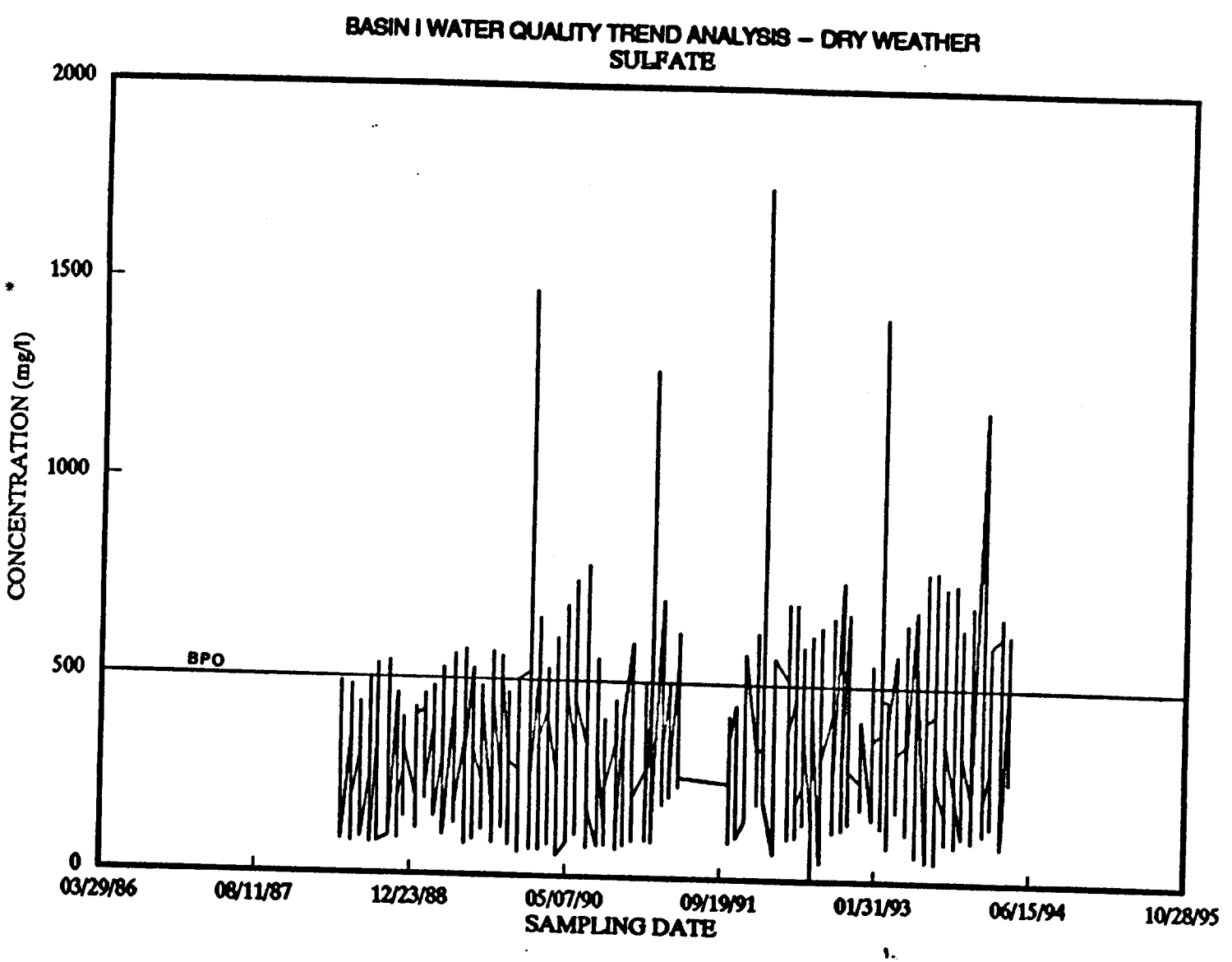
R0061126

BASIN I WATER QUALITY TREND ANALYSIS – DRY WEATHER
CHLORIDE

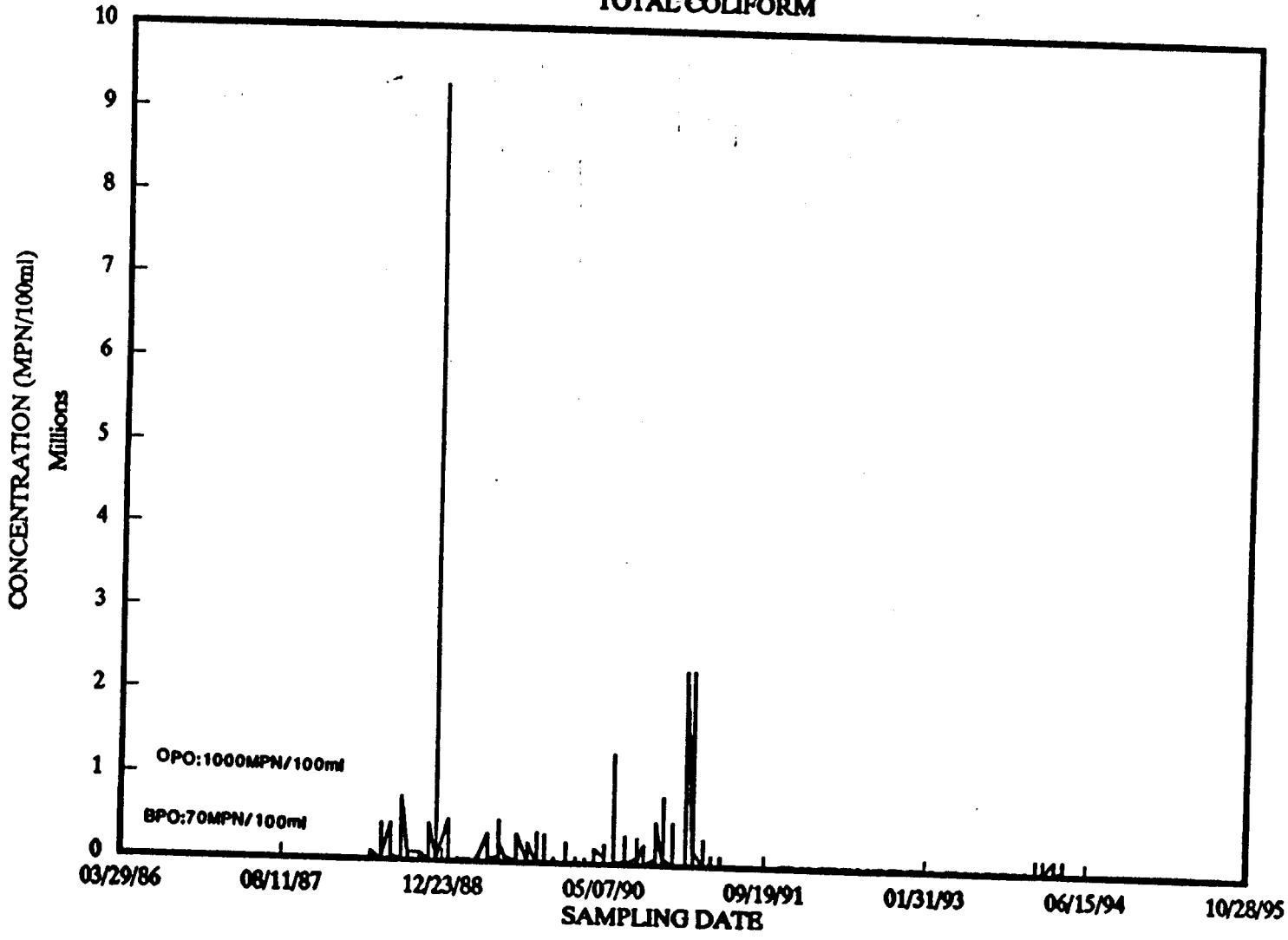


R0061127

VOL 15

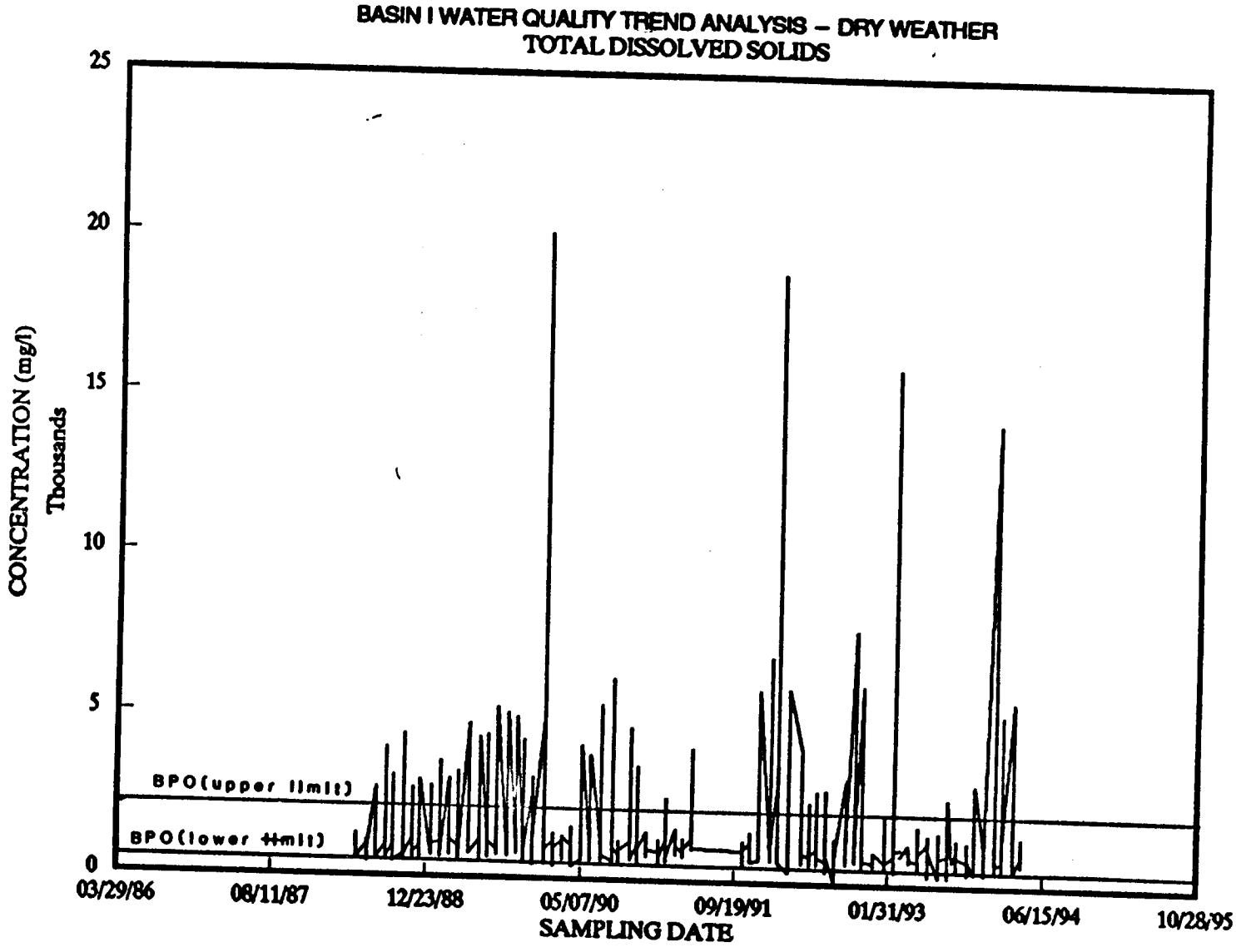

BASIN I WATER QUALITY TREND ANALYSIS – DRY WEATHER
SULFATE
2000
1500
1000
500
0
CONCENTRATION (mg/l)
BPO
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061128


BASIN I WATER QUALITY TREND ANALYSIS – DRY WEATHER
TOTAL COLIFORM
CONCENTRATION (MPN/100ml)
Millions
10
9
8
7
6
5
4
3
2
1
0
OPO:1000MPN/100ml
BPO:70MPN/100ml
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

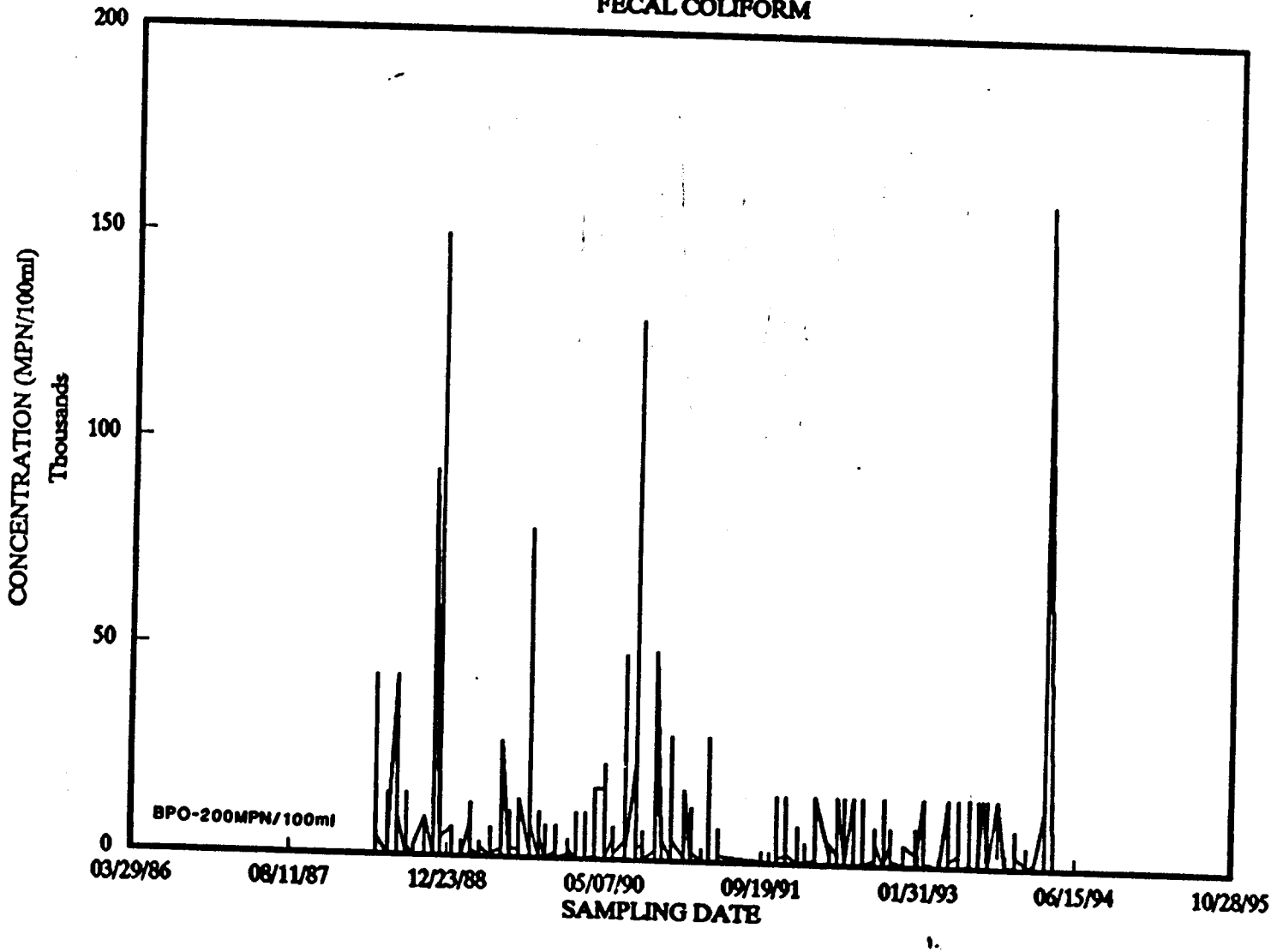
R0061129

BASIN I WATER QUALITY TREND ANALYSIS – DRY WEATHER
TOTAL DISSOLVED SOLIDS



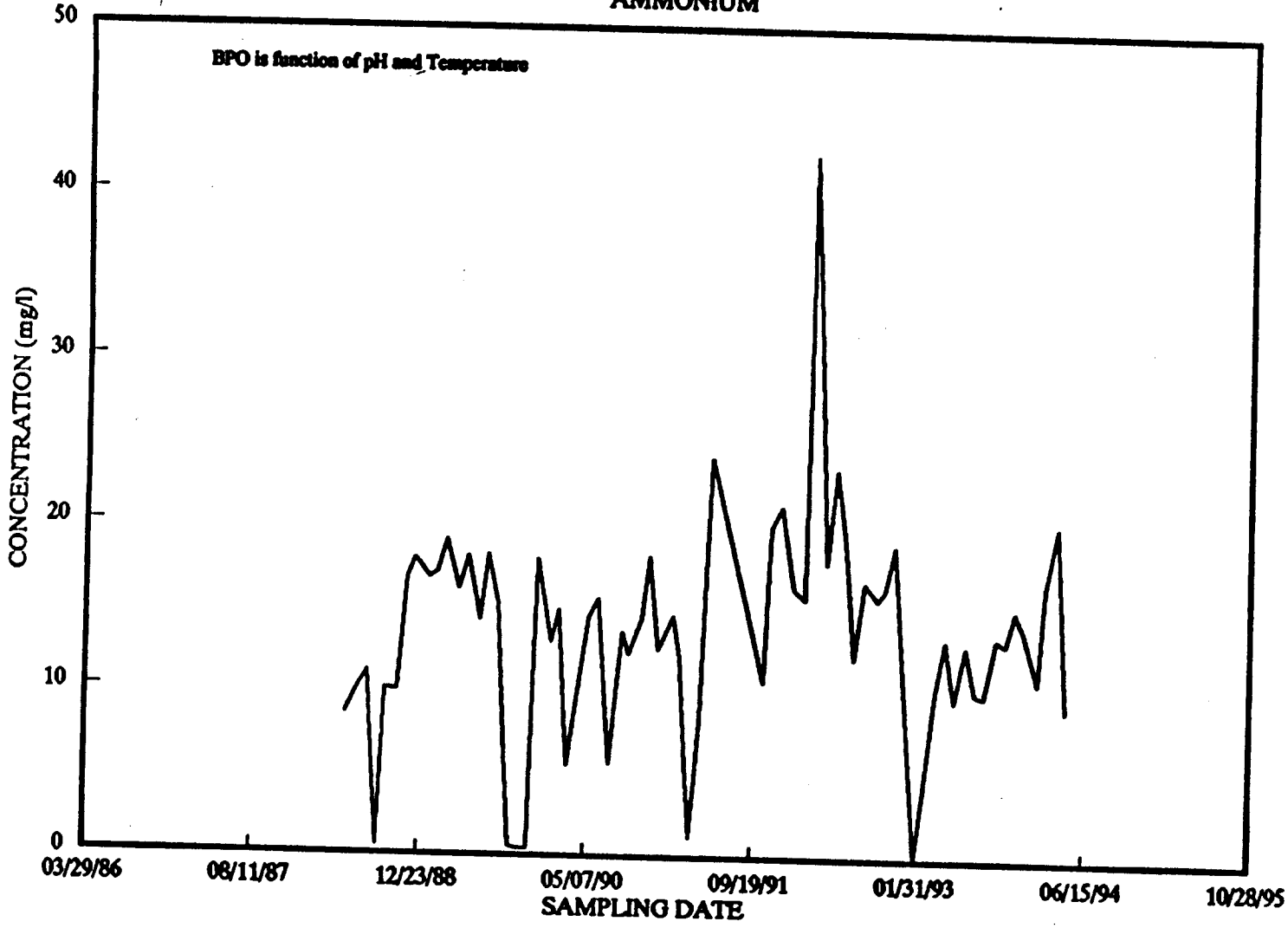
R0061130

VOL 15

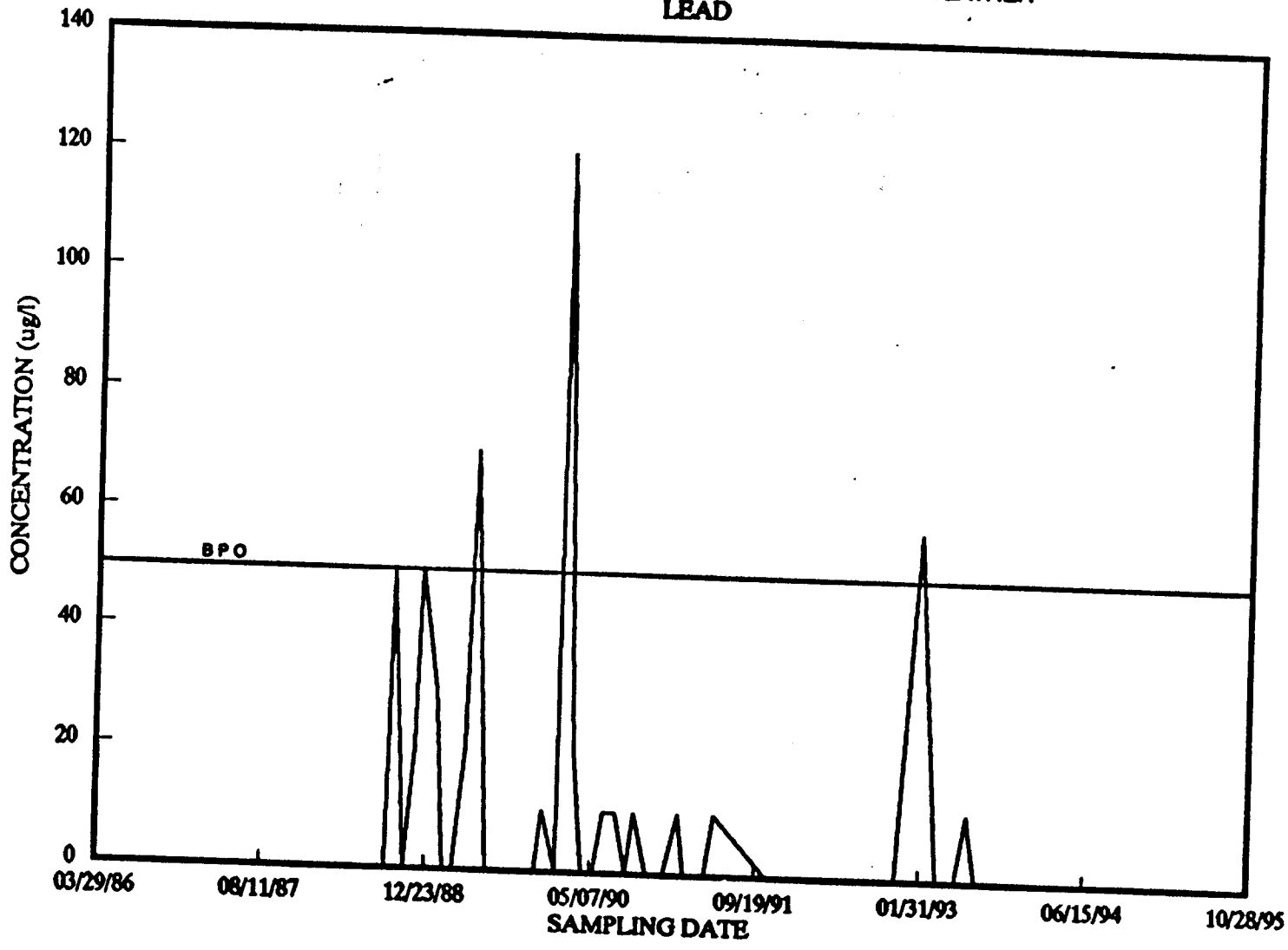

BASIN I WATER QUALITY TREND ANALYSIS – DRY WEATHER
FECAL COLIFORM
CONCENTRATION (MPN/100ml)
Thousands
200
150
100
50
0
BPO-200MPN/100ml
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061131

BASIN II WATER QUALITY TREND ANALYSIS – DRY WEATHER
AMMONIUM

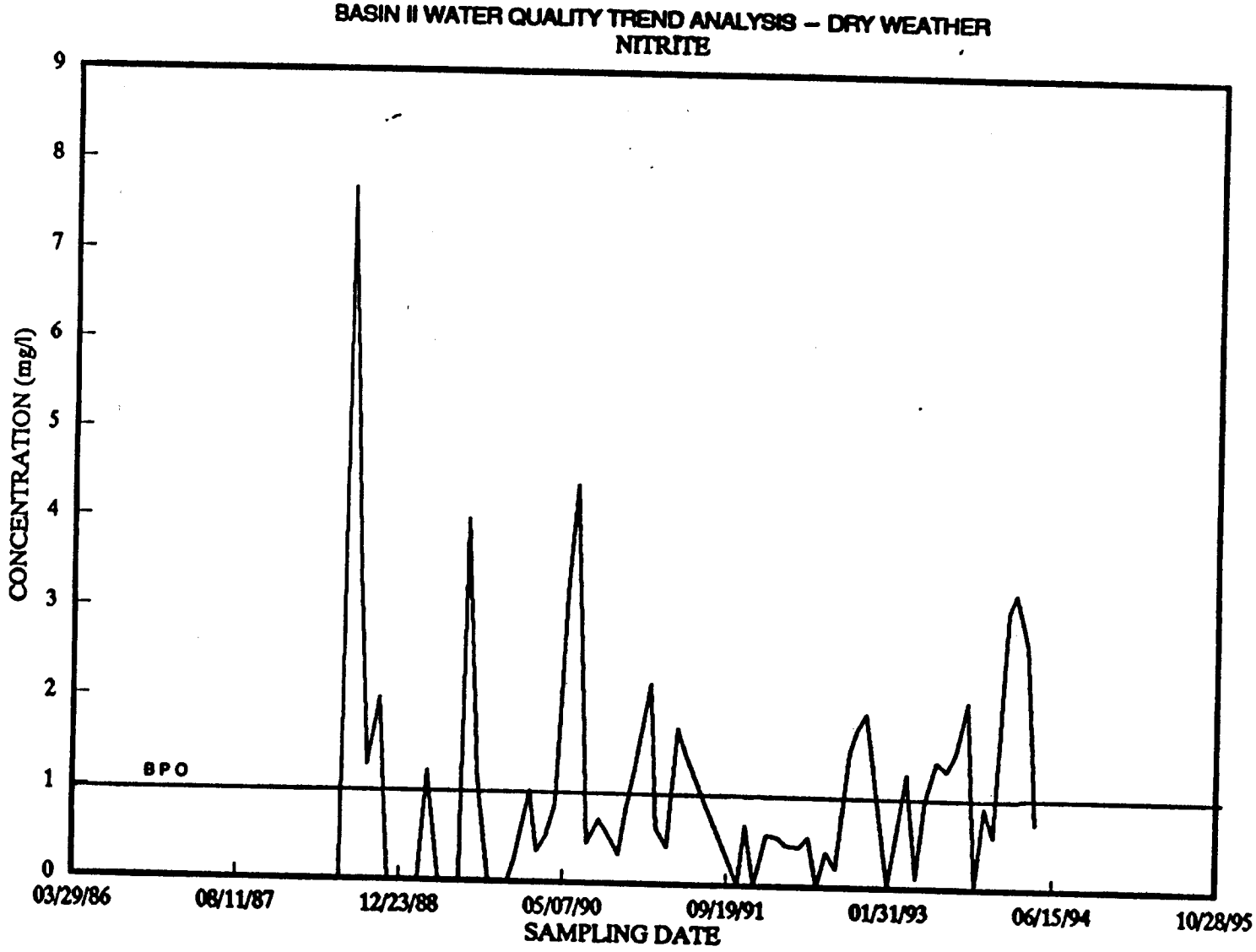


R0061132


BASIN II WATER QUALITY TREND ANALYSIS – DRY WEATHER
LEAD
CONCENTRATION (ug/l)
140
120
100
80
60
40
20
0
BPO
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061133

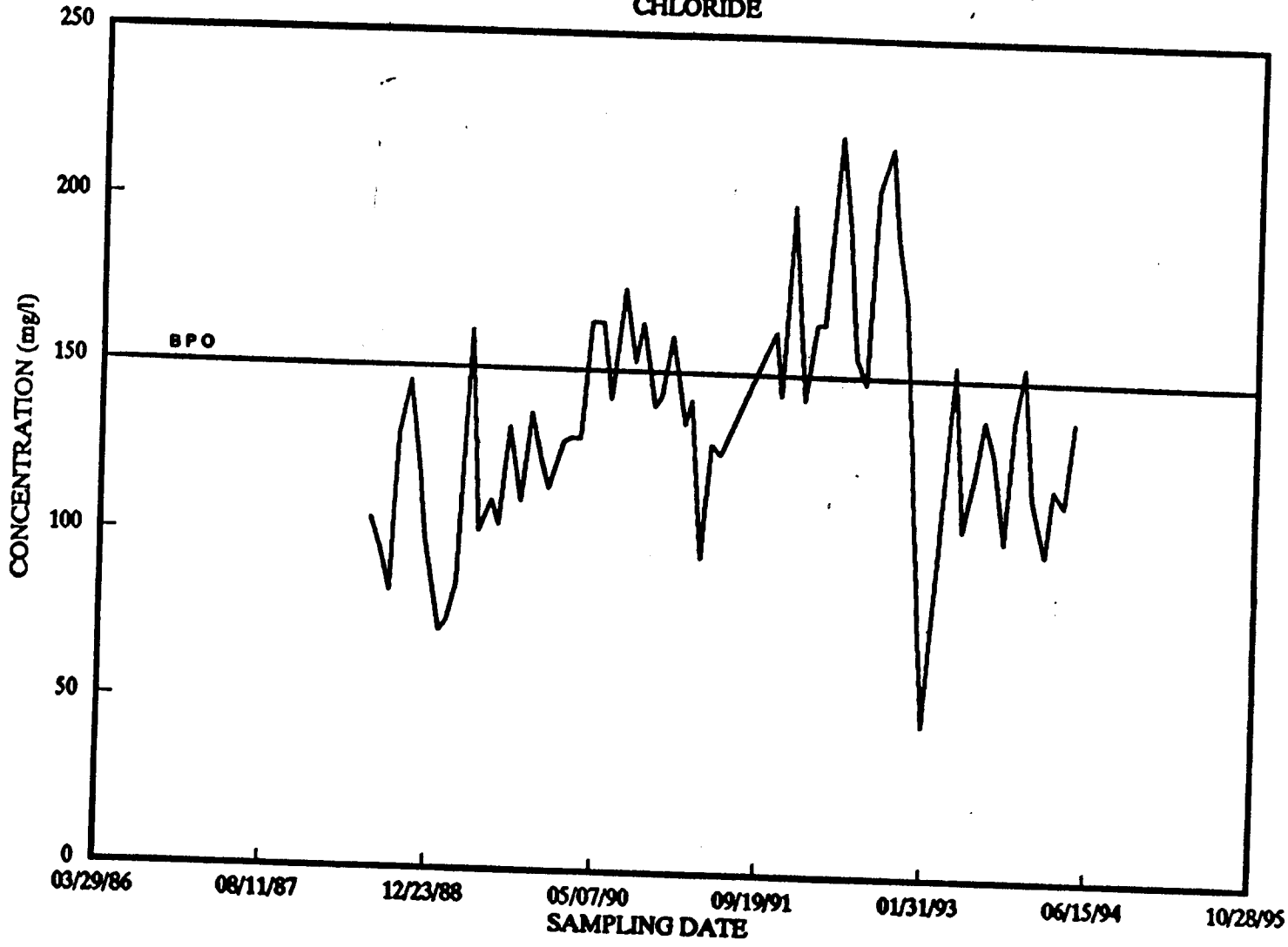
BASIN II WATER QUALITY TREND ANALYSIS – DRY WEATHER
NITRITE



R0061134

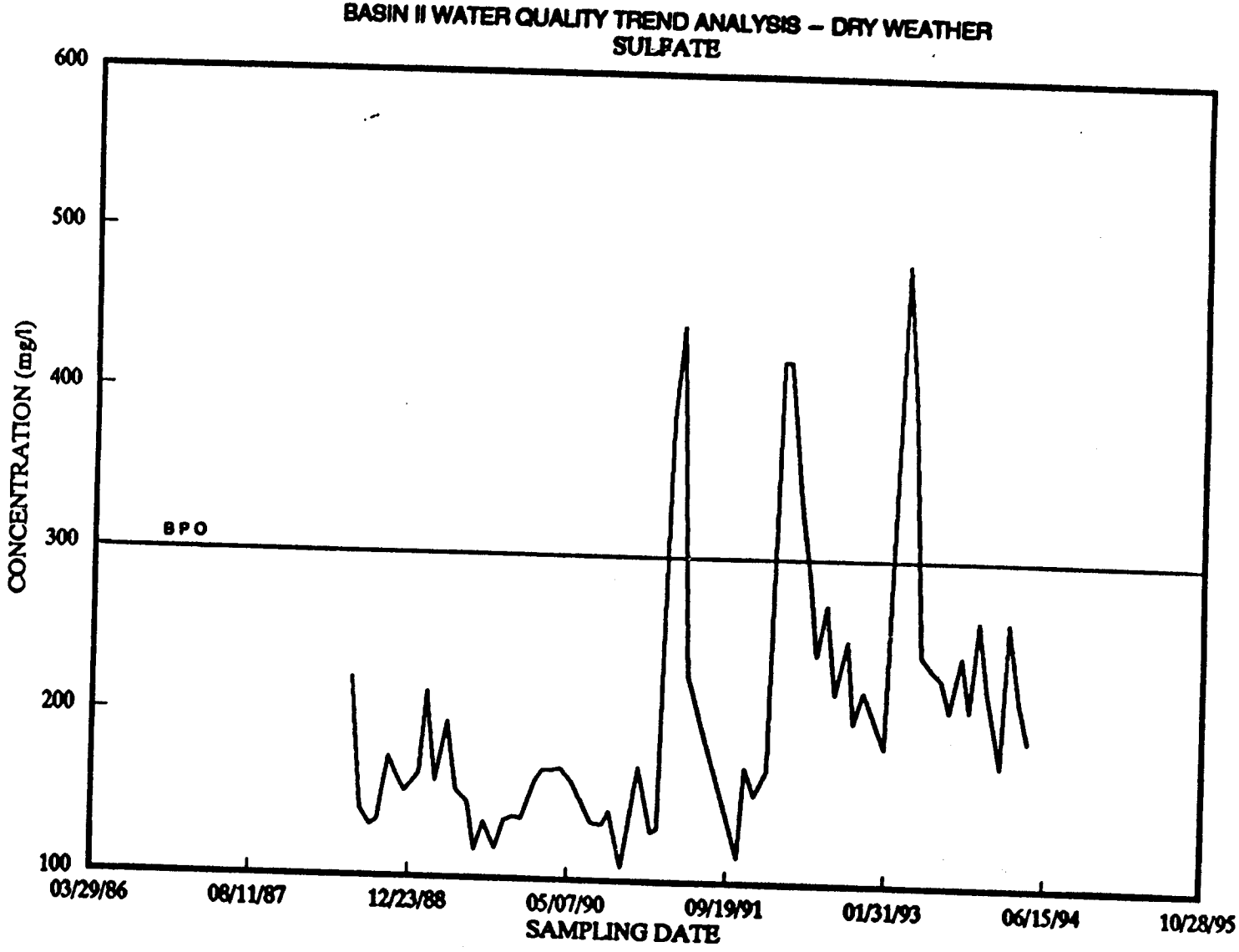
VOL 15

09-4


BASIN II WATER QUALITY TREND ANALYSIS – DRY WEATHER
CHLORIDE
250
200
150
100
50
0
BPO
CONCENTRATION (mg/l)
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061135

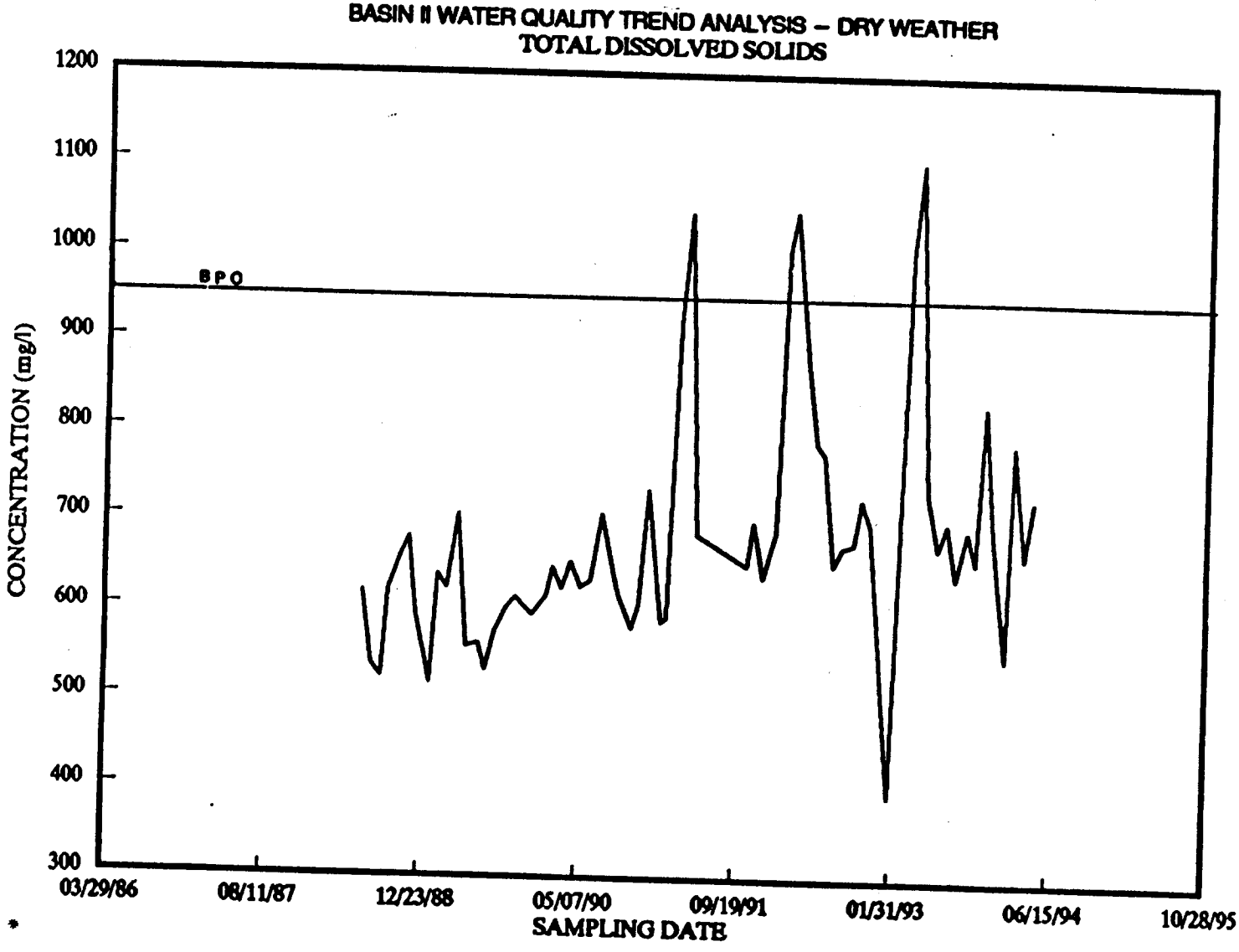
BASIN II WATER QUALITY TREND ANALYSIS – DRY WEATHER
SULFATE



R0061136

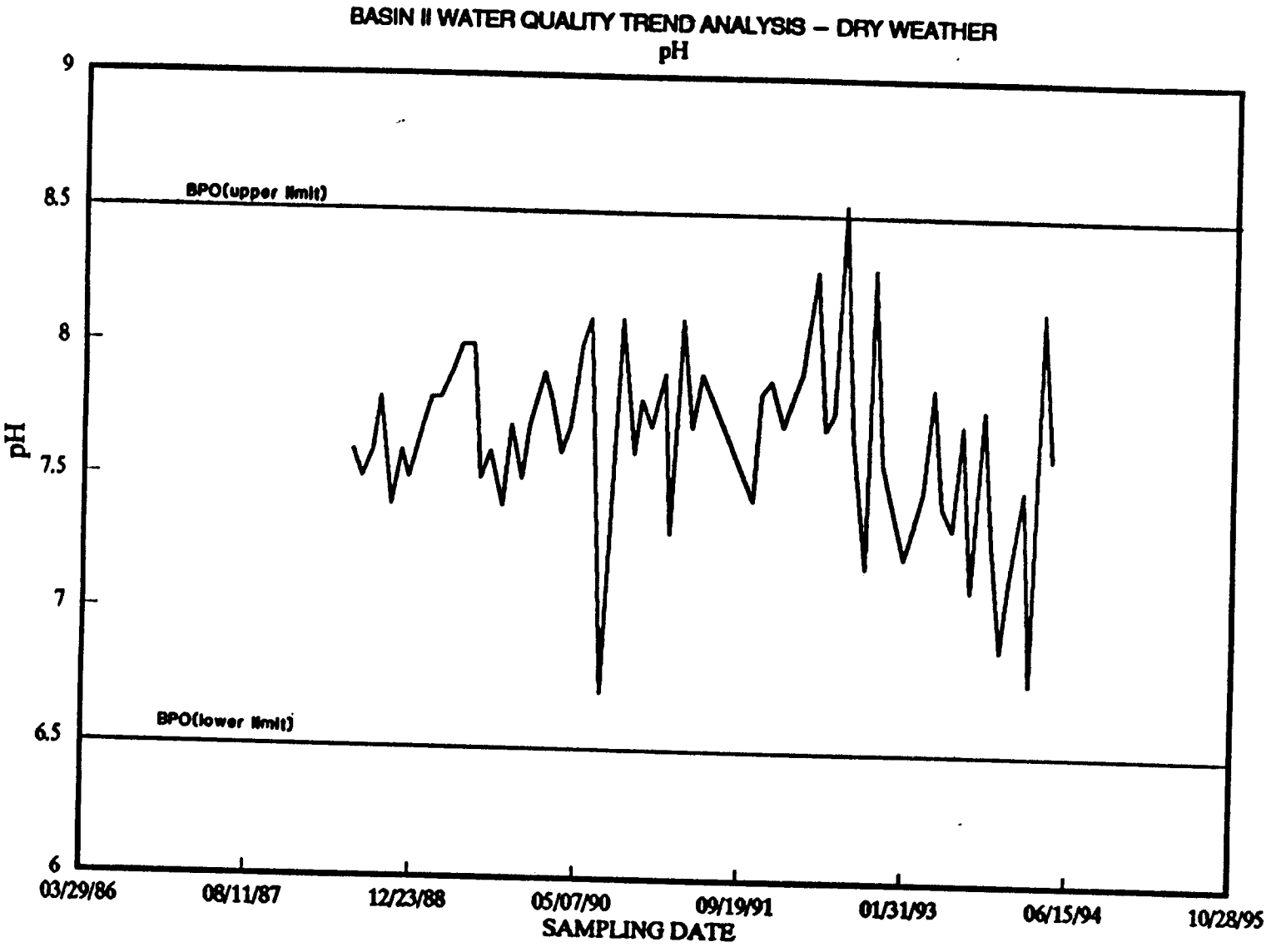
VOL 15

BASIN II WATER QUALITY TREND ANALYSIS – DRY WEATHER
TOTAL DISSOLVED SOLIDS



R0061137

VOL 15

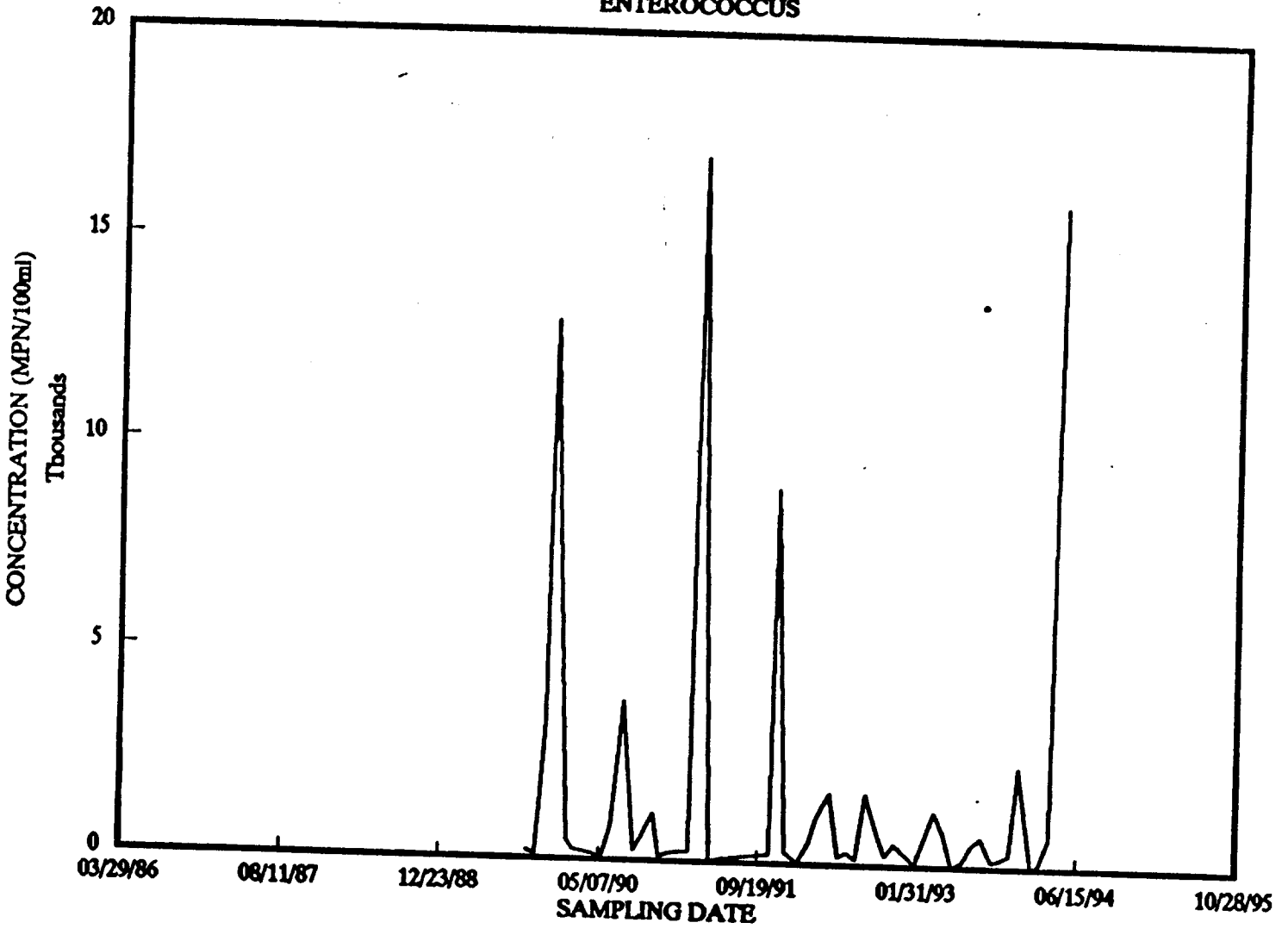


R0061138

VOL 15

09-8

BASIN II WATER QUALITY TREND ANALYSIS – DRY WEATHER
ENTEROCOCCUS

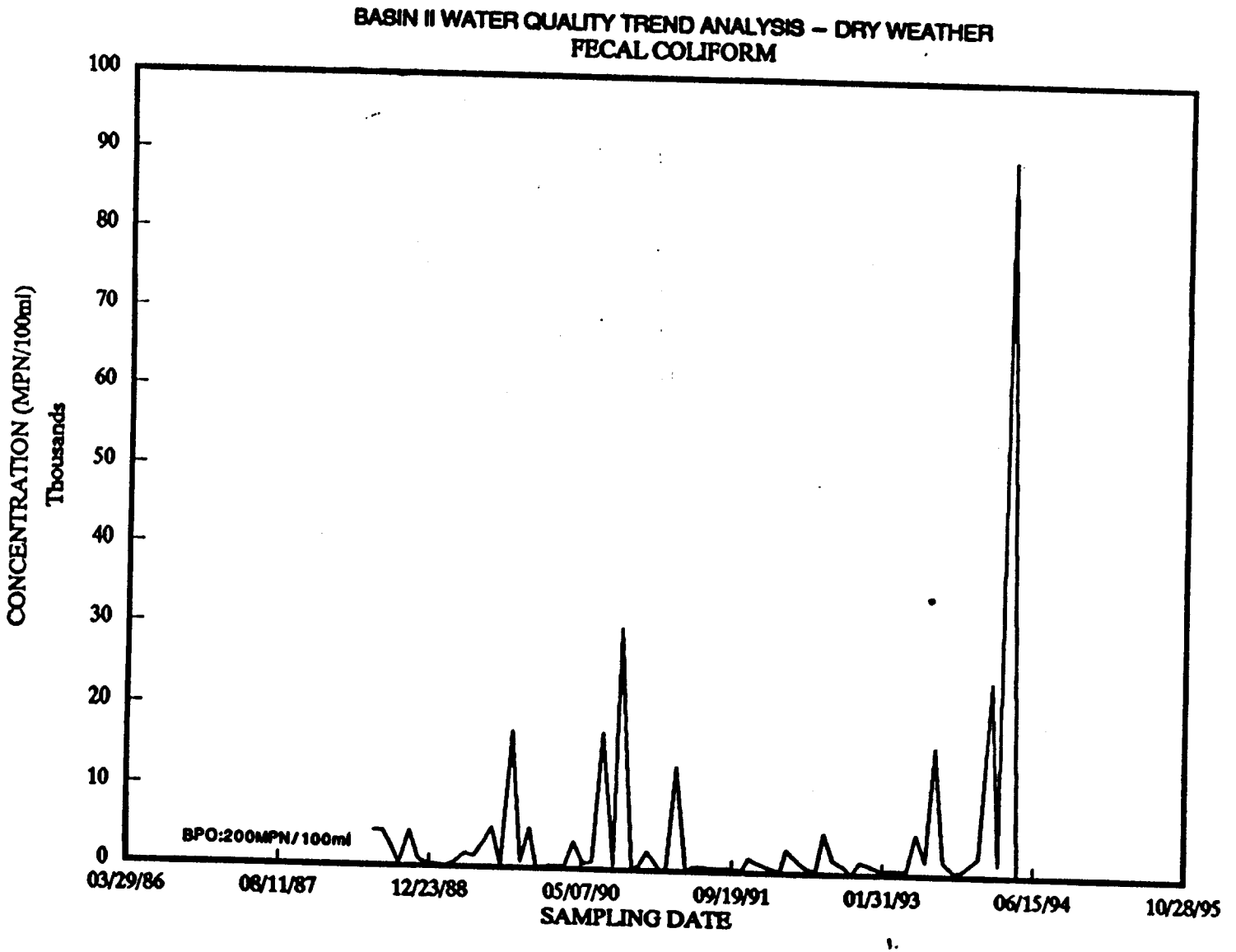


R0061139

09-09

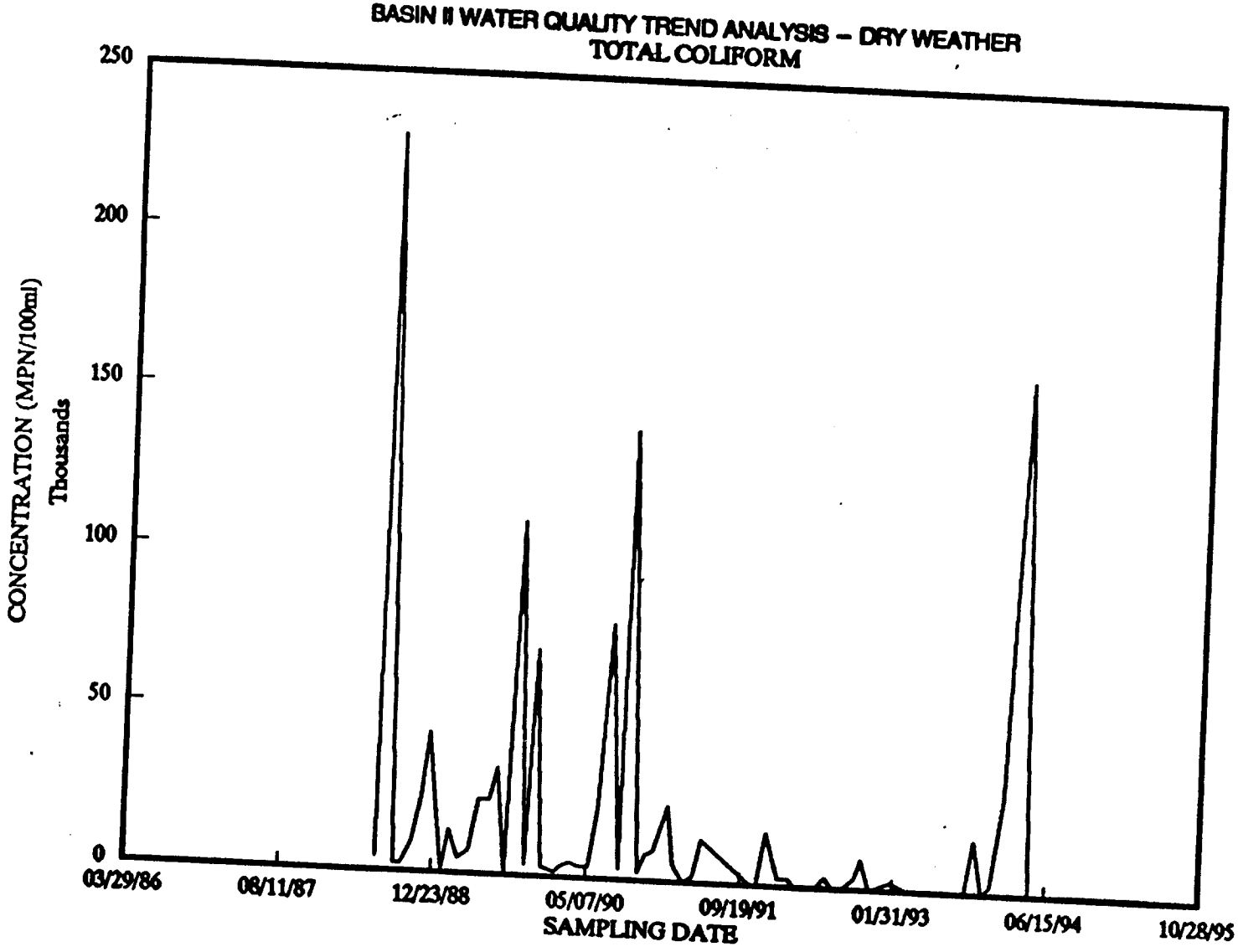
VOL 15

BASIN II WATER QUALITY TREND ANALYSIS – DRY WEATHER
FECAL COLIFORM



R0061140

VOL 15

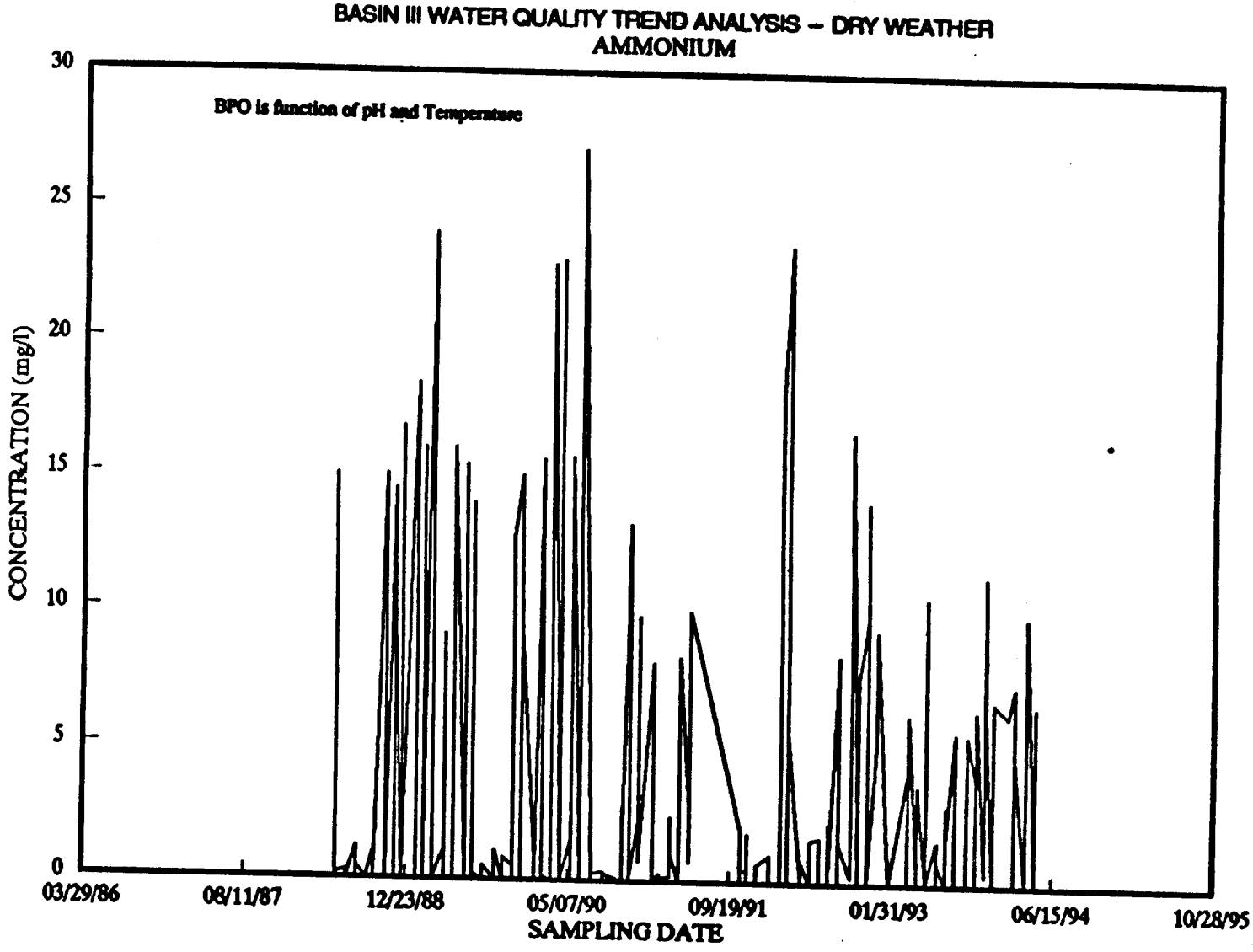


R0061141

-2603

VOL 715

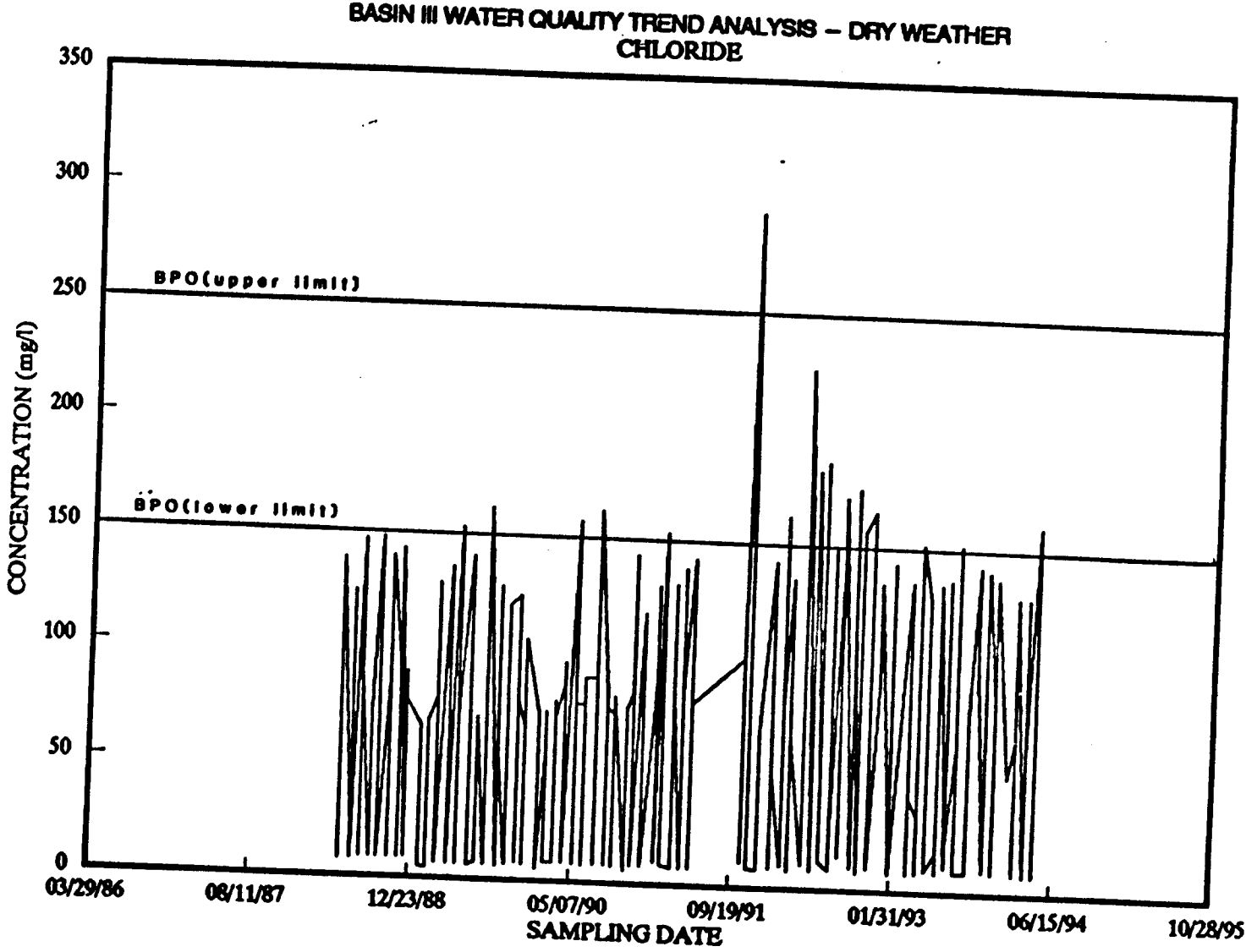
BASIN III WATER QUALITY TREND ANALYSIS – DRY WEATHER
AMMONIUM



R0061142

VOL 15

BASIN III WATER QUALITY TREND ANALYSIS – DRY WEATHER
CHLORIDE

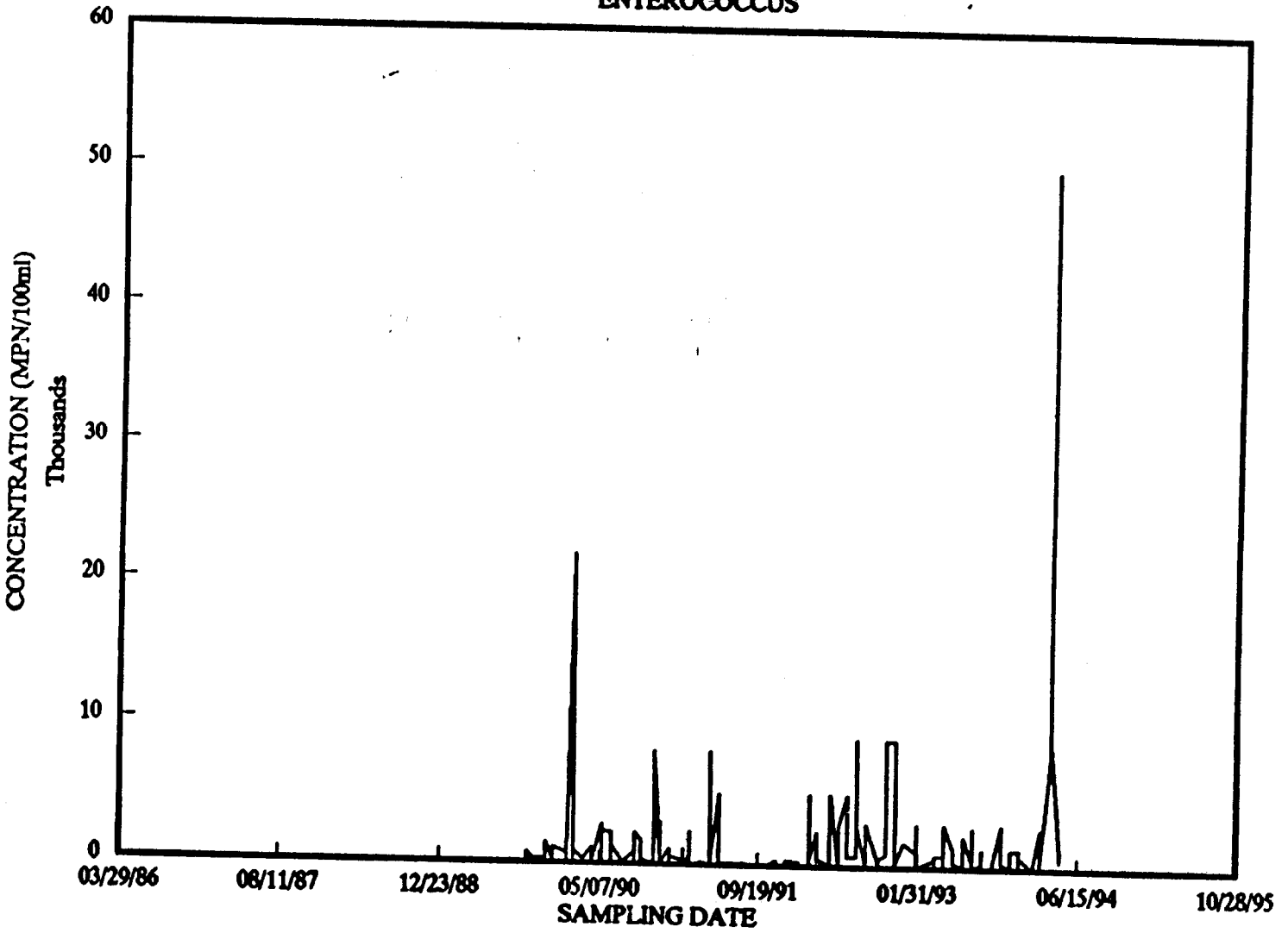


R0061143

VOL 15

C0923

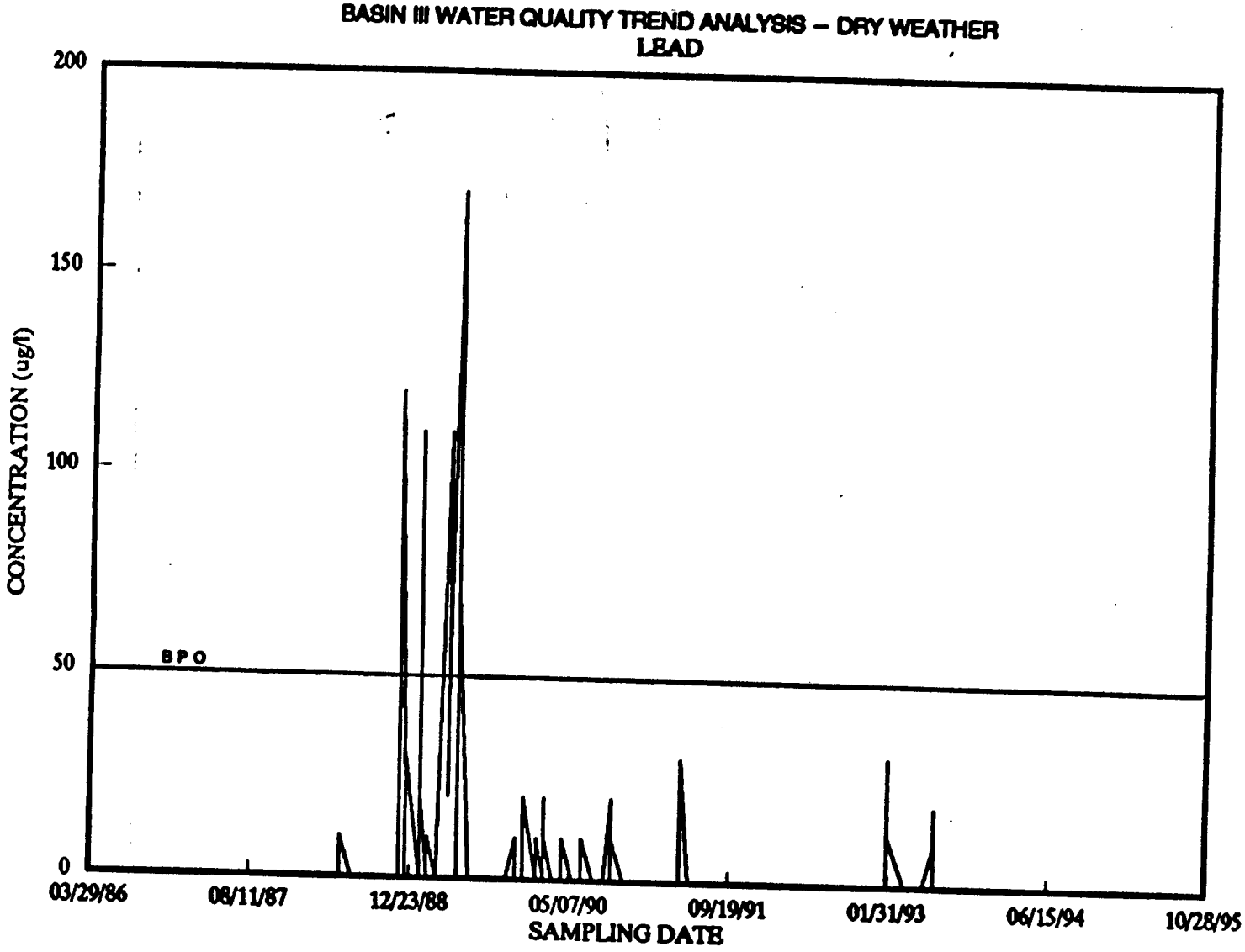
BASIN III WATER QUALITY TREND ANALYSIS – DRY WEATHER
ENTEROCOCCUS



R0061144

42563
VOL 75

BASIN III WATER QUALITY TREND ANALYSIS – DRY WEATHER
LEAD

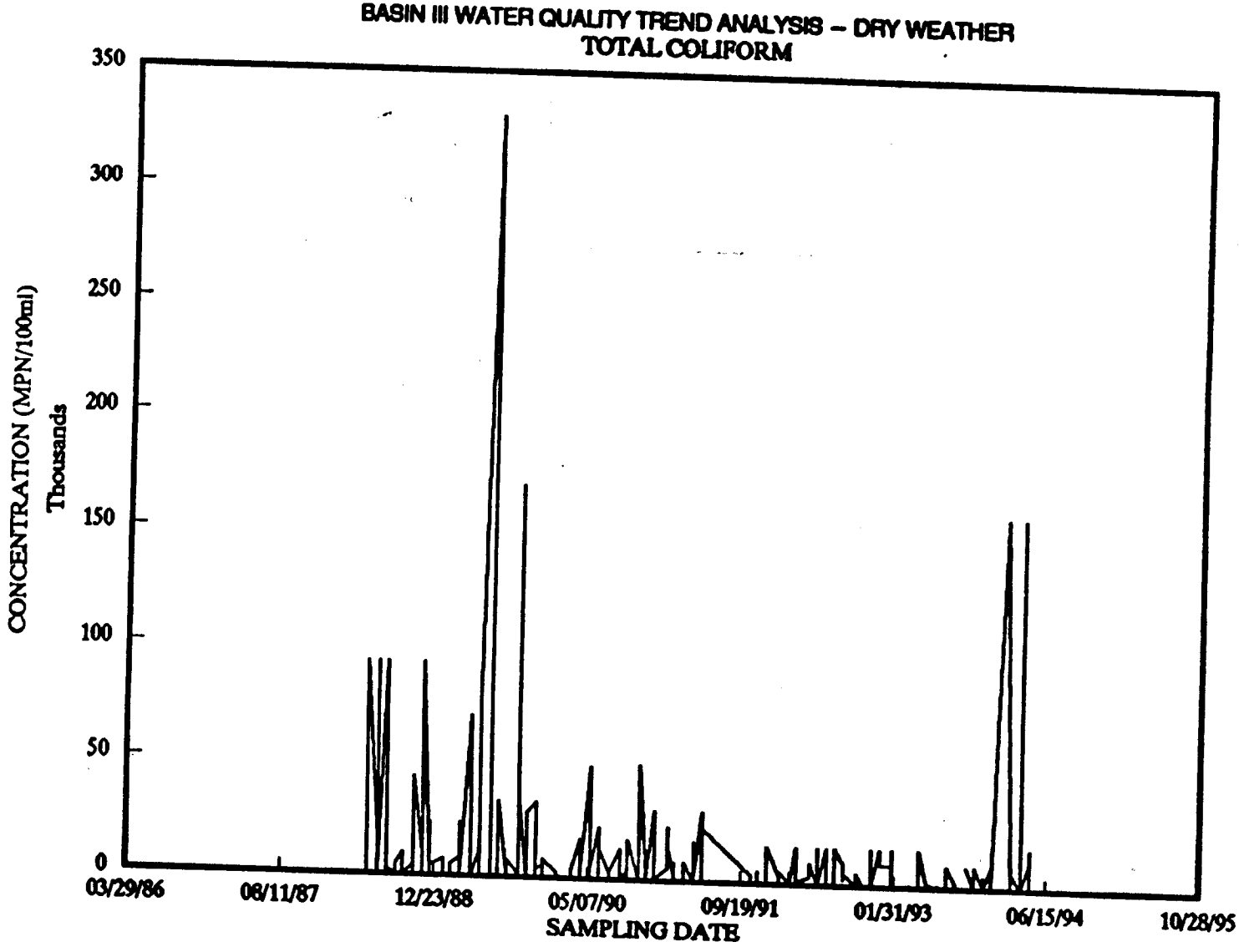


R0061145

VOL 15

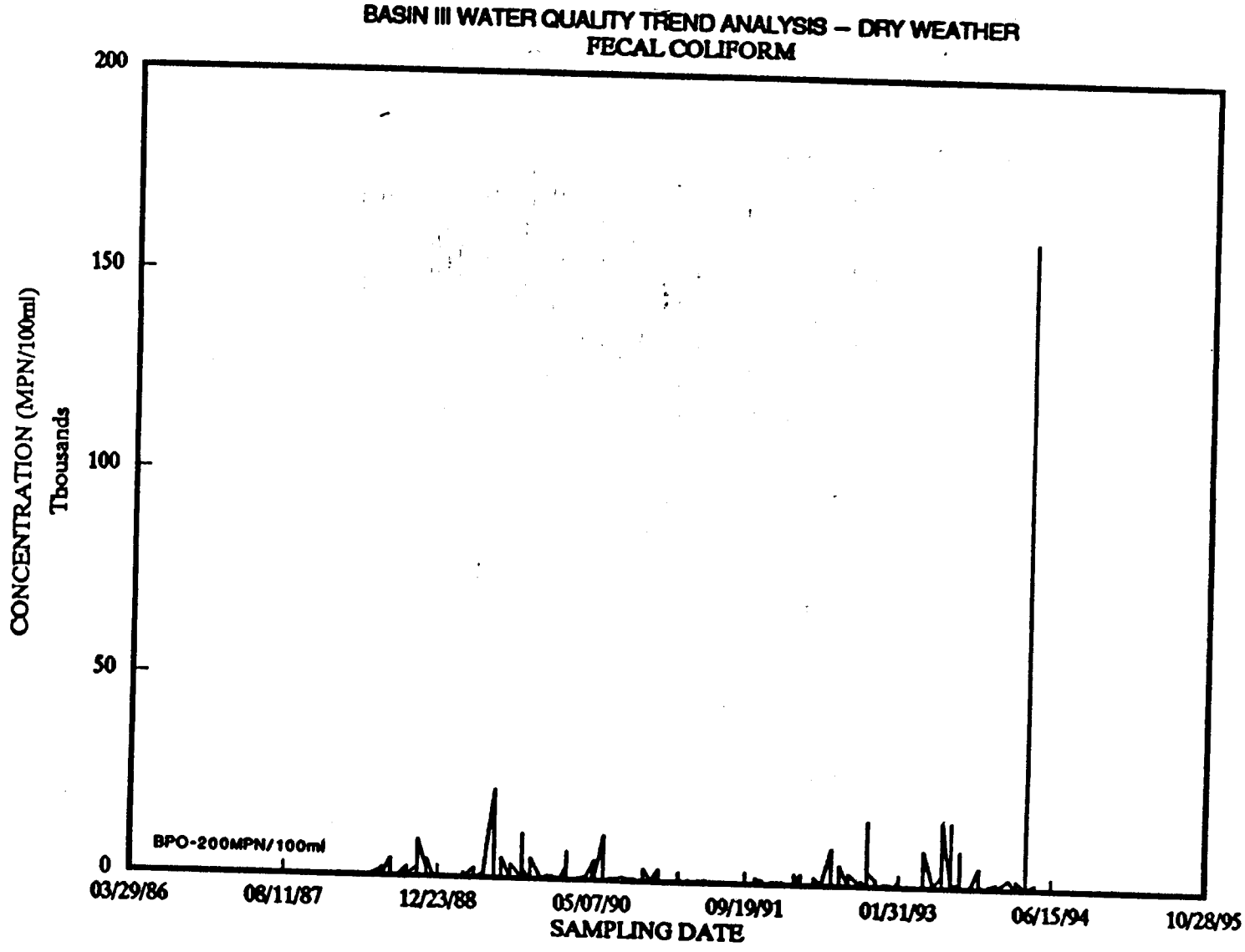
0925

BASIN III WATER QUALITY TREND ANALYSIS – DRY WEATHER
TOTAL COLIFORM

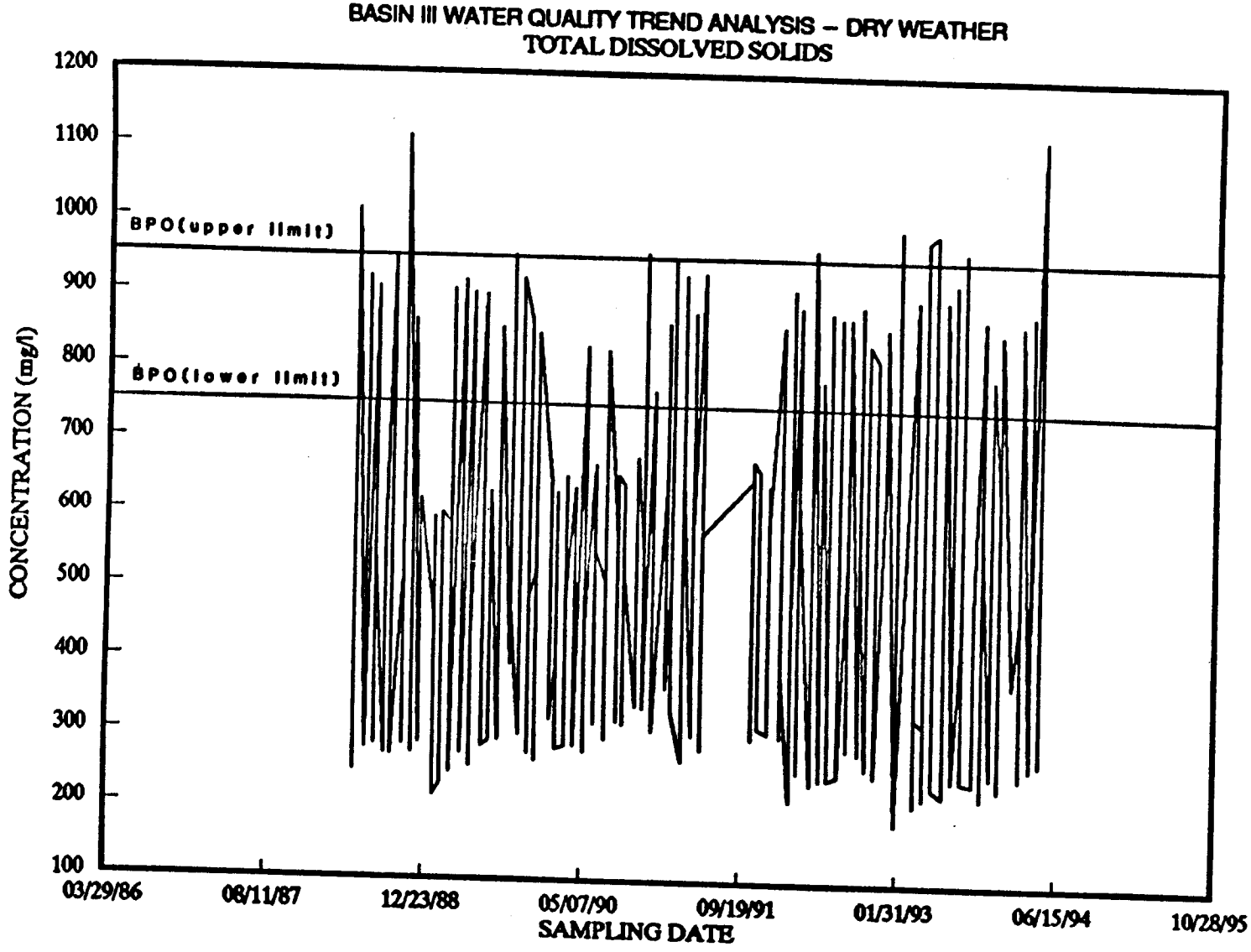


R0061146

VOL 15

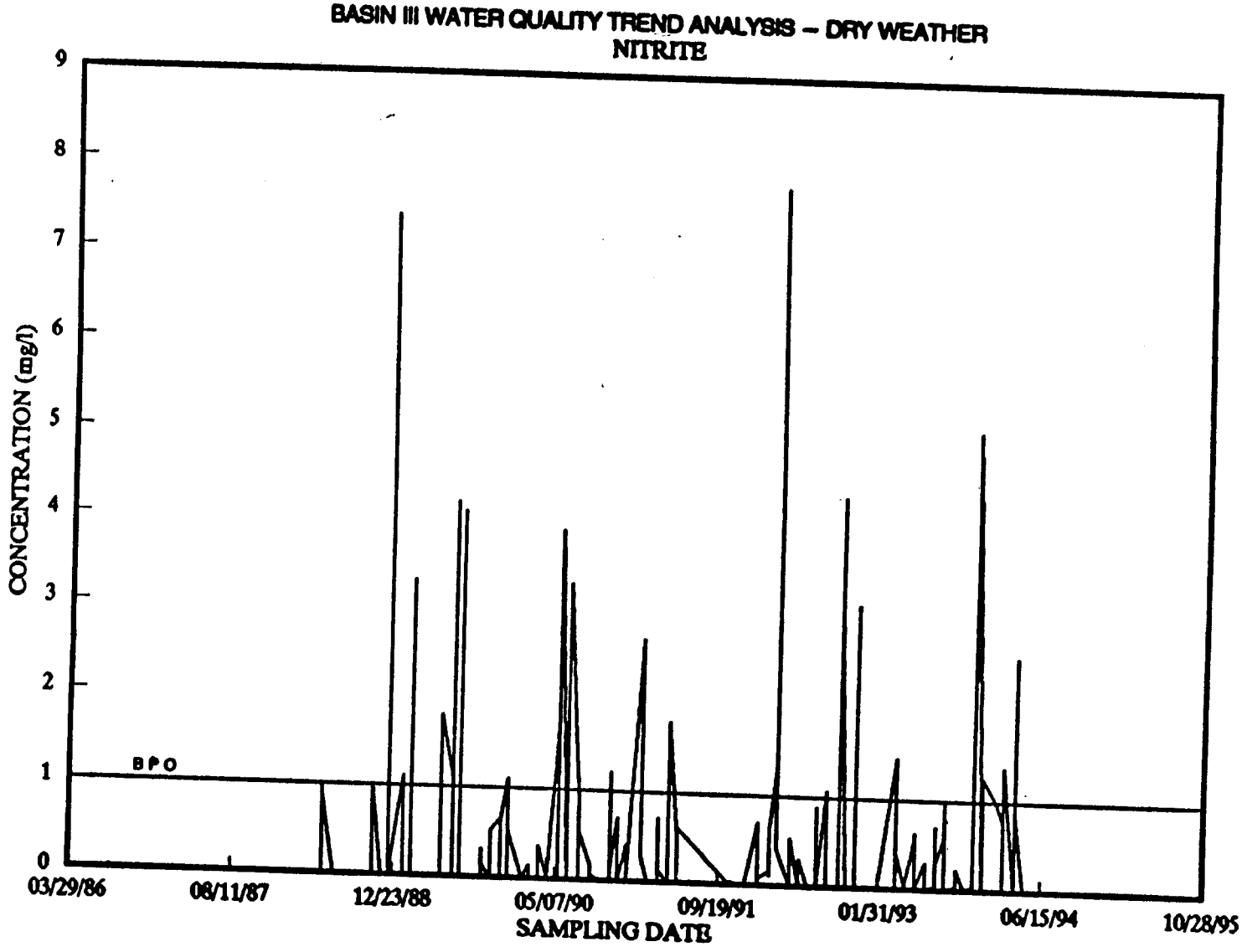

BASIN III WATER QUALITY TREND ANALYSIS – DRY WEATHER
FECAL COLIFORM
CONCENTRATION (MPN/100ml)
Thousands
200
150
100
50
0
BPO-200MPN/100ml
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061147


BASIN III WATER QUALITY TREND ANALYSIS – DRY WEATHER
TOTAL DISSOLVED SOLIDS
CONCENTRATION (mg/l)
1200
1100
1000
900
800
700
600
500
400
300
200
100
BPO(upper limit)
BPO(lower limit)
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061148

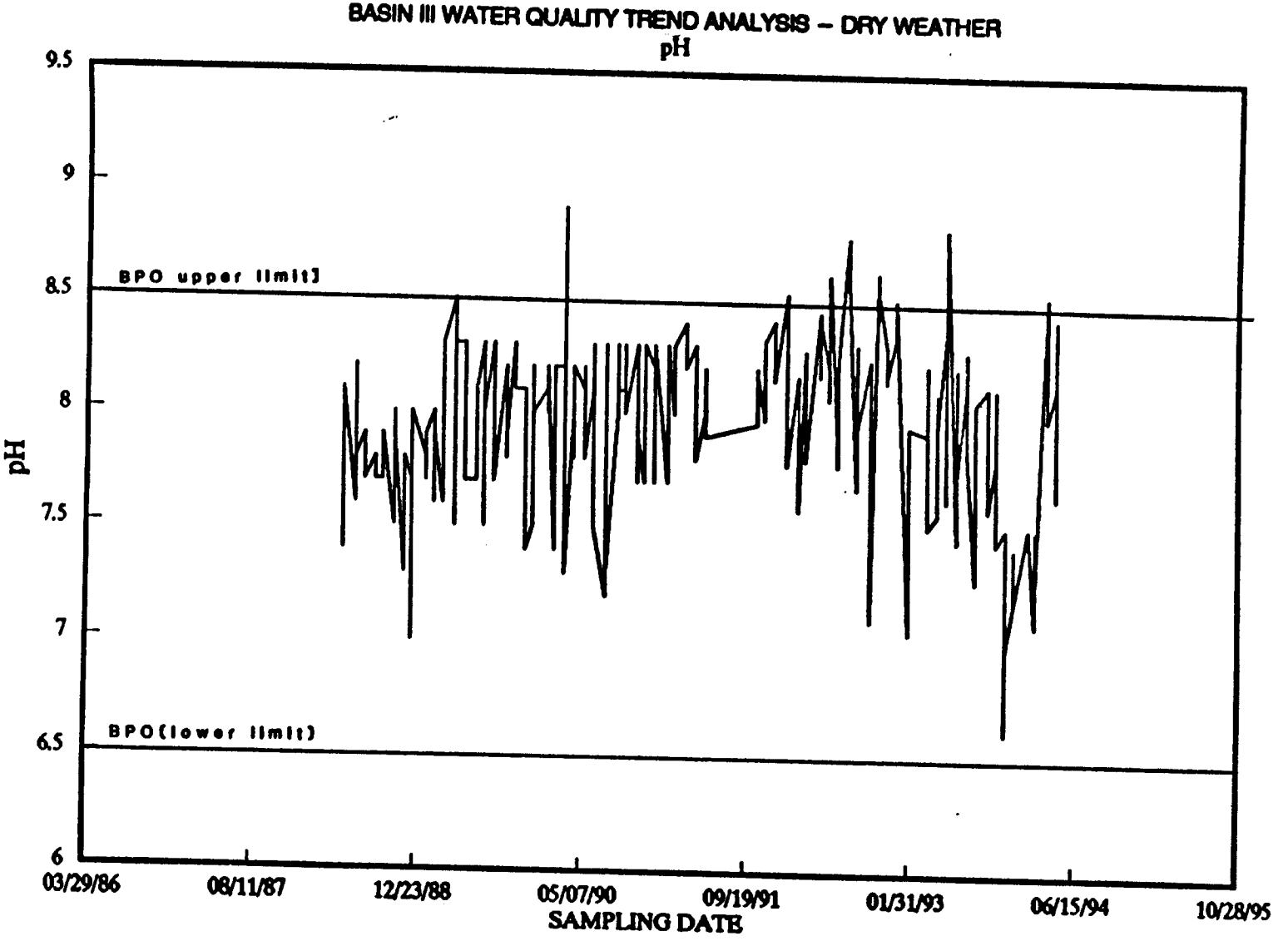
BASIN III WATER QUALITY TREND ANALYSIS – DRY WEATHER
NITRITE



R0061149

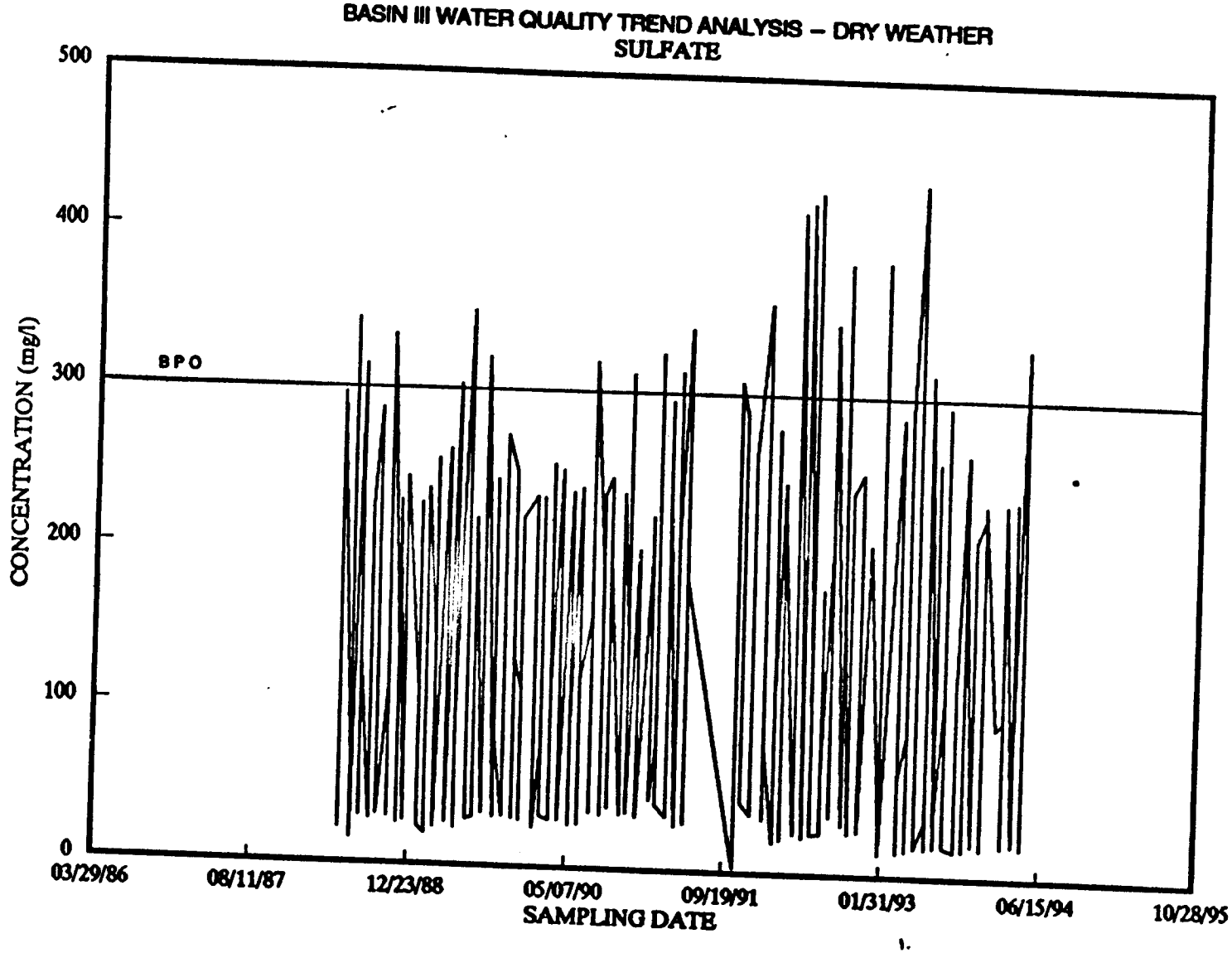
VOL 15

0929


BASIN III WATER QUALITY TREND ANALYSIS – DRY WEATHER
pH
9.5
9
8.5
8
7.5
7
6.5
6
pH
BPO upper limit
BPO(lower limit)
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061150

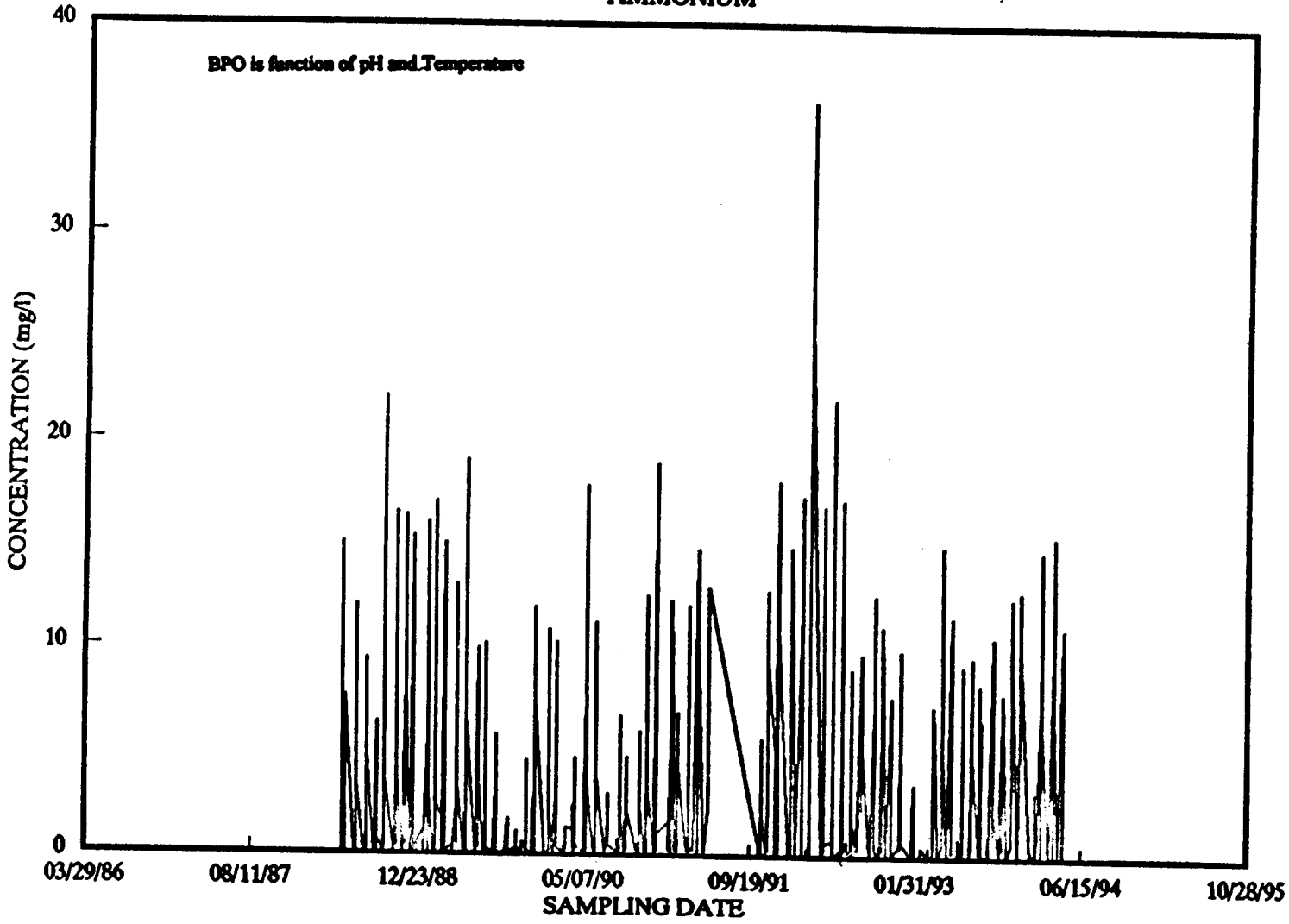
BASIN III WATER QUALITY TREND ANALYSIS – DRY WEATHER
SULFATE



R0061151

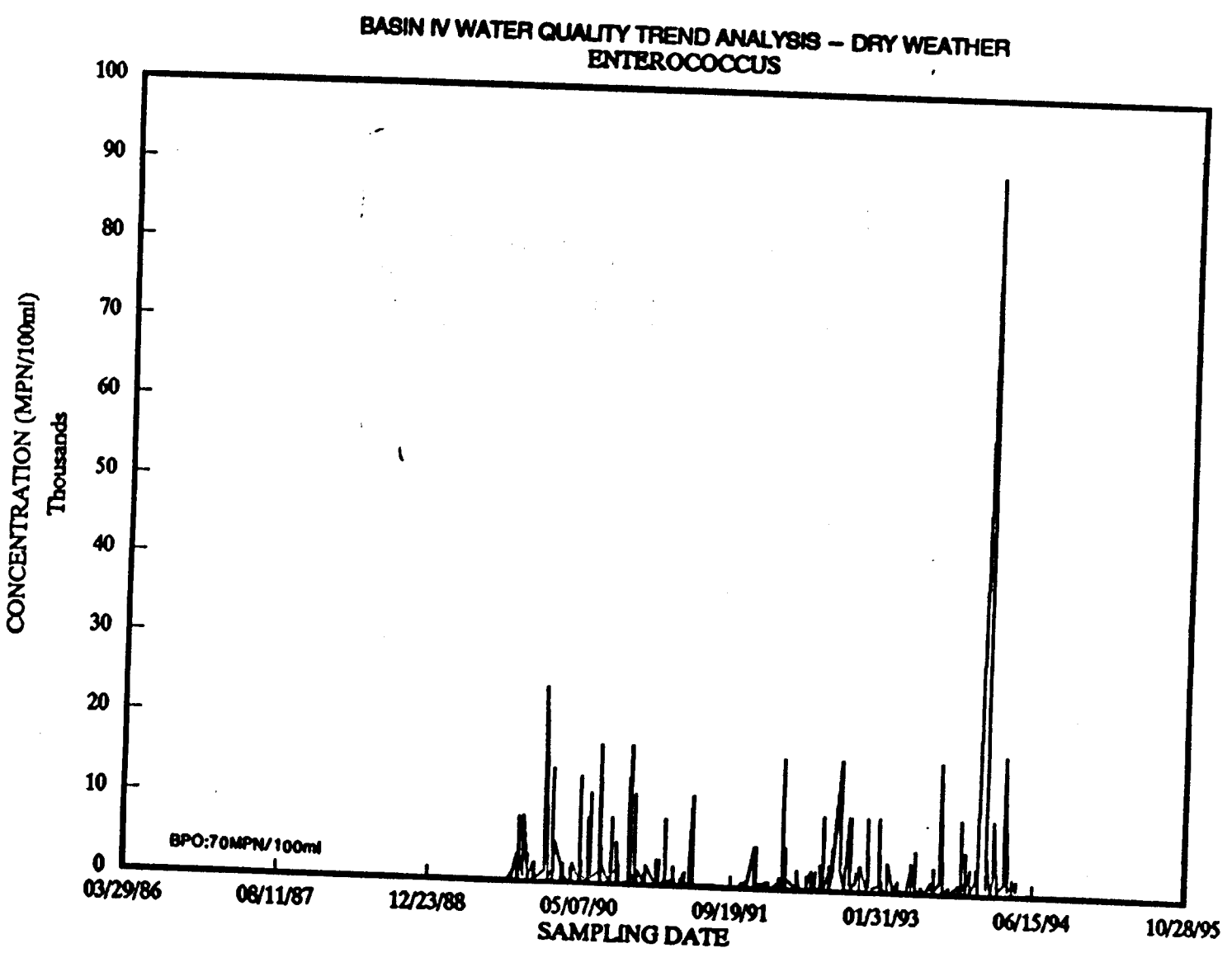
VOL 15

BASIN IV WATER QUALITY TREND ANALYSIS – DRY WEATHER
AMMONIUM



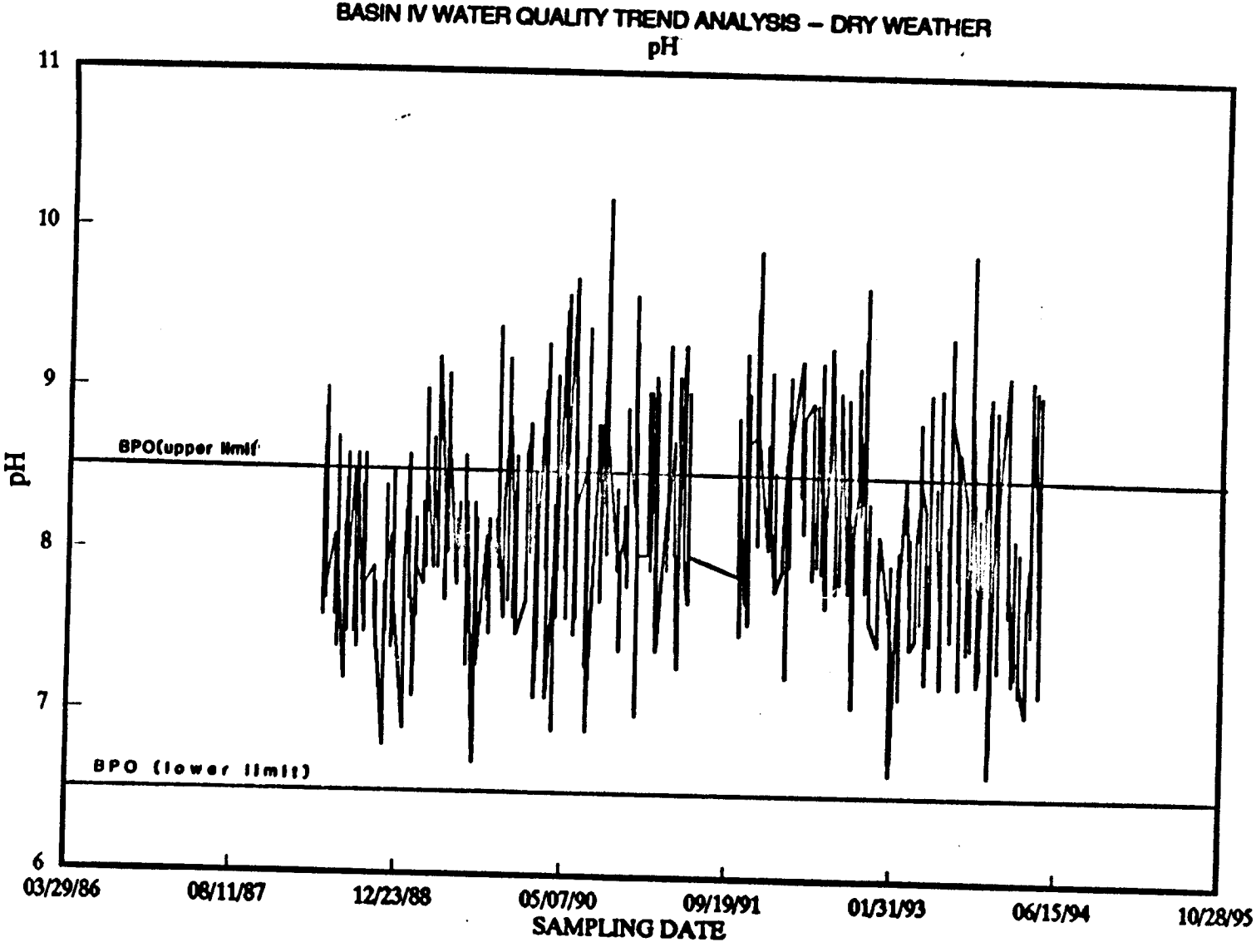
R0061152

VOL 15

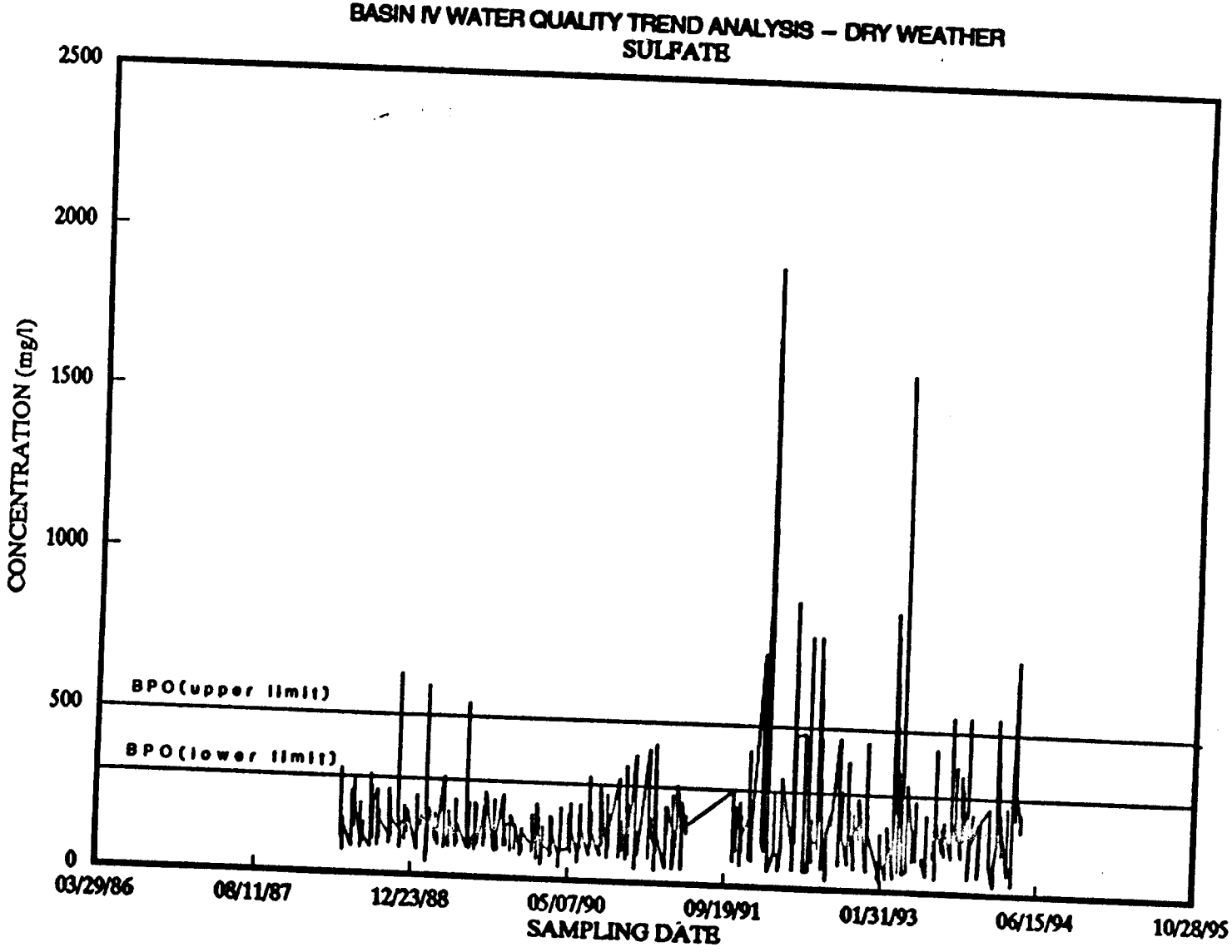


R0061153

EE563 VOL 75


BASIN IV WATER QUALITY TREND ANALYSIS – DRY WEATHER
pH
11
10
9
8
7
6
pH
BPO(upper limit)
BPO (lower limit)
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

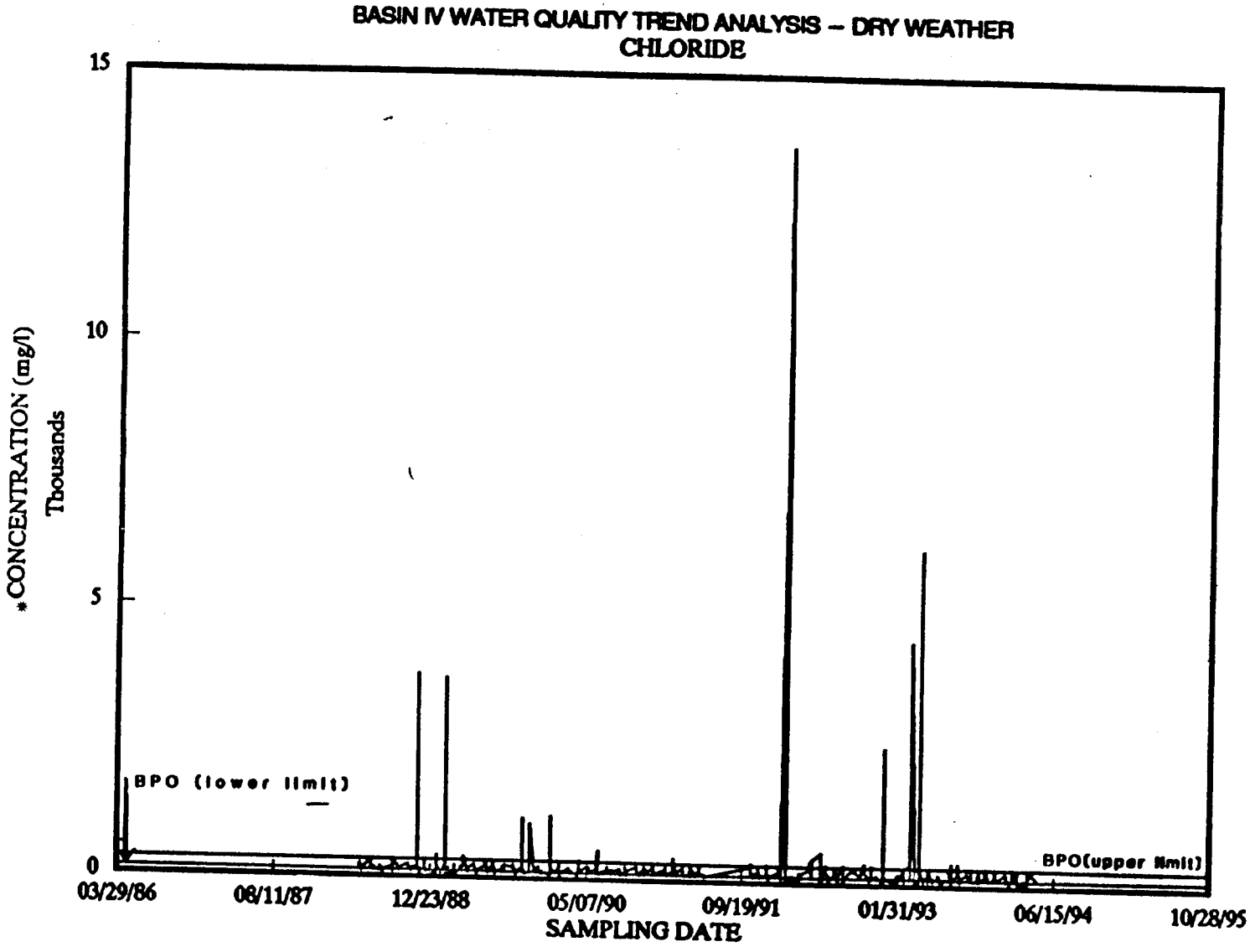
R0061154



R0061155

5363 VOL 75

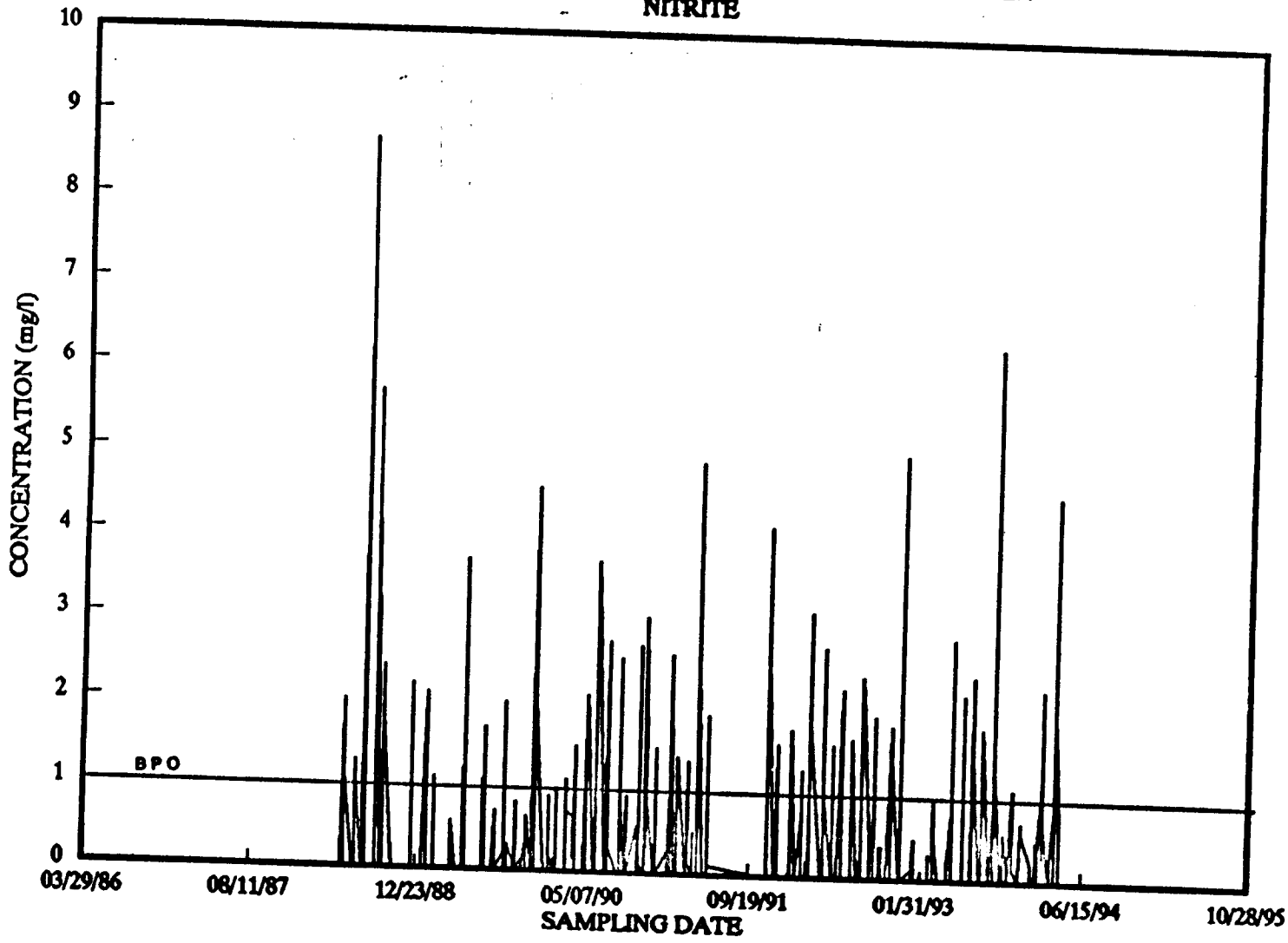
BASIN IV WATER QUALITY TREND ANALYSIS – DRY WEATHER
CHLORIDE



R0061156

VOL 15

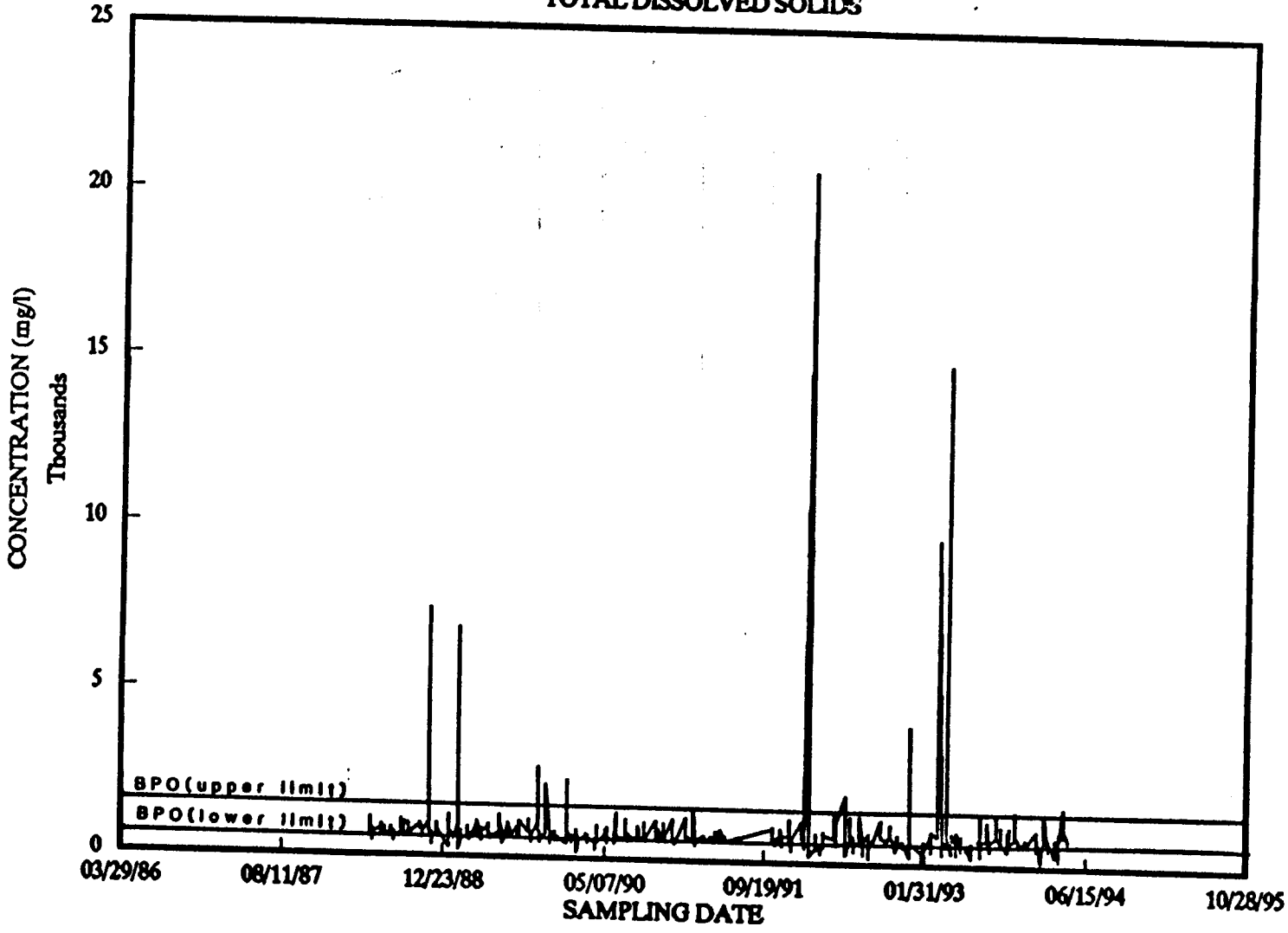
BASIN IV WATER QUALITY TREND ANALYSIS – DRY WEATHER
NITRITE



R0061157

VOL 15

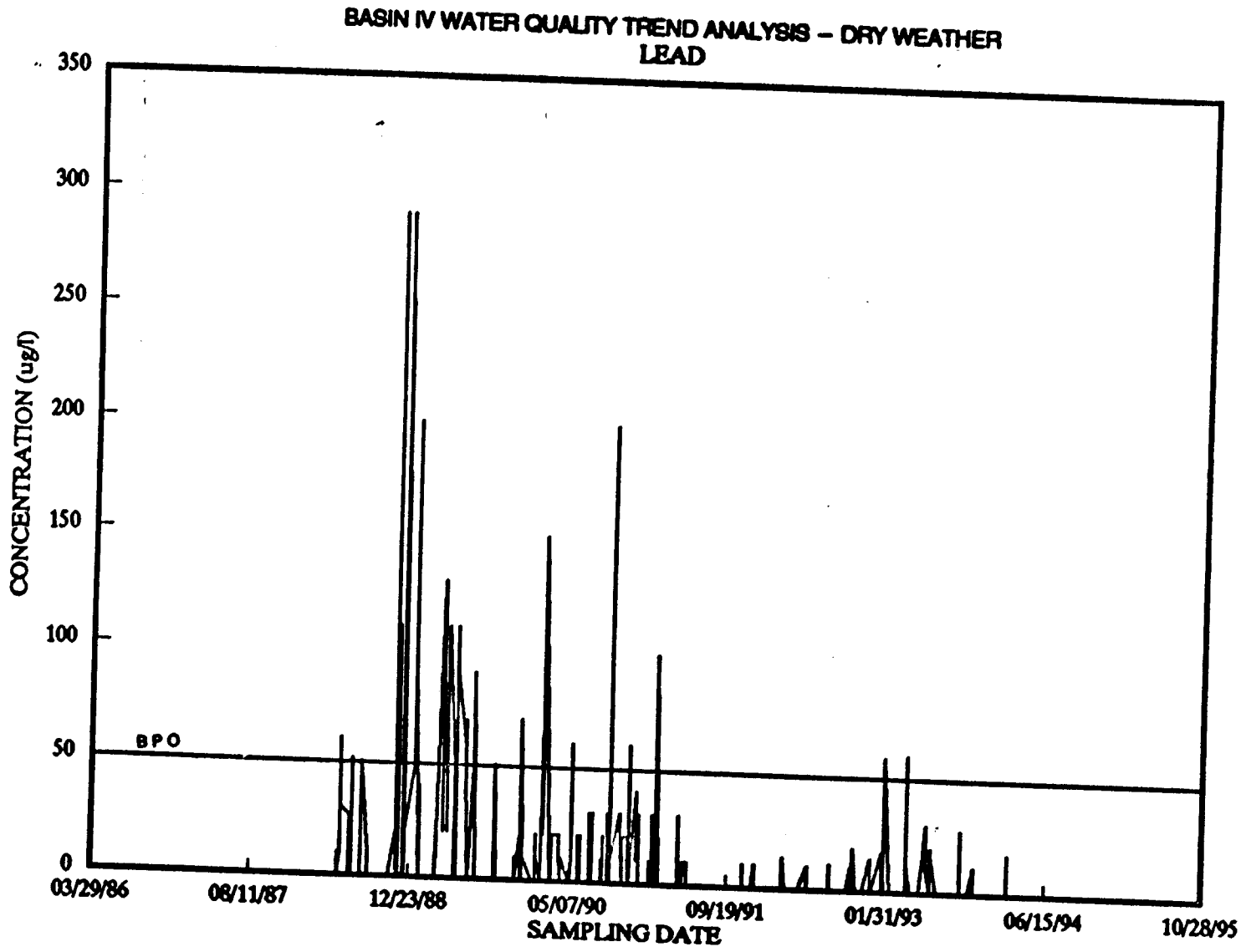
BASIN IV WATER QUALITY TREND ANALYSIS – DRY WEATHER
TOTAL DISSOLVED SOLIDS



R0061158

VOL 15

BASIN IV WATER QUALITY TREND ANALYSIS – DRY WEATHER
LEAD

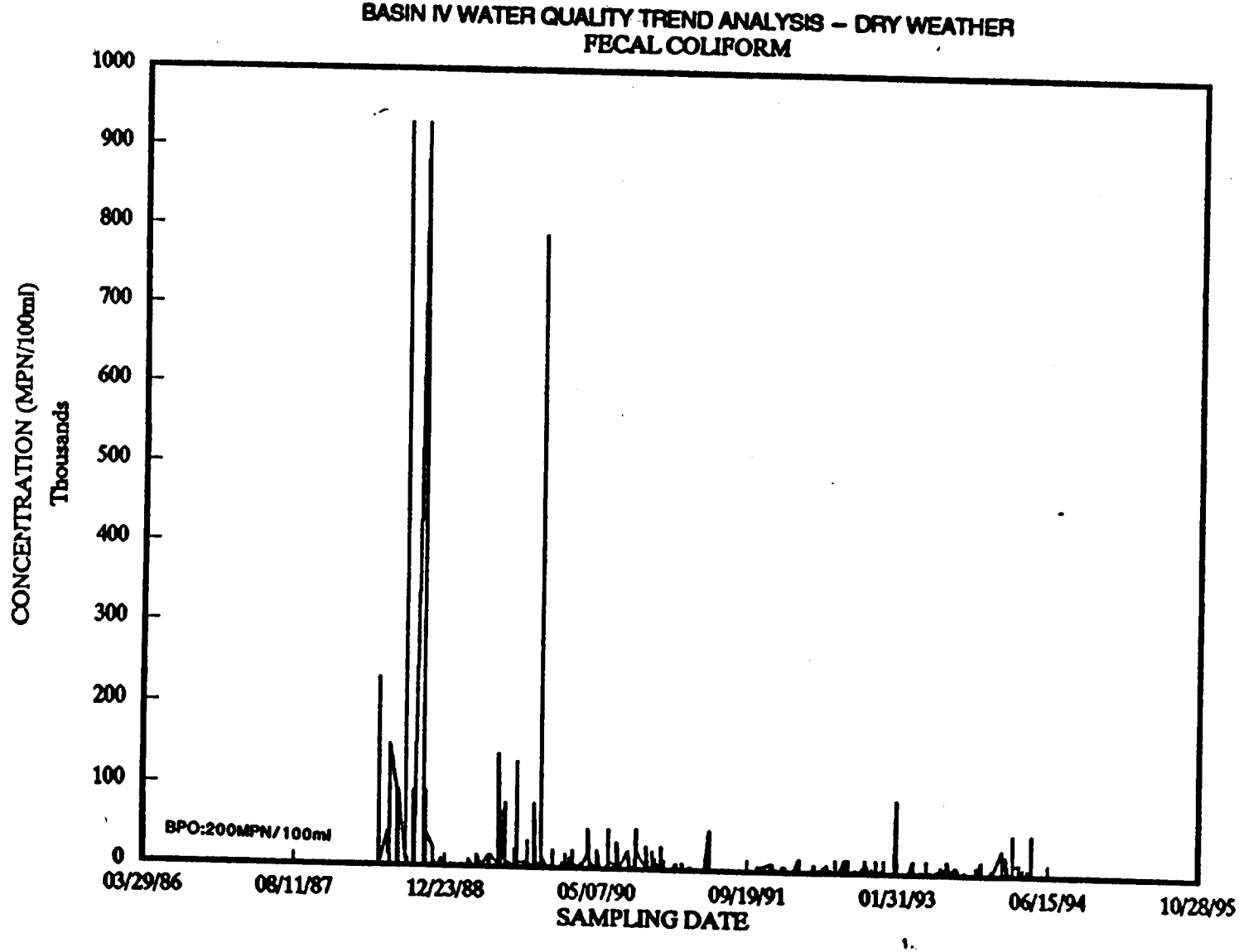


R0061159

VOL 15

0939

BASIN IV WATER QUALITY TREND ANALYSIS – DRY WEATHER
FECAL COLIFORM

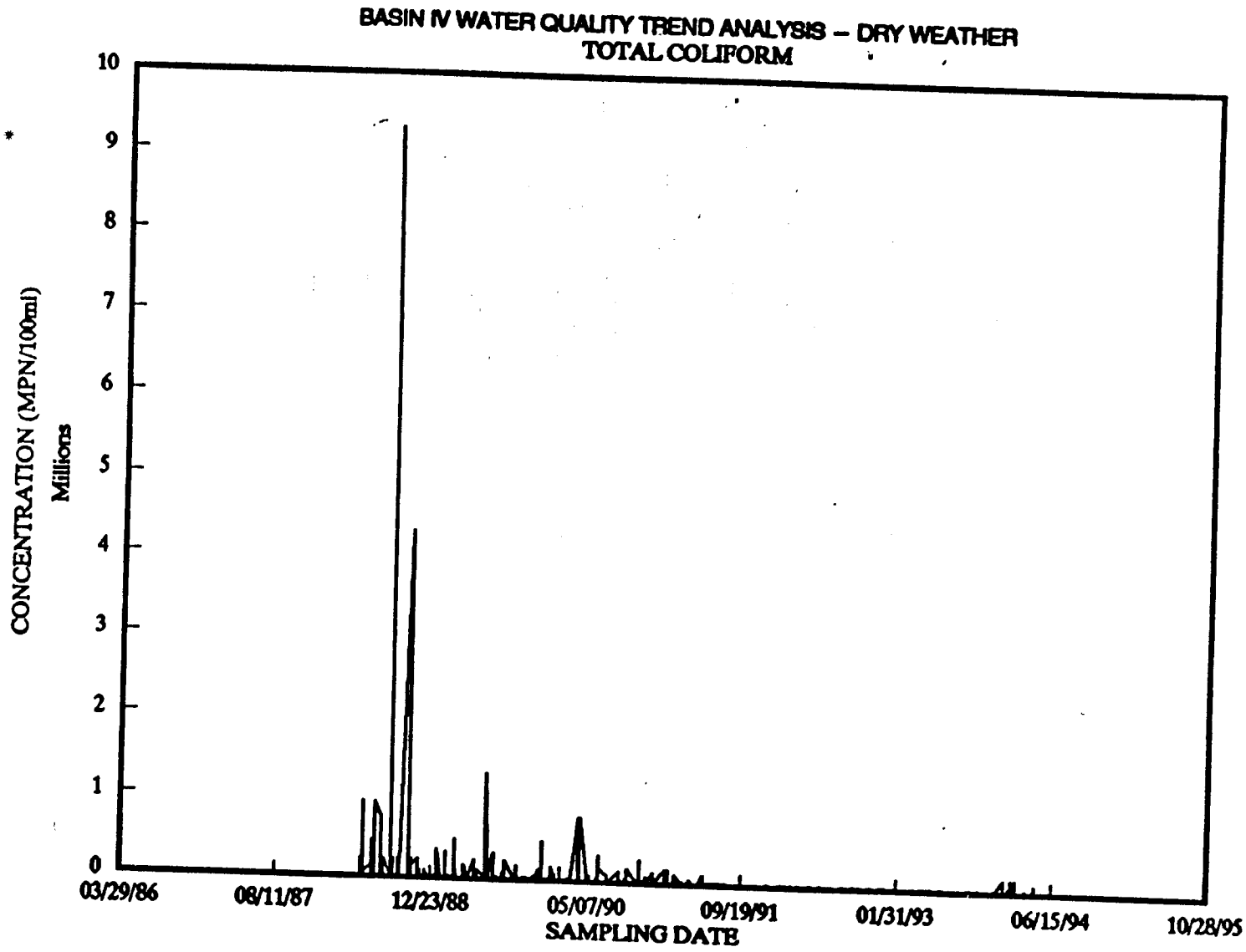


R0061160

VOL 15

0940

BASIN IV WATER QUALITY TREND ANALYSIS – DRY WEATHER
TOTAL COLIFORM

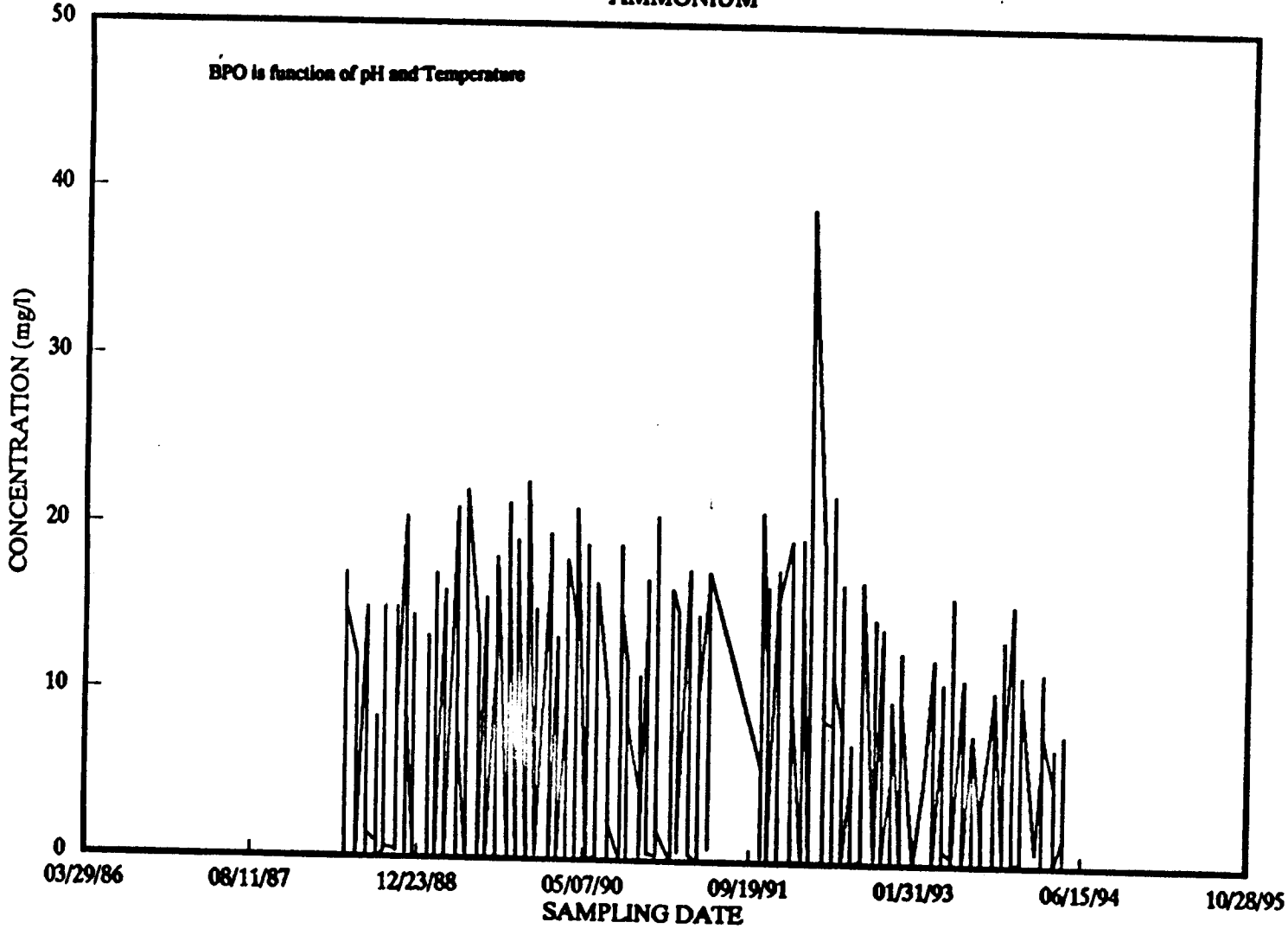


R0061161

VOL 15

094

BASIN V SOUTH WATER QUALITY TREND ANALYSIS – DRY WEATHER
AMMONIUM

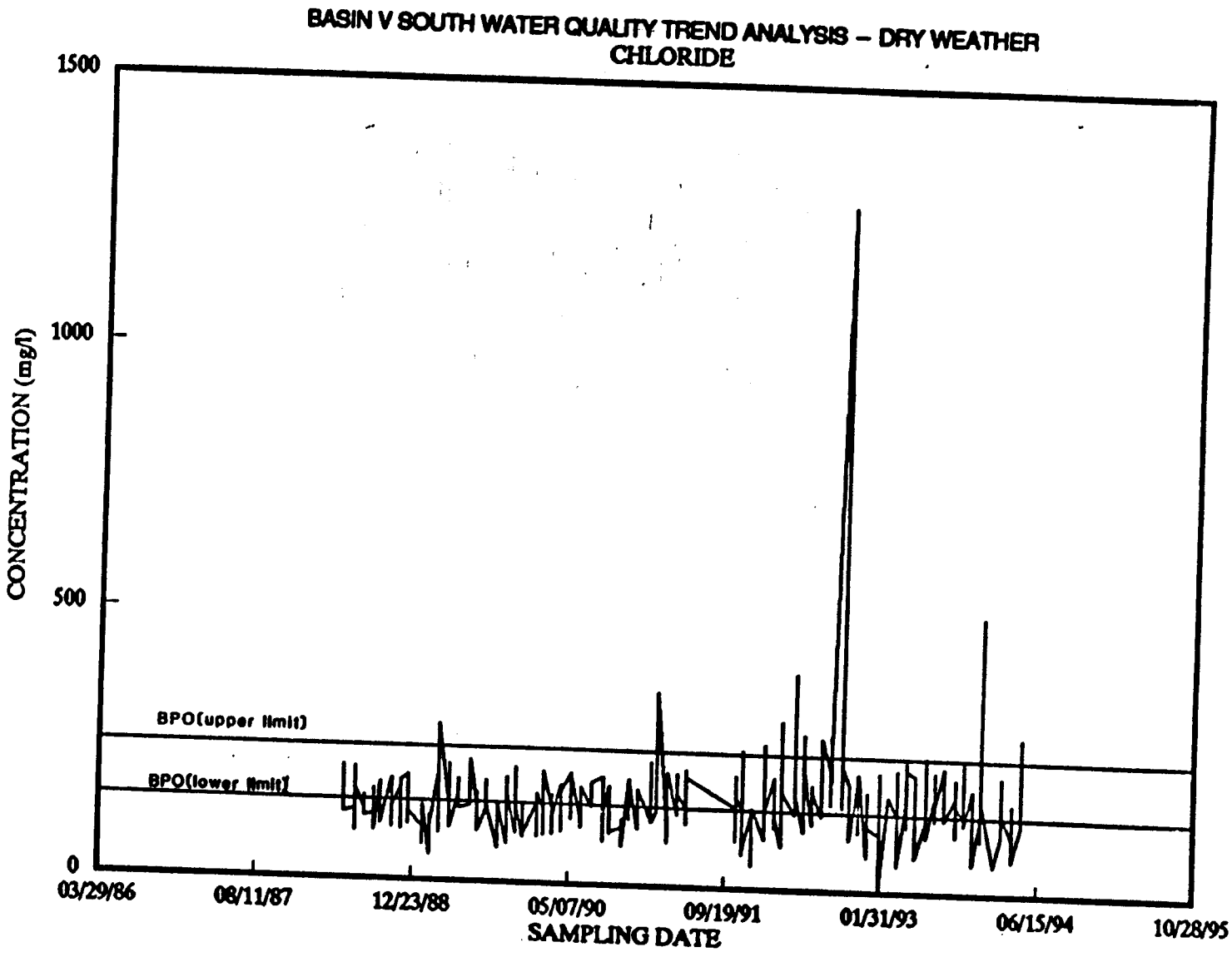


R0061162

VOL 15

0942

BASIN V SOUTH WATER QUALITY TREND ANALYSIS – DRY WEATHER
CHLORIDE

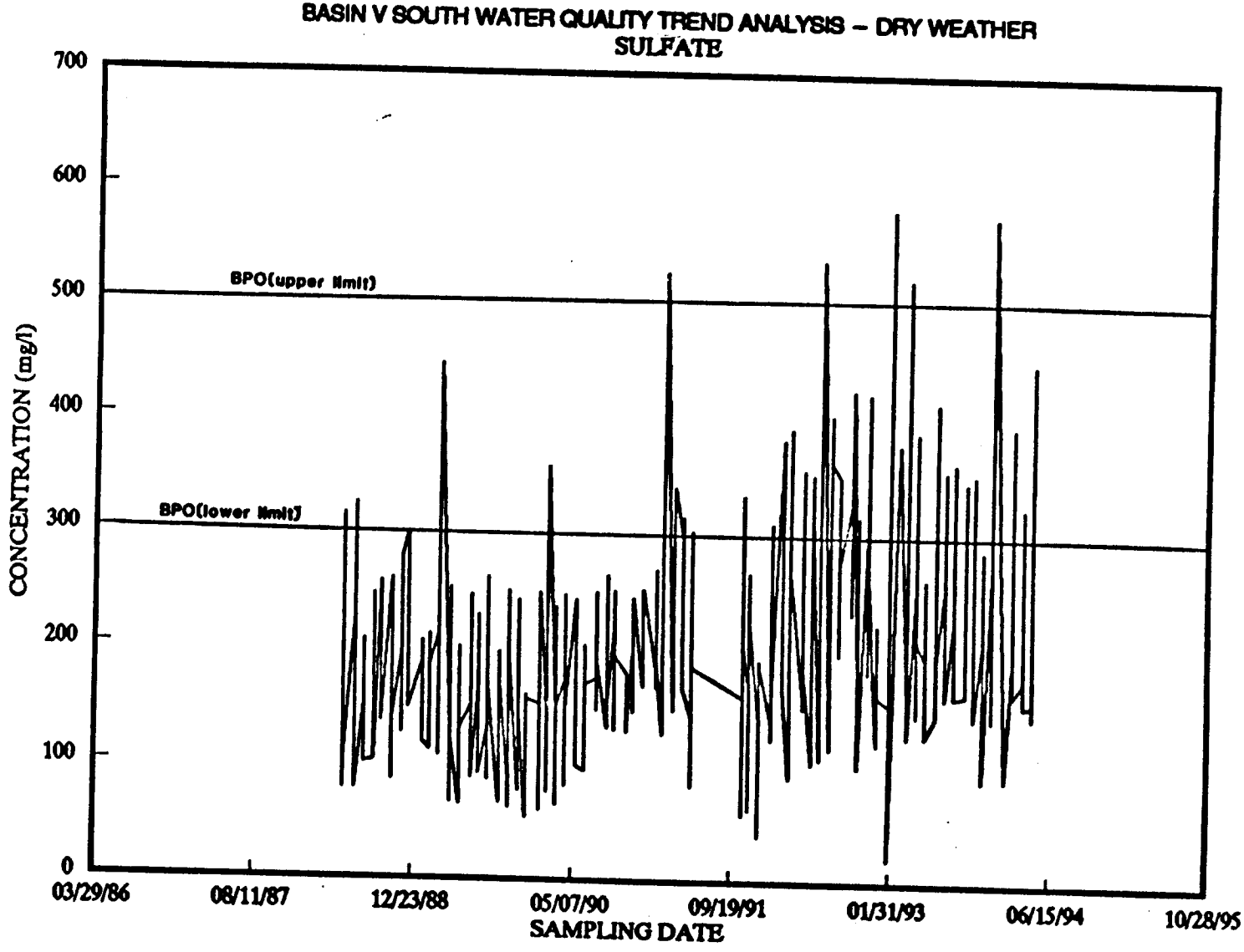


R0061163

VOL 15

0943

BASIN V SOUTH WATER QUALITY TREND ANALYSIS – DRY WEATHER
SULFATE

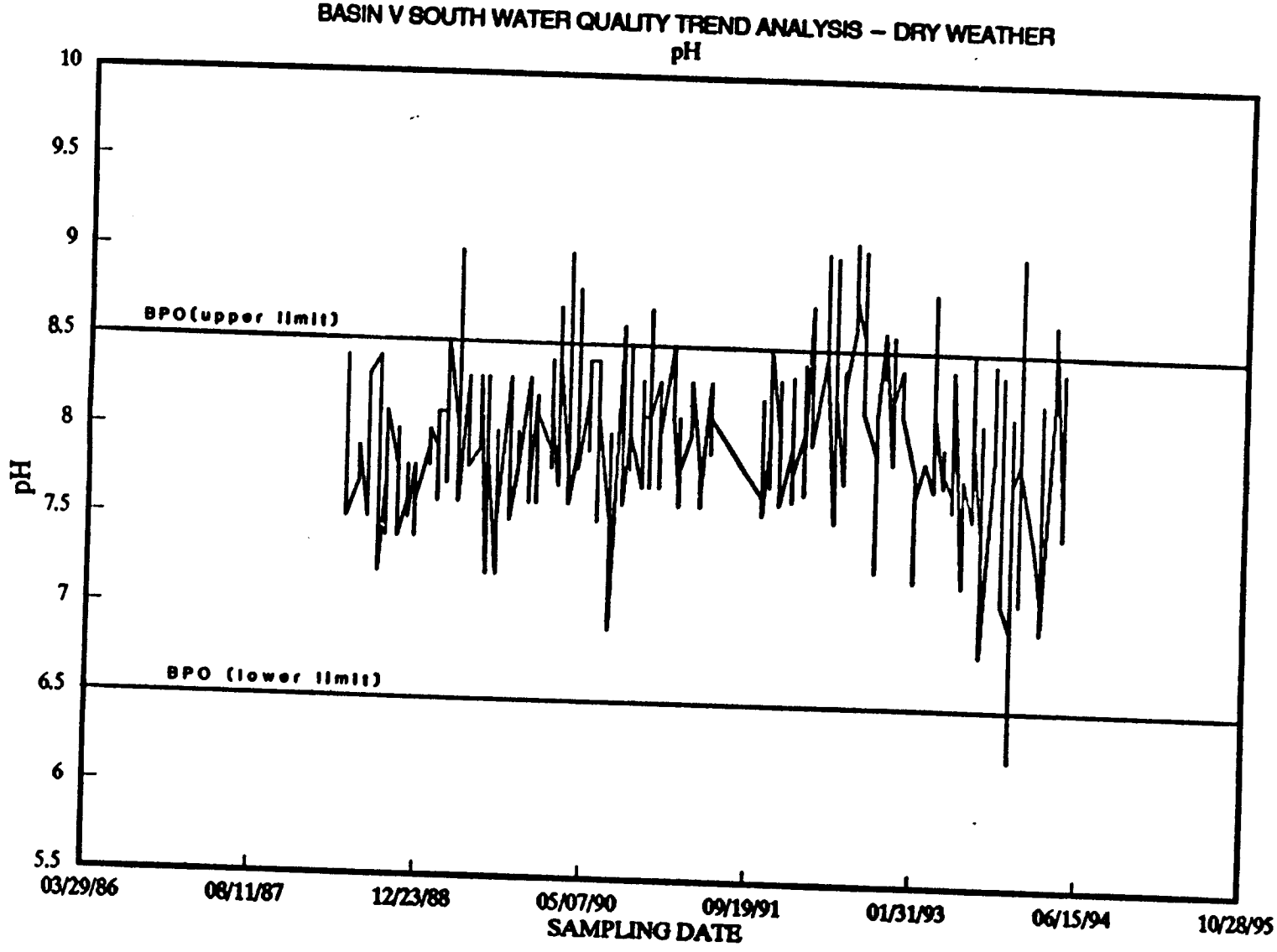


R0061164

0944

VOL 15

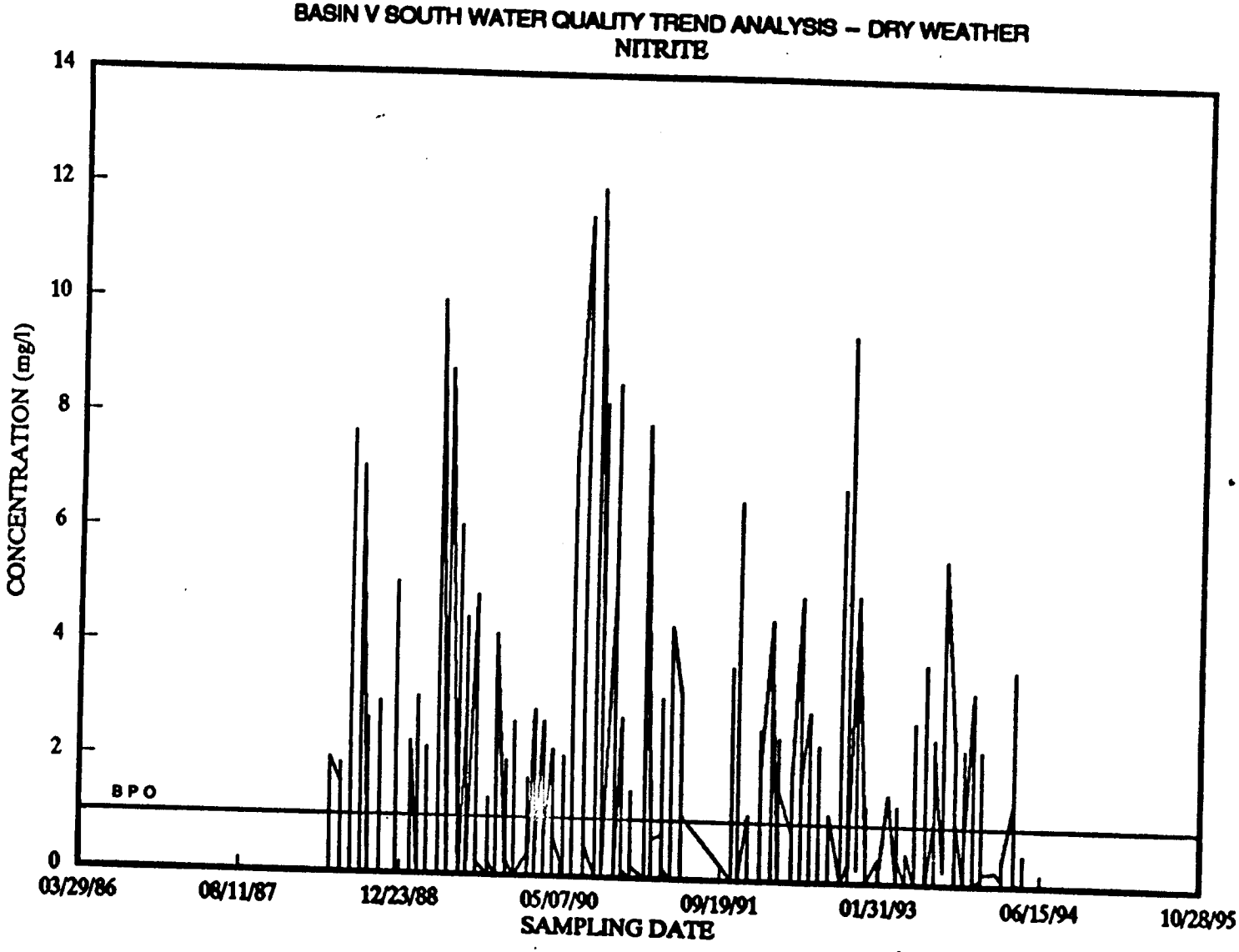
BASIN V SOUTH WATER QUALITY TREND ANALYSIS – DRY WEATHER



R0061165

0945

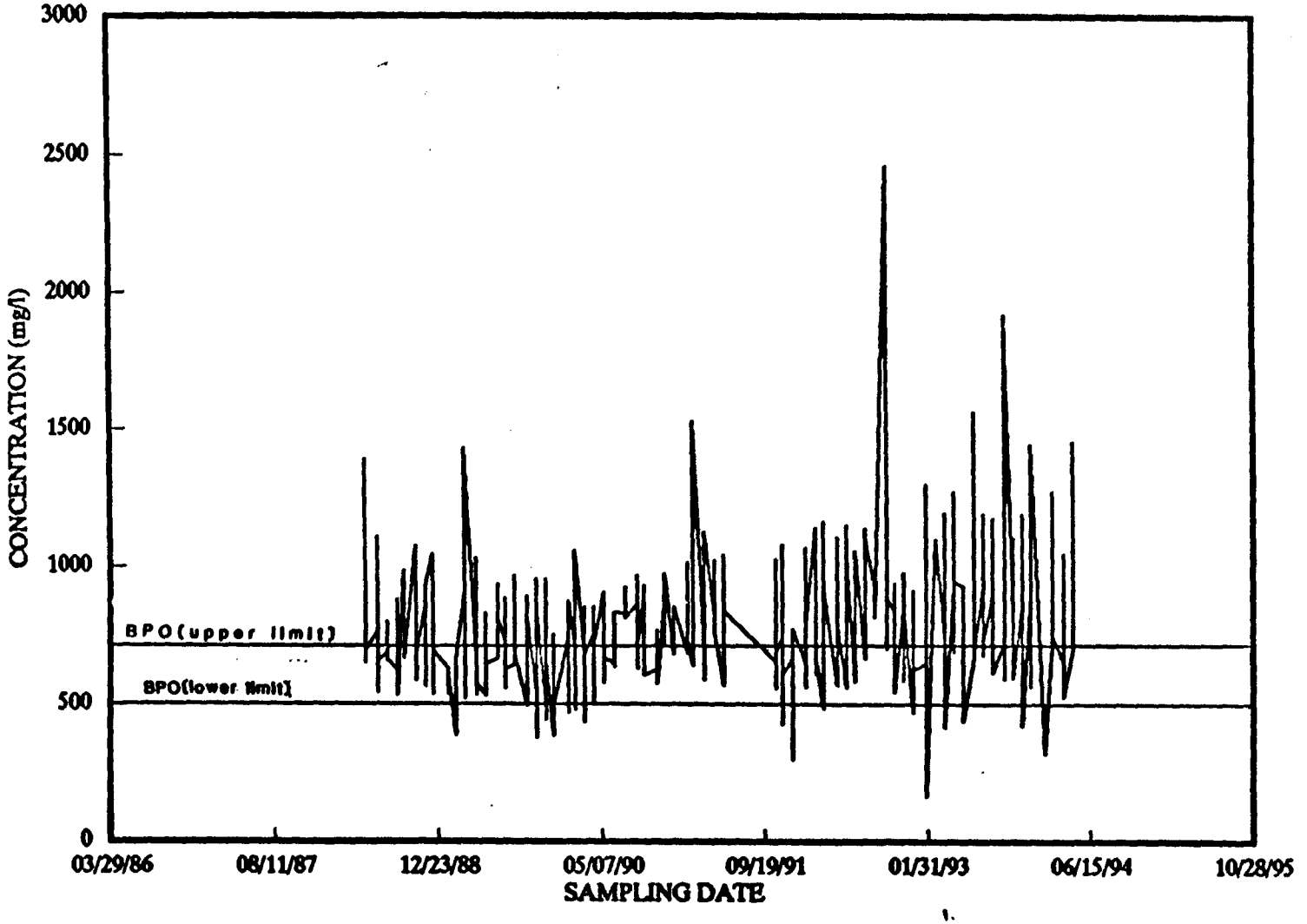
VOL 15



R0061166

5763 VOL 75

BASIN V SOUTH WATER QUALITY TREND ANALYSIS – DRY WEATHER
TOTAL DISSOLVED SOLIDS

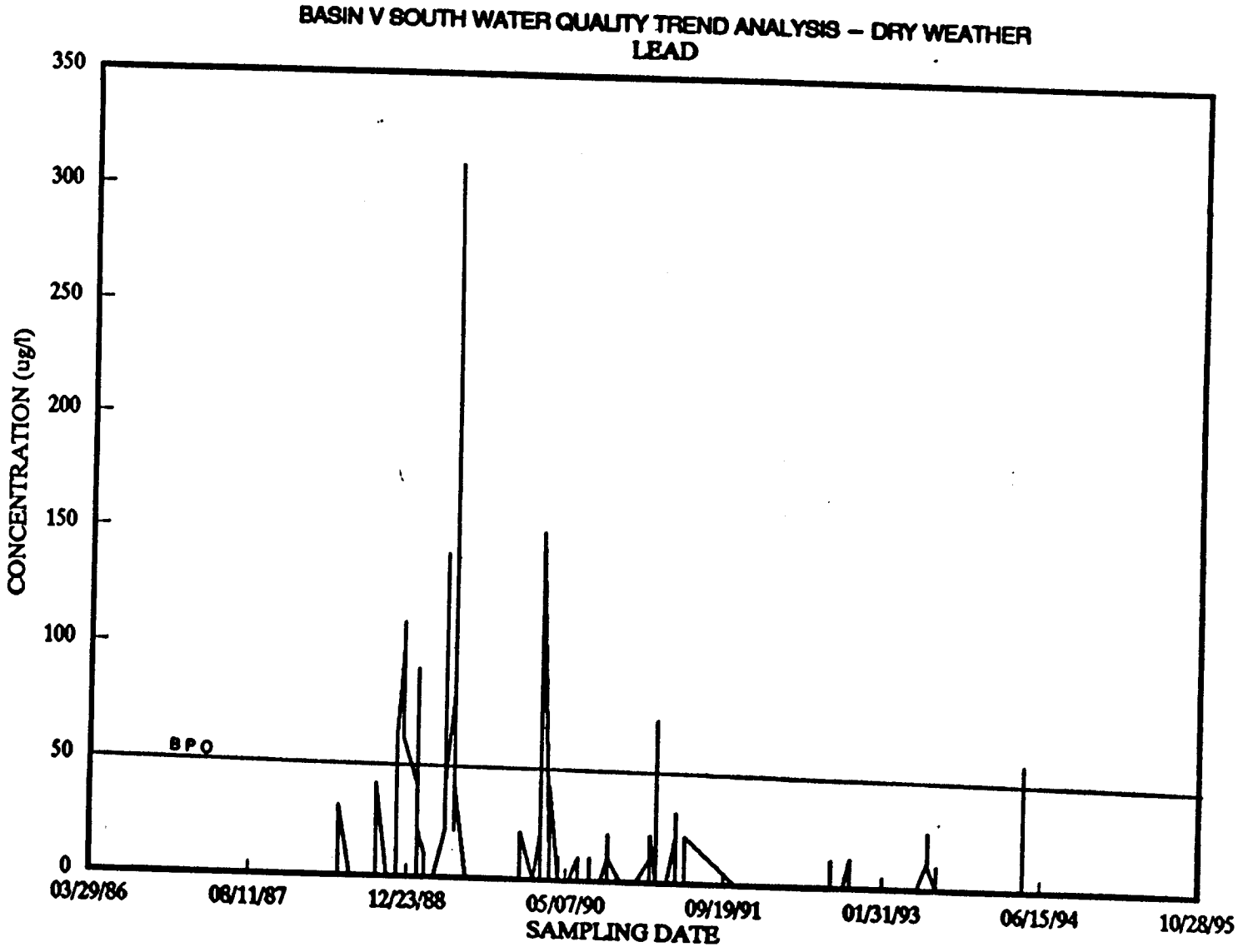


R0061167

VOL 15

0947

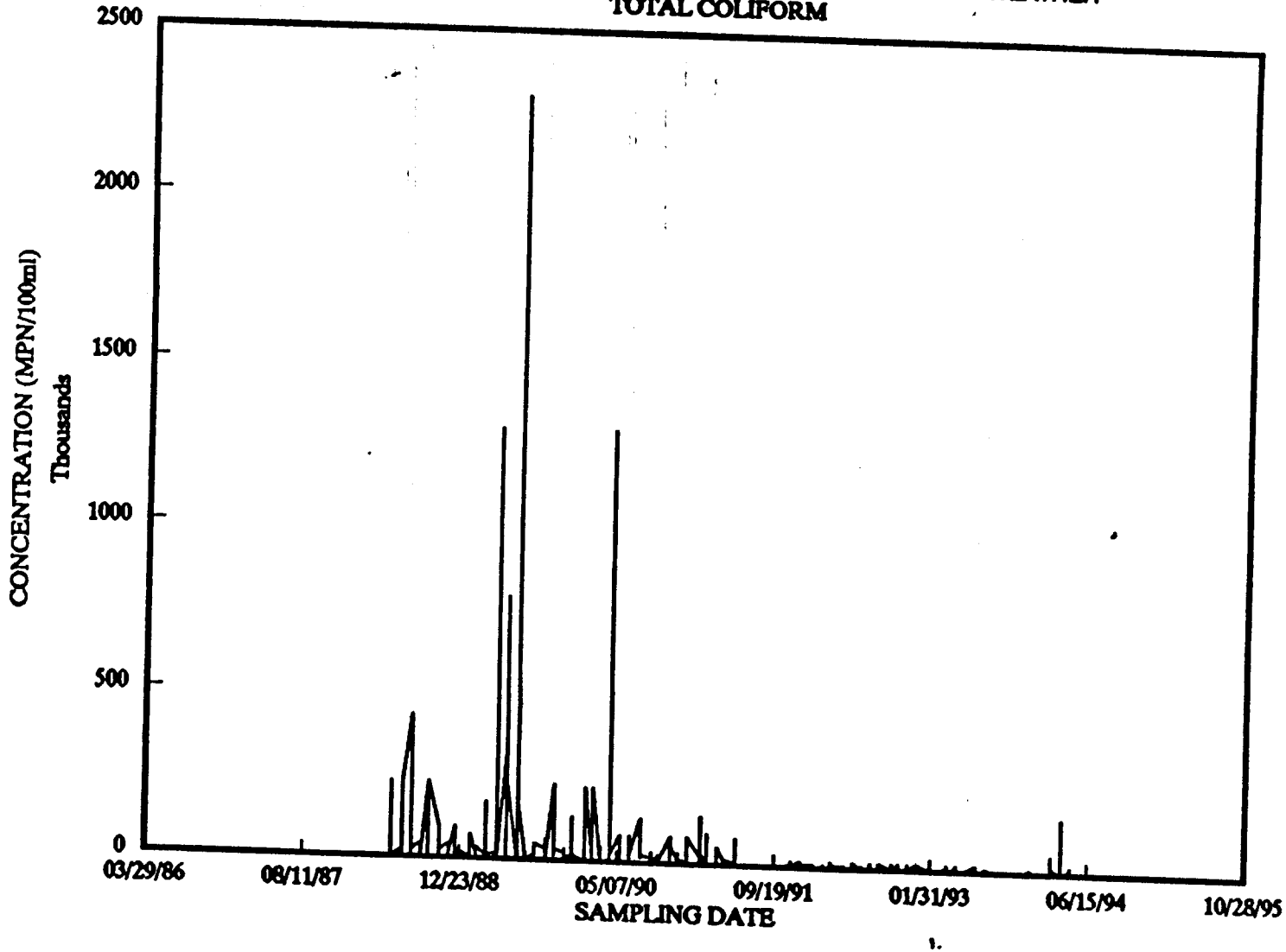
BASIN V SOUTH WATER QUALITY TREND ANALYSIS – DRY WEATHER
LEAD



R0061168

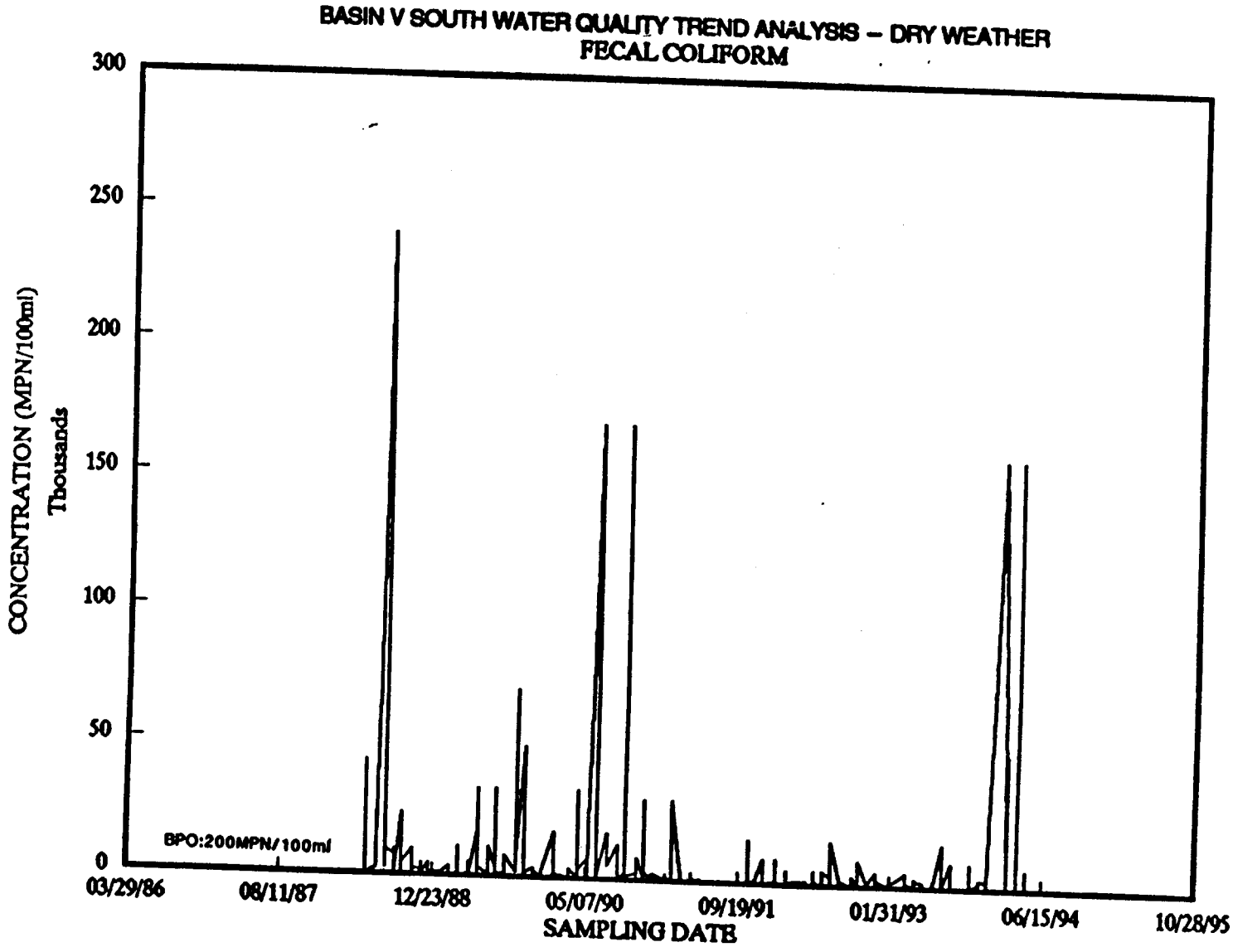
C948

VOL 15



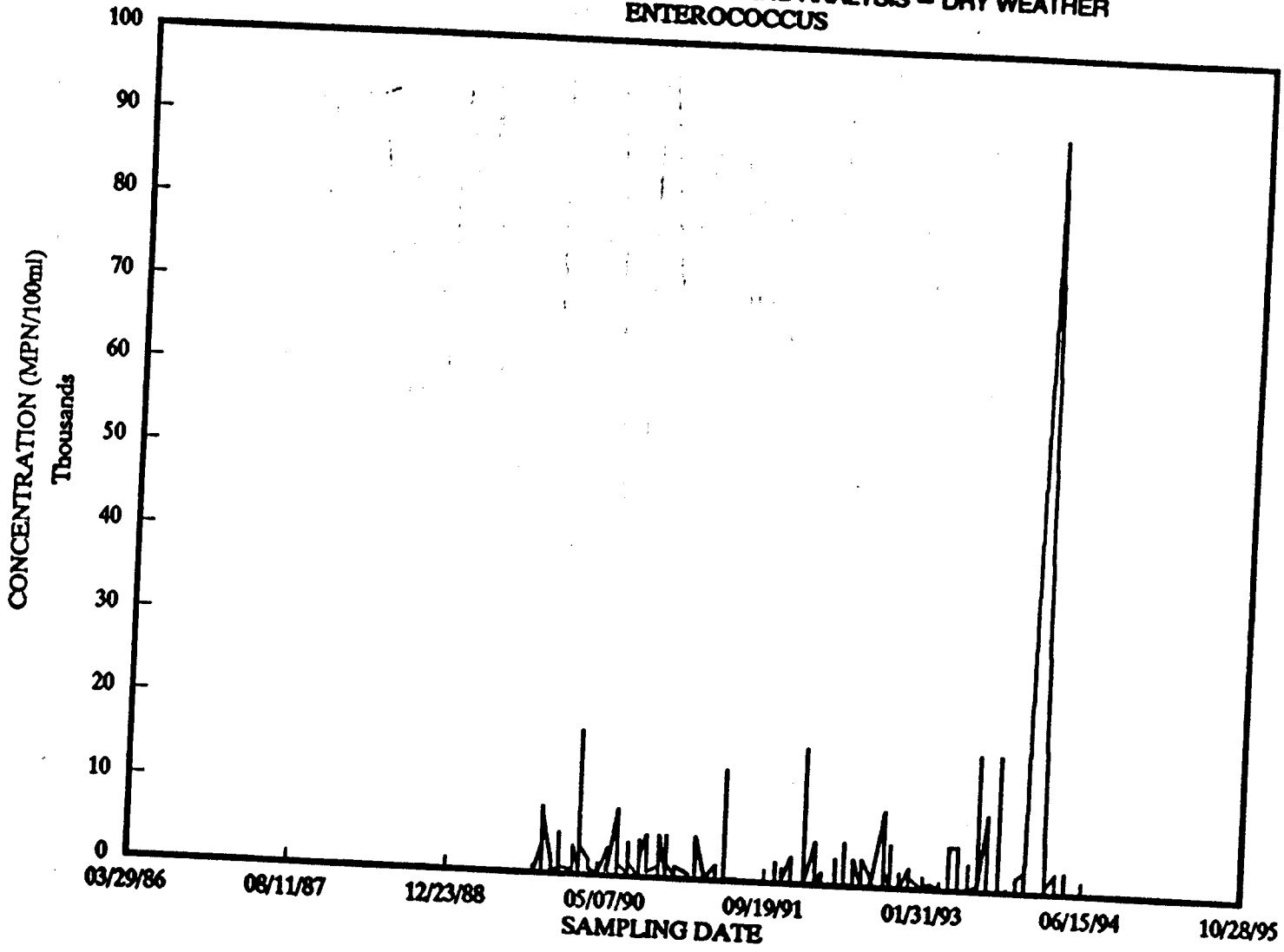
R0061169

C0979
VOL 75


BASIN V SOUTH WATER QUALITY TREND ANALYSIS – DRY WEATHER
FECAL COLIFORM
CONCENTRATION (MPN/100ml)
Thousands
300
250
200
150
100
50
0
BPO:200MPN/100ml
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061170

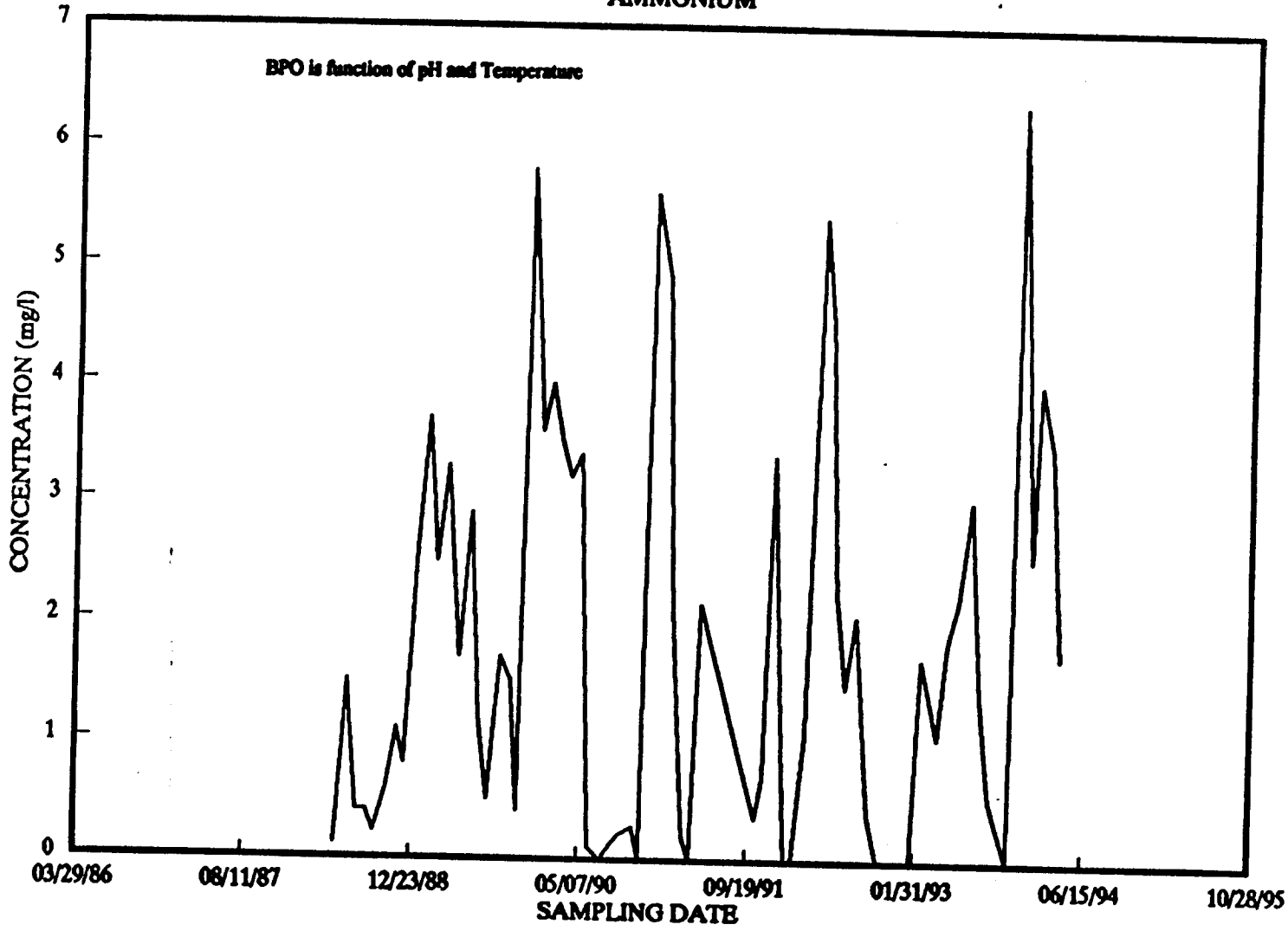
BASIN V SOUTH WATER QUALITY TREND ANALYSIS – DRY WEATHER
ENTEROCOCCUS



R0061171

VOL 15

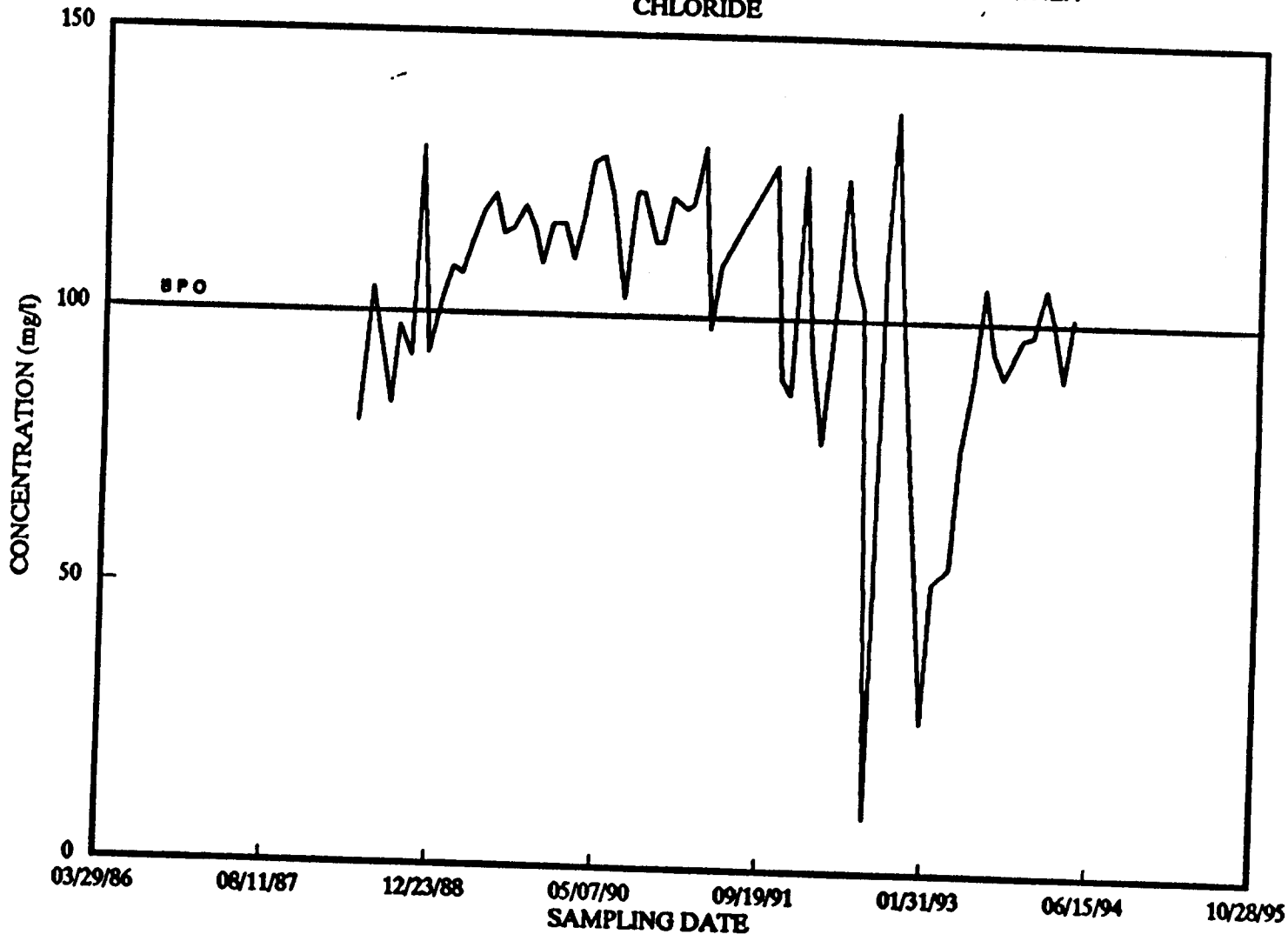
BASIN V NORTH WATER QUALITY TREND ANALYSIS – DRY WEATHER
AMMONIUM



R0061172

VOL 15

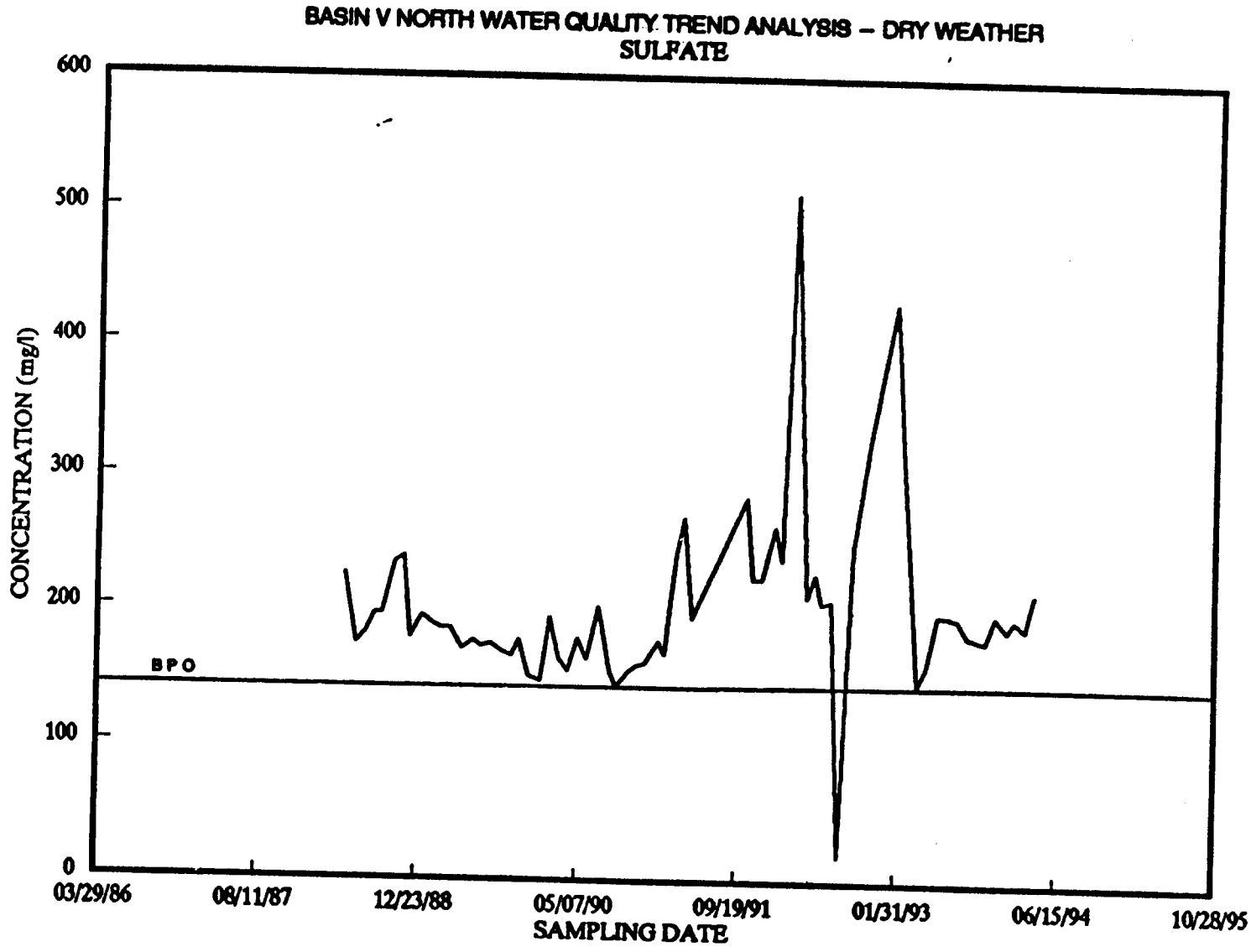
BASIN V NORTH WATER QUALITY TREND ANALYSIS – DRY WEATHER
CHLORIDE



R0061173

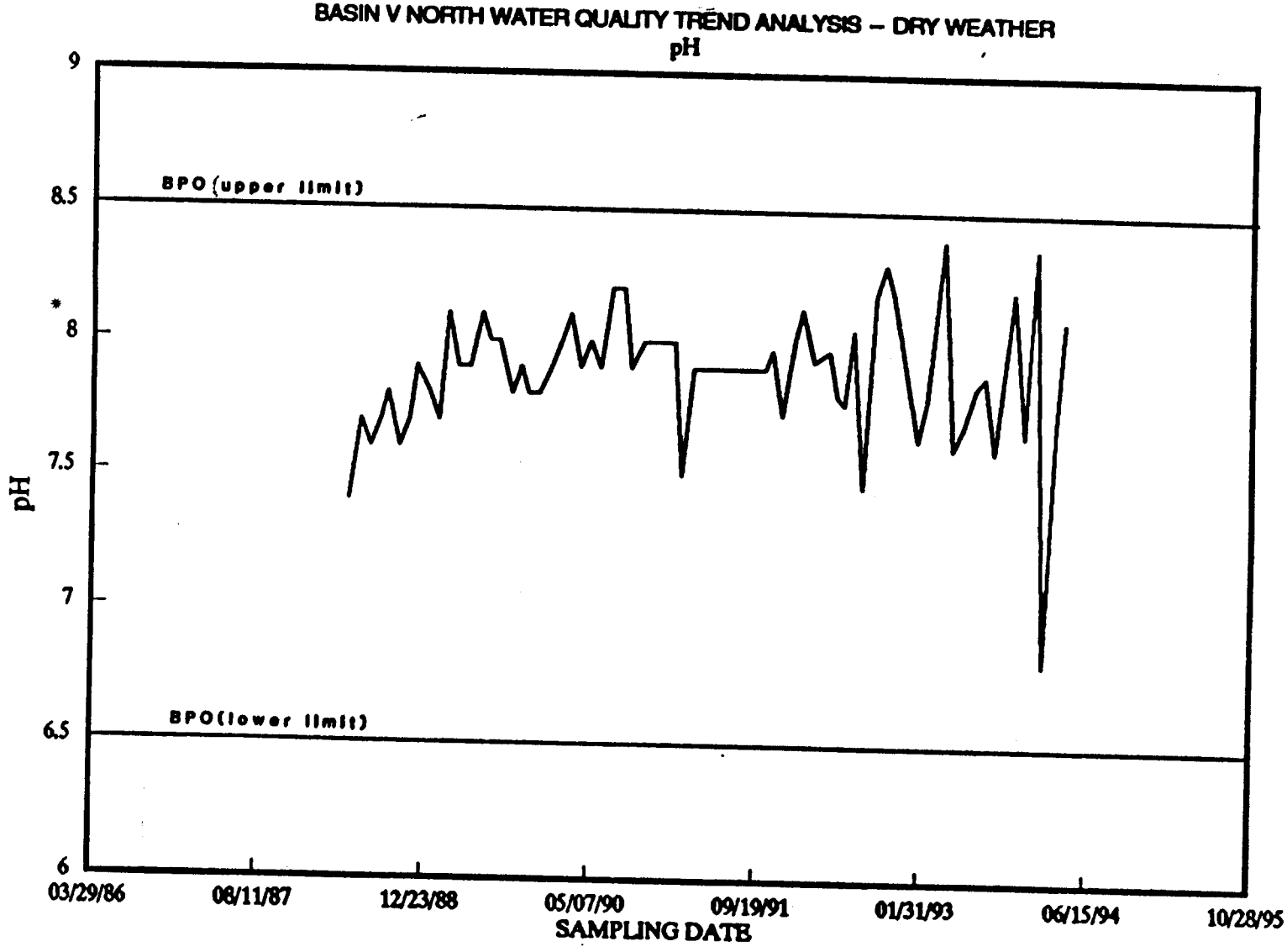
VOL 15

0953



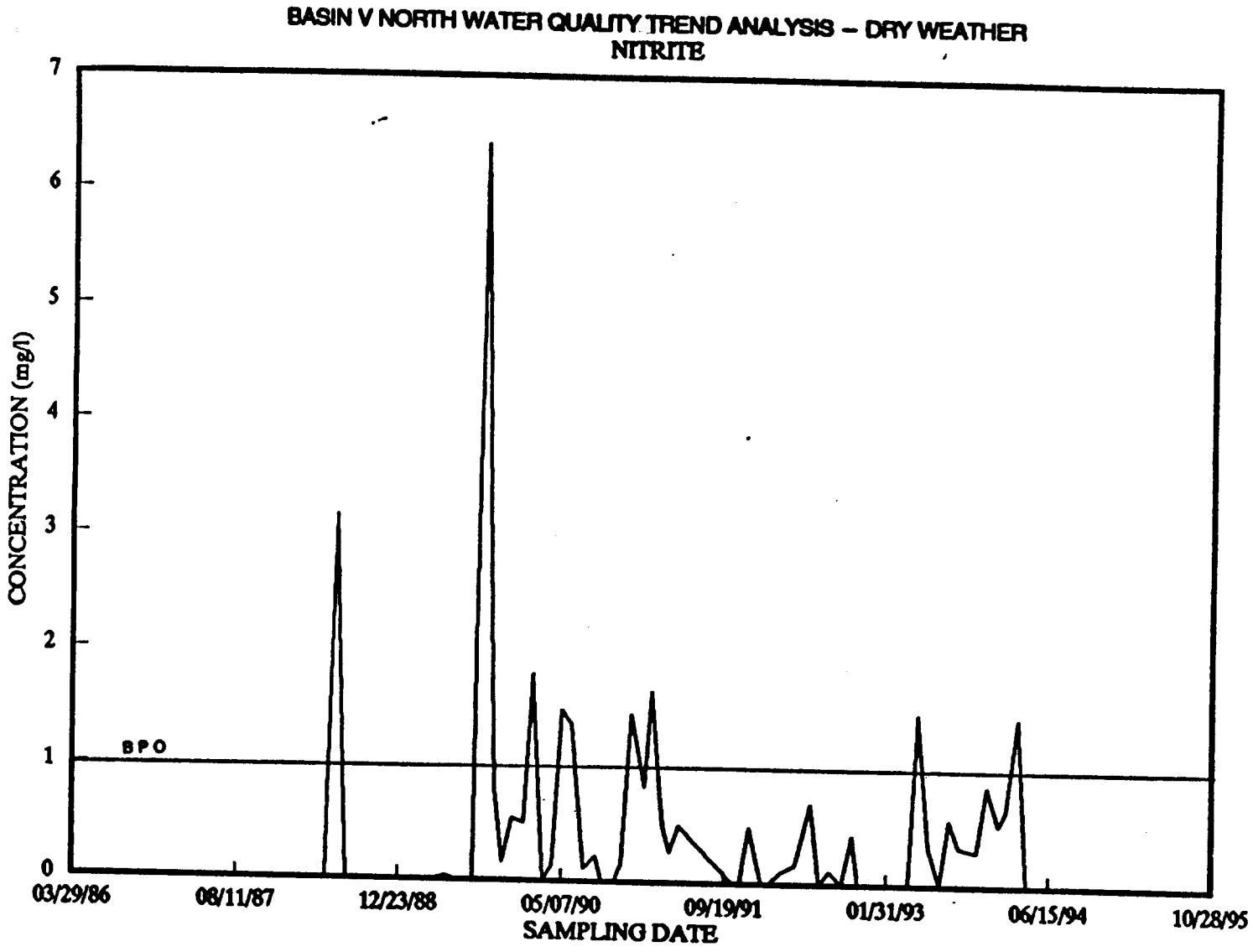
R0061174

45963
VOL 715


BASIN V NORTH WATER QUALITY TREND ANALYSIS – DRY WEATHER
pH
9
8.5
8
7.5
7
6.5
6
pH
BPO (upper limit)
BPO (lower limit)
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

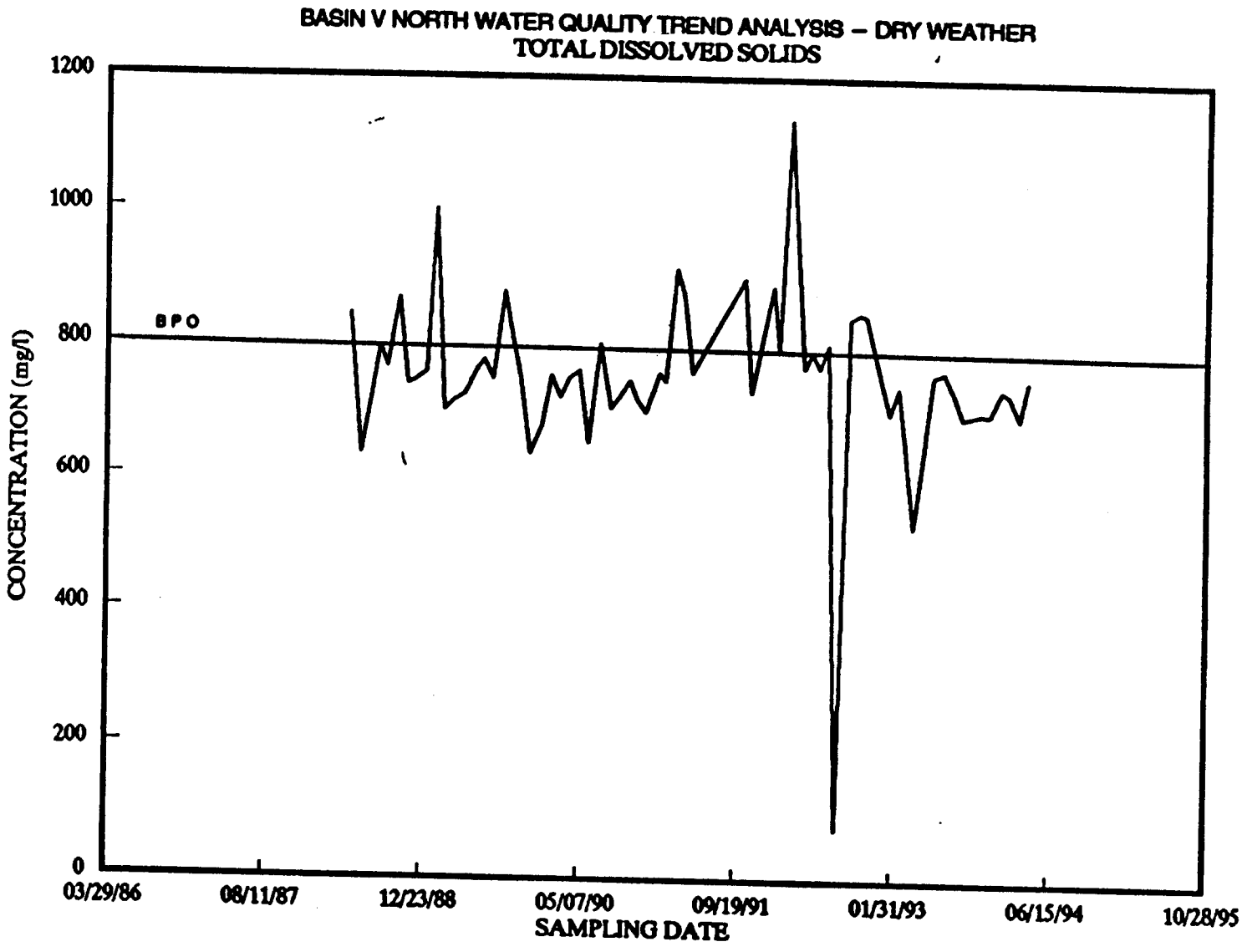
R0061175

BASIN V NORTH WATER QUALITY TREND ANALYSIS – DRY WEATHER
NITRITE



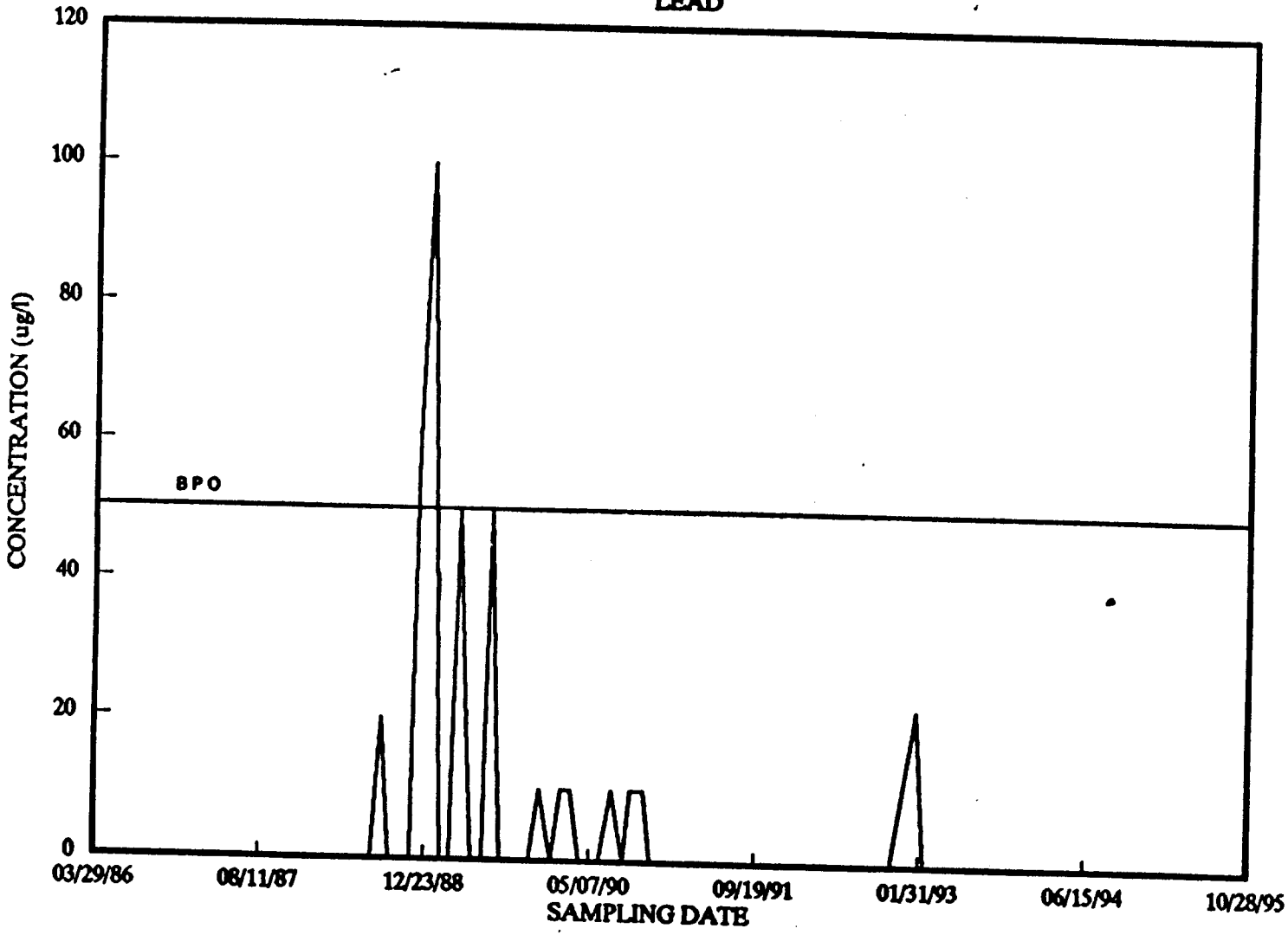
R0061176

VOL 15


BASIN V NORTH WATER QUALITY TREND ANALYSIS – DRY WEATHER
TOTAL DISSOLVED SOLIDS
1200
1000
800
600
400
200
0
BPO
CONCENTRATION (mg/l)
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061177

BASIN V NORTH WATER QUALITY TREND ANALYSIS – DRY WEATHER
LEAD

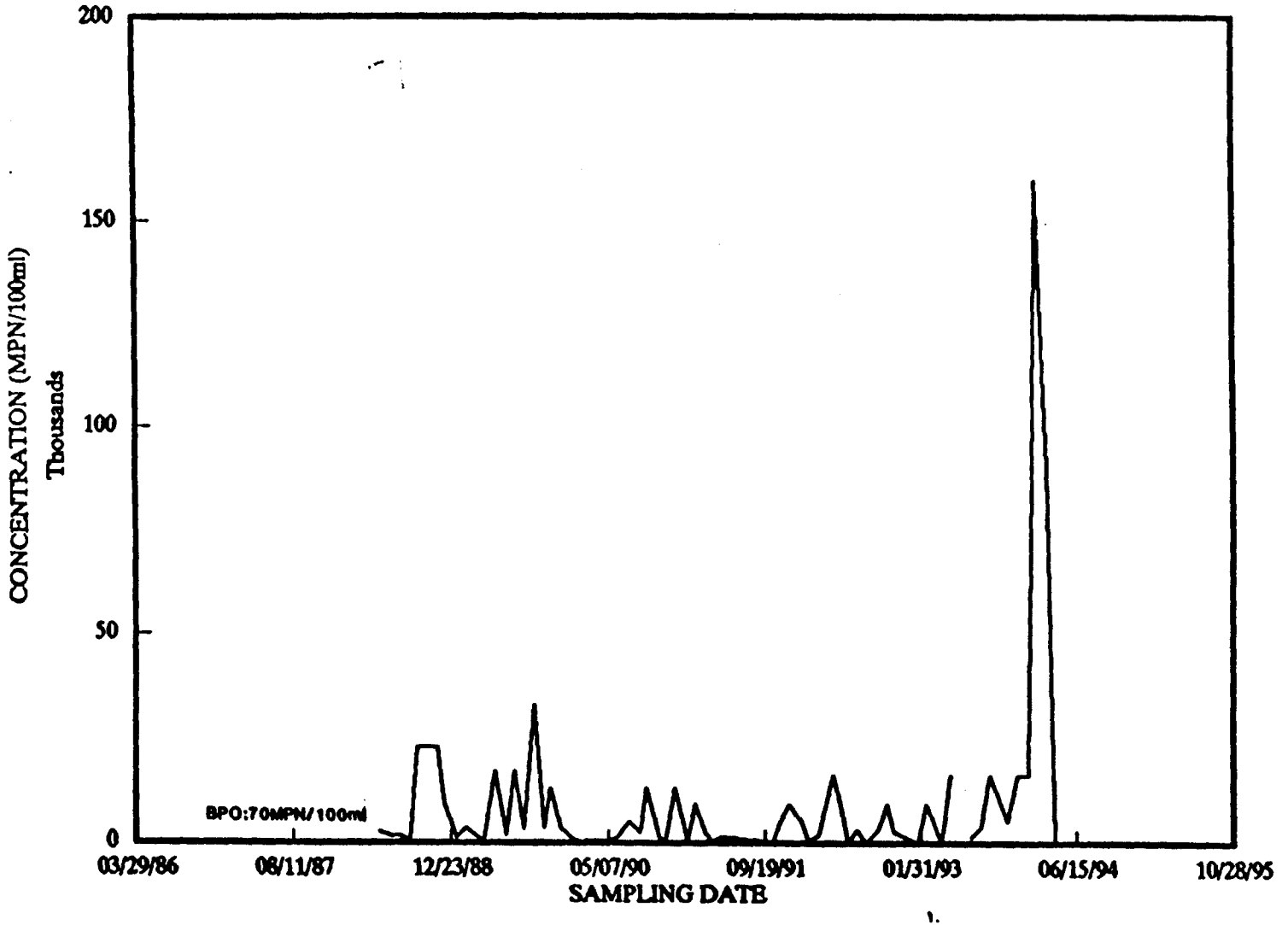


R0061178

VOL 15

0958

BASIN V NORTH WATER QUALITY TREND ANALYSIS – DRY WEATHER
TOTAL COLIFORM

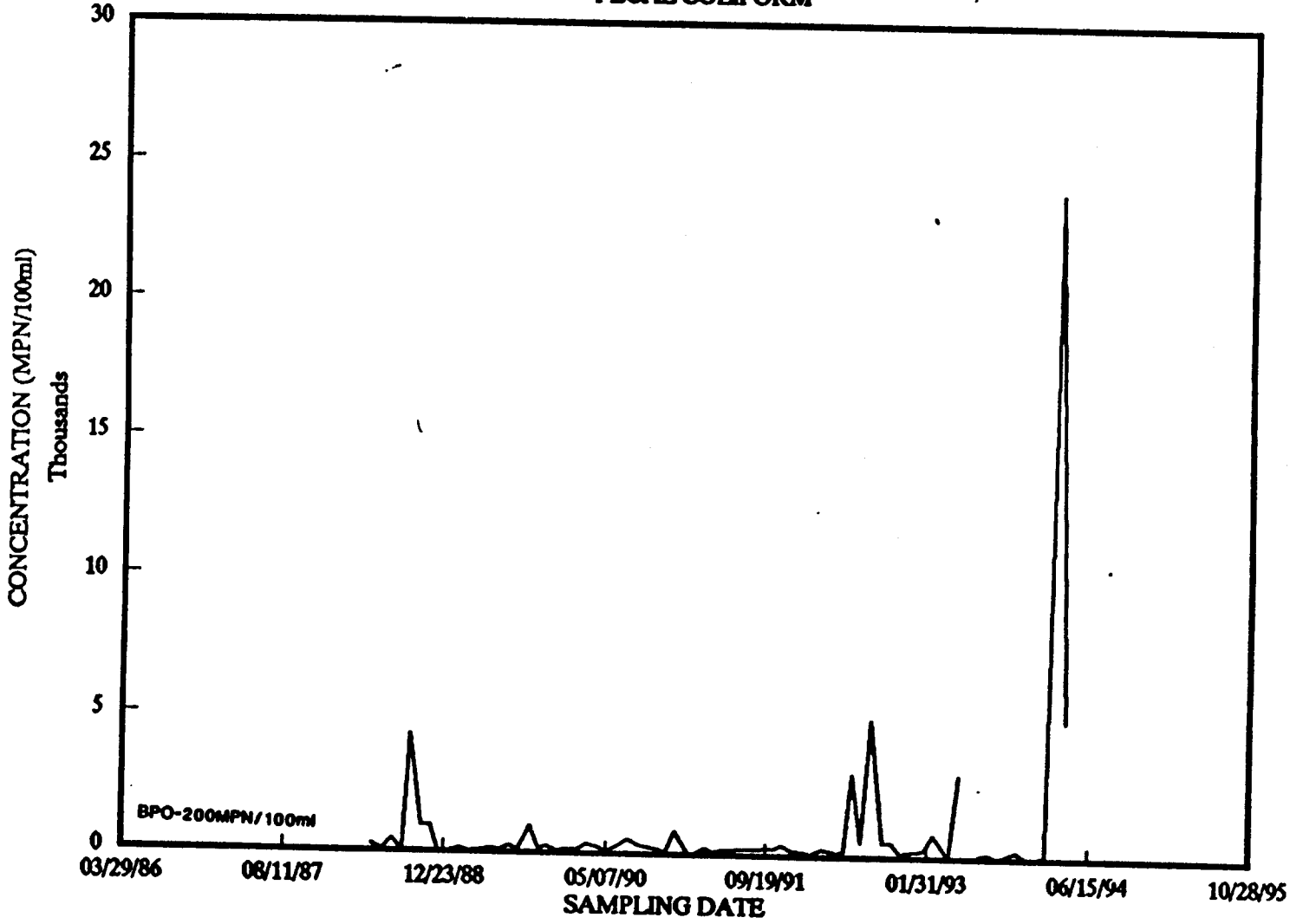


R0061179

0959

VOL 15

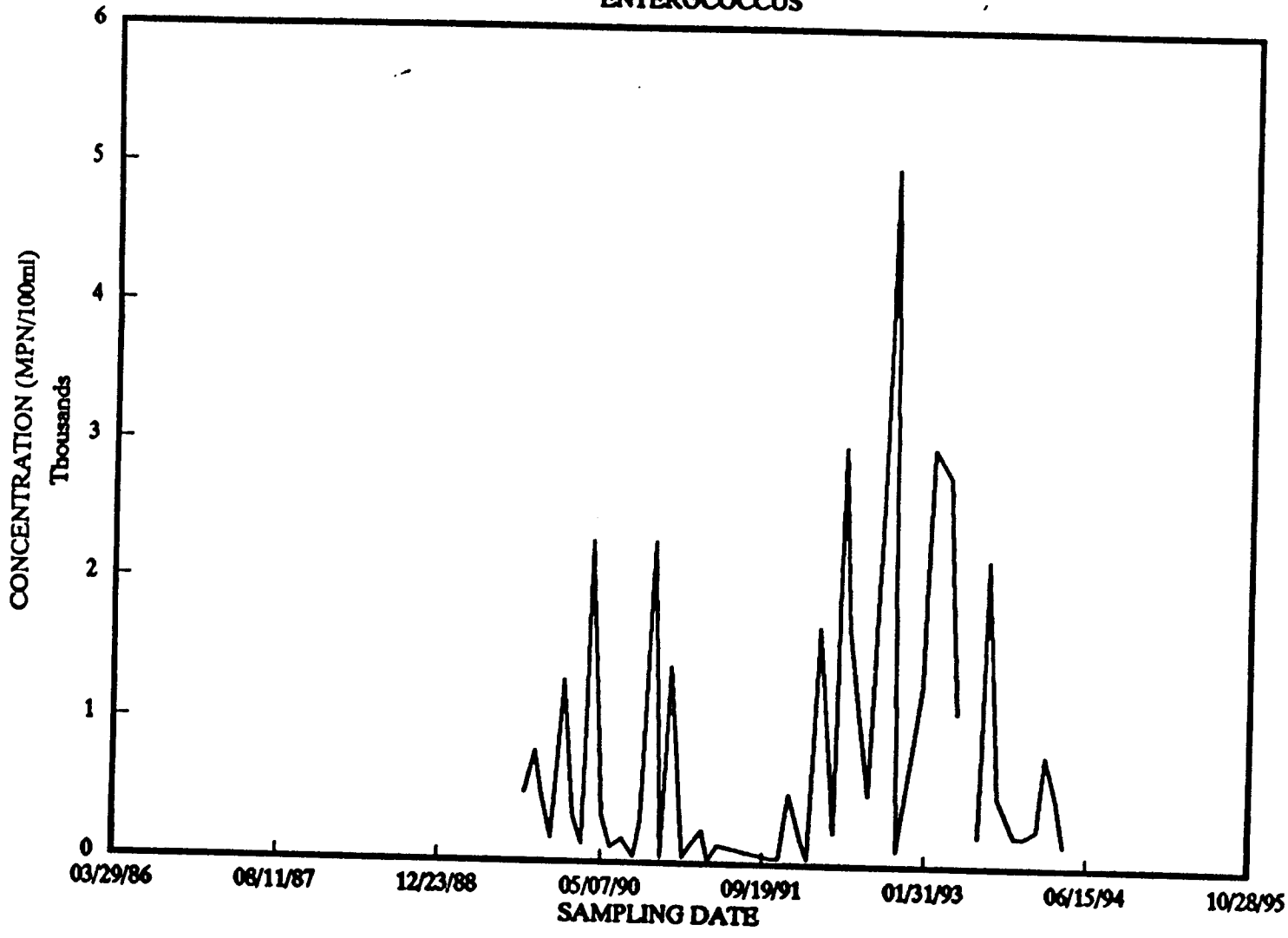
BASIN V NORTH WATER QUALITY TREND ANALYSIS – DRY WEATHER
FECAL COLIFORM



R0061180

VOL 15

BASIN V NORTH WATER QUALITY TREND ANALYSIS – DRY WEATHER
ENTEROCOCCUS



R0061181

VOL 15

STORM WEATHER

VOL 15
0962
R0061182

VOL 15

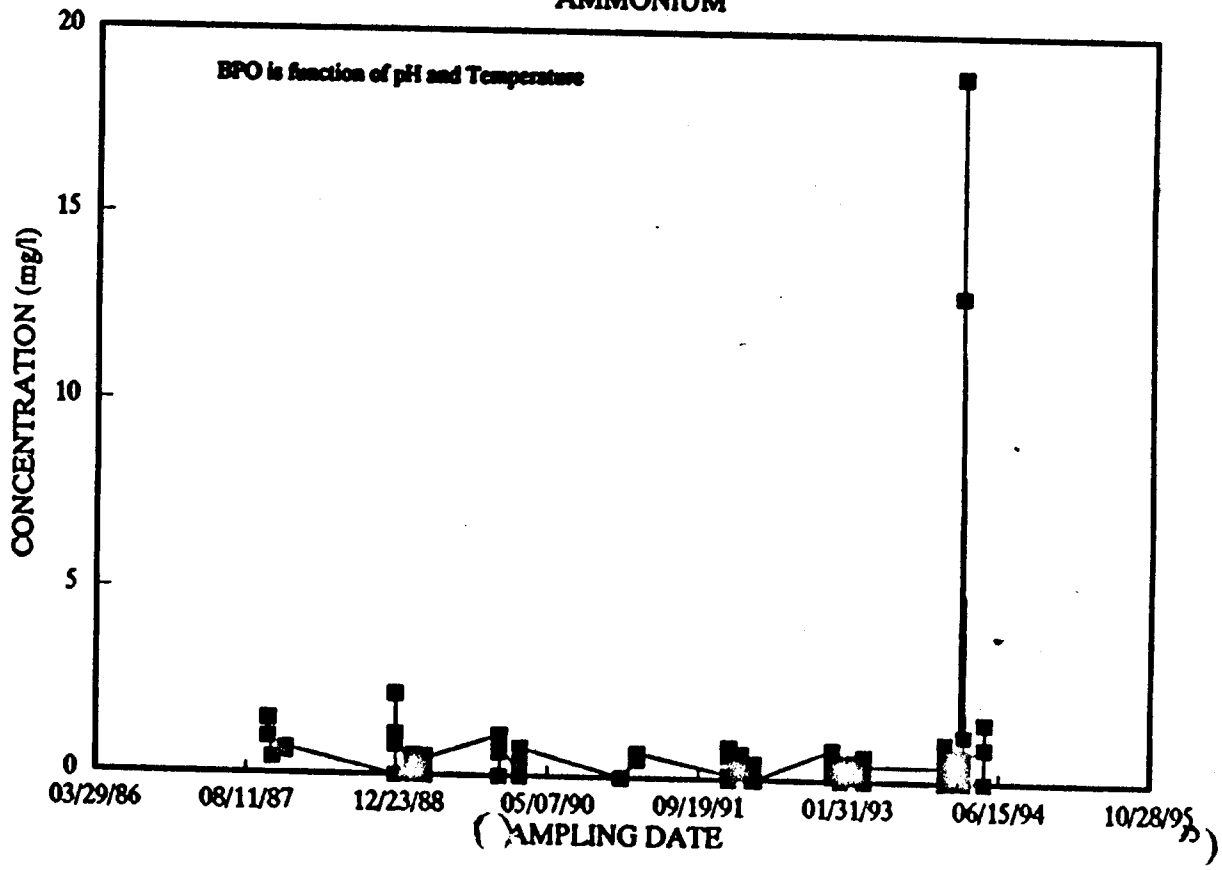
0963

GRAPH LEGEND

BPO: BASIN PLAN (DRAFT 1994) OBJECTIVE
OPO: OCEAN PLAN (1990) OBJECTIVE

R0061183

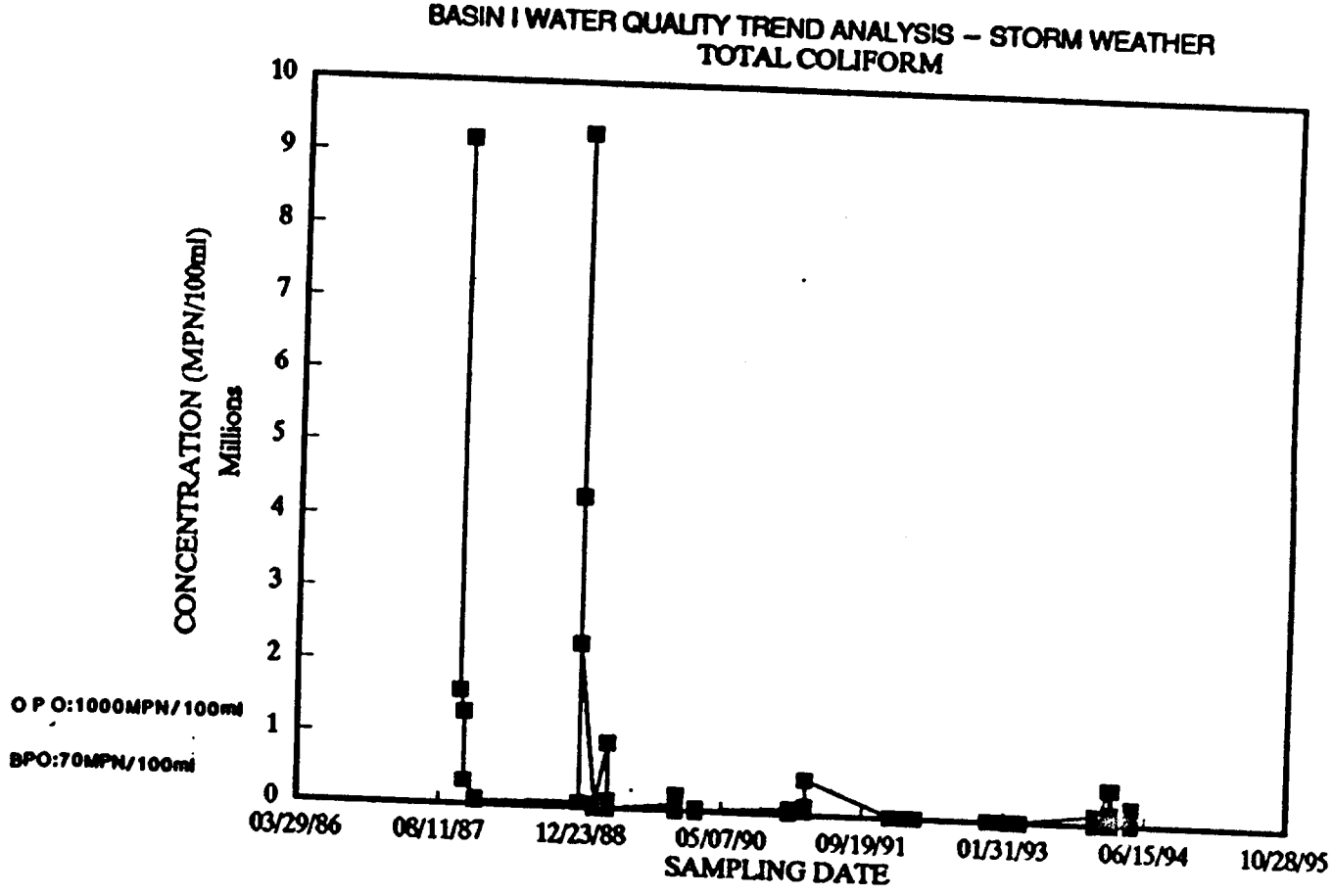
BASIN I WATER QUALITY TREND ANALYSIS – STORM WEATHER
AMMONIUM



R0061184

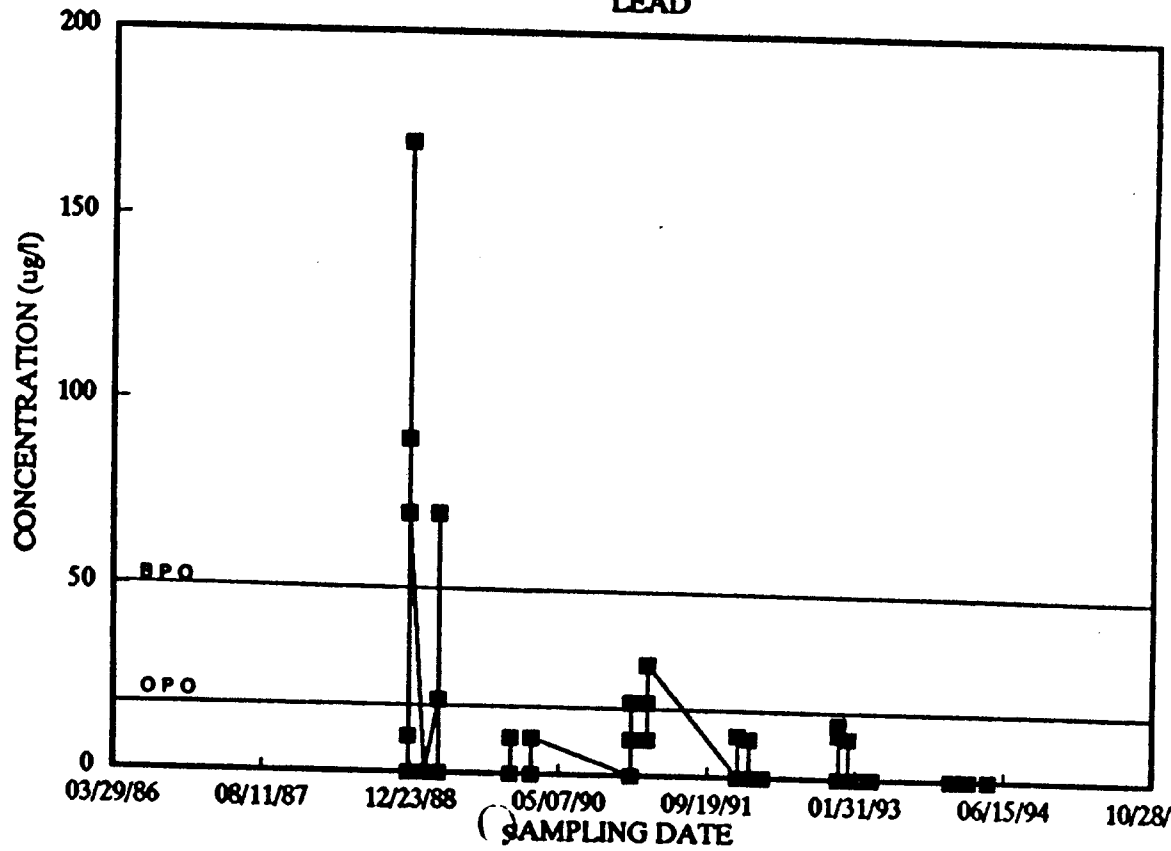
VOL 15

0964


BASIN I WATER QUALITY TREND ANALYSIS – STORM WEATHER
TOTAL COLIFORM
CONCENTRATION (MPN/100ml)
Millions
10
9
8
7
6
5
4
3
2
1
0
O P O:1000MPN/100ml
BPO:70MPN/100ml
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

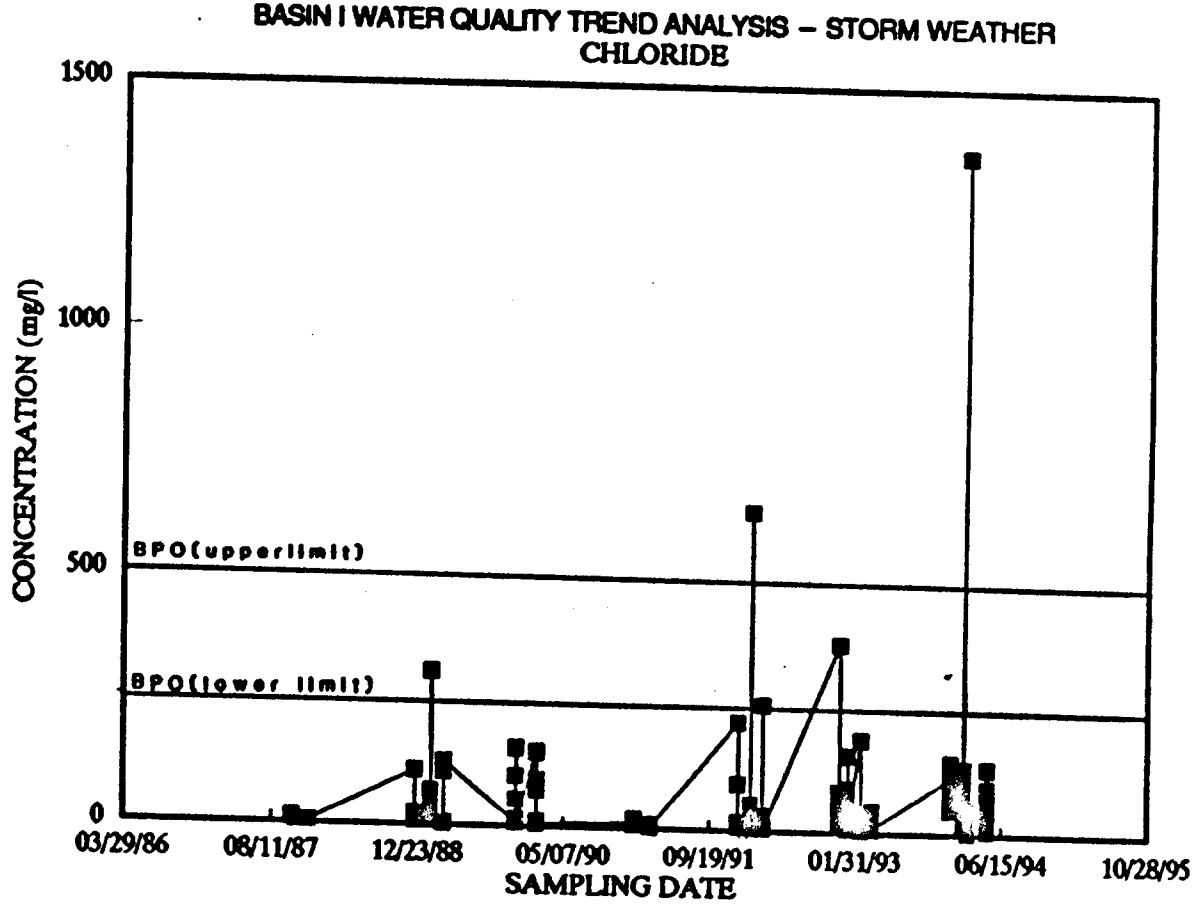
R0061185

BASIN I WATER QUALITY TREND ANALYSIS – STORM WEATHER
LEAD



R0061186

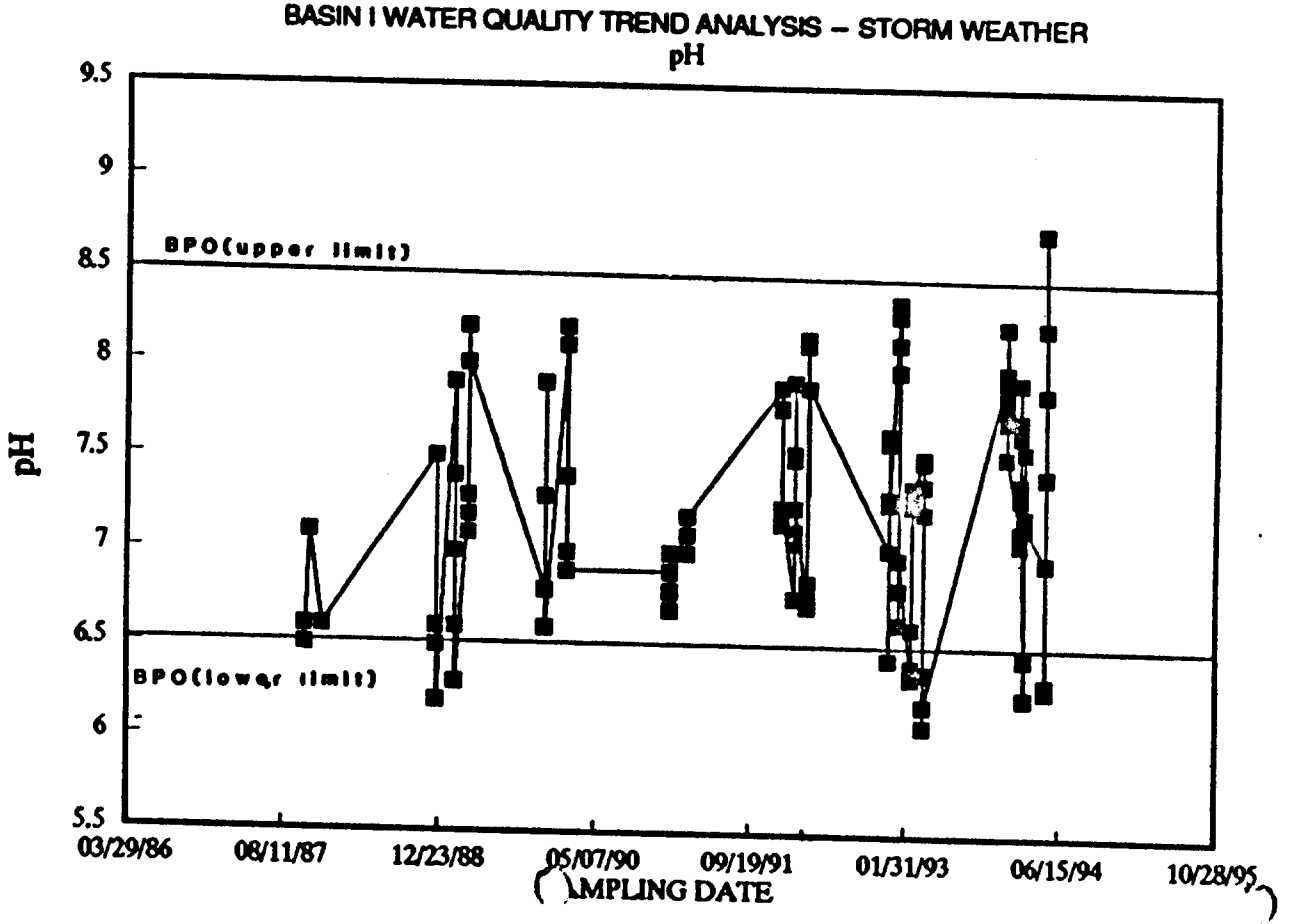
VOL 15


BASIN I WATER QUALITY TREND ANALYSIS – STORM WEATHER
CHLORIDE
CONCENTRATION (mg/l)
1500
1000
500
0
BPO(upperlimit)
BPO(lower limit)
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061187

BASIN I WATER QUALITY TREND ANALYSIS – STORM WEATHER

pH

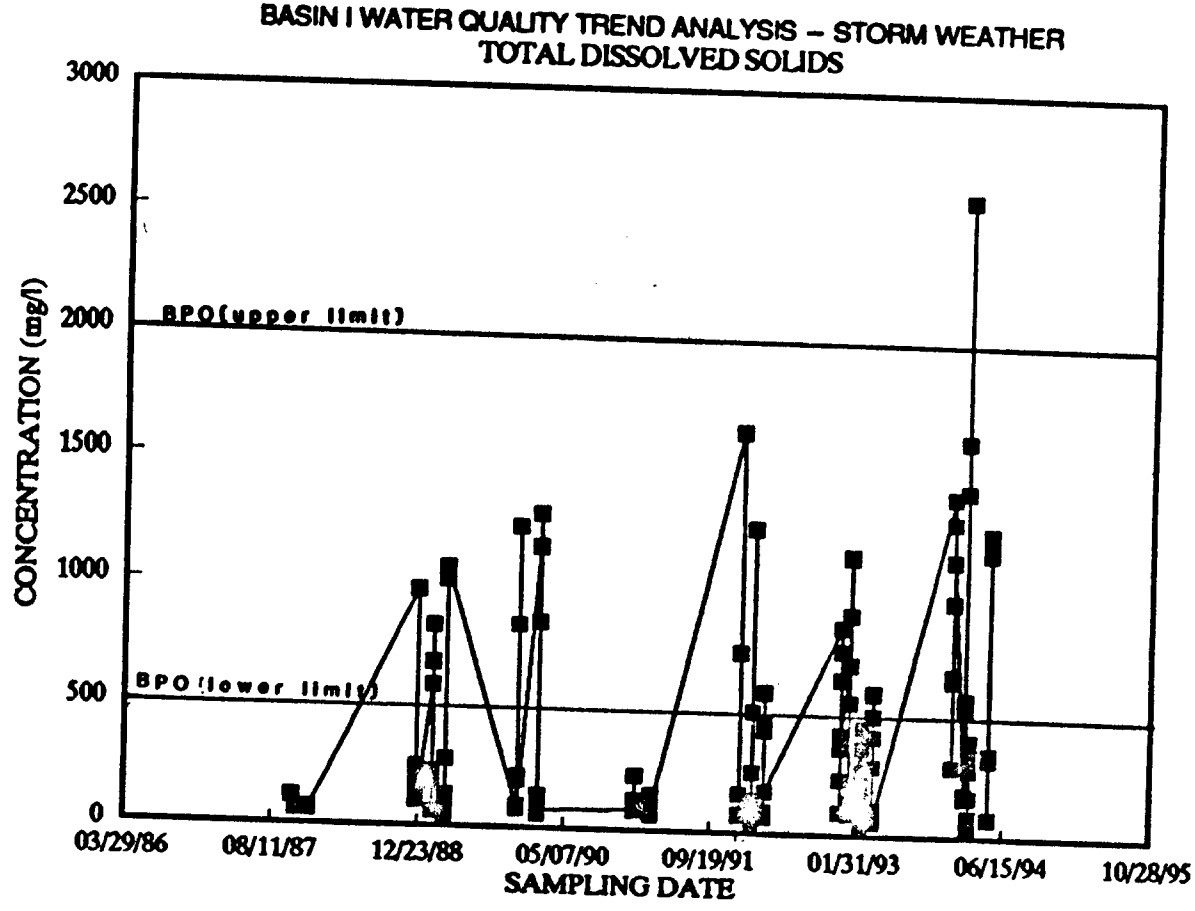


R0061188

VOL 15

0968

BASIN I WATER QUALITY TREND ANALYSIS – STORM WEATHER
TOTAL DISSOLVED SOLIDS

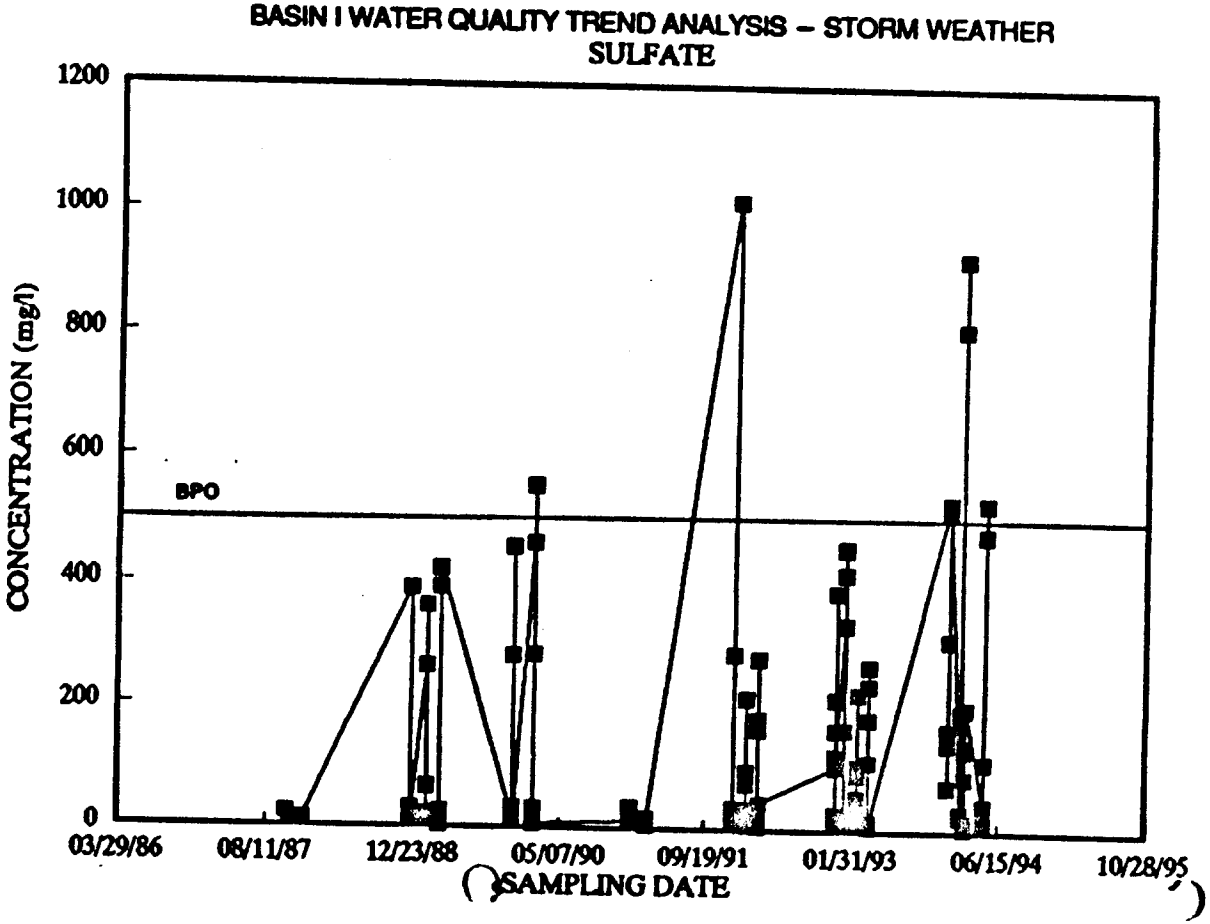


R0061189

VOL 15

0969

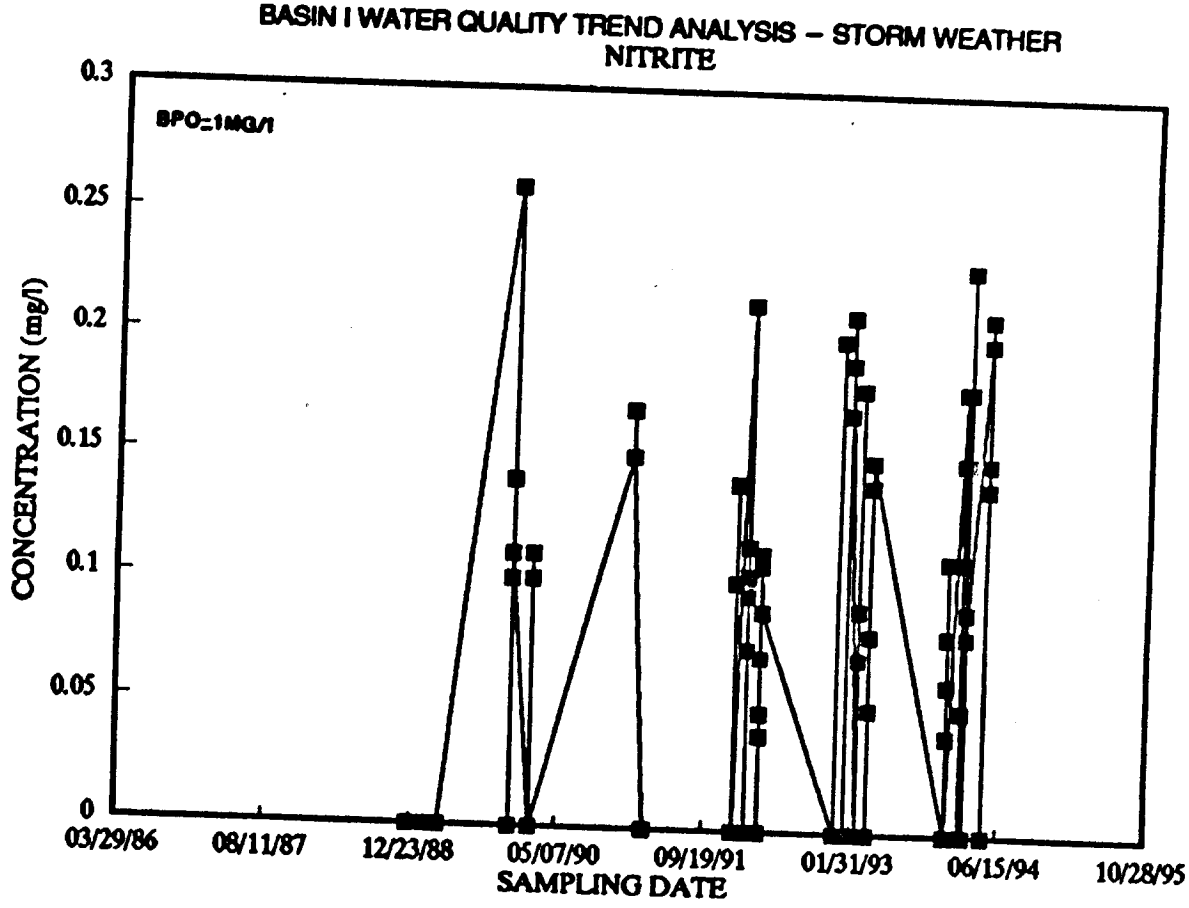
BASIN I WATER QUALITY TREND ANALYSIS – STORM WEATHER
SULFATE



R0061190

VOL 15

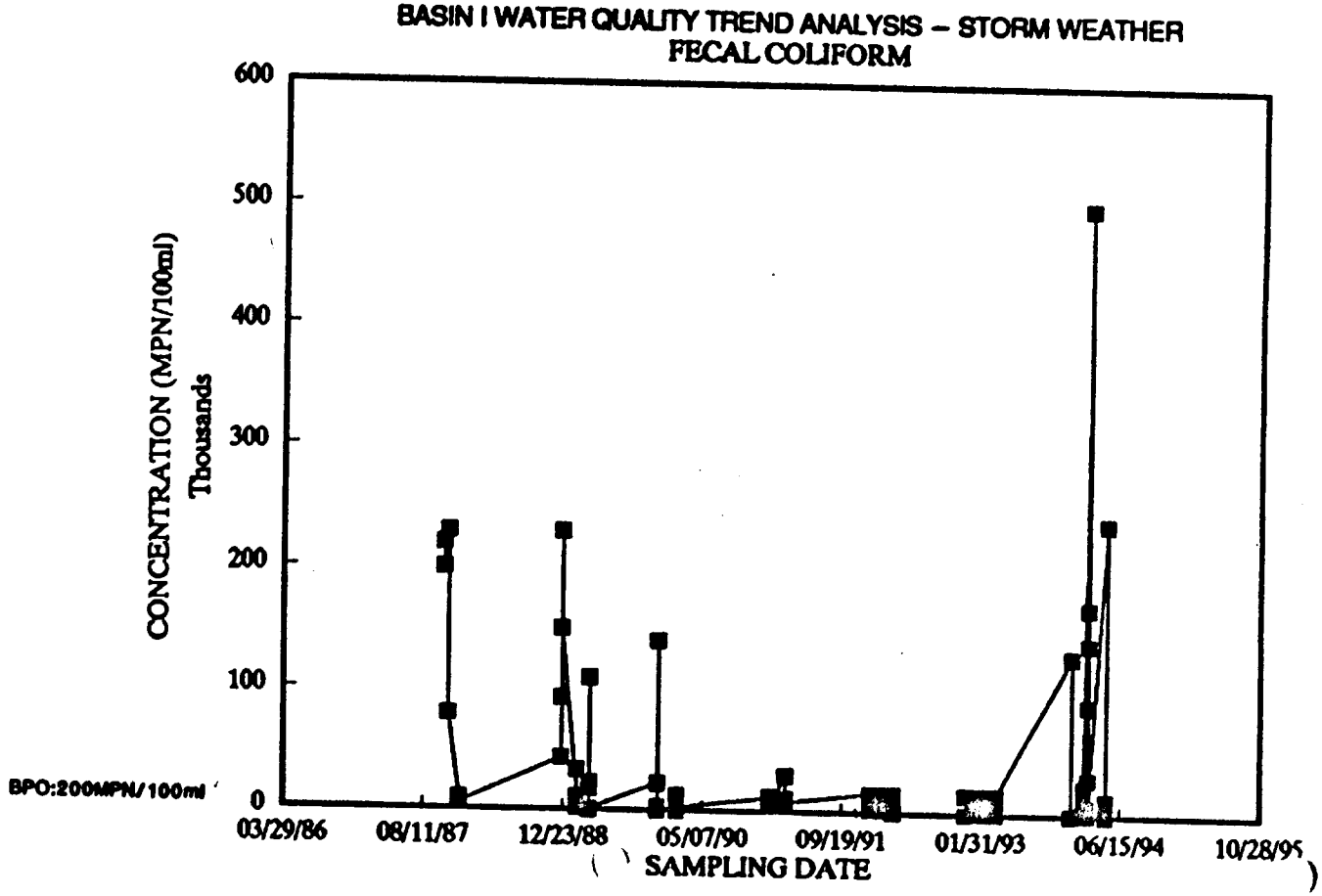
BASIN I WATER QUALITY TREND ANALYSIS – STORM WEATHER
NITRITE



R0061191

VOL 15

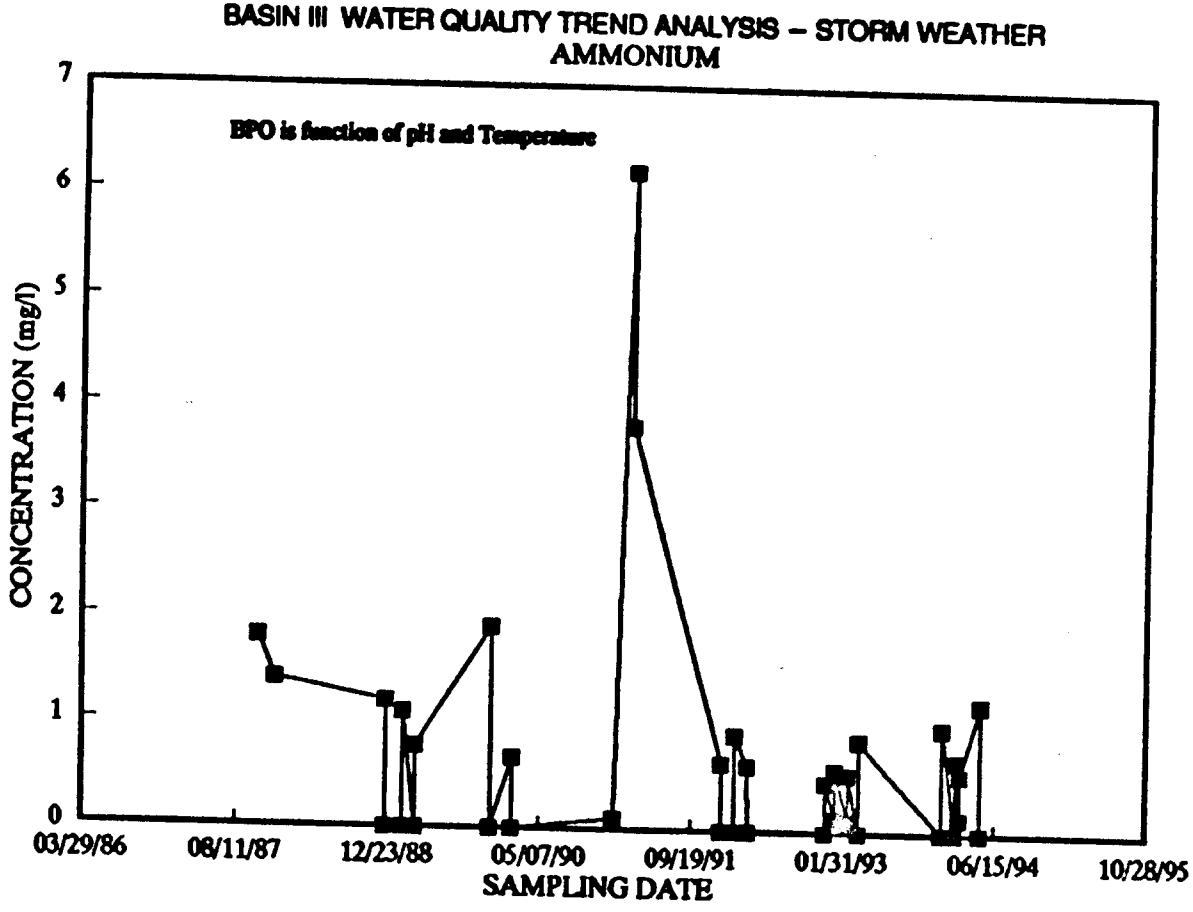
BASIN I WATER QUALITY TREND ANALYSIS – STORM WEATHER
FECAL COLIFORM



R0061192

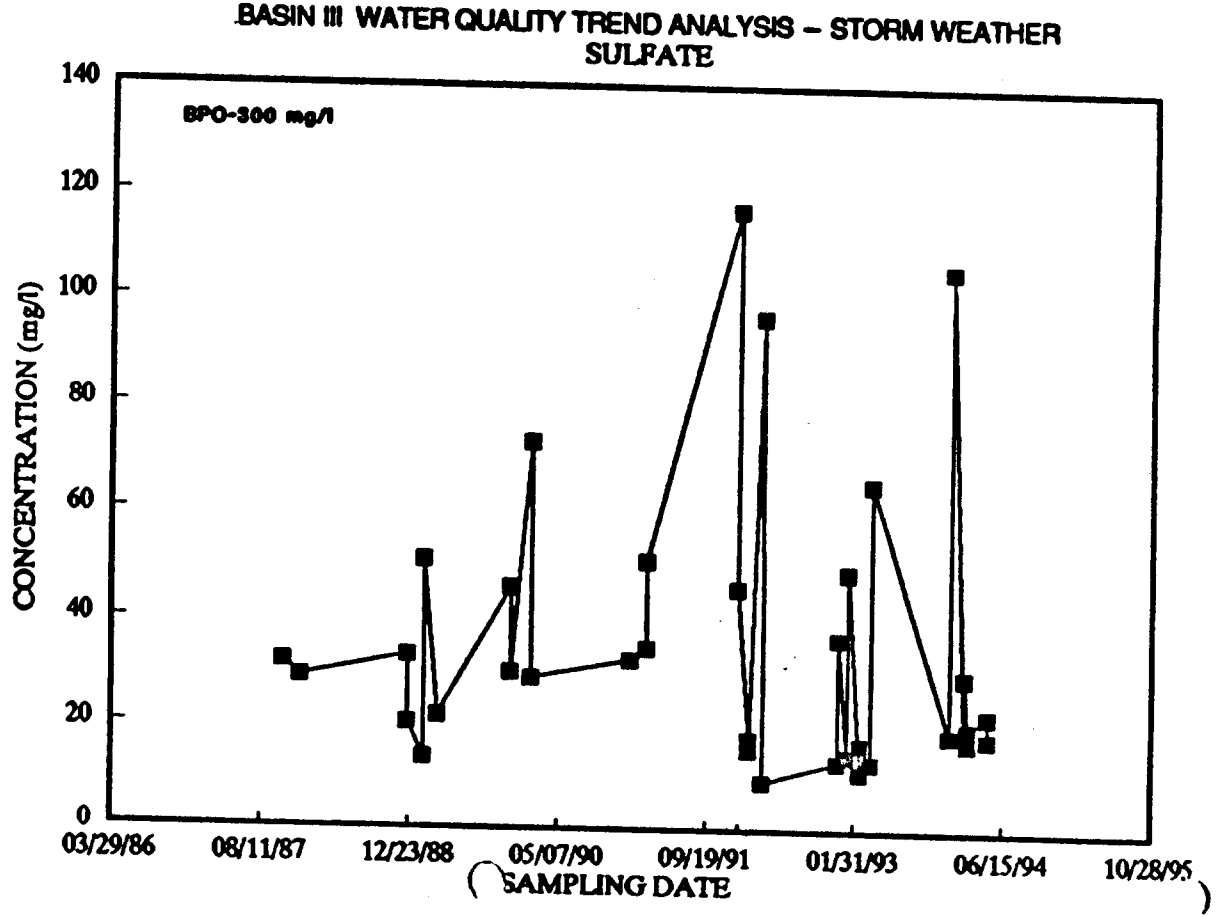
VOL 15

BASIN III WATER QUALITY TREND ANALYSIS – STORM WEATHER
AMMONIUM



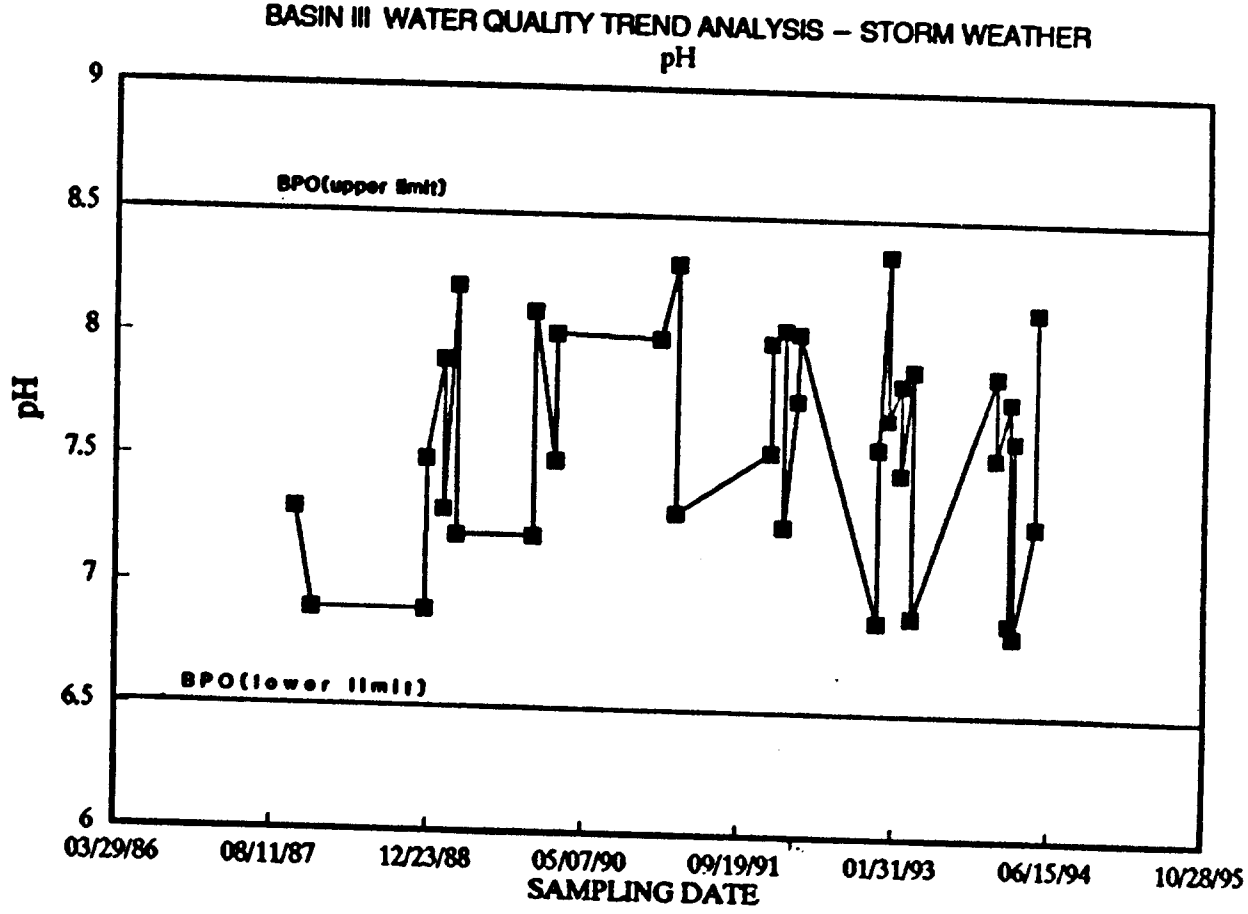
R0061193

VOL 15


BASIN III WATER QUALITY TREND ANALYSIS – STORM WEATHER
SULFATE
BPO-300 mg/l
CONCENTRATION (mg/l)
0
20
40
60
80
100
120
140
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061194

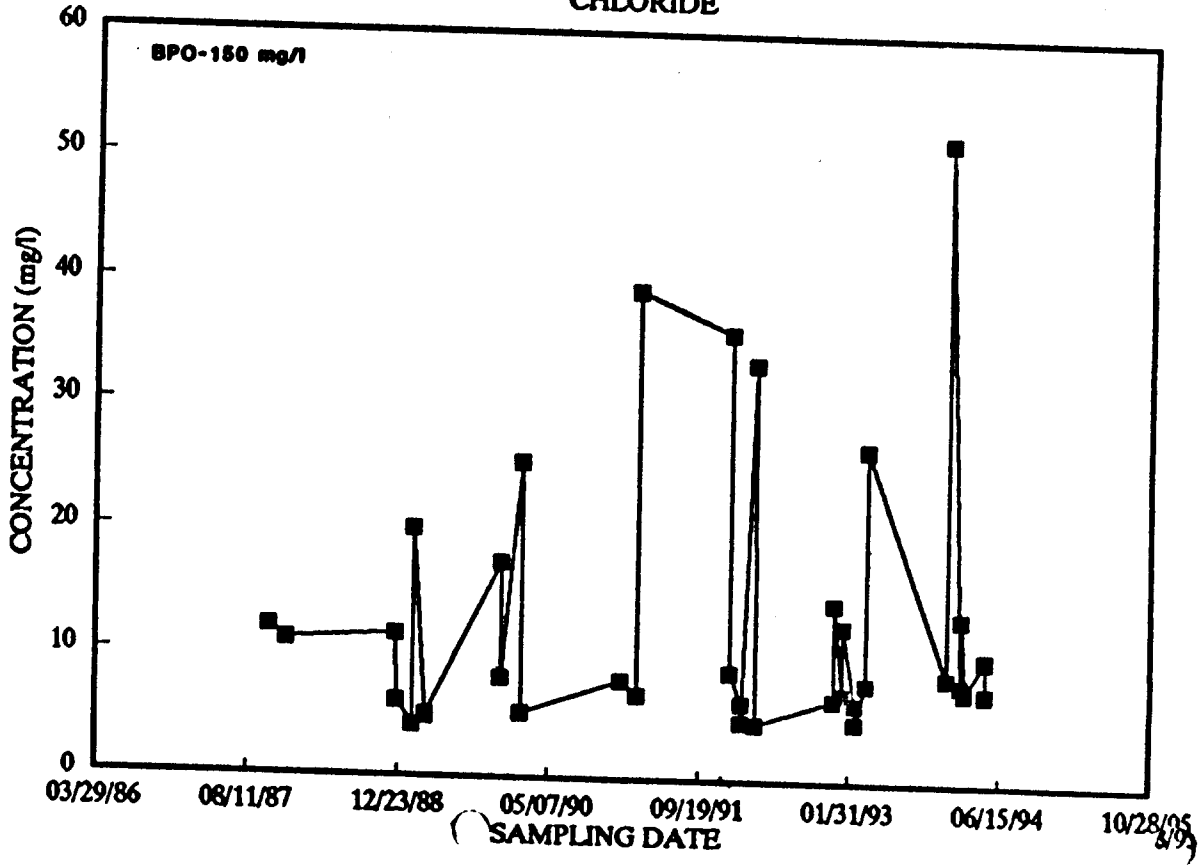
BASIN III WATER QUALITY TREND ANALYSIS – STORM WEATHER



R0061195

VOL 15

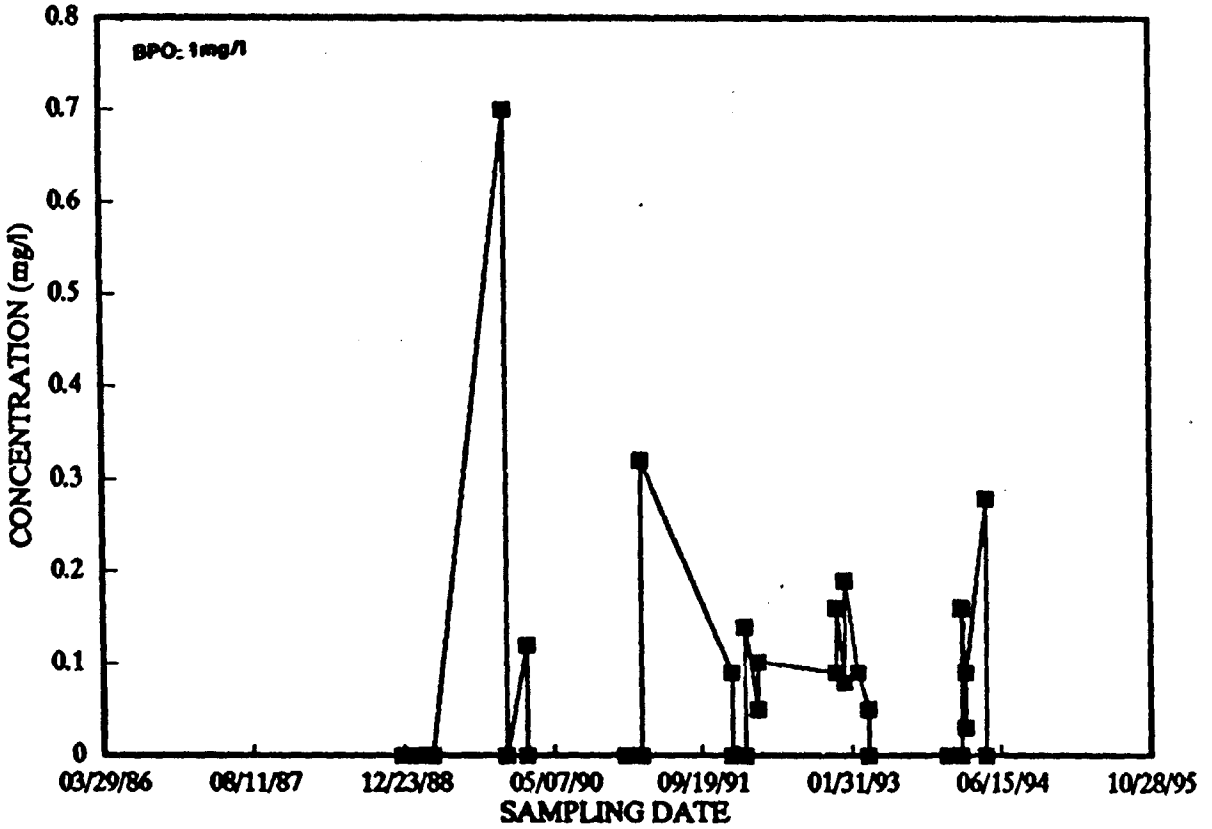
BASIN III WATER QUALITY TREND ANALYSIS – STORM WEATHER
CHLORIDE



R0061196

VOL 15

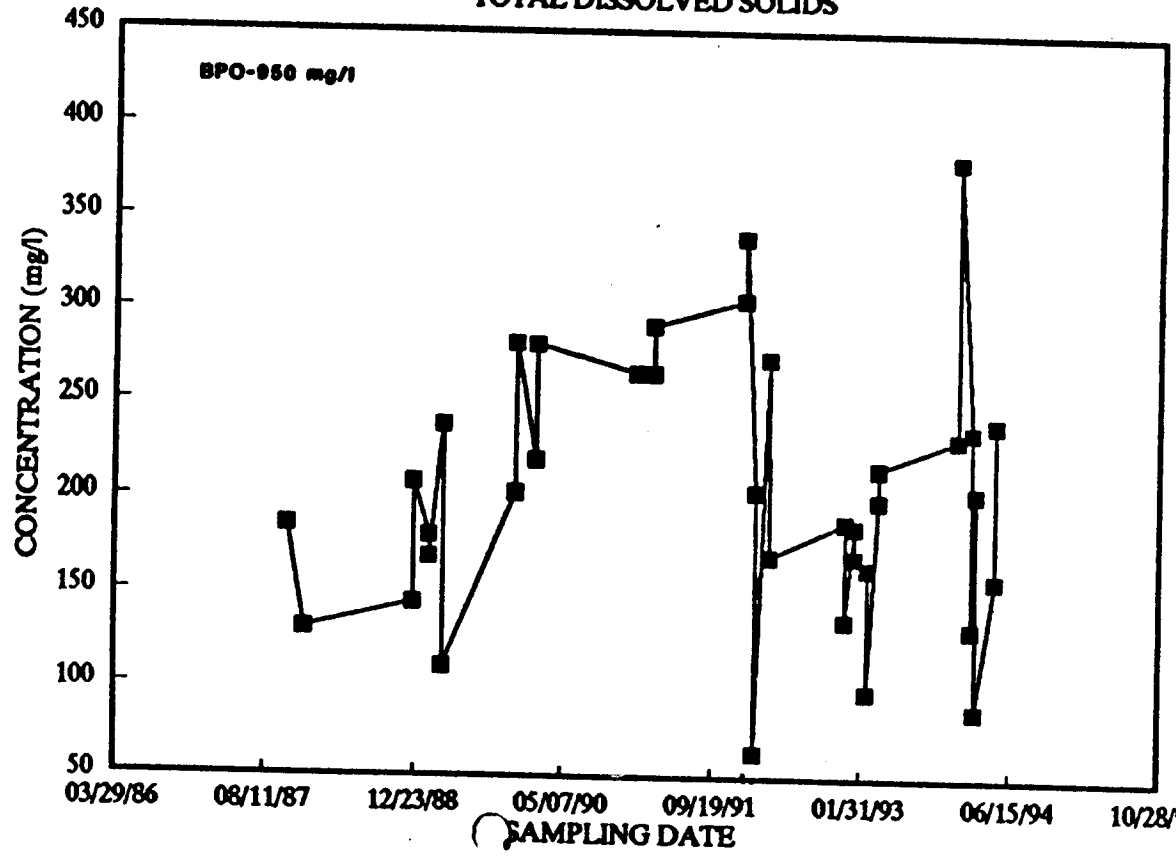
BASIN III WATER QUALITY TREND ANALYSIS – STORM WEATHER
NITRITE



R0061197

VOL 15

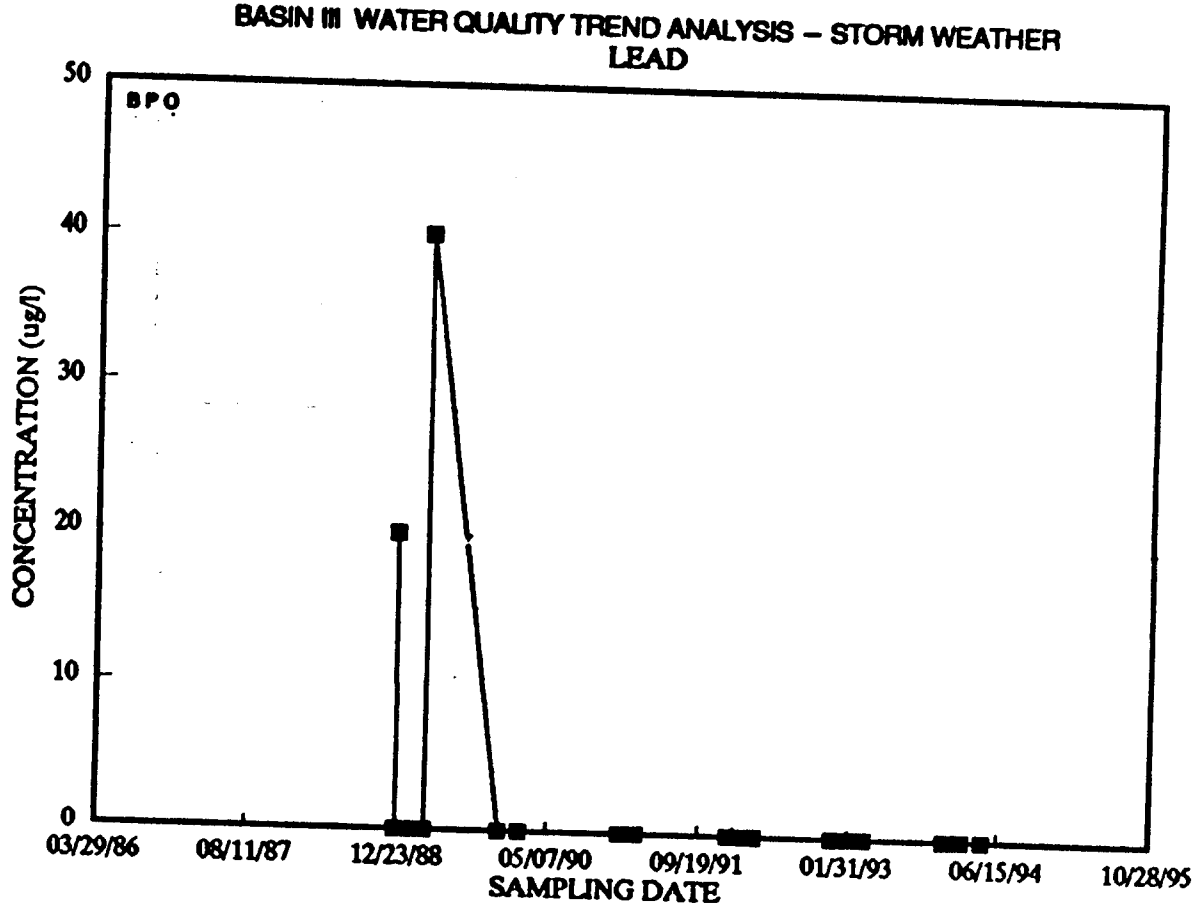
BASIN III WATER QUALITY TREND ANALYSIS – STORM WEATHER
TOTAL DISSOLVED SOLIDS



R0061198

VOL 15

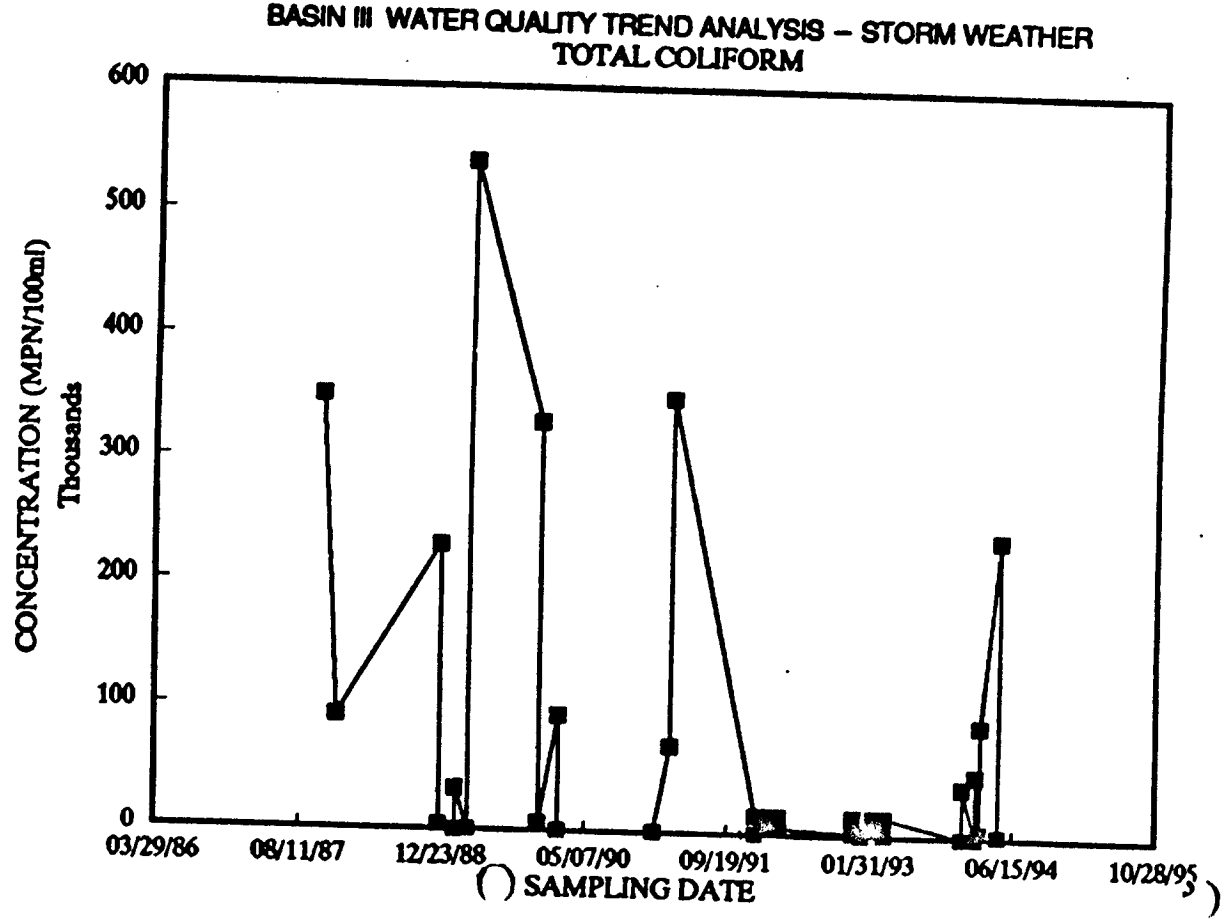
BASIN III WATER QUALITY TREND ANALYSIS – STORM WEATHER
LEAD



R0061199

VOL 15

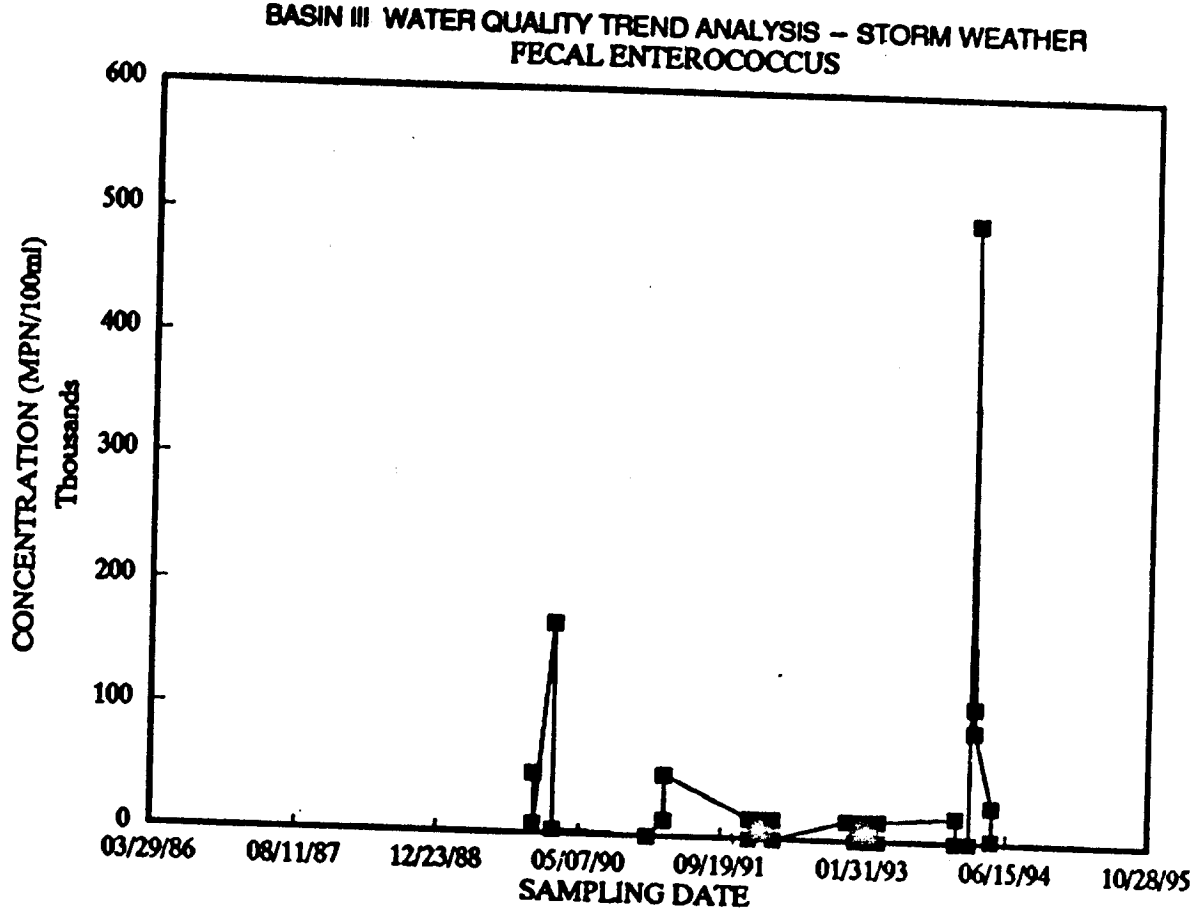
BASIN III WATER QUALITY TREND ANALYSIS – STORM WEATHER
TOTAL COLIFORM



R0061200

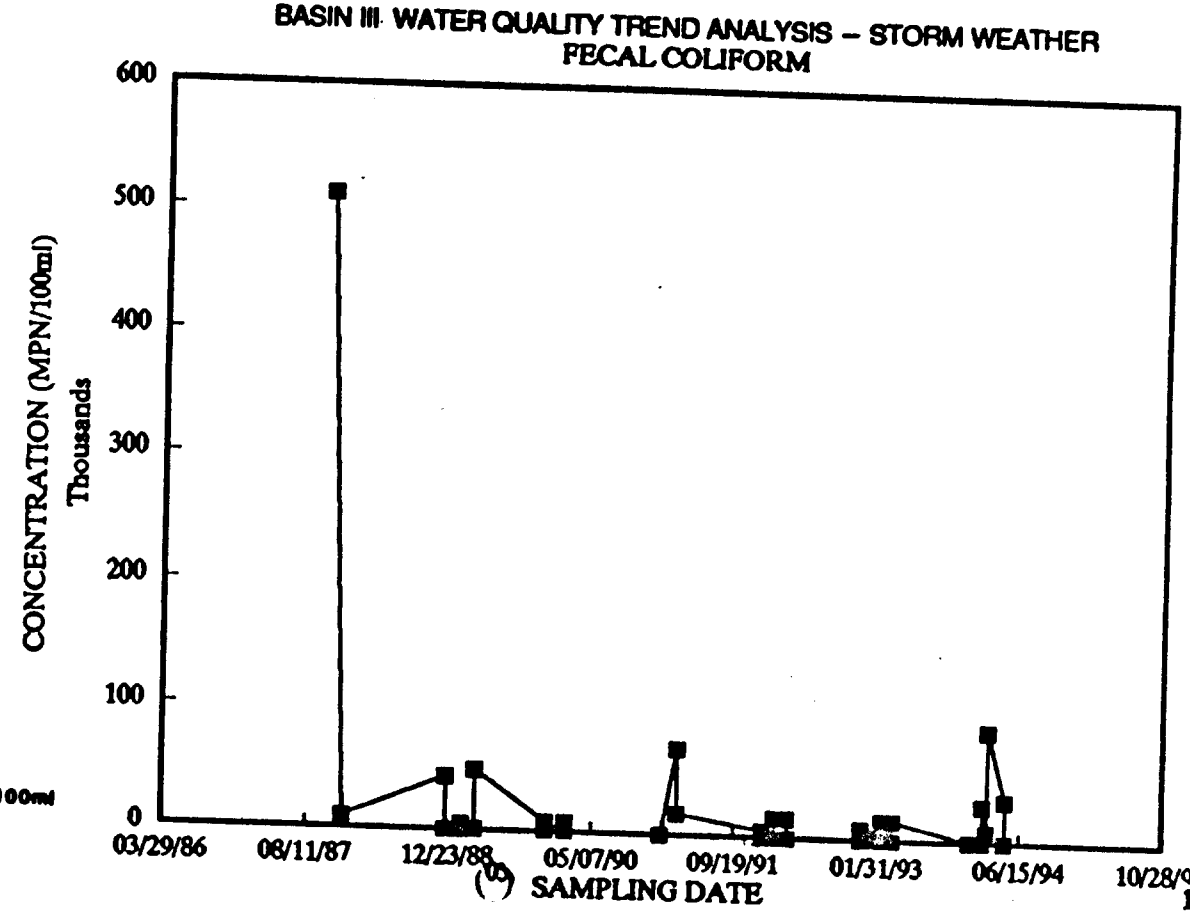
VOL 15

BASIN III WATER QUALITY TREND ANALYSIS – STORM WEATHER
FECAL ENTEROCOCCUS



R0061201

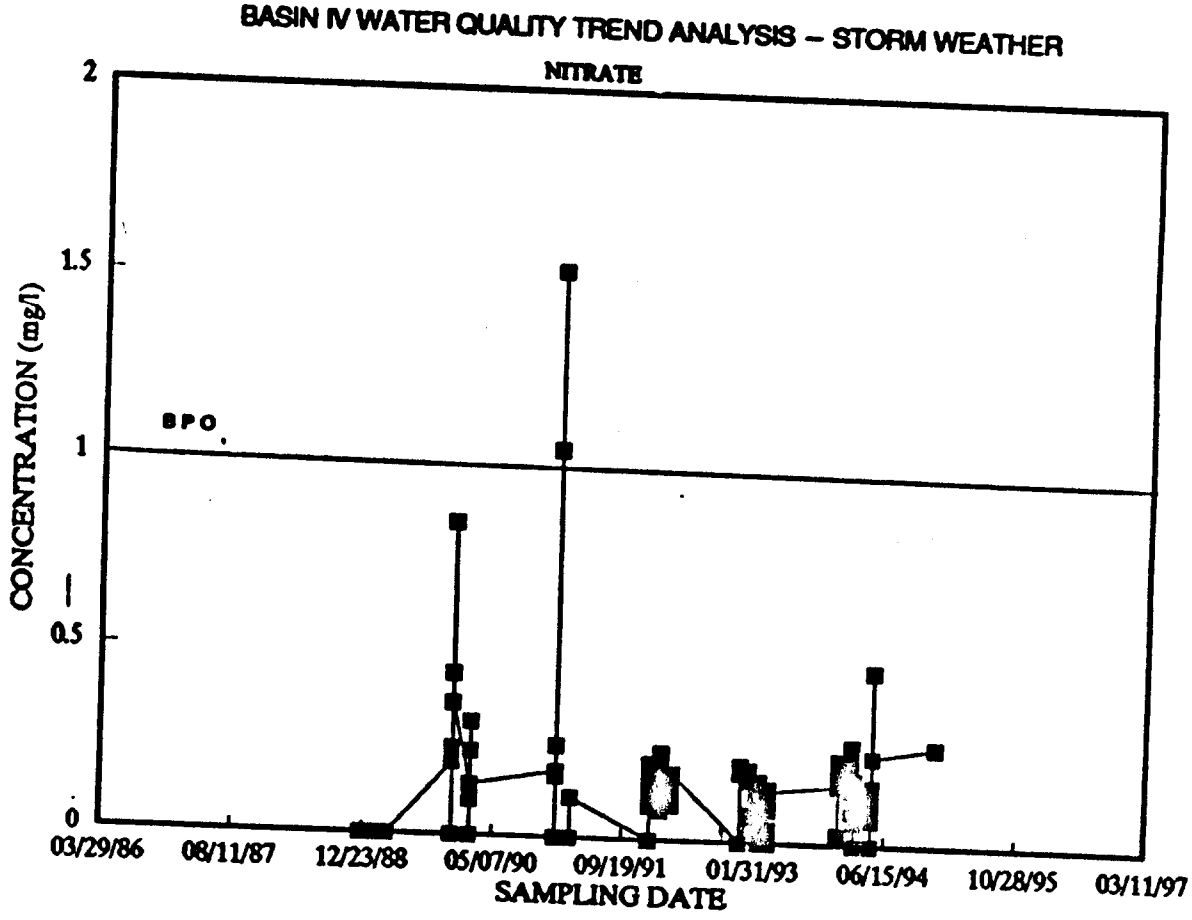
VOL 15



R0061202

28653 VOL 75

BASIN IV WATER QUALITY TREND ANALYSIS – STORM WEATHER

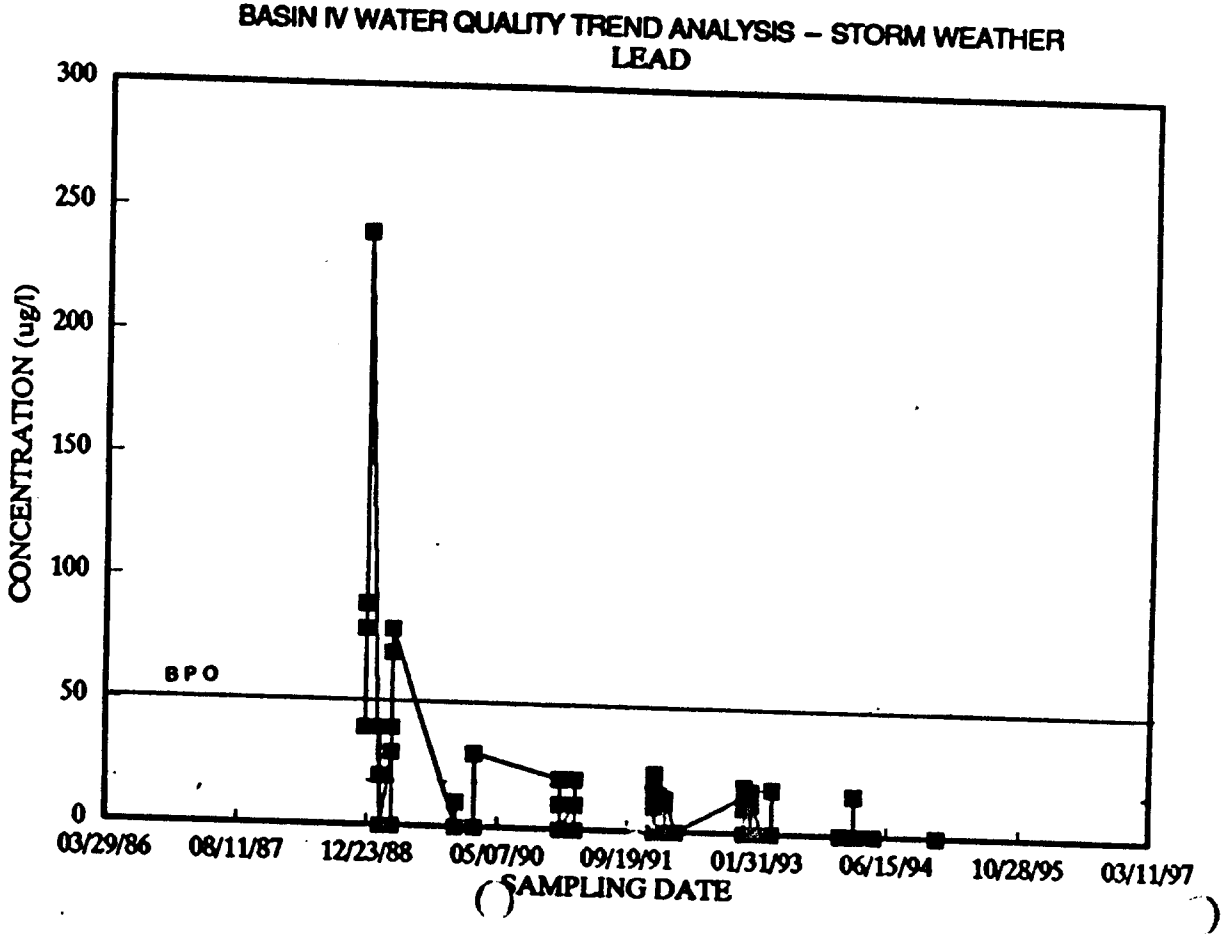


R0061203

VOL 15

C983

BASIN IV WATER QUALITY TREND ANALYSIS – STORM WEATHER
LEAD

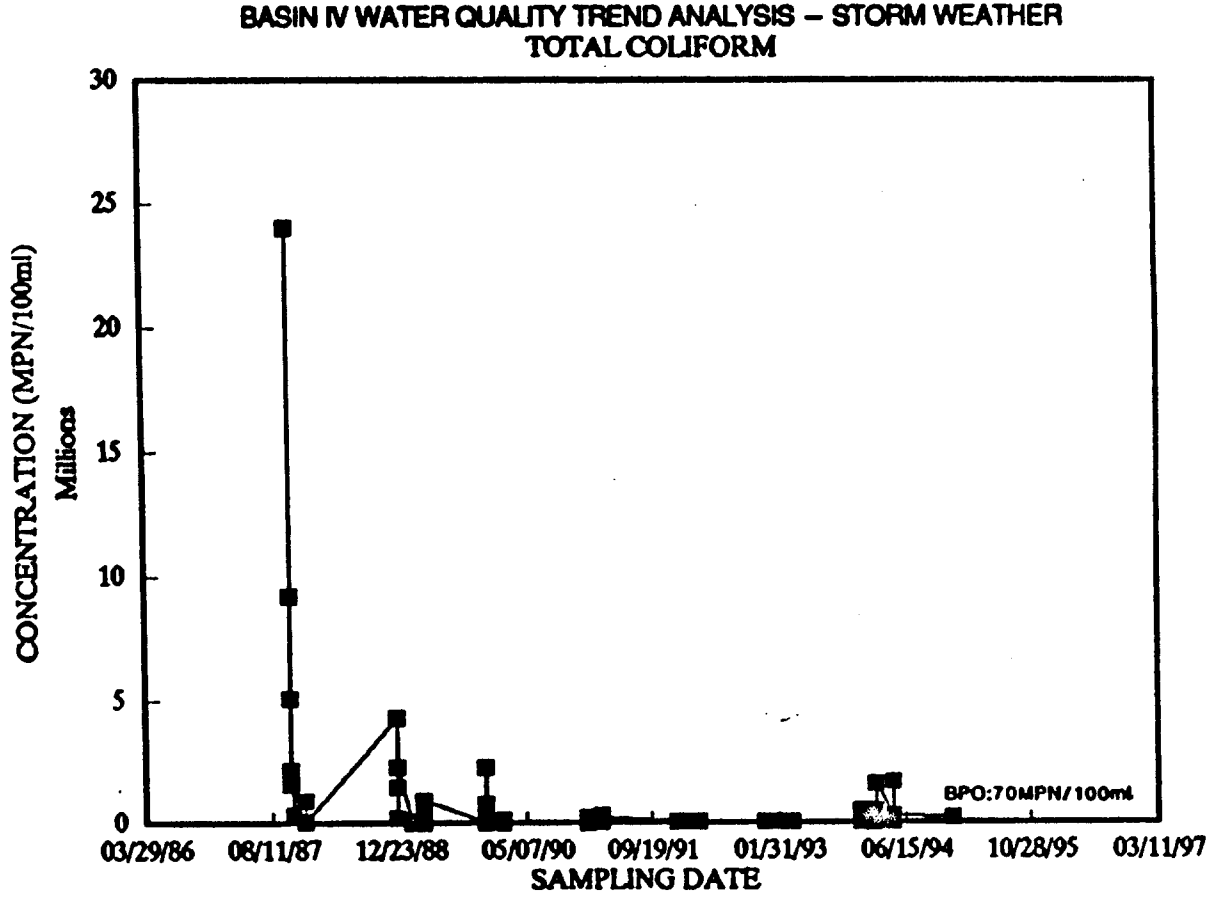


R0061204

VOL 15

0984

BASIN IV WATER QUALITY TREND ANALYSIS – STORM WEATHER
TOTAL COLIFORM

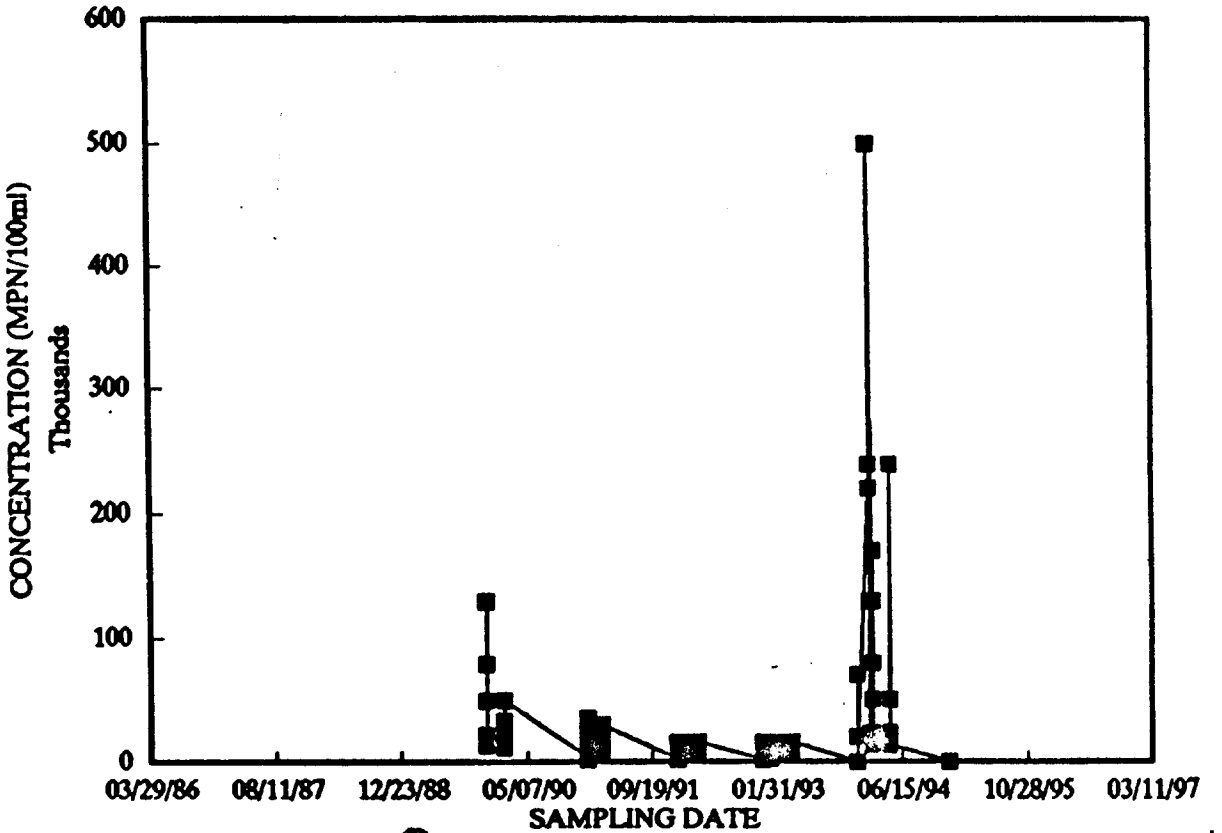


R0061205

VOL 15

C985

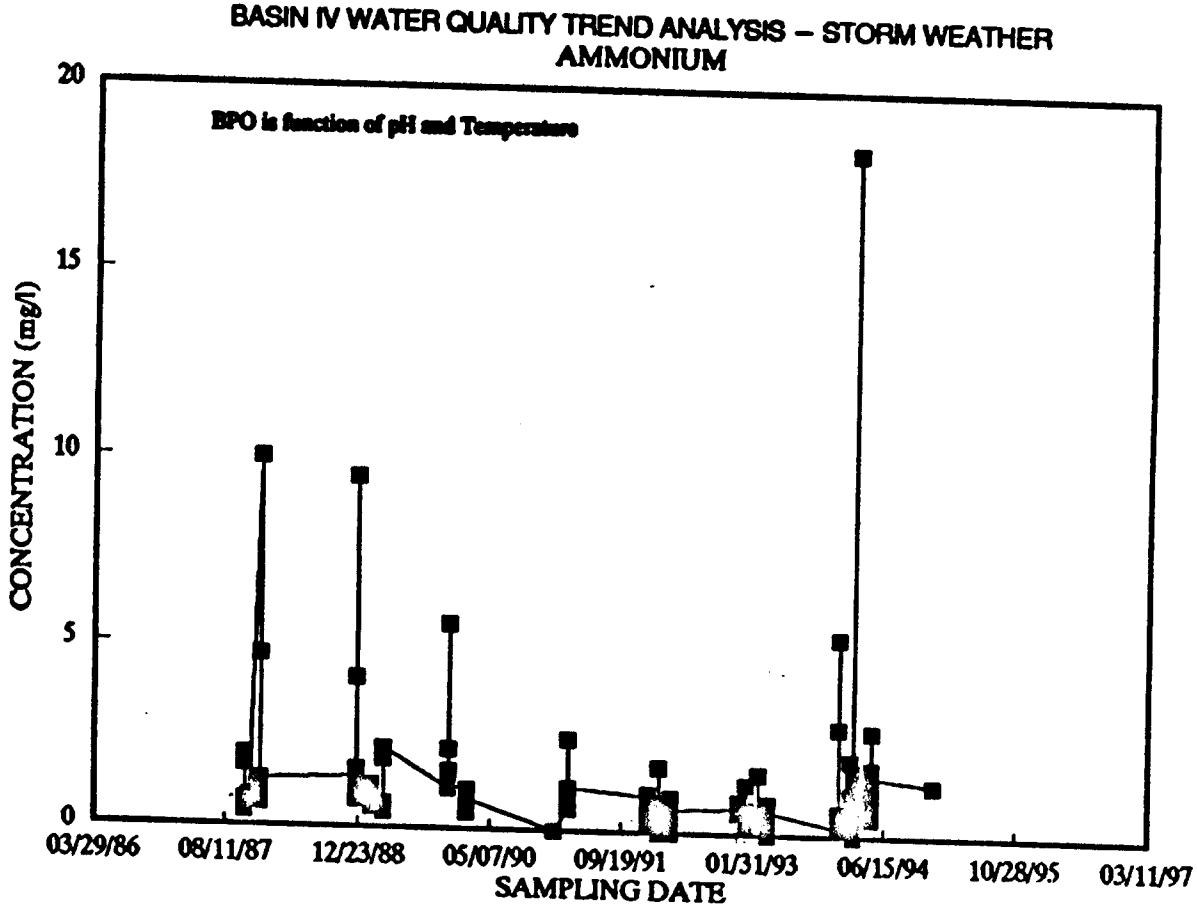
BASIN IV WATER QUALITY TREND ANALYSIS – STORM WEATHER
FECAL ENTEROCOCCUS



R0061206

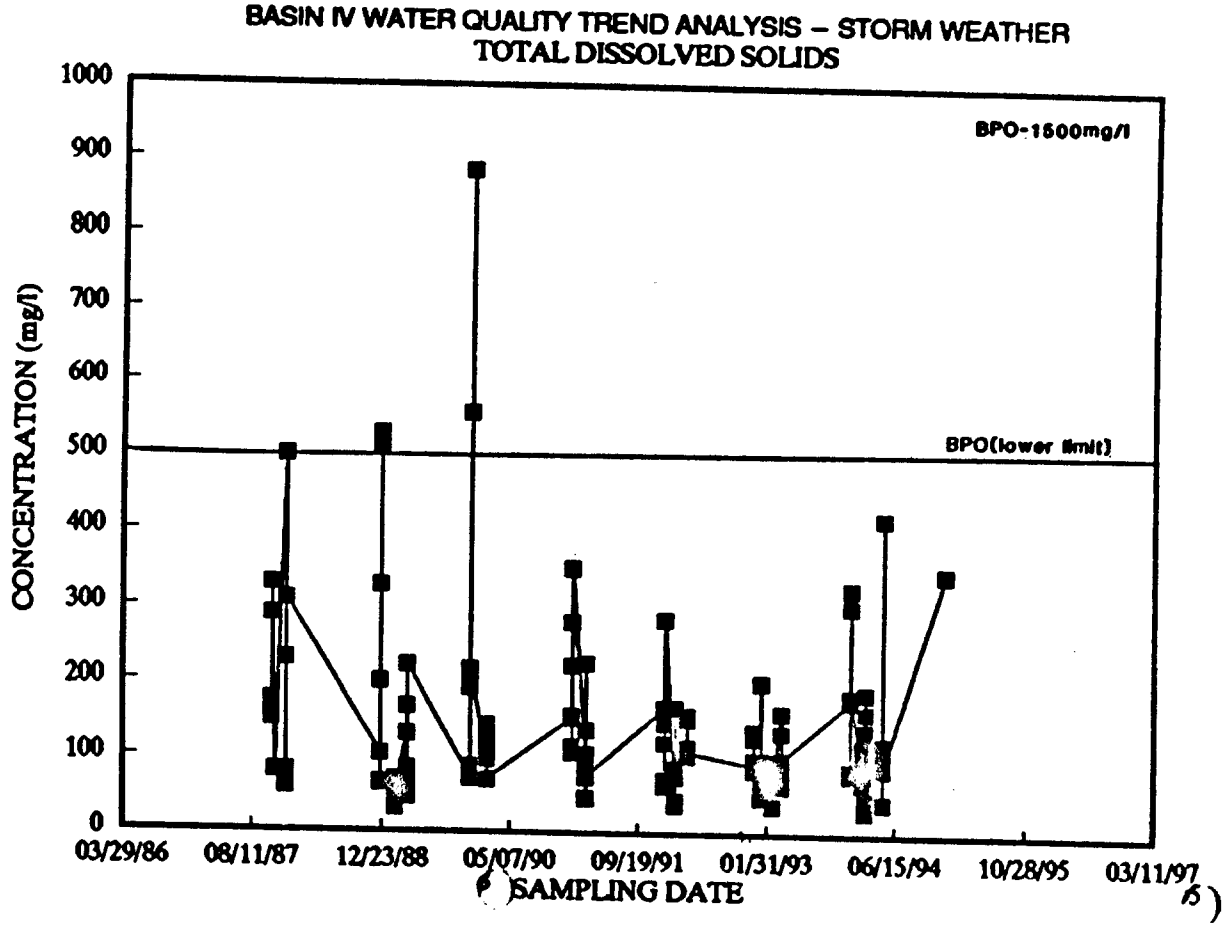
VOL 15

BASIN IV WATER QUALITY TREND ANALYSIS – STORM WEATHER
AMMONIUM



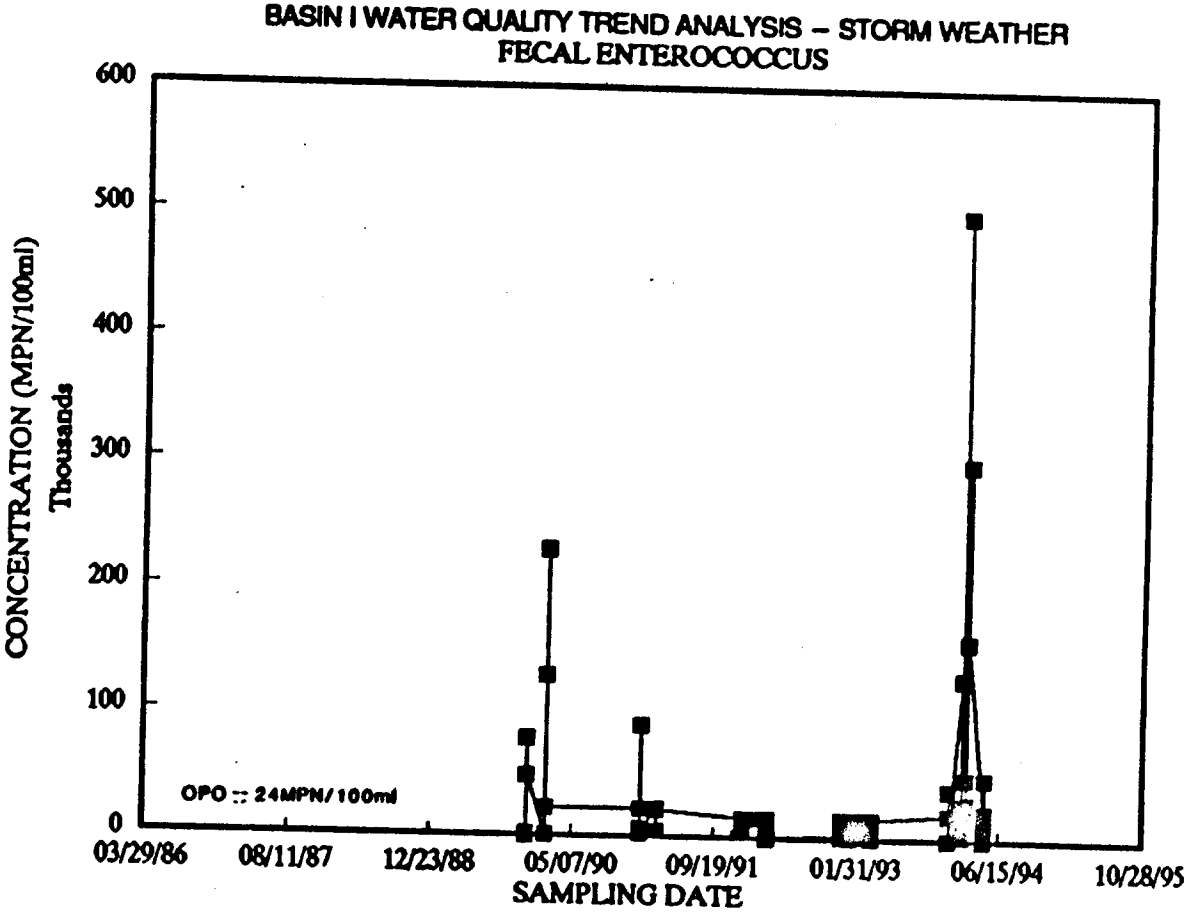
R0061207

VOL 15



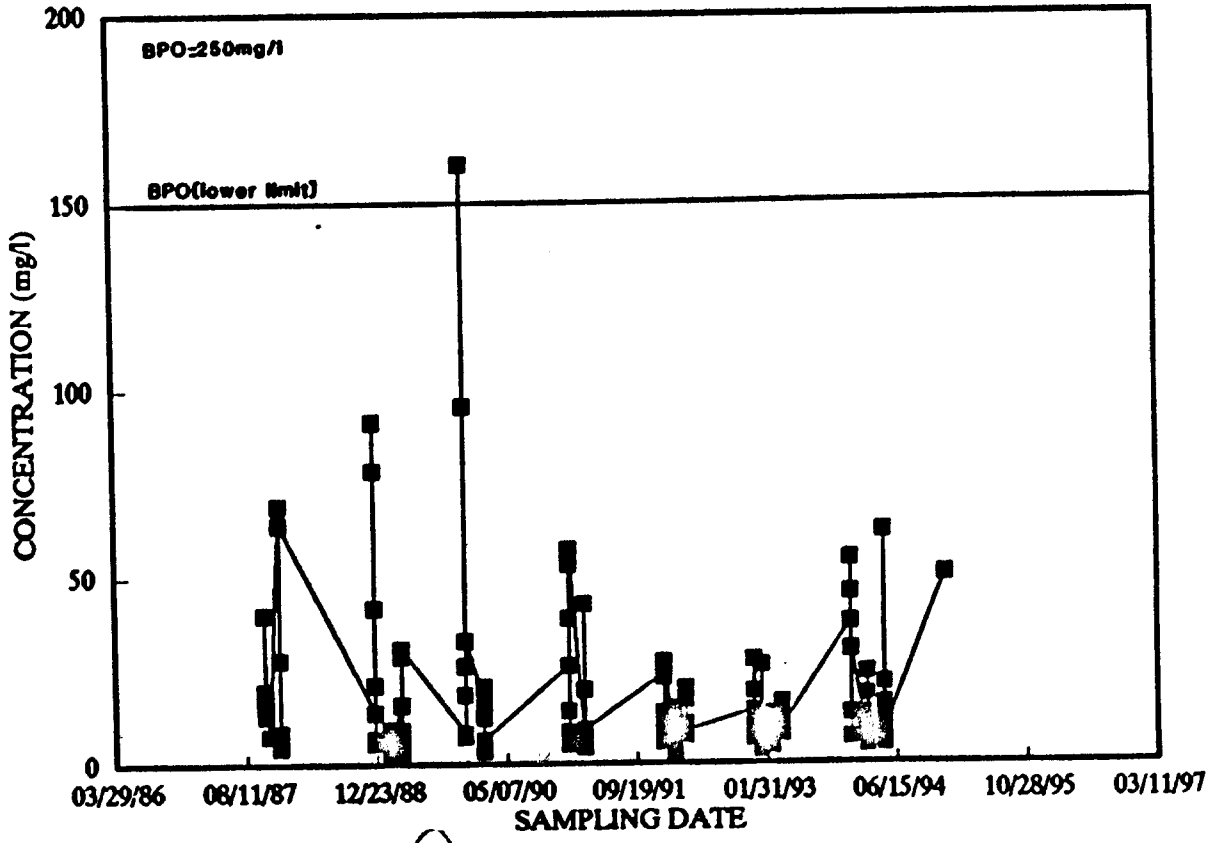
R0061208

8863 VOL 75


BASIN I WATER QUALITY TREND ANALYSIS – STORM WEATHER
FECAL ENTEROCOCCUS
CONCENTRATION (MPN/100ml)
Thousands
600
500
400
300
200
100
0
OPO = 24MPN/100ml
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061209

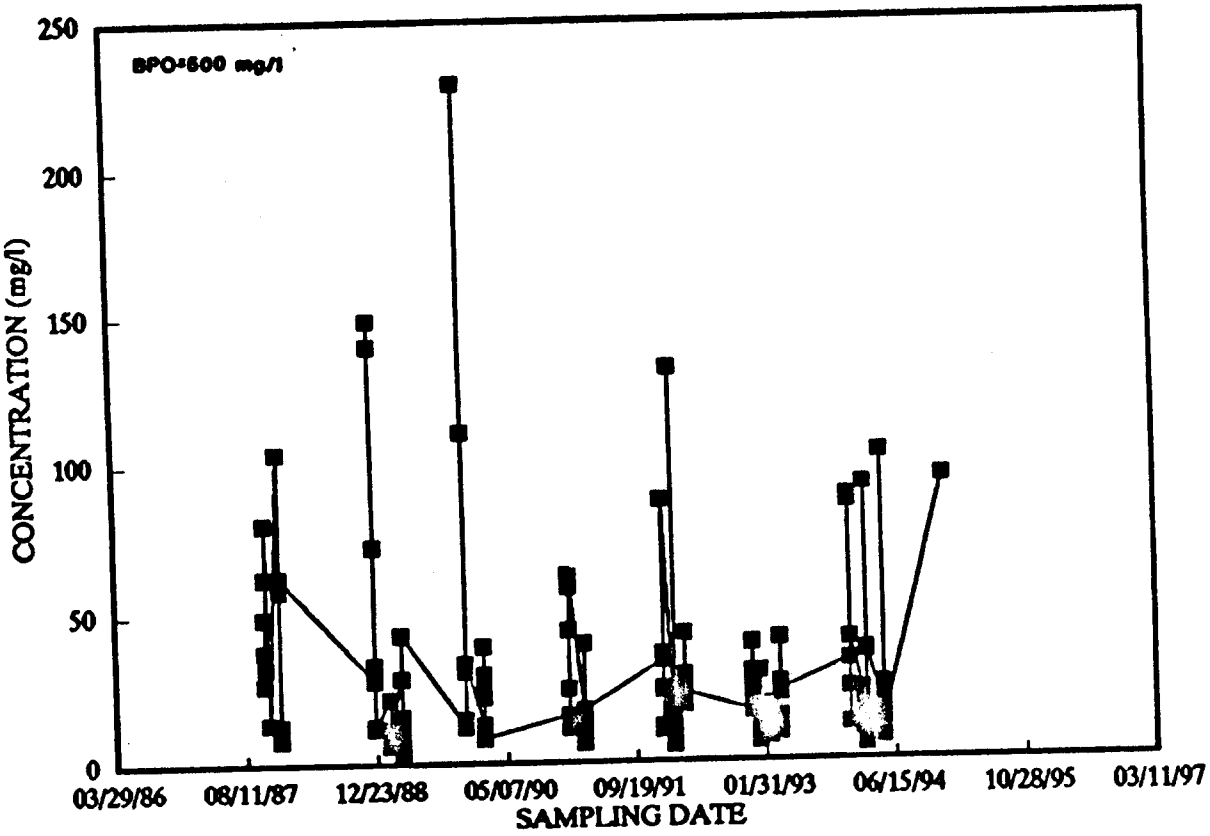
BASIN IV WATER QUALITY TREND ANALYSIS – STORM WEATHER
CHLORIDE



R0061210

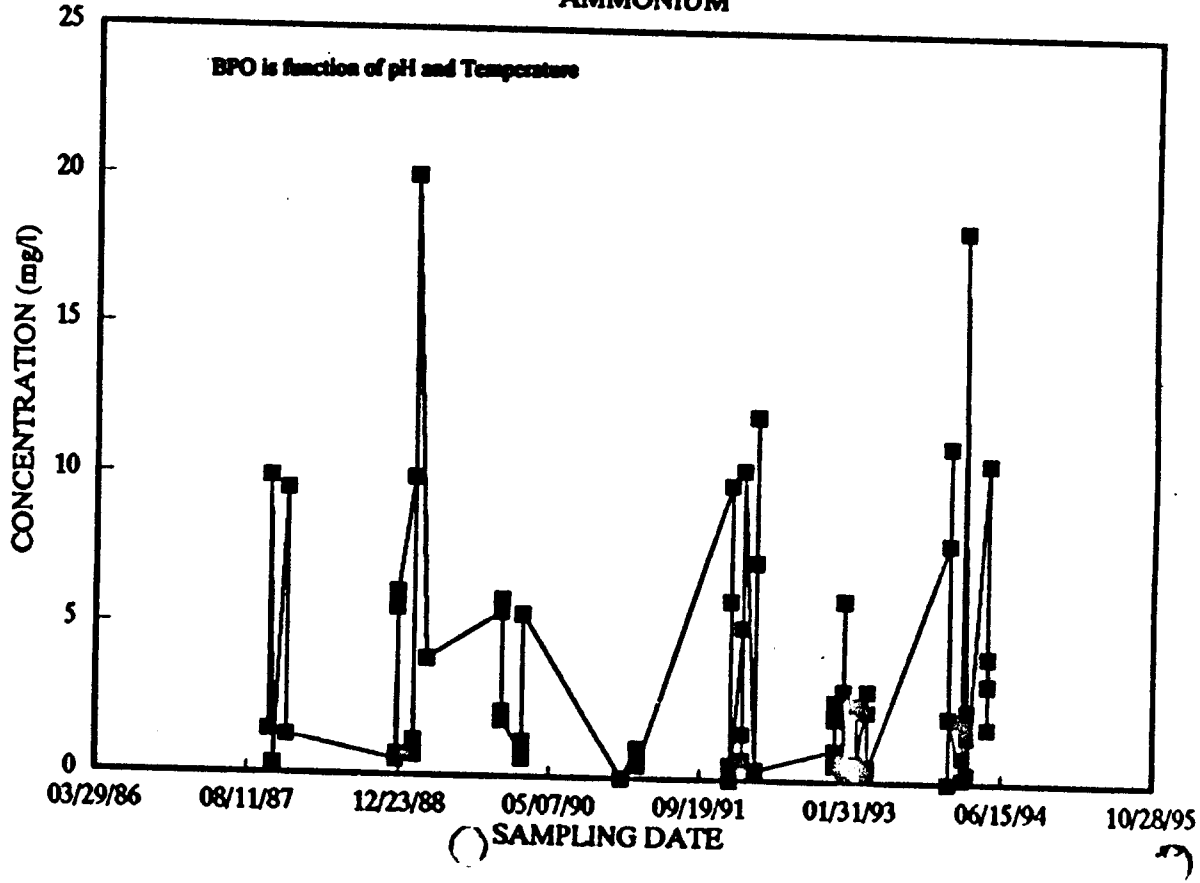
VOL 15

BASIN IV WATER QUALITY TREND ANALYSIS – STORM WEATHER
SULFATE



R0061211

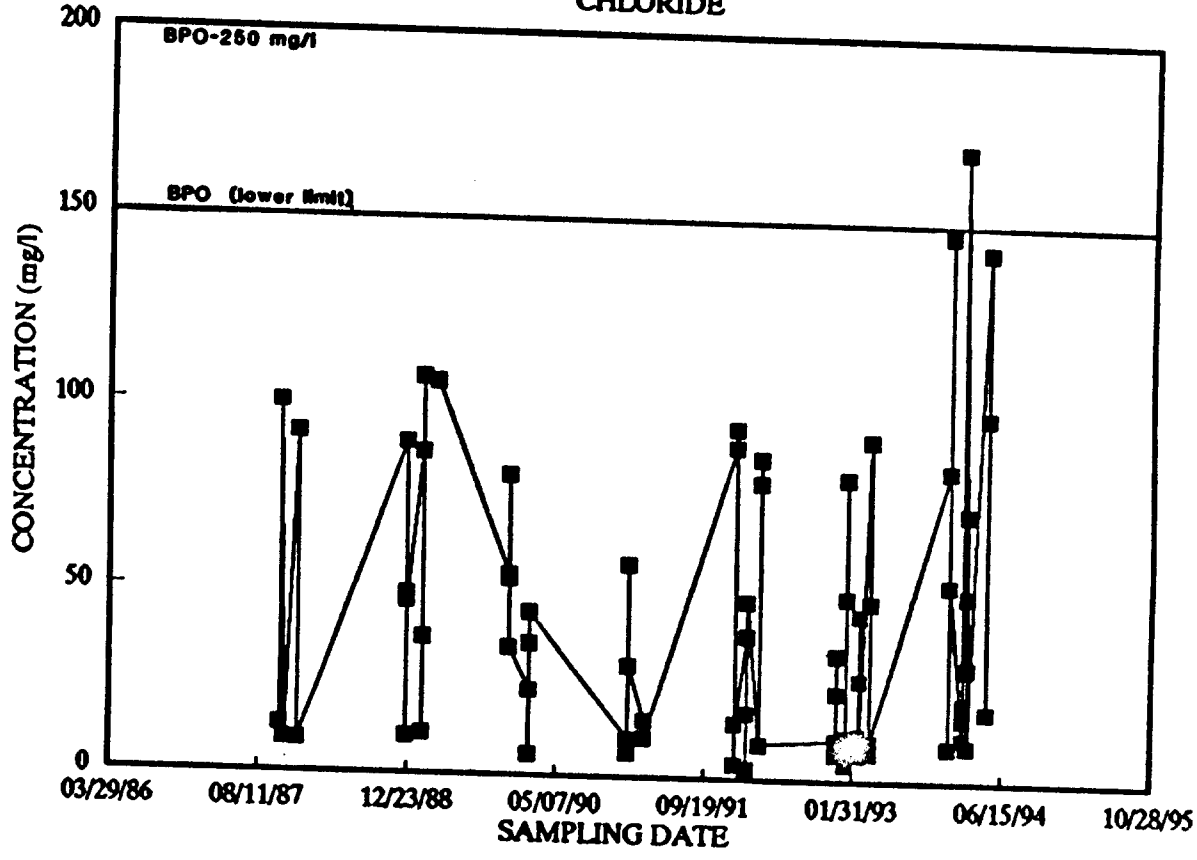
BASIN V SOUTH WATER QUALITY TREND ANALYSIS – STORM WEATHER
AMMONIUM



R0061212

26663
VOL 75

BASIN V SOUTH WATER QUALITY TREND ANALYSIS – STORM WEATHER
CHLORIDE

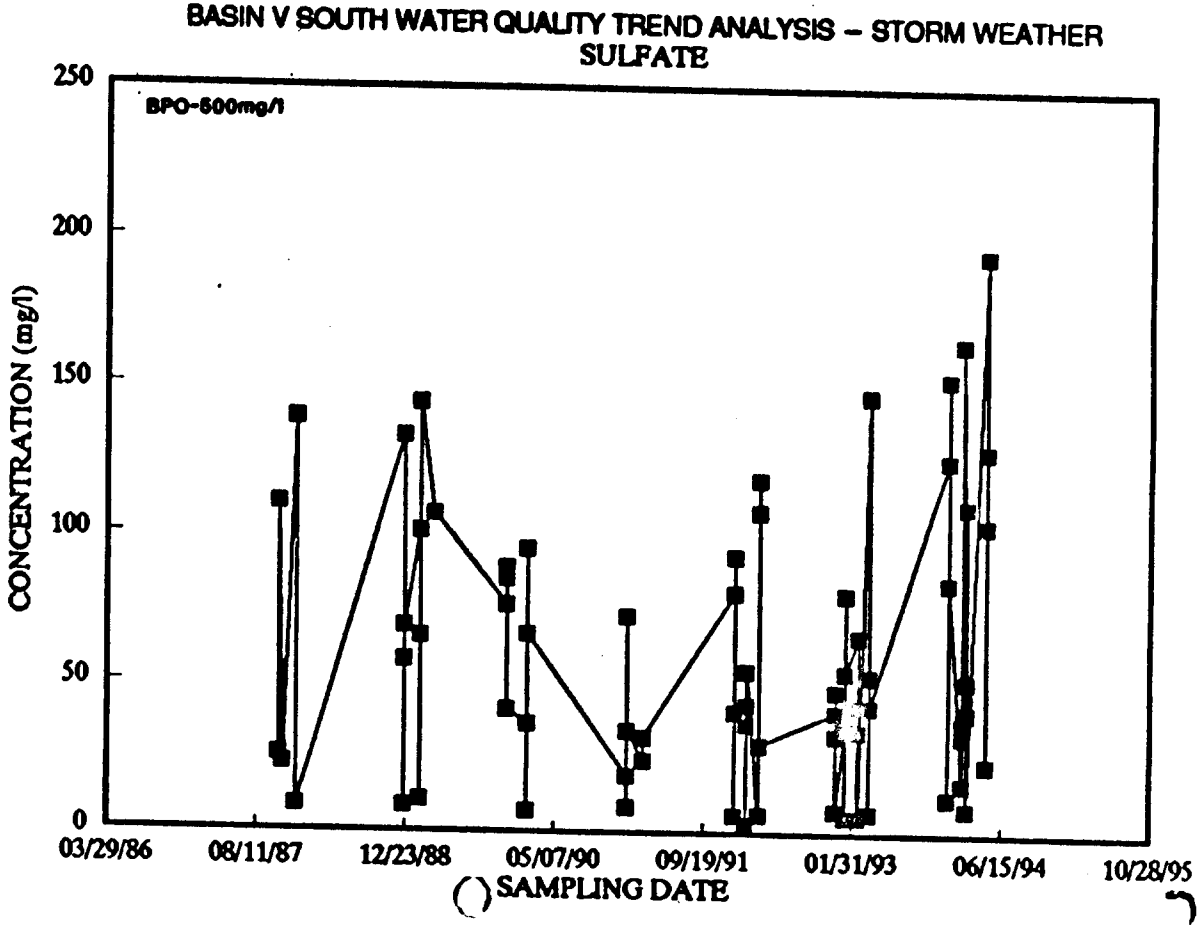


R0061213

C993

VOL 15

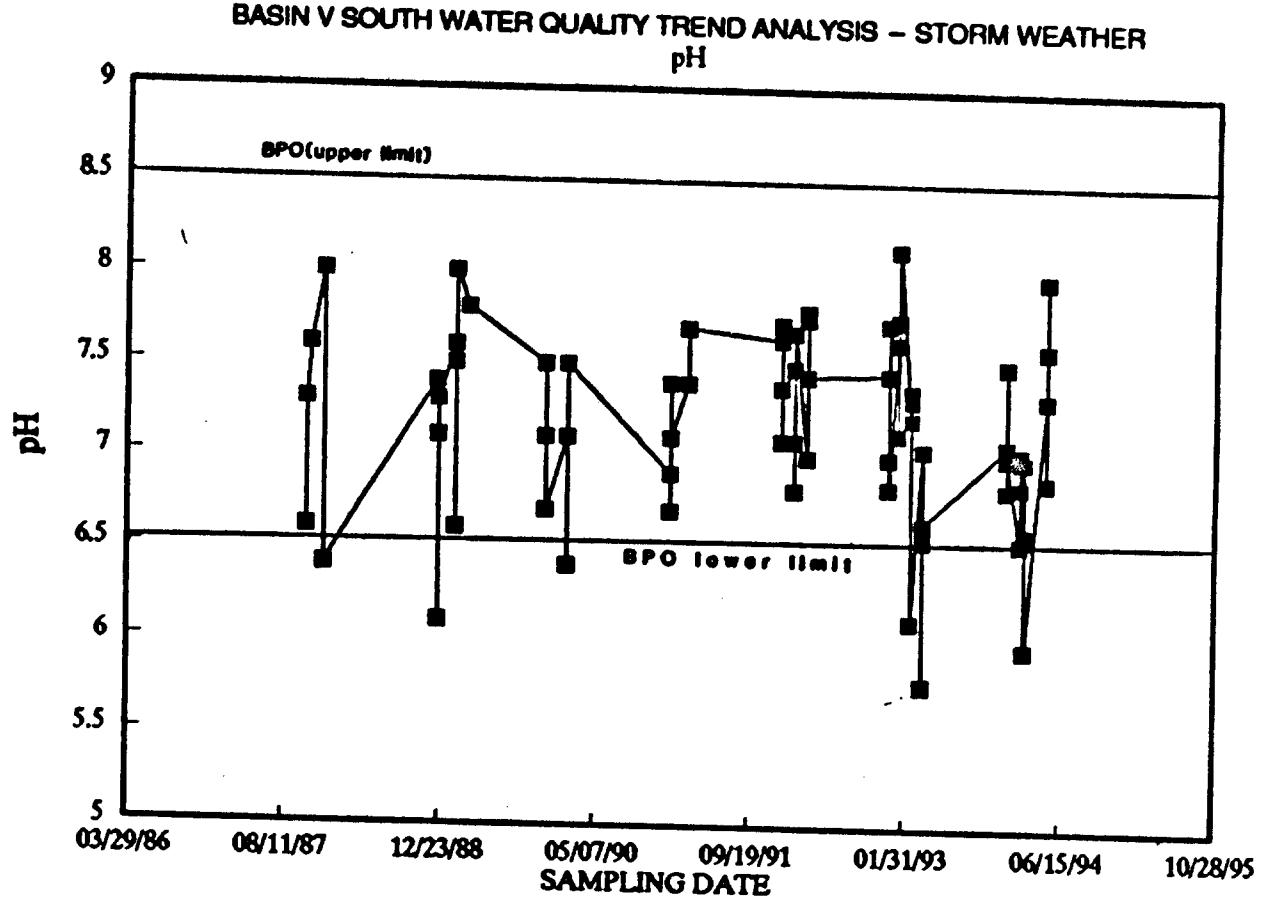
BASIN V SOUTH WATER QUALITY TREND ANALYSIS – STORM WEATHER
SULFATE



R0061214

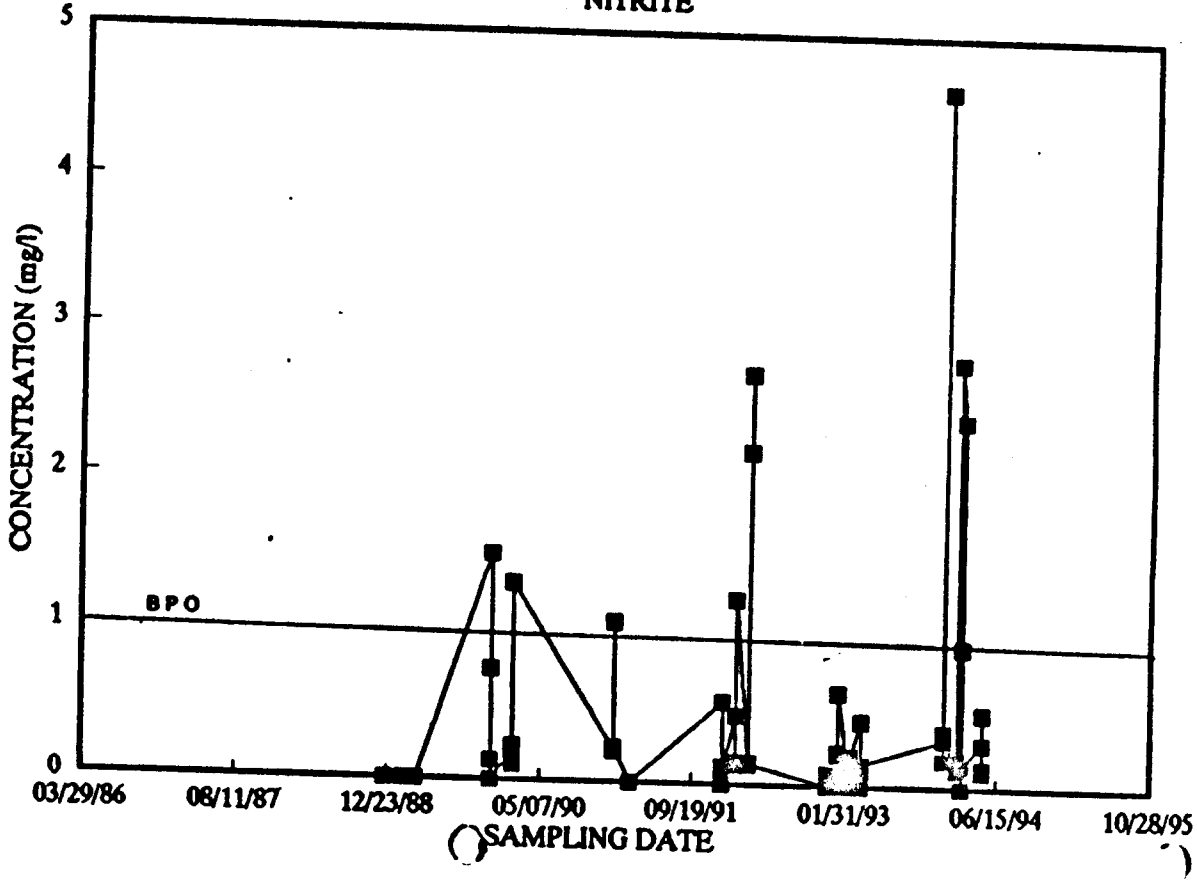
VOL 15

0994


BASIN V SOUTH WATER QUALITY TREND ANALYSIS – STORM WEATHER
pH
BPO(upper limit)
BPO lower limit
pH
9
8.5
8
7.5
7
6.5
6
5.5
5
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061215

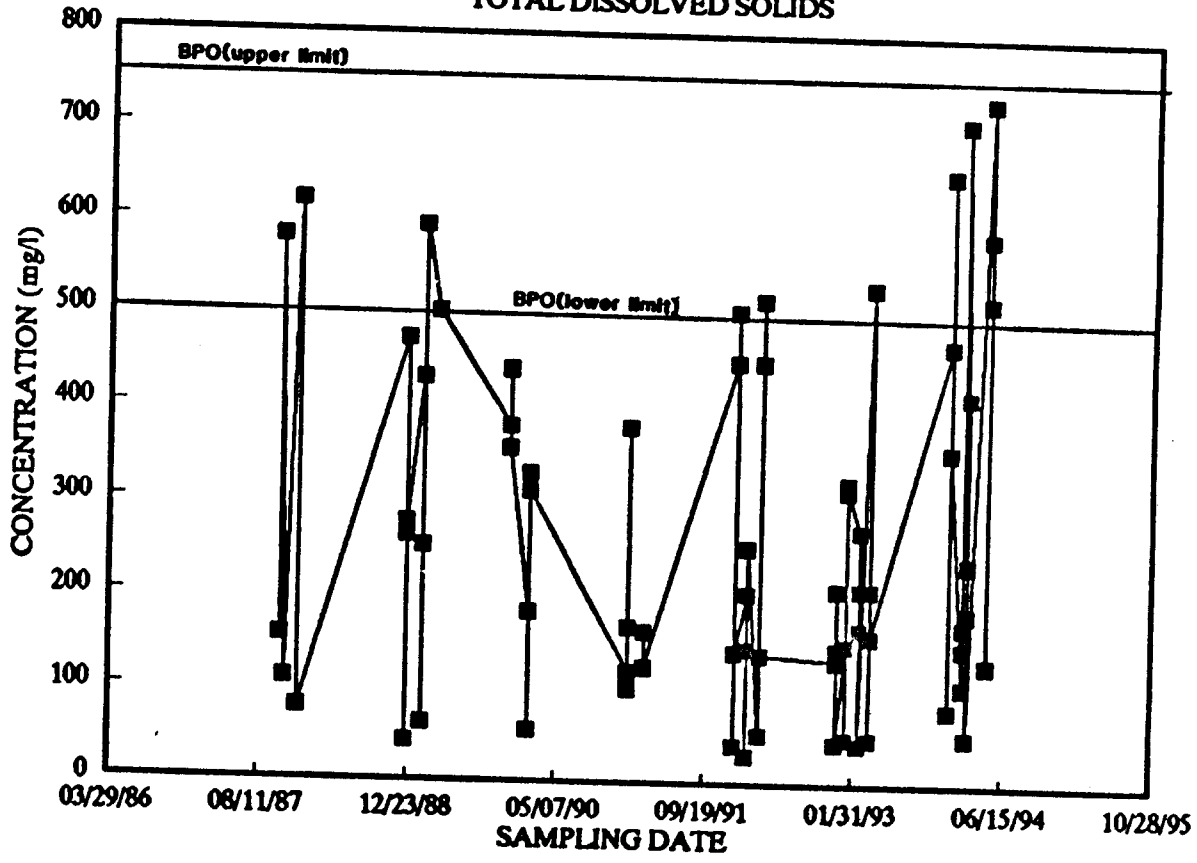
BASIN V SOUTH WATER QUALITY TREND ANALYSIS – STORM WEATHER
NITRITE



R0061216

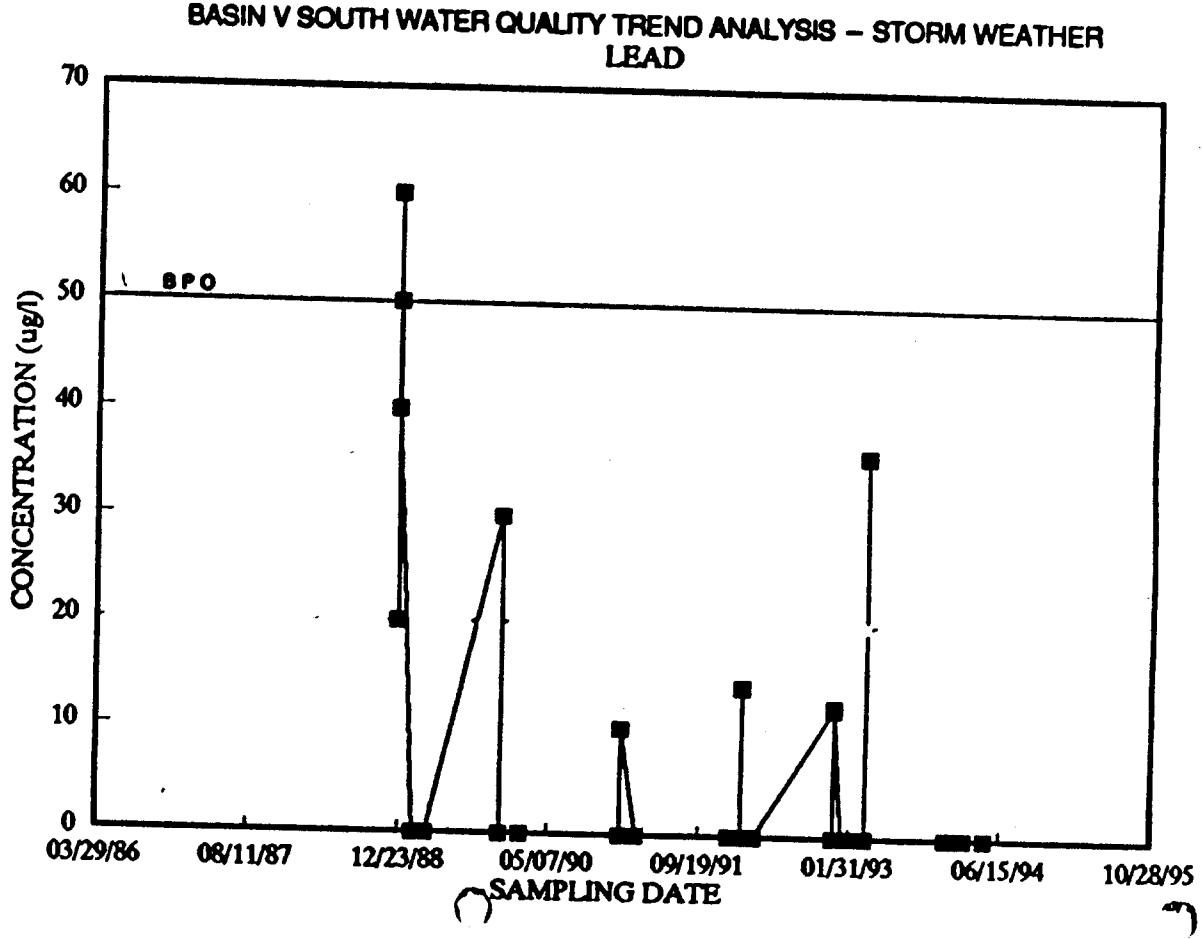
0996 15 VOL

BASIN V SOUTH WATER QUALITY TREND ANALYSIS – STORM WEATHER
TOTAL DISSOLVED SOLIDS



R0061217

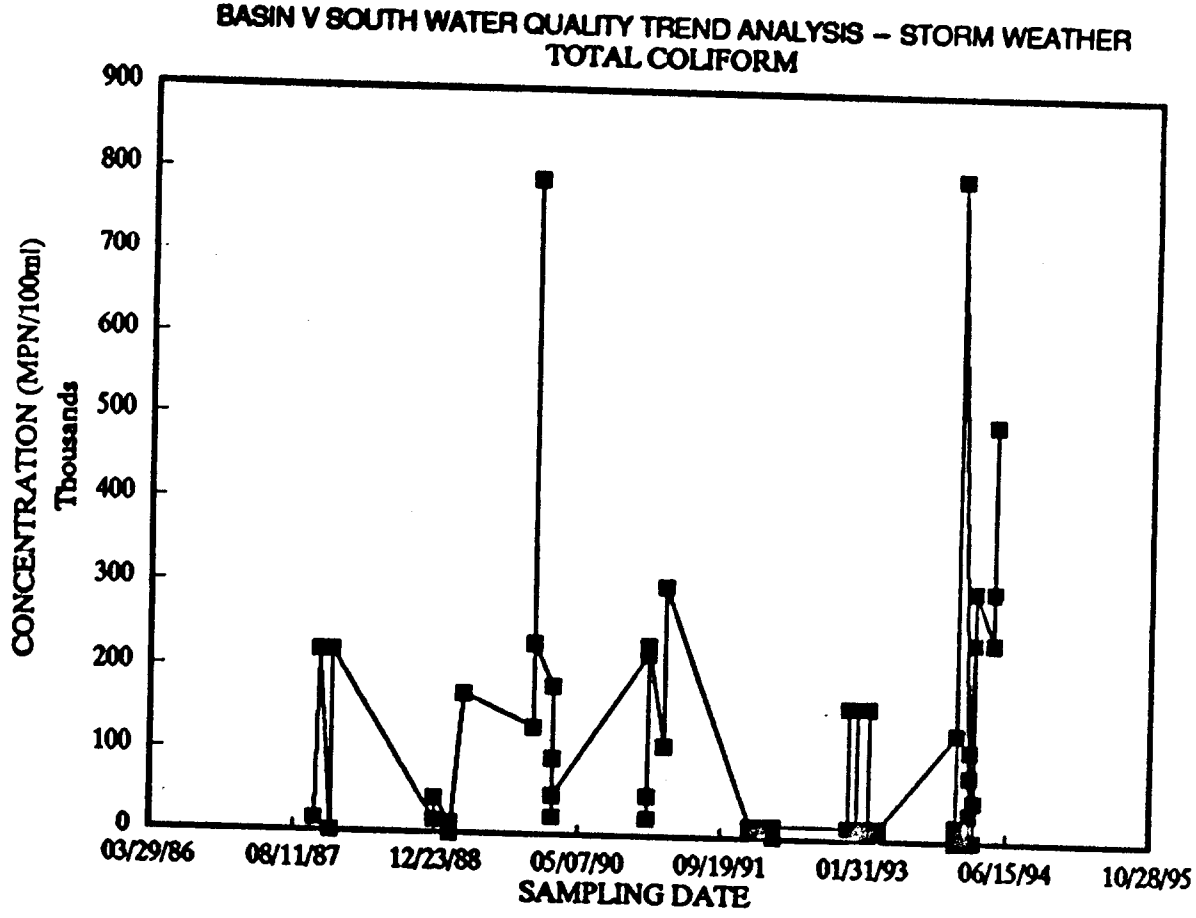
BASIN V SOUTH WATER QUALITY TREND ANALYSIS – STORM WEATHER
LEAD



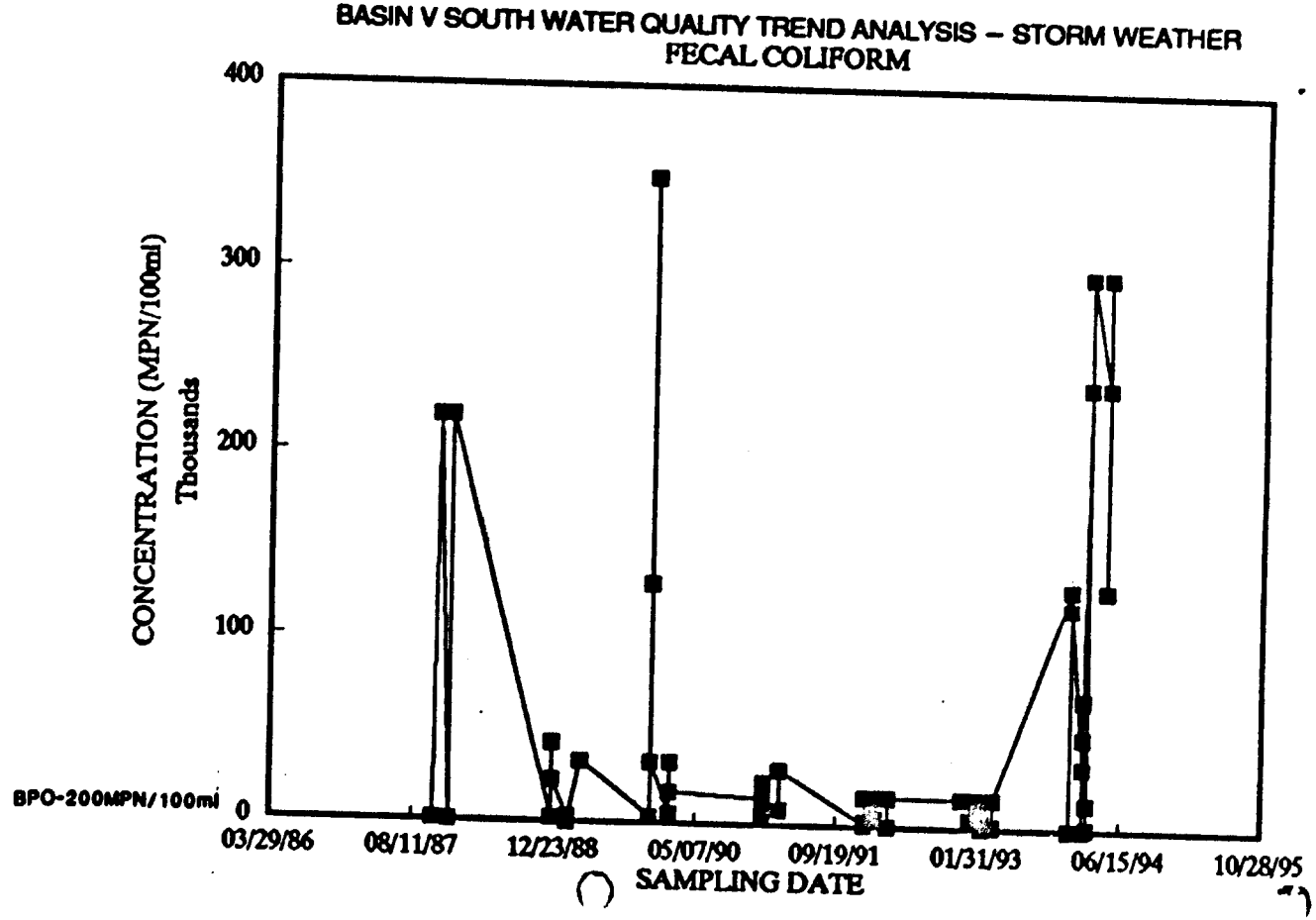
R0061218

VOL 15

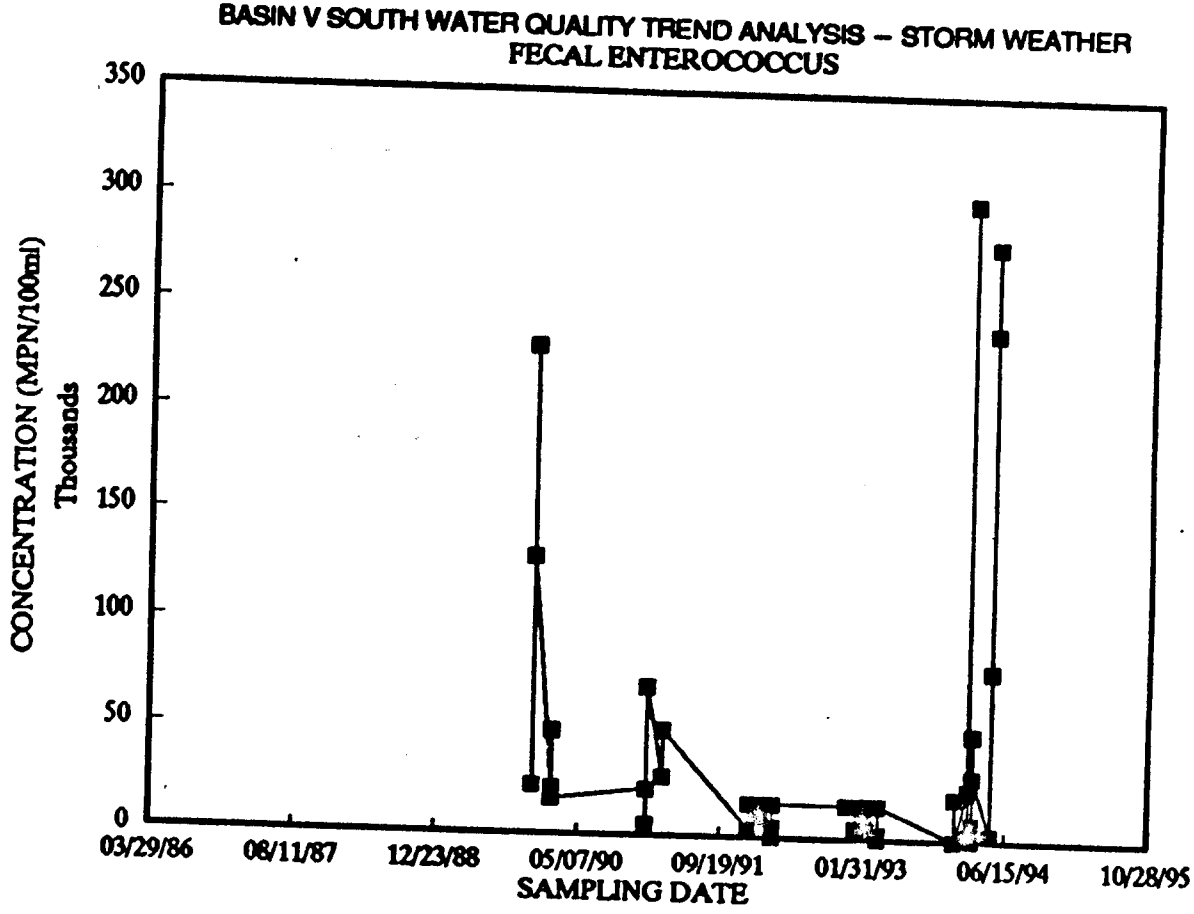
0998


BASIN V SOUTH WATER QUALITY TREND ANALYSIS – STORM WEATHER
TOTAL COLIFORM
CONCENTRATION (MPN/100ml)
Thousands
900
800
700
600
500
400
300
200
100
0
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061219

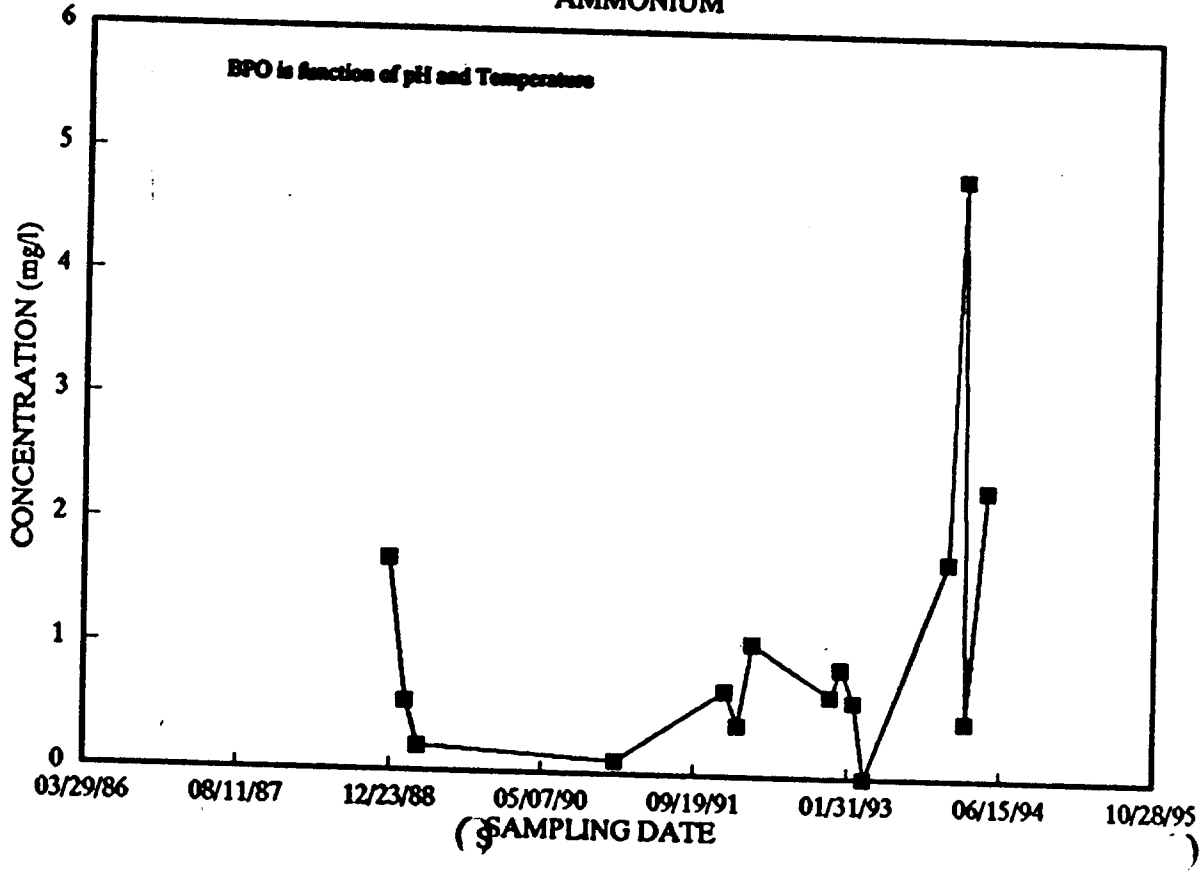

BASIN V SOUTH WATER QUALITY TREND ANALYSIS – STORM WEATHER
FECAL COLIFORM
CONCENTRATION (MPN/100ml)
Thousands
400
300
200
100
0
BPO-200MPN/100ml
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061220

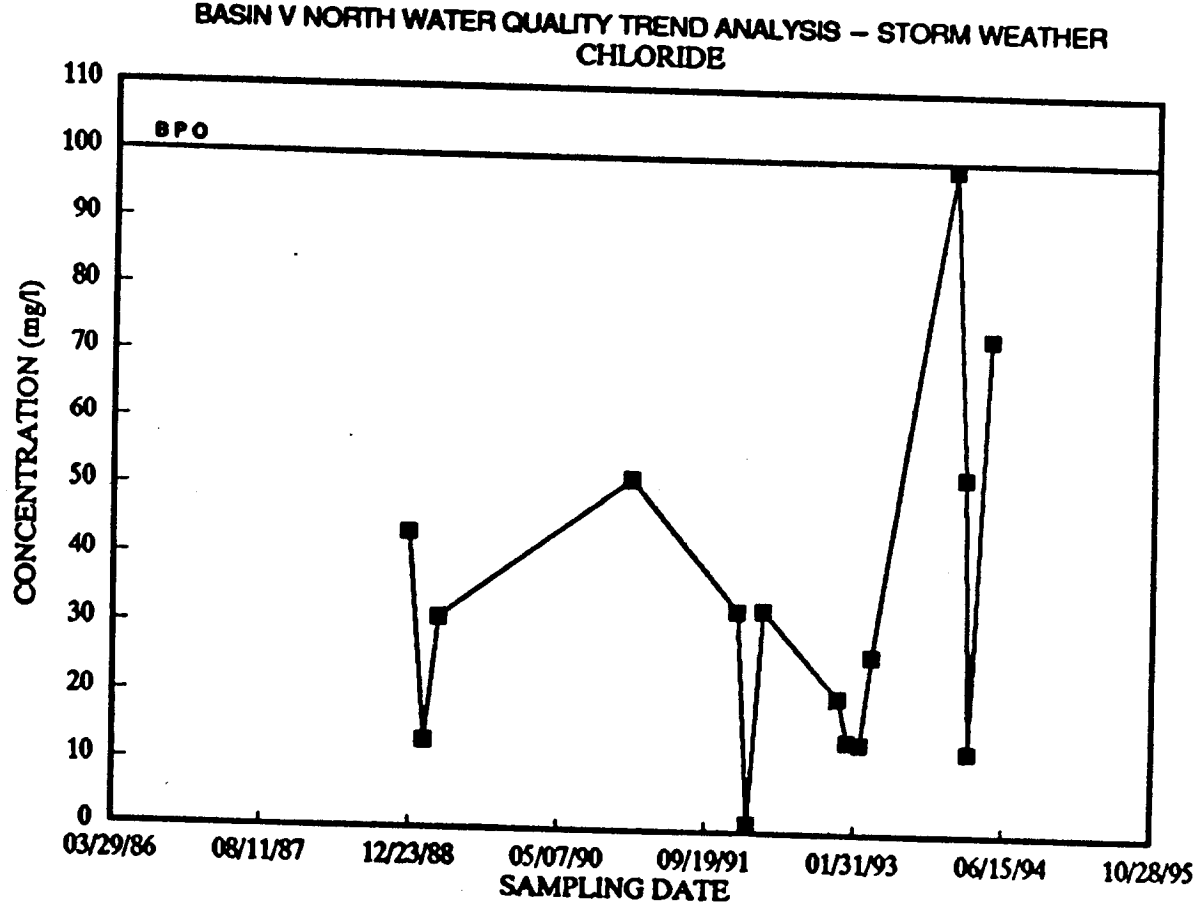

BASIN V SOUTH WATER QUALITY TREND ANALYSIS – STORM WEATHER
FECAL ENTEROCOCCUS
CONCENTRATION (MPN/100ml)
Thousands
350
300
250
200
150
100
50
0
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061221

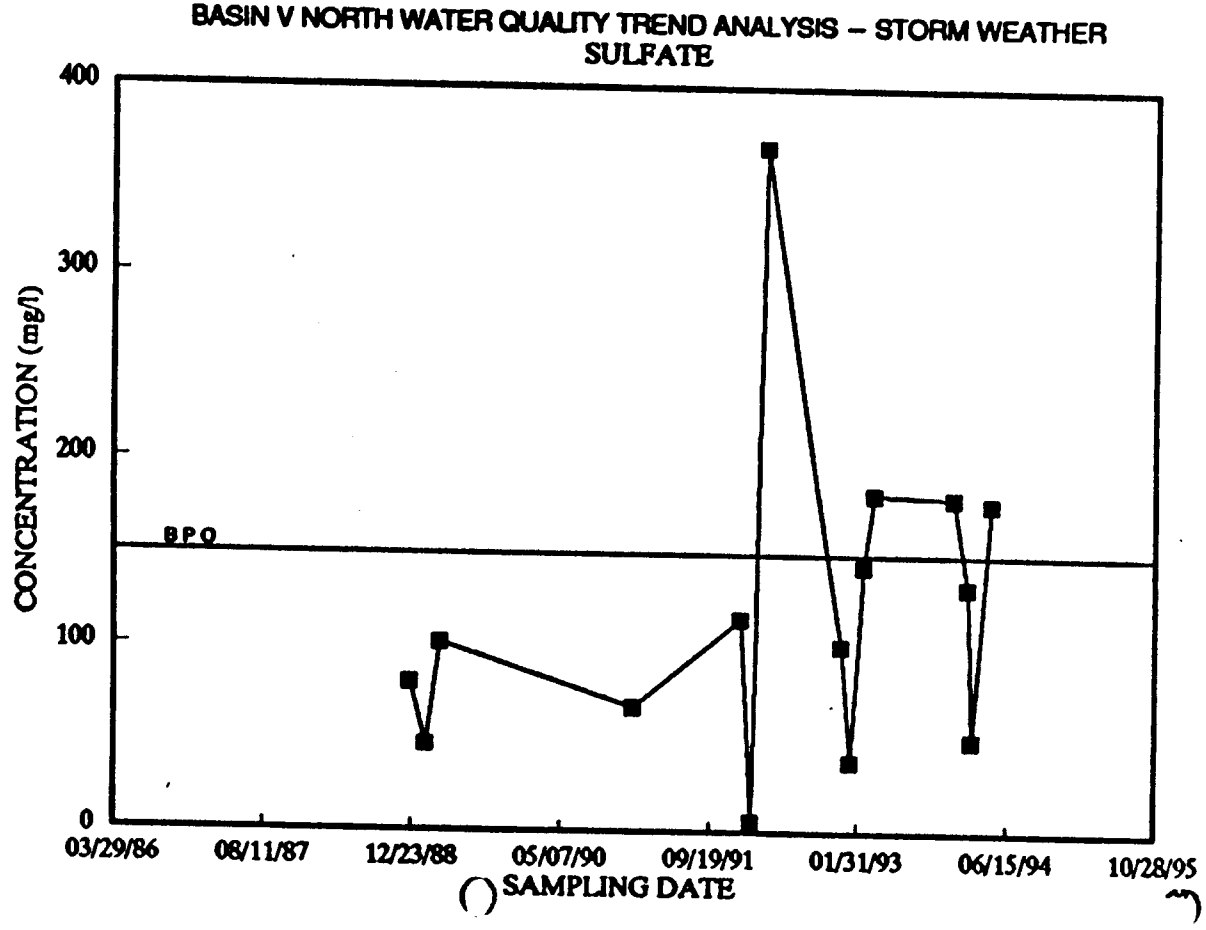
BASIN V NORTH WATER QUALITY TREND ANALYSIS – STORM WEATHER
AMMONIUM



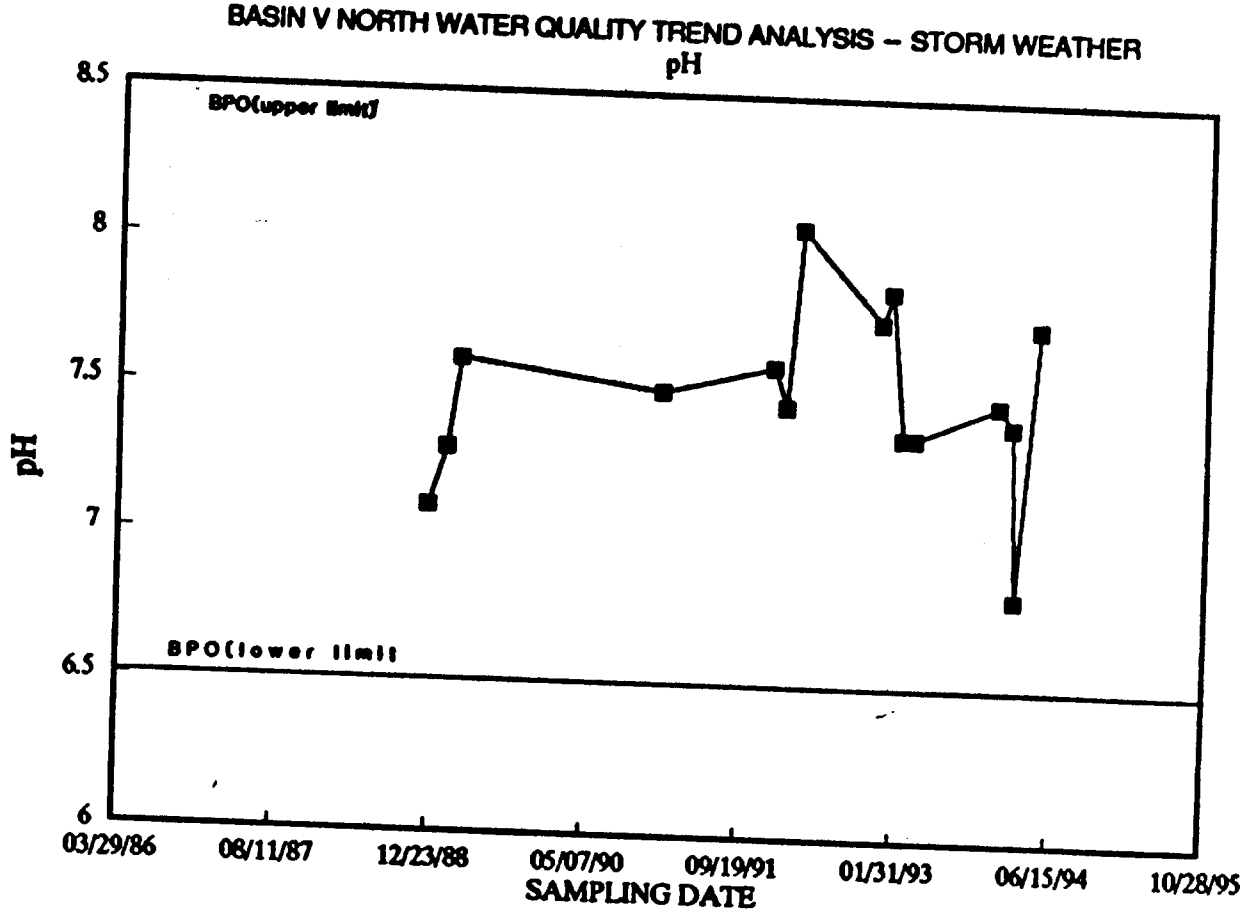
R0061222


BASIN V NORTH WATER QUALITY TREND ANALYSIS – STORM WEATHER
CHLORIDE
BPO
CONCENTRATION (mg/l)
110
100
90
80
70
60
50
40
30
20
10
0
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

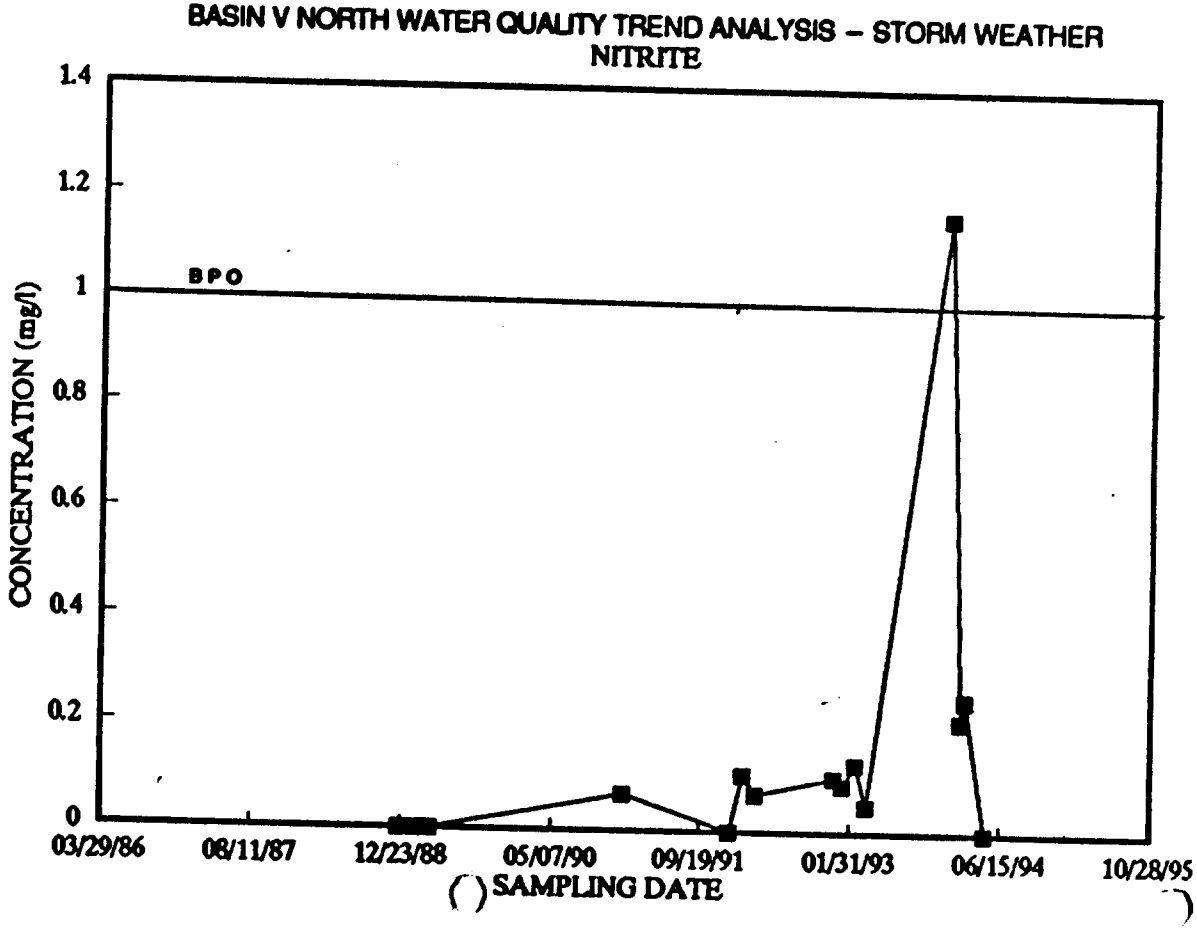
R0061223


BASIN V NORTH WATER QUALITY TREND ANALYSIS – STORM WEATHER
SULFATE
400
300
200
100
0
CONCENTRATION (mg/l)
BPO
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061224

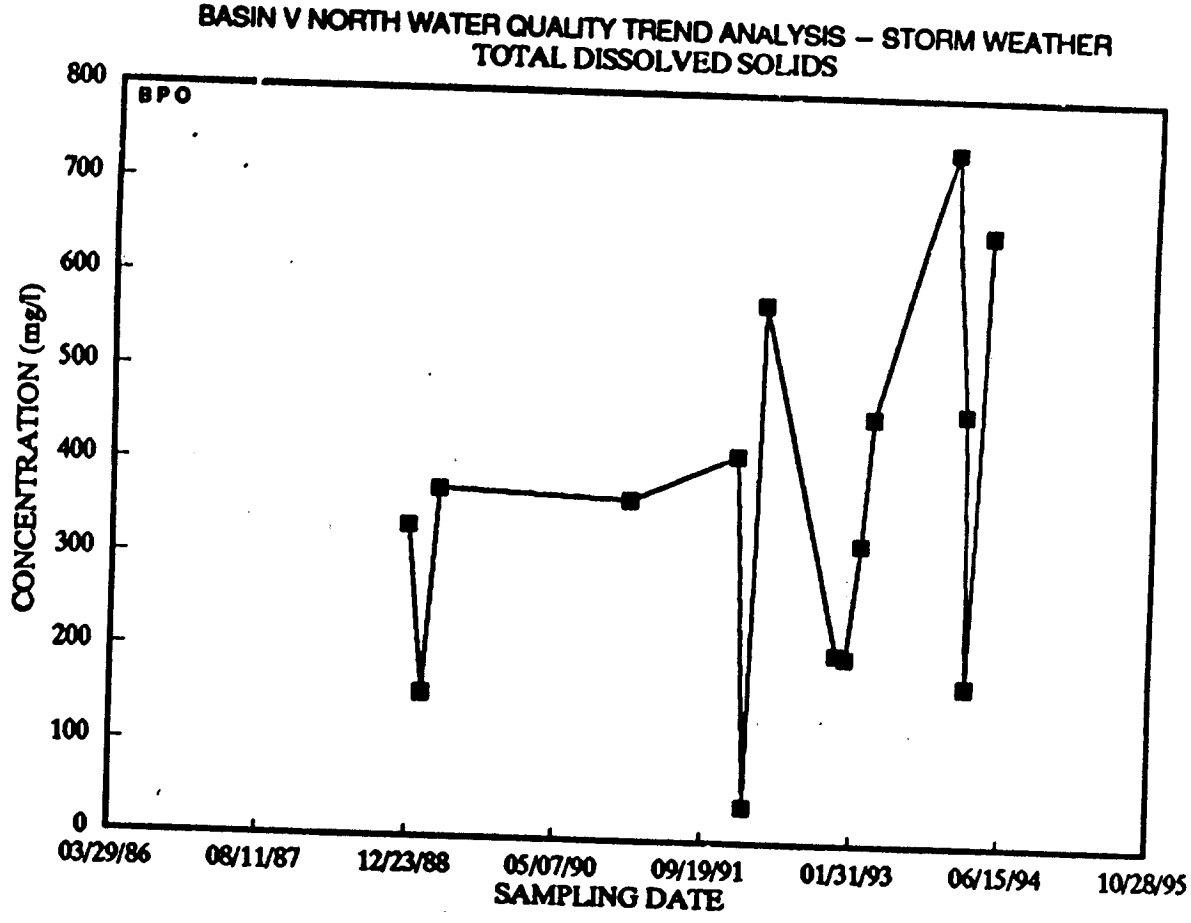

BASIN V NORTH WATER QUALITY TREND ANALYSIS -- STORM WEATHER
pH
BPO(upper limit)
BPO(lower limit
8.5
8
7.5
7
6.5
6
pH
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061225


BASIN V NORTH WATER QUALITY TREND ANALYSIS – STORM WEATHER
NITRITE
1.4
1.2
1
0.8
0.6
0.4
0.2
0
BPO
CONCENTRATION (mg/l)
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061226

BASIN V NORTH WATER QUALITY TREND ANALYSIS – STORM WEATHER
TOTAL DISSOLVED SOLIDS



R0061227

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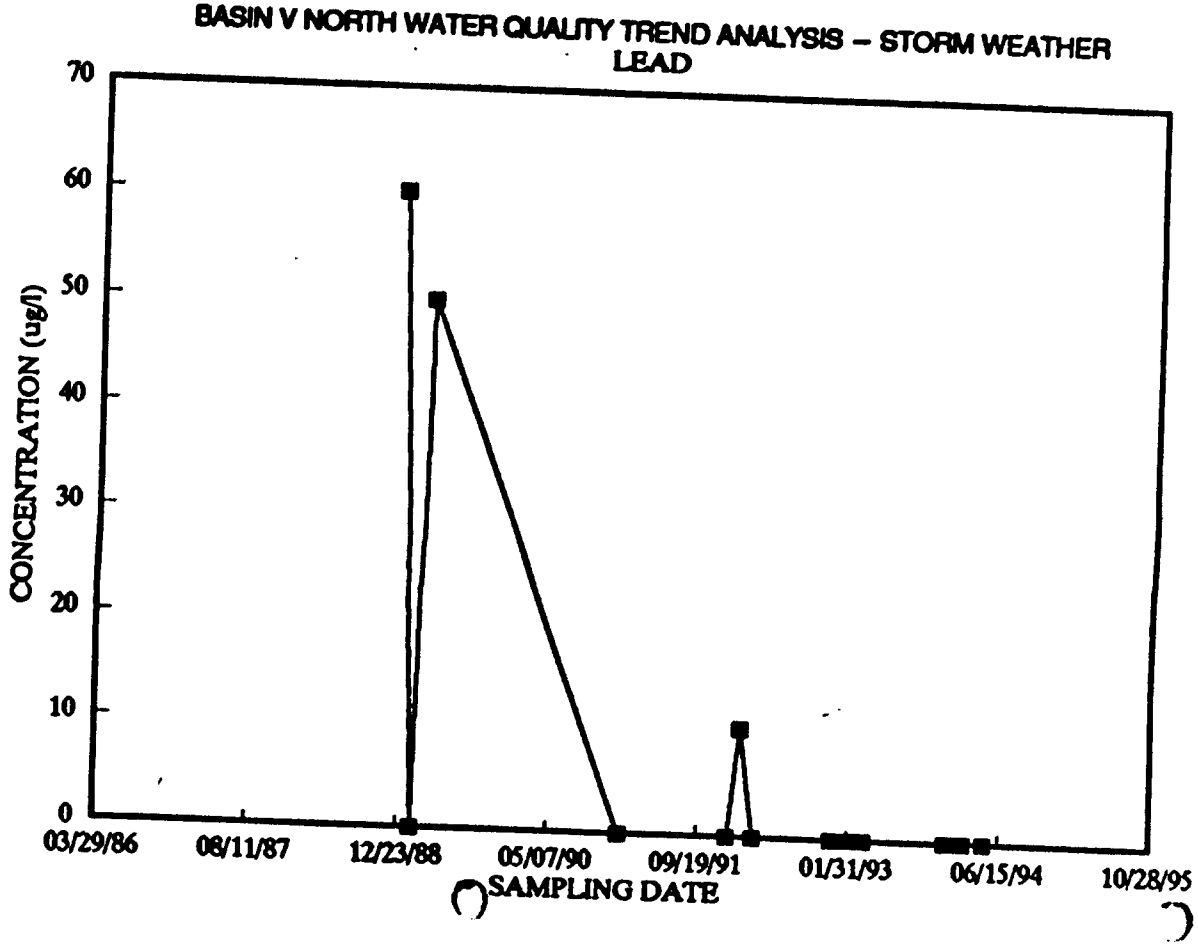
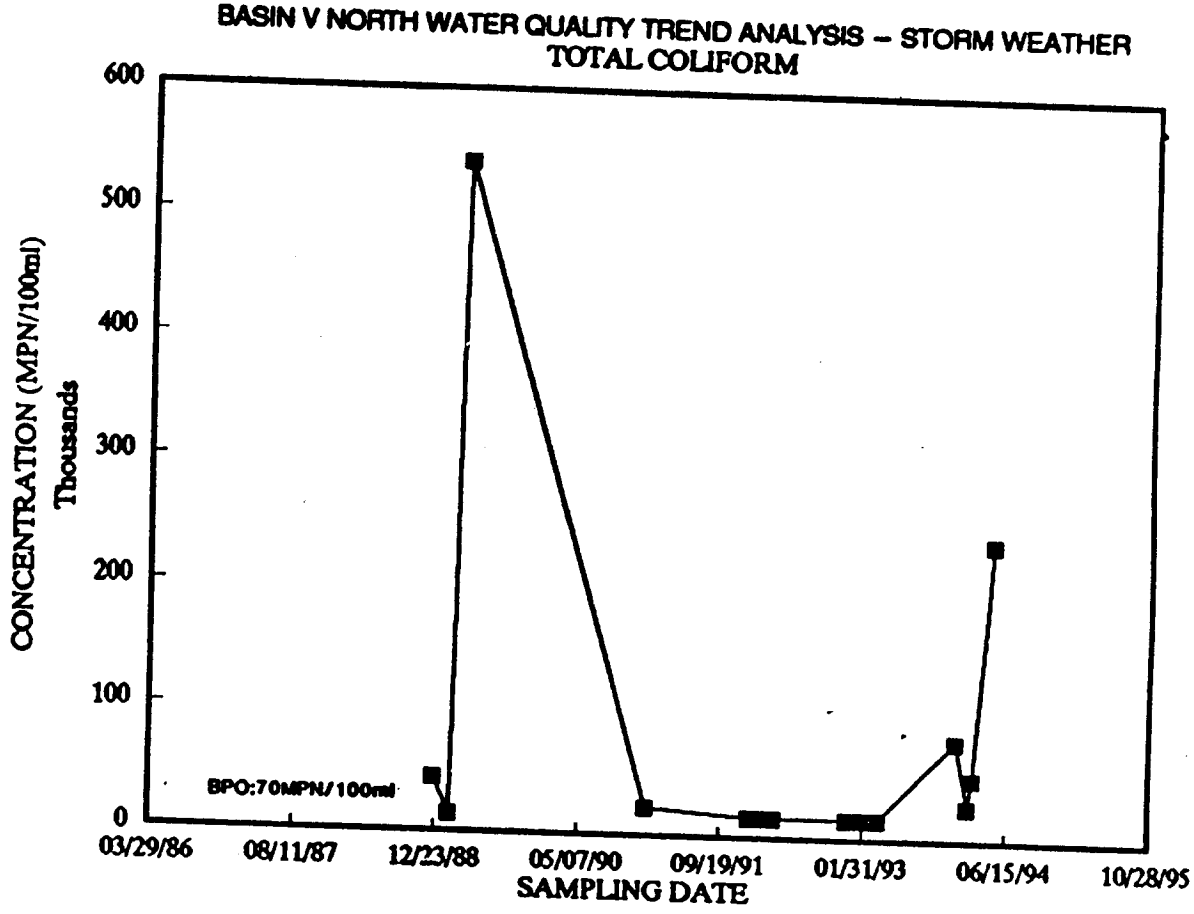
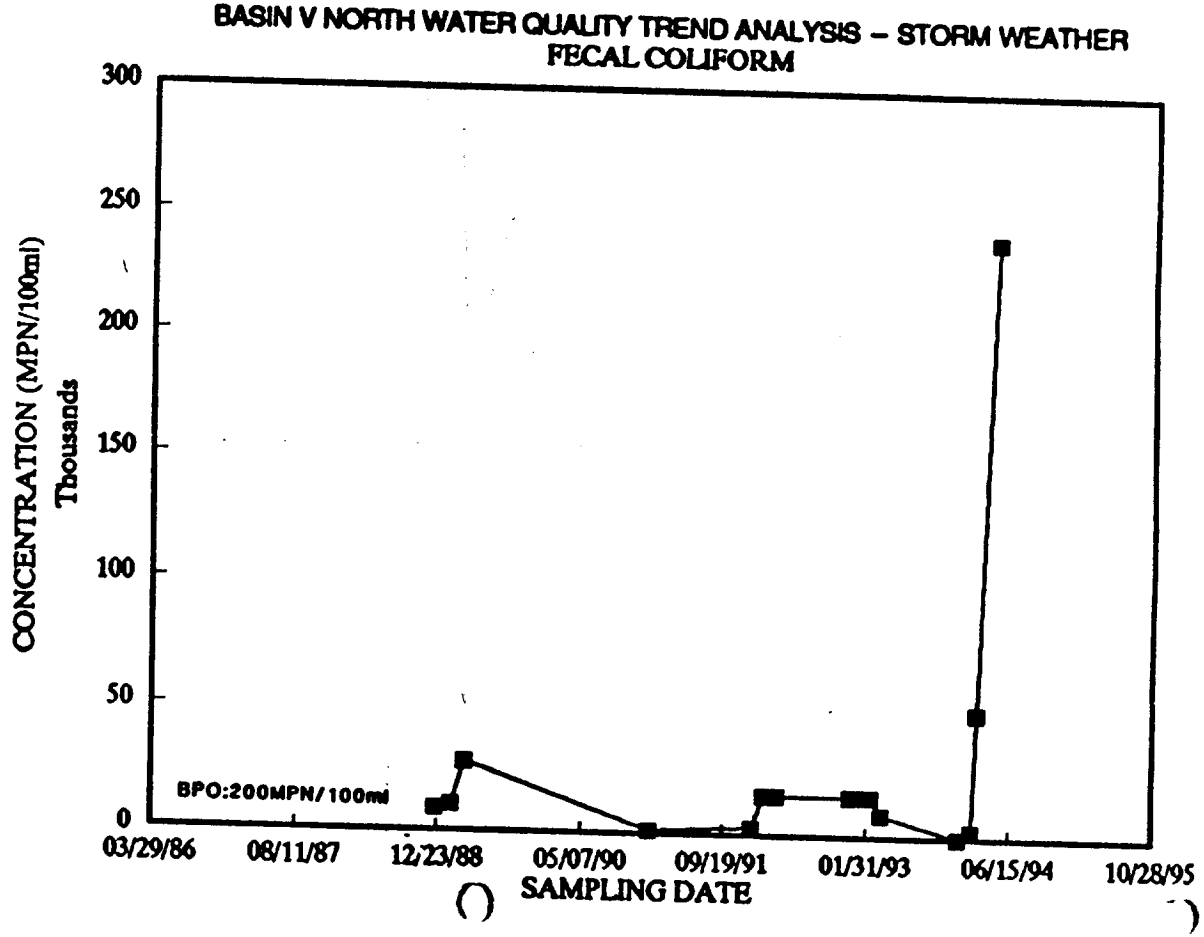

BASIN V NORTH WATER QUALITY TREND ANALYSIS – STORM WEATHER
LEAD
CONCENTRATION (ug/l)
70
60
50
40
30
20
10
0
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

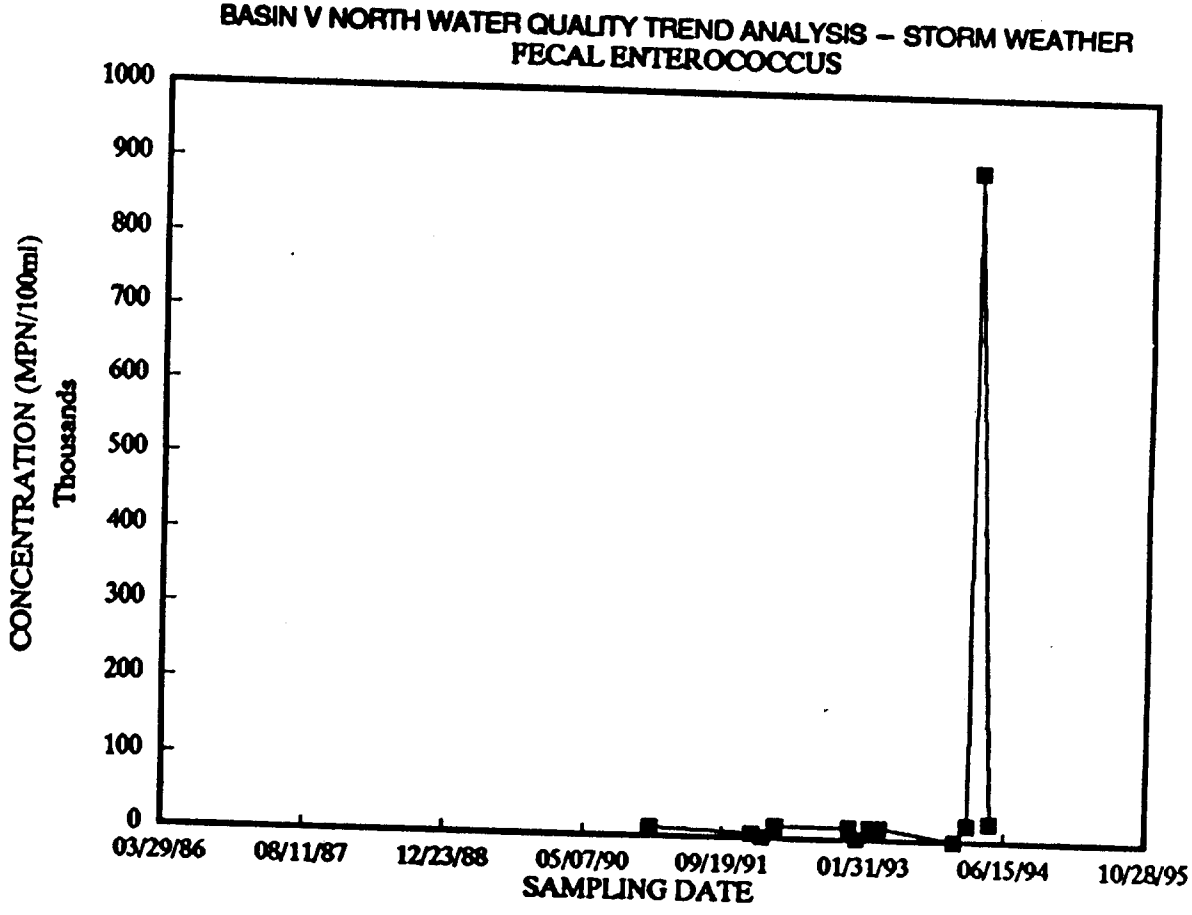
R0061228


BASIN V NORTH WATER QUALITY TREND ANALYSIS – STORM WEATHER
TOTAL COLIFORM
CONCENTRATION (MPN/100ml)
Thousands
600
500
400
300
200
100
0
BPO:70MPN/100ml
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061229


BASIN V NORTH WATER QUALITY TREND ANALYSIS – STORM WEATHER
FECAL COLIFORM
CONCENTRATION (MPN/100ml)
Thousands
300
250
200
150
100
50
0
BPO:200MPN/100ml
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061230


BASIN V NORTH WATER QUALITY TREND ANALYSIS – STORM WEATHER
FECAL ENTEROCOCCUS
CONCENTRATION (MPN/100ml)
Thousands
1000
900
800
700
600
500
400
300
200
100
0
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
SAMPLING DATE

R0061231

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BEST MANAGEMENT PRACTICES
Matrix

Revision: 11/08/96

Num	CITY	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1.	AGOURA HILLS	10	10	10	10	10	10	10	10	10	X	10	10	10
2.	ALHAMBRA	P	10	10	10	10	10	10	10	10	10	10	10	10
3.	ARCADIA	P	5	P	10	10	10	10	5	P	X	10	10	5
4.	ARTESIA	P	10	5	P	10	10	10	P	10	X	10	10	X
5.	AZUSA	P	P	P	P	5	5	10	5	5	P	P	10	P
6.	BALDWIN PARK	P	10	X	P	10	10	10	5		5	5	10	
7.	BELL	P	P	P	P	10	P	10	5	P	P	P	10	P
8.	BELLFLOWER	10	10	10	P	10	10	10	5	10	P	10	10	P
9.	BELL GARDENS	P	P	P	P	P	5	10	P	P	P	10	10	P
10.	BEVERLY HILLS	10	10	10	5	10	10	10	10	10	10	10	10	10
11.	BRADBURY													
12.	BURBANK	X	X	10	P	10	10	10	5	5	P	10	10	5
13.	CALABASAS	5	10	5	P	10	10	10	5	X	X	10	10	5
14.	CAL TRANS	5	5	10	5	5	5	5	5	* NA	* NA	* NA	* NA	10
15.	CARSON	5	10	10	10	10	5	10	5	10	5	10	10	5
16.	CERRITOS	P	10	P	P	10	5	10	5	5	X	X	10	5
17.	CLAREMONT	P	P	P	P	10	5	10	X	5	X	5	10	5
18.	COMMERCE	P	P	5	P	10	10	10	10	5	P	10	10	5
19.	COMPTON	P	5	X	P	10	5	10	10	10	5	10	10	5
20.	COVINA	P	5	10	5	5	5	10	P	P	P	10	10	5
21.	CUDAHY	P	P	P	P	10	10	10	5	10	P	P	10	P
22.	CULVER CITY	10	10	10	10	10	10	10	10	10	10	10	10	5
23.	DIAMOND BAR	10	10	10	5	10	* NA	10	5	10	5	10	10	5
24.	DOWNEY	5	5	10	P	10	10	10	5	5	5	10	10	5
25.	DUARTE	P	10	10	10	10	10	10	5	10	5	10	10	5

08-Nov-96

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BEST MANAGEMENT PRACTICES
Matrix

Revision: 11/08/94

Num	CITY	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
26.	EL MONTE	10	P	10	5	10	5	10	5	10	5	5	10	X
27.	EL SEGUNDO	10	10	5	10	10	10	10	10	10	10	10	10	10
28.	GARDENA	P	P	5	P	10	X	10	P	10	P	10	10	P
29.	GLENDALE	X	5	P	X	10	5	10	5	10	X	10	10	X
30.	GLENDORA	10	10	P	10	10	10	10	P	5	10	10	10	10
31.	HAWAIIAN GARDENS	P	10	X	P	10	10	10	5	5	5	X	10	5
32.	HAWTHORNE	10	10	10	5	10	10	10	10	5	5	10	10	10
33.	HERMOSA BEACH	10	10	P	10	10	5	10	10	P	P	10	10	P
34.	HIDDEN HILLS	P	10	10	10	10	5	10	5	* NA	* NA	10	10	10
35.	HUNTINGTON PARK	P	5	P	P	10	10	10	10	P	P	5	10	5
36.	INDUSTRY	P	10	10	5	10	10	10	10	5	10	P	10	10
37.	INGLEWOOD	10	X	P	10	10	10	10	5	5	5	5	10	10
38.	IRWINDALE	P	5	P	X	10	10	10	X	10	P	10	10	X
39.	LA CANADA-FLINTRIDGE	P	10	10	10	10	10	10	5	10	10	10	10	X
40.	LA HABRA HEIGHTS	P	10	5	P	10	X	X	X	X	X	5	10	5
41.	LAKEWOOD	P	10	P	P	10	10	10	P	10	X	5	10	10
42.	LA MIRADA	P	10	5	10	10	X	10	P	X	5	P	10	10
43.	L.A. CO. PUBLIC WORKS	5	10	10	10	10	10	10	10	10	10	10	10	10
44.	LA PUENTE	P	10	5	10	10	10	10	X	10	5	10	10	P
45.	LA VERNE	P	X	X	X	5	5	10	5	5	X	10	10	10
46.	LAWNDALE	P	X	P	X	10	5	10	X	10	X	5	10	X
47.	LOMITA	P	X	X	X	10	5	10	X	10	X	10	10	5
48.	LONG BEACH	P	10	P	5	10	10	10	P	10	5	10	10	P
49.	LOS ANGELES	5	10	5	10	10	5	10	10	10	5	10	10	10
50.	LYNWOOD	P	10	P	10	10	10	10	5	10	P	X	10	X

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BEST MANAGEMENT PRACTICES
Matrix

Revision: 11/08/94

Num	CITY	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
51.	MALIBU	10	10	10	10	5	* NA	10	10	P	10	10	10	5
52.	MANHATTAN BEACH	10	10	10	10	10	10	10	10	5	10	10	10	10
53.	MAYWOOD	P	P	P	P	10	P	10	5	P	P	P	10	P
54.	MONROVIA	X	10	P	10	10	10	10	5	P	P	10	10	5
55.	MONTEBELLO	5	10	10	P	10	10	10	10	5	5	10	10	5
56.	MONTEREY PARK	P	5	5	10	10	10	10	5	P	5	10	10	5
57.	NORWALK	P	10	10	P	10	10	10	5	10	5	P	10	10
58.	PALOS VERDES ESTATES	10	10	10	10	10	10	10	5	5	5	10	10	10
59.	PARAMOUNT	P	P	P	P	10	10	10	5	P	5	5	10	5
60.	PASADENA	P	10	10	10	10	10	10	10	10	P	10	10	10
61.	PICO RIVERA	10	P	10	5	10	10	10	10	5	5	5	10	5
62.	POMONA	P	10	10	P	10	10	10	5	10	5	10	10	10
63.	RANCHO PALOS VERDES	10	10	5	10	10	10	10	10	P	10	10	10	10
64.	REDONDO BEACH	10	10	10	5	10	10	10	10	5	5	10	10	5
65.	ROLLING HILLS	5	10	10	10	10	* NA	* NA	10	* NA	* NA	10	10	10
66.	ROLLING HILLS ESTATES	10	10	10	10	10	10	10	10	10	10	10	10	10
67.	ROSEMEAD	P	10	P	5	10	10	10	5	P	5	10	10	5
68.	SAN DIMAS	5	10	10	P	10	10	10	5	10	X	10	10	5
69.	SAN FERNANDO	10	10	10	P	10	10	10	5	10	5	10	10	10
70.	SAN GABRIEL	P	10	X	5	10	10	10	X	5	X	10	10	5
71.	SAN MARINO	10	10	10	10	10	10	10	10	P	10	10	10	10
72.	SANTA CLARITA	5	10	10	10	5	10	10	X	10	5	10	10	10
73.	SANTA FE SPRINGS	X	10	10	5	10	10	10	5	10	10	5	10	5
74.	SANTA MONICA	10	10	10	10	10	10	10	5	10	10	10	10	10
75.	SIERRA MADRE	X	X	X	X	10	10	10	X	5	X	10	10	5

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BEST MANAGEMENT PRACTICES
Matrix

Revision: 11/08/94

Num	CITY	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
76.	SIGNAL HILL	P	10	10	10	10	10	10	10	10	10	10	10	10
77.	SOUTH EL MONTE	P	10	X	10	10	10	10	5	10	10	10	10	10
78.	SOUTH GATE	P	5	10	10	10	10	10	P	10	5	10	10	10
79.	SOUTH PASADENA	X	X	X	X	10	10	10	5	10	X	10	10	5
80.	TEMPLE CITY	X	X	X	X	10	10	10	5	10	5	10	10	5
81.	TORRANCE	5	10	10	10	10	10	10	10	5	10	10	10	10
82.	VENTURA COUNTY	P	X	10	10	5	* NA	10	5	10	5	10	10	10
83.	VERNON	P	10	10	5	10	10	10	5	10	5	10	10	P
84.	WALNUT	P	10	10	P	10	10	10	5	10	10	10	10	5
85.	WEST COVINA	5	5	10	5	10	10	10	5	10	5	5	10	5
86.	WEST HOLLYWOOD	10	10	10	10	10	10	10	10	10	10	10	10	10
87.	WESTLAKE VILLAGE	10	10	5	10	10	* NA	10	5	5	10	10	10	10
88.	WHITTIER	5	X	10	5	10	10	10	5	10	P	10	10	5
Total	Fully Implemented (10)	23	55	44	36	79	61	84	26	45	20	64	86	33
	Partially Implemented (5)	13	11	12	16	7	16	1	43	21	31	12	0	35
	Planned/Proposed (P)	44	11	21	27	1	2	0	9	14	17	7	0	11
	Not Implemented (X)	7	10	10	8	0	3	1	9	3	17	3	0	7
	NA/No City Response	1	1	1	1	1	6	2	1	5	3	2	2	2
%	Fully Implemented (10)	26.14%	62.50%	50.00%	40.91%	89.77%	69.32%	95.45%	29.55%	51.14%	22.73%	72.73%	97.73%	37.50%
	Partially Implemented (5)	14.77%	12.50%	13.64%	18.18%	7.95%	18.18%	1.14%	48.86%	23.86%	35.23%	13.64%	0.00%	39.77%
	Planned/Proposed (P)	50.00%	12.50%	23.86%	30.68%	1.14%	2.27%	0.00%	10.23%	15.91%	19.32%	7.95%	0.00%	12.50%
	Not Implemented (X)	7.95%	11.36%	11.36%	9.09%	0.00%	3.41%	1.14%	10.23%	3.41%	19.32%	3.41%	0.00%	7.95%
	NA/No City Response	1.14%	1.14%	1.14%	1.14%	1.14%	6.82%	2.27%	1.14%	5.68%	3.41%	2.27%	2.27%	2.27%

**SYMBOLS

10 Fully Implemented
5 Partially Implemented
P Planned/Proposed
X Not Implemented
* NA Not Applicable
No City Response

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NPDES PERMIT NO. CA 0061654

TASK 5.2

REPORT OF WASTE DISCHARGE (ROWD)

VOLUME 8 OF 8 (TASK 5.2.1)

SECTION B - Work Plan for the Phase I, II, and III Stormwater Monitoring Program

LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS
WASTE MANAGEMENT DIVISION
WATER QUALITY SECTION

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SECTION B

Work Plans for the Phase I, II, and III
Stormwater/Urban Runoff Monitoring Program

Work plans for the Monitoring Program for all three Phases have been previously submitted to the Regional Board as required by the current NPDES Permit. Two work plans were submitted: one for Phase I, and another for Phases II and II. With the exception of the actual monitoring site locations, all other elements of the two work plans are the same (i.e., sampling methodology, constituents to be sampled, frequency of sampling, QA/QC, etc.). Therefore, only the site description portion of the Phase I work plan is included herein. For all other Monitoring Program elements, please refer to the Phase II and II work plan herein.

Also, Appendices 1 through 4 of the Phase II and III work plan will only be included in the copy of the ROWD provided to the Regional Board. These Appendices are available upon request by contacting the Los Angeles County Department of Public Works, Waste Management Division, Water Quality Section, at (818) 458-6972.

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NPDES PERMIT NO. CA 0061654

PHASE I

SANTA MONICA BAY DRAINAGE BASIN

PROPOSED STORMWATER/URBAN RUNOFF MONITORING PROGRAM



LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS
WASTE MANAGEMENT DIVISION
WATER QUALITY SECTION

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R0061238

II. PROPOSED MONITORING SITES

SITE SELECTION CRITERIA

A. Monitoring Site Selection Overview

In order to characterize the quality of runoff from the Santa Monica Bay Drainage Basin, a combination of single land-use sites and large watersheds representing multiple land uses ("mass emissions" sites) have been selected.

For the Santa Monica Bay Drainage Basin nine monitoring sites have been proposed. Four of the nine sites will be mass emissions stations. Five will be land-use specific stations. The remaining site will function as both a mass emissions and land-use specific monitoring station. Additional land-use specific monitoring stations will be proposed as part of the monitoring program to be developed for Phase III of the NPDES Permit. As stated in our third-year report, dated July 1, 1993, we estimated submittal of the proposed monitoring program for Phase II to the RWQCB by February 28, 1994.

The proposed monitoring sites represent an effort to select the most suitable locations based on our established criteria for sampling. Where feasible, we have incorporated into the program those storm drains which have water quality issues which are of concern to the community.

B. Specific Criteria for Mass Emissions Monitoring Sites

Mass emissions monitoring sites shall be located at the outlet (or the furthest downstream position practicable) of watersheds contributing the largest relative inputs to the Santa Monica Bay. These watersheds will typically have a complex multiple land-use composition. See Figure II-1.

C. Specific Criteria for Land-Use Specific Monitoring Sites

Land use-specific monitoring sites shall be located in watersheds where the upstream tributary area is comprised predominantly of one land use. It is important that the contributing watershed be at least 50 acres in size, in order to produce effective runoff characteristics.

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D. Criteria for both Mass Emissions and Land-Use Specific Sites

In selecting a specific storm drain for inclusion as either a mass emissions or land-use specific site, the following technical and operational requirements were addressed:

- What type of sampling equipment is to be used, and what limitations exist?
- What are the hydraulics of the underground storm drain, open channel/natural watercourse? What is the Design Q?
- Is there past flow data available for the given stream?
- What past hydrology studies have been performed in the watershed?. What is the hydrologic Q?
- If the storm drain is underground, is it currently under designed? Could it experience surcharge conditions?
- Within the watershed, what is the corresponding land use? Is land use uniform and homogenous throughout the upper tributary area? If yes, this is a possible land-use site.
- Has previous sampling in the potential watershed been conducted in the past? Where? When? Why?
- Are tidal or backwater influences a concern?
- Is the location selected the only outfall point for the upstream watershed, or are there multiple outfall points?
- Is the storm drain structurally sound at present? Will installation of sampling equipment compromise the stability of the storm drain?
- Will the monitoring equipment impede flow or reduce flood protection?
- For natural watercourses, is there an existing improved section where a rating curve can be easily established?
- What is the practicable design distance from the storm drain invert (low flow) to the location where the sampler shall be placed?
- Can electric power be provided, in a cost- effective manner, to the site?

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- Will additional right-of-way be required?
- Will the sampler installation interfere with projects planned or in progress in the general vicinity?
- If located in a residential neighborhood, will the location of the automated sampler and its operation result in any objections from the local residents?

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PROPOSED MASS EMISSIONS AND LAND-USE SPECIFIC MONITORING SITES

A. The following locations have been proposed as Mass Emissions sites:

1. Ballona Creek at Los Angeles County Department of Public Works Stream Gauge No. F38C-R in the City of Los Angeles.

The Ballona Creek station will be located at the existing stream gauge station between Sawtelle Boulevard and Sepulveda Boulevard. This facility currently measures stream flow and precipitation. At this location, the upstream tributary watershed of Ballona Creek is 88.7 square miles. The entire Ballona Creek watershed at its outlet to the ocean is 127.1 square miles, but because of tidal influences the sampling site must be located upstream. Therefore, the actual sampled watershed is less.

The land-use breakdown is as follows:

Open Space/Agriculture	19%
Low Density Residential	1%
Single Family Residential	25%
Low Density Multi-Family	5%
High Density Multi-Family/Institutional	32%
Commercial	14%
Industrial	4%

The overall impervious factor for this watershed is 53%.

Ballona Creek, at the gaging station, is an improved (concrete lined) trapezoidal channel. The vertical lift from the invert of the channel to the sampler location is approximately 30 feet. The horizontal distance is approximately 100 feet. Due to the elevation difference, an auxiliary pump will be required. See Figure III-3 for the proposed sampler installation.

This proposal replaces the existing County Department of Public Works Surface Water Quality Monitoring Station at the Sawtelle Boulevard bridge.

2. Malibu Creek at County Stream Gauge No. F130-R in Unincorporated County of Los Angeles.

The Malibu Creek monitoring station will be located at the existing stream gauge station, off of Malibu Canyon Road, south of Piuma Road. The existing facility provides flow measurement only. Because of

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tidal influences and the lack of any downstream improved section, the sampling site must be located here. Constructing an improved section at a location downstream would be costly, and would yield little difference in results. At this location, the tributary watershed to Malibu Creek is 104.9 square miles. The entire Malibu Creek watershed at its outlet to the ocean is 109.9 square miles. Therefore the actual sampled watershed is less.

The land-use breakdown is as follows:

Open Space/Agriculture	54%
Low Density Residential	29%
Single Family Residential	7%
Low Density Multi-Family	4%
High Density Multi-Family/Institutional	1%
Commercial	4%
Industrial	1%

The overall impervious factor for this watershed is 13%.

There are at least seven agencies, presently, that are monitoring the quality of surface water, sediment, groundwater and/or the overall health of the ecosystem (bioassessment and biomonitoring) within the Malibu Creek watershed. This proposed sampling location will replace the existing County Department of Public Works Surface Water Quality Sampling Station at Cross Creek Road.

3. **County of Los Angeles Kenter Canyon Storm Drain in the City of Santa Monica.**

Kenter Canyon Storm Drain is an underground brick arch drain. It outlets at the west end of Pico Boulevard. The outlet structure is commonly referred to as the Pico-Kenter storm drain. This outlet is the combination of three storm drains: Kenter Canyon, Caltrans 10 Freeway Storm Drain, and County Bond Issue Project No. 249, Pico Boulevard Drain, Line B. Only flows from the Kenter Canyon Storm Drain will be sampled.

The location where sampling will be conducted is upstream of the outlet structure. The tributary watershed area for Kenter Canyon Storm Drain is 6.4 square miles (the tributary area of the Caltrans drain and Pico Boulevard Drain is 0.8 square miles).

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The land-use breakdown is as follows:

Open Space/Agriculture	5%
Low Density Residential	39%
Single Family Residential	22%
Low Density Multi-Family	8%
High Density Multi-Family/Institutional	10%
Commercial	12%
Industrial	4%

The overall impervious value for this watershed is 39%.

The Pico-Kenter Drain has been a focal point for Santa Monica Bay with regards to the quality of dry-weather flows. The City of Santa Monica is currently pumping dry-weather flows to a City of Los Angeles sanitary sewer line, existing below The Promenade.

The County Department of Public Works presently samples the Pico-Kenter outlet structure. This proposed sampling location replaces the existing County Department of Public Works Surface Water Quality Monitoring Station at the Pico-Kenter outlet structure.

4. County of Los Angeles Bond Issue Project No. 1105, Line A, in the Cities of Hermosa and Redondo Beach.

Project No. 1105, Line A is an underground box/pipe in Herondo Street from Hermosa Avenue/Harbor Drive to Pacific Coast Highway. The proposed sampling location is near the intersection of Herondo Street and Valley Drive. At this location, the tributary watershed area is 4.23 square miles.

The land-use break down is as follows:

Open Space/Agriculture	2%
Low Density Residential	0%
Single Family Residential	63%
Low Density Multi-Family	16%
High Density Multi-Family/Institutional	4%
Commercial	10%
Industrial	5%

The overall impervious value for this watershed is 50%.

It is proposed that the sampling station be placed in the center median of Herondo Street. This is due to the lack of adequate sidewalk clearance. Tidal influences, depth to storm drain invert, and surcharge effects are the major factors impacting the selection of this site.

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B. The following locations have been chosen as Land-Use Specific sites:

1. Trancas Canyon at Private Drain No. 658 in the City of Malibu.

The Trancas Canyon watershed is proposed for the monitoring of open space. The upstream watershed of Private Drain (PD) No. 658 is virtually undeveloped, with the only significant development being the Malibu Country Club in the upper reach. The Santa Monica Mountains National Recreation Area is the largest land holder in the watershed.

The proposed monitoring site is to be located at the upstream end of PD No. 658, adjacent to the northerly end of Paseo Canyon Drive. PD No. 658 is a reinforced concrete trapezoidal channel. Immediately upstream exists a small debris basin which will provide protection for the sampler. The residential area surrounding PD No. 658 is privately maintained. Installation of the monitoring station will be dependent on our ability to satisfy the requirements of the local homeowners association. The tributary watershed area is 7.45 square miles.

The land-use breakdown is as follows:

Open Space/Agriculture	97%
Low Density Residential	3%
Single Family Residential	0%
Low Density Multi-Family	0%
High Density Multi-Family/Institutional	0%
Commercial	0%
Industrial	0%

The overall impervious value for this watershed is 1%.

It is anticipated that because of the size, impervious value, soil types, and vegetation within the watershed, little to no dry-weather flows will exist. This has been previously observed.

2. County Bond Issue Project No. 5401, Line A in the City of Manhattan Beach.

Project No. 5401 is proposed for the monitoring of a single family residential area.

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At the proposed monitoring location, Project No. 5401 is an underground box drain. This storm drain discharges to a pond in Polliwog Park. During a storm, the pond serves as a detention basin for flood control. After reaching a certain elevation, stormwater in the pond is pumped over a hill, under Manhattan Beach Boulevard, to the west to Project No. 552. One potential location for placement of the sampler appears to be in the park, however, because stormwater may back up into the drain, an alternative location for sampling is at Redondo Avenue and 11th Street. The tributary watershed area is approximately 200 acres.

The land-use breakdown is as follows:

Open Space/Agriculture	0%
Low Density Residential	0%
Single Family Residential	98%
Low Density Multi-Family	0%
High Density Multi-Family/Institutional	0%
Commercial	2%
Industrial	0%

The overall impervious value for this watershed is 42%.

Homes and lots are generally similar in type and size throughout the tributary drainage area, providing an ideal homogenous land use.

3. City of Los Angeles Storm Drain No. D-2361 located in downtown Los Angeles.

The City's Storm Drain No. D-2361 is proposed for the monitoring of a commercial/industrial land use.

The proposed monitoring site is near the intersection of 21st Street and Grand Avenue. Storm Drain No. D-2361 is a 48" diameter pipe. The tributary watershed area is about 150 acres.

The land-use breakdown is as follows:

Open Space/Agriculture	0%
Low Density Residential	0%
Single Family Residential	0%
Low Density Multi-Family	0%
High Density Multi-Family/Institutional	0%
Commercial	49%
Industrial	51%

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The overall impervious value for this watershed is 91%.

It is believed with all certainty that this storm drain will experience, at some time, surcharge conditions. The storm drain is more than 50 years old and is undersized. Based on our research, however, this would be the only location available in the Santa Monica Bay Drainage Basin for the monitoring of a sizeable industrial area.

4. City of Santa Monica Pier Storm Drain adjacent to the Santa Monica Mall.

The City's Pier Storm Drain is proposed to be a monitoring site for commercial land use.

The monitoring site will be located at the intersection of Second Street and Colorado Avenue. The section of drain under consideration is from Ocean Avenue to 2nd Street in Colorado Avenue. This reach of drain empties into a manhole shaft of a deeper storm drain which subsequently discharges below the Santa Monica Pier. The tributary watershed area is approximately 50 acres.

The land-use breakdown is as follows:

Open Space/Agriculture	0%
Low Density Residential	0%
Single Family Residential	0%
Low Density Multi-Family	0%
High Density Multi-Family/Institutional	4%
Commercial	96%
Industrial	0%

The overall impervious value for this watershed is 92%.

This watershed is dominated by the Santa Monica Mall. The remaining land-use elements are commercial office buildings, small shops, restaurants and high density apartments/hotels.

5. County Bond Issue Project No. 558, Line A in the City of Palos Verdes Estates.

The monitoring location proposed for Project 558 will not only be utilized as a mass emissions station, but also function as a single family residential land-use site.

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The monitoring site for this storm drain will be in the vicinity of the intersection of Paseo Lunado and Palos Verdes Drive West. The tributary watershed area is approximately 1.7 square miles.

The land-use breakdown is as follows:

Open Space/Agriculture	14%
Low Density Residential	0%
Single Family Residential	81%
Low Density Multifamily	3%
High Density Multifamily/Institutional	0%
Commercial	2%
Industrial	0%

The overall impervious value for the watershed is 40%.

It is anticipated that because of the size, impervious value, soil types, and vegetation within the watershed, little to no dry-weather flows will exist. This has been previously observed.

Monitoring Site Installation

The monitoring sites have been prioritized for installation as follows:

Ballona Creek
Malibu Creek
Trancas Canyon (Private Drain 658)
Kenter Canyon
Herondo Drain (Bond Issue Project 1105)
Bond Issue Project 558
Bond Issue Project 5401
City of Santa Monica Storm Drain
City of Los Angeles Storm Drain

Priority has been given to the open channel sites, which are the easiest to install plus serve as the mass emissions stations. The remaining sites involve the underground drains. We are targeting to have as many sites as possible operational by the onset of the rainy season, with the remainder to follow as soon as possible during the rainy season.

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NPDES PERMIT NO. CA0061654
PHASES II & III

PROPOSED STORMWATER/URBAN RUNOFF MONITORING PROGRAM (Mass Emissions Sites)

LOS ANGELES COUNTY
DEPARTMENT OF PUBLIC WORKS

WASTE MANAGEMENT DIVISION
WATER QUALITY MANAGEMENT SECTION

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APPENDIX 1

Step-by-Step Procedure for Runoff Estimation

APPENDIX 2

Surface Water Sampling Instruction Manual

APPENDIX 3

Quality Assurance Manual

APPENDIX 4

Supplemental Quality Assurance Manual

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1. INTRODUCTION

As required by National Pollutant Discharge Elimination System (NPDES) Permit No. CA0061654, a proposed Stormwater/Urban Runoff Monitoring Program for Phase II and III of the Permit, the Upper Los Angeles River (II), Upper San Gabriel River (III), Lower Los Angeles River (IV), Lower San Gabriel River (V), and Santa Clara River Drainage Basins is hereby submitted to the Regional Water Quality Control Board, Los Angeles Region (RWCQB), for approval. Comments and concerns made by the RWQCB in its December 21, 1993 letter to the Los Angeles County Department of Public Works (LACDPW) related to our proposed Santa Monica Bay Stormwater/Urban Runoff Monitoring Program, have been incorporated into this report.

The monitoring program described herein includes the establishment of fifteen monitoring sites for both mass emissions and individual land use monitoring. Five mass emissions sampling sites are identified in this report. One other mass emission sampling site will be located in the Santa Clarita Valley Basin (Santa Clara River Watershed), and will be identified later this year in a supplemental report to the RWQCB. Eight land use specific sites will likewise be identified in the supplemental report to be submitted later this year to the RWQCB.

Storm samples will be collected for five storms per year. Dry-weather samples will be collected bimonthly. Samples will be tested for a wide range of constituents including Bacteria; General Minerals; Biochemical Oxygen Demand; Total Organic Carbon and total Petroleum Hydrocarbons; Volatile Organic Compounds and Suspended Solids; Volatile Suspended Solids; and Semi-volatile Organic Compounds.

Automated refrigerated water samplers will be utilized in the collection of flow-composite samples. These samplers will be located on the ground surface in secure enclosures allowing easy access for retrieval of samples. The samplers have large (10 gallon) water collection capacity, and, thus, can be programmed in advance to cover a wide range of storm sizes without requiring one or more bottle change outs during a storm event.

Data collected by the program will be used for water quality modelling to estimate pollutant loads to receiving waters. Also, questions concerning what types of pollutants emanate from various land uses will be addressed. Lastly, data collected over the years under this program can be used in an attempt to assess any long-term trends in water quality.

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II. PROPOSED MONITORING SITES

A. SITE SELECTION CRITERIA

1. Monitoring Site Selection Overview

In order to characterize the quality of runoff from the Phase II and III areas, a combination of large watersheds representing multiple land uses ("mass emissions" sites) and single land use sites are to be selected.

For these Drainage Basins fifteen monitoring sites are proposed. Six of the fifteen sites will be mass emissions stations (one to be submitted at a later date). Nine proposed sites will be land use specific stations (to be submitted at a later date) where smaller homogenous land use watersheds will be sampled.

The proposed monitoring sites represent an effort to select the most suitable locations based on our established criteria for sampling. Where feasible, we have incorporated into the program those storm drains which have water quality issues which are of concern to the community.

2. Specific Criteria for Mass Emissions Monitoring Sites

Mass emissions monitoring sites have been proposed along drainage systems covering the largest tributary watershed area feasible within each drainage basin. These watersheds will typically have a complex multiple land use composition.

In selecting a specific storm drain for inclusion as either a mass emissions or land use specific site, the following technical and operational requirements were addressed:

- What type of sampling equipment is to be used, and what limitations exist?
- What are the hydraulics of the underground storm drain, open channel/natural watercourse? What is the Design Q?
- Is there past flow data available for the given stream?
- What past hydrology studies have been performed in the watershed?. What is the hydrologic Q?
- If the storm drain is underground, is it currently under designed? Could it experience surcharge conditions?
- Within the watershed, what is the corresponding land use? Is land use uniform and homogenous throughout the upper tributary area? If yes, this is a possible land use site.
- Has previous sampling in the potential watershed been conducted in the past? Where? When? Why?

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- Are tidal or backwater influences a concern?
- Is the location selected the only outfall point for the upstream watershed, or are there multiple outfall points?
- Is the storm drain structurally sound at present? Will installation of sampling equipment compromise the stability of the storm drain?
- Will the monitoring equipment impede flow or reduce flood protection?
- For natural watercourses, is there an existing improved section where a rating curve can be easily established?
- What is the practicable linear distance from the storm drain invert (low flow) to the location where the sampler shall be placed?
- Can electric power be provided, in a cost-effective manner, to the site?
- Will additional right-of-way be required?
- Will the sampler installation interfere with projects planned or in progress in the general vicinity?
- If located in a residential neighborhood, will the location of the automated sampler and its operation result in any objections from the local residents?

B. Monitoring Site Installation

The monitoring sites have been prioritized for installation as follows:

Los Angeles River @ Wardlow Road
Rio Hondo Channel @ Beverly Boulevard
San Gabriel River @ San Gabriel River Parkway
Coyote Creek @ Spring Street
Los Angeles River @ Tujunga Avenue

We propose to have these sites operational by the onset of the 1995-96 rainy season.

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C. PROPOSED MASS EMISSIONS MONITORING SITES

1. LOS ANGELES RIVER downstream of Wardlow Road at Los Angeles County Department of Public Works Stream Gage No. F319-R in the City of Long Beach.

The Los Angeles River monitoring station will be located at the existing stream gage station between Willow Street and Wardlow Road. This facility currently measures stream flow and precipitation. At this location, the total upstream tributary drainage area for Los Angeles River is 815 square miles. This river is the largest watershed outletting to the Pacific Ocean in Los Angeles County. Tidal influences dictate the position for the sampling site.

Los Angeles River, at the gaging station, is an improved (concrete lined) trapezoidal channel. The vertical lift from the invert of the low-flow channel to a sampler location above the western levee is approximately 23 feet. Since the vertical lift exceeds 15 feet, an auxiliary pump will be needed to perform automated sampling. The linear distance from the top of the river levee to the low-flow channel exceeds 200 feet. The linear distance posses some concern. Pump wear and tear for reverse and forward pump cycles for this linear distance would be excessive. Since it is typical to find dry weather flows uniformly across the channel at this location (the low-flow channel can no longer carry the volume of flow found in the river), it maybe feasible to locate the strainer along the invert near the side of the river as the preferred design. Another option for placement of the automated sampler involves lowering the sampling equipment adjacent to the toe of the levee slope, and jacking the necessary conduits through the levee. This design may eliminate the need for an auxiliary pump if the strainer is positioned near the side of the river, however, it cannot compromise the levee by allowing storm water to migrate through the conduits.

The Los Angeles River sampling location below the Wardlow Road bridge (Old TG PG 70B-6/ New TG PG 795C-1) has been an active stream gaging station since 1931.

Flows in the River are partially regulated by the following: Sepulveda, Pacoima, Big Tujunga, Hansen, Devil's Gate, Lopez Debris Dam, as well as Whittier Narrows, Santa Anita, Sawpit, Eaton, Sierra Madre, and Santa Fe Dams; Project No. 85 Diversion; as well several spreading grounds, and debris basins. This will require an immense coordination effort in gathering, collecting and interpreting water quality data collected from this station. Because these dams and spreading grounds serve as flood control and water conservation facilities, small storms may not produce significant runoff from particular areas within the watershed, and therefore not contribute to the flow which is measured at the Wardlow Road gaging station. Large storms which produce significant runoff maybe detained, only to be released at a time when it is believed that potential flooding hazard conditions have subsided. There are numerous other scenarios which may occur, all impacting our water quality monitoring efforts at this site.

The overwhelming majority of the flows found in the River during dry weather periods are the result of NPDES permitted point discharges regulated by the California Regional Water Quality Control Board.

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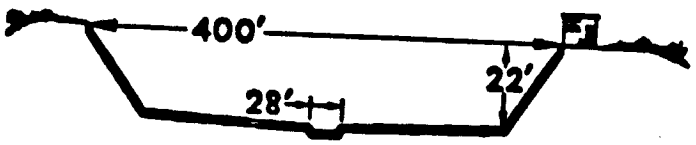
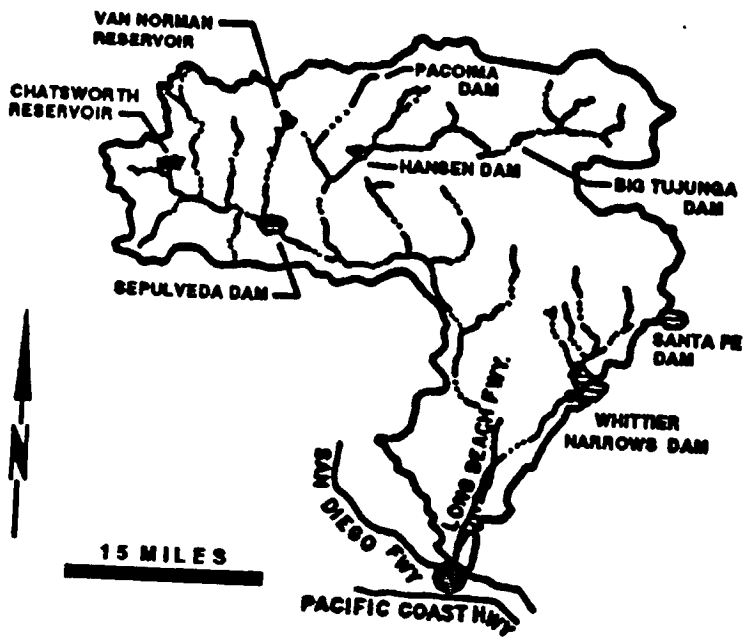
Various land uses exist within the River's tributary watershed area. Residential areas of various sizes and densities include single family, duplexes, condominiums / townhomes, and apartments. Commercial strips of many uses, malls, office buildings, etc., can be found within the watershed. Industrial developments of all types and sizes are identified within the tributary watershed. Undeveloped or open space properties are typically found in the foothill areas, but are not limited specifically to these areas. A percentage breakdown for these land uses will be included in the supplemental Monitoring Program Report to be submitted later this year.

This proposal will replace the existing County Department of Public Works surface water grab sampling site at Wardlow Road.

CROSS-SECTION



DRAINAGE AREA



LOS ANGELES RIVER AT WARDLOW ROAD

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2. **COYOTE CREEK below Spring Street at Los Angeles County Department of Public Works Stream Gage No. F354-R in the City of Long Beach.**

The Coyote Creek station will be located at the existing stream gage station below Spring Street. This facility currently measures stream flow and precipitation. At this location the upstream tributary area is 185 square miles (extending into Orange County). The confluence with San Gabriel River dictates the position for the sampling site.

Coyote Creek, at the gaging station, is an improved (concrete lined) trapezoidal channel. The vertical lift from the invert of the low-flow channel to a sampler location above the western levee is approximately 20 feet. Since the vertical lift exceeds 15 feet, an auxiliary pump will be needed to perform automated sampling. The linear distance to the low-flow channel is nearly 60 feet, and does not appear to be a problem. The strainer and pressure transducer can be mounted in the low-flow channel. Another option being explored for placement of the automated sampling equipment involves lowering the equipment along the backside of the levee towards the toe of the levee slope, and jacking the necessary conduits through the levee. This design may eliminate the need for an auxiliary pump, however, it cannot compromise the levee by allowing storm water to migrate through the conduits during a storm.

The Coyote Creek sampling location below the Spring Street (Old TG PG 76F-1 / New TG PG 796H-2) has been an active stream gaging station since 1963.

Flows in the River are partially regulated by the following: Fullerton, Brea, and Carbon Canyon Dams. This factor will require coordination with Orange County in gathering, collecting and interpreting water quality data collected from this station. Because these dams, as well as other facilities serve as flood control structures, small storms may not produce significant runoff from particular areas within the watershed, and therefore not contribute to the flow which is measured at the Spring Street gaging station. Large storms which produce significant runoff maybe detained, only to be released at a time when it is believed that potential flooding hazard conditions have subsided. There are numerous other scenarios which may occur, all impacting our water quality monitoring efforts at this site.

The overwhelming majority of the flows found in the Creek during dry weather periods are the result of NPDES permitted point discharges regulated by the California Regional Water Quality Control Board.

Various land uses exist within the Creek's tributary watershed area. Residential areas of various sizes and densities include single family, duplexes, condominiums / townhomes, and apartments. Commercial strips of many uses, malls, office buildings, etc., can be found within the watershed. Industrial developments of all types and sizes are identified within the tributary watershed. Undeveloped or open space properties are typically found in the foothill areas, but are not limited specifically to these areas. A percentage breakdown for these land uses will be included in the supplemental Monitoring Program Report to be submitted later this year.

This proposed sampling location will replace the existing LACDPW surface water quality grab sampling stations at Orangethorpe Boulevard and at Willow Street.

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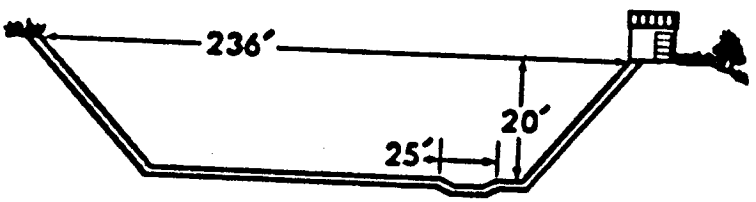
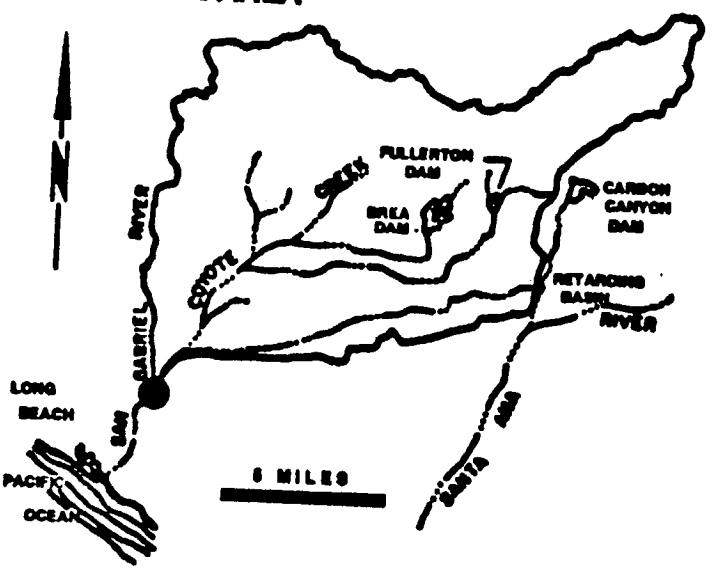
CROSS-SECTION



DRAINAGE AREA



COYOTE CREEK BELOW SPRING STREET

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3. **LOS ANGELES RIVER at Tujunga Avenue at Los Angeles County Department of Public Works Stream Gage No. F300-R in the City of Los Angeles.**

This Los Angeles River station will be located at the existing stream gage station above Tujunga Avenue. This facility currently measures stream flow. At this location the upstream tributary area is 401 square miles (almost half of the entire Los Angeles River watershed area).

Los Angeles River, at the gaging station, is an improved (concrete lined) open box channel. The vertical lift from the invert of the low-flow channel to a sampler location above the northerly wall of the channel is approximately 19 feet. Since the vertical lift exceeds 15 feet, an auxiliary pump will be needed to perform automated sampling. The linear distance to the low-flow channel is nearly 90 feet, and does not appear to pose a problem. The strainer and pressure transducer can be mounted in the low-flow channel. The auxiliary pump would have to be mounted in a vault in the channels northern wall between 10 and 15 feet above the invert.

The Los Angeles River proposed sampling location above the Tujunga Avenue bridge (Old TG PG 23D-4 / New TG PG 562J-6), and downstream of the Tujunga Wash outfall has been an active stream gaging station since 1950.

Flows in the River are partially regulated by the following: Sepulveda, Pacoima, Big Tujunga, Hansen, Lopez Debris Dams; also Project No. 85 Diversion; as well as several spreading grounds and debris basins. This will require an immense coordination effort in gathering, collecting and interpreting water quality data collected from this station. Because these dams and spreading grounds serve as flood control and water conservation facilities, small storms may not produce significant runoff from particular areas within the watershed, and therefore not contribute to the flow which is measured at the Tujunga Avenue gaging station. Large storms which produce significant runoff maybe detained, only to be released at a time when it is believed that potential flooding hazard conditions have subsided. There are numerous other scenarios which may occur, all impacting our water quality monitoring efforts at this site.

The overwhelming majority of the flows found in the River during dry weather periods are the result of NPDES permitted point discharges regulated by the California Regional Water Quality Control Board.

Various land uses exist within the River's tributary watershed area. Residential areas of various sizes and densities include single family, duplexes, condominiums / townhomes, and apartments. Commercial strips of many uses, malls, office buildings, etc., can be found within the watershed. Industrial developments of all types and sizes are identified within the tributary watershed. Undeveloped or open space properties are typically found in the foothill areas, but are not limited specifically to these areas. A percentage breakdown for these land uses will be included in the supplemental Monitoring Program Report to be submitted later this year.

This proposal will replace the existing LACDPW surface water quality grab sampling station at Tujunga Avenue.

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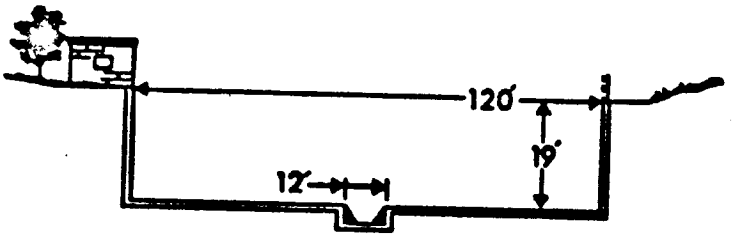
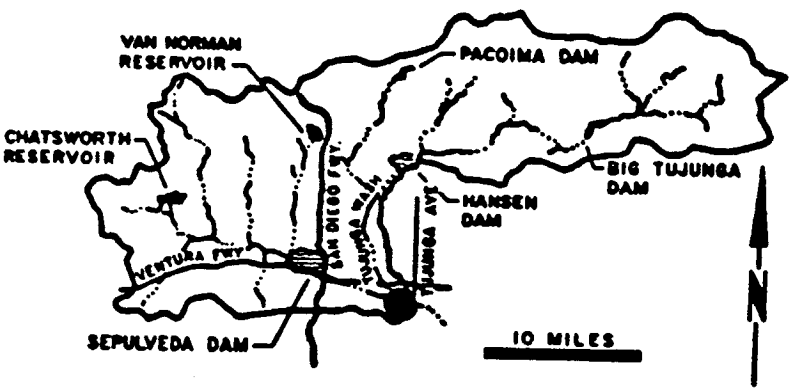
CROSS-SECTION



DRAINAGE AREA



LOS ANGELES RIVER AT TUJUNGA AVENUE

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4. **RIO HONDO CHANNEL - Above Beverly Boulevard, and downstream of Whittier Narrows Dam, at U.S.G.S. - U.S. Army Corps of Engineers Stream Gage No. 11102300 or E327-R.**

Rio Hondo Channel station will be located at the existing stream gage station above Beverly Boulevard. This facility currently measures stream flow. At this location the upstream tributary area is 124 square miles (excluding the area above Santa Fe Dam).

Rio Hondo Channel, at the gaging station, is an improved (concrete lined) trapezoidal channel. The vertical lift from the invert of the low-flow channel to a sampler location above the western levee is approximately 19 feet. Since the vertical lift exceeds 15 feet, an auxiliary pump will be needed to perform automated sampling. The linear distance to the channel's invert (there is no low-flow channel) is nearly 50 feet and does not appear to be a problem. The strainer and pressure transducer can be mounted in the invert of channel. Another option for placement of the automated sampler involves lowering the equipment along the backside of the levee towards the toe of the levee slope, and jacking the necessary conduits through the levee. This design may eliminate the need for an auxiliary pump, however, it cannot compromise the levee by allowing storm water to migrate through the conduits. The U.S.G.S. indicates that discharges below 100 cfs are poor for stream gaging.

The Rio Hondo Channel sampling location above the Beverly Boulevard bridge (Old TG PG 54F-1 / New TG PG 676F-1) has been an active stream gaging station since 1965 and is operated by the U.S.G.S. and the U.S. Army Corps of Engineers.

Flows in the Channel are partially regulated by the following: Sierra Madre, Santa Anita, Sawpit, Eaton, Santa Fe and Whittier Narrows Dams; as well as several spreading grounds and debris basins. This factor will require an immense coordination effort in gathering, collecting and interpreting water quality data collected from this station. Because these dams, as well as other facilities serve as flood control structures, small storms may not produce significant runoff from particular areas within the watershed, and therefore not contribute to the flow which is measured at the Beverly Boulevard gaging station. Large storms which produce significant runoff maybe detained, only to be released at a time when it is believed that potential flooding hazard conditions have subsided. There are numerous other scenarios which may occur, all impacting our water quality monitoring efforts at this site.

The overwhelming majority of the flows found in the Channel during dry weather periods are the result of NPDES permitted point discharges regulated by the of California Regional Water Quality Control Board.

Various land uses exist within the Channel's tributary watershed area. Residential areas of various sizes and densities include single family, duplexes, condominiums / townhomes, and apartments. Commercial strips of many uses, malls, office buildings, etc., can be found within the watershed. Industrial developments of all types and sizes are identified within the tributary watershed. Undeveloped or open space properties are typically found in the foothill areas, but are not limited specifically to these areas. A percentage breakdown for these land uses will be included in the supplemental Monitoring Program Report to be submitted later this year.

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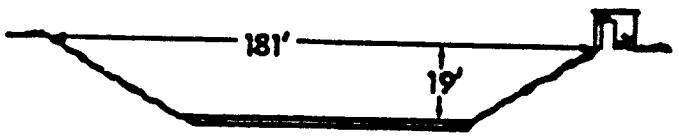
This proposal will replace the existing LACDPW surface water quality grab sampling station at Stewart & Gray.

CROSS-SECTION



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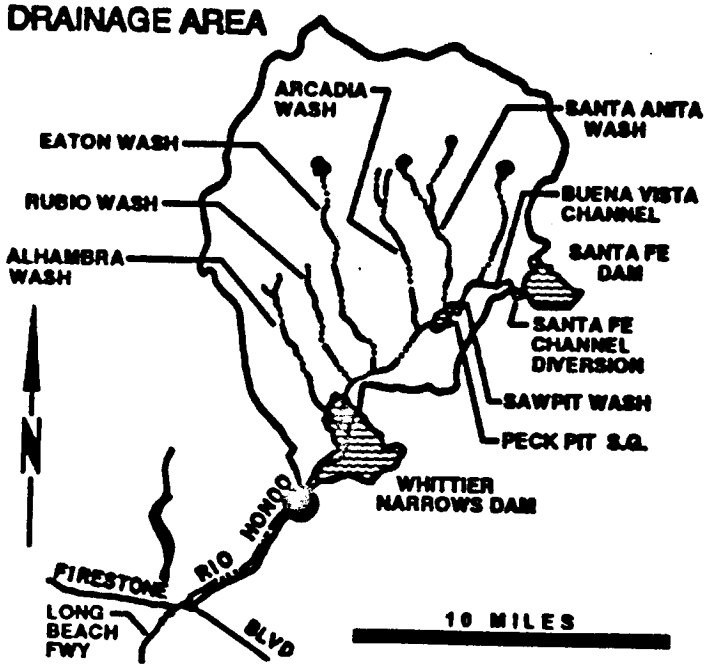

RIO HONDO CHANNEL ABOVE BEVERLY BOULEVARD

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5. **SAN GABRIEL RIVER - Downstream of San Gabriel River Parkway, downstream of Whittier Narrows Dam at Los Angeles County Department of Public Works Stream Gage No. F263C-R.**

The San Gabriel River monitoring station will be located at the existing stream gage station, below San Gabriel River Parkway. This facility currently measures stream flow. At this location the upstream tributary area is 460 square miles.

San Gabriel River, at the gaging station, is a grouted rock-concrete stabilizer along the western levee, and a natural section on the eastern side. Flow measurement and water sampling will occur in the grouted rock area along the western levee of the river. The vertical lift from the invert of the concrete stabilizer to a sampler location above the western levee is approximately 15 feet. Since the vertical lift to the sampler would be in excess of 15 feet, an auxiliary pump to perform automated sampling may be warranted. The linear distance to the concrete stabilizer is nearly 70 feet. The linear distance to the concrete stabilizer does not appear to be a problem. The strainer and pressure transducer will be mounted in the concrete stabilizer.

The San Gabriel River sampling location below the San Gabriel River Parkway bridge (Old TG PG 55C-1 / New TG PG 676J-2) has been an active stream gaging station since 1968.

Flows in the River are partially regulated by the following: Whittier Narrows, Big Dalton, San Dimas, Puddingstone Diversion, Puddingstone, Live Oak, Thompson Creek, Santa Fe, Morris, San Gabriel, and Cogswell Dams; as well several spreading grounds; and debris basins. This will require an immense coordination effort in gathering, collecting and interpreting water quality data collected from this station. Because these dams and spreading grounds serve as flood control and water conservation facilities, small storms may not produce significant runoff from particular areas within the watershed, and therefore not contribute to the flow which is measured at the San Gabriel River Parkway gaging station. Large storms which produce significant runoff maybe detained, only to be released at a time when it is believed that potential flooding hazard conditions have subsided. There are numerous other scenarios which may occur, all impacting our water quality monitoring efforts at this site.

The overwhelming majority of the flows found in the River during dry weather periods are the result of NPDES permitted point discharges regulated by the California Regional Water Quality Control Board.

Various land uses exist within the River's tributary watershed area. Residential areas of various sizes and densities include single family, duplexes, condominiums / townhomes, and apartments. Commercial strips of many uses, malls, office buildings, etc., can be found within the watershed. Industrial developments of all types and sizes are identified within the tributary watershed. Undeveloped or open space properties are typically found in the foothill areas, but are not limited specifically to these areas. A percentage breakdown for these land uses will be included in the supplemental Monitoring Program Report to be submitted later this year.

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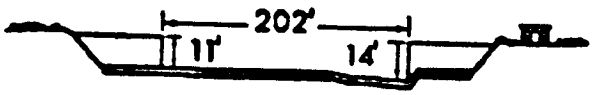
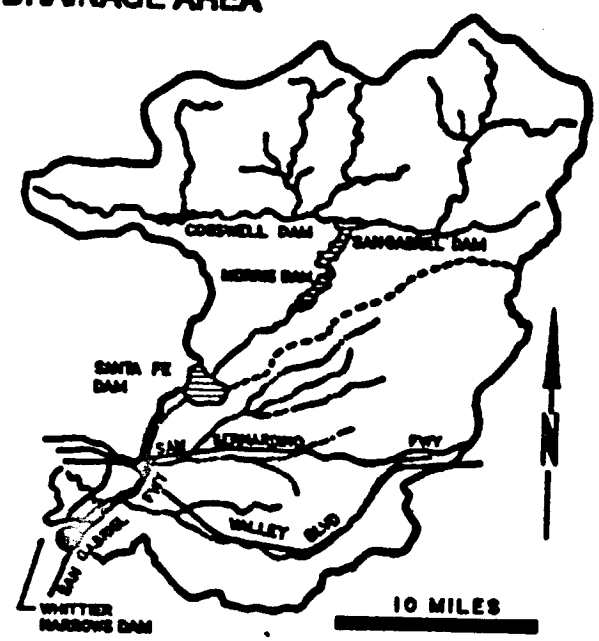
CROSS-SECTION



DRAINAGE AREA



SAN GABRIEL RIVER DOWNSTREAM OF SAN GABRIEL PARKWAY

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III. MONITORING EQUIPMENT

A. WATER QUALITY SAMPLERS

Refrigerated Water Quality Samplers

Stormwater sampling for this NPDES permit must include a technique for collecting flow composite samples for storms as well as time composite samples for dry weather applications. The utilization of automatic refrigerated water quality samplers (Figure III-1) represent the best available technology at present to meet the goals of the Permit.

The water quality samplers to be utilized at each of the monitoring sites will be AC powered to carry the load needed to provide refrigeration. All samples will be stored at 4°C.

Each sampler will incorporate a peristaltic pump for sample collection. Due to the inability of the peristaltic pump to effectively pump beyond a vertical lift of 15 feet, a water tight auxiliary pump will be required at all stations. The reason for the the auxiliary pump to be water tight is that it may become submerged for periods of time during a storm. For underground drains the auxiliary pump needs also to be rated explosion proof. The explosion proof rating is required for the auxiliary pump because gases in a confined space, such as an underground storm drain, may excite the pumps motor causing an explosion. Most of our sites have vertical lifts in excess of 15 feet, requiring auxiliary pumps.

Each sampler will be securely stored in a steel box, similar to a traffic signal controller enclosure. Samplers will be located on the sidewalk or secured right-of-way for closed conduits or along the banks of open channels and natural watercourses.

B. FLOW MONITORING

Flow monitoring equipment is a fundamental aspect of water quality sampling. Because the Monitoring Program proposal includes flow composite sampling during storms, flow monitoring equipment must be utilized with the sampler. There are various makes and models of flow meters. Some of the various flow meters available utilize pressure transducers, ultrasonic sensors, bubblers, stilling wells utilizing a float, etc.

The above mentioned flow measuring devices are designed for open-channel flow conditions. The water elevation in a storm drain is measured by the flow monitoring equipment and then, from either a rating table previously established at the site, or from an equation such as Manning's a flow rate is determined. The County's Department of Public Works uses rating tables which are generated from analysis of storm drain cross sections and upstream/downstream flow characteristics. The rating tables are modified if it is demonstrated in the field that the stream velocity measurements indicate a non-uniform relationship with the calculated table values. Past efforts in stormwater flow measurement indicates that all of the proposed stations will require time and multiple storm events to gather necessary data needed for calibration of the measurement devices.

The type of flow measurement device selected for use is a pressure transducer. The maximum depth of flow for the proposed five sites approaches 23 feet. With the pressure transducer fixed at the bottom of the drain, a depth range from dry condition to 23 feet will have to be measured. The flow meter incorporating the pressure transducer must be compatible with the sampler.

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Closed conduits, however, present an additional problem (none of the proposed five sampling sites identified in this report are within enclosed drains). Many closed conduits surcharge during storm conditions, usually caused by the conduit being undersized for its tributary watershed. The frequency of surcharging is dependent on the degree to which the storm drain is undersized. When surcharge conditions are reached, the drain now functions under pressure flow. The flow measurement devices discussed above are only operable under open channel flow conditions. The measurement of flow under pressure would require the use of velocity meters. These are very costly devices that would need to be located directly in the flow stream. Therefore, efforts were made to select storm drains that do not surcharge, or do so infrequently to an extent that flow measurements are not significantly compromised.

C. RAIN GAGE

For every monitoring station, a minimum of one automatic (intensity measuring) rain gage will be placed within the upper tributary watershed. Los Angeles County Department of Public Works operates various automatic rain gages throughout the County. Existing gages in close proximity to the proposed monitored watersheds will be utilized in calculating stormwater runoff and shall be essential to developing runoff characteristics of these watersheds.

Large watersheds such as those identified in this Report will require multiple rain gages to accurately characterize the rainfall. The number and location of these additional rain gages is currently being researched.

D. EQUIPMENT INSTALLATION

The approach taken for the installation of sampling equipment is important to those who will maintain it. Access, ease of operation, safety, protection from the elements, etc., are typical design considerations. Each station's design must take into account at least these basic elements.

Figures III-2, III-3, and III-4 show typical installations of sampling equipment in storm drains utilized in the Monitoring Program.

Selected site conditions will dictate the approach taken with regards to installation of the monitoring equipment.

The automated sampler intake hose and the flow meter pressure transducer cable must be protected from trash and debris, vandalism, and the physical forces of the flow velocity during storm events. It must also be installed to allow routine inspection and maintenance. Therefore, the intake hose and pressure transducer cable will be placed in separate conduits below the invert surface, a few inches below the channel's finished surface.

The strainer and pressure transducer will likewise be located within a protective enclosure to shield them from trash and debris and to minimize vandalism.

As stated before an auxiliary peristaltic pump will be needed at many sites due to the hydraulic lift requirements. This will complicate installation, maintenance and operations. The auxiliary pump will be placed above the low-flow, dry weather level to ensure that it will not be continuously submerged. A seperate conduit will be utilized to run power to the auxiliary pump.

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Figure III-1

Refrigerated Water Sampler

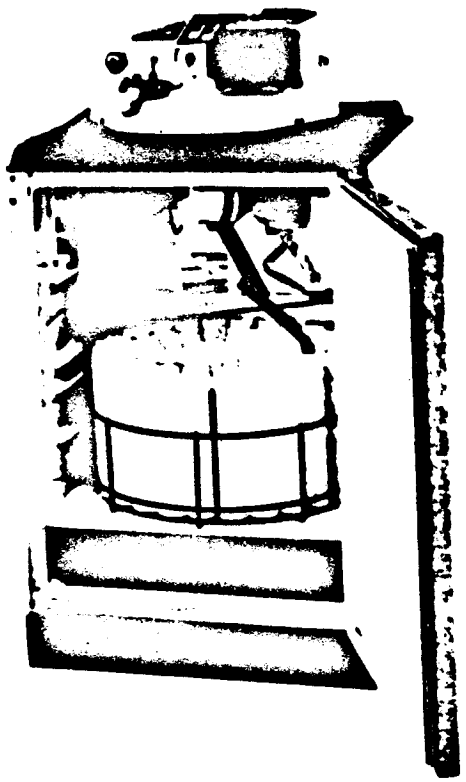

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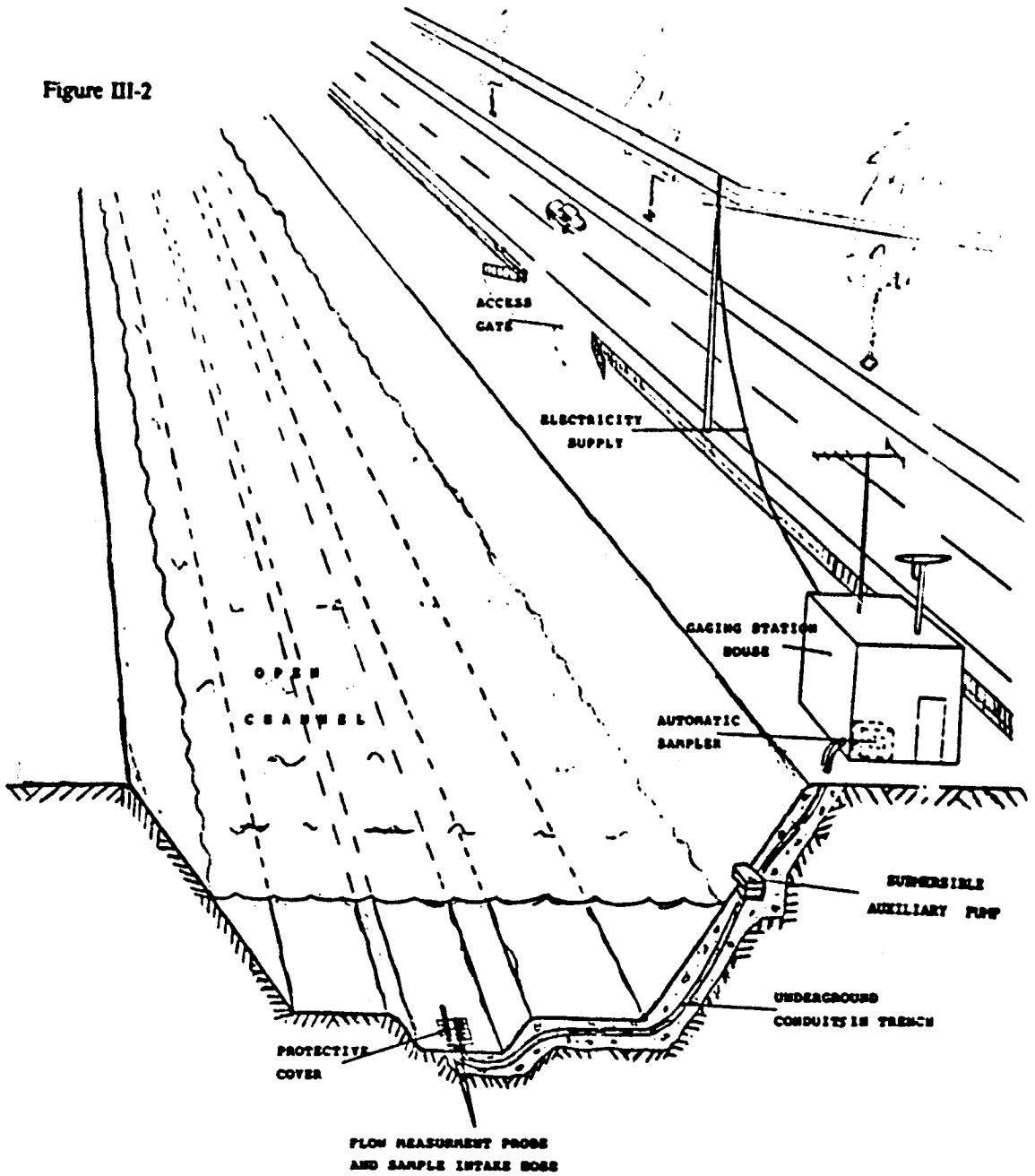
Figure III-2



MODIFIED BY: TJS	LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS
DATE 04/15/94	CONCEPTUAL DRAWING FOR AUTOMATED SAMPLING SYSTEM INSTALLATION IN AN OPEN CHANNEL
NOT TO SCALE	

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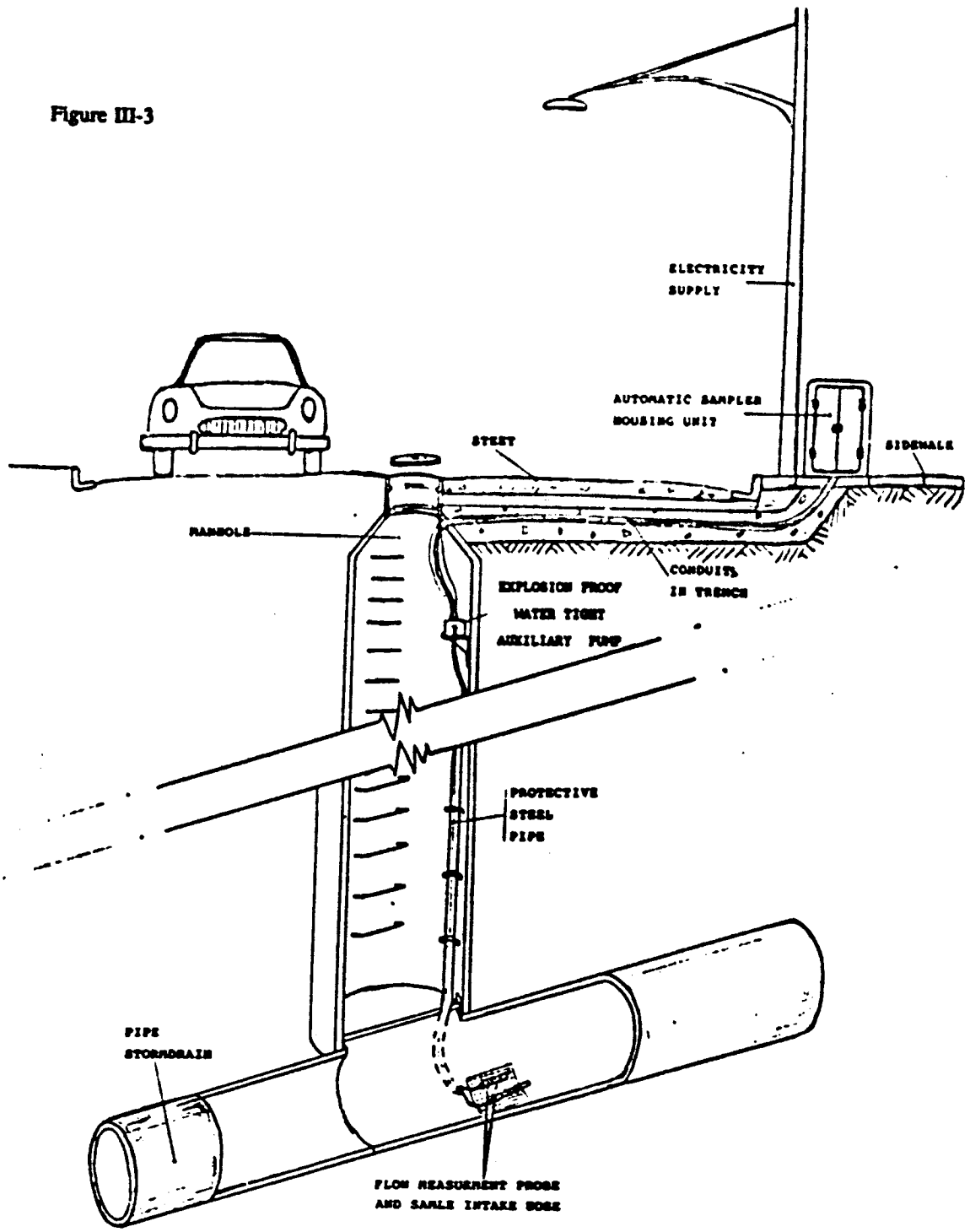
Figure III-3



MODIFIED BY: TJS	LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS
DATE 04/15/94	CONCEPTUAL DRAWING FOR AUTOMATED SAMPLING SYSTEM INSTALLATION IN A PIPE STORM DRAIN
NOT TO SCALE	

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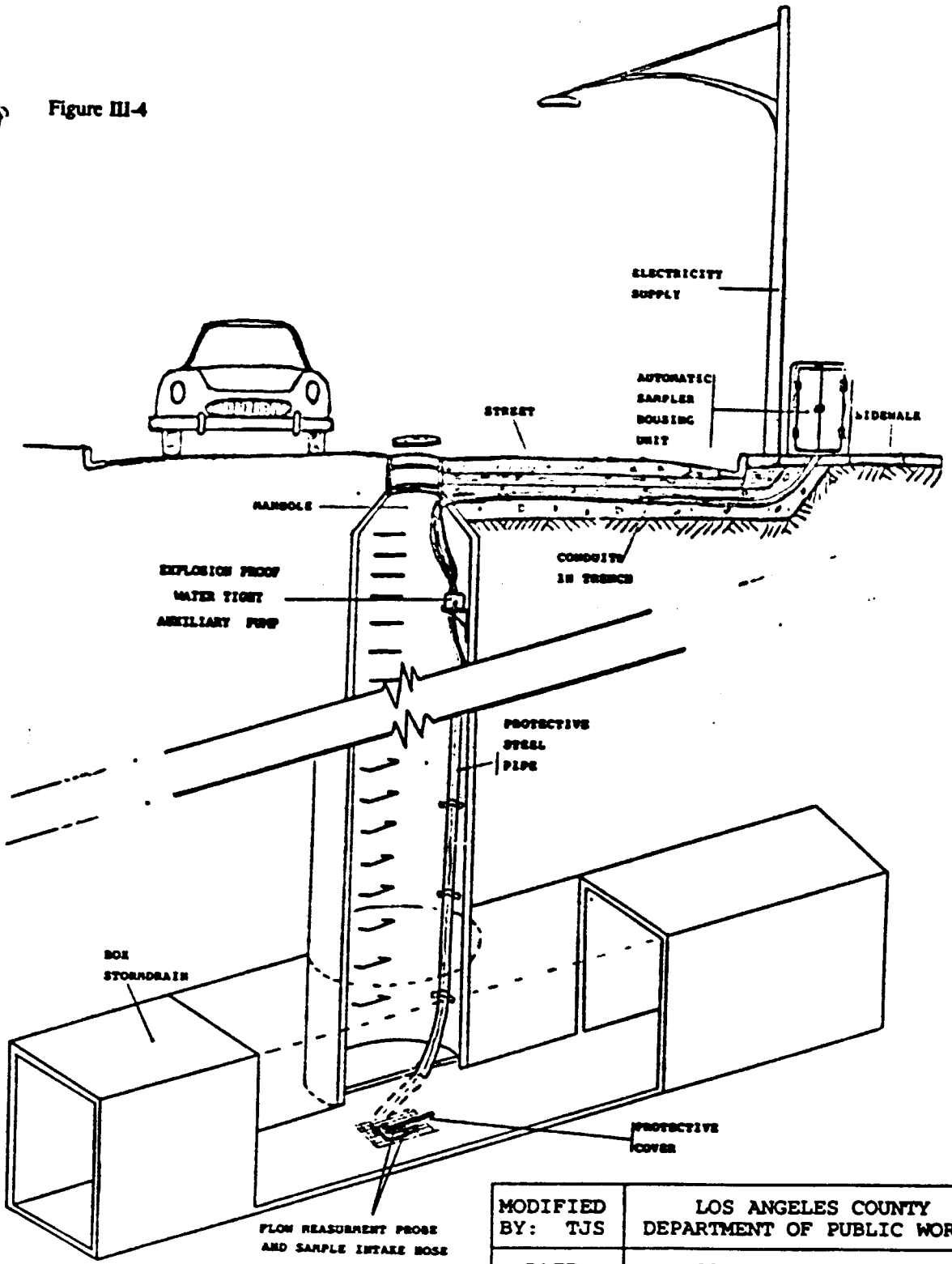
Figure III-4



MODIFIED BY: TJS	LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS
DATE 04/15/94	CONCEPTUAL DRAWING FOR AUTOMATED SAMPLING SYSTEM INSTALLATION IN A BOX STORM DRAIN
NOT TO SCALE	

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IV. MONITORING EQUIPMENT PROGRAMMING

A. Storm Weather Sampling

The automated sampler will need to be properly programmed in order to collect a representative flow-composite sample.

To program the sampler, the following information is needed: target storm size, flow rate to trigger sampling, estimate of runoff volumes, total sample volume required, number of sample intervals desired, sample volume to be collected at each interval, and flow rate to end sampling.

B. Storm Size to be Sampled

The "Surface Drainage Water Quality Monitoring Program" report, prepared by Woodward-Clyde Consultants for the Santa Monica Bay Restoration Project, analyzed local rainfall data to determine the appropriate storm size to be targeted for monitoring. Based on their analysis, targeted storm events should be between 6 and 25 hours in duration and average rainfall of about 0.4 to 1.7 inches.

C. Minimum Sample Volume to be Collected

The minimum volume of stormwater needed to perform the necessary analyses is shown below, (for composite flow-weighted samples only):

Constituent	Quantity
Semivolatile Organic Compounds	1 L
Pesticides and PCBs	1 L
Herbicides	1 L
Soluble Metals	500 ml
Other Constituents	4,325 ml
	7,825 ml = 8 Liters or approx. 2 Gallons

The refrigerated automated sampler has a total capacity of 10 gallons. Subtracting the two gallons required for analysis, the sampler will have an eight gallon reserve capacity. Therefore, the sampler will be programmed to collect two gallons of stormwater from a 0.4" storm. With the eight gallon excess capacity, the sampler would theoretically have adequate capacity to handle storms up to two inches in size (0.4" x 5 = 2.0"). This will significantly reduce the need to change bottles during a storm event.

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D. Estimate of Runoff Volume

To program the sampler, the estimated runoff volume from a minimum precipitation of a 0.4-inch storm event over the entire area of a watershed must be calculated. The procedure used to estimate the runoff volume of the above storm is taken from the Los Angeles County Department of Public Works Hydrology Manual, which is generally accepted by agencies within Los Angeles County for the performance of hydrology studies.

The procedure to be used is briefly described below.

a) Calculate the Overall Runoff Coefficient for the Watershed:

$$C_D = 0.9\ IMP + Cu\ (1 - IMP)$$

where:

IMP = Proportion impervious for the land use comprising the watershed.

C_u = Undeveloped area runoff coefficient (based on soil type and rainfall intensity).

C_D = Developed area runoff coefficient.

For watersheds with multiple land use types, the overall C_D for the watershed is the weighted average of the C_D for each land use type:

$$C_D = \frac{\sum_{1-n} C_{DX} A_X}{\sum_{1-n} A_X}$$

b) Calculate the rainfall volume for the watershed:

The rainfall volume is calculated by multiplying the storm size, in inches, by the area of the watershed.

c) Calculate the runoff volume for the watershed:

The resultant runoff volume is determined from the following formula:

Runoff Volume = Rainfall Volume x (C_D)

(A detailed example of the above procedure can be found in Appendix 1).

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E. Determination of Sampling Parameters

As discussed previously, eight liters of stormwater runoff will need to be collected by composite sampling. A minimum of 20 aliquots will be collected from each storm to obtain the eight liter composite sample. Therefore, the volume of sample to be collected at each aliquot is:

8 liters/20 aliquots = 400 ml

The 20 aliquots will be spaced at equal runoff volume intervals throughout the storm. Therefore, the size of the runoff volume interval (▲ runoff volume) for a specific watershed would be determined as follows:

▲ runoff volume = total runoff volume / 20

where:

total runoff volume = total estimated runoff volume for targeted storm.

The flow rate at which storm sampling would be initiated at each station would be dependent on whether the site has any consistent dry weather or base flow.

For stations that do not have any dry weather flow, sampling would be initiated upon detection of flow. For those having dry weather flow, sample collection would begin after detecting a flow rate above the maximum-observed, yearly dry weather flow level. Sampling would halt when the flow returns to 120 percent of pre-storm base flow. As the monitoring program progresses, more specific operational criteria for the samplers at each station can be developed based on site specific flow information.

F. Dry Weather Sampling

Dry weather flow samples will be collected at all sites exhibiting adequate dry weather flow. For those sites with continuous dry weather flow, a 24-hour composite sample will be collected. For those with intermittent flow, a sample will be collected as flow is available.

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V. MONITORING CONSTITUENTS

A. List of Constituents

The selection of the monitoring constituents was based on an evaluation of the EPA final stormwater regulations and the existing monitoring program of the LACDPW. Initially, the constituents monitored during dry weather and under storm conditions will be the same. As water quality data is gathered over time and analyzed, revisions to the list of constituents monitored for both dry weather and under storm conditions may be made as deemed appropriate.

B. Constituents and Sample Collection Methods

The sample collection methods proposed for use are a combination of grab sampling and composite sampling. The details of each method will be elaborated in Part VI: Sampling Procedures. The definitions of sample types are:

- **Grab Sample** - a discrete, individual sample taken within a short period of time, usually less than 15 minutes.
- **Composite Sample** - a mixed or combined sample formed by combining a series of individual and discrete samples (aliquots) of specific volume, collected at specific volume intervals.

The time required to complete the cycle of compositing a sample covers a wide range, from a few hours to over to over 24 hours.

However, certain constituents have very short holding times and specific collection or preservation needs. The existence of and concentration of these constituents cannot be tested by composite samples and must be analyzed from grab samples.

All constituents listed in Table V-1 will be tested by composite sampling. Those listed in Table V-2 must be collected manually by grab samples.

Grab samples are preferred for certain water quality tests because field measurements such as pH and temperature should be instantaneous measurements of stormwater; bacteria have a short holding time; oil and grease tends to adhere on the surfaces that it contacts; volatile organic compounds (VOCs) have a tendency to volatilize when in contact with air; and cyanide is very reactive and unstable.

C. Chemical Analysis Methods

The chemical analysis methods for each constituent is listed in Tables V-1 and V-2. Also listed are the associated detection limits, sample volumes, preservation needs, and holding times required of each analysis method.

Weather forecasting and estimation of storm size is an inexact science. Therefore, rainstorms may occur where the total sample volume collected via composite sampling is insufficient to perform all the desired analyses.

Table V-3 presents a prioritized list of the water quality tests to be performed on the composite sample. For those storms where an insufficient total sample volume has been collected, the tests to be performed will be in accordance with the priority listed on Table V-3.

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TABLE V - 1

CONSTITUENTS TO BE TESTED (FLOW COMPOSITE SAMPLES)

LIST OF CONSTITUENTS	EPA METHOD	DETECTION LIMIT (ug/l)	SAMPLE VOLUME	HOLDING TIME	PRESERVATIVE
Semivolatile Organic Compounds					
Acids	8250				
Benzoic Acid	8250	<5			
Benzyl Alcohol	8250	<5			
2-Chlorophenol	8250	<2			
2, 4-Dichlorophenol	8250	<2			
2, 6-Dichlorophenol	8250	<2			
2, 4-Dimetylphenol	8250	<2			
4, 6-Dinitro-2-metylphenol	8250	<3			
2,4-Dinitrophenol	8250	<3			
2-Methylphenol	8250	<3			
4-Methylphenol	8250	<3			
2-Nitrophenol	8250	<3			
4-Nitrophenol	8250	<3		Samples must be	
4-Chloro-3-methylphenol	8250	<3		extracted within 7	
Pentachlorophenol	8250	<2		days and extract	
Phenol	8250	<1			
2,3,4,6-Tetrachlorophenol	8250	<1	1 LITER Total		Cool 4° C
2,4,5-Trichlorophenol	8250	<1	For All Constituents	must be completely	80 mg of NA2S2031
2,4,6-Trichlorophenol	8250	<1	For EPA Method 8250		
	8250			analyzed within	
Base/Neutral	8250				
Acenapthene	8250	<0.5		40 days.	
Acenapthylene	8250	<0.5			
Acetophenone	8250	<3		See footnote 2	See footnote 8
Aniline	8250	<3		Page 33	Page 33
Anthracene	8250	<0.5			
4-Aminobiphenyl	8250	<3			
Benzidine	8250	<3			
Benzo(a)anthracene	8250	<1			
4-Chloroaniline	8250	<1			
1-Chloronapthalene	8250	<1			
p-Dimethylaminoazobenzene	8250	<3			
7,12-Dimethylbenz(a)-anthracene	8250	<1			
a-,a-Dimethylphenethylamine	8250	<3			
Benzo(a)pyrene	8250	<1			
Benzo(b)flouranthene	8250	<1			
Benzo(k)flouranthene	8250	<1			
Chlordane	8250	<1			
Bis(2-chloroethoxy)methene	8250	<1			
Bis(2-chlorisopropyl)ether	8250	<1			
Bis(2-chloroethyl)ether	8250	<1			
Bis(2-ethylhexyl)phtalate	8250	<3			

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TABLE V - 1

CONSTITUENTS TO BE TESTED (FLOW COMPOSITE SAMPLES)

LIST OF CONSTITUENTS	EPA METHOD	DETECTION LIMIT (ug/l)	SAMPLE VOLUME	HOLDING TIME	PRESERVATIVE
Base/Neutral (continued)	8250				
4-Bromophenyl phenyl ether	8250	<1			
Butyl benzyl phthalate	8250	<3			
2-Chloronapthalene	8250	<1			
4-Chlorophenyl phenyl ether	8250	<1			
Chrysene	8250	<1			
Dibenz(a,j)acridine	8250	<3			
Dibenz(a,h)anthracene	8250	<1			
1,3-Dichlorobenzene	8250	<0.5			
1,4-Dichlorobenzene	8250	<0.5			
1,2-Dichlorobenzene	8250	<0.5		Samples must be	
3,3-Dichlorobenzidine	8250	<3		extracted within 7	
Diethylphthalate	8250	<0.5		days and extract	
Dimethylphthalate	8250	<0.5			
Di-n-butylphthalate	8250	<3	1 LITER Total	must be completely	Cool 4° C
2,4-Dinitrotoluene	8250	<0.5	For All Constituents	analyzed within	80 mg Na2s2O3
2,6-Dinitrotoluene	8250	<0.5	For EPA Method 8250		
Diphenylamine	8250	<3			
1,2-Diphenylhydrazine	8250	<3			
Di-n-octylphtalate	8250	<3		40 days.	
Ethyl methanesulfonate	8250	<3			
Fluoranthene	8250	<1		See footnote 2	See footnote 8
Fluorene	8250	<1		Page 33	Page 33
Hexachlorobenzene	8250	<0.5			
Hexachlorobutadiene	8250	<1			
Hexachlorocyclopentadiene	8250	<3			
Hexachloroethene	8250	<1			
Indeno(1,2,3-cd)pyrene	8250	<1			
Isophorone	8250	<0.5			
3-Methylcholanthrene	8250	<3			
Methyl methanesulfonate	8250	<3			
Napthalene	8250	<0.5			
1-Napthylamine	8250	<3			
2-Napthylamine	8250	<3			
2-Nitroaniline	8250	<3			
3-Nitroaniline	8250	<3			
4-Nitroaniline	8250	<3			
Nitrobenzene	8250	<0.5			
N-Nitroso-di-n-butylamine	8250	<3			
N-Nitrosodimethylamine	8250	<3			
N-Nitrosodiphenylamine	8250	<3			
N-Nitroso-di-N-propylamine	8250	<1			
N-Nitrosopiperidine	8250	<3			
Pentachlorobenzene	8250	<3			
Phenacitin	8250	<3			
Phenanthrene	8250	<0.5			

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TABLE V - 1

CONSTITUENTS TO BE TESTED (FLOW COMPOSITE SAMPLES)

LIST OF CONSTITUENTS	EPA METHOD	DETECTION LIMIT (ug/l)	SAMPLE VOLUME	HOLDING TIME	PRESERVATIVE
Base/Neutral (continued)	8250		1 LITER Total For All Constituents For EPA Method 8250		Cool 4° C 80 mg NA2S2O3
2-Picoline	8250	<3			
Pronamide	8250	<5			
Pyrene	8250	<0.5			
1,2,4,5-Tetrachlorobenzene	8250	<3			
1,2,4,-Trichlorobenzene	8250	<0.5			
Pesticides	8250				
Aldrin	8250	<2	1 LITER Total For All Constituents For EPA Method 8250	Samples must be extracted within 7 days and extract must be completely analyzed within 40 days. See footnote 2 Page 33	Cool 4° C 80 mg Na2S2O3
alpha-BHC	8250	<1			
beta-BHC	8250	<5			
delta-BHC	8250	<4			
gamma-BHC (Lindane)	8250	<1			
Chlordane	8250	<2			
4,4'-DDD	8250	<1			
4,4'-DDE	8250	<1			
4,4'-DDT	8250	<1			
Dieldrin	8250	<0.5			
Endosulfan I	8250	<1			
Endosulfan II	8250	<1			
Endosulfan sulfate	8250	<1			
Endrin	8250	<1			
Endrin aldehyde	8250	<1			
Endrin ketone	8250	<1			
Heptachlor	8250	<0.5			
Heptachlor epoxide	8250	<0.5			
Methoxychlor	8250	<2			
Toxaphene	8250	<1			
Polychlorinated Biphenyls	8250				
Aroclor-1016	8250	<1			Cool 4° C Adjust pH 5-9 80 mg Na2S2O3
Aroclor-1221	8250	<1			
Aroclor-1232	8250	<1			
Aroclor-1242	8250	<1			
Aroclor-1248	8250	<1			
Aroclor-1254	8250	<1			
Aroclor-1260	8250	<1			

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TABLE V-1

CONSTITUENTS TO BE TESTED (FLOW COMPOSITE SAMPLES)

LIST OF CONSTITUENTS	EPA METHOD	DETECTION LIMIT (ug/l)	SAMPLE VOLUME	HOLDING TIME	PRESERVATIVE
Pesticides	608				
Aldrin	608	0.05			
alpha-BHC	608	0.05			
beta-BHC	608	0.05		Samples must be	
delta-BHC	608	0.05		extracted within 7	
gamma-BHC (Lindane)	608	0.05		days and extract	
Chlordane	608	0.05			
4, 4'-DDD	608	<0.1		must be completely	Cool 4° C Adjust Ph 5-9 80 mg NA2S203
4, 4'-DDE	608	<0.1			
4, 4'-DDT	608	<0.1		analyzed within	
Dieldrin	608	<0.1		40 days.	
Endosulfan I	608	<0.1			
Endosulfan II	608	<0.1			
Endosulfan sulfate	608	<0.1	1 LITER Total For All Constituents For EPA Method 608	See footnote 2 Page 33	See footnote 8 Page 33
Endrin	608	<0.1			
Endrin aldehyde	608	<0.1			
Heptachlor	608	0.05			
Heptachlor epoxide	608	0.05			
Methoxychlor	608	<0.5			
Toxaphene	608	<1.0			
Polychlorinated Biphenyls	608				
Aroclor-1016	608	<1			
Aroclor-1221	608	<1			
Aroclor-1232	608	<1			
Aroclor-1242	608	<1			
Aroclor-1248	608	<1			
Aroclor-1254	608	<1			
Aroclor-1260	608	<1			
Herbicides tested at spreading grounds					
Prometryn	619		1 LITER Total For EPA Method 619		
Altrazine	619				
Simazine	619	<2 mg/l			Cool 4°C
Cyanazine	619				

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TABLE V - 1

CONSTITUENTS TO BE TESTED (FLOW COMPOSITE SAMPLES)

LIST OF CONSTITUENTS	EPA METHOD	DETECTION LIMIT	SAMPLE VOLUME	HOLDING TIME	PRESERVATIVE
Metals (Total and Soluble)					
Antimony	204.2	10ppb			
Arsenic	206.2	10ppb			
Barium	208.2	100ppb			
Beryllium	210.2	5ppb			
Boron	212.3	200ppb			
Cadmium	213.2	10ppb			
Calcium	215.2	200ppb			
Chromium	218.2	10ppb			
Copper	219.2	10ppb			
Iron	236.2	100ppb	500 mls	6 months	HNO3 to pH <2
Lead	239.2	10ppb			
Magnesium	242.1	200ppb			
Manganese	243.2	30ppb			
Mercury	245.1	1ppb			
Nickel	249.2	10ppb			
Potasium	258.1	1ppm			
Selenium	270.2	5ppb			
Silver	272.2	10ppb			
Sodium	273.1	5ppb			
Thallium	279.2	10ppb			
Zinc	289.2	30ppb			
Others					
Dissolved Phosphorus	300	0.05ppm	50mls	24 hrs	Filter on site Cool 4°C
Total Phosphorus	300	0.05ppm	50mls	28 days	H2SO4 to pH <2
Turbidity	180.1	0.1NTU	100mls	48 hrs	Cool 4°C, H2SO4 to pH <2
Total Suspended Solids	160.2	2ppm	100mls	7 days	Cool 4°C
Total Dissolved Solids	160.1	2ppm	100mls	7 days	Cool 4°C
Volatile Suspended Solids	160.4	2ppm	100mls	7 days	Cool 4°C
Total Organic Carbon	415.1	1ppm	25mls	28 days	Cool 4°C, H2SO4 to pH <2
Total Petroleum Hydrocarbon	418.1	1ppm	1L	28 days	5ml of 50% HCL
Biochemical Oxygen Demand	405.1	2ppm	1L	48 hrs	Cool 4°C
Chemical Oxygen Demand	410.4	20 - 900ppm	500mls	28 days	Cool 4°C, H2SO4 to pH <2
Total Ammonia Nitrogen	350.2	0.1ppm	500mls	28 days	Cool 4°C, H2SO4 to pH <2
Total Kjeldahl Nitrogen	351.2	0.1ppm	100mls	28 days	Cool 4°C, H2SO4 to pH <2
Nitrate - Nitrate	"4110"	0.1ppm	100mls	14 days	Cool 4°C
Alkalinity	310.1	2ppm	100mls	28 days	Cool 4°C
Specific Conductance	120.1	1umho/cm	100mls	6 months	H2SO4 to pH <2
Total Hardness	130.2	2ppm			
Chloride	"4110"	2ppm	2ppm	28 days	None
Fluoride	"4110"	0.1ppm	0.1ppm	28 days	None
Sulfate	"4110"	2ppm	2ppm	28 days	Cool 4°C

See footnote 8 Page 33

* Standard Methods for the Examination of Water and Wastewater, 1989, 17th Edition, published jointly by APHA, AWWA and WPCF.

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TABLE V-2

CONSTITUENTS TO BE TESTED (GRAB SAMPLES)

LIST OF CONSTITUENTS	EPA METHOD	DETECTION LIMIT (ug/l)	SAMPLE VOLUME	HOLDING TIME	PRESERVATIVE
Volatile Organic Compounds	8240A				
Acetonitrile	8240A	10.0			
Acrolein	8240A	10.0			
Acrylonitrile	8240A	0.5			
Benzene	8240A	0.5			
Bromoform	8240A	0.5			
2-Butanone	8240A	10.0			
Carbon Disulfide	8240A	10.0			
Carbon Tetrachloride	8240A	0.5			
Chlorobenzene	8240A	0.5			
Chlorodibromomethane	8240A	0.5			
Chloroethane	8240A	0.5			
2-Chloroethyl vinyl ether	8240A	1.0			
Chloroform	8240A	0.5			
Dibromomethane	8240A	0.5			
1,4-Dichloro-2-butene	8240A	10.0			
Dichlorobromomethane	8240A	0.5			
Dichlorodifluoromethane	8240A	0.5			
1,1-Dichloroethane	8240A	0.5			
1,2-Dichloroethane	8240A	0.5			
1,1-Dichloroethene	8240A	0.5			
trans-1,2-Dichloroethene	8240A	0.5			
1,2-Dichloropropane	8240A	0.5	40 ml Total For All Constituents For Method 8240A	14 days	Cool 4°C 10 mg of Na2SO3
cis-1,3-Dichloropropene	8240A	0.5			
trans-1,3-Dichloropropene	8240A	0.5			
Ethanol	8240A	10.0			
Ethylbenzene	8240A	1.0			
Ethylene Oxide	8240A	10.0			
Ethyl Metacrylate	8240A	0.5			
2-Hexanone	8240A	5.0			
Iodomethane	8240A	0.5			
Methyl Bromide	8240A	5.0			
Methyl Chloride	8240A	5.0			
Methylene chloride	8240A	1.0			
4-Methyl-2-pentanone	8240A	5.0			
Styrene	8240A	0.5			
1,1,2,2-Tetrachloroethane	8240A	0.5			
Tetrachloroethane	8240A	0.5			
Toluene	8240A	1.0			
Trichlorofluoromethane	8240A	1.0			
1,2,3-Trichloropropane	8240A	0.5			
1,1,1-Trichloroethane	8240A	1.0			
1,1,2-Trichloroethene	8240A	1.0			
Trichloroethene	8240A	0.5			
Vinyl acetate	8240A	5.0			
Vinyl chloride	8240A	0.5			
Xylene (Total)	8240A	0.5			

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TABLE V - 2

CONSTITUENTS TO BE TESTED (GRAB SAMPLES)

LIST OF CONSTITUENTS	EPA METHOD	DETECTION LIMIT	SAMPLE VOLUME	HOLDING TIME	PRESERVATIVE
Bacteria					
1. Total Coliform	*9221B*	<20mpn/100ml	100 mls	6 hours	4°C, .008% Na2SO3
2. Fecal Coliform	*9221B*	<20mpn/100ml	100 mls	6 hours	4°C, .008% Na2SO3
3. Fecal Streptococcus	*9221B*	<20mpn/100ml	100 mls	6 hours	4°C, .008% Na2SO3
Oil and Grease	413.2	1 ppm	1L/1000mls	28 days	4°C, H2SO4 to pH <2
Total Phenols	420.1	0.1 ppm	500 mls	28 days	4°C, H2SO4 to pH <2
Cyanide	335.2	0.01 ppm	500 mls	14 days	Cool 4°C, NaOH to pH <2 0.6g ascorbic acid
pH	150.1	0 - 14	25 mls	immediately	none
Temperature				immediately	none

* Standard Methods for the Examination of Water and Wastewater, 1989, 17th Edition, published jointly by APHA, AWWA, and WPCP.

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FOOTNOTES (Tables V-1 and V-2)

1 Should be added to empty sample container to be used for collection of sample if residual chlorine is present in the sample.

2 Samples must be extracted within seven days and extract must be completely analyzed within 40 days.

3 Use NaOH or H_2SO_4, as needed, to adjust the pH. Volume of acid of base must be noted.

4 If Aldrin is one of the pesticides to be tested and the sample is known to have residual chlorine present, then this preservative should in the empty sample container to be used for the collection of the sample.

5 Maximum holding time is 24 hours when sulfide is present. Optionally, sample may be tested with lead acetate paper before pH adjustment, to determine if sulfide is present. If sulfide is present, it can be removed with the addition of Cadmium nitrate powder until a negative spot is obtained. The sample then should be filtered and NaOH added to adjust the pH to > 12.

6 Should only be used in the presence of residual chlorine.

7 This is an arbitrary selected holding time. None is given in EPA method 418.1 - the approved method to use for TPH testing.

8 According to 40 CFR 136.3 Table II Notes, Note (2): "For composite chemical samples, each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed."

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TABLE V-3

MONITORING PROGRAM TEST PRIORITY

Order of Preference for Stormwater Testing

Constituent	EPA Method	Sample Quantity (ml)
1. Heavy Metals (dissolved and Total)	200 Series	500
2. Total Petroleum Hydrocarbons (TPH)	418.1	1000
3. Semivolatile Organic Compounds	8250	1000
4. Pesticides (PCBs)	8250 or 608	1000
5. Total Suspended Solids (TSS)	160.1	100
6. Volatile Suspended Solids (VSS)	160.1	100
7. Total Organic Carbon (TOC)	415.1	25
8. Chemical Oxygen Demand (COD)	410.4	500
9. Specific Conductance	120.1	100
10. Total Dissolved Solids (TDS)	160.1	100
11. Turbidity	180.1	100
12. Biochemical Oxygen Demand (BOD)	405.1	1000
13. Dissolved Phosphorus	300	50
14. Total Phosphorus	300	50
15. Total Ammonia Nitrogen	350.2	500
16. Total Kjeldahl Nitrogen	351.3	100
17. Nitrate - Nitrite	4110*	100
18. Alkalinity	310.1	100
19. Chloride	4110*	50
20. Fluoride	4110*	300
21. Sulfate	4110*	50
22. Herbicides at Spreading Grounds	619	1000
	Total	7825 ml**

* Standard Methods for the Examination of Water and Wastewater, 1989, 17th Edition, published jointly by APHA, AWWA, and WPCF.

** Volatile Organic Compounds, Bacteria, Oil & Grease, Total Phenols, Cyanide, pH, and Temperature will be tested from grab samples to a total quantity of 2,365 ml.

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VI. SAMPLING PROCEDURES

This Stormwater/Urban Runoff Monitoring Program is divided into two sub-programs, namely: the dry weather flow monitoring sub-program, and the storm weather flow monitoring sub-program. For each of these sub-programs, two types of samples will be collected at each monitoring location: Grab samples and composite samples. The constituents to be analyzed for either a grab or composite sample are discussed in Section V, and the automated sampling equipment to be used is described in Section III.

A. Storm Sampling

1. Pre-storm Preparation

In preparing and mobilizing personnel and equipment for a given sampling event, LACDPW will utilize the weather forecasts from the National Weather Service and from Pacific Weather Analysis, along with other Department resources such as the LACDPW Alert System. The Alert System is a system of rain and stream flow gages within the LACDPW flood control system which predicts/measures runoff amounts at key locations and transmits the data via telemetry to LACDPW headquarters. Important deciding factors in mobilizing for a storm sampling event include the probability of rainfall, its expected amount, and its intensity. When a representative storm is expected, sampling personnel will prepare for collection of grab samples and verify that the automated samplers are activated for composite flow sampling.

2. Grab Samples

All attempts will be made to collect grab samples during the beginning of the storm on the rising limb of the hydrograph. Such timing is expected to provide concentrations reflecting the higher levels of contaminants which are expected to be observed in the first part of a storm event as compared to those observed during the remainder of the event.

Grab samples will normally be collected using manual sampling equipment such as bucket with rope, dipper, funnel, etc. For manual grab sampling, please refer to Appendix 2 - "Surface Water Sampling Instruction Manual". Grab sample bottles, however, would have to be filled using manual operation of the automated samplers if sample points are inaccessible, such as the closed conduit sampling stations.

3. Flow-Composite Samples

Flow-composite storm samples will be obtained using an automated sampler to collect samples at flow paced intervals. Samples collected at each station will be combined in the laboratory to create a single flow-weighted sample from each station for analysis.

During a storm event, the sampler is programmed to activate automatically when the water level in the channel or storm drain exceeds the maximum annual dry weather flow rate. A sample will be collected each time a set volume of water has passed the monitoring point. The sample will be distributed into glass containers within the refrigerated sampler. The containers will need to accumulate a minimum of eight liters of runoff during each storm, so as to ensure a sufficient sample volume available to perform the necessary laboratory analyses. The automated sampler will deactivate when the water level in the channel or storm drain falls to about 120 percent of the observed maximum annual dry

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weather flow rate. For detailed discussion on the automated sampler programming, please see Section IV.

Upon conclusion of the storm event, samples will be retrieved from the automated samplers. Samples will be retrieved within the maximum allowable holding times required of the various test methods. At the same time samples are collected, rainfall and runoff data will be logged and stored for transfer to the office.

B. Dry Weather Sampling

The frequency of dry weather sampling is once every other month. This frequency was established based on the assumption that the majority of the flow during dry weather is from discharges that are presently covered by permits issued by the RWQCB. The deviation in test results from time to time would therefore be expected to be minor.

As water quality data is gathered under this program, it may be necessary to increase the frequency of monitoring of some constituents, and likewise may be necessary to decrease or eliminate the monitoring frequency of other constituents, shown not to be of a concern.

1. Grab Samples

Grab samples will normally be collected using manual sampling equipment such as bucket with rope, dipper, funnel, etc. For manual grab sampling, please refer to Appendix 2 - "Surface Water Sampling Instruction Manual". Grab sample bottles, however, would have to be filled using automated samplers if sample points are inaccessible, such as closed conduit sampling stations. Specific grab samples will be collected each time composite samples are retrieved.

2. Flow-Composite Samples

During dry weather, an eight liter composite sample will be collected over a 24-hour period.

Samples will be retrieved and delivered to the laboratory within the maximum allowable holding times of all the various test methods.

C. Sample Transfer and Chain of Custody

The LACDPW contracts for laboratory services with the Los Angeles County Agricultural Commission Laboratory, located at 11012B Garfield Avenue, South Gate, CA 90280.

LACDPW maintains a sampling protocol involving appropriate procedures for manually collecting surface water samples and transferring custody of samples. This sampling protocol is detailed in the attached Surface Water Sampling Instruction Manual (Appendix 2). In addition LACDPW maintains frequent contact with our contract laboratory as to the proper containers and handling of samples in order to effect appropriate analyses of the constituents of interest. A chain of custody record will be completed for each sample collected to allow step-by-step accounting of the sampling path from origin to analysis. Important information on the custody form includes:

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- Name of Person(s) collecting the sample
- Sample Laboratory ID numbers
- Date and Time of Sample Collections
- Names and signatures of all persons handling the samples in the field and in the laboratory.

D. Personnel Training

LACDPW's Surface Water Sampling Instruction Manual (Appendix 2) deals with procedures and equipment used in surface water sampling for both manual and automated sampling, grab samples and composite samples, chain-of-custody, and safety of the field personnel. A copy of this manual is issued to all field personnel.

Prior to sampling, all water quality field personnel are provided training that includes familiarization with all the sampling areas, procedures for proper labeling, handling and storage of sample bottles, getting samples from each monitoring site to the laboratory, handling chain-of-custody, performing manual sampling, and operating automatic sampling equipment.

E. Health and Safety

General health and safety issues and concerns when performing water quality monitoring is also addressed in the LACDPW Health & Safety Program for all its employees. The program requires each employee to complete a safety matrix, which details hazards, that could be encountered in performing his/her duties. Safety Directives covering instructions on how to deal with said hazards are issued each employee. Example of hazards on a field sampler's safety matrix include: hazardous weather conditions, working in confined spaces, hazards associated with chemicals, snakes, poison ivy, traffic, falling, drowning, etc.

It is also LACDPW policy to require field sampling personnel to undergo a minimum of 40 hours of Hazardous Materials Awareness training, and subsequent required review courses. This training includes instructions on how to evaluate potentially hazardous situations and safety concerns.

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VII. FIELD QUALITY ASSURANCE/QUALITY CONTROL PLAN

A. Overview

Properly performed monitoring station set up, water sample collection, transport, and laboratory analysis are vital to the collection of accurate data. Quality Assurance / Quality Control is an essential component of the Monitoring Program.

It is important to note that this Quality Assurance/Quality Control Plan is for the fixed sites described in the Monitoring Plan, Section II, and not for the planned Illegal/Illicit Discharge Investigation Program which will have its own QA/QC plan.

This QA/QC Plan describes the procedures for bottle labeling, chain-of-custody tracking, field setup, the sampler equipment check and setup, sample collection, the use of field blanks to assess field contamination, the use of field duplicate samples, and transportation to the lab. The QA/QC Plan shall be in place and enforced at all times.

An important part of this QA/QC Plan is the continued learning process of all field personnel. Field personnel must be adequately trained from the onset and must continue to have new information about stormwater sampling techniques shared with them. During the early stages of implementation, field personnel will evaluate the field activities and the possible effects on the QA/QC Plan. Enhancement of the Plan, if needed, will be implemented and an updated QA/QC Plan submitted to the Regional Water Quality Control Board for their use.

B. Bottle Preparation

Bottles will be grouped in sets. For each monitoring station, a minimum of three sets will exist in order to guarantee a consistent rotation of bottles. All bottle labels will be generic in appearance and will look similar to the following example:

BOTTLE NUMBER: _____ of _____	DATE:
STATION NAME:	TIME:
☐ GRAB OTHER: ☐ COMPOSITE _____	PRESERVATIVES:
LABORATORY ANALYSIS REQUESTED:	TEMPERATURE:
	COLLECTED BY:

Figure VII-1

Bottles shall be cleaned at the laboratory. After the bottles are returned, they will be labeled and stored away as a set package. Each station will have the same number, size and types of bottles existing for each rotation, unless special grab samples are requested. Clean bottles utilized for composite sampling will be replaced in the sampler at the time of each bottle collection, assuring a pre-setup sampling routine. All bottles not in use will be stored in plastic ice chests used for

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transporting bottles. The size of composite sample bottles has been limited to a maximum of 2½ gallons each, to ensure ease of handling.

C. Chain-of-Custody Procedure

Chain-of-custody procedures and forms provide legal evidence that a sample has not been tampered with. This is achieved by establishing a written record tracing possession of the sample from collection through its final analysis. Primarily we are interested in field chain-of-custody procedures. The contract laboratory's own QA/QC includes chain-of-custody procedures which are in agreement with the field procedures. (See attached Laboratory QA/QC plan.) The chain-of-custody forms will remain at all times with the corresponding samples. Chain-of-custody forms shall be filled out and signed by field staff before actual physical possession of water samples are turned over either to other staff or to the laboratory. A sample chain-of-custody form is presented as Figure VII-2.

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COUN OF LOS ANGELES
DEPARTMENT OF PUBLIC WORKS
WASTE MANAGEMENT DIVISION
900 SOUTH FREMONT AVENUE, ALHAMBRA, CA 91803
PHONE NO (818) 458-6972, FAX NO (818) 458-3534

FIGURE VII - 2
CHAIN-OF-CUSTODY RECORD

DATE_____ PAGE____ OF____

PROJECT NAME
COMPANY NAME DEPARTMENT OF PUBLIC WORKS
REFERENCE WASTE MANEMENT DIVISION
ADDRESS 900 SOUTH FREMONT AVENUE
ALHAMBRA, CA 91803-1331
SAMPLERS (SIGNATURE)

SAMPLE I.D.	DATE	TIME	LOCATION	STA NO	METHODS								NUMBER OF CONTAINERS	COMMENTS/ CONTAINER TYPE

1 RELINQUISHED BY	DATE	3 RELINQUISHED BY	DATE	5 RELINQUISHED BY	DATE
SIGNATURE		SIGNATURE		SIGNATURE	
PRINTED NAME	TIME	PRINTED NAME	TIME	PRINTED NAME	TIME
COMPANY		COMPANY		COMPANY	
2 RECEIVED BY	DATE	4 RECEIVED BY	DATE	6 RECEIVED BY	DATE
SIGNATURE		SIGNATURE		SIGNATURE	
PRINTED NAME	TIME	PRINTED NAME	TIME	PRINTED NAME	TIME
COMPANY		COMPANY		COMPANY	

TOTAL NUMBER OF CONTAINERS

SAMPLE CONDISTIONS
RECEIVED ON ICE YES/NO
SEALED YES/NO

SPECIAL SHIPMENT/HANDLING OR STORAGE REQUIREMENTS

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D. Field Setup Procedures

All field sampling locations are fixed sites, with the sampler placed on public road rights of way or flood control rights of way. One field staff member can conduct the sampler setup, but two staff members are necessary for sample collection at each monitoring station. After each sample collection, field staff will prepare the sampler to collect samples either in storm mode or in dry weather mode. Staff members will also inspect visible hoses and cables to ensure proper working conditions in accordance with site design. Inspection of the strainer, pressure transducer and auxiliary pump can only occur during daylight hours in non-storm conditions.

During a storm event, grab samples will be collected during the initial portion of the storm (on the rising limb of the hydrograph) and subsequently taken directly to the lab. The automated sampler will be checked at the time grab samples are collected to ensure proper working conditions at the site (to see if flow composite samples are being collected). Dry weather collection techniques will be similar with a 24-hour composite sample and subsequent grab samples being collected.

After a sampling event, all bottles will be collected and samples packed with ice and foam insulation inside individually marked ice chest(s). Field personnel will transport these samples to the Department of Public Works headquarters. Chain-of-custody forms will be completed by field staff before relinquishing them to other staff personnel for transportation of the samples to the laboratory. Under no circumstance will samples be removed from the ice chest during transportation from the field to the laboratory. All samples transported to the laboratory will meet the holding time criteria described in Section V.

E. Travel Blanks and Field Duplicates

Potential field contamination will be assessed through analysis of travel blanks and duplicate composite samples. The use of field travel blanks for each monitoring station during every sampling event, represents an attempt to quantify post sampling contamination. The Monitoring Program will also include the use of field duplicates to assess the accuracy of lab results. The collection of a field duplicate will occur for each sampling event. The duplicate will be for one sampling station, unknown to the laboratory. At the present time, this methodology for assessing post sampling contamination and the accuracy of laboratory testing procedures will provide adequate data to measure the accuracy of the results provided to us from the laboratory.

LABORATORY QUALITY ASSURANCE/QUALITY CONTROL

The Los Angeles County Department of Public Works has contracted with the Office of the County Agricultural Commissioner/Weights and Measures Environmental Toxicology Laboratory for all laboratory analysis. A part of this Quality Assurance/Quality Control Plan for the Monitoring Program includes the QA/QC for the Laboratory which is enclosed as two documents (see Appendices 3 and 4). The Laboratory QA/QC Plan is a part of the Monitoring Program.

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VIII. DATA STORAGE AND REPORTING

The following categories of data are being collected as part of the monitoring program:

- Rainfall
- Runoff
- Water Quality Test Data
- Quality Assurance/Quality Control Information

All of the data will be stored in electronic format to allow for ease of retrieval interpretation, and graphic presentation.

Rainfall and runoff data will be collected from each monitoring station after each storm event and stored in a central file. The data will be arranged by monitoring station to show the total rainfall amount and total runoff volume, plus a hydrograph for each sampled storm event.

Water quality data for each monitoring station will be stored in a PC database. QA/QC information will be stored in a PC database.

For each sampled storm event, a report will be prepared summarizing the rainfall, runoff, and water quality data. At the end of each storm season (July 1 to June 30), a yearly monitoring report will be prepared summarizing the data collected.

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IX. PROGRAM MANAGEMENT

Implementation and overall coordination of the Monitoring Program activities, including evaluation of the contract laboratory services will be the responsibility of the Program Manager. The Program Manager will assign field sampling personnel from a pool of technical staff (14 currently available) trained in sampling procedures and methods.

The Program Manager is responsible for evaluation of weather forecasts as provided by our storm forecasting service, and will decide on which storms warrant mobilization for the sampling activities. The Program Manager will assign one of the Field Engineers as an Event Coordinator, who will coordinate the sampling event with the designated field personnel.

For storm weather and dry weather sampling, the stations have been divided into two groups as shown below. The stations have been apportioned based on anticipated difficulty of sampling as well as travel to and from each station.

GROUP	MONITORING STATIONS
1	Los Angeles River @ Tujunga Avenue
	Los Angeles River @ Wardlow Road
2	San Gabriel River @ San Gabriel River Parkway
	Rio Hondo Channel @ Beverly Boulevard
	Coyote Creek @ Spring Street

Two individuals will be assigned to perform field sampling for each group. Each sampling crew will be responsible for all the sampling activities needed at each site within each group. Each staff member assigned to a Group of stations will be responsible for: Field equipment maintenance and operation; proper collection and handling of samples; and field QA/QC and field sampling protocol.

The Program Manager will be responsible for on-going review, and evaluation of the overall QA/QC program related to sampling and laboratory procedures.

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X. ESTIMATION OF POLLUTANT LOADINGS

One of the objectives of the monitoring program is to assess the annual pollutant loadings from large watersheds within these Drainage Basins. Knowing the types and quantities of pollutants discharged from these watersheds are important in assessing the impacts of stormwater on receiving waters.

A. Model Selection

The model to be utilized to calculate basin-wide mass pollutant loadings is the Simple Method as described in the EPA's "Guidance Manual for the Preparation of Part 2 of the NPDES Permit Applications for Discharges from Municipal Separate Storm Sewer Systems." Due to the size of these Drainage Basins, this method will provide a good estimate of pollutant loadings, without requiring the extensive amount of detailed hydrologic and hydraulic data needed by more sophisticated models. Once pollutant loads have been estimated basin wide, an initial assessment can be made as to their potential impacts on receiving waters. Subsequently, more detailed, dynamic modelling of select, representative watersheds in these Drainage Basins can be performed to more accurately track and assess pollutant impacts.

B. Calculation Procedure

Calculation of annual pollutant loadings will be performed as follows:

1. Calculate annual pollutant loads for each drainage area.

   Utilizing the formula below, calculate annual pollutant loads for each drainage area:

   Equation 1:

$$L_i = \frac{(P)\ (CF)\ (Rv_i)}{12}\ (C_i)\ (A_i)\ (2.72)$$

   where:

   L_i = Annual pollutant load (lb/drainage area/yr)
   P = Annual precipitation (in/yr)
   CF = Correction factor that adjusts for storms where no runoff occurs
   Rv_i = Weighted-average runoff coefficient for the drainage area
   C_i = Event mean concentration of pollutant (mg/L)
   A_i = Drainage area (acres)

   The numbers 12 and 2.72 are conversion factors that account for unit conversions.

   Each of the parameters in Equation 1 is defined below:

   - Annual pollutant load is the total amount of a specific pollutant discharged in pounds per time period (in this case, per year) for the particular drainage area being modeled.
   - Annual precipitation is the total inches of rainfall occurring in a single year. Estimates of the annual rainfall are calculated utilizing the historical rainfall data

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compiled for Los Angeles County by the Los Angeles County Flood Control District and, subsequently, the LACDPW.

- **Correction factor** is an adjustment factor for the number of storm events that do not actually produce any runoff (i.e., the percentage of storm events that have a total accumulation greater than a specific threshold value). This value will be calculated based on a review of historic rainfall data for Los Angeles County.

- **Weighted-average runoff coefficient** is a relative measure of the percentage of rainfall that becomes surface runoff. Runoff coefficients will be calculated utilizing the procedure described in Section IV.

- **Event mean concentration of pollutant** is the event mean concentration value for the specific pollutant determined from an analysis of the flow-weighted composite samples obtained by the monitoring program.

- **Drainage area** is the size of the area being modeled.

2. Use the per-drainage area annual pollutant loads to calculate per-watershed annual pollutant loads.

The following equation will be used to calculate per-watershed annual pollutant loads.

Equation 2:

$$L_w = \Sigma L_i$$

where:

L_w = Annual pollutant load for a particular watershed

ΣL_i = Summation of individual annual pollutant loadings from all drainage areas within a specific watershed

3. Use the per-watershed annual pollutant loadings to calculate basin-wide annual pollutant loads.

The following equation will be used to calculate basin-wide annual pollutant loads.

Equation 3:

$$L_n = \Sigma L_w$$

where:

L_n = Annual pollutant load for entire basin

ΣL_w = Summation of individual annual pollutant loadings from all watersheds within the basin

The above procedure can also be utilized to estimate seasonal pollutant loads and per storm event pollutant loads as needed.

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Constituents to be Modeled

Annual pollutant loadings will be calculated for the following constituents:

BOD_5	Total Phosphorus
COD	Dissolved Phosphorus
TSS	Cadmium
Dissolved Solids	Copper
Total Nitrogen	Lead
Total ammonia plus organic nitrogen	Zinc

Development of Annual Pollutant Loadings

We are targeting installation of our monitoring stations to commence May 1995. Upon completion of the storm season, April 1996, and assuming sufficient storms have occurred for sampling and that sampling equipment can be calibrated, event mean concentrations will be calculated. We estimate that the pollutant loads could be developed by August 1, 1996.

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XI. LONG-TERM TRENDS IN STORMWATER/URBAN RUNOFF QUALITY

As discussed in Section II, a total of fifteen fixed-station monitoring sites are proposed for the Upper and Lower Los Angeles River, Upper and Lower San Gabriel River, and the Santa Clarita Valley (Santa Clara River) Drainage Basins. The locations of five of these sites have been chosen to be representative of the various watersheds within the Basin. The locations to be selected and included in a supplemental submittal, one mass emissions sampling site in the Santa Clarita Valley Basin and nine land use specific sites, will meet the same criteria as established in this Monitoring Program Report.

In addition to providing data necessary for calculation of the event mean concentrations, long-term data from these sites can be evaluated for trends. The objective of this evaluation is to determine if there are any statistically significant differences in pollutant concentrations and loadings which could be related to the implementation of Best Management Practices (BMPs) as opposed to random variability in hydrologic factors such as the frequency, intensity, and duration of storm events.

Complicating this evaluation is the fact that there is no, location specific, baseline data available prior to the implementation of BMPs. Monitoring at these selected sites will commence concurrently with implementation of various BMPs. Therefore, dependent on the number of storms available, at least five or more years of data will be needed before reasonable statistical analysis of trends could be performed due to the large degree of natural variability. Therefore, we recommend that any statistical analysis of trends be performed after the conclusion of the fifth year of monitoring.

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APPENDIX 1

STEP-BY-STEP PROCEDURE

FOR

RUNOFF ESTIMATION

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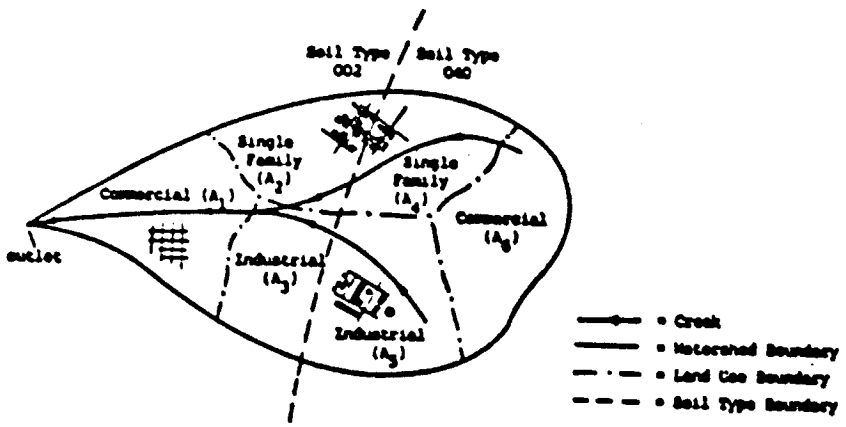
EXAMPLE

1. Calculate the Runoff Coefficient for a Study Area

   Typical Example: The Study Area shown is comprised of two soil types and three land-use types.



Upon examining the Study Area, there are six unique soil types - land-use type combination areas. The areas are numbered 1 through 6. The data for these areas is summarized below:

Area Number	Soil Type	Land Use	Imp.	Area (Square Miles)
1	002	COM	.95	6
2	002	SF	.42	2
3	002	IND	.90	3
4	040	SF	.42	3
5	040	IND	.90	2
6	040	COM	.95	3

In general, the runoff coefficient is first calculated for each individual area. A weighted average calculation is performed to arrive at the overall runoff coefficient for the Study Area.

The detailed procedures is described below:

a) First the Undeveloped Runoff Coefficient (C_u) is determined for each area from the runoff coefficient curve for the soil type for the area. This is done by first choosing th rainfall intensity (in/hr). With this rainfall intensity value go to the runoff coefficient curve and select C_u.

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b) The developed Runoff Coefficient (C_D) is then calculated for each area based on the following formula:

$C_D = .9IMP + C_y (1-IMP)$

The IMP is the imperviousness value assigned to the land use within each area.

c) After calculating C_D for each individual area, a weighted average calculation is performed to come up with the average C_D for the entire Study Area.

Now we will calculate C_D for the Study Area:

Select rainfall intensity

The rainfall intensity to be used will be 1.5 in/hr. If the rainfall intensity is not known or no specific value is to be used, then C_y automatically goes to the minimum or default value of 0.1 which is the same for all soil types. The calculation process should be established to use the default value unless a user specified rainfall intensity is provided.

Determine C_y

The Study Area is comprised of two soil types. C_y for these soil types is:

Soil type	C_y
002	.79
040	.75

Calculate C_D

Calculate C_D for each area:

Area No.	C_y	Imp.	C_D
1	.79	.95	.89[1]
2	.79	.42	.83
3	.79	.90	.79
4	.75	.42	.81
5	.75	.90	.89
6	.75	.95	.89

1) C_D for Area 1 = .9(.95) + .79(1-.95) = 0.89

Therefore, C_D for the Study Area is:

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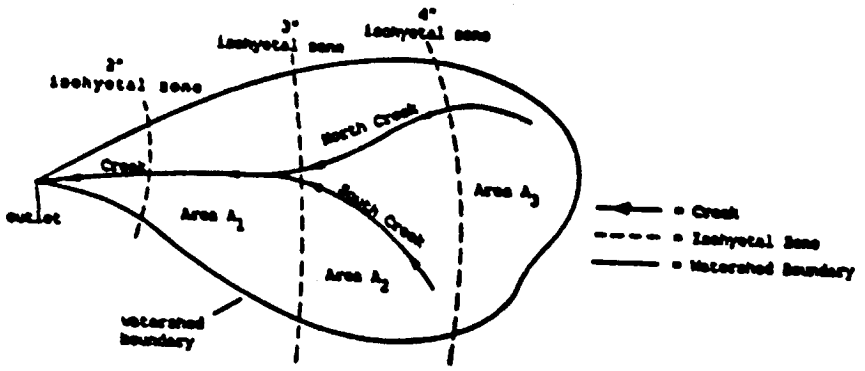
$$C_D \text{ Study Area} = \frac{C_{D1}\,\text{Area}_1 + C_{D2}\,\text{Area}_2 + C_{D3}\,\text{Area}_3 \ldots}{(\text{Area}_1 + \text{Area}_2 + \text{Area}_3 \ldots)}$$

$$= \frac{.89(6) + .83(2) + .79(3) + .81(3) + .89(2) + .89(3)}{(6+2+3+3+2+3)}$$

$$= .86$$

2. Calculate Rainfall Volume Over the Study Area

The Study Area is shown below and encompasses the indicated isohyetal zones.



The total area of the Study Area is 10 mi^2. The portion of the Study Area encompassed by each isohyetal zone is listed below:

Zone	Area(mi^2)
2"	3
3"	7
4"	9

The total rainfall volume deposited on the study area is:

$$\text{rainfall volume} = [2(3) + 3(7) + 4(9)]\ (640\ \tfrac{\text{acres}}{\text{mile}^2})\ (1/12)$$

$$= 3360 \text{ Acre-feet}$$

$$\text{or } \frac{3360}{19(\text{mi}^2)}\ \frac{12\ (\frac{\text{inches}}{\text{foot}})}{(640\ \frac{\text{acre}}{\text{mile}^2})} = 3.3\text{" depth over the entire study area}$$

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3. Calculate the Runoff Volume for a Study Area

For the Study Area used in this example, the runoff coefficient (C_p)=0.86.

runoff volume = Rainfall Volume (C_p)

= 3360 Acre•feet (0.86)

= 2890 Acre•feet

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APPENDIX 2

SURFACE WATER SAMPLING

INSTRUCTION MANUAL

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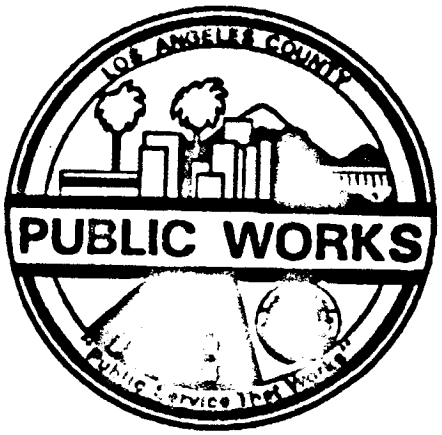
SURFACE WATER SAMPLING INSTRUCTION MANUAL



LOS ANGELES COUNTY
DEPARTMENT OF PUBLIC WORKS

WASTE MANAGEMENT DIVISION

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1. INTRODUCTION

This manual covers collection of surface water samples for the Department's Stormwater/Urban Runoff Monitoring Program, and compliments the sampling procedures contained in the Work Plan for the Stormwater/Urban Runoff Monitoring Program (Work Plan).

Two sampling techniques, Manual Sampling (sampling by hand) and Automated Sampling (sample collection by use of powered devices such as the Automated sampler) are used in the monitoring program. Both manual sampling and automated sampling techniques are discussed in this sampling manual, with reference to the above-mentioned Work Plan.

Samples collected for both dry weather and storm flow monitoring programs are typed either "Grab" or "Composite". Grab sample is an individual discreet sample collected for characterizing water quality at a particular time. Grab samples normally would be collected using manual sampling techniques, unless sampling collection can only be achieved using automatic samplers, such as at manhole stations that are very deep and not accessible using manual grab sampling equipment. Composite samples are series of individual samples collected at paced intervals and combined to create a single weighted composite. Composite samples would normally be obtained, using automated sampling techniques.

The following instructions will help you collect samples and transport water samples safely and correctly. Safety is of the utmost importance, but if a sample is not collected or transported correctly, the subsequent lab analysis results will be compromised or invalidated.

It should be noted that these instructions are merely a guide to meet the specific needs of the Department. They are not intended to be a comprehensive guide to water quality sampling. Numerous textbooks, handbooks, and manuals are available for those interested in more detailed information on sampling methodology.

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II. COLLECTION OF SAMPLES

Water samples will be collected in bottles supplied by the contract laboratory. All sample bottles, except bacteria bottles have been acid-washed and thoroughly rinsed with distilled water to eliminate contamination. Bacteria bottles contain a dechlorinating chemical. DO NOT RINSE THE SAMPLE BOTTLES BEFORE FILLING.

However, the bucket, dipper and funnel should be rinsed at each new sampling location. Use the water at each new site to rinse off any contaminates left in the bucket from prior sites.

DO NOT USE SOAP OR ANY OTHER DETERGENTS TO CLEAN SAMPLING EQUIPMENT.

A. Manually Collecting Grab Samples

A Manual grab is collected by inserting a container (bucket, dipper, etc.) under the surface of the water body to be sampled and/or dipping a container down current of a discharge with the container opening facing upstream. The following manual sampling procedures should be followed, in accordance with the source of the sample as well as requirements for certain analyses:

1. Nonflowing - Reservoirs, Lakes, and Ponds

The sampling technique will depend on the location and purpose of the investigation. The following general rules should be observed:

a. Select a location away from areas where water may tend to be stagnant.

b. Take samples at a location that is definable in plan and depth so that subsequent samples can be taken from the same location. This is important where a study is to be made regarding water quality changes with time.

2. Flowing Water

a. When sampling with a bucket and line from above the streamflow, first attach the line to the bridge railing or some other firmly fixed object. Lower the bucket gently into the center of the channel. Make sure the bucket is submerged to avoid the collection of floating debris.

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b. When sampling for oil and grease, sample should be collected at the air/water interface to insure collection of representative samples.

c. Avoid hitting the bottom of the channel so that deposited sediments are not collected.

d. When using the bucket and line adjacent to the low-flow channel, gently swing the bucket into the center of the flow to collect the sample.

e. After raising the bucket, take the temperature of the sample immediately for at least 30 seconds.

f. Pour off any floating debris and decant the water from the bucket into the sample bottles.

3. Bacteriological Samples

Bacteriological samples should be taken under sterile conditions, observing the following precautions (also refer to Section C 2. Sample Bottles):

a. Do not rinse the bottle. The bacteria bottle contains a dechlorinating chemical which must mix with the sample.

b. Do not fill the bottle completely; leave about 1/2 inch to allow mixing of the contents.

c. When sampling, prevent contaminating the lip and cover of the sampling bottle by avoiding contact with anything but the sample or the source of the sample.

B. Collecting Grab Samples By Automated Sampler

Collection of grab samples can also be accomplished by using the automated samplers. This is accomplished by temporarily bypassing the automated sampling program and utilizing the pumping unit of the automated sampler to fill the grab sample bottles. This sampling technique may be used if sample points for grab samples are inaccessible, such as at sampling stations that are very deep below the ground surface and cannot be accessed using manual grab sampling equipment. However, once the grab samples are collected, the automated sampling system must be restored to its ready mode for performing its programmed functions.

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C. Flow Composite Samples

Flow weighted composite samples are collected using the automated samplers, programmed to collect samples for Storm Sampling (at flow paced intervals), and for Dry Weather Sampling (at fixed time intervals). For both storm sampling and dry-weather sampling, sample bottles must be retrieved within the maximum holding times required of the various test methods. Sample bottles are to be placed in coolers with frozen blue ice for transport to the laboratory for compositing and analysis.

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III. SAMPLING EQUIPMENT

You will be provided with the sampling equipment necessary for your assignment. The equipment may consist of the following items:

- Bucket and rope
- Sample bottles
- Thermometer
- Personal equipment: (if applicable)
  - Hard hat and vest
  - Flashlight
  - Thomas Guide and location sketch
  - Rubber Gloves

A. Bucket and Rope

All surface samples collected manually by the Water Quality Management/Storm Water Section are of the type known as "grab samples". Under this procedure a sample may be collected in a bucket at a randomly selected time, over a period of time not to exceed 15 minutes.

B. Sample Bottles

You will be provided with the appropriate sample bottles and containers by the contract laboratory. Sample containers are easy to contaminate, therefore, AVOID TOUCHING the mouth of the bottle or the inner surface of the cap. Except when otherwise stated all containers should be filled to within 1" of the top NEVER TO OVERFLOWING. Identify the sample and provide necessary information requested on the container label using a waterproof ink pen. Place all glass containers into plastic protective bubble pack bags, and/or pack the containers in the cooler with shock absorbing materials to minimize the possibility of breakage. Add frozen blue ice, and deliver to the contract laboratory.

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1. CONTAINER IDENTIFICATION

Group	I.D.	Container Type
A	Gen Min	1 L Plastic
B	Gen Min	1 L Plastic
	Micro	125 ml Plastic (Sterile)
	TPH	1 L Glass
C	Gen Min	1 L Plastic
	Micro	125 ml Plastic (sterile)
	TPH, Cr+6	1 L Glass
	Metals	500 ml Plastic w/ HN03
	O & G	1 L Glass
	Pest	2 L Glass
D	Gen Min	1 L Plastic
	Micro	125 ml Plastic (sterile)
	TPH, Cr+6	1 L Glass
	Metals	500 ml Plastic w/ HN03
	O & G	1 L Glass w/ H2S04
	Pest	2 L Glass
	TOC	125 ml Glass
	BOD	250 ml Plastic
E	Gen Min	1 L Plastic
	Micro	125 ml Plastic (sterile)
	TPH, Cr+6	1 L Glass
	Metals	500 ml Plastic w/ HN03
	O & G	1 L Glass w/ H2S04
	Pest	2 L Glass
	TOC	125 ml Glass
	BOD	250 ml Plastic
		VOA(2) 40 ml Glass Vial
F	Gen Min	1 L Plastic
	Micro	125 ml Plastic (sterile)
	TPH, Cr+6	1 L Glass
	Metals	500 ml Plastic w/ HN03
	O & G	1 L Glass w/ H2S04
	Pest	2 L Glass
	TOC	125 ml Glass
	BOD, Solids	250 ml Plastic
	VOA	(2) 40 ml Glass Vial

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G	Gen Min	1 L Plastic
	Micro	125 ml Plastic (sterile)
	TPH, Cr+6	1 L Glass
	Metals	500 ml Plastic w/ HN03
	O & G	1 L Glass w/ H2S04
	Pest	2 L Glass
	Herb	2 L Glass
	BNA	2 L Glass
	TOC	125 ml Glass
	BOD, Solids	250 ml Plastic
	VOA	(2) 40 ml Glass Vial
H	Gen Min	1 L Plastic
	Micro	125 ml Plastic (sterile)
	TPH, Cr+6	1 L Glass
	Metals	500 ml Plastic w/ HN03
	O & G	1 L Glass w/ H2S04
I	Gen Min	1 L Plastic
	Micro	125 ml Plastic (sterile)
	TPH, Cr+6	1 L Glass
	Metals	500 ml Plastic w/ HN03
	O & G	1 L Glass w/ H2S04
	TOC	125 ml Glass
	BOD	250 ml Plastic

2. **SPECIFIC INSTRUCTIONS**

a. General Mineral (Gen Min):

Fill unpreserved container to within 1" of the top. It is not necessary to rinse out the container with the sample. Tighten the cap to prevent leakage.

b. Microbiology (Micro):

Fill unpreserved 1 Liter plastic container to within 1" of the top. It is not necessary to rinse out the container with the sample. Tighten the cap to prevent leakage. Place container in cooler with "Blue Ice" to minimize the effect of high temperatures on deaths of microbes. The maximum holding time for bacteria samples is six hours from the time of collection. Therefore, the samples must immediately be transported to the laboratory. Also, refer to preceding Section B 3. Bacteriological Samples.

c. Total Petroleum Hydrocarbon (TPH or TPH, Cr+6):

Fill unpreserved container to within 1" of the top. It is not necessary to rinse out the container with the sample. Tighten the cap to prevent leakage. This container is glass and, if possible, should be placed into a bubble bag for transportation to prevent breakage.

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d. Metals:

Fill preserved container to within 1" of the top. DO NOT RINSE OUT OR OVERFILL. Contains Nitric Acid as a preservative. Tighten cap to prevent leakage.

e. Oil and Grease (O & G) :

Fill preserved container to within 1" of the top. DO NOT RINSE OUT OR OVERFILL. Contains Sulfuric Acid as a preservative. Tighten cap to prevent leakage. This container is glass and, if possible, should be placed into a bubble bag for transportation to prevent breakage.

f. Pesticide-PCB's (Pest-PCB):

Fill unpreserved container to within 3" of the top. It is not necessary to rinse out the container with the sample. Tighten the cap to prevent leakage. This container is glass and, if possible, should be placed into a bubble bag for transportation to prevent breakage.

g. Total Organic Carbon (TOC):

Fill unpreserved container to within 1" of the top. It is not necessary to rinse out the container with the sample. Tighten the cap to prevent leakage. This container is glass and, if possible, should be placed into a bubble bag for transportation to prevent breakage.

h. Biological Oxygen Demand (BOD):

Fill unpreserved container to within 1" of the top. It is not necessary to rinse out the container with the sample. Tighten the cap to prevent leakage.

i. Volatile Organics (EPA 601/602):

Slowly fill the two 40ml vials to overflowing, being careful not to aerate the sample. Carefully place the cap onto the vial and tighten to prevent leakage. Make sure that the teflon surface of the septum (hard white side) is facing the sample, the soft silicon side of the septum should be visible from the top of the cap. Invert the vials to confirm proper sample collection (bubbles should not be observed). If bubbles are present, open the vials, add more sample, reseal the vials, and recheck for air bubbles. Place the glass vials into the plastic protective bubble bag and, if possible, store in a cooler with "Blue Ice".

j. Base-Neutral-Acid Extractables (BNA):

Fill unpreserved container to within 3" of the top. It is not necessary to rinse out the container with the sample. Tighten the cap to prevent leakage. This container is glass and, if possible, should be placed into a bubble bag for transportation to prevent breakage.

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k. Herbicides (Herb):

Fill unpreserved container to within 3" of the top. It is not necessary to rinse out the container with the sample. Tighten the cap to prevent leakage. This container is glass and, if possible, should be placed into a bubble bag for transportation to prevent breakage.

3. SPECIAL SAMPLES

a. Organic Nitrogen (TKN):

Fill preserved 250 ml plastic container to within 1" of the top. DO NOT RINSE OUT OR OVERFILL. Contains Sulfuric Acid as a preservative. Tighten cap to prevent leakage.

b. Radioactivity (Gross alpha & beta):

Fill preserved 1 Liter plastic container to within 1" of the top. DO NOT RINSE OUT OR OVERFILL. Contains Nitric Acid as a preservative. Tighten cap to prevent leakage.

c. Asbestos:

Fill unpreserved 1 Liter plastic container to within 1" of the top. It is not necessary to rinse out the container with the sample. Tighten the cap to prevent leakage.

d. Chlorinated Organic Substances (COS):

Use same sampling procedure as for EPA 601/602. The EPA reference manual is available in the Water Quality Section.

e. Nitrite-N (1 ppb DL):

Fill unpreserved 125 ml plastic container to within 1" of the top. It is not necessary to rinse out the container with the sample. Tighten the cap to prevent leakage.

C. Thermometer

Water temperatures are always taken during sampling, and you will be provided with a thermometer for this purpose.

D. Dissolved Oxygen Meter

If your assignment requires the measurement of dissolved oxygen, you will be provided with a DO meter and instructions on its use. Calibration of the meter is essential prior to each use. Instructions to operate the DO meter will be provided prior to usage.

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E. Personal Equipment

Before leaving on a sampling assignment, make sure that you have all of the personal equipment necessary to carry out your assignment. This would include your hard hat and vest, gloves,flashlight if necessary, Thomas Guide, etc, and location sketches showing the various surface sampling stations and access points.

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IV. SAFETY

Safety Reminders:

1. Safety is more important than the samples. Never place yourself in a dangerous or unsafe sampling situation.
2. Always park your vehicle where it is safe. Pull into an access road or park your vehicle on a street where parking is permitted and walk to the site. NEVER PARK ON A BRIDGE.
3. Wear your hard hat and a high-visibility vest when you leave your vehicle.
4. Wear waterproof boots with high-traction soles when walking or standing on wet surfaces. Slippery surfaces should be avoided.
5. Never stand or walk in moving water.
6. Never get too close to a low-flow channel. Use your bucket and line to obtain a surface sample.
7. Never enter an enclosed drain, tunnel, or a confined space.
8. If waters are flowing outside the low-flow channel, lower the bucket and line from a bridge.
9. When sampling from a bridge, always tie one end of your rope to the railing or some other firmly fixed object. Do not lean excessively over the guard rail.
10. Be alert for hazardous situations. Your personal safety is your first responsibility. Common sense safety precautions must be exercised if you come upon an unusual material, discharge, smell, dumping, etc. Take note of your observations. Your notes may be used in follow-up investigations and/or supporting future analytical findings. Sample must not be taken if common sense judgement indicate that your safety is jeopardized.
11. Wear gloves when handling samples and wash your hands with soap and water when finished.
12. Wash all equipment, boots, gloves, bucket, etc., when finished.
13. When ascending or descending unstable or slippery slopes and embankments, avoid holding breakable bottles, and pointed or sharp objects with bare hands.
14. Each employee has Physical Class Limitations established under the Occupational Health Manual of Policies and Procedures of the Department. Exerting physical efforts or lifting weights over your physical class limit must be avoided to prevent physical injury. Ice chests with full sample bottles may exceed the weight-class requirements; in such cases, the ice chest must be transported by a minimum of two persons.

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V. LABELING AND FIELD OBSERVATIONS

Each sample bottle will normally be pre-labeled by the Water Quality Unit. It is important, however, that each sample be identified as to the source, date, and time of acquisition. If a sample is taken from a large body of water, for example, the location should be described in such a way as to enable the same sample point to be relocated in the future if it becomes necessary.

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VI. DELIVERY OF SAMPLES

Samples should be delivered to the contract laboratory as soon as possible to prevent alteration of the sample between time of sampling and time of analysis. In order to avoid the need to preserve the samples overnight, samples should be delivered to the contract laboratory no later than 5:00 p.m., unless prior arrangement with the contract laboratory is made.

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VII. CHAIN OF CUSTODY

The Chain-of-Custody Record form shown must be completed for each delivery of samples to the contract laboratory. When sampling for potential court case litigation, consult the laboratory for the appropriate testing procedures, splitting and sealing of samples, and chain of custody.

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Date _____ Page ___ of ___

Figure VII - 2
CHAIN-OF-CUSTODY RECORD

PROJECT NAME: _____

DEPARTMENT NAME: LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS

DIVISION NAME: WASTE MANAGEMENT/STORMWATER SECTION

SAMPLERS SIGNATURE: _____

SAMPLE NUMBER	DATE	TIME	LOCATION SAMPLED	METHODS										NO. OF CONTAINERS	COMMENTS/ CONTAINER TYPE

1. RELINQUISHED BY: SIGNATURE / PRINTED NAME / DEPARTMENT / DIVISION / COMPANY	DATE / TIME	3. RELINQUISHED BY: SIGNATURE / PRINTED NAME / DEPARTMENT / DIVISION / COMPANY	DATE / TIME	5. RELINQUISHED BY: SIGNATURE / PRINTED NAME / DEPARTMENT / DIVISION / COMPANY	DATE / TIME	- TOTAL NUMBER OF CONTAINERS
2. RECEIVED BY: SIGNATURE / PRINTED NAME / DEPARTMENT / DIVISION / COMPANY	DATE / TIME	4. RECEIVED BY: SIGNATURE / PRINTED NAME / DEPARTMENT / DIVISION / COMPANY	DATE / TIME	6. RECEIVED BY: SIGNATURE / PRINTED NAME / DEPARTMENT / DIVISION / COMPANY	DATE / TIME	SAMPLE CONDITIONS RECEIVED ON ICE YES / NO SEALED YES / NO SPECIAL SHIPMENT/HANDLING OR STORAGE REQUIREMENTS:

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VIII. PHONE LIST

The following are some frequently-used phone numbers:

LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS

Waste Management Division Water Quality Management Section	(818) 458-6972

Flood Maintenance Division

Field Offices

Eaton Yard	(818) 798-6761
Hansen Yard	(818) 896-0594
Imperial Yard	(310) 861-0316
83rd Street Yard	(213) 776-7610

AGRICULTURAL COMMISSIONER/WEIGHTS & MEASURES

Environmental Toxicology Lab	(310) 940-6778

SWS
8/9/93

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APPENDIX 3

QUALITY ASSURANCE MANUAL

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COUNTY OF LOS ANGELES
OFFICE OF
Agricultural Commissioner/
Weights and Measures

VOL 15

ENVIRONMENTAL TOXICOLOGY LABORATORY

Quality Assurance Manual

11012 Garfield Avenue, Bldg. B South Gate, Ca 90280

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QA OBJECTIVES

1. Establish the laboratory's ability to qualitatively and quantitatively analyzed various types of environmental samples for pollutants by:

   - identifying the qualifications and responsibilities of laboratory personnel;
   - enumerating the existing laboratory instrumentation and equipment together with the procedures for their sevice and maintenance to assure proper operation;
   - providing sources of analytical methods accepted by regulatory agencies for use in the laboratory.

2. Provide guidelines pertaining to sampling protocols, chain-of-custody, and storage of samples to maitain sample integrity prior to analyses.

3. Define the laboratory's calibration procedures and frequency of calibration.

4. Identify all the necessary steps to validate the laboratory's results.

5. Define all the necessary quality control checks that must be followed prior to the analysis and/or in the course of analyzing samples.

6. Identify all laboratory records and information needed to document the quality of analyses performed in the laboratory.

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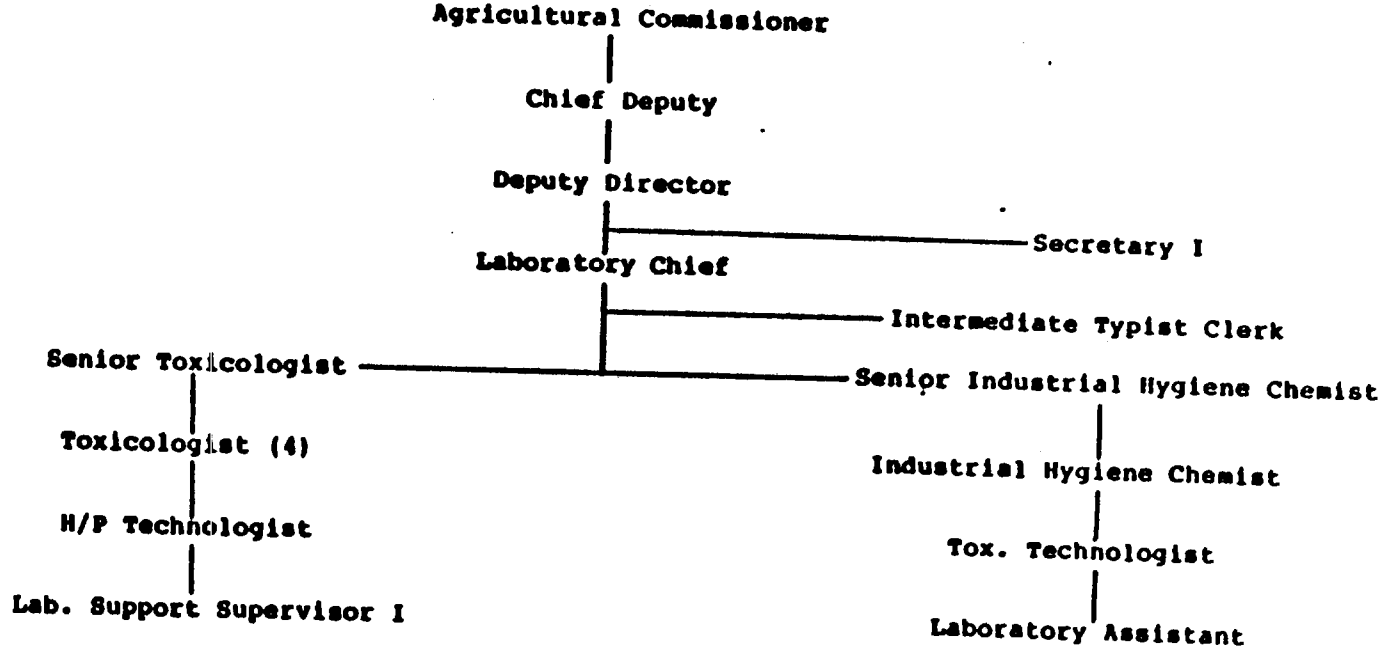
COUNTY OF LOS ANGELES
Office of Agricultural Commissioner/Weights and Measures
ENVIRONMENTAL TOXICOLOGY LABORATORY

Organizational Chart



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1. Organization

A. Minimum Personnel Qualification and Background

1. Deputy Director Graduation from an accredited college with specialization in chemistry, biochemistry, biology, or agricultural chemistry, and three years experience in analytical chemistry, biochemistry, pharmacology, or toxicology laboratory. An advanced degree in chemistry or biochemistry will be accepted for the required experience on the basis of one year for Master's degree and two years for a Ph.D.

2. Chief-A Bachelor of Science degree and at least three years experience in chemistry, biochemistry, pharmacology, biology, or toxicology, one year of which must have involved the chemical analysis of environmental samples. An advanced degree in chemistry or biochemistry will be accepted for the required experience on the basis of one year for a Master's degree and two years for a Ph.D.

3. Senior Toxicologist-Graduation from an accredited college with specialization in chemistry or biochemistry, and two years experience in analytical chemistry, biochemistry, pharmacology, or toxicology. An advanced degree in chemistry or biochemistry will be accepted for the required experience on the basis of one year for a Master's degree and two years for a Ph.D.

4. Senior Industrial Hygiene Chemist-Master of science degree with a major in general or physical chemistry and five years experience as a professional chemist conducting basic analytical research in chemistry, or four years experience as as Industrial Hygiene Chemist.

5. Toxicologist-Graduation from an accredited college with specialization in chemistry or biochemistry, and one year experience in analytical chemistry, biochemistry, pharmacology, or toxicology. Completion of one year graduate work in an accredited college with specialization in chemistry or biochemistry will be accepted for the required experience.

6. Industrial Hygiene Chemist-Bachelor of science degree with major in chemistry a biochemistry, and either (1) a Master's degree in chemistry, biochemistry, or a related field of environmental chemistry and two years experience as a professional chemist doing increasingly complex analytical procedures, or (2) four years experience as a professional chemist doing increasingly complex analytical procedures.

7. Herbicide Pesticide Technologist-Graduation from an accredited college with specialization in chemistry, biochemistry, toxicology, biological & natural sciences and six months experience performing chemical analyses or completion of sixty semester units of which 16 must have been in chemistry and two years experience performing toxicological analyses.

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8. Toxicological Technologist-same as Herbicide/Pesticide Technologist.

9. Senior Laboratory Assistant-Six months experience at the laboratory assistant level.

10. Laboratory Assistant-Six months experience in laboratory work in a public health, medical, chemical, or biological laboratory, or completion of a course in laboratory science such as general chemistry or bacteriology.

B. Personnel Responsibilities

1. Deputy Director

-Directs, plans, assigns, reviews and evaluates work performed by laboratory personnel.

-Provides consultation in environmental toxicology to DHS, Agriculture Comm. and other agencies.

-Testifies as an expert witness for Los Angeles County on the analysis and interpretation of findings.

-Supervises the analysis and interpretation of laboratory data and correlates this with biochemical and metabolic effects.

-Publish scientific papers and reports. Make presentations concerning H/P contamination in our community. Attends and participates in conventions, meetings and conferences of professional organizations concerning H/P.

2. Chief

-Assists in the planning, assignment, supervision, and review of the work of laboratory personnel.

-Provides technical direction to laboratory personnel in performing a variety of chemical analyses of water, soil, plant, animal and other environmental samples utilizing various techniques such as spectrophotometry, chromatography, gravimetric, and volumetric analyses.

-Establishes and sets up special test procedures for detecting pesticides and other chemicals for which the laboratory has minimal or no experience, including all required and necessary quality control steps in such procedures.

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-Establishes minimum quality control guidelines for all methods and tests performed in the laboratory.

-Develops laboratory statistics and reports on analytical procedures in assisting laboratory personnel in making the more difficult or unusual determinations, to identify priorities, and to establish work flow measures.

-Conducts training of laboratory personnel.

-May testify as an expert witness for the Chief Environmental Toxicologist.

3. Senior Toxicologist

-Provides technical guidance to laboratory personnel and performs chemical analyses to determine the presence and quantity of pesticides and other chemicals of interest in samples submitted to the laboratory for study utilizing wet and instrumental methods.

-Develops procedures for and conducts non-routine analysis on samples involving new and uncommon pesticides where standard methods are not established.

-Routinely monitors at regular intervals the accuracy and precision of laboratory results by checking quality control data obtained by laboratory personnel as part of their daily workload.

-Ensures that all quality control guidelines of the laboratory are met and recorded in specific quality control record books.

-Prepares daily work assignments of lower level laboratory personnel.

-Engages in continuing research and experimentation to develop and improve analytical procedures.

-Writes reports on analyses outlining methods used and results.

-Assists the Supervising Toxicologist in performing an analysis of unknown substances.

-Contacts pathologists, law enforcement officers, pharmacists and others to obtain information on cases as necessary.

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4. Senior Industrial Hygiene Chemist

-Prepares work schedules, assigns and rotates Industrial Hygiene Chemists to various jobs, evaluates work performance and recommends resolutions to employee relations problems.

-Tests or directs the testing of new equipment, prepares written evaluations, and makes recommendations for its acquisition; prepares written instructions on the application and operation of new equipment for the procedure manual.

-Supervises a program of quality control to ensure the accuracy of test reports.

-Orients new employees to the overall operations of the section and trains or supervises their training.

-Serves as the consultant to Public Health Programs staff on problems relating to toxic and potentially dangerous chemicals.

-Analyzes samples that require the highest level of technical skill, experience and knowledge.

-Instructs environmental health personnel in the proper procedures for collecting field samples.

-Calibrates all laboratory equipment for the section.

5. Toxicologist

-Performs chemical analyses of water, soil, plant, animal, and other samples utilizing standard laboratory techniques such as spectrophotometry, chromatography and gravimetric and volumetric analysis.

-Follows accepted procedures and required quality control measures for conducting routine analyses such as determinations for pesticides and other organic/inorganic compounds.

-Writes reports on analyses outlining methods used and results.

-Contacts inspectors, law enforcement officers, and others to obtain information on cases as necessary.

-Assists the Senior Toxicologist in performing analysis of unknown substances.

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-Prepares standard chemical solutions and reagents to specific requirements.

6. Industrial Hygiene Chemist

-Collects field samples and conducts surveys regarding industrial hygiene, sanitation, and exposure of workers to health hazards.

-Conducts laboratory and field analyses of abrasives, solvents, and other materials used in industrial plants and makes specialized measurements of air samples to identify and measure contaminants.

-Maintains and operates a chemical laboratory, anticipating needs for ordering chemicals and equipment.

-Develops new and special methods, procedures and equipment to be used for chemical and physical determinations in laboratory and field studies.

-Conducts research on problems of toxicology and other chemical problems as necessary for industry, County and other governmental agencies.

-Maintains laboratory records and prepares reports on results of studies and projects.

-Interprets data and confers with engineers, various divisions of the Health Department, and industrial managers to solve chemical problems concerning industrial health and hazards to workers.

-Operates a variety of laboratory and field testing equipment.

7. Herbicide/Pesticide Technologist

-Performs chemical procedures requiring the use of analytical apparatus to confirm existence of herbicides and pesticides in plant, soil, water, and animal tissue specimens.

-Utilizes techniques such as gas chromatography in chemical analyses of various specimens to determine the quantity of herbicides and pesticides present.

-Follows quality control guidelines on all chemical procedures and analyses performed.

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-Conducts preliminary research contributing to the development of new methods and procedures for the purpose of enhancing the quality of test analysis.

-Prepares standard chemical solutions and reagents to specific requirements.

-Performs routine maintenance on laboratory equipment and apparatus including cleaning and calibration.

-Prepares written reports delineating technical procedures exercised during analysis and test findings.

-Interprets gas chromatography graphs to determine specimen findings and submits interpretations to a Senior Toxicologist for review.

8. Toxicological Technologist

-Performs chemical analysis of environmental and biological samples using established procedures to determine the presence or absence of pesticides.

-Utilizes known instrumentation techniques such as gas and high pressure liquid chromatographs to determine the quality and quantity of pesticides present.

-Follows quality control gridelines on all chemical procedures and analyses performed.

-Prepares reference standards, chemical solutions, and reagents to specific requirements.

-Performs routine maintenance on laboratory equipment and apparatus including cleaning and calibration.

-Interprets charts and reading generated by various laboratory instruments used and submits interpretations to a toxicologist or senior toxicologist for review.

-Maintains register of all samples which includes detailed information on the methods used and findings.

-Assist in the development of new methods and procedures to improve the quality and reliability of test results.

-Follows experimental procedures under the guidance of a senior toxicologist to test for new pesticides.

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9. Senior Laboratory Assistant

-Trains laboratory assistants in the specific procedures established by the laboratory for the preparation of samples for analysis by toxicological technologists and toxicologists, the preparation of reagents, and the performance of other such laboratory tasks.

-Observes the performance of other laboratory assistants of their assigned tasks both in training and on-the-job situations, and makes corrections necessary to assure maintenance to established quality and quantity standards.

-Prepares samples for laboratory testing by adding reagents, solvents, and/or standards using prescribed techniques and instruments appropriate to the type of sample.

-Processes samples for subsequent analysis by higher level personnel by performing duties such as extractions and filtrations.

-Operates laboratory equipment pre-calibrated by qualified personnel to perform assigned tasks such as platform shakers, rotovaporators, and pH meters.

-Prepares specific quantities of reagents and solutions of compounds including acids and bases, following written procedures, by mixing components to standard ratios using such laboratory apparatus as weighing balances and volumetric glasswares; lifts and moves containers holding several gallons or other substantial quantities of constituent parts or compounds produced.

-Performs routine maintenance on miscellaneous devices such as water baths, rotovaporators, and platform balances.

-Cleans and treats glassware used in laboratory testing following steps and procedures prescribed by higher level personnel.

-Stores apparatus, glassware, and other supplies in designated areas when not in use.

-Stores reagents and chemicals in designated areas as required by safety rules and regulations.

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10. Laboratory Assistant

-Receives samples such as water, soil, plant, etc. together with standard laboratory request form providing information such as sample I.D. and tests to be performed; verifies sample I.D. and assigned laboratory I.D. number by matching information on request form and sample container.

-Assigns laboratory identification to all samples received and writes this I.D. number on request forms and corresponding sample containers.

-Logs in sample information such as sample I.D., laboratory I.D. number, and tests to be performed in laboratory record book.

-Stores all samples received in appropriate storage locations and submit corresponding laboratory request forms to senior toxicologist.

-Prepares samples for analyses by chopping, weighing, and/or measuring where appropriate.

-Performs preliminary work on samples such as adding solvents and reagents, setting-up necessary glassware, and loading on platform shakers.

-Operates automatic laboratory equipment pre-calibrated by qualified personnel such as a pH meter to perform specific test.

-Transcribes laboratory test results from laboratory worksheets into permanent record book.

-Cleans & treats glassware used in laboratory testing following steps & procedures prescribed by higher level personnel.

-Cleans and stores apparatus, glassware and other supplies in designated areas when not in use.

-Stores reagents and chemicals in designated areas as required by safety rules and regulations.

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II. Sampling Procedures

A. Hazardous Waste

1. Organochlorine pesticides, Polychlorinated Biphenyls, and Organophosphorous Pesticides.

Wide mouth borosilate or soda glass container of 16 oz. size should be used. The container must have tight, screw-type lid with teflon liner. Sample bottle must not be prewashed with the sample before collection. Composite sample should be collected in refrigerated glass container.

The sample must be iced or refrigerated from the time of collection until extraction. Preservatives should not be used in the field unless more than 24 hour will be elapse before delivery to laboratory. If the sample will not be extracted within 48 hours of collection, the sample should be adjusted to pH range of 6.0 to 8.0 with sodium hydroxide or sulfuric acid. Note the volume of acid or base added to the sample.

All samples must be extracted within 7 days and completely analyzed within 30 days of collection for organochlorine, pesticide and polychlorinated biphenyls, and analyzed within 14 days of collection for organophosphorous pesticides.

2. Phenols

Wide mouth borosilate or soda glass container must be used, and the container must not be prewashed with sample before collection. Composite samples should be collected in refrigerated glass container.

The sample must be iced or refrigerated from the time of collection until extraction. If free chlorine is present in the sample, add 35 mg. of sodium thiosulfate per ppm free chlorine per liter/kg. Adjust the sample pH to approximately 2, as measured by pH paper with sulfuric acid solution or 10 N sodium hydroxide. record the weight of sodium thiosulfate and volume of sulfuric acid or sodium hydroxide used.

All samples must be extracted within 7 days and completely analyzed within 30 days of collection.

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3. Halogenated Volatile Organics, Non-Halogenated Volatile Organics, and Acrolein, Acrylonitrile, Acetonitrile.

Samples must be collected in glass containers of at least 25 ml. size. Fill the sample container in such a manner that no air bubbles pass through the sample as the container is being filled. Seal the bottle so that no air bubbles are entrapped in it. Solid and semisolid samples are to be taken in the same way.

The samples must be iced or refrigerated from the time of collection until extraction. If the sample may contain free or combined chlorine, add 10 mg. sodium thiosulfate per. 40 ml./gm. for up to 5 ppm. chlorine. Fill the container with sample just to overflowing, seal the container, and shake vigorously for 1 minute.

All the samples must be analyzed within 14 days of collection.

4. Base, neutral, acid extractables.

All samples must be collected in glass container with teflon-lined screw caps. The samples must be iced or refrigerated at 4°c from time of collection until extraction. All samples must be extracted within 14 days of collection and completely analyzed within 40 days of extraction.

5. Phthalate Esters, Nitroaromatics, Cyclic Ketones, Poly nuclear Aromatic Hydrocarbons and Chlorinated Hydrocarbons.

All samples must be collected in refrigerated glass containers and the containers must not be prewashed with sample before collection. The sample must be iced or refrigerated from time of collection until extraction. Chemical preservative should not be used unless more than 24 hour will elapse before delivery to the laboratory. If the samples will not be extracted within 48 hours of being collected, the sample should be adjusted on a pH range of 6.0-8.0 with sodium hydroxide or sulfuric acid. Record the amount of acid or base used.

All samples must be extracted within 7 days and completely analyzed within 30 days of collection.

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6. Toxic Metals

All sample containers must be prewashed with detergents, acids and deionized water. Plastic and glass containers are acceptable. Aqueous samples must be acidified to pH less than 2 with nitric acid. Non-aqueous sample shall be refrigerated. The maximum holding time of sample for mercury is 38 days in glass container and 13 days in plastic container.

7. Non-metallic

a. Cyanide

Oxyidizing agents decompose most cyanides. To test the presence of oxidizing agents, test a drop of liquid sample with potassium iodidestarch test paper: a blue color indicates the need for treatment. Add ascorbic acid a few crystals at a time until a drop of sample produce no color on the test paper. Then add an additional 0.6 gm. of ascorbic acid for each liter of liquid sample.

Samples must be preserved with 2 ml. of 10 N. sodium hydroxide per liter of sample at time of collection (pH is greater than or equal to 12).

Samples should be refrigerated at 4°c and analyzed as soon as possible.

Sample could be stored in glass or plastic container.

b. Fluoride

Sample should be collected in glass or plastic container.
Maximum holding time is 28 days.

c. Sulfide

Sample should be collected in glass or plastic container. Aqueous samples must be preserved with zinc acetate or the analysis must be started immediately.

8. Physical property testing

All samples should be collected in glass container with teflon liner and stored at 4°c.

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B. Drinking Water

1. Organochlorine Pesticides and Nitrogen - and Phosphorus-Containing Pesticides

Use 1-L borosilicate glass bottle with TEF-fluorocarbon lined screw cap, add 10 mL. of mercuric chloride as preservative to the bottle for a concentration of 10 mg/L.

When sampling tap water, allow the system to flush for about 10 minutes to stabilize temperature. Adjust the water flow to approx. 500 ml./min. befor collecting the sample. Note that the bottle must not be pre-rinsed with the sample. If a well is to be sample, collect the water in a wide-mouth beaker then transfer to the sample bottle with preservative. Seal the bottle then shake vigorously for 1 minute.

Store the sample at 4°c. Extract within 7 days of collection and analyze within 40 days of extraction.

2. Volatile Organic Compounds

Use 40 ml. vials with screw caps equipped with PTFE-faced silicone septum. These vials maybe ordered from Pierce or equivalent pre-cleaned and ready to use. Carry a field blank filled with reagent water to the sampling site with empty vials.

Fill sample bottles to overflowing. No air bubbles should pass through the samples as the bottle is filled, or be trapped in the bottle when the bottle is sealed.

When sampling tap water, allow the system to flush for about 10 minutes to reach stable temperature. Adjust water flow to about 500 ml./min. them collect the sample. If a well is to be sampled, collect the water in a wide-mouth beaker then transfer to the sample vial.

Collect all samples in duplicate.

Adjust pH of sample to< 2 by the addition of 2 drops of 50% HCl. Seal the sample bottle with the PTFE-face down and shake vigorously for 1 minute. Immediately store sample at 4°c after collection. Analyze samples within 14 days of collection.

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3. Carbamate Pesticides

Use 100-ml. or larger capacity glass or plastic bottle equipped with screw cap. Carry a field blank filled with Type II water to the sampling site with the empty sample bottle. Add 7 mg/100 ml. of sodium thiosulfate to the empty bottles and field blanks as preservative.

Do not pre-rinse container with sample before sampling.

When sampling tap water, allow the system to flush for about 10 minutes to obtain stable temperature. Adjust the flow to approx. 500 ml./min. then collect water in a wide-mouth beaker the carefully transfer the sample to the bottle. Fill the bottle within 2 cm. of the top.

In the laboratory, samples to be analyzed for oxamyl, 3-hydroxycarbofuran, and carbanyl must be further preserved immediately at the laboratory by adjusting pH to 3. This maybe done with the addition of 50% HCL.

Store samples at 4°c and extract within 7 days of collection and complete the analysis within 40 days of extraction.

4. Trace Metals

Use 125-ml. polyethylene bottles with screw caplid. Prior to use, wash bottle with detergent and tap water; rinse with 1:1 nitric acid, tap water, 1:1 hydrochloric acid, tap water, and finally de-ionized water in that order.

For determination of dissolved or suspended metals, no preservative need be added at the time of collection. For determination of total metals, both dissolved and suspended, acidify sample to pH 2 or less with the addition of 1:1 redistilled HNO_3 at the time of collection. For determination of total recoverable metal acidify sample at the time of collection with 0.625 ml. of conc. $HN\ O_3$ for 125 ml. of sample. Analyze sample within 30 days of collection.

C. Sample Labeling and Identification

Immediately after collection, the sample must be sealed, labeled, and the sample analysis request form filled out for each sample.

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1. Sample Labels

Sample labels are used for the specific identification of samples. Gummed paper labels affixed to the containers are adequate, but it should not be affixed to the sample lids. The labels should be filled out at time of collection and should include the following information:

Field Number
Name of Collector
Date and Time
Place of Collection

2. Sample Seals

Sample seals are used to detect unauthorized tampering of samples after collection, upto the time of analysis. The seals must be affixed to the sample container in a way that it has to be broken in order to open the sample container.

Seals must be affixed to the container by the collector.

3. Sample Analysis Request Form

Sample analysis request form accompanies the sample when it is delivered to the laboratory. The field portion of this form should be completed by the collector. The laboratory section is for completion by the laboratory analyst. The sample request form should include at the minimum:

Name of Collector
Date and Time of Collection
Location of Sampling Site
Field Number
Type of Sample
Analysis Requested
Date Received by the Laboratory
Laboratory Number
Results of Analysis
Date of Analytical Report
Name of Analyst
Remarks on Sample

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III. Sample Custody

When a sample arrives, it should be logged in immediately. The laboratory receiving personnel should look at the sample to verify:

-Is the proper container used?
-Is the container properly filled?
-Is the quantity sufficient?
-Is the sample seal intact?
-Is the sample request form filled properly?

If the answer to any of the above question is no, the laboratory supervisor must be notified immediately. Also, the receiving personnel must verify if the sample had been appropriately preserved. If not, if must be preserved according to instructions in Table 1. This Table is posted for reference in the receiving area.

All samples received must be logged in a logbook and a unique laboratory number must be noted on the sample container, sample analysis request form, and log-book. In addition, the logbook must include information of laboratory sample number, sample identification information, type and condition of sample, and analysis requested. The recipient of the sample should sign the chain of custody form (see below).

Chain of Custody

Chain of Custody is a documentation of the sample history form collection to data reporting. A sample is considered under a person's custody if (1) it is in a person's physical possession, (2) in view of the person after he has taken possession, (3) secured by that person so that no one can tamper with the sample, or (4) secured by that person in an area which is restricted to authorized personnel.

The chain of custody form records the history of sample possession from collection, to analysis, and finally, to sample disposal. The form is printed on the same sheet as the sample request form. It must accompany the sample upon delivery to the laboratory. Information on the chain of custody form should include at least the following:

Name of the person in possession of sample
Affiliation of the person in possession
Date in possession

Once the sample has been logged in and the laboratory assume responsibility for it, the sample must be stored in a secure location. Whether the location should be refrigerated or not depends on the type

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of sample or analysis requested. Refer to Table 1 for storage conditions. Typically, all samples for organic analyses must be stored in the refrigerator/freezer. Samples for trace metal analysis maybe stored at room temperature except those requiring Chromium VI analysis. The latter must be refrigerated.

Refrigerator/Freezer used for sample storage must be different from those used for storing standards. In addition, samples for volatile analysis must be stored separately form non-volatiles. On each refrigerator/freezer, a chart is posted outside to record daily temperature readings, date, and name of person monitoring the temperature.

After properly receiving and securing the sample, worksheets are written up providing information on sample laboratory number, type, analysis requested, received date, and maximum holding time. Table 1 posted in the receiving area also contain information on holding times as a guide in preparing the work sheets.

A copy of this section on sample custody is posted in the receiving area to serve as a guide for the receiving personnel.

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Table 1

A. Hazardous Waste

Analysis Requested	Storage & Preservation	Maximum Holding Time
Inorganic Tests:		
Cyanide, total & amenable to chlorination	P, G Cool, 4°C, NaOH to pH 12, 0.6g ascorbic acid	14 days
Fluoride	P None required	28 days
Hydrogen ion (pH)	P, G None required	analyze immed.
Metals:		
Chromium VI	P, G 4°C	24 hours
Mercury	P, G HNO_3 to pH 2	28 days
Metals except chromium VI and mercury	P, G HNO_3 to pH 2	6 months
Phenols	G only Filter immediately, Cool, 4°C cool, 4 C, H_2SO_4 to ph 2	28 days
Sulfide	P, G Cool, 4°C, zinc acetate plus sodium hydroxide to pH 9	7 days
Organic Tests:		
Purgeable Halocarbons	G, Teflon-lined septum Cool, 4°C 0.008% $Na_2S_2O_3$	14 days
Purgeable aromatic hydrocarbons	G, Teflon-lined septum Cool, 4°C 0.008% $Na_2S_2O_3$, HCl to pH2	14 days
Acrolein and acrylonitrile	G, Teflon-lined septum Cool, 4°C 0.008% $Na_2S_2O_3$, adjust ph to 4-5	14 days
Phenols	G, Teflon-lined cap Cool, 4°C, 0.008% $Na_2S_2O_3$	7 days until extraction 40 days after extractio
Phthalate esters	G, Teflon-lined cap Cool, 4°C	7 days until extraction 40 days after extractio
PCBs acrylonitrile	G, Teflon-lined cap Cool, 4°C	40 days after extractio
Nitroaromatics and isophorone	G, Teflon-lined cap Cool, 4°C, 0.008% $Na_2S_2O_3$ store in dark	40 days after extractio
Polynuclear aromatic hydrocarbons	G, Teflon-lined cap Cool, 4°C 0.008% $Na_2S_2O_3$ store in dark	40 days after extractio
Chlorinated hydrocarbons	G, Teflon-lined cap Cool, 4°C	40 days after extractio
Pesticides Tests:		
Pesticides	G, Teflon-lined cap Cool, 4°C, pH 5-9	40 days after extractio

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B. Drinking Water

Analysis Requested	Storage & Preservation	Maximum Holding Time
Volatile Organic Chemicals	4°C, Acidify to pH 2 with 1+1 HCl (1 drop/20 ml. sample)	14 days
Base/Neutral and Acid Extractables, Non-purgeable Organic Chemicals	4°C, Protected from light, For chlorinated waters add Sodium Thiosulfate, 80 mg/L of sample	Extract within 7 days; complete analysis with 40 days of extraction
Ethylene Dibromide (EDB) Dibromochloropropane (DBCP)	4°C, No chemical Preservative	28 days
Organohalide Pesticides and Aroclors	4°C, Sodium Thiosulfate, 3 mg crystals/	Extract within 7 days; complete analysis with 40 days of extraction
Nitrogen or phosphorus Containing Pesticides	4°C, *Mercuric Chloride to 10 mg/L	14 days
Chlorinated Pesticides	4°C, *Mercuric Chloride to 10 mg/L	Extract within 7 days; complete analysis with 40 days of extraction
Chlorinated Herbicides	4°C, No chemical preservative	Extract within 7 days; complete analysis with 40 days of extraction
N-Methyl Carbamoyloximes	4°C**, Sodium Thiosulfate, 7 mg/100 ml.; Acidity to pH3 with HCl (1+1) (Samples for Aldicarb and Endothall must be frozen)	Extract within 7 days; complete analysis with 40 days of extraction
Bentazon	4°C, No chemical preservative	Extract within 7 days; complete analysis with 40 days of extraction

*Use caution in handing this toxic chemical. Dispose of contaminated sample in appropriate manner.

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IV. Calibration Procedures and Frequency of Calibration

A. Standards and References

1. Sources of Standards

99% of our standards come from the following sources:

Quality Assurance Branch
EMSL - Cincinnati
U.S. Environmental Protection Agency
Cincinnati, Ohio 45268

U.S. Environmental Protection Agency
Pesticides & Industrial Chemical Repository
(MD-8)
Research Triangle Park, NC 27711

Supelco, Inc.
Supelco Park
Bellefonte, PA 16823-0048

Aldrich Chemicals
P.O. Box 2060
Milwaukee, Wisconsin 53201

National Bureau of Standards
Gaithersburg, Maryland 20899

All standards are obtained from reliable sources who can certify the purity of the materials.

Upon receipt, all neat standards are entered into an inventory book which includes the data received, who received it, source or supplier, lot number, conc./purity, expiration date, date opened, and who opened the bottle. The bottle itself containing the neat standard is labelled with the data received and initialled, expiration date, and date opened and initialled.

2. Preparation of Standards

Standards are prepared as outlined in the laboratory's specific Standard Operating Procedures (SOP) Manual. All information pertinent in the preparation of the standard are entered in the laboratory's Standard Preparation Book. Which include the following:

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PREPARATION OF CONCENTRATED STOCK STANDARDS

No _____ Date ___/___/___ Chemist _____

Compound _____ Lot No. _____ Purity _____

Final Gross Wt. _____g Dilution Vol. _____ml

*Tare Wt. _____g Concentr. _____mg/ml

Net Wt. _____g

**Adj. Net Wt. _____mg

PREPARATION OF STANDARDS OF INTERMEDIARY CONCENTRATION

NO._____ Date___/___/___ Chemist_____

Compound _____

Strength of Concentrated Stock:_____mg/ml

Aliquot of Concentrated Stock _____ml

Dilution Volume _____ml

Final Concentration _____mg_{ml}

PREPARATION OF FINAL WORKING STANDARD SOLUTIONS

No. ____ Date___/___/___ Chemist_____

	Compound	Parent Sol. Number	Conc. of Parent Sol. ng/ul	Aliq. Vol. ml	Dilution Vol. (ml)	Final Conc. pg/ul
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						

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Standard solution bottles are also labelled individually with the concentration, solvent used, date prepared, expiration date and initials of the preparer.

3. Storage of Standards

All degradable and volatile organic compounds are stored in a freezer at below 0°C. This is true for any concentration: neat or solution.

Trace metal standards, except chromium VI, are stored at room temperature. Chromium VI is refrigerated.

4. External Reference Standards

Whenever possible, check standards are ordered from the EPA or NIST. These are used to verify the accuracy of the working standards. If unavailable from EPA or NIST, standards from another supplier or different lot number from the same supplier are used as check standards.

B. Calibration Procedures and Frequency

Specific calibration procedures are included in the analytical method and in the operator manual of that instrument. Each analytical instrument is calibrated at least daily when in use. The analyst is responsible for calibration. All the calibration data are kept in specific QC books.

There are calibration guidelines in the use of gas chromatographs, HPLC's, and atomic absorption spectrophotometers. These guidelines are applicable regardless of the instruments' make and model.

GC and HPLC Calibration Guidelines

1. Calibration Curve

Initially before use, a 5-point calibration curve must be established for each analyte of interest in order to determine the linearity of the concentration range of interest in the GC system to be used. A calibration curve is established by plotting the system response, as in peak height or peak area, versus the concentration of the standard applied to the system. The concentration of the standards used must correspond to the expected range of concentration in real samples, or must define the working range of the detector used. One standard concentration that must be included should be near but above the method detection limit (check individual method references for tabulated list of MDLs). An alternative to establishing a calibration curve is

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the definition of calibration factors (CFs) for the analyte of of interest at each standard concentrations.

$$CF = \frac{\text{Total Peak Area/Height}}{\text{Mass Injected (ng)}}$$

For each analyte, five CFs would be obtained. Calculate the percent relative standard deviation of the CFs. If the %RSD is less than 20%, it can be assumed that the line defined by the CFs is linear through the origin and that the CF can be used instead of a calibration curve for calculation of the concentration of the analyte in real samples.

2. Calibration Standard

On a daily basis, a calibration standard must be injected and analyzed in the GC system to be used in the analysis. The response of the standards must fall within ±15% of the established calibration curve or factor (see appropriate QC Record Book for current values). If outside the ±15% limit, the cause of change must be determined and corrected, if possible. If the problem is one that is inherent in the system and cannot be corrected, then a new 5-point calibration curve must be established (see Pre-Analysis QC Requirements) before any real sample can be analyzed. Monitor the response of the calibration standard every 10 samples. The ±15% limit must be met with every injection of the standard. Record daily calibration parameter in Form 2.

3. Retention Time (RT) Windows

Prior to any new analyte testing and each time a new GC column is installed, retention time windows must be defined initially for each analyte and its corresponding surrogate and matrix spike standards there after. To determine the RT windows, make a minimum of three injections of all single analyte standard mixture and multiresponse analyte like chlordane over a 71-hour period. Calculate the standard deviation of the absolute RTs of each analyte with every injection. For multiresponse analyte, choose a major peak from the group of peaks and calculate the standard deviation of its absolute RTs from every injection. The RT windows are defined as the ±3S, where S is the standard deviation, of the absolute retention time for each analyte. Record all RTs and windows in Form 2. From the injection of the calibration standard of the analyte of interest, determine the retention time and make certain it falls within the established windows.

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AA Spectrophotometer Calibration Guidelines

Calibration Curve

- must be prepared each day with a minimum of a reagent blank and three standards at different levels of concentrations. Determine the absorbances of each blank and standards. Plot the absorbances versus the concentrations. This plot establishes the linear curve for the day of the atomic absorption spectrophotometer used. Follow themanufacturer's instructions in preparing the calibration curve for the particular instrument used. Verify the curve every ten samples by analyzing a blank and a mid-level standard. The results of the verification should be within +20% of the original curve. If not a new curve must be generated. Use form 3 to record calibration data.

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for _____

Date	Conc. (ng)	Response	Acceptable CFs	Remarks

Form 1

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Gas Chromatographic Conditions:

System:_____ Carrier Flow:_____

Column:_____ Detector:_____

Col. Temp.:_____

Analyte \ Date	RETENTION TIMES								WINDOWS

_____ ATOMIC ABSORPTION CALIBRATION CURVE

DATE/ ANALYST	STANDARD CONCENTRATION					CORRECTIVE ACTION/ COMMENTS
	0 ppm/ abs	ppm/ abs	ppm/ abs	ppm/ abs	ppm/ abs	
	0 ppm/ abs	ppm/ abs	ppm/ abs	ppm/ abs	ppm/ abs	
	0 ppm/ abs	ppm/ abs	ppm/ abs	ppm/ abs	ppm/ abs	
	0 ppm/ abs	ppm/ abs	ppm/ abs	ppm/ abs	ppm/ abs	
	0 ppm/ abs	ppm/ abs	ppm/ abs	ppm/ abs	ppm/ abs	
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	0 ppm/ abs	ppm/ abs	ppm/ abs	ppm/ abs	ppm/ abs	
	0 ppm/ abs	ppm/ abs	ppm/ abs	ppm/ abs	ppm/ abs	
	0 ppm/ abs	ppm/ abs	ppm/ abs	ppm/ abs	ppm/ abs	

[redacted]

FORM 3

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V. Analytical Procedures

A. Methods Used

All the analytical procedures used are from published sources from the following list:

1. Test Methods for Evaluating Solid Waste, SW-846, 3rd Edition, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. November, 1986.

2. Methods for Chemical Analysis of Water and Wastewater, EPA-600/4-79-020, 1984 U.S. Environmental Protection Agency.

3. Standard Methods for the Examination of Water and Wastewater, 15th and 16th Edition, APHA-AWWA-WPCF, Washington, D.C. (1980-1085).

4. The Determination of Inorganic Anions in Water by Ion Chromatograph - Method 300.0, EPA-600/4-84-017, March 1984, U.S. Environmental Protection Agency.

5. EPA Drinking Water Methods, 500 Series.

If applicable; certain methods are written in out line form for routine use in the laboratory. They are included in the laboratory's Standard Operating Procedure (SOP) Manual. For any analyst using methods for the first time, it is recommended that references noted on the upper right hand corner of the outlined form be thoroughly studied prior to the use of the outline.

B. Detection Limit

Method Detection Limit (MDL)

Method detection limit is the lowest concentration level detectable in the laboratory instrument. It corresponds to an analyte signal-to-noise ratio of two with the analyte being introduced to the instrument in clean solution, i.e., reagent water or reagent grade organic solvent. Typically, the laboratory has the same MDL as those listed under specific analytical methods such as the EPA 500 series. The laboratory verifies that the listed MDLs are indeed applicable by directly injecting or introducing standards at the MDL level to the instrument and obtaining a signal-to-noise ratio of at least two from the injection.

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Practical Quantitation Limit (PQL)

Practical quantitation limit (PQL) is the lowest quantifiable level that can be reliably achieved during a routine laboratory analysis of an analyte in a given matrix. This value is typically higher than the MDLs because it is matrix dependent. In determining PQLs, the laboratory follows the method given in the publication EPA-600/4-82-057, Appendix A.

C. Record of Analysis

For each analytical batch, all pertinent data related to the analysis including method used, sample weight or volume, dilutions, standard concentrations, description of instruments used and name of analyst are entered into a permanent log-book (Hazardous Waste) or worksheets (drinking water) which are filed as permanent records of the laboratory.

D. The laboratory maintains Standard Operating Procedures (SOP) Manual for both hazardous waste and drinking water analyses. These manuals contain the different analytical methods used in the laboratory in outline form. This is a cookbook-type outline generated from published methods which includes, whenever applicable, the following:

1. Scope and Applications
2. Detection limits (instrument and method)
3. Precision and Bias
4. Working range
5. Summary of Method
6. Sample collection, preservation, and holding times
7. Comments
   - A. Interferences
   - B. Helpful hints
8. Safety issues (specific to the method)
9. Apparatus
10. Reagents and standards
11. Procedure (detailed step-by-step)
    - A. Sample preparation
    - B. Calibration
    - C. Analysis
12. QA/QC requirements
    - A. QC samples
    - B. Acceptance criteria (precision and accuracy)
    - C. Corrective action required
13. Calculations
14. Reporting
    - A. Reporting units
    - B. Reporting limits
    - C. Significant figures and reporting values below detection limit
15. References
    - A. Method source
    - B. Deviations from source method and rationale

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VI. Data Reduction, Validation and Reporting

A. Data Reduction

Equations and calculation procedures are included in the laboratory's SOPs. All the calculations must be attached to the copy of laboratory report for filing. Corrections for the blanks maybe made where appropriate. Calculations by the instrument/integrator is acceptable.

B. Data Validation

All results generated by the laboratory must be validated through the simultaneous analyses of required quality control (QC) samples/standards with the unknown sample. These include:

1. Instrument calibration with three concentration levels of standard and continuing single standard calibration every ten sample of an analytical batch.

2. Analysis of a method blank every batch of 20 samples for hazardous waste (every batch of 10 samples for drinking water) or type of matrix, which ever is more frequent.

3. Analysis of matrix spiked samples in duplicate at least once for every batch of 20 samples for hazardous waste (every batch of 10 samples for drinking water) or type of matrix which ever is more frequent.

4. Once during the analysis, an external reference standard should be used to check the concentration of the calibration standard.

After completing the analyses of an analytical batch, results of the above QCs must be recorded and plotted in the appropriate quality control chart (see form 4). Precision and accuracy control charts are maintained to determine if the QC results of an analysis are within established control limits. Control limits are initially set after the analysis of ten matrix spike and duplicate samples.

Thereafter, they are periodically set to reflect current performance.

It is the responsibility of the analyst to determine that all appropriate quality control operations have been performed and that all QC results fall within established limits. If any of the required QC is out of control the analyst must initiate corrective actions.

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C. Data Reporting

Analytical results are ready to be reported as soon as it is verified that all quality control data fall within the laboratory's established limits. All data generated, both for the actual sample and the quality control sample must be entered in the appropriate worksheet, log-book and QC books. All information related to the sample analysis such as weight, volume, and QC results must be recorded. All results reported to the submitting agency would be presented with the appropriate number of significant figures, proper units such as ppm, method used, and practical quantitation limits. Worksheets, instrument out puts (e.g. chromatogram), analytical results, sample request for and report of analysis form are put together in a file and submitted to the laboratory supervisor for review. The supervisor signifies his/her approval by signing the report of analysis form to be sent to the submitting agency.

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PRESICION AND ACCURACY DATA

Matrix/Unit _____

Analyte: _____

	1	2	3	4	5	6	7	8	9	10	11	12
Batch #												
Date												
amt. spike												
unspiked												
spike 1												
spike 2												
ave.												
spike difference												

Accuracy

	1	2	3	4	5	6	7	8	9	10	11	12
Ave.												

Precision

	1	2	3	4	5	6	7	8	9	10	11	12
Ave.												

Form 4

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VII. Internal Quality Control Procedures

In order to document the laboratory's ability to test for the analyte of interest, certain quality control procedures are followed. These procedures are divided into two: (1) pre-analysis QC requirements and (2) daily or on-going QC requirements.

1. Pre-Analysis QC Requirements - QC Check Samples

   The laboratory's ability to generate results with acceptable accuracy and precision using a published method must first be verified before the analysis of actual samples. This is done through the analysis of four QC check samples prepared according to Sec. 8.6.2, Method 8000, SW-846. Briefly, QC check samples are prepared by spiking four aliquots of reagent water with known amounts of the analytes in the method to be used. The average recovery ($\bar{R}$) of the analytes in ug/L and the standard deviation (s) in ug/L of the recoveries are calculated and compared with those listed under the QC Acceptance Criteria Table found at the end of each published method. If the $\bar{R}$ and s values calculated fall within the limits defined in the table, then the system performance is acceptable and analysis of actual samples can begin. If any individual analyte's $\bar{R}$ or s fall outside the limit, then the system performance in unacceptable for that analyte. QC check samples must then be analyzed just for the analyte that failed. If re-analysis produced results within limits, then the system performance is acceptable. Repeated failure signifies a general problem with the measurement system. If this occurs, the source of the problem must be located and corrected - then QC check samples must again be ran for <u>all</u> the analytes.

2. Daily QC Requirements

   On a daily basis or each time a sample or batch of samples is analyzed, certain quality control samples must be ran: method blanks, duplicates, and matrix spike/matrix spike duplicates. From these quality control samples, control charts may then be generated which would allow for the establishment of accuracy and precision limits for the laboratory.

   Method Blank

   The analytical result of the method blank (or reagent blank) must be free of any analyte contamination. If contaminated, the source of contamination must be determined and corrected. After correction, the batch must then be re-analyzed if the sample quantity permits; or

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if not, results of the analysis maybe released with appropriate warnings on the nature of the contamination.

Hazardous waste - blanks must be ran once every analytical batch of 20 samples or less or each type of matrix whichever is more frequent. Since it is impossible to obtain a universal matrix blank for non-aqueous/solid samples, only reagent water is used.

Drinking water - blanks must be ran once every analytical batch of ten or less. Reagent grade water is used as blank.

Duplicate Samples

Duplicate samples are prepared by dividing a sample in two and analyzing them separately. Duplicate samples serve the purpose of monitoring the precision of measurement system. The results of the duplicate analyses must be within 20% of each other. If not an error has occured and it must be determined and corrected. The batch must then be re-analyzed. If the duplicate samples are negative for the analytes tested, then the matrix spike (see below) must be ran in duplicate to measure the precision. Duplicates must be ran once for every batch of 20 hazardous waste samples or less or each matrix type whichever is more frequent. Drinking water analysis requires duplicates to be ran every 10 samples.

Matrix Spike/Matrix Spike Duplicates (MS/MSD)

A predetermined amount of the analyte standard is added to a sample matrix to prepare the matrix spike sample. If the unknown samples to be analyzed are expected to be negative, then the sample matrix for spiking is first split into duplicates prior to the addition of the standard. Both matrix spike and matrix spike duplicate are analyzed simultaneously with the unknown samples. Recoveries of the analyte from the spike samples measure the accuracy of the method and the percent difference between the matrix spike and matrix spike duplicate assesses the precision of the analysis. The level of standard for spiking must be at the regulatory level or the method quantification limit. Samples with analyte concentration greater than 0.1% do not require the analysis of matrix spikes. Matrix spike and matrix spike duplicates must be ran for 5 % of the total analytical batch or each matrix type of hazardous waste. Drinking water requires the analysis of MS/MSD for 10% of the analytical batch. The accuracy and precision obtained from the MS/MSD must fall within the established lower and upper control limits of the laboratory. Continuing spike recoveries are recorded in form 4.

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3. Other QC Requirements

Periodically, samples are re-analyzed by another analyst. This is especially true in situations wherein a seemingly valid result is obtained but does not agree with the history of the sample.

Good Laboratory Practices

Good laboratory practices are followed to assure continued production of reliable results. These include not only topics previously discussed, i.e., sample custody, calibration, analytical procedures, data handling, and internal quality control procedures, but also glassware cleaning, verification that the sample containers, reagents and laboratory water are free of contamination, local and state safety codes are followed, fume hoods are routinely monitored, and hazardous waste are disposed of properly.

1. Glassware cleaning - glassware used for metal analysis should be acid washed. Refer to the published analytical methods for detailed procedures. Glassware used for organic analysis should be washed with solvent used in the analytical procedure. If trace amount of the organic contamination is found, it maybe necessary to clean the glassware in a muffle furnace.

2. Only reagent grade chemicals are used.

3. Type II deionized water is used in the analytical method and for method blanks.

4. Sample containers must be verified to be free of contamination. To accomplish this, a container from every lot received is rinsed with water or methanol, whichever is applicable, and analyzed.

5. Air flow in the fume hoods are monitored periodically by qualified personnel. The maximum operating height of the fume hood door is marked accordingly.

6. Safety procedures are adhered to. The laboratory has a safety manual that is distributed to all personnel. It covers topics on emergency procedures as in cases of fire or chemical spills, laboratory safety procedures with regards to handling different types of chemicals and executing certain laboratory tasks, and state-required hazardous material communication procedures.

7. Local and state safety codes are incorporated in the laboratory safety manual. As with all other safety procedures in the manual, they must be adhered to.

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VIII. Performance and System Audits

The laboratory undergoes periodic performance and system audits through external and internal proficiency samples.

External Proficiency Samples

Currently, the laboratory has three sources of external proficiency samples. They are the California Dept. of Food and Agriculture, California Dept. of Health Services, and the Environmental Protection Agency.

CDFA Proficiency Samples

On a quarterly basis, the CDFA sends a minimum of four proficiency samples to the laboratory. Fifty percent of these are plant tissues and the other 50% are environmental samples such as water, soil, and swabs. The samples are spiked with pesticides from the organochlorine, organophosphorus, and/or carbamate group. Results of the proficiency sample analyses are sent back to CDFA for evaluation and they in turn mailback to the laboratory statistical analysis of results as compared with theoretical valves and other laboratories' results.

CDHS

Periodically, the laboratory had received performance evaluation samples from the CDHS. The samples received were for both hazardous waste and drinking water analysis. The samples were spiked with some of the analytes the laboratory was accredited for. As with the CDFA proficiency samples, after submitting the P.E. sample results to CDHS, the laboratory receives a statistical analysis of the results reflecting the comparison of results with the CDHS's accept/reject criterion.

EPA

On January 1990, the laboratory enrolled with the EPA to participate with the latter's Performance Evaluation Sample Program in water pollution. As a result, the laboratory anticipates receiving and analyzing P.E. sample for waste water periodically in the future.

Internal Proficiency Sample

Effective January 1990, the laboratory, on a quarterly basis, prepares and analyzes internal proficiency samples. A minimum of three samples are involved representing any of the environmental samples such as water, soil, plant, and wipe. The proficiency samples are spiked with some of the analytes typically ran in the laboratory. Reports are prepared from the results of the proficiency samples and compiled in the appropriate QC record book.

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IX. Preventive Maintenance

All minor maintenance and repair needed are accomplished by laboratory personnel. For major breakdowns, sufficient funds are budgeted annually to enable the laboratory to obtain service calls from qualified manufacturer's service engineers. The laboratory maintains a log book on any repair or maintenance of instruments.

All microbalance and platform balance are calibrated annually by qualified service engineers. On a weekly basis, the calibration of the balances are verified with standard weights.

All other service and maintenance needed by our laboratory for instruments and equipments are referred to their corresponding manufacturers. Based on yearly service expenses of the past years, sufficient amount budgeted annually to cover any future costs.

With the exception of Tracor Instruments which is located in Texas, all other manufacturers of our instruments could provide service within 48 hours after notification. Tracor has no local service representative so they take approximately one week before they send a serviceman.

The laboratory maintains a log book on instrument maintenance and repair for all major equipment used in the laboratory. It contains records on when an instrument is maintained and/or serviced, who provided the service, and what actions were taken.

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X. Assessment of Accuracy and Precision

Accuracy

Accuracy means the nearness of a result or the average of a set of result to the true value. Accuracy is represented by the percent recovery (R) if an analyte from a given matrix using a specific method. The percent recovery may be calculated as:

$$R = \frac{A-B}{T} \times 100\%$$

where: A is the calculated concentration of the analyte in the spiked matrix after analysis

B is the background concentration of the analyte in the matrix blank, if any.

T is the known value of the analyte spiked in the matrix blank.

To set the accuracy control limits of an analyte in a given matrix using a specific method, calculate the average of R values ($\bar{R}$) and their standard deviation (S_r). The accuracy control limit as recommended by the EPA is then defined as:

$$RLCL = \bar{R} - 2S_r$$
$$RUCL = \bar{R} + 2S_r$$

where: RLCL is the accuracy lower control limit
RUCL is the accuracy upper control limit.

Precision

Precision is the measurement of agreement of a set of replicate results among themselves without the assumption of any prior information as to the true value. Precision is measured using replicate or duplicate sample analysis. Precision as relative percent difference (RPD) is calculated as:

$$RPD = \frac{X_1 - X_2}{X} \times 100\%$$

where: X_1 and X_2 are results of duplicate analyses

X is the average of X_1 and X_2

As recommended by EPA, the laboratory's precision limit is ±20%.

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Control Charts

Precision and accuracy control charts are maintained for at least 10% of the analytes (min. 3 and max. 10) for a given method using form 4. Control limits are initially set after 10 data points. Thereafter, limits are periodically set to reflect current performance.

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XI. Corrective Action

Corrective action is initiated in out-of-control situations. A situation is considered out-of-control if any of the laboratory's internal quality control samples (see section VII) are outside established limits, i.e.:

1. Method blanks are coming out positive for the analyte of interest signifying that the analytical system is contaminated.

2. Results of duplicate samples are outside the 20% limit.

3. Spike recoveries fall outside the established laboratory's accuracy control limits.

For any of the above conditions, the senior personnel assigned to the unit will be notified immediately. It is his/her responsibility to decide which of the following corrective actions must be taken:

1. The analyst provides additional information or recalculations.

2. Instrument calibration and operation are checked. Calibration standards are checked and new ones are prepared if necessary. Instrument malfunctions are corrected.

3. New reagents are used if needed.

4. The analyst repeats the analysis of spiked samples using the same method.

5. A different analyst repeats the analysis of spiked samples using the same method.

6. The analyst repeats the analysis of spiked samples using a modified or new method.

No laboratory result will be sent until the problem is solved. All out-of-control situations and the corrective actions taken are documented by the senior personnel and submitted to the laboratory supervisor and/or chief for review.

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XII. Quality Assurance Report

On a monthly basis, senior personnel assigned to different units submit quality assurance reports for review by laboratory supervisor/chief. The reports contain a summary of the unit's QA activities during the period. The report includes the following information:

1. Date of analysis
2. Number of samples in the batch
3. Analytical batch number
4. Type of matrix
5. Analyte tested
6. Number of method blanks and results.
7. Number of matrix spikes and results
8. Number of duplicates and results
9. Detection limits
10. Name of analyst

In additon a copy of reports on out-of-control situations and corrective actions taken during the period are attached. The laboratory supervisor and/or chief reviews the QA report, signifies approval by signing them, and the reports are filed accordingly.

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APPENDIX I

Calculation of standard deviation s from replicate measurements. e.g. lead in soil in mg/kg.

X	$(X-\bar{X})$	$(X-\bar{X})^2$
49.8	0.80	0.64
48.9	-0.10	0.01
51.3	2.3	5.29
51.3	2.3	5.29
45.9	-3.1	9.61
44.3	-4.7	22.09
52.2	3.2	10.24
50.0	1.0	1.0
47.6	-1.4	1.96

$\bar{X} = 49.0$ $\qquad \Sigma = 56.13$

$n = 9$

$$s = \sqrt{\frac{\Sigma(X-\bar{X})^2}{n-1}}$$

$$s = \sqrt{\frac{56.13}{9-1}}$$

$$s = \sqrt{7.016}$$

$$s = 2.65$$

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APPENDIX 4

SUPPLEMENTAL QUALITY ASSURANCE MANUAL

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R0061367

COUNTY OF LOS ANGELES
Office of
Agricultural Commissioner/
Weights and Measures

ENVIRONMENTAL TOXICOLOGY LABORATORY

MICROBIOLOGY

Supplemental Quality Assurance Manual

11012 Garfield Avenue, Bldg. B South Gate, CA. 90280

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R0061368

NOTE: This is a supplemental manual to be used in conjunction with the Laboratory's previous Quality Assurance Manual.

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QA OBJECTIVES

1. Establish the laboratory's ability to perform qualitative and quantitative microbiology testing of drinking water and wastewater by:

   - identifying the qualifications and responsibilities of laboratory personnel (in previous QA Manual);
   - enumerating the existing laboratory instrumentation and equipment used in microbiology testing together with the procedures for their service and maintenance to assure proper operation;
   - providing sources of analytical methods accepted by regulatory agencies for use in the laboratory.

2. Provide guidelines pertaining to sampling protocols, chain-of custody, and storage of samples to maintain sample integrity prior to analyses.

3. Define the laboratory's calibration procedures and frequency of calibration.

4. Identify all the necessary steps to validate the laboratory's results.

5. Define all the necessary quality control checks that must be followed prior to the analysis and/or in the course of analyzing samples.

6. Identify all laboratory records and information needed to document the quality of analyses performed in the laboratory.

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SAMPLING PROCEDURES

Containers

Approved container for bacteriological sampling are presterilized Nasco Whirl-Pak bag or 4 oz. sterilized Nalgene or glass bottles. All samples containers must contain two drops of 10% sodium thiosulfate. One sample bottle from each batch of bottles prepared must be checked for sterility by adding several sterile tubes of single strenght lauryl tryptose and incubating for 48 hours and checking for growth.

Collection

Samples must be representative of the potable water distribution system. Water taps used for sampling are free of aerators, strainers, hose attachments, mixing type faucets, and purification devices. Maintain a steady water flow for at least 2 minutes to clear the service line before sampling. Collect at least a 100 mL sample volume, allow at least ¼ inch air space to facilitate mixing of sample by shaking. Do not rinse sample container!

Holding/travel time between sampling and analysis is not to exceed 30 hours for potable water samples. If laboratory is required by State regulation to analyze samples after 30 hours and up to 48 hours, the laboratory is to indicate that the data may be invalid because of excessive delay before sample processing. No samples received after 48 hours are to be analyzed. Sample collectors who deliver samples directly to the laboratory should ice samples immediately after sample collection. All samples received in the laboratory are to be analyzed on the day of receipt.

Waste and surface water sample holding time is not to exceed 6 hours.

Labeling and Identification

Immediately after collection, the sample bottle must be labeled and the sample analysis request and report form filled out for each sample.

1. **Sample Labels**

   Samples labels are used for the specific identification of samples collected. Gummed paper labels affixed to the containers are adequate, but it should not be affixed to the sample lids. The labels should be filled

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out at the time of collection and should include the following information:

Sampling Site
Name of Collector
Date and Time of Collection

2. Sample Analysis Request and Report Form

The sample analysis request and report form (exhibit 1) accompanies the sample when it is delivered to the laboratory. The collector should complete the field portion of this form by providing information on sample site location, sample type, purpose of the sample, date and time of collection, free chlorine residual, collector's initial, and any remains.

Upon receipt of the sample the laboratory will log-in the sample and at the minimum, the following information will be stored and maintained:

Date of Collection, Receipt, and Analysis
Time of Collection, Receipt, and Analysis
Receiving personnel initial
Client and/or System name
Sample Site location and/or description
Purpose of the sample
Assigned individual laboratory identify number
Name of the Analyst
Analysis Requested
Results of Analysis
Remarks on the sample (if any)

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COUNTY OF LOS ANGELES
Agricultural Commissioner/Weights & Measures
Environmental Toxicology Laboratory
11012B Garfield Ave., South Gate, Ca. 90280

SAMPLE FOR MICROBIOLOGICAL EXAMINATION

Date	Time	Lab No.

Laboratory Use Only

Purveyor and Address		County	Date/Hour Collected
Sampling Point	System Number	Collected By	Bottle Cap Number

Type of Sample: __ Drinking (Any Source) __ Sewage __ Surface __ Other

Send Report To:
Name:
Agency:
Address:
Phone Number:

Analysis Requested and Remarks:
__ Coliform __ Fecal Coliform
__ SPC __ Other

(To be filled in by laboratory only)

Tube/Portion Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Portions in ml	(hr.)																				
Presumptive Test	24																				
	48																				
Confirmed Test	24																				
	48																				
E. C.	24																				

Laboratory Remarks
__ Leaked in transit
__ Unsufficient sample

Results
Coliform/100ml
__ MPN
__ MF

Fecal Coliform/100ml
__ MPN
__ MF

SPC/ml at 35C | Cl$_2$ Res. mg/liter

Analyst | Date | Director | Date

Exhibit 1
-6-

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EQUIPMENT TEMPERATURE AND USE RECORD

Incubator Temperature

The total coliform incubator are maintained at 35± 0.5°c and have a thermometer graduated in at least 0.5°c increments. A daily log of the temperatures read to 0.1°c are kept together with the date the entry was made and the initial of the person making the entry (see exhibit 2).

Water Bath Temperature (For Fecal Coliform)

Similarly, the fecal coliform water bath are maintained at 44.5± 0.2°c and have a thermometer graduated in at least 0.2°c increments. A log of the temperatures when the water bath is in use read to 0.1°c are kept together with the date the entry is made and the initials of the person making the entry (see exhibit 3).

Sterilizing Oven Temperature

A thermometer immersed in a sand bath is kept inside the sterilizing over to monitor the temperature. Records of all items being sterilized, total sterilization time, and temperature are kept (see exhibit 4).

Autoclave

An autoclave/Sterilization log is maintained. The log includes the date, time in, time out, total elapsed time, sterilization time, items sterilized, sterility controls, maximum temperature reached, and any maintenance performed (see exhibit 5).

Certified Thermometer

All thermometers used in laboratory are crosschecked against a certified thermometer annually. Records of calibrations and corrections are maintained (see exhibit 6).

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INCUBATOR # _____

Make/Model _____

DATE	TIME	TEMP.	INITIAL	DATE	TIME	TEMP.	INITIAL

WATER BATH # ____
Make/Model #_____

DATE	TIME	TEMP.	INITIAL	DATE	TIME	TEMP.	INITIAL

STERILIZING OVEN # ____
Make/Model _____

DATE	ITEMS STERILIZED	TOTAL TIME	TEMP.	INITIAL	REMARKS

AUTOCLAVE

Make/Model_____

DATE	TIME IN	TIME OUT	TOTAL TIME	ITEMS STERILIZED	MAX. TEMP.	CONTROL	INITIAL

Exhibit 5

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THERMOMETER CALIBRATION

DATE	THERMOMETER NUMBER	CERTIFIED THERMOMETER #	CALIBRATION/ CORRECTION	INITIAL	REMARKS

LABORATORY WATER QUALITY MONITORING

Bottled water is purchased from an outside source with an accompanying certificate of suitability. This is the water used to prepare the media. The parameters in the certificate include:

PARAMETER	LIMITS	FREQUENCY
Conductivity	>0.5 megohms resistance or <2 micromhos/cm at 25°c	Monthly
Pb, Cd, Cr, Cu, Ni, and Zn	Not greater than 0.05 mg/L per contaminant. Collectively, no greater than 0.1mg/L	Annually
Total Chlorine Residual	Nondetectable	Monthly
Heterotrophic	<500/mL	Monthly
Quality of Reagent	Ratio 0.8 - 3.0	Annually

Copies of the certificates of suitability are kept and maintained on file.

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MEDIA PREPARATION

The attached exhibit 7 is completed for each batch of media prepared. The information included in the form are:

- Data of preparation
- Preparer's initial
- Media prepared
- Weight of dehydrated media taken
- pH of autoclaved media
- Test of media with positive/negative cultures
- Sterility check

All completed media preparation forms are kept in a binder for easy reference.

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DATE MEDIA PREPARATION

PREPARED BY:				
BATCH NO.:				
Manufacturer:				
Control Number:				
Quantity Desired:				
Weight of Media Needed:				
Date Dry Media Opened:				
Weight of Beaker & Dry Media:				
Tare Weight of Beaker:				
Weight of Media:				
Distilled Water: pH				
Spec. Conductance:				
Standard Plate Count:				
Chlorine Residual:				
pH Meter Standardized:				
pH of Media Desired:				
pH Before Sterilization:				
pH After Sterilization:				
Autoclave Condition:				
Autoclave Temperature:				
Time of Run: On				
Off				
Length of Time on Sterilize:				
Manner Dispensed:				
No. of Pipetter Used:				
Volume in mL:				

Exhibit 7

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ANALYTICAL PROCEDURES

Methods

The methods followed by the laboratory taken from Standard Methods for the Examination of Water and Wastewater, 16th edition, 1985 are:

Total Coliform by Multi-Tube Fermentation (MPN)	Method 908A
Fecal Coliform by MPN	Method 908C
Total Coliform by Membrane Filter (MF)	Method 909A
Fecal Coliform by MF	Method 909C

The outline forms of the above methods are attached as Appendix A of this supplemental manual.

Quality Control

1. For each bottle of media positive, negative, and sterile checks will be performed and a log of the check results will be maintained (see exhibit 8).

2. Positive and sterile checks will be performed for every batch of prepared media and a log of the check results will be maintained (see exhibit 9).

3. Positive and negative controls are ran with each analytical batch for EC test.

4. For each analytical batch tested by membrane filtration technique, a sterile control is ran at the beginning and end of the sample run, and a positive control is ran after the last sample.

5. For each lot of membrane filters, sterile and positive checks are ran.

6. The Completed Test must be done every three months or every positive confirmed potable water sample, which ever applies. A log of all positive potable confirmed sample is maintained.

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DRY MEDIA QC

DATE REC'D.	TYPE OF MEDIA	MANUFACTURER	LOT NUMBER	CHECK DATE	POSITIVE CHECK	NEGATIVE CHECK	STERILE CHECK	INITIAL

PREPARED MEDIA QC

CHECK DATE	BATCH NUMBER	POSITIVE CHECK	STERILE CHECK	INITIAL	CHECK DATE	BATCH NUMBER	POSITIVE CHECK	STERILE CHECK	INITIAL

MEMBRANE FILTER QC

DATE RECEIVED	MANUFACTURER	LOT NUMBER	CHECK DATE	POSITIVE CHECK	STERILE CHECK	INITIAL	REMARKS

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APPENDIX A: Methodology Outline

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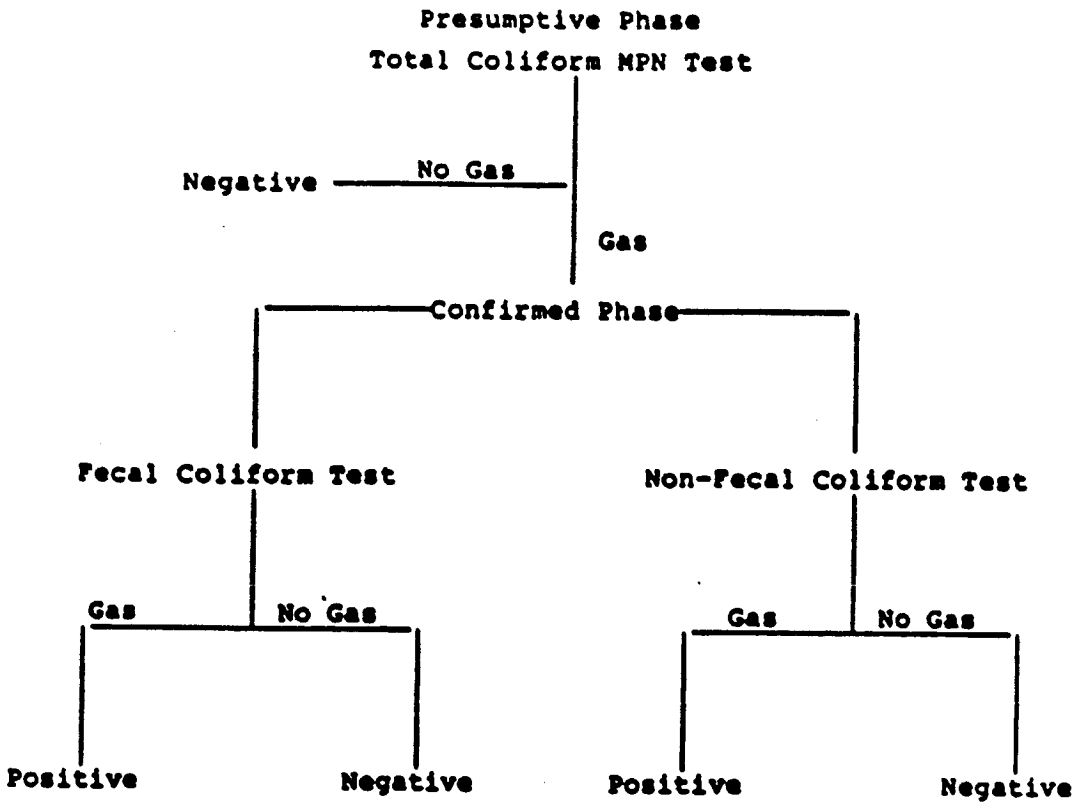
SUMMARY
OF
MULTIPLE-TUBE FERMENTATION TECHNIQUE
FOR THE COLIFORM GROUP



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R0061389

Effective Date: May 1991
Reference: Standard Method 908A

Total Coliform Multiple Tube Test

Reagents: Presumptive phase fermentation tubes with lauryl tryptose broth.

Quality Control:

Perform duplicate analyses on 10% of samples or at least one sample per test run.

Procedure:

1. Pipet ten 10 ml portions of the sample in a series of presumptive phase fermentation tubes; mix thoroughly.
2. Incubate fermentation tubes at 35± 0.5°c.
3. After 24± 2h, shake the tubes and examine for gas formation then take the following steps:

Gas Formation	Step To Proceed
Yes	Positive Test - continue to test for fecal and non-fecal coliforms.
No	Continue to step 4 below.

4. Continue incubating up to 48± 3h then again reexamine for gas formation.

Gas Formation	Steps To Proceed
Yes	Positive Test - continue to test for fecal and non-fecal coliform.
No	Negative Test - procedure completed

NOTE: For drinking and recreational water samples with heavy growth but no gas formation, continue on to test for non-fecal coliforms.

Calculation: See Calculation: Estimation of Bacterial Density

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R0061390

Effective Date: May 1991
Reference: Standard Method 908

Fecal Coliform Test

Reagent: EC Medium Tubes

Quality Control:

Run one each positive and negative controls for each analytical batch.

Procedure:

1. Gently shake or rotate presumptive tube.
2. With a sterile 3 mm metal loop, transfer one loopful of culture to EC medium tubes.
3. Incubate tubes in a water bath at 44.5± 0.2°c for 24± 2hr. Be certain to Place all EC tubes in the water bath within 30 minutes after the transfer of the culture.
4. Periodically check the EC medium tube during the incubation period for any gas formation.

Gas Formation	Steps To Proceed
Yes	Positive - fecal coliforms present
No	Coliforms present are of non-fecal origin and next step will depend on the result of the non-fecal coliform test.

Calculation: See Calculation: Estimation of Bacterial Density

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Effective Date: May 1991
Reference: Standard Method 908A

Non-Fecal Coliform Test

Reagent: Brilliant Green Lactose Bile Broth (BGB) fermentation tube.

Procedure:

1. Gently shake or rotate primary fermentation tube showing gas.
2. With a sterile metal loop 3 mm in diameter, transfer one loopful of culture to a BGB fermentation tube.
3. Incubate BGB tube for 48± 3 hr. at 35± 0.5°c.
4. Periodically check BGB tubes during the incubation period for any gas formation.

Gas Formation	Steps To Proceed
Yes	Positive Confirmed Test - proceed to completed test for 10% of positive samples or at least one positive source water every quarter.
No	Negative Confirmed Test - procedure completed.

Calculation: See Calculation: Estimation of Bacterial Density

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Effective Date: May 1991
Reference: Standard Method 9221D, 16th ed.

Calculation: Estimation of Bacterial Density

This method is used to calculate the Most Probable Number (MPN) of coliform/100 ml of sample.

No. of Tubes Giving Positive Reaction Out of 10 of 10 ml Each	MPN Index/ 100 ml	95% Confidence Limits (Approximate) Lower	Upper
0	<1.1	0	3.0
1	1.1	0.03	5.9
2	2.2	0.26	8.1
3	3.6	0.69	10.6
4	5.1	1.3	13.4
5	6.9	2.1	16.8
6	9.2	3.1	21.1
7	12.0	4.3	27.1
8	16.1	5.9	36.8
9	23.0	8.1	59.5
10	>23.0	13.5	Infinite

No. of Tubes Giving Positive Reaction Out of 5 of 10 ml each	MPN Index/ 100 ml	95% Confidence Limits Lower	Upper
0	2.2	0	6.0
1	2.2	0.1	12.6
2	5.1	0.5	19.2
3	9.2	1.6	29.4
4	16.0	3.3	52.9
5	16.0	8.0	Infinite

For volumes other 5ml or 10ml, use the following equation to solve for the MPN value:

$$\text{MPN value (from table)} \times \frac{10}{\text{Largest vol. tested}} = \text{MPN/100ml}$$

Note: MPN value is taken from table 9221:V of the Standard Methods.

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Total Coliform Membrane Filter Procedure

Reagents: LES Endo Agar in petri dishes

Quality Control:

Run a sterile control at the beginning and end of the analytical batch and a positive control after the last sample.

Procedure:

1. Assemble filtration apparatus according to manufacturer's instruction.
2. Filter 100 ml sample under partial vacuum.
3. Rinse filtration apparatus with filter still in place with three 20 ml partions of sterile dilution water.
4. Remove membrane filter with a sterile forcep and place it on LES Endo Agar-filled petri dishes with a rolling motion to prevent entrapment of air.
5. Incubate dish for 22 to 24 hr. at 35± 0.5°c.
6. Count colonies that have pink to dark-red color with a metallic green-gold surface sheen using low-powered dissecting microscope.
7. Confirm all sheen colonies counted or a minimum of five colonies from drinking water samples by transferring growth from each colony to parallel tubes of lauryl tryptose broth and brilliant green lactose bile (BGB) broth.
8. Incubate both tubes at 35± 0.5°c for 48 hr.
9. Formation of gas in the BGB tubes confirms the colony as coliform. If only the lauryl tryptose broth showed any gas production, then transfer to a second BGB tubes. This second BGB tube must produce gas at 35± 0.5°c with 48 hr. to verify the colony as coliform.

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Calculation:

$$\frac{\text{(Total) Coliform Colonies}}{100\ \text{ml}} = \frac{\text{Coliform Colonies Counted X100}}{\text{ml sample filtered}}$$

95% Confidence Limits Using 100 ml Sample.

Number of Coliform Colonies Counted	95% Confidence Limits Lower	Upper
1	0.025	3.0
2	0.35	4.7
3	0.81	6.3
4	1.4	7.7
5	1.6	11.7
10	4.8	18.4

For counts, c, greater than 20 organism, the above limits maybe calculated by:

$$\text{Upper Limit} = c + [2(2 + \sqrt{c})]$$
$$\text{Lower Limit} = c - [2(1 + \sqrt{c})]$$

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Effective Date: May 1991
Reference: Standard Method 909C

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Fecal Coliform Membrane Filter Procedure

Reagents: M-FC Broth

Quality Control:

Run a Sterile control at the beginning and end of the analytical batch and a positive control after the last sample.

Procedure:

1. Preparation of culture dish: Place a sterile absorbent pad in each culture dish and pipet approximately 2 ml M-FC broth to saturate the pad. carefully remove any excess liquid from culture dish.

2. Assemble filtration apparatus according to manufacturer's instruction.

3. filter 100 ml sample under partial vacuum.

4. Rinse filtration apparatus with filter still in place with three 20 ml partions of sterile dilution water.

5. Remove membrane filter with sterile forcep and place it on prepared culture dish in a rolling motion to prevent entrapment of air.

6. Seal petri dishes, submerge in water bath, and incubate for 24± 2h at 44.5± 0.2°c. Anchor dishes below water surface to maintain critical temperature requirements. Make certain that the petri dishes are in the water bath within 30 minutes after filtration.

7. Count colonies in various shades of blue using low powered microscope. These are colonies produced by fecal coliform bacteria.

Calculation:

$$\text{(Total) Coliform Colonies/100 ml} = \frac{\text{Coliform Colonies Counted X100}}{\text{ml sample filtered}}$$

95% Confidence Limits: The same as for Total Coliform Membrane Filter Technique.

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R0061396

Effective Date: September 1991
Reference: Standard Method
14th Edition
Method 910A

Presumptive Test for Fecal Streptococcus Group

(Multiple-Tube Technique)

Reagents: Presumptive Phase Tubes with Azide Dextrose Broth

Quality Control:

1. Perform duplicate analyses on 10% of samples or at least one sample per test run.
2. Run Sterility Check and Positive Control with each batch of samples.

Procedure:

1. Pipet ten 10ml sample in a series of presumptive phase tubes: mix thoroughly.
2. Incubate tubes at 35 deg C ± 0.5 deg C.
3. After 24±2 hours, shake and examine tubes for turbidity then take the following steps:

Turbid	Step to Proceed
yes	Positive Test - continue to test fecal and non-fecal streptococcus.
no	Continue to step 4 below.

4. Continue incubating up to 48±3 hours then again re-examine for turbidity.

Turbid	Step to Proceed
yes	Positive Test - continue to test for fecal and non-fecal streptococcus.
no	Negative - procedure completed.

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R0061397

Effective Date: September 1991
Reference: Standard Method
14th Edition
Method 910A

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Confirmed Test for Fecal Streptococcus

Reagent: Petri dishes with Enterococcesel (BBL trade name)

Quality Control:

Run one each of positive and sterile controls with each batch.

Procedure:

1. Gently shake or rotate presumptive tube.
2. With a sterile 3mm metal loop, streak a portion of the growth from each positive presumptive tube (with azide dextrose broth) on a petri dish containing enteroccocosel agar.
3. Incubate the dish inverted at 35±0.5 deg C for 24±2 hours.
4. Brownish-black colonies with brown halos confirm the presence of fecal streptococcus.

Calculation: See Calculation: Estimation of Bacterial Density

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Effective Date: September 1991
Reference: Standard Methods
14th edition
Method 910A

Confirmed Test for the Enterococcus Group

Reagent: Brain Heart Infusion Broth tubes containing 6.5% Sodium Chloride.

Procedures:

1. Transfer brownish-black colonies with brown halos to a tube of brain heart infusion broth containing 6.5% NaCl.
2. Incubate at 45 deg C for 24 hours.
3. Periodically check the tubes during incubation for growth.
4. Growth in 6.5% NaCl broth indicates that the colony belongs to the enterococcus group.

Calculation: See Calculation: Estimation of Bacterial Density

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R0061399

Effective Date: September 1991
Reference: Standard Methods
14th edition
Method 9108

Membrane Filter Procedure for Fecal Streptococcus

Reagents: KF Streptococcus Agar

Quality Control:

Run a sterile control at the beginning and end of the analytical batch and a positive control after the last sample.

Procedure:

1. Assemble filtration apparatus according to manufacturer's instructions.
2. Filter 100ml of sample under partial vacuum.
3. Remove membrane filter with a sterile forcep and place it on directly to KF Streptococcus agar medium in petri dish with a rolling motion to prevent entrapment of air.
4. Invert culture plates and incubate at 35±0.5 deg C for 48 hours.
5. Count colonies that have dark red to pink color using a low power binocular, wide field dissecting microscope.

Calculation:

$$\frac{\text{Total Colonies}}{\text{100ml}} = \frac{\text{Colonies Counted X 100}}{\text{ml sample filtered}}$$

For 95% Confidence Limits using 100ml sample, check Standard Method 909A.6.

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